A REGIONAL APPROACH TO WASTEWATER INFRASTRUCTURE PLANNING

WHITE PAPER

HOUSTON - GALVESTON AREA COUNCIL
Community & Environmental Planning Department

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Regional Wastewater Infrastructure Planning Challenges in the 13-County Texas Upper Gulf Coast Planning Region

I. Introduction

A burgeoning economy, explosive population growth, and a general lack of geographical constraints on outward expansion have alternately benefited and challenged the 13-county Upper Gulf Coast Planning Region (Region). This dichotomy is especially apparent in the greater Houston Metropolitan area, where the benefits of relatively low land costs and high economic prosperity have created the counterpart disadvantage of a developmental pattern characterized by rapid, uncoordinated growth.

The effects of this growth phenomenon have had a pronounced impact on the development of our wastewater infrastructure. Absent a coherent system of regional coordination, this growth has spurred the rapid development of a distributed, patchwork mosaic of primarily small, single-entity plants rather than larger, regional facilities. The costs of expediency are reflected in the economic, regulatory and environmental issues that this less efficient model of wastewater treatment creates through loss of efficiency and economies of scale, and through greater impact on our local waterways. Ideally, these mounting challenges would prompt a retroactive condensing of groups of small, existing plants (consolidation) and a new paradigm for incentivizing regional treatment solutions for new growth (coordination).

However, efforts to consolidate the existing infrastructure are hampered by the lack of a guiding regional authority or incentives and the increasing costs and logistical challenges of retrofitting a large, aging, and diffuse infrastructure network. Further complicating the matter is the significant portion of the population still served by on-site septic system that is not yet accounted for in the current wastewater treatment network. Regardless, failing to address the current challenges can only result in greater economic and environmental costs for the region's population.

While the area's current wastewater challenges are daunting on their own, projections indicate the Region's population will grow by another 3.5 million people before 2035. Without a reconsideration of the current approach to wastewater infrastructure development, this additional population will only serve to dramatically exacerbate the scale and costs of the existing situation. To tackle this decidedly regional issue, an equally regional perspective and solution must be considered. Recent efforts by Harris County and the Harris County Flood Control District to regionalize wastewater infrastructure in their jurisdiction are a potential framework example for an equivalent approach for the Region as a whole.

II. Present Challenges

With growth comes an inevitable need for utility services. Beginning in the 1970's and 80's, the rapid expansion of the Region's population lead to a vast proliferation of wastewater treatment plants and related infrastructure, primarily centered on the Houston Metropolitan Area and surrounding counties. An abundance of undeveloped land, coupled with the ability of developers to utilize funding mechanisms like MUDs, helped enable "leapfrog" growth in which non-

contiguous areas, expanding outwards, were developed concurrently with little coordination. For example, unincorporated Harris County saw the creation of over 400 separate political subdivisions (e.g., municipal utility districts, water conservation and improvement districts, and fresh water supply districts; most with their own individual water well(s) and wastewater treatment plants) during this time.

The end result of this expansive growth pattern is a set of unintended consequences that serve as the primary challenges that currently face the region's wastewater infrastructure: a disproportionately large number of plants, a reliance on smaller, single-entity plants, a widespread and diffuse infrastructure network, and a reliance on on-site sewage facilities (OSSFs) for both established areas and new development.

Proliferation of Facilities

Due to the rapid population expansion and lack of regional coordination of new facility development, the Houston area now has a disproportionately large number of wastewater plants and facilities. There are over 2078 permitted wastewater outfalls, representing 1479 permitted plants or entities, throughout the 13-county Region (Figure 1). A significant portion of these outfalls are located in the city limits of the City of Houston, in the City's extra-territorial jurisdiction (ETJ), or in unincorporated Harris County. This distribution reflects the dense concentration of growth in the Houston metropolitan area.

Figure 1: Wastewater Outfalls in the 13-County Upper Gulf Coast Planning Region

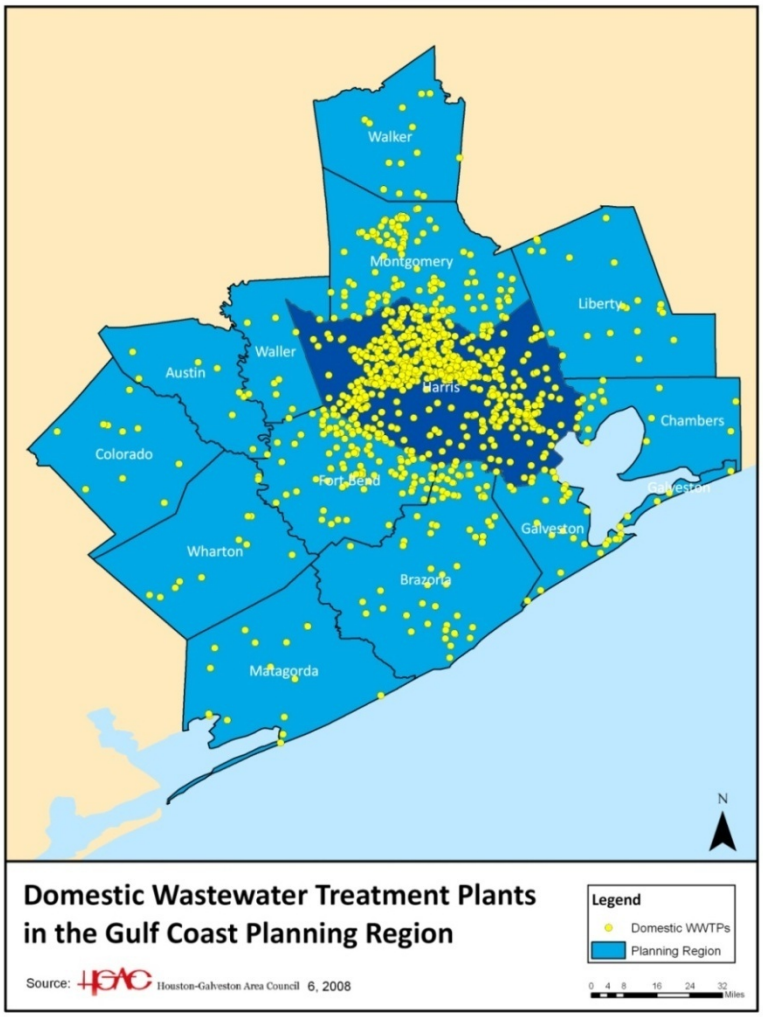
Plant type	Number of Entities/Plants	Total Outfalls
Industrial	389	978
Domestic	1090	1100

More than half of these outfalls are domestic wastewater treatment facilities, with large concentrations in west and northwest Harris County. The seemingly large number of industrial outfalls is deceptive, as many of the industrial users maintain multiple permitted outfalls per permit/facility while domestic users often have a single outfall per permit. Therefore, while there are a large number of industrial outfalls, especially along the Houston Ship Channel area, they make up only one third of the permitted dischargers.

The remaining two thirds of the outfalls are composed of municipal (Cities, MUDs, and other political subdivisions) and private (mobile home parks, businesses, etc.) dischargers of domestic

wastewater (Figure 2). As growth in Harris County and the Region as a whole continues to expand outwards into previously undeveloped areas, domestic wastewater facilities are the predominant type of new discharge permits being granted. While this expansion has typically followed major transportation corridors, it has also spread as infill in remote, unincorporated county areas as the suburbs and exurbs have expanded.

