WATER MASTER PLAN

Prepared for:

City of Waco

October 2015

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Prepared for:

City of Waco

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FNI Project No.WAL13575
City Project No. 162737

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EXECUTIVE SUMMARY

1.0 Introduction

The City of Waco is a growing community located in central Texas, within McLennan County. The City currently provides water service to 131,139 people and is home to Baylor University. The population within the service area is projected to grow by almost 40,000 people in the next 25 years. Accommodating this growth in an efficient and cost effective manner, while also focusing on the maintenance of existing water system assets, is the purpose of this 2015 Water Master Plan.

The project team of Freese and Nichols, Inc. and The Wallace Group was retained in 2013 by the City of Waco to prepare a Water Master Plan. The goals of the Water Master Plan were to evaluate the integrity of the existing water distribution system and water supply to recommend a phased and integrated Capital Improvement Plan (CIP) through the year 2040. The recommended improvements will serve as a basis for the design, construction, and financing of facilities required to meet Waco's water capacity and system renewal needs. The major elements of the scope of this project included:

- Population and Water Demand Projections
- Water Supply Analysis
- Hydraulic Water Model Development
- Field Testing and Water Model Calibration
- Existing and Future System Hydraulic Analysis
- Water System Capital Improvement Plan
- Water Master Plan Report

2.0 Population

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

The City of Waco Planning Department and the Waco MPO worked together to develop the 2010 and 2040 population projections. The City utilized the Waco MPO TAZs with 2010 and 2040. The City's Planning and Zoning Services staff also developed 2022 population projections for the master planning effort. For the Water Master Plan, FNI and TWG utilized the TAZ projections to plan for the 2015, 2020, 2030, and 2040 planning periods. **Table ES-1** shows the population projections for 2015, 2020, 2030 and 2040. The yearly growth rates for each planning period based on the TAZ projections from the MPO that fell within the water service areas.

Table ES-1: Population Projections

Year	Population	Yearly Growth Rate
2015	131,139	1.06%
2020	138,539	1.10%
2030	154,179	1.08%
2040	167,633	0.84%
Average	**-**	**0.99%**

3.0 Water Demands

A water utility must be able to supply water at rates that fluctuate over a wide range. Rates most important to the hydraulic design and operation of a water distribution system are average day (AD), maximum day (MD), and peak hour (PH). Average day use is the total annual water use divided by the number of days in the year. The average day 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. Treatment and supply facilities are typically designed based on the maximum day rate. 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.

Water demands were projected for existing, 2020, 2030 and 2040 conditions. The evaluation of historical data provided a basis for determining the design criteria used to project water demands. Large non-residential water users were also examined to ensure those demands were being accounted for in future projections. Three years of billing data were analyzed to determine an average water usage for the top users. After analyzing the residential and commercial demand, the large customer demands and the wholesale customer demands, the project team developed multiple alternatives for future water demands to be served by the City of Waco. Due to changing dynamics in water supply in McLennan County, FNI/TWG worked with the City to develop potential water demand projection alternatives. For the purpose of developing the capital improvements plan (CIP), the project team utilized Alternative 2:

100% of Waco and 50% of Wholesale Demand for Peak Day Demands (50% of Peak demand to be met by conjunctive use with groundwater supply), since it makes the most sense for the City of Waco and limits the amount of additional water supplies needed in the future. **Table ES-2** summarizes the projected water demands for the City of Waco for the 2015, 2020, 2030 and 2040 planning periods.

Table ES-2: Water Demand Projections

Year	Waco Avg. Day Demand (mgd)	Wholesale Avg. Day Demand (mgd)	Total Avg. Day Water Demand (mgd)	Waco MD to AD Peaking Factor	Waco Max. Day Demand (mgd)	Wholesale Max. Day Demand (mgd)	Total Max. Day Water Demand (mgd)
2015	**28.33**	**7.91**	**36.24**	**1.70**	**48.17**	**9.87**	**58.04**
2020	**31.74**	**11.13**	**42.87**	**1.70**	**53.96**	**12.10**	**66.06**
2030	**35.73**	**12.20**	**47.93**	**1.70**	**60.74**	**13.25**	**73.99**
2040	**39.49**	**13.18**	**52.66**	**1.70**	**67.13**	**15.15**	**82.28**

4.0 Water Supply Analysis

The primary objective of the water supply analysis is to evaluate how much supply is available from existing supplies and compare the existing supplies and projected demands to identify supply shortages. Another objective is to develop strategies for potential future supply sources required to meet the projected needs for future decades.

4.1 Existing Supplies

Waco holds Texas water rights for supplies from Lake Brazos and Lake Waco. Lake Waco is owned and operated by the U.S. Army Corps of Engineers (USACE). The reservoir is located on the Bosque River in McLennan County. The City of Waco contracts with USACE for storage space in the reservoir and owns two Texas water rights authorizing storage and use from the reservoir: Certificate of Adjudication (CA) 12-2315 and Permit/Application P-5094. City of Waco also has a water right to access supplies from Lake Brazos authorized by CA 12-4340. The water right authorizes: Diversion of 5,600 acre-feet for municipal and industrial uses. City of Waco is currently operating two water wells within the city limits.

4.2 Water Availability Modeling

Water availability modeling was performed to develop yield estimates for Lake Waco. The TCEQ Brazos WAM was used to estimate the reservoir yield for the period of record. However, the period of record in this model extended from 1940-1997 and did not include hydrology for the recent years. As part of this study, a separate spreadsheet model was developed to extend the hydrology from 1997-2014. A firm yield model was also developed to determine the firm yield of Lake Waco using the combined hydrology from the WAM (1940-1996) and the spreadsheet model (1997-2014).

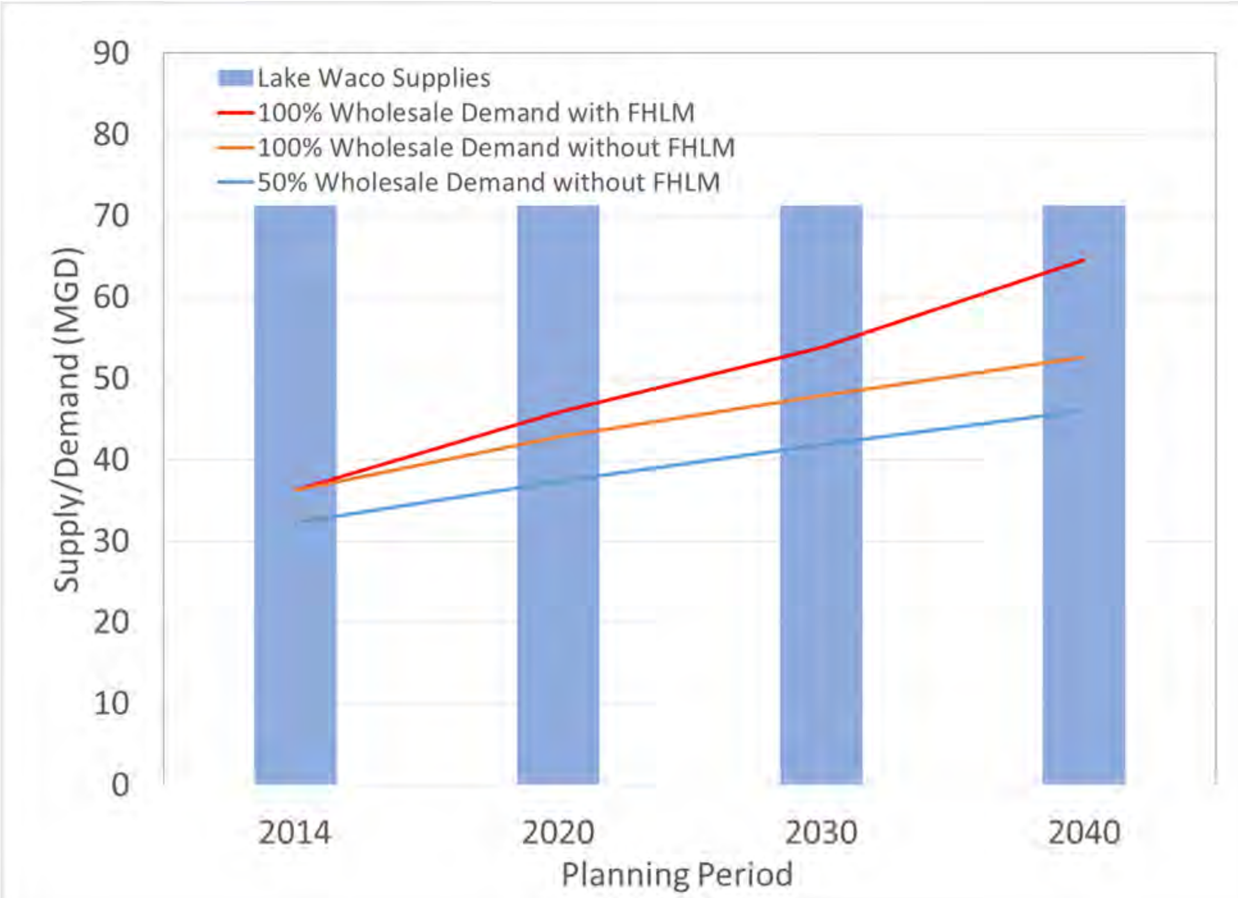
Firm yield was calculated using the Modified Brazos WAM. Under current conditions, the firm yield of Lake Waco is 81,070 acre-feet per year, which is 1,200 acre-feet per year more than the authorized diversion of 79,870 acre-feet per year. The additional yield is small and probably not worth pursuing additional authorizations and will eventually disappear with further sediment accumulation, so the current available supply using the Modified Brazos WAM would be 79,870 acre-feet per year. The yield computed using the Modified Brazos WAM reflected the worst case scenario for 1940 through 1996. The critical period for this analysis is from 1951 through 1956. The critical period, or critical drought, is the period of low inflow that determines the yield of a reservoir.

5.0 Water Supply Strategies

Three future demand scenarios were considered for developing the CIP plan to address City of Waco's infrastructure needs for the future decades. Alternative 2 was chosen since it represents a conjunctive use strategy that results in a decrease on the dependency of ground water usage to meet maximum day demands throughout McLennan County. A study of the local groundwater suggests that the current usage rates are not sustainable into the 2070 planning period. The future demand projections are presented in **Table ES-2** above.

The total permitted diversions from Lake Waco are 79,870 acre-feet/year. The firm yield of Lake Waco based on the water availability modeling is about 81,070 acre-feet/year. The total permitted diversions limit the supply available to City of Waco as the firm yield is greater than the total permitted diversions. Available supplies are compared against the projected demands to identify any supply shortages or surpluses. If a shortage is identified in the future decades, water supply strategies are evaluated to meet the shortage in the supply availability. Comparison of the supply and demand numbers for the near-term and long term future is included in **Figure ES-1**. It should be noted that Lake Waco supplies are sufficient to meet the 2015 demand for all scenarios.

Figure ES-1: Comparison of Lake Waco Supply vs. Water System Demand



5.1 Potential Strategies

The following is the list of potential strategies identified for City of Waco to supplement the Lake Waco water supply.

1. Local Groundwater Supply
2. Imported Groundwater Supply
3. Conjunctive Use
4. Conservation
5. Lake Brazos
6. Lake Bosque
7. Lake Creek Reservoir
8. Tradinghouse Creek Reservoir
9. Wastewater Reuse

10. Aquifer Storage and Retention
11. Purchase from Brazos River Authority

A fact sheet was developed by summarizing the relevant information associated with each one of the strategies listed above. Each factsheet includes a description of the strategy, a location map (where applicable), supply reliability assessment, infrastructure configuration, cost estimate, regulatory and permitting requirements, timing/schedule, and a summary of potentials risks/benefits/challenges associated with the strategy. Selection of the most preferred strategy or a combination of strategies is primarily based on the following variables:

1. Supply Reliability
2. Cost
3. Risk
4. Stakeholder Preference

Subsections 5.2.1 to **5.2.11** include the fact sheets for all the selected strategies. A comparative analysis of the strategies and the strategy recommendations are included in **Section 5.3**.

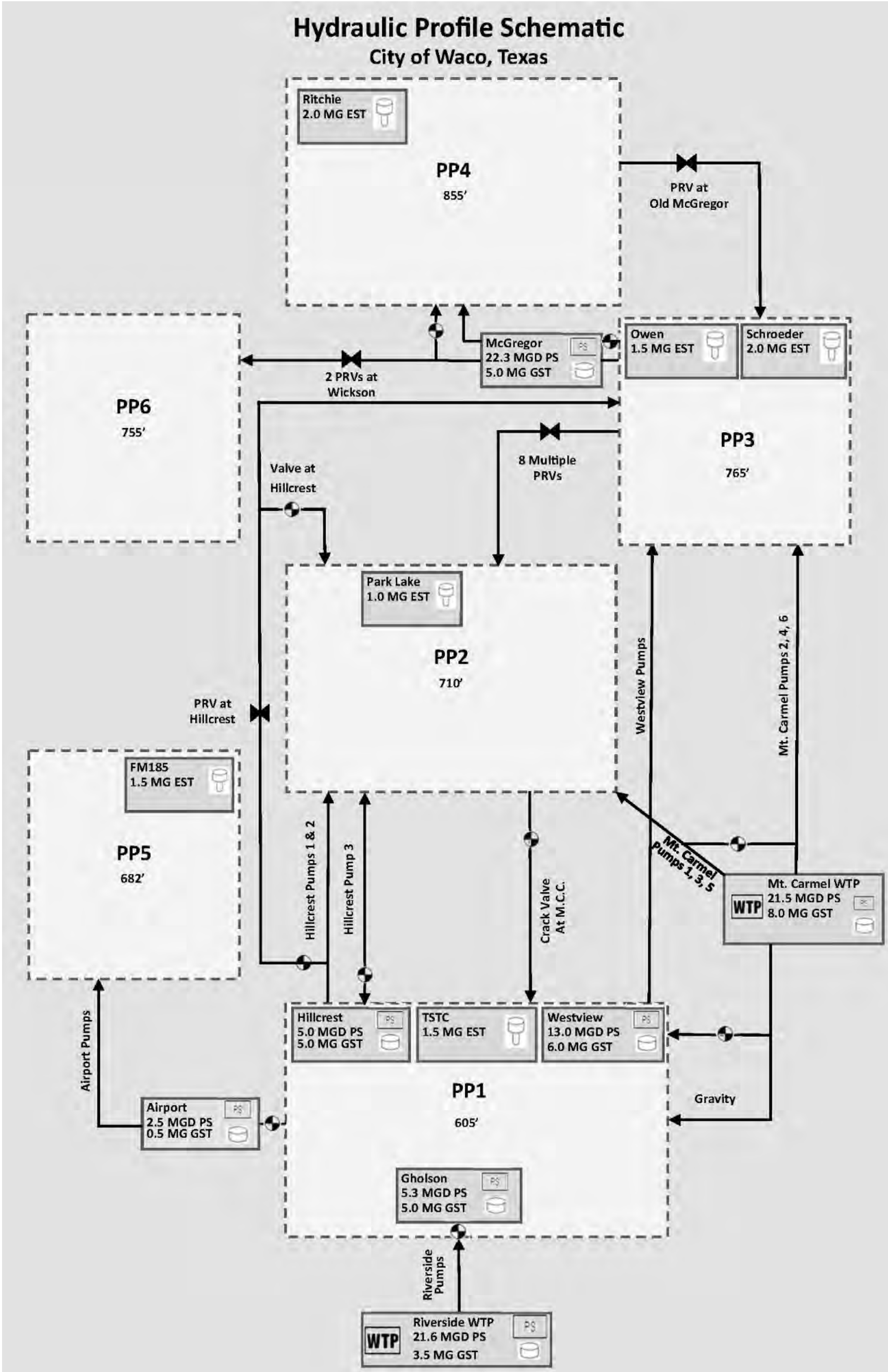
5.2 Recommended Strategies and Summary of Water Supply Evaluation

City of Waco's water supply plan is developed as a pro-active planning approach for the City as the City does not anticipate any shortages in the near term decades for an average day demand projection scenario. Recommended strategy is selected based on a comparison of the unit costs associated with each one of the individual strategies, reliability of the supply source to meet City of Waco's needs, risks and challenges associated in the process of securing the source of supply, environmental impacts, and the stakeholder preference. Conservation is the most recommended strategy as it does not take a significant capital investment but will provide long term returns in terms of supply reduction and cost savings. Based on the preliminary discussions with the City of Waco, it was determined that the Conjunctive Use strategy is the most preferred strategy for the City to address the needs arising during the CIP period from 2020 – 2040. Various potential demand scenarios were evaluated and the scenario with 50% of the wholesale customer demand without FHLM was identified as the most probable demand scenario. The conjunctive use strategy is a combination of use from City's groundwater supplies and the surface water supplies from Lake Waco. The additional supplies from groundwater can safely address used conjunctively with surface water without significantly impacting the aquifer levels in the Carrizo. The City may choose to develop the most feasible strategy among the additional strategies to meet the demands in the long term future.

6.0 Existing Water Distribution System

The existing water distribution system includes high service pumps stations at two water treatment plants: (Mt. Carmel WTP and Riverside WTP, six elevated storage tanks (ESTs), the Airport GST and Pump Station, the Gholson GST and Booster Pump Station, the Hillcrest GST and Pump Station, the Westview GST and Pump Station, the Old McGregor GST and Pump Station and 14 Pressure Reducing Valves (PRVs). The existing distribution system has over 155 MGD of total pumping capacity at various facilities spread throughout the City. The City's water distribution system is currently separated into six pressure planes: Pressure Plane 1 through 6. **Figure ES-2** is a schematic of the Waco water distribution system.

Figure ES-2: Water Distribution Schematic



7.0 Field Testing and Model Calibration

7.1 Pressure Testing

Field pressure testing was conducted August 15 – 27, 2013. A total of 23 pressure recorders were installed throughout the distribution system. Minimum, maximum and average pressure was recorded every 5 minutes at each location. Complete data from all recorders was collected from August 19th at 12:00 AM through August 26th at 12:00 AM.

7.2 Water Model Development

The project team spent a significant amount of effort on water model development and calibration, as the model is a valuable tool to evaluate system operation and serves as the basis for determining the timing of future improvements. The City of Waco's water model was developed using H2OMap Water software by Innovyze® and consists of all pipes in the distribution system. The model contains 26,283 links with diameters ranging in size from 1-inch to 42-inch. All pumping, storage and valve facilities were added to the model based on as-built drawings and information provided by the City.

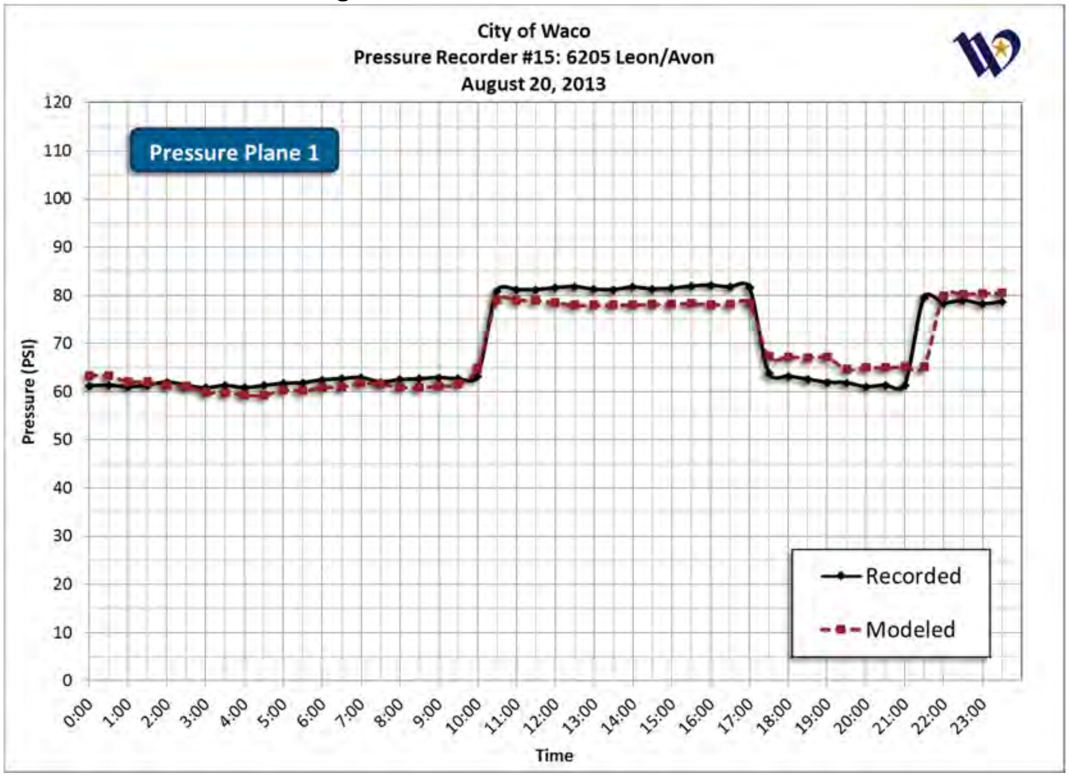
7.2 Water Model Calibration

In order to verify that the hydraulic model accurately represents actual distribution system operation, a model calibration analysis was performed. The calibration process involves adjusting system operation, roughness coefficients, demand allocation and diurnal curves to match a known condition. The 24-hour period occurring from 12:00 am on August 20th to 12:00 am on August 21th was selected for calibration. This day was selected because demands were relatively high, and there was a good correlation of data between the pressure recorders and the SCADA.

The results of the EPS calibration are summarized in the graphs and tables included in **Appendix B**. The graphs show modeled flows, pressures and tank levels versus recorded data at pump stations, tanks, and pressure recorder locations. **Figure ES-3** provides an example of the calibration effort. Each monitored location, or facility, includes 48 data points (one for each half-hour of the calibration) where the recorded and modeled values were compared.

The model was calibrated such that the storage tanks were within 5 ft of recorded levels 98% of the time, pressures were within 5 psi of City SCADA 89% of the time, and pump station flows were within 5% of recorded values 75% of the time. The results suggest a good correlation between recorded and modeled values, and model is calibrated well within the industry standards and provide confidence in the accuracy of the model.

Figure ES-3: Pressure Calibration



8.0 Distribution System Analysis

As a public water utility, the City of Waco must comply with the rules and regulations for public water systems set forth by the Texas Commission on Environmental Quality (TCEQ) in Chapter 290. Hydraulic analyses were conducted to identify deficiencies in the City of Waco's existing water distribution system and to establish a capital improvements plan to reinforce the existing system and meet projected water demands through 2040. Various combinations of improvements and modifications were investigated to determine the most appropriate approach for meeting projected demands. Considerations used for developing the CIP included evaluating storage and pumping, meeting required fire flows, maintaining proper residual pressures and reducing water age.

The water distribution system was analyzed for three operating conditions: winter day demands, average day demands, and maximum day demands. A 24-hour extended period simulation (EPS) was performed for each operating scenario. By examining the water 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 pumping facilities are adequate to meet the required demand at an acceptable pressure.

9.0 Water System Reliability Analysis

A water system reliability analysis was performed utilizing the calibrated water model to determine the City's ability to serve demands with one of the two water treatment plants out of service. A high level review of both plant's current and future capacities was reviewed to determine what level of service could be maintained if either water treatment plant were to be taken out of service. Once an acceptable level of service was determined, two scenarios were developed. The first scenario consisted of the Riverside WTP supplying water demands citywide with the Mt. Carmel WTP out of service. The second scenario consisted of Mt. Carmel supplying water demands citywide with the Riverside WTP out of service. The 2040 capital improvement projects described in **Section 10** were assumed to be in service for the system reliability analysis.

10.0 Capital Improvement Plan

A capital improvement plan (CIP) was developed for the City of Waco to promote a high level of water service that encourages residential and commercial development. The recommended improvements will provide the required capacity and reliability to meet projected water demands through the 2040 planning period. The recommended projects for the water system are presented on **Figure ES-2**. Locations shown for new mains and other recommended improvements were generalized for hydraulic analyses. Specific alignments and sites will be determined as part of the design process. 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 2015 dollars and include an allowance for engineering, surveying, and contingencies. **Table ES-3** summarizes the costs of the water system CIP for the City of Waco. The recommended projects for the water system are presented on **Figure 10-1**.

Table ES-3: Water System Capital Improvement Plan

	Proj. No.	Water Distribution System Capital Improvement Plan	Cost
2020 Improvements	1	Hillcrest PS and GST Rehabilitation and 24-inch Water line Replacement	$ 15,661,020
	2	Westview PS and GST Rehabilitation	$ 8,085,000
	3	5.0 MGD Airport Pump Station	$ 3,307,510
	4	FM-185 20-inch Water Line Replacement in PP 5	$ 8,524,540
	5	24-inch, 30-inch, and 36-inch Faulkner Water Line in PP 1	$ 10,160,060
	6	16-inch Water Line and 8-inch Water Line with Pressure Reducing Valves in PP 4	$ 5,798,280
	7	15.0 MGD Low Head Pump Station at Mt. Carmel WTP	$ 4,557,000
	8	20-inch and 24-inch Replacement Water Line in PP3	$ 6,271,770
	9	3.0 MG Ground Storage Tank at Old McGregor Pump Station	$ 2,646,000
	10	16-inch and 24-inch Water Lines in PP3	$ 7,289,740
	11	16-inch, 20-inch, and 24-inch Water Lines in PP 2	$ 10,017,400
	12	1.0 MG Bagby Elevated Storage Tank in PP2	$ 2,377,000
	13	12-inch Water Line in PP4	$ 2,647,630
	14	24-inch and 12-inch Water Lines in PP6	$ 3,561,600
	15	72-inch Parallel Raw Water Line	$ 1,314,190
	16	Expand Riverside Treatment Capacity to 45 MGD	$ 10,363,510
	17	Pilot Leak Detection Study	$ 52,920
	18	Citywide Automatic Meter Reading	$ 20,580,000
		2020 Capital Improvements Total	***$ 123,215,170***
2030 Improvements	19	20-inch Parallel Water Line in PP1	$ 14,047,920
	20	1.0 MG Ground Storage Tank at Airport Pump Station	$ 882,000
	21	24-inch Replacement Water Line in PP3	$ 4,702,690
	22	30-inch Parallel Water Line in PP4	$ 3,898,440
	23	1.0 MG Elevated Storage Tank in PP6	$ 2,377,000
	24	8.0 MGD Low Head Pump Station at McGregor Pump Station	$ 3,675,000
	25	20-inch/24-inch Replacement Water Line in PP3	$ 4,271,040
	26	24-inch Water Line in PP3	$ 8,973,700
	27	16-inch Replacement Water Line along HWY 84 in PP6	$ 4,512,410
		2030 Capital Improvements Total	***$ 47,340,200***

Table ES-3 Continued: Water System Capital Improvement Plan

2040 Improvements	28	9.0 MGD Mt. Carmel H.S.P.S. Firm Capacity Expansion	$ 1,470,000
	29	20-inch/24-inch Replacement Water Line in PP1	$ 7,425,430
	30	12-inch Water Lines in PP5	$ 5,798,130
	31	20-inch Water Line in PP2	$ 2,943,690
	32	20-inch Water Line Replacement in PP3	$ 2,616,990
	33	16-inch Replacement Water Line in PP4	$ 1,263,030
	34	16-inch/12-inch Replacement Water Line in PP4	$ 6,245,610
	35	12-inch Water Line in PP4	$ 3,652,960
	36	12-inch Water Line in PP2	$ 1,117,510
	37	16-inch Water Line in PP1	$ 4,849,250
	38	16-inch and 12-inch Water Line in PP3	$ 2,312,320
	39	20-inch transmission Line in PP1	$ 2,085,940
	40	16-inch/12-inch Water Line and PRV Stations in PP6	$ 9,330,390
	41	16-inch/12-inch Water Lines and PRV Station in PP7	$ 10,554,600
	42	12-inch Water Lines in PP7	$ 14,138,470
	43	12-inch Water Line in PP5	$ 2,988,090
	44	16-inch Water Line in PP1	$ 3,023,370
	45	16-inch Water Line in PP1	$ 670,320
		2040 Capital Improvements Total	***$ 82,486,100***
Replacement and Renewal	R1	30-inch Renewal Water Line in PP1	$ 1,749,310
	R2	20/24/30-inch Renewal Water Line in PP1	$ 2,373,480
	R3	16-inch Renewal Water Line in PP1	$ 1,860,150
	R4	16-inch Renewal Water Line in PP1	$ 1,793,110
	R5	16-inch Renewal Water Line in PP1	$ 1,508,230
	R6	16/24-inch Renewal Water Line in PP1	$ 1,667,280
	R7	20/24-inch Renewal Water Line in PP1	$ 1,805,160
	R8	16/20-inch Renewal Water Line in PP1	$ 2,038,900
	R9	16-inch Renewal Water Line in PP1	$ 2,094,760
	R10	20-inch Renewal Water Line in PP1	$ 1,758,120
	R11	20-inch Renewal Water Line in PP1	$ 2,121,220
	R12	20-inch Renewal Water Line in PP1	$ 2,140,320
	R13	20-inch Renewal Water Line in PP1	$ 1,528,800
	R14	20-inch Renewal Water Line in PP1	$ 1,643,470
	R15	20-inch Renewal Water Line in PP1	$ 1,662,580
	R16	24-inch Renewal Water Line in PP1	$ 1,995,980
	R17	24-inch Renewal Water Line in PP1	$ 2,317,900
	R18	24-inch Renewal Water Line in PP1	$ 2,382,290
		Replacement and Renewal	***$ 34,441,060***
GRAND TOTAL			***$ 287,482,530***

11.0 Redevelopment Analysis

Following the development of the growth CIP, the project team performed a 2040 system analysis of the water distribution system for areas targeted for redevelopment. The project team delineated two redevelopment areas that cover 2,250 acres and 1,750 acres. These locations have been identified by the City as key areas where Waco is expecting to experience large-scale growth and transformation. The redevelopment areas were selected for a variety of reasons. Some reasons include access to major forms of transportation, proximity to higher education institutions (Baylor University), and development of mixed use urban villages (McLane Stadium, Downtown, etc.). The potential redevelopment is expected to occur by 2040 for the purposes of this study.

11.1 Redevelopment Capital Improvement Plan

Based on the results of the water system capacity and condition analysis, the project team developed improvements to serve future growth related to redevelopment. For the purposes of this study, the team concentrated on smaller distribution lines localized to the redevelopment areas for the Redevelopment CIP and not large transmission mains, where proposed improvements are identified in the **Section 10**. Condition related improvements were identified for water lines with a pipe age greater than 50 years and/or consisting of more problematic pipe materials such as Asbestos Cement. The capacity and condition improvements were combined to represent the proposed redevelopment improvements. The proposed improvements address capacity and condition issues from the analysis of the Riverside and Downtown redevelopment areas. The recommended CIP lines for redevelopment related growth for the Riverside and Downtown redevelopment areas are shown in purple on the capital improvement plan in **Figure 10-1**.

1.0 INTRODUCTION

The City of Waco is a growing community located in central Texas, within McLennan County. The City currently provides water service to 131,139 people and is home to Baylor University. The population within the service area is projected to grow by almost 40,000 people in the next 25 years. Accommodating this growth in an efficient and cost effective manner, while also focusing on the maintenance of existing water system assets, is the purpose of this 2015 Water Master Plan. This report has been prepared to provide the City of Waco a planning tool that will serve as a guide for short-term and long-term improvements to the infrastructure within the water distribution system.

1.1 SCOPE OF WORK

Freese and Nichols, Inc. (FNI) and the Wallace Group (TWG) were retained in 2013 by the City of Waco to prepare a Water Master Plan. The goals of the Water Master Plan were to evaluate the integrity of the existing water distribution system and water supply to recommend a phased and integrated Capital Improvement Plan (CIP) through the year 2040. The recommended improvements will serve as a basis for the design, construction, and financing of facilities required to meet Waco’s water capacity and system renewal needs. The major elements of the scope of this project included:

- Population and Water Demand Projections
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- Hydraulic Water Model Development
- Field Testing and Water Model Calibration
- Existing and Future System Hydraulic Analysis
- Water System Capital Improvement Plan
- Water Master Plan Report

1.2 LIST OF ABBREVIATIONS

Table 1-1: Abbreviations

Abbreviation	Actual
AD	Average Day Demand
CCN	Certificate of Convenience and Necessity
CIP	Capital Improvement Program
EPS	Extended Period Simulation
EST	Elevated Storage Tank
ETJ	Extraterritorial Jurisdiction
FHLM	Falls, Hill, Limestone, and McLennan
FNI	Freese and Nichols, Inc.
GIS	Geographic Information System
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
HGL	Hydraulic Grade Line
lf	Linear Feet
MD	Maximum Day Demand
MG	Million Gallons
mgd	Million Gallons per Day
MPO	Metropolitan Planning Organization
PH	Peak Hour Demand
PRV	Pressure Reducing Valve
PS	Pump Station
psi	Pounds per Square Inch
SCADA	Supervisory Control and Data Acquisition
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
TWG	The Wallace Group
WL	Water Line
W.S.C.	Water Supply Corporation
WTP	Water Treatment Plant

2.0 POPULATION

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

2.1 SERVICE AREA

The existing service area for Waco's water system is generally defined by the city limits. The City encompasses an area of approximately 100 square miles. The City also serves wholesale customers in McLennan County. Existing wholesale customers include:

- City of West
- City of Woodway
- City of Hewitt
- City of Lacy Lakeview
- City of Robinson
- Central Bosque
- City of Bellmead (Emergency only)

FNI and TWG worked with the City of Waco, and the Waco Metropolitan Planning Organization (MPO) to determine the future water service area. The City and the MPO are in the process of finalizing a Comprehensive Plan. For the comprehensive plan, the City and the MPO developed two scenarios for growth: the "Trend Scenario" and the "Alternative Land-Use Scenario".

The trend scenario follows the historical growth trend outside of the heart of the City. This scenario is a continuation of the "urban sprawl" that the City has experienced from 2000 through 2010. The major growth areas of this scenario are in the China Springs area and along the Highway 84 corridor. The majority of the growth in Waco is projected to occur within the existing city limits, but on the outer edges, either through the development of vacant land or through redevelopment.

The alternative land-use scenario consists of a more evenly distributed population growth that focuses growth within downtown Waco, as well as more sustainable growth in the areas outside of the heart of the City. The alternative land use scenario represents for Waco what is occurring in other large cities in Texas. Redevelopment of land in downtown areas from commercial and industrial land uses to residential mixed-use has led to large growth booms in the heart of other cities. The alternative land use scenario accounts for a large population growth in downtown and surrounding areas along the river and near the Baylor campus.

In a meeting between the City of Waco, the MPO, and other planning consultants, it was determined that both scenarios have advantages and disadvantages. The trend scenario does not account for redevelopment in the inner-city and results in increasing costs for extension of utilities and other infrastructure, while the alternative scenario is aggressive in its planning for growth in the heart of the City. It was determined that the realistic growth pattern will be a combination of the two scenarios. Therefore, the City and the MPO developed the “Combined Scenario” in which the highest population projection for each planning area was utilized. The first 10 years will follow the trend scenario and experience growth outside of the heart and around 2022 the outside growth will slow and growth in the heart of the City will pick up. **Figure 2-1** displays Waco’s existing and future water service planning areas.

2.2 HISTORICAL POPULATION

The City of Waco provided yearly population data for 2000 through 2012. Historical population information was provided by the City of Waco Planning Department, the US Census Bureau and the Texas Water Development Board (TWDB). The data indicated an average growth rate of 0.92% annual growth over the last 11 years. **Table 2-1** shows the City’s historical population and growth rate from 2010 through 2012.

Table 2-1: Historical Population

Year	Population	Annual Growth
2000	113,726	-
2001	115,517	1.55%
2002	116,120	0.52%
2003	117,001	0.75%
2004	118,408	1.19%
2005	118,875	0.39%
2006	119,479	0.51%
2007	120,813	1.10%
2008	122,029	1.00%
2009	123,250	0.99%
2010	124,805	1.25%
2011	126,691	1.49%
2012	127,018	0.26%
Average	**-**	**0.92%**

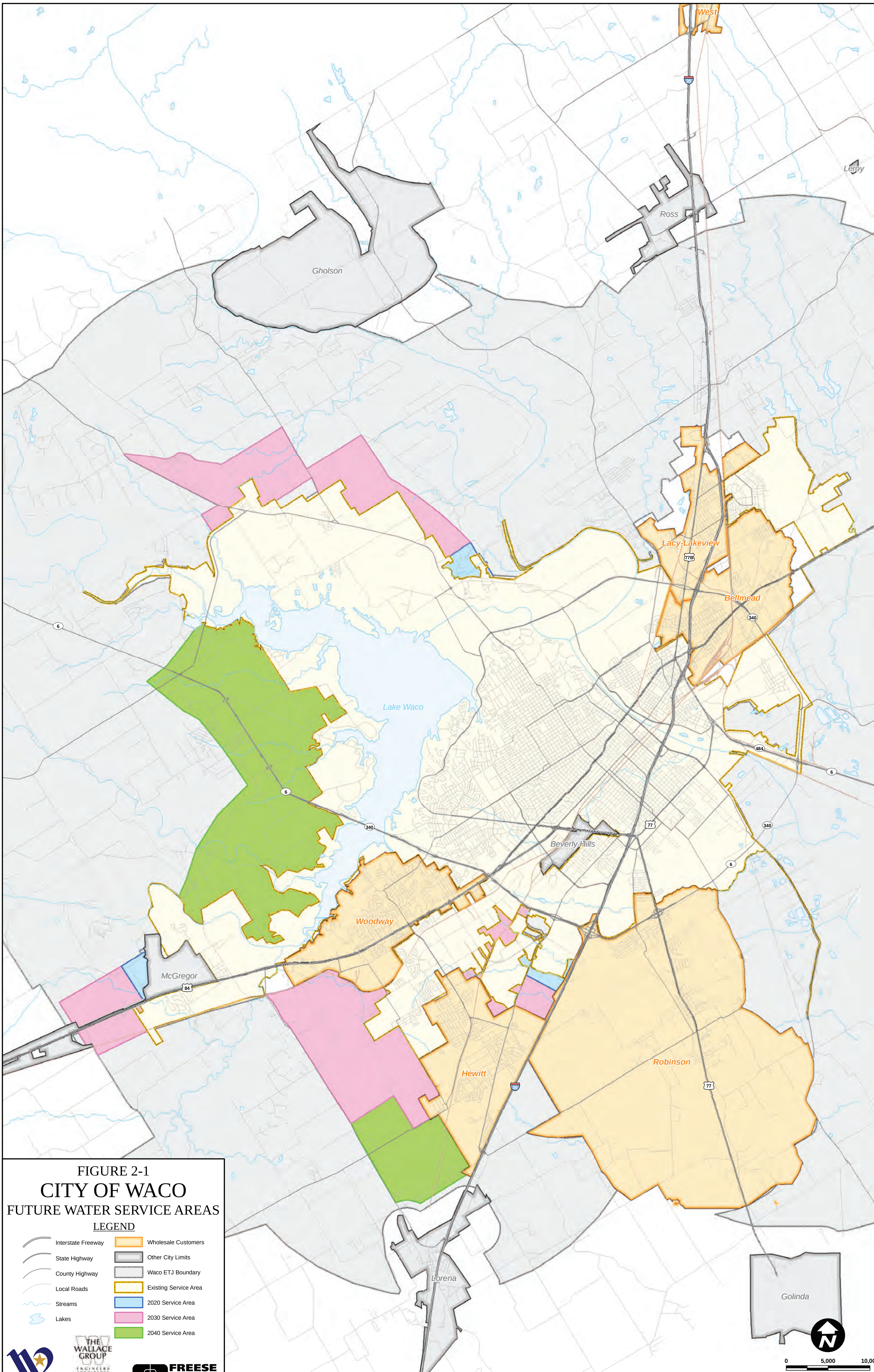

FIGURE 2-1
CITY OF WACO
FUTURE WATER SERVICE AREAS

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2.3 POPULATION PROJECTIONS

Growth projections are an important component of the water master planning process. The magnitude and distribution of the growth in population and employment will dictate where future water infrastructure is required. The City of Waco Planning Department and the Waco MPO worked together to develop the 2010 and 2040 population projections. The same projections were utilized for the Wastewater Maser Plan, although the planning areas are slightly different. The Waco MPO coordinates transportation planning activities for all of McLennan County. “The MPO was established to ensure that transportation decisions within the MPO area are performed in a continuing, comprehensive and cooperative process.”[1] As part of the transportation efforts, the MPO develops in-depth population projections by traffic analysis zone (TAZ). The City is currently working to finalize a Comprehensive Plan as discussed in Section 2.1. The City utilized the Waco MPO TAZs with 2010 and 2040. The City’s Planning and Zoning Services staff also developed 2022 population projections for the master planning effort. For the Water Master Plan, the project team utilized the TAZ projections to plan for the 2015, 2020, 2030, and 2040 planning periods. **Table 2-2** shows the population projections for 2015, 2020, 2030 and 2040. The yearly growth rates for each planning period based on the TAZ projections from the MPO that fell within the water service areas. **Figure 2-2** displays the population by traffic analysis zone for each planning period. **Figure 2-3** displays the employment by traffic analysis zone for each planning period

Table 2-2: Population Projections

Year	Population	Yearly Growth Rate
2015	131,139	1.06%
2020	138,539	1.10%
2030	154,179	1.08%
2040	167,633	0.84%
Average	**-**	**0.99%**

[1] "THE CITY OF WACO TEXAS." *Metropolitan Planning Organization*. Web. 15 July 2015.

FIGURE 2-2
CITY OF WACO
POPULATION BY TRAFFIC ANALYSIS ZONE

LEGEND

- Interstate Freeway
- State Highway
- County Highway
- Local Roads
- Streams
- Lakes
- Wholesale Customers
- Other City Limits
- Waco ETJ Boundary
- Existing Service Area
- 2020 Service Area
- 2030 Service Area
- 2040 Service Area

TAZ ID
2010 Population
2020 Population
2030 Population
2040 Population

THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS

FREESE AND NICHOLS

FIGURE 2-3
CITY OF WACO
EMPLOYMENT POPULATION BY TRAFFIC ANALYSIS ZONE

3.0 WATER DEMANDS

A water utility must be able to supply water at rates that fluctuate over a wide range. Yearly, monthly, daily and hourly variations in water use occur, with higher use 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. Rates most important to the hydraulic design and operation of a water distribution system are average day (AD), maximum day (MD), and peak hour (PH). Average day use is the total annual water use divided by the number of days in the year. The average day 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. Treatment and supply facilities are typically designed based on the maximum day rate. 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

Historical water usage records were analyzed for the years 2008 through 2013. The City provided daily water production data that was used to calculate annual average day demand, maximum day to average day peaking factors and per-capita consumption. The City of Waco's historical water usage is summarized in **Table 3-1**.

Table 3-1: Historical Water Usage

Year	Population	Average Day Demand (mgd)	Average Day Total Per-capita (gpcd)	Maximum Day Demand (mgd)	Max. to Avg. Peaking Factor
2008	122,029	27.78	228	49.19	1.77
2009	123,250	27.92	227	49.49	1.77
2010	124,805	27.29	219	48.34	1.77
2011	126,691	29.07	229	47.76	1.64
2012	127,018	25.94	204	41.62	1.60
2013	128,195	25.29	197	44.93	1.78
Average	**-**	**-**	**217**	**-**	**1.72**

The utility billing data was also utilized in the analysis of historical water usage. Water consumption from the last five years was reviewed and evaluated based on billed usage type. Residential per-capita water usage was calculated for each year and is presented in **Table 3-2**. The residential per-capita usage peaked in 2011 because it was a drier year than normal. An average non-residential per-acre usage was calculated based on current city zoning and is also presented in **Table 3-2**.

Table 3-2: Historical Water Consumption by Customer Type

Year	Residential Consumption (mgd)	Residential Per-capita (gpcd)	Commercial Consumption (mgd)	Employment Per-employee (gped)
2011	14.44	114	14.60	215
2012	12.32	97	13.29	193
2013	12.59	98	13.74	198
Average	**-**	**103**	**-**	**202**

3.2 WHOLESALE WATER DEMANDS

The City of Waco is a wholesale water provider to surrounding cities in McLennan County. Surveys were prepared and sent to existing and potential customers to determine projected water needs to assist in assessing the water demand needs for Waco's service area. The survey included projected needs through the 2040 planning period. Over 50 surveys were sent to surrounding municipalities and WSCs. The City received responses from 13 customers and compiled data from the proposed FHLM WSC. **Table 3-3** is a list of existing and potential customers that were surveyed.

Table 3-3: Existing and Potential Wholesale Customers

Wholesale Water Customers			
Existing Customers	City of Woodway	Potential Customers	McLennan County WCID #2
	City of Hewitt		FHLM WSC Northwest
	City of Lacy Lakeview		FHLM WSC Southeast
	City of Robinson		Cross Country WSC
	Central Bosque		Patrick WSC
	City of Bellmead (Emergency Only)		North Bosque WSC
			Aqua Texas, Inc.
			East Crawford WSC
			City of Lorena
			Levi WSC

Following the receipt of the wholesale customer surveys, a meeting was held to discuss the projected needs. The purpose of the meeting was to discuss how the demand from each city will be met in the future. The City of Waco has the capacity in Lake Waco and the treatment capabilities to serve the customer cities. A further discussion of the water supply is presented in Section 5.

3.3 PROJECTED WATER DEMANDS

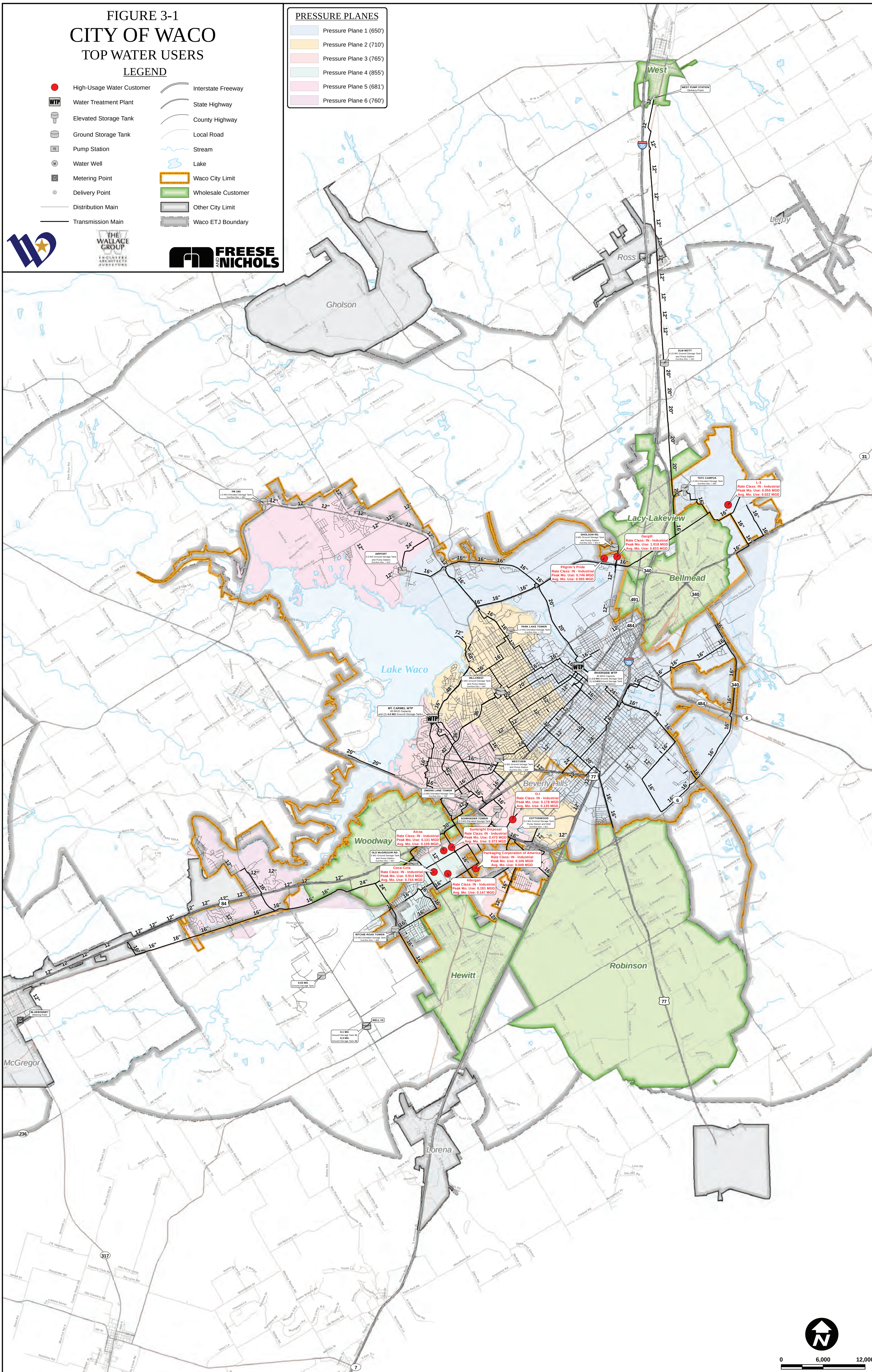
Water demands were projected for existing, 2020, 2030 and 2040 conditions. The evaluation of historical data provided a basis for determining the design criteria used to project water demands. Although the historical employment per-capita usage averaged 202 gped over the last three years, a slightly lower per-capita rate was selected for projecting employment demand due to the type of anticipated development. The per-employee rate varies between each pressure plane due to the varying usage rates between large water users and average water users.

Historical water usage data indicated the maximum day to average day peaking factor ranged from 1.60 to 1.78 over the last six years; therefore, a peaking factor of 1.70 was selected for future year demands. SCADA records were reviewed to help select a peak hour to maximum day peaking factor. The maximum hourly peaking factors were determined from the diurnal patterns for each pressure plane. The base year represents existing conditions using the selected design criteria. The base year demand does not necessarily reflect what actually occurred in 2014, but rather what could occur based on historical dry weather trends.

Large non-residential water users were also examined to ensure those demands were being accounted for and associated with the correct model node. Three years of billing data were analyzed to determine an average water usage for the top users. Nine billing meters had a significantly higher historical usage rate, so those were designated as large users and assigned a demand based on the actual usage from the last three years. **Figure 3-1** is a map of the location of the largest water customers. The large users in order according to the billing meter data are:

1. Coca-Cola
2. Pilgrim's Pride
3. Cargill
4. Sunbright Disposal
5. O-I
6. Alcoa
7. Allergan
8. Packaging Corporation of America
9. L-3

FIGURE 3-1
CITY OF WACO
TOP WATER USERS



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After analyzing the residential and commercial demand, the large customer demands and the wholesale customer demands, the project team developed multiple alternatives for future water demands to be served by the City of Waco. The City of Waco provides drinking water that is treated from Lake Waco. **Sections 4.0** and **5.0** in this report discuss the available water supply and yield of Lake Waco. Due to changing dynamics in water supply in McLennan County, FNI/TWG worked with the City to develop potential water demand projection alternatives. These alternatives allow the City to determine the impact of serving additional wholesale demand. The three water demand alternatives that were analyzed are as follows:

- Alternative 1: 100% of Waco and 100% of the Wholesale Demand for Average and Peak Day
- Alternative 2: 100% of Waco and 50% of Wholesale Demand for Peak Day Demands (50% of Peak demand to be met by conjunctive use with groundwater supply)
- Alternative 3: 100% of Waco and 100% of Wholesale Demand including Falls, Hills, Limestone, and McLennan Counties (FHLM) W.S.C Demand for Average and Peak Day Demands

For the purpose of developing the capital improvements plan (CIP) in **Section 10.0**, the team utilized Alternative 2 based, since it makes the most sense for the City of Waco and limits the amount of additional water supplies needed in the future. The projections in this section **do not** account for additional conservation measures such as reduced irrigation and increased installation of low-flow fixtures and appliances. The wholesale customer demands were provided by each of the wholesale customers. **Figure 3-2** provides a graphical illustration of the historical and projected water demands for the City of Waco through 2040. **Table 3-4** summarizes the water demands by pressure plane. The maximum day demand is projected to increase 24.24 mgd between 2015 and 2040. The highest growth rate is projected in Pressure Plane 5. The China Springs development that is a fast growing development in Waco is located in PP5.

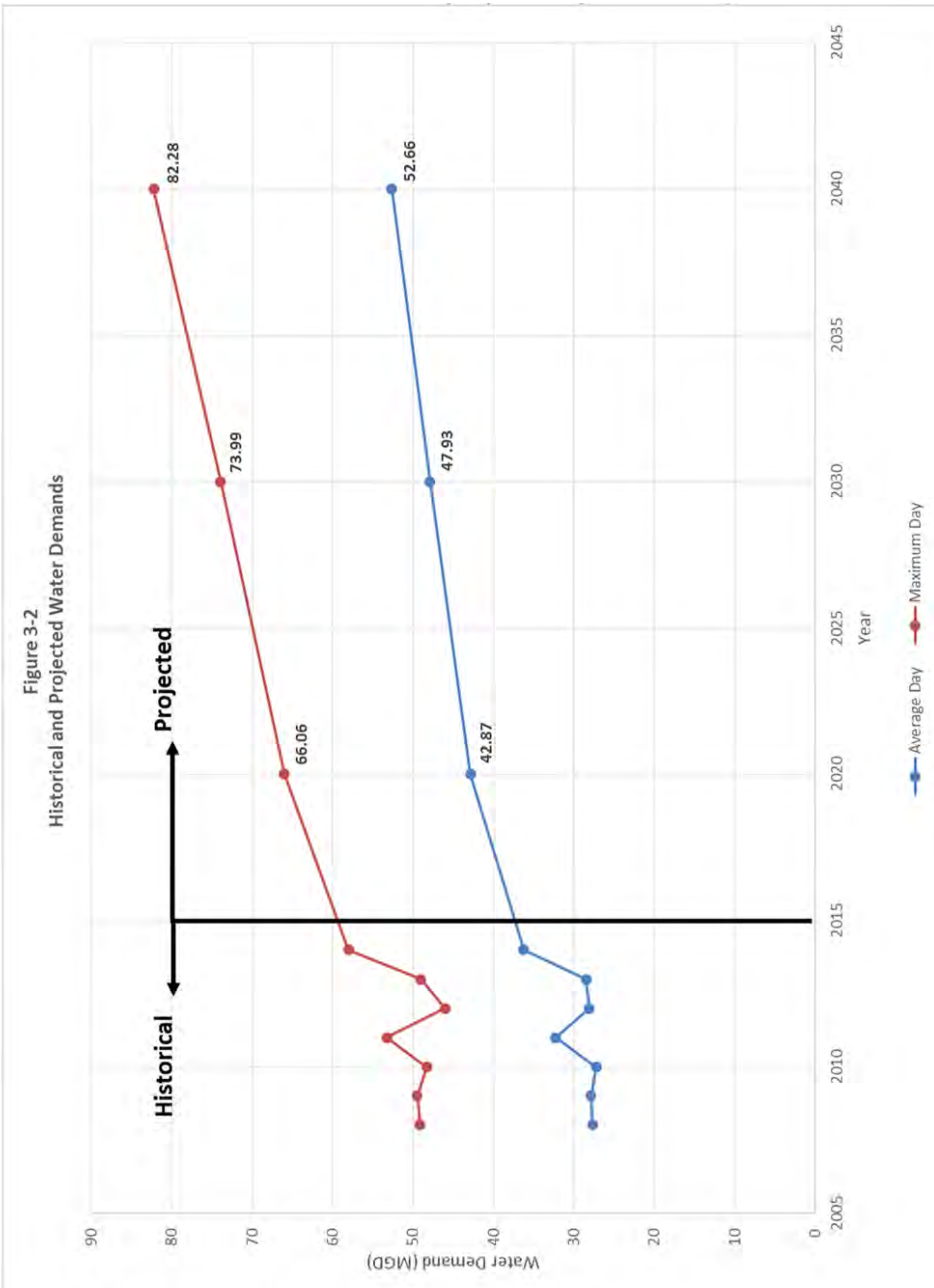


Figure 3-2
Historical and Projected Water Demands

Table 3-4: Projected Water Demands by Pressure Plane

Pressure Plane	2014 Population	Residential per Capita Demand (gpcd)	2014 Average Day Residential Demand (mgd)	2014 Employment	Employment per Capita Demand (gped)	2014 Average Day Employment Demand (mgd)	City of Waco 2014 Average Day Demand (mgd)	2014 Wholesale Average Day Demand (mgd)	2014 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	Wholesale Maximum Day Demand (mgd)	2014 City of Waco Maximum Day Demand (mgd)	Total 2014 Maximum Day Water Demand (mgd)
PP1	58,312	110	6.41	27,312	125	3.41	9.83	1.96	**11.79**	1.70	1.97	16.71	**18.67**
PP2	36,899	125	4.61	12,199	200	2.44	7.05	-	**7.05**	1.70	-	11.99	**11.99**
PP3	18,352	175	3.21	25,443	125	3.18	6.39	2.13	**8.52**	1.70	2.33	10.87	**13.20**
PP4	7,264	185	1.34	4,420	125	0.55	1.90	3.82	**5.72**	1.70	5.58	3.22	**8.80**
PP5	4,571	215	0.98	605	200	0.12	1.10	-	**1.10**	1.70	-	1.88	**1.88**
PP6	2,939	685	2.01	238	200	0.05	2.06	-	**2.06**	1.70	-	3.50	**3.50**
Total	**128,336**	**145**	**18.58**	**70,217**	**139**	**9.76**	**28.33**	**7.91**	**36.24**	**-**	**9.87**	**48.17**	**58.04**

Pressure Plane	2020 Population	Residential per Capita Demand (gpcd)	2020 Average Day Residential Demand (mgd)	2020 Employment	Employment per Capita Demand (gped)	2020 Average Day Employment Demand (mgd)	City of Waco 2020 Average Day Demand (mgd)	2020 Wholesale Avg. Day Demand (mgd)	2020 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2020 Wholesale Maximum Day Demand (mgd)	City of Waco 2020 Maximum Day Demand (mgd)	Total 2020 Maximum Day Water Demand (mgd)
PP1	49,579	110	5.45	25,607	125	3.20	8.65	2.23	**10.89**	1.70	2.23	14.71	**16.95**
PP2	50,889	132	6.71	17,041	200	3.41	10.12	0.92	**11.04**	1.70	0.92	17.20	**18.12**
PP3	19,990	177	3.54	26,923	125	3.37	6.90	2.80	**9.70**	1.70	2.80	11.74	**14.53**
PP4	8,112	187	1.51	4,634	125	0.58	2.09	3.84	**5.94**	1.70	4.82	3.56	**8.38**
PP5	5,909	215	1.27	722	200	0.14	1.41	-	**1.41**	1.70	-	2.41	**2.41**
PP6	3,828	642	2.46	271	200	0.05	2.51	1.33	**3.85**	1.70	1.33	4.27	**5.60**
PP7	232	150	0.03	60	125	0.01	0.04	-	**0.04**	1.70	-	0.07	**0.07**
Total	**138,539**	**151**	**20.98**	**75,258**	**143**	**10.76**	**31.74**	**11.13**	**42.87**	**-**	**12.10**	**53.96**	**66.06**

Table 3-4: Projected Water Demands by Pressure Plane (cont.)

Pressure Plane	2030 Population	Residential per Capita Demand (gpcd)	2030 Average Day Residential Demand (mgd)	2030 Employment	Employment per Capita Demand (gped)	2030 Average Day Employment Demand (mgd)	City of Waco 2030 Average Day Demand (mgd)	2030 Wholesale Avg. Day Demand (mgd)	2030 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2030 Wholesale Maximum Day Demand (mgd)	City of Waco 2030 Maximum Day Demand (mgd)	Total 2030 Maximum Day Water Demand (mgd)
PP1	54,249	110	5.97	28,075	125	3.51	9.48	2.30	**11.78**	1.70	2.30	16.11	**18.41**
PP2	53,302	133	7.07	18,390	200	3.68	10.75	1.03	**11.78**	1.70	1.03	18.28	**19.31**
PP3	21,959	179	3.93	29,369	125	3.67	7.60	3.21	**10.81**	1.70	3.21	12.93	**16.14**
PP4	10,150	189	1.92	5,569	125	0.70	2.62	4.24	**6.85**	1.70	5.28	4.45	**9.73**
PP5	9,711	215	2.09	1,274	200	0.25	2.34	-	**2.34**	1.70	-	3.98	**3.98**
PP6	4,468	622	2.78	496	200	0.10	2.88	1.42	**4.30**	1.70	1.42	4.89	**6.31**
PP7	340	150	0.05	62	125	0.01	0.06	-	**0.06**	1.70	-	0.10	**0.10**
Total	**154,179**	**154**	**23.81**	**83,235**	**124**	**11.92**	**35.73**	**12.20**	**47.93**	**-**	**13.25**	**60.74**	**73.99**

Pressure Plane	2040 Population	Residential per Capita Demand (gpcd)	2040 Average Day Residential Demand (mgd)	2040 Employment	Employment per Capita Demand (gped)	2040 Average Day Employment Demand (mgd)	City of Waco 2040 Average Day Demand (mgd)	2040 Wholesale Avg. Day Demand (mgd)	2040 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2040 Wholesale Maximum Day Demand (mgd)	City of Waco 2040 Maximum Day Demand (mgd)	Total 2040 Maximum Day Water Demand (mgd)
PP1	57,943	110	6.37	31,638	125	3.95	10.33	2.37	**12.70**	1.70	2.57	17.56	**20.12**
PP2	54,900	133	7.31	20,188	200	4.04	11.35	1.14	**12.49**	1.70	1.17	19.30	**20.47**
PP3	23,369	180	4.22	31,081	125	3.89	8.10	3.58	**11.68**	1.70	4.08	13.77	**17.85**
PP4	12,254	191	2.34	5,955	125	0.74	3.09	4.59	**7.68**	1.70	5.83	5.25	**11.08**
PP5	11,046	215	2.37	1,520	200	0.30	2.68	-	**2.68**	1.70	-	4.55	**4.55**
PP6	5,744	595	3.42	566	200	0.11	3.53	1.50	**5.03**	1.70	1.50	6.00	**7.50**
PP7	2,377	150	0.36	476	125	0.06	0.42	-	**0.42**	1.70	-	0.71	**0.71**
Total	**167,633**	**157**	**26.39**	**91,424**	**143**	**13.10**	**39.49**	**13.18**	**52.66**	**-**	**15.15**	**67.13**	**82.28**

4.0 WATER SUPPLY ANALYSIS

The primary objective of the water supply analysis is to evaluate how much supply is available from existing supplies and compare the existing supplies and projected demands to identify supply shortages. Another objective is to develop strategies for potential future supply sources required to meet the projected needs for future decades.

The City of Waco supplies water to residential, commercial and irrigation users within the City. In addition to this, the City also supplies the following wholesale customer cities referenced in **Table 3-3**.

The City of Beverly Hills is included within the current service area, but its customers receive retail service from Waco's distribution system. Based on the information provided in 2011 Brazos G Regional Plan, Waco supplies meet the entire demand for Beverly Hills and Lacy Lakeview. The other customer cities rely primarily on local groundwater supplies and use water from Waco as an alternative source of supply. According to the water use data provided by the City, the wholesale customer use accounts for about 10% of water use, residential customers account for approximately 35%, commercial use accounts for approximately 32% and irrigation use accounts for about 8% of the total water use.

The details of the supply available from existing supply sources are discussed in this section. **Section 4.1** includes an overview of Waco's existing supplies. **Section 4.2** discusses the results of the water availability modeling conducted using the Texas Commission on Environmental Quality's (TCEQ) Brazos water availability model (WAM). **Section 4.3** is a discussion of additional analyses using additional hydrologic data to include recent years in the WAM. **Section 4.4** includes a discussion on inflows and firm yield of existing supplies.

The definition of drought of record is critical for estimating the available supplies. A detailed analysis of the drought of record is included in **Section 4.5**. This analysis is based on tree-ring studies extending the hydrologic period of record back to 1500's and the data for the recent years from the Brazos WAM and hydrology extension. In addition to the surface water supplies, the City and its wholesale customers own groundwater supplies. A discussion of the local groundwater resources in presented in **Section 4.6**.

4.1 EXISTING WATER SUPPLIES

The City of Waco holds Texas water rights for supplies from Lake Brazos and Lake Waco. Lake Waco is owned and operated by the U.S. Army Corps of Engineers (USACE). The reservoir is located on the Bosque

River in McLennan County. The City of Waco contracts with USACE for storage space in the reservoir and owns two Texas water rights authorizing storage and use from the reservoir: Certificate of Adjudication (CA) 12-2315 and Permit/Application P-5094. The reservoir serves as a water supply for the City of Waco and provides flood control in the Bosque River and Brazos River Basins.

The original Lake Waco was built in 1930 by the city and was located about a half mile upstream of the current dam. The original reservoir stored about 39,000 acre-feet of water. Construction of the current Lake Waco began on June 13, 1958, and deliberate impoundment began on February 26, 1965[2]. The reservoir initially had a total storage of 726,400 acre-feet, which included 553,300 acre-feet of flood storage, 104,100 acre-feet of water supply storage and 69,000 acre-feet of sediment reservoir[3]. In 2003, the conservation pool of the reservoir was raised from 455 feet to 462 feet[4]. This increased the reservoir's conservation storage to 158,700 acre-feet. The original bottom elevation for contracted storage was 427 feet[5].

CA 12-2315, as amended, is associated with the diversion and storage of water in the current Lake Waco, prior to the pool raise. The water right authorizes:

a. Diversion of 39,100 acre-feet per year for municipal and industrial purposes with a priority date of January 10, 1929
b. Diversion of 19,100 acre-feet per year for municipal and industrial purposes with a priority date of April 16, 1958
c. Diversion of 900 acre-feet per year for irrigation purposes with a priority date of February 21, 1979
d. Storage of 104,100 acre-feet of water – no priority date specified

P-5094 authorizes increased storage and diversion associated with raising the top of conservation storage in 1962. The water right authorizes the diversion and use of 20,770 acre-feet per year in addition to the diversions authorized in CA 12-2315 for municipal purposes, as follows:

a. Diversion and use of 20,081 acre-feet per year with a priority date of September 12, 1986
b. Diversion and use of 688 acre-feet per year with a priority date of January 21,

[2] Texas Water Development Board: Volumetric and Sedimentation Survey of Waco Lake, May 2011 Survey, prepared for the City of Waco, October 2012.
[3] Pertinent data from COE website
[4] 2011 Volumetric Survey
[5] U.S. Army Corps of Engineers, Fort Worth District: Recommendation Report Waco Lake Storage Reallocation Study Brazos River Basin, Texas, October 1982.

1988

c. 1 acre-foot per year does not have an associated priority date (probably a typo). Assigned a priority date of September 12, 1986

d. Storage of an additional 87,962 acre-feet below elevation 462 feet with a priority date of September 12, 1986

The storage between elevations 427 feet and 455 feet contains 34,000 acre-feet of sediment storage, so the water supply storage of 104,100 acre-feet is not for the entire storage between those two elevations.

The storage authorized in P-5094 appears to be more than the incremental increase in storage associated with the pool raise (54,600 acre-feet), so some of the storage authorized in P-5094 is located below elevation 455 feet.

The City of Waco also has a water right to access supplies from Lake Brazos authorized by CA 12-4340. The water right authorizes:

a. Diversion of 5,600 acre-feet for municipal and industrial uses at a priority date of June 29, 1914

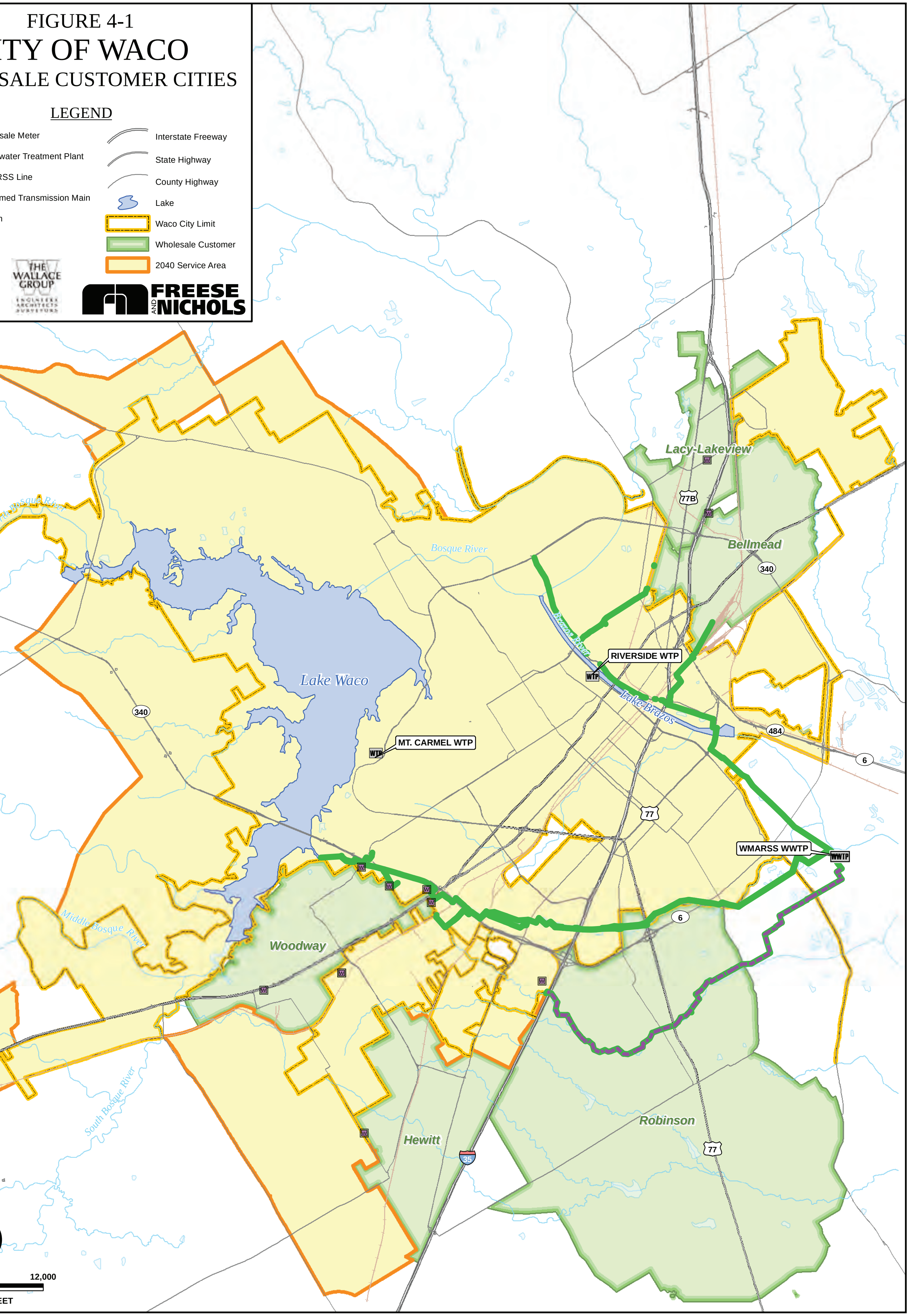
b. Storage of 3,537 acre-feet at a priority date of January 8, 1968

This water right provides access to supplies on the Brazos River in the City of Waco. The original dam was constructed in 1970 and revisions, and updates were completed in 2007. City of Waco does not currently use supplies from Lake Brazos to meet demands. The lake is primarily used for recreational purposes.

A bed and banks reuse Permit 5840 authorizes the City of Waco to convey 42,344 acre-feet/year return flows from Waco Metropolitan Area Regional Sewage System Wastewater Treatment Plant (WMARSS) and divert 42,175 acre-feet/year for reuse at a priority date of July 13, 2004. Currently the reuse supplies are used by Sandy Creek Power Plant by means of a 20-inch pipeline.

City of Waco is currently operating two ground water wells within the city limits. Prior to 2007, the city used the groundwater supply to meet a portion of customer demands. However, more recently the City has discontinued using the groundwater wells for water supply purposes. The City of Waco’s supply sources and service area are shown in **Figure 4-1**.

FIGURE 4-1
CITY OF WACO
WHOLESALE CUSTOMER CITIES



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Updated: Friday, October 09, 2015

4.2 WATER AVAILABILITY MODELING USING BRAZOS WAM

4.2.1 Yield Modeling of Lake Waco

Several regions in Texas have experienced severe drought conditions in the recent past. According to National Oceanic Atmospheric Administration (NOAA), 2011 is the driest single year on the record for the entire state. In many parts of the state, the dry conditions continued in subsequent years. Several lakes dropped below 50 percent of the conservation capacity, thus resulting in a severe threat to the supply availability. Priority calls made by senior water right holders in the Brazos Basin resulted in suspension of diversions or impoundments by junior water right holders in the basin. The uncertainty associated with the recent hydrologic events and the significant impact on the supply availability necessitated a detailed review of the impact of recent hydrology on supply reliability for Lake Waco.

Water availability modeling was performed to develop yield estimates for Lake Waco. The TCEQ Brazos WAM was used to estimate the reservoir yield for the period of record; however, the period of record in this model extended from 1940 to 1997 and did not include hydrology for the recent years. As part of this study, a separate spreadsheet model was developed to extend the hydrology from 1997 through 2014. A firm yield model was also developed to determine the firm yield of Lake Waco using the combined hydrology from the WAM (1940-1996) and the spreadsheet model (1997-2014).

A few issues were identified in the manner in which Lake Waco's water rights and related assumptions were represented in the TCEQ Brazos WAM. The TCEQ Brazos WAM was modified to rectify these issues. The revised model is termed as the "Modified Brazos WAM" for the remainder of this report. The changes to the WAM are listed below.

1. TCEQ WAM does not allow diversions under P-5094 access to storage authorized under CA 12-2315. Stored water should be available for use at any priority date. It would also be very difficult to separate the two authorizations in practice, particularly since they are not associated with a particular elevation in the reservoir. This assumption was revised.
2. Original area-capacity was used for Lake Waco in the TCEQ Brazos WAM, which would not show loss of yield due to sedimentation. The area capacity information from 2011 TWDB volumetric survey for Lake Waco was incorporated into the Modified Brazos WAM. The 2011 storage is 2,889 acre-feet less than the storage authorized in the TCEQ water right.

3. TCEQ Brazos WAM did not account for the 10 cfs leakage reported by USACE. This leakage amount was captured in the spreadsheet yield model.
4. TCEQ Brazos WAM had an incorrect value for the diversions authorized by P-5094 at the September 1986 priority date. This value was revised from 20,089 acre-feet per year to 20,082 acre-feet per year in the Modified Brazos WAM.
5. The TCEQ Brazos WAM reported an incorrect storage for diversions authorized by P-5094 at September, 1986 priority. This value was revised from 88,062 acre-feet to 87,952 acre-feet of storage in the Modified Brazos WAM.
6. The Modified WAM used a single storage pool for Lake Waco instead of the multiple pools used in the TCEQ WAM. The total storage of 189,773 acre-feet was assumed to be available for all diversions.
7. The Modified Brazos WAM limited water supply use to storage above 427 feet (8,986 acre-feet), to be consistent with the Corps contract.

In addition to the changes listed above, a few changes were made to the programming logic to represent the City of Waco's water rights accurately. Firm yield was calculated using the Modified Brazos WAM. Under current conditions, the firm yield of Lake Waco is 81,070 acre-feet per year, which is 1,200 acre-feet per year more than the authorized diversion of 79,870 acre-feet per year. The additional yield is small and probably not worth pursuing additional authorizations and will eventually disappear with further sediment accumulation, so the current available supply using the Modified Brazos WAM would be 79,870 acre-feet per year. The yield computed using the Modified Brazos WAM reflected the worst case scenario for 1940 through 1996. The critical period for this analysis is from 1951 through 1956. The critical period, or critical drought, is the period of low inflow that determines the yield of a reservoir.

4.3 HYDROLOGY EXTENSION

Hydrology was extended from 1997 to 2014 to check if extension of hydrology will impact the firm yield and supply availability determined. Data required to extend the hydrology was collected from USACE, USGS, City of Waco, and other sources. Inflows were calculated for 1997 through 2014, and subsequently the firm yield was estimated for the entire period of record. **Figures 4-2** and **4-3** include traces of Lake Waco elevation and storage respectively for the historical period of record used in the WAM model and the spreadsheet model. The figures are based on operation with a demand of 79,870 acre-feet per year.

It was observed that dry conditions in the recent past did not result in a significant impact on the lake levels. While the lake levels have dropped in response to the dry conditions, they are higher than the 1950s elevations. It should be noted that the lake has only recently recovered from the recent dry conditions. Continued low inflows could result in a new drought of record and lower yields for Lake Waco.

Figure 4-2: Lake Waco Elevation for Historical Period of Record (1940-2014)

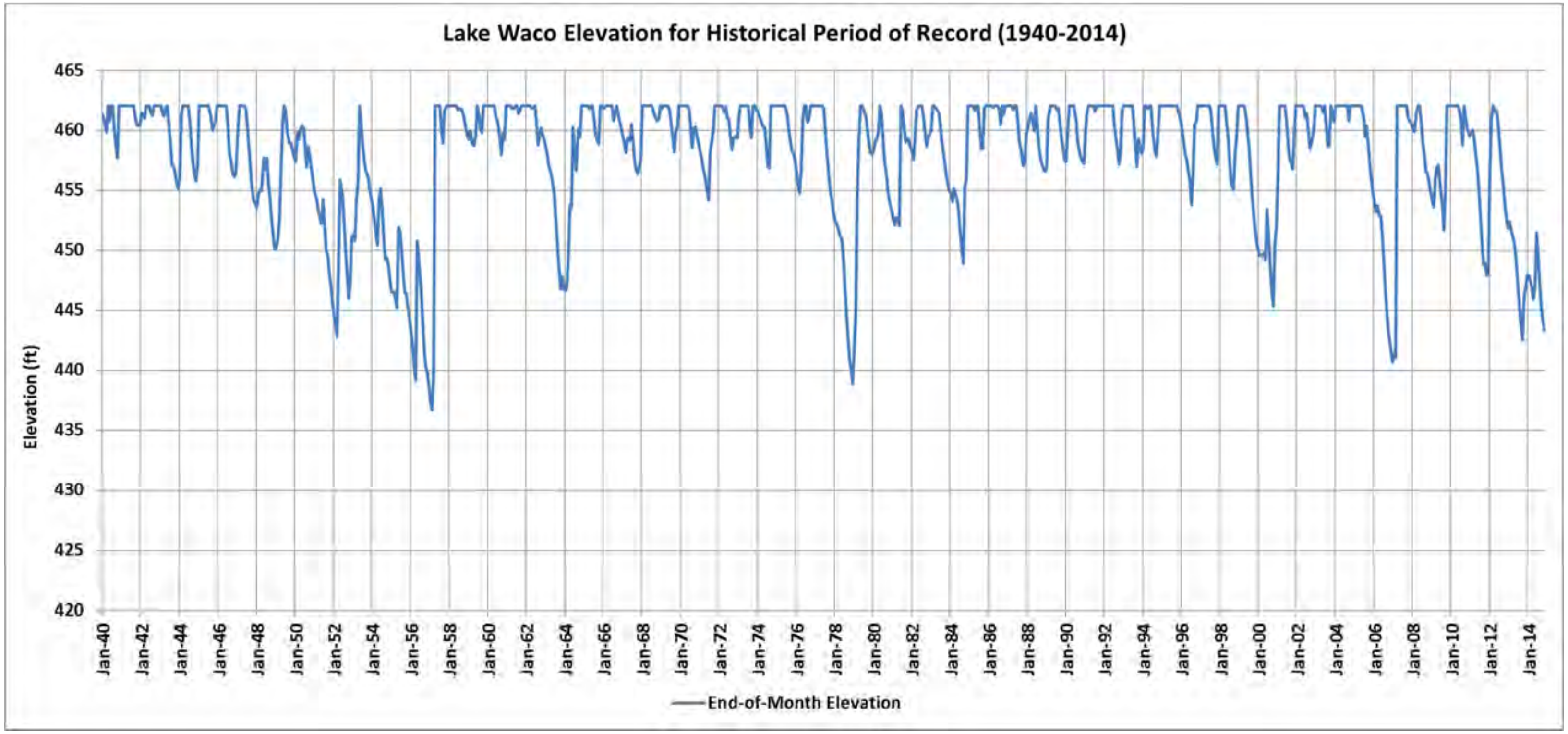
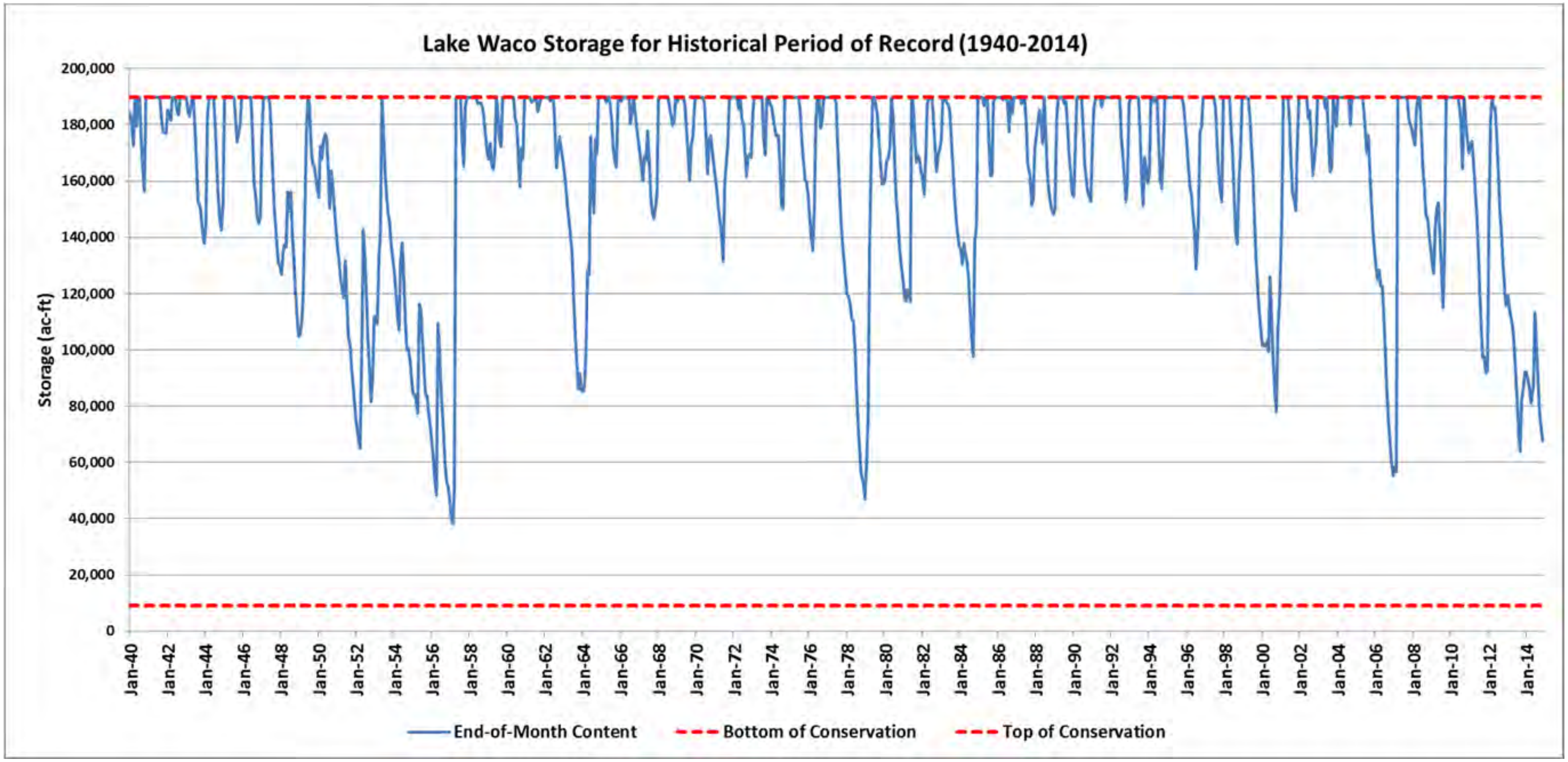


Figure 4-3: Lake Waco Storage Traces for Historical Period of Record (1940-2014)



4.4 INFLOWS AND FIRM YIELD OF EXISTING SURFACE WATER SUPPLIES

Firm yield of Lake Waco was recomputed using the hydrologic data for the entire period of record (1940-2014). A spreadsheet based yield model was developed to compute the firm yield for the data extending from 1940 through 2014. It was easier to take data from the WAM model and recreate the storage and elevation traces for the period 1940 through 1996 than to update the WAM model with the hydrology for the later years. Storage traces from the WAM model compare well with the spreadsheet model, thus calibrating the spreadsheet model to the WAM data.

Figure 4-4 shows the lake storage trace for the firm yield analysis. Even with the stressed hydrologic conditions of the recent years, it was noted that the dry conditions in the 1950's still govern the firm yield of the lake. The firm yield of Lake Waco using hydrology from 1940 through 2013 is the same as the firm yield computed using the WAM data for 1940 through 1996; therefore, the firm yield for Lake Waco is 81,070 acre-feet/year.

Annual inflows to the Lake Waco for the historical period of record from 1940 through 2014 were computed and summarized in **Figure 4-5**. It was concluded that the inflows to Lake Waco in the recent years are similar in magnitude to the inflows captured in the past. Releases to downstream senior water right holders were tracked both in the WAM output and the spreadsheet model. These are included in **Figure 4-6**. It should be noted that there is not clear approach for determining the releases to downstream senior users outside of the WAM model. WAM is a priority driven model and provides a priority-based value for the amount released from Lake Waco to downstream users. The spreadsheet model does not reflect the priority-based relations as well as the WAM model, and therefore the releases to downstream senior users were approximated based on the pattern of historical releases observed in the WAM output. It should also be noted that the releases to downstream senior users for a given year in the spreadsheet model were distributed uniformly among all months of a given year whereas the releases from the WAM output are reflective of the months in which the releases were made.

Figure 4-4: Storage of Lake Waco for the Firm Yield Analysis for Historical Period of Record (1940-2014)

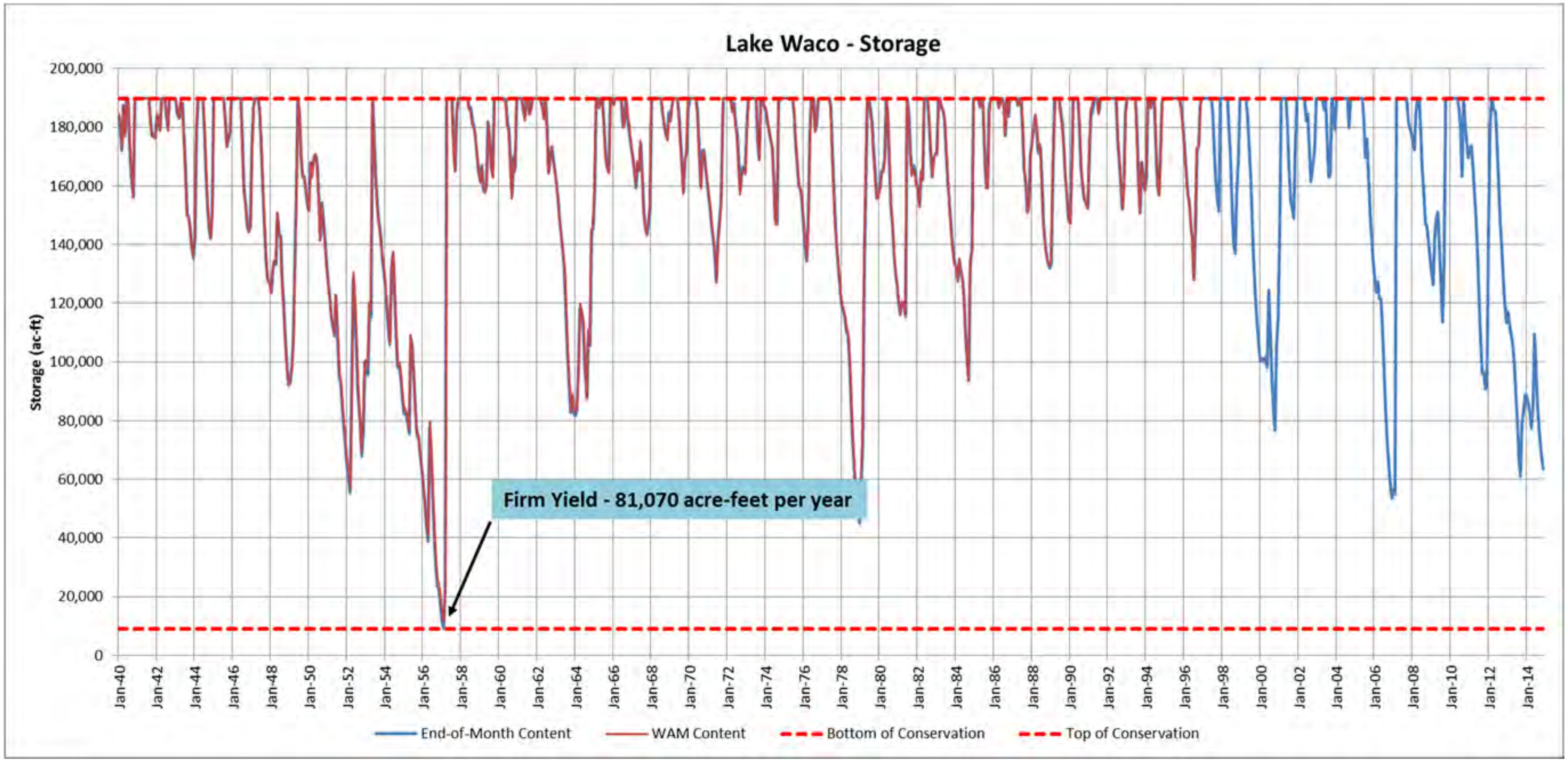


Figure 4-5: Summary of Inflows to Lake Waco for Historical Period of Record (1940-2014)

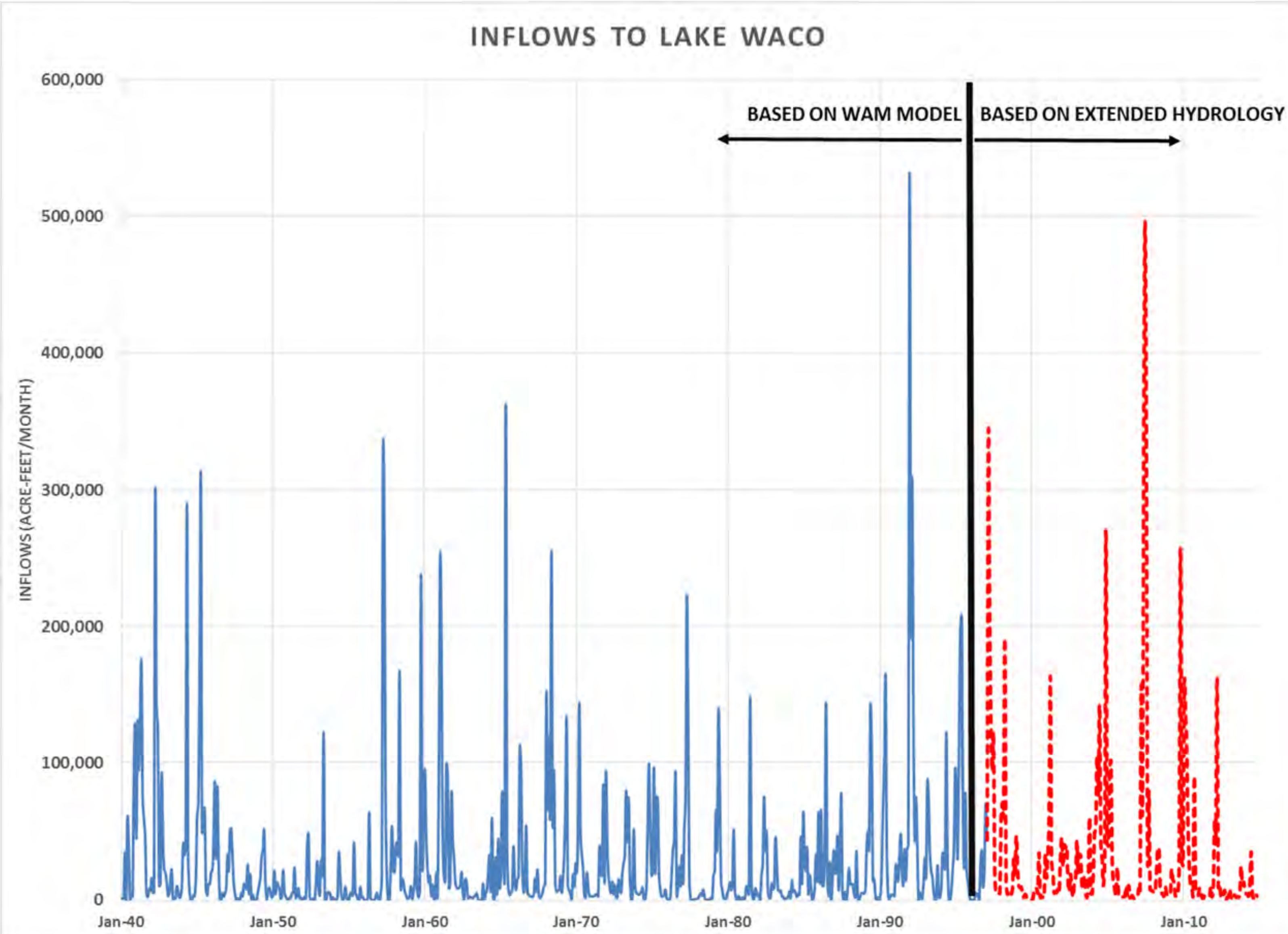
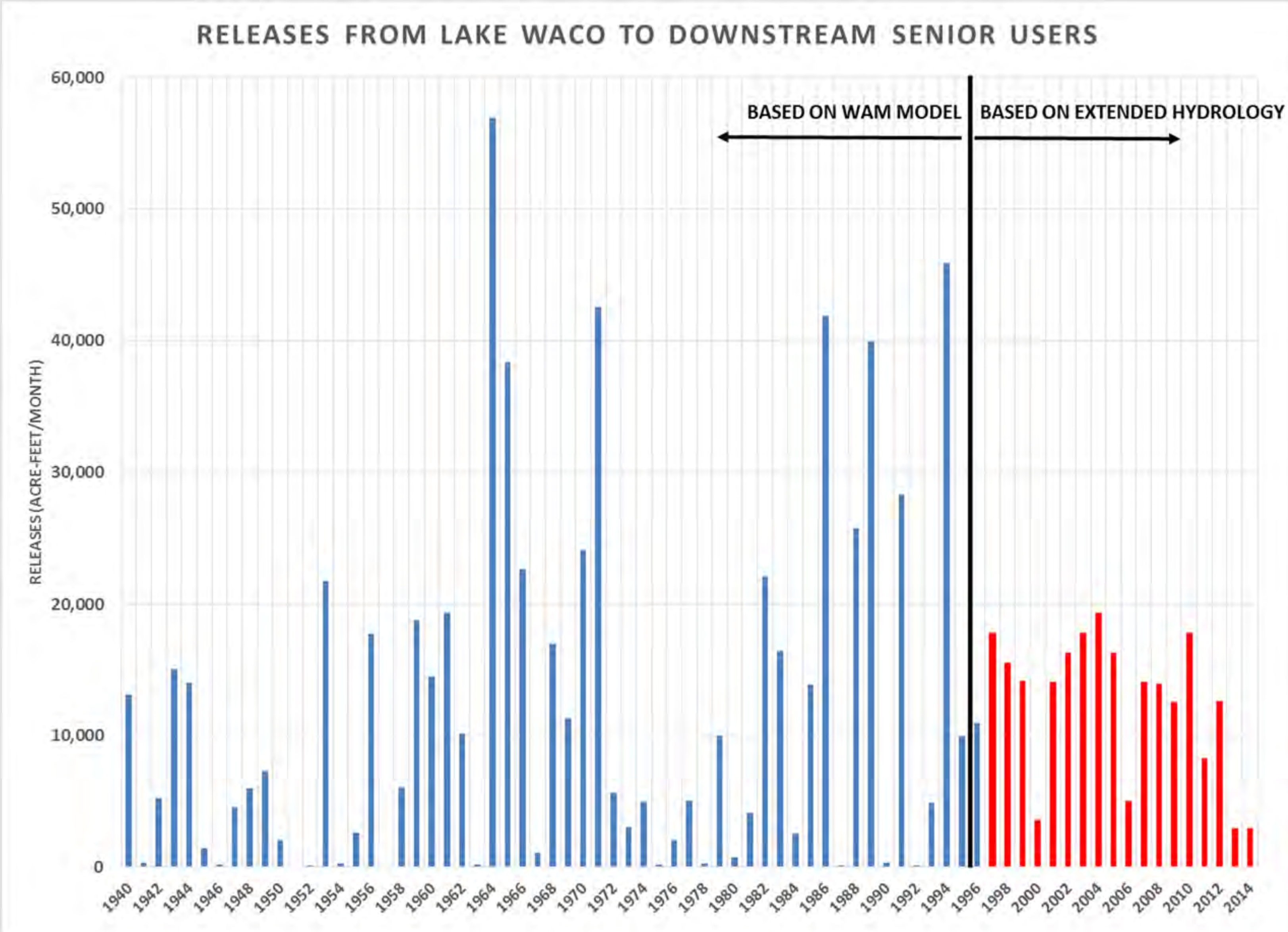


Figure 4-6: Summary of Releases from Lake Waco to Downstream Senior Water Right Holders for Historical Period of Record (1940-2014)



4.5 DROUGHT OF RECORD ANALYSIS

Drought of Record is an important hydrologic metric for water supply planning. Generally, Drought of Record is defined as the length of time when the reservoir goes from full to empty, and the reservoir supplies are at an all-time low, thus it is the period of low flow that determines the reservoir yield. Drought of Record is specific to a water body (lake or reservoir). Drought of Record cannot be defined as a probability. Irrespective of the period of record of data, there will be only one drought of record associated with a water body. The drought of record currently applied for Lake Waco was based on the hydrologic data from 1940 through 1996. Lake Waco's critical period is six years, and the drought of record is from 1951 through 1956.

Hydrologic events worse than the drought of record can occur, thus impacting the firm yield available from the source. Current uncertainty associated with the supply availability for water sources and the recent dry conditions in the state prompted the City of Waco to look at extending the period of record considered for determining the drought of record. The purpose of this subsection is to discuss the review of Lake Waco hydrology based on the observed data (1940-2014) and paleo records (1550-1894) reconstructed by means of tree ring studies.

It should be noted the discussion included in this section is based on a preliminary review of reports published on tree ring studies conducted close to Lake Waco. This review is not comprehensive in any sense. The information presented in this section can be used for academic purposes only. Any changes to the definition of Drought of Record or firm yield of Lake Waco should be based on a detailed study focused on the extended period of record encompassing the paleo data and observed data.

4.5.1 Tree Ring Studies

The summary included in this sub-section is based on the information presented in a study funded by Guadalupe-Blanco River Authority and published in Texas Water Journal[6]. Climate-sensitive annual tree rings were used as proxies for reconstructing Palmer Drought Severity Index (PDSI) in Southeast and South Central regions of state of Texas. Using the tree ring samples in South Central Texas region, the authors

[6] Malcolm K. Cleveland, Todd H Votteler, Daniel K. Stahle, Richard C. Casteel, Jay L. Banner. "*Extended Chronology of Drought in South Central, Southeastern and West Texas*". Texas Water Journal, Volume 2, Number 1, 2011. ISSN 2160-5319.

were able to reconstruct climate from 1500 through 2008 and calibrate their reconstructions of PDSI with the observed PDSI for the overlap period.

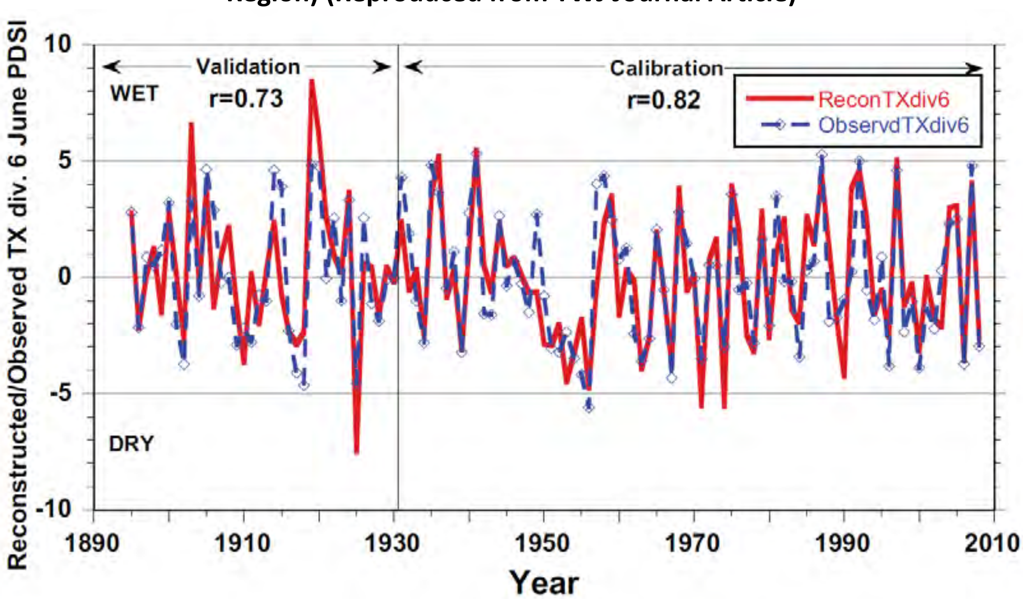
The PDSI incorporates temperature, precipitation and soil moisture capacity of a given location. Positive indices indicate normal or above normal conditions and negative indices indicate drought. The lower the PDSI number, the more severe the drought is presumed to be. Summer (June) PDSI is the most commonly used metric as it is the most representative of the dry conditions. The degree of drought and wetness in PDSI are designated as shown in **Table 4-1**.

Table 4-1: PDSI Designations for Degrees of Drought and Wetness

Number	Degree of Normalcy	PDSI Index	Degree of Drought	PDSI Index
1	Near Normal	0.5 to -0.5		
2	Incipient Wetness	0.5 to 1.0	Incipient Drought	-0.5 to -1.0
3	Mild Wetness	1.0 to 2.0	Mild Drought	-1.0 to -2.0
4	Moderate Wetness	2.0 to 3.0	Moderate Drought	-2.0 to -3.0
5	Severe Wetness	3.0 to 4.0	Severe Drought	-3.0 to -4.0
6	Extreme Wetness	>4.0	Extreme Drought	< -4.0

Waco is assumed to be close to Texas Climate Division 6 (Edwards Plateau) and hence the discussion below is focused on the Division 6 results. The validation and calibration of the tree ring data and the actual observation for Texas Climate Division 6 (Edwards Plateau) are reproduced in **Figure 4-7**.

Figure 4-7: Comparison of Reconstructed and Observed June PDSI for Division 6 (Edwards Plateau Region) (Reproduced from TWJ Journal Article)



According to the information from NOAA's National Climatic Data Center, both 2011 and 1956 are categorized as extreme single-year droughts with PDSI below -4. The PDSIs for droughts with various critical periods for climate division 6 (Edwards Plateau) are included in **Figure 4-8**. Comparisons were based on 1-yr, 2-yr, 3-yr, 4-yr, 5-yr, 6-yr, 7-yr, 10-yr, 15-yr, 20-yr and 30-yr lengths of drought. It can be noted that the 1950-s drought ranks at the top for droughts with critical periods of 4-yr, 5-yr, 6-yr, 7-yr and 10-yrs. There are other drought periods from 1700s that rank higher for shorter critical periods than 6-yr and 7-yr; however, since Lake Waco's critical period from observed data is 6 years, comparisons to the 6-year critical period are most relevant. The tree ring study reports do not show a drought that appears to be more severe than the 1951-1956 Drought of Record for Lake Waco in the last 508 years (1500-2014). That does not mean that the future droughts would have to be six years long. There could be shorter and severe droughts. There are many regions in Texas (especially in West Texas) that are experiencing long and severe droughts, and Lake Waco could possibly be affected by similar conditions, if the scientific consensus on long-term variability and uncertainty in climate data proves to be valid. A review of the Lake Waco storage traces for the observed period (1940-2014) in **Figure 4-4** indicates that the 1951-1956 period is the drought-of-record for Lake Waco. The current lake levels are low, and it is a cause for concern, but they are not as low as the 1950s.

Figure 4-8: Reconstructed Droughts of 1-7 and 10-yr lengths for Climate Division 6 (Edwards Plateau)

Table 3. Climate division 6 (Edwards Plateau) June PDSI, 1500–2008 reconstructed droughts of 1-7 and 10-year lengths in order of severity. Overlaps between time periods in a column have been eliminated.

Case	Single Year	2 Year Avg	3 Year Avg	4 Yr/Avg	5 Yr/Avg	6 Yr/Avg	7 Yr/Avg	10 Yr/ Avg
1 Driest	1716 -7.71	1715–16 -6.64	1714–16 -6.02	1714–17 -4.67	1713–17 -3.75	1951–56 -3.21	1950–56 -3.16	1707–16 -2.60
2	1925 -7.51	1785–86 -5.72	1840–42 -3.86	1953–56 -3.57	1952–56 -3.26	1711–16 -3.20	1711–17 -2.83	1948–57 -2.38
3	1528 -6.84	1789–90 -5.70	1643–45 -3.82	1805–08 -3.44	1571–75 -2.73	1785–90 -3.07	1785–91 -2.35	1571–80 -1.75
4	1538 -6.40	1644–45 -5.24	1741–43 -3.70	1728–31 -3.39	1641–45 -2.71	1704–09 -2.40	1571–77 -2.25	1777–86 -1.62
5	1644 -6.35	1805–06 -5.08	1805–07 -3.63	1559–62 -3.23	1786–90 -2.66	1572–77 -2.33	1703–09 -2.24	1840–49 -1.62
6	1786 -6.34	1841–42 -5.08	1785–87 -3.55	1642–45 -3.18	1804–08 -2.63	1750–55 -2.21	1749–55 -1.96	1854–63 -1.49
7	1542 -6.24	1730–31 -4.67	1572–74 -3.51	1571–74 -3.08	1728–32 -2.50	1728–33 -2.12	1523–29 -1.88	1523–32 -1.46
8	1789 -5.82	1632–33 -4.65	1729–31 -3.47	1839–42 -2.95	1559–63 -2.49	1803–08 -2.07	1664–70 -1.84	1748–57 -1.45
9	1790/ -5.57	1886–87 -4.39	1523–25 -3.44	1522–25 -2.81	1838–42 -2.41	1559–64 -2.03	1772–78 -1.80	1800–09 -1.42
10	1715 -5.56	1742–43 -4.18	1954–56 -3.26	1741–44 -2.76	1521–25 -2.25	1523–28 -2.02	1801–07 -1.79	1885–94 -1.38
11	1730/ -5.56	1704–05 -4.13	1560–62 -3.22	1775–78 -2.49	1890–94 -2.15	1776–81 -1.98	1854–60 -1.71	1597–1606 -1.32
12	1974 -5.54	1819–20 -4.12	1776–78 -3.18	1749–52 -2.44	1705–09 -2.08	1838–43 -1.91	1838–44 -1.66	1559–68 -1.27
13	1971 -5.50	1524–25 -3.96	1703–05 -3.18	1891–94 -2.37	1774–78 -2.06	1601–06 -1.85	1600–06 -1.66	1664–73 -1.26
14	1601/ -5.48	1528–29 -3.95	1789–91 -3.16	1854–57 -2.25	1750–54 -2.04	1664–69 -1.75	1886–92 -1.58	1909–18 -1.24
15	1842/ -5.48	1561–62 -3.93	1818–20 -3.16	1703–06 -2.18	1739–43 -1.90	1855–60 -1.72	1728–34 -1.57	1962–71 -1.12
16	1742 -5.44	1953–54 -3.88	1750–52 -3.09	1971–74 -2.16	1528–32 -1.87	1641–46 -1.69	1559–65 -1.49	1696–1705 -0.88
17	1805 -5.28	1847–48 -3.75	1892–94 -3.08	1817–20 -2.12	1666–70 -1.87	1738–43 -1.66	1738–44 -1.41	1850–59 -0.83
18	1632/ -5.18	1538–39 -3.72	1631–33 -3.04	1949–52 -2.12	1963–67 -1.78	1889–94 -1.55	1961–67 -1.25	1925–34 -0.82
19	1785 -5.11	1892–93 -3.59	1847–49 -2.74	1915–18 -2.07	1859–63 -1.73	1847–52 -1.55	1642–48 -1.12	1994–2003 -0.83
20	1806 -4.87	1551–52 -3.55	1950–52 -2.62	1630–33 -2.05	1970–74 -1.70	1962–67 -1.52	1912–18 -1.10	1736–45 -0.70

ably. The Guadalupe River State Park (GRP) and SBP sites are confined to river banks with relatively minor human disturbance. The KSS site contains a long-established commercial park with considerable human disturbance, including bulldozer work, soil compaction by heavy human traffic, extensive modifications to the original hydrology, and anthropogenic damage to the trees. In addition, the KSS trees grow in a wide variety of hydrologic micro-sites, far more variable than the

4.6 GEOLOGY AND HYDROGEOLOGY OF MCLENNAN COUNTY

For this evaluation, R.W. Harden and Associates, Inc. (RWH&A) compiled and reviewed available information pertaining to the geologic structure, aquifer productivity and groundwater quality, including published and unpublished reports, maps, well construction records, water quality analyses, well testing records and geophysical logs. The majority of information obtained is compiled from Texas Water Development Board (TWDB) reports and the TWDB well database with additional information from RWH&A files.

Surface geology in McLennan County consists predominantly of Cretaceous age deposits cropping out in a northwest to southeast trending belt, and Quaternary age alluvium flood plain deposits meandering northwest to southeast through the County. Cretaceous age formations characterize the majority of the subsurface sediments, consisting of sands, shales, marls and limestones characteristic of a fluvial to marine environment.

The Brazos River Alluvium (Alluvium) and two members of the Trinity Group are the principal aquifers in the County. The Alluvium is characterized by Quaternary age clay, sand, silt and gravel in stream and terrace deposits which yield small to large quantities of water where present. The Cretaceous age Trinity Group includes two distinct aquifers, the Hensell and Hosston sandstones, separated by layers of shale and limestone, which yield large quantities of water throughout the County.

4.6.1 Brazos River Alluvium

The Brazos River Alluvium is a major source of water for irrigation and domestic use in McLennan County. The aquifer is unconfined and consists of fine to coarse sands, gravels, silts and clays deposited in floodplain and ancient terrace deposits by river and overbank flows. The deposits extend to the east and west from the present day Brazos River in a band spanning up to about 7 miles across as shown in **Figure 4.9**. Depths of the alluvium wells in McLennan County range from approximately 20 to 60 feet below ground level (bgl), with an average depth of 30 feet bgl. Due to the meandering nature of rivers and associated deposits, production is inconsistent, and the supply available from wells can range from less than 250 to over 800 gallons per minute (gpm). Recharge to the aquifer occurs through downward percolation of rain water falling on the flood plain, flow from surrounding bedrock, and potentially from the Brazos River during flood stage flows. Water levels collected within the last 14 years indicate average water levels of about 25 feet bgl and that the alluvium discharges groundwater to the Brazos River. In localized areas where the water table has been pumped below the river elevation, surface water from the Brazos River may be a source of recharge.

Little information exists on site-specific aquifer characteristics in McLennan County, but studies conducted on wells and test holes in counties south of McLennan County indicate transmissivities ranging from about 7,000 to 208,000 gallons per day per foot (gpd/ft) with an average of about 42,000 gpd/ft. The large range of values underscores the variability in hydraulic characteristics of the Alluvium.

On average, water withdrawn from the Alluvium in McLennan County is fresh and of good quality. Seventeen wells historically tested by the TWDB indicate the average Total Dissolved Solid (TDS) concentrations of about 700 milligrams per liter (mg/L), with only two wells exceeding drinking water standards. Although chloride and sulfate concentrations were elevated in some individual wells, average concentrations of all wells sampled are significantly below secondary drinking water standards. Secondary drinking water standards are considered aesthetic nuisances, as opposed to health hazards. Nitrate was the sole constituent sampled which exceeded state primary drinking water standards and have an established maximum contaminant level (MCL). An average nitrate concentration of 35 mg/L was measured; the MCL for nitrate is 10 mg/L. It should be noted that recent water quality data was not located and water samples were dated between 1955 and 1993. Nitrates are commonly associated with agricultural activity and high densities of septic systems. Changing land use and development of groundwater away from agricultural areas and in more urban areas may show lower concentrations of nitrates; however, development of unconfined aquifer in urban areas may be more subject to other sources of contamination such as leaks from underground gasoline storage tanks and chemicals from dry cleaning facilities. A testing program to prove up the water quality information provided herein is advised.

4.6.2 Trinity Group

In McLennan County, the Trinity Group consists of the following five stratigraphic units: the Glen Rose Limestone, Hensell Sandstone, Pearsall Formation, Sligo Formation, and the basal Hosston Sandstone. Sycamore gravels are located at lower elevations of the base of the Trinity and are hydraulically connected to the overlying Hosston, where present. For purposes of this report, the Sycamore is considered part of the Hosston. The Hensell and Hosston sandstones act as the principal aquifers in the county, while the other interbedded units act as confining beds. Both aquifers (Henselll and Hosston) act as major sources of water. Production from the Hensell, predominantly used for domestic, public supply, and industrial use, occurs mainly west of the Balcones Fault Zone as shown in **Figure 4.9**, which bisects the county from northeast to southwest and has been observed to vertically offset subsurface formations in McLennan County by up to 400 feet. The Hosston sandstone is a major source of water for public and industrial wells throughout the county. A small subset of wells in the county screen and produce from both aquifers.

A. Hensell Sandstone

The Hensell sandstone is composed of fine to coarse-grained white quartz sand with minor interbedded layers of green to red clay. In the Waco area, the Hensell has a thickness of about 50 to 70 feet and lies about 1,000 to 2,000 feet bgl. Recharge to the aquifer occurs mainly through downward percolation of precipitation and stream seepage received on the outcrop located about 50 to 100 miles west of Waco as shown in **Figure 4-9**. Water levels measured since the year 2000 show an average water level of about 550 feet bgl. A pumping test in the Hensell in the town of McGregor shows a transmissivity value of 1,100 gpd/ft and a hydraulic conductivity of 26 gallons per day per square foot (gpd/ft2). The aquifer test, hydraulic conductivity and formation thickness data suggest a transmissivity values between 1,000 and 2,000 gpd/ft are likely in the aquifer. In general, transmissivity is lower east of the Balcones Fault Zone than to the west. This has resulted in the majority of Hensell wells constructed west of the Balcones Fault Zone.

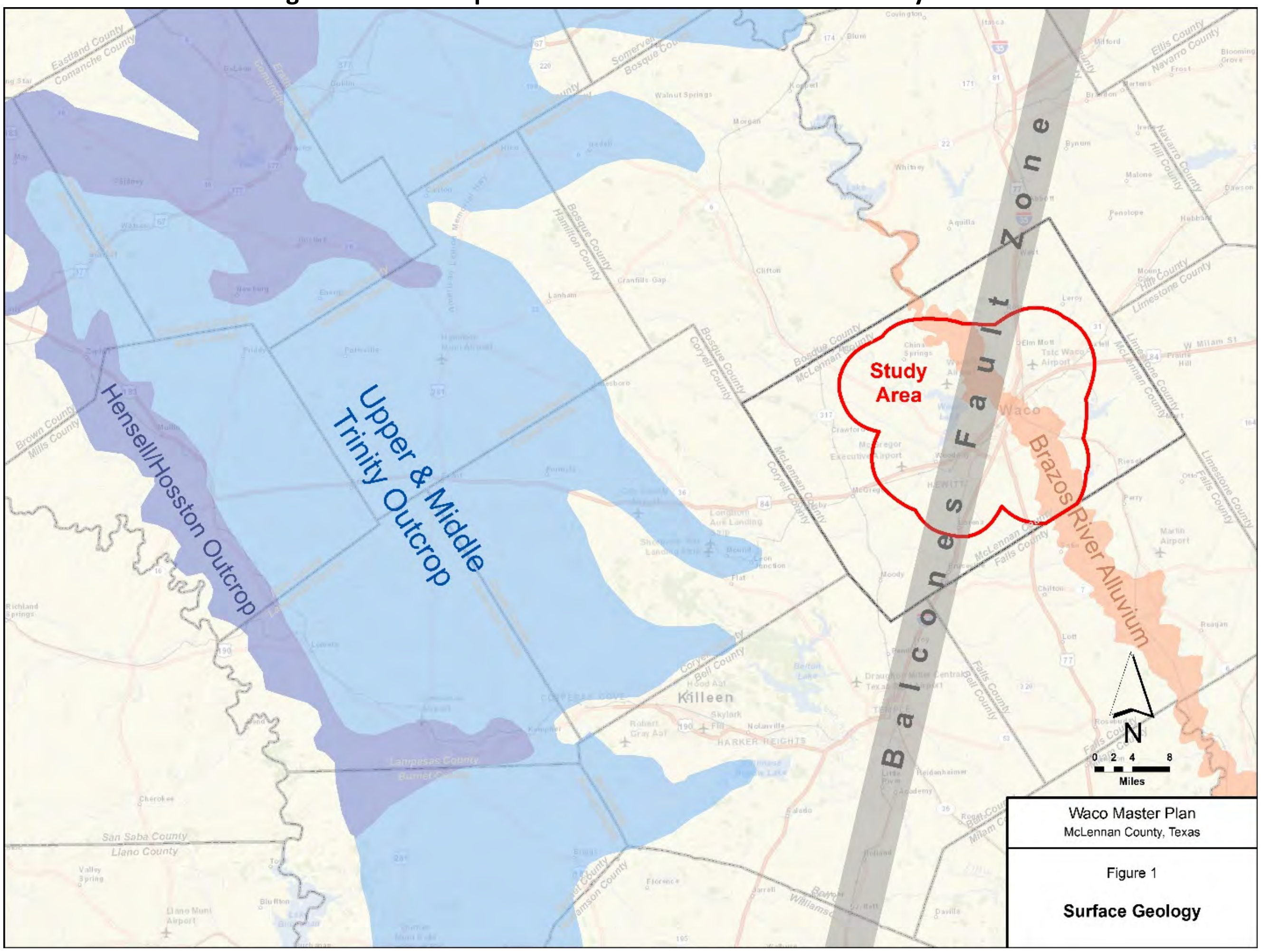
Water quality of the Hensell aquifer in McLennan County is generally fresh. Although elevated concentrations of TDS, nitrate, fluoride, chloride and sulfate have been observed in individual wells, the average water is typically fresh with an average TDS concentration of 851 mg/L and, on average, all major constituents tested by the TWDB are below state MCLs.

