



# CITY OF WEST UNIVERSITY PLACE

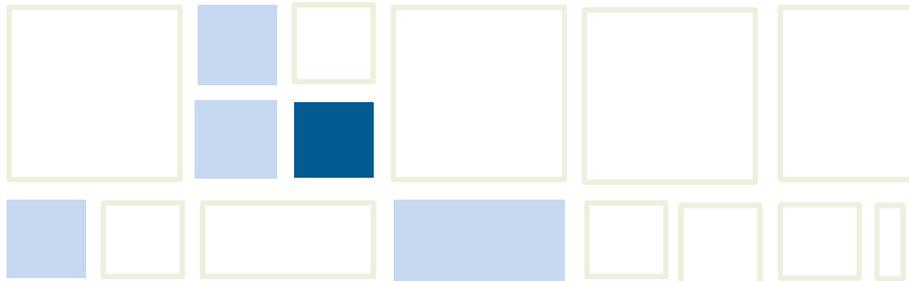
## 2021 WATER SYSTEM ASSESSMENT TECHNICAL MEMORANDUM

**PREPARED FOR:**

City of West University Place

**PREPARED BY:**

Freese and Nichols, Inc.  
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# 2021 WATER SYSTEM ASSESSMENT

Prepared for:

**City of West University Place**



05/20/2021

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FNI Project No.: WUP20540

# TECHNICAL MEMORANDUM

## Water System Assessment



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**SUBJECT:** Water System Assessment Technical Memorandum

**DATE:** May 20, 2021

**PROJECT:** Drinking Water Distribution System Assessment



## 1.0 INTRODUCTION AND CONTENTS

The City of West University Place (City or West University) is a two square mile community located inside the Houston 610 Loop and bordered by the Cities of Bellaire, Southside Place and Houston. West University owns and maintains a water distribution system that supplies a combination of ground water from wells and surface water from the City of Houston to approximately 15,700 residents as well as commercial and institutional customers.

In July of 2020, the City retained Freese and Nichols, Inc. (FNI) to conduct a *Drinking Water Distribution System Assessment* (Water System Assessment or Study). The objective was to conduct a hydraulic modeling study of the City's water system and develop recommendations for water system improvements. The major scope items of this study were to **a)** develop and calibrate a hydraulic water model, **b)** conduct water system capacity analyses, **c)** develop water system improvements, and **d)** document the study and recommendations in this Technical Memorandum. FNI coordinated with the City of West University and IDS Engineering Group (IDS) throughout this study.

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## 2.0 EXISTING WATER SYSTEM

West University’s water distribution system includes two groundwater wells, two elevated storage tanks, four ground storage tanks, two booster pump stations, two water supply connections from the City of Houston, and a network of underground water lines. The existing water distribution system is shown on **Figure 2-2**.

### 2.1 WATER SUPPLY

#### Groundwater

The City owns and operates two groundwater wells, one at the **Milton** Water Plant and one at the **Wakeforest** Water Plant. West University conducted pump testing on both wells during this study in August 2020. A summary of the tested and rated well capacities are shown in **Table 2-1**. The well pump performance test reports are included in **Appendix A**.

**Table 2-1: Existing Groundwater Wells**

Well Name	Tested Capacity <sup>(1)</sup>		Rated Capacity <sup>(2)</sup>	
	gpm	MGD	gpm	MGD
<b>Milton Water Plant</b>	1,674	2.41	1,500	2.16
<b>Wakeforest Water Plant</b>	1,972	2.84	1,675	2.16
<b>Total Well Capacity</b>	<b>3,646</b>	<b>5.25</b>	<b>3,175</b>	<b>4.32</b>
<b>Firm Well Capacity</b>	<b>1,674</b>	<b>2.41</b>	<b>1,675</b>	<b>2.16</b>

(1) Tested capacities from 2020 Well Pump Performance Test Reports

(2) Rated capacities from TCEQ Drinking Water Watch (March 2021)

#### Subsidence Regulations

The City of West University Place is a permittee of the Harris-Galveston Subsidence District (HGSD) and is required to supply a portion of its annual water demand from surface water. West University is located in Area 2 of the HGSD, which has a groundwater withdrawal limitation of no more than 20% of total water demand. West University receives a 30% groundwater credit via participation in the HGSD’s Water Conservation Program, reducing the City’s annual regulatory surface water requirement to at least 50% of the total water supply.

### Surface Water Contract

West University has a 40-year take-or-pay surface water supply contract with the City of Houston from January 1994 that is provided in **Appendix B**. The surface water is delivered at two metered connections in West University. The contract has a minimum monthly usage requirement, with the option to revise the monthly usage amount no more than once each calendar year. In the initial 1994 contract, the minimum monthly take-or-pay amount was 43.79 million gallons (MG). The contract has since been revised and West University's current minimum monthly requirement is 32.75 MG. The contract also restricts peak usage to 1,500 gallons per minute (gpm) at each surface water connection.

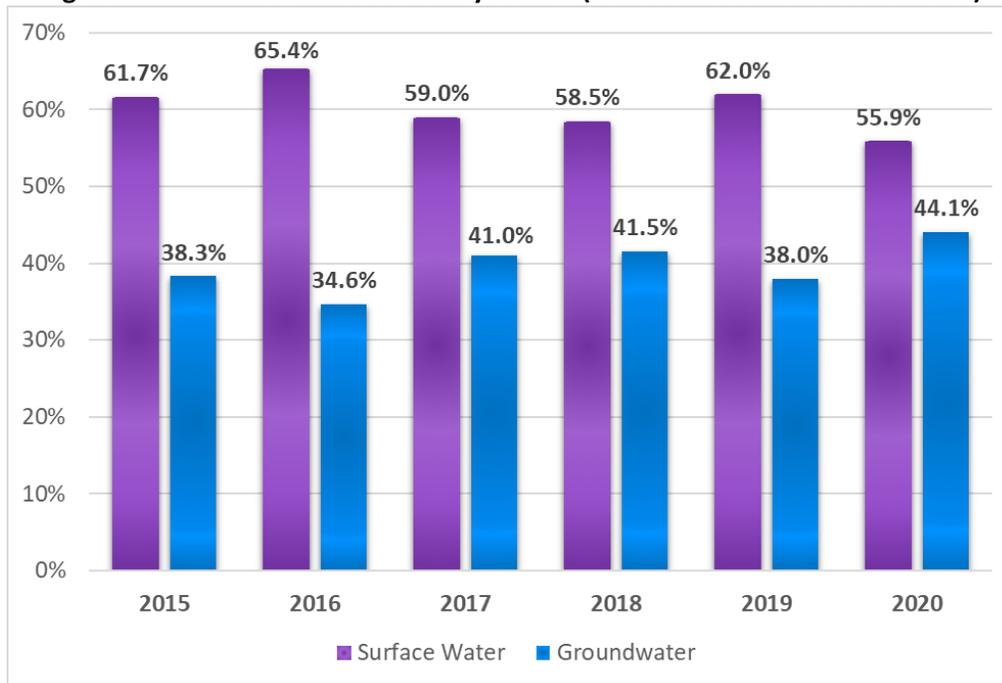
### Surface Water Connections

The metered surface water connections are located at the **Wakeforest** Water Plant, and at the corner of Bissonnet Street and Wesleyan Street, as shown on **Figure 2-2**. Surface water from the metered connection at Bissonnet and Wesleyan is conveyed directly to the ground storage tanks at the **Milton** Water Plant. At both **Milton** and **Wakeforest** water plants, groundwater and surface water are mixed within the ground storage tanks before being pumped into the distribution system. In 2020, the City changed to chloramine disinfection at the groundwater plants to match the surface water supply from the City of Houston. Liquid ammonia sulfate is introduced at the Milton Plant and mixed in the GSTs prior to distribution.

### Water Supply Analysis

The City's production records show that since 2015, surface water accounts for a majority of the City's water supply. **Figure 2-1** shows a breakdown of surface water vs. groundwater from January 2015 to September 2020.

**Figure 2-1: Water Production by Source (Surface Water vs. Groundwater)**





## 2.2 PUMP STATIONS

West University Place operates two booster pump stations located at the **Milton** and **Wakeforest** Water Plants. Individual pump capacities from the TCEQ Drinking Water Watch (DWW) and other sources are shown in **Table 2-2**. As part of this *Water System Assessment*, FNI performed field pump testing on all six booster pumps to develop tested pump curves. This is discussed further in **Section 4.0**.

**Table 2-2: Existing Pumping Facilities**

Facility Name	Pump Number	Rated Capacity					
		TCEQ <sup>(1)</sup>		Alternative from IDS Report <sup>(2)</sup>		Pump Nameplates <sup>(3)</sup>	
		gpm	MGD	gpm	MGD	gpm	MGD
Milton Water Plant	1	2,000	2.88	1,500	2.16	1,400	2.02
	2	2,000	2.88	1,500	2.16	1,400	2.02
	3	1,500	2.16	1,500	2.16	-	-
	4	1,000	1.44	1,500	2.16	1,500	2.16
	<b>Total Capacity</b>	<b>6,500</b>	<b>9.36</b>	<b>6,000</b>	<b>8.64</b>	-	-
	<b>Firm Capacity</b>	<b>4,500</b>	<b>6.48</b>	<b>4,500</b>	<b>6.48</b>	-	-
Wakeforest Water Plant	1	1,500	2.16	1,500	2.16	-	-
	2	1,500	2.16	1,500	2.16	1,500	2.16
	<b>Total Capacity</b>	<b>3,000</b>	<b>4.32</b>	<b>3,000</b>	<b>4.32</b>	-	-
	<b>Firm Capacity</b>	<b>1,500</b>	<b>2.16</b>	<b>1,500</b>	<b>2.16</b>	-	-
<b>Total Pumping Capacity</b>		<b>9,500</b>	<b>13.7</b>	<b>9,000</b>	<b>12.96</b>	-	-
<b>Firm Pumping Capacity</b>		<b>7,500</b>	<b>10.8</b>	<b>6,000</b>	<b>8.64</b>	-	-

(1) From TCEQ Drinking Water Watch (March 2021)

(2) From 2020 IDS *Water System Capacity Letter Report*

(3) From pump nameplates identified in the 2020 Smith Pump Field Assessment Report (**Appendix E**). Unable to identify rated capacities from pump nameplates for two pumps.

