Innovative approaches
Practical results
Outstanding service

2018 WATER MASTER PLAN UPDATE

Prepared for:

City of The Colony

April 24, 2019

Prepared by:

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

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FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

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FNI Project Number: COY18149

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

The City of The Colony (City) is a growing community located in the Dallas-Fort Worth Metroplex. The City provides water to a service area of approximately 10.5 square miles. The City's overall population is projected to grow by more than 25,000 people before reaching Buildout conditions. A growth of approximately 5,000 people, is expected in the Austin Ranch area which is within city limits but is not included in the City's water service area. Water service is provided to the Austin Ranch area by the City of Plano. The City of The Colony's water service area is defined in greater detail in **Section 2.1** of the main report, but generally encompasses the city limits excluding Austin Ranch, and represents the region in which the City maintains infrastructure and delivers water to customers. The City's water service area is expected to grow by approximately 20,000 people before reaching Buildout conditions. Accommodating this growth in an efficient and cost-effective manner, while maintaining a safe and reliable water supply for the citizens of The Colony, is the focus of this Water Master Plan Update. Additionally, the City's Wastewater Master Plan has been updated concurrently with this Water Master Plan which allowed syncing of key assumptions and methodology between the two plans. The major elements of the scope of this Water Master Plan Update project included:

- Population and water demand projections
- Focused field pressure testing and water model update
- Water supply evaluation for existing and future conditions
- Distribution system hydraulic capacity analysis
- Water system capital improvement plan and water master plan report

2.0 POPULATION AND LAND USE

Population and land use are important elements in the analysis of water distribution systems. Water demands depend 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, along with land use, provides the basis for projecting and allocating future water demands. This Water Master Plan Update was prepared in conjunction with the City's Wastewater Master Plan Update to maintain unity with assumptions and methodology where possible. The spatial distribution of the projected water demands in the system was determined from land use assumptions used concurrently

in the Wastewater Master Plan Update. The projected population and commercial acreage for each planning period is shown in **Table ES-1**.

Table ES-1: Projected Population and Commercial Acreage Summary

	WATER SERVICE AREA		AUSTIN RANCH(1)		OVERALL CITY	
Year	Population	Non-Residential Acreage	Population	Non-Residential Acreage	Population	Non-Residential Acreage
2018	39,019	1,314	3,273	0	42,292	1,314
2023	44,871	1,544	3,564	0	48,436	1,544
2028	48,926	1,779	4,551	0	53,477	1,779
Buildout	59,207	1,882	8,934	16	67,600	1,897

(1) Austin Ranch is within city limits, but water service is provided to the area by the City of Plano

3.0 WATER DEMAND PROJECTIONS

Water demands were projected for 2018, 2023, 2028, and Buildout conditions. Historical water production data was analyzed, and an overall average demand of 125 gpcd was determined. This overall gpcd was used in conjunction with the population projections to calculate average day demands. Peaking factors were then applied to the average day demand to determine the maximum day and peak hour projected demand conditions. The peak hour demands represent the peak hour demand during the maximum day demand condition. **Table ES-2** presents the projected water demand for each planning year for the water service area.

Table ES-2: Projected Water Demands(1)

Year	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Peak Hour Demand (MGD)
2018	4.88	9.75	17.56
2023	5.61	11.22	20.19
2028	6.12	12.23	22.02
Buildout	7.40	14.80	26.64

(1) Projected Water Demands do not include the Austin Ranch Pressure Plane, which is served by the City of Plano.

4.0 EXISTING WATER SYSTEM

The City of The Colony's water distribution system currently consists of a network of water lines, four elevated storage tanks, seven ground storage tanks, five booster pumping stations, five groundwater

wells, and one automated control valve for filling the Tribute Ground Storage Tank. The service area is divided into The Colony and Tribute pressure planes. The Austin Ranch pressure plane is within The Colony's city limits, but its demands are served by the City of Plano. The City primarily relies on wholesale water suppliers to provide water to its residents supplemented by groundwater supply. Currently, the City purchases treated surface water from Dallas Water Utilities (DWU) and the City of Plano.

5.0 MODEL UPDATE AND CALIBRATION

A hydraulic model was updated as a tool in the evaluation of the City of The Colony's water distribution system. The City selected the InfoWater software by *Innovyze®* for modeling the water system. The model network was developed from the City's geographic information system (GIS) and design plans. SCADA data was supplemented by temporary field pressure testing for the calibration of the model. The calibration process involved adjusting system operation, pipeline roughness coefficient (Hazen-Williams C-values), demand allocation, and peaking factors to match a known condition. The 24-hour period occurring on March 11, 2018 from 12:00 am to 12:00 am on March 12, 2018 was selected for calibration. A close correlation between modeled and observed values was achieved, creating a high degree of confidence in the accuracy of the model.

6.0 WATER SYSTEM ANALYSIS AND HYDRAULIC MODELING

Hydraulic model analyses were conducted to identify deficiencies in the City of The Colony's existing water distribution system and to analyze the capacities of the system under projected future demand conditions. Parameters used in evaluating the system through buildout conditions included meeting projected demands, increasing system reliability, meeting required fire flows, and maintaining proper residual pressures. FNI identified an existing need to improve system reliability to the Tribute/Wynnwood Peninsula area and a projected need to add additional elevated storage capacity to meet future needs in the Grandscape area.

7.0 WATER SYSTEM CAPITAL IMPROVEMENTS PLAN

The modeling and water system analysis results identified an existing need to improve system reliability and a projected elevated storage deficiency which may affect the water distribution system's ability to provide water to satisfy demands through buildout conditions. Therefore, the following capital improvement projects are recommended:

1. Tribute Well- Drilling a new well at the Tribute EST/Wynnwood PS site to add a redundant water supply source for the Tribute/Wynnwood Peninsula.

2. Redundant Tribute PS Pipeline- Construct a new 12-inch waterline parallel to the existing 20-inch waterline from the Tribute PS to the intersection of Boyd Road and Lebanon Road.

3. Grandscape EST- Construct a new 1.0 MG EST in the Grandscape area.

1.0 INTRODUCTION

The City of The Colony (City) is a growing community located in the Dallas-Fort Worth Metroplex. The City provides water to a service area of approximately 10.5 square miles. The City's overall population is projected to grow more than 25,000 people before buildout conditions are reached. A growth of approximately 5,000 people, is expected in the Austin Ranch area which is within city limits but is not included in the City's water service area. Water service is provided to the Austin Ranch area by the City of Plano. The City of The Colony's water service area is defined in greater detail in **Section 2.1**, but generally encompasses the city limits excluding Austin Ranch, and represents the region in which the City maintains infrastructure and delivers water to customers. The City's water service area is expected to grow by approximately 20,000 people before reaching Buildout conditions. Accommodating this growth in an efficient and cost-effective manner, while maintaining a safe and reliable water supply for the citizens of The Colony, is the focus of this *Water Master Plan Update*. This report has been prepared to provide the City of The Colony with a planning tool to serve as a guide for 5-year, 10-year, and Buildout improvements to the water infrastructure.

1.1 SCOPE OF WORK

Freese and Nichols, Inc. (FNI) was retained in 2018 by the City of The Colony to prepare a *Water Master Plan Update*. The goals of the *Water Master Plan Update* were to evaluate the performance of the existing water system and recommend a phased Capital Improvements Plan (CIP) through Buildout. The recommended improvements will serve as a basis for the design, construction, and financing of facilities required to meet The Colony's water capacity and system renewal needs. Additionally, the City's Wastewater Master Plan has been updated concurrently with this Water Master Plan which allowed syncing of key assumptions and methodology, such as land use and population projections, between the two plans. The major elements of the scope of this Water Master Plan Update project included:

- Population and water demand projections
- Focused field pressure testing and water model update
- Water supply evaluation for existing and future conditions
- Distribution system hydraulic capacity analysis
- Water system capital improvement plan and water master plan report

1.2 LIST OF ABBREVIATIONS

Table 1-1 provides a list of abbreviations used in this report.

Table 1-1: Abbreviations

Abbreviation	Full Nomenclature
AD	Average Day Demand
CCN	Certificate of Convenience and Necessity
CIP	Capital Improvements Plan
DWU	Dallas Water Utilities
EPS	Extended period analysis
EST	Elevated Storage Tank
ETJ	Extraterritorial Jurisdiction
ft/s	feet per second
FNI	Freese and Nichols, Inc.
GIS	Geographic Information System
gpad	gallons per acre per day
gpcd	gallons per capita per day
gpm	gallons per minute
GST	Ground Storage Tank
HGL	Hydraulic Grade Line
MD	Maximum Day Demand
MG	Million Gallons
MGD	Million Gallons per Day
MSL	Mean Sea Level
NCTCOG	North Central Texas Council of Governments
O&M	Operation and Maintenance
PH	Peak Hour Demand
PP	Pressure Plane
PRV	Pressure Reducing Valve
PS	Pump Station
psi	pounds per square inch
SCADA	Supervisory Control and Data Acquisition
TCEQ	Texas Commission on Environmental Quality
TSZ	Traffic Survey Zones
TWDB	Texas Water Development Board

2.0 POPULATION AND LAND USE

Population and land use are important elements in the analysis of water distribution systems. Water demands depend 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, along with land use, provides the basis for projecting future water demands.

2.1 SERVICE AREA

The service area for the Colony's water system includes an area of approximately 10.5 square miles generally bounded by Lake Lewisville and the City of Lewisville to the west, the City of Frisco and the City of Plano to the east, and the City of Carrollton to the south. The city is sub-divided into three different pressure planes: Tribute PP, The Colony PP, and Austin Ranch PP. The Tribute PP encompasses the Wynnwood Peninsula in the northern area of the city. The Colony PP is centrally located and encompasses the majority of the city. Together, the Tribute PP and The Colony PP make up the water service area for the City of the Colony. The Austin Ranch PP is located in the southern extents of the city limits along Windhaven Parkway and east of the railroad tracks. Water service is provided to the Austin Ranch PP by the City of Plano. **Figure 2-1** illustrates the City's water service area and depicts the City's three pressure planes.

2.2 HISTORICAL POPULATION

Population data for the City of The Colony was obtained from the North Central Texas Council of Governments (NCTCOG) from 2011 through 2017. An average growth rate of 2.15% was observed over the last 7 years. **Table 2-1** shows the historical overall city populations for the City of The Colony, including the Austin Ranch area.

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FIGURE 2-1
CITY OF THE COLONY
WATER SERVICE AREA

LEGEND

- Water Service Area
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- The Colony City Limit
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES

- The Colony
- Tribute
- Austin Ranch (Service from Plano)

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,400
SCALE IN FEET

Table 2-1: Historical Overall City Population

Year	Population(1)	Population Growth	Growth Rates
2011	36,230		-
2012	36,590	360	0.99%
2013	37,510	920	2.51%
2014	38,730	1,220	3.25%
2015	39,310	580	1.50%
2016	39,810	500	1.27%
2017	41,160	1,350	3.39%
Average	-	-	**2.15%**
Maximum	-	-	**3.39%**

(1) Based on NCTCOG estimates. NCTCOG population values represent the entire city population, including the Austin Ranch area.

2.3 PROJECTED POPULATION

Population projections were developed concurrently with the City's Wastewater Master Plan Update to maintain uniformity between the two plans. The population projections are based on the *TWDB 2016 Region C Water Plan* which provides a 50-year outlook on population projections, water demand, water supply, and water management strategies. The *2016 Region C Water Plan* projects that the City will reach an overall buildout population of 67,600 people by 2050.

For the Master Plan Updates, it was assumed that the City would reach Buildout conditions by 2040. For the initial 5-year planning period, FNI assumed a population growth rate of 2.75%, approximately midway between the historical average (2.15%) and the historical maximum (3.39%). Detailed population spatial allocation was broken down by wastewater sub-basin and determined based on residential development information provided by the City. Much of the growth during the five-year planning period is expected in the Tribute area, along the Highway 121 corridor, and in the Indian Creek area. Population growth is expected to decrease to 2.00% annually, slightly lower than the historical average, between 2023 and Buildout. During the ten-year planning horizon, growth is expected south of Highway 121 in the "Grandscape" area and southern Indian Creek region.

Table 2-2 presents the overall population projections for the City of The Colony. Note that these overall projections include the Austin Ranch[1] PP which is within the city limits but outside the City's water service

[1] The City of Plano provides water service to the Austin Ranch PP. The Austin Ranch area is outside the City's water service area.

area**. Table 2-3** presents a breakdown of the population projections by planning period for each of the pressure planes. **Figure 2-2** shows population distribution by wastewater sub-basin for each planning year.

Table 2-2: Overall City of the Colony Population Projections

Year	Population	Growth Rate
2018	42,292	2.75%
2019	43,455	2.75%
2020	44,650	2.75%
2021	45,878	2.75%
2022	47,139	2.75%
2023	48,436	2.75%
2024	49,405	2.00%
2025	50,393	2.00%
2026	51,400	2.00%
2027	52,428	2.00%
2028	53,477	2.00%
2029	54,547	2.00%
2030	55,637	2.00%
2031	56,750	2.00%
2032	57,885	2.00%
2033	59,043	2.00%
2034	60,224	2.00%
2035	61,428	2.00%
2036	62,657	2.00%
2037	63,910	2.00%
2038	65,188	2.00%
2039	66,492	2.00%
Buildout	67,600	-

Table 2-3: Population Projection Breakdown by Planning Period

Year	POPULATION				
	The Colony PP	Tribute PP	Total Water Service Population (Colony PP + Tribute PP)	Austin Ranch PP	Total Overall City Population (Colony PP+ Tribute PP+ AR PP)
2018	35,000	4,019	**39,019**	3,273	**42,292**
2023	39,261	5,610	**44,871**	3,564	**48,436**
2028	43,316	5,610	**48,926**	4,551	**53,477**
Buildout	52,063	7,144	**59,207**	8,394	**67,600**

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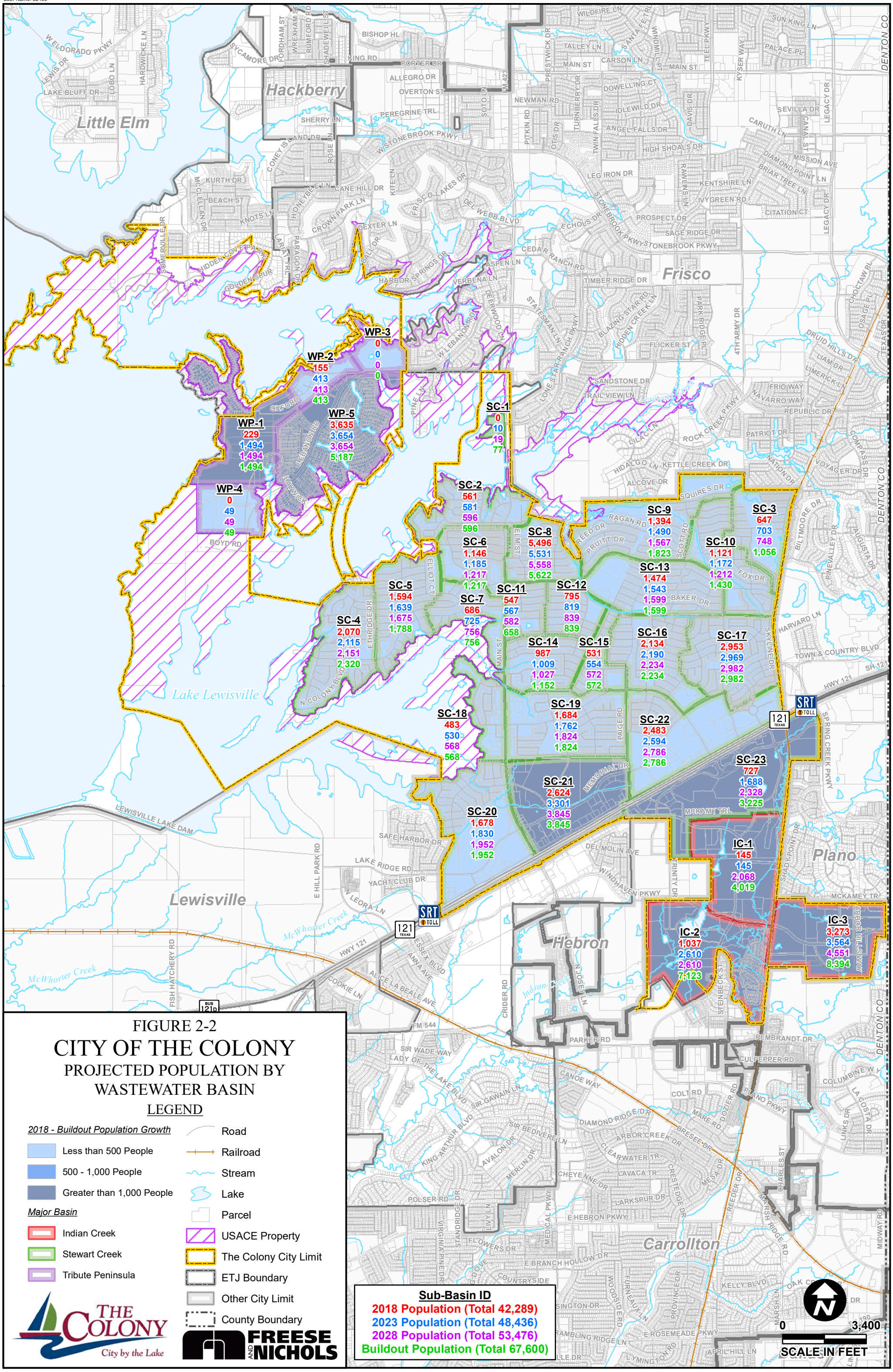

FIGURE 2-2

CITY OF THE COLONY

PROJECTED POPULATION BY WASTEWATER BASIN

LEGEND

2018 - Buildout Population Growth

- Less than 500 People
- 500 - 1,000 People
- Greater than 1,000 People

Major Basin

- Indian Creek
- Stewart Creek
- Tribute Peninsula

- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- The Colony City Limit
- ETJ Boundary
- Other City Limit
- County Boundary

THE COLONY
City by the Lake

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Sub-Basin ID
2018 Population (Total 42,289)
2023 Population (Total 48,436)
2028 Population (Total 53,476)
Buildout Population (Total 67,600)

0 3,400
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2.4 LAND USE

While water demand projections were determined using an overall gpcd based on historical usage, the spatial distribution of the projected water demands in the system was determined from land use assumptions used concurrently in the Wastewater Master Plan Update. The City provided plans for recently constructed developments, and input about future developments expected in the upcoming five and ten-year planning periods. These expected developments are shown on **Figure 2-3**. To capture growth related to commercial, retail, office, institutional, and industrial development, a non-residential acreage for each planning period was developed. The future development data was used to calculate the intermediate and Buildout non-residential acreages, by wastewater sub-basin. **Table 2-4** summarizes the non-residential acreage by planning year for the water service area. **Figure 2-4** presents the commercial acreages by wastewater sub-basin for each planning period. In the wastewater model, these land use assumptions were used to determine and allocate wastewater flows in the model. To maintain uniformity between the City's Water Master Plan Update and Wastewater Master Plan Update, future water demands were allocated in the water model proportionally to the distribution of future wastewater flows in the wastewater model. Demands were allocated to the wastewater sewer basins in conjunction with the Wastewater Master Plan based on undeveloped areas within the overall water service area. Specific parcels identified for future development were point loaded accordingly.

Table 2-4: Non-residential Acreage

Year	Tribute PP (Acres)	The Colony PP (Acres)	Total Water Service Area[(1)] (Acres)	Growth (Acres)
2018	20	1,294	1,314	-
2023	98	1,446	1,544	230
2028	98	1,681	1,779	235
Buildout	109	1,773	1,882	103

[(1)] Total Water Service Area does not include the Austin Ranch area.

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FIGURE 2-3
CITY OF THE COLONY
PROJECTED DEVELOPMENT

LEGEND

Projected Development
- 5-Year Residential
- 5-Year Commercial
- 10-Year Residential
- 10-Year Commercial
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

THE COLONY
City by the Lake

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0 3,400
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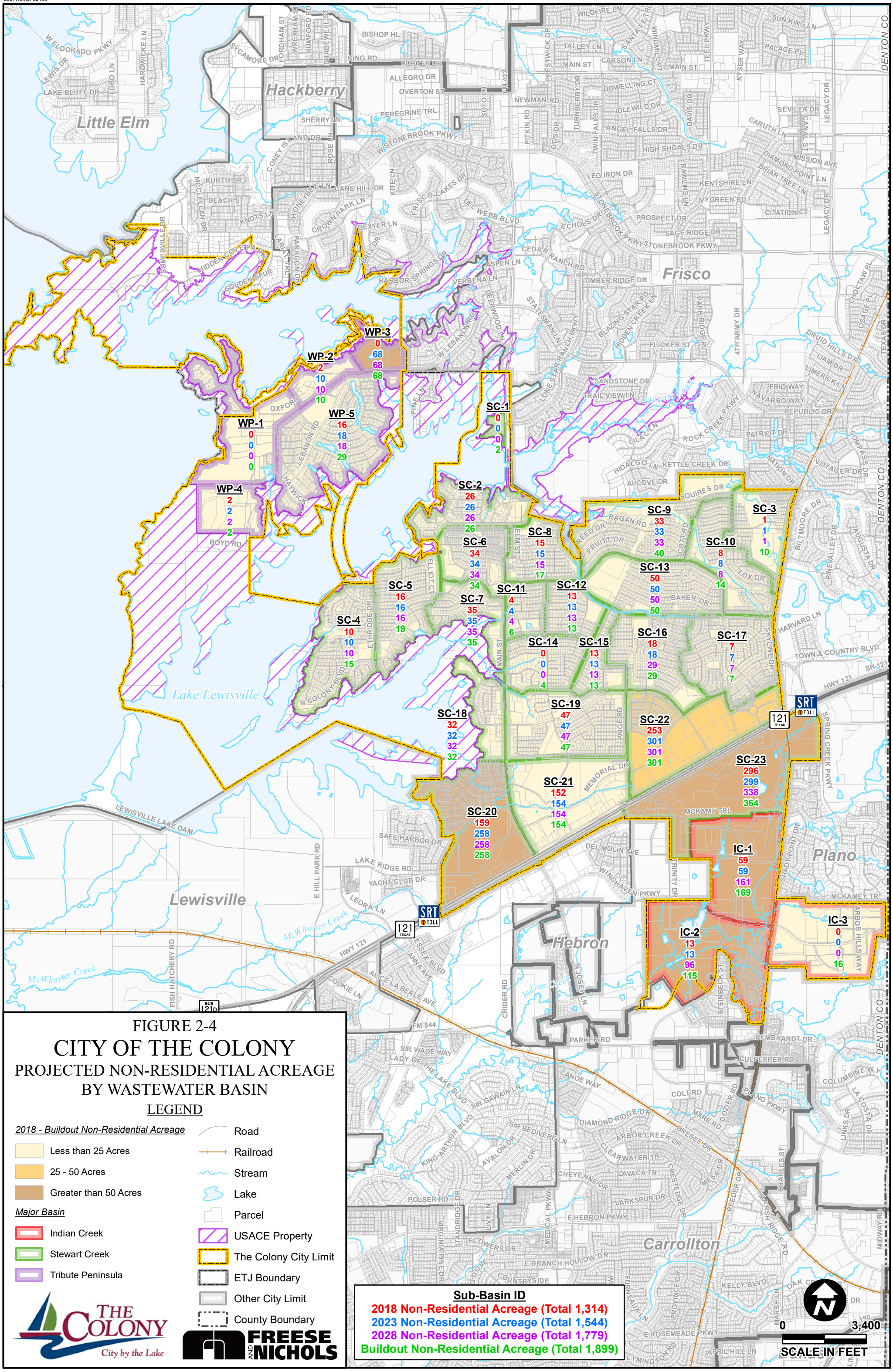


FIGURE 2-4

CITY OF THE COLONY

PROJECTED NON-RESIDENTIAL ACREAGE BY WASTEWATER BASIN

LEGEND

2018 - Buildout Non-Residential Acreage

- Less than 25 Acres
- 25 - 50 Acres
- Greater than 50 Acres

Major Basin

- Indian Creek
- Stewart Creek
- Tribute Peninsula

- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- The Colony City Limit
- ETJ Boundary
- Other City Limit
- County Boundary

THE COLONY
City by the Lake

FREESE AND NICHOLS

Sub-Basin ID
2018 Non-Residential Acreage (Total 1,314)
2023 Non-Residential Acreage (Total 1,544)
2028 Non-Residential Acreage (Total 1,779)
Buildout Non-Residential Acreage (Total 1,899)

N

0 3,400
SCALE IN FEET

3.0 WATER DEMAND PROJECTIONS

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

3.1 HISTORICAL WATER DEMANDS

Reviewing historical water demands provides insight into selecting design criteria used to project future water demands. Historical water production data was analyzed from 2010 through 2017. The City provided daily water production data that was used in conjunction with NCTCOG population data to calculate annual average day demand, maximum day to average day peaking factors, and per capita consumption. **Table 3-1** provides a breakdown of the historical water supply usage by source, and **Figure 3-1** provides a graphical representation of water usage by source. The City of The Colony's historical water usage is summarized in **Table 3-2**.

Table 3-1: Historical Usage by Source

Year	Average Groundwater Usage (MGD)	Average DWU Usage (MGD)	Average Plano Usage (MGD)	Total Average Usage (MGD)	% Groundwater Usage	% DWU Usage	% Plano Usage
2013	0.72	3.53	0.38	4.63	15%	76%	8%
2014	0.62	3.59	0.39	4.60	13%	78%	8%
2015	0.87	3.55	0.41	4.84	18%	73%	9%
2016	0.95	3.58	0.39	4.93	19%	73%	8%
2017	1.12	3.72	0.37	5.21	21%	71%	7%
AVERAGE	**0.86**	**3.59**	**0.39**	**4.84**	**18%**	**74%**	**8%**

Figure 3-1: 2013-2017 Average Water Usage by Source

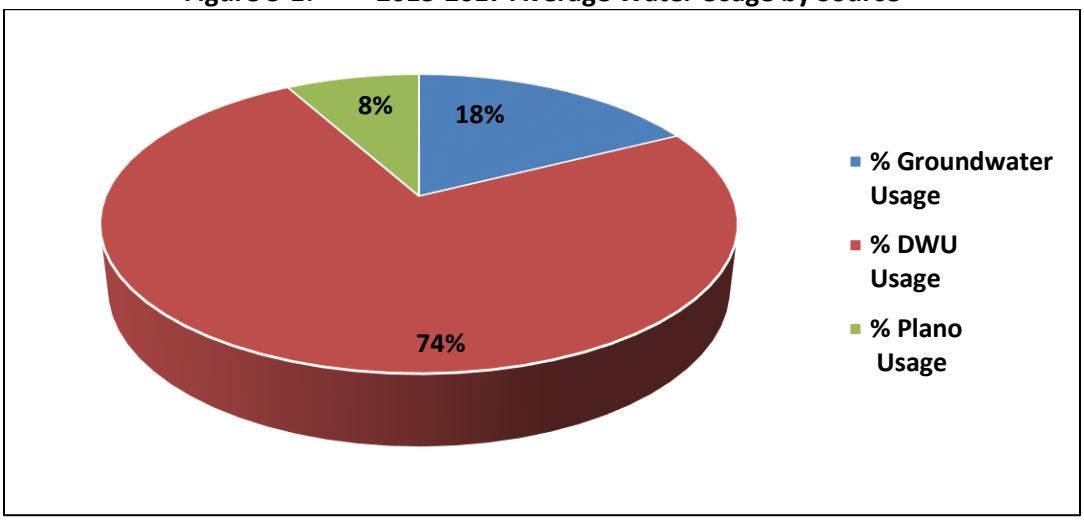


Table 3-2: Historical Water Usage

Year	Population [1]	The Colony PP Average Day Demand (MGD)	Austin Ranch PP Average Day Demand (MGD)	Tribute PP Average Day Demand (MGD)	Total Average Day Demand (MGD)	Average Day Demand (gpcd)	The Colony PP Maximum Day Demand (MGD)	Austin Ranch PP Maximum Day Demand (MGD)	Tribute PP Maximum Day Demand (MGD)	Total Maximum Day Demand (MGD)	Maximum Day to Average Day Peaking Factor
2011	36,230	4.44	0.37	0.13	4.94	136	9.50	0.43	0.26	10.18	2.06
2012	36,590	4.16	0.37	0.14	4.67	128	8.18	0.37	0.43	8.99	1.93
2013	37,510	4.00	0.38	0.17	4.55	121	8.02	0.42	0.37	8.81	1.94
2014	38,730	3.90	0.39	0.27	4.56	118	6.83	0.39	0.51	7.73	1.69
2015	39,310	4.10	0.41	0.28	4.80	122	8.02	0.56	1.29	9.87	2.06
2016	39,810	4.11	0.39	0.37	4.88	123	7.20	0.54	1.05	8.80	1.80
2017	41,160	4.28	0.37	0.45	5.11	124	6.26	0.95	1.02	8.23	1.61
Average		**4.14**	**0.38**	**0.26**	**4.79**	**125**	**7.72**	**0.52**	**0.70**	**8.94**	**1.87**
Maximum		**4.44**	**0.41**	**0.45**	**5.11**	**136**	**9.50**	**0.95**	**1.29**	**10.18**	**2.06**

(1) Historical population data from NCTCOG

3.2 WATER DEMAND PROJECTIONS

Water demands were projected for 2018, 2023, 2028, and Buildout conditions. The evaluation of historical data provided a basis for determining the design criteria used to project water demands for The Colony and Tribute service areas.

Historical water usage data indicated the maximum day to average day peaking factor ranged from 1.61 to 2.06 over the last seven years, with an average value of 1.87. A peaking factor of 2.0 was selected for future year demands in the City. The City's overall historical average day demand ranged from 118 gpcd to 136 gpcd, with an average value of 125 gpcd. The average demand of 125 gpcd was selected for future year projections. A peak hour to maximum day peaking factor of 1.8 was selected for the system. The design criteria and water demand projections for each pressure plane and the total system are shown in **Table 3-3**, **Table 3-4**, **Table 3-5**, and **Table 3-6**. The base year represents existing conditions using the selected design criteria. The base year demand does not necessarily reflect what actually occurred in 2018 but rather what could have occurred based on historical trends. **Figure 3-2** illustrates the historical and projected water demand for the City of The Colony.