B. Hosston Sandstone

The Hosston sandstone is composed of fine to coarse, red to white silty sand, interbedded with shale and cemented locally with calcite. Coarse gravels have been encountered at the base of the formation in a number of wells and contributes to the higher average hydraulic conductivity of the Hosston. The Hosston generally thickens to the east, ranging from about 100 feet in the northwestern portion of the Waco region to over 600 feet in the southeastern portion. The top of the aquifer exists about 1,100 to 2,500 feet bgl in the Waco Region. Recharge to the aquifer occurs mainly through downward percolation of precipitation and stream losses where streams cross the outcrop. Data collected since 2000 shows an average water level of about 630 feet bgl. Transmissivity in the Hosston has been found to range from 5,000 to 10,000 gpd/ft and the hydraulic conductivity has been observed to range 18 to 71 gpd/ft^2. Generally, the transmissivity increases to the east with the thickening of the sands.

Water quality of the Hosston aquifer in McLennan County is generally fresh. Although elevated concentrations of TDS, fluoride, chlorides and sulfates have been observed in individual wells, the average water is fresh with a TDS value of 721 and, on average, all major constituents tested for by the TWDB are below state MCLs.

Figure 4-9: Aquifer Locations near McLennan County



5.0 WATER SUPPLY STRATEGIES

5.1 COMPARE LONG-TERM SUPPLY AND DEMAND

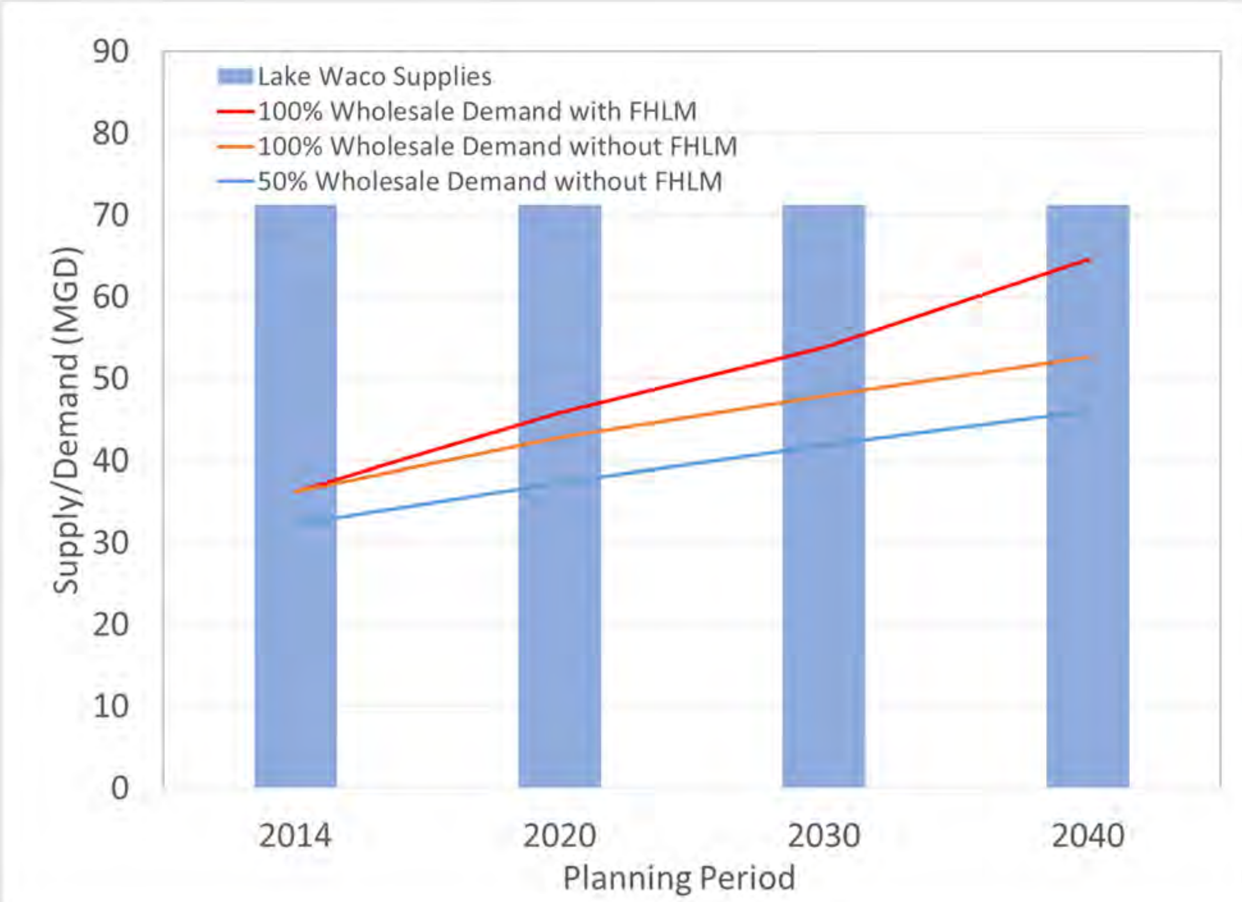
Three future demand scenarios were considered for developing the CIP plan to address the City of Waco's infrastructure needs for the future decades. Two of the three demand scenarios did not consider the future water demands associated with a planned regional water supply company, FHLM WSC, and a third worst case scenario included demands for FHLM WSC. The demand scenarios are as follows: 1) 100% of Wholesale Demand without FHLM 2) 50% of Wholesale Demand w/o FHLM, and 3) 100% of Wholesale Demand with FHLM. The future demand projections for the three alternatives are presented in **Table 5-1**.

The total permitted diversions from Lake Waco are 79,870 acre-feet/year. The firm yield of Lake Waco based on the water availability modeling is about 81,070 acre-feet/year. The total permitted diversions limit the supply available to City of Waco, as the firm yield is greater than the total permitted diversions. Available supplies are compared against the projected demands to identify any supply shortages or surpluses. If a shortage is identified in the future decades, water supply strategies are evaluated to meet the shortage in the supply availability. Comparison of the supply and demand projections for the near-term and long term is included in **Figure 5-1**. It should be noted that Lake Waco supplies are sufficient to meet the average day demands for all three scenarios. In the worst case demand projection scenario using maximum day demands, the City of Waco will need an additional 7 MGD in 2020, increasing to an additional 38 MGD in 2040. In the best case demand projection scenario using maximum day demands, the City will need an additional 3 MGD in 2030 and an additional 11 MGD in 2040.

Table 5-1: Summary of Demand Projection Scenarios

Number	DESCRIPTION	SUPPLY/DEMAND (MGD)			
		2014	2020	2030	2040
AVERAGE DAY DEMAND PROJECTION SCENARIOS					
1	100% Wholesale Demand without FHLM	36.24	42.87	47.93	52.67
2	50% Wholesale Demand without FHLM	32.28	37.31	41.83	46.08
3	100% Wholesale Demand with FHLM	36.24	45.83	53.78	64.54
SUPPLIES (MGD)					
1	Lake Waco	71.2	71.2	71.2	71.2

Figure 5-1: Comparison of Supply and Demand Scenarios for City of Waco



At this time, there isn't enough information available to define the trend of future demand projections for the City. A sound strategy evaluation must focus on addressing the worst case demand projection scenario, so the water supply evaluation includes strategies to address the best case and worst case demand projection scenarios. As there are no shortages associated with the use of average day demands, the strategies discussed further in section 5.2 are developed with the intention of pro-active planning for City of Waco and not with an intent to meet the shortage.

5.2 DISCUSSION OF POTENTIAL STRATEGIES

A strategy is defined as a water supply alternative that can independently or in combination with another alternative help address the supply shortages for City of Waco. The following is the list of potential strategies identified for City of Waco.

12. Local Groundwater Supply
13. Imported Groundwater Supply

14. Conjunctive Use
15. Conservation
16. Lake Brazos
17. Lake Bosque
18. Lake Creek Reservoir
19. Tradinghouse Creek Reservoir
20. Wastewater Reuse
21. Aquifer Storage and Retention
22. Purchase from Brazos River Authority

A fact sheet was developed by summarizing the relevant information associated with each one of the strategies listed above. Each factsheet includes a description of the strategy, a location map (where applicable), supply reliability assessment, infrastructure configuration, cost estimate, regulatory and permitting requirements, timing/schedule, and a summary of potentials risks/benefits/challenges associated with the strategy. Selection of the most preferred strategy or a combination of strategies is primarily based on the following variables:

5. Supply Reliability
6. Cost
7. Risk
8. Stakeholder Preference

Subsections 5.2.1 to **5.2.11** include the fact sheets for all the selected strategies. A comparative analysis of the strategies and the strategy recommendations are included in **Section 5.3**.

5.2.1 Local Groundwater

Description

The Local Groundwater strategy assumes that all regional groundwater users continue to use groundwater as they have in the past and increases in pumpage will continue as they have in the past. Groundwater modeling was conducted to evaluate regional impacts of incremental groundwater pumping increases on artesian water levels of the Hosston and Hensell members of the Trinity aquifer. The Texas Water Development Board (TWDB) Northern Trinity and Woodbine Aquifers Groundwater Availability Model (GAM) Run 08-06 was used as the basis for analyses, utilizing the MODFLOW code distributed by the U.S. Geological Survey to analyze impacts.

Pumpage inputs were not modified from the original model inputs except for the project participants shown in **Table 5-2**, which were developed from recent surveys of each entity's projected growth.

Table 5-2: Increasing Pumpage Distribution

Water Producer	Pumpage (ac-ft/year)				Number of Wells	Aquifer Distribution	
	2012	2020	2030	2040		Hensell	Hosston
Aqua Texas WSC	926	1,022	1,148	1,291	16	100%	0%
City of Bellmead	1,262	1,392	1,565	1,759	5	0%	100%
Bold Spring WSC	197	218	245	275	4	0%	100%
Cargill	387	428	481	540	1	0%	100%
Chalk Bluff WSC	389	429	482	542	3	0%	100%
Cross Country WSC	438	483	543	610	4	100%	0%
City of Hewitt	2,426	2,678	3,010	3,383	4	0%	100%
City of Lacy Lakeview	0	0	0	0	0	0%	0%
McLennan County WCID 2	190	209	235	265	3	0%	100%
North Bosque WSC	407	449	504	567	3	100%	0%
City of Robinson	1,497	1,652	1,857	2,087	5	0%	100%
Ross WSC	314	347	390	438	3	0%	100%
Sanderson Farms	1,162	1,283	1,442	1,621	2	0%	100%
South Bosque	10	11	13	14	1	100%	0%
City of Waco	211	232	261	293	2	0%	100%
City of West	184	203	228	256	1	0%	100%
City of Woodway	1,749	1,930	2,169	2,438	6	0%	100%
County-Other	3,575	3,945	4,434	4,984	n/a	47%	53%

a. Pumpage Distribution

Tables 5.2 shows pumpage between years 2012 and 2040, including pumpage from individual producers and “county-other” pumpage, which represents other minor water usage in the County such as irrigation, livestock, and domestic pumpage from unidentified producers. Pumpage for the entities listed in Table 5.2 is distributed between the Hensell and Hosston layers according to information provided by the City. The distribution of “county-other” pumpage, and pumpage from other users who are not project participants was unchanged from the original model.

The location of pumping wells was unmodified from the locations shown in the GAM, except as described below. Because the pumpage amounts for the project participants are different than those shown in the GAM, differences in pumpage between 1999 and 2012 were linearly interpolated to obtain a starting point for the simulations contained herein. For entities with multiple pumping wells, the total pumpage was distributed evenly between wells.

For pumping wells that are not included in the GAM (or incorrectly located in the GAM), but are shown on Table 5.1, the TWDB wells database was used to obtain a location, which was confirmed by plotting the entity’s CCN.

b. Model Construction

Figure 5.2 shows the general extent of the model in Central and North-Central Texas. The up dip boundary of the model to the west is defined by the outcrop of the aquifer. The down dip boundary to the east is defined by the Mexia-Talco Fault Zone. The down dip boundary is represents a no-flow boundary imposed by the vertical offset of the Trinity created by the faulting, which prevents meaningful hydraulic communication between the areas east and west of the Mexia-Talco Fault Zone. The Balcones Fault Zone which trends north-south through McLennan County also creates more localized boundaries within the Trinity that restrict hydraulic communication across the fault and result in artesian pressure declines that are larger than declines in unfaulted regions of the Trinity. No changes were made to the original model inputs for structure, boundary conditions, storativity, transmissivity, or recharge.

c. Model results

Figures 5.3 and 5.4 depict artesian water pressure decline from 2012 to 2040 in the Hensell and Hosston aquifers, respectively. **Figure 5-5** shows the line of cross section depicted in **Figures 5-6** and **5-7** (as well as all cross sections shown herein). The cross sections shown in **Figure 5-6** and **5-7** show the relative position of the aquifer and the artesian pressure surface in 2012 and 2040. Although there may be difference of up to 10 percent between measured water levels and simulated water levels, the change in the water levels are reasonably accurate for the pumpage volume and time of pumping. Artesian pressure declines of up to about 400 feet in the Hosston, and 340 feet in the Hensell are projected to occur in Waco under the increasing pumpage option.

Figure 5-2: Regional Model Extent

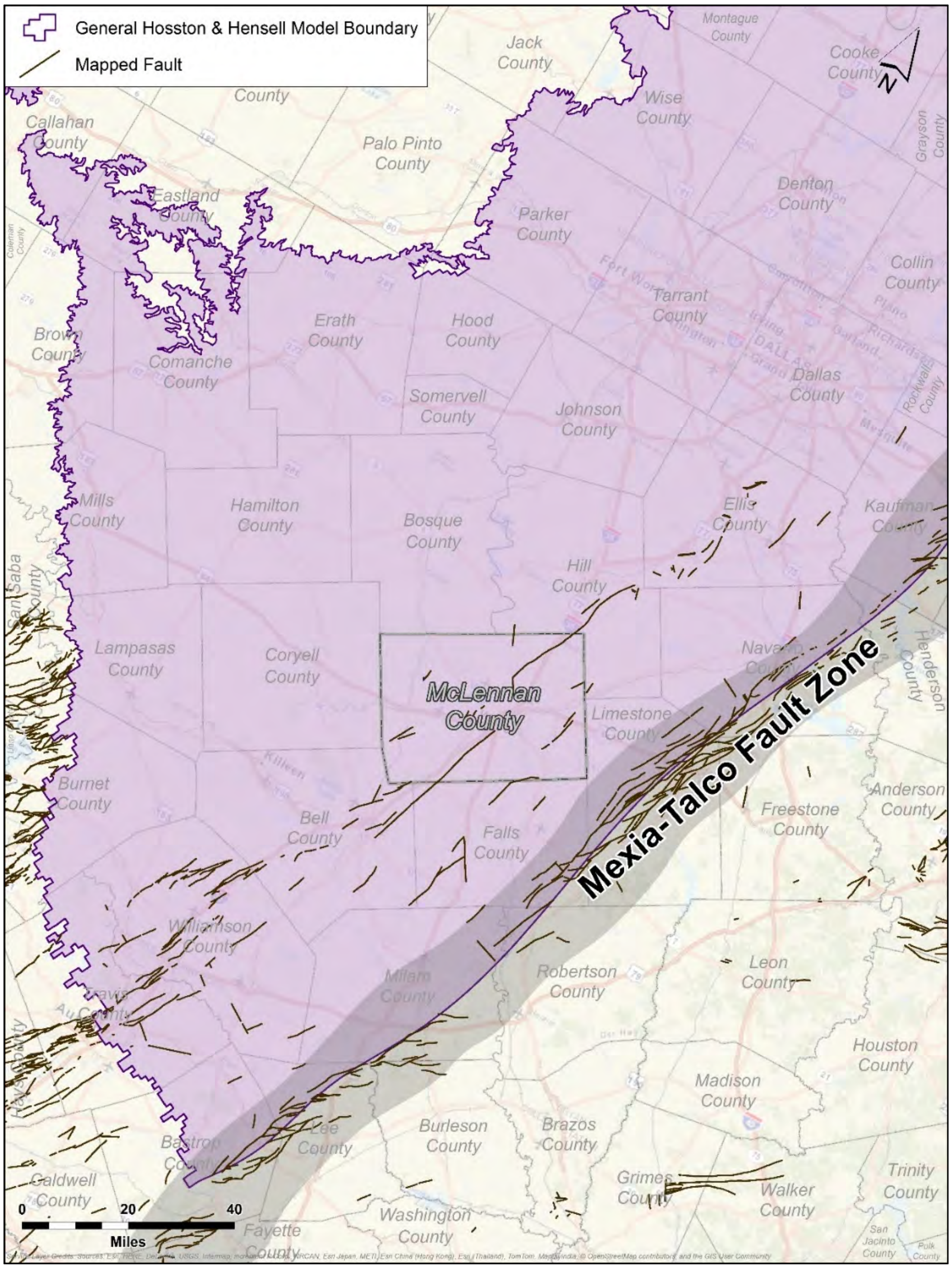


Figure 5-3: Increasing Pumpage - Artesian Pressure Decline, 2012 and 2040, Hosston Aquifer

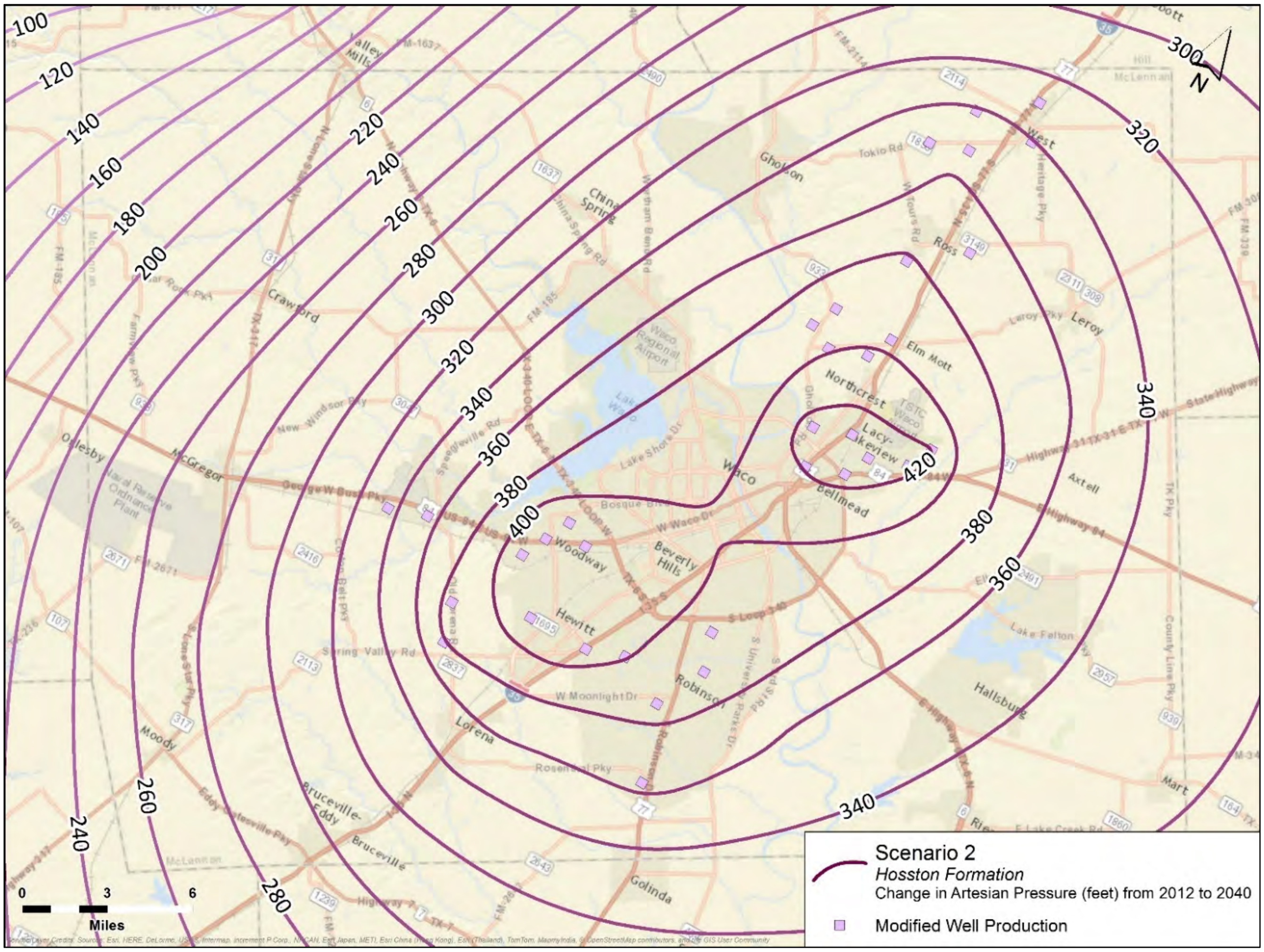


Figure 5-4: Increasing Pumpage - Artesian Pressure Decline, 2012 and 2040, Hensell Aquifer

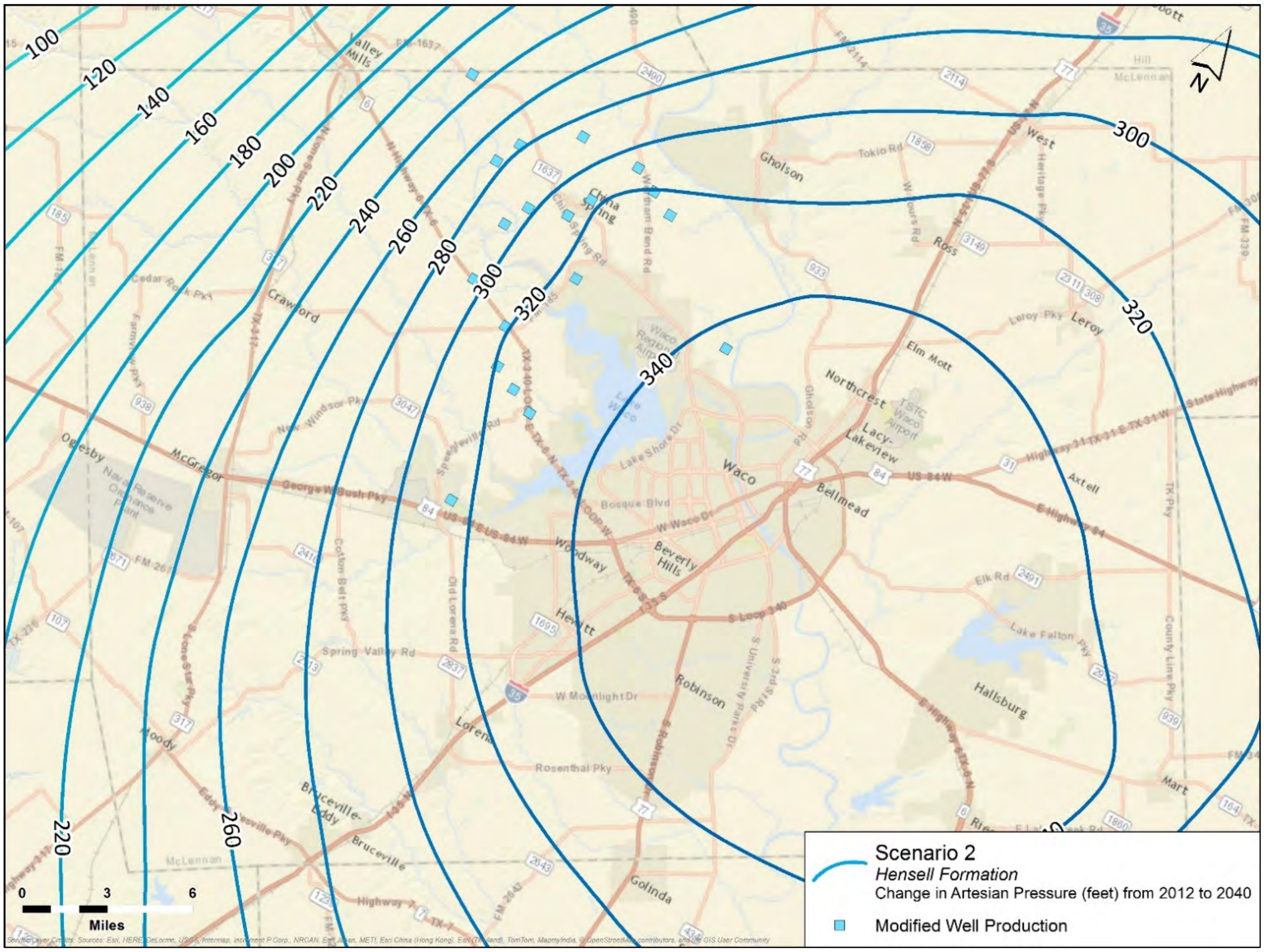


Figure 5-5: Increasing Pumpage - Artesian Pressure Decline, 2012 and 2040, Hensell Aquifer

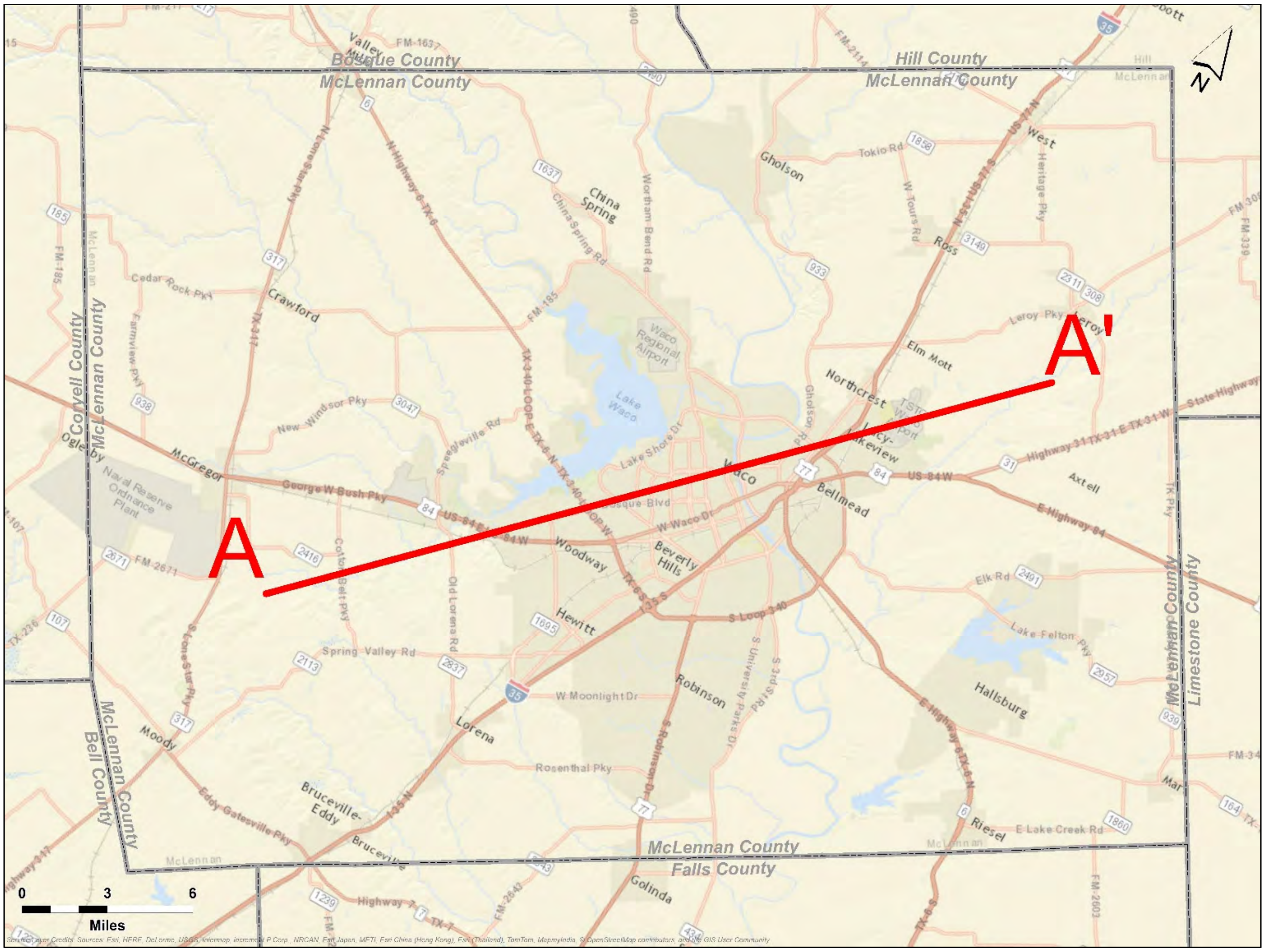


Figure 5-6: Increasing Pumpage - Artesian Pressure Level in the Hosston Aquifer

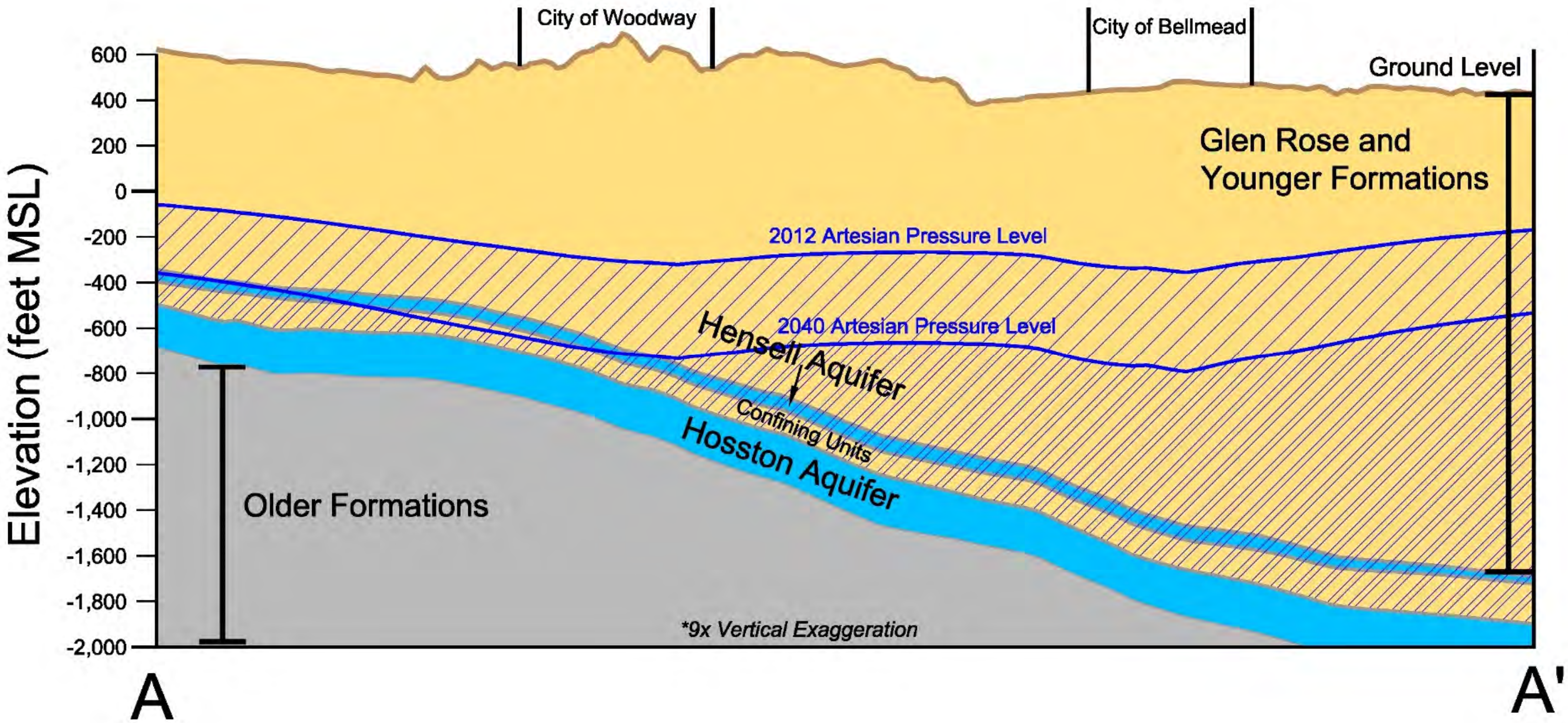
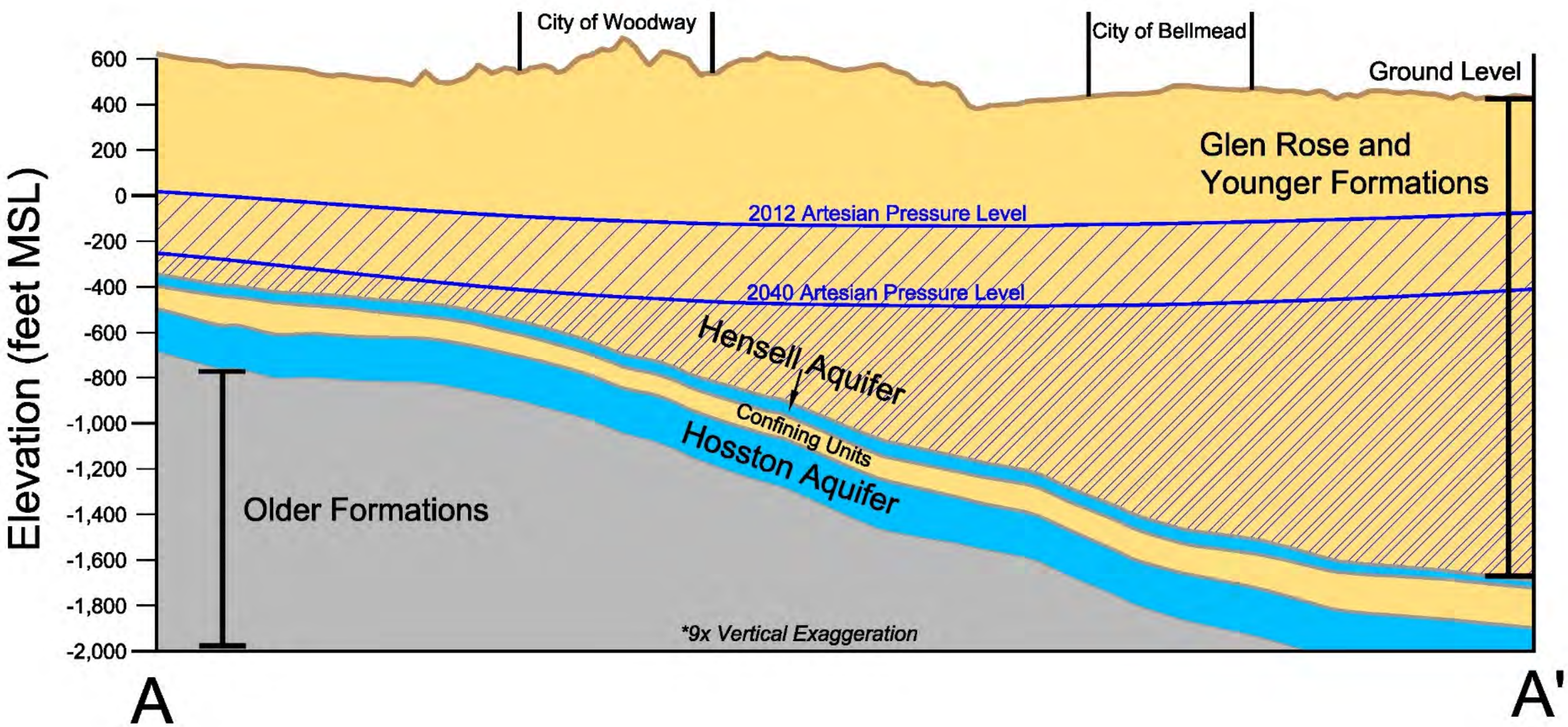


Figure 5-7: Increasing Pumpage - Artesian Pressure Level in the Hensell Aquifer



Supply Reliability

Suburban communities in the Waco metropolitan area have historically relied on groundwater supplies from the Trinity aquifer. While this has resulted in artesian pressure declines of up to 700 feet or more, has presented challenges to the design of the existing infrastructure, and has increased groundwater production costs, the "supply" itself remains an essentially unchanged resource in terms of the quantity of groundwater in the County. Using data from the TWDB Northern Trinity Groundwater Availability Model (NTGAM), the Hensell and Hosston members of the Trinity aquifer held 31,305,822 acre-feet of groundwater prior to groundwater development (~1890's), and today those aquifer members contain 31,209,665 acre-feet, a reduction in storage of 0.3% as shown in **Figure 5-8**.

While the storage numbers show that, despite 120 years of use, the Trinity aquifer remains nearly full; however, cost and infrastructure considerations may limit the amount of water that can be practically used for supply purposes. The principal limitation with the current infrastructure is its age and design. Casing leaks due to corrosion of well casings are the likely cause of water quality degradation in some wells. Well designs that have narrowed casings and small liner sizes limit the ability of some users to lower pumping equipment, and increasing lift costs have made other options more attractive. Despite these challenges, the Trinity aquifer in McLennan County remains a highly reliable and essentially drought-proof water supply.

Figures 5-9 and **5-10** show the amount of remaining available drawdown in the Hensell and Hosston members of the Trinity aquifer. Available drawdown is the difference in artesian pressure elevation and the top of the aquifer. These figures show that additional Trinity groundwater supplies can be developed without causing any dewatering of the aquifer in McLennan County. However, if additional groundwater supplies are required a detailed review of current well construction records will be necessary to determine the feasibility of doing so with current well design. Increasing production from current volumes may require installation of new pumping equipment and/or replacement of the wells with a design that can accommodate deeper pump setting.

Figure 5-8: Trinity Aquifer Storage

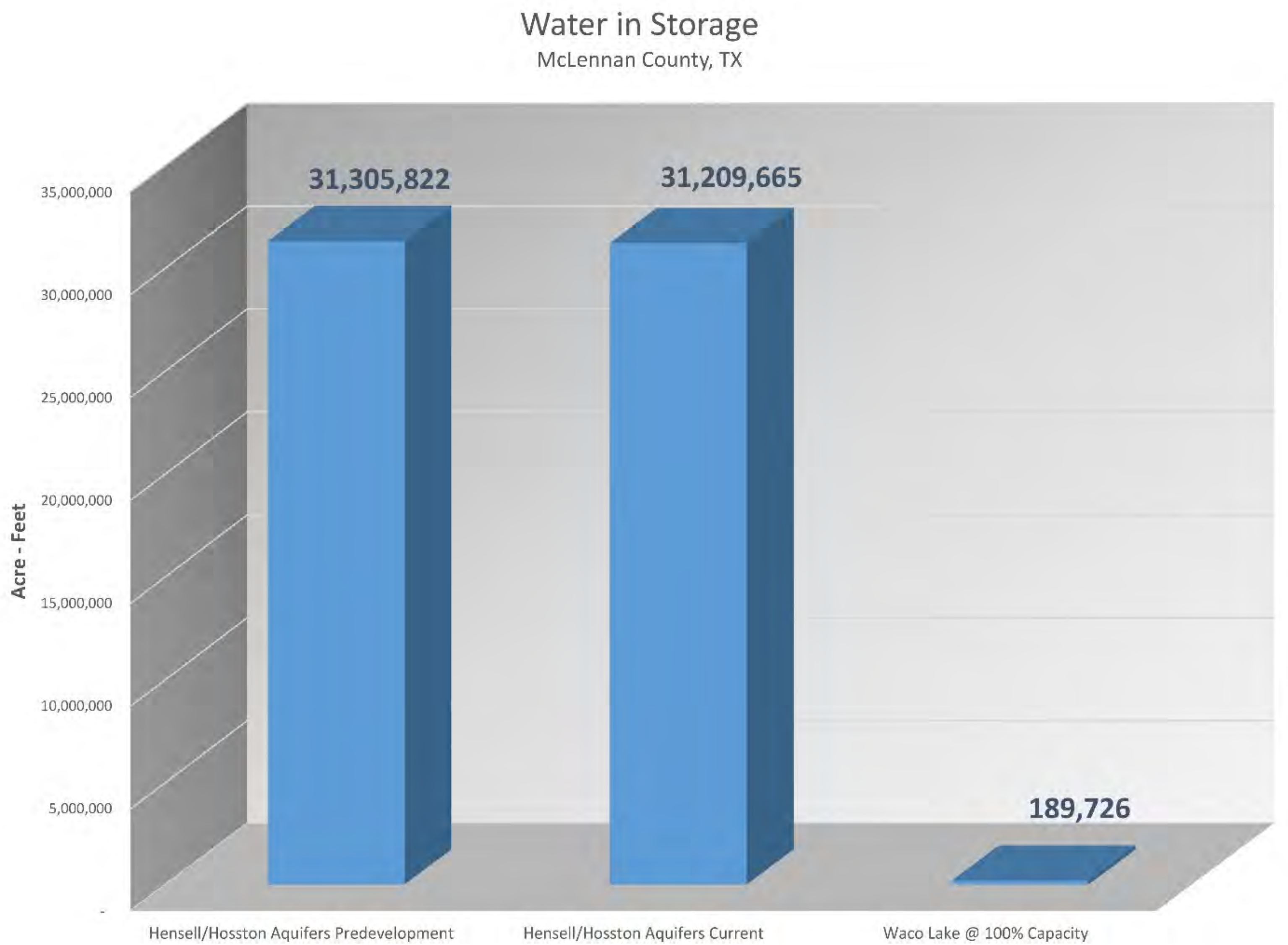


Figure 5-9: Available Drawdown in the Hensell

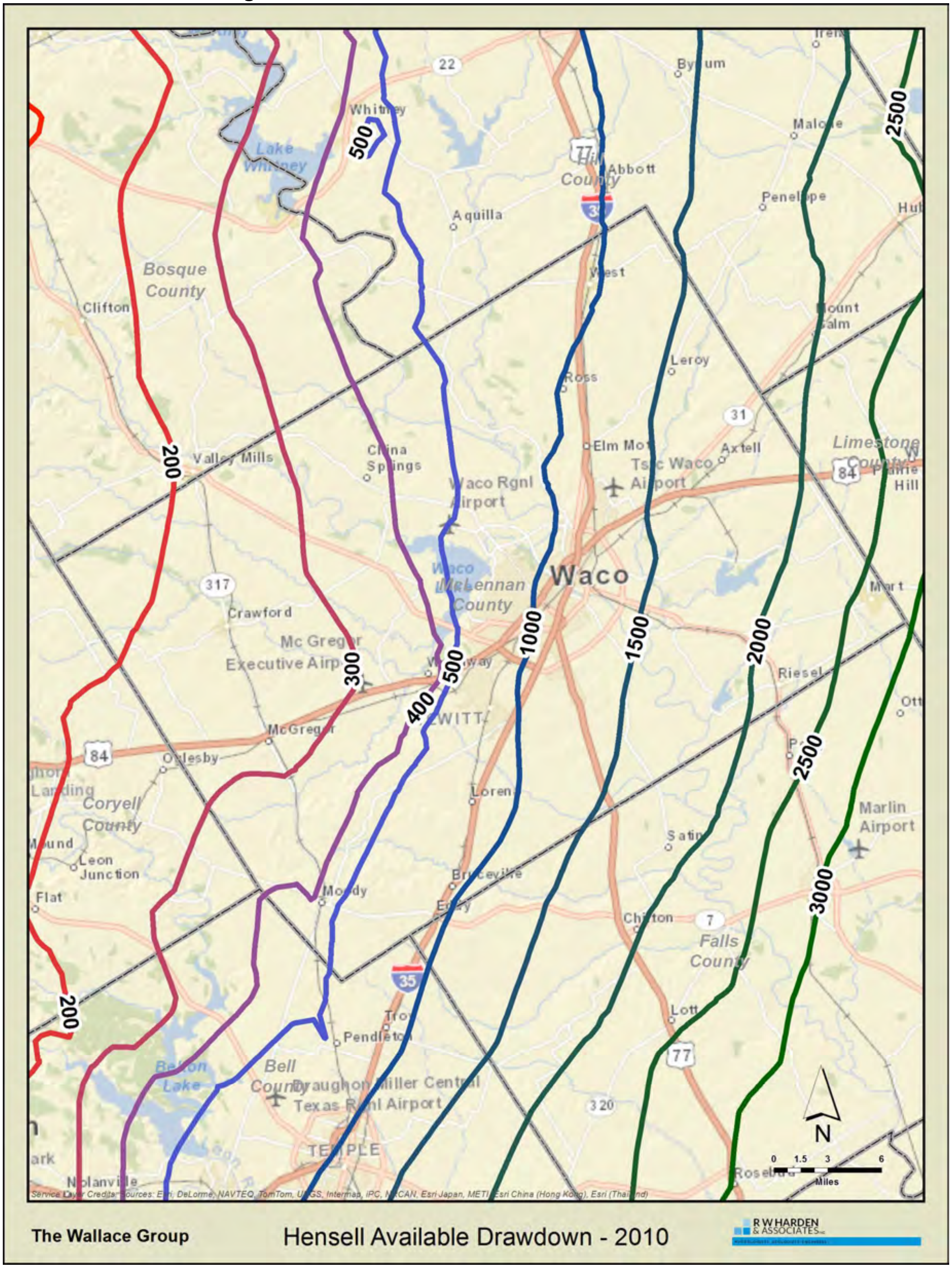
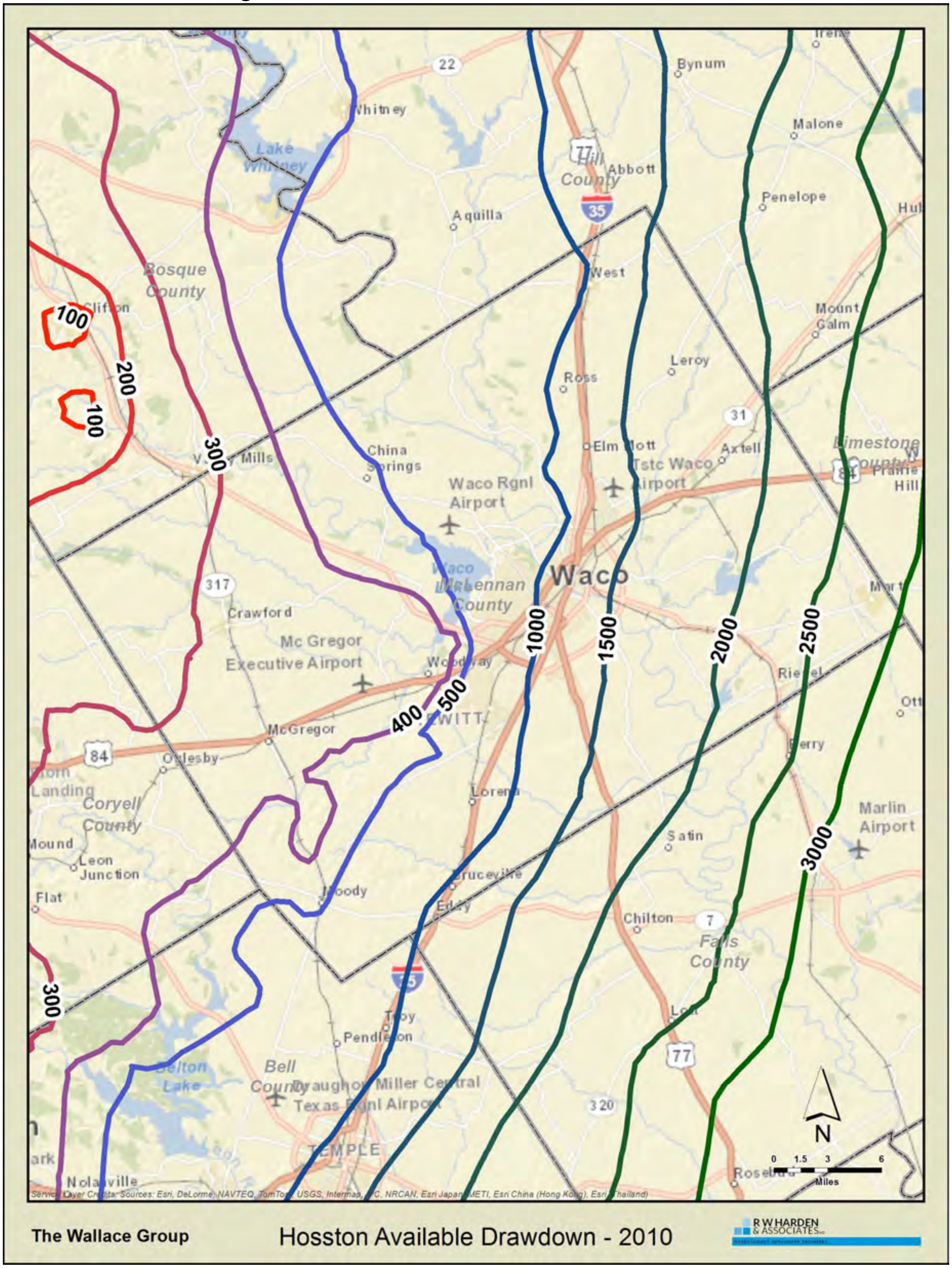


Figure 5-10: Available Drawdown in the Hosston



Cost

Assuming an electrical cost of $0.09/KWh, the additional lift cost is expected to rise an additional $0.16/1000 gallons for water produced from the Hosston and an additional $0.14/1000 gallons in the Hensell.

Additional costs may include setting existing pumps deeper ($30,000-50,000), setting new pumping equipment ($200,000-$1,000,000), and complete well and pump replacement ($1,000,000-$2,500,000). The costs for these will be highly variable depending on the capacity and depth of each well, and the specifics of each design.

Potential Benefits/Risk/Challenges

The potential benefits to continuing to using groundwater as it has been in the past are:

- Reliable and drought-proof supply
- Consistent water quality
- Possibly favorable cost compared to other sources

The potential risks and challenges to using groundwater as it has been in the past are:

- Inability to obtain production permits from the Middle Trinity Groundwater Conservation District
- Decreasing well yields due to limited available drawdown
- Additional cost to groundwater user
- Possibly unfavorable cost compared to other sources.

5.2.2 Imported Groundwater

Description

Groundwater importation to the Waco metropolitan area would most likely come from the portions of the Carrizo-Wilcox aquifer located 70 to 100 miles east and southeast of Waco. The Carrizo-Wilcox aquifer is underutilized resource that has the potential to yield supplies greater than the City of Waco's current and future demands. Developing an imported supply would likely take many years and the costs and political challenges would not likely compare favorably to the City's current supply options. Therefore, only a cursory review of this strategy is provided at this time.

Supply Reliability

Due to proximity to Waco, only the Counties of Freestone, Leon, Madison, Brazos, Robertson, Milam and Burleson Counties are currently considered feasible options for importation of Carrizo-Wilcox aquifer groundwater. Data obtained from the Central Carrizo-Wilcox Groundwater Availability Model (CCWGAM) indicate the 686,817,767 acre-feet of groundwater is currently in storage. From predevelopment time (roughly 1900) through present, storage in the Carrizo-Wilcox in the referenced counties has declined about 0.1%. This suggests that additional supplies are available for development and that if Waco's entire existing supply (71 MGD) was replaced by imported groundwater from this region for 30 years, the maximum change in storage could, at most, only represent an additional 0.33 percent decline in storage. In reality, water flowing in from adjacent counties and recharge would limit the storage reduction to an amount less than 0.33 percent. Therefore, imported groundwater represents a significant drought-proof future supply in the event that other more, local and cost-effective supplies become unavailable.

Cost

Cost estimates of developing Carrizo-Wilcox groundwater supplies for Waco have not been prepared. However, San Antonio Water Systems (SAWS) has entered into a contract with a private firm to develop 50,000 acre-feet per year of groundwater from the Carrizo-Wilcox in Burleson County and transport it via a 130 mile pipeline to San Antonio. San Antonio's take-or-pay price for this supply is about $6.75 per thousand gallons, inclusive of costs for construction, debt service, operation and maintenance, engineering, and profit. Due to Waco's proximity to the supply, its ability to obtain lower financing rates and elimination of profit, costs could probably be reduced.

Regulatory/Permitting Requirements

The following includes a list of the more significant permits and approvals that would likely be required for developing the supply:

- U.S Army Corps of Engineers 404 Permit
- Environmental Impact Statement
- Drilling, Production, and Transport Permits from the Post Oak Savanah, Brazos Valley, and/or Mid-East Texas Groundwater Conservation Districts
- County Construction Permits
- Approvals from Texas Commission on Environmental Quality (TCEQ) for the development of a new water system, which would include approvals to construct wells and treatment facilities, and approvals for use of the system.

Timing/Schedule

It is estimated that a project of this nature would take a minimum of five years to develop, and more likely, seven to ten years.

Potential Benefits/Risk/Challenges

The following is a list of potential benefits to the importation of Carrizo-Wilcox groundwater:

a) Drought-proof supply
b) Increase in artesian pressure in the Trinity aquifer in McLennan County which would benefit in-county groundwater users
c) Relieves pressure on Lake Waco supplies making them available for other uses

The following is a list of potential risks from the importation of Carrizo-Wilcox groundwater:

a) Loss of permits or production cutbacks from Groundwater Conservation Districts
b) Development of large groundwater supplies in close proximity to the City's well field which necessitate the drilling of additional wells to maintain production and/or the need to lower and replace existing pumping equipment

The following is a list of potential challenges from the importation of Carrizo-Wilcox groundwater:

a) Obtaining leases from a sufficient amount of continuous acreage to meet GCD requirements

b) Obtaining production permits

c) Negative public perception

d) Financing and construction cost variability between the time the project is planned and when it is implemented.

5.2.3 Conjunctive Use

Description

Conjunctive use is a method used by water purveyors to optimize the use of multiple sources of water while reducing drought risk, creating supply diversity, and potentially reducing costs – or delaying expenditures. The more important benefits of conjunctive use are drought resistance and supply diversity. It is important to re-evaluate each of these benefits at the time of implementation to ensure that the assumptions provided are still viable.

The City of Waco is seeking to regionalize water supply for the Waco metropolitan area by providing a relatively constant surface water supplies to surrounding communities, yet continue to use groundwater as a peaking supply to meet supply shortfalls during high demand months. Demand projection scenario assuming 50% of the wholesale demand without FHLM is considered in this study, as listed in the **Table 5-1**. Assuming that all the surface water from Lake Waco is used on a constant basis, the groundwater usage is assumed to meet the peak usage while conjunctively supplementing the surface water use.

The modeling methods used are the same as for the "Local Groundwater" section (5.2.1). **Tables 5-3** and **5-4** show simulated pumpage amounts used in the model. Table 5.3 shows the pumpage amount used assuming that the project participants continue to pump the same amount of groundwater in 2040 as they did in 2012. **Figures 5-11** and **5-12** show the change in water level under this conjunctive use option for the Hosston and Hensell aquifer, respectively. **Figures 5-13** and **5-14** show the relative positions of the artesian pressure surface along the line of cross section shown in **Figure 5-3**. It is important to note that users other than the project participants are continuing to increase their pumpage though the 2012 to 2040 period and that most of the additional drawdown is the result of those increases in usage.

Table 5-4 shows the pumpage amount used assuming that the project participants decrease the amount of groundwater in 2040 from 2012 pumpage amounts. **Figures 5-15** and **5-16** show the change in water level under this conjunctive use option for the Hosston and Hensell aquifer, respectively. **Figures 5-17** and **5-18** show the relative positions of the artesian pressure surface along the line of cross section shown in Figure 5.3. Even under the decreased pumpage condition shown in **Table 5-4**, artesian pressure declines continue, although at a reduced rate. The principal reason for these declines is the continued increase in groundwater pumpage by users in McLennan and adjacent counties.

Table 5-3: Constant Pumpage Distribution

Water Producer	Pumpage (ac-ft/year)				Number of Wells	Aquifer Distribution	
	2012	2020	2030	2040		Hensell	Hosston
Aqua Texas WSC	926	926	926	926	16	100%	0%
City of Bellmead	1,262	1,262	1,262	1,262	5	0%	100%
Bold Spring WSC	197	197	197	197	4	0%	100%
Cargill	387	387	387	387	1	0%	100%
Chalk Bluff WSC	389	389	389	389	3	0%	100%
Cross Country WSC	438	438	438	438	4	100%	0%
City of Hewitt	2,426	2,426	2,426	2,426	4	0%	100%
City of Lacy Lakeview	0	0	0	0	0	0%	0%
McLennan County WCID 2	190	190	190	190	3	0%	100%
North Bosque WSC	407	407	407	407	3	100%	0%
City of Robinson	1,497	1,497	1,497	1,497	5	0%	100%
Ross WSC	314	314	314	314	3	0%	100%
Sanderson Farms	1,162	1,162	1,162	1,162	2	0%	100%
South Bosque	10	10	10	10	1	100%	0%
City of Waco	211	211	211	211	2	0%	100%
City of West	184	184	184	184	1	0%	100%
City of Woodway	1,749	1,749	1,749	1,749	6	0%	100%
County-Other	3,575	3,575	3,575	3,575	n/a	47%	53%

Table 5-4: Decreasing Pumpage Distribution

Water Producer	Pumpage (ac-ft/year)				Number of Wells	Aquifer Distribution	
	2012	2020	2030	2040		Hensell	Hosston
Aqua Texas WSC	926	766	654	645	16	100%	0%
City of Bellmead	1,262	1,044	892	880	5	0%	100%
Bold Spring WSC	197	163	140	138	4	0%	100%
Cargill	387	321	274	270	1	0%	100%
Chalk Bluff WSC	389	322	275	271	3	0%	100%
Cross Country WSC	438	362	310	305	4	100%	0%
City of Hewitt	2,426	2,008	1,716	1,692	4	0%	100%
City of Lacy Lakeview	0	0	0	0	0	0%	0%
McLennan County WCID 2	190	157	134	132	3	0%	100%
North Bosque WSC	407	336	287	283	3	100%	0%
City of Robinson	1,497	1,239	1,058	1,044	5	0%	100%
Ross WSC	314	260	222	219	3	0%	100%
Sanderson Farms	1,162	962	822	810	2	0%	100%
South Bosque	10	9	7	7	1	100%	0%
City of Waco	211	174	149	147	2	0%	100%
City of West	184	152	130	128	1	0%	100%
City of Woodway	1,749	1,447	1,236	1,219	6	0%	100%
County-Other	3,575	2,959	2,528	2,492	n/a	47%	53%

Figure 5-11: Constant Pumpage - Artesian Pressure Decline, 2012 and 2040, Hosston Aquifer

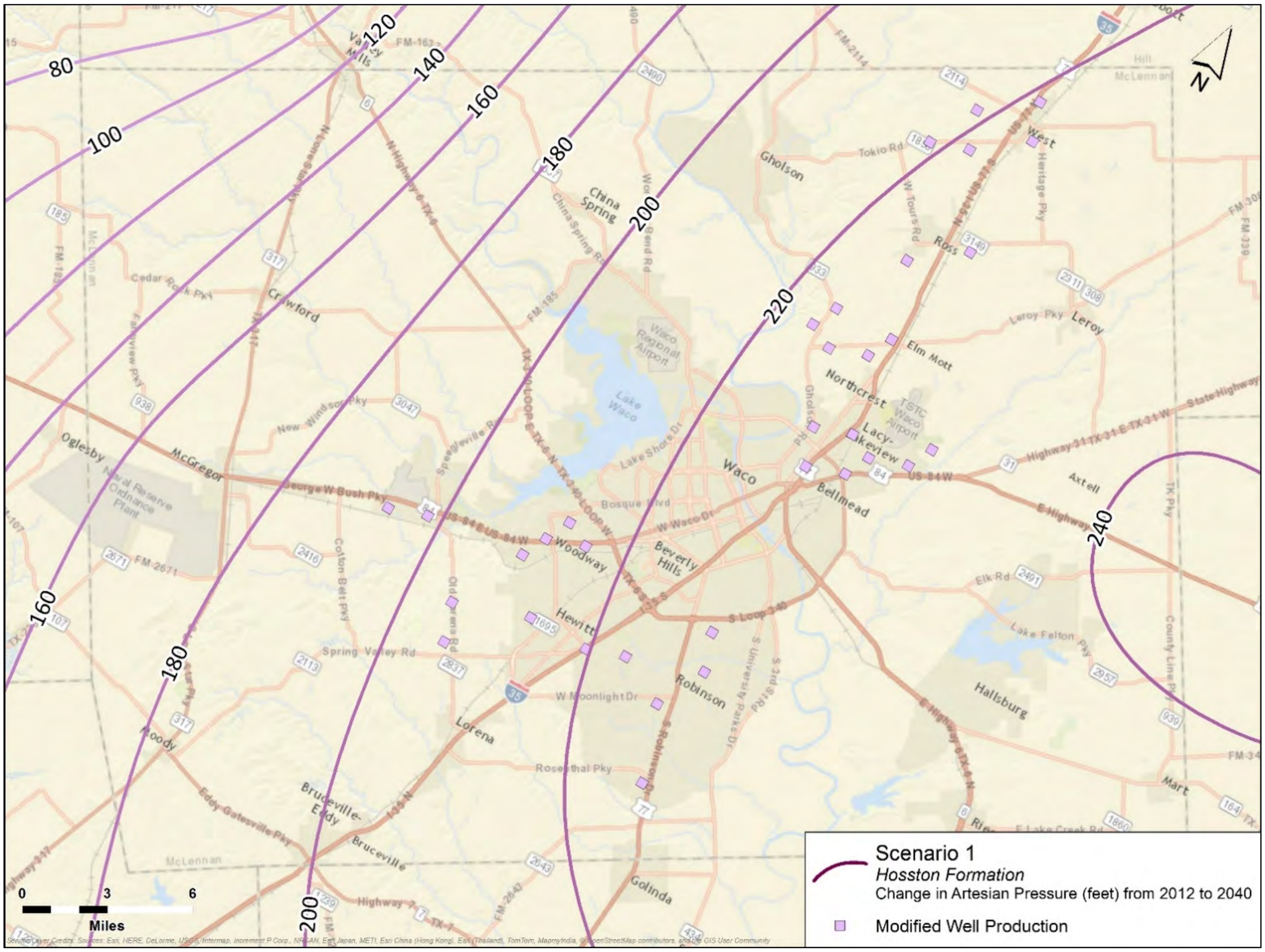


Figure 5-12: Constant Pumpage - Artesian Pressure Decline, 2012 and 2040, Hensell Aquifer

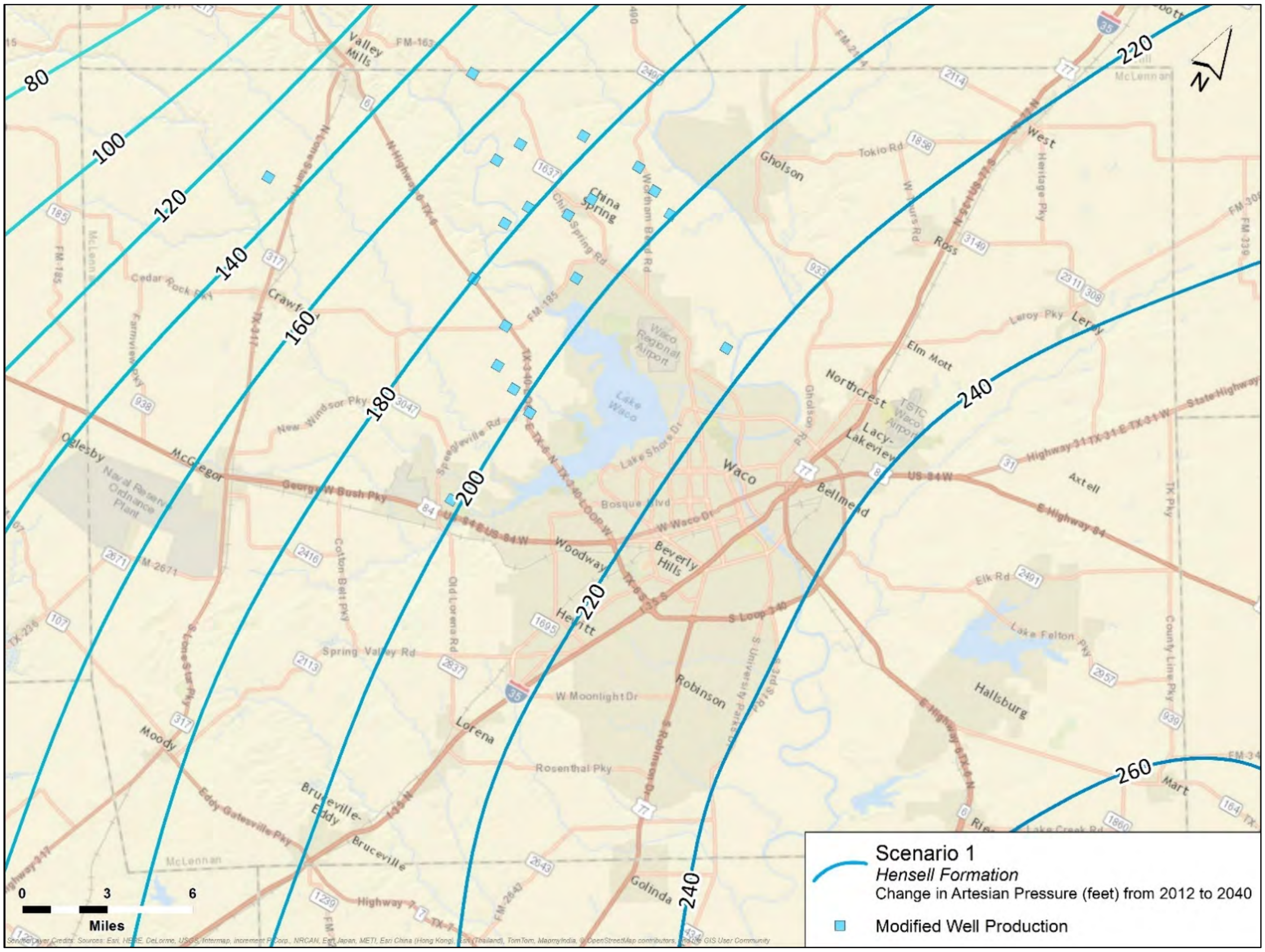


Figure 5-13: Constant Pumpage - Artesian Pressure Level in the Hosston Aquifer

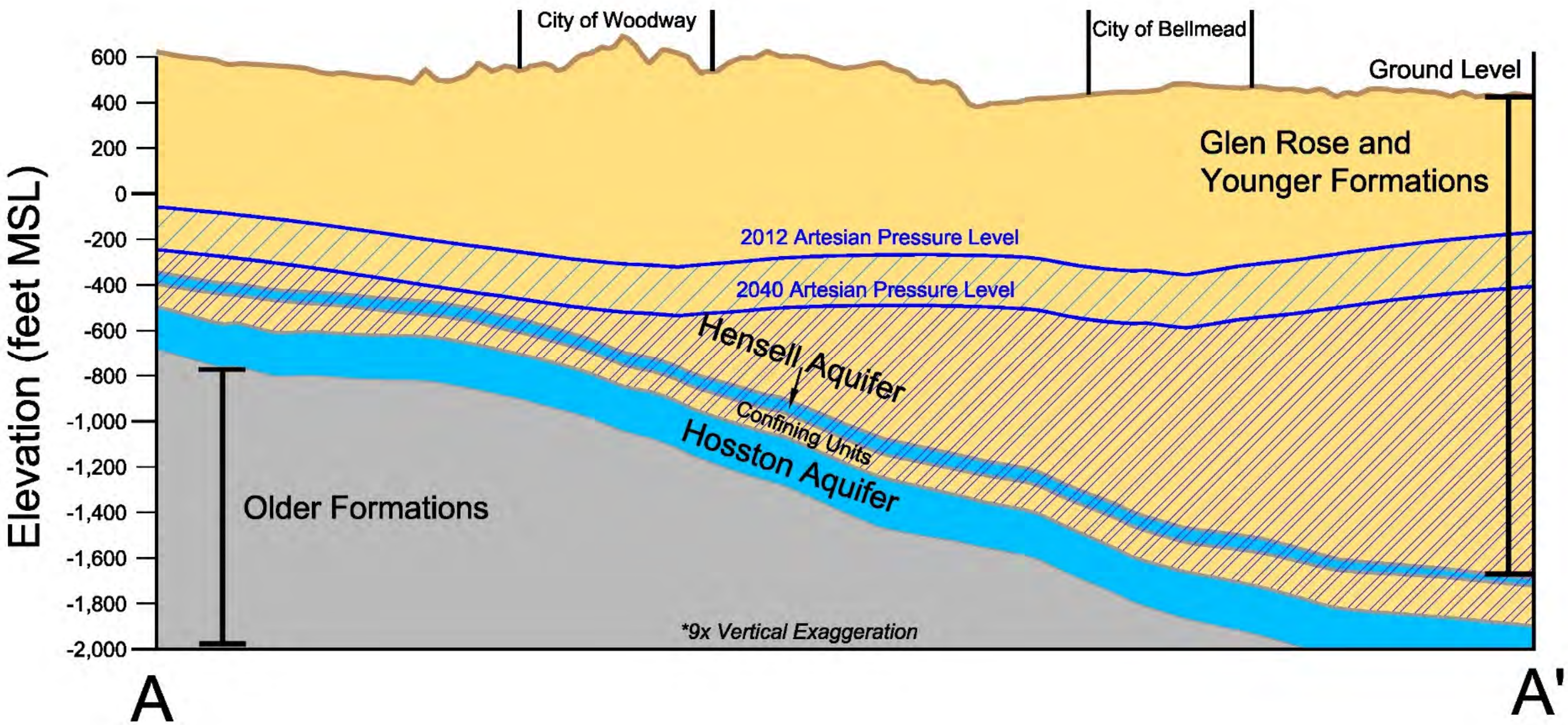


Figure 5-14: Constant Pumpage - Artesian Pressure Level in the Hensell Aquifer

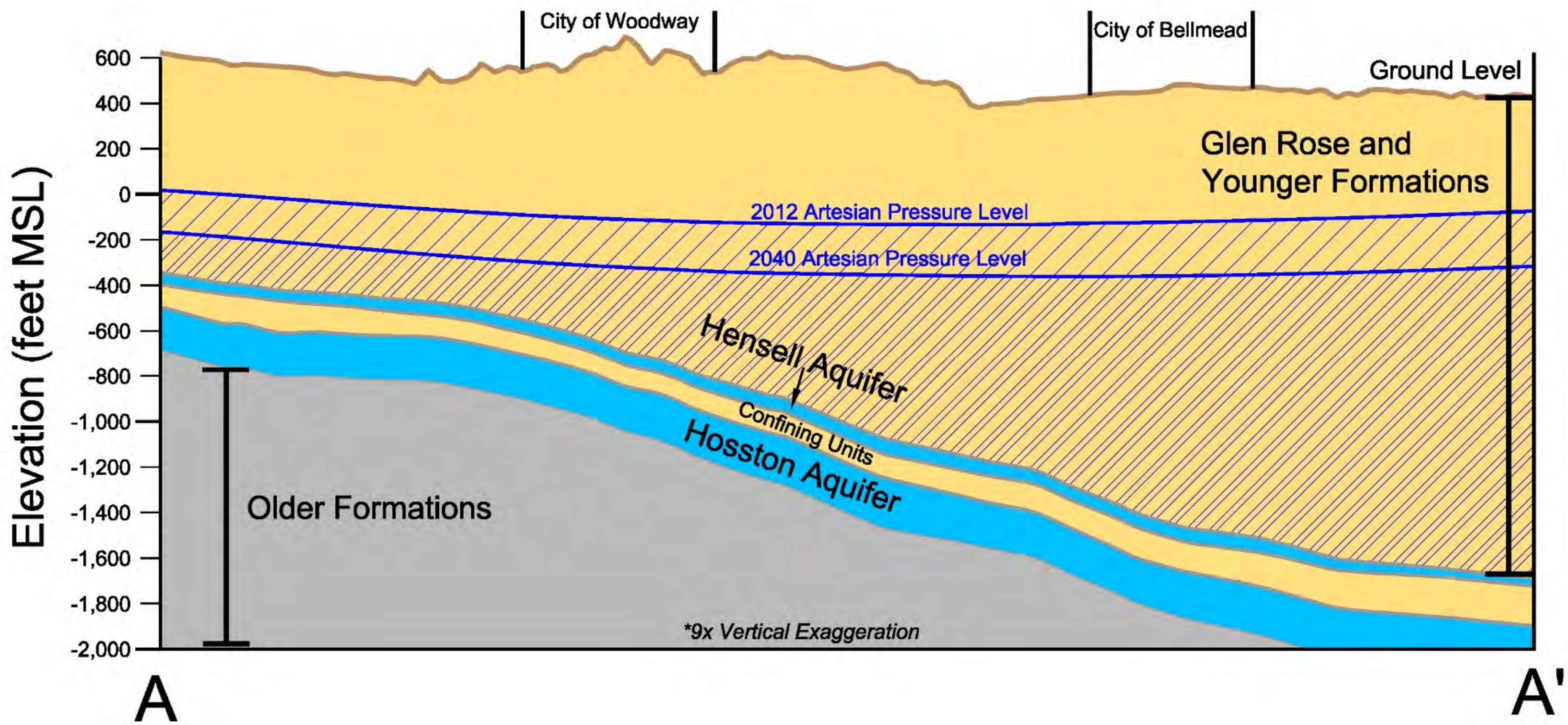


Figure 5-15: Decreasing Pumpage - Artesian Pressure Decline, 2012 and 2040, Hosston Aquifer

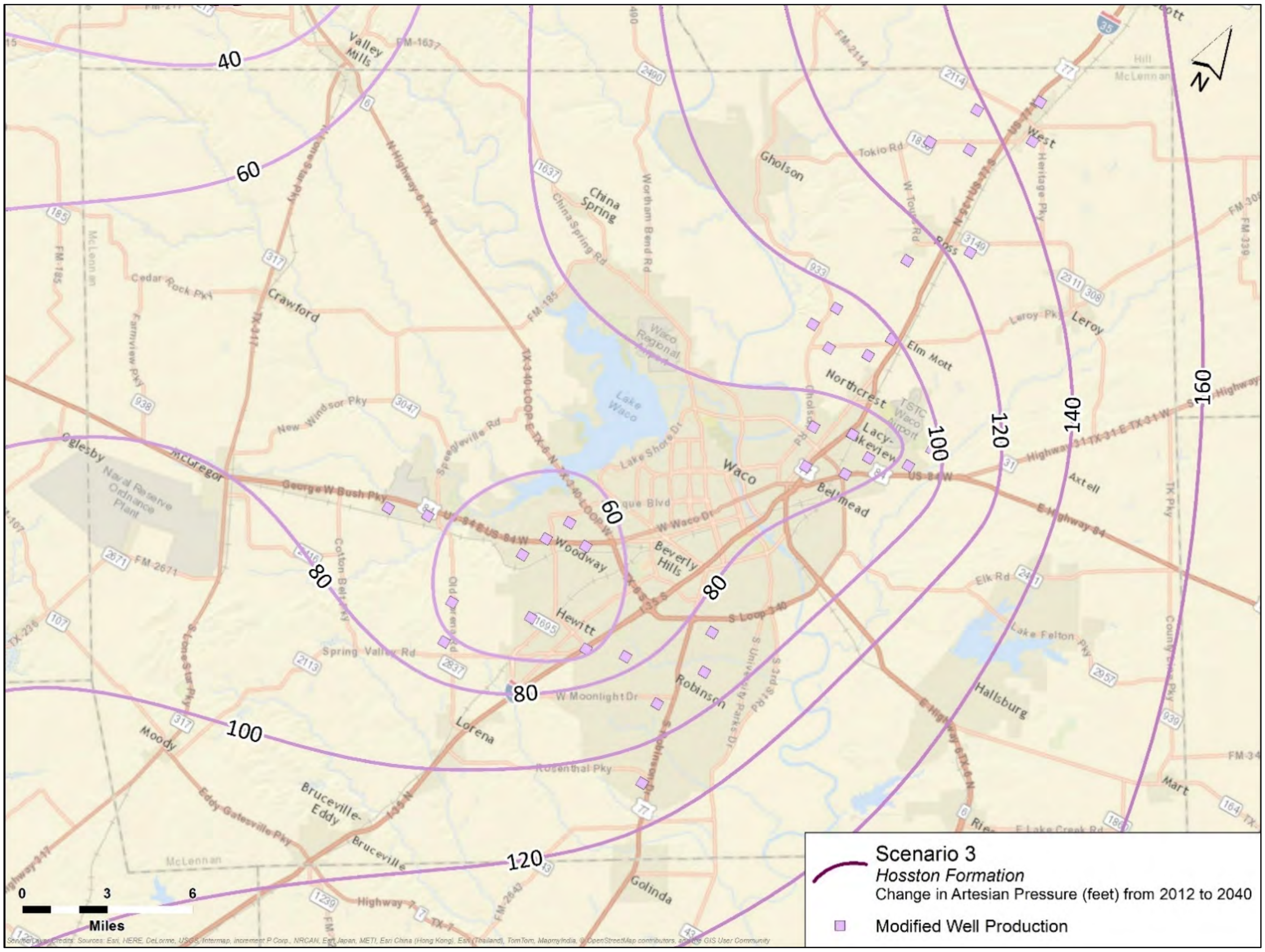


Figure 5-16: Decreasing Pumpage - Artesian Pressure Decline, 2012 and 2040, Hosston Aquifer

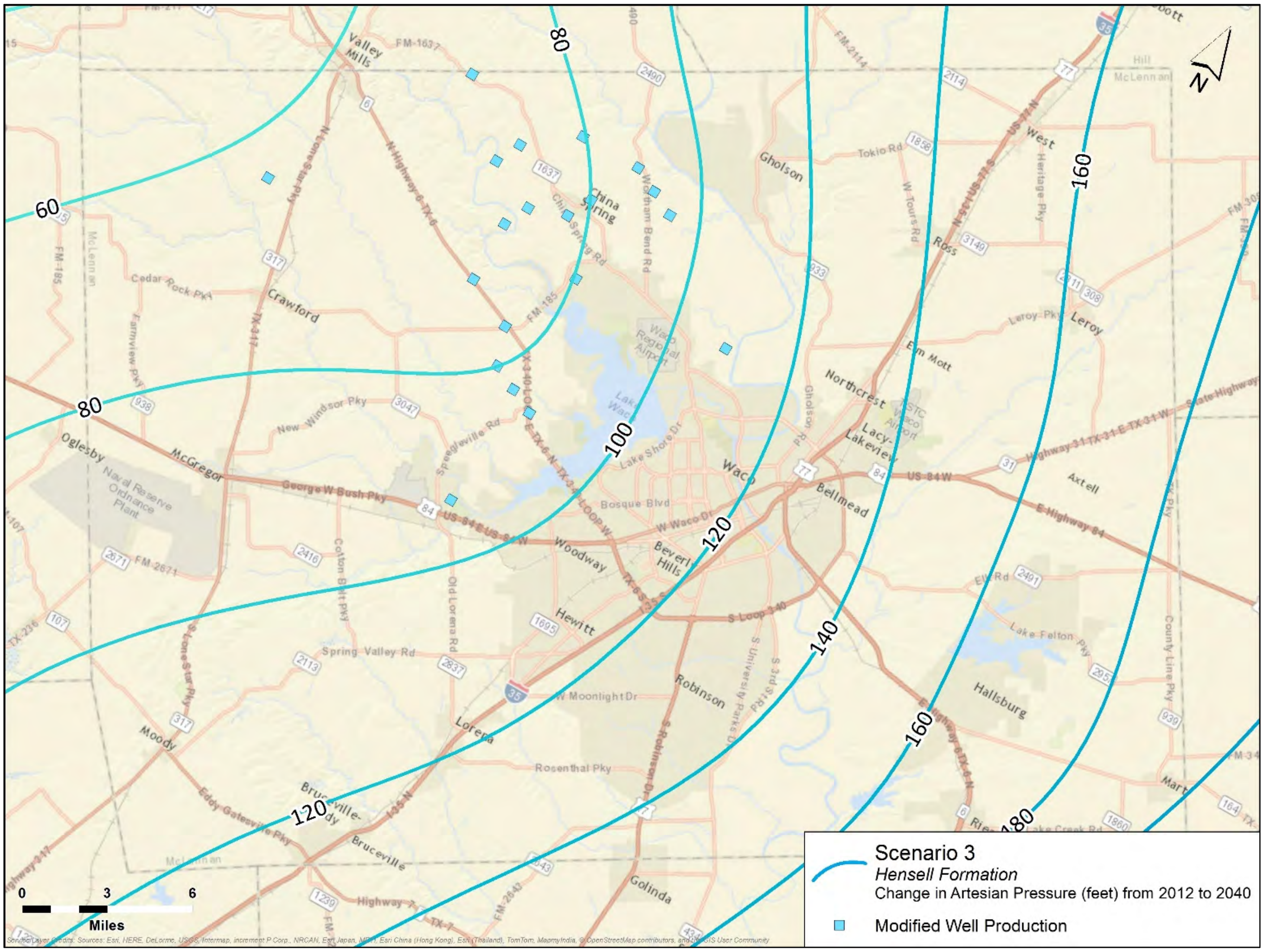


Figure 5-17: Decreasing Pumpage - Artesian Pressure Level in the Hosston Aquifer

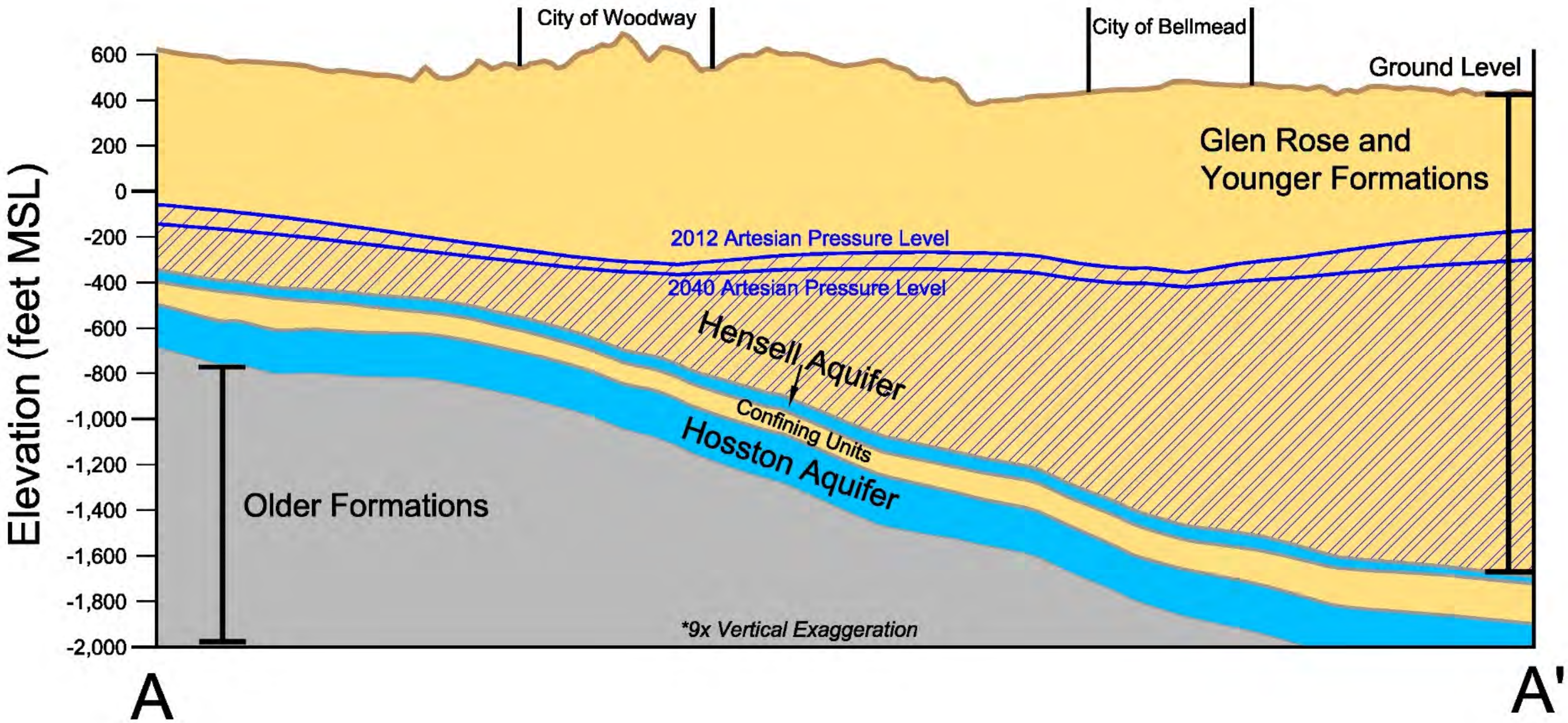
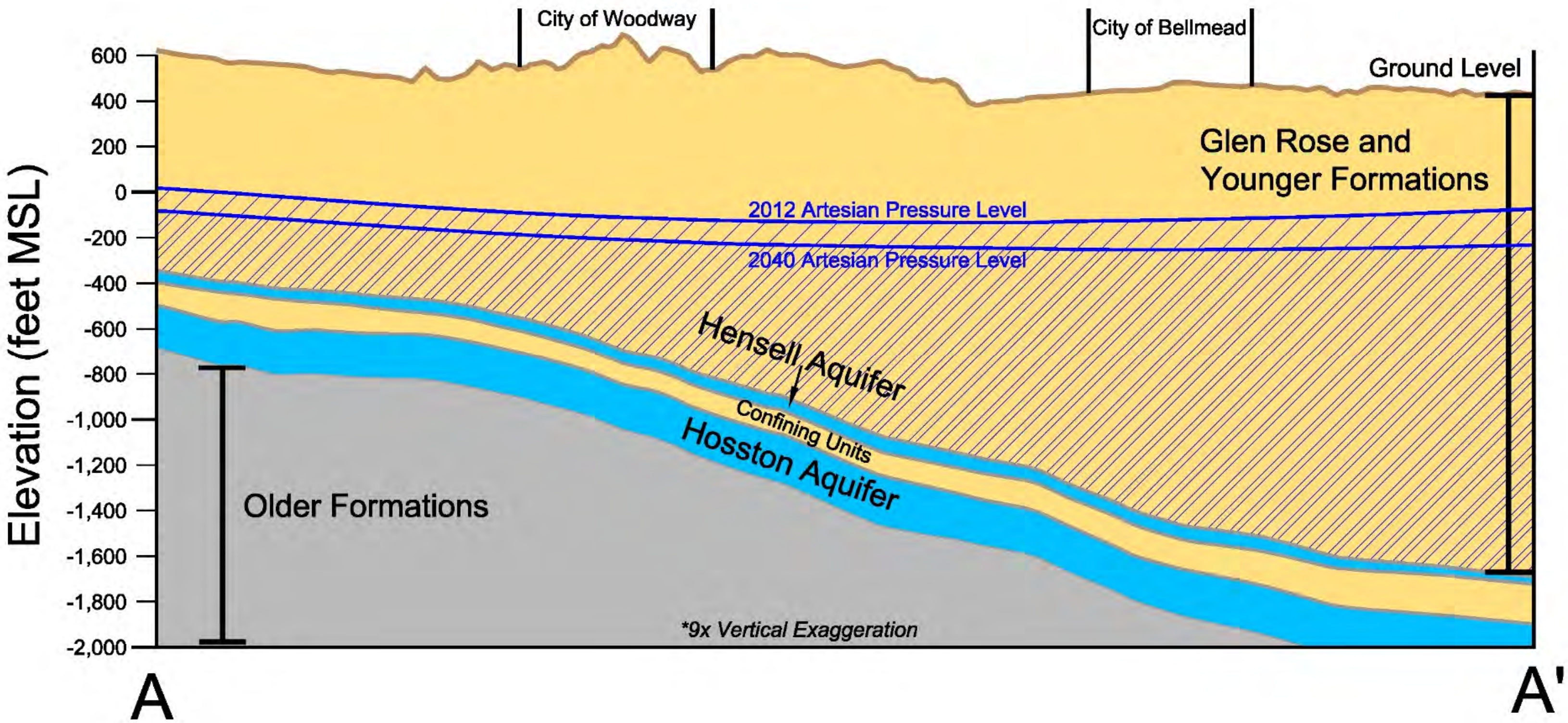


Figure 5-18: Decreasing Pumpage - Artesian Pressure Level in the Hensell Aquifer



Supply Reliability

Neither maintaining (Table 5.3) nor decreasing (Table 5.4) pumpage from 2012 volumes results in a significant change to the reliability of the supply because neither appreciably changes the volume of water in storage. However, there are cost benefits to both maintaining and decreasing the pumpage when compared to increasing pumpage which are discussed below. The additional supplies required to meet the growing demands of the customers currently relying on groundwater will be met by the surface water supplies from Lake Waco. It was assumed that all of the permitted amount from Lake Waco will be utilized to meet the future demand.

Cost

Conjunctive use, as presented herein, will represent an overall reduction in the rate of unit cost increases for users whose wells are fully amortized when compared to the local groundwater option (Section 5.2.1) which describes an increase of groundwater use at a rate that is proportional to projected growth. Because maintaining and decreasing groundwater use continues to result in groundwater declines – due to increases in use by others – the cost for obtaining groundwater will continue to increase, albeit at a lower rate than if groundwater use continues to increase. For constant use, the cost of continuing to pump groundwater, will increase about $0.09/1000 gallons in both the Hensell and Hosston between 2012 and 2040. If groundwater use is decreased at the rate described in Table 5.4, the increased cost to pump the Hosston will be about $0.05/1000 gallons, and about $0.03/1,000 gallons in the Hensell. Decreasing pumpage also results in reduced groundwater conservation district fees. Both constant and decreasing groundwater usage may also result in lower pump replacement cost and avoid -or delay- the need to replace pumping equipment and/or drill additional well to maintain production.

Users who have debt service payments will experience an increase in unit cost of Trinity well water due to underutilization.

There is no additional cost incurred in developing surface water supplies in the Lake Waco or transfer of the supplies from the Lake to the treatment plants. Discussion of the infrastructure required for the treatment and distribution of the supplies is included in the CIP Plan for the City of Waco.

Timing/Schedule

Changes to well operating can be implemented immediately after replacement sources become available.

Potential Benefits/Risk/Challenges

The following is a list of potential benefits to the current conjunctive use plans when compared to the increasing use of groundwater described in Section 5.2.1:

a) Reductions in the rate of increase in operating costs
b) Decreased groundwater conservation district fees
c) Allows room in the groundwater conservation district's desired future condition and modeled available groundwater for other users to more easily obtain permits for their production.

The following is a list of potential risks from the current conjunctive use plan:

a) Corrosion in existing wells goes undetected while the wells are idle, resulting in potential degradation in Trinity groundwater quality due to poor quality water leaking into the Trinity aquifer
b) Degradation of pumping equipment that goes undetected until the well is turned on.
c) Increased reliance on Lake Waco and associated loss of drought resistance
d) Insufficient time and/or money for users to drill additional wells to respond to drought conditions and loss (or reduction) in supply from Lake Waco
e) Other users (non-project participants) increase groundwater production because the pumpage reductions by project participants provide an economic incentive (decreased lift costs) to pump more groundwater

The following is a list of challenges from the current conjunctive use plan:

a) Maintenance of wells and pumping equipment during idle time.

5.2.4 Conservation

Description

Increase in population and economic development coupled with the uncertainty in supply availability has led to growth in water demands and stress on existing supplies for City of Waco. The City strongly advocates conservation practices and implemented several water conservation measures as described in the City's 2014 Water Conservation Plan. Current implementation measures include metering and measuring raw water diversions, meter replacement program, annual water audits, repairs of leaking water lines, and public education programs. It recommended that the City continue to pursue these measures not just during drought conditions but also during normal conditions. In addition to the measures listed in the City's Water Conservation Plan, the following advanced measures are recommended as part of the conservation strategy:

1. Water waste ordinance (permanent time of day and day of week restrictions for outdoor watering)
2. Landscape ordinance proposing low water use landscaping
3. Enhanced public school education
4. Leak detection, repair, and pipeline replacement

Supply Reliability

It is assumed that the City of Waco will continue supporting the implementation measures listed in the conservation plan and incorporating the measures listed in the strategy. The city has an active leak detection program and about 70 full-time employees to respond to leaks and repairs in a timely manner. It is expected that the City will continue with this program. The amount of additional water savings depends on how proactively each program is implemented and how responsive the City's customers are. Similar programs implemented in Cities such as Dallas, Austin, and San Antonio have resulted in substantial savings. The water savings from a proactive conservation strategy is expected to result in 3-4% reduction in the total water demand. On an average, about 2-3 MGD reductions are expected from the adoption of advanced conservation measures.

Cost

A detailed cost estimate was not developed for this strategy but the unit costs from similar conservation programs are reported for comparison purposes.

Total Capital Cost - $ 2,000,000

Annual Cost with Debt Service - $ 0.06 per thousand gallons

Annual Cost after Debt Service - $ -0.25 per thousand gallons (cost savings)

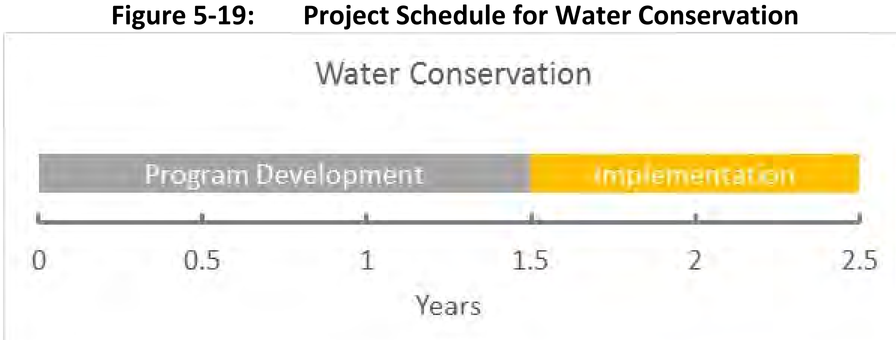
Regulatory/Permitting Requirements

There are no special regulatory requirements associated with the water conservation strategy. The City is required to report their water conservation programs to TCEQ and TWDB. The City also needs to prepare and furnish the Water Conservation Plan and Drought Contingency Plans to TCEQ every five years. They are also required to submit the annual water loss audit to TWDB. The City should demonstrate a strong water conservation program if the City is planning to develop new surface water projects or seeking funds from the State for the projects.

Timing/Schedule

Typical Water Conservation Programs take about a year or 1.5 years to develop and an additional year to implement. **Figure 5-19** includes a preliminary project schedule for this strategy.

Figure 5-19: Project Schedule for Water Conservation



Potential Benefits/Risk/Challenges

1. Lack of active customer participation
2. Opposition to implementation of conservation measures during normal hydrologic conditions
3. Economic viability and pay back from implementing the strategies

5.2.5 Lake Brazos

Description

Lake Brazos Dam is located on the Brazos River within the city limits of Waco. The dam is near the La Salle Avenue Bridge. The original purpose of constructing the dam was to widen the river and stabilize the river flows. The old dam construction was completed in 1970. The old dam was replaced with the new dam in 2007. The Lake covers a surface area of 523 acres. The top of the dam is at 376 ft above MSL.

City of Waco also has a water right to access supplies from Lake Brazos authorized by CA 12-4340. The water right authorizes:

a) Diversion of 5,600 acre-feet for municipal and industrial uses at a priority date of June 29, 1914

b) Storage of 3,537 acre-feet at a priority date of January 8, 1968

This water right provides access to supplies on Brazos River in the City of Waco. Currently the City of Waco does not use supplies from Lake Brazos to meet demands. The lake is primarily used for recreational purposes.

Supply Reliability

A yield model was run using the TCEQ Brazos WAM, and the supply was found to be reliably available to the City of Waco for use. The water right is senior to most of the water rights in Brazos Basin, thus securing the supplies in the priority allocation process. It is assumed that City of Waco will divert all the supplies are authorized for diversion. On an average, this strategy will result in 5 MGD of supply available.

Infrastructure Configuration

The strategy proposed here includes a transmission line from the Lake Brazos Dam to the Riverside WTP. Delivery to Riverside was considered because of the proximity of the WTP to the Lake Brazos Dam. **Figure 5-20** includes a conceptual layout of the transmission pipeline. A 90 HP intake pump station and a 24-inch pipeline are the infrastructure elements required to convey the supply. The hydraulic gradeline of the transmission system is shown in **Figure 5-22**.

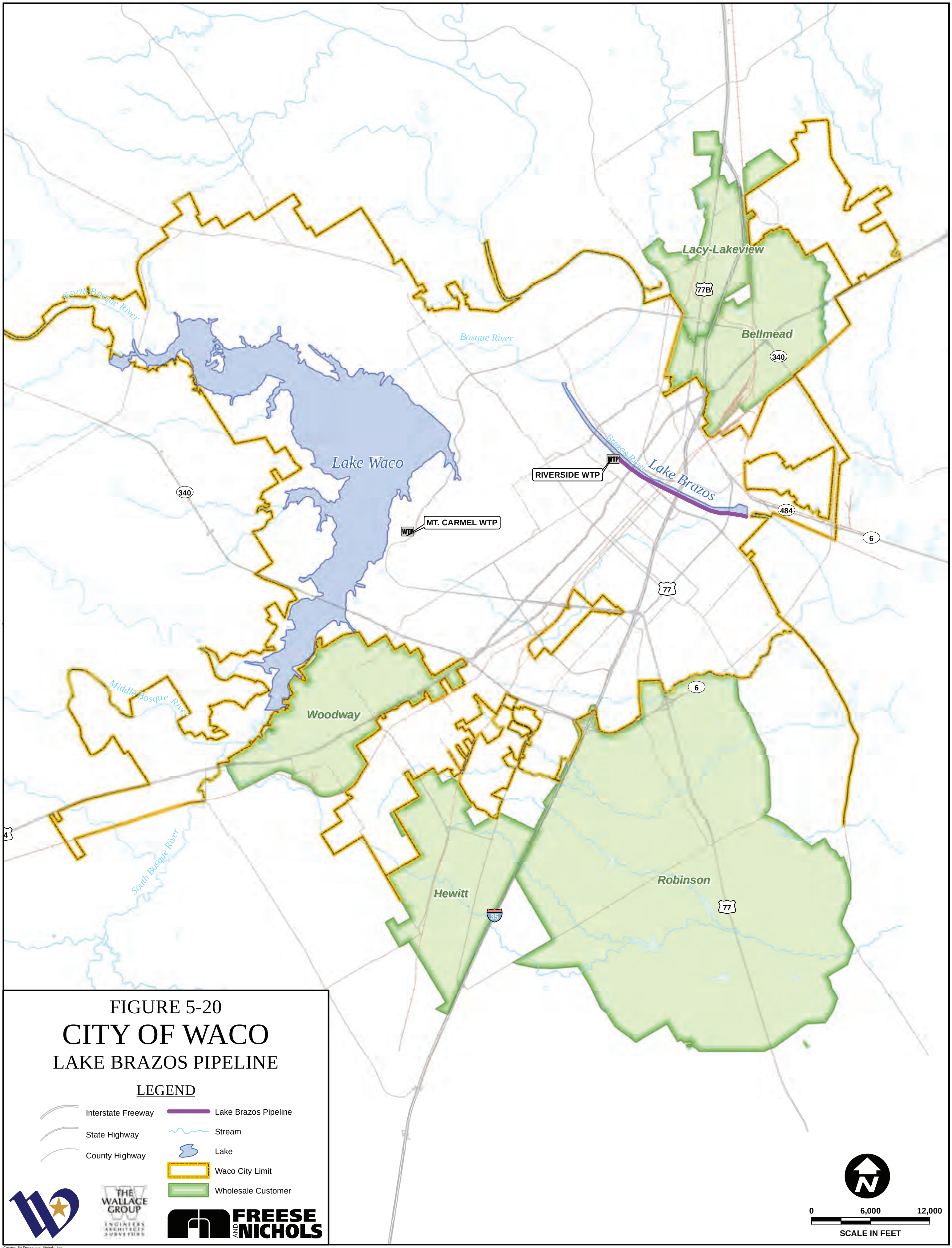


FIGURE 5-20
CITY OF WACO
LAKE BRAZOS PIPELINE

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Updated: Friday, October 09, 2015

Cost

A detailed cost estimate is developed for this strategy and included along with this fact sheet in **Table 5-5**.

Capital Cost

Total Capital Cost: $ 9,439,000

Annual Cost

- Total annual cost during debt repayment period: $807,000
- Total annual cost after debt is paid: $121,000
- Annual unit cost of water until amortization based on 5,600 acft/yr: $0.44 per 1,000 gallons
- Annual unit cost of water after amortization based on 5,600 acft/yr: $0.07 per 1,000 gallons

Regulatory Permitting Requirements

As the City owns the dam and the water right permit to access the supplies, there are no regulatory or permitting requirements associated with this strategy.

Timing/Schedule

As there is no permitting process associated with this strategy, it is assumed that the infrastructure design will be completed in two years and construction in another two years. **Figure 5-21** includes a preliminary project schedule.

Figure 5-21: Project Schedule for Lake Brazos

Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

a) Authorized permitted diversions at priority date senior to most users in Brazos River Basin

b) Proximity of the supply source to the City of Waco's WTP location and service area

The following is a list of potential risks of this strategy:

a) The project may be affordable but it will not meet all the needs by itself

b) Local opposition from parties interested in the recreational benefits of the Lake

c) The water quality of Lake Brazos may require additional treatment. Potential increase in treatment costs. Possibly blending this small supply with other raw water at Riverside WTP may help address the water quality issues.

Figure 5-22: HGL of the Transmission Pipeline from Lake Brazos to Riverside WTP

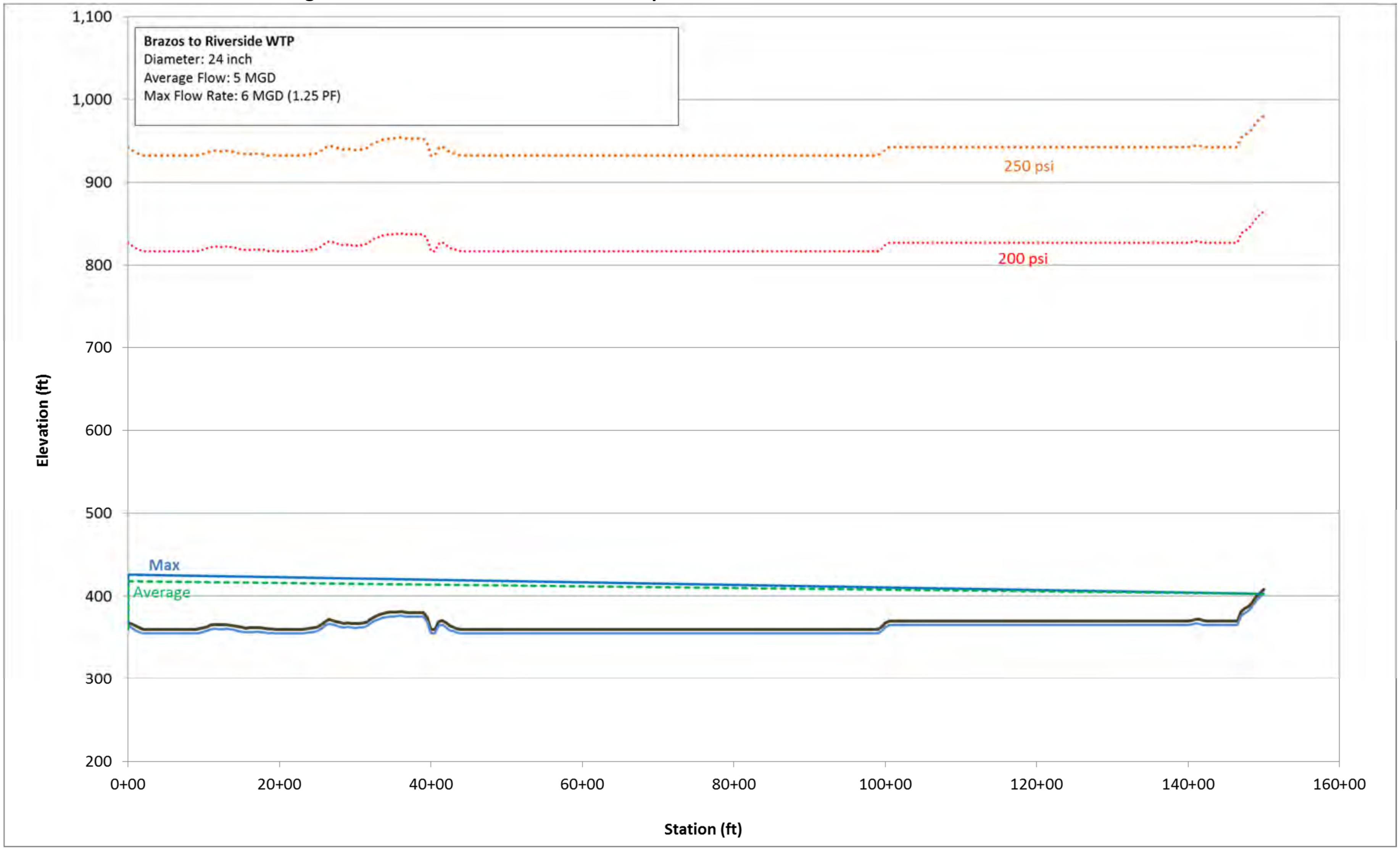


Table 5-5: Lake Brazos to Riverside WTP Long Term Strategy Detailed Cost Estimate

City of Waco Long Term Water Supply Strategy
Lake Brazos to Riverside Water Treatment Plant

Probable Owner:		**5,600**	**Average Acre-Feet per Year**		
Peak Delivery:		**6**	**Peak MGD**	Peaking Factor =	1.25
CONSTRUCTION COSTS					
TRANSMISSION FACILITIES					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline (Rural)	24 in	0	LF	$109	$0
Pipeline (Urban)	24 in	15,150	LF	$152	$2,295,225
Street Repair		3,788	LF	$250	$946,875
ROW Easements (Rural)		0	LF	$16	$0
ROW Easements (Urban)		15,150	LF	$39	$594,164
Permitting and Mitigation					$28,000
Engineering and Contingencies (30%)					$689,000
Subtotal of Pipeline					**$4,553,264**
Pump Station(s)	**Size**	**Quantity**	**Unit**		
Intake Pump Station	91 HP	1	LS	$1,730,000	$1,730,000
Vehicle Bridge to Intake	12' Wide	6750	SF	$180	$1,215,000
Permitting and Mitigation					$21,000
Engineering and Contingencies (35%)					$606,000
Subtotal of Pump Stations					**$3,572,000**
TRWD CONSTRUCTION TOTAL					**$8,125,000**
Interest During Construction	**(48 months)**				**$1,314,000**
TOTAL COST					**$9,439,000**
ANNUAL COSTS					
Debt Service (6% for 30 years)					$686,000
Electricity ($0.09 per kWh)					$42,000
Pump Station & Pipeline Operation & Maintenance					$79,000
Total Annual Costs					**$807,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot					$144
Per 1,000 Gallons					$0.44
UNIT COSTS (After Amortization)					
Per Acre-Foot					$22
Per 1,000 Gallons					$0.07

*For cost estimating purposes, 10% was added to the pipeline lengths to account for slope distances and routing around obstacles.

5.2.6 Lake Creek Reservoir

Description

Lake Creek Reservoir is located in McLennan County in Brazos River Basin, near City of Waco. The reservoir is owned and operated by Luminant. The reservoir and dam are sited on a tributary of Brazos River. The reservoir was intended to provide condenser-cooling water for steam-electric generating station owned by Luminant. Reservoir and dam construction was completed in 1953, and the first generating unit began using the water supply since 1953; however, the supply from this reservoir is currently not being used for power generation. The Lake Creek Reservoir has a normal pool capacity of 8,400 acre-feet and a maximum impoundment capacity of 10,580 acre-feet. The reservoir covers an area of about 550 acres. The top of the conservation is at 405 feet above MSL.

Texas water right Certificate of Adjudication 12-4345 (CA 12-4345) authorizes Lake Creek Reservoir. CA 12-4345 authorizes a storage of 8,500 acre-feet and permitted diversions of 8,996 acre-feet per year from Brazos River to the reservoir. The priority date for diversions of 8,000 acre-feet/year from Brazos River to the reservoir, storage in the reservoir, and the diversion from the reservoir is March 6, 1951. The priority date for the storage of additional 500 acre-feet of storage is March 5, 1952. The diversions from the Brazos River are to be used as a supplement to supplies from the reservoir. The water right also authorizes diversion and consumptive use of 10,000 acre-feet per year from the reservoir.

Supply Reliability

The TCEQ Brazos WAM was used to determine the yield of the Lake Creek water right. The yield analysis was based on the hydrologic period of record from 1940 through 1997. The yield of Lake Creek Reservoir supplemented by the diversions from Brazos River was determined to be 10,000 acre-feet per year. In actuality, the yield is slightly larger than 10,000 acre-feet per year, but the diversions are limited to the maximum amount authorized by the water right of 10,000 acre-feet per year. **Figure 5-23** shows the storage fluctuations for a demand of 10,000 acre-feet per year. It can be noted that the Lake Creek Reservoir was close to being empty in early 1957. **Figure 5-24** include the annual diversions from the Brazos River to Lake Creek reservoir diverted under the water right CA 12-4345. It was observed that full diversions of the water right are not available in more than half of the years in the period of record.

Figure 5-23: Supply Reliability of Lake Creek Reservoir

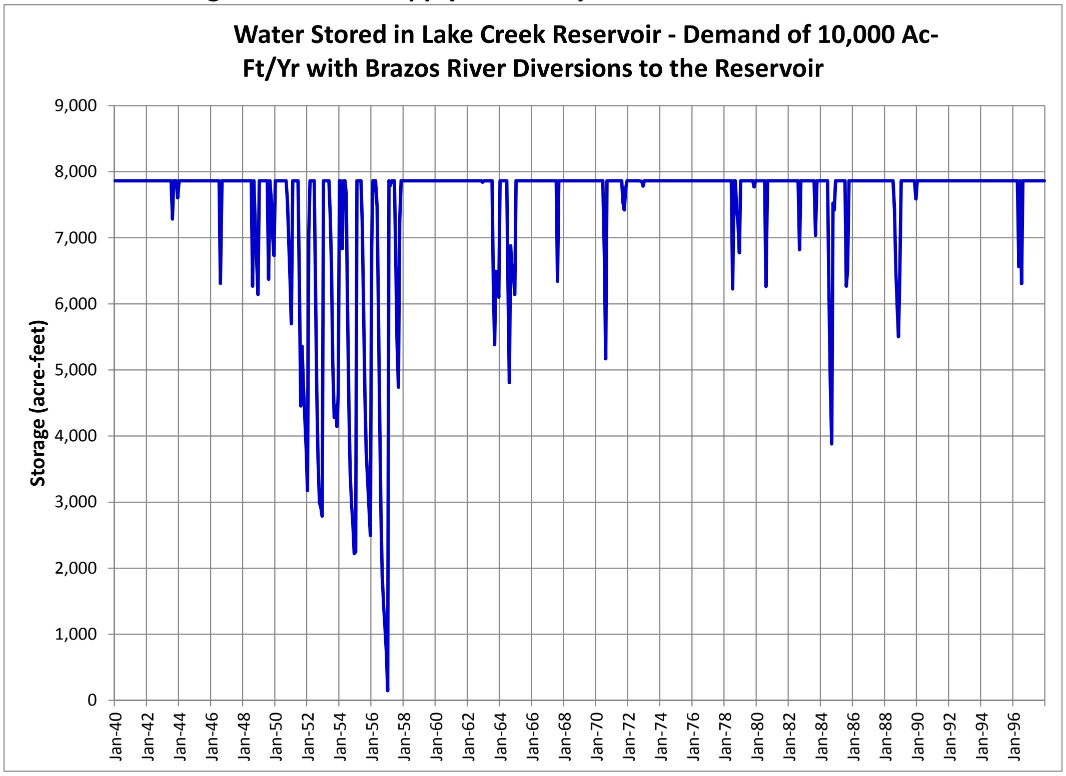
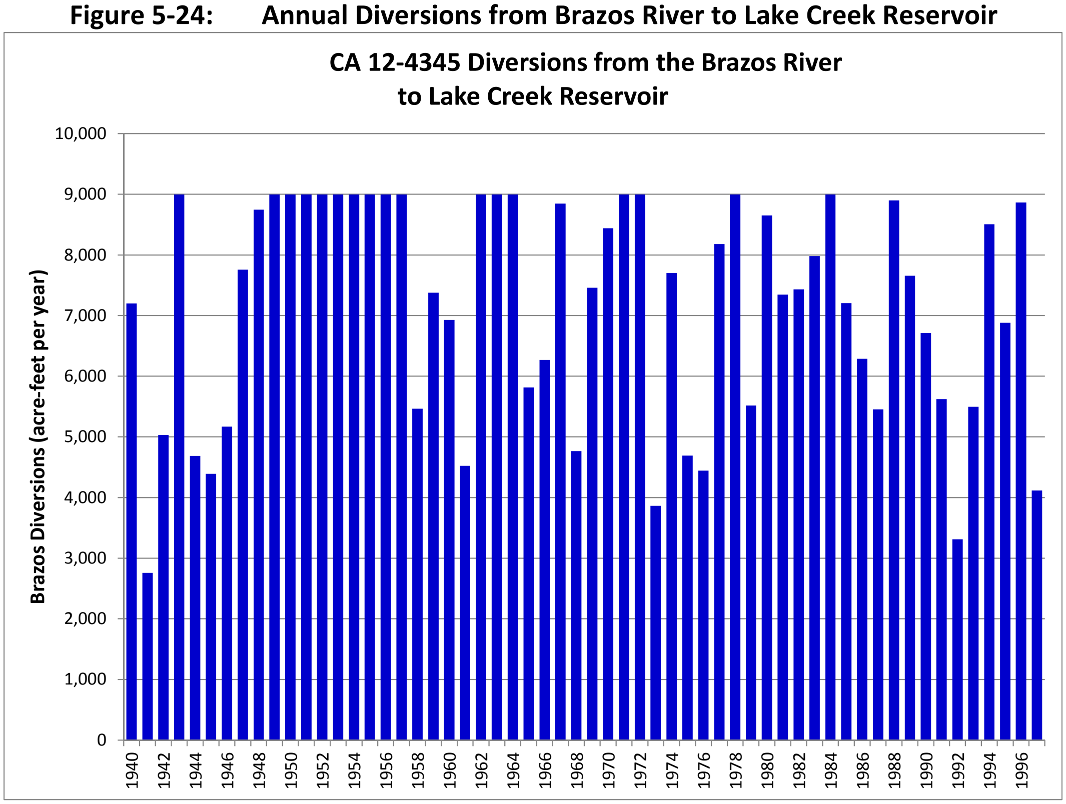


Figure 5-24: Annual Diversions from Brazos River to Lake Creek Reservoir



Infrastructure Configuration

Owing to the close proximity of Lake Creek Reservoir to City of Waco's service area, the City can consider a strategy to transfer supplies from the reservoir to the Mount Carmel WTP by means of a transmission pipeline. The facilities required for this strategy include an intake pump station at the Lake Creek dam, transmission pipeline, and booster pump station to deliver the supplies to the treatment plant. The Mount Carmel WTP rated capacity is about 66 MGD. The build out capacity of this plant is about 90 MGD. Upon expansion, there could be approximately 24 MGD capacity available at this plant to treat new supplies. Assuming that City of Waco will access the entire amount of authorized supplies from Lake Creek (9 MGD or 10,000 acre-feet/year), the treatment plant has sufficient capacity to treat the supplies. **Figure 5-25** shows the location map of the reservoir and the transmission system. **Figure 5-27** includes the hydraulic gradeline associated with the transmission system.

Cost

Capital Cost - The total capital cost for this strategy is $41,647,000. It was assumed that the Lake Creek dam is in good condition. It was also considered that the City of Waco will purchase the rights to authorized diversions and lake storage. The reservoir and dam will be owned and operated by the City of Waco. The cost for improvements to the water treatment plant is not included in the capital cost. The treatment plant expansion cost is incuded in the CIP cost estimate regardless of which supply strategy the City pursues.

Annual Cost - No discussions have been initiated with Luminant to negotiate the cost of purchasing the reservoir and dam. There is a potential that the additional cost of purchasing resevoir and dam may increase the overall cost for this project. The detailed cost estimate is included in **Table 5-6**.