## 2.3 STORAGE FACILITIES

West University utilizes four ground storage tanks (GSTs) and two elevated storage tanks (ESTs). Two of the GSTs are located at the **Milton** Water Plant and the other two GSTs are located at the **Wakeforest** Water Plant. One of the ESTs is located at the **Wakeforest** Water Plant. The second EST is located away from both water plants at 3700 Bellaire Boulevard and is referred to as the Bellaire EST. Both the **Wakeforest** Water Plant and the Bellaire EST are located outside of West University’s City limits. **Table 2-3** summarizes the storage facilities in West University’s distribution system. In 2020, the City added solar powered mixers inside all storage tanks to maintain high quality water.

**Table 2-3: Summary of Storage Facilities**

Type	Facility Name	Address	Storage Capacity <sup>(1)</sup>		Surveyed Ground Elevation <sup>(2)</sup> (ft MSL)	Bottom of Bowl Elevation <sup>(3)</sup> (ft MSL)	Height/ Overflow Elevation <sup>(3)</sup> (ft/ft MSL)	Year of Construction <sup>(4)</sup>
			Gallons	MG				
Ground	Milton Water Plant	3825 Milton	1,500,000	1.5	-	-	32	1957
			400,000	0.4			32	
	Wakeforest Water Plant	4854 Wakeforest St.	500,000	0.5			36.3	1992
			500,000	0.5			36.3	
Total Ground Storage Capacity			2,900,000	2.9	-	-	-	-
Elevated	Bellaire EST	3700 Bellaire Blvd.	250,000	0.25	49.56	160.54	191.7	1935
	Wakeforest Water Plant	4854 Wakeforest St.	500,000	0.5	53.62	153.60	191.1	1991
Total Elevated Storage Capacity			750,000	0.75	-	-	-	-

(1) Storage capacity from TCEQ Drinking Water Watch (March 2021) and 2020 IDS *Water System Capacity Letter Report*

(2) Surveyed ground elevations for elevated storage tanks from IDS survey (2021).

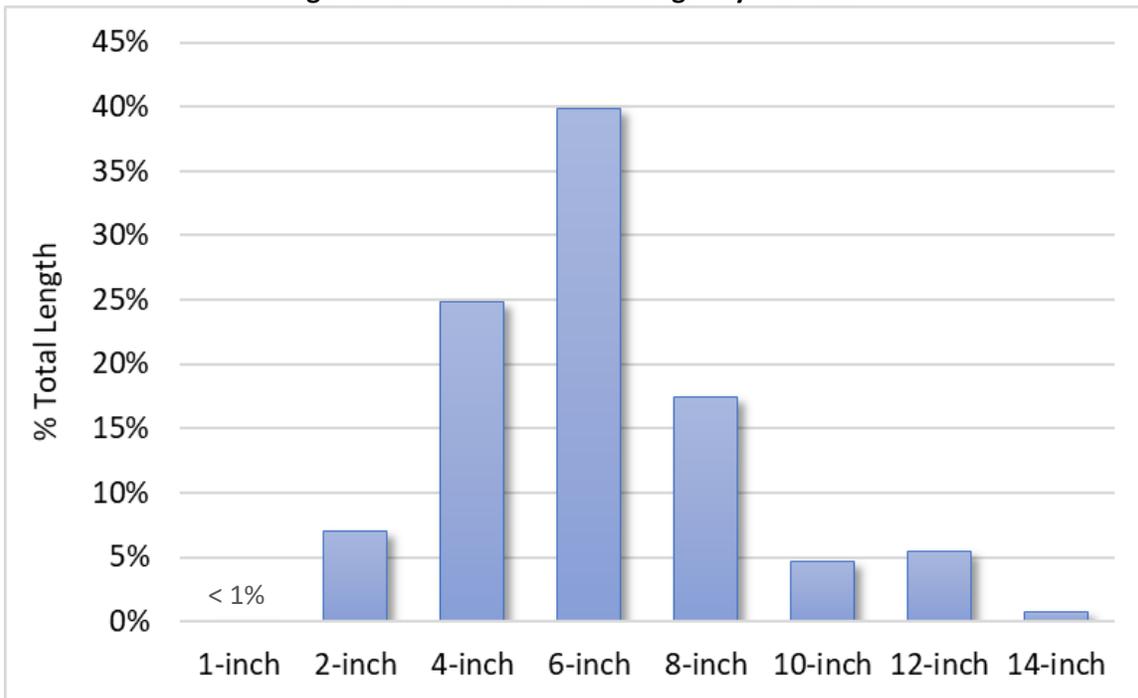
(3) Height of ground storage tanks from as-built plans. Bottom of bowl and overflow elevations of elevated storage tanks from 2021 survey data.

(4) Year of construction from 2020 IDS *Water System Capacity Letter Report*

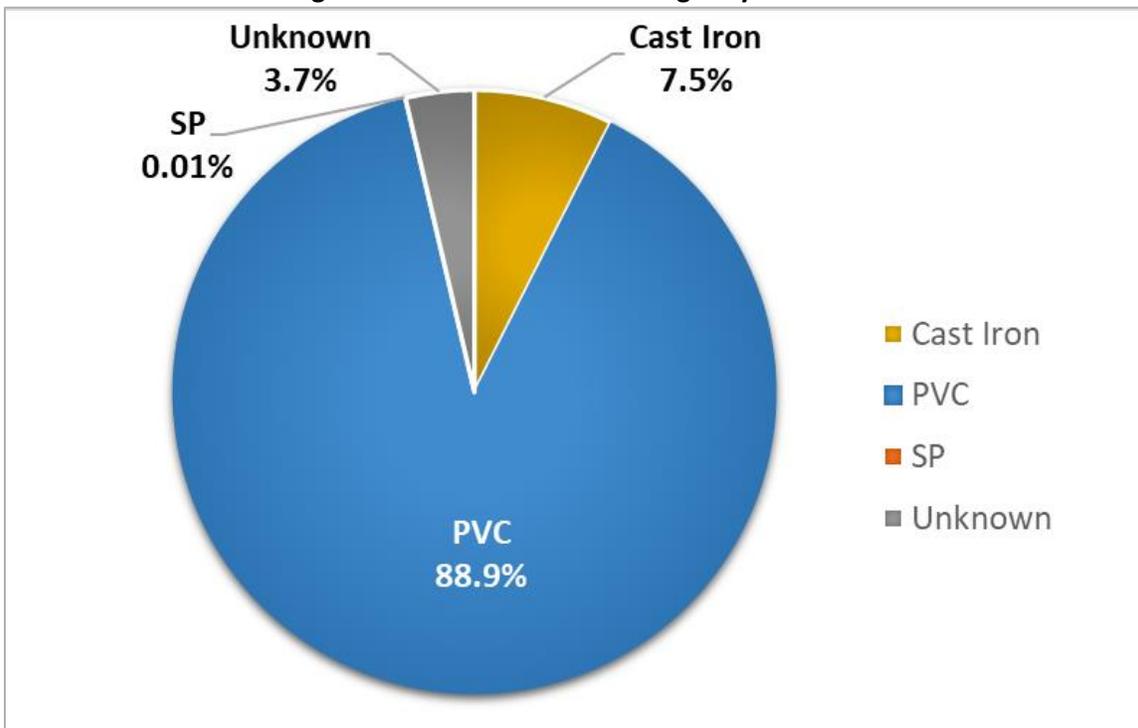
## 2.4 WATER MAINS

The City has approximately 58 miles of pipes as part of the water distribution system. This study utilized water main information from a geographic information system (GIS) geodatabase provided by IDS in September 2020. West University’s water distribution network consists of water mains ranging in size from 1-inch to 14-inches in diameter. **Figure 2-3** presents a breakdown of water main length by diameter. The majority of the water mains are 4-inches and 6-inches in diameter. Information on materials was provided in the City’s GIS for 96% of the water mains. Most of the known water main material is PVC, as illustrated on **Figure 2-4**. The City’s GIS also includes the date the water mains were installed. **Figure 2-5** shows the length of pipe by installation year.

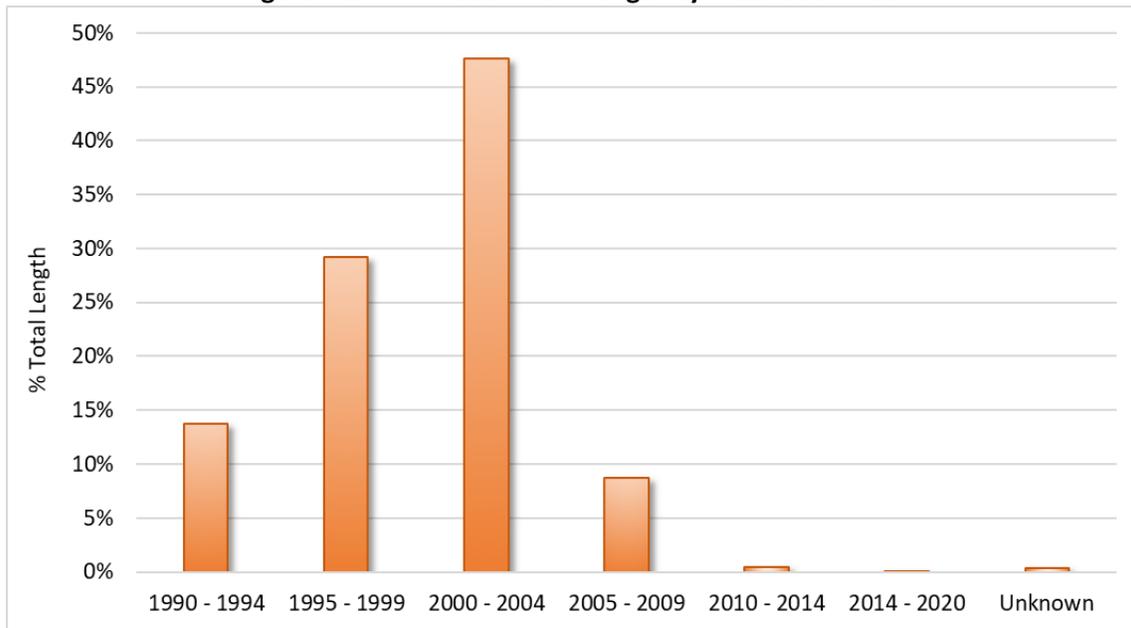
**Figure 2-3: Water Main Length by Diameter**



**Figure 2-4: Water Main Length by Material**



**Figure 2-5: Water Main Length by Installation Year**



### 3.0 WATER DEMANDS

A water utility must be able to supply water at rates that fluctuate over time. Flow rates most important to the hydraulic design and operation of a pump station and distribution system are average day (AD), maximum day (MD), and peak hour (PH) demands.

