Texas Water Development Board

City of Sugar Land
Contract Report No. 1148311259

Decentralized Wastewater Treatment in the City of Sugar Land and Sugar Land's Extra Territorial Jurisdictions

Final Report

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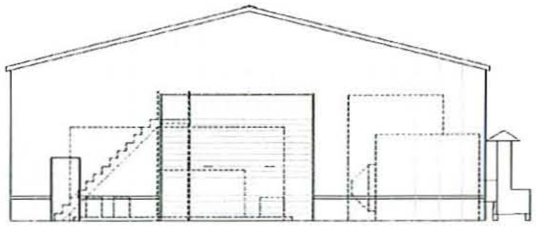

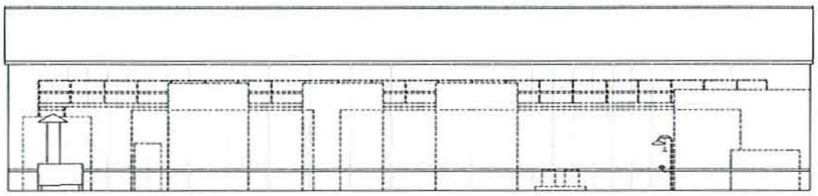

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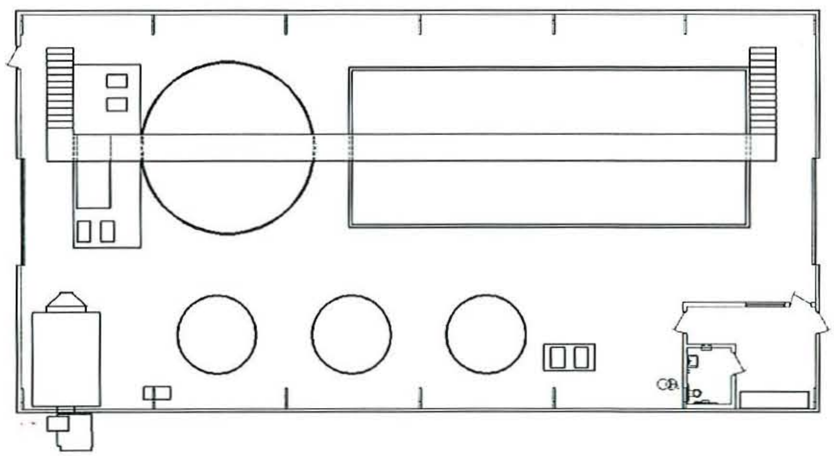

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Texas Water Development Board

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1 Executive Summary

Texas has relied heavily on groundwater resources to meet its need for potable water. The primary reason is that the majority of the state is underlain by aquifers that are readily accessible and contain water that is uncontaminated and requires minor treatment for use as a source of potable water. As the years have passed, growth in the state has put pressure on these groundwater resources, forcing many communities to begin using surface water as an alternative to meet the public need. As population and demand will continue to increase, both groundwater and surface water sources will be hard pressed to meet the needs of a growing populace and industrial base. This is true not only in Texas, but throughout the United States and the world. While once it was believed that we had an unlimited supply of fresh water, it has become apparent that we are rapidly approaching a point where available resources will not be able to meet the needs of a growing population without a philosophical change towards managing and use of our water resources.

The Texas Legislature created the Harris–Galveston Coastal Subsidence District (HGCSD) in 1975 and the Fort Bend Subsidence District (FBSD) in 1989 to regulate groundwater resources and control land subsidence. The goal of HGCSD and FBSD is to reduce groundwater use. They did so by setting mandatory limits on groundwater withdrawals and requiring conversion to alternative sources. As these conversion percentages take effect, the strain on other sources of water, particularly surface water, will increase. The drought conditions recently experienced in Texas revealed that there are limits to our resources and that it is time to throw away the book of past practices and look for new ways of meeting the water needs of the State.

In light of these facts, the City of Sugar Land and the area under its Extra-Territorial Jurisdiction (ETJ), created a *Goundwater Reduction Plan* (GRP) for meeting future water needs within the constraints of the goals established by the state of Texas and the FBSD. To aid in this process, this study was authorized to investigate the possibility of using decentralized wastewater treatments plants (Scalping Plants) as an alternative source of water and a means of helping to meet the City of Sugar Land's GRP. The purpose of this study was to investigate the feasibility of using 0.05 and 100,000 gpd wastewater treatment plants as a source of reclaimed water for irrigation and industrial users. The three primary objectives of this study were:

- Research the use of decentralized wastewater treatment facilities in use throughout Texas, the United States, and other countries. While doing so, examine the types of wastewater treatment technology that could be effectively used in this application.
- Determine the potential for construction and operation of small decentralized wastewater treatment facilities by evaluating the existing wastewater collection and treatment system, evaluating possible sites for installation of such a facility, and identify the construction and Operation and Maintenance (O&M) costs of treatment technology best suited for this application.
- Determine the potential impact of decentralized wastewater treatment facilities by evaluating the permitting requirements associated with these facilities, the effect of these facilities on the wastewater collection system and treatment plants, comparative costs of reclaimed water versus other "Alternative Sources" of water, and the potential impact to the City of Sugar Land GRP.

The final task would be to make recommendations for pursuing decentralized wastewater facilities as a means of meeting the City of Sugar land GRP.

After completing the study, it was found that there are many locations where effluent from wastewater treatment plants is being reclaimed and used for irrigation, industrial use, and as a source of potable water. The size of these plants ranged in size based on their designated purpose and use. However, very few of these plants were operating as decentralized facilities, with the majority of those that were operated in this capacity used not only as a source of reclaimed water, but also as an educational location for people to see how wastewater is treated and the potential for its use. From review of these plants and other sources, it was determined that two processes best fit this application. Those two processes were the activated sludge process (ASP) and membrane bio-reactors (MBR). Most of the plants identified used one of these two processes, with the decentralized facilities all using the MBR process.

After identifying five potential sites for installation of these small decentralized wastewater facilities, each site was studied more closely. It was found that three of the sites were prime locations for current and future installation of these facilities, while the other two were found to be better served by installing a reclaimed water facility at a nearby wastewater treatment plant (WWTP). After reviewing the two process technologies, ASP and MBR, it was decided that even though the MBR process is cleaner and has a smaller footprint that the ASP process would be recommended due to its lower costs and familiarity in operation. It was also seen that while the 50,000 gallons per day (gpd) plant was very expensive, the cost of the 100,000 gpd plant showed greater promise. Because of this, a 200,000 gpd plant was added to the study to see what affect size had on the feasibility of installation of these facilities.

While extensive, the permit process for these facilities was not found to be a major obstacle to use of these plants, as long as sufficient planning and design was done before submitting the application. The effects of these facilities on the wastewater collection system were mixed, based on the number of facilities installed both in existing and future developments. Acceptance and aggressive use of these systems would significantly impact future collection system projects, both their size and costs. The effect on the domestic wastewater treatment plants were minimal except for the North WWTP, where aggressive use of reclaimed water facilities could drastically change current plans for the City of Sugar Land and the future use of the North WWTP.

The most amazing finding in the study was once costs were determined, and a comparison was made between the various sources of water, it was found that the cost of reclaimed water from a 200,000 gpd plant had one of the lowest costs, making it a viable alternative for installation. The 100,000 gpd plants were found to be on the borderline between being discounted as being too costly or considered for future use. More serious design planning would need to be completed to determine its feasibility. However, it was clear that 50,000 gpd plants were too costly and should not be considered in future plans.

Finally, several recommendations were made for use of these facilities both in current and future plans for the City of Sugar Land. It was found that use of reclaimed water is a viable source of water for the City and should be aggressively pursued and planned for in current and future plans. These recommendations also included present and future sites for installation of these facilities, installation of reclaimed water facilities at all existing wastewater treatment plants, and the development of guidelines for all new residential and commercial developments.

2 Introduction

Shortage of freshwater is an increasing problem faced by many parts of the world. Rapidly growing population in Texas and the Houston area has placed a strain on the existing water sources. Reuse and reclamation of wastewater promises to be a viable option to supplement groundwater or surface water. It also eases the strain on the existing domestic wastewater treatment plant, and reduces the costs associated with further expansion of the treatment plants. Further, reuse technologies such as Membrane Bioreactors (MBRs) occupy very little floor space and can be housed in residential areas, which is an advantage in urban areas.

Decentralized wastewater systems, also referred to as onsite or septic wastewater systems, are so called due to their location away from the main domestic wastewater treatment facility. They are typically present close to the source, such as individual homes and businesses, and also include systems that serve clusters of individual homes, large capacity septic systems, and small collection and treatment systems including package plants. (USEPA, 2005)

This report will deal with a specific kind of scalping or decentralized treatment plant that will draw wastewater from a main trunk line as a side stream, treat it to a high quality standard and distribute it to facilities that will use it for irrigational and industrial purposes.

2.1 Goals/Objectives

The main goals of this report are to study and present the feasibility of the installation and use of scalping plants in the City of Sugarland, discuss various treatment technologies that can be used for scalping plants, and discuss the potential impacts of such plants. The three primary objectives of this study were:

- Research the use of decentralized wastewater treatment facilities in use throughout Texas, the United States, and other countries. While doing so, examine the types of wastewater treatment technology that could be effectively used in this application.
- Determine scalability of facilities and technology for volumes between 50,000 and 100,000 gallons per day (gpd), which is the anticipated size of proposed Sugar Land Scalping Plants.
- Determine the potential for construction and operation of small decentralized wastewater treatment facilities by evaluating the existing wastewater collection and treatment system, evaluating possible sites for installation of such a facility, and identify the construction and Operation and Maintenance (O&M) costs of treatment technology best suited for this application.
- Determine the potential impact of decentralized wastewater treatment facilities by evaluating the permitting requirements associated with these facilities, the effect of these facilities on the wastewater collection system and treatment plants, comparative costs of reclaimed water versus other "Alternative Sources" of water, and the potential impact to the City of Sugar Land GRP.

3 Decentralized Wastewater Treatment Technology

Based on an EPA report, various types of decentralized wastewater treatment systems including those that discharge into the ground or into surface waters account for treatment systems that serve 25% of the U.S. population and were used in one-third of all new housing and commercial developments as of 1997 (USEPA, 2005). Septic sewage systems made up a major portion of this, but decentralized scalping plants are beginning to be looked at as a viable alternative to centralized treatment systems. In Texas, water reuse has been occurring since the late 1800s. Initially it was used primarily for irrigation of agriculture, but presently it is also being used for power plant cooling water, commercial and municipal irrigation, river and stream flow enhancement, natural gas exploration activities, and augmentation of drinking water supplies (TWDB, 2011).

3.1 Facilities currently in Use or Planned

Although no entity in Texas currently uses reclaimed water for direct potable use, many entities use the water for Indirect Potable Reuse (IPR) and Non-potable Reuse (NPR). This section identifies and explains the processes used by a few centralized and decentralized wastewater reclamation plants that are operational in Texas, the U.S. and other countries.

3.1.1 City of Midland, Texas

The City of Midland proposed and designed the first decentralized wastewater treatment facility in Texas. The construction of this MBR Satellite Reuse Plant is proposed to start in June 2012. The plant is designed to treat 200,000 gpd to meet summer irrigation needs of Midland College and possibly other locations. An influent pump station (IPS) will use three 100,000 gpd pumps to pump wastewater from an existing 33-inch sewer line to the MBR plant through a 6-inch pipe. Preliminary treatment consists of fine screens at the headworks of the treatment unit and coarse screens provided at the IPS, along with a provision for a future grit removal system. A conventional activated sludge process (ASP) will be used for biological treatment, followed by, membrane filtration and chlorine contact basins for disinfection. The biological treatment and MBR treatment processes will be operated in 2 parallel trains to provide flexibility to build the plant in two stages. The treated water will be stored in a newly built 500,000-gallon ground storage tank for subsequent distribution (Purvis, Mathur, & Vandertulip, 2011). The total estimated cost of construction will be $6.6 million including the cost of the water distribution lines. Based on a conversation with Stuart Purvis, Director of Utilities, City of Midland, it was learnt that the facility has also been designed to allow the general public to tour, hence increasing the cost of construction to have a large footprint and increased aesthetics.

3.1.2 City of Anaheim, California

The city of Anaheim is building a water reclamation facility (WRF) that is anticipated to be completed by October 2012. The WRF is being built in 2 phases to reach a peak capacity of 130,410 gpd to produce 100,000 gpd of reclaimed water, thereby reducing their water imports by 35 million gallons every year. Grinder pumps will be used to pump water from the trunk sewer line in to the treatment facility. Pretreatment will consist of fine screens, after which wastewater will flow by gravity into the MBR unit. The MBR process is a 4-stage Bardenpho process with anoxic and post-anoxic zones to achieve low effluent total nitrogen concentrations. The effluent is then collected in a 500-gallon equalization tank followed by an ozonation system. UV treatment is the final step after ozonation. Odor control will be achieved by a carbon filter system with plain carbon media. The treated water will be used for landscape irrigation and other indoor and outdoor uses in future developments (Moore, 2009). The total construction cost associated with this plant is $6.5 million. Based on a conversation with Mike Jouhari, Water Operations Manager, City of Anaheim, it was learnt that, similar to The City of Midland, the high cost of construction is due to the fact that the plant is being built as a demonstrational facility for public viewing and is intended for marketing wastewater technology. Additionally, it has various sustainable features, and is located in a highly populated area next to the city hall.

3.1.3 Hawks Prairie Reclaimed Water Satellite Facility, Washington

The Martin Way Reclaimed Water Plant treats up to 2.0 million gallons per day (mgd) of wastewater to produce high quality water to serve the LOTT alliance, which is a regional consortium of the cities of Lacey, Olympia, Tumwater, and northern Thurston Counties in Washington. The plant has been designed to be aesthetically pleasing and compatible with its surrounding neighborhood, with most of the treatment process occurring in underground tanks, covered with above-ground eco-roofs. The satellite treatment facility, located on a 3.4-acre site, consists of the Martin Way Treatment Plant, the Hawks Prairie Reclaimed Water Ponds, and three miles of distribution pipes. The whole satellite system itself is a part of a 20-year wastewater resource management plan that consists of 3 satellite facilities that initially treated 1 mgd and will ultimately treat 5 mgd each (Cupps & Morris, 2005). The treatment technology consists of a MBR system for secondary treatment followed by UV disinfection. The total construction of the satellite treatment facility was $35 million. The recycled water is being used to fill lakes, recharge the groundwater and other irrigation purposes (LOTT Clean Water Alliance, 2010).

3.1.4 City of Tempe, Arizona

The city of Tempe commissioned the Kyrene Water Reclamation Plant in 2006 at a cost of $40 million. This is an example of a large-scale reclamation plant with a capacity of 9 mgd which meets the high quality of effluent standards used for irrigation of golf courses, groundwater aquifer recharge, cooling water at a generating station and other industrial uses. An existing conventional wastewater treatment plant was retrofitted with MBRs, along with other major upgrades to treat the water to reuse quality standards (City of Tempe, 2012). The preliminary treatment consisted of a grit removal system, 3 mm coarse screens, 2 mm fine screens and equalization basins. The secondary treatment that initially consisted of 2 clarifiers and sand filters was retrofitted with 4 parallel membrane trains for each clarifier. The membranes were directly inserted into the biological treatment tank rather than having them as a separate unit. The effluent is then sent to a UV disinfectant system and discharged directly into the water reuse system (GE Power & Water, 2012).

3.1.5 City of Odessa, Texas

The City of Odessa's wastewater reuse program was initiated in 1949, due to the shortage of drinking water arising from the arid climate. Initially, 3 mgd of primary treated wastewater was provided for irrigation. Additional secondary treatment units were added in the 1950s due to a demand from a petrochemical plant. In the 1980s, the quality of effluent was improved to meet Type I reuse standards. Currently, 6 mgd is reclaimed from the Bob Derrington Water

Reclamation Plant, where 3 mgd is used by a local industry in its cooling tower and fire protection and 3 mgd is used for irrigation purposes in golf courses, city parks, and one of Texas's first residential reuse projects. An activated sludge plant, combined with filtration and chlorine disinfection is used to meet Type I effluent standards (City of Odessa, 2012) (McReynold, 2006).

3.1.6 San Antonio, Texas

The San Antonio Water System (SAWS) started its water recycling plan in 1996 and currently has the country's largest recycled water delivery system. SAWS supplies 29 mgd of highly treated effluent to golf courses, parks, and commercial and industrial customers in the City through 80 miles of pipeline. The reclaimed water is also used to provide base flow in the upper San Antonio River and Salado Creek, which has helped in improving the aquatic ecosystems. SAWS uses three water reclamation centers, Medio Creek Water Recycling Center (WRC), Leon Creek WRC, and Dos Rios WRC, to achieve its capacity. While the Dos Rios and Leon Creek WRCs use conventional activated sludge facilities, the Medio Creek WRC uses extended aeration as the secondary treatment process, followed by chlorination as the disinfection process. Solids processing utilizes thickeners, anaerobic digesters, and de-watering by belt presses and drying beds. In addition to water reclamation, the biosolids generated during treatment are used to generate compost that is sold through local retailers, and 900,000 cubic feet of methane gas generated during treatment is sold on the open market (San Antonio Water System, 2012).

3.1.7 City of Lubbock, Texas

The City of Lubbock initiated a Type I water reclamation project in 2004, to deal with increasing water shortage due to a 10 year drought that started in 2002. Lake Meredith went from being the city's major water supply source (90%) in 1999 to contributing less than 5% in 2011 (City of Lubbock, 2011). Upgrades to the existing Southeast Water Reclamation Plant (SEWRP) were started in phases in 2005, and will be completed in 2015. Currently, the plant treats about 18 mgd to Type I quality effluent and discharges into streams. Integrated Fixed Film Activated Sludge treatment is used along with UV disinfection and filtration to produce high quality effluent (City of Lubbock, 2012).

3.1.8 City of Fort Worth, Texas

Due to an increase in the population of the Dallas-Fort Worth metropolitan area, one of the largest cities not built along a coastal area or a major waterway, the Fort Worth Water Department undertook a Reclaimed Water Priority and Implementation Plan in 2007. This plan studied various water reuse options including effluent from existing WWTP's and additional Water Recycling Centers (WRC's) or scalping plants and the associated uses for the treated water along with the cost associated with implementation (City of Fort Worth, 2007). Based on this plan, the Village Creek Water Reclamation Facility (VCWRF) was chosen to provide Type I and Type II reclaimed water to the City of Arlington, City of Euless, and the Dallas-Fort Worth International Airport. This plant has a rated capacity of 166 mgd. Apart from the water reuse, the biosolids are used for land applications, and the methane produced during anaerobic digestion is captured and used to generate electricity. This energy accounts for 90% of the energy required for the aeration of the plant. The plant uses conventional activated sludge process followed by sand filtration and chlorination to achieve a Type I quality effluent. Since the plant is located in a residential community, odor control is a major criterion. This is achieved by using wet scrubbers and carbon adsorption scrubbers, along with chlorination of incoming wastewater (City of Fort Worth, 2012).

3.1.9 Orange County Water District, California

The Orange County Water District's water reclamation project started in 1976 when Water Factory 21 processed activated sludge secondary effluent from the Orange County Sanitation Districts Plant No.1. This plant used lime clarification, re-carbonation, ammonia stripping towers, mixed media filtration, granular activated carbon, chlorination, reverse osmosis. This water was then pumped into a blending reservoir, mixed with deep well water, and injected into aquifers. Constructed at a cost of $481 million, their new groundwater replenishment system uses advanced tertiary treatment systems like microfiltration, reverse osmosis, and UV disinfection with Hydrogen Peroxide. This Advanced Water Purification Facility has been operational since 2008, can produce up to 70 mgd of treated water, and serves 600,000 residents in north and central Orange County. The treated water is further stabilized by decarbonation and lime addition to raise pH and add hardness and alkalinity. The water processed here is then injected into the Talbert Gap Seawater Intrusion Barrier, and Kraemer and Miller Basins. Monitoring of the Advanced Water Purification Facility has shown that the reclaimed water contains no pathogenic bacteria, viruses, or parasites, and continually meets all drinking water standards. Concentrations of pharmaceuticals, endocrine disrupting compounds, and trihalomethanes (THMs) are also reduced to very low or immeasurable levels, resulting in a higher quality of water than other sources in Orange County (Groundwater Replenishment System, 2012).

3.1.10 Irvine Ranch Water District, California

Irvine Ranch Water District produces reclaimed water through the Michelson and Los Alisos water reclamation plants that treat water to the standards specified in the California Water Recycling Criteria for high level non-potable uses. The tertiary treatment process consists of the addition of alum and polymers and dual media filters made from anthracite and sand. Reclaimed water is made available to a 181-square-mile service area, with a population of 330,000. Reclaimed water lines are installed in all new property along with domestic water and sewer lines. Older properties are retrofitted with reclaimed water when the service become available to them, adding up to 4,500 reclaimed water connections. The total capacity of the water reclamation plants is 20.5 mgd. Most of the reclaimed water is used for irrigation, with 80% of all business and public area landscaping occurring through reclaimed water (Irvine Ranch Water District, 2012).

3.1.11 Singapore NEWater Project

Singapore has been producing non-potable reuse water since the early 1970s and initiated its NEWater reclamation program in 1998 to raise their reclaimed water standards to surpass the World Health Organization (WHO) and the U.S. Environmental Protection Agency's (USEPA) drinking water standards. Currently, it provides non-potable reclaimed water to industries, and commercial buildings, and potable reuse through discharge to the raw water supply reservoirs. The water reclamation plants use ASP effluent and micro-screening, microfiltration, reverse osmosis with thin-film aromatic polyamide composite membranes, and UV disinfection to produce high quality effluent. Chlorine is also added before and after microfiltration to control membrane biofouling. All the water reclamation plants contributing to the NEWater project have a capacity of about 110 mgd. The total capital cost of the project was $2.2 million per mgd capacity. Annual operation and maintenance costs are about $985 per million gallons.

The NEWater project also involved a two-year health effects testing program to evaluate public health impact of unidentified and unregulated chemical contaminants. Studies conducted on mice and fish showed no carcinogenic or estrogenic effects. Additionally, grab sampling in various locations on the treatment train, to measure suitability as a raw water source, established a water quality that surpassed the benchmark set by WHO and the USEPA. Most of the parameters even had values less than the values for the potable water supplied through the Singapore Water Utilities Board (Singapore National Water Agency, 2012).

3.1.12 El Paso, Texas

El Paso's water reclamation and reuse efforts started in1963. The quantity of reclaimed water has been steadily improving and at present, contributes 5.83 mgd. This water travels through 26 miles of pipeline for non-potable reuse to various locations in northwest El Paso and through 4 reclamation plants, namely the Fred Harvey, Haskell Street, Roberto Bustamante, and Northwest Wastewater Reclamation Plants. Additionally, another 3.1 mgd is also used for in-plant uses and potable use through groundwater recharging. All the plants are equipped to meet Type I urban reclaimed water use. The Fred Harvey Water Reclamation Project has the following secondary treatment processes:

- Combination of conventional biological treatment along with powdered activated carbon (PACT ™) with a patented two-stage system process for secondary treatment that removes organics, and achieves nitrification and de-nitrification.
- High lime treatment to remove phosphorus and heavy metals
- A traveling-bridge sand filter to remove parasites and turbidity. Granular activated carbon is added during filtration to remove residual organics and improve taste, odor, and color
- Disinfected by ozonation. Residual chlorine is added to prevent biological growth after discharge.

The Haskell Street Wastewater Treatment Plant uses an advanced secondary treatment system, including energy efficient anoxic treatment basins, biological nitrification and a sand filter to meet Type I quality standards. The Roberto Bustamante Wastewater Treatment Plant uses advanced secondary treatment through extended aeration ASP, biological nitrification, and caustic air scrubbers for odor control. The Northwest Wastewater Treatment Plant uses lime stabilization for sludge processing, Ultraviolet (UV) treatment for disinfection, and caustic air scrubbers for odor control. The Northwest Wastewater Treatment Plant has the highest reclaimed water production and services residential irrigation uses (El Paso Public Utilities Board, 2012).