- Total annual cost during debt repayment period: $3,653,000
- Total annual cost after debt is paid: $627,000
- Annual unit cost of water until amortization based on 10,000 acft/yr: $1.12 per 1,000 gallons
- Annual unit cost of water after amortization based on 10,000 acft/yr: $0.19 per 1,000 gallons

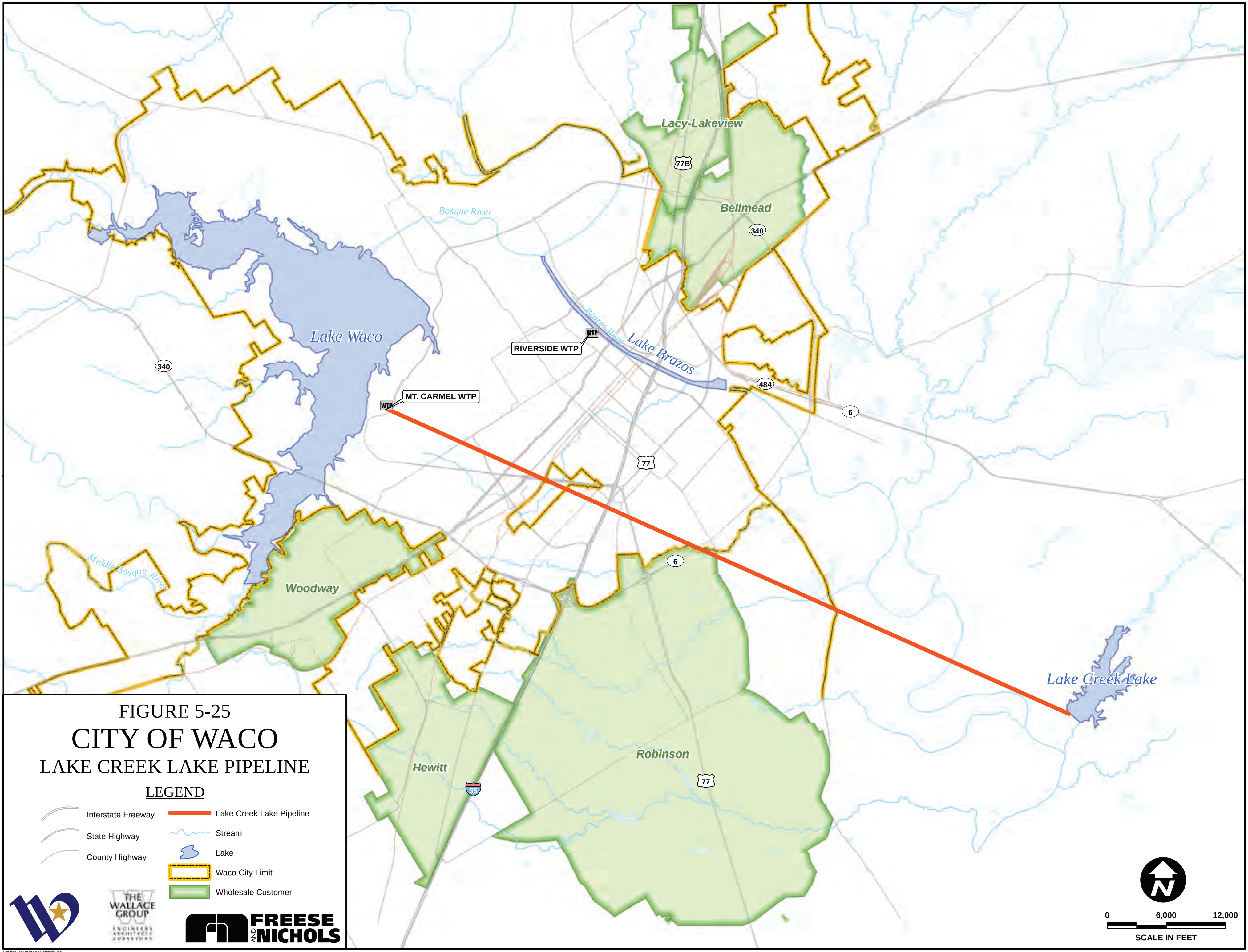


FIGURE 5-25
CITY OF WACO
LAKE CREEK LAKE PIPELINE

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Updated: Friday, October 09, 2015

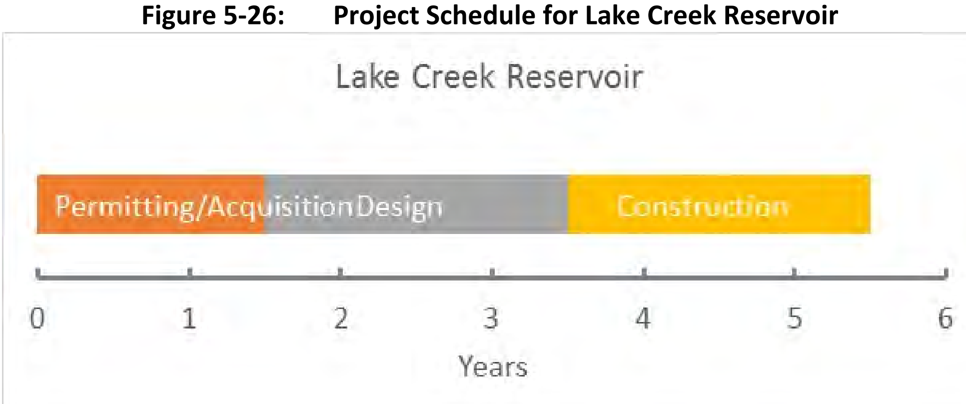
Regulatory/Permitting Requirements

- The City of Waco will have to either contract with Luminant to use their supply and pay a cost for the raw water or purchase the water rights from Luminant. If they purchase the raw water from Luminant, there are no regulatory requirements associated with the water purchase contract. If the City chooses to purchase the reservoir, dam and the water rights associated with the reservoir, there will be some regulatory processes associated with that.
- The City can choose to use the diversions authorized in the current water right to meet industrial use only. If the City chooses to use the diversions for municipal use, the water right permits must be amended for the change in use.

Timing/Schedule

The reservoir and dam are currently operational. If the City of Waco choses to purchase the dam and reservoir from Luminant, they do not need to replace the dam. There may be a need to do some improvements on the dam. The City of Waco will have to locate a separate intake to access the supplies. It may take the City about 18 months to go through the permitting and acquisition of the water rights, reservoir and the dam. It will take the City another two years to design the intake facility and the transmission pipeline. It is assumed that the construction of intake pump station and the transmisison pipeline will be completed in two years. The project schedule is shown in **Figure 5-26**.

Figure 5-26: Project Schedule for Lake Creek Reservoir



Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

a) Supply source available close to the City of Waco service area

b) There is no need to go through the lengthy process of securing water rights and the reservoir permitting process. Luminant already owns the water rights, reservoir and dam. The City of Waco can either lease the supplies or purchase them from Luminant

The following is a list of potential risks of this strategy:

a) Potential water quality issues associated with the source

b) Purchase costs associated with the acquisition of water rights, reservoir and dam

c) This supply is considered to be high in TDS and required advanced treatment or blending before use. Water can be blended at WTPs or pumped to Lake Waco and blended. The amount that can be blended depends on acceptable salt waters in finished water. The City could potentially blend up to a point and then institute advanced treatment at the treatment plants. Supplies can be acquired now and the final decision on blending/treatment made later.

Figure 5-27: HGL for the Transmission System from Lake Creek to Mount Carmel WTP

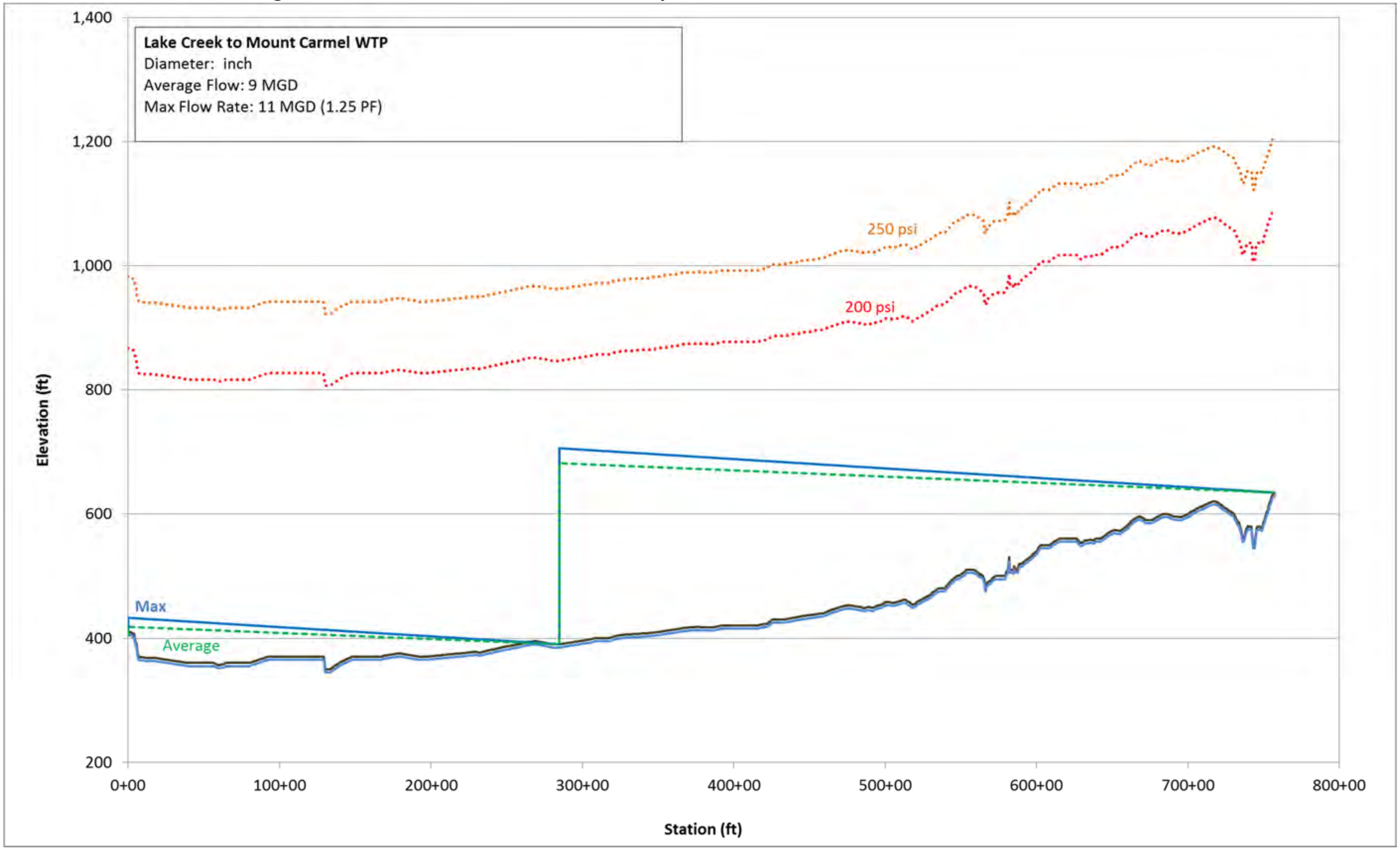


Table 5-6: Lake Creek to Mount Carmel WTP Strategy Detailed Cost Estimates

City of Waco Long Term Water Supply Strategy
Lake Creek to Mount Carmel Water Treatment Plant

Probable Owner:	**10,000**	**Average Acre-Feet per Year**			
Peak Delivery:	**11**	**Peak MGD**	Peaking Factor =	1.25	

CONSTRUCTION COSTS

TRANSMISSION FACILITIES

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline (Rural)	30 in	0	LF	$145	$0
Pipeline (Urban)	30 in	76,508	LF	$203	$15,492,769
Street Repair		19,127	LF	$250	$4,781,719
ROW Easements (Rural)		0	LF	$16	$0
ROW Easements (Urban)		76,508	LF	$39	$3,000,530
Permitting and Mitigation					$186,000
Engineering and Contingencies (30%)					$4,648,000
Subtotal of Pipeline					**$28,109,018**
Pump Stations	**Size**	**Quantity**	**Unit**		
Intake Pump Station	69 HP	1	LS	$1,635,000	$1,635,000
Booster Pump Station	776 HP	1	LS	$5,015,000	$5,015,000
Dam		1	LS	$500,000	$500,000
Permitting and Mitigation					$20,000
Engineering and Contingencies (35%)					$572,000
Subtotal of Pump Stations					**$7,742,000**
TRWD CONSTRUCTION TOTAL					**$35,851,000**
Interest During Construction	**(48 months)**				**$5,796,000**
TOTAL COST					**$41,647,000**
ANNUAL COSTS					
Debt Service (6% for 30 years)					$3,026,000
Electricity ($0.09 per kWh)					$392,000
Pump Station & Pipeline Operation & Maintenance					$235,000
Total Annual Costs					**$3,653,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot					$365
Per 1,000 Gallons					$1.12
UNIT COSTS (After Amortization)					
Per Acre-Foot					$63
Per 1,000 Gallons					$0.19

*For cost estimating purposes, 10% was added to the pipeline lengths to account for slope distances and routing around obstacles.

5.2.7 Tradinghouse Creek Reservoir

Description

Tradinghouse Creek Reservoir is owned and operated by Luminant. The reservoir is constructed on the Tradinghouse Creek in the Brazos River Basin in McLennan County. The reservoir and the dam are located near FM 2957, east of the City of Waco. The reservoir and dam construction was completed in 1968, and impoundment began in July 1968. The reservoir has a drainage area of 2,010 acres. The reservoir has a normal capacity of 37,814 acre-feet and maximum impoundment of 57,032 acre-feet. The top of the conservation pool elevation is 470 ft MSL.

Supply Reliability

Tradinghouse Creek Reservoir is authorized by CA 12-4342, which authorizes the storage of 37,800 acre-feet in the reservoir and the diversion and consumptive use of 15,000 acre-feet per year from the reservoir. These supplies are accessible at a priority date of September 16, 1966. CA 12-4342 also authorizes the diversion and consumptive use of 12,000 acre-feet per year run-of-river diversions form the Brazos River at a priority date of August 21, 1926. The total authorized diversion and consumptive use available from both the reservoir and the river diversion is 27,000 acre-feet (12,000 acre-feet per year from the Brazos River and 15,000 acre-feet per year from the reservoir).

The Brazos WAM was used to estimate the available yield from Luminant's water right CA 12-4342. The yield analysis is based on the hydrologic period of record, 1940-1997. The diversions from the reservoir and the Brazos River were modeled separately to estimate the firm yield of these supplies. The firm yield of the authorized diversion of 15,000 acre-feet per year from the Tradinghouse Creek Reservoir was determined to be 4,900 acre-feet per year. Similarly, the firm yield of the authorized diversion of 12,000 acre-feet per year from the Brazos River was determined to be 8,877 acre-feet per year.

Infrastructure Configuration

Owing to the close proximity of Tradinghouse Creek Reservoir to City of Waco's service area, the City can consider a strategy to transfer supplies from the reservoir to the Riverside WTP by means of a transmission pipeline. The facilities required for this strategy include an intake pump station at the Tradinghouse Creek dam, transmission pipeline, and booster pump station to deliver the supplies to the treatment plant. The Riverside WTP rated capacity is 24 MGD. The build-out capacity of this plant is 45 MGD. There is up to 21 MGD of capacity available at this plant to treat new supplies. Assuming that City of Waco will access the entire amount of authorized supplies from Tradinghouse Creek (12 MGD or 13,777 acre-feet/year), the treatment plant has sufficient capacity to treat the supplies. In order to be able to use all the supplies from the Tradinghouse Creek Reservoir, the City may have to upgrade the WTP for additional treatment options. The updates to the treatment facility are not included in the cost estimate. **Figure 5-28** shows the location map of the reservoir and the transmission system. The hydraulic gradeline for the transmission system is included in **Figure 5-30**.

Cost

Capital Cost - The total capital cost for this strategy is $32,468,000. It was assumed that the Tradinghouse Creek dam is in good condition. It was also considered that City of Waco will purchase the rights to authorized diversions and lake storage. The reservoir and dam would be owned and operated by the City of Waco. The cost for improvements to the water treatment plant is not included in the capital cost. The treatment plant improvement cost is included in the CIP cost estimate regardless of which strategy the City chooses to pursue. The detailed cost estimate is included in **Table 5-7**.

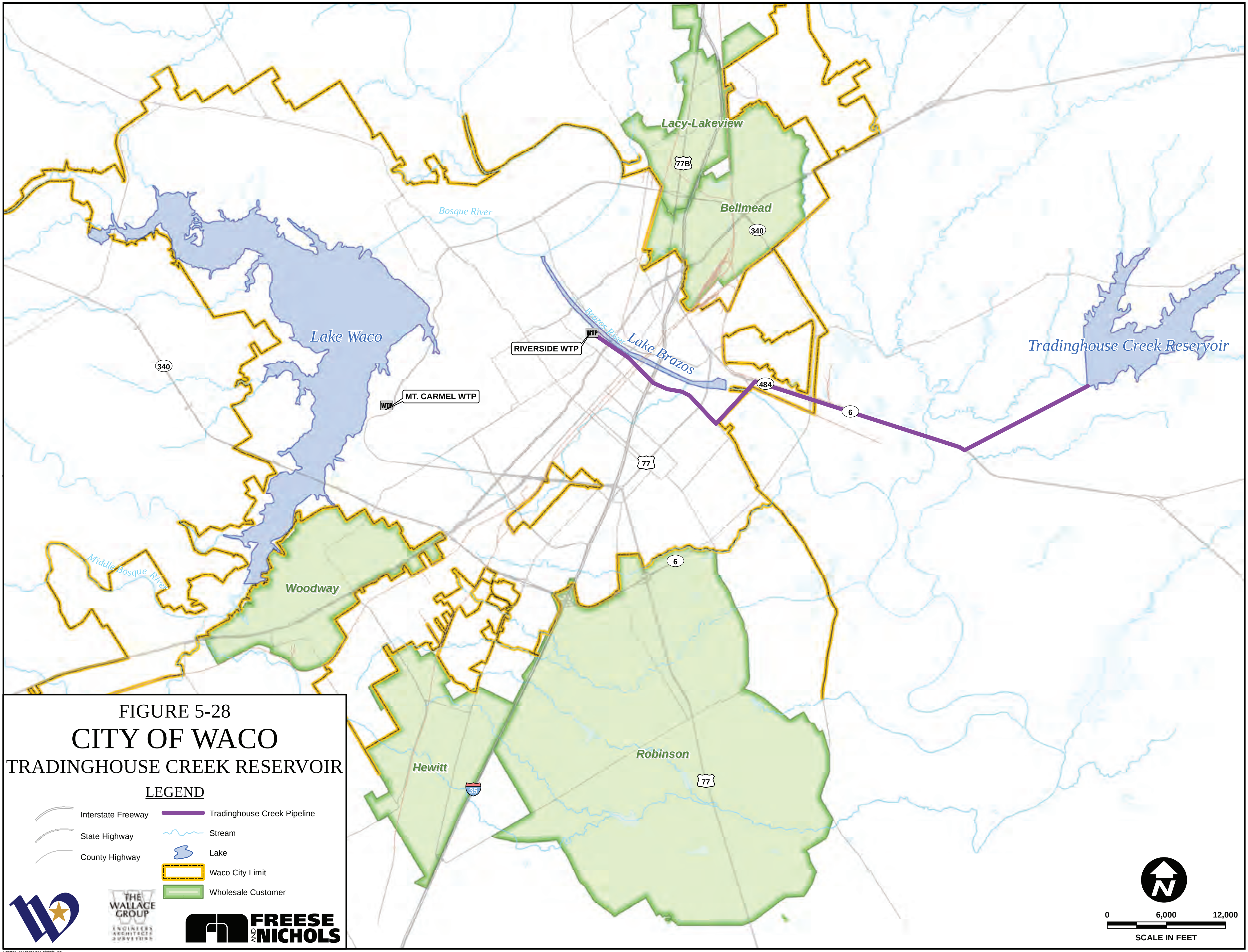
Annual Cost - No discussions have been initiated with Luminant to negotiate the cost of purchasing the reservoir and dam. There is a potential that the additional cost of purchasing resevoir and dam may increase the overall cost for this project.

- Total annual cost during debt repayment period: $2,548,000
- Total annual cost after debt is paid: $189,000
- Annual unit cost of water until amortization based on 13,777 acft/yr: $0.57 per 1,000 gallons
- Annual unit cost of water after amortization based on 13,777 acft/yr: $0.04 per 1,000 gallons

Regulatory/Permitting Requirements

- City of Waco will have to either contract with Luminant to use their supply and pay a cost for the raw water or purchase the water rights from Luminant. If they purchase the raw water from Luminant, there are not regulatory requirements associated with the water purchase contract. If the City choses to purchase the reservoir, dam, and the water rights associated with the reservoir, there will be some regulatory processes associated with that.
- The City can chose to use the diversions authorized in the current water rights to meet industrial use only. If the City choses to use the diversions for municipal use, the water right permits must be amended for the change in use.

FIGURE 5-28
CITY OF WACO
TRADINGHOUSE CREEK RESERVOIR



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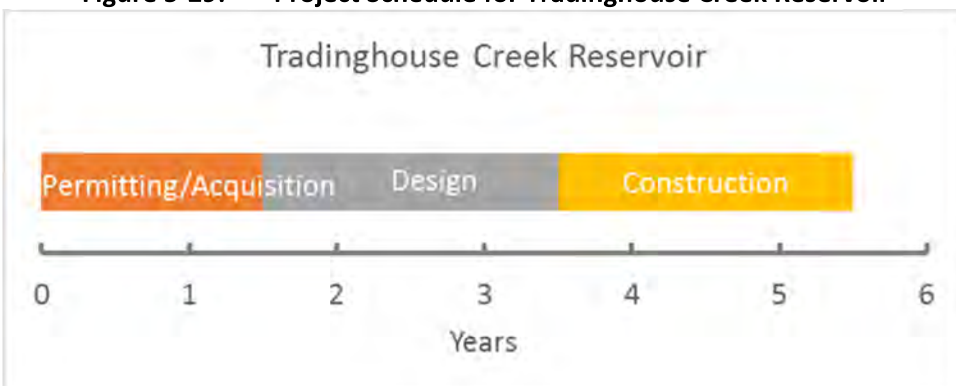
Updated: Friday, October 09, 2015

Timing/Schedule

The reservoir and dam are currently operational. If the City of Waco chooses to purchase the dam and reservoir from Luminant, it is not required to replace the dam. There may be a need to do some improvements on the dam. The City of Waco will have to locate a separate intake to access the supplies. It may take the City about 18 months to go through the permitting and acquisition of the water rights, reservoir and the dam. It will take the City another two years to design the intake facility and the transmission pipeline. It is assumed that the construction of intake pumpstation and the transmisison pipeline will be completed in two years. The project schedule is shown in the **Figure 5-29**.

Figure 5-29: Project Schedule for Tradinghouse Creek Reservoir



Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

a) Supply source available close to the City of Waco service area
b) There is no need to go through the lengthy process of securing water rights and reservoir permitting process. Luminant already owns the water rights, reservoir and dam. The City of Waco can either lease the supplies or purchase them from Luminant

The following is a list of potential risks of this strategy:

a) Potential water quality issues associated with the source
b) Purchase costs associated with the acquisition of water rights, reservoir, and dam
c) This supply is considered to be high in TDS and required advanced treatment or blending before use. Water can be blended at WTPs or pumped to Lake Waco and blended. The amount that can be blended depends on acceptable salt waters in finished water. The City could potentially blend up to a point and then institute advanced treatment at the

treatment plants. Supplies can be acquired now and a final decision on blending/treatment made later.

Figure 5-30: HGL for Transmission System from Tradinghouse Creek Reservoir to Riverside WTP

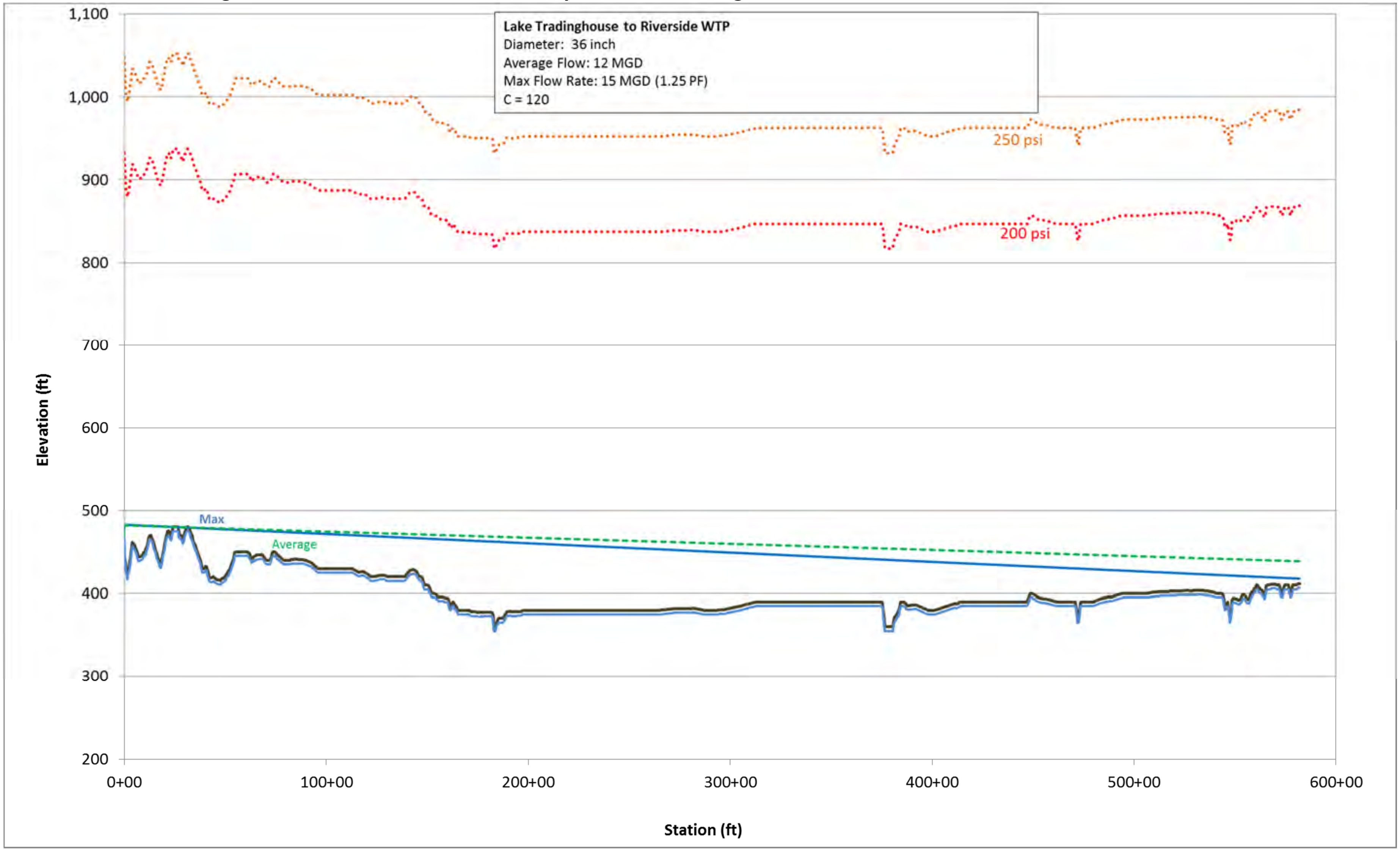


Table 5-7: Lake Tradinghouse Reservoir to Riverside WTP Strategy Detailed Cost Estimates

City of Waco Long Term Water Supply Strategy

Lake Tradinghouse Reservoir to Riverside Water Treatment Plant

Probable Owner:		**13,777 Average Acre-Feet per Year**			
Peak Delivery:		**15 Peak MGD**		Peaking Factc 1.25	
CONSTRUCTION COSTS					
TRANSMISSION FACILITIES					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline (Rural)	36 in	0	LF	$180	$0
Pipeline (Urban)	36 in	40,400	LF	$253	$10,201,000
Pipeline (Rural)	36 in	0	LF	$180	$0
Pipeline (Urban)	36 in	18,200	LF	$253	$4,595,500
Street Repair		14,650	LF	$250	$3,662,500
ROW Easements (Rural)		0	LF	$16	$0
ROW Easements (Urban)		58,600	LF	$39	$2,298,220
Permitting and Mitigation					$178,000
Engineering and Contingencies (30%)					$4,439,000
Subtotal of Pipeline					**$25,374,220**
Pump Station(s)	**Size**	**Quantity**	**Unit**		
Intake Pump Station	44 HP	1	LS	$1,524,000	$1,524,000
Dam		1	LS	$500,000	$500,000
Permitting and Mitigation					$18,000
Engineering and Contingencies (35%)					$533,000
Subtotal of Pump Stations					**$2,575,000**
CONSTRUCTION TOTAL					**$27,949,000**
Interest During Construction	**(48 months)**				**$4,519,000**
TOTAL COST					**$32,468,000**
ANNUAL COSTS					
Debt Service (6% for 30 years)					$2,359,000
Electricity ($0.09 per kWh)					$21,000
Pump Station & Pipeline Operation & Maintenance					$168,000
Total Annual Costs					**$2,548,000**
					$189,000
UNIT COSTS (Until Amortized)					
Per Acre-Foot					$185
Per 1,000 Gallons					$0.57
UNIT COSTS (After Amortization)					
Per Acre-Foot					$14
Per 1,000 Gallons					$0.04

*For cost estimating purposes, 10% was added to the pipeline lengths to account for slope distances and routing around obstacles.

5.2.8 Lake Bosque

Description

The Bosque River is located in the Erath, Bosque and McLennan counties, originating near Stephenville and flowing to its confluence with the Brazos River. The Bosque River watershed covers portions of five counties (Erath, Bosque, Coryell, McLennan, and Hamilton) and terminates in Lake Waco. The drainage area for the watershed is about 1,650 square miles. The three major tributaries of the Bosque River, North Bosque, Middle Bosque and South Bosque converge in Lake Waco. A lake on the largest tributary of the Bosque River, the North Bosque River, could develop additional yield from the watershed. In early 1980s, the TWDB funded several studies to conduct a feasibility analysis for locating a reservoir on the North Bosque River.

Several site locations were evaluated in a TWDB study dated 1982, "Water Supply Alternatives for Bosque County". The most preferred site location named Lake Bosque considered the dam location on the North Bosque River just north of City of Meridian. The location of Lake Bosque is shown in **Figure 5-31**. This preferred site has a normal pool elevation of 830 ft MSL, conservation storage of 102,909 ac-ft, surface area of 4,564 acres, and a firm yield of 17,900 acre-feet per year (15.98 MGD). An Environmental Assessment report was completed for this site location, and it was found to be favorable for reservoir construction.

Supply Reliability

Several water supply planning studies for McLennan and Bosque counties included Lake Bosque as a strategy. In the earlier reports, the Lake Bosque project was developed for a list of participants in Bosque and McLellan Counties. Because of the yield required to meet the 2040 demands for City of Waco and its customers, it was assumed that City of Waco will be the lone project sponsor for the Lake Bosque reservoir construction and utilize the full yield. The firm yield of Lake Bosque on its own is approximately 10,570 acre-feet/year. The firm yield of Lake Bosque used for this study was determined based on the assumption that Lake Bosque and Lake Waco will be operated as a system and that the system operation will result in an increase in yield that is attributable to Lake Bosque. The firm yield of Lake Bosque for this system operation option is approximately 17,900 acre-feet/year.

Infrastructure Configuration

It is assumed that City of Waco will own and operate Lake Bosque. There is no need for a pipeline transmission system as Lake Bosque and Lake Waco will be operated as a system. In the system operations scenario, it was assumed that the raw water supplies from Lake Bosque will be released to Lake Waco via the North Bosque River, thus precluding the delivery and transmission pipeline otherwise required. It was assumed that the supplies from Lake Bosque will be treated at the City of Waco WTPs.

Cost

Capital Cost - The total capital cost for this strategy is $142,410,000. It was assumed City of Waco would be the lone sponsor for the reservoir construction costs. There is no need for an intake pump station at the dam because supplies from Lake Bosque will be released to Lake Waco via North Bosque River. The reservoir and dam would be owned and operated by the City of Waco. The cost for improvements to the water treatment plant is not included in the capital cost. The treatment plant expansion cost is included in the CIP cost estimate regardless of which strategy the City chooses to pursue. The detailed cost estimate is included in **Table 5-8** below.

Annual Cost -

- Total annual cost during debt repayment period: $10,160,000
- Total annual cost after debt is paid: $1,280,000
- Annual unit cost of water until amortization based on 17,900 acft/yr: $1.74 per 1,000 gallons
- Annual unit cost of water after amortization based on 17,900 acft/yr: $0.22 per 1,000 gallon

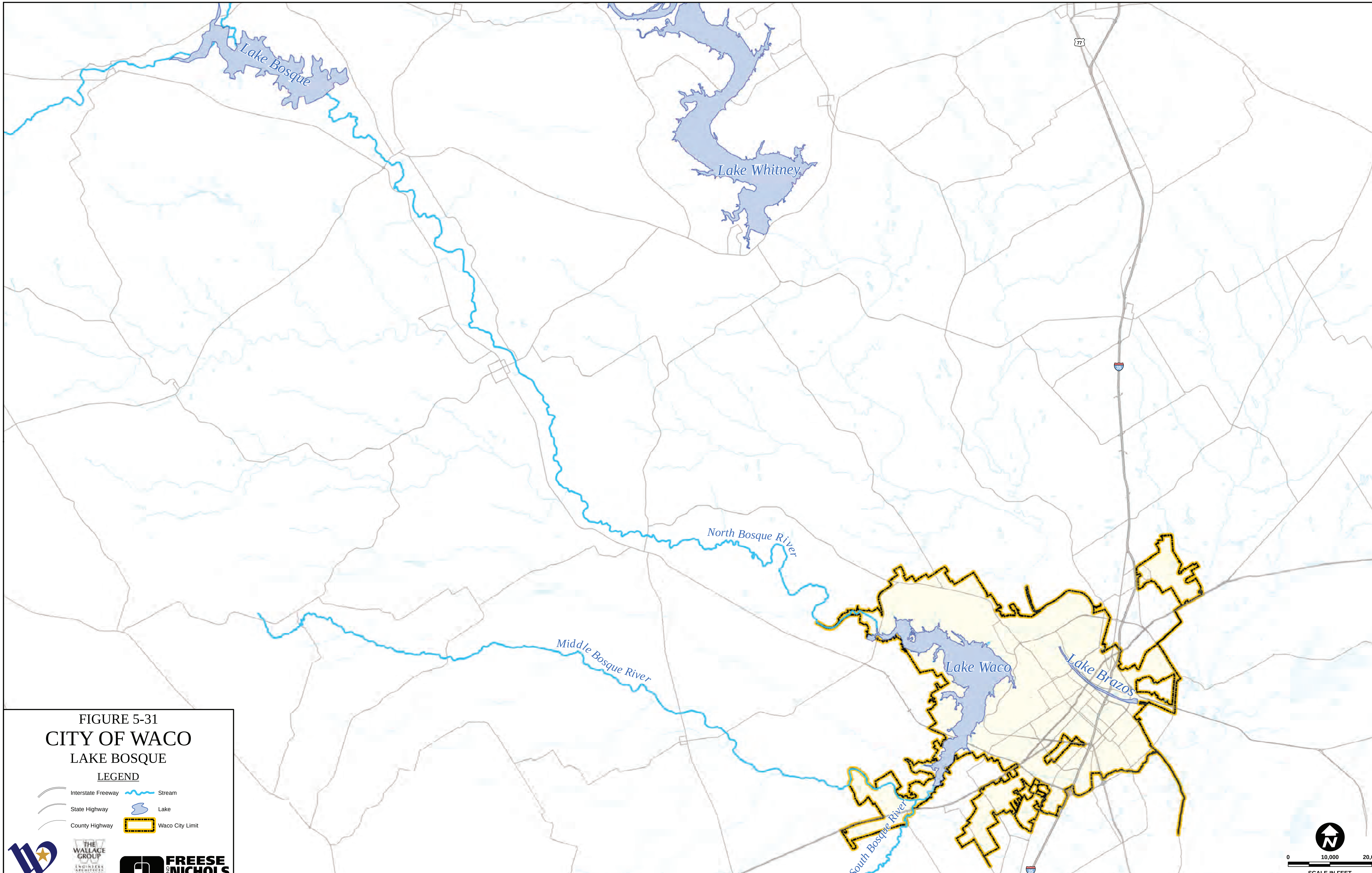


FIGURE 5-31
CITY OF WACO
LAKE BOSQUE

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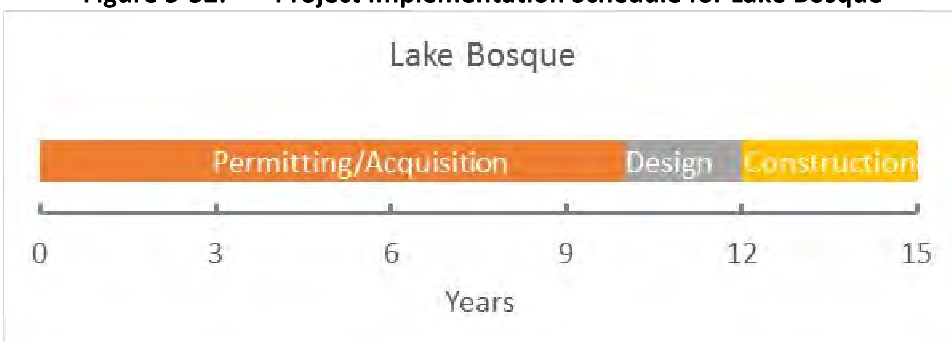
Regulatory/Permitting Requirements

The City of Waco will have to apply for a water right permit to use supplies from the Bosque River for municipal and industrial use. The City will also have to go through the 404 and other permitting processes involved in site acquisition and reservoir construction. There are significant regulatory/permitting requirements associated with this strategy.

Timing/Schedule

Because of the lengthy process associated with the water rights application and reservoir permitting, it is assumed that the regulatory process will take ten years. The initial planning and design of the reservoir is assumed to take approximately two years. The reservoir construction is assumed to take approximately 2.5 years. The project schedule for this strategy is included in **Figure 5-32**.

Figure 5-32: Project Implementation Schedule for Lake Bosque



Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

a) Significant amount of supply available to meet City's growing water demands
b) No need for a transmission pipeline as supplies can be transferred to Lake Waco through North Bosque River

The following is a list of potential risks of this strategy:

a) Significant regulatory and permitting requirements associated with the strategy
b) Significant costs associated with the reservoir construction
c) Potential water quality issues associated with the source of supply.

Table 5-8: Lake Bosque Strategy Detailed Cost Estimate

City of Waco Long Term Water Supply Strategy Cost Estimate
Lake Bosque
September 2014 Dollars

Supply (Ac-ft)	17,900			
Supply (MGD)	16.0			
Construction Cost:	**Quantity**	**Unit**	**Unit Price**	**Total**
Embankment	1	LS	$30,000,000	$30,000,000
Land Acquisition (4,564 acres)	1	LS	$8,900,000	$8,900,000
Spillway & Outlet Works	1	LS	$26,000,000	$26,000,000
Utility & Roadway Relocations	1	LS	$6,000,000	$6,000,000
Total Construction Costs:				**$70,900,000**
Other Project Cost:	**Quantity**	**Unit**	**Unit Price**	**Total**
Construction Contingencies @ 20%			20%	$14,180,000
Engineering, Legal & Financial @ 15%			15%	$10,640,000
Land, Easements & Conflicts	4,564	Acre	$4,700	$21,450,000
Environmental Studies, Mitigation & Permitting	1	LS	$17,800,000	$17,800,000
Interest During Construction (3 Years)				$7,440,000
Total Other Project Costs:				**$71,510,000**
Total Capital Cost:				**$142,410,000**
Annual Costs:	**Quantity**	**Unit**	**Unit Price**	**Total**
Debt Service (40 yrs. @ 5.5%)				$8,880,000
Operation and Maintenance @ 1.5%				$1,280,000
Total Annual Costs:				**$10,160,000**
During Amortization				
Cost of Water ($Per MGD)				**$1,743**
Cost of Water ($Per 1,000 Gallons)				**$1.74**
After Amortization				
Cost of Water ($Per MGD)				**$220**
Cost of Water ($Per 1,000 Gallons)				**$0.22**

5.2.9 Reuse

Description

The City of Waco owns and operates the WMARSS wastewater treatment plant (WWTP) located on the east side of the City. The plant has capacity to treat up to 25 MGD of wastewater. Approximately 15 MGD of the treated effluent from the WWTP is delivered to Sandy Creek/Dynegy plant by means of a 15 MGD reclaimed water pump station, 12-mile long pipeline, and a 40 MG terminal storage pond at the Sandy Creek Plant. This pipeline system is dedicated to serving the Sandy Creek Plant.

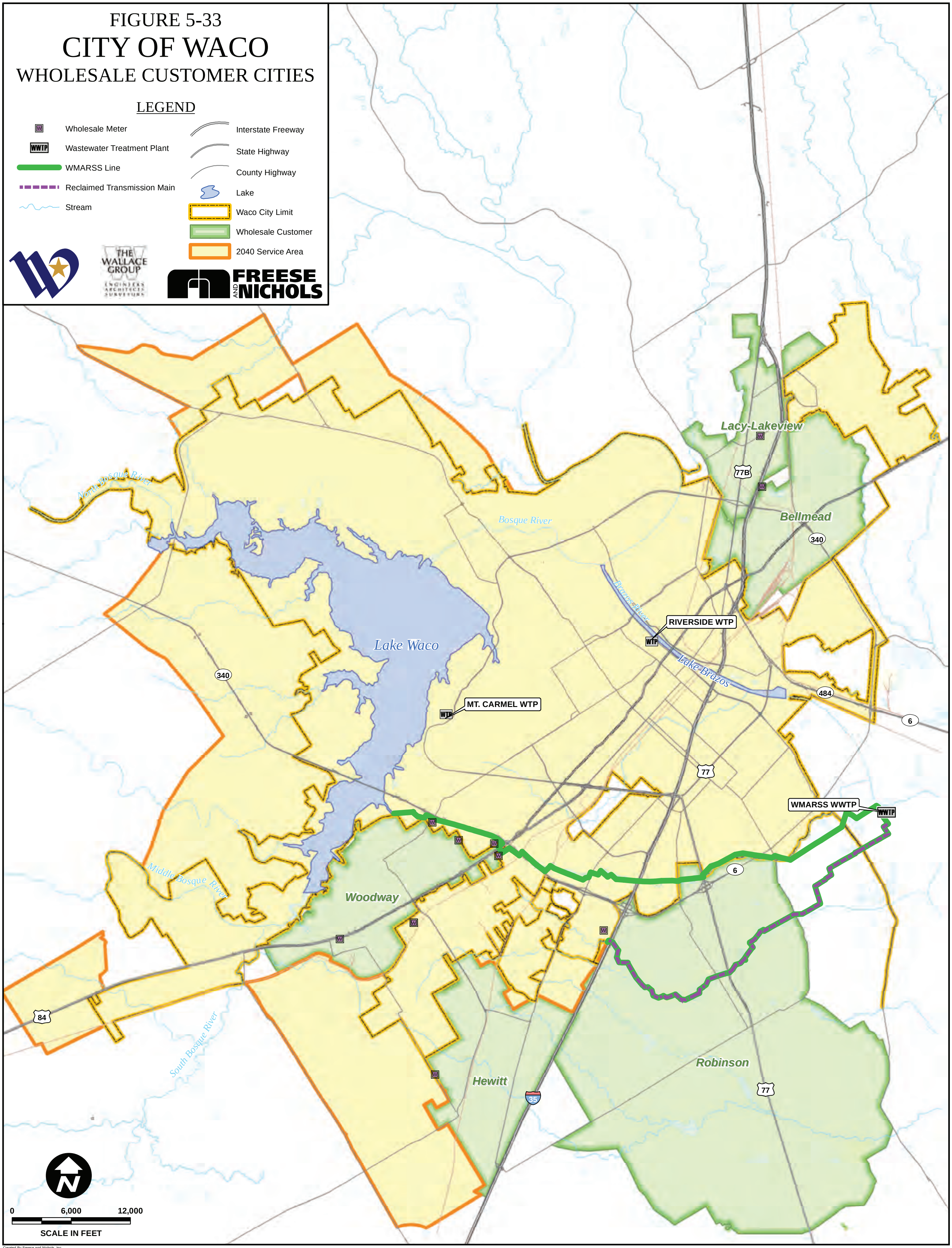
One of the proposed strategies is for City of Waco to divert approximately 7 MGD of firm supplies from the WMARSS WWTP to the Lake Waco. The purpose of this strategy would be to diversify the supply portfolio and incorporate a drought-proof source into the City of Waco supply portfolio. The additional 7 MGD will increase the yield of the Lake Waco and add supplies to the location that can be accessed easily using the existing infrastructure. It is assumed that the reuse supplies from the WMARSS WWTP will be delivered into Lake Waco by means of a booster pump station and a pipeline.

Supply Reliability

The reuse supply is considered to be highly reliable and drought-proof. No evaporative or transfer losses are considered as the treated effluent is transferred to the lake by means of a close conduit system. Any loss of reliability due to permitting issues and environmental flow standards is not known at this time.

Infrastructure Configuration

It is assumed that City of Waco will own and operate the transmission pipeline from the WMARSS WWTP to the Lake Waco. An 11-mile pipeline and a booster pump station are included in the infrastructure configuration required to deliver the reuse supplies from the WMARSS WWTP to the Lake Waco. Depending on the assimilative capacity of Lake Waco, additional retrofitting may be required at the WMARSS plant for additional treatment of the reclaimed water. This strategy evaluation does not include the additional retrofitting at the WMARSS WWTP. It was assumed that the reuse supply will be treated at the City of Waco WTPs. Expansion of the treatment plant capacity to handle the additional flows is included in the CIP Plan and therefore not discussed here. **Figure 5-33** includes a location map of the transmission system for the reuse strategy. **Figure 5-35** includes a hydraulic grade line for the proposed pipeline.



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Cost

Capital Cost - The total capital cost for this strategy is $22,272,000. It was assumed City of Waco would be the lone sponsor for the infrastructure costs. The strategy includes the capital cost for an 11-mile long pipeline, booster pump station, and storage tanks. The cost for improvements to the water treatment plant to receive and treat the additional supplies is not included in the capital cost. The treatment plant expansion cost is included in the CIP cost estimate. The detailed cost estimate is included in **Table 5-9**.

Annual Cost -

- Total annual cost during debt repayment period: $2,041,000
- Total annual cost after debt is paid: $423,000
- Annual unit cost of water until amortization based on 7,847 acft/yr: $0.80 per 1,000 gallons
- Annual unit cost of water after amortization based on 7,847 acft/yr: $0.17 per 1,000 gallons

Regulatory/Permitting Requirements

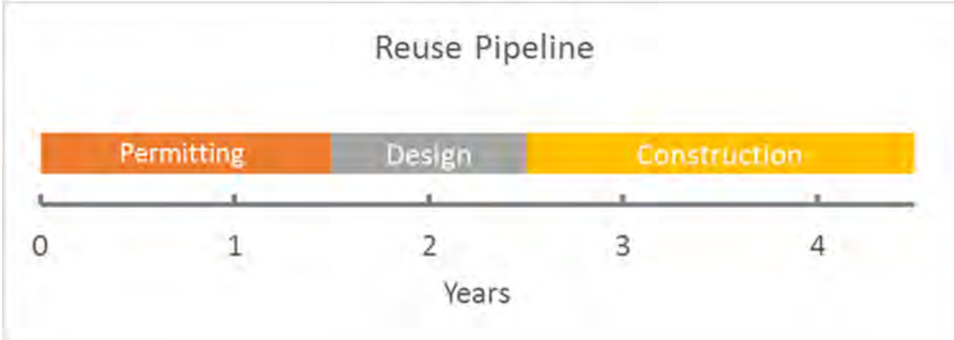
The City of Waco would have to apply for a bed and banks permit to transfer the reuse supplies to Lake Waco. It is uncertain how the environmental flow standards will impact their ability to recover 100% of the reuse supplies added to the lake Waco. Until further information is available regarding the environmental flows, it is assumed that City of Waco can recover 100% of the reuse supplies transferred to Lake Waco.

The water quality impacts of adding the reuse supplies to Lake Waco are unclear at this stage of the study. A detailed study focusing on the water quality of Lake Waco, the quality of the treated effluent from the WMARSS plant, the assimilative capacity of the Lake, and the mixing concentrations is required to further evaluate the water quality impacts.

Timing/Schedule

The bed and banks permitting process is assumed to take approximately 1 to 2 years. The initial planning and design of the transmission system is assumed to take approximately one year. The construction is assumed to take approximately two years. The project schedule for this strategy is included in **Figure 5-34**.

Figure 5-34: Project Implementation Schedule for Reuse Pipeline



Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

c) Significant amount of supply available to meet City's growing water demands

d) Drought-proof supply source

The following is a list of potential risks of this strategy:

d) Significant regulatory and permitting requirements associated with the strategy

e) Potential public and political opposition to the addition of reclaimed water to the Lake Waco

f) Potential water quality issues associated with the source of supply.

Figure 5-35: HGL for Transmission System for Reuse Pipeline from WMARSS WWTP to Lake Waco

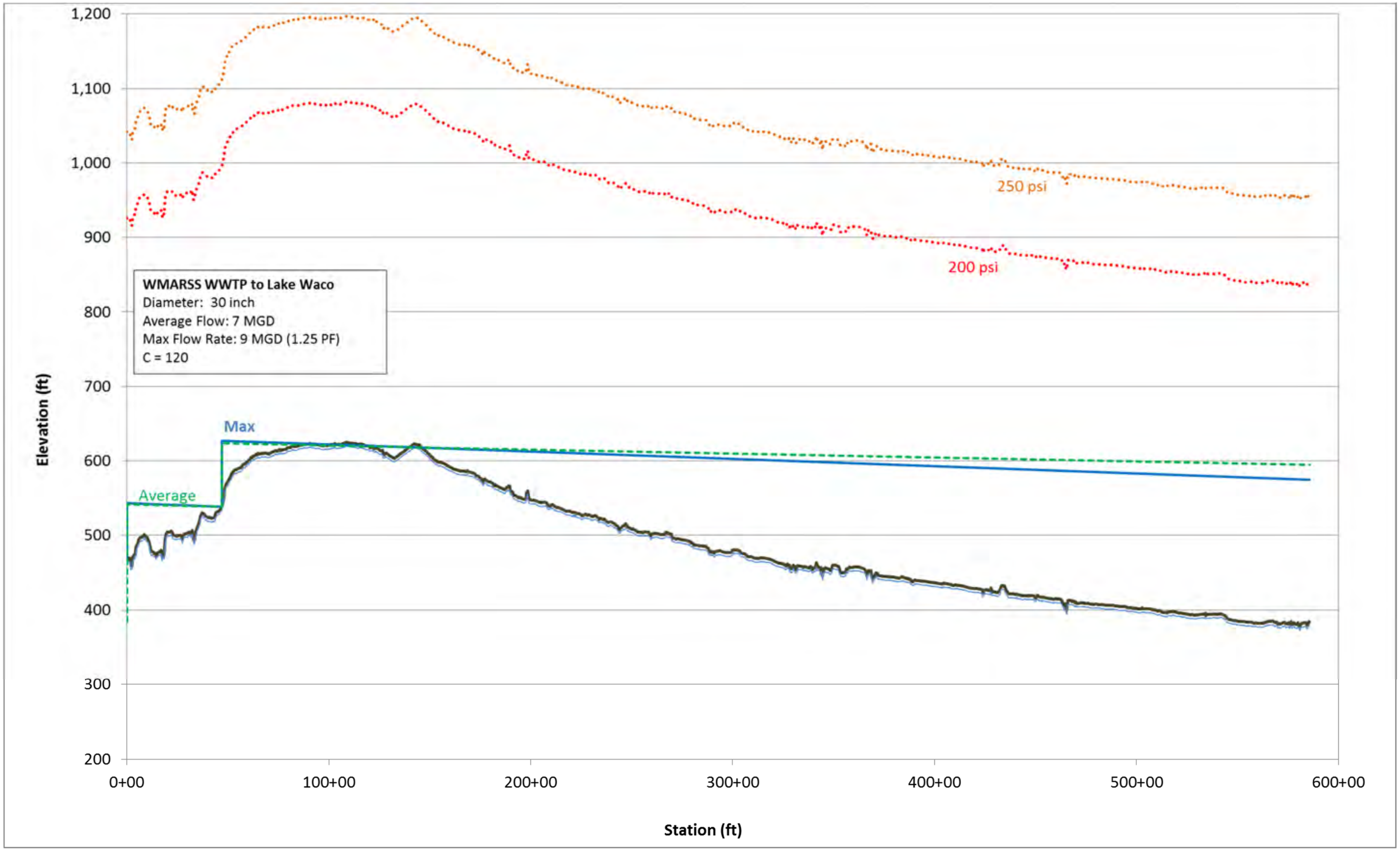


Table 5-9: Reuse Pipeline Strategy Detailed Cost Estimate

City of Waco Long Term Water Supply Strategy
WMARSS WWTP to Lake Waco

Probable Owner:		**7,847 Average Acre-Feet per Year**			
Peak Delivery:		**9 Peak MGD**		Peaking Factor =	1.25
CONSTRUCTION COSTS					
TRANSMISSION FACILITIES					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline (Rural)	30 in	45,000	LF	$145	$6,525,000
Pipeline (Urban)	30 in	13,563	LF	$203	$2,746,508
Street Repair		3,391	LF	$250	$847,688
ROW Easements (Rural)		45,000	LF	$16	$726,701
ROW Easements (Urban)		13,563	LF	$39	$531,924
Permitting and Mitigation					$111,000
Engineering and Contingencies (30%)					$2,781,000
Subtotal of Pipeline					**$14,269,820**
Pump Stations	**Size**	**Quantity**	**Unit**		
Intake Pump Station	152 HP	1	LS	$2,234,000	$2,234,000
Booster Pump Station	170 HP	1	LS	$1,859,000	$1,859,000
Permitting and Mitigation					$27,000
Engineering and Contingencies (35%)					$782,000
Subtotal of Pump Stations					**$4,902,000**
CONSTRUCTION TOTAL					**$19,172,000**
Interest During Construction	**(48 months)**				**$3,100,000**
TOTAL COST					**$22,272,000**
ANNUAL COSTS					
Debt Service (6% for 30 years)					$1,618,000
Electricity ($0.09 per kWh)					$245,000
Pump Station & Pipeline Operation & Maintenance					$178,000
Total Annual Costs					**$2,041,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot					$260
Per 1,000 Gallons					$0.80
UNIT COSTS (After Amortization)					
Per Acre-Foot					$54
Per 1,000 Gallons					$0.17

*For cost estimating purposes, 10% was added to the pipeline lengths to account for slope distances and routing around obstacles.

5.2.10 Aquifer Storage and Recovery

Description

Aquifer storage and recovery (ASR) is the process in which the natural groundwater supplies are enhanced by means of man-made operations such as injection wells and/or infiltration basins. In most cases, surface water from reservoirs is injected into the groundwater aquifers during normal and wet hydrologic conditions with the intent to store the supplies in groundwater aquifers for a later use. The surface water is treated to permissible water quality standards so as to not impact the inherent quality of the groundwater supplies.

Supply Reliability

It is assumed that the entity injected water into the groundwater storage has the right to retrieving all the supply that was injected minus the losses involved in the injection and retrieval. In that sense, this source of supply is considered to be highly reliable. Because the supply is moved from surface water location to under the ground, it is not subject to losses due to evaporation.

Infrastructure Configuration

This strategy is not considered feasible for City of Waco at this time. There are several alternative sources with lower unit cost per gallon that are available at this time. Aquifer storage and recovery will be an expensive alternative compared to the other strategies. Therefore, the infrastructure requirements are not evaluated in detail at this time.

Cost

Specific cost estimates were not developed for this strategy as it is found to be cost-prohibitive at this time.

Regulatory/Permitting Requirements

While ASR strategy has been adopted in other parts of the United States, there are very few projects implemented in Texas.

Timing/Schedule

Based on similar projects that are being evaluated, a schedule was estimated for this strategy. The project schedule is shown in **Figure 5-36**. Because of the limited number of examples from entities that implemented this strategy, the schedule provided is a best estimate of what it might take to implement this strategy. The actual timing needs to be evaluated and updated as more information becomes available.

Figure 5-36: Implementation Schedule for Aquifer Recovery and Storage

Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

a) Reliable source of supply that is not subject to evaporative losses

The following is a list of potential benefits of this strategy:

a) Lack of clarity in the legislative guidance
b) Expensive strategy compared to other strategies evaluated for City of Waco at this time.

5.2.11 Purchase Water from BRA

Description

Because of the proximity to Brazos River Authority's supply sources to the City of Waco, one of the feasible options for the City of Waco to consider is to purchase water from BRA's system.

Supply Reliability

BRA's current supplies are contracted out to their existing customers; however, BRA may have sufficient supplies available to sell to City of Waco after the system permit is issued. This is a reliable source of supply provided that the system permit for operating the BRA's reservoirs will be granted.

Infrastructure Configuration

The City of Waco will connect to the BRA's system for their supplies. Water can be released into Lake Brazos from the BRA reservoirs. No additional infrastructure is required to connect to the BRA's supplies.

Cost

The fee for contracting with BRA and the cost of water can be determined by negotiating with BRA. Currently, no negotiations are underway regarding this source of supply. BRA has a current system cost of $69.50 per acre-feet per year, take or pay. The price is subject to change over time.

Regulatory/Permitting Requirements

There are no known regulatory and permitting requirements associated with this strategy as this involves contracting with BRA to connect supplies to City of Waco; however, BRA is going through a contested case hearing process for the approval of their systems operation permit. Therefore, the availability of supplies from BRA's reservoirs is subject to uncertainty associated with the outcome of the system operation permit approval.

Timing/Schedule

There are no schedule limitations associated with this strategy. It is assumed that water supply will be available for use as soon as a contract with BRA is negotiated.

Potential Benefits/Risk/Challenges

The following is a list of potential benefits of this strategy:

a) Readily available source of supply
b) No need to go through significant permitting process and construction of infrastructure required to transfer water

The following is a list of potential benefits of this strategy:

a) Availability of supplies is dependent on the outcome of BRA's systems operation permit application
b) Cost of the strategy is dependent on the price negotiated with BRA
c) This supply is considered to be high in TDS and required advanced treatment or blending before use. Water can be blended at WTPs or pumped to Lake Waco and blended. Amount that can be blended depends on acceptable salt waters in finished water. City could potentially blend up to a point and then institute advanced treatment at the treatment plants. Supplies can be acquired now and final decision on blending/treatment made later.

5.3 RECOMMENDED STRATEGIES AND SUMMARY OF WATER SUPPLY EVALUATION

City of Waco's water supply plan is developed as a pro-active planning approach for the City as the City does not anticipate any shortages in the near term decades for an average day demand projection scenario. Recommended strategy is selected based on a comparison of the unit costs associated with each one of the individual strategies, reliability of the supply source to meet City of Waco's needs, risks and challenges associated in the process of securing the source of supply, environmental impacts, and the stakeholder preference. Conservation is the most recommended strategy as it does not take a significant capital investment but will provide long term returns in terms of supply reduction and cost savings. Based on the preliminary discussions with the City of Waco, it was determined that the Conjunctive Use strategy is the most preferred strategy for the City to address the needs arising during the CIP period from 2020 – 2040. Various potential demand scenarios were evaluated and the scenario with 50% of the wholesale customer demand without FHLM was identified as the most probable demand scenario. The conjunctive use strategy is a combination of use from City's groundwater supplies and the surface water supplies from Lake Waco. The additional supplies from groundwater can safely address used conjunctively with surface water without significantly impacting the aquifer levels in the Carrizo.

An alternative and a secondary strategy for the City is to invest in the reuse pipeline to connect the available treated effluent from the City's WMARSS plant to the Lake Waco. Including this strategy will help the City of Waco diversify their water supply portfolio and also invest in an alternative source of supply that is also drought-proof. Also included in this study is a discussion of several additional potentially feasible strategies along with a preliminary estimate of the unit cost. The City may choose to develop the most feasible strategy among the additional strategies to meet the demands in the long term future.

6.0 EXISTING WATER DISTRIBUTION SYSTEM

The existing water distribution system includes high service pumps stations at two water treatment plants: (Mt. Carmel WTP and Riverside WTP, six elevated storage tanks (ESTs), the Airport GST and Pump Station, the Gholson GST and Booster Pump Station, the Hillcrest GST and Pump Station, the Westview GST and Pump Station, the Old McGregor GST and Pump Station and 14 Pressure Reducing Valves (PRVs), all shown on **Figure 6-1**. A profile schematic of the existing distribution system facilities is shown on **Figure 6-2**. A more detailed description of the facilities within each pressure plane is discussed in the following sections.

6.1 WATER TREATMENT PLANTS

In 2011 the City of Waco completed the first direct air filtration (DAF) plant in Texas. The DAF plant was built next to Lake Waco to enhance the drinking water quality throughout Waco. With a capacity of 90 MGD, the DAF plant serves as pretreatment of the raw surface water for both the Riverside and Mt. Carmel WTPs. The new plant alleviated taste and odor issues with the use of dissolved air flotation, ozone and hydrogen peroxide.

The DAF plant supplies water to two water treatment plants. The rated capacity of the DAF plant is 90 MGD. The Mt. Carmel WTP has a current rated capacity of 66 MGD and the Riverside WTP has a rated capacity of 24 MGD. Each plant utilizes biologically active filtration to remove the biodegradable dissolved organic carbon in the water as a result of the ozonation at the DAF plant.

The Riverside WTP was originally constructed in 1914 with a firm capacity of 5 MGD. The plant was last expanded in 1980 and has a rated capacity of 28 MGD. The Riverside WTP high service pump station has a firm pumping capacity of 47.0 MGD and supplies treated water to PP1, PP2 and PP5. However, the City will not pump more than approximately 20 MGD to avoid water main leaks due to aging infrastructure in the downtown area.

The Mt. Carmel WTP was constructed in the early 1960's with an original capacity of 20 MGD. The plant was built to serve the western portion of the City. The MT Carmel WTP provided a second source for treated water in the distribution system and allowed the City to expand its service area farther west. The Mt. Carmel WTP has been expanded to a current rated capacity of 66 MGD. The high service pump stations have a combined firm capacity of 26.57MGD and supplies treated water to PP2, PP3, PP4, and PP6.

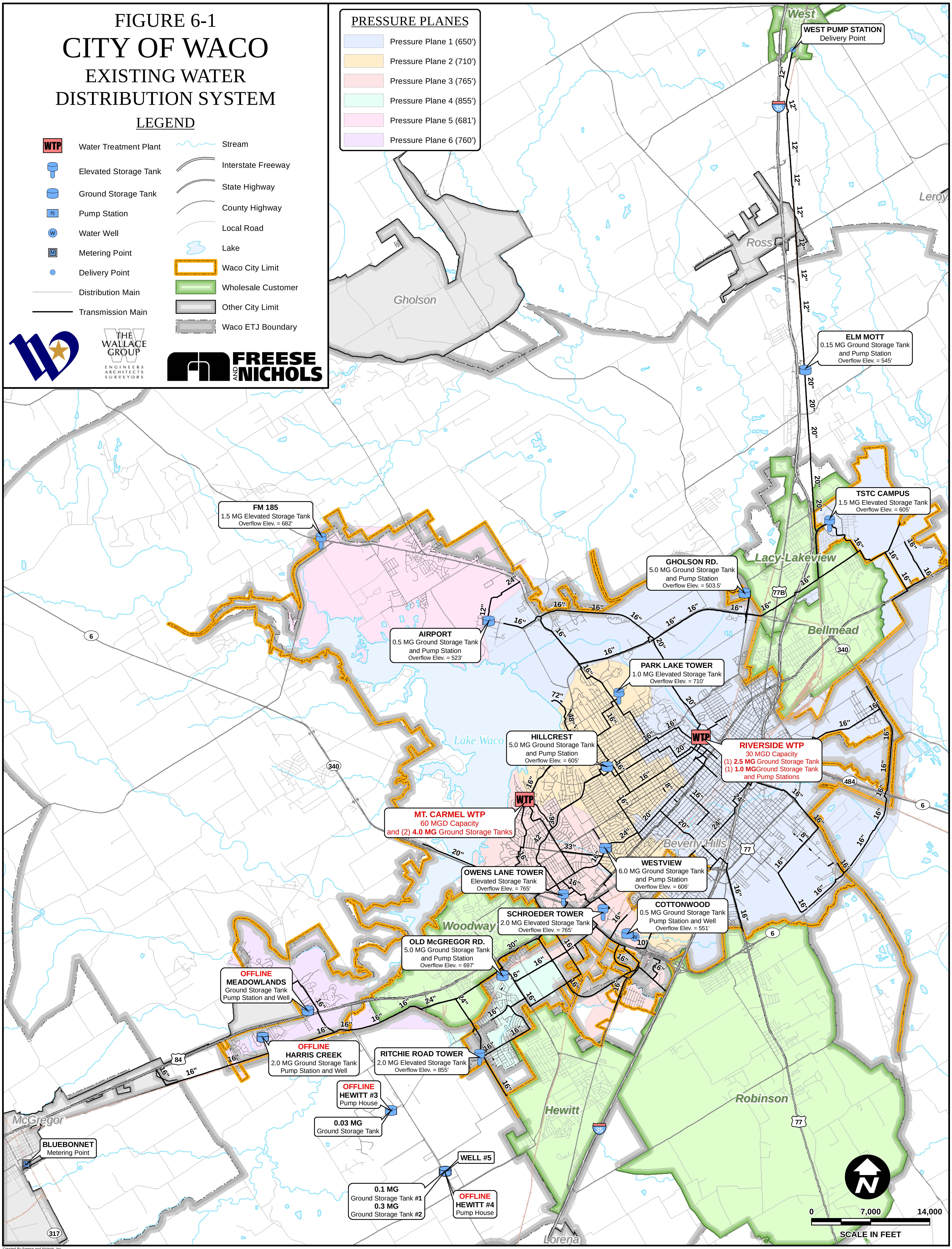


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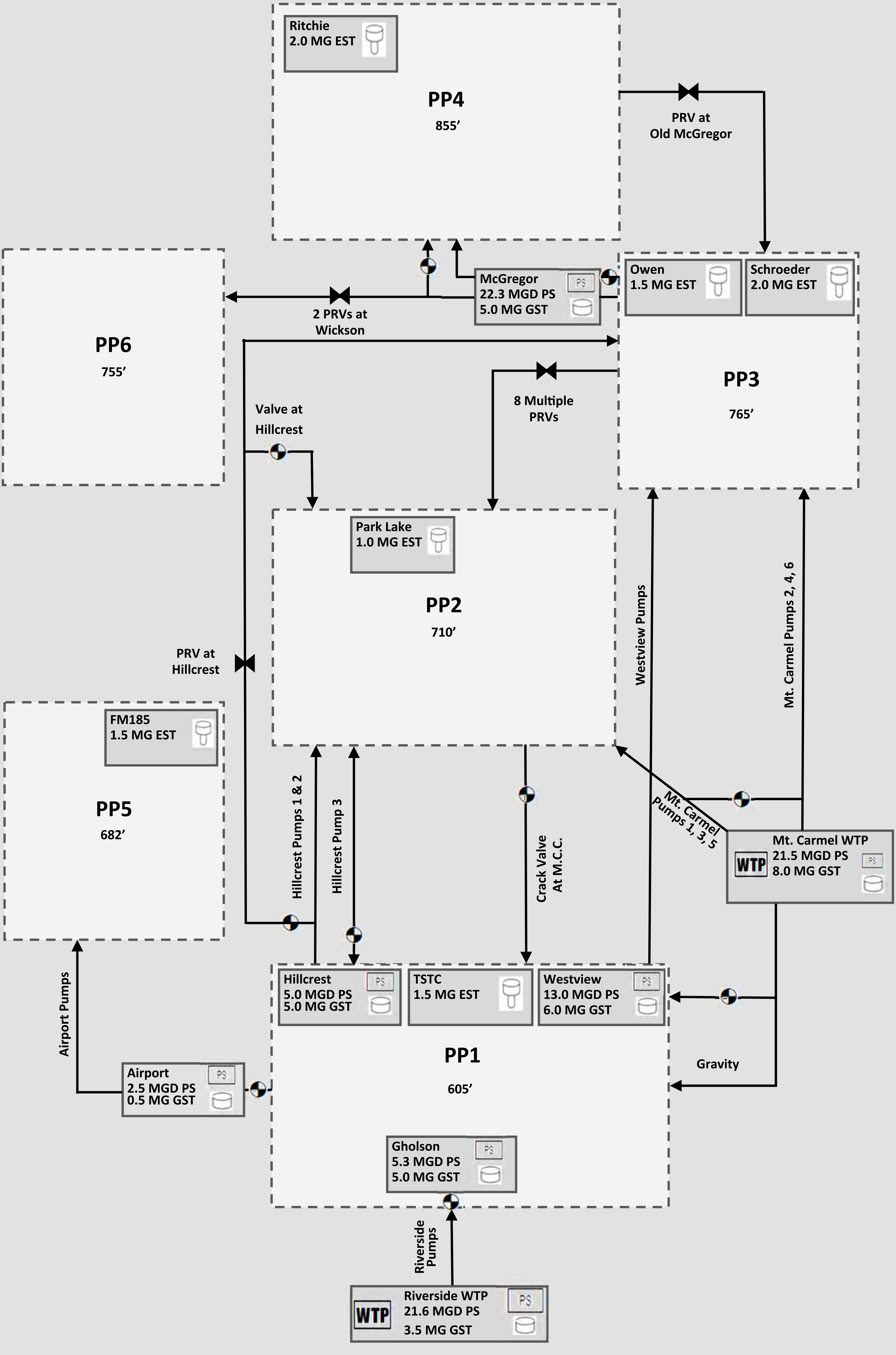
Figure 6-2
Hydraulic Profile Schematic



6.2 PRESSURE PLANES

The City's water distribution system is currently separated into six pressure planes: Pressure Plane through 6.

6.2.1 Pressure Plane 1

Pressure Plane 1 (PP1) covers the downtown and northeastern portion of the City with an elevated storage overflow elevation of 605 feet. PP1 has one true elevated storage tank on the Texas State Technical College (TSTC) campus, but the Westview and Hillcrest GSTs can also serve as elevated storage for PP1. Under normal conditions, the Riverside WTP serves all of PP1. Due to aging infrastructure in the downtown area, the full pumping capacity at Riverside cannot be utilized due to the potential for pipe breaks under higher flows and pressures. Therefore, the Gholson GST and Booster Pump Station are necessary to serve the TSTC area and wholesale customers north along I-35. PP5 is served entirely through PP1. During peak demand periods, the City will open a valve on an 8-inch line along Lake Shore Dr. near the Park Lake Tower to transfer water from PP2 to PP1 to help feed the Airport GST. There are approximately 17,400 connections in PP1.

6.2.2 Pressure Plane 2

PP2 serves the central portion of Waco with an elevated storage overflow elevation of 710 feet. The Park Lake Tower provides 1.0 MG of elevated storage for PP2. The Schroeder Tower in PP3 provides elevated storage to PP2 through the operation of multiple PRVs between the two pressure planes. The Hillcrest Pump Station is supplied by both WTPs and pumps into PP2. Under normal operation the portion of PP2 north of Franklin Avenue is served by the Hillcrest Pump Station and the Park Lane Tower. Due to the increased ground elevation, the portion south of Franklin Avenue is only served by PRVs between PP3 and PP2. Two pumps at the Westview Pump Station can also pump into PP2; however, the pumps are not sized to pump directly into PP2, and a PRV must be utilized to reduce the pressure from the pump station in order serve PP2. There are approximately 14,400 connections in PP2.

6.2.3 Pressure Plane 3

PP3 serves the western portion of Waco with an elevated storage overflow elevation of 765 feet. The 1.5 MG Owens EST and the 2.0 MG Schroeder EST provide 3.0 MG of elevated storage to PP3 after taking into account the 0.5 MG transferred to PP2. PP3 is served by the Westview Pump Station, which is supplied by both WTPs. In addition, pumps 2, 4, and 6 at the Mt. Carmel WTP supply the pressure plane and also the Old McGregor Pump Station which serves PP4. The capacity of the gravity supply line from the Mt. Carmel WTP to the Westview PS limits how many pumps at the Westview PS can actually be operated at a time. During peak demands, the City can open a PRV at the Old McGregor PS in PP4 to provide additional supply to the pressure plane. There are approximately 7,200 connections in PP3.

6.2.4 Pressure Plane 4

PP4 serves the southwest portion of Waco, between the Cities of Woodway and Hewitt, with an elevated storage overflow elevation of 855 feet. The Ritchie Road Tower provides elevated storage for PP4 and PP6. The Old McGregor PS is supplied by Mt. Carmel WTP from PP3 and serves PP4. In addition to PP4 demands, the Old McGregor PS also serves PP6 through two PRVs due to the lower ground elevations in that pressure plane. There are approximately 3,900 connections in PP4.

6.2.5 Pressure Plane 5

PP5 serves the northern portion of Waco with an elevated storage overflow elevation of 682 feet. The FM 185 EST provides 1.5 MG of elevated storage to the pressure plane. The Airport Pump Station is supplied by the Riverside WTP from PP1 and serves PP5. During peak demands, customers at higher elevations within the pressure plane experience low water pressures. This is caused by the inability of the Airport PS to maintain the level of the FM 185 EST during peak demands. Water age has also been a concern recently and is caused by poor turn over in the FM 185 EST during the summer months. There are approximately 2,400 connections in PP5.

6.2.6 Pressure Plane 6

PP6 serves the portion of Waco west of the City of Woodway with an elevated storage overflow elevation of 755 feet. The Ritchie Road Tower, in PP4, provides elevated storage to PP6 through two PRVs at the boundary between the two pressure planes. The Old McGregor PS serves demand in PP6 through the two PRVs. During peak demands, customers at higher elevations within the pressure plane may experience low pressure. The City is in the process of incorporating automated controls at both PRVs which adjust the PRV setting based on flow. This will allow PP6 to operate at a more consist pressure as demand fluctuates. There are approximately 1,900 connections in PP6.

6.3 PUMPING FACILITIES

The existing distribution system has over 155 MGD of total pumping capacity at various facilities spread throughout the City. **Table 6-3** provides a summary of the existing pumps for each pressure plane. Factory pump curves for each facility can be found in **Appendix A**. The project team conducted site visits of each pump station to review the general condition of the facility, number of pumps, size of pumps, piping layout and to verify pump operating capacity for model calibration. **Table 6-4** provides a summary of the pump station site visits and includes operational information for each pump station.

Table 6-3: Summary of Pump Station Facilities

Pressure Plane	Facility Name	Pump Number	Rated Head Capacity (feet)	Flow (gpm)	Flow (MGD)	Rated Power (HP)	Manufacturer
Presure Plane 1	Riverside WTP	Pump 4 MGD	220	2,800	4.0	200	Aurora
		Pump 6 MGD	205	4,200	6.0	300	Aurora
		N10 in Hole	235	6,950	10.0	600	Allis Chalmers
		S10 in Hole	235	6,950	10.0	600	De Laval
		N10 Clearwell	192	6,950	10.0	500	Layne and Bowler
		S10 Clearwell	192	6,950	10.0	500	Layne Turbine
	Gholson	No. 2	200	2,640	3.8	200	Paco
		No. 3	200	2,640	3.8	200	Paco
	Total Pumping Capacity			***40,080***	***57.7***		
	Firm Pumping Capacity			***33,130***	***47.7***		
Pressure Plane 2	Mount Carmel WTP	No. 1	135	3,475	5.0	150	Samsco-Byron Jackson
		No. 3	135	3,475	5.0	150	Samsco-Byron Jackson
		No. 5	187	3,500	5.0	200	Veriline
	Hillcrest	No. 1	134	2,900	4.2	125	Aurora
		No. 2	134	2,900	4.2	125	Aurora
		No. 3	134	2,900	4.2	125	Aurora
	Westview	No. 1	205	4,000	5.8	250	Byron Jackson
		No. 2	205	4,000	5.8	250	Byron Jackson
	Total Pumping Capacity			***27,150***	***39.1***		
	Firm Pumping Capacity			***23,150***	***33.3***		

Table 6-3: Summary of Pump Station Facilities (Cont.)

Pressure Plane	Facility Name	Pump Number	Rated Head Capacity (feet)	Flow (gpm)	Flow (MGD)	Rated Power +(HP)	Manufacturer
Pressure Plane 3	**Mount Carmel WTP**	No. 2	210	4,000	5.8	300	Peerless
		No. 4	210	4,000	5.8	300	Peerless
		No. 6	242	7,750	11.2	600	Gould
	Westview	No. 3	246	2,600	3.7	250	Aurora
		No. 4	246	2,600	3.7	300	Aurora
	Total Pumping Capacity			***20,950***	***30.2***		
	Firm Pumping Capacity			***13,200***	***19.0***		
Pressure Plane 4	**Old McGregor**	No. 1	200	2,880	4.1	200	Paco
		No. 2	200	2,880	4.1	200	Paco
		No. 3	200	2,880	4.1	200	Paco
		No. 4	200	2,880	4.1	200	Paco
	Total Pumping Capacity			***11,520***	***16.6***		
	Firm Pumping Capacity			***8,640***	***12.4***		
Pressure Plane 5	**Airport**	No. 1	296	856	1.2	100	Aurora
		No. 2	296	856	1.2	100	Aurora
	Total Pumping Capacity			***1,712***	***2.5***		
	Firm Pumping Capacity			***856***	***1.2***		
Pressure Plane 6	**Old McGregor**	No. 5	200	2,880	4.1	200	Paco
		No. 6	200	2,880	4.1	200	Paco
	Total Pumping Capacity			***5,760***	***8.3***		
	Firm Pumping Capacity			***2,880***	***4.1***		

Table 6-4: Summary of Pump Station Facility Site Visit

Pump Station	Electrical									Back-Up Power					Mechanical												Structure			Pumps	Observation		Date	Comments
	MCC Wiring			Instrumentation			SCADA			Installed Generator			Back-Up Capacity (%)	Wired For Portable Generator? (Y/N)	Cooling-Ventilation			Piping Condition			Valves Condition			Meter Condition			Condition			No. Of Pumps	Operating GPM	Operating Ft. Hd.		
	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor			Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor					
Airport	X			X			X			X			50%	?	X				X		X			X				X		2	P1-1100	194	4/28/2014	Pump Bases Need Replacing, Sump Pumps Discharge to Bar Ditch
Cottonwood	X			X			X							N	X			X			X			N/A			X			2	N/A	215	4/28/2014	
Elm Mott	X			X			X							N	X			X			X			X			X			2	P1-620	185	4/28/2014	
Gholson Road	X			X			X			X			50%	?	X			X			X			X			X			2	P2-2840	198.6	4/28/2014	
Hillcrest		X			X		X							N		X				X		X		X				X	X	3	P1-2250	152	4/23/2014	Dual Feed, Piping Leak Repairs Under Slab, Building in Fair Condition, Clearwell Poor Condition - Short Circuiting
Westview			X		X		X					X	25%			X				X			X		X			X	X	4	P3-3200, P1-1940	222, 166	4/23/2014	Building Fair Condition, Clearwell Poor Condition
Lorena RD Well Site		X		X			X							N			X	X				X			N/A				X	3	P1-425, P2-525	148	5/21/2014	Mechanical - ClaValves need adjusting.
Old McGregor Rd		X		X			X					X	17%			X			X			X		X				X		6	P1-2235	180	5/21/2014	Back-Up Power - Can run only P2 or P3, not both. Cannot run P3 and P4 at same time on same disconnect. Ground storage tank needs painting.
Riverside WTP - Backwash	X			X			X							N					X			X		X				X		1	N/A	N/A	6/13/2014	Ventilation - Outdoors. Building over valve needs work.
Riverside WTP - S10 & N10 Clearwell		X			X			N/A						N		X			X			X			X		X			6	S10-7000	192	6/13/2014	S10 Pump has excessive leaking.
Riverside WTP - 4 MGD			X			X	X							N			X		X			X			X			X		6	2500	192	6/13/2014	Flow Meters not in closure. MCC cannot get parts. Overhead crane needs attention. Floor needs pair or replacement. Not all PSI gauges connected to SCADA.
Riverside WTP - 6 MGD			X			X	X							N			X		X			X			X			X		6	3100	192	6/13/2014	Flow Meters not in closure. MCC cannot get parts. Overhead crane needs attention. Floor needs pair or replacement. Not all PSI gauges connected to SCADA.
Riverside WTP - N10 In Hole			X			X			X					N			X		X			X			X			X		6	7013	219	6/13/2014	
Riverside WTP - S10 In Hole			X			X			X					N			X		X			X			X			X		6	7510	219	6/13/2014	
Riverside WTP - Recirculation Pumps 1 & 2	X				X			N/A		X				N		X		X			X				N/A		X			2	N/A	N/A	6/13/2014	Not in service.
Mt. Carmel WTP Service Pumps 1 & 2		X		X			X							N		X			X			X		X				X		6	P2-4580, P4-4500	161, 162	6/3/2014	
Mt. Carmel WTP Filtered Water Pumps	X			X			X							N	X			X					X	X			X			4	N/A	N/A	6/13/2014	3 of 4 ARV's do not work. P4 locked up. Name plate data same on all pumps.
Mt. Carmel WTP Backwash Pump	X			X				N/A						N					X			X			N/A			N/A		1	N/A	N/A	6/3/2014	Ventilation - Pump Outside.
Mt. Carmel WTP Recirculation Pumps 1 & 2		X		X			X							N			X		X			X			N/A			X		2	N/A	N/A	6/3/2014	

Condition Assessment:
Good - Sound, Very Acceptable
Fair - Normal Wear and Tear Apparent
Poor - Needs Work Soon, Problems in Near Future Possible or Probable

6.3.1 Airport Pump Station

The Airport PS serves PP5 and is supplied by the Riverside WTP in PP1. The pump station consists of a 0.5 MG ground storage tank and an enclosed pump station with two Aurora 88-03947-2 pumps. A SCADA controlled valve is utilized to regulate the flow of potable water from PP1 into the 0.5 MG ground storage tank. The total and firm pumping capacity of the pump station are 2.6 MGD and 1.3 MGD, respectively. The Airport PS is utilized to meet demands in PP5 and fill the FM 185 EST.

6.3.2 Gholson Pump Station

The Gholson PS is a booster pump station that serves PP1 and is supplied by the Riverside WTP in PP1. The pump station consists of a 5.0 MG ground storage tank and an enclosed pump station with two PACO 3705401 pumps. A SCADA controlled valve is utilized to regulate the flow of water from PP1 into the 5.0 MG ground storage tank. The total and firm pumping capacity of the pump station are 7.6 MGD and 3.8 MGD, respectively. The Gholson PS is operated as a booster pump station and is utilized to meet demands in PP1, fill the TSTC Tower, and supply the Elm Mott GST and PS as needed.

6.3.3 Hillcrest Pump Station

The Hillcrest PS serves PP2 and is supplied by both WTPs. The pump station consists of a 5.0 MG ground storage tank and an enclosed pump station with three Aurora 90-04624 pumps. Potable water from PP1 is conveyed, through a dedicated 20-inch water line, to the 5.0 MG ground storage tank which acts as elevated storage for PP1. Potable water from PP3 is pumped from the Mt. Carmel WTP to the Hillcrest PS. The Mt. Carmel PS supplies water through a dedicated 36-inch water line directly to the intake of pump 3 at the Hillcrest PS. A PRV drops the pressure form Mt. Carmel before supplying water to the suction side of pump 3 at Hillcrest. Pump 3 is used for 3-4 hours every day to turn over the water in the 36-inch supply line from Mt. Carmel. The total and firm pumping capacity of the pump station are 12.6 MGD and 8.4 MGD, respectively. The Hillcrest PS is utilized to meet demands in PP2 and fill the Park Lane Tower.

6.3.4 Old McGregor Pump Station

The Old McGregor PS serves PP4/PP6 and is supplied by the Mt. Carmel WTP in PP3. The pump station consists of a 5.0 MG ground storage tank and an enclosed pump station with six PACO pumps. A SCADA controlled valve is utilized to regulate the flow of treated water from PP3 into the 5.0 MG ground storage tank. The total and firm pumping capacity of the pump station are 24.9 MGD and 16.5 MGD, respectively.

The Old McGregor PS is fills the Ritchie Road Tower and also meets demands in PP6 through two SCADA controlled PRVs.

6.3.5 Westview Pump Station

The Westview PS serves PP2/PP3 and is supplied by both WTPs. The pump station consists of a 6.0 MG ground storage tank and two separate pump stations with a total of four pumps. The original pump station is enclosed with two AURORA 01-384968 pumps and serves PP3. The second pump station is outside with two Byron Jackson 18 KXH pumps and serves PP2. Water from PP1 is conveyed, through a dedicated 20-inch water line to the 6.0 MG ground storage tank which acts as elevated storage for PP1. Water from PP3 is conveyed by gravity directly from the Mt. Carmel WTP into the 6.0 MG ground storage tank. The total and firm pumping capacities of the PP3 pump station are 11.6 MGD and 5.8 MGD, respectively. The total and firm pumping capacities of the PP2 pump station are 7.4 MGD and 3.7 MGD, respectively. The Westview PS fills the Owens and Schroeder Towers.

6.4 STORAGE FACILITIES

Waco's water system has clear wells at both of the water treatment plants and each of the five additional pump stations. **Table 6-5** provides a summary of the City of Waco's existing ground storage facilities.

Table 6-5: Ground Storage Facilities

Pressure Plane	Name	Capacity (gallons)	High Water Level (ft)
PP1	Riverside WTP	3,500,000	409.2
	Gholson	5,000,000	503.5
	PP1 TOTAL	**8,500,000**	
PP2	Hillcrest	5,000,000	605.00
	PP2 TOTAL	**5,000,000**	
PP3	Mount Carmel	8,000,000	627.1
	Westview	6,000,000	606.0
	PP3 TOTAL	**14,000,000**	
PP4	Old McGregor	5,000,000	697.0
	PP4 TOTAL	**5,000,000**	
PP5	Airport	500,000	523.0
	PP5 TOTAL	**500,000**	
	Total Ground Storage	**33,000,000**	

Table 6-6 provides a summary of the City of Waco's existing elevated storage facilities. It is important to note that the capacities provided in the following tables refer to the total capacity of each storage facility in the pressure plane that it primarily serves. The Hillcrest and Westview GSTs also serve as elevated storage for Pressure Plane 1. The functional capacities of each storage tank for each pressure plane will be addressed in **Section 9.6** regarding the existing and future pumping and storage capacities.

Table 6-6: Elevated Storage Tanks

Pressure Plane	Name	Capacity (gallons)	Bottom of Bowl Elevation (ft)	Overflow Elevation (ft)	Operating Range (ft)	Date Constructed
PP1	TSTC	1,500,000	565.0	605.0	40.0	2000
	PP1 TOTAL	**1,500,000**				
PP2	Park Lake	1,000,000	665.0	710.0	45.00	1986
	PP2 TOTAL	**1,000,000**				
PP3	Owen Lane	1,500,000	730.0	765.0	30.0	1968
	Schroeder	2,000,000	725.0	765.0	40.0	2000
	PP3 TOTAL	**3,500,000**				
PP4	Ritchie	2,000,000	803.0	855.0	52.0	1986
	PP4 TOTAL	**2,000,000**				
PP5	FM 185	1,500,000	642.0	682.0	40.0	2007
	PP5 TOTAL	**1,500,000**				
	Total Elevated Storage	**9,500,000**				

7.0 FIELD TESTING AND MODEL CALIBRATION

7.1 PRESSURE TESTING

Field pressure testing was conducted August 15 – 27, 2013. A total of 23 pressure recorders were installed throughout the distribution system. Minimum, maximum and average pressure was recorded every 5 minutes at each location. Complete data from all recorders was collected from August 19th at 12:00 AM through August 26th at 12:00 AM. The locations of the pressure recorders can be found in **Figure 7-1**.

7.2 WATER MODEL DEVELOPMENT

The project team spent a significant amount of effort on water model development and calibration, as the model is a valuable tool to evaluate system operation and serves as the basis for determining the timing of future improvements. The City of Waco's water model was developed using H2OMap Water software by Innovyze® and consists of all pipes in the distribution system.

7.2.1 Physical Network

The water model was developed using H2OMap Water software by Innovyze®. City staff sent the team the GIS shapefiles of water mains, nodes, storage tanks, and pump stations to import into the model. Once the team received the shapefiles from the City, FNI and TWG evaluated the data to locate connectivity issues. The issues ranged from water lines that crossed in the model but were not connected to water lines that were not snapped together at endpoints. The project team worked with the City to address the issues before importing the data into the modeling software. The model contains 26,283 links with diameters ranging in size from 1-inch to 42-inch. Links were added to connect ground and elevated storage tanks to the distribution system along with piping at pump stations and water treatment plants.

All pumping, storage and valve facilities were manually added to the model based on as-built drawings and information provided by the City. There are over 24,450 model nodes, 29 pumps, 19 valves, and 19 tanks (including treatment plant clearwells) in the existing system model. Model nodes in the distribution system were assigned an elevation based on the 10-foot ground contour data provided by the City. Elevations for facilities (tanks, pumps, and valves) were assigned using as-built drawings and information from City staff.

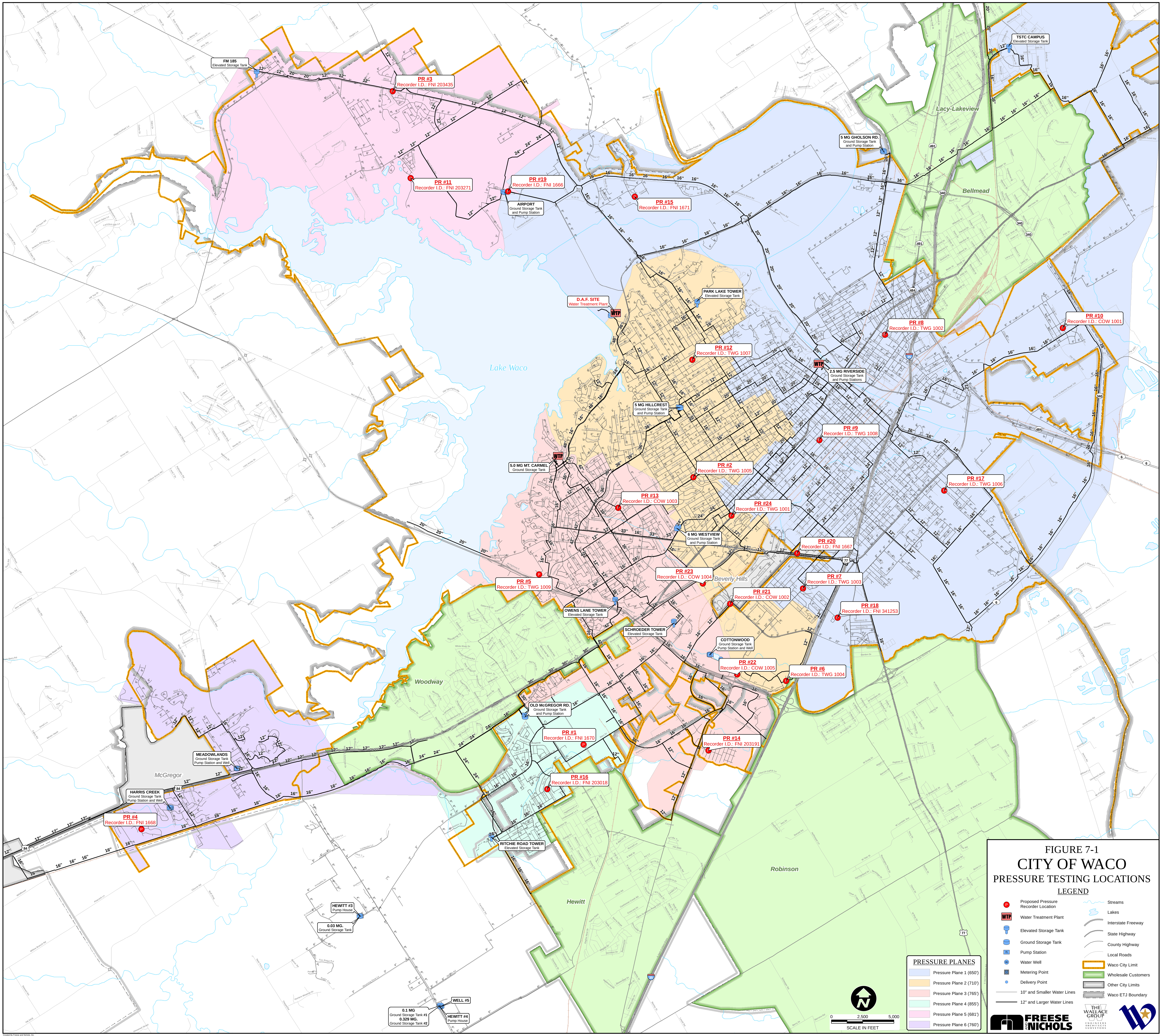


FIGURE 7-1
CITY OF WACO
PRESSURE TESTING LOCATIONS
LEGEND
Proposed Pressure Recorder Location
Water Treatment Plant
Elevated Storage Tank
Ground Storage Tank
Pump Station
Water Well
Metering Point
Delivery Point
10" and Smaller Water Lines
12" and Larger Water Lines
Streams
Lakes
Interstate Freeway
State Highway
County Highway
Local Roads
Waco City Limit
Wholesale Customers
Other City Limits
Waco ETJ Boundary
PRESSURE PLANES
Pressure Plane 1 (650')
Pressure Plane 2 (710')
Pressure Plane 3 (765')
Pressure Plane 4 (855')
Pressure Plane 5 (681')
Pressure Plane 6 (760')
0 2,500 5,000
SCALE IN FEET
FREESE AND NICHOLS
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
PR #1 Recorder I.D.: FNI 1670
PR #2 Recorder I.D.: TWG 1005
PR #3 Recorder I.D.: FNI 203435
PR #4 Recorder I.D.: FNI 1668
PR #5 Recorder I.D.: TWG 1009
PR #6 Recorder I.D.: TWG 1004
PR #7 Recorder I.D.: TWG 1003
PR #8 Recorder I.D.: TWG 1002
PR #9 Recorder I.D.: TWG 1008
PR #10 Recorder I.D.: COW 1001
PR #11 Recorder I.D.: FNI 203271
PR #12 Recorder I.D.: TWG 1007
PR #13 Recorder I.D.: COW 1003
PR #14 Recorder I.D.: FNI 203191
PR #15 Recorder I.D.: FNI 1671
PR #16 Recorder I.D.: FNI 203018
PR #17 Recorder I.D.: TWG 1006
PR #18 Recorder I.D.: FNI 341253
PR #19 Recorder I.D.: FNI 1666
PR #20 Recorder I.D.: FNI 1667
PR #21 Recorder I.D.: COW 1002
PR #22 Recorder I.D.: COW 1005
PR #23 Recorder I.D.: COW 1004
PR #24 Recorder I.D.: TWG 1001
FM 185 Elevated Storage Tank
AIRPORT Ground Storage Tank and Pump Station
TSTC CAMPUS Elevated Storage Tank
5 MG GHOLSON RD. Ground Storage Tank and Pump Station
D.A.F. SITE Water Treatment Plant
PARK LAKE TOWER Elevated Storage Tank
2.5 MG RIVERSIDE Ground Storage Tank and Pump Stations
5 MG HILLCREST Ground Storage Tank and Pump Station
5.0 MG MT. CARMEL Ground Storage Tank
6 MG WESTVIEW Ground Storage Tank and Pump Station
OWENS LANE TOWER Elevated Storage Tank
SCHROEDER TOWER Elevated Storage Tank
COTTONWOOD Ground Storage Tank Pump Station and Well
OLD McGREGOR RD. Ground Storage Tank and Pump Station
MEADOWLANDS Ground Storage Tank Pump Station and Well
HARRIS CREEK Ground Storage Tank Pump Station and Well
RITCHIE ROAD TOWER Elevated Storage Tank
HEWITT #3 Pump House
0.03 MG. Ground Storage Tank
WELL #5
0.1 MG Ground Storage Tank #1 0.329 MG. Ground Storage Tank #2
HEWITT #4 Pump House
Lake Waco
Lacy-Lakeview
Bellmead
Beverly Hills
Woodway
McGregor
Hewitt
Robinson

7.2.2 Facility and Additional Pipeline Data

Multiple point pump curves from various sources including the previous water model and pump manufacturer data were used to build the model. Tank curves can be entered in the model, which determine the volume versus height relationship of the tank. Initial Hazen-Williams roughness coefficients for pipes were assigned based on the installation year and pipe material, as listed in **Table 7-1**. The project team used an updated pressure plane shapefile to establish closed links, which separate the pressure plane boundaries.

Table 7-1: Initial Hazen-Williams Pipe Roughness Coefficients

Pipe Material	Before 1960	1960-1969	1970-1979	1980-1989	1990-2013	No Year
Concrete	100	110	120	125	130	100
Cast Iron	90	100	110	115	120	100
Copper	100	110	120	125	130	100
Ductile Iron	100	110	120	125	130	100
Unknown Material	100	110	120	125	130	100
PVC	110	120	130	135	140	110
Steel	--	--	--	--	130	100

7.2.3 Demand Allocation

As part of the population and water demand projections in **Section 3.0**, the team geocoded the water billing meter data. This spatial data served as the basis for the water demand allocation. The water demand was determined by averaging the water usage for each billing meter over the three months of the year with the highest demand. This period represents the peak water demand and serves as the basis for sizing future capital improvements. The water demands were divided into three categories: residential, non-residential and wholesale usage. The information from the geocoded billing meter database was spatially joined to the exported model nodes. Once demands were allocated to the model nodes, they were scaled to match the demands of the selected calibration day.

7.3 EXTENDED PERIOD SIMULATION (EPS) MODEL CALIBRATION

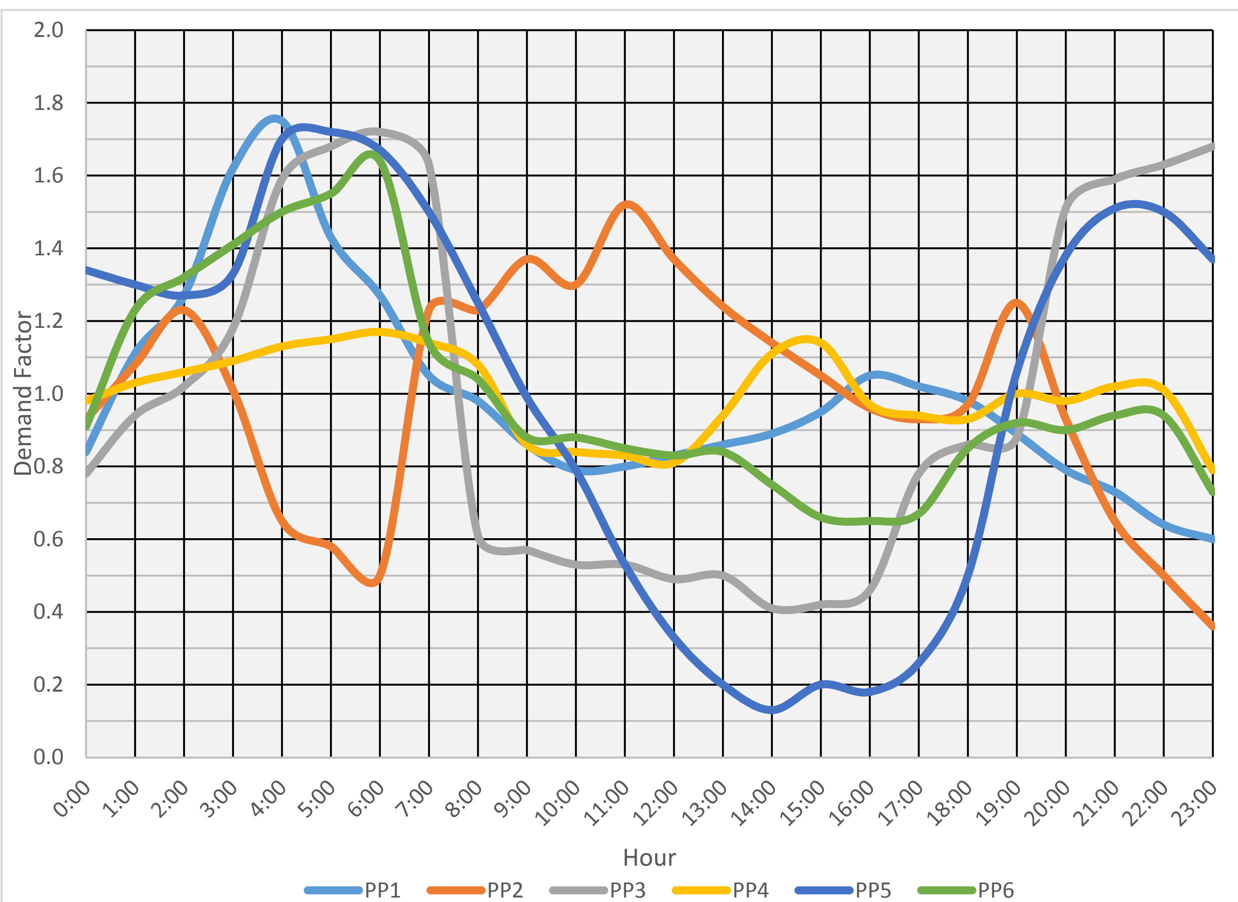
In order to verify that the hydraulic model accurately represents actual distribution system operation, a model calibration analysis was performed. The calibration process involves adjusting system operation, roughness coefficients, demand allocation and diurnal curves to match a known condition. The 24-hour period occurring from 12:00 am on August 20th to 12:00 am on August 21th was selected for calibration.

This day was selected because demands were relatively high, and there was a good correlation of data between the pressure recorders and the SCADA. This section provides a summary of the calibration process, the adjustments made during the calibration and the modeled results versus the SCADA recorded values.

7.3.1 Calibration Process

The City provided SCADA data in 30-minute intervals during the pressure testing period. The SCADA reports included treatment plant output and pressure, ground and elevated storage tank levels, transfer valve status and on/off status for system pumps. Flow and tank level data was utilized to calculate an overall diurnal curve by examining water going into (supply) and out of (demand) the distribution system. The calculated total system demand for August 20th was 38.1 MGD with a peak of 62.75 MGD. **Figure 7-2** shows the calculated system diurnal curves by pressure plane for August 20, 2013.

Figure 7-2: System Diurnal Curves by Pressure Plane, August 20, 2013



The calculated diurnal curve suggests high usage in the early morning hours which is likely related to irrigation. Diurnal factors for the 24-hour period varied between each pressure plane.

- PP1: 0.60 to 1.75
- PP2: 0.36 to 1.52
- PP3: 0.41 to 1.72
- PP4: 0.79 to 1.17
- PP5: 0.13 to 1.72
- PP6: 0.65 to 1.64

7.3.2 Calibration Controls and Adjustments

During the EPS calibration, adjustments were made to the model in order to match the known conditions of August 20, 2013. The operational controls were based on the time of day changes reflected in the SCADA data. Timing controls were used on the pumps and valves in the calibration to match a known condition and match the SCADA data. Moving beyond model calibration, the model controls were based on parameters such as pressures or tank levels, unless a certain item had a regularly specified time control. The 30-minute SCADA values are an instantaneous reading at a given time and do not account for changes in between data points; therefore, adjustments to the settings at the pumps and valves were necessary to account for fluctuations between calibration points.

7.3.3 Pump Controls

The pump on/off status provided by the City for each pump in the system provided a starting point for calibration. Pump on/off levels were modified at pump stations where the model did not replicate actual system operations. Pumps were not tested at the time of calibration, and original manufacturer's curves were used in the model.

7.3.4 Pump Adjustments

Observed flows at the Westview PS and the Riverside WTP were lower than modeled flows using the original manufacturer's pump curves. Pump curves for these pumps were adjusted to decrease the discharge flow and achieve a better correlation to the observed flows.

7.3.5 Valve Controls

The City of Waco currently operates 11 pressure reducing valves shown in **Figure 7-3**. The valves were modeled as pressure reducing valves. The majority of these valves are on the pressure plane boundary between PP3 and PP2, allowing water to drop down from PP3 to supply PP2. The area in PP2 south of Franklin Ave. is primarily served by water through these PRVs. The PRV setting for each valve on **Figure 7-3** is detailed in **Table 7-2**.

Table 7-2: PRV Locations and Settings

PRV #	Location	High Plane Reading (PSI)	Low Plane Reading (PSI)
734452	Proctor and 32nd St.	75	30
811503	Zackary and Cobbs Dr.	96	62
801110	2601 Wooded Acres Dr.	90	88
953088	Sanger and New Rd.	75	40
1044065	Westview and Station St.	90	60
1044066	U.S. 84 and Villa Dr.	96	63
1043075	4920 Franklin Ave.	88	60
1171047	5200 Beverly Dr.	84	68
1262031	5600 Bagby Ave.	88	56
1441010	U.S. 84 and Wickson Rd.	118	75
1141018	Wickson Rd. and Old McGregor Rd.	92	60

A flow control valve was added to the model on the boundary of PP1 and PP2 to simulate a partially open valve that the City turns during peak demand periods. A setting of 60 psi was used to match system conditions.

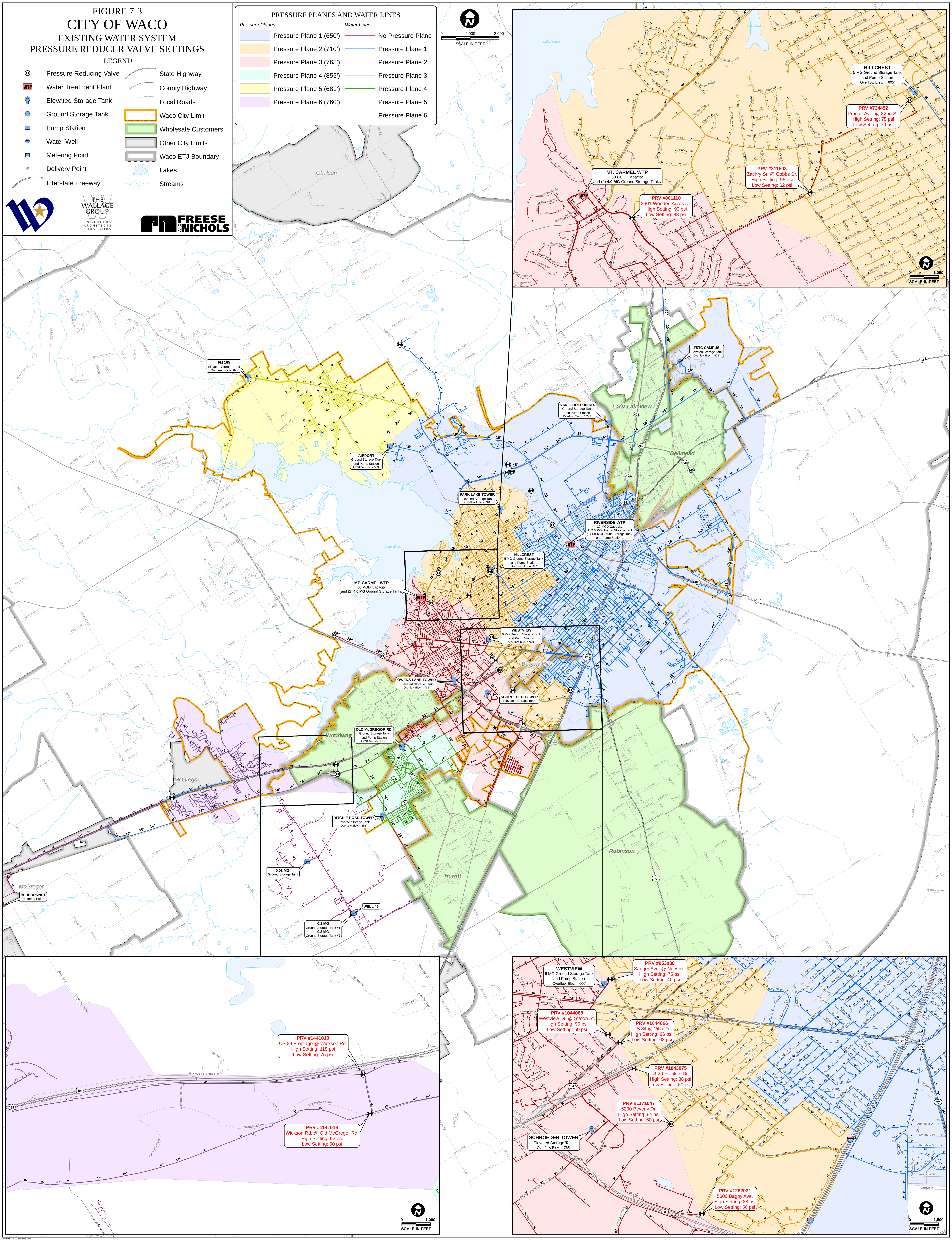


FIGURE 7-3
CITY OF WACO
EXISTING WATER SYSTEM
PRESSURE REDUCER VALVE SETTINGS
LEGEND
Pressure Reducing Valve
Water Treatment Plant
Elevated Storage Tank
Ground Storage Tank
Pump Station
Water Well
Metering Point
Delivery Point
Interstate Freeway
State Highway
County Highway
Local Roads
Waco City Limit
Wholesale Customers
Other City Limits
Waco ETJ Boundary
Lakes
Streams
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
PRESSURE PLANES AND WATER LINES
Pressure Planes
Pressure Plane 1 (650')
Pressure Plane 2 (710')
Pressure Plane 3 (765')
Pressure Plane 4 (855')
Pressure Plane 5 (681')
Pressure Plane 6 (760')
Water Lines
No Pressure Plane
Pressure Plane 1
Pressure Plane 2
Pressure Plane 3
Pressure Plane 4
Pressure Plane 5
Pressure Plane 6
SCALE IN FEET
Gholson
HILLCREST
5 MG Ground Storage Tank and Pump Station
Overflow Elev. = 605'
PRV #734452
Proctor Ave. @ 32nd St.
High Setting: 75 psi
Low Setting: 30 psi
PRV #811503
Zachry St. @ Cobbs Dr.
High Setting: 96 psi
Low Setting: 62 psi
MT. CARMEL WTP
60 MGD Capacity
and (2) 4.0 MG Ground Storage Tanks
PRV #801110
2601 Wooded Acres Dr.
High Setting: 90 psi
Low Setting: 88 psi
FM 185
Elevated Storage Tank
Overflow Elev. = 682'
AIRPORT
Ground Storage Tank and Pump Station
Overflow Elev. = 523'
5 MG GHOLSON RD.
Ground Storage Tank and Pump Station
Overflow Elev. = 553.5'
TSTC CAMPUS
Elevated Storage Tank
Overflow Elev. = 805'
Lacy-Lakeview
Bellmead
PARK LAKE TOWER
Elevated Storage Tank
Overflow Elev. = 710'
RIVERSIDE WTP
30 MGD Capacity
(1) 2.5 MG Ground Storage Tank
(1) 1.0 MG Ground Storage Tank
and Pump Stations
Lake Waco
WESTVIEW
6 MG Ground Storage Tank and Pump Station
Overflow Elev. = 606'
Beverly Hills
OWENS LANE TOWER
Elevated Storage Tank
Overflow Elev. = 765'
SCHROEDER TOWER
Elevated Storage Tank
OLD MCGREGOR RD.
Ground Storage Tank and Pump Station
Overflow Elev. = 697'
Woodway
McGregor
RITCHIE ROAD TOWER
Elevated Storage Tank
Overflow Elev. = 855'
0.03 MG.
Ground Storage Tank
WELL #5
0.1 MG
Ground Storage Tank #1
0.3 MG
Ground Storage Tank #2
Hewitt
Robinson
BLUEBONNET
Metering Point
PRV #1441010
US 84 Frontage @ Wickson Rd.
High Setting: 118 psi
Low Setting: 75 psi
PRV #1141018
Wickson Rd. @ Old McGregor Rd.
High Setting: 92 psi
Low Setting: 60 psi
PRV #953088
Sanger Ave. @ New Rd.
High Setting: 75 psi
Low Setting: 40 psi
PRV #1044065
Westview Dr. @ Staton St.
High Setting: 90 psi
Low Setting: 60 psi
PRV #1044066
US 84 @ Villa Dr.
High Setting: 96 psi
Low Setting: 63 psi
PRV #1043075
4920 Franklin Dr.
High Setting: 88 psi
Low Setting: 60 psi
PRV #1171047
5200 Beverly Dr.
High Setting: 84 psi
Low Setting: 68 psi
SCHROEDER TOWER
Elevated Storage Tank
Overflow Elev. = 765'
PRV #1262031
5600 Bagby Ave.
High Setting: 88 psi
Low Setting: 56 psi

7.3.6 Calibration Results

The results of the EPS calibration are summarized in the graphs and tables included in **Appendix B**. The graphs show modeled flows, pressures and tank levels versus recorded data at pump stations, tanks, and pressure recorder locations. **Figures 7-4** through **7-6** provide an example of the calibration effort for pressure, tank levels, and pumping. Each monitored location, or facility, includes 48 data points (one for each half-hour of the calibration) where the recorded and modeled values were compared.

The model was calibrated such that the storage tanks were within 5 ft of recorded levels 98% of the time, pressures were within 5 psi of City SCADA 89% of the time, and pump station flows were within 5% of recorded values 75% of the time. The results suggest a good correlation between recorded and modeled values, and model is calibrated well within the industry standards and provide confidence in the accuracy of the model.

Figure 7-4: Pressure Calibration

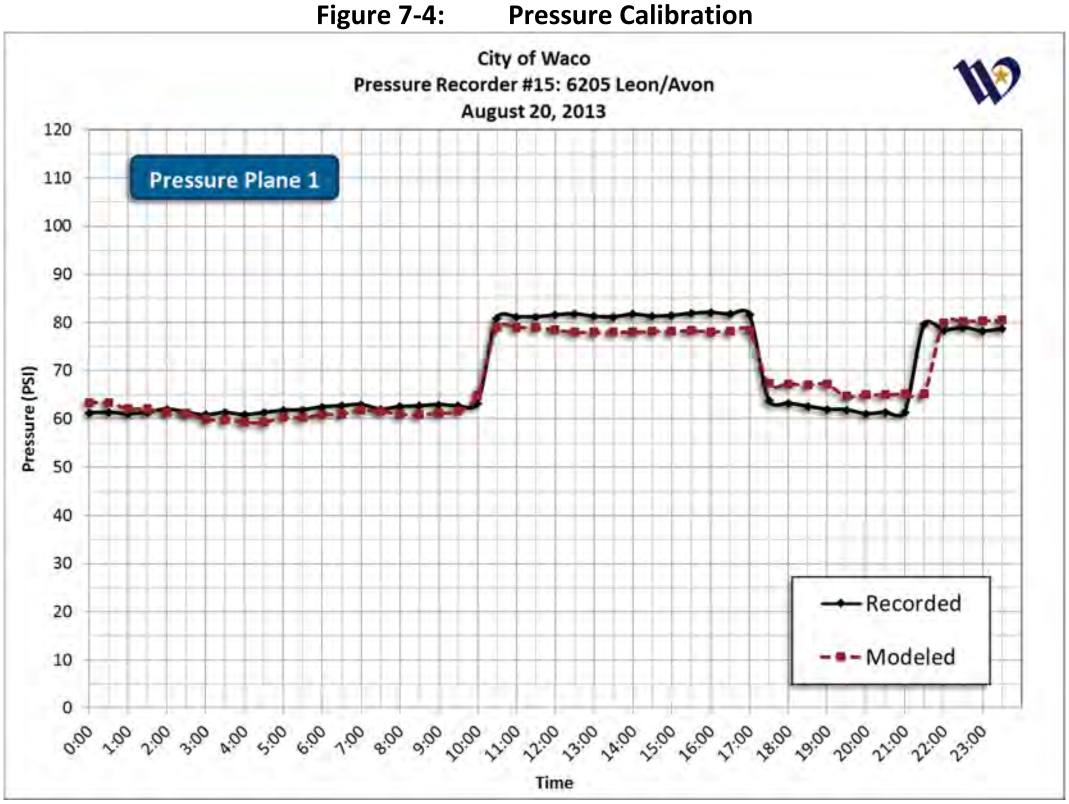


Figure 7-5: Tank Level Calibration

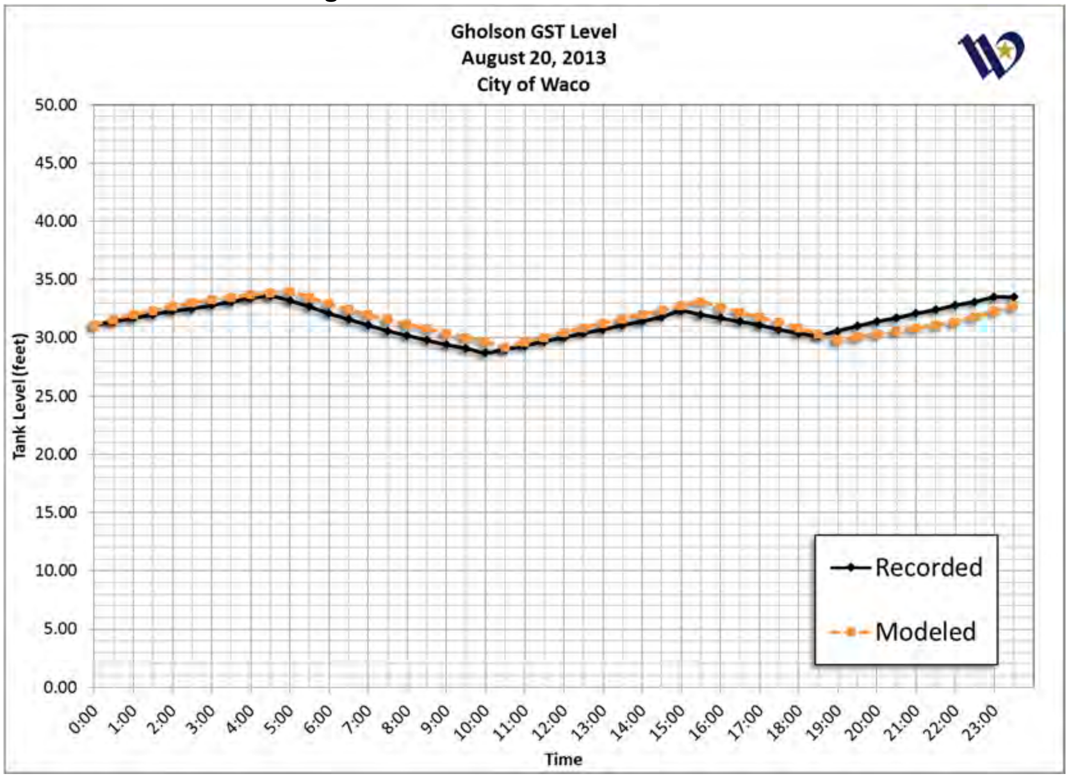
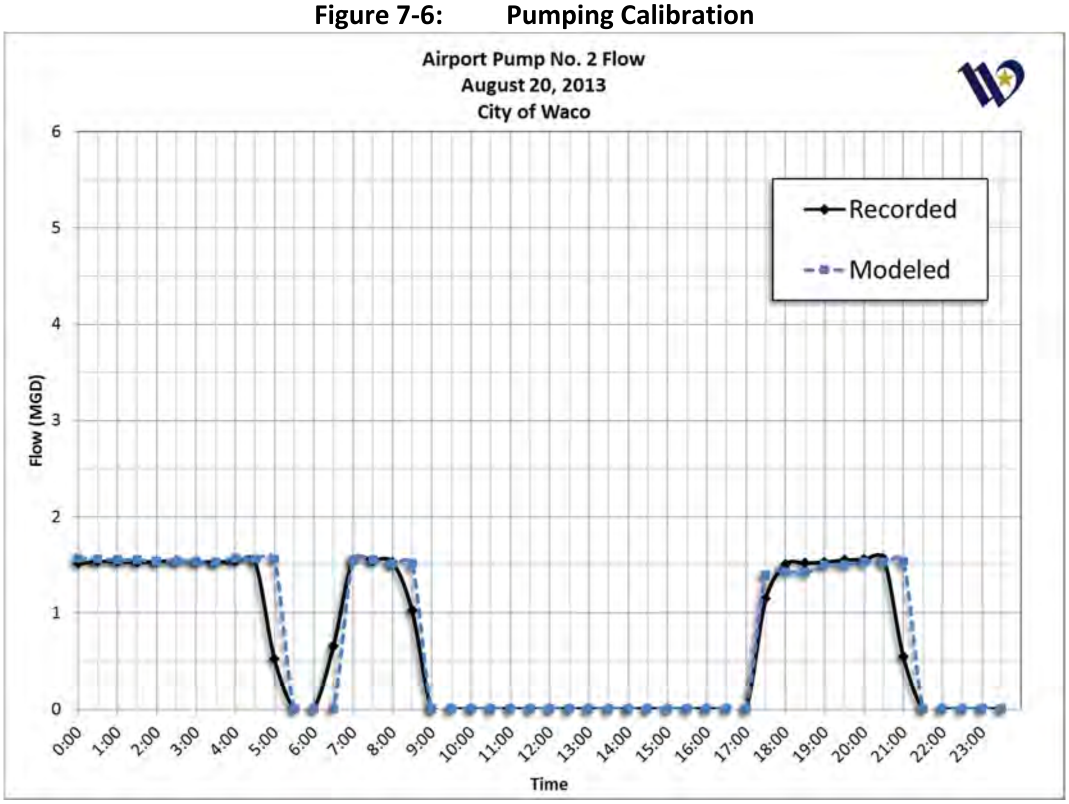


Figure 7-6: Pumping Calibration



8.0 DISTRIBUTION SYSTEM ANALYSIS

As a public water utility, the City of Waco must comply with the rules and regulations for public water systems set forth by the Texas Commission on Environmental Quality (TCEQ) in Chapter 290. Hydraulic analyses were conducted to identify deficiencies in the City of Waco's existing water distribution system and to establish a capital improvements plan to reinforce the existing system and meet projected water demands through 2040. Various combinations of improvements and modifications were investigated to determine the most appropriate approach for meeting projected demands. Considerations used for developing the CIP included evaluating storage and pumping, meeting required fire flows, maintaining proper residual pressures and reducing water age.