- **Average day** use is the total annual water use 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** use 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

West University provided daily water production data from January 2015 through August 2020. Historical annual average day demand, maximum day demand, per-capita consumption, and maximum day to average day peaking factors were analyzed by FNI and are summarized in **Table 3-1**. The City’s historical maximum day demand is 5.61 MGD. A breakdown of water production (groundwater vs. surface water) by month from January 1, 2015 – September 1, 2020 is included in **Appendix C**.

**Table 3-1: Historical Water Production**

Year	Population <sup>(1)</sup>	Population Growth Rate (%)	Average Day Demand <sup>(2)</sup> (MGD)	Average Day Per-Capita Consumption (gpcd)	Maximum Day Demand <sup>(2)</sup> (MGD)	MD:AD Peaking Factor
2015	15,604	-	2.07	133	4.51	2.2
2016	15,516	- 0.56%	2.12	137	4.36	2.1
2017	15,433	- 0.53%	2.20	143	5.12	2.3
2018	15,477	0.29%	2.17	140	5.56	2.6
2019	15,676	1.29%	2.17	138	4.28	2.0
2020 <sup>(3)</sup>	15,741	0.41%	2.17	138	5.61	2.6
<b>Average</b>	-	-	<b>2.15</b>	<b>138</b>	<b>4.91</b>	<b>2.3</b>
<b>Maximum</b>	-	-	<b>2.20</b>	<b>143</b>	<b>5.61</b>	<b>2.6</b>

(1) Historical population data from City

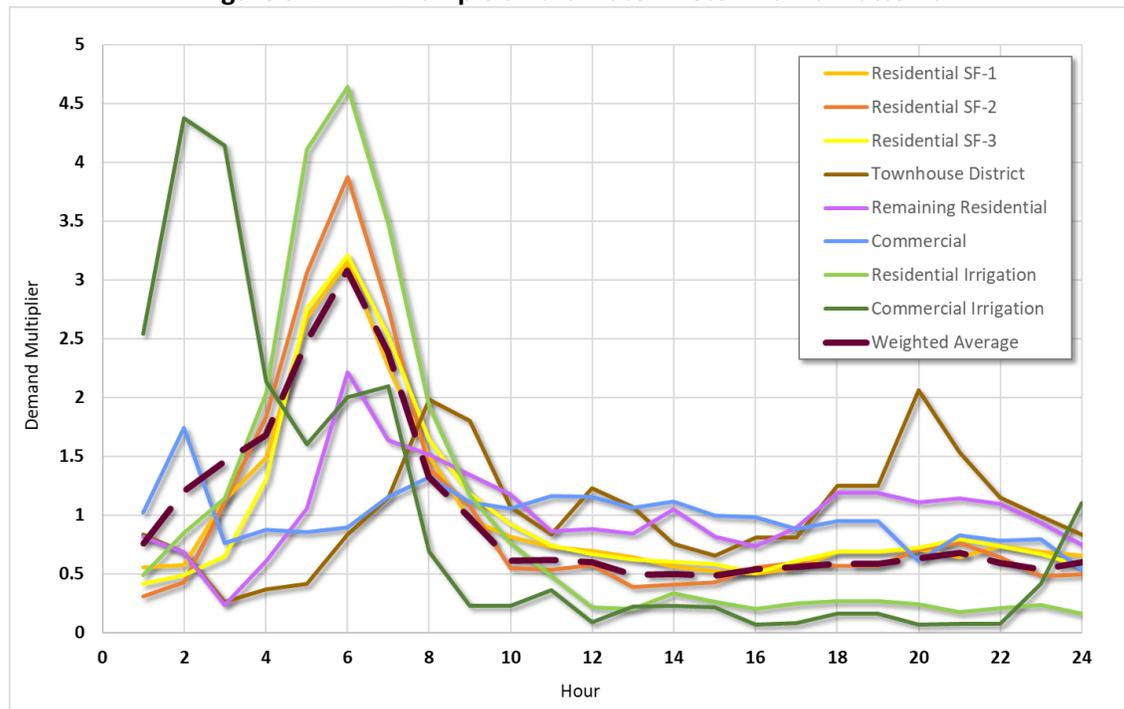
(2) Average and maximum day water demand from water production data from City; 2020 average and max day demand from January 1 – September 1, 2020

(3) 2020 maximum day demand includes adjusted Wakeforest Well production data

### 3.2 SMART WATER METER DATA

West University has smart water meters that record hourly consumption at all meter locations throughout the City. The City provided this smart meter data from October 1, 2019 to September 30, 2020 for the purposes of this study. This water consumption data was utilized during hydraulic model development (Section 5.0) and system analyses to develop diurnal patterns and distribute demands in the model. Figure 3-1 shows an example of the diurnal patterns developed utilizing the smart meter data.

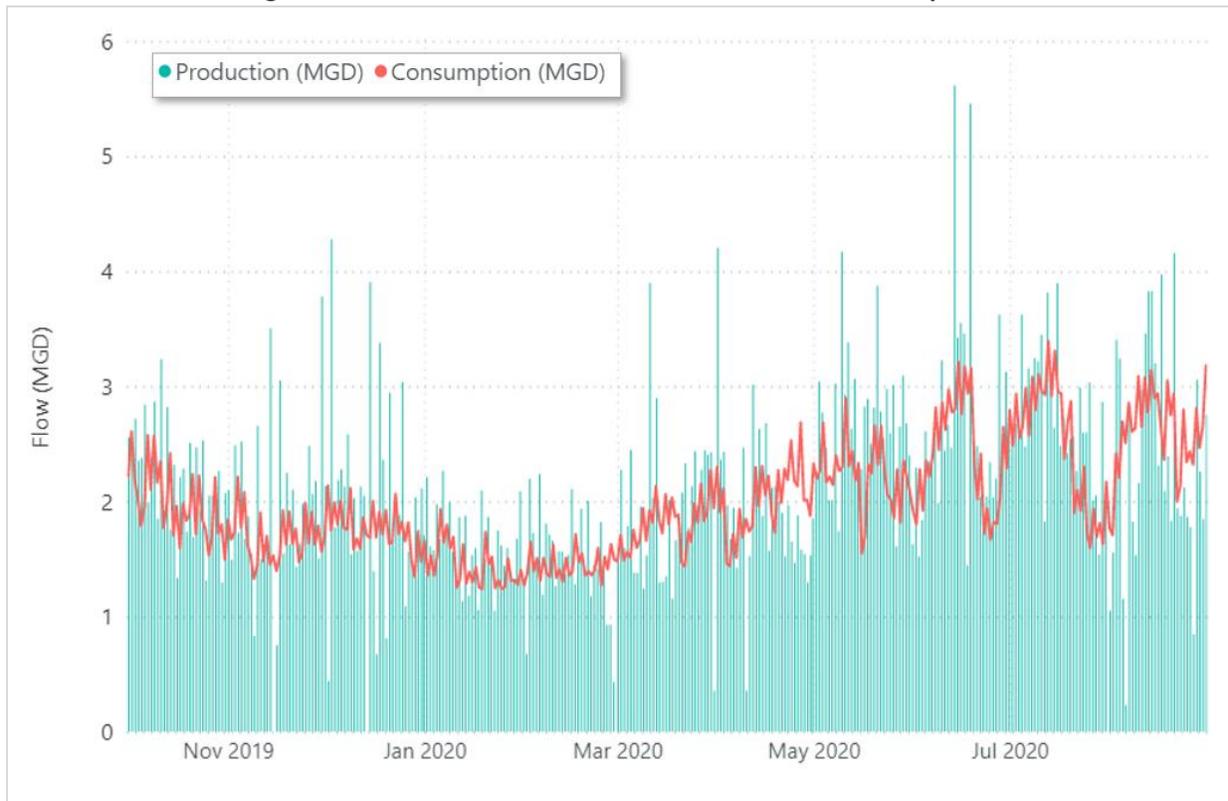
Figure 3-1: Example Smart Water Meter Diurnal Patterns



#### 3.2.1 Water Production Data vs. Smart Water Meter Consumption Data

Daily water production data is utilized to assess total water system demand for water supply and includes the volume of water required to fill ground and elevated storage tanks. Hourly smart water meter data is utilized for distributing demands and identifying the timing of peak hourly demands at an individual customer level or by class or rate schedule (residential, commercial, or irrigation). Figure 3-2 compares daily water production and smart water meter consumption data for the 1-year period from October 1, 2019 to September 30, 2020. The figure shows that the maximum day consumption data is up to 2.2 MGD lower than the maximum day production; however, the average percent difference over the year is within ~7.5%. The modeled demands for system analyses were based on the water production data.

