CITY OF LEAGUE CITY

WATER MASTER PLAN

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September, 2011

CDM

STATE OF TEXAS
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City of League City

Water Master Plan

September 2011

Report

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Executive Summary

The City of League City (City) is facing significant water supply and infrastructure challenges in order to meet future water demands. The City population is expected to continue to grow at an approximate 3.4% rate and more than double and by the anticipated 2040 buildout year. The City also faces operational challenges associated with aging infrastructure, operation of numerous small water wells and booster stations, and the fact that major pipelines within the system operate as both transmission and distribution lines preventing the larger booster stations from operating as designed. The existing water system is currently showing signs of performance issues that must be addressed for both existing and future water needs. During peak demand times, pressures are consistently low, particularly in problem areas in the eastern section of the City. These low pressures are approaching the required minimum pressure limits on water distribution systems which have been established to protect the health, safety and welfare of the public.

The City contracted CDM to develop a system wide plan to guide the City through the future water supply, infrastructure and operational challenges and ensure a reliable and high performing water system.

ES.1 Project Objectives

The specific project objectives are to provide the City with a comprehensive water master plan, addressing the following project needs:

- Plan to accommodate the significant growth anticipated. The population of League City is expected to more than double between now and future City buildout.

- Ensure that the water system meets TCEQ requirements and other design criteria. Specific criteria include enclosed/protected equipment, standby pump capacity, adequate storage throughout the system, and adequate fire flow capacity.

- Address problems created by the current hybrid transmission/distribution system which currently prevent the larger booster pump stations from meeting peak demand conditions.

- Plan for future water source requirements for immediate and future demand needs.

ES.2 Project Approach

To simulate the City's water system, a water model was created using Bentley's WaterGEMS V8i and incorporated GIS data provided by League City as the model base. Demand alternatives were created using the available monthly meter billing data and total daily usage data to simulate average annual, average summer, and maximum day conditions. Meetings were held with City staff to ensure that the proper operational controls and water facility layouts were entered into the model.

To validate the model, the existing scenario results were compared to meter and pressure data from various sites throughout the City to verify that the model was accurately representing the system. Anecdotal evidence of problem locations was verified by City staff.

ES.3 System Characterization and Performance

The existing water system functions adequately under average conditions. The system does, however, experience consistently low pressure under current peak summer day conditions in several major areas of the City. **Figure ES-1** shows the existing water pressures throughout the system during the instantaneous peak time of the maximum day without the State Highway 3 Booster Station (SH3 BS) in operation. **Figure ES-2** presents the pressure differential between the maximum day conditions with and without the operation of SH3 BS. Modeled pressures increased as much as 20 psi with the operation of SH3 BS, with the east central part of the City receiving the most benefit.

For **Figures ES-1** and **ES-2**, the pumping values shown are the flow rates calculated by the model for the existing facilities in order to meet the indicated demand scenario. It should also be noted that the pressures indicated are the lowest instantaneous pressures recorded in the model during the peak hour, day, etc… of each demand scenario and may not reflect continuous or sustained pressures during the indicated scenario.

To achieve even the pressures seen in **Figures ES-1** and **ES-2** on the maximum day, special summer operational procedures are required when SH3 BS is not in operation. The Meadow Bend Booster Station's influent valve to the ground storage tanks is closed to allow more water to reach the South Shore Harbor Booster Station. Also, the connection to Gulf Coast Water Authority (GCWA) line from the Thomas Mackey Plant is closed from 10 AM to 4 PM to ensure that the 2 MGD received there is utilized at peak times. These summer operational controls are labor intensive. Eliminating this type of manual control is ideal to ensure system can run more efficiently and the operations staff can focus on special problems or equipment issues. With SH3 BS in operation, these manual controls should not be necessary.

There are nine booster stations in League City, varying in age from 26 to 48 years old. The majority of the facilities are small and the existing wells require improvement or relocation due to deterioration. There are three elevated storage tanks (EST), with only the Brittany Bay EST performing properly as a true elevated tank. Alabama EST was built in 1962 and functions as a tall ground storage tank. South Shore EST was built in 2006 but can't be refilled during periods of moderate to high demand due to lack of pressure.

Some characteristics of the existing system leave it vulnerable. The majority of the City's water enters through SH3 BS and travels down a single 42-inch/39-inch line to

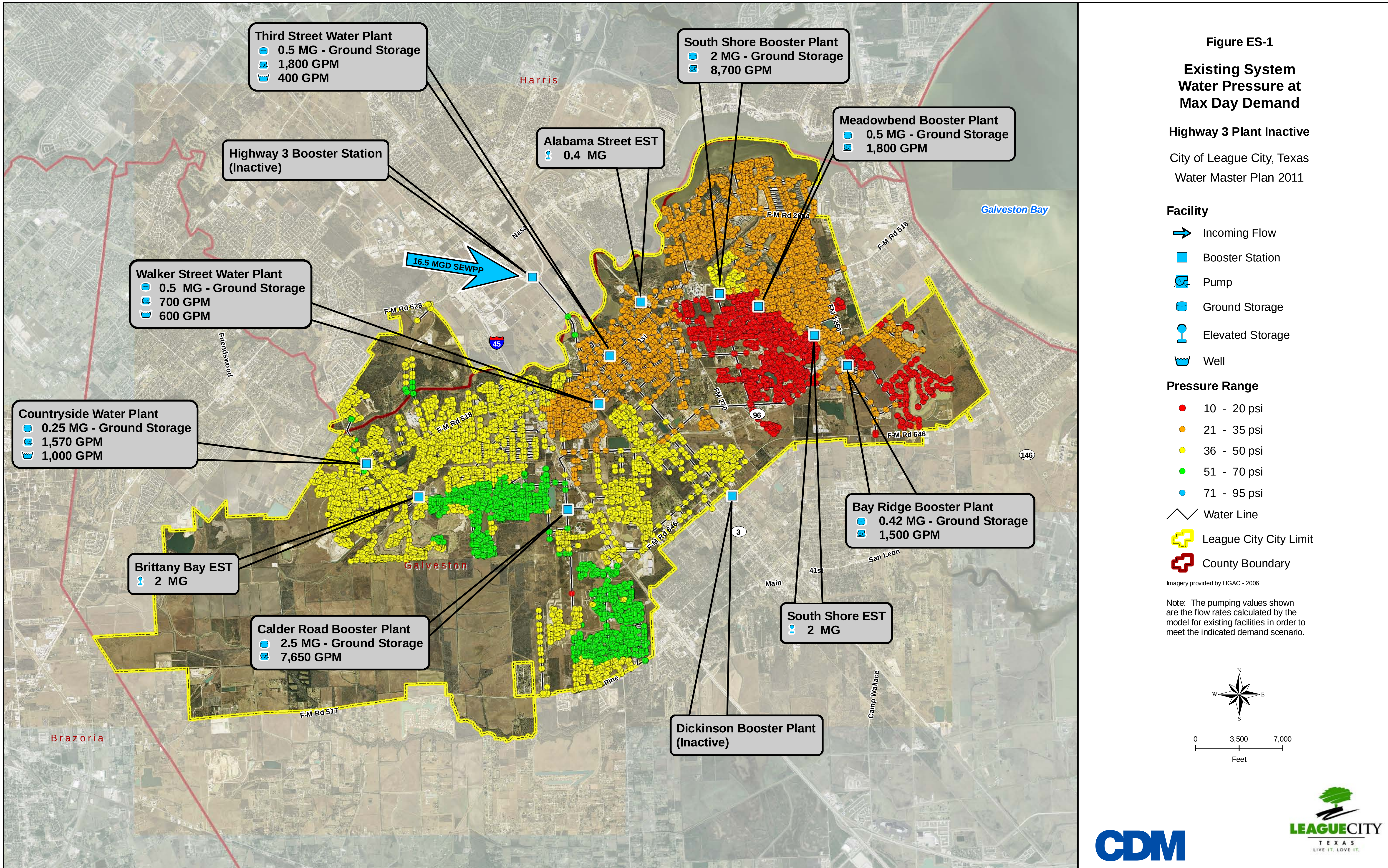

Figure ES-1

Existing System Water Pressure at Max Day Demand

Highway 3 Plant Inactive

City of League City, Texas
Water Master Plan 2011

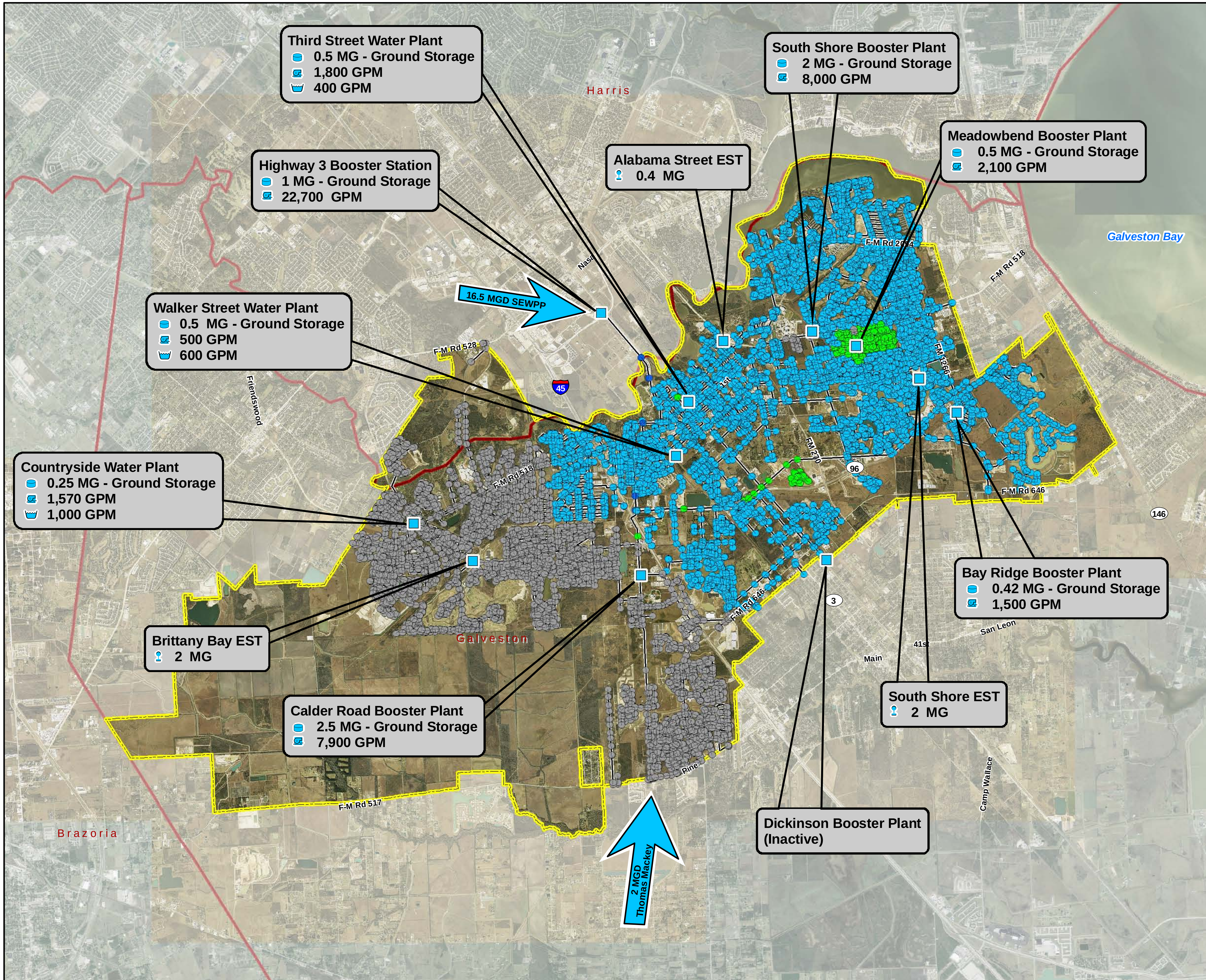

Figure ES-2

Existing System
Differential Water Pressure at Max Day Demand

Highway 3 Plant Inactive

City of League City, Texas

Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Pump
- Ground Storage
- Elevated Storage
- Well

Pressure Change

- No Change
- 1 - 10 psi
- 11 - 20 psi
- 21 - 30 psi
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

Note: The pumping values shown are the flow rates calculated by the model for existing facilities in order to meet the indicated demand scenario.

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Calder BS and various large taps. If something were to happen to this water line or to SH3 BS, then the City would lose access to nearly 90% of its water supply.

All water pumping facilities except SH3 BS and the emergency Dickinson BS are located outside and exposed with no enclosure protecting the equipment. To meet current security standards, all of the facilities need to be secured in a building. Also required is a stand-by pump at each facility. Currently several stations have all pumps running up to 24 hours a day to meet current demand.

The largest single functional issue is the existing hybrid distribution/transmission line. The lines that connect SH3 BS to South Shore Harbor BS was originally designed as a transmission line, however various taps and connections have been permitted. This significantly lowers pressure on the east side of the City. Based on model results and the need for a transmission line to supply South Shore Harbor BS, a new low service booster station at SH3 and transmission line from SH3 directly to the South Shore Harbor BS is recommended as a Priority 1 project by year 2020.

ES.4 System Operation

The water system operation requires careful attention during the summer months. The summer operational procedures mentioned above were developed to minimize pressure losses during these high demand times. Centralization of current water production/pumping facilities to only a few key facilities would greatly improve system efficiency, reduce O&M costs, and make better use of City resources. Deciding which facilities to make future investments in, is fairly simple as is which facilities to decommission.

ES.5 Future Water Challenges

Based on the modeling results, additional source water in addition to the presently secured 23.5 MGD (this includes the 5 MGD City of Houston connection at Beamer Road) will be required for League City between 2020 and 2030, provided that adequate pumping capacity upgrades and additional storage recommended by year 2020 has been added to the system to meet increased peak demands. Ultimately, an additional 21.5 MGD of water is required to meet the demands of buildout. **Figure ES-3** shows the peak day demand through buildout versus the current secured water sources if current usage patterns are not modified.

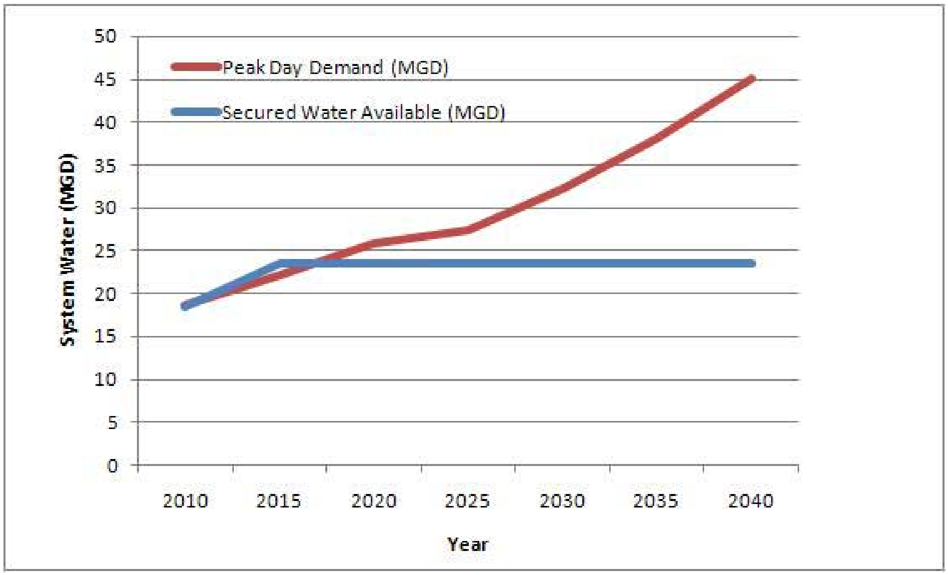


Figure ES-3
Comparison of Secured Water Sources and Future Demand

GCWA and the City of Houston's SEWPP are the only two treated source water providers available to serve the City. At the present time, there is no treatment capacity available for purchase from either facility. The Mackey Plant is currently rated for 20 MGD. The remaining raw water rights and expansion capabilities total 40 MGD. However, those future raw water rights and treatment capacity have already been contracted to other entities. As a result, there is no available treated water capacity available in the future from the Mackey Plant.

The SEWPP is currently rated for 200 MGD with future raw water rights and expansion capability to 240 MGD total. All 200 MGD capacity is currently purchased (of which the City owns 21.5 through GCWA). The future 40 MGD raw water and subsequent SEWPP expansion capacity has not been purchased yet and is available for sale. However, based on the SEWPP's modular configuration, the plant can only be expanded in 40 MGD modules once funding is in place to purchase all 40 MGD.

Should the City choose to wait to purchase additional treated water capacity or miss the opportunity to purchase any or all of the available 40 MGD capacity, the City of Houston does have additional raw water rights and expansion capability at the SEWPP facility. The current master plan for the SEWPP indicates a site plan for an additional 120 MGD (360 MGD total). However, the City of Houston does not currently have raw water infrastructure (raw water pump station or pipeline facilities), treated water infrastructure or treated water delivery infrastructure in place. All of these facilities require long range planning which will likely take many years before implementation.

It should also be noted that the City of Houston is in the process of planning the replacement of the existing 42-inch treated water supply line that extends down SH3 from the SEWPP to the City's SH3 BS. The replacement costs will be shared with all the co-participants. It is unclear at this time if the line will be upsized for future capacity, who would pay for that capacity and how those cost would be shared with the other co-participants.

As far as future capacity is concerned, the only foreseeable way to obtain additional water from the Thomas Mackey Plant would be to take advantage of the GCWA's inability to provide water already contracted to the communities east of League City caused by a lack of adequate transmission capacity.

The Mackey plant currently has contracts for 6.03 MGD that it has difficulty supplying to communities east of League City, including Kemah, Bayview, Baycliff, San Leon as well as MUD 51 due to lack of transmission capacity. These entities own future water rights in the Mackey Plant (when expanded) totaling an additional 5.35 MGD.

One possible scenario is for the City of League City to provide treated water to these cities from League City's existing connection to the SEWPP connection at the SH3 BS by constructing a low service pump station and additional transmission capacity. League City could then take the initial 8.03 (6.03 MGD plus the existing 2.0 MGD) from the Mackey Plant to supply League City's water demand. Future supply (5.35 MGD) locations to these communities east of League City could be negotiated at a future date. In this scenario the City does not gain additional source water capacity, but it allows the City to take more water from its GCWA connection point to the south of the City instead of depending almost solely on its City of Houston connection to the north of the City. This is advantageous because it diversifies the source water supply for League City so that if something were to happen to either source water facility, an adequate supply of water can be maintained. At the present time, this "water swap" is the only way to get additional water from the Mackey Plant to the City.

Based on water planning discussions with the City's existing source water providers, two separate 2020 scenarios were created with different source water assumptions. Neither scenario considers a net overall gain in source water quantity.

- ***2020 Scenario: Same Source –*** This scenario considers added storage as a means of accommodating peak demand.
- ***2020 Scenario: Water Swap –*** This scenario considers storage to accommodate peak demand as well as providing a more balanced source water split between the SEWPP and the Mackey Plant. Infrastructure necessary to convey the water to the communities east of the City would also be necessary.

Two different buildout scenarios were created based on likely future water source options.

- ***Buildout Scenario: Same Source –*** This scenario first option includes all of the future water required (21.5 MGD) coming from the SEWPP at the SH3 BS. The SH3 BS would serve as the single point of delivery from the SEWPP.

- ***Buildout Scenario: Water Swap -*** This scenario considers a portion of the future source water requirement from the SEWPP at the SH3 BS (additional 10.5 MGD) and a portion of the future source water requirement from the Mackey Plant (additional 11 MGD) at the Calder Road connection point. This option builds on the "water swap" 2020 scenario described above. Additional source water and infrastructure totaling 11 MGD would be necessary at the SH3 BS facility and subsequently the South Shore BS in order to supply the communities east of the City.

ES.6 Recommended Plan

ES.6.1 Existing CIP Projects

Through the performance assessment of each CIP within the various scenarios of the model many CIP projects were determined to have no benefit to the water system based on the new planning data, source water identification, and transmission versus distribution pipeline operational philosophy. The projects were eliminated based on effectiveness. Smaller wells and booster stations with planned improvements were also eliminated based on the future recommendation to decommission these facilities. The eliminated CIP projects and the associated total savings is outlined in **Table ES-1**.

Eliminated CIP Project	Cost Savings
Raise West Side Elevated	$2,500,000
Countryside Pump Station & Well	$1,475,000
New East Side Elevated #2	$3,000,000
Walker Street Pump Station & Well	$1,265,000
Meadow Bend Pump Station	$1,350,000
Eastside Trunk Lines	$2,700,000
Supplemental 24" Water Supply from Calder Rd to SH3	$1,200,000
Third Street Pump Station & Well	$1,265,000
Upsize Water Lines on FM518 near Countryside WS	$900,000
Total Savings	**$15,655,000**

Table ES-1
Current CIP Projects Recommended for Elimination

ES.6.2 Development of CIP Projects

After eliminating unnecessary projects, the developed scenarios results were analyzed based on established evaluation criteria. After identifying a problematic area during the maximum day conditions, alternatives to improve pressures in those areas were developed and evaluated utilizing the model. At the end of this analyses process, each scenario was ultimately able to operate for seven days of maximum day conditions with all system pressures over 35 psi.

Once all of the improvement projects needed to reach the immediate 2020 water demand and buildout demand were compiled, they were categorized based on prioritization. For the newly identified projects, planning level cost estimates were also created. The projects were categorized into four different levels of priority. **Figure ES-4** shows the prioritization for the immediate CIP projects. **Figure ES-5** shows the prioritization for the buildout CIP projects. The locations shown are conceptual. It will be necessary to identify and evaluate specific the routing during preliminary engineering design.

Two alternatives for both 2020 and buildout demand conditions are presented based on the two water source options discussed above.

ES.6.3 Immediate (2020) Requirements – No Additional Source Water

Priority 1 projects are the most urgent to complete by 2020. They have a significant impact on the system's redundancy and take the burden off of the main transmission line leading from SH3 BS for providing water to the majority of League City. The booster station improvements are also critical to meet the objective of decommissioning the minor water facilities. Priority 1 projects and their associated cost for booster stations and pipelines can be seen in **Table ES-2** and **Table ES-3** respectively. These are the most urgent projects to be completed by 2020.

Priority 2 projects are needed by 2020, however they are not as imperative to the basic functionality of the water system as Priority 1 projects. **Table ES-2** and **Appendix E** shows the project prioritization for immediate need projects. The individual figures and project descriptions for all CIP projects can be found in **Appendix D**. Priority 2 projects and their associated cost for booster stations and pipelines can be seen in **Table ES-4** and **Table ES-5**, respectively. These are the next projects to be completed by 2020.

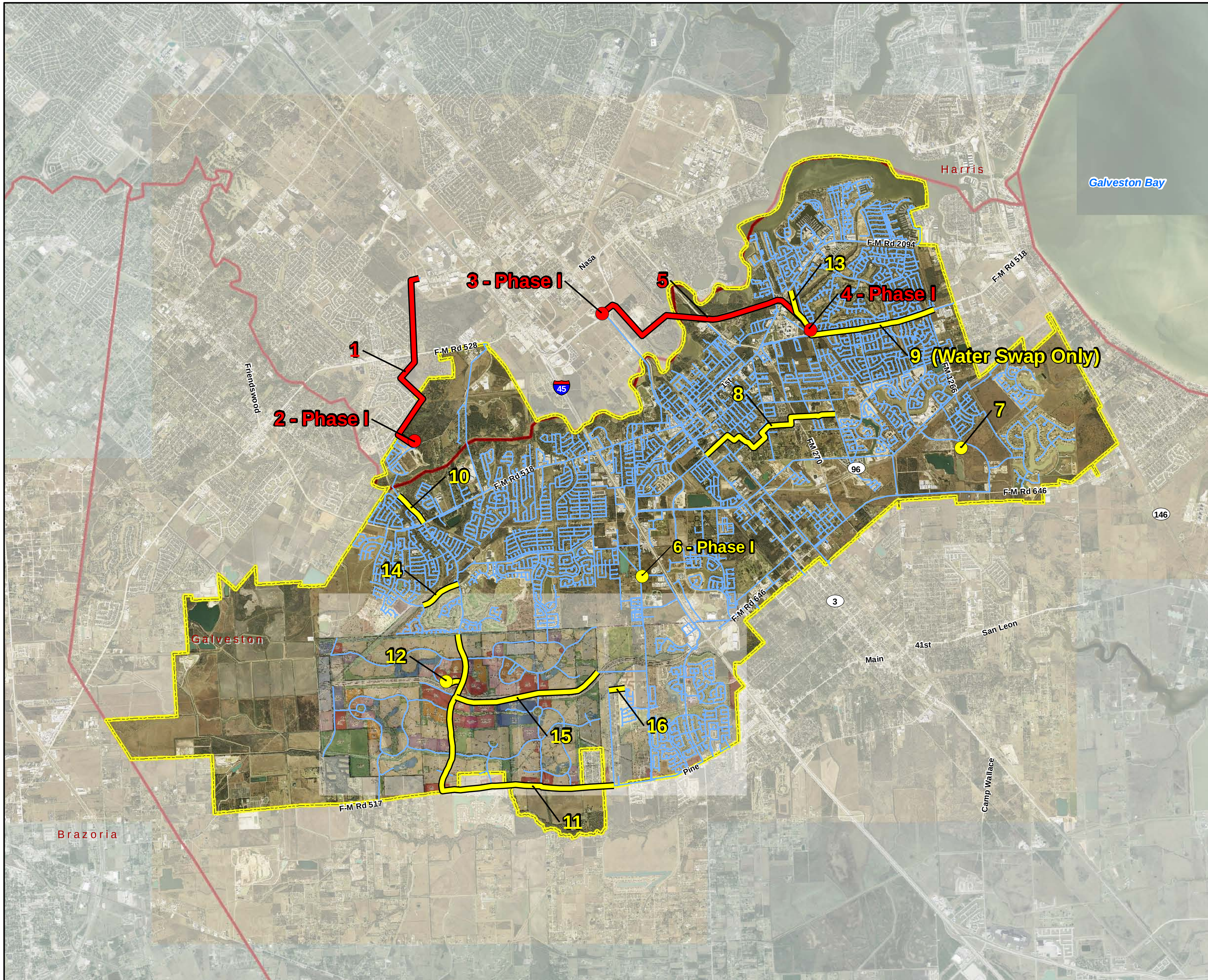
The only new project identified in Priority 1 is the proposed 36-inch transmission line from SH3 BS to South Shore Harbor BS as well as low service pump improvements to the SH3 BS. The remaining projects are in the current capital improvements plan, however the costs for the water facilities have been updated based on new capacity requirements associated with each scenario.