3.2 Wastewater Reuse Technologies

The ability to use decentralized wastewater treatment plants requires that all forms of current wastewater treatment technology be reviewed and a determination be made on the technology that lends itself best to the application. This section gives a brief account of the various technologies generally associated with wastewater reuse. 30 TAC, chapter 321 prohibits the use of treatment technologies like unaerated primary treatment units (including Imhoff tanks and primary clarifiers), trickling filters, pond or lagoon treatment systems, flow equalization basins, and unenclosed screenings storage containers for scalping plants; hence these will not be discussed.

3.2.1 Activated Sludge Process

An activated sludge process (ASP) is a wastewater treatment process that utilizes air and biological processes. A typical process schematic is shown in Figure 3.1. A pretreatment process is followed by secondary biological treatment, followed by filtration and disinfection. The pretreatment process consists of removal of inert matter and large solids. A primary clarifier is typically used in large treatment plants before the secondary biological processes. In a scalping plant, only a bar screen and grit chamber can be used before an aeration unit. The actual ASP begins in the aeration unit which is a suspended-growth reactor that has microbial aggregate or flocs. The microorganisms consume and oxidize organics in the sewage. The activated sludge, also called mixed liquor, is held in suspension in the aeration unit by blowing air or other mechanical methods (Rittman & McCarty, 2001). When this mix of raw sewage and flocs flows into the settling unit, the clean water is removed for further treatment and discharge. The heavier solids known as the sludge settle down in the bottom of the settling unit. Part of the sludge is returned back into the aeration unit to continue the biological processes and is known as the return activated sludge (RAS). Excess settled sludge, also known as waste activated sludge (WAS) is typically digested in an aerobic digester or removed for further treatment. In case of a scalping plant, the sludge can be put back into the wastewater lines to be treated at the central WWTP. The effluent from the settling unit undergoes optional further treatment in a filtration unit, and needs to be disinfected to obtain a Type I reuse quality effluent. ASPs are one of the most commonly used wastewater treatment processes and have been successfully operated in all flow ranges (Metcalf&Eddy(AECOM), 2007).

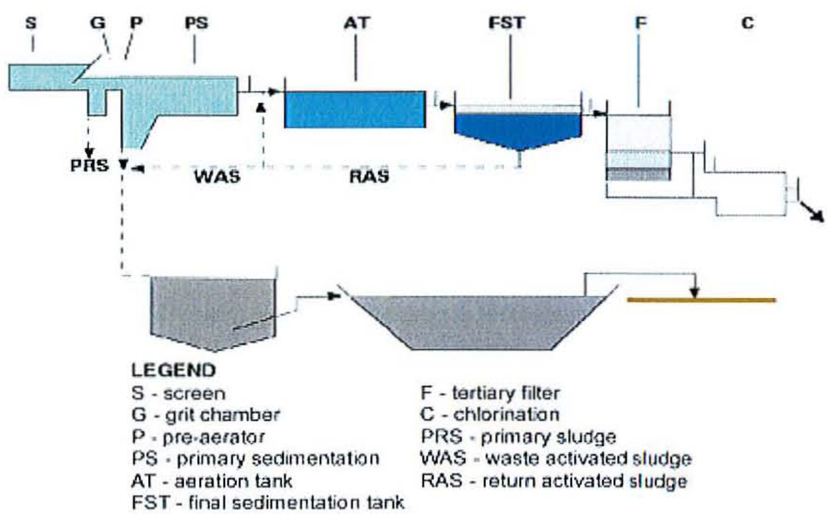


Figure 3-1: Typical ASP Process Schematic (United Nations Environment Programme, 2011)

3.2.2 Biological Nutrient Removal (BNR) Process

BNR involves adding nutrient removal processes to conventional ASP for nitrogen and phosphorus removal. This is preferred when the treated water is discharged into surface waters systems and essential for groundwater recharge, since excess nutrients leads to problems. Nitrogen and phosphorus removal can be achieved through processes like the bardenpho treatment process, and nitrification and denitrification. Since, nitrogen and phosphorus removal in reclaimed water is not required by 30 TAC Chapter 210 as mentioned in Section 4.2, BNR is not considered for this study.

3.2.3 Membrane Bioreactor

Membrane Bioreactors (MBRs) combine a traditional activated sludge biological removal system with a membrane to provide solids removal and improved effluent quality. The presence of membranes in the system removes the need to have a gravity sedimentation chamber and media filtration for separating the biomass, thereby reducing the space associated with housing such systems. This reduced footprint makes the membranes ideal for use in residential areas and for use in satellite treatment applications or scalping plants. Further, as identified in Section 3.1, MBRs are one of the most commonly used technologies for scalping plants, and have been customized and successfully operated in very small and very large-scale flow conditions.

A typical MBR configuration consists of a pretreatment unit, followed by a bioreactor that consists of an aeration zone and the membrane unit. A typical MBR configuration is shown in Figure 3.2. Typically, MBRs require particle sizes greater than 2 or 3 mm to be filtered out so that they do not damage the membranes. This can be achieved using screens, grit chambers, and primary clarification in larger centralized plants. For a scalping plant, due to the space constraints, only a fine screen is required to reduce particle buildup in the membrane. Additionally, pre-screening also helps to reduce inert solids and organic matter loadings in the bioreactor. This is followed by an aeration unit, which has coarse or fine bubble diffusers that use air to provide oxygen for the biological processes and also for cleaning the membranes to prevent fouling. The clear water after the separation is then sucked out of the chamber with vacuum pumps, or allowed to flow out under gravity. (Rittman & McCarty, 2001).

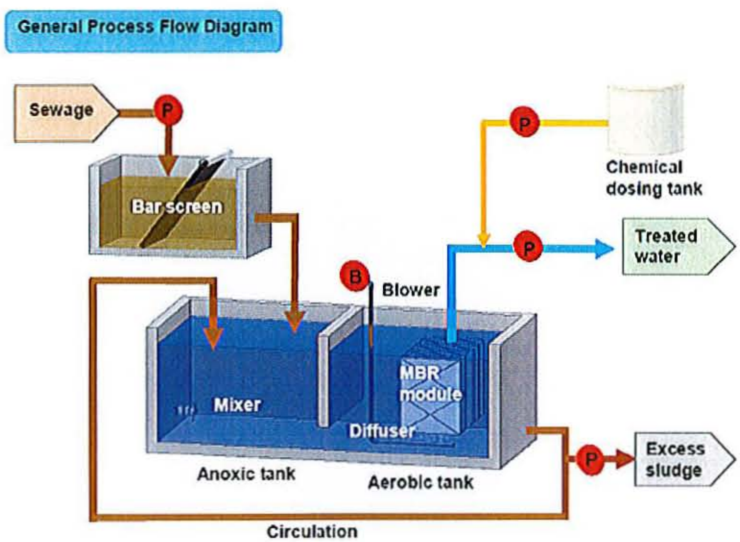


Figure 3-2: Typical MBR Process Schematic (Hitachi Aqua-Tech Engineering Pte. Ltd., 2012)

The membrane unit is the most important part of the MBR. A membrane is a material that selectively allows some physical and chemical components to pass through. The degree of selectivity depends on the pore size of the membrane. Typically, Microfiltration (MF) or Ultrafiltration (UF) membranes are used in MBRs. To achieve maximum removal of particulates along with microorganisms for a reuse application, a MF membrane needs to be used. Pore sizes of MF membranes range from 0.1 – 10 μm (Metcalf&Eddy(AECOM), 2007). Membranes come in various configurations. However, the most commonly used are either hollow-fiber or flat-plate. Hollow-fiber membranes consist of an assembly of thousands of bundles of hollow fibers which are inserted into a pressure vessel. The waste feed can be applied from the inside or outside of the membrane and effluent can be sucked out on the other side. Flat-plate membranes are made up of a series of flat membrane sheets and support plates. The water to be treated passes between the membranes of two adjacent assemblies, and the plate supports the membranes and provides a passage for permeate to flow out of the unit.

Various configurations of MBRs are available in the market. The two major types are the immersed MBR (iMBR) and sidestream MBR (sMBR). An iMBR has the membrane unit submerged in the aeration zone of the bioreactor and a sMBR houses the membrane in a separate chamber. An iMBR is less energy intensive, but it typically requires a larger number of membranes which cause a greater pressure drop across the unit. The iMBR has a smaller footprint, but is more expensive due to the larger number of membranes used. It typically has a lower lifespan than a sMBR, due to excessive air scouring. This problem can be mitigated by using coarse bubble diffusers in the aeration zone in place of fine bubble diffusers. A sMBR performs better in terms of fouling of the membrane, maintenance and life of the membrane. However, it requires additional pumping equipment to transfer the mixed liquor from the bioreactor to the membrane (Butterworth-Heinemann, 2011).

3.2.4 Rotating Biological Contactors

A rotating biological contactor (RBC) is a secondary treatment process that consists of a series of closely spaced, parallel, circular disks that are mounted on a rotating shaft that is partially submerged in the wastewater. These circular disks act as a surface on which microorganisms can grow and degrade the organic contents of wastewater. The discs are exposed to the atmosphere during their rotation which aids in the oxidation. RBCs have some relative advantages including short retention time, large surface area, low power requirements, and low sludge production. However, RBCs are maintenance intensive and are typically associated with some major issues with the shaft bearings and mechanical drive units. Even though package RBC plants are available in all sizes, they are not the preferred choice of operators for wastewater reuse (Mountain Empire Community College, 2012).

3.2.5 Sequencing Batch Reactor

A sequencing batch reactor (SBR) is an activated sludge process that is designed to operate in non-steady state conditions with aeration and sludge settlement, both occurring in the same tank. A SBR has aeration and sedimentation occurring in a time sequence rather than a space sequence like in a conventional ASP. A typical SBR has 5 treatment steps or stages which fill, react, settle, decant and idle. The first step is the anoxic fill stage that creates an environment that favors the multiplication of microorganisms with good settling characteristics. The aerated fill is the second portion of the first stage, where nitrification and denitrification occurs at the beginning of the stage and ends when the tank is full or maximum filling time is achieved. The second step or react stage continues aeration until complete biodegradation of BOD and nitrogen is achieved. Some microorganisms are also degraded in the stage due to lack of organics, thereby reducing the sludge volume. The third step or settle stage follows, where aeration is discontinued, and solid separation occurs, and the mixed liquor suspended solids (MLSS) settles to the bottom of the tank. The next step is decant stage, where the clear treated effluent is removed from the top of the tank, without disturbing the settled MLSS. The last step is the idle stage, where further settling occurs and sludge is discarded to reduce the volume (Abreu & Estrada, 2012). A high degree of maintenance and operational difficulty is associated with a SBR due to its numerous steps. With some SBR configurations, there is also a potential for discharging the floating or settled sludge during the decanting phase.

3.2.6 Technologies for Further Consideration

After reviewing TCEQ regulations and different technologies and their applicability and operability, it was decided that the best options for this application were the ASP and MBR. Both technologies are characterized by their ease of operation, ability to be operated under low flow, fully contained treatment units, and fit well within the parameters for this application. In the next section, both processes will be discussed in detail. Their merits, projected constructions costs, and O&M costs will be detailed so that the best option can be determined. Additionally, since this decentralized wastewater treatment facility will most likely need to be housed in a containment structure; exhaust systems, odor control systems, and containment buildings will be discussed. Various maintenance issues exist with an RBC and the high degree of difficulty of operation of a SBR make them unfit for a small scale application. Further, the decentralized wastewater treatment facilities under consideration will likely not have a dedicated operator, making the RBC and SBR unreliable and less favorable for this application.

4 Potential for Development of Small Decentralized Wastewater Treatment Facilities

Task III of this study is to determine the potential for developing small decentralized wastewater treatments facilities (Scalping Plants) in the Sugar Land GRP area. Completing this task involves selecting potential sites for the Scalping Plants, investigating the requirements for these types of plants, deciding what treatment technologies to pursue, and determining probable costs for construction of these plants. The following sections will detail the results of this investigation.

4.1 Potential Locations for Decentralized Treatment Facilities in the Sugar Land GRP Area

The City of Sugar Land's 2012 Wastewater Master Plan Update (2012 WWMPU) was analyzed and used as the primary tool for researching available wastewater supply and demand in the City's ETJ. The City of Sugar Land and its ETJ encompass an approximately 55 square mile area including areas within the Sugar Land City Limits, New Territory, Riverstone, Greatwood, Tara Plantation, Royal Lake Estates, and Estate Residential Scenario (the undeveloped area located south of the Brazos between the Brazos River and FM 2759). A Sugar Land area map is shown on Figure 4-1.

The City and its ETJ are further divided into wastewater treatment plant (WWTP) service areas. Two of the WWTP's are located within the city limits and primarily serve areas within those limits. The North WWTP serves residents north of US Highway 59, as well as the Sugar Creek Subdivision south of US Highway 59. The South WWTP serves the remaining area within the City limits south of US Highway 59 (excluding Sugar Creek Subdivision), as well as the Riverstone development which is currently part of the ETJ. The City owns and operates both the North and South WWTPs through a contract with the Brazos River Authority.

The West WWTP serves the New Territory development (ETJ) and Riverpark. The West WWTP is owned by FB MUD #112. However, the plant currently serves City residents in the Riverpark subdivision. Ultimately, ownership of the plant will be transferred to the City of Sugar Land. The Greatwood and Tara Plantation WWTPs serve unincorporated areas south of US Highway 59 and the Brazos River all within the City's ETJ. The WWTPs are currently owned by Plantation MUD and Fort Bend MUD #106, respectively, and the plants are operated by contract firms. There is also a sixth service area, currently named Estate Residential Scenario, located in the City's ETJ south of the Brazos River. This area is currently unserved, but does have some limited development and will ultimately require wastewater collection and treatment services.

Existing and projected development data was presented in the 2012 WWMPU. Aggressive growth is projected for Sugar Land and its ETJ. Using the planning areas from the 2012 WWMPU, preliminary sites were selected for further study. These sites are Lift Station #116, Lift Station #142, Lift Station #52, Lift Station #63, and the Greatwood area. The reasons why these areas were selected are detailed below. A map showing the locations of these sites and other major infrastructure discussed in this study is shown on Figure 4-2.

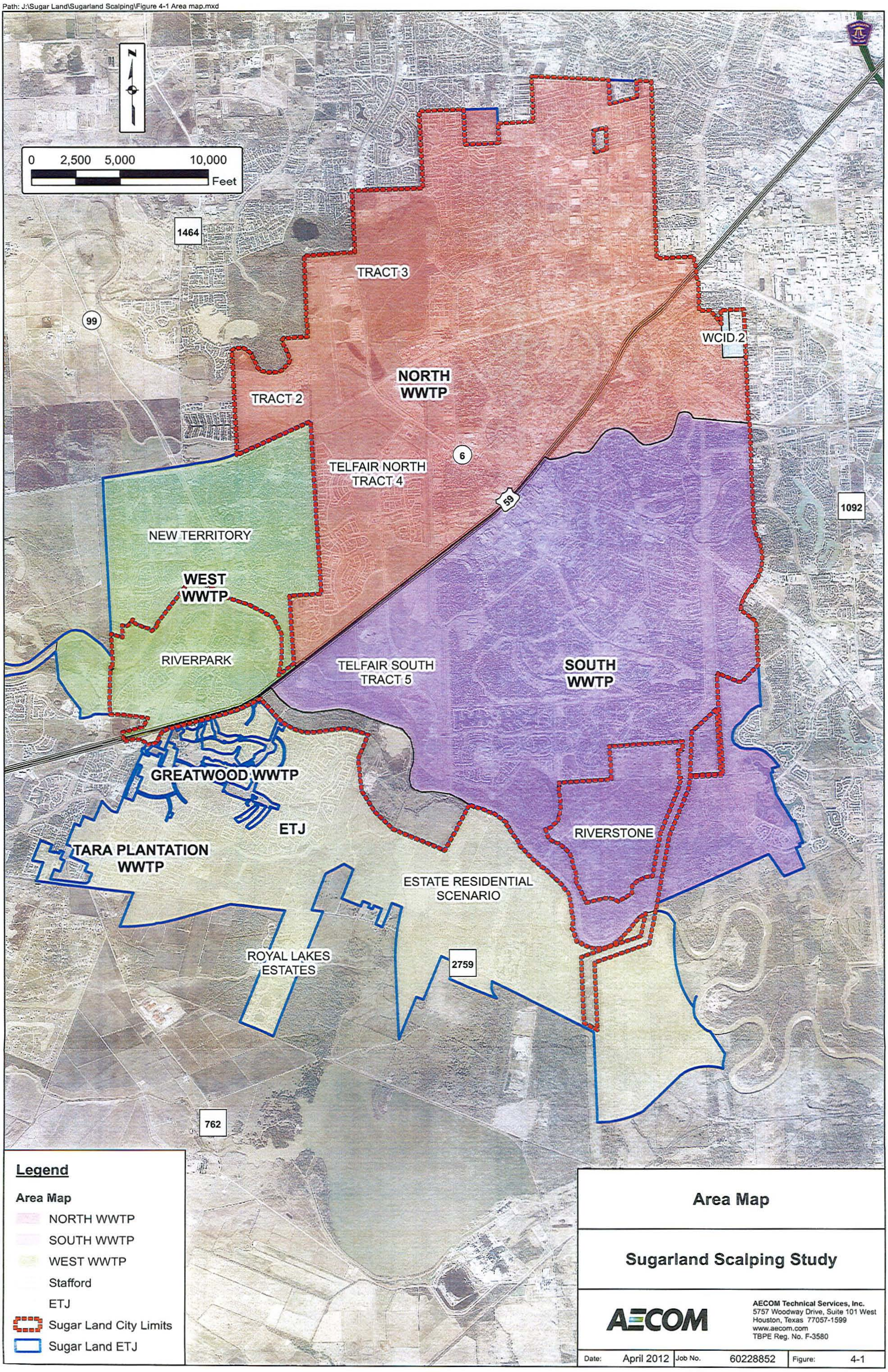


Figure 4-1: Area Map – Sugar Land Scalping Study

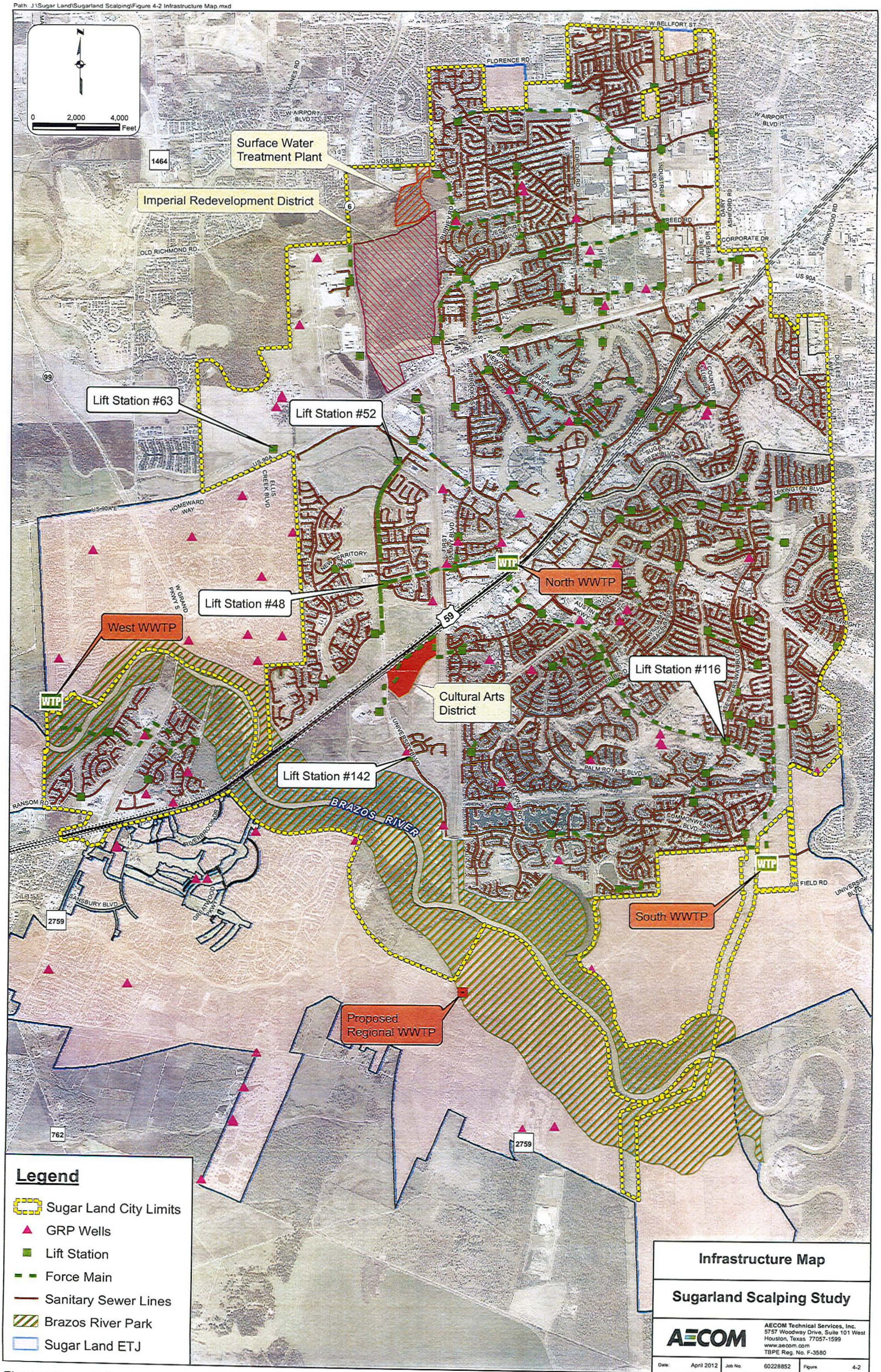


Figure 4-2: Infrastructure Map – Sugar Land Scalping Study

The best potential location for a Scalping Plant was decided to be near an existing lift station. A lift station is the preferred location because the flow is consistent and concentrated in one location, the size of the wet wells provides ample room for installation of diversion pumping facilities, and it should have a source of power sufficient to operate a Scalping Plant. (See Section 5.2 for a more detailed justification for using a site near existing lift stations)

4.1.1 Lift Station #116 (LS #116)

Most of the developed area south of U.S. 59 and west of Highway 6 is collected through a large force main system that flows to the South WWTP. The alignment of this force main coincides with the northern boundary of the Sweetwater Golf Course. LS #116 is in close proximity to the Sweetwater Golf Course and is the largest of the lift stations in the South WWTP drainage area with an estimated flow of 2.14 mgd. Representatives of the Sweetwater Country Club have stated that their club has an annual non-potable water use of 100 to 150 million gallons or an average daily flow of approximately 0.27 to 0.41 mgd. This appears to be a perfect site for installation of a Scalping Plant due to the flow at the lift station and the demand from the country club. Representatives for the country club have also stated their willingness to participate in paying for some of the costs associated with installation of one of these plants. LS #116 was evaluated in more detail and the results of that evaluation can be found in Section 5.2.

4.1.2 Lift Station #142 (LS #142)

Telfair South, TxDOT Tract 5 is located south of U.S. 59 along University Avenue, adjacent the Brazos River. Plans for this area include future expansion of the Telfair South subdivision and the University of Houston Sugar Land Campus, an entertainment district, an outdoor concert venue, and the Brazos River Park. Table 4-1 shows the current and predicted equivalent single family connections (ESFC) for the TxDOT Tract 5 area.

Table 4-1: TxDOT Tract 5 Equivalent Single Family Connections (ESFC)[a].