Table 3-3: Water Demand Projections for Tribute Pressure Plane

Year	Population	Average Day Per-Capita (gpcd)	Average Day Demand (MGD)	MD:AD Peaking Factor	Maximum Day Demand (MGD)	PH:MD Peaking Factor	Peak Hour Demand (MGD)
2018	4,019	125	0.50	2.0	1.00	1.8	1.81
2023	5,610	125	0.70	2.0	1.40	1.8	2.52
2028	5,610	125	0.70	2.0	1.40	1.8	2.52
Buildout	7,144	125	0.89	2.0	1.79	1.8	3.21

Table 3-4: Water Demand Projections for The Colony Pressure Plane

Year	Population	Average Day Per-Capita (gpcd)	Average Day Demand (MGD)	MD:AD Peaking Factor	Maximum Day Demand (MGD)	PH:MD Peaking Factor	Peak Hour Demand (MGD)
2018	35,000	125	4.38	2.0	8.75	1.8	15.75
2023	39,261	125	4.91	2.0	9.82	1.8	17.67
2028	43,316	125	5.41	2.0	10.83	1.8	19.49
Buildout	52,063	125	6.51	2.0	13.02	1.8	23.43

Table 3-5: Total Water Service Area(1) Water Demand Projections

Year	Population	Average Day Per-Capita (gpcd)	Average Day Demand (MGD)	MD:AD Peaking Factor	Maximum Day Demand (MGD)	PH:MD Peaking Factor	Peak Hour Demand (MGD)
2018	39,019	125	4.88	2.0	9.75	1.8	17.56
2023	44,871	125	5.61	2.0	11.22	1.8	20.19
2028	48,926	125	6.12	2.0	12.23	1.8	22.02
Buildout	59,207	125	7.40	2.0	14.80	1.8	26.64

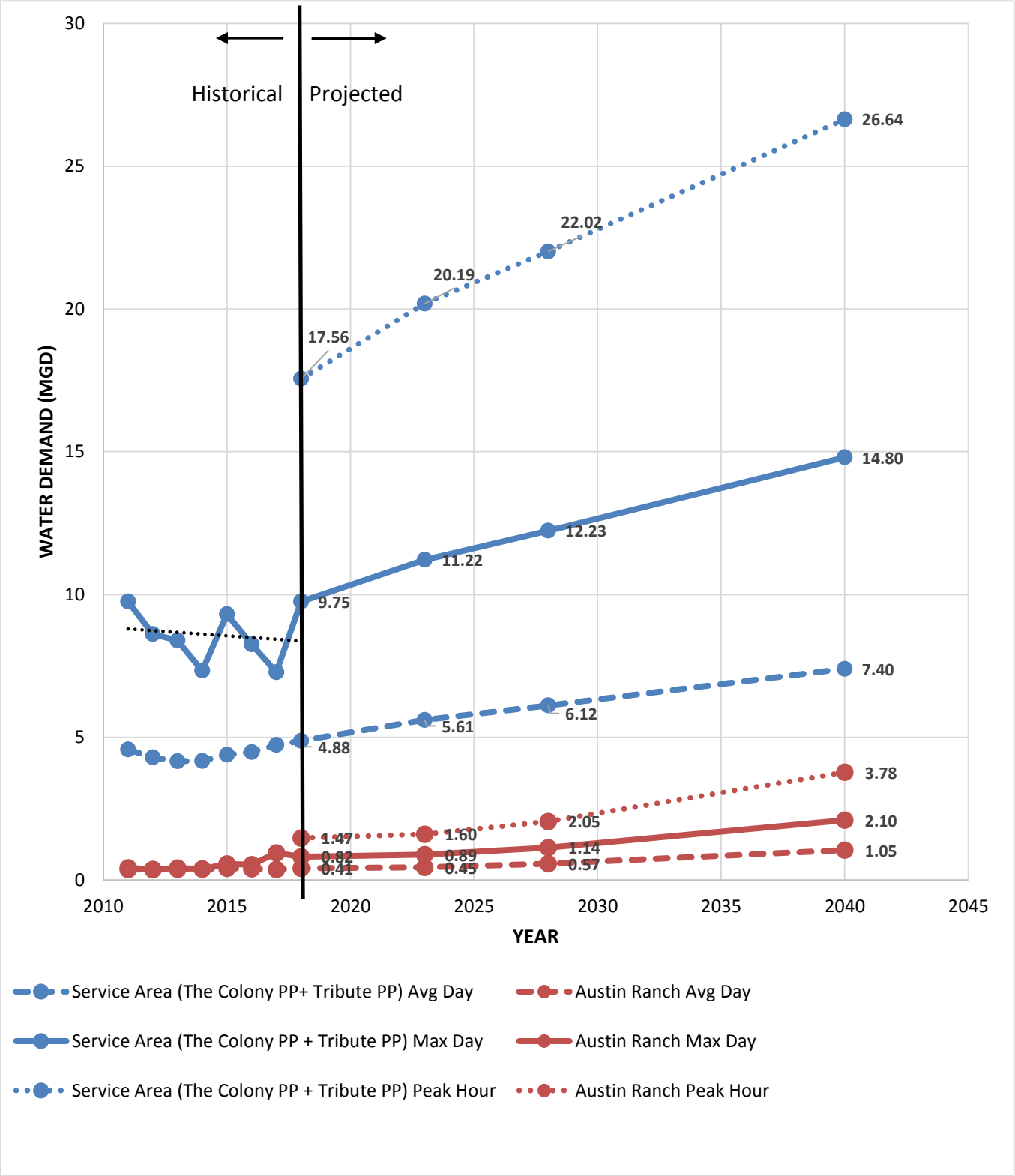
(1) Total Water Service Area does not include the Austin Ranch Pressure Plane which is served by The City of Plano.

Table 3-6: Water Demand Projections for Austin Ranch(1) Pressure Plane

Year	Population	Average Day Per-Capita (gpcd)	Average Day Demand (MGD)	MD:AD Peaking Factor	Maximum Day Demand (MGD)	PH:MD Peaking Factor	Peak Hour Demand (MGD)
2018	3,273	125	0.41	2.0	0.82	1.8	1.47
2023	3,564	125	0.45	2.0	0.89	1.8	1.60
2028	4,551	125	0.57	2.0	1.14	1.8	2.05
Buildout	8,394	125	1.05	2.0	2.10	1.8	3.78

(1) The Austin Ranch Pressure Plane is within the city limits but is outside the water service area. The City of Plano provides water service to the Austin Ranch Pressure Plane.

Figure 3-2: Historical and Projected Water Demands



4.0 EXISTING WATER SYSTEM

The City of The Colony's water distribution system currently consists of a network of water lines, five pump stations, four elevated storage tanks, seven ground storage tanks, five groundwater well sites, and one automated control valve for filling the Tribute Ground Storage Tank. **Figure 4-1** shows the existing water distribution system for the City of The Colony. Additionally, a full-size map of **Figure 4-1** is provided in **Appendix E**.

4.1 WATER SUPPLY

The City of The Colony primarily relies on wholesale water suppliers to provide water to its residents. Currently, the City purchases treated surface water from Dallas Water Utilities (DWU), and The City of Plano. The existing maximum rate from DWU is 10.0 MGD (7,013 gpm) at the Office Creek Pump Station. The City of Plano maximum supply rate is 4.0 MGD (2,778 gpm) to supply the Austin Ranch pressure plane. Existing groundwater well capacity is approximately 9.3 MGD (6,465 gpm). **Table 4-1** summarizes the available water supply from each source. Groundwater wells are maintained to supplement supply and buffer summer peak demands; groundwater wells are discussed in more detail in **Section 4.7**.

Table 4-1: Water Supply Summary

Source	Water Supply	
	(MGD)	(gpm)
City GW Wells	9.3	6,465
DWU	10.0	7,013
City of Plano	4.0	2,778
Total	**23.0**	**16,256**

4.2 PRESSURE PLANES

The distribution system is separated into two pressure planes (PPs): the Tribute PP and The Colony PP. The Tribute PP encompasses the Wynnwood Peninsula in the northwestern portion of the service area. The Colony PP generally encompasses the remainder of the City limits, excluding the Austin Ranch area. The Austin Ranch area is currently served by the City of Plano and is separate from the Colony's water system.

The Colony PP has a static hydraulic gradient of 735 feet, and ground elevations range from approximately 524 feet to 624 feet. The primary water supply to The Colony PP is through a 36" transmission main which

delivers water from DWU to the City's Office Creek GST. From there, water is re-pumped out into the distribution system. Additionally, five groundwater wells are used to supplement water supply within The Colony PP. Each groundwater well pumps into an onsite GST(s), and from there the water is re-pumped into the distribution system.

The Tribute PP is fed by a 24-inch transmission line which transfers water from the Colony PP along Highway 423 (Main Street) to the Tribute GST. The Tribute Pump Station fills the Tribute EST which has an overflow elevation of 698 feet, which sets the static hydraulic gradient. Ground elevations of the service connections in the Tribute PP range from approximately 527 feet to 556 feet.

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\(Figure_4-1)_Existing_Water_System_11x17.mxd
Updated: Tuesday, April 23, 2019 9:31:23 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

Little Elm
Hackberry
Frisco
Plano
Carrollton
Hebron
Lewisville
Lake Lewisville

FIGURE 4-1
CITY OF THE COLONY
EXISTING WATER SYSTEM

LEGEND

- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES

- The Colony
- Tribute
- Austin Ranch (Service from Plano)

THE COLONY
City by the Lake

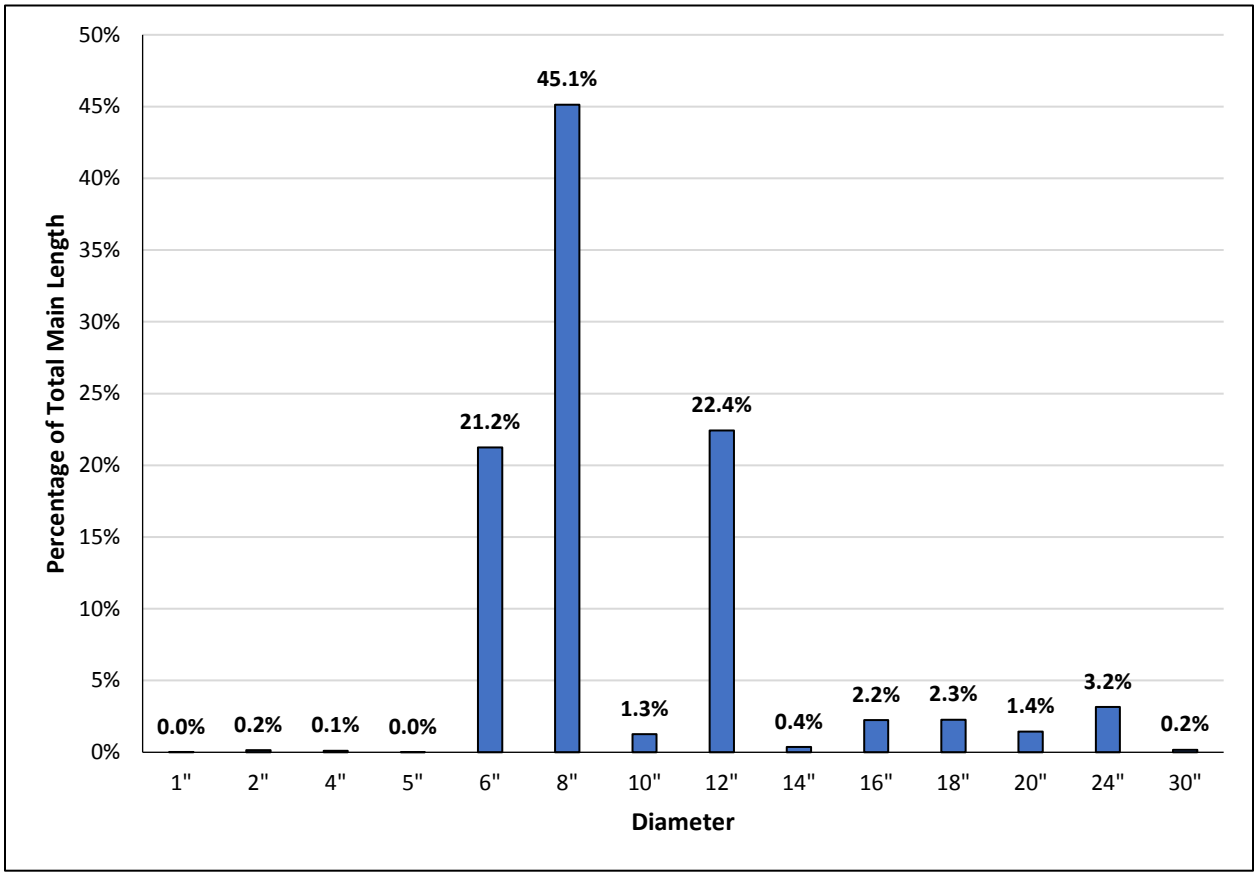
FREESE AND NICHOLS

0 3,000
SCALE IN FEET

4.3 WATER LINES

The City of The Colony's water model system consists of 178 miles of water lines, ranging in size from 1-inch to 30-inches. **Figure 4-2** illustrates the percentage of modeled water line length by diameter based on information from the City's Geographic Information System (GIS).

Figure 4-2: Water Line Length by Diameter



4.4 PUMP STATIONS

The Office Creek Pump Station is supplied from DWU through a 36-inch supply line from the southwest. The Office Creek Pump Station distributes water to the Colony Pressure Plane and has a total capacity of 24.5 MGD and a firm capacity of 15.8 MGD. The Clover Valley pump station has a total capacity of 3.3 MGD with a firm capacity of 1.4 MGD. The Main and Whitt site has two independent pump stations— one which pumps from the 0.4 MG GST and the other which pumps from the 0.6 MG GST. The pump station which draws from the 0.4 MG GST has a total capacity of 1.7 MGD with a firm capacity of 0.7 MGD. The pump station which draws from the 0.6 MG GST has a total capacity of 4.0 MGD and a firm capacity of 2.0

MGD. North Colony Pump Station #3 has a total capacity of 6.0 MGD with a firm capacity of 3.0 MGD. The Wynnwood Pump Station supplies the Tribute Pressure Plane and has a total capacity of 5.8 MGD and a firm capacity of 4.3 MGD. Firm pumping capacity represents the pump station capacity with the largest pump out of service. **Table 4-1** provides a summary of the City's pumping facilities in gallons per minute (gpm) and million gallons per day (MGD).

Table 4-2: Summary of Pump Stations

Pump Station	Pump Number	Rated Capacity (gpm)	Rated Capacity (MGD)
Clover Valley PS #1	1	500	0.72
	2	500	0.72
	3	1,300	1.87
	Total Capacity	**2,300**	**3.31**
	Firm Capacity	**1,000**	**1.44**
Main and Whitt PS #2 (0.4 MG GST Train)	1	700	1.01
	2	500	0.72
	Total Capacity	**1,200**	**1.73**
	Firm Capacity	**500**	**0.72**
Main and Whitt PS #2 (0.6 MG GST Train)	1	1,400	2.02
	2	1,400	2.02
	Total Capacity	**2,800**	**4.03**
	Firm Capacity	**1,400**	**2.02**
North Colony PS #3	1	2,100	3.02
	2	2,100	3.02
	Total Capacity	**4,200**	**6.05**
	Firm Capacity	**2,100**	**3.02**
Office Creek PS #4	1	2,000	2.88
	2	4,500	6.48
	3	4,500	6.48
	4	6,000	8.64
	Total Capacity	**17,000**	**24.48**
	Firm Capacity	**11,000**	**15.84**
Tribute PS	1	1,000	1.44
	2	1,000	1.44
	3	1,000	1.44
	4	1,000	1.44
	Total Capacity	**4,000**	**5.76**
	Firm Capacity	**3,000**	**4.32**

4.5 STORAGE FACILITIES

The City currently utilizes seven ground storage tanks (GSTs) within the distribution system. Two 3.0 million gallon (MG) GSTs are located at the Office Creek Pump Station facility. The tanks are filled from the DWU supply line and/or Trinity Well #4, and they provide suction to the Office Creek Pump Station. One 0.4 MG GST is situated at the Clover Valley Pump Station facility. The tank is filled by two groundwater wells, Trinity Well #1 and Paluxy Well #2, and provides suction to the Clover Valley Pump Station. The Main and Whitt Pump Station facility has two GSTs: one 0.4 MG tank and one 0.6 MG tank. Both tanks are filled with groundwater from Trinity Well #2 and provide suction to the on-site pump stations. A 1.0 MG GST is filled by Trinity Well #3 and provides suction to Pump Station #3. The Tribute Pump Station facility has one 1.0 MG GST which is filled from The Colony Pressure Plane through a 24" transmission main and provides suction to the Tribute Pump Station.

Additionally, four ESTs are located throughout the distribution system. The Clover EST, Chesapeake EST, and North Colony EST all serve The Colony Pressure Plane. The Tribute EST serves the Tribute Pressure Plane. **Table 4-2** presents a summary of the City's existing ground storage tanks and **Table 4-3** shows the elevated storage facilities.

Table 4-3: Existing System Ground Storage Tank Facilities

Pressure Plane Supplied	Tank Name	Capacity (MG)	
Colony	Clover GST	0.4	
	Main and Whitt GST	0.4	0.6
	North Colony GST	1.0	
	Office Creek GST	3.0	3.0
	SubTotal	**8.4**	
Tribute	Tribute GST	1.0	
	SubTotal	**1.0**	
Total Ground Storage		**9.4**	

Table 4-4: Existing System Elevated Storage Tank Facilities

Pressure Plane Supplied	Tank Name	Capacity (MG)	Overflow Elevation (feet)
Colony	Clover EST #1	0.5	735
	North Colony EST #2	0.5	735
	Chesapeake EST #3	1.0	735
	SubTotal	**2.0**	
Tribute	Tribute EST	1.0	698
	SubTotal	**1.0**	
Total Elevated Storage		**3.0**	-

4.6 CONTROL VALVES

The City operates one automated control valve for filling the Tribute Ground Storage Tank . The valve opens to allow water from the Colony PP to fill the Wynnwood/Tribute GST.

4.7 GROUNDWATER WELLS

The City of The Colony currently operates five groundwater wells. The groundwater is used to supplement the purchased surface water. On average over the past five years, approximately 20% of the City's water supply to the Colony and Tribute PP's has come from groundwater. The remaining 80% has been supplied by DWU. Each of the groundwater facilities consist of a groundwater well, a ground storage tank(s), and a pump station. At these facilities, the groundwater well fills the GST (the Office Creek GST is also filled

by the DWU wholesale supply line) that provides suction for the pump station to pump groundwater into the distribution system. **Table 4-4** provides a summary of the groundwater well facilities.

Table 4-5: Existing System Groundwater Well Facilities

Well	Pump Station	Address	Pressure Plane	Ground Storage Capacity (Gallons)	Well Capacity (gpm)
Trinity Well #1	Clover Valley PS #1	5033 Clover Valley	The Colony	400,000	175
Paluxy Well #2	Clover Valley PS #1	5033 Clover Valley	The Colony		610
Trinity Well #2	Main and Whitt PS #2	6908 Main St.	The Colony	1,000,000	1,500
Trinity Well #3	North Colony PS #3	5755 North Colony Blvd.	The Colony	1,000,000	2,000
Trinity Well #4	Office Creek PS #4	4180 Main St.	The Colony	6,000,000	2,180
				TOTAL =	**6,465**

5.0 MODEL UPDATE AND CALIBRATION

The hydraulic model is one of the most critical elements in the analysis of water distribution systems. Field pressure testing was performed to assist with the calibration of the water system model. The calibrated water system model was then used to conduct hydraulic analyses to identify deficiencies in the City of The Colony's existing water distribution system before analyzing projected future conditions.

5.1 FIELD TESTING

To assist with model calibration and supplement available operational data, field pressure testing was conducted March 5, 2018 – March 27, 2018. Ten pressure recorders were installed throughout the distribution system based on geographic coverage and areas of high and low elevations. Locations of the pressure recorders are illustrated on **Figure 5-1**. Minimum, maximum, and average pressures were recorded every five minutes at each location. Pressure generally ranged from about 40 psi to 80 psi. Pressure Recorder #1 malfunctioned during the recording period, and the data could not be recovered. **Appendix A** includes the pressure recorder data for Pressure Recorders #2-10 from the field testing period.

5.2 MODEL UPDATE AND CALIBRATION

5.2.1 Physical Network

The previous water model was converted from H20Map Water by Innovyze® to InfoWater by Innovyze® and includes all pipes in the distribution system. FNI digitized recent project as-builts and final design plans into GIS to update the City's GIS records. New pipes were imported into the model from the City's updated GIS. The model includes 2,613 pipes, ranging in size from 1-inch to 30-inches. Initial Hazen-Williams roughness coefficients for new pipelines imported into the model were assigned a C-value of 130. Existing C-values, ranging from 100-155, were maintained for pipes already in the model from the previous model update. All pumping, and storage facilities were updated manually, as needed, based on as-built drawings and information provided by the City.

The Tribute pressure plane was modeled using a control valve to regulate the filling of the GST and by closing the bypass piping to isolate the Tribute pressure plane from the Colony pressure plane. The filling rate was based on SCADA data for the GST.

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Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\(Figure_5-1)_Pressure_Recorder_Locations_11x17.mxd
Updated: Tuesday, April 23, 2019 9:31:15 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

PR #1, PR #2, PR #3, PR #4, PR #5, PR #6, PR #7, PR #8, PR #9, PR #10

DWU Water Supply Line

FIGURE 5-1
CITY OF THE COLONY
PRESSURE RECORDER LOCATIONS

LEGEND

- Pressure Recorder
- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES

- The Colony
- Tribute
- Austin Ranch (Service from Plano)

THE COLONY City by the Lake

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5.2.2 Demand Allocation

Existing demands were allocated to the model using customer billing accounts. The active water meters in July 2017 were spatially located and the associated consumption was assigned to the nearest model node. Of the 13,178 meters FNI received data for, 99% were able to be matched to locations within the City limit by geocoding. These geocoded water meters are shown on **Figure 5-2**.

Since the Water Master Plan Update was prepared concurrently with the Wastewater Master Plan Update, water demands and sewer flows allocation methodology for future planning scenarios was consistent between the two plans. Demands for known future developments were assigned as point demands, and the remaining demand growth was globally apportioned by wastewater sub-basin.

5.2.3 Extended Period Simulation Calibration

To verify that the hydraulic model accurately represented the actual distribution system, a model calibration analysis was performed. The calibration process involves adjusting system operation, C-values, demand allocation, and peaking factors to match a known condition. The 24-hour period occurring on March 11, 2018 from midnight to midnight was selected for calibration. Demands assigned to model nodes were scaled up to match the calibration day demand of 4.04 MGD. The following sections provide a summary of the calibration process, the adjustments made during calibration, and the modeled results compared to the actual recorded values.

5.2.4 Diurnal Pattern

The City provided Supervisory Control and Data Acquisition (SCADA) readings for ground and elevated storage tank levels and pump station flow rates. Flow and tank level data were utilized to calculate an overall diurnal pattern by examining water going into (supply) and out of (demand) the distribution system. For calibration, a composite diurnal curve was created by averaging the calculated diurnal curves from March 1, 2018 through March 30, 2018. **Figure 5-3** shows the composite calculated system diurnal pattern which was used for calibration and maximum day analyses. Diurnal factors for the “composite” 24-hour period ranged from 0.5 to 1.35.

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Job No.: COY17543
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Updated: Tuesday, April 23, 2019 9:39:19 AM
User Name: 02499

FIGURE 5-2
CITY OF THE COLONY
WATER BILLING METERS
NOVEMBER 2017 CONSUMPTION

LEGEND

November 2017 Consumption (1,000 gallons)

- Less than 10
- 10 - 25
- 25 - 50
- 50 - 100
- Greater than 100
- USACE Property

- Road
- Railroad
- Stream
- Lake
- Parcel
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

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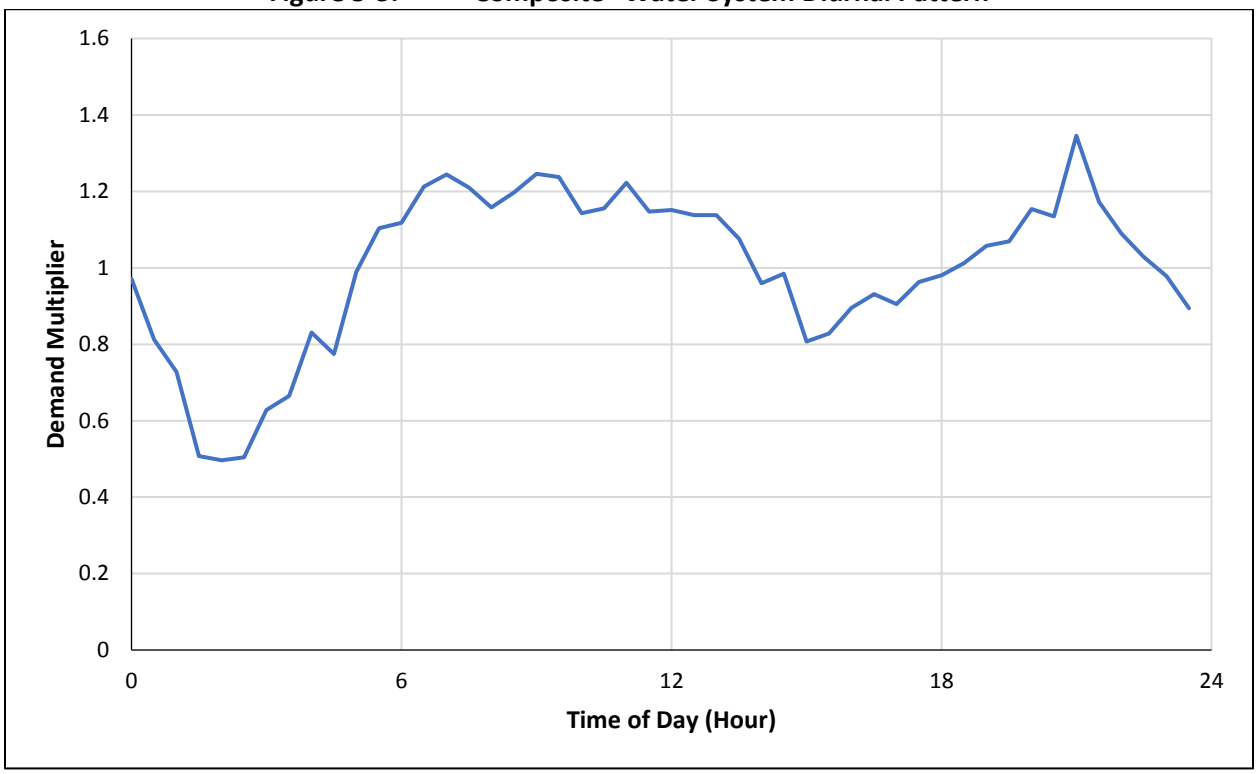
0 3,000
SCALE IN FEET

Figure 5-3: "Composite" Water System Diurnal Pattern



5.2.5 Calibration Controls and Adjustments

During the extended period simulation (EPS) calibration, adjustments were made to the model to match the known conditions of March 11, 2018. The half hour SCADA values are an instantaneous reading of flows and tank levels at a given time and do not account for changes between readings. For calibration, pump controls were set to turn pumps on and off at according the reported SCADA data. The minor losses in the model at the pump stations were adjusted to account for headloss associated with smaller diameter piping, bends, and valving that is internal to the pump stations. These minor loss adjustments were based on pump station record drawings and also a calibration effort to simulate the flowrates that were provided in from SCADA.

The control valve which regulates flow into the Wynnwood/Tribute GST was modeled as a flow control valve to simulate the throttled position in the field and to regulate the filling of the tank while minimizing the effects on the pressures upstream within The Colony PP.

5.2.6 Calibration Results

Figure 5-4, Figure 5-5, and **Figure 5-6** show representative calibration graphs. The results suggest a good correlation between recorded and modeled values and provide confidence in the accuracy of the model. The flow, pressure, and tank modeled results versus City recorded SCADA data for the EPS calibration are summarized on the graphs included in **Appendix B**.

