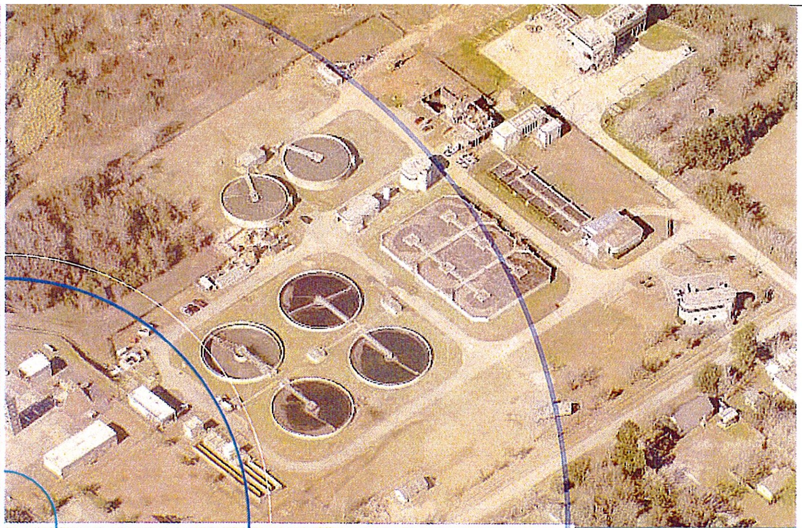

CITY OF LEAGUE CITY
WASTEWATER MASTER PLAN

VOLUME 1

STATE OF TEXAS
JEFFREY S. PETERS
86347
LICENSED
PROFESSIONAL ENGINEER

1-27-12

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January 2012

CDM Smith

City of League City

Wastewater Master Plan

January 2012

INSIDE COVER

Report

TBPE Firm Registration No. F-3043

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Executive Summary

The City of League City (City) has experienced tremendous residential, commercial and industrial growth in the past several years. The City is expected to continue to grow at an approximate 3.4% rate and more than double by the anticipated 2040 buildout year. This wastewater collection system model and master plan is the first significant update since 2002. One of the most significant improvements is the utilization of a dynamic model platform that can analyze time variation of flows and potential peak flow problems. In order to accurately identify any possible deficiencies and recommend future permanent wastewater system improvements, a major update to the wastewater model in a dynamic format and the wastewater master plan was necessary.

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

ES.1 Project Objectives

The specific project objectives are to provide the City with a comprehensive wastewater 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 wastewater system meets TCEQ requirements and other design criteria. This includes sewer line design, lift station capacity and adequate wastewater treatment plant capacity.

The remainder of the Executive Summary will provide a brief summary of the wastewater master plan report and the proposed recommendations.

ES.2 Project Approach

To simulate the City's wastewater system, a wastewater model was created using Bentley's SewerGEMS Sanitary V8i that incorporated GIS data provided by League City as the base model. Wastewater production scenarios were developed based on winter water billing data, existing and future population, existing wastewater flow data, and existing wastewater commitments. Meetings were held with City staff to ensure that connectivity issues were resolved accurately and existing problem areas were identified.

To validate the model, the existing scenario results were compared to wastewater treatment plant data for dry and wet weather to verify that the model was accurately representing the system. Additionally, all major gravity trunk lines greater than 15-inches in diameter were surveyed in the field to verify the pipe size and slopes in order to ensure the accuracy of the model.

ES.3 System Characterization and Performance

The existing wastewater collection system functions adequately under dry weather conditions. **Figure ES-1** shows how much capacity of each gravity line is used during the peak time of dry weather. Problems arise under wet weather conditions for several areas in the system. **Figure ES-2** shows how much capacity of each gravity line is used during the peak time of a 2-year 24-hour storm wet weather event. Specific information regarding the severity of the existing wet weather issues, including the magnitude of the corresponding rainfall event, was not available. The wet weather problems identified by the City of League City staff are in the following areas:

- Dallas Salmon WWTP gravity service area.
- Webster Lift Station service area (trailer park)
- Bayou Brae Lift Station service area
- East Main Lift Station service area, specifically the Glen Cove service area
- Butler Rd Lift Station service area, specifically Safari Lift Station (trailer park), Bay Colony MUD 14/15 Lift Station, and Clear Creek Village Lift Station

There are approximately 70 lift stations in League City, each with two or three pumps. The four largest lift stations are East Main, Smith Lane, Butler Road and Hewitt Road, all contributing flow to the Dallas Salmon WWTP sewershed. The other much smaller Countryside WWTP is scheduled for decommissioning after the Southwest Water Reclamation Facility is operational in late 2012. At this point the flows to Countryside WWTP will be redirected to Southwest Water Reclamation Facility.

ES.4 Scenario Development

The following outlines the future wastewater generation scenarios created from the base of recommended improvements:

- 2020 Dry Weather Scenario. This includes the average dry weather generation and infiltration anticipated in 2020.
- 2020 Wet Weather Scenario. This includes the average dry weather generation and infiltration anticipated in 2020 as well as wet weather inflow and infiltration from a 2-year, 24-hour storm.
- Buildout Dry Weather Scenario. This includes the average dry weather generation and infiltration anticipated in buildout.
- Buildout Wet Weather Scenario. This includes the average dry weather generation and infiltration anticipated in buildout as well as wet weather inflow and infiltration from a 2-year, 24-hour storm.

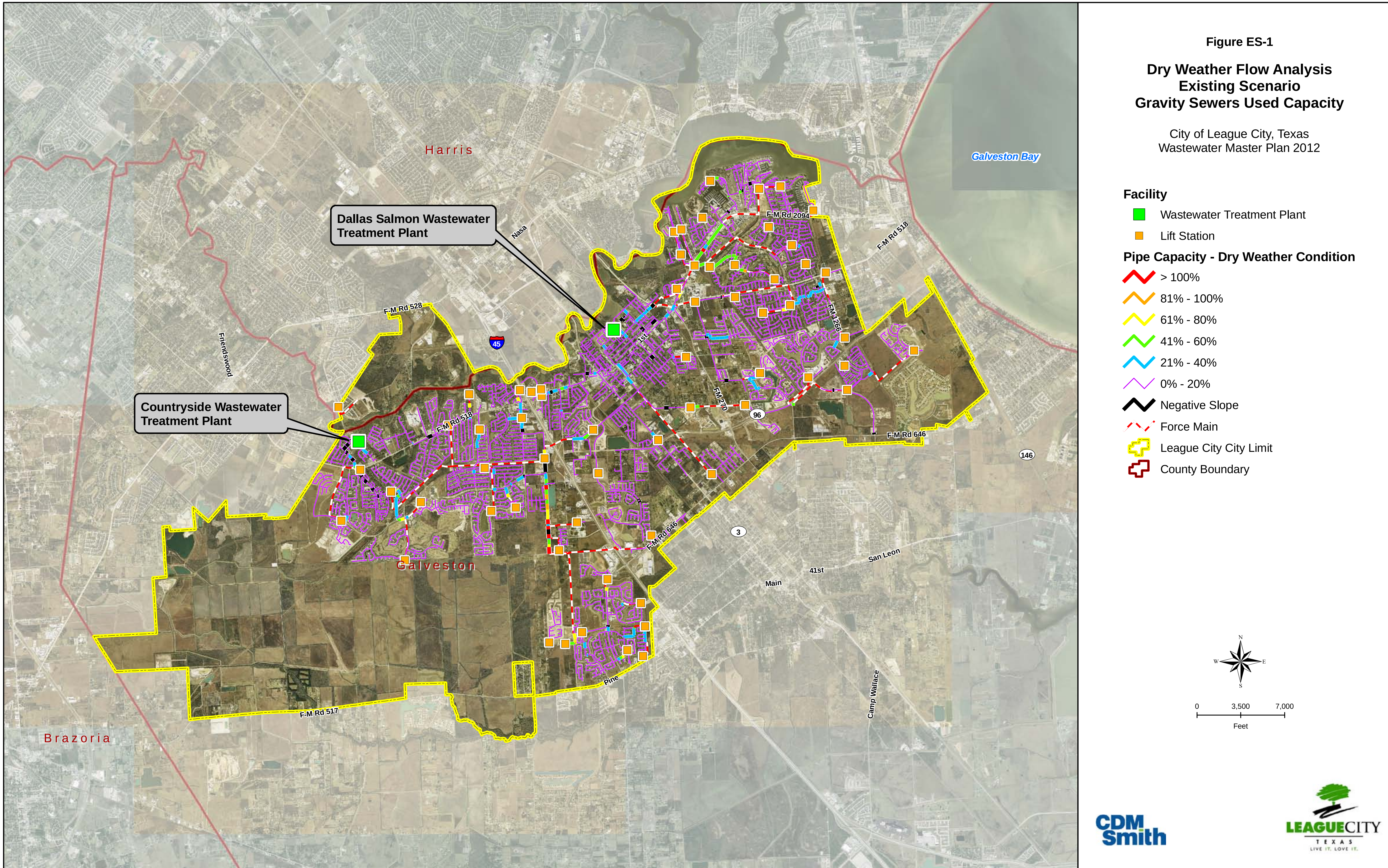

Figure ES-1

Dry Weather Flow Analysis
Existing Scenario
Gravity Sewers Used Capacity

City of League City, Texas
Wastewater Master Plan 2012

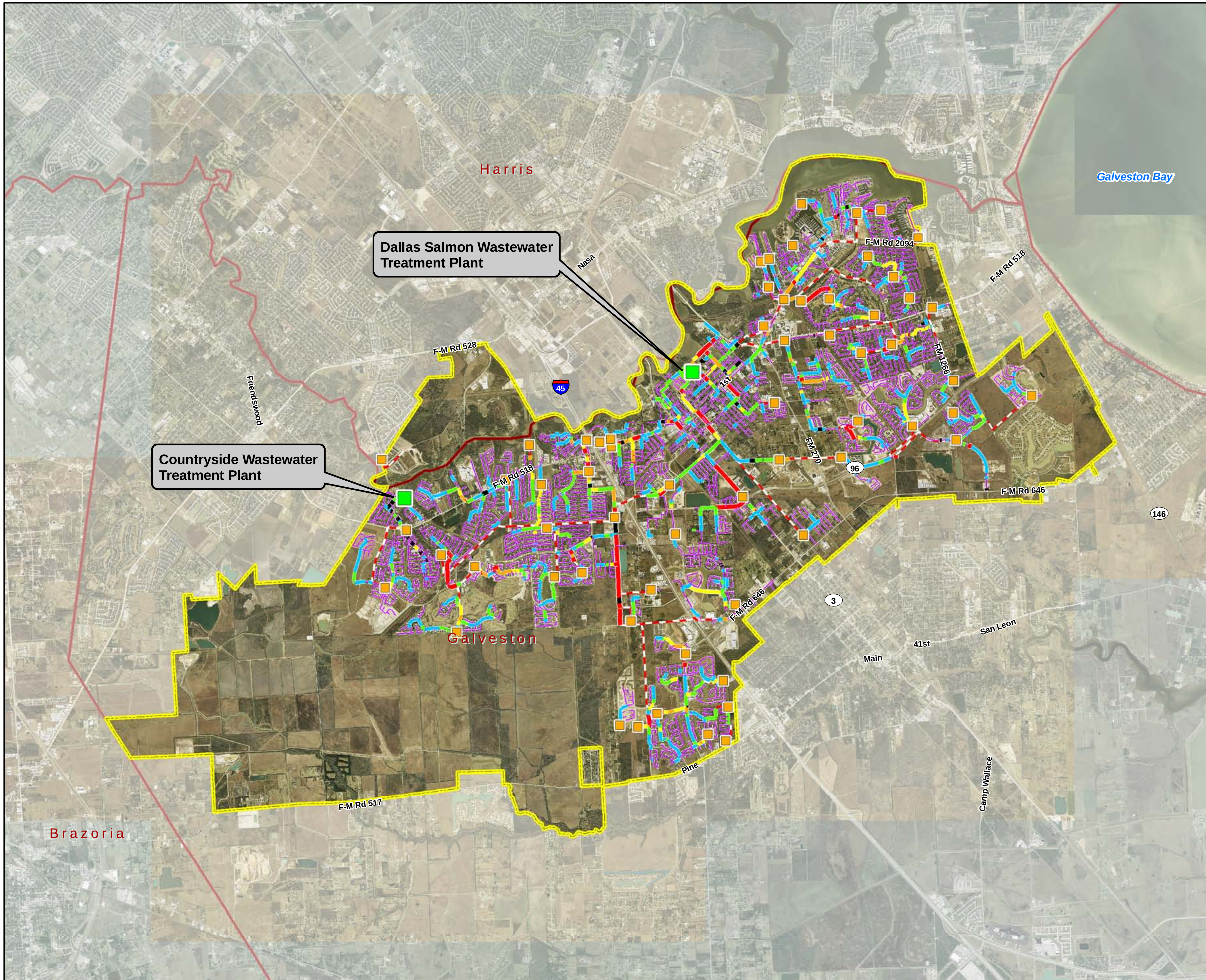

Figure ES-2

Wet Weather Flow Analysis
Existing Scenario
Gravity Sewers Used Capacity

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Wastewater Treatment Plant
- Lift Station

Pipe Capacity - Wet Weather Condition

- > 100%
- 81% - 100%
- 61% - 80%
- 41% - 60%
- 21% - 40%
- 0% - 20%
- Negative Slope
- Force Main
- League City City Limit
- County Boundary

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ES.5 Recommended Plan

ES.5.1 Development of CIP Projects

The developed scenarios results were analyzed based on established evaluation criteria. After identifying a problematic area during the peak dry or wet conditions, alternatives to alleviate overflows or surcharging in those areas were developed and evaluated utilizing the model. At the end of this analyses process, each scenario was ultimately able to operate with gravity lines at less than 80 percent capacity assuming each of the recommended alternatives were implemented.

Once all of the improvements projects needed to pass the 2020 and buildout wastewater flows were compiled, they were categorized based on prioritization. For the newly identified projects, planning level cost estimates were also created.

ES.5.2 Project Prioritization

The projects were categorized into four different levels of priority. **Table ES-1** details the evaluation criteria associated with each priority.

Priority Ranking	System Flow Condition	Criteria
Priority 1	All Conditions	Flow diversion to SWWRF
Priority 2	Wet Weather	Overflowing manholes
Priority 3	Dry Weather	Pipes surcharged
Priority 4	Wet Weather	Pipes surcharged

Table ES-1
Priority Ranking Criteria

Table ES-2 shows the identified CIP projects through ultimate buildout. Also shown are the planning level costs for each project as well as the scenario when the need for the project is first identified. **Figure ES-3** shows the prioritization for all the proposed CIP projects.

Project ID	Priority	Project Title	Recommended Scenario	Total Project Cost ($)
1	1	Divert Countryside WWTP, Countryside 1 LS and Westover Park LS to SWWRF	Existing[1]	$1,400,000 [5]
2	1	Divert Countryside 2 LS, Magnolia Creek North, and Magnolia Creek South to SWWRF	Existing[1]	$830,000 [5]
3	2	Bay Colony 14-15 LS Force Main	2020 [2]	$2,140,000

Table ES-2
CIP Projects Opinion of Probable Construction Cost

Project ID	Priority	Project Title	Recommended Scenario	Total Project Cost ($)
4	3	New Gravity Line along Calder Rd	Existing[1]	$5,180,000
5	4	Bypass gravity line from MH 6408 to MH 1040 with extended force main from Harbor Park 1 LS	Buildout[3]	$210,000
6	4	West Main LS and Force Main Improvement[4]	Buildout[3]	$1,580,000 [5]
7	4	New Hobbs Rd Lift Station and Force Main	Buildout[3]	$600,000 [5]

Notes:
1 CIP projects required to address deficiencies predicted in the Existing Scenario
2 CIP projects required to address deficiencies predicted in the 2020 Scenario
3 CIP projects recommended to address deficiencies predicted in Buildout Scenario (modeling did not assume an exact time frame for buildout analysis)
4 Engineering design has been completed
5 Costs developed by League City

Table ES-2
CIP Projects Opinion of Probable Construction Cost - Continued

ES.5.2 Wastewater Treatment Plant Expansions

Preliminary results from the buildout scenarios for the ultimate treatment flows at the two WWTPs are shown in **Table ES-3**. The average dry weather flows should not be confused with average daily flows (ADF) which will include some rain events. After analysis of the available historical flow data for the WWTPs, the estimated ADF was calculated by adding 20 percent to the projected average dry weather flow at buildout. This ADF value was then converted to a peak 2-hour flow using a peaking factor of 3.1 developed in the City's 2006 Wastewater Master Plan Update. No major WWTP expansions are necessary through the planning period ending in 2020.

Wastewater Treatment Plant	Average Dry Weather Flow	Estimated ADF[1]	Peak 2-Hour Flow[2]
Dallas Salmon Wastewater Treatment Plant	6,400 gpm (9.2 MGD)	7,700 gpm (11.1 MGD)	23,800 gpm (34.3 MGD)
Southwest Water Reclamation Facility	4,000 gpm (5.7 MGD)	4,800 gpm (6.9 MGD)	14,900 gpm (21.5 MGD)

Notes:
1 Calculated by adding 20% to Average Dry Weather Flow based on available historical WWTP flow data
2 Calculated by multiplying Estimated ADF by 3.1, the peaking factor used in the 2006 Wastewater Master Plan Update

Table ES-3
Flows Projected for WWTPs in Buildout Scenarios

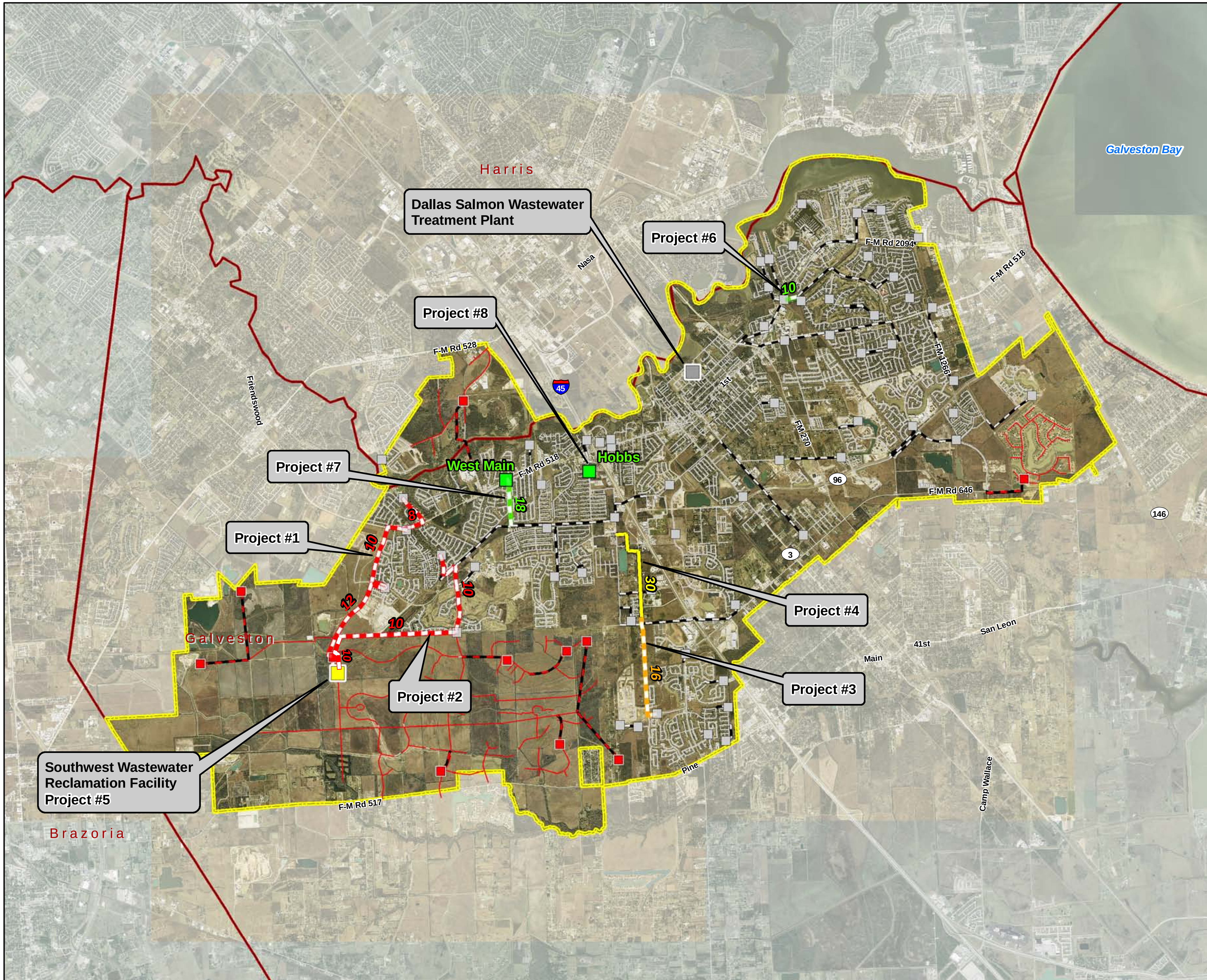

Figure ES-3

Prioritization for CIP Projects

City of League City, Texas
Wastewater Master Plan 2012

Wastewater Treatment Plant
- Priority 3
- No Improvement

Lift Station
- Priority 4
- No Improvement
- Future Lift Station

Gravity Line
- Priority 3
- No Improvement
- Future Development

Force Main
- Priority 1
- Priority 2
- Priority 4
- Future Force Main
- No Improvement
- League City City Limit
- County Boundary

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Section 1
Introduction

1.1 Project Background

The City of League City has experienced tremendous residential and commercial growth in the past several years and is expected to continue to grow. This wastewater collection system model and master plan is the first significant update since 2002. One of the most significant improvements over previous versions is the utilization of a dynamic model platform that can analyze time variation of flows and potential peak flow problems. In order to accurately identify any possible deficiencies and recommend permanent wastewater system improvements, a major update to the wastewater model in a dynamic format and the wastewater master plan is necessary.

1.2 Objective

The objective of this study is to provide recommendations for improvements to the City's wastewater system as required 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 based on the growth scenario provided by the City.

- Ensure that the wastewater system meets TCEQ requirements and recommendations. This includes sewer line design, lift station capacity and adequate wastewater treatment plant capacity.

1.3 Scope of Work

This study consists of the following tasks outlined below:

- Review of Historic Documents
- Wastewater Production and Projections
- Model Improvement and Update
- Model Verification
- Model Analysis
- Project Development

1.3.1 Review Historic Documents

Existing information and previous studies were reviewed to understand the existing wastewater system performance and the projected future system requirements.

