GOVERNING URBAN SMALL WATER SYSTEMS: PARADOX OR PERIL FOR WATER PROVISIONS IN HOUSTON, TX

A Thesis

by

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ABSTRACT

The majority of water systems in the United States consist of small water systems and are most often seen in rural areas. Yet the greater Houston area is disproportionately served by over 350 small systems, an unusually high number for the nation's fifth largest metropolitan area. Prior to this exploratory research, it was unknown why water provisioning in this area is so fragmented, considering other cities of similar size are served by much larger systems. In addition, very little is known about which populations are served by these small water systems and why they have such a prominent role in the Houston area's urban water provisioning.

This study utilized both qualitative and quantitative methods to determine the characteristics of Houston's small water systems to discover their role and capacity and evaluate how this unusual water provisioning system affects its ability to serve the population. First, the project used questionnaires and semi-structured interviews of system managers to determine the characteristics of Houston's small water systems (e.g. ownership type, technology usage, expertise in water provision, pricing, emergency preparedness). Second, the project described the environmental performance level and demographic characteristics of communities served by these systems. Last, this research determined if any populations or communities are disproportionately served by these systems and if they are safe and economically sustainable.

Qualitative findings indicate that small water systems struggle to provide service at the same level as larger systems. Quantitative findings were inconclusive, but suggest some populations may be disproportionately served. I argue that this overabundance of small systems demonstrates a reliance on neoliberal policymaking that results in overall poorer outcomes for the disproportionately large population served by inadequate small systems. Improvements in

reporting methods will be necessary for future research to determine the level at which populations are affected though.

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NOMENCLATURE

CCN	Certificate of Convenience and Necessity
CCR	Customer Confidence Report
EJ	Environmental Justice
EPA	Environmental Protection Agency
LWS	Large Water System
MHP	Mobile Home Park
MUD	Municipal Utility District
PUC	Public Utility Commission
PWS	Public Water System
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SWS	Small Water System
TWDB	Texas Water Development Board
WSC	Water Supply Corporation

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CHAPTER I

INTRODUCTION

Water governance in the United States has experienced a gradual shift towards neoliberal policymaking over the past few decades, whereby public utilities have seen the infiltration of private actors, resulting in mounting commodification and privatization of water supplies. This once public governance landscape has expanded to include a large number of privately-owned, for-profit water systems, management services, and public-private partnerships. Policymaking of this kind splinters centralized institutions and creates a proliferation of small, private systems. This fragmentation disproportionately affects those along urban fringes and rural areas, especially those of low socio-economic status (Bakker 2010). It comes as part of a larger trend in overall governance that focuses on utilizing market solutions in an effort to fill the gaps left by ever reducing federal and state funding.

Although many stand to benefit from this shift, others are left out in the cold, as small water systems (SWS) and private systems have been shown to produce poorer outcomes for those who are served by them. SWS experience higher levels of Environmental Protection Agency (EPA) violations than systems of larger size, and private systems on average charge their customers higher prices than their public counterparts (Mack and Wrase 2017; Oxenford and Barrett 2016). Additionally, SWS have the highest rates of private ownership. 72% of very small systems (serving 500 people or less) and 21% of small systems (serving between 501 and 3,300 people) fall under private ownership,

meaning a large number of those being served by these small systems are a greater risk of paying higher costs for less safe water (US EPA 2011).

Moreover, minority and low-income communities have historically been excluded and disadvantaged in regards to infrastructure access and water services (Balazs and Ray 2014). This exclusion was even executed through legislature in the past, but in recent times "there is no direct causal path between race and class and disproportionate burdens; rather, race and class are imbricated in almost all the factors and actors that have historically combined, and still combine, to produce this composite burden" (Balazs and Ray 2014). Despite that legislation no longer directly inhibits access, past decision-making has ingrained inequalities into the physical landscape. Because little to no indemnification has occurred, marginalized communities continue to bear the brunt of environmental injustices and continue to be passed over (Vanderwarker 2012). Even with extensive documentation of these disadvantages in both academic and policymaking literature, minority communities are still less likely to have access to safe water infrastructure (Leker and Gibson 2018). Considering these facts, it is likely that communities of color and low socioeconomic status are being disadvantaged by substandard SWS at a disproportionately high rate. There is currently a dearth of literature that assesses what populations are being served by these systems and the extent to which SWS affect marginalized communities.

This study examines the case of Harris County, Texas, home to Houston, the fourth largest city in the United States. Here, SWS exist at over four times the rate of any other city of comparable size (US EPA 2017). Additionally, Harris County has higher than average rates of minority and low-income populations, when compared to the national average (Plumer and Popovich 2018). Since literature demonstrates that minority and low-

income communities are disproportionately affected by subpar systems and disadvantaged by environmental injustices, it is important to have a measure of how this proliferation of SWS in Harris County affects these populations and to examine if there is a connection between these types of higher risk systems and marginalized groups. At the time this research began, there was no measure of water system service boundaries or what populations were served by Harris County's water systems, meaning it was impossible to determine if any populations that were being put at higher risk due to the water systems available to them.

This study aims to investigate the effect that a proliferation of SWS has on the populations of Harris County, with the intent of identifying the implications this type of unusual governance has on those who are vulnerable to poor environmental outcomes. First, I utilize questionnaires and semi-structured interviews to interact with system operators to determine the characteristics of Houston's small water systems, gain insight into how they operate, find commonalities between them, and learn more about the struggles they face. Second, I apply GIS analysis to determine the demographics of the populations being served by Houston's SWS and describe their environmental performance to find if they are safe and economically sustainable for the communities they serve. Lastly, I conduct statistical analysis to establish if any groups are being disproportionately served by SWS. Together, these objectives will provide a better understanding of the effects of neoliberal policymaking on water governance outcomes.

Findings reveal that neoliberal policymaking has played an instrumental role in Harris County's current water governance landscape, with some of the most extensive fragmentation in the nation. Interview results tell a story of struggling SWS providers who

have little power to remediate their situations, with high costs, few resources, and a difficult to navigate regulatory environment. Although regression results were inconclusive, they suggest that fragmentation exists at high level for all of Houston's population groups due to decades of prioritization of neoliberal business interests.

This study represents an original concept in a study area with an anomaly that has not yet been studied, and will demonstrate a deeper understanding of how SWS affect water governance and are affected by water governance, especially in marginalized communities. This exploratory study will facilitate future research on the topic and in the study area.

In addition, this study will fill an important gap in the study of water and society, in the context of social science, as it will be the first to examine, both quantitatively and qualitatively, the effects of the greater Houston area's unusual water provisioning. Previous studies have lacked a focus on the effects of fragmentation and small water systems on urban populations and communities.

CHAPTER II

BACKGROUND AND SIGNIFICANCE

Despite misconceptions that water security in the United States is a guarantee, many do not have adequate access to clean and safe drinking water. This chapter draws on the theories of political ecology and examines case studies to address the ways in which growing privatization and neoliberalization of water provisioning has affected marginalized populations. I focus on both the current body of scholarly literature and recent news stories to demonstrate how this governance transition has largely shifted the burden and obscured accountability, leading to less safe and affordable outcomes for these communities.

Case Studies

Although there are limited studies regarding the state of the nation's water as a whole, case studies can give context to water governance failures in the United States. Existing academic research indicates that these cases are not just random instances; a systemic bias exists, in which some populations are disproportionately affected by water insecurity.

Flint Water Crisis

The well-known case of Flint, MI provides insight into the risks that minority and low-income communities face when accessing water service. In 2014, after City of Flint changed their source of drinking water to save on costs, many of the water pipes throughout the city became contaminated with poisonous lead, due to improper chemical

treatment. City officials refused to take action or even admit the contamination existed for 18 months following, until Flint residents took it upon themselves to have their water tested. Six years later the situation is still in the process of being remediated, and a large number of pipes still have not yet been replaced (Peplow 2018; Romo 2020). The Flint water crisis, like many other environmental crises in the United States, disproportionately affects low-income and minority communities. Flint's population is 57% Black, and 42% of residents live under the poverty line (Ranganathan 2016). Additionally, Black communities within Flint were more likely to be exposed to contamination as they lived in areas of the city with the most neglected water networks (Peplow 2018). While overt racial segregation did not create the Flint crisis, de facto racism (e.g. redlining, white flight, getting passed over for federal funding) was codified into Flint's urban infrastructure and policymaking throughout the twentieth century, creating an environment that led to a great deal of infrastructure neglect and outright abandonment in Black and low-income communities, including lead leeching into drinking water through the water pipes (Ranganathan 2016). Policymakers justified the decision to cut infrastructure costs with "the shrewd, neoliberal language of fiscal austerity", framing it solely as a financial decision (Ranganathan 2016, p. 27). Despite this money saving measure, residents of Flint were paying the highest water rates in the nation while they were being poisoned by lead, at nearly double the national average (Wisely 2016).

Cases of this type of infrastructure neglect can be found all over the United States. Similar cases occurred in primarily low-income and minority neighborhoods of Washington DC and Detroit over a decade earlier than Flint, where lead was found to be leeching into the water supply as well. Despite knowledge of the problem as early as 2001,

the DC water utility did not attempt resolve the issue until 2004, going so far as to withhold tests that showed high violation levels from federal regulators (Shaver and Hedgpeth 2016). Additionally, many high-risk homes were identified in Detroit but still have never been tested to ensure residents' safety (Wisely and Spangler 2016). Cases like Flint, DC, and Detroit confirm research that indicates there is growing water insecurity in the United States, disproportionately affecting the nation's already marginalized communities. These types of injustice will continue to grow in salience as infrastructure in the United States continues to deteriorate; approximately 7.3 million lead service lines are currently in use throughout the country, and there is currently no plan in place to repair these potentially toxic pipes (Gostin 2016).

Native Americans Living on Reservations

Many ethnic groups face unique struggles when navigating water governance in the United States. Native Americans living on reservations have long struggled to control and access resources in which they are entitled to. *Winters v. United States* (1908) was the first case to set a precedent that guaranteed access to water on reservations for farming and everyday use. Subsequent legislation has expanded and clarified these rights as well. Despite the existence of laws that pledge to assure access, federal and state governments have frequently overlooked or failed to uphold the sovereign water rights of Native American communities, and reservations have historically been excluded and disadvantaged in negotiating for access. Fair decision-making is also compounded by varied water laws across states that create difficulties in allocating water rights in a way that does not disadvantage any involved group. Consequently, many reservations still

continue to struggle to establish and maintain adequate water rights to this day (Kellough 2011).

Although issues of access and quality have been addressed by the US government, one important aspect of Native American water rights that has been excluded altogether from policymaking decisions is the recognition of the connection between water and sacred religious beliefs. For many indigenous groups, the significance of not harming water sources goes beyond solely practical quality concerns, as water is seen to have its own life that needs protections. Tribes like the Standing Rock Lakota, who have spent years protesting the Dakota Access Pipeline, have fought for the consideration of these beliefs to be included into law to ensure the protection of their sacred land, but the government has chosen not to address these needs (LaPier 2017).

Despite the importance of these beliefs, regulatory agencies have largely failed to accommodate issues of quality, even at a practical level. Water systems located in Native American reservations are approximately 60% more likely to experience quality violations than other systems (US EPA 2013). Many Native Americans who lack complete plumbing are at a higher risk of contamination due to the necessity of using unregulated water sources. This issue disproportionately affects Native Americans, as they are more likely to have incomplete plumbing than any other ethnic group in the United States, with a rate nearly four times higher than average (Deitz and Meehan 2019; Kaljur and Beheler 2017). In fact, Deitz and Meehan found that living on Navajo or Apache reservations in Arizona increases a household's risk of incomplete plumbing by 13 times (2019). Wescoat et al. notes that on some reservations, plumbing is so inadequate that it resembles plumbing in rural areas in the US from over a century ago (2007). Many communities who lack

complete plumbing must rely on livestock wells and springs or water brought by water haulers to provide them with fresh water, even though these sources are not regulated to the same degree as public water systems and are often at risk of contamination from nearby uranium mines (US EPA 2018).

Unincorporated Areas and Colonias

Marginalized communities often also experience problems with limited access to water, compounding water quality violations. Lack of services is an issue for many communities along the edges of urban areas. Millions of households in the US fall within unincorporated areas, meaning they are located outside the boundaries of any municipality. This can be problematic, as residents often do not have access to important resources that are generally provided by municipalities, one of which being water services. Ranganathan and Balazs note that these communities very often "lack adequate public investment, at least one basic service (e.g., water, sewers), and are faced with severe socioeconomic disadvantages" (2015, p. 407). Additionally, those who must self-supply water due to lack of services face more severe health risks as well. Although overall contamination outbreaks in the US have decreased over the past few decades, those who must rely on self-supplied water sources have experienced an increased number of outbreaks, as a result of lack of standards and monitoring (Naman and Gibson 2015).

These issues are prevalent among unincorporated areas along the US-Mexico border, called colonias. Colonias are makeshift communities that often lack basic infrastructure and services, although even in rare instances where infrastructure is available, residents frequently cannot afford it. As a result, water services are fragmented and sparse, and

residents get their water from unreliable or unsafe sources, often resorting to water vending machines and garden hoses (Jepson and Lee Brown 2014; Jepson and Vandewalle 2016).

The ways in which Texas governance bodies have addressed colonias' restricted access to services has exacerbated their effect. Development of colonias has been restricted through legislation, and they are often forced to exist under county level jurisdiction, which is rarely equipped to provide water services. Additionally, throughout the latter half of the twentieth century, many local governments worked to de-annex colonias that fell within municipalities so that the residents would not have any authority to participate in policymaking, while at the same time crafting legislation that would make it difficult for the residents to distribute their own water (Jepson and Lee Brown 2014). Unrealistically stringent code requirements made it so colonias that were unable to meet standards were denied EPA funding (Ward 1999). In 2017, the governor of Texas even vetoed the Colonia Initiatives Program and other assistance programs that would provide aid to colonias struggling with safe water access (Jones and Atkin 2018). These hardline political decisions have created a reliance on stopgap measures, intensified by neoliberal governance measures that have reduced residents' ability to participate in decision making.

Although not as dire as the situation in the colonias, residents of unincorporated areas across Texas face challenges associated with this unique jurisdictional dead zone. Unincorporated communities in Harris County face frequent shutoffs, expensive charges, and poor-quality water, with no ability to hold their utility providers accountable. Residents of an unincorporated area in Harris County called Castlewood spent multiple years fighting their private, investor-owned water provider to remediate these issues, but because the provider had exclusive access via a Certificate of Convenience and Necessity

(CCN), the residents did not even have the power to introduce a different water provider. Although multiple TCEQ investigations found severe violations, it took three years for regulators to force the utility to provide adequate infrastructure that would prevent monthly shut offs. During that time, residents had no option but to adopt expensive stopgap measures like bottled water to ensure they had regular access to water (Satija and Ura 2015).

Mobile Home Parks

Many low-income communities, such as mobile home parks (MHP), also face problems related to water governance. Residents living in MHP have the highest rates of service shut-offs and are almost three times more likely to experience a water service interruption than those in other housing unit types. Even after controlling for externalities (e.g. socioeconomic status, physical housing quality, subnational location), both standalone mobile homes and MHP are more likely to experience subpar water service in relation to other housing types (Pierce and Jimenez 2015). Additionally, residents of mobile homes have a much higher rate of incomplete plumbing than the average American household, at nearly 15% (Deitz and Meehan 2019).

There are reports from all over the nation of MHP experiencing intermittent water service, with residents sometimes going days or months without water access. In some areas, interruptions and quality issues have become so severe that residents have been forced to outright abandon their homes (Zwerdling 2016). Some residents are able to manage insufficient water access by seeking out alternative sources (e.g. bottled water), but others are left without their homes altogether, when MHP choose to close with little or

no warning in response to rising water costs (Ridle 2019; Williams 2019). Because a large majority of mobile home owners only own their building, and not the land that it sits on, they often have very little control over governance decisions that affect them, leaving them vulnerable to insecurity.

Incomplete plumbing is also an issue that largely affects mobile home communities. Living in a MHP increases a household's risk of incomplete plumbing 18.5 times (Deitz and Meehan 2019). This unfortunate reality is likely exacerbated by the large numbers of renters in MHP, as over 50% of those with incomplete plumbing are renters.

Homelessness

Homelessness poses its own set of problems when it comes to water quality and access, which can be intensified in hotter climates. Finding consistent access to water for drinking, cooking, and hygiene is difficult, especially for homeless individuals who do not live in permanent structures (e.g. shelters, rehab centers), since water sources are often privatized and behind physical barriers. Personal factors, such as illness or monetary issues, can create barriers for water access as well, and even when assistance exists, many homeless individuals do not have any way to find or access those resources (DeMyers et al. 2017). Homeless individuals in hotter climates are even at higher risk of negative health effects, like dehydration or heatstroke. These negative effects are often compounding, leading to a cycle that is difficult to recover from; for example, chronic dehydration can lead to dental degradation, which can lead to difficulties eating.

Policymaking is often used to create additional barriers to water security for homeless individuals. Efforts are made by businesses and governments that make it more difficult to

access publicly located taps and restroom facilities. Additionally, public funding has been shrinking over the past few decades, and many municipalities have been criminally prosecuting homeless individuals severely for violations like loitering or public urination (Ross 2011). Some cities have gone as far as enacting initiatives that target the homeless with harsh punishments for minor offenses like jaywalking in an effort to drive them away. In Los Angeles, the 'Safer Cities' initiative resulted in over half the population of Skid Row arrested for minor crimes, in many cases causing a loss of housing, social services, and jobs (Timmons 2015). This form of policymaking leaves many homeless individuals without any way to access life-sustaining resources that they need, while at the same time criminalizing the only options they have. While these decisions aim to curtail homeless populations, it can have the opposite intended effect, as it creates obstacles that only make it more difficult to escape homelessness.

In Phoenix, all of these factors have come together to create a hostile environment for the homeless population there. Extremely hot temperatures (sometimes even reaching over 110º F), coupled with a lack of covered public space create a dangerous physical environment. Additionally, the majority of resources and services for the homeless are located in the downtown industrial areas, where environmental hazards and urban heat island effects are at their greatest. Despite this, the city has enacted a number of policies that only serve to worsen water insecurity among Phoenix's homeless population. Public space is sparse and highly regulated to keep the homeless away through criminalization of activities like sleeping, sharing food, and panhandling (DeMyers et al. 2017). While many of these decisions are made in the name of public safety, they ignore, or even outright threaten, the safety of homeless populations.

The Problem

As the above case studies demonstrate, marginalized communities bear the brunt of violations and face the largest barriers in regards to water access and safety. The issues that contribute to fractured water governance in the US are complex and myriad, ranging from material inadequacies to governance decision-making.

Affordability

One of the largest contributors to the problem of water insecurity is affordability. At present, approximately 12% of households in the United States cannot comfortably afford their water bills. This struggle is not equally distributed across the nation though; the populations most likely to be affected by rising water costs are those in low-income states and are often clustered in urban areas (Mack and Wrase 2017).

Despite growing unaffordability, aging infrastructure and climate change threaten to continue increasing costs significantly (Mack and Wrase 2017). Additionally, water providers across the US over the last few decades have implemented little to no rate increases, and as a result neglect of aging infrastructure has intensified. In fact, per capita federal spending on water infrastructure (adjusted for inflation) has decreased 86% since 1977, forcing municipalities and states to find ways to fill the gap (Krantz 2018).

At present, most funding comes from the local government level, and many municipalities feel they have been hung out to dry by federal and state governments and have run out of funding sources to turn to. As a result, they struggle to finance water services for their customers (Walton 2013). Many small communities have been forced to

move to privatized services as a result of reduced funding, even when they are opposed to privatization, because their financial pressures are too great (Grant 2013). Due to cost pressures like these, the EPA predicts that water service costs could increase by four times over the next few decades, which will further impede low-income households from being able to pay their bills (Baird 2010). Mark and Wrase's projections show that water costs could raise so much over the next five years that as many as 36% of households may no longer be able to afford their bills (2017). The consequences of unpaid bills can be severe. Americans in some jurisdictions are even at risk of being forced to sell their homes via tax sales due to unpaid utility bills (Harrison 2018). The effects of these rising costs are intensifying over time as well because, on average, incomes are not rising with increasing costs but stagnating (Walton 2013).

The US government at all levels does little to ensure adequate water access for low-income individuals. Programs that aim to alleviate poverty do little to tackle water issues, and water policies rarely accommodate low-income households (Wescoat et al. 2007). In fact, less than 30% of water and wastewater utilities offer customer assistance programs, and often the programs focus on shrinking overdue bills rather than making water more affordable for those who cannot pay their bills (Jones and Moulton 2016; US EPA 2016a). Though many low-income households are struggling to pay their water bills, the EPA has not set any enforceable standard on water affordability in the United States. Instead the agency has opted to evaluate median income of a municipality to determine if residents within that jurisdiction need assistance, which fails to account for areas that experience income inequality. Even with that measure in place, there is no mandate that guarantees water access to low-income households who meet this qualification (Baird 2010). Those

served by private systems are likely to encounter additional hardships as well, since rates of private systems exceed those of public systems, as they are not restricted to cost-recovery. Instead they have more freedom to set rates to ensure profit (Mack and Wrase 2017). This problem of affordability will only continue to intensify, as private companies (and to a smaller extent, governments) have begun buying excess water rights to ensure their access is secured in the future.

As case studies across the US demonstrate, issues of race and ethnicity are intertwined in discourse on affordability. Because minority groups are significantly more likely to live below the poverty line, they are disproportionately affected by rising water prices. For example, nationwide poverty rates for Native American, Hispanic, and Black households stand around 25%, while the poverty rate for white households is less than 12% (Morello 2013). This is also important from a health standpoint, as studies have shown that lower income neighborhoods have higher instances of health violations, so, as a result, minority communities are more heavily affected by unsafe water systems (Bullard and Johnson 2000). Additionally, because of the disproportionate concentration of minority communities in low-income areas, those individuals are at a higher risk of ill health effects caused by psychosocial stressors associated with residing in a high-stress environment (Payne-Sturges and Gee 2006). These factors do not mean that overt racism is necessarily occurring though; wealthier minority neighborhoods are not at higher risk of health violations (Switzer and Teodoro 2017). Instead, this inequality has been maintained and propagated materially in many cities throughout the United States through decades of neglectful policymaking and land use planning (Ranganathan 2016).

Environmental Injustice

Research unequivocally shows that environmental hazards, historically and now, are not distributed evenly throughout society, instead concentrated in low-income and minority communities (Bullard 1993; Cole and Foster 2001; US EPA 2018; Grove et al. 2018; Harvey 1997). Although there is often racism at the root of environmental injustice, in a number of cases it is simply a callous financial decision. In one example in the United States, a fracking executive stated that they avoid wealthy areas because individuals there have the resources to litigate against entities who excessively pollute (Jones and Moulton 2016). Regardless of intent, minority communities are affected by environmental hazards at disproportionate rates due to higher instances of poverty, as they do not have the resources that wealthier communities have to fight these injustices. Although Environmental Justice (EJ) advocates have made efforts for decades to remediate these discriminatory practices and governance failures, disparities still remain. This may be in part because the EPA ignores or dismisses nine out of ten formally filed environmental justice complaints (Lombardi et al. 2015). Water issues, especially issues of access, that low-income communities face garner little response because they have limited political salience. Only cases of severe environmental injustice receive notoriety or aid (Wescoat 2007). Additionally, "legacies of discrimination" still exist in many marginalized communities, where decades-old land use planning decisions are embedded into the landscape and continue to disadvantage the residents who live there (Vanderwarker 2012).

Although the EJ movement had begun to gain traction with government agencies by the 1990s and had begun to construct equitable environmental policies, the growth of neoliberalized institutions in the United States created an environment where this type of

governance was untenable. In practice, there has been little to no effort to redistribute environmental risk equally, as instead the focus lay in building trust in communities that have been identified as EJ communities (Holifield 2004). If not adequately addressed, the effects of water insecurity will only continue to grow and worsen as time goes on.

Governance Practices in the United States

Current research on urban water governance focuses on the growing shift that has occurred over the past few decades from public control and management to privatization, termed neoliberalism. For much of the twentieth century, water in the United States was publicly controlled, regulated, and operated, but from the 1980s onwards, the industry began to experience pressures that made it difficult to continue operating as a public utility. The cost of providing water began to rise, due to aging infrastructure in need of repairs, and concurrently, the federal government reduced funding for local infrastructure projects (Flynn and Boudouris 2005; Krantz 2018). Because public service had begun to experience these growing failures, privatization offered an enticing promise of more cost-efficient service (Bakker 2010). To support this claim, proponents of privatization pushed the idea of 'state failure', asserting that the state had inherent structural defects that would always keep it from running efficiently, while at the same time lauding the private sector as innovative and not beholden to social policy goals like employment generation or wealth redistribution (Bakker 2003). Opponents of privatization argue that public services can operate most effectively when properly supported and resourced, since public services only need to maintain cost-recovery, not profit, to be successful. These opponents also raise concern over the level of democratic accountability, as when services are privatized,

communities' control over participation and decision-making is reduced or severed. Additionally, many feel that it is unethical to profit from water, since it is necessary for sustaining life (Bakker 2010). Shiva notes that internationally a large number of societies have encoded this idea into law by prohibiting private water ownership altogether (2002). Due to this contention over ideals, privatization has been largely opposed since the shift began, with protests around the globe. While, to date, there are a handful of proponents of this transition, many scholars note that this shift has largely been a failure due to poor quality and infrastructure and lack of equitable access (Bakker 2010; Swyngedouw 2004).

Neoliberalism has not been able to follow through on its original promises of lowered cost and greater efficiency. Instead, it is a large contributor as to why water has become less affordable for many users over the past few decades. Failing infrastructure continues to be neglected, but despite this, water prices have not decreased or even remained stable, instead steadily increasing in major US cities 25% on average since 2010 (Walton 2013). This failure to create better proposed outcomes is because in shifting to privatization, the legal and economic framework is altered to focus on cost recovery, which is incompatible with ensuring equitable access for all (Bakker 2010).

When larger municipalities, such as Atlanta and New Orleans, began to block privatization efforts, private companies largely shifted their focus to rural areas and small communities who do not have the organization or financial independence to resist, and rural areas continue to be the focus of most privatization efforts today. Opposition is growing in these areas as well though, with projects being blocked and pressure put on local governments to look at alternatives such as re-municipalizing water utilities (Flynn and Boudouris 2005). Some scholars urge participants to move beyond seeing water

debates as linearly public or private though, as many successful models are a composite of both (Bakker 2010). This requires solutions that move beyond solely privatizing or municipalizing. For example, because small municipalities often struggle to provide adequate utilities for their small number of constituents, a growing trend has been emerging in which jurisdictions join their utility operations with other nearby jurisdictions, making them less vulnerable to population and more able to capitalize on economies of scale and higher levels of expertise (Flynn and Boudouris 2005).

Challenges Facing Small Water Systems

SWS, defined by the US EPA as systems who provide water service to 3,300 people or less, face additional challenges in providing adequate water service due to their small size and diverse ownership (e.g. private, quasi-public, public) (2009). These factors create a high level of fragmentation, which results in varied adequacy of service. Since SWS experience higher levels of violations than systems of larger size, these inequalities in service are especially impactful for smaller systems (Oxenford and Barrett 2016). Although SWS have higher violation rates, they are largely monitoring and reporting violations, rather than health violations (Rubin 2013). While this bodes well for health outcomes of those served by SWS, it suggests that SWS operators do not have the same access to resources or ability to provide the same level of service as larger systems. Due to SWS's size, they cannot benefit from economies of scale, meaning that it is often difficult or impossible for them to provide water at a price and quality that larger systems can offer (Balazs and Ray 2014). SWS have higher cost rates than larger systems for a number of reasons. They generally have less customers to spread their increasing costs across, and

their service areas often have less dense coverage, meaning that they have to maintain more infrastructure for fewer customers (Espinola 2017). Additionally, since SWS do not have the same access to resources, they do not have the same level of expertise, labor pool availability, and technology as larger systems and, as a result, may not be able to determine the severity of the problems they encounter or even identify that they have existing problems (Cobler 2018). SWS providers also encounter difficulties operating effectively due diminishing customer bases and a lack of engagement in long-range planning (Mack and Wrase 2017). These factors mean that residents living in areas dominated by SWS likely pay more money for lower quality water.

Since SWS often lack the same access to funds that larger systems have access to, it is much more difficult to operate, and many are in a constant state of dire financial straits. Fixed costs of doing business mean that smaller systems must invest a higher per capita price in order to have the infrastructure needed to operate. Although state officials have blamed SWS for not taking advantage of money they say is always available for assistance, that blame is disingenuous as that money exists largely in the form of loans and is predominantly chosen to be allocated to larger systems. SWS are not unaware of these funds; many have chosen not to seek this money for a variety of reasons. Interviews with Texas water providers have shown that while some SWS simply can't afford the loan payments, others feel that the money would not solve their long-standing problems and want to seek other solutions. Some SWS even feel that the EPA regulations are too stringent and actively choose not to follow them, although this places them out of compliance (Cobler 2018).

