City of Killeen

Water and Wastewater Master Plan

May 2007

Prepared for:

City of Killeen

KIL06188

Prepared by:

Freese and Nichols, Inc.
4055 International Plaza
Suite 200
Fort Worth, TX 76109
817/735-7300

City of Killeen

Water and Wastewater Master Plan

May 2007

Prepared for:

City of Killeen

KIL06188

Prepared by:

Freese and Nichols, Inc.
4055 International Plaza
Suite 200
Fort Worth, TX 76109
817/735-7300

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1-1

1.1 Introduction 1-1

1.2 Population 1-1

1.3 Water Demands 1-2

1.4 Water Capital Improvement Plan 1-3

1.5 Wastewater Flows 1-3

1.6 Wastewater Capital Improvement Plan 1-4

1.7 Recommended System Improvements 1-5

2.0 POPULATION 2-1

2.1 Historical and Existing Population 2-1

2.2 Population and Commercial Growth Projections 2-1

2.3 Population and Commercial Area Distribution 2-2

3.0 WATER DEMANDS 3-1

3.1 Historical and Existing Water Demands 3-1

3.2 Projected Water Demands 3-2

4.0 EXISTING WATER SYSTEM 4-1

4.1 Existing Water Distribution System 4-1
A. Lower Pressure Plane 4-1
B. Middle Pressure Plane 4-4
C. Upper Pressure Plane 4-4
D. Airport Pressure Plane 4-5

4.2 Water System Field Testing and Model Calibration 4-5

4.3 Water System Design Criteria 4-10
A. Water Transmission Lines (8-inch and larger) 4-10
B. Elevated Storage Tanks 4-11
C. Ground Storage Tanks 4-11

D. Pump Stations 4-11

4.4 Existing Water System Analysis 4-11

5.0 FUTURE WATER SYSTEM 5-1

5.1 Future Water Supply 5-1

5.2 Future Pressure Plane Delineation 5-1

5.3 Pumping and Elevated Storage Requirements 5-1
A. Elevated Storage 5-2
B. Pumping Capacity 5-2
C. 2016 System Summary 5-2

6.0 WATER SYSTEM CAPITAL IMPROVEMENT PLAN 6-1

6.1 Water System Improvements from 2007 to 2009 6-1
A. **Water Service Extension and Looping for Proposed Growth (Projects 1W & 3W)** 6-1
B. **Increase Bundrant Elevated Storage Capacity to 1.5 MG (Project 2W)** 6-2
C. **Pump Station 3 Pumping Capacity Expansion (Project 4W)** 6-2
D. **Downtown Condition Assessment Priority Renewal Plan (Project A)** 6-2

6.2 Water System Improvements from 2010 to 2012 6-2
A. **Increased Transmission Capacity to the Bundrant EST (Project 5W)** 6-2
B. **Water Service Extension and Looping in the LPP and UPP (Projects 6W&7W)** 6-3
C. **South Delivery Point and Increased Capacity to UPP (Projects 8W, 9W & 10W)** 6-3
D. **Downtown Rehabilitation (Project B)** 6-3

6.3 Water System Improvements from 2013 to 2015 6-4
A. **New Pump Station and Ground Storage Tank Serving the Northeast LPP (Project 11W)** 6-4
B. **Airport Pressure Plane Looping and PRV (Project 12W)** 6-4
C. **UPP Service Extension and Increased Elevated Storage Capacity (Project 13W)** 6-4
D. **16-Inch Water Line along 38th Street (Project 14W)** 6-4
E. **LPP Pump Station and Transmission Lines (Project 15W)** 6-4
F. **Downtown Rehabilitation (Project C)** 6-5

6.4 Water System Improvements from 2016 to 2018 6-5
A. **Pressure Plane Modifications (Project 16W)** 6-5
B. **Increased Transmission Capacity & Looping in UPP (Projects 19W & 20W)** 6-5

C. **Increased Transmission Capacity & Looping in LPP (Projects 18W, 21W & 25W)** 6-5
D. **Extend Water Service and Looping (Project 22W)** 6-6
E. **Water Service Extension in LPP (Projects 17W & 23W)** 6-6
F. **Increased Airport Pressure Plane Boundary and Pumping Capacity (Project 24W)** 6-6

6.5 Water System Improvements from 2019 to 2021 6-7
A. **Water Service Extension in the LPP and Elevated Storage (Projects 27W & 29W)** 6-7
B. **Increased Transmission Capacity in LPP (Project 28W)** 6-7
C. **Water Service Extension and Looping for the UPP (Projects 26W & 31W)** 6-7
D. **Additional South Delivery Point Storage and Pumping Capacity (Project 30W)** 6-7

6.6 Water System Improvements from 2022 to 2024 6-7
A. **Water Service Extension and Looping in the LPP (Projects 32W & 33W)** . 6-7

7.0 WASTEWATER FLOWS 7-1

7.1 Historical and Existing Wastewater Flows 7-1

7.2 Projected Wastewater Flows 7-2

8.0 EXISTING WASTEWATER SYSTEM 8-1

8.1 Existing Wastewater Collection System 8-1

8.2 Wastewater Model Development 8-1

8.3 Wastewater System Field Testing 8-4

8.4 Dry Weather Model Calibration 8-4

8.5 Wet Weather Model Calibration 8-5

8.6 Wastewater System Design Criteria 8-7
A. **Sewer Trunk Lines (Interceptors)** 8-7
B. **Lift Station Pumping Capacity** 8-7
C. **Lift Station Wet Well Capacity** 8-9
D. **Force Mains** 8-9

8.7 Existing Wastewater System Analysis 8-9

9.0 FUTURE WASTEWATER SYSTEM 9-1

9.1 Design Storm Conditions 9-1

10.0 WASTEWATER SYSTEM CAPITAL IMPROVEMENT PLAN 10-1

10.1 Wastewater System Improvements from 2007 to 2009 10-3
A. **Lift Station Upgrade to Support Growth in Long Branch Sub-basin (Project 1S)** 10-3
B. **Collection Interceptor to Support Growth (Projects 2S, 3S)** 10-3
C. **Collection System to Support Growth in SH 195 Sub-basin (Projects 4S, 5S)** 10-4
D. **Reduction of Inflow and Infiltration in the City (Project A)** 10-4

10.2 Wastewater System Improvements from 2010 to 2012 10-4
A. **Collection System for New Service Areas and Interconnectivity (Projects 6S, 9S)** 10-4
B. **Collection System to Support Growth in South (Projects 7S, 10S, 12S, 13S)** 10-5
C. **CMOM/SSO Program (Project B)** 10-5
D. **Reduction of I/I to Free up Treatment and Collection Capacity (Projects 8S & C)** 10-6
E. **Lift Station Upgrade in Central Sub-basin (Project 11S)** 10-6

10.3 Wastewater System Improvements from 2013 to 2015 10-6
A. **New Collection System to Support Growth in Long Branch (Projects 14S & 15S)** 10-6
B. **Collection System to Support Growth South of the City (Projects 16S & 17S)** 10-7
C. **Interceptor to Support Growth in the Central Sub-basin (Project 18S)** 10-7
D. **Collection System to Support Growth in South Nolan Sub-basin (Project 19S)** 10-7

10.4 Wastewater System Improvements from 2016 to 2018 10-7
A. **Collection System to Support Growth in the South (Projects 20S, 21S, 22S, 24S)** 10-7
B. **New Gravity Main in the North (Project 23S)** 10-8

10.5 Wastewater System Improvements from 2019 to 2021 10-8
A. **Addition of a Parallel Major Interceptor to Trimmier Creek WWTP (Project 25S)** 10-8
B. **Development of SH 195 Corridor (Projects 26S, 27S, 28S)** 10-8
C. **Rehabilitation of Lift Station 1(Project 29S)** 10-9

10.6 Wastewater System Improvements from 2022 to 2024 10-9
A. **New Collection System to support Growth in the South (Project 30S)** 10-9
B. **New Collection System to support Growth in the North (Project 31S)** 10-9

11.0 SUMMARY CAPITAL IMPROVEMENT COSTS AND BOND PROGRAM 11-1

LIST OF TABLES

Table 1.1 Historical Growth 1-1
Table 1.2 Projected Population Growth 1-2
Table 1.3 Projected Water Demands 1-2
Table 1.4 Projected Wastewater Flows 1-4
Table 1.5 CIP Summary Bond Projects 1-5
Table 1.6 Administrative, Regulatory, & Operational Project Costs 1-5
Table 2.1 Historical Population and Growth 2-1
Table 2.2 Projected Population and Annual Growth Rate 2-2
Table 2.3 City of Killeen Population By Census Tract and Time Period 2-6
Table 3.1 Historical Water Usage Data 3-1
Table 3.2 City of Killeen Top 20 Individual Water Users 3-2
Table 3.3 Projected Water Demands 3-3
Table 3.4 Summary of Projected Water Demands by Pressure Plane 3-4
Table 4.1 Existing Lower Pressure Plane Facilities 4-3
Table 4.2 Existing Middle Pressure Plane Facilities 4-4
Table 4.3 Upper Pressure Plane Existing Facilities 4-5
Table 4.4 Airport Pressure Plane Existing Facilities 4-5
Table 7.1 Historical Wastewater Flows 7-1
Table 7.2 Comparison of Wastewater Flow to Water Usage 7-2
Table 7.3 Projected Wastewater Flows 7-3
Table 7.4 Summary of Projected Wastewater Flows by Major Wastewater Basin ... 7-4
Table 11.1 Summary of Capital Improvement Costs and Bond Program 11-2

LIST OF FIGURES

Figure 4.1 Lower and Middle Pressure Plane – Field Pressure Testing Results..... 4-8
Figure 4.2 Upper and Airport Pressure Planes – Field Pressure Testing Results ... 4-9
Figure 4.3 Existing Modeled System Elevated and Storage Tank Analysis 4-14
Figure 5.1 Lower Pressure Plane Required Elevated Storage 5-4
Figure 5.2 Upper & Middle Pressure Plane Required Elevated Storage 5-5
Figure 5.3 Airport Pressure Plane Required Elevated Storage 5-6
Figure 5.4 Lower Pressure Plane Required Firm Pumping Capacity 5-7
Figure 5.5 Upper & Middle Pressure Plane Required Firm Pumping Capacity 5-8
Figure 5.6 Airport Pressure Plane Required Firm Pumping Capacity 5-9
Figure 5.7 2016 Modeled System Elevated and Storage Tank Analysis 5-10
Figure 9.1 Design Storm RDII Graph 9-2

LIST OF PLATES

Plate 1 ETJ & CCN Study Area.....2-3
Plate 2 Census Tract & Planning Areas Population Projection……...2-5
Plate 3 Existing Water System……4-2
Plate 4 Water Calibration ……..……..4-7
Plate 5 Future Water Capital Improvements Plan……5-3
Plate 6 Existing Wastewater System……..…….8-3
Plate 7 Dry Weather Calibration…….…….8-6
Plate 8 Wet Weather Calibration…….……...8-8
Plate 9 Future Wastewater Capital Improvements Plan…..…….……..10-2

LIST OF APPENDICES

Appendix A Water Capital Improvement Plan Cost Estimate ……A-1

Appendix B Wastewater Capital Improvement Plan Cost Estimate ……..B-1

Appendix C Water Background Information ……...C-1

Appendix D Wastewater Background Information ……..D-1

1.0 EXECUTIVE SUMMARY

1.1 Introduction

Freese and Nichols, Inc. was retained in 2006 by the City of Killeen to prepare a Water and Wastewater Master Plan Update and development of a Capital Improvement Plan (CIP). The service area includes the City's existing city limits and extraterritorial jurisdiction (ETJ). To develop a plan to meet projected water demands and wastewater flows through 2031, computer models of the water and wastewater systems were developed. The City selected the *H_20Map Water* and *H_20 Map Sewer* software packages for modeling Killeen's water and wastewater systems.

1.2 Population

The City of Killeen experienced a 23% growth in population between 1990 and 2000. Due to its proximity to major transportation corridors, recreational opportunities, abundant water supply, availability of developable land, and the Fort Hood economic engine, the City of Killeen is expected to see significant growth in the future. **Table 1.1** displays the historical growth that has occurred in Killeen since the 2000 Census, and **Table 1.2** displays the projected population growth that may occur through 2031. The 2006 population is included in **Table 1.2** as a baseline.

Table 1.1 Historical Growth

Year	Census Population	Percent Growth
1999	82,327	
2000	86,911	5.6%
2001	89,858	3.4%
2002	93,587	4.1%
2003	100,911	7.8%
2004	102,461	1.5%
2005	106,145	3.6%

Table 1.2 Projected Population Growth

Year	Projected Population	Annual Growth Rate
2006	113,419	-
2011	137,992	4.0%
2016	163,891	3.5%
2031	256,576	3.0%

The growth that may occur within the City of Killeen's water and wastewater utility service area over the next 25 years required Freese and Nichols to develop an updated plan to serve future utility system needs. This growth will require expansion and rehabilitation of current utility infrastructure operated and maintained by the City of Killeen.

1.3 Water Demands

Currently, the City of Killeen's potable water is supplied by Bell County Water Control and Improvement District #1 (BCWCID #1). The average day, maximum day, and peak hour water demands for the City of Killeen are listed in **Table 1.3**. The total maximum day water demand is expected to increase from 24.10 MGD in 2006 to 37.61 MGD in 2016.

Table 1.3 Projected Water Demands

Year	Population	Avg. Day Demand (MGD)	Max. Day Demand (MGD)	Peak Hour Demand (MGD)
2006	113,419	14.18	24.10	43.38
2011	137,992	17.94	30.50	54.89
2016	163,891	22.13	37.61	67.70
2031	256,576	35.92	61.07	109.92

1.4 Water Capital Improvement Plan

The proposed water Capital Improvement Plan (CIP) is divided into three-year bond packages and includes pumping, storage, and distribution system improvements necessary to continue providing quality water service under future water demands. One of the most crucial water utility system improvements to support future growth of the city is a new potable water supply point in the southern portion of the City. As the City continues growing, it will become increasingly difficult and more expensive to maintain adequate capacity in the south with the current water supply facilities. Therefore, a new south supply point is recommended to facilitate future growth. Other major water improvement projects include the following:

- Acquisition of selected West Bell Water Supply Corporation Infrastructure
- New Bundrant Elevated Tank – Increase elevated storage capacity to 1.5 MG
- Distribution piping to extend service throughout expanding city limits
- Pump Station 3 Upgrades – Increase in pumping capacity to 18.0 MGD
- South Delivery Point – 5.0 MG ground storage tank, 7.0 MGD upper pressure plane pump station, 7.0 MGD lower pressure plane pump station
- Water system renewal program to prioritize replacement of debilitated and inadequate lines
- Future elevated storage in both the upper and lower planes in the far southern parts of the City

1.5 Wastewater Flows

Historically, all of the City of Killeen's wastewater flow has been treated by BCWCID #1 at the 38th Street Wastewater Treatment Plant (WWTP), which is located along South Nolan Creek in the northeastern portion of the City. In early 2007, the new South WWTP along Trimmier Creek became operational and started receiving flows from the City of Killeen. The new South WWTP and future wastewater collection system improvements will be critical to support the growth of the City and provide adequate long-term capacity within the existing wastewater

collection network. The total average day and peak wet weather wastewater flows for each planning period for the City of Killeen are displayed in **Table 1.4**.

Table 1.4 Projected Wastewater Flows

Year	Population	Average Day Flow (MGD)	Peak Wet Weather Flow (MGD)
2006	113,419	11.91	47.64
2011	137,992	15.18	60.72
2016	163,891	18.85	75.39
2031	256,576	29.51	118.02

1.6 Wastewater Capital Improvement Plan

In order to support the future growth in the City of Killeen, the proposed wastewater CIP includes multiple sewer interceptors and several lift station improvements. In addition to development in the southern portion of the City, several upgrades to the existing wastewater collection system are recommended to support growth and sustain existing wastewater services. One of the major projects in the existing system is the need for an updated Inflow/Infiltration (I/I) Study, which will help pinpoint areas of the system that require rehabilitation to reduce overall flow to the BCWCID #1 WWTPs. This will preserve existing system capacity for future growth and reduce the costs of excessive wastewater treatment.

Other major wastewater improvement projects include the following:

- Rehabilitation of Lift Station #8
- Southern interceptor system to deliver flow to new South WWTP
- I/I Study to identify and solve excessive peak wet weather flows in older portions of the City
- Airport Lift Station Upgrades – Expand to 2.0 MGD pumping capacity
- Collection system and lift stations to support development in the south

1.7 Recommended System Improvements

Based upon the evaluation of the City of Killeen's water and wastewater systems, Freese and Nichols developed a Capital Improvement Plan with cost estimates in three-year bond packages from 2007 through 2024. The water and wastewater systems were evaluated with projected populations through 2031, which resulted in improvements to meet the projected growth. A summary of the major system estimated CIP costs is displayed in **Table 1.5**.

The unit costs used to calculate CIP costs were escalated for each bond period to account for inflation. Summaries of the water and wastewater unit costs are included in **Appendices A** and **B**, respectively.

Table 1.5 CIP Summary Bond Projects

SYSTEM	2007-2009 CIP Costs	2010-2012 CIP Costs	2013-2015 CIP Costs	2016-2018 CIP Costs	2019-2021 CIP Costs	2022-2024 CIP Costs
Water	$11,057,908	$15,835,173	$14,910,239	$15,988,495	$20,397,786	$3,843,114
Wastewater	$ 9,917,071	$11,964,798	$16,030,620	$15,976,475	$12,046,221	$6,102,951
Total	**$20,974,978**	**$27,799,971**	**$30,940,859**	**$31,964,970**	**$32,444,007**	**$9,946,065**

In addition to the CIP projects, projects based on regulatory and operational considerations include an I/I study, water and wastewater rehabilitation planning, and TCEQ required regulatory improvements. A summary of costs for these projects are listed in **Table 1.6**.

Table 1.6 Administrative, Regulatory, & Operational Project Costs

SYSTEM	2007-2009	2010-2012	2013-2015	2016-2018	2019-2022
Water	$155,000	$1,680,000	$1,680,000	TBD	TBD
Wastewater	$260,000	$3,188,000	$0	TBD	TBD
Total	**$415,000**	**$4,868,000**	**$1,680,000**	**TBD**	**TBD**

2.0 POPULATION

2.1 Historical and Existing Population

The City provided Freese and Nichols with the historical growth in the number of water accounts from 1999 through 2005 and historical population for the Census 2000 and October 2002. A correlation between the water accounts and population was established for the baseline population and used to help determine population. These factors included 2.9 people/connection for residential connections, 2 people/unit and 23 units/account for Class A3 (>4) multifamily connections, 2.2 people/unit for mobile homes connections, 2 people/unit and 2.3 units/account for Class A5 (<5) multifamily connections. Historical population and growth rates can be found in **Table 2.1**. In analyzing this data, it shows an annual average growth rate from 2000 to 2005 of 4.08%.

Table 2.1 Historical Population and Growth

Year	Population	Percent Growth
1999	82,327	
2000	86,911	5.6%
2001	89,858	3.4%
2002	93,587	4.1%
2003	100,911	7.8%
2004	102,461	1.5%
2005	106,145	3.6%

2.2 Population and Commercial Growth Projections

The City of Killeen is geographically positioned to experience significant growth for at least the next 25 years. Several of the factors that will contribute to this growth are described below.

- Two major water reservoirs, Belton Lake and Stillhouse Hollow Lake, are less than 15 miles from Killeen and provide a major source of recreational activities to the area and a reliable water supply.

- The City of Killeen is located approximately 50 miles southwest of Waco and 50 miles north of Austin. Three existing transportation corridors are located in or near the City of Killeen, IH 35, US 190, and SH 195.

These factors will provide a catalyst for the continued growth of Killeen and the surrounding areas. Since 2000, the City population has increased more than 30%, and the City currently provides utility services to approximately 113,419 people.

Projected population was determined based on historical growth rates, available land for development, future service areas, and establishing future growth rates through the year 2031. A summary of the projected population and growth rates is shown in **Table 2.2**.

Table 2.2 Projected Population and Annual Growth Rate

Year	Projected Population	Annual Growth Rate
2006	113,419	-
2011	137,992	4.0%
2016	163,891	3.5%
2031	256,576	3.0%

2.3 Population and Commercial Area Distribution

The future growth areas were based on development trends within and adjacent to the City, availability of land, topography and the certificate of convenience and necessity (CCN) boundaries of other entities. **Plate 1** shows the CCN boundaries of entities within Killeen's extraterritorial jurisdiction boundary (ETJ).

CCN BOUNDARIES

- CITY OF KILLEEN
- WEST BELL COUNTY WSC
- CHISHOLM TRAIL SUD
- CITY OF HARKER HEIGHTS
- DOG RIDGE WSC
- 439 WATER SUPPLY CORPORATION
- KEMPNER WSC
- SALADO WSC

CITY OF KILLEEN CCN

439 WATER SUPPLY CORPORATION CCN

CITY OF HARKER HEIGHTS CCN

DOG RIDGE WSC CCN

KEMPNER WSC CCN

WEST BELL COUNTY WSC CCN

CHISHOLM TRAIL SUD CCN

SALADO WSC CCN

0 10,000

SCALE IN FEET

PLATE 1

CITY OF KILLEEN

ETJ AND CCN STUDY AREA

LEGEND

- Major Roads
- Streams
- Lakes
- Ft. Hood Installation Area
- Killeen City Limits
- Kileen ETJ

Freese and Nichols

Freese and Nichols, Inc.
[KIL06188]: H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_1)-ETJ_and_CCN_Study_Area_Map.mxd
Printing Date: Tuesday, June 26, 2007

Population data for the year 2000 by census tract was obtained from the U.S. Census Bureau. This information along with recent development data was utilized to distribute population and commercial growth for the 2006, 2011, 2016, and 2031 planning periods as shown in **Plate 2** and **Table 2.3**. The City's current zoning categories were combined into four main categories: Single Family Residential, Multi-family Residential, Commercial and Industrial. Because the City does not have a future land use plan in the ETJ, it was necessary to make assumptions on future land use types based on information known on future developments and by comparing the breakdown of residential and commercial land use in other areas of the City.

Freese and Nichols, Inc.
[KIL06188]: H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_2)-Census_Tract_and_Planning_Areas_Population_Projection_Map.mxd
Printing Date: Tuesday, June 26, 2007

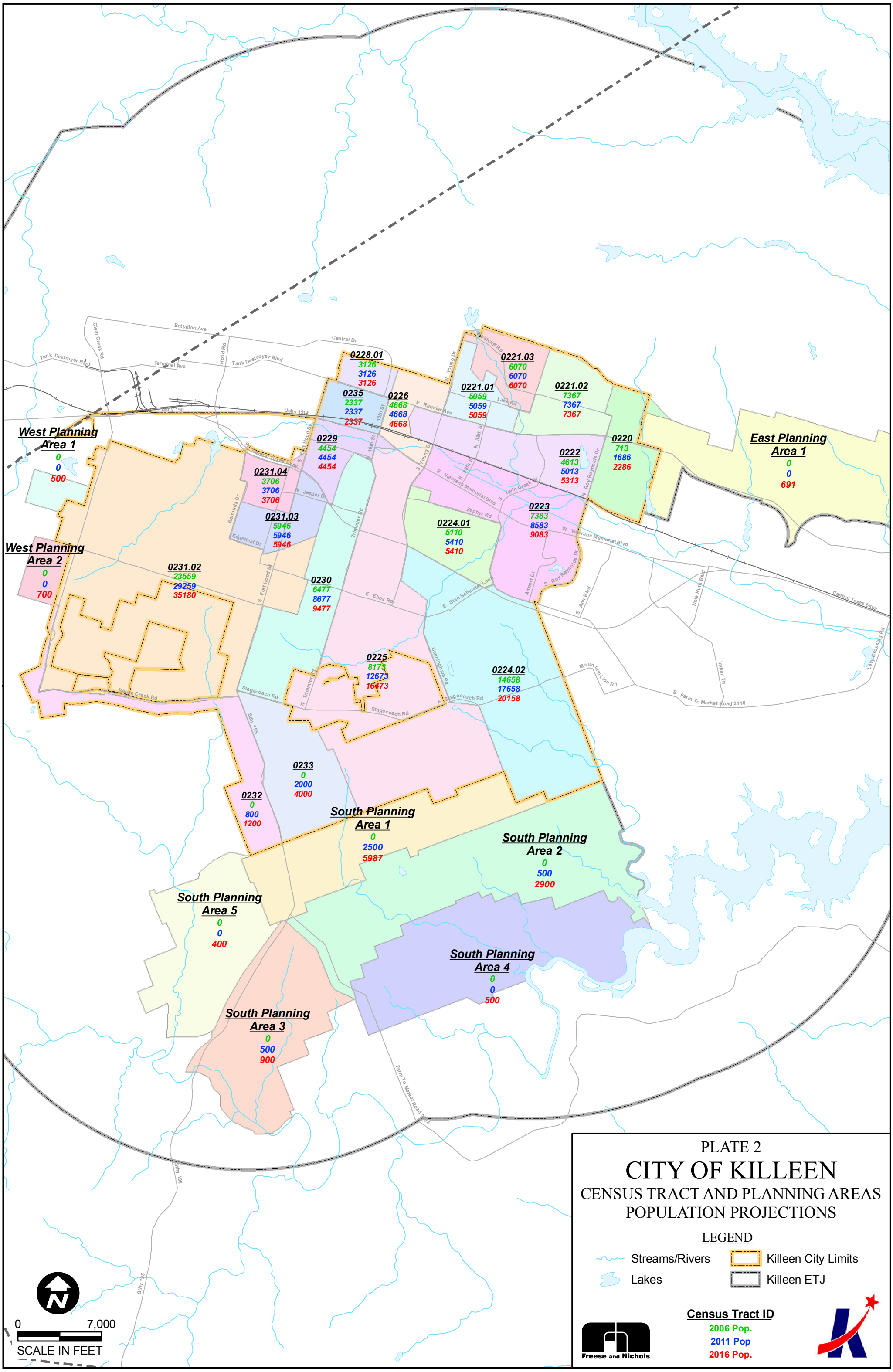


Table 2.3 City of Killeen Population By Census Tract and Time Period

Census Tract within ETJ	2000 Population	2006 Population	2011 Population	2016 Population	2031 Population	Total Acres
0220	186	713	1,686	2,286	5,671	953
0220 EPA1	0	0	0	691	6,664	1,360
0221.01	5,059	5,059	5,059	5,059	5,059	545
0221.02	7,367	7,367	7,367	7,367	7,367	936
0221.03	4,745	6,070	6,070	6,070	6,070	654
0222	3,288	4,613	5,013	5,313	5,913	1,285
0223	4,624	7,383	8,583	9,083	10,083	2,139
0224.01	3,785	5,110	5,410	5,410	5,410	904
0224.02	9,847	14,658	17,658	20,158	24,658	3,889
0225	6,038	8,173	12,673	16,473	30,884	5,963
0226	4,668	4,668	4,668	4,668	4,668	556
0228.01	3,126	3,126	3,126	3,126	3,126	277
0229	4,454	4,454	4,454	4,454	4,454	553
0230	5,423	6,477	8,677	9,477	12,035	2,010
0231.02	13,638	23,559	29,259	35,180	50,297	7,819
0231.02 WPA1	4,620	0	0	500	0	272
0231.02 WPA2	3,706	0	0	700	0	369
0231.03	0	5,946	5,946	5,946	5,946	655
0231.04	0	3,706	3,706	3,706	3,706	424
0232	0	0	800	1,200	5,237	1,464
0233	0	0	2,000	4,000	15,429	1,552
0233 SPA1	0	0	2,500	5,987	11,301	2,451
0233 SPA2	0	0	500	2,900	5,662	4,240
0233 SPA3	0	0	500	900	14,594	2,696
0233 SPA4	0	0	0	500	6,698	3,356
0233 SPA5	0	0	0	400	3,307	2,362
0235	2,337	2,337	2,337	2,337	2,337	406
Total	**86,911**	**113,419**	**137,992**	**163,891**	**256,576**	**50,090**

3.0 WATER DEMANDS

3.1 Historical and Existing Water Demands

Historical water usage records from 1999 through 2005 were obtained from the City and evaluated to establish average day per capita usage rates and maximum day to average day peaking factors. This data is summarized in **Table 3.1**.

Table 3.1 Historical Water Usage Data

Year	Served Population	Avg. Day Water Usage (MGD)	Avg. Day Water Usage (gpcd)	Maximum Day Water Usage (MGD)	Max. Day to Avg. Day Ratio
1999	82,327	9.95	121	17.91	1.80
2000	86,911	10.56	121	18.26	1.73
2001	89,858	11.41	127	18.80	1.65
2002	93,587	12.09	129	19.84	1.64
2003	100,911	12.28	122	21.12	1.72
2004	102,461	10.86	106	16.75	1.54
2005	106,145	11.91	112	21.17	1.78
Average			**120**		**1.69**

The City also provided information about consumption for large water users. **Table 3.2** shows the top 20 individual water users in the City.

Table 3.2 City of Killeen Top 20 Individual Water Users

	Customer	2005 Annual Consumption (1,000 gal)	2005 Average Day Usage (MGD)
1	Transit Mix Concrete	156,908	0.43
2	Ellison H. S.	154,708	0.42
3	Metroplex Hospital	151,861	0.42
4	Killeen I.S.D.	93,974	0.26
5	Zip Cleaners	65,367	0.18
6	Sheraton Plaza Hotel	65,029	0.18
7	Wells Laundromat	60,220	0.16
8	City of Killeen Parks Department	59,376	0.16
9	City of Killeen	57,240	0.16
10	Killeen I.S.D.	55,094	0.15
11	Killeen Ready Mix	54,840	0.15
12	Killeen I.S.D.	52,278	0.14
13	Sallie Mae Loan Service Center	52,069	0.14
14	City of Killeen	50,558	0.14
15	City of Killeen Regional Airport	48,823	0.13
16	Bell Haven Nursing Home	48,226	0.13
17	Wal-Mart Stores	48,208	0.13
18	La Quinta Inn #527	47,478	0.13
19	Killeen I.S.D.	47,092	0.13
20	Killeen Hilton	46,264	0.13
	TOTAL	**1,415,613**	**3.88**

It is important from a planning perspective that large users be identified to ensure adequate infrastructure exists to support the demands.

3.2 Projected Water Demands

Based on a review of the historical water usage data, it is recommended that an average day per capita rate of 125 gpcd be used to project 2006 average day demands and 130 gpcd for 2011 average day demands. Average day per capita rates of 135 gpcd and 140 gpcd are recommended for the 2016 and 2031 average day demands, respectively. The increase in demands over time is based on historical usage trends and the trend to use irrigation systems for the many new single family developments.

FNI recommends using an average day to maximum day peaking factor of 1.7 for projecting future maximum day demands. Historical maximum day to peak hour peaking factors were not available. The American Water Works Association (AWWA) recommends using a peaking value between 1.5 and 3.0; therefore, Freese and Nichols recommends using a maximum day to peak hour peaking factor of 1.8 based on the type of development in the City of Killeen.

A summary of the total projected demands for the 2011, 2016 and 2031 planning periods is shown in **Table 3.3**. Projected demands will be distributed based on population and commercial acreage throughout the City.

Table 3.3 Projected Water Demands

Year	Avg. Day Demand (MGD)	Max Day Demand (MGD)	Peak Hour Demand (MGD)
2006	14.18	24.10	43.38
2011	17.94	30.50	54.89
2016	22.13	37.61	67.70
2031	35.92	61.07	109.92

Table 3.4
Summary of Projected Water Demands by Pressure Plane

2006							
Customer Base	**Served Population**	**Avg Day Usage Rates**	**Avg Day Demand (MGD)**	**Max Day/ Avg Day Ratio**	**Max Day Demand (MGD)**	**Peak Hour/ Max Day Ratio**	**Peak Hour Demand (MGD)**
Lower Pressure Plane	63,735	125 gpcd	7.97	1.70	13.54	1.80	24.38
Middle Pressure Plane	6,346	125 gpcd	0.79	1.70	1.35	1.80	2.43
Upper Pressure Plane	39,626	125 gpcd	4.95	1.70	8.42	1.80	15.16
Airport Pressure Plane	3,712	125 gpcd	0.46	1.70	0.79	1.80	1.42
Total City	113,419		14.18	-	24.10	-	43.38
2011							
Customer Base	**Served Population**	**Avg Day Usage Rates**	**Avg Day Demand (MGD)**	**Max Day/ Avg Day Ratio**	**Max Day Demand (MGD)**	**Peak Hour/ Max Day Ratio**	**Peak Hour Demand (MGD)**
Lower Pressure Plane	74,183	130 gpcd	9.64	1.70	16.39	1.80	29.51
Middle Pressure Plane	6,896	130 gpcd	0.90	1.70	1.52	1.80	2.74
Upper Pressure Plane	51,541	130 gpcd	6.70	1.70	11.39	1.80	20.50
Airport Pressure Plane	5,372	130 gpcd	0.70	1.70	1.19	1.80	2.14
Total City	137,992		17.94	-	30.50	-	54.89
2016							
Customer Base	**Served Population**	**Avg Day Usage Rates**	**Avg Day Demand (MGD)**	**Max Day/ Avg Day Ratio**	**Max Day Demand (MGD)**	**Peak Hour/ Max Day Ratio**	**Peak Hour Demand (MGD)**
Lower Pressure Plane	83,751	135 gpcd	11.31	1.70	19.22	1.80	34.60
Middle Pressure Plane	7,096	135 gpcd	0.96	1.70	1.63	1.80	2.93
Upper Pressure Plane	66,392	135 gpcd	8.96	1.70	15.24	1.80	27.43
Airport Pressure Plane	6,652	135 gpcd	0.90	1.70	1.53	1.80	2.75
Total City	163,891		22.13	-	37.61	-	67.70
2031							
Customer Base	**Served Population**	**Avg Day Usage Rates**	**Avg Day Demand (MGD)**	**Max Day/ Avg Day Ratio**	**Max Day Demand (MGD)**	**Peak Hour/ Max Day Ratio**	**Peak Hour Demand (MGD)**
Lower Pressure Plane	118,902	140 gpcd	16.65	1.70	28.30	1.80	50.94
Middle Pressure Plane	7,436	140 gpcd	1.04	1.70	1.77	1.80	3.19
Upper Pressure Plane	120,668	140 gpcd	16.89	1.70	28.72	1.80	51.69
Airport Pressure Plane	9,570	140 gpcd	1.34	1.70	2.28	1.80	4.10
Total City	256,576		35.92	-	61.07	-	109.92

4.0 EXISTING WATER SYSTEM

The City of Killeen does not currently operate any water treatment facilities. The City has contracts with BCWCID #1 that is the wholesale provider of water for the region. Water is purchased from BCWCID #1, which is delivered to the city at five different locations. **Plate 3** summarizes the orientation of the pressure planes and the location and capacities of the pumping and storage facilities. The operation of the system is explained in further detail in the following sections.

4.1 Existing Water Distribution System

A. Lower Pressure Plane

The Lower Pressure Plane (LPP) is comprised primarily of the North and East areas of the city as shown in **Plate 3**. Water is supplied to the system through Pump Stations 1, 2, 3 and 5. Pump Station 3 is largest pump station with a total capacity of 11.5 MGD. Pump Station 3 also supplies water to the Upper Pressure Plane (UPP) by delivering water into a ground storage tank located at Pump Station 4. Approximately 2 to 4 MGD is currently being transferred through an isolated 24-inch water line that goes through the Middle Pressure Plane (MPP). Pump Stations 1 and 2 are the original pump stations in the City and therefore the oldest. These pump stations are used occasionally during the peak summer time periods. Pump Station 5 supplies most of the area in the north portion of the City. **Table 4.1** summarizes the facilities in the LPP.

Pump Station #5
(4- 1800 GPM Pumps)

2.5 MG
Ground Storage Tank

0.25 MG Park St.
Elevated Storage Tank
(Overflow Elev. 1000')

0.25 MG Bundrant
Elevated Storage Tank
(Overflow Elev. 1000')

WCID #1
3 - 5.0 MG
Ground Storage Tanks

Pump Station #6
(3- 3500 GPM Pumps)

Pump Station #1

0.25 MG
Ground Storage Tank

2.0 MG
Ground Storage Tank

Pump Station #2

1.0 MG 8th Street
Elevated Storage Tank
(Overflow Elev. 1000')

Pump Station 3
(4- 2000 GPM Pumps)

2 - 5.0 MG
Ground Storage Tank

Pump Station #4

1- 0.4 MG
2 - 2.50 MG
Ground Storage Tanks

Airport Pump Station

1.0 MG Rodeo
Elevated Storage Tank
(Overflow Elev. 1000')

1.0 MG Airport
Elevated Storage Tank
(Overflow Elev. 1164')

2 - 1.5 MG McMillan
Elevated Storage Tank
(Overflow Elev. 1125')

2.5 MG Southeast
Elevated Storage Tank
(Overflow Elev. 1000')

0 4,000
SCALE IN FEET

PLATE 3
CITY OF KILLEEN
EXISTING WATER SYSTEM

LEGEND

- Existing Water Lines
- Existing Dist. Lines
- Existing Trans. Lines
- Existing Trans. Lines Greater than 16"
- Elevated Storage Tanks
- Ground Storage Tanks
- Pump Stations
- Rail Roads
- Streets
- Streams/Rivers
- Lakes
- Parcels
- Bell County Boundary
- Killeen City Limits
- Killeen ETJ
- Airport Pressure Plane
- Upper Pressure Plane
- Middle Pressure Plane
- Lower Pressure Plane

Freese and Nichols

Freese and Nichols, Inc.
[KIL06188]; H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_3)-Existing_Water_System_Map.mxd
Printing Date: Tuesday, June 26, 2007

Table 4.1 Existing Lower Pressure Plane Facilities

Pumping Facility	**Capacity (Firm Capacity)**
Pump Station 1	
Pump 1	0.72 MGD
Pump 2	1.08 MGD
Pump 3	1.08 MGD
Total	**2.88 MGD (2.16 MGD)**
Pump Station 2	
Pump 1	1.73 MGD
Pump 2	1.73 MGD
Pump 3	1.73 MGD
Total	**5.19 MGD (3.46 MGD)**
Pump Station 3	
Pump 1	2.88 MGD
Pump 2	2.88 MGD
Pump 3	2.88 MGD
Pump 4	2.88 MGD
Total	**11.52 MGD (8.64 MGD)**
Pump Station 5	
Pump 1	2.65 MGD
Pump 2	2.65 MGD
Pump 3	2.65 MGD
Total	**7.95 MGD (5.3 MGD)**
Ground Storage Facility	
Pump Station 1 Ground Storage Tank	0.25 MG
Pump Station 2 Ground Storage Tank	2.0 MG
Pump Station 3 Ground Storage Tank	10.0 MG
Pump Station 5 Ground Storage Tank	2.5 MG
Total	**14.75 MG**
Elevated Storage Facility	
Rodeo Tank	1.0 MG
Park Street Tank	0.25 MG
Southeast Tank	2.5 MG
Bundrant Tank	0.25 MG
Total	**4.0 MG**

B. Middle Pressure Plane

The Middle Pressure Plane (MPP) is bordered by the UPP and LPP. The MPP is located from Santa Rosa Dr. to South W.S. Young Dr. with the Central Texas Expressway on the south border and a combination of Terrace Dr. and Bryce Dr. making up the north border. The MPP was created from the LPP because the pressures provided by the LPP and the 8th Street EST were not adequate. The MPP is now served by the UPP. The 8th Street EST is inside the limits of the MPP but is not currently in service. The UPP supplies the MPP through a pressure reducing valve (PRV) located just south of Pump Station 4 on a 16-inch water line along Jasper Dr. Due to concerns of high pressures in the lower elevation areas in the MPP, a PRV was installed to keep pressures in the MPP in the 50 to 60 psi range. The MPP is supplied entirely by the 16-inch water line along Jasper Dr. from Pump Station 4, which branches off into a combination of a 10-inch and 12-inch water lines. The 24-inch water line that supplies water to Pump Station 4 passes through this pressure plane; however, it is isolated from service lines and other transmission lines in the MPP. **Table 4.2** summarizes the facilities in located in the MPP.

Table 4.2 Existing Middle Pressure Plane Facilities

Pumping Facility	**Capacity (Firm Capacity)**
Pump Station 4	Transfer from UPP
Elevated Storage Facility	
8th Street Tank	Inactive

C. Upper Pressure Plane

The Upper Pressure Plane (UPP) is comprised of the southern and western most portions of the city. Water is supplied to the UPP through Pump Stations 4 and 6. The UPP also supplies water to a booster pump station facility that supplies the Airport Pressure Plane. The UPP has two 1.5 MG ground storage tanks south of Stan Schlueter Rd. that are located on a hill and therefore are able to operate as elevated storage for the UPP. **Table 4.3** summarizes the facilities located in the UPP.