Figure 5-4: North Colony EST Calibration Results

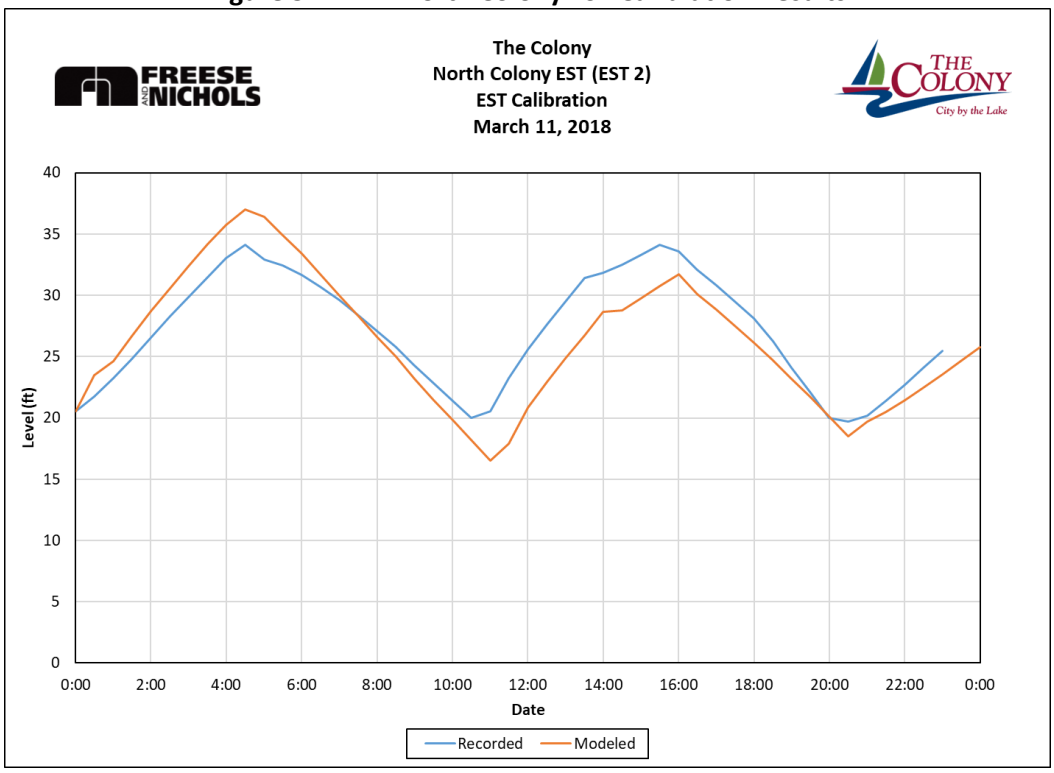


Figure 5-5: Pressure Recorder #6 Calibration Results *(Stewart Blvd at Northpark Dr)*

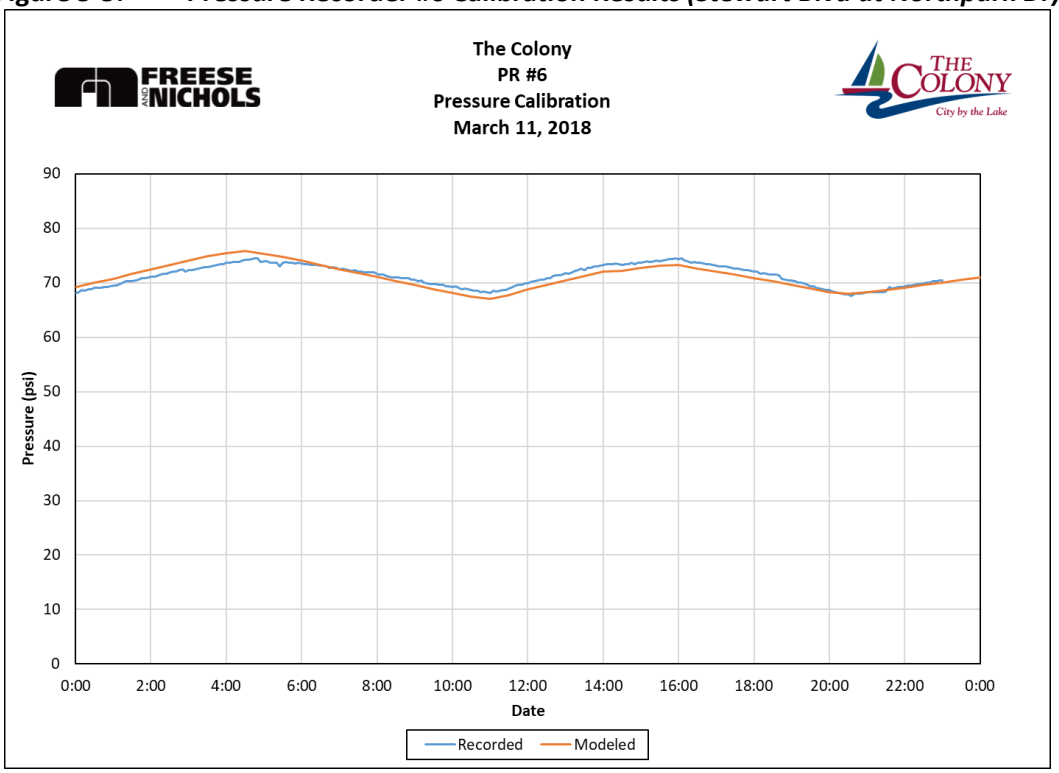
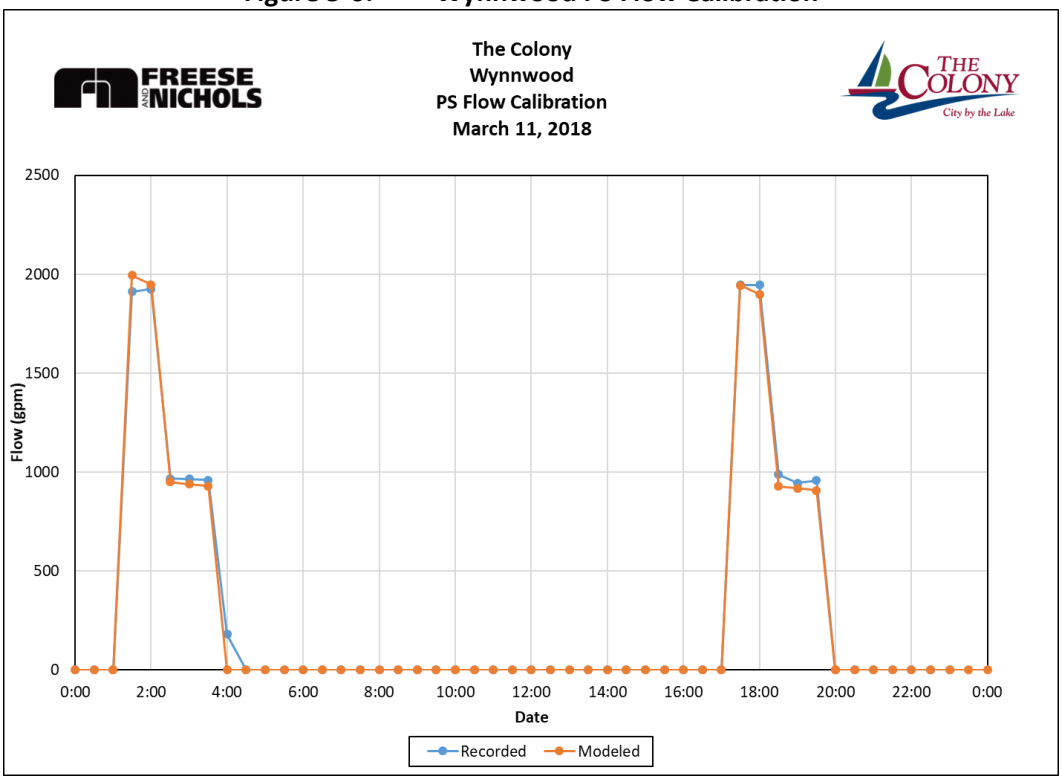


Figure 5-6: Wynnwood PS Flow Calibration



6.0 WATER SYSTEM ANALYSIS AND HYDRAULIC MODELING

As a public water utility, the City of The Colony 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 model analyses were conducted to identify any deficiencies in the City of The Colony's existing water distribution system and to analyze future conditions through Buildout. Parameters used in evaluating the system included increasing system reliability, meeting required fire flows, and maintaining proper residual pressures.

6.1 DESIGN CRITERIA

FNI developed and utilized design criteria to evaluate system operation under existing and future conditions. These criteria are typically more stringent than TCEQ requirements and take into consideration many additional factors including operational flexibility, fire suppression, and energy efficiency.

6.1.1 Service Pumping and Storage Capacity

FNI recommends a combination of pumping and elevated storage to meet peak hour demands with service pumping responsible for meeting 125% of the maximum day demands and elevated storage meeting the difference between peak hour demands and 125% of maximum day demands. The design criteria used to analyze elevated storage tank capacity is the volume required to provide adequate equalization storage for peak hour demands plus emergency storage for fire protection. It is typically assumed that half of the elevated storage tank capacity is used to meet peak hourly demands in excess of the maximum day rate (equalization volume), while the other half of the tank is used for fire protection and emergency conditions (fire/emergency volume). For the recommended elevated storage calculation, a fire flow requirement of 3,000 gpm for a 3-hour duration was selected. The design criteria used to analyze ground storage tank capacity was the ability to supply 8 to 12 hours of maximum day demand.

6.1.2 Pressure

TCEQ regulations state that under normal operating conditions, a minimum pressure of 35 psi must be maintained at all times throughout the system. The exception to this rule is under emergency fire flow situations where the pressure is then permitted to drop to 20 psi until the emergency is addressed.

6.1.3 Fire Flow

Residential and commercial fire flow requirements typically range from 1,000 to 1,500 gpm, while some industrial fire flows can approach 3,000 gpm or greater. According to ISO requirements, the maximum fire flow that a city is required to provide is 3,500 gpm. Fire flows needed in excess of 3,500 gpm, must be met by individual development.

6.1.4 Velocity and Headloss

A maximum water line velocity of 5 feet/second (ft/s) and a maximum friction loss of 3 feet (ft) per 1,000 ft of water line length are recommended for water transmission lines (diameter larger than 16-inches). A maximum water line velocity of 7 ft/s and a maximum friction loss of 7 ft/1,000 ft are recommended for water distribution lines (diameter 16-inches and smaller).

6.2 TCEQ CAPACITY REQUIREMENTS—EXISTING SYSTEM

6.2.1 Existing Water Supply Capacity

As a public water utility, the City of The Colony must comply with the rules and regulations for public water systems set forth by TCEQ in Chapter 290. The City is required to meet TCEQ water supply requirements of having a firm transfer pumping capacity combined with a total groundwater pumping capacity of 0.6 gpm per connection. The City provided an estimated number of connections in each PP as of March 2017. **Table 6-1** presents the TCEQ water supply requirements for the existing water system.

Table 6-1: Existing TCEQ Water Supply Capacity Requirements

	Existing Connections	Existing Water Supply Capacity[1] (MGD)	TCEQ Requirement 0.6 gpm/connection (MGD)	Meets TCEQ Requirement?
The Colony + Tribute	15,251	19.3	13.2	Yes
Austin Ranch	3,096	4.0	2.7	Yes

(1) Existing water supply capacity to the Colony and Tribute areas include 10.0 MGD from DWU, and 9.3 MGD from groundwater. Existing water supply to the Austin Ranch area includes purchased water from the City of Plano.

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

6.2.2 Existing Storage Capacity

The City is required to meet the TCEQ elevated storage capacity requirement of 100 gallons per connection and the total storage capacity requirement of 200 gallons per connection. The number of connections per PP was used to calculate the TCEQ minimum required storage. A comparison of the City's existing storage by PP to TCEQ requirements is shown in **Table 6-2**.

Table 6-2: Existing TCEQ Storage Requirements

Pressure Plane	Existing Connections	Total Storage[1] (MG)		Elevated Storage (MG)		Meets TCEQ Requirement?	Elevated Storage per Connection (gal/conn.)
		Existing	Required	Existing	Required		
Colony	14,307	-	-	2.0	1.4	Yes	-
Tribute	944	-	-	1.0	0.1	Yes	-
Total	**15,251**	**12.4**	**3.1**	**3.0**	**1.5**	**Yes**	**196**

(1) Total Storage is evaluated on the whole system and not on an individual pressure plane basis.

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

6.2.3 Existing Pumping Capacity

In addition to storage and water supply requirements, the City is also required to meet the service pumping capacity requirements presented in **Table 6-3**.

From **Table 6-2**, The Colony has 196 gallons per connection of elevated storage; therefore, Condition 2 from **Table 6-3** applies. Based on the City's projected demands, Condition 2b is the lesser of Condition 2 and governs the City's service pumping capacity, which requires that the City be able to meet peak hourly demands with firm pumping capacity.

Table 6-3: TCEQ Service Pumping Requirements

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

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

The City currently has enough firm pumping capacity in each pressure plane to meet existing peak hour demands as shown in **Table 6-4.**

Table 6-4: Peak Hour Demands and Pumping Capacity

Pressure Plane	Peak Hour Demand	Firm Pumping Capacity	TCEQ Requirement Met?
The Colony	10,938 gpm (15.75 MGD)	16,000 gpm (23.04 MGD)	YES
Tribute	1,257 gpm (1.81 MGD)	3,000 gpm (4.32 MGD)	YES

6.3 FUTURE WATER SYSTEM ANALYSIS

6.3.1 Future Required Water Supply Capacity

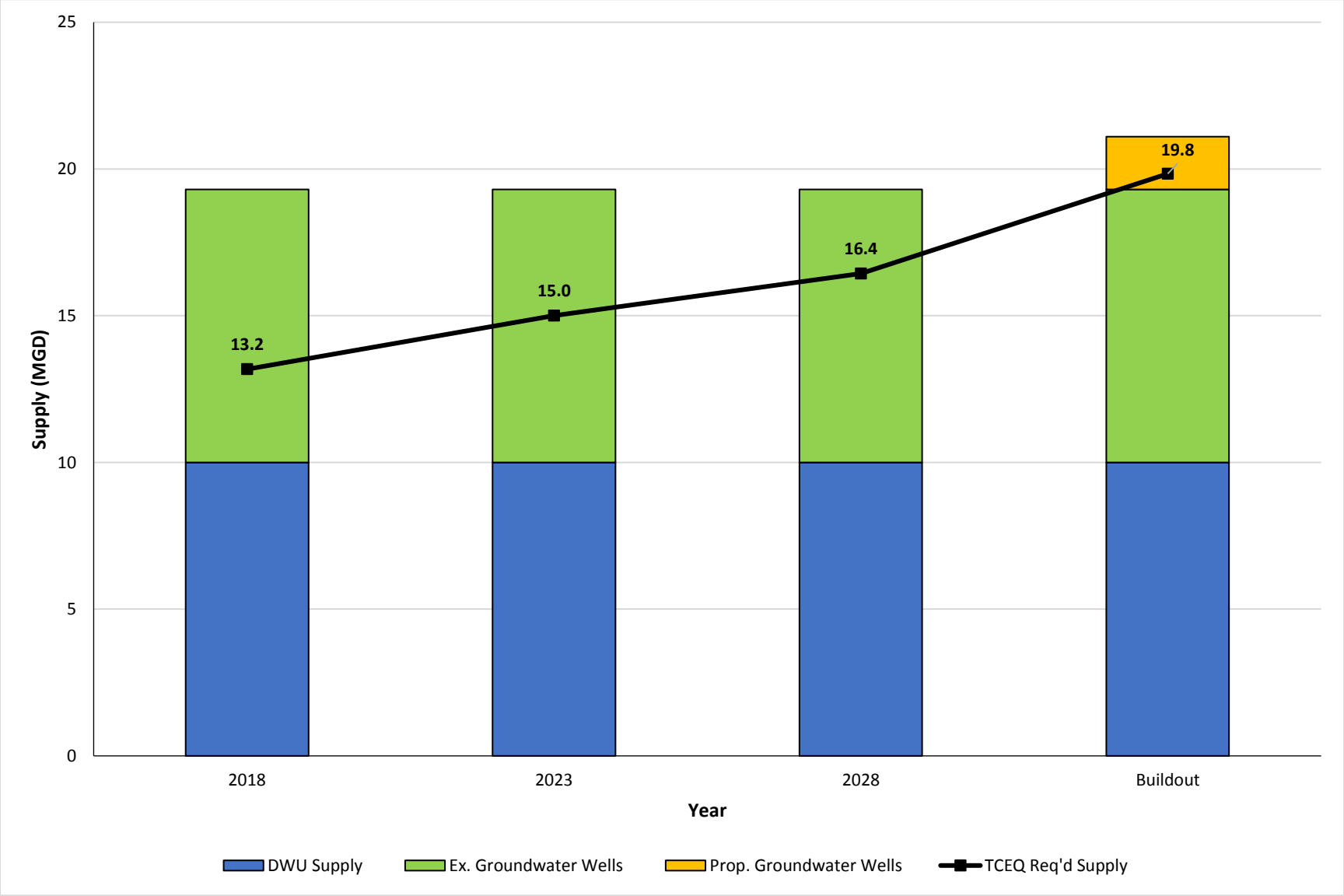
Table 6-5 shows the City's water supply capacity compared to TCEQ water supply requirements for future planning periods. This information is presented graphically in **Figure 6-1**.

Table 6-5: Projected Water Service Area[(1)] Water Supply Capacity Requirements

Year	Number of Connections	TCEQ Requirement 0.6 gpm/connection (MGD)	Water Supply Capacity (MGD)
2018	15,251	13.2	19.3
2023	17,366	15.0	19.3
2028	19,024	16.4	19.3
Build-out	22,960	19.8	21.1

(1) Water Service Area does not include the Austin Ranch PP.

Figure 6-1: Required Future Supply Compared to Existing Supply



6.3.2 Future Required Storage Capacity

The City is required to meet the TCEQ total storage requirements of 200 gallons per connection and elevated storage capacity requirement of 100 gallons per connection. Table 6-6 shows the City's elevated storage capacities compared to TCEQ storage requirements for future planning periods.

Figure 6-2 through **Figure 6-3** show FNI recommended elevated storage for each PP compared with existing elevated storage capacities. FNI design criteria are typically more stringent than TCEQ requirements as they incorporate maintaining adequate equalization volume for peak hour demands as well as storage for emergency situations such as fire suppression.

The existing elevated storage capacity of 2.0 MG in the Colony PP allows the City to meet TCEQ minimum elevated storage requirements for existing conditions. However, an elevated storage shortfall is projected by 2023 in The Colony PP. Additional elevated storage in The Colony PP is recommended to meet 2023 needs through Buildout. A new 1.0 MG EST project (CIP Project #1) has been identified as necessary to satisfy future projected conditions. The existing elevated storage of 1.0 MG in the Tribute PP is sufficient to meet TCEQ minimum and FNI recommended elevated storage requirements through Buildout conditions. The City's existing storage (elevated and ground) satisfies TCEQ total storage criteria through Buildout conditions.

Table 6-6: Projected Storage Capacity Requirements

Year	Connections	TCEQ Required Total Storage 200 gal/con. (MG)	TCEQ Required Elevated Storage 100 gal/con. (MG)	Peak Demand[1] (MGD)	Peak Volume[2] (MG)	Fire Volume[3] (MG)	Elevated Storage Design Criteria[4] (MG)	Recommended Elevated Storage[5] (MG)	Existing Elevated Storage (MG)
COLONY Pressure Plane Storage Evaluation									
2018	14,307	2.86	1.43	5.69	0.95	0.54	1.90	2.00	2.00
2023	16,049	3.21	1.60	6.38	1.06	0.54	2.13	3.00	
2028	17,706	3.54	1.77	7.04	1.17	0.54	2.35	3.00	
Build-Out	21,282	4.26	2.13	8.46	1.41	0.54	2.82	3.00	
TRIBUTE Pressure Plane Storage Evaluation									
2018	944	0.19	0.09	0.66	0.11	0.54	0.65	1.00	1.00
2023	1,318	0.26	0.13	0.91	0.15	0.54	0.69	1.00	
2028	1,318	0.26	0.13	0.91	0.15	0.54	0.69	1.00	
Build-Out	1,678	0.34	0.17	1.15	0.19	0.54	0.73	1.00	

[1] Peak Demand = Peak Hour - (1.15) X Maximum Day.

[2] Peak Volume = Peak Demand for a duration of 4 hours.

[3] Fire Volume = 3,000 gpm X 3 hours.

[4] Greater of (2 X Peak Volume) or (Peak Volume + Fire Volume).

[5] Recommended storage capacities reflect existing system and phased improvements.

Figure 6-2: The Colony Pressure Plane Recommended Elevated Storage Capacity

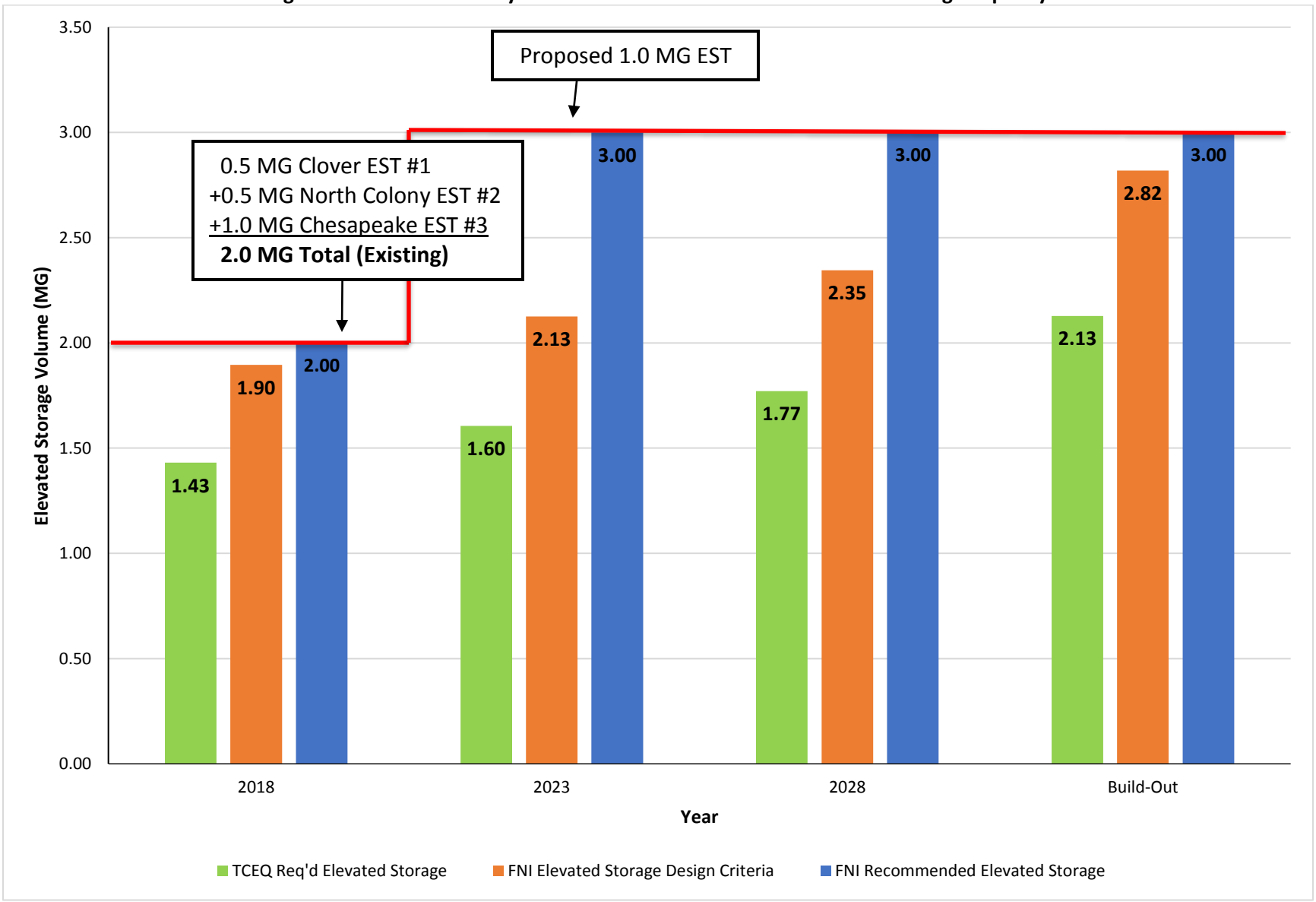
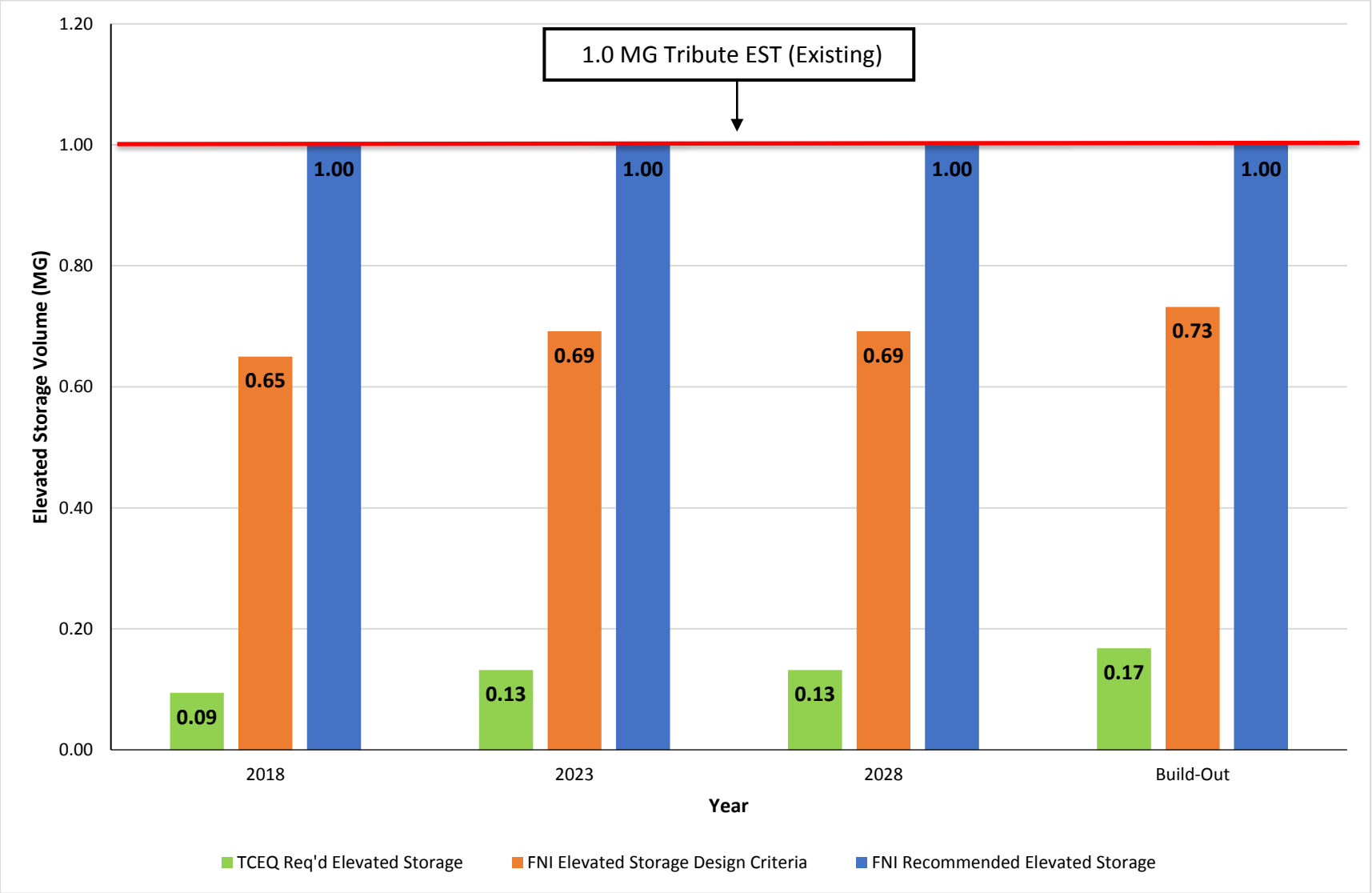


Figure 6-3: Tribute Pressure Plane Recommended Elevated Storage Capacity



6.3.3 Future Required Pumping Capacity

Table 6-7 and **Table 6-8** along with **Figure 6-4** and **Figure 6-5** show existing pumping capacities compared to FNI recommended pumping for the Colony PP and Tribute PP, respectively. Based on FNI's design criteria that firm pumping capacity be equal or greater than 125% of maximum day demand, the Colony and Tribute PPs meet or exceed total recommended pumping capacity through Buildout. No pumping improvements have been identified necessary to satisfy projected future conditions.

Additionally, the model results included the appendix show that the City will be able to meet the peak hour demands with the largest pump out of service and maintain a minimum of at least 35 psi throughout the water system.

Table 6-7: The Colony Pressure Plane Pumping Recommendations

Year	Maximum Day Demand (MGD)	FNI Recommended Pumping Capacity(1) (MGD)	Firm Pumping Capacity (MGD)	FNI Recommended Pumping Criteria Satisfied?
2018	8.75	10.94	23.04	YES
2023	9.82	12.28	23.04	YES
2028	10.83	13.54	23.04	YES
Buildout	13.02	16.28	23.04	YES

(1) FNI Recommended Pumping Capacity is 125% of Maximum Day Demand.

Table 6-8: Tribute Pressure Plane Pumping Recommendations

Year	Maximum Day Demand (MGD)	FNI Recommended Pumping Capacity(1) (MGD)	Firm Pumping Capacity (MGD)	FNI Recommended Pumping Criteria Satisfied?
2018	1.00	1.26	4.32	YES
2023	1.40	1.75	4.32	YES
2028	1.40	1.75	4.32	YES
Buildout	1.79	2.23	4.32	YES

(1) FNI Recommended Pumping Capacity is 125% of Maximum Day Demand.