Description/Location	GRP No.	Year 2012	Year 2021	Year Ultimate
TxDOT Tract 5 Planning	TF-C-1	0	400	688
TxDOT Tract 5 Planning (Commercial)	TF-C-2	0	100	112
TxDOT Tract 5 Planning (Mixed use)	TF-MU-1	0	200	320
TxDOT Tract 5 Planning (Single Family)	TF-SF-24	46	46	46
TxDOT Tract 5 Planning (Single Family)	TF-SF-25	40	40	40
TxDOT Tract 5 Planning (Single Family)	TF-SF-26	74	74	74
TxDOT Tract 5 Planning (Single Family)	TF-SF-27	107	107	107
TxDOT Tract 5 Planning (Educational)	TF-UH-1	50	712	712
TxDOT Tract 5 Planning (Educational)	TF-UH-2	0	608	608
TxDOT Tract 5 Planning (Educational)	TF-UH-3	0	840	840
Subtotal ESFC		317	3,127	3,547
Approximate Base Flow (MGD):		0.07	0.70	0.8

[a] 2012 Wastewater Master Plan Update

LS #142 serves this area and has a current flow of 0.07 mgd but it is expected to grow to 0.8

mgd. This growth in flow will increase after the flow from LS #141 is diverted to Lift Station #142. This would be an ideal site to install a scalping plant. This scalping plant could then serve users in that area such as Lakes of Avalon and Crescent Lakes. Since the area is expected to grow and develop, which increases ranking as an area for further consideration. LS #142 was evaluated in more detail and the results of that evaluation can be found in section 5.2.

4.1.3 Lift Station #52 (LS #52)

Lift Station #52 plays a key role in the further development of the area north of U.S. 59 and west of highway 6. Several new developments are planned for this area that will eventually flow to this lift station which makes it a prime candidate for decentralized treatment. Contributing areas include the Imperial Redevelopment District, new home of the Sugar Land Skeeters minor league baseball team, and TxDOT Tract 2, site of the recently closed state prison. Table 4-2 shows the current and predicted ESFC's for this area.

LS #52 has a current flow of 0.3 mgd but it is expected to grow to 1.5 mgd. It is located in the heart of Sugar Land's growth and is surrounded by many potential users for reclaimed water. This would be an ideal site to install a scalping plant. This scalping plant could then serve users such as Telfair North, the Sugar Lake area and possibly NALCO. Development of this alternative could also offset future pumping costs to the North WWTP.

Current master planning shows flows being diverted from the North WWTP to the West WWTP in New Territory. Much of this flow will have to be pumped and re-pumped multiple times to reach these plants. Decentralized treatment will reduce pumping costs and possibly reduce the capital expenditures for future force mains when the North WWTP is eventually closed. Since the area is expected to grow and develop, this helps to increase its ranking as an area for further consideration. LS #52 was evaluated in more detail and the results of that evaluation can be found in Section 5.2.

Table 4-2: Lift Station #52 Planning Area Equivalent Single Family Connections (ESFC)[(a)].

Description/Location	GRP No.	Year		
		2012	2021	Ultimate
Lift Station #52 Planning Area	Various	140	3,000	4,574
Subtotal ESFC		140	3,000	4,574
Approximate Base Flow (MGD):		0.03	.675	1.02

[(a)] 2012 Wastewater Master Plan Update

4.1.4 Lift Station #63 (LS #63)

This area is currently undeveloped and LS #63 will be a developer driven project and will contribute to the flows of Lift Station #52 and the North WWTP. Table 4-3 shows the current and predicted ESFC's for this area. This undeveloped TxDOT Tract 2 area provides a green field possibility for reuse. A reuse distribution system could be required of all new developments and be easily implemented during the planning phase of the projects. Based on expected growth and development in this area, LS #63 was evaluated in more detail and the results of that evaluation can be found in Section 5.2.

Table 4-3: TxDOT Tract 2 Equivalent Single Family Connections (ESFC)[a].

Description/Location	GRP No.	Year		
		2012	2021	Ultimate
TxDOT Tract 2 Planning (Floodway)	479	0	0	0
TxDOT Tract 2 Planning (Industrial)	480	0	900	2143
Subtotal ESFC		0	900	2143
Approximate Base Flow (MGD):		0	0.2	0.48

(a) 2012 Wastewater Master Plan Update

4.1.5 Greatwood

This area is expected to grow over the next few years, but due to small area that is being considered, there does not seem to be a readily apparent area that would fit the installation of a Scalping Plant. However, there is a large opportunity for use of reclaimed water by a 225-acre park that is in close proximity to the site of a proposed regional wastewater treatment plant presented in the *2011 Water and Wastewater Master Plan for the City of Sugar Land – Extra-Territorial Jurisdiction South of the Brazos River Report*. This area was evaluated and the results can be found in Section 5.3.

4.2 Quality Criteria for Reclaimed Water

Title 30, Chapter 210.33 of the Texas Administrative Code (TAC) dealing with environmental quality contains the quality criteria and regulations associated with the use of reclaimed water in the state of Texas. Two basic types of reclaimed water have been defined based on the type of reuse. The reclaimed water producer, at a minimum, will only transfer reclaimed water that meets the quality as described for each type of specific use. A complete list of Type I and Type II criteria for urban, irrigational, recreational, and industrial reuse with treatment and monitoring requirements is presented in *Appendix 8.2.*

4.2.1 Definition of Terms

- BOD_5 (Biochemical Oxygen Demand) - A measurement of the amount of oxygen utilized by the decomposition of organic material, over a period of 5 days in a wastewater sample. BOD_5 is used as a measurement of the readily decomposable organic content of a wastewater.
- $CBOD_5$ (Carbonaceous Biochemical Oxygen Demand) – The CBOD5 test measures waste loadings to treatment plants and in evaluating the CBOD-removal efficiency of such treatment systems. This test measures the molecular oxygen utilized during a 5-day incubation period for the biochemical degradation of organic material (carbonaceous demand) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. It also may measure the amount of oxygen used to oxidize reduced forms of nitrogen (nitrogenous demand) unless their oxidation is prevented by an inhibitor.
- Turbidity - A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays. A measure of fine suspended matter in liquids. An analytical quantity usually reported in turbidity units.

- Nephelometric Turbidity Units (NTU) - A measurement unit of the clarity of water, dependent on the amount of suspended matter.
- Fecal coliform - Bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.
- Escherichia Coli (E.coli) - A bacterium found in the intestinal tracts of warm-blooded animals. Their presence in water or sludge is an indicator of fecal contamination.
- Enterococci - Bacteria commonly found in the feces of humans and other warm-blooded animals. Their presence in water is considered to verify fecal pollution.
- Colony Forming Units (CFU) - A measure of living cells in which a colony represents a group of cells derived from a single cell. This is used to determine the number of living bacterial cells in a sample. It helps determine the degree of contamination in samples of water, wastewater, or the magnitude of the infection in humans and animals.

4.2.2 Type I Reclaimed Water Use

Type I reclaimed water use is defined as the use of reclaimed water where contact between humans and the reclaimed water is likely. The following is the quality criteria required for a 30-day average period.

- BOD_5: 5 milligrams/liter (mg/l)
- $CBOD_5$: 5 mg/l
- Turbidity: 3 NTU
- Fecal coliform or E.coli (30-day geometric mean): 20 CFU/100 milliliters (ml)
- Fecal coliform or E.coli (maximum single grab sample): 75 CFU/100 ml
- Enterococci (30-day geometric mean): 4 CFU/100 ml
- Enterococci (maximum single grab sample): 9 CFU/100 ml

Type I urban reuse involves using the reclaimed water for residential irrigation, irrigation of public parks, golf courses with unrestricted public access, filling public amenity lakes, schoolyards or athletic fields, fire protection, toilet flushing, and other uses.

4.2.3 Type II Reclaimed Water Use

Type II reclaimed water use is defined as the use of reclaimed water where contact between humans and the reclaimed water is unlikely. For a system other than a pond system, a 30-day average period should have the following qualities:

- BOD_5: 20 mg/l
- $CBOD_5$: 15 mg/l
- Fecal coliform or E.coli (30-day geometric mean): 200 CFU/100 ml
- Fecal coliform or E.coli (maximum single grab sample): 800 CFU/100 ml
- Enterococci (30-day geometric mean): 35 CFU/100 ml
- Enterococci (maximum single grab sample): 89 CFU/100 ml

Type II urban reuse includes irrigation of limited access highway rights-of-way and other areas where human access is restricted or unlikely to occur, for soil compaction and dust control in construction areas where application procedures minimize aerosol drift to public areas.

4.3 Design Requirements for a Decentralized Treatment Plant

Additionally, Chapter 321, subchapter P of Title 30 also applies to decentralized wastewater treatment plants, including requirements and restrictions on design and location of the treatment plants. The major restrictions for the treatment system are:

- It must be a closed loop process, where the treated water or pollutants cannot be discharged into any waterbody.
- The treatment unit must have a lesser hydraulic capacity than the central wastewater treatment plant with which it is associated.
- The treatment unit cannot dispose or treat sludge, or accept trucked or hauled wastes. All the sludge produced needs to be conveyed through the collection system into a permitted wastewater treatment plant.

More detailed information related to these requirements is covered in Section 5.1. Additionally, the next two sections details significant requirements affecting the placement and containment of a decentralized treatment plant.

4.3.1 Buffer Zone Requirements for a Decentralized Treatment Plant

The proposed site for a decentralized treatment plant will minimize possible contamination of surface water and groundwater and not have unsuitable site characteristics. Buffer zone requirements are imposed on decentralized treatment plants, thereby locating them at a certain distance away from the nearest property line. No residential structure can be built in the buffer zone. In order to qualify for an enhanced buffer zone designation, a decentralized treatment plant must comply with one of the following requirements:

- A treatment unit not located in a building may not be closer than 300 feet from the nearest property line;
- A treatment unit located within an enclosed building without exhaust air systems and odor control technology may not be located closer than 150 feet from the nearest property line; and
- A treatment unit located within an enclosed building with exhaust air systems and odor control technology may not be located closer than 50 feet from the nearest property line.

The applicant for a decentralized treatment plant must own or have sufficient property interest to the land necessary to meet the buffer zone requirements so that residential structures are prohibited within the buffer zone.

4.3.2 "Nuisance of Odor" Requirements for a Decentralized Treatment Plant

A decentralized treatment plant must meet the following "nuisance of odor" requirements:

- Applicant must submit a "nuisance odor" prevention request for approval by the Permitting Authority. This request will be in the form of an engineering report, prepared and sealed by a licensed professional engineer, supporting the request.

- The applicant will submit sufficient evidence of legal restrictions prohibiting residential structures within the part of the buffer zone not owned by the applicant.
- While the decentralized treatment plant is permitted, the "nuisance odor" prevention plan will remain in effect and be followed at all times, will ensure sufficient property ownership or interest, and will maintain easements prohibiting residential structures, as appropriate.

Since the scalping locations are in close proximity to residential and business areas, it is assumed that to meet the buffer zone and "nuisance for odor" requirements of 30 TAC: Chapter 309.13, the decentralized treatment plant will need to be enclosed within a building with exhaust air systems and odor control technology.

4.4 Wastewater Reuse Technologies

As discussed at the end of Section 3.2, it was decided that the best process options for Scalping Plants were the activated sludge process (ASP) and membrane bioreactors (MBR). The merits, projected construction costs, and O&M costs of both processes are detailed so that the best option can be determined. Additionally, a discussion of exhaust systems, odor control systems, and containment buildings are included in this chapter.

4.4.1 Activated Sludge Process (ASP)

The ASP is one of the most commonly used biological treatment process for wastewater treatment or reuse. It has a long history with proven performances, is a well understood treatment process and is adaptable to various wastewater characteristics. It has a relatively uncomplicated design, and is not complicated to operate. While ASP does not produce an effluent quality equivalent to MBR units, it still produces good quality effluent to meet Type I reuse requirements. ASP units have a larger footprint compared to MBRs and require an additional clarifier for sludge settling. Due to their high prevalence and use in the wastewater industry, convenient package plants can be obtained, which makes them inexpensive compared to other reuse options. Although traditionally costs associated with odor reduction is higher in an ASP, the problem is reduced since a scalping plant does not handle sludge, thereby eliminating the need for sludge processing facilities.

Cost Analysis

Based on research from the study, it was decided to include an evaluation for a 200,000 gpd plant along with the 50,000 gpd and 100,000 gpd plants. According to a report published by the *WaterReuse Research Foundation*, based on data acquired from 24 conventional ASP plants all over the country, the average unit construction cost was $0.85 million for a 50,000 gpd plant, $1.2 million for a 100,000 gpd plant and $1.8 million for a 200,000 gpd plant. The same study collected information about annual O&M costs. A 50,000 gpd plant was estimated to have an average annual O&M costs for materials, electricity, and labor of $95,000 every year. A 100,000 gpd plant was estimated to have an average annual O&M costs for materials, electricity, and labor of $140,000 every year. A 200,000 gpd plan was estimated to have an average annual O&M costs for materials, electricity, and labor of $210,000 every year (Salveson, Zhou, Finney, & Ly, 2010). Obviously there is a significant cost advantage for larger plants.

Based on proposals from various ASP package plant manufacturers for 50,000 gpd, 100,000 gpd, and 200,000 gpd package units, AECOM prepared a preliminary budgetary estimate which is shown in Tables 4-4 and 4-5. The total estimated cost of construction for 50,000 gpd, 100,000 gpd, and 200,000 gpd units are $1.622 million, $1.893 million, and $2.410 million respectively, based on an average of both manufacturer quotes. The entire facility will have an approximate width, length, and height of 60 feet, 120 feet and 20 feet, respectively as shown in Figures 4.3 and 4.4.

Table 4-4: **Construction costs for 50,000, 100,000, and 200,000 gpd ASP Package Plants (Environmental Improvements and Five Star Disk Filter).**

Item	No. of Items	Total Costs		
		50,000 gpd [b]	100,000 gpd [b]	200,000 gpd [b]
Five Star Cloth Media Disc Filter	1	$120,000	$130,000	$140,000
Activated Sludge Treatment Unit with Chlorination Equipment	1	$235,000	$265,000	$355,000
Metal Containment Building and Concrete Slab	1	$65,000	$95,000	$110,000
Exhaust air systems and odor control technology	1	$155,000	$155,000	$155,000
Effluent Storage Tanks	3	$18,000	$21,000	$24,000
Reclaimed Water Booster Pumps (2), Effluent Transfer Pumps (2), and Solids Transfer Pumps (2)	1	$24,000	$30,000	$36,000
Lift Station (Piping, pumps, controls, and bypass equipment)	1	$120,000	$130,000	$140,000
Installation and Overhead Costs (30%)	1	$225,600	$247,800	$288,000
Cost of Permit	1	$300	$300	$300
Subtotal		$977,900	$1,074,100	$1,248,300
Contingency (35%)		$342,265	$375,935	$436,905
Total Construction		$1,320,165	$1,450,035	$1,685,205
Professional Services (20%) [a]		$264,033	$290,007	$337,041
Total Installation Costs		$1,584,198	$1,740,042	$2,022,246

[a] Professional Services include Engineering Design, Legal, Administration, and other costs associated with a construction project.

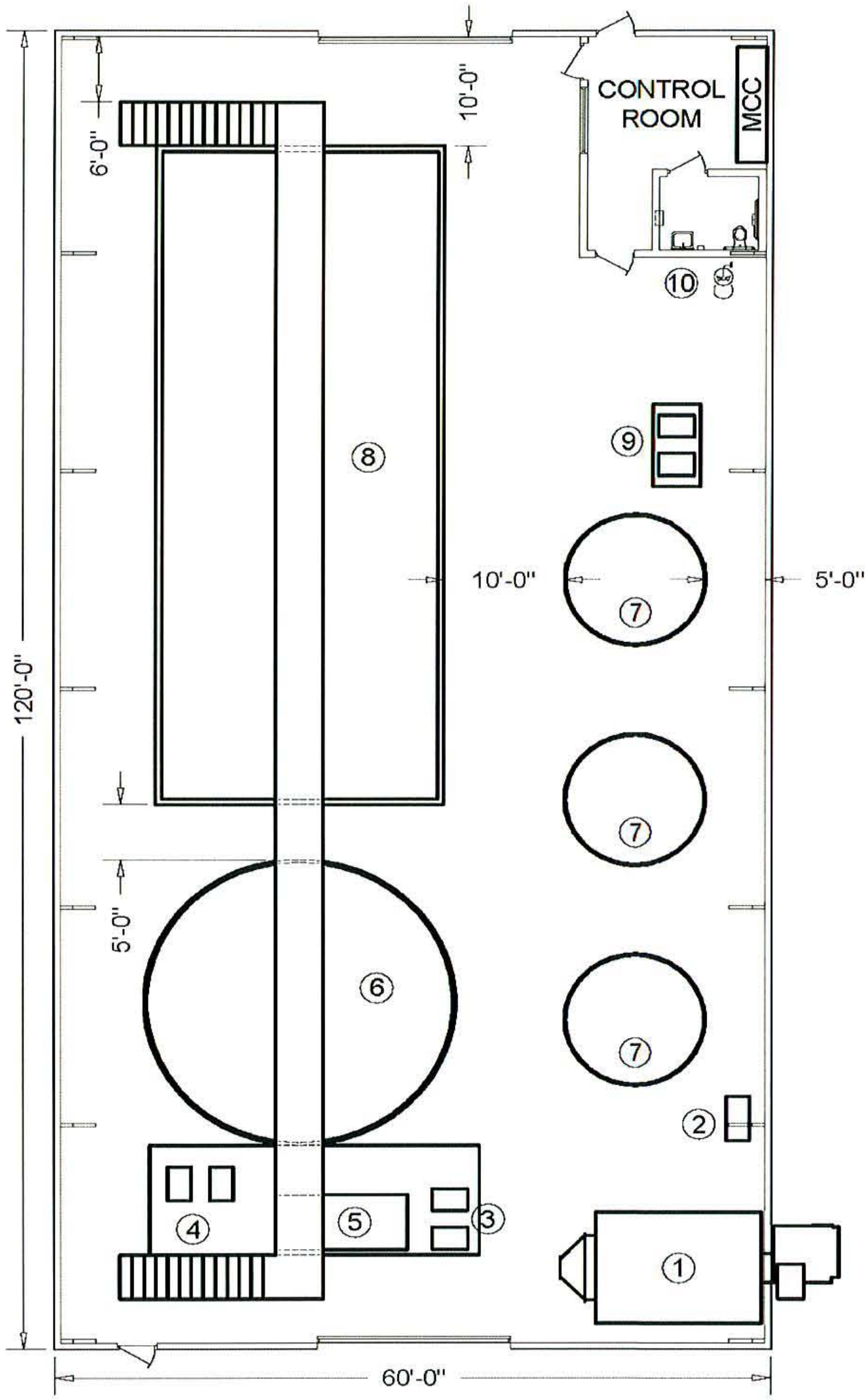
[b] Plant prices are based on producing a 10-15-3 effluent at the designed flows.

Table 4-5: Construction costs for 50,000, 100,000, and 200,000 gpd ASP Package Plants (Ashbrook Simon-Hartley).

Item	No. of Items	Total Costs		
		50,000 gpd [b]	100,000 gpd [b]	200,000 gpd [b]
Activated Sludge Treatment Unit and cloth media disk filter	1	$330,500	$475,300	$793,400
Metal Containment Building and Concrete Slab	1	$80,000	$95,000	$355,000
Exhaust air systems and odor control technology	1	$155,000	$155,000	$110,000
Chlorine Contact Basin / Disinfection	1	$60,000	$65,000	$155,000
Effluent Storage Tanks	3	$18,000	$21,000	$24,000
Reclaimed Water Booster Pumps (2), Effluent Transfer Pumps (2), and Solids Transfer Pumps (2)	1	$24,000	$30,000	$36,000
Lift Station (Piping, pumps, controls, and bypass equipment)	1	$120,000	$130,000	$140,000
Installation and Overhead Costs (30%)	1	$236,250	$291,390	$398,520
Cost of Permit	1	$300	$300	$300
Subtotal		$1,024,050	$1,262,990	$1,727,220
Contingency (35%)		$358,418	$442,047	$604,527
Total Construction		$1,382,468	$1,705,037	$2,331,747
Professional Services (20%) [a]		$276,493	$341,007	$466,349
Total Installation Costs		$1,658,961	$2,046,044	$2,798,096

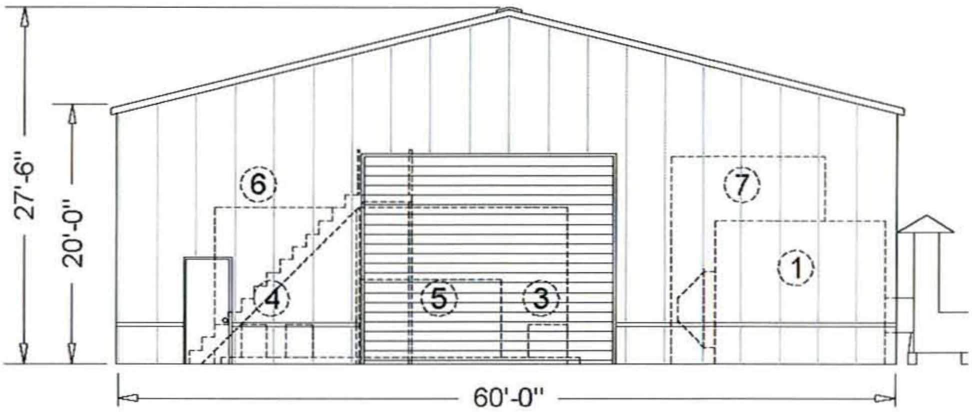
[a] Professional Services include Engineering Design, Legal, Administration, and other costs associated with a construction project.

[b] Design of plants include ability to increase flows by 50% without violating standards due to overdesign of system detention times and allowances for solids loading in the plants.

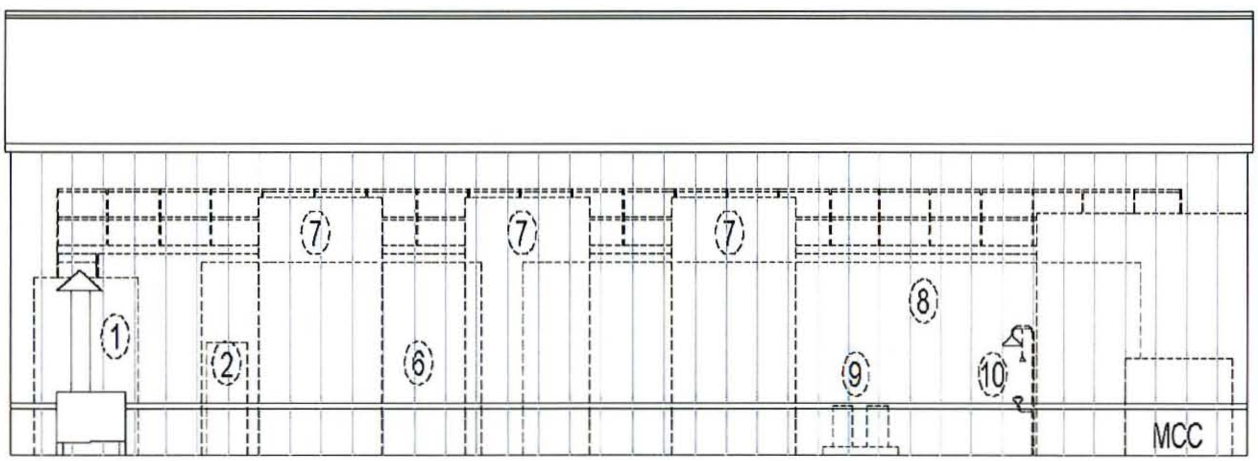


1. Exhaust Venting & Odor Control
2. Salt Chlorination System (2' w x 4' l x 7' h)
3. Effluent Transfer Pumps (4' w x 7.5' l Base)
4. Backwash Pumps
5. Filter (5' w x11' l x 6' h)
6. Clarifier (26' Dia x 12' h)
7. Reclaimed Water Storage Tank (12' Dia x 16' h)
8. Aeration Chamber (24' w x 60' l)
9. Water Booster Pumps (4' w x 8' l Base)
10. Emergency Shower

Figure 4-3: Package ASP Floor Plan



Front Elevation



Side Elevation

1. Exhaust Venting & Odor Control
2. Salt Chlorination System (2'wx4'lx7'h)
3. Effluent Transfer Pumps (4'wx7.5'l Base)
4. Backwash Pumps
5. Filter (5' w x11' l x 6' h)
6. Clarifier (26' Dia x12'h)
7. Reclaimed Water Storage Tank (12' Dia x16'h)
8. Aeration Chamber (24'wx60'l)
9. Water Booster Pumps (4'wx8'l Base)
10. Emergency Shower

Figure 4-4: Package Activated Sludge Plant Elevations

4.4.2 Membrane Bioreactors

MBRs have some clear advantages over conventional treatment processes, and are more suited for a satellite treatment unit. MBRs operate with higher suspended solids concentration; hence, their reactor hydraulic retention time is smaller, thereby reducing the reactor size. Additionally, MBRs do not require a clarifier, further reducing the footprint size. Apart from the treatment unit being more compact than conventional processes, the required ancillary facilities like odor control systems and containment buildings are also smaller. The small pore sizes of the membranes helps in producing high quality effluent that is low in BOD, total suspended solids (TSS), turbidity and even bacteria, thereby removing the need to have a separate disinfection unit. The MBRs also produce a more stable sludge that is less susceptible to upsets, and have a more stable operation. Return sludge systems are eliminated in iMBRs or greatly reduced in small sMBR plants used in scalping plants, thereby making it simpler to operate. Additionally, the MBR process is fully automated, and hence it requires reduced operator attention. Another advantage is that significantly lower biosolids handling is required compared to an ASP, thereby reducing odor issues, and also reducing the footprint and cost of odor control measures (Butterworth-Heinemann, 2011). MBRs also remove nitrogen and phosphorus to less than 5 mg/l and 1 mg/l, respectively. Removal of nutrients becomes an important issue when the reclaimed water is intended to refill lakes, ponds, and other surface water systems, since the excess of these nutrients causes eutrophication and destruction of aquatic life in the ecosystem.