Table 4.3 Upper Pressure Plane Existing Facilities

Pumping Facility	Capacity (Firm Capacity)
Pump Station 4	
Pump 1	2.88 MGD
Pump 2	2.88 MGD
Pump 3	3.67 MGD
Pump 4	3.67 MGD
Total	**13.10 MGD (9.43 MGD)***
Pump Station 6	
Pump 1	5.04 MGD
Pump 2	5.04 MGD
Pump 3	5.04 MGD
Total	**15.12 MGD (10.08 MGD)**
Ground Storage Facility	
Pump Station 4 Ground Storage Tank	1.5 MG
Pump Station 6 Ground Storage Tank	15.0 MG
Total	**16.5 MG**
Elevated Storage Facility	
McMillan Mountain Elevated Tank (1 & 2)	3.0 MG

***Limited in pumping by supply from Pump Station 3 to approximately 3 MGD presently.**

D. Airport Pressure Plane

The Airport Pressure Plane (APP) is the smallest of all of the pressure planes and is served by an in-line booster pump station that is supplied by the UPP. The Airport EST operates at an overflow of 1,164-feet, which is 39-feet higher than the UPP. **Table 4.4** summarizes the system facilities in the APP.

Table 4.4 Airport Pressure Plane Existing Facilities

Pumping Facility	Capacity (Firm Capacity)
Pump Station 7	
Pump 1	1.51 MGD
Pump 2	1.51 MGD
Total	**3.02 MGD (1.51 MGD)**
Elevated Storage Facility	
Airport Tank	1.0 MG

4.2 Water System Field Testing and Model Calibration

The hydraulic model of the City of Killeen's water system was built using the H20Map modeling software. The model was created to comply with the Stage 2

Disinfectants/Disinfection Byproduct Rule (DBPR). The most stringent of these criteria is the requirement to model 50% of the total pipe length in the City's water system. This results in modeling all 10-inch and larger water lines, a majority of the 8-inch water lines and some key 6-inch water lines. This rule also requires the model to simulate the operation of the water system over a period of several days. **Plate 4** shows the water lines that are included in the hydraulic water model, along with the pressure testing locations.

The water model was constructed using the City's GIS water line shapefiles. After the water lines were imported into the software, the ground storage tanks, pumps and elevated tanks were added to the model using as-built drawings and pump curves from the City. Roughness coefficients were assigned to water lines using pipe age and material where available. The next steps in model development were to distribute water demands in the model and perform calibration of the model using Supervisory Control and Data Acquisition (SCADA) data and the pressure testing data collected during field testing performed in late May.

The distribution system was divided into two sections with each section being monitored by the pressure recorders for a one week period. The MPP and LPP were grouped together in the first week of field testing and the pressure recorder locations are shown in blue in **Plate 4**. The UPP and APP were grouped together in the second week and the pressure recorder locations are shown in red in **Plate 4**.

Figures 4.1 and **4.2** show the results of pressure testing conducted throughout the City from May 26 to June 9. **Figure 4.1** summarizes the LPP and MPP pressure recorder data. Pressure recorder 3 is not included, as it was placed at the discharge of

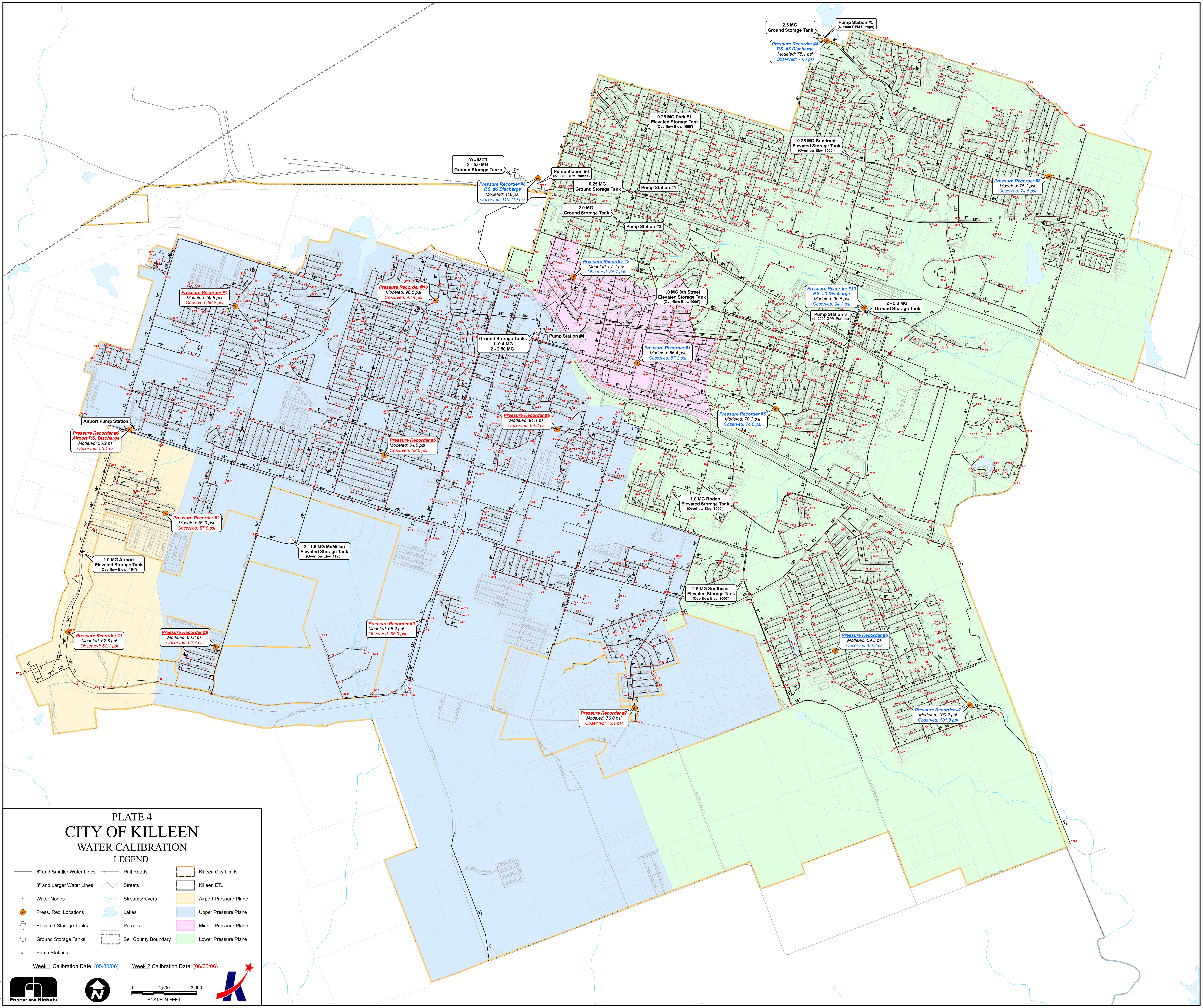


PLATE 4
CITY OF KILLEEN
WATER CALIBRATION
LEGEND
6" and Smaller Water Lines
8" and Larger Water Lines
Water Nodes
Press. Rec. Locations
Elevated Storage Tanks
Ground Storage Tanks
Pump Stations
Rail Roads
Streets
Streams/Rivers
Lakes
Parcels
Bell County Boundary
Killeen City Limits
Killeen ETJ
Airport Pressure Plane
Upper Pressure Plane
Middle Pressure Plane
Lower Pressure Plane
Week 1 Calibration Date: (05/30/06)
Week 2 Calibration Date: (06/05/06)
Freese and Nichols
0
1,500
3,000
SCALE IN FEET
Freese and Nichols, Inc.
[KIL06188]: H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_4)-Water_Calibration_Map.mxd
Printing Date: Tuesday, June 26, 2007
2.5 MG
Ground Storage Tank
Pump Station #5
(4- 1800 GPM Pumps)
Pressure Recorder #4
P.S. #5 Discharge
Modeled: 75.1 psi
Observed: 74.0 psi
0.25 MG Park St.
Elevated Storage Tank
(Overflow Elev. 1000')
0.25 MG Bundrant
Elevated Storage Tank
(Overflow Elev. 1000')
WCID #1
3 - 5.0 MG
Ground Storage Tanks
Pump Station #6
(3- 3500 GPM Pumps)
Pressure Recorder #6
P.S. #6 Discharge
Modeled: 118 psi
Observed: 115-119 psi
0.25 MG
Ground Storage Tank
Pump Station #1
2.0 MG
Ground Storage Tank
Pump Station #2
Pressure Recorder #8
Modeled: 75.1 psi
Observed: 74.5 psi
Pressure Recorder #2
Modeled: 57.4 psi
Observed: 55.7 psi
1.0 MG 8th Street
Elevated Storage Tank
(Overflow Elev. 1000')
Pressure Recorder #10
P.S. #3 Discharge
Modeled: 90.5 psi
Observed: 94.3 psi
2 - 5.0 MG
Ground Storage Tank
Pump Station 3
(4- 2000 GPM Pumps)
Pressure Recorder #4
Modeled: 59.8 psi
Observed: 56.8 psi
Pressure Recorder #10
Modeled: 90.5 psi
Observed: 93.4 psi
Ground Storage Tanks
1- 0.4 MG
2 - 2.50 MG
Pump Station #4
Pressure Recorder #1
Modeled: 56.4 psi
Observed: 57.2 psi
Pressure Recorder #5
Modeled: 70.3 psi
Observed: 74.0 psi
Airport Pump Station
Pressure Recorder #6
Airport P.S. Discharge
Modeled: 55.9 psi
Observed: 55.1 psi
Pressure Recorder #6
Modeled: 91.1 psi
Observed: 89.8 psi
Pressure Recorder #5
Modeled: 54.5 psi
Observed: 52.0 psi
1.0 MG Rodeo
Elevated Storage Tank
(Overflow Elev. 1000')
Pressure Recorder #2
Modeled: 59.9 psi
Observed: 57.8 psi
2 - 1.5 MG McMillan
Elevated Storage Tank
(Overflow Elev. 1125')
1.0 MG Airport
Elevated Storage Tank
(Overflow Elev. 1164')
2.5 MG Southeast
Elevated Storage Tank
(Overflow Elev. 1000')
Pressure Recorder #9
Modeled: 65.2 psi
Observed: 65.9 psi
Pressure Recorder #1
Modeled: 62.8 psi
Observed: 62.1 psi
Pressure Recorder #3
Modeled: 60.8 psi
Observed: 62.7 psi
Pressure Recorder #6
Modeled: 59.3 psi
Observed: 60.2 psi
Pressure Recorder #7
Modeled: 76.0 psi
Observed: 76.1 psi
Pressure Recorder #7
Modeled: 100.2 psi
Observed: 101.8 psi

Figure 4.1 Lower and Middle Pressure Plane - Field Pressure Testing Results
May 26, 2006 - June 2, 2006
City of Killeen

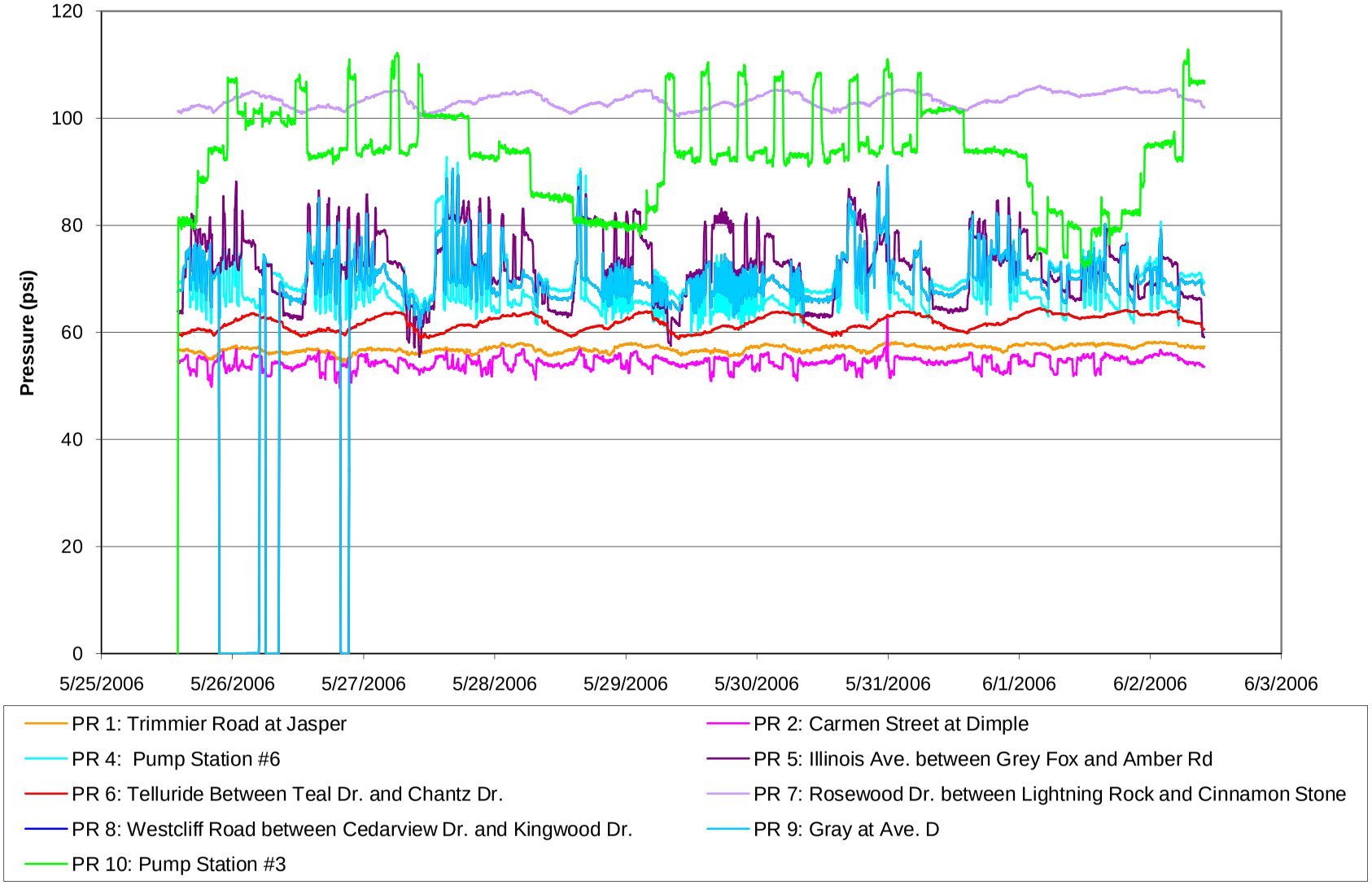
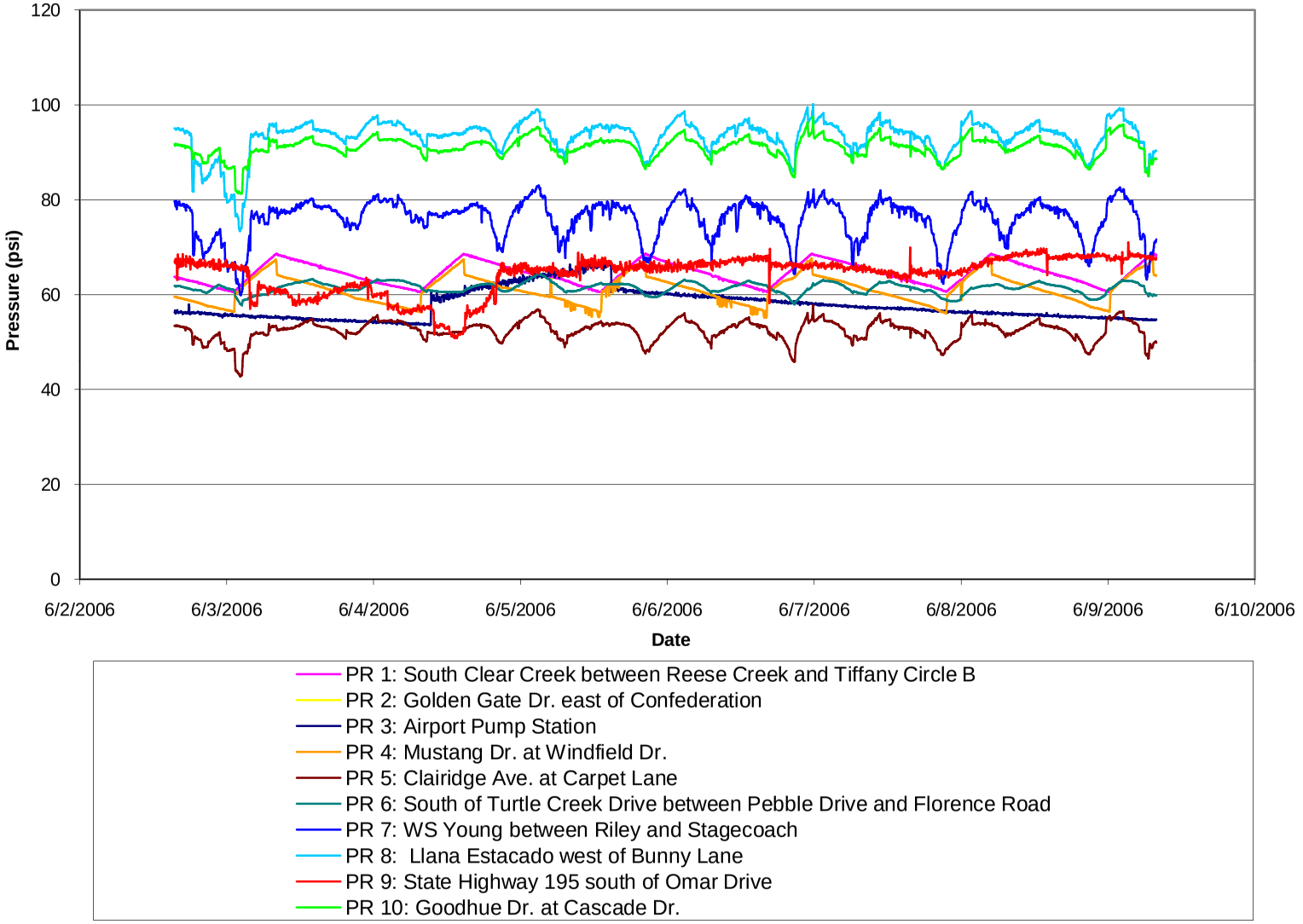


Figure 4.2 Upper and Airport Pressure Planes - Field Pressure Testing Results
June 2, 2006 - June 9, 2006
City of Killeen



Pump Station 6. Since Pump Station 6 serves the UPP, it was used to predict the discharge pressure during the second week of field testing. **Plate 4** summarizes the UPP and APP pressure recorder data. The data from the first week of pressure testing was used to predict the pressures for Pump Station 6.

Once field testing was completed, the demands for the system were distributed based on the City's existing GIS parcel shapefile data. Demands for each parcel were calculated based on Killeen's most recent land use map. These demands were distributed throughout the model using Thiessen polygons that assign each parcel's demand to a node in the water model. This method confirms a high degree of accuracy when performing model calibration.

The model was calibrated for two different dates, one for each field testing time period. The first calibration was performed to match the field results from May 30, 2006 and the second time period was calibrated to the field results recorded on June 5, 2006. The model was calibrated to be within 3 to 4 psi of the field observed pressures. As shown in **Plate 4,** the majority of the pressures are within 1 to 2 psi.

4.3 Water System Design Criteria

Freese and Nichols worked with the City of Killeen staff to establish design criteria for future water facilities. Criteria were developed for sizing water transmission lines, elevated storage tanks, ground storage tanks and pump stations for the water system.

A. Water Transmission Lines (8-inch and larger)

Water transmission lines shall be sized to maintain a minimum of 35 psi throughout the system during peak hour demand conditions. In addition, the transmission lines shall be designed for a maximum pipeline velocity of 7 feet/second and a maximum friction loss of 5 feet per 1,000 feet of pipeline length for 8-inch and larger water lines.

B. Elevated Storage Tanks

The design criteria used to size elevated storage tank capacity is the capacity to provide adequate storage for peak hour demands plus emergency storage for fire protection. The required capacity for the peak hour demands is calculated as the storage volume to allow a minimum of a 3-hour drain time using two-thirds of the tank volume during summer peak hour operating conditions. The required capacity for emergency fire protection storage is calculated as the volume of water needed to meet a 3,000 gpm fire for a 4-hour time period, which typically is met through the remaining one-third of the tank volume. In addition to these criteria, the City must also meet the TCEQ elevated storage capacity of 100 gallons per connection. The recommended design criteria to provide storage for peak hour demands plus fire protection is the most stringent criteria and therefore recommended for use in sizing future elevated storage facilities for the City of Killeen.

C. Ground Storage Tanks

The design criteria recommended to size ground storage tank capacity within each pressure plane is to provide adequate storage volume to meet eight hours of maximum day summer demand. In addition to these criteria, the City must also meet the TCEQ ground storage capacity requirement of 200 gallons per connection. The recommended criterion of eight hours of storage capacity is more conservative and was used to size the recommended ground storage capacity.

D. Pump Stations

The design criteria recommended for pump station capacity is providing a firm pumping capacity to meet 125% of the summer maximum day demands. The firm pumping capacity is defined as the total available pumping capacity with the largest pump out of service.

4.4 Existing Water System Analysis

The purpose of analyzing the existing system is to examine the distribution system, consisting of 8-inch and larger water lines and any smaller lines critical for system

looping, under four major operating conditions. These operating conditions are average day, maximum day, peak hour and maximum day with fire flow. The TCEQ required minimum pressure within a distribution system is 35 psi under peak hour demand conditions and 20 psi during maximum day fire flow scenario. Under recommended fire flow capacity of 1000 gpm, residual pressures throughout the system can be no lower than 20 psi. The water system is analyzed for additional criteria, including the headloss and velocities in the pipelines. Typically, headloss in water lines should not exceed 5 feet/1000 feet and velocities should not exceed 7 feet/second.

There are several specific areas in the distribution system that are not providing adequate fire protection capacities of at least 1,000 gpm. The majority are in the LPP and are caused by a lack of looping of smaller diameter lines or insufficient transmission capacity. The LPP has three major areas that are not able to provide adequate fire flows. The location of these areas and the reasons for the low available fire flow are:

1. The area west of the Rodeo EST along the border between the UPP and LPP boundaries delivers a maximum of 700 gpm. This condition is caused by the area having higher elevations and only being supplied by 6-inch water lines.
2. The area immediately south of the Bundrant EST delivers a maximum of 900 gpm. This condition is caused by the insufficient capacity of the Bundrant EST.
3. The area along Schwald Rd. from Transit Dr. to Ridge Haven Dr. along the northern city limit line delivers a maximum of 600 gpm. This condition is caused by transmission capacity and the fact that a 6-inch water line is responsible for supplying the entire development along N. 60th St.

The UPP has two areas that experience low fire flow availability. First, the development along Yates Rd. is supplied water through a series of 6-inch and 3-inch water lines, which are able to supply only 400 gpm during fire flow conditions. The

second area is located in the development south of Old Copperas Cove Rd. and Pennington Ave. and delivers a fire flow of only 750 gpm at the TCEQ required minimum residual pressure of 20 psi due to high elevations in sections of the development. The problem areas are addressed in the capital improvement section of this report.

The next criteria analyzed for deficiencies were the headloss and velocities experienced in the pipes during all the operational conditions. There were no pipes 8-inch and larger in any of the operating conditions that experienced velocities in excess of 7 feet/second. However, there were a few pipes that measured in excess of 5 feet/1000 feet of headloss in the maximum day and peak hour conditions. Most of the excess headloss was experienced in short sections of the distribution system leading to and from pumping and storage facilities and ranged between 5 and 6 feet/1000 feet. It has been determined that these facilities are in an acceptable range of operating conditions and are not deficient.

Figure 4.3 summarizes the existing conditions used during the hydraulic model analysis. This figure is used during the analysis to determine if the elevated storage or pump station in a designated area is deficient by providing a tabular summary of the fill and drain rates for each elevated storage tank and the discharge flow and pressure of each pump station. The elevated storage tanks should fill in less than eight to 10 hours during the average day conditions and drain in no more than three hours during peak hours. **Figure 4.3** shows that the Rodeo, Southeast, and McMillan ESTs are taking longer than eight to 10 hours to fill. This may indicate insufficient transmission or pumping capacity. However, during peak hour demands, the elevated tanks do not drain faster than three hours, which indicates that there is sufficient elevated storage capacity. These deficiencies will be addressed by the future capital improvement plan.

Figure 4.3
Existing Modeled System Elevated and Storage Tank Analysis

A. Water Demands

	Average Day	Max Day	Peak Hour
Lower Pressure Plane	7.97 MGD	13.54 MGD	24.38 MGD
Middle Pressure Plane	0.79 MGD	1.35 MGD	2.43 MGD
Upper Pressure Plane	4.95 MGD	8.42 MGD	15.16 MGD
Airport Pressure Plane	0.46 MGD	0.79 MGD	1.42 MGD
TOTAL SYSTEM DEMAND	14.2 MGD	24.1 MGD	43.4 MGD

B. Existing System

Tank Location Lower Pressure Plane	Tank Vol. (MG)	Avg Day/ Tank Refilling (MGD)	Avg Day/ Tank Refilling Status	Fill Time Avg Day (hr)	Max Day Inflow (MGD)	Max Day Current Status	Peak Hour Inflow (MGD)	Peak Hour Current Status	Drain Time at Pk Hr* (hr)
Park St.	0.25	2.30	Filling	1.74	1.55	Filling	-0.56	Draining	7.13
Bundrant	0.25	1.01	Filling	3.96	0.31	Filling	-1.35	Draining	2.96
Rodeo	1.00	0.69	Filling	23.17	-0.31	Draining	-1.95	Draining	8.20
Southeast	2.50	2.53	Filling	15.78	0.51	Filling	-3.78	Draining	10.58
DELIVERY SOURCE		Inflow (MGD)	Pressure (psi)		Inflow (MGD)	Pressure (psi)	Inflow (MGD)	Pressure (psi)	
Pump Station #1		1.3	70		1.4	65	1.5	58	
Pump Station #2		1.4	90		1.5	87	1.7	82	
Pump Station #3		9.8	80		10.1	77	10.5	73	
Pump Station #5		4.7	86		5.1	82	5.8	75	
Pump Station #4 Transfer		-4.0			-4.0		-4.0		
Total		13.2			14.1		15.6		

Tank Location Upper Pressure Plane	Tank Vol. (MG)	Avg Day/ Tank Refilling (MGD)	Avg Day/ Tank Refilling Status	Fill Time Avg Day (hr)	Max Day Inflow (MGD)	Max Day Current Status	Peak Hour Inflow (MGD)	Peak Hour Current Status	Drain Time at Pk Hr* (hr)
McMillan	3.00	3.27	Filling	14.70	1.20	Filling	-2.04	Draining	23.52
Airport	1.00	2.18	Filling	7.34	-0.66	Draining	-1.42	Draining	11.27
DELIVERY SOURCE		Inflow (MGD)	Pressure (psi)		Inflow (MGD)	Pressure (psi)	Inflow (MGD)	Pressure (psi)	
Airport Pump Station		2.5	61		0.0	56	0.0	55	
Pump Station #4		3.7	95		3.9	92	7.9	91	
Pump Station #6		6.3	123		8.2	121	8.9	121	
Total		12.5			12.1		16.9		
Total Net Delivery		23.15			30.20		36.47		
Maximum System Pressure			123			121		116	
Minimum System Pressure			31			30		23	

* Drain Time @ Peak Hour is based on 2/3 of the tank volume
* Fill Time @ Average Day is based on 2/3 of the tank volume.

5.0 FUTURE WATER SYSTEM

5.1 Future Water Supply

The City of Killeen purchases water from BCWCID #1 and currently maintains six delivery points. As the City expands to the south, the existing and expanded pumping facilities will not be able to efficiently supply and support the development in the south. To adequately supply the southern development, an additional supply point will be needed along with an additional pumping facility. The 10-year Water Capital Improvement Map, **Plate 5**, identifies the new delivery point and pump station as Project 9. It has been estimated that the City of Killeen will need 40 MGD of supply from BCWCID #1 by the year 2016 and 62 MGD of supply by the year 2031.

5.2 Future Pressure Plane Delineation

The future City of Killeen distribution system will require some adjustments. Analysis of the future system with the proposed water system improvements have identified several areas where it is recommended that the existing pressure plane boundaries be altered to maintain the design criteria discussed in the preceding section. By the year 2013, the MPP should be consolidated into the UPP with the construction of the improvements identified in Project 16W. Also part of Project 16W is the expansion of the UPP to begin service to the customers east of the Rodeo EST. Due to the high ground elevation and proximity to the Rodeo EST, this area of the LPP experiences low pressures and fire flow during the existing and future 2016 maximum day with fire flow and peak hour demand scenarios. The next pressure plane alteration is the expansion of the APP to serve the development south of the W. Stan Schlueter Loop. This area also experiences lower than 35 psi pressures and low fire flow in the existing and future 2016 time period during maximum with fire flow and peak hour demand periods.

5.3 Pumping and Elevated Storage Requirements

The future pumping and elevated storage requirements have been analyzed for the 2011, 2016 and 2031 time periods. The following figures demonstrate the existing

system capacities and the required capacities to sustain the future growth as outlined in the capital improvement plan.

A. Elevated Storage

Figures 5.1 through **5.3** show the elevated storage for the LPP, the consolidated UPP and MPP, and the APP as compared to the elevated storage required to maintain adequate fire flow and the system's ability to supply water during peak demand periods.

B. Pumping Capacity

Figures 5.4 through **5.6** show the pumping capacity for the LPP, the consolidated UPP and MPP, and the APP as compared to the pumping capacity required to maintain adequate tank operation and meet demands during maximum day demand periods.

C. 2016 System Summary

Figure 5.7 summarizes the modeled water system results from the 2016 scenario. The CIP improvements modeled in the 2016 system demonstrate the impact on the elevated and pumping operation in the City. When compared to the existing system tank analysis in **Figure 4.3**, the added transmission and pumping capacity allow the elevated storage tanks to generally fill within the desired 8 to 10-hour timeframe during average day. The elevated tanks take longer than three hours to drain during peak hours. This demonstrates that there is adequate pumping capacity to fill the elevated tanks and adequate elevated storage to supply the system during peak hour and still maintain enough tank volume to provide fire flow protection.

A Condition Assessment Priority Renewal Study

B Water System Rehabilitation/Renewal Project

C Water System Rehabilitation/Renewal Project

2.5 MG Ground Storage Tank

Pump Station #5 (4- 1800 GPM Pumps)

0.25 MG Park St. Elevated Storage Tank (Overflow Elev. 1000')

WCID #1 3 - 5.0 MG Ground Storage Tanks

Pump Station #6 (3- 3500 GPM Pumps)

Pump Station #1

0.25 MG Ground Storage Tank

1.5 MG Elevated Storage Tank

0.25 MG Bundrant Elevated Storage Tank (Overflow Elev. 1000')

2.0 MG Ground Storage Tank

Pump Station #2

1.0 MG 8th Street Elevated Storage Tank (Overflow Elev. 1000')

Pump Station 3 (4- 2000 GPM Pumps)

Pump Station 3 Expansion
Increase Capacity to 16.0 MGD

2 - 5.0 MG Ground Storage Tank

Pump Station #4

Ground Storage Tanks
1- 0.4 MG
2 - 2.50 MG

Airport Pump Station Expansion
Increase Capacity to 3.0 MGD

1.0 MG Rodeo Elevated Storage Tank (Overflow Elev. 1000')

2 - 1.5 MG McMillan Elevated Storage Tank (Overflow Elev. 1125')

2.5 MG Southeast Elevated Storage Tank (Overflow Elev. 1000')

1.0 MG Airport Elevated Storage Tank (Overflow Elev. 1164')

20" Bell Co. Water Supply Line

4 MGD Quarry Road Pump Station

2 MG Storage Tank

42" Bell Co. South Water Supply Line

South Delivery Point
5.0 MG G.S.T.
5.0 MG G.S.T.
7.0 MGD UPP P.S.
7.0 MGD LPP P.S.
7.0 MGD UPP P.S. Expan.

1.5 MG Ground Storage Tank for Elevated Storage (Overflow Elev. 1125')

Valve to Isolate UPP and LPP

1.0 MG Elevated Storage Tank (Overflow Elev. 1000')

PRV

Project #	Administrative and Regulatory Project Description
A	Condition Assessment Priority Renewal Program
B	Downtown Rehabilitation
C	Downtown Rehabilitation

Project #	CIP and Bond Project Description
1W	12/16/20" along Reese Creek Rd.
2W	1.5 MG Bundrant EST Expansion
3W	12/16" Southeast Loop
4W	Pump Station 3 Upgrade
5W	12/16" along N. Young Drive
6W	12/16" Onion Road Water Line
7W	12/24" Trimmier Road Water Line
8W	24/30" along Chaparral Road
9W	5 MG GST, 7 MGD PS, 30" Line
10W	20" Line along Chaparral Rd
11W	4 MGD PS 16" along FM 439
12W	12" Airport/ Upper PP
13W	12/20" & 1.5 GST W of Chap. Rd
14W	16" Water Line along 38th Street
15W	16/20/24"& 7.0 MGD PS Lower PP
16W	Pressure Plane Modifications
17W	12/16" at Chaparral & Bell PS
18W	12" along NE City Limits
19W	20" along 195 and Fort Hood St.
20W	12" South of Chaparral Road
21W	12" along FM 439
22W	12" Railroad To FM 439
23W	12/16/20" East Stagecoach Road
24W	Airport PS Expans. & PP Mods
25W	12/16" SW part of Lower PP
26W	12" by FM 2484
27W	1.0 MG EST in Lower PP & PRV's
28W	16" Vet. Mem. Blvd to Railroad
29W	12/16" South Lower PP Loop
30W	5.0 MG GST & 7.0 MGD PS Expan.
31W	16" West of 195 in Upper PP
32W	12" Water Line in SE Lower PP
33W	12" Water Line in NW Lower PP

PLATE 5

CITY OF KILLEEN

FUTURE WATER CAPITAL IMPROVEMENTS PLAN

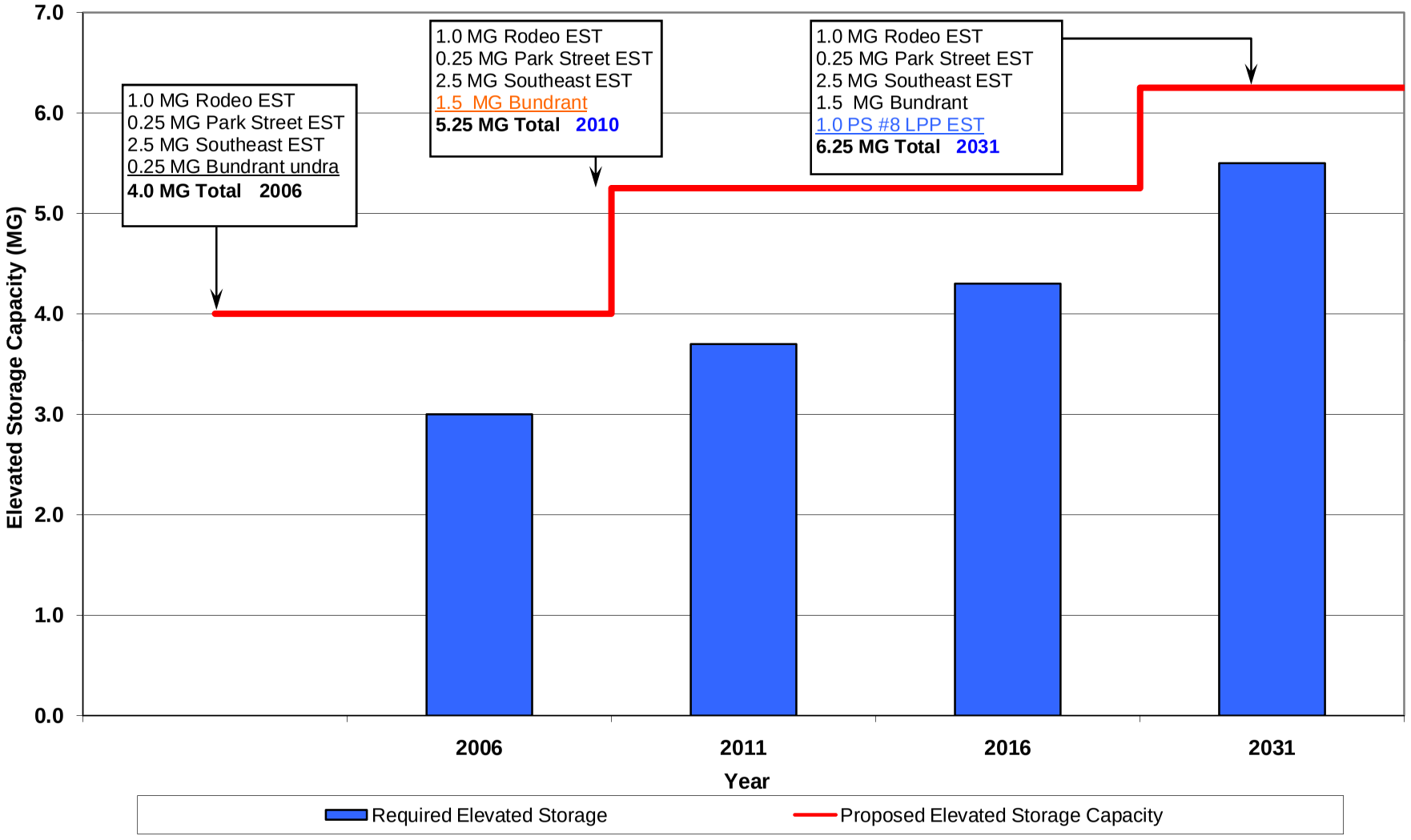
LEGEND

2007 E.S.T.
2007 P.S.
2010 G.S.T.
2010 P.S.
2013 G.S.T.
2013 P.S.
E.S.T. Beyond 2016
Existing E.S.T.
Existing G.S.T.
Existing P.S.
2007 Improvements
2010 Improvements
2013 Improvements
2016 Improvements
2019 Improvements
2022 Improvements
6" and Smaller Water Lines
8" and Larger Water Lines
Streams/Rivers
Lakes
Bell County Boundary
Killeen City Limits
Killeen ETJ
Airport Pressure Plane
Upper Pressure Plane
Middle Pressure Plane
Lower Pressure Plane
Ft. Hood Installation Area

Freese and Nichols

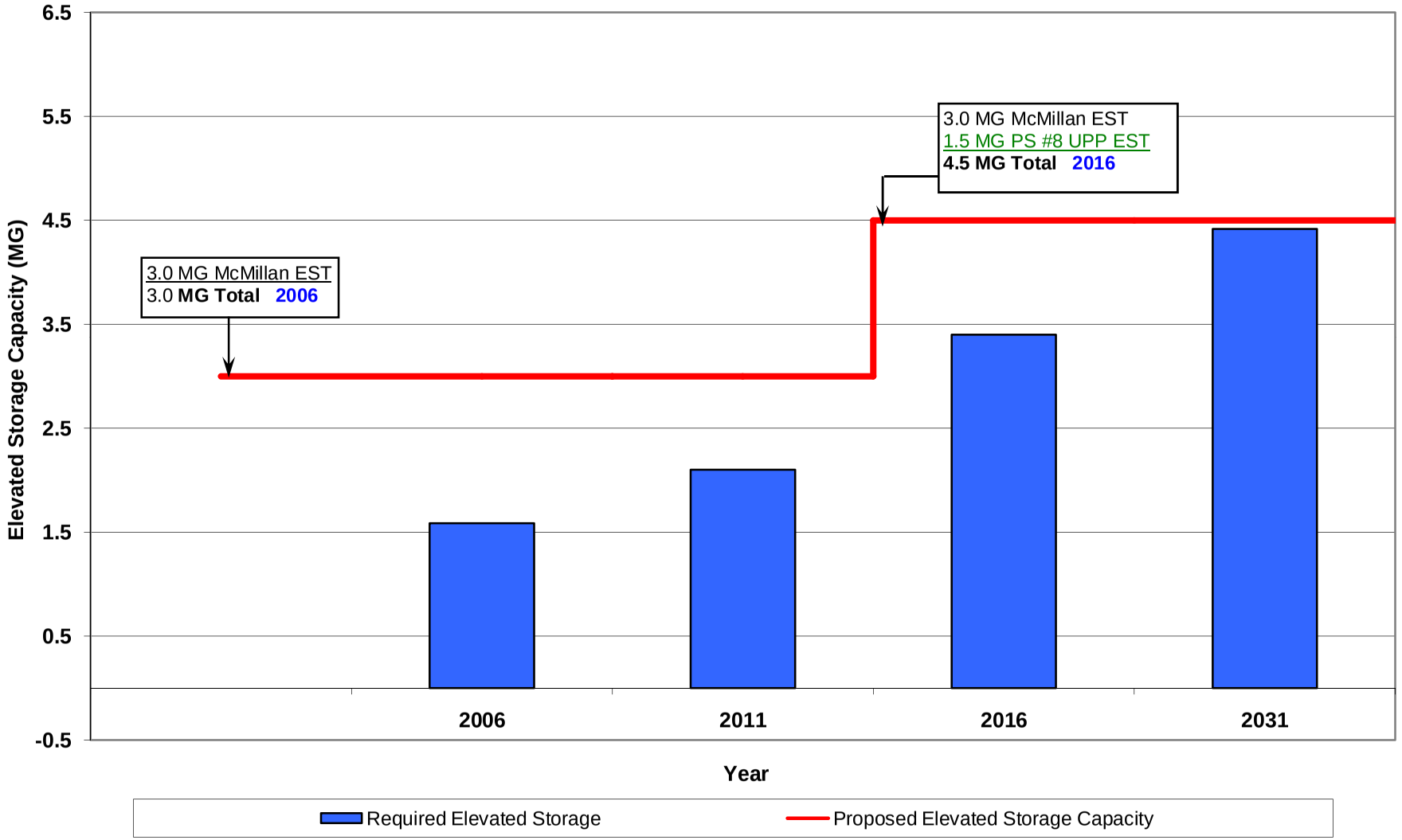
0 2,000 4,000
SCALE IN FEET

Figure 5.1 Lower Pressure Plane Required Elevated Storage
City of Killeen



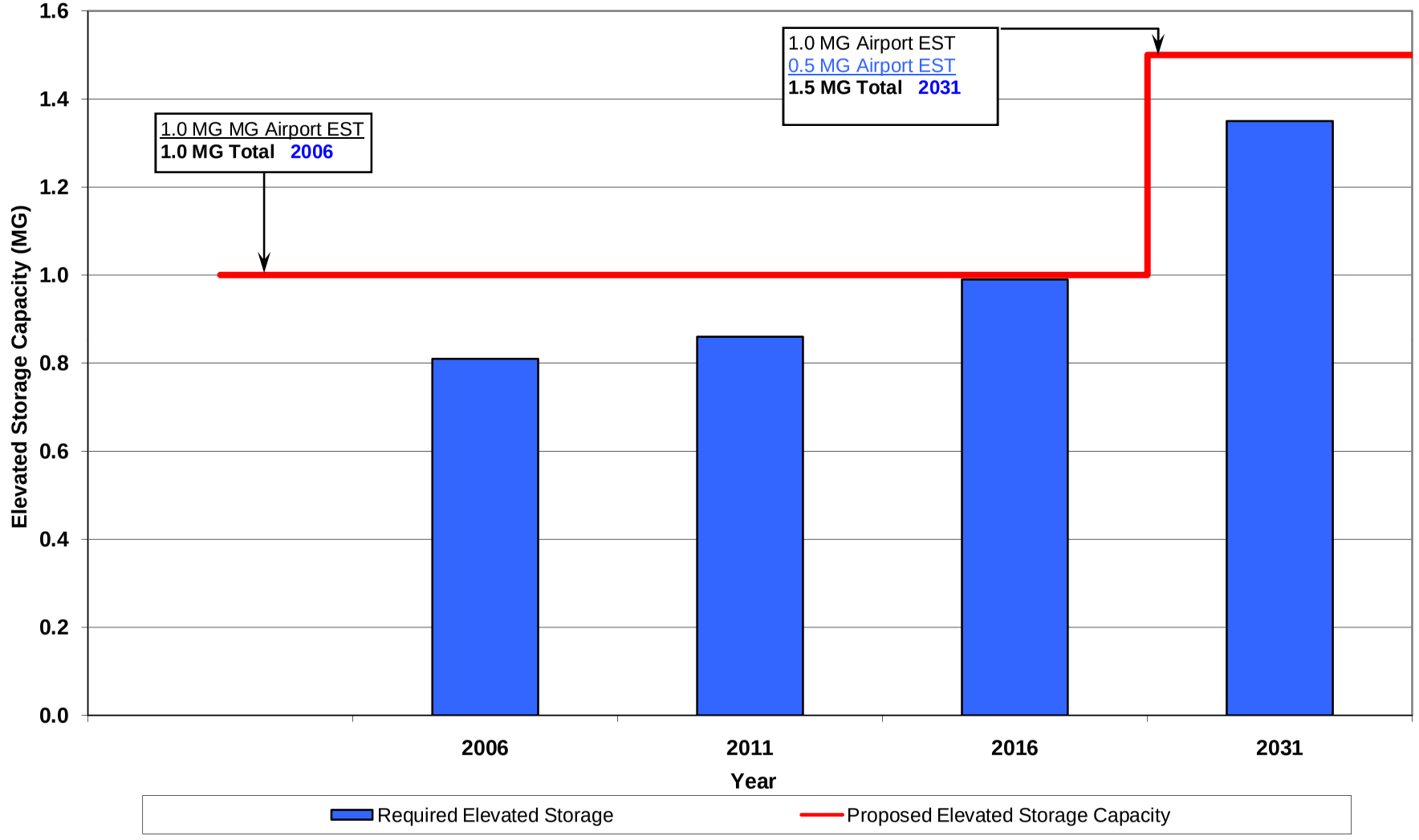
*__Note__: Required Elevated Storage Capacity is based on meeting 40% of peak hour demands for 4 hours plus storage for fire flow.