Figure ES-4

Prioritization for Immediate CIP Projects

City of League City, Texas

Water Master Plan 2011



CIP Projects

- Priority 1 - For 2020
- Priority 2 - For 2020
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

	Projects	Priority
1	Beamer Road 24" Water Line Extension	Priority 1 - For 2020
2	Northside (Beamer Rd) Booster Plant Improvements - Phase I	Priority 1 - For 2020
3	Highway 3 Booster Plant Improvements - Phase I	Priority 1 - For 2020
4	South Shore Booster Plant Improvements - Phase I	Priority 1 - For 2020
5	New 36" Line - Highway 3 to South Shore	Priority 1 - For 2020
6	Calder Road Booster Plant Improvements - Phase I	Priority 2 - For 2020
7	New East Side Elevated Storage Tank	Priority 2 - For 2020
8	Trunk Line - Walker Plant to Louisiana	Priority 2 - For 2020
9	New 36" Line - South Shore to Eastern CIties	Priority 2 - For 2020
10	New 24" Distribution Line - FM 518 to Alderwood	Priority 2 - For 2020
11	New 18" Trunk Line - Bay Area Boulevard	Priority 2 - For 2020
12	New West Side EST & 18" Line to Project 11	Priority 2 - For 2020
13	New 18" Trunk Line - SSH Plant to FM 2094	Priority 2 - For 2020
14	New 24" Water Line along League City Parkway	Priority 2 - For 2020
15	New 24" Water Lines to West Side	Priority 2 - For 2020
16	New 8" Line - Cross Colony to Mary Lane	Priority 2 - For 2020

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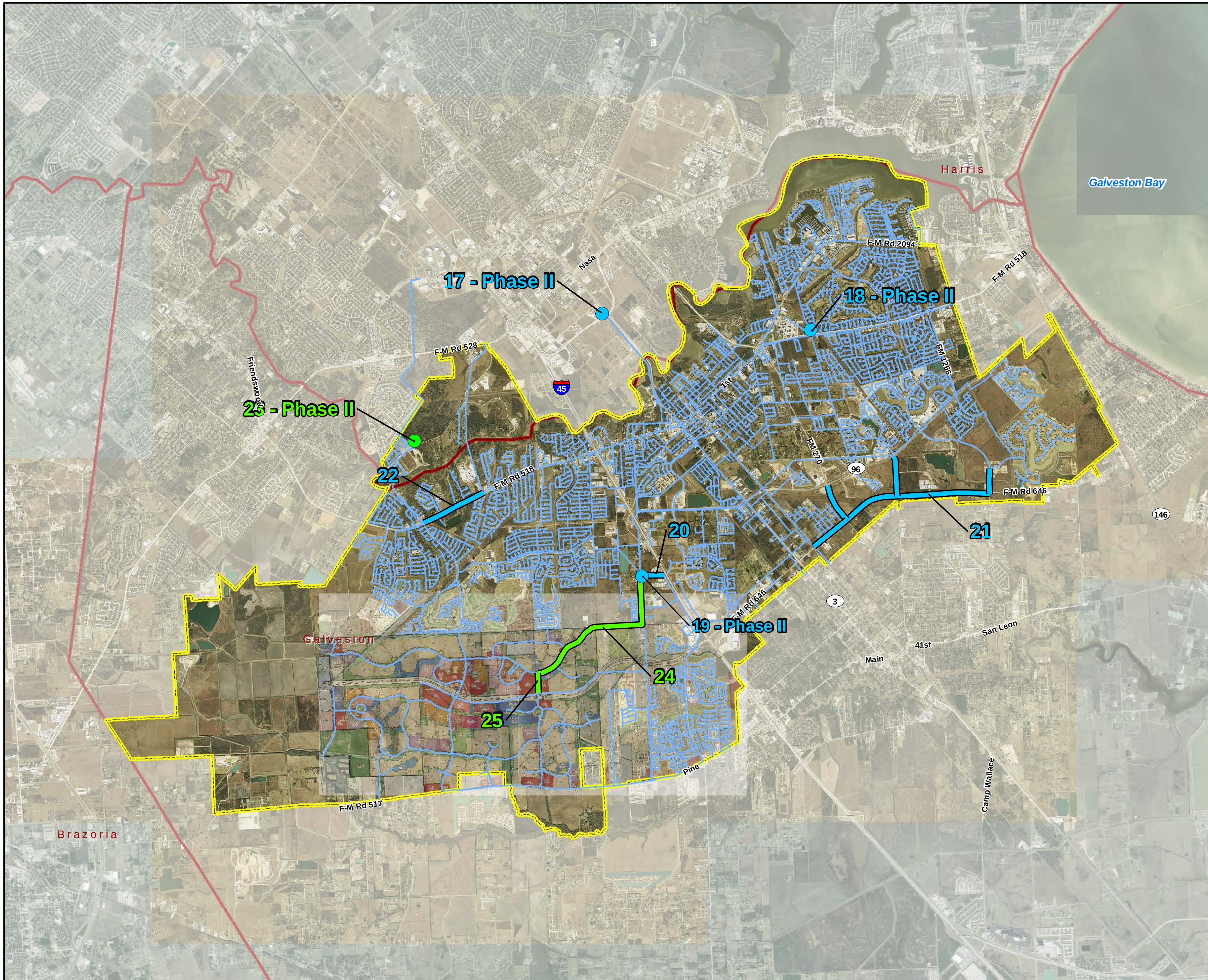
Figure ES-5

Prioritization for Buildout CIP Projects

City of League City, Texas
Water Master Plan 2011



CIP Projects

- Priority 3 - For Buildout
- Priority 4 - For Buildout
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

	Projects	Priority
17	Highway 3 Booster Plant Improvements - Phase II	Priority 3 - For Buildout
18	South Shore Booster Plant Improvements - Phase II	Priority 3 - For Buildout
19	Calder Road Booster Plant Improvements - Phase II	Priority 3 - For Buildout
20	Upsize to 24" - Calder Road to I-45	Priority 3 - For Buildout
21	New 24" Trunk Lines - South East Service Area	Priority 3 - For Buildout
22	Upsize to 18" - Bay Area to Palomino along Main Street	Priority 3 - For Buildout
23	Northside (Beamer Rd) Booster Plant Improvements - Phase II	Priority 4 - For Buildout
24	New 24" Line - Calder Booster Plant to South West Development	Priority 4 - For Buildout
25	New 24" Line - North/South Line in South West Development	Priority 4 - For Buildout

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	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 BS Phase I Upgrade	6	HS-4,000 LS-4,000	$15,120,000
2	South Shore Harbor BS Phase I Upgrade	3	1,870	$8,800,000
3	Northside BS Phase I	6	4,500	$7,600,000
Total Cost				**$31,520,000**

Table ES-2
Priority 1 Station Project Costs for 2020 Scenario with No Additional Source Water

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	36" Line from SH3 Take Point to SSH BS	17,200	36	$10,930,000
2	Beamer Rd 24" WL Extension	16,000	24	$1,800,000
Total Cost				**$12,730,000**

Table ES-3
Priority 1 Pipeline Project Costs for 2020 Scenario with No Additional Source Water

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Calder BS Phase I Upgrade	-	1,950	$5,810,000
2	New East Side Elevated	2	-	$3,000,000
3	New West Side Elevated Tank	2	-	$3,000,000
Total Cost				**$11,810,000**

Table ES-4
Priority 2 Station Project Costs for 2020 Scenario with No Additional Source Water

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	18" Line to New West Elevated Storage Tank	1,300	18	$380,000
2	24" Line Parallel to League City Parkway	2,700	24	$1,600,000
3	8" Line from Cross Colony to Mary Ln	1,600	8	$230,000
4	24" Distribution Line - FM518 to Alderwood	3,000	24	$835,000
5	New Water Lines to the West Side	15,000	24	$5,610,000
6	Trunk Line from SSH BS to FM2094	3,800	18	$700,000
7	Trunk Line from Walker WS to Louisiana	17,500	24	$4,000,000
8	Trunk Lines along Bay Area Boulevard	23,500	18	$3,500,000
Total Cost				**$16,855,000**

Table ES-5
Priority 2 Pipeline Project Costs for 2020 Scenario with No Additional Source Water

ES.6.4 Immediate (2020) Requirements – GCWA Water Swap

Priority 1 projects and their associated cost for booster stations and pipelines can be seen in **Table ES-6** and **Table ES-7** respectively for the 2020 GCWA water swap alternative.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 BS Phase I Upgrade	6	HS-4,000 LS-8,000	$16,340,000
2	South Shore Harbor BS Phase I Upgrade	3	HS-1,870 LS-4,500	$10,740,000
3	Northside BS Phase I	6	4,500	$7,600,000
Total Cost				**$34,680,000**

Table ES-6
Priority 1 Station Project Costs for 2020 Scenario with Water Swap

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	36" Line from SH3 Take Point to SSH BS	17,200	36	$10,930,000
2	Beamer Rd 24" WL Extension	16,000	24	$1,800,000
			Total Cost	**$12,730,000**

Table ES-7
Priority 1 Pipeline Project Costs for 2020 Scenario with Water Swap

Priority 2 projects and their associated cost for booster stations and pipelines can be seen in **Table ES-8** and **Table ES-9**, respectively.

Project Title		Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Calder BS Phase I Upgrade	-	1,950	$5,810,000
2	New East Side Elevated	2	-	$3,000,000
3	New West Side Elevated Tank	2	-	$3,000,000
Total Cost				**$11,810,000**

Table ES-8
Priority 2 Station Project Costs for 2020 Scenario with Water Swap

Project Title		Length (ft)	Diameter (in)	Total Cost
1	18" Line to New West Elevated Storage Tank	1,300	18	$380,000
2	24" Line Parallel to League City Parkway	2,700	24	$1,600,000
3	8" Line from Cross Colony to Mary Ln	1,600	8	$230,000
4	24" Distribution Line - FM518 to Alderwood	3,000	24	$835,000
5	New Water Lines to the West Side	15,000	24	$5,610,000
6	Trunk Line from SSH BS to FM2094	3,800	18	$700,000
7	Trunk Line from Walker WS to Louisiana	17,500	24	$4,000,000
8	Trunk Lines along Bay Area Boulevard	23,500	18	$3,500,000
9	36" Line from South Shore to Eastern Cities	12,000	36	$6,330,000
Total Cost				**$23,185,000**

Table ES-9
Priority 2 Pipeline Project Costs for 2020 Scenario with Water Swap

ES.6.5 Buildout Requirements – 21.5 MGD from SEWPP

Priority 3 projects are the most urgent to complete between 2020 and buildout. Priority 4 projects are needed by buildout, however they are not as imperative to the basic functionality of the water system as Priority 3 projects.

Priority 3 projects for both booster station and pipeline upgrades for the buildout scenario that consists of all source water from the City of Houston SEWPP can be seen in **Table ES-10** and **Table ES-11**.

Project Title		Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 Phase II Upgrade	-	LS-8,000	$3,280,000
2	South Shore Harbor BS Phase II Upgrade	3	13,900	$9,180,000
3	Calder Rd BS Phase II Upgrade	6	8,950	$11,210,000
Total Cost				**$23,670,000**

Table ES-10
Priority 3 Station Project Costs for Buildout Scenario with Additional 21.5 MGD from SEWPP

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	Line from Bay Area to Palomino on Main St	4,700	18	$1,360,000
2	24" Line from Calder BS to East	1,600	24	$596,000
3	Southeast Service Area Trunks	11,000	24	$4,150,000
Total Cost				**$6,106,000**

Table ES-11
Priority 3 Pipeline Project Costs for Buildout Scenario with Additional 21.5 MGD from SEWPP

Priority 4 pipeline and booster station projects for this scenario and their associated costs are presented in **Table ES-12** and **Table ES-13**.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Northside BS Phase II Upgrade	-	1,500	$1,730,000
Total Cost				**$1,730,000**

Table ES-12
Priority 4 Station Project Costs for Buildout Scenario with Additional 21.5 MGD from SEWPP

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	24" Line from Calder BS to SW Development	12,700	24	$4,760,000
2	24" North-South Line in SW Development	1,400	24	$524,000
Total Cost				**$5,284,000**

Table ES-13
Priority 4 Pipeline Project Costs for Buildout Scenario with Additional 21.5 MGD from SEWPP

ES.6.6 Buildout Requirements – GCWA Water Swap

Priority 3 projects for both booster station and pipeline upgrades for the buildout scenario that consists of the GCWA water swap can be seen in **Table ES-14** and **Table ES-15**.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 Phase II Upgrade	-	LS-12,000	$3,830,000
2	South Shore Harbor BS Phase II Upgrade	3	HS-5,900 LS-3,000	$8,400,000
3	Calder Rd BS Phase II Upgrade	6	16,260	$12,800,000
Total Cost				**$25,030,000**

Table ES-14
Priority 3 Station Project Costs for Buildout Scenario with Water Swap

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	Line from Bay Area to Palomino on Main St	4,700	18	$1,360,000
2	Southeast Service Area Trunks	11,000	24	$4,150,000
Total Cost				**$5,510,000**

Table ES-15
Priority 3 Pipeline Project Costs for Buildout Scenario with Water Swap

Priority 4 pipeline and booster station projects for this scenario and their associated cost are presented in **Table ES-16** and **Table ES-17**.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Northside BS Phase II Upgrade	-	1,500	$1,730,000
Total Cost				**$1,730,000**

Table ES-16
Priority 4 Station Project Costs for Buildout Scenario with Water Swap

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	24" Line from Calder BS to SW Development	12,700	24	$4,760,000
2	24" North-South Line in SW Development	1,400	24	$524,000
Total Cost				**$5,284,000**

Table ES-17
Priority 4 Pipeline Project Costs for Buildout Scenario with Water Swap

ES.6.7 Additional Source Water – Planning Level Cost Estimates

Planning level cost estimates for the purchase of additional treated water to assist the City in project planning and development for each potential option may be found below. The cost for additional treatment capacity can be broken down into 3 parts: raw water facilities, treatment facilities and distribution facilities.

ES.6.7.1 Replacement of Existing 42-Inch Supply Line from SEWPP

The City of Houston is in the process of planning the replacement of the existing 42-inch treated water supply line that extends down SH3 from the SEWPP to the City's SH3 BS. The replacement costs will be shared with all the co-participants. It is unclear at this time if the line will be upsized for future capacity, who would pay for that capacity and how those costs would be shared with the other co-participants. As such, for the purposes of this report, we have tried to provide a basic planning level cost based on the following assumptions:

- The line size will be replaced with the same size line, i.e., no upsizing.
- New pipe material will be welded steel.
- The existing SH3 ROW is fully utilized. Therefore, additional ROW will be required. The additional/new ROW/easement costs are assumed to be 25% of the line cost.
- Pro-rata costs for the replacement line are assumed to be based on current capacity percentages in each line segment. The quantity percent shown is a weighted average over the entire length.

Costs for the replacement line are shown in **Table ES-18**.

Item No.		Quantity	Units	Unit Cost	Total Cost
1	42-inch Treated Water Line from SEWPP to SH3 BS	48%	40,900 LF	$600	$11.800,000
2	ROW/Easement Costs	25%	LS	$	$3,000,000
Subtotal					$14,800,000
City of Houston Management Fee (Required by Contract) – 20%					$3,000,000
Subtotal					$17,800,000
Contingency – 20%					$3,600,000
TOTAL					$21,400,000

Table ES-18
Share of SEWPP Distribution Line Replacement to be Paid by League City
Planning Level Cost Estimates

ES.6.7.2 Option 1 – Buy-Into Available SEWPP 40 MGD Capacity

To ensure sufficient source water as recommended in the CIP projects for buildout condition, the City will need to buy-into all or a portion of SEWPP's planned 40 MGD capacity before it is allocated to other customers. For this option, raw water facilities are already constructed and available for operation. The City would be charged the pro-rata cost of construction based on the capacity purchased plus interest for the raw water pumping and pipeline facilities. The planning level cost estimate for raw water transmission, 40 MGD plant expansion and upsizing of the treated conveyance system is presented in **Table ES-19**.

Item No.		Quantity	Units	Unit Cost	Total Cost
1	Raw Water Infrastructure Capital Recovery	1	LS	$20,000,000	$20,000,000
2	SEWPP 40 MGD Expansion	40,000,000	GAL	$2.50	$100,000,000
3	60-Inch Treated Water Line from SEWPP to SH3 BS - (includes 25% ROW/Easement costs)	64%	40,900 LF	$1,000	$26,000,000
Subtotal					$146,000,000
City of Houston Management Fee (Required by Contract) – 20%					$29,000,000
Subtotal					175,000,000
Contingency – 20%					$35,000,000
19					**$210,000,000**

Table ES-19
Option 1 – Buy-into Available SEWPP 40 MGD Expansion Capacity
Planning Level Cost Estimates

ES.6.7.3 Option 2 – Buy-into a SEWPP's Future Expansion Project

If the City is unable to buy-into the SEWPP's 40 MGD expansion capacity that is currently available as outlined in Option 1, they will need to buy-into a future expansion project at a later date. This option will require new construction and major upgrades to the source water pump station and transmission line from Coastal Water Authority (CWA) to the SEWPP, construction of the initial 40 MGD of the future planned 120 MGD unit and upsizing the existing transmission line along SH3 from the SEWPP to SH3 BS. The planning level cost estimate in 2011 dollars for all 40 MGD capacity is presented in **Table ES-20**.

Item No.		Quantity	Units	Unit Cost	Total Cost
1	Raw Water Infrastructure Capital Recovery	1	LS	$40,000,000	$40,000,000
2	SEWPP 40 MGD Expansion	40,000,000	GAL	$3.50	$140,000,000
3	60-Inch Treated Water Line from SEWPP to SH3 BS - (includes 25% ROW/Easement costs)	64%	40,900 LF	$1,000	$26,000,000
Subtotal					$206,000,000
City of Houston Management Fee (Required by Contract) – 20%					$41,000,000
Subtotal					247,000,000
Contingency – 20%					$49,000,000
TOTAL					**$296,000,000**

Table ES-20
Option 2 – Buy-into a SEWPP's Future Expansion Project
Planning Level Cost Estimates

Section 1 Introduction

1.1 Project Background

During the summer drought of 2009, the City of League City experienced low water pressure in areas served from the State Highway 3 Booster Station (SH3 BS) which necessitated activation of city wide water conservation plans. Currently the SH3 BS's purpose is to receive wholesale treated water from the City of Houston's Southeast Water Purification Plant (SEWPP) through a required air gap and into ground storage facilities, then re-pump for transmission and distribution purposes to the City of League City. The air gap into the ground storage tanks is required by the Texas Commission on Environmental Quality (TCEQ). The SH3 BS was rehabilitated approximately six years ago for such purpose after being acquired from the Gulf Coast Water Authority (GCWA). However, the station was never commissioned. To date, the City of League City has been utilizing residual line pressure from the City of Houston.

The piping network leading from the SH 3 BS is currently being utilized as both a transmission and distribution system. Typically, transmission and distribution lines are separated as they provide two different services. Transmission lines are used to provide large quantities of water to end wholesale users which in physical terms usually means ground storage tanks or reservoirs. The transmission lines are usually operated at lower pressures than distribution lines when possible as the higher pressures may not be necessary. Distribution lines are the systems of pipe networks that deliver treated water to the end customer and provide fire protection. Distribution lines are typically operated at higher pressures than transmission lines.

City staff has reported significant pressure problems on the east side of the City during periods of high demand. This is particularly attributable to the dual transmission/distribution system as the major lines are being used provide water to end user customers and to fill several ground storage tanks scattered throughout the system. As a result, operations staff has to engage in labor intensive manual workarounds to manipulate the system during high demand conditions.

Simulating a system with these types of complex operations requires detailed modeling to accurately calculate proper pump design points, adequate transmission and distribution line sizes, ground storage tank capacity, and additional booster pump capacity. In order to accurately identify any possible deficiencies and recommend future permanent water system improvements, a major update to the water model and master plan, including future planned service areas was necessary.

The recent drought conditions and the realization of operational challenges helped identify the need for a comprehensive water planning document to best manage the existing infrastructure, optimize system wide operations, and identify new infrastructure and source water requirements to plan for future growth.

1.2 Objective

The objective of this study is to identify areas that require improvements to the City's water system in order to meet the following needs:

- Plan to accommodate the significant growth anticipated. The population of League City is expected to more than double between now and future City buildout.

- Ensure that the water system meets TCEQ requirements and other design criteria. Specific criteria includes enclosed/protected equipment, standby pump capacity, adequate storage throughout the system and adequate fire flow capacity.

- Address problems created by the current hybrid transmission/distribution system which currently prevent the larger booster pump stations from meeting peak demand conditions.

- Plan for future water source requirements for immediate and future demand needs.

1.3 Scope of Work

This study consists of the following tasks outlined below:

- Review of Historic Documents
- Demand Allocations and Projections
- Model Improvement and Update
- Model Verification
- Model Analysis
- Project Development

1.3.1 Review Historic Documents

For this first task, existing information and previous studies were reviewed to understand City needs. Water usage, system wide operational data, and existing future planning data provided by City staff were analyzed to understand how the existing water system performs and the projected future system requirements.

1.3.2 Demand Allocations and Projections

Demand development is one of the key aspects of hydraulic model development. Existing demand was allocated based on water billing data and existing water production and pumping data. Future demand allocation was based on City predicted development. An ultimate buildout scenario based on density and land use was developed after working closely with the City planning staff.

1.3.3 Model Development

The model development included building the water model based on the existing GIS system and incorporating the following to complete the model configuration.

- Verifying GIS data is updated and includes all water service areas
- Building all facilities into the model and accurately representing their existing system operation
- Appropriately distributing water demands based on water usage data and geo-coded water meters
- Establishing an appropriate peaking factor using available operational data
- Establishing a water loss factor to be applied system wide
- Establishing a diurnal demand pattern to accurately represent the variation in water demand throughout the day
- Verifying the facility operations through water operation data and meetings for City staff review
- Establishing existing and future scenarios within the model for identifying existing and future water system needs

1.3.4 Model Verification

After review of the model configuration was completed and modifications to model inputs performed and confirmed by the City, the hydraulic model was verified. The verification process is a result of data collected from the distribution system that reflects actual operation. The data was used to compare model predictions to field conditions and to adjust model parameters if necessary to better reflect the existing water system operations and performance.

1.3.5 Model Analysis

Model analysis includes a complete review of current conditions using the verified distribution system model. These simulations will evaluate the water system using defined evaluation criteria under both current and future flow conditions, and subsequently identify potential improvements. Using the verified model, operation scenarios were created that utilize the existing system layout. Through the model analysis phase, immediate and future water system issues were identified and projects developed to provide solutions to these issues.

1.3.6 Project Development

The previous tasks generated a list of potential projects. All of the available documents, reports, data, and model results have been reviewed and recommendations were developed under this task. This task developed the recommended plan for system improvements, and how they will be incorporated into the City's CIP.

1.3.7 Data Sources

The data sources provided by the City of League City provide adequate information to populate and provide context for the model. The following information was provided by League City:

- Daily city water consumption and sources for January, 2008 to January, 2010
- Monthly individual billing data for January, 2008 to May, 2010
- 2002 League City Water Master Plan
- Population projections from 2009 to 2040
- Projected development from 2010 to 2020
- Land use projection for buildout scenario
- Identifying physical and operational information for all water facilities

1.3.8 Report Structure

The report sections and contents are briefly described below:

- ***Section 1*** - Introduction. The project background, objectives and scope are explained and the structure of the report presented.

- ***Section 2*** – System Data Development. This section covers the available historical documents including population, land use and water production data. The demand development is briefly explained.

- ***Section 3*** – Water Infrastructure. This section describes the existing water infrastructure including booster and water stations, storage tanks, and pipelines.

- ***Section 4*** – Hydraulic Model Development. The model development process is explained in this section, with detailed information on model construction, demand development, assumptions, verification, as well as the planning and evaluation criteria used.

- ***Section 5*** – System Performance Assessment. This section discusses the existing system's model performance results including water demands, existing pressures and overall observations.

- ***Section 6*** – CIP Project Development. This section explains how the needed CIP projects were identified and shows the recommended projects for each modeled scenario.

- ***Section 7*** – Recommended Plan. This section describes the project prioritization system and gives the planning level cost estimate for each recommended project.

Section 2
System Data Development

2.1 Study Area

The City of League City, Texas is located just south of the Houston Metroplex in northern Galveston County. The City is located approximately 29 miles southeast of downtown Houston and 27 miles northwest of Galveston, with Interstate 45 cutting through the center of the City. A map of the City, with the extraterritorial jurisdiction (ETJ), and its vicinity is shown in **Figure 2-1**. It should be noted that whenever possible, information from the City's Planning Department was used in the population and growth projections to provide consistency with the Planning Department's Comprehensive Plan.

The study area consists of predominantly flat, gentle terrain that slopes to the east. The elevations vary from 4 feet above sea level along Clear Lake to the north to 34 feet above sea level in the undeveloped southwest corner of the City.

The City provides water service to local customers only. The service area consists of residential, commercial and industrial developments as well as open space such as community parks, golf courses and cemeteries. Commercial use areas are concentrated along I-45, State Highway 3, and FM 518. A large proposed mixed use commercial and residential development is in the currently undeveloped southwest corner of the City.

2.2 Population

In 2009, CDS Market Research completed a population study for the City of League City as part of the development of the City's Comprehensive Plan through the year 2040. It was the intent to use the same population data source for the water master plan as the City's Comprehensive Plan. However, during the development of this water master plan, the final 2010 census population data was released for the City. The population reported by the US Census of 83,560 is approximately 9,000 more than the values indicated in the CDS study. **Table 2-1** shows the population projected for five year intervals between 2010 and 2040 for the original CDS Market Research projection and adjusted based on the 2010 census and the City's planning department projected growth between 2010 and 2020. Per discussions with City staff, the net increase in population for the first 10 year planning window remained approximately the same. The adjusted 2010 population was used to create a per capita water usage rate from the 2008-2009 billing data that was then applied to future scenarios.

The City's projection estimates through 2020 detailed the planned commercial and residential growth for various neighborhoods. The information contained yearly growth estimates through the 2020 planning year including the number of residential housing units, the estimated population, and the projected acreage of commercial development.

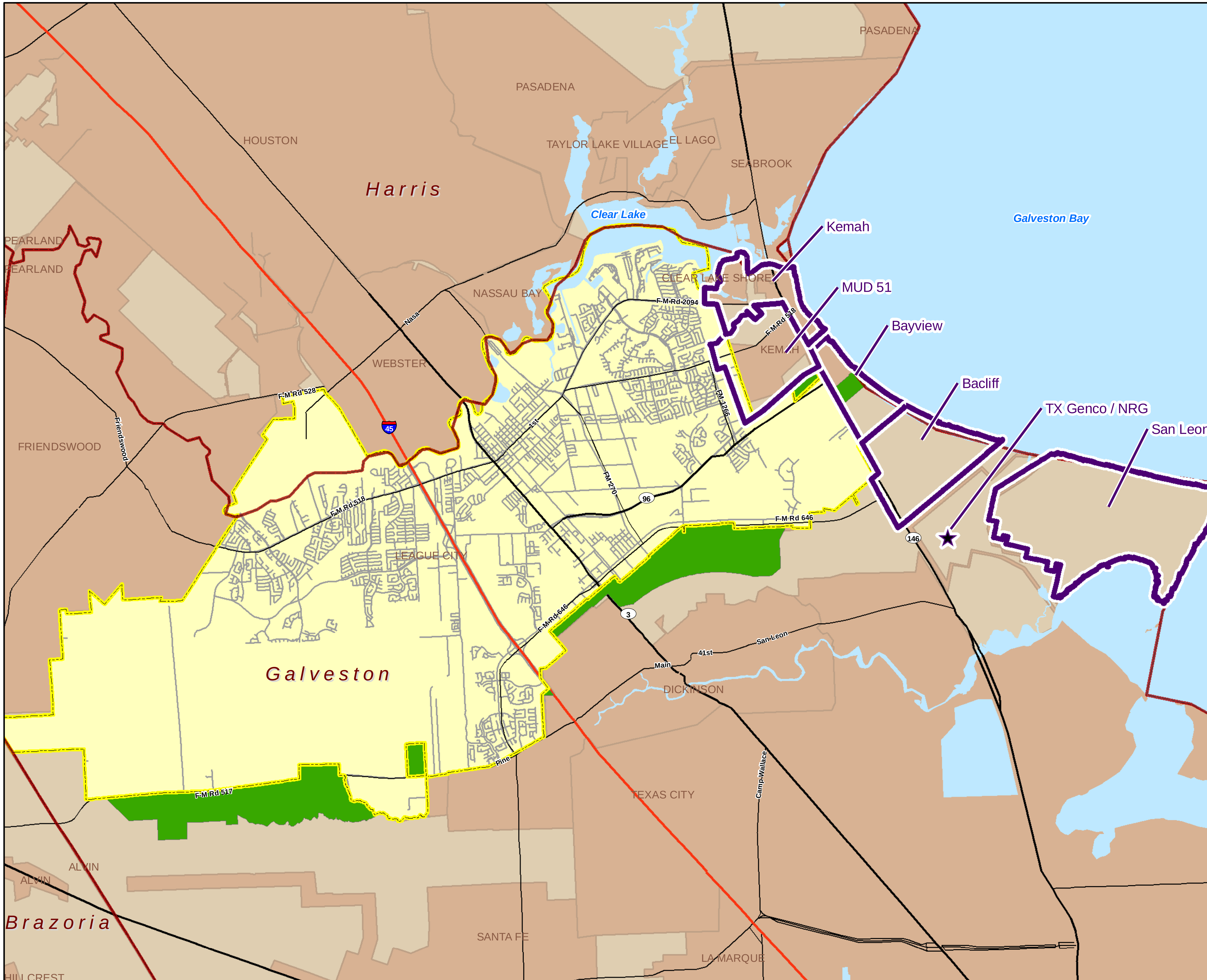

Figure 2-1

City of League City Location Map

City of League City, Texas

Water Master Plan 2011

Legend

- County Boundary
- League City ETJ
- League City City Limit
- Urban Area

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Year	Originally Projected Population[1]	Adjusted Population Based on 2010 Census
2010	74,218	83,560
2015	87,723	99,485
2020	103,685	115,410
2025	122,551	122,551
2030	144,851	144,851
2035	171,207	171,207
2040	202,360	202,360

Notes:
[1] Population projections furnished by the City of League City Planning Department from CDS Market Research, 2009. A 3.4 percent growth rate was used to project population. 3.4% was anticipated by CDS Market Research through 2014 and was continued to 2040.