Figure 6-4: The Colony Pressure Plane Recommended Pumping Capacity

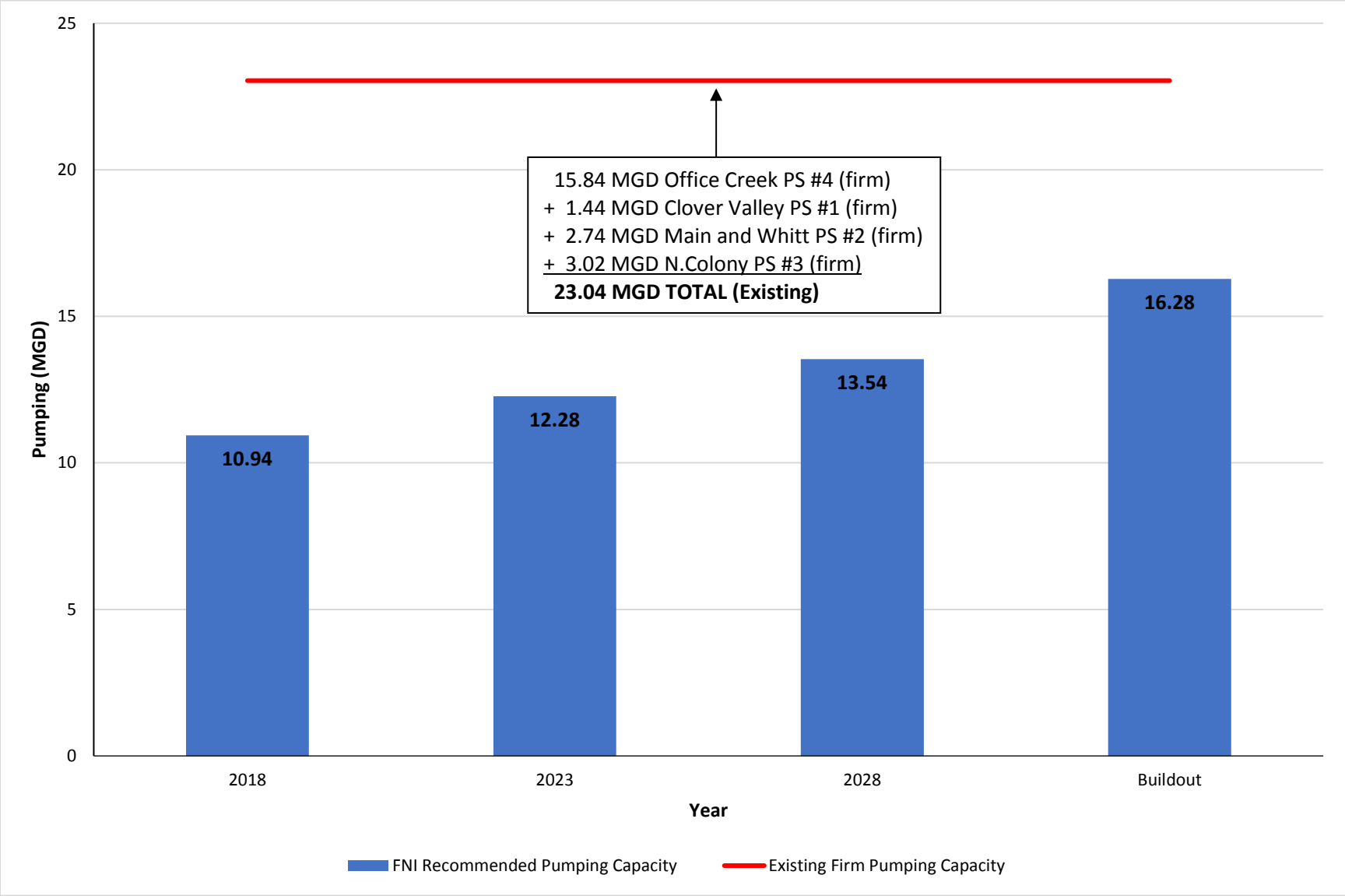
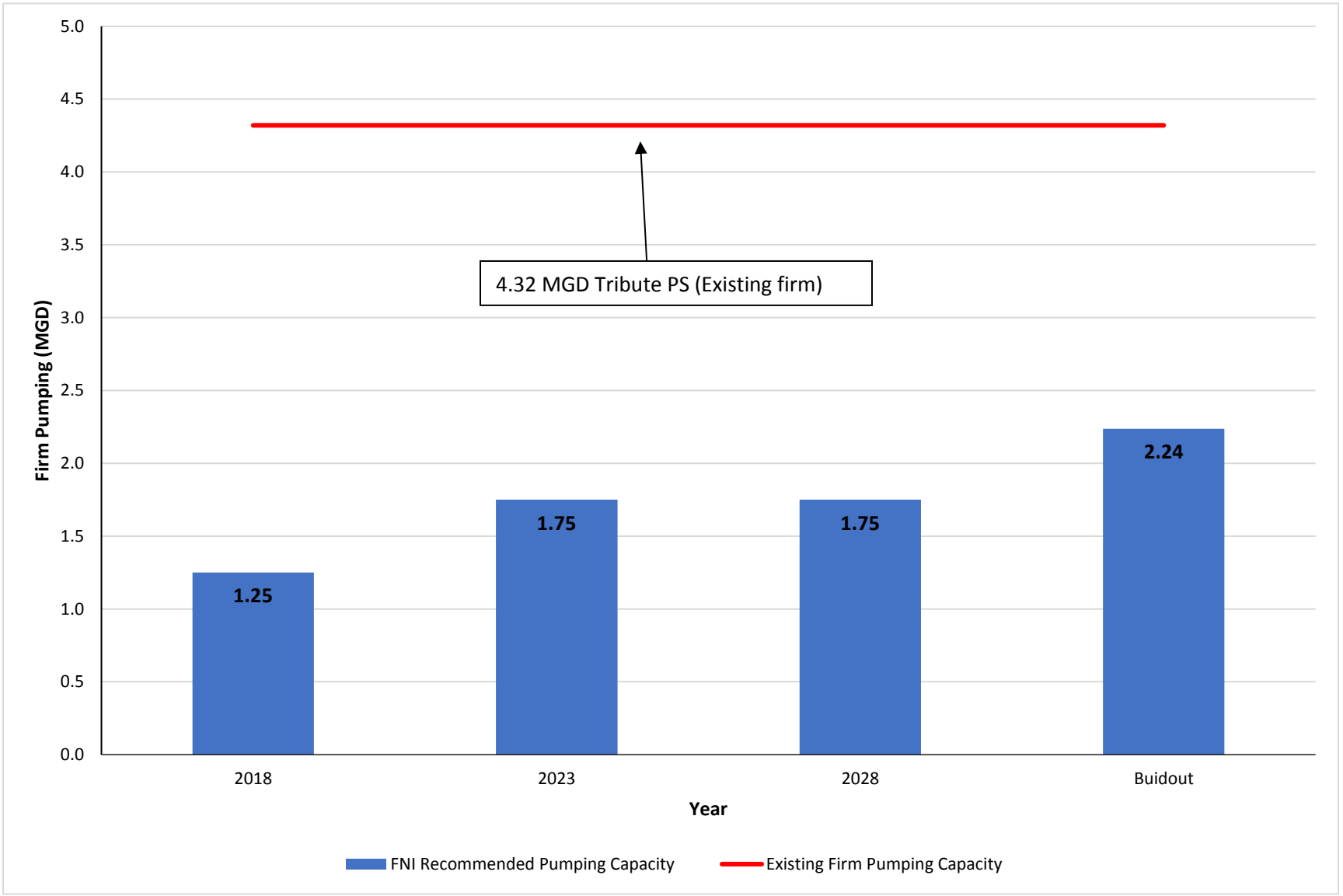


Figure 6-5: Tribute Pressure Plane Recommended Pumping Capacity



6.4 HYDRAULIC MODELING ANALYSIS

Hydraulic modeling analyses were performed on the distribution system under maximum day demand conditions. Twenty-four-hour EPS model runs were performed for maximum day demand conditions for the existing system, 2023, 2028, and buildout scenarios to identify existing and potential future system deficiencies and size ultimate infrastructure and determine phasing, as required. By examining the distribution system under these various operating conditions, it is possible to determine where issues with pressures occur, if tanks are filling or draining properly, and if the service pumping facilities are adequate to meet the required demand at acceptable pressures.

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

The City provided SCADA data for the existing pumping station operations, elevated storage tank levels, ground storage tank levels, and well operations. The SCADA data was analyzed to determine the typical operating parameters for the water system including normal tank operating levels and the lead and lag pumping controls for each of the water booster pumping stations. These parameters were programed into the model to simulate a 24-hour EPS. Modeled pumping and storage operations for the existing and 2040 system are shown in **Figure 6-6** through **Figure 6-9.**

Figure 6-6: Tribute Pressure Plane – Existing System Maximum Day Operations

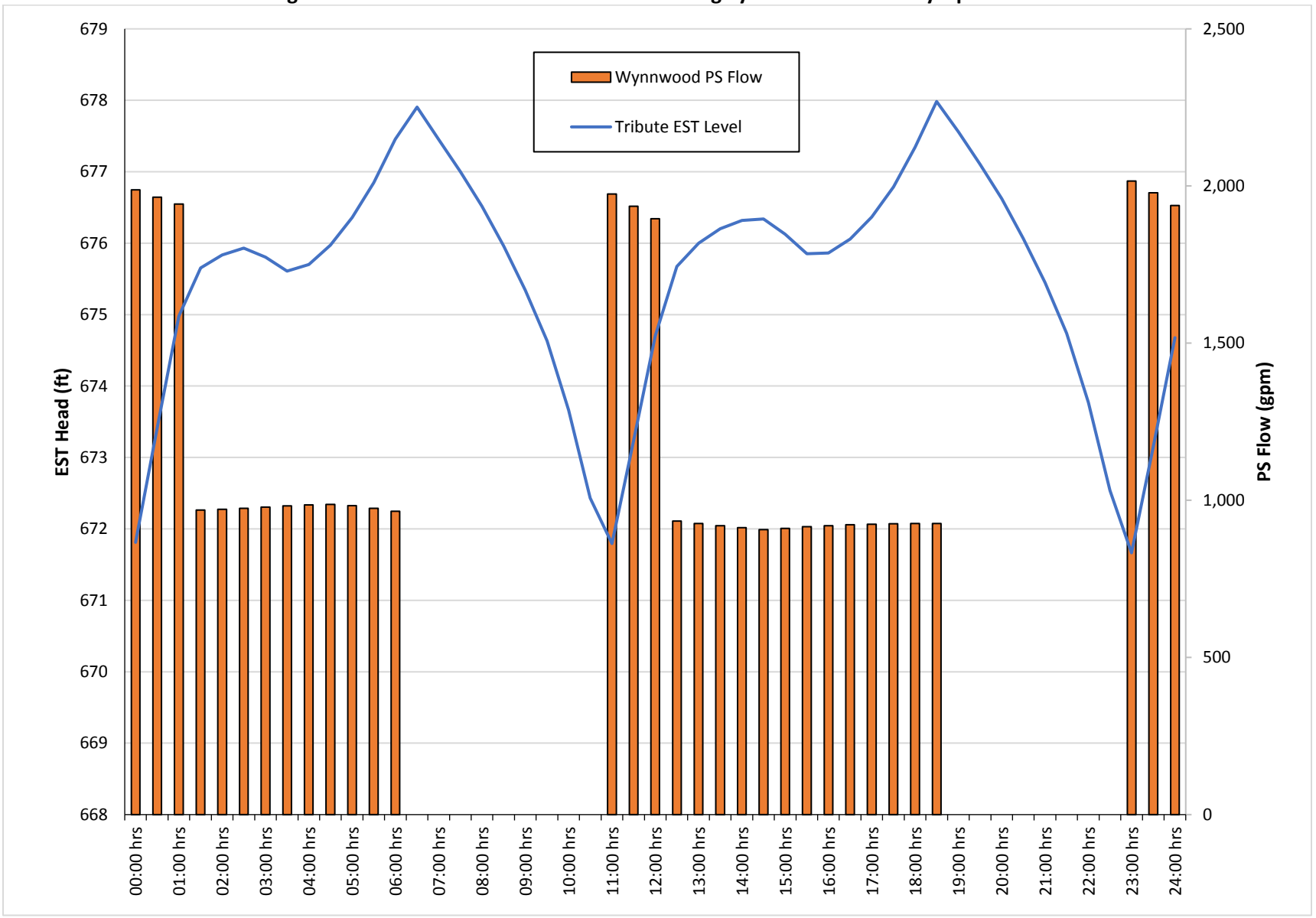


Figure 6-7: Tribute Pressure Plane – Buildout System Maximum Day Operations

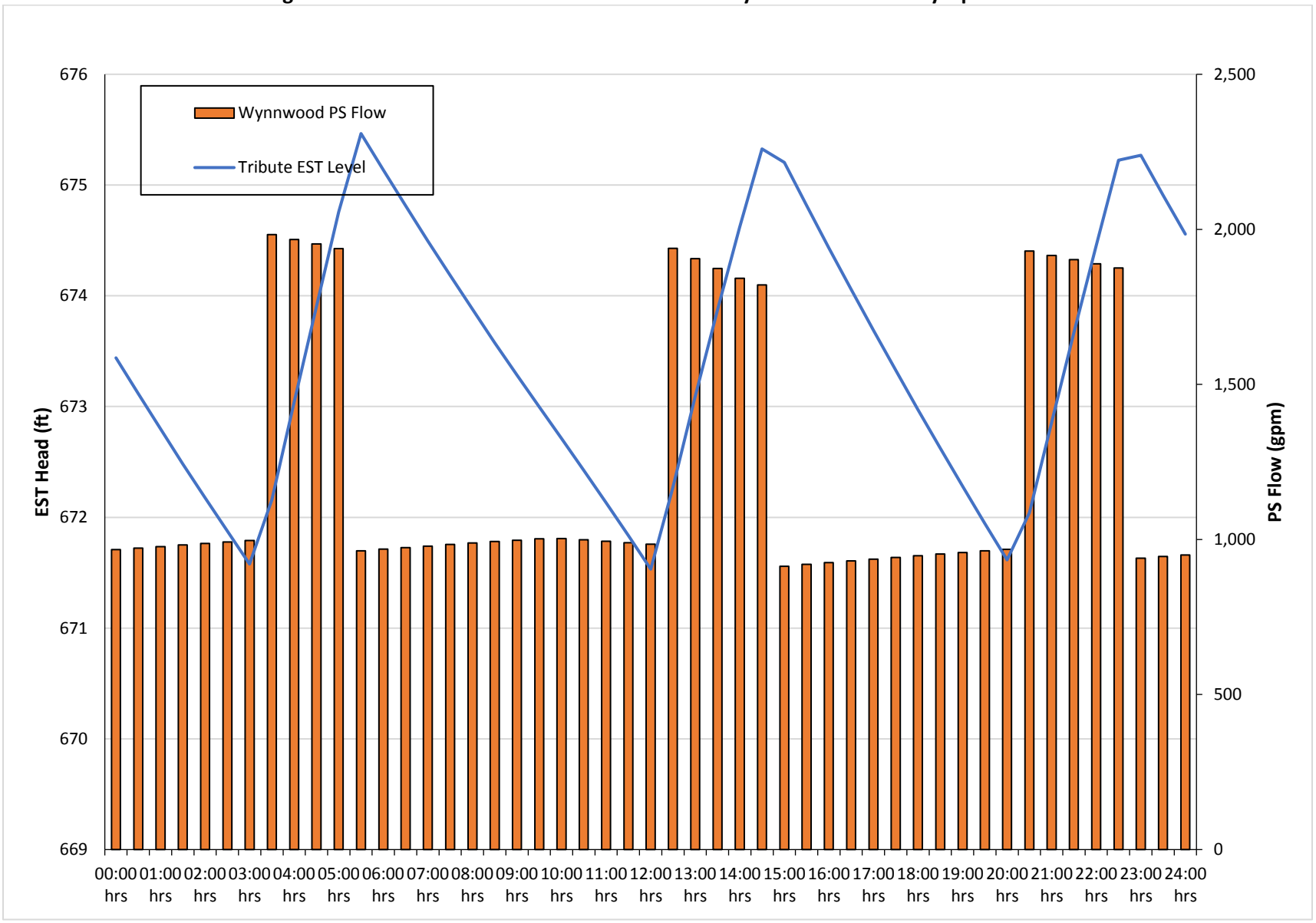


Figure 6-8: The Colony Pressure Plane – Existing System Maximum Day Operations

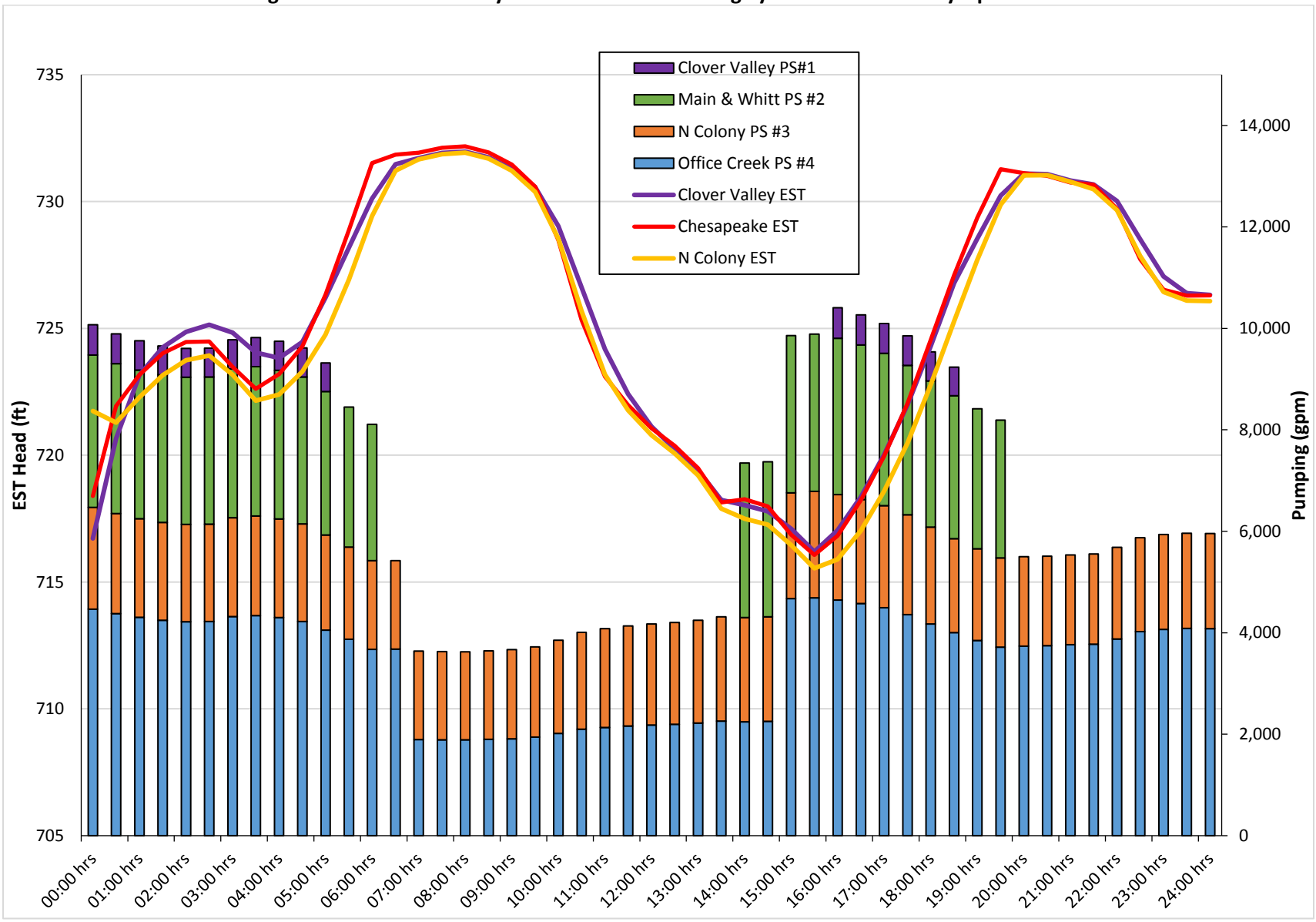
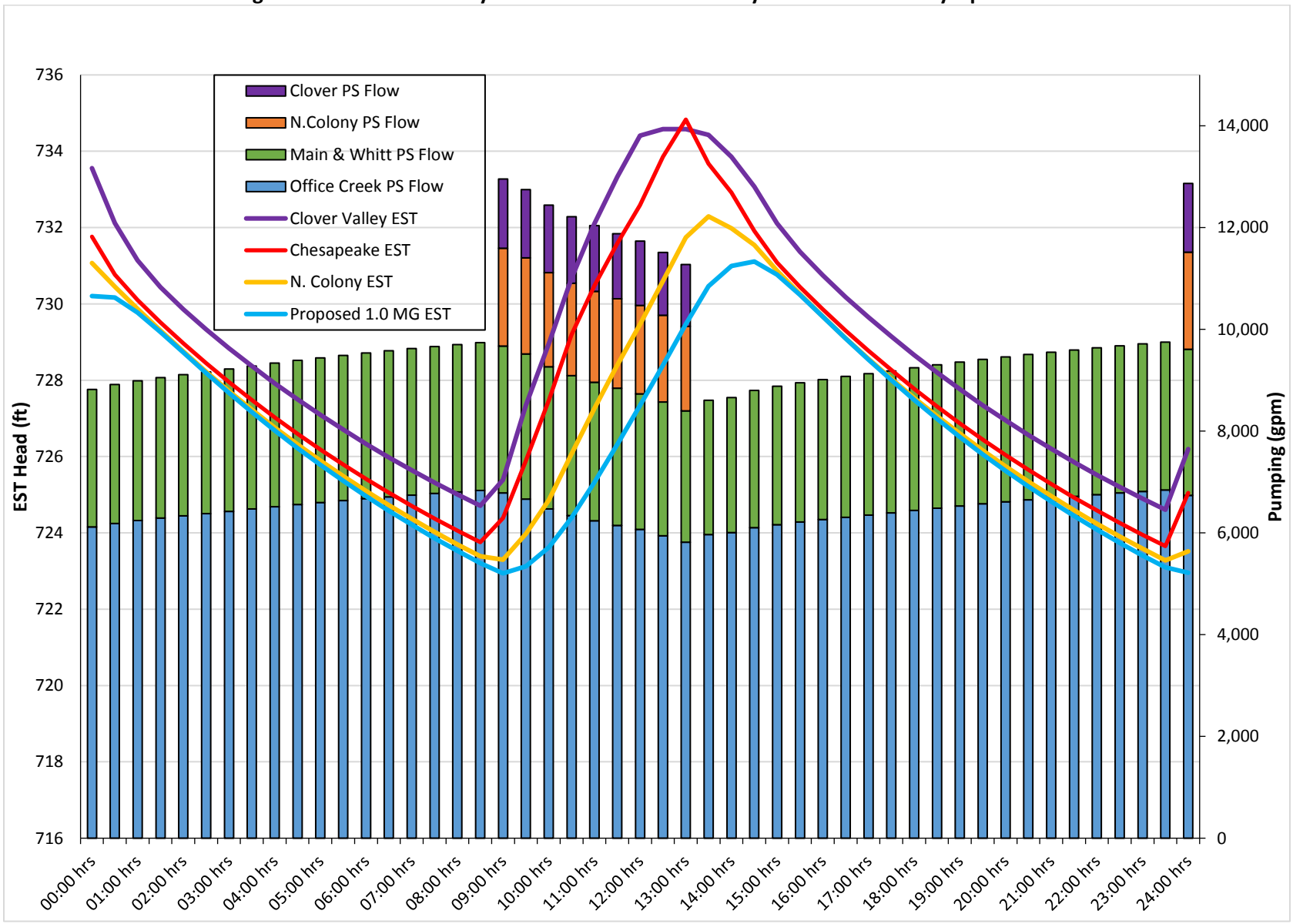


Figure 6-9: The Colony Pressure Plane – Buildout System Maximum Day Operations



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 minimum pressures under maximum day demands can be found in **Appendix C.** 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 pressures under maximum day demands, FNI analyzed and evaluated the existing system water lines based on the design velocity and headloss criteria. Mapping was created to display the results and can be found in **Appendix C**.

6.4.1 Fire Flow Analysis

To evaluate the fire suppression capabilities of the system, a fire flow analysis was conducted under maximum day demand conditions for the existing and buildout system. 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 and maintaining velocity of less than 10 feet per second in nearby water lines. A fire flow contour map was also prepared to show the available fire flow throughout the distribution system. The majority of the City has an available fire flow greater than 1,500 gpm. The fire flow map for existing and future system conditions can be found in **Appendix C**.

6.4.2 Water System Improvements

After discussions with City staff to review the modeling results for existing and future conditions, three water system improvement projects were identified. The need for additional elevated water storage in the Colony PP to meet future demands was identified; therefore, a new 1.0 MG EST is proposed in the Grandscape area.

A new parallel 12-inch waterline from the Tribute PS to the intersection of Boyd Road and Lebanon Road is proposed to add redundancy to the Tribute area water system. In the event of failure of the existing 20-inch waterline, the parallel 12-inch waterline will have capacity to supply maximum day demands in the Tribute PP.

A water supply shortfall of 0.5 MGD was identified in Buildout conditions along with an opportunity to improve system reliability by adding a redundant source of water to Tribute PP. Currently, a single 24" transmission main supplies the Tribute PP with water from The Colony PP. A new 1,250 gpm (1.8 MGD) groundwater well is proposed near the Tribute/Wynnwood GST site to increase supply and system reliability. The proposed well will provide adequate water supply to satisfy projected Buildout demands in the Tribute PP.

7.0 WATER SYSTEM CAPITAL IMPROVEMENTS PLAN AND RECOMMENDATIONS

7.1 CAPITAL IMPROVEMENTS PLAN

Throughout the existing and future system analysis process, three capital improvement projects were identified as necessary for the City of The Colony in order to allow high quality water service that enables residential and commercial development. **Figure 7-1** presents a map of the proposed CIP projects and **Table 7-1** provides a summary of the CIP projects and associated cost estimates. Detailed cost estimates are provided for each CIP project in **Appendix E**.

CIP Project #1: Grandscape EST—An elevated storage shortfall in The Colony PP was identified beginning in 2023. A new 1.0 MG EST is proposed in the Grandscape area of The Colony PP to provide adequate elevated storage to satisfy elevated storage criteria through Buildout conditions. The proposed EST will also increase fire flow storage in the area and bolster system reliability and help maintain normal operating pressures during periods of peak demands.

CIP Project #2: Redundant Tribute PS Pipeline— This project involves construction of a redundant 12-inch waterline parallel to the existing 20-inch waterline from the Tribute PS to the intersection of Boyd Road and Lebanon Road. The parallel 12-inch water line will have the capacity to supply maximum day demands in the event of failure of the 20-inch water line.

CIP Project #3: Tribute Groundwater Well— An overall water supply shortfall of 0.5 MGD for the City's water service area was identified in Buildout conditions. Additionally, the 24" transmission main which supplies the Tribute PP was identified as a supply reliability risk. Failure of the single feed 24" transmission main would cut off supply to the Tribute PP until necessary repairs could be made. A new 1,250 gpm (1.8 MGD) groundwater well is proposed in the Tribute PP at the Tribute/Wynnwood GST site. A 1,250 gpm well will satisfy projected Buildout water supply requirements and add supply redundancy to the Tribute PP. In the event of failure of the 24" transmission main, the proposed 1,250 gpm Tribute well will have adequate capacity to supply projected Buildout maximum day demands.

Table 7-1: CIP Summary

Phase	Project #	Project Name	Estimated Cost
Short	1	Grandscape EST	$ 5,631,600
Short	2	Redundant Tribute PS Pipeline	$ 385,200
Intermediate	3	Tribute Groundwater Well	$ 4,212,000
		TOTAL	**$ 10,228,800**

The proposed system will provide the required capacity and reliability to meet projected water demands through Buildout.

7.2 OPERATIONAL RECOMMENDATIONS

The City should consider the operation of its Tribute Pressure Plane. The Tribute PP is at a lower hydraulic grade line (EST overflow at elevation of 698') compared with the main Colony PP (EST overflow at elevation 735'). However, the City currently pumps into the Tribute EST from the water supplied through the Tribute GST which is filled through a control valve supplied from the Colony PP. The City could benefit from operational optimization and gain efficiencies associated with supplying the Tribute EST with a control valve directly supplied from the Colony PP and bypassing the GST and pumping station. Based on preliminary modeling, this is achievable under the existing system conditions with the addition of some additional piping and valving. The City should further consider this alternative operational strategy.

Additionally, operational conditions associated with the existing Chesapeake EST could also provide some pressure benefits in the area in the vicinity of the EST. The area surrounding the Chesapeake EST are some of the highest ground elevations within the City's water service area. As a result of elevation, this area experiences some of the lower pressures within the system. While the system pressures remain above the required minimum 35 psi, the City could operate the Chesapeake EST at higher elevations to provide the most benefit of the elevated storage in this area. The proposed 1.0 MG EST located in the Grandscape area will also help provide more stable operating pressures during higher demands periods.

7.3 RECOMMENDATIONS FOR FUTURE STUDY

The City operates and maintains a well-developed water distribution system. The City does not anticipate major growth over the planning horizon, and as the City develops towards it's buildout potential the modeling and master plan have only identified several areas for system improvements to continue to

provide a high level of service. In addition to CIP projects, the City could also benefit from additional water system evaluations.

Water Quality Study and Nitrification Action Plan (NAP): One of the next steps with a water system model and master plan is utilizing the calibrated water model to perform water age or water quality modeling. A water quality model can help the City identify areas of extended residence time within the distribution system where water quality can be a concern. In addition, if the City is to consider operational changes in the system as discussed in Section 7.2 above, a water quality model can help the City evaluate impacts to the water age associated with changes in operations. A water quality model can also serve to help the City evaluate sampling sites for its NAP to meet TCEQ regulations.

Asset Management and Risk Based Analysis: An inventory of the City's water system assets in an asset management tool can help provide the means to track problem areas and identify potential system improvement or repairs before failure occurs. In addition to a central database for tracking work order history, and asset condition, an asset management database can also provide the opportunity to perform a risk analysis for the City's assets and identify system facilities (including pumps, tanks, pipes, etc.) that are most critical to the water system based on likelihood and consequences of failure. A risk-based approach to prioritized system maintenance and repairs can help save the City repair costs in the long term.