Cost Analysis

While the MBR process is the most suited for a scalping plant away from the central treatment unit, the major disadvantage of MBR over traditional methods is the high initial cost of the membrane modules. MBRs are a relatively new technology; hence, limited data is available on membrane life, and thus there is a potential for high recurring costs for membrane replacement. Membrane manufacturers typically mention that membranes have a 7-10 year replacement period.

Based on information gathered while doing this study, it was decided to include an evaluation for a 200,000 gpd plant along with the 50,000 gpd and 100,000 gpd plants. According to a report published by the *WaterReuse Research Foundation*, based on data acquired from 24 conventional MBR plants all over the country, the average unit construction cost was $3.0 million for a 50,000 gpd plant, $4.5 million for a 100,000 gpd plant and $6.2 million for a 200,000 gpd plant. The same study collected information about annual O&M costs. However, only 5 of the 24 plants surveyed had sufficient O&M data, since it is a relatively newer technology. Based on this, a 50,000 gpd plant was estimated to have an average annual O&M costs for materials, electricity, and labor of $73,000 every year. A 100,000 gpd plan was estimated to have an average annual O&M costs for materials, electricity, and labor of $109,500 every year. A 200,000 gpd plan was estimated to have an average annual O&M costs for materials, electricity, and labor of $146,000 every year (Salveson, Zhou, Finney, & Ly, 2010).

Based on proposals from various MBR package plant manufacturers for 50,000 gpd, 100,000 gpd, and 200,000 gpd package units, AECOM prepared a preliminary budgetary estimate which is shown in Tables 4-6 and 4-7. The total estimated cost of construction for 50,000 gpd, 100,000 gpd, and 200,000 gpd units are $1.65 million, $2.19 million, and $3.13 million respectively, based on an average of both manufacturer quotes. Based on the treatment system provided by Annua, the total length, width, and height will be 65 feet, 60 feet and 20 feet, respectively.

Table 4-6: Construction costs for 50,000, 100,000, and 200,000 gpd MBRs (Annua).

Item	No. of Items	Total Costs		
		50,000 gpd	100,000 gpd	200,000 gpd
Membrane BioReactor and Drum Screen with Compactor	1	$400,000	$655,000	$985,000
Metal Containment Building and Concrete Slab	1	$32,000	$40,000	$48,000
Exhaust air systems and odor control technology	1	$100,000	$100,000	$100,000
Chlorine Contact Basin / Disinfection	1	$60,000	$65,000	$70,000
Effluent Storage Tanks	3	$18,000	$21,000	$24,000
Reclaimed Water Booster Pumps (2), Effluent Transfer Pumps (2), and Solids Transfer Pumps (2)	1	$24,000	$30,000	$36,000
Lift Station (Piping, pumps, controls, and bypass equipment)	1	$120,000	$130,000	$140,000
Installation and Overhead Costs (30%)	1	$226,200	$310,800	$420,900
Cost of Permit	1	$300	$300	$300
Subtotal		$980,500	$1,347,100	$1,824,200
Contingency (35%)		$343,175	$471,485	$638,470
Total Construction		$1,323,675	$1,818,585	$2,462,670
Professional Services (20%) [a]		$264,735	$363,717	$492,534
Total Installation Costs		$1,588,410	$2,182,302	$2,955,204

[a] Professional Services include Engineering Design, Legal, Administration, and other costs associated with a construction project.

Table 4-7: Construction costs for 50,000, 100,000, and 200,000 gpd MBRs (Smith and Loveless).

Item	No. of Items	Total Costs		
		50,000 gpd	100,000 gpd	200,000 gpd
Membrane BioReactor with Fine Screens	1	$458,000	$655,000	$1,146,250
Metal Containment Building and Concrete Slab	1	$32,000	$43,000	$53,000
Exhaust air systems and odor control technology	1	$100,000	$100,000	$100,000
Chlorine Contact Basin / Disinfection	1	$60,000	$65,000	$70,000
Effluent Storage Tanks	3	$18,000	$21,000	$24,000
Reclaimed Water Booster Pumps (2), Effluent Transfer Pumps (2), and Solids Transfer Pumps (2)	1	$24,000	$30,000	$36,000
Lift Station (Piping, pumps, controls, and bypass equipment)	1	$120,000	$130,000	$140,000
Installation and Overhead Costs (30%)	1	$243,600	$313,200	$470,775
Cost of Permit	1	$300	$300	$300
Subtotal		$1,055,900	$1,357,500	$2,040,325
Contingency (35%)		$369,565	$475,125	$714,114
Total Construction		$1,425,465	$1,832,625	$2,754,439
Professional Services (20%) [a]		$285,093	$366,525	$550,888
Total Installation Costs		$1,710,558	$2,199,150	$3,305,327

[a] Professional Services include Engineering Design, Legal, Administration, and other costs associated with a construction project.

4.4.3 Exhaust Air Systems and Odor Control Technology

Odor issue arises in wastewater treatment plants due to the high organic loading in raw wastewater, which is usually present in an anaerobic or septic condition. Most of the odor in a treatment plant is produced in the pretreatment and primary screening stage of a treatment plant. The odor produced in the solids handling stage is eliminated in a scalping plant. Hydrogen sulfide (H_2S) is the most common gas that needs to be handled by an odor control facility. In anaerobic conditions, sulfate-producing bacteria multiply and produce H_2S as a byproduct. H_2S has low solubility in water, is very odoriferous, causes corrosion problems in containment buildings and is toxic to humans. Other organic compounds such as mercaptans and amines also produce a bad odor, but to a lesser extent than H_2S.

Odor control can be by either solid adsorption or liquid scrubbing. The solid media adsorption process, also known as air scrubbing, is the type of odor control technology recommended for these small units. Air scrubbing is one of the most flexible and commonly used technologies for odor control arising from H_2S, other organics and ammonia. In this process, the contaminants are adsorbed on to the surface of the media. This is a completely physical process, which is clean and eliminates the uncertainty associated with a biological process and the liquid disposal associated with a wet air scrubbing process. A multi-stage scrubbing can be used to eliminate different types of targeted gasses by using different media in each of the stages (Harshman & Barnette, 2012).

AECOM approached Purafil to prepare a proposal for this study. Based on the larger footprint associated with an ASP, Purafil proposed a parallel bed scrubbing unit. The actual unit will consist of 2 pairs of a 2 stage media which will allow air to pass through it horizontally and a stack that will exhaust the treated air into the atmosphere through a duct in the roof. This unit will be capable of controlling odor in a 130,000 ft^3 room, by incorporating 6 air changes in an hour. When the building is not occupied, the air changes can be minimized to 2 per hour and increased to 6 when occupied by operating personnel, thereby achieving a significant savings in energy costs. This will be achieved by using motion sensors in the room or sensors in the doors. The total cost of the unit will be $155,000.

4.4.4 Containment Buildings

Based on the buffer zone requirements mentioned in Section 4.3.1, the entire treatment facility must be completely enclosed, along with odor control and exhaust systems to be eligible for the lowest buffer zone requirement of 50 ft from the nearest residential property. In order to achieve this criterion, AECOM recommends a pre-fabricated steel building, with insulation, heating, cooling, and air exhaust systems. Apart from the steel enclosure, all the treatment units will also be placed on special concrete foundations. Based on a 60' x 120' footprint for an ASP, and the concrete foundations, the cost of the building is estimated to be $355,000.

4.4.5 Recommendation

After evaluating ASP and MBR treatment units for a Scalping Plant, AECOM recommends the ASP, since it has the lowest construction costs. As mentioned in Section 4.4.1, ASPs are relatively cheaper than MBRs, and their operation and maintenance is well documented. Among the two manufacturers presented, Ashbrook Simon-Hartley's package treatment unit was selected as the basis of design and projected costs in Section 5, since they had a more robust system and an effluent quality that satisfied Type I reuse standards. Additionally, their treatment unit can accommodate a peak flow of 1.5 times the given flow, which will be advantageous if it is decided to expand the scalping plant in the future.

Although an ASP has been recommended and used as the basis of design, an MBR unit has a lot of advantages over the ASP, as mentioned in Section 4.4.2. AECOM recommends MBRs as a feasible alternative to be considered in the design stage, if the City of Sugar Land decides to pursue the project. As shown in Tables 4.6 and 4.7, the initial construction costs of MBRs are only slightly higher than ASPs and their O&M costs are lower. Additionally, as mentioned in Section 3, all of the satellite treatment facilities researched use MBRs for reuse applications, which indicates their growing acceptance in the wastewater industry.

5 Potential Impacts of Decentralized Wastewater Treatment Facilities

Task III of this study is to determine the potential impacts of developing decentralized wastewater treatments facilities as a reclaimed water supply for the Sugar Land GRP. As a relatively small wastewater treatment system, a decentralized wastewater treatment facility (Scalping Plant) has a high cost of construction and O&M expenses per MGD as compared to most domestic wastewater treatment plants. It is important to not focus totally on these costs when determining their value, but instead looks at all of the benefits and consequences of utilizing this technology. In this section, the potential impact of installation of these plants on wastewater collections systems and treatment plants, future construction and expansion plans and costs, comparative costs of reclaimed water versus other alternative sources of water, and effects on Sugar Land's GRP will be studied and discussed. Based on these evaluations, final recommendations will be made on the viability of using Scalping Plants. In Texas, Scalping Plants are classified as reclaimed water production facilities.

5.1 Permit Requirements for Reclaimed Water Production Facilities

This section deals with the obstacles that need to be overcome in order to get the permits and authorizations necessary to construct and operate a reclaimed water production facility (RWPF). The following general requirements, restrictions, and application requirements must be met to permit, build, and operate a RWPF. In order to assure the accuracy of the information in this section, much of the information and text derived for this section has been taken directly from the identified chapters of the Texas Administrative Code, Title 30: Environmental Quality. Chapters that have been copied or covered in this section are 30 TAC: Chapter 30, Chapter 210, Chapter 217, Chapter 305, Chapter 309, Chapter 312, and Chapter 321. A more detailed listing of the permit requirements can be found in *Appendix 8.3*.

5.1.1 General Requirements and Restrictions for a RWPF

An applicant for authorization to produce reclaimed water at a RWPF must have a domestic wastewater permit for a domestic wastewater treatment facility that is located at the end of the collection system to which the RWPF will be connected and an authorization to use reclaimed water. This authorization cannot alter the permitted flow or effluent limits of the associated domestic wastewater treatment facility or be authorized at a flow rate that could cause interference with the operation of the domestic wastewater treatment facility or a violation of the wastewater treatment facility's permit. Additionally, the hydraulic capacity of a single RWPF or group of RWPF's cannot individually or collectively exceed the permitted hydraulic capacity of the associated domestic wastewater treatment facility.

A RWPF cannot discharge wastewater or pollutants into waters of Texas and cannot treat or dispose of sludge at the site. Sludge must be conveyed through the collection system to the permitted domestic wastewater treatment facility where it will be treated and disposed of in accordance with the facility's permit and all applicable rules. Finally, the owner of the RWPF may not accept trucked or hauled wastes at the RWPF.

5.1.2 Application Requirements for a RWPF

In order to complete an application for the construction and operation of a RWPF, the following requirements must be met:

1. Owners of the land upon which each RWPF is to be located will be identified.
2. Written consent of the owner(s) of the land upon which each facility is to be located will be obtained before submitting permit (30 TAC: Chapter 305.43).
3. An authorized RWPF is not required to hold a wastewater discharge permit except as provided in 30 TAC: Chapter 210.5.
4. To meet the requirements found in 30 TAC: Chapters 305, the required permit will need to include the following items as a minimum:
    a. The name, mailing address, and location of the RWPF for which the application is submitted;
    b. The ownership status as federal, state, private, public, or other entity;
    c. The applicant's name, mailing address, and telephone number;
    d. The wastewater permit number of the associated domestic wastewater treatment facility;
    e. A brief description of the nature of the reclaimed water use;
    f. Signature of a principal executive officer or ranking elected official;
    g. A copy of the recorded deed or tax records showing ownership, or a copy of a contract or lease agreement between the applicant and the owner of any lands to be used for the RWPF;
    h. A copy of the applicant's reuse authorization or a copy of a concurrent application;
    i. A preliminary design report for the RWPF that includes the design flow, design calculations, the size of the adopted treatment units, a flow diagram, and the proposed effluent quality (see Sections 4.2 and 5.1.3 for details);
    j. A buffer zone map and report indicating how the RWPF will meet buffer zone requirements (see Section 4.3.1 for details);
    k. A county general highway map (with scale clearly shown) to identify the relative location of the domestic wastewater treatment facility, the main lines of the collection system, and the RWPF and at least a one-mile area surrounding the RWPF.
    l. One original United States Geological Survey 7.5 minute quadrangle topographic map or an equivalent high quality color copy showing the boundaries of land owned, operated or controlled by the applicant and to be used as a part of the RWPF. The map shall extend at least one-mile beyond the boundaries of the RWPF.
5. Applicant must show a positive history of previous compliance to existing permits. Demonstrated poor performance in meeting past or current permit requirements will impact the successful application for new facilities, unless these poor performances can be explained or it can be shown that the new facilities will assist in meeting these permit requirements.

5.1.3 Plans and Specifications Requirements for a RWPF

30 TAC: Chapter 321 details the base requirements that need to be met before a RWPF can be permitted and allowed to operate. These requirements are:

1. Plans and specifications for a RWPF must meet the design criteria and the operation, maintenance, and safety requirements in 30 TAC: Chapter 217. The design will incorporate sufficient provisions to ensure that effluent quality meets the required limits, even during a power supply failure or failure of a treatment unit or process.
2. A RWPF will be designed to convey all wastewater to the domestic wastewater treatment facility any time the RWPF is not in operation.
3. The RWPF will be designed to convey all sludge received or produced at the facility to the domestic wastewater treatment facility. Sludge can be held in an aerated storage vessel for discharge to the collection system if the entire sludge contents are completely discharged at least once within a 24-hour period.
4. The RWPF will be designed and operated to minimize odor and other nuisance conditions (see Sections 4.3.2 and 4.4.3 for details).
5. The following treatment processes are prohibited from being used in a RWPF:
    a. Unaerated primary treatment units (including Imhoff tanks and primary clarifiers);
    b. Trickling filters;
    c. Pond or lagoon treatment systems;
    d. Flow equalization basins; and
    e. Unenclosed screenings storage containers.
6. All plans and specifications of a RWPF must also meet the design requirements detailed in 30 TAC: 217, for the treatment process chosen for the RWPF.
7. The means of transporting reclaimed water from the RWPF to the provider or users will need to be identified in the application process for this facility, and in the plans and specification for the RWPF and its distribution system. Key valves, distribution points, maintenance, and means of distinguishing the reclaimed water piping from potable water piping is a critical component of a reclaimed water use system and the application process.

5.1.4 Public Notice Requirements

If the applicant for a RWPF qualifies for an enhanced buffer zone designation (see section 4.3.1 for details), no public notice is required. However, if the applicant does not qualify for an enhanced buffer zone designation, public notice is required, and the following steps must be met:

- This public notice requires placement of a sign at the site location, identifying all key information required by this statute, and maintained during the full length of the public comment period.
- Publish notice of the Permitting Authority's (PA) preliminary determination on the permit application at least once during the public comment period. This notice will be placed in a newspaper of general circulation in the area where the RWPF is located or expected to be located.

- The public comment period will begin on the first day the notice is published and will end 30 days later unless a public meeting is required to be held. If a public meeting is required, the public comment period ends either 30 days after the initial notice is published or at the conclusion of the public meeting, whichever is later.

The public may submit a written request for a public meeting to the Texas Commission of Environmental Quality (TCEQ) during the comment period. If it is determined that there is sufficient interest in holding a public meeting, one will be scheduled.

5.1.5 Specific Requirements for the Owner/Producer/Provider of a RWPF

The Owner/Producer/Provider of a RWPF must meet the following requirements during construction and operation a RWPF:

- Employ or contract with one or more licensed wastewater treatment facility operators or wastewater facility operations companies holding a valid license or registration per the requirements of 30 TAC: Chapter 30, Subchapter J. The operator or wastewater facilities operations company will have the same level of license or higher as the operator license of the permitted domestic wastewater treatment facility associated with the RWPF.
- Notify the permitting authority at least 45 days before completion and at least 45 days before operation of a RWPF.
- Obtain written approval to provide reclaimed water before providing reclaimed water to an user.
- Provide a signed agreement authorizing the transfer of the reclaimed water to a user who is providing reclaimed water to another user.
- Enter into a water supply contract or other binding agreement with all users of reclaimed water and provide evidence that this contract or agreement has the authority to terminate water use that is noncompliant with 30 TAC: Chapter 210.
- When providing effluent meeting the Type II quality criteria and having a new use that must meet Type I quality criteria, additional treatment will be required. The additional treatment must be authorized. The Owner will notify and be granted an authorization before design and operation of new treatment facilities. Authorization may be granted after review of the proposed plans and specifications submitted for the additional treatment.
- Maintain an O&M Plan that is part of the water supply contract or other binding agreement.

5.1.6 Specific Requirements for the User of Reclaimed Water

The user of reclaimed water may be required to apply for and obtain a permit to utilize reclaimed water if the reclaimed water use poses potential or actual adverse impacts upon human health, soil and ground resources, or aquatic life. If the provided effluent meets Type II quality criteria, the user must not change uses or applications without notifying the Owner. If the new use or application requires effluent meeting the Type I quality criteria, the user must be granted authorization before using reclaimed water for this new use or application.

5.2 Impact of Reclaimed Water Production Facilities on the Wastewater Transmission System and Expansion of that System

The City of Sugar Land and the surrounding areas are planning wastewater collector expansion projects that extend to 2023. The costs of these projects as estimated in the 2012 WWMPU totals $13,893,000 in planning and construction costs. To completely eliminate any of these projects would be relatively difficult due to the projected growth of this area and the limited scope and size of the Scalping Plants that are being studied. However, installations of appropriately located and sized plants can reduce the size of some of these expansion projects and delay the need for other expansion projects.

It has been decided that the best places to locate a Scalping Plant is near an existing lift station. A lift station site is the preferred location for the following reasons:

- The flow is concentrated in one location.
- The flow at the site is more consistent than in a manhole.
- The size of the wet wells of the lift stations provides ample room for installation of diversion pumping facilities.

Information on the flows at each lift station in the City of Sugar Land and its service area was pulled from the 2012 WWMPU. Although high end users of potable water for irrigation and other non-drinking purposes were provided, as a result of this study, several questions were identified that would affect the placement and sizing of Scalping Plants. These questions are as follows:

1. Willingness of these users to accept reclaimed water in lieu of potable water.
2. Patterns of use of reclaimed water to verify that the usage is consistent enough to warrant installation of a plant in that vicinity.
3. Willingness of the City of Sugar Land to finance installation of reclaimed water distribution lines to users of reclaimed water.
4. Availability of right-of-way and easements for installation of reclaimed water distribution lines.

Since the boundaries of this study simply focus on the cost effectiveness and viability of installation of Scalping Plants, several assumptions are made. The first assumption is that if answers to questions 1 and 2 justify the need for installation of a Scalping Plant, that 100% of the reclaimed water developed by the plant will be utilized. The second assumption related to questions 3 and 4 is that reclaimed water distribution systems will be installed and the cost charged to the user will reflect a proportional cost for this installation.

A representative number of sites were investigated for the potential benefits for installation of Scalping Plants and their impact on future expansion to the wastewater collection system. At each site, the assumptions stated above will be utilized in detailing the benefits of installation of Scalping Plants. Three major sites were selected for review and the results are summarized below. For full details of the results of the study, see *Appendix 8.4*.

5.2.1 Lift Station #116

Based on information obtained from the City of Sugar Land, Lift Station (LS) #116 currently has a daily flow of approximately 2.14 MGD that feeds to the South WWTP. Its flow is not expected to increase over the next ten years and no collection system expansion plans are targeted in this area. Thus, installation of a Scalping Plant at this site would not have an obvious impact on future collections system expansion plans.

5.2.2 Lift Station #142

Based on information found in the 2012 WWMPU and detailed in Section 4.1.2; Lift Station #42 (LS #142) has an estimated current flow of 0.07 mgd but is expected to increase to 0.8 mgd over the next 5 to 10 years. The flow will increase when LS #141 is diverted to Lift Station #142. With the expected growth in the near future, this area is a good area for installation of a 200,000 gpd Scalping Plant at the same time that LS #141 is diverted to LS #142. The addition of a 200,000 gpd plant at this site would allow the diversion of LS #141 to LS #142, without the need to complete the Phase 1 expansion of LS #142. This scalping plant could serve users in the area such as the Lakes of Avalon and Crescent Lakes. As the area grows, additional units could be added as necessary at appropriate locations to handle new users in the area. Developers should be required to run reclaimed water piping in all new areas and developments.

The potential savings for installation of a 200,000 gpd Scalping Unit at LS #142 for future collection system expansion costs would be obvious in looking at future plans for LS #142 and LS #141. Project WW-1 (Phase 1 expansion of LS #42), WW-2 (Diversion of LS #141), and WW-4 (Phase 2 expansion of LS #142) are slated for this area at an estimated cost of $5,700,500. If Project WW-2 was completed at the same time as installing a 200,000 gpd Scalping Plant, the need for Project WW-1 would not be necessary, saving the City of Sugar Land $590,000. If this Scalping Plant is installed, WW-4 could be delayed until an analysis of future flows at LS #142 could be completed based on considering the following:

- Potential growth in the area and the estimated flows that can be diverted using additional Scalping Plants as the area is developed.
- After estimating the flows that can be handled by Scalping Plants, determine the remaining flow that will need to be carried in the new force main from LS #142 to the Riverstone Master Lift Station.
- Develop guidelines and requirements for inclusion of reclaimed water systems (both Scalping Plants and distribution systems) in all new developments. All new developments, both residential and commercial, should include plans for use of reclaimed water. The plan should include installation of reclaimed water distribution systems to those areas that can utilize reclaimed water, primary use of reclaimed water for irrigation and non-drinking water applications, and installation of appropriately sized Scalping Plants to handle the projected need for that development or collection of users.
- As additional areas are developed following these new guidelines, Scalping Plants will be installed to serve these new users.

If these new guidelines are instituted and followed, the net flows handled by LS #142 will be reduced. This should result in a reduction in the costs associated with WW-4.