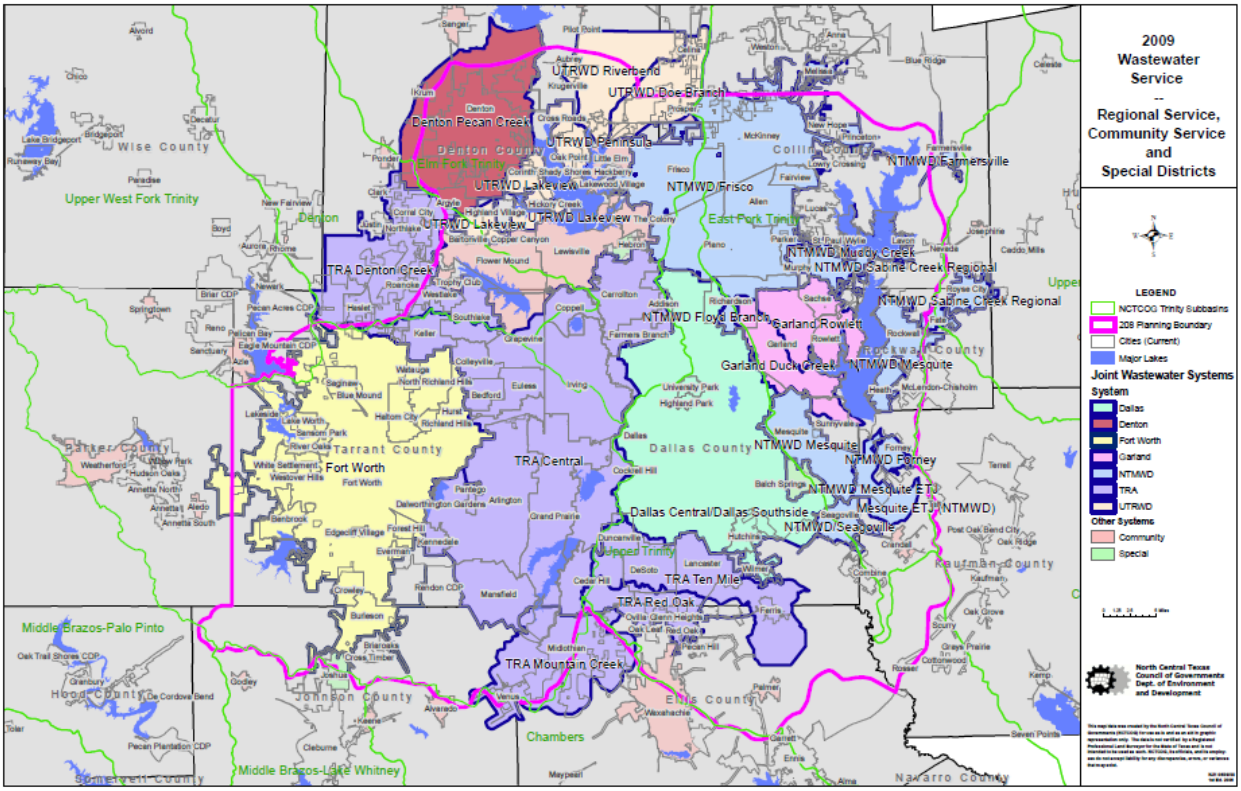
Figure 2: Domestic Wastewater Treatment Plant Distribution



In comparison to other urban centers in Texas and the United States, the number of domestic wastewater treatment plants in the Houston area is relatively excessive. For the sake of comparison, the Dallas/Fort Worth area has far fewer plants, and large consolidated service areas (Figure 3). In the absence of regional coordination akin to the development of the Regional Water Authorities (to meet Subsidence District mandates), the expansion of wastewater treatment facilities has been characterized by incremental and often noncontiguous advancement. As development spreads out from the metropolitan core to outlying counties, this pattern is also being carried forward and represents a concern for the long term sustainability of the area's

wastewater infrastructure, especially when combined with a trend toward smaller, single-entity treatment facilities.

Figure 3: Consolidated Wastewater Service Areas in the Dallas/Fort Worth Metroplex



Smaller Facilities

The same factors (lack of geographic constraint, leap-frog development, lack of regional coordination) that have lead to the disproportionately large number of treatment facilities in the Region have also contributed to a tendency toward a smaller average plant size. Developers of areas that do not have direct access to existing wastewater infrastructure (whether based on geographic or political separation) often implement a single-user (often small-scale) facility as either a temporary or permanent treatment solution. The ability to implement a solution for a single user, matched to their specific needs and volumes, is more expedient on the front end than negotiating a volume share of a regional facility and dealing with the hurdles coordination may bring. Therefore, without a prevailing counter-incentive or mandated requirement to consider regional solutions, developers have an economic incentive to employ these small, single entity plants. The legacy of this developmental pattern is that small and intermediate-sized plants have

become the prevailing means of wastewater treatment in the region and are often used as permanent substitutes for participation in regional wastewater treatment facilities.

Of the domestic wastewater facilities in the Region, only 79 are "regional" plants[1]. 279 are "intermediate" plants, and 742 are "small" (or "package") plants (Figure 4).

Figure 4: Domestic Wastewater Treatment Facilities by Permitted Capacity

Total Number of Domestic Wastewater Treatment Plants in the Region	Number of Regional Domestic Plants (>3.0 MGD)	Number of Intermediate Domestic Plants (between 0.50 and 3.0 MGD)	Number of Small Domestic Plants (< 0.50 MGD)
1100	79	279	742

The distribution of plant sizes reflects the trend that has developed in the absence of any incentivized or regulated consolidation of treatment facilities.

With rare exception, small plants do not possess the treatment capabilities and financial resources of larger, regional plants. Likewise, while intermediate plants provide good treatment under most conditions and are less susceptible to overloading than small plants, they cannot match the low per gallon treatment costs that regional plants are able to achieve. Small plants are often unmanned, increasing the likelihood that spills go undetected for longer periods of time. Because smaller plants often rely on a smaller tax/funding base than large regional plants, they have a greater cash flow issue when it comes to repair and replacement of infrastructure, and especially in dealing with unforeseen issues. The impacts of regulatory efforts like the Total Maximum Daily Load (TMDL) program efforts underway in many local waterways can include greater permit restrictions for wastewater plants. Smaller plants, with their more limited resources and non-specialized staff, bear a greater burden and potential cost under these restrictions.

[1] Domestic wastewater treatment facilities in the Region vary widely in size, treatment type/capability and number of entities served. For the purpose of this analysis, "regional plants" are defined as treatment facilities with permitted capacities in excess of 3 million gallons a day (MGD). "Intermediate plants" have capacities between 0.5 and 3 MGD, and "small plants" have capacities less than 0.5 MGD.

Regional treatment plants have the ability to overcome deficiencies associated with small and intermediate plants due to economies of scale. Regional plants also generally have more restrictive operating requirements resulting in comparatively fewer pollutants, in smaller concentrations, being released into receiving streams. In addition, regional plants have the financial base to make improvements and upgrade treatment processes when necessary, without placing an undue burden on customers. This financial base is often complemented by the ability to devote a more specialized staff and greater degree of resources to focus on a long-range infrastructure management focus than smaller plants. From a regulatory standpoint, the use of regional plants reduces the number of point source discharges that state and local agencies must regulate.