**Figure 3-2: Historical Water Production and Consumption**

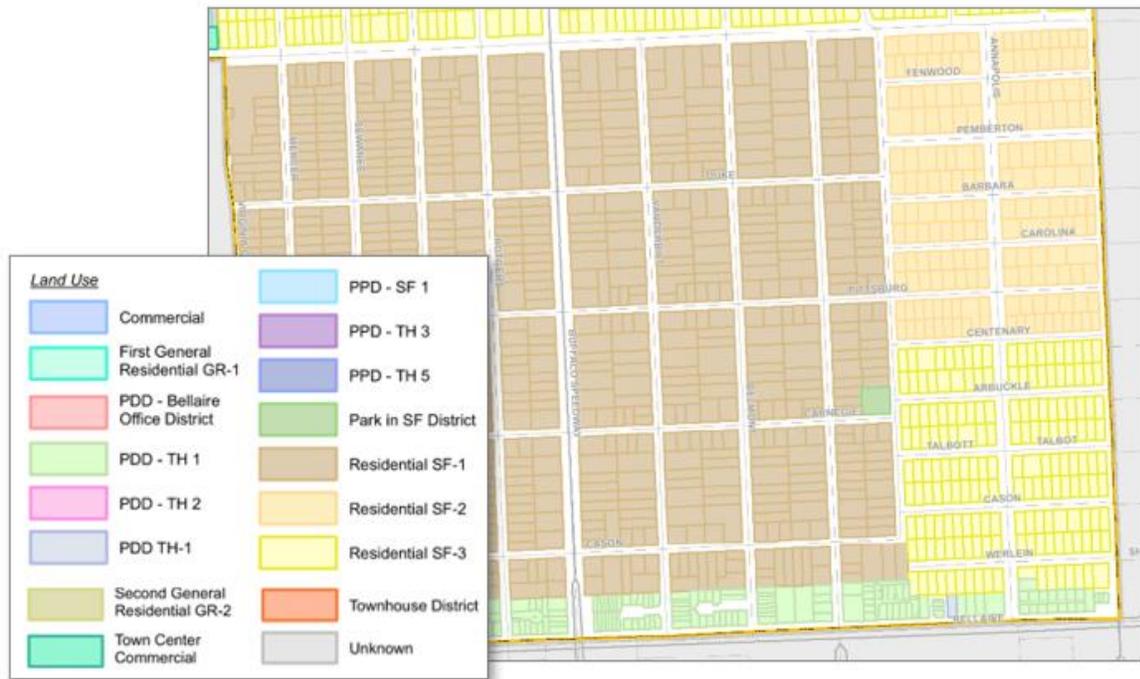


### 3.3 PROJECTED WATER DEMANDS FROM REDEVELOPMENT

West University is landlocked and fully built out. However, there is potential for an increase in water demands due to redevelopment of single-family homes throughout the City. When the smaller, older homes in West University are replaced with larger residences, the existing ¾-inch water meter is often converted into an irrigation meter and a new 1-inch meter is installed. These water meters and the corresponding increase in water usage are recorded in the City’s smart water meter data. FNI conducted a water demand analysis to study the effects of this redevelopment and develop a corresponding water demand projection.

FNI utilized Harris County Appraisal District (HCAD) parcel data and the City’s land use information as shown on **Figure 3-3** to identify single-family homes less than or equal to 2,700 square feet. These lots were identified for potential redevelopment. Smart water meter data was analyzed to determine the difference in water consumption between the smaller homes and the newer, larger residences.

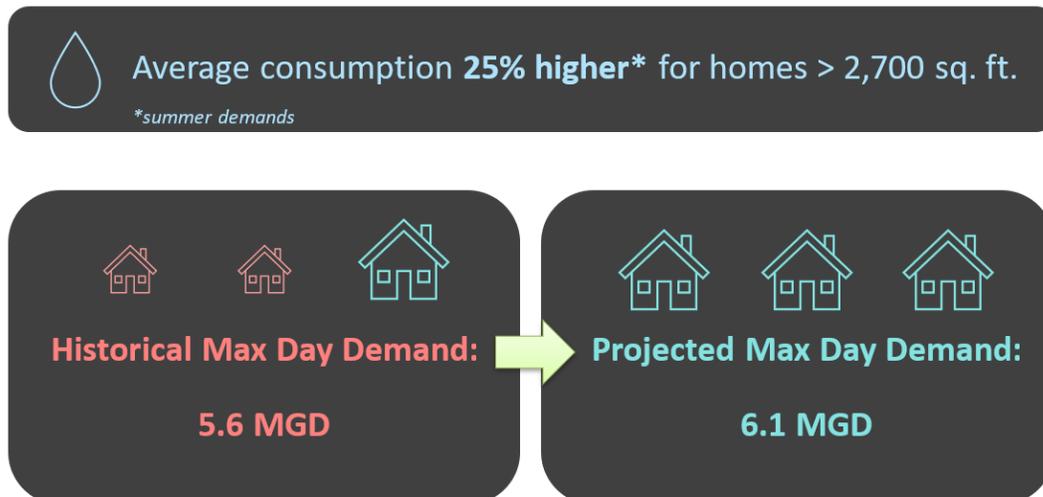
**Figure 3-3: Excerpt of Subdivision and Zoning**



Redevelopment Demand Analysis

The smart water meter data shows the average consumption during summer is 25% higher for residences greater than 2,700 square feet as compared to the smaller homes. If the remaining homes less than 2,700 square feet in West University were to be replaced with larger residences with this higher water consumption, the analysis projects that the City-wide maximum day water demand would increase from 5.6 MGD to 6.1 MGD. The redevelopment demand analysis is summarized on **Figure 3-4**.

**Figure 3-4: Redevelopment Demand Analysis**



## 4.0 FIELD TESTING

### 4.1 PRESSURE TESTING

Field pressure testing was conducted from August 12 to August 24, 2020. A total of eight (8) pressure recorders were installed at hydrants throughout the distribution system to capture system pressures and operational conditions and are shown on **Figure 4-1**. Pressure recorder location information and recorded ranges of pressure at each location are provided in **Table 4-1**. None of the pressure recorder locations indicated readings below the TCEQ required minimum pressure of 35 psi. **Figure 4-2** shows recorded pressure at all locations during pressure testing. Individual plots for each pressure recorder are included in **Appendix D**. The pressure recorded data was utilized for hydraulic model calibration and system analyses.

**Table 4-1: Field Pressure Testing Results (8/12/2020 – 8/24/2020)**

Pressure Recorder No.	Location	Observed Pressure Range (psi)
PR-01	4256 Albans Rd.	49 - 68
PR-02	3701 Nottingham	50 - 70
PR-03	Wakeforest Water Plant	54 - 73
PR-04	Milton Water Plant	51 - 72
PR-05	3025 University	47 - 68
PR-06	4153 Oberlin	50 - 68
PR-07	2737 Arbuckle	46 - 68
PR-08	Bellaire EST	49 - 64

### 4.2 PUMP TESTING

FNI retained Smith Pump Company, Inc. (Smith Pump) to perform field pump testing on all six booster pumps in West University’s distribution system in September 2020. Smith Pump developed a tested pump curve for each booster pump. These field-tested pump curves were utilized in the hydraulic water model and are discussed further in the modeling discussion in **Appendix F**. The tested pump curves are included in the *Milton Street Pump Station Field Assessment* and the *Wakeforest Pump Station Field Assessment* in **Appendix E**. An example of the tested pump curves is shown on **Figure 4-3**.

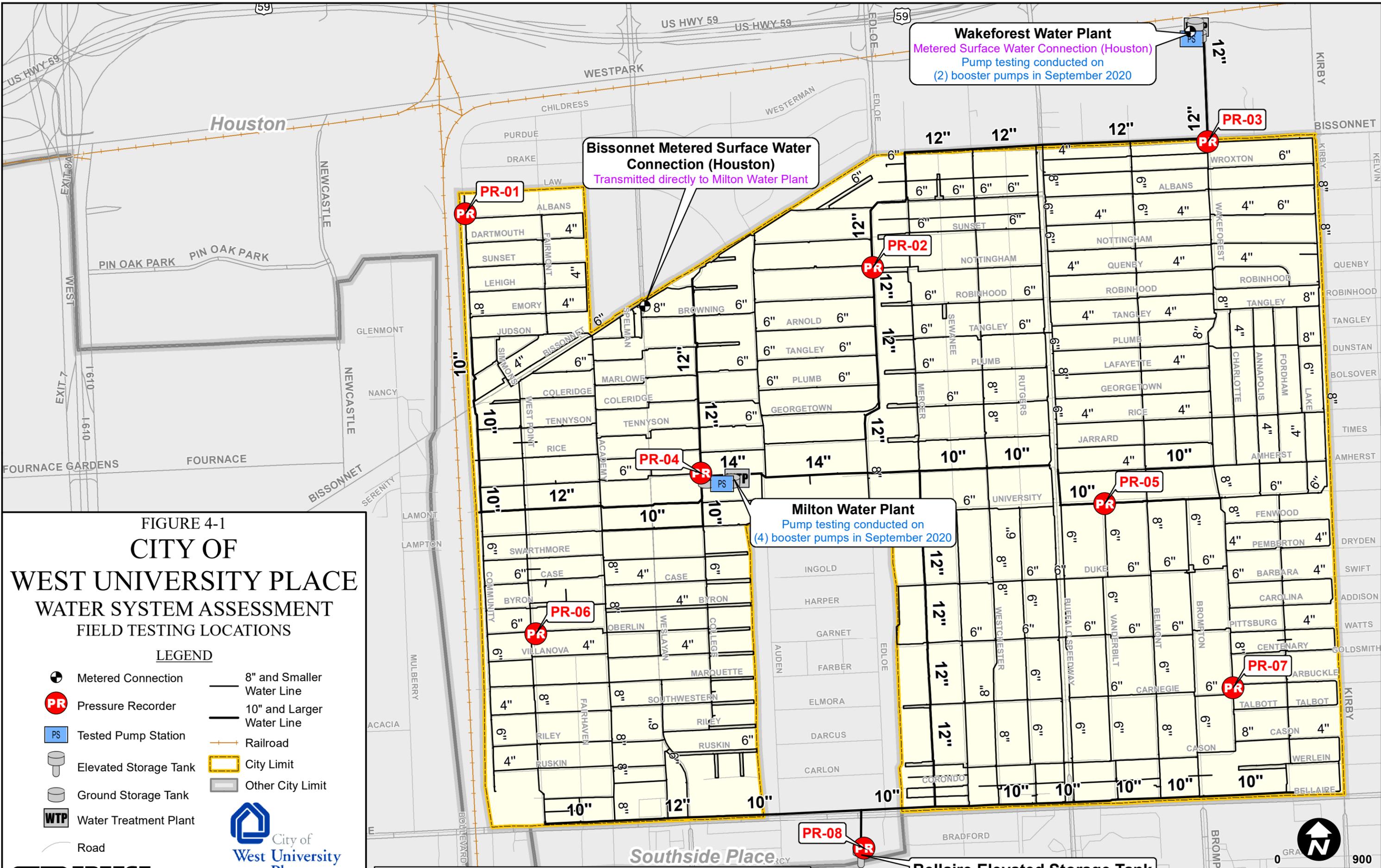


FIGURE 4-1  
CITY OF  
WEST UNIVERSITY PLACE  
WATER SYSTEM ASSESSMENT  
FIELD TESTING LOCATIONS

**LEGEND**

- Metered Connection
- Pressure Recorder
- Tested Pump Station
- Elevated Storage Tank
- Ground Storage Tank
- Water Treatment Plant
- Road
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Railroad
- City Limit
- Other City Limit



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Figure 4-2: Field Pressure Recorder Data

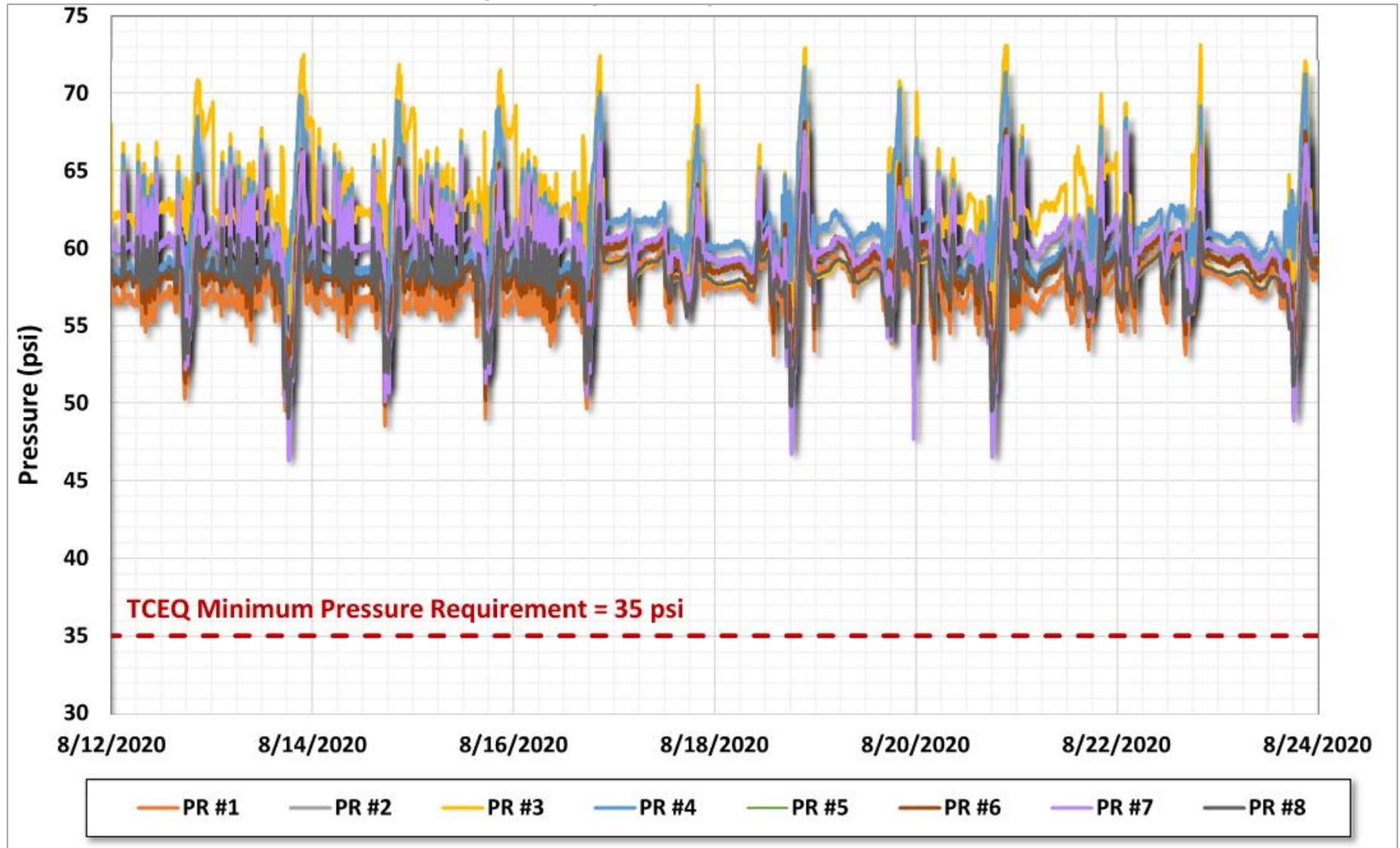
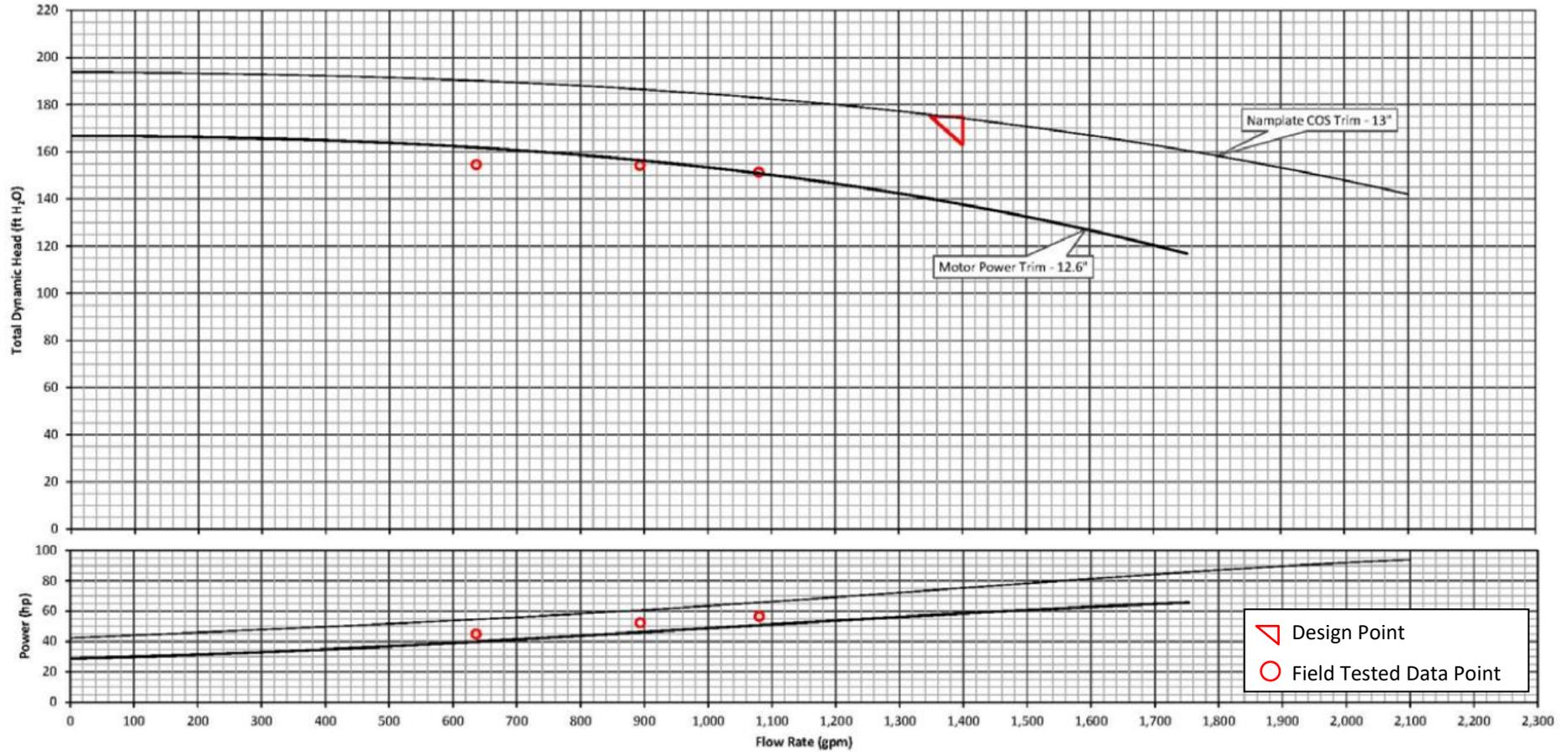


Figure 4-3: Milton Booster Pump 1 Field Tested Pump Curve



## 5.0 MODEL DEVELOPMENT AND CALIBRATION

For this study, a hydraulic water model was developed to analyze and evaluate West University's distribution system. The model was constructed in InfoWater® hydraulic modeling software by Innovyze, which makes use of engineering equations and mathematical algorithms to determine the flows and pressures that would occur in a distribution system under a specified set of conditions. The hydraulic water model was created utilizing the City's GIS files, facility inventory information, and data collected during field testing (Section 4.0). A 24-hour extended period simulation (EPS) model calibration was performed to verify that the hydraulic model accurately represents West University's distribution system operations. Details of the hydraulic water model and calibration process are documented in Appendix F. A screenshot of the hydraulic model is shown on Figure 5-1.

Figure 5-1: West University's Hydraulic Water Model



## 6.0 DISTRIBUTION SYSTEM ANALYSES

Hydraulic analyses were conducted to identify deficiencies in West University’s existing water distribution system and to develop water system improvement recommendations. Various combinations of improvements and modifications were investigated to determine the most appropriate approach for improving system operations and meeting projected water demand.