8.1 DESIGN CRITERIA

The project team worked with City staff to develop design criteria to identify the existing system deficiencies, which affect the timing and size of capital improvement projects.

8.1.1 Pressure

TCEQ regulations require that under normal operating conditions, a minimum pressure of 35 pounds per square inch (psi) much be maintained at all times. The exception to this rule is under emergency fire flow situations where the pressure is then allowed to drop to 20 psi until the emergency is addressed. FNI/TWG and City staff set a goal for all future system improvements to maintain a minimum pressure of 40 psi, which is more rigorous than the TCEQ minimum standards.

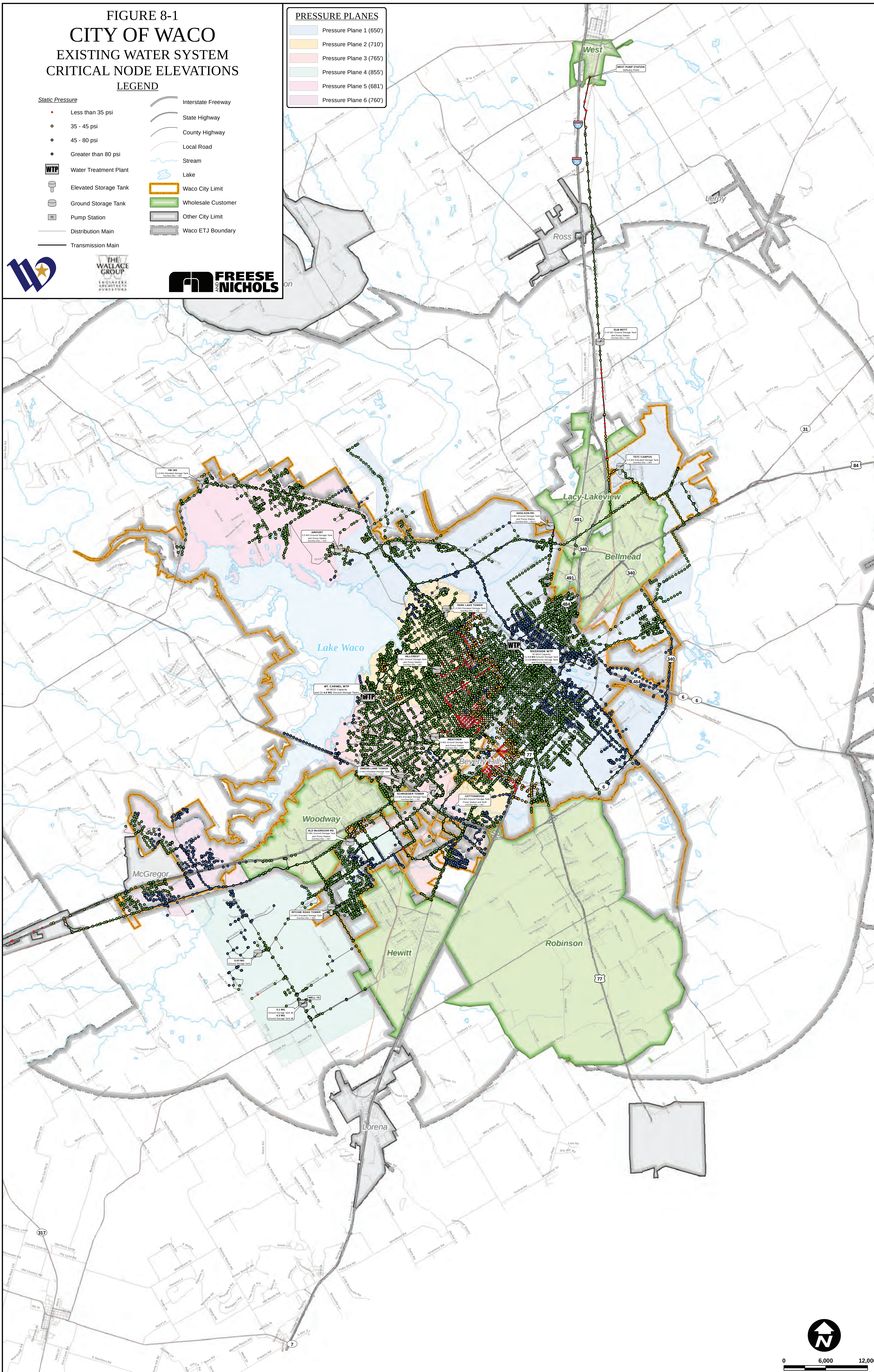
8.1.2 Velocity and Headloss

The design criteria established for this Water Master Plan are that water mains shall be designed for a maximum pipeline velocity of 7 feet/second (ft/s) and a maximum friction loss of 3.5 feet per 1,000 feet (ft/1,000-ft) of pipeline length.

8.2 PRESSURE PLANE DELINEATION

The project team analyzed and evaluated the pressure plane delineation to determine if the existing boundaries allow Waco to provide a consistent level of service across the City. The team utilized the water model nodes to determine areas of critical node elevations. A node is deemed critical when the elevation is such that the desired design criteria for pressure cannot be met based on the operational storage levels in the elevated storage tanks. For example, in PP1 where the overflow elevation is 757 feet, a node having an elevation of 493 feet or greater is critical because when the hydraulic grade line (HGL) reaches the lower limit of the effective storage range, then theoretically that node would violate the desired design criteria.

Figure 8-1 shows the critical node elevations in the City's existing distribution system. Some critical node elevation areas in the PP1 include the area around Beverly Hills. This area is a potential candidate for pressure plane boundary modifications.



Created By Freese and Nichols, Inc.
Job No.: WAL13575
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-1)-Critical_Node_Elevations.mxd
Updated: Friday, October 09, 2015

8.3 EXISTING SYSTEM ANALYSIS

8.3.1 Elevated Storage

The City is required to meet the TCEQ minimum elevated storage capacity requirement of 100 gallons per connection. The amount of elevated storage affects the required TCEQ minimum pumping capacity as discussed further in **Section 8.3.3**. The number of connections per pressure plane from the demand database was used to calculate the TCEQ minimum required storage. A comparison of the City's existing elevated storage by pressure plane to TCEQ requirements is shown in **Table 8-1**.

Table 8-1: TCEQ Elevated Storage Requirements

Pressure Plane	# of Connections	TCEQ Required Storage (MG)	Existing Elevated Storage (MG)
PP1	17,400	1.74	3.0
PP2	14,400	1.44	1.5
PP3	7,200	0.72	3.0
PP4 & PP6*	5,800	0.58	2.0
PP5	2,400	0.24	1.5
Total	**47,200**	**4.72**	**11.0**

**PP6 is served by PP4 through 2 PRVs and therefore meets TCEQ minimum standards*

Based on the regulations, Waco is in compliance with the minimum amount of elevated storage required by the TCEQ. The project team and City staff set a goal that the required elevated storage for each pressure plane be equal to or greater than 40% of peak hour demand for four hours. This elevated storage criteria is more conservative than the TCEQ requirements and would also decrease the amount of pumping capacity required. The amount of storage to meet the design criteria included in **Table 8-2**.

Table 8-2: Design Criteria Elevated Storage Requirements

Pressure Plane	Peak Hour Demand (MGD)	40% Peak Hour for 4 Hours (MG)	Existing Elevated Storage (MG)
PP1	28.7	1.9	3.0
PP2	18.2	1.2	1.5
PP3	18.7	1.2	3.0
PP4 and PP6*	9.5	0.7	2.0
PP5	3.2	0.2	1.5
Total	**78.4**	**5.2**	**11.0**

**PP6 is served by PP4 through 2 PRVs and therefore meets TCEQ minimum standards*

8.3.2 Clearwell Storage

TCEQ regulations state that a public surface water providing utility is required to have at least 5% of their daily treatment plant capacity in a covered clearwell storage facility (TAC §290.45(b)(2)(D)). **Table 8-3** shows the required and available amount of clearwell storage at Waco's treatment plants. Each plant has at least 10% of clearwell storage versus treatment plant capacity, which is double the TCEQ requirement.

Table 8-3: TCEQ Clearwell Storage Requirements

Water Treatment Plant	Treatment Capacity (MGD)	TCEQ Required Storage Capacity (MG)	Clearwell Storage (MG)	% Storage vs. Treatment Capacity
Riverside	24	1.2	3.5	15%
Mount Carmel	66	3.3	8.0	12%
Total	**90**	**4.5**	**11.5**	**13%**

8.3.3 Pumping Capacity Evaluation

In addition to storage requirements, the City is also required to meet the pumping capacity requirements presented in **Table 8-4**. Based on the TCEQ elevated storage requirements, the City utilized the second condition and option A.

Table 8-4: TCEQ Pumping Capacity Requirements

<table>
<tr><th>Condition</th><th>Service Pumping Capacity Requirement*</th></tr>
<tr><td>1. If providing at least 200 gallons per connection of elevated storage</td><td>Two service pumps with a minimum combined capacity of 0.6 gpm per connection at each pressure plane.</td></tr>
<tr><td rowspan="3">2. If providing less than 200 gallons per connection of elevated storage</td><td>The lesser of (a) or (b):</td></tr>
<tr><td>(a) Total pumping capacity of 2.0 gpm per connection</td></tr>
<tr><td>(b) Total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service</td></tr>
</table>

*Capacity requirement from TAC §290.45(b)(2)(F)

Based on the pumping capacity criteria summarized in **Table 8-4**, the existing pumping capacity was evaluated and is summarized by pressure plane in **Table 8-5**.

Table 8-5: TCEQ Pumping Capacity Summary

Pressure Plane	# of Connections	TCEQ Required Pumping Capacity (MGD)	Existing Firm Pumping Capacity (MGD)
PP1	17,400	15.03	40.1
PP2	14,400	12.44	19.8
PP3	7,200	6.22	38.5
PP4 and PP6*	5,800	5.01	20.8
PP5	2,400	2.07	2.5
Total			**121.7**

**PP6 is served by PP4 through 2 PRVs and therefore meets TCEQ minimum standards*

Based on the regulations, Waco is in compliance with the minimum amount of pumping capacity required by the TCEQ. FNI/TWG and City staff set a goal that the pumping capacity requirement for each pressure plane be equal to or greater than 60% of peak hour demand. This pumping capacity criteria is more conservative than the TCEQ requirements and would provide the City with increased reliability. The amount of pumping capacity per pressure plane to meet the design criteria is included in **Table 8-6**.

Table 8-6: Design Criteria Pumping Capacity Summary

Pressure Plane	Peak Hour Demand (MGD)	60% Peak Hour Demand (MGD)	Existing Firm Pumping Capacity (MGD)
PP1	32.1	19.3	40.1
PP2	18.2	10.9	19.8
PP3	22.7	13.6	38.5
PP4 and PP6*	16.0	9.6	20.8
PP5	3.2	1.9	2.5
Total	**92.3**	**55.4**	**121.7**

**PP6 is served by PP4 through 2 PRVs and therefore meets TCEQ minimum standards*

8.3.4 Hydraulic Analysis

The water distribution system was analyzed for three operating conditions: winter day demands, average day demands, and maximum day demands. A 24-hour extended period simulation (EPS) was performed for each operating scenario. By examining the water 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 pumping facilities are adequate to meet the required demand at an acceptable pressure.

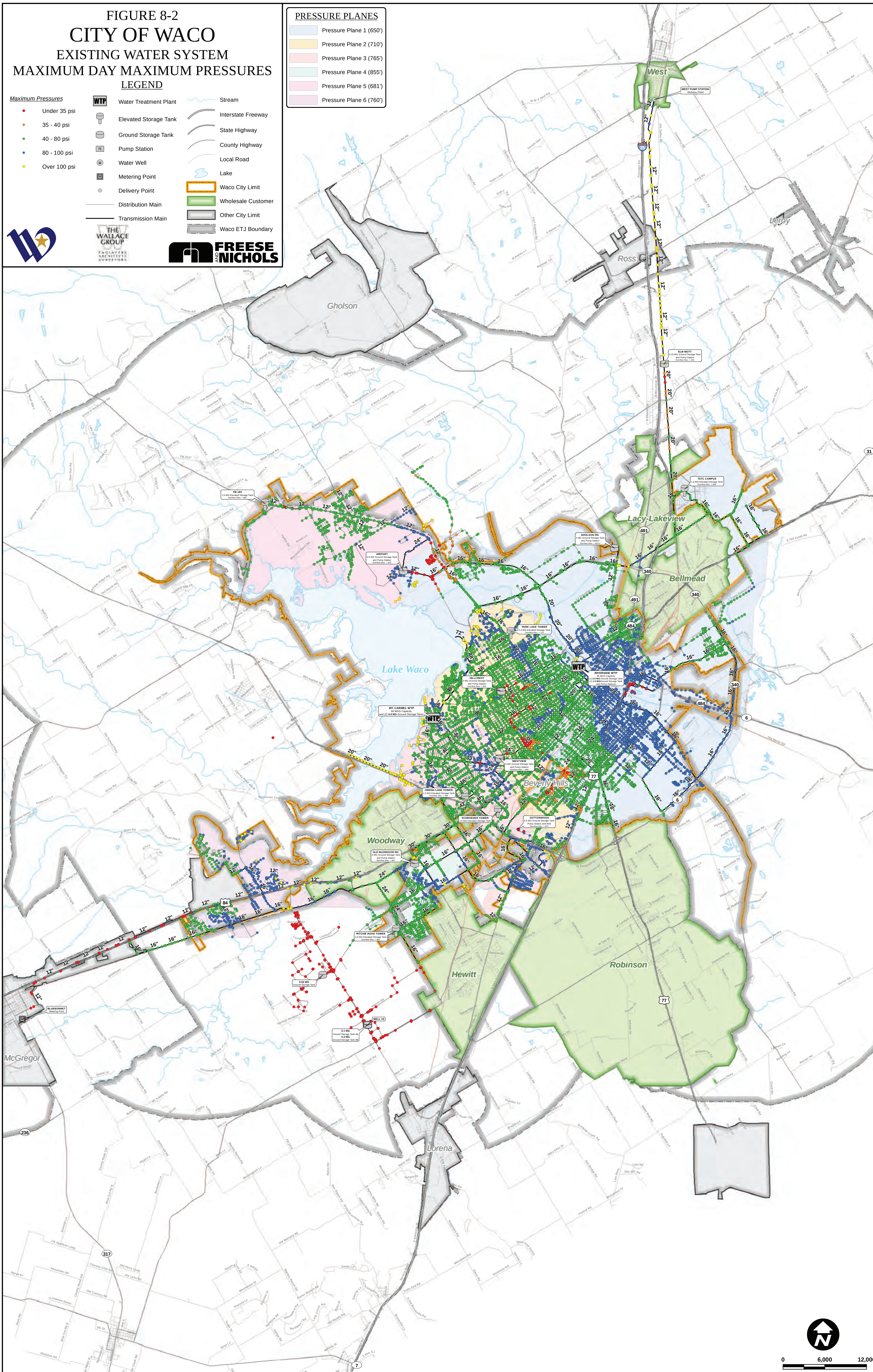
Color-coded pressure maps were prepared to illustrate the residual pressure calculated at model junctions. The maps helped identify potential problem areas in the system and were used as a tool to ensure that reasonable pressure ranges were maintained throughout the system. The maps showing the maximum and minimum pressures under maximum day demands can be found in **Figures 8-2** and **8-3**. 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.

In addition to documenting minimum and maximum pressures under maximum day demands, the project team evaluated the existing system pipes based on the design velocity and headloss criteria. This was done to determine which areas are stressed when demands are higher. The major water mains from the Mt. Carmel and Riverside WTPs had high headloss gradients. The water mains which violated the selected design criteria were scattered throughout the City. Mapping was created to highlight the areas which violate the design velocity and headloss criteria and can be found in the maximum day model results in **Figures 8-4 and 8-5**.

FIGURE 8-2

CITY OF WACO

EXISTING WATER SYSTEM
MAXIMUM DAY MAXIMUM PRESSURES



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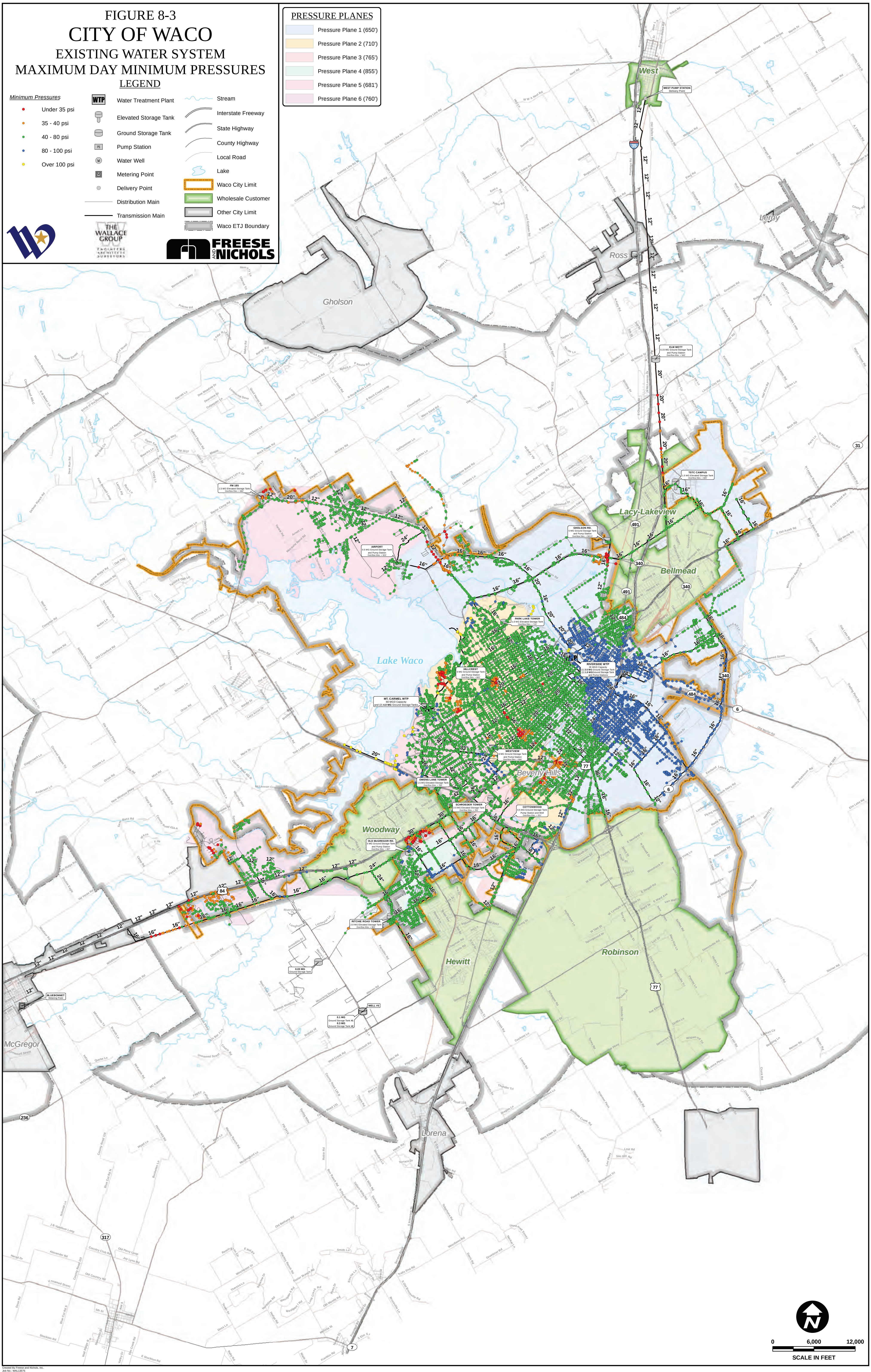
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-2)-Existing_Max_Day_Max_Pressure.mxd
Updated: Friday, October 09, 2015

FIGURE 8-3

CITY OF WACO

EXISTING WATER SYSTEM
MAXIMUM DAY MINIMUM PRESSURES



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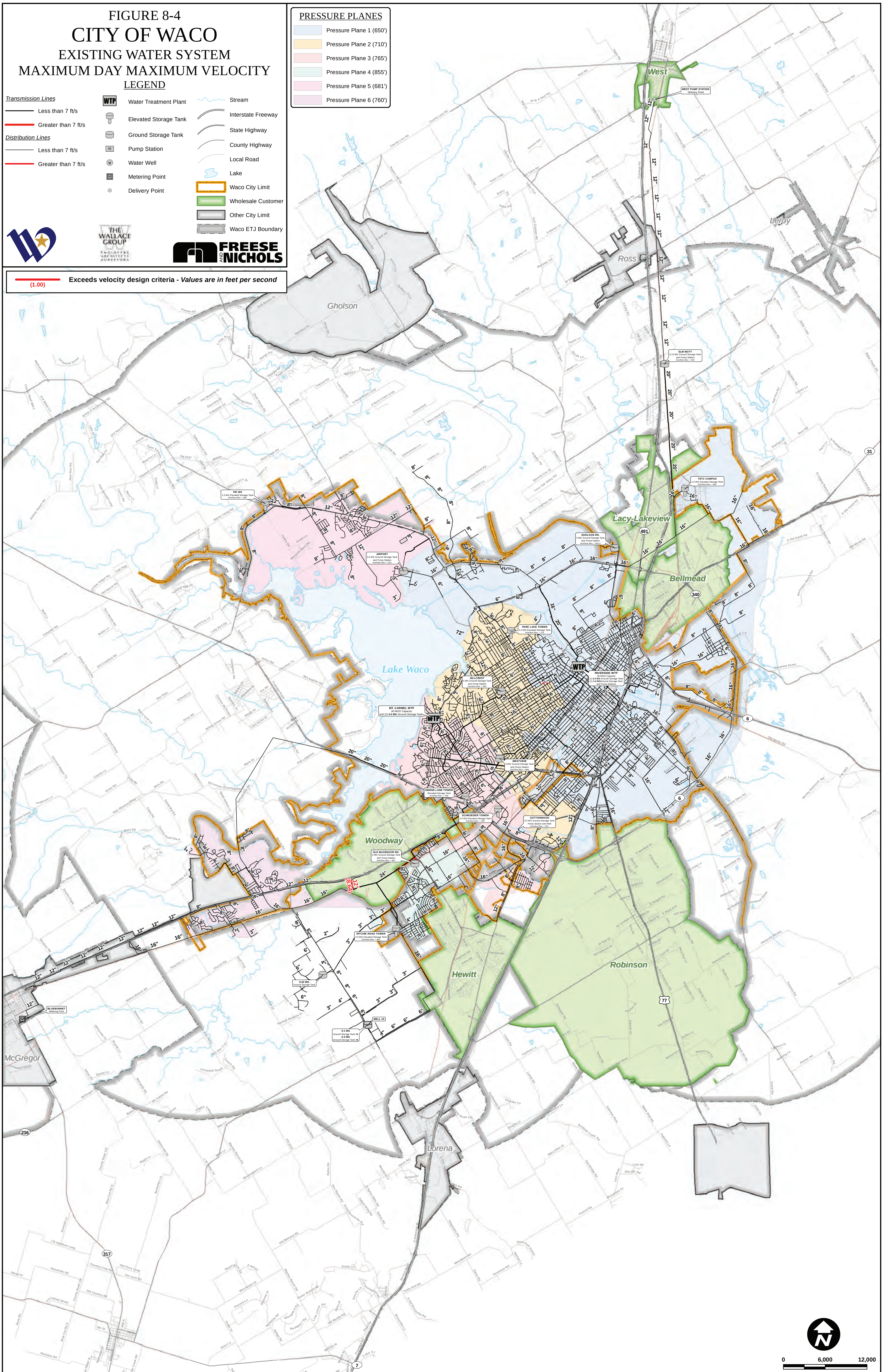
Updated: Friday, October 09, 2015



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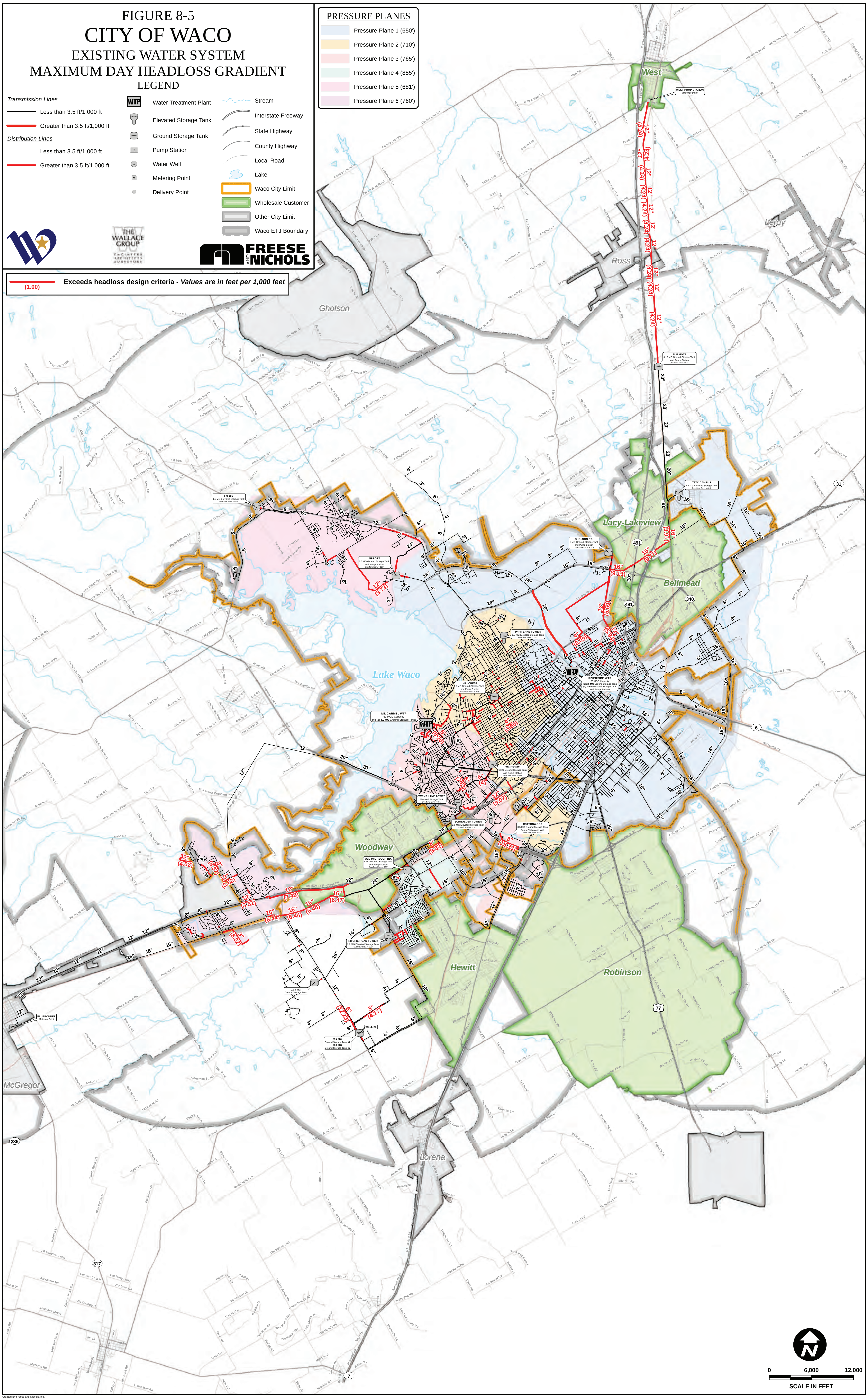

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Job No.: WAL13575
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-5)-Existing_Max_Day_Max_Headloss.mxd
Updated: Friday, October 09, 2015

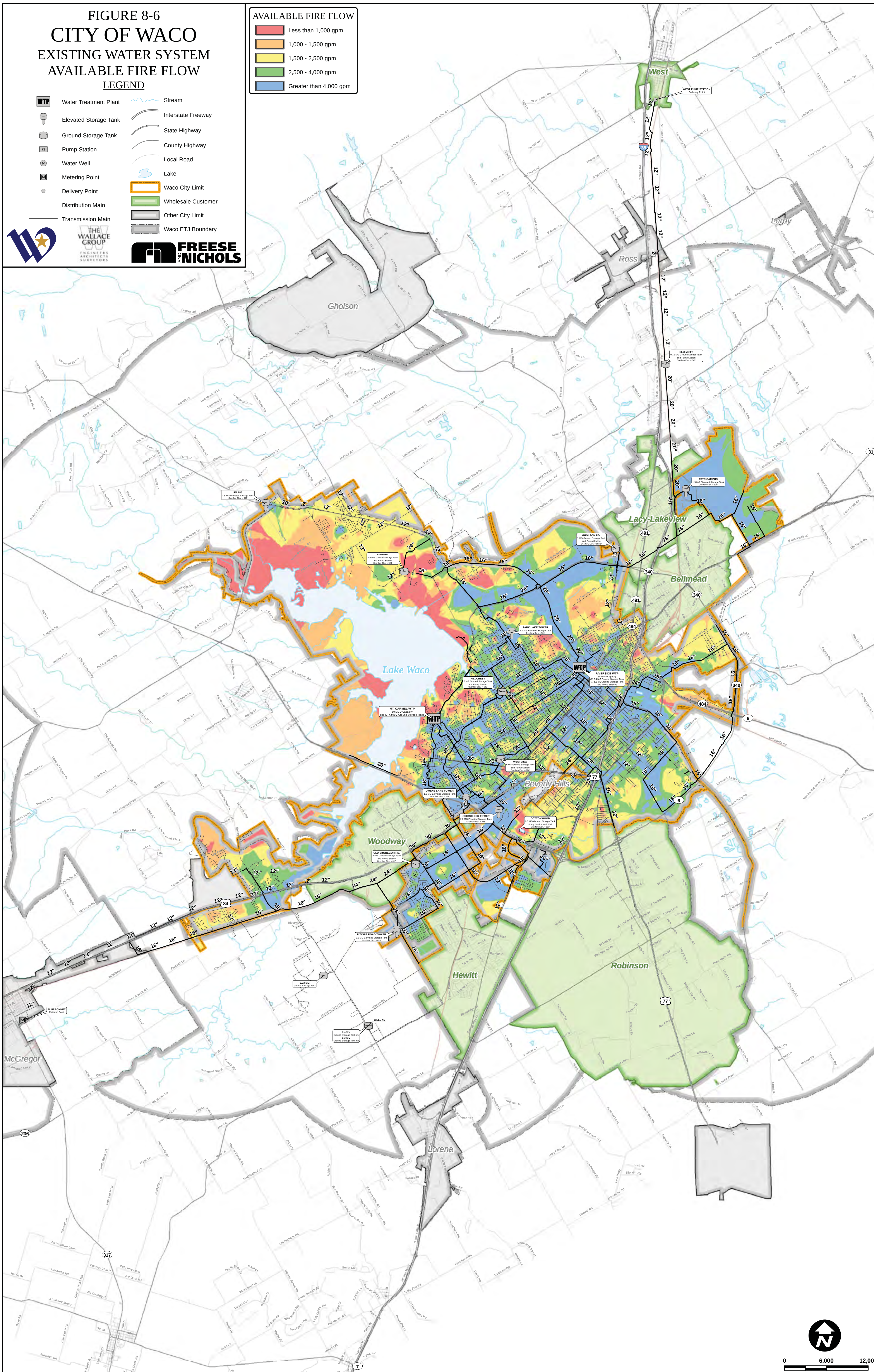
8.3.5 Fire Flow Analysis

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 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 are in PP5 and PP1. Areas with small mains in the model (less than 6-inches) and dead end mains also showed to have low available fire flows. The majority of the City has an available fire flow greater than 1,500 gpm. The fire flow results for existing system conditions are shown in **Figure 8-6**.

8.3.6 Water Age Analysis

Water age modeling was conducted under maximum day demand conditions to determine if water age is a contributor to poor water quality. 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 analysis calculates the age within Waco's system as a hydraulic calculation based on how usage affects the rate of flow over time throughout the system.

A 21-day simulation was performed under average day and maximum day demand conditions to ensure a consistent pattern of water age had been established in the model. The water age map for existing system conditions can be found in **Figure 8-7**. When both plants are operating, an area near the FM 185 EST shows to have an age of over one week. This area is located near the northwest edge of PP5, which may account for limited circulation in the area. Other areas that experience high water ages are at the end of dead end water lines where the demand is small. If the water in a dead end line is not used by the system, then the water age will continue to increase into perpetuity.



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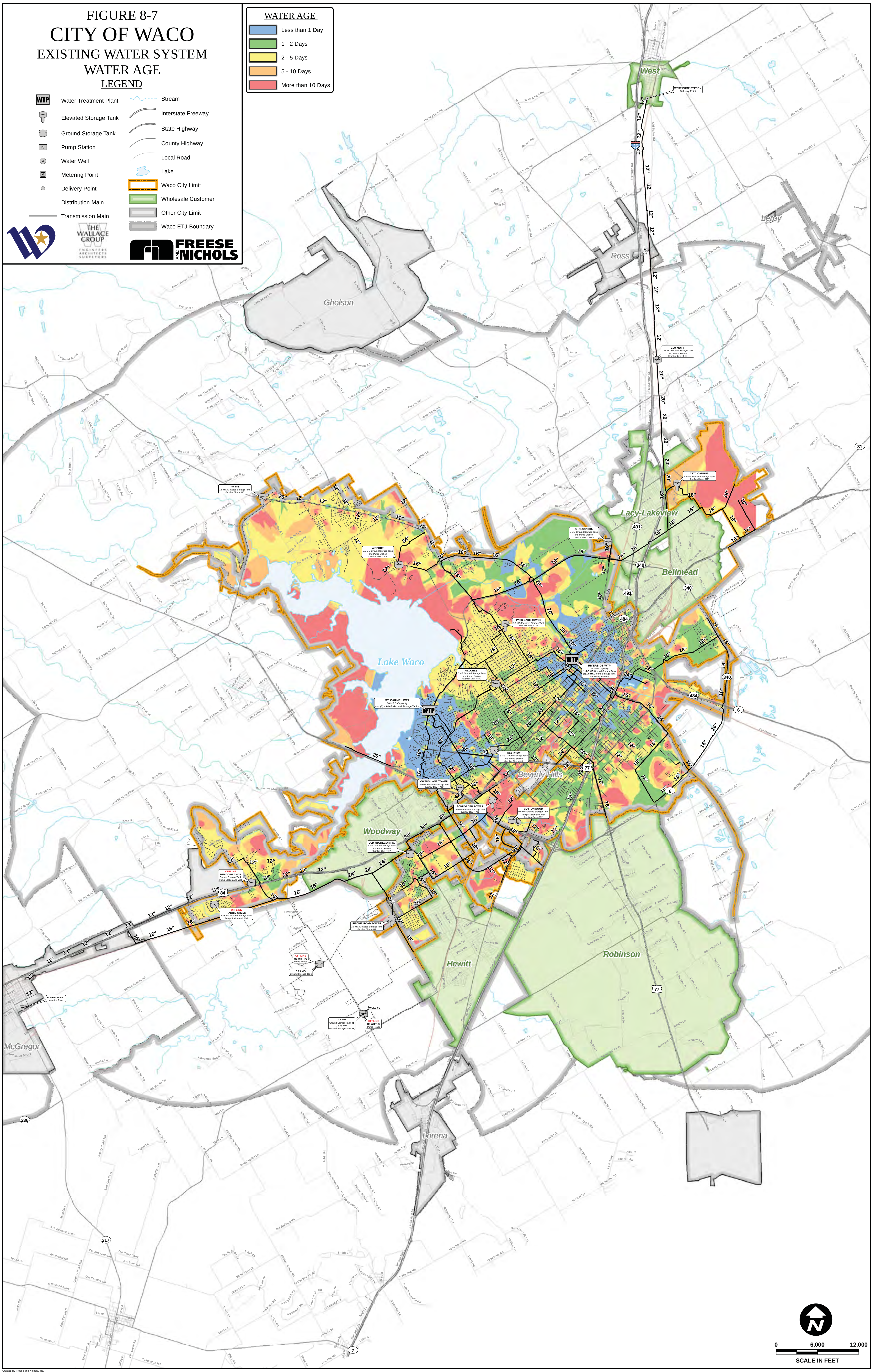
Updated: Friday, October 09, 2015



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Job No.: WAL13575
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-7)-Existing_Water_Age.mxd
Updated: Friday, October 09, 2015

8.4 FUTURE SYSTEM ANALYSIS

8.4.1 Elevated Storage

The City is required to meet the TCEQ minimum elevated storage capacity requirements to serve growth in the 2020, 2030 and 2040 planning periods. The amount of elevated storage affects the required TCEQ minimum pumping capacity as discussed further in **Section 8.4.3**. **Table 8-7** summarizes the amount of elevated storage required for each planning period to meet the City's criteria. The elevated storage requirements for each pressure plane by planning period can be found in **Appendix C**.

Table 8-7: Future Elevated Storage Requirements

Pressure Plane	Existing Storage (MG)	Required 2020 Storage (MG)	Required 2030 Storage (MG)	Required 2040 Storage (MG)
PP1	3.0	1.69	1.85	2.01
PP2	1.5	1.74	1.85	1.96
PP3	3.0	1.35	1.48	1.58
PP4	2.0	0.28	0.35	0.41
PP5	1.5	0.28	0.46	0.52
PP6	0.0	0.47	0.53	0.66
PP7	0.0	0.01	0.01	0.08
Total	**11.0**	**5.8**	**6.5**	**7.2**

8.4.2 Clearwell Storage

Based on the future system analysis, the existing water treatment plants have adequate capacity to meet the 2040 demand projections. **Table 8-8** shows the required and available amount of clearwell storage at Waco's treatment plants with the future uprated capacity. Each plant has at least 10% of clearwell storage versus treatment plant capacity, which is double the TCEQ requirement.

Table 8-8: TCEQ Clearwell Storage Requirements

Water Treatment Plant	Treatment Capacity (MGD)	TCEQ Required Storage Capacity (MG)	Clearwell Storage (MG)	% Storage vs. Treatment Capacity
Riverside	24	1.2	3.5	15%
Mount Carmel	66	3.3	8.0	12%
Total	**90**	**4.5**	**11.5**	**13%**

8.4.3 Pumping Capacity Evaluation

Similar to the existing system analysis, the team and City staff set a goal that the future pumping capacity requirement for each pressure plane be equal to or greater than 60% of peak hour demand. The amount of storage to meet the City's requirement is included in **Table 8-9**. The pumping capacity requirements for each pressure plane by planning period can be found in **Appendix C**.

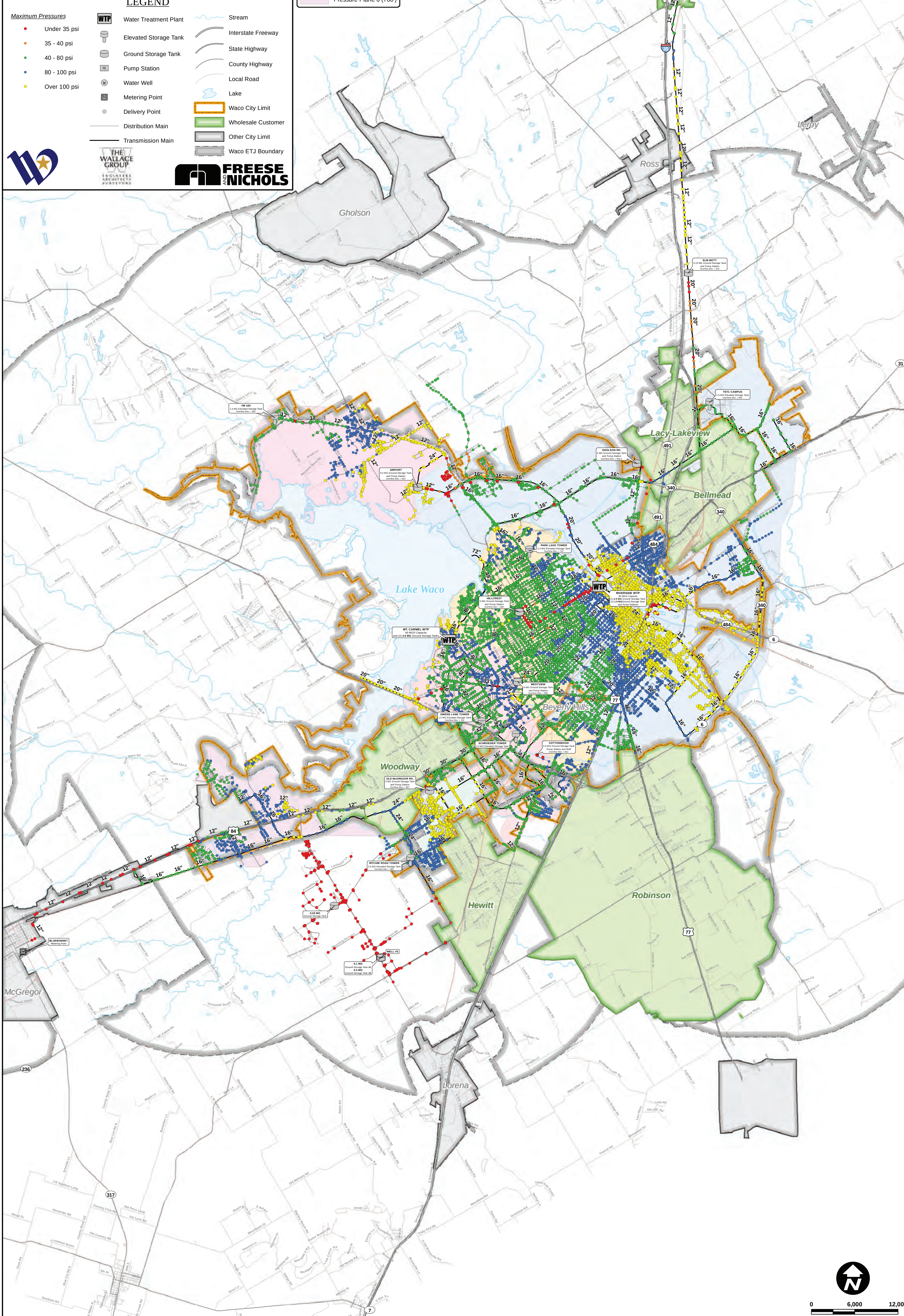
Table 8-9: Future Pumping Capacity Requirements

Pressure Plane	Existing Pumping Capacity (MGD)	Required 2020 Pumping Capacity (MGD)	Required 2030 Pumping Capacity (MGD)	Required 2040 Pumping Capacity (MGD)
PP1	37.7	17.5	19.0	20.8
PP2	39.1	16.5	17.6	18.7
PP3	30.2	15.0	16.7	18.4
PP4	16.6	5.9	6.8	7.8
PP5	5.0	2.5	4.1	4.7
PP6	8.3	5.5	6.2	7.4
PP7	0.0	0.1	0.1	0.7
Total	**55.4**	**63.0**	**70.5**	**78.4**

8.4.4 Buildout Hydraulic Analysis

The same set of hydraulic analyses from the existing system were simulated under buildout conditions to determine if additional problems arise due to existing limitations with the current infrastructure. **Figures 8-8** through **8-11** contains mapping showing the results of the maximum/minimum pressures, velocity and headloss analyses under buildout demands without improvements.

FIGURE 8-8
CITY OF WACO
EXISTING WATER SYSTEM WITH BUILDOUT DEMAND (MAXIMUM PRESSURE)



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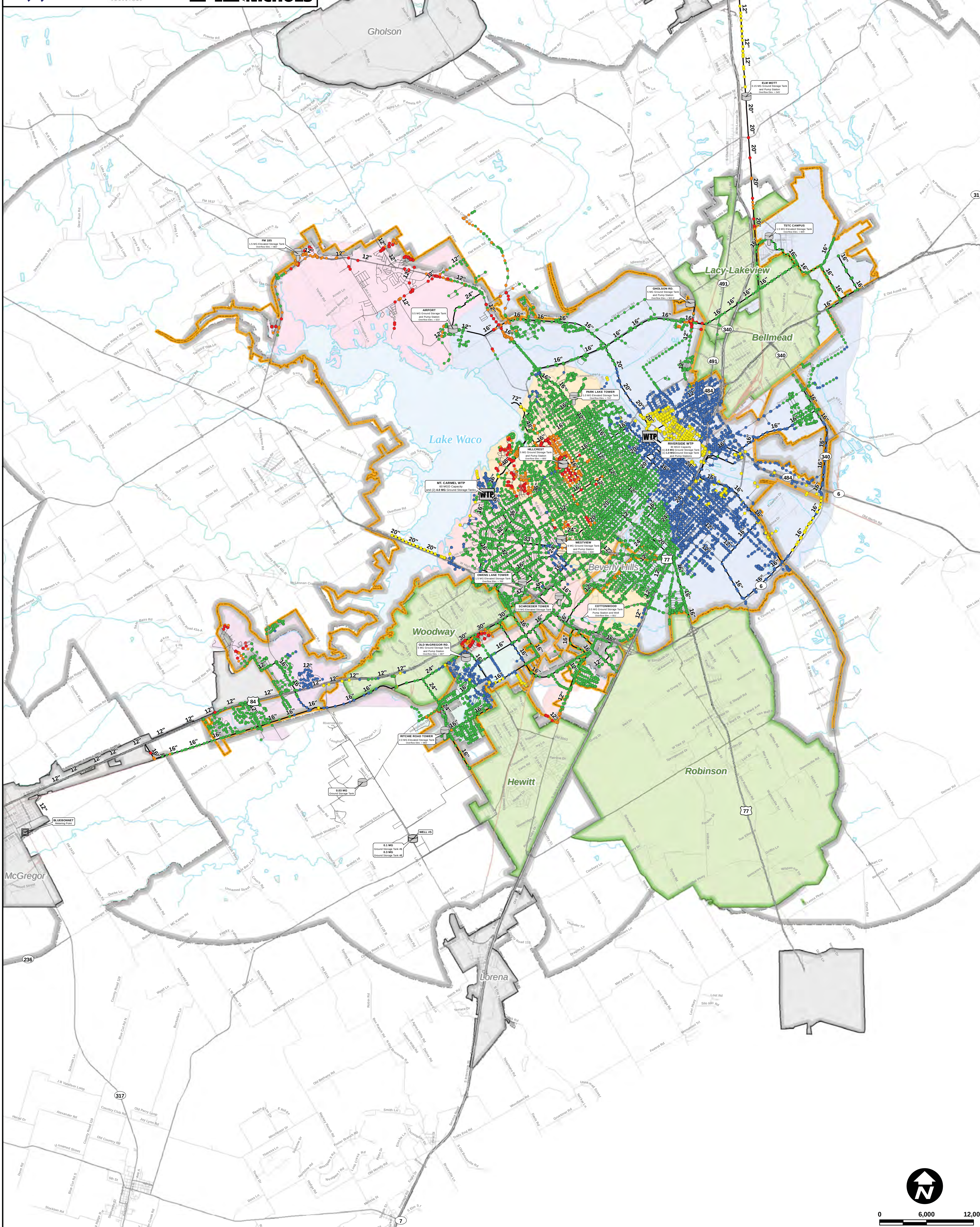
Updated: Friday, October 09, 2015

FIGURE 8-9
CITY OF WACO
EXISTING WATER SYSTEM WITH BUILDOUT DEMAND (MINIMUM PRESSURE)



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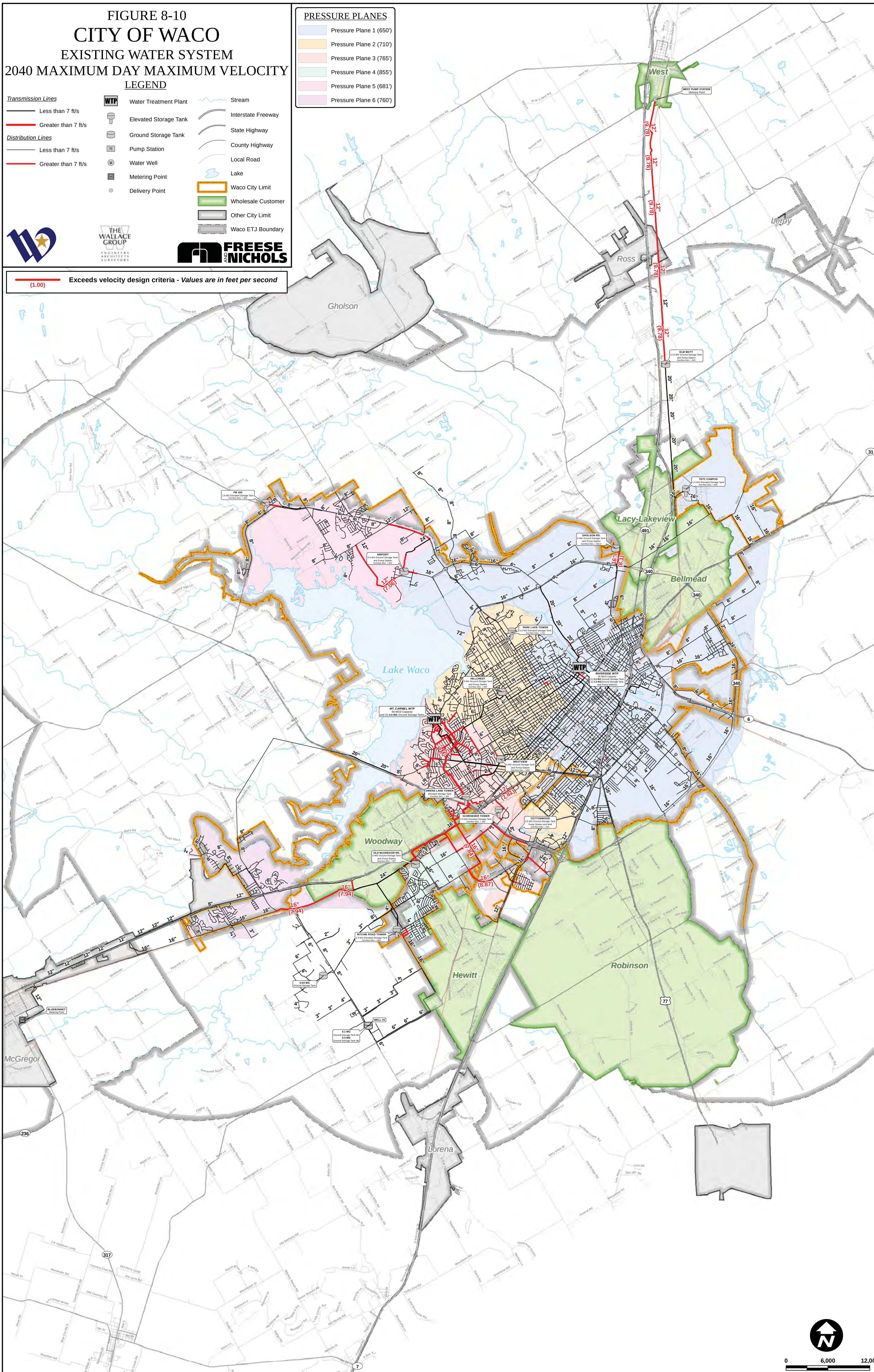

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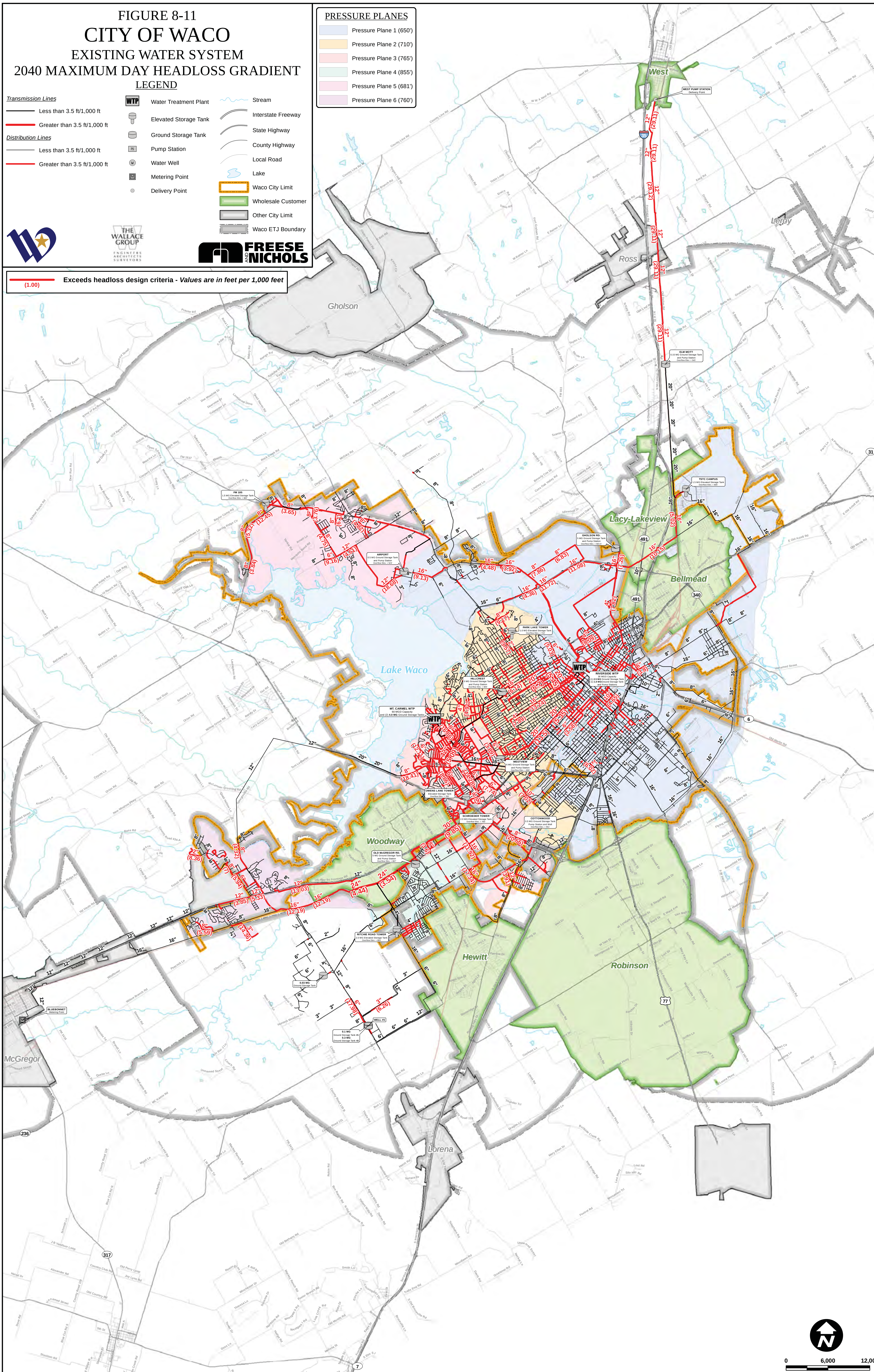

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Job No.: WAL13575
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-11)-2040_Max_Day_Max_Headloss.mxd
Updated: Friday, October 09, 2015

8.4.5 Water System Improvements

The project team 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 major operational changes and improvements to the distribution system other than piping projects include:

- Recapture lost capacity at Riverside WTP due to aging distribution infrastructure
- Add new elevated storage tanks in PP2 and PP6 to increase effective storage
- Replace the existing Hillcrest and Westview GSTs
- Expand PP2 to include portion of PP1 that experiences low pressure (near HEB)
- Expand and modify Old MacGregor GST and PS to serve PP6

8.4.6 Fire Flow Analysis

Once the improvements were identified and entered into the hydraulic model, the fire flow scenario was simulated to determine if any existing deficiencies were addressed with the improvements. The results show overall improvement in the available fire flow. The only areas where the system does not have enough fire flow capacity is on dead end water lines. The fire flow map for 2040 system with the proposed water system improvements can be found in **Figure 8-12**.

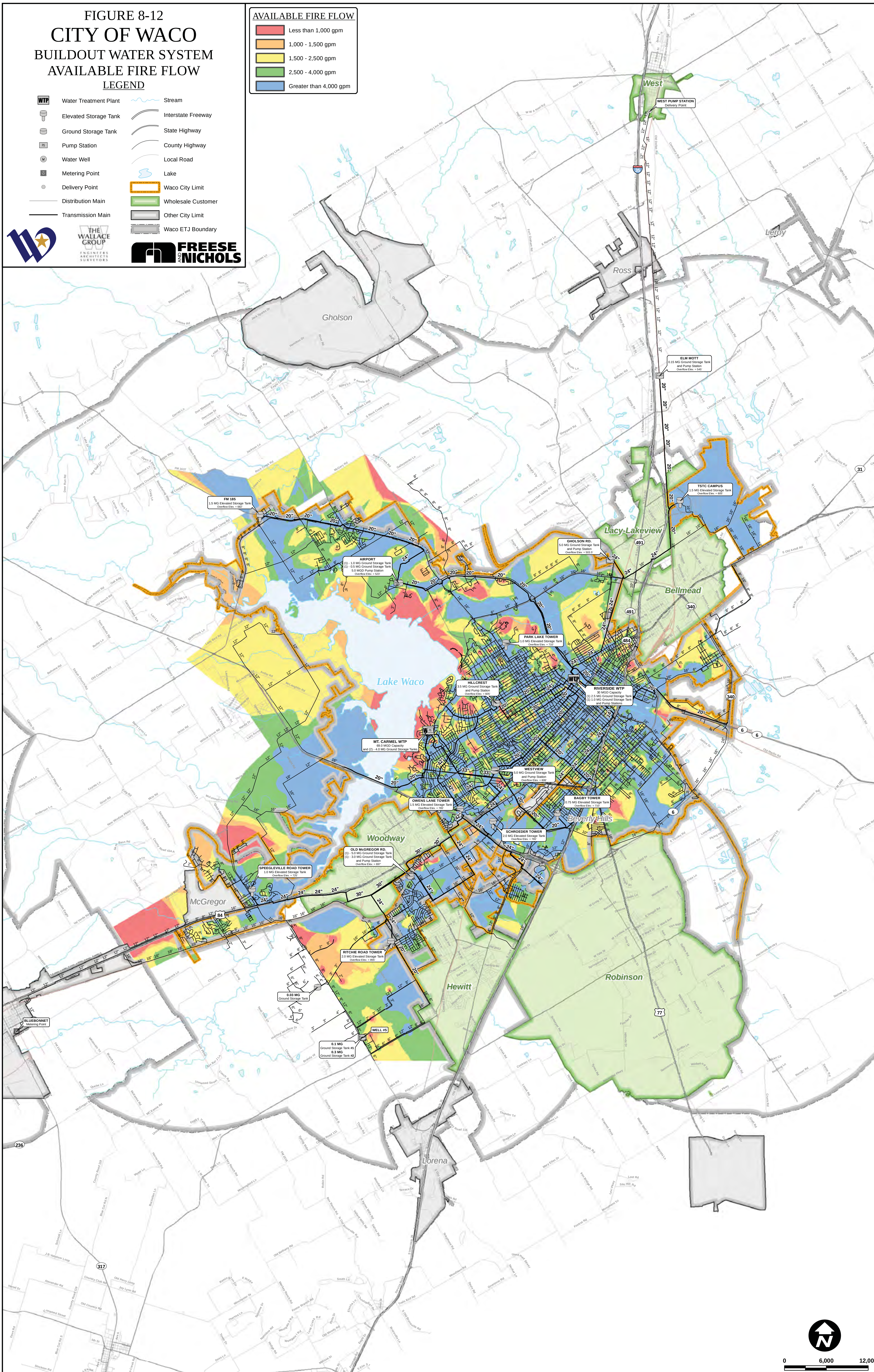
8.4.7 Water Age Analysis

Similar to the fire flow analysis, the water age scenario was simulated with the recommended improvements to predict how improvements affect the water age. The results of the water age modeling indicate that the future improvements will have a positive impact on water age. The lower age can be attributed to the increased demands and fully utilizing the infrastructure as the system approaches ultimate buildout conditions. There are areas where the water age is greater than 10 days. These areas are on smaller dead end water lines in the system. The water age map for the 2040 system with the proposed water system improvements can be found in **Figure 8-13**.

FIGURE 8-12

CITY OF WACO

BUILDOUT WATER SYSTEM AVAILABLE FIRE FLOW



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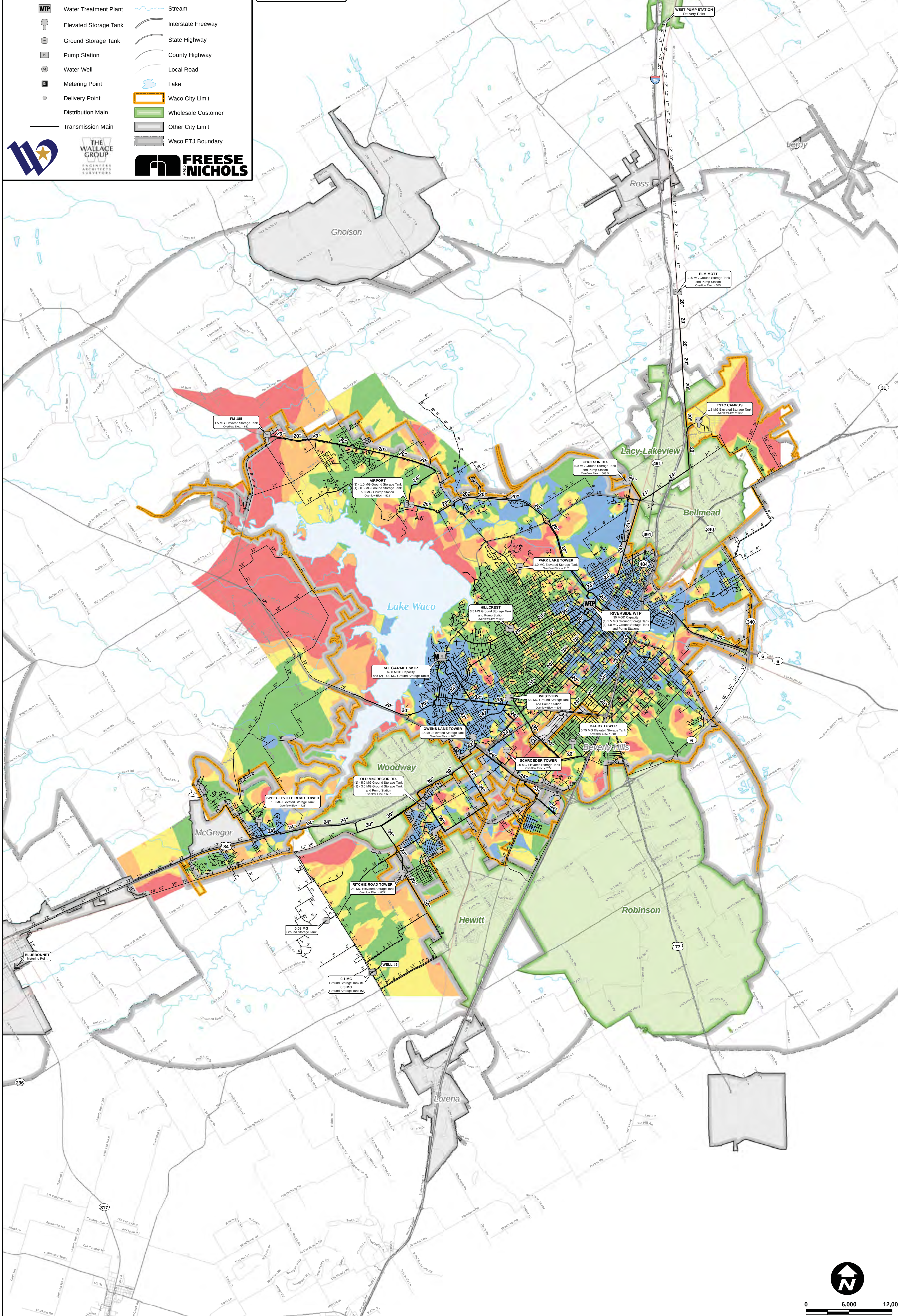
Job No.: WAL13575
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-12)-Buildout_FF.mxd
Updated: Friday, October 09, 2015

FIGURE 8-13
CITY OF WACO
BUILDOUT WATER SYSTEM WATER AGE



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Job No.: WAL13575
Location: H:\W_WW_PLANNING\Deliverables\20-Draft_Master_Plan\(Figure_8-13)-Buildout_Water_Age.mxd
Updated: Friday, October 09, 2015

9.0 WATER SYSTEM RELIABILITY ANALYSIS

A water system reliability analysis was performed utilizing the calibrated water model to determine the City's ability to serve demands with one of the two water treatment plants out of service. A high level review of both plant's current and future capacities was reviewed to determine what level of service could be maintained if either water treatment plant were to be taken out of service. Once an acceptable level of service was determined, two scenarios were developed. The first scenario consisted of the Riverside WTP supplying water demands citywide with the Mt. Carmel WTP out of service. The second scenario consisted of Mt. Carmel supplying water demands citywide with the Riverside WTP out of service. The 2040 capital improvement projects described in **Section 10** were assumed to be in service for the system reliability analysis.

9.1 LEVEL OF SERVICE FOR RELIABILITY ANALYSIS

The existing and future treatment capacity was reviewed for the Riverside and Mt. Carmel water treatment plants to determine the level of service available for the reliability analysis. **Table 9-1** summarizes the treatment process capacity at each plant.

Table 9-1: Existing Water Treatment Plant Capacities

Water Treatment Plant	Existing Treatment Capacity (MGD)	Future Treatment Capacity (MGD)	High Service Pump Station Capacity (MGD)
Riverside	24	30	40.6
Mount Carmel	66	90	21.0
Total	**90**	**127**	

Currently the City is not able to utilize the full treatment capacity of the Riverside WTP due to transmission line restrictions in the distribution system. For the purposes of this analysis, it was assumed that these restrictions were removed, and the full treatment capacity of the Riverside WTP was utilized. **Table 9-2** summarizes the projected 2040 winter, average day and maximum day water demands and includes 50% of the wholesale customer demands. The treatment process capacities were compared with the demands shown in **Table 9-2** to determine each plant's level of service. The highest demand that either water treatment plant could meet on its own was considered its maximum level of service. Once the level of service for each plant was determined, the system reliability analysis was performed.

Table 9-2: Projected 2040 Water Demands

Pressure Plane	Winter Day (MGD)	Average Day (MGD)	Maximum Day (MGD)
PP1	7.26	12.70	20.12
PP2	7.14	12.49	20.47
PP3	6.67	11.68	17.85
PP4	4.39	7.68	11.08
PP5	1.53	2.68	4.55
PP6	2.87	5.03	7.50
PP7	0.24	0.42	0.71
Total	**30.1**	**52.66**	**82.28**

A comparison of the 2040 water demands and the treatment plant capacities indicates that the limiting factor for the level of service as it pertains to the system reliability is the Riverside WTP process capacity of 32 MGD. In the event that the Mt. Carmel WTP is taken out of service, the maximum demand that could be met with only the Riverside WTP are the 2040 winter demands of 30.1 MGD. The level of service analyzed as part of the system reliability was the feasibility of either water treatment plant meeting citywide 2040 winter day demands while the other was out of service. This would allow the City to take one of the water treatment plants out of service for maintenance or to reduce operating cost during the winter season when demands are low.

9.2 ANALYSIS OF SUPPLY FROM RIVERSIDE WATER TREATMENT PLANT

The 2040 planning year model with capital improvements was utilized to perform the reliability analysis of supplying city and wholesale winter water demands from the Riverside WTP. The Riverside WTP directly or partially serves PP1, PP2, PP3, and PP5. PP1 is directly served by the high service pumps at the Riverside WTP. PP2 is partially served by the Hillcrest and Westview Pump Stations, which are supplied by both water treatment plants. PP3 is partially served by a separate set of pumps at the Westview Pump Station, which is partially supplied by the Riverside WTP. PP5 is completely served by the Airport Pump Station which re-pumps flow from PP1 into PP5. Currently the only pressure planes the Riverside WTP does not serve are PP4 and PP6 which is only served by the Mt. Carmel WTP through the Old McGregor pump station. Future PP6 and PP7 would be served by separate pumps at the Old McGregor PS site and therefore only served by Mt. Carmel WTP.

The team performed a system reliability analysis with the Riverside WTP supplying total winter demand of the City and 50% of the wholesale customer demand. PP1 and PP5 would continue to be served by the high service pumps at the plant and the Gholson PS as needed. The proposed 24-inch water line (Project 5) from the Riverside WTP to the Gholson PS would allow the City to send water directly to the pump station. PP2 demands would be met by the Hillcrest PS with the proposed 20-inch water line (Project 11) increasing flow conveyed to the southern portion of the pressure plane. The proposed Bagby EST (Project 12) will allow the City to close the PRVs between PP2 and PP3 while maintaining adequate water pressure in this area. Based on the system reliability analysis, the main challenge of supplying the entire City's demand with just the Riverside WTP is conveying flow to PP3, PP4, PP6, and PP7, which have a combined winter demand of 12.83 MGD. In order for the Riverside WTP to meet these demands, flow must be conveyed from the Westview PS into PP3. Valves at the plant can be closed to force flow into the dedicated new 20-inch transmission line to the Westview PS. Once flow is conveyed to the Westview PS the existing pumps which can pump into PP3 can meet the demands of PP3, PP5, PP6, and PP7.

Based on the Riverside WTP system reliability analysis, the PP3 pumps at the Westview PS are the only way for the Riverside WTP to serve PP3, PP5, PP6, and PP7. The project team recommends that the City keep these two pumps for system reliability and emergency operation.

9.3 ANALYSIS OF SUPPLY FROM MY. CARMEL WATER TREATMENT PLANT

A second system reliability analysis was performed consisting of serving the City and wholesale winter demands with only the Mt. Carmel WTP in service. The 2040 planning year model with capital improvement projects was utilized for the analysis. The Mt. Carmel WTP directly or partially serves PP1, PP2, PP3, and PP4. PP1 is partially served by the high service pump station at the Mt. Carmel WTP, which pump into the ground pumping tanks at the Hillcrest and Westview pump station sites. Because these tanks serve as ground and elevated storage to different pressure planes, they provide a water to move water east from Mt. Carmel. PP2 is partially served by Mt. Carmel WTP through seven pressure reducing valves (PRVs), which convey flow specifically to the southern portion of PP2. PP2 is served by the Hillcrest and Westview Pump Stations which also receive flow from the Mt. Carmel WTP. PP3 is directly served by the high service pump station at the plant and a second pump station at the Westview PS site. PP4 is served directly by the Old McGregor PS which is supplied by the Mt. Carmel WTP high service pump station. Currently the only pressure plane that the Mt. Carmel WTP does not serve is PP5 which is only served by the Riverside WTP through the Airport Pump Station. Future PP6 and PP7 will be served by separate pumps at the Old McGregor PS site and therefore are only served by Mt. Carmel WTP.

The project team performed a system reliability analysis with the Mt. Carmel WTP supplying total winter demand of the City and 50% of the wholesale customer demand. PP2, PP3 and PP4 would continue to be served by the high service pumps at the plant. Based on the system reliability analysis, the main challenge of supplying the entire City's demand with just the Riverside WTP is conveying flow to PP1 and PP5, which have a combined winter demand of 8.79 MGD. In order for the Mt. Carmel WTP to meet these demands, flow must be conveyed from the Hillcrest and Westview Pump Stations into PP1. A portion of the demands in PP1 can be served by the ground storage tanks at both sites which act as elevated storage for the pressure plane. Flow from PP2 can be transferred through the 16-inch valve at China Springs Rd. and Lake Shore Dr., north of the Park Lake Tower, to PP1. This point of transfer would also supply the Airport PS, which serves pressure plane five. In the past the City has opened this valve to help meet peak hour demands in pressure plane five and pressure plane one.

Based on the Mt. Carmel WTP system reliability analysis, the plant could serve the winter demands of the entire City. Additional field testing is recommended to verify that PP2 can adequately serve the Airport PS.

10.0 CAPITAL IMPROVEMENT PLAN

A capital improvement plan (CIP) was developed for the City of Waco to promote a high level of water service that promotes residential and commercial development. The recommended improvements will provide the required capacity and reliability to meet projected water demands through the 2040 planning period. The recommended projects for the water system are presented on **Figure 10-1**. Locations shown for new mains and other recommended improvements were generalized for hydraulic analyses. Specific alignments and sites will be determined as part of the design process. 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 2015 dollars and include an allowance for engineering, surveying, and contingencies. This plan is based on the water demands in Alternative 2 presented in Section 3. CIP maps were also developed for the larger demand scenarios in Alternatives 1 and 3 scenarios and are presented in **Appendix E**.

10.1 2020 CAPITAL IMPROVEMENT PLAN

The 2020 CIP contains 18 projects which have an estimated cost of $123,215,170. **Appendix A** contains a detailed single sheet summary for each project highlighting drivers, location and cost. These projects were selected to be part of the 2020 CIP because they address deficiencies in Waco’s system or they are needed to meet the overall desired goals for optimizing operations, enhancing the level of service, or increasing system reliability. **Table 10-1** summarizes the costs of the 2015-2020 water system CIP for the City of Waco.

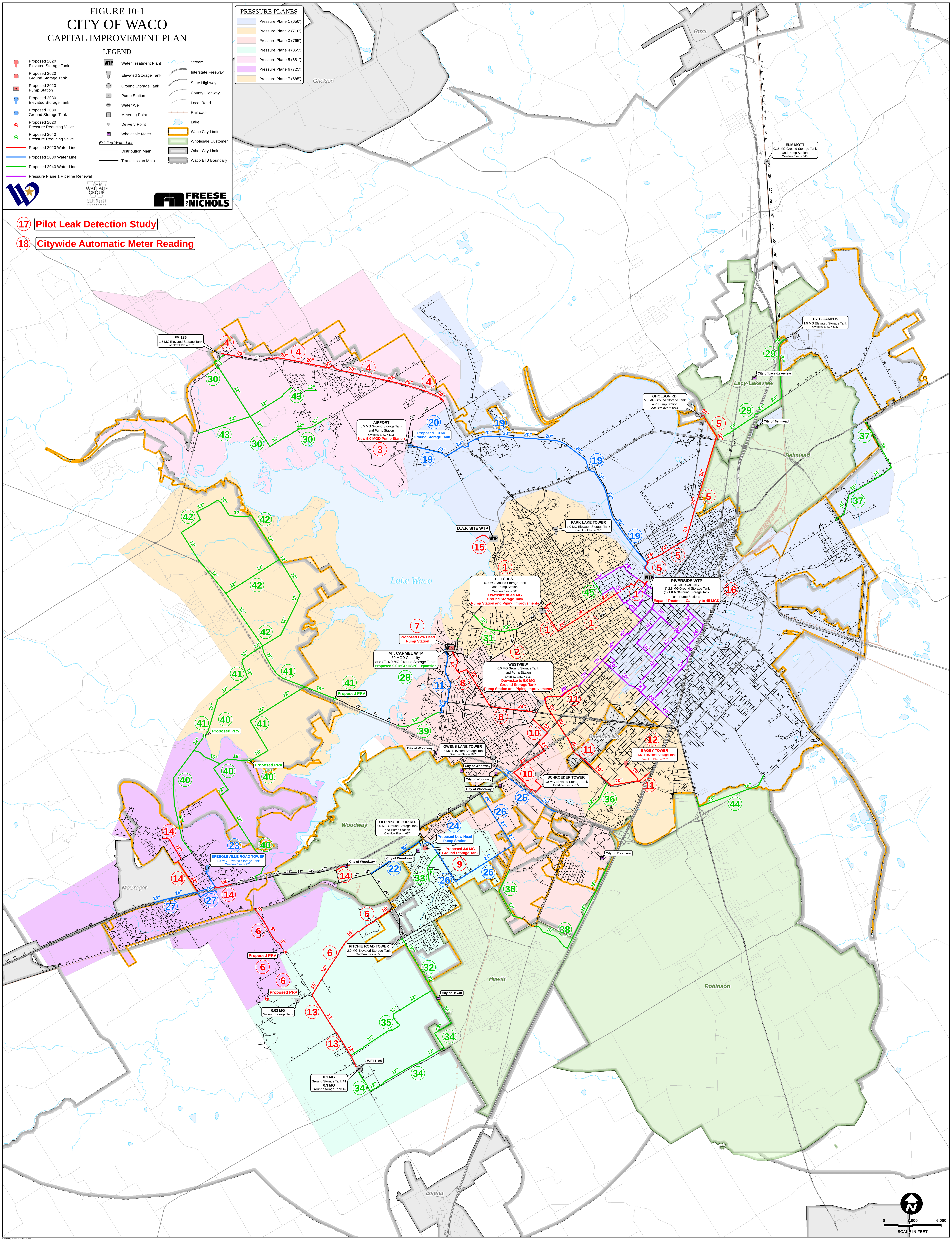


FIGURE 10-1
CITY OF WACO
CAPITAL IMPROVEMENT PLAN

Table 10-1: Proposed 2015-2020 Water System CIP

Proj. No.	Water Distribution System Capital Improvement Plan	Cost
1	Proposed Hillcrest PS and GST Rehabilitation and 24-inch Water line Replacement	$ 15,661,020
2	Proposed Westview PS and GST Rehabilitation	$ 8,085,000
3	5.0 MGD Airport Pump Station	$ 3,307,510
4	Proposed FM-185 20-inch Water Line Replacement in PP 5	$ 8,524,540
5	24-inch, 30-inch, and 36-inch Faulkner Water Line in PP 1	$ 10,160,060
6	16-inch Water Line and 8-inch Water Line with Pressure Reducing Valves in PP 4	$ 5,798,280
7	15.0 MGD Low Head Pump Station at Mt. Carmel WTP	$ 4,557,000
8	Proposed 20-inch and 24-inch Replacement Water Line in PP3	$ 6,271,770
9	3.0 MG Ground Storage Tank at Old McGregor Pump Station	$ 2,646,000
10	16-inch and 24-inch Water Lines in PP3	$ 7,289,740
11	16-inch, 20-inch, and 24-inch Water Lines in PP 2	$ 10,017,400
12	1.0 MG Bagby Elevated Storage Tank in PP2	$ 2,377,000
13	12-inch Water Line in PP4	$ 2,647,630
14	24-inch and 12-inch Water Lines in PP6	$ 3,561,600
15	72-inch Parallel Raw Water Line	$ 1,314,190
16	Expand Riverside Treatment Capacity to 45 MGD	$ 10,363,510
17	Pilot Leak Detection Study	$ 52,920
18	Citywide Automatic Meter Reading	$ 20,580,000
	Capital Improvements Total 2020	***$ 123,215,170***

Project 1: Proposed Hillcrest PS & GST Rehabilitation and 24-inch Replacement Water line

This project is the rehabilitation of the Hillcrest PS, including replacement of site piping and the reduction of the ground storage capacity from 5.0 MG to 3.5 MG. This project also includes a 24-inch water line to replace the existing 20-inch water line from the Riverside WTP to 3.5 MG Hillcrest GST. The existing Hillcrest PS and GST are roughly 100 years old. The tank was originally sized to serve the western portion of the City. Upon completion of the Mt. Carmel WTP and associated clearwells, the reliance on the Hillcrest PS to supply water to the western portion of the City was reduced. The existing 5 MG tank is in poor condition and requires replacement with a new, smaller 3.5 MG tank at the existing site, which meets TCEQ requirements for ground storage capacity for PP2.

Project 2: Proposed Westview PS and GST Rehabilitation

This project is the rehabilitation of the Westview PS, replacement of site piping, and reduction of existing ground storage capacity from 6.0 MG to 5.0 MG. As with the Hillcrest GST, the Westview PS and GST was originally sized to supply the western portion of the City. The addition of Mt. Carmel and the clearwells reduced the reliance on Hillcrest and Westview Pump Stations to serve the western portion of the City. The pump station and site piping modifications will allow the pump station to serve PP2 without requiring a pressure reducing valve. The PP3 pump station at Hillcrest will remain to provide emergency supply from the Riverside WTP in the event the Mt. Carmel WTP is taken out of service.

Project 3: 5.0 MGD Airport Pump Station

This project is a replacement of the existing Airport PS with a new 5.0 MGD pump station. Based on the existing system analysis, the Airport Pump Station does not meet firm pumping capacity requirements. Replacing the existing pump station with a 5.0 MGD pump station will increase the capacity to meet existing and 2040 planning year firm pumping capacity requirements. This project also includes a back-up power generator to maintain service during emergency power outages.

Project 4: Proposed FM-185 20-inch Water Line Replacement in PP 5

This project will replace the existing 12-inch water line along FM-185 in PP5 with a proposed 20- inch water line. A portion of this project is already under design as part of the TXDOT project to widen FM-185 from Pioneer Parkway to Country Aire Drive This project includes the additional portions of the proposed 20-inch water line from Country Aire Drive to the FM-185 EST which will result in a continuous 20-inch water line to supply the FM-185 EST. Existing system analysis results indicate that the City has difficulty supplying water to the northern portion of PP1 and maintaining tank levels at the Gholson GST and TSTC EST. The proposed 24/30/36-inch water line will provide a direct feed from the Riverside WTP to the Gholson PS & GST, increasing supply to the northern portion of PP1.

Project 5: 24-inch, 30-inch, and 36-inch Faulkner Water line in PP 1

This project is a 36-inch, 30-inch and 24-inch water line in PP1 connecting Riverside WTP to Gholson PS and GST. Existing system analysis results indicate that the City has difficulty supplying water to the northern portion of PP1 and maintaining tank levels at the Gholson GST and TSTC EST. The proposed 24/30/36-inch water line will provide a direct feed from the Riverside WTP to the Gholson PS & GST, increasing supply to the northern portion of PP1.

Project 6: New 16-inch Water line and 8-inch Water line with Pressure Reducing Valves in PP 4

This project is a new 16-inch water line along Chapel Road from Ritchie Road to F.M. 2837 and a new 8-inch water line along F.M. 2837 north of Leutwyler Lane in PP4. The proposed 8-inch water line includes two Pressure Reducing Valves to transfer a portion of customers in PP4 to PP6. The City of Waco recently began providing service to the area west of Hewitt which is growing at a rapid rate. Based on 2040 model results the infrastructure is not adequately sized to serve future growth. The proposed 16-inch water line will supply surface water to this area and allow the City of Waco to turn over control of the ground water wells that are owned by the City of Hewitt. The 8-inch water line and PRV's addresses high pressure customer complaints by transferring service of the area to PP6 which operates at a lower elevation.

Project 7: 15.0 MGD Low Head Pump Station at Mt. Carmel WTP

This project is a new 15.0 MGD Low Head Pump Station at Mt. Carmel to pressurize the 33-inch gravity line from Mt. Carmel WTP to Westview GST. Based on the existing system analysis, water supplied by the Mt. Carmel WTP, by gravity through the 33-inch water line, to the Westview PS is limited by the head differential between the two facilities. The proposed new low head pump station will increase the transmission capacity by pressurizing the 33-inch water line and will allow for a more consistent flow rate to be supplied between the two facilities.

Project 8: Proposed 20-inch and 24-inch Replacement Water line in PP3

This project is a new 20-inch and 24-inch water transmission line to replace the existing 16-inch water line in PP3 from Mount Carmel WTP to the existing 24-inch water line at Valley Mills Drive & Sanger Avenue. The Westview PS currently serves the southern portion of PP3. Based on future system improvements, the Westview PS will only serve PP 3 in emergency situations and Mt. Carmel WTP will serve the entire PP3 service area. Model results indicate that due to aging infrastructure in PP 3, there are high headlosses in the water lines between Mt. Carmel and the southern portion of PP3. The proposed 20/24-inch water line replaces the existing 16-inch water line which increases the water supply to the middle and southern portions of PP3 from the Mt. Carmel WTP.

Project 9: 3.0 MG Ground Pumping Tank at Old McGregor Pump Station

This project is a new 3.0 MG GST to meet pumping capacity requirements at the Old McGregor Pump Station. Based on the analysis of the pumping capacity at the Old McGregor Pump Station, there is insufficient pumping capacity to meet existing and future customers in Pressure Planes 4 and 6. The addition of a 3.0 MG GST meets existing and future pumping capacity needs.

Project 10: 16-inch and 24-inch Water lines in PP3

This project is a new 16-inch and 24-inch water transmission line from the existing 24-inch water line along to the Schroeder EST. Analysis of the existing system indicates that the Owen and Schroeder ESTs do not float together. This is due to high headloss in the water lines supplying the Schroeder EST. The new transmission line to the Schroeder EST reduces headlosses in the surrounding water lines and increases the supply to allow the tanks to float more closely together.

Project 11: 16-inch, 20-inch, and 24-inch Water lines in PP 2

This project is a new 24-inch, 20-inch, and 16-inch water transmission line connecting the proposed 0.75 MG Bagby EST to the Westview GST. The southern portion of PP2 is served via PRVs which convey flow from PP3 to PP2. The proposed 24/20/16-inch water line is required to tie the proposed Bagby EST into the distribution system and eliminate the need to operate the PRVs to meet future demands.

Project 12: 1.0 MG Bagby Elevated Storage Tank in PP2

This project is a new 1.0 MG EST located on Bagby Ave. in PP2. Based on the future elevated storage capacity evaluation, PP 2 has inadequate elevated storage to meet future demands. The existing Park Lane EST and Hillcrest PS are unable to serve the southern portion of PP2. PRVs are currently required to convey flow from PP3. The proposed Bagby EST would eliminate the need for the PRVs and meet the future elevated storage capacity needs of PP2.

Project 13: 12-inch Water line in PP4

This project is a new 12-inch water line along F.M. 2837 from Chapel Road to Bluebonnett Lane in PP4. The City of Waco recently began providing service to the area west of Hewitt. This area of Waco is growing at a rapid rate. The infrastructure is not sized to be able to serve the proposed increase. The addition of the new 12-inch water line will extend water service in this area and allow the City of Waco to turn over control of the ground water wells that are owned by the City of Hewitt.

Project 14: 24-inch and 12-inch Water lines in PP6

This project is a new 24-inch along SH 84 east of Church Road and 12- inch Water lines along Bosque Lane north of SH 84 in PP6. The proposed 24-inch line replaces an existing 16-inch to allow for increased conveyance to the proposed Speegleville Road Tower from the proposed Low Head PS at the Old McGregor PS site. Based on the existing system analysis the northern portion of PP6 water lines had excessive headloss during the maximum day scenario. The proposed 12-inch water lines will reduce the headloss in this area, resulting in improved water pressure.

Project 15: 72-inch Parallel Raw Water line

This project is a new parallel 72-inch raw water line from the Lake Waco Dam to the DAF Plant. The existing 72-inch raw water line that feeds the DAF is in poor condition and has a leak. A new 72-inch line will allow for the repair of the existing raw water line and provide a redundant feed to the DAF.

Project 16: Expand Riverside Treatment Capacity to 45 MGD

The current rated capacity of the Riverside Water Treatment Plant is 28 MGD. The buildout capacity of the WTP is 45 MGD. This project will increase the capacity from 28 MGD to 45 MGD to help the City meet the treated water demand in 2040.

Project 17: Pilot Leak Detection Study

This project is a pilot leak detection study at the Mt. Carmel Water Treatment Plant. Leak detection studies are designed to help utilities inexpensively find where water is leaking in the system without having to dig up pipelines and other infrastructure. Finding where water is leaking at the Mt. Carmel WTP will help the City save money from lost water supplies, as well as, realize the full capacity of the plant.

Project 18: Citywide Automatic Meter Reading (AMR) System

Automatic Meter Reading Systems is technology that automatically collects consumption, diagnostic, and status data from water meters throughout the City. The technology minimizes the time required by City staff to collect water meter data from the field.

10.2 2030 CAPITAL IMPROVEMENT PLAN

The 2020-2030 CIP contains 9 projects which have an estimated cost of $47,340,200. **Appendix A** contains a detailed single sheet summary of each project highlighting drivers, location and cost. **Table 10-2** summarizes the costs of the 2030 water system CIP for the City of Waco.

Table 10-2: Proposed 2020-2030 Water System CIP

Proj. No.	Water Distribution System Capital Improvement Plan	Cost
19	20-inch Parallel Water Line in PP1	$ 14,047,920
20	1.0 MG Ground Storage Tank at Airport Pump Station	$ 882,000
21	Proposed 24-inch Replacement Water Line in PP3	$ 4,702,690
22	Proposed 30-inch Parallel Water Line in PP4	$ 3,898,440
23	Proposed 1.0 MG Elevated Storage Tank in PP6	$ 2,377,000
24	8.0 MGD Low Head Pump Station at McGregor Pump Station	$ 3,675,000
25	Proposed 20-inch/24-inch Replacement Water Line in PP3	$ 4,271,040
26	24-inch Water Line in PP3	$ 8,973,700
27	Proposed 16-inch Replacement Water Line along HWY 84 in PP6	$ 4,512,410
	2030 Capital Improvements Total	***$ 47,340,200***

Project 19: 20-inch Parallel Water Line in PP1

This project consists of a new 20-inch water line along F.M. 3051 from the Riverside WTP to the Airport GST. During maximum day existing system conditions, model results indicate that it is difficult convey water to the Airport PS and GST from the Riverside WTP. This project will increase the transmission capacity to the Airport Ground PS and GST to meet future demands in PP5.

Project 20: 1.0 MG Ground Storage Tank at Airport Pump Station

This project consists of a new 1.0 MG GST located at the Airport PS and GST. Based on analysis of the storage capacity at the Airport Pump Station, there is insufficient storage capacity to meet design criteria in PP5. The addition of a 1.0 MG GST meets existing and future storage capacity needs.

Project 21: Proposed 24-inch Replacement Water line in PP3

This project consists of a replacement of the existing 16-inch water line in PP3 along Mt. Carmel Drive from the Mt. Carmel WTP to Fish Pond Road with a new 24-inch transmission water line. Based on future system improvements, the Westview PS will only serve PP3 in emergency situations and Mt. Carmel WTP will serve the entire PP3 service area. Model results indicate that due to aging infrastructure in PP3, there are high headlosses in the water lines between Mt. Carmel and the southern portion of PP3. The proposed 24-inch water line replaces the existing 16-inch water line which increases the water supply to the middle and southern portions of PP3 from the Mt. Carmel WTP. This project will also support future growth on the west side of Lake Waco in future PP7.

Project 22: Proposed 30-inch Parallel Water line in PP4

This projects consists of a parallel 30-inch water line of an existing 24-inch water line in PP4 along Old McGregor Road from the Old McGregor PS to Ritchie Road with a new 30-inch water line to supply PP6. The northern portion of PP4 is served by the Old McGregor PS through two PRVs due to the area's lower ground elevation compared to the rest of PP4. The proposed parallel 30-inch water line provides a dedicated supply line to the area north of SH 84. Upon completion of the proposed pump station improvements (Project 21) at the Old McGregor PS, the area north of SH 84 will be incorporated into PP6 and the existing PRVs can be abandoned. The proposed 20-inch water line is sized to meet future demands in PP6 and future PP7 on the westside of Lake Waco.

Project 23: Proposed 1.0 MG Elevated Storage Tank in PP6

This project consists of a new 1.0 MG elevated storage tank in PP6 east of Speegleville Road and Wheatland Drive. The northern portion of PP4 is served by the Old McGregor PS through two PRVs due to the area's lower ground elevation compared to the rest of PP4. The proposed 1.0 MG EST provides dedicated elevated storage to the area north of SH 84. Upon completion of the proposed pump station improvements (Project 21) at the Old McGregor PS, the area north of SH 84 will be incorporated into future PP6 and the existing PRVs can be abandoned. Based on the City's elevated storage requirements, the proposed 1.0 MG EST is sized to meet projected 2040 demands in PP6 and future PP7 on the westside of Lake Waco.

Project 24: 8.0 MGD Low Head Pump Station at McGregor Pump Station

This project consists of a new 8.0 MGD low-head pump station at the Old McGregor PS site to supply PP6. The northern portion of PP4 is served by the Old McGregor PS through two PRVs due to the area's lower ground elevation compared to the rest of PP4. The proposed 8.0 MGD low head PS provides dedicated pumping capacity to the area north of SH 84. The proposed pump station and additional improvements (Projects 18 and 19) will allow the City to operate the area north of SH 84 as a separate proposed PP6, and the existing PRVs can be abandoned. Based on the City's firm pumping requirements, the proposed 8.0 MGD low head pump station at the Old McGregor PS site is sized to meet projected 2040 demands in PP6 and future PP7 on the westside of Lake Waco.

Project 25: Proposed 20-inch/24-inch Replacement Water line in PP3

This project consists of a replacement of the existing 16-inch water line with a 20/24-inch water line along SH 6 from American Plaza to Exchange Parkway in PP3. The wholesale water demand for the City of Robinson is projected to increase by 2040. Based on model results, the proposed project will provide the transmission capacity required to meet this wholesale demand as well as improve water supply to the southern portion of PP3.

Project 26: 24-inch Water Line in PP3

This project consists of a replacement of the existing 16 -inch water line along Jewell Drive then southwest along Mars Drive and northwest along F.M. 1695 to the Old McGregor PS with a 24-inch water line in PP3. Based on model results, the Old McGregor PS site will require additional supply and transmission capacity to meet the projected city and wholesale 2040 demands. This project will provide a dedicated supply line for the proposed low-head pump station (Project 21) at the Old McGregor PS site to meet 2040 demands for PP6 and PP7.

Project 27: Proposed 16-inch Replacement Water Line along HWY 84 in PP6

This project consists of a replacement of the existing 12-inch water line along US 84 from Speegleville Road to Harris Creek Road with a new 16-inch water line in PP6. Based on model results, the existing 12-inch water line has insufficient capacity to meet projected 2040 water demands in the western portion of PP6. The proposed project will increase transmission capacity and increase available fire flow to this portion of PP6.

10.3 2040 CAPITAL IMPROVEMENT PLAN

The 2040 CIP contains 18 projects, which have an estimated cost of $82,486,100. **Appendix A** contains a detailed single sheet summary of each project highlighting drivers, location and cost. **Table 10-3** summarizes the costs of the 2040 water system CIP for the City of Waco.

Table 10-3: Proposed 2030-2040 Water System CIP

Proj. No.	Water Distribution System Capital Improvement Plan	Cost
28	9.0 MGD Mt. Carmel H.S.P.S. Firm Capacity Expansion	$ 1,470,000
29	20-inch/24-inch Replacement Water Line in PP1	$ 7,425,430
30	12-inch Water Lines in PP5	$ 5,798,130
31	20-inch Water Line in PP2	$ 2,943,690
32	20-inch Water Line Replacement in PP3	$ 2,616,990
33	16-inch Replacement Water Line in PP4	$ 1,263,030
34	16-inch/12-inch Replacement Water Line in PP4	$ 6,245,610
35	12-inch Water Line in PP4	$ 3,652,960
36	12-inch Water Line in PP2	$ 1,117,510
37	16-inch Water Line in PP1	$ 4,849,250
38	16-inch and 12-inch Water Line in PP3	$ 2,312,320
39	20-inch transmission Line in PP1	$ 2,085,940
40	16-inch/12-inch Water Line and PRV Stations in PP6	$ 9,330,390
41	16-inch/12-inch Water Lines and PRV Station in PP7	$ 10,554,600
42	12-inch Water Lines in PP7	$ 14,138,470
43	12-inch Water Line in PP5	$ 2,988,090
44	16-inch Water Line in PP1	$ 3,023,370
45	16-inch Water Line in PP1	$ 670,320
	2040 Capital Improvements Total	***$ 82,486,100***

Project 28: 9.0 MGD Mt. Carmel H.S.P.S. Firm Capacity Expansion

This project consists of a 9.0 MGD expansion of the H.S.P.S. firm capacity at the Mt. Carmel WTP, in PP3, from 60 MGD to 69 MGD. Based on the firm pumping capacity requirements, the Mt. Carmel H.S.P.S has insufficient capacity to meet the projected 2040 water demands of PP3, PP4, PP6, and PP7 in addition to the wholesale customer demands. This project expands the firm capacity of the pump station to meet these projected demands.

Project 29: 20-inch/24-inch Replacement Water Line in PP1

This project consists of a replacement of the existing 16-inch water line along Meyers Lane from Industrial Boulevard to F.M. 2418 then north along F.M. 2418 to the TSTC EST with a 20/24-inch water line in PP1. Based on the existing system analysis, the 16-inch water line has insufficient capacity, which resulted in excess headloss and the inability to maintain the TSTC tank level during peak demands. This project will provide additional supply to the TSTC tank to meet future growth.

Project 30: 12-inch Water lines in PP5

This project consist of a new 12-inch water line from Flat Rock Road along Yankie Road to the FM 185 EST in PP5. Based on the existing system analysis the northern portion of PP5 experiences water age related issues. This project will reduce these issues by providing additional looping and transmission capacity to FM 185 EST. In addition this project will serve future growth north of Lake Waco.

Project 31: 20-inch Water line in PP2

This project consists of a new 20-inch water line from Lake Shore Drive along Hillcrest Drive to Cobbs Drive in PP2. This project connects the existing 16-inch along Lake Shore Drive to the existing 36-inch along Cobbs Drive to provide looping and improved transmission capacity for the Hillcrest PS.

Project 32: 20-inch Water line Replacement in PP3

This project replaces an existing 16-inch water line from the Ritchie Road Tower along Ritchie Road to the Hewitt delivery meter with a new 20-inch water line in PP3. Based on 2040 model results additional transmission capacity will be required to serve the increased demand from the Hewitt wholesale customer and growth in the southern portion of PP3.

Project 33: 16-inch Replacement Water line in PP4

This project consists of a new 16-inch water line to replace the existing 12-inch water line from FM1695 along Chapel Road to Woodgate Drive in PP4. This project increases looping and provides additional transmission capacity for the Ole McGregor PS in PP4.

Project 34: 16-inch/12-inch Replacement Water line in PP4

This project consists of a new 16-inch water line to replace the existing 8-inch water line from the Hewitt wholesale meter along Ritchie Road to FM2113 then a new 12-inch water line along FM2113 to the proposed 12-inch water line (Project 13) along FM2837 in PP4. This project provides additional transmission capacity and looping to serve the western portion of PP4 formerly served by the Hewitt water system.

Project 35: 12-inch Water line in PP4

This project consists of a new 12-inch water line from Ritchie Road along Warren Road to FM 2837 in PP4. This project provides additional transmission capacity and looping to serve the western portion of PP4 formerly served by the Hewitt water system.

Project 36: 12-inch Water line in PP2

This project consist of a new 12-inch water line from New Road along Bagby Avenue to the existing 12-inch water line north of SH 6 in PP2. This project increases looping and provides additional transmission capacity for the proposed Bagby Tower (Project 12) in PP4.

Project 37: 16-inch Water line in PP1

This project consists of a new 16-inch water line from SH 340 along Selby Lane to Highway 84 in PP1. This project increases looping and provides additional transmission capacity for the TSTC Tower in PP1.

Project 38: 16-inch and 12-inch Water line in PP3

This project consists of a new 16-inch water line from Corporation Parkway along IH 35 to Old Temple Highway and a new 12-inch water line from Old Temple Highway to Texas Central Parkway in PP3. This project increases looping and provides additional transmission capacity to meet future growth in the southern portion PP3.

Project 39: 20-inch transmission Line in PP1

This project consists of a new 20-inch water transmission line from Stoneleigh Road along Fish Pond Road to SH 6 in PP1. This project will provide transmission capacity to serve growth in the future PP7. This project connects the proposed 24-inch water line (project 13) to the existing 20-inch water line along the SH 6 bridge crossing Lake Waco.

Project 40: 16-inch/12-inch Water line and PRV Stations in PP6

This project is a new 12-inch water line along F.M. 2837 from Chapel Road to Bluebonnet Lane in PP4. The City of Waco recently began providing service to the area west of Hewitt. This area of Waco is growing at a rapid rate. The infrastructure is not sized to be able to serve the proposed increase. The addition of the new 12-inch water line will extend water service in this area and allow the City of Waco to turn over control of the ground water wells that are owned by the City of Hewitt.

Project 41: 24-inch and 12-inch Water lines in PP6

This project consists of a new 12-inch water line from SH 6 along Barrett Road to McLennan Crossing Road, a second 12-inch water line from CR430 along Speegleville Road to McLennan Crossing Road and 16-inch water line from Speegleville Road along McLennan Crossing Road to the PRV station in PP6. This project provides additional transmission capacity and looping to serve future development west of Lake Waco in the northern portion of PP6. This project also consists of 2 PRV stations to transfer water from PP6 to serve growth in the future PP7.

Project 42: 12-inch Water lines in PP7

This project consists of new 12-inch water lines in the northern portion of PP7 northeast of SH 6. This project provides additional transmission capacity and looping to serve future development west of Lake Waco in the PP7.

Project 43: 12-inch Water line in PP5

This project consists of a new 12-inch water line from Tree Lake Drive along Arnett Lane to FM 185 in PP5. This project provides additional transmission capacity and looping to serve future development north of Lake Waco in the PP5. This project also improves water age issues along FM 185 in the western portion of the pressure plane.

Project 44: 16-inch Water line in PP1

This project consists of a new 16-inch water line from 12th Street Road along SH 6 to Highway 77 in PP1. This project increases looping and provides additional transmission capacity in the southern portion of PP1.

Project 45: 16-inch Water line in PP1

This project consists of a new 16-inch water line from Cumberland Avenue along 16th Street to Proctor Avenue in PP1. This project increases looping and provides additional transmission capacity in the western portion of PP1 after the revised pressure plane boundary between PP1 and PP2.

11.0 REDEVELOPMENT ANALYSIS

Following the development of the growth CIP, the project team performed a 2040 system analysis of the water distribution system for areas targeted for redevelopment. The team delineated two redevelopment areas that cover 2,250 acres and 1,750 acres. **Figure 11-1** is an overall map that shows the location of the two redevelopment areas, referred to as the Riverside (orange outline) and Downtown (blue outline) redevelopment areas. These locations have been identified by the City as key areas where Waco is expecting to experience large-scale growth and transformation. The redevelopment areas were selected for a variety of reasons. Some reasons include access to major forms of transportation, proximity to higher education institutions (Baylor University), and development of mixed use urban villages (McLane Stadium, Downtown, etc.). The potential redevelopment is expected to occur by 2040 for the purposes of this study.

11.1 REDEVELOPMENT AREA WATER SYSTEM ANALYSIS

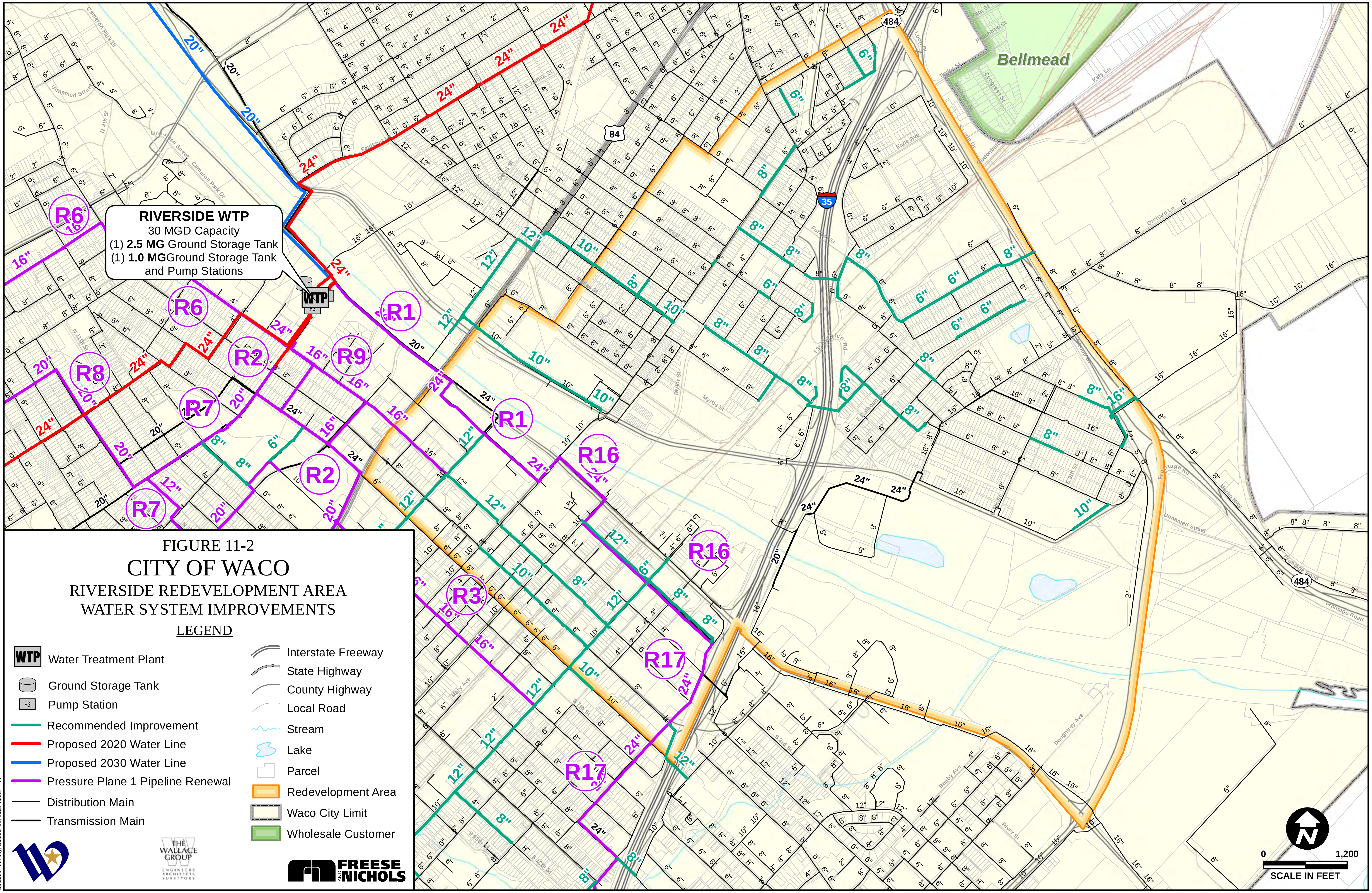
The redevelopment water system analysis consisted of two components, capacity and condition. A capacity analysis of the 12-inch or smaller lines within the boundaries of the Riverside and Downtown redevelopment areas was performed based on the headloss gradient design criteria shown in **Table 11-1**.

Table 11-1: Velocity and Headloss Gradient Design Criteria

Water Line Size	Velocity Criteria	Headloss Gradient
12-inches and Smaller	7.0 ft/s	4.5 ft/1,000 ft
16-inches and Larger	7.0 ft/s	7.0 ft/1,000 ft

Each redevelopment area had demand allocated to the model nodes based on the projections from **Section 3.0** for the 2040 planning period. For the purposes of the redevelopment capacity analysis, capital improvement projects identified in **Section 10** were assumed to be in service. The model was simulated under peak hour conditions to evaluate the velocity and headloss gradient of the pipes. In addition to the capacity analysis, an evaluation of the condition was performed based on a review of the pipe age and material where available. The results of the capacity and condition analysis for the Riverside and Downtown redevelopment areas are shown in **Figures 11-2** and **11-3**. Model nodes that are unable to meet the required fire flow demand are shown as green. Model lines that exceed the velocity or headloss gradient are identified with a red line or red line highlighted in yellow, respectively.

FIGURE 11-1
CITY OF WACO
REDEVELOPMENT AREAS



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Updated: Monday, October 12, 2015 4:52:04 PM

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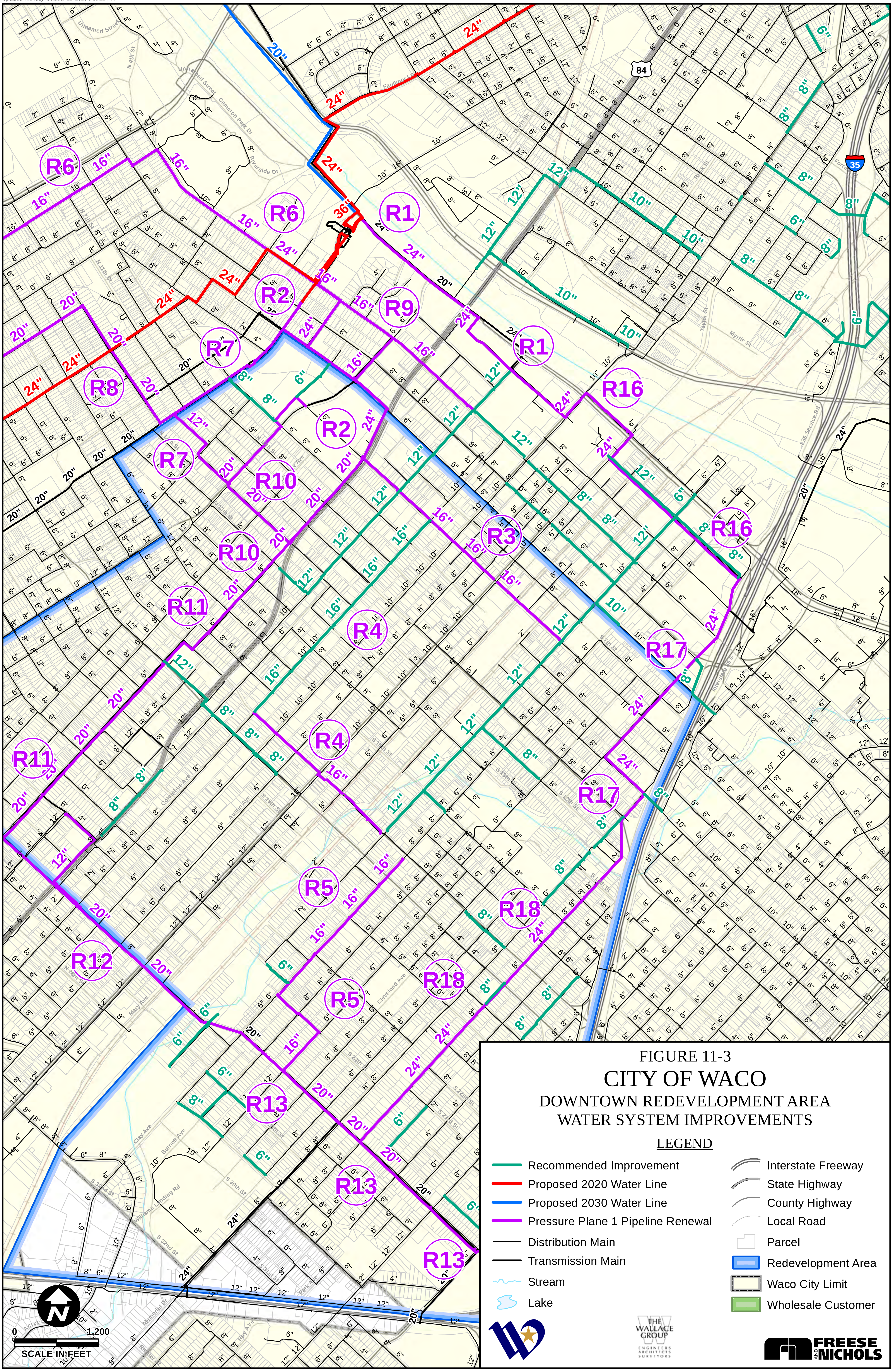
Location: H:\W_WW_PLANNING\Final_Report(Figure_11-3)-Redev_Area2_CIP.mxd
Updated: Monday, October 12, 2015 6:30:21 PM



11.2 REDEVELOPMENT CAPITAL IMPROVEMENT PLAN

Based on the results of the water system capacity and condition analysis, the project team developed improvements to serve future growth related to redevelopment. For the purposes of this study, the team concentrated on smaller distribution lines localized to the redevelopment areas for the Redevelopment CIP and not large transmission mains, where proposed improvements are identified in the **Section 10**. Capacity improvements were identified for water lines which exceeded the headloss gradient design criteria shown in **Table 11-1**. Condition related improvements were identified for water lines with a pipe age greater than 50 years and/or consisting of more problematic pipe materials such as Asbestos Cement. The capacity and condition improvements were combined to represent the proposed redevelopment improvements. The proposed improvements address capacity and condition issues from the analysis of the Riverside and Downtown redevelopment areas. The recommended CIP lines for redevelopment related growth for the Riverside and Downtown redevelopment areas are shown in purple on the capital improvement plan in **Figure 10-1**.

APPENDIX A
CAPITAL IMPROVEMENT PROJECTS
DETAILED COST SHEETS

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2020 Capital Improvement Plan
Project Name

Project # 1

Hillcrest PS and GST Rehabilitation and 24-inch Water line Replacement

Project Description

This project is the rehabilitation of the Hillcrest PS, including replacement of site piping and the reduction of the ground storage capacity from 5.0 MG to 3.5 MG. This project also includes a 24-inch water line to replace the existing 20-inch water line from the Riverside WTP to 3.5 MG Hillcrest GST.

Vicinity Map:

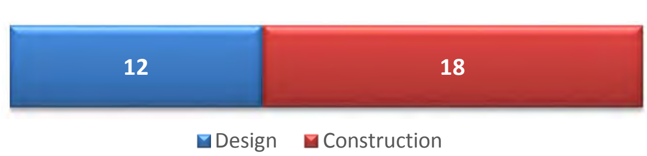
Project Drivers:

The existing Hillcrest PS and GST are roughly 100 years old. The tank was originally sized to serve the western portion of the City. Upon completion of the Mt. Carmel WTP and associated clearwells, the reliance on the Hillcrest PS to supply water to the western portion of the City was reduced. The existing 5 MG tank is in poor condition and requires replacement with a new, smaller 3.5 MG tank at the existing site, which meets TCEQ requirements for ground storage capacity for PP2.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	3.5 MG Ground Storage Tank	1	LS	$2,100,000	$2,100,000
2	Pump Station and Piping Modifications	1	LS	$3,000,000	$3,000,000
3	24" Water Line and Appurtenances	17,250	LF	$192	$3,312,000
4	38" Boring and Casing	800	LF	$665	$532,000
5	20" Water Line and Appurtenances	750	LF	$160	$120,000
6	34" Boring and Casing	50	LF	$595	$29,750
7	Right-of-Way (20' Easement)	18,000	LF	$20	$360,000
8	Pavement Repair (12' wide)	15,000	LF	$80	$1,200,000

Project Timing (months)



	SUBTOTAL:	**$10,653,750**
MOBILIZATION	5%	$532,690
	SUBTOTAL:	**$11,186,440**
CONTINGENCY	25%	$2,796,610
	SUBTOTAL:	**$13,983,050**
ENG/SURVEY	12%	$1,677,970
	SUBTOTAL:	**$15,661,020**

Estimated Total Project Cost: $15,661,020

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2020 Capital Improvement Plan
Project Name

Project # 2

Westview PS and GST Rehabilitation

Project Description

This project is the rehabilitation of the Westview PS, replacement of site piping, and reduction of existing ground storage capacity from 6.0 MG to 5.0 MG.

Project Drivers:

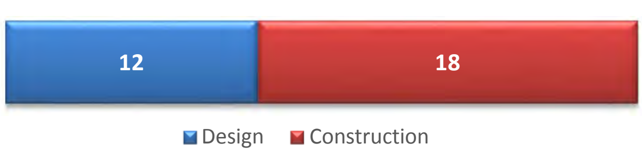
As with the Hillcrest GST, the Westview PS and GST was originally sized to supply the western portion of the City. The addition of Mt. Carmel and the clearwells reduced the reliance on Hillcrest and Westview Pump Stations to serve the western portion of the City. The pump station and site piping modifications will allow the pump station to serve PP2 without requiring a pressure reducing valve. The PP3 pump station at Hillcrest will remain to provide emergency supply from the Riverside WTP in the event the Mt. Carmel WTP is taken out of service.

Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	5 MG Ground Storage Tank	1	LS	$3,000,000	$3,000,000
2	Pump Station and Piping Modifications	1	LS	$2,500,000	$2,500,000

Project Timing (months)



		SUBTOTAL:	$5,500,000
MOBILIZATION	5%		$275,000
		SUBTOTAL:	$5,775,000
CONTINGENCY	25%		$1,443,750
		SUBTOTAL:	$7,218,750
ENG/SURVEY	12%		$866,250
		SUBTOTAL:	$8,085,000

Estimated Total Project Cost: $8,085,000

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2020 Capital Improvement Plan

Project Name — **Project # 3**

5.0 MGD Airport Pump Station

Project Description

This project consists of a replacement of the existing Airport PS with a new 5.0 MGD pump station.

Project Drivers:

Based on the existing system analysis, the Airport Pump Station does not meet firm pumping capacity requirements. Replacing the existing pump station with a 5.0 MGD pump station will increase the capacity to meet existing and 2040 planning year firm pumping capacity requirements. This project also includes a back-up power generator to maintain service during emergency power outages.

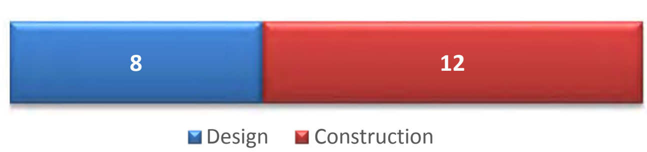
Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	New 5.0 MGD Pump Station	1	LS	$2,000,000	$2,000,000
2	Generator	1	LS	$250,000	$250,000

	SUBTOTAL:	**$2,250,000**
MOBILIZATION	5%	$112,500
	SUBTOTAL:	**$2,362,500**
CONTINGENCY	25%	$590,630
	SUBTOTAL:	**$2,953,130**
ENG/SURVEY	12%	$354,380
	SUBTOTAL:	**$3,307,510**

Project Timing (months)



Estimated Total Project Cost: $3,307,510

City of Waco

Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2020 Capital Improvement Plan

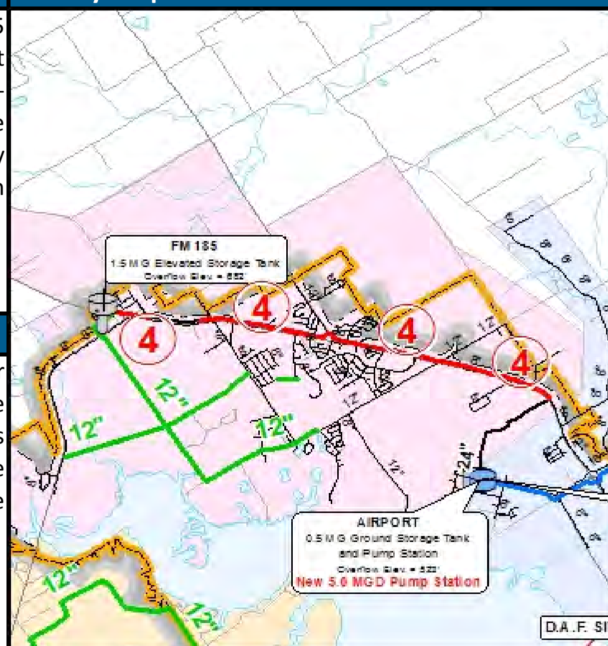
Project Name — **Project # 4**

FM-185 20-inch Water Line Replacement in PP 5

Project Description

This project will replace the existing 12-inch water line along FM-185 in PP5 with a proposed 20- inch Water Line. A portion of this project is already under design as part of the TXDOT project to widen FM-185 from Pioneer Pkwy. to Country Aire Dr. This project includes the additional portions of the proposed 20-inch water line from Country Aire Dr. to the FM-185 EST which will result in a continuous 20-inch Water Line to supply the FM-185 EST.

Vicinity Map:



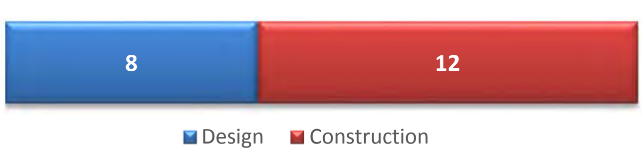
Project Drivers:

Based on the existing system analysis, the existing 12-inch water line along FM-185 experiences high headlosses which increases the difficultly of maintaining the level of the FM-185 EST during periods of high demand. The proposed 20-inch water line will reduce the headloss and allow the City to maintain a consistent tank level in the FM 185 EST during 2040 planning year demands.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	22,000	LF	$160	$3,520,000
2	34" Boring and Casing	200	LF	$595	$119,000
3	Right-of-Way (20' Easement)	22,000	LF	$20	$440,000
4	Pavement Repair (12' wide)	21,500	LF	$80	$1,720,000

Project Timing (months)



		SUBTOTAL:	**$5,799,000**
MOBILIZATION	5%		$289,950
		SUBTOTAL:	**$6,088,950**
CONTINGENCY	25%		$1,522,240
		SUBTOTAL:	**$7,611,190**
ENG/SURVEY	12%		$913,350
		SUBTOTAL:	**$8,524,540**

Estimated Total Project Cost: $8,524,540

City of Waco

Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY

FREESE AND NICHOLS

2020 Capital Improvement Plan

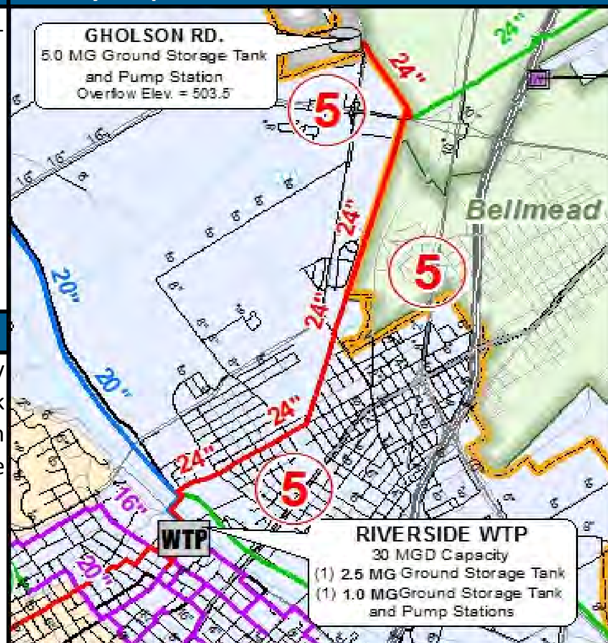
Project Name — **Project # 5**

24-inch, 30-inch, and 36-inch Faulkner Water Line in PP 1

Project Description

This project is a new 36-inch, 30-inch and 24-inch water line in PP1 connecting Riverside WTP to Gholson PS and GST.

Vicinity Map:



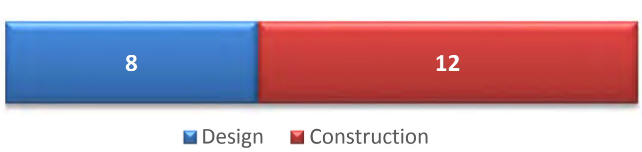
Project Drivers:

Existing system analysis results indicate that the City has difficulty supplying water to the northern portion of PP1 and maintaining tank levels at the Gholson GST and TSTC EST. The proposed 24/30/36-inch water line will provide a direct feed from the Riverside WTP to the Gholson PS & GST, increasing supply to the northern portion of PP1.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	22,500	LF	$192	$4,320,000
2	38" Boring and Casing	800	LF	$665	$532,000
3	30" Water Line and Appurtenances	400	LF	$240	$96,000
4	36" Water Line and Appurtenances	500	LF	$288	$144,000
5	48" Water Line and Appurtenances	400	LF	$384	$153,600
6	Right-of-Way (20' Easement)	23,300	LF	$20	$466,000
7	Pavement Repair (12' wide)	15,000	LF	$80	$1,200,000

Project Timing (months)



	SUBTOTAL:	**$6,911,600**
MOBILIZATION	5%	$345,580
	SUBTOTAL:	**$7,257,180**
CONTINGENCY	25%	$1,814,300
	SUBTOTAL:	**$9,071,480**
ENG/SURVEY	12%	$1,088,580
	SUBTOTAL:	**$10,160,060**

Estimated Total Project Cost: $10,160,060

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP
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FREESE AND NICHOLS

2020 Capital Improvement Plan

Project Name

Project # 6

16-inch Water Line and 8-inch Water Line with Pressure Reducing Valves in PP 4

Project Description

This project is a new 16-inch water line along Chapel Road from Ritchie Road to F.M. 2837 and a new 8-inch water line along F.M. 2837 north of Leutwyler Lane in PP4. The proposed 8-inch water line includes two Pressure Reducing Valves to transfer a portion of customers in PP4 to PP6.

Project Drivers:

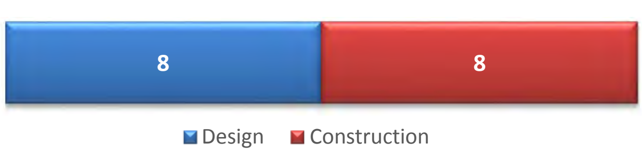
The City of Waco recently began providing service to the area west of Hewitt which is growing at a rapid rate. Based on 2040 model results the infrastructure is not adequately sized to serve future growth. The proposed 16-inch water line will supply surface water to this area and allow the City of Waco to turn over control of the ground water wells that are owned by the City of Hewitt. The 8-inch water line and PRV's addresses high pressure customer complaints by transferring service of the area to PP6 which operates at a lower elevation.

Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	13,000	LF	$128	$1,664,000
2	8" Water Line and Appurtenances	5,300	LF	$64	$339,200
3	PRV Station	2	LS	$50,000	$100,000
4	16" Boring and Casing	100	LF	$352	$35,200
5	Right-of-Way (20' Easement)	18,300	LF	$20	$366,000
6	Pavement Repair (12' wide)	18,000	LF	$80	$1,440,000

Project Timing (months)



		SUBTOTAL:	**$3,944,400**
MOBILIZATION	5%		$197,220
		SUBTOTAL:	**$4,141,620**
CONTINGENCY	25%		$1,035,410
		SUBTOTAL:	**$5,177,030**
ENG/SURVEY	12%		$621,250
		SUBTOTAL:	**$5,798,280**

Estimated Total Project Cost: $5,798,280

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS

2020 Capital Improvement Plan

Project Name | **Project # 7**

15.0 MGD Low Head Pump Station at Mt. Carmel WTP

Project Description

This project is a new 15.0 MGD Low Head Pump Station at Mt. Carmel to pressurize the 33-inch gravity line from Mt. Carmel WTP to Westview GST.

Vicinity Map:

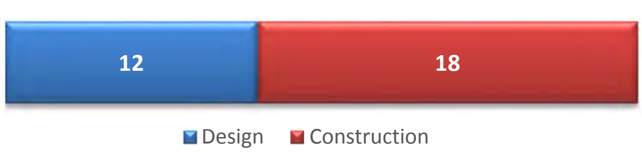
Project Drivers:

Based on the existing system analysis, water supplied by the Mt. Carmel WTP, by gravity through the 33-inch water line, to the Westview PS is limited by the head differential between the two facilities. The proposed new low head pump station will increase the transmission capacity by pressurizing the 33-inch water line and will allow for a more consistent flow rate to be supplied between the two facilities.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pump Station - New 15 MGD	1	LS	$3,000,000	$3,000,000
2	Water Line Condition Assessment	1	LS	$100,000	$100,000

Project Timing (months)



	SUBTOTAL:	**$3,100,000**
MOBILIZATION	5%	$155,000
	SUBTOTAL:	**$3,255,000**
CONTINGENCY	25%	$813,750
	SUBTOTAL:	**$4,068,750**
ENG/SURVEY	12%	$488,250
	SUBTOTAL:	**$4,557,000**

Estimated Total Project Cost: $4,557,000

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS

2020 Capital Improvement Plan
Project Name

Project # 8

20-inch and 24-inch Replacement Water Line in PP3

Project Description

This project is a new 20-inch and 24-inch water transmission line to replace the existing 16-inch water line in PP3 from Mount Carmel WTP to the existing 24-inch water line at Walley Mills Drive & Sanger Avenue.

Vicinity Map:

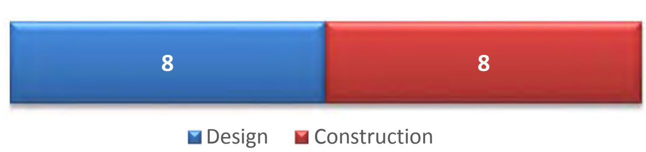
Project Drivers:

The Westview PS currently serves the southern portion of PP3. Based on future system improvements, the Westview PS will only serve PP 3 in emergency situations and Mt. Carmel WTP will serve the entire PP3 service area. Model results indicate that due to aging infrastructure in PP 3, there are high headlosses in the water lines between Mt. Carmel and the southern portion of PP3. The proposed 20/24-inch water line replaces the existing 16-inch water line which increases the water supply to the middle and southern portions of PP3 from the Mt. Carmel WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	5,000	LF	$192	$960,000
2	38" Boring and Casing	200	LF	$665	$133,000
3	20" Water Line and Appurtenances	9,200	LF	$160	$1,472,000
4	34" Boring and Casing	500	LF	$595	$297,500
5	Right-of-Way (20' Easement)	14,200	LF	$20	$284,000
6	Pavement Repair (12' wide)	14,000	LF	$80	$1,120,000

Project Timing (months)



		SUBTOTAL:	**$4,266,500**
MOBILIZATION	5%		$213,330
		SUBTOTAL:	**$4,479,830**
CONTINGENCY	25%		$1,119,960
		SUBTOTAL:	**$5,599,790**
ENG/SURVEY	12%		$671,980
		SUBTOTAL:	**$6,271,770**

Estimated Total Project Cost: $6,271,770

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2020 Capital Improvement Plan

Project Name

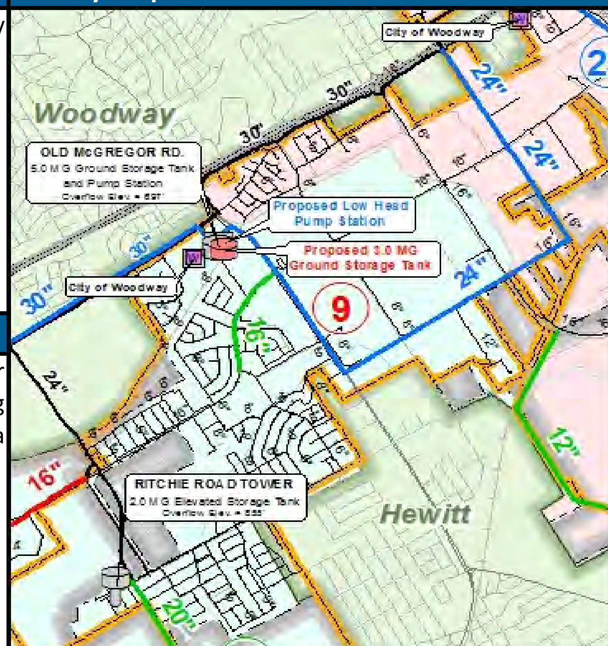
Project # 9

3.0 MG Ground Storage Tank at Old McGregor Pump Station

Project Description

This project is a new 3.0 MG GST to meet pumping capacity requirements at the Old McGregor Pump Station.

Vicinity Map:



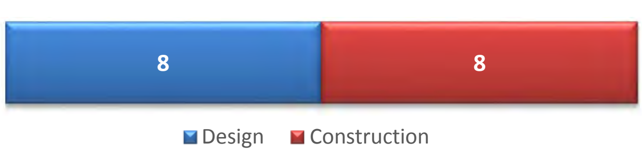
Project Drivers:

Based on the analysis of the pumping capacity at the Old McGregor Pump Station, there is insufficient pumping capacity to meet existing and future customers in Pressure Planes 4 and 6. The addition of a 3.0 MG GST meets existing and future pumping capacity needs.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	3 MG Ground Storage Tank	1	LS	$1,800,000	$1,800,000

Project Timing (months)



		SUBTOTAL:	**$1,800,000**
MOBILIZATION	5%		$90,000
		SUBTOTAL:	**$1,890,000**
CONTINGENCY	25%		$472,500
		SUBTOTAL:	**$2,362,500**
ENG/SURVEY	12%		$283,500
		SUBTOTAL:	**$2,646,000**

Estimated Total Project Cost: $2,646,000

City of Waco

Prioritized CIP Project Summary
October 9, 2015

2020 Capital Improvement Plan
Project Name

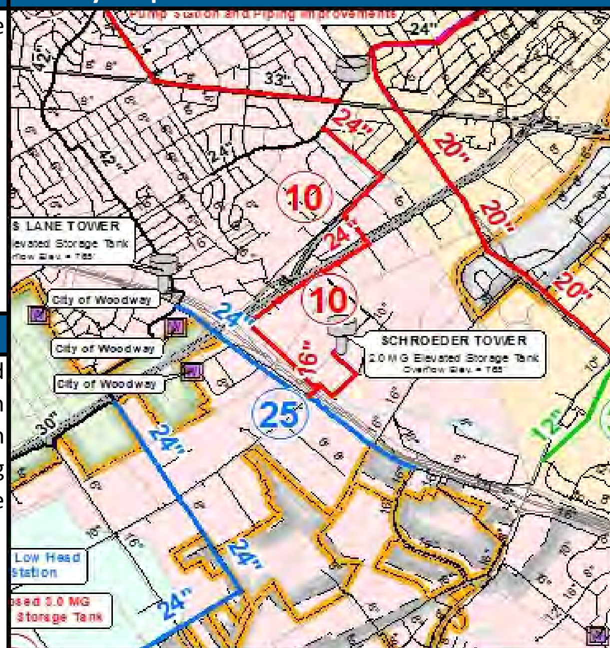
Project # 10

16-inch and 24-inch Water Lines in PP3

Project Description

This project is a new 16-inch and 24-inch water transmission line from the existing 24-inch water line along to the Schroeder EST.

Vicinity Map:



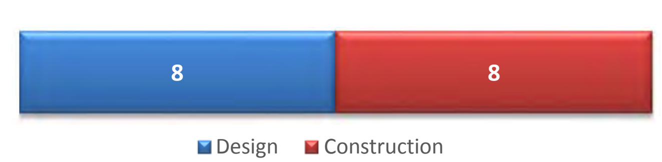
Project Drivers:

Analysis of the existing system indicates that the Owen and Schroeder ESTs do not float together. This is due to high headloss in the water lines supplying the Schroeder EST. The new transmission line to the Schroeder EST reduces headlosses in the surrounding water lines and increases the supply to allow the tanks to float more closely together.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	12,500	LF	$192	$2,400,000
2	38" Boring and Casing	1,000	LF	$665	$665,000
3	16" Water Line and Appurtenances	3,000	LF	$128	$384,000
4	Right-of-Way (20' Easement)	15,500	LF	$20	$310,000
5	Pavement Repair (12' wide)	15,000	LF	$80	$1,200,000

Project Timing (months)



	SUBTOTAL:	**$4,959,000**
MOBILIZATION	5%	$247,950
	SUBTOTAL:	**$5,206,950**
CONTINGENCY	25%	$1,301,740
	SUBTOTAL:	**$6,508,690**
ENG/SURVEY	12%	$781,050
	SUBTOTAL:	**$7,289,740**

Estimated Total Project Cost: $7,289,740

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2020 Capital Improvement Plan
Project Name

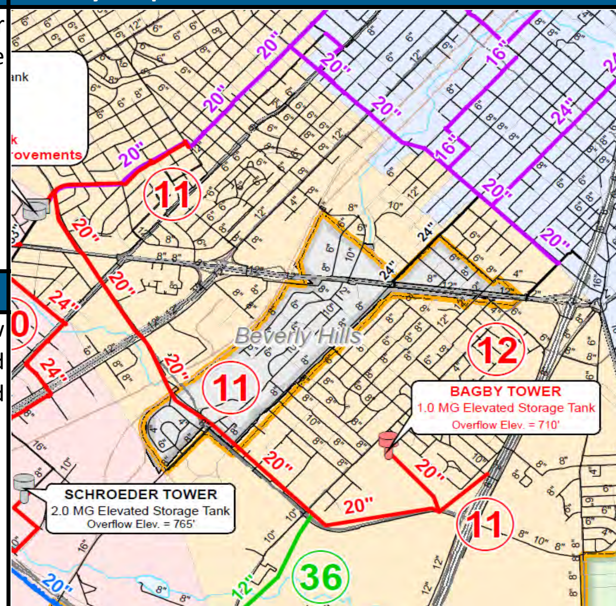
Project # 11

16-inch, 20-inch, and 24-inch Water Lines in PP 2

Project Description

This project is a new 24-inch, 20-inch, and 16-inch water transmission line connecting the proposed 0.75 MG Bagby EST to the Westview GST.

Vicinity Map:



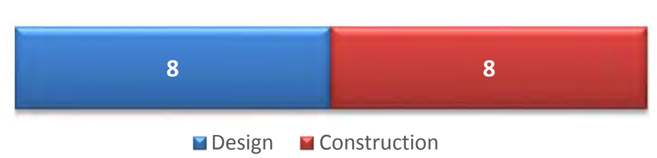
Project Drivers:

The southern portion of PP2 is served via PRVs which convey flow from PP3 to PP2. The proposed 24/20/16-inch water line is required to tie the proposed Bagby EST into the distribution system and eliminate the need to operate the PRVs to meet future demands.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	5,100	LF	$192	$979,200
2	38" Boring and Casing	450	LF	$665	$299,250
3	20" Water Line and Appurtenances	18,400	LF	$160	$2,944,000
4	34" Boring and Casing	1,500	LF	$595	$892,500
5	16" Water Line and Appurtenances	200	LF	$128	$25,600
6	Right-of-Way (20' Easement)	23,700	LF	$20	$474,000
7	Pavement Repair (12' wide)	15,000	LF	$80	$1,200,000

Project Timing (months)



		SUBTOTAL:	**$6,814,550**
MOBILIZATION	5%		$340,730
		SUBTOTAL:	**$7,155,280**
CONTINGENCY	25%		$1,788,820
		SUBTOTAL:	**$8,944,100**
ENG/SURVEY	12%		$1,073,300
		SUBTOTAL:	**$10,017,400**

Estimated Total Project Cost: $10,017,400

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2020 Capital Improvement Plan
Project Name

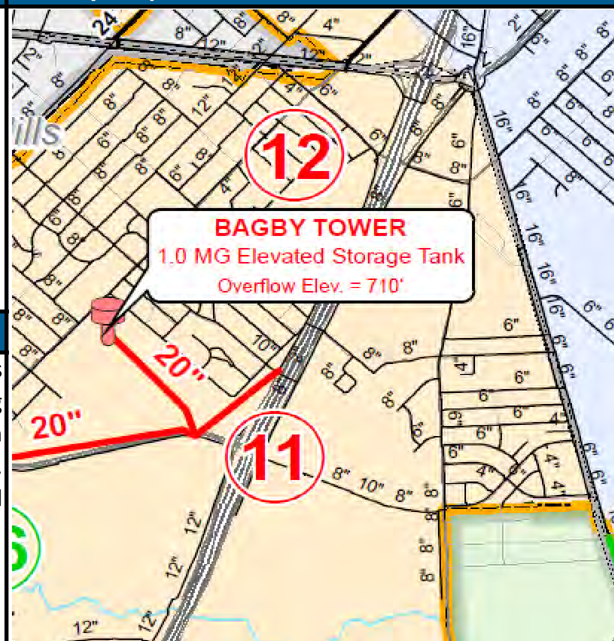
Project # 12

1.0 MG Bagby Elevated Storage Tank in PP2

Project Description

This project is a new 1.0 MG EST located on Bagby Ave. in PP2.

Vicinity Map:



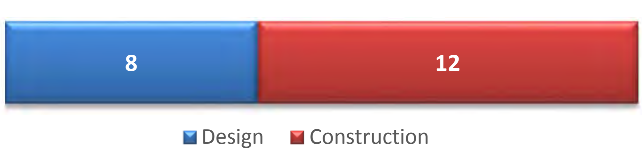
Project Drivers:

Based on the future elevated storage capacity evaluation, PP 2 has inadequate elevated storage to meet future demands. The existing Park Lane EST and Hillcrest PS are unable to serve the southern portion of PP2. PRVs are currently required to convey flow from PP3. The proposed Bagby EST would eliminate the need for the PRVs and meet the future elevated storage capacity needs of PP2.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1.0 MG Elevated Storage Tank	1	LS	$1,617,000	$1,617,000

Project Timing (months)



	SUBTOTAL:	**$1,617,000**
MOBILIZATION	5%	$80,850
	SUBTOTAL:	**$1,697,850**
CONTINGENCY	25%	$424,470
	SUBTOTAL:	**$2,122,320**
ENG/SURVEY	12%	$254,680
	SUBTOTAL:	**$2,377,000**

Estimated Total Project Cost: $2,377,000

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2020 Capital Improvement Plan
Project Name

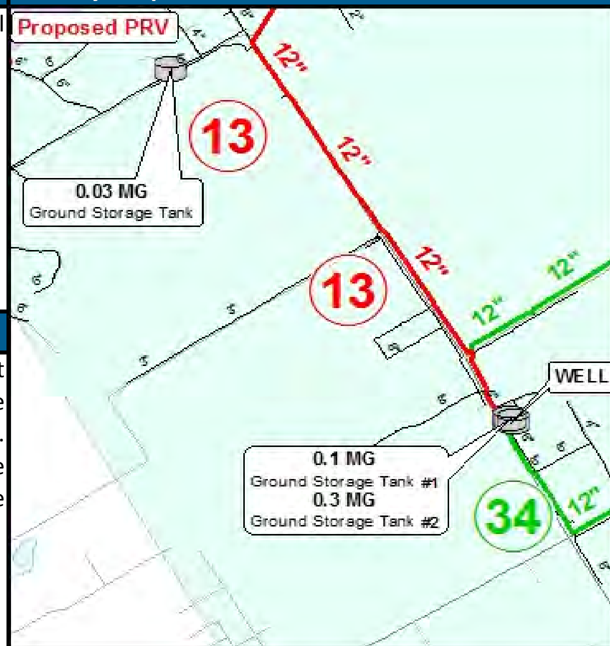
Project # 13

12-inch Water Line in PP4

Project Description

This project is a new 12-inch water line along F.M. 2837 from Chapel Road to Bluebonnett Lane in PP4.

Vicinity Map:



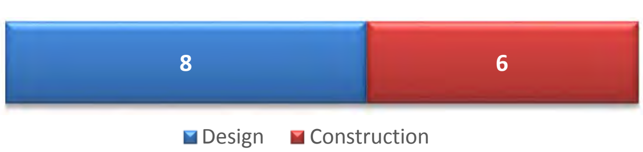
Project Drivers:

The City of Waco recently began providing service to the area west of Hewitt. This area of Waco is growing at a rapid rate. The infrastructure is not sized to be able to serve the proposed increase. The addition of the new 12-inch water line will extend water service in this area and allow the City of Waco to turn over control of the ground water wells that are owned by the City of Hewitt.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Water Line and Appurtenances	9,100	LF	$96	$873,600
2	20" Boring and Casing	50	LF	$350	$17,500
3	Right-of-Way (20' Easement)	9,100	LF	$20	$182,000
4	Pavement Repair (12' wide)	9,100	LF	$80	$728,000

Project Timing (months)



	SUBTOTAL:	**$1,801,100**
MOBILIZATION	5%	$90,060
	SUBTOTAL:	**$1,891,160**
CONTINGENCY	25%	$472,790
	SUBTOTAL:	**$2,363,950**
ENG/SURVEY	12%	$283,680
	SUBTOTAL:	**$2,647,630**

Estimated Total Project Cost: $2,647,630

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2020 Capital Improvement Plan
Project Name

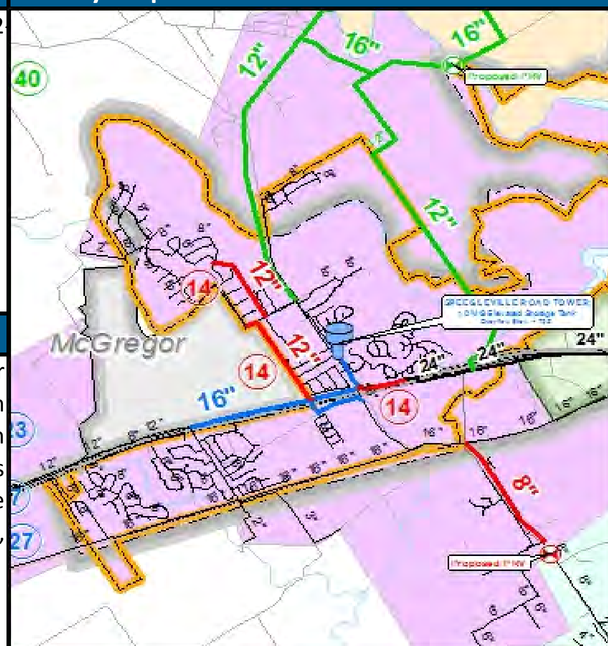
Project # 14

24-inch and 12-inch Water Lines in PP6

Project Description

This project is a new 24-inch along SH 84 east of Church Road and 12-inch Water lines along Bosque Lane north of SH 84 in PP6.

Vicinity Map:



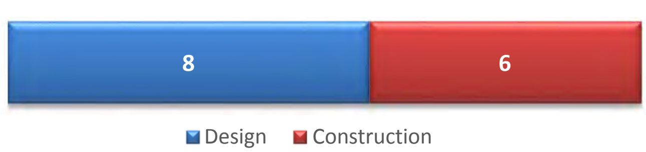
Project Drivers:

he proposed 24-inch line replaces an existing 16-inch to allow for increased conveyance to the proposed Speegleville Road Tower from the proposed Low Head PS at the Old McGregor PS site. Based on the existing system analysis the northern portion of PP6 water lines had excessive headloss during the maximum day scenario. The proposed 12-inch water lines will reduce the headloss in this area, resulting in improved water pressure.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	1,900	LF	$192	$364,800
2	16" Water Line and Appurtenances	1,600	LF	$128	$204,800
3	12" Water Line and Appurtenances	7,500	LF	$96	$720,000
4	38" Boring and Casing	50	LF	$665	$33,250
5	Right-of-Way (20' Easement)	11,000	LF	$20	$220,000
6	Pavement Repair (12' wide)	11,000	LF	$80	$880,000

Project Timing (months)



	SUBTOTAL:	**$2,422,850**
MOBILIZATION	5%	$121,150
	SUBTOTAL:	**$2,544,000**
CONTINGENCY	25%	$636,000
	SUBTOTAL:	**$3,180,000**
ENG/SURVEY	12%	$381,600
	SUBTOTAL:	**$3,561,600**

Estimated Total Project Cost: $3,561,600

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2020 Capital Improvement Plan
Project Name

Project # 15

72-inch Parallel Raw Water Line

Project Description
This project consists of a new parallel 72-inch raw water line from the Lake Waco Dam to the DAF Plant

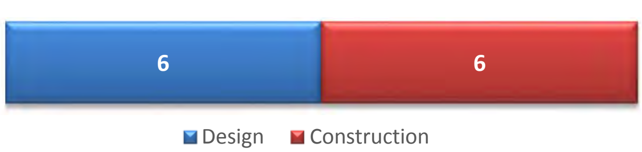
Project Drivers:
The existing 72-inch raw water line that feeds the DAF is in poor condition and has a leak. A new 72-inch line will allow for the repair of the existing raw water line and provide a redundant feed to the DAF.

Vicinity Map:


Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	72" Water Line and Appurtenances	1,500	LF	$576	$864,000
2	Right-of-Way (20' Easement)	1,500	LF	$20	$30,000

Project Timing (months)



		SUBTOTAL:	$894,000
MOBILIZATION	5%		$44,700
		SUBTOTAL:	$938,700
CONTINGENCY	25%		$234,680
		SUBTOTAL:	$1,173,380
ENG/SURVEY	12%		$140,810
		SUBTOTAL:	$1,314,190

Estimated Total Project Cost: $1,314,190

City of Waco

Prioritized CIP Project Summary
October 9, 2015

2020 Capital Improvement Plan

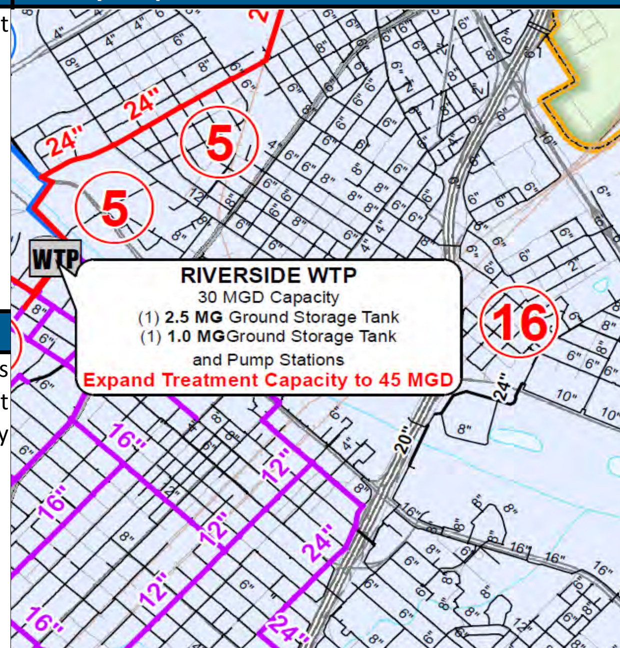
Project Name | **Project #** 16

Expand Riverside Treatment Capacity to 45 MGD

Project Description

Expand the treatment capacity of the Riverside Water Treatment Plant to 45 MGD

Vicinity Map:



Project Drivers:

The current rated capacity of the Riverside Water Treatment Plant is 28 MGD. The buildout capacity of the WTP is 45 MGD. This project will increase the capacity from 28 MGD to 45 MGD to help the City meet the treated water demand in 2040.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Expanded Treatment Capacity to 45 MGD	1	LS	$7,050,000	$7,050,000
				SUBTOTAL:	**$7,050,000**
		MOBILIZATION		5%	$352,500
				SUBTOTAL:	**$7,402,500**
		CONTINGENCY		25%	$1,850,630
				SUBTOTAL:	**$9,253,130**
		ENG/SURVEY		12%	$1,110,380
				SUBTOTAL:	**$10,363,510**

Estimated Total Project Cost: **$10,363,510**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2020 Capital Improvement Plan
Project Name — **Project # 17**

Pilot Leak Detection Study

Project Description
Pilot Leak Detection Study

Vicinity Map:

Project Drivers:
Leak detection studies are designed to help utilities inexpensively find where water is leaking in the system without having to dig up pipelines and other infrastructure. Finding where water is leaking at the Mt. Carmel WTP will help the City save money from lost water supplies, as well as, realize the full capacity of the plant.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pilot Leak Detection Study	1	LS	$36,000	$36,000
				SUBTOTAL:	$36,000
		MOBILIZATION		5%	$1,800
				SUBTOTAL:	$37,800
		CONTINGENCY		25%	$9,450
				SUBTOTAL:	$47,250
		ENG/SURVEY		12%	$5,670
				SUBTOTAL:	$52,920

Estimated Total Project Cost: $52,920

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2020 Capital Improvement Plan
Project Name
Project # 18

Citywide Automatic Meter Reading

Project Description
Replace all meters in the City with Automatic Meter Reading systems.

Vicinity Map:

Project Drivers:
Automatic Meter Reading Systems is technology that automatically collects consumption, diagnostic, and status data from water meters throughout the City. The technology minimizes the time required by City staff to collect water meter data from the field.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Automatic Meter Reading	1	LS	$14,000,000	$14,000,000

		SUBTOTAL:	**$14,000,000**
MOBILIZATION	5%		$700,000
		SUBTOTAL:	**$14,700,000**
CONTINGENCY	25%		$3,675,000
		SUBTOTAL:	**$18,375,000**
ENG/SURVEY	12%		$2,205,000
		SUBTOTAL:	**$20,580,000**

Estimated Total Project Cost: $20,580,000

City of Waco

Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2030 Capital Improvement Plan

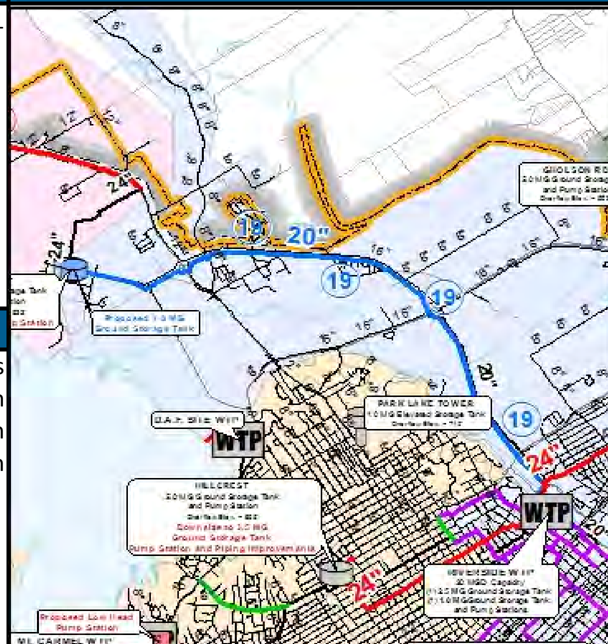
Project Name | **Project # 19**

20-inch Parallel Water Line in PP1

Project Description

This project consists of a new 20-inch water line along F.M. 3051 from the Riverside WTP to Airport GST.

Vicinity Map:



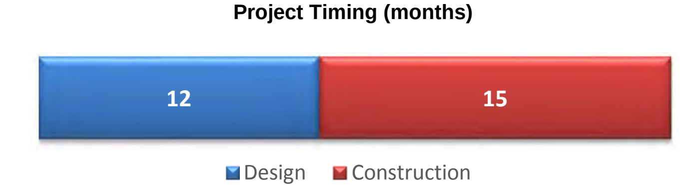
Project Drivers:

During maximum day existing system conditions, model results indicates that it is difficult convey water to the Airport PS & GST from the Riverside WTP. This project will increase the transmission capacity to the Airport Ground PS & GST to meet future demands in PP5.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	35,800	LF	$160	$5,728,000
2	33" Water Line and Appurtenances	1,100	LF	$264	$290,400
3	Right-of-Way (20' Easement)	36,900	LF	$20	$738,000
4	Pavement Repair (12' wide)	35,000	SY	$80	$2,800,000

Project Timing (months)



SUBTOTAL:		**$9,556,400**
MOBILIZATION	5%	$477,820
SUBTOTAL:		**$10,034,220**
CONTINGENCY	25%	$2,508,560
SUBTOTAL:		**$12,542,780**
ENG/SURVEY	12%	$1,505,140
SUBTOTAL:		**$14,047,920**

Estimated Total Project Cost: $14,047,920

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2030 Capital Improvement Plan
Project Name

Project # **20**

1.0 MG Ground Storage Tank at Airport Pump Station

Project Description

This project consists of a new 1.0 MG GST located at the Airport PS & GST.

Vicinity Map:

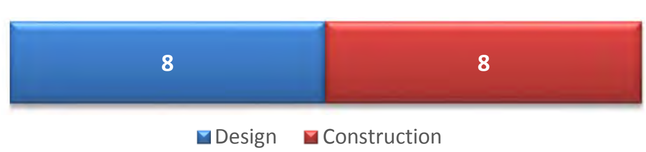
Project Drivers:

Based on analysis of the ground storage capacity at the Airport Pump Station, there is insufficient ground storage capacity to meet future customers in PP5. The addition of a 1.0 MG GST meets existing and future ground storage capacity needs.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1 MG Ground Storage Tank	1	LS	$600,000	$600,000

Project Timing (months)



	SUBTOTAL:	**$600,000**
MOBILIZATION	5%	$30,000
	SUBTOTAL:	**$630,000**
CONTINGENCY	25%	$157,500
	SUBTOTAL:	**$787,500**
ENG/SURVEY	12%	$94,500
	SUBTOTAL:	**$882,000**

Estimated Total Project Cost: **$882,000**

City of Waco

Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2030 Capital Improvement Plan

Project Name | **Project #** 21

24-inch Replacement Water Line in PP3

Project Description

This project consists of a replacement of the existing 16-inch water line in PP3 along Mt. Carmel Drive from the Mt. Carmel WTP to Fish Pond Road with a new 24-inch transmission water line.

Project Drivers:

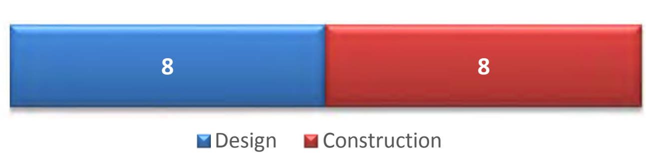
Based on future system improvements, the Westview PS will only serve PP3 in emergency situations and Mt. Carmel WTP will serve the entire PP3 service area. Model results indicate that due to aging infrastructure in PP3, there are high headlosses in the water lines between Mt. Carmel and the southern portion of PP3. The proposed 24-inch water line replaces the existing 16-inch water line which increases the water supply to the middle and southern portions of PP3 from the Mt. Carmel WTP. This project will also support future growth on the westside of Lake Waco in future PP7.

Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	30" Water Line and Appurtenances	1,500	LF	$240	$360,000
2	24" Water Line and Appurtenances	8,300	LF	$192	$1,593,600
3	38" Boring and Casing	700	LF	$665	$465,500
4	Right-of-Way (20' Easement)	9,800	LF	$20	$196,000
5	Pavement Repair (12' wide)	7,300	LF	$80	$584,000

Project Timing (months)



	SUBTOTAL:	**$3,199,100**
MOBILIZATION	5%	$159,960
	SUBTOTAL:	**$3,359,060**
CONTINGENCY	25%	$839,770
	SUBTOTAL:	**$4,198,830**
ENG/SURVEY	12%	$503,860
	SUBTOTAL:	**$4,702,690**

Estimated Total Project Cost: $4,702,690

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2030 Capital Improvement Plan

Project Name

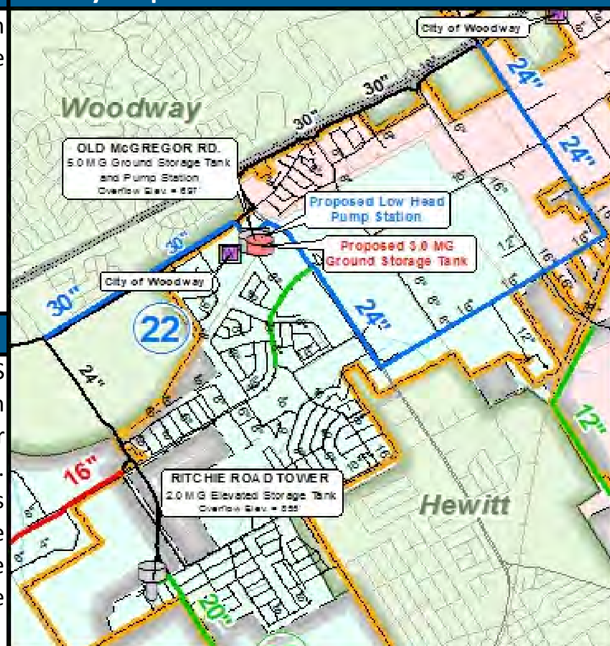
Project # 22

30-inch Parallel Water Line in PP4

Project Description

This projects consists of a parallel of an existing 24-inch water line in PP4 along Old McGregor Road from the Old McGregor PS to Ritchie Road with a new 30-inch water line to supply the future PP6.

Vicinity Map:



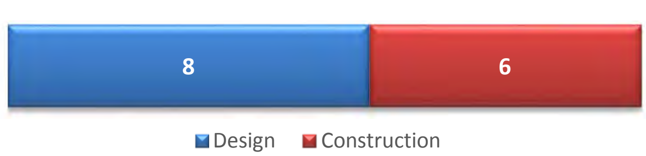
Project Drivers:

The northern portion of PP4 is served by the Old McGregor PS through two PRVs due to the areas lower ground elevation compared to the rest of PP4. The proposed parallel 30-inch water line provides a dedicated supply line to the area north of SH 84. Upon completion of the proposed pump station improvements (project 21) at the Old McGregor PS the area north of SH 84 will be incorporated into future PP6 and the existing PRVs can be abandoned. The proposed 20-inch water line is sized to meet future demands in PP6 and future PP7 on the westside of Lake Waco.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	30" Water Line and Appurtenances	7,000	LF	$240	$1,680,000
2	48" Boring and Casing	400	LF	$840	$336,000
3	Right-of-Way (20' Easement)	7,000	LF	$20	$140,000
4	Pavement Repair (12' wide)	6,200	LF	$80	$496,000

Project Timing (months)



	SUBTOTAL:	**$2,652,000**
MOBILIZATION	5%	$132,600
	SUBTOTAL:	**$2,784,600**
CONTINGENCY	25%	$696,150
	SUBTOTAL:	**$3,480,750**
ENG/SURVEY	12%	$417,690
	SUBTOTAL:	**$3,898,440**

Estimated Total Project Cost: $3,898,440

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2030 Capital Improvement Plan
Project Name

Project # 23

1.0 MG Elevated Storage Tank in PP6

Project Description

This project consists of a new 1.0 MG elevated storage tank in PP6 east Speegleville Road & Wheatland Drive.

Project Drivers:

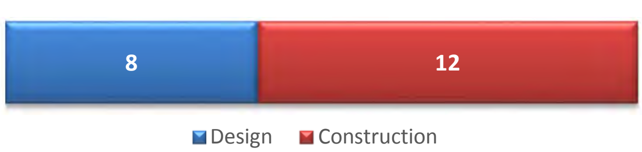
The northern portion of PP4 is served by the Old McGregor PS through two PRVs due to the areas lower ground elevation compared to the rest of PP4. The proposed 1.0 MG EST provides dedicated elevated storage to the area north of SH 84. Upon completion of the proposed pump station improvements (project 21) at the Old McGregor PS the area north of SH 84 will be incorporated into future PP6 and the existing PRVs can be abandoned. Based on the City's elevated storage requirements, the proposed 1.0 MG EST is sized to meet projected 2040 planning year

Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1.0 MG Elevated Storage Tank	1	LS	$1,617,000	$1,617,000

Project Timing (months)



	SUBTOTAL:	**$1,617,000**
MOBILIZATION	5%	$80,850
	SUBTOTAL:	**$1,697,850**
CONTINGENCY	25%	$424,470
	SUBTOTAL:	**$2,122,320**
ENG/SURVEY	12%	$254,680
	SUBTOTAL:	**$2,377,000**

Estimated Total Project Cost: $2,377,000

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2030 Capital Improvement Plan
Project Name

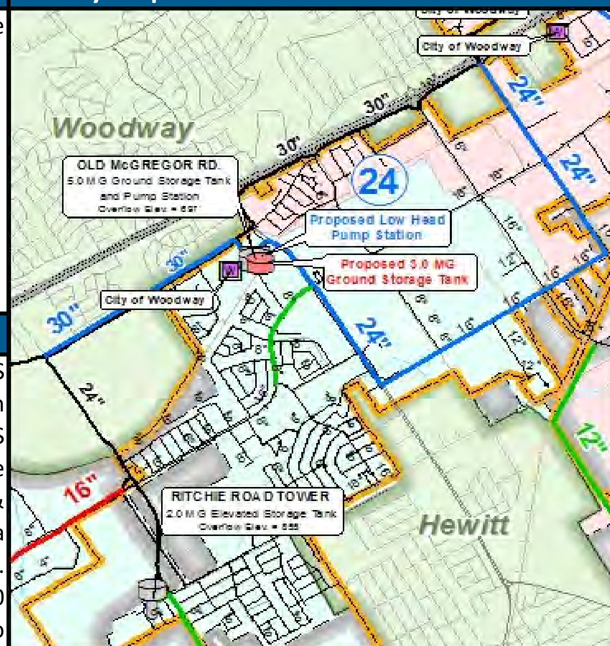
Project # 24

8.0 MGD Low Head Pump Station at McGregor Pump Station

Project Description

This project consists of a new 8.0 MGD low head pump station at the Old McGregor PS site to supply PP6.

Vicinity Map:



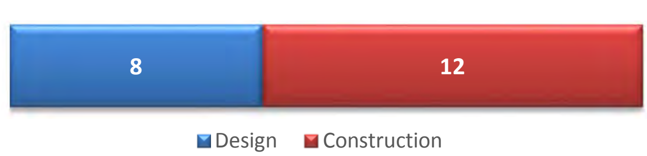
Project Drivers:

The northern portion of PP4 is served by the Old McGregor PS through two PRVs due to the areas lower ground elevation compared to the rest of PP4. The proposed 8.0 MGD low head PS provides dedicated pumping capacity to the area north of SH 84. The proposed pump station and additional improvements (project 18 & 19) will allow the City to operate the area north of SH 84 as a separate proposed PP6 and the existing PRVs can be abandoned. Based on the City's firm pumping requirements, the proposed 8.0 MGD low head pump station at the Old McGregor PS site is sized to

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pump Station - New 8.0 MGD	1	LS	$2,500,000	$2,500,000

Project Timing (months)



	SUBTOTAL:	**$2,500,000**
MOBILIZATION	5%	$125,000
	SUBTOTAL:	**$2,625,000**
CONTINGENCY	25%	$656,250
	SUBTOTAL:	**$3,281,250**
ENG/SURVEY	12%	$393,750
	SUBTOTAL:	**$3,675,000**

Estimated Total Project Cost: $3,675,000

City of Waco

Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2030 Capital Improvement Plan

Project Name **Project #** **25**

20-inch/24-inch Replacement Water Line in PP3

Project Description

This project consists of a replacement of the existing 16-inch water line with a 20/24-inch water line along SH 6 from American Plaza to Exchange Parkway in PP3.

Vicinity Map:

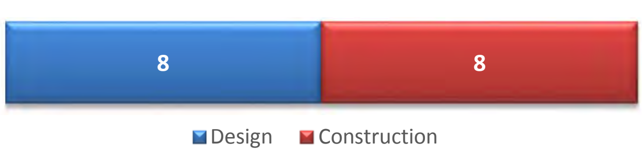
Project Drivers:

The wholesale water demand for the City of Robinson is projected to rise by 2040. Based on model results the purposed project will provide the transmission capacity required to meet this wholesale demand as well as improve water supply to the southern portion of PP3.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	4,500	LF	$192	$864,000
2	20" Water Line and Appurtenances	4,400	LF	$160	$704,000
3	38" Boring and Casing	650	LF	$665	$432,250
4	33" Water Line and Appurtenances	50	LF	$264	$13,200
5	Right-of-Way (20' Easement)	9,000	LF	$20	$180,000
6	Pavement Repair (12' wide)	8,900	LF	$80	$712,000

Project Timing (months)



		SUBTOTAL:	$2,905,450
MOBILIZATION	5%		$145,280
		SUBTOTAL:	$3,050,730
CONTINGENCY	25%		$762,690
		SUBTOTAL:	$3,813,420
ENG/SURVEY	12%		$457,620
		SUBTOTAL:	$4,271,040

Estimated Total Project Cost: $4,271,040

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2030 Capital Improvement Plan
Project Name

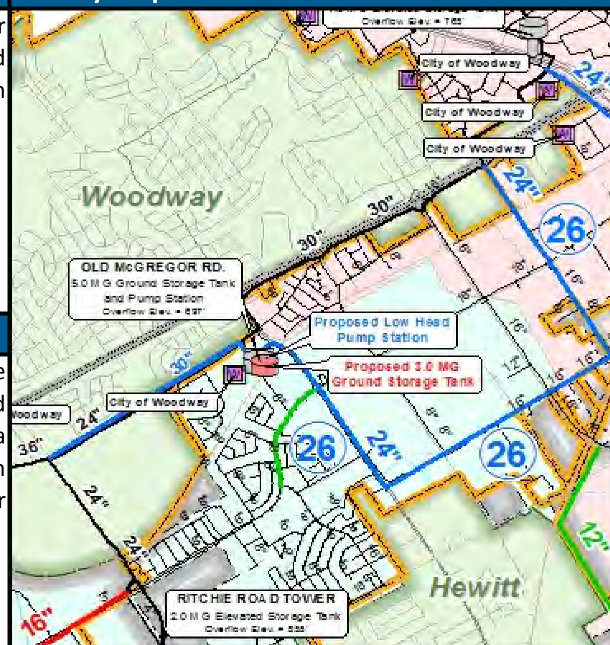
Project # 26

24-inch Water Line in PP3

Project Description

This project consists of a replacement of the existing 16 -inch water line along Jewell Drive then southwest along Mars Drive and northwest F.M. 1695 to the Old McGregor PS with a new 24-inch water line in PP3.

Vicinity Map:



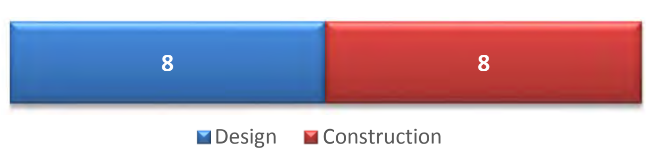
Project Drivers:

Based on model results the Old McGregor PS site will require additional supply and transmission capacity to meet the projected City and Wholesale 2040 demands. This project will provide a dedicated supply line for the proposed low head pump station (project 21) at the Old McGregor PS site to meet 2040 demands for PP6 and PP7.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	19,900	LF	$192	$3,820,800
2	38" Boring and Casing	550	LF	$665	$365,750
3	Right-of-Way (20' Easement)	19,900	LF	$20	$398,000
4	Pavement Repair (12' wide)	19,000	LF	$80	$1,520,000

Project Timing (months)



	SUBTOTAL:	**$6,104,550**
MOBILIZATION	5%	$305,230
	SUBTOTAL:	**$6,409,780**
CONTINGENCY	25%	$1,602,450
	SUBTOTAL:	**$8,012,230**
ENG/SURVEY	12%	$961,470
	SUBTOTAL:	**$8,973,700**

Estimated Total Project Cost: $8,973,700

City of Waco

Prioritized CIP Project Summary
October 9, 2015

2030 Capital Improvement Plan
Project Name

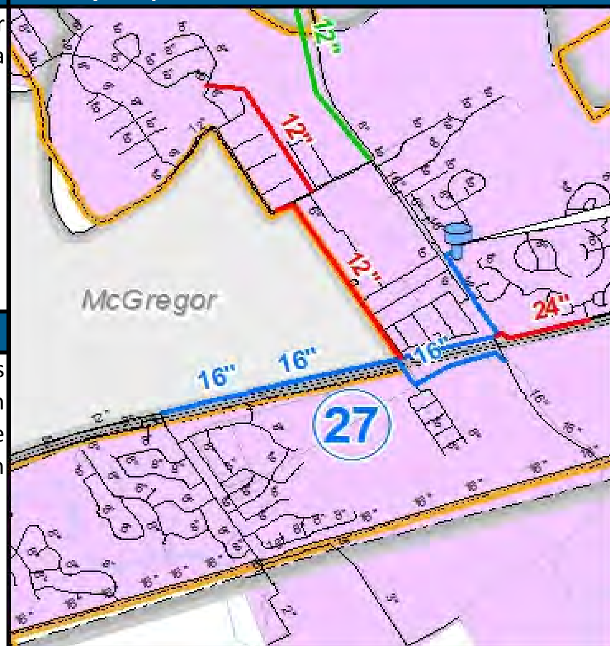
Project # 27

16-inch Replacement Water Line along HWY 84 in PP6

Project Description

This project consists of a replacement of the existing 12-inch water line along US 84 from Speegleville Road to Harris Creek Road with a new 16-inch water line in PP6.

Vicinity Map:

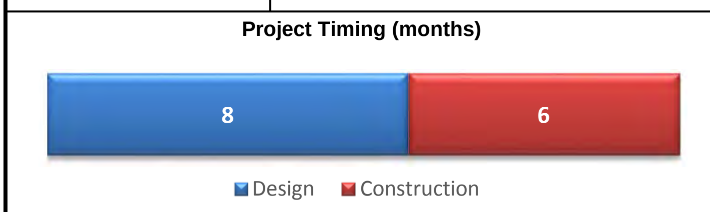


Project Drivers:

Based on model results the existing 12-inch water line has insufficient capacity to meet projected 2040 water demands in western portion of PP6. The proposed project will increase transmission capacity and increase available fire flow to this portion of PP6.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	2,400	LF	$192	$460,800
2	16" Water Line and Appurtenances	9,200	LF	$128	$1,177,600
3	38" Boring and Casing	50	LF	$665	$33,250
4	34" Boring and Casing	400	LF	$595	$238,000
5	Right-of-Way (20' Easement)	11,600	LF	$20	$232,000
6	Pavement Repair (12' wide)	11,600	LF	$80	$928,000



	SUBTOTAL:	$3,069,650
MOBILIZATION	5%	$153,490
	SUBTOTAL:	$3,223,140
CONTINGENCY	25%	$805,790
	SUBTOTAL:	$4,028,930
ENG/SURVEY	12%	$483,480
	SUBTOTAL:	$4,512,410

Estimated Total Project Cost: $4,512,410

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

Project # 28

9.0 MGD Mt. Carmel H.S.P.S. Firm Capacity Expansion

Project Description

This project consists of a 9.0 MGD expansion of the H.S.P.S. firm capacity at the Mt. Carmel WTP, in PP3, from 60 MGD to 69 MGD.

Vicinity Map:

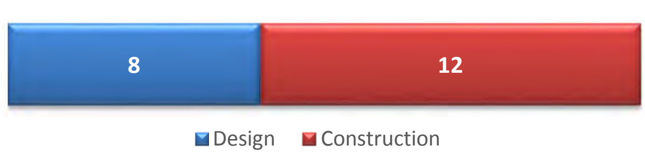
Project Drivers:

Based on the firm pumping capacity requirements, the Mt. Carmel H.S.P.S as insufficient capacity to meet the projected 2040 water demands of PP3, 4, 6, and 7 in addition to the wholesale customer demands. This project expands the firm capacity of the pump station to meet these projected demands.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pump Station - Expansion 9 MGD	1	LS	$1,000,000	$1,000,000

Project Timing (months)



	SUBTOTAL:	**$1,000,000**
MOBILIZATION	5%	$50,000
	SUBTOTAL:	**$1,050,000**
CONTINGENCY	25%	$262,500
	SUBTOTAL:	**$1,312,500**
ENG/SURVEY	12%	$157,500
	SUBTOTAL:	**$1,470,000**

Estimated Total Project Cost: $1,470,000

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2040 Capital Improvement Plan

Project Name

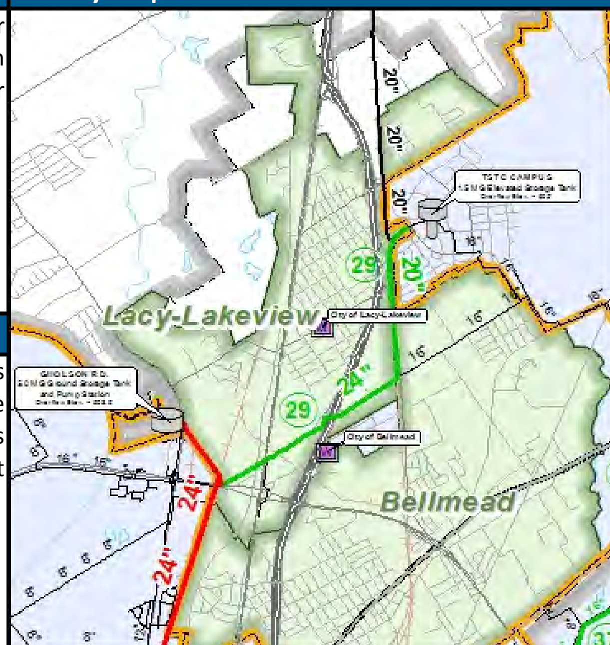
Project # 29

20-inch/24-inch Replacement Water Line in PP1

Project Description

This project consists of a replacement of the existing 16-inch water line along Meyers Lane from Industrial Boulevard to F.M. 2418 then north along F.M. 2418 to the TSTC EST with a new 20/24-inch water line in PP1.

Vicinity Map:



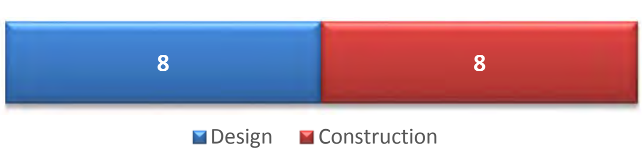
Project Drivers:

Based on the existing system analysis the 16-inch water line has insufficient capacity which resulted in excess headloss and the inability to maintain the TSTC tank level during peak demands. This project will provide additional supply to the TSTC tank to meet future growth.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	8,400	LF	$192	$1,612,800
2	20" Water Line and Appurtenances	6,700	LF	$160	$1,072,000
3	38" Boring and Casing	1,300	LF	$665	$864,500
4	Right-of-Way (20' Easement)	15,100	LF	$20	$302,000
5	Pavement Repair (12' wide)	15,000	LF	$80	$1,200,000

Project Timing (months)



	SUBTOTAL:	**$5,051,300**
MOBILIZATION	5%	$252,570
	SUBTOTAL:	**$5,303,870**
CONTINGENCY	25%	$1,325,970
	SUBTOTAL:	**$6,629,840**
ENG/SURVEY	12%	$795,590
	SUBTOTAL:	**$7,425,430**

Estimated Total Project Cost: $7,425,430

City of Waco

Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan

Project Name | **Project # 30**

12-inch Water Lines in PP5

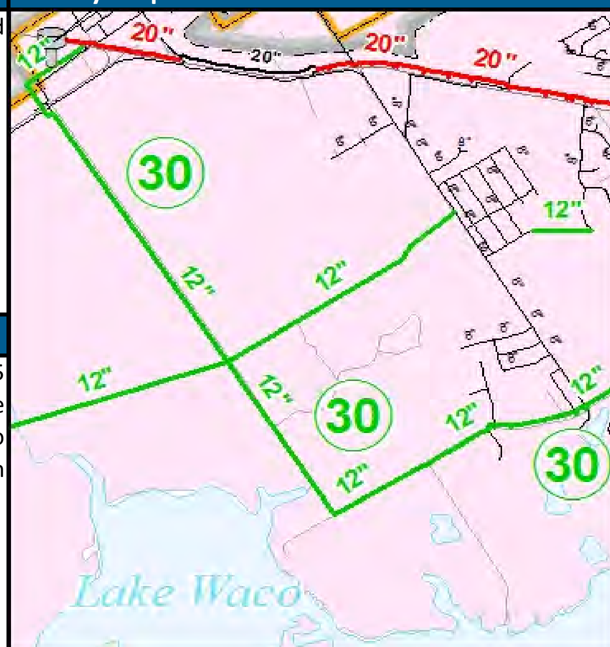
Project Description

This project consist of a new 12-inch water line from Flat Rock Road along Yankie Road to the FM 185 EST in PP5.

Project Drivers:

Based on the existing system analysis the northern portion of PP5 experiences water age related issues. This project will reduce these issues by providing additional looping and transmission capacity to FM 185 EST. In addition this project will serve future growth north of Lake Waco.

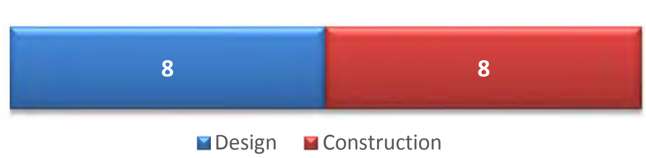
Vicinity Map:



Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Water Line and Appurtenances	19,800	LF	$96	$1,900,800
2	20" Boring and Casing	250	LF	$350	$87,500
3	Right-of-Way (20' Easement)	19,800	LF	$20	$396,000
4	Pavement Repair (12' wide)	19,500	LF	$80	$1,560,000

Project Timing (months)



	SUBTOTAL:	$3,944,300
MOBILIZATION	5%	$197,220
	SUBTOTAL:	$4,141,520
CONTINGENCY	25%	$1,035,380
	SUBTOTAL:	$5,176,900
ENG/SURVEY	12%	$621,230
	SUBTOTAL:	$5,798,130

Estimated Total Project Cost: $5,798,130

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

Project # **31**

20-inch Water Line in PP2

Project Description

This project consists of a new 20-inch water line from Lake Shore Drive along Hillcrest Drive to Cobbs Drive in PP2.

Project Drivers:

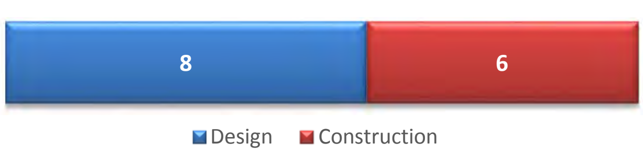
This project connects the existing 16-inch along Lake Shore Drive to the existing 36-inch along Cobbs Drive to provide looping and improved transmission capacity for the Hillcrest PS.

Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	6,100	LF	$160	$976,000
2	34" Boring and Casing	700	LF	$595	$416,500
3	Right-of-Way (20' Easement)	6,100	LF	$20	$122,000
4	Pavement Repair (12' wide)	6,100	LF	$80	$488,000

Project Timing (months)



	SUBTOTAL:	**$2,002,500**
MOBILIZATION	5%	$100,130
	SUBTOTAL:	**$2,102,630**
CONTINGENCY	25%	$525,660
	SUBTOTAL:	**$2,628,290**
ENG/SURVEY	12%	$315,400
	SUBTOTAL:	**$2,943,690**

Estimated Total Project Cost: $2,943,690

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP
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FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name

Project # **32**

20-inch Water Line Replacement in PP3

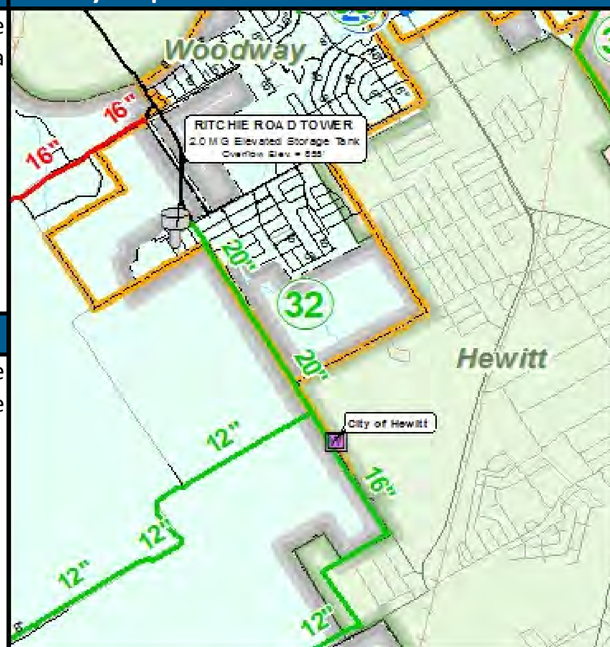
Project Description

This project replaces an existing 16-inch water line from the Ritchie Road Tower along Ritchie Road to the Hewitt delivery meter with a new 20-inch water line in PP3.

Project Drivers:

Based on 2040 model results additional transmission capacity will be required to serve the increased demand from the Hewitt wholesale customer and growth in the southern portion of PP3.

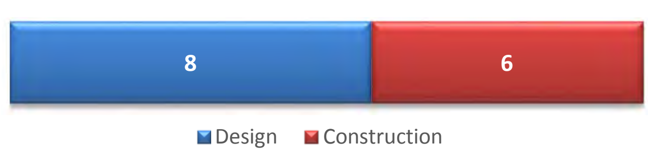
Vicinity Map:



Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	500	LF	$192	$96,000
2	38" Boring and Casing	50	LF	$665	$33,250
3	20" Water Line and Appurtenances	5,700	LF	$160	$912,000
4	34" Boring and Casing	200	LF	$595	$119,000
5	Right-of-Way (20' Easement)	6,200	LF	$20	$124,000
6	Pavement Repair (12' wide)	6,200	LF	$80	$496,000

Project Timing (months)



	SUBTOTAL:	**$1,780,250**
MOBILIZATION	5%	$89,020
	SUBTOTAL:	**$1,869,270**
CONTINGENCY	25%	$467,320
	SUBTOTAL:	**$2,336,590**
ENG/SURVEY	12%	$280,400
	SUBTOTAL:	**$2,616,990**

Estimated Total Project Cost: **$2,616,990**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name

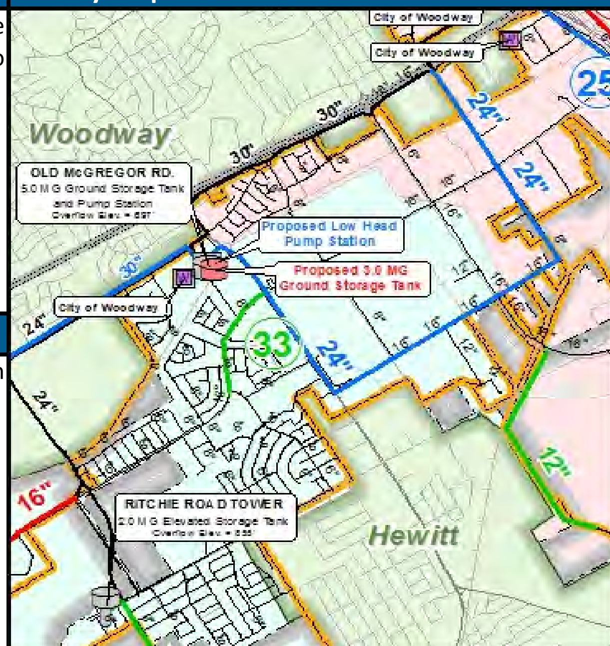
Project # 33

16-inch Replacement Water Line in PP4

Project Description

This project consists of a new 16-inch water line to replace the existing 12-inch water line from FM1695 along Chapel Road to Woodgate Drive in PP4.

Vicinity Map:



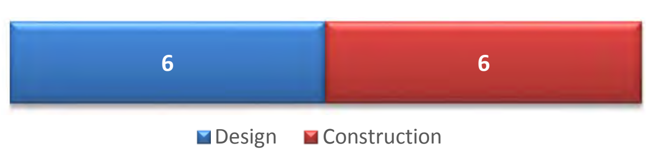
Project Drivers:

This project increases looping and provides additional transmission capacity for the Ole McGregor PS in PP4.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	3,400	LF	$128	$435,200
2	24" Boring and Casing	200	LF	$420	$84,000
3	Right-of-Way (20' Easement)	3,400	LF	$20	$68,000
4	Pavement Repair (12' wide)	3,400	LF	$80	$272,000

Project Timing (months)



		SUBTOTAL:	**$859,200**
MOBILIZATION	5%		$42,960
		SUBTOTAL:	**$902,160**
CONTINGENCY	25%		$225,540
		SUBTOTAL:	**$1,127,700**
ENG/SURVEY	12%		$135,330
		SUBTOTAL:	**$1,263,030**

Estimated Total Project Cost: $1,263,030

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

Project # 34

16-inch/12-inch Replacement Water Line in PP4

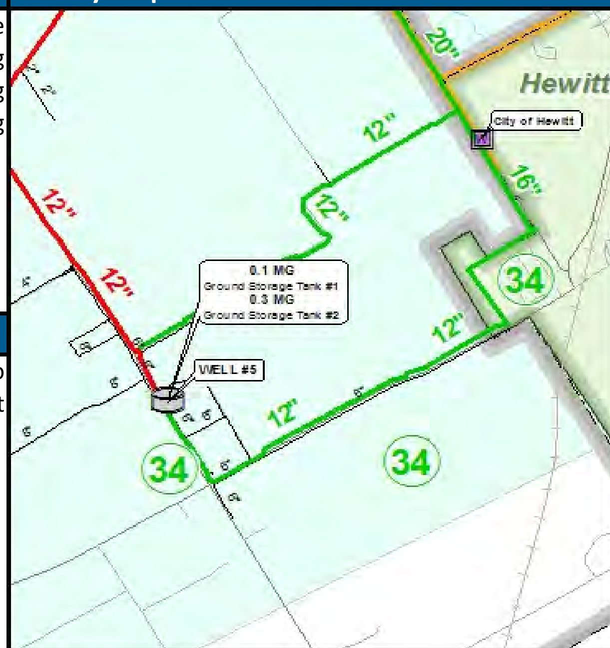
Project Description

This project consists of a new 16-inch water line to replace the existing 8-inch water line from the Hewitt wholesale meter along Ritchie Road to FM2113 then a new 12-inch water line along FM2113 to the proposed 12-inch water line (Project 13) along FM2837 in PP4.

Project Drivers:

This project provides additional transmission capacity and looping to serve the western portion of PP4 formerly served by the Hewitt water system.

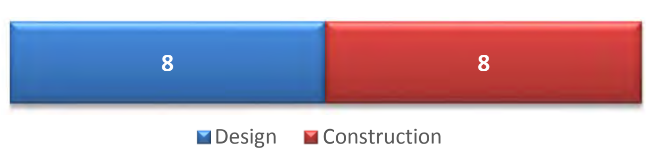
Vicinity Map:



Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	8,600	LF	$128	$1,100,800
2	12" Water Line and Appurtenances	12,400	LF	$96	$1,190,400
3	20" Boring and Casing	50	LF	$350	$17,500
4	Right-of-Way (20' Easement)	21,000	LF	$20	$420,000
5	Pavement Repair (12' wide)	19,000	LF	$80	$1,520,000

Project Timing (months)



	SUBTOTAL:	**$4,248,700**
MOBILIZATION	5%	$212,440
	SUBTOTAL:	**$4,461,140**
CONTINGENCY	25%	$1,115,290
	SUBTOTAL:	**$5,576,430**
ENG/SURVEY	12%	$669,180
	SUBTOTAL:	**$6,245,610**

Estimated Total Project Cost: $6,245,610

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

Project # 35

12-inch Water Line in PP4

Project Description

This project consists of a new 12-inch water line from Ritchie Road along Warren Road to FM 2837 in PP4.

Vicinity Map:

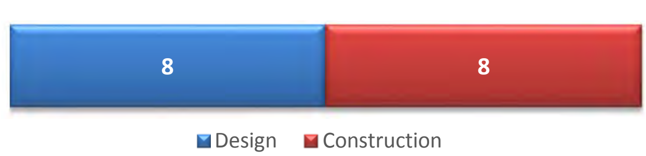
Project Drivers:

This project provides additional transmission capacity and looping to serve the western portion of PP4 formerly served by the Hewitt water system.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Water Line and Appurtenances	12,500	LF	$96	$1,200,000
2	20" Boring and Casing	100	LF	$350	$35,000
3	Right-of-Way (20' Easement)	12,500	LF	$20	$250,000
4	Pavement Repair (12' wide)	12,500	LF	$80	$1,000,000

Project Timing (months)



	SUBTOTAL:	**$2,485,000**
MOBILIZATION	5%	$124,250
	SUBTOTAL:	**$2,609,250**
CONTINGENCY	25%	$652,320
	SUBTOTAL:	**$3,261,570**
ENG/SURVEY	12%	$391,390
	SUBTOTAL:	**$3,652,960**

Estimated Total Project Cost: $3,652,960

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name
Project # 36

12-inch Water Line in PP2

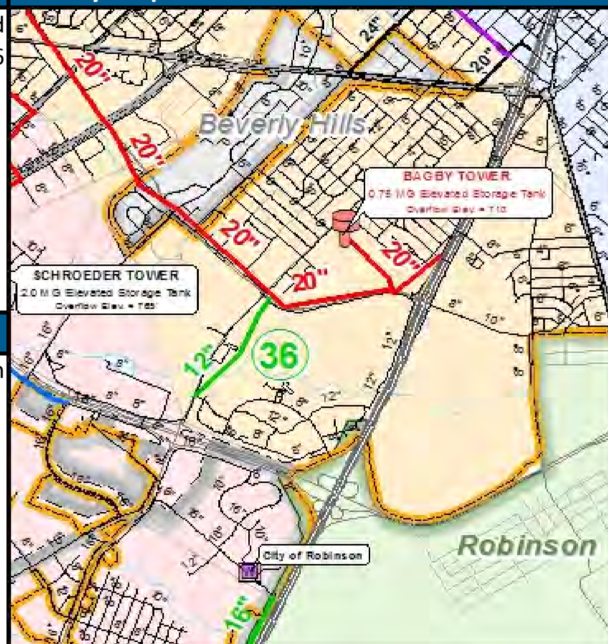
Project Description

This project consist of a new 12-inch water line from New Road along Bagby Avenue to the existing 12-inch water line north of SH 6 in PP2.

Project Drivers:

This project increases looping and provides additional transmission capacity for the proposed Bagby Tower (project 12) in PP4.

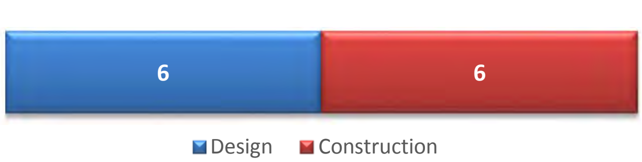
Vicinity Map:



Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Water Line and Appurtenances	3,700	LF	$96	$355,200
2	20" Boring and Casing	100	LF	$350	$35,000
3	Right-of-Way (20' Easement)	3,700	LF	$20	$74,000
4	Pavement Repair (12' wide)	3,700	LF	$80	$296,000

Project Timing (months)



	SUBTOTAL:	**$760,200**
MOBILIZATION	5%	$38,010
	SUBTOTAL:	**$798,210**
CONTINGENCY	25%	$199,560
	SUBTOTAL:	**$997,770**
ENG/SURVEY	12%	$119,740
	SUBTOTAL:	**$1,117,510**

Estimated Total Project Cost: $1,117,510

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name

Project # **37**

16-inch Water Line in PP1

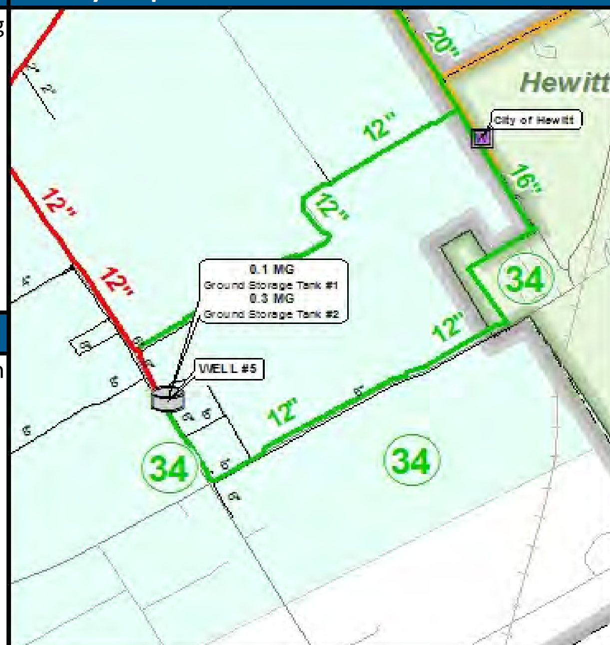
Project Description

This project consists of a new 16-inch water line from SH 340 along Selby Lane to Highway 84 in PP1.

Project Drivers:

This project increases looping and provides additional transmission capacity for the TSTC Tower in PP1.

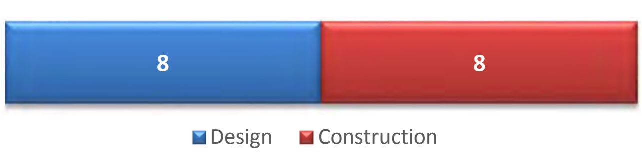
Vicinity Map:



Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	14,100	LF	$128	$1,804,800
2	24" Boring and Casing	200	LF	$420	$84,000
3	Right-of-Way (20' Easement)	14,100	LF	$20	$282,000
4	Pavement Repair (12' wide)	14,100	LF	$80	$1,128,000

Project Timing (months)



	SUBTOTAL:	**$3,298,800**
MOBILIZATION	5%	$164,940
	SUBTOTAL:	**$3,463,740**
CONTINGENCY	25%	$865,940
	SUBTOTAL:	**$4,329,680**
ENG/SURVEY	12%	$519,570
	SUBTOTAL:	**$4,849,250**

Estimated Total Project Cost: **$4,849,250**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name

Project # 38

16-inch and 12-inch Water Line in PP3

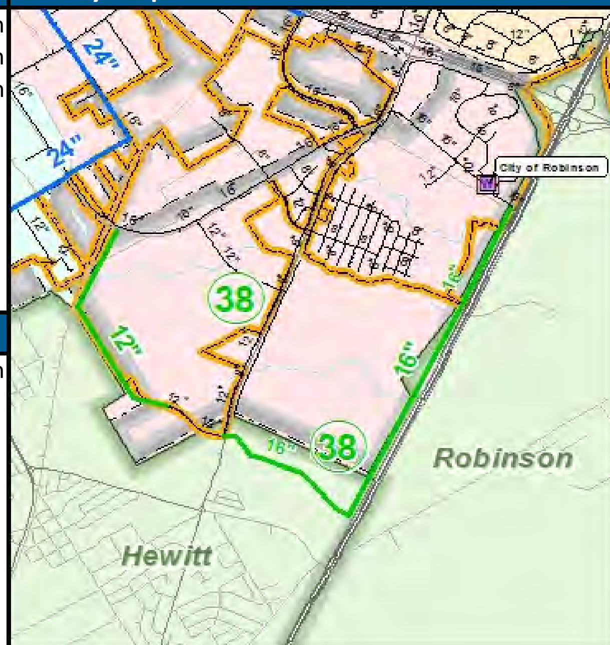
Project Description

This project consists of a new 16-inch water line from Corporation Parkway along IH 35 to Old Temple Highway and a new 12-inch water line from Old Temple Highway to Texas Central Parkway in PP3.

Project Drivers:

This project increases looping and provides additional transmission capacity to meet future growth in the southern portion PP3.

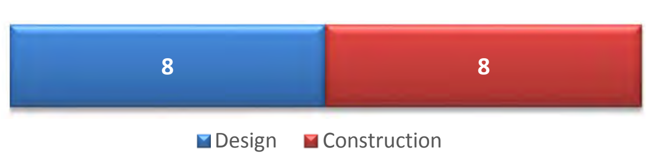
Vicinity Map:



Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	1,400	LF	$128	$179,200
2	12" Water Line and Appurtenances	6,300	LF	$96	$604,800
3	20" Boring and Casing	100	LF	$350	$35,000
4	Right-of-Way (20' Easement)	7,700	LF	$20	$154,000
5	Pavement Repair (12' wide)	7,500	LF	$80	$600,000

Project Timing (months)



		SUBTOTAL:	$1,573,000
	MOBILIZATION	5%	$78,650
		SUBTOTAL:	$1,651,650
	CONTINGENCY	25%	$412,920
		SUBTOTAL:	$2,064,570
	ENG/SURVEY	12%	$247,750
		SUBTOTAL:	$2,312,320

Estimated Total Project Cost: $2,312,320

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

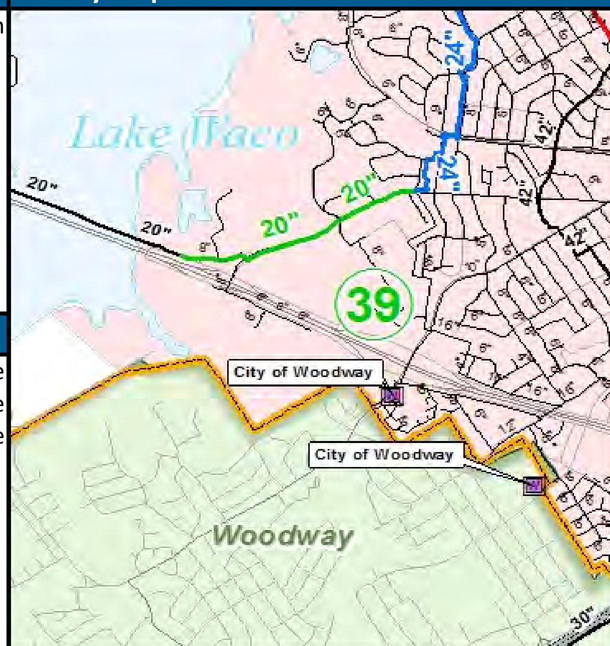
Project # 39

20-inch transmission Line in PP1

Project Description

This project consists of a new 20-inch water transmission line from Stoneleigh Road along Fish Pond Road to SH 6 in PP1.

Vicinity Map:



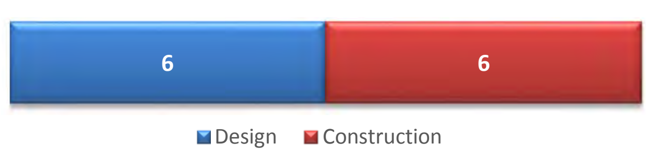
Project Drivers:

This project will provide transmission capacity to serve growth in the future PP7. This project connects the proposed 24-inch water line (project 13) to the existing 20-inch water line along the SH 6 bridge crossing Lake Waco.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	5,000	LF	$160	$800,000
2	34" Boring and Casing	200	LF	$595	$119,000
3	Right-of-Way (20' Easement)	5,000	LF	$20	$100,000
4	Pavement Repair (12' wide)	5,000	LF	$80	$400,000

Project Timing (months)



		SUBTOTAL:	**$1,419,000**
MOBILIZATION	5%		$70,950
		SUBTOTAL:	**$1,489,950**
CONTINGENCY	25%		$372,490
		SUBTOTAL:	**$1,862,440**
ENG/SURVEY	12%		$223,500
		SUBTOTAL:	**$2,085,940**

Estimated Total Project Cost: $2,085,940

City of Waco

Prioritized CIP Project Summary

October 9, 2015

THE WALLACE GROUP
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FREESE AND NICHOLS

2040 Capital Improvement Plan

Project Name

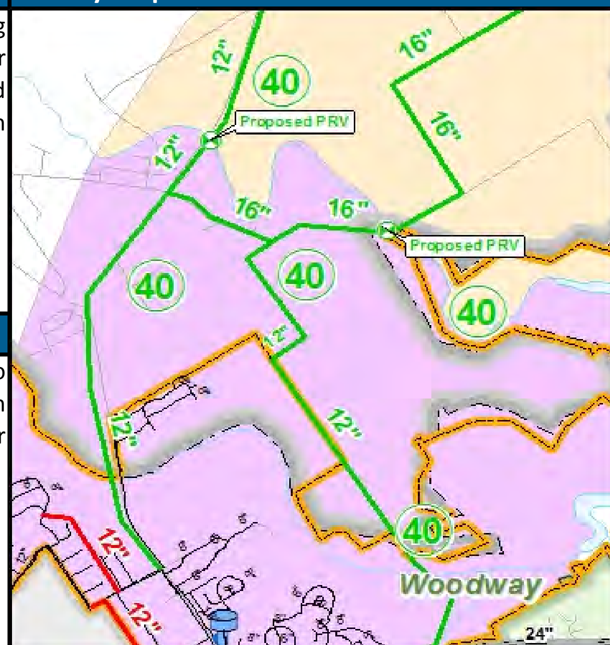
Project # 40

16-inch/12-inch Water Line and PRV Stations in PP6

Project Description

This project consists of a new 12-inch water line from SH 6 along Barrett Road to McLennan Crossing Road, a second 12-inch water line from CR430 along Speegleville Road to McLennan Crossing Road and 16-inch water line from Speegleville Road along McLennan Crossing Road to the PRV station in PP6.

Vicinity Map:



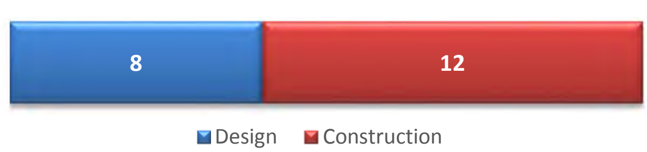
Project Drivers:

This project provides additional transmission capacity and looping to serve future development west of Lake Waco in the northern portion of PP6. This project also consists of 2 PRV stations to transfer water from PP6 to serve growth in the future PP7.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	6,400	LF	$128	$819,200
2	12" Water Line and Appurtenances	25,000	LF	$96	$2,400,000
3	PRV Station	2	LS	$50,000	$100,000
4	Right-of-Way (20' Easement)	31,400	LF	$20	$628,000
5	Pavement Repair (12' wide)	30,000	LF	$80	$2,400,000

Project Timing (months)



	SUBTOTAL:	**$6,347,200**
MOBILIZATION	5%	$317,360
	SUBTOTAL:	**$6,664,560**
CONTINGENCY	25%	$1,666,140
	SUBTOTAL:	**$8,330,700**
ENG/SURVEY	12%	$999,690
	SUBTOTAL:	**$9,330,390**

Estimated Total Project Cost: $9,330,390

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name

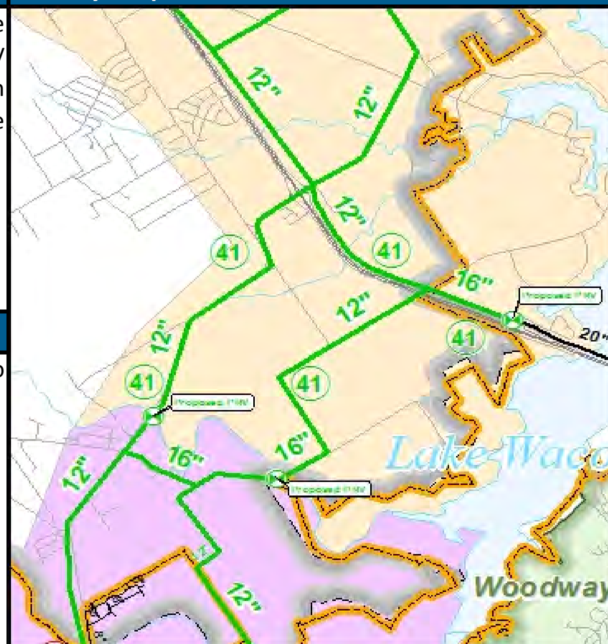
Project # 41

16-inch/12-inch Water Lines and PRV Station in PP7

Project Description

This project consist of a new PRV station along SH 6 west of Lake Waco and a new 16-inch water line from the proposed SH 6 PRV Station to Overflow Road. This project also consists of a new 16-inch water line from the proposed Speegleville Road PRV station to the proposed 16-inch water line along SH 6 in PP7.

Vicinity Map:



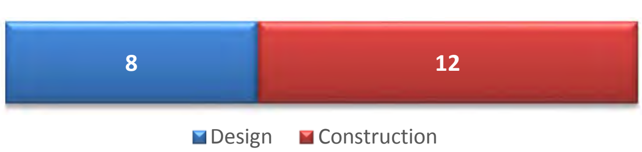
Project Drivers:

This project provides additional transmission capacity and looping to serve future development west of Lake Waco in the PP7.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	11,500	LF	$128	$1,472,000
2	12" Water Line and Appurtenances	23,000	LF	$96	$2,208,000
3	PRV Station	1	LS	$50,000	$50,000
4	Right-of-Way (20' Easement)	34,500	LF	$20	$690,000
5	Pavement Repair (12' wide)	34,500	LF	$80	$2,760,000

Project Timing (months)



		SUBTOTAL:	**$7,180,000**
MOBILIZATION	5%		$359,000
		SUBTOTAL:	**$7,539,000**
CONTINGENCY	25%		$1,884,750
		SUBTOTAL:	**$9,423,750**
ENG/SURVEY	12%		$1,130,850
		SUBTOTAL:	**$10,554,600**

Estimated Total Project Cost: $10,554,600

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

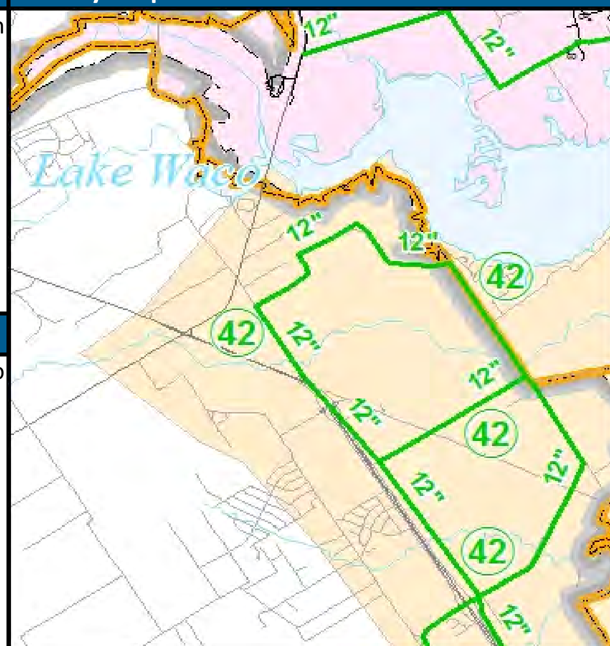
Project # **42**

12-inch Water Lines in PP7

Project Description

This project consists of new 12-inch water lines in the northern portion of PP7 northeast of SH 6.

Vicinity Map:



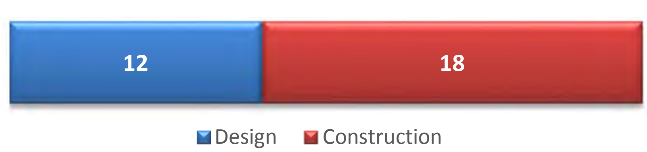
Project Drivers:

This project provides additional transmission capacity and looping to serve future development west of Lake Waco in the PP7.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Water Line and Appurtenances	48,000	LF	$96	$4,608,000
2	20" Boring and Casing	600	LF	$350	$210,000
3	Right-of-Way (20' Easement)	48,000	LF	$20	$960,000
4	Pavement Repair (12' wide)	48,000	LF	$80	$3,840,000

Project Timing (months)



	SUBTOTAL:	**$9,618,000**
MOBILIZATION	5%	$480,900
	SUBTOTAL:	**$10,098,900**
CONTINGENCY	25%	$2,524,730
	SUBTOTAL:	**$12,623,630**
ENG/SURVEY	12%	$1,514,840
	SUBTOTAL:	**$14,138,470**

Estimated Total Project Cost: **$14,138,470**

City of Waco

Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY

FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name

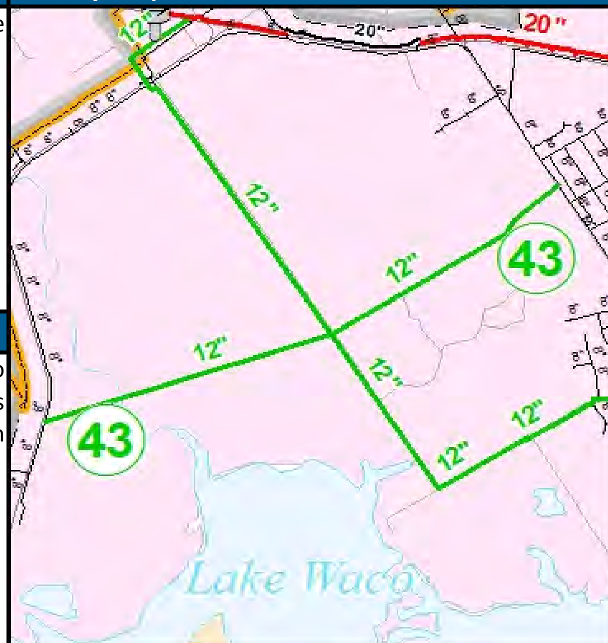
Project # 43

12-inch Water Line in PP5

Project Description

This project consists of a new 12-inch water line from Tree Lake Drive along Arnett Lane to FM 185 in PP5.

Vicinity Map:



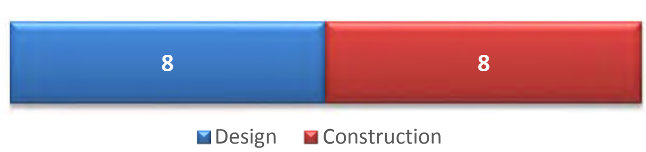
Project Drivers:

This project provides additional transmission capacity and looping to serve future development north of Lake Waco in the PP5. This project also improves water age issues along FM 185 in the western portion of the pressure plane.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" Water Line and Appurtenances	12,200	LF	$96	$1,171,200
2	20" Boring and Casing	50	LF	$350	$17,500
3	Right-of-Way (20' Easement)	12,200	LF	$20	$244,000
4	Pavement Repair (12' wide)	7,500	LF	$80	$600,000

Project Timing (months)



		SUBTOTAL:	**$2,032,700**
MOBILIZATION	5%		$101,640
		SUBTOTAL:	**$2,134,340**
CONTINGENCY	25%		$533,590
		SUBTOTAL:	**$2,667,930**
ENG/SURVEY	12%		$320,160
		SUBTOTAL:	**$2,988,090**

Estimated Total Project Cost: $2,988,090

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

2040 Capital Improvement Plan
Project Name
Project # 44

16-inch Water Line in PP1

Project Description

This project consists of a new 16-inch water line from 12th Street Road along SH 6 to Highway 77 in PP1.

Project Drivers:

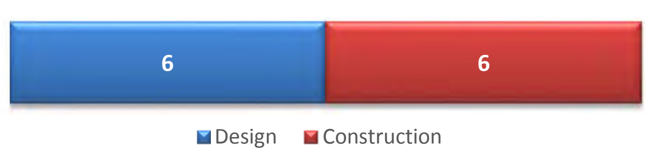
This project increases looping and provides additional transmission capacity in the southern portion of PP1.

Vicinity Map:

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	8,900	LF	$128	$1,139,200
2	34" Boring and Casing	100	LF	$595	$59,500
3	Right-of-Way (20' Easement)	8,900	LF	$20	$178,000
4	Pavement Repair (12' wide)	8,500	LF	$80	$680,000

Project Timing (months)



	SUBTOTAL:	**$2,056,700**
MOBILIZATION	5%	$102,840
	SUBTOTAL:	**$2,159,540**
CONTINGENCY	25%	$539,890
	SUBTOTAL:	**$2,699,430**
ENG/SURVEY	12%	$323,940
	SUBTOTAL:	**$3,023,370**

Estimated Total Project Cost: $3,023,370

City of Waco
Prioritized CIP Project Summary
October 9, 2015

2040 Capital Improvement Plan
Project Name

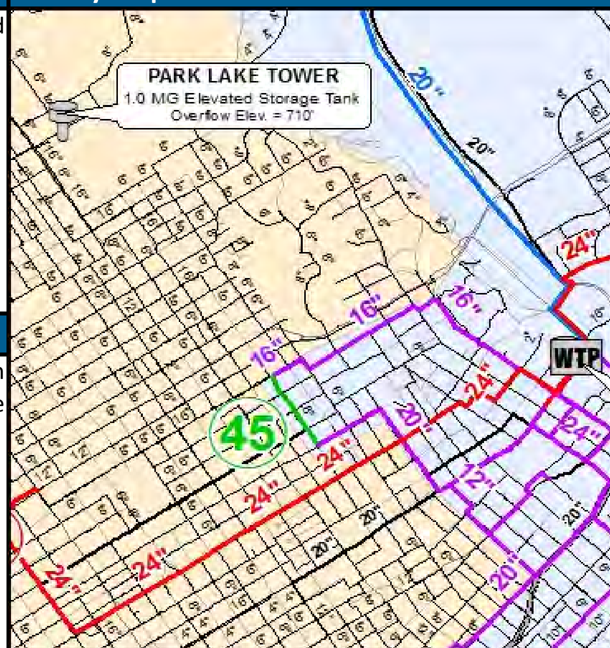
Project # **45**

16-inch Water Line in PP1

Project Description

This project consists of a new 16-inch water line from Cumberland Avenue along 16th Street to Proctor Avenue in PP1.

Vicinity Map:



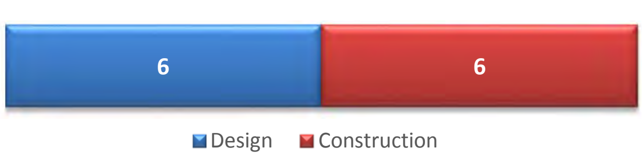
Project Drivers:

This project increases looping and provides additional transmission capacity in the western portion of PP1 after the revised pressure plane boundary between PP1 and PP2.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	2,000	LF	$128	$256,000
2	Right-of-Way (20' Easement)	2,000	LF	$20	$40,000
3	Pavement Repair (12' wide)	2,000	LF	$80	$160,000

Project Timing (months)



	SUBTOTAL:	**$456,000**
MOBILIZATION	5%	$22,800
	SUBTOTAL:	**$478,800**
CONTINGENCY	25%	$119,700
	SUBTOTAL:	**$598,500**
ENG/SURVEY	12%	$71,820
	SUBTOTAL:	**$670,320**

Estimated Total Project Cost: **$670,320**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP
Project Name

Project # **R1**

30-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 24-inch and parallel 20-inch water lines from the Riverside WTP, along North University Parks Drive, to Jefferson Avenue.

Project Drivers:

The 24-inch water line being replaced was installed in 1956 and the 20-inch water line was installed in 1944. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	30" Water Line and Appurtenances	3,500	LF	$240	$840,000
2	Right-of-Way (20' Easement)	3,500	LF	$20	$70,000
3	Pavement Repair (12' wide)	3,500	LF	$80	$280,000
				SUBTOTAL:	**$1,190,000**
		MOBILIZATION		5%	$59,500
				SUBTOTAL:	**$1,249,500**
		CONTINGENCY		25%	$312,380
				SUBTOTAL:	**$1,561,880**
		ENG/SURVEY		12%	$187,430
				SUBTOTAL:	**$1,749,310**

Estimated Total Project Cost: **$1,749,310**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP
Project Name

Project # R2

20/24/30-inch Renewal Water Line in PP1

Project Description
This renewal project replaces the existing 20/24/30-inch water line from North 4th Street & Colcord Avenue, south along Kentucky Avenue, east along 6th Street, south along US 84 to 11th Street.

Project Drivers:
The 20/24/30-inch water line being replaced was installed in 1951. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	30" Water Line and Appurtenances	1,350	LF	$240	$324,000
2	24" Water Line and Appurtenances	2,800	LF	$192	$537,600
3	20" Water Line and Appurtenances	1,300	LF	$160	$208,000
4	Right-of-Way (20' Easement)	5,450	LF	$20	$109,000
5	Pavement Repair (12' wide)	5,450	LF	$80	$436,000
6	0	0	0	$0	$0
				SUBTOTAL:	**$1,614,600**
		MOBILIZATION		5%	$80,730
				SUBTOTAL:	**$1,695,330**
		CONTINGENCY		25%	$423,840
				SUBTOTAL:	**$2,119,170**
		ENG/SURVEY		12%	$254,310
				SUBTOTAL:	**$2,373,480**

Estimated Total Project Cost: $2,373,480

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
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Replacement and Renewal CIP
Project Name

Project # R3

16-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 12/16-inch water line along 8th Street from US 84 to Webster Avenue and south along Columbus Avenue from 8th Street to 11th Street.

Project Drivers:

The 12/16-inch water line being replaced was installed in 1944. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP. Based on 2040 modeling results the 12-inch water line as insufficient capacity to meet demands in the downtown area.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	5,550	LF	$128	$710,400
2	Right-of-Way (20' Easement)	5,550	LF	$20	$111,000
3	Pavement Repair (12' wide)	5,550	LF	$80	$444,000
				SUBTOTAL:	**$1,265,400**
		MOBILIZATION		5%	$63,270
				SUBTOTAL:	**$1,328,670**
		CONTINGENCY		25%	$332,170
				SUBTOTAL:	**$1,660,840**
		ENG/SURVEY		12%	$199,310
				SUBTOTAL:	**$1,860,150**

Estimated Total Project Cost: $1,860,150

City of Waco

Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP

Project Name — **Project # R4**

16-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 10/16-inch water line along Columbus Avenue from 11th Street to 17th Street and east along 17th Street to Webster Avenue.

Project Drivers:

The 12/16-inch water line being replaced was installed in 1944. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP. Based on 2040 modeling results the 10-inch water line as insufficient capacity to meet demands in the downtown area.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	5,350	LF	$128	$684,800
2	Right-of-Way (20' Easement)	5,350	LF	$20	$107,000
3	Pavement Repair (12' wide)	5,350	LF	$80	$428,000
				SUBTOTAL:	**$1,219,800**
		MOBILIZATION		5%	$60,990
				SUBTOTAL:	**$1,280,790**
		CONTINGENCY		25%	$320,200
				SUBTOTAL:	**$1,600,990**
		ENG/SURVEY		12%	$192,120
				SUBTOTAL:	**$1,793,110**

Estimated Total Project Cost: $1,793,110

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

Replacement and Renewal CIP
Project Name

Project # **R5**

16-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 12/16-inch water line along Clay Avenue from 17th Street to 24th Street and east along 24th Street to Ross Avenue then south along Ross Avenue to 26th Street.

Project Drivers:

The 12/16-inch water line being replaced was installed in 1944. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP. Based on 2040 modeling results the 10-inch water line as insufficient capacity to meet demands in the downtown area.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	4,500	LF	$128	$576,000
2	Right-of-Way (20' Easement)	4,500	LF	$20	$90,000
3	Pavement Repair (12' wide)	4,500	LF	$80	$360,000
				SUBTOTAL:	**$1,026,000**
		MOBILIZATION		5%	$51,300
				SUBTOTAL:	**$1,077,300**
		CONTINGENCY		25%	$269,330
				SUBTOTAL:	**$1,346,630**
		ENG/SURVEY		12%	$161,600
				SUBTOTAL:	**$1,508,230**

Estimated Total Project Cost: **$1,508,230**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP
Project Name | **Project #** **R6**

16/24-inch Renewal Water Line in PP1

Project Description
This renewal project replaces the existing 16/24-inch water line along FM1637 from Tennessee Avenue to Jefferson Avenue and from FM1637 south along Bosque Boulevard to 26th Street.

Project Drivers:
The 24-inch water line being replaced was installed in 1951 and the 16-inch water line was installed in 1944. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	800	LF	$192	$153,600
2	16" Water Line and Appurtenances	3,950	LF	$128	$505,600
3	Right-of-Way (20' Easement)	4,750	LF	$20	$95,000
4	Pavement Repair (12' wide)	4,750	LF	$80	$380,000
5	0	0	0	$0	$0
				SUBTOTAL:	**$1,134,200**
		MOBILIZATION		5%	$56,710
				SUBTOTAL:	**$1,190,910**
		CONTINGENCY		25%	$297,730
				SUBTOTAL:	**$1,488,640**
		ENG/SURVEY		12%	$178,640
				SUBTOTAL:	**$1,667,280**

Estimated Total Project Cost: $1,667,280

City of Waco

Prioritized CIP Project Summary

October 9, 2015

Replacement and Renewal CIP

Project Name

Project # R7

20/24-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20/24-inch water line along Colcord Avenue from FM1637 to 11th Street and a new 20-inch water line west along 11th Street to Bosque Boulevard.

Project Drivers:

The 20/24-inch water line being replaced was installed in 1944. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP. Based on 2040 modeling results the 10-inch water line as insufficient capacity to meet demands in the downtown area.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	1,000	LF	$192	$192,000
2	20" Water Line and Appurtenances	3,600	LF	$160	$576,000
3	Right-of-Way (20' Easement)	4,600	LF	$20	$92,000
4	Pavement Repair (12' wide)	4,600	LF	$80	$368,000
5	0	0	0	$0	$0
				SUBTOTAL:	**$1,228,000**
			MOBILIZATION	5%	$61,400
				SUBTOTAL:	**$1,289,400**
			CONTINGENCY	25%	$322,350
				SUBTOTAL:	**$1,611,750**
			ENG/SURVEY	12%	$193,410
				SUBTOTAL:	**$1,805,160**

Estimated Total Project Cost: $1,805,160

City of Waco
Prioritized CIP Project Summary
October 9, 2015

THE WALLACE GROUP engineers architects surveyors A CP&Y COMPANY
FREESE AND NICHOLS

Replacement and Renewal CIP
Project Name **Project # R8**

16/20-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20-inch water line along 12th Street from Colcord Boulevard to Windsor Avenue and a new 16-inch water line along 16th Street from Windsor Avenue to Proctor Avenue.

Project Drivers:

The 20-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP. The new 16-inch water line will provide better connectivity to the existing 16-inch water line which conveys flow to the Park Lane EST.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	3,800	LF	$160	$608,000
2	16" Water Line and Appurtenances	1,750	LF	$128	$224,000
3	Right-of-Way (20' Easement)	5,550	LF	$20	$111,000
4	Pavement Repair (12' wide)	5,550	LF	$80	$444,000
5	0	0	0	$0	$0
				SUBTOTAL:	**$1,387,000**
			MOBILIZATION	5%	$69,350
				SUBTOTAL:	**$1,456,350**
			CONTINGENCY	25%	$364,090
				SUBTOTAL:	**$1,820,440**
			ENG/SURVEY	12%	$218,460
				SUBTOTAL:	**$2,038,900**

Estimated Total Project Cost: $2,038,900

City of Waco
Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP
Project Name

Project # R9

16-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 16-inch water line along FM 1637 from Tennessee Avenue to Proctor Avenue then southwest along Proctor Avenue to 16th Street.

Project Drivers:

The 16-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" Water Line and Appurtenances	6,250	LF	$128	$800,000
2	Right-of-Way (20' Easement)	6,250	LF	$20	$125,000
3	Pavement Repair (12' wide)	6,250	LF	$80	$500,000
				SUBTOTAL:	**$1,425,000**
		MOBILIZATION		5%	$71,250
				SUBTOTAL:	**$1,496,250**
		CONTINGENCY		25%	$374,070
				SUBTOTAL:	**$1,870,320**
		ENG/SURVEY		12%	$224,440
				SUBTOTAL:	**$2,094,760**

Estimated Total Project Cost: $2,094,760

City of Waco
Prioritized CIP Project Summary
October 9, 2015

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FREESE AND NICHOLS

Replacement and Renewal CIP
Project Name | **Project # R10**

20-inch Renewal Water Line in PP1

Project Description
This renewal project replaces the existing 16/20-inch water line along Bosque Boulevard from 9th Street to 12th Street then southeast along12th Street to Waco Drive the south along Waco Drive to 14th Street .

Project Drivers:
The 16/20-inch water line being replaced was installed in 1951. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	4,600	LF	$160	$736,000
2	Right-of-Way (20' Easement)	4,600	LF	$20	$92,000
3	Pavement Repair (12' wide)	4,600	LF	$80	$368,000
				SUBTOTAL:	**$1,196,000**
		MOBILIZATION		5%	$59,800
				SUBTOTAL:	**$1,255,800**
		CONTINGENCY		25%	$313,950
				SUBTOTAL:	**$1,569,750**
		ENG/SURVEY		12%	$188,370
				SUBTOTAL:	**$1,758,120**

Estimated Total Project Cost: $1,758,120

City of Waco

Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP
Project Name

Project # R11

20-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20-inch water line along Waco Drive from 14th Street to 26th Street.

Project Drivers:

The 20-inch water line being replaced was installed in 1951. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	5,550	LF	$160	$888,000
2	Right-of-Way (20' Easement)	5,550	LF	$20	$111,000
3	Pavement Repair (12' wide)	5,550	LF	$80	$444,000
				SUBTOTAL:	**$1,443,000**
		MOBILIZATION		5%	$72,150
				SUBTOTAL:	**$1,515,150**
		CONTINGENCY		25%	$378,790
				SUBTOTAL:	**$1,893,940**
		ENG/SURVEY		12%	$227,280
				SUBTOTAL:	**$2,121,220**

Estimated Total Project Cost: $2,121,220

City of Waco

Prioritized CIP Project Summary
October 9, 2015

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Replacement and Renewal CIP

Project Name — **Project # R12**

20-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20-inch water line along 26th Street from Waco Drive to Ross Avenue.

Project Drivers:

The 20-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	5,600	LF	$160	$896,000
2	Right-of-Way (20' Easement)	5,600	LF	$20	$112,000
3	Pavement Repair (12' wide)	5,600	LF	$80	$448,000
				SUBTOTAL:	**$1,456,000**
		MOBILIZATION		5%	$72,800
				SUBTOTAL:	**$1,528,800**
		CONTINGENCY		25%	$382,200
				SUBTOTAL:	**$1,911,000**
		ENG/SURVEY		12%	$229,320
				SUBTOTAL:	**$2,140,320**
		Estimated Total Project Cost:			**$2,140,320**

City of Waco
Prioritized CIP Project Summary
October 9, 2015

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Replacement and Renewal CIP
Project Name

Project # R13

20-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20-inch water line along 26th Street from Ross Avenue to Bagby Avenue.

Project Drivers:

The 20-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	4,000	LF	$160	$640,000
2	Right-of-Way (20' Easement)	4,000	LF	$20	$80,000
3	Pavement Repair (12' wide)	4,000	LF	$80	$320,000
				SUBTOTAL:	**$1,040,000**
		MOBILIZATION		5%	$52,000
				SUBTOTAL:	**$1,092,000**
		CONTINGENCY		25%	$273,000
				SUBTOTAL:	**$1,365,000**
		ENG/SURVEY		12%	$163,800
				SUBTOTAL:	**$1,528,800**

Estimated Total Project Cost: $1,528,800

City of Waco
Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP
Project Name

Project # R14

20-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20-inch water line along Waco Drive from 26th Street to 36th Street.

Project Drivers:

The 20-inch water line being replaced was installed in 1951. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	4,300	LF	$160	$688,000
2	Right-of-Way (20' Easement)	4,300	LF	$20	$86,000
3	Pavement Repair (12' wide)	4,300	LF	$80	$344,000
				SUBTOTAL:	**$1,118,000**
		MOBILIZATION		5%	$55,900
				SUBTOTAL:	**$1,173,900**
		CONTINGENCY		25%	$293,480
				SUBTOTAL:	**$1,467,380**
		ENG/SURVEY		12%	$176,090
				SUBTOTAL:	**$1,643,470**

Estimated Total Project Cost: $1,643,470

City of Waco
Prioritized CIP Project Summary
October 9, 2015

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FREESE AND NICHOLS

Replacement and Renewal CIP
Project Name

Project # R15

20-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 20-inch water line along Waco Drive from 36th Street to Westview PS.

Project Drivers:

The 20-inch water line being replaced was installed in 1951. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	20" Water Line and Appurtenances	4,350	LF	$160	$696,000
2	Right-of-Way (20' Easement)	4,350	LF	$20	$87,000
3	Pavement Repair (12' wide)	4,350	LF	$80	$348,000
				SUBTOTAL:	**$1,131,000**
		MOBILIZATION		5%	$56,550
				SUBTOTAL:	**$1,187,550**
		CONTINGENCY		25%	$296,890
				SUBTOTAL:	**$1,484,440**
		ENG/SURVEY		12%	$178,140
				SUBTOTAL:	**$1,662,580**

Estimated Total Project Cost: $1,662,580

City of Waco
Prioritized CIP Project Summary
October 9, 2015

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Replacement and Renewal CIP
Project Name — **Project # R16**

24-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 24-inch water line along Washington Avenue to University Parks Drive then southeast along 2th Street from Franklin Avenue to IH 35.

Project Drivers:

The 24-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	4,650	LF	$192	$892,800
2	Right-of-Way (20' Easement)	4,650	LF	$20	$93,000
3	Pavement Repair (12' wide)	4,650	LF	$80	$372,000
				SUBTOTAL:	**$1,357,800**
		MOBILIZATION		5%	$67,890
				SUBTOTAL:	**$1,425,690**
		CONTINGENCY		25%	$356,430
				SUBTOTAL:	**$1,782,120**
		ENG/SURVEY		12%	$213,860
				SUBTOTAL:	**$1,995,980**

Estimated Total Project Cost: $1,995,980

City of Waco

Prioritized CIP Project Summary
October 9, 2015

Replacement and Renewal CIP

Project Name — **Project # R17**

24-inch Renewal Water Line in PP1

Project Description

This renewal project replaces the existing 24-inch water line along IH 35 from 2th Street to 12th Street.

Project Drivers:

The 24-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

Opinion of Probable Cost:

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	5,400	LF	$192	$1,036,800
2	Right-of-Way (20' Easement)	5,400	LF	$20	$108,000
3	Pavement Repair (12' wide)	5,400	LF	$80	$432,000
				SUBTOTAL:	**$1,576,800**
		MOBILIZATION		5%	$78,840
				SUBTOTAL:	**$1,655,640**
		CONTINGENCY		25%	$413,910
				SUBTOTAL:	**$2,069,550**
		ENG/SURVEY		12%	$248,350
				SUBTOTAL:	**$2,317,900**

Estimated Total Project Cost: $2,317,900

City of Waco
Prioritized CIP Project Summary
October 9, 2015

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FREESE AND NICHOLS

Replacement and Renewal CIP
Project Name — **Project #** **R18**

24-inch Renewal Water Line in PP1

Project Description
This renewal project replaces the existing 24-inch water line along Gruely from 12th Street to 26th Street.

Project Drivers:
The 24-inch water line being replaced was installed in 1956. The City's ability to pump from the Riverside WTP is limited due to line failures on older water lines in PP1. This project will allow the City utilize the full pumping capacity at the Riverside WTP.

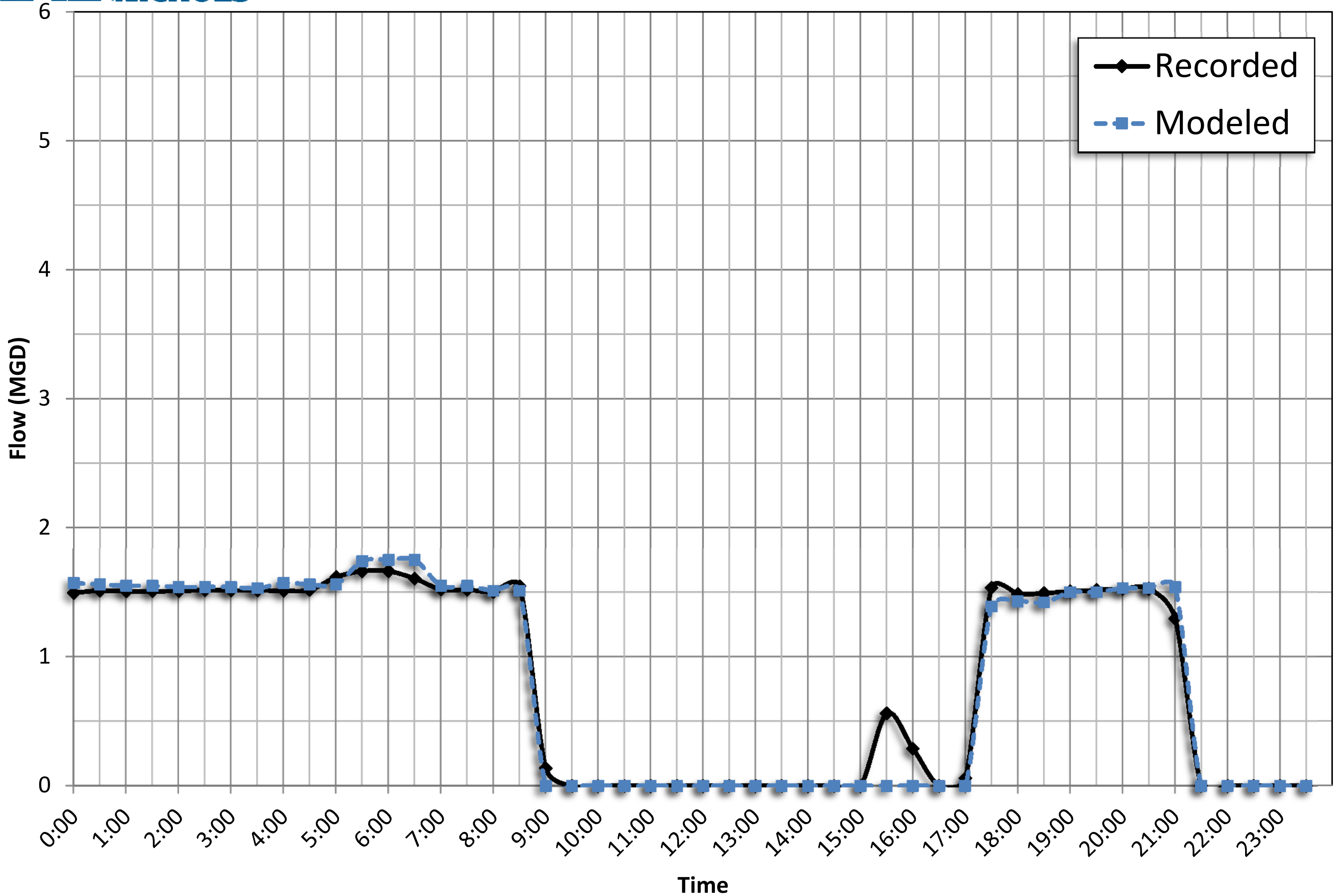
Opinion of Probable Cost:

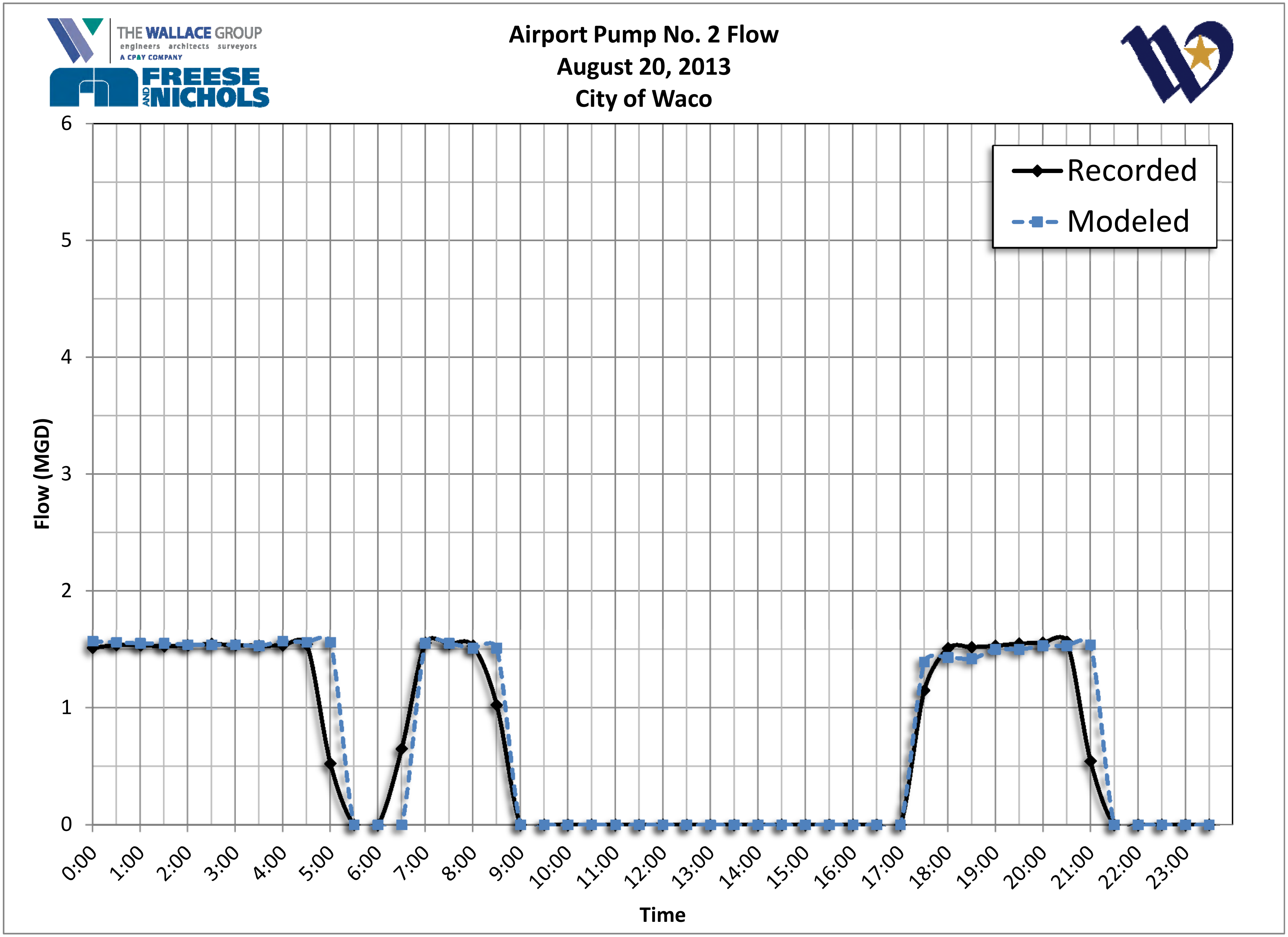
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	24" Water Line and Appurtenances	5,550	LF	$192	$1,065,600
2	Right-of-Way (20' Easement)	5,550	LF	$20	$111,000
3	Pavement Repair (12' wide)	5,550	LF	$80	$444,000
				SUBTOTAL:	**$1,620,600**
		MOBILIZATION		5%	$81,030
				SUBTOTAL:	**$1,701,630**
		CONTINGENCY		25%	$425,410
				SUBTOTAL:	**$2,127,040**
		ENG/SURVEY		12%	$255,250
				SUBTOTAL:	**$2,382,290**

Estimated Total Project Cost: **$2,382,290**

APPENDIX B
WATER MODEL CALIBRATION RESULTS

Airport Pump No. 1 Flow
August 20, 2013
City of Waco





THE WALLACE GROUP
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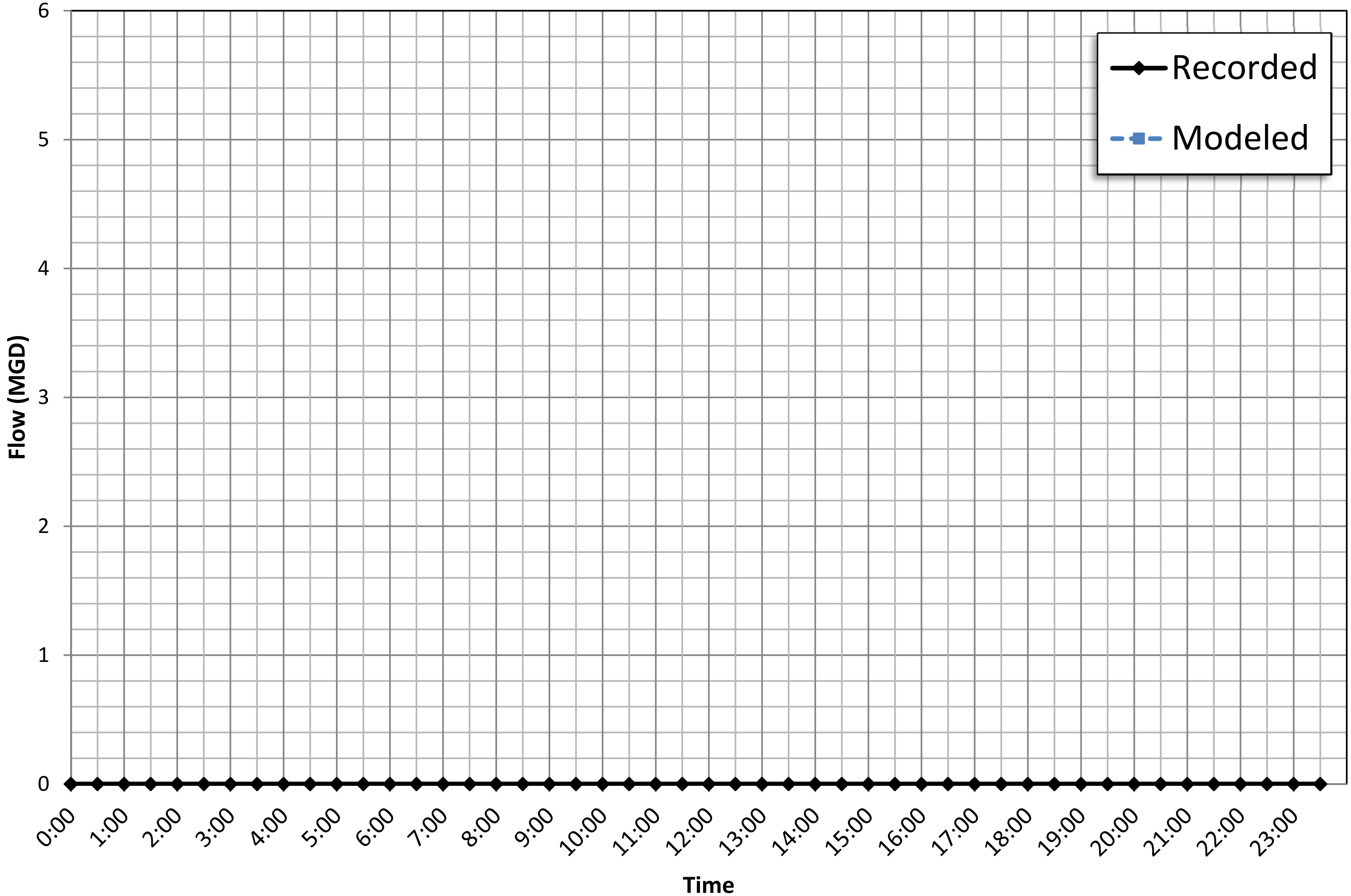
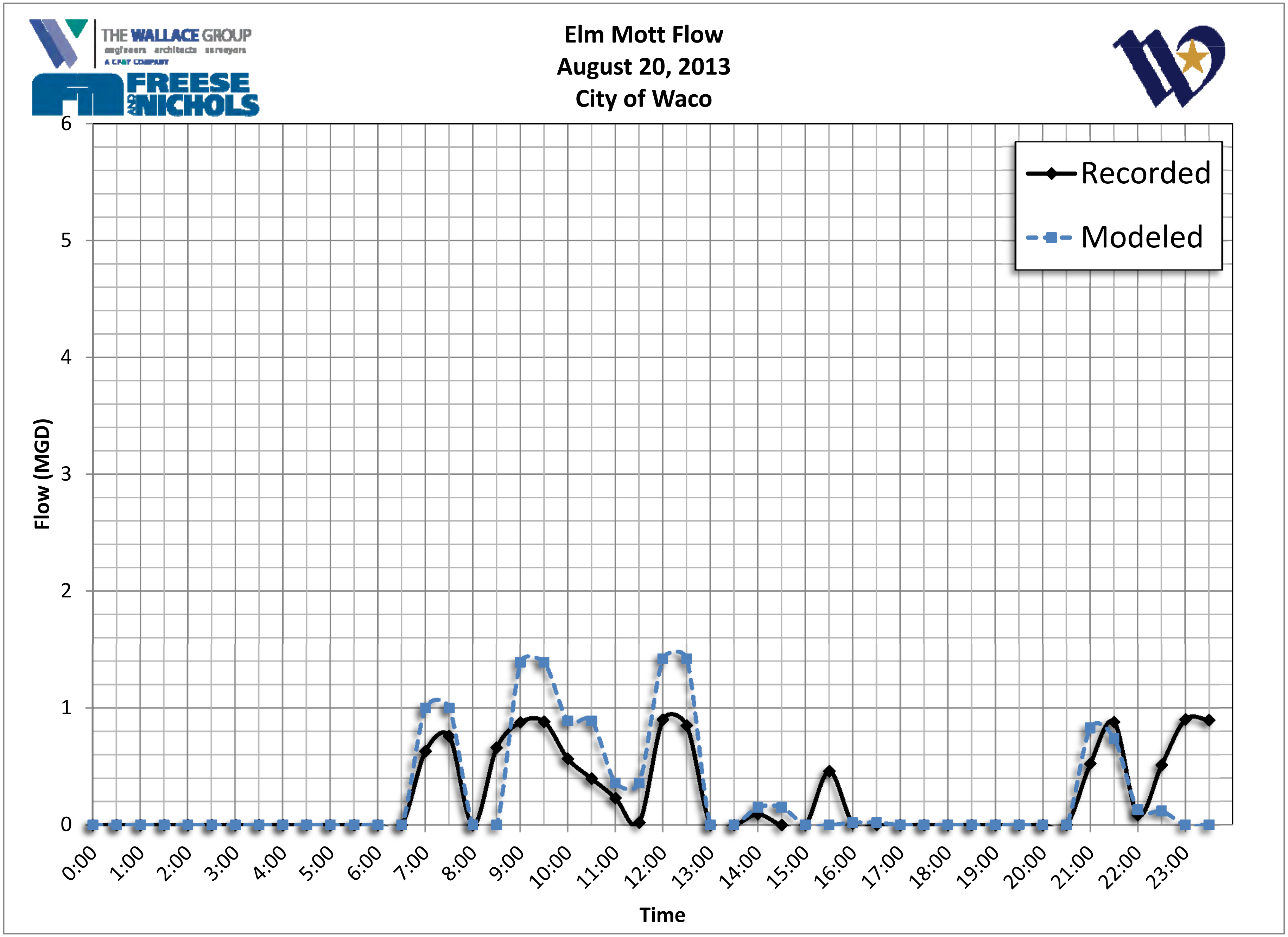
FREESE AND NICHOLS
Airport Pump No. 2 Flow
August 20, 2013
City of Waco
Flow (MGD)
6
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

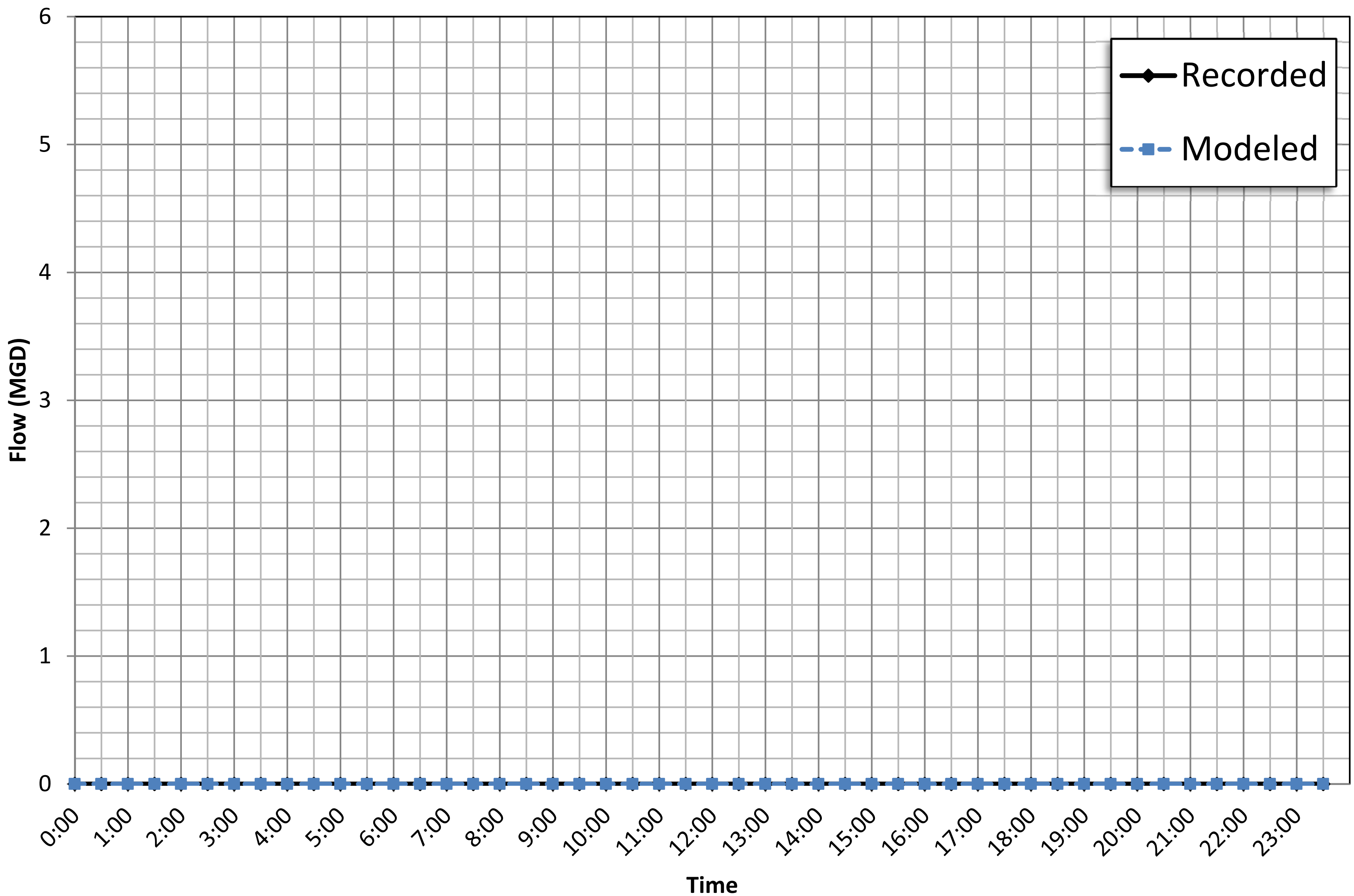
Cottonwood Flow
August 20, 2013
City of Waco



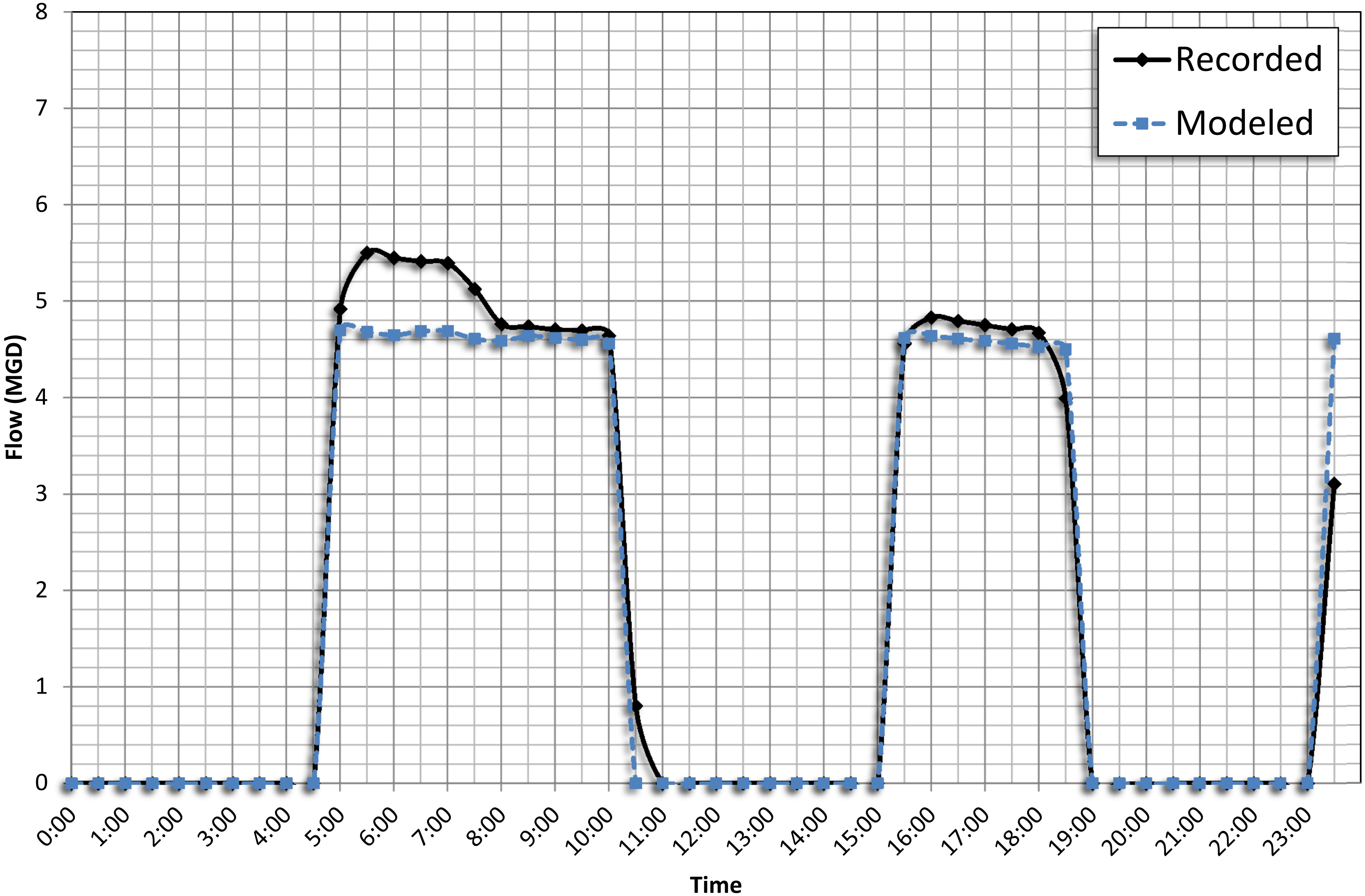


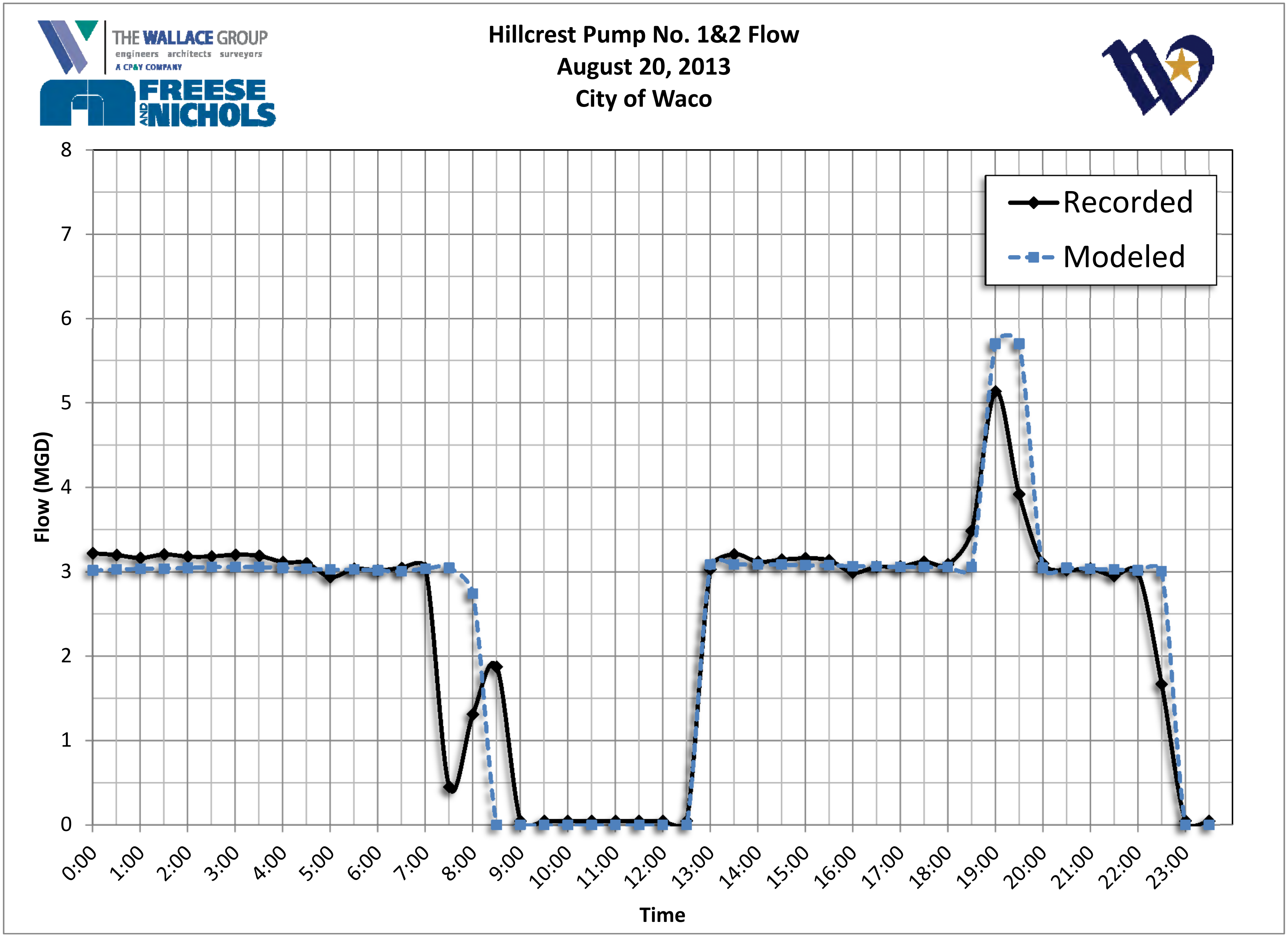
Elm Mott Flow
August 20, 2013
City of Waco
Flow (MGD)
0
1
2
3
4
5
6
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

Gholson Pump No. 1 Flow
August 20, 2013
City of Waco



Gholson Pump No. 2 Flow
August 20, 2013
City of Waco





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FREESE AND NICHOLS
Hillcrest Pump No. 1&2 Flow
August 20, 2013
City of Waco
Flow (MGD)
0
1
2
3
4
5
6
7
8
Recorded
Modeled
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
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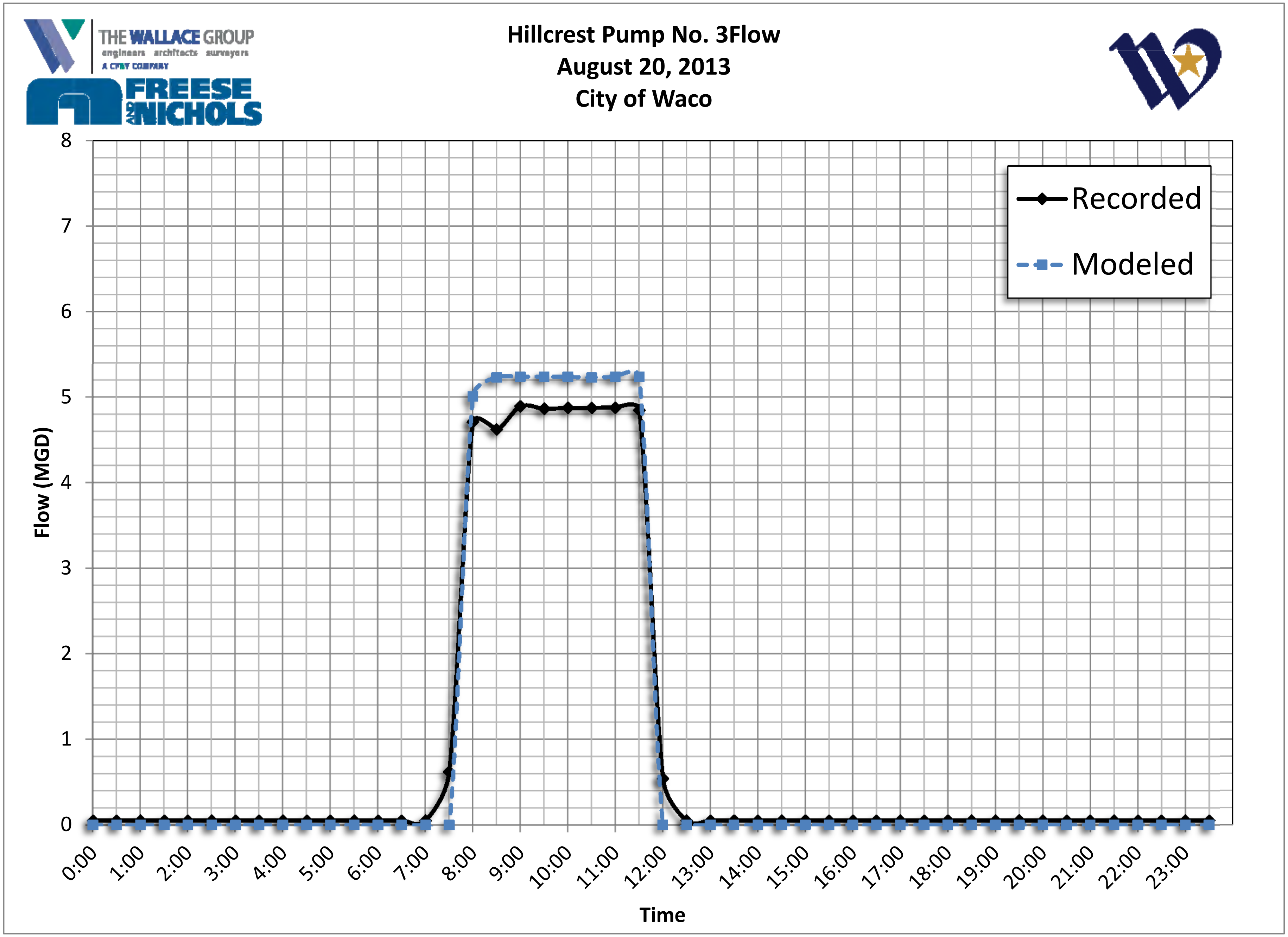
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time



Hillcrest Pump No. 3Flow
August 20, 2013
City of Waco
THE WALLACE GROUP
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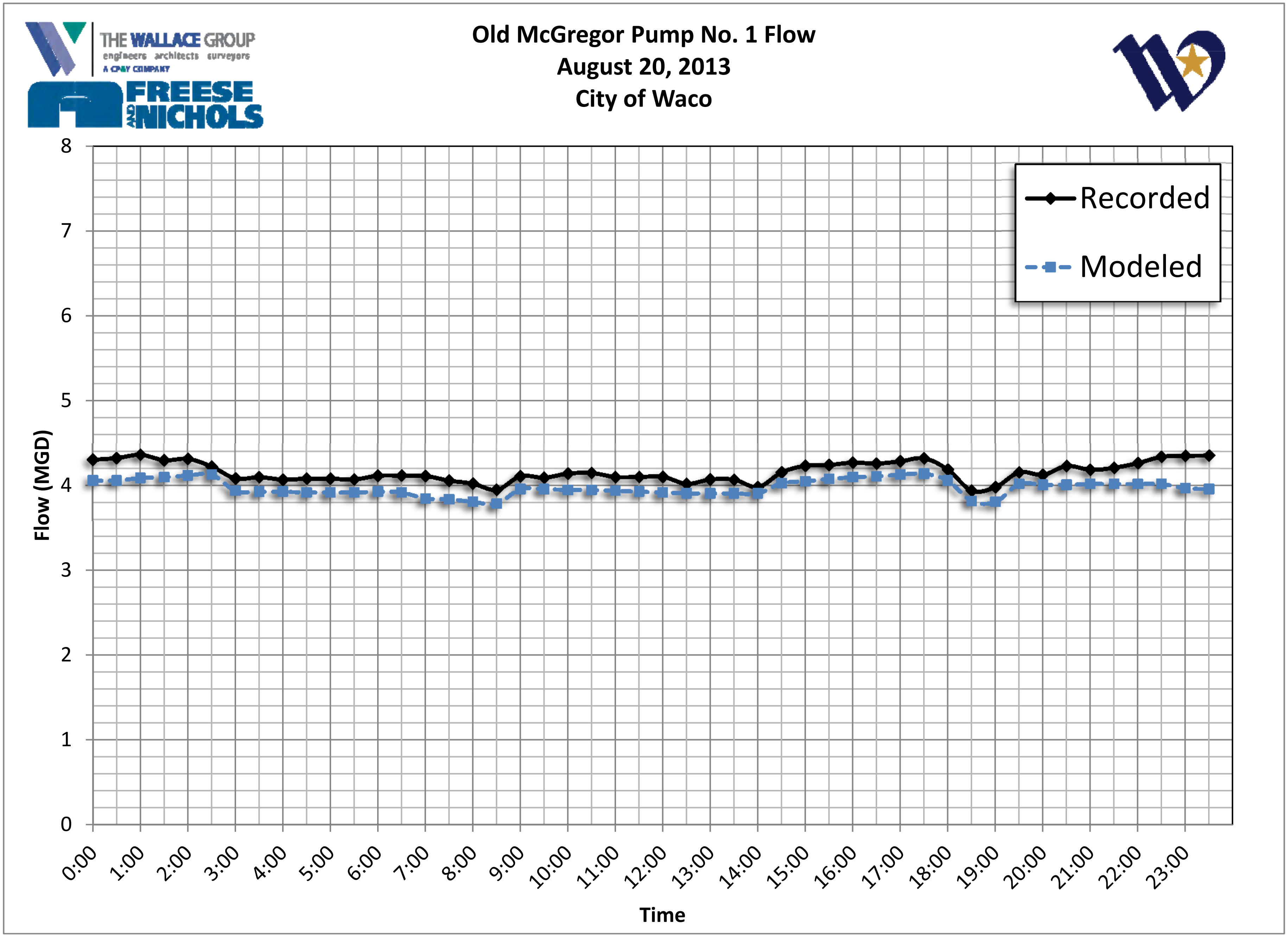
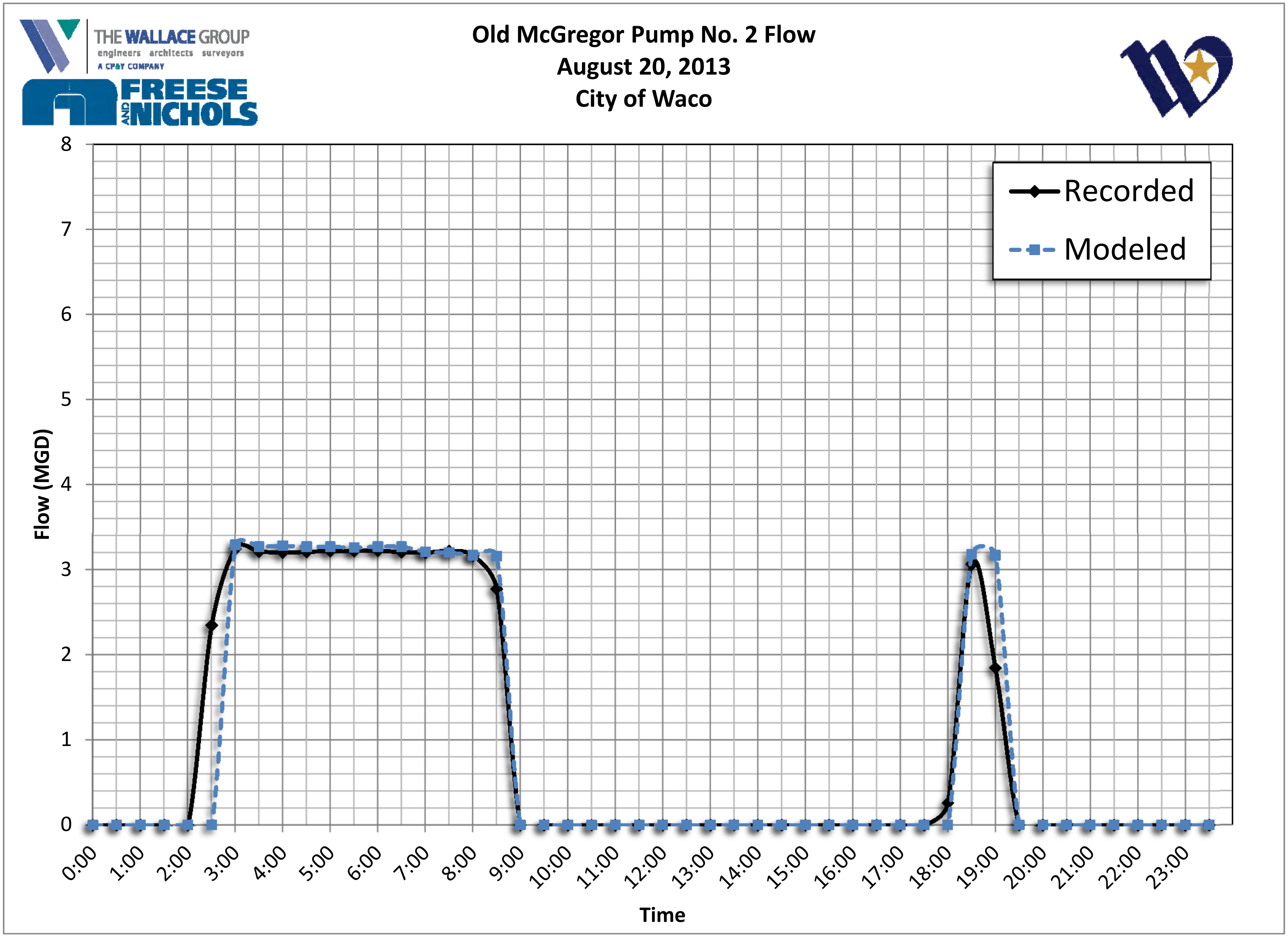
A CP&Y COMPANY
FREESE AND NICHOLS
Flow (MGD)
0
1
2
3
4
5
6
7
8
Time
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Recorded
Modeled


Old McGregor Pump No. 1 Flow
August 20, 2013
City of Waco
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Flow (MGD)
8
7
6
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled



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FREESE AND NICHOLS
Old McGregor Pump No. 2 Flow
August 20, 2013
City of Waco
Recorded
Modeled
Flow (MGD)
8
7
6
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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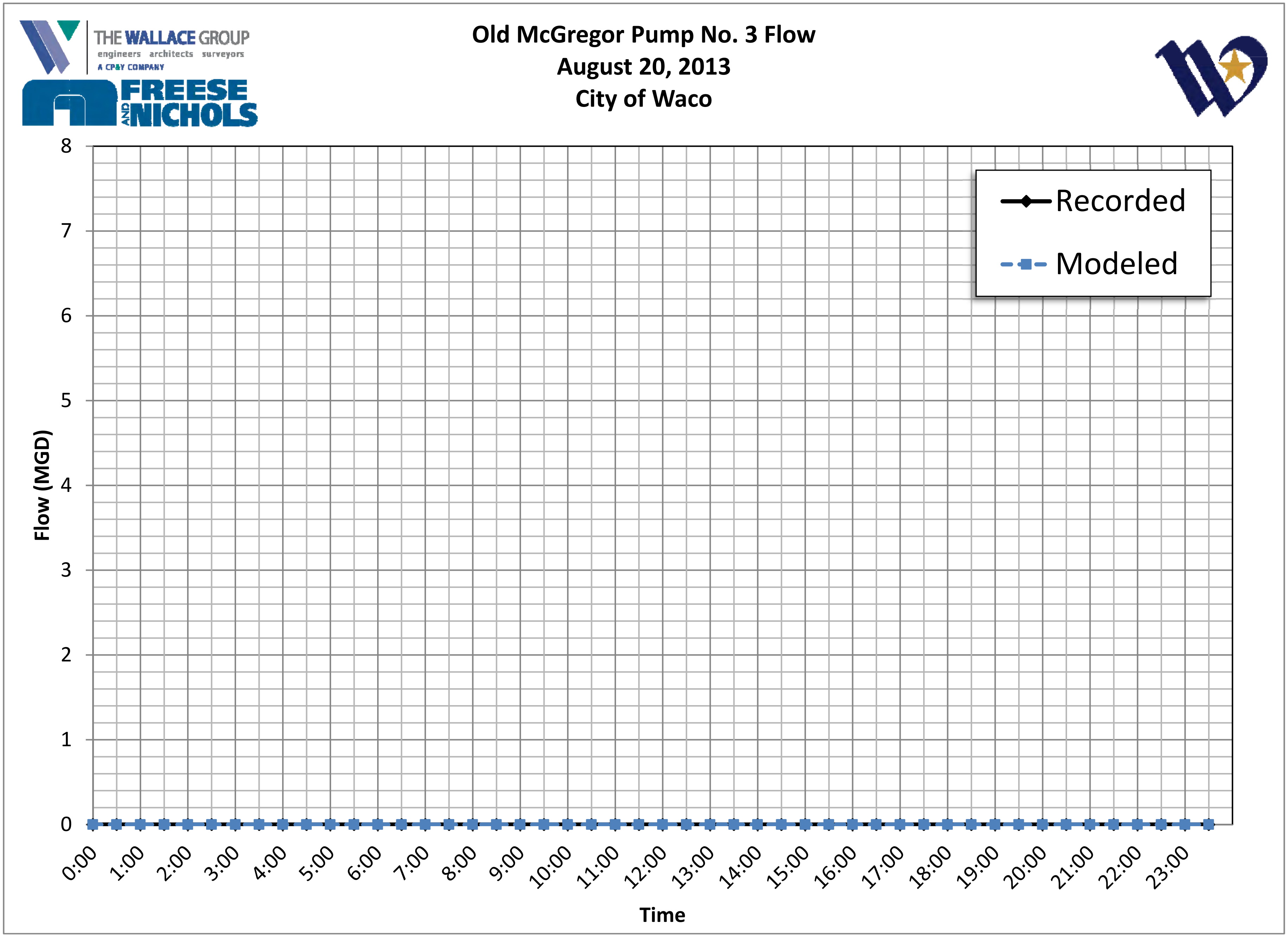
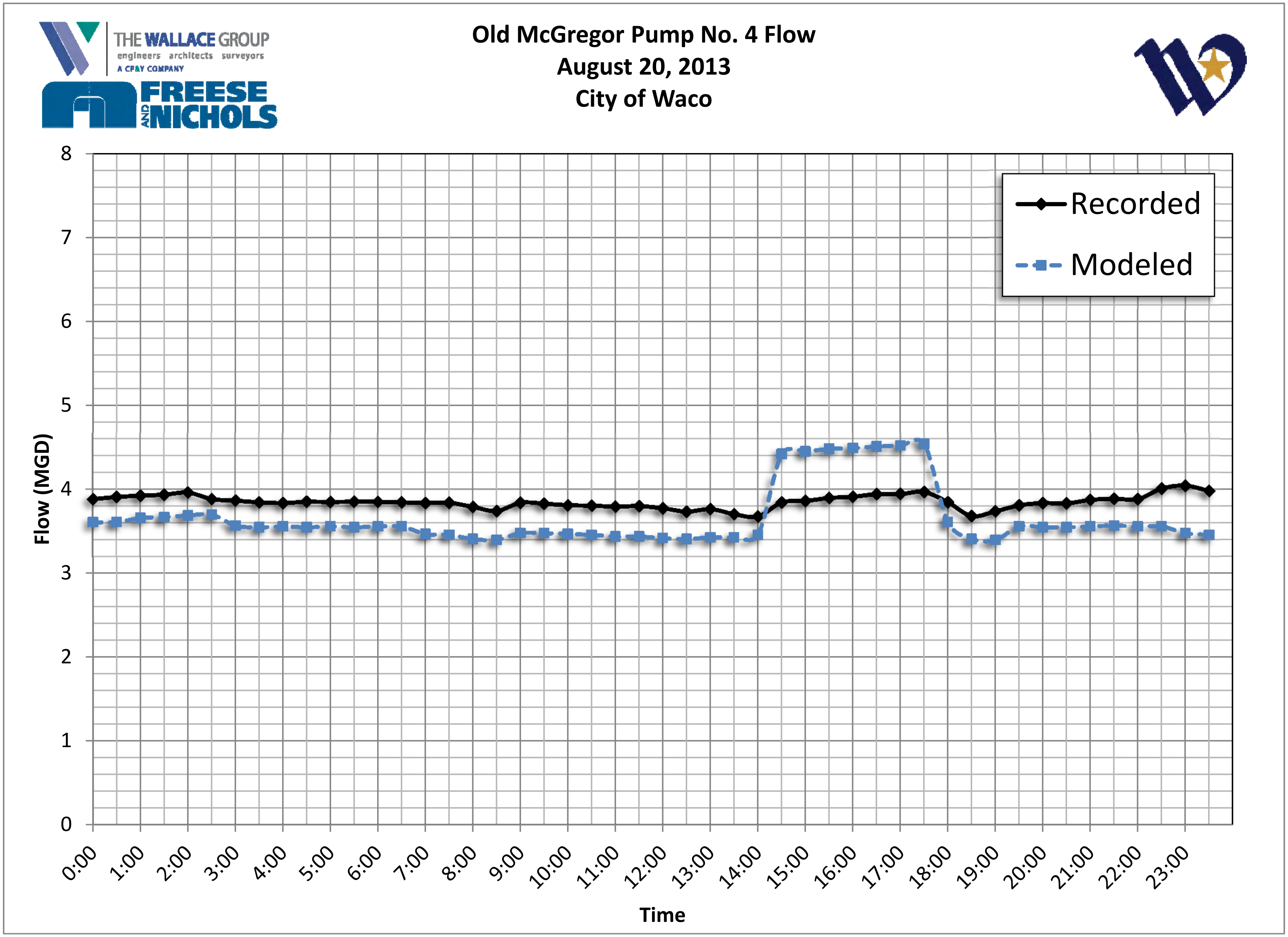
21:00
22:00
23:00
Time


Old McGregor Pump No. 3 Flow
August 20, 2013
City of Waco
Flow (MGD)
8
7
6
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled


THE WALLACE GROUP
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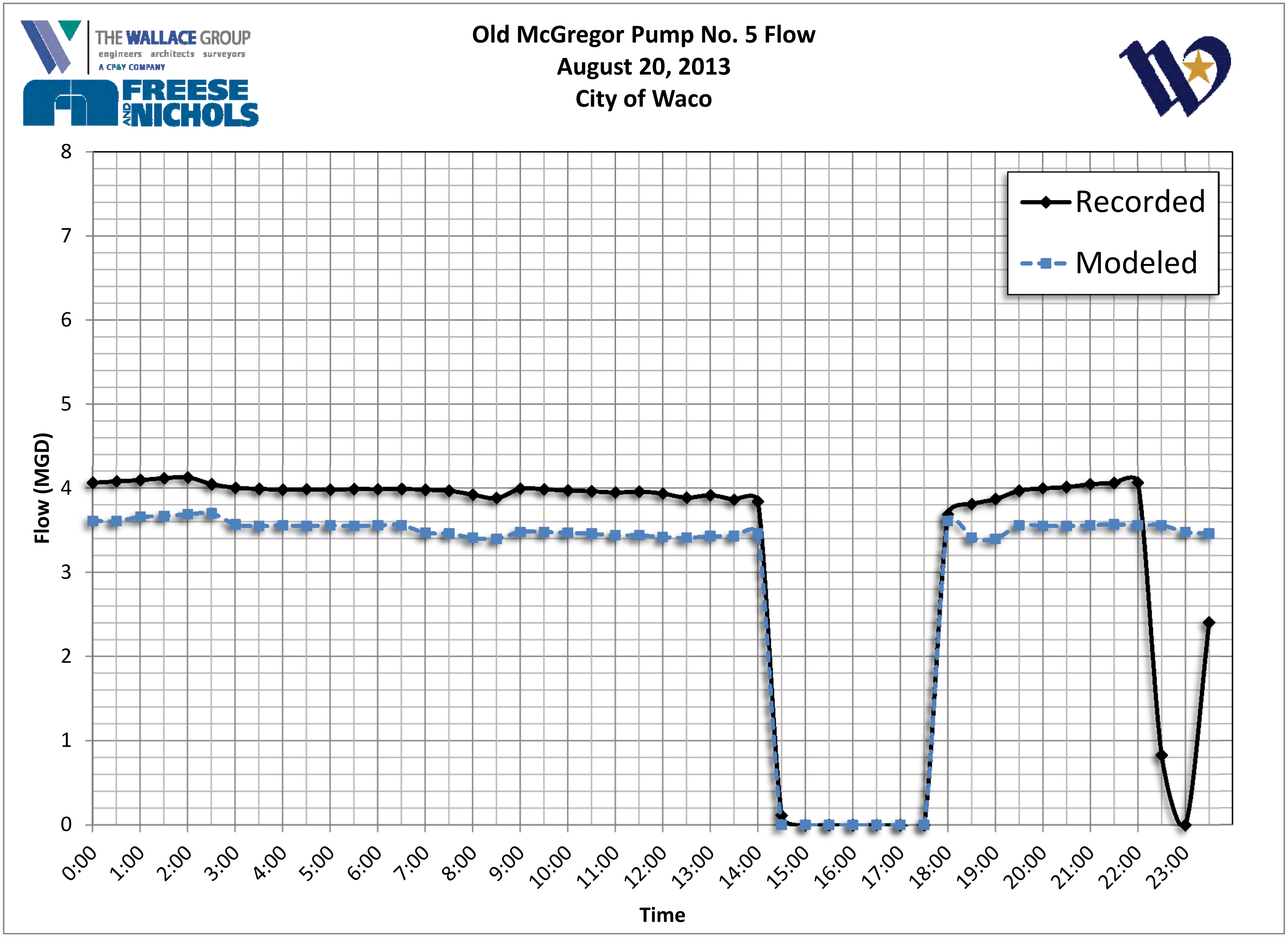
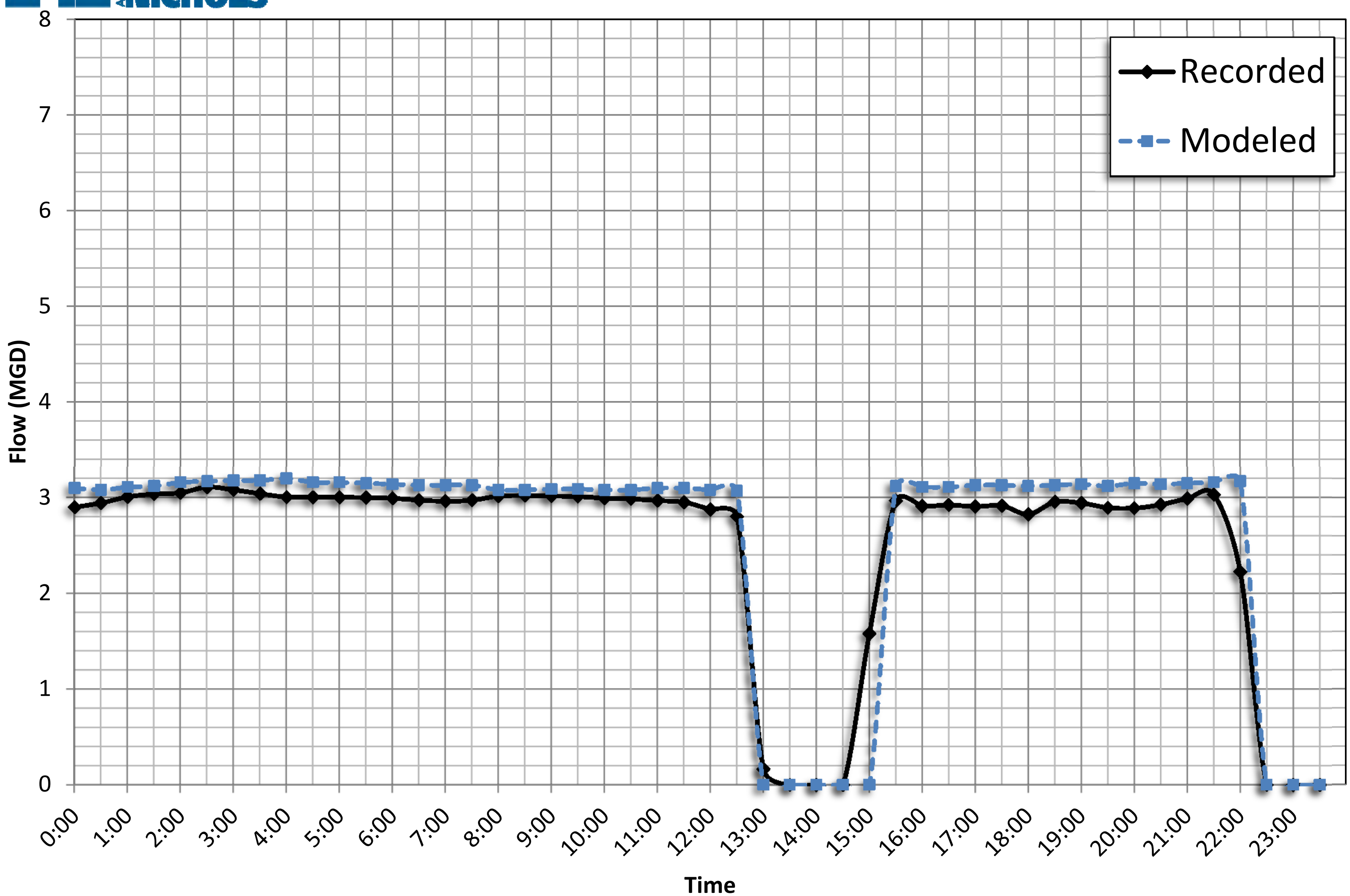
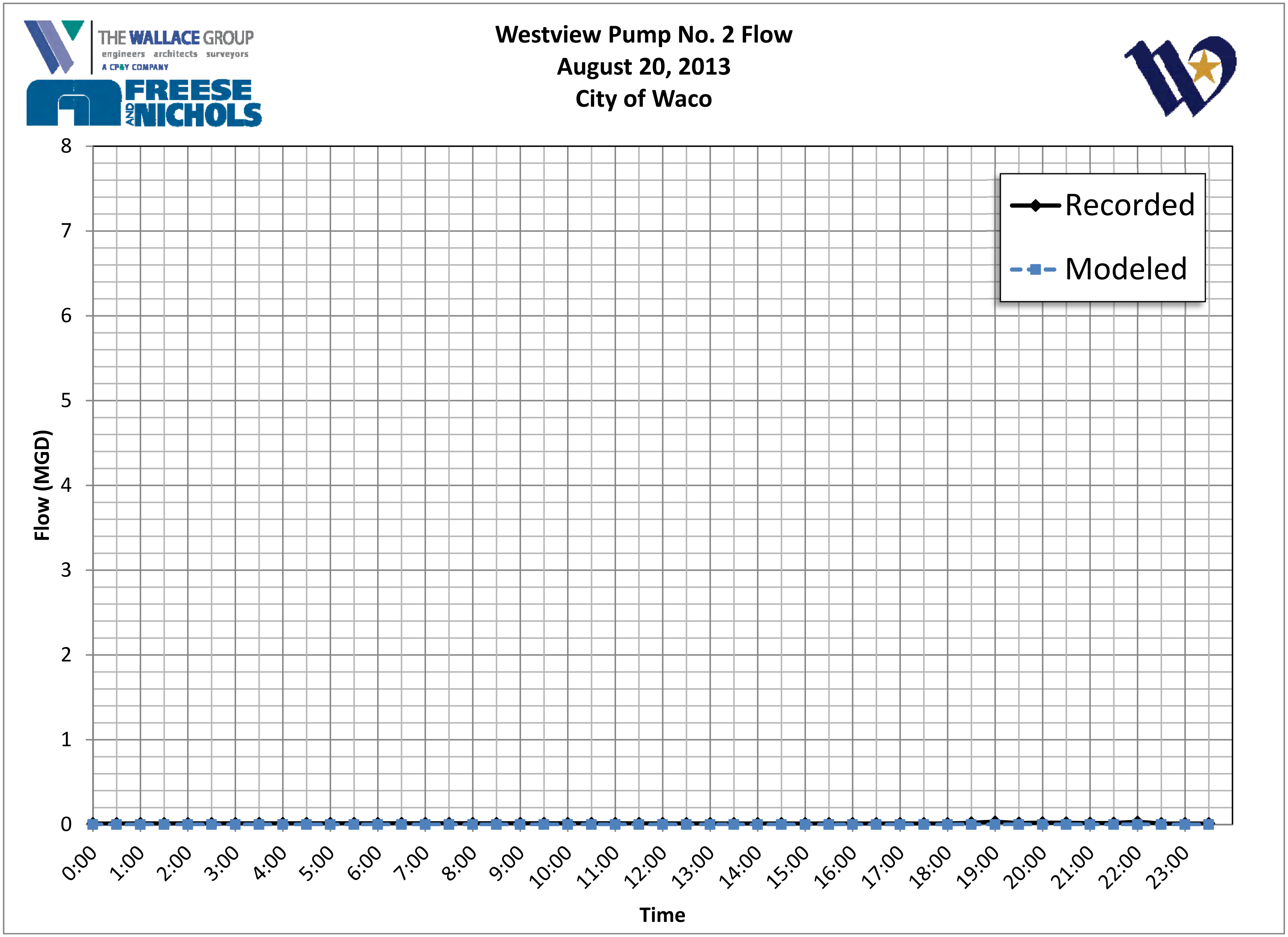
A CP&Y COMPANY
FREESE AND NICHOLS
Old McGregor Pump No. 4 Flow
August 20, 2013
City of Waco
Flow (MGD)
0
1
2
3
4
5
6
7
8
Time
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Recorded
Modeled

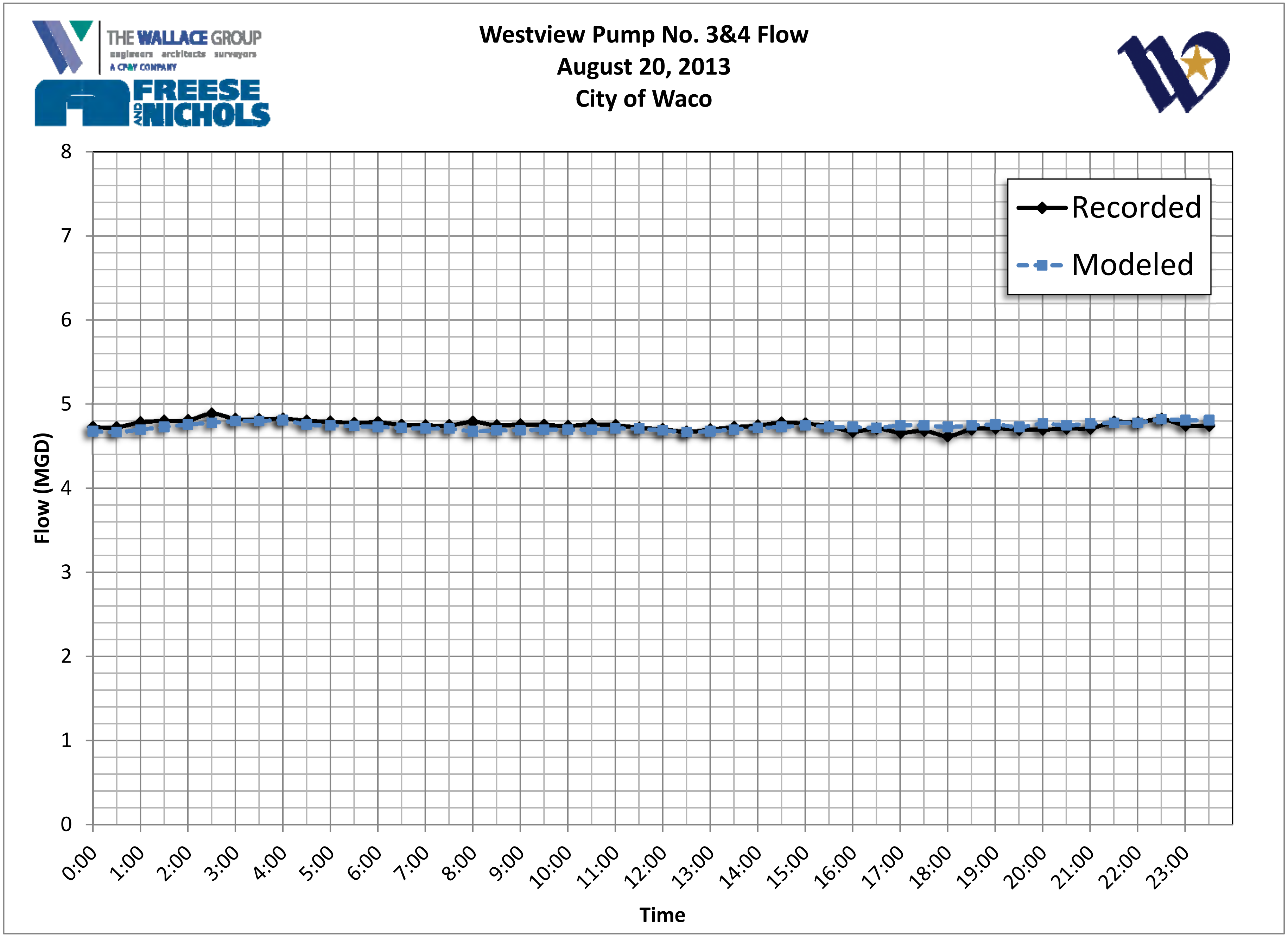

Old McGregor Pump No. 5 Flow
August 20, 2013
City of Waco
Flow (MGD)
8
7
6
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

Westview Pump No. 1 Flow
August 20, 2013
City of Waco





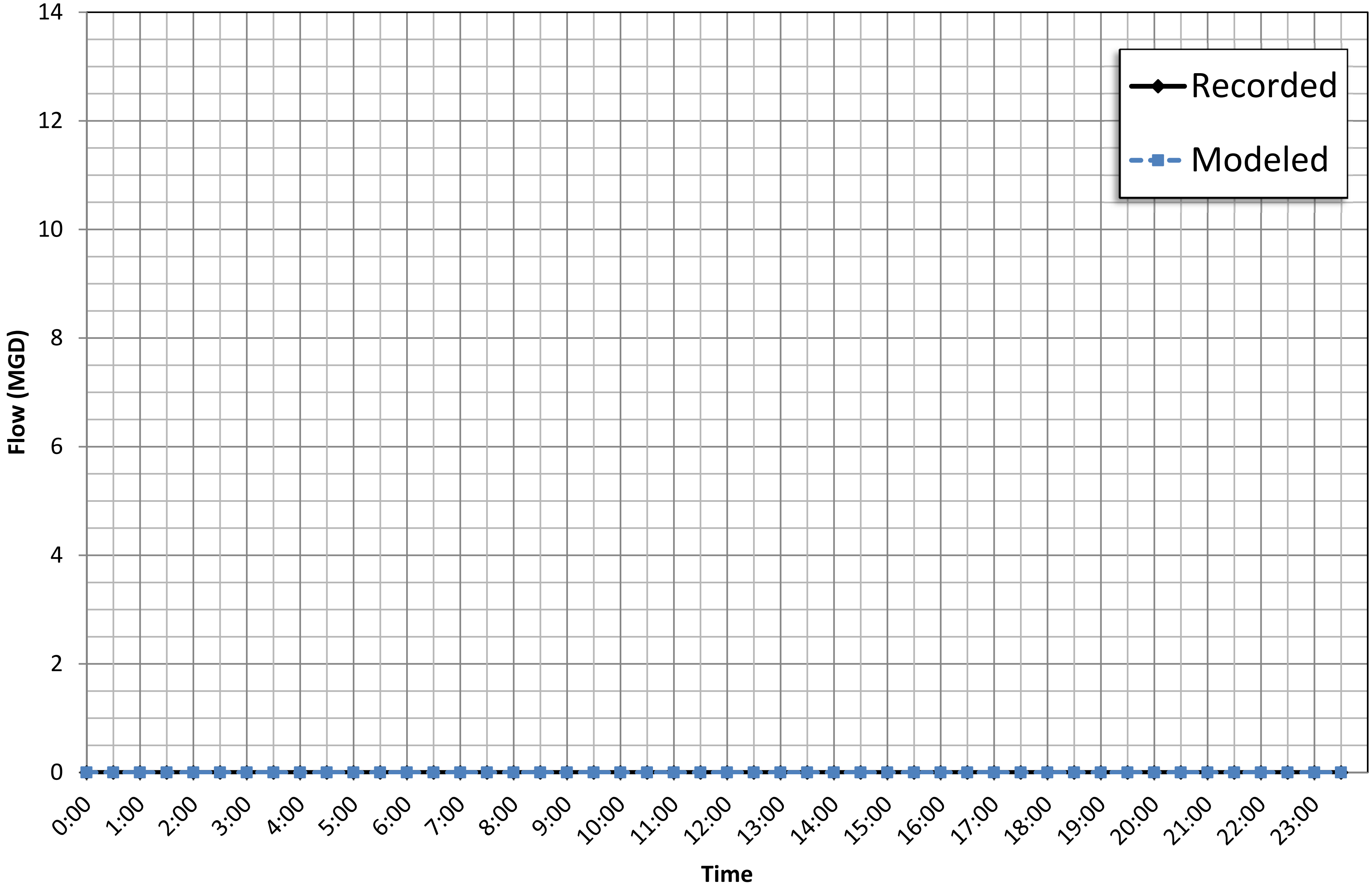
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Westview Pump No. 2 Flow
August 20, 2013
City of Waco
Recorded
Modeled
Flow (MGD)
8
7
6
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time



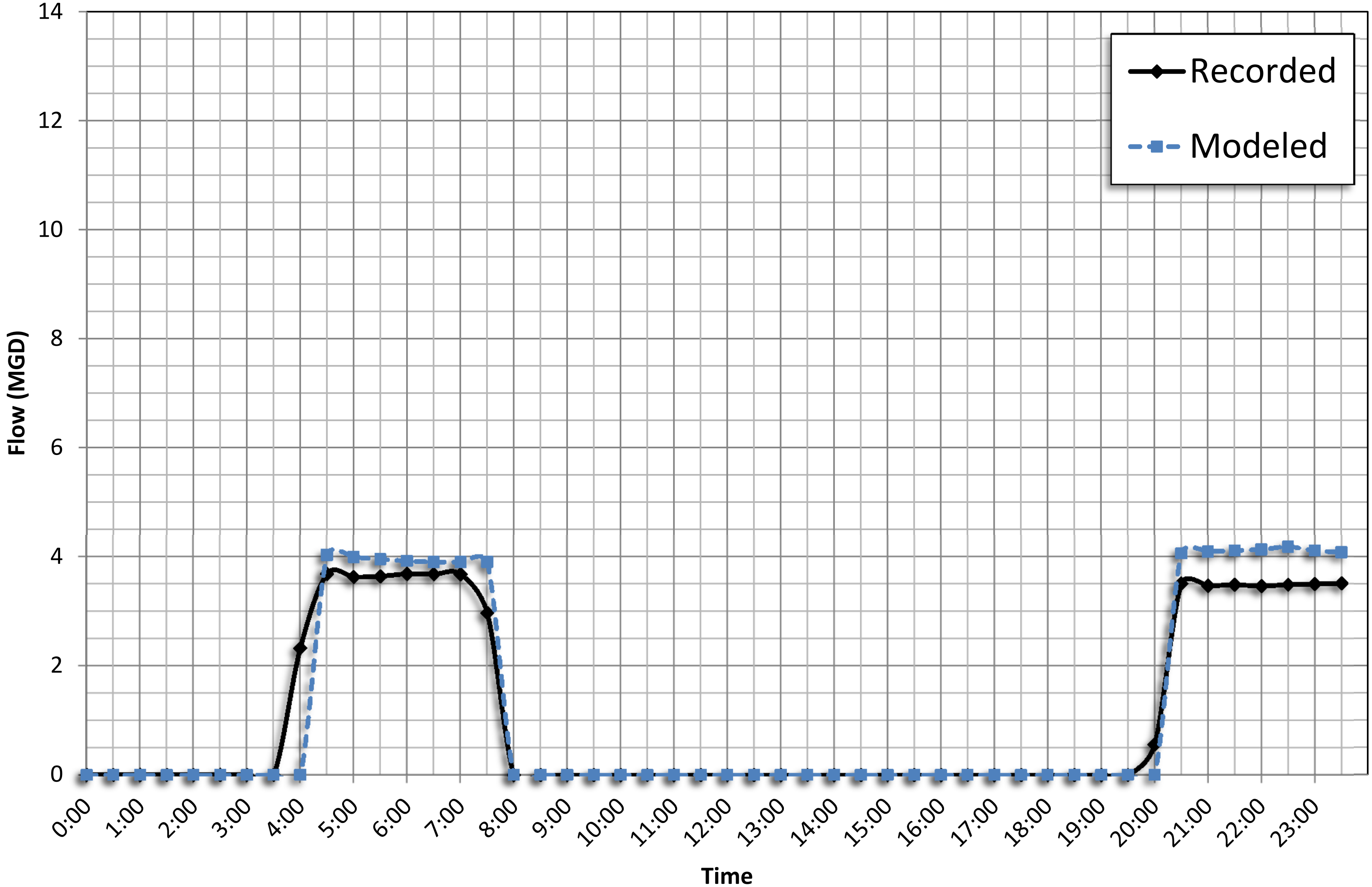
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Westview Pump No. 3&4 Flow
August 20, 2013
City of Waco
Recorded
Modeled
Flow (MGD)
Time
0
1
2
3
4
5
6
7
8
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00

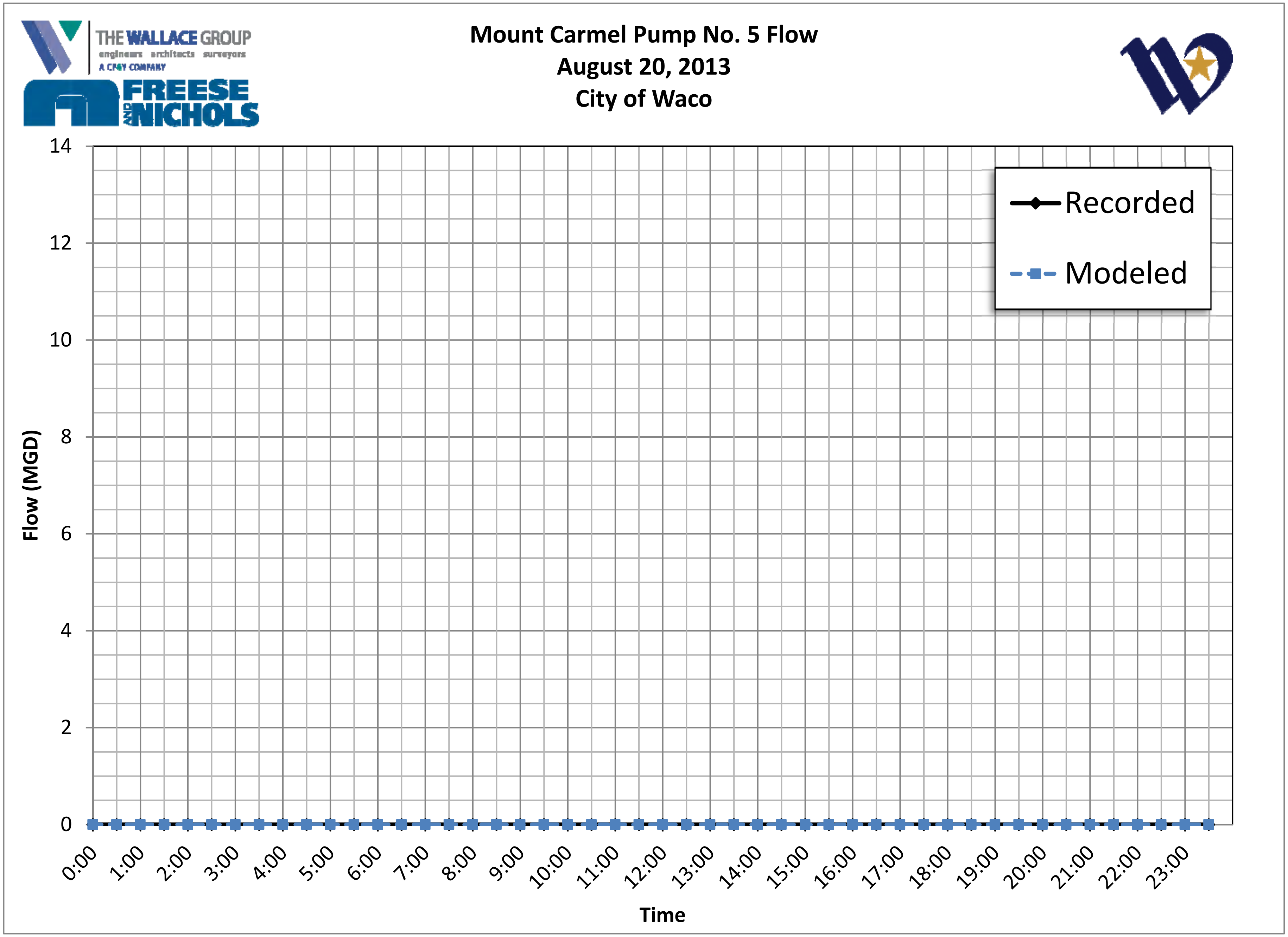
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS

Mount Carmel Pump No. 1 Flow
August 20, 2013
City of Waco



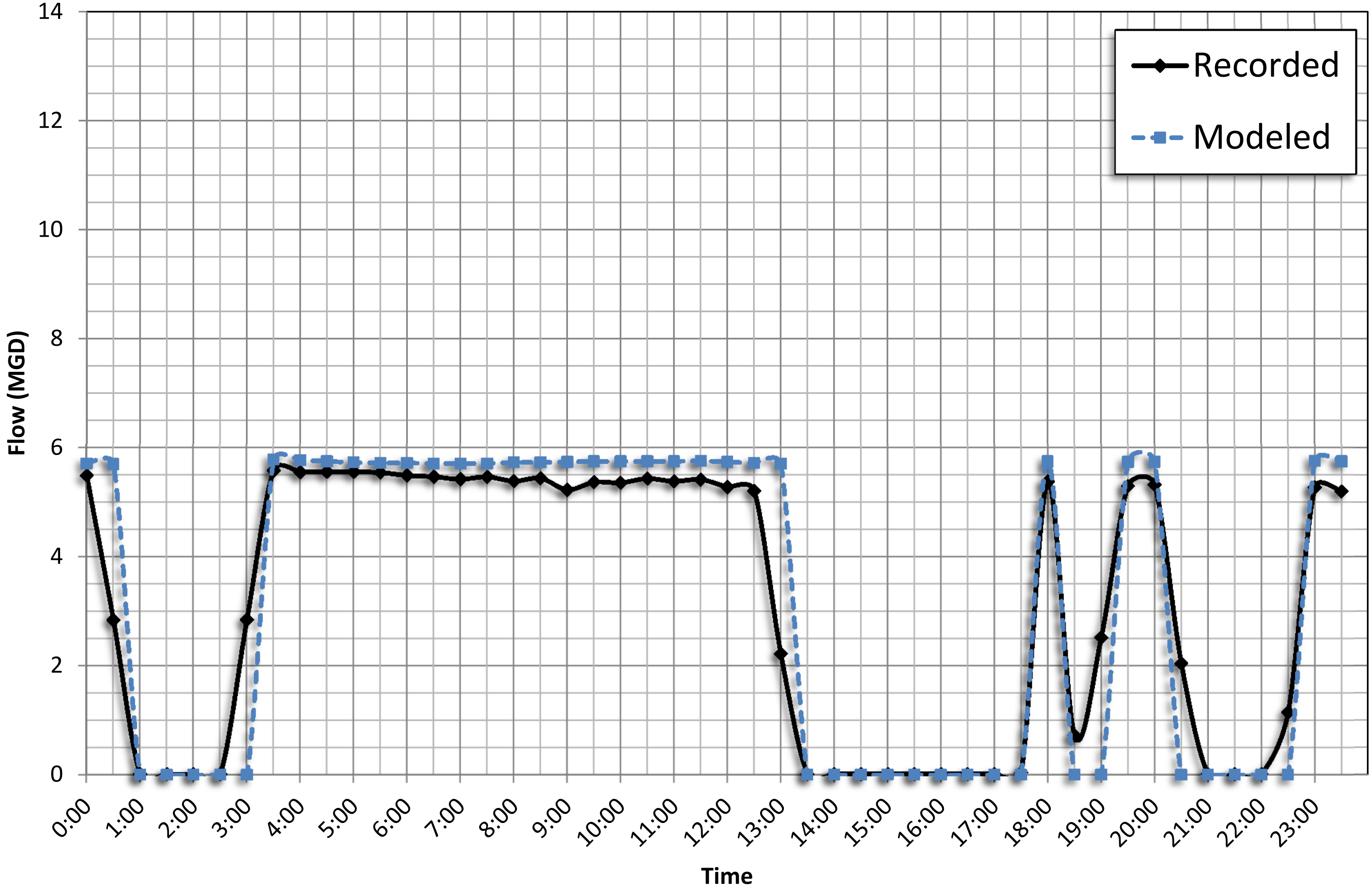
Mount Carmel Pump No. 3 Flow
August 20, 2013
City of Waco

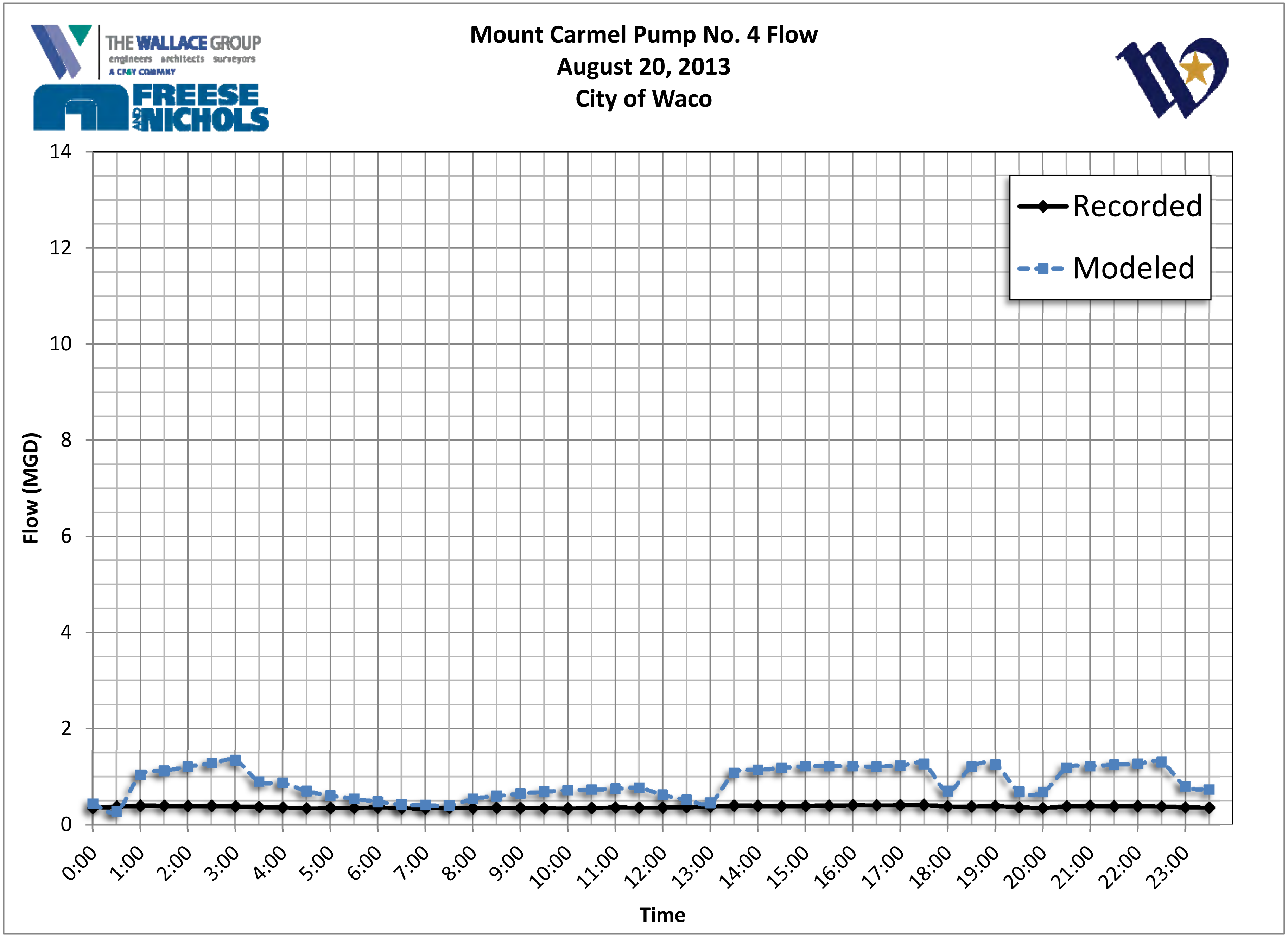




Mount Carmel Pump No. 5 Flow
August 20, 2013
City of Waco
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Flow (MGD)
14
12
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

Mount Carmel Pump No. 2 Flow
August 20, 2013
City of Waco





Mount Carmel Pump No. 4 Flow
August 20, 2013
City of Waco
Flow (MGD)
Time
Recorded
Modeled
0
2
4
6
8
10
12
14
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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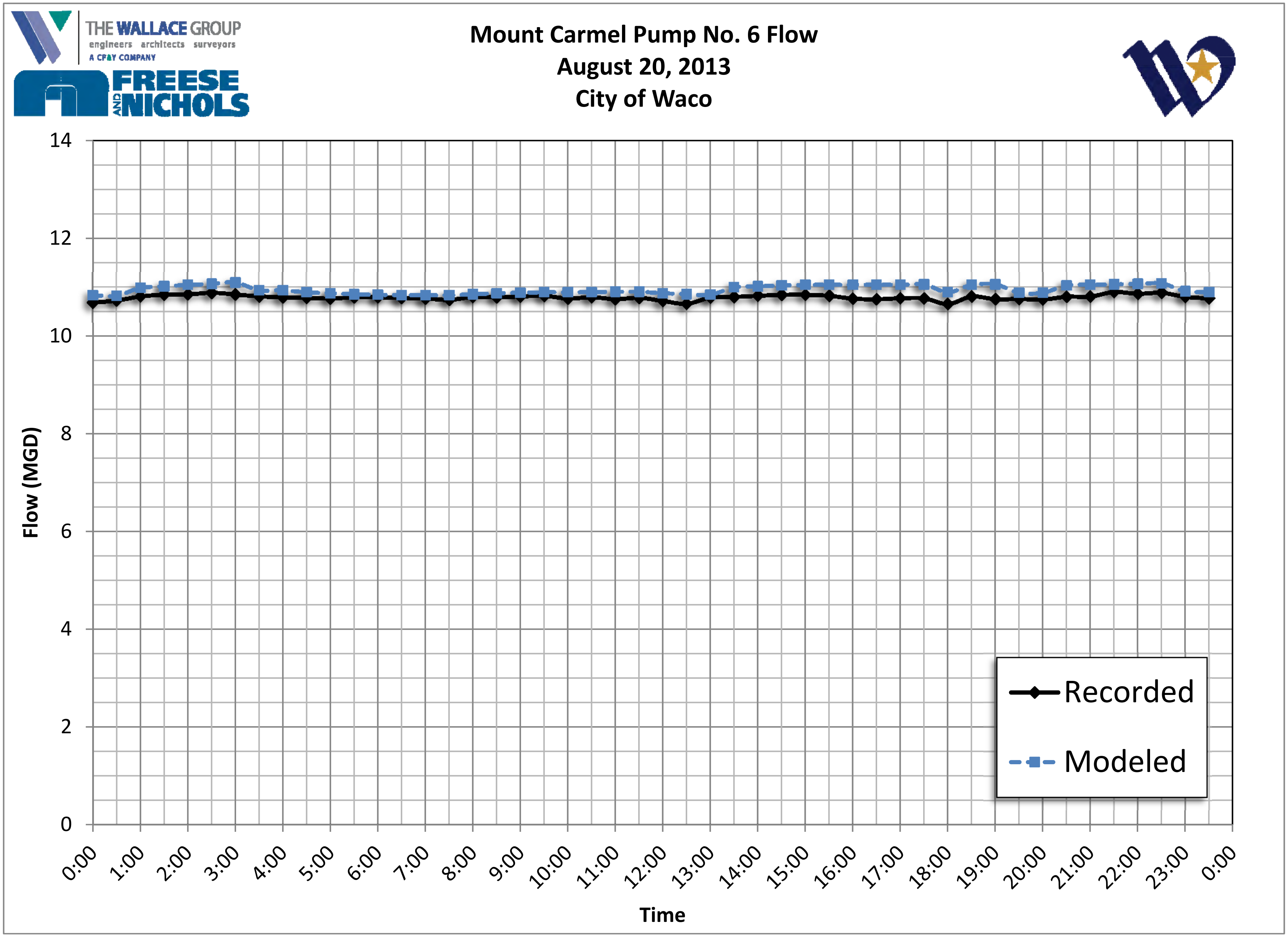
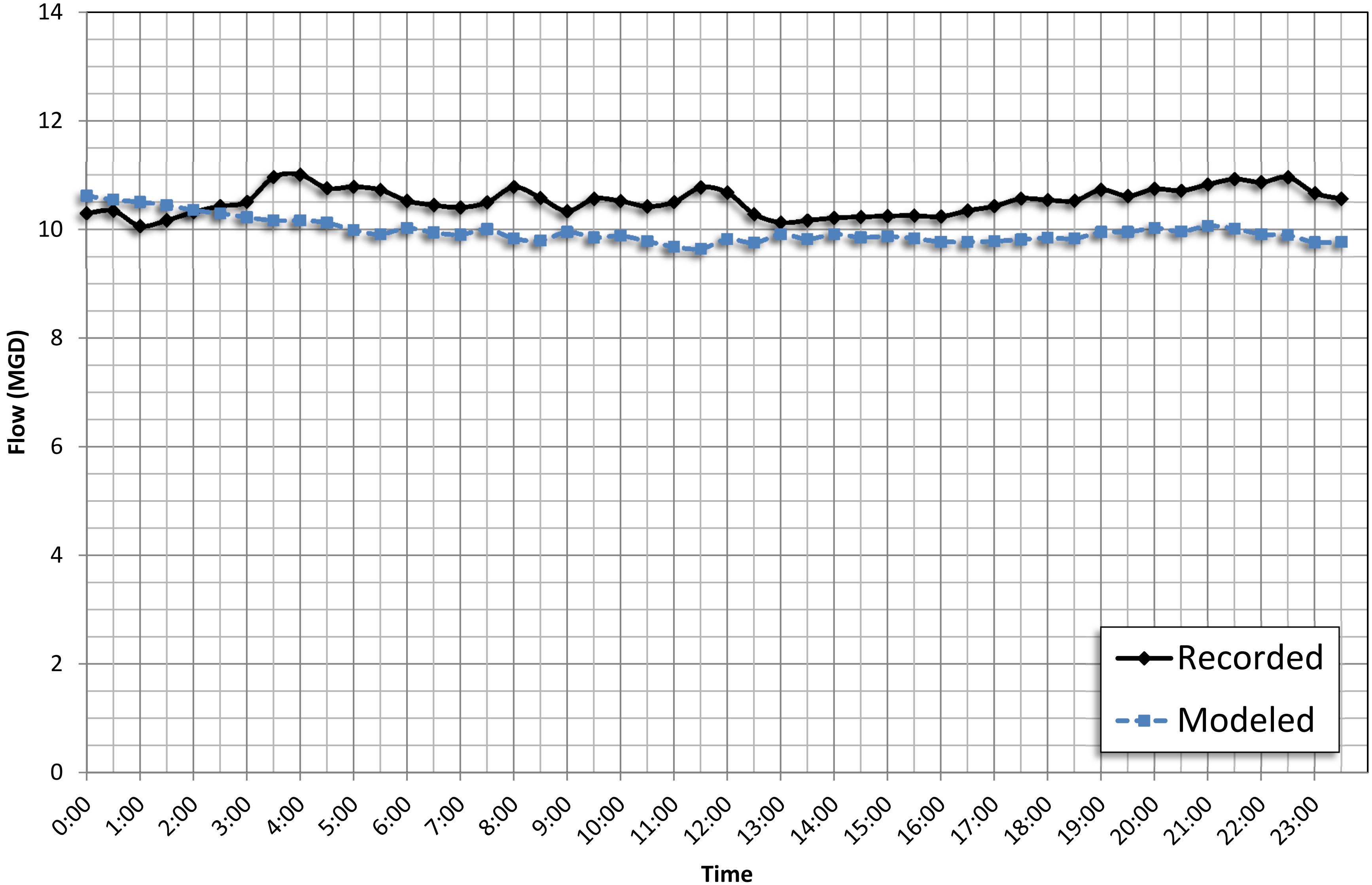
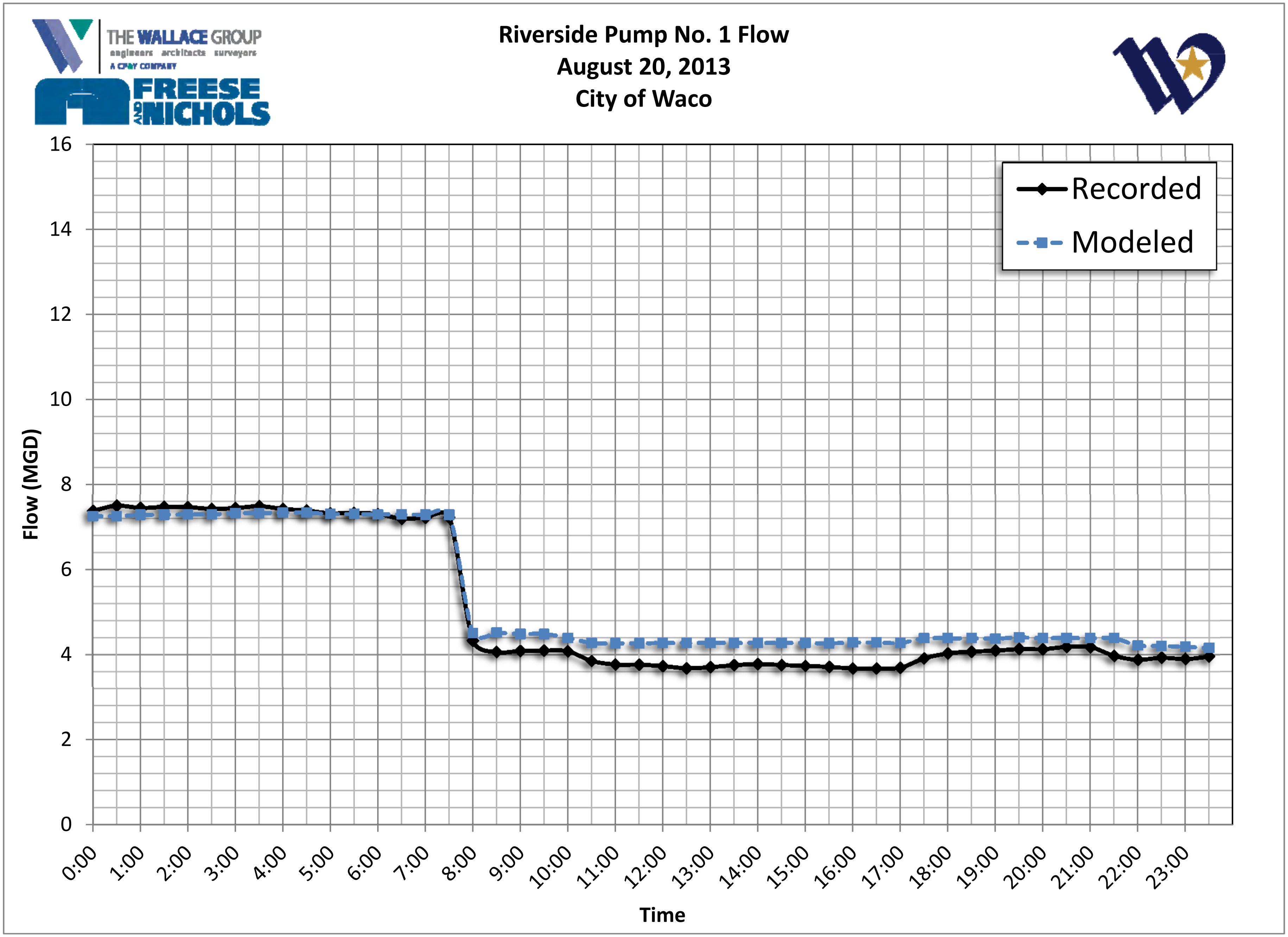
21:00
22:00
23:00

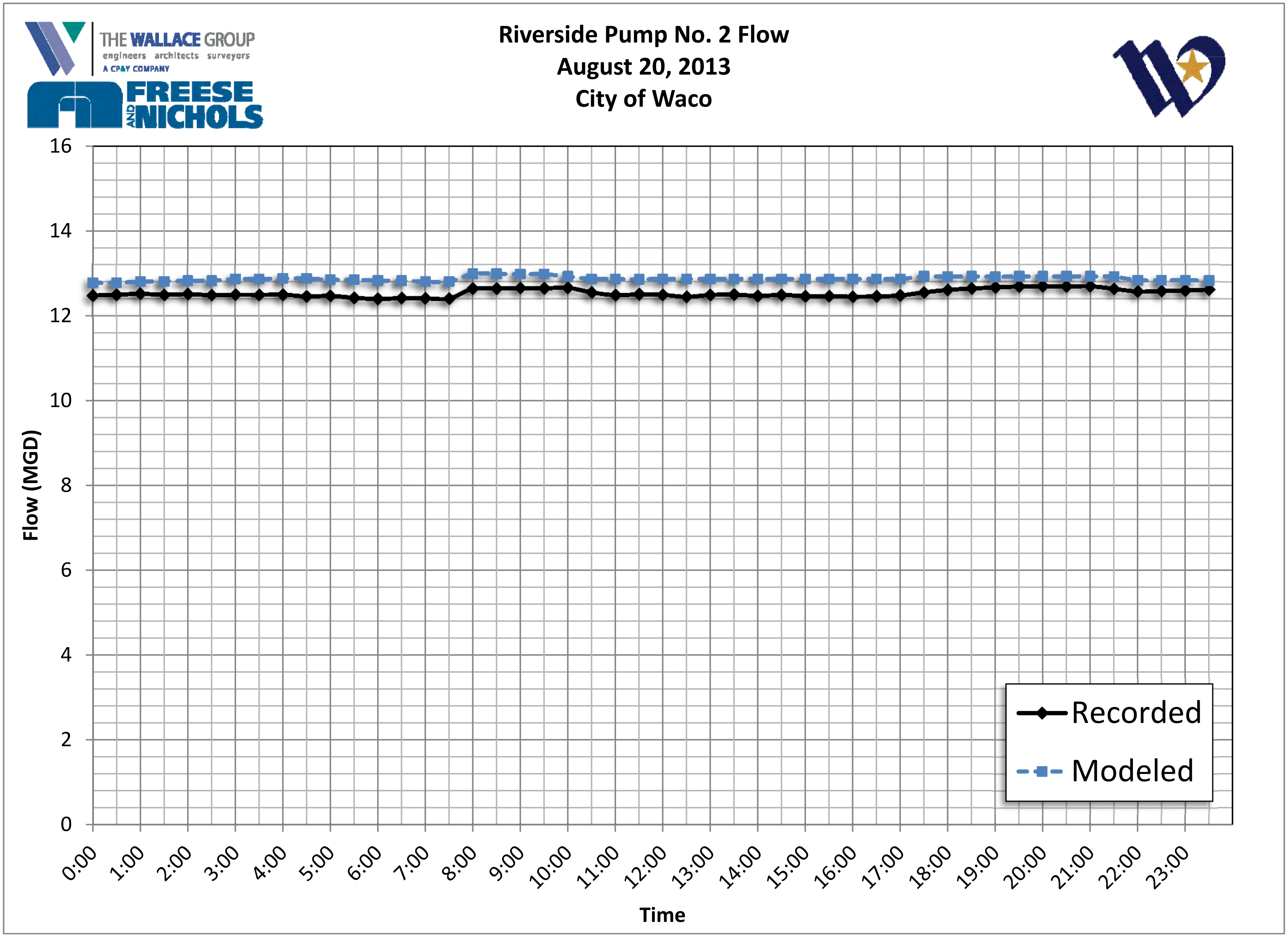


THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Mount Carmel Pump No. 6 Flow
August 20, 2013
City of Waco
Flow (MGD)
14
12
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
Recorded
Modeled

Mount Carmel Pump 33-inch Gravity Line Flow
August 20, 2013
City of Waco

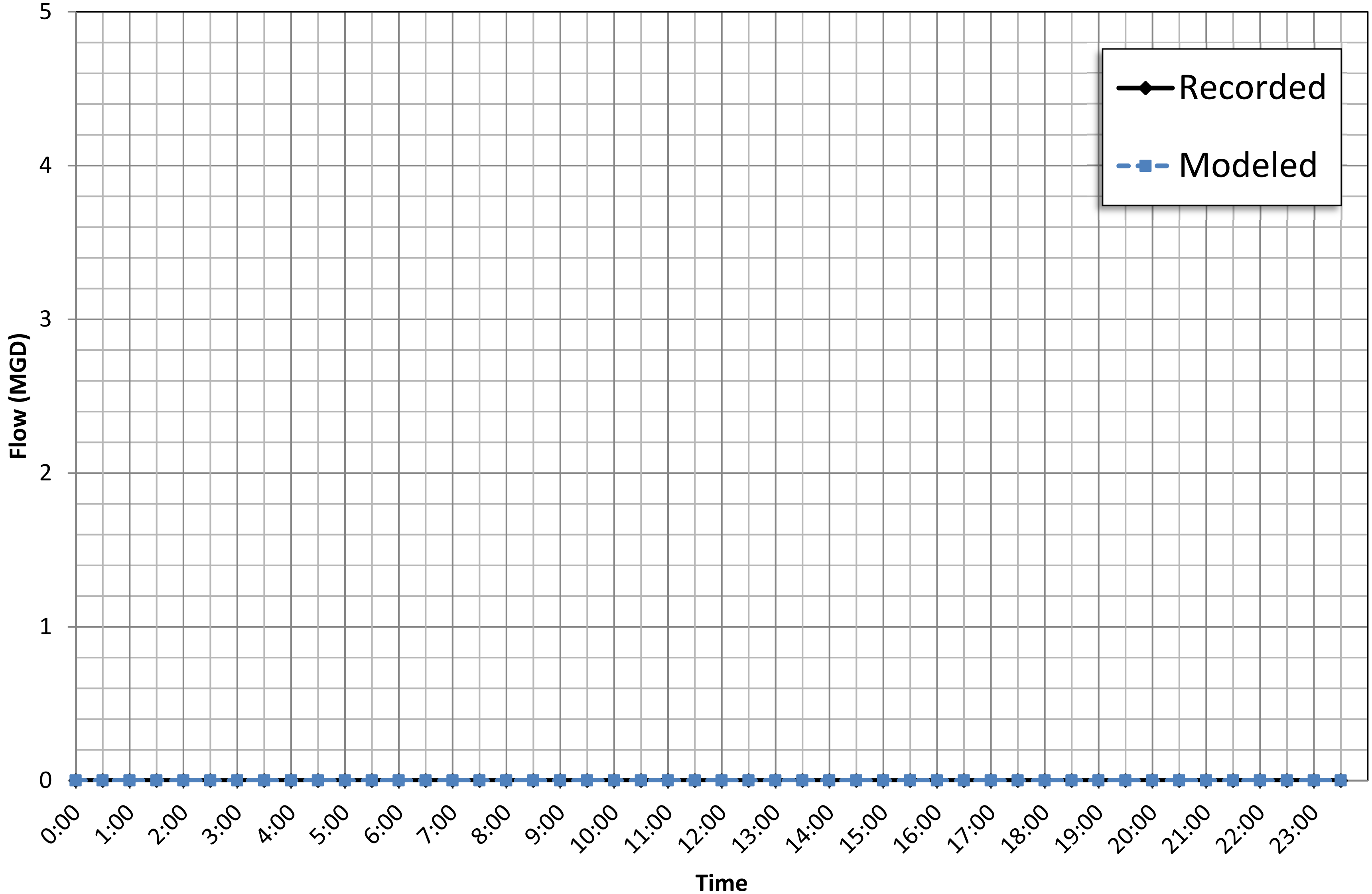


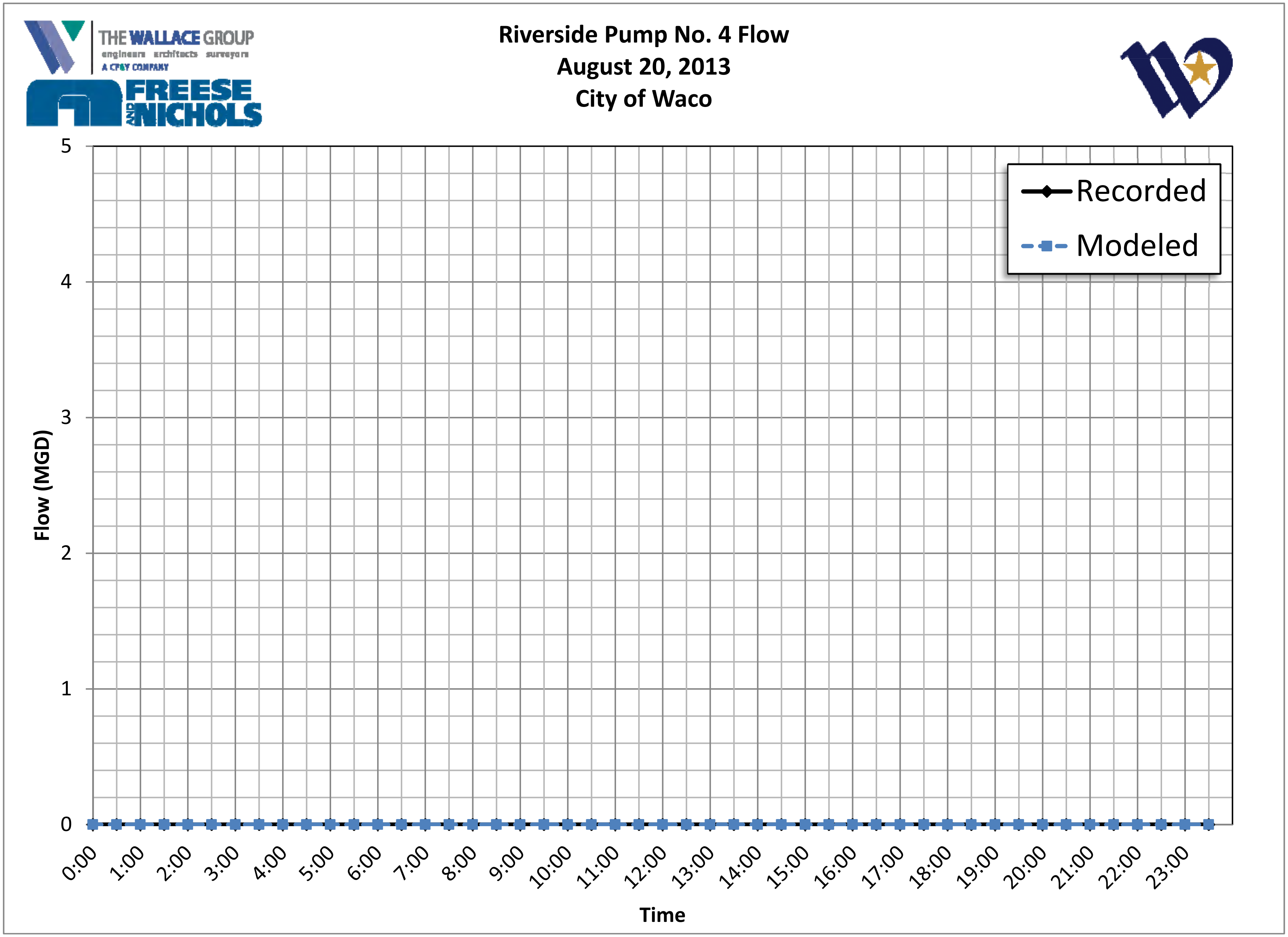

Riverside Pump No. 1 Flow
August 20, 2013
City of Waco
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Flow (MGD)
16
14
12
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled



THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Riverside Pump No. 2 Flow
August 20, 2013
City of Waco
Flow (MGD)
16
14
12
10
8
6
4
2
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

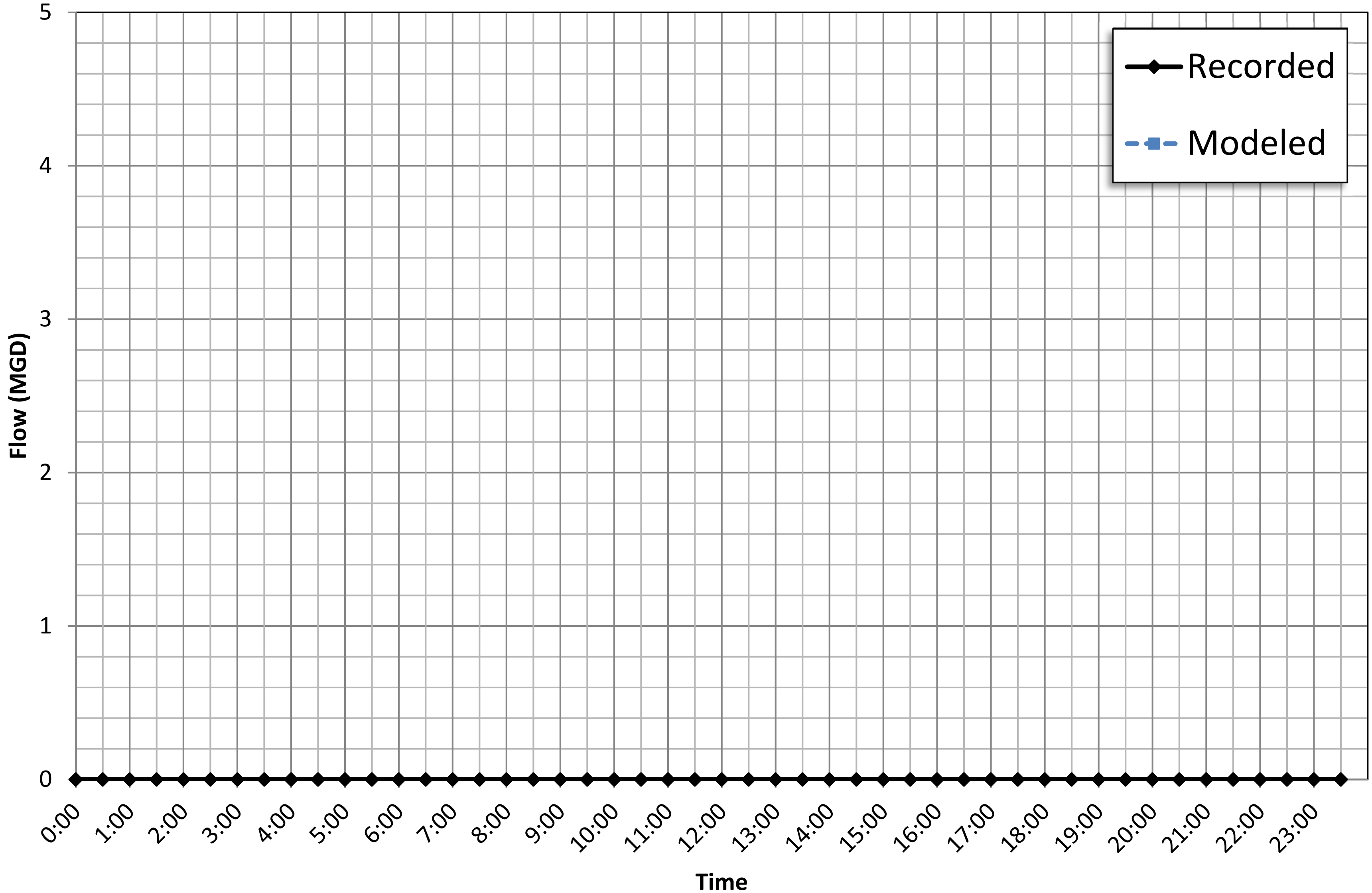
Riverside Pump No. 3 Flow
August 20, 2013
City of Waco

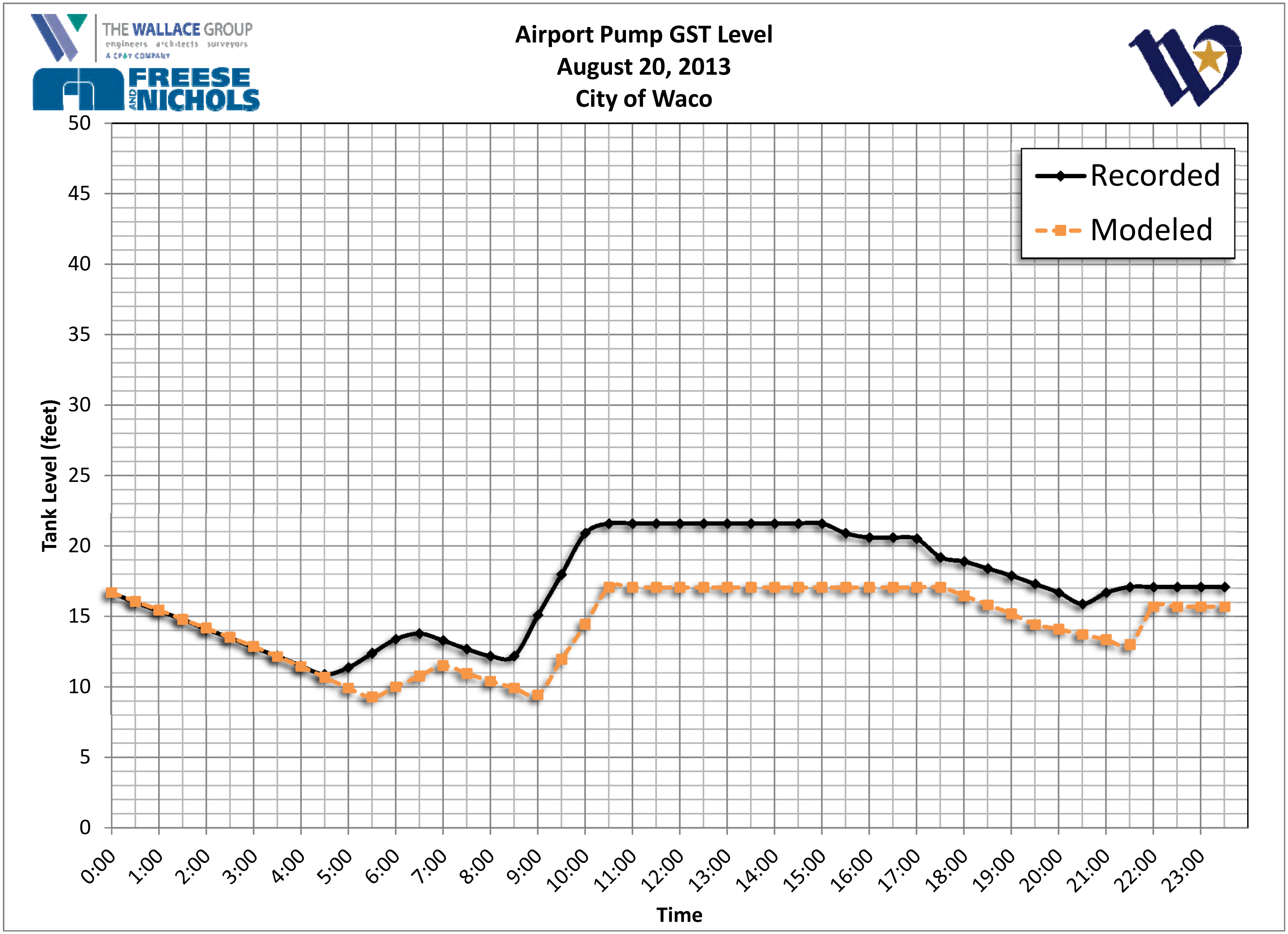




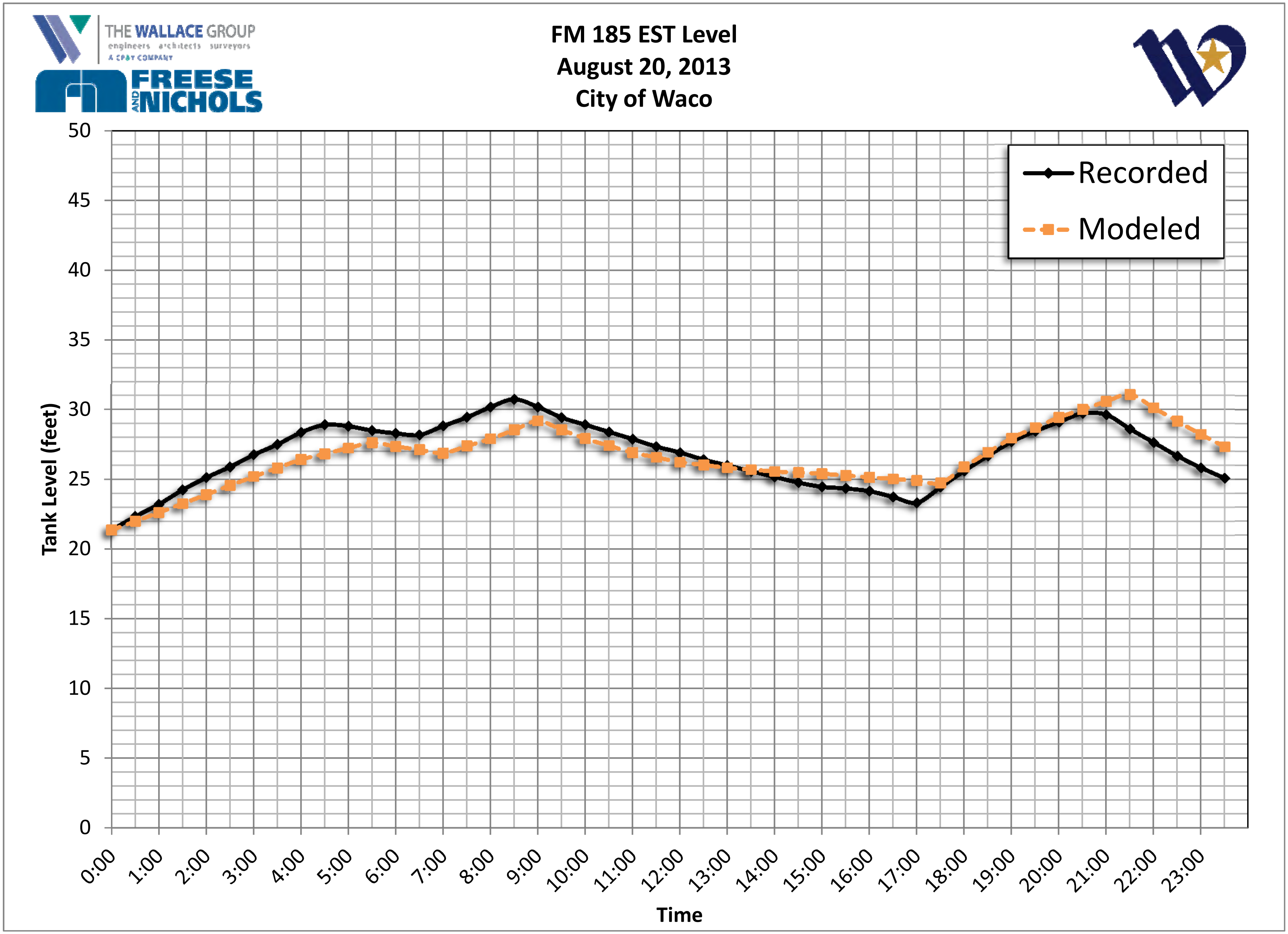
THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Riverside Pump No. 4 Flow
August 20, 2013
City of Waco
Recorded
Modeled
Flow (MGD)
5
4
3
2
1
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

Riverside Pump No. 5 Flow
August 20, 2013
City of Waco

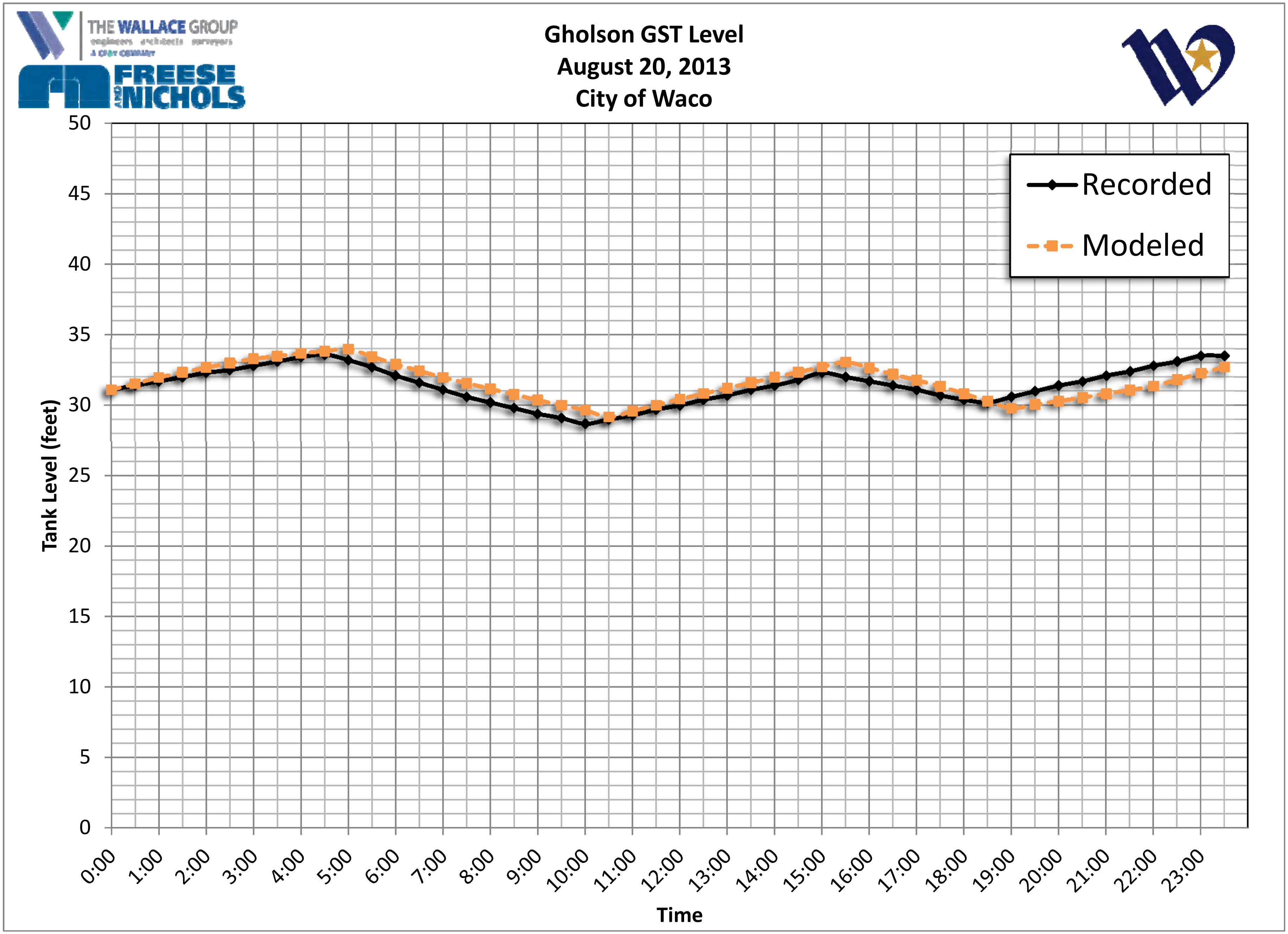




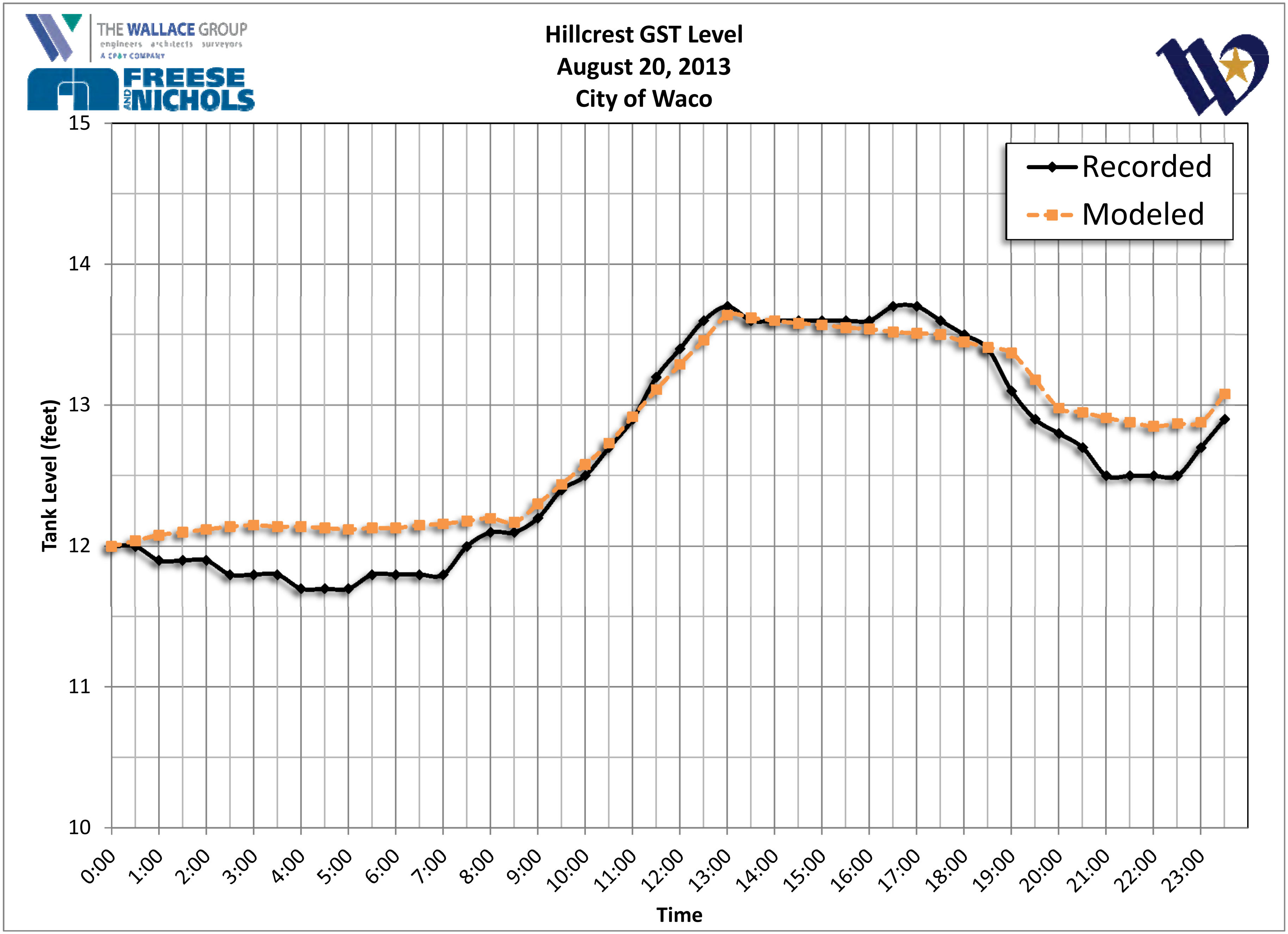
Airport Pump GST Level
August 20, 2013
City of Waco
THE WALLACE GROUP
engineers architects surveyors
FREESE AND NICHOLS
Recorded
Modeled
Tank Level (feet)
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

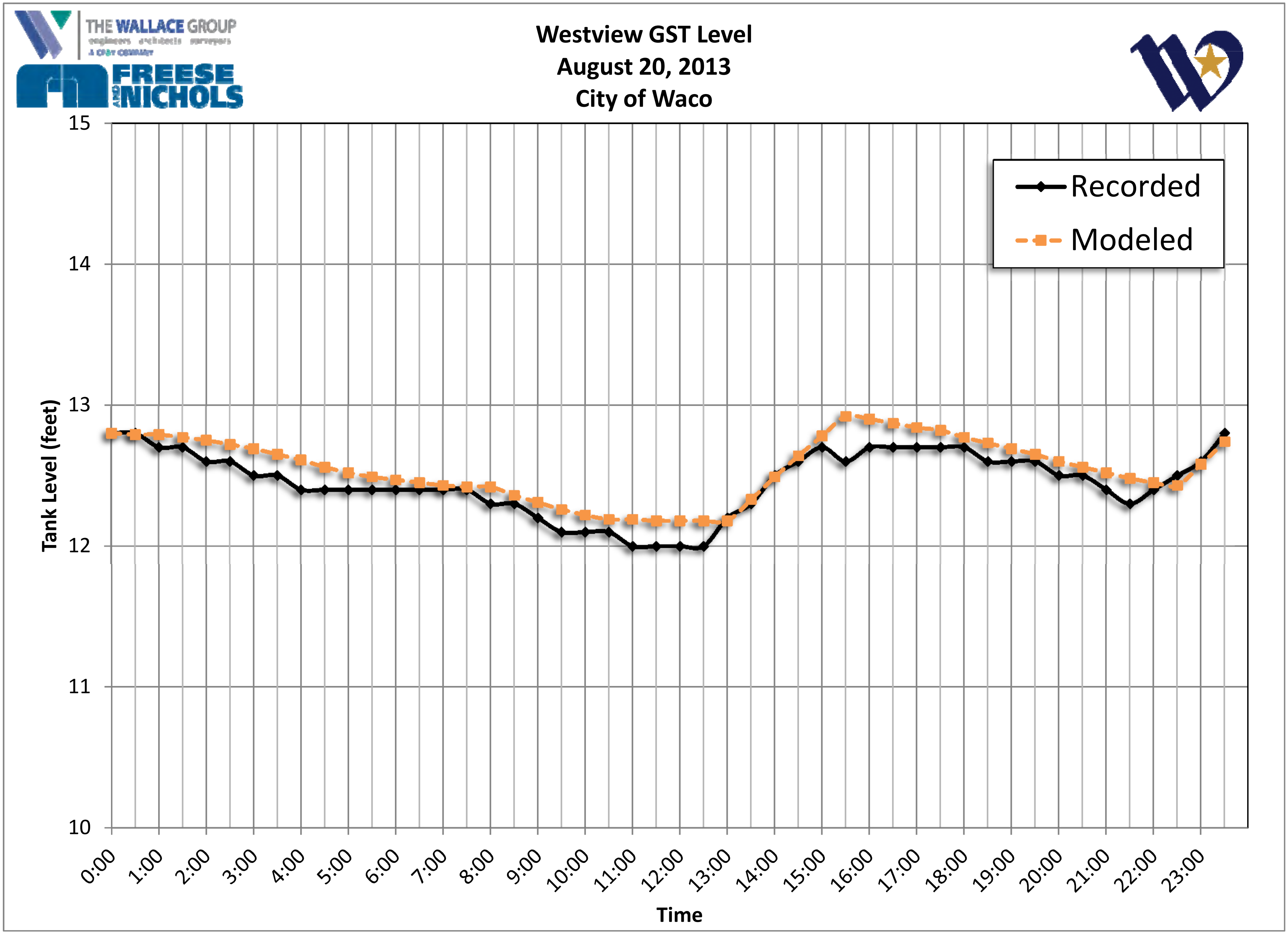


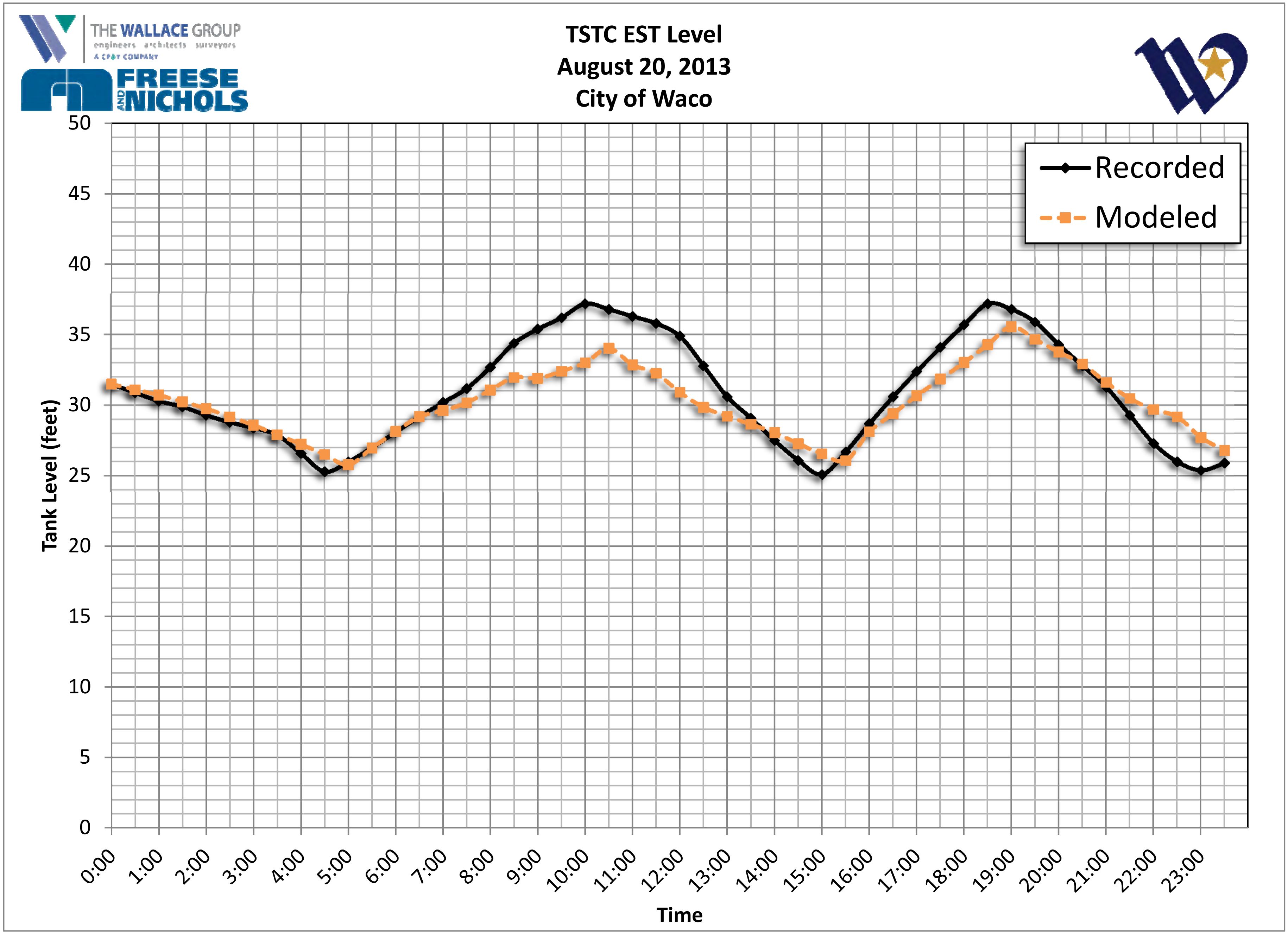
FM 185 EST Level
August 20, 2013
City of Waco
Tank Level (feet)
50
45
40
35
30
25
20
15
10
5
0
Recorded
Modeled
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time



Gholson GST Level
August 20, 2013
City of Waco
Tank Level (feet)
Time
Recorded
Modeled
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
THE WALLACE GROUP
FREESE AND NICHOLS

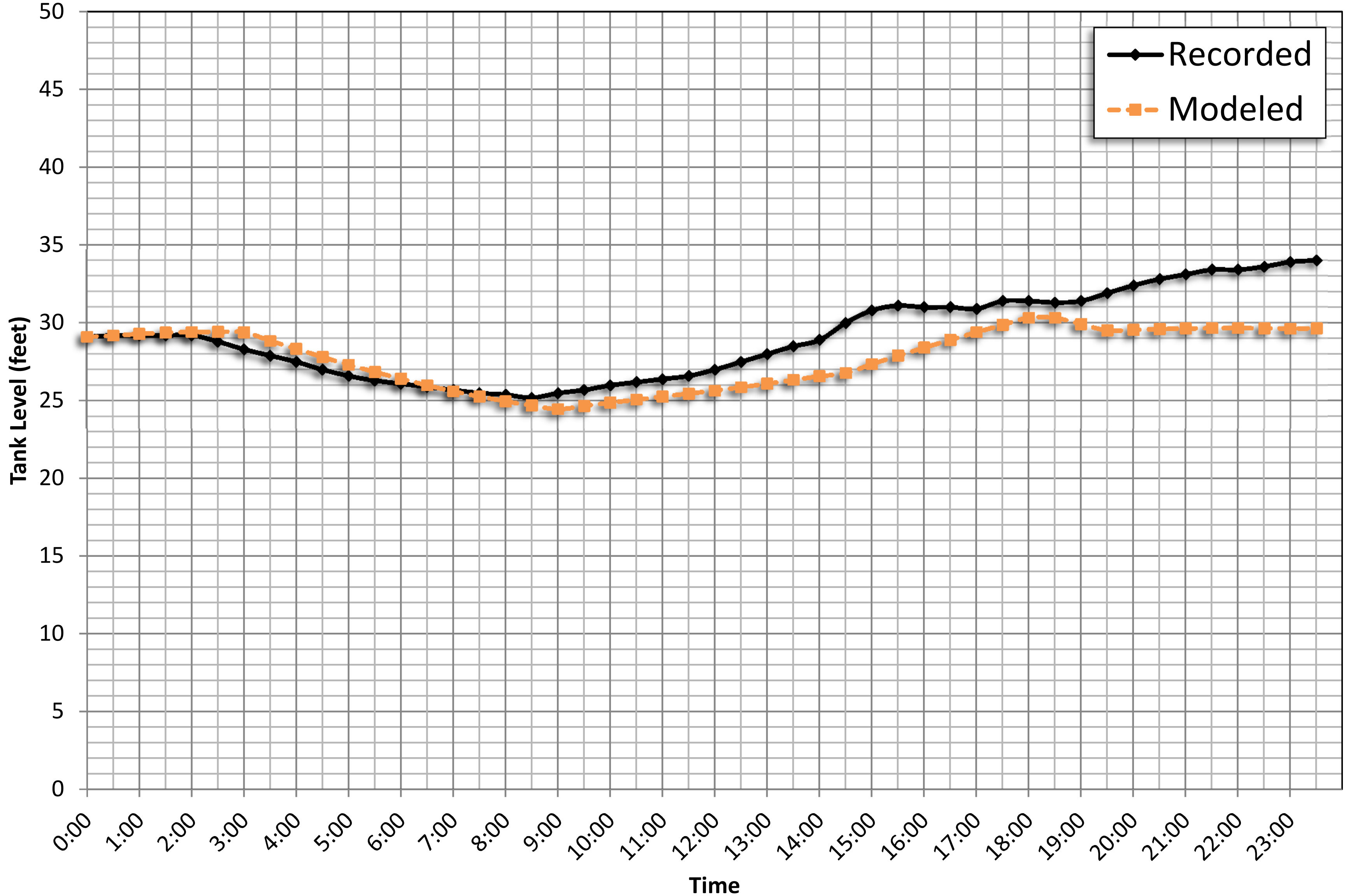

Hillcrest GST Level
August 20, 2013
City of Waco
THE WALLACE GROUP
engineers architects surveyors
FREESE AND NICHOLS
Recorded
Modeled
Tank Level (feet)
15
14
13
12
11
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

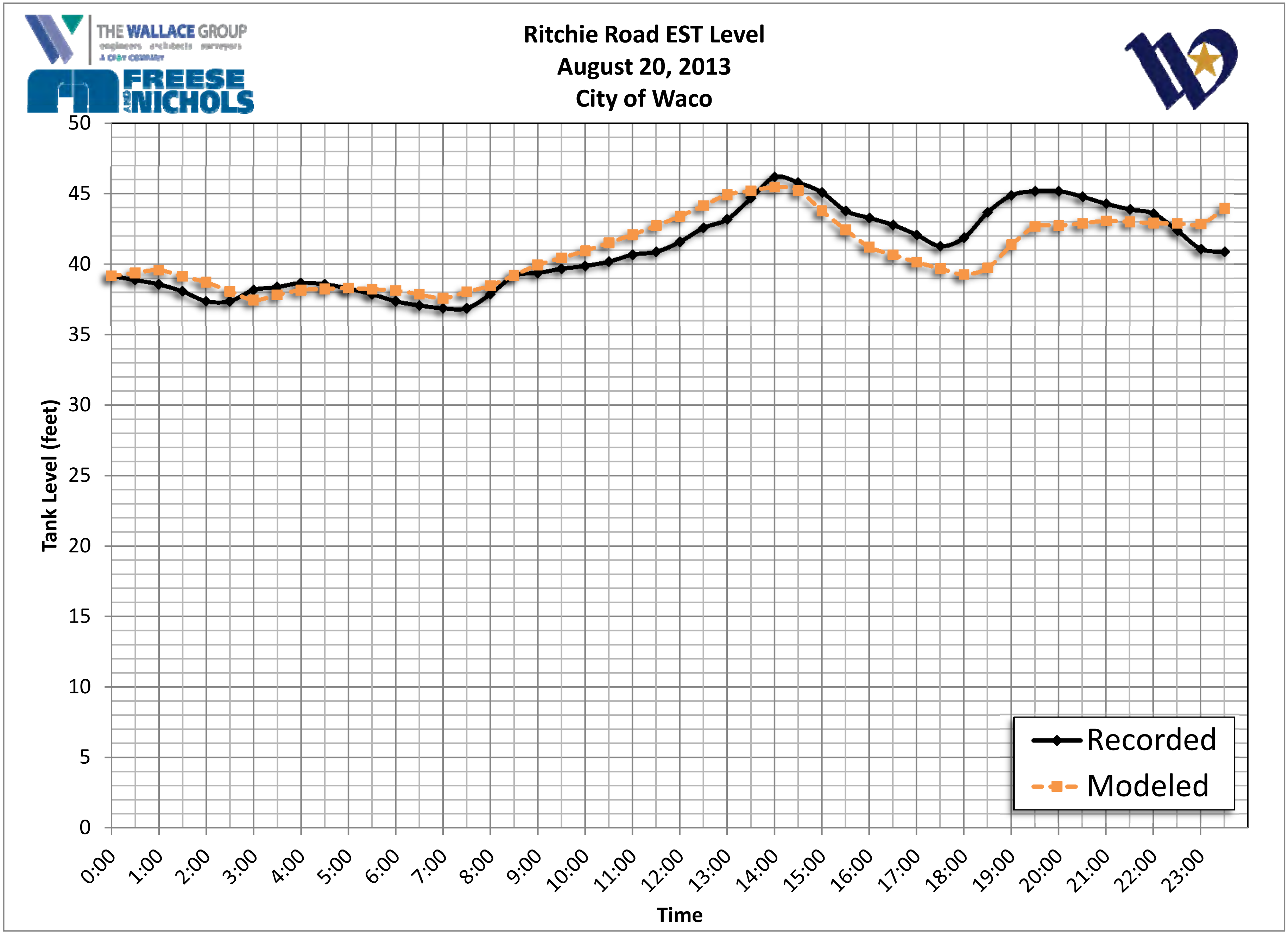

THE WALLACE GROUP
FREESE AND NICHOLS
Westview GST Level
August 20, 2013
City of Waco
Recorded
Modeled
Tank Level (feet)
15
14
13
12
11
10
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time



THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
TSTC EST Level
August 20, 2013
City of Waco
Recorded
Modeled
Tank Level (feet)
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

Old McGregor GST Level
August 20, 2013
City of Waco





THE WALLACE GROUP
FREESE AND NICHOLS
Ritchie Road EST Level
August 20, 2013
City of Waco
Tank Level (feet)
Time
Recorded
Modeled
0
5
10
15
20
25
30
35
40
45
50
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
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15:00
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18:00
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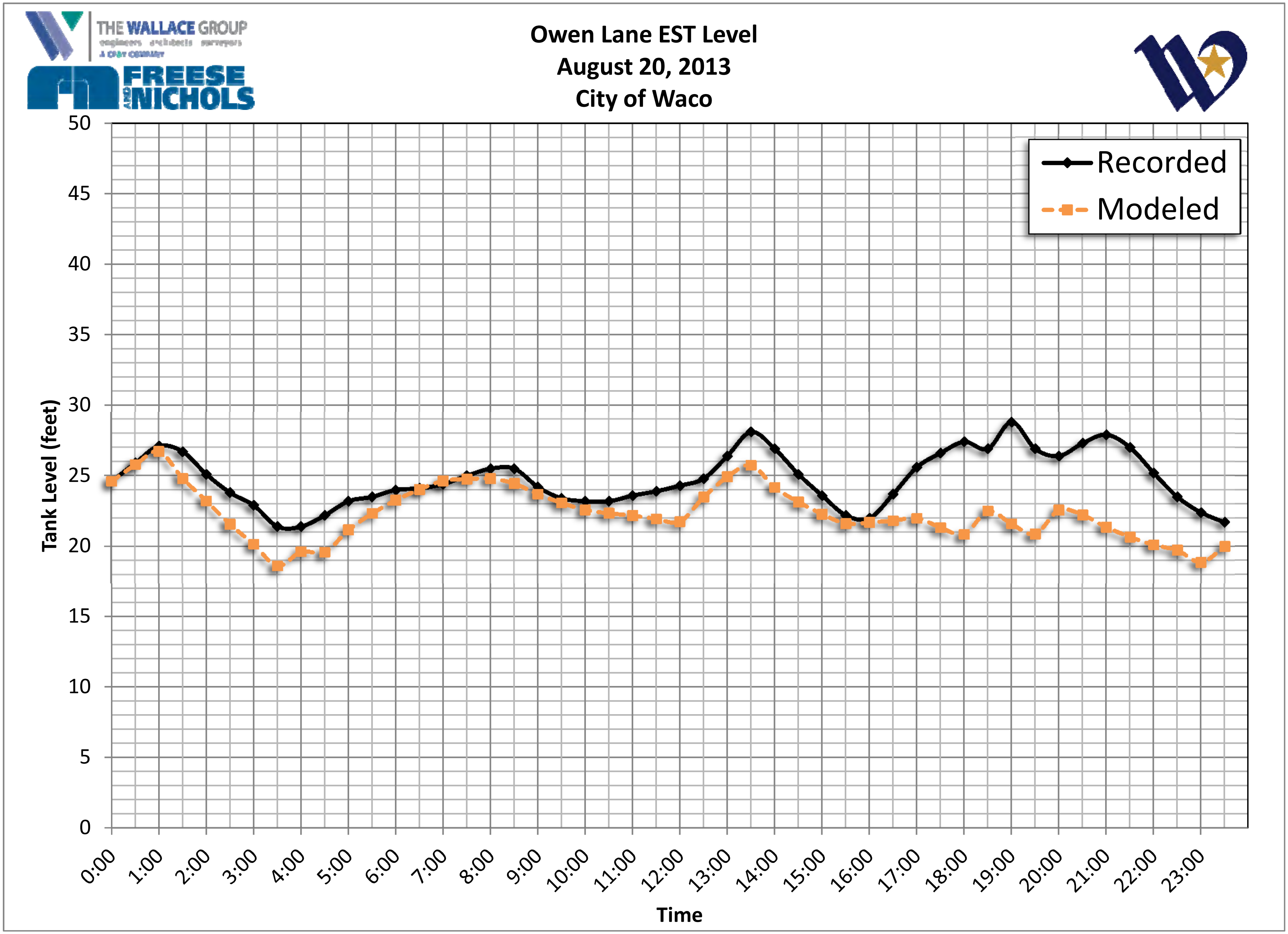
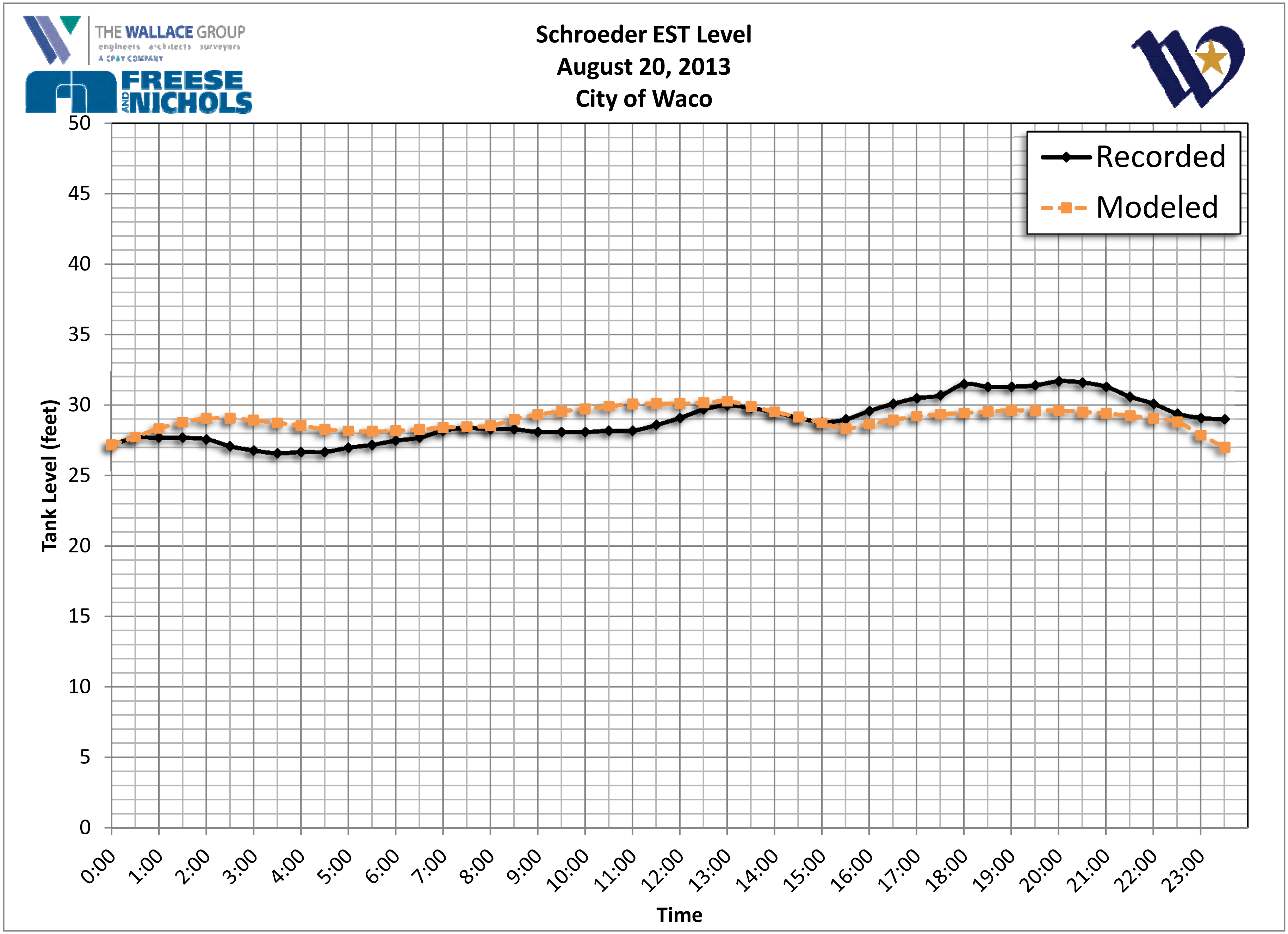
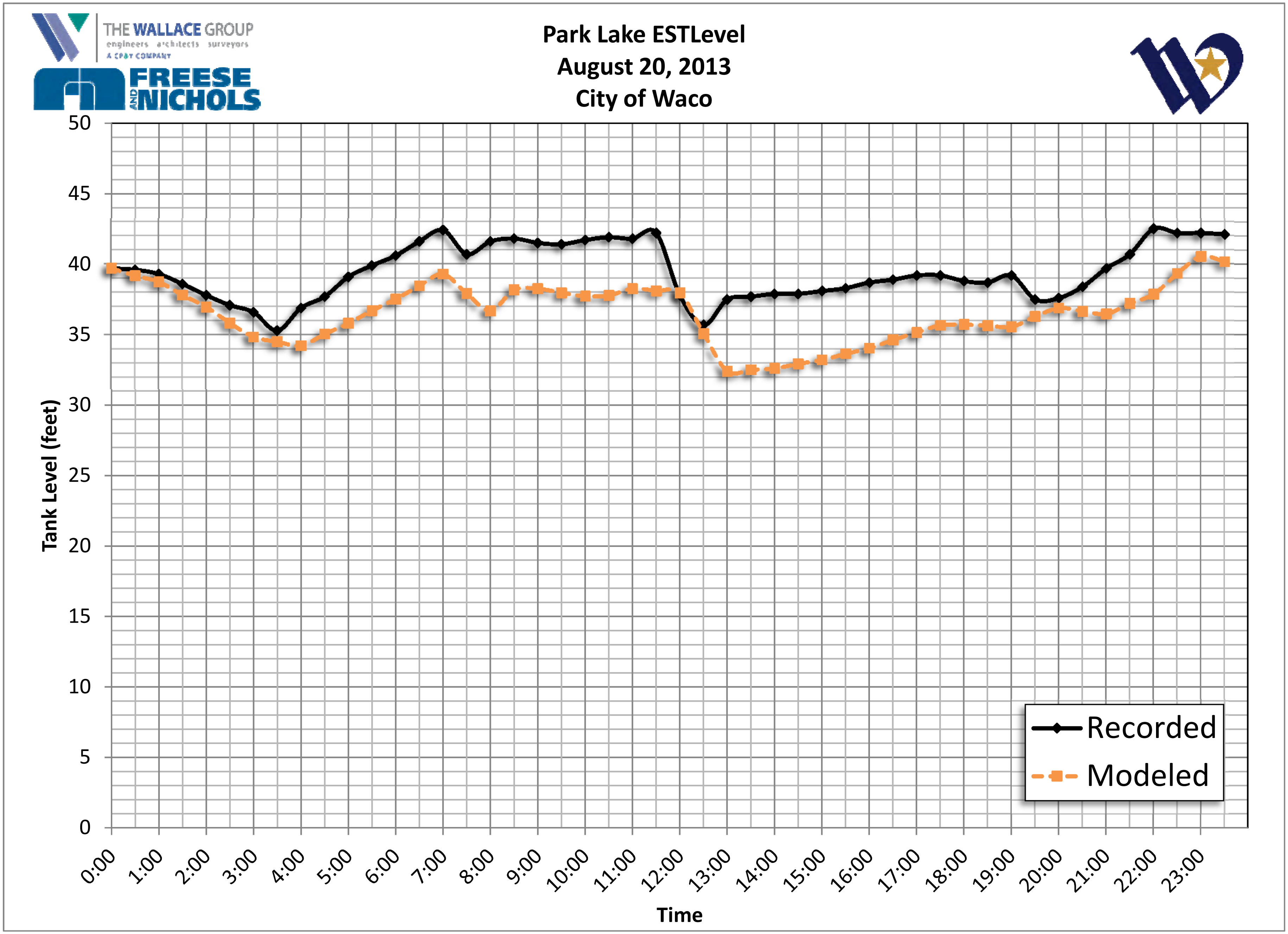
20:00
21:00
22:00
23:00

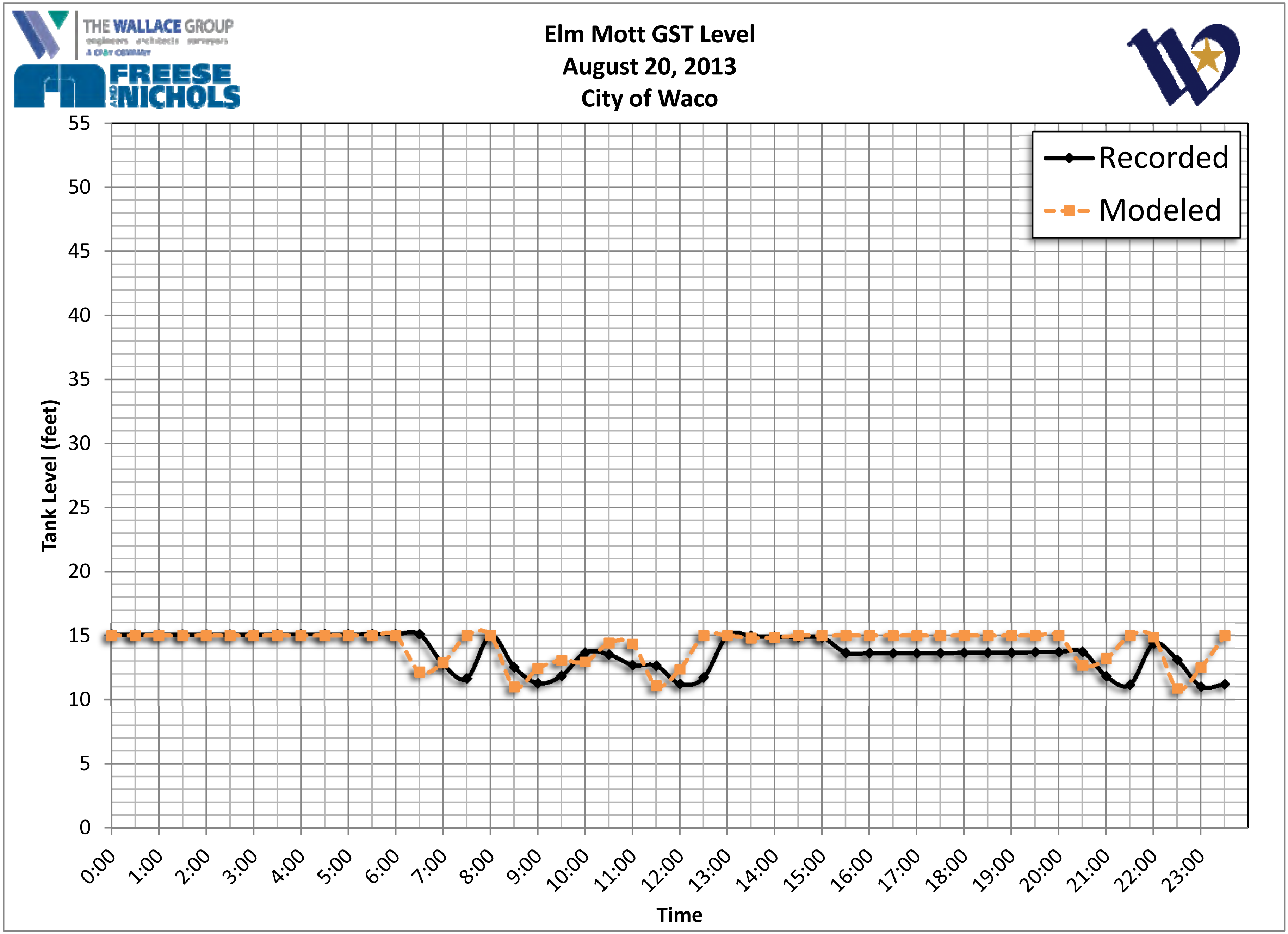


Owen Lane EST Level
August 20, 2013
City of Waco
Recorded
Modeled
Tank Level (feet)
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time


THE WALLACE GROUP
engineers architects surveyors
A CP&Y COMPANY
FREESE AND NICHOLS
Schroeder EST Level
August 20, 2013
City of Waco
Recorded
Modeled
Tank Level (feet)
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

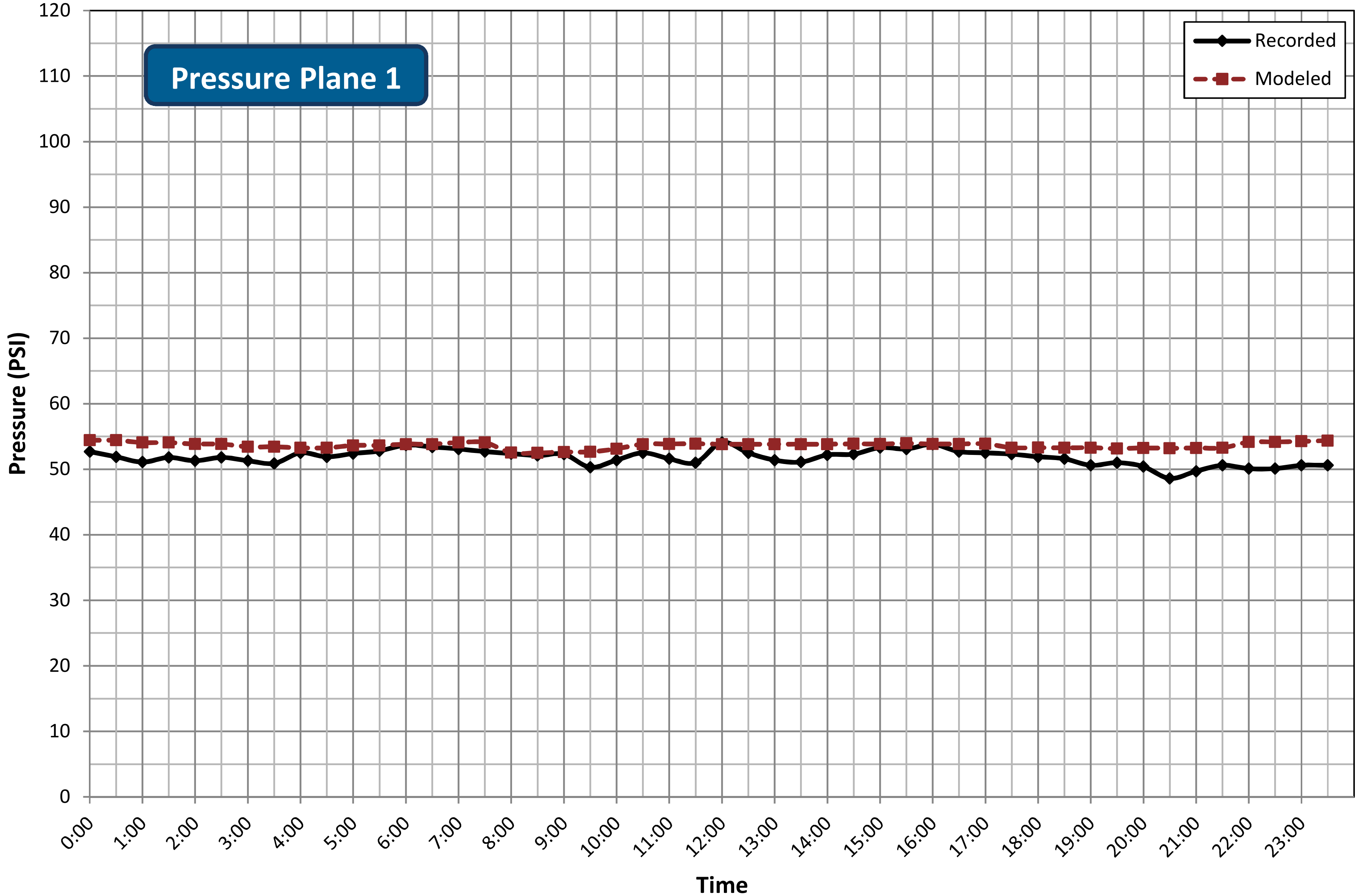


Park Lake ESTLevel
August 20, 2013
City of Waco
THE WALLACE GROUP
FREESE NICHOLS
Tank Level (feet)
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

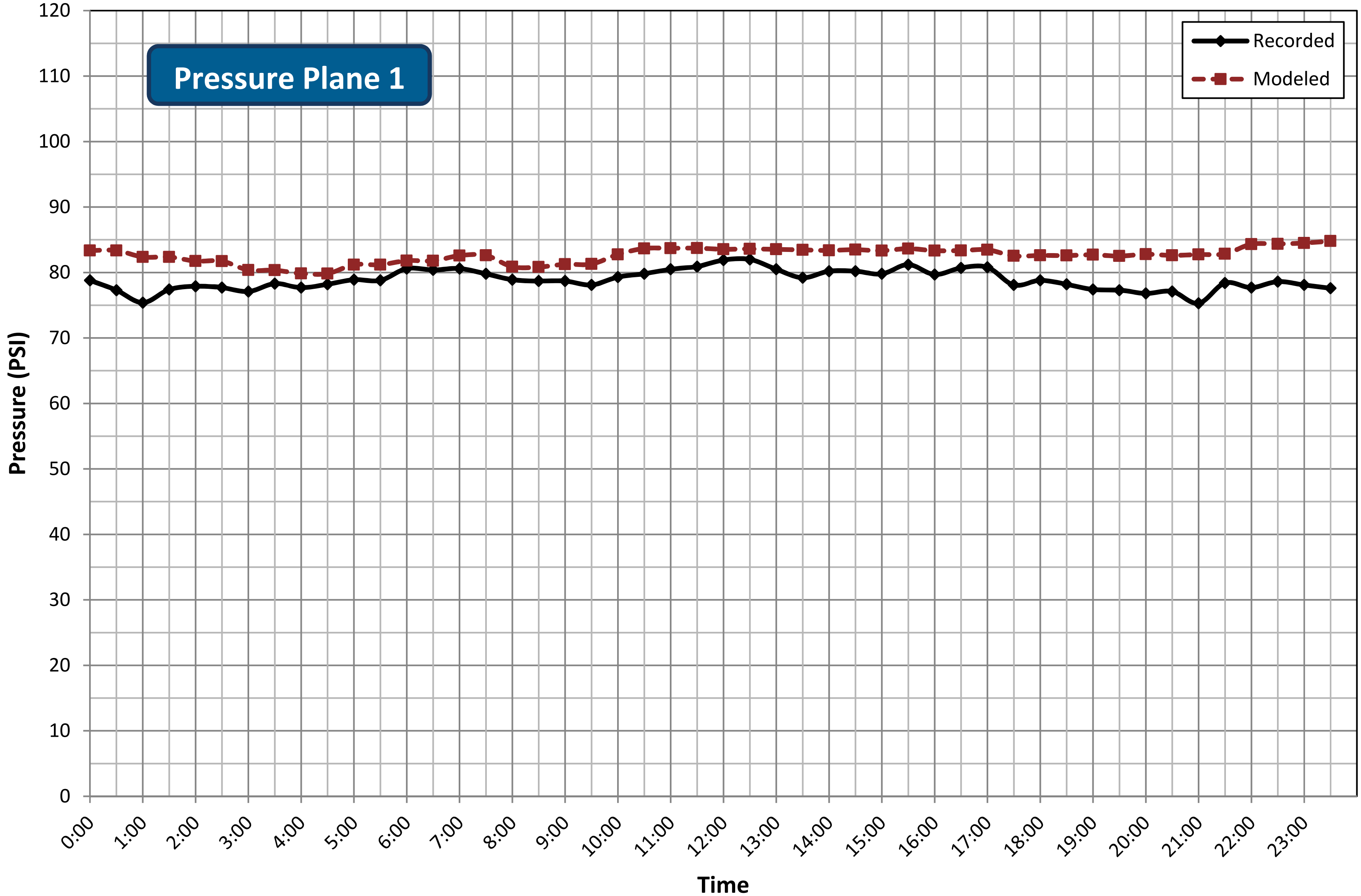


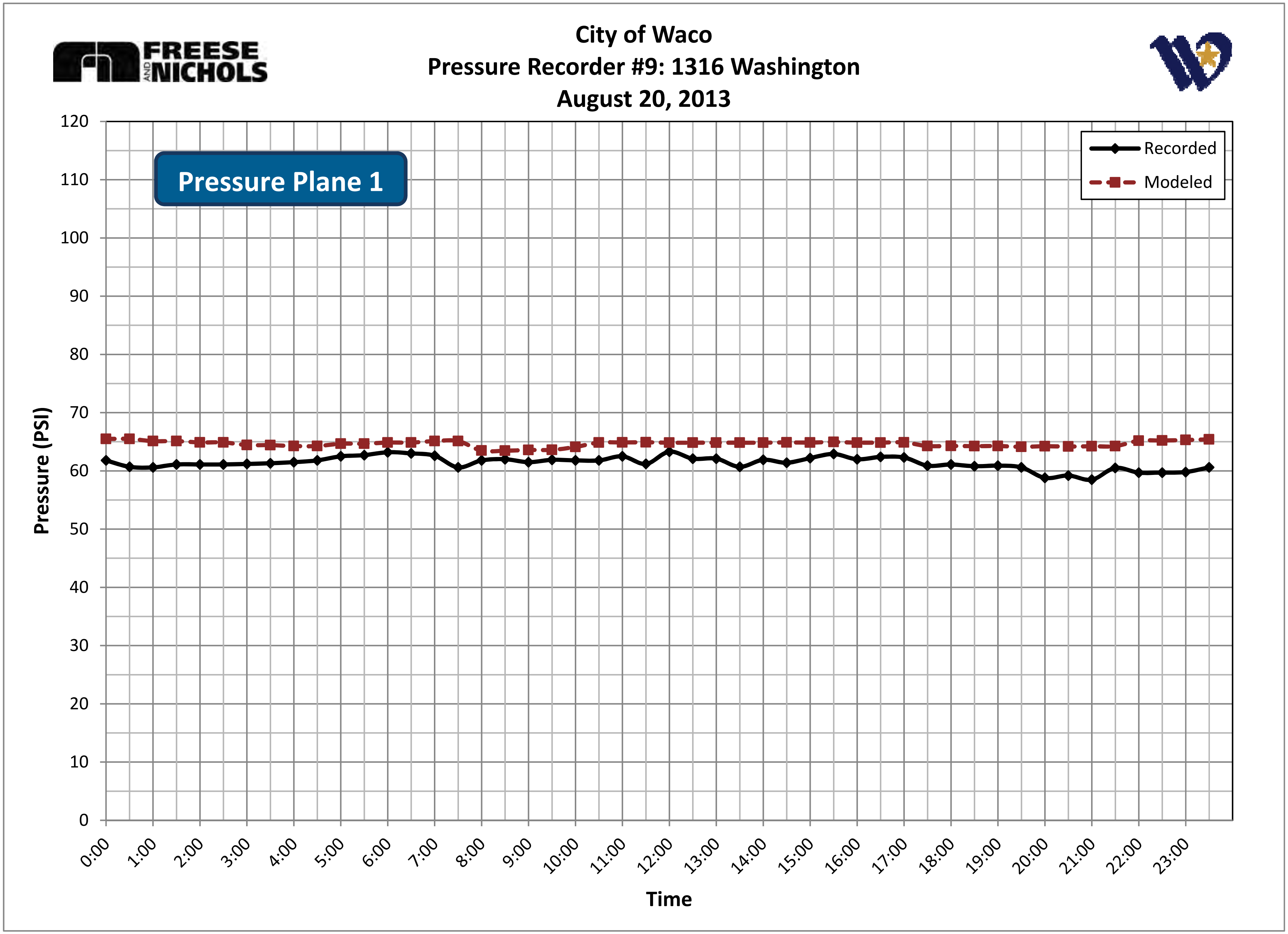
THE WALLACE GROUP
FREESE NICHOLS
Elm Mott GST Level
August 20, 2013
City of Waco
Recorded
Modeled
Tank Level (feet)
55
50
45
40
35
30
25
20
15
10
5
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

City of Waco
Pressure Recorder #7: 3617 Bagby
August 20, 2013

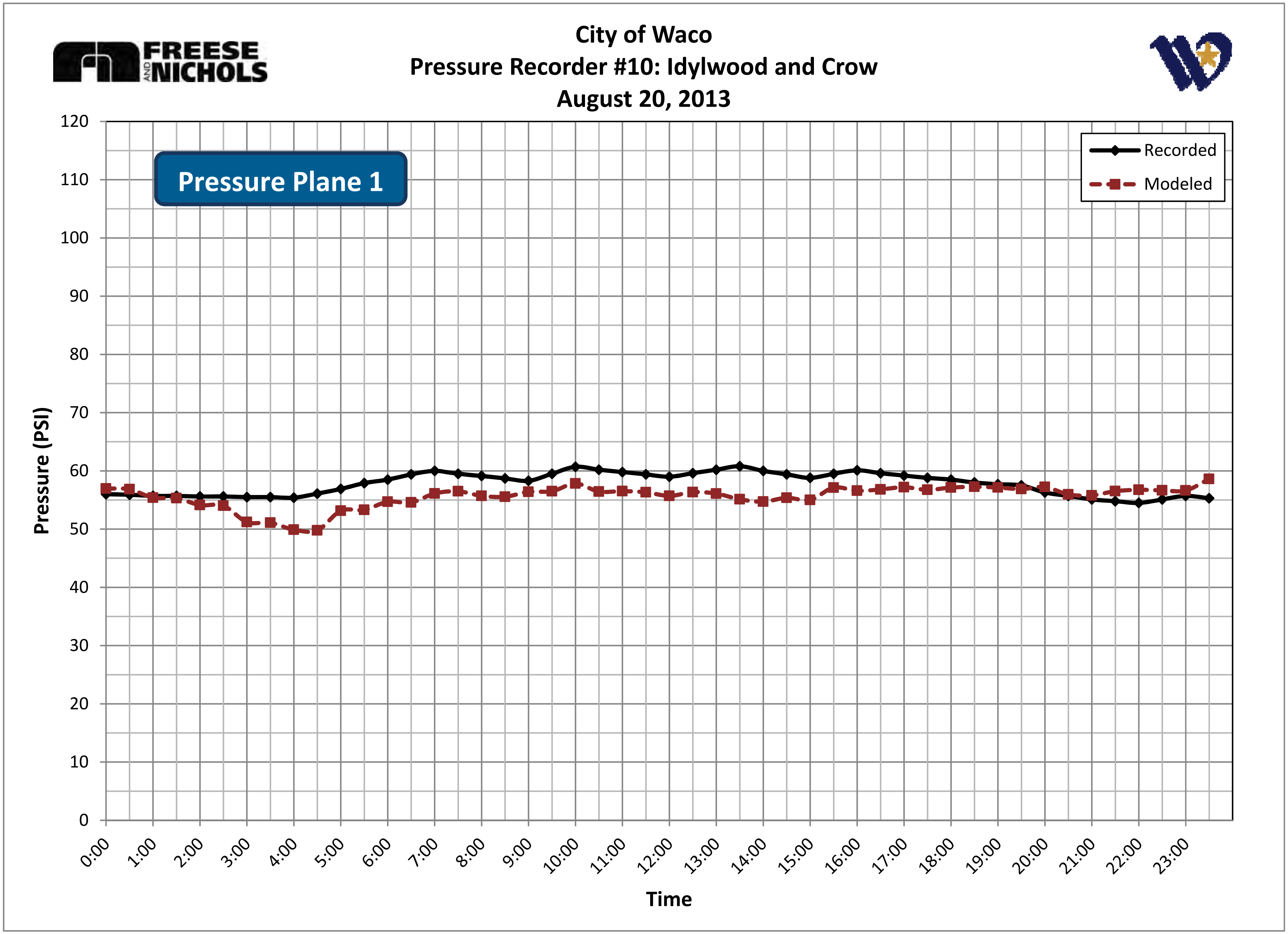


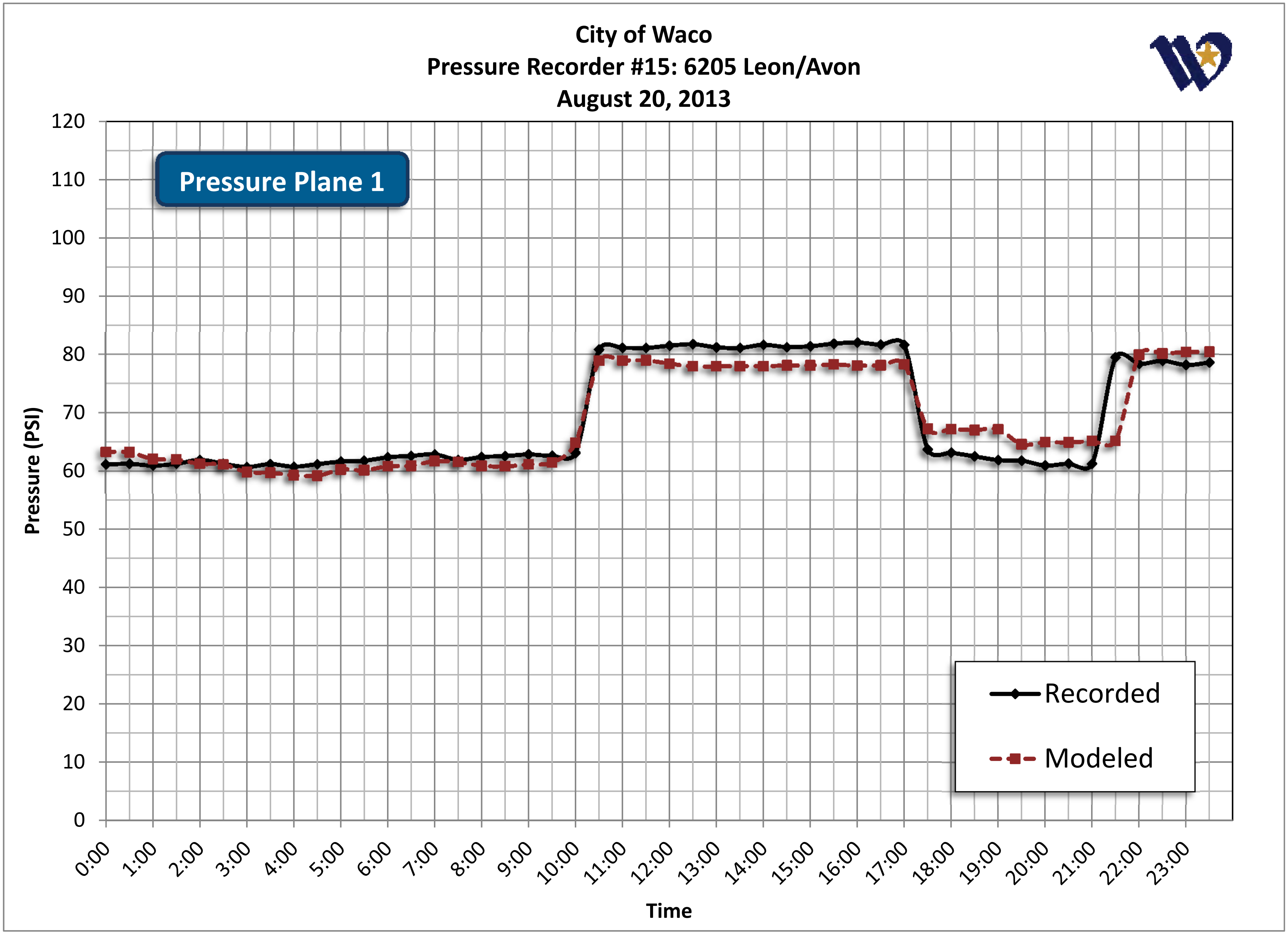
City of Waco
Pressure Recorder #8: Garrison and Chestnut
August 20, 2013



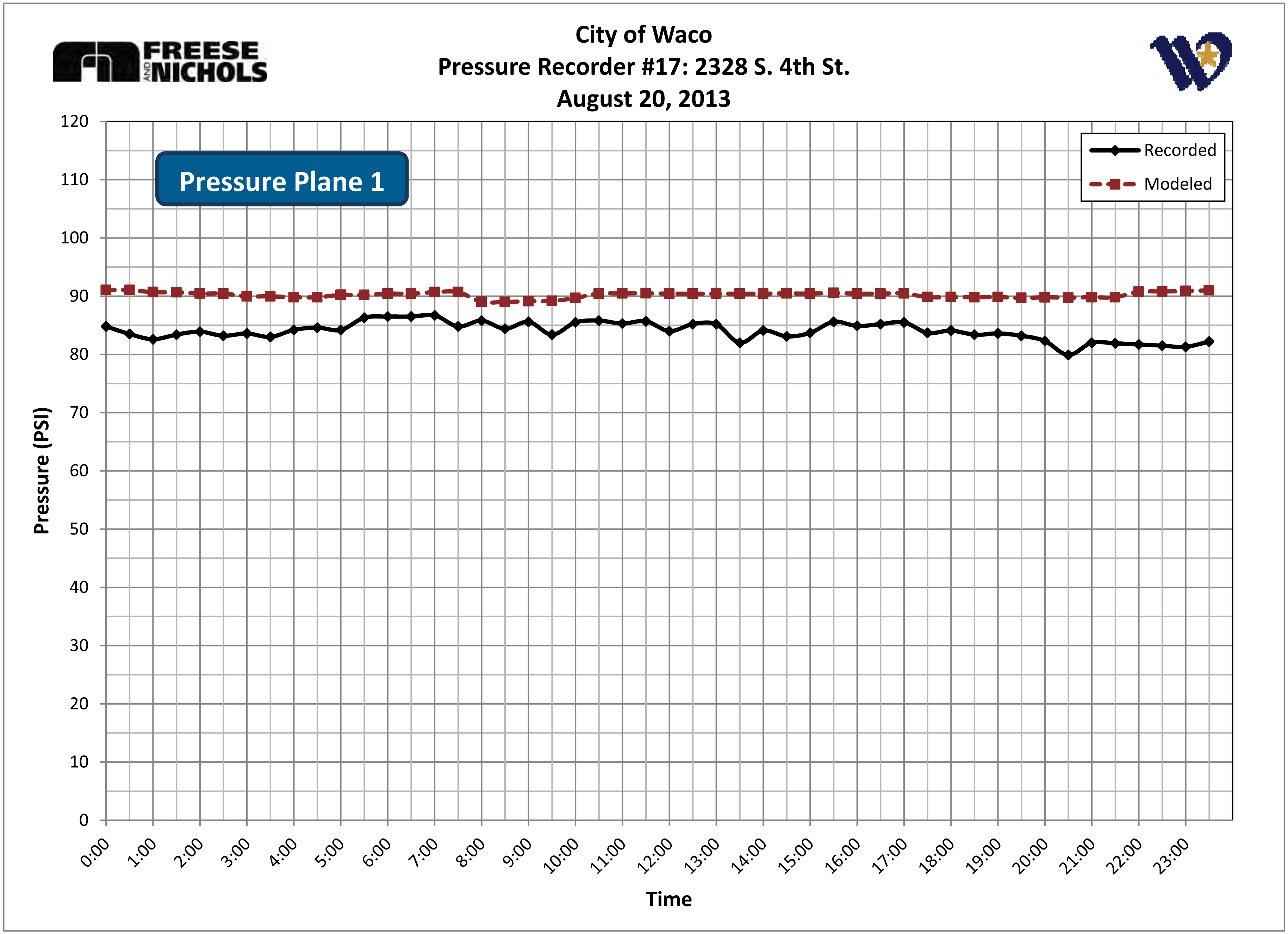


FREESE AND NICHOLS
City of Waco
Pressure Recorder #9: 1316 Washington
August 20, 2013
Pressure Plane 1
Recorded
Modeled
Pressure (PSI)
0
10
20
30
40
50
60
70
80
90
100
110
120
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

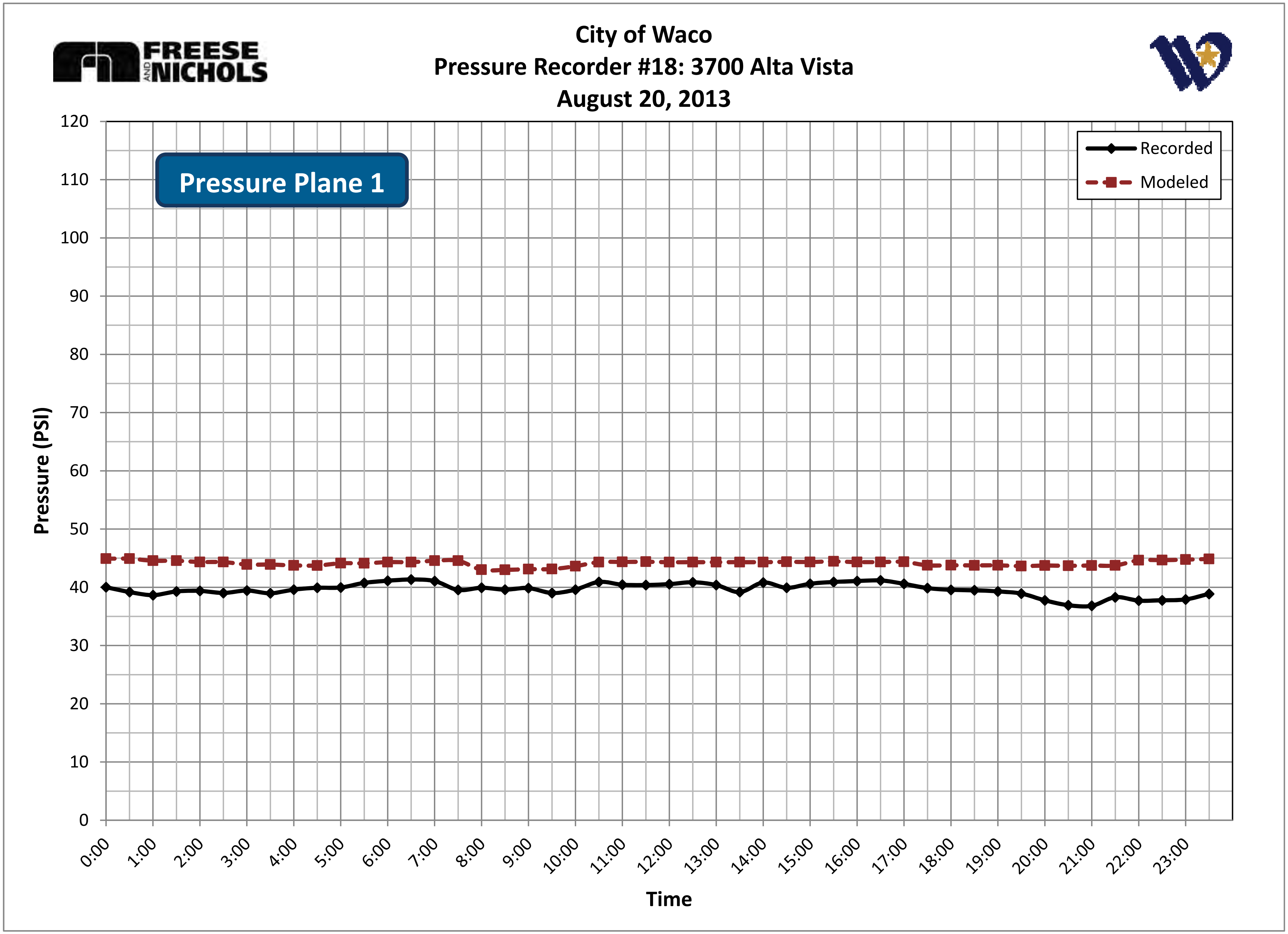

FREESE AND NICHOLS
City of Waco
Pressure Recorder #10: Idylwood and Crow
August 20, 2013
Pressure Plane 1
Recorded
Modeled
Pressure (PSI)
Time
0
10
20
30
40
50
60
70
80
90
100
110
120
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00



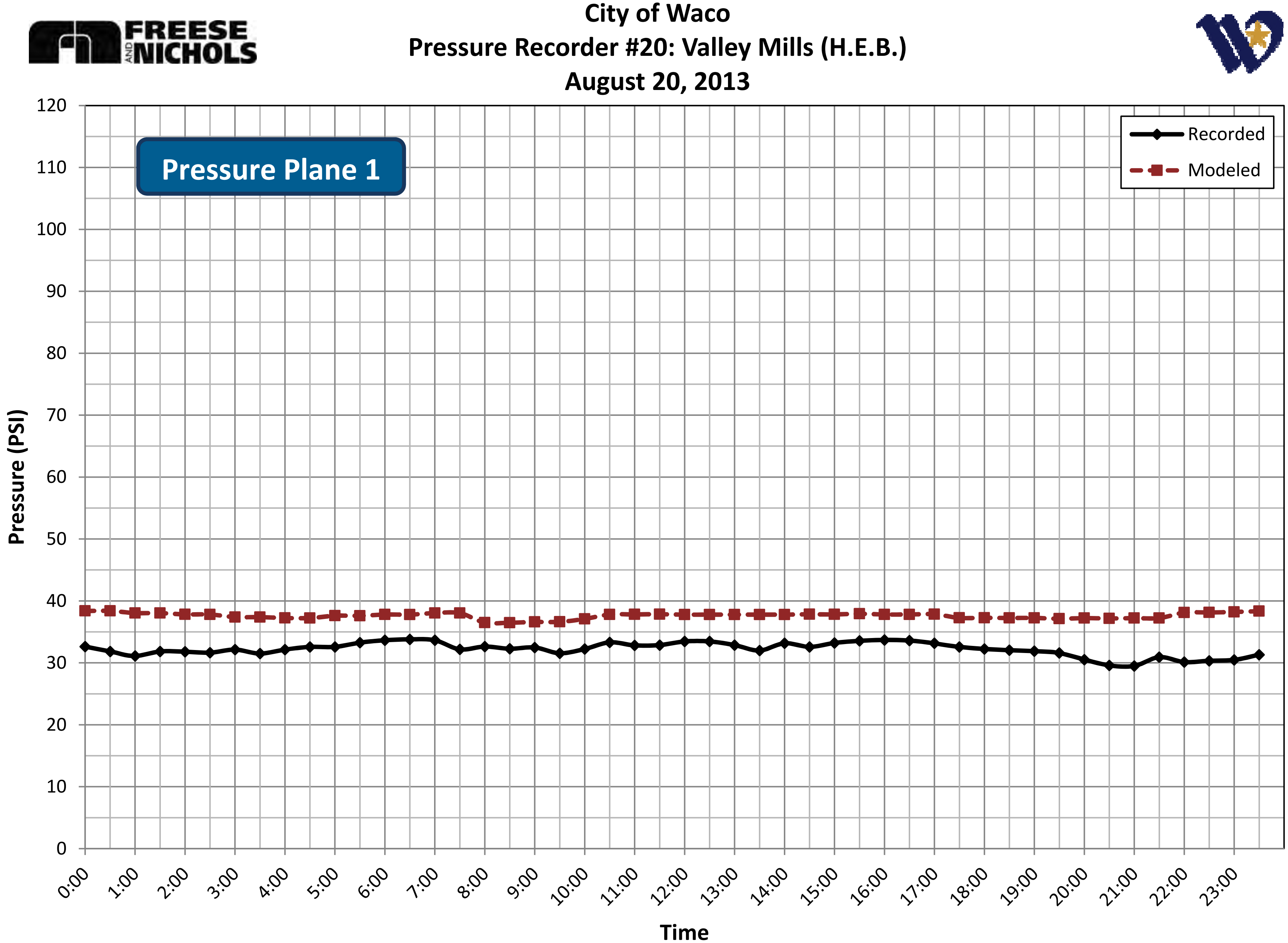
City of Waco
Pressure Recorder #15: 6205 Leon/Avon
August 20, 2013
Pressure Plane 1
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
Recorded
Modeled

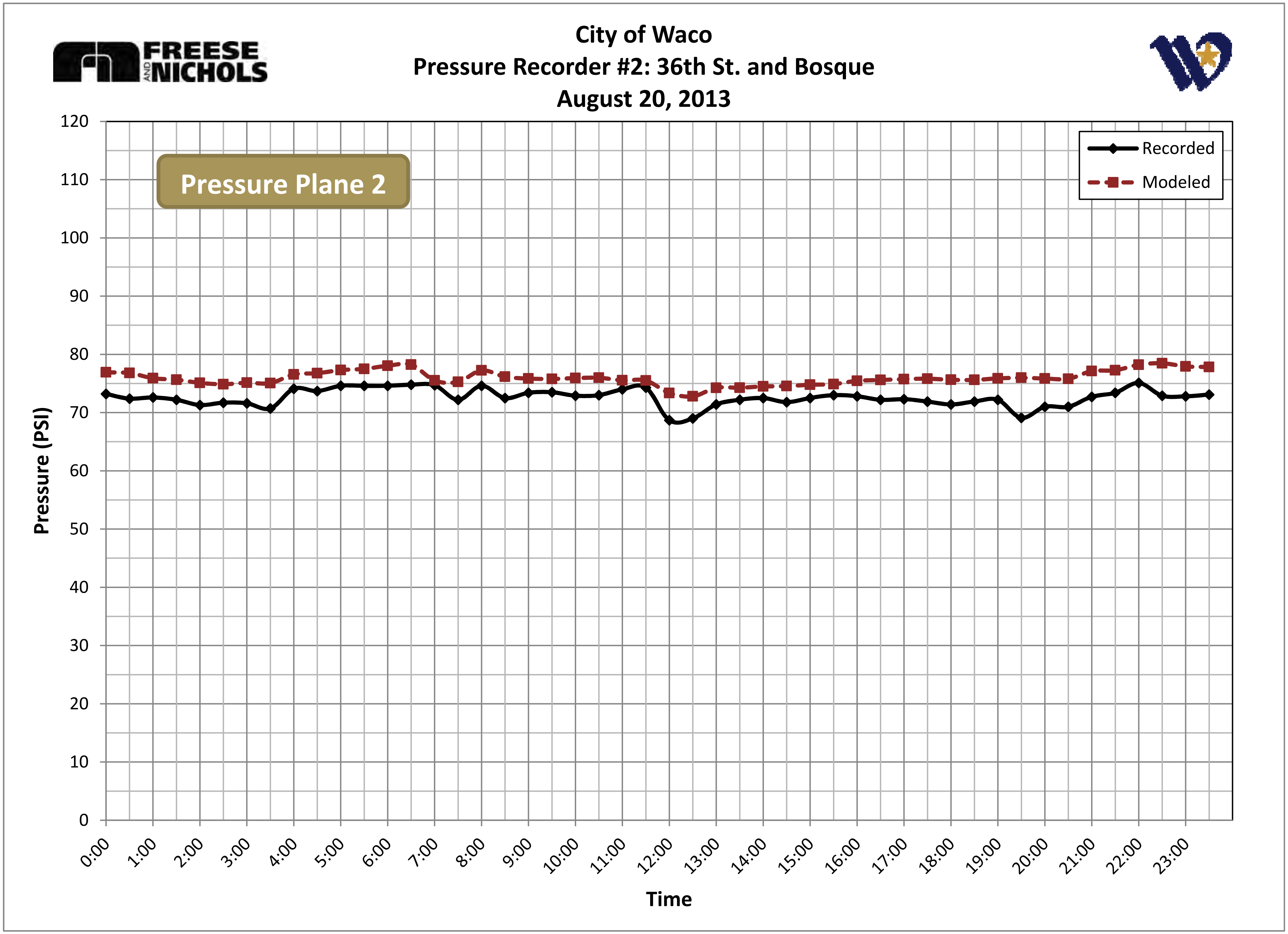


FREESE AND NICHOLS
City of Waco
Pressure Recorder #17: 2328 S. 4th St.
August 20, 2013
Pressure Plane 1
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time


FREESE AND NICHOLS
City of Waco
Pressure Recorder #18: 3700 Alta Vista
August 20, 2013
Pressure Plane 1
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

City of Waco
Pressure Recorder #20: Valley Mills (H.E.B.)
August 20, 2013





City of Waco
Pressure Recorder #2: 36th St. and Bosque
August 20, 2013
Pressure Plane 2
Recorded
Modeled
Pressure (PSI)
Time
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
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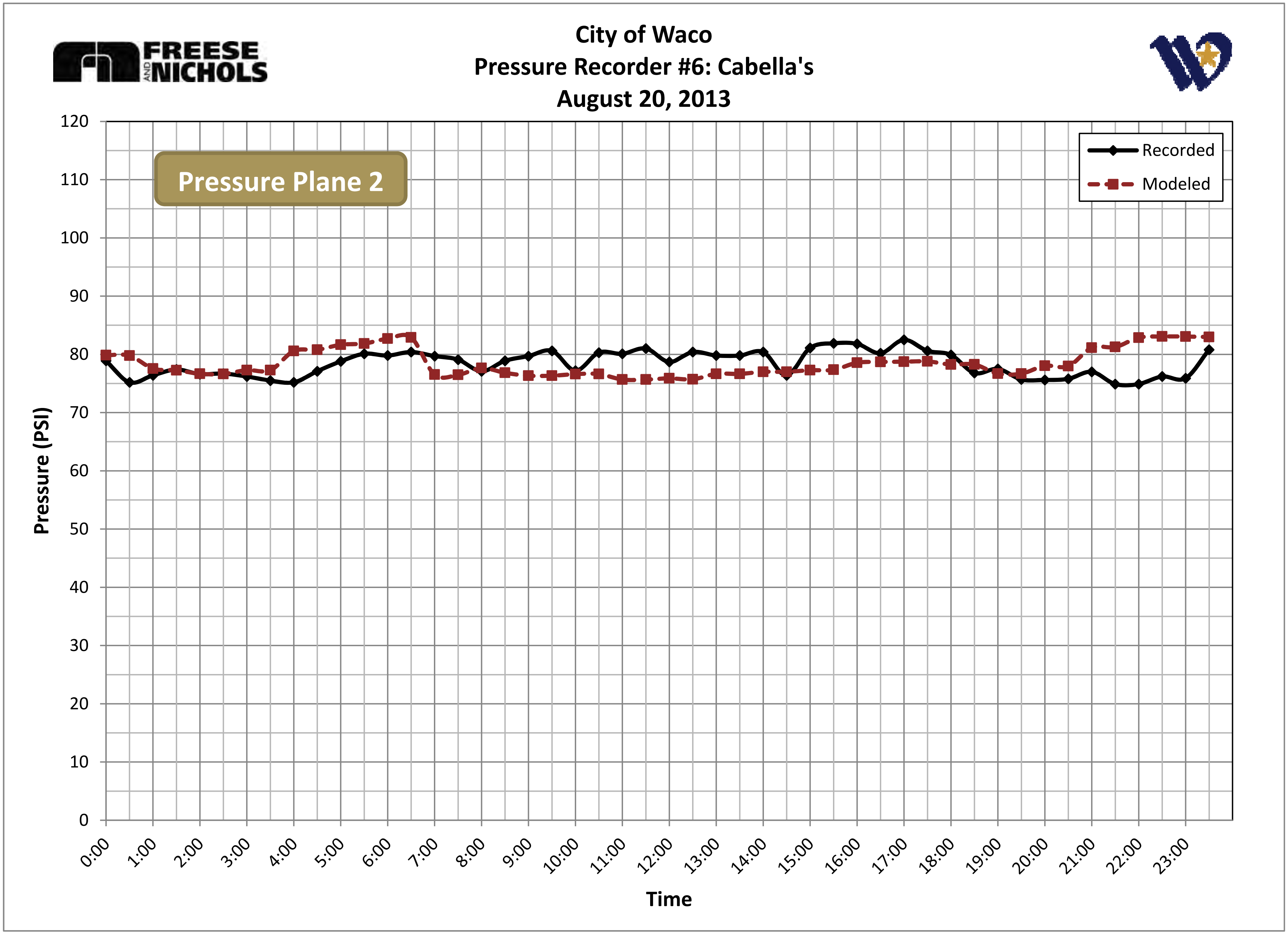
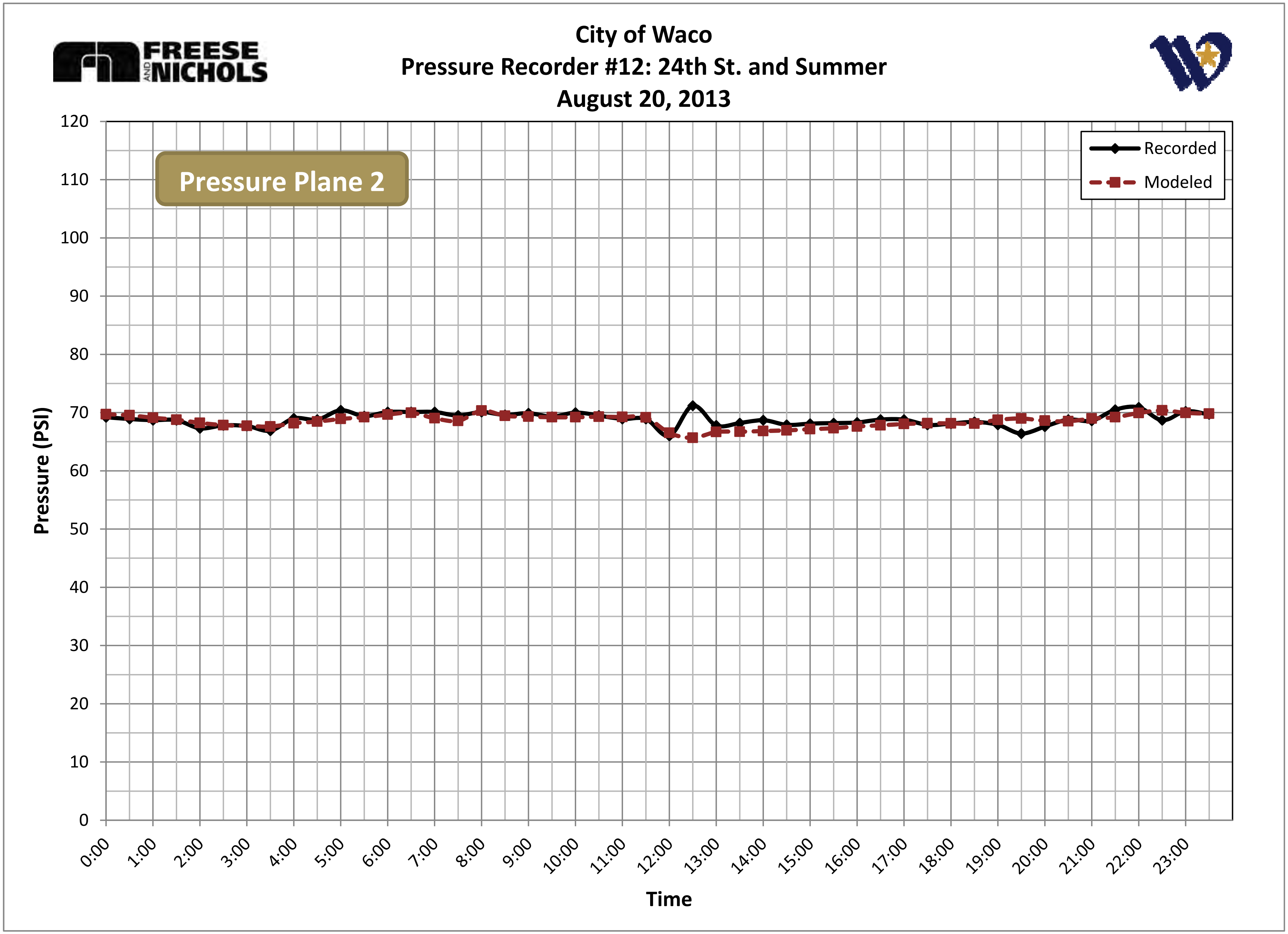
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00

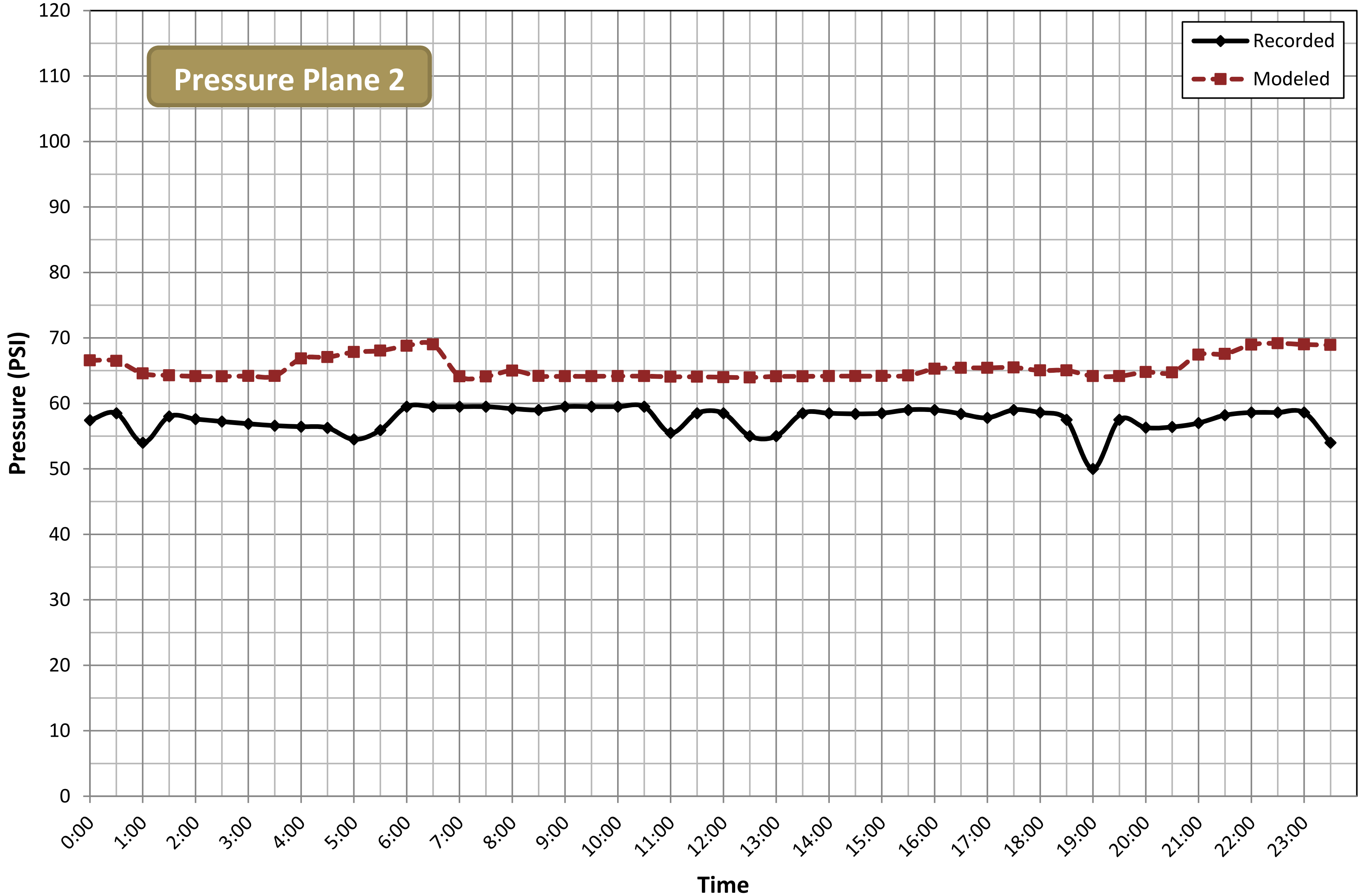


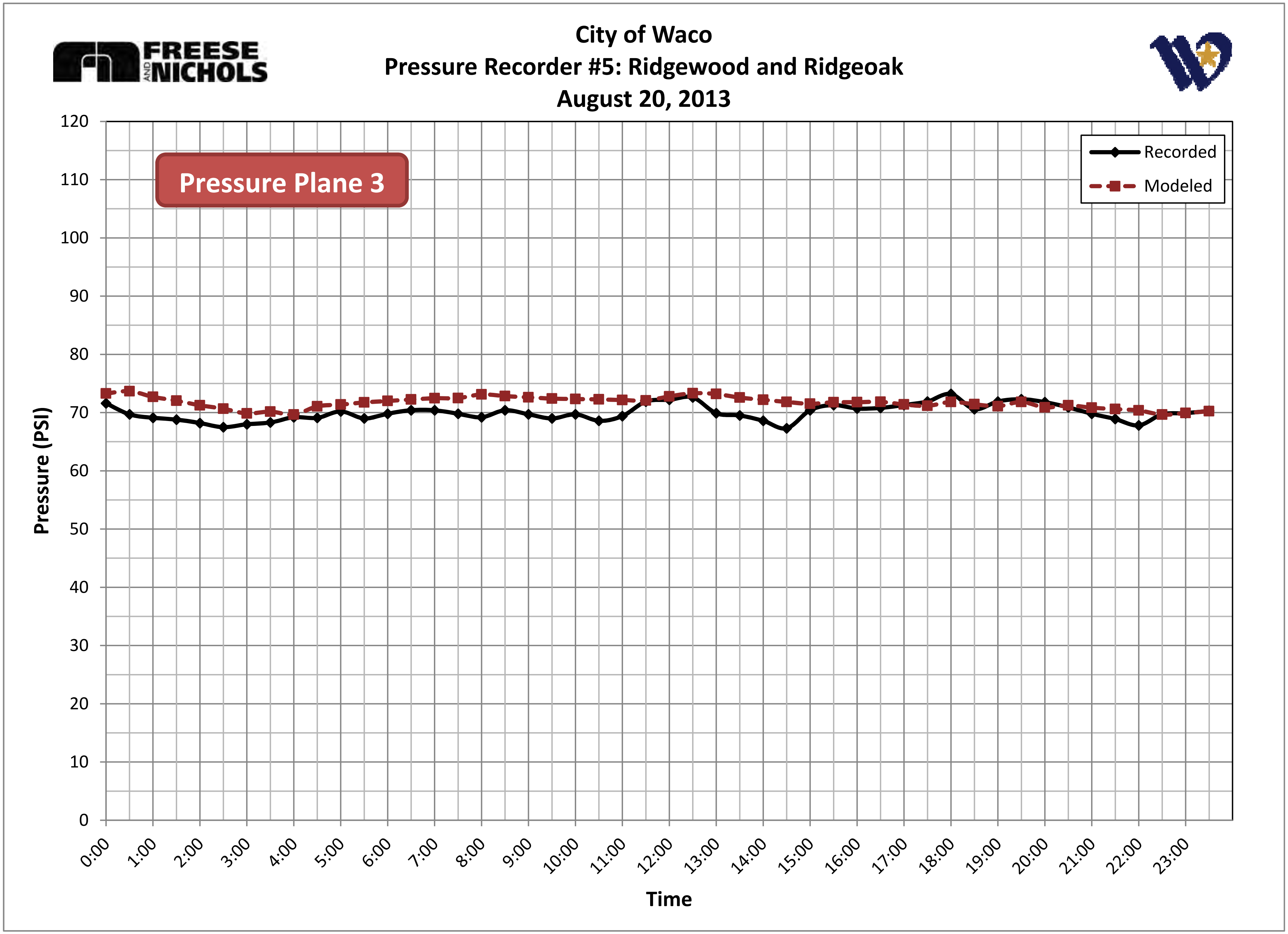
FREESE AND NICHOLS
City of Waco
Pressure Recorder #6: Cabella's
August 20, 2013
Pressure Plane 2
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time



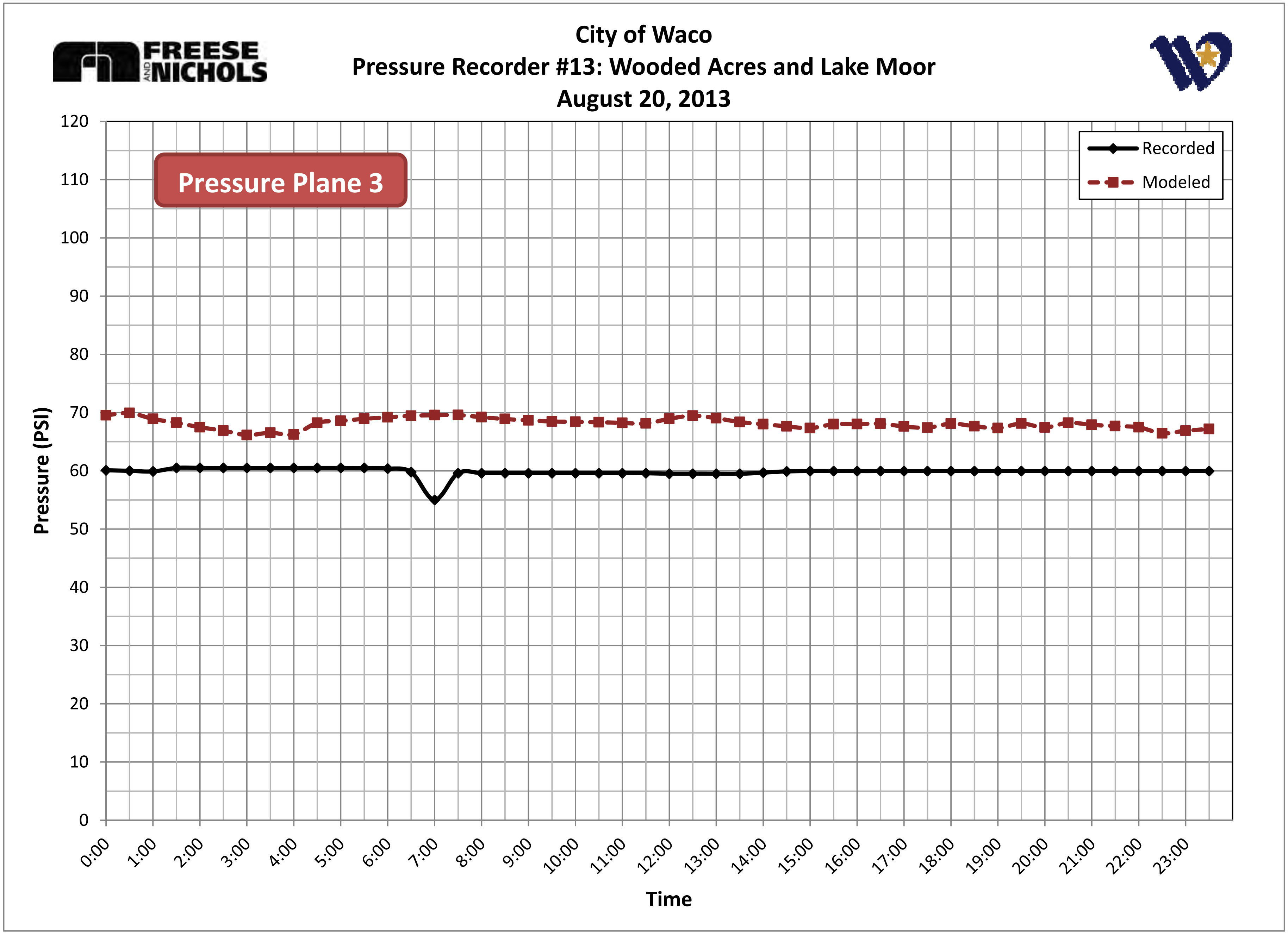
FREESE AND NICHOLS
City of Waco
Pressure Recorder #12: 24th St. and Summer
August 20, 2013
Pressure Plane 2
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

City of Waco
Pressure Recorder #23: Commerce @ Home Zone
August 20, 2013

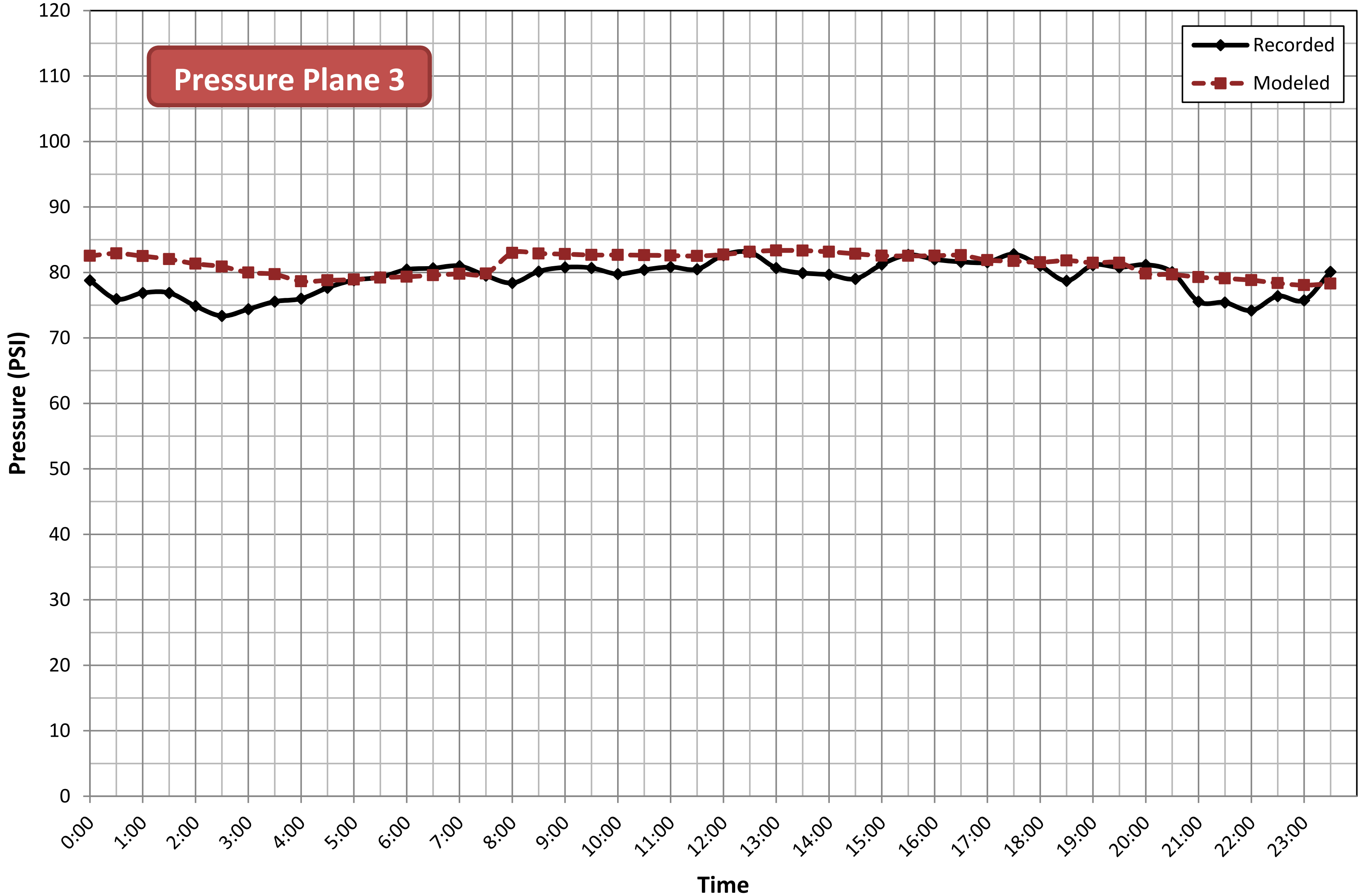


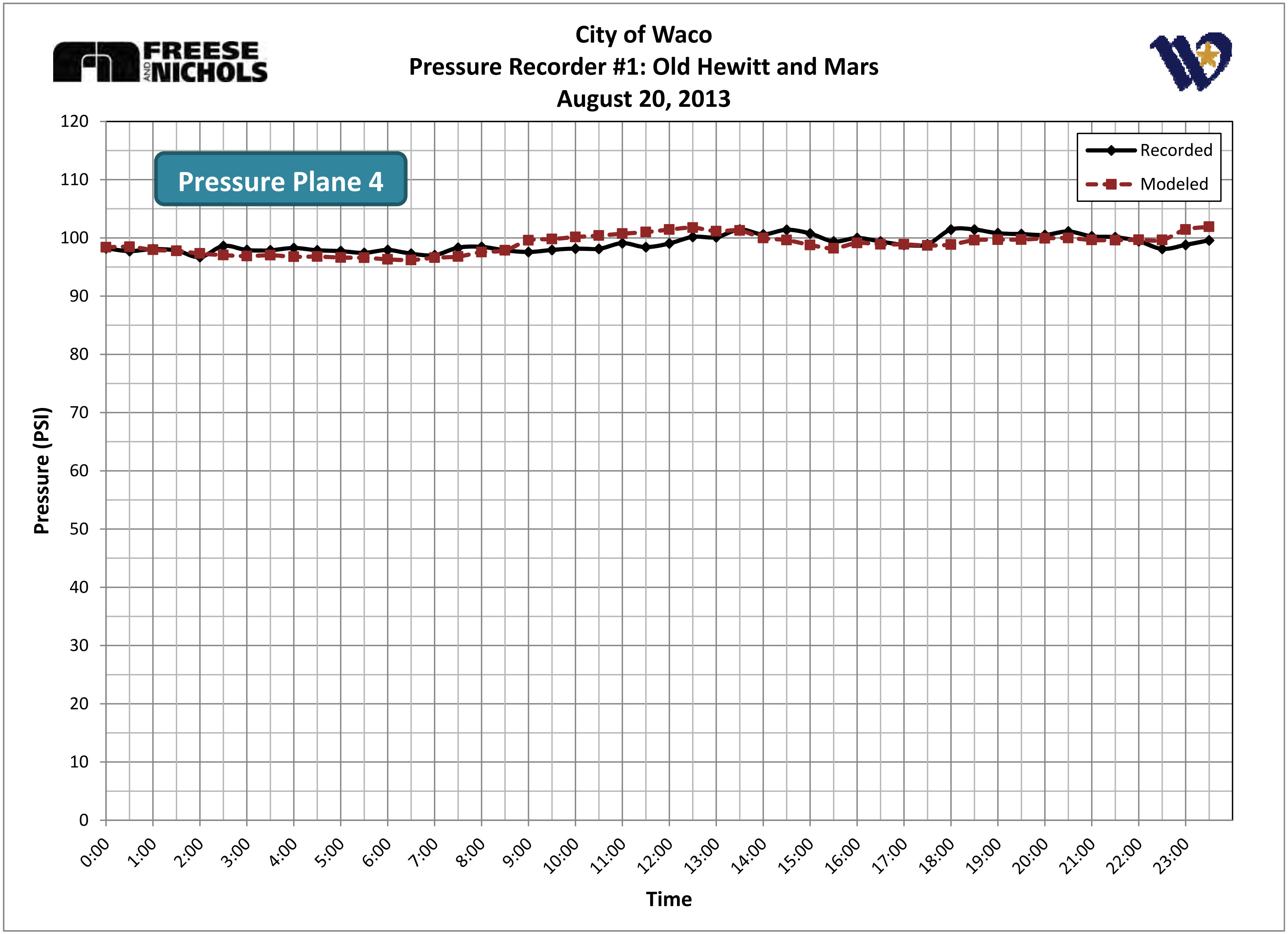


FREESE AND NICHOLS
City of Waco
Pressure Recorder #5: Ridgewood and Ridgeoak
August 20, 2013
Pressure Plane 3
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

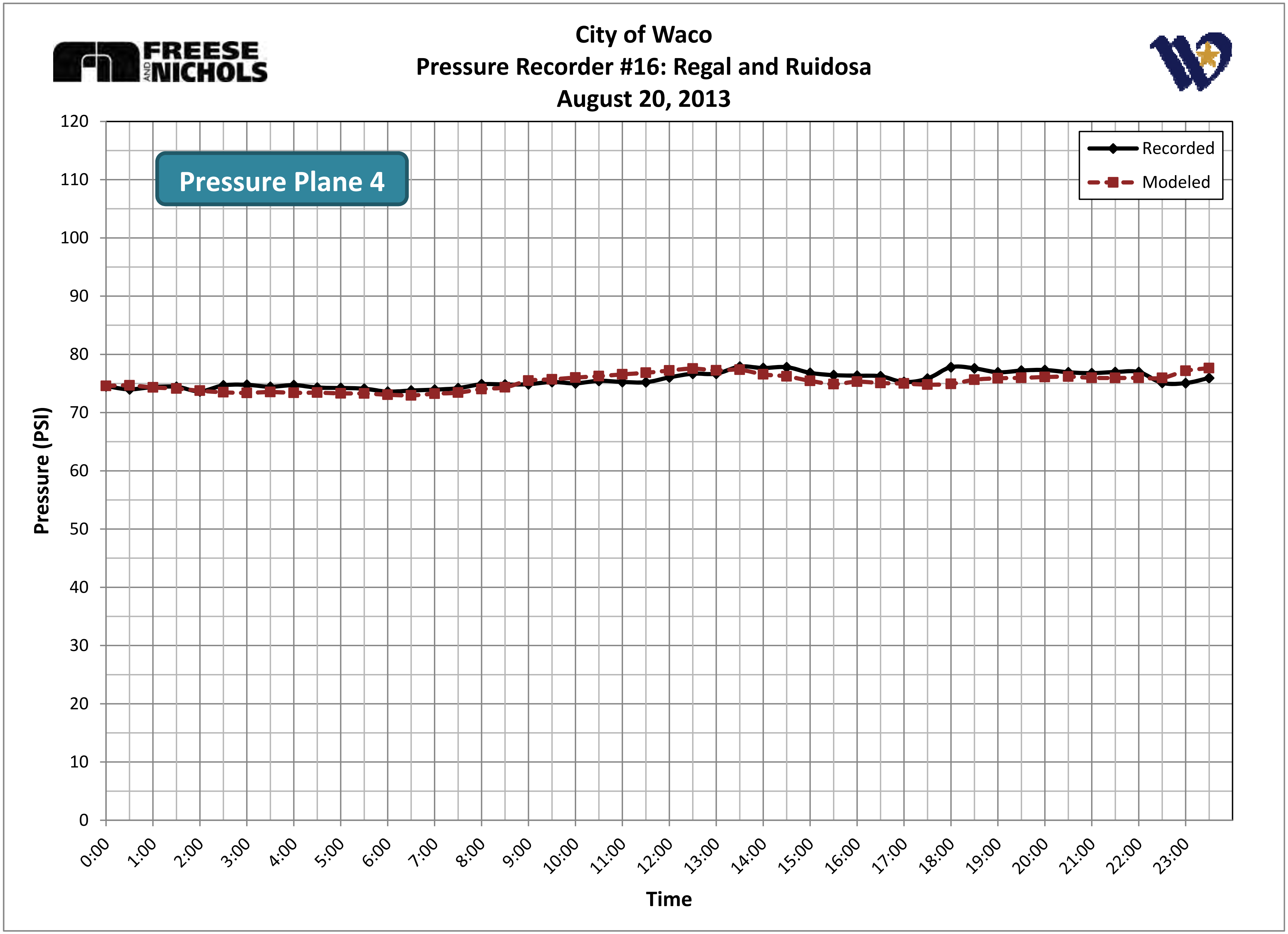

City of Waco
Pressure Recorder #13: Wooded Acres and Lake Moor
August 20, 2013
Pressure Plane 3
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

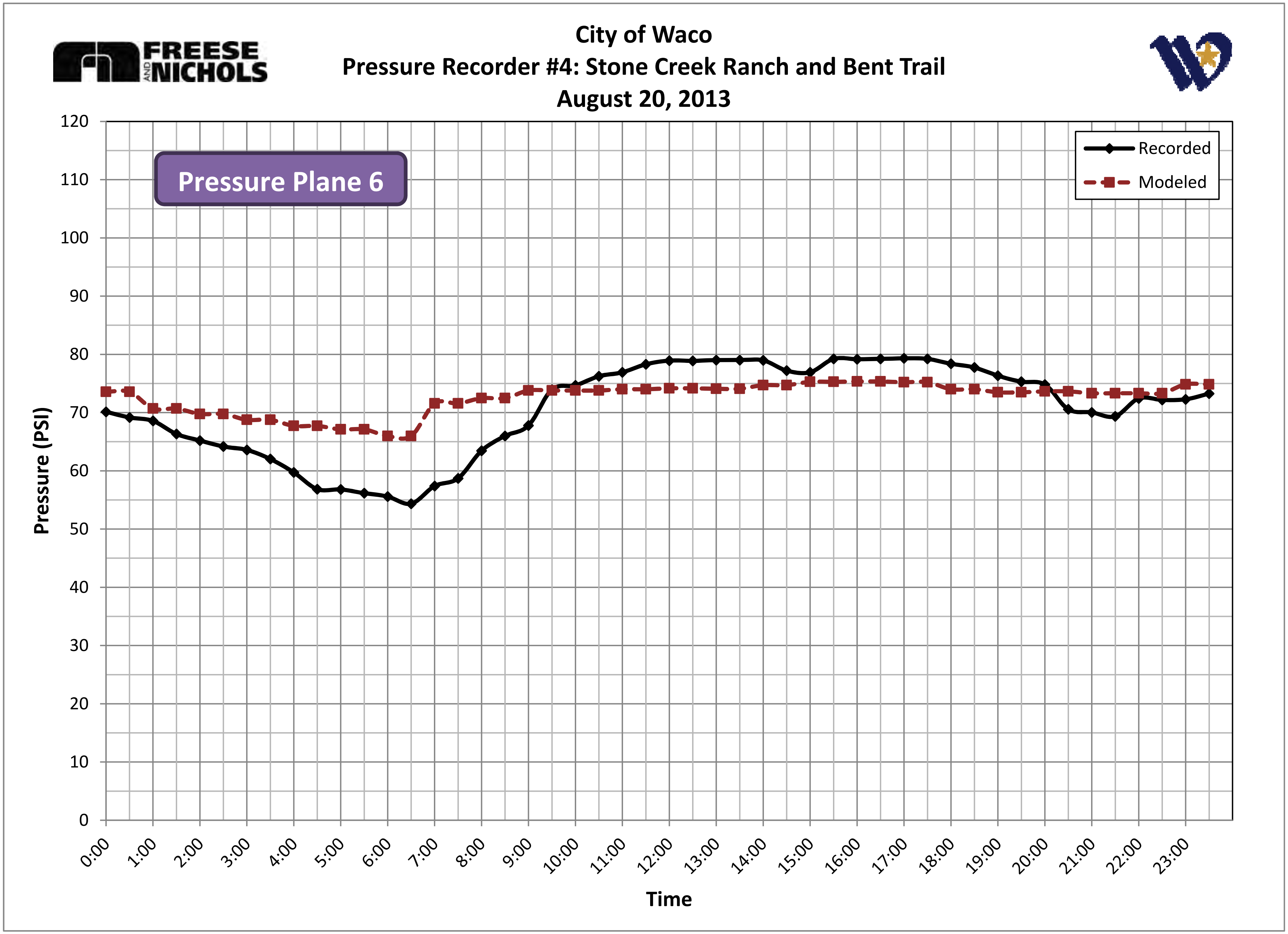
City of Waco
Pressure Recorder #14: Crystal and Tuscany
August 20, 2013



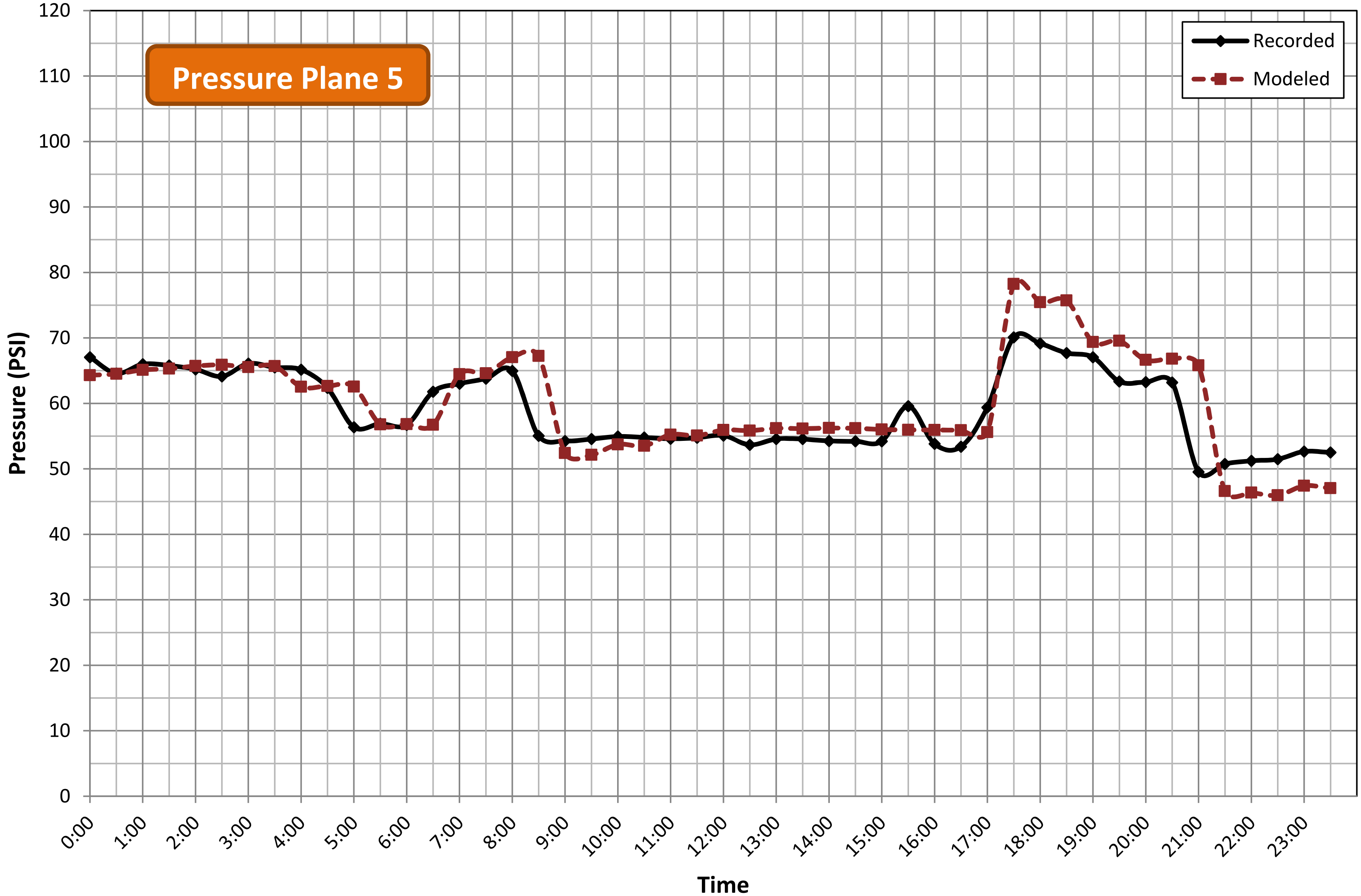


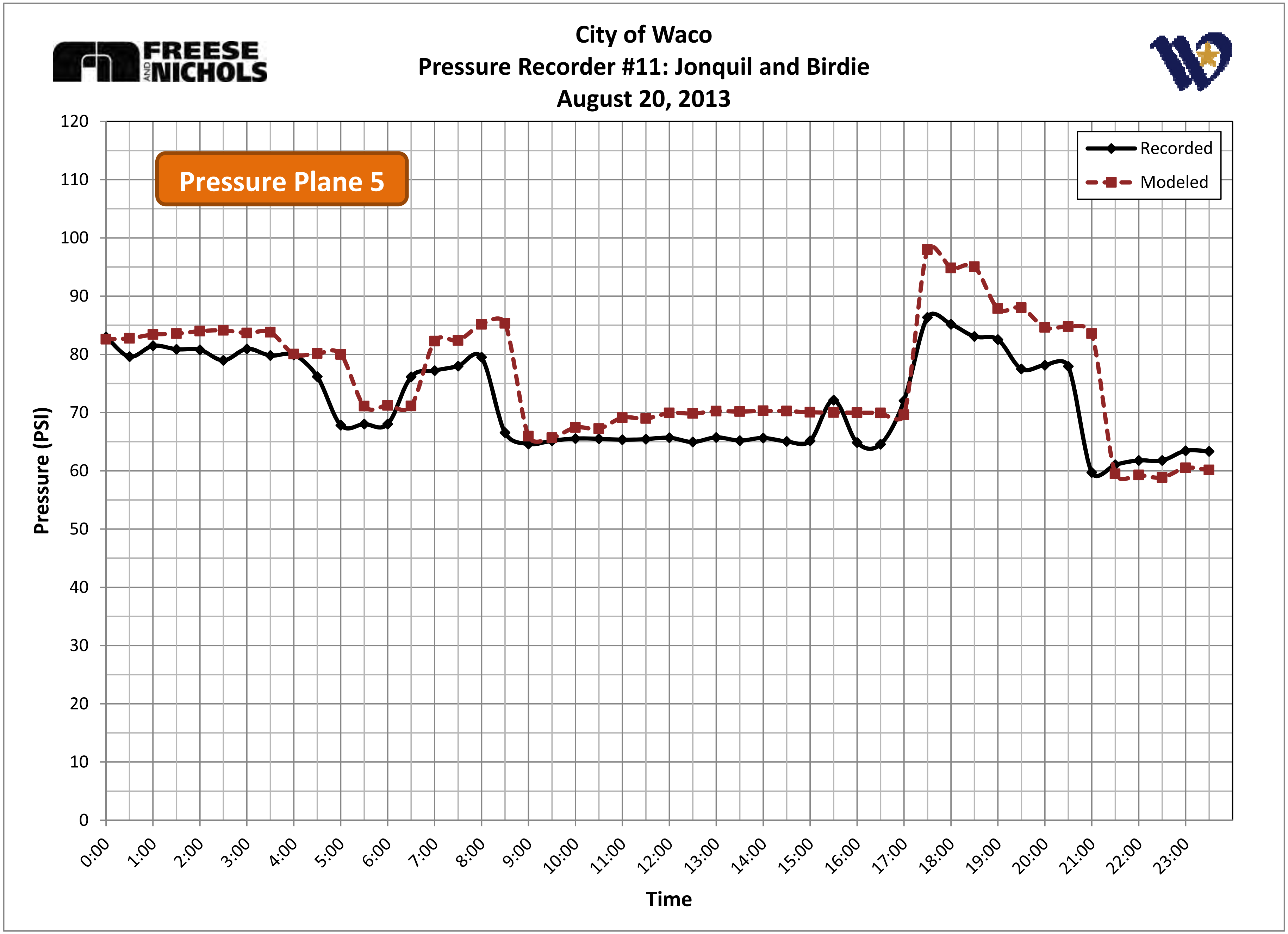
FREESE AND NICHOLS
City of Waco
Pressure Recorder #1: Old Hewitt and Mars
August 20, 2013
Pressure Plane 4
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time


FREESE AND NICHOLS
City of Waco
Pressure Recorder #16: Regal and Ruidosa
August 20, 2013
Pressure Plane 4
Recorded
Modeled
Pressure (PSI)
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

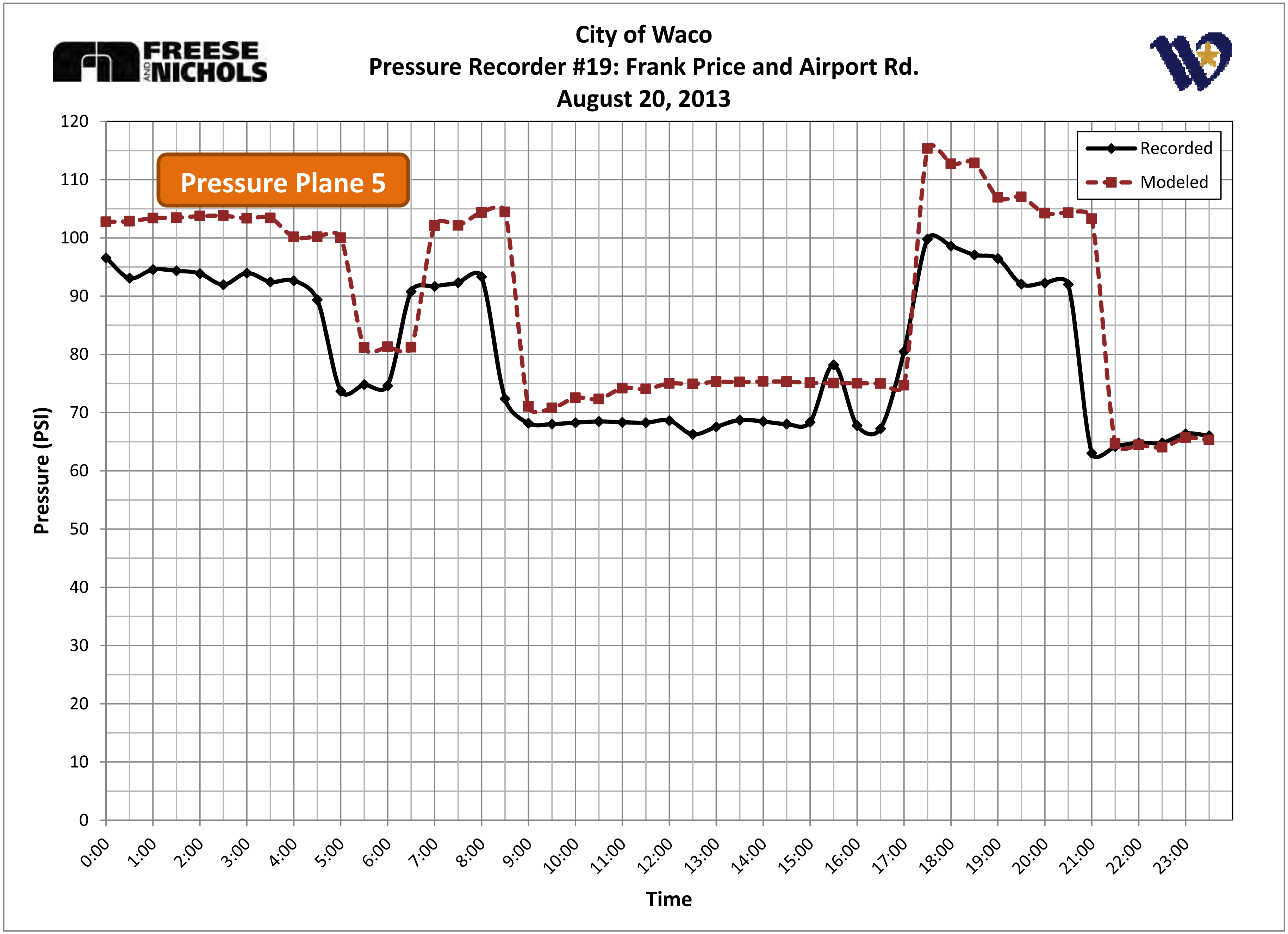

City of Waco
Pressure Recorder #4: Stone Creek Ranch and Bent Trail
August 20, 2013
Pressure Plane 6
Recorded
Modeled
Pressure (PSI)
Time
0
10
20
30
40
50
60
70
80
90
100
110
120
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00

City of Waco
Pressure Recorder #3: 10100 Cougar Ridge Parkway
August 20, 2013



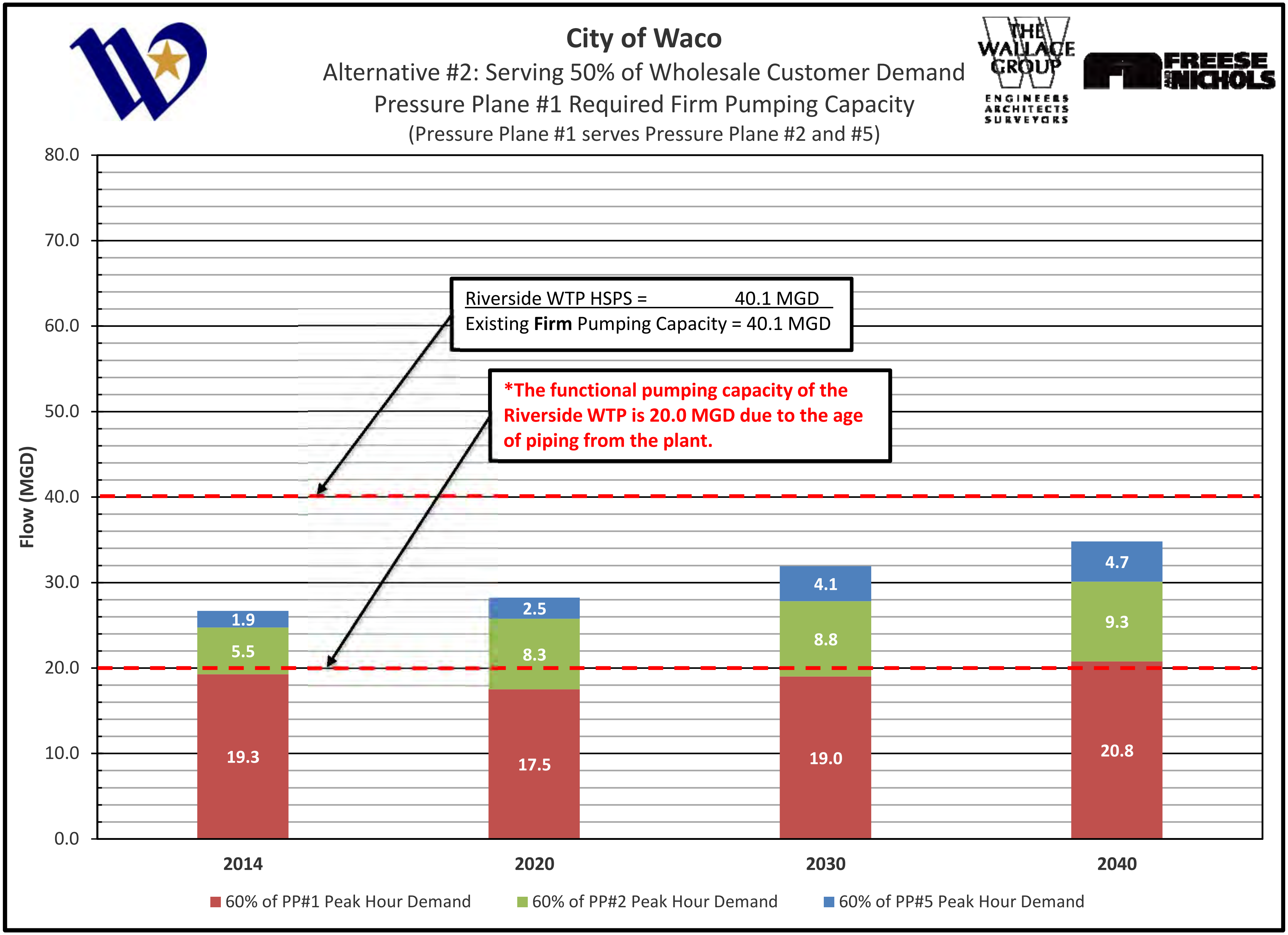


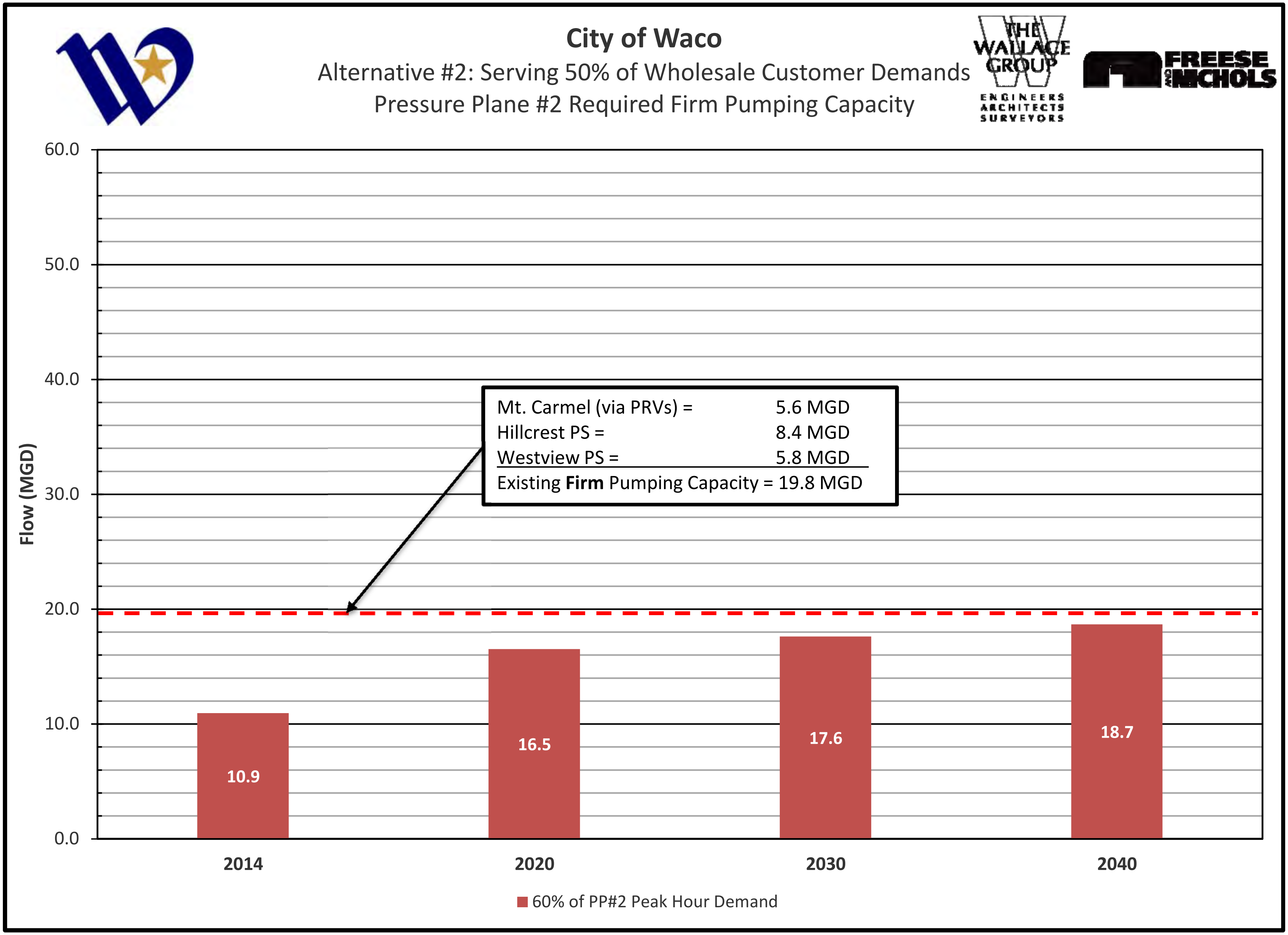
FREESE AND NICHOLS
City of Waco
Pressure Recorder #11: Jonquil and Birdie
August 20, 2013
Pressure Plane 5
Recorded
Modeled
Pressure (PSI)
0
10
20
30
40
50
60
70
80
90
100
110
120
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time

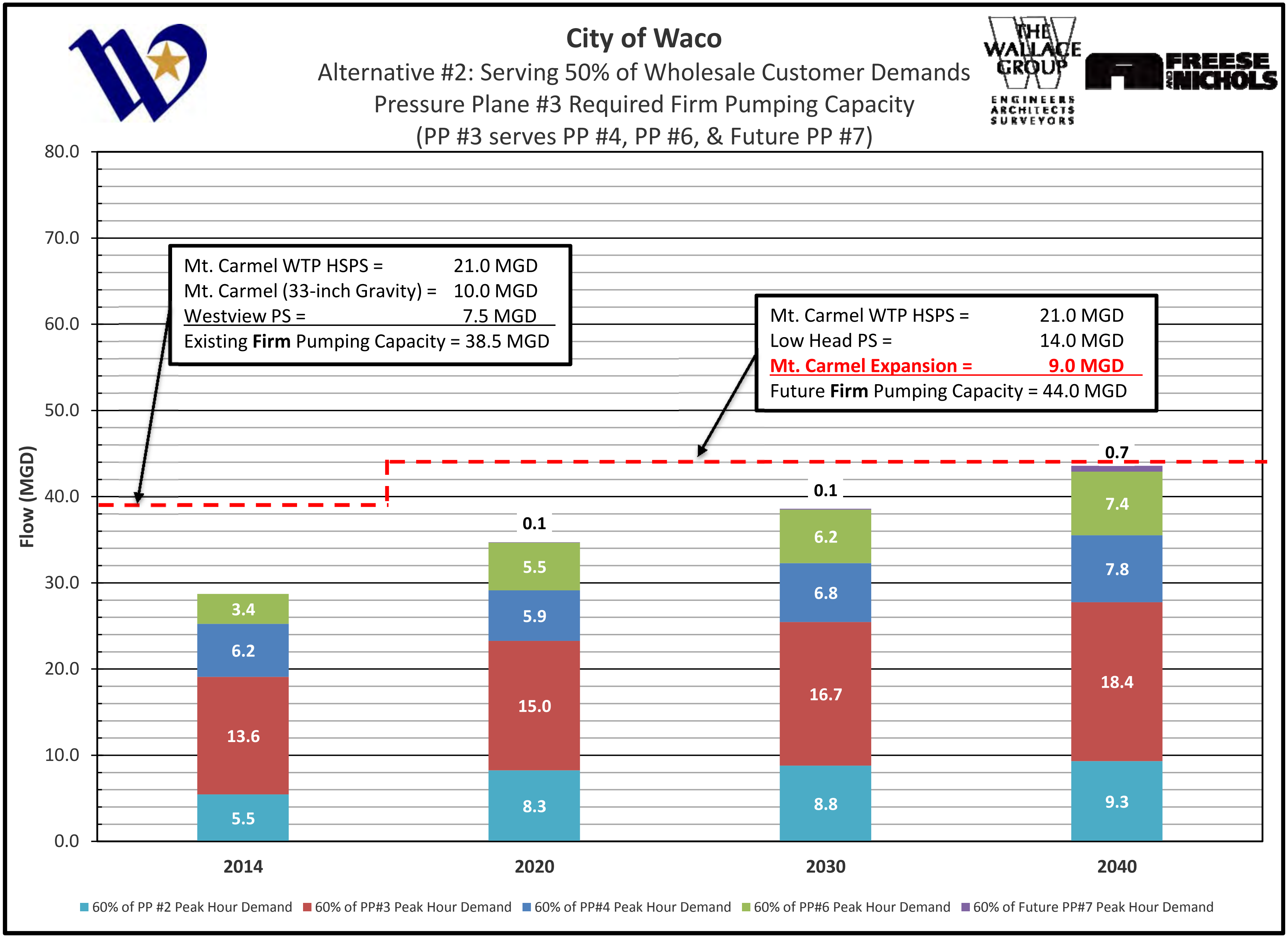


FREESE AND NICHOLS
City of Waco
Pressure Recorder #19: Frank Price and Airport Rd.
August 20, 2013
Pressure Plane 5
Recorded
Modeled
Pressure (PSI)
Time
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00

APPENDIX C
FUTURE SYSTEM STORAGE
AND PUMPING CAPACITY REQUIREMENTS

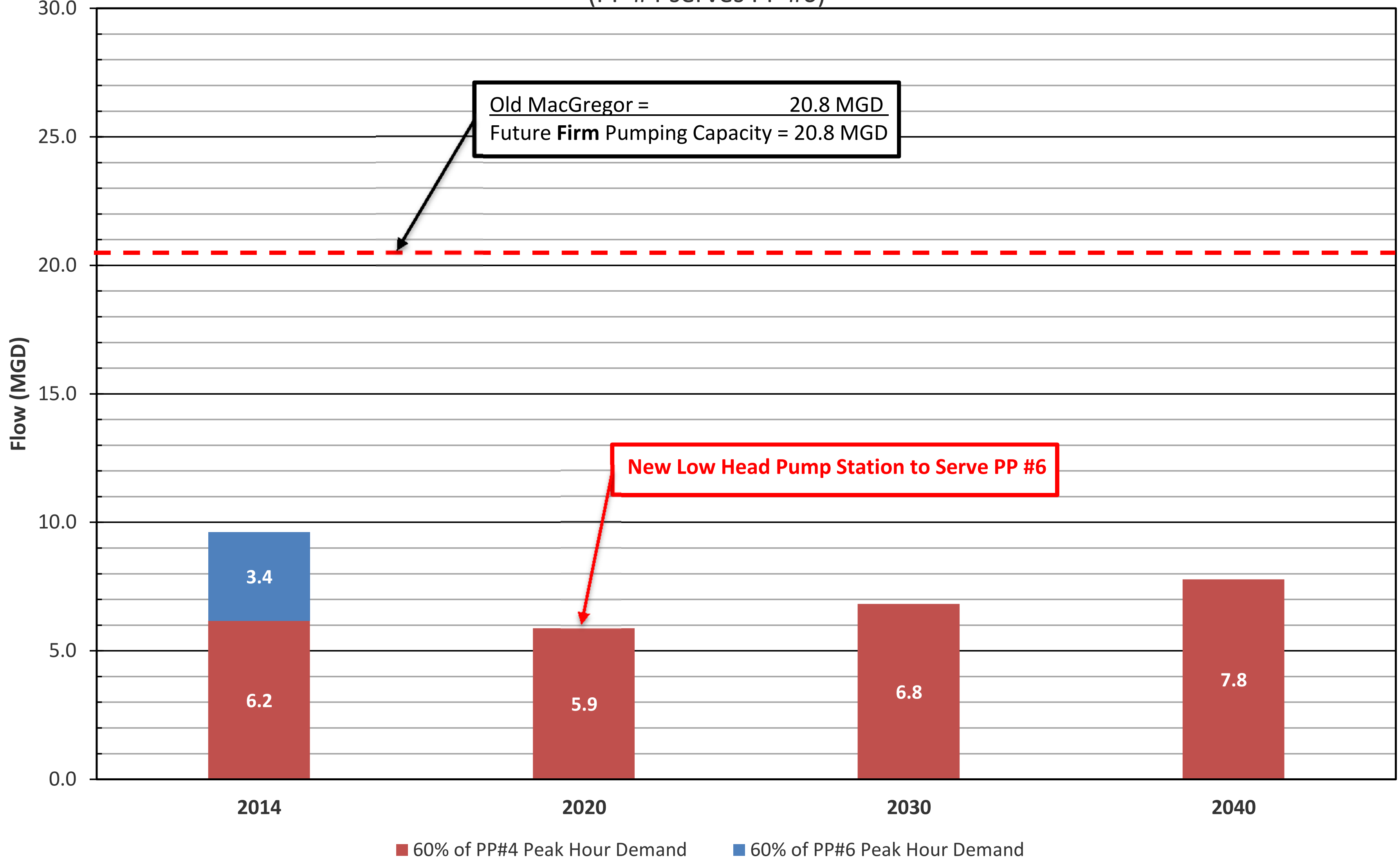

City of Waco
Alternative #2: Serving 50% of Wholesale Customer Demand
Pressure Plane #1 Required Firm Pumping Capacity
(Pressure Plane #1 serves Pressure Plane #2 and #5)
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Riverside WTP HSPS = 40.1 MGD
Existing Firm Pumping Capacity = 40.1 MGD
*The functional pumping capacity of the Riverside WTP is 20.0 MGD due to the age of piping from the plant.
Flow (MGD)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1.9
5.5
19.3
2.5
8.3
17.5
4.1
8.8
19.0
4.7
9.3
20.8
2014
2020
2030
2040
60% of PP#1 Peak Hour Demand
60% of PP#2 Peak Hour Demand
60% of PP#5 Peak Hour Demand

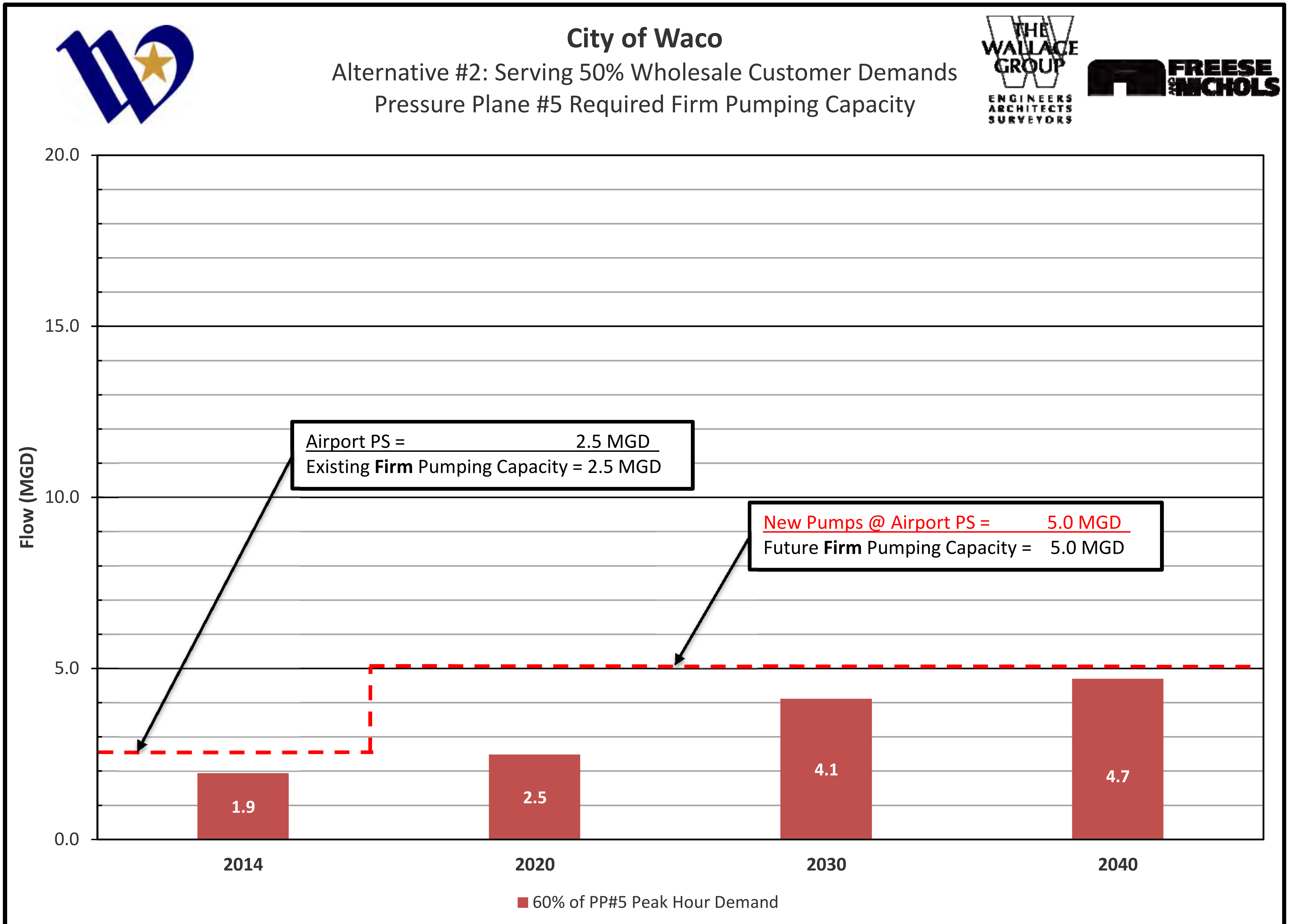

City of Waco
Alternative #2: Serving 50% of Wholesale Customer Demands
Pressure Plane #2 Required Firm Pumping Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Flow (MGD)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Mt. Carmel (via PRVs) = 5.6 MGD
Hillcrest PS = 8.4 MGD
Westview PS = 5.8 MGD
Existing Firm Pumping Capacity = 19.8 MGD
10.9
16.5
17.6
18.7
2014
2020
2030
2040
60% of PP#2 Peak Hour Demand


City of Waco
Alternative #2: Serving 50% of Wholesale Customer Demands
Pressure Plane #3 Required Firm Pumping Capacity
(PP #3 serves PP #4, PP #6, & Future PP #7)
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Mt. Carmel WTP HSPS = 21.0 MGD
Mt. Carmel (33-inch Gravity) = 10.0 MGD
Westview PS = 7.5 MGD
Existing Firm Pumping Capacity = 38.5 MGD
Mt. Carmel WTP HSPS = 21.0 MGD
Low Head PS = 14.0 MGD
Mt. Carmel Expansion = 9.0 MGD
Future Firm Pumping Capacity = 44.0 MGD
Flow (MGD)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2014
2020
2030
2040
5.5
13.6
6.2
3.4
8.3
15.0
5.9
5.5
0.1
8.8
16.7
6.8
6.2
0.1
9.3
18.4
7.8
7.4
0.7
60% of PP #2 Peak Hour Demand
60% of PP#3 Peak Hour Demand
60% of PP#4 Peak Hour Demand
60% of PP#6 Peak Hour Demand
60% of Future PP#7 Peak Hour Demand

City of Waco

Alternative #2: Serving 50% of Wholesale Customer Demands
Pressure Plane #4 Required Firm Pumping Capacity
(PP #4 serves PP #6)



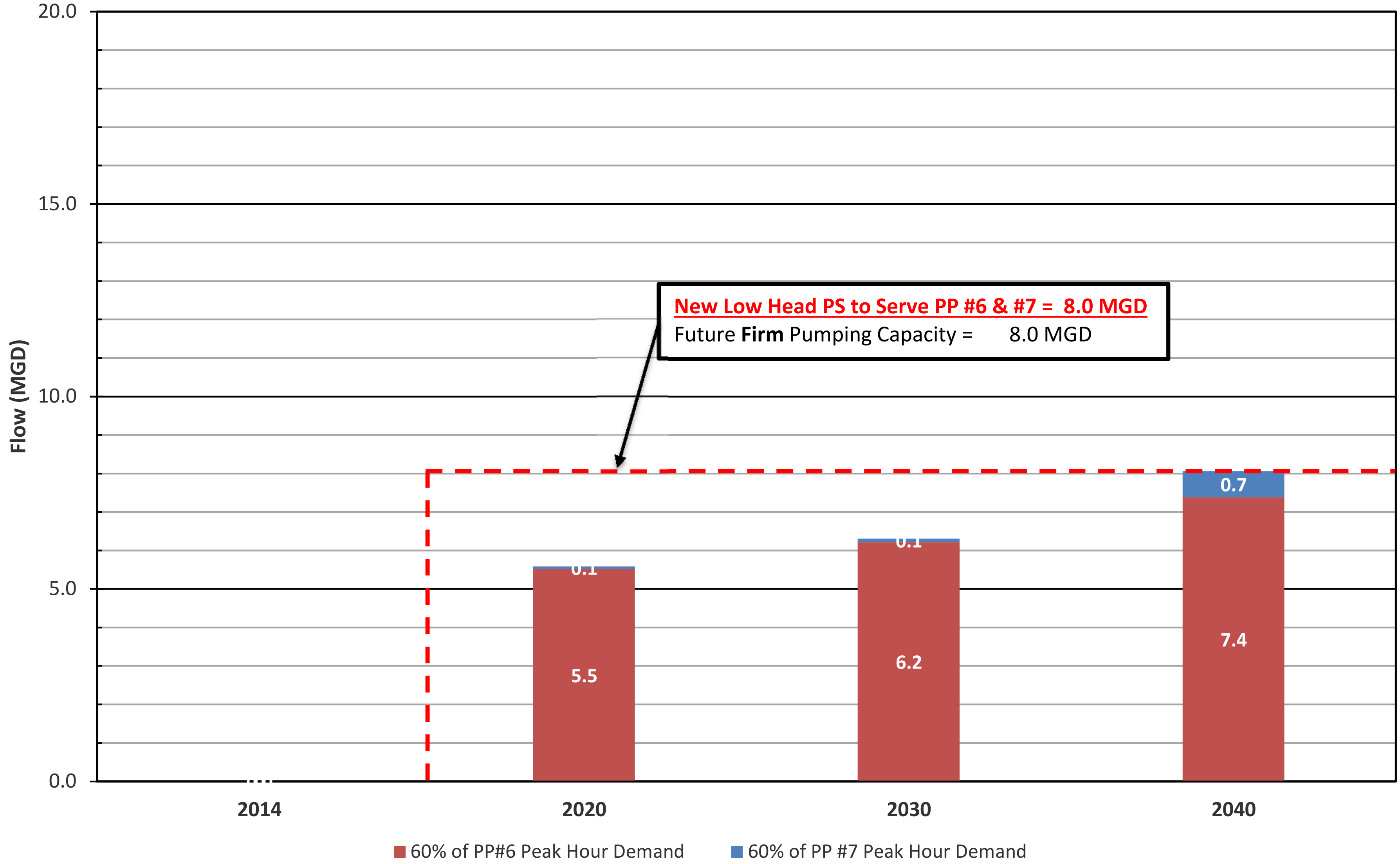


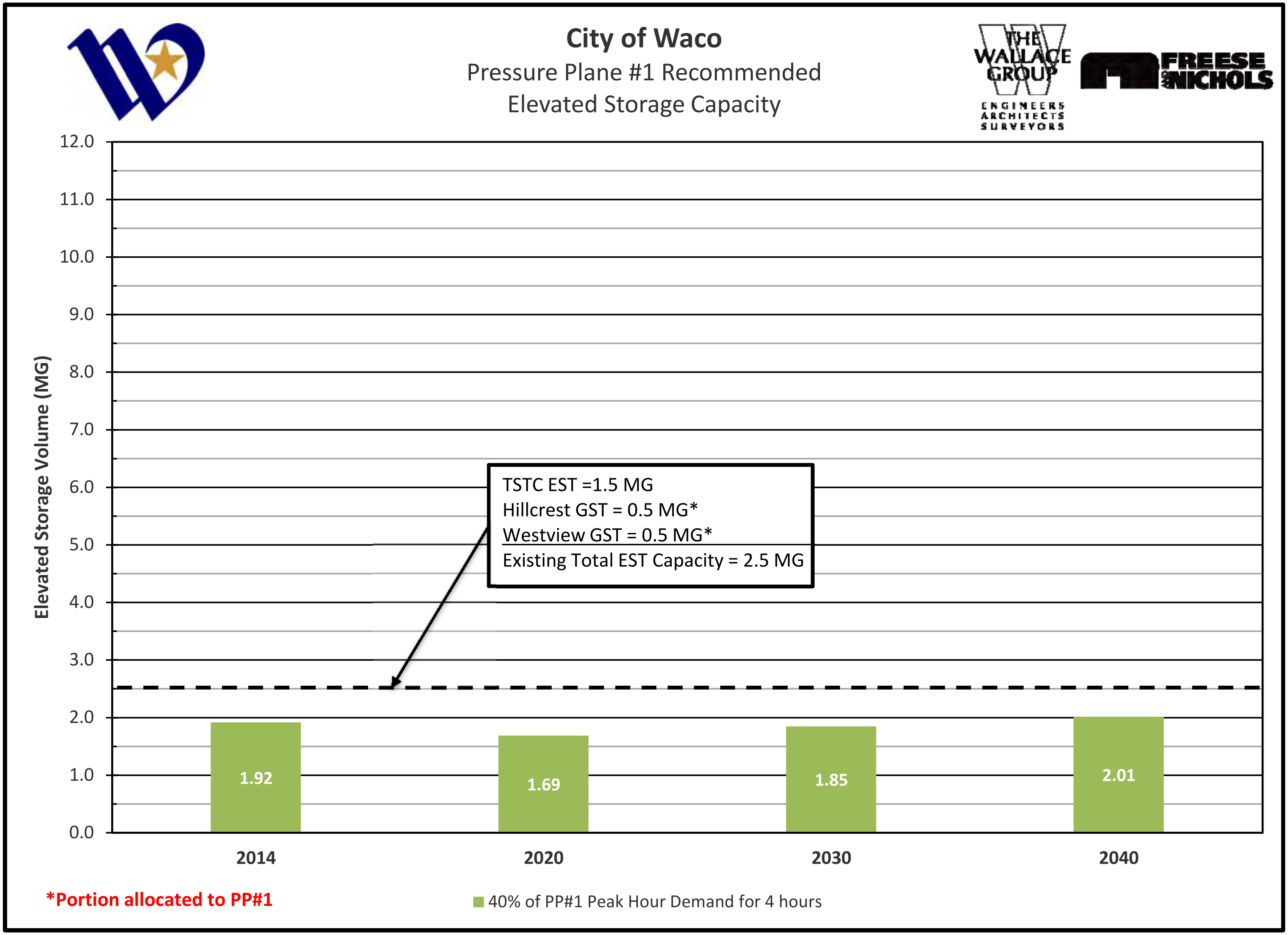
City of Waco
Alternative #2: Serving 50% Wholesale Customer Demands
Pressure Plane #5 Required Firm Pumping Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Flow (MGD)
20.0
15.0
10.0
5.0
0.0
Airport PS = 2.5 MGD
Existing Firm Pumping Capacity = 2.5 MGD
New Pumps @ Airport PS = 5.0 MGD
Future Firm Pumping Capacity = 5.0 MGD
1.9
2.5
4.1
4.7
2014
2020
2030
2040
60% of PP#5 Peak Hour Demand

City of Waco

Alternative #2: Serving 50% of Wholesale Customer Demands

Pressure Plane #6 and #7 Required Firm Pumping Capacity

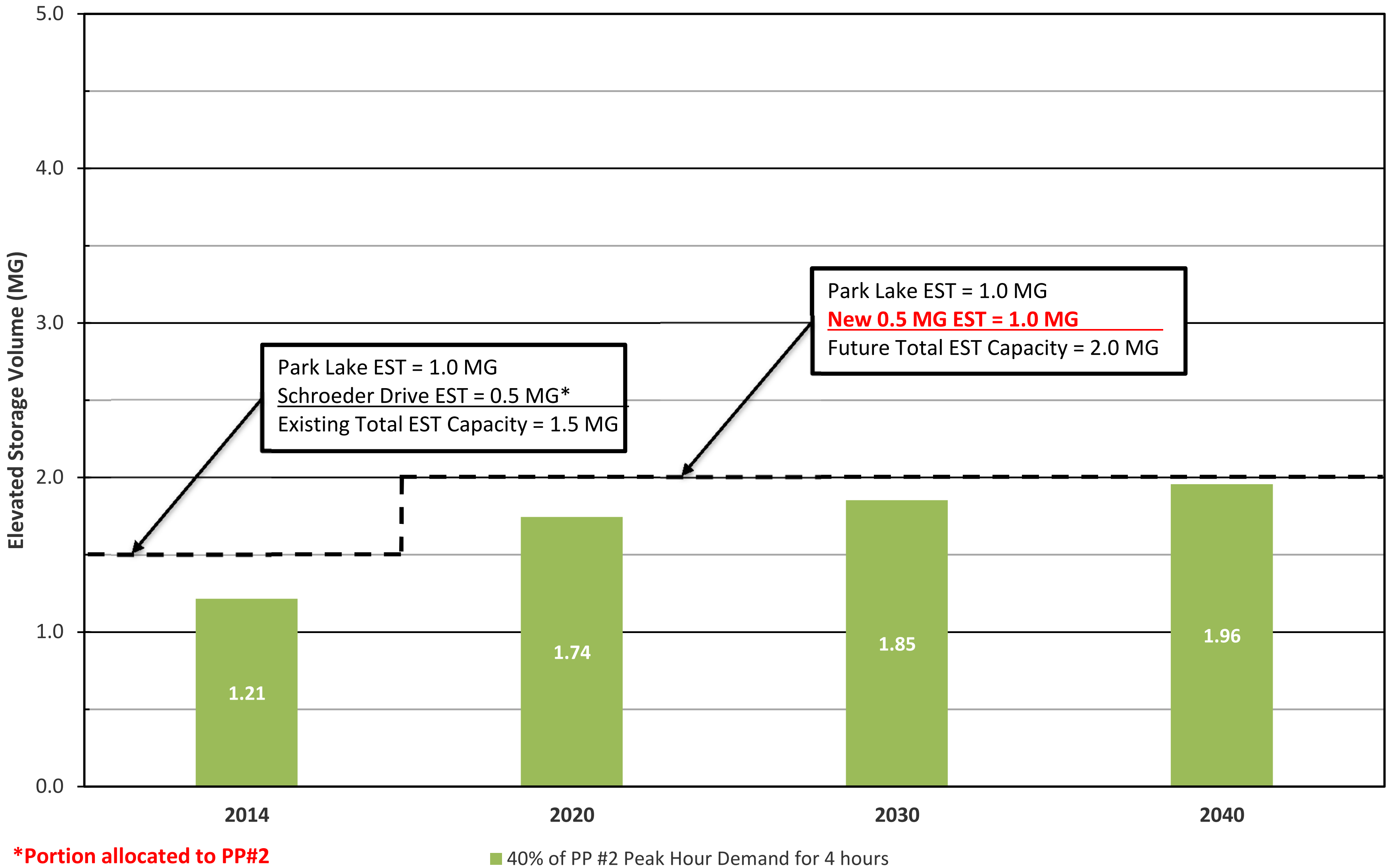




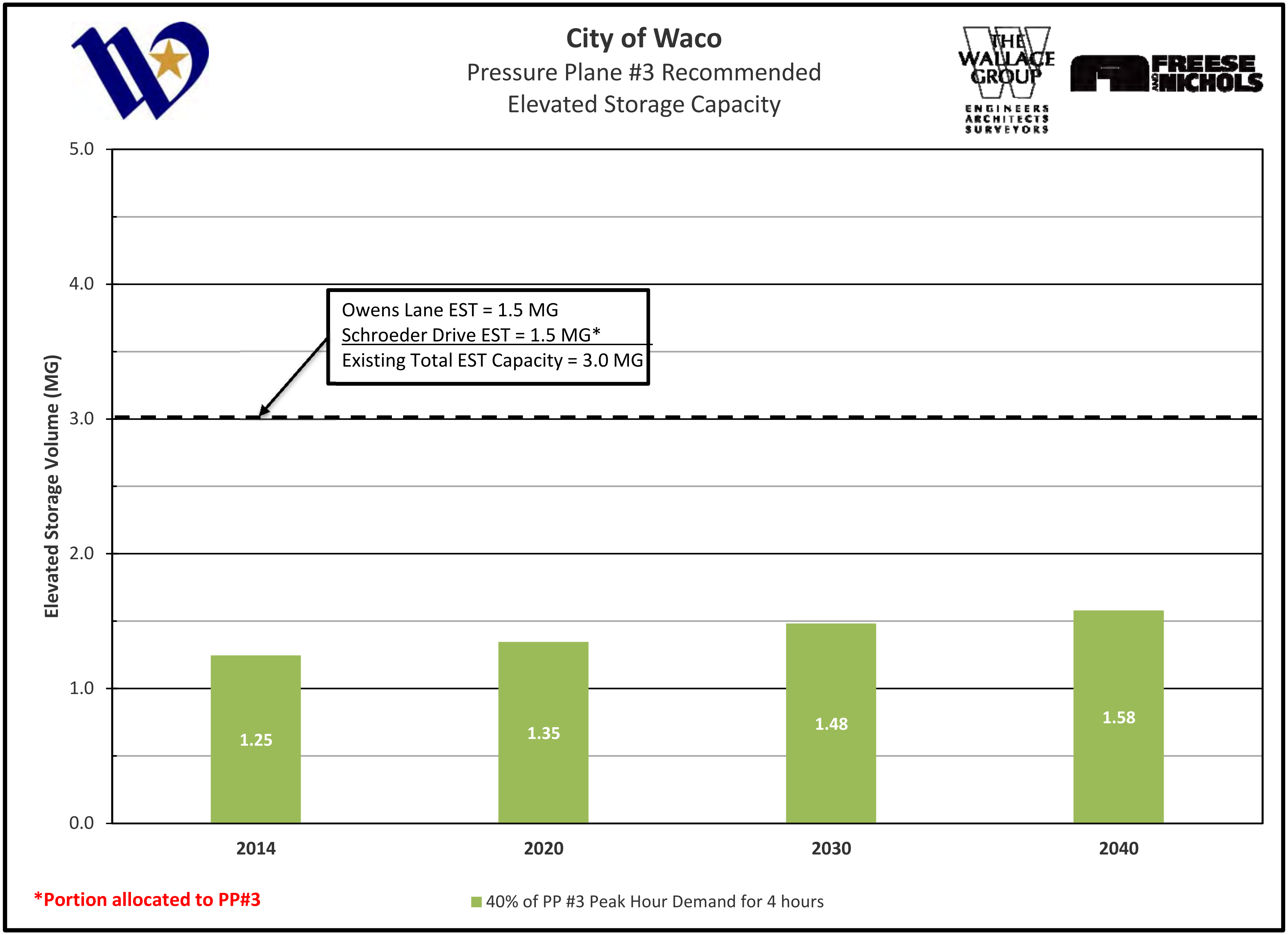
City of Waco
Pressure Plane #1 Recommended
Elevated Storage Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Elevated Storage Volume (MG)
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
TSTC EST =1.5 MG
Hillcrest GST = 0.5 MG*
Westview GST = 0.5 MG*
Existing Total EST Capacity = 2.5 MG
1.92
1.69
1.85
2.01
2014
2020
2030
2040
*Portion allocated to PP#1
40% of PP#1 Peak Hour Demand for 4 hours

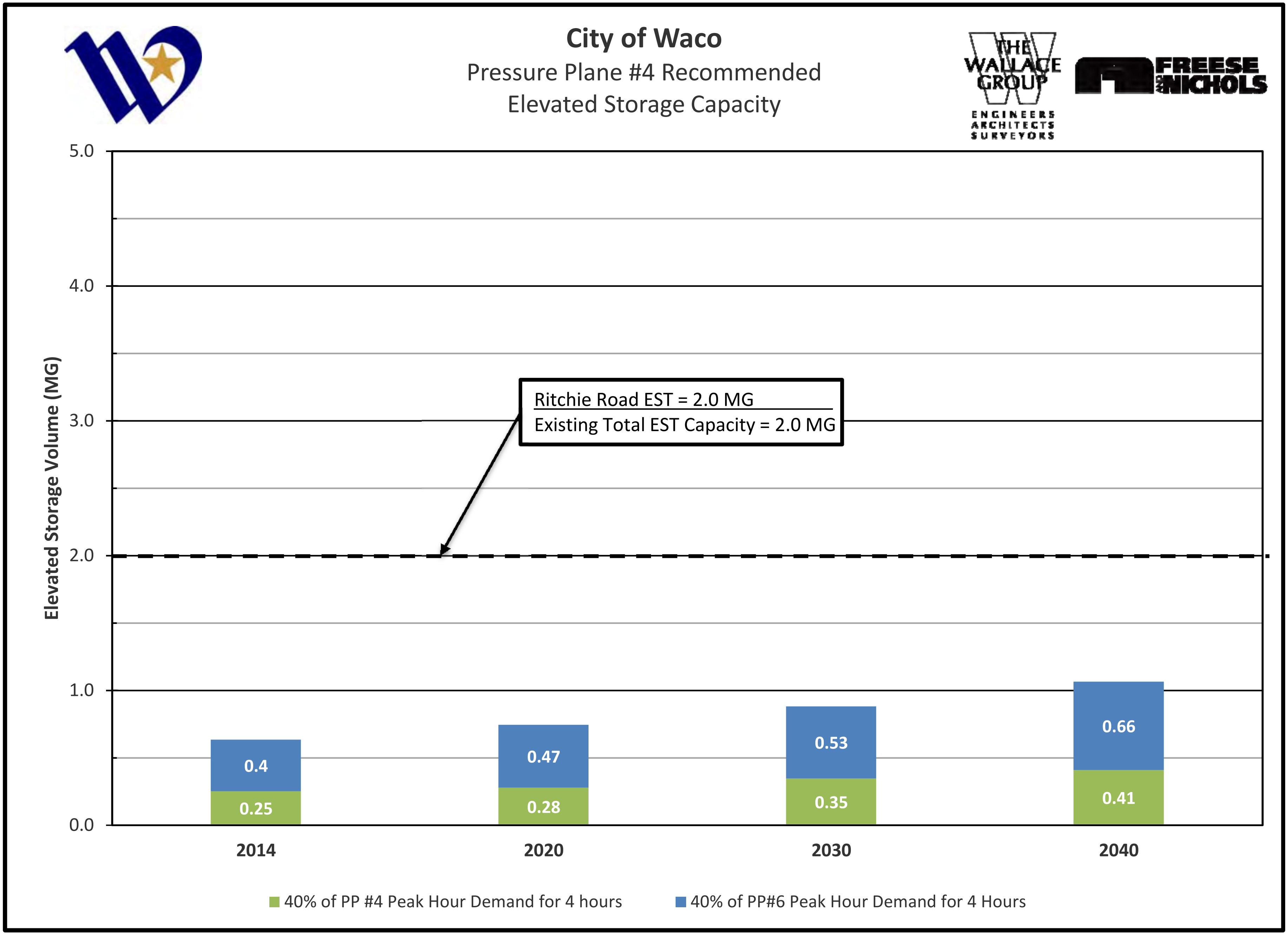
City of Waco

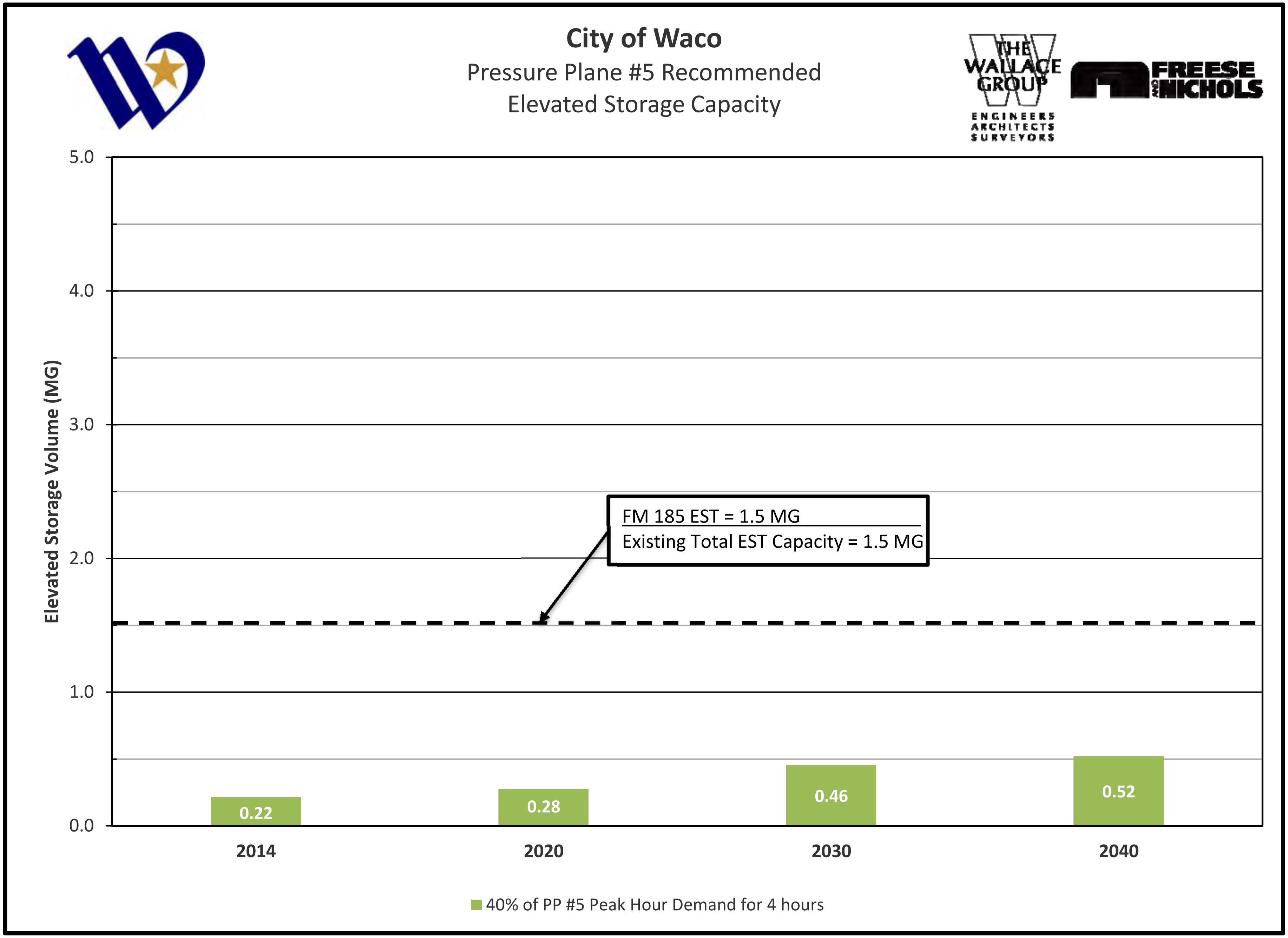
Pressure Plane #2 Recommended
Elevated Storage Capacity



*Portion allocated to PP#2

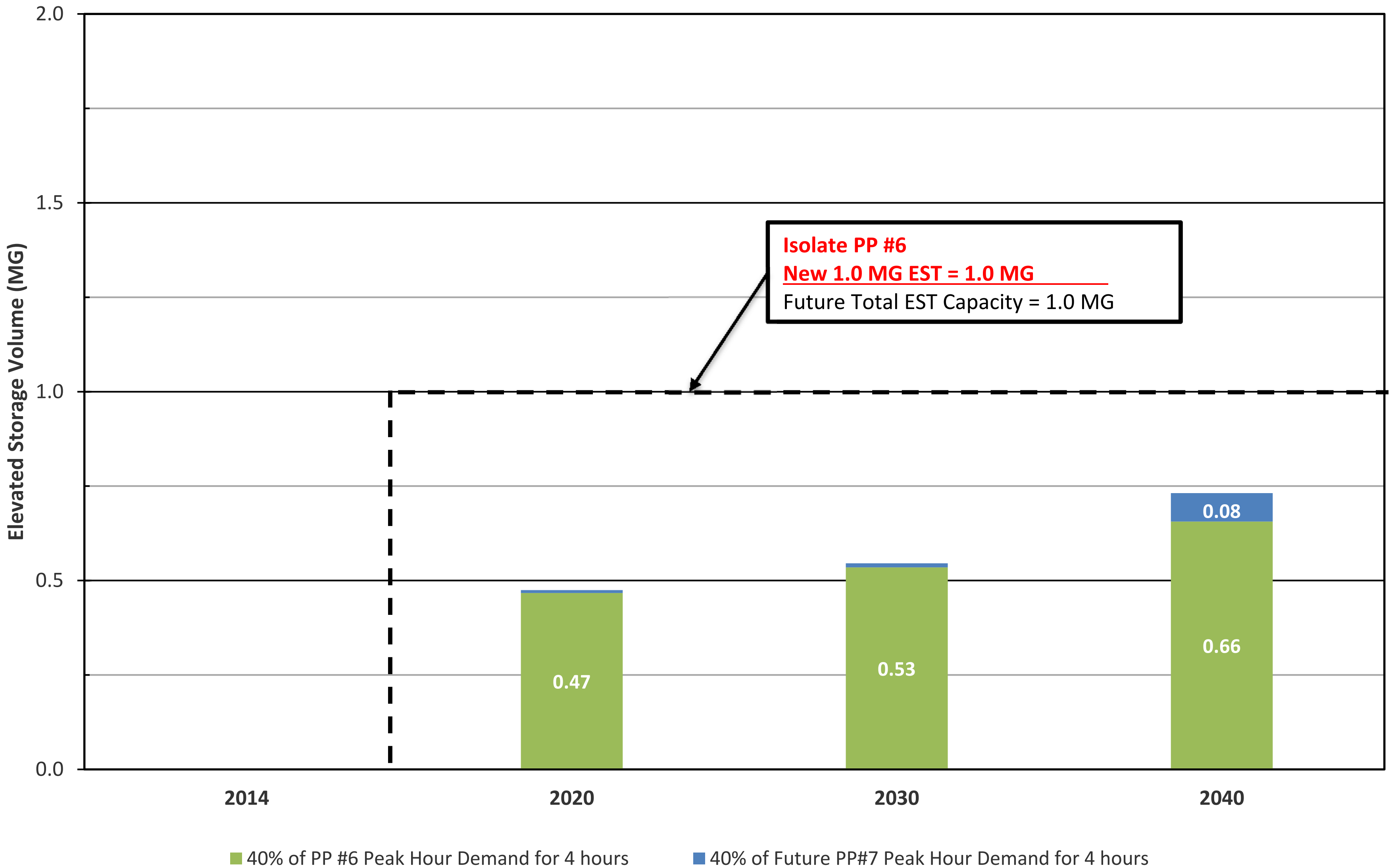

City of Waco
Pressure Plane #3 Recommended
Elevated Storage Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Elevated Storage Volume (MG)
5.0
4.0
3.0
2.0
1.0
0.0
Owens Lane EST = 1.5 MG
Schroeder Drive EST = 1.5 MG*
Existing Total EST Capacity = 3.0 MG
1.25
1.35
1.48
1.58
2014
2020
2030
2040
*Portion allocated to PP#3
40% of PP #3 Peak Hour Demand for 4 hours


City of Waco
Pressure Plane #4 Recommended
Elevated Storage Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Elevated Storage Volume (MG)
5.0
4.0
3.0
2.0
1.0
0.0
Ritchie Road EST = 2.0 MG
Existing Total EST Capacity = 2.0 MG
0.4
0.25
0.47
0.28
0.53
0.35
0.66
0.41
2014
2020
2030
2040
40% of PP #4 Peak Hour Demand for 4 hours
40% of PP#6 Peak Hour Demand for 4 Hours


City of Waco
Pressure Plane #5 Recommended
Elevated Storage Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Elevated Storage Volume (MG)
5.0
4.0
3.0
2.0
1.0
0.0
FM 185 EST = 1.5 MG
Existing Total EST Capacity = 1.5 MG
0.22
0.28
0.46
0.52
2014
2020
2030
2040
40% of PP #5 Peak Hour Demand for 4 hours

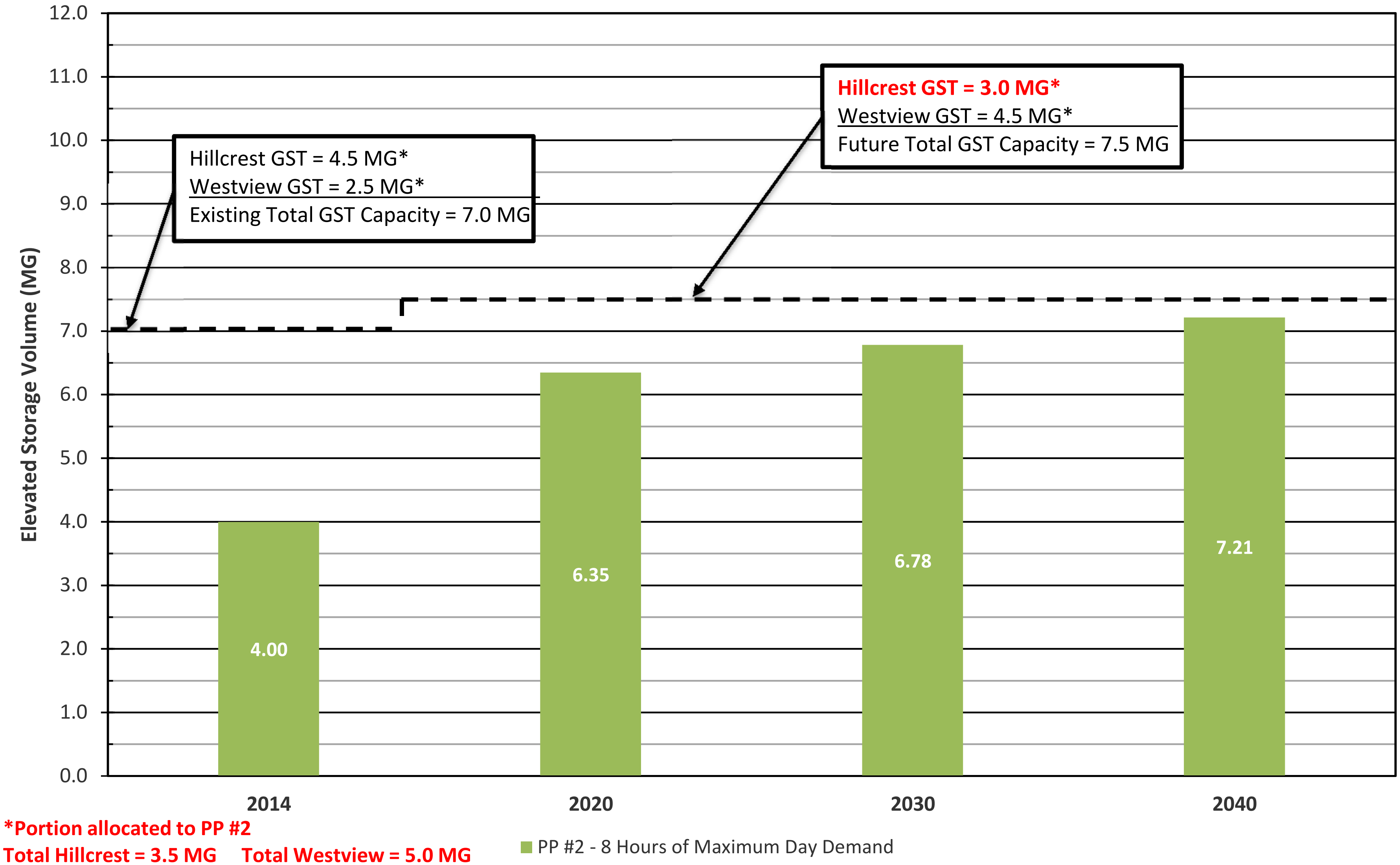
City of Waco

Pressure Plane #7 Recommended
Elevated Storage Capacity



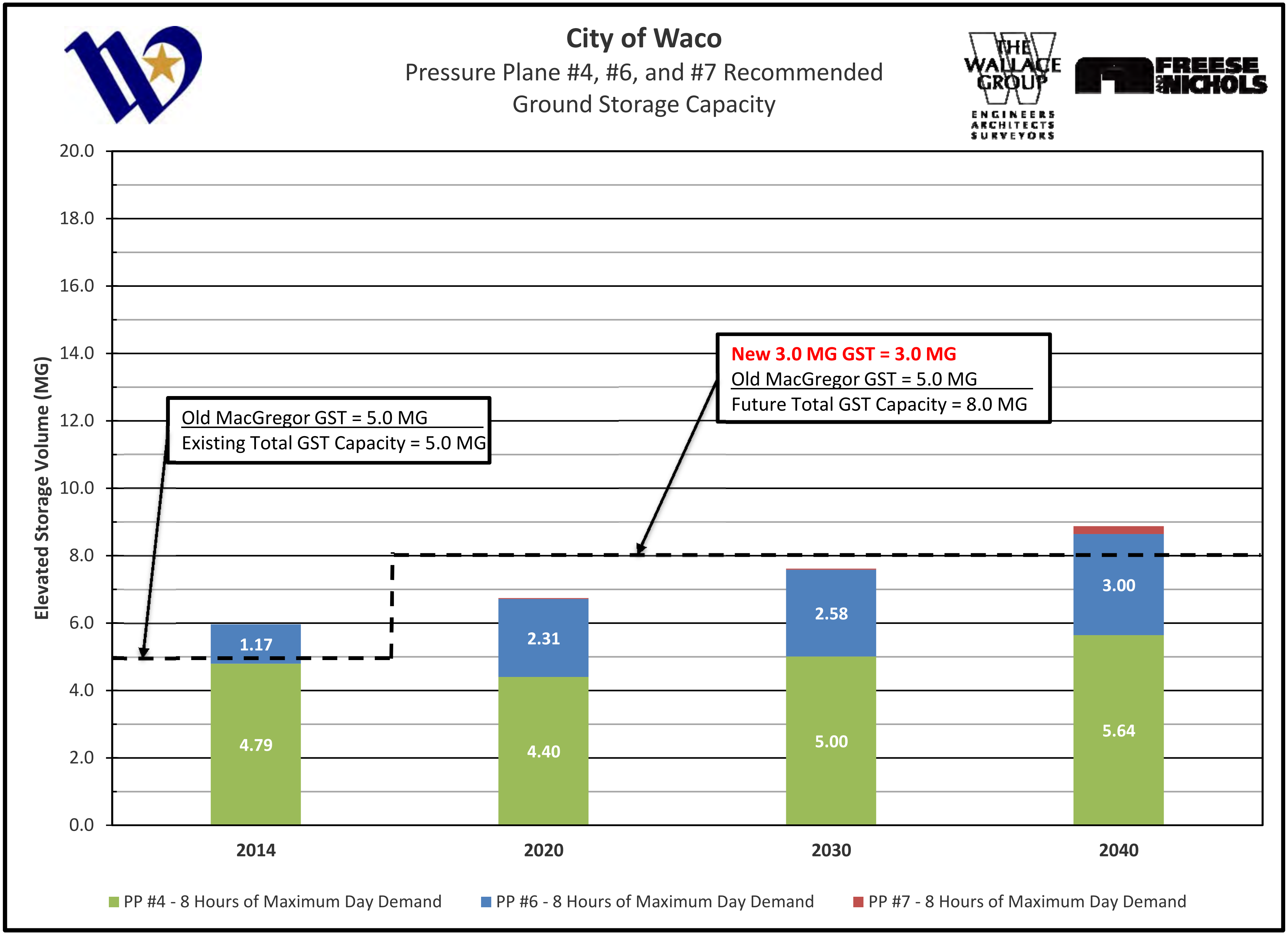
City of Waco

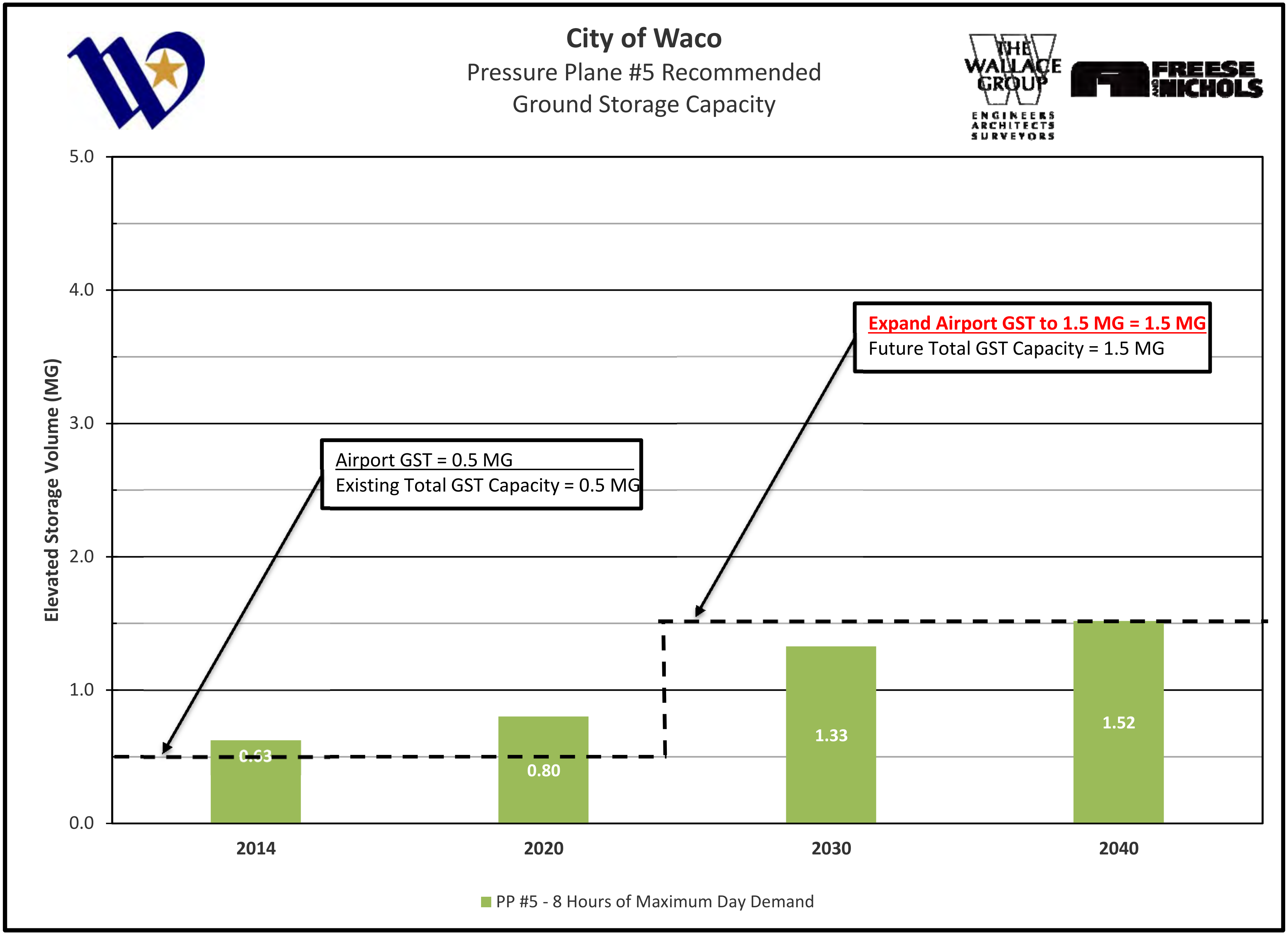
Pressure Plane #2 Recommended
Ground Storage Capacity



*Portion allocated to PP #2

Total Hillcrest = 3.5 MG   Total Westview = 5.0 MG


City of Waco
Pressure Plane #4, #6, and #7 Recommended
Ground Storage Capacity
THE WALLACE GROUP
ENGINEERS
ARCHITECTS
SURVEYORS
FREESE AND NICHOLS
Elevated Storage Volume (MG)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Old MacGregor GST = 5.0 MG
Existing Total GST Capacity = 5.0 MG
New 3.0 MG GST = 3.0 MG
Old MacGregor GST = 5.0 MG
Future Total GST Capacity = 8.0 MG
1.17
4.79
2.31
4.40
2.58
5.00
3.00
5.64
2014
2020
2030
2040
PP #4 - 8 Hours of Maximum Day Demand
PP #6 - 8 Hours of Maximum Day Demand
PP #7 - 8 Hours of Maximum Day Demand


City of Waco
Pressure Plane #5 Recommended
Ground Storage Capacity
THE WALLACE GROUP
ENGINEERS ARCHITECTS SURVEYORS
FREESE AND NICHOLS
Elevated Storage Volume (MG)
5.0
4.0
3.0
2.0
1.0
0.0
Expand Airport GST to 1.5 MG = 1.5 MG
Future Total GST Capacity = 1.5 MG
Airport GST = 0.5 MG
Existing Total GST Capacity = 0.5 MG
0.63
0.80
1.33
1.52
2014
2020
2030
2040
PP #5 - 8 Hours of Maximum Day Demand

APPENDIX D
PUMP CURVES

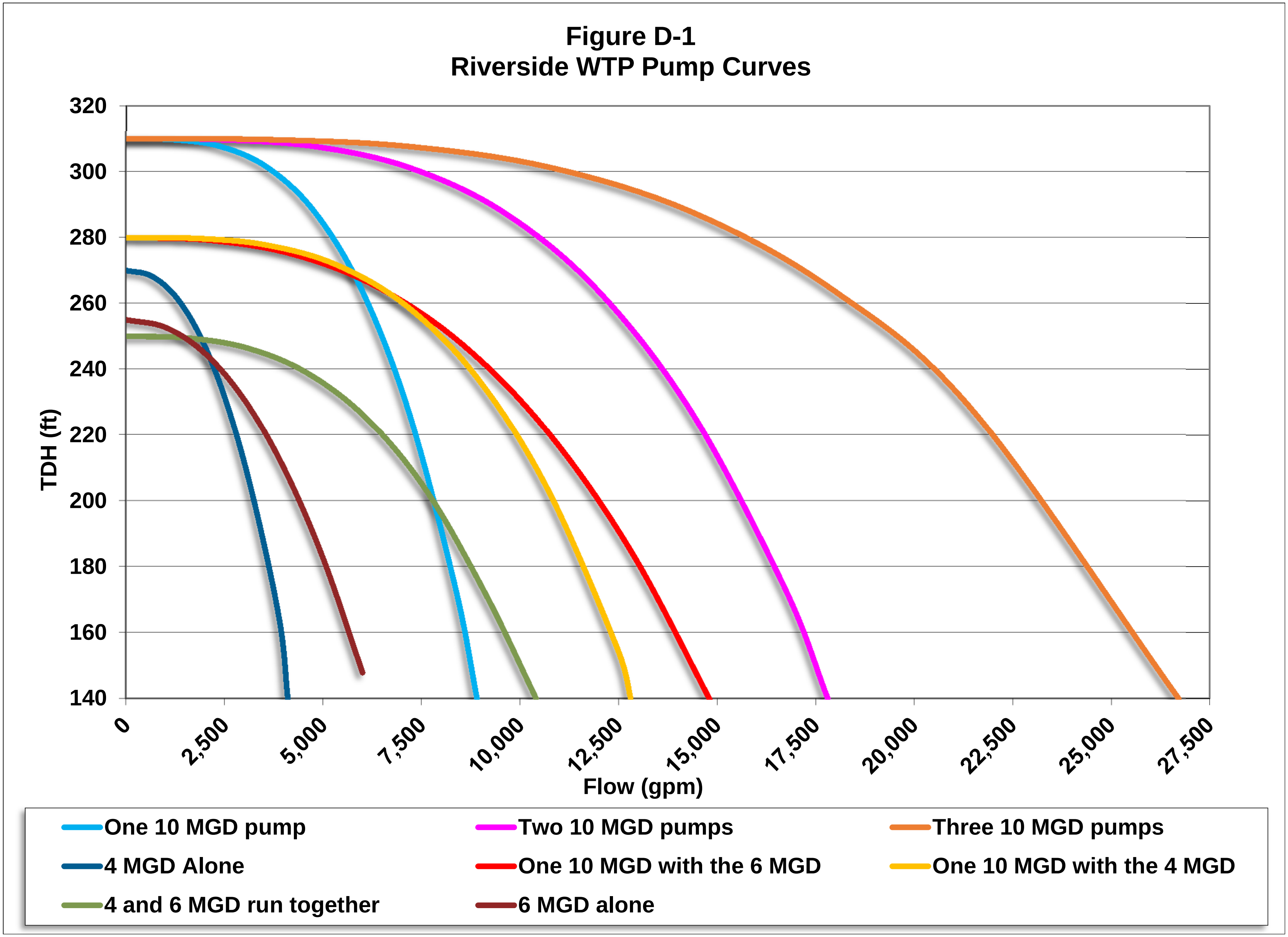


Figure D-1
Riverside WTP Pump Curves
TDH (ft)
320
300
280
260
240
220
200
180
160
140
0
2,500
5,000
7,500
10,000
12,500
15,000
17,500
20,000
22,500
25,000
27,500
Flow (gpm)
One 10 MGD pump
Two 10 MGD pumps
Three 10 MGD pumps
4 MGD Alone
One 10 MGD with the 6 MGD
One 10 MGD with the 4 MGD
4 and 6 MGD run together
6 MGD alone

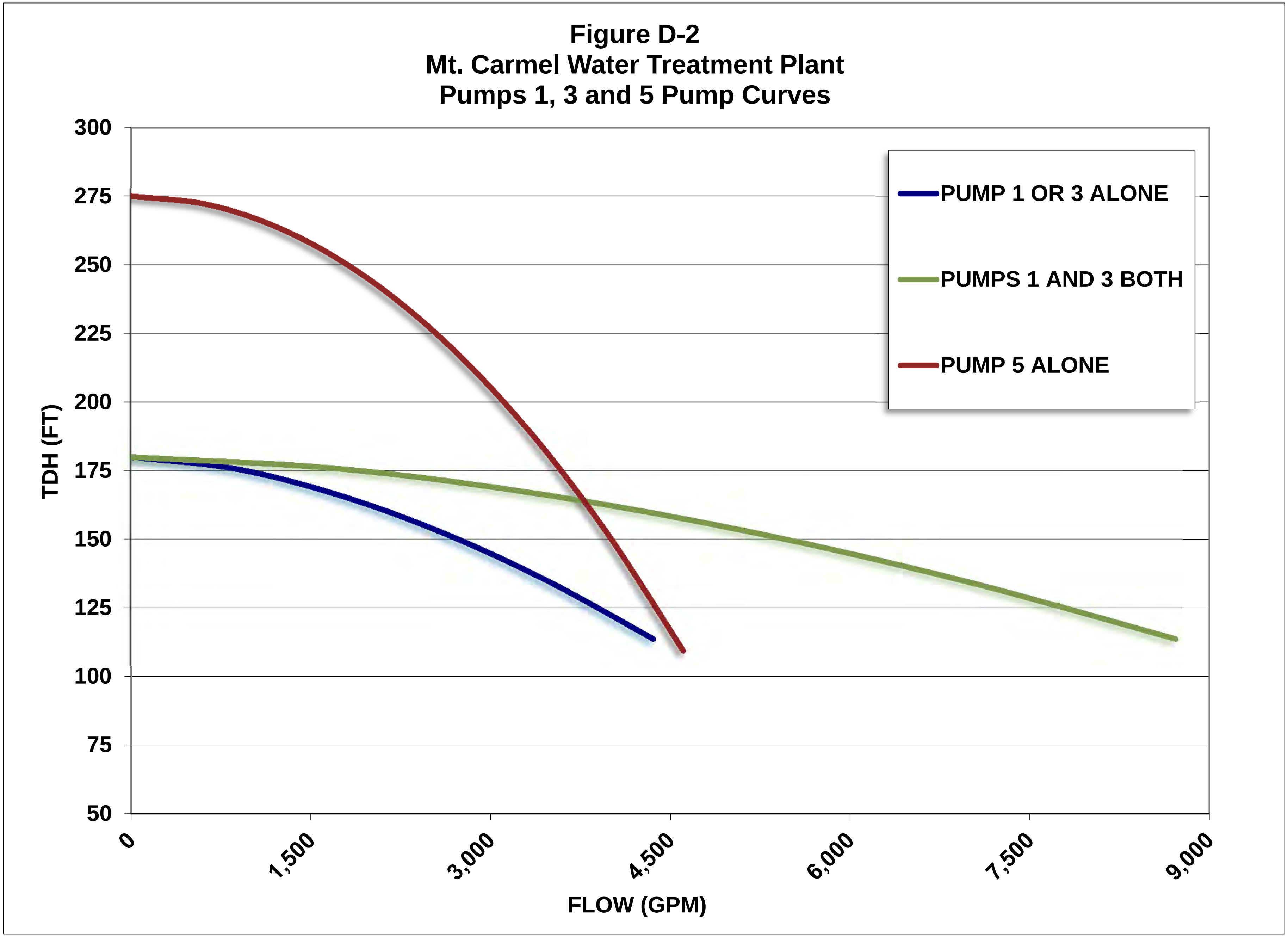


Figure D-2
Mt. Carmel Water Treatment Plant
Pumps 1, 3 and 5 Pump Curves
TDH (FT)
300
275
250
225
200
175
150
125
100
75
50
0
1,500
3,000
4,500
6,000
7,500
9,000
FLOW (GPM)
PUMP 1 OR 3 ALONE
PUMPS 1 AND 3 BOTH
PUMP 5 ALONE

Figure D-3
Mt. Carmel Water Treatment Plant
Pumps 2, 4 and 6 Pump Curves

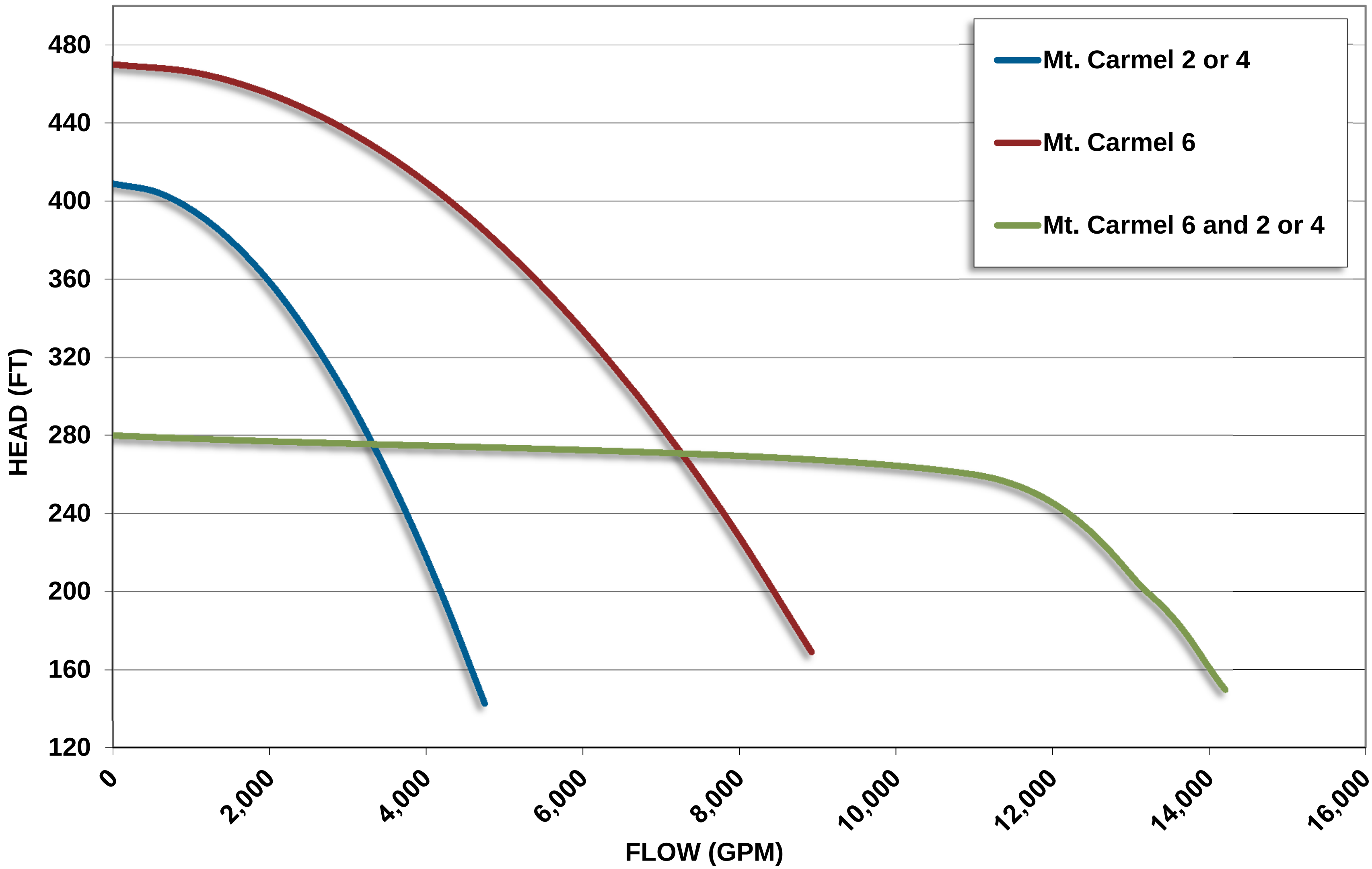
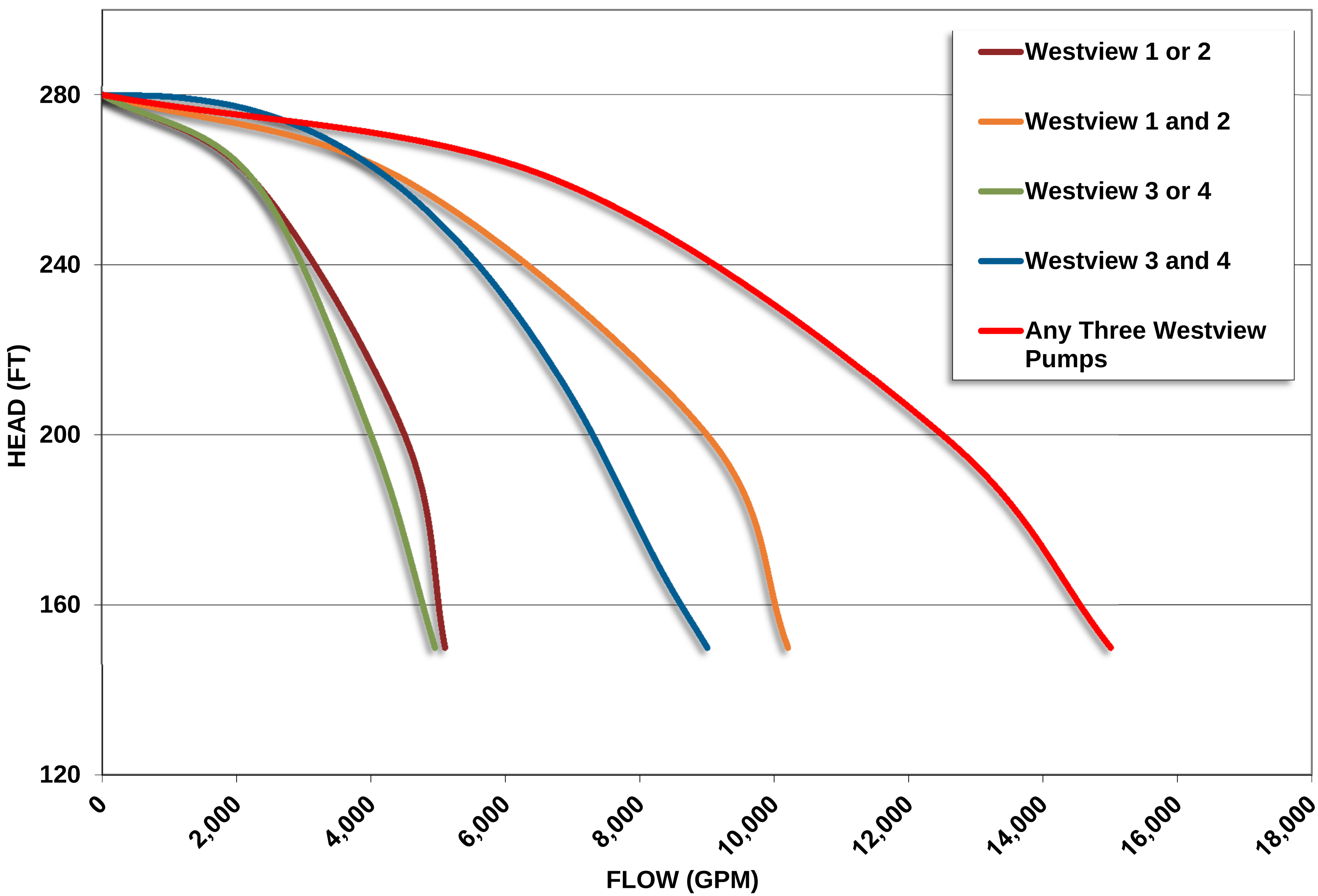


Figure D-4
Westview Pump Station Pump Curves



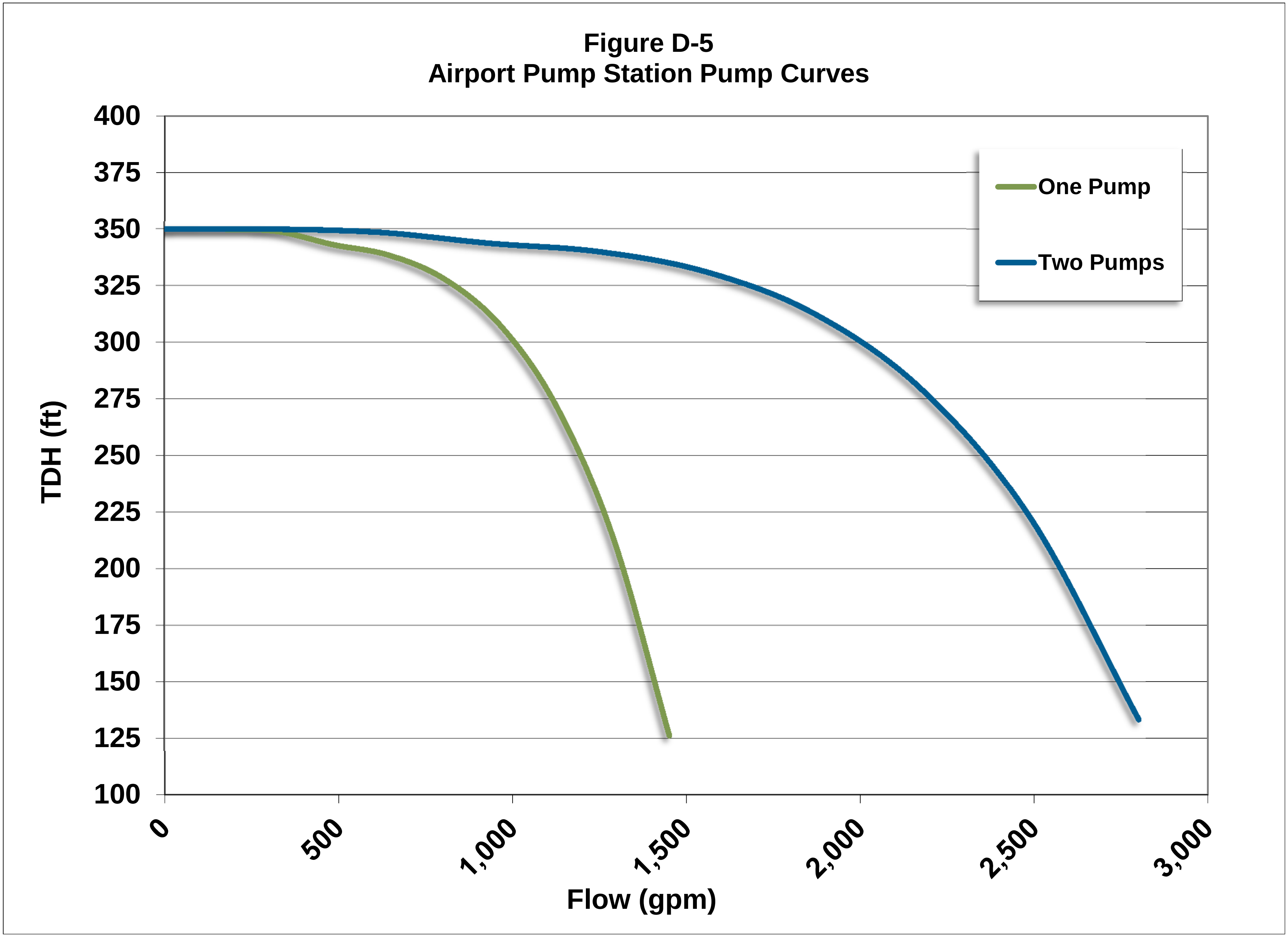


Figure D-5
Airport Pump Station Pump Curves
400
375
350
325
300
275
250
225
200
175
150
125
100
TDH (ft)
0
500
1,000
1,500
2,000
2,500
3,000
Flow (gpm)
One Pump
Two Pumps

Figure D-6
Hillcrest Pump Station Pump Curves

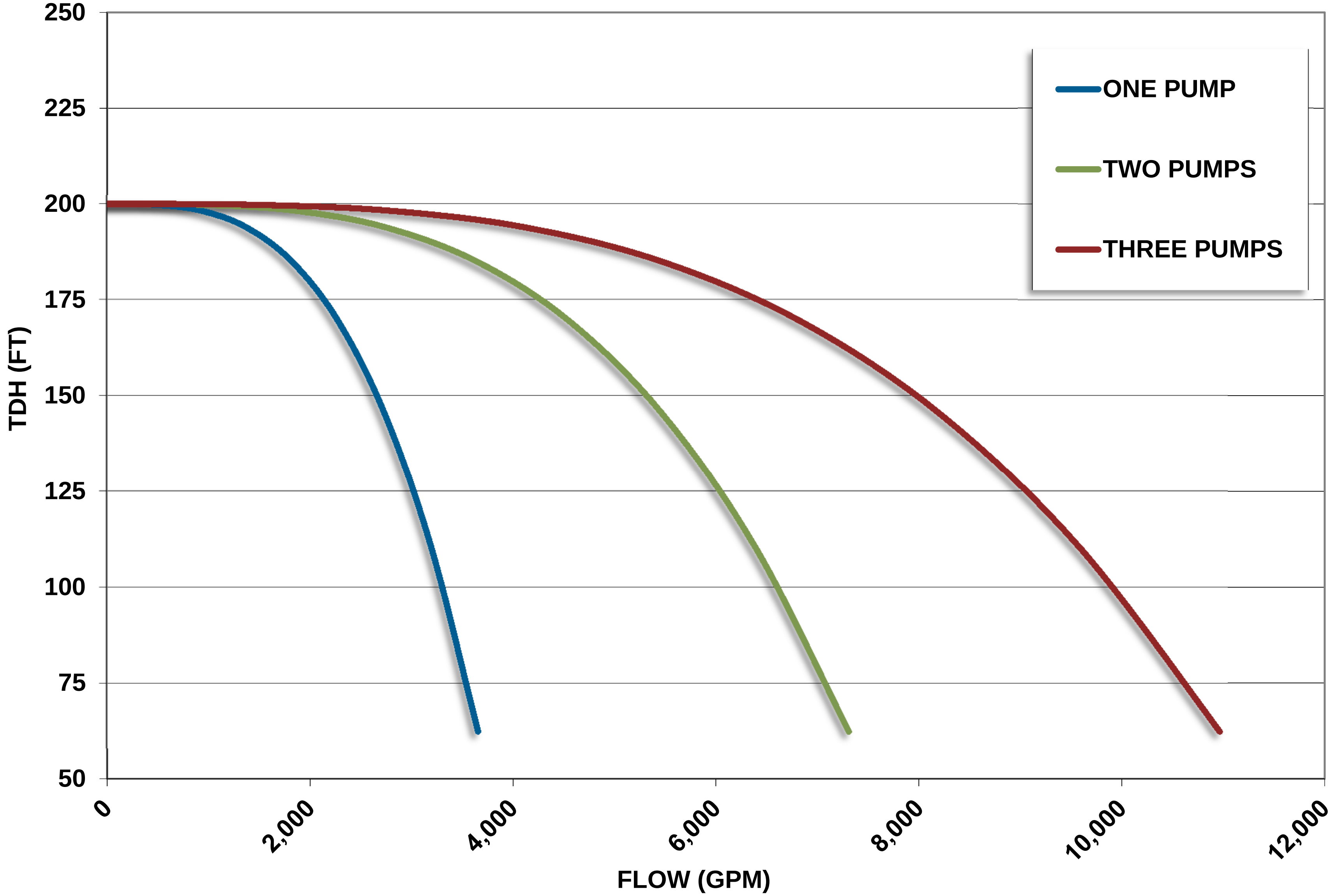
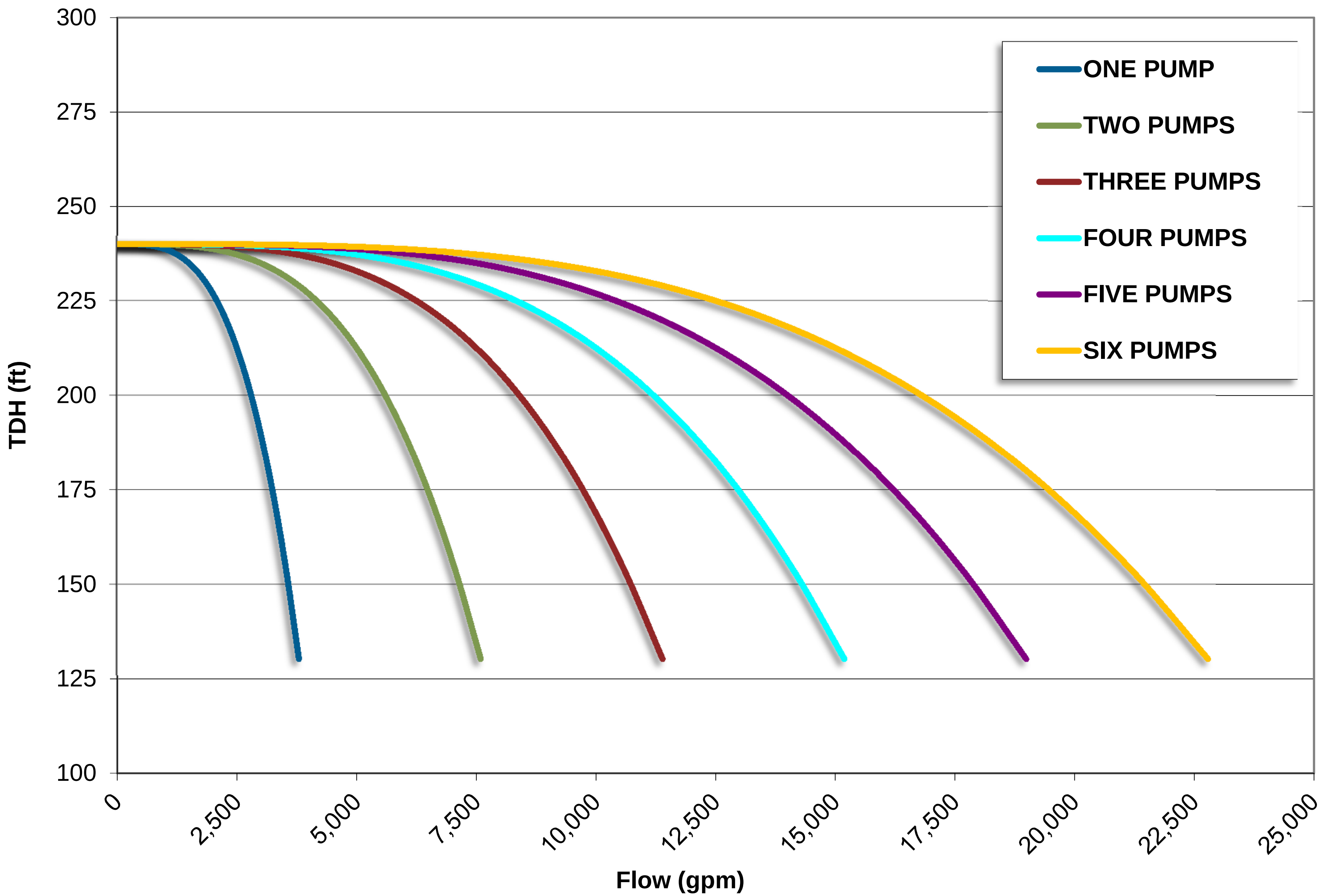


Figure D-7
Old McGregor Pump Station Pump Curves



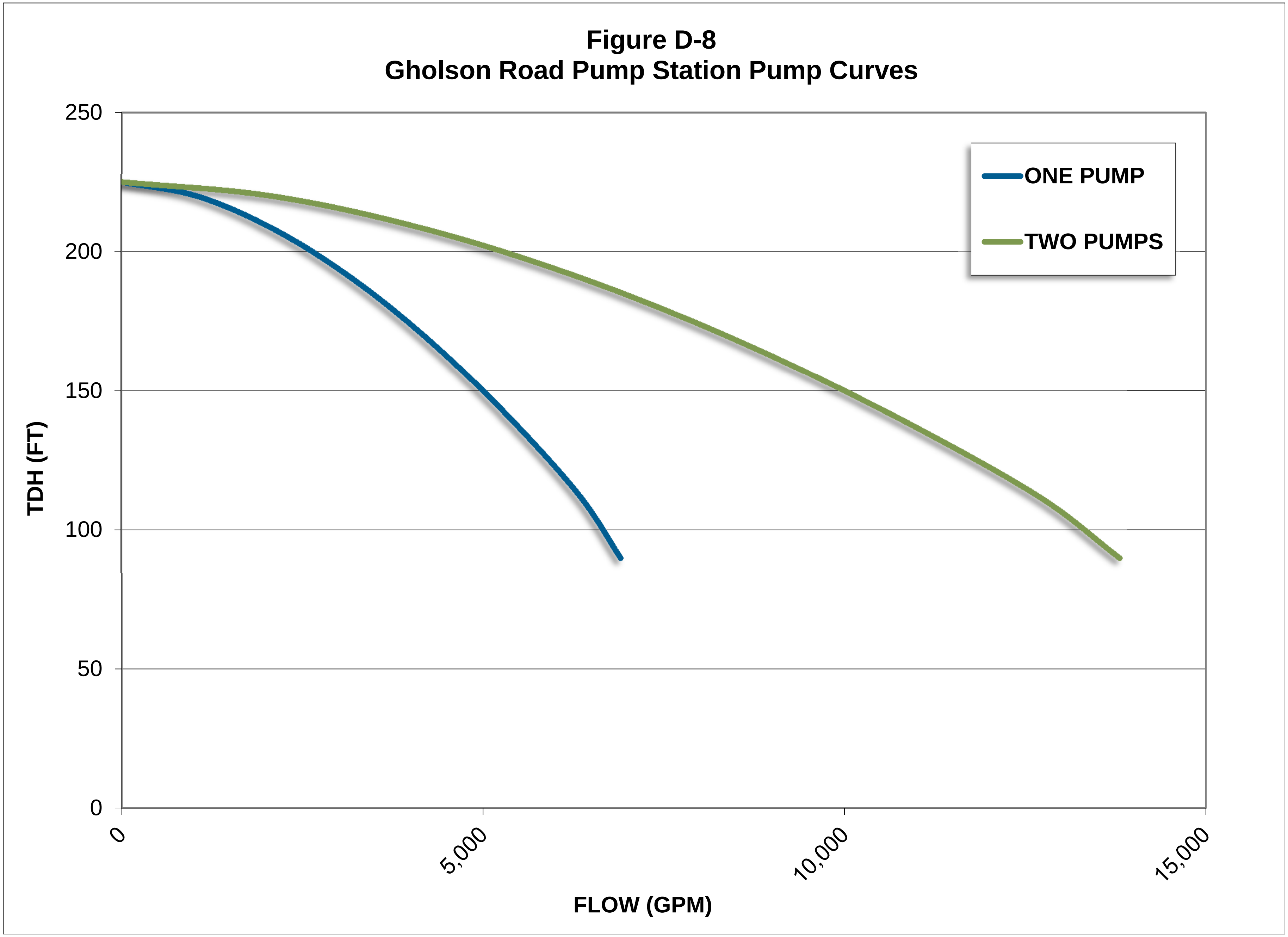


Figure D-8
Gholson Road Pump Station Pump Curves
250
200
150
100
50
0
TDH (FT)
0
5,000
10,000
15,000
FLOW (GPM)
ONE PUMP
TWO PUMPS

APPENDIX E
ADDITIONAL ALTERNATIVES CAPITAL IMPROVEMENTS PLAN

ALTERNATIVE WATER DEMAND CAPITAL IMPROVEMENT PLANS

During the master planning process, the project team developed three separate water demand alternatives based on different levels of service to wholesale water customers. Ultimately, the City determined that Alternative 2 that represents conjunctive water use where the City serves 100% of the Waco water demand and 50% of the wholesale water demand was the most reasonable approach. The report presents the CIP and cost estimates based on these assumptions. However, the project team additionally developed a Capital Improvement Plan to serve the City of Waco based on the population and water demand projections for Alternative 1 and Alternative 3 in Section 3 of this report.

Alternative 1 assumes that the City of Waco will serve 100% of the Waco average day and maximum day water demand and 100% of the wholesale customer average day and maximum day water demand. Alternative 3 assumes that 100% of the Waco demand and 100% of wholesale customer maximum day demand, including Falls, Hills, Limestone, and McLennan Counties (FHLM) W.S.C., is served through the Waco distribution system. The demands in these alternative scenarios are greater than the demands in Alternative 2 in the report and therefore, many of the projects require a larger pipeline diameter to serve the larger demand. For these scenarios, the project team developed CIPs to serve the larger demand, but did not proceed with phasing or cost estimating based on direction from the City. However, the project team has included **Figures E-1** and **E-2** as a reference if the City chooses to change course and serve more of the wholesale demand. **Tables E-1** and **E-2** list the demand assumptions represented in the model for Alternatives 1 and 3.

Table E-1: Projected Alternative 1 Water Demands by Pressure Plane

Pressure Plane	2014 Population	Residential per Capita Demand (gpcd)	2014 Average Day Residential Demand (mgd)	2014 Employment	Employment per Capita Demand (gped)	2014 Average Day Employment Demand (mgd)	City of Waco 2014 Average Day Demand (mgd)	2014 Wholesale Average Day Demand (mgd)	2014 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	Wholesale Maximum Day Demand (mgd)	2014 City of Waco Maximum Day Demand (mgd)	Total 2014 Maximum Day Water Demand (mgd)
PP1	58,312	110	6.41	27,312	125	3.41	9.83	1.96	11.79	1.70	3.93	16.71	20.64
PP2	36,899	125	4.61	12,199	200	2.44	7.05	-	7.05	1.70	-	11.99	11.99
PP3	18,352	175	3.21	25,443	125	3.18	6.39	2.13	8.52	1.70	4.66	10.87	15.53
PP4	7,264	185	1.34	4,420	125	0.55	1.90	3.82	5.72	1.70	11.15	3.22	14.37
PP5	4,571	215	0.98	605	200	0.12	1.10	-	1.10	1.70	-	1.88	1.88
PP6	2,939	685	2.01	238	200	0.05	2.06	-	2.06	1.70	-	3.50	3.50
Total	**128,336**	**145**	**18.58**	**70,217**	**139**	**9.76**	**28.33**	**7.91**	**36.24**	**-**	**19.74**	**48.17**	**67.91**

Pressure Plane	2020 Population	Residential per Capita Demand (gpcd)	2020 Average Day Residential Demand (mgd)	2020 Employment	Employment per Capita Demand (gped)	2020 Average Day Employment Demand (mgd)	City of Waco 2020 Average Day Demand (mgd)	2020 Wholesale Avg. Day Demand (mgd)	2020 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2020 Wholesale Maximum Day Demand (mgd)	City of Waco 2020 Maximum Day Demand (mgd)	Total 2020 Maximum Day Water Demand (mgd)
PP1	49,579	110	5.45	25,607	125	3.20	8.65	2.23	10.89	1.70	4.47	14.71	19.18
PP2	50,889	132	6.71	17,041	200	3.41	10.12	0.92	11.04	1.70	1.84	17.20	19.04
PP3	19,990	177	3.54	26,923	125	3.37	6.90	2.80	9.70	1.70	5.59	11.74	17.33
PP4	8,112	187	1.51	4,634	125	0.58	2.09	3.84	5.94	1.70	9.64	3.56	13.20
PP5	5,909	215	1.27	722	200	0.14	1.41	-	1.41	1.70	-	2.41	2.41
PP6	3,828	642	2.46	271	200	0.05	2.51	1.33	3.85	1.70	2.67	4.27	6.94
PP7	232	150	0.03	60	125	0.01	0.04	-	0.04	1.70	-	0.07	0.07
Total	**138,539**	**151**	**20.98**	**75,258**	**143**	**10.76**	**31.74**	**11.13**	**42.87**	**-**	**24.21**	**53.96**	**78.16**

Table E-1: Projected Alternative 1 Water Demands by Pressure Plane (cont.)

Pressure Plane	2030 Population	Residential per Capita Demand (gpcd)	2030 Average Day Residential Demand (mgd)	2030 Employment	Employment per Capita Demand (gped)	2030 Average Day Employment Demand (mgd)	City of Waco 2030 Average Day Demand (mgd)	2030 Wholesale Avg. Day Demand (mgd)	2030 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2030 Wholesale Maximum Day Demand (mgd)	City of Waco 2030 Maximum Day Demand (mgd)	Total 2030 Maximum Day Water Demand (mgd)
PP1	54,249	110	5.97	28,075	125	3.51	9.48	2.30	11.78	1.70	4.61	16.11	20.72
PP2	53,302	133	7.07	18,390	200	3.68	10.75	1.03	11.78	1.70	2.07	18.28	20.34
PP3	21,959	179	3.93	29,369	125	3.67	7.60	3.21	10.81	1.70	6.42	12.93	19.35
PP4	10,150	189	1.92	5,569	125	0.70	2.62	4.24	6.85	1.70	10.56	4.45	15.01
PP5	9,711	215	2.09	1,274	200	0.25	2.34	-	2.34	1.70	-	3.98	3.98
PP6	4,468	622	2.78	496	200	0.10	2.88	1.42	4.30	1.70	2.84	4.89	7.73
PP7	340	150	0.05	62	125	0.01	0.06	-	0.06	1.70	-	0.10	0.10
Total	**154,179**	**154**	**23.81**	**96,253**	**124**	**11.92**	**35.73**	**12.20**	**47.93**	**-**	**26.50**	**60.74**	**87.24**

Pressure Plane	2040 Population	Residential per Capita Demand (gpcd)	2040 Average Day Residential Demand (mgd)	2040 Employment	Employment per Capita Demand (gped)	2040 Average Day Employment Demand (mgd)	City of Waco 2040 Average Day Demand (mgd)	2040 Wholesale Avg. Day Demand (mgd)	2040 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2040 Wholesale Maximum Day Demand (mgd)	City of Waco 2040 Maximum Day Demand (mgd)	Total 2040 Maximum Day Water Demand (mgd)
PP1	57,943	110	6.37	31,638	125	3.95	10.33	2.37	12.70	1.70	5.13	17.56	22.69
PP2	54,900	133	7.31	20,188	200	4.04	11.35	1.14	12.49	1.70	2.34	19.30	21.64
PP3	23,369	180	4.22	31,081	125	3.89	8.10	3.58	11.68	1.70	8.16	13.77	21.93
PP4	12,254	191	2.34	5,955	125	0.74	3.09	4.59	7.68	1.70	11.67	5.25	16.91
PP5	11,046	215	2.37	1,520	200	0.30	2.68	-	2.68	1.70	-	4.55	4.55
PP6	5,744	595	3.42	566	200	0.11	3.53	1.50	5.03	1.70	3.00	6.00	9.00
PP7	2,377	150	0.36	476	125	0.06	0.42	-	0.42	1.70	-	0.71	0.71
Total	**167,633**	**157**	**26.39**	**91,424**	**143**	**13.10**	**39.49**	**13.18**	**52.66**	**-**	**30.30**	**67.13**	**97.43**

Table E-2: Projected Alternative 3 Water Demands by Pressure Plane

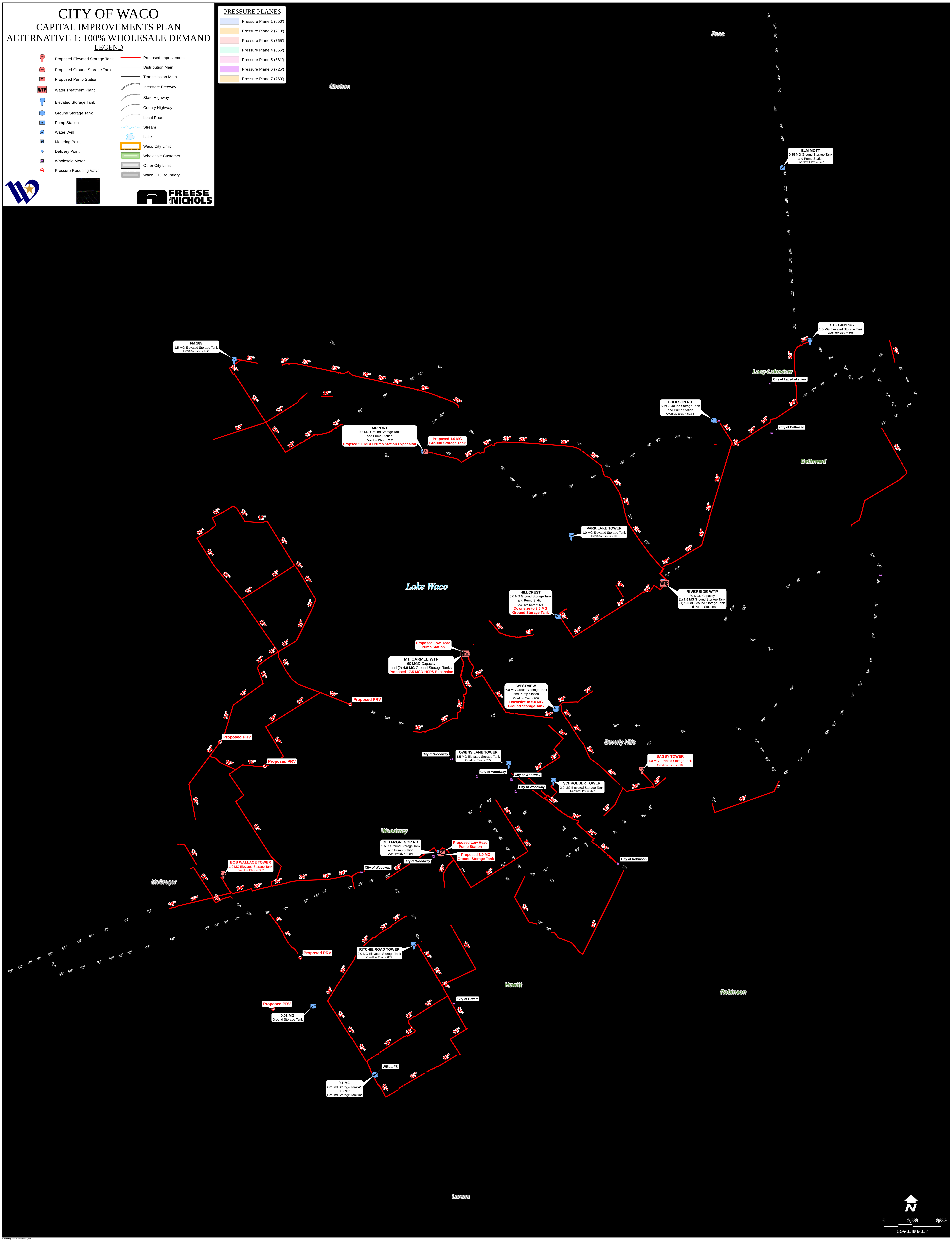
Pressure Plane	2014 Population	Residential per Capita Demand (gpcd)	2014 Average Day Residential Demand (mgd)	2014 Employment	Employment per Capita Demand (gped)	2014 Average Day Employment Demand (mgd)	City of Waco 2014 Average Day Demand (mgd)	2014 Wholesale Average Day Demand (mgd)	2014 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	Wholesale Maximum Day Demand (mgd)	2014 City of Waco Maximum Day Demand (mgd)	Total 2014 Maximum Day Water Demand (mgd)
PP1	58,312	110	6.41	27,312	125	3.41	9.83	1.96	11.79	1.70	3.93	16.71	20.64
PP2	36,899	125	4.61	12,199	200	2.44	7.05	-	7.05	1.70	-	11.99	11.99
PP3	18,352	175	3.21	25,443	125	3.18	6.39	2.13	8.52	1.70	4.66	10.87	15.53
PP4	7,264	185	1.34	4,420	125	0.55	1.90	3.82	5.72	1.70	11.15	3.22	14.37
PP5	4,571	215	0.98	605	200	0.12	1.10	-	1.10	1.70	-	1.88	1.88
PP6	2,939	685	2.01	238	200	0.05	2.06	-	2.06	1.70	-	3.50	3.50
Total	**128,336**	**145**	**18.58**	**70,217**	**139**	**9.76**	**28.33**	**7.91**	**36.24**	**-**	**19.74**	**48.17**	**67.91**

Pressure Plane	2020 Population	Residential per Capita Demand (gpcd)	2020 Average Day Residential Demand (mgd)	2020 Employment	Employment per Capita Demand (gped)	2020 Average Day Employment Demand (mgd)	City of Waco 2020 Average Day Demand (mgd)	2020 Wholesale Avg. Day Demand (mgd)	2020 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2020 Wholesale Maximum Day Demand (mgd)	City of Waco 2020 Maximum Day Demand (mgd)	Total 2020 Maximum Day Water Demand (mgd)
PP1	49,579	110	5.45	25,607	125	3.20	8.65	2.23	10.89	1.70	4.47	14.71	19.18
PP2	50,889	132	6.71	17,041	200	3.41	10.12	0.92	11.04	1.70	1.84	17.20	19.04
PP3	19,990	177	3.54	26,923	125	3.37	6.90	2.80	9.70	1.70	5.59	11.74	17.33
PP4	8,112	187	1.51	4,634	125	0.58	2.09	3.84	5.94	1.70	9.64	3.56	13.20
PP5	5,909	215	1.27	722	200	0.14	1.41	-	1.41	1.70	-	2.41	2.41
PP6	3,828	642	2.46	271	200	0.05	2.51	1.33	3.85	1.70	2.67	4.27	6.94
PP7	232	150	0.03	60	125	0.01	0.04	-	0.04	1.70	-	0.07	0.07
Total	**138,539**	**151**	**20.98**	**75,258**	**143**	**10.76**	**31.74**	**11.13**	**42.87**	**-**	**24.21**	**53.96**	**78.16**

Table E-2: Projected Alternative 3 Water Demands by Pressure Plane (cont.)

Pressure Plane	2030 Population	Residential per Capita Demand (gpcd)	2030 Average Day Residential Demand (mgd)	2030 Employment	Employment per Capita Demand (gped)	2030 Average Day Employment Demand (mgd)	City of Waco 2030 Average Day Demand (mgd)	2030 Wholesale Avg. Day Demand (mgd)	2030 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2030 Wholesale Maximum Day Demand (mgd)	City of Waco 2030 Maximum Day Demand (mgd)	Total 2030 Maximum Day Water Demand (mgd)
PP1	54,249	110	5.97	28,075	125	3.51	9.48	2.30	11.78	1.70	4.61	16.11	20.72
PP2	53,302	133	7.07	18,390	200	3.68	10.75	1.03	11.78	1.70	2.07	18.28	20.34
PP3	21,959	179	3.93	29,369	125	3.67	7.60	3.21	10.81	1.70	6.42	12.93	19.35
PP4	10,150	189	1.92	5,569	125	0.70	2.62	4.24	6.85	1.70	10.56	4.45	15.01
PP5	9,711	215	2.09	1,274	200	0.25	2.34	-	2.34	1.70	-	3.98	3.98
PP6	4,468	622	2.78	496	200	0.10	2.88	1.42	4.30	1.70	2.84	4.89	7.73
PP7	340	150	0.05	62	125	0.01	0.06	-	0.06	1.70	-	0.10	0.10
Total	**154,179**	**154**	**23.81**	**96,253**	**124**	**11.92**	**35.73**	**12.20**	**47.93**	**-**	**26.50**	**60.74**	**87.24**

Pressure Plane	2040 Population	Residential per Capita Demand (gpcd)	2040 Average Day Residential Demand (mgd)	2040 Employment	Employment per Capita Demand (gped)	2040 Average Day Employment Demand (mgd)	City of Waco 2040 Average Day Demand (mgd)	2040 Wholesale Avg. Day Demand (mgd)	2040 Total Average Day Water Demand (mgd)	MD to AD Peaking Factor	2040 Wholesale Maximum Day Demand (mgd)	City of Waco 2040 Maximum Day Demand (mgd)	Total 2040 Maximum Day Water Demand (mgd)
PP1	57,943	110	6.37	31,638	125	3.95	10.33	2.37	12.70	1.70	16.79	17.56	34.35
PP2	54,900	133	7.31	20,188	200	4.04	11.35	1.14	12.49	1.70	2.34	19.30	21.64
PP3	23,369	180	4.22	31,081	125	3.89	8.10	3.58	11.68	1.70	8.16	13.77	21.93
PP4	12,254	191	2.34	5,955	125	0.74	3.09	4.59	7.68	1.70	11.67	5.25	16.91
PP5	11,046	215	2.37	1,520	200	0.30	2.68	-	2.68	1.70	-	4.55	4.55
PP6	5,744	595	3.42	566	200	0.11	3.53	1.50	5.03	1.70	3.00	6.00	9.00
PP7	2,377	150	0.36	476	125	0.06	0.42	-	0.42	1.70	-	0.71	0.71
Total	**167,633**	**157**	**26.39**	**91,424**	**143**	**13.10**	**39.49**	**13.18**	**52.66**	**-**	**41.96**	**67.13**	**109.09**



CITY OF WACO
CAPITAL IMPROVEMENTS PLAN
ALTERNATIVE 1: 100% WHOLESALE DEMAND
LEGEND
Proposed Elevated Storage Tank
Proposed Ground Storage Tank
Proposed Pump Station
Water Treatment Plant
Elevated Storage Tank
Ground Storage Tank
Pump Station
Water Well
Metering Point
Delivery Point
Wholesale Meter
Pressure Reducing Valve
Proposed Improvement
Distribution Main
Transmission Main
Interstate Freeway
State Highway
County Highway
Local Road
Stream
Lake
Waco City Limit
Wholesale Customer
Other City Limit
Waco ETJ Boundary
FREESE AND NICHOLS
PRESSURE PLANES
Pressure Plane 1 (650')
Pressure Plane 2 (710')
Pressure Plane 3 (765')
Pressure Plane 4 (855')
Pressure Plane 5 (681')
Pressure Plane 6 (725')
Pressure Plane 7 (760')
Ross
Gholson
ELM MOTT
0.15 MG Ground Storage Tank and Pump Station
Overflow Elev. = 545'
TSTC CAMPUS
1.5 MG Elevated Storage Tank
Overflow Elev. = 605'
Lacy-Lakeview
City of Lacy-Lakeview
GHOLSON RD.
5 MG Ground Storage Tank and Pump Station
Overflow Elev. = 503.5'
City of Bellmead
Bellmead
FM 185
1.5 MG Elevated Storage Tank
Overflow Elev. = 882'
AIRPORT
0.5 MG Ground Storage Tank and Pump Station
Overflow Elev. = 523'
Proposed 5.0 MGD Pump Station Expansion
Proposed 1.0 MG Ground Storage Tank
PARK LAKE TOWER
1.0 MG Elevated Storage Tank
Overflow Elev. = 710'
Lake Waco
HILLCREST
5.0 MG Ground Storage Tank and Pump Station
Overflow Elev. = 805'
Downsize to 3.5 MG Ground Storage Tank
RIVERSIDE WTP
30 MGD Capacity
(1) 2.5 MG Ground Storage Tank
(1) 1.0 MG Ground Storage Tank
and Pump Stations
Proposed Low Head Pump Station
MT. CARMEL WTP
60 MGD Capacity
and (2) 4.0 MG Ground Storage Tanks
Proposed 17.5 MGD HSPS Expansion
WESTVIEW
6.0 MG Ground Storage Tank and Pump Station
Overflow Elev. = 606'
Downsize to 5.0 MG Ground Storage Tank
Proposed PRV
Beverly Hills
City of Woodway
OWENS LANE TOWER
1.5 MG Elevated Storage Tank
Overflow Elev. = 765'
BAGBY TOWER
1.0 MG Elevated Storage Tank
Overflow Elev. = 710'
SCHROEDER TOWER
2.0 MG Elevated Storage Tank
Overflow Elev. = 765'
Woodway
OLD McGREGOR RD.
5 MG Ground Storage Tank and Pump Station
Overflow Elev. = 697'
Proposed Low Head Pump Station
Proposed 3.0 MG Ground Storage Tank
BOB WALLACE TOWER
1.0 MG Elevated Storage Tank
Overflow Elev. = 725'
McGregor
City of Robinson
RITCHIE ROAD TOWER
2.0 MG Elevated Storage Tank
Overflow Elev. = 855'
Hewitt
City of Hewitt
Robinson
0.03 MG Ground Storage Tank
WELL #5
0.1 MG Ground Storage Tank #1
0.3 MG Ground Storage Tank #2
Lorena
N
0
3,000
6,000
SCALE IN FEET

CITY OF WACO

CAPITAL IMPROVEMENTS PLAN
ALTERNATIVE 3: 100% WHOLESALE DEMAND INCLUDING FHLM

LEGEND

- Proposed Elevated Storage Tank
- Proposed Ground Storage Tank
- Proposed Pump Station
- Water Treatment Plant
- Elevated Storage Tank
- Ground Storage Tank
- Pump Station
- Water Well
- Metering Point
- Delivery Point
- Wholesale Meter
- Pressure Reducing Valve
- Proposed Improvement
- Distribution Main
- Transmission Main
- Interstate Freeway
- State Highway
- County Highway
- Local Road
- Stream
- Lake
- Waco City Limit
- Wholesale Customer
- Other City Limit
- Waco ETJ Boundary

FREESE AND NICHOLS

PRESSURE PLANES

- Pressure Plane 1 (650')
- Pressure Plane 2 (710')
- Pressure Plane 3 (765')
- Pressure Plane 4 (855')
- Pressure Plane 5 (681')
- Pressure Plane 6 (725')
- Pressure Plane 7 (760')