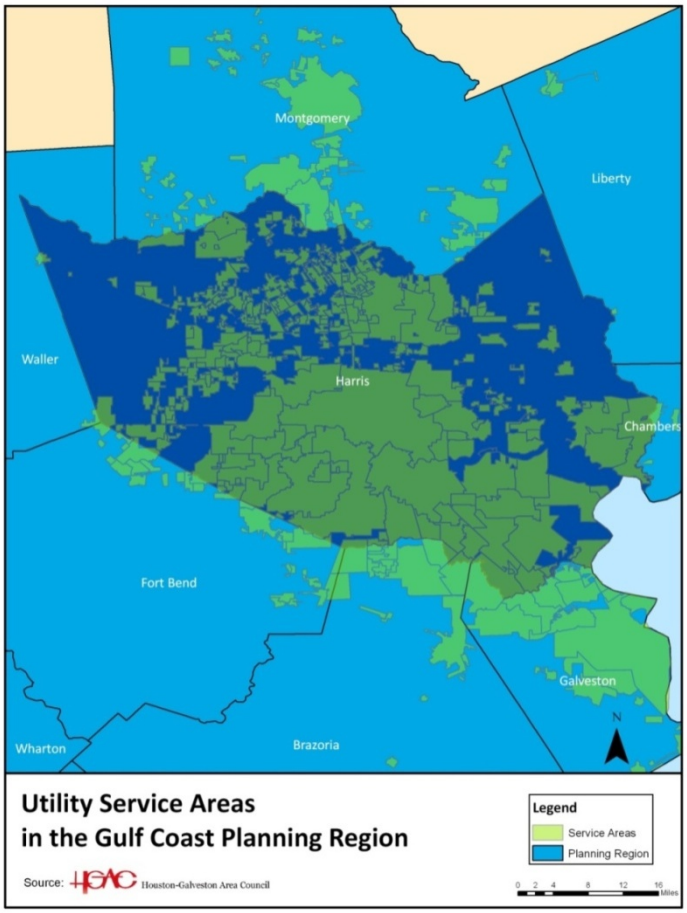
The combination of a large number of plants with a generally small average size plant size, with each having their own disadvantages for a sustainable regional wastewater infrastructure, also indirectly set up a third challenge to consolidation. Instead of a cohesive, integrated wastewater network, the Region is left with a diffuse and widespread archipelago of small facilities.

Diffuse and Widespread Network

Regional consolidation of wastewater infrastructure is driven by both economic and environmental considerations. The underlying economic incentive is based on the benefits of the economies of scale inherent to larger plants. One of the primary balancing consideration when discussing consolidation are the costs of transmission lines between a regional plant and its participant collection systems. If there are four small package plant communities in close proximity, a regional facility would prove cost efficient, as the cost of the trunk lines to connect the system would likely be less than the economy of scale savings generated by the larger facility. As distance increases between the communities served, the economic feasibility of the regional facility likewise decreases. The current wide and diffuse network of treatment facilities mirrors the “leap-frog” development style that dominates the Region’s outward expansion of growth.

While small facilities closer to the Region’s denser cores are prime candidates for consolidation, outlying areas where development is more diffuse face transmission line costs that may outstrip the economic benefits of a regional facility’s economy of scale. Even in the Region’s central areas, the network is fragmented enough (e.g., the distribution of utility service areas shown in Figure 5) to provide a challenge to easy consolidation.

Figure 5: Utility Service Areas in and around Harris County

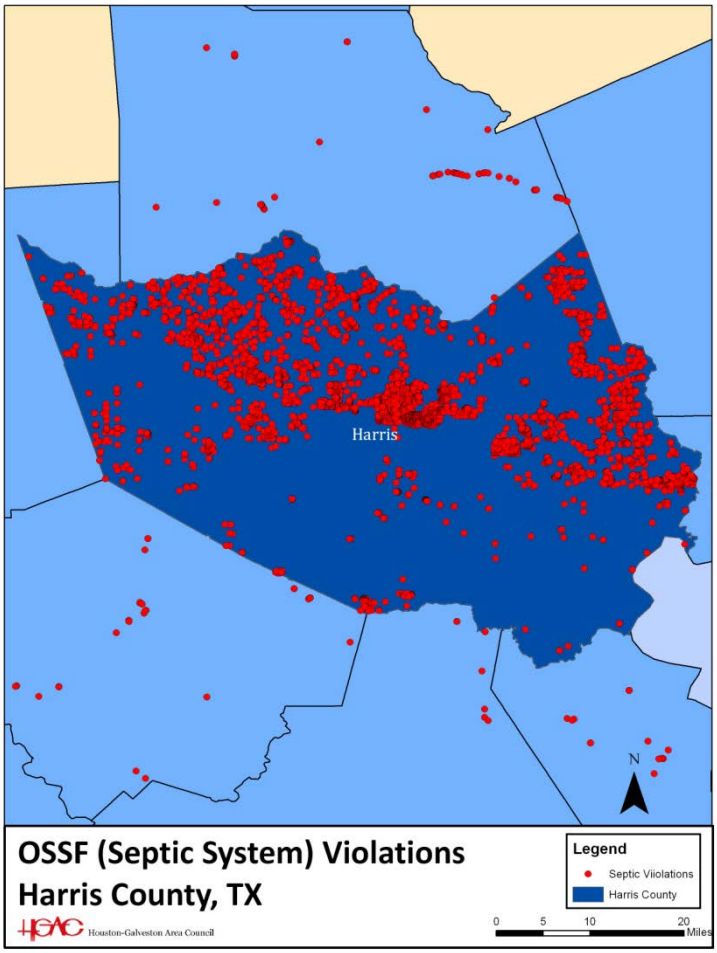


Continued Reliance on OSSFs

OSSFs (colloquially, septic systems) are a traditional method of providing wastewater treatment to areas that cannot feasibly be served by sanitary sewer. While small package plants have proven an increasingly feasible alternative to new OSSF construction, the Region also has large swaths of unincorporated county areas containing legacy OSSF communities that have not yet been converted over to sanitary sewer. Some new developments in areas farther from the urban cores have also continued to utilize OSSFs as a treatment solution. Any effort at regional consolidation must overcome the twin hurdles of retrofitting existing OSSFs and incentivizing or regulating new development towards wastewater solutions other than OSSFs. The former can represent a significant cost outlay and logistical issue, while the implementation of the latter requires coordination of viable alternatives, some of which may not be available or feasible in all

areas. Poorly-maintained or aging OSSFs can be a significant cost to remediate and represent an appreciable source of bacterial contamination in local waterways. Many of the legacy OSSF communities in the greater Houston Metropolitan area have dense occurrences of violations, indicating the potential for costly future remediation and bacterial contamination for local waterways (Figure 6).

Figure 6: OSSF Violations in Harris County, TX



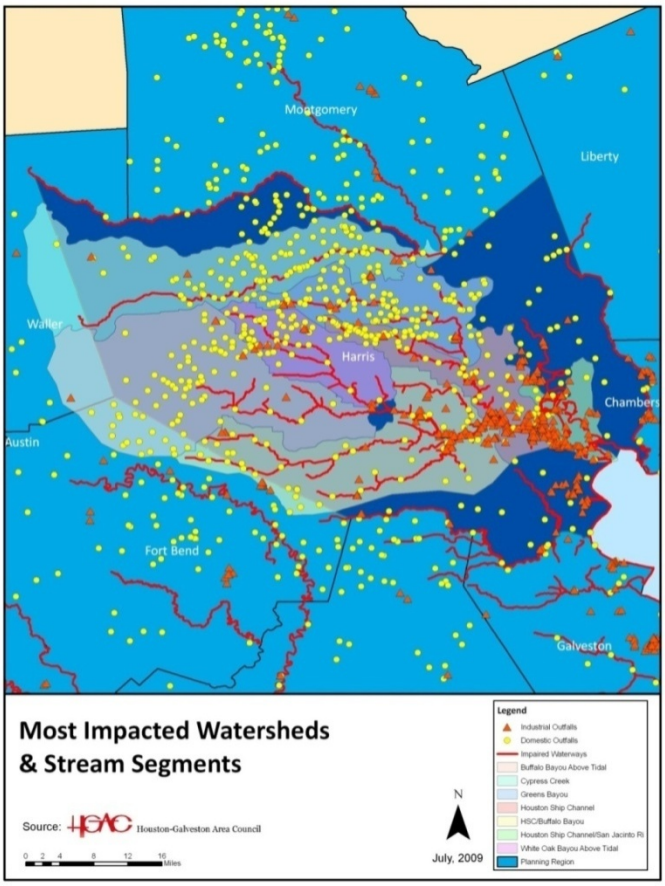
III. Impacts

The four challenges outlined above represent significant concerns for the Region, due to their environmental and economic impacts. The costs and logistical problems associated with these impacts point to the necessity for regional consolidation of existing infrastructure and a framework for application of similar principles to new growth.