### 6.1 TCEQ ANALYSES

As a public water utility, the City of West University Place must comply with the rules and regulations for public water systems set forth by the Texas Commission on Environmental Quality (TCEQ) in Chapter 290. FNI conducted an existing system evaluation to compare the City’s water supply, storage, and pumping capacity against TCEQ regulations. This evaluation utilizes the existing number of **6,200 connections** from TCEQ Drinking Water Watch.

#### 6.1.1 Water Supply

The City is required to meet the TCEQ water supply requirement of two or more wells having a total capacity of 0.6 gpm per connection. West University Place’s tested groundwater supply capacity was combined with the City’s peak usage restriction from its water supply contract with Houston and used for this analysis. The estimated existing number of connections was used to calculate the minimum required water supply capacity. **Table 6-1** presents the TCEQ water supply requirements for the existing water system. Based on the regulations, the City is currently in compliance with the minimum water supply capacity requirement.

**Table 6-1: Existing TCEQ Water Supply Capacity Requirements**

Population	Number of Connections <sup>(1)</sup>	Existing Water Supply Capacity (MGD)		TCEQ Requirement <sup>(2)</sup> 0.6 gpm/conn. (MGD)
15,741	6,200	6.73	>	5.36

(1) Existing connections TCEQ Drinking Water Watch

(2) According to TCEQ Chapter 290.45(b)(1)(D)(i).

### 6.1.2 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. **Table 6-2** presents the TCEQ storage requirements for West University Place’s existing water system. Based on the regulations, the City is in compliance with the minimum requirements for total and elevated storage. The City currently provides over 121 gallons per connection of elevated storage.

**Table 6-2: Existing TCEQ Storage Requirements**

Population	Number of Connections	Total Storage (MG)			Elevated Storage (MG)			
		Existing		Required <sup>(1)</sup> (200 gal/conn)	Existing		Required <sup>(2)</sup> (100 gal/conn)	Optional (200 gal/conn)
15,741	6,200	3.65	>	1.24	0.75	>	0.62	1.24

(1) According to TCEQ Chapter 290.45(b)(1)(D)(ii).

(2) According to TCEQ Chapter 290.45(b)(1)(D)(iv).

### 6.1.3 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 6-3**.

**Table 6-3: General TCEQ Service Pumping Requirements**

Condition		Service Pumping Capacity Requirement <sup>(1)</sup>
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	<b>The Lesser of (a) or (b):</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).

West University Place does not have greater than 200 gallons per connection of elevated storage; therefore, *Condition 1* from **Table 6-3** is not satisfied. Based on the City’s elevated storage capacity, *Condition 2b* is lesser of *Condition 2* and governs 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 **Appendix G** 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 system. These model results are discussed further in **Section 6.2**.

## 6.2 HYDRAULIC ANALYSIS

A 24-hour EPS hydraulic model analysis was performed on the distribution system under projected maximum day demand conditions. By examining the distribution system under 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. An EPS model analysis evaluates the ability of the system to provide adequate supply to meet demands while maintaining levels in storage facilities.

### Demand Conditions

The water system analyses discussed in this section utilized EPS model runs with the projected 6.1 MGD demands discussed in **Section 3.3**. During a maximum day EPS analysis, the peak hour demand is simulated through the use of diurnal patterns. The peak hour demand represents the single hour of the year with the highest system demand and is used to assess the ability of the distribution system to maintain minimum residual pressures. Lower demand periods throughout the day are also simulated in EPS modeling. This is when the system’s ability to replenish storage tanks is evaluated.

### Pump Controls

The City also provided typical pump controls for both water plants based on the Bellaire EST level. The City’s set points are utilized under different operational scenarios and include set point guidelines, high usage, and deep cycle. These set points have options to lead with the **Wakeforest** pumps or the **Milton** pumps. During maximum day demand system analysis runs, FNI utilized the ‘high usage’ pump set points with **Milton** Water Plant leading. These set points are shown in **Table 6-4**.

**Table 6-4: Maximum Day Demand System Analysis Pump Controls**

Facility Name	Pump Number	Control	Pump On	Pump Off
<b>Milton Water Plant</b>	Lead	Bellaire EST Level (feet)	24	28.5
	Lag 1		22	23
	Lag 2		19	20
	Lag 3		17	19
<b>Wakeforest Water Plant</b>	Lead		23	24
	Lag 1		19	22

### Minimum Pressures

Minimum pressures under the projected maximum day demands were analyzed using the 24-hour EPS model run. Color-coded pressure maps were prepared to illustrate the residual pressure calculated at model junctions and are included in **Appendix G**. Minimum pressures shown on the maps represent the lowest value of the pressures experienced during the 24-hour simulation. **The model analysis shows that under the projected 6.1 MGD demand and firm pumping conditions (largest pump in the system out of service), the City is unable to maintain a minimum pressure of at least 35 psi throughout the system.**

### Headloss

Headloss throughout the existing system was also analyzed during the projected maximum day system analysis model run to identify water lines with high head loss that could contribute to low system pressures. **The 12-inch distribution line leaving the Wakeforest Water Plant was shown in the model to have high headloss causing a significant loss of pressure in the water system.** Additionally, it was noted that the City has a high percentage of 4-inch and smaller water mains that contribute to high headloss and lower system pressures.

### Fire Flow

To evaluate the fire suppression capabilities of the system, a fire flow model analysis was conducted under projected maximum day demand conditions. TCEQ requires a minimum residual pressure of 20 psi be maintained under fire flow conditions. 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 small lines (less than 6-inches) and dead-end lines. The majority of the City has an available fire flow greater than 1,500 gpm.** The fire flow map can be found in **Appendix G**.

## **6.3 WATER AGE AND SOURCE TRACE MODELING**

### Water Age

Water age modeling was conducted under average day demand conditions (2.2 MGD) with two different operational scenarios: **1)** Milton Water Plant pumps leading and **2)** Wakeforest Water Plant pumps leading. For the purposes of alternatives comparison, the initial age of the surface water delivered to the

ground storage tanks at both water plants was assumed to be zero. The model scenarios were configured to run 60-day simulations, and the water age results were averaged over the last 24 hours of each simulation period. Dead end nodes and nodes with no demand were excluded from analysis.

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. Water age results are included in **Appendix G**.

#### Source Trace

In addition to water age modeling, the source tracing module in the Innovyze® InfoWater software was utilized to assess the influence areas of the City's water plants. Source tracing calculates the percentage of water reaching any node in the network that had its origin at a particular source. It can show to what degree water from a given source blends with that from other sources, and how the spatial pattern of this blending changes over time.

Source trace modeling was conducted under average day demand conditions (2.2 MGD) under two different operational scenarios: **1)** Milton Water Plant leading and **2)** Wakeforest Water Plant leading. Source trace mapping is included in **Appendix G**. The contour gradient shows the contribution percentages of the Milton and Wakeforest Water Plants.

## **6.4 WATER SYSTEM RESILIENCY**

Water system analyses were conducted to evaluate system resiliency under two key operating conditions:

- Removal of the Bellaire EST for scheduled replacement
- Loss of a water well or City of Houston surface water

### 6.4.1 Bellaire EST Analysis

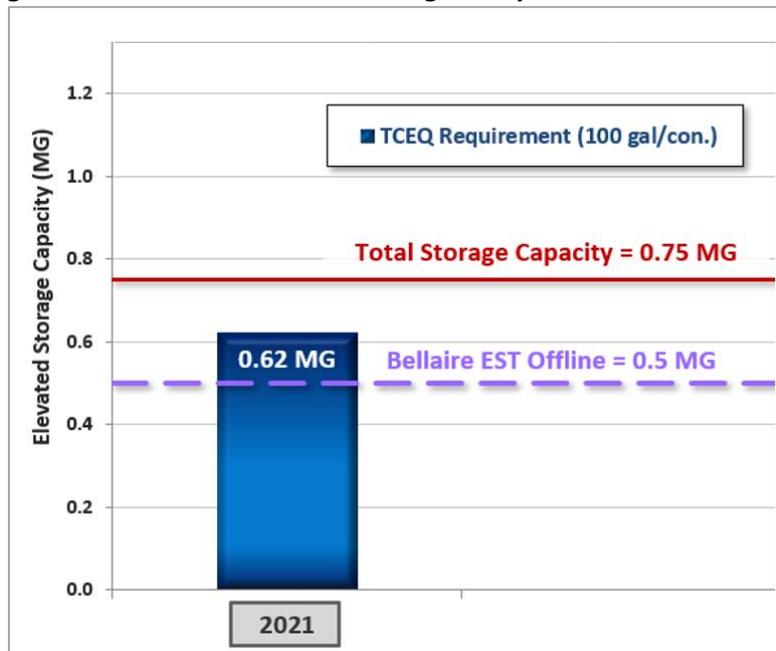
The Bellaire EST was constructed in 1935 and will need to be replaced in the near future due to age. The following two analyses were conducted to assess whether the Bellaire EST could be removed before a replacement elevated tank is constructed:

- TCEQ minimum requirements for elevated storage
- Hydraulic modeling of the existing system under existing maximum day demands (5.6 MGD)

The City is unable to meet the TCEQ elevated storage capacity requirement of 100 gallons per connection with Bellaire EST offline. This analysis is shown on **Figure 6-2**.