Figure 5.2 Upper & Middle Pressure Plane Required Elevated Storage
City of Killeen



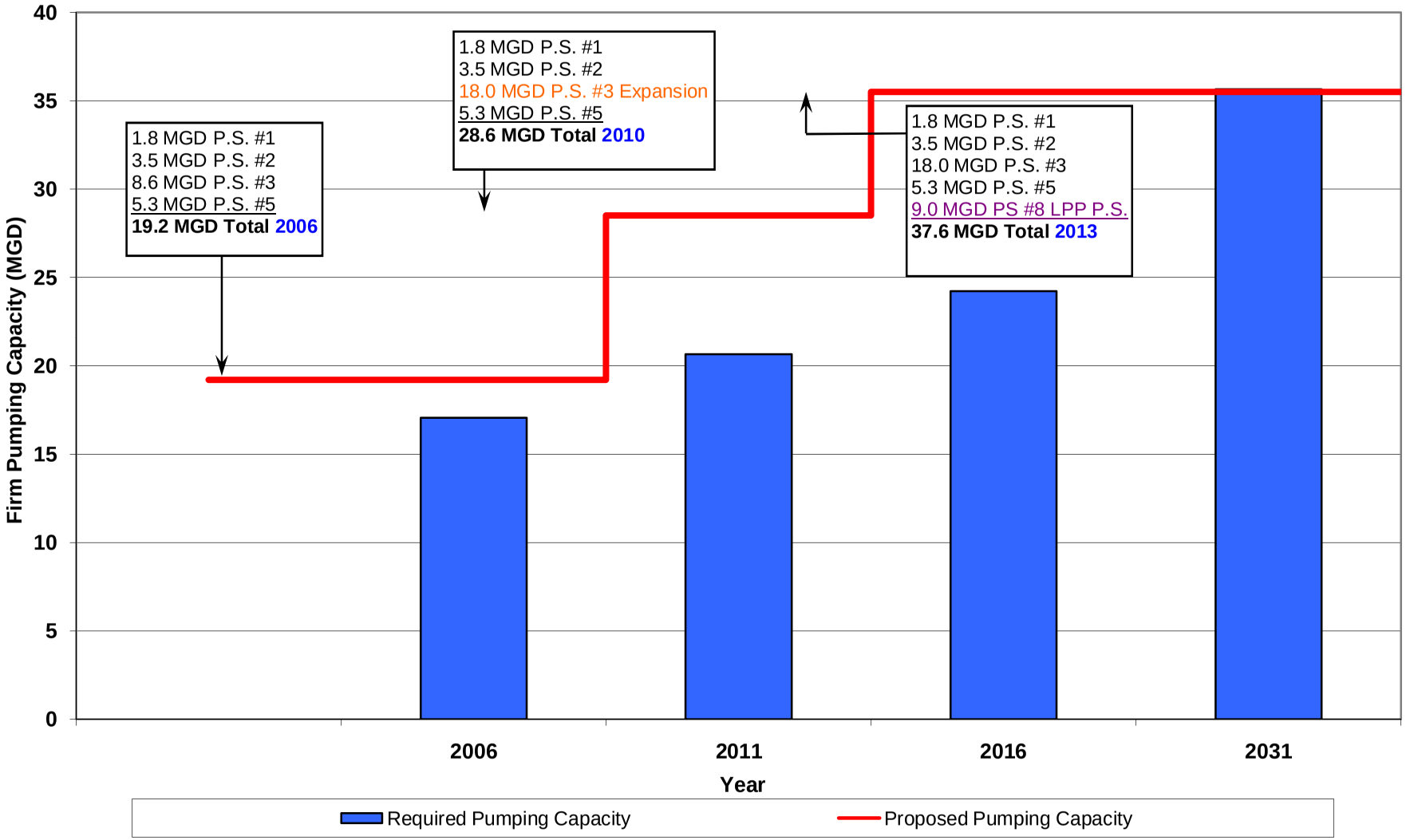
*__Note__: Required Elevated Storage Capacity is based on meeting 40% of peak hour demands for 4 hours plus storage for fire flow.

Figure 5.3 Airport Pressure Plane Required Elevated Storage
City of Killeen



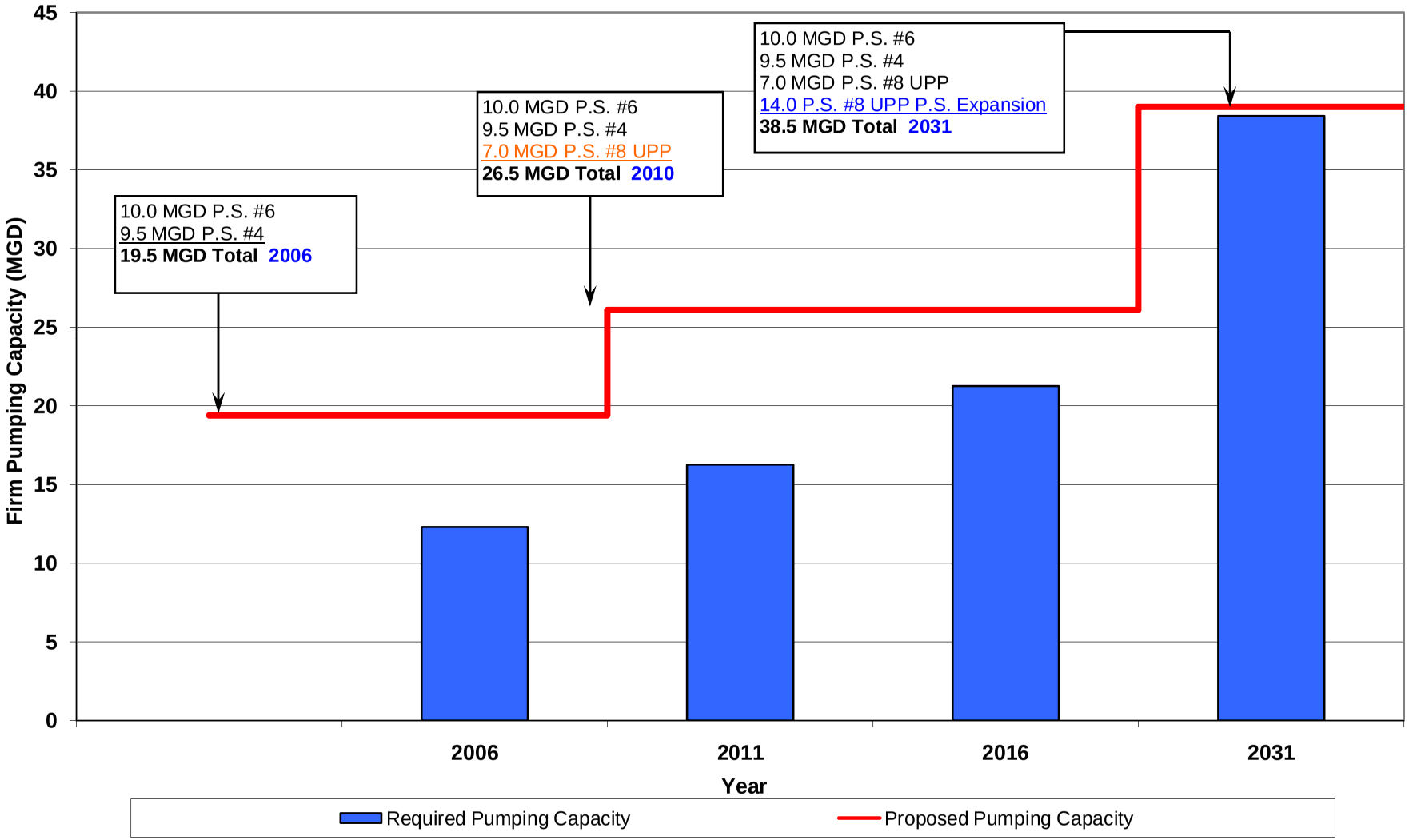
*__Note__: Required Elevated Storage Capacity is based on meeting 40% of peak hour demands for 4 hours plus storage for fire flow.

Figure 5.4 Lower Pressure Plane Required Firm Pumping Capacity
City of Killeen



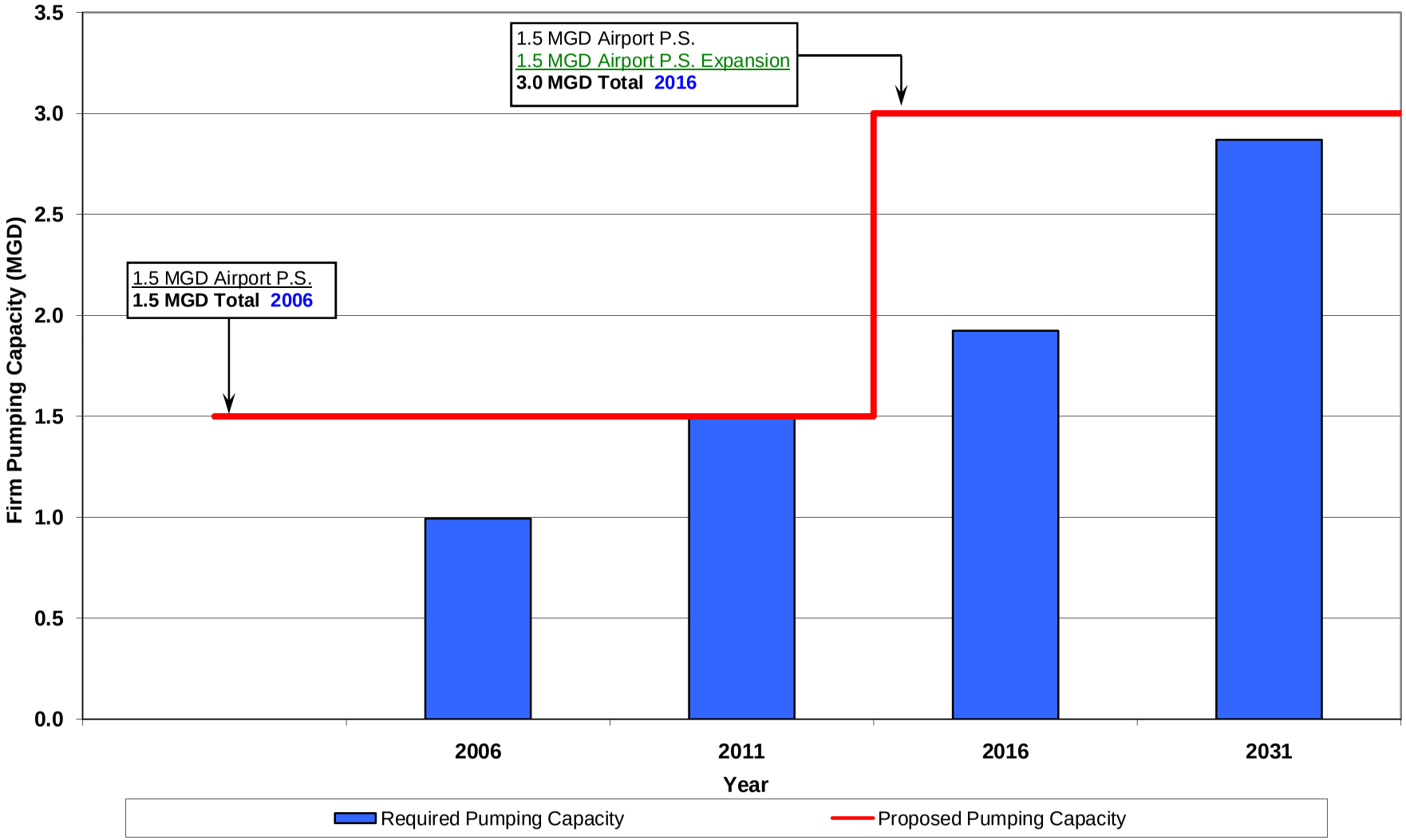
*__Note__: Required Firm Pumping Capacity is based on supplying 70% of peak hour demands.

Figure 5.5 Upper & Middle Pressure Plane Required Firm Pumping Capacity
City of Killeen



*__Note__: Required Firm Pumping Capacity is based on supplying 70% of peak hour demands.

Figure 5.6 Airport Pressure Plane Required Firm Pumping Capacity
City of Killeen



*__Note__: Required Firm Pumping Capacity is based on supplying 70% of peak hour demands.

Figure 5.7
2016 Modeled System Elevated and Storage Tank Analysis

A. Water Demands

	Average Day	Max Day	Peak Hour
Lower Pressure Plane	11.3 MGD	19.2 MGD	34.6 MGD
Middle Pressure Plane	1.0 MGD	1.6 MGD	2.9 MGD
Upper Pressure Plane	9.0 MGD	15.2 MGD	27.4 MGD
Airport Pressure Plane	0.9 MGD	1.5 MGD	2.7 MGD
TOTAL SYSTEM DEMAND	22.1 MGD	37.6 MGD	67.7 MGD

B. Existing System

Tank Location Lower Pressure Plane	Tank Vol. (MG)	Avg Day/ Tank Refilling (MGD)	Avg Day/ Tank Refilling Status	Fill Time Avg Day (hr)	Max Day Inflow (MGD)	Max Day Current Status	Peak Hour Inflow (MGD)	Peak Hour Current Status	Drain Time at Pk Hr* (hr)
Park St.	0.25	1.18	Filling	3.38	1.32	Filling	-1.85	Draining	2.16
Bundrant	1.50	4.18	Filling	5.74	4.49	Filling	-2.77	Draining	8.68
Rodeo	1.00	1.96	Filling	8.18	0.64	Filling	-1.52	Draining	10.56
Southeast	2.50	5.92	Filling	6.76	2.75	Filling	-3.29	Draining	12.16
DELIVERY SOURCE		Inflow (MGD)	Pressure (psi)		Inflow (MGD)	Pressure (psi)	Inflow (MGD)	Pressure (psi)	
Pump Station #1		0.0	65		1.7	64	0.0	50	
Pump Station #2		0.0	72		0.0	69	0.0	54	
Pump Station #3		17.8	88		18.6	85	19.7	80	
Pump Station #5		6.7	69		9.8	68	6.9	64	
Pump Station #7 - LPP		3.8	68		3.9	65	7.0	61	
PS #4 Transfer		-6.0			-6.0		-6.0		
Total		22.3			28.1		27.5		

Tank Location Upper Pressure Plane	Tank Vol. (MG)	Avg Day/ Tank Refilling (MGD)	Avg Day/ Tank Refilling Status	Fill Time Avg Day (hr)	Max Day Inflow (MGD)	Max Day Current Status	Peak Hour Inflow (MGD)	Peak Hour Current Status	Drain Time at Pk Hr* (hr)
McMillan	3.00	5.07	Filling	9.47	-0.15	Draining	-11.20	Draining	4.29
Airport	1.00	1.63	Filling	9.82	-0.80	Draining	-1.48	Draining	10.84
Proposed UPP	1.50	1.85	Filling	8.65	1.13	Filling	-6.12	Draining	3.92
DELIVERY SOURCE		Inflow (MGD)	Pressure (psi)		Inflow (MGD)	Pressure (psi)	Inflow (MGD)	Pressure (psi)	
Airport Pump Station		3.0	59		1.5	57	1.5	55	
Pump Station #4		7.1	99		4.1	92	5.5	81	
Pump Station #6		10.0	128		7.9	122	11.8	113	
Pump Station #7 - UPP		7.0	123		6.9	120	8.7	106	
Total		27.2			20.4		27.6		
Total Net Delivery		46.45			46.97		53.63		
Maximum System Pressure			128			122		113	
Minimum System Pressure			43			40		36	

* Drain Time @ Peak Hour is based on 2/3 of the tank volume
* Fill Time @ Average Day is based on 2/3 of the tank volume.

6.0 WATER SYSTEM CAPITAL IMPROVEMENT PLAN

The capital improvement plan has six planning periods: 2007-2009, 2010-2012, 2013-2015, 2016-2018, and 2019-2021 and 2022-2031. The 2031 period was chosen because it coincides with the Texas Water Development Board (TWDB) Region G Water Plan. All of the proposed capital improvements for the water system are shown in **Plate 5**. Unit costs used to estimate projected costs of the water system improvements are in **Appendix A**. These costs are for the principal water facilities in the water system and do not include individual service connections or subdivision internal lines. The Water CIP cost estimate tables can be found in **Appendix A**.

Unit costs were based on reviewing bid tabs for several projects ranging in size. The 2007 time period costs were based on 2007 dollars and each subsequent planning period cost was adjusted for inflation. A complete cost table for each time period can be found in **Appendix A**. The costs include an allowance for engineering, surveying, geotechnical engineering and contingencies. The project costs include right-of-way acquisition for pump stations and tanks only. It is recommended that these improvements be constructed generally in the order listed; however, it is understood that development in certain areas of the City's service area may make it necessary to construct some future improvements sooner than anticipated.

Having utilized the hydraulic water model to analyze the water distribution systems capacity and transmission deficiencies in both the existing and future conditions, the improvements necessary to meet future growth were summarized into three-year phases. These phases identify the most pertinent projects necessary to meet the growing demands as they are currently projected. The following sections identify these projects and explain their purpose.

6.1 Water System Improvements from 2007 to 2009

A. Water Service Extension and Looping for Proposed Growth (Projects 1W & 3W)

Project 1W provides an extension of water service and looping to the west portion of the city nearest the airport along SH 201 and extends service to the West Bell County Water Supply Corporation (WBCWSC) service area along Stagecoach

Road. Project 1W also connects a 12-inch water line along SH 195 to an existing 12-inch water line, which will provide service in the south portion of the UPP and provide fire flow to the area along Yates Rd. Project 3W extends service and provides looping for proposed development in the south portion of the LPP. Projects 1W and 3W are both either in the design phase or are under construction.

B. **Increase Bundrant Elevated Storage Capacity to 1.5 MG (Project 2W)**

The existing 0.25 MG Bundrant EST will be replaced with a 1.5 MG EST. This additional capacity is necessary to provide increased storage capacity and mandated fire flow protection for the growth being experienced in the northeast portion of the City in the LPP. Project 2W is also in the design/construction phase.

C. **Pump Station 3 Pumping Capacity Expansion (Project 4W)**

As the LPP continues to grow, the existing 10 MGD pumping capacity of the existing Pump Station 3 facility will need to be expanded to 18 MGD. This expansion will provide water to the Rodeo and Southeast ESTs and most of the south portion of the LPP. The expansion will also increase the ability to transfer additional water to Pump Station 4 and the UPP.

D. **Downtown Condition Assessment Priority Renewal Plan (Project A)**

Much of the infrastructure in the original downtown area of Killeen is aging and will require replacement. This proactive project will identify and prioritize projects that are most in need of replacement and critical to the distribution system.

6.2 Water System Improvements from 2010 to 2012

A. **Increased Transmission Capacity to the Bundrant EST (Project 5W)**

The increased capacity of the Bundrant EST creates a need for additional water lines to adequately supply water to and from the EST. Project 5W is an additional 16-inch water line north along N. 38th St. to increase the amount of water that can be supplied to the Bundrant EST from Pump Station 5. The 16/12-inch water line west along Poage St. and south along W.S. Young Ave. will increase the transmission capacity from the Bundrant Tank to the downtown area.

B. **Water Service Extension and Looping in the LPP and UPP (Projects 6W&7W)**

Project 6W extends a series of 12-inch and 16-inch water lines in the LPP to provide water service to a portion of the WBCWSC service area. The 16-inch water line connects to an existing 16-inch water line at Stagecoach Rd. and to the 16-inch identified in Project 3W, providing looping and service to additional areas. Project 7W serves in a similar capacity by looping water lines identified in Project 1W and providing service to currently undeveloped areas in the WBCWSC service area.

C. **South Delivery Point and Increased Capacity to UPP (Projects 8W, 9W & 10W)**

As the southernmost portions of the city continue to grow, expanding existing pumping facilities will not provide adequate transmission and fire flow to the far southern areas. The proposed location of the new South Delivery Point is at the intersection of Chaparral Rd. and East Trimmier Rd. The South Delivery Point is expected to need a 5 MG GST and an initial 7 MGD of pumping capacity for the UPP. Project 9W will be needed in conjunction with Projects 8W and 10W as it provides the necessary transmission capacity to the UPP. It has been projected that the area in the southern section of the UPP will develop before areas in the south section of the LPP. Therefore, the 30-inch water line from the South Pump Station will be isolated from the LPP distribution system and be tied directly into the UPP distribution system. Project 8W will extend a 30-inch and 24-inch water line from the isolated 30-inch water line, which will make a looped system upon connecting to the 24-inch water line in Project 7W, and Project 10W will extend a 20-inch water line to the existing 12-inch water line along SH 195.

D. **Downtown Rehabilitation (Project B)**

Upon completion of Project A, the Condition Assessment Renewal Plan, several projects will be identified for replacement. This project involves renewing the most critical water lines for the 2010 time period.

6.3 Water System Improvements from 2013 to 2015

A. New Pump Station and Ground Storage Tank Serving the Northeast LPP (Project 11W)

Project 11W includes the building of a new 4 MGD Quarry Road Pump Station and 2 MG Storage Tank connected to an existing 12-inch water line through a 16-inch water line. These additions to the LPP will be used to serve the expanding area in the north and allow more growth to the east.

B. Airport Pressure Plane Looping and PRV (Project 12W)

As the area near the airport grows, additional transmission capacity will be necessary to meet the increased demand. The 12-inch water line along the eastern border of the Airport Pressure Plane (APP) will provide a redundant supply of water for fire flow. The PRV connecting the UPP and the APP will allow additional supply into the APP without expanding the Airport Pump Station.

C. UPP Service Extension and Increased Elevated Storage Capacity (Project 13W)

Project 13W includes 12-inch water lines looping in undeveloped areas in the southern section of the UPP. A 20-inch water line will connect to Project 10W and supply a proposed 1.5 MG EST with an overflow of 1,125-feet. This EST will provide pressure and future fire flow demand.

D. 16-Inch Water Line along 38th Street (Project 14W)

Project 14W identifies the need for a 16-inch water line from Pump Station 3 north to the Bundrant EST along S. 38th St. that will create a redundant supply for the Bundrant EST. This 16-inch line also increases the ability of Pump Station 3 to transfer water further north if Pump Station 5 experienced problems.

E. LPP Pump Station and Transmission Lines (Project 15W)

In the 2013 time period, the southern portion of the LPP is projected to grow. Because of this growth and the addition of the South Delivery Point in Project 15W, an additional pumping facility will be necessary to serve the new growth in this area. A 7 MGD pump station will be necessary to supply water to the southern LPP area. Also as a part of Project 15W, a 20-inch water line will connect to the 16-inch water line along East Trimmier Rd., and a 16-inch water

line will connect to the existing 16-inch water line bordering the Southeast city limit line. To transmit this water to the system, Project 15W will provide looping along the UPP and LPP border by connecting to the 16-inch water line proposed in Project 3W.

F. **Downtown Rehabilitation (Project C)**

Upon completion of Project A, the Condition Assessment Renewal Plan, several projects will have been identified for replacement. These projects will renew the most critical water lines for the 2013 time period and improve fire flow availability.

6.4 Water System Improvements from 2016 to 2018

A. **Pressure Plane Modifications (Project 16W)**

The existing MPP runs along the north portion of US 190 and is primarily fed from Pump Station 4 in the UPP through a PRV and has been identified to be consolidated into the UPP. To achieve this, several 8-inch lines will have to be tied into the system to ensure adequate pressure will be available to the new UPP area. An 8-inch water line along Trimmier Rd. and Marigold will be connected into the new UPP area. The area to the west of the Rodeo EST also experiences lower pressures during maximum and peak hour demand conditions. It is also recommended that this area be brought into the UPP.

B. **Increased Transmission Capacity & Looping in UPP (Projects 19W & 20W)**

Project 19W parallels an existing 12-inch water line along SH 195 and connects to the 20-inch/16-inch water line identified in Project 1W. This line will allow additional supply to the southern portions of the City from Pump Station 4. Project 20W extends water service to the southern most section of the UPP along SH 195 and loops the easterly border of the UPP. These lines are identified and sized to meet the transmission and fire flow capacity for the area.

C. **Increased Transmission Capacity & Looping in LPP (Projects 18W, 21W & 25W)**

Projects 18W and 21W provide looping and service to the northeast section of the LPP and to future developments. Project 25W provides looping in the southeast

section of the city and provides service to future developments. All lines are sized to meet fire flow demands.

D. **Extend Water Service and Looping (Project 22W)**

Project 22W will provide water service to the areas growing in the northeast section of the City and will loop the existing system by connecting to the existing 12-inch water line on N. Roy Reynolds Dr. and the proposed 16-inch water line on Rancier Ave.

E. **Water Service Extension in LPP (Projects 17W & 23W)**

The 16-inch line in Project 23W will create a loop to serve future development areas and connect to Project 25W and Project 17W. The future EST will be supplied water from the South Delivery Point Pump Station through the proposed 16-inch water line in Project 17W, which then runs north connecting to Project 3W with a 12-inch water line.

F. **Increased Airport Pressure Plane Boundary and Pumping Capacity (Project 24W)**

The area south of W. Stan Schlueter Loop experiences pressures lower than 35 psi under peak hour demands and low fire flow availability in the existing and future 2016 time periods under maximum day demand conditions. It is recommended that the development served by the water line along Judson Ave. be moved into the APP. As the APP continues to grow, additional pumping capacity will be necessary to meet the maximum day demands. The Airport Pump Station should be expanded to 3.0 MGD.

The next pressure plane alteration is the expansion of the APP to serve the development south of the W. Stan Schlueter Loop. This area would experience pressures lower than 35 psi in the future 2016 time period during maximum and peak hour demand periods without alteration.

6.5 Water System Improvements from 2019 to 2021

A. Water Service Extension in the LPP and Elevated Storage (Projects 27W & 29W)

Project 29W provides water service to future development areas in the south portion of the LPP. A 16-inch line connects to Project 23W and will supply the 1.0 MG EST required to serve adequate fire flow and peak hour demand conditions in Project 27W. The line has been sized to meet adequate fire flow and transmission capacities required to serve the area.

B. Increased Transmission Capacity in LPP (Project 28W)

Project 28W is a 16-inch water line that will parallel an existing 8-inch water line along W. Veterans Memorial Blvd. to increase the transmission capacity of Pump Station 3 to the northeastern section of the City.

C. Water Service Extension and Looping for the UPP (Projects 26W & 31W)

Project 26W will provide service for future development by creating a loop connecting a 12-inch water line from Project 20W to a 12-inch water line in Project 13W and running south along SH 195 incorporating the area southeast of SH 195 around FM 2484. Project 31W would extend service west of SH 195 connecting the 1.5 MG GST in Project 13W to the 12-inch water line in Project 26W with a 16-inch water line.

D. Additional South Delivery Point Storage and Pumping Capacity (Project 30W)

The continued growth in the UPP and limited pumping from the north section of the UPP will require the South Delivery Point Pump Station to be expanded by 7 MGD. In order to supply this system properly during peak time periods, the additional pumping capacity will require an additional 5 MG ground storage tank.

6.6 Water System Improvements from 2022 to 2024

A. Water Service Extension and Looping in the LPP (Projects 32W & 33W)

Project 32W will provide a 12-inch loop to the easternmost section of the south LPP area. This line has also been sized to meet the fire flow requirements and provide the needed transmission capacity into this area. The northeast corner of

the LPP will need to be supplied by Project 33W which is a 12-inch water line along FM 439. These water lines will be necessary to sustain pressure and fire flows in the future developing areas.

7.0 WASTEWATER FLOWS

7.1 Historical and Existing Wastewater Flows

As part of the analysis, Freese and Nichols reviewed the historical cumulative monthly wastewater flows from 2000 to 2005. From the data, a gross monthly average daily flow was calculated for each year in MGD and per capita. The data from 2000-2005 is summarized in **Table 7.1.**

Table 7.1 Historical Wastewater Flows

Year	Population	Monthly Avg. Daily Flow (MGD)	Monthly Avg. Daily Flow (gpcd)
2000	86,911	9.42	108
2001	89,858	11.78	131
2002	93,587	11.20	120
2003	100,911	10.62	105
2004	102,461	13.60	133
2005	106,145	12.77	120
Average		**11.99**	**122**

Historical wastewater records from the City and BCWCID #1 were reviewed to help determine historical average day wastewater flows and wet weather peaking factors. During the data analysis, it was determined that the City's per capita flow is significantly affected by the rate of inflow and infiltration (I/I). Typically, wastewater collection systems see a return of 65% to 80% of a service area's water usage. Historical meter data for the City's water and wastewater systems indicate a high rate of wastewater flow as compared to the City's water usage and are displayed in **Table 7.2**. This is a direct result of excessive inflow and infiltration leading to a strong recommendation for the City to conduct a detailed inflow/infiltration study to identify solutions to eliminate these excess flows that rob the collection system of capacity and results in excessive treatment costs.

Table 7.2 Comparison of Wastewater Flow to Water Usage

Month	Monthly Total (gallons)	Rainfall Total (inches)	Wastewater/Water Flow Percentage
Water December 2005 Sewer December 2005	291,251,411 250,318,737	0.2	86%
Water November 2005 Sewer November 2005	348,326,589 309,533,226	1.2	89%
Water October 2005 Sewer October 2005	406,714,552 319,066,289	0.9	78%
Water September 2005 Sewer September 2005	431,607,308 300,346,764	1.8	70%
Water August 2005 Sewer August 2005	396,836,764 458,473,506	7.7	116%
Water July 2005 Sewer July 2005	487,510,748 377,183,613	4	77%
Water June 2005 Sewer June 2005	452,512,004 350,549,520	0.5	77%
Water May 2005 Sewer May 2005	401,018,312 391,131,285	3.8	98%
Water April 2005 Sewer April 2005	343,142,304 384,056,483	0.88	112%
Water March 2005 Sewer March 2005	313,633,932 557,001,190	3.3	178%
Water February 2005 Sewer February 2005	252,149,540 508,864,863	3.7	202%
Water January 2005 Sewer January 2005	291,182,720 444,228,965	4.55	153%

7.2 Projected Wastewater Flows

The projected wastewater loads for the 2006 and future periods were calculated using the projected populations, flow monitoring data from the testing period, and other historical meter data. From the historical data in **Table 7.1,** we can conclude that the per capita flow is trending up over time. Due to the historical data identifying I/I issues, an analysis of the flow during the testing period was conducted to determine an accurate per capita flow. It was determined that the per capita flow for 2006 is 105 gpcd and that the average peaking factor for a 5-year/6-hour design-storm for the City of Killeen is approximately 4.0. Freese and Nichols recommends that the per capita flow for all subsequent time periods increase as indicated in **Table 7.3**. The factors used for calculating the future wastewater loads are summarized in **Table 7.3**. **Table**

7.4 summarizes the projected wastewater flows by major wastewater basin for the 2006, 2011, 2016 and 2031 planning periods.

Table 7.3 Projected Wastewater Flows

Year	Average Day per capita (gpcd)	Average Day Flow (MGD)	Peak Wet Weather Factor	Peak Wet Weather Flow (MGD)
2006	105	11.91	4.00	47.64
2011	110	15.18	4.00	60.72
2016	115	18.85	4.00	75.39
2031	115	29.51	4.00	118.02

Table 7.4
Summary of Projected Wastewater Flows by Major Wastewater Basin

2006					
Major Basin	**Served Population**	**Avg Day Flow Rates**	**Avg Day Flow (MGD)**	**Wet Weather Peaking Factor**	**Peak Wet Weather Flow (MGD)**
South Nolan	35,877	105 gpcd	3.77	4.00	15.07
Central	30,955	105 gpcd	3.25	4.00	13.00
Long Branch	22,621	105 gpcd	2.38	4.00	9.50
WWTP	11,140	105 gpcd	1.17	4.00	4.68
SH 195	2,126	105 gpcd	0.22	4.00	0.89
Trimmier Creek	10,700	105 gpcd	1.12	4.00	4.49
Total City	113,419		11.91	-	47.64
2011					
Major Basin	**Served Population**	**Avg Day Flow Rates**	**Avg Day Flow (MGD)**	**Wet Weather Peaking Factor**	**Peak Wet Weather Flow (MGD)**
South Nolan	40,985	110 gpcd	4.51	4.00	18.03
Central	36,732	110 gpcd	4.04	4.00	16.16
Long Branch	24,867	110 gpcd	2.74	4.00	10.94
WWTP	11,192	110 gpcd	1.23	4.00	4.92
SH 195	6,664	110 gpcd	0.73	4.00	2.93
Trimmier Creek	17,552	110 gpcd	1.93	4.00	7.72
Total City	137,992		15.18	-	60.72
2016					
Major Basin	**Served Population**	**Avg Day Flow Rates**	**Avg Day Flow (MGD)**	**Wet Weather Peaking Factor**	**Peak Wet Weather Flow (MGD)**
South Nolan	45,125	115 gpcd	5.19	4.00	20.76
Central	40,327	115 gpcd	4.64	4.00	18.55
Long Branch	26,562	115 gpcd	3.05	4.00	12.22
WWTP	11,235	115 gpcd	1.29	4.00	5.17
SH 195	14,133	115 gpcd	1.63	4.00	6.50
Trimmier Creek	26,509	115 gpcd	3.05	4.00	12.19
Total City	163,891		18.85	-	75.39
2031					
Major Basin	**Served Population**	**Avg Day Flow Rates**	**Avg Day Flow (MGD)**	**Wet Weather Peaking Factor**	**Peak Wet Weather Flow (MGD)**
South Nolan	56,732	115 gpcd	6.52	4.00	26.10
Central	51,595	115 gpcd	5.93	4.00	23.73
Long Branch	42,228	115 gpcd	4.86	4.00	19.43
WWTP	11,320	115 gpcd	1.30	4.00	5.21
SH 195	26,849	115 gpcd	3.09	4.00	12.35
Trimmier Creek	67,851	115 gpcd	7.80	4.00	31.21
Total City	256,576		29.51	-	118.02

8.0 EXISTING WASTEWATER SYSTEM

8.1 Existing Wastewater Collection System

The existing collection system currently conveys wastewater to the BCWCID #1 South Nolan and Trimmier Creek WWTPs. The South Nolan WWTP total treatment capacity is 21 MGD, with 15 MGD of treatment capacity at Plant #1 and 6 MGD of treatment capacity at Plant #2. The Trimmier Creek WWTP was constructed with an initial treatment capacity of 6 MGD. The City of Killeen's service area is divided into six sub-basins: Central, Long Branch, South Nolan, Trimmier, WWTP, and SH 195. Most portions of the Central, Long Branch, WWTP, and South Nolan Sub-basins gravity flow to the South Nolan WWTP. The Trimmier and SH 195 sub-basins' natural flow lines are away from South Nolan WWTP and are being redirected to the Trimmier Creek WWTP, eliminating some of the existing lift stations. Where possible, it is desirable to construct gravity wastewater lines and avoid lift stations to avoid the additional energy and operations and maintenance costs associated with lift stations.

8.2 Wastewater Model Development

The model of the City of Killeen's wastewater system includes 10-inch and larger wastewater gravity lines, key 8-inch wastewater gravity lines and force mains for all major lift stations. **Plate 6** shows the wastewater lines that are included in the wastewater model. The wastewater model was constructed using the City's Geographical Information System (GIS) Spatial Data Engine (SDE) database to include wastewater lines and manhole shapefiles. Invert elevations for major interceptors were added using as-built drawings. If as-builts of the pipe inverts were not available, inverts were back calculated either from known inverts using TCEQ minimum slope requirements or by straight line interpolation if an upstream and downstream invert was available. The budget did not include the cost to field verify inlet elevations. Wet wells and pumps at lift stations were added to the model using as-built drawings and pump curves from the City.

Once the census tract populations were determined, each of the six sub-basins in the study area was intersected with the census tracts to determine the 2006 through 2031 population estimates by sub-basin. A summary of flows by sub-basin is displayed in **Table 7.4** "Summary of Projected Wastewater Flows by Major Wastewater Basin." For all planning periods, the sub-basin populations were distributed to each manhole using Thiessen-polygons to determine a population that contributes flow to each manhole. The populations by census tract are displayed in **Plate 2**. After distributing the wastewater loads, dry weather and wet weather calibrations of the model were performed based upon flow monitoring from May through June 2006.