In many areas of Texas served by SWS, thousands of people have been exposed to contamination that has been known to exist for years, but there has been little to no remediation effort. Instead, because arsenic occurs naturally in these areas' soil, water systems are only required to inform customers that elevated arsenic levels exist in the water but that it is not an emergency and additional safety measures are not necessary, despite that elevated arsenic levels are known to be associated with ill health effects (Jansen 2016).

Complex regulatory requirements also create an environment that makes it difficult for SWS to operate effectively. Because the large majority of Americans are served by larger systems, drinking water regulations are created with those systems in mind. Many SWS do not have the administrative capacity to meet all regulations, and as a result they must cherry-pick which regulations to follow. So, although regulations have become more stringent in recent times, SWS who are unable to comply with these regulations are not benefit from their intended effects (Balazs and Ray 2014).

Other very small systems (fewer than 25 people or 15 connections) fall into a unique regulatory gap that keeps them from being subject to Safe Drinking Water Act (SDWA) regulations, due to their small size. Although this may seem like a boon in an environment that is difficult and expensive to regulate, it leaves millions of people across the United States at high risk of arsenic contamination and other health risks that they may not even be aware they are at risk from. Despite knowledge of the potential harm of this loophole, the US Congress has made decisions to uphold the laws that keep it in place (Daniels et al. 2008).

Many of these problems inherent to SWS only compound and grow more damaging as time passes, but existing scholarly research largely excludes SWS in their analysis, even though 82% of all water systems in the US are classified as small (US EPA 2009). Because SWS only serve a small percentage of the population though, neglect and lack of enforcement has been overlooked, leading to some Americans living at a higher risk of ill health effects and a cost disadvantage, often without even the knowledge that anything is amiss.

Limitations

Together, these case studies provide snapshots that assist in gaining perspective on growing water insecurity among vulnerable and marginalized groups across the United States, but they are still limiting, as they are sporadic and do not provide any systemic measure of this insecurity. For example, the aforementioned study regarding complete plumbing, while a useful indicator of income-related water insecurity, is still limiting as it does not illustrate affordability of water for the affected group. Additionally, very few studies focus on the systemic effects that SWS as a whole have on those who rely on them. To date, only one scholarly article has ever examined SWS governance from a comprehensive lens, although it is not specific to the United States; instead it examines SWS governance across wealthy, developed nations. It confirms that SWS research "is fragmented across diverse disciplines and topics, with most studies examining individual governance features (e.g., regulatory exclusions) in specific geographic contexts" (McFarlane and Harris 2018). This dearth of literature makes it difficult to even ascertain the challenges faced by SWS and create solutions to better serve these communities. Given

the gaps in current literature, it is impossible to fully assess the reality of water insecurity in the United States.

CHAPTER III

RESEARCH DESIGN AND METHODS

Current scholarly research contends that publicly-owned water systems and systems serving larger populations are predominately better equipped to serve their customers from an economic and health standpoint (Bakker 2010; Oxenford and Barrett 2016; Swyngedouw 2004). This study addresses the degree to which incommensurate numbers of SWS in the Houston region affect the ability of providers to deliver safe and economically sustainable service to their communities. To achieve this, I examined SWS in the greater Houston area to determine how their size and ownership type affect performance and ability to provide service. I carried out questionnaires, interviews, GIS analysis, and statistical analysis in order to examine and compare operation methods, outcomes, and demographic distribution to reveal any patterns that demonstrate any effects that the growing privatization movement has had on Houston's waterscape.

Study Area

The study area, shown in Figure 1 (see Appendix A), is Harris County, located in the southeastern region of Texas. It is the fifth largest metropolitan area in the US. At the last census, the population was 4,092,459 and is currently estimated to be approximately 4.7 million (US Census 2017). Although over half of these residents live within Houston city limits, the remaining portion resides in surrounding suburban and peri-urban areas. Harris County has the largest unincorporated area population of any county in the United States, at over 2 million, and 80% of population growth since 2000 has been concentrated in this

area. While Harris County provides some public services to residents within its unincorporated area, it is underfunded and struggles to provide adequate services for this growing population. Additionally, this list of services does not include water utilities (Harris County Budget Management Department 2019). As a result, water service in this area is largely decentralized and reliant on small utilities like Municipal Utility Districts (MUD) and private providers.

Although most urban areas in the US are served primarily by large water systems, communities in the greater Houston area are served by over 350 small public, quasi-public, or privately-owned water systems. Other metropolitan areas of similar size have far fewer SWS, with none reaching even a fraction of the systems housed in Harris County. For comparison, Cook County (Chicago metropolitan area) has a total of 51 SWS, and Dallas and Tarrant Counties combined (Dallas-Fort Worth metropolitan area) have a total of 65 SWS (US EPA 2017).

Analysis of these small systems has largely been overlooked by scholars though because these systems only provide water for approximately 5% of the total US population (US EPA 2009). At that rate, the population dependent on SWS in Harris County can be estimated at approximately 235,000 (US Census Bureau 2017b). This population is likely even more substantial though, due to an overabundance of small systems in Harris County.

Another factor that adds to the importance of examining SWS in this study area is that the population of Harris County includes minority and low-income populations at a higher rate than the national average, which is significant as literature shows that SWS are most often concentrated in low-income and minority communities (Plumer and Popovich 2018). At present, 19.7% of the county's population is Black, 43.0% is Hispanic, and 16.6% live

below the poverty line (US Census Bureau 2017b). Table 1 (see Appendix B) compares these numbers with statistics for the entire United States. Furthermore, Houston has been identified as one of ten US cities with the worst drinking water, and water quality tests have shown several pollutants well above the nation average, including multiple contaminants above EPA standards (McIntyre 2011). At present, it has not been identified why Houston is served so differently than other cities of relative size or if any populations are being disproportionately affected by systems with known limitations, and so it offers an ideal study location.

Research Objectives

My main research question is: to what extent does the disproportionately high number of SWS in Harris County affect the populations they serve? To assess the Houston area's water systems, I utilized three research objectives in this study to support my data and test the following hypotheses:

Hypothesis 1: Minority and low-income populations are disproportionately served by small water systems in the greater Houston area.

Hypothesis 2: Small water systems in the greater Houston area are less safe and economically sustainable than larger systems.

Objective One: Define the characteristics of Houston area's small water systems

This objective incorporates an exploratory process that involves researching existing data sources and interactions with SWS managers, contractors, and other individuals in similar roles through the use of surveys and semi-structured interviews to determine how

effectively Houston's SWS are able to be managed. Because this data has not been previously compiled, I utilized the EPA Safe Drinking Water Information System (SDWIS) database and survey and interview results to determine and compare systems' characteristics, including ownership type, emergency preparedness and resilience, service area and billing practices, infrastructure and technology usage, financial practices, and hiring practices to create a comprehensive overview of these systems' structure. SDWIS contains publicly available information on all public water systems (PWS) in the United States. PWS refers to systems that serve the public, rather than systems that are publicly owned. Only community water systems were included this study, as transient water systems (e.g. campgrounds, schools, office buildings) do not provide water to households (US EPA 2019).

The rationale behind this objective is to find any existing patterns between or within different SWS. Because scholarly research provides evidence that SWS provide lower levels of service and poorer outcomes to their communities, it is critical to determine if these patterns hold true for an anomalous study area or if Houston's unique water provisioning provides different outcomes. This objective will contribute to better understanding of the effects SWS have on health risks and financial outcomes of individuals who oftentimes do not have any other options for water service. If the Houston region shows evidence of the same outcomes as SWS across the United States, its effects could be much more substantial, reaching a significantly larger portion of the population than SWS in other areas of the nation.

For this objective, I collected data through online research and evaluation of publicly available data sources and combined this with the EPA's SDWIS database to identify and create a record of appropriate water systems to facilitate the survey and interview process.

Objective Two: Describe the demographic characteristics and environmental performance levels of communities served by small water systems

This objective serves to ascertain which populations or communities are being served by SWS and may be at higher risk of negative health effects and/or higher cost of service due to the water service choices (or lack thereof) available to them. It will also determine if any water system types or traits are causing increased risks due to their inefficiencies, as scholarly research demonstrates that customers of SWS experience overall higher health risks and subpar service (Oxenford and Barrett 2016). To accomplish this objective, I utilized GIS tools to merge multiple databases that provided spatial data encompassing all areas containing SWS boundaries and the communities being served by them. Prior to this research, no data existed that demonstrated which populations or areas were being served by Houston's water systems.

For this objective, US Census block group data describes the overall demographic characteristics of the served communities. Texas Water Development Board (TWDB) data provides spatial data containing service area boundaries for each water system. GIS analysis will provide insight about how SWS are serving Harris County overall to complement Objective One's survey and interview results that provide examples and context regarding performance indicators of individual systems.

Objective Three: Determine if any populations or communities are disproportionately served by small water systems and if they are safe and economically sustainable

This objective utilizes quantitative analysis to determine the level at which any populations or communities are experiencing diminished service, increased risks, or heightened costs as a result of the types of water systems that are available to them. Statistical analysis demonstrates to what extent SWS serve populations within each race/ethnicity group and income bracket and determines if any groups are being served by SWS at disproportionate levels (i.e. higher than random chance of being served by SWS).

For this objective, I utilized demographic data for each water system that was prepped through GIS in Objective Two to perform statistical analysis in R to determine if the populations being served by SWS differed significantly from those served by larger water systems (LWS).

Data Collection

For this study, I utilized a mix of qualitative (surveys and semi-structured interviews) and quantitative methods (GIS and statistical analysis) to achieve my overall research objectives, which are intended to address the broader question of how different types of water provisioning affect the Houston region's marginalized communities. This spatial approach will determine if any populations or communities are disproportionately served by these systems and if they are safe and economically sustainable.

Standard methodological practices were used to create survey and interview questions and data (Dillman et al. 2014). For the survey process, I developed a questionnaire to be sent to water system managers and individuals in similar roles via email or snail mail, with

contact information provided from SDWIS's database. Interviews were conducted via phone or in-person in a semi-structured format to gain more in-depth and targeted information. Initially interviews were intended as a follow-up to the survey to provide personalized information about each chosen water system, but due to lack of response in the survey stage, the interview process became the primary method of qualitative data collection. Resulting data was used to add context regarding the area's small water systems that cannot be obtained via the SDWIS database or US Census data regarding how these systems function.

For GIS analysis, I collected demographic data provided by the US Census and water system data provided by the EPA. Demographic data included total population count, population count by race/ethnicity, income by household, and income per capita. The SDWIS database provided information regarding water system name and population count, contact information, and violation data (see Appendix E). Because the US government does not currently provide income data at the block level, all data was analyzed at the block group level.

For statistical analysis, I utilized the Census and EPA data collected for Objective Two that had been merged using GIS. This data included all demographic data and water system information listed in Objective Two, except within the confines of each water system boundary rather than block group. Because Census data is confined to the block group level, the best available data is only an estimate of the populations within these water system boundaries though and may differ slightly from exact populations within these areas.

Site Selection

For my survey samples, I used a stratified random selection of sites to ensure that all sites were chosen in an impartial manner but also systematically include versatile system types and locations. Because these factors and populations are not evenly dispersed geographically, a randomized selection process ensures that a diverse sample of systems is chosen, while safeguarding the researcher from selection bias. Stratification of the process is also necessary, as it reduces sampling error by guaranteeing that the variables being tested are not excluded through random chance, which could result in imprecise results (Dillman et al. 2014). To accomplish this process, I separated my systems into different criteria for site selection based on location, system size, and ownership type and then used a random number generator to choose an equal number of sites from each category (generated numbers corresponded with site cell numbers in my spreadsheet).

First, I separated locations into five categories, based on the address listed in the SDWIS database – central, north, east, south, and west. I included location to ensure chosen sites were evenly distributed across Harris County and not clustered. This factor is important because Harris County as a whole contains a mixture of urban, peri-urban, and rural areas. Due to low-response rate and the prevalence of the City of Houston system in the city center, it was not possible to interview any SWS located in the central category. Next, I separated system size into three categories based on population served count – 1-1100, 1101-2200, and 2201-3300. I included system size to determine if population served numbers have any effect on water providers ability to serve their customers because, although literature shows that SWS have worse outcomes, there is no existing data on whether this is concentrated within any particular size of SWS. Lastly, I separated

ownership type into three categories – public, quasi-public, and private. I included ownership type to determine if any form of water system ownership or management creates differences in level of service or violations, since there is evidence that private ownership creates worse outcomes for their customers. Quasi-public is defined as systems that are publicly owned, but managed by private operators. Because SDWIS does not contain information about ownership type beyond public or private, I had to discover this information using publicly available web resources. These sources included water system websites, syndicate websites, and the Public Utility Commission (PUC) website. It was critical to not only have information regarding ownership type, but also if it is being operated independently or by a syndicate, since it is possible that provisioning methods are different each between them. I applied the term syndicate to any management company that owns and/or operates multiple water systems. Some syndicates outright buy water systems, while others only manage the operations of public systems.

After sites had been identified, I had to determine the best candidate at that site to be a survey recipient or interviewee. Because contact information provided in SDWIS did not provide any specific individual as a point of contact, I had to rely on publicly available information and water system employees to assist in determining the most appropriate survey recipient or interviewee. Before proceeding with interviews, I ensured that each representative had knowledge all survey topics – ownership type, emergency preparedness and resilience, service area and billing practices, infrastructure and technology usage, financial practices, and hiring practices.

Surveys

Surveys can be useful in providing an in-depth view of the attitudes and behaviors of a group. Prior to this study, little was known regarding the ways in which small water providers operate and provide service to their customers, and so this process offers an exploration into the driving factors and outcomes of SWS through examining Houston's unusual water provisioning methods.

Using existing scholarly research and preliminary research results as a guide, I created a set of survey questions, broken into sections by topic. Literature used to determine appropriate questions is available in Appendix D-2. The first section of questions (see Appendix D-1) included screening questions to ensure the candidate was appropriately knowledgeable to complete the survey and to provide background information about their role in their organization and their role and history in the water industry in Houston. This information is helpful in understanding the interviewee's perspective on not only their own role and organization, but also to determine their level of experience and how well they can speak to trends in Houston's water industry as a whole.

The second set of questions (see Appendix D-1) contained information regarding ownership type. The questions provided the opportunity to gain more in-depth information about the ways each water system operates. The purpose of this set of questions was to help determine the focus of each water systems' services and business practices.

The third section (see Appendix D-1) consisted of questions measuring the water systems' adaptive capacity. These questions provided information regarding the level of emergency preparedness and resilience each water system has in dealing with a constantly changing environment, both physically and socially. This information is critical when

assessing each water systems' ability to serve their customers well in the face of expected changes like population growth and future water needs. It also assesses their ability to respond to unexpected changes, such as natural disasters, line breaks, and other emergency situations.

In the fourth set (see Appendix D-1), I asked questions regarding service area and billing. These questions provide information about the ways each water system interacts with their customers. The purpose these questions served was to determine the level of day-to-day and emergency service that each water system provides, by assessing how often they interact and in what languages, if they offer online services, and procedures and assistance for customers unable to pay their bills. This allowed me to gain knowledge of how accessible they are to the communities they serve and what level of assistance they can provide to non-English-speaking or low-income customers.

The fifth section (see Appendix D-1) was composed of questions regarding infrastructure and technology usage to learn more about each water systems' production of serviceable water and treatment processes. The questions contained information regarding maximum operating capacity, level of automation, technical specifications, and available treatment options. This information is helpful in understanding the technical capabilities of the water systems and if they are adequate for providing service to their customers. It can also assist in comparing capabilities among similarly sized water systems.

The sixth set of questions (see Appendix D-1) included information regarding the financials of each water system. It contained questions about their current and future business plans and also government assistance options available to them and if they have chosen to pursue any. These questions were important in determining each water system's

focus (i.e. more customer driven or profit driven) and long-term financial viability of the systems. This demonstrates not only how well they can currently serve their clients, but also if they will be able to adequate provide adequate, affordable service in the future.

In the final section (see Appendix D-1), I asked questions regarding water systems' hiring practices. These questions serve to gauge the level of expertise available to water systems and their perceptions regarding the level of adequacy of their available labor pool. Because scholarly research indicates that many SWS often cannot find adequate expertise in their available labor pools, it is important to ascertain what level of adequacy they are able to reach and if it is comparable to larger systems (Jocoy 2000).

After creating the survey questionnaire, I used the contact information provided by the SDWIS database to send my questionnaire via email to the water systems chosen in the sampling process (Appendix D-3). I did not receive a single response. I then expanded my sample using the same stratified random process. I still did not receive a single response. I continued this process until I had emailed every SWS in the database that had provided an email address to the EPA. I still did not receive a single response. Although low-response rates are possible, no response is very unusual, so I reached out via phone to individual water systems using the provided contact information to see if I could identify the problem. After reaching out to a number of systems, I determined that the SDWIS contact information reported to the EPA in most cases does not lead to the intended water system. Although I initially planned to also send questionnaires via mail, I encountered the same dead ends as I did with the email contact information and was able to verify that the provided information was largely inaccurate before sending. As a result, I concluded it would be a waste of time and money to send surveys to mostly incorrect addresses.

Interviews

Interviews were initially intended as a follow up to the survey questionnaires to allow for more in-depth and nuanced answers and to account for questions that could not be anticipated during the survey process. Due to the 0% response rate of survey questionnaires, they became the primary method of qualitative data collection. Although the original study design plan I created called for the creation of interview questions based on answers from the questionnaire results, this was impossible due to my inability to obtain respondents. Instead, interview questions originated from the survey questionnaire, some with slight modification to allow the interviewee to expand on or discuss topics that may not have been anticipated during the preliminary research process.

At the start of the survey process, suitable water system candidates were identified using stratified random sampling. I reached out to these potential interviewees via phone, using the contact information available in SDWIS. In cases where systems did not provide direct contact information to the EPA, I was often able to find contact information that was publicly available on their websites or the PUC website to reach them. In some cases, because no specific contact person was identified in SDWIS, I had to navigate to the correct individual by relying on a script of information (Appendix D-4) made to assist the person at the water systems' main phone line with identifying the most appropriate individual.

After reaching out to all potential candidates identified during the original sampling process, I still did not find anyone willing to participate in an interview. Although this was due in part to inadequate contact information, even in cases where I was able to reach

organizations and speak to the appropriate candidate, all declined to be interviewed. To identify a larger pool of candidates, I expanded my original list by utilizing the same stratified random method used in the initial survey process, which yielded five participants. Although these results were well below what would generally be expected or desired for a study of this type, I was unable to conduct a third round of sampling due to time constraints, as the process of finding candidates was so unexpectedly time consuming.

I conducted five interviews between June 2018 and August 2018. This study involves interviews with water providers who represent a range of public, quasi-public, and private water systems. Interviewees include an Operations Manager of a privately owned and operated water utility, a City Administrator of a publicly owned and operated municipal utility, a Director of a Water Supply Corporation (WSC), a President of a WSC, and the co-owner and operator of a privately-owned syndicate.

Transcripts and Coding

I transcribed each interview verbatim, using recordings taken during the interview. Transcriptions include all introductions, questions and answers, and even any off-topic discussion. Although the initial study design plan called for the use of MAXQDA, a qualitative analysis software tool, to code interview results, due to the small pool of responses, I was able to adequately code all qualitative interview data manually in Word. Choosing to process coding themes and categories manually does not disadvantage the researcher or compromise the quality of data, since software programs do not do any analysis, only assist in compiling (Basit 2003).

Coding is an important aspect of qualitative research analysis, as it allows the researcher to better understand their data by "allocating units of meaning to the descriptive or inferential information compiled during a study" (Basit 2003). Due to the exploratory nature of this study, I used inductive coding to find and build connections and patterns between all interviews after they had been conducted. Although this process formally began after transcribing, it is important to be mindful of possibilities, as ideas and patterns begin to emerge from the beginning of research. While developing questions and at the end of each interview, I reflected on and made notes regarding possible themes. These actions provide the ability to ground these themes with existing scholarly research.

To begin coding, I reviewed each transcription to refamiliarize myself with all my data and develop rudimentary codes by choosing statements that were significant. Statements were selected based on strong associations with a topic, opinion, or interview question related to existing research outcomes. Due to the small pool of responses and varied roles of interviewees, especially strong statements that were not echoed by multiple interviewees were still considered for significance. After selecting statements, a few recurring concepts emerged, which I then formed into three formal codes: (1) affordability, (2) operations, and (3) compliance.

The affordability code encompasses responses where providers discussed issues of affordability or profit that prevented them from providing service. The operations code incorporates responses where providers discussed issues involving how their management practices or infrastructure were constrained by their limitations as a small provider. The Compliance code encompasses responses where providers discussed their interactions with regulatory agencies and their ability to meet regulatory compliance standards.

GIS Data Preparation

For this study, I initially used three datasets for my GIS analysis. US Census Bureau block group data provided information about the demographic make-up of each block group area. SDWIS data provided information regarding water system identification, population served count, and violation levels of each water system. Spatial data containing partial water utility service boundaries was obtained from the PUC website by utilizing a shapefile containing CCN boundaries. Although CCN provide a spatial representation of water system service areas, they are only applied when a utility is given exclusive rights to provide retail water and sewer utility service to an area. Although CCN only account for approximately 25% of water systems in Harris County, at the time research began, it was the only existing spatial data that provided any water utility service area boundaries (Public Utility Commission of Texas 2018). When research was partially complete, TWDB released shapefile data containing the service boundaries of all water systems within Texas, and my research was updated to include this higher quality data. In addition to service boundaries, this data source included water system name, PWS id (unique identifier used in SDWIS database), and county served.

Analysis was conducted with the overall objective of determining which populations are being served by SWS in Harris County. In the first step, I collected and combined data sources. Although Census data and TWDB data both provide spatial information, block group boundaries unevenly overlap with water system boundaries, making it impossible to determine which population are served by individual water systems. I used the Identity tool

to break the Census block groups into smaller polygon slivers that matched water system boundaries. Next, I calculated population estimates for each sliver based on the percent of each block group sliver's total area within a water system boundary. I then used the Summary Statistics tool to combine each sliver's population to provide a total population estimate for each water system. This step prepared the data so that it can be determined which population groups are served by small water systems. To complete my analysis, I prepared the data for visualization and analysis by defining SWS and LWS, calculating all population counts as percentages, and breaking incomes into brackets (e.g. poverty, low, middle, high). SWS were defined by the EPA's 3,300 or less definition, and LWS were defined as any system serving more than 3,300.

Although all data sources that were utilized contained the most complete data currently available, inherent limitations exist. TWDB water system data is missing a small number of boundaries, due to unavailable information, so two water systems listed in the SDWIS database could not be accounted for and had to be excluded. Additionally, because the smallest unit of measure for census demographic data is at the block group level and does not include exact addresses for privacy reasons, population totals for each water system are estimated based on the percentage of block group area that fell with the water system boundary and may not reflect exact population totals.

Statistical Model Approach

While the GIS analysis I performed provides useful visualization data and insight into overlying trends of racial and income disparities that exist within the greater Houston area's water systems, it lacks the ability to uncover spatial trends in the data that cannot be

visually identified or analyzed. Additional statistical analysis provides a more in-depth understanding of these patterns by determining the exact degree at which the project's populations are affected and if that effect is statistically significant. Statistical significance can be defined as confidence that the outcomes demonstrate the effect being tested, rather than those patterns being a result of random chance (Murphy et al. 2014). To conduct this analysis, I utilized the data that I prepped using GIS, which provided demographic data for each of Harris County's water systems that was not previously available from any existing sources. All analysis was completed using the statistical software package R.

For this study, I utilized logistic regressions to determine if any populations in Harris County are being served by SWS at a disproportionately high rate. Two separate tests were implemented, one for race/ethnicity and one for income. Logistic regressions are typically utilized when the outcome (dependent) variable is dichotomous and the predictor (independent) variables are either continuous or categorical. This type of model measures how strongly the independent variables affect the dependent variable and is used to predict or determine which binary category the dependent variable will fall into (Field et al. 2012). To apply that concept to the study, the tests are measuring how strongly race/ethnicity and income affect what size of water system (i.e. small or large) populations are being served by. The advantages of using this type of model over similar models are that it does not assume the data is normally distributed or has equal variance between population groups. It is critical to ensure the data meets all assumptions of a model or the quality of its predictive outcomes may be compromised (Hair et al. 2013).

When performing any statistical analysis, it is important to justify selection of variables to ensure only relevant data is included, since each new predictor variable affects the

outcome of the test. For both tests, the dependent variable is dichotomous, indicating if a water system is small or large. SWS were denoted as 1, as it is the variable of interest, and LWS were denoted as 0. Using population served counts from the SDWIS database, all systems with a count of 3,300 or less were designated as small, and all systems with a count larger than 3,300 were designated as large. For the race/ethnicity test, I chose to include four variables – White, Black, Hispanic, and Asian – as they are the sizeable demographic groups within Harris County (US Census 2017). For the income test, I chose to include five variables – poverty, low, lower middle, upper middle, and high – based on 16 household income brackets defined by the US Census (shown in Table 2, see Appendix B). Because the US Census does not designate class distinctions, I utilized poverty threshold, median household income, and mean household income to inform my decision on how to most appropriately group this data (Semega et al. 2019).

To complete the preparation of my data, I performed a Variance Inflation Factor (VIF) test on both datasets to check for multicollinearity between independent variables. Multicollinearity exists in situations where two or more independent variables have a high level of linear correlation. It can be problematic in regressions, as it raises the standard error of coefficients and reduces the ability to interpret the importance of each individual variable. Because these issues become more severe as collinearity increases though, low collinearity can be safely ignored (Field et al. 2012). Both tests had VIF outputs above the threshold for high variance, which indicated that there were high levels of multicollinearity between at least two independent variables. To correct this, I removed a variable from each dataset that exhibited high collinearity. In the race/ethnicity dataset, I removed the White category, and in the income dataset I removed the Poverty category. The test outputs are

then read by interpreting each remaining coefficient as a deviation from the removed variable.

Although this solution can result in omitted variable bias, wherein the model attributes the effect of the removed variable to the remaining variables, in this situation it is preferable to leaving the collinearity unaddressed, since the high variance exhibited by the variables makes it impossible to understand the effect of individual predictors. While some research may be interested in the overall effects of a group of predictors, understanding the effects of individual variables is essential to answering this study's hypothesis. All methods of correcting collinearity have drawbacks, and there is no method insusceptible to affecting the outcomes of the model (Menard 2010).

The last step in this section of my research was to evaluate how well my data fits in the logistic regression models. It is important to determine fit to ensure the outcomes predicted by the model align with observed values. Pseudo R^2 tests can be utilized for logistic regression models to determine fit by approximating "the proportion of the total variability of the outcome that is accounted for by the model" (UCLA: Statistical Consulting 2011). In other words, the test measures how well the independent variables can predict the variability of the outcome variable (this variability is what the model is aiming to test). There are a number of pseudo-R^2 tests that can be used to evaluate model fit that utilize different methods of evaluation, none with any clear advantage over the others. I chose to use the Nagelkerke method, as it produces an output between 0 and 1, with 1 indicating perfect model fit (Hair et al. 2013).

CHAPTER IV

QUALITATIVE RESULTS AND DISCUSSION

In this chapter I will discuss the business and operating practices of the water provisioning organizations I interviewed and identify how these practices are shaped by the limitations of SWS and the regulatory environment that surrounds them. This chapter provides analysis that advances our understanding of Houston's unusual provisioning methods and SWS's ability to sustainably provide service. Findings reveal several barriers faced by SWS that impede their ability to provide this service.

Survey Results

Because contact was not made with water systems until the data collection phase, it was impossible to know that the contact information provided by the EPA would not lead to water systems in the majority of cases. As a result, none of the standard methods of minimizing non-responses could be utilized.

Low Response Rate

Although low response rates are possible during a survey or interview process, the level of reluctance I encountered was unusual. After reaching out to a number of selected contacts from the SDWIS database, it became clear that a large majority did not lead to the intended water systems. The provided phone numbers instead often led to syndicate main lines or legal representation that would not do more than confirm a connection to the water system, although some refused to do even that. None would provide contact information to

the water system they were associated with. Another issue I faced was that many of the systems listed in SDWIS had duplicate contact information, all leading to the syndicate that operates them rather than the systems proper, and so the pool of candidates I had at my disposal was much smaller than originally anticipated.

Of the information that did seemingly lead to the intended system, a large number of contacts never answered phone calls or returned voicemails, despite 5+ calls on multiple days. Some phone numbers were completely out of service or always had a busy signal. Others led to unrelated entities altogether; one number even led to a mobile home business located in Colorado that had no apparent connection to Texas or any water system at all. A web search of provided addresses presented similar results, leading only down dead ends.