Environmental Impacts

The environmental impacts resulting from the current wastewater development pattern primarily affect our local waterways. The Region has a vast network of rivers, streams, creeks, bayous and sloughs, many of which are impaired by bacteria, often greatly in excess of state and national standards. While wastewater plants are not the sole source of bacterial contamination, they remain a significant issue for the water quality in our local waterways. Many of our most impacted waterways also have the densest concentrations of wastewater outfalls (e.g., Figure 7, depicting this correlation in the urban core of the Region).

Figure 7: Wastewater Outfalls and Impaired Waterways in Harris County



Bacterial contamination can result from the improper maintenance of wastewater infrastructure, differences in treatment efficiencies based on plant size, spills or overflows, and failing or improperly maintained OSSFs. While these inputs may be secondary to nonpoint source pollution (diffuse pollution washed into waterways by rain), they are still a contributing factor

and are exacerbated by the dominance of small facilities. Operating requirements are less stringent at smaller plants and they face fewer regulatory inspections. Furthermore, during high flow conditions (rain events) small plants are more susceptible to overloading and may have to "pass through" untreated wastewater into receiving streams. Due to cost considerations, operations at small plants are typically unmanned, with operators relying on remote sensing or drive-by checks to discover problems. Small plants also have a lesser ability to bear the costs of upgrading or repairing aging infrastructure. This can lead to a critical lack of responsiveness when operational problems do arise. Additionally, in a survey of 723 domestic plants in the Region, 581 had exceeded an average life span and are reaching, or have exceeded, the point where they will require major repairs/improvements[2] (especially in those cases when the small facilities were originally designed as temporary solutions). The culmination of these factors results in a relatively higher risk of pollutant loading to the receiving stream.

Economic Impacts

The economic impacts of our current paradigm of wastewater infrastructure development are incurred both in day to day operations and life-cycle costs. A larger array of smaller plants does not benefit from the same economies of scale that larger, regional plants do. While costs of treatment vary widely based on the type of treatment and the nature of the influent, an average estimate for economy of scale savings in treatment cost per gallon for a regional plant is between 9-37%[3] as compared to an equivalent volume treated in small or intermediate plants. The discrepancy between the two size categories illustrates the ongoing hidden cost of the preponderance of smaller plants.

A brief survey of local regional plants produced a wide variety of treatment costs, including municipal system average costs both well below and appreciably over $1.00 per thousand gallons treated. To truly quantify the impact to the region, more detailed economic analysis should be completed. However, for the sake of an overview of the comparative costs of small and regional plants, the following example scenarios are offered. A recent study for a local regional plant (to serve a permitted capacity of 5 MGD) projected a yearly operations cost of $2,600,000. This equates to a treatment cost of roughly $1.42 per 1000 gallons.[4] Using an estimate of 20% (a

[2] Based on a sampling of 723 domestic wastewater plants from data collected for the Houston-Galveston Area Council's 2009 Water Quality Master Plan Update. For the purpose of this discussion, 20 years is used as an average plant life-span. Smaller or temporary plants may need repair/rehabilitation far sooner, while some very large plants may have a greater design age.

[3] Ed. ReVelle, Charles and Arthur McGarity. Design and Operation of Civil and Environmental Engineering Systems. New York: John Wiley & Sons, Inc., 1997.

[4] Estimate based on yearly operation costs without debt service for construction.

hypothetical middle range value selected from the aforementioned range) costs savings based on economy of scale, a small plant would hypothetically have a treatment cost of $1.71 per 1000 gallons. The yearly cost avoidance for this example, therefore, would be approximately $520,000. On the local level this is a significant cost difference.

This effect is pronounced if extrapolated out to the whole of Harris County. Harris County, at the Region's core, has a population estimated to be approximately 3.98 million.[5] Assuming an average of 100 gallons[6] of effluent per capita, per day (gcpd), this is equivalent to a total county volume of 398,000,000 gallons per day, or 145,270,000,000 gallons a year. If the treatment costs from the study above are used for reference, the cost to treat that effluent in a scenario where all flows were served by regional plants would thus be $206,960,000 per year. Comparatively, in a scenario where all flows were served by small plants with a 20% efficiency loss, the same volume would represent an equivalent cost of $248,352,000 per year (Figure 8). The difference between those two scenarios would represent a yearly cost avoidance of $41,392,000. If extrapolated again to the Region as a whole, the effect magnifies accordingly.

Additionally, these figures are somewhat conservative as the regional plant used as a reference point is fairly small compared to the Region's average regional wastewater treatment plant size of 9.8 MGD. As size increases, so does the economy of scale savings (though not in direct proportionality). Therefore, the greater the degree of consolidation and the larger volumes of wastewater a single plant can treat, the lesser the economic impact. In the example above, a third scenario in which treatment was provided at larger regional plants could exhibit even greater cost avoidances. Conversely, the smaller the average plant size, the greater the cost to the region.

Figure 8: Hypothetical Treatment Scenario, Harris County: Regional vs. Small Plants

Plant Size	Cost per 1000 gallons treated	Daily Volume in gallons	Daily Cost	Yearly Cost	Yearly Cost Avoidance
Regional	$1.4247	398,000,000	$567,013.70	$206,960,000.00	$41,392,000.00
Small	$1.7096	398,000,000	$680,416.44	$248,352,000.00	*NA*

In reality, even with the implementation of a targeted program of consolidation of existing facilities and coordination of new capacity, most areas would have a mix of facility sizes.

[5] As estimated by the US Census Bureau at http://quickfacts.census.gov/qfd/states/48/48201.html.

[6] Hopkins, Lewis D., Knaap, Gerrit J., and Xu, Xiaohuan. "Economies of scale in wastewater treatment and planning for urban growth." Environmental and Planning B: Planning and Design 31 (2004):879-893.

However, as these scenarios depict, the closer the ratio is to dominance by small facilities, the greater the cost.

Life cycle costs for small plants are relatively greater than for larger plants. Smaller plants often bear greater financing costs for upgrades and repairs, based on having less available capital and thus a greater need to sell debt. As their credit rating are not likely to be as desirable as larger, well financed regional plants, they not only must pay more in interest as they sell more debt, but must also pay a greater percent interest to do so (loan programs like the Clean Water State Revolving Fund notwithstanding). The cost of construction for a regional plant is not directly proportional to the cost of a smaller plant. Part of this is based on redundancy. While a regional plant has larger facilities, it has only one set of them. Therefore it bears an incremental cost increase for size rather than the cost of having multiple smaller units. (e.g., a large clarifier is not likely to be double the cost of a unit half its size.) This basic economy of scale concept effect is magnified over the life cycle of a facility.

There are also less tangible costs associated with the environmental impacts on our local waterways and resources. Contributions to bacteria and other pollutant loading in our waterways increase the amount and cost of environmental remediation that must be undertaken (via the TMDL process, etc). Increased pollutant loading from wastewater facilities contributes to detrimental impacts on local fisheries, oyster beds and recreational activities on the water, all of which bears repercussions for the local economy in terms of lost revenue and lost jobs. These losses represent, in turn, a decreased tax base for local governments and thus a potential decrease in services to local residents.

