Innovative approaches
Practical results
Outstanding service

2016 WATER AND WASTEWATER CONDITION AND CAPACITY ASSESSMENT STUDIES

Prepared for:

City of Huntsville

November 2016

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

Freese and Nichols, Inc. (FNI) was retained in 2015 by the City of Huntsville to prepare the *Water and Wastewater Condition and Capacity Assessment Studies*. The City currently provides water and wastewater service to approximately 40,000 people, including seven Texas Department of Criminal Justice (TDCJ) units and Sam Houston State University (SHSU). The population within the service area is projected to grow from 40,101 to 55,156 for water service and from 39,894 to 54,949 for wastewater service by 2041. The goals of the *Water and Wastewater Condition and Capacity Assessment Studies* were to evaluate the existing water and wastewater systems and recommend water and wastewater phased Capital Improvement Plans (CIPs) through 2041. The major elements of the scope of this city-wide study included:

- Wastewater Flow Monitoring and Data Analysis
- Wastewater System Inventory and Model Development
- Water Model Development and Field Testing
- Water and Wastewater System Model Calibration
- Population, Water Demand and Wastewater Flow Projections
- Water and Wastewater System Capacity and Operations Analyses
- Water and Wastewater System Risk Based Condition Assessment
- Sanitary Sewer Evaluation Survey (SSES)
- Water and Wastewater System Condition and Capacity CIP and Report

2.0 POPULATION

Population and projected land use are important elements in the analysis of water distribution and wastewater collection systems. Water demands and wastewater loads are dependent on the residential population and commercial development served by the systems and determine the sizing and location of system infrastructure. A thorough analysis of historical and projected populations provides the basis for future water demands and wastewater loads. The projected population and commercial acreage for each planning period is shown in **Table ES-1**. Water and wastewater projected population and commercial acreage are different due to differences in the existing and future service areas.

Table ES-1: Projected Population and Commercial Acreage

Year	Population		Commercial Acreage	
	Water Service Area	Wastewater Service Area	Water Service Area	Wastewater Service Area
2016	40,101	39,894	1,825	1,404
2021	42,669	42,462	1,933	1,512
2026	45,908	45,701	2,138	1,717
2041	55,156	54,949	2,744	2,323

3.0 WATER DEMAND PROJECTIONS

Reviewing historical water demands provides insight into selecting design criteria for projecting future water demands. Annual average day demand, maximum day to average day peaking factors, and per-capita consumption were reviewed and provided a basis for determining the design criteria used to project water demands. **Table ES-2** summarizes the projected water demands by usage type.

Table ES-2: Projected Water Demands by Usage Type (MGD)

Demand Type	Entity Type	2015	2021	2026	2041
Average Day	Residential	3.57	3.83	4.19	5.41
	Non-Residential	1.13	1.20	1.33	1.70
	SHSU	0.62	0.76	0.89	0.89
	TDCJ	1.72	1.72	1.72	1.72
	Total	**7.05**	**7.51**	**8.13**	**9.73**
Maximum Day	Residential	6.07	6.51	7.12	9.20
	Non-Residential	1.92	2.04	2.25	2.89
	SHSU	1.06	1.29	1.51	1.51
	TDCJ	2.93	2.93	2.93	2.93
	Total	**11.98**	**12.77**	**13.81**	**16.54**
Peak Hour	Residential	10.62	11.40	12.46	16.10
	Non-Residential	3.37	3.57	3.94	5.06
	SHSU	1.86	2.25	2.65	2.65
	TDCJ	5.13	5.13	5.13	5.13
	Total	**20.97**	**22.35**	**24.18**	**28.94**

4.0 EXISTING WATER SYSTEM

The City of Huntsville's water system consists of 279 miles of water lines, ranging in size from 0.75-inches to 30-inches. The City relies on treated surface water from the Trinity River Authority Surface Water Treatment Plant and seven groundwater wells to provide water to its residents. The Palm Street and Spring Lake Water Plants distribute water throughout the City. The distribution system facilities also include four ground storage tanks and two elevated storage tanks. The City's water distribution system currently has two pressure planes, Upper and Lower, separated by 17 pressure reducing valves (PRVs). A small PRV zone also exists in the Elkins Lake subdivision.

5.0 WATER SYSTEM ANALYSES AND HYDRAULIC MODELING

A hydraulic model was developed as a tool in the evaluation of the City of Huntsville's water distribution system. The City selected the WaterGEMS software by Bentley® for modeling the water system. City staff provided the GIS shapefiles of water lines that were imported into the model using the City's facility identification number as the unique ID. The calibration process involved adjusting system operational parameters, roughness values, demand allocation, and peaking factors to match a known condition. The 24-hour period occurring on August 25, 2015, was selected for calibration. The results suggest a good correlation between recorded and modeled values and provide confidence in the accuracy of the model.

Hydraulic analyses were conducted to identify deficiencies in the City of Huntsville's existing water distribution system and to establish a capital improvements plan (CIP) to address deficiencies in the existing system and meet projected water demands through 2041. The existing distribution system was evaluated to assess current supply, pumping, and storage capacity, residual pressures, fire flow capacity, and water age. Results show that the City currently meets Texas Commission on Environmental Quality (TCEQ) requirements for minimum supply, storage and service pumping capacities. The City's existing elevated storage tanks are not tall enough to provide the TCEQ minimum required pressure of 35 psi throughout the City. Undersized water lines leaving the Palm Street Water Plant also cause excessive headloss and contribute to low water system pressures. The majority of the water system can provide at least 1,500 gpm of fire flow.

Water system improvements were developed to accommodate the anticipated residential and non-residential growth through 2041 and address existing system deficiencies. Challenges facing the water system include low water system pressure in high elevation areas, high water system pressure in low elevation areas and excessive headloss in undersized water lines. FNI worked with City staff to develop and identify water system improvements to accommodate future growth while optimizing the existing system operations and infrastructure. Some of the recommended operational changes and improvements to the distribution system include:

- New Upper Pressure Plane EST with higher overflow elevation and new Palm Street Pump Station
- New Lower Pressure Plane Pump Station and repurposing the existing 2.0 MG Palm Street EST for use in the Lower Pressure Plane
- Improved distribution system connectivity between pump stations and ESTs
- Pressure plane boundary modifications to address low pressures in the Lower Pressure Plane

6.0 WATER LINE RENEWAL PROGRAM

In addition to the Water System CIP, FNI developed a water line rehabilitation prioritization program to address aging infrastructure needs. The program is based on a combination of physical data (water line age, material, capacity, and repair data) and maintenance data (critical locations, water quality complaints, and limited access areas) to prioritize candidates for replacement. Small, aging water lines can be subject to leakage, potential taste and odor problems from biofilms, loss in carrying capacity from C-factor reduction, maintenance difficulties, and inoperable valves. Therefore, replacing water lines in poor condition can potentially improve water quality, increase available fire flow, and reduce maintenance issues. Twenty renewal CIP projects were developed city-wide.

7.0 WATER SYSTEM CAPITAL IMPROVEMENTS PLAN

A CIP was developed for the City of Huntsville to maintain high quality water service that promotes and sustains residential and commercial development. The recommended improvements will provide the required capacity and reliability to meet projected water demands through year 2041. It is recommended that these projects be implemented as City funding allows. Capital costs were calculated for recommended CIP projects. The costs are in 2016 dollars and include an allowance for engineering, surveying, and contingencies. **Tables ES-3** and **ES-4** summarize the cost of the water system capacity and rehabilitation CIPs by planning period.

Table ES-3: Water System Capacity CIP Summary

Phase	Project Number	Project Description	Cost
2016 - 2021	1	12/18/20/24-inch Montgomery Road Water Lines	$ 4,840,900
	2	2 MG Elevated Storage Tank along Talltimbers Lane	$ 5,086,000
	3	New 7,500 gpm Palm Street Pump Station	$ 2,990,000
	4	12/20/24/30-inch Sycamore Avenue and SH 30 Water Lines	$ 6,504,800
	5	Repurpose 2 MG Palm Street EST to 1 MG Lower Pressure Plane EST	$ 149,500
	6	New 4,800 gpm Lower Pressure Plane Water Plant with 2 MG GST	$ 4,858,800
	7	New Pumps at the Spring Lake Water Plant	$ 157,000
	8	18-inch SH 75 South Water Lines Phase 1	$ 957,200
	9	8-inch and 12-inch Elkins Lake Water Lines	$ 509,600
	10	Transfer Customers along Avenue I to Upper Pressure Plane	$ 314,000
		Total 2016 - 2021	**$ 26,367,800**
2022 - 2026	11	12-inch Veterans Memorial Parkway Water Line	$ 895,000
	12	16-inch Sam Houston Avenue Water Line	$ 1,144,400
	13	12-inch North SH 30 Water Line	$ 458,400
	14	18-inch SH 75 South Water Lines Phase 2	$ 2,349,400
	15	12-inch 9th Street and Avenue C Water Lines	$ 567,600
	16	12-inch IH 45 Water Line (19th Street to Crosstimbers Street)	$ 1,091,400
		Total 2022 - 2026	**$ 6,506,200**
2027 - 2041	17	1.5 MG Elevated Storage Tank at Palm Street	$ 4,784,000
	18	2 MGD TRA Surface Water Treatment Plant Expansion	$ 799,900
	19	12-inch Bearkat Boulevard Water Line	$ 617,300
	20	6-inch Dahlia Road Water Line	$ 1,142,900
	21	8-inch and 6-inch FM 2821 Water Lines	$ 375,300
	22	6-inch Northeast SH 30 Water Lines	$ 615,400
	23	8-inch Moffett Springs Road Water Line	$ 903,400
	24	8-inch Goodrich Drive and Old Colony Road Water Lines	$ 443,300
	25	6-inch Spring Lake Water Lines	$ 278,500
	26	8-inch Fraser Road Water Line	$ 102,400
		Total 2026 - 2041	**$ 10,062,400**
		Grand Total	**$ 42,936,400**

Table ES-4: Water System Renewal Program CIP Summary

Project Number	Project Description	Cost
1	Old Colony Road/Trinity Cutoff Rehabilitation	$ 1,216,200
2	Robinson Way/ 25th Street Rehabilitation	$ 736,900
3	Mance Park Middle School Rehabilitation	$ 1,014,600
4	Boettcher Drive Rehabilitation	$ 1,172,100
5	11th Street/Hickory Drive Rehabilitation	$ 1,274,100
6	Avenue I/Bobby K Marks Drive Rehabilitation	$ 1,266,300
7	Josey Street/11th Street Rehabilitation	$ 1,159,000
8	Avenue O/17th Street Rehabilitation	$ 1,231,400
9	FM 2821/Martin Luther King Drive Rehabilitation	$ 1,165,000
10	Avenue J/21th Street/22nd Street Rehabilitation	$ 1,174,300
11	Pine Shadows Rehabilitation	$ 1,172,100
12	Smith Hill Road/Mary Avenue Rehabilitation	$ 647,200
13	Elkins Lake: Augusta Drive/Greenbriar Drive Rehabilitation	$ 1,225,400
14	Bearkat Village Apartments Rehabilitation	$ 1,200,000
15	Highland Townhomes Rehabilitation	$ 1,222,200
16	Spring Lake: Spring Drive/January Lane Rehabilitation	$ 937,800
17	Elkins Lake: Greentree Drive/Greenbriar Drive Rehabilitation	$ 1,138,100
18	Thomason Street/Birmingham Street/Avenue J Rehabilitation	$ 747,300
19	Elkins Lake: Fairway Drive/Foxbriar Drive Rehabilitation	$ 1,187,800
20	Cline Street/Hayman Street Rehabilitation	$ 1,323,100
	Total	**$ 22,210,900**

8.0 EXISTING WASTEWATER SYSTEM

The City of Huntsville's wastewater system consists of three wastewater treatment plants (WWTPs), approximately 116 miles of gravity wastewater lines ranging from 4-inches to 36-inches, and 26 lift stations throughout the collection system. The majority of the wastewater lines are clay tile or PVC. The wastewater system is divided into three service areas that are each served by a wastewater treatment plant. The three wastewater treatment plants are:

- A.J. Brown (formerly known as Parker Creek)
- N.B. Davidson (also called the South Plant)
- Robinson Creek

9.0 WASTEWATER FLOW MONITORING

FNI conducted flow monitoring at 12 locations and gathered rainfall depths at three locations within Huntsville's wastewater system. The flow monitoring and rainfall data was used to characterize dry weather and wet weather flows at key points within the wastewater system, evaluate wet weather inflow/infiltration (I/), calibrate the hydraulic model of the wastewater collection system, and select basins for Sanitary Sewer Evaluation Surveys (SSES).

A wet weather analysis was performed to calculate the volume of I/I in each of the 12 flow monitor basins. The discrete volume of I/I within each sub basin has been categorized as high, moderate, or low.

- Four basins had I/I considered to be high
- Three basins had moderate I/I volumes
- The remaining five basins had low I/I

The flow monitor basins, SSES priority rankings, discrete I/I volumes, and categories of I/I are summarized in **Table ES-5.**

Silt accumulation was observed at the flow monitoring sites: **RC-01**, **RC-03**, **RC-04**, and **AJ-10**. These areas should be programmed into a regularly scheduled sewer cleaning program.

Table ES-5: Summary of I/I by Flow Monitor Basin and Categories of I/I

Flow Monitor ID	WWTP Basin	Basin Priority Ranking	Basin I/I (Gal/LF)
RC-01	Robinson Creek	1	30.9
AJ-12[(1)]	A.J. Brown	2	4.0
AJ-08	A.J. Brown	3	4.8
AJ-10	A.J. Brown	4	4.3
NB-06	N.B. Davidson	5	2.8
AJ-11	A.J. Brown	6	2.7
RC-04	Robinson Creek	7	2.1
NB-07	N.B. Davidson	8	1.9
RC-02	Robinson Creek	9	1.8
RC-03	Robinson Creek	10	1.8
RC-05	Robinson Creek	11	1.4
AJ-09	A.J. Brown	12	1.1

Categories of I/I

(gal/LF)	Description
I/I Greater than 4.0	*High* amount of I/I
I/I Between 2.0 - 3.9	*Moderate* amount of I/I
I/I Less than 2.0	*Low* amount of I/I

(1) The AJ-12 Basin was moved to Priority Ranking 2 due to shallow lines and the subsequent high risk for sanitary sewer overflows.

The results of this analysis were used to develop sewer basin SSES rehabilitation/renewal CIP recommendations. These CIP projects are discussed in **Section 11**.

10.0 WASTEWATER FLOW PROJECTIONS

FNI developed projected wastewater flows for the 5-year, 10-year and 25-year planning periods. Average day and peak wastewater flows were developed for each of the three WWTP service areas and the 12 flow monitor basins.

Wastewater flow projections for future developments were added to the existing flows to determine the projected future average day flows. Design criteria for average day wastewater flows for the 5-year, 10-year, and 25-year planning periods were developed by analyzing historical wastewater flows, water distribution and billing records, population, and commercial acreage. **Table ES-6** summarizes the total projected average day wastewater flows by planning period and WWTP service area.

Table ES-6: Summary of Projected Average Day Wastewater Flows

Wastewater Service Area	Projected Average Day Wastewater Flows (MGD)			
	2016	2021	2026	2041
Robinson Creek	1.20	1.41	1.52	1.92
N. B. Davidson	1.12	1.15	1.20	1.34
A. J. Brown	2.70	2.83	3.17	3.91
Total	**5.02**	**5.39**	**5.89**	**7.17**

11.0 SANITARY SEWER EVALUATION SURVEY

As part of the overall *Water and Wastewater Condition and Capacity Assessment Studies* project, FNI conducted SSES in the RC-01 and AJ-12 wastewater basins. These basins were identified as having high levels of I/I during the wastewater flow monitoring evaluation portion of this study (**Section 9.0**). The SSES efforts carried out in each basin are described in **Table ES-7.** The results of these SSES efforts were used to develop rehabilitation projects with the goal of reducing I/I and sanitary sewer overflows.

Table ES-7: Wastewater Sub Basin SSES Efforts

Wastewater Sub Basin	SSES Efforts Conducted	Notes
RC-01	• Manhole Inspections	This basin was identified as having the highest level of I/I (**30.9 Gal/LF**) identified during the June – July 2015 wastewater flow monitoring period. Smoke testing was not conducted in this sub basin due to the relatively good condition of the 36-inch wastewater line.
AJ-12	• Flow Monitoring • Manhole Inspections • Smoke Testing	This basin was identified as having a high level of I/I (**4.0 Gal/LF**) and was prioritized for SSES efforts during this study due to shallow lines and the subsequent high risk for sanitary sewer overflows due to surcharging.

FNI recommends continuing SSES efforts in the remaining basins identified as having high or moderate levels of I/I during the wastewater flow monitoring evaluation (**Section 9.0**). A SSES Rehabilitation/Renewal CIP was developed to address SSES activities and rehabilitation/renewal of deficiencies identified in the collection system as a result of these evaluation efforts. These project costs include the following SSES efforts:

- Focused Flow Monitoring
- Manhole Inspections
- Smoke Testing

A placeholder cost of $1,000,000 was included in each project to fund the rehabilitation or renewal of manholes and gravity lines, based on the results of the planned SSES field efforts. Typical rehabilitation efforts for manholes include application of coatings, raising manhole rims to grade, and repairing frames and covers. Typical rehabilitation efforts for wastewater lines include point repairs and slip lining.

12.0 RISK BASED ASSESSMENT OF LIFT STATIONS

A risk based assessment was performed on all of the City's lift stations to develop a prioritized list of lift station rehabilitation CIP recommendations. A risk based assessment consists of a condition assessment and a criticality assessment. The condition assessment included a visual inspection of each lift station. The criticality assessment, or consequence of failure, included an analysis of the proximity of each lift station to critical areas, as well as the residential population served. Each lift station was assigned a condition and criticality score based on the results of the assessments. The condition and criticality scores were used to assign a risk category (extreme, high, moderate, or low) to each asset.

The lift stations included in the rehabilitation CIP meet the following criteria:

- The lift station risk based assessment resulted in a Fair, Poor or Very Poor condition score or the lift station was classified as High or Extreme Risk.
- The lift station firm capacity does not need to be expanded.
- The lift station is not planned to be consolidated.

Lift stations that don't meet these criteria are addressed in the capacity CIP. There are ten lift stations that meet these criteria. An additional two lift stations (TxDOT #1 and TxDOT #2) are recommended for decommissioning.

13.0 WASTEWATER MODEL DEVELOPMENT AND CALIBRATION

FNI developed a hydraulic model of the existing wastewater system in Bentley's SewerGEMS® software. This model consists of all 8-inch and larger wastewater lines and their associated manholes, catchments, and 21 lift stations and their associated force mains.

Field survey and data collection was performed at 60 manholes throughout the wastewater system. This survey and data collection effort was performed at locations where the City's GIS database was missing invert information or contained conflicting invert data. Additional sites were chosen to verify connectivity and force main discharge inverts. The results of the manhole survey and data collection effort were incorporated into the wastewater hydraulic model and delivered to the City in a separate GIS geodatabase.

FNI calibrated the wastewater hydraulic model to dry weather flows from July 1 through July 8, 2015. Wet weather calibration built upon the dry weather calibration so that the model closely matched observed wet weather flows. The observed storm events from June 17, 18 and 20 were chosen for the wet weather calibration. The RTK hydrograph method was utilized to model the additional flows that entered the wastewater system during these events. Calibration results within the standard tolerances of +/- 5% of measured average day flows (dry weather) and +/- 10% of observed peak flows (wet weather) were generally achieved throughout the modeled system. These dry and wet weather calibration results provide a high level of confidence that the model is closely matching real world conditions and suitable to use for hydraulic analyses and CIP development.

14.0 WASTEWATER SYSTEM ANALYSES AND HYDRAULIC MODELING

Hydraulic analyses were conducted to identify deficiencies in the City's existing wastewater collection system and to establish a capital improvements plan to address deficiencies in the existing system and accommodate the projected wastewater flows through 2041. A 5-year, 6-hour design storm was utilized for the existing and future system analyses. This design storm is commonly used in Texas and provides a reasonable balance between level of service and wastewater infrastructure costs. Various combinations of improvements and modifications were investigated to determine the most appropriate approach for conveying projected flows. Considerations in developing the improvements plan included maintaining regulatory compliance, increasing system reliability, simplifying system operations, conveying peak wet weather flows, and reducing surcharging and sanitary sewer overflows.

15.0 WASTEWATER CAPITAL IMPROVEMENTS PLAN

A wastewater CIP was developed for Huntsville to address existing condition and capacity issues and provide conveyance capacity for the projected growth in the wastewater service area. Specific SSES and Lift Station renewal and rehabilitation CIPs were developed to address condition issues unrelated to capacity. It is recommended that these projects be implemented as City funding allows. Capital costs were calculated for all recommended CIP projects. The costs are in 2016 dollars and include an allowance for engineering, surveying, and contingencies. **Table ES-8**, **Table ES-9** and **Table ES-10** summarize the Capacity, SSES and Lift Station capital improvements plans.

Table ES-8: Wastewater Capacity CIP Summary

Phase	Project Number	Project Description	Cost
2016 - 2021	1	Rehabilitation of A.J. Brown WWTP at 4.15 MGD Capacity	$ 23,470,380
	2	New Elkins Lake Dam Lift Station and Associated Improvements	$ 4,679,070
	3	Replace 30-inch with 48-inch trunk line to A.J. Brown WWTP	$ 4,017,370
	4	Replace 30-inch with 42-inch trunk line in the AJ-08 Basin (Segment A)	$ 3,616,110
	5	Replace 30-inch with 42-inch trunk line in the AJ-08 Basin (Segment B)	$ 3,149,970
	6	Replace 30-inch with 42-inch trunk line in the AJ-08 Basin (Segment C)	$ 3,598,770
	7	Replace 24-inch with 42-inch gravity line in the AJ-10 Basin	$ 5,986,280
	8	Replacement 10/12/15/18/21/30/36-inch gravity lines in the AJ-10 Basin	$ 3,331,360
	9	Replace 8/12-inch with 12/15/21-inch gravity lines in the AJ-11 Basin	$ 3,461,160
	10	Replace 8/10-inch with 12/18-inch gravity lines in the AJ-11 Basin	$ 2,178,820
	11	Replace 8-inch with 10/12-inch gravity lines in the AJ-10 Basin	$ 966,260
	12	Replace 8/10/12-inch with 10/12/21-inch gravity lines in the RC-03 Basin	$ 2,738,550
	13	Rehabilitate & Expand Hitchin' Post Lift Station from 0.15 to 0.30 MGD (Firm Capacity)	$ 247,220
	14	Replace 8-inch with 10-inch gravity lines in the AJ-12 Basin	$ 846,170
		Total 2016 - 2021	**$ 62,287,490**
2022 - 2026	15	Expansion of New Elkins Lake Dam LS to 6.5 MGD (Firm Capacity)	$ 593,820
	16	Expansion of Post Office LS to 4.0 MGD (Firm Capacity) & Replacement 21/24-inch lines	$ 5,066,780
	17	Expansion of the Waters Edge LS to 1.7 MGD (Firm Capacity)	$ 1,199,740
	18	Replace 10-inch with 18/21-inch gravity lines in the AJ-09 Basin	$ 2,724,190
	19	Expansion of the Tanyard Creek LS to 3.1 MGD (Firm Capacity)	$ 3,099,140
	20	Replace 8-inch with 10-inch gravity lines in Brookview Subdivision	$ 1,053,980
	21	Replace 21/24-inch with 24/27-inch gravity lines in the RC-04 Basin	$ 4,470,800
	22	Rehabilitation & Expansion of the McGary Creek LS to 4.75 MGD (Firm Capacity)	$ 2,840,500
	23	Replace 8/12/18-inch with 12/21-inch gravity lines in the RC-05 Basin	$ 4,874,000
		Total 2022 - 2026	**$ 25,922,950**
2027 - 2041	24	Replace 8-inch with 10-inch gravity line in the RC-03 Basin	$ 301,400
	25	Expand N.B. Davidson 2-hr Peak Flow Treatment Capacity to 6.5 MGD	$ 448,500
	26	Expand A.J. Brown WWTP to 5.0 MGD	$ 7,475,000
		Total 2027 - 2041	**$ 8,224,900**
		Grand Total	**$ 96,435,340**

Table ES-9: Sewer Basin SSES Rehabilitation/Renewal CIP Summary

Project Number	Project Description	Cost
B1	RC-01 Basin (Manhole Rehabilitation)	$120,360
B2	AJ-12 Basin (Sub Basin E Manhole and Line Rehabilitation)	$312,000
B3	AJ-12 Basin Rehabilitation and Renewal (Sub Basins A, D, C, and B)	$1,433,790
B4	AJ-08 Basin Rehabilitation and Renewal	$1,664,870
B5	AJ-10 Basin Rehabilitation and Renewal	$1,945,550
B6	NB-06 Basin Rehabilitation and Renewal	$1,744,640
B7	AJ-11 Basin Rehabilitation and Renewal	$1,726,320
B8	RC-04 Basin Rehabilitation and Renewal	$1,657,310
	Sewer Basin Rehabilitation/Renewal Total	**$ 10,604,840**

Table ES-10: Lift Station Rehabilitation CIP Summary

Project Number	Project Description	Cost
LS 1	Brook Hollow (BH) Lift Station Rehabilitation	$ 545,060
LS 2	Elkins Lake Equestrian Center (EC) Lift Station Rehabilitation	$ 371,000
LS 3	Elkins Lake #1 (EL 1) Lift Station Rehabilitation	$ 369,040
LS 4	Bayes (BA) Lift Station Rehabilitation	$ 574,000
LS 5	Elkins Lake #3 (EL 3) Lift Station Rehabilitation	$ 417,000
LS 6	Elkins Lake #2 (EL 2) Lift Station Rehabilitation	$ 386,000
LS 7	Simmons Street (SS) Lift Station Rehabilitation	$ 284,000
LS 8	McCoy's (MC) Lift Station Rehabilitation	$ 233,870
LS 9	Airport (AP) Lift Station Rehabilitation	$ 225,830
LS 10	Transfer Station (TS) Lift Station Rehabilitation	$ 275,640
LS 11	Decommission TxDOT #1 Lift Station and Install Aerobic System	$ 290,160
LS 12	Decommission TxDOT #2 Lift Station and Install Aerobic System	$ 354,120
	Lift Station Rehabilitation Total	**$ 4,325,720**

1.0 INTRODUCTION

The City of Huntsville is a growing community located in Walker County, Texas. The City currently provides water and wastewater service to approximately 40,000 people, including five Texas Department of Criminal Justice (TDCJ) units and Sam Houston State University (SHSU). The population within the service area is projected to grow from 40,101 to 55,156 for water service and from 39,894 to 54,949 for wastewater service by 2041. Accommodating this growth in an efficient and cost effective manner, while also focusing on the maintenance of existing water system assets, was the focus of the *Water and Wastewater Condition and Capacity Assessment Studies*. This report has been prepared to provide the City of Huntsville with a planning tool to serve as a guide for 5-year, 10-year and 25-year improvements to the water and wastewater infrastructure.

1.1 SCOPE OF WORK

Freese and Nichols, Inc. (FNI) was retained in 2015 by the City of Huntsville to prepare the *Water and Wastewater Condition and Capacity Assessment Studies*. The goals of the *Water and Wastewater Condition and Capacity Assessment Studies* were to evaluate the existing water and wastewater systems and recommend water and wastewater phased Capital Improvement Plans (CIPs) through 2041. The recommended improvements will serve as a basis for the design, construction, and financing of facilities required to meet Huntsville's water and wastewater capacity and system renewal needs. The major elements of the scope of this project included:

- Wastewater Flow Monitoring and Data Analysis
- Wastewater System Inventory and Model Development
- Water Model Development and Field Testing
- Water and Wastewater System Model Calibration
- Population, Water Demand and Wastewater Flow Projections
- Water and Wastewater System Capacity and Operations Analyses
- Water and Wastewater System Risk Based Condition Assessment
- Sanitary Sewer Evaluation Survey (SSES)
- Water and Wastewater System Renewal CIP
- Water and Wastewater System CIP and Report

1.2 LIST OF ABBREVIATIONS

Abbreviation	Actual
AD	Average Day
ADS	ADS Environmental Services
AADF	Annual Average Daily Flow
ASCE	American Society of Civil Engineers
CCTV	Closed-Circuit Television
CIP	Capital Improvement Plan
d/D	Depth to Diameter Ratio
EPS	Extended Period Simulation
EST	Elevated Storage Tank
ETJ	Extraterritorial Jurisdiction
FNI	Freese and Nichols, Inc.
gal/LF	Gallons per Linear Foot
G&A	Gorrondona and Associates
GIS	Geographic Information System
gpad	Gallons per Acre per Day
gpcd	Gallons per Capita per Day
gpm	Gallons per Minute
HGL	Hydraulic Grade Line
IH	Interstate Highway
I/I	Inflow and Infiltration
LF	Linear Feet
LS	Lift Station
MCC	Motor Control Center
MD	Maximum Day
MG	Million Gallons
MGD	Million Gallons per Day
OPCC	Opinion of Probable Construction Cost
O&M	Operations and Maintenance
PF_D	Dry Weather Peaking Factor
PF_W	Wet Weather Peaking Factor
PH	Peak Hour
psi	Pounds per Square Inch
RBA	Risk Based Assessment
SCADA	Supervisory Control and Data Acquisition
SH	State Highway
SHSU	Sam Houston State University
SSES	Sanitary Sewer Evaluation Survey
SSO	Sanitary Sewer Overflow
TBRG	Tipping Bucket Rain Gauge
TCEQ	Texas Commission on Environmental Quality
TDCJ	Texas Department of Criminal Justice
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
USGS	United States Geological Survey
WEF	Water Environment Federation
WWTP	Wastewater Treatment Plant

2.0 POPULATION

Population and projected land use are important elements in the analysis of water distribution and wastewater collection systems. Water demands and wastewater loads are dependent on the residential population and commercial development served by the systems and determine the sizing and location of system infrastructure. A thorough analysis of historical and projected populations provides the basis for future water demands and wastewater loads.

2.1 SERVICE AREA

The water service area consists of the current city limits and a portion of the City's Extra-Territorial Jurisdiction (ETJ) northwest along IH 45 and west and northeast along State Highway (SH) 30. The wastewater service area consists of the current city limits and a portion of the City's ETJ west, southwest and northeast of the city limits. The water and wastewater service areas are shown on **Figure 4-1** and **Figure 8-1**.

2.2 HISTORICAL POPULATION

The City of Huntsville consists of three major population entities: TDCJ, SHSU and City residents. The U.S. Census provided yearly population data for 2010 for the entire city. Historical data provided by the U.S. Census, SHSU and TDCJ was utilized to develop historical populations for City residents from 2011 through 2014. The overall growth rate ranges from 0.5% to 1.3% over the last five years. **Table 2-1** presents the historical populations for the City of Huntsville wastewater service area. The water service area contains an additional neighborhood with 207 City residents.

Table 2-1: Historical Population

Year	City(1)	SHSU(2)	TDCJ(3)	Total	Overall Growth Rate
2010	24,245	2,988	11,315	38,548	-
2011	24,451	3,284	11,315	39,050	1.3%
2012	24,660	3,284	11,315	39,259	0.5%
2013	24,870	3,284	11,315	39,469	0.5%
2014	25,081	3,284	11,315	39,680	0.5%

1) 2010 is U.S. Census total minus SHSU and TDCJ. 2010-2014 is 0.85% growth for City residents only.
2) SHSU on campus housing capacity based on apartment data provided by the City and SHSU.
3) Current TDCJ populations used for all historical and future planning periods per Glenn Isbell, TDCJ.

2.3 PROJECTED POPULATION

The magnitude and distribution of the growth in population will dictate where future water and wastewater infrastructure is required. It is important to note that projecting future population is challenging, especially for relatively small geographic areas, such as individual cities, because it can be difficult to predict how fast or slow development will occur when there are a variety of circumstances that can impact it.

Future population projections for each planning year were developed based on input from City staff on proposed developments and FNI's analysis. Based on the projected development and historical trends, an annual growth rate of 1.5% was used to project the 2021 City population, 5% to project the 2026 City population and 0.7% to project the 2041 City population. SHSU is projected to add one new 700 bed dormitory by 2021, a new 700 bed dormitory by 2026 and a new 500 bed dormitory by 2041. The TDCJ population is not anticipated to change. **Table 2-2** presents the wastewater service area projected population for each planning period. The water service area projected population for each planning period contains 207 additional City residents, and the projected commercial acreage for each planning period contains 421 additional acres of commercial.

Table 2-2: Wastewater Service Area Projected Population

Year	City[1]	SHSU[2]	TDCJ[3]	Total	Overall Growth Rate	Commercial Acreage
2016	25,295	3,284	11,315	39,894	-	1,404
2021	27,163	3,984	11,315	42,462	1.3%	1,512
2026	29,702	4,684	11,315	45,701	0.5%	1,717
2041	38,450	5,184	11,315	54,949	0.5%	2,323

1) 2021-2041 is based on development data from the City's Development Services Department.
2) SHSU on campus housing capacity based on apartment data provided by the City and SHSU.
3) 2015 TDCJ populations used for all historical and future planning periods per Glenn Isbell (TDCJ).

The total population and commercial acreage for each planning year was distributed throughout the City using future developments as identified by the City's Development Services Department and meetings with City staff. **Figure 2-1** shows the location of anticipated developments. The City provided information on the anticipated land use, and FNI assumed three units per acre for future single family residential and ten units per acre for future multi-family residential land use. The 2010 U.S. Census density of 2.32 people per unit was used to determine the population resulting from anticipated development. Detailed information on population growth by water system pressure plane and wastewater system basin are included in **Tables 2-3** and **2-4**, respectively.

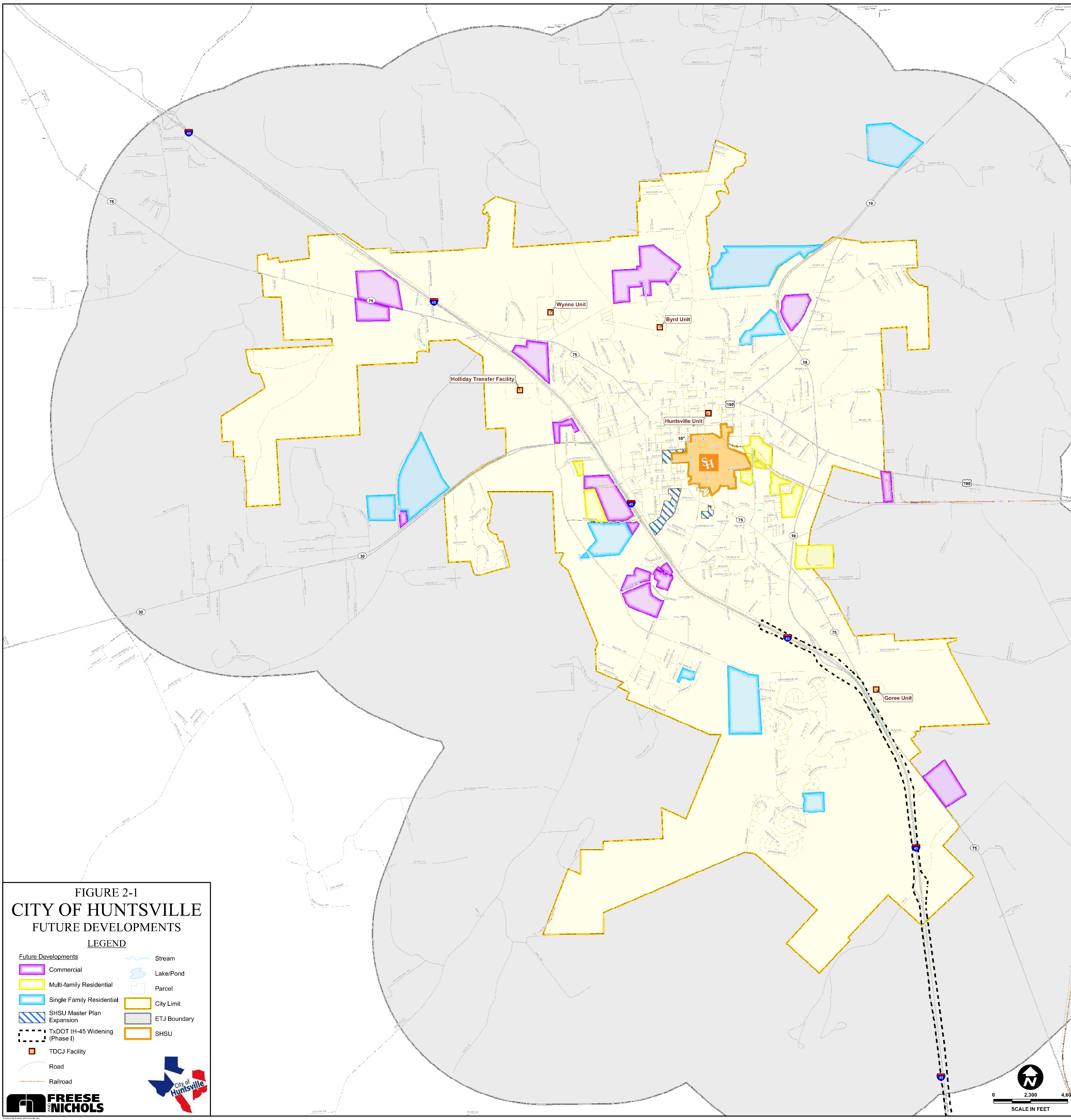
FIGURE 2-1
CITY OF HUNTSVILLE
FUTURE DEVELOPMENTS
LEGEND
Future Developments
Commercial
Multi-family Residential
Single Family Residential
SHSU Master Plan Expansion
TxDOT IH-45 Widening (Phase I)
TDCJ Facility
Road
Railroad
Stream
Lake/Pond
Parcel
City Limit
ETJ Boundary
SHSU
FREESE AND NICHOLS
City of Huntsville
Wynne Unit
Byrd Unit
Holliday Transfer Facility
Huntsville Unit
Goree Unit
0
2,300
4,600
SCALE IN FEET

Table 2-3: Population Projections by Water Pressure Plane

Pressure Plane	2016				2021				2026				2041			
	Huntsville Only	SHSU	TDCJ	Total	Huntsville Only	SHSU	TDCJ	Total	Huntsville Only	SHSU	TDCJ	Total	Huntsville Only	SHSU	TDCJ	Total
Upper	17,027	3,144	4,199	24,370	19,443	3,984	7,517	30,944	21,370	4,684	7,517	33,571	27,365	5,184	7,517	40,066
Lower	8,475	140	7,116	15,731	7,927	0	3,798	11,725	8,539	0	3,798	12,337	11,292	0	3,798	15,090
Total	**25,502**	**3,284**	**11,315**	**40,101**	**27,370**	**3,984**	**11,315**	**42,669**	**29,909**	**4,684**	**11,315**	**45,908**	**38,657**	**5,184**	**11,315**	**55,156**

Table 2-4: Population Projections by Wastewater Basin

Sewer Basin		2016				2021				2026				2041			
		Huntsville Only	SHSU	TDCJ	Total	Huntsville Only	SHSU	TDCJ	Total	Huntsville Only	SHSU	TDCJ	Total	Huntsville Only	SHSU	TDCJ	Total
Robinson Creek	RC-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RC-02	1,393	0	0	1,393	1,486	0	0	1,486	1,898	0	0	1,898	2,734	0	0	2,734
	RC-03	3,583	0	0	3,583	4,894	0	0	4,894	5,139	0	0	5,139	5,637	0	0	5,637
	RC-04	332	0	0	332	332	0	0	332	988	0	0	988	2,320	0	0	2,320
	RC-05	919	0	2,563	3,482	919	0	2,563	3,482	919	0	2,563	3,482	919	0	2,563	3,482
	Subtotal	**6,227**	**0**	**2,563**	**8,790**	**7,631**	**0**	**2,563**	**10,194**	**8,943**	**0**	**2,563**	**11,506**	**11,609**	**0**	**2,563**	**14,172**
N.B. Davidson	NB-06	1,151	0	0	1,151	1,383	0	0	1,383	1,383	0	0	1,383	1,383	0	0	1,383
	NB-07	2,395	0	1,636	4,031	2,395	0	1,636	4,031	2,395	0	1,636	4,031	2,395	0	1,636	4,031
	Unmetered	483	0	0	483	483	0	0	483	483	0	0	483	483	0	0	483
	Subtotal	**4,029**	**0**	**1,636**	**5,665**	**4,261**	**0**	**1,636**	**5,897**	**4,261**	**0**	**1,636**	**5,897**	**4,261**	**0**	**1,636**	**5,897**
A.J. Brown	AJ-08	7	0	0	7	7	0	0	7	619	0	0	619	1,861	0	0	1,861
	AJ-09	474	0	0	474	474	0	0	474	474	0	0	474	474	0	0	474
	AJ-10	6,783	0	7,116	13,899	6,783	0	7,116	13,899	6,783	0	7,116	13,899	6,783	0	7,116	13,899
	AJ-11	1,200	0	0	1,200	1,200	0	0	1,200	1,200	0	0	1,200	1,642	0	0	1,642
	AJ-12	6,575	3,284	0	9,859	6,575	3,984	0	10,559	7,190	4,684	0	11,874	11,587	5,184	0	16,771
	Unmetered	0	0	0	0	232	0	0	232	232	0	0	232	232	0	0	232
	Subtotal	**15,039**	**3,284**	**7,116**	**25,439**	**15,271**	**3,984**	**7,116**	**26,371**	**16,498**	**4,684**	**7,116**	**28,298**	**22,580**	**5,184**	**7,116**	**34,880**
Total		**25,295**	**3,284**	**11,315**	**39,894**	**27,163**	**3,984**	**11,315**	**42,462**	**29,702**	**4,684**	**11,315**	**45,701**	**38,450**	**5,184**	**11,315**	**54,949**

3.0 WATER DEMAND PROJECTIONS

A water utility must be able to supply water at rates that fluctuate over time. Yearly, monthly, daily, and hourly variations in water use occur, with higher use typically occurring during dry years and in hot months. Also, water use typically follows a diurnal pattern, being low at night and peaking in the early morning and late afternoon. Flow rates most important to the hydraulic design and operation of a water treatment plant and distribution system are average day (AD), maximum day (MD), and peak hour (PH) demands. Average day demand is the total annual water demand divided by the number of days in the year. The average day demand rate is used as a basis for estimating maximum day and peak hour demands. Maximum day demand is the maximum quantity of water used on any one day of the year. Water supply facilities are typically designed based on the maximum day demand. Peak hour demand is the peak rate at which water is required during any one hour of the year. Since minimum distribution pressures are usually experienced during peak hour, the sizes and locations of distribution facilities are generally determined based on this condition.

3.1 HISTORICAL WATER DEMANDS

Reviewing historical water demands provides insight into selecting design criteria used to project future water demands. Historical water production and consumption data was analyzed from 2010 through 2014. FNI obtained recent water production data from Public Works staff that consisted of average and maximum daily usage. Historical annual average day distribution in million gallons per day (MGD), peaking factors and per-capita consumption in gallons per capita day (gpcd) are summarized in **Table 3-1**. Water billing data for January 2010 through May 2015 provided by Utility Billing was reviewed by usage class and is summarized in **Table 3-2**. Historical TDCJ water demand is summarized in **Table 3-3**.

Table 3-1: Historical Water Usage

Year	Water Service Area Population	Average Day Demand (gpcd)	Average Day Demand (MGD)	MD:AD Peaking Factor	Maximum Day Demand (MGD)
2010	38,755	167	6.47	1.54	9.97
2011	39,257	179	7.01	1.45	10.16
2012	39,466	157	6.21	1.53	9.50
2013	39,676	171	6.78	1.51	10.22
2014	39,887	173	6.92	1.67	11.52
	Average	**169**	**-**	**1.54**	**-**
	Maximum	**179**	**-**	**1.67**	**-**
	Minimum	**157**	**-**	**1.45**	**-**

Table 3-2: January 2010 – May 2015 Water Consumption by Class

Year	Population			Commercial Acreage	Residential Average Day Demand		SHSU Average Day Demand		TDCJ Average Day Demand		Non-Residential Average Day Demand	
	Huntsville	SHSU	TDCJ		gpcd	MGD	gpcd	MGD	gpcd	MGD	gpad	MGD
2010	24,452	2,988	11,315	1,825	86	2.10	113	0.34	141	1.59	371	0.68
2011	24,658	3,284	11,315	1,825	104	2.56	166	0.54	131	1.48	567	1.03
2012	24,867	3,284	11,315	1,825	84	2.09	152	0.50	140	1.59	398	0.73
2013	25,077	3,284	11,315	1,825	85	2.13	91	0.30	140	1.58	445	0.81
2014	25,288	3,284	11,315	1,825	76	1.93	92	0.30	151	1.71	284	0.52
				Average	**87**	**-**	**123**	**-**	**141**	**-**	**413**	**-**
				Maximum	**104**	**-**	**166**	**-**	**151**	**-**	**567**	**-**
				Minimum	**76**	**-**	**91**	**-**	**131**	**-**	**284**	**-**

Table 3-3: Historical TDCJ Demand

Facility	Population	2010 Average Day Demand (MGD)	2011 Average Day Demand (MGD)	2012 Average Day Demand (MGD)	2013 Average Day Demand (MGD)	2014 Average Day Demand (MGD)	Average Day Demand(1) (gpcd)
Wynne	3,318	0.41	0.45	0.46	0.41	0.42	138
Holliday	2,563	0.17	0.12	0.12	0.14	0.15	64
Huntsville (Walls)	2,151	0.38	0.32	0.37	0.40	0.45	210
Byrd	1,647	0.18	0.17	0.17	0.17	0.20	123
Goree	1,636	0.33	0.33	0.38	0.33	0.34	234
	Average	**1.47**	**1.39**	**1.50**	**1.44**	**1.57**	**-**

(1) Based on population and maximum annual average day demand for each TDCJ unit from 2010 through 2014.

3.2 WATER DEMAND PROJECTIONS

Water demands were projected for the 2016, 2021, 2026 and 2041 planning periods. The evaluation of historical data in **Tables 3-1** and **3-2** provided a basis for determining the design criteria used to project water demands. Based on the review of this data, FNI recommends using an average day demand of 140 gpcd for City residents, 190 gpcd for SHSU, 620 gpad for non-residential acreage, and the maximum historical gpcd for each of the TDCJ unit populations from **Table 3-3**.

Maximum Day Demand

In selecting a peaking factor to project maximum day demands, FNI reviewed historical peaking factors and the years in which those peaking factors occurred. Historical water usage data indicated the maximum day to average day peaking factor ranged from 1.45 to 1.67 over the last five years; therefore, a peaking factor of 1.70 was selected for future demands.

Peak Hour Demand

After reviewing historical SCADA hourly demand to determine the peak hour to maximum day peaking factor, FNI recommends using a peaking factor of 1.75 to project the peak hour demand.

Table 3-4 summarizes the design criteria used for the water demand projections. **Figure 3-1** provides a graphical illustration of the historical and projected water demands for the City of Huntsville through 2041. **Table 3-5** summarizes the projected water demands by usage type.

Table 3-4: Water Demand Projection Design Criteria

Future Demand Type		Average Day Water Use
Residential		140 gpcd
SHSU		190 gpcd
Non-Residential		620 gpad
TDCJ	Wynne	138 gpcd
	Holliday	64 gpcd
	Huntsville (Walls)	210 gpcd
	Byrd	123 gpcd
	Goree	234 gpcd

Figure 3-1: Historical and Projected Water Demands

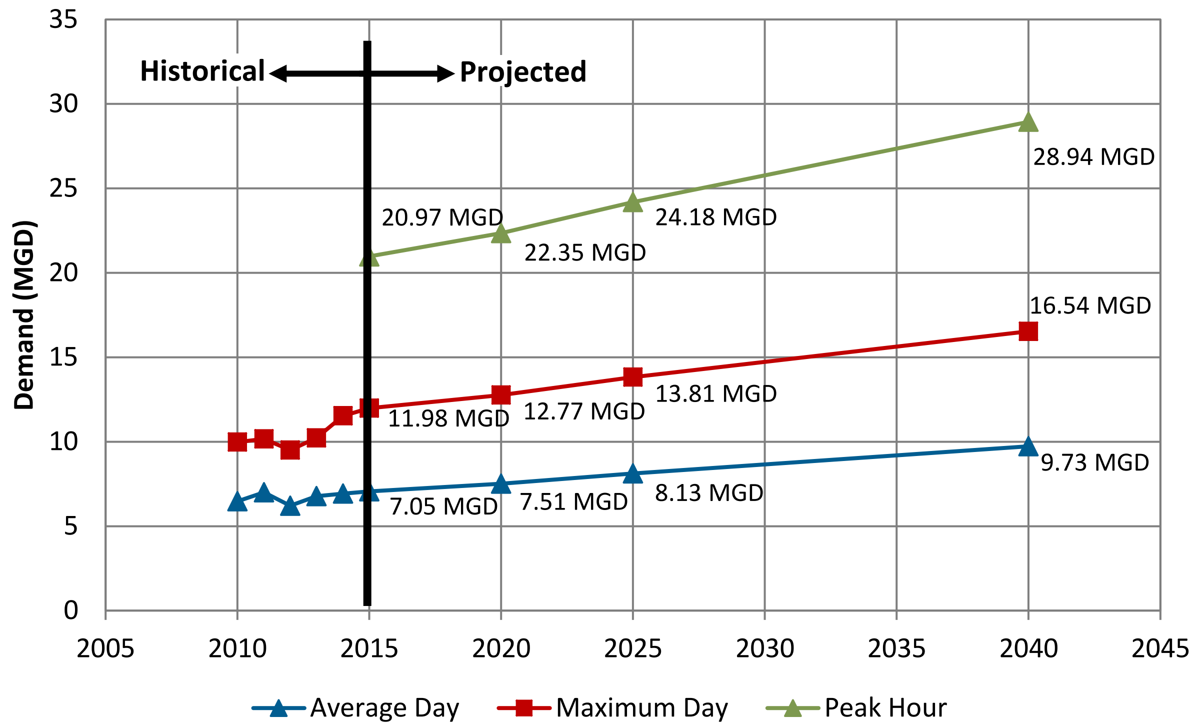

Table 3-5: Projected Water Demands by Usage Type (MGD)

Demand Type	Entity Type	2015	2021	2026	2041
Average Day	Residential	3.57	3.83	4.19	5.41
	Non-Residential	1.13	1.20	1.33	1.70
	SHSU	0.62	0.76	0.89	0.89
	TDCJ	1.72	1.72	1.72	1.72
	Total	**7.05**	**7.51**	**8.13**	**9.73**
Maximum Day	Residential	6.07	6.51	7.12	9.20
	Non-Residential	1.92	2.04	2.25	2.89
	SHSU	1.06	1.29	1.51	1.51
	TDCJ	2.93	2.93	2.93	2.93
	Total	**11.98**	**12.77**	**13.81**	**16.54**
Peak Hour	Residential	10.62	11.40	12.46	16.10
	Non-Residential	3.37	3.57	3.94	5.06
	SHSU	1.86	2.25	2.65	2.65
	TDCJ	5.13	5.13	5.13	5.13
	Total	**20.97**	**22.35**	**24.18**	**28.94**

4.0 EXISTING WATER SYSTEM

The City of Huntsville's water system consists of a network of water lines, the Palm Street Water Plant, the Spring Lake Water Plant, four ground storage tanks (GSTs), two elevated storage tanks (ESTs), and seven groundwater wells. **Figure 4-1** shows the existing water distribution system for the City of Huntsville.

4.1 PRESSURE PLANES

The City's water distribution system has two pressure planes: Upper and Lower. Ground elevations in the Upper Pressure Plane range between 280 feet and 500 feet. The Upper Pressure Plane operates at a static hydraulic gradient of 597 feet established by the overflow elevation of the 2.0 million gallon (MG) and 0.5 MG ESTs at the Palm Street Pump Station. Water system pressure near the Spring Lake Water Plant is maintained by a hydropneumatic tank. Ground elevations in the Lower Pressure Plane range between 265 feet and 475 feet. The Lower Pressure Plane operates at a static hydraulic gradient of 540 feet established by the pressure settings of 17 pressure reducing valves (PRVs). A small pressure zone also exists in the Elkins Lake subdivision, where a hydraulic gradient of 540' is established by four PRVs.

4.2 WATER LINES

The City of Huntsville's water system consists of 279 miles of water lines, ranging in size from 0.75-inches to 30-inches. **Figure 4-2** illustrates the percentage of water line length by diameter. **Figure 4-3** shows a summary of the water line material based on information from the City's Geographic Information System (GIS) and City staff. Research of as-built drawings and field investigation were utilized to populate missing attributes.

4.3 WATER SUPPLY

The City relies on treated surface water from the Trinity River Authority (TRA) Surface Water Treatment Plant (SWTP) and seven groundwater wells to provide water to its residents. The City owns the water rights to a total of 24 MGD of surface water supply at Lake Livingston, which supplies the TRA SWTP. Treated water is pumped from the TRA SWTP to the Palm Street Pump Station GSTs through a 10-mile long, 30-inch transmission line. The TRA SWTP has a firm pumping capacity of 10 MGD available to the City of Huntsville. Five of the City's groundwater wells supply the Palm Street Water Plant and two supply the Spring Lake Water Plant. A summary of the existing groundwater supply capacity in gallons per minute (gpm) and MGD is shown in **Table 4-1**.

Table 4-1: Existing Groundwater Wells

Well Number	Address	Permitted Capacity[1]		Tested Capacity[1]	
		gpm	MGD	gpm	MGD
13	6013 HWY 75 S	900	1.30	868	1.25
15	3514 Boettcher	1,005	1.45	839	1.21
17	3518 Powell Rd.	825	1.19	1,054	1.52
21	Palm Street	1,005	1.45	1,005	1.45
18	709 IH 75	960	1.38	960	1.38
19	3391 Autumn/ Spring Lake Plant	915	1.32	917	1.32
20	253 Broadmoor/ Spring Lake Plant	930	1.34	702	1.01
TOTAL		**6,540**	**9.42**	**6,345**	**9.14**

(1) Data from TCEQ Water System Data Sheet downloaded April 27, 2015.

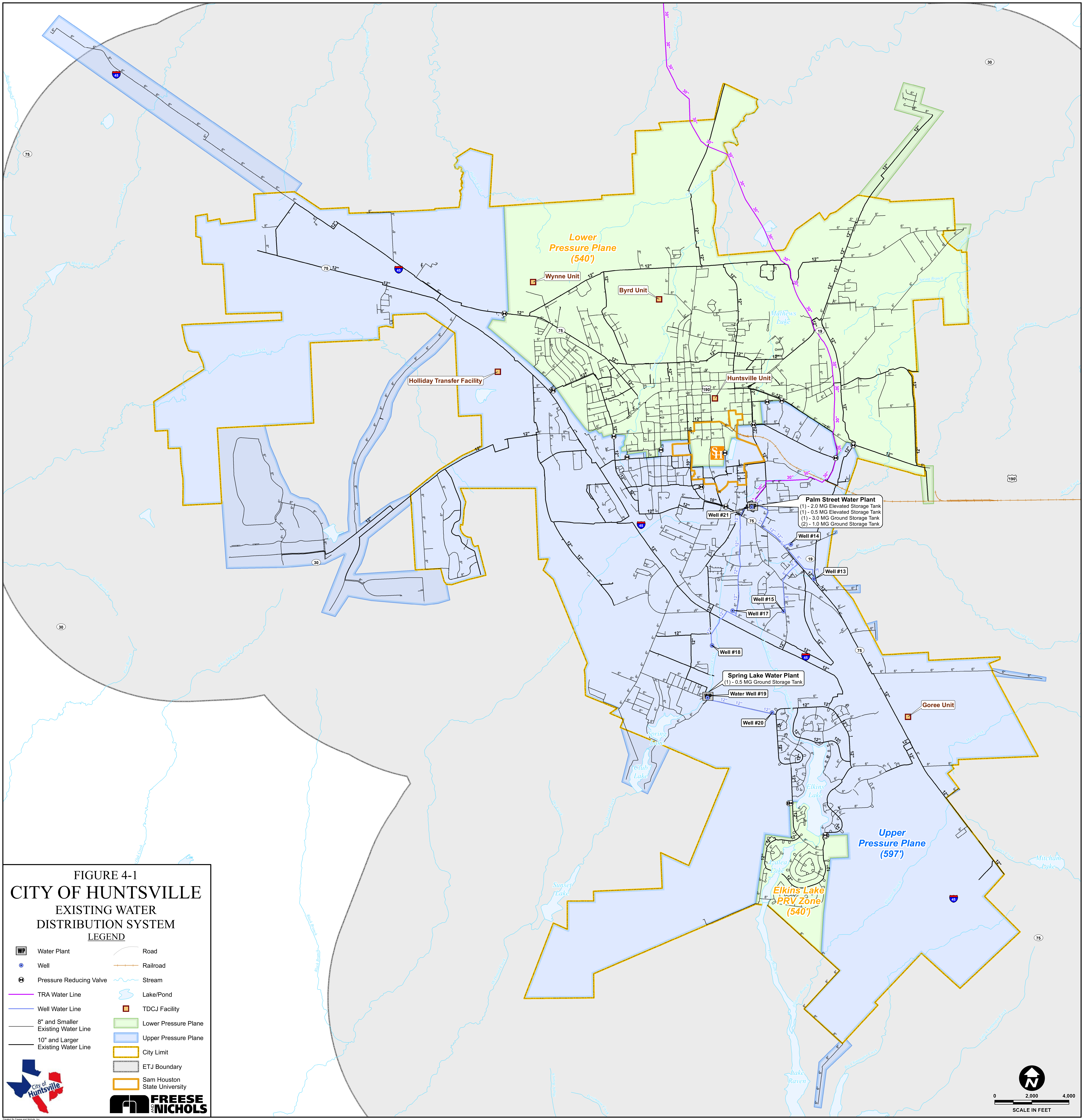

FIGURE 4-1
CITY OF HUNTSVILLE
EXISTING WATER DISTRIBUTION SYSTEM

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Job No.: HVL15249
Location: H:\W_WW_PLANNING\Final_Report\(Figure_4-1)-Water_Existing_System.mxd
Updated: Thursday, November 17, 2016 4:57:44 PM

Figure 4-2: Water Line Length by Diameter

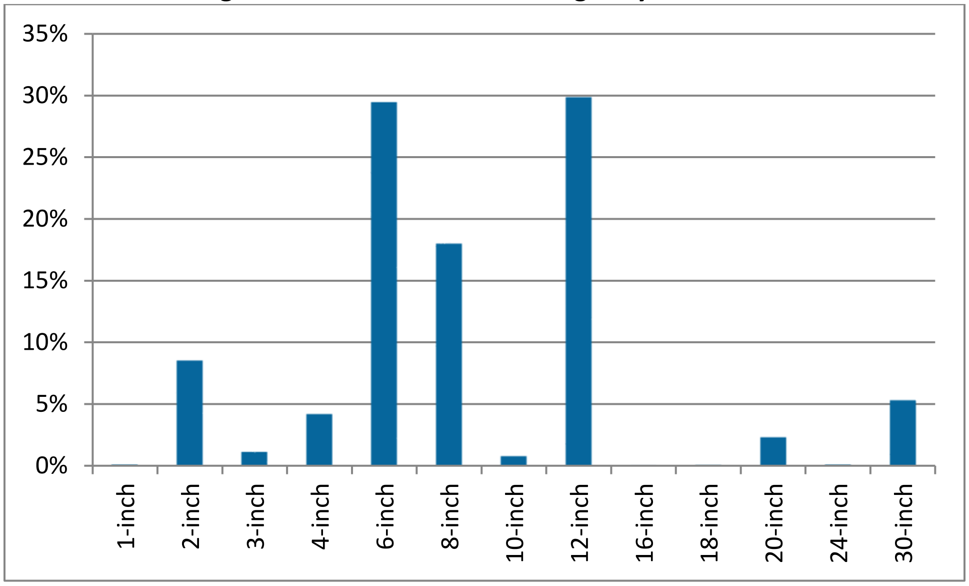
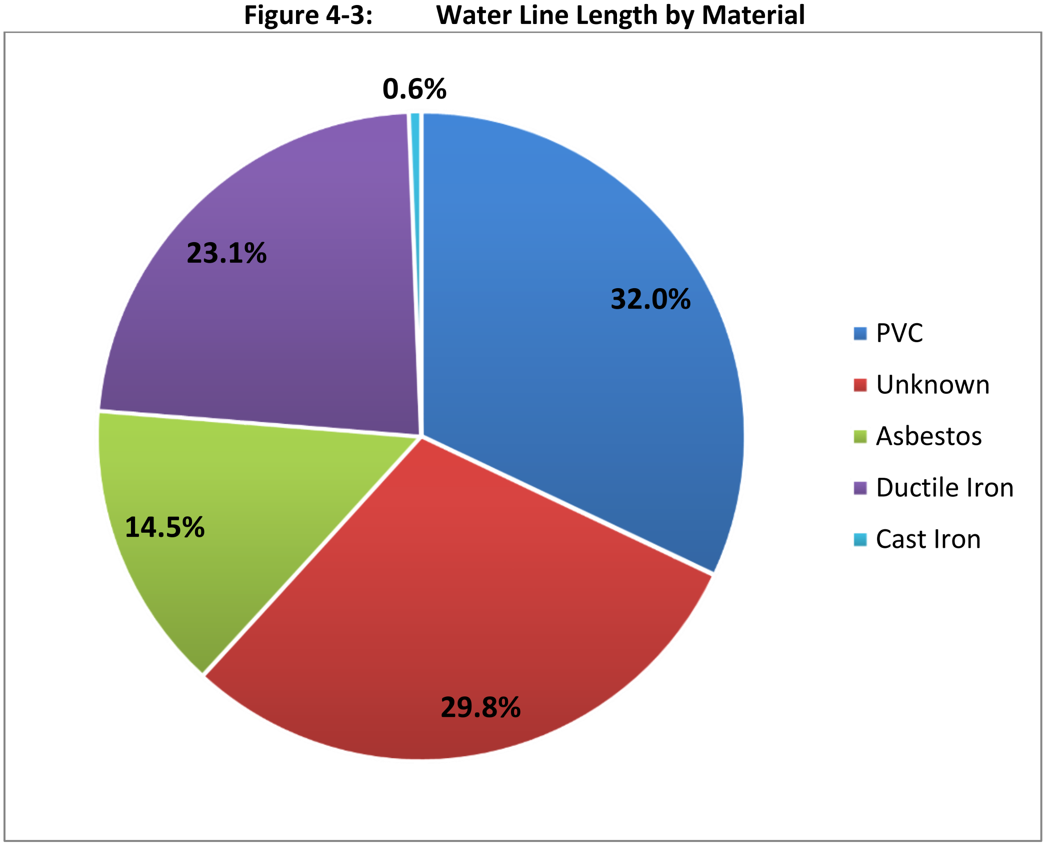


Figure 4-3: Water Line Length by Material



4.4 STORAGE FACILITIES

The City currently utilizes three GSTs at the Palm Street Water Plant: one 3.0 MG tank and two 1.0 MG tanks. The GSTs are filled by the 30-inch transmission water line from the TRA WTP and five groundwater wells. One 0.5 MG GST at the Spring Lake Water Plant is supplied by two groundwater wells. There is one 0.5 MG EST and one 2.0 MG EST at the Palm Street Water Plant; both tanks have an overflow elevation of 597 feet.

4.5 PUMP STATIONS

The City has three pump stations: Old Palm Street, New Palm Street and Spring Lake. The City has a total system pumping capacity of 21.6 MGD and a firm system pumping capacity of 18.7 MGD, which is the capacity with the largest pump out of service. **Table 4-2** provides a summary of pumping facilities. The pumping facilities serve both pressure planes.

Table 4-2: Existing Pumping Facilities

Pump Station Name	Pump Number	Rated Capacity (gpm)	Rated Capacity (MGD)
Old Palm Street	1	1,000	1.44
	2	1,000	1.44
	3	2,000	2.88
	4	2,000	2.88
New Palm Street	1	1,750	2.52
	2	1,750	2.52
	3	1,750	2.52
	4	1,750	2.52
Spring Lake	1	1,000	1.44
	2	500	0.72
	3	500	0.72
	System Total	**15,000**	**21.6**
	System Firm	***13,000***	***18.7***

5.0 WATER SYSTEM ANALYSES AND HYDRAULIC MODELING

The hydraulic model is one of the most critical elements in the analysis of water distribution systems. Field pressure and pump testing were performed to assist with the calibration of the water system model. The calibrated water system model was then used to conduct hydraulic analyses to identify deficiencies in the City of Huntsville's existing water distribution system and to establish a capital improvements plan to improve the existing system and meet projected water demands through 2041.

5.1 WATER MODEL DEVELOPMENT

A calibrated water model serves as a key decision-making tool to help determine the sizing and location of system infrastructure in both the present and future planning periods. The following subsections document the development and calibration of the water system hydraulic model used as part of the *Water and Wastewater Condition and Capacity Assessment Studies* for the City of Huntsville. The procedures used for model construction are presented, as well as the results of the calibration process.

5.1.1 Field Pressure Testing

To assist with model calibration and supplement available operational data, field pressure testing was conducted August 21 – 31, 2015. A total of 12 pressure recorders were installed throughout the distribution system. Locations of the pressure recorders are illustrated on **Figure C-1** in **Appendix C**. Minimum, maximum and average pressures were recorded every five minutes at each location. Complete data from all recorders was collected from August 22 at 12:00 AM through August 30 at 12:00 AM. **Appendix C** includes the pressure recorder data from the field testing period.

5.1.2 Field Pump Testing

FNI completed pump testing at the Palm Street Water Plant as part of the *2015 Palm Street Water Plant Condition Assessment* and at the Spring Lake Water Plant as part of this study. The goals of the pump testing were as follows:

- Establish where the pumps operate in relation to original specifications
- Develop updated curves for pumps not recently tested
- Verify pump capacities for model calibration

FNI developed a protocol and detailed testing sequences for the Spring Lake Water Plant, and the results of the tests can be found in **Appendix C**. During the Spring Lake pump testing, FNI learned that the City maintains pump discharge valves at least 80% closed at all times to ensure the Spring Lake pumps operate within an acceptable range on their pump curve.

5.1.3 Physical Network

The water model was developed using the WaterGEMS software by Bentley®. City staff provided the GIS shapefiles of water lines that were imported into the model using the City's facility identification number as the unique ID. The model contains 4,548 links with diameters ranging in size from 0.75-inches to 30-inches. FNI added elements to connect facilities to the distribution system. Elements added to the model by FNI were given the prefix "FNI" before an ID number. Initial Hazen-Williams roughness coefficients for water lines were assigned based on the installation year, shown in **Table 5-1**.

Table 5-1: Initial Hazen-Williams C-Value Assignments

Water Line Installation Year	C-Value
Before 1960	100
1960-1979	110
1980-1999	120
2000-Present	130

All pumping and storage facilities were manually added to the model based on as-built drawings and information provided by the City. All pumps were assigned their field tested pump curve. Variable area tank curves were developed to accurately model changes in tank volume. In the water model, there are 4,270 junctions, 11 pumps, 6 storage tanks, 21 PRVs, one reservoir at the Spring Lake Water Plant representing groundwater wells, and one reservoir representing both the TRA SWTP transmission line and groundwater wells at the Palm Street Water Plant. Model nodes in the distribution system were assigned an elevation based on the two-foot ground contour data provided by the City. Elevations for facilities (tanks and pumps) were assigned using as-built drawings and two-foot contour elevations. The elevated storage tanks at the Palm Street Water Plant were modeled as a single 2.5 MG EST to avoid the challenges of model imbalance and multiple interim iterations associated with modeling storage tanks in close proximity in extended period simulations.

5.1.4 Demand Allocation

FNI allocated demands to the model using water customer billing accounts. The active water meters were spatially located, and the associated consumption was assigned to the nearest model node. The water demands were divided into two categories: residential and non-residential usage. The information from the customer billing database was joined to the parcel shapefile by the unique customer address. FNI used the spatial join function in GIS to distribute August 2014 demands to the model nodes. Once demands were allocated to the model nodes, they were scaled to match the demands of the selected calibration day. Water demands at large apartment complexes and TDCJ units were recorded by City staff and manually entered into the water model as point demands.

5.2 EXTENDED PERIOD SIMULATION CALIBRATION

In order to verify that the hydraulic model accurately represents actual distribution system operation, a model calibration was performed. The calibration process involves adjusting system operational parameters, roughness values, demand allocation, and diurnal patterns to match a known system condition. The 24-hour period occurring on August 25, 2015, was selected for calibration. This day was selected because there were no irregularities in system operations. This section provides a summary of the calibration process, the adjustments made during calibration and the modeled results versus the actual recorded values.

5.2.1 Calibration Process

The City provided Supervisory Control and Data Acquisition (SCADA) data during the pressure testing period. The SCADA reports included pump station flow and ground and elevated storage tank levels. Flow and tank level data were utilized to calculate an overall diurnal pattern by examining water going into (supply) and out of (demand) the distribution system. The calculated total system demand for August 25 was 9.6 MGD with a peak demand of 14.45 MGD. **Figure 5-1** shows the calculated system diurnal pattern for August 25, 2015. The calculated diurnal pattern suggests high usage in the early morning hours, which is likely related to irrigation and TDCJ water usage. Diurnal factors for the 24-hour period ranged from 0.48 to 1.51.

During calibration, two diurnal patterns were derived from the calculated system diurnal pattern and adjusted to better represent the demand experienced in the Upper and Lower Pressure Planes, shown on **Figure 5-2**.

Figure 5-1: Calculated Water System Diurnal Pattern for August 25, 2015

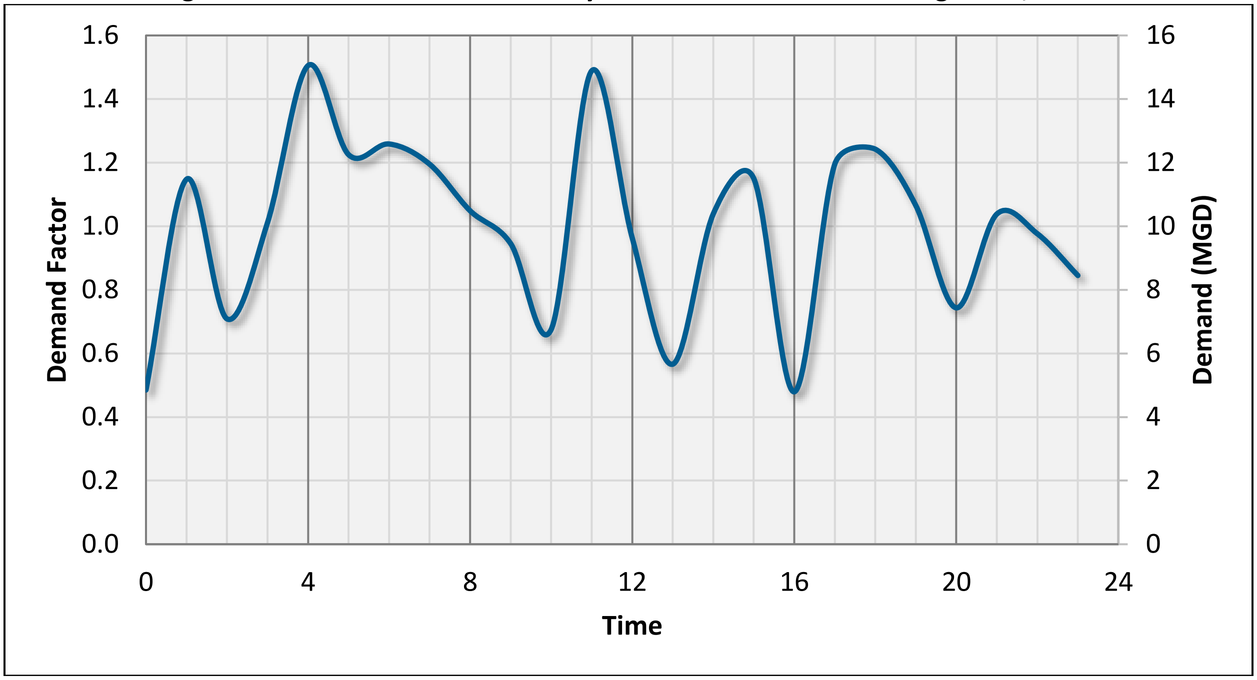
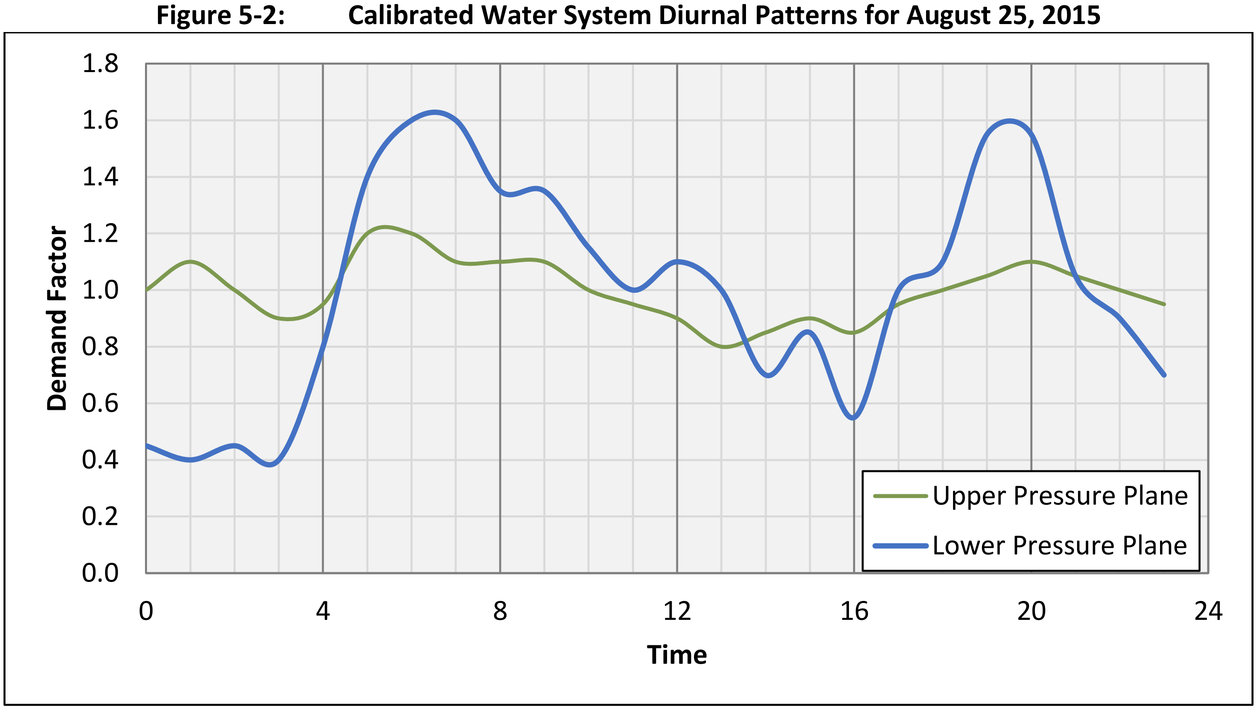


Figure 5-2: Calibrated Water System Diurnal Patterns for August 25, 2015



5.2.2 Calibration Controls and Adjustments

During the extended period simulation (EPS) calibration, adjustments were made to the model in order to match the known conditions of August 25, 2015. The operational controls were based on the time of day changes reflected in the SCADA data. Timing controls were used on the pumps during calibration because a known condition is trying to be matched from the SCADA data. Going forward, the model controls will be based on parameters, such as pressures or tank levels, unless a certain item has a regularly specified time control. The SCADA values are an instantaneous reading at a given time based on data recorded every five minutes, and do not account for changes between data points; therefore, adjustments to the settings at the pumps and valves were necessary to account for fluctuations between calibration points. PRVs were assigned the pressure setting provided by the City.

5.2.3 Calibration Results

The results of the EPS calibration are summarized on the graphs included in **Appendix D**. The graphs show modeled flows, levels and pressures versus recorded data at facilities and pressure recorder locations. Calibration statistics are presented in **Tables 5-2**, **5-3** and **5-4.** Each monitored location includes 24 data points (one for each hour of the calibration) where the recorded and modeled values were compared. The percentages presented in the tables were determined by the number of points that fell within the given measurement range. Palm Street Pump Station flow was considered as a total of the New and Old pump stations. At the Spring Lake Water Plant, partially closed valves and the presence of a hydropneumatic tank created challenges when trying to match the model to the recorded flows and pressures. The results suggest a good correlation between recorded and modeled values and provide a high level of confidence in the accuracy of the model. The model is calibrated well within the industry standards.

Table 5-2: Pump Flow Calibration Statistical Summary

Facility	Flow Within 10%
Palm Street Water Plant	92%
Spring Lake Water Plant	58%

Table 5-3: Tank Level Calibration Statistical Summary

<table>
<tr><th colspan="2">Facility</th><th>Within 5 feet</th></tr>
<tr><td rowspan="4">Palm Street Water Plant</td><td>West 1.0 MG GST 1</td><td>100%</td></tr>
<tr><td>East 1.0 MG GST 2</td><td>100%</td></tr>
<tr><td>3.0 MG GST</td><td>100%</td></tr>
<tr><td>2.5 MG EST(1)</td><td>100%</td></tr>
<tr><td colspan="2">Spring Lake Water Plant 0.5 MG GST</td><td>100%</td></tr>
<tr><td colspan="2">Average</td><td>100%</td></tr>
</table>

(1) Combination of 2.0 MG and 0.5 MG ESTs.

Table 5-4: Pressure Calibration Statistical Summary

Pressure Plane	Pressure ID	Within 5 psi
Upper	PR #1 - 201671	100%
	PR #2 - 205546	100%
	PR #3 - 203271	100%
	PR #4 - 204228	100%
	PR #5 - 205543	100%
Lower	PR #6 - 201669	100%
	PR #7 - 203191	100%
	PR #8 - Loan	100%
	PR #9 - 203436	100%
	PR #10 - 201667	100%
	PR #11 - 203019	100%
	PR #12 - 205545	100%
Average		**100%**

5.3 EXISTING WATER SYSTEM ANALYSIS

The existing distribution system was evaluated to assess current supply, pumping, and storage capacity, residual pressures, and fire flow capacity. This analysis was performed to determine if there are any existing system deficiencies and also to provide a baseline for the current level of service. The parameters that were evaluated are discussed in the following sections.

5.3.1 Existing Water Supply Capacity

As a public water utility, the City of Huntsville must comply with the rules and regulations for public water systems set forth by TCEQ in Chapter 290. The City is required to meet TCEQ water supply requirements of having a SWTP firm transfer pumping capacity combined with a total groundwater pumping capacity of 0.6 gpm per connection. The estimated existing number of equivalent connections (i.e. 300 apartment units equals 300 connections) was used to calculate the minimum required water supply capacity. **Table 5-5** presents the TCEQ water supply requirements for the existing water system.

Table 5-5: 2016 TCEQ Water Supply Capacity Requirements

Water Service Area Population	Number of Connections	Existing Water Supply Capacity (MGD)	TCEQ Requirement 0.6 gpm/con (MGD)	Existing Gallons per Connection of Water Supply (gpm/con)
40,101	20,286	17.7	17.5	0.6

Based on the regulations, the City is currently in compliance with the minimum water supply capacity requirement.

5.3.2 Existing Storage Capacity

The City is required to meet the TCEQ total storage capacity requirement of 200 gallons per connection and elevated storage capacity requirement of 100 gallons per connection. The estimated existing number of connections was used to calculate the TCEQ minimum required storage. **Table 5-6** presents the TCEQ storage requirements for the existing water system.

Table 5-6: 2016 TCEQ Storage Capacity Requirements

Water Service Area Population	Number of Connections	Total Storage (MG)		Elevated Storage (MG)	
		Existing	Required (200 gal/con)	Existing	Required (100 gal/con)
40,101	20,286	8.0	4.1	2.5	2.0

Based on the regulations, the City is in compliance with the minimum amount of total and elevated storage capacity requirements.

5.3.3 Existing Pumping Capacity

In addition to storage and water supply requirements, the City is also required to meet the service pumping capacity requirements presented in **Table 5-7**. **Table 5-8** presents the TCEQ service pumping requirements for the existing water system.

From **Table 5-6**, Huntsville has 123 gallons per connection of elevated storage; therefore, Condition 1 from **Table 5-7** is not satisfied. Based on the City's projected demands, Condition 2b is the lesser of Condition 2 and governs the City's service pumping capacity, which requires that the City be able to meet peak hourly demands with firm pumping capacity. Model results included in **Section 5.3.4** show that the City is not able to meet peak hourly demands with the largest pump out of service and maintain a minimum pressure of at least 35 psi throughout the water system. However, this is due to significant headloss in the City's water lines leaving the Palm Street Water Plant and the City's low EST overflow elevations and is not due to a lack of firm pumping capacity. **Section 5.4.6** outlines recommendations to reduce water line headloss and increase the City's water system pressure by adding ESTs with higher overflow elevations.

Table 5-7: TCEQ Service Pumping Requirements

Condition	Service Pumping Capacity Requirement[1]
1. If providing at least 200 gallons per connection of elevated storage	Two service pumps with a minimum combined capacity of 0.6 gpm per connection at each pressure plane
2. If providing less than 200 gallons per connection of elevated storage	**The lesser of (a) or (b):** (a) Total pumping capacity of 2.0 gpm per connection (b) Total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service

(1) According to 290.45(b)(1)(D)(iii).

Table 5-8: 2016 TCEQ Pumping Capacity Requirements

Water Service Area Population	Number of Connections	Peak Hour Demand (MGD)	Existing Firm Pumping Capacity (MGD)	TCEQ Requirement 2.0 gpm/con (MGD)
40,101	20,286	21.1	18.7	58.4

5.3.4 Hydraulic Analysis

Hydraulic analyses were performed on the distribution system under maximum day and average day demand conditions. A 24-hour EPS was performed under maximum day demand conditions. By examining the distribution system under these various operating conditions, it is possible to determine where issues with pressures occur, if tanks are filling or draining properly, and if the service pumping facilities are adequate to meet the required demand at acceptable pressures.

A maximum day EPS model run evaluates the ability of the system to provide adequate supply to meet demands while maintaining levels in storage facilities. During a maximum day EPS analysis, the peak hour demand is also simulated through the use of the diurnal patterns developed in **Section 5.2.1**. Peak hour demand represents the single hour of the year with the highest system demand. Peak hour simulations are used to assess the ability of the distribution system to maintain minimum pressures. Lower demand periods throughout the day are simulated in EPS modeling as well. This is when the system's ability to replenish storage tanks is evaluated.

Color-coded pressure maps were prepared to illustrate the residual pressure calculated at model junctions. The maps helped identify potential problem areas in the system and were used as a tool to ensure that reasonable pressure ranges were maintained throughout the system. A map showing the minimum pressures under maximum day demands can be found in **Appendix E.** Minimum pressures shown on the maps represent the lowest value of the pressures experienced during the 24-hour simulation, usually occurring during the peak hour demand. Minimum pressures are shown to fall below 35 psi near the middle of the City. An evaluation of the current elevated storage and City wide ground elevations revealed that the current height of the City's ESTs is too low to maintain adequate pressure. The ESTs must be kept mostly full to ensure that system-wide pressures are above 35 psi. This leads to water quality problems such as high water age and thermal stratification. This also reduces the effective storage of the EST, since levels cannot be allowed to fall below 30 feet of the 40-foot head range. It is recommended that the City increase the hydraulic gradient in the Upper Pressure Plane to ensure TCEQ minimum pressure requirements are met at all times.

In addition to documenting minimum pressures under maximum day demands, FNI analyzed and evaluated the existing system water lines based on the following headloss criteria:

- Water lines 16-inches in diameter and smaller: maximum headloss of 7 feet per 1,000 ft of water line length
- Water lines larger than 16-inches: maximum headloss of 3 feet per 1,000 ft of water line length

All of the water lines leaving the Palm Street Water Plant are shown to experience excessive headloss due to undersized water lines, which contribute to low water system pressure. It is recommended that the City increase the size of the distribution lines leaving the Palm Street Water Plant along Sam Houston Avenue, Avenue I, SH 75, and Montgomery Road. Mapping was created to highlight the areas where the headloss criteria is exceeded and can be found in **Appendix E**.

5.3.5 Fire Flow Analysis

To evaluate the fire suppression capabilities of the system, a fire flow analysis was conducted under maximum day demand conditions. TCEQ requires a minimum residual pressure of 20 psi be maintained while delivering the fire flow demand. For this analysis, a steady-state model run was utilized to calculate the available fire flow at each fire hydrant node in the system with a pressure of 20 psi. A fire flow contour map was also prepared to show the available fire flow throughout the distribution system. Areas shown to have an available fire flow less than 1,000 gpm include the Texas Department of Transportation (TxDOT) rest areas in the northwest area of the City, a neighborhood along SH 30 on the west side of the City and the Spring Lake area, among other areas. High elevation areas, areas with small lines in the model (less than 6-inches) and dead end lines also showed to have low available fire flow. The majority of the City has an available fire flow greater than 1,500 gpm. The fire flow map for existing system conditions can be found in **Appendix E**.

5.3.6 Water Age Analysis

Water age modeling was conducted under existing average day demand conditions to establish a baseline and determine the impact that increased demands and system improvements have on water age. While water age does not directly cause poor water quality, it is known that chlorine residual degrades over time, and disinfection byproduct levels increase over time; therefore, increasing water age can lead to the loss of chlorine residual and the formation of disinfection byproducts. The model analysis calculates the water age within the distribution system based on how usage affects the rate of flow over time throughout the system.

A 21-day simulation was performed under average day demand conditions to ensure a consistent pattern of water age was established in the model. The age of water leaving the Palm Street and Spring Lake Water Plants is zero in the hydraulic model. Overall, the majority of the City's water is less than two days old. Areas with dead end water lines and along the extremities of the water system have water age between two and ten days old. These areas are the farthest water distribution points from the Palm Street and Spring Lake Water Plans and have little circulation. **Appendix E** includes contour maps showing the water age throughout the system for existing system conditions with and without the use of the City's automatic flush valves. Dead end water lines with no demand were not included on the contour mapping.

5.4 FUTURE WATER SYSTEM ANALYSIS

Various combinations of improvements and system modifications were investigated to determine the most appropriate approach for meeting projected demands. Parameters used in developing the capital improvements plan included increasing system reliability, meeting required fire flows, and maintaining proper residual pressures.

5.4.1 Pressure Plane Delineation

The City currently utilizes PRVs to establish the Lower Pressure Plane hydraulic gradient of 540 feet. The 17 PRVs required for the Lower Pressure Plane are routinely repaired and replaced. To alleviate the associated maintenance challenges and provide the Lower Pressure Plane with a reliable source of water, it is recommended that the City create an isolated Lower Pressure Plane by completely isolating the two pressure planes. The existing PRVs would be replaced with closed pressure plane valves to completely separate the Upper and Lower Pressure Planes, and a new Lower Pressure Plane Water Plant would be constructed to supply the Lower Pressure Plane. The existing Palm Street EST would be converted to a Lower Pressure Plane EST with a hydraulic gradient of 580 feet, and a new EST with a hydraulic gradient of 630 feet would be constructed in the Upper Pressure Plane. These improvements will provide both pressure planes with adequate service pumping and elevated storage capacity. Recommended projects are discussed further in **Section 7.0**. The following sections describe the future required capacity and hydraulic analyses of the City's future water system.

5.4.2 Future Required Water Supply Capacity

Table 5-9 shows the City's total water supply capacity versus TCEQ water supply requirements for future planning periods. Since both the Upper and Lower Pressure Planes are supplied by the same TRA transmission water line and SWTP, future water supply requirements were evaluated for the entire water system. It is recommended that the City pursue an Alternative Capacity Requirement (ACR) with TCEQ to utilize historical water demand information to calculate a lower water supply requirement. The recommended water supply capacity shown below is based on an estimated ACR of 0.47 gpm per connection.

Table 5-9: Projected Water Supply Capacity Requirements

Year	Water Service Area Population	Number of Connections	Existing Water Supply Capacity (MGD)	TCEQ Requirement 0.6 gpm/con (MGD)	Estimated TCEQ ACR Requirement 0.47 gpm/con (MGD)	Recommended Capacity(1) (MGD)
2021	42,669	21,585	17.7	18.7	14.6	17.7
2026	45,908	23,224	17.7	20.1	15.7	17.7
2041	55,156	27,902	17.7	24.1	18.9	19.2

(1) It is recommended that the City add 1.5 MGD of transfer pumping capacity at TRA SWTP to meet estimated ACR of 0.47 gpm per connection through 2041.

It is recommended that the City plan to add 1.5 MGD of transfer pumping capacity at the TRA SWTP to meet estimated TCEQ ACR requirements.

5.4.3 Future Required Storage Capacity

Tables 5-10 and **5-11** show the City's total and elevated storage capacities versus TCEQ storage requirements for future planning periods for the Upper and Lower Pressure Planes, respectively.

Table 5-10: Projected Upper Pressure Plane Storage Capacity Requirements

Year	Water Service Area Population	Number of Connections	Total Storage (MG)		Elevated Storage (MG)		
			Existing	Required (200 gal/con)	Existing	Required (100 gal/con)	Recommended(1)
2021	30,944	15,654	8.0	3.1	-	1.6	2.0
2026	33,571	16,983	8.0	3.4	-	1.7	2.0
2041	40,066	20,268	8.0	4.1	-	2.0	2.0

(1) Includes future 2 MG EST (overflow elevation 630 feet) in the Upper Pressure Plane and repurposing the existing 2.0 MG Palm Street EST for the Lower Pressure Plane.

Table 5-11: Projected Lower Pressure Plane Storage Capacity Requirements

Year	Water Service Area Population	Number of Connections	Total Storage (MG)		Ground Storage (MG)	Elevated Storage (MG)	
			Reqd. (200 gal/con)	Recommended	Recommended(1)	Reqd. (100 gal/con)	Recommended(2)
2021	11,725	5,931	1.2	3.0	2.0	0.6	1.0
2026	12,337	6,241	1.2	3.0	2.0	0.6	1.0
2041	15,090	7,634	1.5	3.5	2.0	0.8	1.5

(1) It is recommended that the City maintain enough ground storage at the Lower Pressure Plane Water Plant to store 8 hours of maximum day demand.
(2) 2021 and 2026 includes 1 MG for existing Palm Street EST converted to the Lower Pressure Plane and a future 1.5 MG EST by 2041 (overflow elevation 580 feet).

The existing total storage capacity of 8 MG will enable the City to meet TCEQ minimum total storage requirements in the Upper Pressure Plane through 2041. A new 2 MG EST is recommended to be constructed near Talltimbers Lane by 2021 to serve the Upper Pressure Plane and meet TCEQ minimum elevated storage requirements.

It is recommended that the City construct a 2 MG GST at the new Lower Pressure Plane Water Plant to ensure TCEQ minimum total storage requirements are met, and the City is able to supply at least eight hours of maximum day demand if water supply from the TRA SWTP was temporarily unavailable. The existing Palm Street EST is recommended to be repurposed to a 1 MG EST through piping modifications and installing an altitude valve by 2021 to serve the Lower Pressure Plane and meet TCEQ minimum elevated storage requirements.

5.4.4 Future Required Service Pumping Capacity

Tables 5-12 and **5-13** show the City's service pumping capacities versus the TCEQ service pumping requirement, for future planning periods for the Upper and Lower Pressure Planes, respectively.

Table 5-12: Projected Upper Pressure Plane Service Pumping Capacity Requirements

Year	Water Service Area Population	Number of Connections	Existing Firm Pumping Capacity (MGD)	Recommended Capacity[(1)] (MGD)
2021	30,944	15,654	18.7	10.3
2026	33,571	16,983	18.7	11.2
2041	40,066	20,268	18.7	13.7

(1) It is recommended that the City plan to meet 70% of peak hourly demand with service pumping capacity. Recommended capacity includes a new 10.8 MGD Palm Street Pump Station.

Table 5-13: Projected Lower Pressure Plane Service Pumping Capacity Requirements

Year	Water Service Area Population	Number of Connections	Existing Firm Pumping Capacity (MGD)	Recommended Capacity[(1)] (MGD)
2021	11,725	5,931	-	5.3
2026	12,337	6,241	-	5.8
2041	15,090	7,634	-	6.8

(1) It is recommended that the City plan to meet 70% of peak hourly demand with service pumping capacity. Recommended capacity includes a new 6.8 MGD Lower Pressure Plane Pump Station.

As part of the *Palm Street Water Plant Condition Assessment* conducted by FNI in 2015, alternative options were presented to the City to bring the existing Palm Street Water Plant into acceptable condition. The City selected the option to construct a new pump station and abandon the existing Palm Street Pump Stations. It is recommended that the City construct a 7,500 gpm pump station at Palm Street to provide the Upper Pressure Plane with service pumping capacity by 2021. Model results included in **Section 5.4.6** show that the City will be able to meet peak hourly demands with the largest pump out of service and maintain a minimum pressure of at least 35 psi throughout the Upper Pressure Plane.

It is also recommended that the City construct a 4,800 gpm pump station to provide the Lower Pressure Plane with service pumping capacity by 2021. Model results included in **Section 5.4.6** show that the City will be able to meet peak hourly demands with the largest pump out of service and maintain a minimum pressure of at least 35 psi throughout the Lower Pressure Plane.

5.4.5 2041 Hydraulic Analysis without Improvements

The same set of hydraulic analyses from the existing system were simulated under 2041 conditions to determine if additional problems arise due to existing limitations with the current infrastructure.

Appendix E contains mapping showing the results of the minimum pressures and headloss analyses under 2041 conditions without improvements.

Minimum Pressure

In addition to existing areas with low pressure, discussed in **Section 5.3.4**, under 2041 maximum day demand conditions without improvements, the water system pressure in the majority of the City falls below the minimum required pressure of 35 psi. During the peak hour, water levels in the Palm Street EST fall below 30 feet. A higher Upper Pressure Plane EST overflow elevation and large diameter distribution lines are needed to reduce headloss in the water system and maintain pressures above 35 psi.

Headloss

The water distribution lines leaving the Palm Street Water Plant exceed the 3 ft/1,000-ft headloss criteria under 2041 maximum day demand conditions without improvements. Larger diameter water distribution lines are needed to reduce the headloss in the water system.

Fire Flow

In addition to existing areas with low available fire flow, discussed in **Section 5.3.5**, available fire flow along the outskirts of the City falls below 1,000 gpm under 2041 conditions without system improvements. A higher Upper Pressure Plane EST overflow elevation and large diameter distribution lines are needed to reduce headloss in the water system and maintain pressure above 20 psi during emergency conditions.

The addition of the projected 2041 water demands to the existing water system showed that water system improvements are needed to meet future demand, meet minimum capacity and pressure requirements, and maintain ideal operating conditions.

5.4.6 Water System Improvements

FNI worked with City staff to develop and identify water system improvements to accommodate future growth while optimizing the existing system operations and infrastructure. Some of the recommended operational changes and improvements to the distribution system include:

- New Upper Pressure Plane EST with higher overflow elevation and new Palm Street Pump Station
- New Lower Pressure Plane Pump Station and repurposing the existing 2.0 MG Palm Street EST for use in the Lower Pressure Plane
- Improved distribution system connectivity between pump stations and ESTs
- Pressure plane boundary modifications to address low pressures in the Lower Pressure Plane

Specific capital improvement projects to accomplish the above are discussed in detail in **Section 7.0**. Hydraulic analyses of the maximum day EPS, fire flow and water age scenarios were performed to confirm that CIP projects addressed existing and future water system deficiencies. Maps showing model results are included in **Appendix E**. The results show improvement in system pressures as well as the available fire flow throughout the City.

6.0 WATER LINE RENEWAL PROGRAM

In addition to the Water System CIP, the City tasked FNI with developing a water line rehabilitation prioritization program. The program is based on a combination of physical data (water line age, material, capacity, and repair data) and maintenance data (critical locations, water quality complaints, and limited access areas) to prioritize candidates for replacement.

6.1 WATER LINE ASSESSMENT PARAMETERS

Water line diameter, material and age were obtained from the City's GIS. City staff provided mapping comments that filled in a large amount of missing water line material information, and FNI populated the GIS database based on the City's comments.

Diameter

The water line size provides an indication of fire flow capacities and headloss. Small water lines have low fire flow capacity and experience high headloss.

Material

Certain water line materials have less flexible joints, are subject to leakage and are difficult to repair. Other water line materials are subject to potential corrosion problems. The assigned point value for water lines with unknown material was between the values assigned for ductile iron and asbestos cement.

Age

Water line age provides a potential indication to a number of potential problems such as leakage, potential taste and odor problems from biofilms, loss in carrying capacity from increased head loss and inoperable valves.

Capacity

Water line capacity was evaluated using the water system model to determine maximum available fire flow while maintaining 20 psi. Fire flow capacities ranged from zero to 5,000 gpm. Water lines with less than 1,000 gpm of available fire flow were considered to have insufficient capacity, and water lines with greater than 2,000 gpm of available fire flow were considered to have adequate capacity.

Repairs

Repair history data from 2014 through 2016 was obtained from the City's work order database and geocoded in GIS. Water line repair history from work order information indicated the locations with chronic reliability issues and areas of maintenance concern. This evaluation parameter was based on the frequency of repairs or maintenance activities.

Critical Lines

Water quality complaints were obtained from the City's work order database. Water lines within 100 feet of a school or medical facility were identified as water lines in high risk areas. Areas with water quality issues resulting from red water problems or dead end configurations were also addressed through the critical water line parameter.

6.2 ASSESSMENT AND PRIORITIZATION PROCESS

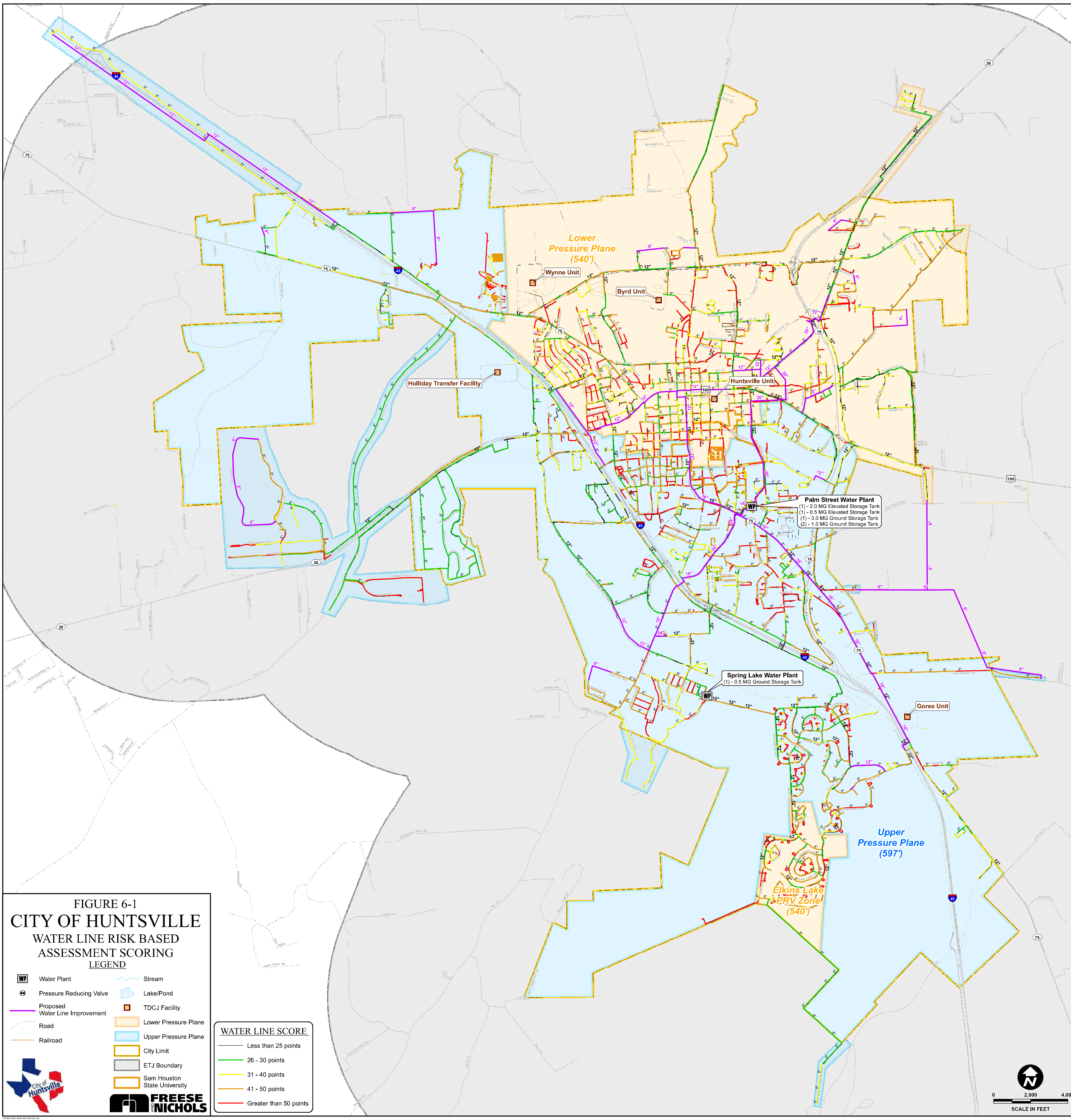
Table 6-1 shows each parameter with its respective scoring values. The total score for a water line was calculated by adding the points assigned for each of the six parameters. The maximum possible score for any given water line is 100 points. The water lines in the study area ranged from 8 to 77 points. Water lines with higher scoring represent candidate lines with the greatest need for replacement. More weight was given to the water line repair and water line capacity parameters because they concentrate more on the actual performance of the water lines rather than the water line characteristics. **Figure 6-1** shows the water lines in the study area and the scoring ranges.

Table 6-1: Water Line Prioritization Scoring System

Scoring Parameter	Category	Points[1]
Diameter (max = 15 points)	3" and smaller water line	15
	4" water line	10
	6" water line	5
	8" and larger water line	2
Material (max = 15 points)	Cast Iron/Galvanized Steel/Copper	15
	Asbestos Concrete	13
	Null/None	12
	Ductile Iron	11
	Reinforced Concrete	8
	Polyvinyl Chloride/C-900/C-909/C-905/Welded Steel	6
Water Line Age (max = 15 points)	Before 1970	15
	1970 to 1985	10
	1985 to 2000	6
	After 2000	2
Water Line Capacity (max = 20 points)	Fire Flow < 1,000 gpm	20
	Fire Flow 1,000 gpm - 1,500 gpm	12
	Fire Flow 1,500 gpm - 2,000 gpm	7
	Fire Flow > 2,000 gpm	0
Water Line Repair (max = 20 points)	6 or more breaks	20
	3 - 5 breaks	12
	1 - 2 breaks	7
	No breaks	0
Critical Water Line (max = 15 points)	High Risk Area[2]	15
	Red Water/Access Problems	11

(1) Diameter + Material + Age + Capacity + Repairs + Critical Water Lines = Maximum 100 Points.

(2) Water lines near medical or school facilities.



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6.3 RENEWAL CAPITAL IMPROVEMENTS PLAN

Based on the scoring results, a total score of 30 points was used as a minimum score for candidate replacement lines. These candidate replacement lines were grouped into constructible projects, shown on **Figure 6-2**. Cost estimates were developed for the recommended projects and are summarized in **Table 6-2**. Some smaller segments of water lines that had a score lower than 30 points but were needed for project connectivity were included in a project. The sizing of projects were based on geography and a total cost of approximately $1,000,000. After the projects were grouped, they were prioritized according to the average project score and repair history. The average project score is the total score of all the water lines in that project divided by the number of water lines. Detailed cost estimates can be found in **Appendix F**.

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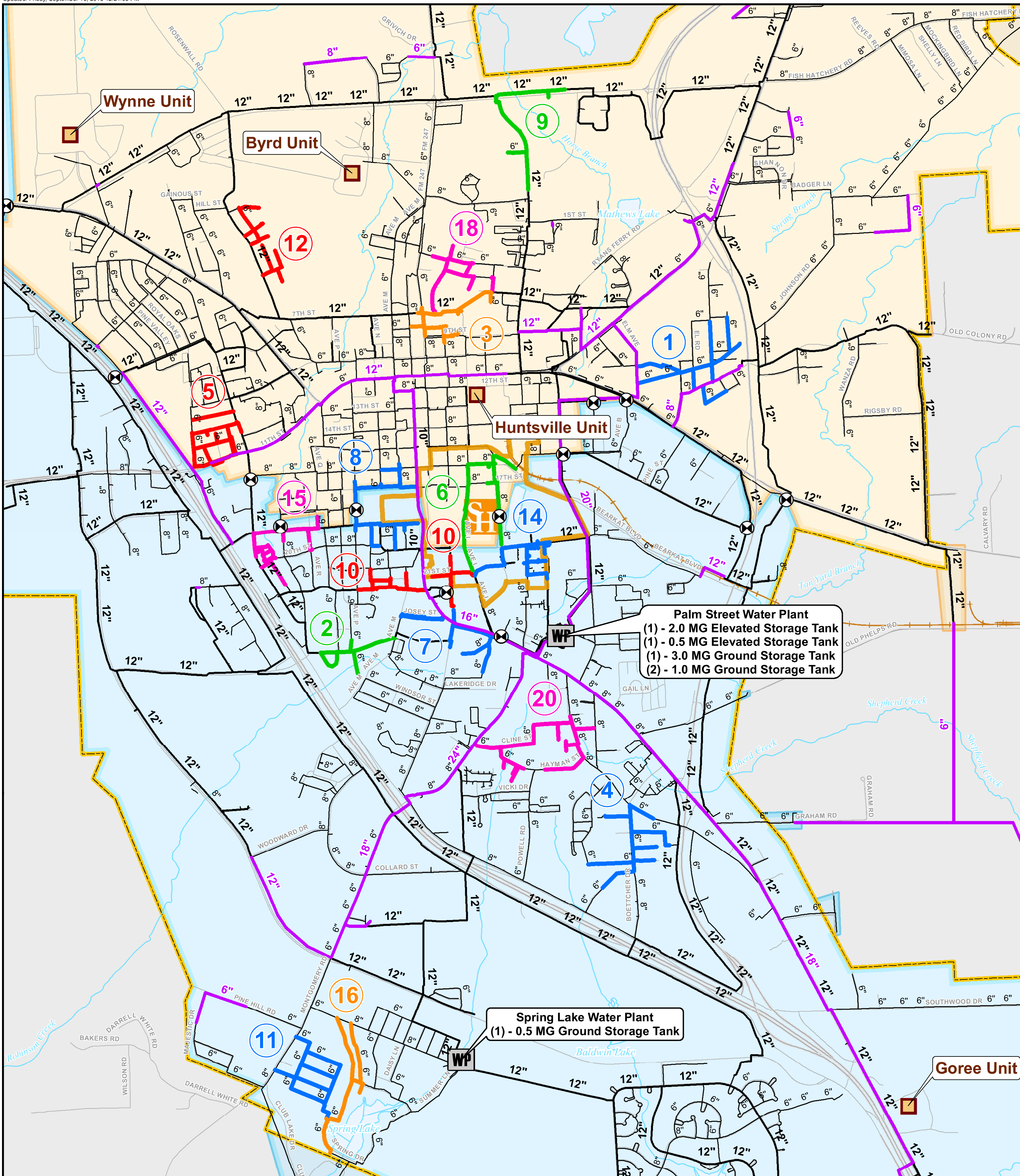

FIGURE 6-2
CITY OF HUNTSVILLE
WATER LINE RENEWAL PROJECTS

LEGEND

- Pressure Reducing Valve
- Water Plant
- Proposed Water Line Improvement
- Road
- Railroad
- Stream
- Lake/Pond
- TDCJ Facility
- Lower Pressure Plane
- Upper Pressure Plane
- City Limit
- ETJ Boundary

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City of Huntsville

Table 6-2: Water System Renewal Program CIP Summary

Project Number	Project Description	Cost
1	Old Colony Road/Trinity Cutoff Rehabilitation	$ 1,216,200
2	Robinson Way/ 25th Street Rehabilitation	$ 736,900
3	Mance Park Middle School Rehabilitation	$ 1,014,600
4	Boettcher Drive Rehabilitation	$ 1,172,100
5	11th Street/Hickory Drive Rehabilitation	$ 1,274,100
6	Avenue I/Bobby K Marks Drive Rehabilitation	$ 1,266,300
7	Josey Street/11th Street Rehabilitation	$ 1,159,000
8	Avenue O/17th Street Rehabilitation	$ 1,231,400
9	FM 2821/Martin Luther King Drive Rehabilitation	$ 1,165,000
10	Avenue J/21th Street/22nd Street Rehabilitation	$ 1,174,300
11	Pine Shadows Rehabilitation	$ 1,172,100
12	Smith Hill Road/Mary Avenue Rehabilitation	$ 647,200
13	Elkins Lake: Augusta Drive/Greenbriar Drive Rehabilitation	$ 1,225,400
14	Bearkat Village Apartments Rehabilitation	$ 1,200,000
15	Highland Townhomes Rehabilitation	$ 1,222,200
16	Spring Lake: Spring Drive/January Lane Rehabilitation	$ 937,800
17	Elkins Lake: Greentree Drive/Greenbriar Drive Rehabilitation	$ 1,138,100
18	Thomason Street/Birmingham Street/Avenue J Rehabilitation	$ 747,300
19	Elkins Lake: Fairway Drive/Foxbriar Drive Rehabilitation	$ 1,187,800
20	Cline Street/Hayman Street Rehabilitation	$ 1,323,100
	Total	**$ 22,210,900**

7.0 WATER SYSTEM CAPITAL IMPROVEMENTS PLAN

A capital improvements plan was developed for the City of Huntsville to maintain high quality water service that promotes residential and commercial development. The recommended improvements will provide the required capacity and reliability to meet projected water demands through year 2041. The recommended capacity related projects for the water system are presented on **Figure 7-1**.

Locations shown for new lines and other recommended improvements were generalized for hydraulic analyses. Specific alignments and sites will be determined as part of the design process. Water projects currently under design are shown in **orange** on **Figure 7-1**. Water lines to be constructed by future development are shown in **purple** on **Figure 7-1** and were included and correctly sized for the hydraulic analysis. It is recommended that these projects be constructed generally in the order listed; however, development or renewal patterns may make it necessary to construct some projects sooner than anticipated.

Capital costs were calculated for the recommended improvements. The costs are in 2016 dollars and include an allowance for engineering, surveying, and contingencies. Costs do not include easements or land acquisition. The following sections describe how the CIP projects contribute to major operational changes and water system improvements. **Table 7-1** summarizes the costs of the water system capacity CIP for the City of Huntsville. **Table 7-2** summarizes the costs of the water system rehabilitation CIP for the City of Huntsville. Detailed cost estimates are included in **Appendix A**.

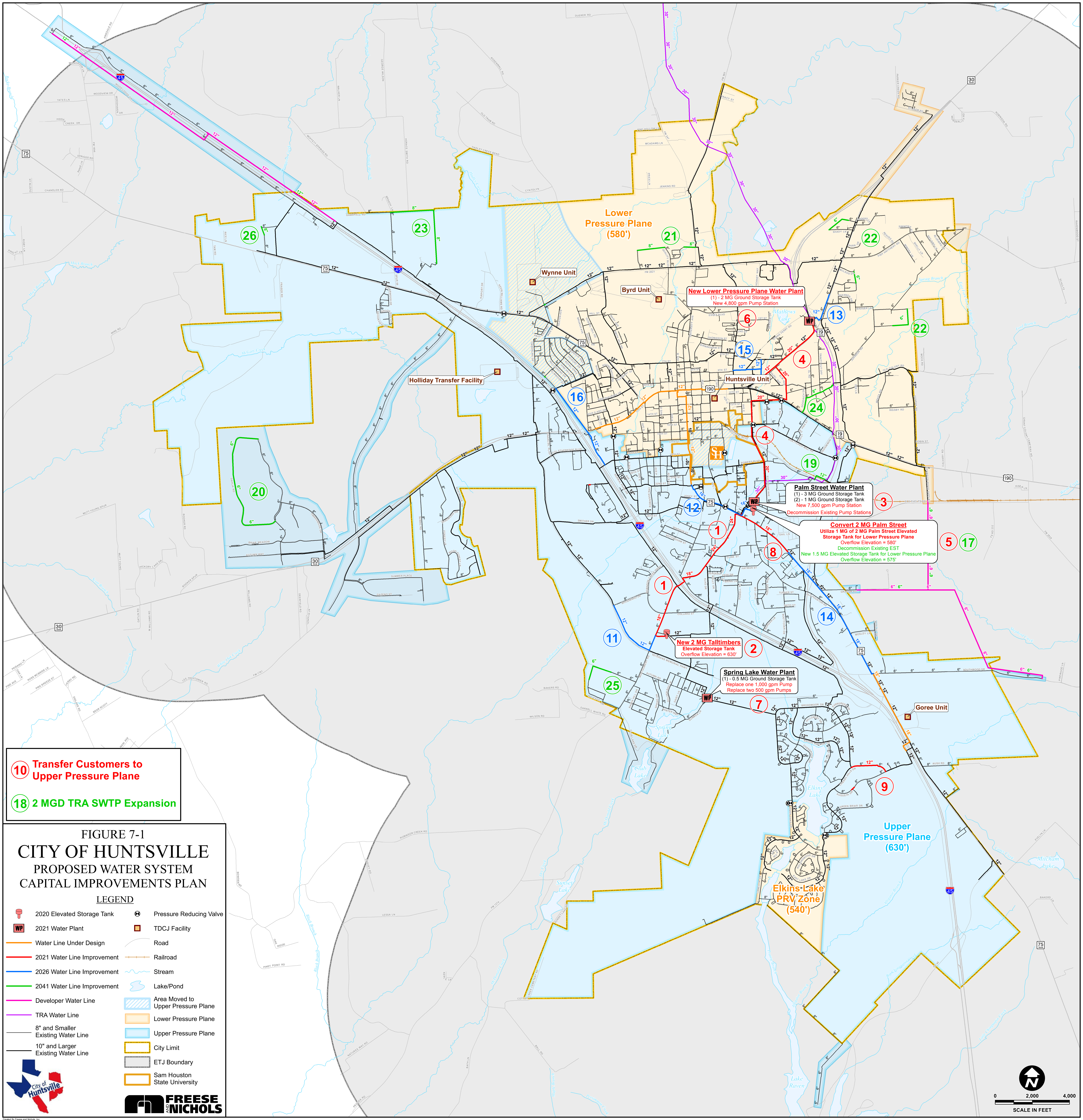

FIGURE 7-1
CITY OF HUNTSVILLE
PROPOSED WATER SYSTEM
CAPITAL IMPROVEMENTS PLAN

Table 7-1: Water System Capacity CIP Summary

Phase	Project Number	Project Description	Cost
2016 - 2021	1	12/18/20/24-inch Montgomery Road Water Lines	$ 4,840,900
	2	2 MG Elevated Storage Tank along Talltimbers Lane	$ 5,086,000
	3	New 7,500 gpm Palm Street Pump Station	$ 2,990,000
	4	12/20/24/30-inch Sycamore Avenue and SH 30 Water Lines	$ 6,504,800
	5	Repurpose 2 MG Palm Street EST to 1 MG Lower Pressure Plane EST	$ 149,500
	6	New 4,800 gpm Lower Pressure Plane Water Plant with 2 MG GST	$ 4,858,800
	7	New Pumps at the Spring Lake Water Plant	$ 157,000
	8	18-inch SH 75 South Water Lines Phase 1	$ 957,200
	9	8-inch and 12-inch Elkins Lake Water Lines	$ 509,600
	10	Transfer Customers along Avenue I to Upper Pressure Plane	$ 314,000
		Total 2016 - 2021	**$ 26,367,800**
2022 - 2026	11	12-inch Veterans Memorial Parkway Water Line	$ 895,000
	12	16-inch Sam Houston Avenue Water Line	$ 1,144,400
	13	12-inch North SH 30 Water Line	$ 458,400
	14	18-inch SH 75 South Water Lines Phase 2	$ 2,349,400
	15	12-inch 9th Street and Avenue C Water Lines	$ 567,600
	16	12-inch IH 45 Water Line (19th Street to Crosstimbers Street)	$ 1,091,400
		Total 2022 - 2026	**$ 6,506,200**
2027 - 2041	17	1.5 MG Elevated Storage Tank at Palm Street	$ 4,784,000
	18	2 MGD TRA Surface Water Treatment Plant Expansion	$ 799,900
	19	12-inch Bearkat Boulevard Water Line	$ 617,300
	20	6-inch Dahlia Road Water Line	$ 1,142,900
	21	8-inch and 6-inch FM 2821 Water Lines	$ 375,300
	22	6-inch Northeast SH 30 Water Lines	$ 615,400
	23	8-inch Moffett Springs Road Water Line	$ 903,400
	24	8-inch Goodrich Drive and Old Colony Road Water Lines	$ 443,300
	25	6-inch Spring Lake Water Lines	$ 278,500
	26	8-inch Fraser Road Water Line	$ 102,400
		Total 2026 - 2041	**$ 10,062,400**
		Grand Total	**$ 42,936,400**

Table 7-2: Water System Renewal Program CIP Summary

Project Number	Project Description	Cost
1	Old Colony Road/Trinity Cutoff Rehabilitation	$ 1,216,200
2	Robinson Way/ 25th Street Rehabilitation	$ 736,900
3	Mance Park Middle School Rehabilitation	$ 1,014,600
4	Boettcher Drive Rehabilitation	$ 1,172,100
5	11th Street/Hickory Drive Rehabilitation	$ 1,274,100
6	Avenue I/Bobby K Marks Drive Rehabilitation	$ 1,266,300
7	Josey Street/11th Street Rehabilitation	$ 1,159,000
8	Avenue O/17th Street Rehabilitation	$ 1,231,400
9	FM 2821/Martin Luther King Drive Rehabilitation	$ 1,165,000
10	Avenue J/21th Street/22nd Street Rehabilitation	$ 1,174,300
11	Pine Shadows Rehabilitation	$ 1,172,100
12	Smith Hill Road/Mary Avenue Rehabilitation	$ 647,200
13	Elkins Lake: Augusta Drive/Greenbriar Drive Rehabilitation	$ 1,225,400
14	Bearkat Village Apartments Rehabilitation	$ 1,200,000
15	Highland Townhomes Rehabilitation	$ 1,222,200
16	Spring Lake: Spring Drive/January Lane Rehabilitation	$ 937,800
17	Elkins Lake: Greentree Drive/Greenbriar Drive Rehabilitation	$ 1,138,100
18	Thomason Street/Birmingham Street/Avenue J Rehabilitation	$ 747,300
19	Elkins Lake: Fairway Drive/Foxbriar Drive Rehabilitation	$ 1,187,800
20	Cline Street/Hayman Street Rehabilitation	$ 1,323,100
	Total	**$ 22,210,900**

7.1 WATER PROJECTS FROM 2016 TO 2021

Project 1: 12/18/20/24-inch Montgomery Road Water Lines

This project includes the construction of 12-inch, 18-inch, 20-inch, and 24-inch replacement water lines along Montgomery Road from the Palm Street Water Plant to the new Talltimbers Lane EST **(Project 2)**. This project is recommended to connect the Palm Street Water Plant to the new Talltimbers Lane EST and replace aging water lines.

Project 2: 2 MG EST along Talltimbers Lane

This project includes the construction of a new 2 MG elevated storage tank along Talltimbers Lane near Montgomery Road. This Upper Pressure Plane EST is recommended to have an overflow elevation of 630 feet. This project is recommended to maintain minimum water system pressure as required by TCEQ and increase elevated storage capacity in the Upper Pressure Plane.

Project 3: New 7,500 gpm Palm Street Pump Station

This project includes the construction of a new 7,500 gpm pump station at the Palm Street Water Plant. The existing pump stations are recommended to be decommissioned. This project is recommended to replace degrading pump stations and piping at the Palm Street Water Plant and maintain water levels in the new Talltimbers Lane EST **(Project 2)**.

Project 4: 12/20/24/30-inch Sycamore Avenue and SH 30 Water Lines

This project includes the construction of 12-inch, 20-inch, 24-inch, and 30-inch new and replacement water lines along Sycamore Avenue and SH 30 from the new Lower Pressure Plane Water Plant **(Project 6)** to the repurposed Palm Street EST **(Project 5)**. This project is recommended to connect the new Lower Pressure Plane Water Plant to the repurposed Palm Street EST.

Project 5: Repurpose 2 MG Palm Street EST as 1 MG Lower Pressure Plane EST

This project includes the repurposing of the existing 2 MG Palm Street EST as a 1 MG Palm Street EST with piping modifications and a new altitude valve set to an overflow elevation of 580 feet for the Lower Pressure Plane. Only the bottom 23 feet of the EST is planned to be utilized, resulting in 1 MG of elevated storage for the Lower Pressure Plane. This project is recommended to maintain minimum water system pressure as required by TCEQ and provide elevated storage capacity in the Lower Pressure Plane.

Project 6: New 4,800 gpm Lower Pressure Plane Water Plant with 2 MG GST

This project includes the construction of a new 4,800 gpm Lower Pressure Plane Pump Station with a 2 MG GST near the intersection of SH 30 and SH 19. This project is recommended to provide service pumping capacity in the Lower Pressure Plane, maintain water levels in the Lower Pressure Plane Palm Street EST and provide a second, reliable water plant for the City. The new water plant will receive water from the existing 30-inch TRA water supply line.

Project 7: New Pumps at the Spring Lake Water Plant

This project includes the replacement of a 1,000 gpm and two 500 gpm pumps at the Spring Lake Water Plant. This project is recommended to replace aging pumps and maintain water levels in the new Talltimbers Lane EST **(Project 2)**.

Project 8: 18-inch SH 75 South Water Lines Phase 1

This project includes the construction of 18-inch replacement water lines along SH 75 South from the Palm Street Water Plant to Old Phelps Road. This project is recommended to reduce excessive headloss in existing water lines from the Palm Street Water Plant to the Goree Unit and Elkins Lake subdivision.

Project 9: 8-inch and 12-inch Elkins Lake Water Lines

This project includes the construction of 8-inch and 12-inch replacement water lines along Cherry Hills Drive and Augusta Drive in the Elkins Lake subdivision. This project is recommended to reduce excessive headloss in existing water lines, improve water distribution capacity and replace aging water lines in the Elkins Lake subdivision.

Project 10: Transfer Customers along Avenue I to Upper Pressure Plane

This project includes disconnecting existing water meters from the 8-inch Lower Pressure Plane water line and connecting them to the 12-inch Upper Pressure Plane water line along Avenue I between Bowers Boulevard and Sam Houston Avenue. This project is recommended to improve water pressure and available fire flow to existing customers along Avenue I.

7.2 WATER PROJECTS FROM 2022 TO 2026

Project 11: 12-inch Veterans Memorial Parkway Water Line

This project includes the construction of new 12-inch water lines along Veterans Memorial Parkway from Woodward Drive to Montgomery Road to connect existing 6-inch and 12-inch water lines. This project is recommended to eliminate dead end water lines, reduce headloss in existing water lines and improve available fire flow near the new Talltimbers Lane EST **(Project 2)**.

Project 12: 16-inch Sam Houston Avenue Water Line

This project includes the construction of 16-inch water lines to replace existing 10-inch and 12-inch water lines along Sam Houston Avenue from the Palm Street Water Plant to 22nd Street. This project is recommended to connect the Lower Pressure Plane to the repurposed Palm Street EST **(Project 5)** and increase water distribution capacity in the Lower Pressure Plane.

Project 13: 12-inch North SH 30 Water Line

This project includes the construction of 12-inch water lines to replace existing 6-inch water lines along SH 30 from the Lower Pressure Plane Water Plant to Easley Circle. This project is recommended to reduce excessive headloss in smaller existing water lines and replace aging water lines near the new Lower Pressure Plane Water Plant.

Project 14: 18-inch SH 75 South Water Lines Phase 2

This project includes the construction of 18-inch water lines to replace existing 12-inch water lines along SH 75 South from Old Phelps Road to Southwood Drive. This project is recommended to reduce excessive headloss in smaller existing water lines from the Palm Street Water Plant to the Goree Unit and Elkins Lake subdivision.

Project 15: 12-inch 9th Street and Avenue C Water Lines

This project includes the construction of 12-inch water lines to replace existing 6-inch water lines along 9th Street and Avenue C. This project is recommended to reduce excessive headloss in smaller existing water lines, increase water distribution capacity and replace aging water lines in the Lower Pressure Plane.

Project 16: 12-inch IH 45 Water Line (19th Street to Crosstimbers Street)

This project includes the construction of new 12-inch water lines along IH 45 from 19th Street to Crosstimbers Street. This project is recommended to connect existing water lines, reduce headloss in smaller existing water lines and improve available fire flow.

7.3 WATER PROJECTS FROM 2027 TO 2041

Project 17: 1.5 MG Lower Pressure Plane EST at Palm Street

This project includes the construction of a new 1.5 MG EST at Palm Street. This Lower Pressure Plane EST is recommended to have an overflow elevation of 575 feet. This project is recommended to replace the existing 2 MG EST at Palm Street due to the age of the tank by this planning period and increase elevated storage capacity in the Lower Pressure Plane.

Project 18: 2 MGD TRA Surface Water Treatment Plant Expansion

This project includes the construction of a new 2 MGD clarifier at the TRA SWTP and is contingent upon a water supply ACR from TCEQ. This project is recommended to provide additional water supply capacity for the City to meet water demands through 2041.

Project 19: 12-inch Bearkat Boulevard Water Line

This project includes the construction of new 12-inch water lines along Bearkat Boulevard from Varsity Circle to SH 19. This project is recommended to connect existing water lines, reduce headloss in existing water lines and improve available fire flow east of Sam Houston State University.

Project 20: 6-inch Dahlia Road Water Line

This project includes the construction of 6-inch replacement water lines along Dahlia Road. This project is recommended to reduce excessive headloss in existing water lines, replace aging water lines and increase available fire flow in the Timberwilde subdivision.

Project 21: 8-inch and 6-inch FM 2821 Water Lines

This project includes the construction of new 8-inch water lines from the end of American Legion Drive to the end of Quality Boulevard and new 6-inch water lines from the end of Quality Boulevard to FM 247. This project is recommended to connect dead end water lines and increase available fire flow in the north area of the City.

Project 22: 6-inch Northeast SH 30 Water Lines

This project includes the construction of new 6-inch water lines near Shady Lane, McLeod Drive and Johnson Road. This project is recommended to connect dead end water lines and increase available fire flow in the northeast area of the City.

Project 23: 8-inch Moffett Springs Road Water Line

This project includes the construction of new 8-inch water lines along Moffat Springs Road. This project is recommended to connect dead end water lines and increase available fire flow in the northwest area of the City.

Project 24: 8-inch Goodrich Drive and Old Colony Road Water Lines

This project includes the construction of 8-inch replacement water lines along Goodrich Drive and Old Colony Road. This project is recommended to reduce excessive headloss in existing water lines and replace aging water lines.

Project 25: 6-inch Spring Lake Water Lines

This project includes the construction of new 6-inch water lines along Pine Hill Road and Majestic Drive. This project is recommended to connect dead end water lines and increase available fire flow in the Spring Lake neighborhood.

Project 26: 8-inch Fraser Road Water Line

This project includes the construction of new 8-inch water lines along Fraser Road. This project is recommended to connect dead end water lines and increase available fire flow.

8.0 EXISTING WASTEWATER SYSTEM

The City of Huntsville's wastewater collection system consists of three wastewater treatment plants (WWTPs), approximately 116 miles of gravity wastewater lines ranging from 4-inches to 36-inches, and 26 lift stations throughout the collection system. The existing wastewater system is shown on **Figure 8-1**.

8.1 WASTEWATER SERVICE AREAS

The wastewater system is divided into three service areas that are each served by a wastewater treatment plant (WWTP). The three wastewater treatment plants are:

- A.J. Brown (formerly known as Parker Creek)
- N.B. Davidson (also called the South Plant)
- Robinson Creek

Table 8-1 summarizes the permitted capacities of each treatment plant and the year of construction.

Table 8-1: Wastewater Treatment Plant Facilities

Wastewater Treatment Plant	Permitted Capacity		Year Constructed	Year Expanded
	Average Day Flow (MGD)	Peak Flow (MGD)		
A.J. Brown	4.15	10.5	1978	1994
N.B. Davidson	1.6	4.0	1973	1983
Robinson Creek	2.5	7.5	2000	N/A

8.2 LIFT STATIONS AND FORCE MAINS

As of July 2016, the City owns and maintains 26 lift stations located throughout the three wastewater service areas. These lift stations have approximately 8 miles of associated force mains, with diameters ranging from 2-inches to 18-inches. The total number of lift stations per service area is as follows:

- A.J. Brown – 5 Lift Stations
- N.B. Davidson – 14 Lift Stations
- Robinson Creek – 7 Lift Stations

FNI assembled a lift station inventory using data obtained from City staff, construction drawings, pump vendors, and lift station site visits conducted during the risk based assessment. The lift station inventory is provided in **Appendix G**.

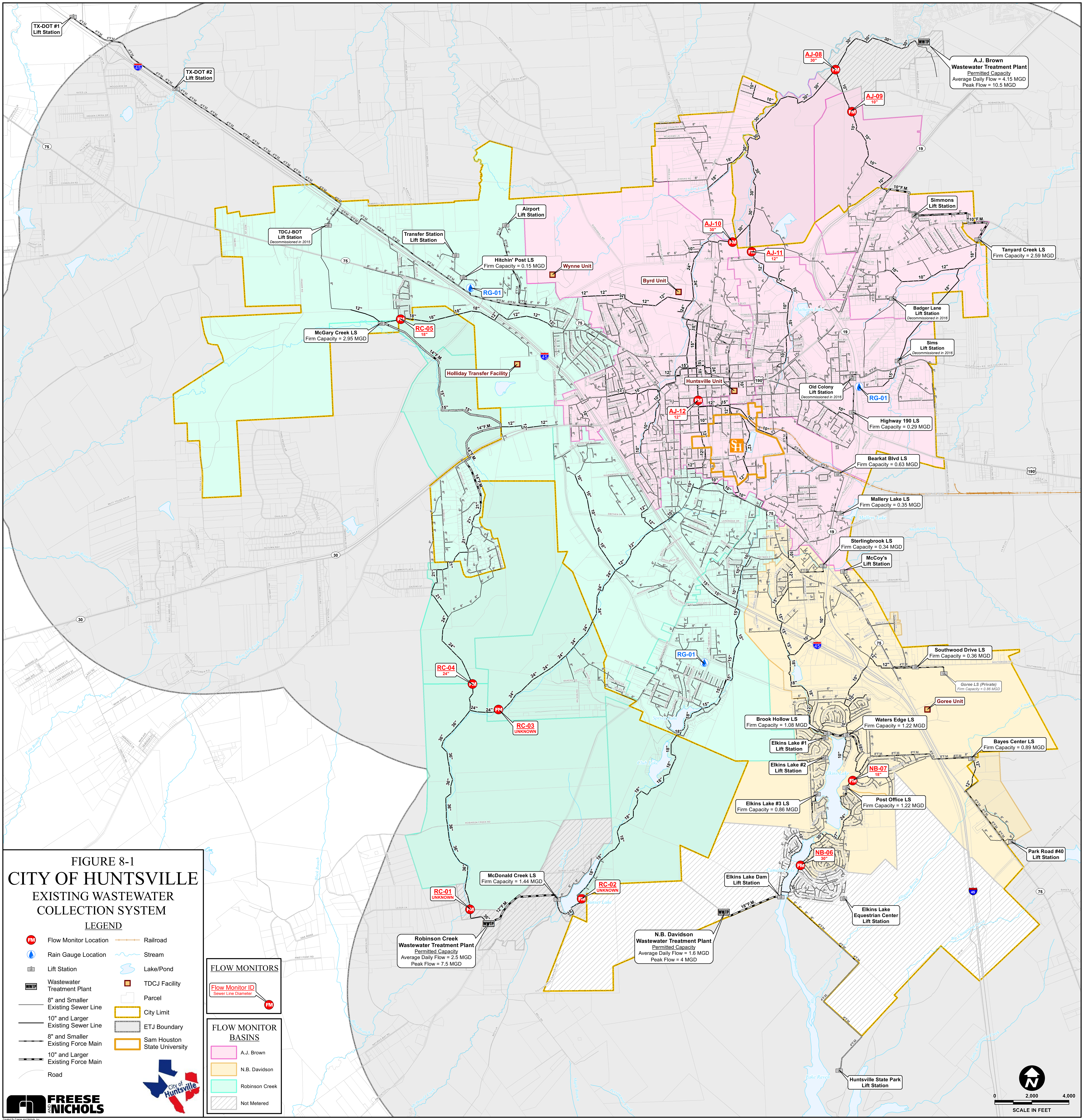

FIGURE 8-1
CITY OF HUNTSVILLE
EXISTING WASTEWATER COLLECTION SYSTEM

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8.3 GRAVITY MAINS

Huntsville's existing wastewater system consists of approximately 116 miles of gravity collector mains and interceptors. Pipeline diameters range in size from 4-inches to 36-inches, and the majority of the wastewater lines are clay tile or PVC. **Figure 8-2** illustrates the percentage of pipe length by diameter. **Figure 8-3** illustrates the percentage of pipe length by material.

Figure 8-2: Gravity Pipe Length by Diameter

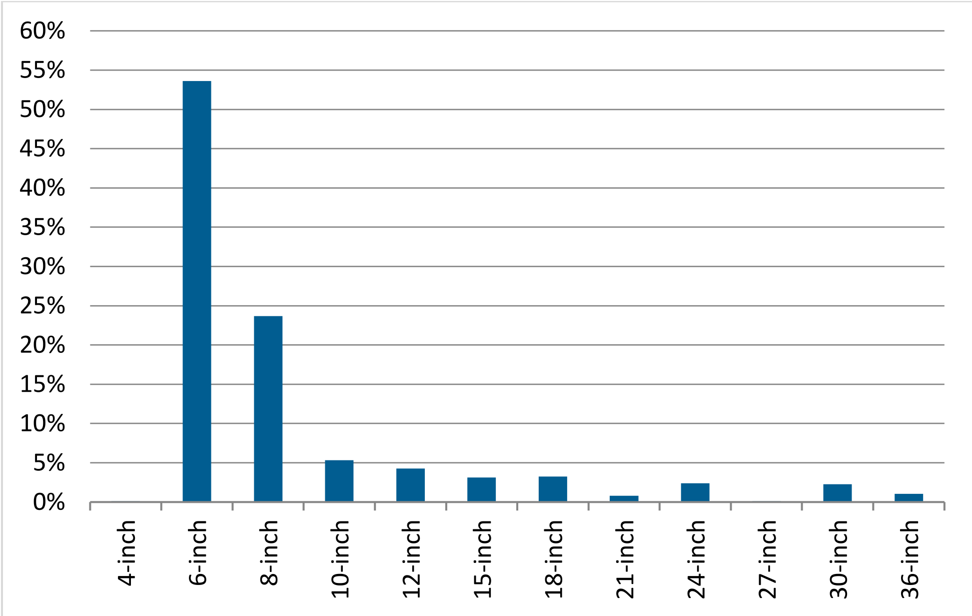
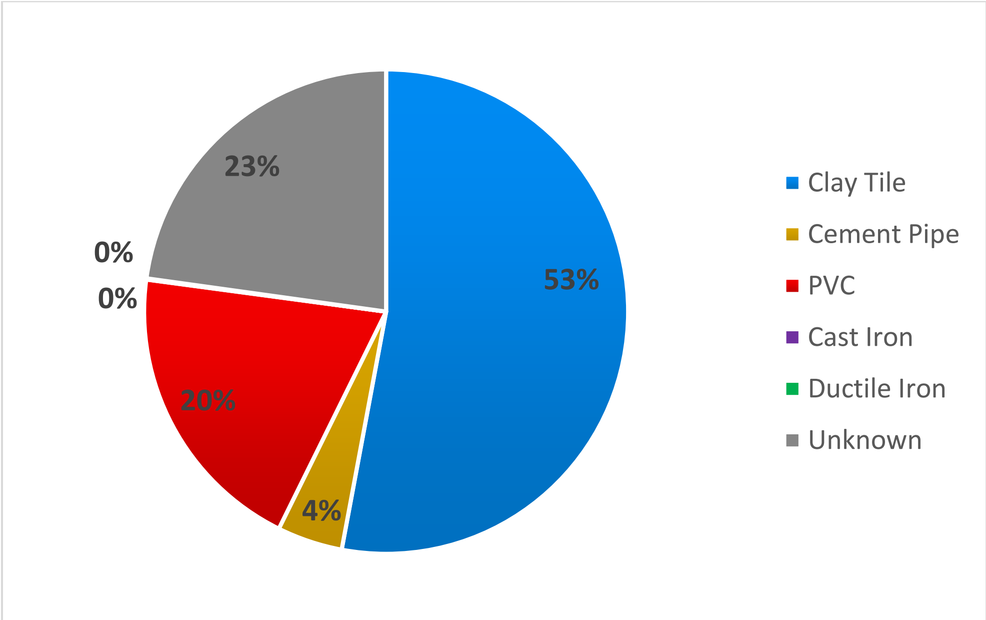


Figure 8-3: Gravity Pipe Length by Material



9.0 WASTEWATER FLOW MONITORING

FNI conducted flow monitoring and recorded rainfall throughout the wastewater system as part of the *Water and Wastewater Condition and Capacity Assessment Studies* project. The flow monitoring and rainfall data was used to characterize dry weather and wet weather flows at key points within the wastewater system, evaluate wet weather inflow and infiltration (I/I), calibrate the hydraulic model of the wastewater collection system, and select basins for Sanitary Sewer Evaluation Surveys (SSES).

9.1 FIELD TESTING

Dry weather and wet weather system responses within the three WWTP service areas were evaluated by installing wastewater flow monitors to observe and document existing flow conditions. Rainfall data was simultaneously collected with rain gauges. A total of 12 flow monitors and three rain gauges were used for this study. All flow monitors and rain gauges were installed and maintained by ADS Environmental Services (ADS).

9.1.1 Flow Monitor and Rain Gauge Placement

Flow monitoring locations were chosen to support the goals of the wastewater system evaluation and overall *Condition and Capacity Assessment Studies*. FNI worked with the City to choose flow monitoring sites. Flow monitors were generally placed at major outfalls within the WWTP basins such that the linear footage of lines between each flow monitor was relatively consistent. Consideration was also given to areas of the wastewater system with known or suspected I/I issues. The flow monitor locations were used to delineate 12 flow monitor basins. Three rain gauges were also installed around the City to capture rainfall during the field testing period. The locations of the flow monitors are provided in **Table 9-1**. The locations of the rain gauges are provided in **Table 9-2**. The WWTP service areas, flow monitor basins, flow monitors and rain gauges are shown on **Figure 8-1**. **Figure 9-1** is a schematic showing the relationships between each flow monitor and basin. Site installation reports with more detailed location information for the flow monitors and rain gauges are provided in **Appendix H**.

Table 9-1: Flow Monitor Locations

Flow Monitor ID	WWTP Basin	Line Diameter[1] (in)	Address / Location	GIS Manhole ID
RC-01	Robinson Creek	35	Easement NW of WWTP	4
RC-02	Robinson Creek	17.25	188 Sunset Lake Road	5387
RC-03	Robinson Creek	22.5	Easement off of Wilson Rd.	378
RC-04	Robinson Creek	29.25	Easement south of Summer Place St.	5472
RC-05	Robinson Creek	18	Brookside Dr.	3364
NB-06	N.B. Davidson	27.25	2096 W. Green Briar Dr.	4696
NB-07	N.B. Davidson	21	Elkins Lake at Golf Club parking lot	4327
AJ-08	A.J. Brown	30	Approx. 1 mi. NW of Jct. Hwys 19 & 30	4160
AJ-09	A.J. Brown	9.75	Easement west of Ellisor Rd. dead end	4129
AJ-10	A.J. Brown	30	200 yds east of 162 Hwy 247	3857
AJ-11	A.J. Brown	12	FM 2821, NE of MLK Jr. Dr.	3804
AJ-12	A.J. Brown	12	1354 Ave. M	2392

(1) Field verified diameters

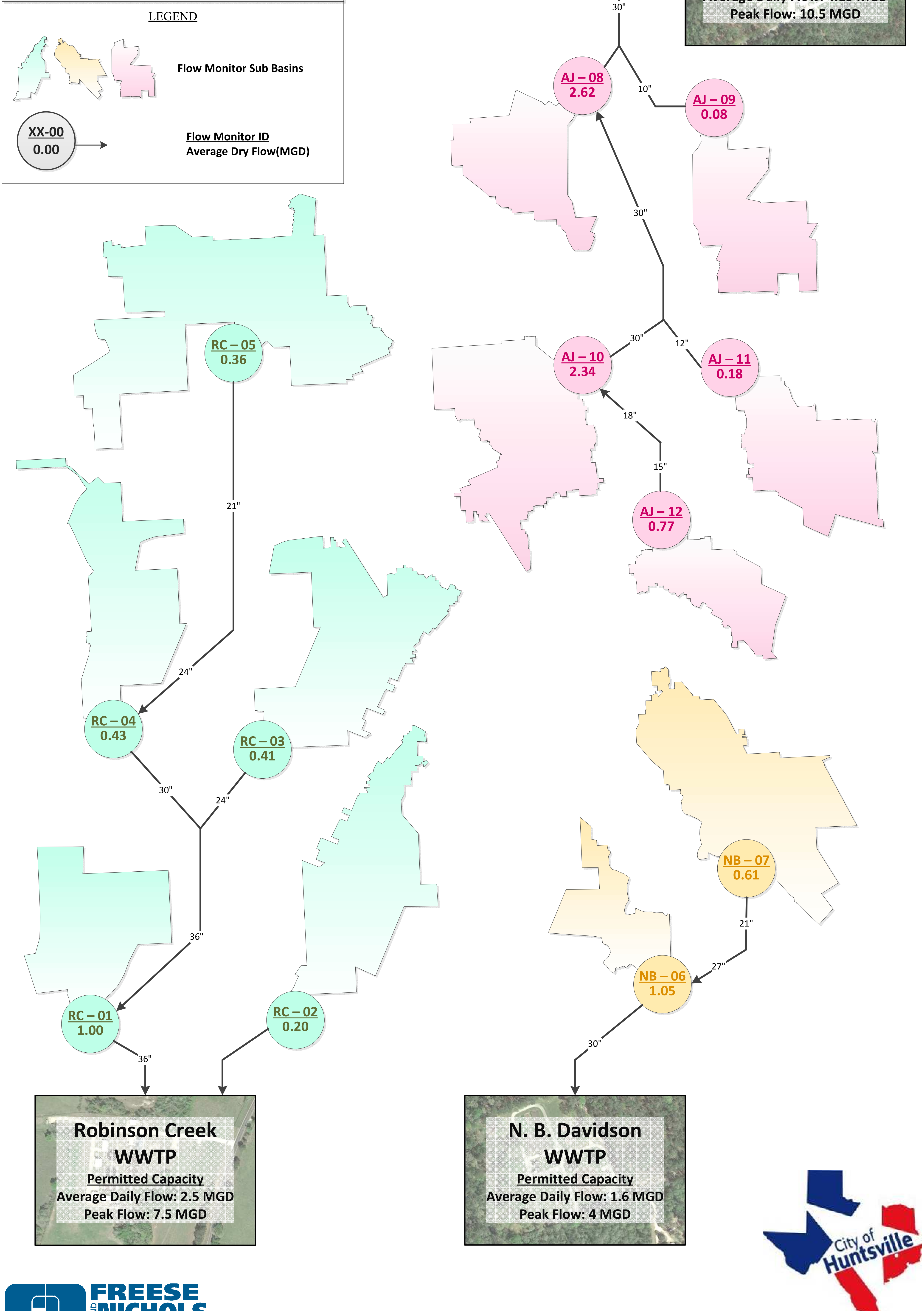
Table 9-2: Rain Gauge Locations

Rain Gauge ID	Address / Location
RG-01	Hwy. 75 & Hwy. 45 / Shell Truck Stop
RG-02	Old Colony Rd. @ Hwy. 19 / Old Colony Lift Station
RG-03	Veteran's Memorial Pkwy. S / Fire Station # 1

9.1.2 Field Testing Period

ADS installed 12 flow monitors and three rain gauges over a period of several days in May 2015. The wastewater flow monitoring and rainfall data collection began on May 19, 2015, and continued through July 7, 2015, for a total of 50 days.

FIGURE 9-1
CITY OF HUNTSVILLE
FLOW MONITOR BASIN SCHEMATIC



9.1.3 Flow Monitor and Rain Gauge Equipment

Wastewater flow monitoring was performed using area-velocity flow monitors manufactured, installed and maintained by ADS. Flow monitors were mounted near the top of each manhole and were connected to flow, depth and velocity sensors positioned in the incoming wastewater pipe. Each flow monitor was equipped with an ultrasonic depth sensor mounted at the crown of the wastewater line and a velocity sensor mounted at or near the invert of the wastewater line. A pressure depth sensor was also mounted at or near the invert to measure surcharge depths. For each flow monitor location, the following procedures were followed:

- Site Investigation – ADS reviewed available wastewater maps and verified preliminary flow monitor locations. A trained field crew then investigated each identified location to confirm whether suitable hydraulic conditions exist. In some cases, the actual site was relocated upstream or downstream from the suggested location in order to obtain better hydraulic conditions, provide better access or mitigate safety concerns.
- Equipment Installation – Following final site selection, flow monitors were installed using a stainless steel band with attached sensors (ultrasonic depth, velocity and pressure depth).
- Sensor Calibration – Prior to exiting the manhole, independent measurements of flow, depth and velocity were obtained and compared to the recorded measurements by the flow monitor. These measurements were used to compute any depth and velocity adjustments needed to fine-tune the recorded measurements by the flow monitor.
- Routine Maintenance – Each temporary flow monitor location was visited weekly to collect data. During each visit, the flow data were reviewed on-site to verify data quality, the flow monitor battery was checked, and the sensors were cleaned, where necessary. Independent flow depth and velocity measurements were obtained to confirm the accuracy of the flow monitor. If problems were identified, they were corrected or the flow monitor was replaced.

Rainfall during the study period was captured using a standard tipping bucket rain gauge. This type of rain gauge is the most common technology available and operates by funneling rainfall to a bucket assembly that is divided into two equal compartments. When one compartment has collected a known amount of rainfall, the bucket tips and drains its contents. As the first compartment tips, the second compartment is positioned under the funnel, and the time that the tip occurs is recorded. Each tip of the bucket generates an electronic pulse that is recorded by an ADS RainAlert II data logger.

9.1.4 Flow Monitor and Rain Gauge Data

Flow monitoring and rain gauge data were collected in five-minute time step intervals. Hydrographs and flow depth plots for each flow monitor site are provided in **Appendix I**. The hydrographs display flow rate data vs. time for the duration of the field testing period, along with the observed rainfall intensities. Similarly, the depth plots show the depth of flow vs. time. Diurnal patterns showing the weekday and weekend flow patterns for each flow monitor site are provided in **Appendix J**.

9.2 FLOW MONITOR AND RAIN GAUGE DATA EVALUATION

FNI reviewed and evaluated the flow monitor and rain gauge data collected during the field testing period. The following sections discuss the dry weather flow, wet weather flow and rain gauge data.

9.2.1 Rainfall Data Evaluation

A total of eleven storm events were observed during the flow monitoring period (May 19 – July 7). Typical design storm events used in Southeast Texas are 2-year, 6-hour and 5-year, 6-hour storms. According to the Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas, the depth of rainfall for a 2-year 6-hour storm is approximately 2.9 inches and the depth of rainfall for a 5-year 6-hour storm is approximately 3.9 inches. The two largest observed storms (June 18 and May 25, respectively) were significant rain events in Huntsville; however, they were smaller than these design storms.

The observed rainfall and the associated measured flow responses were used to calibrate the hydraulic model to observed wet weather conditions. Storm durations and total rainfall amounts for the observed storms are given in **Table 9-3**. The five-minute rainfall intensities are plotted with the flow monitor data on the hydrographs and depth plots in **Appendix I**.

Table 9-3: Storm Event Data during Flow Monitoring

Storm Date	Duration (min)	Duration (hours)	Total Rainfall Depth (1) (in)
5/21/2015	540	9	0.47
5/24/2015	420	7	1.18
5/25/2015	300	5	1.36
5/27/2015	180	3	0.64
6/12/2015	180	3	0.73
6/13/2015	360	6	0.44
6/16/2015	720	12	0.43
6/17/2015	180	3	0.42
6/18/2015	780	13	3.16
6/20/2015	240	4	0.36
6/28/2015	180	3	0.95

(1) Average of three rain gauges

9.2.2 Wastewater Flow Rates and Peaking Factors

Dry weather flow conditions are characterized by evaluating flow monitor data observed during normal conditions, excluding wet weather events and the periods associated with the recovery from these events. The average dry weather and maximum dry weather flow rates are determined from the dry weather diurnal pattern for each flow monitor location and summarized in **Table 9-4**. The resulting dry weather peaking factor (PF_D) is also provided. The 2-hour peak wet weather flow rate for each flow monitor location is also provided, along with the corresponding wet weather peaking factor (PF_W). Wet weather peaking factors above 4 are considered to be excessive and highlighted **red** in **Table 9-4**.

Table 9-4: Dry Weather and Wet Weather Flow Rates

Flow Monitor ID	Avg Dry Weather Flow (MGD)	Max Dry Weather Flow (MGD)	2-hr Peak Wet Weather Flow (MGD)	Dry Weather Peaking Factor - PF_D Max Dry Flow / Avg Dry Flow	Wet Weather Peaking Factor - PF_W Peak Wet Flow / Avg Dry Flow
RC-01	1.00	1.25	5.74	1.2	**5.7**
RC-02	0.20	0.25	1.22	1.3	**6.1**
RC-03	0.41	0.51	2.46	1.2	**6.0**
RC-04	0.43	0.54	2.61	1.3	**6.0**
RC-05	0.36	0.46	1.44	1.3	4.0
NB-06	1.05	1.25	2.94	1.2	2.8
NB-07	0.61	0.72	1.87	1.2	3.1
AJ-08	2.62	3.12	9.97	1.2	3.8
AJ-09	0.08	0.11	0.94	1.3	**11.5**
AJ-10	2.34	2.77	9.62	1.2	**4.1**
AJ-11	0.18	0.27	2.97	1.5	**16.2**
AJ-12	0.77	0.89	2.76	1.2	3.6

9.2.3 Wastewater Depth to Diameter Ratios

The maximum flow depths during dry weather and wet weather flows, their corresponding depth-to-diameter (d/D) ratios, and the manhole depths at each flow monitoring site are provided in **Table 9-5**. Depth-to-diameter ratios can be used to identify capacity issues in wastewater systems. The American Society of Civil Engineers (ASCE) and the Water Environment Federation (WEF) recommend that sewers with diameters up to 15 inches be designed to flow with dry weather d/D ratios of 0.5, and sewers with diameters 18 inches and larger be designed to flow with dry weather d/D ratios of 0.75. Wet weather d/D ratios should not exceed 1.0, as this indicates surcharging in the system.

The dry weather d/D ratios at all flow monitor locations meet the recommended criteria. This indicates adequate capacity in the system to convey dry weather flows. The wet weather d/D ratios show that eight of the flow monitor locations surcharged, indicating a hydraulic grade line above the top of the pipe and insufficient capacity to convey observed maximum wet weather flows. None of the observed surcharges resulted in overflows at the flow meter locations. The eight wet weather d/D ratios greater than 1.0 are highlighted **red** in **Table 9-5**. All of the flow monitor locations in the A.J. Brown Basin surcharged during peak flows. Two of these locations, AJ-11 and AJ-12, indicated surcharging to within 3 feet of the manhole rim. These surcharge depths are highlighted **red** in **Table 9-5**.

Table 9-5: Dry Weather and Wet Weather Depth to Diameter Ratios

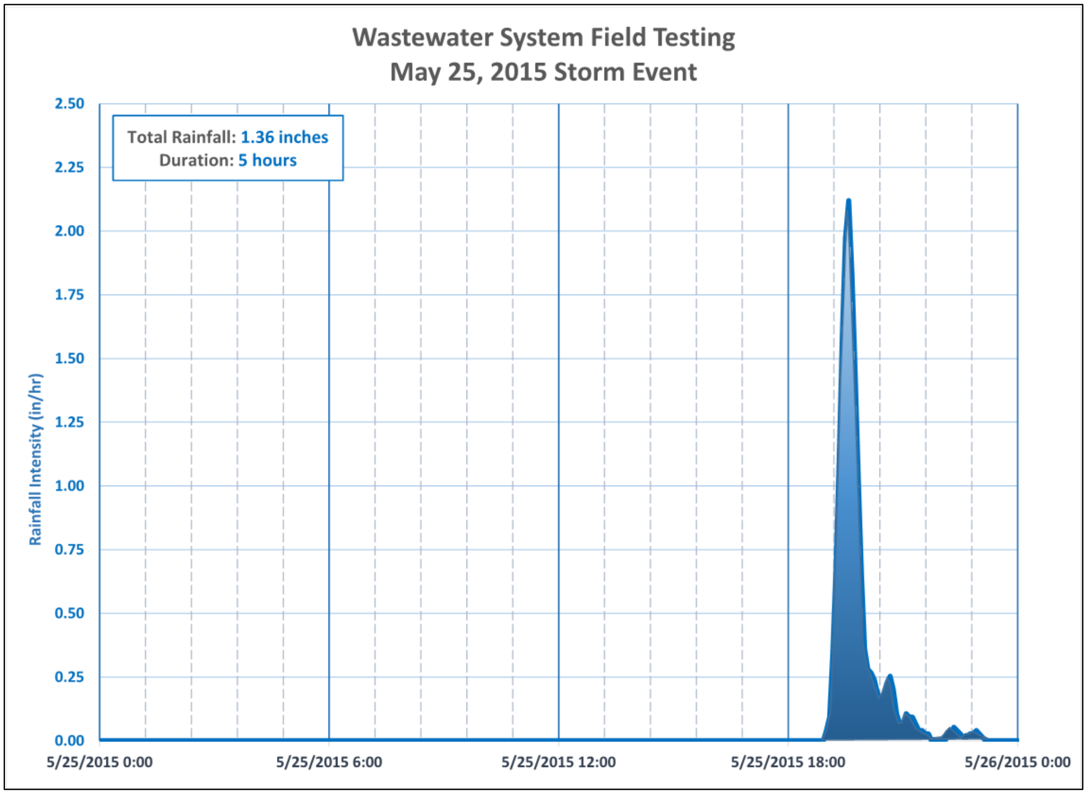
Flow Monitor ID	Field Verified Pipe Inner Diameter (in)	Max Dry Depth (in)	Dry Weather d/D	Max Wet Depth (in)	Wet Weather d/D	Surcharge Depth Above Pipe (ft)	Surcharge Depth Below Rim (ft)	Manhole Depth(1) (ft)
RC-01	35	9.0	0.26	96.8	**2.77**	5.2	3.9	12.0
RC-02	17.25	4.5	0.26	10.1	0.59	-	6.7	7.5
RC-03	22.5	6.9	0.31	14.5	0.64	-	6.8	8.0
RC-04	29.25	6.2	0.21	12.6	0.43	-	9.0	10.0
RC-05	18	5.4	0.30	88.7	**4.93**	5.9	3.1	10.5
NB-06	27.25	5.3	0.19	7.6	0.28	-	15.9	16.5
NB-07	21	6.0	0.29	89.8	**4.28**	5.7	4.5	12.0
AJ-08	30	10.8	0.36	109.0	**3.63**	6.6	2.9	12.0
AJ-09	9.75	2.0	0.21	30.6	**3.14**	1.7	4.5	7.0
AJ-10	30	12.4	0.41	117.5	**3.92**	7.3	8.2	18.0
AJ-11	12	4.2	0.35	52.6	**4.38**	3.4	**2.1**	6.5
AJ-12	12	5.6	0.47	25.6	**2.13**	1.1	**2.4**	4.5

* ADS measured manhole depth

9.2.4 Inflow and Infiltration (I/I) Analysis

During wet weather events, significant amounts of extraneous water can enter a sewer system. A comparison of flow monitor data from dry weather and wet weather periods can provide a quantification of inflow and infiltration (I/I). This can be thought of as the "leakiness" of a flow monitor basin. FNI utilized the system response from the May 25 storm event to conduct an I/I analysis of the Huntsville wastewater system. This event had the second highest total rainfall depth of the storms observed during the flow monitoring period. A total of 1.36 inches of rain fell over 5 hours. Additionally, the rainfall during this storm event was approximately evenly distributed across all three rain gauges. This means that an analysis of I/I throughout the system will give a more meaningful, relative ranking of the leakiness of each flow monitor basin. **Figure 9-2** shows a hyetograph of the May 25 storm event, plotting rainfall intensity vs. time.

Figure 9-2: Rainfall Hyetograph



ADS and FNI performed a wet weather analysis to study the wastewater system's flow response to this rain event and calculated the discrete volume of I/I per flow monitor sub basin. This was accomplished by subtracting the flows during average dry days within the field testing period from the flows during the May 25 storm event, then any I/I from upstream flow monitor basins was subtracted. Using this method, the discrete volume of I/I for the May 25 storm event was calculated for each flow meter basin.

Each basin's discrete I/I was calculated as a volume in millions of gallons (MG), which was then divided by the linear footage of gravity mains in that basin to calculate the I/I as gal/LF of pipe to normalize the results across the flow monitor basins. The results of this I/I analysis are presented in **Table 9-6**. I/I equal to or greater than 4.0 gallons per linear foot is considered to be excessive. Five of the basins had I/I equal to or greater than 4.0 gallons per linear foot, and three of these are in the A.J. Brown WWTP Basin. These values are highlighted **red** in **Table 9-6**.

Table 9-6: Summary of I/I by Flow Monitor Basin

Flow Monitor ID	WWTP Basin	Basin I/I (MG)	Linear Footage of Gravity Mains	Basin I/I (gal/LF)
RC-01	Robinson Creek	0.48	15,582	**30.9**
RC-02	Robinson Creek	0.20	108,713	1.8
RC-03	Robinson Creek	0.20	112,342	1.8
RC-04	Robinson Creek	0.13	63,624	2.1
RC-05	Robinson Creek	0.13	91,186	1.4
NB-06	N.B. Davidson	0.22	77,406	2.8
NB-07	N.B. Davidson	0.27	140,332	1.9
AJ-08	A.J. Brown	0.24	49,448	**4.8**
AJ-09	A.J. Brown	0.08	71,657	1.1
AJ-10	A.J. Brown	0.90	211,881	**4.3**
AJ-11	A.J. Brown	0.32	118,800	2.7
AJ-12	A.J. Brown	0.42	106,124	**4.0**

9.3 SUMMARY AND CONCLUSIONS

The flow monitor and rain gauge data provided information that was utilized in the wastewater hydraulic modeling and CIP development for the wastewater system study. The results of the data analysis are presented below.

9.3.1 Hydraulic Modeling Data Quality

The five minute data collected from the temporary flow monitors and rain gauges is suitable to calibrate the hydraulic model. The seven day period from July 1 through July 7 provides consistent, dry weather flow data from all 12 flow monitor sites. Storm events from late May and mid-June provide good flow data for wet weather calibration. The hydraulic model was calibrated to dry weather flows from the one-week period beginning July 1, and wet weather flows from the June 18, 2015 observed storm event. There are small gaps in the data collected by flow meters RC-01, AJ-08, AJ-09, AJ-11, and AJ-12. These periods were not used to compute dry weather flows and did not affect the hydraulic model calibration.

9.3.2 Flow Monitoring Site Hydraulics and Dry Weather Performance Summary

An analysis of flow monitoring site hydraulics and dry and wet weather flows was performed. Observations and recommendations are summarized below:

- Dry weather peaking factors and depth-to-diameter (d/D) ratios indicate that the majority of the wastewater system has adequate capacity to convey current dry weather flows.
- Eight of the flow monitor locations indicated surcharged water levels during wet weather events; however, none of these water levels reached the manhole rims. The closest a surcharged level came to a manhole rim at a monitored site was 2.1 feet.
- The 36-inch pipe monitored by RC-01 had an average dry weather flow of 1.0 MGD. The capacity of this line based on the inverts in GIS is 11.8 MGD. This indicates available capacity for growth in the Robinson Creek WWTP Basin.
- The flow data from RC-04 indicates a decrease in maximum pumping rates at the McGary Creek Lift Station between May 30 and June 10.
- The flow depth data from RC-05 indicates what seems to be uncharacteristic surcharging of the 18-inch line upstream of the McGary Creek Lift Station during the periods of May 19-22 and May 26-29. City staff confirmed that construction was ongoing at the McGary Creek lift station during this time.
- The flow depth data from NB-07 indicates numerous surcharges between June 8 and June 26, during periods of both dry and wet weather. This flow monitor location is located upstream of the Elkins Lake Post Office Lift Station.
- Silt was observed at four of the flow monitoring sites: RC-01, RC-03, RC-04, and AJ-10. The measured silt depths ranged from 0.5 to 2.0 inches. Silt accumulation causes loss of capacity in the system. Therefore, these areas should be inspected periodically as part of a preventative sewer cleaning program to determine the frequency of cleaning needed at these locations.

9.3.3 Wet Weather and Inflow and Infiltration (I/I) Summary

A wet weather analysis was performed to calculate the volume of I/I in each flow monitor basin. Calculating the I/I per flow monitor basin helped identify which areas of the wastewater system were prioritized for future condition assessment (SSES) work later in the Condition and Capacity Assessment Study. This information was combined with hydraulic capacity modeling of the projected future wastewater system loads to prioritize system improvements in the integrated CIP. The 12 flow meter basins were ranked according to the relative volumes of discrete I/I measured during the May 25 storm event. The discrete volume of I/I within each basin was categorized as high, moderate, or low. The flow meter basins and their respective I/I volumes and classifications are shown on **Figure 9-3**. The flow meter basins, SSES priority rankings, discrete I/I volumes, and categories of I/I are summarized in **Table 9-7**.

Table 9-7: Summary of I/I by Flow Monitor Basin and Categories of I/I

Flow Monitor ID	WWTP Basin	Basin Priority Ranking	Basin I/I (gal/LF)
RC-01	Robinson Creek	1	**30.9**
AJ-12(1)	A.J. Brown	2	**4.0**
AJ-08	A.J. Brown	3	**4.8**
AJ-10	A.J. Brown	4	**4.3**
NB-06	N.B. Davidson	5	**2.8**
AJ-11	A.J. Brown	6	**2.7**
RC-04	Robinson Creek	7	**2.1**
NB-07	N.B. Davidson	8	**1.9**
RC-02	Robinson Creek	9	**1.8**
RC-03	Robinson Creek	10	**1.8**
RC-05	Robinson Creek	11	**1.4**
AJ-09	A.J. Brown	12	**1.1**

Categories of I/I

(gal/LF)	Description
I/I Greater than 4.0	*High* amount of I/I
I/I Between 2.0 - 3.9	*Moderate* amount of I/I
I/I Less than 2.0	*Low* amount of I/I

(1) The AJ-12 Basin was moved to Priority Ranking 2 due to shallow lines and the subsequent high risk for sanitary sewer overflows.

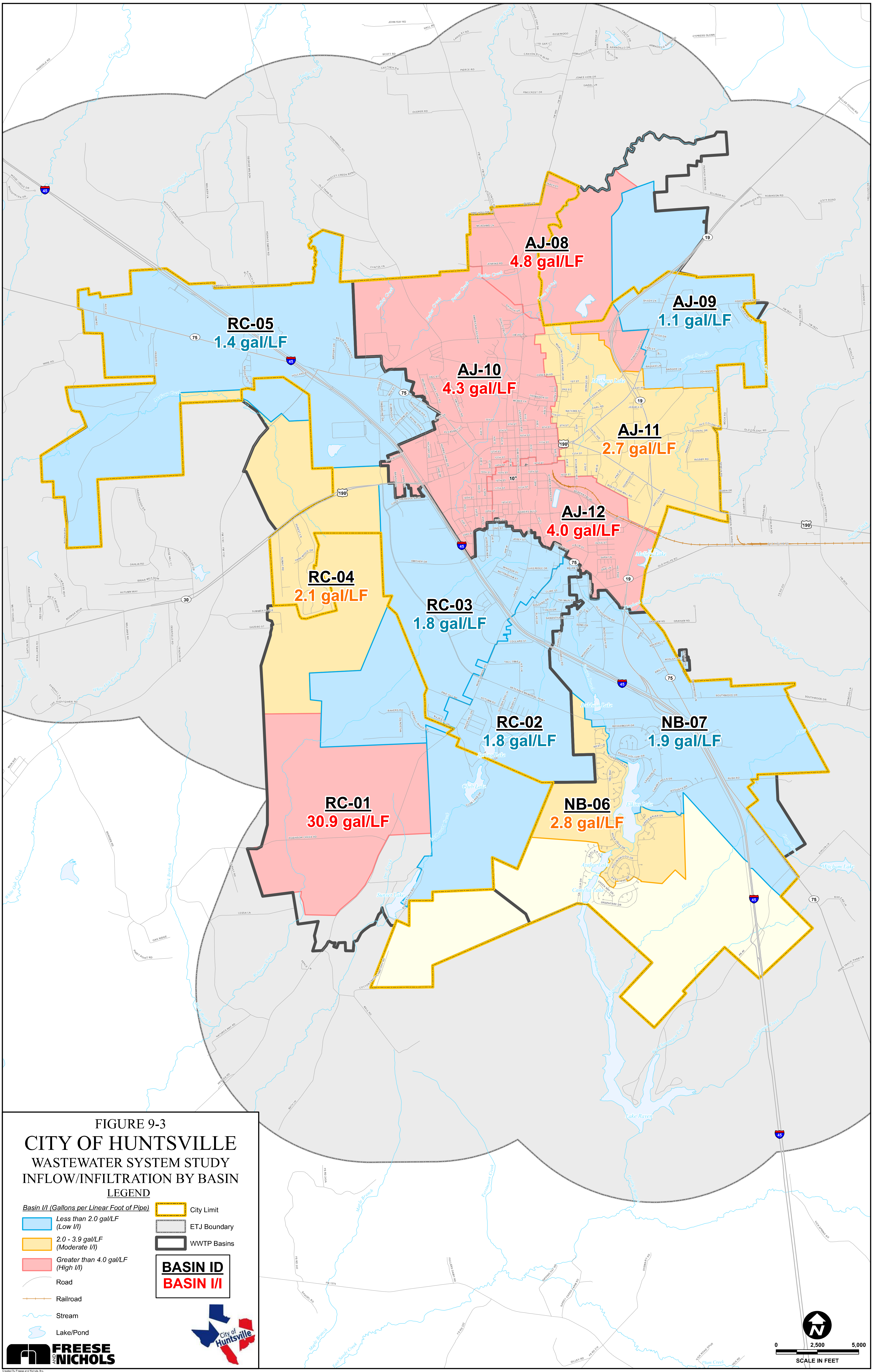


FIGURE 9-3
CITY OF HUNTSVILLE
WASTEWATER SYSTEM STUDY
INFLOW/INFILTRATION BY BASIN

10.0 WASTEWATER FLOW PROJECTIONS

The performance of a wastewater collection system is dependent on the amount of water being conveyed through the system. To determine locations where future capacity improvements are necessary, existing and future wastewater flow projections must be developed. Huntsville's wastewater flows are generated by residential, commercial and industrial sources, with large components of residential flows being generated by SHSU and the TDCJ facilities inside the wastewater service area. Future population and commercial water usage projections are critical to the development of short and long term capital improvements. FNI developed projected wastewater flows for the 5 year, 10 year, and 25 year planning periods for the Wastewater System Study. These flows were utilized in the wastewater hydraulic model to plan future wastewater system improvements and treatment plant expansions. Wastewater treatment plants are typically sized for average day flows, while the collection system infrastructure, including lift stations, is sized to convey peak wastewater flows.

10.1 HISTORICAL WASTEWATER FLOWS

Historical WWTP effluent flows for all three plants were provided by the City. The average day and peak 2-Hour flows for each plant are summarized in **Table 10-1**.

Table 10-1: Historical WWTP Flows

Year	Total WWTP Average Day Flow (MGD)	Robinson Creek WWTP Flows		N.B. Davidson WWTP Flows		A.J. Brown WWTP Flows	
		Average Day (MGD)	Peak 2-Hr (MGD)	Average Day (MGD)	Peak 2-Hr (MGD)	Average Day (MGD)	Peak 2-Hr (MGD)
2010	4.53	1.13	4.40	0.73	2.19	2.67	11.25
2011	4.39	1.05	8.04	0.67	1.78	2.66	9.62
2012	4.75	1.04	4.77	0.86	3.30	2.85	14.35
2013	4.70	1.08	6.14	0.84	5.40	2.77	12.61
2014	4.76	1.15	5.39	0.75	3.88	2.86	11.54
Average	4.62	1.09	-	0.77	-	2.76	-

Note: All flows adjusted based on dry weather flow monitoring data

A sewer return rate was calculated for each WWTP service area based on water production and WWTP flows from 2010 through 2014. FNI calculated the percentage of water consumed in each WWTP service area based on meter billing data. The resulting return rates are presented in **Table 10-2**.

Table 10-2: Wastewater Return Rates

WWTP Service Area	Average Day Annual Flows 2010 - 2014		Return Rate (%)
	Total Water Production (MGD)	Total Wastewater Effluent[1] (MGD)	
Robinson Creek	1.47	1.09	74%
N.B. Davidson	1.14	0.77	68%
A.J. Brown	4.07	2.76	68%
Huntsville Total	6.68	4.62	69%

(1) Adjusted WWTP effluent flows based on dry weather flow monitoring data

10.2 WASTEWATER FLOW PROJECTIONS

10.2.1 Existing Wastewater Flows

FNI utilized the flow monitoring data from May through July 2015 to distribute the average day wastewater flows to the 12 wastewater basins identified by flow monitoring. The census density of 2.32 people per residential water meter was used to distribute the Huntsville population within each wastewater basin. The SHSU and TDCJ populations were assigned to the appropriate flow monitor basin based on campus housing and correctional facility locations. The resulting per capita (gpcd) values ranged from 78 to 382 per basin. Existing peak flows were developed in the calibrated hydraulic model during the existing system analysis. Wastewater model calibration and existing system analysis are discussed in **Sections 13.0** and **14.0**.

The existing populations, average day flows, wastewater basin per capita flows, and peak flows are shown in **Table 10-3**. The existing per capita flows and peak flows were held constant throughout all planning periods.

Table 10-3: Existing Wastewater Flows

Flow Monitor Basin		2016 Population				Average Day[(1)] Dry Weather Flow (MGD)	Basin Per Capita Flow (gpcd)	Peak Flow[(2)] (MGD)
		City	SHSU	TDCJ	Total			
Robinson Creek	RC-01	0	0	0	0	0.16	-	9.25
	RC-02	1,393	0	0	1,393	0.20	144	1.11
	RC-03	3,583	0	0	3,583	0.41	114	3.47
	RC-04	332	0	0	332	0.07	211	4.76
	RC-05	919	0	2,563	3,482	0.36	103	2.50
	Total	**6,227**	**0**	**2,563**	**8,790**	**1.20**	-	-
N. B. Davidson	NB-06	1,151	0	0	1,151	0.44	382	3.35
	NB-07	2,395	0	1,636	4,031	0.61	151	2.24
	NB-101 (Unmetered)	483	0	0	483	0.07	-	-
	Total	**4,029**	**0**	**1,636**	**5,665**	**1.12**	-	-
A. J. Brown	AJ-08	7	0	0	7	0.10	-	15.65
	AJ-09	474	0	0	474	0.08	169	1.38
	AJ-10	6,783	0	7,116	13,899	1.57	113	16.12
	AJ-11	1,200	0	0	1,200	0.18	150	2.34
	AJ-12	6,575	3,284	0	9,859	0.77	78	3.29
	AJ-101 (Unmetered)	0	0	0	0	-	-	-
	Total	**15,039**	**3,284**	**7,116**	**25,439**	**2.70**	-	-
Huntsville Total		**25,295**	**3,284**	**11,315**	**39,894**	**5.02**	**-**	**-**

(1) 2015 discrete basin average day dry weather flows from May/June, 2015 flow monitoring.
(2) Peak flows based on calibrated model design storm analysis.

10.2.2 Projected Wastewater Flows

Wastewater flow projections for future developments were added to the 2015 existing flows to determine the projected future average day flows. Design criteria for average day wastewater flows for the 5 year, 10 year, and 25 year planning periods were developed by analyzing historical wastewater flows, water distribution and billing records, populations and commercial acreage. Based on this analysis, FNI recommends 105 gpcd for Huntsville residential flows, 143 gpcd for SHSU residential flows, and 465 gpad for commercial flows. These values represent a conservative 75% wastewater return rate of the projected water demand criteria. **Table 10-4** summarizes the wastewater flow rates utilized to calculate projected average day wastewater flows.

Table 10-4: Wastewater Flow Rate Design Criteria

Wastewater Flow Type	Flow Rate
Huntsville Residential	105 gpcd
SHSU Residential	143 gpad
Commercial	465 gpad

Future average day wastewater flows were calculated by applying the flow rates in **Table 10-4** only to the new population and commercial acreage in each planning period. Peak wastewater flows from future growth were calculated using a peak flow to average daily flow peaking factor of 4.0. All calculated future flows were added to the existing flows to determine the total projected wastewater flows in each planning period. **Table 10-5** summarizes the total projected average day wastewater flows by planning period and WWTP service area. **Table 10-6** presents the projected average day and peak wastewater flows per flow monitor basin within each of the wastewater service areas.

Table 10-5: Summary of Projected Average Day Wastewater Flows

Wastewater Service Area	Projected Average Day Wastewater Flows (MGD)			
	2016	2021	2026	2041
Robinson Creek	1.20	1.40	1.52	1.92
N. B. Davidson	1.12	1.15	1.20	1.34
A. J. Brown	2.70	2.82	3.17	3.91
Total	**5.02**	**5.37**	**5.89**	**7.17**

The total projected average day wastewater flows for each WWTP are graphed against the current TCEQ permitted capacities of each WWTP on **Figure 10-1, Figure 10-2** and **Figure 10-3**.

Table 10-6: Projected Wastewater Flows

Flow Monitor Basin		2016				2021				2026				2041			
		Total Population	Total Acreage (ac)	Average Day[1] Flow (MGD)	Peak Flow[2] (MGD)	Total Population	Total Acreage (ac)	Average Day Flow[3] (MGD)	Peak Flow (MGD)	Total Population	Total Acreage (ac)	Average Day Flow[3] (MGD)	Peak Flow (MGD)	Total Population	Total Acreage (ac)	Average Day Flow[3] (MGD)	Peak Flow (MGD)
Robinson Creek	RC-01	0	0	0.16	9.25	0	0	0.16	9.25	0	0	0.16	9.25	0	0	0.16	9.25
	RC-02	1,393	25	0.20	1.11	1,486	25	0.21	1.15	1,898	25	0.25	1.36	2,734	25	0.34	1.92
	RC-03	3,583	221	0.41	3.47	4,894	329	0.60	4.22	5,139	338	0.63	5.09	5,637	478	0.74	6.43
	RC-04	332	17	0.07	4.76	332	17	0.07	4.76	988	27	0.14	5.05	2,320	27	0.28	5.91
	RC-05	3,482	440	0.36	2.50	3,482	440	0.36	2.50	3,482	440	0.36	2.50	3,482	695	0.48	2.97
	Robinson Creek Total	**8,790**	**703**	**1.20**	**-**	**10,194**	**811**	**1.40**	**-**	**11,506**	**831**	**1.54**	**-**	**14,172**	**1,225**	**2.01**	**-**
N. B. Davidson	NB-06	1,151	25	0.44	3.35	1,383	25	0.46	3.45	1,383	25	0.46	3.54	1,383	25	0.46	3.64
	NB-07	4,031	180	0.61	2.24	4,031	180	0.61	2.24	4,031	180	0.61	2.24	4,031	275	0.65	2.42
	NB-101 (Unmetered)	483	5	0.07	-	483	5	0.07	-	483	5	0.07	-	483	5	0.07	-
	N.B. Davidson Total	**5,665**	**210**	**1.12**	**-**	**5,897**	**210**	**1.15**	**-**	**5,897**	**210**	**1.15**	**-**	**5,897**	**305**	**1.19**	**-**
A. J. Brown	AJ-08	7	4	0.10	15.65	7	4	0.10	15.65	619	4	0.16	15.91	1,861	70	0.33	16.81
	AJ-09	474	4	0.08	1.38	474	4	0.08	1.38	474	4	0.08	1.38	474	4	0.08	1.38
	AJ-10	13,899	151	1.57	16.12	13,899	151	1.57	16.12	13,899	336	1.66	16.46	13,899	360	1.67	16.85
	AJ-11	1,200	179	0.18	2.34	1,200	179	0.18	2.34	1,200	179	0.18	2.34	1,642	206	0.24	2.58
	AJ-12	9,859	107	0.77	3.29	10,559	107	0.87	3.69	11,874	107	1.03	4.75	16,271	107	1.57	7.93
	AJ-101 (Unmetered)	0	46		-	232	46	0.02	-	232	46	0.02	-	232	46	0.02	-
	A.J. Brown Total	**25,439**	**491**	**2.70**	**-**	**26,371**	**491**	**2.82**	**-**	**28,298**	**676**	**3.14**	**-**	**34,380**	**793**	**3.90**	**-**
Huntsville total		**39,894**	**1,404**	**5.02**	**-**	**42,462**	**1,512**	**5.37**	**-**	**45,701**	**1,717**	**5.83**	**-**	**54,449**	**2,323**	**7.10**	**-**

(1) 2015 discrete basin average day dry weather flows from May/June, 2015 flow monitoring.
(2) Peak flows based on calibrated model design storm analysis.
(3) Future residential flows are 105 gpcd for City residents and 143 gpcd for SHSU. All future commercial flows are 465 gpad.

Figure 10-1: Projected Average Day Wastewater Flow (Robinson Creek WWTP)

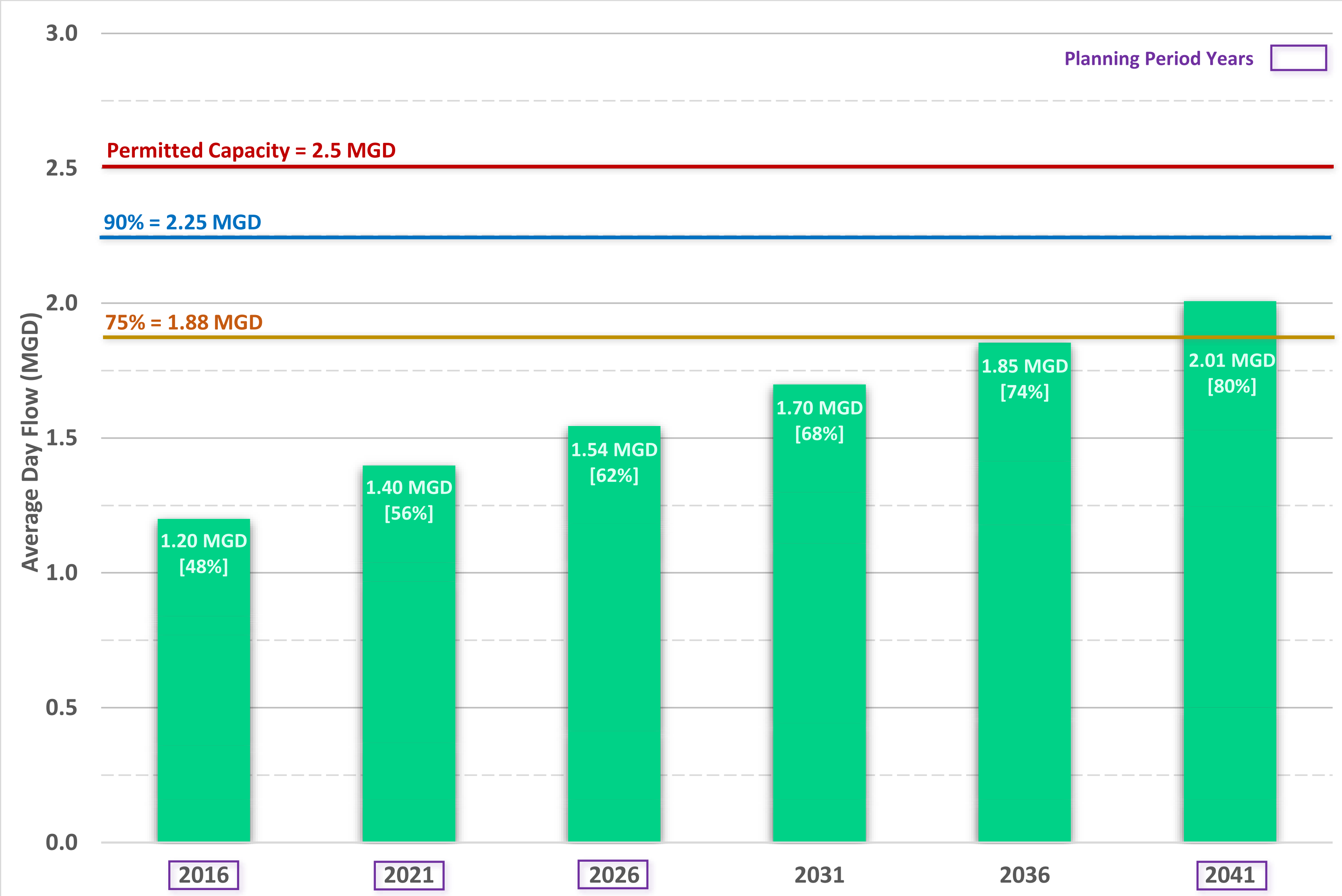


Figure 10-2: Projected Average Day Wastewater Flow (N.B. Davidson WWTP)

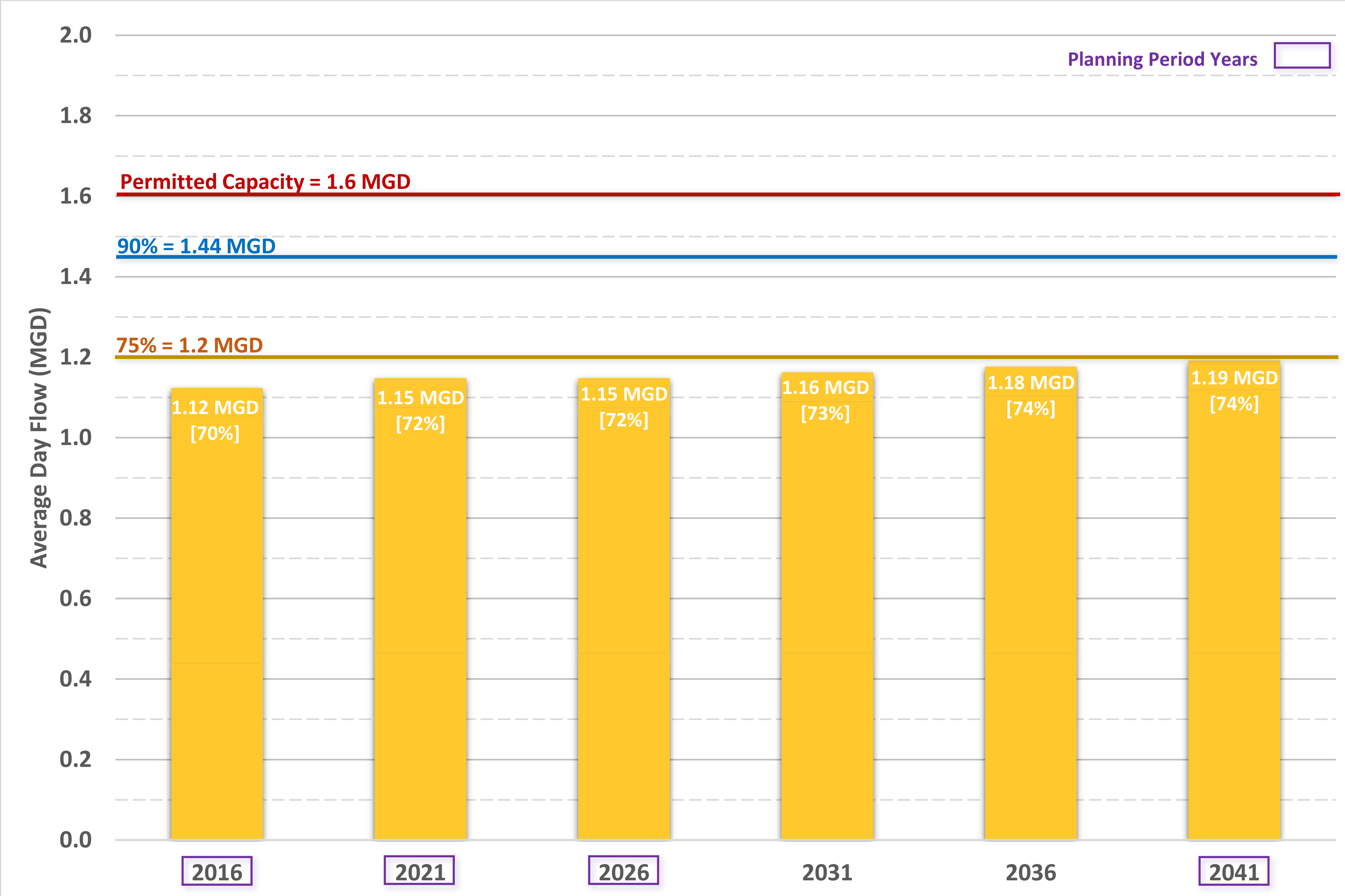
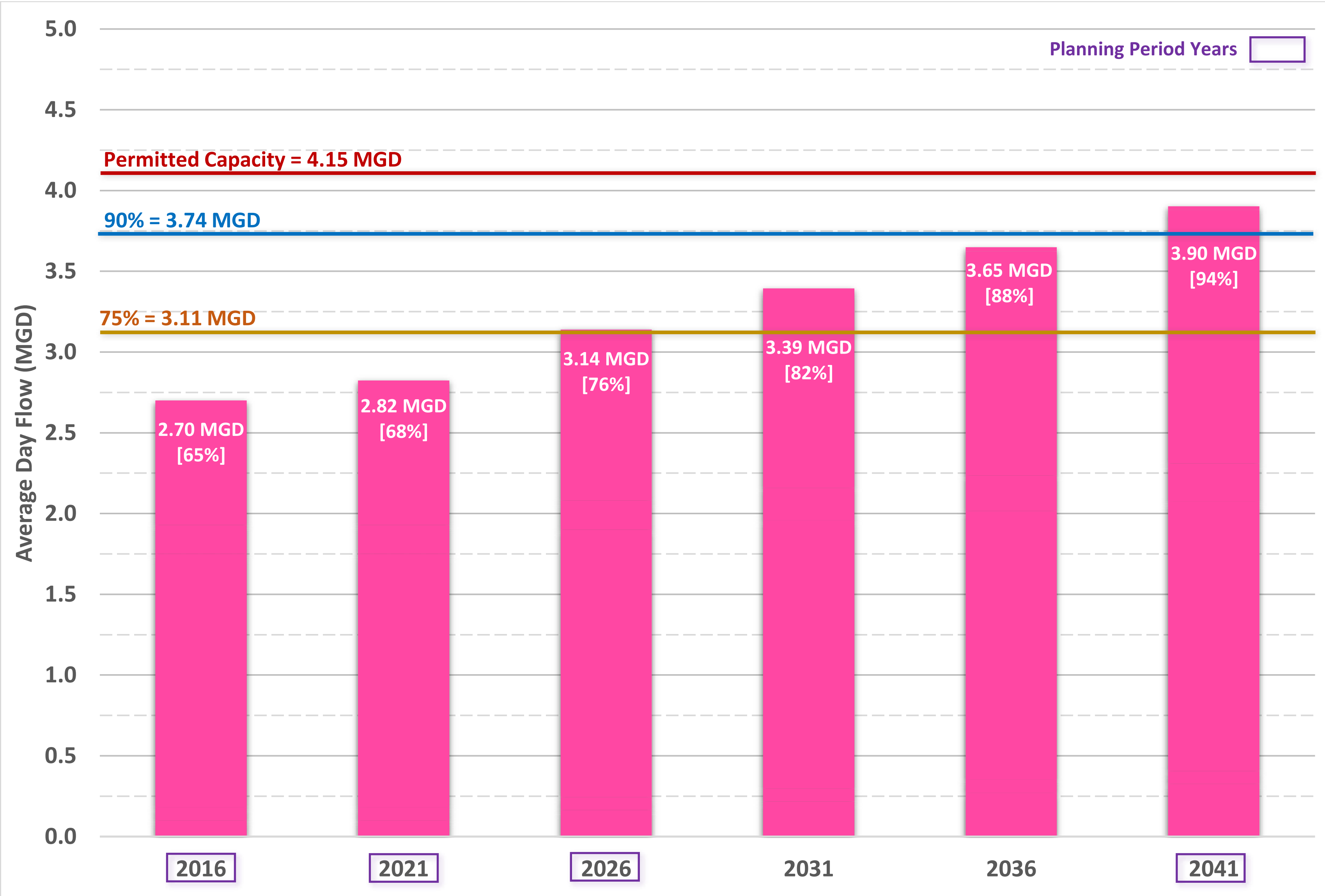


Figure 10-3: Projected Average Day Wastewater Flow (A.J. Brown WWTP)



11.0 SANITARY SEWER EVALUATION SURVEY (SSES)

As part of the overall *Water and Wastewater Condition and Capacity Assessment Studies* project, FNI conducted SSES in the RC-01 and AJ-12 wastewater basins. These basins were identified as having high levels of I/I during the wastewater flow monitoring evaluation portion of this study (**Section 9.0**). The SSES efforts carried out in each basin are described in **Table 11-1**. The results of these SSES efforts were used to develop rehabilitation projects with the goals of reducing I/I and sanitary sewer overflows and extending the life of sewer infrastructure.

Table 11-1: Wastewater Sub Basin SSES Efforts

Wastewater Sub Basin	SSES Efforts Conducted	Notes
RC-01	• Manhole Inspections	This basin was identified as having the highest level of I/I (**30.9 Gal/LF**) identified during the June – July 2015 wastewater flow monitoring period. Smoke testing was not conducted in this sub basin due to the relatively good condition of the 36-inch wastewater line.
AJ-12	• Flow Monitoring • Manhole Inspections • Smoke Testing	This basin was identified as having a high level of I/I (**4.0 Gal/LF**) and was prioritized for SSES efforts during this study due to shallow lines and the subsequent high risk for sanitary sewer overflows due to surcharging.

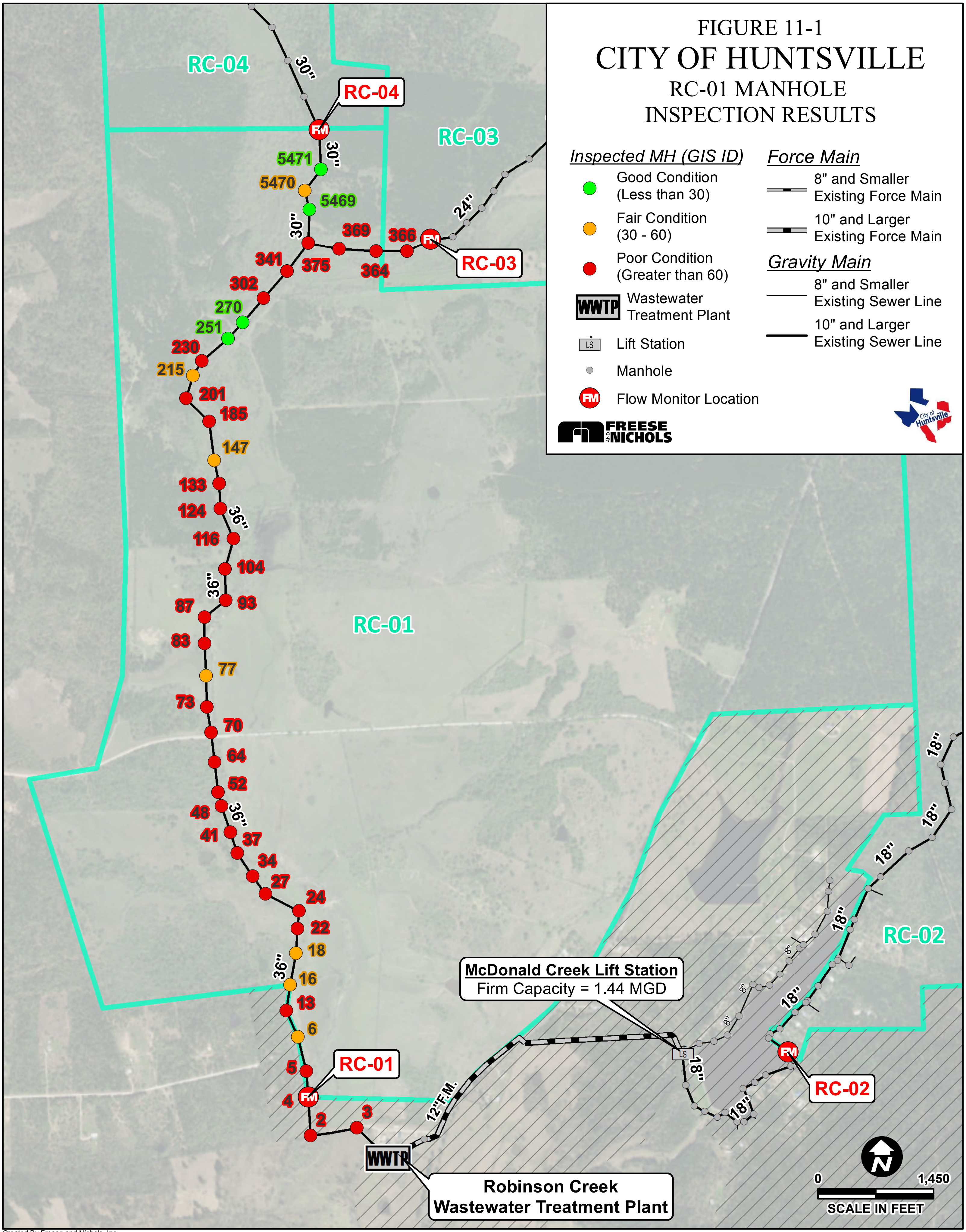
11.1 RC-01 BASIN SSES RESULTS

11.1.1 Manhole Inspections

Manhole inspections were performed on every manhole in the RC-01 Basin, with the exception of MH 0003, which could not be opened. ADS performed visual manhole inspections during which the condition of each manhole was inspected from cover to invert. Structural defects, operation and maintenance (O&M) concerns, and infiltration sources were noted. The manholes were then scored on a 100 point system, with 0 being the best and 100 being the worst. The results of the manhole inspections are shown in **Table 11-2**. The inspected manholes, color coded by the resulting condition score, are shown on **Figure 11-1**. The manhole inspection report, including inspection sheets, are provided in **Appendix K**. Thirty-eight of the 42 inspected manholes resulted in Fair or Poor condition scores. It is recommended that all of the manholes be sealed with an H_2S resistant liner, and that additional repairs to the frames and/or covers be conducted on four of the manholes. The recommended project cost is included in **Section 11.3** as **Project B1**.

Table 11-2: RC-01 Manhole Inspection Scores

Manhole Condition	Number of Manholes	Score Range
Good	4	0 - 30
Fair	7	31 - 60
Poor	31	61 - 100
Total	42	-



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11.2 AJ-12 BASIN SSES RESULTS

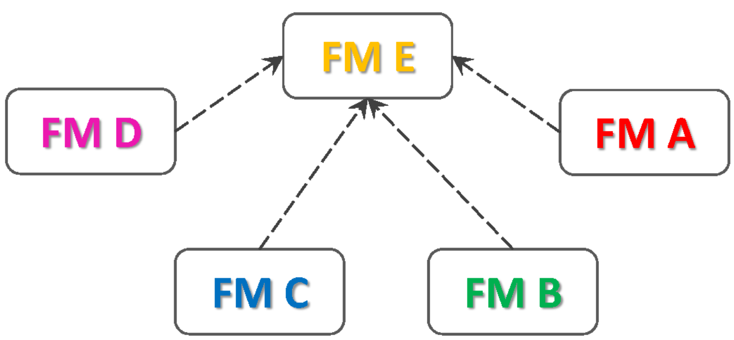
Focused flow monitoring, manhole inspections, and smoke testing were performed in the AJ-12 Basin. These are all typical components of a SSES. SSES flow monitoring is conducted over smaller areas than the system-wide monitoring performed as part of the flow monitoring evaluation discussed in **Section 9.0**. The standard order of these SSES activities is 1) flow monitoring, 2) manhole inspections, and 3) smoke testing.

The focused SSES flow monitoring is used to identify where the majority of I/I is coming from within a given basin. The remaining SSES efforts can then be focused on that portion of the wastewater basin to maximize rehabilitation and renewal dollars to reduce I/I. As part of this study, FNI conducted SSES flow monitoring in the AJ-12 Basin to identify the portion of the network (sub basin) contributing the most I/I. The subsequent manhole inspections and smoke testing focused on that sub basin.

11.2.1 Flow Monitoring

FNI chose five flow monitoring sites within the AJ-12 Basin to conduct SSES flow monitoring. Locations were chosen such that the five resulting sub basins were approximately equal in size (linear footage). **Figure 11-2** is a schematic of the five SSES flow monitors. Their locations and the resulting five sub basins, A – E, are shown on **Figure 11-3**. The flow meters were installed and serviced by ADS, and collected data from November 11, 2015, through January 4, 2016, (55 days). One rain gauge was also used to collect rainfall data during this period. The rain gauge was located at the Bearkat Lift Station.

Figure 11-2: AJ-12 SSES Flow Monitor Schematic



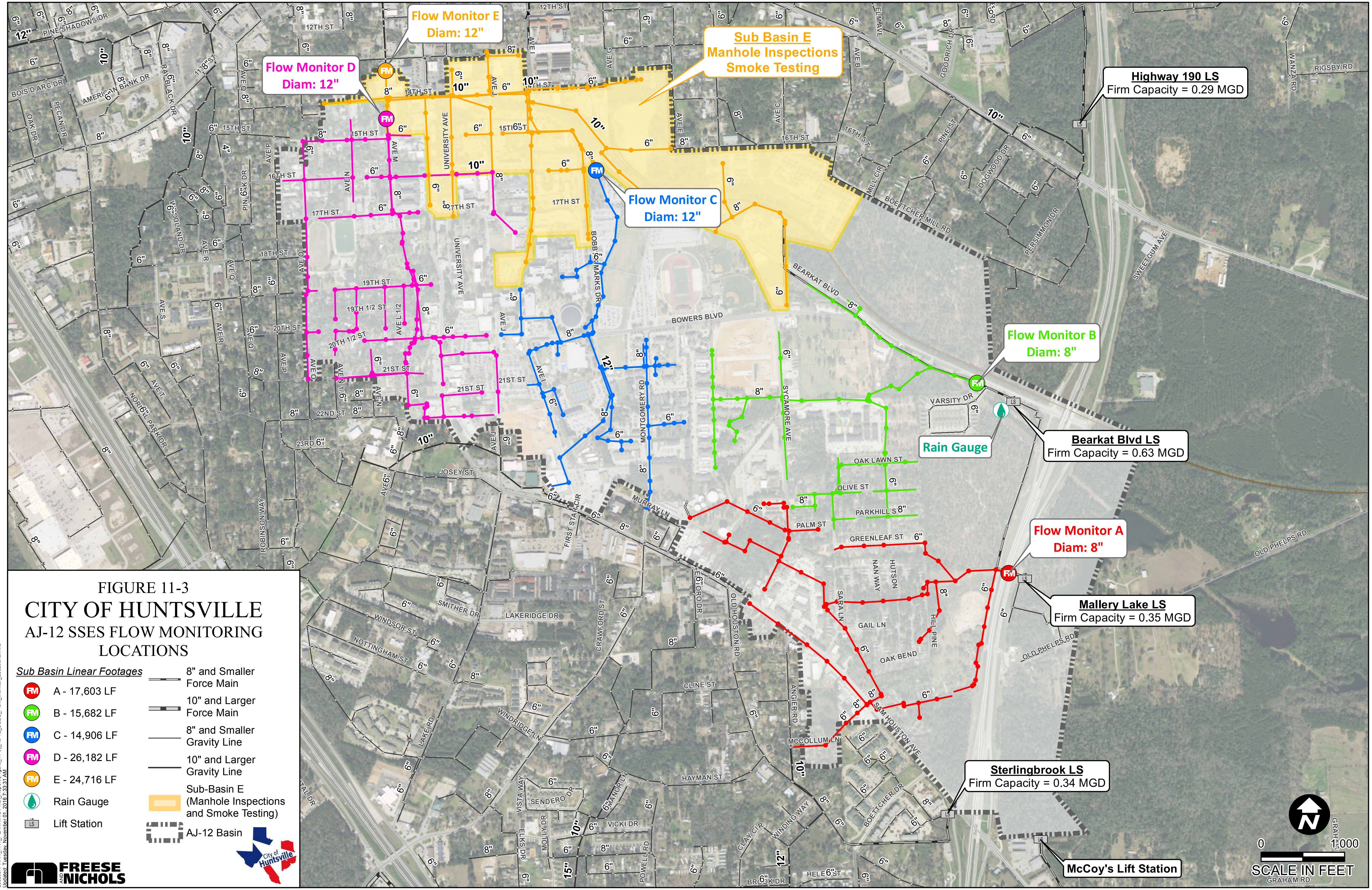


FIGURE 11-3

CITY OF HUNTSVILLE

AJ-12 SSES FLOW MONITORING LOCATIONS

SSES Flow Monitoring and Rainfall Data

FNI reviewed and evaluated the flow monitoring and rainfall data collected during the SSES flow monitoring period. A total of three storm events were recorded. **Table 11-3** summarizes the observed storm events.

Table 11-3: SSES Flow Monitoring Storm Events

Date	Duration (hrs)	Total Rainfall (in)
11/17/2015	10	4.0
12/12/2015	24	4.3
12/27/2015	24	2.4

Hydrographs and flow depth plots for the five SSES flow monitor sites are provided in **Appendix L**. The hydrographs display flow rate data vs. time for the duration of the field testing period, along with the observed rainfall intensities. Similarly, the depth plots show the depth of flow vs. time.

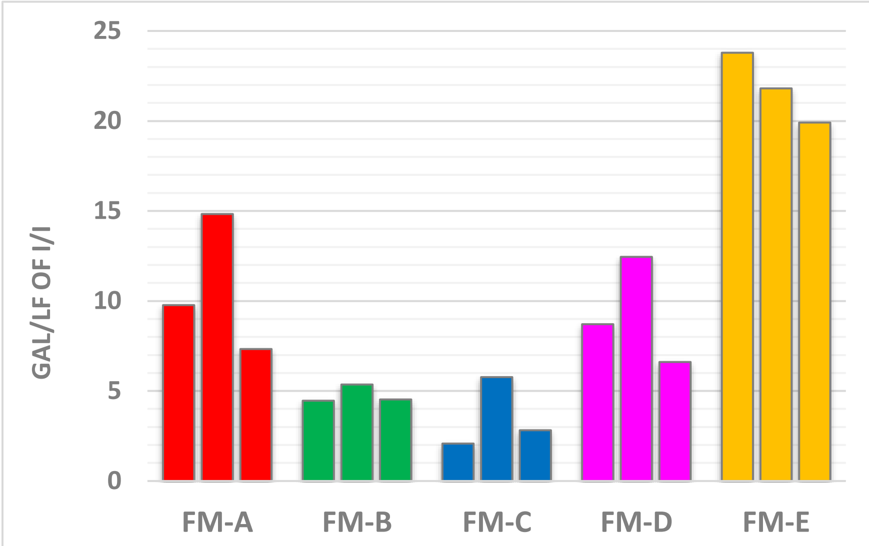
SSES Flow Monitoring I/I Analysis

The discrete I/I within each of the five sub Basins (A – E) was calculated as a volume in millions of gallons (MG). This was then divided by the linear footage of the gravity mains in that sub basin to calculate the observed I/I as gal/LF of pipe. **Table 11-4** shows the resulting normalized I/I per sub basin, and **Figure 11-4** displays the same I/I information graphically.

Table 11-4: Normalized I/I per Sub Basin

Basin	Normalized I/I (gal/LF)				
	Sub Basin A	Sub Basin B	Sub Basin C	Sub Basin D	Sub Basin E
11/17/2015	9.77	4.46	2.08	8.71	23.79
12/12/2015	14.83	5.36	5.77	12.45	21.81
12/27/2015	7.33	4.53	2.82	6.61	19.91
Average	**10.64**	**4.78**	**3.56**	**9.26**	**21.84**

Figure 11-4: Normalized I/I per Sub Basin by Storm Event



The area with the most I/I in all three storm events was Sub Basin E. Therefore, subsequent manhole inspections and smoke testing were carried out in this sub basin. Due to the high levels of I/I, it is recommended that manhole inspections and smoke testing be carried out in the remainder of the AJ-12 Sub Basins (A, B, C, and D).

11.2.2 Manhole Inspections (AJ-12 Sub Basin E)

Manhole inspections were performed on 90 manholes in AJ-12 Sub Basin E. ADS performed visual manhole inspections during which the condition of each manhole was inspected from cover to invert. Structural defects, operation and maintenance (O&M) concerns, and infiltration sources were noted. The manholes were then scored on a 100-point system, with 0 being the best and 100 being the worst. The results of the manhole inspections are shown in **Table 11-5**. The inspected manholes, color coded by the resulting condition score, are shown on **Figure 11-6**. The manhole inspection report, including inspection sheets, is provided in **Appendix M**. Sixteen of the 90 inspected manholes resulted in Fair or Poor condition scores. Rehabilitation efforts are recommended for 34 of the manholes. The recommendations include repairing covers and frames, the installation of inflow dishes, resealing frames, repairing pipe connection cracks, and the application of an H2S resistant liner to some manholes. The project cost for the recommended manhole rehabilitation efforts in AJ-12 Sub Basin E is included in **Section 11.3**.

Table 11-5: AJ-12 Sub Basin E Manhole Inspection Results

Manhole Condition	Number of Manholes	Score Range
Good	74	0 - 30
Fair	9	31 - 60
Poor	7	61 - 100
Total	90	-

11.2.3 Smoke Testing (AJ-12 Sub Basin E)

Smoke testing is a common diagnostic method used to locate and identify potential sources of inflow and infiltration within a sanitary sewer system. During smoke testing, a special non-toxic, non-staining smoke is blown into a selected portion of the system to check for defects. These defects indicate sources of inflow and infiltration in the collection system. Approximately 23,000 linear feet (93%) of the sewer lines in Sub Basin E were checked for defects via smoke testing. A total of 20 defects were identified. Examples of the defects found in AJ-12 Sub Basin E are shown in **Figure 11-5**. The results of the smoke testing are shown in **Table 11-6** and displayed on **Figure 11-7**. The smoke testing report, including field inspection sheets with more detailed information on the locations of the defects, is provided in **Appendix N**.

Table 11-6: AJ-12 Sub Basin E Smoke Testing Results

Defect Type	Number of Defects
Manhole	8
Sewer Line	4
Service Lateral	8
Total	20

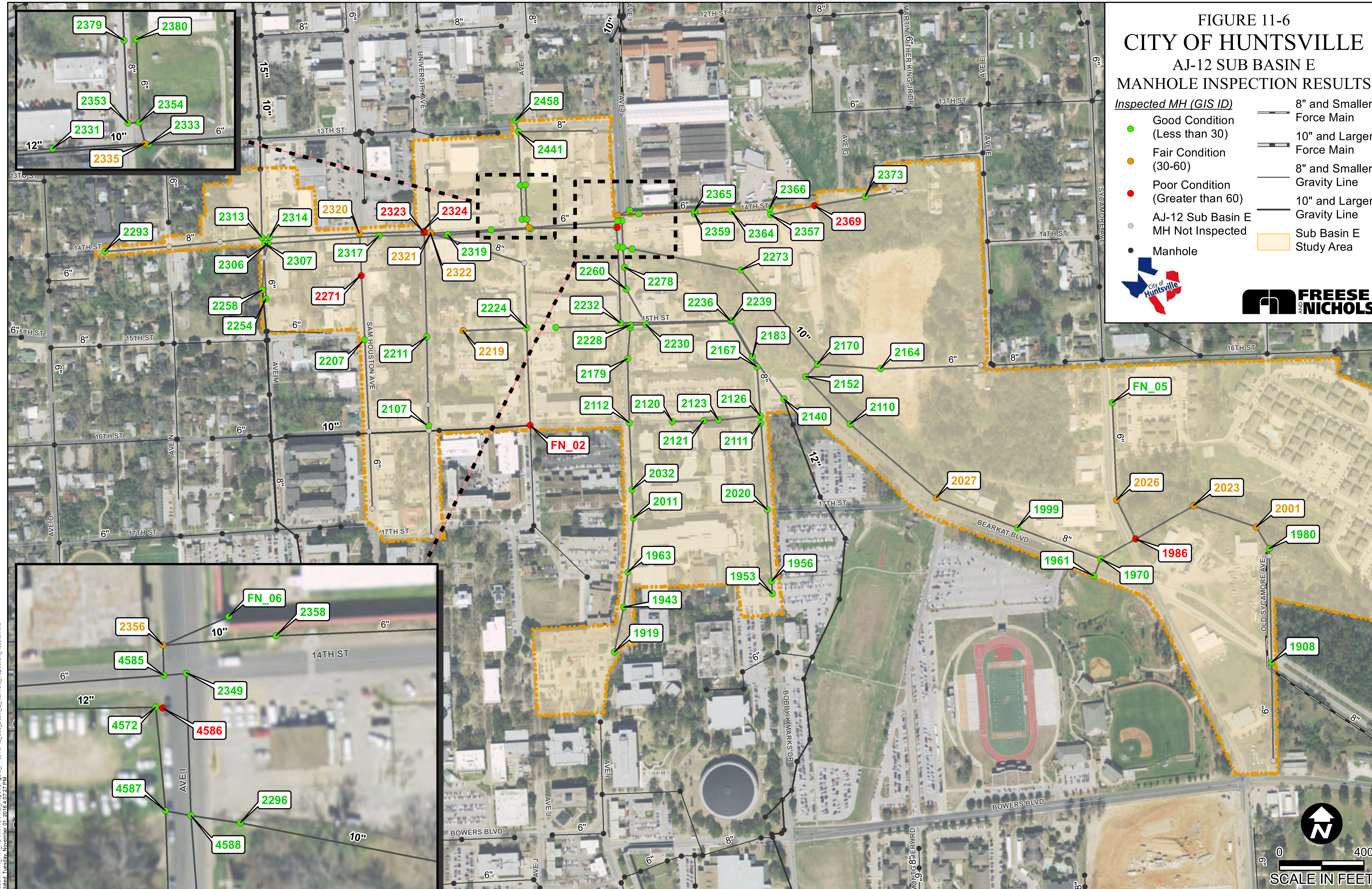
Figure 11-5: Examples of AJ-12 Sub Basin E Smoke Testing Defects

Sewer Line Leak & Manhole Wall Leak

Sewer Line Leak

Service Lateral Leak

Inflow Through Pick Holes



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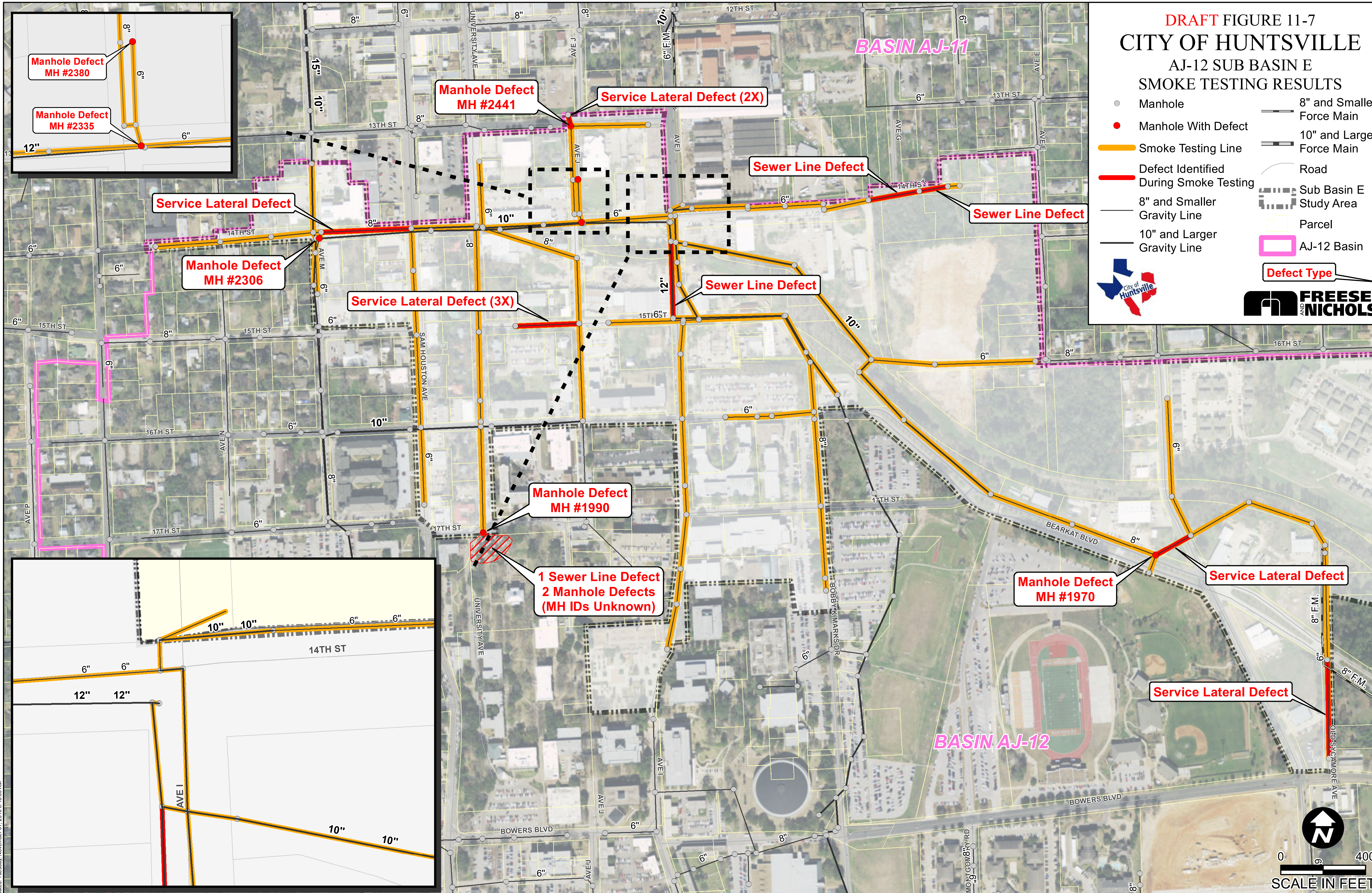

DRAFT FIGURE 11-7
CITY OF HUNTSVILLE
AJ-12 SUB BASIN E
SMOKE TESTING RESULTS
Manhole
Manhole With Defect
Smoke Testing Line
Defect Identified During Smoke Testing
8" and Smaller Gravity Line
10" and Larger Gravity Line
8" and Smaller Force Main
10" and Larger Force Main
Road
Sub Basin E Study Area
Parcel
AJ-12 Basin
Defect Type
City of Huntsville
FREESE AND NICHOLS
BASIN AJ-11
BASIN AJ-12
Manhole Defect MH #2380
Manhole Defect MH #2335
Manhole Defect MH #2441
Service Lateral Defect (2X)
Sewer Line Defect
Sewer Line Defect
Service Lateral Defect
Manhole Defect MH #2306
Service Lateral Defect (3X)
Sewer Line Defect
Manhole Defect MH #1990
1 Sewer Line Defect
2 Manhole Defects
(MH IDs Unknown)
Manhole Defect MH #1970
Service Lateral Defect
Service Lateral Defect
12TH ST
13TH ST
14TH ST
15TH ST
16TH ST
17TH ST
BEARKAT BLVD
BOWERS BLVD
UNIVERSITY AVE
SAM HOUSTON AVE
BOBBY K MARKS DR
OLD SYCAMORE AVE
AVE I
AVE J
AVE M
AVE N
AVE P
AVE G
AVE E
8" F.M.
0
400
SCALE IN FEET

11.3 SEWER BASIN SSES REHABILITATION/RENEWAL CIP

FNI recommends continuing SSES efforts in the remaining basins identified as having high or moderate levels of I/I during the wastewater flow monitoring evaluation (**Section 9.0**). A SSES Rehabilitation/Renewal CIP was developed to address SSES activities and rehabilitation/renewal of deficiencies identified in the collection system as a result of these evaluation efforts. These project costs include the following SSES efforts:

- Focused Flow Monitoring
- Manhole Inspections
- Smoke Testing

A placeholder cost of $1,000,000 was included in each project for the identified basin to fund the rehabilitation or renewal of manholes and gravity lines, based on the results of the planned SSES field efforts. Typical rehabilitation efforts for manholes could include application of coatings, raising manhole rims to grade, and repairing frames and covers. Typical rehabilitation efforts for wastewater lines could include point repairs and slip lining.

Costs for flow monitoring, smoke testing, and manhole inspections are provided as estimates based on previous similar projects. For wastewater basins with high levels of I/I, costs were included for inspecting and testing 80% of the manholes and lines within the basin. For basins with moderate levels of I/I, costs were included for inspecting and testing 50% of the lines and manholes within the basin.

The SSES Rehabilitation/Renewal projects are summarized in **Table 11-7**. The total project costs include an allowance for engineering, surveying, and contingencies. These projects were prioritized based on the amount of I/I observed during the flow monitoring evaluation. It is recommended that these projects be implemented as City funding allows. Detailed descriptions of each project are included in this section. Opinions of Probable Construction Cost (OPCCs) for each project are included in **Appendix B**.

Table 11-7: SSES Rehabilitation/Renewal CIP Summary

Project Number	Project Description	Cost
B1	RC-01 Basin (Manhole Rehabilitation)	$120,360
B2	AJ-12 Basin (Sub Basin E Manhole and Line Rehabilitation)	$312,000
B3	AJ-12 Basin Rehabilitation and Renewal (Sub Basins A, D, C, and B)	$1,433,790
B4	AJ-08 Basin SSES, Rehabilitation and Renewal	$1,664,870
B5	AJ-10 Basin SSES, Rehabilitation and Renewal	$1,945,550
B6	NB-06 Basin SSES, Rehabilitation and Renewal	$1,744,640
B7	AJ-11 Basin SSES, Rehabilitation and Renewal	$1,726,320
B8	RC-04 Basin SSES, Rehabilitation and Renewal	$1,657,310
	SSES Rehabilitation/Renewal Total	**$ 10,604,840**

Project B1: RC-01 Basin (Manhole Rehabilitation)

This project includes the rehabilitation of the manholes in the RC-01 Basin, as per the findings of the SSES manhole inspections carried out during the *Condition and Capacity Assessment Study*. The SSES of this basin revealed corrosion of the concrete manholes and defects of frames and covers. It is recommended that an H_2S resistant liner be applied to all manholes in this basin. It is anticipated that this project will reduce the amount of I/I being sent to the Robinson Creek WWTP.

Project B2: AJ-12 Basin (Sub Basin E Manhole and Line Rehabilitation)

This project includes the rehabilitation of the manholes in the AJ-12 Sub Basin E, as per the findings of the SSES Manhole Inspections carried out during the *Condition and Capacity Assessment Study*. The SSES of this basin revealed corrosion of the concrete manholes and defects of frames and covers. It is recommended that an H_2S resistant liner be applied to 16 manholes in this sub basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

Project B3: AJ-12 Basin Rehabilitation and Renewal (Sub Basins A, D, C, and B)

Focused flow monitoring was performed in five sub basins within the AJ-12 Basin as part of the overall *Water and Wastewater System Condition and Capacity Assessment Study*. A detailed SSES, including manhole inspections and smoke testing, was conducted in the sub basin with the most I/I (Sub Basin E). FNI recommends that SSES efforts be continued in the remaining four sub basins (A, D, C, and B). High and moderate levels of I/I were measured in the four remaining sub basins (A, D, C, and B). A detailed

SSES in these areas will help to identify sources of I/I. Once these sources are identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the wastewater system. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

Project B4: AJ-08 Basin SSES, Rehabilitation and Renewal

This project includes focused flow monitoring throughout the AJ-08 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system. The citywide flow monitoring conducted during this study identified high levels of I/I in the AJ-08 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

Project B5: AJ-10 Basin SSES, Rehabilitation and Renewal

This project includes focused flow monitoring throughout the AJ-10 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system. The citywide flow monitoring conducted during this study identified high levels of I/I in the AJ-10 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

Project B6: NB-06 Basin SSES, Rehabilitation and Renewal

This project includes focused flow monitoring throughout the NB-06 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system. The citywide flow monitoring conducted during this study identified moderate levels of I/I in the NB-06 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the N.B. Davidson WWTP.

Project B7: AJ-11 Basin SSES, Rehabilitation and Renewal

This project includes focused flow monitoring throughout the AJ-11 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system. The citywide flow monitoring conducted during this study identified moderate levels of I/I in the AJ-11 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

Project B8: RC-04 Basin SSES, Rehabilitation and Renewal

This project includes focused flow monitoring throughout the RC-04 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system. The citywide flow monitoring conducted during this study identified moderate levels of I/I in the RC-04 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the Robinson Creek WWTP.

12.0 RISK BASED ASSESSMENT OF LIFT STATIONS

FNI performed a risk based assessment on all of the City's lift stations. The risk based assessment considered condition and criticality components to evaluate the risk of failure of each lift station. The results of this assessment were used to develop prioritized projects for the rehabilitation and capacity capital improvement plans.

12.1 LIFT STATION RISK BASED ASSESSMENT

The condition assessment included a visual inspection of each lift station and its components. The criticality assessment, or consequence of failure, included an analysis of the proximity of each lift station to critical or environmentally sensitive areas, as well as the residential population served. Each lift station was assigned overall condition and criticality scores based on the results of the assessments. These scores were used to assign a risk category (high, medium, or low) to each asset. Lift station rehabilitation projects were developed based on the results of the risk based assessment and included in the wastewater CIP.

12.1.1 Lift Station Condition Assessment

FNI developed a list of electrical, structural, mechanical, and site components to be inspected at each lift station site. A condition weighting factor was assigned to each component group based on the relative importance of the component to the overall function of the lift station. Major components in each of these categories were evaluated separately. **Table 12-1** illustrates the condition component groups, parameters, and weighting for the lift station facilities.

Table 12-1: Condition Assessment Component Groups and Weightings

Component Group	Weight Factor
Electrical – MCC, Back-up Power, Cables	20%
Instrumentation – SCADA & alarms	15%
Pumps and Motors	20%
Structure - Hatches, Corrosion, Cracks, Leaking, Ventilation, Odor Control	20%
Piping and Valves	15%
Site - Drainage, Access Drive, Security, Fencing	10%
Total Weighting	**100%**

Site visits for the 30 lift stations were performed on June 9 and 10, 2015. The condition inspections were conducted by a team of design, electrical and modeling engineers from FNI, as well as wastewater operations staff from the City. FNI assigned numerical scores ranging from 1 to 5 to each component group based on the physical condition as seen during the inspection and information provided by the City staff relating to its operational performance. **Table 12-2** shows the guidelines used during assignment of numerical scores for component groups.

Table 12-2: Guidelines for Condition Scores

Condition Rating	Scoring Guidelines
1	**Very good** condition; no improvements recommended to maintain function
2	**Good** condition; minor improvements recommended to maintain function
3	**Fair** condition; improvements recommended to improve performance or efficiency
4	**Poor** condition; improvements recommended to maintain reliability
5	**Very Poor** Condition; rehabilitation or replacement required

In conjunction with the condition assessment site visits, FNI reviewed approximately two years (March 2013 to December 2014) of lift station work order history provided by the City. This information was screened for maintenance issues including instances of de-ragging, cleaning of return lines, failures of the SCADA system, issues with transducers, and operational issues with pumps or generators. It was found that the average number of work orders per lift station was 4.9. Based on this data, FNI developed the work order impact criteria shown in **Table 12-3**. The inspected condition score of lift stations with greater than five work orders was increased by 0.25 points. Eleven of the 30 lift stations were penalized as such to reflect above average maintenance history. The work order impact criteria was developed to have a performance component influence on the inspected condition scores since the assessments were visual, and no equipment testing was performed.

Table 12-3: Work Order Impact Scores

No. of Work Orders	Impact to Condition Score
≥ 5	+ 0.25
Less than 5	0

Once the visual site inspections and work order history analysis were completed, ranges were assigned for the condition scores, and categories were designated from very good to very poor as shown in **Table 12-4**. Final condition scores for each lift station are shown in **Table 12-5**.

Table 12-4: Condition Score Ranges

Condition Rating	Min	Max
Very Good	0.00	1.50
Good	1.51	2.25
Fair	2.26	3.00
Poor	3.01	3.50
Very Poor	3.51	5.00

Table 12-5: Lift Station Condition Score Summary

Lift Station	Condition Score	Rating
Airport	2.75	Fair
Bayes	2.40	Fair
Bearkat Blvd	2.75	Fair
Brook Hollow	3.10	Poor
Elkins Lake Dam	3.55	Very Poor
Elkins Lake #1	3.50	Poor
Elkins Lake #2	3.35	Poor
Elkins Lake #3	2.65	Fair
Elkins Lake Post Office	1.55	Good
Elkins Lake Equestrian Center	3.35	Poor
Hitchin' Post	3.50	Poor
Highway 190	2.65	Fair
Mallery Lake	2.35	Fair
McCoy's	2.70	Fair
McGary Creek	3.00	Fair
Old Colony	3.75	Very Poor
Simmons Street	2.35	Fair
Southwood Drive	2.10	Good
Tanyard Creek	2.25	Good
TDCJ BOT	3.70	Very Poor
Waters Edge	1.90	Good
Park Road 40	2.25	Good
McDonald Creek	2.20	Good
Transfer Station	2.60	Fair
Sims	2.85	Fair
Sterlingbrook	1.75	Good
TXDOT #1 (Rest Area 45)	1.90	Good
TXDOT #2 (Rest Area 1696)	3.60	Very Poor
Badger Lane	1.55	Good
Huntsville State Park	2.25	Good

12.1.2 Lift Station Criticality Assessment

FNI performed a criticality assessment for each lift station based on three categories:

- Proximity to High Impact Areas
- Population Served
- Proximity to Environmentally Sensitive Areas

Table 12-6 shows the scoring parameters used and the weighting factors assigned to each lift station criticality category.

Table 12-6: Condition Assessment Component Groups and Weightings

CRITICALITY CATEGORIES & WEIGHTING SYSTEM	
Proximity to High Impact Areas (25%)	**Population Served (25%)**
≤ 1000 ft from school or university = 5 ≤ 1000 ft from golf course = 4 ≤ 1000 ft from commercial structure = 3 ≤ 2,000 ft from any structure = 2 >2,000 ft from any structure = 0	> 2,000 = 5 1,001 – 2,000 = 4 501 – 1,000 = 3 251 – 500 = 2 ≤ 250 = 1
Proximity to Environmentally Sensitive Areas (50%)	
> 75 ft from any water body, or inside Sam Houston National Forest = 5 76 – 150 ft from any water body, or < 500 ft from Sam Houston National Forest = 4 151 – 300 ft from any water body, or < 1,500 ft from Sam Houston National Forest = 3 301 – 600 ft from any water body = 2 > 600 ft from any water body, or > 1,500 from Sam Houston National Forest = 0	

GIS tools were utilized to determine the distance from each lift station to the high impact areas and environmentally sensitive areas. Geocoded water meters were used to determine the existing population within each lift station service area.

Once the proximity and population analyses were completed, ranges were assigned for the criticality scores, and categories were designated from very low impact to very high impact. **Table 12-7** shows the scores associated with the rating categories of the criticality assessment. Final criticality scores for each lift station are shown in **Table 12-8**.

Table 12-7: Criticality Score Ranges

Criticality Rating	Min	Max
Very Low Impact	0.00	1.00
Low Impact	1.01	3.00
Moderate Impact	3.01	3.49
High Impact	3.5	3.99
Very High Impact	4.00	5.00

Table 12-8: Lift Station Criticality Score Summary

Lift Station	Criticality Score	Rating
Airport	0.25	Very Low
Bayes	4.00	Very High
Bearkat Blvd	4.25	Very High
Brook Hollow	3.75	High
Elkins Lake Dam	4.00	Very High
Elkins Lake #1	3.25	Moderate
Elkins Lake #2	2.75	Low
Elkins Lake #3	3.75	High
Elkins Lake Post Office	3.75	High
Elkins Lake Equestrian Center	3.50	High
Hitchin' Post	1.00	Very Low
Highway 190	4.00	Very High
Mallory Lake	4.00	Very High
McCoy's	2.50	Low
McGary Creek	3.25	Moderate
Old Colony	4.00	Very High
Simmons Street	3.50	High
Southwood Drive	0.75	Very Low
Tanyard Creek	3.50	High
TDCJ BOT	0.75	Very Low
Waters Edge	4.00	Very High
Park Road 40	3.25	Moderate
McDonald Creek	3.25	Moderate
Transfer Station	0.25	Very Low
Sims	3.25	Moderate
Sterlingbrook	3.50	High
TXDOT #1 (Rest Area 45)	0.25	Very Low
TXDOT #2 (Rest Area 1696)	2.75	Low
Badger Lane	3.50	High
Huntsville State Park	3.25	Moderate

12.1.3 Lift Station Risk Assessment

FNI utilized the results of the condition and criticality assessments to develop a risk based assessment of the City's lift stations. Risk scores were calculated by the summation of the condition and criticality scores for each lift station. These risk scores were divided into four ranges (extreme, high, moderate, and low) to assign a risk of failure to each lift station. The resulting risk scores, ranges, and risk of failure ratings are shown in **Table 12-9.**

Table 12-9: Risk Score Ranges

Risk Rating	Min	Max
Low Risk	0.00	3.00
Moderate Risk	3.01	5.75
High Risk	5.76	7.00
Extreme Risk	7.01	10.00

The lift stations were arranged into a risk rating matrix, which graphically shows the condition and criticality ratings, as well as the overall risk of failure rating. The risk matrix is shown in **Table 12-10**. **Table 12-11** shows the condition, criticality, and overall risk of failure ratings in a tabular format. Detailed lift station risk based assessment sheets including facility information, individual component group scores for condition and criticality, and additional comments for each lift station are included in **Appendix O**.

Several lift stations that received a good condition score received a moderate risk rating due to the high criticality score. These lift stations should continue to be well maintained to minimize lift station downtime given the high consequence of failure of these facilities.

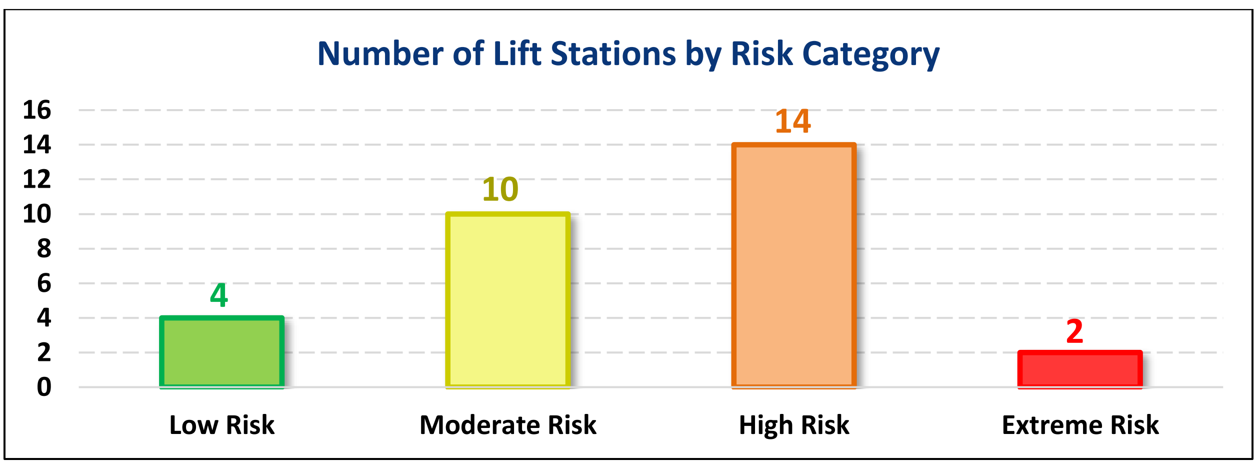
Table 12-10: Lift Station Risk Rating Matrix

Risk Rating = Condition + Criticality	Condition Ranking				
Criticality Ranking	**Very Good**	**Good**	**Fair**	**Poor**	**Very Poor**
Very Low Impact		TXDOT #1 (Rest Area 45) Southwood Drive	Transfer Station Airport	Hitchin' Post	TDCJ BOT (1)
Low Impact			McCoy's	Elkins Lake #2	TXDOT #2 (Rest Area 1696)
Moderate Impact		McDonald Creek Huntsville State Park Park Road 40	Sims (1) McGary Creek	Elkins Lake #1	
High Impact		Badger Lane (1) Sterlingbrook Elkins Lake Post Office Tanyard Creek	Simmons Street Elkins Lake #3	Equestrian Center Brook Hollow	
Very High Impact		Waters Edge	*Mallery Lake* (WFTC) Bayes *Highway 190* (WFTC) *Bearkat* (WFTC)		Elkins Lake Dam Old Colony (1)

(1) These lift Stations were decommissioned by the City in 2015 and 2016, during the Wastewater System Study.
(WFTC) These lift stations are planned to be consolidated by the City as part of the West Fork Tanyard Creek project.

Table 12-11: Summary of Lift Station Risk Based Assessment

Lift Station	Condition Rating	Criticality Rating	Risk Rating
Old Colony	Very Poor	Very High	Extreme Risk
Elkins Lake Dam	Very Poor	Very High	Extreme Risk
Bearkat Blvd	Fair	Very High	High Risk
Brook Hollow	Poor	High	High Risk
Elkins Lake Equestrian Center	Poor	High	High Risk
Elkins Lake #1	Poor	Moderate	High Risk
Highway 190	Fair	Very High	High Risk
Bayes	Fair	Very High	High Risk
Elkins Lake #3	Fair	High	High Risk
TXDOT #2 (Rest Area 1696)	Very Poor	Low	High Risk
Mallery Lake	Fair	Very High	High Risk
McGary Creek	Fair	Moderate	High Risk
Elkins Lake #2	Poor	Low	High Risk
Sims	Fair	Moderate	High Risk
Waters Edge	Good	Very High	High Risk
Simmons Street	Fair	High	High Risk
Tanyard Creek	Good	High	Moderate Risk
Park Road 40	Good	Moderate	Moderate Risk
Huntsville State Park	Good	Moderate	Moderate Risk
McDonald Creek	Good	Moderate	Moderate Risk
Elkins Lake Post Office	Good	High	Moderate Risk
Sterlingbrook	Good	High	Moderate Risk
McCoy's	Fair	Low	Moderate Risk
Badger Lane	Good	High	Moderate Risk
Hitchin' Post	Poor	Very Low	Moderate Risk
TDCJ BOT	Very Poor	Very Low	Moderate Risk
Airport	Fair	Very Low	Low Risk
Transfer Station	Fair	Very Low	Low Risk
Southwood Drive	Good	Very Low	Low Risk
TXDOT #1 (Rest Area 45)	Good	Very Low	Low Risk



12.2 LIFT STATION REHABILITATION CIP

Utilizing the results of the risk based assessment, FNI developed a lift station rehabilitation CIP. The lift stations recommended for rehabilitation meet the following criteria:

- The lift station risk based assessment resulted in a Fair, Poor or Very Poor condition score or the lift station was classified as High or Extreme Risk.
- The lift station firm capacity does not need to be expanded.
- The lift station is not already planned to be consolidated by the City.

Lift stations that don't meet these criteria are addressed in the capacity CIP. There are ten lift stations that meet these criteria. These projects are prioritized based on the risk based assessment scores. It is recommended that they be carried out as City funding allows.

FNI developed costs for each lift station rehabilitation based on the results of the lift station condition assessment. Opinions of Probable Construction Cost (OPCCs) were developed for all lift station rehabilitation projects in 2016 dollars, breaking out the rehabilitation costs by component group. These costs are provided as estimates based on previous similar engineering experience and include an allowance for engineering, surveying, and contingencies. The OPCCs are provided in **Appendix B**. The lift station rehabilitation projects are summarized in **Table 12-10.** Descriptions of each lift station rehabilitation project are included below. All ten of these lift stations are shown in **tan** on **Figure 15-1**.

Table 12-12: Lift Station Rehabilitation CIP Summary

Project Number	Project Description	Cost
LS 1	Brook Hollow (BH) Lift Station Rehabilitation	$ 545,060
LS 2	Elkins Lake Equestrian Center (EC) Lift Station Rehabilitation	$ 371,000
LS 3	Elkins Lake #1 (EL 1) Lift Station Rehabilitation	$ 369,040
LS 4	Bayes (BA) Lift Station Rehabilitation	$ 574,000
LS 5	Elkins Lake #3 (EL 3) Lift Station Rehabilitation	$ 417,000
LS 6	Elkins Lake #2 (EL 2) Lift Station Rehabilitation	$ 386,000
LS 7	Simmons Street (SS) Lift Station Rehabilitation	$ 284,000
LS 8	McCoy's (MC) Lift Station Rehabilitation	$ 233,870
LS 9	Airport (AP) Lift Station Rehabilitation	$ 225,830
LS 10	Transfer Station (TS) Lift Station Rehabilitation	$ 275,640
LS 11	Decommission TxDOT #1 Lift Station and Install Aerobic System	$ 290,160
LS 12	Decommission TxDOT #2 Lift Station and Install Aerobic System	$ 354,120
	Lift Station Rehabilitation Total	**$ 4,325,720**

Project LS 1: Brook Hollow Lift Station Rehabilitation

This project includes the rehabilitation of the Brook Hollow Lift Station. The condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station are recommended for rehabilitation.

Project LS 2: Elkins Lake Equestrian Center Lift Station Rehabilitation

This project includes the rehabilitation of the Elkins Lake Equestrian Center Lift Station. The condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station are recommended for rehabilitation.

Project LS 3: Elkins Lake #1 Lift Station Rehabilitation

This project includes the rehabilitation of the Elkins Lake # 1 Lift Station. The condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station are recommended for rehabilitation.

Project LS 4: Bayes Lift Station Rehabilitation

This project includes the rehabilitation of the Bayes Lift Station. The condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station are recommended for rehabilitation.

Project LS 5: Elkins Lake #3 Lift Station Rehabilitation

This project includes the rehabilitation of the Elkins Lake # 3 Lift Station. The condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station, with the exception of the site, are recommended for rehabilitation.

Project LS 6: Elkins Lake #2 Lift Station Rehabilitation

This project includes the rehabilitation of the Elkins Lake # 2 Lift Station. The condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station are recommended for rehabilitation.

Project LS 7: Simmons Street Lift Station Rehabilitation

This project includes the rehabilitation of the Simmons Street Lift Station. The condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the high risk category. All components of this lift station are recommended for rehabilitation.

Project LS 8: McCoy's Lift Station Rehabilitation

This project includes the rehabilitation of the McCoy's Lift Station. The condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the moderate risk category. All components of this lift station are recommended for rehabilitation.

Project LS 9: Airport Lift Station Rehabilitation

This project includes the rehabilitation of the Airport Lift Station. The condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the low risk category. All components of this lift station are recommended for rehabilitation.

Project LS 10: Transfer Station Lift Station Rehabilitation

This project includes the rehabilitation of the Transfer Station Lift Station. The condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the low risk category. All components of this lift station are recommended for rehabilitation.

Project LS 11: Decommission TxDOT #1 Lift Station and Install Aerobic system

This project includes the decommissioning of the TxDOT #1 Lift Station and the installation of an aerobic system. The lift station serves a small amount of flow, and discharges into the TxDOT #2 Lift Station.

Project LS 12: Decommission TxDOT #2 Lift Station and Install Aerobic system

This project includes the decommissioning of the TxDOT #2 Lift Station and the installation of an aerobic system. The lift station serves a small amount of flow and does not cycle regularly, resulting in a septic environment. The lift station condition assessment resulted in a very poor rating and the risk based assessment for this lift station was in the high risk category. It is anticipated that this lift station would have to be rehabilitated on a recurring basis due to the flow conditions.

13.0 WASTEWATER MODEL DEVELOPMENT AND CALIBRATION

The City selected the Bentley SewerGEMS® hydraulic modeling software, which has dynamic modeling capabilities as well as GIS interoperability. These features allow for more realistic flow representation over time and the ability to maintain relationships between the modeled wastewater assets and those in the City's GIS database. In this study, all wastewater lines with diameters of 8 inches or larger were included in the model. FNI built and calibrated the hydraulic wastewater model to serve as a basis for all future modeling scenarios and CIP development.

13.1 GIS DATABASE UPDATES

At the beginning of this study, the City completed an update of the City's wastewater GIS database. This updated GIS data was given to FNI and formed the basis of the hydraulic model.

13.1.1 Manhole Survey and Data Collection Effort

FNI retained Gorrondona and Associates (G&A) to survey and perform field data collection of 60 manholes throughout the wastewater system. This survey and data collection effort was performed at locations where the City's GIS database was missing invert or elevation information or contained conflicting invert data. Additional sites were chosen to verify connectivity and force main discharge inverts. Data collected at sewer manholes included:

- X, Y coordinates
- Rim elevation
- Measure downs to inverts of all incoming and outgoing lines
- Diameter, material and direction of all incoming and outgoing lines
- Manhole material and general condition

The results of the manhole survey and data collection effort were delivered to the City in a GIS geodatabase and incorporated into the wastewater hydraulic model.

13.2 MODEL NETWORK DEVELOPMENT

The completed hydraulic model consists of approximately 2,642 wastewater lines, 2,629 manholes, 3 outfalls, 5,385 catchments, 21 lift stations, and 42 pumps. FNI reviewed the modeled wastewater network for proper connectivity. The wastewater model includes the following recently completed sewer projects:

- **8-inch and 12-inch BOT/TDCJ/Hwy 75 Sanitary Sewer Extension**
  (Decommissioned TDCL BOT Lift Station to McGary Creek Lift Station)
- **8-inch and 18-inch OCR 5 and OCR 6 Sanitary Sewer Projects**
- **15-inch and 18-inch Town Creek Sanitary Sewer Replacement Phases I and II Improvements**
  (Avenue M from 9th to 14th Street, 14th Street from Avenue M to Avenue I, and Bearkat Blvd. from 17th Street to Sycamore Ave.)

13.2.1 Manholes

The majority of the manholes in the City's GIS contained rim elevations. Missing rim elevations were populated using survey information and elevations obtained from contour data. The "GISID" Field from the City's manhole dataset is preserved in the SewerGEMS model as the "Label" field. Manhole rim elevations and pipe inverts for the BOT/TDCJ/Hwy 75 Sanitary Sewer Extension and the Town Creek Sanitary Sewer Replacement Phases I and II Improvements were added to the hydraulic model based on construction plans.

13.2.2 Wastewater Lines

The majority of the wastewater lines in the City's GIS contained diameter and invert elevation information. Missing inverts were populated using survey data, adjacent inverts, minimum slopes, construction drawings, and engineering judgment. Diameters were updated, where necessary, to reflect information collected during manhole surveys or from construction drawings. Gravity line invert and diameter information for the recently completed sewer projects was populated using construction plans. A manning's roughness coefficient of 0.013 was assigned to the wastewater lines in the hydraulic model.

13.2.3 Lift Stations and Force Mains

FNI input lift stations and force mains into the model based on GIS data, information provided by the City, and general knowledge of the lift station layouts, including wet well dimensions, obtained during the condition assessment site visits. Modeled pumping capacities were based on pump curve or design points obtained from the City staff, construction plans, and pump vendors. Force main high points were determined using a triangulated irregular network (tin) surface FNI developed from 2-ft contours. This process was performed to accurately reflect the head conditions experienced at the lift stations. Twenty-one of the City's lift stations were included in the hydraulic model. The modeled lift stations are shown in **Table 13-1**.

Table 13-1: Modeled Lift Stations

WWTP Service Area	Lift Station	Firm Capacity (MGD)
A.J. Brown	Bearkat	0.63
	Highway 190	0.29
	Mallery Lake	0.35
	Old Colony(1)	*Unknown*
	Simmons	*Unknown*
	Sims(1)	*Unknown*
	Tanyard Creek	2.59
N.B. Davidson	Bayes	0.89
	Brook Hollow	1.08
	Elkins Lake # 1	*Unknown*
	Elkins Lake # 2	*Unknown*
	Elkins Lake # 3	0.86
	Elkins Lake Dam	4.0 (2)
	Elkins Lake Post Office	1.22
	Park Road	*Unknown*
	Southwood Drive	0.36
	Sterlingbrook	0.34
	Waters Edge	1.21
Robinson Creek	Hitchin' Post	0.15
	McDonald Creek	1.44
	McGary Creek	2.95

(1) Decommissioned by the City in 2016
(2) Assumed from WWTP Peak Permitted Capacity

The remaining seven lift stations have small service areas and subsequently small firm pumping capacities. The residential and commercial flows generated within these service areas were included in the hydraulic model; however, the lift stations were not modeled. The non-modeled lift stations are shown in **Table 13-2**.

Table 13-2: Non-modeled Lift Stations

WWTP Service Area	Lift Station	Firm Capacity (MGD)
A.J. Brown	Badger[(1)]	*Unknown*
N.B. Davidson	Elkins Lake Equestrian Center	0.22
	Huntsville State Park	*Unknown*
Robinson Creek	Airport	0.09
	TDCJ-BOT [(2)]	*Unknown*
	TX-DOT #1	*Unknown*
	TX-DOT #2	*Unknown*

(1) Decommissioned by the City in 2016
(2) Decommissioned by the City in 2015

13.2.4 Catchments

SewerGEMS® stores hydrologic runoff information important to wet weather calibration in catchments. FNI generated catchments around all manholes in the system. The catchments were generated as Thiessen polygons around each manhole and are bounded by the limits of the associated flow meter sub basins. The outflow manholes to 8-inch and larger modeled lines were determined for catchments generated around manholes on 6-inch and smaller lines based on the sewer network connectivity.

13.3 FLOW ALLOCATION

FNI allocated wastewater loads to the hydraulic model using the geocoded water customer billing account information discussed in **Section 5.1.4**. An average of the active water meters from the December 2014 and January 2015 billed water consumption was used to remove irrigation water from the data. GIS tools were used to determine which meters fell within the wastewater catchments, and a return rate was applied to generate wastewater loads. These loads were then applied to the hydraulic model at the outflow manholes associated with the catchments.

Wastewater flows for the Goree, Byrd, Wynne, and Holliday Units were recorded by City staff during the flow monitoring period and manually entered into the hydraulic model.

13.4 DRY WEATHER CALIBRATION

Dry weather calibration is conducted so that the hydraulic model closely matches observed dry weather flows. These dry weather flows represent residential, commercial, industrial and groundwater flows during a period without any additional measurable I/I due to rainfall. FNI chose a seven day period from July 1 to July 8, 2015 for the dry weather calibration.

Diurnal patterns for each flow monitor basin were loaded into the model, based on the patterns observed during the flow monitoring period. The dry weather wastewater flows were then factored as necessary until the aggregate flows in each wastewater basin closely matched the observed flow monitor data. The standard for dry weather flow calibration is +/- 5%, and this was achieved for the average daily flows at each of the 12 flow monitor sites. Calibration plots demonstrating the dry weather model calibration results are provided in **Appendix P**.

13.5 WET WEATHER CALIBRATION

Wet weather calibration builds upon the dry weather calibration and is performed so that the model closely matches observed wet weather flows. These wet weather flows represent the sum of the dry weather flows plus the additional I/I that enters the wastewater system during a rainfall event. FNI chose the observed storm events from June 17, 18, and 20 for the wet weather calibration. The total rainfall (based on the average of the three rain gauges) from these storm events was approximately 3.9 inches.

FNI utilized the RTK hydrograph method to model the additional flows that entered the wastewater system during the observed calibration storms. This method utilizes three hydrographs that each contain three parameters which are modified to achieve calibration: flow of water into the system (R), the time to peak flow (T), and the ratio of time until normalization of flow to time to peak (K). The combination of the three component hydrographs form the total response (additional I/I) that is observed in the wastewater system. The RTK parameters and the component hydrographs are illustrated in **Figure 13-1** and **Figure 13-2**.

Figure 13-1: RTK Parameters

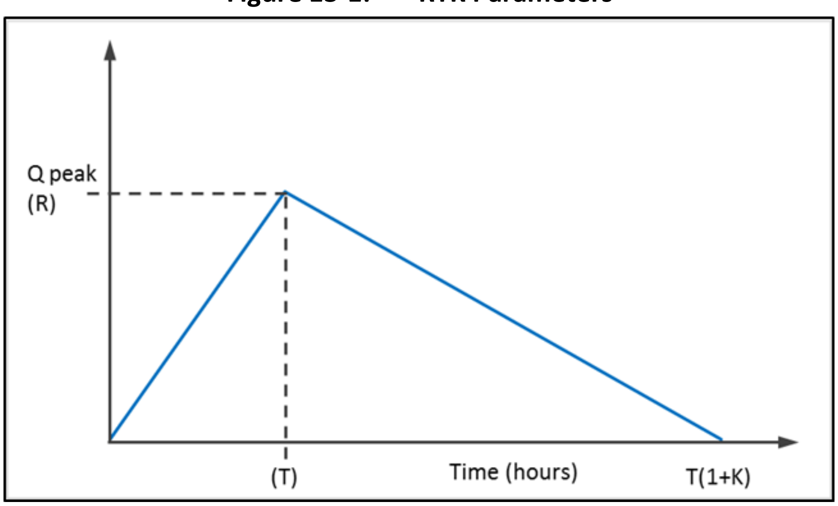
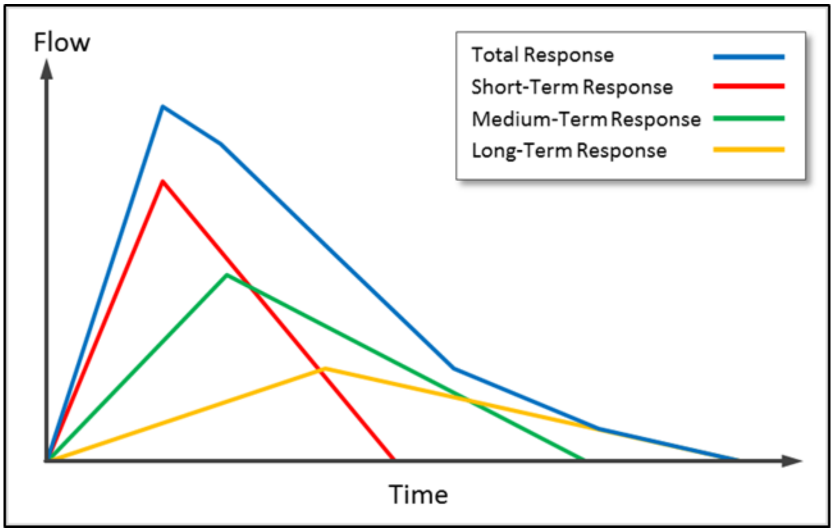


Figure 13-2: RTK Component Hydrographs



Separate RTK hydrographs were developed for each wastewater basin to account for the different land uses, soil properties, amounts of impervious cover, and condition of the wastewater lines in each sub basin. In the SewerGEMS model, the RTK hydrographs were applied to the catchments in each wastewater sub basin. The observed rainfall hyetographs measured during the calibration rainfall events was then applied to the model. The model calculates the I/I that enters the wastewater system using the values in the RTK hydrographs and the contributing area of each catchment. These values were adjusted until the modeled wet weather flows closely matched the observed wet weather flows. The standard for wet weather calibration in +/- 10% of the observed peak flows. This was achieved for every flow monitor site with the exception of AJ-11. This site experienced significant surcharging during the observed rainfall events. The model shows a lower peak flow during the June 18 storm event, but still predicts significant surcharging, leading to confidence that the model flows can be used for upsizing the infrastructure in this area. Calibration plots demonstrating the wet weather model calibration results are also provided in **Appendix P**.

The dry and wet weather calibration results provide a high level of confidence that the model is closely matching real world conditions and suitable to use for hydraulic analyses and CIP development. The model is calibrated well within the industry standards.

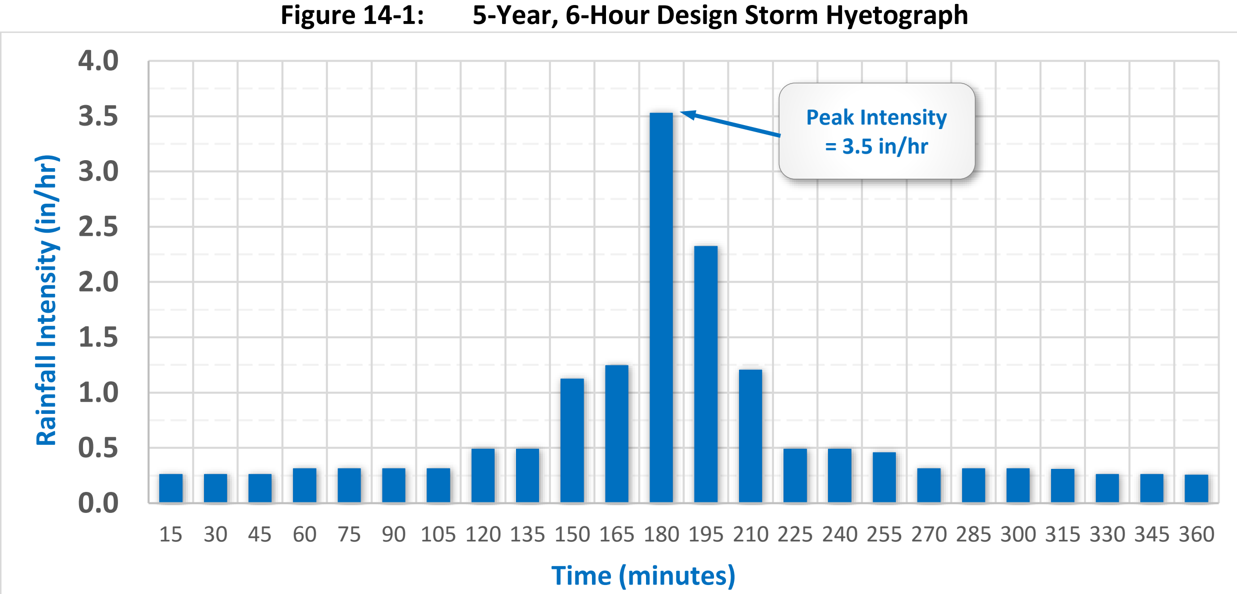
14.0 WASTEWATER SYSTEM ANALYSES AND HYDRAULIC MODELING

Hydraulic analyses were conducted to identify deficiencies in the City's existing wastewater collection system and establish a capital improvements plan to address deficiencies in the existing system and accommodate the projected wastewater flows through 2041. Various combinations of improvements and modifications were investigated to determine the most appropriate approach for conveying projected flows. Considerations in developing the CIP included increasing system reliability, simplifying system operations, consolidation of lift stations, conveying peak wet weather flows, and reducing surcharging and sanitary sewer overflows.

14.1 DESIGN STORM

A 5-year 6-hour design storm was utilized for the existing and future system analyses. This design storm is commonly used in Texas and provides a reasonable balance between level of service and wastewater infrastructure cost. The size of the 5-year 6-hour storm was determined using historical storm event data for the region of Conroe. The historical data was analyzed and summarized in the United States Geological Survey (USGS) Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas. The 5-year, 6-hour design storm for the City of Huntsville is a 3.95-inch rainfall event. The shape of the design storm hyetograph (rainfall vs. time) was developed using the alternating block method. The 5-year, 6-hour design storm hyetograph that was applied to the wastewater model is shown in **Figure 14-1**.

Figure 14-1: 5-Year, 6-Hour Design Storm Hyetograph



14.2 EXISTING WASTEWATER SYSTEM ANALYSES

The critical flow condition for analyzing a wastewater collection system is peak wet weather. Flow, depth, and velocity are important factors when analyzing the peak wet weather simulations. When the design storm is applied to the calibrated model, the effects of I/I in the system can be seen. As the storm intensifies (shown through time in **Figure 14-1**), additional flow enters the system. The model determines the point in time at which the amount of water from the design storm event reaches the peak within the system. This peak represents the most taxing load the system experiences under the design storm event.

14.2.1 Existing System Model Results

Figure 14-2 displays a color coded map that illustrates the surcharged state of modeled lines and manholes under the peak conditions of a 5-year, 6-hour design storm event (3.9 inches) for Huntsville. The red lines indicate surcharging. This can occur due to a lack of capacity in that gravity line segment or a downstream restriction (i.e. insufficient lift station pumping or insufficient capacity in a downstream line). Locations where the predicted maximum hydraulic grade line (HGL) rises to within 3 feet of the manhole rim are shown as yellow circles on the map. The locations of predicted sanitary sewer overflows as a result of the modeled 5-year 6-hour storm are shown as red circles on the map.

The following areas of the existing system were identified as having capacity constraints:

A.J. Brown Service Area

- The 30-inch trunk line to the A.J. Brown WWTP (AJ-10 Basin) is experiencing significant surcharging under the 5-year 6-hour design storm peak flows. This is due to inadequate capacity in the line. The model is predicting sewer overflows under the design storm conditions.
- The 10-inch sewer in the AJ-09 Basin is experiencing significant surcharging under the 5-year 6-hour design storm peak flows. This is due to a combination of the high HGL resulting from the surcharging in the 30-inch trunk line and inadequate capacity in the existing 10-inch line to convey upstream flows, including pumped flows from the Tanyard Creek Lift Station.
- The model is predicting significant surcharging and a number of sanitary sewer overflows within the AJ-10, AJ-11, and AJ-12 Basins. This is due to a combination of the moderate and high levels of inflow/infiltration as measured during the flow monitoring period (**Section 9.0**) and inadequate capacity in the existing wastewater lines to convey the 5-year, 6-hour design storm peak flows.

Robinson Creek Service Area

- The gravity lines immediately upstream of the McGary Creek Lift Station are experiencing surcharging. This is due to a lack of capacity in the lift station to convey the 5-year, 6-hour design storm peak flows. The City expanded the McGary Creek Lift Station over the course of this study; however, this expansion only provided enough wet well capacity to consolidate the TDCJ-BOT Lift Station and did not provide for an increase in the firm capacity of the lift station.
- The model is showing significant surcharging and overflows in the gravity lines in the **RC-05** Basin east of IH-45. This indicates a lack of capacity in the existing gravity lines to convey the 5-year, 6-hour design storm peak flows.
- The model is showing surcharging upstream of the Hitchin' Post Lift Station, indicating a lack of firm pumping capacity to convey the existing design storm peak flows.
- The model is showing surcharging in the gravity lines serving the Brookview Neighborhood. This is due to inadequate capacity in these lines to convey the 5-year, 6-hour design storm peak flows.

N.B. Davidson Service Area

- The model is indicating that the gravity lines immediately upstream of the Waters Edge Lift Station are surcharging under the 5-year, 6-hour design storm peak flow conditions. This is due to a lack of firm pumping capacity in the Waters Edge Lift Station to convey the combination of 5-year, 6-hour design storm peak flows from the lift station service area and the pumped flows from the upstream list stations.
- The 10-inch gravity lines in the NB-07 Basin around the IH-45 crossing are experiencing surcharging. This is due to inadequate capacity in the line to convey the Southwood Drive and Goree Lift Station pumped flows.
- The lines upstream of the Post Office Lift Station are experiencing surcharging under the 5-year, 6-hour design storm peak flow conditions. The firm capacity of the Post Office Lift Station is not adequate to convey the combination of design storm peak flows from the lift station service area and the firm pumping capacities of the upstream lift stations.
- The model is showing surcharging in the 8-inch lines downstream of the Elkins Lake # 3 Lift Station. These lines are not sized to convey the firm pumping capacity of the Elkins Lake # 3 Lift Station.

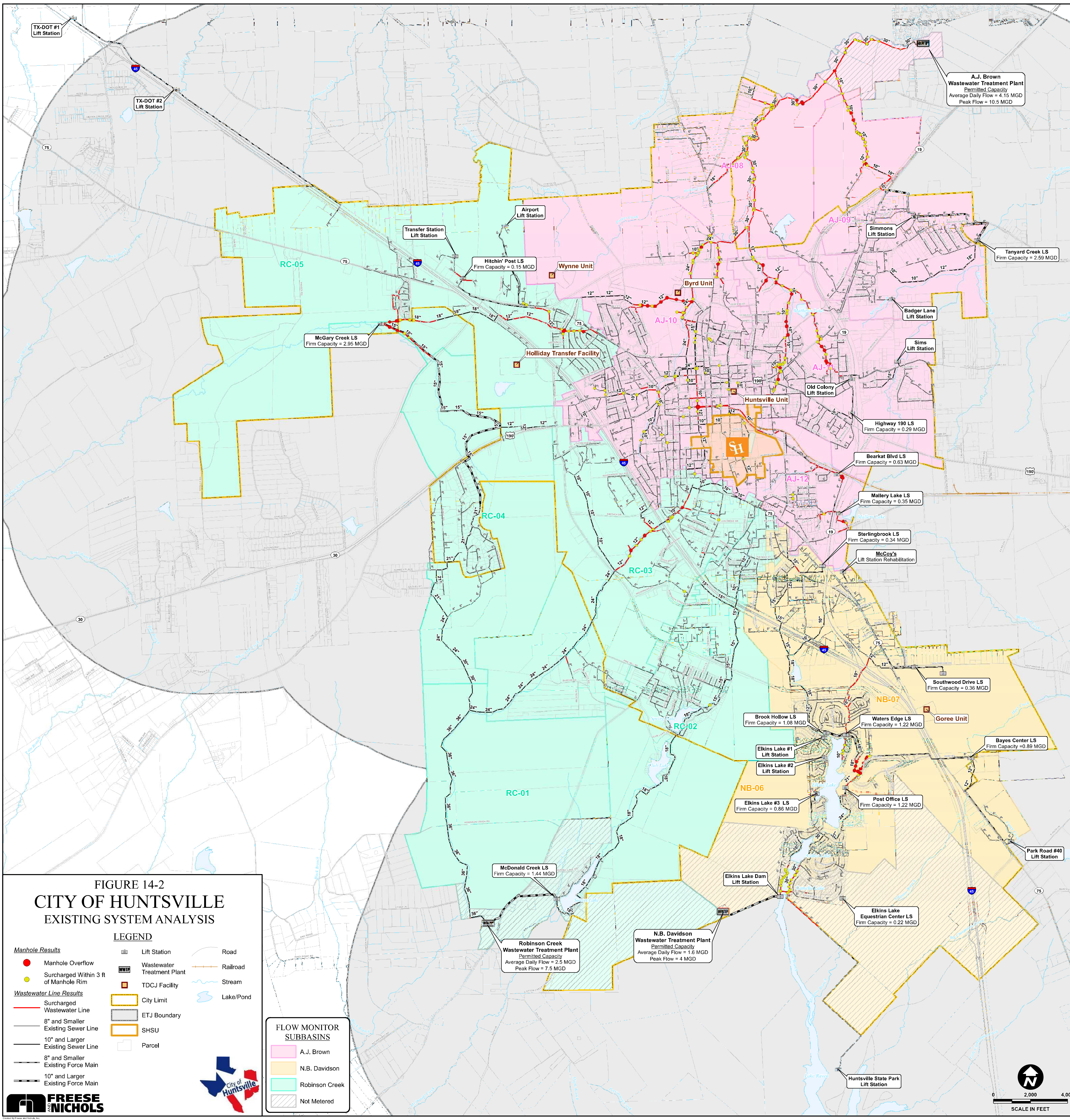


FIGURE 14-2
CITY OF HUNTSVILLE
EXISTING SYSTEM ANALYSIS
LEGEND
Manhole Results
Manhole Overflow
Surcharged Within 3 ft of Manhole Rim
Wastewater Line Results
Surcharged Wastewater Line
8" and Smaller Existing Sewer Line
10" and Larger Existing Sewer Line
8" and Smaller Existing Force Main
10" and Larger Existing Force Main
Lift Station
Wastewater Treatment Plant
TDCJ Facility
City Limit
ETJ Boundary
SHSU
Parcel
Road
Railroad
Stream
Lake/Pond
FLOW MONITOR SUBBASINS
A.J. Brown
N.B. Davidson
Robinson Creek
Not Metered
FREESE AND NICHOLS
City of Huntsville
SCALE IN FEET
0
2,000
4,000
TX-DOT #1 Lift Station
TX-DOT #2 Lift Station
A.J. Brown Wastewater Treatment Plant
Permitted Capacity
Average Daily Flow = 4.15 MGD
Peak Flow = 10.5 MGD
Airport Lift Station
Transfer Station Lift Station
Hitchin' Post LS
Firm Capacity = 0.15 MGD
Wynne Unit
Byrd Unit
Simmons Lift Station
Tanyard Creek LS
Firm Capacity = 2.59 MGD
Badger Lane Lift Station
Sims Lift Station
McGary Creek LS
Firm Capacity = 2.95 MGD
Holliday Transfer Facility
Old Colony Lift Station
Huntsville Unit
Highway 190 LS
Firm Capacity = 0.29 MGD
Bearkat Blvd LS
Firm Capacity = 0.63 MGD
Mallery Lake LS
Firm Capacity = 0.35 MGD
Sterlingbrook LS
Firm Capacity = 0.34 MGD
McCoy's Lift Station Rehabilitation
Southwood Drive LS
Firm Capacity = 0.36 MGD
Goree Unit
Brook Hollow LS
Firm Capacity = 1.08 MGD
Waters Edge LS
Firm Capacity = 1.22 MGD
Bayes Center LS
Firm Capacity =0.89 MGD
Elkins Lake #1 Lift Station
Elkins Lake #2 Lift Station
Elkins Lake #3 LS
Firm Capacity = 0.86 MGD
Post Office LS
Firm Capacity = 1.22 MGD
Park Road #40 Lift Station
McDonald Creek LS
Firm Capacity = 1.44 MGD
Elkins Lake Dam Lift Station
Elkins Lake Equestrian Center LS
Firm Capacity = 0.22 MGD
Robinson Creek Wastewater Treatment Plant
Permitted Capacity
Average Daily Flow = 2.5 MGD
Peak Flow = 7.5 MGD
N.B. Davidson Wastewater Treatment Plant
Permitted Capacity
Average Daily Flow = 1.6 MGD
Peak Flow = 4 MGD
Huntsville State Park Lift Station
AJ-08
AJ-09
AJ-10
AJ-11
AJ-12
RC-01
RC-02
RC-03
RC-04
RC-05
NB-06
NB-07

14.3 FUTURE WASTEWATER SYSTEM ANALYSES

FNI conducted hydraulic analyses to establish a capital improvements plan to convey projected wastewater flows through 2041. Many of the recommended capacity projects also address existing condition issues in the wastewater system.

14.3.1 Design Criteria for Gravity Lines

When determining the size of proposed wastewater lines, TCEQ provides specific design criteria. TCEQ §217.53 (l)(1) dictates that collection systems must be designed to maintain a minimum velocity of 2 feet/second. Maintaining these velocities discourages the settling of solids. In accordance with this, TCEQ has established minimum slope guidelines in §217.53 (l)(2)(A). These are shown in **Table 14-1**.

Table 14-1: TCEQ Minimum Slopes

Size of Pipe (in)	Minimum Slope (ft/ft)
6	0.00500
8	0.00335
10	0.00250
12	0.00200
15	0.00150
18	0.00115
21	0.00095
24	0.00080
27	0.00070
30	0.00060
33	0.00055
36	0.00045
39	0.00040

For pipes greater 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.

Additionally, TCEQ §217.53 (j)(3) states “An owner must ensure that the collection system has capacity to prevent a surcharge.” Proposed developer wastewater lines consider the TCEQ minimum slope criteria, and the recommended wastewater lines are sized to convey the projected peak 5-Year 6-Hour design storm flows without surcharging conditions.

14.3.2 Design Criteria for Lift Stations and Force Mains

TCEQ design criteria §217.61 (c) states "The firm pumping capacity of a lift station must handle the peak flow." Firm pumping capacity is defined as the maximum pumping capacity with the largest pumping unit out of service. TCEQ §217.67 (a) also states that force mains shall be sized to convey the lift station pumping capacity at a minimum velocity of 3 feet/second for duplex lift stations and 2 feet/second with one pump operating at a lift station with three or more pumps. Recommended lift station firm pumping capacities and force main sizes are based on these TCEQ criteria.

At lift stations where expansion in firm pumping capacity is recommended, the existing wet wells were evaluated for capacity based on the TCEQ minimum pump cycle times. These cycle times are listed in **Table 14-2**.

Table 14-2: TCEQ Minimum Pump Cycle Times

Pump Horsepower	Minimum Cycle Times (minutes)
< 50	6
50 – 100	10
> 100	15

14.3.3 Existing System Model Results under 2041 Peak Flows

FNI created future hydraulic model scenarios to analyze needed capital improvements. These scenarios added the projected peak wastewater loads for each planning period to the existing system. This approach shows what improvements are needed in each of the three CIP planning periods (2021, 2026, and 2041). **Figure 14-3** displays the modeled results of the 5-year 6-hour design storm with projected 2041 flows on the existing wastewater system. The following areas of concern were identified (in addition to the existing system issues discussed in **Section 14.2**).

Robinson Creek Service Area

- The 8-inch gravity lines along Veterans Memorial Parkway are showing surcharging due to the projected development in that area.

A.J. Brown Service Area

- Some additional surcharging in the A.J. Brown service area is predicted in the model due to the additional flows from developments.

14.3.4 Wastewater Treatment Plant Capacity Analyses

N.B. Davidson Service Area

The current permitted peak 2-hour flow for the N.B. Davidson WWTP is 4.0 MGD. The hydraulic modeling, flow projections, and recommended infrastructure upgrades in the N.B. Davidson service area will require an increase in the firm capacity of the New Elkins Lake Dam Lift Station by 2026. It is recommended that the City consider an increase in the peak flow treatment capacity at the N.B. Davidson plant in the 2027-2041 planning period.

A.J. Brown Service Area

The current permitted average daily flow for the A.J. Brown WWTP is 4.15 MGD. The projected wastewater flows to the A.J. Brown WWTP are 3.9 MGD by 2041. This represents 95% of the permitted treatment capacity.

TCEQ §305.126, commonly referred to as the 75/90 rule, requires a WWTP permit holder to begin planning for expansion of the treatment facility when the average daily or average annual flow reaches 75% of the permitted capacity. When the average daily or average annual flow reaches 90% of the permitted capacity, the permit holder shall obtain necessary authorization from the commission to commence construction of the necessary additional treatment facilities.

Based on the wastewater flow projections of the average daily flows, the City will need to expand the treatment capacity for the A.J. Brown service area during the 2027-2041 planning period.

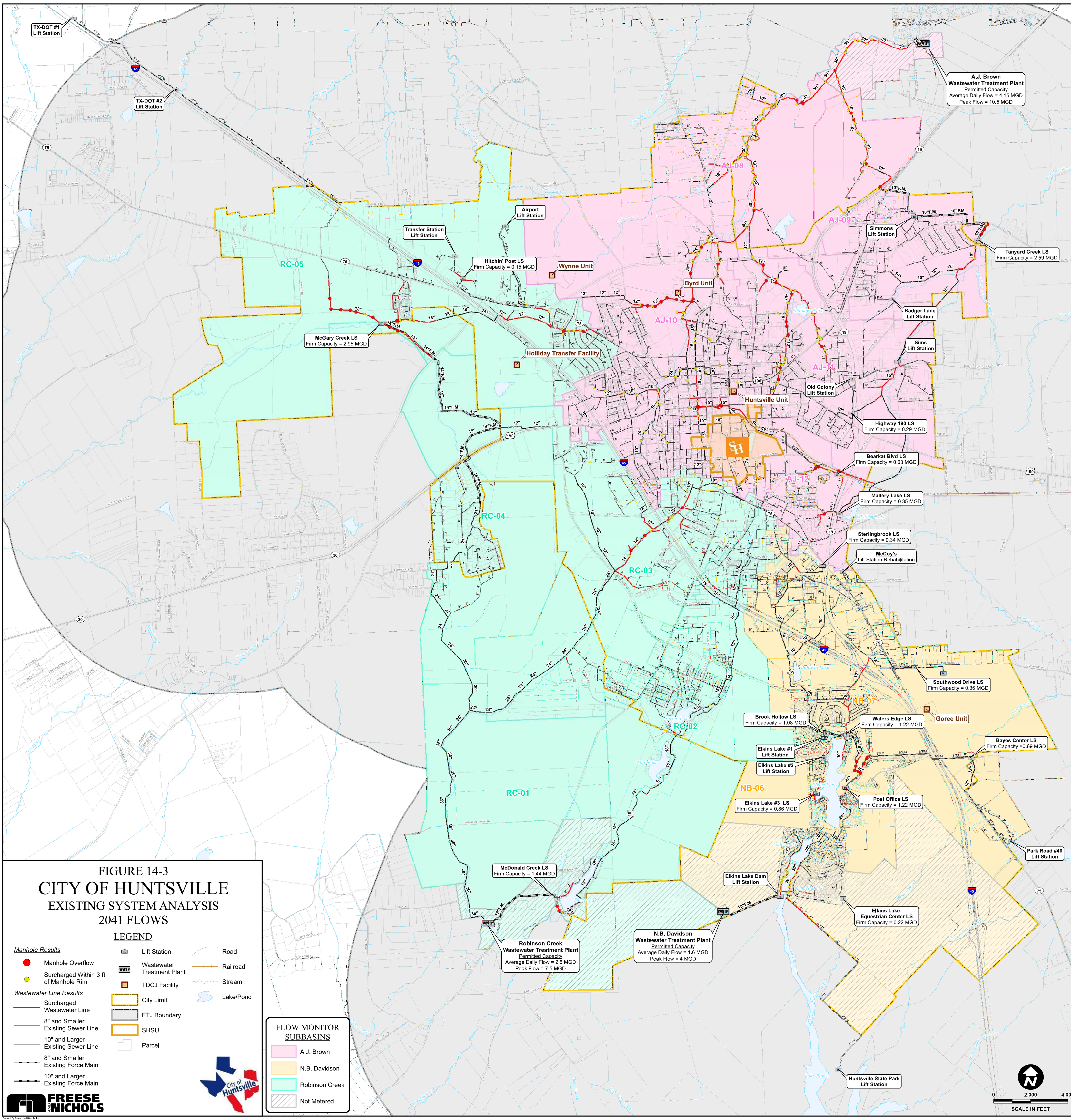


FIGURE 14-3
CITY OF HUNTSVILLE
EXISTING SYSTEM ANALYSIS
2041 FLOWS
LEGEND
Manhole Results
Manhole Overflow
Surcharged Within 3 ft of Manhole Rim
Wastewater Line Results
Surcharged Wastewater Line
8" and Smaller Existing Sewer Line
10" and Larger Existing Sewer Line
8" and Smaller Existing Force Main
10" and Larger Existing Force Main
Lift Station
Wastewater Treatment Plant
TDCJ Facility
City Limit
ETJ Boundary
SHSU
Parcel
Road
Railroad
Stream
Lake/Pond
FLOW MONITOR SUBBASINS
A.J. Brown
N.B. Davidson
Robinson Creek
Not Metered
TX-DOT #1 Lift Station
TX-DOT #2 Lift Station
A.J. Brown Wastewater Treatment Plant
Permitted Capacity
Average Daily Flow = 4.15 MGD
Peak Flow = 10.5 MGD
Airport Lift Station
Transfer Station Lift Station
Hitchin' Post LS
Firm Capacity = 0.15 MGD
Wynne Unit
Byrd Unit
Simmons Lift Station
Tanyard Creek LS
Firm Capacity = 2.59 MGD
Badger Lane Lift Station
Sims Lift Station
McGary Creek LS
Firm Capacity = 2.95 MGD
Holliday Transfer Facility
Old Colony Lift Station
Huntsville Unit
Highway 190 LS
Firm Capacity = 0.29 MGD
Bearkat Blvd LS
Firm Capacity = 0.63 MGD
Mallery Lake LS
Firm Capacity = 0.35 MGD
Sterlingbrook LS
Firm Capacity = 0.34 MGD
McCoy's
Lift Station Rehabilitation
Southwood Drive LS
Firm Capacity = 0.36 MGD
Goree Unit
Brook Hollow LS
Firm Capacity = 1.08 MGD
Waters Edge LS
Firm Capacity = 1.22 MGD
Bayes Center LS
Firm Capacity =0.89 MGD
Elkins Lake #1 Lift Station
Elkins Lake #2 Lift Station
Elkins Lake #3 LS
Firm Capacity = 0.86 MGD
Post Office LS
Firm Capacity = 1.22 MGD
Park Road #40 Lift Station
McDonald Creek LS
Firm Capacity = 1.44 MGD
Elkins Lake Dam Lift Station
Elkins Lake Equestrian Center LS
Firm Capacity = 0.22 MGD
Robinson Creek Wastewater Treatment Plant
Permitted Capacity
Average Daily Flow = 2.5 MGD
Peak Flow = 7.5 MGD
N.B. Davidson Wastewater Treatment Plant
Permitted Capacity
Average Daily Flow = 1.6 MGD
Peak Flow = 4 MGD
Huntsville State Park Lift Station
RC-01
RC-02
RC-03
RC-04
RC-05
AJ-08
AJ-09
AJ-10
AJ-11
AJ-12
NB-06
NB-07
SCALE IN FEET
0
2,000
4,000
FREESE AND NICHOLS
City of Huntsville
Created By Freese and Nichols, Inc.
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15.0 WASTEWATER CAPITAL IMPROVEMENTS PLAN

A capital improvements plan was developed for the City's wastewater system. These projects address deficiencies in the existing system's ability to convey wastewater flows and provide the required conveyance capacity to serve the projected residential and commercial growth through the 2041 planning period. Many of these projects also address condition issues based on the results of the wastewater system risk based assessment.

Wastewater projects currently under design by the City are not included in the CIP, and are shown in **orange** on **Figure 15-1**. All recommended infrastructure is sized to convey the projected 2041 peak wastewater flows (including I/I). It is recommended that these projects be constructed generally in the order listed; however, development or renewal patterns may make it necessary to construct some projects sooner than anticipated. Locations shown for new lines and other recommended improvements were generalized for hydraulic analyses. Specific alignments and sites will be determined as part of the design process. Wastewater infrastructure to be constructed by future development is indicated in **purple** on **Figure 15-1** and was correctly sized during the hydraulic analyses for the projected peak wastewater flows.

Capital costs were calculated for all recommended improvements and do not include individual service connections or subdivision lines. The costs are provided as estimates based on previous similar engineering experience in 2016 dollars and include an allowance for engineering, surveying, and contingencies. Costs do not include easements or land acquisition. The pipeline and manhole unit costs are given in **Table 15-1**.

Table 15-1: Pipeline and Manhole Unit Costs

Pipeline Diameter	Cost/Diam-in/LF
≥ 36-in	$ 9
≤ 33-in	$ 8
Manholes	**Cost/Manhole**
Standard 5-ft Diameter	$10,000
Each additional foot of depth	$500/foot

Table 15-2 summarizes the costs for each project by phase of the wastewater system capacity CIP. The wastewater system renewal and rehabilitation CIP summaries are also included in this section.

- **Table 15-3** summarizes the SSES Rehabilitation/Renewal CIP (discussed in **Section 11.0**)
- **Table 15-4** summarizes the Lift Station Rehabilitation CIP (discussed in **Section 12.0**)

Table 15-5 summarizes the recommendations for each lift station in the Huntsville wastewater system.

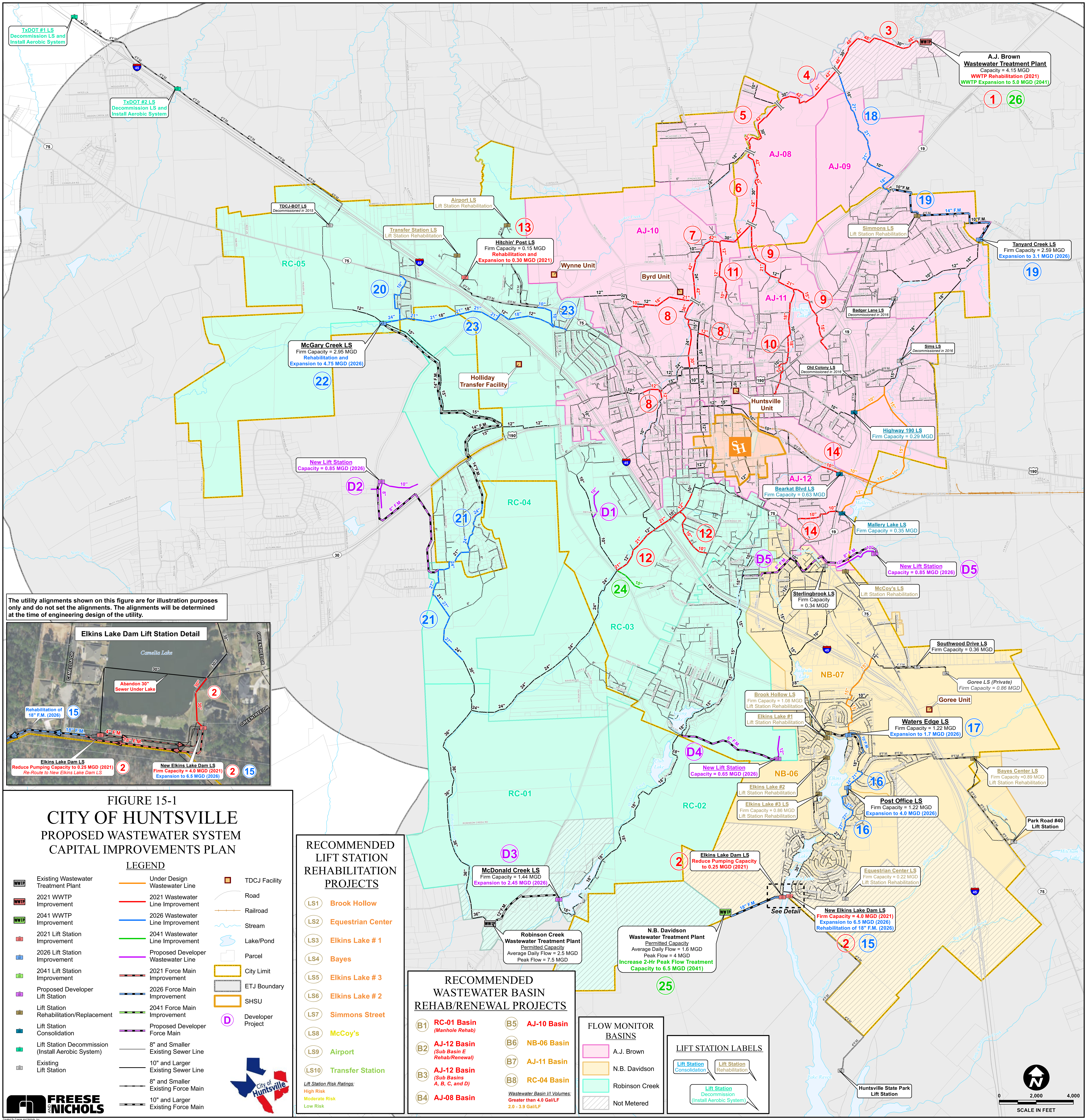

FIGURE 15-1
CITY OF HUNTSVILLE
PROPOSED WASTEWATER SYSTEM
CAPITAL IMPROVEMENTS PLAN

Table 15-2: Wastewater Capacity CIP Summary

Phase	Project Number	Project Description	Cost
2016 - 2021	1	Rehabilitation of A.J. Brown WWTP at 4.15 MGD Capacity	$ 23,470,380
	2	New Elkins Lake Dam Lift Station and Associated Improvements	$ 4,679,070
	3	Replace 30-inch with 48-inch Trunk Line to A.J. Brown WWTP	$ 4,017,370
	4	Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment A)	$ 3,616,110
	5	Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment B)	$ 3,149,970
	6	Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment C)	$ 3,598,770
	7	Replace 24-inch with 42-inch Gravity Line in the AJ-10 Basin	$ 5,986,280
	8	Replacement 10/12/15/18/21/30/36-inch Gravity Lines in the AJ-10 Basin	$ 3,331,360
	9	Replace 8/12-inch with 12/15/21-inch Gravity Lines in the AJ-11 Basin	$ 3,461,160
	10	Replace 8/10-inch with 12/18-inch Gravity Lines in the AJ-11 Basin	$ 2,178,820
	11	Replace 8-inch with 10/12-inch Gravity Lines in the AJ-10 Basin	$ 966,260
	12	Replace 8/10/12-inch with 10/12/21-inch Gravity Lines in the RC-03 Basin	$ 2,738,550
	13	Rehabilitate & Expand Hitchin' Post Lift Station from 0.15 to 0.30 MGD (Firm Capacity)	$ 247,220
	14	Replace 8-inch with 10-inch Gravity Lines in the AJ-12 Basin	$ 846,170
		Total 2016 - 2021	**$ 62,287,490**
2022 - 2026	15	Expansion of New Elkins Lake Dam LS to 6.5 MGD (Firm Capacity)	$ 593,820
	16	Expansion of Post Office LS to 4.0 MGD (Firm Capacity) & Replacement 21/24-inch Lines	$ 5,066,780
	17	Expansion of the Waters Edge LS to 1.7 MGD (Firm Capacity)	$ 1,199,740
	18	Replace 10-inch with 18/21-inch Gravity Lines in the AJ-09 Basin	$ 2,724,190
	29	Expansion of the Tanyard Creek LS to 3.1 MGD (Firm Capacity)	$ 3,099,140
	20	Replace 8-inch with 10-inch Gravity Lines in Brookview Subdivision	$ 1,053,980
	21	Replace 21/24-inch with 24/27-inch Gravity Lines in the RC-04 Basin	$ 4,470,800
	22	Rehabilitation & Expansion of the McGary Creek LS to 4.75 MGD (Firm Capacity)	$ 2,840,500
	23	Replace 8/12/18-inch with 12/21-inch Gravity Lines in the RC-05 Basin	$ 4,874,000
		Total 2022 - 2026	**$ 25,922,950**
2027 - 2041	24	Replace 8-inch with 10-inch Gravity Line in the RC-03 Basin	$ 301,400
	25	Expand N.B. Davidson 2-hr Peak Flow Treatment Capacity to 6.5 MGD	$ 448,500
	26	Expand A.J. Brown WWTP to 5.0 MGD	$ 7,475,000
		Total 2027 - 2041	**$ 8,224,900**
		Grand Total	**$ 96,435,340**

Table 15-3: Sewer Basin SSES Rehabilitation/Renewal CIP Summary

Project Number	Project Description	Cost
B1	RC-01 Basin (Manhole Rehabilitation)	$120,360
B2	AJ-12 Basin (Sub Basin E Manhole and Line Rehabilitation)	$312,000
B3	AJ-12 Basin Rehabilitation and Renewal (Sub Basins A, D, C, and B)	$1,433,790
B4	AJ-08 Basin Rehabilitation and Renewal	$1,664,870
B5	AJ-10 Basin Rehabilitation and Renewal	$1,945,550
B6	NB-06 Basin Rehabilitation and Renewal	$1,744,640
B7	AJ-11 Basin Rehabilitation and Renewal	$1,726,320
B8	RC-04 Basin Rehabilitation and Renewal	$1,657,310
	SSES Rehabilitation/Renewal Total	**$ 10,604,840**

Table 15-4: Lift Station Rehabilitation CIP Summary

Project Number	Project Description	Cost
LS 1	Brook Hollow (BH) Lift Station Rehabilitation	$ 545,060
LS 2	Elkins Lake Equestrian Center (EC) Lift Station Rehabilitation	$ 371,000
LS 3	Elkins Lake #1 (EL 1) Lift Station Rehabilitation	$ 369,040
LS 4	Bayes (BA) Lift Station Rehabilitation	$ 574,000
LS 5	Elkins Lake #3 (EL 3) Lift Station Rehabilitation	$ 417,000
LS 6	Elkins Lake #2 (EL 2) Lift Station Rehabilitation	$ 386,000
LS 7	Simmons Street (SS) Lift Station Rehabilitation	$ 284,000
LS 8	McCoy's (MC) Lift Station Rehabilitation	$ 233,870
LS 9	Airport (AP) Lift Station Rehabilitation	$ 225,830
LS 10	Transfer Station (TS) Lift Station Rehabilitation	$ 275,640
LS 11	Decommission TxDOT #1 Lift Station and Install Aerobic System	$ 290,160
LS 12	Decommission TxDOT #2 Lift Station and Install Aerobic System	$ 354,120
	Lift Station Rehabilitation Total	**$ 4,325,720**

Table 15-5: Summary of Lift Station Recommendations

	Lift Station Name	Recommendation	Phase	Notes
Robinson Creek	Airport	Rehabilitation		
Robinson Creek	Hitchin' Post	Expansion of Firm Capacity	2021	Identified by the City as needing Rehabilitation/Replacement
Robinson Creek	McGary Creek	Expansion of Firm Capacity	2026	
Robinson Creek	McDonald Creek	Expansion of Firm Capacity	Developer	
Robinson Creek	TDCJ-BOT	N/A - Decommissioned	*Completed*	*Completed in 2015; gravity flow to McGary Creek LS
Robinson Creek	Transfer Station	Rehabilitation		
Robinson Creek	TX-DOT #1	Installation of Aerobic System		
Robinson Creek	TX-DOT #2	Installation of Aerobic System		Identified by the City as needing Rehabilitation/Replacement
N.B. Davidson	Bayes	Rehabilitation		
N.B. Davidson	Brook Hollow	Rehabilitation		Identified by the City as needing Rehab/Replacement
N.B. Davidson	Elkins Lake #1	Rehabilitation		
N.B. Davidson	Elkins Lake #2	Rehabilitation		
N.B. Davidson	Elkins Lake #3	Rehabilitation		
N.B. Davidson	Elkins Lake Dam	Expansion of Firm Capacity	2021 / 2026	Relocation to east side of Camelia Lake
N.B. Davidson	Equestrian Center	Rehabilitation		
N.B. Davidson	Elkins Lake Post Office	Expansion of Firm Capacity	2026	
N.B. Davidson	Huntsville State Park	No Action Recommended		
N.B. Davidson	McCoy's	Rehabilitation		
N.B. Davidson	Park Road 40	No Action Recommended		
N.B. Davidson	Southwood Drive	No Action Recommended		
N.B. Davidson	Sterlingbrook	No Action Recommended		
N.B. Davidson	Waters Edge	Expansion of Firm Capacity	2026	
A.J. Brown	Badger Lane	N/A - Decommissioned	*Completed*	*Completed in 2016; gravity flow to Tanyard Creek LS
A.J. Brown	Bearkat	Consolidation		To be consolidated via the West Fork Tanyard Creek Sewer
A.J. Brown	Highway 190	Consolidation		To be consolidated via the West Fork Tanyard Creek Sewer
A.J. Brown	Mallery Lake	Consolidation		To be consolidated via the West Fork Tanyard Creek Sewer
A.J. Brown	Old Colony	N/A - Decommissioned	*Completed*	*Completed in 2016; gravity flow to Tanyard Creek LS
A.J. Brown	Simmons	Rehabilitation		
A.J. Brown	Sims (Lane)	N/A - Decommissioned	*Completed*	*Completed in 2016; gravity flow to Tanyard Creek LS
A.J. Brown	Tanyard	Expansion of Firm Capacity	2026	

Recommendation Color Code	Number of Lift Stations per Recommendation
No Action Recommended	4
Installation of Aerobic System	2
N/A - Decommissioned	4
Consolidation	3
Expansion	7
Rehabilitation	10
TOTAL	***30***

15.1 WASTEWATER PROJECTS FROM 2016 TO 2021

Project 1: Rehabilitation of A.J. Brown WWTP at 4.15 MGD Capacity

This project includes the rehabilitation of the A.J. Brown WWTP at the current rated capacity of 4.15 MGD. The risk based condition assessment of this plant resulted in several processes being classified as high and very high risk ratings. FNI recommends that the WWTP be rehabilitated to allow for reliable service. The wastewater flow projections show the need to expand the A.J. Brown WWTP in the future. This is recommended in the 2041 planning period **(Project 26)**.

Project 2: New Elkins Lake Dam Lift Station and Associated Improvements

This project includes the construction of a new 4.0 MGD Elkins Lake Dam Lift Station (expandable to 6.5 MGD) on the east side of Elkins Lake and the rehabilitation of the existing lift station, with a reduction of firm pumping capacity to 0.25 MGD. This project will decommission the problematic 30-inch gravity line that currently runs underneath Elkins Lake. Additionally, this project is recommended to alleviate existing pumping deficiencies at the Elkins Lake Dam Lift Station and allow for necessary upstream lift station expansions **(Projects 17** and **18)**.

Project 3: Replace 30-inch with 48-inch Trunk Line to A.J. Brown WWTP

This project includes the construction of a 48-inch replacement trunk line along Parker Creek to the A.J. Brown WWTP. The recommended lines are sized to serve future development in the A.J. Brown service area and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 4: Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment A)

This project includes the construction of Segment A of a 42-inch replacement trunk line in the AJ-08 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 5: Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment B)

This project includes the construction of Segment B of a 42-inch replacement trunk line in the AJ-08 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 6: Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment C)

This project includes the construction of Segment C of a 42-inch replacement trunk line in the AJ-08 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 7: Replace 24-inch with 42-inch Gravity Line in the AJ-10 Basin

This project includes the construction of a 42-inch replacement gravity line in the AJ-10 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 8: Replacement 10/12/15/18/21/30/36-inch Gravity Lines in the AJ-10 Basin

This project includes the construction of various replacement gravity lines in the AJ-10 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 9: Replace 8/12-inch with 12/15/21-inch Gravity Lines in the AJ-11 Basin

This project includes the construction of 12-inch, 15-inch, and 21-inch replacement gravity lines in the AJ-11 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 10: Replace 8/10-inch with 12/18-inch Gravity Lines in the AJ-11 Basin

This project includes the construction of 12-inch and 18-inch replacement gravity lines in the AJ-11 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 11: Replace 8-inch with 10/12-inch Gravity Lines in the AJ-10 Basin

This project includes the construction of 10-inch and 12-inch replacement gravity lines in the AJ-10 Basin. The recommended lines will alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 12: Replace 8/10/12-inch with 10/12/21-inch Gravity Lines in the RC-03 Basin

This project includes the construction of 10-inch, 12-inch, and 21-inch replacement gravity lines in the RC-03 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 13: Rehabilitate & Expand Hitchin' Post Lift Station from 0.15 to 0.30 MGD (Firm Capacity)

This project includes the rehabilitation of the Hitchin' Post Lift Station and the expansion of the firm pumping capacity from 0.15 MGD to 0.30 MGD. The recommended lift station rehabilitation addresses the condition related issues, and the recommended expansion is sized to convey the projected peak 2041 flows. The lift station condition assessment resulted in a poor condition score. The SCADA and hydraulic modeling show that this lift station's wet well is surcharging above the pipe under existing wastewater loads and design storm conditions.

Project 14: Replace 8-inch with 10-inch Gravity Lines in the AJ-12 Basin

This project includes the construction of 10-inch replacement gravity lines in the AJ-12 Basin. The recommended lines are sized to serve future development and convey peak wet weather wastewater flows from the Bearkat and Mallery Lake Lift Station service areas to the West Fork Tanyard Creek Sewer. The additional capacity provided by these replacement lines will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

15.2 WASTEWATER PROJECTS FROM 2022 TO 2026

Project 15: Expansion of New Elkins Lake Dam LS to 6.5 MGD (Firm Capacity)

This project includes the expansion of the firm capacity of the new Elkins Lake Dam lift station from 4.0 MGD to 6.5 MGD. This project also includes the rehabilitation of the 18-inch force main to the N.B.

Davidson WWTP. The expansion of the Post Office Lift Station **(Project 17)** will require an increase in firm pumping capacity at this lift station. The lift station wet well was sized for this recommended firm capacity of 6.5 MGD **(Project 2)**.

Project 16: Expansion of Post Office LS to 4.0 MGD (Firm Capacity) & Replacement 21/24-inch Lines

This project includes the expansion of the firm capacity of this lift station from 1.22 MGD to 4.0 MGD. Also included are replacement 21/24-inch gravity lines upstream and downstream of the lift station and a larger 16-inch force main. The existing total firm capacity of the three lift stations that pump into Post Office (Brook Hollow, Waters Edge, and Bayes Center) is 3.67 MGD. The flow monitoring data showed surcharging conditions at this lift station. The recommended increase in firm capacity is sized to convey the existing and future projected peak wastewater flows. The additional capacity provided by this lift station expansion and gravity line replacement will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 17: Expansion of the Waters Edge LS to 1.7 MGD (Firm Capacity)

This project includes the expansion of the firm capacity of the Waters Edge Lift Station from 1.22 MGD to 1.7 MGD. This project also includes a 10-inch force main to replace the existing 8-inch force main. The existing Waters Edge Lift Station does not have the capacity to receive the combined flows from the Goree LS (firm capacity = 0.86 MGD), Southwood Drive Lift Station (firm capacity = 0.36 MGD), and additional service area. The recommended expansion to the firm capacity will allow the Waters Edge Lift Station to serve the Goree Unit and the northern portion of the Elkins Lake Country Club. The additional capacity provided by this lift station expansion will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 18: Replace 10-inch with 18/21-inch Gravity Lines in the AJ-09 Basin

This project includes the construction of 18-inch and 21-inch replacement gravity lines in the AJ-09 Basin. The recommended lines are sized to convey projected peak 2041 wastewater flows from the West Fork Tanyard Creek project. This includes flows from the Mallery Lake, Bearkat, Highway 190, Old Colony, Sims, and Badger Lane Lift Stations that will be pumped through the Tanyard Creek Lift Station. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 19: Expansion of the Tanyard Creek LS to 3.1 MGD (Firm Capacity)

This project includes the expansion of the firm capacity of the Tanyard Creek Lift Station from 2.59 MGD to 3.1 MGD. This project also includes a 14-inch force main to replace the existing 10-inch force main. The West Fork Tanyard Creek trunk line will add the wastewater flows from six upstream lift stations (Mallery Lake, Bearkat, Highway 190, Old Colony, Sims, and Badger Lane) to the Tanyard Creek Lift Station. The recommended expansion to 3.1 MGD to sized to convey projected peak 2041 wastewater flows.

Project 20: Replace 8-inch with 10-inch Gravity Lines in Brookview Subdivision

This project includes the construction of 10-inch replacement gravity lines in the Brookview Subdivision. The recommended lines are sized to convey a portion of the future commercial development flow anticipated along Hwy 75. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by surcharging conditions within the calibrated model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 21: Replace 21/24-inch with 24/27-inch Gravity Lines in the RC-04 Basin

This project includes the construction of 24-inch and 27-inch replacement gravity lines in the RC-04 Basin. The expansion of the McGary Creek Lift Station **(Project 23)** will send additional flow through these gravity lines. The recommended lines are sized to convey projected peak 2041 wastewater flows from the RC-04 and RC-05 Basins. The additional capacity provided by these replacement lines will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 22: Rehabilitation & Expansion of the McGary Creek LS to 4.75 MGD (Firm Capacity)

This project includes the rehabilitation and expansion of the McGary Creek Lift Station from 2.95 MGD to 4.75 MGD. The existing capacity of 2.95 MGD reflects the total capacity of both wet wells at this lift station. The recommended lift station rehabilitation addresses the condition related issues and the recommended expansion is sized to convey the projected peak flows through the 2041 planning period. The lift station condition assessment resulted in a fair condition score. The hydraulic modeling and system analysis showed surcharging in the collection system east of IH-45. When these restrictions are alleviated

(Project 24), the calibrated hydraulic model shows that additional pumping capacity will be required at this lift station.

Project 23: Replace 8/12/18-inch with 12/21-inch Gravity Lines in the RC-05 Basin

This project includes the construction of 12-inch and 21-inch replacement gravity lines in the RC-05 Basin. The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by these replacement lines will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

15.3 WASTEWATER PROJECTS FROM 2027 TO 2041

Project 24: Replace 8-inch with 10-inch Gravity Line in the RC-03 Basin

This project includes the construction of 10-inch replacement gravity lines in the RC-03 Basin. This project increases the capacity of the existing wastewater line to serve projected development. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

Project 25: Expand N.B. Davidson WWTP 2-hr Peak Flow Treatment Capacity to 6.5 MGD

This project includes improvements to the N.B. Davidson WWTP to expand the 2-hr peak flow treatment capacity to 6.5 MGD. This project is required due to the increased firm capacity projected to be needed at the Elkins Lake Dam lift station. An increase in the 2-hr peak treatment capacity will prevent the collection system from surcharging during wet weather events and help the City maintain regulatory compliance.

Project 26: Expand A.J. Brown WWTP to 5.0 MGD Capacity

This project includes the expansion of the A.J. Brown WWTP from 4.15 MGD to 5.0 MGD. The wastewater flow projections show that the projected average day wastewater flow in the A.J. Brown service area is 3.9 MGD by 2041. It is recommended to expand the A.J. Brown WWTP in order to maintain the recommended WWTP capacity of approximately 80%.

APPENDIX A
Water System CIP Opinions of Probable Construction Cost

City of Huntsville

Water CIP Projects - 2021

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 1

Project Description

12/18/20/24-inch Montgomery Road Water Lines

Detailed Description

This project includes the construction of 12-inch, 18-inch, 20-inch, and 24-inch replacement water lines along Montgomery Road from the Palm Street Water Plant to the new Talltimbers Lane elevated storage tank (Project 2).

Purpose

This project is recommended to connect the Palm Street Water Plant to the new Talltimbers Lane elevated storage tank and replace aging water lines.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" D.I. W.L. & Appurt.	1,000	LF	$192	$192,000
2	20" D.I. W.L. & Appurt.	3,000	LF	$160	$480,000
3	18" D.I. W.L. & Appurt.	5,900	LF	$144	$849,600
4	12" C900 W.L. & Appurt.	900	LF	$96	$86,400
5	34" Boring and Casing	2,000	LF	$595	$1,190,000
6	Pavement Repair	8,800	LF	$50	$440,000
		SUBTOTAL:			$3,238,000
		CONTINGENCY		30%	$971,400
		SUBTOTAL:			$4,209,400
		ENG/SURVEY		15%	$631,500
		SUBTOTAL:			$4,840,900

PROJECT TOTAL **$4,840,900**

City of Huntsville

Water CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 2

Project Description

2 MG Elevated Storage Tank along Talltimbers Lane

Detailed Description

This project includes the construction of a new 2 MG elevated storage tank along Talltimbers Lane near Montgomery Road. This Upper Pressure Plane elevated storage tank is recommended to have an overflow elevation of 630 feet.

Purpose

This project is recommended to maintain water system pressure and increase elevated storage capacity in the Upper Pressure Plane.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	2 MG Elevated Storage Tank	1	LS	$3,402,000	$3,402,000
		SUBTOTAL:			$3,402,000
		CONTINGENCY		30%	$1,020,600
		SUBTOTAL:			$4,422,600
		ENG/SURVEY		15%	$663,400
		SUBTOTAL:			$5,086,000
PROJECT TOTAL					**$5,086,000**

City of Huntsville

Water CIP Projects - 2021

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 3

Project Description

New 7,500 gpm Palm Street Pump Station

Detailed Description

This project includes the construction of a new 7,500 gpm pump station at the Palm Street Water Plant. The existing pump stations are recommended to be decommissioned.

Purpose

This project is recommended to replace degrading pump stations at the Palm Street Water Plant and maintain water levels in the new Talltimbers Lane elevated storage tank.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	10.8 MGD Pump Station	1	LS	$2,000,000	$2,000,000
		SUBTOTAL:			$2,000,000
		CONTINGENCY		30%	$600,000
		SUBTOTAL:			$2,600,000
		ENG/SURVEY		15%	$390,000
		SUBTOTAL:			$2,990,000
PROJECT TOTAL					**$2,990,000**

City of Huntsville

Water CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 4

Project Description

12/20/24/30-inch Sycamore Avenue and SH 30 Water Lines

Detailed Description

This project includes the construction of 12-inch, 20-inch, 24-inch, and 30-inch new and replacement water lines along Sycamore Avenue and SH 30 from the new Lower Water Plant (Project 6) to the converted Palm Street elevated storage tank (Project 5).

Purpose

This project is recommended to connect the new Lower Pressure Plane Water Plant to the converted Palm Street elevated storage tank.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	30" D.I. W.L. & Appurt.	700	LF	$240	$168,000
2	24" D.I. W.L. & Appurt.	200	LF	$192	$38,400
3	20" D.I. W.L. & Appurt.	12,900	LF	$160	$2,064,000
4	12" C900 W.L. & Appurt.	1,100	LF	$96	$105,600
5	38" Boring and Casing	2,000	LF	$665	$1,330,000
6	Pavement Repair	12,900	LF	$50	$645,000
	SUBTOTAL:				$4,351,000
	CONTINGENCY			30%	$1,305,300
	SUBTOTAL:				$5,656,300
	ENG/SURVEY			15%	$848,500
	SUBTOTAL:				$6,504,800
	PROJECT TOTAL				**$6,504,800**

City of Huntsville

Water CIP Projects - 2021

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 5

Project Description

Repurpose 2 MG Palm Street EST to 1 MG Lower Pressure Plane EST

Detailed Description

This project includes the repurposing of the existing 2 MG Palm Street elevated storage tank to a 1 MG Lower Pressure Plane elevated storage tank with piping modifications and a new altitude valve set to an overflow elevation of 580 feet for the Lower Pressure Plane.

Purpose

This project is recommended to maintain water system pressure and provide elevated storage capacity in the Lower Pressure Plane.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Piping Modifications	1	LS	$100,000	$100,000
		SUBTOTAL:			$100,000
		CONTINGENCY		30%	$30,000
		SUBTOTAL:			$130,000
		ENG/SURVEY		15%	$19,500
		SUBTOTAL:			$149,500

PROJECT TOTAL **$149,500**

City of Huntsville

Water CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 6

Project Description

New 4,800 gpm Lower Pressure Plane Water Plant with 2 MG GST

Detailed Description

This project includes the construction of a new 4,800 gpm Lower Pressure Plane pump station with a 2 MG ground storage tank near the intersection of SH 30 and SH 19.

Purpose

This project is recommended to provide service pumping capacity in the Lower Pressure Plane, maintain water levels in the converted Palm Street elevated storage tank and provide second, reliable water plant for the City. The new water plant will receive water from the existing 30-inch Trinity River Authority water supply line.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6.8 MGD Pump Station	1	LS	$1,750,000	$1,750,000
2	2 MG Ground Storage Tank	1	LS	$1,500,000	$1,500,000
		SUBTOTAL:			$3,250,000
		CONTINGENCY		30%	$975,000
		SUBTOTAL:			$4,225,000
		ENG/SURVEY		15%	$633,800
		SUBTOTAL:			$4,858,800

PROJECT TOTAL **$4,858,800**

City of Huntsville

Water CIP Projects - 2021

FREESE AND NICHOLS

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 7

Project Description

New Pumps at the Spring Lake Water Plant

Detailed Description

This project includes the replacement of a 1,000 gpm and two 500 gpm pumps at the Spring Lake Water Plant.

Purpose

This project is recommended to replace aging pumps and maintain water levels in the new Talltimbers Lane elevated storage tank.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1,000 gpm Pump	1	EA	$45,000	$45,000
2	500 gpm Pump	2	EA	$30,000	$60,000

SUBTOTAL:		$105,000
CONTINGENCY	30%	$31,500
SUBTOTAL:		$136,500
ENG/SURVEY	15%	$20,500
SUBTOTAL:		$157,000

PROJECT TOTAL **$157,000**

City of Huntsville

Water CIP Projects - 2021

OPINION OF PROBABLE COST — July 15, 2016

Construction Project Number 8

Project Description

18-inch SH 75 South Water Lines Phase 1

Detailed Description

This project includes the construction of 18-inch replacement water lines along SH 75 South from the Palm Street Water Plant to Old Phelps Road.

Purpose

This project is recommended to reduce excessive headloss in existing water lines from the Palm Street Water Plant to the Goree Unit and Elkins Lake subdivision.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	18" D.I. W.L. & Appurt.	3,300	LF	$144	$475,200
2	Pavement Repair	3,300	LF	$50	$165,000
	SUBTOTAL:				$640,200
	CONTINGENCY			30%	$192,100
	SUBTOTAL:				$832,300
	ENG/SURVEY			15%	$124,900
	SUBTOTAL:				$957,200

PROJECT TOTAL **$957,200**

City of Huntsville

Water CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 9

Project Description

8-inch and 12-inch Elkins Lake Water Lines

Detailed Description

This project includes the construction of 8-inch and 12-inch replacement water lines along Cherry Hills Drive and Augusta Drive in the Elkins Lake subdivision.

Purpose

This project is recommended to reduce excessive headloss in existing water lines, improve water distribution capacity and replace aging water lines in the Elkins Lake subdivision.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" C900 W.L. & Appurt.	2,100	LF	$96	$201,600
2	8" C900 W.L. & Appurt.	300	LF	$64	$19,200
3	Pavement Repair	2,400	LF	$50	$120,000
		SUBTOTAL:			$340,800
		CONTINGENCY		30%	$102,300
		SUBTOTAL:			$443,100
		ENG/SURVEY		15%	$66,500
		SUBTOTAL:			$509,600
PROJECT TOTAL					**$509,600**

City of Huntsville

Water CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 10

Project Description

Transfer Customers along Avenue I to Upper Pressure Plane

Detailed Description

This project includes disconnecting existing water meters from the 8-inch Lower Pressure Plane water line and connecting them to the 12-inch Upper Pressure Plane water line along Avenue I between Bowers Boulevard and Sam Houston Avenue.

Purpose

This project is recommended to provide higher water pressure and available fire flow to existing customers along Avenue I.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SHSU Water Line Tap	21	LS	$10,000	$210,000

SUBTOTAL:		$210,000
CONTINGENCY	30%	$63,000
SUBTOTAL:		$273,000
ENG/SURVEY	15%	$41,000
SUBTOTAL:		$314,000

PROJECT TOTAL **$314,000**

City of Huntsville

Water CIP Projects - 2026

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 11

Project Description

12-inch Veterans Memorial Parkway Water Line

Detailed Description

This project includes the construction of new 12-inch water lines along Veterans Memorial Parkway from Woodward Drive to Montgomery Road to connect existing water lines.

Purpose

This project is recommended to eliminate dead end water lines, reduce headloss in existing water lines and improve available fire flow near the new Talltimbers Lane elevated storage tank.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" C900 W.L. & Appurt.	4,100	LF	$96	$393,600
2	Pavement Repair	4,100	LF	$50	$205,000
		SUBTOTAL:			$598,600
		CONTINGENCY		30%	$179,600
		SUBTOTAL:			$778,200
		ENG/SURVEY		15%	$116,800
		SUBTOTAL:			$895,000
PROJECT TOTAL					**$895,000**

City of Huntsville

Water CIP Projects - 2026

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 12

Project Description

16-inch Sam Houston Avenue Water Line

Detailed Description

This project includes the construction of 16-inch water lines to replace existing 10-inch and 12-inch water lines along Sam Houston Avenue from the Palm Street Water Plant to 22nd Street.

Purpose

This project is recommended to connect the Lower Pressure Plane to the converted Palm Street elevated storage tank and increase water distribution capacity in the Lower Pressure Plane.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" D.I. W.L. & Appurt.	4,300	LF	$128	$550,400
2	Pavement Repair	4,300	LF	$50	$215,000
		SUBTOTAL:			$765,400
		CONTINGENCY		30%	$229,700
		SUBTOTAL:			$995,100
		ENG/SURVEY		15%	$149,300
		SUBTOTAL:			$1,144,400
PROJECT TOTAL					**$1,144,400**

City of Huntsville

Water CIP Projects - 2026

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 13

Project Description

12-inch North SH 30 Water Line

Detailed Description

This project includes the construction of 12-inch water lines to replace existing 6-inch water lines along SH 30 from the Lower Pressure Plane Water Plant to Easley Circle.

Purpose

This project is recommended to reduce excessive headloss in existing water lines and replace aging water lines near the new Lower Pressure Plane water plant.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" C900 W.L. & Appurt.	2,100	LF	$96	$201,600
2	Pavement Repair	2,100	LF	$50	$105,000
		SUBTOTAL:			$306,600
		CONTINGENCY		30%	$92,000
		SUBTOTAL:			$398,600
		ENG/SURVEY		15%	$59,800
		SUBTOTAL:			$458,400
PROJECT TOTAL					**$458,400**

City of Huntsville

Water CIP Projects - 2026

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 14

Project Description

18-inch SH 75 South Water Lines Phase 2

Detailed Description

This project includes the construction of 18-inch water lines to replace existing 12-inch water lines along SH 75 South from Old Phelps Road to Southwood Drive.

Purpose

This project is recommended to reduce excessive headloss in existing water lines from the Palm Street Water Plant to the Goree Unit and Elkins Lake subdivision.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	18" D.I. W.L. & Appurt.	8,100	LF	$144	$1,166,400
2	Pavement Repair	8,100	LF	$50	$405,000
		SUBTOTAL:			$1,571,400
		CONTINGENCY		30%	$471,500
		SUBTOTAL:			$2,042,900
		ENG/SURVEY		15%	$306,500
		SUBTOTAL:			$2,349,400

PROJECT TOTAL **$2,349,400**

City of Huntsville

Water CIP Projects - 2026

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 15

Project Description

12-inch 9th Street and Avenue C Water Lines

Detailed Description

This project includes the construction of 12-inch water lines to replace existing 6-inch water lines along 9th Street and Avenue C.

Purpose

This project is recommended to reduce excessive headloss in existing water lines, increase water distribution capacity and replace aging water lines in the Lower Pressure Plane.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" C900 W.L. & Appurt.	2,600	LF	$96	$249,600
2	Pavement Repair	2,600	LF	$50	$130,000

SUBTOTAL:		$379,600
CONTINGENCY	30%	$113,900
SUBTOTAL:		$493,500
ENG/SURVEY	15%	$74,100
SUBTOTAL:		$567,600

PROJECT TOTAL **$567,600**

City of Huntsville

Water CIP Projects - 2026

OPINION OF PROBABLE COST | **July 15, 2016**

Construction Project Number 16

Project Description

12-inch IH 45 Water Line (19th Street to Crosstimbers Street)

Detailed Description

This project includes the construction of new 12-inch water lines along IH 45 from 19th Street to Crosstimbers Street.

Purpose

This project is recommended to connect existing water lines, reduce headloss in existing water lines and improve available fire flow.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" C900 W.L. & Appurt.	5,000	LF	$96	$480,000
2	Pavement Repair	5,000	LF	$50	$250,000
		SUBTOTAL:			$730,000
		CONTINGENCY		30%	$219,000
		SUBTOTAL:			$949,000
		ENG/SURVEY		15%	$142,400
		SUBTOTAL:			$1,091,400
PROJECT TOTAL					**$1,091,400**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 17

Project Description

1.5 MG Elevated Storage Tank at Palm Street

Detailed Description

This project includes the construction of a new 1.5 MG elevated storage tank at Palm Street. This Lower Pressure Plane elevated storage tank is recommended to have an overflow elevation of 575 feet.

Purpose

This project is recommended to replace the existing 2 MG elevated storage tank at Palm Street and increase elevated storage capacity in the Lower Pressure Plane.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1.5 MG Elevated Storage Tank	1	LS	$3,200,000	$3,200,000
			SUBTOTAL:		$3,200,000
			CONTINGENCY	30%	$960,000
			SUBTOTAL:		$4,160,000
			ENG/SURVEY	15%	$624,000
			SUBTOTAL:		$4,784,000

PROJECT TOTAL **$4,784,000**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 18

Project Description

2 MGD TRA Surface Water Treatment Plant Expansion

Detailed Description

This project includes the construction of a new 2 MGD clarifier at the Trinity River Authority Surface Water Treatment Plant and is contingent upon a water supply Alternative Capacity Requirement from TCEQ.

Purpose

This project is recommended to provide additional water supply capacity for the City to meet water demands through 2041.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	2 MGD TRA SWTP Clarifier	1	LS	$535,000	$535,000

SUBTOTAL:		$535,000
CONTINGENCY	30%	$160,500
SUBTOTAL:		$695,500
ENG/SURVEY	15%	$104,400
SUBTOTAL:		$799,900

PROJECT TOTAL **$799,900**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 19

Project Description

12-inch Bearkat Boulevard Water Line

Detailed Description

This project includes the construction of new 12-inch water lines along Bearkat Boulevard from Varsity Circle to SH 19.

Purpose

This project is recommended to connect existing water lines, reduce headloss in existing water lines and improve available fire flow east of Sam Houston State University.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" C900 W.L. & Appurt.	800	LF	$96	$76,800
2	24" Boring and Casing	800	LF	$420	$336,000
			SUBTOTAL:		$412,800
			CONTINGENCY	30%	$123,900
			SUBTOTAL:		$536,700
			ENG/SURVEY	15%	$80,600
			SUBTOTAL:		$617,300

PROJECT TOTAL **$617,300**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST — July 15, 2016

Construction Project Number 20

Project Description

6-inch Dahlia Road Water Line

Detailed Description

This project includes the construction of 6-inch replacement water lines along Dahlia Road.

Purpose

This project is recommended to reduce excessive headloss in existing water lines, replace aging water lines and increase available fire flow in the Timberwilde subdivision.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	7,800	LF	$48	$374,400
2	Pavement Repair	7,800	LF	$50	$390,000
	SUBTOTAL:				$764,400
	CONTINGENCY			30%	$229,400
	SUBTOTAL:				$993,800
	ENG/SURVEY			15%	$149,100
	SUBTOTAL:				$1,142,900

PROJECT TOTAL **$1,142,900**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 21

Project Description

8-inch and 6-inch FM 2821 Water Lines

Detailed Description

This project includes the construction of new 8-inch water lines from the end of American Legion Drive to the end of Quality Boulevard and new 6-inch water lines from the end of Quality Boulevard to FM 247.

Purpose

This project is recommended to connect dead end water lines and increase available fire flow in the north area of the City.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" C900 W.L. & Appurt.	1,600	LF	$64	$102,400
2	6" C900 W.L. & Appurt.	700	LF	$48	$33,600
3	Pavement Repair	2,300	LF	$50	$115,000
		SUBTOTAL:			$251,000
		CONTINGENCY		30%	$75,300
		SUBTOTAL:			$326,300
		ENG/SURVEY		15%	$49,000
		SUBTOTAL:			$375,300
PROJECT TOTAL					**$375,300**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 22

Project Description

6-inch Northeast SH 30 Water Lines

Detailed Description

This project includes the construction of new 6-inch water lines near Shady Lane, McLeod Drive and Johnson Road.

Purpose

This project is recommended to connect dead end water lines and increase available fire flow in the northeast area of the City.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	4,200	LF	$48	$201,600
2	Pavement Repair	4,200	LF	$50	$210,000
		SUBTOTAL:			$411,600
		CONTINGENCY		30%	$123,500
		SUBTOTAL:			$535,100
		ENG/SURVEY		15%	$80,300
		SUBTOTAL:			$615,400
PROJECT TOTAL					**$615,400**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 23

Project Description

8-inch Moffett Springs Road Water Line

Detailed Description

This project includes the construction of new 8-inch water lines along Moffat Springs Road.

Purpose

This project is recommended to connect dead end water lines and increase available fire flow in the northwest area of the City.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" C900 W.L. & Appurt.	5,300	LF	$64	$339,200
2	Pavement Repair	5,300	LF	$50	$265,000

SUBTOTAL:		$604,200
CONTINGENCY	30%	$181,300
SUBTOTAL:		$785,500
ENG/SURVEY	15%	$117,900
SUBTOTAL:		$903,400

PROJECT TOTAL **$903,400**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 24

Project Description

8-inch Goodrich Drive and Old Colony Road Water Lines

Detailed Description

This project includes the construction of 8-inch replacement water lines along Goodrich Drive and Old Colony Road.

Purpose

This project is recommended to reduce excessive headloss in existing water lines and replace aging water lines.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" C900 W.L. & Appurt.	2,600	LF	$64	$166,400
2	Pavement Repair	2,600	LF	$50	$130,000
		SUBTOTAL:			$296,400
		CONTINGENCY		30%	$89,000
		SUBTOTAL:			$385,400
		ENG/SURVEY		15%	$57,900
		SUBTOTAL:			$443,300
PROJECT TOTAL					**$443,300**

City of Huntsville

Water CIP Projects - 2041

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 25

Project Description

6-inch Spring Lake Water Lines

Detailed Description

This project includes the construction of new 6-inch water lines along Pine Hill Road and Majestic Drive.

Purpose

This project is recommended to connect dead end water lines and increase available fire flow in the Spring Lake neighborhood.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	1,900	LF	$48	$91,200
2	Pavement Repair	1,900	LF	$50	$95,000
		SUBTOTAL:			$186,200
		CONTINGENCY		30%	$55,900
		SUBTOTAL:			$242,100
		ENG/SURVEY		15%	$36,400
		SUBTOTAL:			$278,500

PROJECT TOTAL **$278,500**

City of Huntsville

Water CIP Projects - 2041

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 26

Project Description

8-inch Fraser Road Water Line

Detailed Description

This project includes the construction of new 8-inch water lines along Fraser Road.

Purpose

This project is recommended to connect dead end water lines and increase available fire flow.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" C900 W.L. & Appurt.	600	LF	$64	$38,400
2	Pavement Repair	600	LF	$50	$30,000
		SUBTOTAL:			$68,400
		CONTINGENCY		30%	$20,600
		SUBTOTAL:			$89,000
		ENG/SURVEY		15%	$13,400
		SUBTOTAL:			$102,400

PROJECT TOTAL **$102,400**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 1

Project Description

Old Colony Road/Trinity Cutoff Rehabilitation

Detailed Description

Replacement of existing 2-inch and 6-inch water lines in the area bounded by Riverside Drive to the North, Highway 19 to the East, Phelps Drive to the South, and Elm Avenue to the West.

Purpose

Replace small, deteriorating water lines to alleviate red water issues and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	8,300	LF	$48	$398,400
2	Pavement Repair	8,300	LF	$50	$415,000
		SUBTOTAL:			$813,400
		CONTINGENCY		30%	$244,100
		SUBTOTAL:			$1,057,500
		ENG/SURVEY		15%	$158,700
		SUBTOTAL:			$1,216,200

PROJECT TOTAL **$1,216,200**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 2

Project Description

Robinson Way/ 25th Street Rehabilitation

Detailed Description

Replacement of existing 6-inch and 12-inch water lines in the area bounded by 24th Street to the North, Avenue M to the East/South, and IH 45 to the West.

Purpose

Replace deteriorating water lines to reduce service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	1,900	LF	$48	$91,200
2	12" C900 W.L. & Appurt.	2,100	LF	$96	$201,600
3	Pavement Repair	4,000	LF	$50	$200,000
		SUBTOTAL:			$492,800
		CONTINGENCY		30%	$147,900
		SUBTOTAL:			$640,700
		ENG/SURVEY		15%	$96,200
		SUBTOTAL:			$736,900

PROJECT TOTAL **$736,900**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 3

Project Description

Mance Park Middle School Rehabilitation

Detailed Description

Replacement of existing 2-inch, 4-inch, 6-inch, 8-inch, and 12-inch water lines in the area bounded by 6th Street to the North, Martin Luther King Drive to the East, 10th Street to the South, and Avenue M to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	2,600	LF	$48	$124,800
2	8" C900 W.L. & Appurt.	900	LF	$64	$57,600
3	12" C900 W.L. & Appurt.	2,200	LF	$96.00	211,200
4	Pavement Repair	5,700	LF	$50.00	285,000
		SUBTOTAL:			$678,600
		CONTINGENCY		30%	$203,600
		SUBTOTAL:			$882,200
		ENG/SURVEY		15%	$132,400
		SUBTOTAL:			$1,014,600

PROJECT TOTAL **$1,014,600**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 4

Project Description

Boettcher Drive Rehabilitation

Detailed Description

Replacement of existing 2-inch and 6-inch water lines in the area bounded by Old Sam Houston Road to the North, Highway 19 to the East, North Freeway Service Road to the South, and Estella Stewart Elementary School to the West.

Purpose

Replace small, deteriorating water lines to alleviate red water issues and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	8,000	LF	$48	$384,000
2	Pavement Repair	8,000	LF	$50	$400,000
	SUBTOTAL:				$784,000
	CONTINGENCY			30%	$235,200
	SUBTOTAL:				$1,019,200
	ENG/SURVEY			15%	$152,900
	SUBTOTAL:				$1,172,100

PROJECT TOTAL **$1,172,100**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 5

Project Description

11th Street/Hickory Drive Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch and 12-inch water lines in the area bounded by Pine Shadows Drive to the North, Normal Park Drive to the East, 11th Street to the South, and Hickory Drive to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions and increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	8,100	LF	$48	$388,800
2	12" C900 W.L. & Appurt.	400	LF	$96	$38,400
3	Pavement Repair	8,500	LF	$50	$425,000
		SUBTOTAL:			$852,200
		CONTINGENCY		30%	$255,700
		SUBTOTAL:			$1,107,900
		ENG/SURVEY		15%	$166,200
		SUBTOTAL:			$1,274,100

PROJECT TOTAL **$1,274,100**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST — July 15, 2016

Construction Project Number 6

Project Description

Avenue I/Bobby K Marks Drive Rehabilitation

Detailed Description

Replacement of existing 2-inch, 3-inch, 4-inch, 6-inch, and 8-inch water lines in the area bounded by 16th Street to the North, Avenue H to the East, Bowers Boulevard to the South, and Avenue I to the West.

Purpose

Replace small, deteriorating water lines to increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	500	LF	$48	$24,000
2	8" C900 W.L. & Appurt.	7,000	LF	$64	$448,000
3	Pavement Repair	7,500	LF	$50	$375,000
		SUBTOTAL:			$847,000
		CONTINGENCY		30%	$254,100
		SUBTOTAL:			$1,101,100
		ENG/SURVEY		15%	$165,200
		SUBTOTAL:			$1,266,300

PROJECT TOTAL **$1,266,300**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 7

Project Description

Josey Street/11th Street Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch, 8-inch, and 12-inch water lines in the area bounded by Avenue H to the North, Montgomery Road to the East, Lakeridge Lane to the South, and Avenue M to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	3,200	LF	$48	$153,600
2	8" C900 W.L. & Appurt.	2,000	LF	$64	$128,000
3	12" C900 W.L. & Appurt.	1,600	LF	$96	$153,600
4	Pavement Repair	6,800	LF	$50	$340,000
		SUBTOTAL:			$775,200
		CONTINGENCY		30%	$232,600
		SUBTOTAL:			$1,007,800
		ENG/SURVEY		15%	$151,200
		SUBTOTAL:			$1,159,000

PROJECT TOTAL **$1,159,000**

City of Huntsville

Water Line Rehabilitation

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST — July 15, 2016

Construction Project Number 8

Project Description

Avenue O/17th Street Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch, 8-inch, and 12-inch water lines in the area bounded by 16th Street to the North, Sam Houston Avenue to the West, 20th Street to the South, and Avenue O to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	5,700	LF	$48	$273,600
2	8" C900 W.L. & Appurt.	1,300	LF	$64	$83,200
3	12" C900 W.L. & Appurt.	800	LF	$96	$76,800
4	Pavement Repair	7,800	LF	$50	$390,000
		SUBTOTAL:			$823,600
		CONTINGENCY		30%	$247,100
		SUBTOTAL:			$1,070,700
		ENG/SURVEY		15%	$160,700
		SUBTOTAL:			$1,231,400

PROJECT TOTAL **$1,231,400**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 9

Project Description

FM 2821/Martin Luther King Drive Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch, 8-inch, and 12-inch water lines in the area bounded by FM 2821 to the North, Hornet Way to the East, Essex Boulevard to the South, and Martin Luther King Drive to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	600	LF	$48	$28,800
2	8" C900 W.L. & Appurt.	300	LF	$64	$19,200
3	12" C900 W.L. & Appurt.	4,700	LF	$96	$451,200
4	Pavement Repair	5,600	LF	$50	$280,000
		SUBTOTAL:			$779,200
		CONTINGENCY		30%	$233,800
		SUBTOTAL:			$1,013,000
		ENG/SURVEY		15%	$152,000
		SUBTOTAL:			$1,165,000

PROJECT TOTAL **$1,165,000**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 10

Project Description

Avenue J/21th Street/22nd Street Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch, 8-inch, and 12-inch water lines in the area bounded by Bowers Boulevard to the North, Avenue I to the East, Josey Street to the South, and Avenue P to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	2,600	LF	$48	$124,800
2	8" C900 W.L. & Appurt.	300	LF	$64	$19,200
3	12" C900 W.L. & Appurt.	3,400	LF	$96	$326,400
4	Pavement Repair	6,300	LF	$50	$315,000
	SUBTOTAL:				$785,400
	CONTINGENCY			30%	$235,700
	SUBTOTAL:				$1,021,100
	ENG/SURVEY			15%	$153,200
	SUBTOTAL:				$1,174,300
	PROJECT TOTAL				**$1,174,300**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 11

Project Description

Pine Shadows Rehabilitation

Detailed Description

Replacement of existing 2-inch and 6-inch water lines in the area bounded by Autumn Road to the North, Spring Drive to the East, Knob Oaks Drive to the South, and Montgomery Road to the West.

Purpose

Replace small, deteriorating water lines to alleviate red water issues and increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	8,000	LF	$48	$384,000
2	Pavement Repair	8,000	LF	$50	$400,000
	SUBTOTAL:				$784,000
	CONTINGENCY			30%	$235,200
	SUBTOTAL:				$1,019,200
	ENG/SURVEY			15%	$152,900
	SUBTOTAL:				$1,172,100
PROJECT TOTAL					**$1,172,100**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 12

Project Description

Smith Hill Road/Mary Avenue Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch and 8-inch water lines in the area bounded by FM 2821 to the North, Eastham Thomason Park to the West, 7th Street to the South, and Gospel Hill Road to the West.

Purpose

Replace small, deteriorating water lines to increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	4,300	LF	$48	$206,400
2	8" C900 W.L. & Appurt.	100	LF	$64	$6,400
3	Pavement Repair	4,400	LF	$50	$220,000
		SUBTOTAL:			$432,800
		CONTINGENCY		30%	$129,900
		SUBTOTAL:			$562,700
		ENG/SURVEY		15%	$84,500
		SUBTOTAL:			$647,200

PROJECT TOTAL **$647,200**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 13

Project Description

Elkins Lake: Augusta Drive/Greenbriar Drive Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch and 8-inch water lines in the area bounded by Cherry Hills Drive to the North, IH 45 to the East, Greenbriar Drive to the South and Elkins Lake to the West.

Purpose

Replace small, deteriorating water lines to alleviate red water issues and increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	1,500	LF	$48	$72,000
2	8" C900 W.L. & Appurt.	5,900	LF	$64	$377,600
3	Pavement Repair	7,400	LF	$50	$370,000
		SUBTOTAL:			$819,600
		CONTINGENCY		30%	$245,900
		SUBTOTAL:			$1,065,500
		ENG/SURVEY		15%	$159,900
		SUBTOTAL:			$1,225,400

PROJECT TOTAL **$1,225,400**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 14

Project Description

Bearkat Village Apartments Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch, 8-inch, 10-inch, and 12-inch water lines in the area bounded by Bowers Boulevard to the North, Montgomery Road to the East, South Sam Houston Avenue to the South, and Avenue H to the West.

Purpose

Replace small, deteriorating water lines to increase fire flow and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	1,300	LF	$48	$62,400
2	8" C900 W.L. & Appurt.	400	LF	$64	$25,600
3	10" C900 W.L. & Appurt.	800	LF	$80	$64,000
4	12" C900 W.L. & Appurt.	3,600	LF	$96	$345,600
5	Pavement Repair	6,100	LF	$50.00	305,000
	SUBTOTAL:				$802,600
	CONTINGENCY			30%	$240,800
	SUBTOTAL:				$1,043,400
	ENG/SURVEY			15%	$156,600
	SUBTOTAL:				$1,200,000

PROJECT TOTAL **$1,200,000**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 15

Project Description

Highland Townhomes Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch, 8-inch, and 12-inch water lines in the area bounded by 11th Street to the North, Avenue Q to the East, 22nd Street to the South, and IH 45 to the West.

Purpose

Replace small, deteriorating water lines to avoid service interruptions and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	4,300	LF	$48	$206,400
2	8" C900 W.L. & Appurt.	400	LF	$64	$25,600
3	12" C900 W.L. & Appurt.	2,400	LF	$96	$230,400
4	Pavement Repair	7,100	LF	$50	$355,000
		SUBTOTAL:			$817,400
		CONTINGENCY		30%	$245,300
		SUBTOTAL:			$1,062,700
		ENG/SURVEY		15%	$159,500
		SUBTOTAL:			$1,222,200
PROJECT TOTAL					**$1,222,200**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 16

Project Description

Spring Lake: Spring Drive/January Lane Rehabilitation

Detailed Description

Replacement of existing 2-inch and 6-inch water lines in the area bounded by Veterans Memorial Parkway to the North, Daisy Lane to the East, Huntsville City Limits to the South, and Montgomery Road to the West.

Purpose

Replace deteriorating water lines to reduce service interruptions and increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	6,400	LF	$48	$307,200
2	Pavement Repair	6,400	LF	$50	$320,000
		SUBTOTAL:			$627,200
		CONTINGENCY		30%	$188,200
		SUBTOTAL:			$815,400
		ENG/SURVEY		15%	$122,400
		SUBTOTAL:			$937,800
PROJECT TOTAL					**$937,800**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 17

Project Description

Elkins Lake: Greentree Drive/Greenbriar Drive Rehabilitation

Detailed Description

Replacement of existing 4-inch, 8-inch and 12-inch water lines in the area bounded by River Oaks Drive to the North, Greenbriar Drive to the East, Greentree Drive to the South, and Azalea Lake/Camelia Lake to the West.

Purpose

Replace small, deteriorating water lines to reduce service interruptions, increase fire flow and increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	1,600	LF	$48	$76,800
2	8" C900 W.L. & Appurt.	2,100	LF	$64	$134,400
3	12" C900 W.L. & Appurt.	2,500	LF	$96	$240,000
4	Pavement Repair	6,200	LF	$50	$310,000
		SUBTOTAL:			$761,200
		CONTINGENCY		30%	$228,400
		SUBTOTAL:			$989,600
		ENG/SURVEY		15%	$148,500
		SUBTOTAL:			$1,138,100
PROJECT TOTAL					**$1,138,100**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 18

Project Description

Thomason Street/Birmingham Street/Avenue J Rehabilitation

Detailed Description

Replacement of existing 2-inch and 6-inch water lines in the area bounded by Essex Boulevard to the North, Martin Luther King Drive to the East, Thomason Street to the South, and University Avenue to the West.

Purpose

Replace small, deteriorating water lines to alleviate red water issues, increase fire flow and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	5,100	LF	$48	$244,800
2	Pavement Repair	5,100	LF	$50	$255,000
	SUBTOTAL:				$499,800
	CONTINGENCY			30%	$150,000
	SUBTOTAL:				$649,800
	ENG/SURVEY			15%	$97,500
	SUBTOTAL:				$747,300

PROJECT TOTAL **$747,300**

City of Huntsville

Water Line Rehabilitation

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 19

Project Description

Elkins Lake: Fairway Drive/Foxbriar Drive Rehabilitation

Detailed Description

Replacement of existing 4-inch, 6-inch and 8-inch water lines in the area bounded by River Oaks Drive to the North, Greenbriar Drive to the East, Greentree Drive to the South, and Camelia Lake to the West.

Purpose

Replace small, deteriorating water lines to alleviate red water issues, increase fire flow and increase capacity in critical areas.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	4,500	LF	$48	$216,000
2	8" C900 W.L. & Appurt.	3,100	LF	$64	$198,400
3	Pavement Repair	7,600	LF	$50	$380,000
		SUBTOTAL:			$794,400
		CONTINGENCY		30%	$238,400
		SUBTOTAL:			$1,032,800
		ENG/SURVEY		15%	$155,000
		SUBTOTAL:			$1,187,800

PROJECT TOTAL **$1,187,800**

City of Huntsville

Water Line Rehabilitation

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 20

Project Description

Cline Street/Hayman Street Rehabilitation

Detailed Description

Replacement of existing 2-inch, 6-inch and 8-inch water lines in the area bounded by Cline Street to the North, Old Houston Road to the East, Powell Street to the South, and Montgomery Road to the West.

Purpose

Replace small, deteriorating water lines reduce service interruptions, to alleviate red water issues, increase fire flow, and increase capacity.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" C900 W.L. & Appurt.	8,100	LF	$48	$388,800
2	8" C900 W.L. & Appurt.	800	LF	$64	$51,200
3	Pavement Repair	8,900	LF	$50	$445,000
		SUBTOTAL:			$885,000
		CONTINGENCY		30%	$265,500
		SUBTOTAL:			$1,150,500
		ENG/SURVEY		15%	$172,600
		SUBTOTAL:			$1,323,100

PROJECT TOTAL **$1,323,100**

APPENDIX B
Wastewater System CIP Opinions of Probable Construction Cost

City of Huntsville

Wastewater CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 1

Project Description

Rehabilitation of A.J. Brown WWTP at 4.15 MGD Capacity

Detailed Description

This project includes the rehabilitation of the A.J. Brown WWTP at the current rated capacity of 4.15 MGD.

Purpose

The risk based condition assessment of this plant resulted in several processes being classified as high and very high risk ratings. FNI recommends that the WWTP be rehabilitated to allow for reliable service. The wastewater flow projections show the need to expand the A.J. Brown WWTP in the future. This is recommended in the 2041 planning period (Project 26).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	New Pump Station and New MCCs	1	LS	$2,644,615	$2,644,615
2	New Conventional Aeration Basins	1	LS	$5,638,462	$5,638,462
3	Two (2) new Clarifiers	1	LS	$2,172,308	$2,172,308
4	New Aerobic Digesters	1	LS	$1,438,462	$1,438,462
5	New NPW pumps and Hydropneumatic tank	1	LS	$162,308	$162,308
6	Two (2) Screw Presses	1	LS	$1,405,385	$1,405,385
7	New second mechanical screen, Slide gates	1	LS	$650,000	$650,000
8	New gravity vortex grit removal system	1	LS	$1,023,846	$1,023,846
9	New chlorine building; One (1) new gas chlorinator	1	LS	$513,077	$513,077
10	Curtain baffles and scum baffles, and new CC basin	1	LS	$45,385	$45,385
11	New exhaust fan, and One (1) new gas de-chlorinator	1	LS	$5,385	$5,385
		SUBTOTAL:			$15,699,240
		CONTINGENCY		30%	$4,709,780
		SUBTOTAL:			$20,409,020
		ENG/SURVEY		15%	$3,061,360
		SUBTOTAL:			$23,470,380

PROJECT TOTAL **$23,470,380**

City of Huntsville

Wastewater CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST | **July 15, 2016**

Construction Project Number 2

Project Description

New Elkins Lake Dam Lift Station and Associated Improvements

Detailed Description

This project includes the construction of a new 4.0 MGD Elkins Lake Dam Lift Station (expandable to 6.5 MGD) on the east side of Elkins Lake and the rehabilitation of the existing lift station, with a reduction of firm pumping capacity to 0.25 MGD.

Purpose

This project will decommission the problematic 30-inch gravity line that currently runs underneath Elkins Lake. Additionally, this project is recommended to alleviate existing pumping deficiencies at the Elkins Lake Dam Lift Station and allow for necessary upstream lift station expansions (Projects 17 and 18).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Existing LS Rehab and Reduction to 0.25 MGD	1	EA	$351,000	$351,000
2	New 4.0 MGD Lift Station (Expandable to 6.5 MGD)	1	EA	$2,187,000	$2,187,000
3	Force Mains and Gravity Sewer	1	EA	$717,000	$717,000
	SUBTOTAL:				$3,255,000
	CONTINGENCY			25%	$813,750
	SUBTOTAL:				$4,068,750
	ENG/SURVEY			15%	$610,320
	SUBTOTAL:				$4,679,070

PROJECT TOTAL **$4,679,070**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 3

Project Description

Replace 30-inch with 48-inch Trunk Line to A.J. Brown WWTP

Detailed Description

This project includes the construction of a 48-inch replacement trunk line along Parker Creek to the A.J. Brown WWTP.

Purpose

The recommended lines are sized to serve future development in the A.J. Brown service area and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	48" Pipe < 12 feet deep	5,850	LF	$432	$2,527,200
2	60" Diameter Manhole (8' Depth)	16	EA	$10,000	$160,000
		SUBTOTAL:			$2,687,200
		CONTINGENCY		30%	$806,160
		SUBTOTAL:			$3,493,360
		ENG/SURVEY		15%	$524,010
		SUBTOTAL:			$4,017,370
PROJECT TOTAL					**$4,017,370**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 4

Project Description

Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment A)

Detailed Description

This project includes the construction of Segment A of a 42-inch replacement trunk line in the AJ-08 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	42" Pipe 12 - 20 feet deep	4,450	LF	$504	$2,242,800
2	60" Diameter Manhole (14' Depth)	11	EA	$16,000	$176,000
		SUBTOTAL:			$2,418,800
		CONTINGENCY		30%	$725,640
		SUBTOTAL:			$3,144,440
		ENG/SURVEY		15%	$471,670
		SUBTOTAL:			$3,616,110

PROJECT TOTAL **$3,616,110**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST — July 15, 2016

Construction Project Number 5

Project Description

Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment B)

Detailed Description

This project includes the construction of Segment B of a 42-inch replacement trunk line in the AJ-08 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	42" Pipe 12 - 20 feet deep	3,750	LF	$504	$1,890,000
2	60" Diameter Manhole (13' Depth)	14	EA	$15,500	$217,000

SUBTOTAL:		$2,107,000
CONTINGENCY	30%	$632,100
SUBTOTAL:		$2,739,100
ENG/SURVEY	15%	$410,870
SUBTOTAL:		$3,149,970

PROJECT TOTAL **$3,149,970**

City of Huntsville

Wastewater CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 6

Project Description

Replace 30-inch with 42-inch Trunk Line in the AJ-08 Basin (Segment C)

Detailed Description

This project includes the construction of Segment C of a 42-inch replacement trunk line in the AJ-08 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	42" Pipe 12 - 20 feet deep	4,300	LF	$504	$2,167,200
2	60" Diameter Manhole (14' Depth)	15	EA	$16,000	$240,000
		SUBTOTAL:			$2,407,200
		CONTINGENCY		30%	$722,160
		SUBTOTAL:			$3,129,360
		ENG/SURVEY		15%	$469,410
		SUBTOTAL:			$3,598,770
PROJECT TOTAL					**$3,598,770**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 7

Project Description

Replace 24-inch with 42-inch Gravity Line in the AJ-10 Basin

Detailed Description

This project includes the construction of a 42-inch replacement gravity line in the AJ-10 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	42" Pipe 12 - 20 feet deep	6,300	LF	$504	$3,175,200
2	60" Diameter Manhole (13' Depth)	23	EA	$15,500	$356,500
3	54" Boring and Casing	500	LF	$945.00	$472,500
	SUBTOTAL:				$4,004,200
	CONTINGENCY			30%	$1,201,260
	SUBTOTAL:				$5,205,460
	ENG/SURVEY			15%	$780,820
	SUBTOTAL:				$5,986,280

PROJECT TOTAL **$5,986,280**

City of Huntsville

Wastewater CIP Projects - 2021

FREESE AND NICHOLS

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 8

Project Description

Replacement 10/12/15/18/21/30/36-inch Gravity Lines in the AJ-10 Basin

Detailed Description

This project includes the construction of various replacement gravity lines in the AJ-10 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	10" Pipe < 12 feet deep	750	LF	$80	$60,000
2	12" Pipe < 12 feet deep	2,280	LF	$96	$218,880
3	15" Pipe < 12 feet deep	150	LF	$120	$18,000
4	18" Pipe < 12 feet deep	2,050	LF	$144	$295,200
5	21" Pipe < 12 feet deep	850	LF	$168	$142,800
6	30" Pipe < 12 feet deep	2,650	LF	$240	$636,000
7	36" Pipe < 12 feet deep	1,300	LF	$324	$421,200
8	48" Diameter Manhole (9' Depth)	11	EA	$7,750	$85,250
9	60" Diameter Manhole (9' Depth)	26	EA	$13,500	$351,000
		SUBTOTAL:			$2,228,330
		CONTINGENCY		30%	$668,500
		SUBTOTAL:			$2,896,830
		ENG/SURVEY		15%	$434,530
		SUBTOTAL:			$3,331,360

PROJECT TOTAL **$3,331,360**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 9

Project Description

Replace 8/12-inch with 12/15/21-inch Gravity Lines in the AJ-11 Basin

Detailed Description

This project includes the construction of 12-inch, 15-inch, and 21-inch replacement gravity lines in the AJ-11 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as evidenced by surcharged conditions during flow monitoring. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Pipe < 12 feet deep	850	LF	$96	$81,600
2	15" Pipe < 12 feet deep	3,450	LF	$120	$414,000
3	21" Pipe < 12 feet deep	4,850	LF	$168	$814,800
4	48" Diameter Manhole (11' Depth)	4	EA	$8,250	$33,000
5	60" Diameter Manhole (11' Depth)	29	EA	$14,500	$420,500
6	24" Boring and Casing	250	LF	$420	$105,000
7	34" Boring and Casing	750	LF	$595	$446,250
		SUBTOTAL:			$2,315,150
		CONTINGENCY		30%	$694,550
		SUBTOTAL:			$3,009,700
		ENG/SURVEY		15%	$451,460
		SUBTOTAL:			$3,461,160

PROJECT TOTAL **$3,461,160**

City of Huntsville

Wastewater CIP Projects - 2021

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 10

Project Description

Replace 8/10-inch with 12/18-inch Gravity Lines in the AJ-11 Basin

Detailed Description

This project includes the construction of 12-inch and 18-inch replacement gravity lines in the AJ-11 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Pipe < 12 feet deep	2,300	LF	$96	$220,800
2	18" Pipe < 12 feet deep	4,400	LF	$144	$633,600
3	48" Diameter Manhole (11' Depth)	16	EA	$8,250	$132,000
4	60" Diameter Manhole (11' Depth)	18	EA	$14,500	$261,000
5	24" Boring and Casing	500	LF	$420	$210,000
		SUBTOTAL:			$1,457,400
		CONTINGENCY		30%	$437,220
		SUBTOTAL:			$1,894,620
		ENG/SURVEY		15%	$284,200
		SUBTOTAL:			$2,178,820

PROJECT TOTAL **$2,178,820**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 11

Project Description

Replace 8-inch with 10/12-inch Gravity Lines in the AJ-10 Basin

Detailed Description

This project includes the construction of 10-inch and 12-inch replacement gravity lines in the AJ-10 Basin.

Purpose

The recommended lines will alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	10" Pipe < 12 feet deep	1,850	LF	$80	$148,000
2	12" Pipe < 12 feet deep	1,920	LF	$96	$184,320
3	48" Diameter Manhole (10' Depth)	13	EA	$8,000	$104,000
4	24" Boring and Casing	500	LF	$420	$210,000
		SUBTOTAL:			$646,320
		CONTINGENCY		30%	$193,900
		SUBTOTAL:			$840,220
		ENG/SURVEY		15%	$126,040
		SUBTOTAL:			$966,260

PROJECT TOTAL **$966,260**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 12

Project Description

Replace 8/10/12-inch with 10/12/21-inch Gravity Lines in the RC-03 Basin

Detailed Description

This project includes the construction of 10-inch, 12-inch, and 21-inch replacement gravity lines in the RC-03 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53)

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	10" Pipe < 12 feet deep	3,200	LF	$80	$256,000
2	12" Pipe < 12 feet deep	1,300	LF	$96	$124,800
3	21" Pipe < 12 feet deep	4,750	LF	$168	$798,000
4	48" Diameter Manhole (9' Depth)	18	EA	$7,750	$139,500
5	60" Diameter Manhole (9' Depth)	16	EA	$13,500	$216,000
6	34" Boring and Casing	500	LF	$595	$297,500
		SUBTOTAL:			$1,831,800
		CONTINGENCY		30%	$549,540
		SUBTOTAL:			$2,381,340
		ENG/SURVEY		15%	$357,210
		SUBTOTAL:			$2,738,550

PROJECT TOTAL **$2,738,550**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 13

Project Description

Rehab & Expand Hitchin' Post Lift Station from 0.15 to 0.30 MGD (Firm Capacity)

Detailed Description

This project includes the rehabilitation of the Hitchin' Post Lift Station and the expansion of the firm pumping capacity from 0.15 MGD to 0.30 MGD.

Purpose

The recommended lift station rehabilitation addresses the condition related issues, and the recommended expansion is sized to convey the projected peak 2041 flows. The lift station condition assessment resulted in a poor condition score. The SCADA and hydraulic modeling show that this lift station's wet well is surcharging above the pipe under existing wastewater loads and design storm conditions.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization	1	EA	$3,360	$3,360
2	Electrical - MCC, Back-up Power, Cables	1	LS	$50,000	$50,000
3	Pumps and Motors (Expansion to 0.30 MGD)	1	LS	$25,000	$25,000
4	Instrumentation - SCADA, alarms	1	LS	$5,000	$5,000
5	Structure - Hatches, Corrosion, Cracks, Leaking, Ventil	1	LS	$25,000	$25,000
6	Piping and Valves	1	LS	$10,000	$10,000
7	Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$15,000	$15,000
8	Bypass Pumping	1	LS	$20,000	$20,000
9	Wet Well Coating	400	SF	$30	$12,000
		SUBTOTAL:			$165,360
		CONTINGENCY		30%	$49,610
		SUBTOTAL:			$214,970
		ENG/SURVEY		15%	$32,250
		SUBTOTAL:			$247,220

PROJECT TOTAL **$247,220**

City of Huntsville

Wastewater CIP Projects - 2021

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number 14

Project Description

Replace 8-inch with 10-inch Gravity Lines in the AJ-12 Basin

Detailed Description

This project includes the construction of 10-inch replacement gravity lines in the AJ-12 Basin.

Purpose

The recommended lines are sized to serve future development and convey peak wet weather wastewater flows from the Bearkat and Mallery Lake Lift Station service areas to the West Fork Tanyard Creek Sewer. The additional capacity provided by these replacement lines will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	10" Pipe < 12 feet deep	3,700	LF	$80	$296,000
2	48" Diameter Manhole (11' Depth)	20	EA	$8,250	$165,000
3	24" Boring and Casing	250	LF	$420	$105,000
	SUBTOTAL:				$566,000
	CONTINGENCY			30%	$169,800
	SUBTOTAL:				$735,800
	ENG/SURVEY			15%	$110,370
	SUBTOTAL:				$846,170

PROJECT TOTAL **$846,170**

City of Huntsville

Wastewater CIP Projects - 2026

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 15

Project Description

Expansion of New Elkins Lake Dam LS to 6.5 MGD (Firm Capacity)

Detailed Description

This project includes the expansion of the firm capacity of the new Elkins Lake Dam lift station from 4.0 MGD to 6.5 MGD. This project also includes the rehabilitation of the 18-inch force main to the N.B. Davidson WWTP.

Purpose

The expansion of the Post Office Lift Station (Project 17) will require an increase in firm pumping capacity at this lift station. The lift station wet well was sized for this recommended firm capacity of 6.5 MGD (Project 2).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pump & Motor Replacement (expand firm capacity)	2	EA	$25,000	$50,000
2	16" Force Main	3,100	LF	$112	$347,200

SUBTOTAL:		$397,200
CONTINGENCY	30%	$119,160
SUBTOTAL:		$516,360
ENG/SURVEY	15%	$77,460
SUBTOTAL:		$593,820

PROJECT TOTAL **$593,820**

City of Huntsville

Wastewater CIP Projects - 2026

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST — **July 15, 2016**

Construction Project Number 16

Project Description

Expansion of Post Office LS to 4.0 MGD (Firm Capacity) & 21/24-inch Lines

Detailed Description

This project includes the expansion of the firm capacity of this lift station from 1.22 MGD to 4.0 MGD. Also included are replacement 21/24-inch gravity lines upstream and downstream of the lift station and a larger 16-inch force main.

Purpose

The existing total firm capacity of the three lift stations that pump into Post Office (Brook Hollow, Waters Edge, and Bayes Center) is 3.67 MGD. The flow monitoring data showed surcharging conditions at this lift station. The recommended increase in firm capacity is sized to convey the existing and future projected peak wastewater flows. The additional capacity provided by this lift station expansion and gravity line replacement will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4.0 MGD Lift Station Expansion	1	EA	$1,600,000	$1,600,000
2	16" Force Main	420	LF	$112	$47,040
3	21" Pipe 12 - 20 feet deep	1,200	LF	$252	$302,400
4	24" Pipe 12 - 20 feet deep	300	LF	$288	$86,400
5	27" Pipe 12 - 20 feet deep	2,700	LF	$324	$874,800
6	60" Diameter Manhole (15' Depth)	29	EA	$16,500	$478,500
		SUBTOTAL:			$3,389,140
		CONTINGENCY		30%	$1,016,750
		SUBTOTAL:			$4,405,890
		ENG/SURVEY		15%	$660,890
		SUBTOTAL:			$5,066,780

PROJECT TOTAL **$5,066,780**

City of Huntsville

Wastewater CIP Projects - 2026

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 17

Project Description

Expansion of the Waters Edge LS to 1.7 MGD (Firm Capacity)

Detailed Description

This project includes the expansion of the firm capacity of the Waters Edge Lift Station from 1.22 MGD to 1.7 MGD. This project also includes a 10-inch force main to replace the existing 8-inch force main.

Purpose

The existing Waters Edge Lift Station does not have the capacity to receive the combined flows from the Goree LS (Firm Capacity = 0.86 MGD), Southwood Drive Lift Station (Firm Capacity = 0.36 MGD), and additional service area. The recommended expansion to the firm capacity will allow the Waters Edge Lift Station to serve the Goree Unit and the northern portion of the Elkins Lake Country Club. The additional capacity provided by this lift station expansion will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1.7 MGD Lift Station Expansion	1	EA	$680,000	$680,000
2	10" Force Main	1,750	LF	$70	$122,500

SUBTOTAL:		$802,500
CONTINGENCY	30%	$240,750
SUBTOTAL:		$1,043,250
ENG/SURVEY	15%	$156,490
SUBTOTAL:		$1,199,740

PROJECT TOTAL **$1,199,740**

City of Huntsville

Wastewater CIP Projects - 2026

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 18

Project Description

Replace 10-inch with 18/21-inch Gravity Lines in the AJ-09 Basin

Detailed Description

This project includes the construction of 18-inch and 21-inch replacement gravity lines in the AJ-09 Basin.

Purpose

The recommended lines are sized to convey projected peak 2041 wastewater flows from the West Fork Tanyard Creek project. This includes flows from the Mallery Lake, Bearkat, Highway 190, Old Colony, Sims, and Badger Lane Lift Stations that will be pumped through the Tanyard Creek Lift Station. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	18" Pipe < 12 feet deep	3,050	LF	$144	$439,200
2	21" Pipe < 12 feet deep	5,500	LF	$168	$924,000
3	60" Diameter Manhole (9' Depth)	34	EA	$13,500	$459,000
	SUBTOTAL:				$1,822,200
	CONTINGENCY			30%	$546,660
	SUBTOTAL:				$2,368,860
	ENG/SURVEY			15%	$355,330
	SUBTOTAL:				$2,724,190

PROJECT TOTAL **$2,724,190**

City of Huntsville

Wastewater CIP Projects - 2026

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 19

Project Description

Expansion of the Tanyard Creek LS to 3.1 MGD (Firm Capacity)

Detailed Description

This project includes the expansion of the firm capacity of the Tanyard Creek Lift Station from 2.59 MGD to 3.1 MGD. This project also includes a 14-inch force main to replace the existing 10-inch force main.

Purpose

The West Fork Tanyard Creek trunk line will add the wastewater flows from six upstream lift stations (Mallery Lake, Bearkat, Highway 190, Old Colony, Sims, and Badger Lane) to the Tanyard Creek Lift Station. The recommended expansion to 3.1 MGD to sized to convey projected peak 2041 wastewater flows.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Expand Tanyard Creek LS to 3.1 MGD	1	EA	$1,240,000	$1,240,000
2	14" Force Main	8,500	LF	$98	$833,000
			SUBTOTAL:		$2,073,000
			CONTINGENCY	30%	$621,900
			SUBTOTAL:		$2,694,900
			ENG/SURVEY	15%	$404,240
			SUBTOTAL:		$3,099,140

PROJECT TOTAL **$3,099,140**

City of Huntsville

Wastewater CIP Projects - 2026

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 20

Project Description

Replace 8-inch with 10-inch Gravity Lines in Brookview Subdivision

Detailed Description

This project includes the construction of 10-inch replacement gravity lines in the Brookview Subdivision.

Purpose

The recommended lines are sized to convey a portion of the future commercial development flow anticipated along Hwy 75. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by surcharging conditions within the calibrated model. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	10" Pipe 12 - 20 feet deep	3,300	LF	$120	$396,000
2	48" Diameter Manhole (14' Depth)	16	EA	$9,000	$144,000
3	Pavement Repair	3,300	LF	$50	$165,000

SUBTOTAL:		$705,000
CONTINGENCY	30%	$211,500
SUBTOTAL:		$916,500
ENG/SURVEY	15%	$137,480
SUBTOTAL:		$1,053,980

PROJECT TOTAL **$1,053,980**

City of Huntsville

Wastewater CIP Projects - 2026

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 21

Project Description

Replace 21/24-inch with 24/27-inch Gravity Lines in the RC-04 Basin

Detailed Description

This project includes the construction of 24-inch and 27-inch replacement gravity lines in the RC-04 Basin.

Purpose

The expansion of the McGary Creek Lift Station (Project 23) will send additional flow through these gravity lines. The recommended lines are sized to convey projected peak 2041 wastewater flows from the RC-04 and RC-05 Basins. The additional capacity provided by these replacement lines will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Pipe < 12 feet deep	5,300	LF	$192	$1,017,600
2	27" Pipe < 12 feet deep	5,900	LF	$216	$1,274,400
3	60" Diameter Manhole (11' Depth)	43	EA	$14,500	$623,500
4	Pavement Repair	1,500	LF	$50	$75,000
		SUBTOTAL:			$2,990,500
		CONTINGENCY		30%	$897,150
		SUBTOTAL:			$3,887,650
		ENG/SURVEY		15%	$583,150
		SUBTOTAL:			$4,470,800

PROJECT TOTAL **$4,470,800**

City of Huntsville

Wastewater CIP Projects - 2026

OPINION OF PROBABLE COST **July 15, 2016**

Construction Project Number 22

Project Description

Rehab & Expansion of the McGary Creek LS to 4.75 MGD (Firm Capacity)

Detailed Description

This project includes the rehabilitation and expansion of the McGary Creek Lift Station from 2.95 MGD to 4.75 MGD. The existing capacity of 2.95 MGD reflects the total capacity of both wet wells at this lift station.

Purpose

The recommended lift station rehabilitation addresses the condition related issues and the recommended expansion is sized to convey the projected peak flows through the 2041 planning period. The lift station condition assessment resulted in a fair condition score. The hydraulic modeling and system analysis showed surcharging in the collection system east of IH-45. When these restrictions are alleviated (Project 24), the calibrated hydraulic model shows that additional pumping capacity will be required at this lift station.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Expand McGary Creek LS to 4.75 MGD	1	EA	$1,900,000	$1,900,000
		SUBTOTAL:			$1,900,000
		CONTINGENCY		30%	$570,000
		SUBTOTAL:			$2,470,000
		ENG/SURVEY		15%	$370,500
		SUBTOTAL:			$2,840,500
PROJECT TOTAL					**$2,840,500**

City of Huntsville

Wastewater CIP Projects - 2026

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST — July 15, 2016

Construction Project Number 23

Project Description

Replace 8/12/18-inch with 12/21-inch Gravity Lines in the RC-05 Basin

Detailed Description

This project includes the construction of 12-inch and 21-inch replacement gravity lines in the RC-05 Basin.

Purpose

The recommended lines are sized to serve future development and convey projected peak 2041 wastewater flows. This project will also alleviate the existing lack of capacity in these lines to convey peak wet weather wastewater flows, as predicted by the surcharged conditions within the calibrated hydraulic model. The additional capacity provided by these replacement lines will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Pipe < 12 feet deep	1,450	LF	$96	$139,200
2	15" Pipe < 12 feet deep	1,400	LF	$120	$168,000
3	24" Pipe < 12 feet deep	1,000	LF	$192	$192,000
4	21" Pipe < 12 feet deep	9,000	LF	$168	$1,512,000
5	48" Diameter Manhole (10' Depth)	10	EA	$8,000	$80,000
6	60" Diameter Manhole (10' Depth)	41	EA	$14,000	$574,000
7	34" Boring and Casing	1,000	LF	$595	$595,000
		SUBTOTAL:			$3,260,200
		CONTINGENCY		30%	$978,060
		SUBTOTAL:			$4,238,260
		ENG/SURVEY		15%	$635,740
		SUBTOTAL:			$4,874,000

PROJECT TOTAL **$4,874,000**

City of Huntsville

Wastewater CIP Projects - 2041

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 24

Project Description

Replace 8-inch with 10-inch Gravity Line in the RC-03 Basin

Detailed Description

This project includes the construction of 10-inch replacement gravity lines in the RC-03 Basin.

Purpose

This project increases the capacity of the existing wastewater line to serve projected development. The additional capacity provided by this replacement line will help the City maintain regulatory compliance regarding the prevention of surcharging and sanitary sewer overflows in a gravity sewer system (TCEQ §217.53).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Pipe < 12 feet deep	1,600	LF	$96	$153,600
2	48" Diameter Manhole (10' Depth)	6	EA	$8,000	$48,000
		SUBTOTAL:			$201,600
		CONTINGENCY		30%	$60,480
		SUBTOTAL:			$262,080
		ENG/SURVEY		15%	$39,320
		SUBTOTAL:			$301,400

PROJECT TOTAL **$301,400**

City of Huntsville

Wastewater CIP Projects - 2041

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 25

Project Description

Expand N.B. Davidson WWTP 2-hr Peak Flow Treatment Capacity to 6.5 MGD

Detailed Description

This project includes improvements to the N.B. Davidson WWTP to expand the 2-hr peak flow treatment capacity to 6.5 MGD.

Purpose

This project is required due to the increased firm capacity projected to be needed at the Elkins Lake Dam Lift Station. An increase in the 2-hr peak treatment capacity will prevent the collection system from surcharging during wet weather events and help the City maintain regulatory compliance.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Expand WWTP 2-Hr Peak Flow Treatment Capacity	1	LS	$300,000	$300,000
	SUBTOTAL:				$300,000
	CONTINGENCY			30%	$90,000
	SUBTOTAL:				$390,000
	ENG/SURVEY			15%	$58,500
	SUBTOTAL:				$448,500
PROJECT TOTAL					**$448,500**

City of Huntsville

Wastewater CIP Projects - 2041

OPINION OF PROBABLE COST July 15, 2016

Construction Project Number 26

Project Description

Expand A.J. Brown WWTP to 5.0 MGD Capacity

Detailed Description

This project includes the expansion of the A.J. Brown WWTP from 4.15 MGD to 5.0 MGD.

Purpose

The wastewater flow projections show that the projected average day wastewater flow in the A.J. Brown service area is 3.9 MGD by 2041. It is recommended to expand the A.J. Brown WWTP in order to maintain the recommended WWTP capacity of approximately 80%.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Expand A.J. Brown WWTP to 5.0 MGD	1	LS	$5,000,000	$5,000,000
		SUBTOTAL:			$5,000,000
		CONTINGENCY		30%	$1,500,000
		SUBTOTAL:			$6,500,000
		ENG/SURVEY		15%	$975,000
		SUBTOTAL:			$7,475,000

PROJECT TOTAL **$7,475,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number LS 1

Project Description

Brook Hollow (BH) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Brook Hollow Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	BH - Mobilization	1	LS	$6,390	$6,390
2	BH - Electrical - MCC, Back-up Power, Cables	1	LS	$130,000	$130,000
3	BH - Pumps and Motors	1	LS	$91,000	$91,000
4	BH - Instrumentation - SCADA, alarms	1	LS	$10,000.00	10,000
5	BH - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$40,000.00	40,000
6	BH - Piping and Valves	1	LS	$20,000.00	20,000
7	BH - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$20,000.00	20,000
8	BH - Bypass Pumping	1	LS	$20,000.00	20,000
9	BH - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$349,390
		CONTINGENCY		30%	$104,820
		SUBTOTAL:			$454,210
		ENG/SURVEY		20%	$90,850
		SUBTOTAL:			$545,060

PROJECT TOTAL **$545,060**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number — LS 2

Project Description

Elkins Lake Equestrian Center (EC) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Elkins Lake Equestrian Center Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	EC - Mobilization	1	LS	$5,160	$5,160
2	EC - Electrical - MCC, Back-up Power, Cables	1	LS	$60,000	$60,000
3	EC - Pumps and Motors	1	LS	$30,000	$30,000
4	EC - Instrumentation - SCADA, alarms	1	LS	$20,000	$20,000
5	EC - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$20,000	$20,000
6	EC - Piping and Valves	1	LS	$10,000.00	10,000
7	EC - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$60,000.00	60,000
8	EC - Bypass Pumping	1	LS	$20,000.00	20,000
9	EC - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$237,160
		CONTINGENCY		30%	$71,150
		SUBTOTAL:			$309,000
		ENG/SURVEY		20%	$61,800
		SUBTOTAL:			$371,000

PROJECT TOTAL **$371,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number — LS 3

Project Description

Elkins Lake #1 (EL 1) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Elkins Lake # 1 Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	EL 1 - Mobilization	1	LS	$4,560	$4,560
2	EL 1 - Electrical - MCC, Back-up Power, Cables	1	LS	$80,000	$80,000
3	EL 1 - Pumps and Motors	1	LS	$30,000.00	30,000
4	EL 1 - Instrumentation - SCADA, alarms	1	LS	$5,000.00	5,000
5	EL 1 - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilat	1	LS	$30,000.00	30,000
6	EL 1 - Piping and Valves	1	LS	$10,000.00	10,000
7	EL 1 - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$45,000.00	45,000
8	EL 1 - Bypass Pumping	1	LS	$20,000.00	20,000
9	EL 1 - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$236,560
		CONTINGENCY		30%	$70,970
		SUBTOTAL:			$307,530
		ENG/SURVEY		20%	$61,510
		SUBTOTAL:			$369,040

PROJECT TOTAL **$369,040**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number LS 4

Project Description

Bayes (BA) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Bayes Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	BA - Mobilization	1	LS	$7,200	$7,200
2	BA - Electrical - MCC, Back-up Power, Cables	1	LS	$120,000	$120,000
3	BA - Pumps and Motors	1	LS	$78,000	$78,000
4	BA - Instrumentation - SCADA, alarms	1	LS	$20,000	$20,000
5	BA - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$50,000.00	50,000
6	BA - Piping and Valves	1	LS	$20,000.00	20,000
7	BA - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$40,000.00	40,000
8	BA - Bypass Pumping	1	LS	$20,000.00	20,000
9	BA - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$367,200
		CONTINGENCY		30%	$110,160
		SUBTOTAL:			$478,000
		ENG/SURVEY		20%	$95,600
		SUBTOTAL:			$574,000

PROJECT TOTAL **$574,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number — LS 5

Project Description

Elkins Lake #3 (EL 3) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Elkins Lake # 3 Lift Station. All components of this lift station, with the exception of the site, are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	EL 3 - Mobilization	1	LS	$4,560	$4,560
2	EL 3 - Electrical - MCC, Back-up Power, Cables	1	LS	$110,000	$110,000
3	EL 3 - Pumps and Motors	1	LS	$60,000	$60,000
4	EL 3 - Instrumentation - SCADA, alarms	1	LS	$5,000	$5,000
5	EL 3 - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilat	1	LS	$25,000	$25,000
6	EL 3 - Piping and Valves	1	LS	$15,000	$15,000
7	EL 3 - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$15,000	$15,000
8	EL 3 - Bypass Pumping	1	LS	$20,000.00	20,000
9	EL 3 - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$266,560
		CONTINGENCY		30%	$79,970
		SUBTOTAL:			$347,000
		ENG/SURVEY		20%	$69,400
		SUBTOTAL:			$417,000

PROJECT TOTAL **$417,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number LS 6

Project Description

Elkins Lake #2 (EL 2) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Elkins Lake # 2 Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a poor rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	EL 2 - Mobilization	1	LS	$4,560	$4,560
2	EL 2 - Electrical - MCC, Back-up Power, Cables	1	LS	$90,000	$90,000
3	EL 2 - Pumps and Motors	1	LS	$45,000	$45,000
4	EL 2 - Instrumentation - SCADA, alarms	1	LS	$5,000	$5,000
5	EL 2 - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilat	1	LS	$25,000.00	25,000
6	EL 2 - Piping and Valves	1	LS	$15,000.00	15,000
7	EL 2 - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$30,000.00	30,000
8	EL 2 - Bypass Pumping	1	LS	$20,000.00	20,000
9	EL 2 - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$246,560
		CONTINGENCY		30%	$73,970
		SUBTOTAL:			$321,000
		ENG/SURVEY		20%	$64,200
		SUBTOTAL:			$386,000

PROJECT TOTAL **$386,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number LS 7

Project Description

Simmons Street (SS) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Simmons Street Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the high risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SS - Mobilization	1	LS	$2,790	$2,790
2	SS - Electrical - MCC, Back-up Power, Cables	1	LS	$85,000	$85,000
3	SS - Pumps and Motors	1	LS	$40,000.00	40,000
4	SS - Instrumentation - SCADA, alarms	1	LS	$5,000.00	5,000
5	SS - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$5,000.00	5,000
6	SS - Piping and Valves	1	LS	$10,000.00	10,000
7	SS - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$10,000.00	10,000
8	SS - Bypass Pumping	1	LS	$20,000.00	20,000
9	SS - Wet Well Coating	100	SF	$30.00	3,000
		SUBTOTAL:			$180,790
		CONTINGENCY		30%	$54,240
		SUBTOTAL:			$236,000
		ENG/SURVEY		20%	$47,200
		SUBTOTAL:			$284,000
PROJECT TOTAL					**$284,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST — July 15, 2016

Rehabilitation/Renewal Project Number — LS 8

Project Description

McCoy's (MC) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the McCoy's Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the moderate risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	MC - Mobilization	1	LS	$2,910	$2,910
2	MC - Electrical - MCC, Back-up Power, Cables	1	LS	$50,000	$50,000
3	MC - Pumps and Motors	1	LS	$25,000	$25,000
4	MC - Instrumentation - SCADA, alarms	1	LS	$10,000	$10,000
5	MC - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$10,000	$10,000
6	MC - Piping and Valves	1	LS	$10,000	$10,000
7	MC - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$10,000	$10,000
8	MC - Bypass Pumping	1	LS	20000	20000
9	MC - Wet Well Coating	400	SF	30	12000
		SUBTOTAL:			$149,910
		CONTINGENCY		30%	$44,980
		SUBTOTAL:			$194,890
		ENG/SURVEY		20%	$38,980
		SUBTOTAL:			$233,870

PROJECT TOTAL — $233,870

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number LS 9

Project Description

Airport (AP) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Airport Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the low risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	AP - Mobilization	1	LS	$2,760	$2,760
2	AP - Electrical - MCC, Back-up Power, Cables	1	LS	$50,000	$50,000
3	AP - Pumps and Motors	1	LS	$25,000	$25,000
4	AP - Instrumentation - SCADA, alarms	1	LS	$5,000.00	5,000
5	AP - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$15,000.00	15,000
6	AP - Piping and Valves	1	LS	$10,000.00	10,000
7	AP - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$5,000.00	5,000
8	AP - Bypass Pumping	1	LS	$20,000.00	20,000
9	AP - Wet Well Coating	400	SF	$30.00	12,000
		SUBTOTAL:			$144,760
		CONTINGENCY		30%	$43,430
		SUBTOTAL:			$188,190
		ENG/SURVEY		20%	$37,640
		SUBTOTAL:			$225,830

PROJECT TOTAL **$225,830**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number LS 10

Project Description

Transfer Station (TS) Lift Station Rehabilitation

Detailed Description

This project includes the rehabilitation of the Transfer Station Lift Station. All components of this lift station are recommended for rehabilitation.

Purpose

The lift station condition assessment resulted in a fair rating, and the risk assessment for this lift station was in the low risk category.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	TS - Mobilization	1	LS	$3,690	$3,690
2	TS - Electrical - MCC, Back-up Power, Cables	1	LS	$50,000	$50,000
3	TS - Pumps and Motors	1	LS	$25,000	$25,000
4	TS - Instrumentation - SCADA, alarms	1	LS	$20,000.00	20,000
5	TS - Structure - Hatches, Corrosion, Cracks, Leaking, Ventilatio	1	LS	$25,000.00	25,000
6	TS - Piping and Valves	1	LS	$10,000.00	10,000
7	TS - Site - Drainage, Access Drive, Security, Fencing, Demo	1	LS	$5,000.00	5,000
8	TS - Bypass Pumping	1	LS	$20,000.00	20,000
9	TS - Wet Well Coating	600	SF	$30.00	18,000
		SUBTOTAL:			$176,690
		CONTINGENCY		30%	$53,010
		SUBTOTAL:			$229,700
		ENG/SURVEY		20%	$45,940
		SUBTOTAL:			$275,640

PROJECT TOTAL **$275,640**

City of Huntsville
Wastewater Rehab/Renewal CIP Projects

FREESE AND NICHOLS

City of Huntsville

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number — LS 11

Project Description

Decommission TxDOT # 1 Lift Station and Install Aerobic System

Detailed Description

This project includes the decommissioning of the TxDOT #1 Lift Station and the installation of an aerobic system.

Purpose

This lift station serves a small amount of flow and discharges into the TxDOT # 2 Lift Station.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Convert wet well to manhole	1	LS	$15,000	$15,000
2	Grout fill and abandon existing force main	7,100	LF	$10	$71,000
3	Install Aerobic System	1	LS	$100,000	$100,000
		SUBTOTAL:			$186,000
		CONTINGENCY		30%	$55,800
		SUBTOTAL:			$241,800
		ENG/SURVEY		20%	$48,360
		SUBTOTAL:			$290,160

PROJECT TOTAL **$290,160**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Rehabilitation/Renewal Project Number LS 12

Project Description

Decommission TxDOT # 2 Lift Station and Install Aerobic System

Detailed Description

This project includes the decommissioning of the TxDOT #2 Lift Station and the installation of an aerobic system.

Purpose

This lift station serves a small amount of flow and does not cycle regularly, creating a very septic environment. The lift station condition assessment resulted in a very poor rating and the risk assessment for this lift station was in the high risk category. It is anticipated that this lift station would have to be rehabilitated on a recurring basis due to the flow conditions.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Convert wet well to manhole	1	LS	$15,000	$15,000
2	Grout fill and abandon existing force main	11,200	LF	$10.00	$112,000
3	Install Aerobic System	1	LS	$100,000	$100,000

SUBTOTAL:		$227,000
CONTINGENCY	30%	$68,100
SUBTOTAL:		$295,100
ENG/SURVEY	20%	$59,020
SUBTOTAL:		$354,120

PROJECT TOTAL **$354,120**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number B 1

Project Description

RC-01 Basin (Manhole Rehabilitation)

Detailed Description

This project includes the rehabilitation of the manholes in the RC-01 Basin, as per the findings of the SSES manhole inspections carried out during the Condition and Capacity Assessment Study.

Purpose

The SSES of this basin revealed corrosion of the concrete manholes and defects of frames and covers. It is recommended that an H2S resistant liner be applied to all manholes in this basin. It is anticipated that this project will reduce the amount of I/I being sent to the Robinson Creek WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	RC-01 Basin Manhole Rehabilitation	1	LS	$77,150	$77,150
			SUBTOTAL:		$77,150
			CONTINGENCY	30%	$23,150
			SUBTOTAL:		$100,300
			ENG/SURVEY	20%	$20,060
			SUBTOTAL:		$120,360
PROJECT TOTAL					**$120,360**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST — July 15, 2016

Rehabilitation/Renewal Project Number — B 2

Project Description

AJ-12 Basin (Sub Basin E Manhole and Line Rehabilitation)

Detailed Description

This project includes the rehabilitation of the manholes in the AJ-12 Sub Basin E, as per the findings of the SSES Manhole Inspections carried out during the Condition and Capacity Assessment Study.

Purpose

The SSES of this basin revealed corrosion of the concrete manholes and defects of frames and covers. It is recommended that an H2S resistant liner be applied to 16 manholes in this sub basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	AJ-12 Sub Basin E Manhole Rehabilitation	1	LS	$27,558	$27,558
2	AJ-12 Sub Basin E Gravity Line Renewal	1	LS	$172,442	$172,442
		SUBTOTAL:			$200,000
		CONTINGENCY		30%	$60,000
		SUBTOTAL:			$260,000
		ENG/SURVEY		20%	$52,000
		SUBTOTAL:			$312,000

PROJECT TOTAL **$312,000**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number B 3

Project Description

AJ-12 Basin Rehabilitation and Renewal (Sub Basins A, D, C, and B)

Detailed Description

Focused flow monitoring was performed in five sub basins within the AJ-12 Basin as part of the overall Water and Wastewater System Condition and Capacity Assessment Study. A detailed SSES, including manhole inspections and smoke testing, was conducted in the sub basin with the most I/I (Sub Basin E). FNI recommends that SSES efforts be continued in the remaining four sub basins (A, D, C, and B).

Purpose

High and moderate levels of I/I were measured in the four remaining sub basins (A, D, C, and B). A detailed SSES in these areas will help to identify sources of I/I. Once these sources are identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the wastewater system. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SSES Smoke Testing (Sub Basins A, D, C, & B)	76,600	LF	$0.65	$49,790
2	SSES Manhole Inspections (Sub Basins A, D, C, & B)	330	EA	$210.00	$69,300
3	Rehab/Renewal in Sub Basins A, D, C & B (per SSES)	1	LS	$800,000	$800,000

SUBTOTAL:		$919,090
CONTINGENCY	30%	$275,730
SUBTOTAL:		$1,194,820
ENG/SURVEY	20%	$238,970
SUBTOTAL:		$1,433,790

PROJECT TOTAL **$1,433,790**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST — **July 15, 2016**

Rehabilitation/Renewal Project Number — B 4

Project Description

AJ-08 Basin SSES, Rehabilitation and Renewal

Detailed Description

This project includes focused flow monitoring throughout the AJ-08 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system.

Purpose

The citywide flow monitoring conducted during this study identified high levels of I/I in the AJ-08 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SSES Flow Monitoring	1	EA	$30,000	$30,000
2	SSES Smoke Testing	29,800	LF	$0.65	$19,370
3	SSES Manhole Inspections	85	EA	$210	$17,850
4	Rehab/Renewal of Lines & MHs (per SSES findings)	1	LS	$1,000,000	$1,000,000
		SUBTOTAL:			$1,067,220
		CONTINGENCY		30%	$320,170
		SUBTOTAL:			$1,387,390
		ENG/SURVEY		20%	$277,480
		SUBTOTAL:			$1,664,870

PROJECT TOTAL **$1,664,870**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST — **July 15, 2016**

Rehabilitation/Renewal Project Number — B 5

Project Description

AJ-10 Basin SSES, Rehabilitation and Renewal

Detailed Description

This project includes focused flow monitoring throughout the AJ-10 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system.

Purpose

The citywide flow monitoring conducted during this study identified high levels of I/I in the AJ-10 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SSES Flow Monitoring	1	EA	$30,000	$30,000
2	SSES Smoke Testing	149,900	LF	$0.65	$97,435
3	SSES Manhole Inspections	570	EA	$210	$119,700
4	Rehab/Renewal of Lines & MHs (per SSES findings)	1	LS	$1,000,000	$1,000,000
		SUBTOTAL:			$1,247,135
		CONTINGENCY		30%	$374,150
		SUBTOTAL:			$1,621,290
		ENG/SURVEY		20%	$324,260
		SUBTOTAL:			$1,945,550

PROJECT TOTAL **$1,945,550**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number B 6

Project Description

NB-06 Basin SSES, Rehabilitation and Renewal

Detailed Description

This project includes focused flow monitoring throughout the NB-06 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system.

Purpose

The citywide flow monitoring conducted during this study identified moderate levels of I/I in the NB-06 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the N.B. Davidson WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SSES Flow Monitoring	1	EA	$30,000	$30,000
2	SSES Smoke Testing	55,800	LF	$0.65	$36,270
3	SSES Manhole Inspections	248	EA	$210	$52,080
4	Rehab/Renewal of Lines & MHs (per SSES findings)	1	LS	$1,000,000	$1,000,000
	SUBTOTAL:				$1,118,350
	CONTINGENCY			30%	$335,510
	SUBTOTAL:				$1,453,860
	ENG/SURVEY			20%	$290,780
	SUBTOTAL:				$1,744,640
	PROJECT TOTAL				**$1,744,640**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST July 15, 2016

Rehabilitation/Renewal Project Number B 7

Project Description

AJ-11 Basin SSES, Rehabilitation and Renewal

Detailed Description

This project includes focused flow monitoring throughout the AJ-11 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system.

Purpose

The citywide flow monitoring conducted during this study identified moderate levels of I/I in the AJ-11 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the A.J. Brown WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SSES Flow Monitoring	1	EA	$30,000	$30,000
2	SSES Smoke Testing	52,600	LF	$0.65	$34,190
3	SSES Manhole Inspections	202	EA	$210	$42,420
4	Rehab/Renewal of Lines & MHs (per SSES findings)	1	LS	$1,000,000	$1,000,000

SUBTOTAL:		$1,106,610
CONTINGENCY	30%	$331,990
SUBTOTAL:		$1,438,600
ENG/SURVEY	20%	$287,720
SUBTOTAL:		$1,726,320

PROJECT TOTAL **$1,726,320**

City of Huntsville

Wastewater Rehab/Renewal CIP Projects

OPINION OF PROBABLE COST

July 15, 2016

Construction Project Number B 8

Project Description

RC-04 Basin SSES, Rehabilitation and Renewal

Detailed Description

This project includes focused flow monitoring throughout the RC-04 Basin to identify areas contributing large amounts of I/I. SSES efforts should then be conducted to identify specific sources of I/I. Once identified, it is recommended that the City address them with rehabilitation or renewal projects to reduce excess water entering the system.

Purpose

The citywide flow monitoring conducted during this study identified moderate levels of I/I in the RC-04 Basin. It is anticipated that this project will reduce the amount of I/I being sent to the Robinson Creek WWTP.

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SSES Flow Monitoring	1	EA	$30,000	$30,000
2	SSES Smoke Testing	24,600	LF	$0.65	$15,990
3	SSES Manhole Inspections	78	EA	$210	$16,380
4	Rehab/Renewal of Lines & MHs (per SSES findings)	1	LS	$1,000,000	$1,000,000
		SUBTOTAL:			$1,062,370
		CONTINGENCY		30%	$318,720
		SUBTOTAL:			$1,381,090
		ENG/SURVEY		20%	$276,220
		SUBTOTAL:			$1,657,310
PROJECT TOTAL					**$1,657,310**