Fort Hood Meter Vault #2 (On 8" Sewer Line)

Fort Hood Meter Vault #3 (On 12" Sewer Line)

Fort Hood Meter Vault #4 (On 8" Sewer Line)

Fort Hood Meter Vault #1A (On 30" Sewer Line)

Fort Hood Meter Vault #1B (On 36" Sewer Line)

Lift Station #9

Nolan Creek Wastewater Treatment Plant

Lift Station #1

Lift Station #6

Lift Station #8

Lift Station #7

Lift Station #27

Lift Station

Lift Station #11A

Lift Station #14

Lift Station #15

Lift Station #14A

Lift Station

Lift Station #14B

Lift Station

Lift Station #23

Trimmier Creek Wastewater Treatment Plant

MAJOR SUB-BASINS

- Central Sub-Basin
- Long Branch Sub-Basin
- S.H. 195 Sub-Basin
- South Nolan Creek Sub-Basin
- Trimmer Creek Sub-Basin
- WWTP Sub-Basin

PLATE 6

CITY OF KILLEEN

EXISTING WASTEWATER SYSTEM

LEGEND

- Existing Lift Stations
- Modeled Lift Station
- WW Treatment Plant
- Future WW Treatment Plant
- Existing Sewer Lines
- Existing Force Mains
- Modeled Sewer Lines
- Modeled Force Mains
- Fort Hood Meter Vaults
- Streets
- Streams/Rivers
- Lakes
- Parcels
- Bell County Boundary
- Killeen City Limits
- Killeen ETJ

Freese and Nichols

0 4,000

SCALE IN FEET

Freese and Nichols, Inc.
[KIL06188]; H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_6)-Existing_Wastewater_System_Map.mxd
Printing Date: Tuesday, June 26, 2007

8.3 Wastewater System Field Testing

The wastewater field testing was conducted from May 4, 2006 through June 1, 2006. During this time, three temporary flow meters were installed by Freese and Nichols to record the flow generated by the City of Killeen and record the effect that any rain events had on the system. These three flow meters were placed on critical collection mains. Additional flow data was obtained from meters owned by the City of Killeen and BCWCID #1. These meters helped determine the total flow at the WWTP and the amount of flow contributed to the system by Fort Hood. BCWCID #1 has four meters that record incoming flow from Fort Hood and one meter that records all flow coming from Fort Hood and the City of Killeen. During the monitoring period, a significant rainfall event was recorded which allowed for a discrete calculation of Rainfall Dependent Inflow/Infiltration (RDII) for the City. **Appendix D** contains the wastewater field testing information.

8.4 Dry Weather Model Calibration

The primary components of the wastewater flows in sanitary sewers during dry weather periods are domestic wastewater, industrial wastewater, and groundwater infiltration. Loads that originate from ground water infiltration (GWI) typically enter the sewer system through defective pipes or connections and/or through manhole walls. Other dry weather loads can include water from public fountain drains, pools, cooling water discharges, and other intermittent industrial/commercial discharges. For this study, there are no specific inflows known, and GWI was assumed to be present within the gross gpcd assigned to each manhole. Based on the available data, all flows were distributed on a per capita basis for domestic wastewater flows. The principal sources of domestic sanitary sewer loads are residential areas and commercial developments.

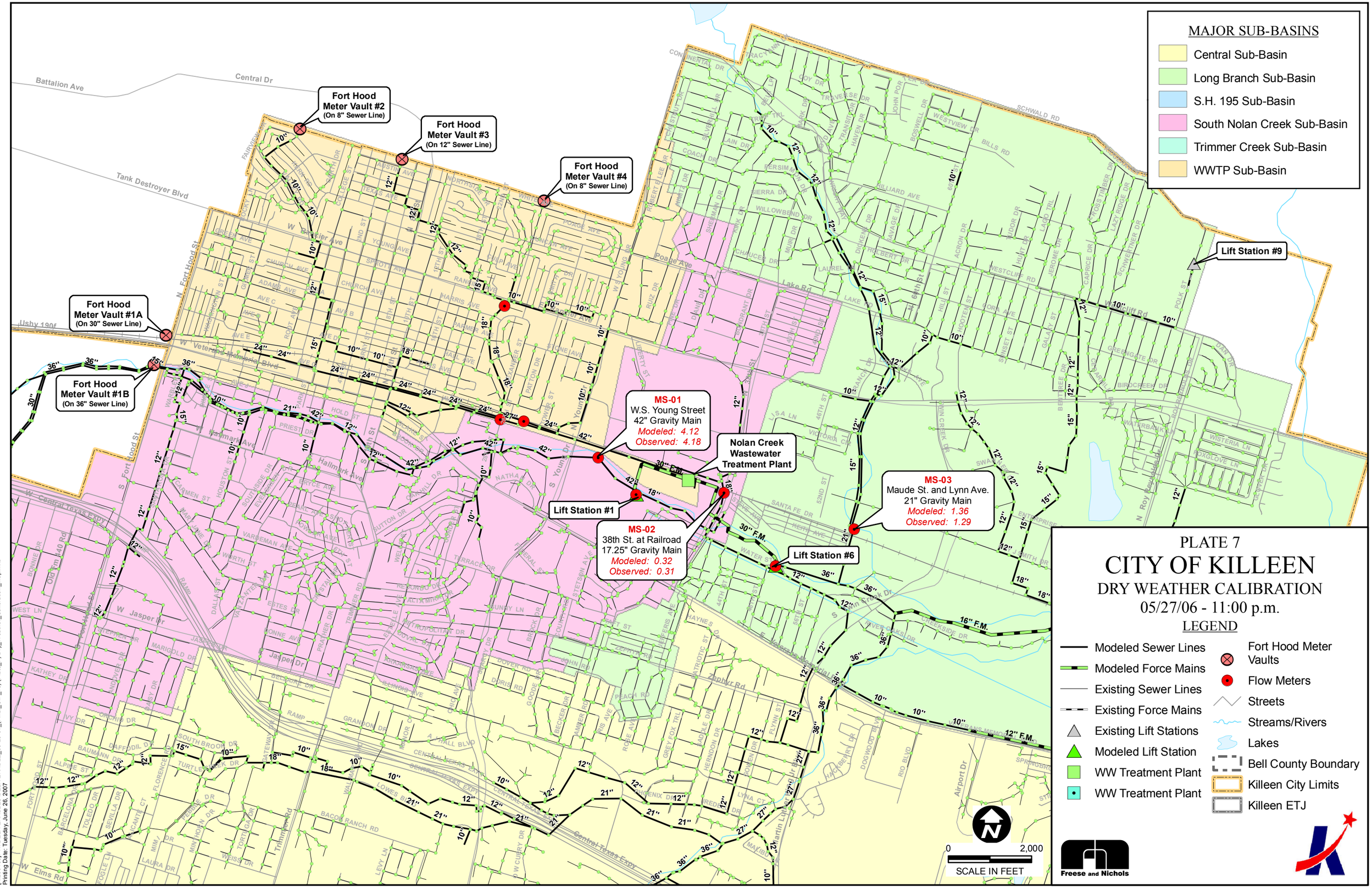
In order to determine a dry weather calibration time period, the metered flow data was analyzed to determine an average hourly flow for a period of 24 hours for each of the three meter locations. For each of the metered locations, the dry weather

calibration time period selected was May 27, 2006. Using each meter's dry weather flow data and the population distribution by sewer sub-basins, an estimated gross gpcd was calculated for each sub-basin. Based on the gpcd and the distributed population within each sub-basin, flows were generated and assigned to each manhole within the sub-basin.

In order to represent the flows entering the system over time, a dry weather pattern was developed for each sub-basin based on the flow meter data. The pattern was calculated by using the measured hourly flow divided by the average daily flow for the calibration time period. Each manhole was then assigned a pattern. At this point, the model was run and compared to the measured dry weather event data. Manning's roughness coefficient was adjusted for various pipes until the model was calibrated for the dry weather event of May 27, 2006. A map of the flow meters observed and modeled flows can be seen in **Plate 7**. The results show a close correlation between the dry weather model flows and those measured in the field for actual conditions. Additional information on the dry weather calibration is contained in **Appendix D**.

8.5 Wet Weather Model Calibration

The primary components of wet weather flows are the same as dry weather flows plus the flows that can be linked to rainfall dependent infiltration and inflows (RDII). When determining wet weather loads, one must consider the hydrologic analysis of excess precipitation and the associated runoff. In order to calibrate the model to a specific rainfall event, recorded flow meter data during a rain event and the model simulation of that event were compared. When analyzing the data for wet weather events it was determined that one significant storm event of 2.5-inches was recorded during the testing period. The event recorded peak wet weather flows less than anticipated due to extremely dry antecedent soil conditions, which lowers the expected RDII. The field data was adjusted to represent more typical weather and saturated soil conditions.



Freese and Nichols, Inc.
[KIL06188]: H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_7)-Dry_Weather_Calibration_Map.mxd
Printing Date: Tuesday, June 26, 2007

For each sub-basin, the dry weather flow event was subtracted from the recorded flow from each storm by each hourly time step to determine the amount of RDII for that storm event for a 24-hour time period. In other words, the difference between the two curves by time step provides the amount of RDII volume generated by that storm event for each sub-basin. For each hourly time step within the storm, the RDII was then divided by the average hourly RDII. The value derived from this calculation produces a 24-hour wet weather RDII pattern for the storm for each sub-basin.

An RDII per diameter-inch of linear foot of pipe was calculated for each sub-basin. To calculate the amount of RDII per diameter-inch of linear foot of pipe the total volume of RDII per sub-basin for each storm was divided by the diameter-inch of linear foot of pipe. The estimated RDII per diameter-inch of pipe was then added to the model. Each sub-basin was then assigned a wet weather pattern. The model was run and the results were compared to the flow meter data collected at each site. In order to calibrate the model, minor adjustments were made to the wet weather patterns. In **Plate 8**, a snapshot of the wet weather calibration model shows the observed versus modeled flows for each flow meter for that rain event. Additional information on the wet weather calibration is contained in **Appendix D**.

8.6 Wastewater System Design Criteria

A. **Sewer Trunk Lines (Interceptors)**

The design criteria for sewer trunk lines or interceptors is based on the TCEQ requirements that meet peak wet weather design flows with no overflows while maintaining a minimum of 2-feet/second cleaning velocity and a maximum of 8-feet/second velocity.

B. **Lift Station Pumping Capacity**

The design criteria for lift station pumping shall be to provide firm pumping capacity to meet 125% of the peak wet weather design flows. The firm pumping capacity is defined as the total available pumping capacity with the largest pump out of service.

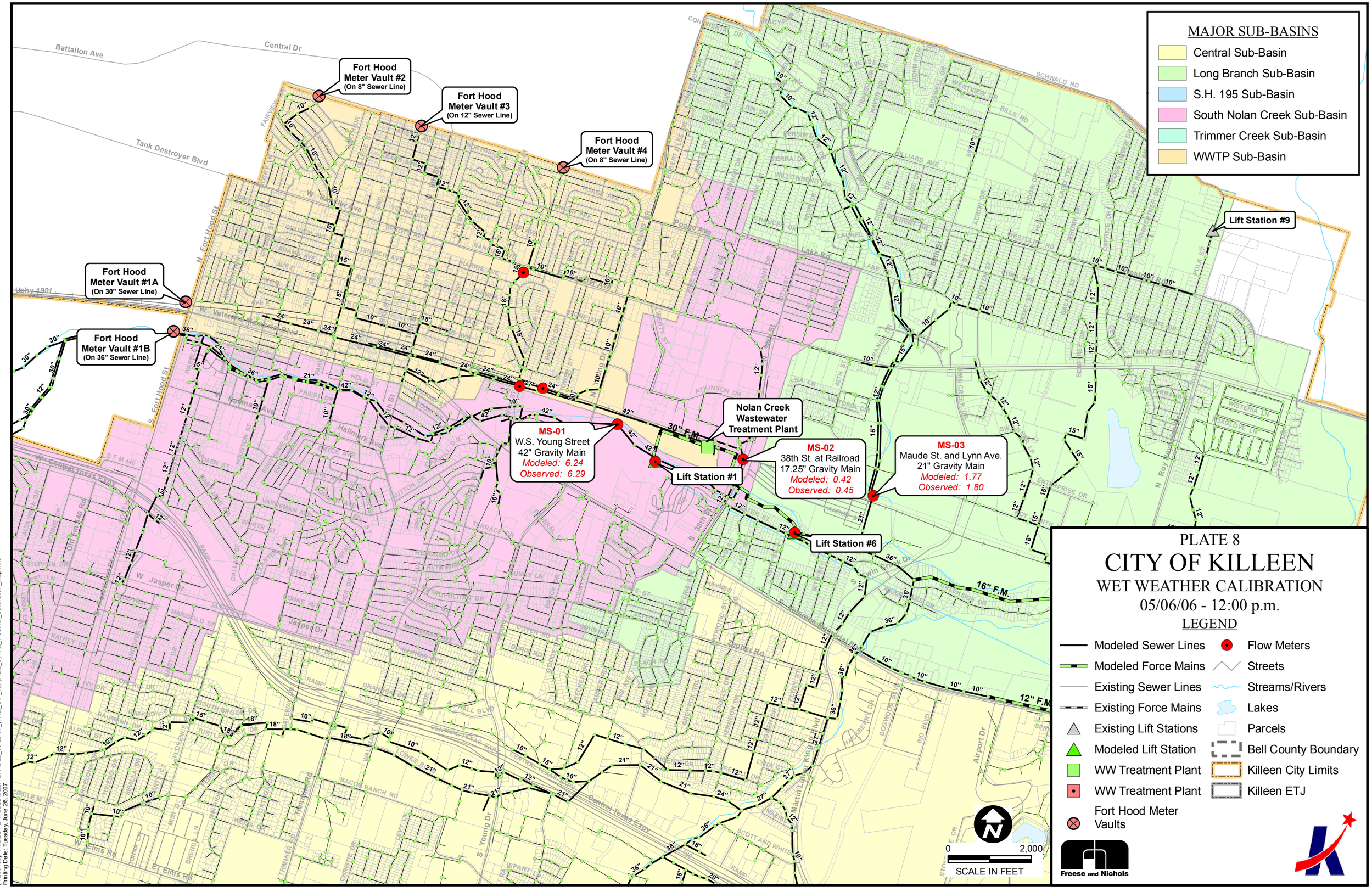


PLATE 8

CITY OF KILLEEN

WET WEATHER CALIBRATION

05/06/06 - 12:00 p.m.

LEGEND

- Modeled Sewer Lines
- Modeled Force Mains
- Existing Sewer Lines
- Existing Force Mains
- Existing Lift Stations
- Modeled Lift Station
- WW Treatment Plant
- WW Treatment Plant
- Fort Hood Meter Vaults
- Flow Meters
- Streets
- Streams/Rivers
- Lakes
- Parcels
- Bell County Boundary
- Killeen City Limits
- Killeen ETJ

Freese and Nichols

Freese and Nichols, Inc.
[KL06188]; H:\DELIVERABLES\DELIVERABLE_06-28-07_(Final_CIP_v3)\(Plate_8)-Wet_Weather_Calbration_Map.mxd
Printing Date: Tuesday, June 26, 2007

C. **Lift Station Wet Well Capacity**

The design criteria for lift station wet wells are to provide adequate volumes to limit pump cycling to once every 10 minutes. Based on this criterion, the required operating volume for each pump can be calculated as:

$$V = \frac{t * Q}{4}$$

where,

t = Maximum pump cycling time (10 minutes)

Q = Lead pump discharge rate (gpm)

V = Required wet well volume between pump start and stop elevation

D. **Force Mains**

The design criteria recommended for force mains is to meet the required pumping capacity of the lift station at a velocity less than 8-feet per second and a maximum discharge pressure of 100 psi and to allow a minimum of 2-feet per second scouring velocity during a single pump operation.

8.7 Existing Wastewater System Analysis

In order to evaluate the existing wastewater collection system, Freese and Nichols staff met with City staff and operations personnel. They were able to identify areas of concern and potential problem areas based on existing conditions and future development. In addition, Freese and Nichols staff investigated various portions of the system during field testing and analyzed historical and current flow monitoring records. The culmination of the analysis was the use of the model to determine the vulnerabilities of the system under varying load conditions to include analysis of the system under the influence of a design storm event, which would produce peak wet weather loads. Based on these factors, areas of concern were identified for the existing system:

- The northern and central portions of the City experience higher than normal rates of Inflow and Infiltration (I/I) resulting in significant overloading of existing lines during peak wet weather conditions.

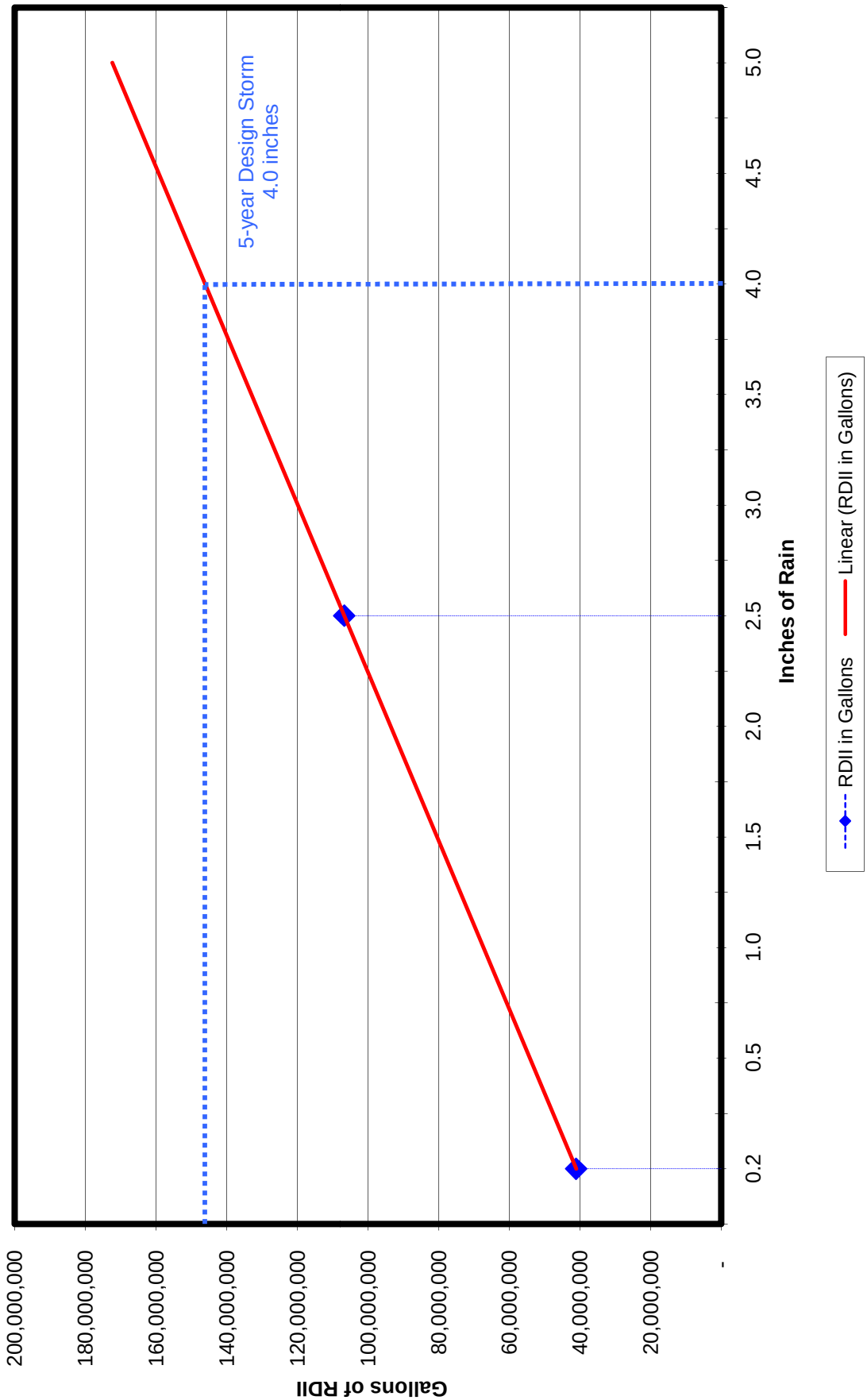
- The City needs to continue constructing improvements in the southern portion of the collection system to transfer additional flows to the Trimmier Creek WWTP in order to reduce the costs associated with pumping and to free up capacity in the interceptors going to the existing South Nolan WWTP.
- Lift Station 8 needs to be rehabilitated or replaced.
- Lift Station 7 needs to be rehabilitated or replaced.
- The collection mains that flow into Lift Stations 1 and 6 experience significant surcharging.

9.0 FUTURE WASTEWATER SYSTEM

9.1 Design Storm Conditions

In order to determine the appropriate pipe capacity for future wastewater loads the appropriate per capita load must be combined with the effect of a 5-year/6-hour storm on the City of Killeen's collection system. The RDII was calculated for both flow monitoring rain events and plotted on a graph. By using the two wet weather points, a trend line was plotted to show the volume of expected RDII that would occur for a 5-year/6-hour design storm (as shown in **Figure 9.1**). From this data, the estimated RDII was calculated for the City and distributed within each sub-basin. By using the existing wet weather flow data, an hourly interpolation of the design storm wet weather flow was developed. The loads in each of the sub-basins were then assigned a 24-hour wet weather pattern for the design storm. When the model was run with the design storm conditions, all gravity mains were analyzed to determine which pipes were surcharged. Surcharged pipes were defined by taking the modeled flow and dividing by the available pipe capacity during free flow conditions. If this ratio was 1.0 or greater, it was considered surcharged. Manholes were also identified as potential Sanitary Sewer Overflows (SSOs) if the manholes had an unfilled depth of less than 2-feet from the rim elevation. Based on the modeling and the analysis, portions of the wastewater collection system were identified for future CIP projects and sized in order to carry future flows.

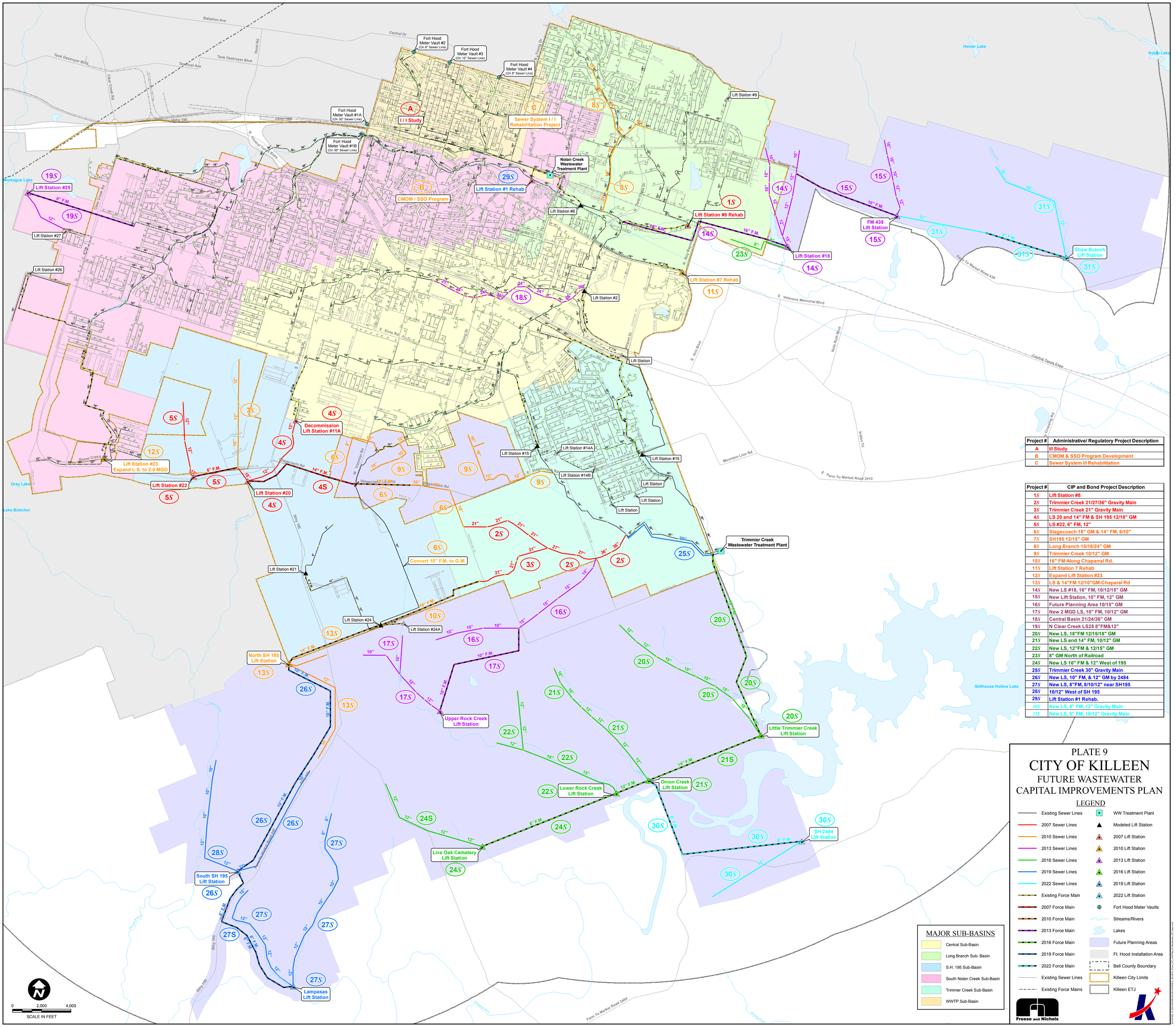
Figure 9.1 Design Storm RDII Graph



10.0 WASTEWATER SYSTEM CAPITAL IMPROVEMENT PLAN

The capital improvement plan has six planning periods: 2007-2009, 2010-2012, 2013-2015, 2016-2018, 2019-2021 and 2022-2031. All of the proposed capital improvements for the wastewater system are shown in **Plate 9**. Unit costs used to estimate projected costs of the wastewater system improvements are in **Appendix B**. These costs are for the principal wastewater collection facilities in the wastewater system and do not include individual service connections or subdivision internal lines. The estimated costs for the wastewater CIP by project can be found in **Appendix B**, Wastewater Capital Improvement Cost Estimates.

Unit costs were based on reviewing bid tabs for several projects ranging in size. These costs include an allowance for engineering, surveying, geotechnical engineering and contingencies. The project costs only include right-of-way acquisition for lift stations and not for wastewater lines. It is recommended that these improvements be constructed generally in the order listed; however, it is understood that development in certain areas of the City and its service areas may make it necessary to construct some future improvements sooner than anticipated. Additional information on the wastewater collection system and its improvements are in **Appendix B**.



Project #	Administrative/ Regulatory Project Description
A	I/I Study
B	CMOM & SSO Program Development
C	Sewer System I/I Rehabilitation

Project #	CIP and Bond Project Description
1S	Lift Station #8
2S	Trimmier Creek 21/27/36" Gravity Main
3S	Trimmier Creek 21" Gravity Main
4S	LS 20 and 14" FM & SH 195 12/18" GM
5S	LS #22, 6" FM, 12"
6S	Stagecoach 18" GM & 14" FM, 8/10"
7S	SH195 12/15" GM
8S	Long Branch 15/18/24" GM
9S	Trimmier Creek 10/12" GM
10S	16" FM Along Chaparral Rd.
11S	Lift Station 7 Rehab
12S	Expand Lift Station #23
13S	LS & 14"FM 12/10"GM-Chaparal Rd
14S	New LS #18, 16" FM, 10/12/15" GM
15S	New Lift Station, 10" FM, 12" GM
16S	Future Planning Area 10/15" GM
17S	New 2 MGD LS, 10" FM, 10/12" GM
18S	Central Basin 21/24/36" GM
19S	N Clear Creek LS25 8"FM&12"
20S	New LS, 18"FM 12/15/18" GM
21S	New LS and 14" FM, 10/12" GM
22S	New LS, 12"FM & 12/15" GM
23S	8" GM North of Railroad
24S	New LS 10" FM & 12" West of 195
25S	Trimmier Creek 30" Gravity Main
26S	New LS, 10" FM, & 12" GM by 2484
27S	New LS, 8"FM, 8/10/12" near SH195
28S	10/12" West of SH 195
29S	Lift Station #1 Rehab.
30S	New LS, 8" FM, 12" Gravity Main
31S	New LS, 8" FM, 10/12" Gravity Main

PLATE 9

CITY OF KILLEEN

FUTURE WASTEWATER CAPITAL IMPROVEMENTS PLAN

LEGEND

- Existing Sewer Lines
- 2007 Sewer Lines
- 2010 Sewer Lines
- 2013 Sewer Lines
- 2016 Sewer Lines
- 2019 Sewer Lines
- 2022 Sewer Lines
- Existing Force Main
- 2007 Force Main
- 2010 Force Main
- 2013 Force Main
- 2016 Force Main
- 2019 Force Main
- 2022 Force Main
- Existing Sewer Lines
- Existing Force Mains
- WW Treatment Plant
- Modeled Lift Station
- 2007 Lift Station
- 2010 Lift Station
- 2013 Lift Station
- 2016 Lift Station
- 2019 Lift Station
- 2022 Lift Station
- Fort Hood Meter Vaults
- Streams/Rivers
- Lakes
- Future Planning Areas
- Ft. Hood Installation Area
- Bell County Boundary
- Killeen City Limits
- Killeen ETJ

MAJOR SUB-BASINS

- Central Sub-Basin
- Long Branch Sub- Basin
- S.H. 195 Sub-Basin
- South Nolan Creek Sub-Basin
- Trimmer Creek Sub-Basin
- WWTP Sub-Basin

Freese and Nichols

10.1 Wastewater System Improvements from 2007 to 2009

A. Lift Station Upgrade to Support Growth in Long Branch Sub-basin (Project 1S)

The area near Roy Reynolds Drive is experiencing growth, which will require an upgrade to Lift Station 8. The projected population through 2016 is over 17,000 people, which will contribute an estimated peak flow of 4.86 MGD to the sub-basin supported by Lift Station 8. The estimated peak wet weather flow of 4.86 MGD is based on a system that has aged sufficiently such that the amount of rainfall dependent inflow and infiltration (RDII) will match the existing peaking factor of 3.9 for that area of the City. Since the majority of the population growth that will occur in the sub-basin will require construction of a new collection system, the estimated rainfall dependent inflow and infiltration (RDII) can be significantly reduced for the first 10 years. It is estimated that through 2016 an estimated peak wet weather flow of 4.0 MGD can be expected. Based on this, it is recommended that the Lift Station #8 Rehabilitation Project install three pumps with a duty point of 1,400 gpm pumps at 80-feet total dynamic head (TDH). This recommendation is only to support the anticipated growth and aging of the system through 2016. Beyond 2016, as the population and the age of the system increases, additional capacity will be required.

B. Collection Interceptor to Support Growth (Projects 2S, 3S)

In order to support growth in the southern portion of the City's service area, a major collection interceptor is needed from Featherline Rd. to just east of East Trimmier Rd. This interceptor network will provide the backbone for the collection system required to service a majority of the growth that will occur for the next 10 years. The interceptor network will carry flow into an existing interceptor that is served by the new BCWCID #1 Trimmier Creek WWTP just south of the City. Future developments, which will be supported by the interceptor, include a new school and police station in the vicinity of Chaparral Rd. and Featherline Rd.

C. **Collection System to Support Growth in SH 195 Sub-basin (Projects 4S, 5S)**

In order to support growth in the SH 195 Sub-basin, a series of gravity mains, lift stations and force mains need to be constructed. When constructed, flow will initially be lifted by force main to a Central Sub-basin gravity main and treatment will occur at the existing BCWCID #1 Nolan Creek WWTP. In the future the flows from these supported areas will be redirected through Project 2S to the Trimmier Creek WWTP. In addition to the new growth that these projects will support, they will also allow the decommissioning of Lift Station 11A, which will reduce the amount of pumping that occurs in the system.

D. **Reduction of Inflow and Infiltration in the City (Project A)**

When evaluating a wastewater collection system, the amount of inflow and infiltration (I/I) entering the system can play a critical role in the assessment and sizing of pipes, lift stations, and required WWTP capacities. I/I simply defined are flows that enter a wastewater collection system that do not originate from a paying customer. Based on the flow monitoring data, it was determined that an excessive I/I rate for the City of Killeen is occurring. Typically, the wastewater system of a City collects about 65% to 80% of the City's water demand. Based on flow meter recordings, the City of Killeen has experienced significant I/I during rain events. Flow monitoring conducted during the study indicates that portions of Long Branch, WWTP, Central and South Nolan Sub-basins merit further study. In order to determine which specific areas in the sub-basins require rehab and/or expansion, the City of Killeen needs to conduct an I/I Study.

10.2 Wastewater System Improvements from 2010 to 2012

A. **Collection System for New Service Areas and Interconnectivity (Projects 6S, 9S)**

These projects will provide dual functions for the overall collection system in Killeen. First, it will allow the flow from Projects 4S and 5S to be redirected to the Trimmier Creek WWTP, which will free up treatment capacity at the existing Nolan Creek WWTP and flow capacity in numerous gravity mains needed to support growth in other areas of the City. Secondly, it will also provide service

for new customers along Stagecoach Rd. from West Trimmier Rd. to East Trimmier Rd.

B. **Collection System to Support Growth in South (Projects 7S, 10S, 12S, 13S)**

Growth along the SH 195 Corridor will need to be serviced. In order to support residential and commercial development along the upper portions of North Reese Creek subcatchement, additional collection mains will need to be constructed north of Reese Creek Road (Project 7S). The construction of these collection mains will gravity flow into Lift Station 20 (Project 4S). In order to support growth in and around the southwestern portion of South Nolan Creek Sub-basin, Lift Station 23 will need to be expanded to a 2.0 MGD firm capacity (Project 12S). Another key portion of the collection system in the South is the construction of gravity mains, a lift station, and force main system to support development expected to occur along the southern portion of the SH 195 corridor (Projects 10S & 13S). This project will collect flows from new customers and which will be lifted eastward to Project 3S where it will gravity flow to the Trimmier Creek WWTP.

C. **CMOM/SSO Program (Project B)**

The EPA Capacity Management Operations and Maintenance (CMOM) program is not official legislation at this time; however, the EPA has expressed to the state governments that the CMOM program will happen at some point in the future. The Texas Commission on Environmental Quality (TCEQ), which is responsible for wastewater system compliance, is currently inviting municipalities to be a part of the Sanitary Sewer Overflow Initiative (SSOI) Program. For now, the criteria being used to select entities for participation in the CMOM/SSOI Program include: large systems, large systems with problems, and medium systems with problems. When systems volunteers for the program, they are asked to develop and implement programs that include the following:

- Reduce/ Eliminate overflows
- Tracking Sanitary Sewer Overflows (SSOs)
- Categorizing SSOs by cause

- SSO Response Plan (Sanitary Sewer Evaluation Studies, capacity analysis, CIP, CMOM audit)
- Backup power requirements for lift stations
- Effluent treatment standards raised for BNR

Freese and Nichols recommends that the City of Killeen take proactive steps to meet impending CMOM standards by executing Project B. Project B will allow the City to get ahead of the pending legislation and develop the programs necessary to meet CMOM standards over a longer time period, instead of being forced to meet those standards based upon future legislation, or worse, through an Administrative Order.

D. **Reduction of I/I to Free up Treatment and Collection Capacity (Projects 8S & C)**

In order to free up treatment and collection capacity to support future growth and to reduce the amount of flow treated at the Nolan Creek WWTP, the study area identified in Project A will require several future projects. Based on existing information, Project A will need to be conducted in order to reduce I/I flows and reduce the likelihood of an administrative order or fines due to sanitary sewer overflows. Since Project A will provide a more in-depth look at the study area, the results from the study may reduce, eliminate, or identify more specific projects for execution.

E. **Lift Station Upgrade in Central Sub-basin (Project 11S)**

Lift Station 7 collects flows in the far eastern portion of the Central Sub-basin and pumps the flow to a gravity main to be treated in the existing Nolan Creek WWTP. In order to ensure dependable service in its service area, Lift Station 7 will need to have extensive rehabilitation performed, or a new lift station will need to be constructed to replace it.

10.3 Wastewater System Improvements from 2013 to 2015

A. **New Collection System to Support Growth in Long Branch (Projects 14S & 15S)**

Future growth along Hay Branch in Long Branch Sub-basin will require a collection system and lift station (Project 14S). The new Hay Branch Lift Station will also receive flows from a new lift station and gravity system located to the northeast along a tributary of South Nolan Creek near FM 439. The FM 439 Lift Station will support growth that will occur north of and along FM 439. Flows from these lift station will be treated at the Nolan Creek WWTP

B. **Collection System to Support Growth South of the City (Projects 16S & 17S)**

As developments occur in the south, new collections systems will have to be constructed to support and convey flows to the Trimmier Creek WWTP. Project 16S and 17S consist of gravity mains and the new Upper Rock Creek Lift Station to support expected development along portions of Rock Creek and immediately south of Chaparral Rd.

C. **Interceptor to Support Growth in the Central Sub-basin (Project 18S)**

The Central Sub-basin will require additional interceptor capacity in order to support the future flow projections. The existing interceptor will have to be upsized to a 21-inch/24-inch/36-inch pipe starting just west of Gateway Drive to the new Lift Station 2. Depending on the results of the I/I study in Project A, this project may be subject to a reduction in scope or the project may shift focus to other collection pipes that feed into it.

D. **Collection System to Support Growth in South Nolan Sub-basin (Project 19S)**

The western portion of South Nolan Sub-basin will require two separate gravity mains, the new Lift Station 25, and an 8-inch force main in order to support commercial and residential growth. Lift Station 25 will be located west of Clear Creek Rd. Flows that are pumped from both lift stations will be transported through the existing collection system in South Nolan Sub-basin and will be treated by the Nolan Creek WWTP.

10.4 Wastewater System Improvements from 2016 to 2018

A. **Collection System to Support Growth in the South (Projects 20S, 21S, 22S, 24S)**

In order to support growth south of Chaparral Rd. multiple lift stations and the supporting gravity collection systems will need to be constructed. Four lift stations aligned in a series will collect flows from their own gravity network and the preceding lift station and pump the flow from the west to the east, where it will ultimately be lifted to the Trimmier Creek WWTP. All four lift stations will be located along tributaries that feed the Lampasas River/Stillhouse Hollow Lake. The flows will be collected and pumped from the Live Oak Cemetery Lift Station (Project 24S), to the Lower Rock Creek Lift Station (Project 22S), to the Onion Creek Lift Station (Project 21S), and the Little Trimmier Creek Lift Station (Project 20S). The Trimmier Creek Lift Station will then lift the flows to the Trimmier Creek WWTP.

B. **New Gravity Main in the North (Project 23S)**

With expansion and growth, a new 8-inch gravity main will be constructed to convey flow to the Hay Branch Lift Station.

10.5 Wastewater System Improvements from 2019 to 2021

A. **Addition of a Parallel Major Interceptor to Trimmier Creek WWTP (Project 25S)**

In order to convey the additional flow as the City grows, a 30-inch parallel interceptor will be required from just east of East Trimmier Rd. to the Trimmier Creek WWTP.

B. **Development of SH 195 Corridor (Projects 26S, 27S, 28S)**

As the SH 195 corridor continues to develop, additional areas will require utility service. In order to support this growth two new lift stations and their subcatchement systems will be required. The new Lampasas Lift Station will collect flows from two collection mains, a 10-inch/12-inch gravity main and an 8-inch/10-inch/12-inch gravity main located along a Lampasas River tributary. The Lampasas Lift Station will then pump the flows to the South SH 195 Lift Station. The South SH 195 Lift Station also collects flows from a new 10-inch/12-inch gravity main just west of SH 195 and a second 10-inch/12-inch gravity main along the southern portion of Reese Creek. The South SH 195 Lift Station will

pump the flows it collects along a new 10-inch force main to the North SH 195 Lift Station constructed in Project 13S.

C. **Rehabilitation of Lift Station 1(Project 29S)**

Lift Station 1 will require rehabilitation in order to effectively convey flows to the Nolan Creek WWTP. Based upon the age of the lift station, it is expected that the pumping units at the lift station will require replacing.

10.6 Wastewater System Improvements from 2022 to 2024

A. **New Collection System to support Growth in the South (Project 30S)**

In order to accommodate additional growth south of Stillhouse Hollow Lake, SH 2484 Lift Station will need to be constructed along with an 8-inch force main to convey the flow collected from a 12-inch gravity main north of the Little Trimmier Creek Lift Station.

B. **New Collection System to support Growth in the North (Project 31S)**

As the City grows further to the East towards Shaw Branch a new gravity main will be installed to support the expansion along with the construction of the Shaw Branch Lift Station to lift flow west through an 8-inch force main to a 12-inch gravity main connected to the FM 439 Lift Station.

11.0 Summary Capital Improvement Costs and Bond Program

Currently the City of Killeen funds its Capital Improvement Program through (three-year) bond packages. In order to assist the City with developing its bond program, Freese and Nichols evaluated projects based on projected needs and put together six, three-year bond packages that will allow for the construction of the projects identified by this report. The bond packages are laid out for the following time periods:

2007-2009
2010-2012
2013-2015
2016-2018
2019-2021
2022-2024

Each of the bond packages lists the most important projects for each time period first. **Table 11.1** summarizes the costs for each bond-package, showing the water and wastewater projects separately and the combined cumulative costs for both programs. The costs shown have been adjusted to provide an estimated cost escalation associated with projected inflation.

Table 11.1
Summary of Capital Improvement Costs and Bond Program

WATER		2007		SANITARY SEWER				
Project	Description	Cost	Cumulative Cost	Project	Description	Cost	Cumulative Cost	Combined Cumulative
1W	12/16/20" along Reese Creek Rd.	$2,931,506	$2,931,506	1S	Lift Station #8	$1,086,200	$1,086,200	$4,017,706
2W	1.5 MG Bundrant EST Expansion	$2,352,000	$5,283,506	2S	Trimmier Creek 21/27/36" Gravity Main	$2,850,052	$3,936,252	$9,219,758
3W	12/16" Southeast Loop	$2,414,402	$7,697,908	3S	Trimmier Creek 21" Gravity Main	$1,076,923	$5,013,176	$12,711,083
4W	Pump Station 3 Upgrade	$3,360,000	$11,057,908	4S	LS 20 and 14" FM & SH 195 12/18" GM	$3,254,435	$8,267,610	$19,325,518
			$11,057,908	5S	LS #22, 6" FM, 12"	$1,649,460	$9,917,071	$20,974,978
TOTAL		**$11,057,908**		**TOTAL**		**$9,917,071**		**$20,974,978**
WATER		**2010**		**SANITARY SEWER**				
Project	Description	Cost	Cumulative Cost	Project	Description	Cost	Cumulative Cost	Combined Cumulative
5W	12/16" along N. Young Drive	$861,638	$861,638	6S	Stagecoach 18" GM & 14" FM, 8/10"	$2,053,237	$2,053,237	$2,914,875
6W	12/16" Onion Road Water Line	$1,770,828	$2,632,466	7S	SH195 12/15" GM	$914,445	$2,967,682	$5,600,148
7W	12/24" Trimmier Road Water Line	$2,108,091	$4,740,557	8S	Long Branch 15/18/24" GM	$2,055,044	$5,022,726	$9,763,283
8W	24/30" along Chaparral Road	$2,339,904	$7,080,461	9S	Trimmier Creek 10/12" GM	$1,447,729	$6,470,455	$13,550,916
9W	5 MG GST, 7 MGD PS, 30" Line	$7,604,248	$14,684,709	10S	16" FM Along Chaparral Rd.	$1,046,514	$7,516,969	$22,201,678
10W	20" Line along Chaparral Rd	$1,150,464	$15,835,173	11S	Lift Station 7 Rehab	$651,840	$8,168,809	$24,003,982
			$15,835,173	12S	Expand Lift Station #23	$779,520	$8,948,329	$24,783,502
			$15,835,173	13S	LS & 14"FM 12/10"GM-Chaparal Rd	$3,016,469	$11,964,798	$27,799,971
TOTAL		**$15,835,173**		**TOTAL**		**$11,964,798**		**$27,799,971**
WATER		**2013**		**SANITARY SEWER**				
Project	Description	Cost	Cumulative Cost	Project	Description	Cost	Cumulative Cost	Combined Cumulative
11W	4 MGD PS 16" along FM 439	$4,646,006	$4,646,006	14S	New LS #18, 16" FM, 10/12/15" GM	$4,377,626	$4,377,626	$9,023,632
12W	12" Airport/ Upper PP	$1,429,716	$6,075,723	15S	New Lift Station, 10" FM, 12" GM	$2,618,368	$6,995,994	$13,071,717
13W	12/20" & 1.5 GST W of Chap. Rd	$2,981,477	$9,057,200	16S	Future Planning Area 10/15" GM	$1,702,973	$8,698,967	$17,756,167
14W	16" Water Line along 38th Street	$1,470,927	$10,528,127	17S	New 2 MGD LS, 10" FM, 10/12" GM	$2,611,385	$11,310,352	$21,838,479
15W	16/20/24"& 7.0 MGD PS Lower PP	$4,382,112	$14,910,239	18S	Central Basin 21/24/36" GM	$2,884,144	$14,194,496	$29,104,735
			$14,910,239	19S	N Clear Creek LS25 8"FM&12"	$1,836,124	$16,030,620	$30,940,859
TOTAL		**$14,910,239**		**TOTAL**		**$16,030,620**		**$30,940,859**
WATER		**2016**		**SANITARY SEWER**				
Project	Description	Cost	Cumulative Cost	Project	Description	Cost	Cumulative Cost	Combined Cumulative
16W	Pressure Plane Modifications	$806,400	$806,400	20S	New LS, 18"FM 12/15/18" GM	$6,114,966	$6,114,966	$6,921,366
17W	12/16" at Chaparral & Bell PS	$1,131,043	$1,937,443	21S	New LS and 14" FM, 10/12" GM	$3,223,214	$9,338,180	$11,275,623
18W	12" along NE City Limits	$864,730	$2,802,173	22S	New LS, 12"FM & 12/15" GM	$3,346,372	$12,684,552	$15,486,725
19W	20" along 195 and Fort Hood St.	$1,821,590	$4,623,763	23S	8" GM North of Railroad	$418,666	$13,103,218	$17,726,981
20W	12" South of Chaparral Road	$1,320,480	$5,944,243	24S	New LS 10" FM & 12" West of 195	$2,873,257	$15,976,475	$21,920,718
21W	12" along FM 439	$1,912,620	$7,856,863				$15,976,475	$23,833,338
22W	12" Railroad To FM 439	$1,372,213	$9,229,075				$15,976,475	$25,205,550
23W	12/16/20" East Stagecoach Road	$4,468,840	$13,697,916				$15,976,475	$29,674,391
24W	Airport PS Expans. & PP Mods	$618,240	$14,316,156				$15,976,475	$30,292,631
25W	12/16" SW part of Lower PP	$1,672,339	$15,988,495				$15,976,475	$31,964,970
TOTAL		**$15,988,495**		**TOTAL**		**$15,976,475**		**$31,964,970**
WATER		**2019**		**SANITARY SEWER**				
Project	Description	Cost	Cumulative Cost	Project	Description	Cost	Cumulative Cost	Combined Cumulative
26W	12" by FM 2484	$3,473,971	$3,473,971	25S	Trimmier Creek 30" Gravity Main	$2,379,103	$2,379,103	$5,853,075
27W	1.0 MG EST in Lower PP & PRV's	$2,483,960	$5,957,931	26S	New LS, 10" FM, & 12" GM by 2484	$3,071,159	$5,450,262	$11,408,194
28W	16" Vet. Mem. Blvd to Railroad	$1,181,914	$7,139,845	27S	New LS, 8"FM, 8/10/12" near SH195	$4,373,798	$9,824,061	$16,963,906
29W	12/16" South Lower PP Loop	$4,783,773	$11,923,618	28S	10/12" West of SH 195	$1,026,000	$10,850,061	$22,773,679
30W	5.0 MG GST & 7.0 MGD PS Expan.	$6,289,920	$18,213,538	29S	Lift Station #1 Rehab.	$1,196,160	$12,046,221	$30,259,759
31W	16" West of 195 in Upper PP	$2,184,248	$20,397,786				$12,046,221	$32,444,007
TOTAL		**$20,397,786**		**TOTAL**		**$12,046,221**		**$32,444,007**
WATER		**2022**		**SANITARY SEWER**				
Project	Description	Cost	Cumulative Cost	Project	Description	Cost	Cumulative Cost	Combined Cumulative
32W	12" Water Line in SE Lower PP	$3,401,691	$3,401,691	30S	New LS, 8" FM, 12" Gravity Main	$2,705,276	$2,705,276	$6,106,967
33W	12" Water Line in NW Lower PP	$441,423	$3,843,114	31S	New LS, 8" FM, 10/12" Gravity Main	$3,397,675	$6,102,951	$9,946,065
TOTAL		**$3,843,114**		**TOTAL**		**$6,102,951**		**$9,946,065**

Appendix A

Water Capital Improvement Plan Cost Estimate

TABLE A.1 WATER UNIT COSTS

Continuous Compounding= Present Value * e^{rn}

Years (n) 3

Rate (r) 2.00%

ROUNDED TO NEAREST DOLLAR

SELECT ITEM	Diameter	Cost per Diameter-inch 2007	2010	2013	2016	2109	2022	Cost per Linear Foot 2007	2010	2013	2016	2019	2022
54" WL & Appurtenances	54	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36	$254	$270	$287	$305	$323	$343
48" WL & Appurtenances	48	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36	$226	$240	$255	$271	$287	$305
42" WL & Appurtenances	42	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36	$198	$210	$223	$237	$251	$267
36" WL & Appurtenances	36	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36	$170	$180	$191	$203	$216	$229
30" WL & Appurtenances	30	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36	$141	$150	$159	$169	$180	$191
24" WL & Appurtenances	24	$4.89	$5.19	$5.51	$5.85	$6.22	$6.60	$117	$125	$132	$141	$149	$158
20" WL & Appurtenances	20	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99	$104	$110	$117	$124	$132	$140
16" WL & Appurtenances	16	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99	$83	$88	$93	$99	$105	$112
15" WL & Appurtenances	15	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99	$78	$83	$88	$93	$99	$105
12" WL & Appurtenances	12	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99	$62	$66	$70	$74	$79	$84
10" WL & Appurtenances	10	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99	$52	$55	$58	$62	$66	$70
8" WL & Appurtenances	8	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99	$41	$44	$47	$50	$53	$56
60" Boring and Casing	60	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$565	$600	$637	$677	$719	$763
54" Boring and Casing	54	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$509	$540	$574	$609	$647	$687
50" Boring and Casing	50	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$471	$500	$531	$564	$599	$636
48" Boring and Casing	48	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$452	$480	$510	$541	$575	$610
40" Boring and Casing	40	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$377	$400	$425	$451	$479	$509
36" Boring and Casing	38	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$358	$380	$404	$429	$455	$483
34" Boring and Casing	34	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$320	$340	$361	$383	$407	$432
32" Boring and Casing	32	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$301	$320	$340	$361	$383	$407
30" Boring and Casing	30	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$283	$300	$319	$338	$359	$381
26" Boring and Casing	26	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$245	$260	$276	$293	$311	$331
20" Boring and Casing	20	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72	$188	$200	$212	$226	$240	$254

Continuous Compounding= Present Value * e^{rn}

Years (n) 3

Rate (r) 1.67%

ROUNDED TO NEAREST TEN THOUSAND DOLLARS

		2007	2010	2013	2016	2109	2022	Lump Sum Cost 2007	2010	2013	2016	2019	2022
Pump Station - New 4 MGD								$1,000,000	$1,050,000	$1,100,000	$1,160,000	$1,220,000	$1,280,000
Pump Station - New 7 MGD								$1,700,000	$1,790,000	$1,880,000	$1,980,000	$2,080,000	$2,190,000
Pump Station - Expans 1 MGD								$325,000	$340,000	$360,000	$380,000	$400,000	$420,000
Pump Station - Expans 7 MGD								$1,750,000	$1,840,000	$1,930,000	$2,030,000	$2,130,000	$2,240,000
Pump Station - Expans 8 MGD								$2,500,000	$2,630,000	$2,770,000	$2,910,000	$3,060,000	$3,220,000
1.5MG Ground Tank								$900,000	$950,000	$1,000,000	$1,050,000	$1,100,000	$1,160,000
2.0 MG Ground Tank								$1,000,000	$1,050,000	$1,100,000	$1,160,000	$1,220,000	$1,280,000
5.0 MG Ground Tank								$2,090,000	$2,200,000	$2,310,000	$2,430,000	$2,550,000	$2,680,000
1.0 MG Elevated Tank								$1,500,000	$1,580,000	$1,660,000	$1,750,000	$1,840,000	$1,930,000
1.5 MG Elevated Tank								$1,750,000	$1,840,000	$1,930,000	$2,030,000	$2,130,000	$2,240,000
Pressure Reducing Valve								$13,000	$14,000	$15,000	$16,000	$17,000	$18,000
System Improvements - Upper & Lower PP											$600,000		
System Improvements - Airport PP											$100,000		
42" Water Supply Allowance with Bell WSC									$0				
ROW for Facility (per Acre)								$11,000	$12,000	$13,000	$14,000	$15,000	$16,000
Pavement Repair								$35	$35	$35	$35	$35	$35

Table A.2
City of Killeen
Water System Improvements Year 2007-2009
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1W	**12/16/20" along Reese Creek Rd.** 20" WL along Stagecoach Rd from SH 201 to W. Trimmier Rd; 16" water line along Reese Creek Rd from Bunny Trail to Highway 195 and 12" WL runs southwest along Highway 195 to existing 12" WL.	12" WL & Appurtenances	7,280	LF	$62	$451,360
		16" WL & Appurtenances	11,180	LF	$83	$927,940
		20" WL & Appurtenances	6,420	LF	$104	$667,680
		30" Boring and Casing	400	LF	$283	$113,200
		Pavement Repair	600	LF	$35	$21,000
					Subtotal	$2,181,180
					Contingency @ 20%	$436,236
					Total Construction Cost	$2,617,416
					Engineering, Surveying & Geotech @ 12%	$314,090
					Total Project Cost	$2,931,506
2W	**1.5 MG Bundrant EST Expansion** Replace Existing 0.25 MG tank with 1.5 MG elevated storage tank.	1.5 MG Elevated Tank	1	LS	$1,750,000	$1,750,000
					Subtotal	$1,750,000
					Contingency @ 20%	$350,000
					Total Construction Cost	$2,100,000
					Engineering, Surveying & Geotech @ 12%	$252,000
					Total Project Cost	$2,352,000
3W	**12/16" Southeast Loop** 16" WL running east from intersection of Featherline Rd and Chaparral Rd to E. Trimmier Rd and north of the intersection about 3000 feet; 12" WL running north along E. Trimmier Rd to existing 12" WL; 12" WL running east about 8000 feet.	12" WL & Appurtenances	11,990	LF	$62	$743,380
		16" WL & Appurtenances	12,150	LF	$83	$1,008,450
		20" Boring and Casing	200	LF	$188	$37,600
		Pavement Repair	200	LF	$35	$7,000
					Subtotal	$1,796,430
					Contingency @ 20%	$359,286
					Total Construction Cost	$2,155,716
					Engineering, Surveying & Geotech @ 12%	$258,686
					Total Project Cost	$2,414,402
4W	**Pump Station 3 Upgrade** Pump Station 3 expansion from 10 MGD to 18 MGD.	Pump Station - Expans 8 MGD	1	LS	$2,500,000	$2,500,000
					Subtotal	$2,500,000
					Contingency @ 20%	$500,000
					Total Construction Cost	$3,000,000
					Engineering, Surveying & Geotech @ 12%	$360,000
					Total Project Cost	$3,360,000

CITY OF KILLEEN
WATER SYSTEM COSTS 2007

$11,057,908

Table A.3
City of Killeen
Water System Improvements Year 2010-2012
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
5W	**12/16" along N. Young Drive** 12" WL along N. Young Dr from Duncan Ave to Poage Ave, 16" WL along Poage Ave to Tucker Dr and along Tucker Dr to Lake Rd; 16" WL along Lake Rd from Tucker Dr to N. 38th St, along N. 38th St to Muir Dr and along Muir Dr to existing 16" WL.	12" WL & Appurtenances	1,850	LF	$66	$122,100
		16" WL & Appurtenances	5,500	LF	$88	$484,000
		Pavement Repair	1,000	LF	$35	$35,000
					Subtotal	$641,100
					Contingency @ 20%	$128,220
					Total Construction Cost	$769,320
					Engineering, Surveying & Geotech @ 12%	$92,318
					Total Project Cost	$861,638
6W	**12/16" Onion Road Water Line** 12" WL running south from the intersection of Onion Rd and Rio Grande Ct to Stagecoach Rd; 16" WL running east along Stagecoach Rd from Featherline Rd to Cunningham Rd and south from Stagecoach Rd and Featherline to proposed 16" WL.	12" WL & Appurtenances	6,390	LF	$66	$421,740
		16" WL & Appurtenances	10,180	LF	$88	$895,840
					Subtotal	$1,317,580
					Contingency @ 20%	$263,516
					Total Construction Cost	$1,581,096
					Engineering, Surveying & Geotech @ 12%	$189,732
					Total Project Cost	$1,770,828
7W	**12/24" Trimmier Road Water Line** 12" WL along Stagecoach Rd from WS Young Dr. to W. Trimmier Rd and along W. Trimmier to Atlas Ave; 24" WL along W. Trimmier Rd from Stagecoach Rd to S. Kelley Ln and 12" WL running west from S. Kelley Ln to Hwy 195.	12" WL & Appurtenances	15,220	LF	$66	$1,004,520
		24" WL & Appurtenances	4,400	LF	$125	$550,000
		Pavement Repair	400	LF	$35	$14,000
					Subtotal	$1,568,520
					Contingency @ 20%	$313,704
					Total Construction Cost	$1,882,224
					Engineering, Surveying & Geotech @ 12%	$225,867
					Total Project Cost	$2,108,091
8W	**24/30" along Chaparral Road** 24" WL along Trimmier Rd from Chaparral to S. Kelley Ln; 30" WL along Chaparral Rd from Trimmier Rd to Featherline Rd.	24" WL & Appurtenances	6,580	LF	$125	$822,500
		30" WL & Appurtenances	5,110	LF	$150	$766,500
		36" Boring and Casing	400	LF	$380	$152,000
					Subtotal	$1,741,000
					Contingency @ 20%	$348,200
					Total Construction Cost	$2,089,200
					Engineering, Surveying & Geotech @ 12%	$250,704
					Total Project Cost	$2,339,904
9W	**5 MG GST, 7 MGD PS, 30" Line** 7 MGD Pump Station and 5 MG Ground Storage Tank; 30" WL along Chaparral Rd from Featherline Rd to Bell Pump Station, serving the Lower Pressure Plane (at E. Trimmier Rd); Allowance for 42" Bell Co. South Water Supply Line.	30" WL & Appurtenances	10,800	LF	$150	$1,620,000
		Pump Station - New 7 MGD	1	LS	$1,790,000	$1,790,000
		5.0 MG Ground Tank	1	LS	$2,200,000	$2,200,000
		Pavement Repair	200	LF	$35	$7,000
		WL Supply Allowance	0	LS	$0	$0
					Subtotal	$5,617,000
					Contingency @ 20%	$1,123,400
					Total Construction Cost	$6,740,400
					Engineering, Surveying & Geotech @ 12%	$808,848
					Facility ROW (5 Acres)	$55,000
					Total Project Cost	$7,604,248
10W	**20" Line along Chaparral Rd** Runs from 195 east to Trimmier along Chaparral Road.	20" WL & Appurtenances	7,100	LF	$110	$781,000
		30" Boring and Casing	250	LS	$300	$75,000
					Subtotal	$856,000
					Contingency @ 20%	$171,200
					Total Construction Cost	$1,027,200
					Engineering, Surveying & Geotech @ 12%	$123,264
					Total Project Cost	$1,150,464
	CITY OF KILLEEN WATER SYSTEM COSTS 2010					**$15,835,173**

Table A.4
City of Killeen
Water System Improvements Year 2013-2015
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
11W	**4 MGD PS 16" along FM 439** 4 MGD pump station and a 2.0 MG ground storage tank near Quarry Road. 16" WL running south and then west from the pump station.	Pump Station - New 4 MGD	1	LS	$1,100,000	$1,100,000
		2.0 MG Ground Tank	1	LS	$1,100,000	$1,100,000
		16" WL & Appurtenances	13,000	LF	$93	$1,209,000
		30" Boring and Casing	150	LF	$319	$47,850
					Subtotal	$3,456,850
					Contingency @ 20%	$691,370
					Total Construction Cost	$4,148,220
					Engineering, Surveying & Geotech @ 12%	$497,786
					Total Project Cost	$4,646,006
12W	**12" Airport/ Upper PP** 12" WL along Reese Creek Rd from S. Hwy 201 east for about 4000 feet; 12" WL running north from Reese Creek Rd to Stan Schlueter Loop and connects to existing 8" WL at Golden Gate Dr	12" WL & Appurtenances	14,391	LF	$70	$1,007,377
		Pavement Repair	400	LF	$35	$14,000
		20" Boring and Casing	200	LF	$212	$42,400
					Subtotal	$1,063,777
					Contingency @ 20%	$212,755
					Total Construction Cost	$1,276,532
					Engineering, Surveying & Geotech @ 12%	$153,184
					Total Project Cost	$1,429,716
13W	**12/20" & 1.5 GST W of Chap. Rd** 20" WL west from S. Hwy 195 then south to proposed 1.5 MG GST. 12" WL running along S. Hwy 195 from Chaparral Rd.	20" WL & Appurtenances	6,028	LF	$117	$705,311
		12" WL & Appurtenances	6,800	LF	$70	$476,000
		20" Boring and Casing	150	LF	$212	$31,800
		Pavement Repair	150	LF	$35	$5,250
		1.5MG Ground Tank	1	LS	$1,000,000	$1,000,000
					Subtotal	$2,218,361
					Contingency @ 20%	$443,672
					Total Construction Cost	$2,662,033
					Engineering, Surveying & Geotech @ 12%	$319,444
					Total Project Cost	$2,981,477
14W	**16" Water Line along 38th Street** 16" WL from Pump Station 3 along Water St to N. 38th St and runs north along N. 38th St to Lake Rd.	16" WL & Appurtenances	8,630	LF	$88	$759,440
		30" Boring and Casing	1,000	LF	$300	$300,000
		Pavement Repair	1,000	LF	$35	$35,000
					Subtotal	$1,094,440
					Contingency @ 20%	$218,888
					Total Construction Cost	$1,313,328
					Engineering, Surveying & Geotech @ 12%	$157,599
					Total Project Cost	$1,470,927
15W	**16/20/24"& 7.0 MGD PS Lower PP** 7 MGD PS with 24" WL running south to proposed 16" WL. 24" WL east approximately 1,500'. 20" WL north along E. Trimmier to proposed 12" WL. 16" WL east along Chaparral to existing 16"WL.	16" WL & Appurtenances	7,500	LF	$93	$697,500
		24" WL & Appurtenances	1,750	LF	$132	$231,000
		20" WL & Appurtenances	3,500	LF	$117	$409,500
		40" Boring and Casing	100	LF	$425	$42,500
		Pump Station - New 7 MGD	1	LS	$1,880,000	$1,880,000
					Subtotal	$3,260,500
					Contingency @ 20%	$652,100
					Total Construction Cost	$3,912,600
					Engineering, Surveying & Geotech @ 12%	$469,512
					Total Project Cost	$4,382,112
	CITY OF KILLEEN **WATER SYSTEM COSTS 2013**					**$14,910,239**

Table A.5
City of Killeen
Water System Improvements Year 2016-2018
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
16W	**Pressure Plane Modifications** Upper and Lower Pressure Plane System Improvements.	12" WL & Appurtenances	1	EA	$600,000	$600,000
					Subtotal	$600,000
					Contingency @ 20%	$120,000
					Total Construction Cost	$720,000
					Engineering, Surveying & Geotech @ 12%	$86,400
					Total Project Cost	$806,400
17W	**12/16" at Chaparral & Bell PS** 16" WL west from proposed Bell PS along Chaparral Rd then a 12" WL north along Chaparral Rd to proposed 16" WL.	12" WL & Appurtenances	4,250	LF	$70	$297,500
		16" WL & Appurtenances	5,850	LF	$93	$544,050
					Subtotal	$841,550
					Contingency @ 20%	$168,310
					Total Construction Cost	$1,009,860
					Engineering, Surveying & Geotech @ 12%	$121,183
					Total Project Cost	$1,131,043
18W	**12" along NE City Limits** 12" WL runs along Schwald Rd from Polk St about 3,000' east and continues south to E. Rancier Rd.	12" WL & Appurtenances	7,980	LF	$70	$558,600
		20" Boring and Casing	400	LF	$212	$84,800
					Subtotal	$643,400
					Contingency @ 20%	$128,680
					Total Construction Cost	$772,080
					Engineering, Surveying & Geotech @ 12%	$92,650
					Total Project Cost	$864,730
19W	**20" along 195 and Fort Hood St.** 20" WL north from intersection of Stagecoach Rd and S. Hwy 195 to existing 20" WL on Stan Schlueter Rd.	20" WL & Appurtenances	10,350	LF	$117	$1,210,950
		34" Boring and Casing	400	LF	$361	$144,400
					Subtotal	$1,355,350
					Contingency @ 20%	$271,070
					Total Construction Cost	$1,626,420
					Engineering, Surveying & Geotech @ 12%	$195,170
					Total Project Cost	$1,821,590
20W	**12" South of Chaparral Road** 12" WL from the intersection of Chaparral Rd and Trimmier Rd to S. Hwy 195 north of FM 2484.	12" WL & Appurtenances	13,430	LF	$70	$940,100
		20" Boring and Casing	200	LF	$212	$42,400
					Subtotal	$982,500
					Contingency @ 20%	$196,500
					Total Construction Cost	$1,179,000
					Engineering, Surveying & Geotech @ 12%	$141,480
					Total Project Cost	$1,320,480
21W	**12" along FM 439** 12" WL along FM 439 then looping back to proposed 12" WL. 12" WL running east to Bell PS.	12" WL & Appurtenances	19,724	LF	$70	$1,380,680
		20" Boring and Casing	200	LF	$212	$42,400
					Subtotal	$1,423,080
					Contingency @ 20%	$284,616
					Total Construction Cost	$1,707,696
					Engineering, Surveying & Geotech @ 12%	$204,924
					Total Project Cost	$1,912,620
22W	**12" Railroad To FM 439** 12" WL running about 5,000' east along Atchison Topeka & Santa Fe Railroad from N. Roy Reynolds Dr, continues north to E. Rancier Ave.	12" WL & Appurtenances	12,768	LF	$70	$893,792
		20" Boring and Casing	600	LF	$212	$127,200
					Subtotal	$1,020,992
					Contingency @ 20%	$204,198
					Total Construction Cost	$1,225,190
					Engineering, Surveying & Geotech @ 12%	$147,023
					Total Project Cost	$1,372,213

Table A.5
City of Killeen
Water System Improvements Year 2016-2018
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
23W	**12/16/20" East Stagecoach Road** 20" WL south from E. Trimmier Rd & Chaparral Rd. 16" WL west approximately 12,500' then north about 5000' and 12" WL west about 3500' with 16" WL running east connecting to proposed 16".	16" WL & Appurtenances	24,830	LF	$93	$2,309,190
		20" WL & Appurtenances	5,420	LF	$117	$634,140
		12" WL & Appurtenances	3,630	LF	$70	$254,100
		30" Boring and Casing	400	LF	$319	$127,600
					Subtotal	$3,325,030
					Contingency @ 20%	$665,006
					Total Construction Cost	$3,990,036
					Engineering, Surveying & Geotech @ 12%	$478,804
					Total Project Cost	$4,468,840
24W	**Airport PS Expans. & PP Mods** Airport and Upper Pressure Plane System Improvements.	Pump Station - Expans 1 MGD	1	LS	$360,000	$360,000
		System Improvements	1	EA	$100,000	$100,000
					Subtotal	$460,000
					Contingency @ 20%	$92,000
					Total Construction Cost	$552,000
					Engineering, Surveying & Geotech @ 12%	$66,240
					Total Project Cost	$618,240
25W	**12/16" SW part of Lower PP** 12/16" WL south from existing 16" WL at Chaparral Road, then west	12" WL & Appurtenances	14,800	LF	$70	$1,036,000
		16" WL & Appurtenances	1,100	LF	$93	$102,300
		20" Boring and Casing	500	LF	$212	$106,000
					Subtotal	$1,244,300
					Contingency @ 20%	$248,860
					Total Construction Cost	$1,493,160
					Engineering, Surveying & Geotech @ 12%	$179,179
					Total Project Cost	$1,672,339

CITY OF KILLEEN
WATER SYSTEM COSTS 2016

$15,988,495

Table A.6
City of Killeen
Water System Improvements Year 2019-2022
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
26W	**12" by FM 2484** 12" WL running about 5000' southwest along State Hwy 195 from the intersection with FM 440; 12" water line runs east from the intersection at FM 440 about 3000' then south about 5000' then east across FM 2484 then north	12" WL & Appurtenances	31,200	LF	$79	$2,464,800
		20" Boring and Casing	500	LF	$240	$120,000
					Subtotal	$2,584,800
					Contingency @ 20%	$516,960
					Total Construction Cost	$3,101,760
					Engineering, Surveying & Geotech @ 12%	$372,211
					Total Project Cost	$3,473,971
27W	**1.0 MG EST in Lower PP & PRV's** 1.0 MG EST in the Southwest area of the Lower Pressure Plane.	1.0 MG Elevated Tank	1	EA	$1,840,000	$1,840,000
					Subtotal	$1,840,000
					Contingency @ 20%	$368,000
					Total Construction Cost	$2,208,000
					Engineering, Surveying & Geotech @ 12%	$264,960
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$2,483,960
28W	**16" Vet. Mem. Blvd to Railroad** 16" WL along E. Veterans Memorial Blvd from east of Rio Blvd to N. Roy Reynolds Dr and north along N. Roy Reynolds Dr to the Railroad.	16" WL & Appurtenances	7,600	LF	$105	$798,000
		30" Boring and Casing	100	LF	$359	$35,900
		Pavement Repair	1,300	LF	$35	$45,500
					Subtotal	$879,400
					Contingency @ 20%	$175,880
					Total Construction Cost	$1,055,280
					Engineering, Surveying & Geotech @ 12%	$126,634
					Total Project Cost	$1,181,914
29W	**12/16" South Lower PP Loop** 16" WL connects into proposed 16" WL south of Rock Creek stream and runs south; 12" WL continues south then east past the Onion Creek stream; 16" WL continues north from the 12" WL.; install PRVs to connect southern Lower Plane Loop	12" WL & Appurtenances	21,400	LF	$79	$1,690,600
		16" WL & Appurtenances	16,331	LF	$105	$1,714,755
		Pressure Reducing Valve	2	EA	$17,000	$34,000
		20" Boring and Casing	500	LF	$240	$120,000
					Subtotal	$3,559,355
					Contingency @ 20%	$711,871
					Total Construction Cost	$4,271,226
					Engineering, Surveying & Geotech @ 12%	$512,547
					Total Project Cost	$4,783,773
30W	**5.0 MG GST & 7.0 MGD PS** New 5 MG Ground Storage Tank and 7.0 MGD Upper Pressure Plane Pump Station Expansion	5.0 MG Ground Tank	1	LS	$2,550,000	$2,550,000
		Pump Station - Expans 7 MGD	1	LS	$2,130,000	$2,130,000
					Subtotal	$4,680,000
					Contingency @ 20%	$936,000
					Total Construction Cost	$5,616,000
					Engineering, Surveying & Geotech @ 12%	$673,920
					Total Project Cost	$6,289,920
31W	**16" West of 195 in Upper PP** 16" WL loop to connect proposed 12" and 20" WL in the far southwest corner of the City.	16" WL & Appurtenances	12,059	LF	$105	$1,266,185
		30" Boring and Casing	1,000	LF	$359	$359,000
					Subtotal	$1,625,185
					Contingency @ 20%	$325,037
					Total Construction Cost	$1,950,221
					Engineering, Surveying & Geotech @ 12%	$234,027
					Total Project Cost	$2,184,248
	CITY OF KILLEEN **WATER SYSTEM COSTS 2019**					**$20,397,786**

Table A.7
City of Killeen
Water System Improvements Year 2022-2024
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
32W	**12" Water Line in SE Lower PP** 12" WL loop in the south east corner of the lower pressure plane connecting the proposed 12" WL in 2019 and proposed 12" WL in 2016 with a pressure reducing valve at the north east corner connecting to the proposed 12" WL in 2016.	12" WL & Appurtenances	28,405	LF	$84	$2,386,020
		20" Boring and Casing	500	LF	$254	$127,000
		Pressure Reducing Valve	1	EA	$18,000	$18,000
					Subtotal	$2,531,020
					Contingency @ 20%	$506,204
					Total Construction Cost	$3,037,224
					Engineering, Surveying & Geotech @ 12%	$364,467
					Total Project Cost	$3,401,691
33W	**12" Water Line in NW Lower PP** 12" WL looping in the northwest corner of the lower pressure plane connecting the 2 MG storage tank to the proposed 16" WL along FM 439.	12" WL & Appurtenances	3,910	LF	$84	$328,440
					Subtotal	$328,440
					Contingency @ 20%	$65,688
					Total Construction Cost	$394,128
					Engineering, Surveying & Geotech @ 12%	$47,295
					Total Project Cost	$441,423

CITY OF KILLEEN
WATER SYSTEM COSTS 2022

$3,843,114

Appendix B
Wastewater Capital Improvement Plan Cost Estimate

TABLE B.1 WASTEWATER UNIT COSTS

Continuous Compounding= Present Value * e^{rn}

Years (n) 3

Rate (r) 2.00%

ROUNDED TO NEAREST DOLLAR

SELECT ITEM	Diameter	Cost per Diameter-inch 2007	2010	2013	2016	2109	2022		Cost per Linear Foot 2007	2010	2013	2016	2019	2022
54" Sanitary Sewer	54	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36		$254	$270	$287	$305	$323	$343
48" Sanitary Sewer	48	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36		$226	$240	$255	$271	$287	$305
42" Sanitary Sewer	42	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36		$198	$210	$223	$237	$251	$267
36" Sanitary Sewer	36	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36		$170	$180	$191	$203	$216	$229
33" Sanitary Sewer	33	$4.71	$5.00	$5.31	$5.64	$5.99	$6.36		$155	$165	$175	$186	$198	$210
30" Sanitary Sewer	30	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$155	$165	$175	$186	$198	$210
27" Sanitary Sewer	27	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$140	$149	$158	$167	$178	$189
24" Sanitary Sewer	24	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$124	$132	$140	$149	$158	$168
21" Sanitary Sewer	21	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$109	$116	$123	$130	$138	$147
18" Sanitary Sewer	18	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$93	$99	$105	$112	$119	$126
15" Sanitary Sewer	15	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$78	$83	$88	$93	$99	$105
12" Sanitary Sewer	12	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$62	$66	$70	$74	$79	$84
10" Sanitary Sewer	10	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$52	$55	$58	$62	$66	$70
8" Sanitary Sewer	8	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$41	$44	$47	$50	$53	$56
60" Boring and Casing	60	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$565	$600	$637	$677	$719	$763
54" Boring and Casing	54	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$509	$540	$574	$609	$647	$687
50" Boring and Casing	50	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$471	$500	$531	$564	$599	$636
48" Boring and Casing	48	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$452	$480	$510	$541	$575	$610
40" Boring and Casing	40	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$377	$400	$425	$451	$479	$509
36" Boring and Casing	38	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$358	$380	$404	$429	$455	$483
34" Boring and Casing	34	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$320	$340	$361	$383	$407	$432
32" Boring and Casing	32	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$301	$320	$340	$361	$383	$407
30" Boring and Casing	30	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$283	$300	$319	$338	$359	$381
26" Boring and Casing	26	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$245	$260	$276	$293	$311	$331
20" Boring and Casing	20	$9.42	$10.00	$10.62	$11.28	$11.98	$12.72		$188	$200	$212	$226	$240	$254
30" Force Main	30	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$155	$165	$175	$186	$198	$210
28" Force Main	28	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$145	$154	$164	$174	$184	$196
26" Force Main	26	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$135	$143	$152	$161	$171	$182
24" Force Main	24	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$124	$132	$140	$149	$158	$168
22" Force Main	22	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$114	$121	$128	$136	$145	$154
20" Force Main	20	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$104	$110	$117	$124	$132	$140
18" Force Main	18	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$93	$99	$105	$112	$119	$126
16" Force Main	16	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$83	$88	$93	$99	$105	$112
14" Force Main	14	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$73	$77	$82	$87	$92	$98
12" Force Main	12	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$62	$66	$70	$74	$79	$84
10" Force Main	10	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$52	$55	$58	$62	$66	$70
8" Force Main	8	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$41	$44	$47	$50	$53	$56
6" Force Main	6	$5.18	$5.50	$5.84	$6.20	$6.59	$6.99		$31	$33	$35	$37	$40	$42
48" Diameter Manhole									$3,500	$3,500	$3,500	$3,700.00	$3,700	$3,700
60" Diameter Manhole									$5,000	$5,000	$5,000	$5,300.00	$5,300	$5,300
72" Diameter Manhole									$6,500	$6,500	$6,500	$6,900.00	$6,900	$6,900
T-Block									$6,500	$6,500	$6,500	$6,900.00	$6,900	$6,900

Continuous Compounding= Present Value * e^{rn}

Years (n) 3

Rate (r) 1.67%

ROUNDED TO NEAREST TEN THOUSAND DOLLARS

		2007	2010	2013	2016	2109	2022		Lump Sum Cost 2007	2010	2013	2016	2019	2022
Lift Station - New 1 MGD									$550,000	$580,000	$610,000	$640,000	$670,000	$700,000
Lift Station - New 1.5 MGD									$600,000	$630,000	$660,000	$690,000	$730,000	$770,000
Lift Station - New 2 MGD									$700,000	$740,000	$780,000	$820,000	$860,000	$900,000
Lift Station - New 2.5 MGD									$750,000	$790,000	$830,000	$870,000	$910,000	$960,000
Lift Station - New 4 MGD									$800,000	$840,000	$880,000	$930,000	$980,000	$1,030,000
Lift Station - New 5 MGD									$1,100,000	$1,160,000	$1,220,000	$1,280,000	$1,350,000	$1,420,000
Lift Station - New 7 MGD									$2,000,000	$2,100,000	$2,210,000	$2,320,000	$2,440,000	$2,570,000
Lift Station - Mod pipes, elec, site									$150,000	$160,000	$170,000	$180,000	$190,000	$200,000
Lift Station - Expans 1 MGD									$325,000	$340,000	$360,000	$380,000	$400,000	$420,000
Lift Station - Expans 2 MGD									$400,000	$420,000	$440,000	$460,000	$480,000	$500,000
Lift Station - Expans 7 MGD									$1,750,000	$1,840,000	$1,930,000	$2,030,000	$2,130,000	$2,240,000
Lift Station - Expans 8 MGD									$2,500,000	$2,630,000	$2,770,000	$2,910,000	$3,060,000	$3,220,000
Lift Station - Rehab #7										$325,000				
Lift Station - Rehab #1													$700,000	
ROW for Facility (per Acre)									$11,000	$12,000	$13,000	$14,000	$15,000	$16,000
Change FM to GM									$150,000	$160,000	$170,000	$180,000	$190,000	$200,000
Pavement Repair									$35	$35	$35	$35	$35	$35
Sewer System I/I Rehab										$2,000,000				
CMOM & SSO Program Development										$500,000				

Table B.2
City of Killeen
Wastewater System Improvements - 2007-2009
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1S	**Lift Station #8** Lift Station # 8 located off the Atchison Topeka & Santa Fe Railroad in the Long Branch Sub-Basin near North Rov	Lift Station - New 4 MGD	1	LS	$800,000	$800,000
					Subtotal	$800,000
					Contingency @ 20%	$160,000
					Total Construction Cost	$960,000
					Engineering, Surveying & Geotech @ 12%	$115,200
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$1,086,200
2S	**Trimmier Creek 21/27/36" Gravity** A 21" gravity main flows eastward from Featherline Rd. into a 27" interceptor until East Trimmier Rd. where it becomes a 36" interceptor which flows into the existing 30" major	21" Sanitary Sewer	7,418	LF	$109	$808,508
		27" Sanitary Sewer	3,956	LF	$140	$553,840
		36" Sanitary Sewer	3,213	LF	$170	$546,227
		60" Diameter Manhole	19	EA	$5,000	$95,000
		72" Diameter Manhole	18	EA	$6,500	$117,000
					Subtotal	$2,120,575
					Contingency @ 20%	$424,115
					Total Construction Cost	$2,544,689
					Engineering, Surveying & Geotech @ 12%	$305,363
					Total Project Cost	$2,850,052
3S	**Trimmier Creek 21" Gravity Main** 21" gravity main flows east from the south end of Featherline Rd. into a 27" interceptor.	21" Sanitary Sewer	6,488	LF	$109	$707,225
		60" Diameter Manhole	16	EA	$5,000	$80,000
					Subtotal	$787,225
					Contingency @ 20%	$157,445
					Total Construction Cost	$944,670
					Engineering, Surveying & Geotech @ 12%	$132,254
					Total Project Cost	$1,076,923
4S	**LS 20 and 14" FM & SH 195 12/18"** 12" gravity main conveys flow south from decommissioned LS #11A to new LS #20; 18" gravity main flows south from Reese Creek Rd. to the new LS. LS #20 lifts flow through a 14" force main along Stagecoach to W Trimmier Rd.	Lift Station - New 5 MGD	1	LS	$1,100,000	$1,100,000
		12" Sanitary Sewer	6,820	LF	$62	$422,809
		18" Sanitary Sewer	1,304	LF	$93	$121,281
		48" Diameter Manhole	17	EA	$3,500	$59,500
		60" Diameter Manhole	3	EA	$5,000	$15,000
		14" Force Main	9,315	LF	$73	$679,995
		T-Block	1	EA	$6,500	$6,500
					Subtotal	$2,405,085
					Contingency @ 20%	$481,017
					Total Construction Cost	$2,886,102
					Engineering, Surveying & Geotech @ 12%	$346,332
					Facility ROW (2 Acres)	$22,000
					Total Project Cost	$3,254,435
5S	**LS #22, 6" FM, 12"** 12" collection main flows south to new LS #22 off of Reese Creek Rd. which lifts flow through a 6" force main along Reese Creek Rd. to an 18" collection main	Lift Station - New 2 MGD	1	LS	$700,000	$700,000
		6" Force Main	3,498	LF	$31	$108,447
		12" Sanitary Sewer	5,728	LF	$62	$355,145
		48" Diameter Manhole	14	EA	$3,500	$49,000
		T-Block	1	EA	$6,500	$6,500
					Subtotal	$1,219,093
					Contingency @ 20%	$243,819
					Total Construction Cost	$1,462,911
					Engineering, Surveying & Geotech @ 12%	$175,549
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$1,649,460
	CITY OF KILLEEN WASTEWATER SYSTEM COSTS 2007					**$9,917,071**

Table B.3
City of Killeen
Wastewater System Improvements - 2010-2012
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
6S	**Stagecoach 18" GM & 14" FM, 8/10"** An 8/10" GM conveys flows north and west across W Trimmier Rd; 14" FM extended along Stagecoach Rd. to an 18" interceptor continuing along Stagecoach Rd. then south along Featherline Rd. to 21" GM.; existing 10" FM is converted to gravity flow along Kelley Lane	8" Sanitary Sewer	3,565	LF	$44	$156,860
		10" Sanitary Sewer	2,519	LF	$55	$138,518
		18" Sanitary Sewer	6,199	LF	$99	$613,652
		14" Force Main	4,301	LF	$77	$331,177
		Change FM to GM	1	LS	$160,000	$160,000
		48" Diameter Manhole	15	EA	$3,500	$52,500
		60" Diameter Manhole	15	EA	$5,000	$75,000
					Subtotal	$1,527,706
					Contingency @ 20%	$305,541
					Total Construction Cost	$1,833,247
					Engineering, Surveying & Geotech @ 12%	$219,990
					Total Project Cost	$2,053,237
7S	**SH195 12/15" GM** 12/15" gravity main flowing south to 18" collection main at Reese Creek Rd.	12" Sanitary Sewer	6,012	LF	$66	$396,805
		15" Sanitary Sewer	2,531	LF	$83	$210,085
		48" Diameter Manhole	21	EA	$3,500	$73,500
					Subtotal	$680,391
					Contingency @ 20%	$136,078
					Total Construction Cost	$816,469
					Engineering, Surveying & Geotech @ 12%	$97,976
					Total Project Cost	$914,445
8S	**Long Branch 15/18/24" GM** New 15/18/24" GM conveying flow south from Persimmons Dr to Lake Inks Ave south past RR to existing 36" interceptor; New 15" gravity main to convey flow near Hooten St west to Lake Inks Ave	15" Sanitary Sewer	3,758	LF	$83	$311,931
		18" Sanitary Sewer	8,287	LF	$99	$820,403
		24" Sanitary Sewer	1,672	LF	$132	$220,717
		60" Diameter Manhole	30	EA	$5,000	$150,000
		72" Diameter Manhole	4	EA	$6,500	$26,000
					Subtotal	$1,529,051
					Contingency @ 20%	$305,810
					Total Construction Cost	$1,834,861
					Engineering, Surveying & Geotech @ 12%	$220,183
					Total Project Cost	$2,055,044
9S	**Trimmier Creek 10/12" GM** A new 10/12" gravity main flows south and east along Stagecoach Rd to existing 15" collection main	10" Sanitary Sewer	8,062	LF	$55	$443,383
		12" Sanitary Sewer	7,535	LF	$66	$497,297
		48" Diameter Manhole	39	EA	$3,500	$136,500
					Subtotal	$1,077,179
					Contingency @ 20%	$215,436
					Total Construction Cost	$1,292,615
					Engineering, Surveying & Geotech @ 12%	$155,114
					Total Project Cost	$1,447,729
10S	**16" FM Along Chaparral Rd.** New 16" FM to replace existing FM will lift flow from LS#24 along Chaparral Rd. to 21" interceptor just west of Featherline Rd.	16" Force Main	8,775	LF	$88	$772,156
		T-Block	1	EA	$6,500	$6,500
					Subtotal	$778,656
					Contingency @ 20%	$155,731
					Total Construction Cost	$934,387
					Engineering, Surveying & Geotech @ 12%	$112,126
					Total Project Cost	$1,046,514
11S	**Lift Station 7 Rehab** Lift Station 7 Rehab located off E Veteran Memorial Blvd. on the edge of the Central Sub-Basin and the Long Branch Sub-Basin	Lift Station - Mod pipes, elec, sit	1	LS	$160,000	$160,000
		Lift Station - Rehab #7	1	LS	$325,000	$325,000
					Subtotal	$485,000
					Contingency @ 20%	$97,000
					Total Construction Cost	$582,000
					Engineering, Surveying & Geotech @ 12%	$69,840
					Total Project Cost	$651,840

Table B.3
City of Killeen
Wastewater System Improvements - 2010-2012
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
12S	**Expand Lift Station #23**	Lift Station - Expans 2 MGD	1	LS	$420,000	$420,000
	Expand Lift Station #23 off Reese Creek Rd. in the South Nolan Creek Sub-Basin	Lift Station - Mod pipes, elec, sit	1	LS	$160,000	$160,000
					Subtotal	$580,000
					Contingency @ 20%	$116,000
					Total Construction Cost	$696,000
					Engineering, Surveying & Geotech @ 12%	$83,520
					Total Project Cost	$779,520
13S	**LS & 14"FM 12/10"GM-Chaparal Rd**	Lift Station - New 2.5 MGD	1	LS	$790,000	$790,000
	10/12" gravity main flows north along SH 195 to the new North SH 195 LS; 14" FM from new LS lifts flow along Chaparral Rd. to LS #24	14" Force Main	7,989	LF	$77	$615,157
		10" Sanitary Sewer	8,116	LF	$55	$446,355
		12" Sanitary Sewer	4,185	LF	$66	$276,200
		48" Diameter Manhole	31	EA	$3,500	$108,500
					Subtotal	$2,236,212
					Contingency @ 20%	$447,242
					Total Construction Cost	$2,683,455
					Engineering, Surveying & Geotech @ 12%	$322,015
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$3,016,469

CITY OF KILLEEN
WASTEWATER SYSTEM COSTS 2010 **$11,964,798**

Table B.4
City of Killeen
Wastewater System Improvements - 2013-2015
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
14S	**New LS #18, 16" FM, 10/12/15" GM** Two 10/12" gravity main convey flow along and to the east of Hay Branch to a 15" gravity main. The flow will be collected at the new LS #18 and lifted through a 16" FM to an existing 36" interceptor near Twin Creek Dr	Lift Station - New 2 MGD	1	LS	$780,000	$780,000
		16" Force Main	14,574	LF	$93	$1,355,377
		T-Block	1	EA	$6,500	$6,500
		10" Sanitary Sewer	5,530	LF	$58	$320,760
		12" Sanitary Sewer	8,234	LF	$70	$576,380
		15" Sanitary Sewer	920	LF	$88	$80,960
		48" Diameter Manhole	34	EA	$3,500	$119,000
		60" Diameter Manhole	2	EA	$5,000	$10,000
					Subtotal	$3,248,978
					Contingency @ 20%	$649,796
					Total Construction Cost	$3,898,773
					Engineering, Surveying & Geotech @ 12%	$467,853
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$4,377,626
15S	**New Lift Station, 10" FM, 12" GM** A new 10/12" gravity main will convey flows south to the new FM 439 LS. The LS will convey flow west through a 10" FM to a 12" interceptor.	Lift Station - New 1 MGD	1	LS	$610,000	$610,000
		10" Force Main	8,172	LF	$58	$473,970
		10" Sanitary Sewer	5,988	LF	$58	$347,307
		12" Sanitary Sewer	5,725	LF	$70	$400,729
		48" Diameter Manhole	29	EA	$3,500	$101,500
		T-Block	1	EA	$6,500	$6,500
					Subtotal	$1,940,006
					Contingency @ 20%	$388,001
					Total Construction Cost	$2,328,007
					Engineering, Surveying & Geotech @ 12%	$279,361
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$2,618,368
16S	**Future Planning Area 10/15" GM** 10" gravity main flows east to a 15" interceptor just west of Chaparral Rd. and will carry flow east to the 36" major interceptor at East Trimmier Rd.	10" Sanitary Sewer	6,562	LF	$58	$380,590
		15" Sanitary Sewer	8,244	LF	$88	$725,503
		48" Diameter Manhole	16	EA	$3,500	$56,000
		60" Diameter Manhole	21	EA	$5,000	$105,000
					Subtotal	$1,267,093
					Contingency @ 20%	$253,419
					Total Construction Cost	$1,520,512
					Engineering, Surveying & Geotech @ 12%	$182,461
					Total Project Cost	$1,702,973
17S	**New 2 MGD LS, 10" FM, 10/12" GM** 10/12" gravity main flows south along Rock Creek to the new Upper Rock Creek LS. The LS will lift flows through a 10" FM north and east to the 15" interceptor at Chaparral Rd.	Lift Station - New 1 MGD	1	LS	$610,000	$610,000
		10" Sanitary Sewer	6,764	LF	$58	$392,329
		12" Sanitary Sewer	4,371	LF	$70	$305,981
		48" Diameter Manhole	28	EA	$3,500	$98,000
		10" Force Main	9,000	LF	$58	$522,000
		T-Block	1	EA	$6,500	$6,500
					Subtotal	$1,934,810
					Contingency @ 20%	$386,962
					Total Construction Cost	$2,321,772
					Engineering, Surveying & Geotech @ 12%	$278,613
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$2,611,385

Table B.4
City of Killeen
Wastewater System Improvements - 2013-2015
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
18S	**Central Basin 21/24/36" GM** 21/24/27" gravity main flows east from Walmart Blvd. across Hwy 190 to a 36" interceptor flowing into LS #2.	21" Sanitary Sewer	1,190	LF	$123	$146,401
		24" Sanitary Sewer	9,078	LF	$140	$1,270,920
		27" Sanitary Sewer	875	LF	$158	$138,250
		36" Sanitary Sewer	2,070	LF	$191	$395,370
		72" Diameter Manhole	30	EA	$6,500	$195,000
					Subtotal	$2,145,941
					Contingency @ 20%	$429,188
					Total Construction Cost	$2,575,129
					Engineering, Surveying & Geotech @ 12%	$309,015
					Total Project Cost	$2,884,144
19S	**N Clear Creek LS25 8"FM&12"** 12" gravity main flows west to LS #25. The 8" force main lifts flow from the LS to an existing 10" gravity main.	Lift Station - New 1 MGD	1	LS	$610,000	$610,000
		8" Force Main	8,692	LF	$47	$408,510
		12" Sanitary Sewer	4,207	LF	$70	$294,469
		48" Diameter Manhole	11	EA	$3,500	$38,500
		T-Block	1	EA	$6,500	$6,500
					Subtotal	$1,357,979
					Contingency @ 20%	$271,596
					Total Construction Cost	$1,629,575
					Engineering, Surveying & Geotech @ 12%	$195,549
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$1,836,124

CITY OF KILLEEN
WASTEWATER SYSTEM COSTS 2013 **$16,030,620**

Table B.5
City of Killeen
Wastewater System Improvements - 2016-2018
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
20S	**New LS, 18"FM 12/15/18" GM** 12/15/18" gravity main flows south along Little Trimmier Creek to the new Little Trimmier Creek LS. The LS will convey flow north an 18" force main to the Trimmier Creek WWTP.	Lift Station - New 5 MGD	1	LS	$1,280,000	$1,280,000
		12" Sanitary Sewer	3,907	LF	$74	$289,085
		15" Sanitary Sewer	6,917	LF	$93	$643,304
		18" Sanitary Sewer	3,616	LF	$112	$404,947
		48" Diameter Manhole	10	EA	$3,700	$37,000
		60" Diameter Manhole	26	EA	$5,300	$137,800
		18" Force Main	15,486	LF	$112	$1,734,421
		T-Block	1	EA	$6,900	$6,900
					Subtotal	$4,533,457
					Contingency @ 20%	$906,691
					Total Construction Cost	$5,440,148
					Engineering, Surveying & Geotech @ 12%	$652,818
					Facility ROW (2 Acres)	$22,000
					Total Project Cost	$6,114,966
21S	**New LS and 14" FM, 10/12" GM** 10/12" gravity main flows south along Onion Creek the new Onion Creek LS. The LS will then lift flows east through a 14" force main to the Little Trimmier Creek LS	Lift Station - New 2 MGD	1	LS	$820,000	$820,000
		12" Sanitary Sewer	8,846	LF	$74	$654,589
		10" Sanitary Sewer	2,947	LF	$62	$182,742
		48" Diameter Manhole	29	EA	$3,700	$107,300
		14" Force Main	7,109	LF	$87	$618,509
		T-Block	1	EA	$6,900	$6,900
					Subtotal	$2,390,040
					Contingency @ 20%	$478,008
					Total Construction Cost	$2,868,048
					Engineering, Surveying & Geotech @ 12%	$344,166
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$3,223,214
22S	**New LS, 12"FM & 12/15" GM** 12/15" gravity main will collect flows along the southern portions of Rock Creek into the new Lower Rock Creek LS. The LS will convey flows to the east through a 12" force main to the Onion Creek LS.	Lift Station - New 2 MGD	1	LS	$820,000	$820,000
		12" Sanitary Sewer	6,938	LF	$74	$513,408
		15" Sanitary Sewer	8,224	LF	$93	$764,799
		12" Force Main	2,735	LF	$74	$202,368
		T-Block	1	EA	$6,900	$6,900
		48" Diameter Manhole	17	EA	$3,700	$62,900
		60" Diameter Manhole	21	EA	$5,300	$111,300
					Subtotal	$2,481,676
					Contingency @ 20%	$496,335
					Total Construction Cost	$2,978,011
					Engineering, Surveying & Geotech @ 12%	$357,361
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$3,346,372
23S	**8" GM North of Railroad** 8" gravity main flows east to LS #18.	8" Sanitary Sewer	5,268	LF	$50	$263,408
		48" Diameter Manhole	13	EA	$3,700	$48,100
					Subtotal	$311,508
					Contingency @ 20%	$62,302
					Total Construction Cost	$373,809
					Engineering, Surveying & Geotech @ 12%	$44,857
					Total Project Cost	$418,666

Table B.5
City of Killeen
Wastewater System Improvements - 2016-2018
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
24S	**New LS 10" FM & 12" West of 195** New 12" gravity main which will convey flow to the new Live Oak Cemetery LS. The LS will convey flow east through a 8" force main to the Lower Rock Creek LS.	Lift Station - New 1.5 MGD	1	LS	$730,000	$730,000
		12" Sanitary Sewer	8,628	LF	$74	$638,505
		8" Force Main	11,385	LF	$50	$569,250
		T-Block	1	EA	$6,900	$6,900
		48" Diameter Manhole	50	EA	$3,700	$185,000
					Subtotal	$2,129,655
					Contingency @ 20%	$425,931
					Total Construction Cost	$2,555,586
					Engineering, Surveying & Geotech @ 12%	$306,670
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$2,873,257

CITY OF KILLEEN
WASTEWATER SYSTEM COSTS 2016

$15,976,475

Table B.6
City of Killeen
Wastewater System Improvements - 2019-2021
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
25S	**Trimmier Creek 30" Gravity Main** 30" interceptor parallels existing 30" interceptor from east of E. Trimmier Rd to the Trimmier Creek WWTP.	30" Sanitary Sewer	9,261	LF	$175	$1,620,666
		72" Diameter Manhole	23	EA	$6,500	$149,500
					Subtotal	$1,770,166
					Contingency @ 20%	$354,033
					Total Construction Cost	$2,124,200
					Engineering, Surveying & Geotech @ 12%	$254,904
					Total Project Cost	$2,379,103
26S	**New LS, 10" FM, & 12" GM by 2484** 10/12" gravity main flows south paralleling SH195 to the new South SH 195 LS. From the LS flows will be lifted north through a 10" force main along SH195 to the North SH 195 LS.	Lift Station - New 1 MGD	1	LS	$640,000	$640,000
		10" Force Main	11,379	LF	$62	$705,514
		T-Block	1	EA	$6,900	$6,900
		10" Sanitary Sewer	1,691	LF	$62	$104,811
		12" Sanitary Sewer	9,827	LF	$74	$727,180
		48" Diameter Manhole	25	EA	$3,700	$92,500
					Subtotal	$2,276,904
					Contingency @ 20%	$455,381
					Total Construction Cost	$2,732,285
					Engineering, Surveying & Geotech @ 12%	$327,874
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$3,071,159
27S	**New LS, 8"FM, 8/10/12" near SH195** 8/10/12" gravity main flows southwest to the new Lampasas LS; another 10/12" interceptor flows southeast to the new LS which will lift flow north across SH195 through a 8" force main to South SH 195 LS	Lift Station - New 1 MGD	1	LS	$670,000	$670,000
		8" Force Main	9,683	LF	$50	$484,150
		8" Sanitary Sewer	6,813	LF	$50	$340,630
		10" Sanitary Sewer	9,709	LF	$62	$601,986
		12" Sanitary Sewer	11,889	LF	$74	$879,764
		48" Diameter Manhole	71	EA	$3,700	$262,700
		T-Block	1	EA	$6,900	$6,900
					Subtotal	$3,246,130
					Contingency @ 20%	$649,226
					Total Construction Cost	$3,895,356
					Engineering, Surveying & Geotech @ 12%	$467,443
					Facility ROW (1 Acre)	$11,000
					Total Project Cost	$4,373,798
28S	**10/12" West of SH 195** 10/12" gravity main flows south to the South SH 195 LS	12" Sanitary Sewer	5,212	LF	$74	$385,673
		10" Sanitary Sewer	5,316	LF	$62	$329,620
		48" Diameter Manhole	13	EA	$3,700	$48,100
					Subtotal	$763,393
					Contingency @ 20%	$152,679
					Total Construction Cost	$916,072
					Engineering, Surveying & Geotech @ 12%	$109,929
					Total Project Cost	$1,026,000
29S	**Lift Station #1 Rehab.** Lift Station #1 Rehab in the South Nolan Creek Sub-Basin.	Lift Station - Mod pipes, elec, sit	1	LS	$190,000	$190,000
		Lift Station - Rehab #1	1	LS	$700,000	$700,000
					Subtotal	$890,000
					Contingency @ 20%	$178,000
					Total Construction Cost	$1,068,000
					Engineering, Surveying & Geotech @ 12%	$128,160
					Total Project Cost	$1,196,160
	CITY OF KILLEEN WASTEWATER SYSTEM COSTS 2019					**$12,046,221**

Table B.7
City of Killeen
Wastewater System Improvements - 2022-2024
Opinions Of Probable Project Cost

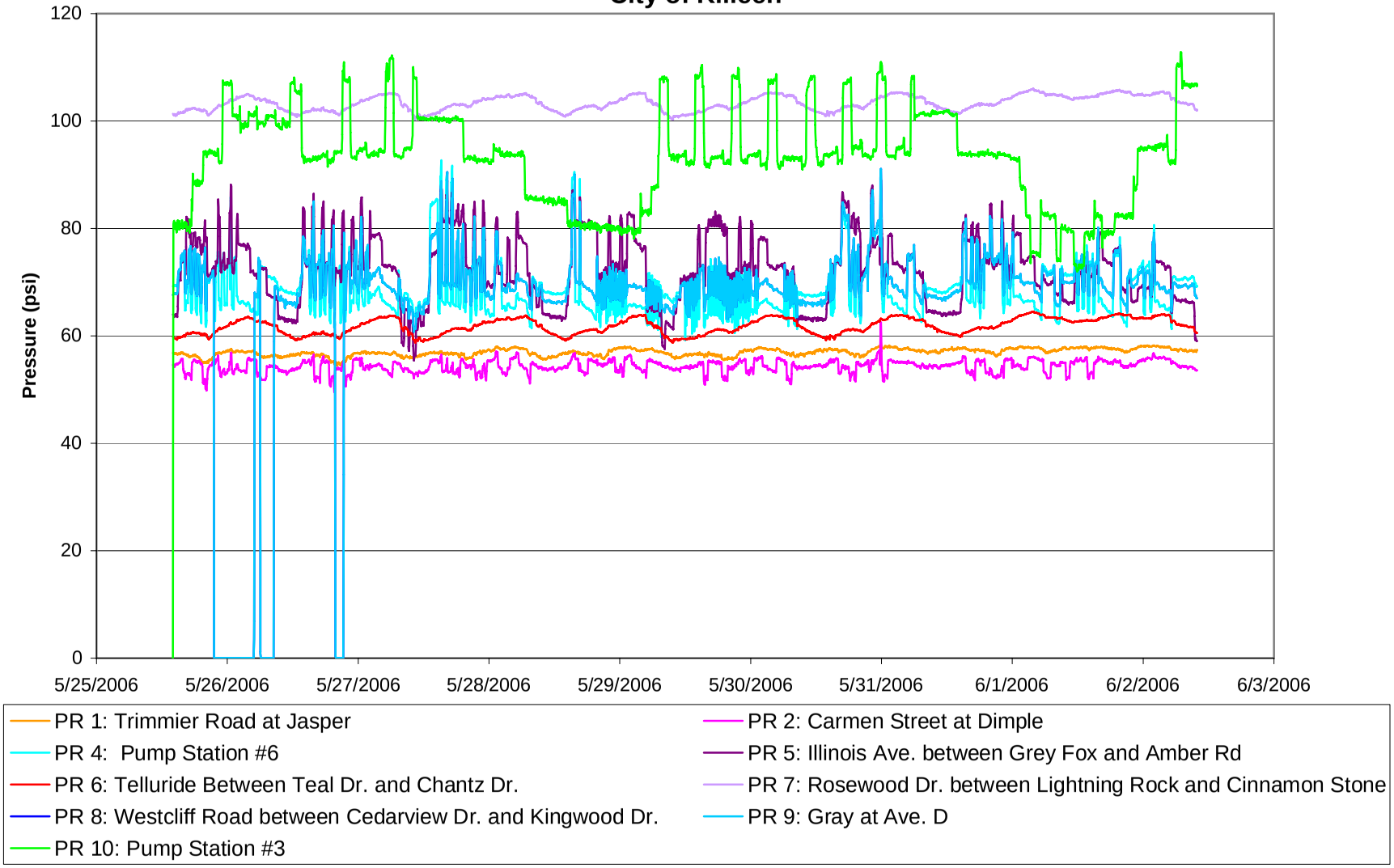
Project Number	Project Description	Construction Items		Quantity	Units	Unit Price	Costs
30S	**New LS, 8" FM, 12" Gravity Main** 12" collection main flows east to the new SH 2484 LS and will then be lifted through a 8" force main to the Little Trimmier Creek LS	8" Force Main		8,947	LF	$50	$447,350
		12" Sanitary Sewer		8,280	LF	$74	$612,720
		T-Block		1	EA	$6,900	$6,900
		Lift Station - New 2 MGD	1	1	LS	$860,000	$860,000
		48" Diameter Manhole		21	EA	$3,700	$77,700
						Subtotal	$2,004,670
						Contingency @ 20%	$400,934
						Total Construction Cost	$2,405,604
						Engineering, Surveying & Geotech @ 12%	$288,672
						Facility ROW (1 Acre)	$11,000
						Total Project Cost	$2,705,276
31S	**New LS, 8" FM, 10/12" Gravity Main** 10/12" gravity main flows southeast to the new Shaw Branch LS which will lift flow west through an 8" force main to a new 12" gravity main that will carry flow to the FM 439 LS	Lift Station - New 1 MGD		1	LS	$670,000	$670,000
		8" Force Main		6,624	LF	$50	$331,200
		12" Sanitary Sewer		13,455	LF	$74	$995,670
		10" Sanitary Sewer		5,571	LF	$62	$345,377
		48" Diameter Manhole		48	EA	$3,700	$177,600
						Subtotal	$2,519,847
						Contingency @ 20%	$503,969
						Total Construction Cost	$3,023,817
						Engineering, Surveying & Geotech @ 12%	$362,858
						Facility ROW (1 Acre)	$11,000
						Total Project Cost	$3,397,675

CITY OF KILLEEN
WASTEWATER SYSTEM COSTS 2022

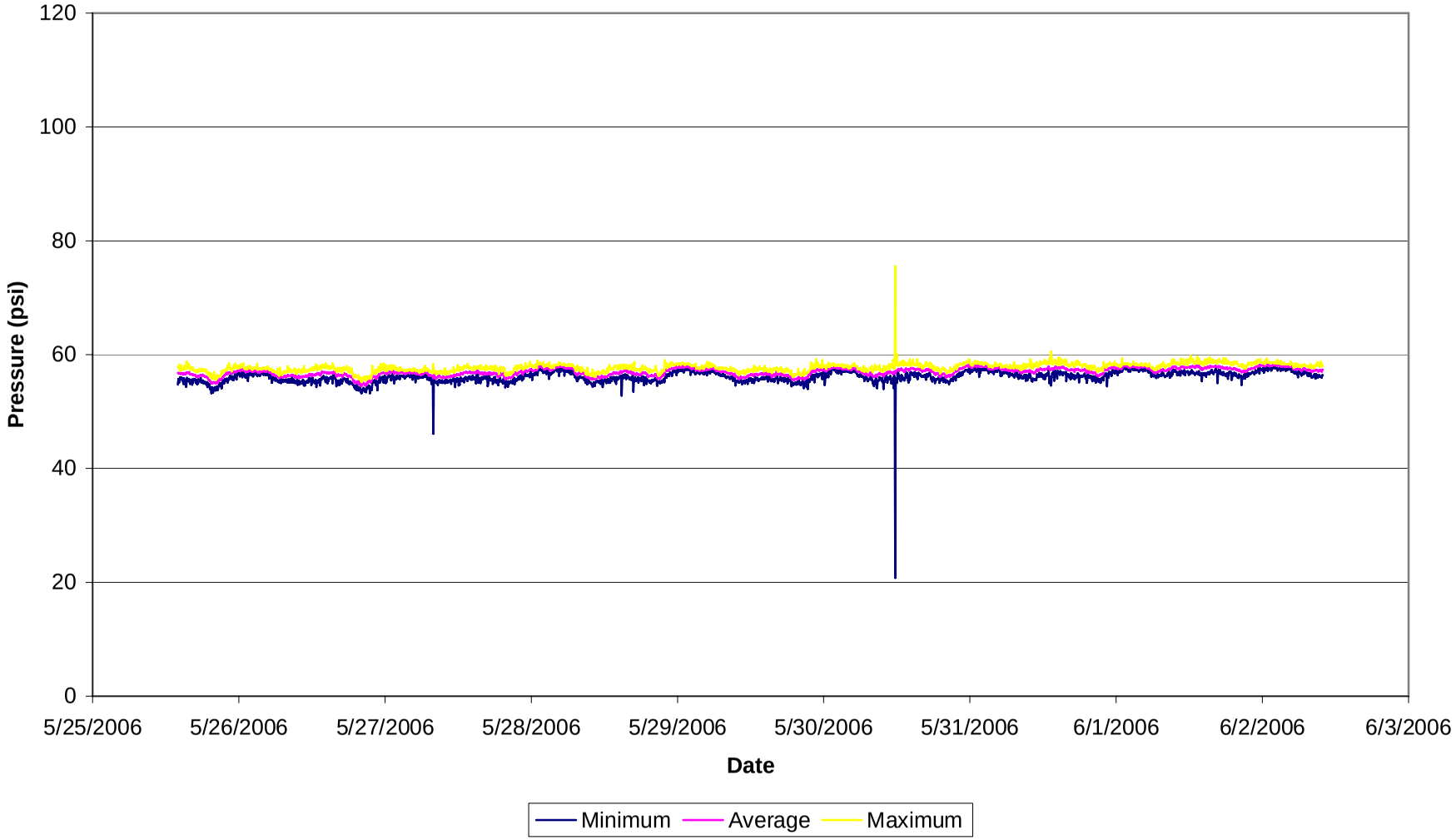
$6,102,951

Appendix C
Water Background Information

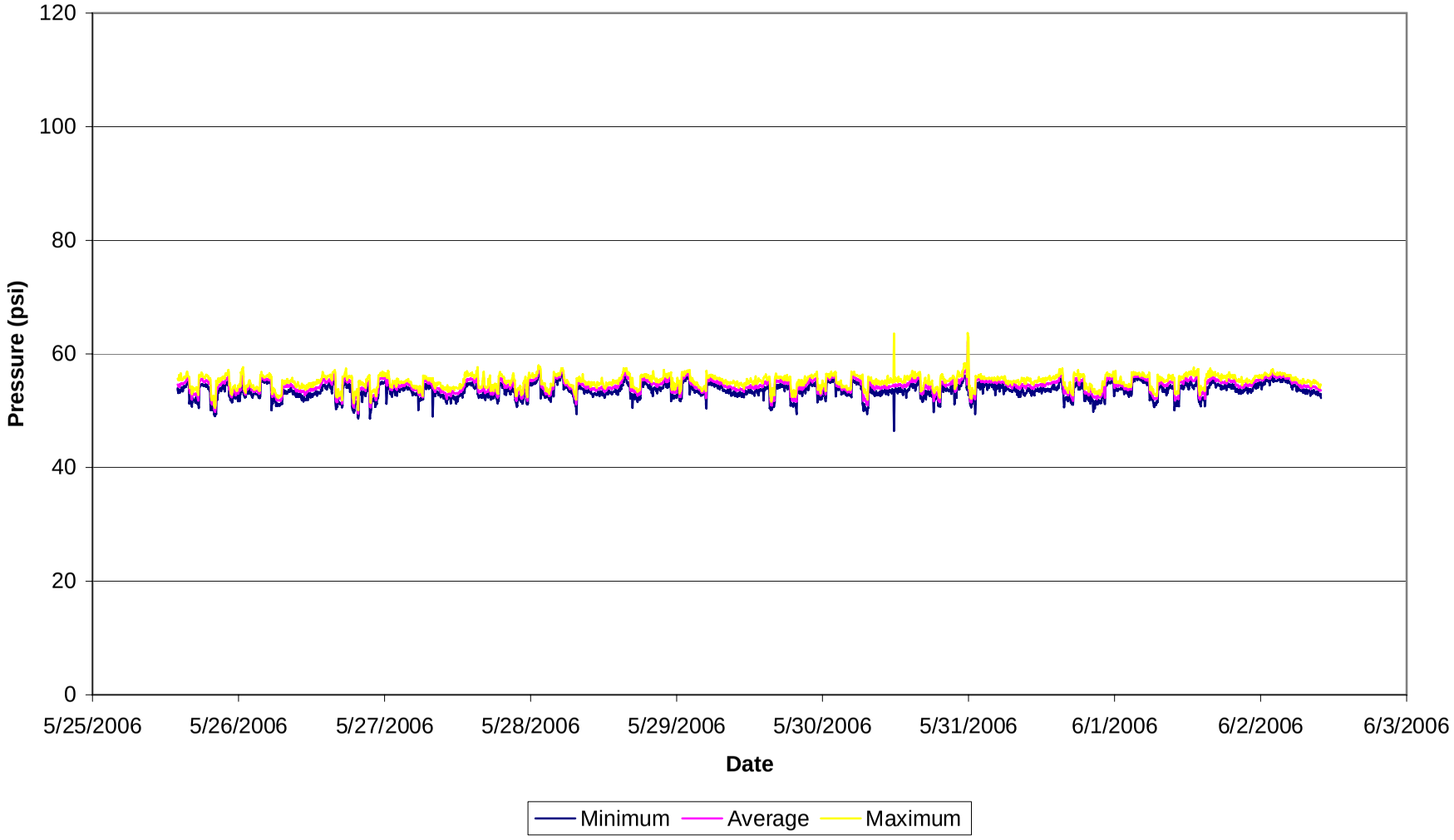
All Pressure Recorders - Lower and Middle Pressure Plane
May 26, 2006 - June 2, 2006
City of Killeen



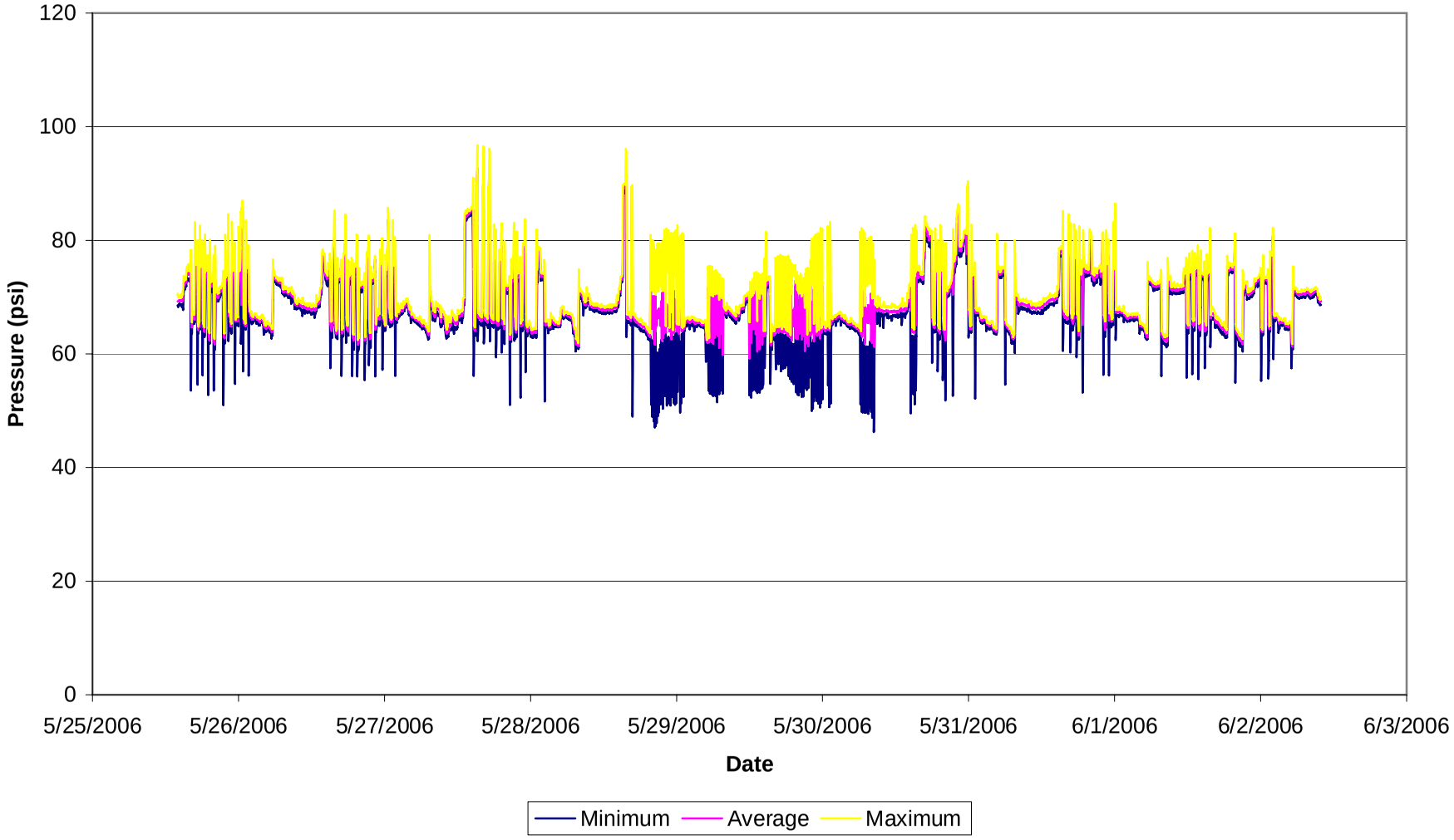
Week 1 - Pressure Recorder #1
Middle Pressure Plane
Trimmier Road at Jasper



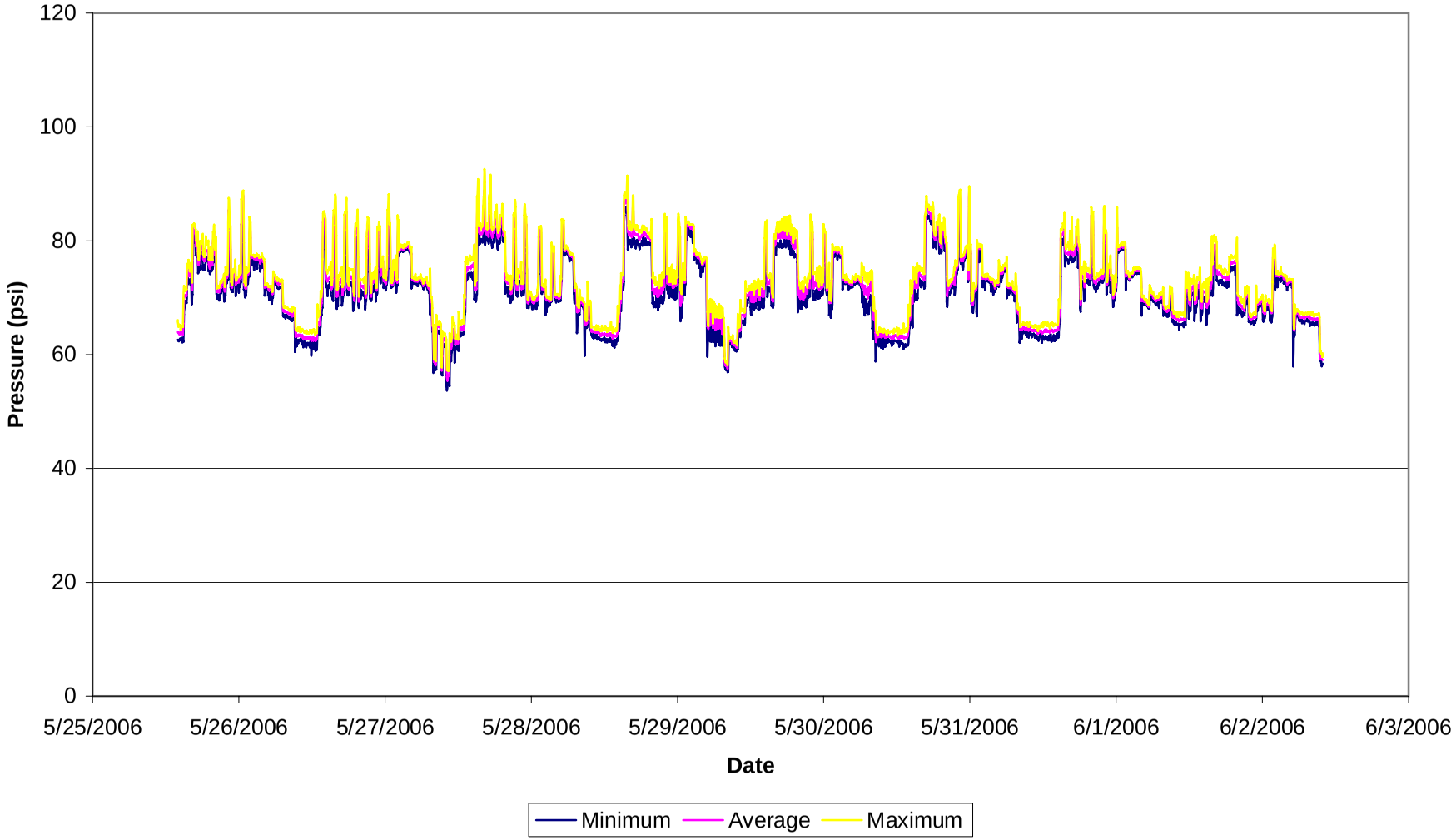
Week 1 - Pressure Recorder #2
Middle Pressure Plane
Carmen Street at Dimple



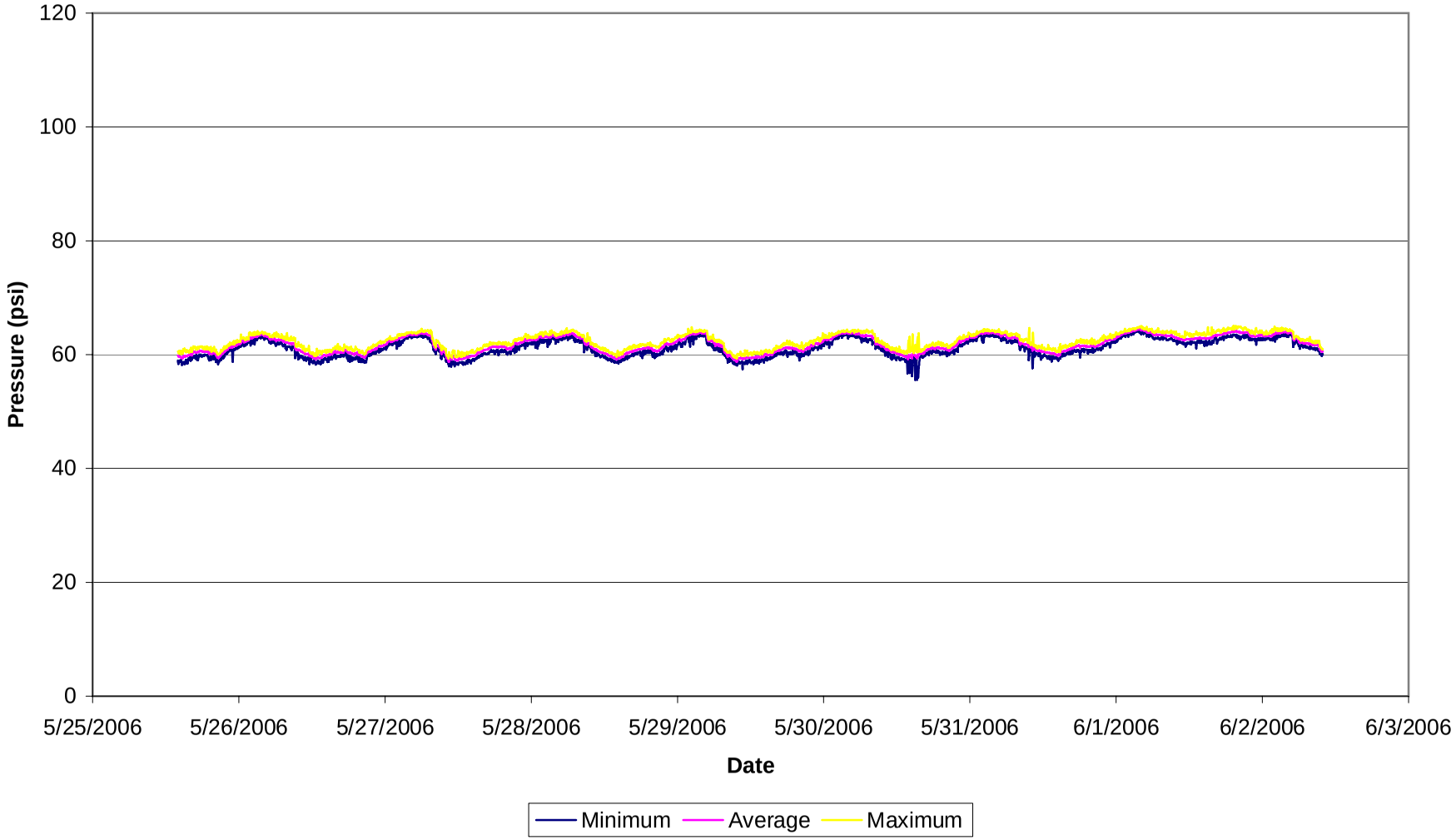
Week 1 - Pressure Recorder #4
Lower Pressure Plane
Discharge side of Pump Station #5



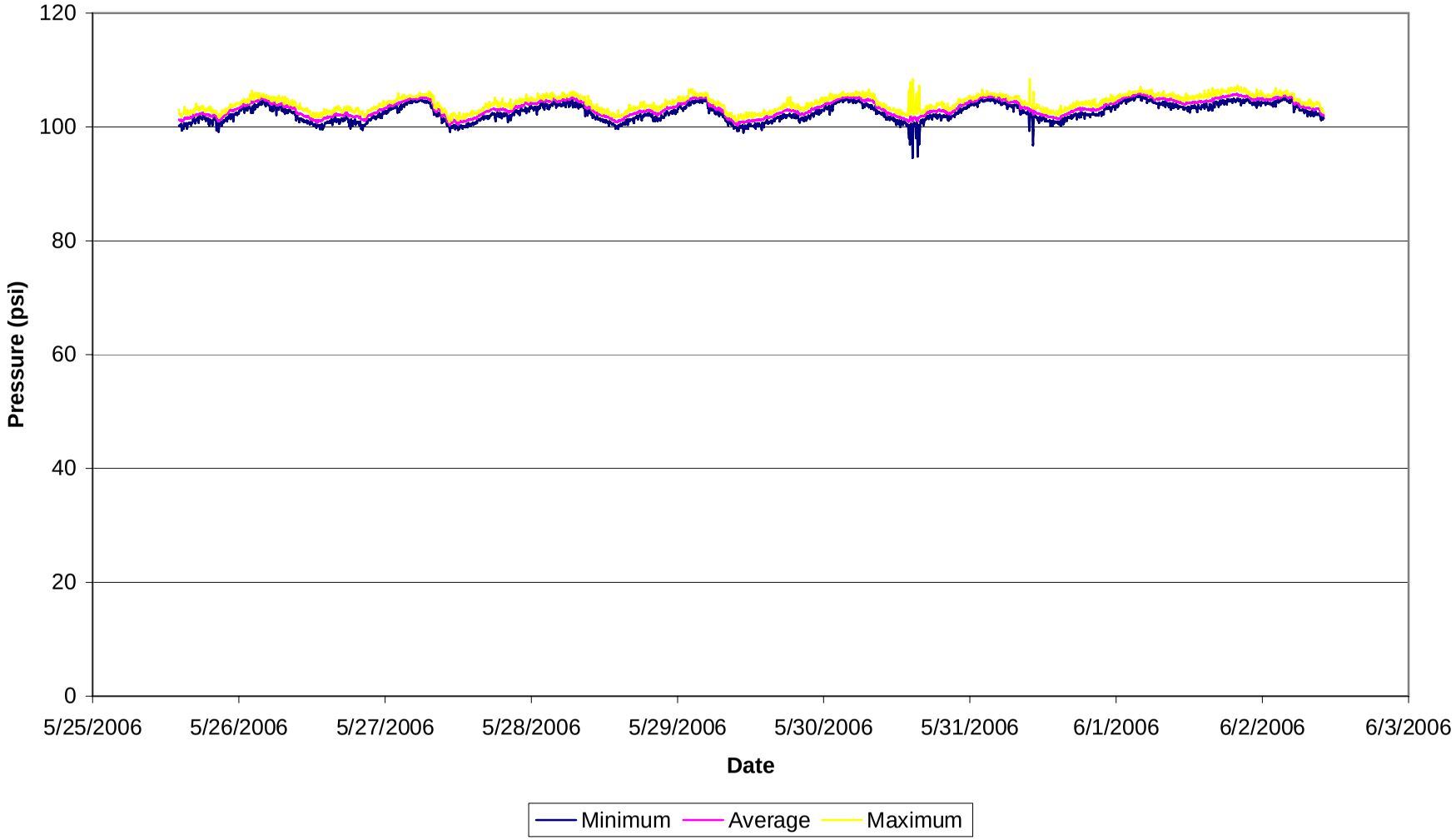
Week 1 - Pressure Recorder #5
Lower Pressure Plane
Illinois Avenue between Grey Fox and Amber Road



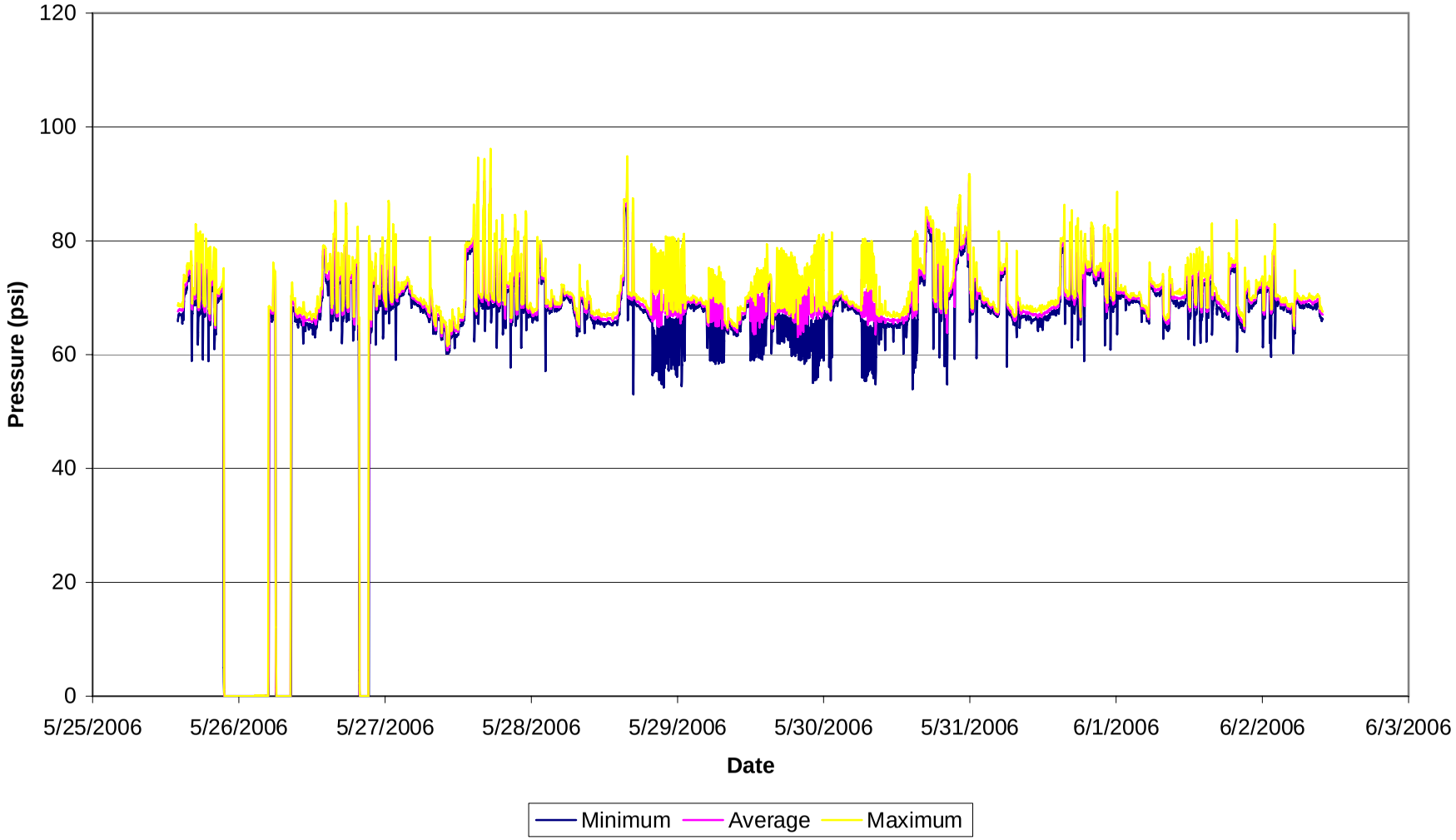
Week 1 - Pressure Recorder #6
Lower Pressure Plane
Telluride Drive between Teal Drive and Chantz Drive



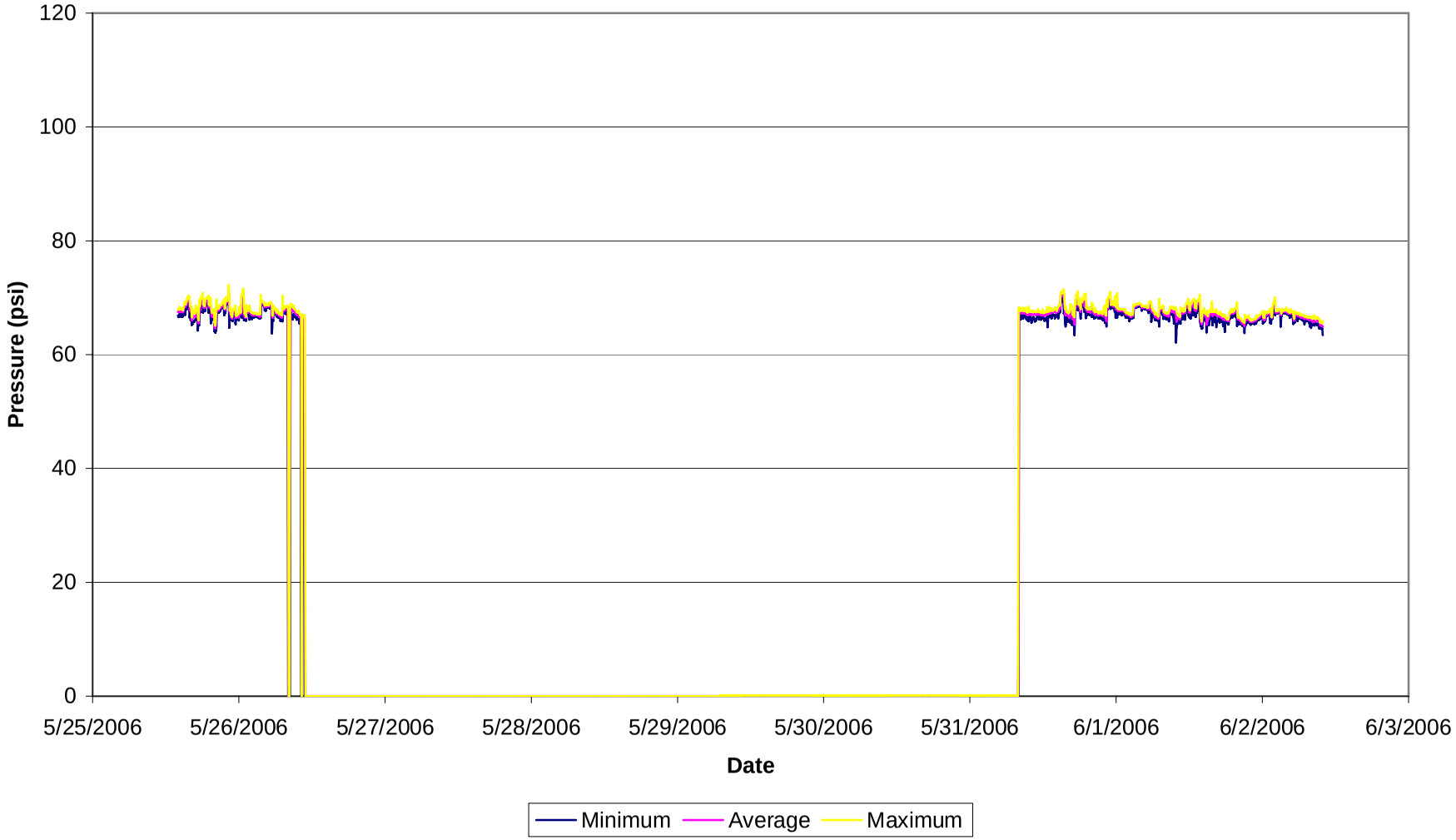
Week 1 - Pressure Recorder #7
Lower Pressure Plane
Rosewood Drive between Lightning Rock and Cinnamon Stone



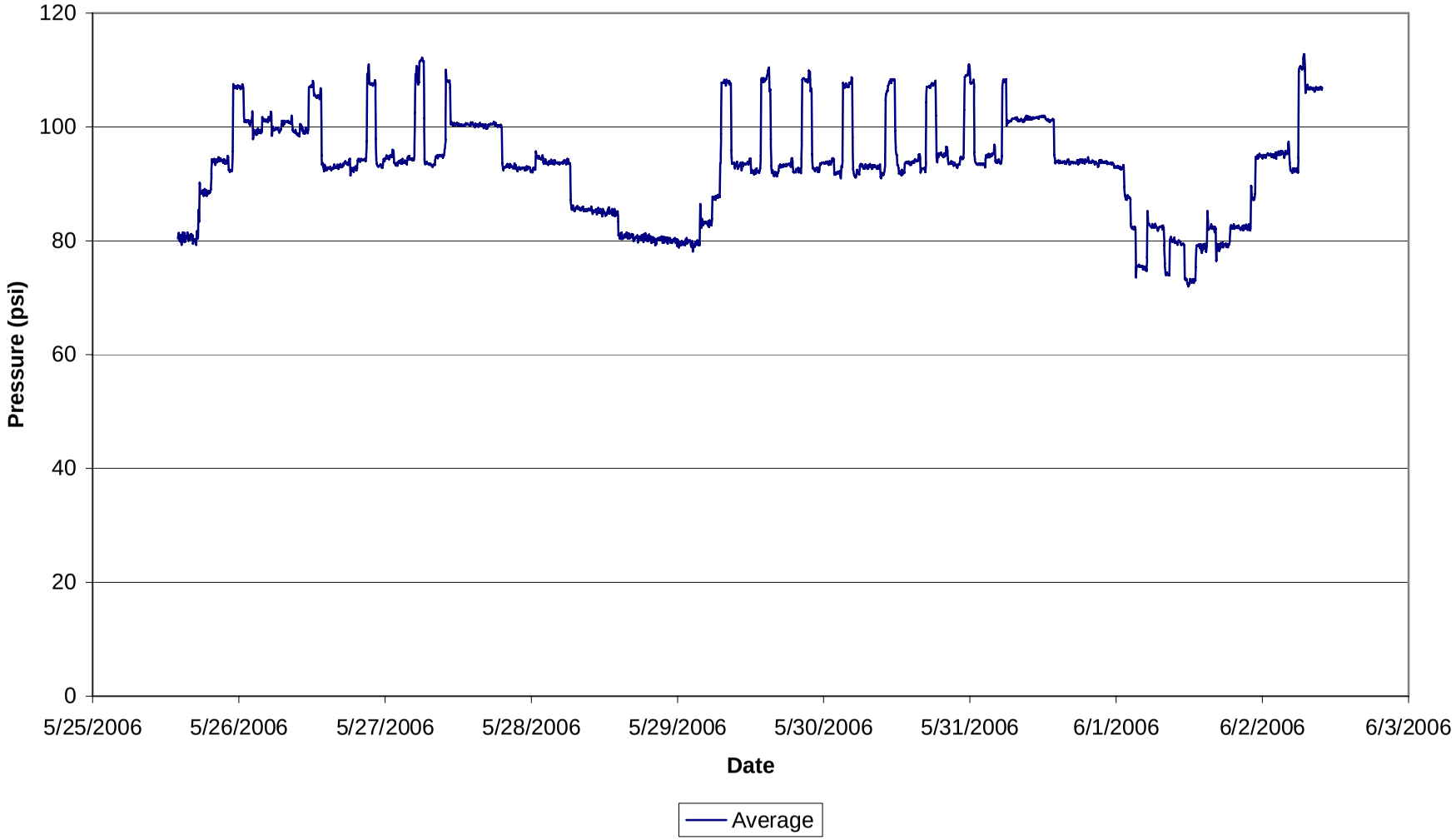
Week 1 - Pressure Recorder #8
Lower Pressure Plane
Westcliff Road between Cedarview Drive ad Kingwood Drive



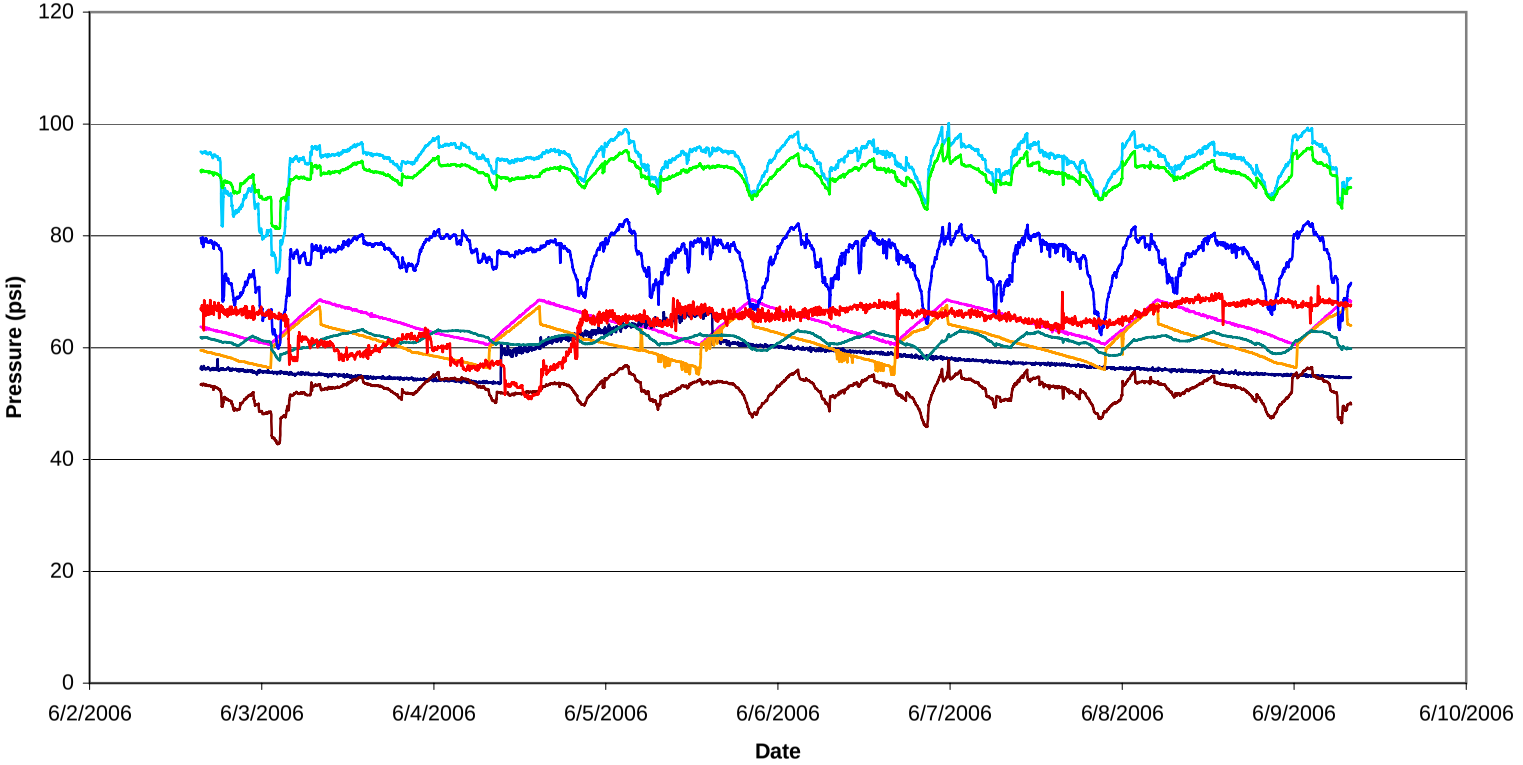
Week 1 - Pressure Recorder #9
Lower Pressure Plane
Gray at Avenue D Drive



Week 1 - Pressure Recorder #10
Lower Pressure Plane
Discharge side of Pump Station #3

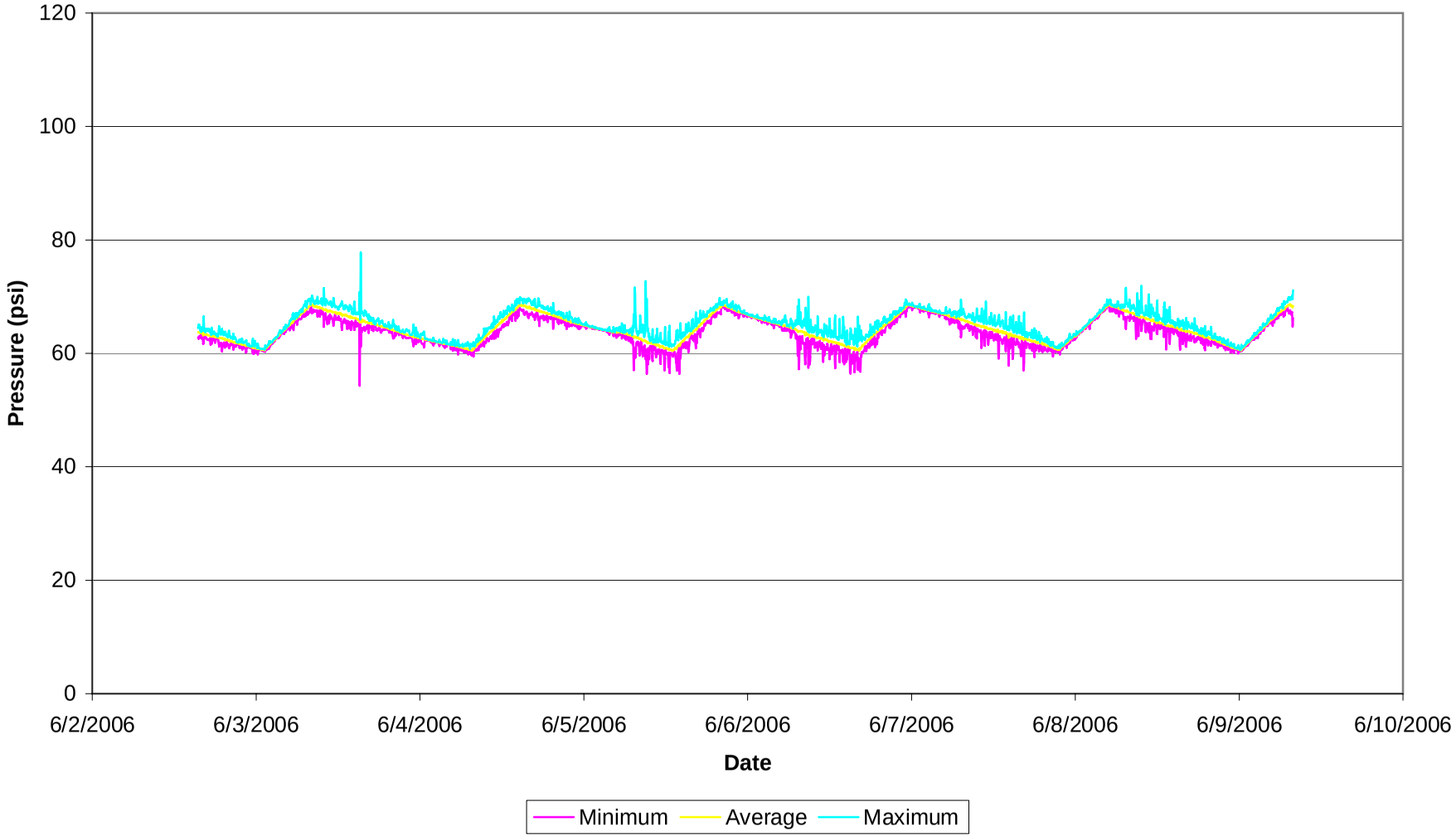


All Pressure Recorders - Upper and Airport Pressure Planes
June 2, 2006 - June 9, 2006
City of Killeen

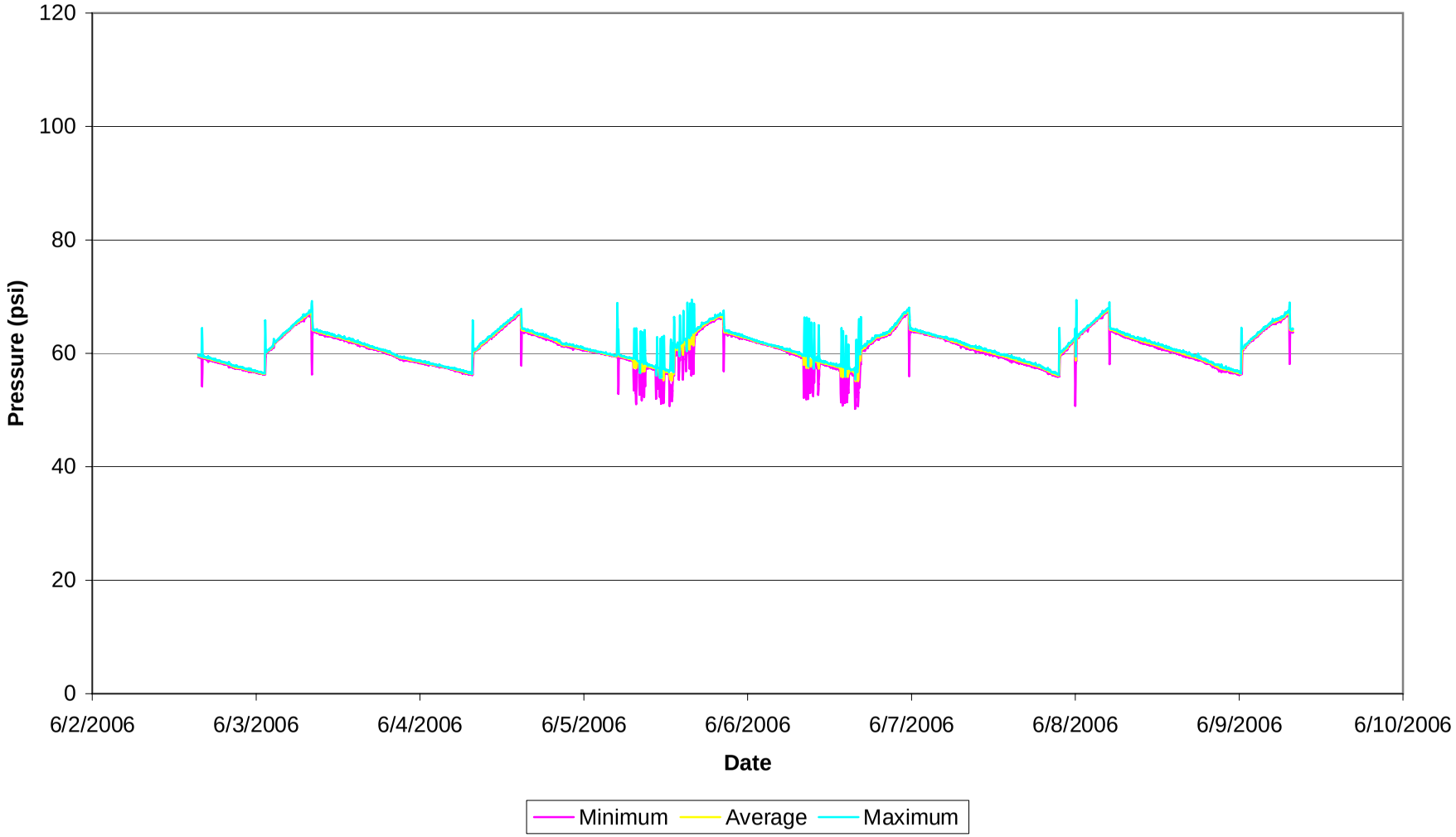


- PR 1: South Clear Creek between Reese Creek and Tiffany Circle B
- PR 2: Golden Gate Dr. east of Confederation
- PR 3: Airport Pump Station
- PR 4: Mustang Dr. at Windfield Dr.
- PR 5: Clairidge Ave. at Carpet Lane
- PR 6: South of Turtle Creek Drive between Pebble Drive and Florence Road
- PR 7: WS Young between Riley and Stagecoach
- PR 8: Llana Estacado west of Bunny Lane
- PR 9: State Highway 195 south of Omar Drive
- PR 10: Goodhue Dr. at Cascade Dr.

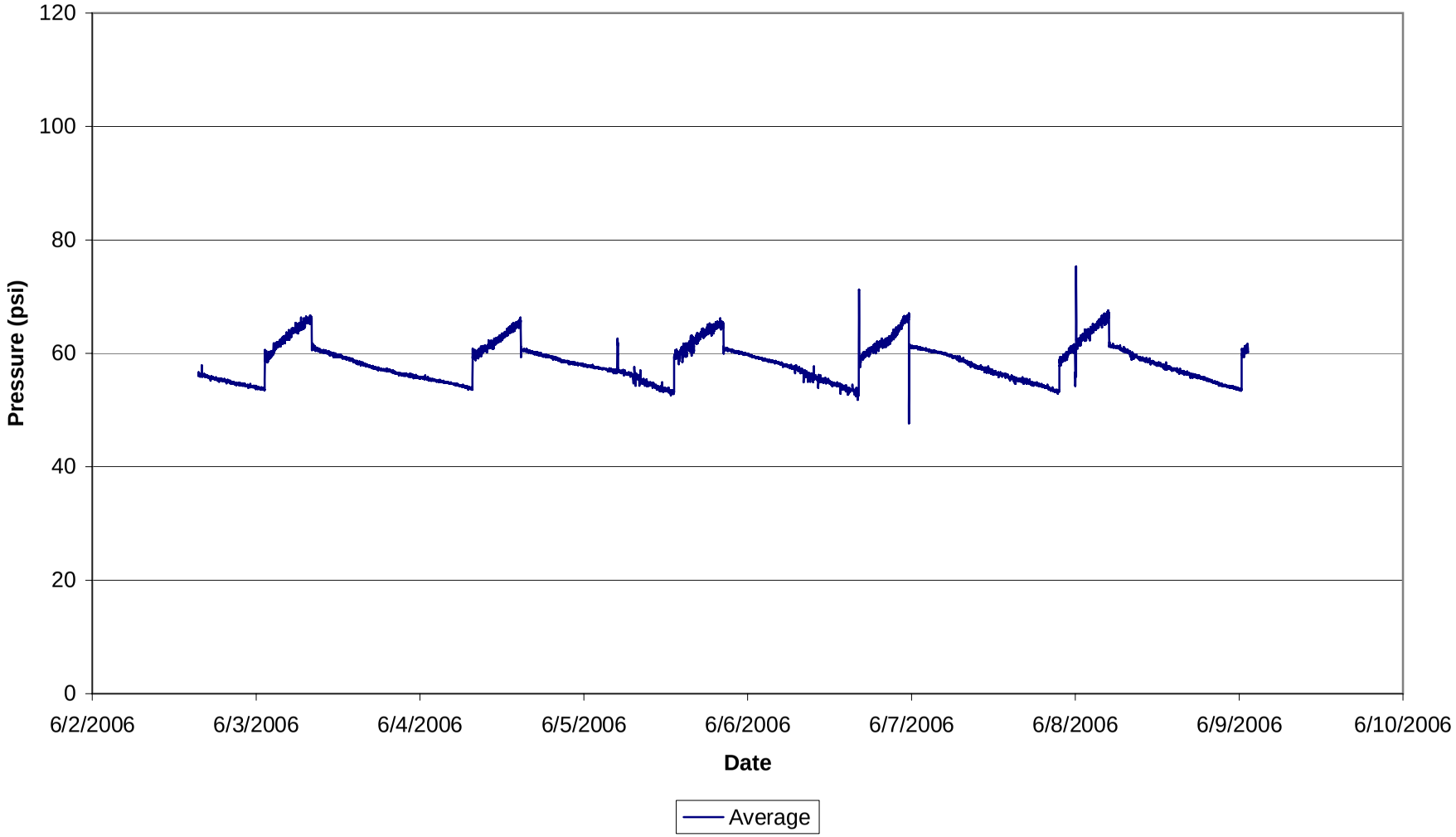
Week 2 - Pressure Recorder #1
Airport Pressure Plane
South Clear Creek Road between Reese Creek Road and Tiffany Circle B



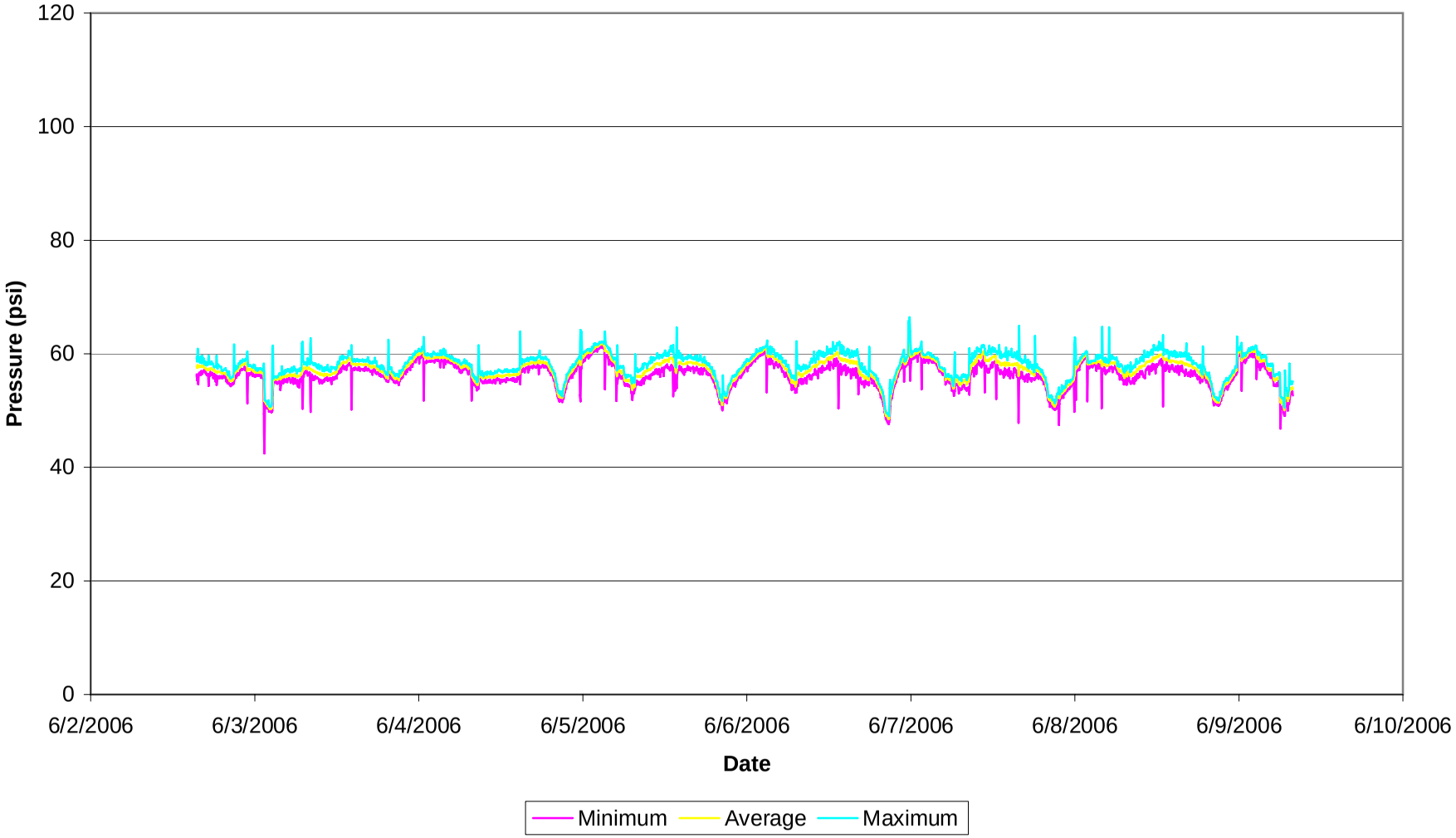
Week 2 - Pressure Recorder #2
Airport Pressure Plane
Golden Gate Drive east of Confederation



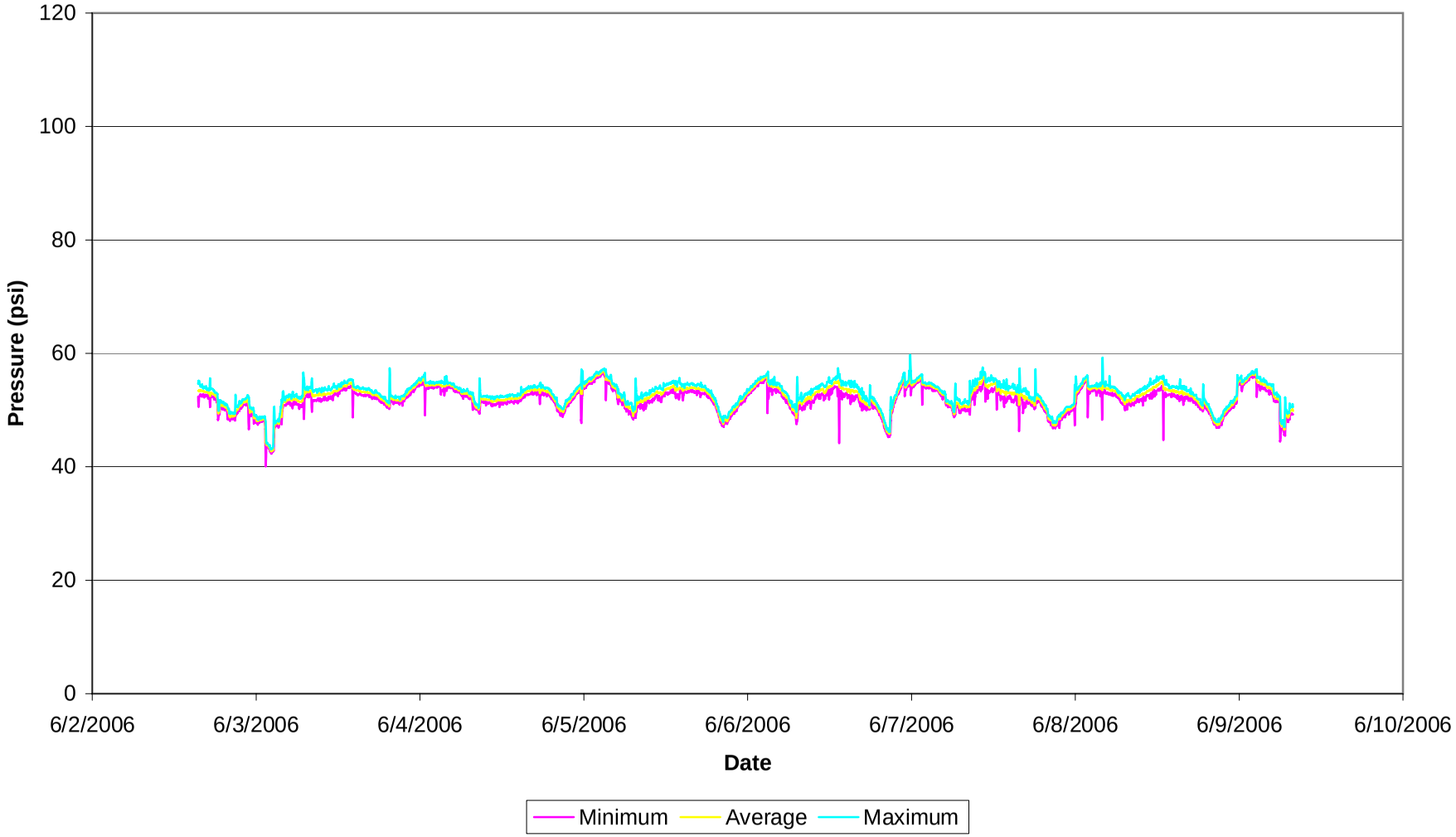
Week 2 - Pressure Recorder #3
Airport Pressure Plane
Discharge side of Airport Pump Station