5.2.3 Area Surrounding Lift Stations #33, #48, #52, #60, and #63

Based on information found in the 2012 WWMPU, and detailed in Section 4.1.3, this area has an estimated current flow of 0.03 mgd but it is expected to grow to 0.675 mgd over the next 5 to 10 years, with a maximum growth to 1.02 mgd. Six construction projects are slated in the area around these five lift stations. LS #52 sits north of Highway 59 and is in close proximity to many identified potential users for reclaimed water. Of the potential users in this area, several key ones would be the Sugar Lake area, NALCO, and Telfair North. Based on usage amounts, this area could be the site of multiple Scalping Plants, ranging in size from 100,000 gpd to 200,000 gpd. The size needed would be based on proximity to users, available flow in the system, ability to install needed distribution systems, and the flow needed by willing users.

In review of potential savings to delays and/or reductions to collections system expansions, this area has six planned projects. Projects WW-3 (expansion of LS #52), WW-5 (expansion of LS #60), WW-7 (expansion of LS #33), WW-8 (Phase I expansion of LS #63), WW-9 (Phase 2 expansion of LS #63), and WW-6 (expansion of LS #48) are slated for this area at an estimated cost of $8,192,500. Since the need for these expansions are predicated on new growth in the area, it is important to note that if the new guidelines for new developments are enacted; some of the increases in flow could be diverted to Scalping Plants and used as a source of reclaimed water. By reducing the flow handled by lift stations in this area, it is very likely that some of these projects could be delayed and that the size of the expansions reduced. This would save construction costs and reduce flow planned for the North WWTP.

In conclusion, it is difficult to predict the actual savings in construction costs for collection system expansion due to the lack of knowledge about what new expansions will occur, the amount of flow associated with use of reclaimed water, and the City of Sugar Land's willingness to construct and fully utilize Scalping Plants. Based on current sites recommended for installation, the savings in construction costs could be extensive and be used to offset a portion of the cost of the Scalping Plants. If new developments are required to utilize reclaimed water where possible, and include the Scalping Plants and reclaimed water distribution systems in their plans, there could be a significant reduction in the scope and costs of future collection system expansions.

5.3 Impact of Reclaimed Water Production Facilities on Domestic Wastewater Treatment Plants and Expansion of those Plants

The City of Sugar Land and the surrounding areas are planning wastewater treatment plant expansion/diversion projects that extend past 2022. The costs of these projects as estimated in the *2012 Wastewater Master Plan Update* (2012 WWMPU) totals $120,191,249 in planning and construction costs. In the years between 2012 and 2022, there are three projects scheduled to be completed through construction at a cost of $36,966,000. The remaining three projects are scheduled to occur in the future past 2022, as growth increases. These projects have a construction cost of $83,283,000. To completely eliminate any of these projects would be relatively difficult due to the projected growth of this area and the limited scope and size of the Scalping Plants that are being studied. However, installations of appropriately located and sized plants can reduce the size of some of these expansion projects and delay the need for other expansion projects.

While the focus of this report is to identify the viability of Scalping Plants, it must also be discussed that the greatest benefit that can be achieved with use of reclaimed water is to establish an RWPF at each of the three main WWTPs.

The potential impacts of Scalping Plants on each WWTP will be discussed individually, in order to assess what savings can be made due to installation of these Scalping Plants. At each WWTP, the assumptions stated for the wastewater collection system will be utilized in presentation of the benefits of installation of Scalping Plants. A summary of the findings are discussed below. Details on the results of these investigations can be found in *Appendix 8.5*.

5.3.1 North Wastewater Treatment Plant (North WWTP)

The North WWTP is located north of Hwy. 59, and its site is land locked due to existing residential and commercial development around the plant. Due to restriction on available land area for future expansions and rapidly approaching its permitted number of connections, the North WWTP is scheduled to have flows diverted to the West WWTP as early as 2020. Currently, the North WWTP has the capability of diverting up to 0.75 MGD to the South WWTP, thus delaying the need to divert flows to the West WWTP. Six future expansion projects are designed around the North WWTP, with the sole purpose of diverting increased flows away from the plant. While all six projects may need to be done in time, each will be discussed as to how Scalping Plants can affect their implementation dates and costs.

WW-11 (Phase I Diversion Force Main), WW-10 (expansion of the West WWTP), and WW-12 (optional interim diversion force main) are slated to occur in the near future. WW-13 (expansion of the West WWTP to 10.0 mgd), WW-14 (improvements at and decommission of the North WWTP project), and WW-15 (Phase II Diversion Force Main) are slated sometime in the future when it is determined that is no longer cost effective to continue to maintain the North WWTP and will divert all of the flow to the West WWTP. If there is a significant impact due to Scalping Plants installed in this area, it is possible that WW-12 could be eliminated, resulting in a cost savings of $396,000.

Even with an aging facility, it would seem that the North WWTP is advantageously located to be an important location for a RWPF. This RWPF could be a significant producer of reclaimed water and important in reducing the use of groundwater. If the number of Scalping Plants utilized in this area is maximized, flow to the North WWTP could be controlled by projects discussed earlier. Funds could be allocated for modernizing the North WWTP and have it operate at a set flow, with any additional flows going to the West WWTP. This would save construction costs, save O&M costs for pumping the wastewater from the North WWTP to the West WWTP, and reduce the costs associated with producing reclaimed water for users in the area.

5.3.2 South Wastewater Treatment Plant (South WWTP)

The additions of Scalping Plants in the area around LS #142 and LS #141 (discussed in Section 5.2) will help in reducing flows to this WWTP. With these flow reductions, there will be a savings in O&M costs related to any flows that are diverted away from this plant. Due to its location and available land area, the South WWTP is a prime location for installation of a RWPF. Even though a more extensive reclaimed water distribution system will need to be installed to transmit the reclaimed water to users, there are some major users in close proximity to the WWTP. The Sweetwater Country Club is close to the WWTP, has appeared to be willing to receive reclaimed water, and has an annual use of 100 to 150 million gallons (0.27 to .41 mgd). Based on Sweetwater Country Club's close proximity to the South WWTP, a line from the WWTP to service Sweetwater Country Club would be the most cost effective method of serving their need, minimizing disruption to the area, and reducing groundwater use.

5.3.3 West Wastewater Treatment Plant (West WWTP)

The West WWTP is scheduled for two major expansion projects due to diversion of flows to the West WWTP from the North WWTP. The first scheduled expansion is slated to be completed in 2020, with a second expansion triggered when it is decided to divert all flows from the North WWTP to the West WWTP. The date for this project is not yet determined and is based on the rate of growth in the area around the North WWTP. The additions of Scalping Plants in the North WWTP collection area will allow reduced flows to be diverted to the West WWTP, thus delaying the first expansion. However, growth around the West WWTP will also help to necessitate an expansion of the WWTP. The first expansion is assumed to be 4.5 mgd (WW-10).

Scalping Plants can only affect this plant based on their effect on the North WWTP. From the information we have received, the area within the West WWTP collection area is not interested in looking at Scalping Plants and their installation is questionable. Therefore, Scalping Plants primary influence will involve their effect on the North WWTP and a reduction in flows diverted to the West WWTP. If a determination is made to allocate funds for modernizing the North WWTP and installing a RWPF at that site, then the future expansion (WW-13) of the West WWTP to 10.0 MGD can be delayed, or the size of the expansion reduced. The reduction in construction costs due to a smaller expansion could be utilized to build a RWPF at this plant along with the necessary reclaimed water distribution system. A RWPF located at the West WWTP would then provide three well located sites for production and distribution of reclaimed water within the City of Sugar Land's jurisdiction.

5.3.4 Greatwood Area - Proposed Regional Wastewater Treatment Plant

This area currently has two wastewater treatment plants, the Greatwood WWTP and the Tara Plantation WWTP. The current flows for the Greatwood WWTP are 1.35 MGD and the Tara Plantation WWTP is 0.55 MGD. With the expected growth in this area, a regional WWTP has been proposed and a site has tentatively been selected. It has been recommended that the flows from the two existing plants be diverted to the new plant, since both existing plants cannot be enlarged due to restrictions in available land. Also, in close proximity to the site selected for the regional WWTP is a 225-acre park. While a Scalping Plant in this area does not seem feasible at this time, this is a good site for installation of a reclamation plant at the new WWTP. The park could use an estimated 0.5 MGD of the effluent from this plant. If this regional WWTP was built and received the flows from the existing two plants, it would have sufficient flow to meet the needs of this park, as well as other public areas. With the expected growth in this area, if new developments were to follow the guidelines discussed in Section 5.2, additional uses for the reclaimed water would present themselves as more area was developed.

The greatest impact that Scalping Plants can have on existing treatment plants is to pull enough flow away from the existing WWTPs, thus delaying and/or reducing the need for future expansions of treatment facilities, lift stations, and force mains. Due to the limited size of Scalping Plants, their use will not eliminate all new flows generated by growth in the area, but can play a significant role in reducing future construction costs, O&M costs for the WWTPs, and O&M costs for lift stations and pumping facilities.

5.4 Comparison of Unit Costs of Reclaimed Water to Alternative Sources

The comparison of unit costs for "Reclaimed Water" produced by a Scalping Plant to the unit costs for "Alternative Sources" of water is not as easy, or as readily apparent as it may seem. Many of the "Alternative Sources" have been used for such an extended period of time that their costs are seen only as those base costs for purchase. It is complex to try and compare these different sources of water since different factors affect each one, so care must be taken to determine a common frame of reference. Several factors need to be considered and decided upon in order to assure that all unit costs are taken into account, so that the comparison is valid. This point is very evident in this instance due to the fact that the Scalping Plants are smaller and are new construction. While the unit costs associated with "Reclaimed Water" from Scalping Plants will include the costs of installation, the O&M costs for operating the plant; other "Alternative Sources" may not naturally includes these same factors in their costs. The problem areas which need to be addressed in comparing unit costs are as follows:

1. Construction Costs

   Since each Scalping Plant is new construction and the costs have not been recovered, these costs will naturally be included in the discussion for these plants. However, every "Alternative Source" of water other then the new water plant also has construction costs associated with them, but are not as readily apparent because they are older and are either partially or fully paid for. However, that does not eliminate the need to account for their cost of construction in the same manner as it is being handled with the Scalping Plants. Table 5-1 details the estimated construction costs associated with each source that is discussed in this comparison, based on a normal life cycle cost of 30 years.

2. Operation and Maintenance Costs

   In the absence of experience in operating Scalping Plants, estimates for the O&M costs associated with these plants are always considered since they are new and unknown. This is not true of many of the Alternative Sources since they have been used for an extended period of time. Often O&M costs are usually no longer associated with individual entities, but instead are lumped into similar costs and considered a part of doing business. Unless careful records are kept for each water well pump, each water treatment or supply plant, each raw water pump, or water distribution or booster pump, O&M costs for operating these individual systems are hard to find. These costs become associated with producing and supplying potable water, and a necessary cost of producing this service. This will also occur with the Scalping Plants once they have been in service for a while and become more common and accepted. Each Alternative Source has an O&M cost associated with it and if exact numbers are not available, then estimated numbers will be used, just as they are being used for the Scalping Plants. Table 5-2 details the estimated O&M costs associated with the Scalping Plants, existing wastewater treatment plants, and the new water treatment plant. The O&M costs for the plants are based on estimated values found in the sources identified in the table. O&M costs associated with the other Alternate Sources are based on numbers received from the City of Sugar Land.

Table 5-1: Projected Construction Costs.

Item Description	Flow		Estimated Total Construction Cost	Payback Cost / 1,000 Gallons (30 Year Cost)[e]
	Gallons Per Year	No. of 1,000 gallon Units		
50,000 gpd ASP Scalping Plant [a]	18,250,000	18,250	$1,658,961	$3.030
100,000 gpd ASP Scalping Plant [a]	36,500,000	36,500	$2,046,044	$1.869
200,000 gpd ASP Scalping Plant [a]	73,000,000	73,000	$2,798,096	$1.278
1,500 gpm Water Well Pump Installation and Treatment Facilities [b]	354,780,000	354,780	$3,600,000	$0.338
1,500 gpm Water Well Pump Installation [c]	275,940,000	275,940	$1,800,000	$0.217
9 MGD Water Treatment Plant and Water Transmission Main [d]	3,015,000,000	3,015,000	$98,000,000	$1.083
1,500 gpm Raw Water Pump Station [c]	275,940,000	275,940	$1,800,000	$0.217

[a] Construction costs are taken from Table 4.5.
[b] Estimated construction costs and flows based on projects recently designed and installed. Flow is based on 45% of peak flow.
[c] Estimated construction costs and flows based on projects recently designed and installed. Flow is based on 35% of peak flow.
[d] Estimated construction costs supplied by the City of Sugar Land, and based on operating 335 days a year
[e] Payback cost is based on a life cycle cost of 30 years.

Table 5-2: Projected Operation and Maintenance (O&M) Costs – Water,[a] Scalping Plants, and Waste Water Treatment Plants[b].

Item Description	Flow		Estimated O&M Cost/Year	Estimated O&M Cost/1,000 gallons
	Gallons Per Year	No. of 1,000 gallon Units		
50,000 gpd ASP Scalping Plant	18,250,000	18,250	$95,000	$5.205
100,000 gpd ASP Scalping Plant	36,500,000	36,500	$140,000	$3.836
200,000 gpd ASP Scalping Plant	73,000,000	73,000	$210,000	$2.877
North Wastewater Treatment Plant - 6 MGD design flow	2,190,000,000	2,190,000	$2,000,000	$0.913
South Wastewater Treatment Plant - 10 MGD design flow	3,650,000,000	3,650,000	$2,400,000	$0.658
West Wastewater Treatment Plant - 2.5 MGD design flow	912,500,000	912,500	$1,200,000	$1.315
Combined Wastewater Treatment Plants - 18.5 MGD design flow	6,752,500,000	6,752,500	$5,600,000	$0.829
City of Sugar Land Water Treatment Plant - 9.0 MGD design flow and Water Force Main	3,015,000,000	3,015,000	$5,000,000	$1.658

[a] Estimated O&M Costs were provided by the City of Sugar Land
[b] Estimated O&M costs were provided *WaterReuse Research Report* (Salveson, Zhou, Finney, & Ly, 2010)

Also, another key factor in doing this evaluation is to clearly identify what is meant when discussing "Reclaimed Water" and the various "Alternative Sources." The various sources that are being covered in this comparison area listed below. A detailed definition of what is covered by each source can be found in *Appendix 8.6.*

- Treated Surface Water (supplied by the new Sugar Land Water Treatment Plant)
- Raw Surface Water
- Treated Groundwater
- Raw groundwater
- Reclaimed Water (50,000 gpd plant, 100,000 gpd plant, and 200,000 gpd plant)

Table 5-3 details costs associated with each source for construction and O&M.

Tables' 5-4 and 5-5 detail costs covered in Table 5-2, as well as additional costs associated with the State of Texas and the City of Sugar Land. Table 5-4 details costs experienced before ground water conversion requirements are met and Table 5-5 details costs experienced after ground water conversion requirements are met, specifically adding in over-conversion credits.

Based on what has been discussed, the comparisons in Tables 5-3, 5-4 and 5-5 will include all costs and savings mentioned above except for the following exceptions and clarifications:

- Rates charged to customers will not be considered since no decision has been made on what rate will be charged for reclaimed water so no comparison can be made in this area.
- Constructions costs for all sources will be determined, either from actual numbers or based on reasonable estimates. The payback terms for all construction will be spread evenly over a period of thirty years.
- Treatment and O&M costs will be calculated on the size of the facility and determined from actual numbers or based on reasonable estimates.
- Rates charged for obtaining these water sources will be current 2012 rates.
- There is a savings of Non-Compliance Fees for using non-groundwater sources for each gallon of water used until groundwater conversion requirements are met. Savings associated with using any non-groundwater source of water, has an inherent beneficial savings of the Non-Compliance Fee based on every gallon that is used, due to the need to meet conversion requirements.
- Over-conversion credits will apply to the full amount used of any non-groundwater source of water. The savings associated with these over-conversion credits will be equivalent to the cost of the Non-Compliance Fee. Any non-groundwater source of water earns over-conversion credits once groundwater conversion requirements have been met.
- The over-conversion credit for reclaimed water will be based on a one to one and a half (1:1½) ratio. All other non-groundwater sources of water will be based on a one to one (1:1) ratio.
- Groundwater will not be charged for Non-Compliance Fees.
- Costs for reclaimed water will come from installation of an activated sludge treatment plant acting as the Scalping Plant. Although the scope of this study was for a 50,000 gpd plant and a 100,000 gpd plant, a 200,000 gpd plant was also included since it appears that the use of a scalping plant becomes more feasible as the plant size increases.

Table 5-3: Projected Annual Cost / 1,000 gallons – Construction and O&M Costs Only (30 year payback on construction costs).

Item Description	Treated Surface Water	Raw Surface Water	Treated Ground Water	Raw Ground Water	50,000 gpd Scalping Plant	100,000 gpd Scalping Plant	200,000 gpd Scalping Plant
Construction Costs [a]	$1.083	$0.217	$0.338	$0.217	$3.030	$1.869	$1.278
O&M Costs of Scalping Plants [c]					$5.205	$3.836	$2.877
O&M Costs of reclaimed water distribution system (estimated as equal to cost of other distribution systems)					$0.056	$0.056	$0.056
O&M Costs saved at domestic WWTP [c]					-$0.829	-$0.829	-$0.829
O&M Costs of treating surface water [c & d]	$1.658						
O&M Costs of pumping raw groundwater (40% of total O&M Costs of $0.2798/1,000 gallons) [d]				$0.112			
O&M Costs of raw water distribution system (20% of total O&M Costs of $0.2798/1,000 gallons) [d]		$0.056		$0.056			
O&M Costs of pumping raw surface water (30% of total O&M Costs of $0.2798/1,000 gallons) [d]		$0.084					
O&M Costs of potable water distribution system (20% of total O&M Costs of $0.2798/1,000 gallons) [d]	$0.056		$0.056				
O&M Costs of pumping and treating groundwater (80% of total O&M Costs of $0.2798/1,000 gallons) [d]			$0.224				
Totals	$2.798	$0.357	$0.618	$0.385	$7.462	$4.931	$3.381

(a) Information taken from Table 5.1 and divided by the number of 1,000 gallon units
(b) $800/year fee divided by the number of 1,000 gallon units taken from Table 5.2
(c) Information taken from Table 5.2.
(d) Information supplied by the City of Sugar Land
(e) This table does not include costs for associated fees (Water Quality, Permit, Raw Water and Groundwater), Non-Compliance Fee Savings/Costs and over-conversion credits

Table 5-4: **Projected Annual Cost / 1,000 gallons Before Conversion Requirements Are Met (30 year payback on construction costs).**

Item Description	Treated Surface Water	Raw Surface Water	Treated Ground Water	Raw Ground Water	50,000 gpd Scalping Plant	100,000 gpd Scalping Plant	200,000 gpd Scalping Plant
Construction Costs [(a)]	$1.083	$0.217	$0.338	$0.217	$3.030	$1.869	$1.278
Cost of Annual Water Quality Fee [(b)]					$0.044	$0.022	$0.011
O&M Costs of Scalping Plants [(c)]					$5.205	$3.836	$2.877
O&M Costs of reclaimed water distribution system (estimated as equal to cost of other distribution systems)					$0.056	$0.056	$0.056
O&M Costs saved at domestic WWTP [(c)]					-$0.829	-$0.829	-$0.829
O&M Costs of treating surface water [(c & d)]	$1.658						
O&M Costs of pumping raw groundwater (40% of total O&M Costs of $0.2798/1,000 gallons) [(d)]				$0.112			
O&M Costs of raw water distribution system (20% of total O&M Costs of $0.2798/1,000 gallons) [(d)]		$0.056		$0.056			
O&M Costs of pumping raw surface water (30% of total O&M Costs of $0.2798/1,000 gallons) [(d)]		$0.084					
Raw Water Fee [(d)]	$0.025	$0.025					
O&M Costs of potable water distribution system (20% of total O&M Costs of $0.2798/1,000 gallons) [(d)]	$0.056		$0.056				
O&M Costs of pumping and treating groundwater (80% of total O&M Costs of $0.2798/1,000 gallons) [(d)]			$0.224				
Pumpage Fee for groundwater [(d)]			$1.320	$1.320			
Non-Compliance Fee Savings (Savings per 1,000 gallons earned due to use of alternate sources of water)	-$3.250	-$3.250			-$3.250	-$3.250	-$3.250
Permit Fee Price [(d)]	$0.015	$0.015	$0.015	$0.015	$0.015	$0.015	$0.015
Totals	-$0.412	-$2.853	$1.953	$1.720	$4.271	$1.718	$0.157

(a) Information taken from Table 5.1 and divided by the number of 1,000 gallon units
(b) $800/year fee divided by the number of 1,000 gallon units taken from Table 5.2
(c) Information taken from Table 5.2.
(d) Information supplied by the City of Sugar Land

Table 5-5: Projected Annual Cost / 1,000 gallons Once Conversion Requirements Are Met (30 year payback on construction costs).

Item Description	Treated Surface Water	Raw Surface Water	Treated Ground Water	Raw Ground Water	50,000 gpd Scalping Plant	100,000 gpd Scalping Plant	200,000 gpd Scalping Plant
Construction Costs [(a)]	$1.083	$0.217	$0.338	$0.217	$3.030	$1.869	$1.278
Cost of Annual Water Quality Fee [(b)]					$0.044	$0.022	$0.011
O&M Costs of Scalping Plants [(c)]					$5.205	$3.836	$2.877
O&M Costs of reclaimed water distribution system (estimated as equal to cost of other distribution systems)					$0.056	$0.056	$0.056
O&M Costs saved at domestic WWTP [(c)]					-$0.829	-$0.829	-$0.829
O&M Costs of treating surface water [(c & d)]	$1.658						
O&M Costs of pumping raw groundwater (40% of total O&M Costs of $0.2798/1,000 gallons) [(d)]				$0.112			
O&M Costs of raw water distribution system (20% of total O&M Costs of $0.2798/1,000 gallons) [(d)]		$0.056		$0.056			
O&M Costs of pumping raw surface water (30% of total O&M Costs of $0.2798/1,000 gallons) [(d)]		$0.084					
Raw Water Fee [(d)]	$0.025	$0.025					
O&M Costs of potable water distribution system (20% of total O&M Costs of $0.2798/1,000 gallons) [(d)]	$0.056		$0.056				
O&M Costs of pumping and treating groundwater (80% of total O&M Costs of $0.2798/1,000 gallons) [(d)]			$0.224				
Pumpage Fee for groundwater [(d)]			$1.320	$1.320			
Over Conversion Credits (credits earned at a rate of 1.0 gallon per 1.0 gallon alternate source water)	-$3.250	-$3.250					
Over Conversion Credits (credits earned at a rate of 1.5 gallons per 1.0 gallon reclaimed water)					-$4.880	-$4.880	-$4.880
Permit Fee Price [(d)]	$0.015	$0.015	$0.015	$0.015	$0.015	$0.015	$0.015
Totals	-$0.412	-$2.853	$1.953	$1.720	$2.641	$0.088	-$1.473

[(a)] Information taken from Table 5.1 and divided by the number of 1,000 gallon units
[(b)] $800/year fee divided by the number of 1,000 gallon units taken from Table 5.2
[(c)] Information taken from Table 5.2.
[(d)] Information supplied by the City of Sugar Land

The cost/1,000 gallons found in Table 5-3 (Projected Annual Cost / 1,000 gallons – Construction and O&M Costs Only), Table 5-4 (Projected Annual Cost / 1,000 gallons Before Conversion Requirements Are Met), and Table 5-5 (Projected Annual Cost / 1,000 gallons Once Conversion Requirements Are Met) are used as the basis for the comparison listed below:

	Cost / 1,000 gallons		
Source of Water	Table 5.3	Table 5.4	Table 5.5
• Treated Surface Water (future Sugar Water Treatment Plant)	$2.798	-$0.412	-$0.412
• Raw Surface Water	$0.357	-$2.853	-$2.853
• Treated Groundwater	$0.618	$1.953	$1.953
• Raw Groundwater	$0.385	$1.720	$1.720
• Reclaimed Water (50,000 gpd Plant)	$7.462	$4.271	$2.641
• Reclaimed Water (100,000 gpd Plant)	$4.931	$1.718	$0.088
• Reclaimed Water (200,000 gpd Plant)	$3.381	$0.157	-$1.473

When comparing each source based only on construction and O&M costs (Table 5.3 data), raw surface water and both groundwater sources have the lowest costs. Raw surface water has the lowest cost of $0.357/1,000 gallons. It is followed by raw groundwater at $0.385/1,000 gallons, and treated groundwater at $0.618/1,000 gallons. This is not unexpected since the facilities for these three sources are less expensive to build and operate, and treated groundwater requires less operational and treatment costs then the other sources. The reclaimed water produced at a 200,000 gpd plant came in fifth at $3.381/1,000 gallons, behind treated surface water at $2.798/1,000 gallons.