The water model was utilized to simulate the removal of the Bellaire EST under the existing 5.6 MGD maximum day demand conditions. **Under these demand conditions, the model shows that minimum pressures fall below 35 psi indicating the City is unable to take Bellaire EST offline under existing operations.**

**Figure 6-1: TCEQ Elevated Storage Analysis Without Bellaire EST**



### 6.4.2 Water Supply Analysis

In February of 2020 and February of 2021, Houston experienced interruptions in their water system operations and was forced to issue boil water notices. During both of these events, West University isolated the City’s water system from Houston and operated solely on groundwater from its two wells. Both events occurred during lower irrigation and system demand periods and West University was able to supply the City’s water demands via the two groundwater wells. This study evaluated West University’s ability to supply the projected maximum day demands under three scenarios:

#### 1. City of Houston Surface Water Offline

- Loss of Houston Surface Water

#### 2. Milton Water Plant Offline

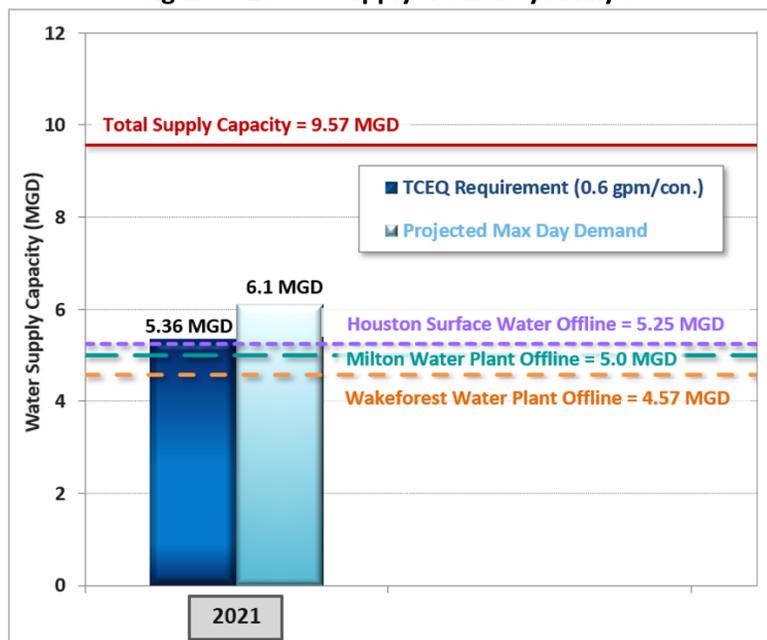
- Loss of the Milton Well and the Milton Surface Water Connection

#### 3. Wakeforest Water Plant Offline

- Loss of the Wakeforest Well and the Wakeforest Surface Water Connection

Figure 6-3 shows the water system supply capacities under the above scenarios compared to the TCEQ requirement of 0.6 gpm per connection and the projected maximum day demand. **This analysis shows West University cannot meet the TCEQ minimum supply requirement of 5.36 MGD, the existing maximum day demand of 5.6 MGD, or the projected maximum day demand of 6.1 MGD under any of the above three scenarios.**

Figure 6-2: Supply Resiliency Analysis



## 7.0 IMPROVEMENT RECOMMENDATIONS

Findings from this *Water System Assessment* study were utilized to develop water system recommendations for the City of West University Place in three overall categories: **1) Facilities** **2) Water Lines**, and **3) General System**. These improvement recommendations were developed based on the hydraulic modeling and capacity assessments and are discussed in more detail in the following sections. The recommendations also considered regulatory (TCEQ) requirements, water system resiliency, and the general condition of the water system facilities based on discussions with City staff. Water facility recommendations are summarized in **Table 7-1** and shown on **Figure 7-1**. The water line renewal recommendations are summarized in **Table 7-2** shown on **Figure 7-2**. It is understood that West University staff and IDS will be utilizing these recommendations to develop projects and opinions of probable construction costs (OPCCs) for the City’s Capital Improvements Plan (CIP). The general system recommendations are discussed in **Section 7.3**.

**Table 7-1: Overview of Facility Recommendations**

Recommendation		Additional Information
A	<b>Bellaire Elevated Storage Tank Replacement</b>	<ul style="list-style-type: none"> <li>Conduct siting study to select new EST location</li> <li>Construct replacement 750,000 gallon EST</li> </ul>
B	<b>New Water Plant</b>	<ul style="list-style-type: none"> <li>Conduct siting study to select new water plant location</li> <li>Construct new water plant that includes 1,500 gpm well, 3 MG ground storage, and 6,500 gpm firm distribution pumping</li> </ul>
C	<b>Milton Water Plant Rehab &amp; Improvements</b>	<ul style="list-style-type: none"> <li>Full water plant rehabilitation</li> <li>Replace both ground storage tanks</li> <li>Replace all four booster pumps and motors with VFDs</li> </ul>
D	<b>Wakeforest Water Plant Rehab &amp; Improvements</b>	<ul style="list-style-type: none"> <li>Full water plant rehabilitation</li> <li>Install flush valve on surface water interconnect</li> <li>install generator and transfer switch</li> <li>Replace both booster pumps and motors with VFDs</li> <li>Upsize 12-inch distribution line to 16-inches</li> </ul>

**Table 7-2: Overview of Water Line Renewal Recommendations**

Recommendation	Additional Information
<b>Upsize all 1, 2, and 4-inch Water Lines to 6-inches</b>	Upsize ~96,550 linear feet of water lines
<b>Replace and Upsize all Cast Iron Water Lines</b>	Replace and upsize ~20,900 linear feet of cast iron water lines
<b>Verify Unknown Water Line Materials</b>	Investigate material of ~6,640 linear feet of water lines and replace if material is found to be cast iron

Level of Service

The facility improvement recommendations allow for 1) independence from City of Houston service disruptions (Self Reliance), 2) a reduction in the likelihood of water facility failure, 3) the addition of system redundancy, 4) regulatory compliance, and 5) an increase in water system demands due to redevelopment. While the existing water system meets supply and storage capacity requirements, the model results show that the City would not be able to meet projected peak hourly demands with the largest pump out of service and maintain a minimum pressure of at least 35 psi throughout the system. The recommended improvements will address this deficiency.

The recommended system improvements (A-D) shown in **Table 7-1** were developed to mitigate the following threats to West University’s water system:  service disruptions from Houston,  infrastructure failure, and  violation of state regulations. **Table 7-3** summarizes the recommended infrastructure and the threats mitigated by each improvement.

**Table 7-3: Summary of Level of Service Considerations**

Recommendation		Mitigated Threats
(A)	Bellaire Elevated Storage Tank Replacement	
(B)	New Well	
	New Pump Station	 
(C)	Milton Water Plant Rehab & Improvements	 
(D)	Wakeforest Water Plant Rehab & Improvements	 

## 7.1 FACILITY RECOMMENDATIONS

### Recommendation A - Bellaire Elevated Storage Tank Replacement

**Summary:** In order to maintain regulatory compliance and to mitigate against infrastructure failure, it is recommended to construct a replacement 750,000 gallon elevated storage tank (EST) at a different location than the existing Bellaire EST site. To identify the new EST site, it is recommended to conduct a siting study that incorporates real estate considerations and hydraulic modeling. A minimum of 0.3 acres (depending on the parcel shape) is recommended for the new EST site. It is recommended that the new facility be generally located within a half mile from West University's City limits. Hydraulic modeling should be incorporated in the siting study as potential siting locations could have hydraulic advantages or require different infrastructure improvements to connect the new EST to the existing system.

#### **Project Drivers:**

**Tank Replacement:** The Bellaire EST was constructed in 1935 and will need to be replaced in the near future due to age. This EST has exceeded the typical life expectancy of elevated storage tanks.

**New Site:** The existing Bellaire EST is on a small site (0.165 acres) and does not have adequate room to construct a replacement tank while keeping Bellaire in service. The construction of a replacement tank on site would require the Bellaire EST to be offline for an extended period of time. The water model shows that the West University water system is unable to meet the TCEQ minimum pressure requirements with the Bellaire EST offline. Therefore, the replacement EST will need to be constructed in a new location to allow the Bellaire EST to remain online during the construction period. Once the new EST is constructed and in service, the existing Bellaire EST can be decommissioned.

**EST Sizing:** The proposed size of 750,000 gallons will provide over 200 gallons of elevated storage per connection for West University. This will provide an additional buffer for peak hour demands and fire flows and reduce the City's booster pumping capacity requirement from a TCEQ regulatory standpoint. The proposed tank size also considers the projected increase in water demands from residential redevelopment.

### Recommendation B - New Water Plant (Well, GST, and Pump Station)

**Summary:** Depending on the desired level of service, it is recommended that West University construct a new water plant that includes a 1,500 gpm well, 3 MG of ground storage tank volume, 6,500 gpm (9.4 MGD) of firm booster pumping capacity, and an additional metered connection to Houston surface water. To identify the location of this facility, it is recommended to conduct a siting study that incorporates both real estate considerations and hydraulic modeling. A minimum of one acre (depending on parcel shape) is recommended for the new water plant site. The hydraulic modeling of the proposed facility and distribution system will be important as the siting of the new plant would impact pump selection and distribution system line sizing/connectivity. It is anticipated that upsizing one or more water line(s) will be required to connect the new water plant to the distribution system.

#### **Project Drivers (Water System Resiliency):**

- West University cannot supply the City's maximum day water demands without surface water from the City of Houston. In February of 2020 and February of 2021, Houston experienced interruptions in their water system operations and was forced to issue boil water notices. During both of these events, West University isolated the City's water system from Houston and operated solely on groundwater from its two wells. Since these interruptions occurred during lower demand periods, the City of West University was able to meet the water demands during these periods. West University cannot supply maximum day (summer) demands with its existing wells.
- The Milton Water Plant is anticipated to need a full rehab which would likely require the entire facility to be taken offline through a summer demand period. Currently, there is not enough pumping at Wakeforest to take the Milton plant offline to conduct a facility rehab.
- A new water plant with a well and a metered connection to Houston water would provide resiliency against an interruption in service from either the Milton or the Wakeforest water plants.

### Recommendation C - Milton Water Plant Rehab & Improvements

**Summary:** Based on the facility's age, it is recommended to budget for a full rehab of the Milton Water Plant in the future. In the near-term, a full condition assessment should be conducted to inform the needed upgrades, develop rehab costs, and identify any critical components that should be addressed prior to the full facility rehab. It is noted that the MCC was replaced in 2009.

**Project Drivers:** The Milton Water Plant is an aging facility that should be programmed for a full rehab. This *Water System Assessment* study focused on a modeling and capacity assessment and did not include a condition assessment of the water facilities.