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Updated: Tuesday, April 23, 2019 9:30:53 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Proposed Well

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

1.0 MG Proposed EST

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

Little Elm
Hackberry
Frisco
Plano
Carrollton
Hebron
Lewisville
Lake Lewisville

FIGURE 7-1
CITY OF THE COLONY
WATER SYSTEM
CAPITAL IMPROVEMENTS PLAN

LEGEND

- Proposed Groundwater Well
- Proposed Elevated Storage Tank
- Proposed Water Line
- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES
- The Colony
- Tribute
- Austin Ranch (Service from Plano)

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,000
SCALE IN FEET

APPENDIX A
Pressure Recorder Data and Mapping

Figure A-1
Field Pressure Testing
March 5, 2018 - March 27, 2018

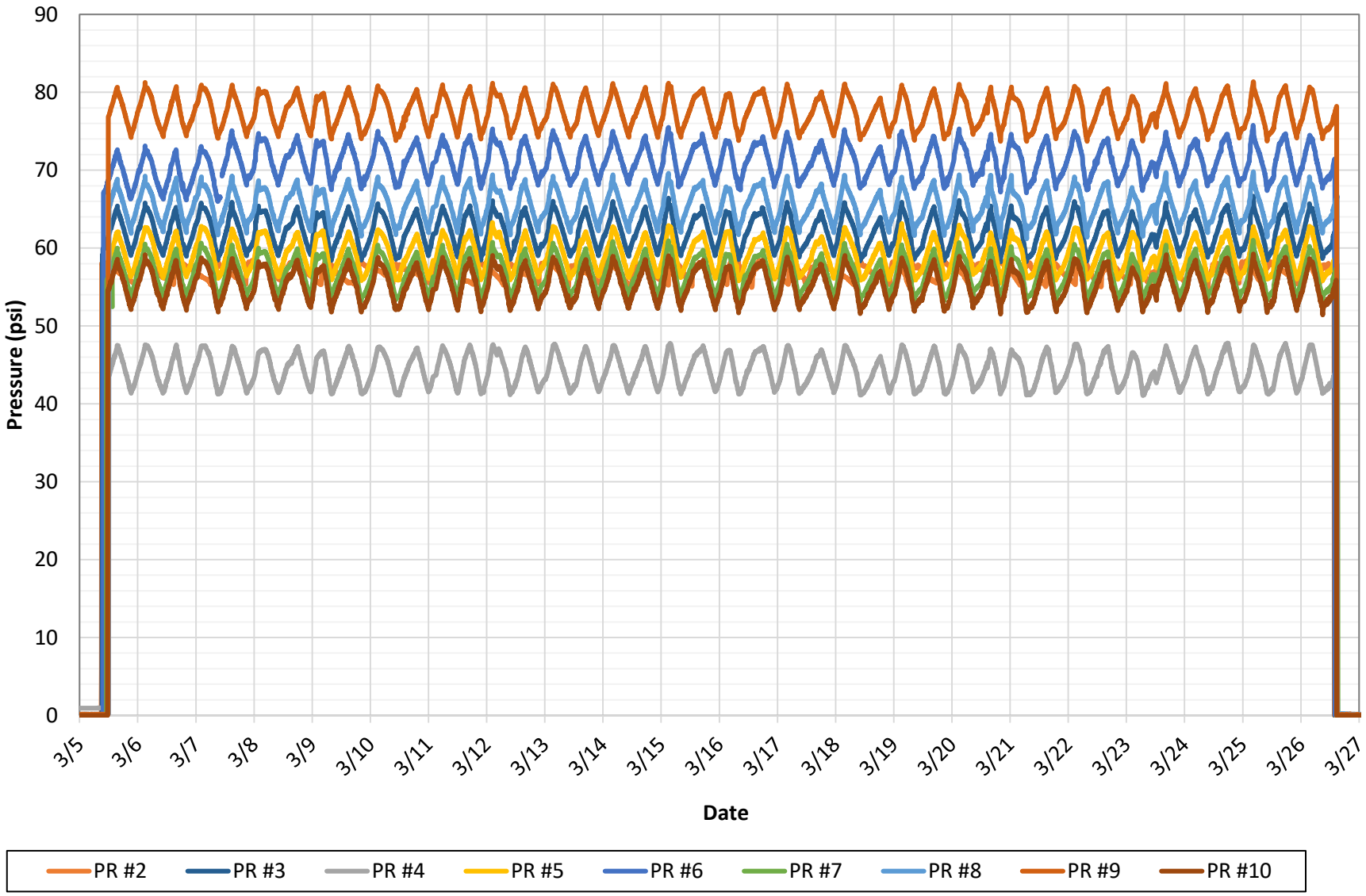


Figure A-2
Field Pressure Testing
PR #2- 3920 Millbank
March 5, 2018 - March 27, 2018

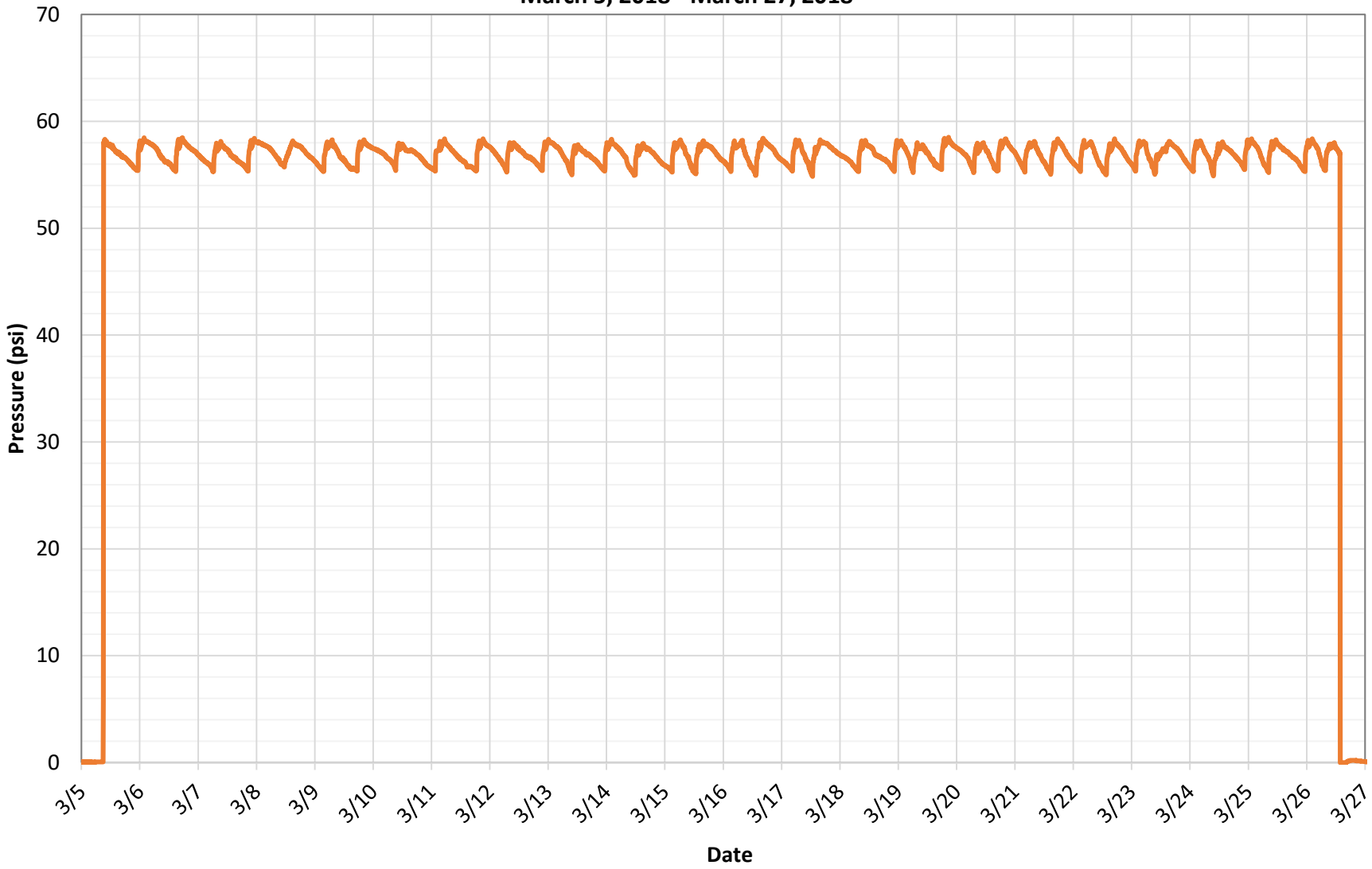


Figure A-3

Field Pressure Testing

PR #3- 6801 Main Street

March 5, 2018 - March 27, 2018

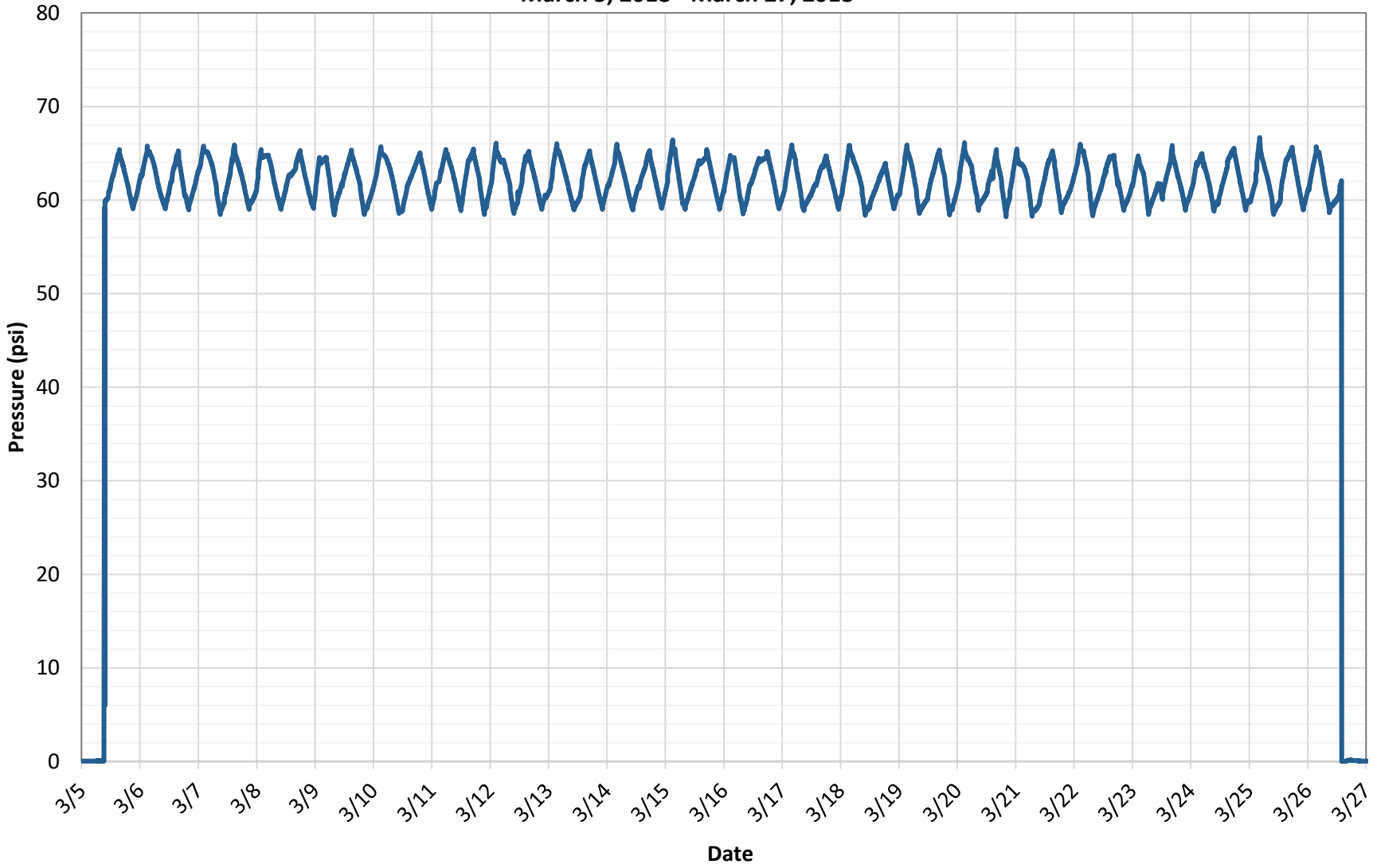


Figure A-4

Field Pressure Testing

PR #4- 6304 Fallwater Trail

March 5, 2018 - March 27, 2018

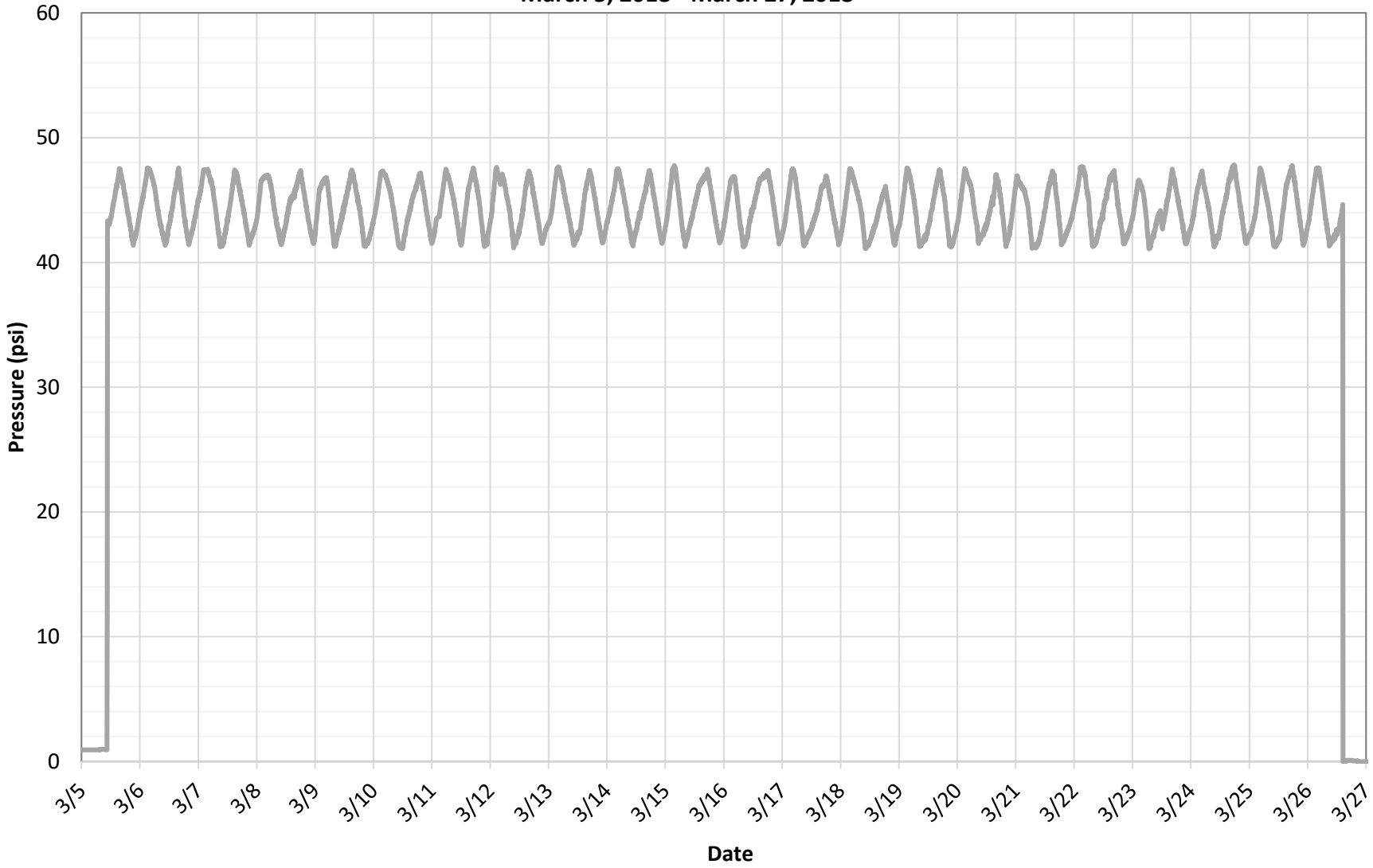


Figure A-5

Field Pressure Testing

PR #5- 5694 North Colony Blvd.

March 5, 2018 - March 27, 2018

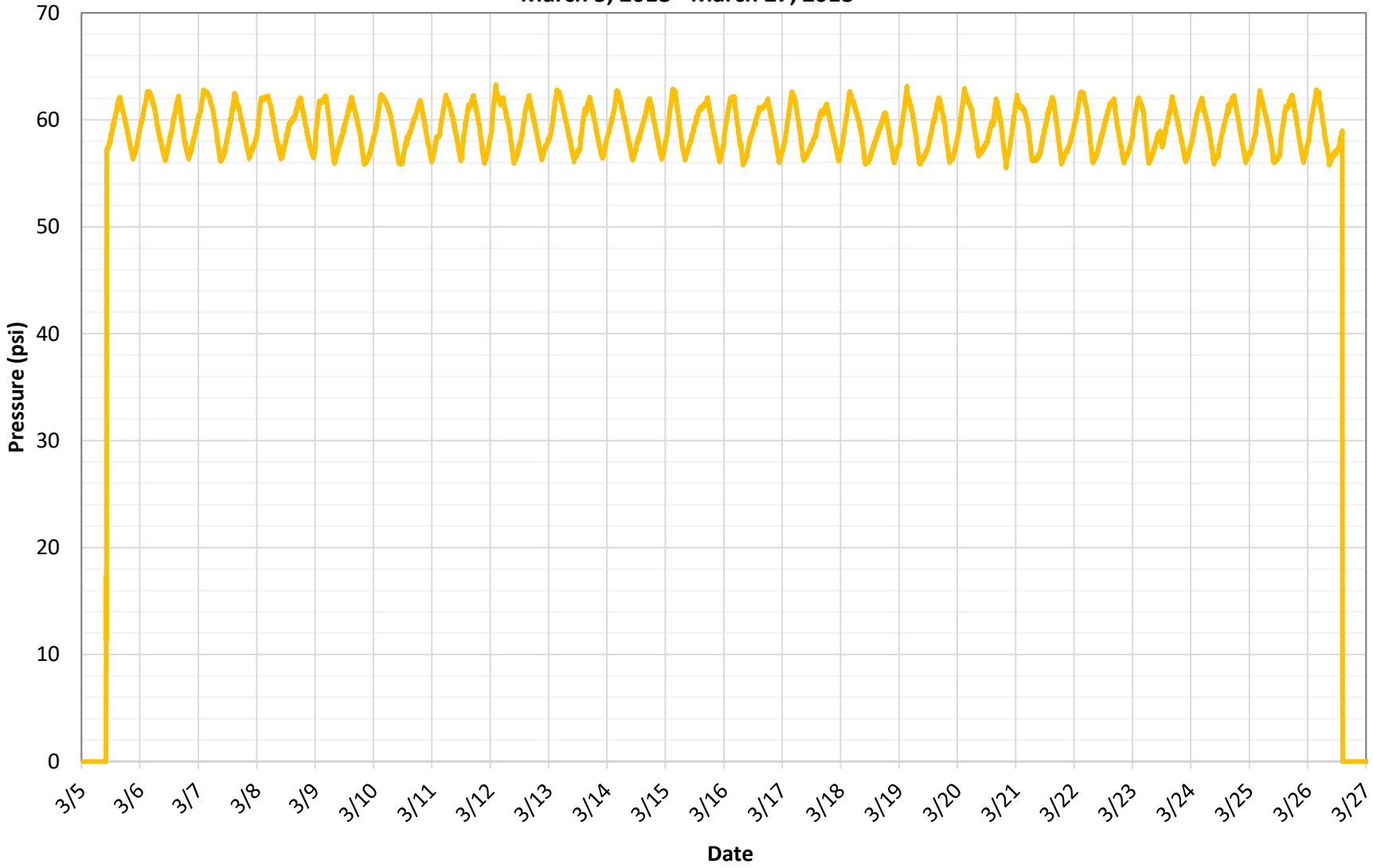


Figure A-6

Field Pressure Testing

PR #6- 6604 Stewart Blvd.

March 5, 2018 - March 27, 2018

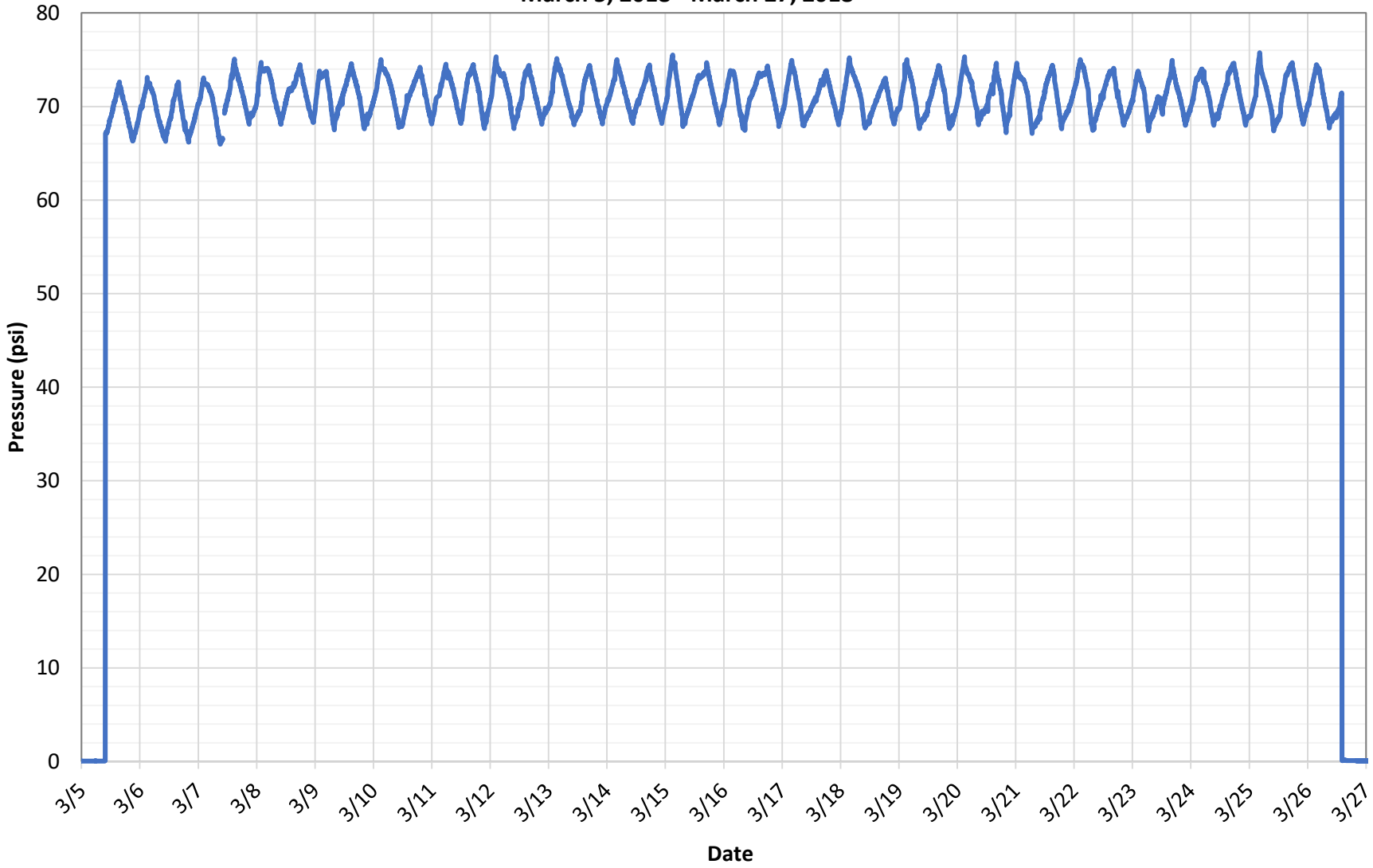


Figure A-7

Field Pressure Testing

PR #7- 4920 Womack

March 5, 2018 - March 27, 2018

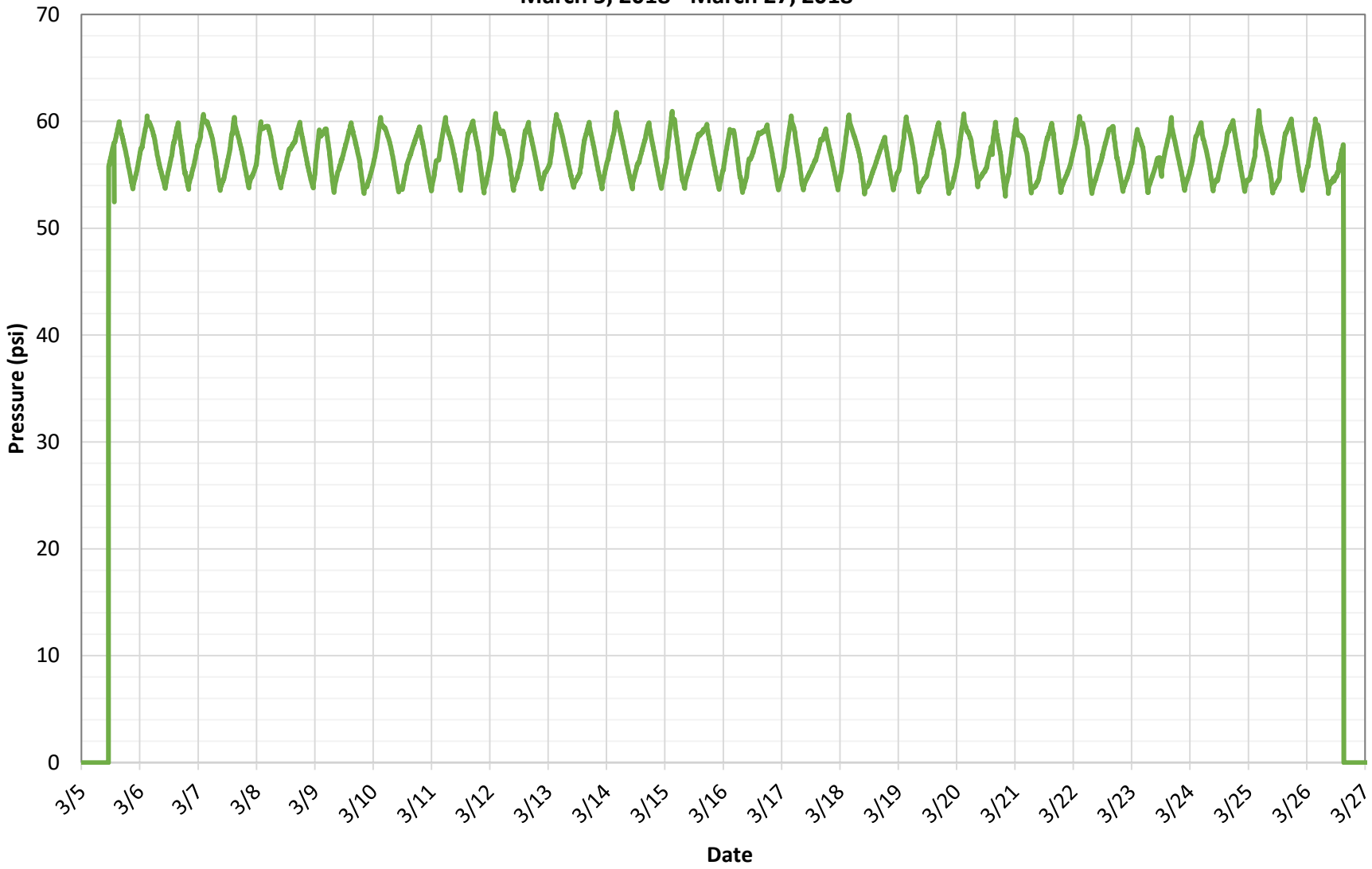


Figure A-8

Field Pressure Testing

PR #8- 4081 Main Street (by Bristol Apts)