The following data and reports were reviewed:

- Wastewater Master Plan 2001/2002 and Updated Wastewater Master Plan 2006;

- Locations in the existing wastewater system with hydraulic capacity issues as identified by City staff;

- Operation of SCADA operated lift stations run time data (one dry weather day and one wet weather day) and lift station pumping records (total flow pumped per month) and treatment plant effluent flow data (past 3 years of records);
- Survey data indicating the pipe size and elevation for major trunk gravity sewer lines (>15-inches);
- Existing City GIS system including gravity sewer and force mains for model conversion; and
- Previous Wastewater Collection System Hydra Model.

1.3.2 Wastewater Production and Projections

Wastewater production and future projections is one of the key aspects of a wastewater collection system model development. Wastewater production was estimated and allocated based on water billing data, existing and future population, existing wastewater flow data, and existing wastewater commitments. Usage was estimated based on the existing data and different user type: residential, commercial and industrial. Future wastewater production was based on City predicted development and future commitments. Based on information from the City planning staff, an ultimate build-out model scenario based on density and land use was developed. It is important to note that the same proposed growth model has been applied uniformly to both the wastewater and water master plans.

1.3.3 Model Improvement and Update

The model improvement activities included a comprehensive review of the existing model configuration and operation and incorporating modifications to reflect changes that have taken place in the system or system operations since the last master plan.

The overall objectives for the modeling include:

- Identifying areas of existing capacity and or minimum velocity concern.
- Identifying lift station system and collection system capacity and capability to deliver peak dry and weather flows with expected future growth.
- Identifying any operations concerns and recommendations.

The updated model will be capable of evaluating changes in projected wastewater production, and the impacts of improvements to the collection system. Operational improvements will be made to the model based on new data on operation of lift stations and treatment facilities and on improved wastewater production distribution, diurnal pattern assignments, physical layout, and peaking factors.

The steps include:

- Verifying the GIS system is updated and includes all wastewater service areas and any additional new wastewater sub-basins;
- Conducting an elevation data survey to obtain ground and sewer invert elevation data on major trunk gravity sewer lines;
- Building all facilities into the model and accurately representing their existing system operation;
- Appropriately distributing wastewater flows based on current wastewater production data and development of base wastewater flow, per capita flows and wet weather flow scenarios;
- Establishing an appropriate peaking factor using available operational data;
- Establishing an infiltration factor to be applied system wide;
- Identifying a diurnal demand pattern to accurately represent the variation in wastewater flow production throughout the day;
- Identifying a design storm and resulting hydrograph to accurately represent wet weather flow production; and
- Establishing existing and future scenarios within the model for identifying existing and future wastewater system needs.

1.3.4 Model Verification

Following the review of the model configuration and necessary modifications to model inputs, the hydraulic model was verified. The verification process is a result of data collected from the collection system that reflects actual operation. The data was used to compare model predictions to field conditions and to adjust model parameters such as, flow factors, rainfall-dependent infiltration/inflow (RDI/I) factors, pump operations, and wet weather peaking factors if necessary to better reflect the existing wastewater system operations and performance. An operational review with City staff was conducted to verify that the model results agree with the system's historical performance per their knowledge and experience.

1.3.5 Model Analysis

Model analysis includes a complete review of current conditions using the verified collection system model. These simulations will evaluate the behavior and adequacy of the system 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. The scenarios were evaluated to identify deficiencies within the City's wastewater infrastructure for existing and future wastewater flows. Capital Improvement Projects (CIP) were identified for use by the City in its planning process.

1.3.6 Project Development

The previous tasks that include historical data review, wastewater production and projections, model update, verification and analysis helped in generating a list of potential projects. Following the review of all the available documents, reports, data, and modeling results, final recommendations were developed. This task developed the recommended plan for system improvements, and how they will be incorporated into the City's CIP. Project costs and a CIP prioritization matrix were developed.

1.3.7 Data Sources

The data sources provided by the City of League City provided 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 water billing data for January, 2008 to May, 2010
- 2002 League City Wastewater Master Plan
- Population and commercial development projections from 2010 to 2020
- Land use projection for buildout scenario
- Identifying physical and operational information for all lift stations and wastewater treatment 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 reviewed.
- ***Section 2 – Service Area and Wastewater Flow Data Development***. This section reviews the available historical documents including population, land use and wastewater flow data. The development of wastewater flow production is briefly explained.
- ***Section 3 – Wastewater Infrastructure***. This section describes the existing wastewater infrastructure including the collection system, lift stations, and wastewater treatment plants.

- ***Section 4 – Hydraulic Model Development***. The model development process is explained in this section, with detailed information on model construction, assumptions, and verification. This section also discusses the existing and future/projected system's model performance. The modeling scenarios are also presented in this section.

- ***Section 5 – Evaluation Criteria and System Performance Assessment***. This section presents the planning and evaluation criteria used to evaluate the existing and projected system performance. The modeling results are presented for the modeling scenarios developed during the hydraulic model development.

- ***Section 6 – CIP Project Development***. This section explains the procedure used to identify the required CIP projects and provide recommendations 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.

1.4 Limitations of Study

The findings and recommendations contained in this study are valid as of the date of this report and based on the information referenced herein. Changes in the amount or patterns of growth within the study area, changes in wastewater flow generation, implementation of more detailed investigations, or changes in regulations may affect the conclusions and recommendations presented in this report. One such detailed investigation that should be considered in future master plans is the collection of flow and rainfall data across the collection system in order to create a more accurate model analyzing wet weather flow conditions. It is recommended that the future updates include adequate budget for the collection of wastewater flow and rainfall data.

Master plans such as this report should be thoroughly reviewed every five to ten years to determine if the assumptions and recommendations are still valid. For rapidly growing communities, such as League City, we recommend that at a minimum, the master plan should be reviewed every five years.

Section 2
Service Area and Wastewater Flow 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 30 feet above sea level in the undeveloped southwest corner of the City.

The City provides wastewater service to local customers only. The service area consists of residential, commercial and industrial developments as well as open space such as community parks, gold 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 southwest corner of the City.

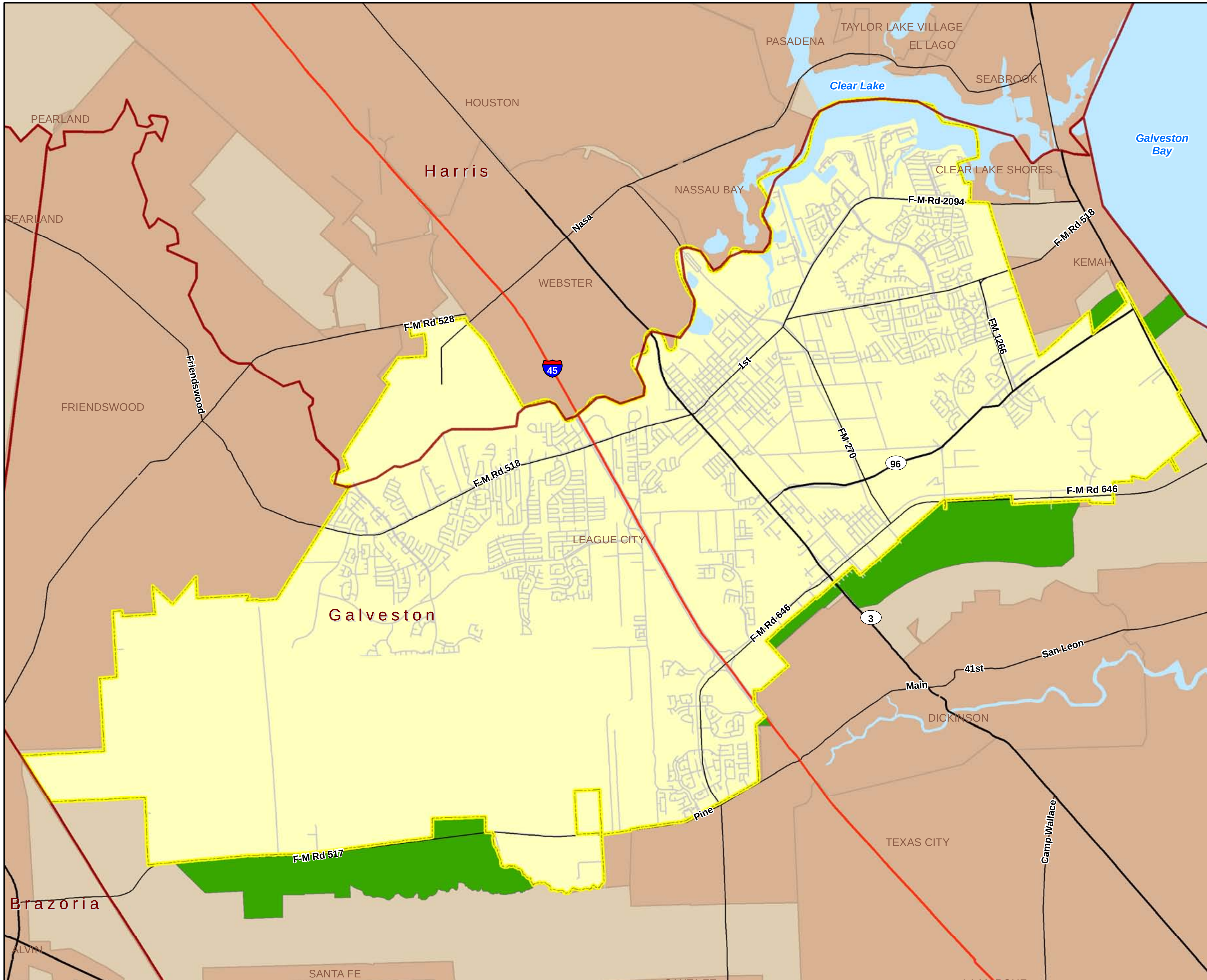
2.2 Population

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 wastewater master plan as the City's Comprehensive Plan. However, during the development of this wastewater 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 2008-2010 billing data that was then applied to future scenarios.

Figure 2-1

City of League City Location Map

City of League City, Texas
Wastewater Master Plan 2012



County Boundary
League City City Limit
League City ETJ
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

[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'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. 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 projections used in this study are 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 new development or maintain current land use by buildout. The future land use planning zones are shown in **Figure 2-2**, as provided by the City's 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.

	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**

Table 2-2
Residential Population Growth 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**

Table 2-3
Commercial Growth in Acres Projected Through 2020

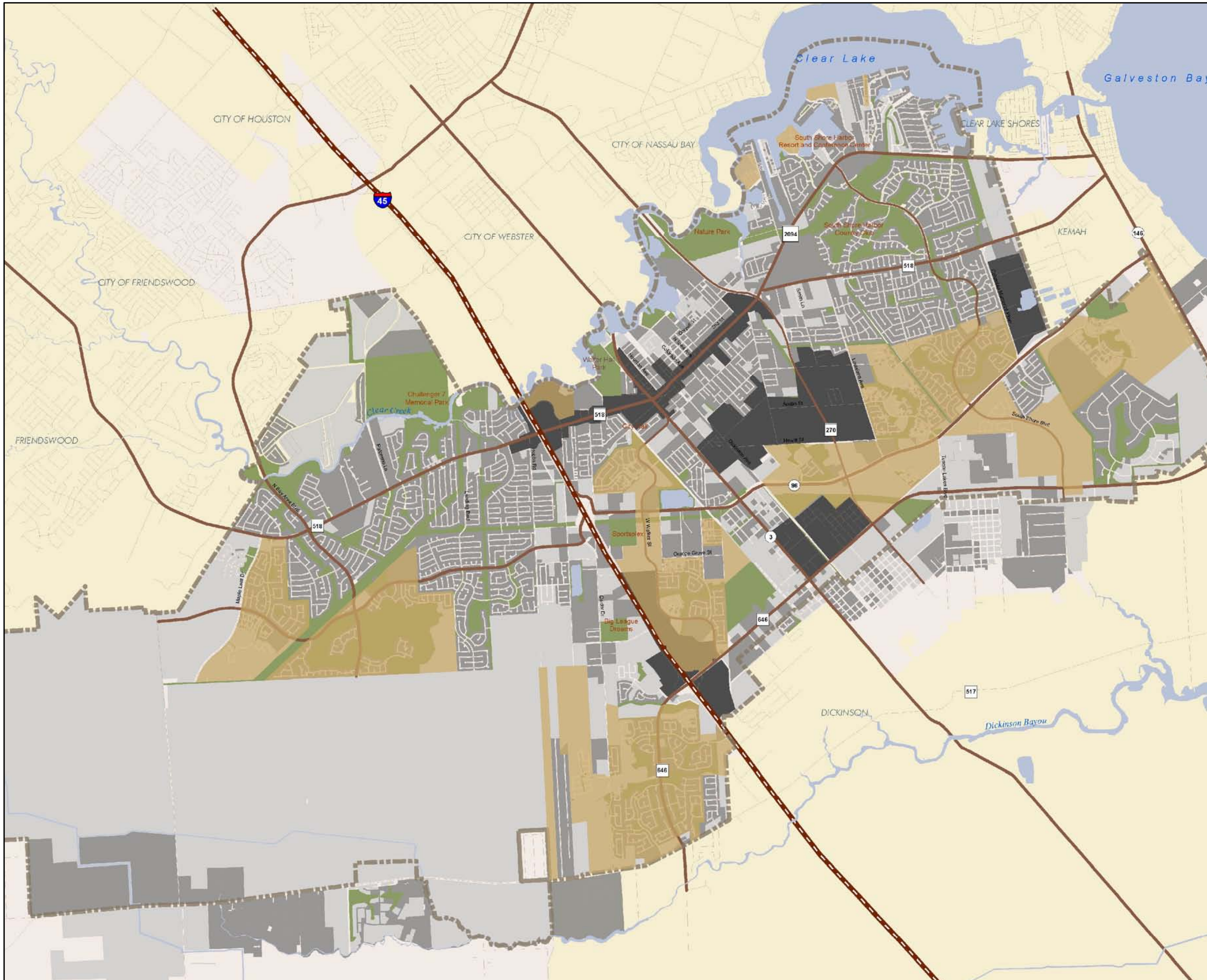


Figure 2-2

Future Development and Maintenance Areas of League City

City of League City, Texas
Wastewater Master Plan 2012

Redevelopment Areas

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

* Does not include Lloyd, McAlister, or Duncan Tracts

Redevelopment Areas provided by the League City Comprehensive Plan

0 3,000 6,000*
Feet

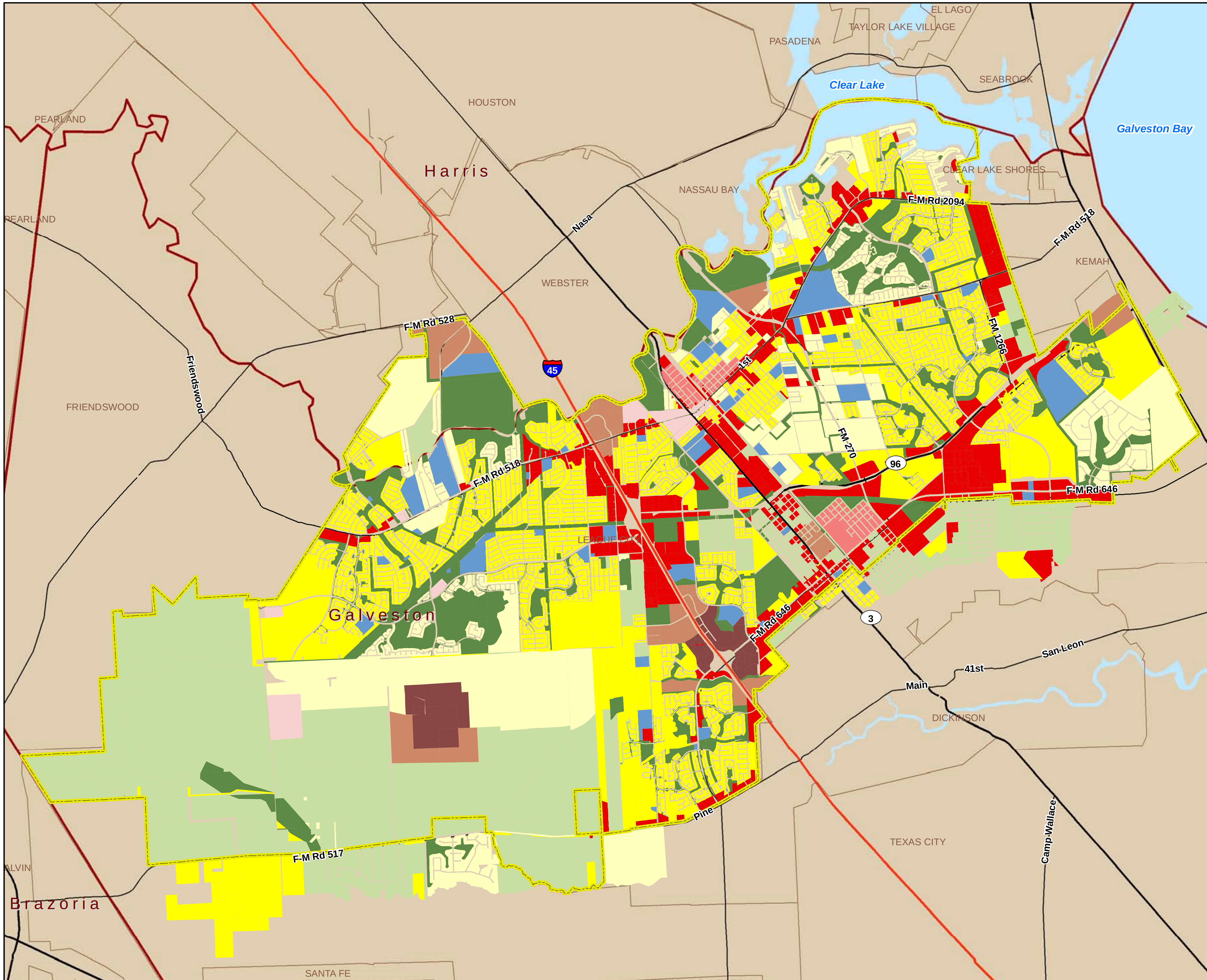
* Approximate Scale

Figure 2-3

Preferred Buildout Land Use Alternative

City of League City, Texas
Wastewater Master Plan 2012

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
W E
S

0 3,000 6,000
Feet

CDM Smith

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To simulate the growth/generation in the wastewater 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	10.13
Enhanced Auto Dominant Commercial	2,823	0
Urban High	508	26.36
Urban Low	954	11.10
Suburban Commercial	277	0
Public/Institutional	1,110	0
Park/Open Space/Natural	4,081	0

Table 2-4
Total Projected Land Use by Category

2.4 Service Areas

The typical wastewater collection system consists of service areas or wastewater drainage areas that are defined by (1) natural contours and geographic conditions that favor drainage towards a certain location, (2) existing collection system infrastructure that separates one area from another or (3) undeveloped areas bound to a certain location. The City is divided into five major service areas which include a total of 70 lift stations. However, eight (8) of the 70 lift stations were not included in the modeling analysis based on City staff recommendation due to their small size.

Currently, the City operates two wastewater treatment plants (WWTP): Dallas Salmon WWTP and Countryside WWTP. The City is also constructing a new WWTP, the Southwest Water Reclamation Facility (SWWRF) which is anticipated to be completed in the 3rd quarter of 2012. The City plans to decommission the Countryside WWTP after the SWWRF is put into service. The SWWRF will serve the Far West service area. The Dallas Salmon WWTP will serve the Near West, Central, Northeast, and Southeast service areas. The location of the existing service areas and the WWTP service areas are shown in **Figure 2-4**. **Figure 2-5** shows the location of the lift station service areas.

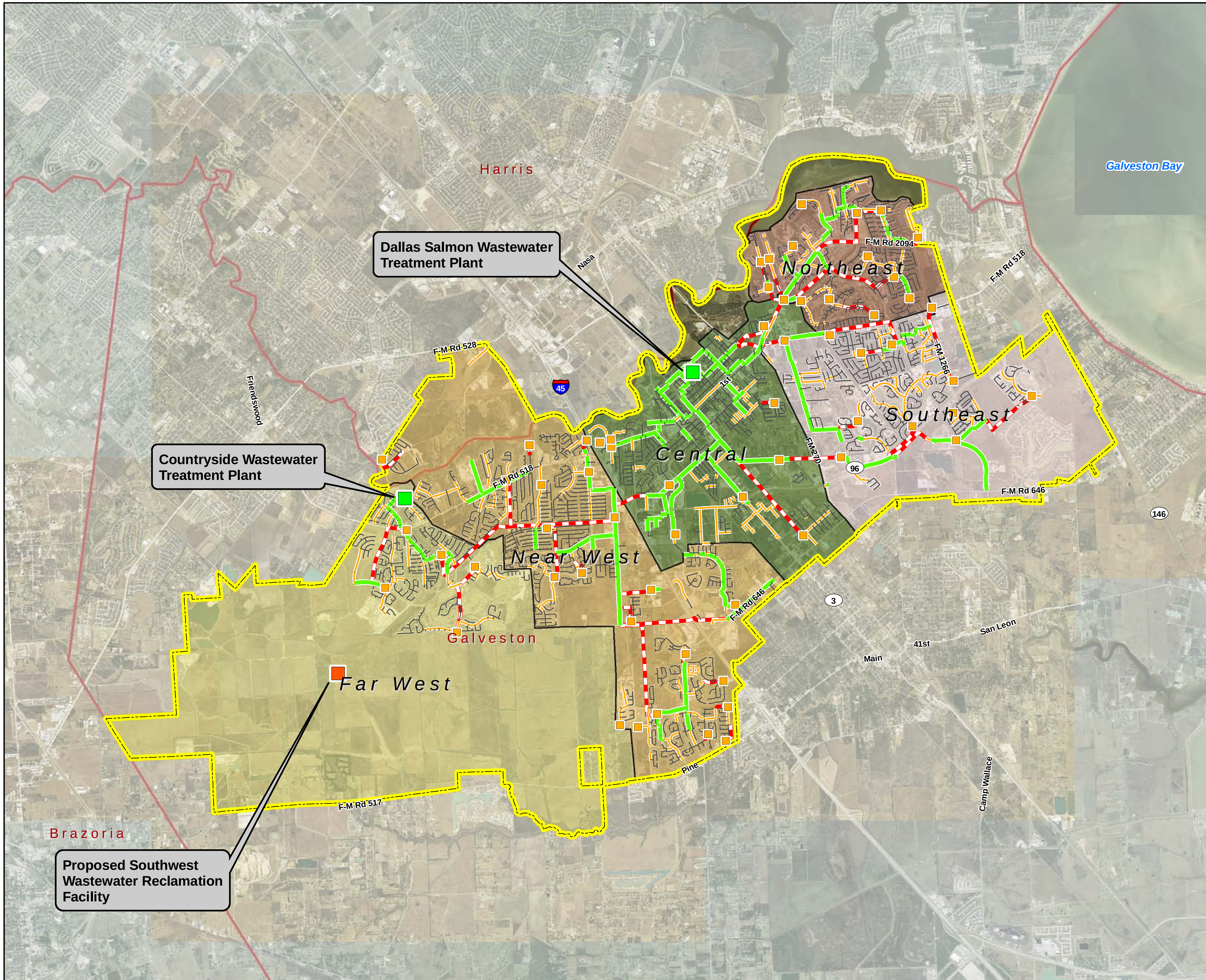

Figure 2-4

Wastewater Service Area Delineations

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Existing Wastewater Treatment Plant
- Proposed Wastewater Treatment Plant
- Lift Station

Gravity Line

- 15" - 60"
- 10" -14"
- < 10"
- Force Main

Service Area

- Central
- Far West
- Near West
- Northeast
- Southeast
- League City City Limit
- County Boundary

N W E S

0 3,500 7,000
Feet

CDM Smith

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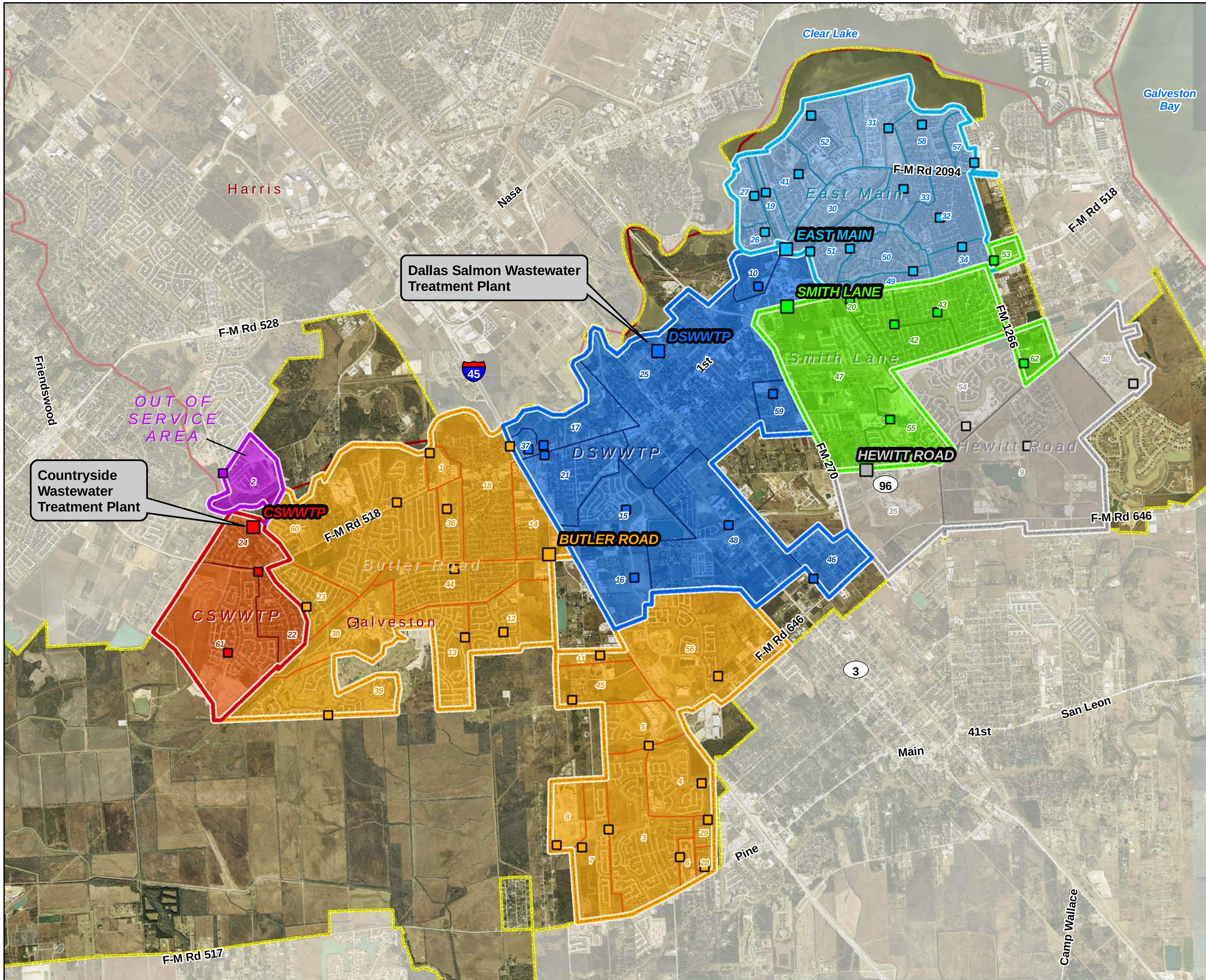

Figure 2-5

Lift Station Service Area Delineations

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Dallas Salmon WWTP
- Countryside WWTP

Lift Stations & Service Areas

- Bulter Road
- CSWWTP
- DSWWTP
- East Main
- SE General Benefit Hewitt
- Smith Lane
- Out of District Sewer Service
- League City City Limit

Lift Stations			
1	Amber Lane	32	Harbour Park 1
2	Autumn Lakes	33	Harbour Park 2
3	Bay Colony 14 - 15	34	Harbour Park 3
4	Bay Colony Meadows	35	Hewitt Road
5	Bay Colony Parkside	36	Landing
6	Bay Colony Retreat	37	LS 21
7	Bay Colony West 1 - 12"	38	Magnolia Creek North
8	Bay Colony West 2 - 10"	39	Magnolia Creek South
9	Bay Ridge	40	Mar Bella
10	Bayou Brae	41	Marina Palms
11	Big League Dreams	42	Meadowbend Parkway
12	Brittany Lakes 1	43	Meadowbend STP
13	Brittany Lakes 2	44	MUD 6
14	Butler Road	45	Safari
15	Centerpointe 1	46	Shell Side
16	Centerpointe 2	47	Smith Lane
17	Clear Creek Crossing	48	South Highway 3
18	Clear Creek Village	49	South Shore 1
19	Constellation	50	South Shore 2
20	Coronado	51	South Shore 3
21	Corum	52	South Shore 4
22	Countryside 1	53	South Shore Lakes
23	Countryside 2	54	South Shore MUD 7
24	Countryside WWTP	55	Tuscan Lakes 1
25	Dallas Salmon WWTP	56	Victory Lakes
26	Davis Road 1	57	Waterford 1
27	Davis Road 2	58	Waterford 2
28	Dove Meadows 1	59	Webster
29	Dove Meadows 2	60	West Main
30	East Main	61	Westover
31	Glen Cove	62	Woodcock

N W E S

0 2,500 5,000
Feet

CDM Smith

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2.5 Development of Wastewater Flow Data

The procedure for developing wastewater flow demands for input into the model is described in this section. The typical components of wastewater flows is described in **Section 2.5.1** and the development of dry and wet weather wastewater flow data is described in **Section 2.5.2** and **Section 2.5.3** respectively.

2.5.1 Wastewater Flow Components

In general, wastewater flows can be divided into three components: base wastewater flow (BWF) or sanitary flow, groundwater infiltration (GWI), and rainfall dependent infiltration and inflow (RDI/I). These three components are illustrated in **Figure 2-6**. Dry weather wastewater flow consists of only BWF and GWI while wet weather wastewater flow consists of all three components. The wet weather flow component (i.e. RDI/I) is of particular importance because it is the increased portion of flow that occurs during a rainfall event.

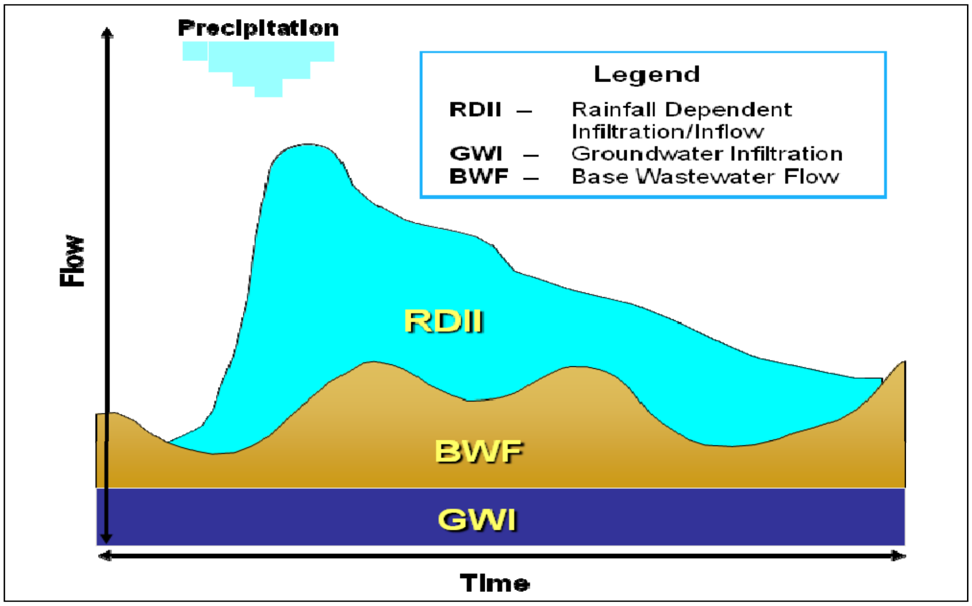

Figure 2-6
Components of Wastewater Flow

BWF is domestic wastewater from residential, commercial, and institutional (schools, churches, hospitals, etc.) sources, as well as industrial wastewater sources. It is affected by the population and land uses in an area and varies throughout the day in response to personal habits and business operations. BWF usually follows a diurnal pattern.

GWI is defined as groundwater entering the collection system through defective pipes, pipe joints, and manhole walls. Unlike BWF, GWI is typically a relatively constant flow throughout the day but may vary seasonally. The magnitude of GWI depends on the depth of the groundwater table above the pipelines, the percentage of the system that is submerged, and the physical condition of the sewer system. GWI is distinct from wet weather induced flows in that GWI occurs even under dry weather conditions.

RDI/I refers to stormwater that enters the wastewater collection system in direct response to the intensity and duration of rainfall events. As the name suggests, RDI/I is made up of inflow and infiltration. Rainfall-dependent inflow is rainfall runoff that directly enters the collection system through illicit stormwater connections and manhole defects. The flow response to inflow is usually relatively rapid, with flows following rainfall patterns closely. Rainfall-dependent infiltration occurs when groundwater in saturated soils leaks into the collection system through cracks in pipes, leaky joints, and similar defects. Infiltration usually occurs slowly, peaking after peak rainfall and taking hours or days to recede. Factors that affect the characteristics of RDI/I can include age, material, and construction quality of the collection lines, local soil properties, and permeability of ground cover (land use).

The dry weather and wet weather flow data is modeled using the following input parameters: (a) base flow; and (b) flow pattern. The base flow is a constant load that is applied to all the manholes in the collections system. The flow pattern is assigned as a wastewater production pattern to each manhole, representing a multiplier against the base flows.

2.5.2 Average Dry Weather Wastewater Flows (ADWF)

As discussed previously, average dry weather wastewater flows (ADWF) are comprised of the BWF (with diurnal variations) and the GWI. Further discussion of each of these components is presented in this section.

2.5.2.1 Dry Weather Base Flow Development (BWF)

The water meter billing data provided by the City was used to calculate the dry weather base wastewater flows (BWF). The billing data contains monthly flow totals from January 2008 to May 2010 for each billed water meter in the City. The BWF was calculated by averaging the monthly billing meter volume for each meter for the winter months (January, February and March) for the years 2008, 2009 and 2010. Flow data for winter months was only considered since there is typically very little irrigation demand in winter and nearly all of the billed water can be assumed to enter the sanitary sewer system. The winter months' average daily flows were calculated from the monthly metered totals. All of the meters were then totaled and compared to the average daily dry weather flows (no rainfall recorded) generated at the WWTP's for the same time period. The difference between the two values was assumed to be GWI and was proportioned evenly over all the meters to calculate the ADWF. **Figure 2-7** shows the ADWF utilizing all billing meters data. The average dry weather flow (ADWF) includes both the BWF and GWI flow components.

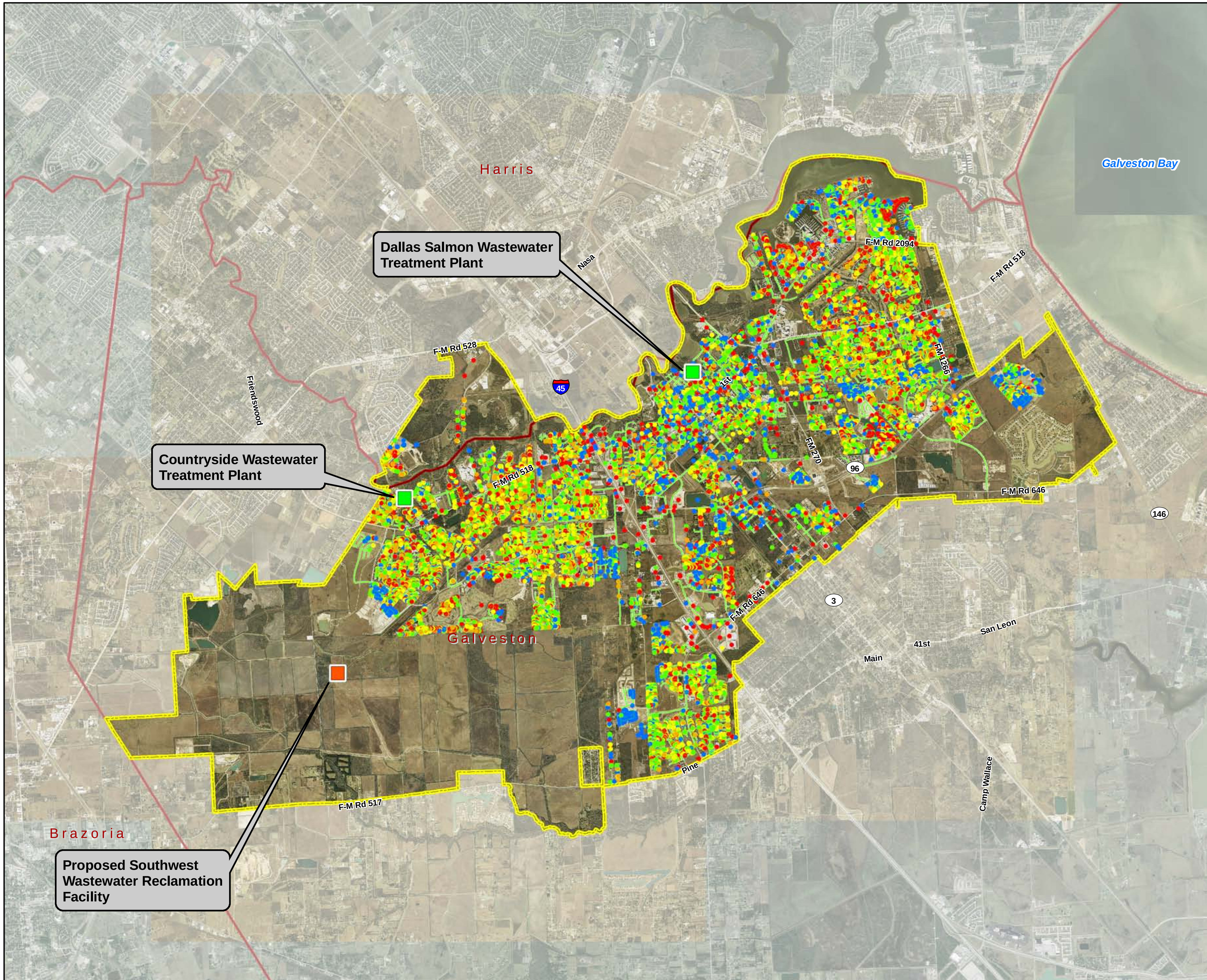

Figure 2-7

Metered Water Usage Data Winter Months 2008 to 2010

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Existiing Wastewater Treatment Plant
- Proposed Wastewater Treatment Plant

Meter Usage

- 0 - 75 gpd
- 76 - 150 gpd
- 151 - 200 gpd
- 201 - 250 gpd
- 251 - 83,000 gpd
- Wastewater Line
- League City City Limit
- County Boundary

N W E S

0 3,500 7,000
Feet

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The City is currently served by two WWTP's, Dallas Salmon and Countryside. The annual average dry weather wastewater flow (ADWF) rates for each WWTP are listed in **Table 2-5**.

WWTP	2007 (MGD)	2008 (MGD)	2009 (MGD)
Dallas Salmon WWTP	5.22	5.51	5.55
Countryside WWTP	0.66	0.44	0.48
Total	5.88	5.95	6.03

Table 2-5
Annual Average Dry Weather Wastewater Flow Rates by Facility

2.5.2.2 Diurnal Curve

The hourly wastewater generation pattern is a diurnal curve in which the wastewater flow for each hour of the day can be expressed as a ratio to the daily wastewater flow rate. The curve applied to the City's collection system was obtained based on the wastewater generation diurnal curve of a typical residentially dominated suburban city of similar size to League City. **Figure 2-8** shows the diurnal curve that represents the wastewater flow coefficient at 1-hour intervals. It is important to note that this curve describes the generation at the point of entry into the collection system. It is does not represent the timing at the wastewater plant, which usually lags behind the collection system by several hours.

The curve was imported to the model and assigned as a wastewater production pattern to each manhole in the collection system, representing a multiplier against the dry weather base wastewater daily flows (BWF). The peak hour of this diurnal curve was found to occur at 7:00 am and represents a factor of 2.19 times the daily flow.

2.5.2.3 Infiltration Factor

GWI makes up a portion of the dry weather flow and is typically measured by examining the minimum night-time flows in the collection system when most base wastewater flows would be very low. Due to lack of flow monitoring data for the collection system, night-time flows for the collection system were not available. Hence the GWI factor was calculated as the difference between the average daily dry weather wastewater flows from WWTP's and average winter month's water usage from City's meter billing data, as described in **Section 2.5.2.1**. The calculated GWI of 1% was applied to each metered flow total to calculate the ADWF.

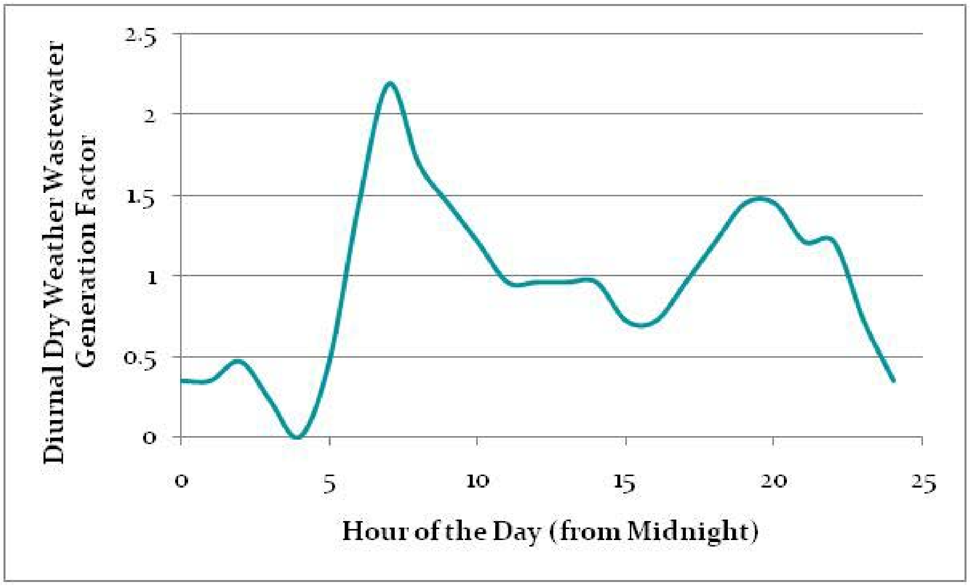

Figure 2-8
Daily Wastewater Flow Pattern used in Dry Weather Flow Modeling

2.5.3 Wet Weather Wastewater Flows

The wet weather wastewater flow is flow that directly enters the collection system through illicit stormwater connections and manhole and pipe defects resulting from a rainfall event. As a general rule for extensive studies, flow monitors are installed in the collection system to measure flow during monitored rainfall events. A flow monitoring program was beyond the scope of this report. As a result, due to the lack of flow monitoring data in the existing collection system, wastewater flows measured during wet weather events at each WWTP were used to develop the wet weather flow data for modeling the collection system. Each wet weather flow event at each WWTP was correlated to a measured rainfall event. The wet weather flow data was applied to every catchment basin within the City's service area and uniformly and/or proportionally added to a unique manhole.

The maximum daily (over a 24-hour period) effluent flow rate for each year of the data analysis period for each WWTP is listed in **Table 2-6**.

WWTP	2007 (MGD)	2008 (MGD)	2009 (MGD)
Dallas Salmon WWTP	19.84	19.98	18.39
Countryside WWTP	1.65	1.20	1.55

Table 2-6
Maximum Daily Effluent Flow Rate by Facility

2.5.3.1 Wet Weather Base Flow Development

Similar to the dry weather flow analysis, the wet weather flow was also modeled based on a time dependent flow/intensity pattern. A fraction of the total rainfall (or "R" factor) will enter the sanitary sewer system through illicit stormwater connections and manhole and pipe defects The "R" value is calculated as described below and applied to the total volume of rainwater that fell within the catchment during a rainfall event. A 2-year 24-hour storm was selected as the design storm event for the modeling analysis. The 2-year 24-hour storm generates 5.23 inches of precipitation (per TxDOT for League City). The precipitation was multiplied by the total acreage of each catchment basin to obtain the total volume of rainfall that fell within that catchment basin. This volume was applied as the base flow using the "R" factor for modeling the sewer system in that catchment basin. Additional discussion on the volume, calculation, methodology, and verification storm analysis is discussed in **Section 4.5.2**.

2.5.3.2 Sewer Inflow Hydrograph

A hydrograph is a plot of stream flow or runoff flow with respect to time. The sanitary sewer inflow hydrograph represents the inches of inflow to the sewer (due to RDI/I) per time for the total duration of the hydrograph. The step by step procedure for the development of the sanitary sewer inflow hydrograph is presented below.

- **Step 1** – Calculation of precipitation during the design storm event.

  The volume of rainfall during the 2-year 24-hour design storm event was calculated to develop the wet weather base flow as described in **Section 2.5.3.1**. This value is also used to develop the sanitary sewer inflow hydrograph.

- **Step 2** – Calculation of wet weather flow treated at the WWTP during the design storm event.

  The difference between the daily dry weather influent flow rate (no measured rainfall) and the daily wet weather influent flow rate (measured rainfall) to the WWTP refer to the total volume of influent wastewater due to the contribution of rainfall or wet weather flow treated at the WWTP.

- **Step 3** – Calculation of the "R" factor.

  The "R" factor represents the fraction of rainfall entering the collection system as RDI/I. The ratio between the total volume of rainfall that fell within the catchment basin (calculated in Step 1) and the total volume of wet weather flow treated at the WWTP (calculated in Step 2) is the "R" factor. The calculated "R" factor for League City is approximately 1.75%.

- **Step 4** – Development of sewer inflow hydrograph.

  Due to the lack of specific field measured flow monitoring data, a typical sewer inflow hydrograph for a 1-h storm event was obtained from literature and verified against other similar cities within the Houston metropolitan region that has soil and geological characteristics similar to League City. This hydrograph was adjusted based on the "R" factor (calculated in Step 3) and a Type III distribution curve from the TxDOT Hydraulic Design Manual for the design storm event (2-year 24-hour storm) event to develop the sewer inflow hydrograph for this project.

The sewer inflow hydrograph was imported to the model and assigned as a wastewater production pattern to each loaded manhole, representing a multiplier against the wet weather base flow loading value. The peak hour of this storm occurs 13 hours after the start of the storm event. **Figure 2-9** shows the sewer inflow hydrograph at 1-hour intervals that is applied to the total volume of rain to fall during a 2-year 24-hour storm event.

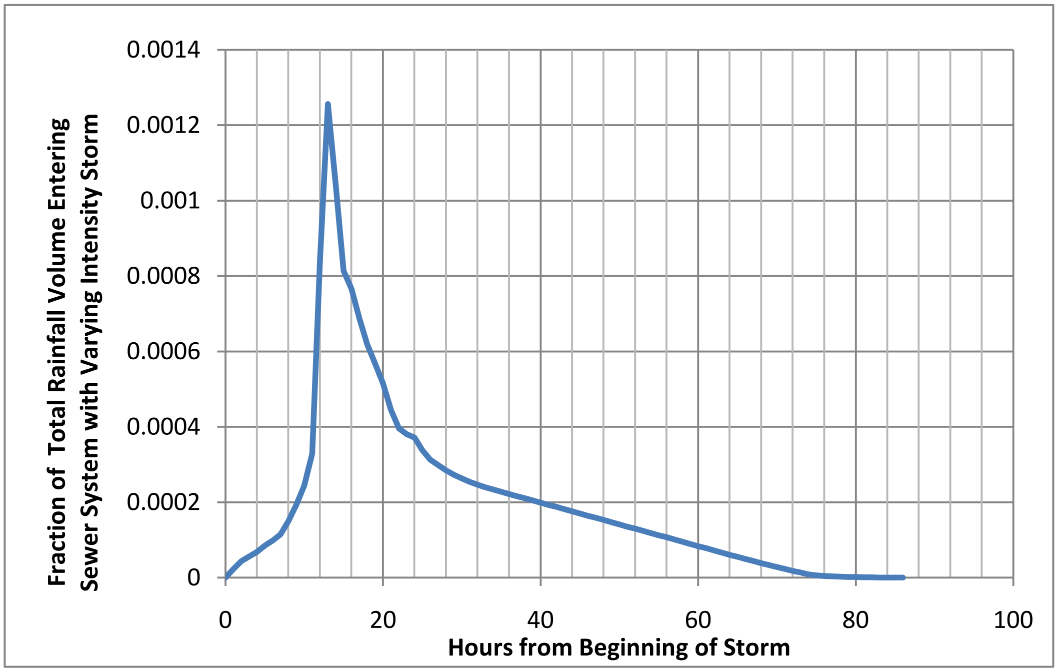

Figure 2-9
Sewer Inflow Hydrograph

2.6 Projected Wastewater Flow

For the existing demand alternative, the recent historical data was summarized and incorporated. As described in **Section 2.5.2**, the existing average dry weather wastewater flow data was calculated using the water billing meter flow data for the winter months and the dry weather WWTP flow data. The average dry weather wastewater generation factors for residential (gal/day/person) and commercial development (gal/day/acre) are presented in **Table 2-7**. The residential factor was calculated by dividing the WWTPs' average dry weather flow from **Table 2-5** by the 2010 population of the City. The commercial factor was calculated based on historical billing meter data for commercial properties and their estimated acreage. The generation factors are assumed to be constant with time.

Residential	71.3 gal/person/day
Commercial Regular	750 gal/acre/day

Table 2-7
Average Dry Weather Wastewater Generation Factors

For future scenarios, projected wastewater flows were developed based on the planning information provided by the City planning department and incorporating the generation factors from **Table 2-7**. Two different data sources were used: growth projections from 2010 to 2020 and city buildout land use projections.

2.6.1 Population Growth Projections from 2010 to 2020

The City planning department provided annual estimates of projected growth between 2010 and 2020. Included in the annual projections was population increase and commercial acreage increase for each neighborhood through 2020 as presented **Section 2.2**. The City also provided GIS information identifying the location and area of each neighborhood.

For each neighborhood projected to have an increase in population, the additional dry weather wastewater flow was calculated by multiplying the projected population change by the residential factor in **Table 2-7**. To realistically incorporate this information into the model without knowing specifically where housing development would occur, this total increase in residential flow was evenly spread over the undeveloped area of the neighborhood.

Similarly, for each neighborhood projected to have an increase in commercial development, the additional dry weather wastewater flow was calculated by multiplying the projected acreage change by the commercial factor in **Table 2-7**. This total increase in commercial flow was evenly spread over the undeveloped area of the neighborhood.

All residential and commercial dry weather flows projected from 2010 to 2020 were incorporated into the 2020 scenario by adding them directly to the existing scenario's average dry weather wastewater flows.

2.6.2 Buildout Land Use Projections

The City planning department provided land use data that was used to develop the average dry weather wastewater flows at buildout, shown in **Figure 2-3**. The City had assigned each category the projected population density seen in **Table 2-4**. As the average dry weather generation rates from **Table 2-7** were assumed to be constant with time, the residential generation rate was multiplied by the population density for each category to arrive at a wastewater flow per acre. To create the dry weather buildout scenario, these wastewater loads were incorporated into the model using a "nearest node" method. This method assigns a category area's load to the closest manhole(s). Since the land use GIS contains 34,000 separate polygon including some redevelopment, it was unrealistic to determine a means of applying the buildout loads directly to the existing dry weather scenario. For buildout, a new wastewater load file was created based only on the ultimate development projected by the City and the residential wastewater generation rate.

2.7 Wastewater Collection System Survey

Pipelines 15-inch and larger were surveyed to ensure the most accurate model results possible for the major trunklines. Survey information gathered from the field and input into the model included manhole rim elevations to verify overflow conditions and pipeline sizes and invert elevations to verify pipe capacity and surcharge conditions. Survey datasheets have been prepared for each segment and manhole and are included in **Appendix A**. **Figure 2-10** shows the survey locations in the City's wastewater collection system. For all other collection system lines that were not surveyed, elevation data based on the United States Geological Survey (USGS) Digital Elevation Model (DEM) was applied.

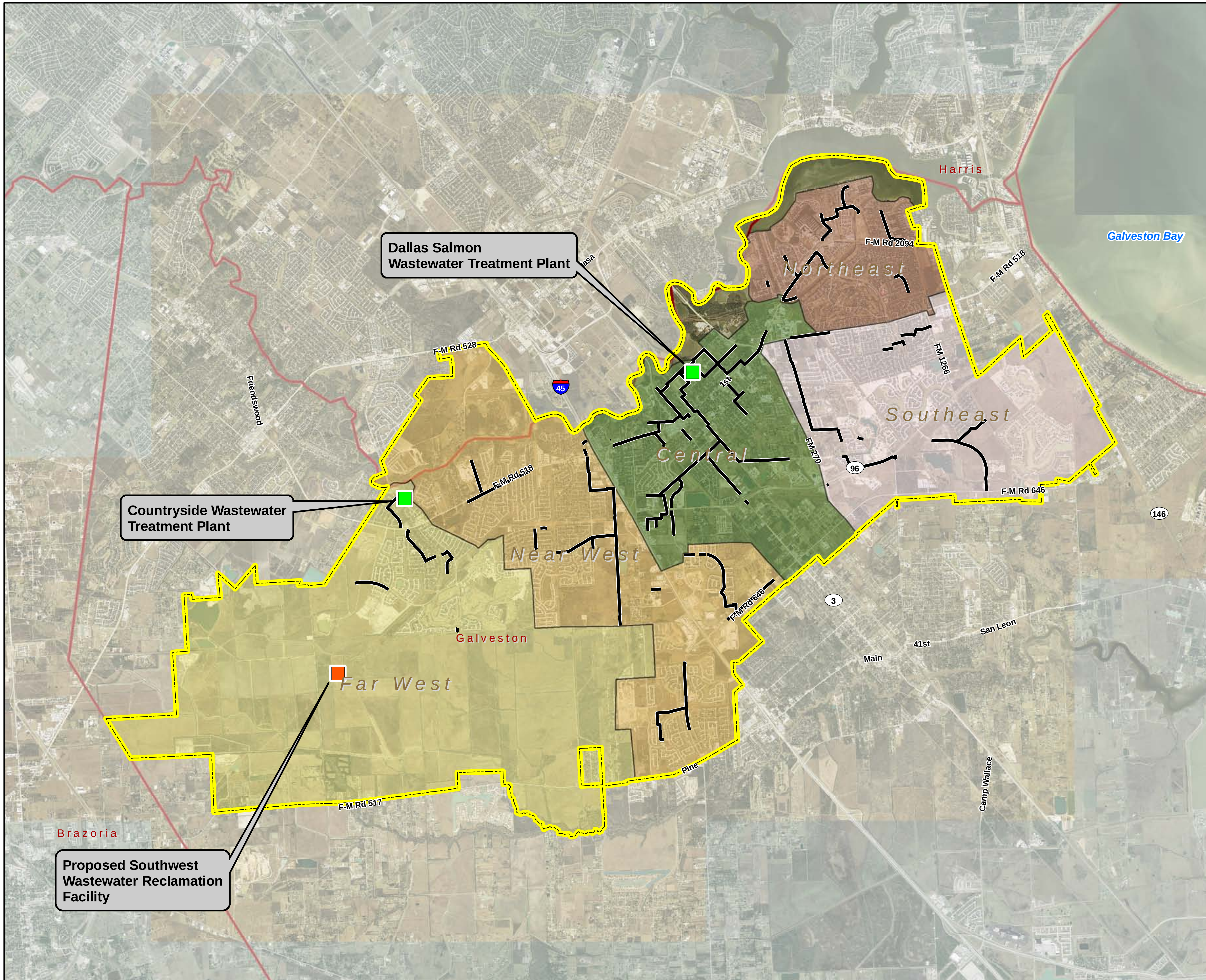

Figure 2-10

Wastewater Collection System Survey Locations

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Existing Wastewater Treatment Plant
- Proposed Wastewater Treatment Plant
- Gravity Line - 15" and Greater

Service Area

- Central
- Far West
- Near West
- Northeast
- Southeast
- League City City Limit
- County Boundary

0 3,500 7,000
Feet

CDM Smith

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Section 3
Wastewater Infrastructure

The existing wastewater infrastructure can be divided into three major categories:

- Gravity collection lines;
- Lift stations and force mains; and
- Wastewater treatment facilities.

The existing wastewater infrastructure for the City is shown in **Figure 3-1**.

3.1 Gravity Collection System

The City's gravity collection system consists of pipes of varying sizes from 6-inches to 54-inches. **Table 3-1** presents a summary of the entire collection system. As presented in **Section 2.6**, a detailed survey of only the main sewer trunk lines was conducted to confirm pipeline invert elevations at specific manhole locations.

Diameter	Total Length (miles)
6”	1.1
8”	194.1
10”	32.5
12”	16.8
14”	1.2
15”	5.9
16”	0.8
18”	6.7
20”	0.9
21”	4.8
24”	7.8
30”	3.5
36”	1.8
42”	1.5
48”	0.2
54”	2.7

Table 3-1
Existing Wastewater
Gravity Collection System

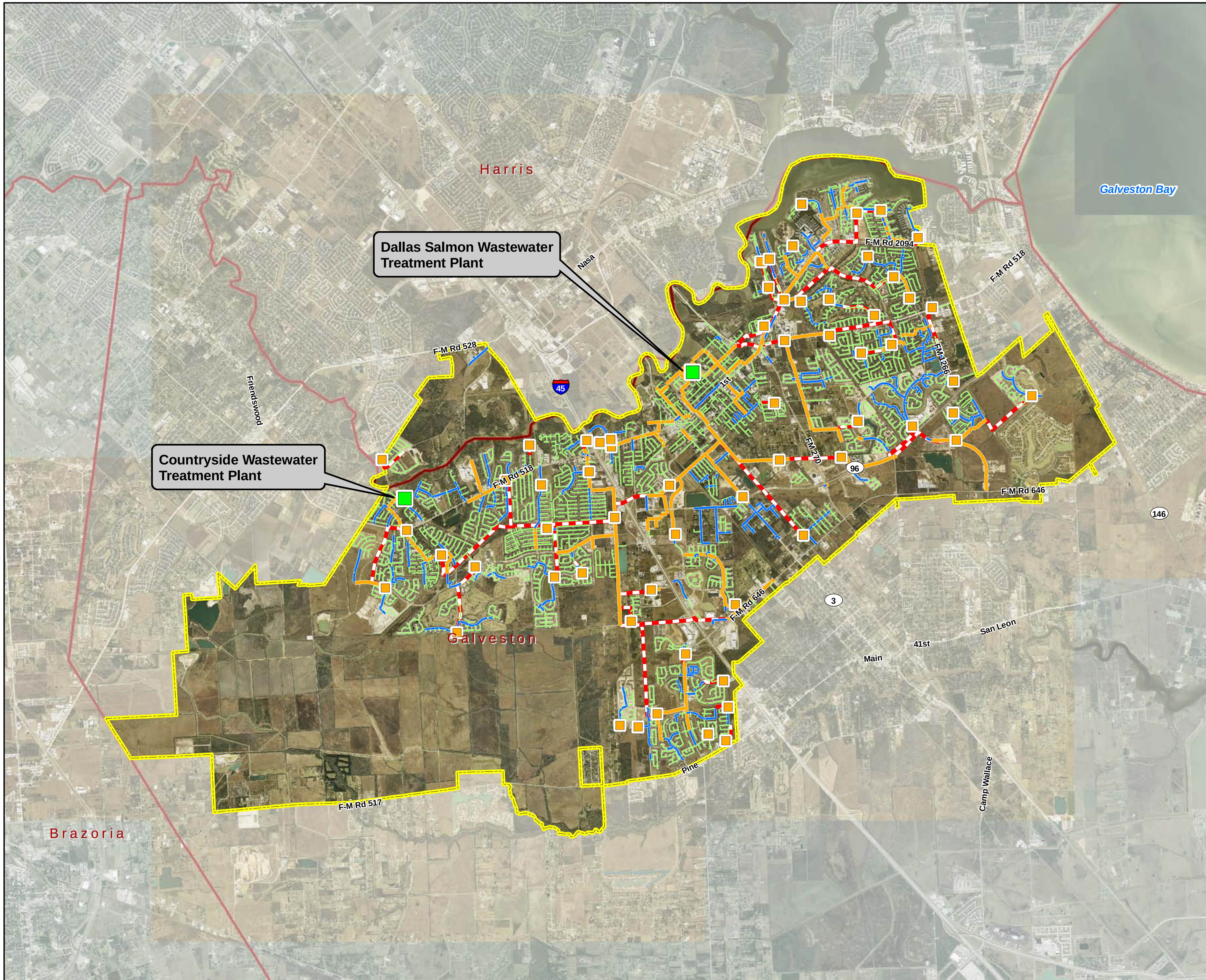

Figure 3-1

Existing Collection System and Facilities

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Wastewater Treatment Plant
- Lift Station

Gravity Line

- 15" - 60"
- 10" -14"
- < 10"
- Force Main
- League City City Limit
- County Boundary

0 3,500 7,000
Feet

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3.2 Lift Stations and Force Mains

The City has 70 lift stations, 62 of which were modeled, within the city limit. **Table 3-2** presents a summary of the lift stations. **Figure 2-5** presented the location of the lift station service areas. **Appendix B** includes the pump curves for all modeled lift stations. **Appendix C** includes the available record drawings for all the modeled lift stations. The largest lift stations are described below.

3.2.1 Smith Lane Lift Station

The Smith Lane Lift Station has a design capacity of 3,950 gpm. The wet well has an active volume of approximately 20,000 gallons based on the operational elevations shown on available construction drawings. There are two identical pumps and a 20-inch ductile iron force main that empties into a 42-inch gravity line that leads to Dallas Salmon WWTP.

3.2.2 Hewitt Road Lift Station

The Hewitt Road Lift Station has a design capacity of 5,800 gpm. The wet well has an active volume of approximately 14,000 gallons based on the operational elevations shown on available construction drawings. There are three identical pumps and a 30-inch ductile iron force main that empties into a 36-inch gravity line that leads to Dallas Salmon WWTP.

3.2.3 East Main Lift Station

The East Main Lift Station has a design capacity of 4,750 gpm. The wet well has an active volume of approximately 38,000 gallons based on the operational elevations shown on available construction drawings. There are three identical pumps and a 24-inch ductile iron force main that empties into the same 42-inch gravity line as Smith Lane Lift Station.

3.2.4 Butler Road Lift Station

The Butler Road lift station has a design capacity of approximately 8,000 gpm. The wet well has an assumed active volume of 58,000 gallons based on the typical depths of similar lift stations. Operational elevations were not available for this station. There are currently two identical pumps and an additional pump added in 2003. The existing 24-inch ductile iron force main empties into a 54-inch gravity line that leads to Dallas Salmon WWTP. Improvements to this station are currently in design. The improvements will increase the station capacity to 10,000 gpm and increase the force main size to 30-inch.

3.3 Wastewater Treatment Plants

As stated in **Section 2.4**, the City currently operates two WWTPs: Dallas Salmon WWTP and Countryside WWTP. It is anticipated that by 2013, the Countryside WWTP will be decommissioned and the new SWWRF plant will be in service.

Number	Name	Model Label	All Pumps Off Elevation (ft)	Lead Pump On Elevation (ft)	Lag Pump 1 On Elevation (ft)	Lag Pump 2 On Elevation (ft)	High Water Alarm Elevation (ft)	Top of Wet Well Elevation (ft)	Number of Pumps	Wet Well Area (ft^2)	Firm Capacity (gpm)	Total Dynamic Head (ft)	Force Main Diameter (in)
1	Alabama	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Amber Lane	WW-31	3.00	4.00	5.00	N/A	10.00	15.00	2	50	30	30	2
3	Autumn Lakes	WW-70	-3.60	1.00	2.00	N/A	3.00	20.50	2	44	460	84	8
4	Bay Colony 14-15	WW-52	-9.75	-8.00	-7.50	-7.00	-6.60	13.75	3	79	1060	94	10
5	Bay Colony Lakes	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Bay Colony Meadows	WW-58	-6.05	-4.00	-3.05	N/A	-3.05	16.43	2	64	545	30	8
7	Bay Colony Park Side	WW-50	-10.50	-3.50	-2.00	N/A	-1.30	8.00	2	50	600	8	8
8	Bay Colony Retreat	WW-56	-4.50	-3.00	-2.00	N/A	0.00	10.00	2	50	218	34	4
9	Bay Colony West - 1 (12" FM)	WW-60	-10.81	-9.31	-8.31	-7.31	-7.31	17.50	3	214	2182	37	12
10	Bay Colony West - 2 (10" FM)	WW-68	-12.87	-11.67	-10.45 On / -11.67 Off	-9.45 On / -10.45 Off	-9.45	14.63	2	113	650	34	10
11	Bay Ridge	WW-62	-15.42	-12.92	-10.56 On / -12.92 Off	-7.50 On / -10.56 Off	-7.50	14.00	3	214	2650	36	20
12	Bayou Brae	WW-15	-5.00	-1.00	0.00	N/A	2.00	13.82	2	78	300	22	6
13	Big League Dreams	WW-69	3.74	9.00	9.44	N/A	10.69	20.33	2	214	390	48	2
14	BLS Storm Water	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	Brittany Lakes 1	WW-43	2.60	4.63	5.13	N/A	5.13	17.10	2	38	390	33	6
16	Brittany Lakes 2	WW-44	0.00	2.50	3.00	N/A	3.70	19.55	2	50	529	37	8
17	Butler Road	WW-38	-1.50	1.00	2.00	3.00	5.00	20.75	3	770	8000	32	24
18	Centerpointe 1	WW-35	-2.40	-1.20	-0.20	N/A	-0.20	20.10	2	50	300	32	6
19	Centerpointe 2	WW-65	0.60	2.10	3.10	4.10	4.10	16.60	3	154	1220	32	18
20	Clear Creek Crossing	WW-28	-9.75	-7.75	-7.00	N/A	-6.75	9.75	2	50	1575	23	8
21	Clear Creek Village	WW-29	-10.00	-8.00	-7.50	-6.47	-6.47	14.79	3	75	1206	63	12
22	Constellation	WW-06	-3.50	-2.00	-1.00	N/A	0.00	15.00	2	50	350	60	12
23	Coronado	WW-17	5.73	6.73	7.73	N/A	7.73	18.60	2	38	220	14	4
24	Corum	WW-32	3.75	5.30	6.30	N/A	6.30	13.25	2	36	300	7	6
25	Countryside 1	WW-40	4.77	8.42	9.70	N/A	9.00	25.75	2	128	1650	26	10
26	Countryside 2	WW-54	-1.00	1.00	2.00	N/A	7.00	15.00	2	79	800	64	10
27	Countryside Park	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	Davis Road 1	WW-09	-6.50	-4.10	-3.35 On / -5.65 Off	N/A	0.00	6.00	3	79	925	41	12
29	Davis Road 2	WW-07	-5.45	-3.20	-2.45 On / -4.70 Off	N/A	0.00	11.00	2	64	770	37	4
30	Dove Meadows 1	WW-53	-2.00	2.40	3.40	N/A	4.40	9.00	2	20	200	19	4
31	Dove Meadows 2	WW-51	-2.00	2.00	3.00	N/A	3.50	10.00	2	20	225	21	6
32	East Main	WW-12	-7.92	-2.50	-1.48	-1.00	-1.48	17.00	2	452	6300	50	24
33	EMS #1	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
34	EMS #2	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
35	Glen Cove	WW-03	-24.30	-14.30	-9.30	-4.40	-4.30	10.00	3	330	2500	70	14
36	Harbor Park 1	WW-08	-10.00	-7.00	-6.00	N/A	-3.00	6.00	2	168	1160	46	10

Table 3-2
Existing Lift Stations Summary Table

Number	Name	Model Label	All Pumps Off Elevation (ft)	Lead Pump On Elevation (ft)	Lag Pump 1 On Elevation (ft)	Lag Pump 2 On Elevation (ft)	High Water Alarm Elevation (ft)	Top of Wet Well Elevation (ft)	Number of Pumps	Wet Well Area (ft^2)	Firm Capacity (gpm)	Total Dynamic Head (ft)	Force Main Diameter (in)
37	Harbor Park 2	WW-05	-7.50	-5.50	-5.00	N/A	-4.50	11.00	2	38	80	20	6
38	Harbor Park 3	WW-10	-8.50	-6.00	-5.50	N/A	-5.00	5.50	2	38	310	22	8
39	Hewitt Rd	WW-61	-10.00	-5.00	-3.00	-2.00	-2.00	17.00	3	214	5800	26	30
40	Landing	WW-34	-0.45	2.00	3.00	N/A	3.00	22.11	2	38	400	27	8
41	LS #21	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
42	Magnolia Creek N	WW-63	-1.50	1.00	1.50	N/A	1.50	17.00	2	50	633	27.71	10
43	Magnolia Creek S	WW-49	-8.50	-3.70	-2.70	N/A	-2.70	18.50	2	50	830	37.5	10
44	Mar Bella	WW-66	-8.60	-7.10	-6.10	-5.10	-5.10	15.40	3	165	1750	47	14
45	Marina Palms	WW-59	2.75	3.27	4.27	N/A	5.27	10.00	2	13	50	9	8
46	Mary Lane	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
47	Meadow Bend Pkwy	WW-21	-3.50	-2.30	-1.50	N/A	-1.00	17.40	2	50	1050	50	8
48	Meadow Bend STP	WW-20	-1.00	4.28	6.44	7.44	7.44	12.00	3	136	2010	44	16
49	MUD 6	WW-39	-2.00	1.00	2.00	3.00	9.00	10.80	3	45	400	57	12
50	Safari	WW-48	5.00	7.00	8.00	N/A	11.00	17.00	2	40	100	30	4
51	Shellside	WW-41	-3.20	-2.00	-0.50	N/A	0.00	18.50	2	50	510	62	6
52	Smith Lane	WW-18	-9.10	-5.20	-0.80	N/A	1.70	14.40	2	324	3950	26	20
53	South Hwy 3	WW-36	-8.70	-5.45	-4.45	N/A	-3.45	14.30	2	38	600	33	18
54	South Shore Mud 7	WW-27	-4.26	-1.15	0.58	N/A	0.58	18.50	2	64	1200	60	12
55	South Shore Harbor 1	WW-14	-5.10	3.14	4.64	N/A	5.64	12.90	2	50	705	68	8
56	South Shore Harbor 2	WW-11	-3.67	2.77	3.77	N/A	5.27	14.33	2	50	966	55	12
57	South Shore Harbor 3	WW-13	-4.50	0.23	1.23	N/A	2.73	12.90	2	50	1236	45	10
58	South Shore Harbor 4	WW-01	0.11	1.11	2.11	N/A	4.11	11.11	2	28	150	24	4
59	South Shore Lakes	WW-57	1.50	2.25	3.00	N/A	4.00	10.25	2	45	300	20	6
60	Sportsplex #1	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	Sportsplex #2	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	Tuscan Lakes 1	WW-67	-8.00	-4.00	-3.00	N/A	-3.00	15.00	2	50	960	32.01	10
63	Tuscan Lakes 2	Not Modeled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
64	Victory Lakes/FM646 #1	WW-47	-6.91	-3.41	0.00	0.00	0.00	16.34	3	50	1466	116	12
65	Waterford 1	WW-04	-3.25	-1.53	-0.19	N/A	-0.19	14.50	2	50	300	47	12
66	Waterford 2	WW-02	-5.40	-3.40	-2.70	-0.20	-0.20	13.00	3	79	400	24	16
67	Webster	WW-23	7.60	8.50	9.50	N/A	11.00	17.60	2	30	135	32	4
68	West Main	WW-33	-7.30	-2.30	-1.5 On / -6.5 Off	N/A	-0.50	26.90	2	50	1200	77	10
69	Westover	WW-45	-1.54	2.00	3.00	N/A	4.28	29.08	2	214	654	46	10
70	Woodcock	WW-22	-5.50	-1.50	-1.25 On / -4.50 Off	N/A	-1.00	12.75	2	38	600	57	8

Table 3-2 (cont)
Existing Lift Stations Summary Table

3.3.1 Countryside Wastewater Treatment Plant

The Countryside WWTP was originally constructed in 1978 and expanded in 1983. The plant consists of an influent lift station, manual bar screen, aerated grit chamber, conventional activated sludge with coarse bubble aeration and centrifugal multi-stage blowers, rectangular secondary clarifiers with traveling bridge collection mechanisms, liquid chlorination, and low-head, mono-media sand filtration. The Countryside WWTP has a permitted average daily flow capacity of 0.66 MGD and a permitted peak flow of 2.02 MGD.

The Countryside WWTP serves a relatively small service area, is limited in expansion capability, and is relatively expensive to operate. Hence the City has been considering decommissioning the plant for several years. As far back as the 1992 Regional Wastewater Plan prepared by Dannenbaum Engineering Corp., it has been identified that the Countryside WWTP would not have the adequate capacity and room to expand to service the growing west side of League City. In 1997, CDM prepared a Countryside Wastewater Treatment Plant Wastewater Management Study, which evaluated options for decommissioning the Countryside WWTP and diverting flow from the Countryside WWTP to other plants.

It was determined that the Countryside flow could be diverted to the new SWWRF that would be required to meet the demands of planned new construction in the Westside Service Area. Recommendations were provided for improvements necessary to keep the plant in operation until the new SWWRF construction is completed. Following the construction of the SWWRF, all the wastewater flow to the Countryside WWTP will be diverted to the SWWRF and the Countryside WWTP will be decommissioned.

3.3.2 Dallas Salmon Wastewater Treatment Plant

The Dallas Salmon WWTP was originally constructed as a 4.0 MGD activated sludge plant. Over the last 20 years, CDM has performed several improvement projects to ensure that the plant's capacity meets the service area demands and more stringent permit limits. In 1993, CDM performed a comprehensive improvements project, which included a wide range of additions and modifications to the plant and increased the treatment capacity to 6 MGD average daily flow. In 1997, CDM removed two of the screw pumps and replaced them with four submersible influent wastewater pumps. In 1998, CDM performed a study to evaluate the possibility of rerating the plant for a greater permitted capacity. This study indicated that with modifications to the blower capacity for the oversized aeration basins, the plant capacity could be increased to 7.5 MGD average daily flow without constructing any new treatment units. The re-rating study was approved and implemented for the facility to be upgraded to 7.5-MGD capacity with the addition of one new centrifugal blower. Two equipment upgrades came in 2003. The first project involved clarifier rehabilitation and the other project involved the installation of a new belt filter press. In 2005, a new submersible lift station and headworks was constructed. In 2006, CDM completed the design for the expansion for the Dallas Salmon WWTP to 12.0 MGD. Construction of the expansion was completed in 2010.

The Dallas Salmon WWTP consists of an influent lift station, a headworks with two mechanical bar screens and a manually-raked bypass screen, and two induced-vortex grit removal units, four aeration basins, four secondary clarifiers, six cloth disk tertiary filters, three UV disinfection channels, and two aerated sludge holding tanks and two belt filter presses for sludge processing.

The Dallas Salmon WWTP is currently rated for 12.0 MGD average daily flow capacity and 36.0 MGD of peak flow capacity. The current discharge permit limits are presented in **Table 3-3**.

Parameter	Value	Units
Average Daily Flow	12.0	MGD
Peak 2-hour Flow	36.0	MGD
Effluent TSS	12	mg/L
Effluent BOD	5	mg/L
Effluent NH3-N	2	mg/L
Effluent Dissolved Oxygen	4	mg/L

Table 3-3
Dallas Salmon WWTP
Existing Discharge Permit Limits

3.3.3 Southwest Water Reclamation Facility

The 2006 Wastewater Master Plan indicated that 5.5 MGD of capacity would be required for the Westside service area by 2015, with an ultimate capacity of about 9.5 MGD. Most recent population projections have concluded that the 2006 master plan recommendations may have been conservative and an initial phase of 4.0 MGD, with planned upgrades to an ultimate flow of 12.0 MGD, would be sufficient to meet the immediate foreseeable development of the Westside service area. These revisions are based on the lower trajectory of development as a result of the economic downturn.

The SWWRF will consist of an influent lift station, a headworks with a single step screen and one stacked tray grit removal system, two aeration basins and two secondary clarifiers, two cloth-disk tertiary filter units, two UV disinfection channels, and two aerated sludge holding tanks and a single dewatering centrifuge for sludge processing.

CDM has been intimately involved in the siting, design and permitting process for the new SWWRF for many years. Currently, the plant is in construction and anticipated to be completed in 2012. The permit limits for the SWWRF are presented in **Table 3-4**.

Parameter	Value	Units
Average Daily Flow	4.0	MGD
Peak 2-hour Flow	12.0	MGD
Effluent BOD_5	5	mg/L
Effluent TSS	5	mg/L
Effluent NH_3-N	2	mg/L
Effluent Dissolved Oxygen	4	mg/L

Table 3-4
SWWRF Discharge Permit Limits

Section 4
Hydraulic Model Development

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

4.1 Overview

The City's wastewater collection system was modeled using the SewerGEMS Sanitary Version V8i software by Bentley Systems. The software is capable of simulating all aspects of the City's wastewater collection 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 wastewater collection system's physical facilities. The data included the following sources:

- ***City Geographic Information Systems (GIS) Database***: Current GIS wastewater system files detailing manholes, gravity collection lines, force mains, lift stations and wastewater treatment facilities were acquired for model inputs.

- ***City Records***: City data such as billing records, pump operational data and plant flow data was configured in the model.

- ***Field Survey Data***: A partial field survey of the wastewater collection system was completed. Invert data for major trunk gravity lines was used for model input.

- ***Rainfall Data***: Rainfall data obtained from five rain gauges located within the City was used to calculate infiltration/inflow parameters in the model.

- ***Record Drawings***: When data was not readily available electronically for lift stations, record drawings were reviewed to determine pipe inverts, pipe diameters, and lift station wet well dimensions for the model.

- ***Assumptions***: A limited number of assumptions were made regarding the configuration of the wastewater collection system.

- ***Interpolations***: Vertical control data, such as pipe inverts, was interpolated between two locations where necessary.

- ***Personal Communication with City Staff***: The institutional knowledge of City staff was used to configure the model as needed.

4.3 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.

4.3.1 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 Manning's Equation n value stored in the model's database for PVC is 0.013, which corresponds to PVC manufacturer's published n value. This value was used for all new pipes created in the model.

4.3.2 Elevation Data

Ground and invert elevation data is the backbone of any wastewater collection system model. As presented in **Section 2**, a partial survey of the wastewater collection system was completed. Manhole rim and pipe invert elevation data was collected on major gravity trunk lines of diameter 15 inches or larger. When invert elevation data was not available for pipelines, invert elevations were determined by using the first known downstream manhole invert elevation, calculating an invert elevation based on three feet of soil cover at the furthest upstream point, and using the model to calculate a constant slope between these two points.

Ground elevation data based on the United States Geological Survey (USGS) Digital Elevation Model (DEM) was applied to the model throughout the wastewater collection system with the exception for manholes that had survey information.

4.3.3 Manhole Diameters

Existing manhole diameters were not provided as part of the collection system GIS database. Where field survey data was not available, the diameters of the modeled manholes were assumed to be 4, 6, or 8 feet depending on the largest incoming pipeline size. A 4-foot diameter manhole was assumed for pipelines 24 inches or less in diameter. A 6-foot diameter manhole was assumed for pipelines with a diameter greater than 24 inches and up to 36 inches. An 8-foot diameter manhole was assumed for pipelines with a diameter greater than 36 inches.

4.3.4 Rainfall Dependent Infiltration and Inflow

Real-time rainfall and flow monitoring data within the wastewater collection system service area was not collected as it was beyond the scope of this master plan study. The fraction of rainfall entering the collection system as RDI/I also known as the "R" factor was determined per the methodology presented in **Section 2**. The calculated "R" factor of 1.75% was assumed to be constant throughout the entire collection system due to lack of information.

4.4 Model Construction

The primary source of information provided by the City was the GIS data for the wastewater network. SewerGEMS is compatible with ArcGIS software which allowed the direct import of GIS data into the model. Model inputs for pipelines included length, diameter, installation year, material and roughness. Pipeline lengths are automatically calculated in the model software based on the geographical length. The model network consists of approximately 310 miles of pipe, including gravity collection lines and force mains. The model network also includes approximately 7,700 manholes. Model inputs for manholes included invert elevations and wastewater flows. For future model scenarios, pipelines and manholes were added to the model as necessary.

Model inputs for the lift stations included wet well size, number of pumps, pump head discharge curves, and pump on and off levels as provided by the City. The aging and wearing of pump components were not considered in the model. Approximately 62 lift stations are included in the model.

4.5 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. Consequently, the data was verified to ensure that pipelines connected in a logical manner and that wastewater flow directions were correctly established. In addition, lift station and force main operations were verified with the City staff.

4.5.1 Dry Weather Flow Model Verification

The dry weather flow model was developed by comparing water billing data to measured wastewater flows at the WWTP's during the winter months (January, February and March) for the years 2008 and 2009 as described in **Section 2.5.2**.

4.5.2 Wet Weather Flow Model Verification

The wet weather flow model was calibrated using measured plant flows associated with the 18-h verification storm event recorded on December 29, 2010. The inches of precipitation during the 18-h verification storm event was calculated by averaging the rainfall quantities that were recorded in the various rain gauges located in the City. **Figure 4-1** shows the rainfall gauge locations in the City. The average precipitation for the 18-h verification storm event was calculated to be 3.23 inches. The base flow and sewer inflow hydrograph for the verification storm event was calculated using a

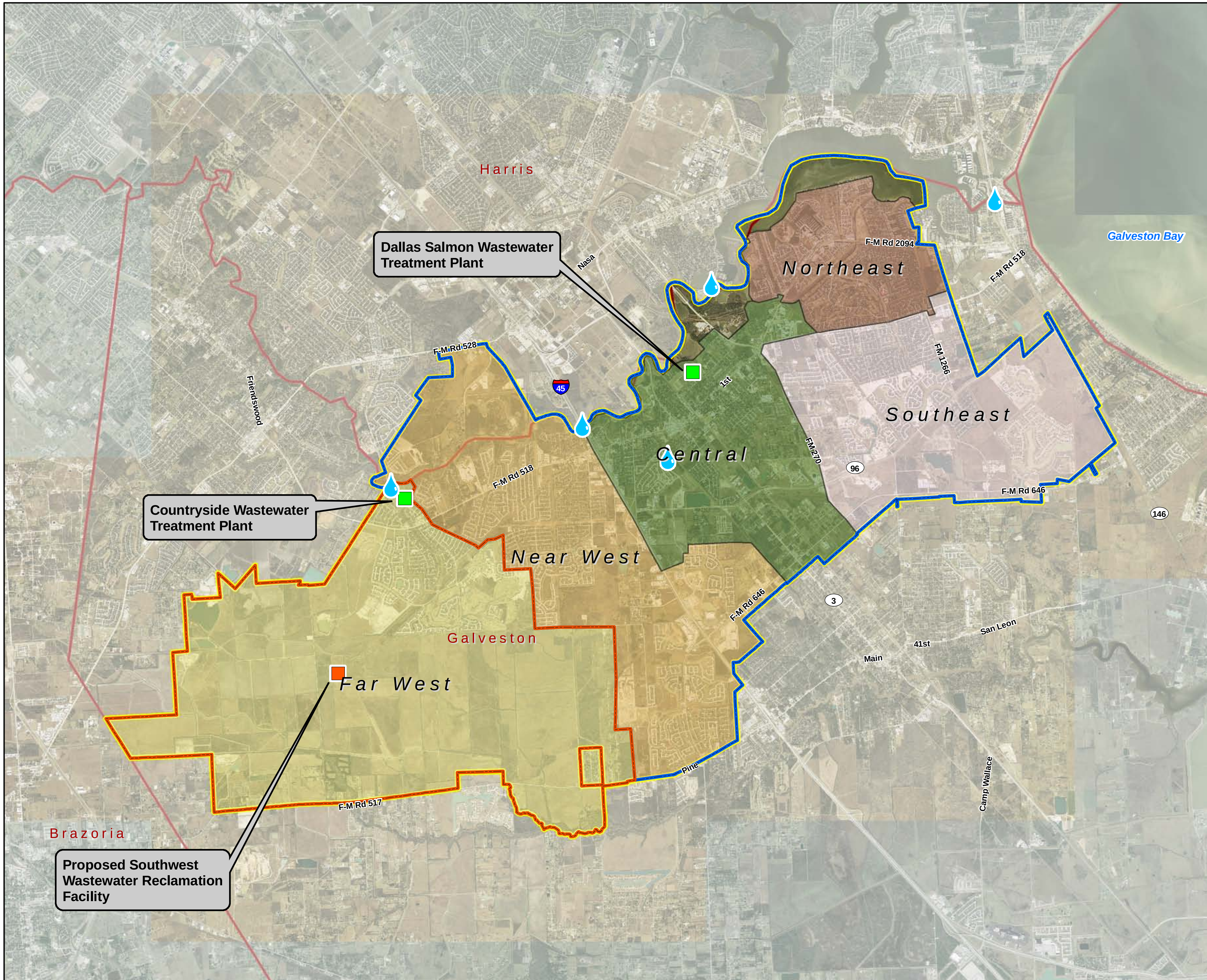

Figure 4-1

Rainfall Gauge Locations

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Rainfall Gauge
- Existing Wastewater Treatment Plant
- Proposed Wastewater Treatment Plant

Proposed Treatment Area

- Dallas Salmon Wastewater Treatment Plant
- Southwest Wastewater Recalmation Facility

Service Area

- Central
- Far West
- Near West
- Northeast
- Southeast
- League City City Limit
- County Boundary

N
W E
S

0 3,500 7,000
Feet

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similar procedure used for the design storm event as described in **Section 2.5.3.1** and **Section 2.5.3.2**.

Figure 4-2 compares the model results for the verification storm to the data collected at Dallas Salmon WWTP. Without flow meters in the collection system, this is the only location where model results can be compared with field data. The inflow was adjusted equally for all manholes until the model results produced approximately the same amount of water as the field data for December 29 and 30.

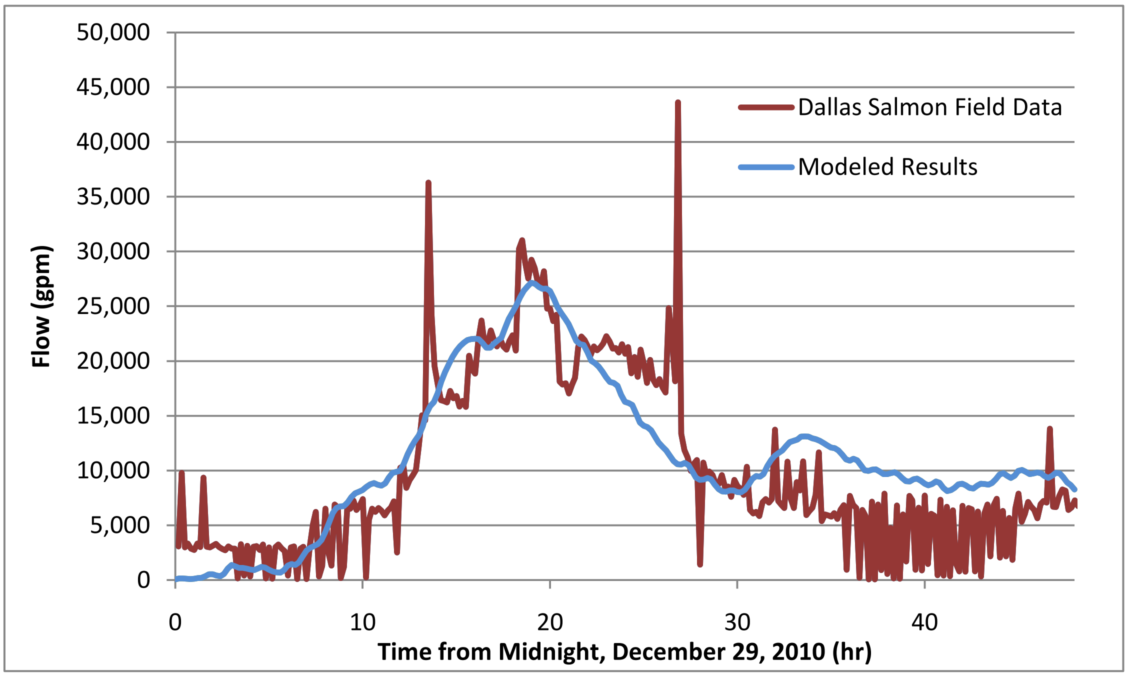

Figure 4-2
Comparison of Modeled Results and Field Data for Verification Storm

4.6 Modeling Scenarios

The wastewater collection system was modeled using four scenarios:

- Existing Scenario;
- Capital Improvement Plan Scenario;
- 2020 Scenario; and
- Buildout Scenario.

Each scenario included a dry weather and wet weather model run. The model results for each scenario were evaluated to determine potential improvement projects for the City. The evaluation criteria and performance assessment of the model results is presented in **Section 5**. The development of the scenarios is described in the following sections.

4.6.1 Existing Scenario

The existing scenario takes into consideration the current wastewater flows in the existing infrastructure. The existing wastewater flow development in dry and wet weather condition was described in **Section 2**.

4.6.2 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.

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

4.6.3 2020 Scenario

The 2020 scenario uses the CIP scenario as a base with the addition of currently unserved customers in the Whispering Lakes subdivision. The City requested that CDM add the Whispering Lakes subdivision to the collection system to plan for converting them off of septic tanks by 2020. The projected wastewater flowrates for commercial and residential property types for 2020 were applied to the CIP scenario to create the 2020 scenario. The development of the projected wastewater flowrates for 2020 is described in **Section 2.6.1**.

4.6.4 Buildout Scenario

The buildout scenario considers the City's desired buildout goal. Unlike the other scenarios, the buildout scenario does not build on existing wastewater flows with the use of growth rates and projected short-term developments. Instead, the buildout scenario considers the planned land use zones at buildout and applies wastewater generation factors to the population density for each land use zone. The development of the projected wastewater flows at buildout is described in **Section 2.6.2**.

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 wastewater collection system and discuss the performance of the system. The wastewater system was evaluated using the hydraulic model and evaluation criteria described in this section. Gravity pipeline surcharging, force main velocities, lift station capacities and WWTP capacities were investigated. Deficiencies within the wastewater infrastructure for existing and future wastewater flows are identified 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 for this master plan was established based on typical planning criteria used in wastewater systems of similar size, local and state codes, engineering judgment, commonly accepted industry standards and input from City staff. The "industry standards" are typical 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. Planning criteria used in the evaluation of the City's wastewater system are presented in the following sections.

5.1.1 Gravity Collection System

The collection system was evaluated under both dry weather and wet weather flow conditions. During dry weather flow condition, TCEQ requires that a collection system be designed to prevent any surcharge in the pipe at the expected peak wastewater flow. Also, a common rule of thumb is that the peak dry wastewater flow shall not exceed 80 percent of the capacity of the pipe flowing full.

Overflows at manholes are prohibited during both dry and wet weather flow conditions. Pipe surcharge during wet weather flow condition is also a critical criterion; however a pipe surcharge during a dry weather flow condition would carry a larger priority. The collection system evaluation criteria are presented in **Table 5-1**.

System Flow Condition	Criteria
Dry Weather	Overflowing manholes
	Pipes surcharged
	Pipes > 80% capacity full flow
Wet Weather	Overflowing manholes
	Pipes surcharged

Table 5-1
Collection System Evaluation Criteria

In addition, TCEQ requires a minimum velocity of 2 ft/s, a maximum velocity of 10 ft/s (otherwise pipe protection required) and a minimum acceptable Manning's n of 0.013. Using the Manning equation with these parameters, TCEQ has determined minimum and maximum slope for gravity sewer lines up to 39 inches as shown in **Table 5-2**. With the exception of service laterals and force mains, the minimum size for gravity collection lines is six inches in diameter. The majority of surveyed lines in League City did not meet the TCEQ minimum recommended slopes in **Table 5-2**.

Size of Pipe *(inches)*	Minimum Slope *(%)*	Maximum Slope *(%)*
6	0.50	12.35
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.11	2.83
21	0.09	2.30
24	0.08	1.93
27	0.06	1.65
30	0.055	1.43
33	0.05	1.26
36	0.045	1.12
39	0.04	1.01
>39	*	*

Source - Figure: 30 TAC §217.53(l)(2)(A)
* For pipes larger than 39 inches in diameter, the slope is determined by Manning's formula to maintain a velocity greater than 2.0 feet per second and less than 10.0 feet per second when flowing full.

Table 5-2
TCEQ Minimum and Maximum Pipe Slopes

5.1.2 Lift Stations and Force mains

The planning criteria for lift stations and force mains are as follows:

- ***Force mains***: Velocities shall not exceed 8 ft/s.
- ***Lift Stations, Pumping Capacity***: Lift stations shall be designed to have a firm capacity that can pump the peak wastewater flow. Firm capacity is defined as the lift station capacity with the largest pump out of service.
- ***Lift Stations, Wet Well Volume***: Wet well storage volume shall be designed to provide adequate storage volume at peak wastewater flow.

For force mains and lift station pumping capacity, the model predicted values could be used directly to assess performance. Lift station wet well volume evaluations require additional information. TCEQ requires a minimum wet well volume based on design pump rate and horsepower to limit pump starts that may lead to excessive wear and tear on the pump. To assess the adequacy of wet well volume, the working volume is compared to the recommended minimum volume as determined based on recommended minimum cycle times. **Figure 5-1** shows a wet well schematic with applicable data points indicated.

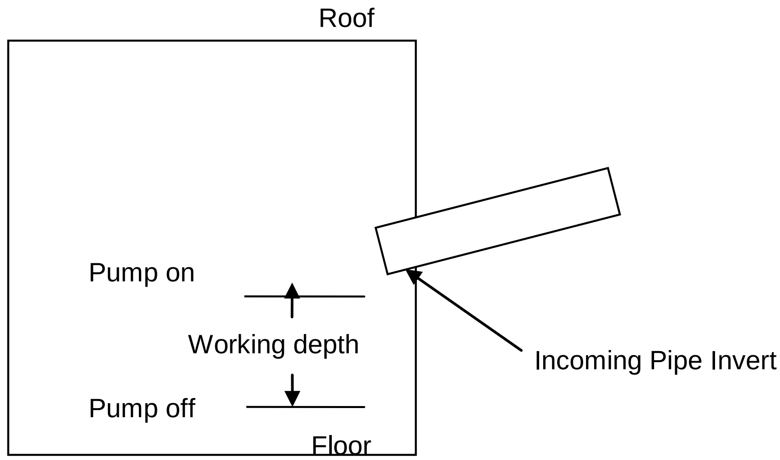

Figure 5-1
Lift Station Wet Well Schematic

Wet wells should be sized to prevent excessive pump starts that could lead to excessive wear and tear on the pump motors. Adequate volume can be calculated from the following equation:

$$Vol = \frac{t \times Q}{29.92}$$

Where Q = pump design capacity (gpm)
t = minimum allowable cycle time (min)
Vol = recommended storage volume (ft^3)

Minimum cycle times required by TCEQ and recommended per CDM Guidelines on Pumps and Pumping Hydraulics are presented in **Tables 5-3** and **5-4**, respectively. Wet well volumes for this master plan are evaluated in accordance with the more conservative criteria which are the CDM-recommended values.

Pump Horsepower (hp)	Minimum Cycle Time (min)
<= 50	6
<= 100	10
> 100	15

Table 5-3
TCEQ Minimum Pump Cycle Times

Pump Horsepower (hp)	Minimum Cycle Time (min)
<= 15	10
<= 50	15
<= 200	20
> 200	30

Table 5-4
CDM Recommended Minimum Pump Cycle Times

5.1.3 Wastewater Treatment Plants

The planning criteria for the WWTPs consist of the existing and future WWTP flows, specifically the average daily flow not exceeding the plant's treatment capacity. In addition, TCEQ requires that when plant flows reach 75% of the permitted average daily flow for three consecutive months, the permittee shall commence engineering and financial planning for the expansion and/or upgrading of the WWTP. Furthermore, TCEQ requires that when plant flows reach 90% of the permitted average daily flow for three consecutive months, the permittee shall obtain necessary authorization from TCEQ to commence construction of the necessary additional treatment and/or collection facilities. **Table 5-5** indicates the 75%/90% flow discharge limits for each of the City's WWTPs.

Flow Parameter	Dallas Salmon WWTP	SWWRF
Permitted Average Daily Flow	12.0 MGD	4.0 MGD
90% Flow	10.8 MGD	3.6 MGD
75% Flow	9.0 MGD	3.0 MGD

Table 5-5
75/90 Percentile Flows at WWTPs

5.2 Performance Assessment

The performance of the collections system was analyzed based on the evaluation criteria presented in **Section 5.1**. The evaluation strategy for each component of the collection system is described below.

5.2.1 Gravity Sewer

The term "percent of pipe capacity used" is used to evaluate gravity sewers. It is calculated by comparing the actual or projected maximum flow in the sewer to the mathematically calculated full capacity of the pipe based on slope. There are a large number of surveyed pipes with negative slope, meaning the pipe capacity is actually negative. The pipes represented in the figures are color coded based on percent capacity used as indicated in the legend. The pipes shown in red are flowing at 100 percent full (or greater) and are considered surcharged. It should be noted that pipes shown as surcharged or manholes shown overflowing are not necessarily over design capacity. A downstream restriction, such as a lift station, may cause flow to back up and surcharge the pipes and manholes even though the pipes have adequate capacity to convey the flow.

5.2.2 Lift Stations and Force Mains

The capacity of the lift stations and force mains were analyzed based on pumping capacity and wet well water levels. The wet well for each lift station was modeled based on pump ON and OFF water level settings. The pump settings were obtained from the record drawings for each lift station and included in the model. Lift stations for which the water level exceeded the high level alarm setting and caused surcharge in upstream gravity sewers were considered deficient.

The velocity in the force mains was analyzed to determine deficiency. Force mains with a velocity greater than 8 ft/s under peak wet weather flow conditions were considered deficient.

5.2.3 WWTPs

The ADF at each WWTPs was analyzed to determine whether a WWTP expansion would be needed. Once a WWTP reaches 75 percent of its permitted ADF, work must begin to design and identify funding for the next expansion. Once the WWTP reaches 90 percent of its permitted ADF, construction needs to commence.

As the average dry weather flow was modeled and not the ADF, it was necessary to convert the average dry weather flow into ADF. Evaluating the WWTP flow data for the years 2007 to 2009 discussed in **Section 2.5.2**, the ADF was approximately 16 percent higher than the average dry weather flow. Given the limited years of data (of which, two were considered "dry years"), this number was rounded up to 20 percent. The estimated ADF at buildout for each WWTP was calculated by adding 20 percent to the projected average dry weather flow. This ADF value was then converted to a peak 2-hour flow using a peaking factor of 3.1 which was developed in the City's 2006 Wastewater Master Plan Update.

5.3 Dry Weather and Wet Weather Capacity Analysis

The hydraulic model was run with peak existing dry weather and wet weather flows (2010) and predicted future dry weather and wet weather flows (2020 and buildout) to confirm existing capacity of the system and determine areas that are predicted to be susceptible to surcharging and overflows. The analysis identifies system components that have limited capacity to convey flows under existing as well as future conditions.

The wet weather design flows contained the average dry weather flow predicted for the planning period combined with the wet weather flows from the design storms. A 2-year design storm was used for this study as discussed in **Section 2.5.3**. The unit hydrograph method described in **Section 2.5.3.2** was used to simulate the RDI/I flows that would occur during the design storm.

5.3.1 Existing Scenario

The modeling results for the dry weather and wet weather analysis for the "Existing Scenario" are presented in **Figure 5-2** and **Figure 5-3** respectively. Information on the full capacity and percentage of the capacity used for all pipes 12-inches and larger for dry and wet weather is located in **Appendix D**. The results indicate the following:

- No manhole overflows were observed
- Majority of the pipes were less than 40% full (blue pipes). The interceptor predicted to be surcharged is the 24-inch line along Butler Road due to poor slope
- No lift stations indicated high water levels in the wet well and did not trigger the high level alarm setting.
- Force mains pumping flow from the following lift stations were predicted to have a velocity between 8 and 10 ft/s.
  - Clear Creek Crossing
  - Clear Creek Village
  - Countryside 1
  - South Shore Harbor 3
- The average dry weather flow to Dallas Salmon WWTP and Countryside WWTP were predicted to be 5.42 MGD (6.50 MGD ADF) and 0.43 MGD (0.52 MGD ADF) respectively.

5.3.2 2020 Scenario

The "2020 Scenario" included the currently planned CIP projects for the City. The modeling results for this scenario were similar to the "Existing Scenario". The results indicate the following:

- The following interceptors were predicted to be surcharged:
  - 24-inch line to East Main lift station
  - 8-inch line that receives flow from the Bayou Brae lift station force main
- No additional force mains have a velocity that exceeds 8 ft/s.
- The average dry weather flow to Dallas Salmon WWTP and SWWRF were predicted to be 6.62 MGD (7.94 MGD ADF) and 1.60 MGD (1.92 MGD ADF) respectively.

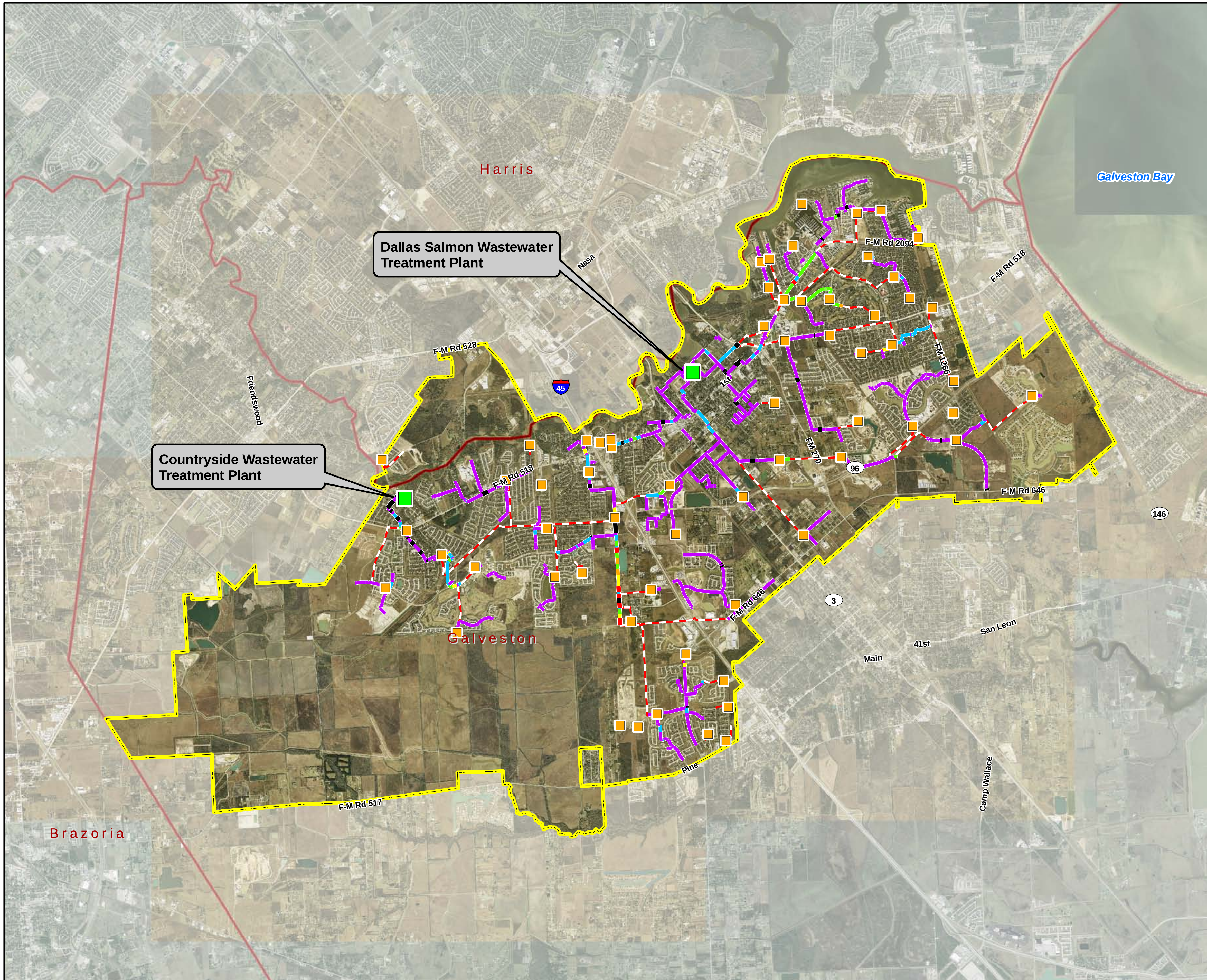

Figure 5-2

Dry Weather Flow Analysis
Existing Scenario
Gravity Sewers Used Capacity

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Wastewater Treatment Plant
- Lift Station

Pipe Capacity - Dry Weather Condition

- > 100%
- 81% - 100%
- 61% - 80%
- 41% - 60%
- 21% - 40%
- 0% - 20%
- Negative Slope
- Force Main
- League City City Limit
- County Boundary

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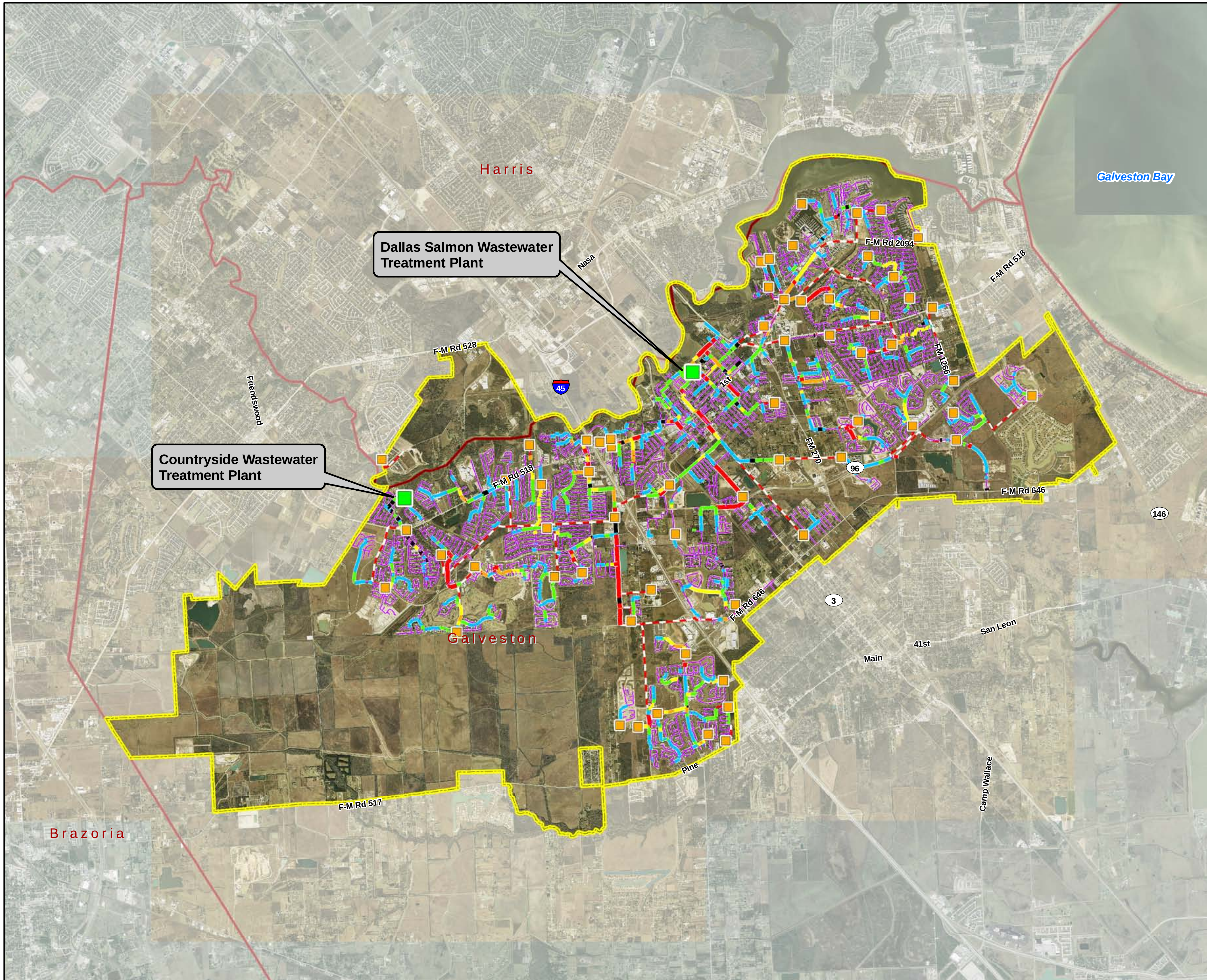

Figure 5-3

Wet Weather Flow Analysis
Existing Scenario
Gravity Sewers Used Capacity

City of League City, Texas
Wastewater Master Plan 2012

Facility

- Wastewater Treatment Plant
- Lift Station

Pipe Capacity - Wet Weather Condition

- > 100%
- 81% - 100%
- 61% - 80%
- 41% - 60%
- 21% - 40%
- 0% - 20%
- Negative Slope
- Force Main
- League City City Limit
- County Boundary

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5.3.3 Buildout Scenario

The results from this scenario indicate the following:

- No manhole overflows were observed in dry weather analysis. However, wet weather analysis predicted manhole overflows in the Bay Colony neighborhood.

- Majority of the gravity lines were less than 40% full (blue pipes) with the exception of:

  - Pipes located in the Bay Colony neighborhood. These trunk lines were predicted to be surcharged in dry weather conditions while their entire collection systems were predicted to be surcharged in wet weather conditions.

  - 12-inch line from South Shore Harbor 2 force main discharge to the South Shore Harbor 3 lift station. Since these segments were not surveyed (diameter less than 15-inch), the extent of surcharging is unclear. Based on the presumed slope, this section is adequate in dry weather but experiences surcharging in wet weather.

  - Line of varying diameter flowing north along S. Shore Blvd. to Bay Ridge lift station. These trunk lines were predicted to be surcharged in wet weather conditions. This is assuming the buildout addition of approximately 500 acres of ETJ area as well as the 2020 addition of the Whispering Lakes Subdivision.

- The water levels exceeded high water levels triggering the high level alarm in the following lift stations during dry weather analysis:

  - Bay Colony 14-15
  - Harbour Park 1

The wet weather analysis also predicted high water levels in these lift stations with a longer duration alarm event.

- No additional force mains have a velocity that exceeds 8 ft/s.

- The average dry weather flow to Dallas Salmon WWTP and SWWRF were predicted to be 9.17 MGD (11.0 MGD ADF) and 5.74 MGD (6.89 MGD ADF) respectively. Below in **Figure 5-4** is a summary of the anticipated growth for both the Dallas Salmon WWTP and the SWWRF.

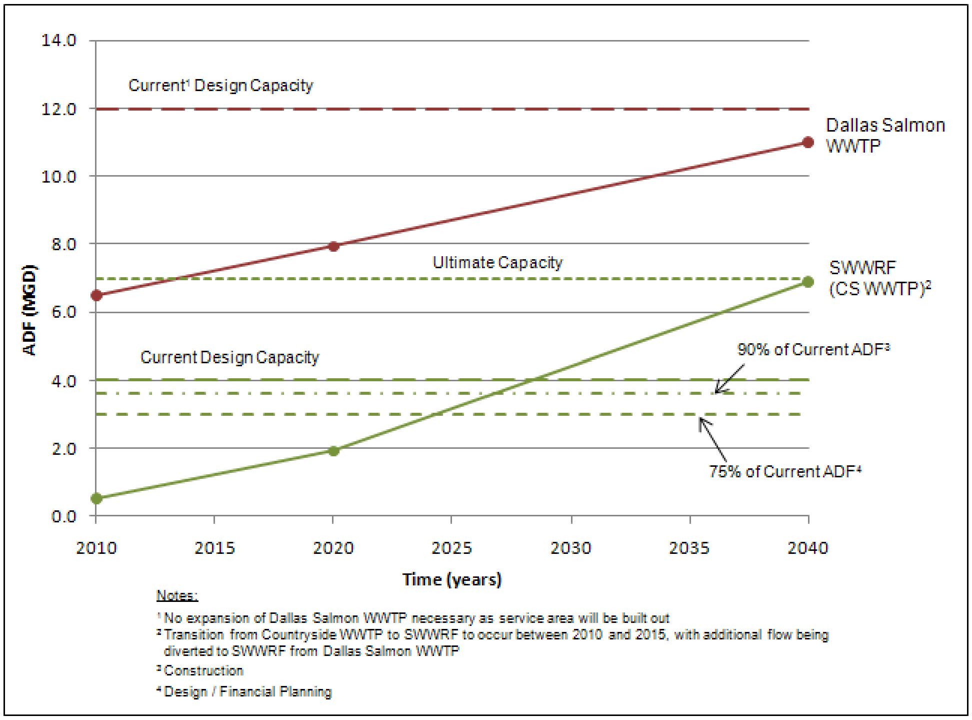

Figure 5-4
ADF Projection for WWTPs through Buildout

Section 6
CIP Projects Development

The dry weather and wet weather modeling results were evaluated based on the evaluation criteria presented in **Section 5** to identify areas with deficiencies in the City's wastewater collection system. This section describes the proposed CIP projects to assist the City in addressing the deficient areas and plan improvements to meet future growth demands. The proposed CIP projects for gravity sewers, manholes (MH), force mains and lift stations (LS) for each modeling scenario are presented below. Large wall-sized figures of the model results are included in **Appendix E**.

6.1 Dry Weather and Wet Weather 2020 Scenario

The modeling results indicate similar deficiencies for the dry weather and wet weather 2020 Scenario. Hence the CIP recommendations are the same for both scenarios. The recommended gravity sewer and force main improvement projects for the 2020 Scenario are outlined below in **Table 6-1** and **Table 6-2** respectively. **Figure 6-**1 illustrates the location of these projects. The existing lift stations do not require any significant improvements under these scenarios.

The gravity sewer project identified in **Table 6-1** is necessary to prevent pipe surcharge. The first two force mains projects identified in **Table 6-2** are necessary to divert wastewater flow from the Countryside WWTP and Dallas Salmon WWTP to the new SWWRF. The Bay Colony 14-15 LS force main is required to prevent wet weather overflows and surcharging.

Project Title	Length (ft)	Diameter (in)	Purpose
New line along Calder Rd[1]	7,450	30	Prevent dry weather surcharging

[1] The new 30-inch line is included in City identified 2012-2016 CIP as combination of 24-inch and 30-inch line.

Table 6-1
Recommended Gravity Sewer Projects for Dry Weather and Wet Weather 2020 Scenario

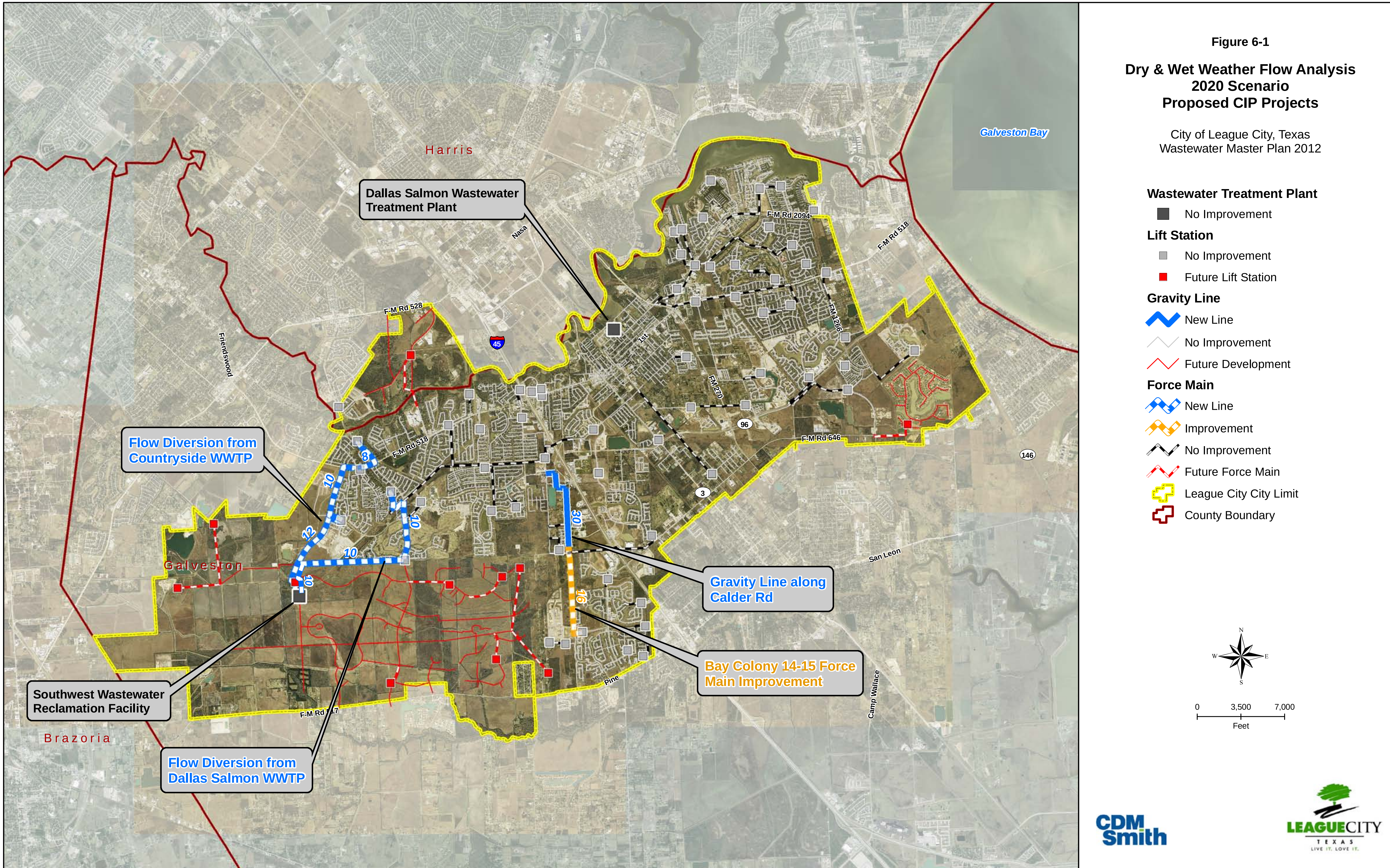

Figure 6-1
Dry & Wet Weather Flow Analysis
2020 Scenario
Proposed CIP Projects
City of League City, Texas
Wastewater Master Plan 2012
Wastewater Treatment Plant
No Improvement
Lift Station
No Improvement
Future Lift Station
Gravity Line
New Line
No Improvement
Future Development
Force Main
New Line
Improvement
No Improvement
Future Force Main
League City City Limit
County Boundary
Galveston Bay
Harris
Galveston
Brazoria
Dallas Salmon Wastewater Treatment Plant
Flow Diversion from Countryside WWTP
Gravity Line along Calder Rd
Bay Colony 14-15 Force Main Improvement
Southwest Wastewater Reclamation Facility
Flow Diversion from Dallas Salmon WWTP
F-M Rd 528
F-M Rd 518
F-M Rd 2094
F-M Rd 646
F-M Rd 517
FM 270
FM 1266
Nasa
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Friendswood
San Leon
Camp Wallace
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Project Title	Length (ft)	Diameter (in)	Purpose
Divert Countryside WWTP, Countryside 1 LS and Westover Park LS to SWWRF	3,600 / 6,500 (existing) / 5,600	8 / 10 (existing) / 12	Diversion to SWWRF
Divert Countryside 2 LS, Magnolia Creek North, and Magnolia Creek South to SWWRF	12,500	10	Diversion to SWWRF
Force Main from Bay Colony 14-15 Lift Station	7,700	16	Prevent wet weather overflows and surcharging

Table 6-2
Recommended Force Main Projects
for Dry Weather and Wet Weather 2020 Scenario

6.2 Dry Weather Buildout Scenario

The recommended gravity sewer, force main and WWTP improvement projects for the dry weather buildout scenario are outlined below in **Table 6-3** to **Table 6-5** respectively. These projects include previously identified projects for the 2020 Scenario listed in **Tables 6-1** and **6-2**. The projects that specifically address improvements in the dry weather buildout scenario are presented in bold. **Figure 6-2** illustrates the location of these projects. The existing lift stations do not require any significant improvements under this scenario. The force main improvement at the West Main LS is required primarily to divert flow around the MUD 6 LS, which currently experiences wet weather issues. The diversion allows the flow from West Main LS to be pumped directly to Butler LS, therefore eliminating this demand and subsequent repumping through the MUD 6 LS. The SWWRF will need to be expanded to accommodate growth in its service area.

Project Title	Length (ft)	Diameter (in)	Purpose
New line along Calder Rd[1]	7,450	30	Prevent dry weather surcharging
[1] The new 30-inch line is included in City identified 2012-2016 CIP as combination of 24-inch and 30-inch line.			

Table 6-3
Recommended Gravity Sewer Projects
for Dry Weather Buildout Scenario

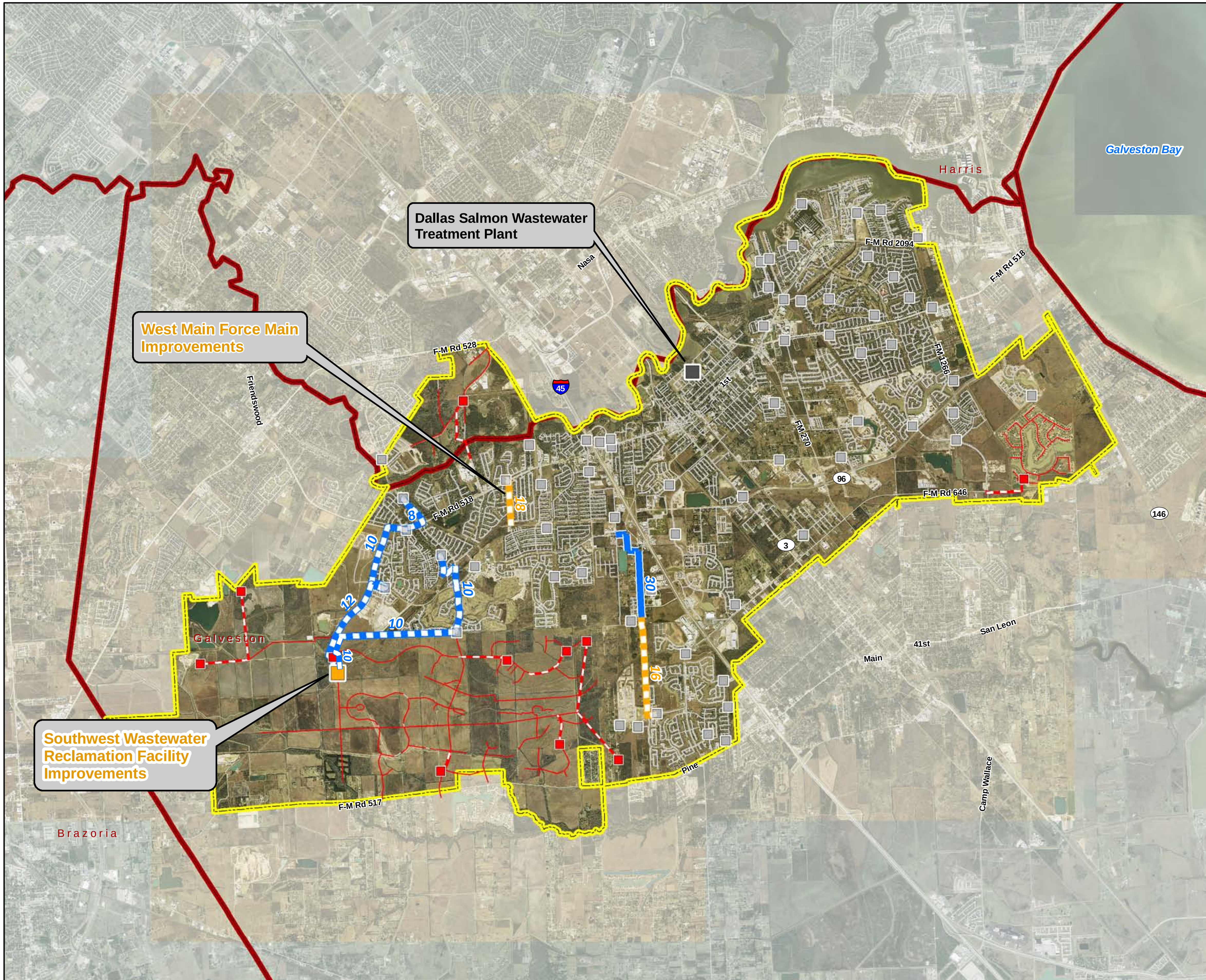

Figure 6-2

Dry Weather Flow Analysis
Build Out Scenario
Proposed CIP Projects

City of League City, Texas
Wastewater Master Plan 2012

Wastewater Treatment Plant

- No Improvement
- Improvement

Lift Station

- No Improvement
- Future Lift Station

Gravity Line

- New Line
- No Improvement
- Future Development

Force Main

- New Line
- Improvement
- No Improvement
- Future Force Main
- League City City Limit
- County Boundary

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Project Title	Length (ft)	Diameter (in)	Purpose
Divert Countryside WWTP, Countryside 1 LS and Westover Park LS to SWWRF	3,600 / 6,500 (existing) / 5,600	8 / 10 (existing) / 12	Diversion to SWWRF
Divert Countryside 2 LS, Magnolia Creek North, and Magnolia Creek South to SWWRF	12,500	10	Diversion to SWWRF
Bay Colony 14-15 LS Force Main	7,700	16	Prevent wet weather overflows and surcharging
West Main LS Force Main Improvement[1]	**6,300**	**18**	**Divert flow from MUD 6 LS**

[1] Engineering Design has been completed

Table 6-4
Recommended Force Main Projects for Dry Weather Buildout Scenario

Project Title	Current Permitted ADF Capacity (MGD)	Required ADF Capacity (MGD)	Purpose
SWWRF Expansion	4.0	7.0	Future development

Table 6-5
Recommended WWTP Projects for Dry Weather Buildout Scenario

Based on the projected growth for the SWWRF service area, the SWWRF will need to be expanded between 2020 and buildout.

6.3 Wet Weather Buildout Scenario

The recommended gravity sewer, force main, lift station and WWTP improvement projects for the wet weather buildout scenario are outlined below in **Table 6-6** to **Table 6-9** respectively. These projects include previously identified projects for 2020 Scenario and the dry weather buildout scenario. The projects that specifically address improvements in the wet weather buildout scenario are presented in bold. **Figure 6-3** illustrates the location of these projects.

The force main extension project from Harbor Park 1 LS is necessary to prevent wet weather pipe surcharge. The lift station improvements at West Main LS are necessary to meet projected growth demands in the northern areas of Near West service area. A new lift station project is proposed at Hobbs Rd to convey flows from the Newport

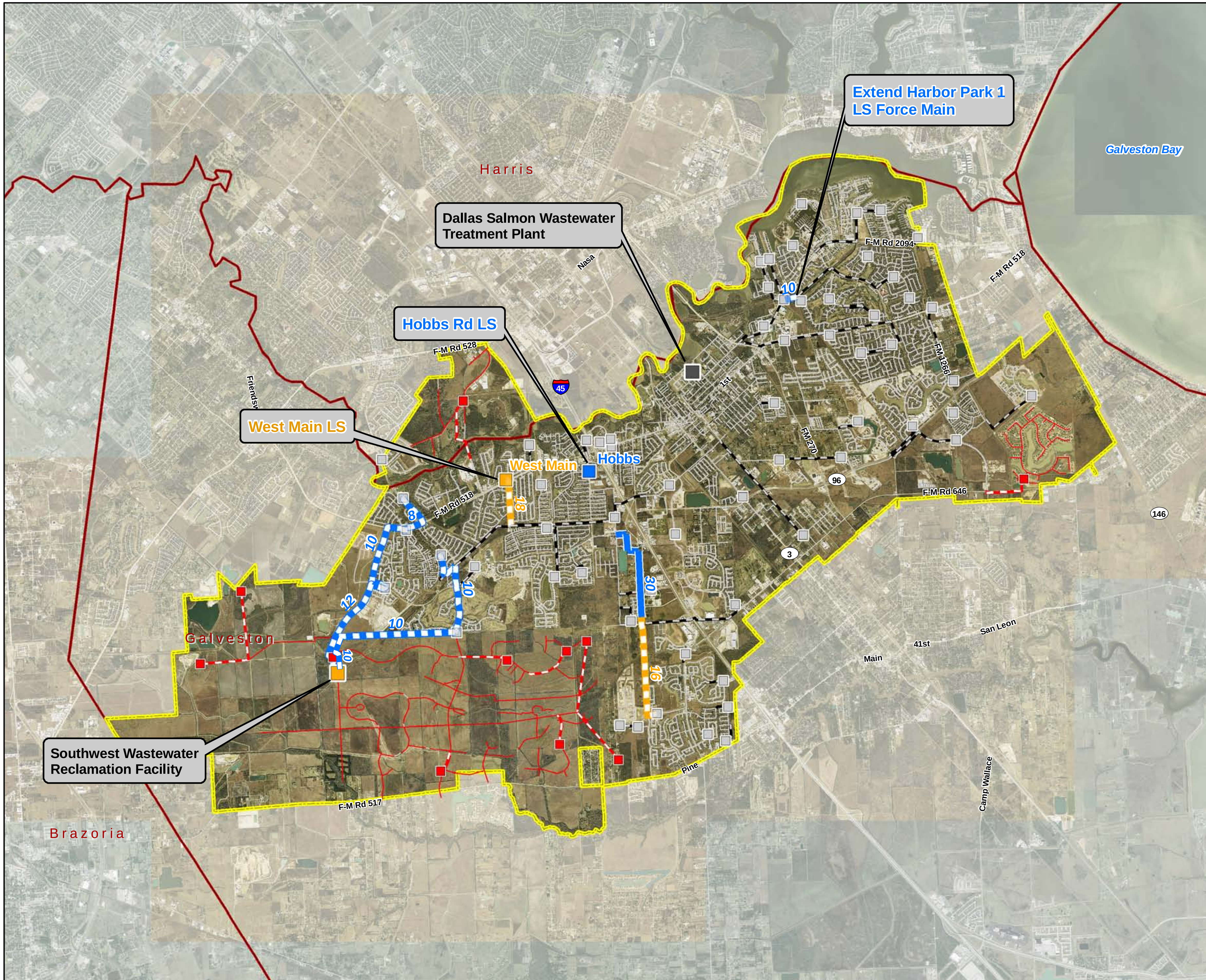

Figure 6-3

Wet Weather Flow Analysis
Build Out Scenario
Proposed CIP Projects

City of League City, Texas
Wastewater Master Plan 2012

Wastewater Treatment Plant
- No Improvement
- Improvement

Lift Station
- New Facility
- Improvement
- No Improvement
- Future Lift Station

Gravity Line
- New Line
- No Improvement
- Future Development

Force Main
- New Line
- Improvement
- No Improvement
- Future Force Main
- League City City Limit
- County Boundary

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subdivision to the collection system on Butler Rd. Currently, the flows from this subdivision are conveyed 2,500 feet north through gravity sewers to Clear Creek Village LS and then pumped back south to the Butler Rd collection system. The new Hobbs Rd lift station will be located near the Butler Rd collection system and hence will require minimum pumping. This will also reduce the flow demand at the Clear Creek Village LS, extending the useful life of its pumps.

Project Title	Length (ft)	Diameter (in)	Purpose
New line along Calder Rd[1]	7,450	30	Prevent dry weather surcharging

[1] The new 30-inch line is included in City identified 2012-2016 CIP as combination of 24-inch and 30-inch line.

Table 6-6
Recommended Gravity Sewer Projects for Wet Weather Buildout Scenario

Project Title	Length (ft)	Diameter (in)	Purpose
Divert Countryside WWTP, Countryside 1 LS and Westover Park LS to SWWRF	3,600 / 6,500 (existing) / 5,600	8 / 10 (existing) / 12	Diversion to SWWRF
Divert Countryside 2 LS, Magnolia Creek North, and Magnolia Creek South to SWWRF	12,500	10	Diversion to SWWRF
Bay Colony 14-15 LS Force Main	7,700	16	Prevent wet weather overflows and surcharging
West Main LS Force main Improvement[1]	6,300	18	Reduce velocity and head loss
Bypass gravity line from MH 6408 to MH 1040 by extending force main from Harbor Park 1 LS	**1,000**	**10**	**Prevent wet weather surcharging**

[1] Engineering Design has been completed

Table 6-7
Recommended Force main Projects for Wet Weather Buildout Scenario

Project Title	Current Firm Capacity (gpm)	Current Head (ft)	Required Firm Capacity (gpm)	Required Head (ft)	Purpose
West Main LS Improvement[1]	**1,200**	**77**	**3,500**	**85**	**Future development**
Hobbs Rd Lift Station and Force Main	**-**	**-**	**900**	**20**	**Reduce load on other LS, shorten time to WWTP**

[1] Engineering design has been completed.

Table 6-8
Recommended Lift Station Projects for Wet Weather Buildout Scenario

Project Title	Current Permitted ADF Capacity (MGD)	Required ADF Capacity (MGD)	Purpose
SWWRF Expansion	4.0	7.0	Future development

Table 6-9
Recommended WWTP Projects for Wet Weather Buildout Scenario

6.4 Eliminated Projects

Some of the projects identified based only on the evaluation criteria during the modeling process presented in **Section 5** were eliminated as projects. The projects and reasons for elimination are presented in **Table 6-10**.

Project Title	Length (ft)	Diameter (in)	Purpose	Reason for Elimination
Clear Creek Village LS Force Main Improvement	1,200	10	Reduce velocity	Velocity exceeds 8 ft/s (but less than 9 ft/s) Area has reached its built out capacity; hence no additional flow due to development is expected
South Shore Harbor 3 LS Force Main Improvement	400	12	Reduce velocity	Velocity exceeds 8 ft/s (but less than 9 ft/s) Area has reached its built out capacity; hence no additional flow due to development is expected Force main is short
Clear Creek Crossing LS Force Main Improvement	420	10	Reduce velocity	Velocity exceeds 8 ft/s (but less than 9 ft/s) Area has reached its built out capacity; hence no additional flow due to development is expected Force main is short
Improvement at Intersection of League City Parkway and Highway 3	250	10	Wet weather surcharging	Sections of line are surcharged but given the major intersection as well as the short length, project was eliminated

Table 6-10
Eliminated Projects

Project Title	Length (ft)	Diameter (in)	Purpose	Reason for Elimination
Gravity Line Collecting Bayou Brae LS's force main	350	8	Dry weather surcharging	Section experiences surcharging but given location and short length, project was eliminated
Gravity Line from South Shore Harbor 2 Force Main Discharge to South Shore Harbor 3 LS	3,200	12	Wet weather surcharging	Since line was not surveyed, impossible to know the severity of surcharging and if improvements would be recommended - Recommend surveying to evaluate in the future
Gravity Line Flowing North Along S. Shore Blvd to Bay Ridge LS	4,200	15 - 21	Wet weather surcharging	Improvements contingent on if ETJ flow is directed to this line in the future. If it is, it needs to be re-evaluted with specific flows since most segments don't meet TCEQ recommended minimum slope

Table 6-10
Eliminated Projects - Continued

6.5 Future Sewer Developments

The City has identified two major areas that are anticipated to develop in future: the area north of Clear Creek and the three development tracts in the southwest part of the City. The exact timeline for development of these areas is not known at this time. To model these areas, the available planning materials were used as a base, and adjusted as necessary to accommodate the anticipated flows for buildout. Pipes of sizes 10-inch and greater were modeled in these areas. The gravity lines were assumed to have a maximum depth of 20 feet and designed to meet TCEQ recommended minimum slopes criteria identified in **Table 5-2**. Lift stations were inserted where appropriate, i.e. the maximum depth of 20 feet for the trunk line was reached.

Figure 6-4 and **Figure 6-5** presents the model results for the future development north of Clear Creek and southwest development tracts with assumed pipe diameters and flow directions. The trunk lines for the southwest development were sloped based on the invert elevation of the 54-inch pipe entering the manhole at the SWWRF, which is set at -0.80 ft.

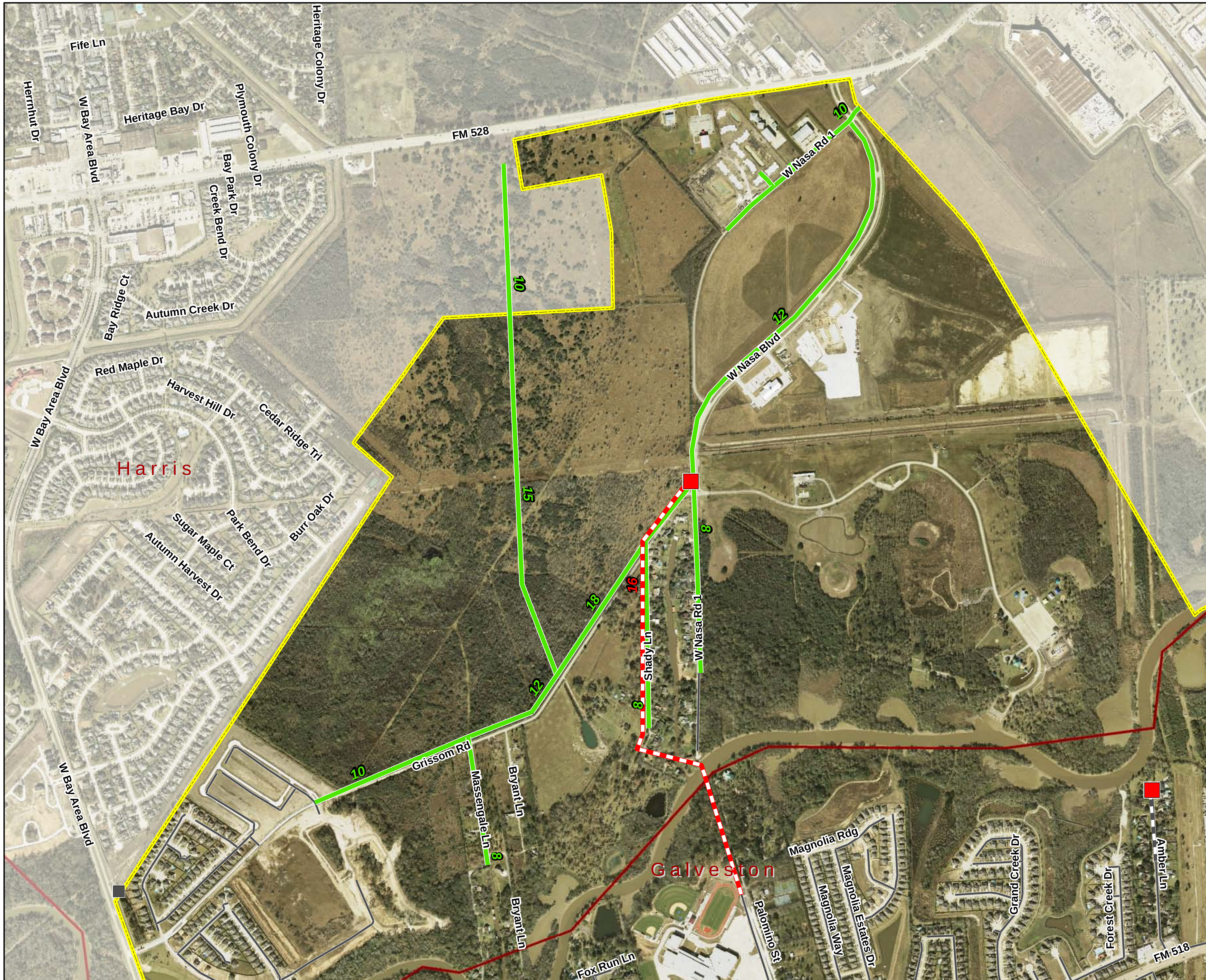
In addition to the two major undeveloped areas, the City has indicated that the Whispering Lakes subdivision will be converted from septic tanks to a central collection system by the year 2020. **Figure 6-6** shows the proposed sewer layout for Whispering Lakes as provided by the City and simplified for modeling purposes.

Figure 6-4

Proposed Sanitary Collection System Layout of Northern Future Development

City of League City, Texas
Wastewater Master Plan 2012

*Based on design performed by Brown & Gay Engineers, Inc, 2009



Future

- Lift Station
- Force Main
- Gravity Line

Existing System

- Lift Station
- Force Main
- Gravity Line
- League City City Limit
- County Boundary

N W E S

0 500 1,000
Feet

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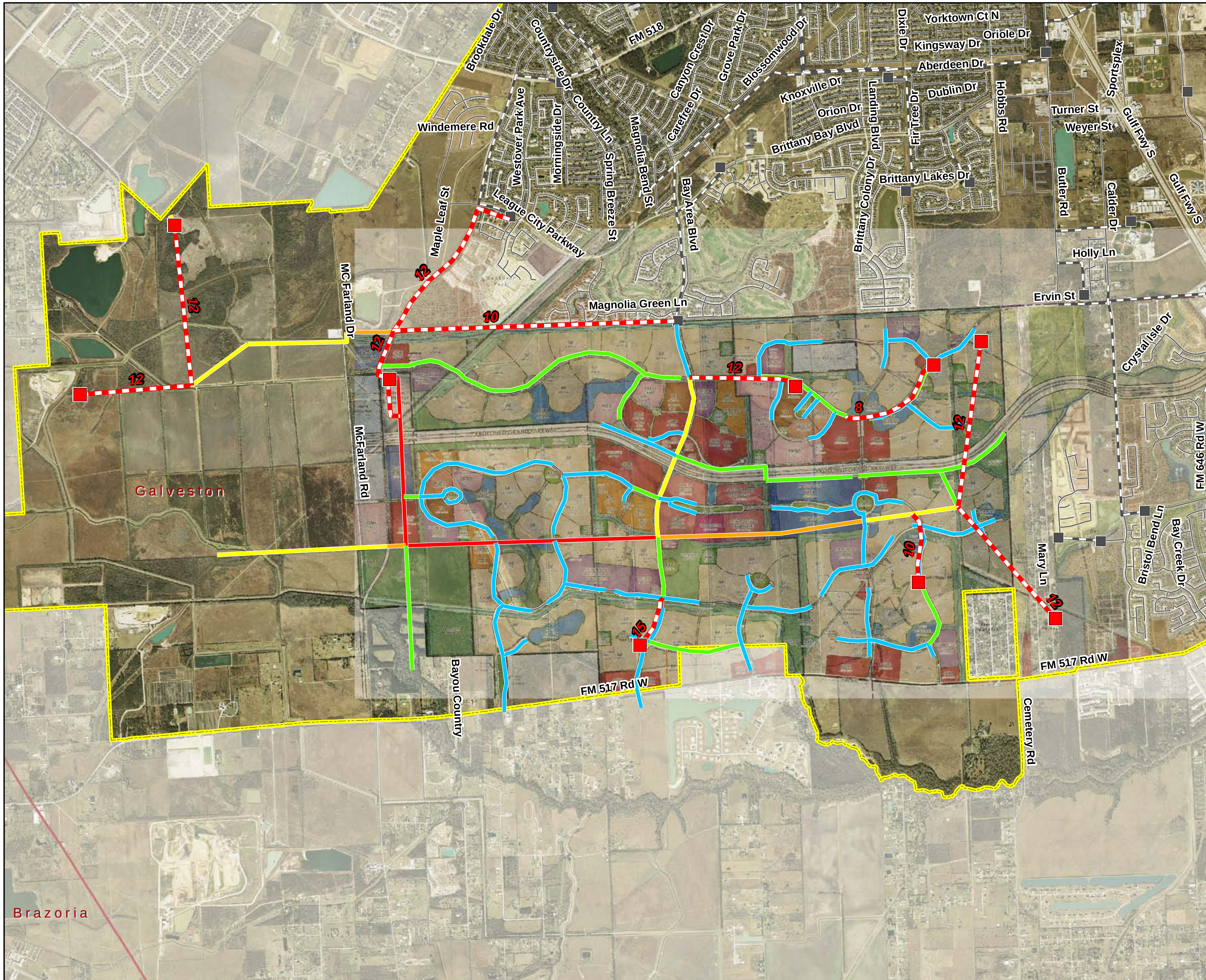
Figure 6-5

Proposed Sanitary Collection System Layout of Southwest Future Development for Wet Weather Buildout Scenario

City of League City, Texas
Wastewater Master Plan 2012



Future

- Lift Station
- Force Main

Future Gravity Lines

- 10" - 12"
- 15" - 18"
- 24" - 30"
- 36" - 42"
- > 42"

Existing System

- Lift Station
- Force Main
- Gravity Line
- League City City Limit
- County Boundary

N
W E
S

0 1,500 3,000
Feet

CDM Smith

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Figure 6-6

Proposed Sanitary Collection System Layout of Whispering Lakes Future Sewer System for Wet Weather Buildout Scenario

City of League City, Texas
Wastewater Master Plan 2012

Future

- Lift Station
- Gravity Line
- Force Main

Existing System

- Lift Station
- Gravity Line
- Force Main
- League City City Limit
- County Boundary

N S W E

0 500 1,000
Feet

CDM Smith

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Section 7
Recommended Plan

This section presents the recommended plan and costs for the implementation of the CIP projects presented in **Section 6**.

7.1 Development of Project Priority

To assist the City with project planning, the CIP projects were separated into categories based on priority ranking criteria presented in **Table 7-1**. The four priority levels indicate the urgency of a project for optimum impact on the wastewater system. Typically the highest priority would be preventing dry weather overflows, however there are no identified dry weather overflows in the modeling results. Priority 2 is identified here as having overflowing manholes in wet weather since this is a TCEQ violation and requires reporting.

Priority Ranking	System Flow Condition	Criteria
Priority 1	All Conditions	Flow diversion to SWWRF
Priority 2	Wet Weather	Overflowing manholes
Priority 3	Dry Weather	Pipes surcharged
Priority 4	Wet Weather	Pipes surcharged

Table 7-1
Priority Ranking Criteria

7.2 Prioritization Matrix for CIP Projects

The prioritization matrix for the recommended CIP projects is presented in **Table 7-2**. **Figure 7-1** shows a pictorial view of prioritized projects. A wall-size map of the project prioritization matrix is included in **Appendix F**.

Project Number	Priority	Project Title	Approximate Length (ft)	Diameter (in)	Required Firm Capacity (gpm)	Required Head (ft)	Recommended Scenario
1	1	Divert Countryside WWTP, Countryside 1 LS and Westover Park LS to SWWRF	3,600 / 6,500 (existing) / 5,600	8 / 10 (existing) / 12	-	-	Existing[1]

Table 7-2
CIP Projects Prioritization Matrix

Project Number	Priority	Project Title	Approximate Length (ft)	Diameter (in)	Required Firm Capacity (gpm)	Required Head (ft)	Recommended Scenario
2	1	Divert Countryside 2 LS, Magnolia Creek North, and Magnolia Creek South to SWWRF	12,500	10	-	-	Existing[1]
3	2	Bay Colony 14-15 LS Force Main	7,700	16	-	-	2020[2]
4	3	New line along Calder Rd	7,450	30	-	-	Existing[1]
5	3	SWWRF Expansion to 7.0 MGD	-	-	-	-	Buildout[3]
6	4	Bypass gravity line from MH 6408 to MH 1040 with extended force main from Harbor Park 1 LS	1,000	10	-	-	Buildout[3]
7	4	West Main LS and Force Main Improvement[4]	6,300	18	3,500	85	Buildout[3]
8	4	Hobbs Rd Lift Station and Force Main	-	-	900	20	Buildout[3]

Notes:

[1] CIP projects required to address deficiencies predicted in the Existing Scenario

[2] CIP projects required to address deficiencies predicted in the 2020 Scenario

[3] CIP projects recommended to address deficiencies predicted in buildout scenario (modeling did not assume an exact time frame for buildout analysis)

[4] Engineering design has been completed

Table 7-2
CIP Projects Prioritization Matrix - Continued

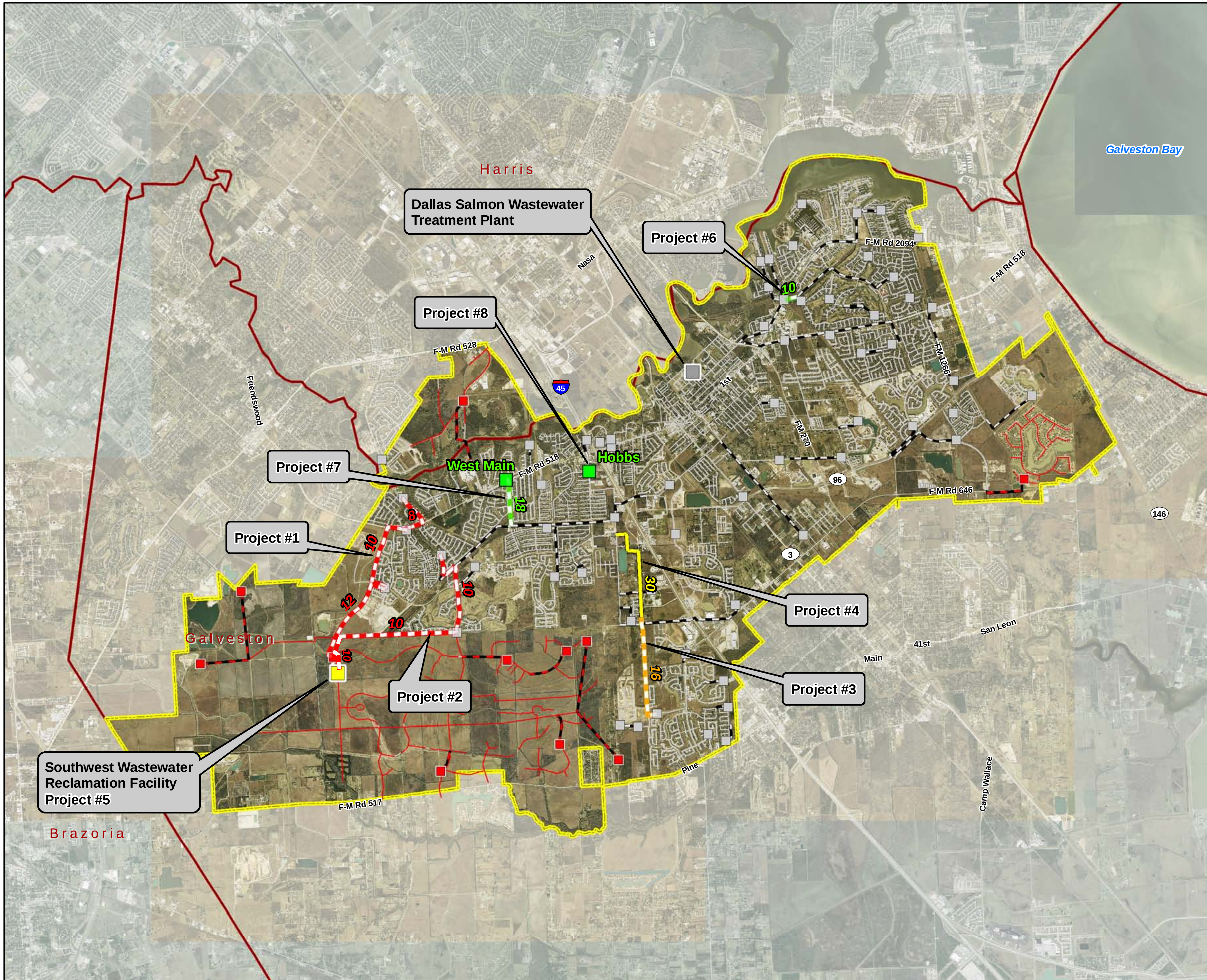

Figure 7-1

Prioritization for CIP Projects

City of League City, Texas
Wastewater Master Plan 2012

Wastewater Treatment Plant
- Priority 3
- No Improvement

Lift Station
- Priority 4
- No Improvement
- Future Lift Station

Gravity Line
- Priority 3
- No Improvement
- Future Development

Force Main
- Priority 1
- Priority 2
- Priority 4
- Future Force Main
- No Improvement
- League City City Limit
- County Boundary

N S W E

0 3,600 7,200
Feet

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7.3 Development of Costs

The CIP pipeline costs were determined using a standard unit cost estimate for the appropriate pipe diameter, pipe material and depth. The gravity sewers were assumed to be made of polyvinyl chloride (PVC) SDR-26 standard material. The force mains were assumed to be made of ductile iron (DI). The gravity sewer unit cost estimate and force main unit cost estimate per linear foot (LF) of pipe are presented in **Table 7-3** and **Table 7-4** respectively. The manhole cost estimate per vertical feet (VF) of manhole depth is presented in **Table 7-5**. All unit costs are inclusive of markups related to raw construction cost.

Diameter (inches)	Open Cut Sewer Inclusive Construction Cost Estimate ($/LF)				
	Depth up to 6 ft	Depth up to 10 ft	Depth up to 14 ft	Depth up to 20 ft	Depth up to 30 ft
8	$60	$80	$130	$230	$500
10	$70	$90	$140	$240	$510
12	$80	$100	$150	$260	$530
15	$100	$120	$170	$280	$550
18	$120	$150	$190	$300	$580
21	$150	$180	$230	$330	$610
24	$180	$210	$260	$370	$640
27	$210	$240	$290	$400	$670
30	$260	$280	$330	$440	$720
36	$350	$380	$430	$540	$820
42	$440	$470	$520	$640	$920
48[1]	$380	$410	$460	$570	$860
54[1]	$450	$490	$540	$650	$940

[1] Hobas used in lieu of PVC as PVC is not available in SDR 26 in these sizes.

Table 7-3
Open Cut Sewer Construction Cost Estimate for PVC-SDR 26 Pipe

Diameter (inches)	Force Main Inclusive Construction Cost Estimate ($/LF)				
	Depth up to 6 ft	Depth up to 10 ft[1]	Depth up to 14 ft[1]	Depth up to 20 ft[1]	Depth up to 30 ft[1]
8	$100	$130	$170	$280	$550
10	$120	$150	$190	$300	$570
12	$140	$170	$210	$320	$590
16	$180	$210	$250	$360	$630
18	$200	$230	$270	$380	$660
24	$260	$290	$340	$450	$730
30	$350	$380	$430	$540	$820
36	$440	$470	$520	$630	$920
42	$540	$570	$620	$730	$1,020
48	$660	$690	$740	$860	$1,140

[1] Depths not used to develop force main cost estimates and included for City reference only.

Table 7-4
Force main Construction Cost Estimate for DI Pipe

Manhole Diameter (ft)	Manhole Inclusive Construction Cost Estimate ($/VF)				
	Depth up to 6 ft	Depth up to 10 ft	Depth up to 14 ft	Depth up to 20 ft	Depth up to 30 ft
4	$3,500	$4,700	$6,000	$8,700	$14,700
6	$6,800	$8,900	$10,800	$14,700	$22,900
8	$12,600	$16,600	$20,800	$27,900	$41,500

Table 7-5
Manhole Construction Cost Estimate

The intended use of this type of estimate is for planning purposes only and gives a basis 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, engineering and right-of-way or easement acquisition.

The total project costs also include the following costs on top of the raw construction costs:

- ***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.

An assumption was made that a 25 feet wide easement would need to be purchased for all pipeline projects. The easement cost was assumed to be $0.50 per square foot of easement. This cost was obtained from similar wastewater master plan projects and will vary from project to project and over time.

The opinion of probable construction cost for the recommended CIP projects is presented in **Table 7-6**. The detailed CIP cost sheets along with the project description for each project is included in **Appendix G**.

Project ID	Priority	Project Title	Recommended Scenario	Total Project Cost ($)
1	1	Divert Countryside WWTP, Countryside 1 LS and Westover Park LS to SWWRF	Existing[1]	$1,400,000 [5]
2	1	Divert Countryside 2 LS, Magnolia Creek North, and Magnolia Creek South to SWWRF	Existing[1]	$830,000 [5]
3	2	Bay Colony 14-15 LS Force Main	2020 [2]	$2,140,000
4	3	New Gravity Line along Calder Rd	Existing[1]	$5,180,000
5	3	SWWRF Expansion to 7.0 MGD	Buildout[3]	$27,000,000
6	4	Bypass gravity line from MH 6408 to MH 1040 with extended force main from Harbor Park 1 LS	Buildout[3]	$210,000
7	4	West Main LS and Force Main Improvement[4]	Buildout[3]	$1,580,000 [5]
8	4	New Hobbs Rd Lift Station and Force Main	Buildout[3]	$600,000 [5]

Notes:
[1] CIP projects required to address deficiencies predicted in the Existing Scenario
[2] CIP projects required to address deficiencies predicted in the 2020 Scenario
[3] CIP projects recommended to address deficiencies predicted in buildout scenario (modeling did not assume an exact time frame for buildout analysis)
[4] Engineering design has been completed
[5] Costs developed by League City

Table 7-6
CIP Projects Opinion of Probable Construction Cost

7.4 Wastewater Treatment Plant Expansions

Preliminary results from the buildout scenarios for the ultimate treatment flows at the two WWTPs are shown in **Table 7-7**. The average dry weather flows should not be confused with average daily flows (ADF) which will include some rain events. See

Section 5.2.3 for further discussion on how average dry weather flow was converted into ADF. **Figure 5-4** in **Section 5.3.3** shows the projected growth and expansion timelines for each WWTP as necessary. No expansion of the Dallas Salmon WWTP will be necessary through the buildout scenario. The SWWRF does not require an expansion through the 2020 planning period, but will require a 3 MGD ADF expansion for the buildout scenario.

Wastewater Treatment Plant	Average Dry Weather Flow	Estimated ADF[1]	Peak 2-Hour Flow[2]
Dallas Salmon Wastewater Treatment Plant	6,400 gpm (9.2 MGD)	7,700 gpm (11.1 MGD)	23,800 gpm (34.3 MGD)
Southwest Water Reclamation Facility	4,000 gpm (5.7 MGD)	4,800 gpm (6.9 MGD)	14,900 gpm (21.5 MGD)

Notes:
[1] Calculated by adding 20% to Average Dry Weather Flow based on available historical WWTP flow data
[2] Calculated by multiplying Estimated ADF by 3.1, the peaking factor used in the 2006 Wastewater Master Plan Update

Table 7-7
Flows Projected for WWTPs in Buildout Scenarios

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