However, there are more costs to consider then construction and O&M costs. Each location, municipality, and water district has unique factors that must be added into the costs associated with evaluating these different sources. The City of Sugar Land is subject to costs associated with the mandatory conversion of groundwater to other water sources at select percentages over a given period of time due to subsidence. With these mandatory conversion requirements come permitting fees, pumpage fees, raw surface water fees, non-compliance fees, and over-conversion credits.

When comparing each source based on the costs incurred by the City of Sugar Land before it meets its conversion requirements (costs for construction, O&M, permit costs, pumpage fees, raw surface water fees and non-compliance fees - Table 5.4 data), raw surface water still has the lowest cost at -$2.853/1,000 gallons. Due to the added fees, the next lowest costs are associated with treated surface water at -$0.412/1,000 gallons and reclaimed water produced at a 200,000 gpd plant at $0.157/1,000 gallons. Both ground water sources fall behind reclaimed water produced at a 100,000 gpd plant as a result of these fees. The cost effectiveness of the reclaimed water plants was a surprise, but it is not unexpected that the cost of groundwater sources would rise due to these fees. Especially since these fees and requirements are designed to force a reduction in the use of groundwater.

Finally, when comparing each source based on the costs incurred by the City of Sugar Land after it meets its conversion requirements (costs for construction, O&M, permit costs, pumpage fees, raw surface water fees and over-conversion credits - Table 5.5 data); raw surface water still has the lowest cost at -$2.853/1,000 gallons. Due to the additional over-conversion credits given to reclaimed water, the next lowest cost is associated with reclaimed water produced at a 200,000 gpd plant at -$1.473/1,000 gallons. Treated surface water has a cost of -$0.412/1,000 gallons and is followed closely by reclaimed water produced at a 100,000 gpd plant at $0.088/1,000 gallons. Both ground water sources still sit behind these four sources as a result of these fees and credits. It must be noted that once the over-conversion credits stop being awarded, the cost of all sources, other than groundwater, will revert back to the costs seen with Table 5.4 since there will continue to be a savings associated with using these other sources because they reduce the amount paid in Non-Compliance fees if conversion quotas are not met. Reclaimed water produced at a 50,000 gpd plant comes in last, as it has in the prior two comparisons.

It is apparent that reviewing the use of Scalping Plants as a source of reclaimed water becomes viable once the flow increases to at least 200,000 gpd. A 50,000 gpd plant has too high of costs associated with it to make it economically feasible. A 100,000 gpd plant is more reasonable, but still poses the need for a high cost passed on to the user. The drawbacks with bigger Scalping Plants is the need for a larger area for installation of the plants, need for an increased number of users to utilize all of the reclaimed water that is produced, and higher installation costs. The advantage to larger plants is reduced costs in all areas and a reduced number of plants necessary to gain substantial benefits.

Based on this preliminary comparison and using data relevant to the City of Sugar Land, it is obvious that use of larger Scalping Plants is a viable alternative for reducing dependence on groundwater and meeting conversion requirements. Scalping Plants are also economically feasible if their location is planned to maximize both the capacity of the plant and users for all the reclaimed water that the plant can produce.

5.5 Evaluation of Potential Impact to the City of Sugar Land GRP due to Reclaimed Water Production Facilities

It is difficult to measure the impact of Scalping Plants and reclaimed water production facilities on the City of Sugar Land's GRP, since it is unknown what commitment the City will make to these facilities. The impact is directly proportional to the City's use of these facilities. If the use of Scalping Plants and reclaimed water production facilities is minimal, the effects will be minimal. It is important to note that in reviewing the 2012 WWMPU and the GRP, that the use of reclaimed water is seen as a minimal contributor to meeting conversion requirements. Surface water was seen as the major contributor for meeting compliance requirements. If a serious commitment is not made to installation of reclamation facilities and the associated distribution systems, users will have no reason to use what is available, or feel compelled to consider its use.

As water needs increase, and available water sources decrease, it does not make sense to continue to produce high quality effluent in wastewater treatment plants and discharge that effluent into streams of much less quality. It does make sense that if money is spent to produce a high quality effluent, then better use of that effluent must be found and utilized. This not only makes good economic sense, it also makes sense as far as posing a serious alternative for meeting future water needs. Not only can the effluent be used for irrigation and industrial use, but, with proper facilities, it can also be used as a future source of potable water. Future growth and declining surface water sources will eventually demand that more creative ideas be used for meeting water supply needs. That is why if plans are made today to utilize all available sources to their maximum benefit, it will, in the long term, save money and prevent shortages. Every day that a municipality or entity waits, makes it more difficult and costly to change systems over to new methods. If municipalities plan for future needs and advancements today, then all new construction projects will have that goal in mind.

In light of this, the impact of Scalping Plants and reclaimed water production facilities can play an important part in the City of Sugar Land meeting its GRP if their implementation are aggressively pursued and utilized. There are several points that need to be considered as not only reasons for doing so, but also to show what impact reclaimed water can have in helping to meet the GRP. These points to consider are:

- Every gallon of reclaimed water that is produced and used reduces the need for groundwater and surface water. As the use of groundwater is being minimized, and surface water sources will be decreased due to increased demand, the costs associated with both of these options will continue to increase.
- Every gallon of reclaimed water has a cost savings attached to it, since it helps the City to meet its conversion requirements. Since the Non-Compliance fee is currently $3.25/1,000 gallons, potentially every 1,000 gallons of reclaimed water that is used saves the City a cost of $3.25. These savings will increase as the rates go up next year and with every increase in the future.
- Currently, every gallon of reclaimed water produced and used in excess of conversion requirements, produce over conversion credits for as long as those credits are given. The benefits to using reclaimed water, is that the over-conversion credits are earned at a rate of 1.5 gallons for each gallon of reclaimed water used, instead of one gallon to one gallon for other sources. These credits can be used by the City during emergencies, or can be sold to other entities for added income.
- Design parameters for water usage of an equivalent single family connections (ESFC) is 400 gallons/day while the design parameters for wastewater treatment for each ESFC is 225 gallons/day. Theoretically, total reclamation of all wastewater effluent would result in a 56.3% reduction in the amount of groundwater or surface water that is currently needed. Realistically, this is not possible due to flows lost due to removal of solids and other occurrences. However, even if only 70% of wastewater effluent was reused either for irrigation, industrial use, or a source of potable water, the impact on the City of Sugar Land's GRP would be significant. While this may not be possible with existing flows, any flows from new developments can be claimed and reutilized.

In conclusion, the impact of reclaimed water on the City of Sugar Land's GRP is totally dependent on how aggressively the City pursues this alternative. If planning and funds are dedicated to incorporating these facilities into the master plan for the City, then the impact for the City can and will be significant. Because of this potential impact, Section 5.6 will outline recommendations that would help to maximize the impacts of these facilities.

5.6 Recommendations for Pursuing Reclaimed Water Production Facilities as a Means of Meeting the City of Sugar Land GRP

Initially, most concerned parties in this matter did not have high expectations that the results of this study would produce recommendations for the City of Sugar Land to pursue construction and operation of 50,000 or 100,000 gpd Scalping Plants. The three primary reasons for this belief were:

- The construction and O&M costs for such small plants would make the costs of producing reclaimed water too high to be cost effective.
- The well documented fact that small wastewater treatment plants are more difficult to operate, are highly susceptible to any changes in the wastewater influent resulting in major problems in the plant, and have high manpower costs to operate and maintain.
- The prevailing theory that any major municipality should move to centralizing wastewater treatment plants to minimize construction and O&M costs, and eliminate smaller, less efficient plants.

As bigger municipalities centralized their facilities, it was easier to meet effluent requirements because the plants were built better and were less susceptible to changes in the incoming wastewater. Also, the costs of operating and maintaining these plants were much lower per million gallon when compared to smaller plants. The drawbacks to larger plants were:

- The need for more lift stations, force mains, and higher collection system construction and O&M costs.
- The site for these plants must be carefully chosen to allow enough room for future expansion and growth.
- If a problem occurred at the plant and the treatment process failed, the effects were much more costly and damaging to the plant and the receiving stream.

Thus, based on these thoughts and beliefs, it was assumed that even with the disadvantages posed by larger plants, use of smaller treatment facilities would be a step backwards. However, the results of this study have shown that these small treatment plants have benefits that were not readily apparent before the study began. In some cases, these benefits actually showed that installation of these plants would not only be cost effective, but beneficial to the City of Sugar Land. Some of the benefits found through this study were:

- Cost benefit through use of reclaimed water of at least $3.25/1,000 gallons because of helping to keep the City of Sugar Land from paying a Non-Compliance fee.
- Cost benefits of receiving over-conversion credits for use of reclaimed water at a rate of 1.5 gallons per 1 gallon of use, resulting in an estimated benefit of $4.88/1,000 gallons.
- Construction and O&M cost reductions of the plants since no preliminary or solids handling is allowed or required at the plant.
- Savings in construction costs for wastewater collection and treatment plant projects.
- Costs of a distribution system are reduced due to the ability to locate a plant closer to users of reclaimed water.
- Savings in O&M costs at the larger, domestic wastewater treatment plants.

- Savings in O&M costs increase if a sufficient number of Scalping Plants are installed allowing for a group of operational personnel to be dedicated to these plants. Their familiarity with the systems will increase the efficiency of the plants and operational personnel.
- Usage increases if new development guidelines include provisions for use of reclaimed water.

Because of these and other benefits, as well as other information learned in this study, the following recommendations are made regarding the installation of Scalping Plants in the City of Sugar Land and it ETJ. Recommendations for each size plant will be detailed, followed by a section that details recommendations for Scalping Plants throughout the City of Sugar Land and its ETJ.

5.6.1 Recommendation for 50,000, 100,000, and 200,000 gpd Scalping Plants

After completing this study, the results were definitive regarding installation of Scalping Plants. It was obvious that bigger Scalping Plants (200,000 gpd or bigger) are more viable than the smaller plants. A 50,000 gpd Scalping Plant was found to be too small to be cost effective due to high construction and O&M costs. Section 5.4 showed that even with a construction payback of ten years, the cost per 1,000 gallons was $8.716, more than double the cost of any other source that was studied. The results for a 100,000 gpd Scalping Plant was not as definitive. Although the construction and O&M costs for these plants were still high, the operational costs of these plants were closer to the other sources, at a cost per 1,000 gallons of $3.841 when considering a construction payback of ten years. This amount is close enough that more detailed engineering might justify their use in the proper application and site.

While the scope of this study was an evaluation of 50,000 or 100,000 gpd Scalping Plants, as the study progressed, it was obvious that as the plant size increased, the viability of installation of these plants improved. A 200,000 gpd plant was included in the study to see if this size plant would be of sufficient size to make it a viable option for the City of Sugar Land. The results of this study proved that not only is this plant a viable alternative, but has the second best cost per 1,000 gallons of all sources studied. The results showed that the cost was $1.098, second only to the cost of using raw surface water. Also, the sites for installation of Scalping Plants that were studied all could effectively use a 200,000 gpd or larger plant to meet the needs of users in the area. As a result, it is the recommendation of this study that the City of Sugar Land seriously pursue the use of 200,000 gpd or larger Scalping Plants in their future wastewater and GRP plans.

5.6.2 Recommendations for the Use of Scalping Plants

Based on information learned in this study, it has become apparent that the City of Sugar Land needs to develop a Water Reclamation Master Plan that includes the aggressive pursuit of using reclaimed water throughout the City and its ETJ. This plan would evaluate sites for reclamation plants, potential users and uses, proposed distribution systems, construction costs, and a schedule for implementation of these recommendations. As water sources become more heavily used, the need for using reclaimed water will increase and will become a critical part of any municipality's water plan. If the City of Sugar Land moves now to plan for and implement the use of reclaimed water, the costs of construction and implementation will be reduced as compared to waiting.

With this in mind, the following recommendations are made regarding the construction and use of reclaimed water.

- The City of Sugar Land should actively pursue the use of Scalping Plants and reclaimed water production facilities. The 2012 WWMPU and the GRP see future needs being met mainly by conversion to surface water, with only minor impact due to reclamation plants. If the City raises expectations for reclaimed water in their short and long range plans, contributions by reclaimed water facilities can play a bigger role in meeting the City's conversion requirements, as well as reducing groundwater and surface water use.
- The City of Sugar Land should develop guidelines and requirements for inclusion of reclaimed water systems (both Scalping Plants and distribution systems) in all new developments. All new developments, both residential and commercial should include plans for use of reclaimed water. This should include installation of reclaimed water distribution systems to those areas that can utilize reclaimed water, planned primary use of reclaimed water for irrigation and non-drinking water applications, and planned installation of appropriately sized Scalping Plants to handle the projected need for that development or collection of users.
- Plans should continue to proceed with WW-1, the Diversion of LS #141 to LS #142. However, included in this project should be the installation of a 200,000 gpd Scalping Plant at LS #142 and the distribution system for reclaimed water produced at this station. Users in the area will need to be contacted and informed on the availability of reclaimed water to meet their irrigation needs, and the design of a distribution system to meet the needs should be undertaken. This will increase the costs of construction for this project, but will help to reduce groundwater use in that area, as well as affect changes to future construction projects.
- As the area around LS #142 continues to grow and develop, require that all developers follow the guidelines mentioned previously, and that new Scalping Plants be installed as needed in newly developed areas.
- Installation of a reclaimed water production facility at the South WWTP, specifically to meet the needs of the Sweetwater Country Club, and other users in that area. This will help to reduce groundwater use in that area and earn income from the sale of reclaimed water to users. If the City of Sugar Land chooses not to install this facility, it should make plans to install a 200,000 gpd or bigger Scalping Plant at LS #116, to meet the needs of the Sweetwater Country Club. This is too large of an opportunity for use of reclaimed water for the City of Sugar Land to not take advantage of, especially since the club is very interested in cutting their costs by using reclaimed water and are willing to participate in the cost of the facility.
- Plans should be made to install Scalping Plants in the area around LS #52, LS #60, and LS #63. This area is slated for tremendous growth over the next few years, and plans for installations of Scalping Plants in this area as growth occurs will help to reduce groundwater use, reduce flows to the North WWTP, and reduce the size and costs of future collection system projects. Meanwhile, potential users in this area should be contacted and find those who would be willing to use reclaimed water in existing areas. Once these users are identified, and the amount of reclaimed water needed is defined, Scalping Plant(s) should be planned and built at well chosen sites in developed areas to meet the needs of these present day users.

- Using information learned from the survey; determine the possibility and costs of building a reclamation facility at the North WWTP and a distribution system to serve that facility. If a maximum flow is determined for the North WWTP, the treatment plant can be modernized and include a reclamation facility. Users in that area can be supplied. Some flows will still need to be diverted to the West WWTP, but not as much as originally planned. These modifications could be paid for by the savings gained from reductions in construction and O&M costs for future plans to divert all flow to the West WWTP and closing of the North WWTP. The idea of using effluent as a source for potable water is not new, but is somewhat bold and innovative. However, as demand for water increases, this is an alternative that needs to be considered. Planning for that now, instead of waiting, can save on future costs of construction.
- The City of Sugar Land needs to claim all increases in wastewater effluent due to new developments through the use of Bed and Banks permits. Currently, regulations state that once surface water (from any source) is returned to the stream, it becomes state water again and is subject to appropriation by others. However, there is a provision that states that the discharger of surface-water-based flows may obtain a Bed to Banks Permit to transport this water to a place of reuse, either themselves or by another potential user. While this cannot be done easily with waters previously discharged into a stream, all new sources of water can be claimed before they are initially released into a stream.
- Future plans for expansion of the West WWTP should include a reclaimed water production facility. Potential users in the area can be identified and supplied reclaimed water from this facility. All new increases in flows at that plant that is not used for reclamation can be claimed by the City of Sugar Land through a Bed and Banks Permit and discharged into the receiving stream or in the long-term future pumped to the surface water plant as a source for potable water treatment as the water crisis in Texas develops.

In conclusion, the City of Sugar Land should actively pursue using reclaimed water as a viable "Alternative Source" for groundwater. Creative and innovative planning and engineering can help the city to reduce groundwater use and meet the water needs for the City.

6 Additional Information

6.1 Public Meetings

Three Public Meetings were held in the City of Sugar Land to provide information to the public on the scope and results of this study. See *Appendix 8.1* for more information on the dates, details, and attendees of these meetings.

6.2 Financial Assistance Available for Wastewater Reclamation Projects

There are many sources of financial assistance for pursuit of Wastewater Reclamation Project. See *Appendix 8.7* for additional details on programs available through the Texas Water Development Board (TDWB).

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8 Appendix

8.1 Public Meetings

Three public meetings were held during the process of completing this study. Details on these meetings are listed below:

A. Public Meeting No. 1

- Date Held: October 24, 2011
- Location: City of Sugar Land City Hall
- Attendees: Tricia Bradbury, President Sugar Lakes HOA; Al Abramczyk, Sugar Lakes HOA; Lann Bookout, TWDB; Colleen Spencer, City of Sugar Land; and SuEllen Staggs, City of Sugar Land
- Notes: This meeting discussed the areas that would be focused on by this study. Some of these areas were: Type I vs. Type II treatment, treatment technologies to consider (Membrane Customized [MBR] plants, Activated Sludge [ASP] package plants and Sequencing Batch Reactor [SBR] package plants), regulatory requirements, possible locations for decentralized wastewater facilities and demand for wastewater reuse. Discussion was held on each of these topics and on what direction AECOM was focusing on to effectively evaluate the use of Scalping Plants. Potential sites, locations, and users were discussed at the meeting. The main users that were discussed were Sweetwater Country Club, Greatwood Golf Course and NALCO. Contacts for each of these entities, as well as TCEQ, were provided at the meeting. Officials from the City of Sugar Land also answered questions that had arisen during the preliminary stages of the study, as well as provided information that would be needed as the study progressed. The general comment from HOA attendees was that this sounded like a great idea and can these plants be used to fill our lakes.

B. Public Meeting No. 2

- Date Held: March 19, 2012
- Location: City of Sugar Land City Hall
- Attendees: Karen Hood, Allan Plummer Engineers; Lann Bookout, TWDB; Karen Daly, City of Sugar Land; SuEllen Staggs, City of Sugar Land; Idahosa Igbinoba, City of Sugar Land; Colleen Spencer, City of Sugar Land; and Kyle Jones, AECOM
- Notes: This meeting was not attended by any private citizens or members of the community. AECOM provided an overview of project progress and identified the areas that were going to be the focus of additional study. Some additional direction, suggestions, and information were provided at that time by personnel from the City of Sugar Land that would help to complete the project. The general discussion held at this meeting showed an

interest in the study and what conclusions were being formed based on the information that had been gathered.

C. Public Meeting No. 3

- Date Held: May 10, 2012
- Location: City of Sugar Land City Hall
- Attendees: Leslye Henderson, Austin Park HOA; T. Schumann, Austin Park HOA; C. Blundan, Austin Park HOA; Lann Bookout, TWDB; SuEllen Staggs, City of Sugar Land; Idahosa Igbinoba, City of Sugar Land; Colleen Spencer, City of Sugar Land; Kyle Jones, AECOM; Michael Rolen, AECOM; and Ambarish Ravichandran, AECOM
- Notes: The results of the final report were given at this meeting. Some very good questions were asked about the methodology that would be used, possible first locations for a Scalping facility, and justification for Scalping Plants over reclamation plants located at the main treatment plants. City of Sugar Land officials were concerned about the method of comparing costs for each source of water and wanted to see the costs compared by strictly considering construction and O&M costs. Also, it was decided that all costs should be based on a per 1,000 gallons basis to make it easier to compare numbers throughout the report. The majority of questions centered around how scalping plants would affect neighborhoods, and what would the nuisances (smells, noise, vibrations) be for Scalping Plants.

8.2 Reclaimed Water Reuse Criteria

Reuse type & Quality	Reclaimed Water Treatment Requirements	Reclaimed Water Monitoring Requirements	Other Information
Unrestricted Urban reuse - Type I	Reclaimed water on a 30-day average to have a quality of: • 5 mg/l BOD_5 or $CBOD_5$ • 10 mg/l for landscape impoundment • Turbidity - 3 NTU • Fecal coliform - 20/100 ml (geometric mean); 75/100 ml (not to exceed in any sample)	Sampling and analysis twice per week for BOD_5 or $CBOD_5$, turbidity, and fecal coliform Periodic fecal coliform sampling in the reclaimed water distribution system may be necessary	Reclaimed water use defined as use of reclaimed water where contact between humans and the reclaimed water is likely. Residential irrigation, irrigation of public parks, golf courses with unrestricted public access, schoolyards or athletic fields, fire protection, toilet flushing, and other uses.
Restricted Urban reuse - Type II	Reclaimed water on a 30-day average to have a quality of: • 30 mg/l BOD_5 with treatment using pond system • 20 mg/l BOD_5 or 15 mg/l $CBOD_5$ with treatment other than pond system • Fecal coliform - 200/100 ml (geometric mean); 800/100 ml (not to exceed in any sample)	Sampling and analysis once a week for BOD_5 or $CBOD_5$ and fecal coliform	Reclaimed water use defined as use of reclaimed water where contact between humans and the reclaimed water is unlikely. Uses include irrigation of limited access highway rights-of-way and other areas where human access is restricted or unlikely to occur. Use of reclaimed water for soil compaction and dust control in construction areas where application procedures minimize aerosol drift to public areas also included.
Agricultural Reuse (Food Crops) - Type I	Direct contact with edible portion of crop unless food crop undergoes pasteurization process. Reclaimed water on a 30 day average to have a quality of: • 5 mg/l BOD_5 or $CBOD_5$ • 10 mg/l for landscape impoundment • Turbidity - 3 NTU • Fecal coliform - 20/100 ml (geometric mean); 75/100 ml (not to exceed in any sample)	Sampling and analysis once a week for BOD_5 or $CBOD_5$ and fecal coliform	Spray irrigation not permitted on food crops that may be consumed raw. Other types of irrigation that avoid contact of reclaimed water with edible portions of food crops are acceptable. Food crops that will be substantially processed prior to human consumption may be spray irrigated.