Even when I was able to get in contact with the intended water system, I encountered extreme reluctance to speak with me. In a number of cases, this was due to gatekeeping, where the provided contact information connected to a main number, and I could not get the admin to let me speak with any other individuals from the company. In other cases where the operator was willing to assist me, I would receive the correct contact information, but despite numerous attempts to reach out on multiple days, I was never able to reach the intended contact. Lastly, multiple water system operators agreed to interview, but after numerous attempts to obtain details or set a date, they would stop responding or decline to interview.

In some cases, I even faced downright hostility. Many contacts simply hung up on me or told me not to call again (despite being the first contact I had with them). In one case, while explaining my research to an individual operating a MHP water system, I was yelled

at and told that we did not need to speak as it would be a "waste of time since [they] follow all TCEQ regulations".

A small number of water systems that were listed did not even know that they were water providers. This occurred only with very small systems, generally with under 100 connections. In all of these cases, they were confused that I was calling and assured me that they did not provide water, even after I confirmed that their information matched that of their organization on the SDWIS database.

Interview Results

Due to low response rate, I was only able to conduct interviews with five water provisioning organizations. Table 3 (see Appendix B) provides a categorization of respondents' roles and aliases given for ease of discussion. Although respondents came from a diverse range of water organizations, key themes emerged from commonalities between them. These themes allowed me to produce three formal codes – (1) affordability, (2) operations, and (3) compliance – to organize these common themes under.

Affordability

Affordability describes the ability of SWS operators to provide service at a cost that is both comparable to larger systems and not an undue burden to their customers. All but one interviewee, regardless of affiliation, had opinions regarding the affordability of being a small water provider.

Respondent B was alone in expressing no issues of affordability. They attributed this to having "a fairly steady and healthy revenue source for [their] operations and capital

projects, and so there's really not a need to fret when it comes to building a new project or placing something". This may be, at least in part, attributed to the fact that the median income for this municipality is more than 25% higher than the state average though (US Census Bureau 2017a). Additionally, they stated that both their constituency and their governing bodies are receptive to infrastructure improvement projects, meaning that even when "[their] finances weren't nearly as good as they are now … the city was still committed to putting money into infrastructure, and they did that through bond issuances and raising the property tax to pay for it, and that was very well supported by residents and businesses alike".

Respondent A expressed some affordability issues, but their struggles were largely framed within profitability concerns. They describe these difficulties as follows:

> "Nothing is cheap in water and wastewater. Everything from repairs to permits to leak repair, booster pumps, lift pumps. Nothing is cheap out there right now, and if it is cheap, you get what you pay for usually. But you know, we're a privately-owned utility company. Even though our bottom line may not look that good at the end of the year, we still make profit."

This focus on profit above all else was apparent throughout my interviews with both for-profit providers. Interviewees A and E, framed all discussion within their ability to generate profit. The discussion was very money focused, which was very in contrast with other systems, where the focus was very much on serving their customers.

Respondent D, who operates a WSC, had very different experiences regarding the affordability of providing water though. Unlike other types of water providers, WSCs do not have the option to refuse service to anyone within their boundary and must annex all

new customers, although some of these costs can be displaced to the new customer (Public Utility Commission of Texas 2019). Respondent D expressed frustration with the burdensome costs of operation that come with this requirement. Texas law exempts water systems with 15 or less connections from testing requirements, as they are no longer classified as PWS and are responsible for ensuring their water safety (Centers for Disease Control and Prevention 2014). Their organization has 16 customers, meaning that if they could choose to refuse service to even one customer, they could greatly lower their operation costs. This cost increase is problematic for their organization because they "don't have economies of scale, because [they] do all the water testing that the major water companies in the City of Houston do on their water, the bacteria, the studies, and the copper and lead … [they] do it for [their] customers, and in the same rigor as any of the major water companies or water entities in Houston". So even though they are required to do the same extensive testing as larger systems, they do not have the same access to capital or other resources. Despite this, Respondent D was not critical of these requirements; they were adamant that the requirements served an important purpose, even if it disadvantaged them.

Respondent C, who also operates a WSC, discussed their organization's struggles with providing service to their customers as well. Their cost margins are so thin that an unexpected line break almost caused them to go bankrupt at one point, as they didn't have the resources to find and fix it. They were also unable to capitalize on a grant they had received because they didn't have the manpower or expertise to make the required improvements within the time limit. After discussing all the financial difficulties they had experienced in the past, I asked why they had chosen to not to pursue annexation from a

larger system. They responded that "if [they] sell or even go with [a nearby municipality], their [customers'] water rates are going to triple, and they can't afford that". These lower rates are possible under a WSC because they rely on volunteers to operate.

Operations

Operations choices or limitations can have a substantial effect on a SWS's ability to provide service, and these limitations are often interwoven with issues of affordability. Operations describes the roles and responsibilities of SWS and the ways in which they use and maintain their systems in order to fulfill their obligation to serve the well-being of their customers. Systems have varying levels of freedom in the operations choices they make though; this ability can be limited by their economic capacity, government regulations, and attitudes of key organization members.

A universal concern among all interviewees was the difficulty they encounter in finding qualified workers, largely due to a lack of applicants and a lack of available capital to pay competitive wages. Respondent A noted that there's "not a big pool of applicants coming through the door", but even when they do have applicants it is "difficult to find someone who wants to work for the wage [they] want to pay". Respondent B is of the mind that their location makes it more difficult to find qualified workers as well, stating that "because where we're located, we compete directly with a lot of petrochemical companies that pay their employees double what our employees make".

Multiple interviewees acknowledged that inadequacies in the physical infrastructure of their system have impeded their operations abilities as well. Respondent B, on the other hand, was very positive about their system's operations. They largely attribute this to the

proactive attitudes of the individuals and organization they work with, stating that "regional structures and groups and organizations can thrive and succeed if you have the right people who are wanting to get those efforts off the ground". Regional structures are important for this municipality, as their success comes from working with two nearby municipalities to create redundancy in their systems and take advantage of economies of scale. This is called a joint powers association, and it gives them "a backup and then a backup to the backup" if they ever find their own resources to be inadequate.

Their municipality has also made a concerted effort to invest in infrastructure to ensure their residents are well taken care of. Even when "[their] finances weren't nearly as good as they are now … the city was still committed to putting money into infrastructure". They also felt that being able to "replace everything at one time versus kind of a shotgun approach to maintenance really goes a long way towards cutting down time and money that [they] need to invest back into the system." They noted that this new infrastructure has created much smoother operations, both on their end and the customer end. And since "a lot of maintenance issues on [their] side have gone away … [they] really don't have many complaints from residents".

Not all water systems have this level of freedom to finance and make improvements though. Some types of water systems are at a distinct disadvantage, simply because of laws in place that make it difficult for them to operate. For example, WSCs are not eligible for a lot of the financial assistance available, further hindering their ability their ability to effectively operate or plan for future growth. Both interviewees from WSCs (Respondents C and D) discussed their struggles with accommodating their customer base on limited resources. The Texas PUC even notes that because "the funds and customer base are so

limited, WSCs generally do not 'over-build' to accommodate future growth" (2019). As a result, WSCs are often operating at the bare minimum to keep water coming out of the faucet. Both interviewees discussed how their systems were established solely as a result of not having any other options for water service where they lived and how it was not a very ideal solution but the only one available to them. This is the case for many small systems operating in the periphery of urban areas, where municipal services do not reach them.

Respondent C discussed how all of their efforts go into just keeping their system operational; consequently, they do not have many resources to explore growth or upgrades that aren't essential. Because they operate using volunteers, they do not have a great deal of access to experienced water operators. A line break caused by municipal yard workers took them a year to find due to lack of expertise and resources. In fact, all of the shortages and interruptions they have experienced during their time in service have been caused by line breaks, which most commonly occur in older infrastructure. Operating with volunteers means that in situations like these that there must be an all hands on deck approach to solving problems. They explained how during a citywide drought restriction, where they were required to monitor usage more closely, even their sleep was disturbed by their volunteer responsibilities:

> "During the drought, we had to keep turning, like overnight, we told all the customers, 'we're shutting everybody's, the whole system is getting shut down, 11pm to 4am. I had one customer that got up at 4. And we did that for months. I did not get to sleep. And then of course during the day, I'd have to monitor it and have to shut it off."

Respondent D had concerns about how well their organization is able to operate with just volunteers as well. Although their day to day operations run fairly smoothly, they do not have much capacity to deal with unexpected expenses or situations. Since "[they] don't have anybody on standby … it's always difficult when [they] have an emergency". One common theme among the SWS providers I spoke to was the correlation between newer infrastructure and lowered maintenance and costs. Respondent D expressed that because they have "all new pipes [they] really haven't had anything like that for about 5 or 6 years". Unfortunately, not all SWS providers can afford to upgrade their infrastructure though, especially when running an organization like a WSC that does not provide much opportunity to account for future needs.

There is concern about how much can be expected from volunteers as well, especially since many are forced to participate since they do not have any other options to get water in their homes. Respondent D expressed their misgivings as follows:

> "Our volunteers are getting tired. So many of us have been doing this for so long that there's a question of how many times and how many years you're willing to step up just to have water come out of your faucets?"

Both Respondents C and D have been volunteers at their WSCs for over a decade. Because of this reliance on volunteers, they feel that they cannot ask for things that they feel are unessential, even if they technically have the capability. Respondent D's WSC has discussed the addition of credit card payments as an option for their customers but concluded that it was too much of an imposition on the volunteer that does their bookkeeping. As a result of this reliance on volunteers, customers are unduly burdened as well.

Unfortunately though, even if a WSC feels that they no longer able to provide service, they cannot just abandon their system or force a larger system to annex them. Respondent D's WSC has attempted annexation by a larger system multiple times but has been rejected each time because the Water Authority they've petitioned to feels that there is too much cost and risk involved in bringing on those new customers, despite already having a wholesale contract with the WSC to provide them water.

When asked what happens if they can no longer provide service to their customers, Respondent D told me they would be in legal trouble because "they submit our shareholders and our Board of Directors to the Attorney General for the state of Texas for fines and personal charges". Although they felt a responsibility to their system and would not consider abandonment, they are not happy with the current process. They feel that better remediation should be available to WSCs who are overwhelmed, explained as follows:

> "There should be a function in the state of Texas that gets between the governance models and allows the state to force a public entity. You know the [nearby municipality] Water Authority is a public entity, they're chartered by the state of Texas, and for them to leave 16 full time customers running their own system is crazy."

These factors raise a question of how well these overwhelmed SWS can provide water to their customers, both in terms of access and quality. Respondent C raised concerns about the quality of their water, stating "when we flush [the water], at times it comes out pure black … and it's like, 'you're drinking that'". When discussing their ability to provide Consumer Confidence Reports (CCR) in languages other than English, which this organization does not feel they have the capacity to provide, they expressed that although

"[the CCR] tells you what's in the water … you really don't want to know anyways because it'll scare you". CCRs are an annual report the EPA requires water providers send to their customers with information about the quality of their water.

Compliance

Providing CCRs in Spanish, as well as English, is a TCEQ requirement and failing to do so puts a water system out of compliance. Compliance describes the ability of SWS operators to fulfill and conform to legal requirements and regulations put in place by governing bodies, such as TCEQ or the state legislature. Respondents C and E both expressed that since they do not have Spanish speaking employees, providing documentation in Spanish is not feasible for them, cost-wise. C has even gotten in trouble with the TCEQ for not being able to do so. They don't attempt to fulfill this requirement though because "it would cost [their organization] a fortune to have those, and people just throw them in the trash. They don't even look at them". Respondent A was also resentful of this regulation and felt that it is unnecessary and may even be a slippery slope, stating "I guess next we'll have to be doing it in Chinese or whatever".

SWS often feel that they have to pick and choose which requirements they find to be the most important, as they're not able to fulfill them all. Respondent C described how they have to wait to make infrastructure improvements, even though they are aware they are out of compliance, stated as follows:

> "We need to get another storage tank because we're actually in violation of not having enough ground storage … We've gotten letters and threats and stuff, but we have until the end of the year to get it done."

Due to constantly being on the line for requirements they cannot fulfill, some organizations can develop a contentious relationship with regulatory agencies. Respondent E feels that it is unclear what the requirements even are at times, due to contradictions between agencies.

Attitudes within organizations can change the way that they feel about and interact with regulatory agencies though. Although Respondent D struggles to meet requirements, they still expressed the importance of them and working to meet them as best as they can, stating, "we've had to get some exceptions from [the TCEQ], but we view the regulations as being 100% compliance on our part, and so if we have an issue, we go ahead and confront them, and usually we're able to work something out".

Although non-compliance is often seen as the result of an inability to meet regulations, some operators choose to not comply with regulations that they are able to fulfill because they do not agree with them or do not like the burden they feel is put on their system.

Both individuals from for-profit organizations, Respondent A and E, have a negative view of regulatory agencies because they feel that their requirements eat into their profits. E expressed that dealing with TCEQ is one of the more egregious parts of providing water and feels that "the regulatory environment has gotten completely out of control, and so every day it's harder and harder for [them] to operate and for [them] as water system owners and the people [they] work for to make any money". Respondent A described how they felt it was unfair that they could not increase rates on two customers that the City of Houston forced them to annex due to their location in the city. Additionally, both A and E refuse to take any forms of government assistance because they do not like the additional regulations that come with them. Respondent A feels that it allows the government to "put

their finger on you more"; Respondent E had similar concerns, stating that, while the terms are often favorable, they would not take any assistance due to "how much information you have to give, and all of the reports you have to do".

The commonalities found in these interviews demonstrate how the existing water provisioning structure creates an environment where SWS by and large struggle to provide service to their customers. The responses from these providers supports the hypothesis that SWS in the greater Houston area are less safe and economically sustainable than larger systems.

Interview Discussion

The current system rewards those who can most successfully generate revenue from their water operations, but is this an appropriate or ethical method to serve communities with a resource that is essential for life? Due to SWS's smaller customer bases and reduced access to resources, they will always struggle to meet their own needs and the needs of those they serve without external assistance. Paired with the fact that many customers do not have an option in who their provider is, due to CCNs and other exclusionary practices, many are being disadvantaged simply because of their geographic location with no avenues of remediation.

Neoliberalism Spells Disaster for SWS

Focusing on profit over equitable access as an end goal determines the metrics by which we measure success and how we perceive the role and responsibilities of these providers. For-profit water systems are above all else beholden to shareholder or owner

interests, meaning their raison d'être is to generate profit, and, as a result, providing the best service for their customers can only be a lower priority. This can be evidenced by the prevalence of water systems who maintain profit in the face of ineffectual, aging infrastructure and poor service for their customers. Houston's water provisioning environment is the culmination of decades-long prioritization of these business interests above all else. These practices have created a proliferation of SWS, resulting in a highly fragmented landscape that is too broad to effectively regulate.

Proponents of neoliberalism assert that privatization allows for greater efficiency by utilizing economies of scale to achieve higher profitability as a result of lower costs. If neoliberalism seeks efficiency through economies of scale, what is the purpose of fragmenting water systems and obscuring ownership? These practices serve to obscure accountability and disrupt liability. Houston's current water provisioning industry is a prime example of this method of privatization. The landscape shows that higher profitability is unevenly distributed and greater efficiency does not necessarily translate to better outcomes for all. Highly fragmented syndicate organizations provide an excellent example of this disparity.

Aqua America Texas, one of the largest syndicates operating in Harris County and the second largest water provider in the US, is the owner behind 54 of Harris County's water systems (Food and Water Watch 2008). Although it is possible that Aqua America can take advantage of economies of scale with this method, there is currently no measure of if these systems are actually more efficient, since they are not required to be publicly accountable. Additionally, because these syndicates are privately-owned, they have no obligation to invest any profit resulting from greater efficiency back into the systems they operate,

meaning that even if they do manage to be more efficient cost-wise, there is no incentive for them to translate that efficiency into lower prices or better service for customers. In fact, on average, privately owned water systems in the United States charge the households they serve 59% more than municipalities for water service (Food and Water Watch 2016).

So while, on the surface, this process may seem to benefit SWS who cannot operate effectively on their own, it does not substantially improve their decision-making power, since the agency of SWS is restrained by the desires of the syndicate. Because of this uneven power dynamic, the desires of the syndicate owners and their shareholders will always be prioritized. Some benefits of partnering with or selling to a syndicate are undeniable. It can give SWS the ability to gain access to operators with expertise that they could not afford and don't have the need to employ fulltime, and they may have backup capital to make needed improvements. But those benefits come with strings attached when ownership is surrendered. If SWS do not willingly enter into these contracts unless they are backed into a financial corner, it shows that they see this option as a last resort.

Syndicates often frame their acquisitions as 'enthusiasm' on the part of water systems, while in the same breath admitting that these systems are greatly influenced "thanks to the squeeze on public finances and…new legislation [that] allows more generous valuations" (Childs 2019). They have used their clout to push for this legislation as a way to entice struggling municipalities and other smaller systems to sell. Although these syndicates hide behind optimistic language and marketing, the reality for these struggling systems is much less auspicious. Many are forced to sell their system as a last-ditch effort to maintain essential infrastructure, in the face of ever-shrinking government funding, and in the end, both public systems and their customers are disadvantaged (Davis 2018; Douglass 2017).

Despite neoliberalism's promises of efficiency creating lower costs, customers of many syndicates see their water bills rise and become more and more unaffordable after acquisition, while the syndicates rake in millions in profit each year. There is little to no scrutiny over the actions of these syndicates from regulatory agencies though. It is difficult to even track their activities, much less seek remediation. Syndicate data is not available on any regulatory databases, and the only way I was able to determine their involvement with a water system was through compiling data from CCRs available on their websites. Using CCR data, I determined that syndicates operate or own at least two-thirds of the water systems in Harris County (see Appendix C), meaning that these organizations have a high level of involvement in the direction of Houston's water provisioning environment, but operate with a great deal of invisibility. Although there are a number of syndicates operating in Harris County, I largely use Aqua America as an example for this model in this chapter because their national presence makes it easier to find data. It is impossible to even find data on some syndicates due to factors like vague, generic names (e.g. Municipal Operating and Consulting, Water District Management, Regional Water) and low salience due to regionality. As a result, these syndicates operate with little oversight or public accountability. It is impossible to find a website for many of these syndicates, much less any information regarding their operating practices.

The data that exists is telling though. Customers of Aqua America often have rates two to three times higher than their neighbors who are served by municipal systems (Food and Water Watch 2008). Syndicates that don't have a large, national reach like Aqua America are not absolved of these issues either. Customers of Quadvest, a smaller syndicate that owns 13 systems in Harris County, have reported skyrocketing prices and extensive

inaccurate billing. One customer even reported a 28% increase in their bill over 4 months, and 23 customers in one community have filed complaints with the Texas PUC over similar issues that have received no remediation (ABC 13 KTRK 2016). Other communities managed by Quadvest have reported increased prices, in the face of ongoing issues with brown water and intermittent access (Walker 2017).

Although syndicates often express that these price hikes are something they have little control over, these organizations game the system by taking advantage of laws that allow for rate increases under certain circumstances. In the state of Texas (and many other jurisdictions), there are laws in place which serve to keep private water providers from exploiting their customers by continually raising their rates without cause. The system utilized in Texas, termed *rate of return*, allows providers to submit a request with regulators to be allowed to charge higher rates after making infrastructure improvements. While on the surface this system may seem beneficial to customers, syndicates have used this as a way to artificially raise prices by making minor or unnecessary improvements and then asking for exorbitant rate increases (Food and Water Watch 2008). In fact, Texas regulators have been identified as the most willing in the nation to provide these types of increases for private providers, which has resulted in an infiltration of large syndicates into the state's market in past years (Dexheimer 2011).

Another tactic that has been pushed by privately owned operators looking to acquire struggling systems are "fair price" laws, which allow systems to sell at a higher price. While on the surface, this may seem beneficial to municipalities and SWS who can no longer afford to maintain their systems, these laws have an insidious side as well. Communities who have become disillusioned with private organizations that have not

delivered on their promises of greater efficiency face hurdles when attempting to extract their systems from private control. Because these privately-owned companies can demonstrate exaggerated values as a result of numerous *rate of return* improvements, communities who lack financial robustness that want to reclaim control over their water provisioning can no longer afford to buy back their systems, leaving them in the control of private companies who are neglecting their customers. Other systems who can afford to fight have been forced to waste money on eminent domain cases that can stretch on for a number of years by private companies that do not want to surrender their cash cows (Douglass 2017).

This kind of regulatory environment creates an uneven playing field, allowing the deep pockets of these syndicates to influence decisions that create disaster for small, local communities. Syndicates such as Aqua America don't just take advantage of existing regulation. They use their clout to push for and influence legislation that softens regulatory laws intended to protect customers from exploitation. One example of this is a system utilized in Texas and a number of other jurisdictions called *file and use*, where providers do not have to wait for approval from regulators after filing to raise rates; they can raise rates immediately after the rate proposal has been filed. This change can be especially difficult for customers living outside of city jurisdictions, as they must raise their own funds to fight rate increases. Although these individuals and small communities have no way to recover these costs, providers have used their influence to encode into Texas law that they can recover any costs incurred during the rate-making process via customer billing, making it a win-win situation for syndicates who don't have to pay even if they lose (Dexheimer 2011). With the regulatory environment of Texas becoming only more

tailored to business interests as years go by, customers of these private systems are forced to pay disproportionately high rates into a system that they have no input into, leaving them feeling hopeless and taken advantage of.

Providing Service in Non-Ideal Circumstances

Customers who are incorporated into syndicates face difficulties, but what happens to SWS who can't operate efficiently on their own but are seen as too high risk to be acquired by a larger system or syndicate? Those seen as too high risk are simply not acquired, and those found to be not profitable enough are unceremoniously dropped. Aqua America, for example, has a policy in which they sell or do not acquire water systems that are experiencing return rates smaller than 10% or have negative growth potential (Food and Water Watch 2008). Struggling water systems that do not fit into this acquisition model find themselves out of luck, as they are overlooked or dropped by syndicates who can't effectively extract profit from them. Yet they're forced to make do in a regulatory environment that does not take their needs into account, provides little to no assistance, and at times even actively disadvantages them. The people served by these systems still need access to services though, even if they aren't profitable. Reducing water systems to their profitability dehumanizes those who are struggling to get access to a vital resource.

While the EPA acknowledges that "small water systems can face unique financial and operational challenges in consistently providing drinking water that meets EPA standards and requirements", the tangible assistance that they offer is inadequate, especially in regards to financial challenges. As part of the 1996 SDWA amendments, the EPA implemented a *capacity development* program, intended to assist SWS with making

technical, managerial, and financial improvements, and this is where the majority of resources for SWS are located. This program contains robust documentation with best practices and self-assessment tools, but the financial assistance that appears is intermittent and difficult to access and understand as it is spread out among various organizations (US EPA 2016b). Although this information is surely helpful, checklists and guides can do little to help SWS that simply do not have the funds or manpower to operate effectively, and those who are already overwhelmed by the responsibilities of operation do not have the capacity to search for and apply for financial assistance that they may not even be awarded. For example, grant finding and writing is a technical and laborious process, and organizations with limited resources, who are in the most need of external assistance, cannot set aside any of those resources to seek them. Smaller systems are also often competing against better equipped organizations that even have grant-writing experts on their staff. But even in cases where they do receive assistance, limited financial resources means that they do not always have the ability to fulfill the reporting or timeline obligations that are attached (US Government Accountability Office 2015). Although other assistance exists in the form of loans, SWS that are already in financial crises are reluctant to take assistance they may be unable to pay back (Fretwell 2019).

It is essential that these systems get access to the financial resources they need though. SWS experiencing financial difficulties have been shown to experience significantly higher EPA violation levels; those with financial difficulties are 67% more likely to experience a monitoring and reporting violation and 27% more likely to experience any type of violation (Eskaf 2015). Compliance of all systems has been rising over the last few years, but SWS continue to experience higher non-compliance rates than larger systems, even

decades after the EPA implemented their capacity development program (US EPA 2012). Although the EPA purports that they provide "significant assistance and resources" to SWS, their consistent rates of higher non-compliance and financial difficulties over a number of years demonstrates that the current level of support from the EPA is inadequate if SWS are to continue to be a significant portion of water provisions serving communities. Despite this, the Trump administration has consistently reduced or hindered financial assistance available for struggling water systems, with the State Revolving Fund, one of the largest and most successful programs, having the lowest budget since 1997 (Douglass 2017).

Poor Governance Practices and Lack of Accountability

Although regulatory agencies are heavily involved in policing water systems, there is little effectual public accountability for systems that are not serving their customers well, and it is difficult for the public to identify all of the issues that endanger communities served by SWS, much less have the power to ameliorate the situation. But when these regulatory agencies fail to do their jobs, inadequate systems are shrouded behind a pretense of accountability. Some for-profit systems may feel that they benefit from this lack of scrutiny, but those served by these crumbling systems are caught in the crossfire. It can take years for the EPA to force changes upon these systems that actually provide tangible assistance for their customers, and in the meantime, these residents are not given any kind of compensation or assistance to ensure they have safe, reliable access to water resources.

Scholars largely agree that both transparency and accountability are paramount to building long-term sustainable systems. Because modern water governance is a complex

process that involves government agencies, private organizations, and societal actors and also serves the public, providing open information and dissemination of knowledge are essential for all parties to work together effectively. In order for private-public partnerships to be successful, they need "functional and efficient institutions require partnerships between public and private sectors that combine healthy competition and effective regulations" (Tortajada 2010).

Looking Forward

Because these SWS lack economies of scale, they are unable to provide the same level of service as larger providers that have greater access to both resources and expertise. These systems will need external assistance if they are going to continue to be a large part of the patchwork that makes up modern water governance. Right now, it is clear that they do not have what they need in order to operate effectively.

In the past couple of years, there has been growing recognition of the struggles faced by SWS and limited remediation has begun. Some municipalities are beginning to fight back against this growing pressure to yield control of their water systems to predatory syndicates and investor-owned utilities. Some cities have remunicipalized their water systems in an effort to make water more accessible to their citizens, but many who do this are faced with costly repairs of systems that have been long neglected under private control (Ulmer and Gerlak 2019). Baltimore is the first city in the US to outright banned water privatization altogether, prompted by concerns over high costs and poorly maintained infrastructure associated with private entities (Biron 2018).

Although recognizing the significance of this growing assistance is important, without tempering the effects of syndicate organizations and private ownership as a whole, small communities that do not have the support of a municipality will continue to be taken advantage of by those only looking to profit off them. It is essential to bring this unconscious bias to the forefront so that populations that are underserved get access to a vital resource.

Qualitative Limitations

Limitations exist within any research. Although the information gathered in these interviews is valuable, the salience of these connections is confined by the small sample size of participants. Despite reaching out to a number of organizations, I could not get all different types or locations to talk with me. Available data sources largely contributed to this limitation. Because the SDWIS database does not provide useable contact information, the transparency of these organizations is compromised to the point that I could not even reach a majority of them. Due to the overreliance on MUDs in Harris County, future research into this topic to determine the effectiveness of this type of provisioning organization would contribute to understanding of Houston's unusual provisioning methods.

CHAPTER V

QUANTITATIVE RESULTS AND DISCUSSION

In this chapter, I present the findings that address my research objectives of determining which populations are served by Harris County's water systems and whether or not any of these populations are disproportionately served by SWS. I will describe to what extent different communities and income groups are served by SWS and the implications this has regarding their health and financial security. GIS results demonstrate which populations are being affected by these barriers, and statistical analysis reveals if any of these populations are being disadvantaged by an overabundance of SWS in their communities.

GIS Results

For this study, 239 LWS and 351 SWS were identified and analyzed. Because the SDWIS and TWDB datasets used for analysis include all active community water systems within Harris County, no sampling was used, and all results are representative and not subject to sampling bias. For this study, GIS results fulfill the research objective of determining which populations are served by SWS in Harris County, as this data has never been previously compiled by any other data sources.

Although GIS was performed for this study with the primary intent of preparing the data for statistical analysis, visual analysis can still provide valuable insights regarding patterns of population distribution. Figures 2-5 (see Appendix A) illustrate the spatial layout of where SWS in Harris County are located and what demographic groups they

serve. Figures 2 and 3 (see Appendix A) demonstrate areas where higher numbers of White and Hispanic populations are being served by SWS, with White populations showing the strongest relationship. Evidence of these populations can be seen for White populations in Figure 2 (see Appendix A) spread across the northern periphery of the urban area and for Hispanic populations in Figure 3 (see Appendix A) in one cluster north of the urban core. Although these areas demonstrate where White and Hispanic populations are more likely to be served by SWS, this dispersal is not indicative of the overall number of SWS that these populations are served by. Table 4 (see Appendix B) shows what percent of each population group is being served by SWS and LWS. Asian populations are served at the highest rate by SWS, while Hispanic populations are served at the lowest rate.

Figures 4 and 5 (see Appendix A) demonstrate that distribution of SWS is fairly evenly distributed across all income groups. There are no areas where any group is strongly disposed to be served by SWS, although the two middle class groups show a slightly higher dispersion along the northern periphery of the city. Like the race/ethnicity breakdown, this dispersal is not indicative of how these populations are served overall. Table 5 (see Appendix B) shows an increase in population served by SWS as income raises.

Logistic Regression Results

Although GIS results show evidence of overall population groups and clusters of population groups that are being served by SWS at a higher rate, additional analysis is required to determine the significance of these findings. In this section, I will examine the relationship water system size has with race/ethnicity and income and present findings on

whether these variables have an effect on what size water system these populations are served by.

Table 6 (see Appendix B) shows the results of the logistic regression model that tests the effect of race/ethnicity groups, using White as a baseline. Among the racial and ethnic groups examined, only the White-Black difference is significant, based on the standard p-value of ≤ 0.05. This means that results can only be interpreted for this variable, as there is too high a chance that the observed outcomes of the remaining variables are not indicative of actual outcomes. Results demonstrate a negative coefficient for Black populations, suggesting that Black populations are less likely to be served by SWS than White populations. These results do not support the hypothesis that minority populations are disproportionately served by SWS, which is contrary to what has been found by existing literature that by and large demonstrate minority populations bear the brunt of environmental burdens.

Table 7 (see Appendix B) demonstrates the results of the logistic regression model that tests the effect of income groups, using Poverty as a baseline. Results show that among the income groups examined, only the Poverty-Upper Middle difference is significant. The Poverty-Lower Middle difference is only slightly above the significance threshold though, at 0.059, and can still be safely interpreted with a high level of confidence that the results are significant. The findings show a negative coefficient for both the Lower Middle and Upper Middle categories, which suggests that both population groups are less likely to be served by SWS than Poverty populations. These results partially support the hypothesis that low-income populations are disproportionately served by SWS, which is compatible

with existing literature that demonstrates that low-income populations have been excluded and disadvantaged in regards to infrastructure access and water services.

Due to the inconclusive results of both models, I performed a correlation matrix to determine if the predictor variables had any relationship to the outcome variable. Correlation matrices provide a measure between -1 and 1, where 1 or -1 is a perfect correlation and 0 indicates no correlation. Results shown in Tables 8 and 9 (see Appendix B) demonstrate very low correlation between the outcome variable and all predictor variables. In fact, in both models, correlations between the independent variables were higher than the correlation between any independent variable and the dependent variable. These findings indicate that it is likely race/ethnicity and income have very little effect on what size water system a population is served by.

Poor model fit can also explain the inconclusive results provided by the models. For the race/ethnicity model, the Nagelkerke R^2 was 0.028, which indicates the independent variables only account for 2.8% of variance in the dependent variable. For the income model, the Nagelkerke R^2 was 0.037, indicating the independent variables only account for 3.7% of variance in the dependent variable. Values this low indicate that the models have very little predictive value (Hu et al. 2006).

Quantitative Discussion

There is limited interpretation that can be done based off the logistic regression results alone, since the majority of variables in both models cannot be evaluated and correlation and predictive capabilities are so low. In this section, I will discuss the implications of these inconclusive results, why they likely defied expectations, and what this means for the

populations being served by Harris County's SWS. I will also focus on the ways that future research could be conducted to expand on the principles utilized in this study and better evaluate the variables that contribute to Houston's unique water provisioning environment.

Data is not sufficient enough to accept or reject the hypothesis that minority and low-income populations are disproportionately served by small water systems in the greater Houston area. Although the models demonstrate that White populations are more likely than Black populations and both Middle income populations are less likely than Poverty populations to be served by SWS, I cannot draw conclusions with confidence about the implications of these findings due to the low predictive value of the models.

Model and Data Limitations

It is likely that the data used to establish independent variables contributed to the models' uncertainty. US Census data was utilized for both models as it gives the most complete picture of the demographic makeup of Harris County, but the data still has limitations. US Census race data and ethnicity data are collected independent of each other, and as a result there is some amount of overlap between all race categories and the Hispanic category (Humes et al. 2010). Because Census data relies on anonymous self-reported survey responses, it is impossible to know the extent of this overlap, and as a result, it cannot be calculated or compensated for. It is possible that this factor could be skewing the White variable to an extent that makes it a poor comparison to minority populations.

There are also limitations in using household income as the sole determiner of which populations are low-income. US Census data does not differentiate or compensate for

household size. This means that large households who have relatively smaller economic power than smaller households who bring in the same amount of money are evaluated at the same level, even though they do not have the same economic resources in actuality. Per capita income does not account for any dependents in a household either, so there is no way to utilize income data to determine the real economic power of a household or individual.

It is also possible that the variables chosen to represent the theoretical constructs of the study do not accurately represent them. Although existing research indicates that low-income populations are disproportionately affected by poor environmental service, there is no single variable or data source that provides a comprehensive indicator of income status. As a result, researchers must define their own parameters for what is considered the threshold for low-income or impoverished populations in their study. Although some researchers create indices that aim to measure overall socioeconomic status (i.e. income, education, occupation), I chose to only include income due to the exploratory nature of this study. It is possible that use of this basic measure of socioeconomic status concealed some economically disadvantaged populations from proper analysis.

Water Governance in Harris County

Although it is still unclear if any vulnerable populations are being disproportionately served by SWS in Harris County, it is evident that a large number of people are still being disadvantaged by these systems at a higher rate than similar urban areas. GIS results demonstrate that approximately 280,000 individuals are served by SWS in Harris County. Because these systems are so prevalent here, it is likely that the entire population,

regardless of demographic breakdown, is affected by these systems at a disproportionate rate. This is supported by Tables 4 and 5 (see Appendix B), which show all races/ethnicities and all income groups except Poverty are served by SWS at a higher rate than the national average of 5% (US EPA 2009). Interview results demonstrate how the populations being served by these systems are being disadvantaged by their inadequacies.

This overabundance of small systems may be attributed to decades of neoliberal policymaking run amok. The city's past governance decisions can lend clues as to how these differences became part of the current landscape. City of Houston has historically prioritized business and development goals and, as a result, has allowed a proliferation of special districts in order to serve these interests. Beginning in the 1970s, rather than expanding existing centralized municipal services, the city chose to fragment their utility services by heavily utilizing MUDs to keep up with the rapid growth the city was experiencing. But lack of accountability and oversight in subsequent years has led to development goals continually being given precedence over public needs. Many private developers have used this leeway to take advantage financially by failing to address environmental degradation they caused, which has had a lasting effect on the city's land and waterscape. Despite attempts to increase oversight in more recent years, these problems continue to exist, as much of this infrastructure remains in place (Mullin 2009). Research from this study also revealed that the fragmentation of Houston's water environment is further complicated by the fact that the majority of these MUDs are now being operated by syndicates, obscuring accountability for who is responsible for these systems behind yet another barrier.

Extensive urban sprawl has complicated Harris County's water provisioning environment and contributed to the overabundance of MUDs as well. For the past few decades, City of Houston has chosen to limit annexation of nearby unincorporated areas, despite having one of the fastest growing unincorporated areas in the nation (Harris County Budget Management Department 2019). As a result, the large population in these areas have less access to government resources than their counterparts within the city's jurisdiction. MUDs were not intended to be permanent fixtures but now dominate Harris County's water provisioning environment. In some of these unincorporated areas, they've taken on so many responsibilities that they now function as that area's primary government. Because their funding and powers are more limited than municipalities though, this means that many of them struggle to provide adequate service, leaving those that they serve at a disadvantage (Shelton et al. 2018).

Despite these clear indications that neoliberal policymaking has created an uneven, unjust water provisioning environment in Harris County, many advocates still speak favorably of these decisions. This predilection for pro-business, free-market solutions alters perceptions about the roles of government and the people. Proponents of neoliberal practices point to affluence as a measure of success of the free market, all while seeking support from government entities in the form of laws and ordinances that give them more economic freedom and control. The decisions that intensify the power of private entities only disadvantage those being served by them though, as these entities are confined by the need to generate profit for their shareholders. A shift from focusing on people to focusing on investments only serves to dehumanize those who are only trying to gain access to a vital resource necessary for life and dignity.

Neoliberalization of water governance also bleeds into the regulatory environment of an area. Fragmenting water services can overwhelm regulatory agencies due to the number of organizations they are responsible for monitoring. The encroachment of private actors greatly increases the number of entities regulatory agencies are responsible for. Stories in earlier chapters tell a story of communities affected by frequent shutoffs and quality issues that go unaddressed for a number of years lend evidence that shows regulatory agencies are either not well-equip enough or too negligent to deal with these transgressions. In fact, a government report found that Texas was recently found to have the highest number of SWS with severe EPA violations of any US state, but the EPA has failed to bring the large majority of those violators back into compliance even after four years (Butler et al. 2016).

Future Research

Although this study could not determine if low-income and minority populations are being disproportionately served by SWS, the information gained from this research can be utilized to guide future research on the topic. Because the measures used for testing were likely a contributing factor as to why the model results were inconclusive, additional variables could be included in future analysis. It is possible that low-income and minority populations are still being disproportionately served. To uncover this, researchers could investigate if low-income subsects of minority populations are being disproportionately served. It's also possible that the income measures were inadequate, so researchers may need to create a better measure of socioeconomic status. The use of model fit measures like pseudo R^2 tests could be utilized to add/remove variables and find if any missing factors that contribute to prevalence of SWS service.

Although there are limited results, findings from this study add some level of confirmation to Teodoro and Switzer's assertion that wealthier minority neighborhoods are not at higher risk of health violations (2017). Future research could utilize both studies to provide a better understanding of the connections between wealth and water system size.

Due to the reliance on regulatory agencies to provide adequate data though, it's possible that at this time there just isn't enough data to clearly uncover the causes of Houston's unusual provisioning methods. Ineffectual reporting measures for the SDWIS database and lack of water service boundary information shows that regulatory agencies are only starting to research this and do not have a heavy investment in remediating the uneven provisioning environment caused by a proliferation of small systems.

CHAPTER VI

CONCLUSIONS

Using a mix of qualitative and quantitative methods, this research developed an exploratory case study that examines the role of SWS within Houston's water provisioning and explores their relationship with marginalized communities. I investigated the characteristics of Houston's SWS and attempted to determine the extent to which Harris County's low-income and minority communities are served by these systems. Results of this analysis indicate that there is evidence that Houston's SWS are at a disadvantage, but it is still unknown if any populations bear the brunt of this shortcoming. This research corroborates existing scholarly literature that demonstrates SWS are not able to provide service at the same level as larger systems, due to their inability to take advantage of economies of scale or access sufficient manpower and technological expertise.

The qualitative research that provided conclusions for this study included survey questionnaires and semi-structured interviews. First, I conducted interviews with water system operators and operations company managers as a means to gain more in-depth knowledge of the ways in which SWS operate and determine their sufficiency. Next, I performed GIS analysis on demographic data to establish which populations are being served by Houston's SWS and to discover if any populations are being disadvantaged as a result of being disproportionately served by inferior systems. Lastly, I completed statistical analysis to determine if any population groups are being served at a disproportionate rate.

Through these methods, I demonstrated how neoliberalization of water governance practices creates an uneven environment in which some populations are deprived of

adequate services that provide an essential resource. Despite the promises of greater efficiency and lower costs, current governance conditions do not translate to equitable outcomes for all.

Although this research clearly demonstrates that these governance practices are harmful to some, the current approach taken by Texas regulators makes it impossible to assess the ways in which the populations served by them are being affected. High levels of fragmentation combined with regulatory agencies that have either an inability or little interest in monitoring copious water providers have resulted in a lack of transparency whereby no parties – regulators, researchers, or citizens – can accurately evaluate system performance. At present, this lack of accountability allows water providers to service their customers poorly with few, if any, consequences.

Regulations serve little purpose if they are unevenly implemented though. If equitable access is important to the state of Texas, improvements are necessary to rectify this situation. Developing better reporting practices is foundational to creating a resolution. Data management such as the SDWIS database is critical for protecting public health, but at present, it cannot even be utilized to verify basic water provider information. I suggest that regulatory agencies push for resources that would allow them to better hold these providers accountable if they do not provide accurate information about their systems. Additionally, because of the heavy utilization of syndicates, water providers should be required to provide information indicating which syndicate organizations they have connections with.

Regulatory agencies must also work together at a higher level if transparency and accountability is to be a goal. Currently, publicly available water data for the state of Texas

is spread across multiple state and national agencies. Because they don't work together to create this data, it is not always compatible and, as a result, can be difficult to analyze (e.g. TWDB water boundaries do not contain demographic data but are poorly compatible with Census boundaries). I suggest two actions that could make this information more accessible. First, a central organization or location should be designated to accommodate this data so that it is accessible without having to search across a number of organizations. Second, regulatory agencies need to have the resources and ambition to work with each other to create data that is better compatible for analysis. It is likely that this improvement will require a restructuring of regulatory agencies' responsibilities altogether though, as many agencies have overlapping jurisdictions that make it difficult to even assess where gaps exist.

Not only would these actions assist regulatory agencies, it would also provide the data necessary for researchers and citizens to better evaluate the performance of water providers. Although some of these goals may seem lofty, until improvements are made to the current system to improve the lack of transparency, it will be impossible to adequately assess the state of water provisioning in Harris County.

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APPENDIX A

FIGURES

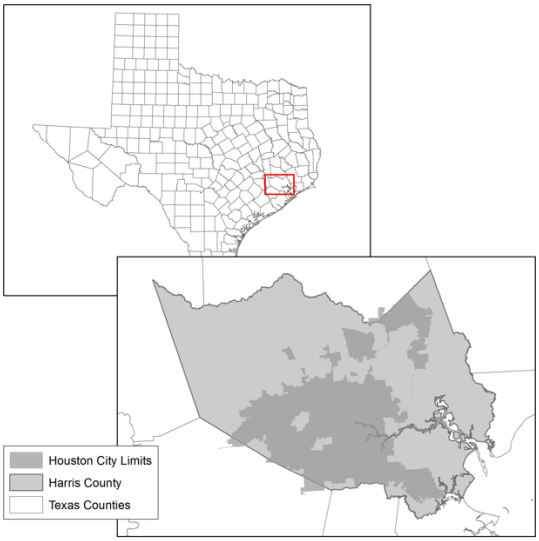

Figure 1. Map of study area (Harris County) in relation to its location in Texas

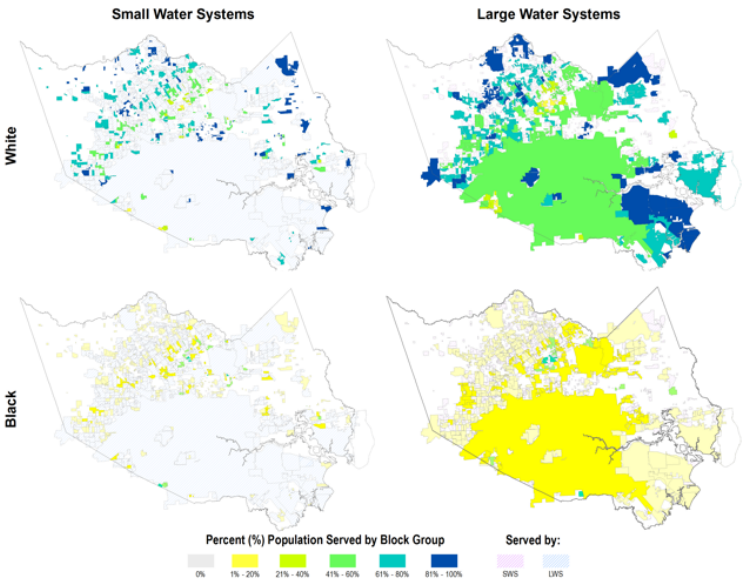

Figure 2. Map of SWS and LWS distribution for White and Black populations

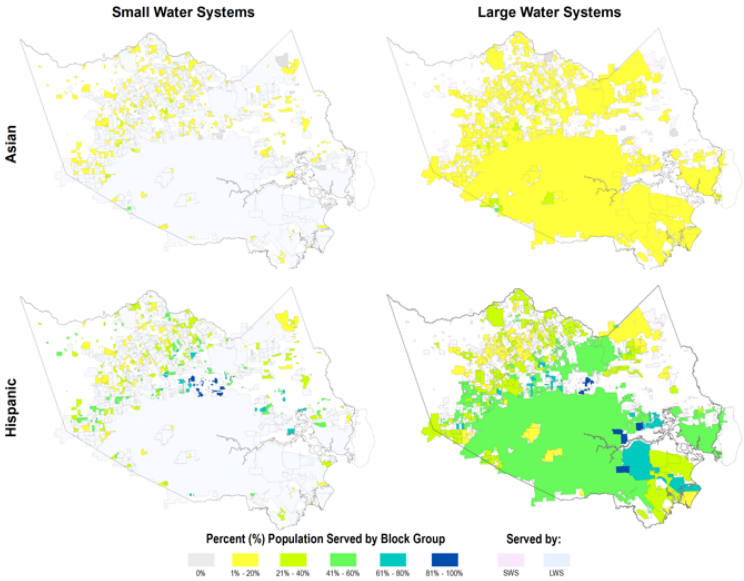

Figure 3. Map of SWS and LWS distribution for Asian and Hispanic populations

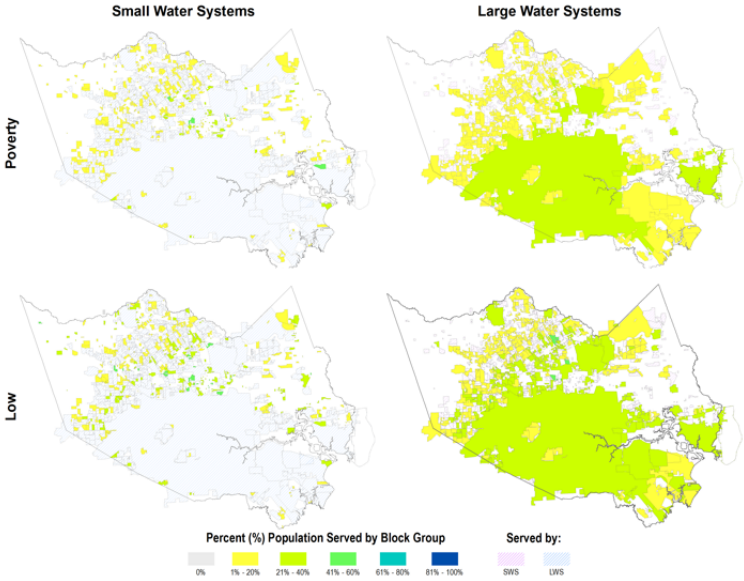

Figure 4. Map of SWS and LWS distribution for Poverty and Low-Income populations

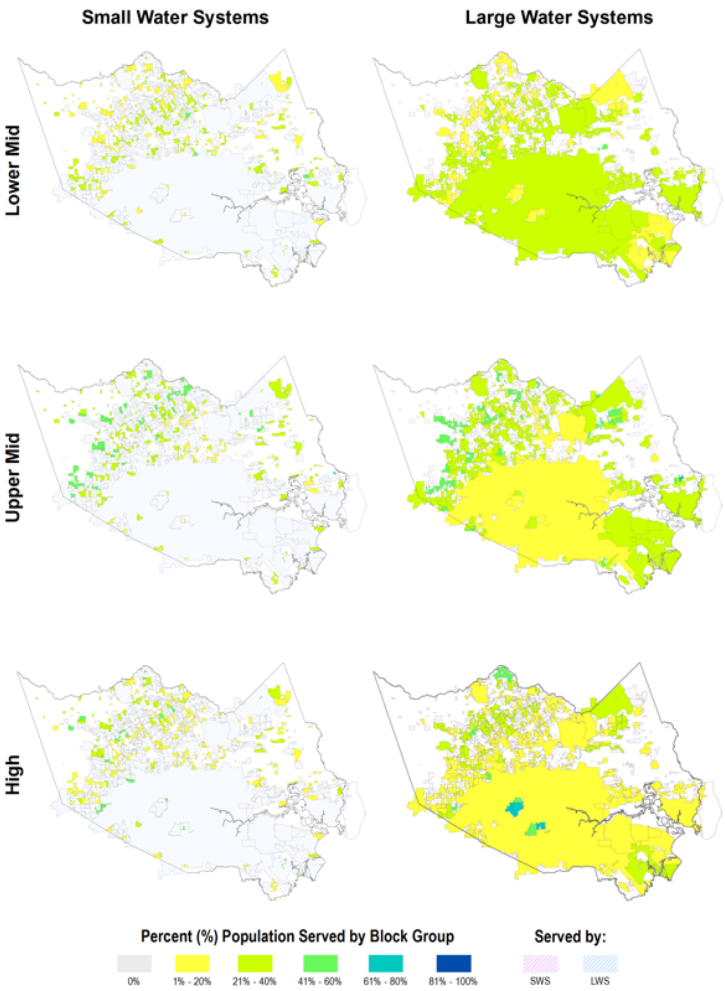

Figure 5. Map of SWS and LWS distribution for Lower-Middle, Upper-Middle, and High-Income populations

APPENDIX B

TABLES

	Harris County	National Avg.
Black	19.7%	13.4%
Hispanic	43.0%	18.1%
White, Not Hispanic	29.7%	60.7%
Below Poverty Line	16.6%	12.3%

Table 1. 2017 population estimates of Harris County compared with national average

Income Bracket	Class Distinction
Less than $10,000	Poverty
$10,000 to $14,999	
$15,000 to $19,999	
$20,000 to $24,999	Low
$25,000 to $29,999	
$30,000 to $34,999	
$35,000 to $39,999	
$40,000 to $44,999	
$45,000 to $49,999	Lower Middle
$50,000 to $59,999	
$60,000 to $74,999	
$75,000 to $99,999	Upper Middle
$100,000 to $124,999	
$125,000 to $149,999	
$150,000 to $199,999	High
$200,000 or more	

Table 2. Class distinctions based on US Census income bracket designations

Role of Interviewee	Alias
Operations Manager of Private Water Utility	Respondent A
City Administrator of Public Municipal Utility	Respondent B
Director of WSC (private non-profit)	Respondent C
President of WSC (private non-profit)	Respondent D
Co-owner and Operator of Private Utility Management	Respondent E

Table 3. Aliases given to interviewees

	Total Pop	White	Black	Asian	Hispanic
SWS	7.17%	7.30%	6.69%	9.14%	5.96%
LWS	92.83%	92.70%	93.31%	90.86%	94.04%

Table 4. Percentages of population served by SWS and LWS by racial/ethnic group

	Total HH	Poverty	Low	Lower Mid	Upper Mid	High
SWS	6.69%	4.26%	5.60%	6.82%	8.42%	8.25%
LWS	93.31%	95.74%	94.4%	93.18%	91.58%	91.75%

Table 5. Percentages of population served by SWS and LWS by income group by household (HH)

	Estimate	Std. Error	z value	p value
(Intercept)	0.560	0.238	2.351	0.019
Black Pop	-1.669	0.616	-2.708	0.007
Asian Pop	-1.606	1.259	-1.275	0.202
Hisp Pop	0.531	0.426	1.248	0.212

Table 6. Logistic regression results for race/ethnicity population groups

	Estimate	Std. Error	z value	p value
(Intercept)	2.284	1.370	1.667	0.095
Low	-0.463	2.167	-0.214	0.831
Lower Mid	-3.395	1.797	-1.890	0.059
Upper Mid	-3.258	1.456	-2.238	0.025
High	-0.414	1.531	-0.271	0.787

Table 7. Logistic regression results for income population groups

	White	Black	Asian	Hisp
LWS or SWS	0.15	-0.11	-0.07	0.07

Table 8. Correlation matrix results between dependent variable and independent variables for race/ethnicity model

	Poverty	Low	Lower Mid	Upper Mid	High
LWS or SWS	0.10	0.08	-0.07	-0.13	0.01

Table 9. Correlation matrix results between dependent variable and independent variables for income model

APPENDIX C

SDWIS DATABASE SAMPLE

PWS Name	PWS Type	Primary Source	Counties Served	Owner Type	GW or SW	Submission Year	Pop Served	#Facilities	#Violations	# Site Visits	Email Address	Phone Number	Phone Ext	Address Line1	Address Line2	City Name	Zip Code	Activity Status
ACRES NORTH MOBILE HOME PARK	Community water system	Ground water	Harris	Private	Groundwater	2017	25	2	0	1	-	-	-	CARTER MCALEXANDER	1714 STRAWN	HOUSTON	77039	Changed from public to non-public
BAREFOOT RV PARK	Community water system	Ground water	Harris	Private	Groundwater	2017	36	7	23	1	robert@savillehomesinc.com	-	-	5401 INWOOD DR	-	HOUSTON	77056-4215	Active
BELLEWOOD WSC	Community water system	Ground water	Harris	Local government	Groundwater	2017	0	10	30	6	-	-	-	1132 GRAY MOSS LN	-	HOUSTON	77055-6840	Changed from public to non-public
BONANZA MOBILE HOME PARK	Community water system	Ground water	Harris	Private	Groundwater	2017	33	2	0	1	-	-	-	RAYMOND A WEBER-OWNER	7402 GARDEN PARK DRIVE	HOUSTON	77075	Changed from public to non-public
BONDALE PROPERTY	Community water system	Ground water	Harris	Private	Groundwater	2017	40	2	0	1	-	-	-	JIM SHELTON	6209 SPINDALE	HOUSTON	77086	Changed from public to non-public
BROOKWOOD MOBILE HOME COMPANY	Community water system	Ground water	Harris	Private	Groundwater	2017	0	9	7	7	-	-	-	109 N POST OAK LN STE 300	-	HOUSTON	77024-7755	Changed from public to non-public
BUFFALO BAYOU MOBILE HOME PARK	Community water system	Ground water	Harris	Private	Groundwater	2017	51	2	9	1	-	-	-	KARL KINS-CO-OWNER	P O BOX 1197	KATY	77492	Changed from public to non-public
C & C MOBILE HOME COMMUNITY	Community water system	Ground water	Harris	Private	Groundwater	2017	87	12	84	7	-	-	-	3514 POSTWOOD DR	-	SPRING	77388-5140	Active
COUNTRY LIVING APARTMENTS	Community water system	Ground water	Harris	Private	Groundwater	2017	144	10	22	8	-	-	-	12406 PERTHSHIRE RD	-	HOUSTON	77024-4105	Active
HARRIS COUNTY MUD 359	Community water system	Ground water	Harris	Local government	Groundwater	2017	85	3	0	0	-	-	-	1300 POST OAK BLVD SUITE 1400	-	HOUSTON	77056	Changed from public to non-public

(US EPA 2017)

APPENDIX D

SURVEY AND INTERVIEW QUESTIONNAIRES

D-1: Survey and Interview Question List

Screening Questions

Are you 18 years or older?

Do you currently work for an agency or department that provides water services in the Houston region?

What agency and department do you work for?

Which of the following statements best describes your involvement in decision making for your organization?
- I am the sole decision maker
- I share decision making with others
- I give input, but someone else usually makes the final decision
- I am not usually involved in decision making

Which of the following best describes your role in your organization?
- Manager
- Operator
- Administrative
- Other (please explain)

Ownership Type Questions

Which label best describes your organization?
- Public
- Private (for profit)
- Private (not for profit)
- Public-Private Partnership

Who makes policy decisions at your organization?
- Board
- Manager
- Other (please explain)

Where is the water you provide to customers sourced from? (Choose all that apply)
- Ground water
- Surface water
- Purchased water

What is the source of the ground water that you provide to customers? (Choose all that apply)
- Well
- Spring
- Other (please explain)

What is the source of the surface water that you provide to customers? (Choose all that apply)
- River or stream
- Lake
- Reservoir
- Other (please explain)

What is the type of purchased water that you receive?
- Finished
- Partially treated
- Untreated

Does your organization have exclusive use of sources or is it shared with other providers?

Does your system provide any non-water related services? If yes, please explain other services provided.

Does your system have a parent company? If yes, please provide name.

Does your system provide service to multiple sites? If yes, how many?

Do any sites have a different company name? If yes, please provide names.

Service Area and Billing Questions

Who does your organization provide water to?
- Residential
- Non-residential

How many households does your organization provide water services to?

How are the households that you service separated?
- By number of individuals in household
- By household
- Multi-family units

Household Type?
- Own
- Rent
- Apartment
- Trailer Park

What is your level of interaction with your customer base?
- More than daily
- Daily
- Weekly
- Monthly
- Infrequently (less than monthly)
- Never

Do any other employees at your organization interact more frequently with your customer base? If so, what is their role, and how often do they interact with customers?

What bill pay options do your customers have for water services? (Choose all that apply)
- Mail
- Online

Face-to-face
Other (please explain)

What languages does your organization provide billing information in? (Choose all that apply)
English
Spanish
Vietnamese
Chinese
Other (please explain)

Which pricing structure does your organization utilize? (Choose all that apply)
Increasing block rates or tiered rates (i.e. per-unit charges for water increases as the amount of water used increases)
Time of day pricing (i.e. prices raise during peak demand periods)
Seasonal rates (i.e. prices rise or fall according to weather conditions and the corresponding demand for water)
Water surcharges - (i.e. higher rate for "excessive" water use, often consumption that exceeds the local or regional average)
Flat fee rates (i.e. prices do not vary by customer characteristics or water usage)
Other (please explain)

What are the non-payment procedures at your organization?
Comply with EPA/TCEQ standards
More lenient than EPA/TCEQ standards
Other (please explain)

Infrastructure and Technology Usage Questions

Do you have knowledge of infrastructure and technology usage at your organization?

What is your organization's average daily production in gallons (i.e. average amount of finished water produced daily)?

What is your organization's peak daily flow (i.e. maximum amount of finished water produced on a single day during a 12-month reporting period)?

What is your organization's system design capacity (i.e. maximum amount of finished water that your plant(s) is designed to produce daily when operating at capacity)?

What type of storage facility does your organization use for finished water?
Fully buried
Partially buried
Ground level
Elevated
Hydropneumatics
Standpipes
Standpipes operated as surge tanks
Other (please explain)

What type of treatment does your facility provide for unfinished water? (Choose all that apply)
Chemical addition
Coagulation/flocculation
Settling and sedimentation
Filtration
Membranes

Softening
Other (please explain)
None, we only purchase finished water

To what extent are computers used in services? (Choose all that apply)
Business operations
Deployment of services
Tracking of services
Other (please explain)

How many pressure zones are utilized in your organization's distribution system?

Does your organization regularly utilize flushing (to clear out stagnant water, provide a measure of cleaning pipes, and maintain water quality) in your distribution system?

How often does your organization test for contaminants?
Compliant with EPA/TCEQ standards
Exceeds EPA/TCEQ standards
Other (please explain)

How does your organization test for contaminants?
In-house
Send to external organization
Other (please explain)

What remedial action(s) is taken in event of contamination?
Follow EPA/TCEQ standards
Exceed EPA/TCEQ standards
Other (please explain)

Financial Questions

Do you have knowledge of financial practices at your organization?

What percent of your organization's revenue is from direct water sales?

What percent of your organization's revenue comes from charges (e.g. connection fees, penalties, and (for publicly owned systems) transfers from the local government's general fund)?

What percent of your organization's revenue comes from non-water related services?

How effective do you think your organization's long-term business plan is for water services?

Which public financial assistance or subsidies through loans does your organization receive? (Choose all that apply)
Drinking Water State Revolving Fund (DWSRF)
Texas Water Development Fund (TWDF)
Economically Distressed Areas Program (EDAP)
Rural Water Assistance Fund (RWAF)
State Participation Program (SPP)
State Water Implementation Fund for Texas (SWIFT)
Other (please explain)
Our organization does not receive any public financial assistance or subsidies through loans

Do you feel that the amount of aid your organization receives is sufficient?

Did you submit an application for public financial assistance? If no, why not?

Expertise in Water Provision Questions

Do you have knowledge of hiring practices at your organization?

How many individuals are employed at your organization?

What is the level of education you strive for when hiring management positions?

What are the experience and training levels you strive for when hiring management positions?

Are you satisfied with the expertise, education, training of management applicants you receive?

What is the education level you strive for when hiring field positions?

What are the experience and training levels you strive for when hiring field positions?

Are you satisfied with the expertise, education, training of field applicants you receive?

How do you search for and recruit job candidates at your organization?

Emergency Preparedness and Resilience (Adaptive Capacity) Questions

Do water shortages or interruptions affect your organization's ability to provide services to your customers?

Do you feel that your current water source(s) are sufficient for meeting projected demand over the next 20 years?

Is your organization pursuing additional water sources?

How often do you discuss strategies to endure drought with others?

Who do you discuss these strategies with? (Choose all that apply)
- Others in your organization
- Others in different water-related organizations
- Other (please explain)

How often do you discuss strategies to endure flooding with others?

Who do you discuss these strategies with? (Choose all that apply)
- Others in your organization
- Others in different water-related organizations
- Other (please explain)

Does your organization have a drought, flood, hurricane plan?

How effective was your plan in past drought events?

How effective was your plan in past flood events?

How effective was your plan in past hurricane events?

Has growing population affected your ability to provide service?

Do state policies either help or inhibit your organization's planning activities?

Does your organization utilize strategies to either reduce demand or conserve water?
- Yes, incentive-based
- Yes, pricing-based
- Yes, ordinance-based
- No

Are these strategies company initiatives or government requirements?

End Screening Questions

What is your age?

What is your gender?

What is the highest level of education you have completed?

What is your race or ethnicity?

D-2: Survey and Interview Questions – Links to Literature

Ownership Type				
Public, private (for-profit or not-for-profit) - investor owned, PPP?				Find correlations or trends based on type of WS
Water source - ground, surface, or purchased?	"groundwater is less exposed to and thus less sensitive to climate conditions compared to surface water" "groundwater systems have the lowest cost; surface water systems are on average 17 percent more costly than groundwater systems, and use of purchased water is 52 percent more costly than groundwater"	Larson, K. L., C. Polsky, P. Gober, H. Chang, and V. Shandas. 2013. Vulnerability of water systems to the effects of climate change and urbanization: a comparison of Phoenix, Arizona and Portland, Oregon (USA). *Environmental Management* 52 (1):179-95. Shih, J.-S., W. Harrington, W. Pizer, and K. Gillingham. 2004. Economies of Scale and Technical Efficiency in Community Water Systems. Resources for the Future:1-35.	p. 182 p. 15	Find correlations or trends based on type of water source
--> If ground or surface -- more details (source - private well, lake, river, etc.)?				
--> If purchased -- finished, partially treated, or untreated water?				
Does your system have exclusive use of this source or is it shared with other providers?	Similar question asked in survey; possible supply points/security of supply points	Milman, A., and A. Short. 2008. Incorporating resilience into sustainability indicators: An example for the urban water sector. *Global Environmental Change* 18 (4):758-767.	p. 762	Shared source may indicate less control over security of source
Does your system provide any non-water related services? If so, what?	Water provision is often only part of SWS services	US Environmental Protection Agency. 2009. 2006 Community Water System Survey.		
Does your system have a parent company? If so, what?				
Does your system provide service to multiple sites?				
--> Do any site have a different company name? If so, what?				

Infrastructure and Technology Usage				
Average daily production Peak daily flow Excess capacity Total storage capacity of system	"An important difference among water systems is the extent to which they have excess capacity. With excess capacity, a system can accommodate fluctuations in demand, planned growth, and firefighting needs. One measure of excess capacity is the ratio of system design capacity to peak daily flow, which is inversely related to system size."	US Environmental Protection Agency. 2009. 2006 Community Water System Survey.	p. 11	Assess how SWS are equipped to deal with fluctuating demand and planned growth
Type of storage facility	"not all storage is equal: clearwells and storage with dedicated inlets and outlets provide contact time, but storage that "rides the line" (i.e., with a common inlet and outlet) may not"	US Environmental Protection Agency. 2009. 2006 Community Water System Survey.	p. 18	Assess the safety of SWS storage facilities
Level of treatment (e.g. chemical addition, coagulation/flocculation, settling and sedimentation, filtration, membranes, softening, etc.)	Majority of small water systems use simpler treatment processes	US Environmental Protection Agency. 2009. 2006 Community Water System Survey.	p. 15	Assess the quality of treatment processes utilized by SWS
Capital investment capabilities? --> % of revenue from direct water sales --> % of revenue from charges (e.g. connection fees, penalties, and, in the case of publicly owned systems, transfers from the local government's general fund) --> % of revenue non-water related	"Small water systems face a number of challenges that can affect their capacity to comply with public health standards. The extent to which small systems can fund their operations through water rates and other charges will have a significant impact on their financial capacity." "characteristics of small systems that hinder their access to capital (such as small customer base, diseconomies of scale, dispersed distribution lines, and remoteness from other water systems)" "Many water system professionals and researchers identify the inability of small water systems to access and acquire capital to address their infrastructure and organizational limitations as the single most difficult and compelling problem they face"	US Environmental Protection Agency. 2009. 2006 Community Water System Survey. Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. *Journal of the American Water Resources Association* 36 (4):811-821.	p. 42 p. 812 p. 814	Assess if ability to comply with health standards and public needs is affected by financial status
Do you feel that your organization has an adequate long-term business plan for your water system?	"Some small systems are unable to attract and pay for qualified operators and thus do not have the managerial expertise to create business plans for their systems"	Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821.	p. 814	Assess if SWS have adequate financial expertise to manage systems

Do you receive public financial assistance? If so, which?	"assertion that small systems experience a greater difficulty accessing funds than other systems calls into question the efficacy of programs that provide aid"	Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821. https://www.tceq.texas.gov/assistance/water/water-and-wastewater-funding-sources https://www.twdb.texas.gov/financial/programs/ http://publications.tamu.edu/WATER/PUB_water_Resources%20for%20Small%20Water%20Systems.pdf	p. 812	Determine if public funding covers gap in economy of scale of SWS
--> If yes, do you feel that the amount of aid you receive is sufficient?	"surveys indicate that the needs of small water systems exceed the amount of aid available"	Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821.	p. 815	Determine if public funding covers gap in economy of scale of SWS
--> If no, did you submit an application for public financial assistance? Why or why not?	"manifestation of' these deficiencies may be the inability even to apply for financial assistance"	Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821.	p. 816	Determine if SWS lack the ability/resources to apply for financial assistance
To what extent are computers used in services? (i.e. business operations, deployment, tracking)	Economies of scale limit amount of technology usage	Shih, J.-S., W. Harrington, W. Pizer, and K. Gillingham. 2004. Economies of Scale and Technical Efficiency in Community Water Systems. *Resources for the Future*:1-35.	p. 2	Level of expertise in provisioning
Does your organization utilize technologies to conserve water?				Level of expertise in provisioning
--> If so, what?				
Use of technologies like pressure zone, flushing, etc.	Higher-end technology is often only used by larger WS	US Environmental Protection Agency. 2009. 2006 Community Water System Survey.	p. 40-41	Are SWS providing lower quality water because they do not (or don't have access to) utilize better technology?

Expertise in Water Provision				
Number of employees in organization	Number and distribution of personnel can indicate efficiency of organization	Alegre, H., and IWA Benchmarking and Performance Assessment Specialist Group. 2017. Performance indicators for water supply services. Third edition. ed.	p. 22	Comparison of employees per connection
What are the education, experience, and training levels you strive for when hiring management positions?	Education and training levels of personnel can indicate efficiency of organization "Some small systems are unable to attract and pay for qualified operators and thus do not have the managerial expertise to create business plans for their systems"	Alegre, H., and IWA Benchmarking and Performance Assessment Specialist Group. 2017. Performance indicators for water supply services. Third edition. ed. Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821.	p. 23-24 p. 814	Comparison of education and training in relation to other factors (i.e. higher vulnerability, pricing, etc.)
--> Are you satisfied with the expertise, education, training of applicants?				
What are the education, experience, training levels you strive for when hiring field positions?	Education and training levels of personnel can indicate efficiency of organization "chronic conditions of poverty in some communities affect the water system's access to resources, technical expertise, and qualified system administrators and operators"	Alegre, H., and IWA Benchmarking and Performance Assessment Specialist Group. 2017. Performance indicators for water supply services. Third edition. ed. Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821.	p. 23-24 p. 814-815	Comparison of education and training in relation to other factors (i.e. higher vulnerability, pricing, etc.)
--> Are you satisfied with the expertise, education, training of applicants?				
Hiring practices				
--> Where is labor pool sourced from?	"chronic conditions of poverty in some communities affect the water system's access to resources, technical expertise, and qualified system administrators and operators"	Jocoy, C. L. 2000. Who Gets Clean Water? Aid Allocation to Small Water Systems in Pennsylvania. Journal of the American Water Resources Association 36 (4):811-821.	p. 814-815	Do SWS lack access to qualified labor pool?
How often test for contaminants? Where send for testing?				
--> Exceed EPA or TCEQ requirement?				
Remedial actions in event of contamination				
Alternative water methods (i.e. water reuse)				

Service Area and Billing Questions				
Number of households serviced?				Does number of households served correlate to ability to provide service?
--> How are they separated (household numbers, families, multi-family, etc.)?				
Level of interaction with customer base?				
--> If any; frequency?				
Type of bill pay (mail, face to face, online, etc.)?				Assess ability to provide service to customer base
--> Multi-language bills? If so, what languages sent?				Assess ability to provide service to customer base
Pricing structure - full-cost, subsidized, etc.	Water systems exhibit economies of scale and costs are both higher and more variable in SWS	Shih, J.-S., W. Harrington, W. Pizer, and K. Gillingham. 2004. Economies of Scale and Technical Efficiency in Community Water Systems. Resources for the Future:1-35.	p. 19	Analyze if SWS pricing structures are affected by size
Characterization of population				
--> Socioeconomic, ethnicity, education	"members of racial and ethnic minorities face greater risk of unsafe drinking water"		p. 11	Analyze if population characterizations affect access to high quality drinking water
--> Household type - own, rent, apartment, trailer parks				
Non-payment procedures				Assess ability to provide service to low-income customers
Involvement or interaction with any agencies other than EPA or TCEQ (outside of testing)				Communication levels

Emergency Preparedness and Resilience (Adaptive Capacity)				
Does your ability to provide services to your customers rely on resource availability?	"Residential water users...may be most susceptible to water shortages or curtailments in metropolitan areas"	Larson, K. L., C. Polsky, P. Gober, H. Chang, and V. Shandas. 2013. Vulnerability of water systems to the effects of climate change and urbanization: a comparison of Phoenix, Arizona and Portland, Oregon (USA). *Environmental Management* 52 (1):179-95.	p. 180	Do water shortages affect SWS's ability to provide service?
Do you feel that your current water source(s) are sufficient for meeting projected demand over the next X years?				
Is your organization pursuing additional water sources?				
Do you use seasonal weather forecasts to cope with resource variability?	Methods in adaptability can raise ability to cope with climate variability	Marshall, N. A. 2010. Understanding social resilience to climate variability in primary enterprises and industries. *Global Environmental Change* 20 (1):36-43.	p. 39-40	Do certain methods of adaptability to climate variability raise ability to provide service?
How often do you discuss strategies to survive drought with others?	Those who prepare for climate variability are better equipped to cope with it	Marshall, N. A. 2010. Understanding social resilience to climate variability in primary enterprises and industries. *Global Environmental Change* 20 (1):36-43.		Does interest in preparation and resiliency translate to better ability to provide service?
--> With others in your organization? With others in different organizations?				Does communication between organizations increase ability to provide service?
Has growing population affected your ability to provide service?	"water managers face the added challenge of rising water demands due to rapid population growth and land use modification" "population growth is a more important stressor to global water systems than climate change, although the extent and effects—direct and indirect—vary across regions"	Larson, K. L., C. Polsky, P. Gober, H. Chang, and V. Shandas. 2013. Vulnerability of water systems to the effects of climate change and urbanization: a comparison of Phoenix, Arizona and Portland, Oregon (USA). *Environmental Management* 52 (1):179-95.	p. 179 p. 180	Has growing population affected SWS's ability to provide adequate service to customers?
Do state policies either help or inhibit your organization's planning activities?	"twice as many water managers in suburban Boston indicated sufficient state support for their planning activities compared to land use planners"	Larson, K. L., C. Polsky, P. Gober, H. Chang, and V. Shandas. 2013. Vulnerability of water systems to the effects of climate change and urbanization: a comparison of Phoenix, Arizona and Portland, Oregon (USA). *Environmental Management* 52 (1):179-95.	p. 182	Do state policies help or inhibit SWS's ability to provide service through planning activities?
Does your organization utilize strategies to either reduce demand or conserve water?	Question asked on p. 183	Larson, K. L., C. Polsky, P. Gober, H. Chang, and V. Shandas. 2013. Vulnerability of water systems to the effects of climate change and urbanization: a	p. 183	Are organizations interested in conservation or is it only accomplished via government intervention? (Independent intervention

		comparison of Phoenix, Arizona and Portland, Oregon (USA). *Environmental Management* 52 (1):179-95.		would show a willingness for long-term solutions rather than short-term economic benefits)
--> Incentive-based, pricing-based, ordinence-based	Question asked on p. 183	Larson, K. L., C. Polsky, P. Gober, H. Chang, and V. Shandas. 2013. Vulnerability of water systems to the effects of climate change and urbanization: a comparison of Phoenix, Arizona and Portland, Oregon (USA). *Environmental Management* 52 (1):179-95.	p. 183	
--> Are these strategies company initiatives or government requirements?				
Does your organization have a drought, flood, hurricane plan?	Impact on region	Dow, K., R. E. O'Connor, B. Yarnal, G. J. Carbone, and C. L. Jocoy. 2007. Why worry? Community water system managers' perceptions of climate vulnerability. *Global Environmental Change* 17 (2):228-237.	p. 231	Analyze vulnerability and ability to provide service after weather event
Have you experienced drought, flood, hurricane in the past X years? If so, how effective was your plan?	Impact on region	Dow, K., R. E. O'Connor, B. Yarnal, G. J. Carbone, and C. L. Jocoy. 2007. Why worry? Community water system managers' perceptions of climate vulnerability. *Global Environmental Change* 17 (2):228-237.	p. 231	Analyze vulnerability and ability to provide service after weather event

D-3: Potential Survey and Interview Participant Call Script

Call to confirm/collect contact information:

Hello, may I please speak to (contact name on list)?

If available:

Hi my name is _____. I am a graduate researcher at Texas A&M University. I am trying to verify some contact information for your organization. Would you be able to assist me with that?

If yes:

We have you listed on the EPA database as a provider of drinking water under (organization name). Is that correct?

Confirm existing information

If no email -- Is there an email to best reach ____?

Thank you, I appreciate your assistance!

If unavailable:

Maybe you can assist me. I am a graduate researcher at Texas A&M University. I am trying to verify some contact information for your organization. Would you be able to assist me with that?

If yes:

We have you listed as a provider of drinking water under (organization name). Is that correct?

Confirm existing information

If no email -- Is there an email to best reach ____?

Thank you, I appreciate your assistance!

If no longer at organization:

Would you be able to provide the new contact information for your organization?

If yes:

Name of person in charge of drinking water management

Address of facility

Email address

D-4: Email Script

Dear _____,

We would like to invite you to participate in a scientific study of urban water provision and water security. The objective of this study is to explore and find more information about how small water systems function and utilize available resources. You have been selected as a possible research participant because you are listed on the EPA's Safe Drinking Water Information System (SDWIS) as the water management contact for your organization. This research is conducted by researchers at Texas A&M University.

What will I do? If you agree to participate in this research, you will be asked questions from a survey related to water system management (e.g. service area, emergency preparedness, water provision). The interview will take approximately ___ minutes.

What are the risks? The risks to participate in the study are minimal.
What are the possible benefits? You will not receive direct benefits or payment.

Do I have to participate? No. Participation is voluntary. You may withdraw from the study at any time, and it will not affect your relations with Texas A&M University.

Who will know about my participation? Your participation in the study will remain confidential. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely. Only Dr. Wendy Jepson and her students will have access to the records.

Who do I contact if I have questions? You may contact Dr. Wendy Jepson (Department of Geography, Texas A&M University, wjepson@tamu.edu) or Kelli Condina (Department of Geography, Texas A&M University, cond1438@tamu.edu) if you have any questions regarding the study.

Who do I contact about my rights as a research participant? This research has been approved by the Institutional Review Board and Human Subjects Protection Program at Texas A&M University. If you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office by phone at (979) 458-4067, or by email: irb@tamu.edu.

Participation. Please make sure you have read the information provided above, asked any questions of your interest, and received satisfactory answers. If you agree to participate, please click the following link: www.qualtrics.survey.com/URL. You can also request a paper survey from the contact information listed above.

Thank you,

Signature

APPENDIX E

SYNDICATE CONNECTIONS

PWS ID	PWS Name	PWS Type	Owner Type	Zip Code	Pop Served	# of Facilities	# of Violations	# of Site Visits	PPP Type	Operator, if different	Source
TX1012276	2920 WEST SUBDIVISION	Community water system	Local government	77362-0837	369	13	0	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1012333	ACORN VILLAGE MOBILE HOME PARK	Community water system	Private	77040-5225	192	12	276	24	3		
TX1011019	ADDICKS UTILITY DISTRICT	Community water system	Local government	77056-3078	4998	25	36	28	2	Inframark	https://www.inframark.com/residents/
TX1012052	ALBURY MANOR UTILITY COMPANY	Community water system	Private	77388-8908	150	14	64	28	4	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010410	ALDINE FOREST SUBDIVISION	Community water system	Private	77039-4121	90	12	0	28	4	Champ's Water Company	https://www.champswater.com/ccr
TX1010825	ALDINE GARDENS MOBILE HOME PARK	Community water system	Private	77069-1317	138	9	48	28	3		
TX1010092	ALDINE MEADOWS	Community water system	Private	78723-2476	219	13	4	20	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/Interchange/Documents/45089_1_864515.PDF
TX1010658	ALDINE OAKS MHP	Community water system	Private	92623-7356	174	8	236	24	3		
TX1010931	ALDINE VILLAGE SUBDIVISION	Community water system	Private	77358-0279	1155	16	8	32	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1011236	ALICE ACRES MOBILE HOME SUBDIVISION	Community water system	Local government	77362-0837	282	14	8	32	0	HMW SUD	http://hmw-sud.com/service-area/
TX1012806	ALTON THEISS SUBDIVISION	Community water system	Private	78723-2476	45	5	12	24	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011920	AMBERWOOD SUBDIVISION	Community water system	Private	77338-5214	150	8	21	24	3		
TX1010574	APACHE MOBILE HOME PARK	Community water system	Private	77228-3871	102	8	20	32	3		
TX1010085	APACHELAND MOBILE HOME SUBDIVISION	Community water system	Private	77532-1186	177	8	100	28	3		
TX1011687	ATASCOCITA ACRES SUBDIVISION	Community water system	Private	78723-2476	381	12	4	32	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf

TX1010162	ATASCOCITA VILLAGE MOBILE HOME PARK	Community water system	Private	77396 -3611	723	10	24	28	3		
TX1011253	AZALEA ESTATES MOBILE HOME COMMUN	Community water system	Private	77358 -0279	69	5	20	28	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1012962	BAKER ROAD MUD	Community water system	Local government	77056 -3078	1116	4	0	25	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010689	BALABAN APARTMENTS 1	Community water system	Private	77037 -2347	102	10	16	20	3		
TX1011028	BALABAN APARTMENTS 2	Community water system	Private	77037 -2347	60	8	28	20	3		
TX1010096	BAMMEL FOREST UTILITY	Community water system	Private	77290 -0038	1023	13	8	32	4	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010809	BAMMEL OAKS ESTATES 1	Community water system	Private	78723 -2476	33	4	4	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010810	BAMMEL OAKS ESTATES 2	Community water system	Private	78723 -2476	234	12	8	29	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010365	BAMMEL UTILITY DISTRICT	Community water system	Local government	77024 -3430	2550	20	8	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013459	BAREFOOT RV PARK	Community water system	Private	77056 -4215	36	7	92	4	3		
TX1012240	BARKALOO HOMEOWNERS ASSOCIATION	Community water system	Private	77522 -1569	60	6	65	32	3		
TX1011613	BARKER CYPRESS MUD	Community water system	Local government	77056 -3078	7170	29	32	24	2	Inframark	https://www.inframark.com/residents/
TX1013526	BAUER RANCH SUBDIVISION	Community water system	Local government	77377 -0409	567	8	8	4	x	Can't find anywhere - not even on PUC website	
TX1012698	BAYBROOK MUD 1	Community water system	Local government	77027 -7537	1065	11	150	20	2	Si Environmental	https://www.sienv.com/mymud/
TX1010212	BAYER WATER SYSTEM	Community water system	Private	77377 -0409	972	16	16	24	4	Quadvest	https://www.quadvest.com/ccrs
TX1011995	BAYOU FOREST VILLAGE MOBILE HOME PARK	Community water system	Private	77279 -9244	195	9	12	24	3		
TX1011742	BAYTOWN AREA WATER AUTHORITY	Community water system	Local government	77522 -0424	0	13	20	52			
TX1010098	BEAUMONT PLACE	Community water system	Private	77383 -1383	1437	14	47	21	4	Quadvest	https://www.quadvest.com/ccrs
TX1012082	BEECHNUT MUD	Community water system	Local government	77010 -3095	1761	12	12	24	2	Municipal District Services	http://www.municipaldistrictservices.com/
TX1010180	BENDER CREEK APARTMENTS	Community water system	Private	77092 -2057	330	10	104	24	3		

TX1011828	BENTWOOD ESTATES MHP	Community water system	Private	79403 -7502	135	11	180	24	3		
TX1010099	BERGVILLE ADDITION	Community water system	Private	78723 -2476	27	7	34	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011860	BERRY HILL ESTATES	Community water system	Private	78723 -2476	144	9	0	25	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011872	BILMA PUD	Community water system	Local government	77019 -7120	5028	27	8	36	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011551	BINFORD PLACE SUBDIVISION	Community water system	Private	75681 -0385	156	9	316	24	3		
TX1010883	BISSONNET MUD	Community water system	Local government	77057 -1799	8133	23	4	36	2	Municipal District Services	http://www.municipaldistrictservices.com/
TX1010647	BLUE BELL MANOR SUBDIVISION	Community water system	Private	77038 -3012	2361	23	20	28	3		
TX1010691	BLUEBONNET MOBILE HOME PARK	Community water system	Private	77346 -1949	93	5	12	32	3		
TX1011084	BOUDREAUX GARDENS	Community water system	Private	78723 -2476	123	11	109	18	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1012741	BOULAIS MOBILE HOME PARK	Community water system	Private	77039 -3038	84	5	164	20	3		
TX1011120	BOYS & GIRLS COUNTRY	Community water system	Private	77447 -9327	100	10	192	28	3		
TX1010887	BRANDYWINE OAKS	Community water system	Local government	77362 -0837	129	6	4	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1011219	BRANDYWINE PINES	Community water system	Local government	77362 -0837	294	14	0	25	0	HMW SUD	http://hmw-sud.com/service-area/
TX1011550	BRIDGESTONE MUD	Community water system	Local government	77019 -7120	18922	39	86	24	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1011014	BRITTMOORE UTILITY	Community water system	Private	78723 -2476	2871	24	16	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010914	C & C MOBILE HOME COMMUNITY	Community water system	Private	77388 -5140	87	12	336	28	3		
TX1010639	CANAL TERRACE SUBDIVISION	Community water system	Private	77532 -1186	480	12	208	32	3		
TX1010532	CANDLELIGHT HILLS SUBDIVISION	Community water system	Private	78723 -2476	2271	18	28	25	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011632	CARBY MOBILE HOME PARK	Community water system	Private	77255 -5528	210	6	56	24	3		
TX1011833	CASTLEWOOD MUD	Community water system	Local government	77057 -1799	2457	13	0	25	2	EDP	http://www.edpwater.com/your-district/

TX1010111	CASTLEWOOD SUBDIVISION	Community water system	Private	77383 -1383	1008	11	47	25	4	Quadvest	https://www.quadvest.com/ccrs
TX1012174	CEDAR BAYOU ESTATES	Community water system	Private	77358 -0279	60	6	52	25	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1010112	CEDAR BAYOU PARK	Community water system	Private	77358 -0279	294	4	28	28	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1013200	CEDAR CREEK FOREST MOBILE HOME COMMUNITY	Community water system	Private	77379 -6610	195	8	4	21	3		
TX1011556	CEDAR OAKS MOBILE HOME COMMUNITY	Community water system	Private	77358 -0279	204	13	12	29	3		
TX1013429	CENTRAL HARRIS COUNTY REGIONAL WATER AUT	Community water system	Local government	77056 -3078	0	3	0	8	x	Manage a lot districts	https://www.chcrwa.com/member-districts/
TX1013146	CHAMPION LAKES ESTATES WATER PLANT	Community water system	Private	77065 -2610	141	9	8	16	3		
TX1010233	CHAMPIONS MUD	Community water system	Local government	77019 -7100	4050	17	64	28	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1010811	CHAPMANS MHP	Community water system	Private	77532 -0230	204	6	8	21	3		
TX1010632	CHARTERWOOD MUD	Community water system	Local government	77046 -0307	5760	30	0	28	2	Municipal District Services	http://charterwoodmud.com/district-information/
TX1010782	CHELFORD CITY MUD	Community water system	Local government	77046 -0905	8574	24	24	24	2	Si Environmental	https://www.sienv.com/mymud/
TX1010767	CHELFORD ONE MUD	Community water system	Local government	77027 -7537	3783	19	12	28	2	Si Environmental	https://www.sienv.com/mymud/
TX1010910	CHIMNEY HILL MUD	Community water system	Local government	77046 -0905	5403	23	28	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1011209	CHINQUAPIN PREPARATORY SCHOOL	Community water system	Local government	77562 -3152	148	9	36	24	1		https://www.tceq.texas.gov/assets/public/comm_exec/agendas/comm/backup/Agendas/2017/07-07-2017/2090PWS.pdf
TX1011410	CIMARRON MUD	Community water system	Local government	77027 -7537	9393	34	4	20	2	Si Environmental	https://www.sienv.com/mymud/
TX1010003	CITY OF BAYTOWN	Community water system	Local government	77522 -0424	72312	38	6	24	1		
TX1010004	CITY OF BELLAIRE	Community water system	Local government	77401 -4411	22473	34	10	17	1		
TX1010106	CITY OF BUNKER HILL VILLAGE	Community water system	Local government	77024 -6231	3999	26	20	24	1		
TX1010007	CITY OF DEER PARK	Community water system	Local government	77536 -0700	32964	35	20	60	1		

TX1010009	CITY OF GALENA PARK	Community water system	Local government	77547-0046	10089	19	36	32	1		
TX1012987	CITY OF HILSHIRE VILLAGE	Community water system	Local government	77055-6737	1014	4	47	28	2	Inframark	https://www.inframark.com/residents/
TX1010013	CITY OF HOUSTON	Community water system	Local government	77251-1562	2233310	1134	24	76	1		
TX1011594	CITY OF HOUSTON BELLEAU WOODS	Community water system	Local government	77251-1562	780	20	20	72	1		
TX1011585	CITY OF HOUSTON DISTRICT 73	Community water system	Local government	77251-1562	4320	24	8	69	1		
TX1011593	CITY OF HOUSTON DISTRICT 82	Community water system	Local government	77251-1562	669	16	8	73	1		
TX1010348	CITY OF HOUSTON UD 5 - KINGWOOD	Community water system	Local government	77251-1562	78078	70	44	72	1		
TX1011902	CITY OF HOUSTON WILLOW CHASE	Community water system	Local government	77251-1562	13536	44	8	52	1		
TX1010014	CITY OF HUMBLE	Community water system	Local government	77338-4305	15338	46	5	24	1		http://www.cityofhumble.com/waterops.html
TX1010015	CITY OF JACINTO CITY	Community water system	Local government	77029-2538	10500	11	12	28	1		
TX1010016	CITY OF JERSEY VILLAGE	Community water system	Local government	77040-1905	7792	31	30	28	1		http://www.ci.jersey-village.tx.us/page/pw.home
TX1010017	CITY OF KATY	Community water system	Local government	77492-0617	17019	48	4	32	1		
TX1010018	CITY OF LA PORTE	Community water system	Local government	77571-6215	34733	49	8	28	1		
TX1010087	CITY OF MORGANS POINT	Community water system	Local government	77571-5735	342	15	69	29	1		
TX1010152	CITY OF NASSAU BAY	Community water system	Local government	77058-3508	4002	18	12	32	1		
TX1010293	CITY OF PASADENA	Community water system	Local government	77503-2523	110058	93	36	28	1		
TX1012281	CITY OF PASADENA EL CARY ESTATES	Community water system	Local government	77501-0672	534	5	28	24	1		
TX1010062	CITY OF SEABROOK	Community water system	Local government	77586-3540	12792	17	4	28	1		
TX1010207	CITY OF SHOREACRES	Community water system	Local government	77571-7262	1400	22	37	28	1		
TX1010294	CITY OF SOUTH HOUSTON	Community water system	Local government	77587-0238	13578	47	84	32	1		

TX1010023	CITY OF SOUTHSIDE PLACE	Community water system	Local government	77005 -3617	1700	16	125	20	1		
TX1010214	CITY OF SPRING VALLEY VILLAGE	Community water system	Local government	77055 -7407	4452	18	25	21	1		
TX1010026	CITY OF TOMBALL	Community water system	Local government	77375 -4623	10000	33	16	25	1		
TX1010226	CITY OF WEBSTER	Community water system	Local government	77598 -5226	13710	22	12	25	1		
TX1010027	CITY OF WEST UNIVERSITY PLACE	Community water system	Local government	77005 -2802	18405	23	84	25	1		
TX1013144	CLASSIC PINES SUBDIVISION	Community water system	Private	78723 -2476	249	9	24	20	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011681	CLAY ROAD MUD	Community water system	Local government	77027 -7537	4218	16	8	24	2	EDP	http://www.edpwater.com/your-district/
TX1010418	CLEAR BROOK CITY MUD	Community water system	Local government	77089 -4220	12390	37	24	36	1		https://cbcmud.com/
TX1010056	CLEAR LAKE CITY WATER AUTHORITY	Community water system	Local government	77058 -2604	85636	64	14	29	1		http://www.clcwa.org/generalinfo.htm#about%20us
TX1010429	CNP UTILITY DISTRICT	Community water system	Local government	77098 -3709	14667	31	4	24	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011845	COE INDUSTRIAL PARK	Community water system	Local government	77362 -0837	84	5	0	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1010116	COLONIAL HILLS	Community water system	Private	78723 -2476	930	10	0	28	4	Aqua Texas	
TX1011806	COLONY M H SUBDIVISION WS	Community water system	Private	77377 -0409	243	8	5	21	4	Quadvest	https://www.quadvest.com/ccrs
TX1010077	CORBELLO WATER SYSTEM	Community water system	Private	77562 -1018	126	9	48	20	3		
TX1013193	CORNERSTONE MOBILE HOME COMMUNITY	Community water system	Private	77375 -3119	95	6	8	20	3		
TX1011692	CORNERSTONE S MUD	Community water system	Local government	77024 -3430	5334	14	0	24	2	Si Environmental	https://www.sienv.com/mymud/
TX1013271	COTTAGE GARDENS	Community water system	Private	77388 -3621	1047	11	64	20	3		
TX1010283	COTTONWOOD PARK WATER SYSTEM	Community water system	Private	77358 -0279	171	8	16	28	3		
TX1013189	COUNTRY CLUB GREENS	Community water system	Private	78723 -2476	405	8	6	20	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx
TX1011501	COUNTRY LIVING APARTMENTS	Community water system	Private	77024 -4105	144	10	88	32	3		

TX1011638	COUNTRY LIVING MOBILE HOME PARK	Community water system	Private	77043 -4312	72	6	84	24	4	Hydro Tech Utilities	http://hydrotechutilities.com/hydrotechutilities.com.p9.hostingprod.com/ customer_links.html
TX1010674	COUNTRY ROAD PARK	Community water system	Private	77024 -4116	150	5	16	24	3		
TX1011260	COUNTRY TERRACE SUBDIVISION	Community water system	Private	77562 -1018	1575	15	135	29	3		
TX1011647	CREEKSIDE ESTATES SOUTH	Community water system	Private	78723 -2476	366	9	0	24	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx
TX1010947	CRICKETT HILL ESTATES	Community water system	Private	78723 -2476	123	6	8	28	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx
TX1010118	CROSBY MUD	Community water system	Local government	77532 -0249	2299	34	60	48	1		http://www.crosbymud.org/
TX1011522	CY CHAMP PUD	Community water system	Local government	77024 -3430	6633	24	4	32	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1010119	CYPRESS BEND SUBDIVISION	Community water system	Private	77383 -1383	684	10	20	21	4	Quadvest	https://www.quadvest.com/ccrs
TX1010354	CYPRESS BROOK ESTATES	Community water system	Private	75501 -8785	81	5	194	20	3		
TX1013296	CYPRESS CREEK RANCH	Community water system	Private	78723 -2476	273	4	0	24	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx
TX1010430	CYPRESS CREEK UTILITY DISTRICT	Community water system	Local government	77019 -2191	3012	15	16	28	2	WET Services	http://www.wetservices.com/clients.html
TX1010629	CYPRESS CROSSING	Community water system	Local government	77362 -0837	126	6	4	29	0	HMW SUD	http://hmw-sud.com/service-area/
TX1011651	CYPRESS FIELDS SUBDIVISION	Community water system	Private	78723 -2476	441	12	96	36	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010919	CYPRESS FOREST PUD	Community water system	Local government	77027 -7537	6387	20	8	32	2	EDP	http://www.edpwater.com/your-district/
TX1010120	CYPRESS FOREST WATER SYSTEM	Community water system	Private	77070 -4013	396	17	16	25	3		
TX1012048	CYPRESS GARDENS MOBILE HOME SUBDIVISION	Community water system	Private	77377 -6308	108	5	136	28	3		
TX1012378	CYPRESS HILL MUD 1	Community water system	Local government	77010 -3095	10068	24	8	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1011792	CYPRESS HILL SUBDIVISION	Community water system	Private	77358 -0279	90	10	24	28	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1010431	CYPRESS KLEIN UTILITY DISTRICT WIMBLETON	Community water system	Local government	77056 -3970	4197	23	20	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html

TX1013341	CYPRESS MEADOWS MHP	Community water system	Private	77340 -2035	51	5	28	16	3		
TX1011552	CYPRESS PASS ESTATES	Community water system	Local government	77362 -0837	123	9	8	25	0	HMW SUD	http://hmw-sud.com/service-area/
TX1010254	CYPRESS PLACE	Community water system	Private	78723 -2476	147	11	0	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey% 209.2.17%20as%20of%201030%20Central.pdf
TX1010603	CYPRESS VILLAGE TRAILER & RV PARK	Community water system	Private	77429 -2305	87	8	32	28	3		
TX1011112	CYPRESSWOOD MHP	Community water system	Private	77254 -1158	96	6	84	24	3		
TX1010432	CYPRESSWOOD UTILITY DISTRICT	Community water system	Local government	77027 -7537	4368	21	8	32	2	EDP	http://www.edpwater.com/your-district/
TX1010686	DEER TRAIL MOBILE HOME PARK	Community water system	Private	77066 -4816	126	5	353	28	3		
TX1010469	DELYNN WATER SYSTEM	Community water system	Private	77521 -9319	78	9	17	28	3		
TX1010927	DOGWOOD TREE WATER SYSTEM	Community water system	Private	77038 -3012	48	6	16	24	3		
TX1010122	DORSETT PLACE	Community water system	Private	78723 -2476	42	8	0	25	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/Interchange/ Documents/45089_1_864515.PDF
TX1010592	DOWDELL PUD	Community water system	Local government	77019 -2191	5022	22	8	28	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1011977	ED LOU MOBILE HOME PARK	Community water system	Private	77484 -6164	108	5	100	20	3		
TX1011268	ED LOU MOBILE HOME PARK 2	Community water system	Private	77041 -2108	78	8	42	13	3		
TX1010459	EL DORADO MOBILE HOME COMMUNITY	Community water system	Private	80109 -7720	747	9	131	28	3		
TX1010471	EL DORADO UTILITY DISTRICT	Community water system	Local government	77046 -0905	4077	19	0	21	2	EDP	http://www.edpwater.com/your-district/
TX1010812	ELIZONDO MOBILE HOME PARK	Community water system	Private	77038 -3331	39	7	22	33	3		
TX1010541	EMERALD FOREST UTILITY DISTRICT	Community water system	Local government	77027 -7537	7326	23	16	28	2	Regional Water	http://www.regionalwater.net/districts/efud.html
TX1010687	ENCANTO REAL UTILITY DISTRICT	Community water system	Local government	77383 -0843	1506	10	16	33	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1010978	ENCHANTED VALLEY ESTATES WSC	Community water system	Local government	77401 -0336	273	11	0	32	2	MOC	http://municipalops.com/districts/
TX1012794	ESTATES OF HOLLY LAKES	Community water system	Local government	77362 -0837	33	7	0	29	1		

TX1013262	ESTATES OF WILLOW CREEK	Community water system	Private	78723-2476	588	10	4	13	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010675	ESTATES WATER CORP	Community water system	Private	77044-6009	45	5	28	24	3		
TX1010706	FAIRVIEW ACRES MOBILE HOME SUBDIVISION	Community water system	Private	77358-0279	150	8	8	36	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1010821	FAIRVIEW GARDENS MHP	Community water system	Private	77041-2127	81	8	38	28	3		
TX1013127	FAIRWAY CROSSING	Community water system	Private	78723-2476	645	8	16	17	4	Aqua Texas	http://www.fairwaycrossing.org/news_details.php?view=article&ref=archive&month=7&year=2015&id=55
TX1010795	FAIRWAY MOBILE HOME VILLAGE	Community water system	Private	77041-5137	60	7	143	36	3		
TX1010340	FALLBROOK UTILITY DISTRICT	Community water system	Local government	77268-0529	6672	22	8	24	2	Water Waste Water Management Services	http://www.wwwmsinc.net/your-district.html
TX1010746	FATIMA FAMILY VILLAGE MHP	Community water system	Private	77037-2528	100	6	84	20	3		
TX1011602	FAULKEY GULLY MUD	Community water system	Local government	77046-0905	8049	25	9	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1011832	FIVE OAKS MOBILE HOME SUBDIVISION	Community water system	Private	77562-1165	741	9	103	33	4	J & S Water Company	http://fospoa.org/contact,five%20oaks,%20fospoa,spring,%20texas,%20home%20owners%20association.html
TX1011252	FOREST HILLS MUD	Community water system	Local government	77057-1762	2268	12	8	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1010264	FOREST MANOR SUBDIVISION	Community water system	Private	77383-1383	288	6	465	29	3		
TX1010435	FOUNTAINHEAD MUD	Community water system	Local government	77006-6512	4908	34	36	32	2	WET Services	http://www.wetservices.com/clients.html
TX1010127	FOUNTAINVIEW SUBDIVISION	Community water system	Private	77056-3820	2703	18	44	24	3		
TX1013088	FOUR SEASONS MHP	Community water system	Private	77532-7274	54	7	0	20	3		
TX1011679	FRY ROAD MUD	Community water system	Local government	77024-3430	3816	15	12	32	2	Inframark	https://www.inframark.com/residents/
TX1011492	GLENWOOD MOBILE HOME SUBDIVISION	Community water system	Private	77358-0279	90	6	4	24	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1011996	GRANT ROAD ESTATES MOBILE HOME SUB	Community water system	Local government	77362-0837	99	7	0	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1011991	GRANT ROAD PUD	Community water system	Local government	77057-1762	2469	21	8	28	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx

TX1010130	GRANTWOOD SUBDIVISION	Community water system	Private	77269 -1885	114	13	61	29	3		
TX1011839	GREEN TRAILS MUD	Community water system	Local government	77056 -3078	2913	16	0	33	2	MOC	http://municipalops.com/districts/
TX1010132	GREENGATE ACRES SUBDIVISION	Community water system	Private	77383 -1383	297	9	112	24	3		
TX1013055	GREENLAND SQUARE SUBDIVISION WS	Community water system	Private	77007 -7724	357	10	12	29	3		
TX1010349	GREENS ROAD MOBILE HOME COMMUNITY	Community water system	Private	77231 -1068	534	10	4	24	3		
TX1010554	GREENWOOD UTILITY DISTRICT	Community water system	Local government	77019 -7120	4335	19	0	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1010011	GREENWOOD VILLAGE	Community water system	Private	78723 -2476	2436	20	155	24	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/ Interchange/Documents/45089_1_864515.PDF
TX1011101	H O E WSC	Community water system	Local government	77362 -1180	378	9	72	17	1		
TX1013011	H2O TECH INC WATER SYSTEM	Community water system	Private	77574 -1133	54	6	209	20	3		
TX1012916	HAMILTON ESTATES WATER SYSTEM	Community water system	Private	75681 -0385	99	5	316	24	3		
TX1010082	HARRIS COUNTY FWSD 1A	Community water system	Local government	77562 -1104	1620	9	309	32	2	MOC	http://municipalops.com/districts/
TX1010590	HARRIS COUNTY FWSD 1B	Community water system	Local government	77562 -4349	672	7	80	24	1		https://hcfwsd1b.org/
TX1010261	HARRIS COUNTY FWSD 27	Community water system	Local government	77522 -0508	2121	8	4	28	1		
TX1010545	HARRIS COUNTY FWSD 45	Community water system	Local government	77060 -1302	543	9	12	28	2	Inframark	https://www.inframark.com/residents/
TX1010260	HARRIS COUNTY FWSD 47	Community water system	Local government	77530 -3210	4500	19	8	24	1		
TX1010238	HARRIS COUNTY FWSD 51	Community water system	Local government	77027 -7537	10401	27	28	20	1		http://fwsd51.com/about.html
TX1010209	HARRIS COUNTY FWSD 58	Community water system	Local government	77532 -0255	1875	21	4	25	2	Inframark	https://www.inframark.com/residents/
TX1010768	HARRIS COUNTY FWSD 6	Community water system	Local government	77530 -4510	1995	19	0	25	1		
TX1010237	HARRIS COUNTY FWSD 61	Community water system	Local government	77019 -2191	17586	46	8	24	1		http://harriscountyfwsd61.org/
TX1013479	HARRIS COUNTY	Community water system	Private	77027 -7537	4074	10	4	4	4	TNG	http://tng-utility.com/where-to-pay-your-water-bill/

	IMPROVEMENT DISTRICT 18										
TX1013205	HARRIS COUNTY LEADERSHIP ACADEMY	Community water system	Local government	77002 -2042	125	8	61	24	1		
TX1010539	HARRIS COUNTY MUD 1	Community water system	Local government	77019 -2191	9822	26	5	29	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010503	HARRIS COUNTY MUD 102	Community water system	Local government	77046 -0905	10212	28	8	24	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011534	HARRIS COUNTY MUD 104	Community water system	Local government	77019 -2191	3921	17	0	32	2	MOC	http://municipalops.com/districts/
TX1011227	HARRIS COUNTY MUD 105	Community water system	Local government	77019 -2191	6885	26	104	24	2	MOC	http://municipalops.com/districts/
TX1013160	HARRIS COUNTY MUD 106	Community water system	Local government	77027 -7537	3813	19	4	17	2	Inframark	https://www.inframark.com/residents/
TX1010620	HARRIS COUNTY MUD 109	Community water system	Local government	77010 -3095	8592	16	20	28	2	Water Waste Water Management Services	http://www.wwwmsinc.net/your-district.html
TX1010426	HARRIS COUNTY MUD 11	Community water system	Local government	77046 -0905	3345	15	16	25	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1010897	HARRIS COUNTY MUD 118	Community water system	Local government	77019 -2191	6684	16	4	29	2	MOC	http://municipalops.com/districts/
TX1010626	HARRIS COUNTY MUD 119	Community water system	Local government	77269 -0406	7089	20	8	20	2	Regional Water	http://www.regionalwater.net/districts/hcmud119.html
TX1010774	HARRIS COUNTY MUD 120	Community water system	Local government	77027 -7537	12414	25	8	24	2	EDP	http://www.edpwater.com/your-district/
TX1012391	HARRIS COUNTY MUD 122	Community water system	Local government	77056 -3018	1227	6	4	29	2	Inframark	https://www.inframark.com/residents/
TX1012229	HARRIS COUNTY MUD 127	Community water system	Local government	77084 -1802	5147	16	20	32	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1012097	HARRIS COUNTY MUD 130	Community water system	Local government	77056 -3970	4302	15	4	28	2	MOC	http://municipalops.com/districts/
TX1010616	HARRIS COUNTY MUD 132	Community water system	Local government	77010 -3095	8463	27	4	32	2	Inframark	https://www.inframark.com/residents/
TX1010599	HARRIS COUNTY MUD 136	Community water system	Local government	77010 -3095	3246	17	12	28	2	MOC	http://municipalops.com/districts/
TX1010923	HARRIS COUNTY MUD 144	Community water system	Local government	77057 -1762	3189	16	8	24	2	MOC	http://municipalops.com/districts/
TX1011243	HARRIS COUNTY MUD 147	Community water system	Local government	77027 -7537	2976	12	4	29	2	Inframark	https://www.inframark.com/residents/
TX1010938	HARRIS COUNTY MUD 148 KINGSLAKE	Community water system	Local government	77401 -4125	4347	14	40	28	2	Water Waste Water Management Services	http://www.wwwmsinc.net/your-district.html

TX1011296	HARRIS COUNTY MUD 149	Community water system	Local government	77056-3078	3675	19	8	28	2	Inframark	https://www.inframark.com/residents/
TX1011250	HARRIS COUNTY MUD 150	Community water system	Local government	77098-3709	8418	29	64	32	2	Si Environmental	https://www.sienv.com/mymud/
TX1010905	HARRIS COUNTY MUD 151	Community water system	Local government	77010-3095	6699	16	4	28	2	Inframark	https://www.inframark.com/residents/
TX1010902	HARRIS COUNTY MUD 152	Community water system	Local government	77010-3093	7353	23	0	28	2	Inframark	https://www.inframark.com/residents/
TX1012133	HARRIS COUNTY MUD 153	Community water system	Local government	77010-3095	8013	16	4	24	2	MOC	http://municipalops.com/districts/
TX1011642	HARRIS COUNTY MUD 154	Community water system	Local government	77010-3093	8535	26	4	28	2	MOC	http://municipalops.com/districts/
TX1012351	HARRIS COUNTY MUD 155	Community water system	Local government	77019-2191	2433	17	36	28	2	Inframark	https://www.inframark.com/residents/
TX1013327	HARRIS COUNTY MUD 156	Community water system	Local government	77027-7597	2115	6	4	20	2	Inframark	https://www.inframark.com/residents/
TX1011430	HARRIS COUNTY MUD 157	Community water system	Local government	77019-2191	10956	36	8	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1012297	HARRIS COUNTY MUD 158	Community water system	Local government	77019-2191	6639	4	8	32	2	MOC	http://municipalops.com/districts/
TX1011705	HARRIS COUNTY MUD 16	Community water system	Local government	77024-3430	6321	22	4	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1011612	HARRIS COUNTY MUD 162	Community water system	Local government	77010-3093	2649	19	16	24	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1012213	HARRIS COUNTY MUD 163	Community water system	Local government	77010-3095	5628	17	8	28	2	Inframark	https://www.inframark.com/residents/
TX1012187	HARRIS COUNTY MUD 165	Community water system	Local government	77027-7537	17763	31	4	28	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1013181	HARRIS COUNTY MUD 166	Community water system	Local government	77056-3078	2658	8	4	21	2	Inframark	https://www.inframark.com/residents/
TX1012842	HARRIS COUNTY MUD 167	Community water system	Local government	77027-7537	10999	25	73	28	2	Water Waste Water Management Services	http://www.wwwmsinc.net/your-district.html
TX1011783	HARRIS COUNTY MUD 168	Community water system	Local government	77479-6609	13008	23	16	21	2	EDP	http://www.edpwater.com/your-district/
TX1012970	HARRIS COUNTY MUD 172	Community water system	Local government	77019-2191	4074	20	8	36	2	H2O Consulting	http://www.hcmud172.com/consultants/
TX1012971	HARRIS COUNTY MUD 173	Community water system	Local government	77019-2191	3852	16	4	21	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011848	HARRIS COUNTY MUD 179	Community water system	Local government	77084-1802	5115	15	8	28	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm

TX1010512	HARRIS COUNTY MUD 18 HEATHERWOOD HUNTERS	Community water system	Local government	77027 -7537	4053	21	24	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1011799	HARRIS COUNTY MUD 180	Community water system	Local government	77383 -0009	4494	16	12	21	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1011824	HARRIS COUNTY MUD 183	Community water system	Local government	77056 -3078	3999	19	8	28	2	Si Environmental	https://www.sienv.com/mymud/
TX1011914	HARRIS COUNTY MUD 185	Community water system	Local government	77019 -2191	4548	13	4	28	2	Inframark	https://www.inframark.com/residents/
TX1012214	HARRIS COUNTY MUD 186	Community water system	Local government	77010 -3093	3951	22	8	28	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1011982	HARRIS COUNTY MUD 188	Community water system	Local government	77027 -7537	9279	14	9	24	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1011809	HARRIS COUNTY MUD 189	Community water system	Local government	77010 -3095	6480	29	92	32	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1012362	HARRIS COUNTY MUD 191	Community water system	Local government	77391 -1890	3057	15	20	24	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013002	HARRIS COUNTY MUD 196	Community water system	Local government	77019 -2191	5964	29	12	29	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1012007	HARRIS COUNTY MUD 200 CRANBROOK	Community water system	Local government	77056 -3078	14697	47	4	36	2	CHCRWA or MOC	https://www.chcrwa.com/member-districts/
TX1012356	HARRIS COUNTY MUD 202	Community water system	Local government	77019 -2191	2652	13	8	29	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1012704	HARRIS COUNTY MUD 205	Community water system	Local government	77056 -3078	1509	4	0	32	2	MOC	https://www.chcrwa.com/member-districts/
TX1012419	HARRIS COUNTY MUD 208	Community water system	Local government	77010 -3095	3642	15	12	28	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1012145	HARRIS COUNTY MUD 211	Community water system	Local government	77098 -3709	363	6	4	25	2	EDP	http://www.edpwater.com/your-district/
TX1012812	HARRIS COUNTY MUD 215	Community water system	Local government	77056 -3078	2562	10	4	32	2	MOC	https://www.chcrwa.com/member-districts/
TX1012577	HARRIS COUNTY MUD 216	Community water system	Local government	77019 -2191	1278	11	8	20	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1011983	HARRIS COUNTY MUD 217	Community water system	Local government	77268 -0529	2529	16	28	28	2	Water Waste Water Management Services	http://www.wwwmsinc.net/your-district.html
TX1013321	HARRIS COUNTY MUD 220	Community water system	Local government	77019 -2191	1698	7	0	16	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1012972	HARRIS COUNTY MUD 221	Community water system	Local government	77449 -1964	4839	14	0	25	2	Inframark	https://www.inframark.com/residents/

TX1013054	HARRIS COUNTY MUD 222	Community water system	Local government	77040 -6091	5934	13	0	28	2	MOC	http://municipalops.com/districts/
TX1010649	HARRIS COUNTY MUD 23	Community water system	Local government	77006 -6512	3546	19	100	21	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1012740	HARRIS COUNTY MUD 230	Community water system	Local government	77027 -7537	6498	14	8	25	2	Regional Water	http://www.regionalwater.net/districts/hcmud119.html
TX1012498	HARRIS COUNTY MUD 233	Community water system	Local government	77098 -3709	297	11	16	25	2	EDP	http://www.edpwater.com/your-district/
TX1012361	HARRIS COUNTY MUD 238	Community water system	Local government	77056 -6145	7152	19	8	29	2	Gulf Utility Service	http://www.gulfutility.net/hcmud238/
TX1012392	HARRIS COUNTY MUD 239	Community water system	Local government	77056 -3078	5550	16	16	32	2	H2O Consulting	http://www.h2oconsulting.net/h2oclients.htm
TX1010572	HARRIS COUNTY MUD 24	Community water system	Local government	77401 -4107	10263	34	18	33	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013306	HARRIS COUNTY MUD 248	Community water system	Local government	77019 -2191	2076	10	4	21	0	Harris County FWSD #61	http://harriscountyfwsd61.org/h-c-mud-248-did-you-know/
TX1013135	HARRIS COUNTY MUD 249	Community water system	Local government	77056 -3078	2685	13	12	28	2	EDP	http://www.edpwater.com/your-district/
TX1010422	HARRIS COUNTY MUD 25 BROOK HOLLOW WEST S	Community water system	Local government	77024 -3430	975	16	116	29	1		
TX1012350	HARRIS COUNTY MUD 250	Community water system	Local government	77057 -1762	849	11	6	24	2	MOC	http://municipalops.com/districts/
TX1012766	HARRIS COUNTY MUD 255	Community water system	Local government	77019 -2191	1185	5	20	29	2	Regional Water	http://www.regionalwater.net/districts/hcmud255.html
TX1012985	HARRIS COUNTY MUD 257	Community water system	Local government	77056 -3078	2202	14	13	28	2	Si Environmental	https://www.sienv.com/mymud/
TX1010715	HARRIS COUNTY MUD 26	Community water system	Local government	77056 -3078	14007	30	20	28	2	MOC	http://municipalops.com/districts/
TX1012866	HARRIS COUNTY MUD 261	Community water system	Local government	77019 -2191	1452	8	12	24	2	TOPS Water	http://topswater.com/district-served/
TX1012330	HARRIS COUNTY MUD 264	Community water system	Local government	77027 -7537	3765	18	12	32	2	Inframark	https://www.inframark.com/residents/
TX1012942	HARRIS COUNTY MUD 276	Community water system	Local government	77056 -3078	4902	15	0	21	2	Inframark	https://www.inframark.com/residents/
TX1012835	HARRIS COUNTY MUD 278	Community water system	Local government	77027 -7537	7500	21	16	32	2	Si Environmental	https://www.sienv.com/mymud/
TX1013063	HARRIS COUNTY MUD 280	Community water system	Local government	77383 -0579	3042	6	0	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013178	HARRIS COUNTY MUD 281	Community water system	Local government	77056 -3078	3609	26	0	20	2	Water District Management Co	http://www.wdmtexas.com/districts-served/

TX1013375	HARRIS COUNTY MUD 282	Community water system	Local government	77383-0579	2616	5	8	16	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013114	HARRIS COUNTY MUD 284	Community water system	Local government	77056-3078	3213	13	8	17	2	Si Environmental	https://www.sienv.com/mymud/
TX1012677	HARRIS COUNTY MUD 285	Community water system	Local government	77027-7537	9876	19	6	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1012532	HARRIS COUNTY MUD 286	Community water system	Local government	77098-3709	7523	16	20	33	2	EDP	http://www.edpwater.com/your-district/
TX1013385	HARRIS COUNTY MUD 287	Community water system	Local government	77027-7537	2604	4	0	8	2	EDP	http://www.edpwater.com/your-district/
TX1013294	HARRIS COUNTY MUD 290	Community water system	Local government	77027-7537	8115	5	0	9	2	MOC	http://municipalops.com/districts/
TX1012941	HARRIS COUNTY MUD 304	Community water system	Local government	77056-3078	4158	14	46	28	2	Je Pa Services	http://www.jepaservices.net/pay-my-bill/
TX1012804	HARRIS COUNTY MUD 316	Community water system	Local government	77391-1750	951	4	0	36	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1012913	HARRIS COUNTY MUD 321	Community water system	Local government	77027-7537	867	7	40	8	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1012542	HARRIS COUNTY MUD 322 FAIRFIELD VILLAGE	Community water system	Local government	77010-3095	3549	4	0	28	2	Inframark	https://www.inframark.com/residents/
TX1011162	HARRIS COUNTY MUD 33	Community water system	Local government	77019-7120	5178	19	28	28	2	Je Pa Services	http://www.jepaservices.net/pay-my-bill/
TX1012917	HARRIS COUNTY MUD 341	Community water system	Local government	77056-3078	2469	16	12	29	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1012973	HARRIS COUNTY MUD 342	Community water system	Local government	77056-3078	3801	4	4	32	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1012974	HARRIS COUNTY MUD 344	Community water system	Local government	77056-3078	3123	15	0	32	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1012768	HARRIS COUNTY MUD 345	Community water system	Local government	77056-3018	3999	14	0	28	2	Inframark	https://www.inframark.com/residents/
TX1012965	HARRIS COUNTY MUD 354	Community water system	Local government	77010-3031	6939	4	36	28	2	Inframark	https://www.inframark.com/residents/
TX1012000	HARRIS COUNTY MUD 36	Community water system	Local government	77056-3078	1422	13	0	25	2	MOC	http://municipalops.com/districts/
TX1012897	HARRIS COUNTY MUD 360	Community water system	Local government	77056	4314	16	0	32	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1013123	HARRIS COUNTY MUD 361	Community water system	Local government	77027-7537	3486	5	4	24	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1013132	HARRIS COUNTY MUD 364	Community water system	Local government	77019-7120	6234	17	40	24	2	MOC	http://municipalops.com/districts/

TX1013009	HARRIS COUNTY MUD 365	Community water system	Local government	77027 -7537	4449	27	4	32	2	Si Environmental	https://www.sienv.com/mymud/
TX1013040	HARRIS COUNTY MUD 367	Community water system	Local government	77027 -7537	6759	16	32	28	2	MOC	http://municipalops.com/districts/
TX1011908	HARRIS COUNTY MUD 368	Community water system	Local government	77019 -7100	9906	30	12	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1013113	HARRIS COUNTY MUD 370	Community water system	Local government	77056 -3078	4617	15	8	25	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1013107	HARRIS COUNTY MUD 371	Community water system	Local government	77019 -2191	2655	15	4	24	2	Inframark	https://www.inframark.com/residents/
TX1013141	HARRIS COUNTY MUD 372	Community water system	Local government	77027 -7537	2427	10	0	28	2	Inframark	https://www.inframark.com/residents/
TX1013450	HARRIS COUNTY MUD 374 CYPRESS CREEK LAKE	Community water system	Local government	77027 -7537	4410	7	4	12	2	Inframark	https://www.inframark.com/residents/
TX1013213	HARRIS COUNTY MUD 383	Community water system	Local government	77027 -7537	4062	25	36	21	2	MOC	http://municipalops.com/districts/
TX1013360	HARRIS COUNTY MUD 387	Community water system	Local government	77410 -1827	3	31	20	12	1		
TX1013265	HARRIS COUNTY MUD 389	Community water system	Local government	77056 -3078	2562	12	40	20	2	Gulf Utility Services	http://www.gulfutility.net/hc-mud-389/
TX1013253	HARRIS COUNTY MUD 391	Community water system	Local government	77027 -7537	7848	26	20	21	2	Inframark	https://www.inframark.com/residents/
TX1013338	HARRIS COUNTY MUD 396	Community water system	Local government	77010 -3093	3060	4	0	16	2	Inframark	https://www.inframark.com/residents/
TX1013295	HARRIS COUNTY MUD 397	Community water system	Local government	77010 -3095	3960	4	0	16	2	Inframark	https://www.inframark.com/residents/
TX1013346	HARRIS COUNTY MUD 399	Community water system	Local government	77056 -3078	1737	4	0	20	2	MOC	https://www.chcrwa.com/member-districts/
TX1013310	HARRIS COUNTY MUD 400 - WEST	Community water system	Local government	77056 -3078	4029	12	8	21	2	EDP	http://www.edpwater.com/your-district/
TX1013289	HARRIS COUNTY MUD 401	Community water system	Local government	77056 -3078	2103	11	0	12	2	MOC	http://municipalops.com/districts/
TX1013362	HARRIS COUNTY MUD 405	Community water system	Local government	77019 -7120	753	9	12	16	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013354	HARRIS COUNTY MUD 412	Community water system	Local government	77027 -7537	3642	15	14	12	2	USW Utility Group?	http://www.lakeshoretx.org/info.php?pnum=3
TX1013329	HARRIS COUNTY MUD 418	Community water system	Local government	77056 -3078	0	16	8	13	x		
TX1013335	HARRIS COUNTY MUD 419	Community water system	Local government	77056 -3078	7389	4	0	9	2	Inframark	https://www.inframark.com/residents/

TX1013399	HARRIS COUNTY MUD 420	Community water system	Local government	77027-7537	1530	12	0	12	2	Inframark	https://www.inframark.com/residents/
TX1013376	HARRIS COUNTY MUD 421	Community water system	Local government	77019-2115	177	11	0	9	2	Inframark	https://www.inframark.com/residents/
TX1010565	HARRIS COUNTY MUD 43	Community water system	Local government	77002-2929	5211	15	16	32	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1013378	HARRIS COUNTY MUD 432	Community water system	Local government	77024-3430	1773	11	0	12	2	MOC	http://municipalops.com/districts/
TX1013350	HARRIS COUNTY MUD 433	Community water system	Local government	77010-3095	3093	16	4	16	2	Inframark	https://www.inframark.com/residents/
TX1013373	HARRIS COUNTY MUD 434	Community water system	Local government	77056-3078	699	8	0	4	2	Inframark	https://www.inframark.com/residents/
TX1010718	HARRIS COUNTY MUD 44	Community water system	Local government	77056-3970	2304	15	16	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013372	HARRIS COUNTY MUD 449	Community water system	Local government	77027-7537	105	10	4	4	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1010903	HARRIS COUNTY MUD 46	Community water system	Local government	77046-0905	4815	14	12	24	2	Je Pa Services	http://www.jepaservices.net/pay-my-bill/
TX1013369	HARRIS COUNTY MUD 468	Community water system	Local government	77027-7537	2175	14	8	12	2	Inframark	https://www.inframark.com/residents/
TX1010896	HARRIS COUNTY MUD 48	Community water system	Local government	77019-7120	456	6	4	24	2	MOC	http://municipalops.com/districts/
TX1013400	HARRIS COUNTY MUD 480	Community water system	Local government	77027-7537	900	12	4	12	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1011462	HARRIS COUNTY MUD 49	Community water system	Local government	77019-2191	6921	18	22	21	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1013511	HARRIS COUNTY MUD 494	Community water system	Local government	77056-3078	420	3	0	4	2	MOC	http://municipalops.com/districts/
TX1013532	HARRIS COUNTY MUD 495	Community water system	Local government	77027-7537	426	9	0	4	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1010500	HARRIS COUNTY MUD 5	Community water system	Local government	77098-3709	5687	24	4	21	2	Inframark	https://www.inframark.com/residents/
TX1010719	HARRIS COUNTY MUD 50	Community water system	Local government	77019-7120	4173	22	69	32	2	MOC	http://municipalops.com/districts/
TX1013390	HARRIS COUNTY MUD 500	Community water system	Local government	77027-7537	1098	11	12	8	2	EDP	http://www.edpwater.com/your-district/
TX1013403	HARRIS COUNTY MUD 501	Community water system	Local government	77027-7537	2565	6	4	8	2	EDP	http://www.edpwater.com/your-district/
TX1013494	HARRIS COUNTY MUD 502	Community water system	Local government	77019-2191	45	3	0	0	2	EDP	http://www.edpwater.com/your-district/

TX1013522	HARRIS COUNTY MUD 504	Community water system	Local government	77027 -7537	594	3	0	4	1		
TX1010720	HARRIS COUNTY MUD 53	Community water system	Local government	77229 -4338	16164	27	16	32	1		http://mud53.com/about.html
TX1013530	HARRIS COUNTY MUD 530	Community water system	Local government	77027 -7537	33	9	0	0	2	EDP	http://www.edpwater.com/your-district/
TX1013586	HARRIS COUNTY MUD 537	Community water system	Local government	77056 -3970	96	3	0	4	2	Gulf Utility Services	http://www.gulfutility.net/hc-mud-537/
TX1010678	HARRIS COUNTY MUD 55 HERITAGE PARK	Community water system	Local government	77010 -3095	15671	21	24	32	2	Si Environmental	https://www.sienv.com/mymud/
TX1011704	HARRIS COUNTY MUD 58	Community water system	Local government	77024 -3430	1800	15	112	36	2	MOC	http://municipalops.com/districts/
TX1010496	HARRIS COUNTY MUD 6 CARRIAGE LANE	Community water system	Local government	77027 -7537	3819	16	16	32	2	EDP	http://www.edpwater.com/your-district/
TX1010721	HARRIS COUNTY MUD 61	Community water system	Local government	77098 -3709	1914	15	28	33	2	MOC	http://municipalops.com/districts/
TX1012285	HARRIS COUNTY MUD 62	Community water system	Local government	77057 -1762	1395	4	0	29	2	MOC	http://municipalops.com/districts/
TX1011513	HARRIS COUNTY MUD 64	Community water system	Local government	77019 -2191	6174	12	8	28	2	MOC	http://municipalops.com/districts/
TX1011678	HARRIS COUNTY MUD 65	Community water system	Local government	77024 -3430	4005	15	0	33	2	MOC	http://municipalops.com/districts/
TX1010600	HARRIS COUNTY MUD 69	Community water system	Local government	77057 -1762	4443	12	4	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011690	HARRIS COUNTY MUD 70	Community water system	Local government	77056 -3078	5763	20	20	33	2	Inframark or MOC	https://www.inframark.com/residents/
TX1011823	HARRIS COUNTY MUD 71	Community water system	Local government	77027 -7537	11439	27	4	24	2	Regional Water	http://www.regionalwater.net/districts/hcmud071.html
TX1010712	HARRIS COUNTY MUD 8	Community water system	Local government	77024 -3430	6066	4	12	28	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1010581	HARRIS COUNTY MUD 81	Community water system	Local government	77027 -7537	11121	34	8	24	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1010630	HARRIS COUNTY MUD 82	Community water system	Local government	77383 -2749	9714	33	32	28	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1012953	HARRIS COUNTY MUD 86	Community water system	Local government	77057 -1762	5373	13	0	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1013343	HARRIS COUNTY MUD 96	Community water system	Local government	77056 -3078	5793	12	0	17	2	MOC	http://municipalops.com/districts/
TX1011781	HARRIS COUNTY UD 14	Community water system	Local government	77010 -3095	2361	15	4	25	2	Regional Water	http://www.regionalwater.net/districts/hcud14.html

TX1011778	HARRIS COUNTY UD 15	Community water system	Local government	77401 -4111	3513	5	0	25	2	MOC	http://municipalops.com/districts/
TX1013156	HARRIS COUNTY UD 16	Community water system	Local government	77098 -3709	4472	14	20	20	2	Inframark	https://www.inframark.com/residents/
TX1010501	HARRIS COUNTY UTILITY DISTRICT 6	Community water system	Local government	77027 -7537	7410	15	12	32	2	Inframark	https://www.inframark.com/residents/
TX1010159	HARRIS COUNTY WCID 1	Community water system	Local government	77562 -3760	7311	16	4	24	1		http://www.hcwcid1.com/
TX1010359	HARRIS COUNTY WCID 109	Community water system	Local government	77056 -3078	6477	30	24	32	2	EDP	http://www.edpwater.com/your-district/
TX1010482	HARRIS COUNTY WCID 110	Community water system	Local government	77056 -3808	8439	25	12	28	2	EDP	http://www.edpwater.com/your-district/
TX1010274	HARRIS COUNTY WCID 113 ENCHANTED VILLAGE	Community water system	Local government	77019 -2191	1212	12	0	36	2	MOC	http://municipalops.com/districts/
TX1010317	HARRIS COUNTY WCID 114	Community water system	Local government	77024 -3430	5427	31	8	29	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1010507	HARRIS COUNTY WCID 116	Community water system	Local government	77019 -7120	3705	18	24	28	2	TOPS Water	http://topswater.com/district-served/
TX1010509	HARRIS COUNTY WCID 119	Community water system	Local government	77098 -3709	8901	32	12	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1010413	HARRIS COUNTY WCID 132	Community water system	Local government	77056 -3970	4008	16	4	32	2	EDP	http://www.edpwater.com/your-district/
TX1010210	HARRIS COUNTY WCID 133	Community water system	Local government	77401 -4103	5013	16	4	24	2	MOC	http://municipalops.com/districts/
TX1010355	HARRIS COUNTY WCID 136	Community water system	Local government	77019 -7120	3048	12	32	29	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013147	HARRIS COUNTY WCID 156	Community water system	Local government	77058 -2604	1137	5	8	25	1		http://www.clcwa.org/156.html
TX1010769	HARRIS COUNTY WCID 21	Community water system	Local government	77530 -3702	7428	25	16	28	1		
TX1010239	HARRIS COUNTY WCID 36	Community water system	Local government	77015 -4649	11065	38	8	29	1		http://harriscountywcid36.com/consultants.htm
TX1010241	HARRIS COUNTY WCID 50 EL LAGO	Community water system	Local government	77586 -6004	3850	21	8	24	1		http://www.wcid50.com/index.html
TX1010244	HARRIS COUNTY WCID 70	Community water system	Local government	77019 -2191	1947	16	20	28	1		http://www.wcid70.com/home.html
TX1010480	HARRIS COUNTY WCID 74	Community water system	Local government	77039 -3722	5886	18	8	28	2	MOC	http://municipalops.com/districts/harris-county-wcid-74/
TX1010113	HARRIS COUNTY WCID 84	Community water system	Local government	77010 -3095	3606	14	0	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/

TX1012370	HARRIS COUNTY WCID 89	Community water system	Local government	77471 -5654	7773	22	36	20	2	Si Environmental	https://www.sienv.com/mymud/
TX1010063	HARRIS COUNTY WCID 91	Community water system	Local government	77024 -3430	3018	14	0	28	2	MOC	http://municipalops.com/districts/
TX1010124	HARRIS COUNTY WCID 92	Community water system	Local government	77383 -0666	4737	15	12	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013175	HARRIS COUNTY WCID 96	Community water system	Local government	77056 -3970	8430	15	5	20	2	Si Environmental	https://www.sienv.com/mymud/
TX1010684	HARRIS COUNTY WCID 99	Community water system	Local government	77019 -7100	1506	13	8	24	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1010249	HARRIS COUNTY WCID FONDREN ROAD	Community water system	Local government	77056 -3970	3078	20	8	24	2	Quail Valley Utility District	https://www.quailvalleyud.org/harris-co-wcid-fondren-road/#
TX1013305	HARRIS MONTGOMERY COUNTIES MUD 386	Community water system	Local government	77056 -3078	10659	4	0	16	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1013365	HARRIS-FORT BEND COUNTIES MUD3	Community water system	Local government	77056 -3078	4227	12	8	12	2	Inframark or EDP?	https://www.inframark.com/residents/
TX1011302	HEATHERGATE ESTATES	Community water system	Private	77383 -1383	318	5	20	20	3		
TX1010548	HEATHERLOCH MUD	Community water system	Local government	77046 -0905	6612	18	41	32	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013582	HEAVENS MOBILE HOME PARK	Community water system	Private	77039 -5341	60	4	482	4	3		
TX1012003	HERMANN OAKS MOBILE HOME VILLAGE	Community water system	Private	97206 -6267	135	8	158	28	3		
TX1013089	HERON LAKES ESTATES	Community water system	Private	78723 -2476	2658	18	4	20	4	Aqua Texas	https://www.aquaamerica.com/ customer-service-center/water-quality.aspx
TX1010012	HIDDEN VALLEY SUBDIVISION	Community water system	Private	77076 -4908	3888	13	16	24	3		
TX1010285	HIGHLAND MOBILE HOME SUBDIVISION	Community water system	Private	77383 -1383	66	5	160	24	3		
TX1010157	HIGHLAND RIDGE SUBDIVISION	Community water system	Private	77383 -1383	579	10	20	20	3		
TX1011734	HOMESTEAD OAKS MOBILE HOME COMM	Community water system	Private	77358 -0279	81	9	16	28	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1011713	HOOKS MOBILE HOME PARK	Community water system	Private	77255 -5669	585	10	80	24	3		
TX1011785	HORSEPEN BAYOU MUD	Community water system	Local government	77027 -7537	6615	28	0	21	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1012904	HOUSE CORRAL STREET WATER SYSTEM	Community water system	Local government	77362 -0837	33	5	12	24	0	HMW SUD	http://hmw-sud.com/service-area/

TX1010700	HUFFMAN HEIGHTS SUBDIVISION	Community water system	Private	77383 -1383	333	11	52	20	3		
TX1013198	HUFFMAN HOLLOW APARTMENTS	Community water system	Private	77357 -0489	228	8	31	20	3		
TX1013191	HUNTER PLACE	Community water system	Private	77040 -1004	561	9	8	24	3		
TX1010615	HUNTERS GLEN MUD	Community water system	Local government	77019 -7120	8352	22	0	29	2	MOC	http://municipalops.com/districts/
TX1013159	HUNTERS VILLAGE SUBDIVISION	Community water system	Private	78723 -2476	90	5	16	16	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey% 209.2.17%20as%20of%201030%20Central.pdf
TX1013180	HYDIES CROSSING	Community water system	Private	77305 -2927	54	8	24	25	4	T & W Water Service	https://www.twwaterservice.com/water-quality-reports
TX1013153	IMPERIAL VALLEY MHC	Community water system	Private	78723 -2476	450	9	0	16	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey% 209.2.17%20as%20of%201030%20Central.pdf
TX1012264	INTERSTATE MUD	Community water system	Local government	77027 -7537	5778	15	8	29	2	Inframark	https://www.inframark.com/residents/
TX1010172	INVERNESS FOREST IMPROVEMENT DISTRICT	Community water system	Local government	77019 -7120	2196	14	18	36	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011684	J & L TERRY LANE	Community water system	Private	77520 -2526	48	6	690	24	3		
TX1010538	JACKRABBIT ROAD PUD	Community water system	Local government	77056 -3078	8406	44	24	24	2	Inframark	https://www.inframark.com/residents/
TX1012868	K ESTATES WATER SYSTEM	Community water system	Private	77044 -6009	40	9	56	20	3		
TX1012710	K LAKE TERRACE	Community water system	Private	77044 -6009	54	10	116	24	3		
TX1010163	KENWOOD SUBDIVISION WATER SYSTEM	Community water system	Private	78723 -2476	156	9	0	28	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/Interchange/ Documents/45089_1_864515.PDF
TX1011766	KICKAPOO FARMS SUBDIVISION	Community water system	Local government	77362 -0837	153	9	0	25	0	HMW SUD	http://hmw-sud.com/service-area/
TX1012892	KINGMONT MOBILE HOME PARK	Community water system	Private	77088 -3241	420	10	24	21	3		
TX1012865	KINGS MANOR MUD	Community water system	Local government	77057 -1799	4398	14	0	25	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011567	KINGSLAND ESTATES WSC	Community water system	Local government	77413 -0085	36	5	125	24	1		
TX1010439	KIRKMONT MUD	Community water system	Local government	77056 -3970	2283	13	4	32	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011536	KITZWOOD SUBDIVISION	Community water system	Private	78723 -2476	90	6	4	24	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx

TX1011143	KLEIN PUD	Community water system	Local government	77019-7120	3495	16	8	24	2	EDP	http://www.edpwater.com/your-district/
TX1010440	KLEINWOOD MUD	Community water system	Local government	77046-0905	2652	27	4	33	2	EDP	http://www.edpwater.com/your-district/
TX1010648	LA CASITA HOMES II	Community water system	Private	77036-4074	75	6	80	32	4	Gulf Utility Services	https://static1.squarespace.com/static/54d3c669e4b03a40912dafd5/t/594d2de02cba5e2de12cd7c4/1498230240697/La+Casita_CCR_TX1010648+-+2017.pdf
TX1010494	LAKE FOREST UTILITY DISTRICT	Community water system	Local government	77019-2191	6291	24	76	24	2	EDP	http://www.edpwater.com/your-district/
TX1010737	LAKE HOUSTON STORAGE	Community water system	Private	77255-5528	294	13	88	24	3		
TX1011741	LAKE MUD	Community water system	Local government	77057-1762	5421	4	12	28	2	TOPS Water	http://topswater.com/district-served/
TX1013288	LAKES OF FAIRHAVEN	Community water system	Private	77377-0409	1401	15	8	17	3		
TX1013050	LAKES OF ROSEHILL WATER SYSTEM	Community water system	Private	78723-2476	1242	21	40	32	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx
TX1011249	LANGHAM CREEK UTILITY DISTRICT	Community water system	Local government	77056-3078	10377	41	22	32	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1012976	LATERNA VILLA MHP	Community water system	Private	22033-1340	285	8	201	25	3		
TX1013249	LAZY ACRES MOBILE HOME PARK	Community water system	Private	77521-7633	72	5	507	24	3		
TX1013111	LINCOLN SQUARE SUBDIVISION PWS	Community water system	Private	77007-7724	207	6	48	16	3		
TX1010663	LONE WILLOW MHP WEST	Community water system	Private	77336-4656	90	7	98	20	3		
TX1010664	LONE WILLOW MOBILE HOME PARK	Community water system	Private	77354-3143	80	6	4	28	3		
TX1010587	LONGHORN MOBILE HOME COMMUNITY	Community water system	Private	95150-7231	330	6	205	32	3		
TX1012408	LONGHORN TOWN UTILITY DISTRICT	Community water system	Local government	77056-3078	1773	13	4	24	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010514	LORI HEIGHTS MOBILE HOME SUBDIVISION	Community water system	Private	77532-1186	111	8	96	24	3		
TX1011870	LOUETTA NORTH PUD	Community water system	Local government	77057-1762	4785	14	0	28	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1010536	LOUETTA ROAD UTILITY DISTRICT	Community water system	Local government	77057-1762	1389	13	12	29	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/

TX1010378	LUCE BAYOU PUD	Community water system	Local government	77046-0307	738	13	0	28	2	Inframark	https://www.inframark.com/residents/
TX1013263	M B MOBILE HOME PARK	Community water system	Private	77530-0160	63	7	36	20	3		
TX1010517	MADING LANE WATER SYSTEM	Community water system	Private	77039-4121	168	11	0	24	3		
TX1010495	MALCOMSON ROAD UTILITY DISTRICT	Community water system	Local government	77024-3430	7245	26	16	25	2	EDP	http://www.edpwater.com/your-district/
TX1011493	MAPLE LEAF MOBILE HOME SUBDIVISION	Community water system	Private	77562-1165	705	8	127	32	3		
TX1010478	MAREK ROAD WATER SYSTEM	Community water system	Private	77038-3012	246	9	18	28	3		
TX1011510	MARKS GLEN SUBDIVISION	Community water system	Private	78723-2476	258	10	36	24	4	Aqua Texas	https://www.aquaamerica.com/customer-service-center/water-quality.aspx
TX1010100	MARY FRANCIS SUBDIVISION	Community water system	Private	78723-2476	1659	16	112	28	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/Interchange/Documents/45089_1_864515.PDF
TX1010379	MASON CREEK UTILITY DISTRICT	Community water system	Local government	77450-2022	8900	43	93	24	1		http://www.mcud.com/services-water.php
TX1011689	MAYDE CREEK MUD	Community water system	Local government	77027-7537	5079	17	28	28	2	EDP	http://www.edpwater.com/your-district/
TX1012982	MCFARLAND VILLAGE APARTMENTS	Community water system	Private	77060-5438	120	5	12	28	3		
TX1012995	MCGEE PLACE	Community water system	Private	77358-0279	99	5	28	28	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1010387	MEADOWHILL REGIONAL MUD	Community water system	Local government	77019-7100	7473	38	36	31	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1010287	MEADOWLAKE ESTATES	Community water system	Private	77383-1383	609	9	44	20	3		
TX1010743	MELROSE MOBILE HOME PARK	Community water system	Private	90505-1317	180	8	16	25	3		
TX1010279	MEMORIAL HILLS UTILITY DISTRICT	Community water system	Local government	77019-2191	1428	15	0	29	2	EDP	http://www.edpwater.com/your-district/
TX1011242	MEMORIAL MUD	Community water system	Local government	77479-6609	5589	21	6	28	2	Si Environmental	https://www.sienv.com/mymud/
TX1010148	MEMORIAL VILLAGES WATER AUTHORITY	Community water system	Local government	77024-2903	11427	37	32	32	1		http://mvwa.org/mvwa/about-mvwa/
TX1013245	MESQUITE MHP	Community water system	Private	77479-3121	60	7	16	16	3		
TX1012166	MILLER MHP	Community water system	Private	77479-3121	90	16	24	12	3		

TX1011107	MILLS ROAD MUD	Community water system	Local government	77046-0905	4872	24	0	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1011718	MISSION BEND MUD 1	Community water system	Local government	77027-7537	6204	26	12	24	2	Si Environmental	https://www.sienv.com/mymud/
TX1011826	MISSION BEND MUD 2	Community water system	Local government	77027-7597	7983	26	36	32	2	Si Environmental	https://www.sienv.com/mymud/
TX1010288	MOBILE HOME ESTATES	Community water system	Private	78723-2476	543	11	0	29	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011685	MORTON ROAD MUD	Community water system	Local government	77056-3078	2823	19	140	28	2	Inframark	https://www.inframark.com/residents/
TX1010728	MOUNT HOUSTON ROAD MUD	Community water system	Local government	77383-0009	4374	20	28	24	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1011957	MOUNT HOUSTON SQUARE	Community water system	Private	77025-1100	93	10	8	24	3		
TX1010362	NEWPORT MUD	Community water system	Local government	77019-2191	10374	29	296	60	2	Professional Utility Services	http://www.professionalutilityservices.com/
TX1010145	NITSCH & SON UTILITY	Community water system	Private	77037-3927	2142	11	4	24	3		
TX1011999	NORTH BELT FOREST SUBDIVISION WATER SYST	Community water system	Private	77039-4121	897	12	4	29	3		
TX1011737	NORTH BELT UTILITY DISTRICT	Community water system	Local government	77019-2191	2493	21	13	28	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1013092	NORTH CHANNEL WATER AUTHORITY	Community water system	Local government	77027-7537	0	4	68	29	x		
TX1010298	NORTH FOREST MUD	Community water system	Local government	77024-3430	1545	13	31	28	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010331	NORTH GREEN MUD	Community water system	Local government	77010-3095	4941	15	8	24	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013298	NORTH HARRIS COUNTY REGIONAL WATER AUTHO	Community water system	Local government	77019-7120	0	60	32	16	x		
TX1010745	NORTH PARK PUD	Community water system	Local government	77019-2191	7389	18	4	20	2	MOC	http://municipalops.com/districts/
TX1010140	NORTH PINES MHP	Community water system	Private	77040-3623	364	5	104	24	3		
TX1010832	NORTH POINT VILLA	Community water system	Private	77388-4623	121	13	80	24	3		
TX1010915	NORTH WOODS ESTATES	Community water system	Private	78723-2476	102	5	0	24	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf

TX1010337	NORTHAMPTON MUD	Community water system	Local government	77057 -1762	7401	26	4	28	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013449	NORTHEAST HARRIS COUNTY MUD 1 EDGEWOOD V	Community water system	Local government	77027 -7537	405	4	12	9	2	MOC	http://municipalops.com/districts/
TX1013448	NORTHEAST HARRIS COUNTY MUD 1 SHELDON RI	Community water system	Local government	77027 -7537	568	5	8	9	2	MOC	http://municipalops.com/districts/
TX1013077	NORTHGATE CROSSING MUD 1	Community water system	Local government	77056 -3970	3066	10	0	29	2	Inframark	https://www.inframark.com/residents/
TX1013078	NORTHGATE CROSSING MUD 2	Community water system	Local government	77046 -3653	3690	10	17	33	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011256	NORTHWEST FREEWAY MUD	Community water system	Local government	77056 -3078	3558	26	4	24	2	Regional Water	http://www.regionalwater.net/districts/nwfmud.html
TX1011649	NORTHWEST HARRIS COUNTY MUD 10	Community water system	Local government	77019 -2191	6450	33	36	25	2	EDP	http://www.edpwater.com/your-district/
TX1011901	NORTHWEST HARRIS COUNTY MUD 12	Community water system	Local government	77019 -2191	2292	13	12	24	2	MOC	http://municipalops.com/districts/
TX1011600	NORTHWEST HARRIS COUNTY MUD 15	Community water system	Local government	77383 -0579	6132	31	12	36	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1011603	NORTHWEST HARRIS COUNTY MUD 16	Community water system	Local government	77019 -7100	2742	21	33	25	2	Je Pa Services	http://www.jepaservices.net/pay-my-bill/
TX1011927	NORTHWEST HARRIS COUNTY MUD 19	Community water system	Local government	77024 -3430	2973	19	28	29	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011998	NORTHWEST HARRIS COUNTY MUD 20	Community water system	Local government	77024 -3430	3402	16	8	33	2	EDP	http://www.edpwater.com/your-district/
TX1011744	NORTHWEST HARRIS COUNTY MUD 21	Community water system	Local government	77046 -0307	1638	19	4	32	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011745	NORTHWEST HARRIS COUNTY MUD 22	Community water system	Local government	77027 -9031	3138	6	0	32	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011746	NORTHWEST HARRIS COUNTY MUD 23	Community water system	Local government	77401 -4111	3528	14	16	34	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1012071	NORTHWEST HARRIS COUNTY MUD 24	Community water system	Local government	77056 -6145	1200	14	10	24	2	MOC	http://municipalops.com/districts/
TX1013258	NORTHWEST HARRIS COUNTY MUD 28	Community water system	Local government	77046 -0307	1611	10	44	21	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1012293	NORTHWEST HARRIS COUNTY MUD 29	Community water system	Local government	77046 -0307	3000	14	32	24	2	EDP	http://www.edpwater.com/your-district/
TX1012951	NORTHWEST HARRIS COUNTY MUD 30	Community water system	Local government	77057 -1762	3225	14	0	28	2	MOC	http://municipalops.com/districts/

TX1013034	NORTHWEST HARRIS COUNTY MUD 32	Community water system	Local government	77056 -3078	3909	19	0	24	2	EDP	http://www.edpwater.com/your-district/
TX1012848	NORTHWEST HARRIS COUNTY MUD 36	Community water system	Local government	77388 -4507	2163	26	28	24	2	Eagle Water Management	http://www.eaglewatermanagement.com/services.html
TX1010884	NORTHWEST HARRIS COUNTY MUD 5	Community water system	Local government	77019 -2191	16368	40	26	45	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1011008	NORTHWEST HARRIS COUNTY MUD 6	Community water system	Local government	77019 -2191	2196	11	0	28	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1011599	NORTHWEST HARRIS COUNTY MUD 9	Community water system	Local government	77019 -2191	7635	19	8	28	2	Inframark	https://www.inframark.com/residents/
TX1010593	NORTHWEST PARK MUD	Community water system	Local government	77024 -3430	17406	31	68	24	2	Si Environmental	https://www.sienv.com/mymud/
TX1011032	NORTHWEST PINES MOBILE HOME COMMUNITY	Community water system	Private	77379 -3195	990	13	80	20	3		
TX1013404	NORTHWOOD MUD 1	Community water system	Local government	77057 -1799	795	9	8	9	1		
TX1011956	NORTHWOODS MOBILE HOME PARK	Community water system	Private	77079 -8100	69	5	97	28	3		
TX1012315	NOTTINGHAM COUNTRY MUD	Community water system	Local government	77027 -7597	6633	19	17	28	2	Si Environmental	https://www.sienv.com/mymud/
TX1011553	O ACES MHP	Community water system	Private	77522 -1809	72	6	16	28	3		
TX1013045	OAK HILL ESTATES WATER SYSTEM	Community water system	Private	77305 -0281	402	9	38	24	4	A-1 Utility	http://www.a1utility.com/home.html
TX1011633	OAK MANOR	Community water system	Private	78723 -2476	102	6	20	24	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1011049	OAKLAND VILLAGE MOBILE HOME COMMUN	Community water system	Private	77562 -1165	150	6	108	32	3		
TX1012981	OAKMONT PUD	Community water system	Local government	77046 -3653	3420	15	0	20	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013066	OAKS OF ROSEHILL	Community water system	Private	77377 -6191	129	6	12	20	3		
TX1011803	OAKWOOD VILLAGE MOBILE HOME SUBDIVISION	Community water system	Private	78723 -2476	171	8	0	24	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010870	ORANGE GROVE WATER SUPPLY	Community water system	Private	77039 -6322	450	8	0	28	3		
TX1012450	ORCHARD CROSSING SUBDIVISION	Community water system	Private	77358 -0279	320	8	32	24	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/

TX1010681	P & B WATER SYSTEM	Community water system	Private	77581-6235	660	10	772	24	3		
TX1012130	PADOK TIMBERS SUBDIVISION WS	Community water system	Private	77044-6009	147	13	201	28	3		
TX1013041	PARK FOREST WATER SYSTEM	Community water system	Private	78723-2476	210	9	0	32	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010192	PARKLAND ESTATES	Community water system	Private	77039-4121	228	9	28	28	3		
TX1010750	PARKWAY UTILITY DISTRICT	Community water system	Local government	77019-7120	6507	14	12	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1010651	PEAKES PARK	Community water system	Private	77578-5308	57	6	80	28	3		
TX1012861	PEEK ROAD MOBILE HOME PARK	Community water system	Private	77084-2267	63	6	64	24	3		
TX1011955	PEEK ROAD UTILITIES	Community water system	Private	78723-2476	483	11	4	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010826	PIN OAK MOBILE HOME PARK	Community water system	Private	90505-1317	345	10	24	24	3		
TX1010751	PINE OAK FOREST WATER	Community water system	Private	75681-0385	126	8	681	20	3		
TX1010535	PINE TRAILS UTILITY	Community water system	Private	78723-2476	6969	12	20	29	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010901	PINE VILLAGE PUD	Community water system	Local government	77019-7120	1920	12	60	29	2	MOC	http://municipalops.com/districts/
TX1012154	PINEWOOD PLACE MOBILE HOME COMMUNITY	Community water system	Private	77396-3611	1050	10	76	24	3		
TX1010078	PITCAIRN WSC	Community water system	Local government	77377-8418	207	12	8	21	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1010384	PONDEROSA FOREST UTILITY DISTRICT	Community water system	Local government	77024-3430	8883	35	4	28	2	MOC	http://municipalops.com/districts/
TX1012957	PONDEROSA MOBILE HOME PARK	Community water system	Private	77041-5740	84	7	556	20	3		
TX1010631	POSTWOOD MUD	Community water system	Local government	77098-3709	3747	15	8	32	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1012986	POWDER MILL ESTATES	Community water system	Private	77377-6191	342	10	4	28	3		
TX1010467	PRESTONWOOD FOREST UTILITY DISTRICT	Community water system	Local government	77024-3430	4998	22	0	28	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1013036	PROVENCE WATER SYSTEM	Community water system	Private	77007-7724	366	10	24	28	3		

TX1011475	QUAILWOOD WATER SYSTEM	Community water system	Private	77038 -3012	48	6	88	24	3		
TX1012019	R&K WEIMAN MHP	Community water system	Private	92649 -2061	279	9	48	32	3		
TX1010196	RALSTON ACRES WATER SUPPLY CORPORATION	Community water system	Local government	77213 -6129	330	9	84	28	2	Hydro Tech Utilities	http://hydrotechutilities.com/hydrotechutilities.com.p9.hostingprod.com/customer_links.html
TX1011528	RAMBLEWOOD UTILITY & WSC	Community water system	Local government	77338 -2546	420	4	36	25	2	Gulf Utility Services	http://www.gulfutility.net/ccr/
TX1012354	RANKIN ROAD WEST MUD	Community water system	Local government	77019 -2191	1827	14	44	28	2	Water Waste Water Management Services	http://www.wwwmsinc.net/your-district.html
TX1010916	RED OAK TERRACE	Community water system	Local government	77362 -0837	156	9	4	24	0	HMW SUD	http://hmw-sud.com/service-area/
TX1010307	REDWOOD ESTATES MOBILE HOME PARK	Community water system	Private	78723 -2476	510	9	8	25	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010945	REED ESTATES WATER SYSTEM	Community water system	Private	77016 -1640	96	6	665	24	3		
TX1010872	REID ROAD MUD 1	Community water system	Local government	77019 -2191	6654	22	4	36	2	MOC	http://municipalops.com/districts/
TX1011928	REID ROAD MUD 2	Community water system	Local government	77056 -6145	4602	20	0	33	2	MOC	http://municipalops.com/districts/
TX1013074	REMINGTON MUD 1	Community water system	Local government	77056 -3078	13338	31	0	28	2	Inframark	https://www.inframark.com/residents/
TX1010578	RENES WATER SYSTEM	Community water system	Private	77050 -4713	105	7	44	24	3		
TX1011834	RENN ROAD MUD	Community water system	Local government	77027 -7537	4086	13	12	29	2	Inframark	https://www.inframark.com/residents/
TX1010197	RESERVOIR ACRES SUBDIVISION	Community water system	Private	77383 -1383	627	9	44	25	4	Quadvest	https://www.quadvest.com/images/ccrs/2016/Reservoir-Acres.pdf
TX1010908	RICE UNIVERSITY	Community water system	Private	77251 -1892	9032	14	12	25	3		https://sustainability.rice.edu/water
TX1012227	RICEWOOD MUD	Community water system	Local government	77056 -3018	4986	15	8	24	2	Inframark	https://www.inframark.com/residents/
TX1011929	RICHEY ROAD MUD	Community water system	Local government	77019 -7100	651	13	8	24	2	TOPS Water	http://topswater.com/district-served/
TX1011071	RIO VILLA WSC	Community water system	Local government	77049 -3209	432	10	24	28	1		
TX1013366	RIVERTON RANCH	Community water system	Private	77066 -4210	39	4	12	4	3		

TX1013393	ROCKY CREEK ESTATES	Community water system	Private	77377 -0409	72	5	0	4	4	Quadvest	https://www.quadvest.com/ccrs
TX1010640	ROLLAN HEIGHTS SUBDIVISION	Community water system	Private	77358 -0279	54	6	12	24	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1012877	ROLLING CREEK UTILITY DISTRICT	Community water system	Local government	77046 -0905	2970	19	20	25	2	Inframark	https://www.inframark.com/residents/
TX1010357	ROLLING FORK PUD	Community water system	Local government	77401 -4125	2391	13	32	28	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1011861	ROLLING OAKS	Community water system	Private	78723 -2476	285	9	16	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey% 209.2.17%20as%20of%201030%20Central.pdf
TX1011971	ROSEWOOD MOBILE HOME PARK	Community water system	Private	77338 -2303	234	6	28	28	3		
TX1012260	ROVING MEADOWS WATER SYSTEM	Community water system	Private	77044 -6009	141	9	44	24	3		
TX1010520	ROYAL COACH MOBILE HOME VILLAGE	Community water system	Private	92659 -0320	546	9	144	25	3		
TX1010579	ROYAL LAKE MOBILE HOME PARK	Community water system	Private	77255 -5528	219	7	64	21	3		
TX1010201	ROYALWOOD MUD	Community water system	Local government	77024 -3430	1017	17	18	24	2	TNG	http://tng-utility.com/where-to-pay-your-water-bill/
TX1010386	SAGEMEADOW UTILITY DISTRICT	Community water system	Local government	77056 -3970	6978	18	12	32	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1010763	SATSUMA PARK VILLA MOBILE HOME PARK	Community water system	Private	77584 -3712	28	5	227	24	3		
TX1011459	SELLERS ESTATES MOBILE HOME COMM	Community water system	Private	77584 -3484	85	5	1911	24	3		
TX1010205	SEQUOIA IMPROVEMENT DISTRICT	Community water system	Local government	77019 -2191	1137	10	4	28	2	MOC	http://municipalops.com/districts/
TX1010388	SHASLA PUD	Community water system	Local government	77024 -3430	2304	12	0	25	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1013468	SHAW ACRES	Community water system	Private	77377 -0409	318	3	9	8	4	Quadvest	https://www.quadvest.com/h20/ccrs
TX1010235	SHELDON ROAD MUD	Community water system	Local government	77049 -1134	1662	17	43	28	1		
TX1010877	SILVERWOODS SUBDIVISION	Community water system	Private	75681 -0385	90	6	259	20	3		
TX1010788	SJOLANDER ROAD MOBILE HOME PARK	Community water system	Private	77387 -7490	126	7	50	24	4	Hydro Tech Utilities	http://hydrotechutilities.com/hydrotechutilities.com.p9.hostingprod.com/customer_links.html
TX1011184	SOUTH TAYLOR LAKE VILLAGE WSC	Community water system	Local government	77586 -5503	60	7	20	29	1		

TX1011911	SOUTHWEST HARRIS COUNTY MUD 1	Community water system	Local government	77019-2191	1584	17	4	24	2	Inframark	https://www.inframark.com/residents/
TX1010389	SPANISH COVE PUD	Community water system	Local government	77019-2191	408	10	20	25	2	Benry Utility Service	http://www.benryus.com/
TX1010654	SPENCER ROAD PUD	Community water system	Local government	77057-1799	4614	28	364	24	2	WET Services	http://www.wetservices.com/clients.html
TX1010334	SPRING CREEK FOREST	Community water system	Private	78723-2476	117	8	16	24	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/Interchange/Documents/45089_1_864515.PDF
TX1010390	SPRING CREEK FOREST PUD	Community water system	Local government	77019-2191	2364	21	12	32	2	M. Marlon Ivy and Associates	http://www.mmia.co/DistrictInfo.aspx
TX1010213	SPRING CREEK VALLEY ESTATES	Community water system	Private	77269-1008	645	13	19	28	4	Gulf Utility Services	http://www.gulfutility.net/ccr/
TX1013261	SPRING MEADOWS MUD	Community water system	Local government	77024-3430	3771	4	12	24	2	TOPS Water	http://topswater.com/district-served/
TX1013017	SPRING WEST MUD	Community water system	Local government	77056-3078	2007	18	0	28	2	EDP	http://www.edpwater.com/your-district/
TX1010255	SPRINGMONT SUBDIVISION	Community water system	Private	77383-1383	522	10	116	20	3		
TX1011925	SRALLA MOBILE HOME PARK	Community water system	Private	77384-4032	165	7	72	24	4	Hydro Tech Utilities	http://hydrotechutilities.com/hydrotechutilities.com.p9.hostingprod.com/customer_links.html
TX1013103	STABLE GATES	Community water system	Private	78723-2476	744	9	15	20	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010216	STETNER ADDITION	Community water system	Private	78723-2476	135	9	8	36	4	Aqua Texas	http://interchange.puc.state.tx.us/WebApp/Interchange/Documents/45089_1_864515.PDF
TX1010760	SUBURBAN MOBILE HOME PARK 2	Community water system	Private	77027-6697	120	9	611	28	3		
TX1013084	SUGARBERRY PLACE	Community water system	Private	84603-1848	864	11	97	28	3		
TX1013187	SUMMER LAKE RANCH	Community water system	Private	78723-2476	465	9	48	20	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010419	SUNBELT FWSD HEATHER GLEN SUBDIVISION	Community water system	Local government	77037-2902	2871	13	28	24	2	MOC	http://municipalops.com/districts/
TX1010292	SUNBELT FWSD HIGH MEADOWS SUBDIVISION	Community water system	Local government	77037-2902	8673	31	20	25	2	MOC	http://municipalops.com/districts/
TX1010117	SUNBELT FWSD NORTHLINE TERRACE	Community water system	Local government	77037-2902	3198	15	24	17	2	MOC	http://municipalops.com/districts/
TX1010188	SUNBELT FWSD OAKGLEN SUBDIVISION	Community water system	Local government	77037-2902	699	10	4	20	2	MOC	http://municipalops.com/districts/
TX1010022	SUNBELT FWSD OAKWILDE SUBDIVISION	Community water system	Local government	77037-2902	6825	25	32	20	2	MOC	http://municipalops.com/districts/

TX1010758	SUNBELT FWSD WOODLAND OAKS SUBDIVISION	Community water system	Local government	77037 -2902	4464	14	16	28	2	MOC	http://municipalops.com/districts/
TX1010533	SUNDOWN MOBILE HOME PARK	Community water system	Private	77255 -5528	282	9	72	28	3		
TX1011984	SUNSET MOBILE HOME PARK 1	Community water system	Private	77088 -3241	63	6	48	24	3		
TX1011972	SUNSET MOBILE HOME PARK 2	Community water system	Private	77088 -3241	132	6	40	28	3		
TX1010218	SWEA GARDENS ESTATES	Community water system	Private	77383 -1700	126	7	0	24	4	MOC	http://municipalops.com/districts/
TX1010219	TALL CEDARS MOBILE HOME SUBDIVISION	Community water system	Private	77383 -1383	165	5	104	24	3		
TX1010220	TALL PINES UTILITY	Community water system	Private	77240 -0526	204	10	0	32	4	MOC	http://municipalops.com/districts/
TX1010863	TALLOWS MOBILE HOME PARK	Community water system	Private	77088 -3241	72	9	40	24	3		
TX1011865	TASFIELD	Community water system	Private	78723 -2476	219	4	4	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010625	TATTOR ROAD MUD	Community water system	Local government	77019 -2191	5385	14	8	28	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011939	TELGE MANOR MHP	Community water system	Private	77065 -2602	132	5	12	24	3		
TX1011805	TELGE TERRACE MOBILE HOME SUBDIVISION	Community water system	Private	77377 -0409	132	5	12	24	4	Quadvest	https://www.quadvest.com/ccrs
TX1010667	TEPATITLAN MOBILE HOME PARK	Community water system	Private	77060 -4609	51	6	541	20	3		
TX1011226	TERRANOVA WEST MUD	Community water system	Local government	77046 -0307	2619	11	0	33	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1012978	THE COMMONS WATER SUPPLY INC	Community water system	Private	77380 -1179	2511	15	32	28	4	Inframark OR Gulf Utility Services	https://www.inframark.com/residents/ OR http://www.gulfutility.net/ccr/
TX1013247	TIDWELL FOREST NEW SUBDIVISION	Community water system	Private	77231 -1068	225	6	7	0	3		
TX1013239	TIMBER CREEK ESTATES	Community water system	Private	77384 -4702	54	6	60	16	3		
TX1010278	TIMBER LANE UTILITY DISTRICT	Community water system	Local government	77019 -2191	19044	41	13	28	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011973	TIMBERCREST VILLAGE	Community water system	Private	77396 -3611	1038	12	28	21	3		

TX1011810	TIMBERDALE MOBILE HOME SUBDIVISION	Community water system	Private	77377 -0409	174	8	4	24	4	Quadvest	https://www.quadvest.com/ccrs
TX1010447	TIMBERLAKE IMPROVEMENT DISTRICT	Community water system	Local government	77024 -3430	2571	19	16	24	2	Regional Water	http://www.regionalwater.net/districts/tid.html
TX1012367	TIMBERWILDE MH SUBDIVISION	Community water system	Local government	77362 -0837	489	10	0	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1011981	TOWER OAK BEND WSC	Community water system	Local government	77070 -4445	381	8	12	24	2	MOC	http://www.tallpinesutility.com/index.php?page=about-tall-pines
TX1010617	TRAIL OF THE LAKES MUD	Community water system	Local government	77019 -7120	8418	29	76	24	2	Si Environmental	https://www.sienv.com/mymud/
TX1011521	TRAILWOOD SUBDIVISION	Community water system	Local government	77362 -0837	108	9	16	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1012397	TREICHEL WOODS ESTATES	Community water system	Local government	77362 -0837	183	8	0	25	0	HMW SUD	http://hmw-sud.com/service-area/
TX1010566	TRINITY AT WINDFERN MOBILE HOME PARK	Community water system	Private	77868 -5829	240	6	96	20	3		
TX1010339	TRINITY ROYAL COACH TRAILS MOBILE HOME	Community water system	Private	77868 -5829	147	12	92	28	3		
TX1012090	TRINITY SPRING OAKS MOBILE HOME PARK	Community water system	Private	77868 -5829	405	10	36	28	3		
TX1013058	TWIN OAKS MHP HARRIS	Community water system	Private	77358 -0279	105	9	8	24	4	Utilities Investment Company	https://utilitiesinvestmentco.com/information/
TX1010252	URBAN ACRES SUBDIVISION	Community water system	Private	77383 -1383	489	9	32	20	3		
TX1011433	VAN MANOR MOBILE HOME PARK	Community water system	Private	77377 -5800	294	8	24	32	3		
TX1011183	VILLA UTILITIES	Community water system	Private	77520 -2526	84	5	733	24	3		
TX1012795	VILLAGE OF NEW KENTUCKY	Community water system	Local government	77362 -0837	453	12	0	28	0	HMW SUD	http://hmw-sud.com/service-area/
TX1013195	WALRAVEN SUBDIVISION	Community water system	Private	78723 -2476	198	8	40	17	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1013389	WATERSTONE ESTATES	Community water system	Private	77377 -0409	225	8	0	9	4	Quadvest	https://www.quadvest.com/ccrs
TX1011186	WAYNEWOOD PLACE CIVIC ASSOCIATION	Community water system	Private	77429 -1540	147	10	20	24	4	Aggregate Water Services	http://www.aggregatewater.com/waynewood-2016/
TX1010925	WEST HARRIS COUNTY MUD 1	Community water system	Local government	77024 -3430	5280	4	24	25	1		https://www.hcmud1.com/
TX1012068	WEST HARRIS COUNTY MUD 10	Community water system	Local government	77024 -3430	6858	18	16	24	2	TOPS Water	http://topswater.com/district-served/

TX1012858	WEST HARRIS COUNTY MUD 11	Community water system	Local government	77024-3430	8205	31	16	24	2	TOPS Water	http://topswater.com/district-served/
TX1012002	WEST HARRIS COUNTY MUD 14	Community water system	Local government	77024-3430	2685	5	0	24	2	MOC	http://municipalops.com/districts/
TX1012001	WEST HARRIS COUNTY MUD 15	Community water system	Local government	77024-3430	654	23	0	24	2	MOC	http://municipalops.com/districts/
TX1012238	WEST HARRIS COUNTY MUD 17	Community water system	Local government	77024-3430	2409	12	8	28	2	EDP	http://www.edpwater.com/your-district/
TX1011029	WEST HARRIS COUNTY MUD 2 CHASE	Community water system	Local government	77057-1762	3780	14	4	28	2	MOC	http://municipalops.com/districts/
TX1011825	WEST HARRIS COUNTY MUD 4	Community water system	Local government	77019-2191	1611	12	4	20	2	EDP	http://www.edpwater.com/your-district/
TX1013356	WEST HARRIS COUNTY MUD 5	Community water system	Local government	77024-3430	1278	4	0	12	2	MOC	http://municipalops.com/districts/
TX1011258	WEST HARRIS COUNTY MUD 6	Community water system	Local government	77057-1762	3348	11	0	32	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1012228	WEST HARRIS COUNTY MUD 7	Community water system	Local government	77019-2191	5467	13	4	29	2	Water District Management Co	http://www.wdmtexas.com/districts-served/
TX1011798	WEST HARRIS COUNTY MUD 9	Community water system	Local government	77905-5027	5961	15	12	28	2	TOPS Water	http://topswater.com/district-served/
TX1013303	WEST HARRIS COUNTY REGIONAL WATER AUTHOR	Community water system	Local government	77027-7537	0	14	12	12	x		
TX1010583	WEST HOUSTON MOBILE HOME COMMUNITY	Community water system	Private	77231-1068	630	13	24	24	3		
TX1010540	WEST MEMORIAL MUD	Community water system	Local government	77491-5211	4359	23	12	20	2	Inframark	https://www.inframark.com/residents/
TX1010670	WEST MONTGOMERY UTILITY	Community water system	Private	77039-4121	1515	16	17	32	3		
TX1011930	WEST PARK MUD	Community water system	Local government	77098-3709	2958	18	76	25	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010277	WESTADOR MUD	Community water system	Local government	77056-3078	5085	29	8	24	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1010028	WESTERN HOMES SUBDIVISION	Community water system	Private	77039-4121	678	14	12	32	4	Champ's Water Company	https://www.champswater.com/ccr
TX1011382	WESTERN MOBILE HOME PARK	Community water system	Private	77407-1729	111	9	42	28	3		
TX1011714	WESTERN PINES MHP	Community water system	Private	77478-3773	1206	12	40	28	3		
TX1010230	WESTERN TRAILS SUBDIVISION	Community water system	Private	78660-2185	129	8	0	40	3		

TX1011947	WESTFIELD GARDEN MOBILE HOME PARK	Community water system	Private	95150-7231	942	9	140	32	3		
TX1010584	WESTFIELD MEADOWS	Community water system	Private	77027-6697	72	10	183	28	3		
TX1010622	WESTGATE SUBDIVISION	Community water system	Private	78723-2476	147	9	11	28	4	Aqua Texas	https://www.aquaamerica.com/media/33626/Harvey%209.2.17%20as%20of%201030%20Central.pdf
TX1010635	WESTLAKE MUD 1	Community water system	Local government	77056-3018	3900	18	4	24	2	Inframark	https://www.inframark.com/residents/
TX1010634	WESTON MUD	Community water system	Local government	77010-3093	5811	24	0	28	2	Municipal District Services	https://portal.municipaldistrictservices.com/
TX1010628	WHEAT MEADOW MOBILE HOME PARK SECTION I	Community water system	Private	77388-4623	48	7	76	21	3		
TX1010613	WHEAT MEADOW MOBILE HOME PARK SECTION II	Community water system	Private	77388-4623	33	11	16	17	3		
TX1011708	WHISPER MEADOWS MOBILE HOME SUBDIVISION	Community water system	Private	77039-4121	66	5	0	28	4	Champ's Water Company	https://www.champswater.com/ccr
TX1011238	WHITE OAK BEND MUD	Community water system	Local government	77019-7120	1824	12	4	21	2	Regional Water	http://www.regionalwater.net/districts/wobmud.html
TX1010322	WHITE OAK MANOR MOBILE HOME PARK	Community water system	Private	77040-3564	630	14	64	28	3		
TX1011812	WILLOW OAKS MOBILE HOME SUBDIVISION	Community water system	Local government	77362-0837	363	10	0	25	0	HMW SUD	http://hmw-sud.com/service-area/
TX1010924	WINDFERN FOREST UTILITY DISTRICT	Community water system	Local government	77002-2770	7170	27	40	28	2	TOPS Water	http://topswater.com/district-served/
TX1010920	WINDWOOD WATER SYSTEM	Community water system	Private	77429-2777	42	9	64	24	3		
TX1012015	WINTERHAVEN SUBDIVISION	Community water system	Private	77269-2346	138	10	177	28	4	Gulf Utility Services	http://www.gulfutility.net/ccr/
TX1011237	WOODCREEK MUD	Community water system	Local government	77057-1762	4398	13	4	28	2	Hays Utility South Corporation	http://www.haysutility.com/your-district/
TX1011796	WOODGATE MOBILE HOME VILLAGE	Community water system	Private	80246-1930	423	9	40	32	3		
TX1010805	WOODLOCH MHP	Community water system	Private	77479-3121	264	6	56	21	3		
TX1011747	ZAM ZAM WATER SUPPLY	Community water system	Private	77040-4241	93	5	562	28	3		

PPP Type Legend	Type
Publicly owned/Publicly operated (different entity)	0
Publicly owned/Publicly operated (independently)	1
Publicly owned/Privately operated	2
Privately owned/Privately operated (independently)	3
Privately owned/Privately operated (different company)	4
Couldn’t obtain information	x