Table 2-1
Population Projections

The City used a factor of 2.78 people per household to estimate the anticipated population from the number of planned housing units. **Table 2-2** shows the residential growth anticipated through 2020 and **Table 2-3** shows the growth due to commercial development for the same period.

2.3 Land Use

Future land use in this study is based on information provided by the City planning department. The City's future land use planning data identifies areas of the City that are projected to undergo redevelopment, new development or maintain the same type of development through buildout. The identification of the future land use planning zones is shown in **Figure 2-2**, as provided by the planning department.

During the development of the Comprehensive Plan, the city Planning Department performed numerous iterations of growth scenarios. The scenario ultimately selected by the City for the build out projections in the Water Master Plan was designated internally as "Scenario 4, DRAFT Preferred Alternative." This land use scenario is illustrated in **Figure 2-3**, as provided by the planning department. A specific time frame when the City would expect to reach buildout was not identified in the Comprehensive Plan. However, after discussions with City Planning staff, a linear growth rate of 3.4% at the assumed planning densities generates a buildout condition in the year 2040.

Table 2-2
Residential Population Growth Projected Through 2020

	New Population by Year											
Residential Development	*Year 2010*	*Year 2011*	*Year 2012*	*Year 2013*	*Year 2014*	*Year 2015*	*Year 2016*	*Year 2017*	*Year 2018*	*Year 2019*	*Year 2020*	*Total*
Autumn Lakes SF	0	0	0	139	139	139	139	139	139	116.76	0	950.76
Bay Colony SF	0	0	139	139	139	139	0	0	0	0	0	556
Bay Colony MF	0	0	0	0	0	372.6	0	0	0	0	0	372.6
Bay Colony West SF	530.98	417	417	417	417	0	0	0	0	0	0	2198.98
Bay View SF	0	0	139	139	0	0	0	0	0	0	0	278
Beacon Island at South Shore Harbour MF	0	0	0	0	0	207	207	207	207	207	207	1242
Centerpointe MF	0	0	0	0	465.75	465.75	465.75	465.75	0	0	0	1863
Constellation Pointe SF	0	0	55.6	0	0	0	0	0	0	0	0	55.6
Cypress Bay SF	0	69.5	69.5	69.5	72.28	0	0	0	0	0	0	280.78
Hidden Lakes SF	0	0	0	278	278	278	278	166.8	0	0	0	1278.8
Magnolia Creek SF	300.24	278	278	278	278	105.64	0	0	0	0	0	1517.88
Mar Bella SF	689.44	486.5	486.5	486.5	311.36	0	0	0	0	0	0	2460.3
River Bend MF	0	0	258.75	258.75	207	0	0	0	0	0	0	724.5
River Bend SF	0	0	27.8	125.1	0	0	0	0	0	0	0	152.9
Sedona, Sec. 2 SF	0	333.6	75.06	0	0	0	0	0	0	0	0	408.66
South Shore Harbour MF	0	0	0	0	0	207	207	207	207	207	97.29	1132.29
Southwest PUDs MF	0	0	0	0	0	0	0	465.75	465.75	465.75	465.75	1863
Southwest PUDs SF	0	0	0	0	0	278	834	1112	1668	1946	2224	8062
Stone Creek SF	0	0	0	0	111.2	0	0	0	0	0	0	111.2
The Peninsula at Clear Lake SF	0	27.8	27.8	27.8	30.58	0	0	0	0	0	0	113.98
Township SF	13.9	0	0	69.5	69.5	61.16	0	0	0	0	0	214.06
Tuscan Lakes MF	0	0	0	258.75	258.75	258.75	244.26	0	0	0	0	1020.51
Tuscan Lakes SF	558.78	417	316.92	0	0	0	0	0	0	0	0	1292.7
Victory Lakes SF	0	0	152.9	0	0	0	0	0	0	0	0	152.9
Westover Park SF	0	208.5	208.5	208.5	208.5	208.5	141.78	0	0	0	0	1184.28
Westwood SF	0	0	0	0	0	278	417	417	417	417	417	2363
TOTAL	2093.34	2237.9	2652.33	2894.4	2985.92	2998.4	2933.79	3180.3	3103.75	3359.51	3411.04	**31850.68**

Prepared by the Planning Department for the Water Wastewater Models, September 10, 2010

Table 2-3
Commercial Growth in Acres Projected Through 2020

	New Commercial Acreage by Year											
Commercial Development	*Year 2010*	*Year 2011*	*Year 2012*	*Year 2013*	*Year 2014*	*Year 2015*	*Year 2016*	*Year 2017*	*Year 2018*	*Year 2019*	*Year 2020*	*Total*
Bay Colony West	0	5	5	5	5	5	10	10	7	0	0	52
Centerpointe	5	5	5	10	10	10	10	10	10	5	0	80
Cypress Bay	0	0	0	0	3	3	3	3	0	0	0	12
Gloria Dei Lutheran	0	0	10	0	10	0	10	0	10	0	10	50
Hidden Lakes	0	0	0	0	5	5	5	5	5	5	5	35
Home Depot/Target Shopping Center	10	5	5	0	0	0	0	0	0	0	0	20
Magnolia Creek	0	0	0	5	5	5	10	6	0	0	0	31
Mar Bella	0	0	5	5	5	5	0	0	0	0	0	20
Nasa Road	0	0	0	0	0	10	10	10	10	10	10	60
River Bend	0	0	0	0	0	5	5	5	5	0	0	20
South Shore Harbour	0	5	6	0	0	0	0	0	0	0	0	11
Southwest PUDs	0	0	0	0	0	0	10	10	10	10	10	50
Tuscan Lakes	10	10	10	10	10	10	10	10	10	10	0	100
Victory Lakes	10	10	10	10	10	10	7	0	0	0	0	67
Westover Park	0	0	0	0	5	5	3	0	0	0	0	13
Westwood	0	0	0	0	0	0	10	10	10	11	0	41
Wycoff Business Park	10	5	5	5	0	0	0	0	0	0	0	25
TOTAL	45	45	61	50	68	73	103	79	77	51	35	**687**

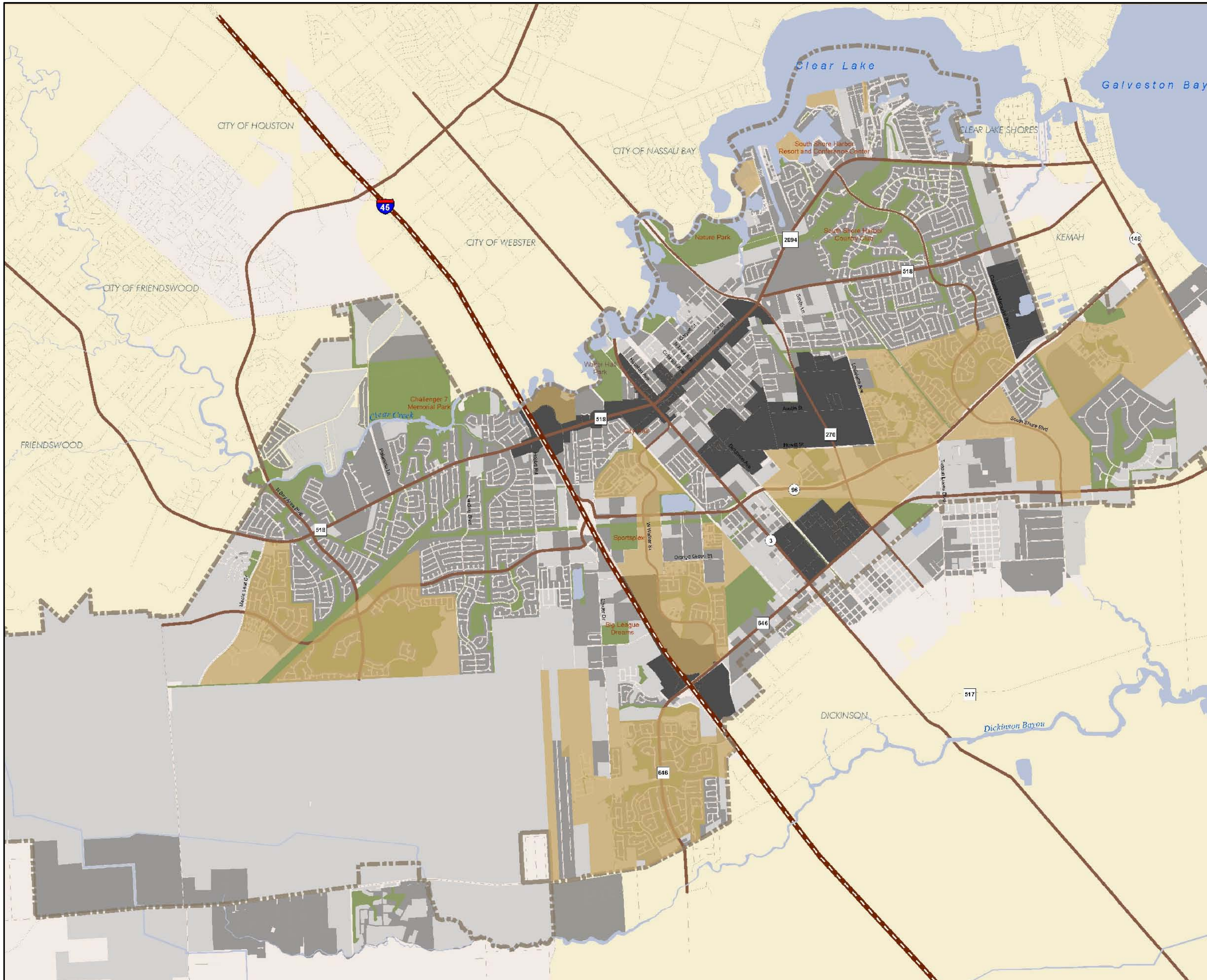

Figure 2-2

Future Development and Maintenance Areas of League City

City of League City, Texas

Water Master Plan 2011

Redevelopment Areas provided by the League City Comprehensive Plan

Redevelopment Areas

- Redevelopment
- New Development
- Maintenance
- Open Space / Park
- PUD*

* Does not include Lloyd, McAlister, or Duncan Tracts

N W E S

0 3,000 6,000*

Feet

* Approximate Scale

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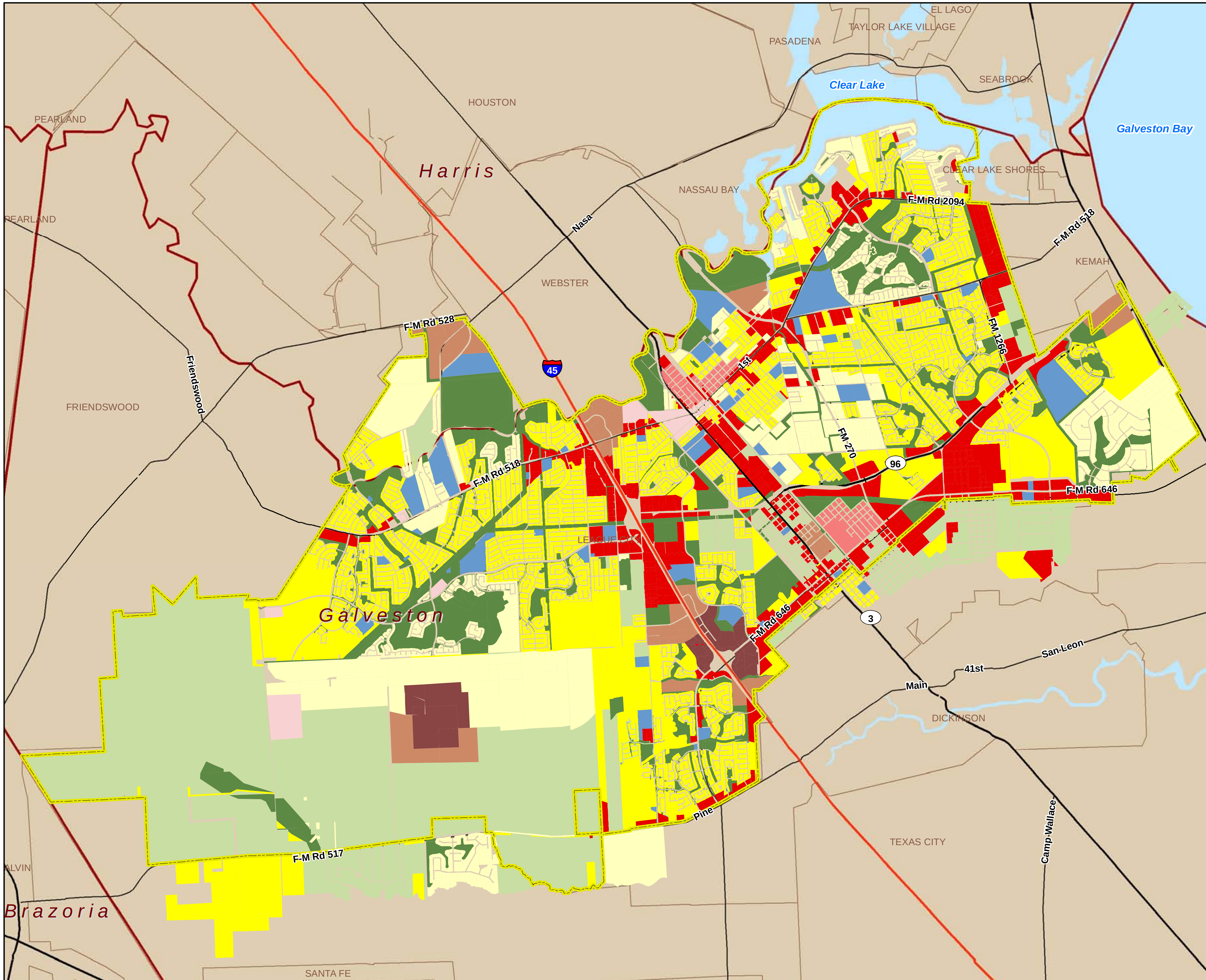

Figure 2-3

Preferred Buildout Land Use Alternative

City of League City, Texas

Wastewater Master Plan 2011

Scenario 4 Draft Preferred Alternative Provided by League City Planning Department in September, 2010 as Buildout Land Use

Land Use

- Rural/Estate Residential
- Suburban Residential
- Suburban Village
- Enhanced Auto Dominant Residential
- Enhanced Auto Dominant Commercial
- Urban High
- Urban Low
- Suburban Commercial
- Public/Institutional
- Park/Open Space/Natural

N S E W

0 3,000 6,000

Feet

CDM

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To simulate the growth/demand in the water model, a GIS layer was created showing the different land use zones for the entire city. This formed the basis of the buildout demand scenario. **Table 2-4** shows the categories of land use used in the future growth scenarios as well as the land area and population densities associated with each category. After the Draft of this report was submitted for City review, the population densities were lowered by the planning department. However, at the direction of the City, the original densities were used in the growth scenarios to provide slightly more conservative infrastructure needs.

Land Use Category	Total Projected Land (acre)	Population Density (people/acre)
Rural/Estate Residential	8,736	8.05
Suburban Residential	4,788	9.57
Suburban Village	226	7.73
Enhanced Auto Dominant Residential	8,650	19.21
Enhanced Auto Dominant Commercial	2,823	0.00
Urban High	508	26.36
Urban Low	954	11.10
Suburban Commercial	277	0.00
Public/Institutional	1,110	0.00
Park/Open Space/Natural	4,081	0.00

Table 2-4
Total Projected Land Use by Category

2.4 Existing Water Production and Demand Development

2.4.1 Water Usage

The City obtains the majority of its source water from two surface water plants. The largest source is the City of Houston's SEWPP. The other is the Thomas Mackey Plant located in Texas City. Water from both sources is contractually provided by GCWA. Other source water includes a small portion from a network of local groundwater wells as well as an interconnect with Galveston County WC&ID No. 1 through the Dickinson Booster Pump Station. **Table 2-5** shows the total usage from the City's water sources for 2008 and 2009 in million gallons per year (MG/yr). While this information is compiled for the entire calendar year, there is a great seasonal fluctuation in the amount of water consumed between winter and summer.

Supply Source	2008 (MG/yr)	2009 (MG/yr)
GCWA (SEWPP)	2,681	2,765
GCWA (Thomas Mackey Plant)	591	610
Dickinson Pump Station (League City)	38	21
All Groundwater Wells	8	70
Total Annual Production (MG/yr)	**3,318**	**3,465**

Table 2-5
League City Water Total Usage by Source

2.4.2 Demand Development

The existing demand alternatives were created using two sources of information: the meter billing data and the total daily water consumption logs. The daily logs indicate how much water was taken from each surface water take point and the groundwater wells. The individual customer meter billing data and consumption log data was analyzed for inconsistencies. Only one month was found to contain significant errors. Individual customer meter billing data for June 2008 was significantly different than the consumption log data and from the same period in 2009. As a result, the June 2008 meter data was discarded and not used in the demand development. **Figure 2-4** and **Appendix A** show the 2008/2009 summer average metered water usage data.

The annual average demand was created for each meter by averaging all available data, excluding June, 2008. **Section 2.4.5** discusses how the data was adjusted for water losses in the system.

The summer average demand was created for each meter by averaging the usable summer months' data. This included May and July through September of 2008 and May through September of 2009. Similarly to the annual average demand, the values were adjusted for water losses in the system.

The maximum day demand of 18.6 MGD was based on the date of the highest total usage recorded in the logs on June 28, 2009. Because daily billing data is not available, a simulation of this demand had to be created for the model. To create this demand, a factor was calculated to convert the summer average demand for each meter to a maximum day demand. The citywide maximum day demand of 18.6 MGD was divided by the total summer average billed demand of 8.7 MGD, excluding June 2008. This factor of 2.1 was uniformly applied to every meter's summer average demand data to simulate the maximum day demand. This factor adjusts for all water entering the system, therefore water losses are already included.

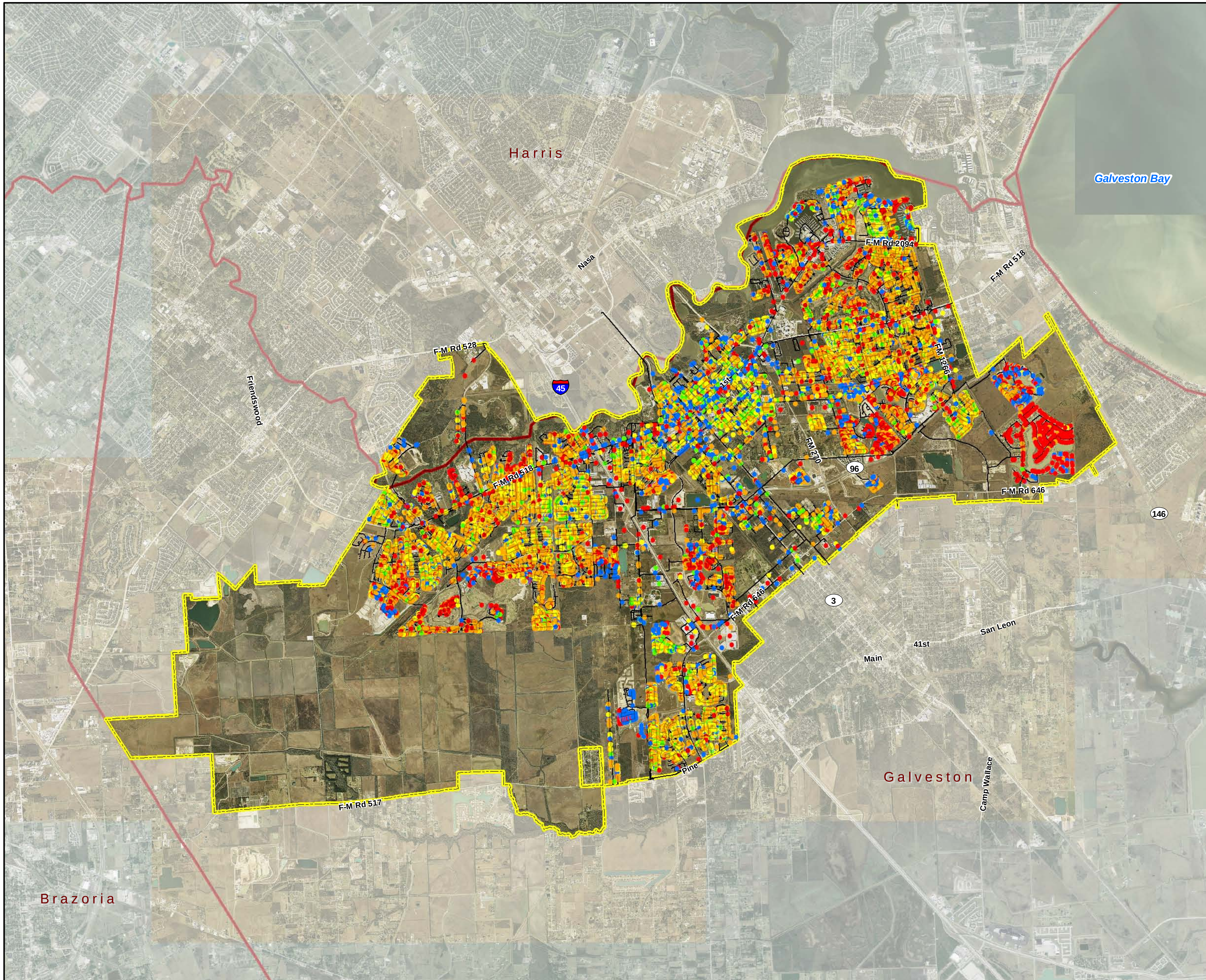

Figure 2-4

2008 and 2009 Summer Average Metered Water Usage Data

City of League City, Texas
Water Master Plan 2011

Meter Usage

- 0 - 70 gpd
- 71 - 120 gpd
- 121 - 200 gpd
- 201 - 500 gpd
- 501 - 110,000 gpd
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

0 3,500 7,000
Feet

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2.4.3 Diurnal Curve

The hourly water demand pattern is a diurnal curve in which the water demand for each hour of the day can be expressed as a ratio to the average daily water demand. While daily usage and demand data was available for the League City water system, there was insufficient hourly data to create the City's diurnal curve. The curve is necessary to determine peak hourly flows. Therefore a standardized curve from literature was applied to the City's demand projections. The standardized curve was based on a similar size city and one that is residentially dominated. The diurnal curve was verified based on real operational SCADA data provided and confirmed the timing for peak and low water use intervals. **Figure 2-5** shows the diurnal curve at 30-minute intervals.

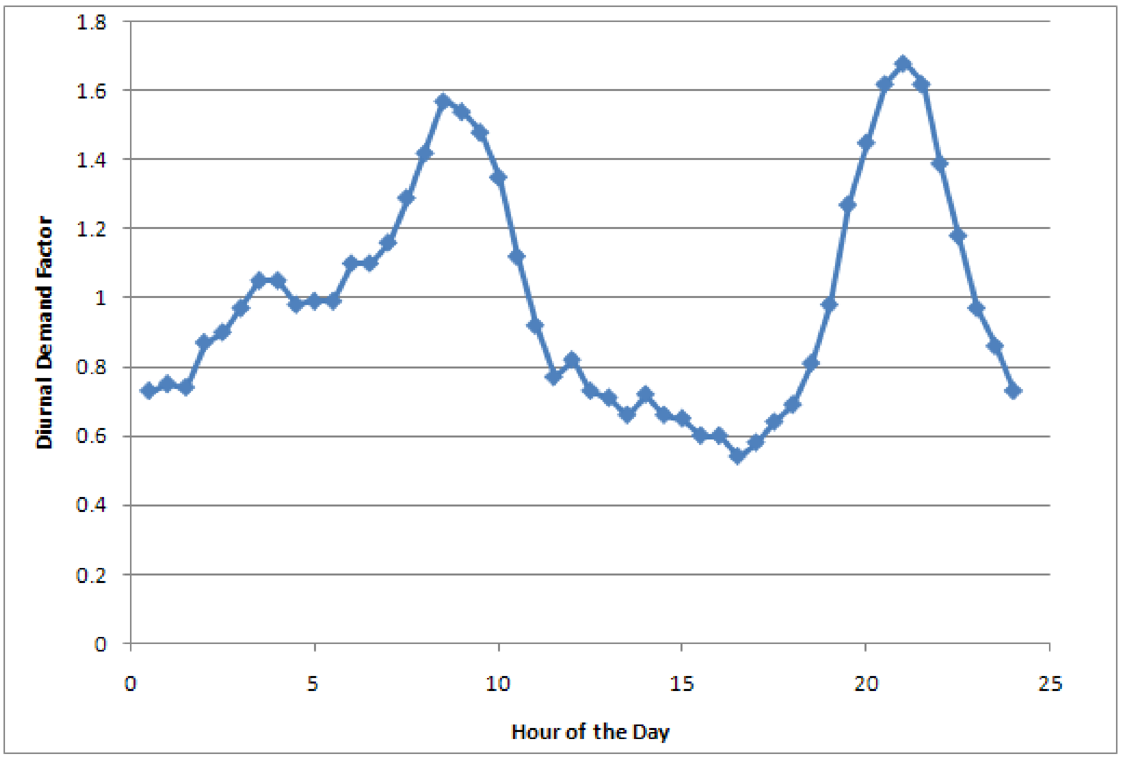


Figure 2-5
Daily Water Demand Pattern used in Water Modeling

The curve is imported to the model and applied to each demand. The peak hour of the diurnal curve is found to occur at 9:00 pm and represents a factor of 1.68 times the daily flow.