While a large part of the Region currently relies on groundwater for its drinking supply, the advent of Groundwater Conservation Districts and Subsidence Districts are leading a transition toward increased surface water use, especially in the Houston area. The quality of effluent discharged upstream can impact the type and extent (and thus, costs) of treatment for surface water users downstream.

Given the sum of these impacts, the current status of the Region's wastewater network accounts for an appreciable and ongoing cost to its economy and environment. Compounding the impacts of the current situation are projections of substantial continued growth throughout the Region.

IV. Growth

By the year 2035, the Region will experience a population surge of an estimated 3.5 million more people. Harris County alone will add an estimated 1.8 million more residents, with rates of growth even higher in the developing counties surrounding the Region's core[7]. Under the current

[7] Population estimates based on Houston-Galveston population forecast projections.

development paradigm, the existing challenges to the sustainability of the Region's wastewater infrastructure would be perpetuated and exacerbated.

While some of that growth will be infill in existing areas, much will be new development in outlying areas. Such development, apart from any required or incentivized regional coordination, is apt to follow the current pattern of small, non-contiguous treatment solutions. At 100 gcpd, that new population would represent a daily addition of 350,000,000 gallons of effluent to be treated. Using the assumptions from the hypothetical treatment scenario described in Figure 8, the yearly cost of treating just the added volume with small plants, in current dollars, would be $218,400,000. Comparatively, the equivalent cost of treating the new volumes with regional plants would be $182,000,000 representing a cost avoidance of $36,400,000. These numbers just account for the treatment costs, and do not include the economy of scale benefit available in the long-term savings on comparative construction costs. Again, it is clear that it is desirable to have regional facilities make up a much larger portion of the Region's total facilities than they currently do. If smaller facilities are utilized for short term expediency, there will also be a longer term cost when consolidation does occur. The costs involved in developing new areas with a regional paradigm in mind are less than the costs of retrofitting those areas once they have already been developed.

Beyond the potential economic impact of the coming population growth, continuing to develop under the current paradigm would contribute further to existing environmental impacts. The increase in wastewater flow, outfalls, and spills that accompany the growth carry with them a proportional increase in the pollutant loading to our local waterways. Focusing on consolidating old growth with a focus on coordinating new growth can limit the number of outfalls, provide for better regulatory capability, and a greater responsiveness and efficiency in treatment, all of which pay dividends in water quality for the Region.

The Region is currently at a vital nexus in the determination of its infrastructure future. Behind it lays the challenges of consolidating a large, diffuse patchwork of small facilities into a more efficient network, while ahead is the challenge of "getting ahead of the curve" of new growth. The lessons of costs incurred under the current situation serve as a poignant impetus for approaching the new era of growth with a proactive, regional perspective.

V. Hurdles

While the prevailing course of wastewater infrastructure development over the past four decades has not been toward consolidation, previous efforts have been put forth towards this end. The Texas Water Commission recognized the trend and developed a "regionalization" policy in the 1970s as a way to encourage long range planning of wastewater treatment service and reduce the reliance on individual wastewater treatment plants. The City of Houston (with support from representatives of the local development community) signed on to the concept in 1988 with Ordinance 88-81, and has enjoyed some limited success with several regional plants in the City limits and surrounding area. However, lacking mandatory adherence requirements and consistent application, this policy has not had the intended impact on wastewater treatment practices in the Houston area.

As the meager gains of the current policy have shown, there are significant hurdles to setting forth a paradigm of retroactive and ongoing consolidation. Between cash flow limitations in financing larger infrastructure, issues in coordinating non-concurrent growth, the desire for individual ownership and control of wastewater treatment facilities, logistical and financial challenges of retrofitting in developed areas, and the lack of cohesive Regional enforcement or incentive, consolidation efforts must overcome some weighty impediments. However, when considered against the potential costs of inaction, these hurdles are not insurmountable.

Financial Hurdles

- **Lack of regional funding mechanisms** is a primary financial impediment to realizing consolidation as a viable strategy. Cash flow limitations and relatively larger financing costs for smaller districts (based on less advantageous credit ratings, etc.) are strong short-term incentives to pursue small plant strategies. Previous efforts recommended seeking regional coordination, but provided no direct funding to assist utility districts, cities, and property owners with regional initiatives. If a group of local districts are better off constructing individual plants from a short term construction cost perspective, there is no regionally-oriented mechanism to bridge the financial gap to make regional facilities a viable option. While statewide infrastructure funding programs (Clean Water State Revolving Fund, et al.) exist, a lack of regional coordination still leads to entities having to fund joint projects in a separate and disjointed manner.
- **Costs of redevelopment** are a unique challenge for retroactive consolidation, as land or easements available for a plant site and collection lines may be limited, involve indirect pathways, and be more expensive. Additional costs, increasing with density, are incurred in working in developed areas as compared to equivalent work done on virgin land. Thus while density in developed areas, especially near the Region's core, may make consolidation attractive, working within the confines of a fully developed area has greater associated costs.
- **Existing OSSF** communities represent a substantial cost to remediate or integrate into a consolidated wastewater network. However, they can have a pronounced impact on public health and bacterial contamination in local waterways. While some new development in more rural areas of the Region is continuing to utilize OSSFs, a significant portion of existing OSSFs are in denser areas of unincorporated Harris and neighboring counties. Additionally, many of these communities are economically disadvantaged, making funding for remediation or sanitary sewer replacement harder to generate.
- **Incentivizing consolidation**, outside of a mandated requirement, must overcome the inherent financial incentive for developers to pursue the most expedient course. Because a developer is focused primarily on the short term, development-specific costs of providing a treatment solution (especially when utilizing funding mechanisms like MUDs), small package plants are an attractive alternative. They do not require coordination with local political subdivisions (development in an ETJ notwithstanding), and they represent low up front construction costs. Participating in a regional plant, while avoiding long-term costs on a regional scale, incurs extra costs and/or time up front. The developer will not bear the life cycle costs of the infrastructure, and therefore

does not need to consider the cost avoidance involved in upsizing transmission infrastructure, etc. to accommodate future regionalization. Absent an incentive or requirement to coordinate or plan for future consolidation, there is an inherent incentive for developers to utilize smaller community-specific plants.

Developmental Hurdles

- **Timing of growth** (except for districts in the same master-planned communities) is rarely concurrent, especially under the "leap-frog" developmental pattern. While a developing area may eventually have several adjacent districts, each district needs treatment service as it comes online. Unless the communities fall under a single developer or are in the ETJ of a City with strong developmental oversight, upsizing infrastructure for future consolidation bears no short-term incentive.
- **Development patterns** in the Region, as a whole, have involved rapid outward expansion. Instituting a consolidation policy that operates on another paradigm may leave a discrepancy between the ideal growth of wastewater infrastructure and the pace and distribution necessary to fulfill the prevalent consumer demand for type and location of community.
- **Optional adherence** to any consolidation effort, without incentives, has not proved a viable model for promoting regional coordination. The lack of a compelling Regional authority or incentivizing body would leave any consolidation/coordination policy to rely on voluntary adherence to a developmental paradigm against which a strong financial incentive exists. No such fully regional framework exists at this time.

Control Hurdles

- **Individual control** is an issue that often compels cities and utility districts to continue to operate small wastewater treatment plants. For these entities, diverting flow to a better-equipped, larger facility may involve relinquishing control of operations to an outside entity (a neighboring utility district, city, or regional wastewater provider). By having sole control over a plant, a city or district can control operation and maintenance expenditures, and ensure that available capacity exists for future growth within the city or district.

Coordination Hurdles

- **Growth in unincorporated areas** promises to be a substantial component of the new development projected for the Region. While municipalities like the City of Houston have some control over development in their ETJ, such control is far less in county areas not under the influence of potential coordinating entities. Without a Regional or county level coordinating entity, influencing external growth will be a limited proposition. As growth pushes out past municipal limits and ETJs, consolidation will be increasingly more difficult to institute ahead of the curve.
- **Lack of a coordinating entity** deprives a group of districts/developments the benefit of a long range planning perspective and a sense of context. Small districts/developers may

not have the resources to investigate and pursue regional facilities. Even when resources are available, doing so separately represents a duplication of effort. Without a central point of contact, it is more difficult for potential cooperating entities to envision, plan, and implement regional solutions.

Any proposed solution to the Region's wastewater issues needs to account for these hurdles in a way that acknowledges them, but seeks to surmount, rather than avoid, potential points of conflict.

VI. Potential Regional Solutions

The uniting thread that runs throughout the impediments to promoting coordination of wastewater infrastructure planning is the lack of any centralized regional guidance. The lack of a regional entity or shared set of policies to provide funding mechanisms and guidance for both retroactive consolidation and the shaping of new growth hinders the Region's ability to promote sustainable long term wastewater solutions.

Even so, there has been some limited success in implementing regional solutions that points to an ability to make such initiatives work in the Region. There are several regional wastewater treatment plants that were constructed and operated through cooperative agreements between utility districts, municipalities, and private property owners ranging in size from smaller facilities serving multiple utility districts to large municipal plants with capacities in excess of 100 MGD. The City of Houston has diverted and abandoned many smaller plants over the years that were acquired through the annexation of utility districts including the Willowbrook Regional Wastewater Treatment Plant which took four small plants off-line and is providing additional capacity for future growth in the area. The City of Houston's Turkey Creek Regional WWTP, which serves the City of Houston along with several Harris County MUDs and various other users, handles flows well in excess of 10 MGD. Additionally, Harris County and the Harris County Flood Control District have adopted a new formal policy on consolidating exist plants and planning for a regional future[8]. The stated goals of the policy are to reduce "the number of water and wastewater treatment plants and…pollutant loads to waterways" through an affirmation and clarification of previous efforts. The success of these projects is primarily due to strong leadership by a larger entity, in the case of the City of Houston, or forward-thinking planning by entities in developing areas. However, neither of these solutions deals with all of the five primary hurdles to implementing a regional solution: **need for adherence, financial considerations, developmental pressures, control concerns and lack of a coordinating regional entity.**

In consideration of potential ways to build upon past successes toward a more regional approach, the following are four potential approaches to solving the challenges that the Region faces: a continuation of the status quo, a coordinated set of enhancements to existing voluntary efforts,

[8] "Water and Wastewater Regionalization Policy for Harris County and Harris County Flood Control District", as passed on April 8, 2008. It should be noted that this policy only applies to facilities owned by, or to which funding is provided by, the County.

enacting a mandated process through state legislature or individual counties (potentially akin to the Subsidence District mandate for groundwater conversion), or the creation of a hybrid mandatory/voluntary model of regional entity to guide and incentivize coordination and consolidation.

Status Quo

As shown, a continuation of the status quo has significant ongoing costs and is arguably detrimental to the long term sustainability of the Region's growth, prosperity and environmental quality. With no sign of growth slowing in the coming decades, a continuation of the current pattern will only exacerbate the existing problems. While previous efforts to promote regional consolidation and coordination have not been wholly without success, voluntary adherence and conflicting incentives have been primary hurdles to implementation.

The benefits of the status quo, from a local perspective are short term expediency, perception of local control, and freedom from potential time constraints and hurdles of coordinating new infrastructure. However, these short term benefits lead to significant long term costs, many of which, as discussed are not able to be projected by the single entities. The negative externalities of the status quo include the loss of efficiency, long term duplication of infrastructure and rehabilitation, greater environmental impact, greater regulatory response, and greater indirect impact on local economies (fisheries, etc).

The status quo, by its nature, does not overcome the five hurdles to regionalization. Rather, it creates an ongoing pattern that would make any future effort harder to implement.

Enhanced Voluntary Measures

The second potential approach is an expansion of existing, primarily voluntary, policies. The intent under this approach is to draw on past and current regionalization efforts, including the 2008 Harris County policy and ongoing efforts by the City of Houston, while taking a step further to produce a more comprehensive regional guiding force. This could be achieved through an agreed-upon set of policies that maintained a constant approach to regional coordination and consolidation across political boundaries. However, this approach would ideally be spearheaded by the creation of a regional entity, or coordinating body of local representatives in order to ensure a self-perpetuating guiding force. While individual entities can exercise some degree of control over development within their boundaries, either aspect of a regional approach would require that they develop a common or complementary set of principles.

The fundamental nature of a voluntary solution would be based on incentivizing development of regional wastewater solutions by providing clearly defined policies, development coordination, guidance, coordination of funding to overcome cash flow limitations, and a regional perspective. Specific actions performed by a regional entity that embodied these principles might include serving as a focal point for existing funding sources (CWSRF grants/loans, etc.), providing planning support for interested parties, conducting cost-benefit analyses on select consolidation opportunities, and providing a regional voice for disseminating information and consolidating support for regional coordination policies. Examples of similar entities are voluntary collective organizations like Chambers of Commerce, nonprofit advocacy organizations and Councils of Government (CoG) which provide support for member entities and/or advocate as a collective. Funding mechanism options may be more limited for such an organization, as it would not derive

direct revenue from regulated entities (as compared to a local or state government or service provider). Potential options would include private fund-raising as a non-profit or a cost-sharing arrangement similar to a CoG, and would most likely rely heavily on grants from other sources to incentivize regional wastewater solutions. While this would allow an organization to provide some measure of incentives, the funding would not necessarily be constant, and this the long term consistency of its influence may be variable.

A successful example of this approach has been the Watershed Protection Plans (WPPs). Funded by EPA nonpoint source program funds administered by state agencies, the WPPs are locally led, stakeholder-driven processes. More to the point, they are voluntary regional approaches to meeting shared concerns. Groups of local stakeholders identify concerns in their watershed and design and implement a Plan to address them. The WPPs provide a funding mechanism, regional perspective, and coordination of local efforts. While some are directly related to mandatory processes in the watersheds (TMDLs), some are implemented in watersheds where impairments do not yet qualify the water bodies for regulatory action, as a preventative measure (e.g. Bastrop Bayou). In either case, while they may be impacted by regulatory efforts, they exist separate from them. However, the ability to create and implement a WPP is often solely dependent on available grant funding.

This approach in general relies heavily on voluntary cooperation between local entities. As this has been a limiting factor in the past, the efficacy of the new efforts as a sole solution may be equally limited. Absent a mandate from either the public or a regulating body, the ability to implement these voluntary measures may be subject to resistance based on perceptions of equity among the diverse areas of the region, preference for local control, and the ability of the body to provide sufficient funding to incentivize its goals. Even if existing entities are able to agree on a common set of regional principles and methods for incentivizing them, new entities are arising at a rapid pace as new MUDs and other districts form with new development. These new entities would not be party to any original agreement, thereby limiting the scope and reach of the influence of any guiding regional entity. However, any progress toward consolidating existing facilities and coordinating new ones would be valuable.

Active political resistance to a voluntary organization or coordinated set of policies would likely be less than to mandates from a regulatory body, although lack of active political support could be equally daunting. In terms of the primary hurdles to implementing a regional solution, a voluntary regional organization, or coordinated set of similar policies across the region, would be able to allay concerns over local control to some extent. It would also help overcome developmental hurdles by providing guidance and coordination, and provide some. It does not inherently provide for guaranteed adherence, and therefore would only be as successful as the commitment of its member entities is strong.

Mandated Requirement

There are some regulatory tools and mandated processes already in place to address wastewater infrastructure development and its impacts, although most deal exclusively with the environmental aspect of the challenges. For waterways on the state's list of impaired waterways (303d), the TMDL process can result in changes to wastewater treatment plant limits. Additionally, the State has the ability, via the TCEQ, to regulate, find liable and force remediation of plants that have experienced spills, overflows or other events that negatively

impact waterways. However, these controls are primarily based in acute environmental impact. While the TMDL may consider the cumulative nature of the plants within its delineated area, regulation via the TCEQ is primarily focused on violations on the single-entity level. Neither is based on the perspective of a regional level, nor do they regulate for economic concerns. Because of the limits of scope of these tools, and their stated purpose of dealing with direct environmental impacts, they do not solely encompass the fully comprehensive regional solution that is required. Instead they are best viewed as a part of the whole.

On a more local level, counties have some degree of control or influence over development within their boundaries, as do municipalities within the confines of the city limits or extraterritorial jurisdiction. However, as with TMDL restrictions based on a single watershed, these restrictions do not equate to a coordinated regional effort. However, these pathways of control are also potentials parts of a greater comprehensive solution.

The advantage a mandated solution has is that it ensures an impetus for change. An example is the Subsidence District/Regional Water Authority model. Concerns over ground subsidence in Harris, Galveston and Fort Bend Counties lead to the creation of Subsidence Districts that regulated groundwater withdrawals. To meet the mandates of the Subsidence Districts, many separate water suppliers joined together to form Regional Water Authorities and other conglomerated groups to pursue a shared solution they might not be able to feasibly implement on their own. While all of the entities were potentially impacted by subsidence, the issue was regional in scope, and did not by itself provide sufficient impetus to prompt single entities to act on their own. Essentially the impact of the problem was too diffuse to overcome the inertia of the status quo. Without the mandate of the Subsidence Districts, it is unlikely any of the regulated entities would have singly decided to incur significant costs in pursuing groundwater reduction strategies.

It is clear that a mandatory solution overcomes adherence issues experienced by previous voluntary approaches. The existing models (Subsidence Districts, TMDL), however, do not necessarily provide regional coordination and guidance, nor do the aforementioned examples provide funding/investment support to foster regional projects. While the Subsidence District model did spur the development of regional water projects, their creation was largely due to varying degrees of local leadership rather than a coordinated effort. The creation of a wastewater infrastructure development district for the region, or aspects thereof, would involve significant cost and political capital. Outside of a publicly visibly concern like subsidence, the support for such an effort would be hard won. While regional efforts aimed at circumventing the hurdles of regional coordination and consolidation through incentives would seem a better match for the political and developmental character of the region, a mandatory approach may be necessary if additional voluntary measures prove insufficient. If such action proved necessary, it would be preferable that any regional district created should also play a more direct role in providing guidance and funding to spur regional solutions. The Subsidence District model, while prone to generating political resistance, may serve as a good basis in that eventuality. If not a solution unto itself, it may help provide the impetus for driving the creation of regional solutions.

Hybrid Authority

The “hybrid model” approach to these regional challenges is based on an examination of the strengths and weaknesses of the three previous approaches. The status quo, some localized

efforts notwithstanding, will only exacerbate the situation. Enhanced voluntary measures, including a potential regional organization, help to overcome some hurdles but lack the sustaining impetus of a mandate. A mandated approach guarantees adherence, but is politically harder to install and does not necessarily provide the guidance, funding support or perception of local control that is embodied by a voluntary approach.

In the voluntary efforts example of the Watershed Protection Plans, local entities were empowered with control over their watershed through the stakeholder driven process. The WPPs themselves served as a coordinating point for local activities, and provide a funding mechanism. However, while the WPPs provided local control, regional coordination, and funding mechanisms, the funding is not self-perpetuating and the model relies on active political and local support. The WPPs also utilize a coordinating regional entity that is lacking in current wastewater regionalization efforts. While a similar approach would be ideal for wastewater consolidation and coordination efforts, previous experiences have indicated that a mandated impetus may be necessary to overcome adherence issues. Furthermore, unlike mandated approaches, voluntary efforts have no mechanism to disincentivize contrary efforts.

In the Subsidence District/Regional Water Authority example, a mandate provided the impetus for incentivizing Regional coordination. The end result was voluntary conglomerations of water users seeking regional solutions. While the manner in which the entities met the mandates was flexible, the ability of the District to disincentivize failure to comply was a key part of the impetus. However, that impetus was not directly linked with regional guidance and funding mechanisms that the resulting groups they would employ. While the Subsidence Districts welcomed cooperative efforts, their role did not extend to coordinating, fostering, and funding the resulting groups. It was left to local leadership to bridge the gap between mandate and solution.

While both examples were relatively successful models, a hybrid possibility between the two exists. A feasible hybrid combination of these two approaches would ideally include a coordinating regional entity, a consistent funding mechanism, meaningful local input, a sustainable impetus (be it a mandate, the threat thereof, or a coordinated agreement among local parties codified in policy), a regional perspective, technical expertise, and the ability to incentivize coordination and consolidation while reserving the potential capacity to disincentivize contrary efforts.

A realistic evaluation of the multi-faceted, sometimes fractious, political nature of the region and the lack of widespread support for previous efforts would seem to indicate that some form of continuing impetus would be needed to ensure the long term sustainability of this approach. Based on past efforts in the Region, an understanding of the existing impediments to regional efforts and an evaluation of potential alternatives, the recommended approach to dealing with the regional wastewater challenges we face is the creation of a Regional Wastewater Authority. As shown in the lessons taken from the Subsidence District and Watershed Protection Plan models, a Regional Wastewater Authority imbued with the ability to create a mandate to create impetus, while focused on a stakeholder-lead regional perspective to achieve support, best fits the unique nature of the Region's wastewater challenges.

VIII. Regional Wastewater Authority

Previous studies have evaluated how a Regional Wastewater Authority might operate. A 1989 Turner Collie and Braden report on regional wastewater infrastructure planning identified several ways to institute this approach, including the creation of a regional authority that could help facilitate purchasing sites, over-sizing sewer lines, and regulating relations between utility districts, cities, and property owners. A previous white paper from the H-GAC described a Regional Authority based on coordinating development and subsidizing consolidation and upsized infrastructure. There are a myriad of potential forms a Regional Authority could take, based on the needs and preferences of the wastewater service entities whose support would be necessary.

Recommended Alternatives

The use of a "hybrid" model approach for a Regional Wastewater Authority could take one of two general forms. Either an enforceable mandate could be integrated and active from its inception or a voluntary model could be used initially with a mandate held in reserve. The former may be less palatable, politically, but would ensure adherence while the latter would foster a sense of local control and may be easier for local entities to accept. The compromise position between these two archetypes is a Regional Authority that has a trial period in which voluntary efforts are applied. At the end of the trial period, failure to meet pre-determined goals (based on evaluation of metrics like membership, funding availability, etc.) would act as "triggers" to initiate a mandate for additional impetus. In this format, the pending imposition of a mandate serves as an impetus for local entities to cooperate with voluntary measures.

Either form would need to carefully consider the current hurdles and adapt strategies to directly address them. To overcome the current hurdles issues of local control, a regional authority would need to likely not own or operate any treatment works, but rather serve a coordination and facilitation function. The primary focus of such an approach would be to provide the tools (funding, coordination, etc) and guidance local entities needed to pursue regional solutions. Towards that end, the role of a Regional Authority would be based on two primary functions: evaluating and facilitating targeted consolidation efforts, and providing incentives/disincentives and regional leadership for coordination efforts. The former would involve cost-benefit analysis of potential consolidation projects, lining up funding to assist in the transition, and serving as a regional advocate for the effort. The latter would involve coordinating among new developments to fund or incentivize regional plants, funding incremental costs of upsizing infrastructure to allow for retroactive consolidation, and establishing relationships with new entities as they emerge.