March 5, 2018 - March 27, 2018

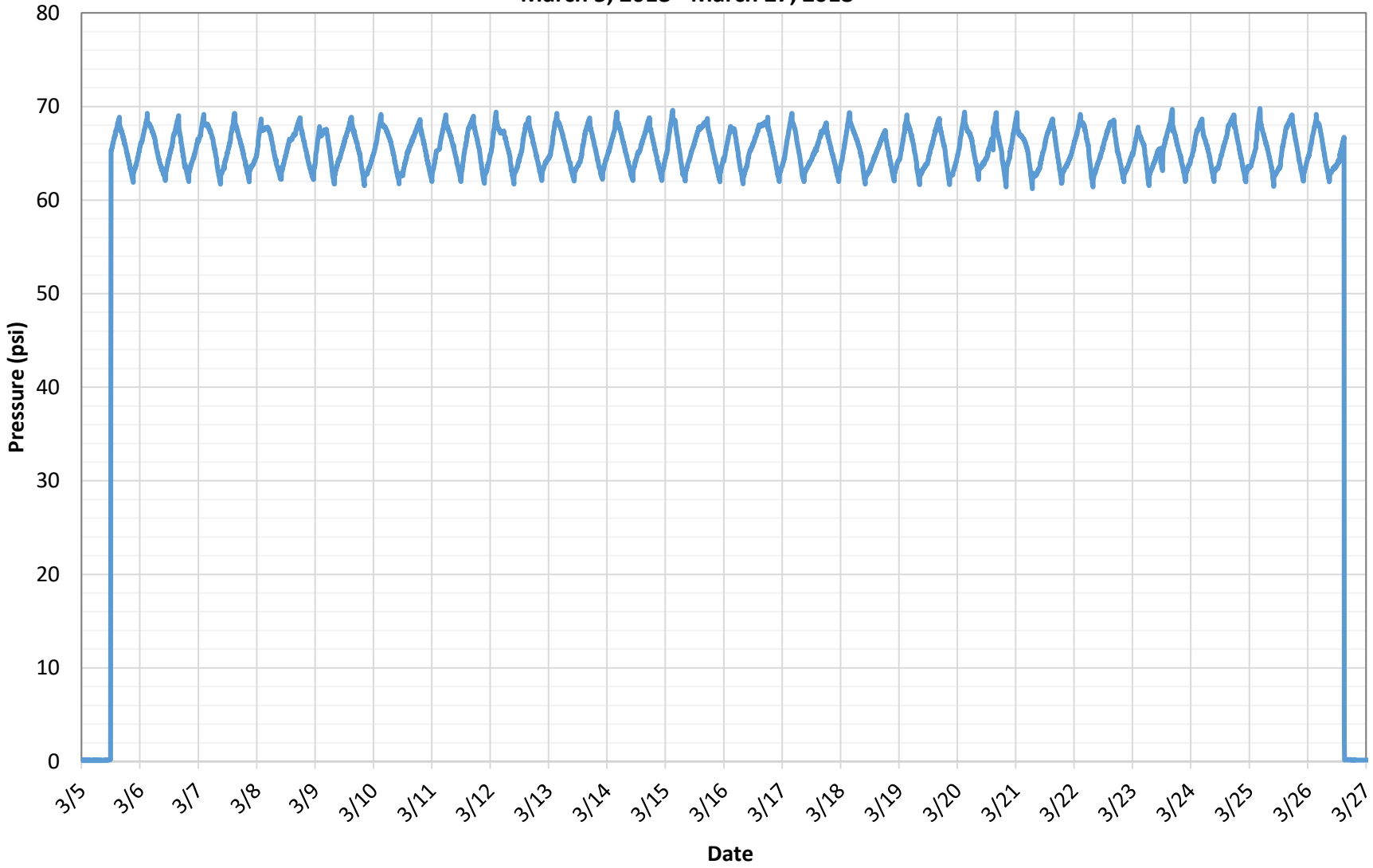


Figure A-9

Field Pressure Testing

PR #9- 3311 Plano Parkway

March 5, 2018 - March 27, 2018

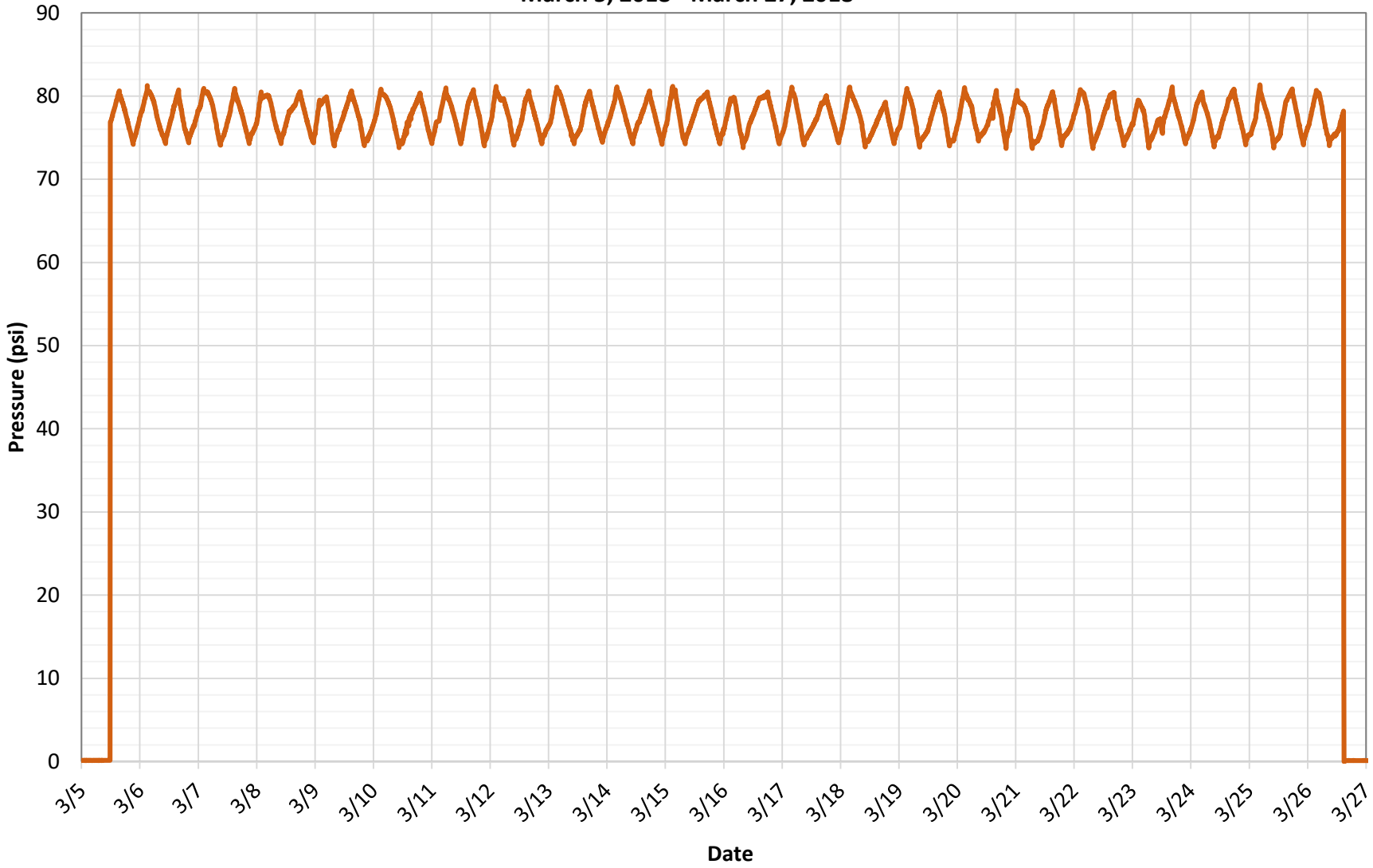
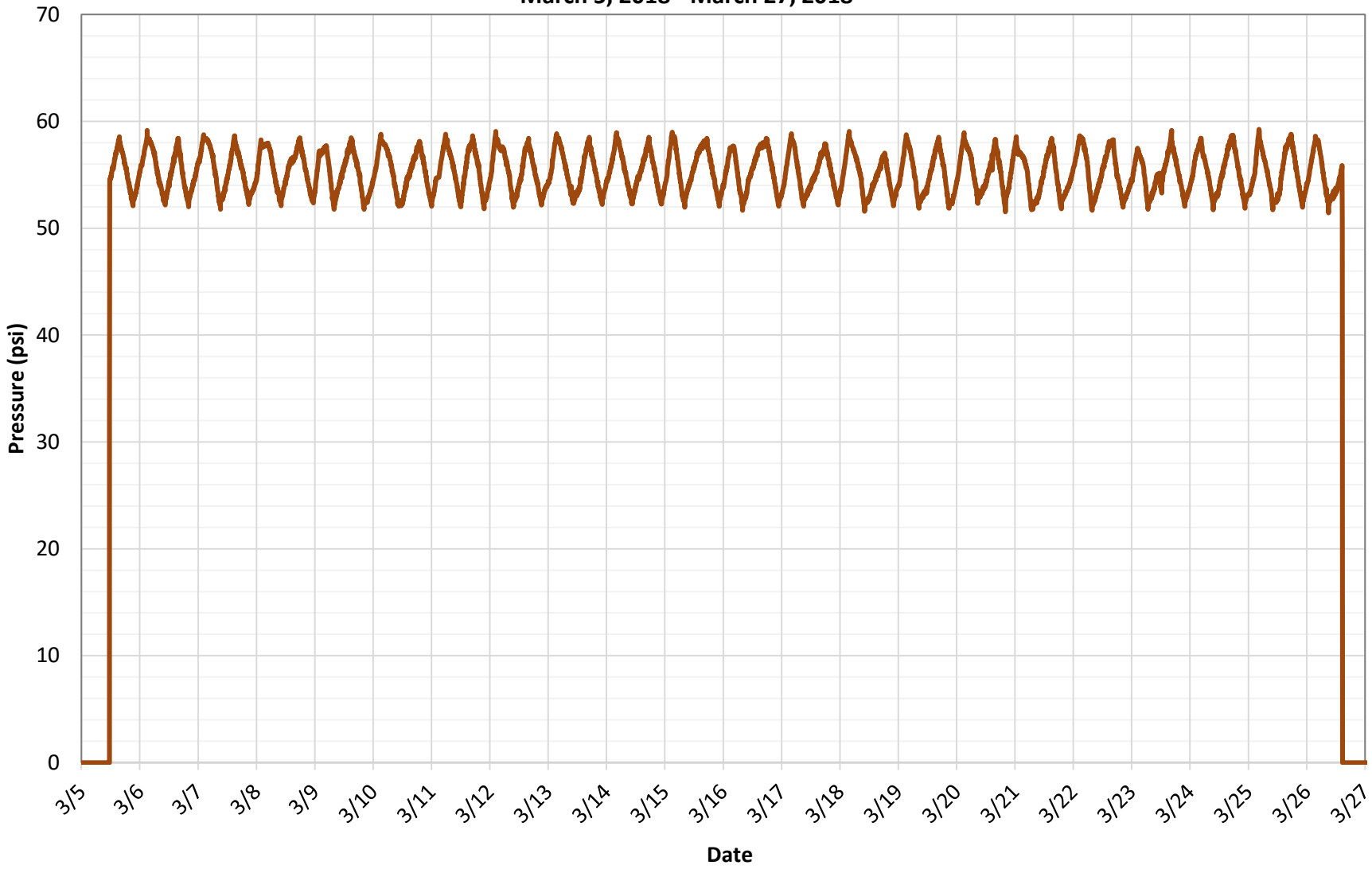