**Additional Considerations:**

- The Milton Water Plant is a critical piece of infrastructure for water supply and distribution to West University that will reach the end of its useful life at some point in the future.
- As part of the full facility rehab, it is recommended to replace both ground storage tanks, replace all four booster pumps and motors, and install variable frequency drives (VFDs) to give the City more operational control of the pump station. The booster pump and motor replacements will also require replacement of associated electrical equipment. It is anticipated that a full rehab of the Milton Water Plant will require the entire facility to be taken offline through a summer demand period.
- It is recommended to incorporate hydraulic modeling into the rehab design and pump selection for the Milton Water Plant. The analysis conducted as part of this study identified different operational head ranges on the existing pumps utilizing the field-tested pump curves. Additionally, the recommended line replacements in the **Water Line Renewal** projects will change the system curve for the Milton pump station.
- Under the existing system configuration, the Milton Water Plant is critically important to system operations and cannot be taken offline for a full rehab. It is anticipated that a full facility rehab would occur after the new water plant comes online (**Recommendation B**) to provide the needed system pumping while the Milton Water Plant is being rehabbed.

## Recommendation D - Wakeforest Water Plant Rehab & Improvements

**Summary:** It is recommended to make the following improvements at the Wakeforest Water Plant:

- Install a generator and transfer switch
- Install a flush valve on the Houston surface water connection
- Upsize the 12-inch cast iron distribution line leaving the Wakeforest Water Plant to 16-inches
- Install a new chlorine analyzer

Based on the facility's age, it is also recommended to budget for a full rehab of the Wakeforest Water Plant in the future. In the near-term, a full condition assessment should be conducted to inform the needed upgrades, develop rehab costs, and identify any critical components that should be addressed prior to the full facility rehab. This *Water System Assessment* study focused on a modeling and capacity assessment and did not include a condition assessment of the water facilities.

**Project Drivers:** A generator and transfer switch at the Wakeforest Water Plant would increase system resiliency and help to mitigate against interruptions in service during events such as freezes and hurricanes. The installation of a flush valve on the Houston surface water connection will help the City maintain water quality for West University after a boil water notice or other potential water quality issue in the City of Houston's water system. Upsizing the 12-inch distribution line from Wakeforest to the distribution system (approx. 2,000 LF) will reduce headloss and lead to an increase in water pressure and available fire flows in portions of the distribution system. Recent ground storage tank inspection reports provided by the City indicated a need for future rehab.

**Additional Considerations:**

- As part of the full facility rehab, it is recommended to replace both booster pumps and motors and install variable frequency drives (VFDs) to give the City more operational control of the pump station. The booster pump and motor replacements will also require replacement of associated electrical equipment.
- It is recommended to incorporate hydraulic modeling into the rehab design and pump selection for the Wakeforest Water Plant. The recommended replacement of the 12-inch water line leaving the Wakeforest facility and the upsizing of the distribution system lines in the **Water Line Renewal** projects will change the system curve for the Wakeforest pump station.



## 7.2 WATER LINE RENEWAL RECOMMENDATIONS

Utilizing the hydraulic water model and diameter and material information from the City's GIS data, FNI identified water lines to be upsized or replaced as part of a Water Line Renewal Program. The water lines recommended for replacement are shown on **Figure 7-2**. It is recommended that all water line replacements be coordinated with planned roadway improvements. The breakdown of linear footage by diameter for water line renewal recommendations is shown in **Table 7-4**.

### *Upsize all 1-inch, 2-inch, and 4-Inch Water Lines to 6-Inch Lines*

**Summary:** Approximately 32% of the City's water mains are less than or equal to 4-inches in diameter. It is recommended to conduct a renewal program to systematically replace these small diameter lines with 6-inch lines.

**Project Drivers:** Small diameter water lines limit distribution pressures and fire flows to large portions of the existing system. The recommended renewal line improvements will help to increase available fire flow capacity and reduce headloss in the system.

**Note:** All 1-inch, 2-inch, and 4-inch cast iron water lines were included in this upsizing recommendation.

### *Replace and Upsize all Cast Iron Water Lines*

**Project Overview:** Approximately 7.5% of the City's water mains are cast iron. It is recommended to replace and upsize all cast iron lines in the West University system as roadway projects are completed or as funds are available.

### *Investigate Unknown Water Line Material*

**Summary:** Approximately 3.7% of the City's water mains have unknown materials. It is recommended to verify any unknown pipe materials that have diameters greater than 4-inches, and to replace any that are cast iron.

**Table 7-4: Water Line Renewal Program Linear Footage by Diameter**

Diameter (in)	Linear Footage
<i>Cast Iron Lines</i>	
6-inch	5,110
8-inch	8,871
10-inch	1,766
12-inch	2,798
14-inch	2,346
<b>Total</b>	<b>20,891</b>
<i>Unknown Line Material</i>	
6-inch	2,274
8-inch	2,843
10-inch	1,415
12-inch	106
<b>Total</b>	<b>6,639</b>
<i>Upsizing Recommendations</i>	
1-inch	12
2-inch	21,172
4-inch	75,362
<b>Total</b>	<b>96,546</b>

### 7.3 REVISED LEAD AND COPPER RULE

The EPA’s Lead and Copper Rule is currently undergoing a revision aimed at removing harmful levels of lead from drinking water, requiring cities to take some level of action. The EPA’s proposed deadline of the Revised Lead and Copper Rule is September 16, 2024 but is still currently under review.

### 7.4 IN PROGRESS AND COMPLETED IMPROVEMENTS

The City recently completed installation of a flush valve at the Milton Water Plant and is currently conducting an American Water Infrastructure Act (AWIA) study to assess the City’s risk and resiliency and develop an emergency response plan.

FIGURE 7-2  
**CITY OF WEST UNIVERSITY PLACE**  
 WATER SYSTEM ASSESSMENT  
 WATER LINE RENEWAL RECOMMENDATIONS

**LEGEND**

*Existing System*

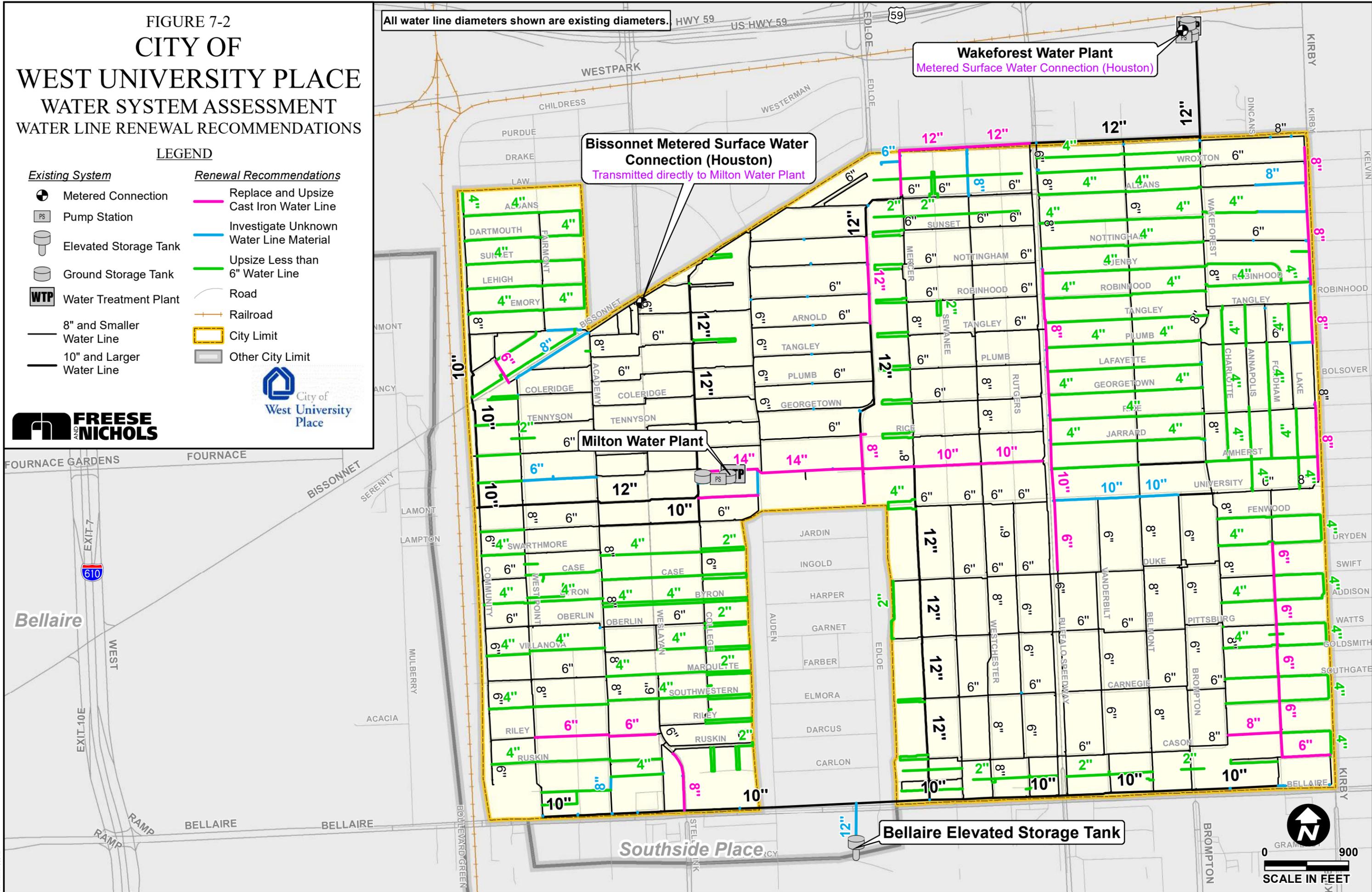
- Metered Connection
- Pump Station
- Elevated Storage Tank
- Ground Storage Tank
- Water Treatment Plant
- 8" and Smaller Water Line
- 10" and Larger Water Line

*Renewal Recommendations*

- Replace and Upsize Cast Iron Water Line
- Investigate Unknown Water Line Material
- Upsize Less than 6" Water Line
- Road
- Railroad
- City Limit
- Other City Limit



All water line diameters shown are existing diameters.



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