2.4.4 Water Loss Factor

A water loss factor is often reflected by the age, condition, and size of the City's water distribution infrastructure and is therefore different for every water system. The water loss factor for the League City water system was calculated for each scenario by comparing the monthly billed water usage with the daily water take logs.

The annual daily average water used in League City based on these daily logs is 9.06 MGD while the annual average billed flow, excluding June 2008, is 7.31 MGD. The wholesale source water delivered was divided by the water billed to develop the factor of 1.24 to adjust for water loss. This factor was multiplied by the annual average usage for each meter to account for water loss in the system (breaks, flushing, inaccurate meters, unmetered usage, leaks, etc…) not represented by the water meter billing data. This factor appears to generally be comparable with communities similar to League City. This same factor was applied to the summer average billing data to include water losses in the summer average demand.

2.5 Elevations

Elevation data was based on the United States Geological Survey (USGS) Digital Elevation Model (DEM) and applied to all model nodes and facilities throughout the water system. Because the overall topography of the City is fairly flat, field surveying was not performed for this study.

Section 3
Water Infrastructure

3.1 System Overview

Contractually, the City of League City purchases treated wholesale water from the Gulf Coast Water Authority (GCWA). Physically, the water comes from two different sources; the City of Houston's Southeast Water Purification Plant (SEWPP) and the Thomas Mackey Water Treatment Plant that is owned and operated by the GCWA in Texas City. The largest allotment of water, 16.5 MGD, is from the City of Houston's SEWPP at a surface water connection point to the north of the City at the State Highway 3 booster station. An additional 5.0 MGD is scheduled to become available through the Beamer Road waterline when the expansion to the SEWPP is completed sometime in 2012. GCWA also provides 2 MGD from the Thomas Mackey Plant to League City from the south conveyed through a 39-inch transmission line directly to the Calder Road booster station. There are small wells scattered throughout the system, however, like the booster stations, most are aging and in need of repair. A majority of the pumps at the booster stations are exposed and will need to be enclosed in the near future to meet Department of Homeland Security guidelines. **Figure 3-1** shows an overview of the existing system with the location and design capacities of the water facilities.

3.2 Booster Stations

Several of the booster stations were taken over from municipal utility districts (MUDs) when they were annexed by the City. The overall age of the water supply infrastructure is demonstrated by the fact that the most recent booster station construction was in 1985, which was over 26 years ago.

There are 29 booster pumps at 9 booster pump stations within the City. Booster pumps are located downstream of the storage reservoirs to pressurize the water to distribution system pressure. **Table 3-1** summarizes the booster pump information at each facility.

3.2.1 State Highway 3 Booster Station

The SH3 BS is the major transmission point for the City's water system. It was originally constructed in 1970 by the GCWA to provide treated water to the city of Galveston. SH3 BS was purchased from the GCWA and after a rehabilitation project was completed in 2003, the facility was never commissioned. The intended purpose of the SH3 BS was to receive water from the City of Houston's SEWPP and pump the treated water to several other ground storage tanks located at other booster pump station sites as well as providing direct distribution pressure to direct customers in League City.

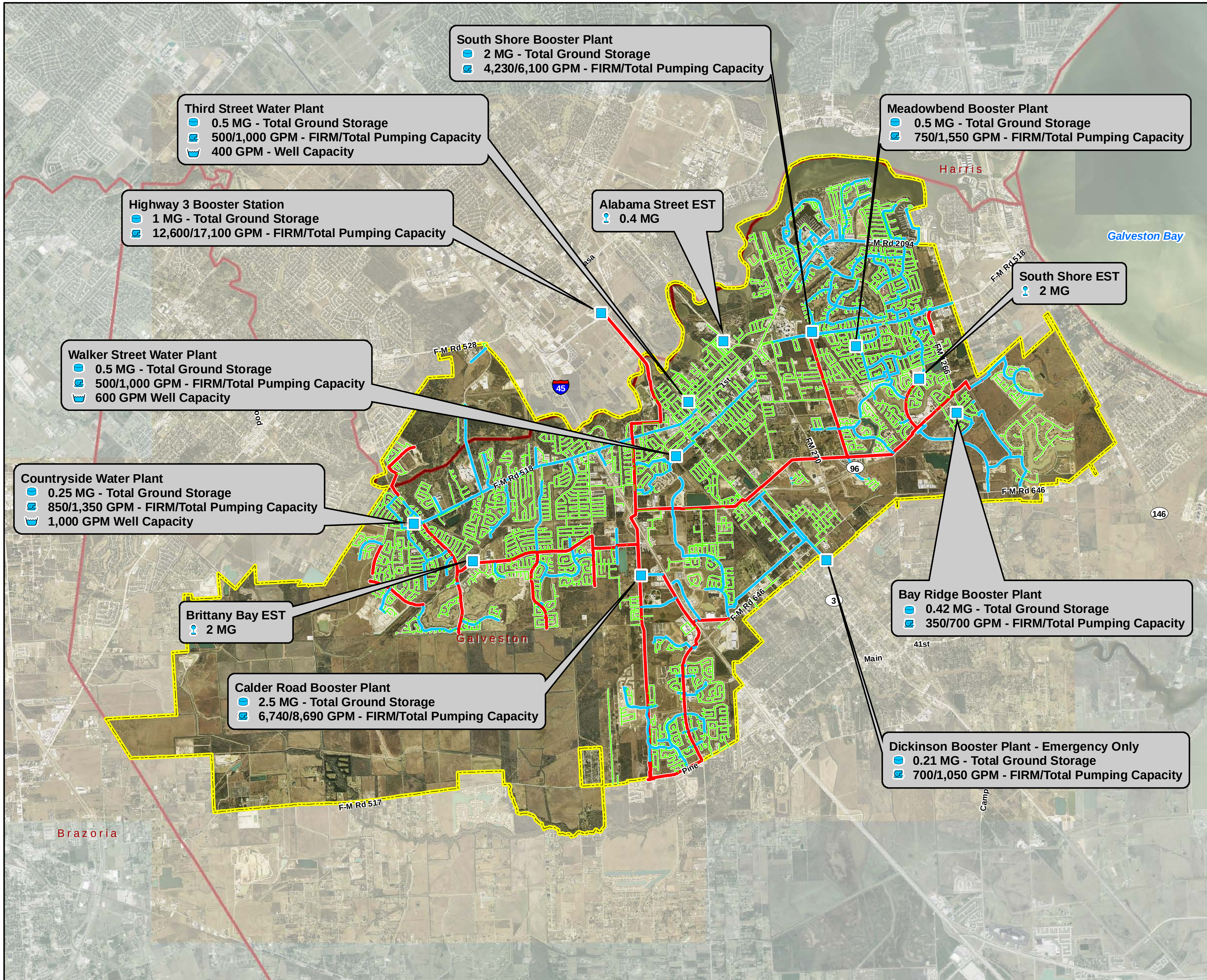


Figure 3-1

Existing Water System

City of League City, Texas
Water Master Plan 2011

Facility

- Water Facility
- Design Pumping
- Ground Storage
- Elevated Storage
- Well

Water Lines

- 16" - 42"
- 10" - 16"
- < 10"
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

N S E W

0 3,500 7,000
Feet

CDM

LEAGUE CITY TEXAS LIVE IT. LOVE IT.

No.	Station Name	Number of Pumps	Design Points	Modeled Operating Points
1.	Bay Ridge	2	350 gpm @ 150 ft 350 gpm @ 150 ft	N/A
2.	Calder	5	850 gpm @ 190 ft 1,780 gpm @ 162 ft 1,780 gpm @ 162 ft 1,950 gpm @ 146 ft 1,950 gpm @ 146 ft	1230 gpm @ 148 ft 1780 gpm @ 148 ft 1780 gpm @ 148 ft 1950 gpm @ 148 ft 1950 gpm @ 148 ft
3.	Countryside	4	100 gpm @ 166 ft 250 gpm @ 166 ft 500 gpm @ 166 ft 500 gpm @ 168 ft	N/A
4.	Dickinson	3	350 gpm @ 124 ft 350 gpm @ 140 ft 350 gpm @ 147 ft	N/A
5.	Hwy 3	4	4,300 gpm @ 145 ft 4,300 gpm @ 188 ft 4,500 gpm @ 188 ft 4,000 gpm @ 160 ft	4000 gpm @ 168 ft 4300 gpm @ 168 ft 4300 gpm @ 168 ft 4500 gpm @ 168 ft
6.	Meadow Bend	3	250 gpm @ 137 ft 500 gpm @ 145 ft 800 gpm @ 132 ft	N/A
7.	South Shore	4	750 gpm @ 153 ft 750 gpm @ 153 ft 1,700 gpm @ 150 ft 1,700 gpm @ 150 ft	1180 gpm @ 141 ft 1180 gpm @ 141 ft 1870 gpm @ 141 ft 1870 gpm @ 141 ft
8.	Third Street	2	500 gpm @ 150 ft 500 gpm @ 150 ft	N/A
9.	Walker Street	2	500 gpm @ 139 ft 500 gpm @ 139 ft	N/A
Total		29		

Table 3-1
Booster Pump Summary

The SH3 BS was purchased with two 4,300 gallon per minute (gpm) pumps, one 4,500 gpm pump, and a one million gallon (MG) ground storage tank. As mentioned previously, soon after purchasing the facility, the City performed necessary plant upgrades that included an additional pump with 4,000 gpm capacity. Given that the majority of the City's water presently comes from the SEWPP, the SH3 BS is a key facility in the water distribution system, directly providing water to the majority of the residences and businesses in the eastern half of the city.

3.2.2 Calder Rd Booster Station

The Calder Rd BS was constructed in 1979 and receives treated water from both the SH3 BS from the north and from the Thomas Mackey Plant from the south. The Calder Rd BS has five pumps of varying sizes: two 1,950 gpm pumps, two 1,780 gpm pumps, and one 850 gpm pump. There is an empty slot for a 6^{th} pump. The facility has two interconnected ground storage tanks (1.0 and 1.5 MGD) that will remain in service in all future phases. A third, aging tank will be taken offline in the near future and was not included in operation of current or future scenarios. The Calder Rd BS serves the majority of the west side of town and is the only major water booster station serving those residents. The station contains two hydropneumatic tanks that currently are not operational and were not considered during the modeling of the water system.

3.2.3 South Shore Harbor Booster Station

The South Shore Harbor BS is located in the northeast section of the City of League City and supplies that area with water. It was built in 1982 and is the largest of the eastside booster stations. However it is at the end of the supply line from SH3 BS and often causes system pressures to drop in the southeast part of the City when filling the ground storage tank during peak demand. South Shore Harbor BS has two 750 gpm pumps, two 1,700 gpm pumps, and two 1.0 MG ground storage tanks. The second tank was added in 2002 and the two tanks are interconnected. It also has one operational hydropneumatic tank that was not considered in the modeling process. According to City staff, on a typical day, South Shore Harbor BS spends between 22 and 24 hours running.

3.2.4 Meadow Bend Booster Station

The Meadow Bend BS has its take point along the Louisiana Avenue water line, just before flow from SH3 BS reaches South Shore Harbor BS. The Meadow Bend BS is a small booster pump station, built in 1978 that feeds the east central areas of the City. The station has three pumps, one each of 250 gpm, 500 gpm and 800 gpm in addition to one 0.5 MG ground storage tank. The tank was added in the mid-1990s. The station was previously the booster station for a MUD development before it was annexed by the City. During the peak demand in the summer months, special measures regarding the operation of Meadow Bend BS are taken. The facility is shut down from 5 to 10 am and from 6 to 11 pm to allow more water to reach South Shore Harbor BS.

3.2.5 Bay Ridge Booster Station

The Bay Ridge BS takes water from the distribution system southeast of South Shore Harbor BS and repumps it to the Bay Ridge, Mar Bella, and Whispering Lakes communities. It was constructed in 1980 and is one of the smallest stations in the League City distribution system, with two 350 gpm pumps and one 0.42 MG ground storage tank. Bay Ridge BS also has an operational hydropneumatic tank which was not considered during the modeling of the water system.

3.2.6 Countryside Booster Station and Water Well

The Countryside BS is on the northwest side of the City and was built in 1985. It provides some treated source water during average demand conditions and more during peak conditions by extending the well run time. There is one 1,000 gpm well pump. There are four total booster pumps: one 100 gpm, one 250 gpm, and two 500 gpm pumps that pump from the 0.25 MG ground storage tank. The well is showing signs of failing, pulling red water that must be treated using polyphosphates. The City indicated that the well would need to be improved or moved to another location in the future if this source of water is still necessary.

3.2.7 Walker Booster Station & Water Well

Walker BS is located in the center of League City and is the first take point along the main transmission line from SH3 BS. It was built in 1970. Walker BS has little room for expansion, which was taken into consideration for future growth. The station has two 500 gpm pumps and one 0.5 MG ground storage tank. The tank was added in the mid-1990s. Walker BS also has a 650 gpm well pump that feeds into the ground storage tank. The well currently has problems with its casing and screens and is used only in emergency situations. According to City staff, the station is used daily and at least one pump is running between 22 and 24 hours every day.

3.2.8 Third Street Booster Station & Water Well

The Third Street BS is located in the north central part of League City and was built in 1963. The station has an operational 300 gpm well. There is a 0.5 MG ground storage tank to collect the water from the well and two 500 gpm booster pumps. The City of League City has been informed that the well is near failing, so the future of this station is uncertain.

3.2.9 Dickinson Booster Station

Dickinson BS is located in the southeast side of League City and connects to Galveston County WC&ID No. 1. The station was constructed in 1985 and this connection is for emergency purposes only. There is no regular usage of water from this source. For the purposes of future planning, this station was not considered in the modeling process.

3.3 Storage

There are 16 storage reservoirs within the City's water distribution system at 12 different sites. The City's storage reservoirs consist of ground storage tanks (GST) and elevated storage tanks (EST). **Table 3-2** shows the modeled current storage in the League City water system at each facility. In general, the GSTs are served by groundwater wells or the transmission/distribution lines. ESTs are served by surplus pressure from the transmission/distribution lines during "off peak" demand times and float on the system to provide additional flow/pressure during the peak demand periods. For modeling purposes, the combined storage capacity of the multiple ground storage tanks at each water station has been represented in the form of a single tank.

Facility Name	Volume (MG)	Modeled Diameter (ft)	Bottom Elevation (ft)	Overflow Elevation (ft)	Height (ft)
Ground Storage Tanks					
Bay Ridge	0.42	55	17.3	41.3	24
Calder	2.5	117	29.0	61.0	32
Countryside	0.25	42	26.2	50.2	24
Dickinson	0.21	39	20.0	44.0	24
Hwy 3	1.0	66	19.7	59.7	40
Meadow Bend	0.5	60	20.9	44.9	24
South Shore	2.0	107	20.0	52.0	32
Third Street	0.5	52	21.4	53.4	32
Walker Street	0.5	52	25.3	57.3	32
Elevated Storage Tanks					
Alabama	0.4	49	13.0	148.2	135
Brittany Bay EST	2.0	107	28.0	159.6	132
South Shore EST	2.0	100	16.6	160.0	143

Table 3-2
Storage Facility Summary

3.3.1 Alabama Elevated Storage Tank

Alabama EST was built in 1962 and has a capacity of 0.40 MG. It is operated as a ground storage tank, as it is equipped with a 250 gpm booster pump. The City of League City indicated the City may be better served using this tank to store reuse water, so it was not considered in future scenarios.

3.3.2 South Shore Elevated Storage Tank

South Shore EST was built in 2006 and is a 2 MG composite construction tank. The tank is located in the southeast section of town between the Meadow Bend BS and Bay Ridge BS. Presently the system pressure drops on peak days when trying to fill the tank.

3.3.3 Brittany Bay Elevated Storage Tank

Brittany Bay EST, also known as Countryside EST, was built in 1989 and is a 2 MG tank. The tank is in daily use. It is presently set to fill in the middle of the night.

3.4 Transmission Lines

There is only one true transmission line in the League City water system. The 39-inch line from the Thomas Mackey Plant on the south side of town is untapped all the way to the Calder BS. The remaining major lines are combinations of transmission and distribution lines. The 42-inch/39-inch line extending south from SH3 BS has a tap for the Walker BS. It also feeds the 24-inch line that heads east along League City Parkway and then north along Louisiana Avenue and there are numerous neighborhood taps on those segments.

The water distribution system for the west side of League City has no transmission lines. The only existing booster pump station on the west side of the city is Countryside BS. It is simply a water well supply facility with a small ground storage tank and booster pump capability. There is no direct feed from Calder BS to Brittany Bay EST, so the tank just floats on the existing distribution system.

3.5 Distribution Lines

The distribution lines in the water system range in size from 1- to 24-inches. All pipelines were included in the hydraulic model developed for this study. A summation of the total length of each pipe diameter based on the GIS data provided by the City is given in **Table 3-3**.

Pipe Diameter (inches)	Total System Length (miles)
1	0.1
2	12.9
4	25.6
6	63.6
8	192.9
10	11.9
12	46.0
16	9.7
18	2.7
24	18.5

Table 3-3
Total Pipe Lengths in Existing Water System

Section 4
Hydraulic Model Development

The modeling methodology follows a logical progression of events including data acquisition, model construction, demand allocation, model verification and system evaluation. The first four activities are described in this section while the system evaluation is presented in **Section 5**.

4.1 Overview

The City's water distribution system was modeled using the WaterGEMS version V8i software by Bentley Systems. The software is capable of simulating all aspects of the League City water system. The following subsections explain how the model was assembled and checked for accuracy.

4.2 Data Collection

At the outset of the study, available data was gathered for the water distribution system's physical facilities. The data provided by City staff included transmission tap locations; tank locations, elevations and volumes; well locations and depths; well pump operating points; booster pump locations, operating points and operational controls; and water supply connection locations.

Data was also gathered on historical and projected populations, water production, and projected land use maps of the City to be used in the development of water production determinations and water demand allocations. The City also provided the current capital improvement project details.

Water billing data was acquired from the City's billing department. The water billing data was important in determining existing water usage and creating the necessary demands in the model for average, summer, and maximum day conditions. The water billing data was geocoded based on the physical location of the meter allowing demand from each meter to be assigned to an accurate location within the model. The water billing data for each meter was broken up by month from January, 2008 through May, 2010. Three demand scenarios were created: average annual, average summer, and maximum day demand. The average annual demand scenario consists of the average usage at each meter location through the two and a half years of water billing data. Refer to **Section 2.4.2** for a detailed explanation of how these demand scenarios were developed.

4.3 Model Construction

The primary source of information provided by the City was the GIS data for the water network. Although the data must be verified once imported into the model, WaterGEMS is compatible with ArcGIS software and allows direct import of GIS data into the model. Model inputs for pipelines include length, diameter, installation year, material and roughness. The pipeline length is automatically calculated in model software based on the geographically determined length.

Junctions are defined as the intersection of two or more pipelines, ends of pipelines, or the location of pipe size changes. Junction input information included elevation and demand data. Demands were applied at the closest junction that followed the existing water distribution path for each water user.

Storage tanks are modeled as cylindrical tanks. Tank elevations and diameters are modeled based on City provided tank height data and calculated diameters based on provided capacity data.

Each supply point is modeled as a fixed-head reservoir feeding into the system. Every water source used a flow control valve to limit outflow based on the capacity at each connection. The flow control valve at the groundwater wells was set to the capacity of the well pump. The flow control valve for each surface water connection was set to the daily permissible flow with the diurnal curve pattern applied to it. This allows for the model to simulate more water entering the system at peak demand times.

All isolation valves throughout the water distribution system were modeled and the appropriate valve positions were determined based on information from the City's water operation staff.

4.4 Demand Allocations

To create the demand alternatives, Thiessen polygons were created around each junction linking it to a billing meter location by encompassing it in a polygon. The appropriate demand alternative was loaded to correspond with each scenario.

4.5 Projected Demand Alternatives

For the existing demand alternative, the recent historical data was summarized and incorporated. For future scenarios, however, projected demand alternatives were developed based on the planning information provided by the City planning department. Two different data sources were used for future scenarios: population growth projections from 2010 to 2020 and city buildout land use projections and densities.

4.5.1 Population Growth Projections from 2010 to 2020

The population projection data included the expected population increase and commercial acreage increase for each neighborhood through 2020. As water usage rates were not provided with these projections, existing use factors were determined using the water meter billing data.

To calculate a per capita water usage specific to League City, the average daily water usage from the take logs was divided by the census population given for League City in 2010, which is 83,560 people. While this per capita usage rate enables calculation of future demand in mostly residential areas, it does not account for future demand in commercial areas. Because the billing data lacked sufficient detail to determine commercial usage rates, an assumed rate was determined in spite of wide-ranging demands and the lack of acreage information available for each meter. The residential and commercial usage rates are shown in **Table 4-1**. It should be noted that the commercial water use rate was only used to help determine localized demand. Since the calculated residential per capita usage rate already included commercial usage, the overall water demand is still based on population projections and the residential average water usage rate. A GIS file designating the mentioned neighborhoods allowed each neighborhood's load to be spread evenly over its area. This data is explained in **Section 2.2** and shown in **Tables 2-2** and **2-3.** For the 2020 scenarios, this load was added on top of the existing demand file to create the proposed total demand in 2020.

Usage Type	Average Water Use Rate
Residential	111 gal/person/day
Commercial Regular	1,000 gal/acre/day

Table 4-1
Residential and Commercial Water Usage Factors

4.5.2 Buildout Land Use Projections

Land use data was provided by the City planning department for the developed buildout scenario. Each category also contained the equivalent population per acre. The usage rates in **Table 4-1** were assumed to be constant with time, and were applied to the land use category's equivalent populations to determine the future water use. This was a stand-alone demand alternative and was not added to any of the previous demand alternatives.

4.6 Modeling Assumptions

Assumptions are necessary when modeling if information is not available or the model needs to be simplified to process data in a timely manner. The following information provides details for how the system was simulated in the model.

4.6.1 Pipe Material and Roughness Factor

The existing pipe materials were imported as a part of the GIS data and no adjustments were made. The majority of the existing pipelines are PVC, therefore all new pipes were created as PVC. The Hazen-Williams C value stored in the model's database for PVC is 150, which corresponds to PVC manufacturers' published C values. This was used for all new pipes created in the model.

4.6.2 Storage Tanks

Given that not all of the set points were available for every tank in the water system, assumptions were made to allow the modeled tanks to fully operate. It was assumed that a tank's labeled capacity refers to the active storage available in the tank. For example, if a tank was labeled as a 1.0 MG tank, the elevations and diameter were set such that 1.0 MG of water existed between the minimum and maximum water surface elevation.

The diameters of the tanks were calculated based on capacity of the tank minimum and maximum water surface elevations. This ensured that while the elevations and dimensions may not exactly match the existing tank, the appropriate amount of storage was available in each location.

Also, when more than one ground storage tank exists at a booster station site, the model's calculation time is considerably longer to balance the water level between the tanks. To simplify this and allow the model to run in a reasonable amount of time, the ground storage tanks were combined into one larger tank, again with the appropriate dimensions to simulate the correct amount of water storage for that facility. Future water storage for one site was simulated in the model with a new, single larger tank with the total volume consisting of existing and the additional future capacity.

4.6.3 Booster Pump Stations

The booster pump stations locations were provided within the water system GIS data. The actual station layout, pumping capacities and storage tank details were provided in schematic layouts. Station isolation valves' open or closed status were based on direction from the City water operations group and the provided station layouts for the existing scenario.

The pump curves for the existing pumps were obtained from manufacturers based on City provided pump capacity and model number information. For future scenarios, individual pumps with adequate additional pumping capabilities were added to a station. Future scenarios were simplified by having only one future pump running that was capable of carrying the station's future load, reducing the run time of the model.

4.7 Model Operations

Summer operational limitations were put upon the Meadow Bend BS for the existing summer scenarios based on feedback from the League City water system operators. Allowing Meadow Bend BS's ground storage tank to fill from the transmission/ distribution line whenever its level is dropping prevents adequate quantities of water from reaching South Shore Harbor BS, a more critical facility. In order to model the existing operation, real time controls were incorporated on the influent valve at the Meadow Bend BS to prevent flow from entering between the hours of 5am and 10 am and 6pm and 11 pm.

Another summer modification that the City's water operations staff uses to boost pressures in the system is to close the valve from the Thomas Mackey plant during the hours of 10 am to 4 pm. This summer operational practice was also incorporated into the model by utilizing real time control settings. This operation practice allows more water to be available for the system during the peak demand morning and evening times. These summer modifications were only incorporated into the existing summer scenarios. For future scenarios, the system is planned such that these special measures are no longer necessary.

4.8 Model Verification

To guarantee that a model is serving its purpose by reasonably representing its real world counterpart, it is important to have accurate data on existing system configuration and operation. For the GIS data, it is important to verify that there are no inaccuracies created during the import process. All crossing connections, isolation valves positions, and booster station layouts were verified with the League City water operations staff, particularly crossing connections in key locations such as in or around booster stations or along major transmission or distribution lines.

General operations information is also extremely important to model verification. The WaterGEMS software allows for reasonably complicated control situations. Therefore the City of League City's water operations staff was interviewed regarding common practices, valve positions, and special circumstances. For example, it was discovered that certain additional manual controls were used for summer days to try to raise the water pressures in key areas of the city. These include closing the Meadow Bend BS's influent valve to allow additional water to reach South Shore Harbor BS as well as closing the connection from the Thomas Mackey plant during low demand times of the day to allow for additional water at peak times of the day. As described above these controls are modeled using real time control settings and allow a more accurate representation of existing system operation.

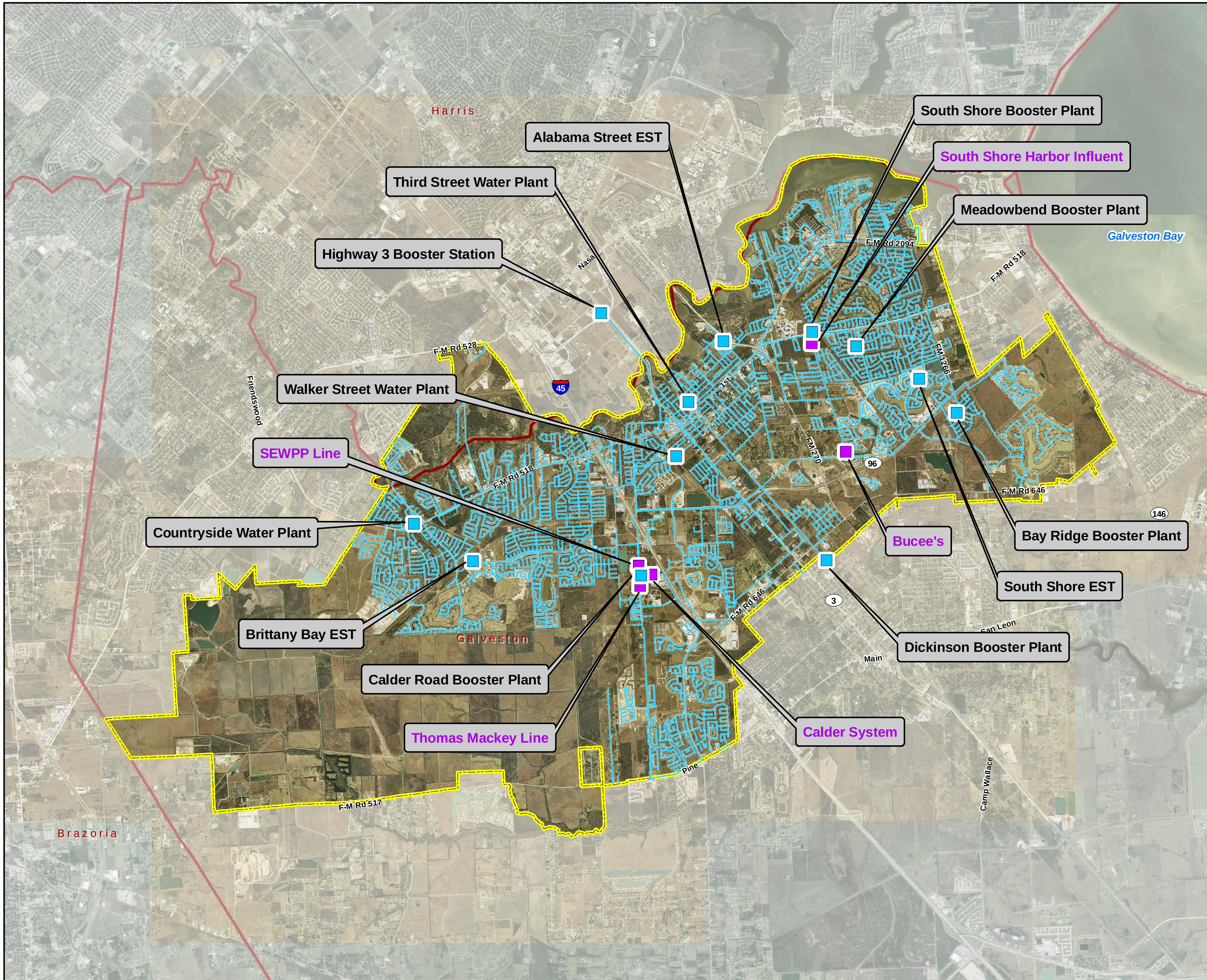
To properly verify the model, it is essential to have measured values against which to compare the modeling results. Pressure data from various sites throughout League City were provided by the City water operations staff to compare with the model's existing scenario results. The sites included the incoming feedline from the SH3 BS at the Calder BS (June, 2009 to June, 2010), the incoming feedline from GCWA at the Calder BS (May, 2009 to July, 2010), the Calder BS system pressure (June, 2009 to June, 2010), the South Shore Harbor BS incoming pressure to the ground storage tanks (October, 2008 to March, 2009) and the Bucee's gas station location at 1702 League City Parkway (July, 2009 to June, 2010). These approximate locations are shown in **Figure 4-1**.

This data was correlated with the corresponding node in the model and pressures were compared for appropriate scenarios. The maximum, average, and minimum values were compiled throughout the year for each day at each site and then specific hourly breakdowns were taken for one summer and one winter week for each site. The model has built in graphing capabilities where existing data can be entered to compare with modeled results and this formed the basis of verification. Adjustments

Figure 4-1

Pressure Validation Locations

City of League City, Texas
Water Master Plan 2011



- Water Facility
- Pressure Gauge Location
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

N
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0 3,500 7,000
Feet

CDM

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were made based on engineering judgment and with the goal of matching the data within the closest accuracy as possible. **Figure 4-2** below shows the model verification chart for the Thomas Mackey water line as it enters the Calder BS for the maximum day demand scenario. The verification data shows the pressure readings for three days during the week of July 1, 2009, the time of the highest system demand. The chart shows that the model closely mimics the actual line pressure, peaking at the same times and with the same magnitude. **Appendix B** contains the verification graphs for all locations and all demand scenarios.

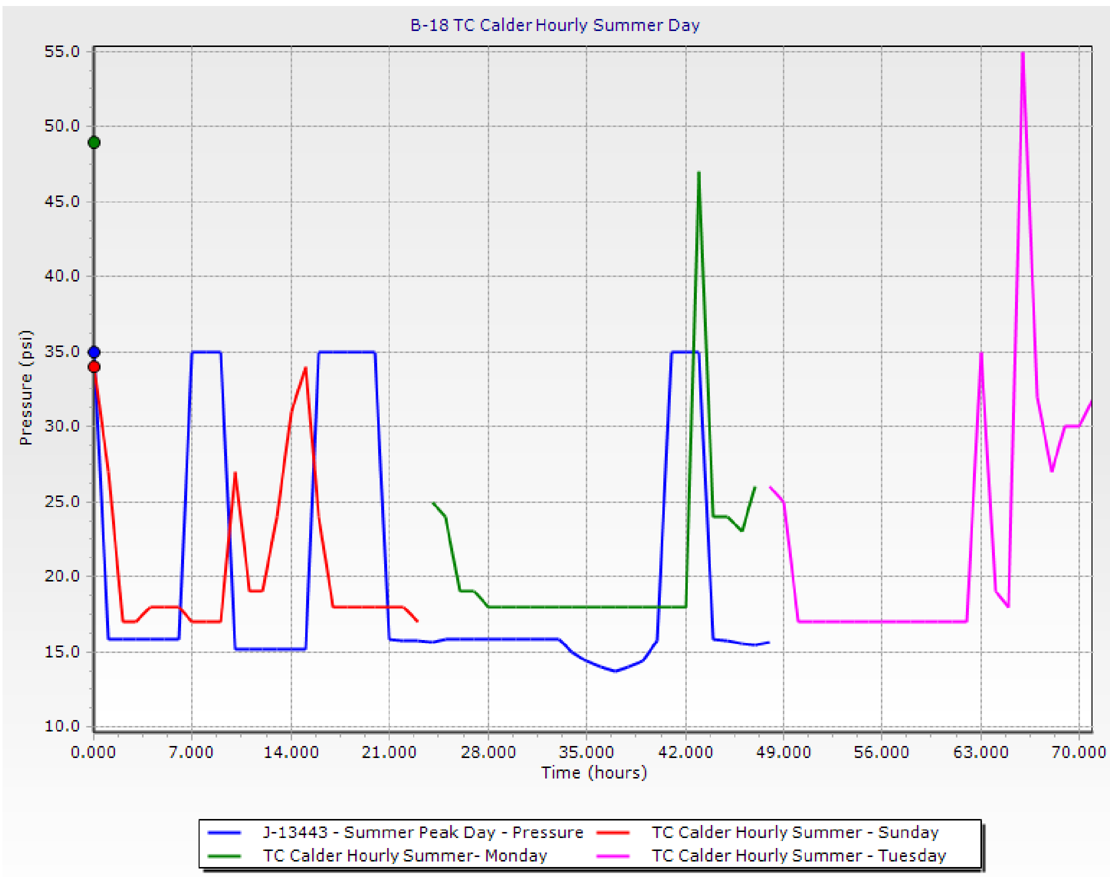

Figure 4-2
Example Model Verification Chart

4.9 Modeling Scenarios

4.9.1 Existing Scenario

Modeling of the existing League City system can be broken down into two separate scenarios. The SH3 BS was not operational when work on the water master plan commenced in 2010, therefore all of the available pressure data was not influenced by the SH3 BS. The model was verified based on the SH3 BS being out of service. However, this was done to calibrate and test the model. The SH3 BS is assumed to be working in future model scenarios.

The existing scenarios take into consideration the current water demand as well as current infrastructure and valve positioning. The operations alternatives were also utilized where appropriate. For example, the pump settings were fixed in existing scenarios while the summer controls were only applied to existing summer average and peak day scenarios.

4.9.2 Capital Improvement Plan Scenario

The capital improvement plan (CIP) scenario includes all of the currently planned projects that will be in place by 2020. The CIP list was provided by the City and was incorporated on the existing model scenario to create the CIP scenario. This was considered an interim scenario between existing and 2020 and used the same demand alternative as the existing scenario. The CIP scenario includes SH3 BS operational and the elimination of the summer control operations.

The purpose of creating this separate scenario was to determine if each of the CIP projects has a positive impact on the water system. Each proposed CIP project was identified as beneficial or not beneficial. Projects identified as not beneficial were also analyzed in future scenarios to determine if they had any future benefit. The future scenarios including 2020 and buildout were based upon the beneficial CIP projects.

In order to reduce maintenance requirements throughout the water system and because of the age of most of the smaller water facilities, the smaller water facilities were not considered operational in future planning scenarios. The CIP projects associated with these facilities were similarly eliminated from the future planning scenarios. The following facilities were eliminated and are recommended for decommissioning:

- Bay Ridge BS
- Meadow Bend BS
- Third Street WS
- Countryside WS
- Walker WS

4.9.3 2020 Scenario

The 2020 scenario uses the CIP scenario as a base, less the CIP projects identified as not beneficial. The development of the 2020 demand alternative is described in detail in **Section 4.5.1**. The total population and acreage changes for commercial and residential property types by 2020 were applied to the existing demand alternative to create the 2020 demand alternative. This additional demand from 2010 to 2020 was added onto the existing maximum day demand, discussed in **Section 2.4.2**.

The future scenarios, including the 2020 scenario, consist of an operational SH3 BS. Future scenarios incorporated beneficial projects from the City's Fiscal Year 2011 – 2015 Proposed CIP. Based on water planning discussions with the City's existing source water providers, two separate 2020 scenarios were created with different source water assumptions. Neither scenario considers a net overall gain in source water quantity. The first scenario considers added storage as a means of accommodating peak demand. The second scenario considers storage to accommodate peak demand as well as providing a more balanced source water split between the SEWPP and the Mackey Plant. Additional detail is provided below.

As mentioned previously, League City currently receives approximately 90% of its surface source water from the SEWPP through the SH3 Booster Station making that one connection to the City a possible single point of failure of the City's water system. In an effort to diversify the source water to increase reliability, opportunities exist to essentially "swap" water sources with neighboring communities.

At the time of this report, the City of Houston does not have available water to sell without a further plant expansion at the SEWPP. The GCWA also does not have additional water available from the Mackey Plant and all the available water rights for the next expansion have already been purchased by other entities. The Mackey plant, however, currently has contracts for 6.03 MGD that it has difficulty supplying to communities east of League City, including Kemah, Bayview, Baycliff, San Leon as well as MUD 51 due to lack of transmission capacity. These entities own future water rights in the Mackey Plant (when expanded) totaling an additional 5.35 MGD.

One possible scenario is for the City of League City to provide treated water to these cities from League City's existing connection to the SEWPP connection at the SH3 BS by constructing additional transmission capacity. League City could then take the initial 8.03 (6.03 MGD plus the existing 2.0 MGD) from the Mackey Plant to supply League City's water demand. Future supply (5.35 MGD) locations to these communities east of League City could be negotiated at a future date. In this scenario the City does not gain additional source water capacity, but it allows the City to take more water from its GCWA connection point to the south of the City instead of depending almost solely on its City of Houston connection to the north of the City. This is advantageous because it diversifies the source water supply for League City so that if something were to happen to either source water facility, an adequate supply of water can be maintained. At the present time, this "water swap" is the only way to get additional water from the Mackey Plant to the City.

Both of the 2020 scenarios utilize the philosophy of decommissioning all minor stations. The major facilities remaining includes the South Shore Harbor BS, Calder BS, SH3 BS and the Northside BS (Not yet constructed, but in the current CIP) to supply water for the entire city. The Alabama EST was also taken offline for future scenarios since it provides little benefit and may be converted to reuse infrastructure. Remaining ESTs include the Brittany Bay EST, South Shore EST and two new elevated tanks proposed in the CIP to handle the city's peak demand.

There is a loss of 2.17 MG of ground storage when decommissioning the minor BS's so that additional storage needs to be constructed at the major facilities remaining in service.

4.9.4 Buildout Scenario

The buildout scenario uses the infrastructure proposed in the 2020 scenario as a basis for ultimate improvements. Unlike the 2020 scenario where the increased demand was modeled in targeted areas in coordination with the Planning Department, the buildout scenario demands were based on the ultimate overall land use described in the Comprehensive Plan without any specific growth information between scenario time periods. Further discussion may be found in **Section 4.5.2**. Additional recommendations were identified in the buildout scenario to address low pressure areas, water transmission and distribution, and additional source water requirements.

Two different buildout scenarios were created based on reasonable future water source options. The first option includes all of the future water required coming from the City of Houston SEWPP at the SH3 BS. The SH3 BS would serve as the single point of delivery from the SEWPP. However, the SH3 BS would be modified into a dual purpose facility; part of the facility would retain the function of delivering distribution pressure through booster pumps while a new low service pump station would be constructed to provide transmission pressure to the South Shore BS. The SH3 BS and South Shore BS would then provide the pressure for the east half of League City. This is a particularly attractive option as it eliminates the hybrid transmission/distribution system. In addition, it eliminates a potential single failure point in the existing 42/39 inch SH3 transmission/distribution line that was originally constructed over 40 years ago.

The second option considers a portion of the future source water requirement from the City of Houston's SEWPP at the SH3 BS (additional 15.5 MGD) and a portion of the future source water requirement from the Mackey Plant (additional 11 MGD) at the Calder Road connection point. This option builds on the "water swap" 2020 scenario described above.

For each scenario, the water system was analyzed to determine large transmission and distribution lines requirements as well as storage and pumping upgrades at booster stations to meet water demands and operational requirements. Specific projects are identified in **Section 6**.

Section 5
Evaluation Criteria and System Performance Assessment

The purpose of this section is to describe the evaluation of the City's existing and future water distribution system and discuss the performance of the system. The water system was evaluated using the hydraulic model and planning criteria and demand projections described in this section. Water sources, node pressures, pipeline velocities, storage tank volumes and booster pump capacities are investigated were evaluated. Recommendations to solve existing deficiencies and meet future demands (including buildout) are provided in this section.

5.1 Planning and Evaluation Criteria

Various planning criteria are used in the evaluation of both the existing and future system hydraulic models. The planning criteria is developed based on water systems similar to League City, local codes, engineering judgment, common accepted industry standards, and input from City staff. The "industry standards" are typically ranges of acceptable values for the criteria in question and therefore, they were utilized more as a check to confirm that the values being developed are reasonable. A list of planning criteria developed through meetings with City staff, and used in the evaluation of the City's water distribution system is shown in **Table 5-1**.

Description	Planning Criteria
Peaking Factors:	
- Maximum Day Demand	2.0 x Average Day Demand
- Peak Hour Demand	1.68 x Maximum Day Demand
Minimum System Pressure	35 psi, with a goal of 50 psi on trunk distribution pipelines
Maximum System Pressure	80 psi, with a goal of 65 psi
Maximum Velocity in Pipe	8 feet per second
Storage Capacities:	
- Operational Storage	25% of Max Day Demand
- Fire Flow Storage	4 hours at 4,000 gpm (1 MG)
- Emergency Storage	Average Day Demand

Table 5-1
Summary of Planning Criteria

There are three primary evaluation criteria: 1) acceptable pressure, 2) maximum acceptable pipeline velocities, and 3) adequacy of storage volumes. Texas Commission on Environmental Quality has a minimum requirement of 100 gallons of ground storage and 100 gallons of elevated storage for each service connection. Based the City's current total population of 83, 560 and an estimated 2.8 people/connection based on City statistics, the minimum required ground storage and elevated storage is 3.0 MG each for a total of 6.0 MG. Projecting a similar number of connections/person and a total population of 202,360 at buildout, the minimum total ground and elevated storage would be 7.2 MG each for a total of 14.4 MG. The TCEQ recommended storage is based on water system operational storage and does not take into account a system's specific water source situation and emergency storage required to mitigate source water risk. The City depends solely on water connections with other identities to provide their water supply. For planning purposes it is recommended to provide additional storage beyond TCEQ required minimum storage. It is recommended that the City plan for storage to provide the 25% of maximum day demand as operational storage, fire flow storage to provide for sufficient water for four hours at 4,000 gpm (1 MG), and emergency storage of 100% of the average day demand. Storage volume and location planning should be reviewed in the future for conformance with connection requirements and the City's source water connection risks.

5.2 Water Demands

The City of League City's water system was evaluated for adequate supply, system pressure, storage and booster pump capacity to deliver sufficient water under existing and future demand scenarios. Existing and future demands from **Section 2-4** are summarized in **Table 5-2** below.

Year	Average Day Demand (MGD)	Maximum Day Demand (MGD)
Existing	9.1	18.6
2020	12.8	25.7
Buildout	22.5	45.0

Table 5-2
Water Demands

5.3 Source Evaluation

The City, through GCWA, is a part owner of 21.5 MGD of capacity in the SEWPP. The City also receives another 2 MGD from the GCWA Mackey Plant for a total treated source water supply of 23.5 MGD. To meet the projected 45 MGD demand at buildout, an additional 21.5 MGD capacity will need to be secured.

GCWA and the City of Houston's SEWPP are the only two treated source water providers available to serve the City. At the present time, there is no treatment capacity available for purchase from either facility. The Mackey Plant is currently rated for 20 MGD with future raw water rights and expansion capability to 40 MGD total. However, those future raw water rights and treatment capacity have already been contracted to other entities. It is our understanding from conversations with the GCWA that based on current yields in the GCWA raw water canal system and subsequent rights from the Brazos River Authority (BRA), there are no additional raw water rights available to GCWA that could feed the Mackey Plant. As a result, there is no available treated water capacity available in the future from the Mackey Plant.

The SEWPP is currently rated for 200 MGD with future raw water rights and expansion capability to 240 MGD total. All of the 200 MGD capacity is currently purchased (of which the City owns 21.5 through GCWA). The future 40 MGD raw water and subsequent SEWPP expansion capacity has not been purchased yet and is available for sale. At the present time, this is the only available treated water source available to the City. However, based on the SEWPP's modular configuration, the plant can only be expanded in 40 MGD modules. As a result, the City of Houston will only expand the plant once funding is in place to purchase all 40 MGD. This could be by one entity or several entities. Thus, at the present time, this is the only available option to readily purchase additional treated water capacity.

Should the City choose to wait to purchase additional treated water capacity or miss the opportunity to purchase any or all of the available 40 MGD capacity, the City of Houston does have additional raw water rights and expansion capability at the SEWPP facility. The current master plan for the SEWPP indicates a site plan for an additional 120 MGD (360 MGD total). However, the City of Houston does not currently have raw water infrastructure (raw water pump station or pipeline facilities), treated water infrastructure or treated water delivery infrastructure in place. All of these facilities require long range planning which will likely take many years before implementation. In addition, the next expansion will be much more expensive to construct than the currently available 40 MGD. Due to the size, scale, and high cost of planning, designing and constructing additional raw water capacity, the City of Houston may likely require the majority of the future raw water infrastructure (minimum of 120 MGD) to be purchased prior to construction which will further increase the implementation period for these facilities.

It should also be noted that the City of Houston is in the process of planning the replacement of the existing 42-inch treated water supply line that extends down SH3 from the SEWPP to the City's SH3 BS. The replacement costs will be shared with all the co-participants. It is unclear at this time if the line will be upsized for future capacity and who would pay for that capacity and how those cost would be shared with the other co-participants. According to the City of Houston, the replacement is imminent, however the timing of said replacement has not been confirmed.

5.4 Supply Evaluation

Under typical conditions, the total capacity of water supplies should be equal to or greater than the maximum day demand (MDD). Demands above MDD are typically supplied from storage. At the present time, the only two facilities that can provide League City with treated surface water are the City of Houston's SEWPP and

GCWA's Mackey Plant. The evaluated total water contributions from each source are shown in **Figure 5-1**. As described in **Section 5.3**, it was determined that additional net water is not possible from the Mackey Plant, therefore scenarios that relied on water from the Mackey Plant in the future were eliminated.

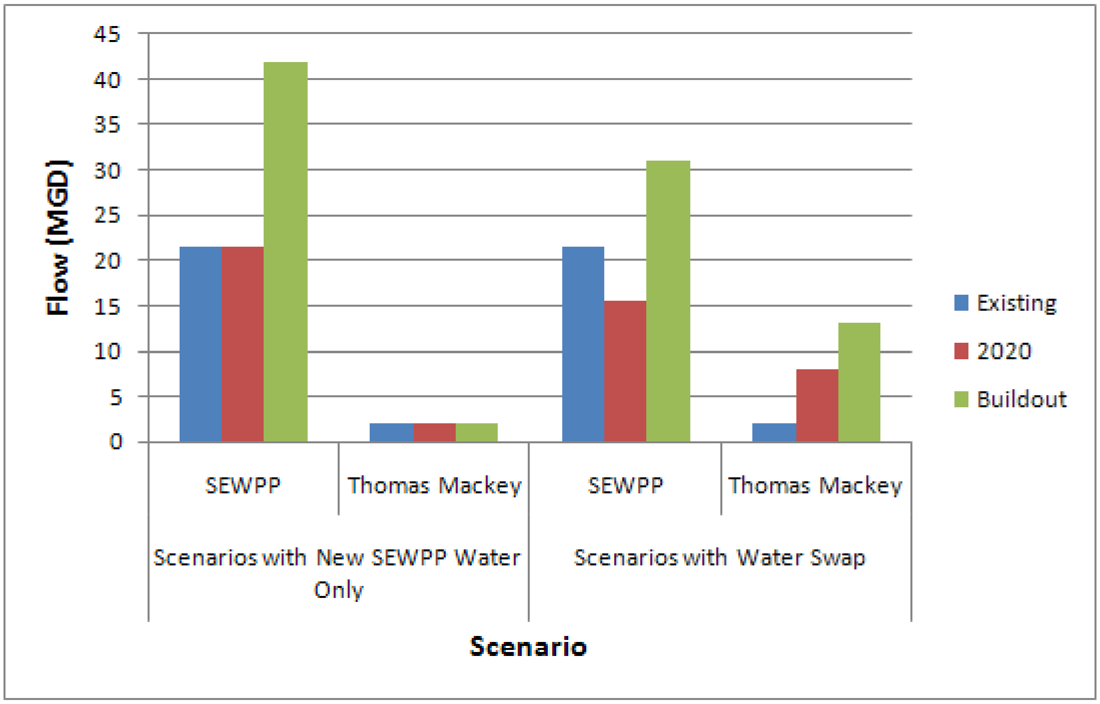

Figure 5-1
Evaluated Source Water Alternatives

5.5 Storage Capacity Evaluation

A summary of the available, required and recommended storage volumes for each scenario are presented in **Table 5-3** and **Figure 5-2**.

Year	ADD (MGD)	MDD (MGD)	Existing Storage (MG)[1]	TCEQ Total Required Storage (MG)	TCEQ Additional Storage Required (MG)	Total Recommended (MG)	Additional Recommended Storage (MG)
Existing	9.1	18.6	15.5	6.0	0	15.5	0
2020	12.8	25.7	15.5	8.2	0	28.5	13
Buildout	22.5	45.0	15.5	14.4	0	37.5	9

Note:
[1] Includes 6 MG at Northside Booster Station and does not include storage at minor facilities recommended for decommissioning

Table 5-3
Storage Capacity Evaluation

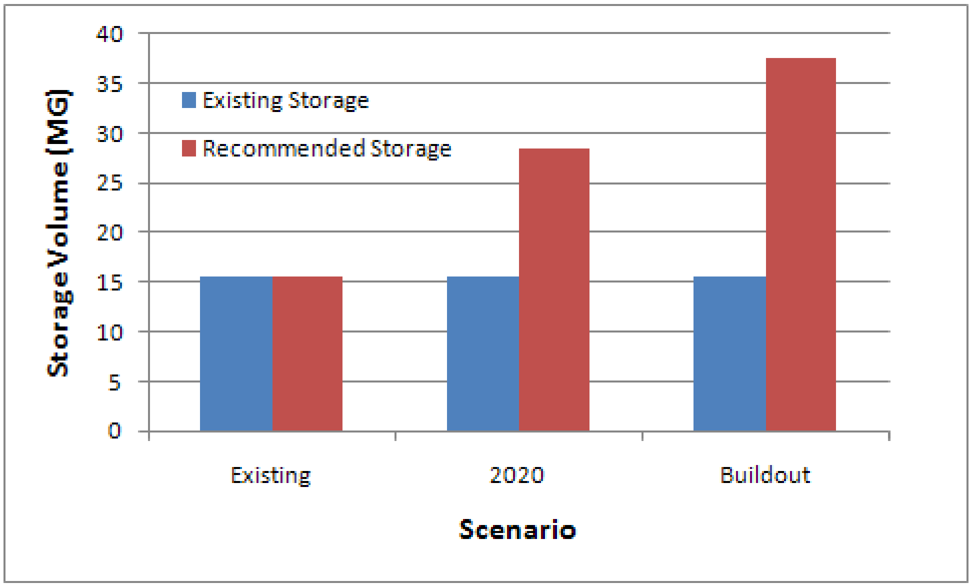

Figure 5-2
Storage Capacity Evaluation

5.6 Existing System Pressure

Several figures were created to understand the existing performance of the water system. In each figure, the booster station's pumping values were taken from the model during the peak demand time in the diurnal curve. **Figure 5-3** shows the water pressure of the existing League City water system at average daily demand without the operation of SH3 BS. The pressures throughout the City are quite adequate, ranging from 50 to 75 psi, with the highest pressures located in the northeast area served by South Shore Harbor BS.

For **Figure 5-3** through **5-6**, the pumping values shown are the flow rates calculated by the model for the existing facilities in order to meet the indicated demand scenario. It should also be noted that the pressures indicated are the lowest instantaneous pressures recorded in the model during the peak hour, day, etc.… of each demand scenario and may not reflect continuous or sustained pressures during the indicated scenario.

Figure 5-4 shows the water pressure of the existing League City water system at average summer demand without the operation of SH3 BS. The pressures ranged from 20 to 65 psi, with the low pressures occurring in the east areas of the City. **Figure 5-5** shows the water pressure of the existing system at the maximum day demand without the operation of SH3 BS. Since SH3 BS operation was tested during the course of this study and operation of it was determined to have provided added benefit to the City's water system, a model scenario was created to validate and quantify the benefit of an operational SH3 BS in its current pumping capacity without

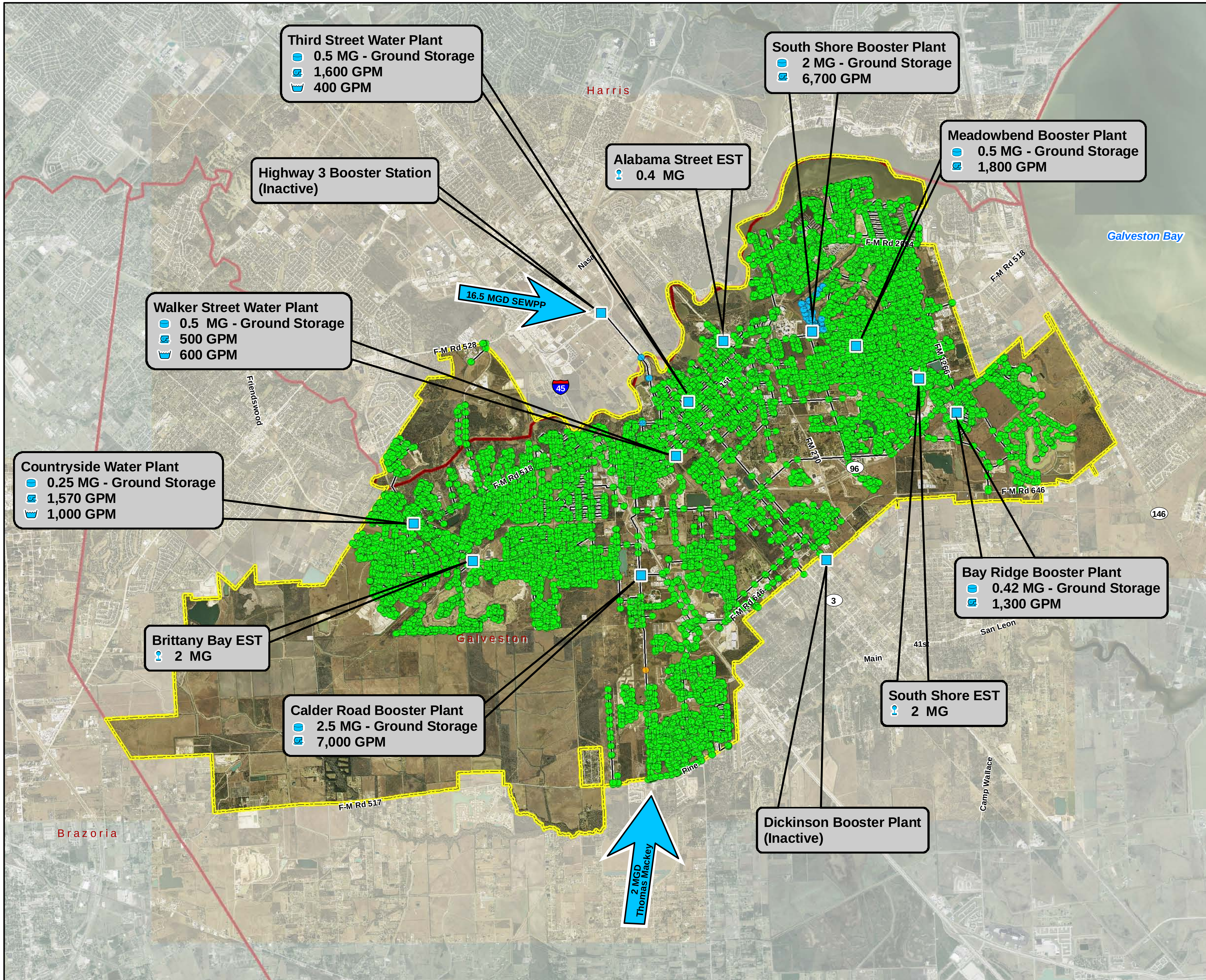

Figure 5-3

Existing System Water Pressure at Average Daily Demand

Highway 3 Plant Inactive

City of League City, Texas

Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Pump
- Ground Storage
- Elevated Storage
- Well

Pressure Range

- 10 - 20 psi
- 21 - 35 psi
- 36 - 50 psi
- 51 - 70 psi
- 71 - 95 psi
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

Note: The pumping values shown are the flow rates calculated by the model for existing facilities in order to meet the indicated demand scenario.