Reuse type & Quality	Reclaimed Water Treatment Requirements	Reclaimed Water Monitoring Requirements	Other Information
Agricultural Reuse (Food Crops) - Type I	Direct contact with edible portion of crop not likely or where food crop undergoes pasteurization process. Reclaimed water on a 30 day average to have a quality of: • 30 mg/l BOD_5 with treatment using pond system • 20 mg/l BOD_5 or 15 mg/l CBOD5 with treatment other than pond system • Fecal coliform - 200/100 ml (geometric mean); 800/100 ml (not to exceed in any sample)		
Agricultural Reuse (Non-Food Crops) - Type I	• 5 mg/l BOD_5 or $CBOD_5$ • 10 mg/l for landscape impoundment • Turbidity - 3 NTU • fecal coliform - 20/100 ml (geometric mean); 75/100 ml (not to exceed in any sample)	Sampling and analysis twice per week for BOD_5 or $CBOD_5$, turbidity, and fecal coliform	Can be used for irrigation of pastures for milking animals.
Agricultural Reuse (Non-Food Crops) - Type II	• 30 mg/l BOD_5 with treatment using pond system • 20 mg/l BOD_5 or 15 mg/l $CBOD_5$ with treatment other than pond system • • Fecal coliform - 200/100 ml (geometric mean); 800/100 ml (not to exceed in any sample)	Sampling and analysis once a week for BOD_5 or $CBOD_5$ and fecal coliform.	Can be used for irrigation of sod farms, silvicluture, and animal feed crops.
Unrestricted Recreational Reuse - Type I	Reclaimed water on a 30-day average to have a quality of: • 5 mg/l BOD_5 or $CBOD_5$ • 10 mg/l for landscape impoundment • Turbidity - 3 NTU • Fecal coliform - 20/100 ml (geometric mean); 75/100 ml (not to	Sampling and analysis twice per week for BOD_5 or $CBOD_5$, turbidity, and fecal coliform	

Reuse type & Quality	Reclaimed Water Treatment Requirements	Reclaimed Water Monitoring Requirements	Other Information
	exceed in any sample)		
Restricted Recreational Reuse - Type II	Reclaimed water on a 30-day average to have a quality of: • 30 mg/l BOD_5 with treatment using pond system • 20 mg/l BOD_5 or 15 mg/l CBOD5 with treatment other than pond system • Fecal coliform - 200/100 ml (geometric mean); 800/100 ml (not to exceed in any sample)	Sampling and analysis once a week for BOD_5 or $CBOD_5$ and fecal coliform	
Industrial Reuse - Type II	Reclaimed water on a 30-day average to have a quality of: • 30 mg/l BOD_5 with treatment using pond system • 20 mg/l BOD_5 or 15 mg/l CBOD5 with treatment other than pond system • Fecal coliform - 200/100 ml (geometric mean); 800/100 ml (not to exceed in any sample)	Sampling and analysis once a week for BOD_5 or $CBOD_5$ and fecal coliform	Use for cooling towers which produce significant aerosols adjacent to public access areas may have special requirements

8.3 Detailed List of Permitting Requirements that need to be Completed for Permitting Reclaimed Water Production Facilities (Scalping Plants)

The following general requirements, restrictions, and application requirements must be met to permit, build, and operate a Reclaimed Water Production Facility (RWPF). In order to assure the accuracy of the information in this section, much of the information and text derived for this section has been taken directly from the identified chapters of the Texas Administrative Code, Title 30: Environmental Quality. Chapters that have been copied or covered in this section are 30 TAC: Chapter 30, Chapter 210, Chapter 217, Chapter 305, Chapter 309, Chapter 312, and Chapter 321.

A. Wastewater Discharge Permit:

A RWPF authorized according to 30 TAC: Chapter 321 is not required to hold a wastewater discharge permit except as provided in 30 TAC: Chapter 210.5. The requirements of this chapter are as follows:

1. Before reclaimed water can be discharged to the waters of Texas, the owner or user will obtain a permit from the Permitting Authority (PA) in accordance with the requirements of 30 TAC: Chapter 305 (see Section D of this chapter for details), except as provided for by 30 TAC: Chapter 210.22 (see Section A.2 of this chapter for details).

2. The following guidelines need to be met for meeting the General Requirements of 30 TAC: Chapter 210.22:

    a. Reuse of untreated wastewater is prohibited.

    b. Food crops that may be consumed raw by humans will not be spray irrigated. Food crops that will be substantially processed before human consumption may be spray irrigated.

    c. There will be no nuisance conditions resulting from the distribution, the use, and/or storage of reclaimed water.

    d. Reclaimed water will not be utilized in a way that degrades ground water quality to a degree adversely affecting its actual or potential uses.

    e. Reclaimed water managed in ponds for storage will be prevented from discharge into waters of the state, except for discharges directly resulting from rainfall events or in accordance with a permit issued by the PA. All other discharges are prohibited. If any unauthorized overflow of a holding pond occurs causing discharge into or adjacent to waters of the state, the user or provider, as appropriate, will report the noncompliance. A written submission of such information will also be provided to TCEQ within five (5) working days of becoming aware of the overflow. Details to be included in this written submission can be found in 30 TAC: Chapter 210.22 (e).

3. The PA may require a reclaimed water user to apply for and obtain a permit to utilize reclaimed water if the reclaimed water uses poses potential or actual adverse impacts upon human health, soil and ground resources, or aquatic life.

4. For purposes of 30 TAC: Chapter 210, no permit issued pursuant to 30 TAC: Chapter 305 will be required for additional treatment required to meet the quality standards of 30 TAC: Chapter 210.33 (see Section F.2 of this chapter for details), unless such additional treatment results in a discharge of wastewater into waters of the state.

5. A reclaimed water provider or user who accepts effluent meeting the Type II quality criteria and that must also meet the Type I quality criteria for a proposed use must provide additional treatment for the proposed new use. The additional treatment must be authorized by the PA. The owner or user must notify and be granted an authorization by the PA before engaging in such activity. Authorization may be granted by the PA after review of the proposed plans and specifications submitted for the additional treatment. This request for authorization may be submitted to the PA along with the notification required by 30 TAC: Chapter 210.4 (see Section A.6 of this chapter for details).

6. The following guidelines need to be met for meeting the notification requirements of 30 TAC: Chapter 210.4:

   a. The reclaimed water provider will notify the PA and obtain written approval to provide reclaimed water before providing reclaimed water to a user. This notification will include:

      (1) A description of the intended use for the reclaimed water, including quantity, quality, origin, and location and purpose of intended use;

      (2) A clear description of the methodology used for complying with the requirements of 30 TAC: Chapter 210, including documentation that the user will be apprised of their responsibilities under 30 TAC: Chapter 210 as a part of the water supply contract or other binding agreement;

      (3) Provide evidence in a water supply contract or other binding agreement of the provider's authority to terminate water use that is noncompliant with 30 TAC: Chapter 210: and

      (4) An Operation and Maintenance Plan that is required under ordinance or is to be part of the water supply contract or other binding agreement, where applicable, and shall contain, as a minimum, the following:

         (a) A labeling and separation plan for the prevention of cross connections between reclaimed water distribution lines and potable water lines;

         (b) Measures that will prevent unauthorized access to reclaimed water facilities;

(c) Procedures for monitoring reclaimed water transfers and use;

(d) Steps the user will utilize to minimize the risk of inadvertent human exposure;

(e) Schedules for routine maintenance;

(f) A plan for carrying out provider employee training and safety relating to reclaimed water treatment, distribution, and management; and

(g) Contingency plan for remedy of system failures, unauthorized discharges, or upsets.

b. If the reclaimed water provider is not the producer, a description of the origin of the reclaimed water, its quality based upon the parameters contained in the underlying waste discharge permit(s), and a signed agreement from the producer authorizing the transfer of the reclaimed water to the provider. If applicable, a reclaimed water provider or user may need to obtain a separate water right authorization from the PA.

c. A producer who chooses to use reclaimed water for a beneficial use only within the boundaries of a wastewater treatment facility permitted by the PA may do so without notification otherwise required by 30 TAC: Chapter 210. In such case, the producer is still required to comply with all applicable requirements of 30 TAC: Chapter 210 pertaining to reclaimed water use.

d. Major changes from a prior notification for use of reclaimed water will be approved by the PA. A major change includes:

(1) A change in the boundary of the approved service area;

(2) The addition of a new producer;

(3) Major changes in the intended use; or

(4) Changes from Type I or Type II uses to the other.

7. If a provider or user elects to treat reclaimed water supplied by the provider or producer, respectively, to a quality better than the minimum standards of 30 TAC: Chapter 210, such treatment does not require a permit or other additional authorization by the PA.

8. Any sewerage sludge generated as a result of reclaimed water treatment undertaken pursuant to 30 TAC: Chapter 210 will be managed in accordance with the requirements of 30 TAC: Chapter 312 (see Section C.4 of this chapter for details).

B. General Requirements for a RWPF

1. An applicant for authorization to produce reclaimed water at a RWPF must have:

a. A domestic wastewater permit for a domestic wastewater treatment facility that is located at the terminus of the collection system to which the RWPF will be connected (30 TAC: Chapter 321.01); and

b. An authorization to use reclaimed water under 30 TAC: Chapter 210.

2. Applications for a RWPF and authorization for reuse of reclaimed water under 30 TAC: Chapter 210 can be submitted at the same time.

3. The authorization of the RWPF cannot alter the permitted flow or effluent limits of the associated domestic wastewater treatment facility.

C. General Restrictions for a RWPF:

1. A RWPF cannot discharge wastewater or pollutants into waters of Texas.

2. The hydraulic capacity of a single RWPF or group of RWPF cannot individually or collectively exceed the permitted hydraulic capacity of the associated domestic wastewater treatment facility.

3. The RWPF cannot be authorized at a flow rate that could cause interference with the operation of the domestic wastewater treatment facility or a violation of the wastewater treatment facility's permit.

4. The RWPF cannot treat or dispose of sludge at the site. It must be conveyed through the collection system to the permitted domestic wastewater treatment facility where it will be treated and disposed of in accordance with the facility's permit and all applicable rules.

5. The owner of the RWPF may not accept trucked or hauled wastes at the RWPF.

6. Authorization under 30 TAC: Chapter 321 does not convey or alter any property right and does not grant any exclusive privilege.

D. Application Requirements for a RWPF:

1. Identification of the owners of the land upon which each facility is to be located.

2. Obtain written consent of the owner(s) of the land upon which each facility is to be located before submitting permit (30 TAC: Chapter 305.43).

3. Based on 30 TAC: Chapter 321.01, since this will be a reclamation facility no wastewater discharge permit is required except as provided in 30 TAC: Chapter 210.5, and thus the requirements of 30 TAC: Chapter 305.48 do not need to be met.

4. To meet the requirements found in 30 TAC: Chapters 305.43, 305.44, 305.47, and 321.309, a permit for a Reclaimed Water Production Facility (RWPF) will be required. The permit will need to include the following items as a minimum:

a. The name, mailing address, and location of the RWPF for which the application is submitted;

b. The ownership status as federal, state, private, public, or other entity;

c. The applicant's name, mailing address, and telephone number;

d. The wastewater permit number of the associated domestic wastewater treatment facility;

e. A brief description of the nature of the reclaimed water use;

f. Signature of a principal executive officer or ranking elected official per 30 TAC: Chapter 305.44;

g. A copy of the recorded deed or tax records showing ownership, or a copy of a contract or lease agreement between the applicant and the owner of any lands to be used for the RWPF;

h. A copy of the applicant's reuse authorization issued under 30 TAC: Chapter 210, or a copy of a concurrent application;

i. A preliminary design report for the RWPF that includes the design flow, design calculations, the size of the adopted treatment units, a flow diagram, and the proposed effluent quality (See Section F of this chapter for details);

j. A buffer zone map and report indicating how the RWPF will meet buffer zone requirements (See Section F.4 of this chapter for details);

k. A County General Highway Map (with scale clearly shown) to identify the relative location of the domestic wastewater treatment facility, the main lines of the collection system, and the RWPF and at least a one-mile area surrounding the RWPF.

l. One original United States Geological Survey 7.5 minute quadrangle topographic map or an equivalent high quality color copy showing the boundaries of land owned, operated or controlled by the applicant and to be used as a part of the RWPF. The map shall extend at least one-mile beyond the boundaries of the RWPF and shall show the following:

  (1) Each well, spring, and surface water body or other water within the map area;

  (2) The general character of the areas adjacent to the facility, including public roads, towns, and the nature of development of adjacent lands such as residential, commercial, agricultural, recreational, undeveloped, or so forth;

m. Other information that reasonably may be requested by the PA.

n. Per 30 TAC: Chapter 305.47, the applicant will be required to keep records throughout the term of the permit, of data used to complete the final application and any supplemental data.

E. Applicant must show a positive history of previous compliance to existing permits. Demonstrated poor performance in meeting past or current permit requirements will impact the successful application for new facilities, unless these poor performances can be explained or it can be shown that the new facilities will assist in meeting these permit requirements.

F. Plans and Specifications Requirements for a RWPF:

30 TAC: Chapter 321 details many of the base requirements that need to be met before a RWPF can be permitted and allowed to operate. These requirements are as follows:

1. 30 TAC: Chapter 321.315 lists the following design requirements for a RWPF:

   a. Plans and specifications for a RWPF must meet the design criteria and the operation, maintenance, and safety requirements in 30 TAC: Chapter 217. The design will incorporate sufficient provisions to ensure that effluent quality meets the required limits, even during a power supply failure or failure of a treatment unit or process.

   b. A RWPF will be designed to convey all wastewater to the domestic wastewater treatment facility any time the RWPF is not in operation.

   c. The RWPF will be designed to convey all sludge received or produced at the facility to the domestic wastewater treatment facility. Sludge can be held in an aerated storage vessel for discharge to the collection system if the entire sludge contents are completely discharged at least once within a 24-hour period.

   d. The RWPF will be designed and operated to minimize odor and other nuisance conditions (see Section F.5 of this chapter for details).

   e. The following treatment processes are prohibited from being used in a RWPF:

      (1) Unaerated primary treatment units (including Imhoff tanks and primary clarifiers);

      (2) Trickling filters;

      (3) Pond or lagoon treatment systems;

      (4) Flow equalization basins; and

      (5) Unenclosed screenings storage containers.

   f. All plans and specifications of a RWPF must also meet the design requirements detailed in 30 TAC: 217, for the treatment process chosen for the RWPF.

2. The quality standards for using reclaimed water are detailed in 30 TAC: Chapter 210.33 and apply to the types of uses of reclaimed water. The reclaimed water producer, at a minimum, will only transfer reclaimed water that meets the quality as described for each type of specific use. These types of specific uses are:

   a. Type I Reclaimed Water Use – Reclaimed water on a 30-day average will have a quality of:

BOD_5 or $CBOD_5$	5 mg/l
Turbidity	3 NTU
Fecal coliform or *E. coli*	20 CFU/100ml *

Fecal coliform or *E. coli*	75 CFU/100 ml **
Enterococci	4 CFU/100 ml *
Enterococci	9 CFR/100 ml **
* 30-day geometric mean	** maximum single grab sample

b. Type II Reclaimed Water Use – Reclaimed water on a 30-day average will have a quality of (for a system other than a pond system):

BOD_5 20 mg/l	
or $CBOD_5$	15 mg/l
Fecal coliform or *E. coli*	200 CFU/100ml *
Fecal coliform or *E. coli*	800 CFU/100 ml **
Enterococci	35 CFU/100 ml *
Enterococci	89 CFR/100 ml **
* 30-day geometric mean	** maximum single grab sample

c. Type II Reclaimed Water Use – Reclaimed water on a 30-day average will have a quality of (for a pond system):

BOD_5	30 mg/l
Fecal coliform or *E. coli*	200 CFU/100ml *
Fecal coliform or *E. coli*	800 CFU/100 ml **
Enterococci	35 CFU/100 ml *
Enterococci	89 CFR/100 ml **
* 30-day geometric mean	** maximum single grab sample

3. The means of transporting reclaimed water from the SWPF to the provider or users will need to be identified in the application process for this facility, and in the plans and specification for the RWPF and its distribution system. Key valves, distribution points, maintenance, and means of distinguishing the reclaimed water piping from potable water piping is a critical component of a reclaimed water use system and the application process.

4. A RWPF must meet buffer zone requirements that include the following requirements (30 TAC: Chapter 321.317):

   a. A RWPF must comply with 30 TAC: Chapter 309.12 requirements that the proposed site minimizes possible contamination of surface water and groundwater selection by considering the following factors:

      (1) Active geologic processes;

      (2) Groundwater conditions such as groundwater flow rate, quality, length of flow path to points of discharge, and aquifer recharge and discharge conditions;

(3) Soil conditions such as stratigraphic profile and complexity, hydraulic conductivity of strata, and separation distance from the facility to the aquifer and points of discharge; and

(4) Climatological conditions

b. A RWPF must comply with 30 TAC: Chapter 309.13 9 (a) – (d) requirements that the proposed site does not have unsuitable site characteristics by requiring the following factors be met:

(1) The RWPF cannot be located in the 100-year flood plain unless the plant unit is protected from flooding and damage that may occur during a flood event;

(2) The RWPF cannot be located in a wetland designated area;

(3) A RWPF cannot be located closer than 500 feet from a public water well as provided by 30 TAC: Chapter 290.41 nor 250 feet from a private water well. Additional separation distances are stipulated, but they apply only if on-site irrigation occurs; and

(4) A RWPF surface impoundment cannot be located in an area overlying the recharge zones of major or minor aquifers, unless the aquifer is separated from the base of the containment structure by material that does not allow for pollutant migration.

c. A RWPF that does not qualify for an enhanced buffer zone designation must locate each treatment unit at least 150 feet from the nearest property line.

d. To qualify for an enhanced buffer zone designation, a RWPF must comply with one of the following requirements:

(1) A RWPF not located in a building may not be closer than 300 feet from the nearest property line;

(2) A RWPF located within an enclosed building without exhaust air systems and odor control technology may not be located closer than 150 feet from the nearest property line; and

(3) A RWPF located within an enclosed building with exhaust air systems and odor control technology may not be located closer than 50 feet from the nearest property line.

e. The applicant for a RWPF must own or have sufficient property interest to the land necessary to meet the buffer zone requirements so that residential structures are prohibited within the buffer zone. Sufficient evidence of its property interest must be submitted to demonstrate that the RWPF meets the applicable buffer zone.

5. A RWPF must meet "nuisance of odor" requirements found in 30 TAC: Chapter 309.13 (e) that includes the following additional requirements:

a. Applicant must submit a "nuisance odor" prevention request for approval by the PA. This request must be in the form of an engineering report, prepared and sealed by a licensed professional engineer, supporting the request. This report must include, at the minimum, addressing the climatological conditions at the site, surrounding land use, wastewater characteristics in affected units within the buffer zone, all potential odor generating units, and proposed solutions to prevent nuisance conditions at the edge of the buffer zone and beyond. Proposed solutions will be supported by actual test data or appropriate calculations. This request will be submitted before construction, either with the permit application for review during the permitting process or submitted after the permit process is complete directly to the PA.

b. The permittee will submit sufficient evidence of legal restrictions prohibiting residential structures within the part of the buffer zone not owned by the applicant. Sufficient evidence takes the form of a suitable restrictive easement, right-of-way, covenant, deed restriction, deed recorded, or a private agreement provided as a certified copy of the original document.

6. If a RWPF cannot meet the buffer zone or "nuisance odor" requirements, a variance will need to be applied for, and will be considered on a case-by-case basis. If the variance is granted, it will be listed as a condition of the permit.

7. Any approved alternative for achieving the requirements of 30 TAC: Chapter 309.13 will remain in effect as long as the RWPF is permitted by the PA. To meet this requirement, the permittee must carry out the "nuisance odor" prevention plan at all times, will ensure sufficient property ownership or interest, and will maintain easements prohibiting residential structures, as appropriate.

8. Since the scalping locations are in close proximity to residential and business areas, it is assumed that to meet the buffer zone and "nuisance for odor" requirements of 30 TAC: Chapter 309.13, the RWPF will need to be enclosed within a building with exhaust air systems and odor control technology.

G. Public Notice Requirements:

1. If the applicant for a RWPF qualifies for an enhanced buffer zone designation in accordance to 30 TAC: Chapter 321.317, no public notice is required.

2. If the applicant for a RWPF does not qualify for an enhanced buffer zone designation in accordance to 30 TAC: Chapter 321.317, public notice is required. This public notice requires placement of a sign at the site location, identifying all key information required by this statute, and maintained during the full length of the public comment period.

3. Publish notice of the PA's preliminary determination on the permit application at least once during the public comment period. This notice will be placed in a newspaper of general circulation in the area where the RWPF is located or expected to be located. Additional requirements are as follows:

a. The applicant will publish notice within 30 days after receiving instruction to publish notice of the PA's preliminary determination on the permit application from the Texas Commission on Environmental Quality (TCEQ). The notice will include all of the information required by this statute.

b. The applicant must file with TCEQ no later than 30 days after receiving the instruction to publish notice of the PA's preliminary determination on the permit application, proof that the notice was published and a copy or copies of the newspaper clipping.

c. The public comment period will begin on the first day the notice is published and will end 30 days later unless a public meeting is required to be held. If a public meeting is required, the public comment period ends either 30 days after the initial notice is published or at the conclusion of the public meeting, whichever is later.

d. The public may submit comments to the TCEQ during the comment period detailing how the application for the RWPF fails to meet the technical requirements or conditions of this rule.

e. The public may submit a written request for a public meeting to the TCEQ during the comment period. If it is determined that there is sufficient interest in holding a public meeting, one will be scheduled.

f. The TCEQ will mail all comments, final technical documents, and decision by the PA to the applicant, and all persons who submitted written comments or completed the sign-in sheet at a public meeting.

H. Additional Requirements and Enforcement Guidelines for a RWPF:

1. The owner of the RWPF will employ or contract with one or more licensed wastewater treatment facility operators or wastewater facility operations companies holding a valid license or registration per the requirements of 30 TAC: Chapter 30, Subchapter J.

2. The operator or wastewater facilities operations company will have the same level of license or higher as the operator license of the permitted domestic wastewater treatment facility associated with the RWPF.

3. The owner will notify the PA at least 45 days before completion and at least 45 days before operation of a RWPF.

4. If a owner of a RWPF fails to comply with the terms of its authorization, or TCEQ rules and regulations, the PA will take enforcement action as provided in the Texas Water Code and in accordance with 30 TAC: Chapter 70.

5. The PA may revoke any RWPF authorization due to noncompliance with the authorization, TCEQ rules and regulations, or other regulations and statutes within the jurisdiction of the PA, but only after notice and the opportunity for a hearing.

I. After obtaining all necessary information and meeting all of the requirements listed above, prepare the permit application for a RWPF and submit it to the appropriate PA.

8.4 Impact on the Wastewater Transmission System

While information on the flows at several lift stations were included in the 2012 WMPU, a representative number of sites were chosen to illustrate the potential benefits for installation of Scalping Plants and their ability to effectively be utilized and have an impact on future expansion to the wastewater collection system. At each site, the assumptions stated above will be utilized in presentation of the benefits of installation of Scalping Plants. Three major sites were selected for review as part of this study and are discussed below:

7.3.1 Lift Station #116 (LS #116)

Based on information obtained from the City of Sugar Land, Lift Station (LS) #116 currently has a daily flow of approximately 2.14 mgd that feeds to the South Wastewater Treatment Plant (WWTP). Its flow is not expected to increase over the next ten years and no collection system expansion plans are targeted in this area. Thus, installation of a Scalping Plant at this site would not have an obvious impact on future collections system expansion plans.

It is noteworthy that LS #116 is in close proximity to the Sweetwater Country Club that has seemed quite willing to receive reclaimed water and has an annual use of 100 to 150 million gallons (0.27 to .41 mgd). However, installation of a 100,000 or 200,000 gpd Scalping Plant would not be sufficient to meet their needs and would require their continued use of potable ground water. There also does not appear to be sufficient land available in the area to place a larger treatment facility that would be capable of meeting the full need of Sweetwater Country Club. Based on Sweetwater Country Club's close proximity to the South WWTP, and minimal if any impact on future collection system expansion plans, it is recommended that a reclaimed water facility be installed at that the South WWTP and a line ran from there to service Sweetwater Country Club. This would seem to be the most cost effective method of serving their need, minimizing disruption to the area, and reducing groundwater use.

7.3.2 Lift Station #142 (LS #142)

Based on information found in the 2012 WMPU, LS #142 has an estimated current flow of 0.07 mgd but it is expected to grow to 0.8 mgd over the next 5 to 10 years. The flow will increase when the flow from LS #141 is diverted to Lift Station #142. This would be an ideal site to initially install a 200,000 gpd Scalping Plant and divert LS #141 to LS #142 at the same time. Although the scope of the project calls for 50,000 gpd to 100,000 gpd Scalping Plants, the addition of a 200,000 gpd plant at this site would allow the diversion of LS #141 to LS #142, without the need to complete the Phase 1 expansion of LS #142. This scalping plant could serve users in the area such as the Lakes of Avalon and Crescent Lakes. As the area grows, additional units could be added as necessary at appropriate locations to handle new users in the area, with developers being required to run reclaimed water piping in all new areas and developments.

The potential savings for installation of a 200,000 gpd Scalping Unit at LS #142 for future collection system expansion costs would be obvious in looking at future plans for LS #142 and LS #141. Project WW-1 is the planned expansion of LS #142, and includes replacement of existing pumps with two 750 gpm pumps and 2,900 linear feet of 10-inch force main. The design phase is planned to begin in 2013 with construction slated to be complete in 2014. The estimated cost of this project is $590,000. Project WW-2 is the planned expansion of LS #141, and includes replacement of existing pumps with two 450 gpm pumps and 1,900 linear feet of 6-

inch force main from LS #141 to LS #142. The design phase is planned to begin in 2013 with construction slated to be complete in 2014. The estimated cost of this project is $924,000. If Project WW-2 was completed at the same time as installing a 200,000 gpd Scalping Plant, the need for Project WW-1 would not be necessary. This would save the City of Sugar Land $590,000.

Installation of a 200,000 gpd Scalping Plant at this site would also affect Project WW-4, the Phase II expansion of LS #142. WW-4 includes the replacement of existing pumps with pumps capable of producing 2,225 gpm and 16,225 linear feet of 16-inch force main. The design phase is planned to begin in 2014 with construction slated to be complete in 2015. The estimated cost of this project is $4,186,500. If this Scalping Plant is installed, WW-4 could be delayed until an analysis of future flows at LS #142 could be completed.

7.3.3 Area Surrounding Lift Stations #33, #48, #52, #60, and #63

Based on information found in the 2012 WMPU, six construction projects are slated in the area around these five lift stations. Current flows are hard to estimate based on the information found in the 2012 WMPU, but it appears that LS #52 has an estimated current flow of 0.03 mgd but it is expected to grow to 0.675 mgd over the next 5 to 10 years due to growth and the projected flow coming from LS #63. LS #52 sits north of Highway 59 and is in close proximity to many identified potential users for reclaimed water. Of the potential users in this area, several key ones would be the Sugar Lake area, NALCO, and Telfair North. Based on usage amounts, this area could be the site of multiple units, ranging in size from 100,000 gpd to 200,000 gpd, based on proximity to users, available flow in the system, ability to install needed distribution systems, and the flow needed by willing users. While one of the biggest advantages of installing Scalping Plants in this area is the reduction of flow to the North WWTP, potential benefits also exist in delaying and/or reducing planned collection system expansions in this area. The biggest unknown about this area is the density of existing buildings and residential areas, and the ease of installing a reclaimed water distribution system and demand of potential users. However, there are areas slated for future development in this area, as evidenced by the projected increase in flow for the area. If the same guidelines were enacted in this area for new developments as covered in the discussion for LS #142, potential sites for additional Scalping Plants would increase.

In review of potential savings to delays and/or reductions to collections system expansions, this area has six planned projects, with the first slated to begin in 2013. One expansion is slated for LS #52, two at LS #63, and one each at LS #33, LS #48 and LS #60. WW-3 is the planned expansion of LS #52 that includes replacement of existing lift station pumps with three new 1,500 gpm pumps. The design phase is planned to begin in 2014 with construction slated to be complete in 2014. The estimated cost of this project is $426,000. While this area will continue to grow, installation of a number of Scalping Plants would have an impact on the current projected size of the required capacities of the new lift station pumps. Every gallon that is diverted from LS #52 to Scalping Plants reduces the need for capacity at LS #52, and will affect the scope and costs of the project.

WW-5 is the planned expansion of LS #60 and includes the replacement of existing pumps with pumps capable of producing 2,350 gpm and the addition of 10,700 linear feet of 16-inch force main. The design phase is planned to begin in 2014 with construction slated to be complete in 2015. The estimated cost of this project is $2,633,500. LS #60 is currently under construction and will include two pumps with a capacity of 1,070 gpm and addition of a 10-inch diameter force main. The WW-5 expansion is slated to begin in 2014 due to expected new developments in that area. Since the need for this expansion is predicated on new growth in the area, it is important to note that if the new guidelines for new developments be enacted, some of the increases in flow could be diverted to Scalping Plants and used as a source of reclaimed water. By reducing the flow handled by this pump station, it is very likely that WW-5 could be delayed and that the size of the expansion would be reduced.

WW-7 is the planned expansion of Airport LS #33 and includes the replacement of existing pumps with two 188 gpm pumps, an 8-foot diameter wet well, and the addition of 2,000 linear feet of 4-inch force main. The design phase is planned to begin in 2015 with construction slated to be complete in 2016. The estimated cost of this project is $816,000. Although the flow at LS #33 is most likely too small to justify installation of a Scalping Plant in this area, with LS #33 feeding LS #60, more flow will be available at LS #60 to be diverted off to Scalping Plants.

LS #63 has two expansion projects slated, both of which are dependent on new growth and development in the area. WW-8 is the Phase I Expansion of LS #63 and includes the installation of two 700 gpm pumps, a 12-foot diameter wet well, and the addition of 8,500 linear feet of 10-inch force main. The design phase is planned to begin in 2015 with construction slated to be complete in 2016. The estimated cost of this project is $1,803,000. WW-9 is the Phase II Expansion of LS #63 and includes the addition of one 700 gpm pump. The design phase is planned to begin in 2021 with construction slated to be complete in 2022. The estimated cost of this project is $150,000. Since this is an undeveloped area and the growth is projected but the rate is unknown, it poses problems in the area of sizing pumps, wet wells, force mains, and destination of flows. The number of Scalping Plants installed, and their sizes will have an impact on the required size of these projects and every gallon that is diverted from LS #63 to Scalping Plants reduces the need for capacity at LS #63. This will affect the scope and costs of these projects.

WW-6 is the planned Expansion of LS #48. This expansion is necessary due to projected increases in flows in the North WWTP service area, including flows from LS #52 and LS #63. This expansion will include major modifications to the lift station to accommodate these increased flows and in preparation for planned future diversions of flows from the North WWTP to the West WWTP. The design phase of this project is planned to begin in 2014 with construction slated to be complete in 2016. The estimated cost of this project is $2,364,000.

8.5 Impact on Domestic Wastewater Treatment Plants

While the focus of this report is to identify the viability of Scalping Plants, it must also be discussed that the greatest benefit that can be achieved with use of reclaimed water is to establish Reclaimed Water Production Facilities (RWPF) at each of the three main WWTPs. The benefits to doing this are as follows:

- The treatment facility is already built and only additional treatment units will need to be added to meet effluent requirements for a Type I effluent. Usually, this will only require addition of filters after the chlorination chambers.
- The primary construction costs will involve the cost of the on-site facilities (water storage tanks, water booster pumps, hydropneumatic tanks, and accessory equipment) and off-site distribution systems.
- Negate the need for treating solids twice. This will occur if solids produced at a Scalping Plant are pumped back into the collection system, versus being hauled to a WWTP via tank truck. The need to remove solids in one of these two methods at a Scalping Plant is due to regulatory requirements that do not allow solids to be treated on the site of a Scalping Plant.
- The reductions to potable water use (groundwater and surface water) will be significant resulting in significant savings both in fees and O&M costs, but through gains in over-conversion credits. Users can also be charged for the reclaimed water and additional funds generated.

While savings in construction costs for Scalping Plants can be gained, as well as higher reductions in the need for potable water (groundwater and surface water), there are disadvantages and/or obstacles in building these facilities. Some of these are:

- The need to build more extensive reclaimed water distribution systems to utilize all of the reclaimed water that is being generated. A large part of these distribution systems will occur in developed areas, increasing the costs of construction for these systems.
- The need to find users who will utilize the reclaimed water that is being generated at the facility. While there are many potential users for reclaimed water, getting the water to them and having them agree to use it will be the greatest challenge.
- Because of Type I effluent requirements, more diligent efforts will need to be made in operating and maintaining the WWTPs. While they are doing well at this time, once the effluent is designated for reclaimed water use, plant upsets and problems will need to be minimized and identified quickly.

But, as stated earlier, the primary consideration of this study is to evaluate what effect, if any, Scalping Plants will have on the WWTP's. As discussed, the number of potential users for reclaimed water is significant but the same questions that affect a Scalping Plant's impact on a wastewater collection system, also affects its impact on WWTPs. To maximize the impact of Scalping Plants on WWTP's, the following actions would need to occur and be critical in future planning:

- As discussed, new guidelines regarding the use of reclaimed water will need to be formulated and put in place so that all new developments, both residential and commercial, will include plans for use of reclaimed water.

- Scalping Plants will need to be considered as a viable part of the Wastewater Master Plan and their use and number be maximized to achieve the greatest benefits.
- Utilize Scalping Plants and the location where they are located not only for production of reclaimed water, but also as a means of reducing demands on existing wastewater collection systems and WWTPs.
- Provide incentives (i.e. reduced rates for reclaimed water versus potable water) for all users who switch to the use of reclaimed water.
- Willingness to invest in reclaimed water distribution systems in developed areas to increase the viability of installation of Scalping Plants.
- Development of a group of operational personnel that are dedicated to operating the Scalping Plants. Smaller plants react differently than bigger plants and operational personnel who are familiar with the smaller plants are mandatory for using them successfully and consistently.

Since the boundaries of this study focuses on the cost effectiveness and viability of installation of Scalping Plants, several assumptions are made. The first assumption is that Scalping Plants will be installed and that 100% of the reclaimed water that is produced will be utilized. The second assumption is that reclaimed water distribution systems will be installed to service willing users. The third assumption is that new developments will be required to include the use of reclaimed water facilities and distribution systems in their plans, including use of reclaimed water at all applicable sites.

The potential impacts of Scalping Plants on each WWTP will be discussed individually, in order to assess what savings can be made due to installation of these Scalping Plants. At each WWTP, the assumptions stated above will be utilized in presentation of the benefits of installation of Scalping Plants. The WWTPs are discussed below.

7.4.1 North Wastewater Treatment Plant (North WWTP)

The North WWTP is located north of Hwy. 59, and its site is land locked due to existing residential and commercial development around the plant. Due to restriction on available land area for future expansions and rapidly approaching its permitted number of connections, the North WWTP is scheduled to have flows diverted to the West WWTP as early as 2020. Currently, the North WWTP has the capability of diverting up to 0.75 mgd to the South WWTP, thus delaying the need to divert flows to the West WWTP. Six future expansion projects are designed around the North WWTP, with the sole purpose of diverting increased flows away from the plant. While all six projects may need to be done in time, each will be discussed as to how Scalping Plants can affect their implementation dates and costs.

WW-11 is the Phase I Diversion Force Main to be installed in 2020 and run from LS #48 to the headworks of the West WWTP. This project includes running 19,200 linear feet of 24-inch force main at a cost of $8,730,000. This project cannot be undertaken until WW-10 is completed. WW-10 is an expansion of the West WWTP that should be completed in 2020. Based on the flows that are diverted from the North WWTP to newly installed Scalping Plants, it is possible that the need for this force main can be delayed for a period of time, or installed and operated with reduced flows being diverted to the West WWTP.

WW-12 is the optional Interim Diversion Force Main to be instituted in 2023. This project includes modifications made at the North WWTP, LS #48, and pump station controls to utilize an existing 16" force main that runs from the North WWTP to LS #48. This project is designed to reverse the current direction of flow in the force main and allow operators to divert excess flows away from the North WWTP. It has an estimated cost of $396,000. If there is a significant impact due to Scalping Plants installed in this area, this expansion can be delayed for a period of time, or not be done at all. If WW-12 is not done, this would have a cost savings of $396,000.

The final three projects are slated sometime in the future when it is determined that is no longer cost effective to continue to maintain the North WWTP and will divert all of the flow to the West WWTP. These three projects are; WW-13, the expansion of the West WWTP to 10.0 mgd, WW-14, the Improvements to the North WWTP and Decommission of the North WWTP project, and WW-15, the Phase II Diversion Force Main. The estimated costs for these three projects are $83,283,000. While it always wise to reduce the number of treatment locations, especially due to aging equipment and maintenance costs, it would seem that the North WWTP is advantageously located to be an important location for a RWPF. The North WWTP could be a significant producer of reclaimed water and important in reducing the City of Sugar Land's dependence on groundwater. If the number of Scalping Plants utilized in this area is maximized, especially in the areas yet to be developed, the increased flow to the North WWTP could be controlled by the previous projects that have been discussed. Then, some of the funds allocated for WW-15 and WW-16 could be diverted to modernizing the North WWTP and having it operate at a set flow, with any additional flows going to the West WWTP. This would save construction costs, save O&M costs for pumping the wastewater from the North WWTP to the West WWTP, and reduce the costs associated with producing reclaimed water for users in the area. The installation and use of Scalping Plants in this area could delay the implementation of these projects long enough to justify looking at a different strategy toward the North WWTP.

7.4.2 South Wastewater Treatment Plant (South WWTP)

The only plan that deals with the South WWTP is the current ability to divert 0.75 mgd from the North WWTP that is discussed in the previous section. The additions of Scalping Plants in the area around LS #142 and LS #141 will also help in reducing flows to this WWTP. Although, only O&M costs can be associated with these flow reductions, there will be a savings related to any flows that are diverted away from this plant. Since no major expansion plans are scheduled for this WWTP, the predominant costs savings associated with installation of Scalping Plants will be the savings for O&M costs.

Due to its location and available land area, The South WWTP is a prime location for installation of a RWPF at the site. Even though a more extensive reclaimed water distribution system will need to be installed to carry the reclaimed water to users, there are some major users in close proximity to the WWTP. As discussed in Section 5.2, the Sweetwater Country Club is close to the WWTP. The Sweetwater Country Club has appeared willing to receive reclaimed water and has an annual use of 100 to 150 million gallons, or 0.27 to .41 mgd. Based on Sweetwater Country Club's close proximity to the South WWTP, it is recommended that a RWPF be installed at that the South WWTP and a line ran from there to service Sweetwater Country Club. This would seem to be the most cost effective method of serving their need, minimizing disruption to the area, and reducing groundwater use.

7.4.3 West Wastewater Treatment Plant (West WWTP)

The West WWTP is scheduled for two major expansion projects due to diversion of flows to the West WWTP from the North WWTP. The first scheduled expansion is slated to be completed in 2020, with a second expansion triggered when it is decided to divert all flows from the North WWTP to the West WWTP. The date for this project is not yet determined and is based on the rate of growth in the area around the North WWTP. The additions of Scalping Plants in the North WWTP collection area will allow reduced flows to be diverted to the West WWTP, thus delaying the first expansion. However, growth around the West WWTP will also help to necessitate an expansion of the WWTP and it is assumed that the first expansion (WW-10) is needed and will occur. WW-10 is the expansion of the West WWTP to 4.50 mgd, and will allow for flows to increase in their collection area, as well as accept diverted flows from the North WWTP.

Scalping Plants can only affect this plant based on their effect on the North WWTP. From the information we have received, the area within the West WWTP collection area is not interested in looking at Scalping Plants and their installation is questionable. Therefore, Scalping Plants primary influence will involve their effect on the North WWTP and a reduction in flows diverted to the West WWTP. If a determination is made to allocate funds for modernizing the North WWTP and installing a RWPF at that site, then the future expansion (WW-13) of the West WWTP to 10.0 mgd can be delayed, or the size of the expansion reduced. The reduction in construction costs due to a smaller expansion could be utilized to build a RWPF at the West WWTP along with the necessary reclaimed water distribution system. This would then provide three well located sites for production and distribution of reclaimed water within the City of Sugar Land's jurisdiction.

The greatest impact that Scalping Plants can have on existing treatment plants is to pull enough flow away from the existing WWTPs, thus delaying and/or reducing the need for future expansions of treatment facilities, lift stations, and force mains. Due to the limited size of Scalping Plants, their use will not eliminate all new flows generated by growth in the area, but can play a significant role in reducing future construction costs, O&M costs for the WWTPs, and O&M costs for lift stations and pumping facilities.

7.4.4 Greatwood Area - Proposed Regional Wastewater Treatment Plant

This area currently has two wastewater treatment plants, the Greatwood WWTP and the Tara Plantation WWTP. The current flows for the Greatwood WWTP are 1.35 mgd and the Tara Plantation WWTP is 0.55 mgd. With the expected growth in this area, a regional WWTP has been proposed and a site has tentatively been selected. It has been recommended that the flows from the two existing plants be diverted to the new plant, since both existing plants cannot be enlarged due to restrictions in available land. Also, in close proximity to the site selected for the regional WWTP is a 225-acre park. While a Scalping Plant in this area does not seem feasible at this time, this seems to be a perfect site for installation of a reclamation plant on the site of the new WWTP. The park could use an estimated 0.5 mgd of the effluent from this plant. If this regional WWTP was built and received the flows from the existing two plants, it would have sufficient flow to meet the needs of this park, as well as other public areas. With the expected growth in this area, if new developments were to follow the guidelines discussed earlier, additional uses for the reclaimed water would occur as more area was developed.

8.6 Defining Sources of Water to be Studied

A key factor in doing this evaluation is to clearly define what is meant when discussing "Reclaimed Water" and the various "Alternative Sources." Defining these items is important to making a fair comparison. The various sources that are being covered in this comparison area as follows:

1. **Treated Surface Water (supplied by the new Sugar Land Water Treatment Plant)**

   While the new water treatment plant is not in operation at this time, it will need to be considered as a future source. When the treatment plant comes on line, it will be a potable water source for the City of Sugar Land. It will also be capable of being used for irrigation and non-drinking purposes, but there will be costs associated with this supply due to treatment requirements and costs associated for use as potable water. Until the award of over-conversion credits expire, use of this type of water will also earn over-conversion credits if the City of Sugar Land has met and exceeded its conversion requirements. It is eligible for conversion credits based on a one to one (1:1) ratio.

   The costs associated with this source of treated surface water are: cost of construction for the water treatment plant, O&M costs for treating the surface water to potable water standards, shared O&M costs for the distribution system and any associated pumps or facilities in the system, and fees charged for each million gallons of surface water that are pumped. Savings associated with treated surface water are: over-conversion credits and the rate at which it is charged to the customer.

2. **Raw Surface Water**

   From the information provided as a basis for this study, raw surface water is supplied by pumping water out of Oyster Creek. From what we understand, this water is untreated and cannot be used as a source of potable water. It can, however, be used for irrigation and non-drinking purposes. It can also be sent to a water treatment plant, where it can be treated and become a source of potable water. For this study, however, it is assumed that raw surface water is untreated and can only be used for non-drinking purposes. Until the award of over-conversion credits expire, use of this type of water will also earn over-conversion credits if the City of Sugar Land has met and exceeded its conversion requirements. It is eligible for conversion credits based on a one to one (1:1) ratio.

   The costs associated with raw surface water are: cost of construction for the pump station, O&M costs for pumping and maintaining this station and associated systems, and fees charged for each million gallons of raw surface water that are pumped. Savings associated with raw surface water are: over-conversion credits and the rate at which it is charged to the customer.

3. **Treated Groundwater**

   Treated groundwater is a source for potable water for the City of Sugar Land. It can also be used for irrigation and non-drinking purposes, but there are costs associated with this supply due to treatment for use as potable water. There is a noncompliance fee associated with overuse of groundwater that goes into effect if conversion percentages are not met.

The costs associated with this source of treated ground water are: cost of construction for the water wells, storage tanks, booster pumps, chlorination facilities, and ancillary systems, O&M costs for pumping and treating the ground water to potable water standards, shared O&M costs for the distribution system and any associated pumps or facilities in the system (these O&M costs are shared with treated surface water), and fees charged for each 1,000 gallons of ground water that are pumped. The savings associated with treated ground water is the rate at which it is charged to the customer.

4. **Raw groundwater**

Raw groundwater is a source for irrigation and non-drinking purposes. From what we understand, this water is untreated and cannot be used as a source of potable water. As with treated groundwater, there is a noncompliance fee associated with overuse of groundwater that goes into effect if conversion percentages are not met.

The costs associated with this source of ground water are: cost of construction for the water wells, storage tanks, booster pumps, and ancillary systems, O&M costs for pumping the ground water, O&M costs for the distribution system and any associated pumps or facilities in the system, and fees charged for each 1,000 gallons of ground water that are pumped. The savings associated with raw ground water is the rate at which it is charged to the customer.

5. **Reclaimed Water**

For purposes of this study, reclaimed water will be Type I effluent that is being discharged from Scalping Plants. The wastewater will be treated and chlorinated, but cannot be used as a source of potable water or be allowed to flow into any waterways, rivers, or creeks. It can only be used for irrigation and non-drinking purposes. Until the award of over-conversion credits expire, use of this type of water will also earn over-conversion credits if the City of Sugar Land has met and exceeded its conversion requirements. It is eligible for conversion credits based on a one to one and a half (1:1½) ratio.

The costs associated with reclaimed water are: cost of construction for the Scalping Plant, O&M costs for treating and maintaining this plant and associated systems, permit fees, and O&M costs for the distribution system and any associated pumps or facilities in the system. Savings associated with reclaimed water are: over-conversion credits, savings in O&M costs at domestic wastewater treatment plants, savings in cost of groundwater or surface water, savings in O&M costs of pumping, treating, and distributing groundwater or surface water, and the rate at which it is charged to the customer.

8.7 Financial Assistance Available for Wastewater Reclamation Projects

The Texas Water Development Board (TWDB) administers loan and grant programs that provide for the construction of water related infrastructure and other water quality improvements. Communities interested in financial assistance can contact TWDB at (512) 463-7853 or email at Financial_Assistance@twdb.texas.gov. Additional contact information is also listed under the individual programs, and Application format for financing is available for download at http://www.twdb.texas.gov/financial/programs/.

Financial Assistance Programs currently available are:

1. **Loans**

- Clean Water State Revolving Fund

  Uses: Planning, acquisition and construction, wastewater treatment, storm water and nonpoint source pollution control, and reclamation/reuse projects.
- Drinking Water State Revolving Fund

  Uses: Planning, acquisition and construction of water related infrastructure, including water supply and Source Water protection.
- Rural Water Assistance Fund

  Uses: Planning, acquisition and construction of water and wastewater related infrastructure; may also be used to obtain service or to finance consolidation or regionalization.
- Water Infrastructure Fund

  Uses: Projects must be recommended water management strategies in the most recent TWDB approved regional water plan or approved State Water Plan. Funds may not be used to maintain a system or to develop a retail distribution system.
- Texas Water Development Fund

  Uses: Planning, acquisition and construction of water related infrastructure, including water supply, wastewater treatment, storm water and nonpoint source pollution control, flood control, reservoir construction, storage acquisition, and agricultural water conservation projects, and municipal solid waste facilities.

2. **Grants**

- Regional Facility Planning Grant Program

  Uses: Studies and analyses to evaluate and determine the most feasible alternatives to meet regional water supply and wastewater facility needs, estimate the costs associated with implementing feasible regional water supply and wastewater facility alternatives, and identify institutional arrangements to provide regional water supply and wastewater services for areas in Texas.
- Regional Water Planning Group Grants

  Uses: planning activities for the long term water supply needs of Texas. Fundable tasks include determining future water demands, availability of future water supplies, and identifying solutions to meet demands. Funds are periodically available.

- Water Research Grant Program

  Uses: Water research that addresses one of the Texas Water Development Board's designated research topics published in its most recent Request For Proposals.

- Flood Protection Planning

  Uses: Evaluation of structural and nonstructural solutions to flooding problems and considers flood protection needs of the entire watershed. Upstream and/or downstream effects of proposed solutions must be considered in the planning. The proposed planning must be regional in nature by inclusion of an entire watershed.

- Economically Distressed Areas Program

  Uses: To bring water and wastewater services to economically distressed areas (designated by TWDB) where the present water and wastewater facilities are inadequate to meet the minimal needs of residents. The program includes measures to prevent future substandard development.

- Agricultural Water Conservation Grants

  Uses: Demonstrations, education, research, technical assistance, and technology transfer. Grants may also be made to political subdivisions for agricultural water conservation projects for purchase and installation (on public or private property) of metering devices to measure irrigation water use in order to quantify effects of different water conservation strategies.

3. Deferred Interest Obligation

- State Participation Program - Regional Water and Wastewater Facilities

  Uses: Construction of regional water or wastewater construction project when the local sponsors are unable to assume debt for the optimally sized facility.