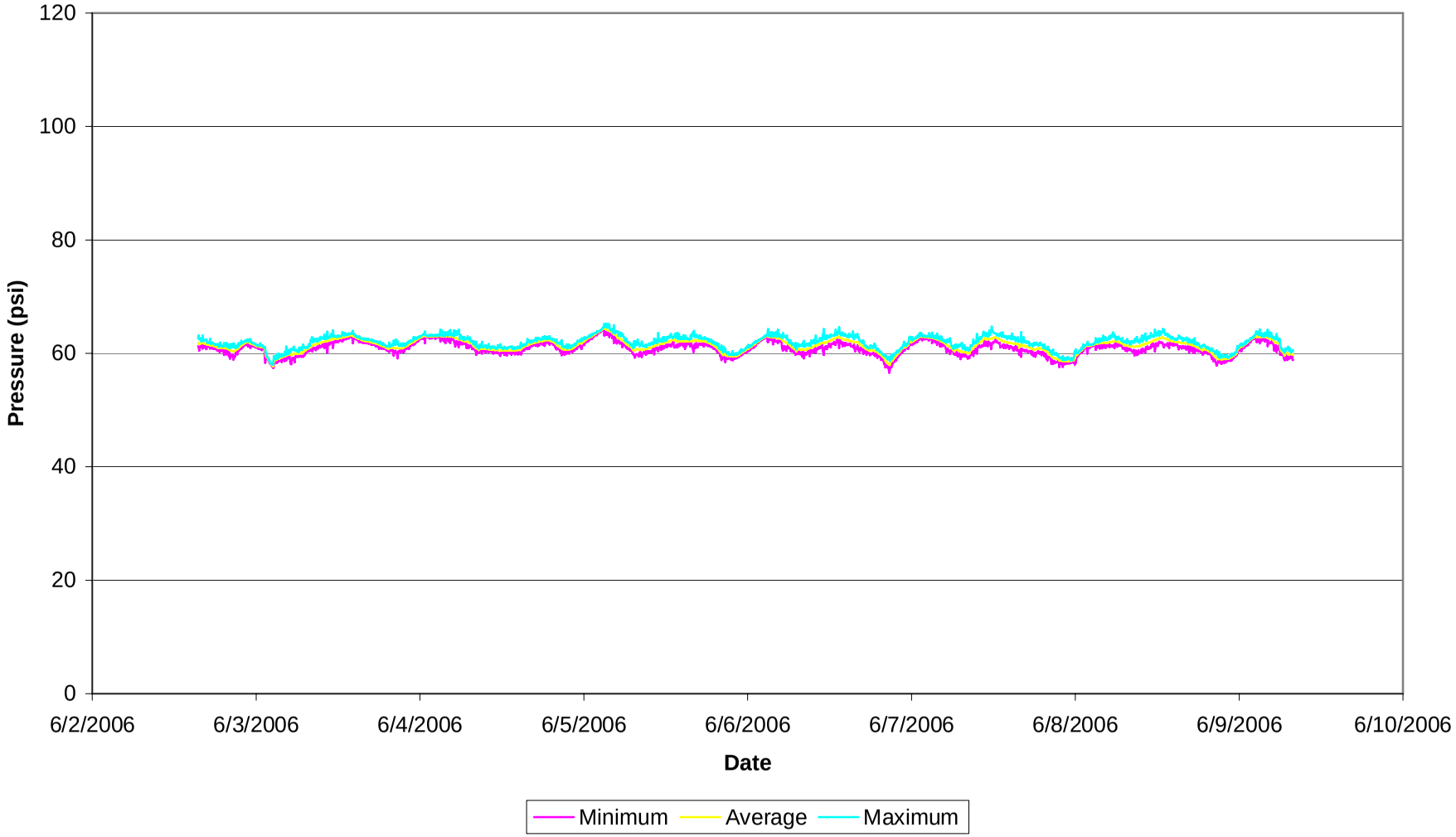
Week 2 - Pressure Recorder #4
Upper Pressure Plane
Mustang Drive at Windfield Drive



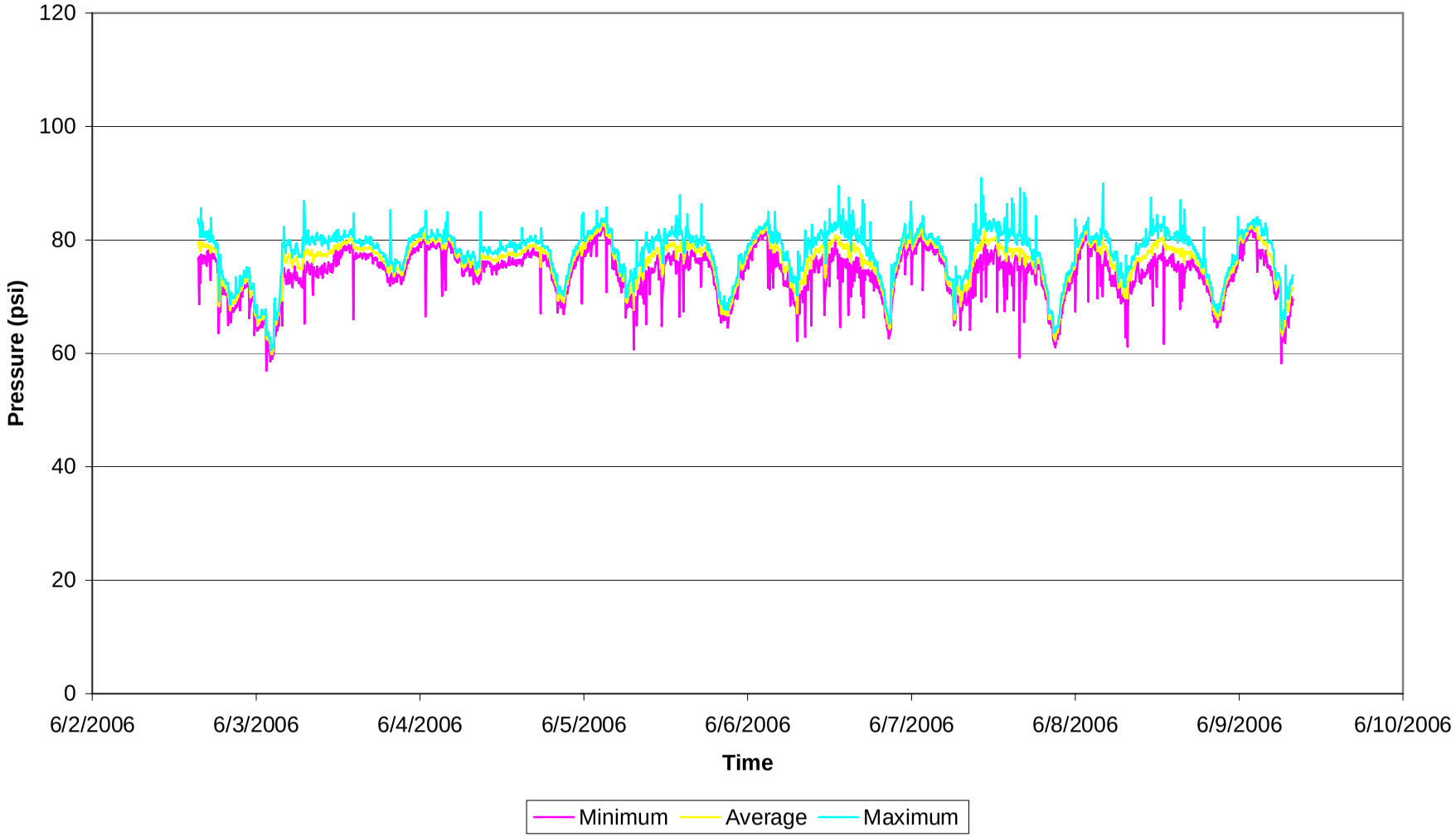
Week 2 - Pressure Recorder #5
Upper Pressure Plane
Clairidge Avenue at Carpet Lane



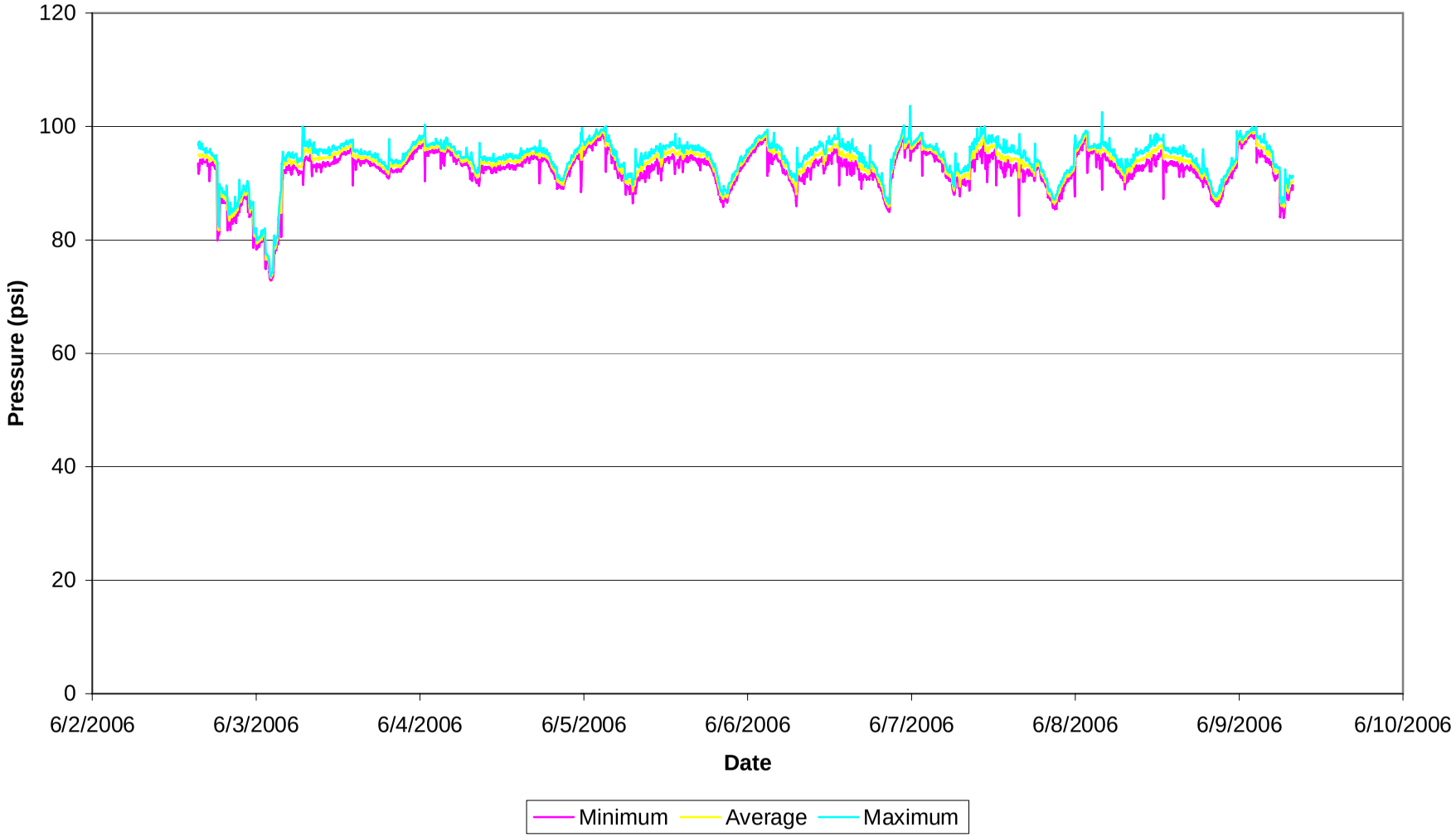
Week 2 - Pressure Recorder #6
Upper Pressure Plane
South of Turtle Creek Drive between Pebble Drive and Florence Road



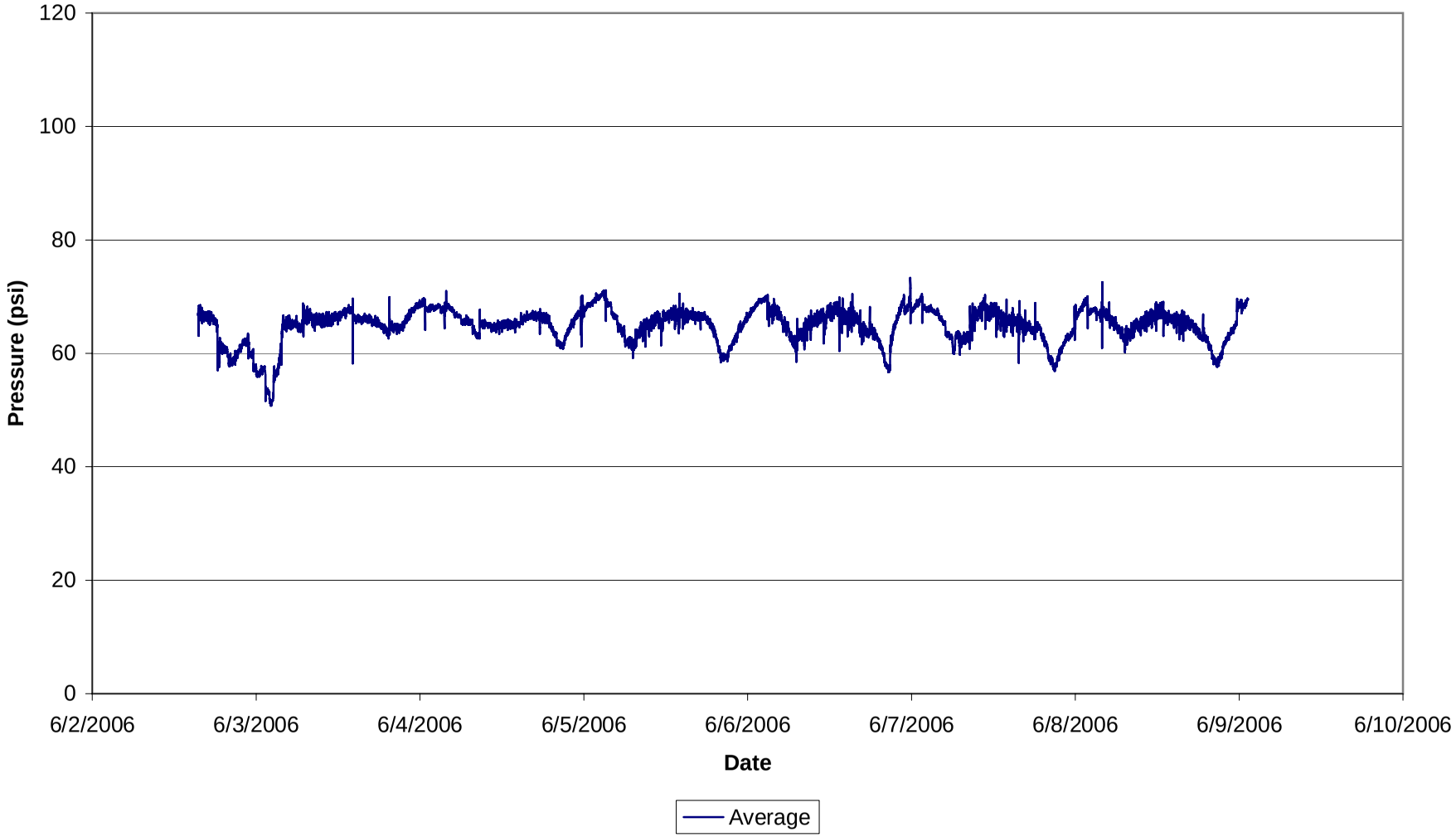
Week 2 - Pressure Recorder #7
Upper Pressure Plane
WS Young between Riley and Stagecoach



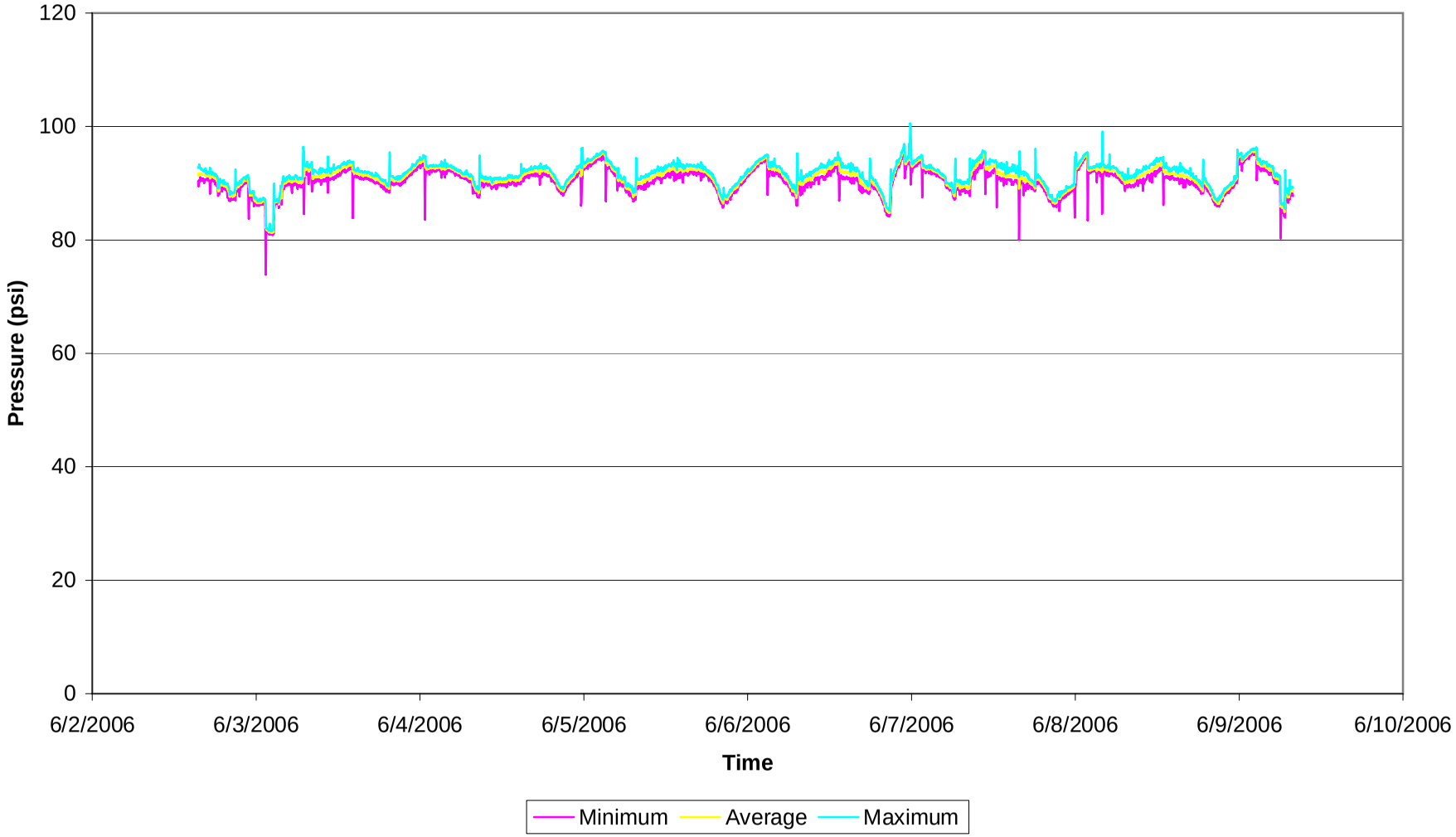
Week 2 - Pressure Recorder #8
Upper Pressure Plane
Llana Estacado west of Bunny Lane



Week 2 - Pressure Recorder #9
Upper Pressure Plane
State Highway 195 south of Omar Drive



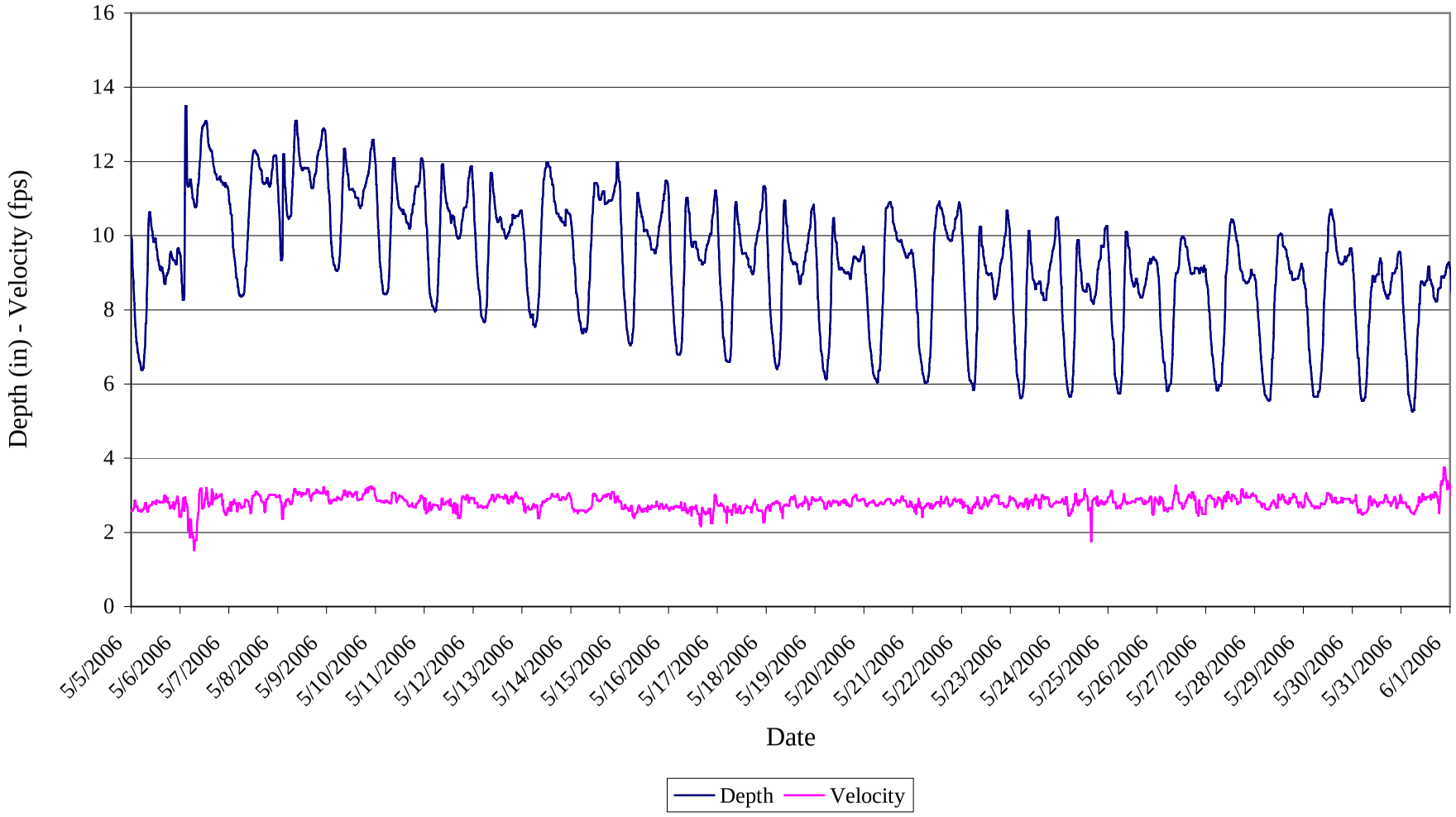
Week 2 - Pressure Recorder #10
Upper Pressure Plane
Goodhue Drive at Cascade Drive



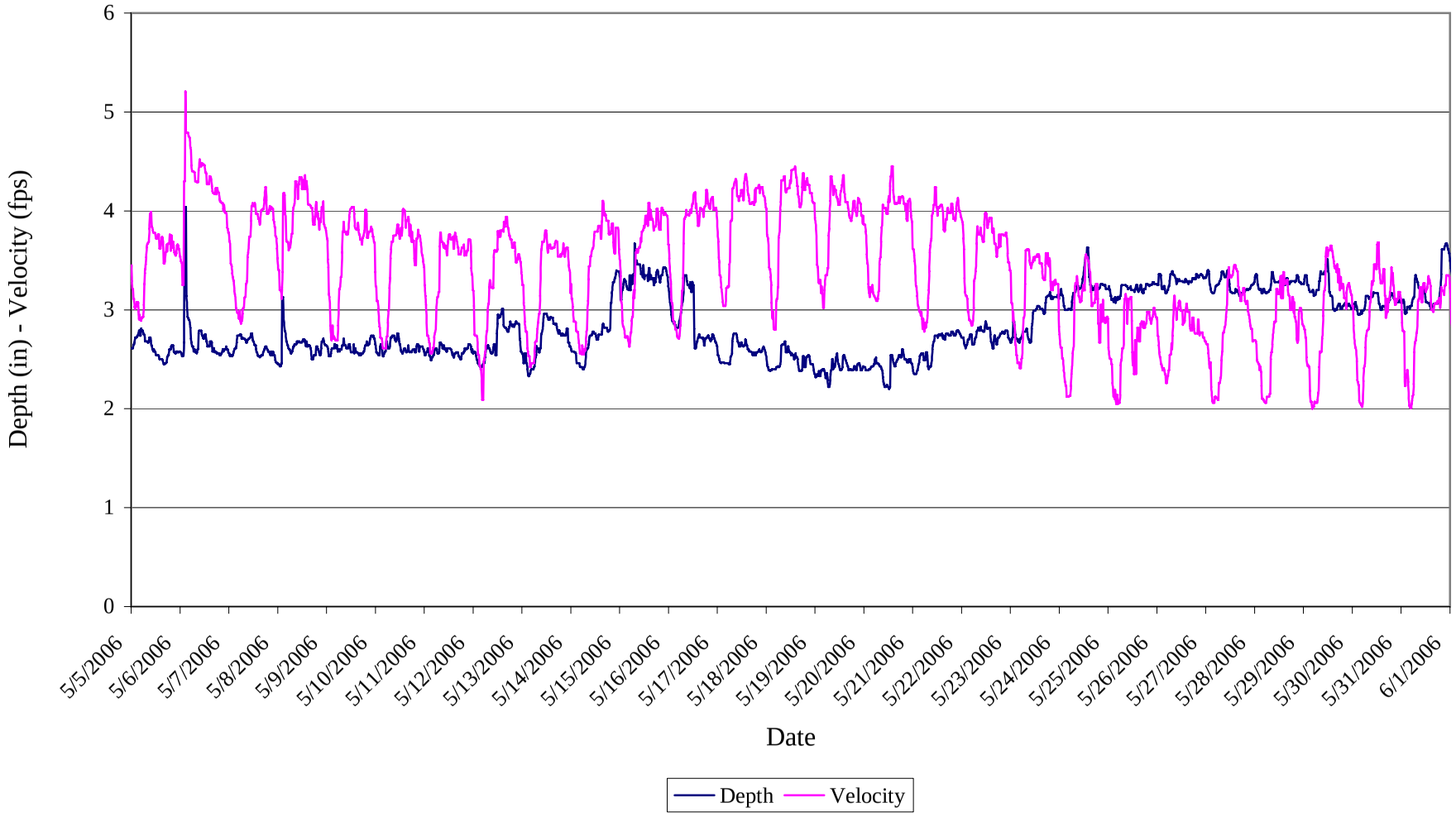
Appendix D
Wastewater Background Information

KILLEEN RAINFALL DATA DURING FLOW MONITORING	
Date	**Precipitation (inches)**
5/1/2006	0.00
5/2/2006	0.00
5/3/2006	0.00
5/4/2006	0.00
5/5/2006	0.00
5/6/2006	2.50
5/7/2006	0.00
5/8/2006	0.00
5/9/2006	0.00
5/10/2006	0.00
5/11/2006	0.00
5/12/2006	0.00
5/13/2006	0.00
5/14/2006	0.20
5/15/2006	0.00
5/16/2006	0.00
5/17/2006	0.00
5/18/2006	0.00
5/19/2006	0.00
5/20/2006	0.00
5/21/2006	0.00
5/22/2006	0.00
5/23/2006	0.00
5/24/2006	0.00
5/25/2006	0.00
5/26/2006	0.00
5/27/2006	0.00
5/28/2006	0.00
5/29/2006	0.00
5/30/2006	0.00
5/31/2006	0.00
TOTAL	2.70

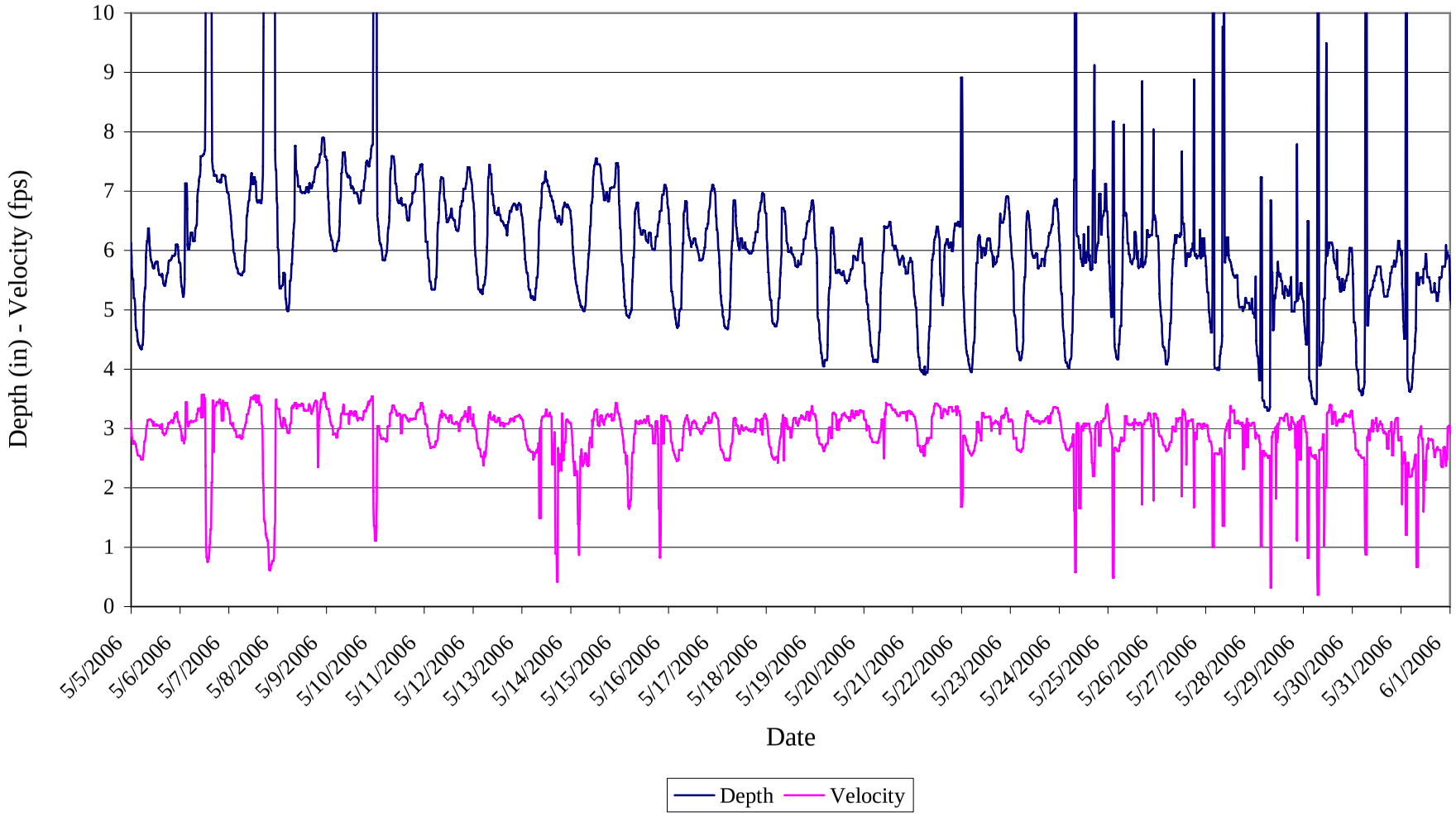
City of Killeen
Wastewater Metering Station #1 (42" line)
106 N. WS Young Dr.



City of Killeen
Wastewater Metering Station #2 (17.25" line)
38th Street at Railroad



City of Killeen
Wastewater Metering Station #3 (21.25" line)
Maude St. at Lynn Ave.



City of Killeen
South Nolan Creek Subbasin Flows

	2006			2011			2016			2031		
Census Tract in Subbasin	Population	Avg Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Wet Weather Flow (MGD)
0221.01	2,074	0.22	0.87	2,074	0.23	0.91	2,074	0.24	0.95	2,074	0.24	0.95
0222	830	0.09	0.35	902	0.10	0.40	956	0.11	0.44	1,064	0.12	0.49
0223	1,107	0.12	0.47	1,287	0.14	0.57	1,362	0.16	0.63	1,512	0.17	0.70
0224.01	409	0.04	0.17	433	0.05	0.19	433	0.05	0.20	433	0.05	0.20
0225	1,153	0.12	0.48	1,162	0.13	0.51	1,341	0.15	0.62	1,445	0.17	0.66
0226	840	0.09	0.35	840	0.09	0.37	840	0.10	0.39	840	0.10	0.39
0229	4,231	0.44	1.78	4,231	0.47	1.86	4,231	0.49	1.95	4,231	0.49	1.95
0230	907	0.10	0.38	1,215	0.13	0.53	1,327	0.15	0.61	1,517	0.17	0.70
0231.02	15,313	1.61	6.43	19,668	2.16	8.65	23,308	2.68	10.72	30,794	3.54	14.17
0231.03	3,805	0.40	1.60	3,805	0.42	1.67	3,805	0.44	1.75	3,805	0.44	1.75
0231.04	3,706	0.39	1.56	3,706	0.41	1.63	3,706	0.43	1.70	3,706	0.43	1.70
0232	0	0.00	0.00	160	0.02	0.07	240	0.03	0.11	547	0.06	0.25
TOTAL	**34,377**	**3.61**	**14.44**	**39,485**	**4.34**	**17.37**	**43,625**	**5.02**	**20.07**	**51,970**	**5.98**	**23.91**

City of Killeen
Central Subbasin Flows

	2006				2011				2016				2031			
Census Tract in Subbasin	**Population**	**Avg Day Flow (MGD)**	**Peak Day Flow (MGD)**	**Peak Wet Weather Flow (MGD)**	**Population**	**Avg Day Flow (MGD)**	**Peak Day Flow (MGD)**	**Peak Wet Weather Flow (MGD)**	**Population**	**Avg Day Flow (MGD)**	**Peak Day Flow (MGD)**	**Peak Wet Weather Flow (MGD)**	**Population**	**Avg Day Flow (MGD)**	**Peak Day Flow (MGD)**	**Peak Wet Weather Flow (MGD)**
0223	3,291	0.35	0.54	1.47	3,825	0.42	0.65	1.79	4,048	0.47	0.72	1.98	4,494	0.52	0.80	2.20
0224.01	4,344	0.46	0.71	1.94	4,599	0.51	0.78	2.16	4,599	0.53	0.82	2.25	4,599	0.53	0.82	2.25
0224.02	3,958	0.42	0.64	1.77	4,768	0.52	0.81	2.24	5,578	0.64	0.99	2.73	6,118	0.70	1.09	3.00
0225	7,032	0.74	1.14	3.15	8,871	0.98	1.51	4.16	10,213	1.17	1.82	5.01	12,205	1.40	2.18	5.98
0230	4,599	0.48	0.75	2.06	6,161	0.68	1.05	2.89	6,729	0.77	1.20	3.30	7,692	0.88	1.37	3.77
0231.02	2,591	0.27	0.42	1.16	3,328	0.37	0.57	1.56	3,944	0.45	0.70	1.93	5,211	0.60	0.93	2.55
0231.03	2,141	0.22	0.35	0.96	2,141	0.24	0.36	1.00	2,141	0.25	0.38	1.05	2,141	0.25	0.38	1.05
0233	0	0.00	0.00	0.00	40	0.00	0.01	0.02	76	0.01	0.01	0.04	136	0.02	0.02	0.07
TOTAL	**27,955**	**2.94**	**4.55**	**12.51**	**33,732**	**3.71**	**5.75**	**15.82**	**37,327**	**4.29**	**6.65**	**18.30**	**42,595**	**4.90**	**7.59**	**20.88**

City of Killeen
Long Branch Subbasin Flows

	2006				2011				2016				2031			
Census Tract in Subbasin	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)
0220	713	0.07	0.12	0.32	2,186	0.24	0.37	1.02	2,786	0.32	0.50	1.37	6,671	0.77	1.18	3.24
0221.01	2,024	0.21	0.33	0.91	2,024	0.22	0.35	0.95	2,024	0.23	0.36	0.99	2,024	0.23	0.36	0.99
0221.02	7,367	0.77	1.20	3.30	7,367	0.81	1.26	3.45	7,367	0.85	1.31	3.62	7,367	0.85	1.31	3.62
0221.03	6,070	0.64	0.99	2.72	6,070	0.67	1.03	2.85	6,070	0.70	1.08	2.98	6,070	0.70	1.08	2.98
0222	3,137	0.33	0.51	1.40	3,409	0.37	0.58	1.60	3,613	0.42	0.64	1.77	4,021	0.46	0.72	1.98
0223	2,953	0.31	0.48	1.32	3,433	0.38	0.59	1.61	3,633	0.42	0.65	1.78	4,033	0.46	0.72	1.98
0224.01	358	0.04	0.06	0.16	379	0.04	0.06	0.18	379	0.04	0.07	0.19	379	0.04	0.07	0.19
AE1	0	0.00	0.00	0.00	0	0.00	0.00	0.00	691	0.07	0.11	0.31	6,664	0.77	1.19	3.27
TOTAL	**22,621**	**2.38**	**3.68**	**10.12**	**24,867**	**2.74**	**4.24**	**11.66**	**26,562**	**3.05**	**4.73**	**13.02**	**37,228**	**4.28**	**6.63**	**18.25**

City of Killeen
WWTP Subbasin Flows

	2006				2011				2016				2031			
Census Tract in Subbasin	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)
0221.01	961	0.10	0.16	0.43	961	0.11	0.16	0.45	961	0.11	0.17	0.47	961	0.11	0.17	0.47
0222	646	0.07	0.11	0.29	702	0.08	0.12	0.33	744	0.09	0.13	0.36	828	0.10	0.15	0.41
0226	3,847	0.40	0.63	1.72	3,847	0.42	0.66	1.80	3,847	0.44	0.69	1.89	3,847	0.44	0.69	1.89
0228.01	3,126	0.33	0.51	1.40	3,122	0.34	0.53	1.46	3,123	0.36	0.56	1.53	3,124	0.36	0.56	1.53
0229	223	0.02	0.04	0.10	223	0.02	0.04	0.10	223	0.03	0.04	0.11	223	0.03	0.04	0.11
0235	2,337	0.25	0.38	1.05	2,337	0.26	0.40	1.10	2,337	0.27	0.42	1.15	2,337	0.27	0.42	1.15
TOTAL	**11,140**	**1.17**	**1.81**	**4.99**	**11,192**	**1.23**	**1.91**	**5.25**	**11,235**	**1.29**	**2.00**	**5.51**	**11,320**	**1.30**	**2.02**	**5.55**

City of Killeen
SH 195 Subbasin Flows

	2006				2011				2016				2031			
Census Tract in Subbasin	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)
0230	972	0.10	0.16	0.43	1,302	0.14	0.22	0.61	1,422	0.16	0.25	0.70	1,625	0.19	0.29	0.80
0231.02	5,654	0.59	0.92	2.53	7,262	0.80	1.24	3.41	8,606	0.99	1.53	4.22	11,370	1.31	2.03	5.57
0232	0	0.00	0.00	0.00	640	0.07	0.11	0.30	960	0.11	0.17	0.47	2,190	0.25	0.39	1.07
0233	0	0.00	0.00	0.00	1,960	0.22	0.33	0.92	3,724	0.43	0.66	1.83	6,664	0.77	1.19	3.27
TOTAL	**6,626**	**0.70**	**1.08**	**2.97**	**11,164**	**1.23**	**1.90**	**5.23**	**14,712**	**1.69**	**2.62**	**7.21**	**21,849**	**2.51**	**3.89**	**10.71**

City of Killeen
Trimmier Creek Subbasin Flows

	2006				2011				2016				2031			
Census Tract in Subbasin	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)	Population	Avg Day Flow (MGD)	Peak Day Flow (MGD)	Peak Wet Weather Flow (MGD)
0224.02	10,700	1.12	1.74	4.79	12,890	1.42	2.20	6.04	15,080	1.73	2.69	7.39	16,540	1.90	2.95	8.11
0225	0	0.00	0.00	0.00	2,661	0.29	0.45	1.25	4,942	0.57	0.88	2.42	14,760	1.70	2.63	7.24
AS1	0	0.00	0.00	0.00	1,500	0.17	0.26	0.70	3,687	0.42	0.66	1.81	10,290	1.18	1.83	5.04
AS2	0	0.00	0.00	0.00	500	0.06	0.09	0.23	1,300	0.15	0.23	0.64	5,662	0.65	1.01	2.78
AS3	0	0.00	0.00	0.00	0	0.00	0.00	0.00	1,500	0.17	0.27	0.74	11,872	1.37	2.12	5.82
AS4	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00	722	0.08	0.13	0.35
AS5	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00	4,698	0.54	0.84	2.30
AS6	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00	3,307	0.38	0.59	1.62
TOTAL	**10,700**	**1.12**	**1.74**	**4.79**	**17,552**	**1.93**	**2.99**	**8.23**	**26,509**	**3.05**	**4.73**	**12.99**	**67,851**	**7.80**	**12.09**	**33.26**