N W E S

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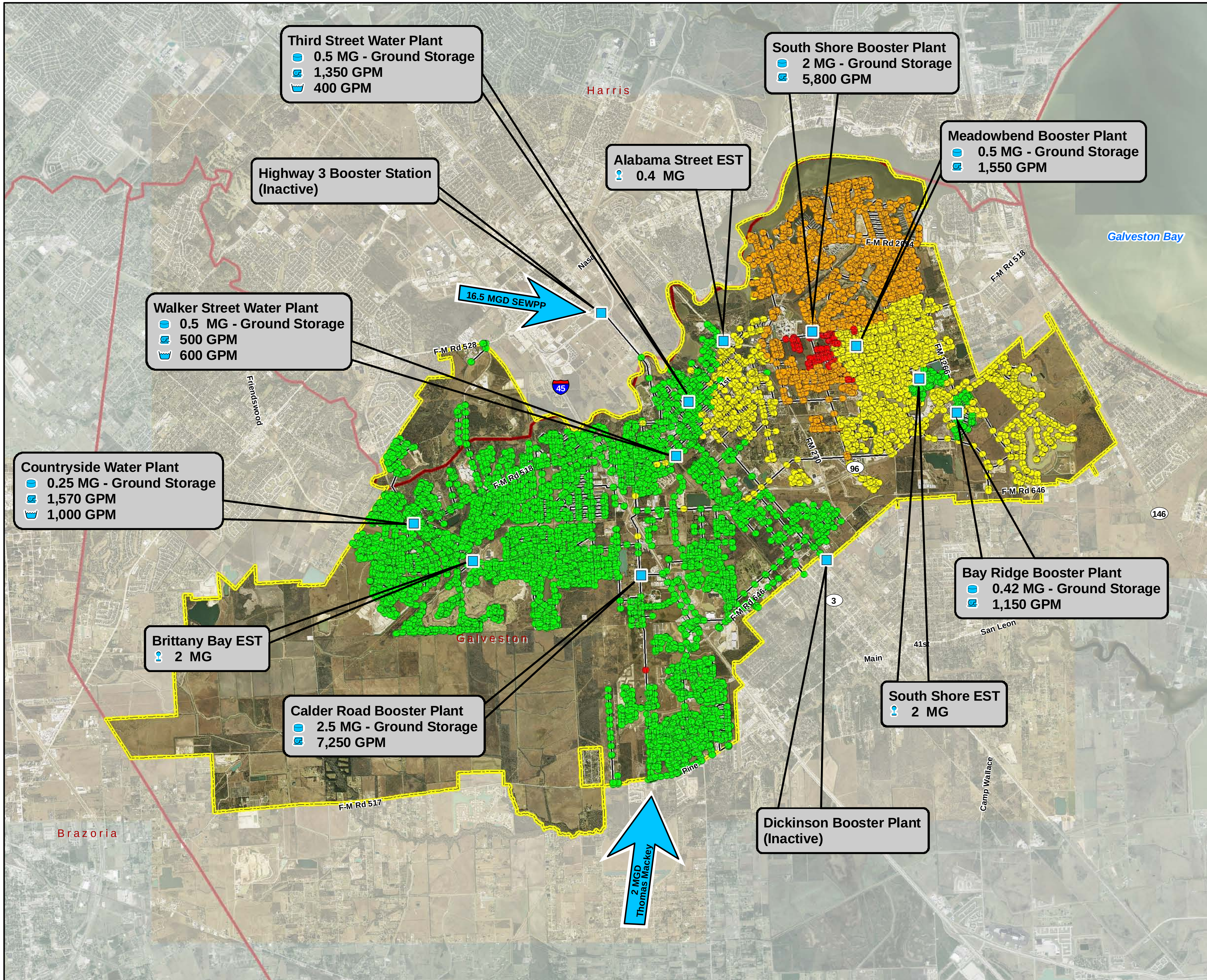

Figure 5-4

Existing System Water Pressure at Average Summer Demand

Highway 3 Plant Inactive

City of League City, Texas

Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Pump
- Ground Storage
- Elevated Storage
- Well

Pressure Range

- 10 - 20 psi
- 21 - 35 psi
- 36 - 50 psi
- 51 - 70 psi
- 71 - 95 psi
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

Note: The pumping values shown are the flow rates calculated by the model for existing facilities in order to meet the indicated demand scenario.

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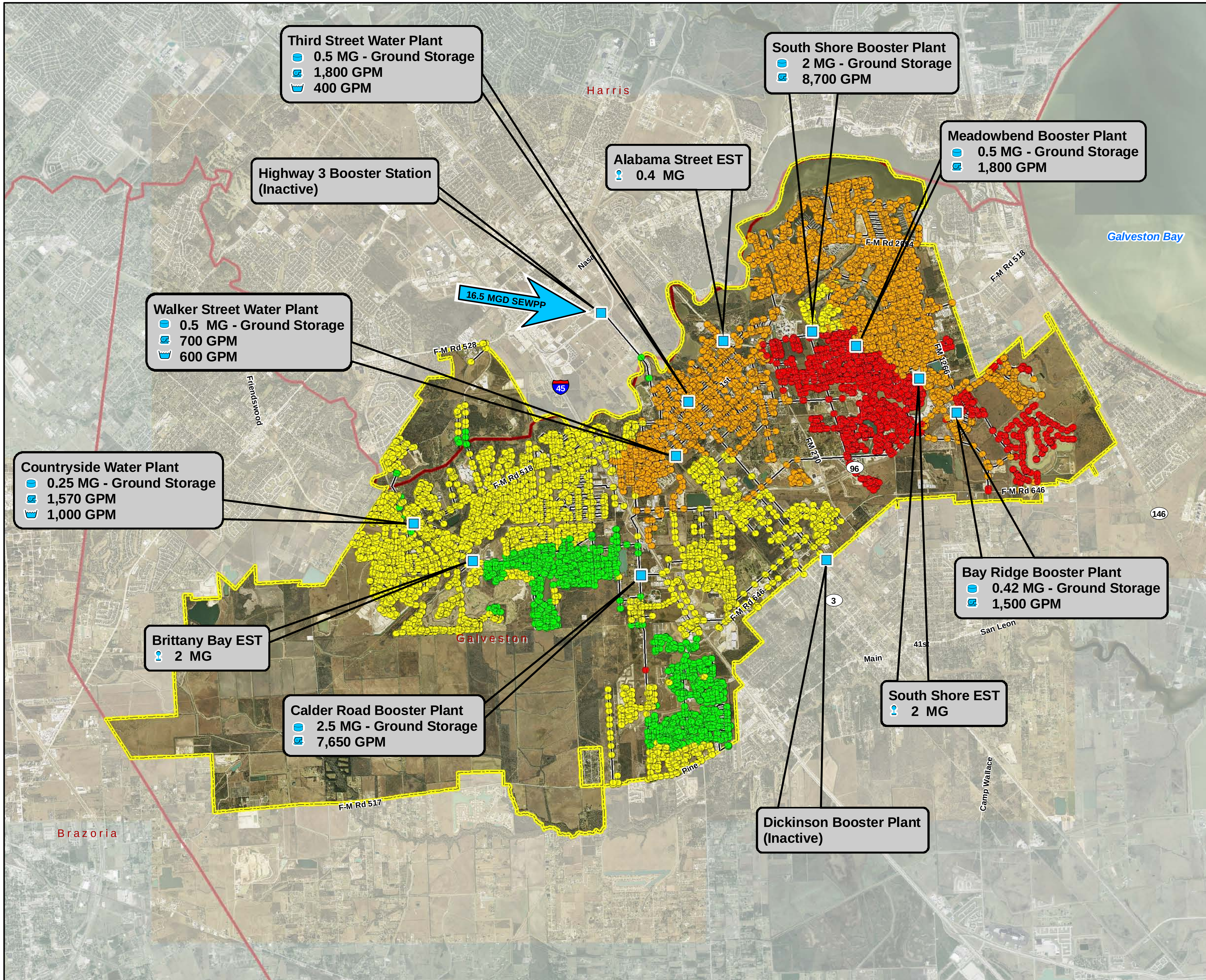

Figure 5-5

Existing System Water Pressure at Max Day Demand

Highway 3 Plant Inactive

City of League City, Texas
Water Master Plan 2011

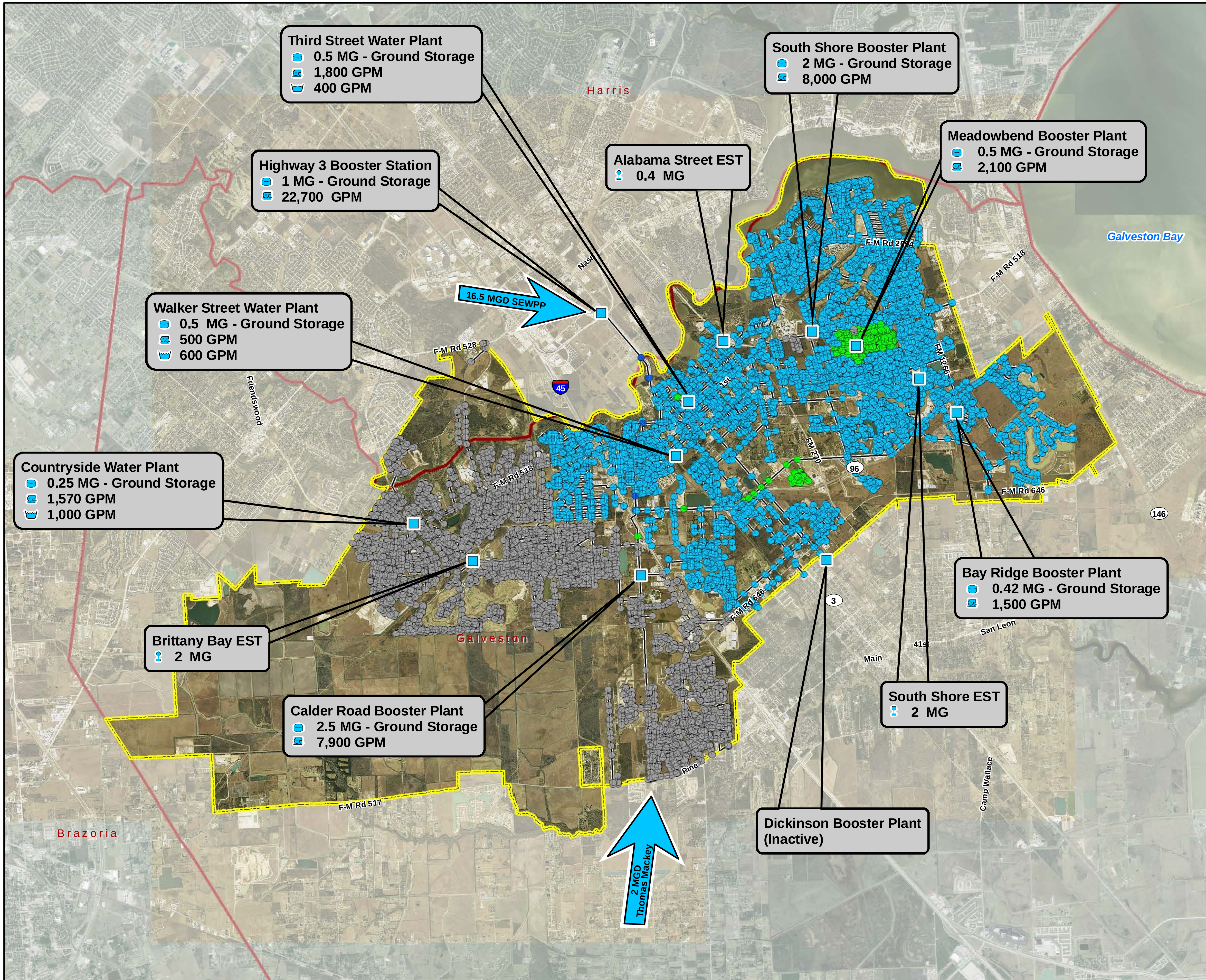

Figure 5-6

Existing System Differential Water Pressure at Max Day Demand

Highway 3 Plant Inactive

City of League City, Texas

Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Pump
- Ground Storage
- Elevated Storage
- Well

Pressure Change

- No Change
- 1 - 10 psi
- 11 - 20 psi
- 21 - 30 psi
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

Note: The pumping values shown are the flow rates calculated by the model for existing facilities in order to meet the indicated demand scenario.

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any modifications. **Figure 5-6** presents the pressure differential between the maximum day conditions with and without the operation of SH3 BS. Modeled pressures increased as much as 20 psi with the operation SH3 BS, with the east central part of the City receiving the most benefit. Only the west area of the City saw no additional benefit from the use of SH3 BS.

Based on anecdotal evidence from City staff, as well as pressure chart data, there are problems with low pressure in the system at peak demand times and peak summer demand days. The anecdotal evidence was provided by the City of League City water operations staff and included the pressure recordings throughout the distribution system. This information indicated that low pressures were most typical in the areas off of Louisiana Avenue, south of the South Shore Harbor BS. Pressure charts for the Bucee's gas station location at the south end of Louisiana Avenue also indicate low pressures during occasional summer days at peak demand times. However, the pressures are still mostly at acceptable levels which is defined as greater than 35 psi (although the Bucee's location experienced low daily pressures between 30 and 35 psi for the week of July 1, 2009). This data is consistent with the anecdotal evidence from City staff regarding pressure problems along Louisiana Avenue.

A major reason for the low pressures in the Louisiana Avenue area is the large number of open taps along Louisiana Avenue and League City Parkway. The lines were originally designed to be transmission lines from SH3 BS to South Shore Harbor BS and Meadow Bend BS to the north of Louisiana Avenue and to Bay Ridge BS and South Shore EST to the east along League City Parkway. Much of the water intended for these sites never reaches them, which leads to low water pressure. Simply closing those taps could improve water pressure in the problem areas of League City. However, the water distribution system is not set up to supply several of these smaller neighborhoods so they presently rely on the hybrid transmission-distribution lines for all their water supply. Closing these valves is not an option unless another connection to a distribution line is made.

Despite the pressure issues that occur during high demand summer days, the water system does not experience pressure issues during the majority of the year. Ideally, it should be the ultimate goal of eliminating the labor intensive special summer operational controls to allow the operations staff to focus on special problems or equipment issues.

5.7 Modeling Evaluation

Once the model was properly verified and results closely mirrored existing system operation and performance data, the results were analyzed for system performance, deficiencies in the defined evaluation criteria identified, and solutions developed. The modeling results are described in the following sections.

5.7.1 Results from Existing Scenarios

The modeling results for the existing scenarios were very similar to those relayed in anecdotal evidence and pressure charts as these represent the existing system operation. The areas located in and around the Louisiana Avenue line showed the lowest pressure readings in the water system, most noticeably on high demand summer days. The system is not currently capable of handling the peak demand seen on June 28, 2009. This total system demand of 18.6 MGD was used as the max day water usage. The pressures are acceptable for low demand times of the day but drop below 35 psi during peak times on the max day. When the model is run with multiple maximum demand days in a row, the system has difficulty recovering for even non-peak times of the day and overall pressures drop.

The summer operation controls were verified in the model to raise pressures in the low-pressure areas. On maximum demand days, however, the controls are not enough to keep all pressures above 35 psi. As stated previously, a major reason for the low pressures is the large number of direct customer taps along the League City Parkway and Louisiana Avenue water lines, essentially making these lines hybrid transmission/distribution lines. As suspected, the water cannot reach the necessary booster stations and elevated storage tank.

An analysis was performed on the existing scenario to determine how much impact closing these Louisiana Avenue and League City Parkway taps would have on system pressure, ensuring that the isolated neighborhoods were reconnected to nearby distribution lines. Pressures increased in the problematic areas an average of 13 psi at peak times on the max day and an average of 6.5 psi throughout the entire system. During a meeting with League City staff on October 25, 2010, it was stated that League City does not wish to remove the existing taps along these two lines, however no new taps would be permitted. This led to the decision to alter the system to create a true transmission line from SH3 BS to South Shore Harbor BS, turning the Louisiana Avenue and League City Parkway lines into true distribution lines. The specific information regarding identification of projects will be discussed in **Section 6**.

Also during the October 25, 2010 meeting with League City staff, a reoccurring comment made was that many of the minor stations were a nuisance to operate or had aging and degrading facilities. Given the small size of most of these stations, CDM evaluated whether or not it is possible to decommission these facilities in the future. Since the system is not currently capable of meeting maximum demand days, changes will need to be made to accommodate this simplification of the water system.

5.7.2 Results from CIP Scenario

The information produced from the CIP scenario model showed that the majority of the CIP projects are very useful for directing flow to needed locations and raising pressures in low-pressure areas. However, there are several projects that did not add a benefit to the water system. The projects identified as not beneficial were also tested in buildout scenarios for effectiveness. All were still determined as non beneficial projects, and were therefore not incorporated into the final 2020 and buildout scenarios.

5.7.3 Results from 2020 Scenarios

With the useful CIP projects incorporated into the existing infrastructure for the 2020 scenario, problems with pressure were still seen due to the increase in demand. The scenarios were subjected to one week of maximum demand days, which exposed the weaknesses in the system that were not remedied with current CIP projects. The largest area of concern is the area south of South Shore Harbor BS along Louisiana Avenue. Water is drawn off of that pipeline before it can reach South Shore Harbor BS, lowering pressures throughout the eastern portion of the City. This was remedied by creating a new low-pressure transmission line directly from the SH3 BS to the South Shore Harbor BS which will also require a new low service pump station facility to be constructed at the SH3 BS.

With the minor stations being decommissioned and the increase in demand, there is not enough source water to supply the City for one week of maximum days. However, the deficit in source water supply versus demand in 2020 is can be made up with additional storage capacity.

With the addition of the projects identified in **Section 6**, the evaluation criteria listed in **Section 5.1** were met. All system pressures at all times exceeded 35 psi and were lower than 85 psi, while meeting TCEQ requirements of at least 20 psi during fire flow. The velocities for all pipelines were less than 8 feet per second.

5.7.4 Results from Buildout Scenarios

For each buildout scenario, the equivalent 2020 scenario was used as the basis for evaluation. With the significant increase in development, and therefore demand, anticipated for buildout, the total needed source water was evaluated to be 45.0 MGD. Given this large increase, the existing booster stations will require a large upgrade in capacity.

After addressing the necessary increases in flow and pumping capacity at the various booster stations, the water system performed well with the exception of major growth areas, including the proposed southwest development and the new north development along Palomino St. These areas will require construction of larger "trunk" water mains. The area around Calder BS will also require improvement, including new lines that will directly convey flow to the proposed southwest development.

With the addition of the projects identified in **Section 6**, the evaluation criteria listed in **Section 5.1** were met when subjected to one week of maximum demand days. All system pressures at all times exceeded 35 psi and were lower than 85 psi, while meeting TCEQ requirements of at least 20 psi during fire flow. The velocities for all pipelines were less than 8 feet per second.

Section 6
CIP Project Development

6.1 Eliminated CIP Projects

Through the performance assessment of each CIP within the various scenarios of the model many CIP projects were determined to have no benefit to the water system based on the new planning data, source water identification, and transmission versus distribution pipeline operational philosophy. Projects developed to renew or replacing aging infrastructure were not eliminated or changed, unless a capacity upgrade was recommended for new infrastructure. The projects were eliminated based on effectiveness. Within the complete water system smaller wells and booster stations with planned improvements were also eliminated based on the future recommendation to decommission these facilities. The eliminated CIP projects and the associated total savings of $15.7 million is outlined in **Table 6-1**.

Eliminated CIP Project	Cost Savings
Raise West Side Elevated	$2,500,000
Countryside Pump Station & Well	$1,475,000
New East Side Elevated #2	$3,000,000
Walker Street Pump Station & Well	$1,265,000
Meadow Bend Pump Station	$1,350,000
Eastside Trunk Lines	$2,700,000
Supplemental 24" Water Supply from Calder Rd to SH3	$1,200,000
Third Street Pump Station & Well	$1,265,000
Upsize Water Lines on FM518 near Countryside BS	$900,000
Total Savings	**$15,655,000**

Table 6-1
Eliminated CIP Projects

It was determined that Dickinson BS should still be upgraded given its emergency use status. If that relationship were to end in the future, then the Dickinson BS project at a total cost of $3.6 million could also be added to the list of eliminated projects in **Table 6-1**.

6.2 2020 Scenario with No Additional Water

The recommended pipeline, storage and booster station capacity upgrade projects for the 2020 scenario with no additional source water are outlined below in **Table 6-2** to **Table 6-4** respectively. **Figure 6-1** and **Appendix C** illustrates the location of these projects. All facility projects take into account required standby pumping.

Project Title	Approximate Length (ft)	Diameter (in)	Purpose
Line - SH3 BS to South Shore BS	17,200	36	System redundancy
Beamer Rd 24" WL Extension	16,000	24	New connection point with SEWPP
Line Along Brittany Bay Blvd	2,700	24	Looping of transmission lines
Line - Cross Colony to Mary Lane	1,600	8	Looping of transmission lines
Line - FM 518 to Alderwood	3,000	24	Looping of transmission lines
Line - SSH Plant to FM 2094	3,800	18	Looping of transmission lines
Line - Walker Plant to Louisiana	17,500	24	Looping of transmission lines
Line to New West Elevated Storage Tank	1,300	18	Future development
New Water Lines to the West Side	15,000	24	Future development
Trunk Lines along Bay Area Boulevard	23,500	18	Future development

Table 6-2
Recommended Pipeline Projects for 2020 Scenario with No Additional Water

Project Title	Existing Storage Capacity (MG)	Proposed Storage Capacity (MG)	Additional Tank Volume (MG)
SH3 BS - Phase I	1	7	6
Northside BS - Phase I	n/a	6	6
South Shore Harbor BS - Phase I	2	5	3
New East Side Elevated	n/a	2	2
New West Side Elevated Tank	n/a	2	2

Table 6-3
Recommended Storage Projects for 2020 Scenario with No Additional Water

Project Title	Existing Firm Pumping Capacity (gpm)	Proposed Firm Pumping Capacity (gpm)	Additional Proposed Pumping Capacity (gpm)
SH3 BS - Phase I	HS-12,600	HS-16,600 LS-4,000	HS-4,000 LS-4,000
Northside BS - Phase I	n/a	4,500	4,500
South Shore Harbor BS - Phase I	4,230	6,100	1,870
Calder Rd BS - Phase I	6,740	8,690	1,950

Table 6-4
Recommended Booster Station Projects for 2020 Scenario with No Additional Water

The figure shows the water sources and quantities used in this scenario. It should be noted that while the scenario is referred to as "2020 Scenario with No Additional Water," it does have a new 5 MGD connection from the Beamer Road line from the SEWPP currently in the design phase and planned for operation by the end of the year 2012. The project was not completed at the time of this study so it was not considered in the existing scenarios. This scenario evaluates what will be operational by 2020 and identifies the required projects to meet required demands on the water system without securing additional source water.

The current CIP pipelines projects recommended for elimination are also identified on **Figure 6-1**. **Figure 6-1** illustrates a schematic layout for future ground storage at each booster station facility. Detailed descriptions of each recommended CIP project along with cost estimates and reference figures can be found in **Appendix D**.

6.3 2020 Scenario with GCWA Water Swap

The recommended pipeline, storage and booster station capacity upgrade projects for the 2020 scenario with the GCWA water swap are outlined below in **Table 6-5** to **Table 6-7** respectively. The recommended CIP projects for this scenario are shown in **Figure 6-2**. **Appendix C** displays the same information on a wall-sized figure. The figure shows the water sources and quantities used in this scenario.

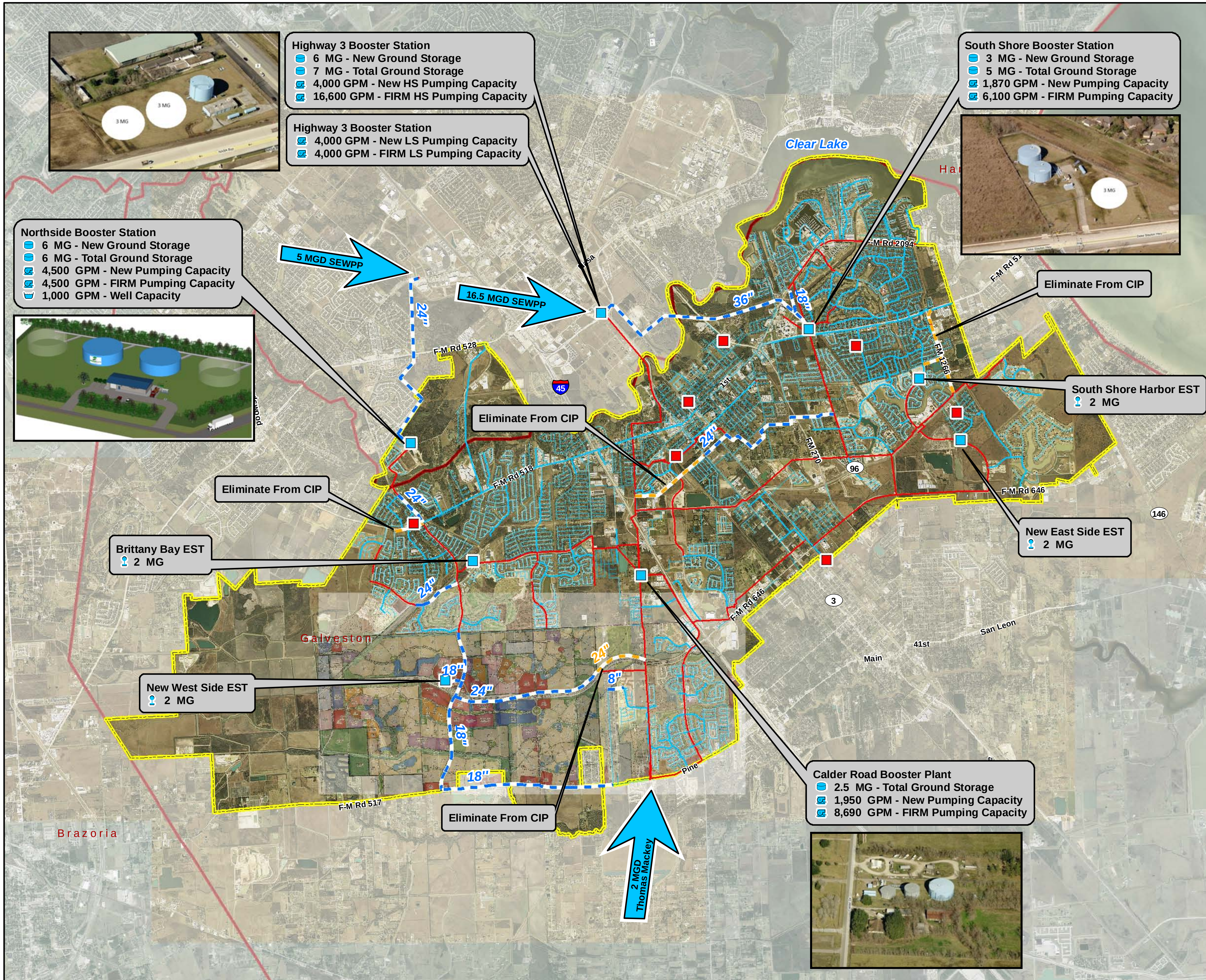

Figure 6-1

2020 Scenario with No New Source Water

City of League City, Texas
Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Inactive Facility
- Pump
- Ground Storage
- Elevated Storage
- Well

Improvements

- New Line
- Remove from CIP

Water Line (2010)

- 16" - 60"
- 10" - 12"
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

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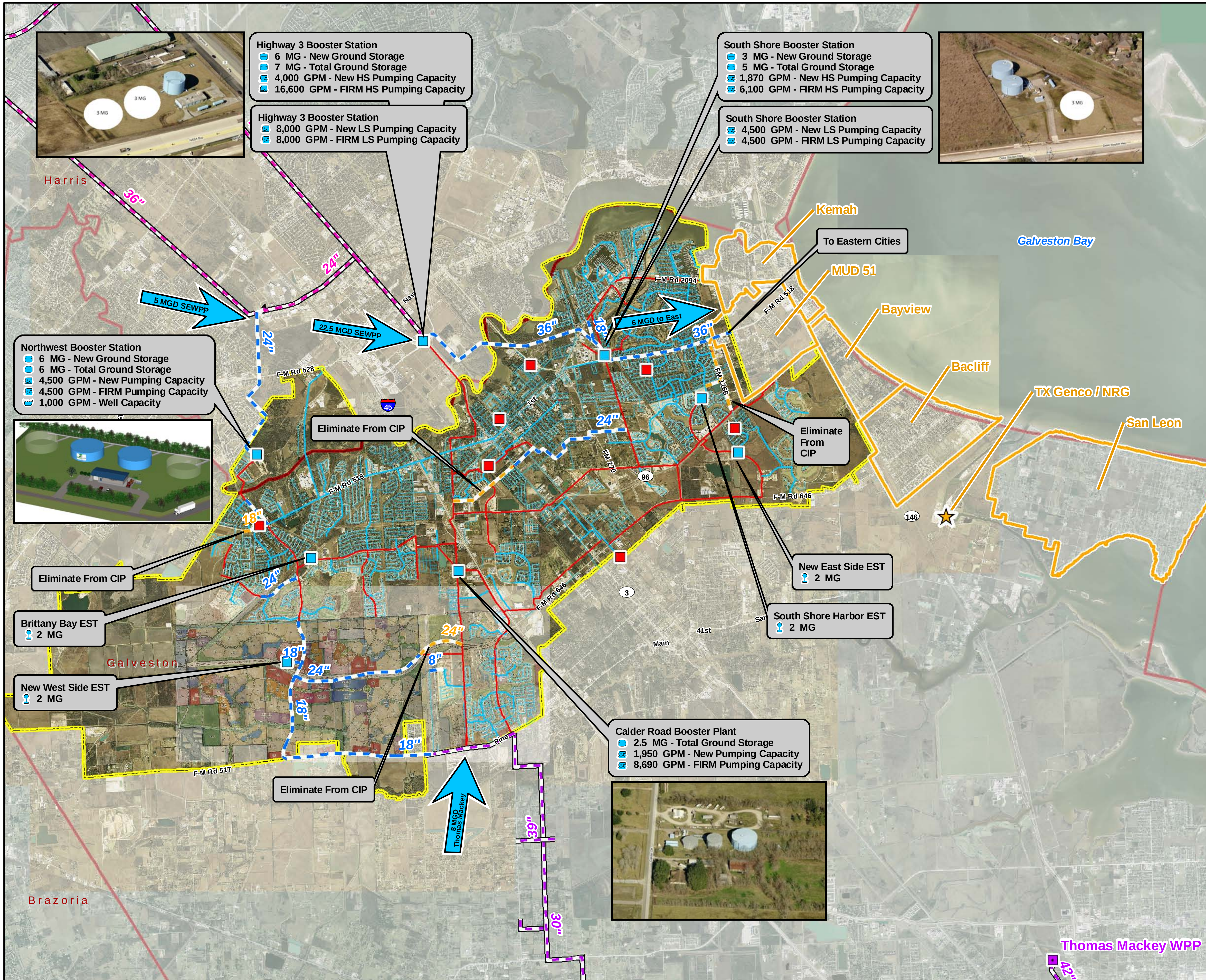

Figure 6-2

2020 Scenario with Water Swap (Phase I)

City of League City, Texas
Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Inactive Facility
- Pump
- Ground Storage
- Elevated Storage
- Well

Improvements

- New Line
- Remove from CIP
- Thomas Mackey WPP
- Thomas Mackey Line
- SEWPP Line (Approx.)
- Gulf Coast Water Authority Customer
- Gulf Coast Water Authority Customer

Water Line (2010)

- 16" - 60"
- 10" - 12"
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

0 4,000 8,000
Feet

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Project Title	Approximate Length (ft)	Diameter (in)	Purpose
Line - SH3 BS to South Shore BS	17,200	36	System redundancy
Beamer Rd 24" WL Extension	16,000	24	New connection point with SEWPP
Line Along Brittany Bay Blvd	2,700	24	Looping of transmission lines
Line - Cross Colony to Mary Lane	1,600	8	Looping of transmission lines
Line - FM 518 to Alderwood	3,000	24	Looping of transmission lines
Line - SSH Plant to FM 2094	3,800	18	Looping of transmission lines
Line - Walker Plant to Louisiana	17,500	24	Looping of transmission lines
Line to New West Elevated Storage Tank	1,300	18	Future development
New Water Lines to the West Side	15,000	24	Future development
Trunk Lines along Bay Area Boulevard	23,500	18	Future development
36" Line from South Shore to Eastern Cities	10,000	36	Transfer responsibilities as purveyor

Table 6-5
Recommended Pipeline Projects for 2020 Scenario with Water Swap

Project Title	Existing Storage Capacity (MG)	Proposed Storage Capacity (MG)	Additional Tank Volume (MG)
SH3 BS - Phase I	1	7	6
Northside BS - Phase I	n/a	6	6
South Shore Harbor BS - Phase I	2	5	3
New East Side Elevated	n/a	2	2
New West Side Elevated Tank	n/a	2	2

Table 6-6
Recommended Storage Projects for 2020 Scenario with Water Swap

Project Title	Existing Firm Pumping Capacity (gpm)	Proposed Firm Pumping Capacity (gpm)	Additional Proposed Pumping Capacity (gpm)
SH3 BS - Phase I	HS-12,600	HS-16,600 LS-8,000	HS-4,000 LS-8,000
South Shore Harbor BS - Phase I	HS-4,230	HS-6,100 LS-4,500	HS-1,870 LS-4,500
Northside BS - Phase I	n/a	4,500	4,500
Calder Rd BS - Phase I	6,740	8,690	1,950

Table 6-7
Recommended Booster Station Projects for 2020 Scenario with Water Swap

An additional 6 MGD of water is shown at both the SEWPP and Mackey Plant connections. Based on the conditions of a possible water swap, the City would be a water purveyor supplying 6 MGD from the City of Houston SEWPP connection point to the eastern cities and MUDs through a low service pump station and transmission pipeline from South Shore BS along FM 518 to Kemah. This transmission alignment is preliminary and should be assessed in preliminary design if selected due to the level of development along FM 518. In exchange for supplying GCWA customers, the City would receive 6 MGD of source water from GCWA at the Calder Road connection point to supply the City's demand. It is clear that the "water swap" scenario would be mutually beneficial to both the City and GCWA and therefore cost sharing opportunities may exist that should be explored upon further project development.

The current CIP pipelines projects recommended for elimination are also identified on **Figure 6-2**. **Figure 6-2** illustrates a schematic layout for future ground storage at each booster station facility. Detailed description of each recommended CIP project along with cost estimates and reference figures can be found in **Appendix D**.

6.4 Buildout Scenario with City of Houston Source Water

The recommended pipeline, storage and high and low service booster station capacity upgrade projects for the buildout scenario with all additional source water supplied from the SEWPP are outlined below in **Table 6-8** to **Table 6-10** respectively. **Figure 6-3** and **Appendix C** illustrates the location of these projects. The figure shows the water sources and quantities used in this scenario.

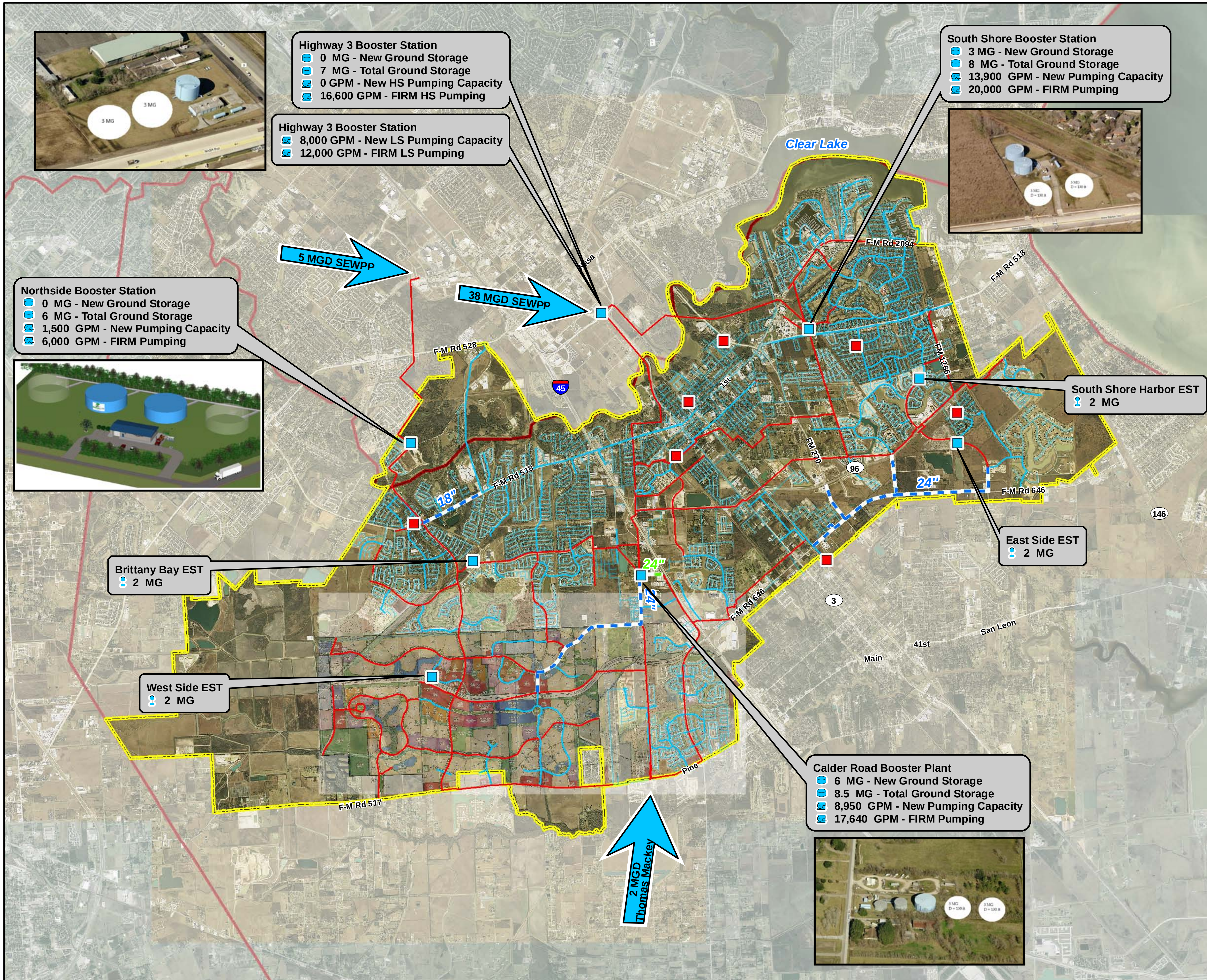

Figure 6-3

Buildout Scenario with Additional 21.5 MGD from SEWPP

City of League City Texas
Water Master Plan 2011

Facility

- Incoming Flow
- Booster Station
- Inactive Facility
- Pump
- Ground Storage
- Elevated Storage

Improvements

- Upsize
- New Line

Water Line (2010)

- 16" - 60"
- 10" - 12"
- League City City Limit

Imagery provided by HGAC - 2006

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Project Title	Approximate Length (ft)	Diameter (in)	Purpose
Line - Bay Area to Palomino along Main Street	4,700	18	Decrease pipeline velocities / future development
Line - Calder Road to I-45	1,600	24	Decrease pipeline velocities
Southeast Service Area Trunks	11,000	24	Future development
Line - Calder BS to South West Development	7,200	24	Future development
Line - North-South Line in SW Development	1,400	24	Future development

Table 6-8
Recommended Pipeline Projects for Buildout Scenario with City of Houston Source Water

Project Title	2020 Storage Capacity (MG)	Proposed Storage Capacity (MG)	Additional Tank Volume (MG)
Calder BS - Phase II	2.5	8.5	6
South Shore Harbor BS – Phase II	5	8	3

Table 6-9
Recommended Storage Projects for Buildout Scenario with City of Houston Source Water

Project Title	2020 Firm Pumping Capacity (gpm)	Proposed Firm Pumping Capacity (gpm)	Additional Proposed Pumping Capacity (gpm)
South Shore Harbor BS - Phase II	6,100	20,000	13,900
Calder BS - Phase II	8,690	17,640	8,950
Northside BS - Phase II	4,500	6,000	1,500
SH3 BS – Phase II	HS-16,600 LS-4,000	HS-16,600 LS-12,000	LS-8,000

Table 6-10
Recommended Booster Station Projects for Buildout Scenario with City of Houston Source Water

As calculated in the supply evaluation, an additional 21.5 MGD based on the 2020 scenario requirements is necessary to meet buildout demand. The source water to supply the demand would be split between the SH3 BS and the South Shore Harbor BS. A total of 2 MGD would be supplied from the Mackey Plant, 5 MGD from the Beamer Rd SEWPP connection and 38 MGD from SEWPP at the SH3 BS, a portion of which would be pumped via a low-service pump station through a transmission line to the South Shore Harbor BS.

6.5 Buildout Scenario with GCWA Water Swap

The recommended pipeline, storage and booster station capacity upgrade projects for the buildout scenario with all additional source water supplied from the SEWPP are outlined below in **Table 6-11** to **Table 6-13** respectively.

Project Title	Approximate Length (ft)	Diameter (in)	Purpose
Line - Bay Area to Palomino along Main Street	4,700	18	Decrease pipeline velocities
Southeast Service Area Trunks	11,000	24	Decrease pipeline velocities
Line - Calder BS to South West Development	7,200	24	Future development
Line - North-South Line in SW Development	1,400	24	Future development

Table 6-11
Recommended Pipeline Projects for Buildout Scenario with Water Swap

Project Title	2020 Storage Capacity (MG)	Proposed Storage Capacity (MG)	Additional Tank Volume (MG
Calder BS - Phase II	2.5	8.5	6
South Shore Harbor BS – Phase II	5	8	3

Table 6-12
Recommended Storage Projects for Buildout Scenario with Water Swap

Project Title	2020 Firm Pumping Capacity (gpm)	Proposed Firm Pumping Capacity (gpm)	Additional Proposed Pumping Capacity (gpm)
South Shore Harbor BS - Phase II	HS-6,100 LS-4,500	HS-12,000 LS-7,500	HS-5,900 LS-3,000
Calder BS - Phase II	8,690	24,950	16,260
Northside BS - Phase II	4,500	6,000	1,500
SH3 BS – Phase II	HS-16,600 LS-8,000	HS-16,600 LS-20,000	LS-12,000

Table 6-13
Recommended Booster Station Projects for Buildout Scenario with Water Swap

Figure 6-4 and **Appendix C** illustrates the location of these projects. The figure shows the water sources and quantities used in this scenario. This scenario adds to the 2020 Phase I GCWA water swap scenario. Phase II of this scenario includes an additional 5 MGD from GCWA at the Calder Road connection point, for a total of 13 MGD. Due to the City's buildout demand requirement of 45.0 MGD the additional 21.5 MGD must be supplied from the SEWPP at the SH3 BS connection. The only difference between this scenario and the other buildout scenario explained in **Section 6.2.4** is that 13 MGD would be coming from the Mackey Plant and 11 MGD of the water supplying South Shore Harbor BS would be pumped to the GCWA customers east of League City city limits.

6.6 Source Water Projects

As discussed in **Section 5.3**, additional raw water facilities, treatment facilities, and treated water conveyance facilities are necessary to satisfy the demand at buildout. Even if no additional source water is secured from the SEWPP, there will be additional costs for replacement of the 42-inch line from the SEWPP along SH3 to the SH3 BS.

Securing additional water through the SEWPP will require an expansion of the SEWPP as well as additional treated water conveyance capacity. Based on the complexity of this upgrade, it would be most advantageous and least expensive to perform the upgrade of this line at the same time it is being replaced as mentioned above. Costs for all these facilities are unique and explained in further detail in **Section 7**.

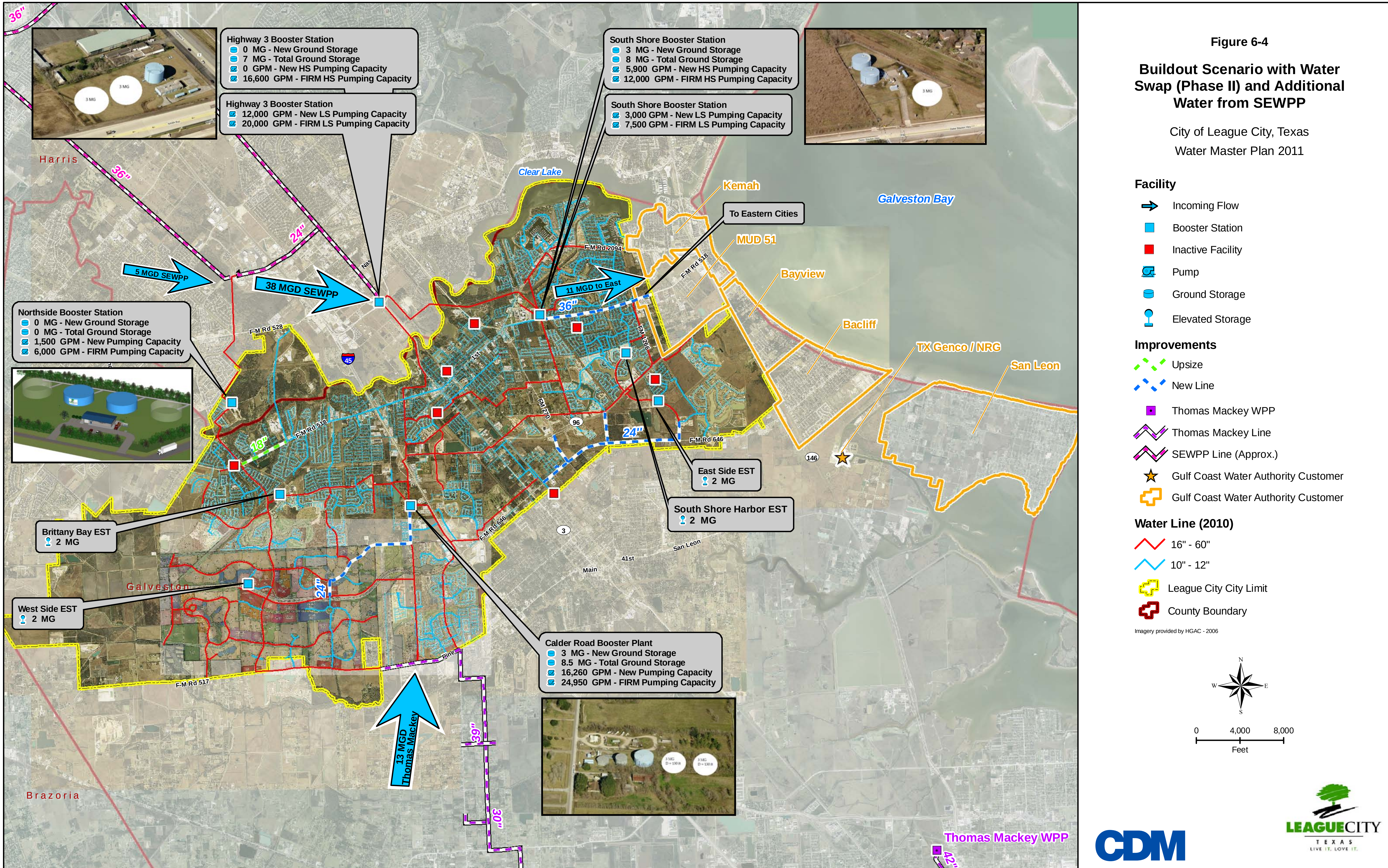


Figure 6-4

Buildout Scenario with Water Swap (Phase II) and Additional Water from SEWPP

City of League City, Texas
Water Master Plan 2011

Section 7
Recommended Plan

7.1 Development of Project Priority

To assist the City with project planning, the recommended CIP projects were separated into categories based on priority. The four priority levels indicate the urgency of a project for optimum impact on the water system. Priorities 1 and 2 are projects that are necessary by 2020 and Priorities 3 and 4 are projects that are needed for buildout conditions. Two separate alternatives have been presented in **Section 4** for each timeframe: one with water only from SEWPP or with a water swap with GCWA to supply their customers east of the City. Since the projects associated with each timeframe's alternatives are slightly different, the recommended prioritization for each alternative will be presented in the following subsections. It is recommended that the City perform a source water planning study to evaluate and determine the best water source identification alternative to meet the City's future water demand requirement.

7.1.1 2020 Projects

Priority 1 projects are the most urgent to complete by 2020. They have a significant impact on the system's redundancy and take the burden off of the main transmission line leading from SH3 BS for providing water to the majority of League City. The booster station improvements are also critical to meet the objective of decommissioning the minor water facilities.

Priority 2 projects are needed by 2020, however they are not as imperative to the basic functionality of the water system as Priority 1 projects. **Figure 7-1** and **Appendix E** shows the project prioritization for immediate need projects. The individual figures and project descriptions for all CIP projects can be found in **Appendix D**.

7.1.1.1 2020 Projects – No Additional Source Water

Table 7-1 shows the Priority 1 water facility projects recommended for the 2020 scenario with no additional source water.

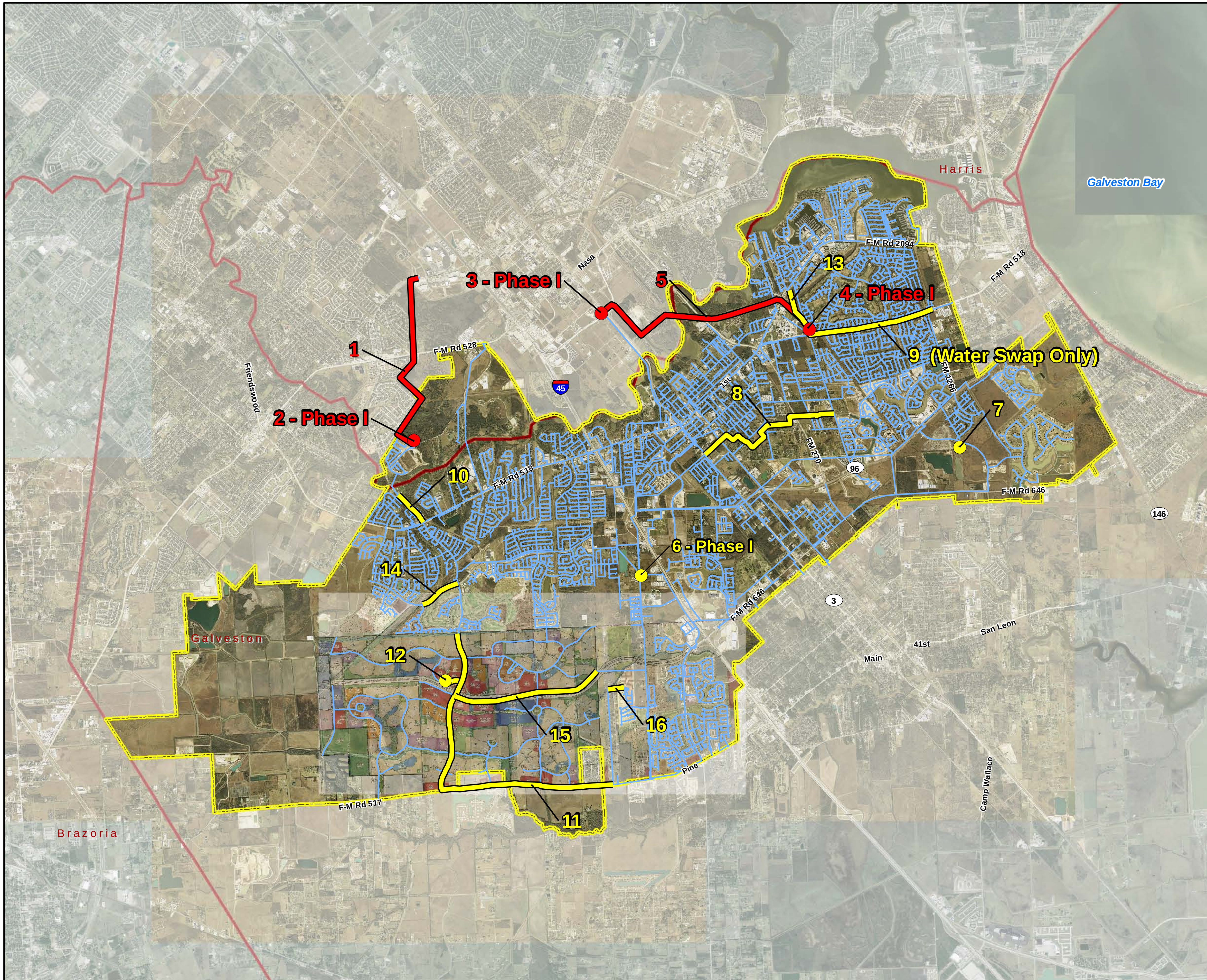
Project Title		Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 BS Phase I Upgrade	6	HS-4,000 LS-4,000	$15,120,000
2	South Shore Harbor BS Phase I Upgrade	3	1,870	$8,800,000
3	Northside BS Phase I	6	4,500	$7,600,000
Total Cost				**$31,520,000**

Table 7-1
Priority 1 Facility Projects for 2020 Scenario with No New Water

Figure 7-1

Prioritization for Immediate CIP Projects

City of League City, Texas
Water Master Plan 2011



CIP Projects

- Priority 1 - For 2020
- Priority 2 - For 2020
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

	Projects	Priority
1	Beamer Road 24" Water Line Extension	Priority 1 - For 2020
2	Northside (Beamer Rd) Booster Plant Improvements - Phase I	Priority 1 - For 2020
3	Highway 3 Booster Plant Improvements - Phase I	Priority 1 - For 2020
4	South Shore Booster Plant Improvements - Phase I	Priority 1 - For 2020
5	New 36" Line - Highway 3 to South Shore	Priority 1 - For 2020
6	Calder Road Booster Plant Improvements - Phase I	Priority 2 - For 2020
7	New East Side Elevated Storage Tank	Priority 2 - For 2020
8	Trunk Line - Walker Plant to Louisiana	Priority 2 - For 2020
9	New 36" Line - South Shore to Eastern CIties	Priority 2 - For 2020
10	New 24" Distribution Line - FM 518 to Alderwood	Priority 2 - For 2020
11	New 18" Trunk Line - Bay Area Boulevard	Priority 2 - For 2020
12	New West Side EST & 18" Line to Project 11	Priority 2 - For 2020
13	New 18" Trunk Line - SSH Plant to FM 2094	Priority 2 - For 2020
14	New 24" Water Line along League City Parkway	Priority 2 - For 2020
15	New 24" Water Lines to West Side	Priority 2 - For 2020
16	New 8" Line - Cross Colony to Mary Lane	Priority 2 - For 2020

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Table 7-2 shows the Priority 1 water pipeline projects recommended for the 2020 scenario with no additional source water.

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	36" Line from SH3 Take Point to SSH BS	17,200	36	$10,930,000
2	Beamer Rd 24" WL Extension	16,000	24	$1,800,000
Total Cost				**$12,730,000**

Table 7-2
Priority 1 Pipeline Projects for 2020 Scenario with No New Water

Table 7-3 shows the Priority 2 water facility projects recommended for the 2020 scenario with no additional source water.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Calder BS Phase I Upgrade	-	1,950	$5,810,000
2	New East Side Elevated	2	-	$3,000,000
3	New West Side Elevated Tank	2	-	$3,000,000
Total Cost				**$11,810,000**

Table 7-3
Priority 2 Facility Projects for 2020 Scenario with No New Water

Table 7-4 shows the Priority 2 water pipeline projects recommended for the 2020 scenario with no additional source water.

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	18" Line to New West Elevated Storage Tank	1,300	18	$380,000
2	24" Line Parallel to League City Parkway	2,700	24	$1,600,000
3	8" Line from Cross Colony to Mary Ln	1,600	8	$230,000
4	24" Distribution Line - FM518 to Alderwood	3,000	24	$835,000
5	New Water Lines to the West Side	15,000	24	$5,610,000
6	Trunk Line from SSH BS to FM2094	3,800	18	$700,000
7	Trunk Line from Walker WS to Louisiana	17,500	24	$4,000,000
8	Trunk Lines along Bay Area Boulevard	23,500	18	$3,500,000
Total Cost				**$16,855,000**

Table 7-4
Priority 2 Pipeline Projects for 2020 Scenario with No New Water

7.1.1.2 2020 Projects – GCWA Water Swap

Table 7-5 shows the Priority 1 water facility projects recommended for the 2020 scenario with the GCWA 6 MGD water swap.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 BS Phase I Upgrade	6	HS-4,000 LS-8,000	$16,340,000
2	South Shore Harbor BS Phase I Upgrade	3	HS-1,870 LS-4,500	$10,740,000
3	Northside BS Phase I	6	4,500	$7,600,000
Total Cost				**$34,680,000**

Table 7-5
Priority 1 Facility Projects for 2020 Scenario with Water Swap

Table 7-6 shows the Priority 1 water pipeline projects recommended for the 2020 scenario with the water swap for 6 MGD.

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	36" Line from SH3 Take Point to SSH BS	17,200	36	$10,930,000
2	Beamer Rd 24" WL Extension	16,000	24	$1,800,000
Total Cost				**$12,730,000**

Table 7-6
Priority 1 Pipeline Projects for 2020 Scenario with Water Swap

Table 7-7 shows the Priority 2 water facility projects recommended for the 2020 scenario with the GCWA 6 MGD water swap.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Calder BS Phase I Upgrade	-	1,950	$5,810,000
2	New East Side Elevated	2	-	$3,000,000
3	New West Side Elevated Tank	2	-	$3,000,000
Total Cost				**$11,810,000**

Table 7-7
Priority 2 Facility Projects for 2020 Scenario with Water Swap

Table 7-8 shows the Priority 2 water pipeline projects recommended for the 2020 scenario with the water swap for 6 MGD.

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	18" Line to New West Elevated Storage Tank	1,300	18	$380,000
2	24" Line Parallel to League City Parkway	2,700	24	$1,600,000
3	8" Line from Cross Colony to Mary Ln	1,600	8	$230,000
4	24" Distribution Line - FM518 to Alderwood	3,000	24	$835,000
5	New Water Lines to the West Side	15,000	24	$5,610,000
6	Trunk Line from SSH BS to FM2094	3,800	18	$700,000
7	Trunk Line from Walker WS to Louisiana	17,500	24	$4,000,000
8	Trunk Lines along Bay Area Boulevard	23,500	18	$3,500,000
9	36" Line from South Shore to Eastern Cities	12,000	36	$6,330,000
Total Cost				**$23,185,000**

Table 7-8
Priority 2 Pipeline Projects for 2020 Scenario with Water Swap

7.1.2 Buildout Projects

Priority 3 projects are the most urgent to complete between 2020 and buildout. Priority 4 projects are needed by buildout, however they are not as imperative to the basic functionality of the water system as Priority 3 projects. **Figure 7-2** and **Appendix E** shows the project prioritization for buildout projects. Detailed figures for each project and project descriptions can be found in **Appendix D**. These priorities should be reassessed and updated on a regular basis depending on the timing of adding extra-territorial jurisdiction (ETJ) areas and the rate of development in the presently undeveloped areas in the southwest part of the City.

7.1.2.1 Buildout Projects – 21.5 MGD from SEWPP

Table 7-9 shows the Priority 3 water facility projects recommended for the buildout scenario with an additional 21.5 MGD from the SEWPP.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 Phase II Upgrade	-	LS-8,000	$3,280,000
2	South Shore Harbor BS Phase II Upgrade	3	13,900	$9,180,000
3	Calder Rd BS Phase II Upgrade	6	8,950	$11,210,000
Total Cost				**$23,670,000**

Table 7-9
Priority 3 Facility Projects for Buildout Scenario with Additional 21.5 MGD from SEWPP

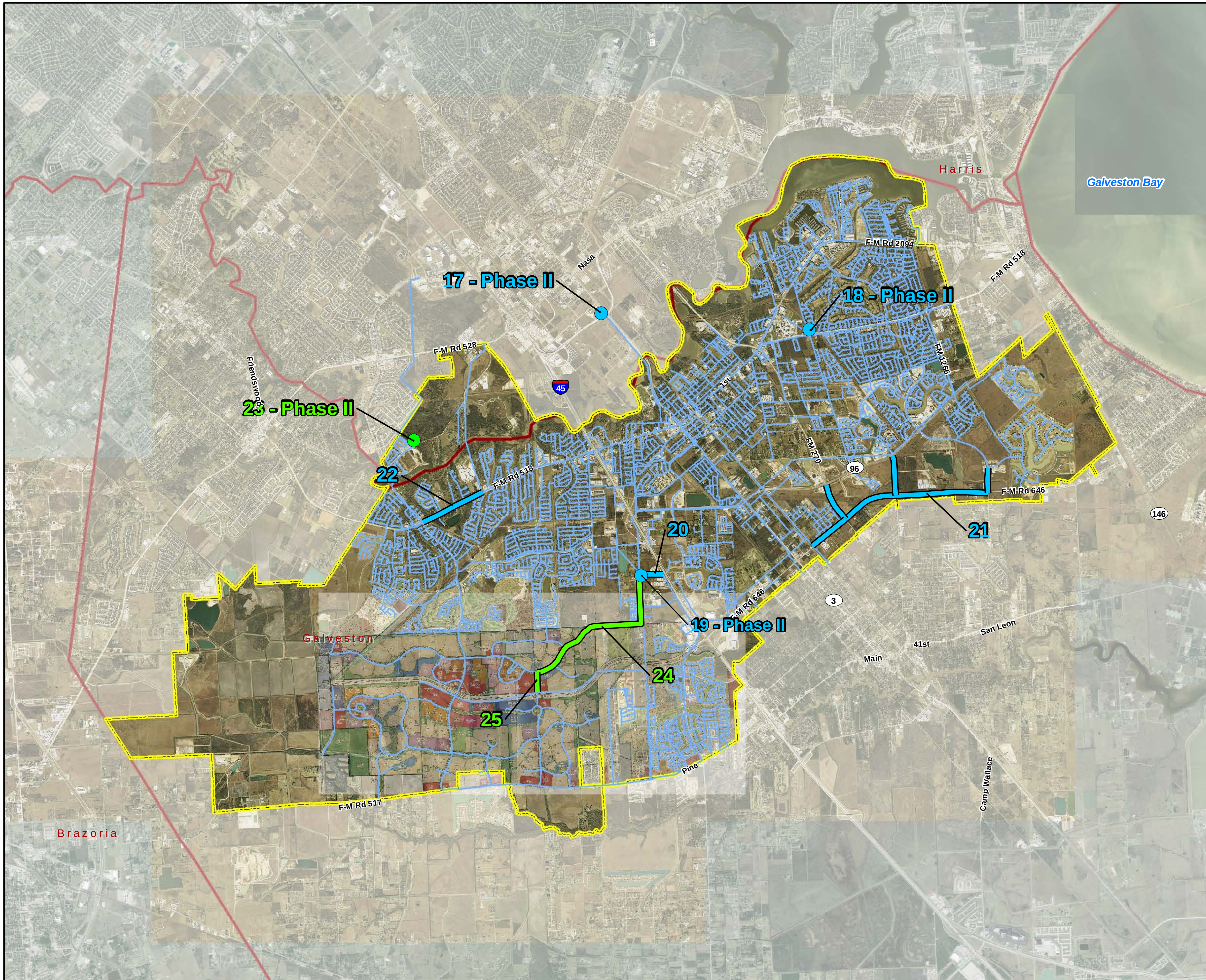

Figure 7-2

Prioritization for Buildout CIP Projects

City of League City, Texas

Water Master Plan 2011

CIP Projects

- Priority 3 - For Buildout
- Priority 4 - For Buildout
- Water Line
- League City City Limit
- County Boundary

Imagery provided by HGAC - 2006

Projects		Priority
17	Highway 3 Booster Plant Improvements - Phase II	Priority 3 - For Buildout
18	South Shore Booster Plant Improvements - Phase II	Priority 3 - For Buildout
19	Calder Road Booster Plant Improvements - Phase II	Priority 3 - For Buildout
20	Upsize to 24" - Calder Road to I-45	Priority 3 - For Buildout
21	New 24" Trunk Lines - South East Service Area	Priority 3 - For Buildout
22	Upsize to 18" - Bay Area to Palomino along Main Street	Priority 3 - For Buildout
23	Northside (Beamer Rd) Booster Plant Improvements - Phase II	Priority 4 - For Buildout
24	New 24" Line - Calder Booster Plant to South West Development	Priority 4 - For Buildout
25	New 24" Line - North/South Line in South West Development	Priority 4 - For Buildout

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Table 7-10 shows the Priority 3 water pipeline projects recommended for the buildout scenario with an additional 21.5 MGD from the SEWPP.

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	Line from Bay Area to Palomino on Main St	4,700	18	$1,360,000
2	24" Line from Calder BS to East	1,600	24	$596,000
3	Southeast Service Area Trunks	11,000	24	$4,150,000
Total Cost				**$6,106,000**

Table 7-10
Priority 3 Pipeline Projects for Buildout Scenario with Additional 21.5 MGD from SEWPP

Table 7-11 shows the Priority 4 water facility projects recommended for the buildout scenario with an additional 21.5 MGD from the SEWPP.

	Project Title	Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Northside BS Phase II Upgrade	1	1,500	$1,730,000
Total Cost				$1,730,000

Table 7-11
Priority 4 Facility Projects for Buildout Scenario with Additional 21.5 MGD from SEWPP

Table 7-12 shows the Priority 4 water pipeline projects recommended for the buildout scenario with an additional 21.5 MGD from the SEWPP.

	Project Title	Length (ft)	Diameter (in)	Total Cost
1	24" Line from Calder BS to SW Development	12,700	24	$4,760,000
2	24" North-South Line in SW Development	1,400	24	$524,000
Total Cost				**$5,284,000**

Table 7-12
Priority 4 Pipeline Projects for Buildout Scenario with Additional 21.5 MGD from SEWPP

7.1.2.2 Buildout Projects – GCWA Water Swap

Table 7-13 shows the Priority 3 water facility projects recommended for the buildout scenario with the water swap for 11 MGD and the remaining water from the SEWPP.

Project Title		Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	State Highway 3 Phase II Upgrade	-	LS-12,000	$3,830,000
2	South Shore Harbor BS Phase II Upgrade	3	HS-5,900 LS-3,000	$8,400,000
3	Calder Rd BS Phase II Upgrade	6	16,260	$12,800,000
Total Cost				**$25,030,000**

Table 7-13
Priority 3 Facility Projects for Buildout Scenario with Water Swap

Table 7-14 shows the Priority 3 water pipeline projects recommended for the buildout scenario with the water swap for 11 MGD and the remaining water from the SEWPP.

Project Title		Length (ft)	Diameter (in)	Total Cost
1	Line from Bay Area to Palomino on Main St	4,700	18	$1,360,000
2	Southeast Service Area Trunks	11,000	24	$4,150,000
Total Cost				**$5,510,000**

Table 7-14
Priority 3 Pipeline Projects for Buildout Scenario with Water Swap

Table 7-15 shows the Priority 4 water facility projects recommended for the buildout scenario with the water swap for 11 MGD and the remaining water from the SEWPP.

Project Title		Storage Added (MGD)	Pumping Added (gpm)	Total Cost
1	Northside BS Phase II Upgrade	-	1,500	$1,730,000
Total Cost				**$1,730,000**

Table 7-15
Priority 4 Facility Projects for Buildout Scenario with Water Swap

Table 7-16 shows the Priority 4 water pipeline projects recommended for the buildout scenario with the water swap for 11 MGD and the remaining water from the SEWPP.

Project Title		Length (ft)	Diameter (in)	Total Cost
1	24" Line from Calder BS to SW Development	12,700	24	$4,760,000
2	24" North-South Line in SW Development	1,400	24	$524,000
Total Cost				**$5,284,000**

Table 7-16
Priority 4 Pipeline Projects for Buildout Scenario with Water Swap

7.2 Development of Costs

Planning level estimates of probable project costs for the identified capital improvement plan projects were categorized two different ways: pipelines and water facility upgrades. The pipeline costs were determined using a standard unit cost for the appropriate diameter. The pipeline unit costs can be seen in **Table 7-17**.

Diameter	Inclusive Cost Per Foot
8"	$100
10"	$120
12"	$140
18"	$200
24"	$260
30"	$350
36"	$440

Table 7-17
Unit Costs for Pipeline Construction

The facility costs were determined using prices from recent comparable projects. For both facilities and pipelines, the costs include the following:

- ***Building Permit, General Liability Insurance, and Bonds*** – 3.5 percent.
- ***General Construction Conditions*** – 6 percent.
- ***Contingency*** – 25 percent of the total construction raw cost. This item covers unanticipated work that will be needed by the Contractor to complete the project.
- ***Engineering and Professional Services*** – 15 percent of the total construction cost. This covers the preliminary engineering and final design work required for the project.

The intended use of this type of estimate is for planning purposes and for comparing alternatives. Costs are given in 2011 dollars without escalation. Cost escalation can be incorporated into future detailed cost estimates. The final cost of any project will depend on the project complexity, actual labor and material costs, competitive market condition, actual site conditions, final scope of work, implementation schedule, continuity of personnel, and engineering.

7.2.1 2020 Projects

7.2.1.1 2020 Projects – No New Water

Table 7-19 summarizes the costs for the Priority 1 projects for the 2020 scenario with no additional water.

Project Title		Total Cost
1	Beamer Rd 24" WL Extension	$1,800,000
2	Northside BS Phase I	$7,600,000
3	State Highway 3 BS Phase I Upgrade	$15,120,000
4	South Shore Harbor BS Phase I Upgrade	$8,800,000
5	36" Line from SH3 Take Point to SSH BS	$10,930,000
Total Cost		**$44,250,000**

Table 7-18
Priority 1 Project Costs for 2020 Scenario with No New Water

Table 7-20 summarizes the costs for the Priority 2 projects for the 2020 scenario with no additional water.

Project Title		Total Cost
1	Calder Rd BS Phase I Upgrade	$5,810,000
2	New East Side Elevated Storage Tank	$3,000,000
3	Trunk Line from Walker WS to Louisiana	$4,000,000
4	24" Distribution Line - FM518 to Alderwood	$835,000
5	Trunk Lines along Bay Area Boulevard	$3,500,000
6	New West Side EST & 18" Line to Bay Area Blvd	$4,690,000
7	Trunk Line from SSH BS to FM2094	$700,000
8	24" Line Along Brittany Bay Blvd	$1,600,000
9	New Water Lines to the West Side	$5,610,000
10	8" Line from Cross Colony to Mary Ln	$230,000
Total Cost		**$29,975,000**

Table 7-19
Priority 2 Project Costs for 2020 Scenario with No New Water

7.2.1.2 2020 Projects – GCWA Water Swap

Table 7-21 summarizes the costs for the Priority 1 projects for the 2020 scenario with the water swap of 6 MGD.

Project Title		Total Cost
1	Beamer Rd 24" WL Extension	$1,800,000
2	Northside BS Phase I	$7,600,000
3	State Highway 3 BS Phase I Upgrade	$16,340,000
4	South Shore Harbor BS Phase I Upgrade	$10,740,000
5	36" Line from SH3 Take Point to SSH BS	$10,930,000
Total Cost		**$47,410,000**

Table 7-20
Priority 1 Project Costs for 2020 Scenario with Water Swap

Table 7-22 summarizes the costs for the Priority 2 projects for the 2020 scenario with the water swap of 6 MGD.

Project Title		Total Cost
1	Calder Rd BS Phase I Upgrade	$5,810,000
2	New East Side Elevated Storage Tank	$3,000,000
3	Trunk Line from Walker WS to Louisiana	$4,000,000
4	36" Line - South Shore to Eastern Cities	$6,330,000
5	24" Distribution Line - FM518 to Alderwood	$835,000
6	Trunk Lines along Bay Area Boulevard	$3,500,000
7	New West Side EST & 18" Line to Bay Area Blvd	$4,690,000
8	Trunk Line from SSH BS to FM2094	$700,000
9	24" Line Along Brittany Bay Blvd	$1,600,000
10	New Water Lines to the West Side	$5,610,000
11	8" Line from Cross Colony to Mary Ln	$230,000
Total Cost		**$36,305,000**

Table 7-21
Priority 2 Project Costs for 2020 Scenario with Water Swap

7.2.2 Buildout Projects

7.2.2.1 Buildout Projects – 21.5 MGD from SEWPP

Table 7-23 summarizes the costs for the Priority 3 projects for the buildout scenario with 21.5 MGD from the SEWPP.

Project Title		Total Cost
1	State Highway 3 Phase II Upgrade	$3,280,000
2	South Shore Harbor BS Phase II Upgrade	$9,180,000
3	Calder Rd BS Phase II Upgrade	$11,210,000
4	24" Line from Calder BS to East	$596,000
5	Southeast Service Area Trunks	$4,150,000
6	18" Line from Bay Area Blvd to Palomino on Main St	$1,360,000
Total Cost		**$29,776,000**

Table 7-22
Priority 3 Project Costs for Buildout Scenario with Additional 21.5 MGD from SEWPP

Table 7-24 summarizes the costs for the Priority 4 projects for the buildout scenario with 21.5 MGD from the SEWPP.

Project Title		Total Cost
1	Northside BS Phase II Upgrade	$1,730,000
2	24" Line from Calder BS to SW Development	$4,760,000
3	24" North-South Line in SW Development	$524,000
Total Cost		**$7,014,000**

Table 7-23
Priority 4 Project Costs for Buildout Scenario with Additional 21.5 MGD from SEWPP

7.2.2.2 Buildout Projects – GCWA Water Swap

Table 7-25 summarizes the costs for the Priority 3 projects for the buildout scenario with the water swap for 11 MGD and the remaining water from the SEWPP.

Project Title		Total Cost
1	State Highway 3 Phase II Upgrade	$3,830,000
2	South Shore Harbor BS Phase II Upgrade	$8,400,000
3	Calder Rd BS Phase II Upgrade	$12,800,000
4	24" Line from Calder BS to East	$596,000
5	Southeast Service Area Trunks	$4,150,000
6	18" Line from Bay Area Blvd to Palomino on Main St	$1,360,000
Total Cost		**$31,136,000**

Table 7-24
Priority 3 Project Costs for Buildout Scenario with Water Swap

Table 7-26 summarizes the costs for the Priority 4 projects for the buildout scenario with the water swap for 11 MGD and the remaining water from the SEWPP.

Project Title		Total Cost
1	Northside BS Phase II Upgrade	$1,730,000
2	24" Line from Calder BS to SW Development	$4,760,000
3	24" North-South Line in SW Development	$524,000
Total Cost		**$7,014,000**

Table 7-25
Priority 4 Project Costs for Buildout Scenario with Water Swap

7.3 Additional Source Water – Planning Level Cost Estimates

This section presents planning level cost estimates for the purchase of additional treated water to assist the City in project planning and development for each potential option. The cost for additional treatment capacity can be broken down into 3 parts: raw water facilities, treatment facilities and distribution facilities.

7.3.1 Replacement of Existing 42-Inch Supply Line from SEWPP

As previously discussed, the City of Houston is in the process of planning the replacement of the existing 42-inch treated water supply line that extends down SH3 from the SEWPP to the City's SH3 BS. The replacement costs will be shared with all the co-participants. It is unclear at this time if the line will be upsized for future capacity, who would pay for that capacity and how those costs would be shared with the other co-participants. According to the City of Houston, the replacement is imminent. As such, for the purposes of this report, we have tried to provide a basic planning level cost based on the following assumptions:

- The line size will be replaced with the same size line, i.e., no upsizing.
- New pipe material will be welded steel.
- The existing SH3 ROW is fully utilized. Therefore, additional ROW will be required. The additional/new ROW/easement costs are assumed to be 25% of the line cost.
- Pro-rata costs for the replacement line are assumed to be based on current capacity percentages in each line segment. The quantity percent shown is a weighted average over the entire length.

Costs for the replacement line are shown in **Table 7-26**.

Item No.		Quantity	Units	Unit Cost	Total Cost
1	42-inch Treated Water Line from SEWPP to SH3 BS	48%	40,900 LF	$600	$11,800,000
2	ROW/Easement Costs	25%	LS	$	$3,000,000
Subtotal					$14,800,000
City of Houston Management Fee (Required by Contract) – 20%					$3,000,000
Subtotal					$17,800,000
Contingency – 20%					$3,600,000
TOTAL					**$21,400,000**

Table 7-26
Share of SEWPP Line Replacement to be Paid by League City Planning Level Cost Estimates

7.3.2 Option 1 – Buy-Into Available SEWPP 40 MGD Capacity

To ensure sufficient source water as recommended in the CIP projects for buildout condition, the City will need to buy-into all or a portion of SEWPP's planned 40 MGD capacity before it is allocated to other customers. For this option, raw water facilities are already constructed and available for operation. The City would be charged the pro-rata cost of construction based on the capacity purchased plus interest for the raw water pumping and pipeline facilities. The treatment plant itself would require expansion of 40 MGD. Much of the required common infrastructure was included in the recent expansion from 120 MGD to 200 MGD, so the cost per gallon of the next 40 MGD should be lower than previous expansions. Lastly, the City will need to upsize the existing transmission line along SH3 or build a new transmission line to convey the additional 21.5 MGD from SEWPP to SH3 BS. Based on maintaining the existing maximum velocity, the line would need to be upsized from the existing 42-inch diameter to a 60-inch diameter line. The planning level cost estimate for all of the 40 MGD capacity is presented in **Table 7-27**. Should the City find other entities in need of SEWPP capacity, these figures could be used to calculate the City's pro-rata share.

Item No.		Quantity	Units	Unit Cost	Total Cost
1	Raw Water Infrastructure Capital Recovery	1	LS	$20,000,000	$20,000,000
2	SEWPP 40 MGD Expansion	40,000,000	GAL	$2.50	$100,000,000
3	60-Inch Treated Water Line from SEWPP to SH3 BS - (includes 25% ROW/Easement costs)	64%	40,900 LF	$1,000	$26,000,000
Subtotal					$146,000,000
City of Houston Management Fee (Required by Contract) – 20%					$29,000,000
Subtotal					175,000,000
Contingency – 20%					$35,000,000
TOTAL					**$210,000,000**

Table 7-27
Option 1 – Buy-into Available SEWPP 40 MGD Expansion Capacity
Planning Level Cost Estimates

7.3.3 Option 2 – Buy-into a SEWPP Future Expansion Project

If the City is unable to buy-into the SEWPP's 40 MGD expansion capacity that is currently available as outlined in Option 1, they will need to buy-into a future expansion project at a later date. The current master plan for the SEWPP indicates a site plan for an additional 120 MGD (360 MGD total). This option will require new construction and major upgrades to the source water pump station and transmission line from Coastal Water Authority (CWA) to the SEWPP. The treatment plant itself would require an expansion of 40 MGD. Because the next major planned expansion is for 120 MGD, some of the infrastructure will have to be sized for the full 120 MGD making the cost per gallon higher than previous expansions. Lastly, like Option 1 above, the City will need to upsize the existing transmission line along SH3 or build a new transmission line to convey the additional 21.5 MGD from SEWPP to SH3 BS. The planning level cost estimate in 2011 dollars for all 40 MGD capacity is presented in **Table 7-28**. Should the City find other entities in need of SEWPP capacity, these figures could be used to calculate the City's pro-rata share.

Item No.		Quantity	Units	Unit Cost	Total Cost
1	Raw Water Infrastructure Capital Recovery	1	LS	$40,000,000	$40,000,000
2	SEWPP 40 MGD Expansion	40,000,000	GAL	$3.50	$140,000,000
3	60-Inch Treated Water Line from SEWPP to SH3 BS - (includes 25% ROW/Easement costs)	64%	40,900 LF	$1,000	$26,000,000
Subtotal					$206,000,000
City of Houston Management Fee (Required by Contract) – 20%					$41,000,000
Subtotal					247,000,000
Contingency – 20%					$49,000,000
TOTAL					**$296,000,000**

Table 7-28
Option 2 – Buy-into a SEWPP's Future Expansion Project
Planning Level Cost Estimates