Figure A-10

Field Pressure Testing

PR #10- Destination Drive

March 5, 2018 - March 27, 2018



APPENDIX B
Water Model Calibration Results

FIGURE B-1

The Colony

PR #2

Pressure Calibration

March 11, 2018

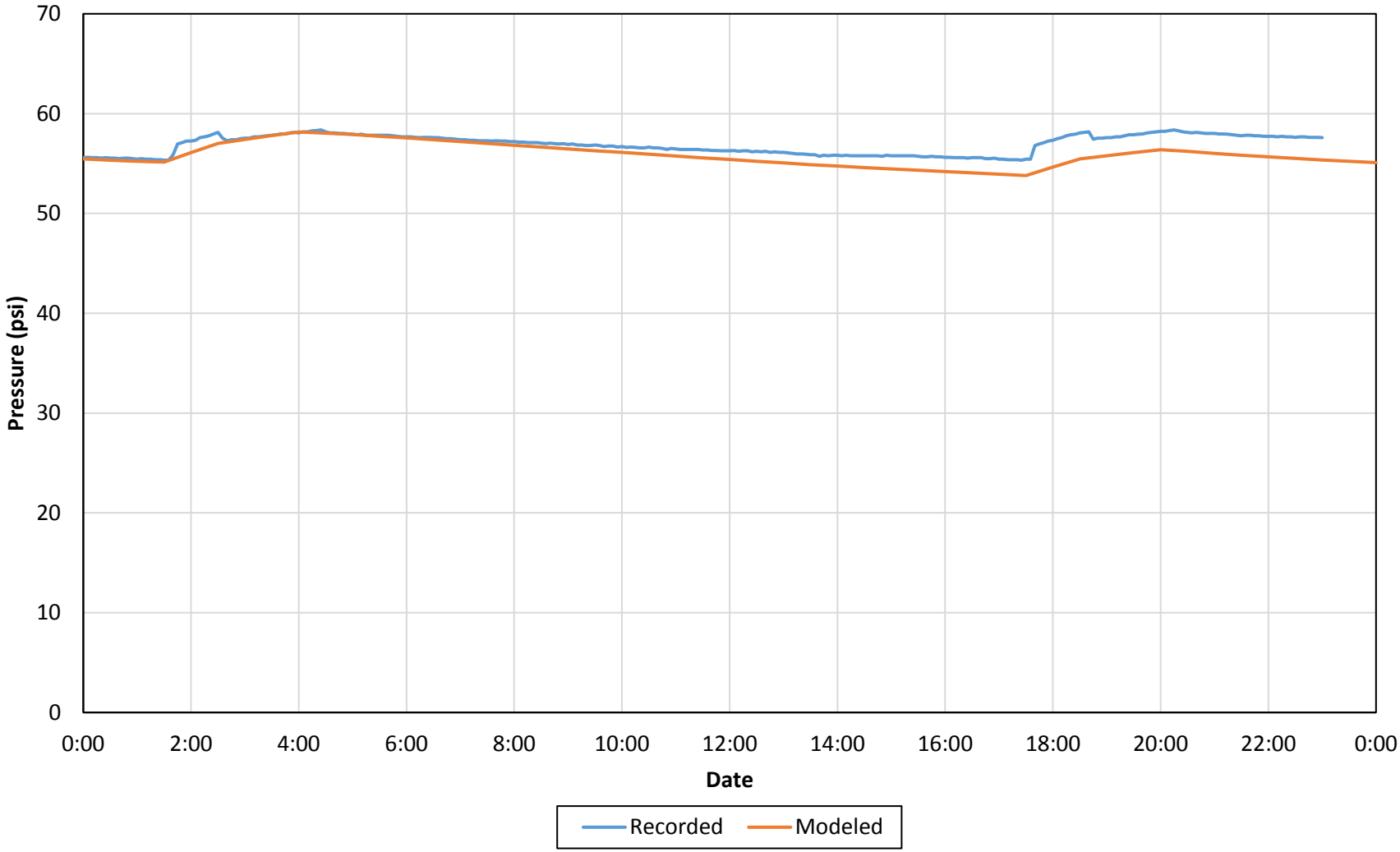


FIGURE B-2
The Colony
PR #3
Pressure Calibration
March 11, 2018

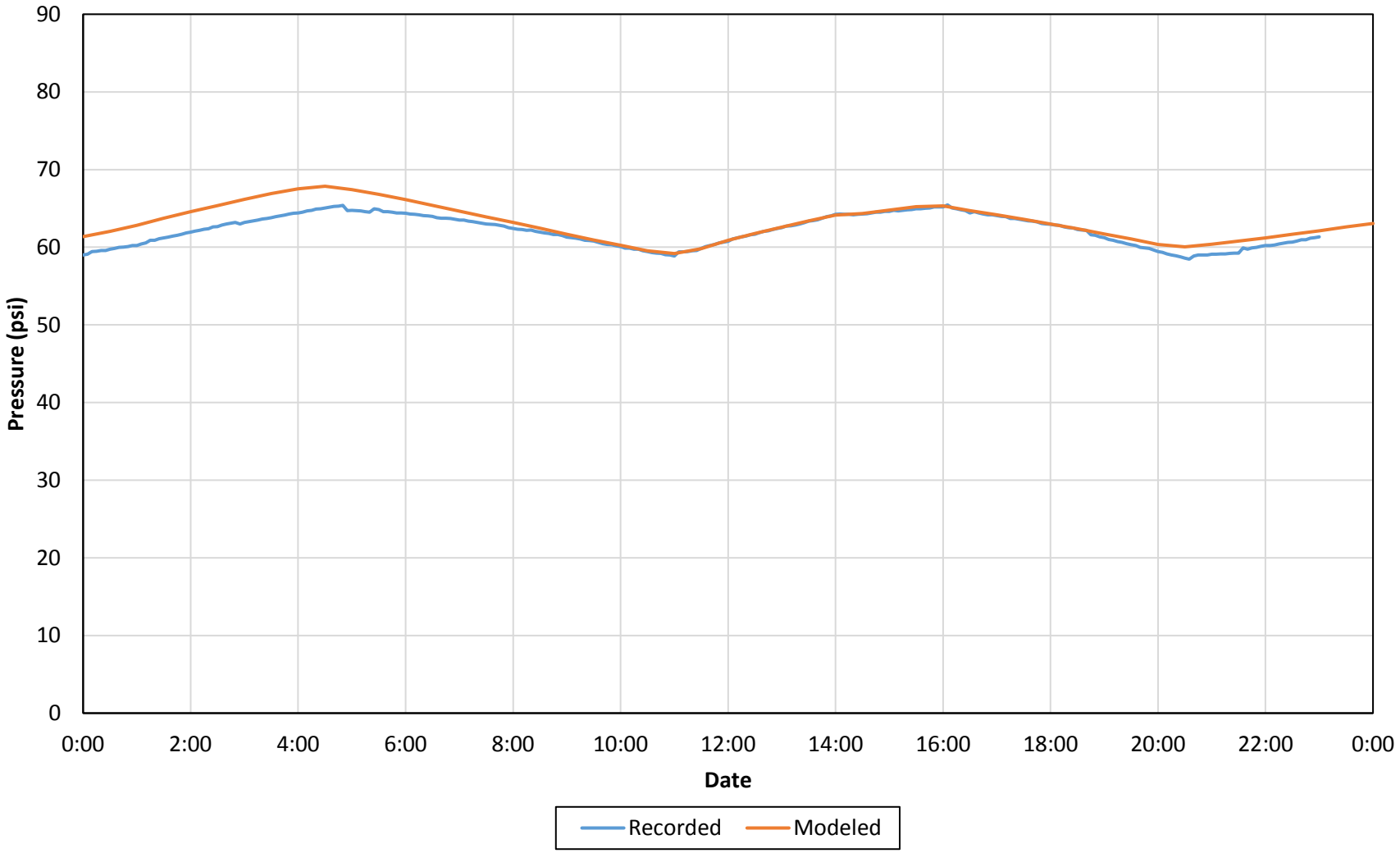


FIGURE B-3
The Colony
PR #4
Pressure Calibration
March 11, 2018

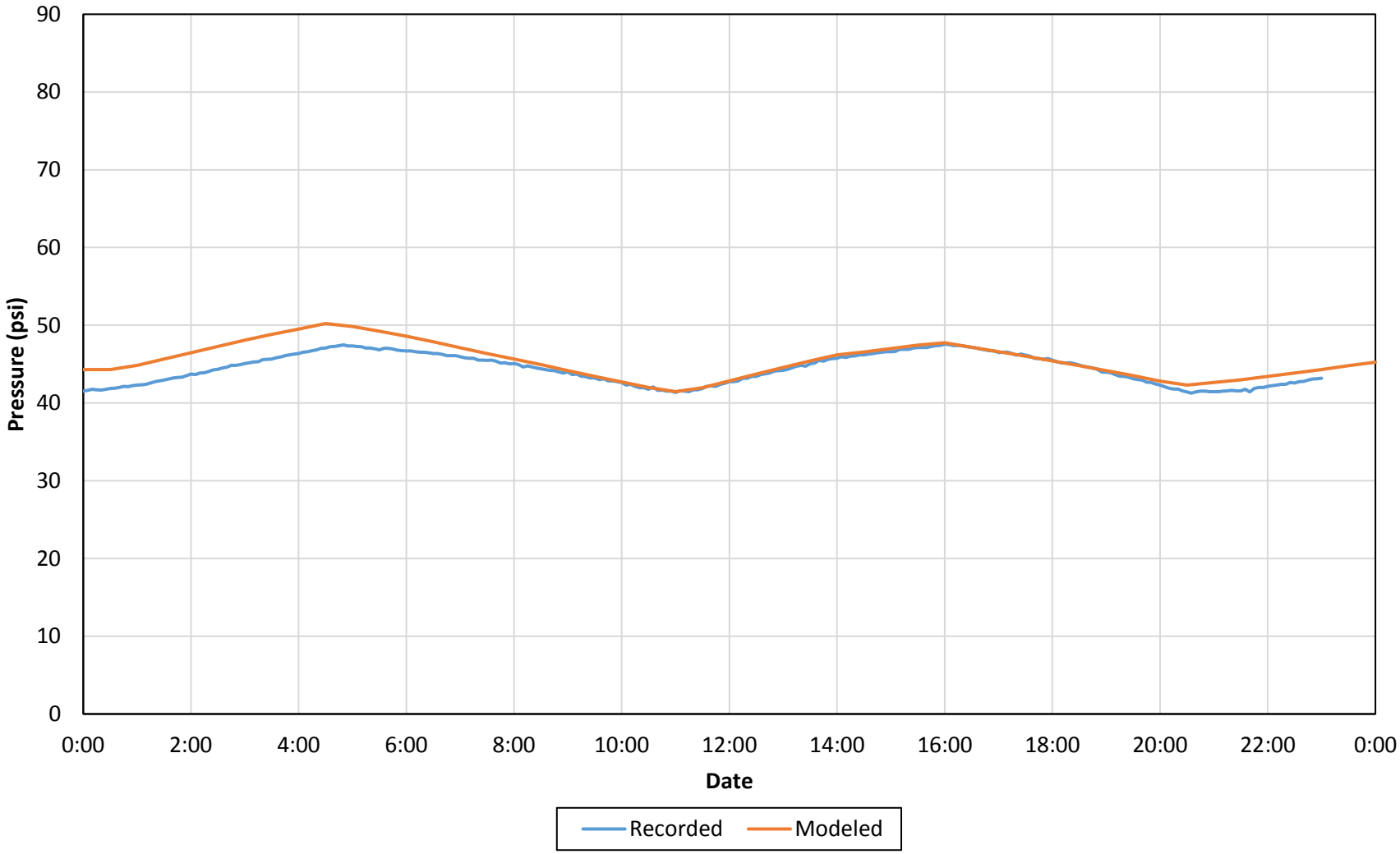


FIGURE B-4
The Colony
PR #5
Pressure Calibration
March 11, 2018

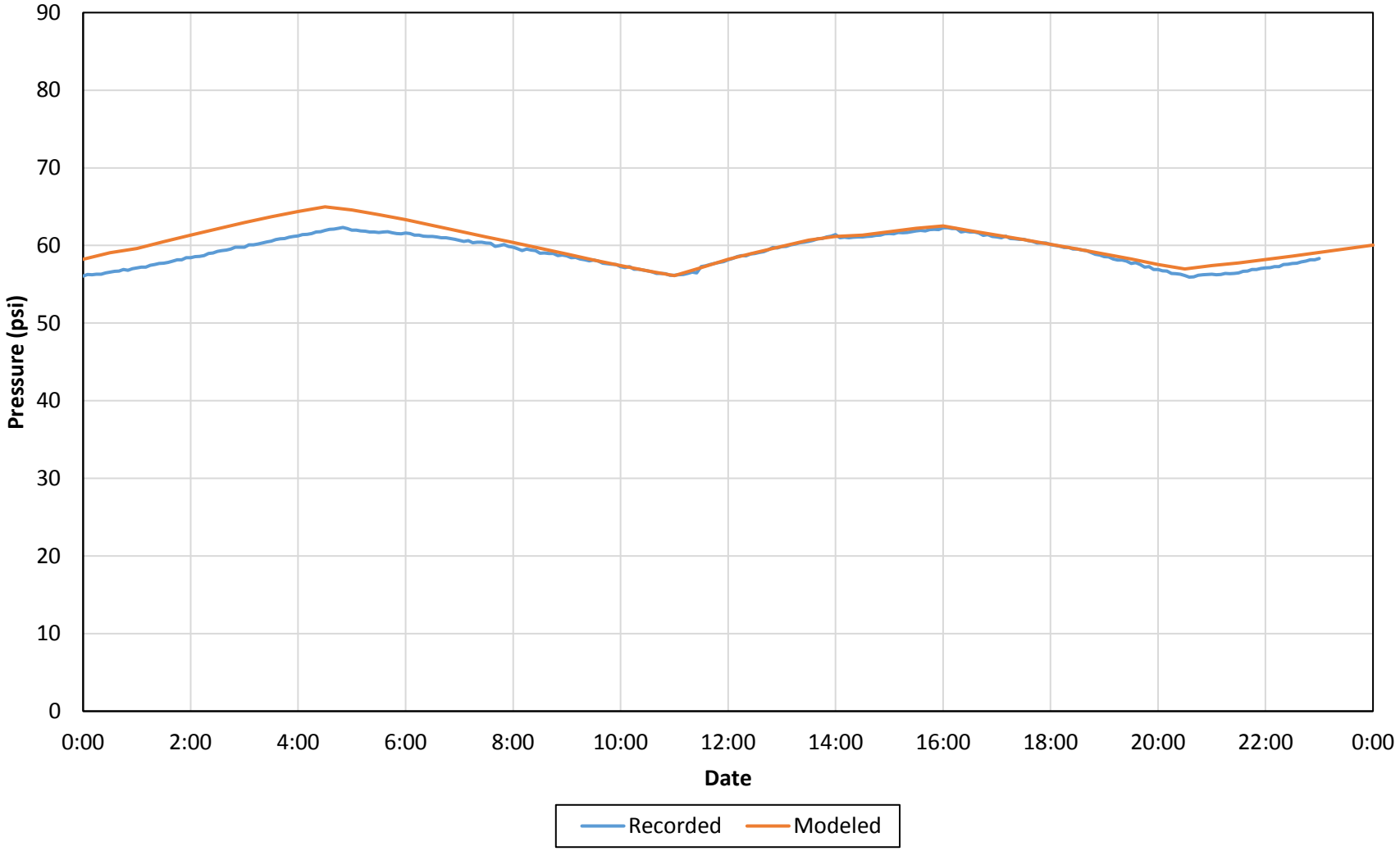


FIGURE B-5

The Colony

PR #6

Pressure Calibration

March 11, 2018

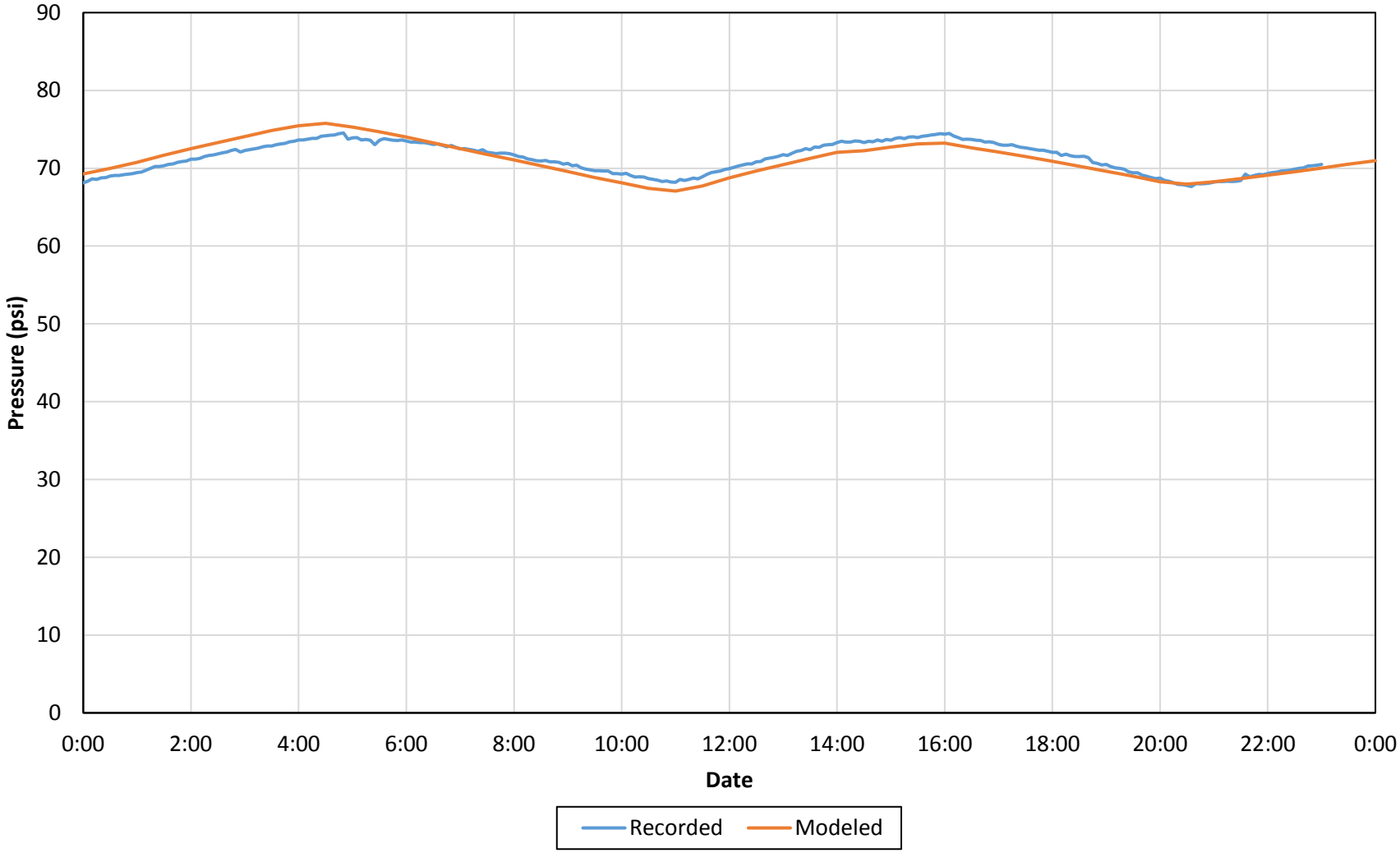


FIGURE B-6
The Colony
PR #7
Pressure Calibration
March 11, 2018

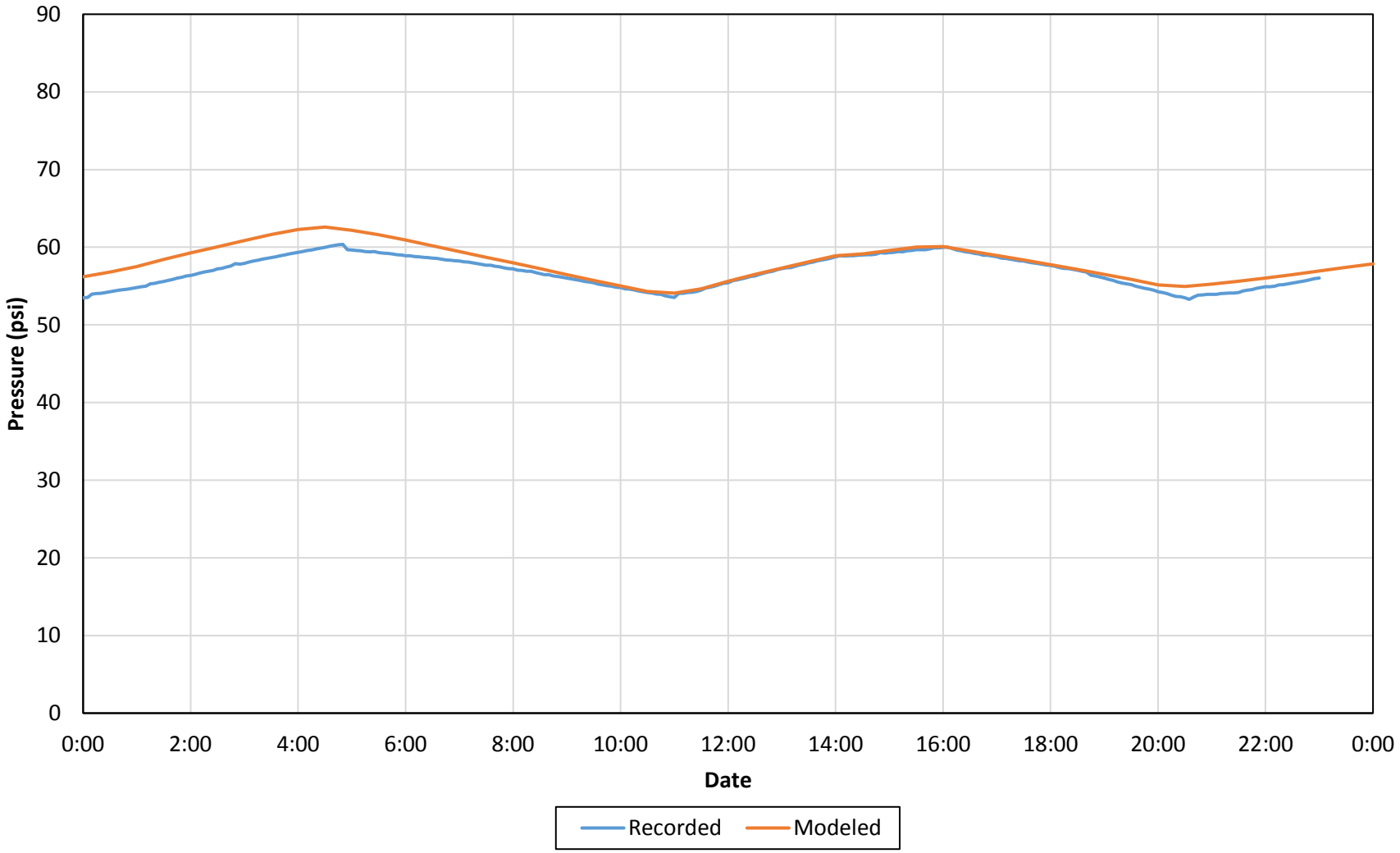


FIGURE B-7

The Colony

PR #8

Pressure Calibration

March 11, 2018

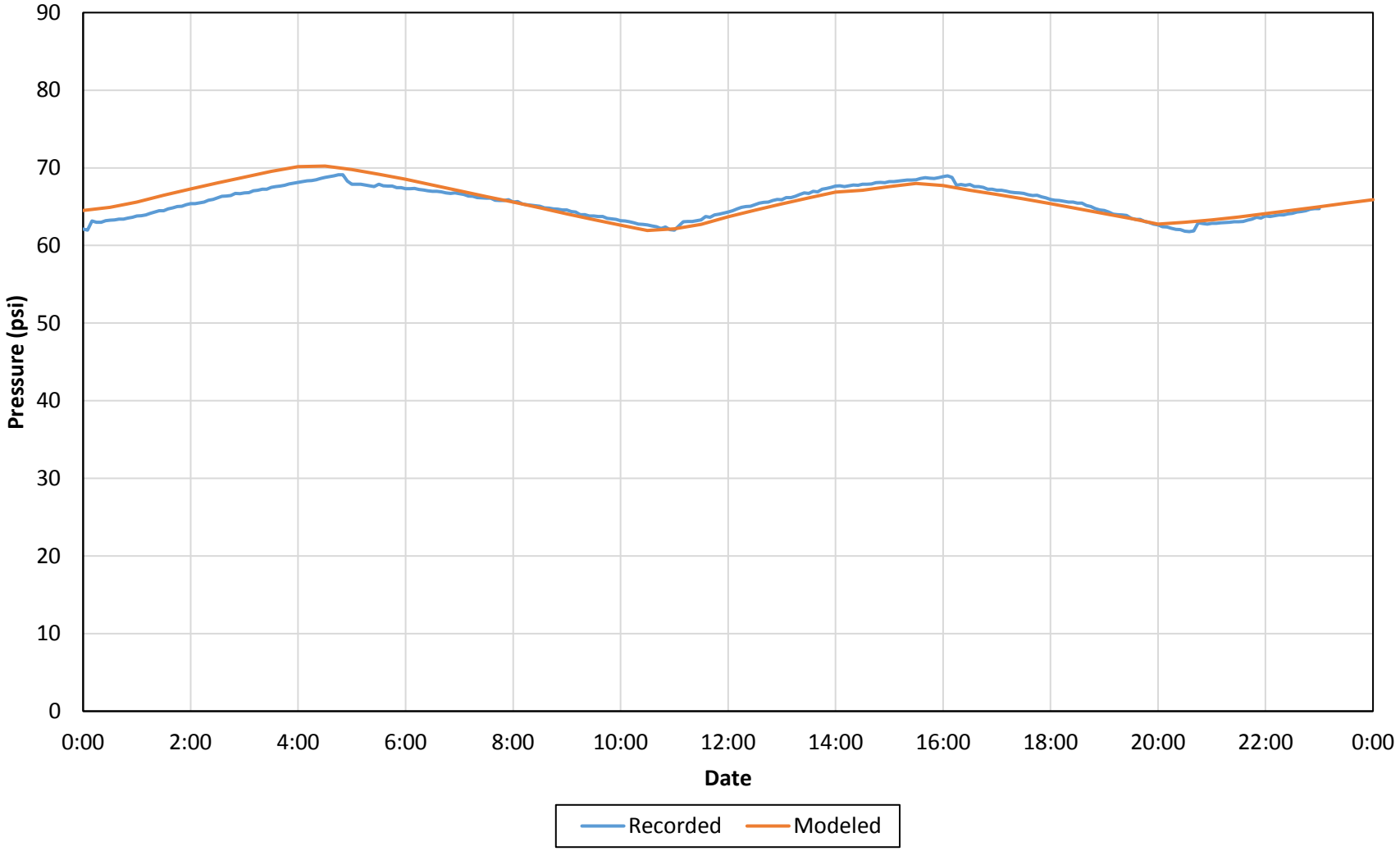


FIGURE B-8

The Colony

PR #9

Pressure Calibration

March 11, 2018

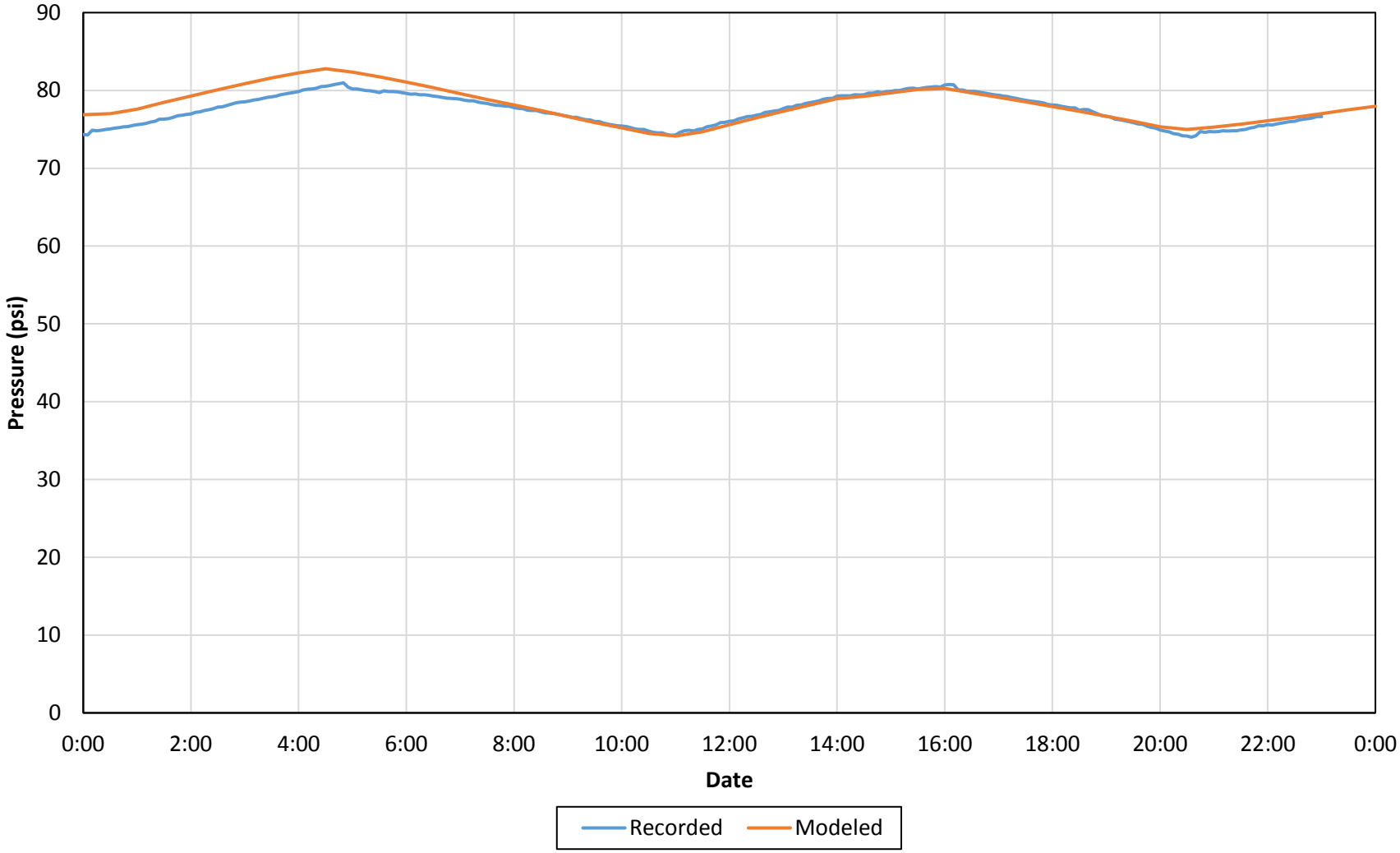


FIGURE B-9
The Colony
PR #10
Pressure Calibration
March 11, 2018

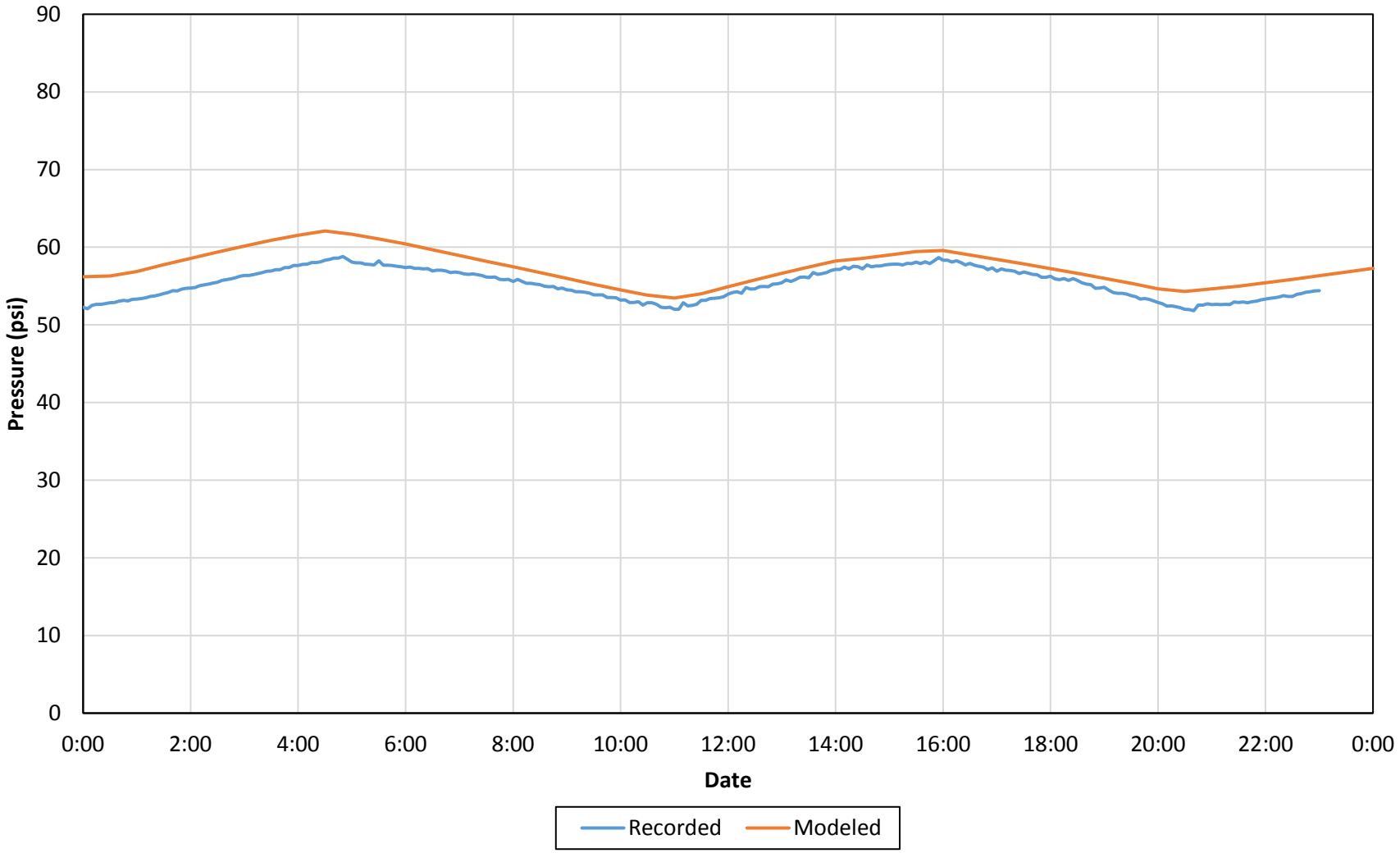


FIGURE B-10
The Colony
Clover Valley (PS #1)
PS Flow Calibration
March 11, 2018

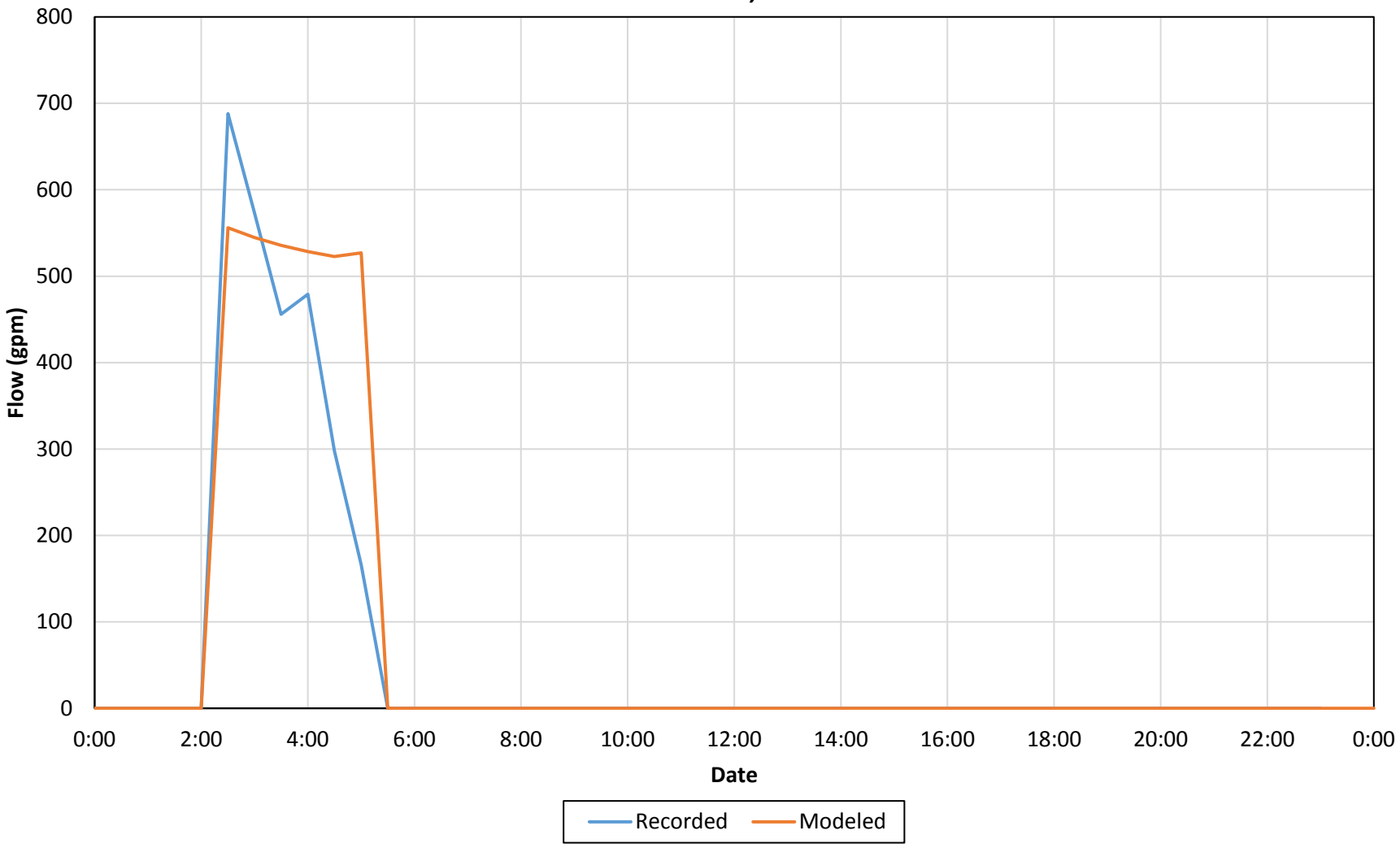


FIGURE B-11
The Colony
Main & Witt (PS #2)
PS Flow Calibration
March 11, 2018

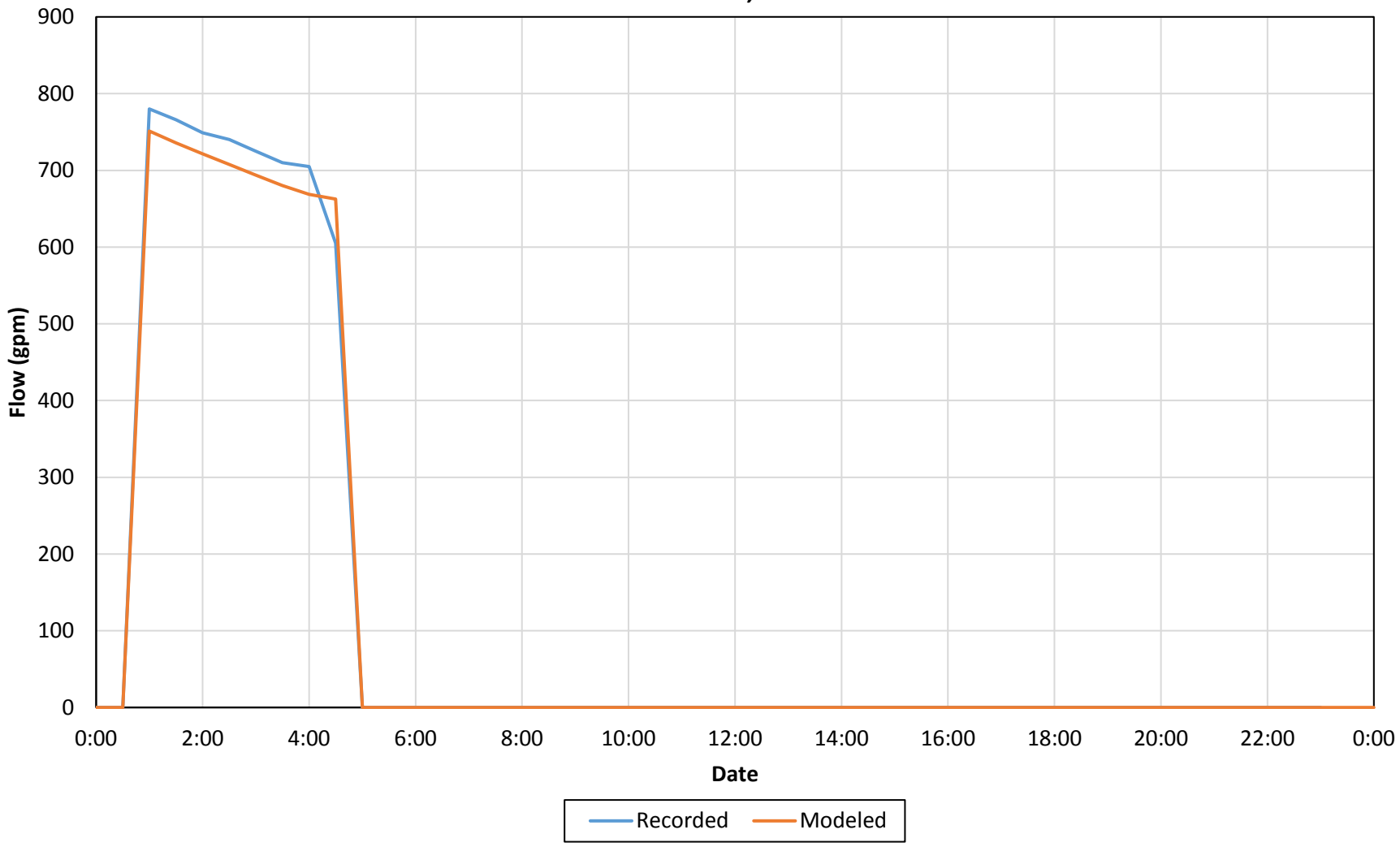


FIGURE B-12

The Colony

North Colony (PS #3)