Potential Funding Mechanisms

One of the crucial elements affecting the efficiency of a proposed Authority is the availability and consistency of funding. Depending on the final form an Authority took, a range of funding options is available.

- **Grants/Loans -** As a Regional entity, the Authority could serve as a focal point for CWSRF funding and other grant programs, which it could use to facilitate consolidation

and coordination/upsizing of new growth. Potential grant or loan sources include the aforementioned CWSRF loans, USDA Rural Utility Service program funding, grants form philanthropic organizations, and other local, state and federal wastewater funding sources (ARRA stimulus, etc).

- **Member Entity Dues –** Similar to the CoG model, a Regional entity could utilize dues from its participant organizations as a primary source of operating capital. This would likely need to be supplemented by other sources for larger projects and may limit the scope of the Authority's efforts. However, it would provide consistent funding and could provide a "turn-key" solution for local entities from the standpoint of cost avoidance.
- **Development Impact Fees –** There are already established impact fees for new development (e.g., utility infrastructure impact fees collected on the municipal level). Using this model, a Regional Authority utilizing a mandate model could generate an impact fee from new development. More detailed economic analysis is necessary to determine the best means of assessing this type of fee, but potential metrics include new permitted wastewater capacity, projected population at build-out, or acres of "greenfield" (i.e., undisturbed or undeveloped land from which ecological services are obtained) area developed. The latter could also serve to promote density (and thus more feasible consolidation) through incentivizing infill and disincentivizing "leapfrog" growth patterns. However, equity issues would need to be considered if impact fees from new development are used to facilitate consolidation of existing facilities.

Successful implementation of this approach would likely utilize more than one source to ensure robust and consistent funding. A recommended approach would be to utilize development impact fees to facilitate coordination/upsizing for new wastewater infrastructure development, supplemented with grants and member dues to help facilitate consolidation efforts.

Additional Elements

Regardless of the final form an Authority may take, there are additional elements that should be considered for their impact on the growth of wastewater infrastructure demand. While not all of these factors may fall under the purview of the proposed Authority, they are worth considering as potentially beneficial alternatives to building additional capacity and infrastructure.

- **Conservation –** While estimates of water "waste" (and thus excess wastewater) vary, there is some appreciable degree of water use that could be curtailed through more comprehensive conservation initiatives. A Regional Authority could assist water and wastewater service providers by providing information and programmatic elements to enhance and coordinate local conservation efforts. Conservation can reduce wastewater flows and impacts on local watersheds, garnering economic and environmental benefits.
- **Density –** The developmental model of the Region, especially in the urban cores and suburban rings, is relatively low density compared to some other urban areas. Lower density means more miles of wastewater collection infrastructure, and less feasible consolidation options (due to increased distance between potential collaborators). While promoting density has a host of benefits for our Region, its specific benefits for wastewater infrastructure are economic advantages related to greater ease of consolidation, and environmental advantages related to preservation of ecological services. Denser development means less "greenfield" areas are disturbed to

accommodate growth, resulting in a greater preservation of ecological services, including natural mechanisms to maintain water quality.

- **Effluent Reuse** - With the advent of groundwater conservation districts and subsidence districts in the Region, an increasingly finite water supply has made reuse of wastewater effluent for non-potable purposes increasingly more economically attractive. Use of treated effluent to replace or supplement existing water supplies could help decrease discharges (and impacts) to local waterways and help meet future regional water demands.

IX. Conclusion

Coordinating new wastewater treatment development and consolidating existing small facilities is a goal that is faced with a substantial series of impediments. As past efforts have shown, the lack of a strong compulsory or incentivized program of adherence, there is little natural incentive for local entities to pursue consolidation/coordination on their own. Utilizing single-entity, small-scale plants is often more expedient and cost-effective in the short term. Combined with a desire for local control and decision-making authority and the "leap-frog" nature of growth in the Region, seeking to coordinate wastewater development may seem an insurmountable uphill battle.

However, even given these considerations, failing to pursue consolidated plants and economies of scale can have a significant long term impact. The development of Cypress Creek is a prime example of a lost opportunity for coordinating wastewater infrastructure for new development. As the area was developing in the 1970s, the Gulf Coast Waste Disposal Authority and San Jacinto River Authority made proposals for a regional wastewater treatment system. The initiative was strongly resisted by developers and municipal utility district boards due to the cost for conveyance of wastewater to regional plants, and the possible loss of autonomy. It was determined that the cost of conveyance infrastructure would outweigh that of individual treatment plants. This situation was exacerbated by spot, or "leap frog", developments that made a regional wastewater system difficult from a cost perspective. As a result, The Texas Water Development Board (TWDB) and Texas Water Commission (TWC) abandoned this concept and issued permits for small, individual treatment plants in the watershed. Today, there are over 85 domestic wastewater treatment plants in the Cypress Creek Watershed, the majority of which are small and intermediate sized. Cypress Creek, along with a significant portion of the other waterways in the Region, is impaired by bacterial contamination. The costs of the regulatory consequences (TMDL, etc.) and retroactive consolidation of smaller plants will outstrip the costs of proactive coordination.

A Regional Authority model bears the most promise as a guiding solution for the coming decades. While a regulatory mandate approach may not best fit the character of development in the Region as a sole solution, it may be a necessary element to ensure adherence. The need for a regulatory mandate could be integrated into a solution or held in readiness should voluntary measures prove ineffective, "triggering" its implementation. However, there is ample opportunity to provide guidance and meaningful incentives for shaping wastewater infrastructure development on a voluntary basis. Funding mechanisms could include contributions from member entities, new development fees, discharge fees, and/or coordination of grant funding

from other sources. The final mix of funding strategies will be dependent on the nature of a regional entity most preferable to local decision-makers. If necessary, the Authority could undergo a trial period in which it serves a select area of the Region (preferably the Regional core centered on Harris County) and then is subsequently expanded if it proves effective and/or necessary for outlying areas.

Under such an initiative, a Regional body could coordinate facility development for groupings of new development and analyze and selectively target older small systems for consolidation. Backed up with integrated funding mechanisms a regional entity could provide a regional perspective and coordinating point for a more comprehensive approach to shaping infrastructure growth. The resources and credibility of a specialized regional entity could help bridge the gap for smaller entities that have limited resources and/or may have concerns over control. As noted, this model has proved effective with the Regional Water Authorities. Whatever final form such an entity takes, the support of local political and developmental communities will be key to its success.

Before a Regional Authority proposal could be implemented, more comprehensive study should be completed. While this paper provides an overview, more in-depth analysis should be performed to provide greater detail on the environmental and economic impact of the current wastewater paradigm. More robust empirical evidence of wastewater impacts on water bodies and detailed and localized cost-benefit evaluations of consolidations are necessary to build a more specific case for this approach. While the arguments in favor of consolidation and coordination are valid and significant, there are dissenting opinions on the desirability of these approaches that should be further explored.

As the Region prepares for continued expansive population growth, it is at a critical juncture in its developmental process. Coordination of new wastewater development and selected consolidation of older systems promises to yield both short term environmental and economic benefits and also the long-term benefits of shaping growth along a more sustainable paradigm.

Recommendations Summary

- Further document evidence of water degradation, environmental benefits of regional coordination, and economic costs of inaction to illustrate need for change.
- Create regional wastewater coordination/consolidation policy
- Establish a regional wastewater authority to provide financial incentives, funding mechanisms, regional perspective, guidance modeled on the Regional Water Authorities
- Consider disincentives for small plants in the future
- Include all domestic plants in regional coordination efforts, not just municipal plants
- Selectively target old, small, and or failing systems for retroactive consolidation
- Seek to incorporate conservation, effluent reuse and other practices
- Coordinate with other related planning efforts (LID,LEED, promotion of density)
- Act soon