PS Flow Calibration

March 11, 2018

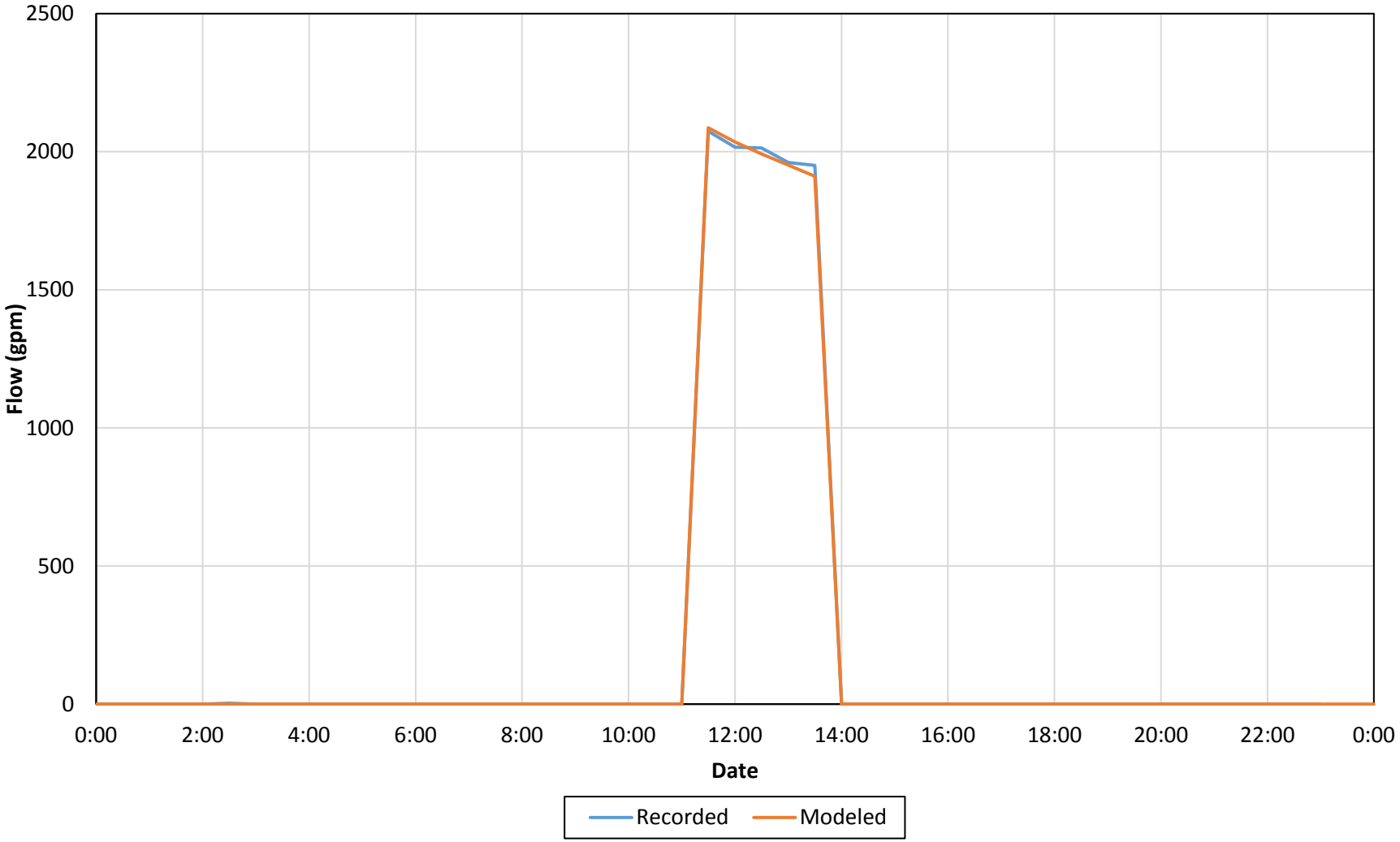


FIGURE B-13
The Colony
Office Creek (PS #4)
PS Flow Calibration
March 11, 2018

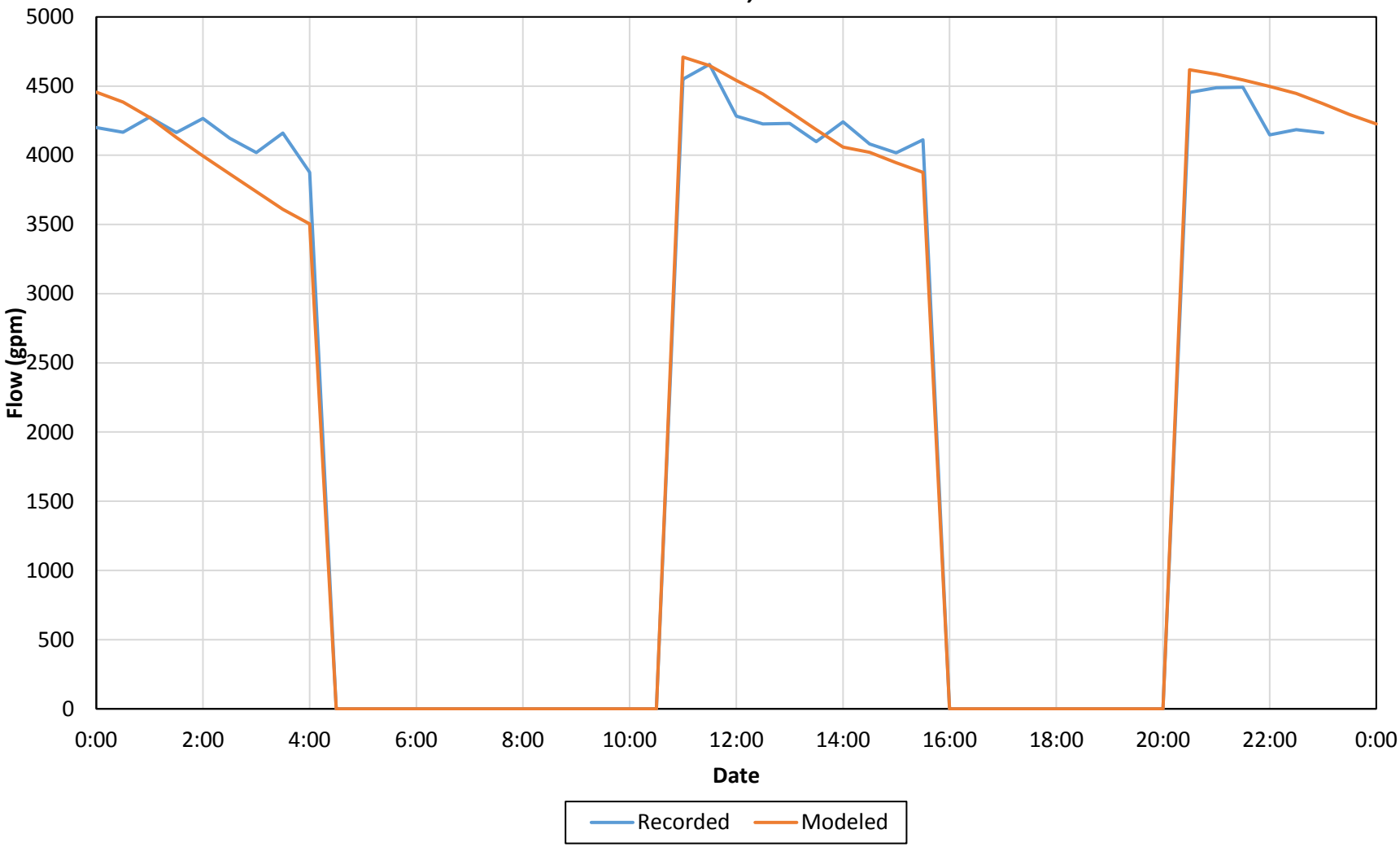


FIGURE B-14
The Colony
Wynnwood
PS Flow Calibration
March 11, 2018

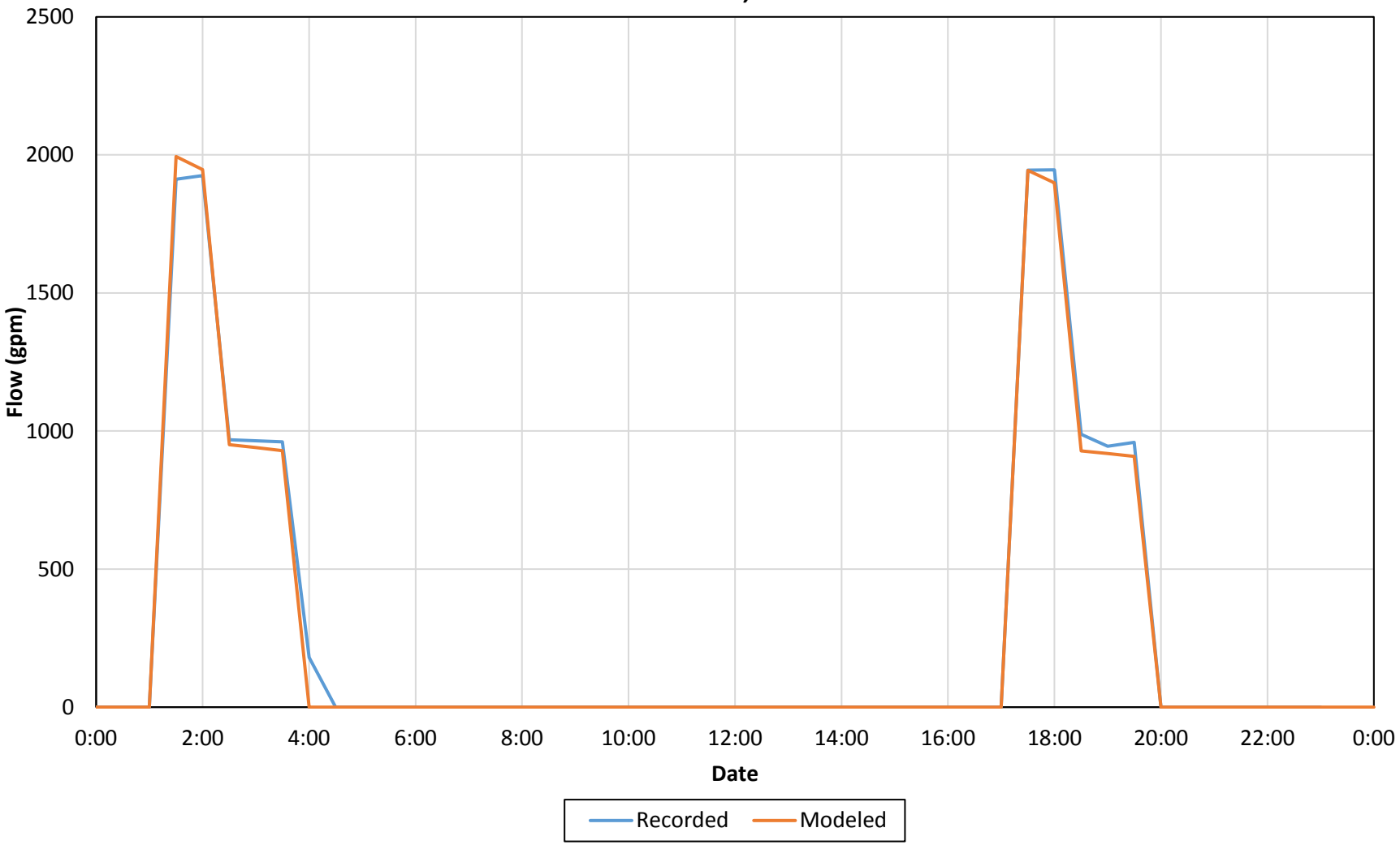


FIGURE B-15
The Colony
Clover EST (EST 1)
EST Calibration
March 11, 2018

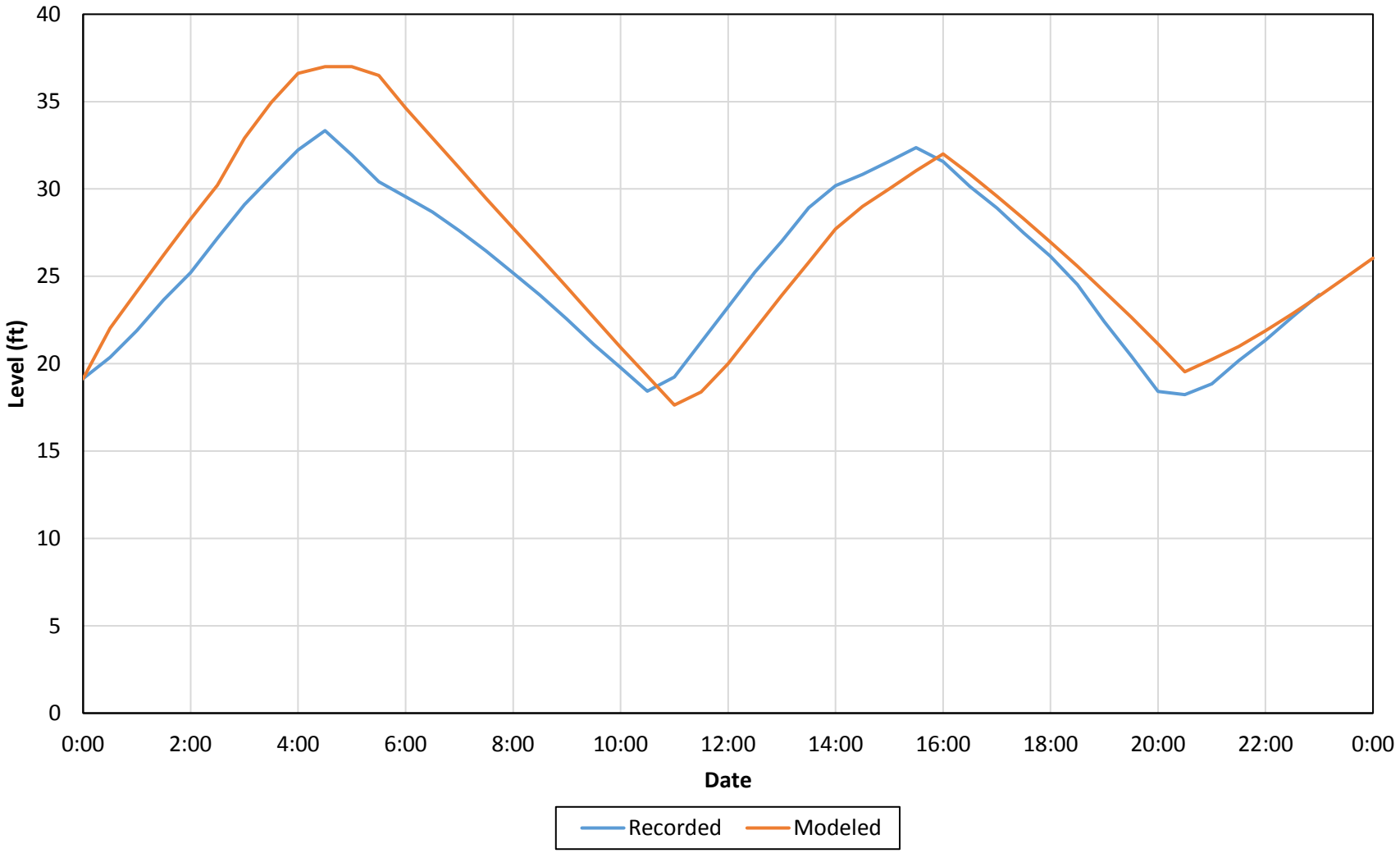


FIGURE B-16
The Colony
North Colony EST (EST 2)
EST Calibration
March 11, 2018

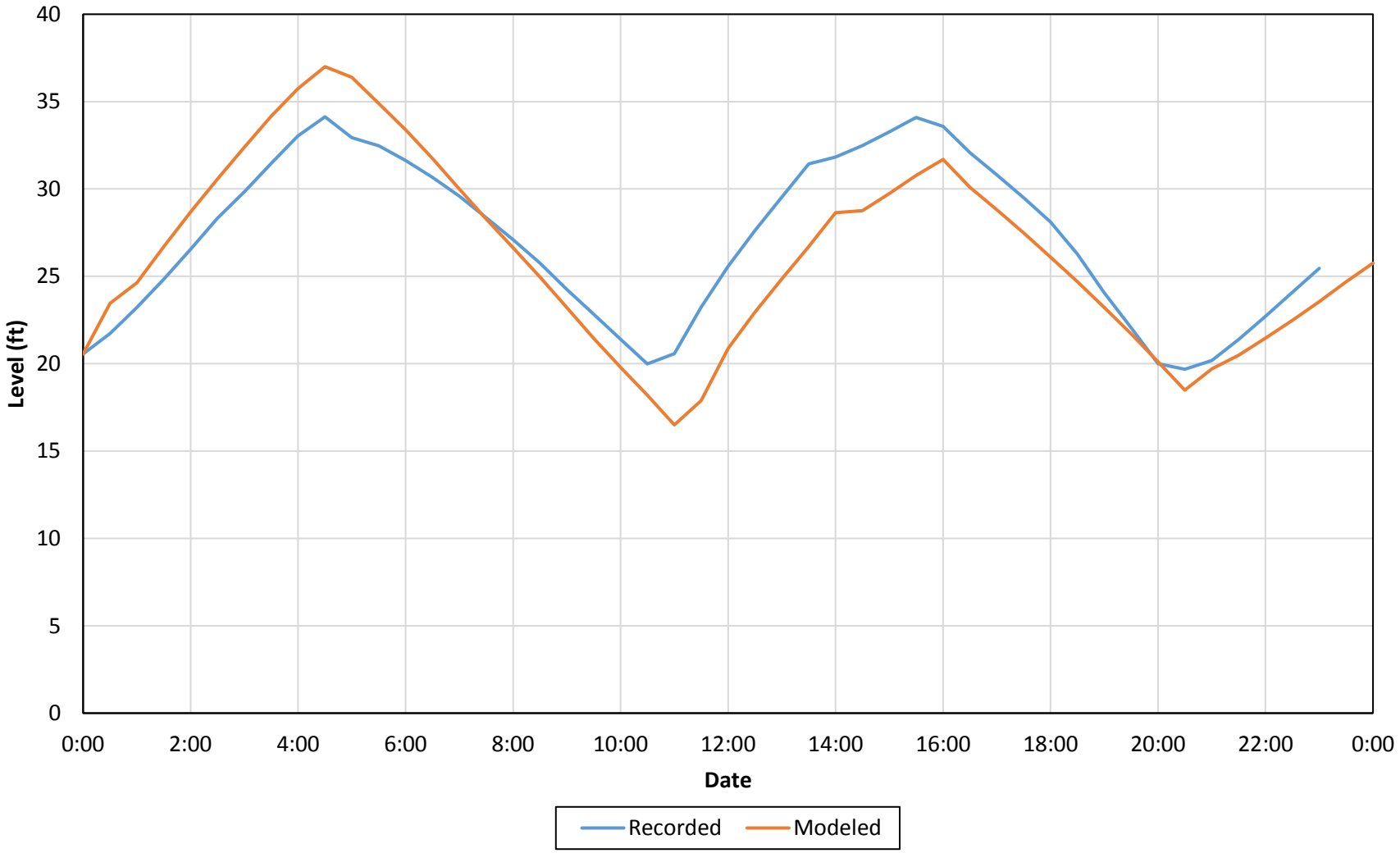


FIGURE B-17

The Colony
Chesapeake EST (EST 3)
EST Calibration
March 11, 2018

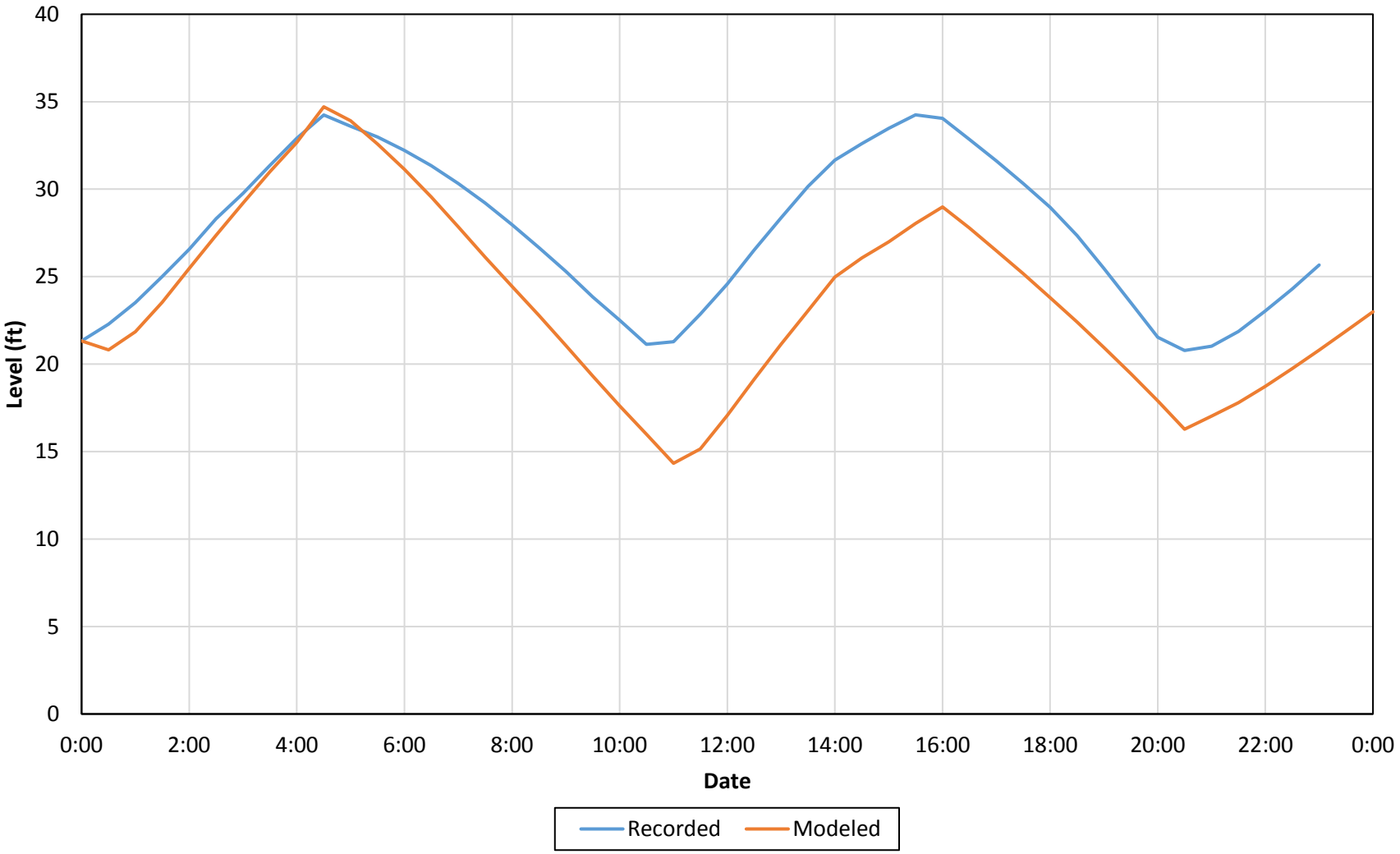


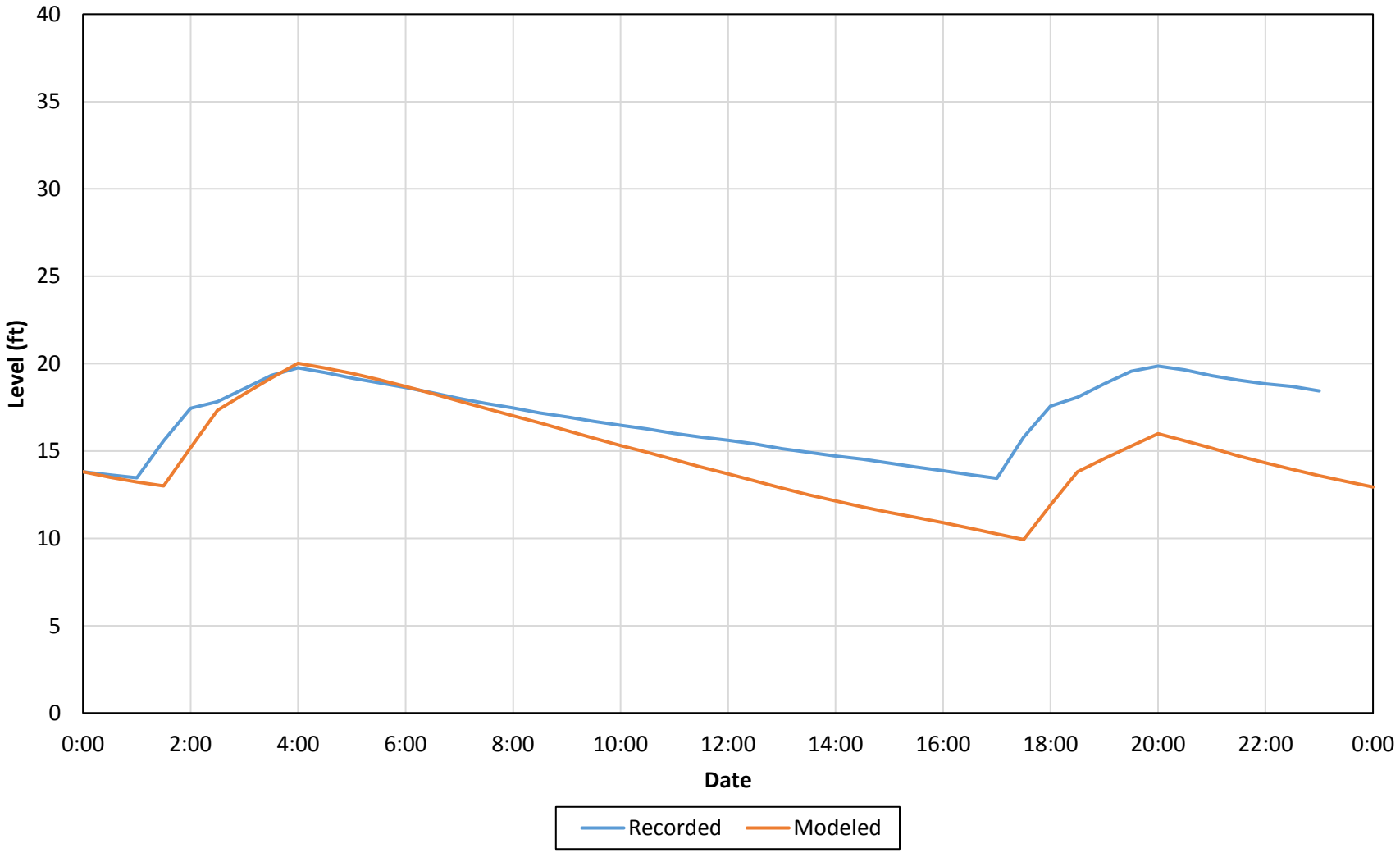
FIGURE B-18

The Colony

Tribute EST (EST 4, Wynnwood)

EST Calibration

March 11, 2018



APPENDIX C
Water System Analysis Mapping

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-1)_2018_Min_Pressures_Results.mxd
Updated: Tuesday, April 23, 2019 9:38:46 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

Hackberry
Little Elm
Frisco
Lewisville
Lake Lewisville
Plano
Carrollton
Hebron

FIGURE C-1
CITY OF THE COLONY
2018 WATER SYSTEM UNDER 2018 PEAK HOUR DEMAND (17.56 MGD) MINIMUM PRESSURES

LEGEND

- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES

- The Colony
- Tribute
- Austin Ranch (Service from Plano)

MINIMUM PRESSURES

- Less than 35 psi
- 35 - 50 psi
- 50 - 80 psi
- Greater than 80 psi

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,000
SCALE IN FEET

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-2)_2018_Max_Velocity_Results.mxd
Updated: Tuesday, April 23, 2019 9:37:08 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

Hackberry
Little Elm
Frisco
Plano
Carrollton
Hebron
Lewisville
Lake Lewisville

FIGURE C-2
CITY OF THE COLONY
2018 WATER SYSTEM UNDER 2018 PEAK HOUR DEMAND (17.56 MGD) MAXIMUM VELOCITY

LEGEND

- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES

- The Colony
- Tribute
- Austin Ranch (Service from Plano)

MAXIMUM VELOCITY

Exceeds Velocity Design Criteria

- 5.0 - 7.0 ft/sec
- Greater than 7.0 ft/sec

0 3,000
SCALE IN FEET

THE COLONY
City by the Lake

FREESE AND NICHOLS

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-3)_2018_Max_Headloss_Results.mxd
Updated: Tuesday, April 23, 2019 9:37:19 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #1
Capacity = 175 gpm

Paluxy Well #2
Capacity = 610 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

Hackberry
Little Elm
Frisco
Plano
Carrollton
Hebron
Lewisville
Lake Lewisville

FIGURE C-3
CITY OF THE COLONY
2018 WATER SYSTEM UNDER 2018 PEAK HOUR DEMAND (17.56 MGD) MAXIMUM HEADLOSS

LEGEND

- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES
- The Colony
- Tribute
- Austin Ranch (Service from Plano)

MAXIMUM HEADLOSS
Exceeds Headloss Design Criteria
- 5.0 - 7.0 ft/1,000 ft
- Greater than 7.0 ft/1,000 ft

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,000
SCALE IN FEET

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-4)_2018_Available FF_Results.mxd
Updated: Tuesday, April 23, 2019 9:37:29 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

Hackberry
Little Elm
Frisco
Lake Lewisville
Lewisville
Plano
Hebron
Carrollton

FIGURE C-4
CITY OF THE COLONY
2018 WATER SYSTEM UNDER 2018 MAXIMUM DAY DEMAND (9.75 MGD) AVAILABLE FIRE FLOW

LEGEND

- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

AVAILABLE FIRE FLOW

- Less than 1,500 gpm
- 1,500 - 3,000 gpm
- 3,000 - 4,500 gpm
- Greater than 4,500 gpm

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,000
SCALE IN FEET

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-5)_BO_Min_Pressures_Results.mxd
Updated: Tuesday, April 23, 2019 9:37:48 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

1.0 MG Proposed EST

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

FIGURE C-5
CITY OF THE COLONY
BUILDOUT WATER SYSTEM UNDER BUILDOUT PEAK HOUR DEMAND (26.64 MGD)
MINIMUM PRESSURES

LEGEND

- Proposed Elevated Storage Tank
- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES
- The Colony
- Tribute
- Austin Ranch (Service from Plano)

MINIMUM PRESSURES
- Less than 35 psi
- 35 - 50 psi
- 50 - 80 psi
- Greater than 80 psi

0 3,000
SCALE IN FEET

THE COLONY City by the Lake

FREESE AND NICHOLS

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-6)_BO_Max_Velocity_Results.mxd
Updated: Tuesday, April 23, 2019 9:38:19 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

1.0 MG Proposed EST

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

FIGURE C-6
CITY OF THE COLONY
BUILDOUT WATER SYSTEM UNDER BUILDOUT PEAK HOUR DEMAND (26.64 MGD) MAXIMUM VELOCITY

LEGEND

- Proposed Elevated Storage Tank
- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES
- The Colony
- Tribute
- Austin Ranch (Service from Plano)

MAXIMUM VELOCITY
Exceeds Velocity Design Criteria
- 5.0 - 7.0 ft/sec
- Greater than 7.0 ft/sec

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,000
SCALE IN FEET

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-7)_BO_Max_Headloss_Results.mxd
Updated: Tuesday, April 23, 2019 9:38:26 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

Paluxy Well #2
Capacity = 610 gpm

Trinity Well #4
Capacity = 2,180 gpm

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

1.0 MG Proposed EST

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

FIGURE C-7
CITY OF THE COLONY
BUILDOUT WATER SYSTEM UNDER BUILDOUT PEAK HOUR DEMAND (26.64 MGD) MAXIMUM HEADLOSS

LEGEND

- Proposed Elevated Storage Tank
- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES
- The Colony
- Tribute
- Austin Ranch (Service from Plano)

MAXIMUM HEADLOSS
Exceeds Headloss Design Criteria
- 5.0 - 7.0 ft/1,000 ft
- Greater than 7.0 ft/1,000 ft

THE COLONY City by the Lake

FREESE AND NICHOLS

0 3,000
SCALE IN FEET

Created by Freese and Nichols, Inc.
Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_C-8)_BO_Available FF_Results.mxd
Updated: Tuesday, April 23, 2019 9:38:58 AM
User Name: 02499

Tribute PS
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute EST
Overflow Elev. = 698'

Main and Whitt PS #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

0.5 MG N Colony EST #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

N Colony PS #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

Trinity Well #1
Capacity = 175 gpm

0.5 MG Clover EST #1
Overflow Elev. = 735'

1.0 MG Chesapeake EST #3
Overflow Elev. = 735'

Paluxy Well #2
Capacity = 610 gpm

Clover Valley PS #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

1.0 MG Proposed EST

Trinity Well #4
Capacity = 2,180 gpm

Office Creek PS #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water Supply Line

FIGURE C-8
CITY OF THE COLONY
BUILDOUT WATER SYSTEM UNDER BUILDOUT MAXIMUM DAY DEMAND (14.80 MGD) AVAILABLE FIRE FLOW

LEGEND

- Proposed Elevated Storage Tank
- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

AVAILABLE FIRE FLOW
- Less than 1,500 gpm
- 1,500 - 3,000 gpm
- 3,000 - 4,500 gpm
- Greater than 4,500 gpm

0 3,000
SCALE IN FEET

THE COLONY
City by the Lake

FREESE AND NICHOLS

APPENDIX D
Full Size Existing System Map

FIGURE 4-1
CITY OF THE COLONY
EXISTING WATER SYSTEM

LEGEND

- Groundwater Well
- Pump Station
- Ground Storage Tank
- Elevated Storage Tank
- 10" and Smaller Water Line
- 12" and Larger Water Line
- Water Supply Line
- Road
- Railroad
- Stream
- Lake
- Parcel
- USACE Property
- Water Service Area
- ETJ Boundary
- Other City Limit
- County Boundary

PRESSURE PLANES

- The Colony
- Tribute
- Austin Ranch (Service from Plano)

Tribute
Pump Station
(1) - 1.0 MG Ground Storage Tank
(4) - 1,000 gpm Pumps

1.0 MG Tribute
Elevated Storage Tank
Overflow Elev. = 698'

Main and Whitt
Pump Station #2
(1) - 0.4 MG Ground Storage Tank
(1) - 0.6 MG Ground Storage Tank
(1) - 500 gpm Pump
(1) - 700 gpm Pump
(2) - 1,400 gpm Pumps

Trinity Well #2
Capacity = 1,500 gpm

0.5 MG North Colony
Elevated Storage Tank #2
Overflow Elev. = 735'

Trinity Well #3
Capacity = 2,000 gpm

North Colony
Pump Station #3
(1) - 1.0 MG Ground Storage Tank
(2) - 2,100 gpm Pumps

Trinity Well #1
Capacity = 175 gpm

Paluxy Well #2
Capacity = 610 gpm

0.5 MG Clover
Elevated Storage Tank #1
Overflow Elev. = 735'

1.0 MG Chesapeake
Elevated Storage Tank #3
Overflow Elev. = 735'

Clover Valley
Pump Station #1
(1) - 0.4 MG Ground Storage Tank
(2) - 500 gpm Pumps
(1) - 1,300 gpm Pump

Trinity Well #4
Capacity = 2,180 gpm

Office Creek
Pump Station #4
(2) - 3.0 MG Ground Storage Tanks
(1) - 2,000 gpm Pump
(2) - 4,500 gpm Pumps
(1) - 6,000 gpm Pump

DWU Water
Supply Line

Little Elm · Hackberry · Frisco · The Colony · Lake Lewisville · Lewisville · Hebron · Carrollton · Plano · Austin Ranch · DENTON CO. · COLLIN CO.

0 1,800 3,600
SCALE IN FEET

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Job No.: COY17543
Location: H:\W_WW_PLANNING\01_DELIVERABLES\00_FINAL_REPORT\01-WATER\Appendix_C\(Figure_4-1)_Existing_Water_System.mxd
Updated: Tuesday, April 23, 2019 9:37:05 AM
User Name: 02499

APPENDIX E
Capital Improvement Plan Projects

City of The Colony

DRAFT Capital Improvement Cost Estimate — **Costs in 2018 Dollars**

Construction Project Number: 1 — **Phase:** short

Project Name: 1.0 MG Elevated Storage Tank

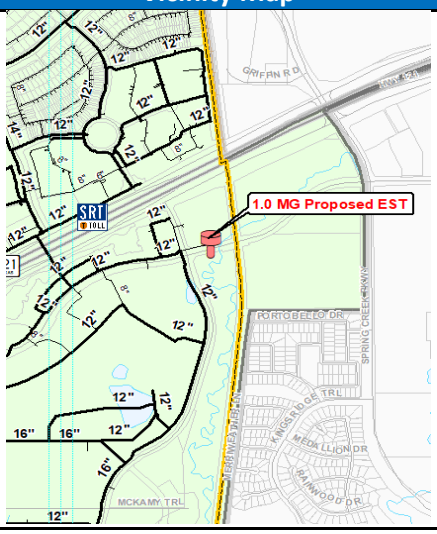
Project Description:

Construct a new 1.0 MG EST in the Grandscape area.

Project Drivers:

An elevated storage shortfall was projected beginning in 2023. A new 1.0 EST will provide supplemental elevated storage to meet requirements through Buildout conditions. Additionally, situating the EST in the Grandscape area will increase fire-flow storage in the area.

Vicinity Map



Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Misc. Tank Site Work	1	LS	$ 350,000	$ 350,000
2	1.0 MG Elevated Storage Tank	1	LS	$ 2,750,000	$ 2,750,000
3	SCADA System Improvements	1	LS	$ 80,000	$ 80,000
4	Land Acquisition	1	Ac	$ 250,000	$ 250,000
5	Residual Control System	1	LS	$ 180,000	$ 180,000
				SUBTOTAL:	**$ 3,610,000**
			CONTINGENCY	30%	$ 1,083,000
				SUBTOTAL:	**$ 4,693,000**
			ENG/SURVEY	20%	$ 938,600
				SUBTOTAL:	**$ 5,631,600**
				Estimated Project Total:	**$ 5,631,600**

Comments:

City of The Colony

DRAFT Capital Improvement Cost Estimate — **Costs in 2018 Dollars**

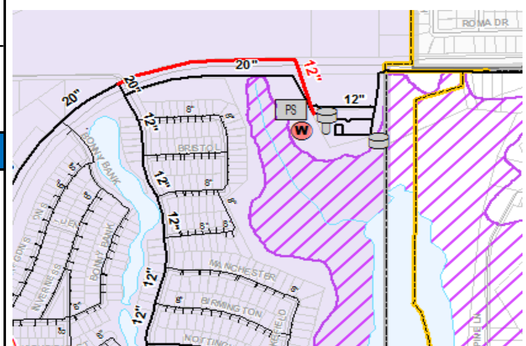
Construction Project Number: 2 — **Phase:** short

Project Name: **Redundant Tribute PS Pipeline**

Project Description:

Construct a redundant 12-inch water line from the Tribute Pump Station to the intersection of Boyd Road and Lebanon Road, parallel to the existing 20-inch water line.

Vicinity Map



Project Drivers:

This project will add redundancy to the Tribute water system. In the event of failure of the existing 20-inch supply line from the pump station, the new 12-inch water line will have the capacity to supply maximum day demands to the Tribute system.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	1,800	LF	$ 108	$ 194,400
2	20" Boring and Casing	150	LF	$ 350	$ 52,500
				SUBTOTAL:	**$ 246,900**
			CONTINGENCY	30%	$ 74,100
				SUBTOTAL:	**$ 321,000**
			ENG/SURVEY	20%	$ 64,200
				SUBTOTAL:	**$ 385,200**
				Estimated Project Total:	**$ 385,200**

Comments:

City of The Colony

DRAFT Capital Improvement Cost Estimate — **Costs in 2018 Dollars**

Construction Project Number: 3 — **Phase:** intermediate

Project Name: Tribute Groundwater Well

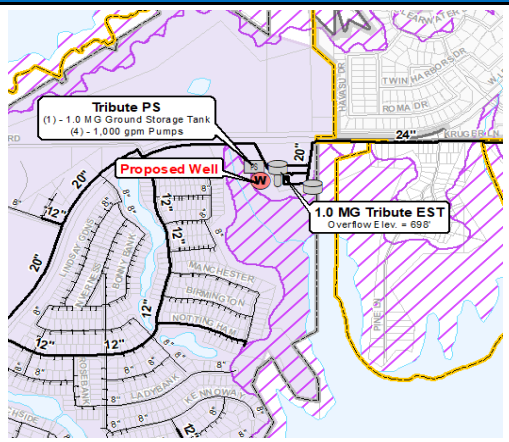
Project Description:

Drill a new 1,250 gpm groundwater well at the Tribute/Wynnwood GST site.

Project Drivers:

A new groundwater well will add additional supply necessary to satisfy Buildout water supply requirements and add redundancy to the water supply system in the Tribute/Wynnwood Peninsula area. The Wynnwood Peninsula is currently supplied through a single 24-inch transmission main from The Colony PP. In the event of failure of the 24-inch transmission main, the Tribute Well will have adequate capacity to supply Buildout maximum day demand.

Vicinity Map



Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	New 1,250 GPM Groundwater Well	1	EA	$ 2,700,000	$ 2,700,000
				SUBTOTAL:	**$ 2,700,000**
			CONTINGENCY	30%	$ 810,000
				SUBTOTAL:	**$ 3,510,000**
			ENG/SURVEY	20%	$ 702,000
				SUBTOTAL:	**$ 4,212,000**
				Estimated Project Total:	**$ 4,212,000**

Comments: