Water Master Plan

City of Kyle, Texas

April 2025

CITY OF KYLE

WATER MASTER PLAN

April 2025

This Report presents the results of the study of the City of Kyle's water supply and water distribution system and presents existing conditions and recommendations based on future demand projections. This study is intended for planning purposes and does not include final design criteria and recommendations.

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1.0 Introduction

The City of Kyle (City) is located approximately 20 miles south of the City of Austin and is in the Central Texas Innovation Corridor along Interstate 35 in Hays County, in an area experiencing significant population growth. The City's population in 2022 was 57,470 and is currently close to 62,000. The City's Water Utilities provides potable water services to most of the city population, however, there are some areas of the City served by other water providers.

The City of Kyle does not operate any surface water treatment facilities but purchases the majority of its water supply as treated water from regional water providers. A smaller source of supply is from groundwater wells operated by the City.

The purpose of the Water Master Plan Report is to analyze the existing water demands of the users and water supply available, and then project the future water demands and required supply, for the next 5-years, 10-years, and ultimate build out. Population growth projections which drive future water usage are provided by the City planning group. Water supply must be increased in coordination with population growth. The water distribution system capacity must be improved in a timeline that ensures the water supply can be received, pumped, and delivered to users at adequate service flow and pressure.

2.0 Existing Water System

The City of Kyle water system consists of eight pump stations, five groundwater wells, ten ground storage tanks (GST), seven elevated storage tanks (EST), and over 218 miles of distribution system piping. The distribution system consists of three separate pressure planes and has over 17,000 service connections. Recent facility additions included in these totals in late 2024 include the Crosswinds pump station with a ground storage tank and Crosswinds elevated storage tank. The population served by the water system is currently about 55,000 and is primarily residential and light commercial usage. Parts of the city are served by other water utilities so that the number of customers of the water system are slightly below the city total population.

2.1 Hydraulic Model Update

The Kyle Water System Hydraulic Model was fully updated to match existing conditions and calibrated to ensure accuracy of model results in 2024. The Kyle hydraulic model is an all-pipes model developed utilizing InfoWater PRO software version 2024.2 from Autodesk. Data utilized to update the hydraulic model included:

1. Record drawings of ground storage tanks and elevated storage tanks
2. Pump capacities, curves, and control settings
3. Water production records for 36 months
4. Water billing records for 36 months
5. GIS layers for system piping, meters, valves, and hydrants
6. Previous hydraulic model developed by others

The hydraulic model with pressure planes identified by color and all pump stations and tanks displayed is shown in Figure 2-1.

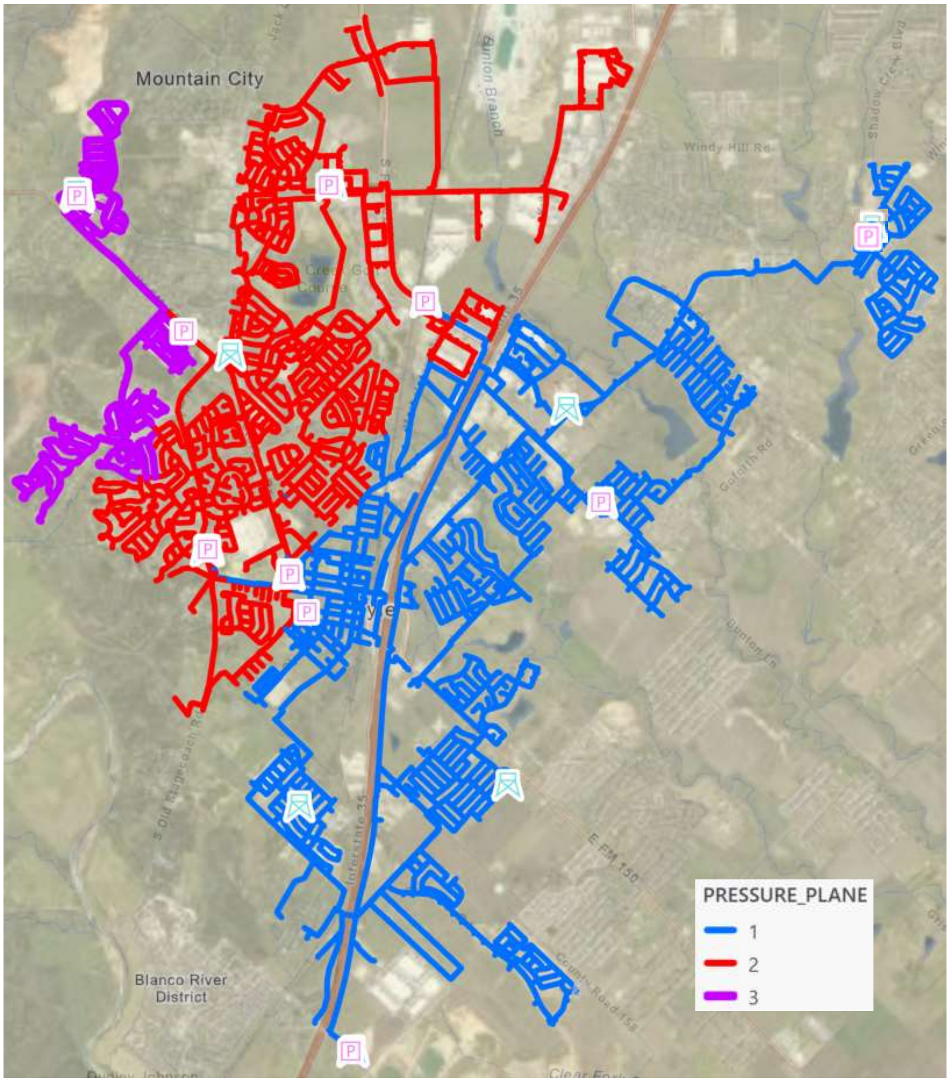


Figure 2-1 Kyle Hydraulic Model

Data utilized to calibrate the hydraulic model included SCADA data for all pump operations and water levels in ground storage and elevated storage tanks. Field pressure data was collected from installed data loggers during the calibration period in July and August 2024. Twenty-eight locations were selected for the data loggers, spread evenly across the three pressure planes. The friction coefficients of system piping and other parameters are adjusted during the calibration process until the model pressure results match the field collected data. The agreement between the actual system field data and the hydraulic model results should generally be within 5%. The results of the Kyle Model calibration were well within the 5% target.

2.2 Existing System Evaluation

The calibrated model was utilized to evaluate the overall performance of the Kyle distribution system under varied conditions to include maximum day demands and peak hour demands. The initial evaluations included:

1. Review of pipe diameters and available capacity
2. Maximum flow velocities experienced in system piping
3. Minimum system pressures during maximum day demand and peak hour demand
4. Available fire flows for fire hydrants throughout the system
5. Water age expected in each pressure plane

Findings and recommendations following the existing system evaluation include a boundary change between pressure plane 1 (PP1) and 2 (PP2) and new transmission lines to relieve a bottleneck in PP1.

2.2.1 Pressure Plane Boundary Change

A pressure plane boundary change is recommended between PP1 and PP2 in the downtown area of Kyle. This area is known for some of the lowest operating pressures within the system. The model indicates that in worst case scenarios with peak hour demands, the pressure in some parts of downtown could drop below 35 psi, which is the minimum acceptable water pressure as required by TCEQ. Additionally, the fire flow available to some fire hydrants in the downtown area can be below the 1,500-gpm recommended minimum. Modifications to the system piping and boundary valves is recommended to change this area from operating in PP1 to being part of PP2. Minimum system pressures will be significantly improved as well as the available fire flow capacity. The area of potential low pressure is shown in Figure 2-2.

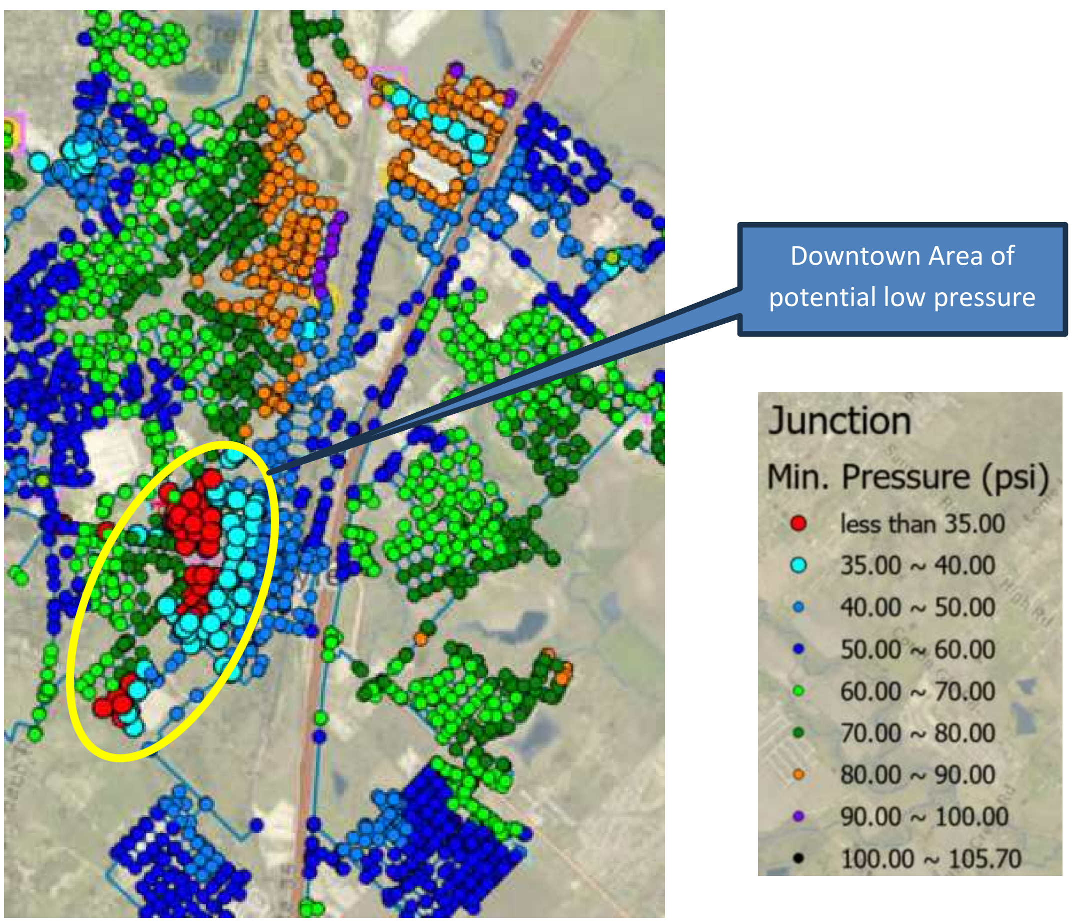


Figure 2-2 Area Identified for Pressure Plane Boundary Change

2.2.2 Elimination of Bottleneck

Elimination of a bottleneck identified in pressure plane 1 is recommended. Dacy Lane EST is in the northern part of PP1 and Post Oak EST is in the southern part of PP1. With maximum demands or near-term future demands slightly above existing, the performance of Dacy EST may become problematic due to restrictions of flow between the northern and southern parts of PP1. Modeling predicts that the water level in Dacy EST will fall below the low level and the EST cannot be refilled timely even when the Post Oak EST is near full. The flow of water between the north and south is restricted by a single 12" line and single 8" line which creates a bottleneck when demands are high. Sufficient water cannot be supplied to Dacy EST when needed without some pipeline capacity improvements. New transmission lines between Post Oak EST, Lehman PS, and Dacy EST were recommended, and improvement projects have begun in 2025. The locations of Dacy and Post Oak ESTs and the location of the bottleneck are shown in Figure 2-3.

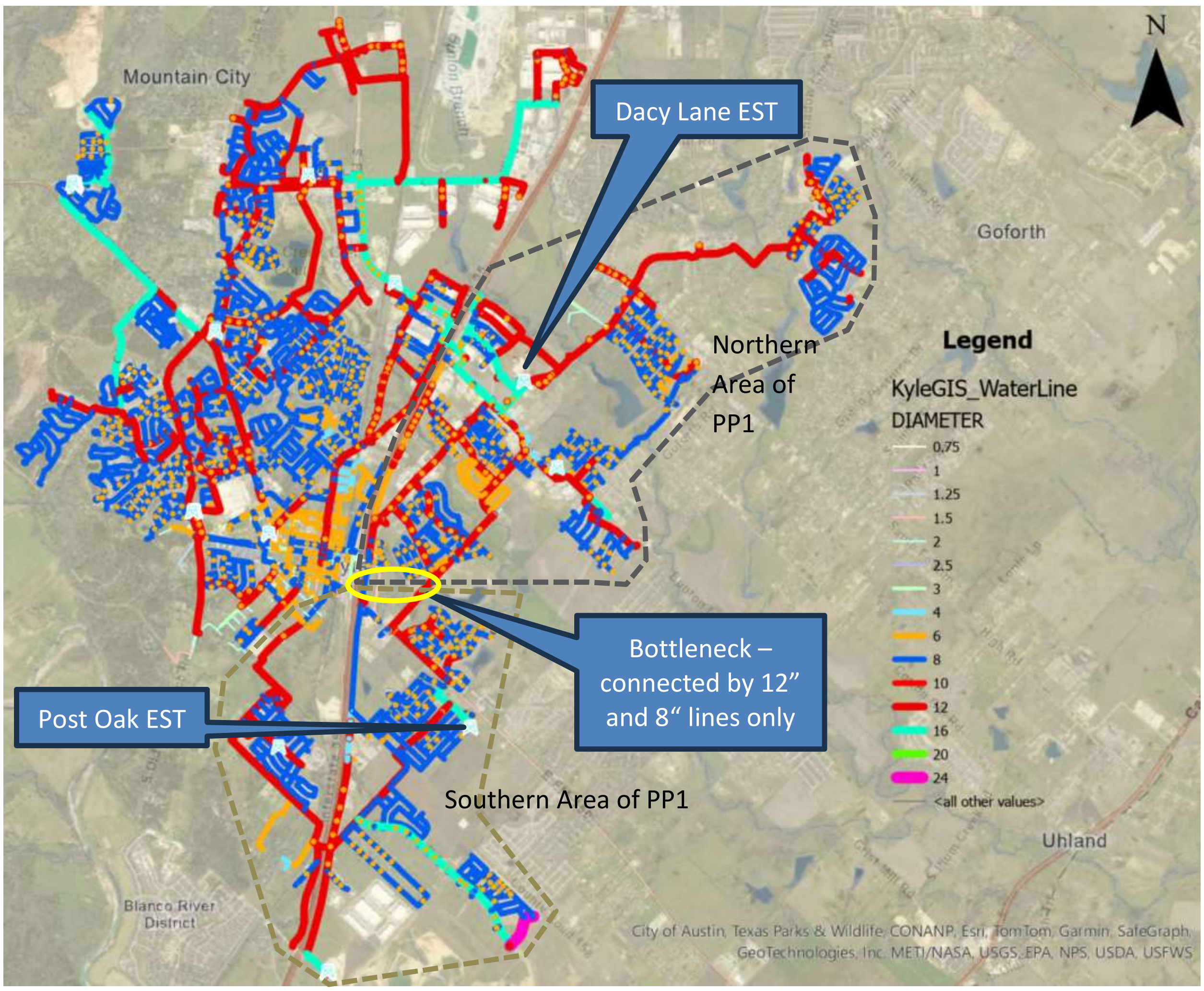


Figure 2-3 Bottleneck Identified in Pressure Plane 1

Other findings and recommendations for the water system are detailed in the Existing Water System Technical Memorandum. The full Existing Water System Technical Memorandum is attached to this Master Plan as Appendix C.

3.0 Demand Projections

Population data, development planning, and intended land use are important elements in planning or expanding a water system. Water demands are driven by residential and commercial development that the City serves, and the timing, location and quantity of water needed plays a big part in determining the size and location of water system infrastructure. The demand projections will be used to develop future water model scenarios, which will be the basis for developing the recommended projects in the Capital Improvement Plan (CIP). This section provides a summary of demand projections developed based on data provided by the City.

3.1 Water Service Area

The City provided a GIS shapefile of the City's current Water Certificate of Convenience and Necessity (CCN). A Water CCN grants a retail public utility the exclusive right to provide retail water utility services within a specified geographic area. The City's Water CCN boundary differs from the City limits, and there are other water providers within the City Limits and Extra-territorial Jurisdiction (ETJ). The figures in Appendix A shows the extents of the water service area, the City limits and ETJ.

3.2 Historical Water Service Area Population and Water Production

3.2.1 Water Service Area Population

The City provided the total number of water service connections from 2018 to 2023. The City recommended using 3.0 people per connection for water service area population projections. As noted in the previous section, the calculated population of the water service area is not equivalent to the City population due to differing boundaries for City Limits, ETJ, and water service CCN area. Table 3-1 - Historical Water Connections and Service Population Estimates shows the historical connection count by year for water service, equivalent water service population, and growth rate.

Table 3-1 - Historical Water Connections and Service Population Estimates

Year	Connections	Water Service Population	% Growth
2018	11,945	35,835	-
2019	12,253	36,759	2.5%
2020	12,782	38,346	4.1%
2021	14,023	42,069	8.8%
2022	14,701	44,103	4.6%
2023	16,600	49,800	11.4%
Average			**6.3%**
Maximum			**11.4%**

The City provided a historical usage estimate of 90 gallons per capita per day (gpcd). A typical connection is assumed to be a living unit equivalent, or LUE, which at 3 people per LUE results in an estimated 270 gallons per day per LUE. Based on a total of 16,600 connections, this results in a calculated total water production estimate of 1,635.9 Million Gallons (MG) in 2023. This is an equivalent to an average demand of 4.5 million gallons per day (MGD).

3.2.2 Water Production

The City provided total water production data from 2018 to 2023, which is the total water produced to serve the above connections. Table 3-2 shows the total production, growth rate, average day demand (ADD), and maximum day demand (MDD). The maximum day demand represents the highest day of water production in the year.

Table 3-2 - Total Water Production

Year	Total Production (MG)	% Increase	Average Day Demand (MGD)	Maximum Day Demand (MGD)
2018	1,064.8	-	2.92	5.40
2019	1,142.4	6.8%	3.13	5.27
2020	1,240.1	7.9%	3.40	5.34
2021	1,308.8	5.2%	3.59	5.88
2022	1,495.2	12.5%	4.10	6.39
2023	1,506.7	0.8%	4.13	6.90
Average		**6.6%**		
Maximum		**12.5%**		

The annual increase in total production is impacted by additional connections, temperature and precipitation patterns, and whether or not water restrictions are in place. Actual demand per capita varies from year to year based on these factors.

3.3 Growth Projections

3.3.1 Projection Methodology

Through a collaborative process with the City, growth projections for the 5-year (2029), 10-year (2034), and ultimate buildout were developed for planning purposes. These growth projections are then used to determine future water demand projections. In coordination with the City's Planning Department and Water Utilities Department, the following process was developed for advancing the development projections:

1. Establish existing development areas within the water service area for current demand conditions to establish existing water demands.
2. Establish known developments over the next 10-15 years through coordination with Planning Department, including location and annual growth rate per development to determine the future water demand within the City Water Service Area from 2024 to 2038. Current and future land use GIS data was provided by the City. Additionally, the number of development units planned for this period was supplied by the City Planning and Development department. Using

the land use type of these developments, LUEs (Living Unit Equivalents) per unit were assigned to each land use type.

3. Establish growth rate for remaining ultimate buildout areas. The areas outside of existing development areas and known developments after 2038 encompass the ultimate buildout areas. For these remaining areas within the City's Water Service Area, the future land use as identified in the Comprehensive Plan was utilized along with estimated annual growth rates. Beyond 2038, the growth rate was assumed to reduce to between 2 – 3% as the City reaches ultimate buildout.

For the known developments identified in Step 2 noted above for the years 2024 - 2038, the City provided the total number of units per year for each known development in the City's Water Service Area. Since the water demand estimates are based on LUEs, the units provided were converted to LUEs. The City does not have specific criteria for converting units to LUEs, however the City of Austin Living Unit Equivalent (LUE) Guidance Document provides guidance on LUE conversions that was used for estimates. The conversion table for proposed residential use is shown below in Table 3-3.

Table 3-3 - Land Use Type

Land Use Type	LUE/unit
Single Family Residence; Modular Home; Mobile Home	1
Condo or Apartment Unit (24+ Units/Acre)	0.5
Duplex	2
Hotel or Motel Room	0.5

Beyond the timeline of known developments identified, the remaining undeveloped areas were estimated utilizing the City's Future Land Use layer in GIS, which is based on the Comprehensive Plan. Land Use types identified include Industrial Warehouse, Regional Commercial, Rural Estate, Traditional Neighborhood, and Urban Mixed Use. Estimates of LUEs per acre for these land use types were applied to the remaining undeveloped areas to generate a total number of LUEs at buildout within the City's Water Service Area. LUE estimates for the remaining development at buildout are calculated in Table 3-4.

Table 3-4 - Additional Development at Buildout (Years 2039 – Buildout)

Land Use	Estimated LUE/Acre	Total Acres	LUEs
Industrial Warehouse	4	624	2,496
Regional Commercial	5	630	3,150
Rural Estate	3	213	639
Traditional Neighborhood	4	1,571	6,284
Urban Mixed Use	15	169	2,535

Development from 2039 to buildout results in 15,104 additional LUEs over this time period.

3.3.2 Growth Rate

The yearly average daily water demand growth rate from 2025 to 2038 was developed based on the anticipated development data by year provided by the City and is presented in Table 3-5 below. The growth rate during this period is based on known developments and living unit equivalents provided by the City's Planning Group. The growth rate during this period tapers from 9.0% to 8.0%. From 2038 to buildout, the annual growth rate eases further to 3.0% then 2.0%. The below noted growth rates result in full buildout within the water CCN in 2048.

Table 3-5 - Water Service Area Growth Rate

Years	Annual % Growth	Basis
2024 - 2028	9.00%	Known Developments
2029 - 2033	8.25%	Known Developments
2034 - 2038	8.00%	Known Developments
2039 - 2043	3.00%	Land Use from 2030 Comprehensive Plan
2044 - 2048	2.00%	Land Use from 2030 Comprehensive Plan

3.3.3 Demand Projections

The Average Day Demand (ADD) is the total volume of water delivered to the system divided by 365 days. The average use in a single day is expressed in gallons per day (gpd) or million gallons per day (MGD). The Maximum Day Demand (MDD) is the maximum daily water use which would occur during a calendar year. Based on historical demand data provided for years 2021 through 2023, the MDD is estimated to be 1.69 times the ADD.

Table 3-6**Error! Reference source not found.** below shows the resulting additional average day water demand and maximum day demand per year based on the above methodology.

Table 3-6 – Water Demand Projections

Year	Total LUE	Added LUEs	Average Day Demand (MGD)	Maximum Day Demand (MGD)
2024	18,484		4.99	8.43
2025	20,148	1,664	5.44	9.19
2026	21,961	1,813	5.93	10.02
2027	23,937	1,976	6.46	10.92
2028	26,092	2,154	7.04	11.91
2029 - 2033	38,783	12,691	10.47	17.70
2034 - 2038	56,985	18,202	15.39	26.00
2039 - 2043	66,061	9,076	17.84	30.14
2044 - 2048	72,126	6,065	19.47	32.91

The above projections are based on historical usage. Recently, there has been an increased focus on development ordinances which promote water conservation and the reduction of water usage for irrigation purposes, which is a significant portion of overall water usage. There are several methods and strategies that can be implemented to promote further water conservation. Following the completion of the Water Master Plan, the City's Water Conservation Plan and Drought Contingency Plan will be updated. The City is currently under water restrictions which are estimated to have reduced water usage in 2024 to approximately 20% for average day demand, and nearly 30% of estimated maximum day demand. Based on this reduction, the future demand projection graphs identify an average day demand with 20% conservation and maximum day demand with 30% conservation to represent a spectrum of demand reduction achieved through conservation measures. During the development of the water conservation plan, specific goals will be set and strategies to achieve these goals will be implemented. The below figures show the average day demand projections and the maximum day demand projections with and without the conservation noted above.

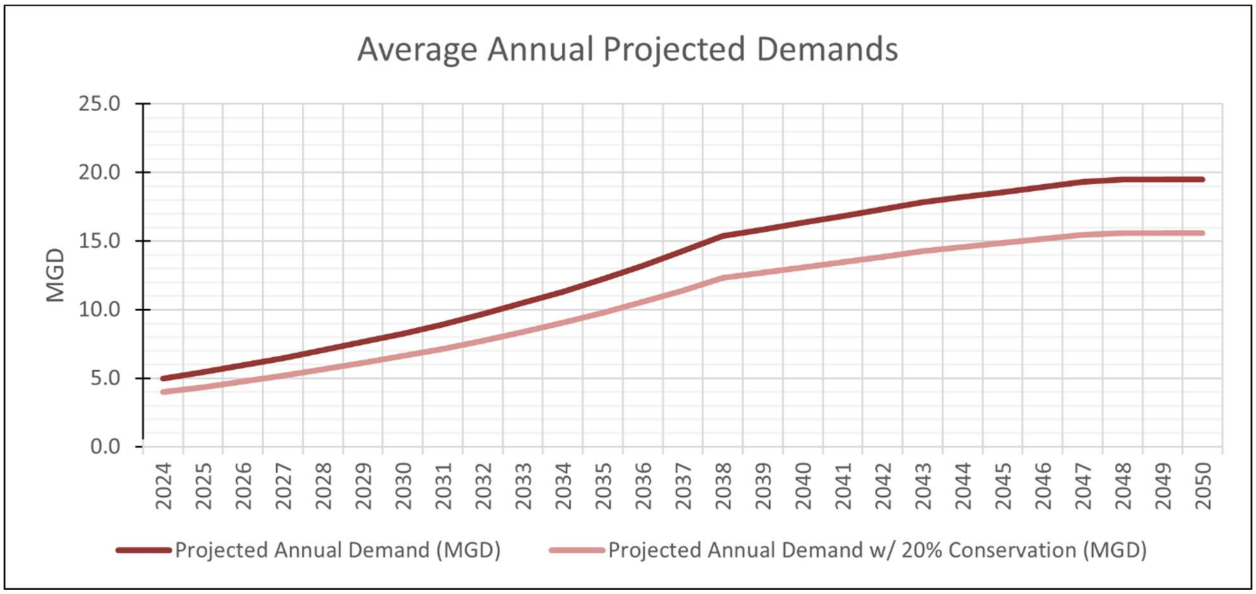


Figure 3-1 Average Day Demand – Annual Projection (MGD)

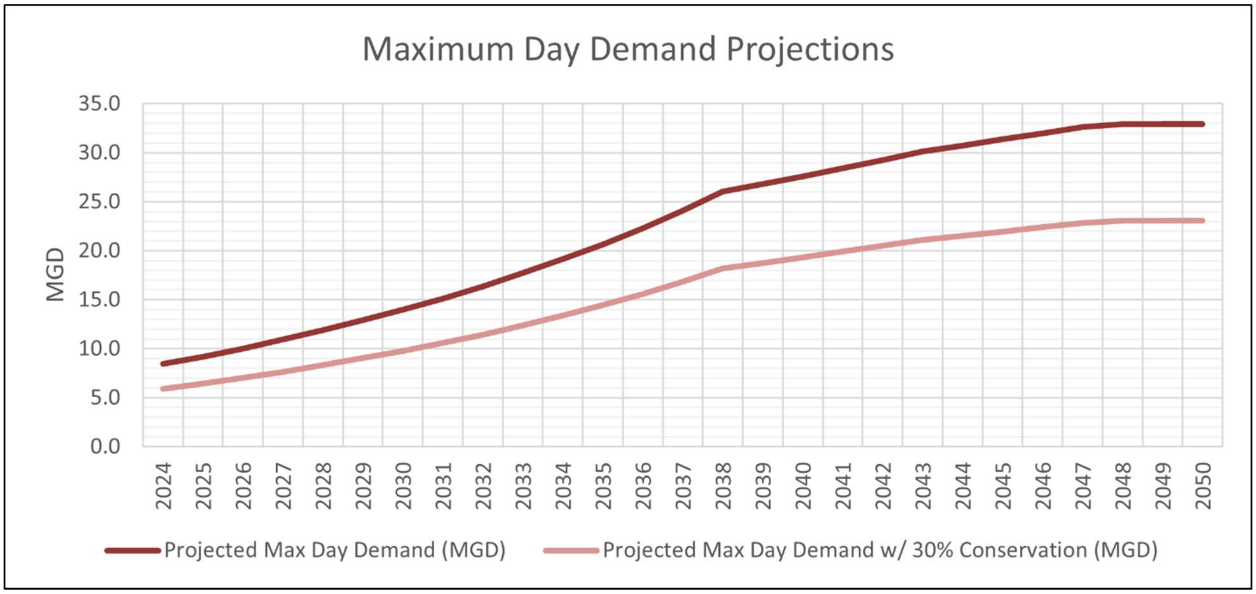


Figure 3-2 Maximum Day Demand Projections (MGD)

4.0 Future Water System Modeling

Future scenarios were added to the updated and calibrated model for time periods of 5-years, 15-years, and ultimate build out of the system. The purpose of the future scenarios is to determine what system capacity improvements will be required as the population and water demands increase in the coming years. Pipeline improvements, pump capacity requirements, and EST improvements and performance can be planned so that system capacity will be adequate to provide the anticipated growth in water usage.

4.1 System Growth

Population growth is projected in 36 developments over the next 15 years which will expand the water system throughout the City of Kyle CCN. The planned developments are shown as colored areas in Figure 4-1. The hydraulic model scenarios with piping and water demands added for the 5-year and 15-year periods are shown in Figure 4-2 and Figure 4-3 respectively.

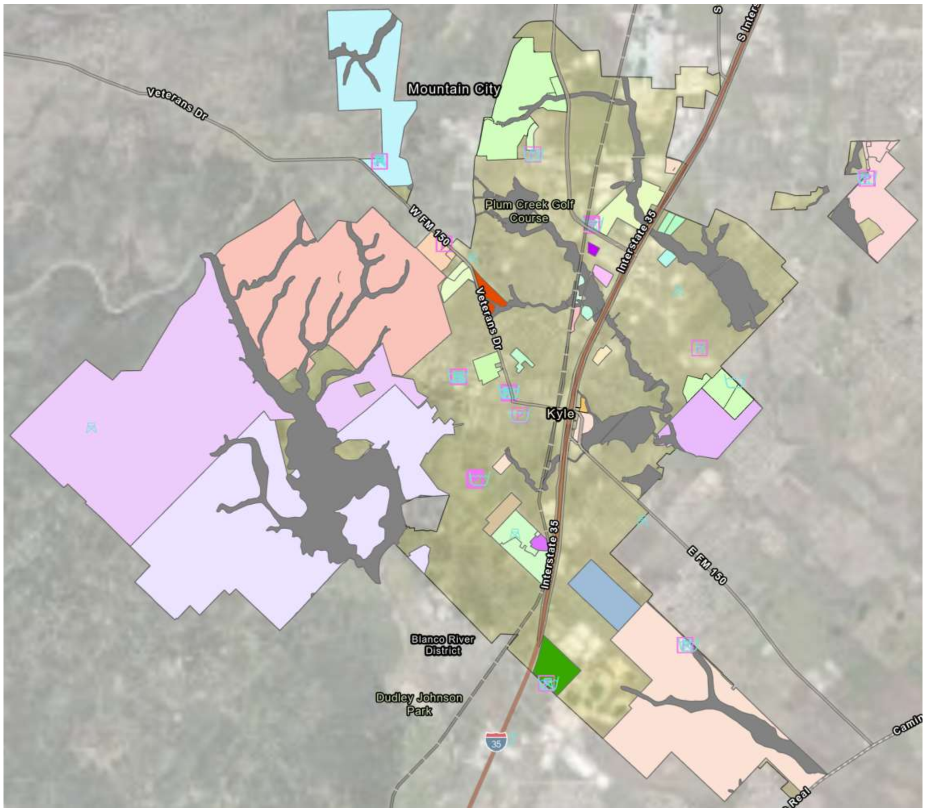


Figure 4-1 Developments with Projected Growth

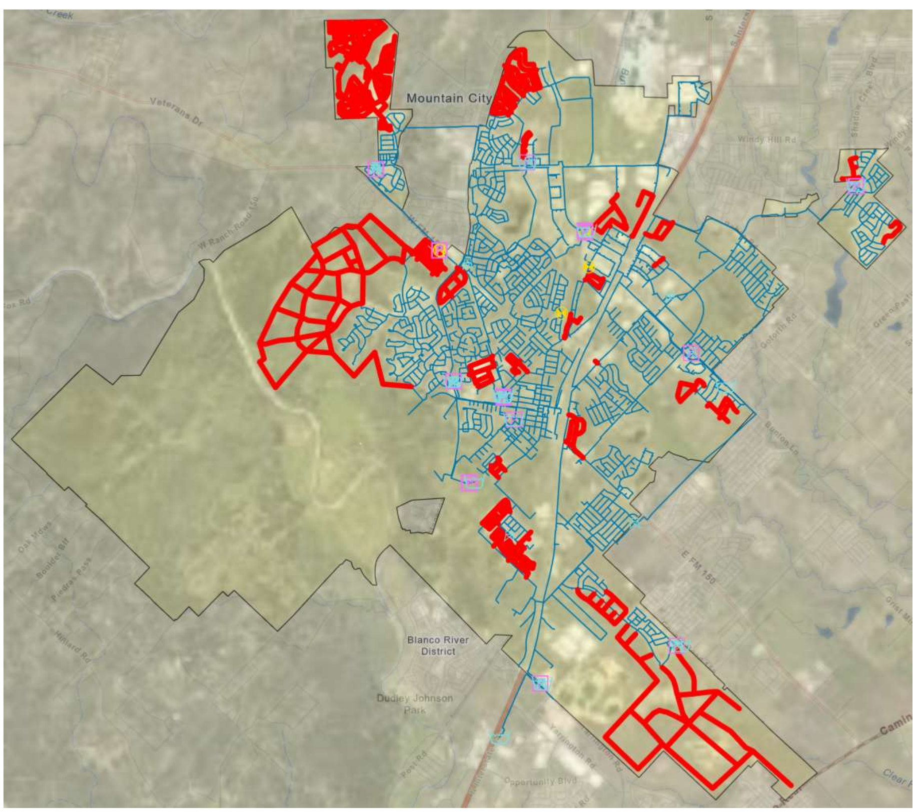


Figure 4-2 Distribution System at 5-year Growth

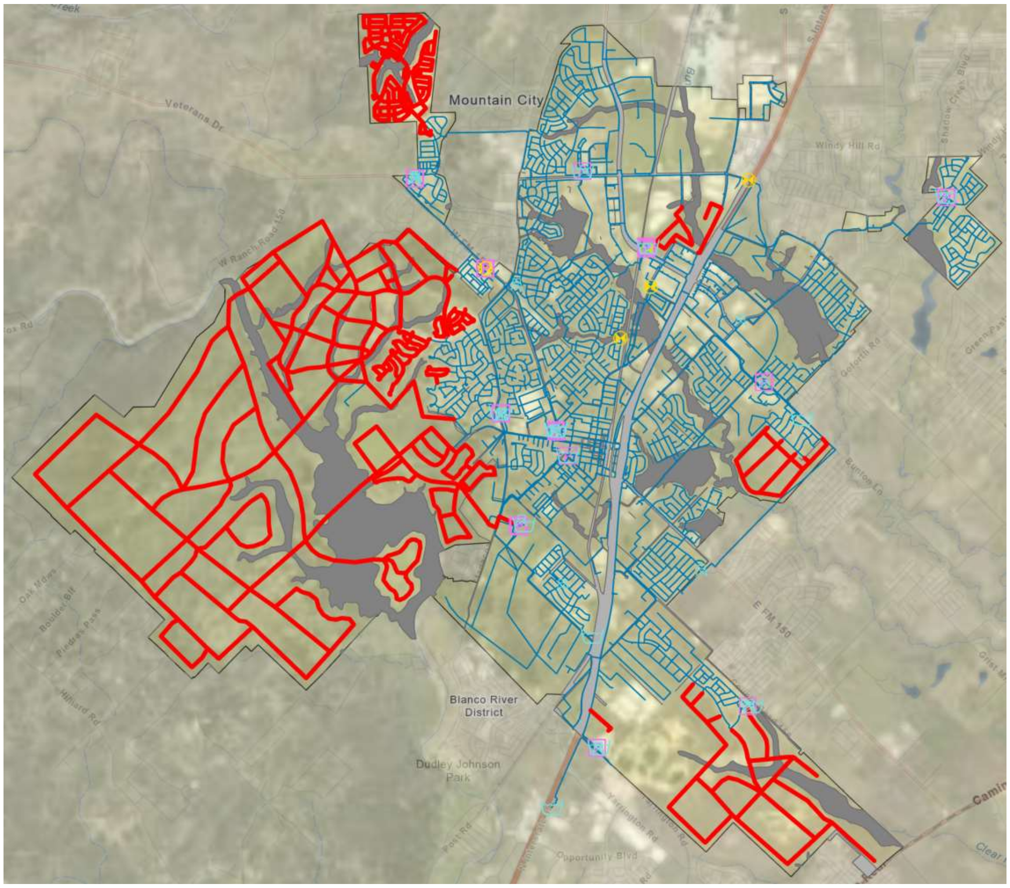


Figure 4-3 Distribution System at 15-year Growth

The 36 developments previously shown in Figure 4-1 are expected to be fully built out within the 15-year timeframe. Other areas within the CCN would remain undeveloped at that point and are planned for development from 2038 to ultimate build out. The areas for development after 2038 are shown with color coding by zoning in Figure 4-4.

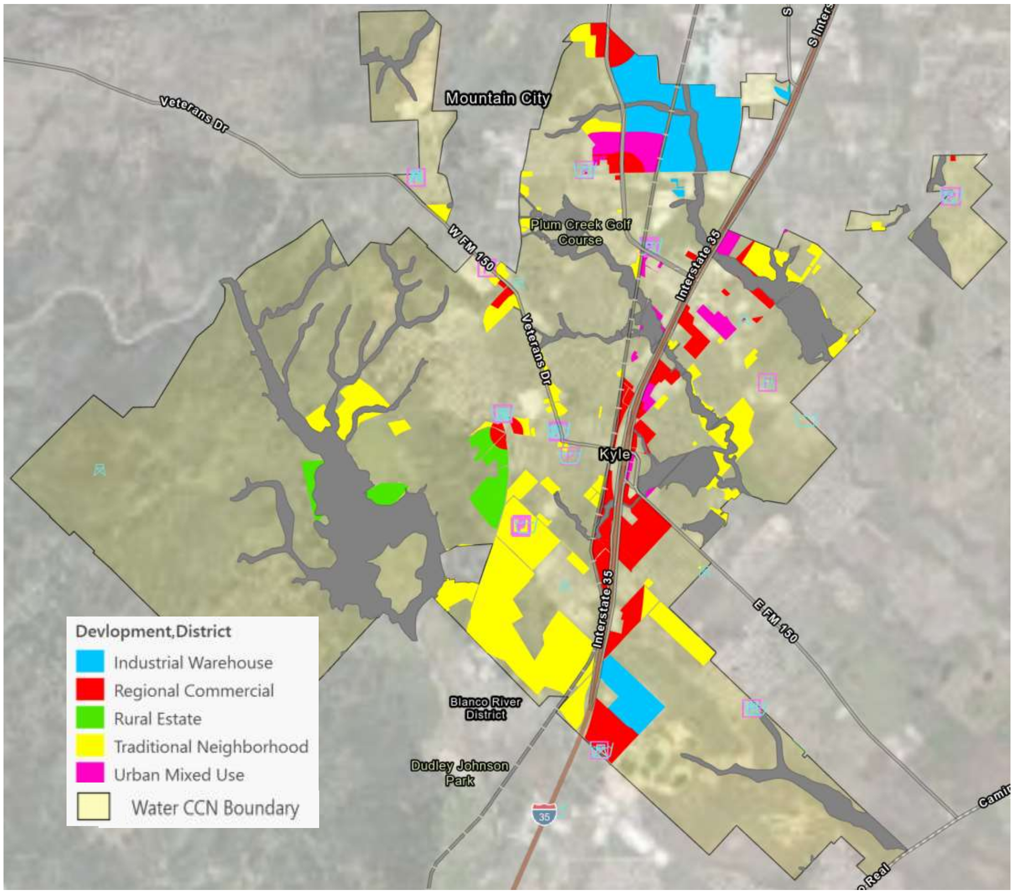


Figure 4-4 Areas with Projected Growth After 2038

4.2 Recommended System Improvements

System improvements identified for the 5-year period include 12 Capital Improvement Projects. These 12 system improvements with start and completion dates are shown in Table 4-1.

Table 4-1 System Improvements for 5-year Timeframe

CIP 2025 - 2029	Start / Status	Completion
1. Waterstone Pump Station	In Construction, 2025	2025
2. Waterstone EST	In Construction, 2025	2026
3. Hoover EST	In Construction, 2025	2025
4. Lehman to Post Oak Transmission Line	In Design 2025	2028
5. Dacy and Seton Extensions	In Design 2025	2028
6. Lehman PS Improvements	In Design 2025	2028
7. 1626 to Veteran’s Road Transmission Line	2025	2028
8. Waterstone to Post Oak Transmission Line	2025 (2026)	2028 (2029)
9. Pressure Plane Boundary Modification	2026	2029
10. Lehman Road Extension	2028	2032
11. ARWA 3 PS North Transmission Line	2027	2032
12. ARWA 3 Pump Station (plus 30” supply line)	2027	2032

The location of the system improvements required in the 5-year timeframe are shown on the system map in Figure 4-5.

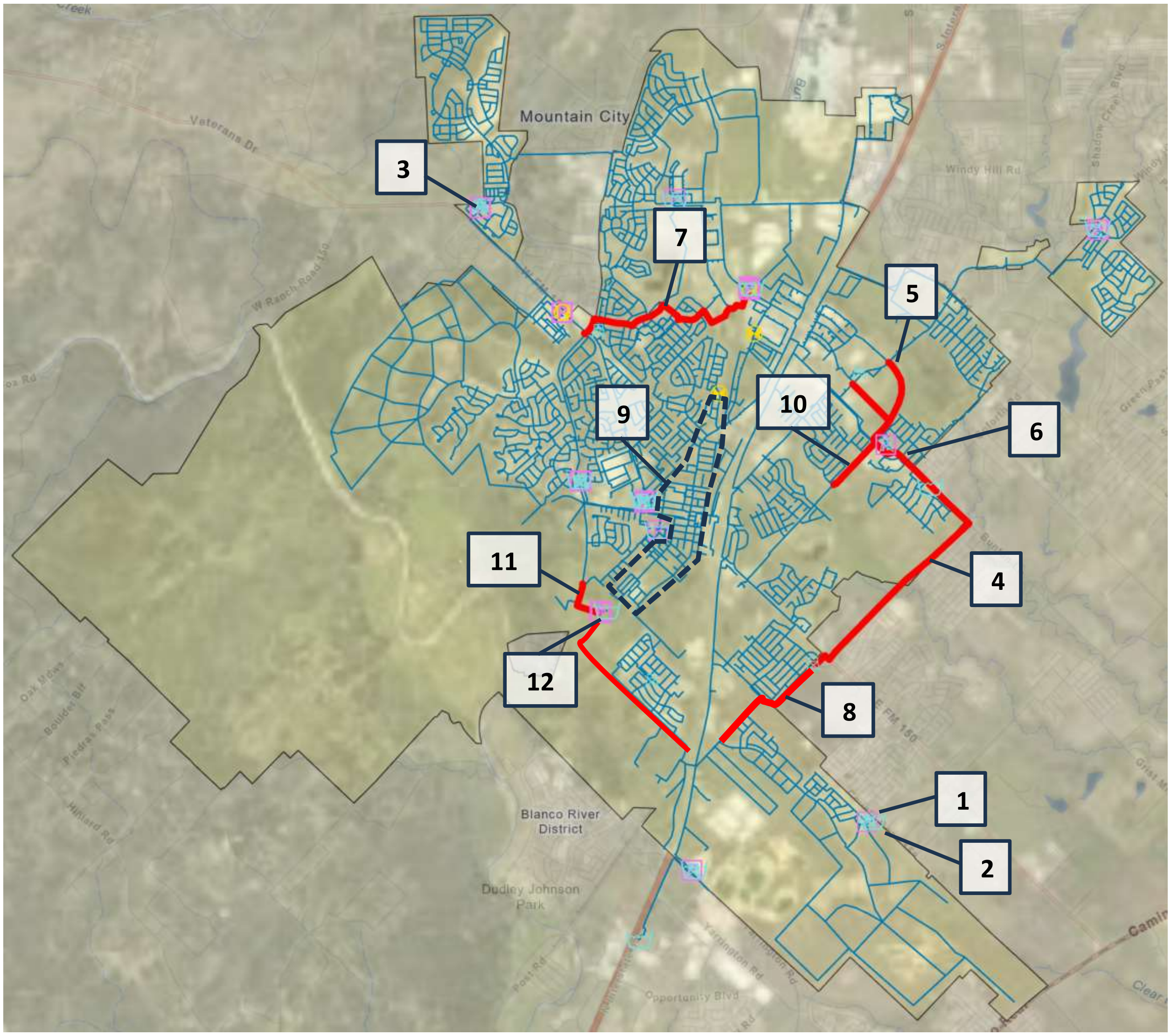


Figure 4-5 System Improvements for 5-year Timeframe

Additional detail for CIP 9, the pressure plane modification, includes new piping and connections to establish the new boundary between PP1 and PP2. The new piping required is shown in Figure 4-6.

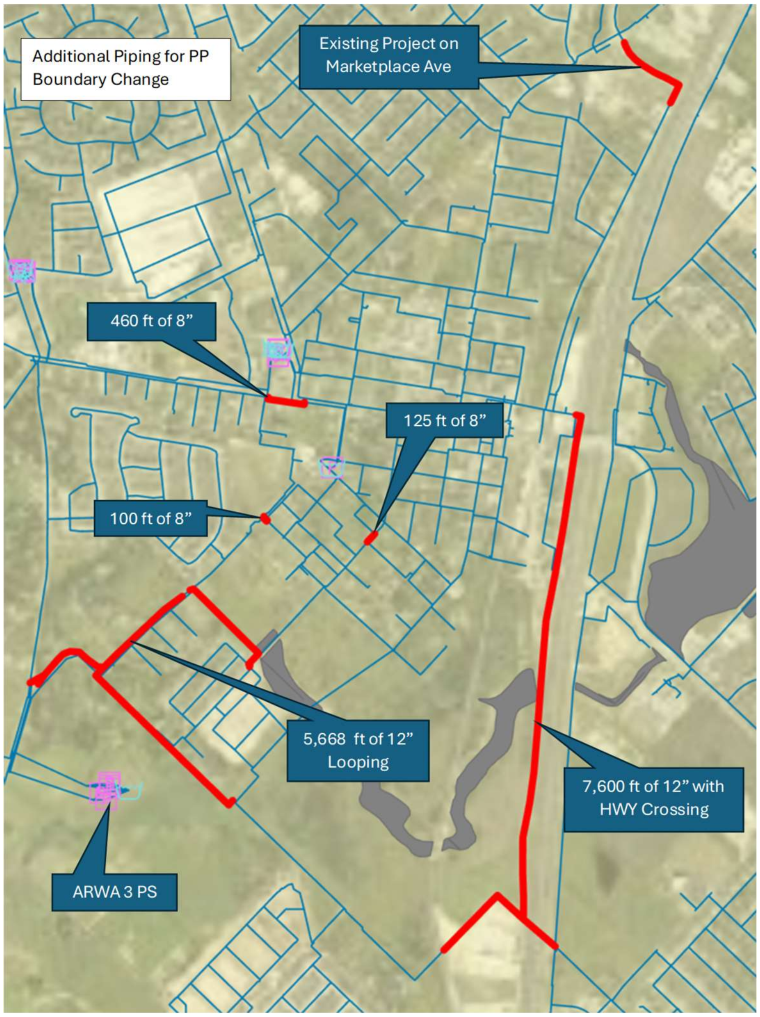


Figure 4-6 Improvements Detail for Pressure Plane Modification

System improvements identified for the 15-year period include 4 Capital Improvement Projects. These 4 system improvements with start and completion dates are shown in Table 4-2.

Table 4-2 System Improvements for 15-year Timeframe

CIP 2028 - 2039	Start / Status	Completion
13. Nance Tract Transmission Line	2030	2038
14. Old Stagecoach Road Improvements	2028 (timing may be coordinated with road improvements)	2038
15. Nance Tract EST	2030 – 2035	2038
16. Pressure Plane 4 pump station and EST	2034 (Depends on buildout on western edge)	2038

The location of the system improvements required in the 15-year timeframe are shown on the following system maps, Figure 4-7 to Figure 4-9.

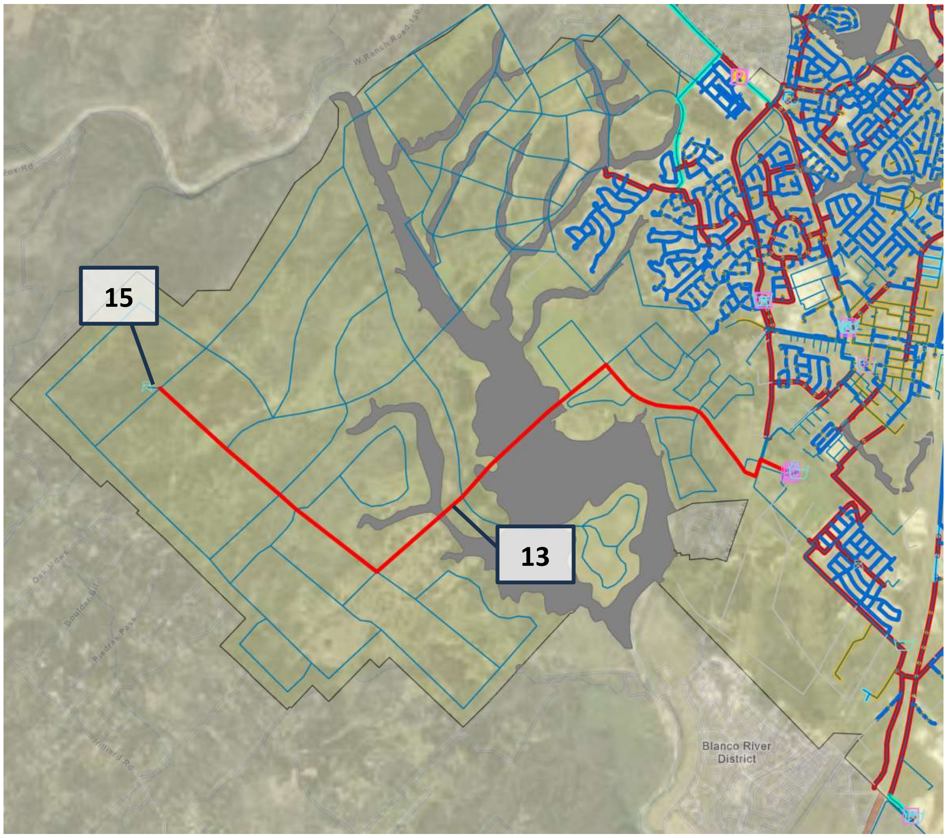


Figure 4-7 Nance Tract Transmission Line and EST

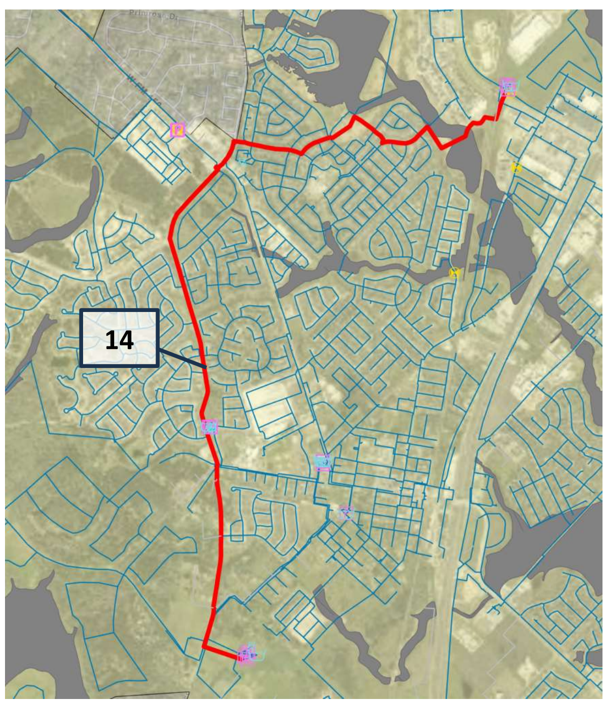


Figure 4-8 Old Stagecoach Road Improvements

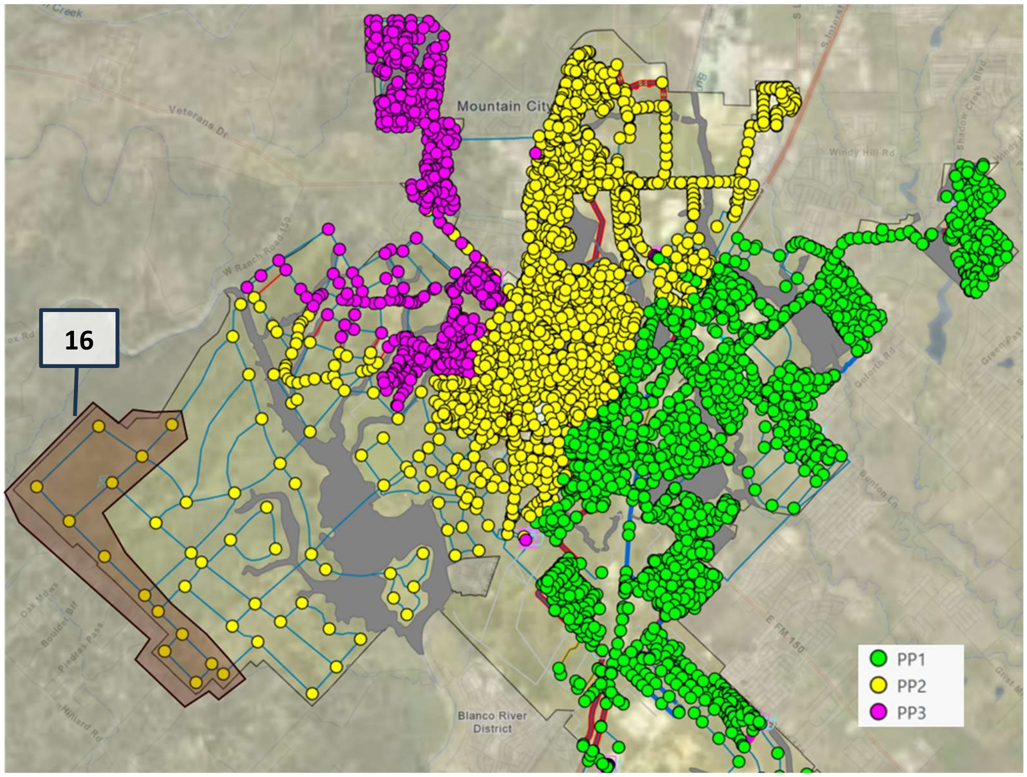


Figure 4-9 Pressure Plane 4

A summary of all the pipe improvements recommended for the 5-year and 15-year periods are shown as the yellow highlighted alignments in Figure 4-10.

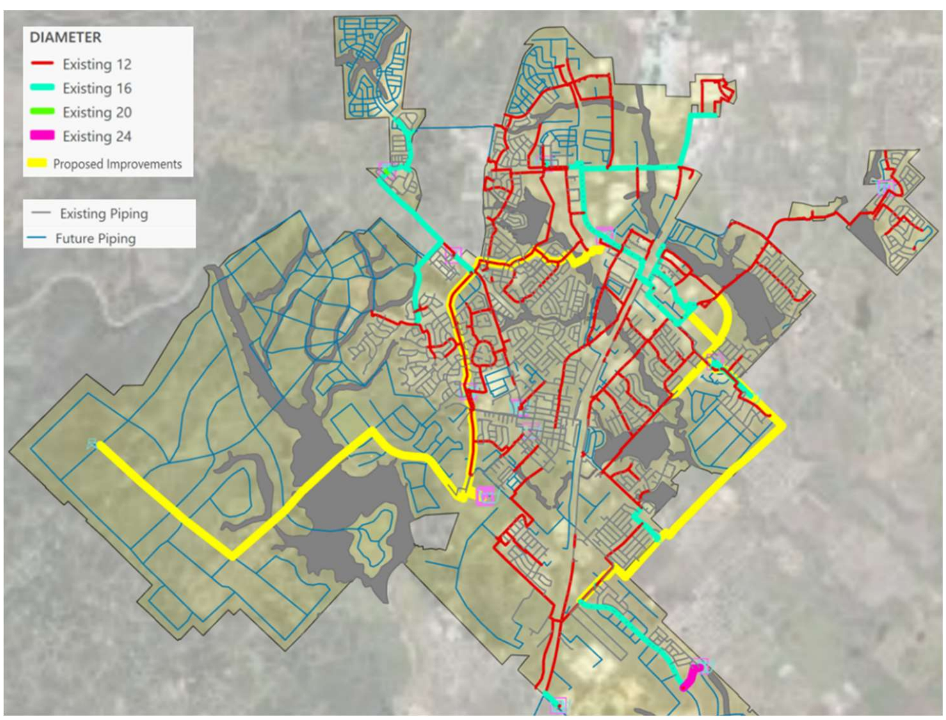


Figure 4-10 Summary of System Piping Improvements

5.0 Existing and Planned Water Supplies

5.1 Water Supplies

The City's existing water supply consists of groundwater and surface water resources. Five groundwater wells supply water to the City as well as treated surface water received from GBRA.

5.1.1 Edwards Aquifer Wells

Four wells (Well 1, Well 2, Well 3, and Well 5) supply groundwater from the Edwards Aquifer. Wells in the Edwards Aquifer are managed by the Edwards Aquifer Authority (EAA), which was created by the Texas Legislature in 1993, to protect the aquifer. The EAA implements a Critical Period Management (CPM) Plan requiring temporary reductions of authorized withdrawal amounts during times of drought. There are five stages of reduced pumping requirements, triggered by declining aquifer levels or spring flow discharge rates calculated in 10-day averages. The City of Kyle is in the San Antonio Pool, Table 5-1 below outlines the pumping permit reductions for the San Antonio pool.

Table 5-1 - Edward Aquifer Authority Critical Period Management Plan – San Antonio Pool

Withdrawal Reductions During Drought				
Critical Period Stage	J-17 Index Well Level (above mean seal level)	San Marcos Springs Flow (cubic feet per second (cfs))	Comal Springs Flow (cfs)	Percent of Water Reduction
No Stage	660 feet or above	96 or above	225 or above	0%
Stage 1	Less than 660 feet	Less than 96	Less than 225	20%
Stage 2	Less than 650 feet	Less than 80	Less than 200	30%
Stage 3	Less than 640 feet	Not Applicable	Less than 150	35%
Stage 4	Less than 630 feet	Not Applicable	Less than 100	40%
Stage 5	Less than 625 feet	Not Applicable	Less than 45/40*	44%

*To enter stage, reading must be less than 45 cfs for a ten-day rolling average, or less than 40 cfs based on a three-day rolling average. To leave stage, the ten-day rolling average must be 45 cfs or greater.

The City has a permit issued in 2009 from the Edwards Aquifer Authority for withdrawal of 432.072 acre-feet per year from the Edwards Aquifer. Historical required reductions between 2009 and 2024 are displayed in Table 5-2. Over this period, the minimum, maximum, and average reductions were 0.00%, 36.64%, and 18.63%, respectively.

Table 5-2 - Historic EEA CPM Plan Reduction

San Antonio Pool Historic Reduction Data	
Year	Percent Reduction
2009	11.80%
2010	NO DATA
2011	19.20%
2012	22.40%
2013	28.90%

Year	Percent Reduction
2014	35.00%
2015	19.70%
2016	NO DATA
2017	3.40%
2018	8.70%
2019	0.00%
2020	6.25%
2021	5.71%
2022	26.68%
2023	36.64%
2024	36.40%

This permit is based on a maximum supply per calendar year. Amounts utilized from these wells can vary by day as long as the total per year is not exceeded.

5.1.2 Barton Springs Well

Groundwater Well 4 that supplies the City is permitted by the Barton Springs Edwards Aquifer Conservation District (BSEACD). BSEACD was created by the Texas Legislature in 1987 to protect groundwater resources in its jurisdiction. BSEACD requires permit holders to implement mandatory pumpage reductions during times of drought. The City holds a Conditional Class B Permit. The permit, issued in 2019, allows for Historical Permitted Pumpage of 506.7 acre-feet per year (165,000,000 gallons/year) and Conditional B Permitted Pumpage of 568.12 acre-feet per year (185,000,000 gallons/year).

Reduction volumes required by the Class B and Historic permit are summarized in Table 5-3 below:

Table 5-3 - BSEACD Conditional Class B and Historic Reduction Volumes

Pumpage Volume Targets During Drought						
	No Drought (Baseline)	Stage 1: Water Conservation Period	Stage 2: Alarm	Stage 3: Critical	Stage 4: Exceptional	Emergency Response Period
	(None)	(Voluntary)	(Mandatory)	(Mandatory)	(Mandatory)	(Mandatory)
Historic	0% Reduction	10% Reduction	20% Reduction	30% Reduction	40% Reduction	50% Reduction
Conditional Class B	0% Reduction	10% Reduction	50% Reduction	75% Reduction	100% Reduction	100% Reduction

The BSEACD permit includes a monthly maximum pumpage, based on a percentage of the annual total included in the permit. The monthly limit is subject to the same drought reductions noted in Table 5-3 above.

5.1.3 GBRA Surface Water

The City has a water supply agreement with Guadalupe-Blanco River Authority (GBRA) that was originally executed in 1998 to receive 5,443 acre-feet per year of treated water from the San Marcos Water Treatment Plant. The water enters the distribution system at Lehman, Yarrington, and Crosswinds Pump Stations.

GBRA's Drought Contingency Plan for Wholesale Water Providers was updated in May 2024 and includes Stage 1 – Stage 6 water shortage conditions, which are summarized in Table 5-4 below. Stage 1 through Stage 3 set voluntary reduction goals based on the water storage level of Canyon Reservoir. Stage 4 and 5 allow for implementation of a pro rata water allocation of up to 30% in Stage 5 based on the water storage level of Canyon Reservoir. Stage 6 represents emergency water shortage conditions caused by (i) mechanical or system failures, (ii) natural or man-made contamination water supply source(s), or (iii) GBRA determines water levels are reduced that could lead to loss of service within 180 days or less.

Table 5-4 – GBRA Drought Response Stages – Canyon Reservoir

GBRA Drought Response Stages			
Stage	**Canyon Reservoir Trigger**	**Percent of Water Reduction**	**Rescinded When**
Stage 1 (Voluntary)	Less than elevation 895 feet (72.6% full)	5% (voluntary)	Elevation greater than 895 feet for 30 days
Stage 2 (Voluntary)	Less than elevation 890 feet (64% full)	10% (voluntary)	Elevation greater than 890 feet for 30 days
Stage 3 (Voluntary)	Less than elevation 885 feet (56% full)	15% (voluntary)	Elevation greater than 885 feet for 30 days
Stage 4 (Pro-Rata)	Less than elevation 880 feet (49% full)	15% (pre-rata)	Elevation greater than 880 feet for 30 days
Stage 5 (Pro-Rata)	Less than elevation 865 feet (31% full)	30% (Pro-Rata)	Elevation greater than 865 feet for 30 days
Stage 6 (Pro-Rata)	Emergency Water Shortage	Situationally Determined	Triggering Conditions Cease to Exist

The GBRA permit is based on a consistent per-day supply quantity.

5.1.4 City of San Marcos Water Supply Interconnect

The City has an agreement with the City of San Marcos that was executed in 2009 for the sale of treated water for water supply in a time of need. The contract allows for delivery of up to 560 acre-feet per year with a maximum daily quantity of 500,000 gallons. The interconnect is located at Yarrington Pump Station. For the purposes of planning, this contract is not included as a permanent daily supply amount, but the quantity is included in a maximum month and maximum day demand scenario.

5.1.5 City of San Marcos Edwards Aquifer Alliance Agreement

The City of Kyle has a water-sharing agreement with the City of San Marcos to utilize up to 500 acre-feet per year of San Marcos' EAA permitted supply through 2026, at which time the agreement will expire. This supply is subject to the same EAA reductions identified in paragraph 5.1.1.

5.2 Planned Water Supply

In addition to the active water supplies identified in Section 5.1, the City is currently participating in projects and agreements that are advancing but are not yet online. Below is a summary of current planned water supplies.

5.2.1 Alliance Regional Water Authority (ARWA)

The City of Kyle is a sponsor and a participating customer of the Alliance Regional Water Authority (ARWA), a regional water partnership comprised of the cities of San Marcos, Kyle and Buda, and the Canyon Regional Water Authority. This project conveys treated water from the Carrizo-Wilcox aquifer to serve the ARWA sponsors. There are currently three phases of this project planned. Table 5-5 below provides a summary of the phases, the year they are planned to be online, and the current stage of the phase.

Table 5-5 – Alliance Regional Water Authority Supply Summary

Phase	Supply (AF/yr)	Year Online	Stage
Phase 1B	1,934	2025	Construction
Phase 1C/D	2,292	2027	Design
Phase 2	5,650	2032	Planning
Total	**9,876**		

Since Phase 2 is still in the planning stage, the City of Kyle will also have the opportunity to increase the supply in this phase as the next project phase progresses.

Once online, this supply is a valuable addition to the City's water portfolio as growth continues. This water source is considered drought-resilient and is not subject to reductions.

The ARWA permit is based on a consistent per-day supply quantity with an instantaneous peaking factor of 1.3.

5.2.2 ARWA Partner Agreements

Over the past year, the City of Kyle has been in discussions with other ARWA partners regarding their short-term water supply needs. The City is currently in the process of coordinating agreements with these partners for a portion of their supply to be utilized by the City of Kyle in the near term. Available supply is anticipated to include approximately 1,120 acre-feet/year or 1.0 million gallons per day (MGD) in 2026, and increasing to 2,240 acre-feet/year or 2.0 MGD from 2027 through 2031 following the completion of the ARWA Phase 1C/D project.

5.3 Current and Planned Water Supply Summary

Table 5-6 summarizes the current supply available to the City including Edwards Aquifer Authority Wells, the BSEACD Well, and the GBRA Surface Water contract.

Table 5-6 - Currently Available Water Supplies

Source		Total Permitted Supply		Max. Mandatory Reduction	Total Firm Supply	
		acre-feet/year	MGD		acre-feet/year	MGD
Edwards Aquifer Authority		432.1	0.39	44%	242.0	0.22
BSEACD	Historic	506.7	0.45	50%	253.4	0.23
	Conditional Class B	568.1	0.51	100%	0.0	0.00
GBRA Surface Water		5,443.0	4.86	30%	3,810.1	3.40
Total		**6,949.9**	**6.20**		**4,305.4**	**3.84**

Table 5-7 summarizes planned supplies that are in various stages of development, including the year they are anticipated to be online. As noted, the ARWA water supply does not include drought reductions.

Table 5-7 – Planned Supplies and Additional Agreements

Source	Year Online	Total Permitted Supply		Max. Mandatory Reduction	Total Firm Supply	
		acre-feet/year	MGD		acre-feet/year	MGD
San Marcos EAA Agreement	**2024 - 2026**	500.0	0.45	44%	280.0	0.25
ARWA Partner Agreements	**2026 Only**	1120.0	1.00	0%	1120.0	1.00
ARWA Partner Agreements	**2027 - 2031**	2240.0	2.00	0%	2240.0	2.00
ARWA Phase 1B	**2025**	1934.0	1.73	0%	1934.0	1.73
ARWA Phase 1C/1D	**2027**	2292.0	2.05	0%	2292.0	2.05
ARWA Phase 2	**2032**	5650.0	5.04	0%	5650.0	5.04

For the purpose of water planning, the total firm supply is assumed to be the condition of maximum mandatory reduction.

Table 5-8 provides a summary of the total firm supply by year between 2024 and 2032 for existing and planned supplies. In 2032, the ARWA Phase 2 project is planned to be online.

Table 5-8 – Total Existing and Planned Firm Supply through 2032 (Million Gallons per Day)

Source		2024	2025	2026	2027	2028	2029	2030	2031	2032
Edwards Aquifer Alliance		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
BSEACD	Historic	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Conditional Class B	-	-	-	-	-	-	-	-	-
GBRA Surface Water		3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40
San Marcos EAA Agreement		0.25	0.25	0.25	-	-	-	-	-	-
ARWA Partner Agreements		-	-	1.00	2.00	2.00	2.00	2.00	2.00	-
ARWA Phase 1B		-	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
ARWA Phase 1C/D		-	-	-	2.05	2.05	2.05	2.05	2.05	2.05
ARWA Phase 2		-	-	-	-	-	-	-	-	5.04
Total (MGD)		**4.09**	**5.82**	**6.82**	**9.62**	**9.62**	**9.62**	**9.62**	**9.62**	**12.66**
Total (Acre-Feet/Year)		**4,588**	**6,524**	**7,644**	**10,779**	**10,779**	**10,779**	**10,779**	**10,779**	**14,190**

The above totals are identified by year in Figure 5-1.

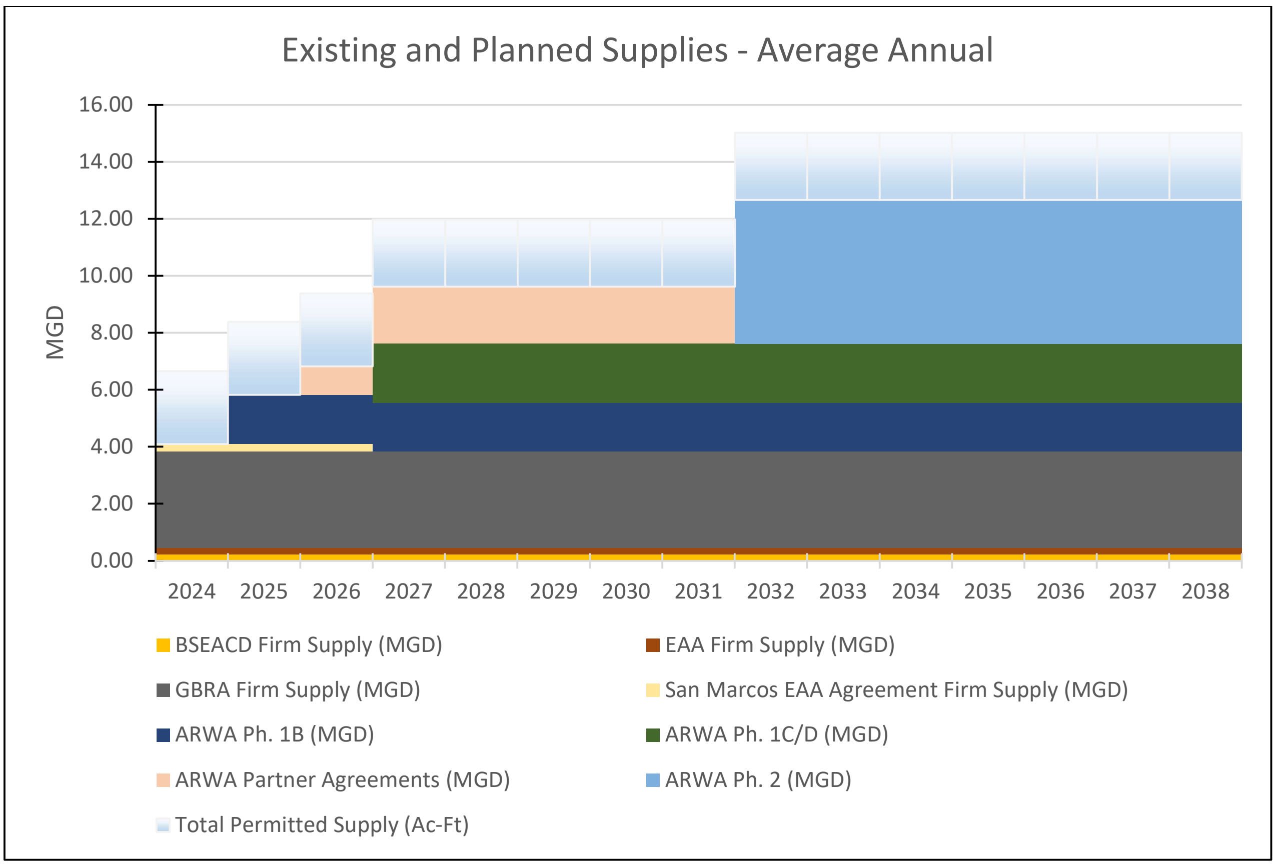


Figure 5-1 Average Annual Existing and Planned Supplies

In addition to evaluating the available permitted water supply on an annual basis, the permits must also allow for the delivery of water to meet a maximum day demand, which equals approximately 1.69 times the average day demand. As noted earlier in this section, each permit contains varying limitations relative to daily supply. Table 5-9 provides a summary of the maximum daily supply associated with each water supply source compared to the average annual supply.

Table 5-9 – Existing and Planned Maximum Daily Firm Supply (Million Gallons per Day)

Source	Average Annual Firm Supply (MGD)	Maximum Day Firm Supply (MGD)
Edwards Aquifer Alliance	0.22	1.01
BSEACD	0.23	1.78
GBRA Surface Water	3.40	4.86
San Marcos EAA Agreement (2024 - 2026)	0.25	0.25
San Marcos Interconnect Agreement	0.50	0.50
ARWA Partner Agreements (2027 - 2031)	2.00	2.00
ARWA Phase 1B	1.73	1.73
ARWA Phase 1C/D	2.05	2.05
ARWA Phase 2	5.04	5.04

The above maximum daily firm supply by source year of availability is identified in Figure 5-2 below through the detailed planning year of 2038.

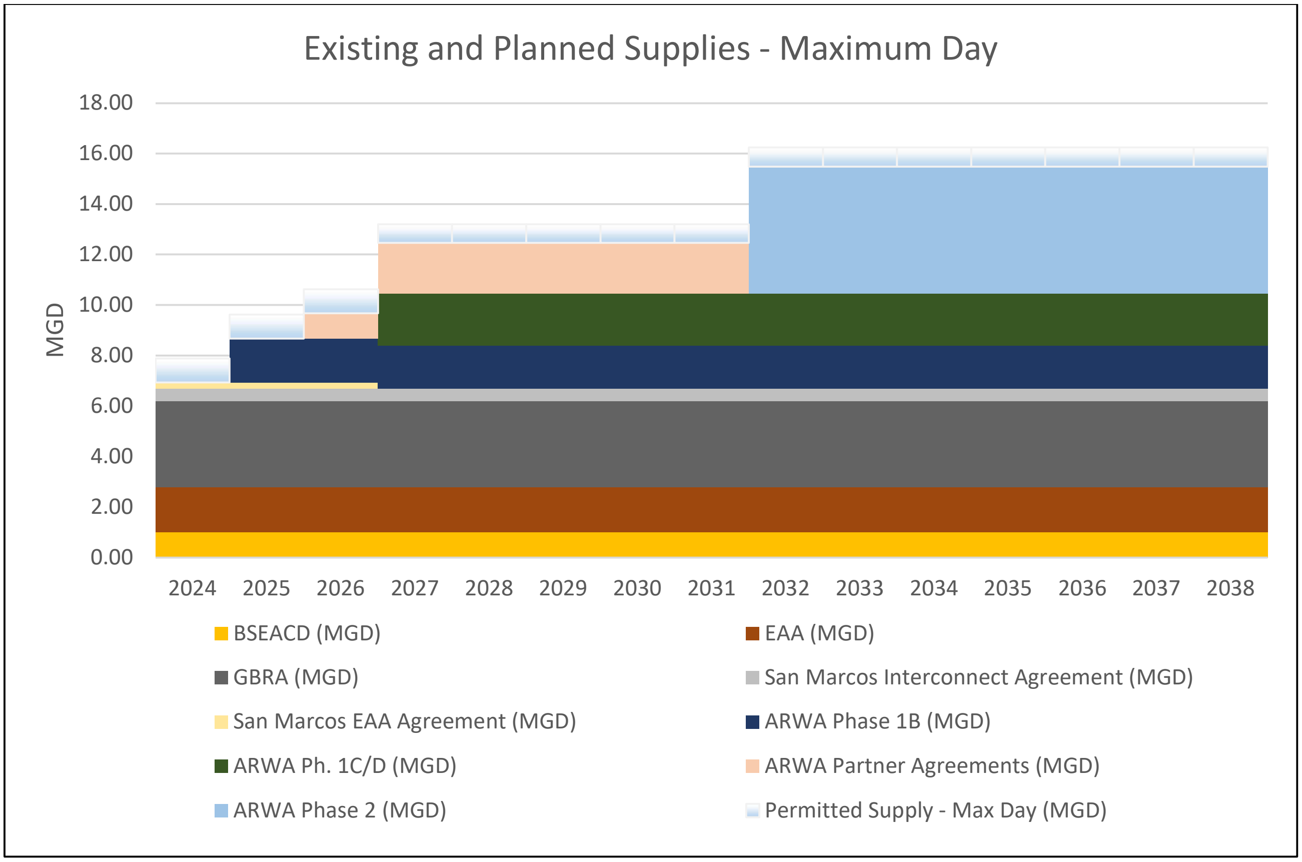


Figure 5-2 Maximum Day Existing and Planned Supplies

The EAA and BSEACD water supplies provide the most flexibility to supply more water to meet high demand periods, therefore it is recommended to concentrate their use to high demand periods.

5.4 Demand Projections and Current Supplies

The detailed planning period for demand projections was developed through 2038. Figure 5-3 shows the projected annual demand in million gallons per day (MGD) and the projected annual demand with up to 20% conservation as presented in the Demand Projections section, compared to the existing and planned firm supply. The total permitted supply is also shown for reference.

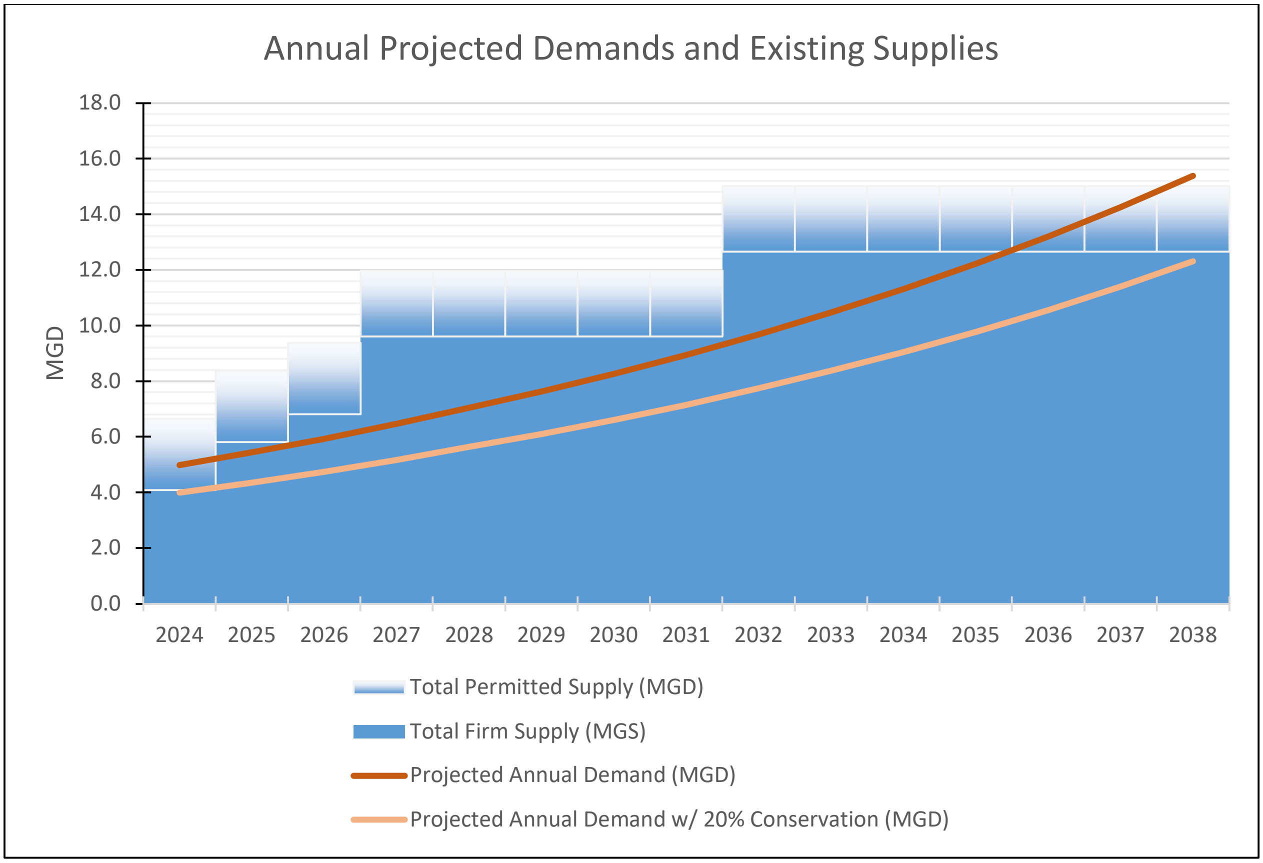


Figure 5-3 Annual Projected Demands and Existing Supplies

The data above shows that existing and planned supplies appear sufficient through 2035.

In addition to meeting the annual projected demands, the supply must also have the capacity to meet the maximum day demands. Figure 5-4 shows the projected maximum day demand in million gallons per day (MGD) and the projected maximum day demand with up to 30% conservation as presented in the Demand Projections section, compared to the existing and planned firm maximum day supply. The total permitted supply is also shown for reference.

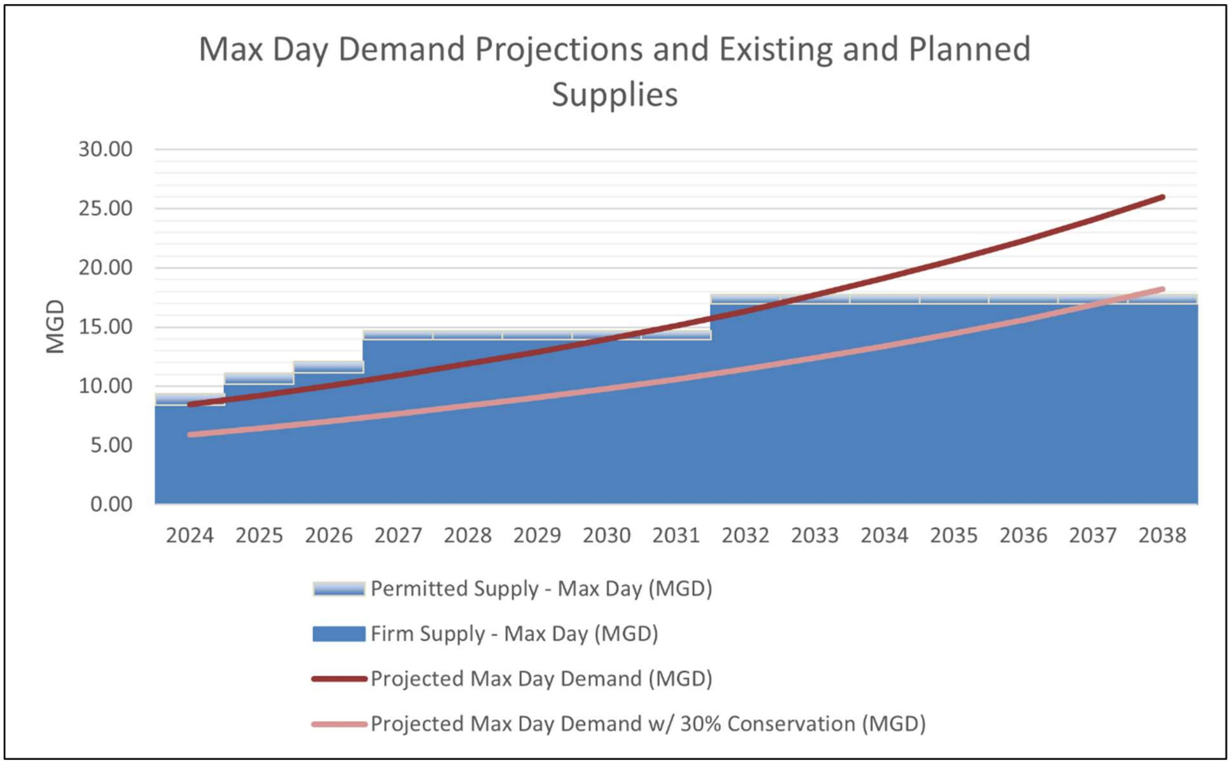


Figure 5-4 Maximum Day Demand Projections and Existing and Planned Supplies

The data above shows that the existing and planned maximum day supply appears sufficient to meet the maximum day demands to 2030, and through 2035 with additional conservation. Since the average day supply is estimated to be sufficient through 2035, strategies such as Aquifer Storage and Recovery (ASR) can be implemented to increase the maximum day supply in the interim without the need to secure new water supply permits. This is discussed further in the next section.

6.0 Water Supply Alternatives

Several water supply alternatives were evaluated based on the future needs established in the previous section. New water supplies generally take several years to develop, including planning, permitting, pilot testing, design, construction and implementation. Therefore, advanced planning is important when implementing new water supply strategies.

6.1 Additional Regional Coordination

The City has continued to coordinate with other water providers in the region to discuss potential supply sharing and near- and long-term water supply availability.

The Guadalupe-Blanco River Authority (GBRA) has been the largest water supplier for the City to date. It is appropriate to consult with GBRA for any potential available water supplies. The City met with the GBRA multiple times over the past year to explore potential short-term and long-term water supplies. The discussion of short-term water supplies is ongoing, and longer-term water supply coordination is continuing through the future WaterSECURE program, discussed in a later section.

City of Buda's water system is the closest to the City's system on the north side. Meetings were held with Buda to learn about their ASR system, opportunities for water supplies, joint water projects, and inter-connection to both City's systems. Both Cities discussed options for interconnections to each other systems and to initiate conversations with the City of Austin for a potential interconnection for emergency water.

City of San Marco's system is already connected to the City of Kyle's system through an existing interconnect to serve each other during emergencies. The Cities have existing water sharing agreements in place, as described in previous sections, and are both sponsors of the ARWA project. The Cities will continue to meet to explore both short-term and long-term water cooperation options as both cities are experiencing significant growth.

6.2 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) systems recharge water from various sources into an aquifer and recover the water later for beneficial use. The injection (or recharge) and extraction (or recovery) are accomplished with wells. Water can be recharged at various intervals and may be stored in the aquifer from months to decades. Stored water can be recovered when normal supplies run low or when demands are higher than normal. This concept is well suited for Kyle due to the multiple water supply agreements that have a daily limit, which does not accommodate seasonal demand changes. An ASR strategy allows the City to store available water during periods of lower demand for use during peak demand days and months.

ASR was identified as a beneficial water supply strategy for the City of Kyle. While it does not provide additional water on an annual basis, it allows for the storage of surplus water for use during peak demand months, resulting in more efficient management of existing water supplies.

A conceptual evaluation of an ASR system for the City of Kyle was performed and is included as Appendix D of this report. In summary, the middle or lower portions of the Trinity Aquifer appear favorable in the City of Kyle for this strategy. The ASR concept for the City is to develop a system to provide 1 to 2 MGD of additional supply during the summer months. Preliminary estimates for Trinity Aquifer well capacity is between 0.3 to 0.4 MGD each, therefore a 2 MGD system would consist of approximately 6 wells. Well spacing would be determined by several factors, including aquifer transmissivity and storativity, porosity, water levels in the aquifer, proximity to other wells, and total production capacity required for summer peak demand. The system would also include a ground storage tank and a pipeline.

The below figure illustrates an idealized cross section of an ASR well in an aquifer where water has been injected, and a buffer zone has developed in the area where native and stored water have mixed in the aquifer. The stored water in Figure 6-1 can be produced without pulling in any of the native ground water. The concept for the City is to store fresh water in a brackish groundwater aquifer. The stored water around the well screen will grow over time, and it is estimated that it will take between 2 – 4 years of recharging water prior to recovering it in the summer months to avoid pulling in water from the buffer zone.

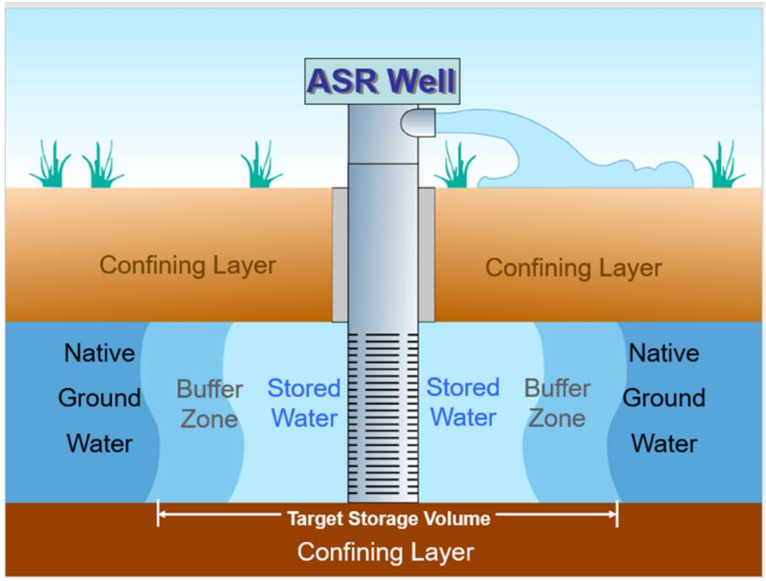


Figure 6-1 Idealized cross-section of an ASR well illustrating the native groundwater zone, the buffer zone, and the stored water zone

The injection wells used in ASR systems are permitted through Texas Commission on Environmental Quality (TCEQ). Wells would also need to be registered and permitted with the groundwater district where it is located.

A conceptual cost estimate was performed for this strategy using the Texas Water Development Board's Uniform Costing Methods tool, which is used for the development of planning costs for the State Water Plan. Using this costing method, the total cost of the project is estimated at $48,500,000.

Prior to full scale implementation of an ASR program, additional testing is recommended. Typical phases of an ASR project include conceptual planning, field testing and demonstration program, design and construction, pilot testing, implementation and operation, and potential expansion. During the demonstration phase, the potential for desalination of groundwater in the Trinity Aquifer may also be evaluated. The planning, field testing, and demonstration phase, including engineering and pilot well drilling, is estimated at approximately $2M to $3M for budgetary purposes.

6.3 Non-Potable Reuse

The most common use for reclaimed water is for irrigation. Seasonally, irrigation can represent a significant use of potable water that, if replaced with reclaimed water, allows conservation of the more valuable potable water resource. Large users, like golf courses, often have ponds or basins for storage which provides flexibility in the hours water is used. As a result, these types of customers do not require integration of storage volume in reclaimed water system. Users who run irrigation directly off the reclaimed system without their own storage would require the reclaimed system to have adequate storage capacity to provide flows regardless of the wastewater treatment plant's diurnal pattern and dry weather flow conditions. The type and volume of storage that irrigation customers require impacts the design and cost of the reclaimed water system.

The City of Kyle currently supplies reclaimed water for irrigation to the Plum Creek Golf Course. There are plans in place to expand this system in a targeted manner for irrigation of sports fields and parks. As part of the ongoing Wastewater Treatment Plant Expansion project, the quality of reclaimed water is planned to improve from Type 2 to Type 1 reuse. In 2024, the City of Kyle adopted a Reclaimed Water Master Plan. In discussions with City staff during development of the Water Master Plan, recent development ordinances encouraging conservation and reduced irrigation make a City-wide expansion of a reclaimed water system for irrigation likely not cost effective for the water supply offset it would provide.

6.4 Potable Reuse

Another form of reclaimed water use is potable reuse. Potable reuse refers to the advanced treatment of municipal wastewater to a level that meets or exceeds drinking water standards, allowing it to be safely reused for drinking and other purposes. There are two types of potable water reuse:

- Indirect Potable Reuse: Uses and environmental buffer, such as a lake, river, or a groundwater aquifer, before the water is treated at a drinking water treatment plant.
- Direct Potable Reuse: Involves the treatment and distribution of water without an environmental buffer.

A benefit of potable reuse is that the supply potential increases as the City grows. In the current water environment, with depleting raw water supply and a municipal water supply deficiency, one of the most valuable water resources available to a City is the resource the City already owns. State law currently allows full utilization of wastewater effluent flow authorized by permit unless discharge is required by permit. Once effluent is discharged to the receiving stream, it becomes water of the State, unless otherwise authorized by permit. The City of Kyle’s wastewater discharge permit does not currently require discharge into Plum Creek.

The City of Kyle Wastewater Treatment Plant (WWTP) averaged approximately 4.2 MGD average flow in 2024. The WWTP is currently in the design phase of an expansion to treat up to 9.0 million gallons per day. The City is currently in the process of coordinating with TCEQ for amending the permit for an interim limit of 9.0 MGD and a final limit of 12.0 MGD.

Potable reuse of effluent requires significant testing, regulatory approvals, testing, public information campaign, funding, and implementation.

Indirect Potable Reuse

The incorporation of indirect potable reuse to diversify water supply for water security could be accomplished by either injecting reclaimed water into an aquifer, also referred to Aquifer Storage and Recovery (ASR) as previously described, or by pumping into a reservoir. With no current regulations for this strategy, specific coordination with the Texas Commission on Environmental Quality (TCEQ) on the water quality requirements, blended water characterization, treatment technologies, and pilot testing are required. For the implementation of this strategy, evaluation and identification of an environmental buffer is needed.

Direct Potable Reuse

Direct potable reuse (DPR) can be defined as the conveyance of treated wastewater effluent through an advanced treatment facility followed by blending with raw drinking water, which is then sent through a water treatment plant without the use of an environmental buffer. DPR can significantly bolster resiliency to severe drought. To date there are only two DPR systems in Texas with one being in Big Spring and the other being in Wichita Falls. However, many municipalities are currently in the process of adding DPR to their water supply including the advanced water purification facility in El Paso currently under construction and several other projects currently planned in the region. The Texas Commission on Environmental Quality (TCEQ) developed a guidance manual in 2022 to regulate direct potable reuse facilities.

Reuse Next Steps

The City's Strategic Plan identifies a strategic focus to create sustainable and resilient infrastructure, and plan for water and wastewater needs by encouraging sustainability and utilizing reclaimed water. To this end, it is recommended to develop an amendment to the Reclaimed Water Master Plan to evaluate the feasibility of Indirect or Direct Potable Reuse as a water supply strategy. There are many factors that will require specific evaluation, such as review of potential environmental buffers, facility locations, quantities, water quality, public involvement and education, and development of a more detailed cost estimate based on findings

A conceptual cost estimate was performed for this strategy representing an advanced water treatment facility with a capacity of 6.0 MGD peak capacity, 3.0 MGD average, and piping using the Texas Water Development Board's Uniform Costing Methods tool, which is used for the development of planning costs for the State Water Plan. Using this costing method, the total cost of the project is estimated at $143,000,000. This cost will need to be further developed during the feasibility study due to the number of potential variables.

The above noted TCEQ Direct Potable Reuse for Public Water Systems guidance manual outlines the requirements and process for DPR approval. The TCEQ approval process includes 12 months of wastewater effluent sampling and characterization, followed by conducting a pilot-scale study, development of design plans and specifications, construction of the DPR plant, and full scale verification. Due to the timeline and complexity of the planning and permitting requirements for this strategy, the feasibility study is recommended following the adoption of the Water Master Plan.

6.5 GBRA WaterSecure

The Guadalupe-Blanco River Authority (GBRA) is currently in the planning phase of their WaterSECURE program, a regional water supply project that is anticipated to include many miles of pipeline and treatment facilities that provide potable water from off-channel reservoir southeast of Victoria, Texas to entities within Central Texas. Based on preliminary discussions between the City and GBRA, it is estimated that the City of Kyle could purchase up to 4.1 MGD or more as part of this program for supply that is planned to be online by 2033. For the purpose of this study, this water is estimated to be available by 2034 to provide an additional year for planning purposes. This alternative would provide additional diversity to the City's water portfolio, while continuing the City's current water strategy of purchasing and not operating their own facilities. This project will offer the potential to supply raw or treated water, however the supply in the vicinity of Kyle is expected to be treated. Current capital costs for this water supply are estimated at approximately $55,000 per acre-foot. This project is still in the planning phase, and more detailed cost and contract information is expected to be provided in the Spring of 2025.

6.6 Summary

The current and planned supplies are summarized in Section 5. Based on this evaluation, future water supply strategies and sources will be needed to meet the future growth and increased water needs. Based on the water supply alternatives evaluated, the following strategies are recommended for further evaluation and implementation to meet future water demands:

- Continue to coordinate with neighboring water providers, ARWA and GBRA for expanded supply
- Aquifer Storage and Recovery – 1.0 MGD online in 2030, expand to 2.0 MGD
- GBRA WaterSECURE – 4.1 MGD online in 2034
- Direct or Indirect Potable Reuse – 3.0 MGD online in 2036, expand to 6.0 MGD in 2041
- Update Water Conservation Plan and Drought Contingency Plans to set goals for future demands

As noted in this study, it is important to continue to seek new water supply alternatives and quantities as they become available. As such, it is recommended to continue discussions with ARWA for the potential to increase water supply as part of the Phase 2 project, as well as discussions with GBRA to increase participation in the WaterSECURE program. These projects are in the early stages of development, and it will be to the City's benefit to have multiple options available to select the most advantageous solution for the City. In addition, the City may also consider remaining open to additional Edwards Aquifer water supply if it becomes available in the future. A summary of the additional supply alternatives by the year they are anticipated to be available is provided in Table 6-1.

Table 6-1 Supply Option Summary Table

Supply Option	Supply	Capital Cost ($)	Unit Cost ($/ac-ft)	Year Available
Aquifer Storage and Recovery*	2.0 MGD*	$48,500,000	$21,650	2030
GBRA WaterSECURE	4.1 MGD 4,600 Acre-Ft./Year	$253,000,000**	$55,000	2034
Indirect/Direct Potable Reuse	3.0 MGD (Ph. 1) 3,360 Acre-Ft./Year (Expandable)	$143,000,000	$42,600	2036

*Not an additional supply. ASR stores water during low demand periods for use during dry and high demand periods

**Estimate of City of Kyle's share of project capital cost based on $/ac-ft unit cost provided by GBRA

Figure 6-2 shows the annual supply and demand impact of the above additional supply alternatives by year proposed to bring online as compared to the demand projections. This is intended to show one alternative of several possibilities for the City. As noted in the Demand Projections section, Full buildout of the Water CCN is projected to occur in 2048.

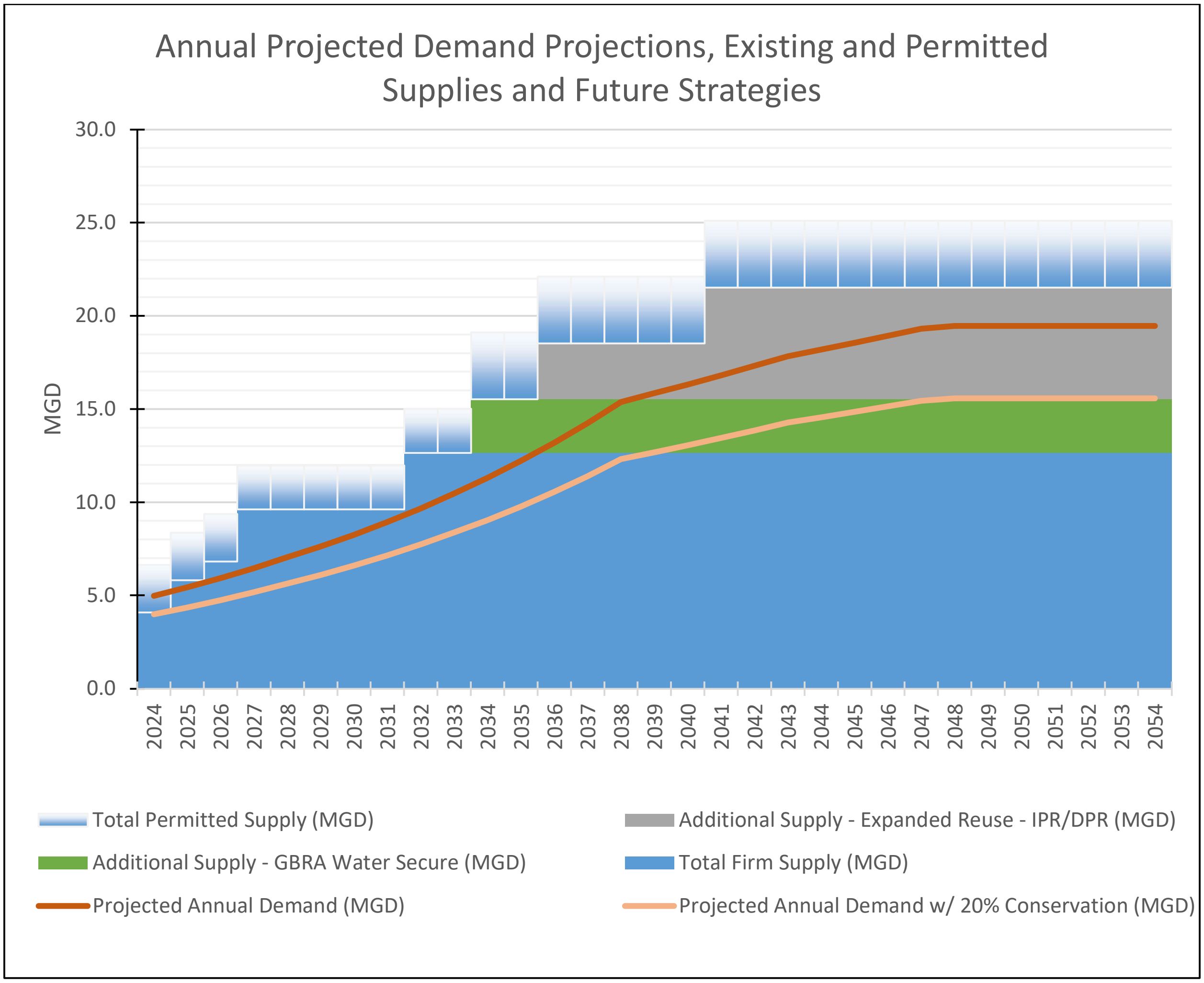


Figure 6-2 Annual Projected Demand, Existing and Permitted Supplies and Future Strategies

Figure 6-3 shows the maximum day supply and demand impact of the above additional supply alternatives by year proposed to bring online as compared to the demand projections. This is intended to show one alternative of several possibilities for the City. As noted in the Demand Projections section, Full buildout of the Water CCN is projected to occur in 2048.

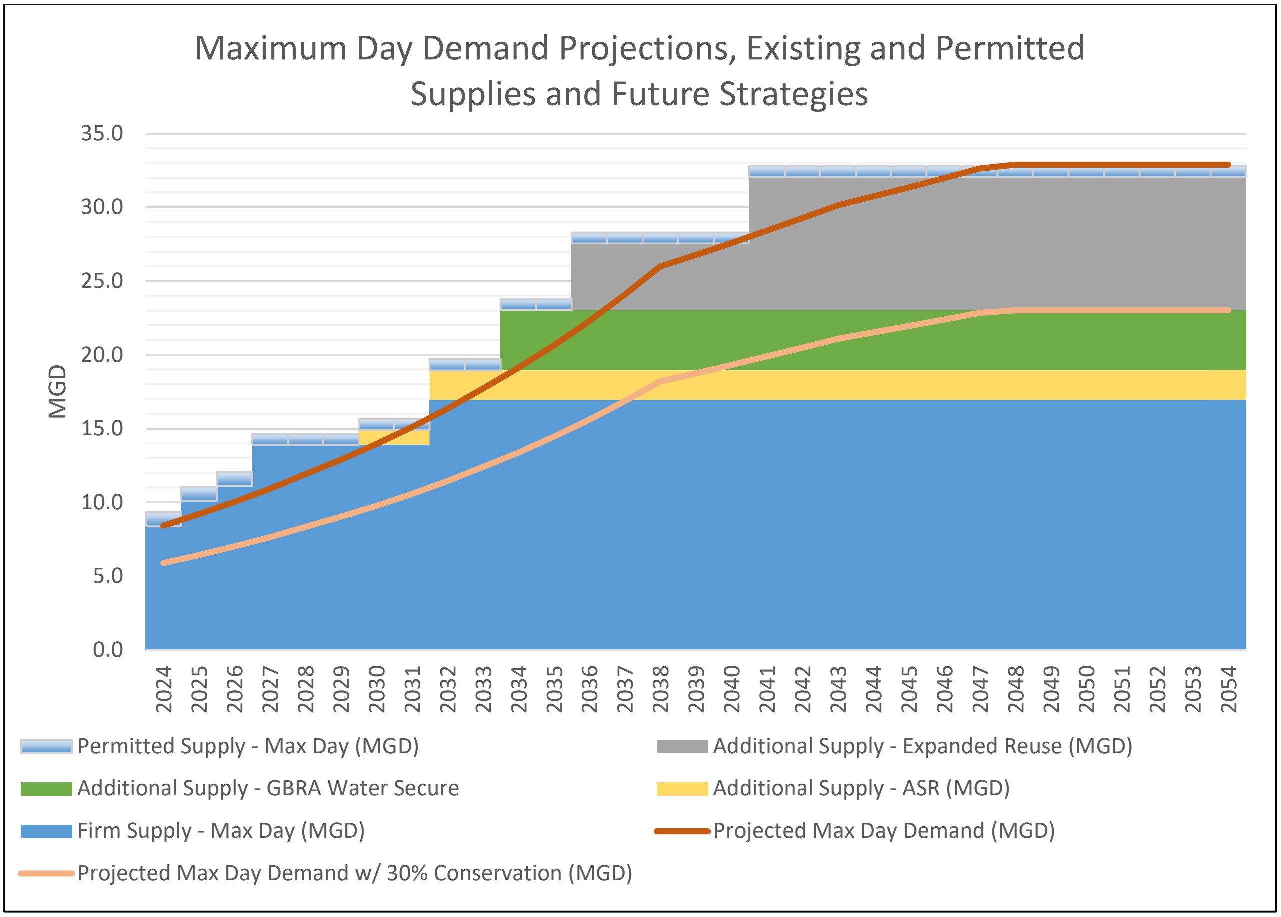


Figure 6-3 Maximum Day Demand Projections, Existing and Permitted Supplies and Future Strategies

7.0 Capital Improvement Plan Development

7.1 Capital Improvements

Several Capital Improvements Plans have been developed based on water demands, supplies, the system model predicted required improvements to grow and improve the water system. The following description of projects are developed based on the predicted demands. A summary of the capital improvements by timeframe and total estimated cost is provided in Table 7-1. Project Summaries including estimated timelines and planning level cost estimates can be found in Appendix B.

Table 7-1 Summary of CIP Projects

<table>
<tr><th>5-Year Timeframe</th><th>15-Year Timeframe</th><th>Beyond 15-Year</th></tr>
<tr><td>Population growth planned in 31 developments by 2028. 12 CIP Projects needed to provide system capacity:

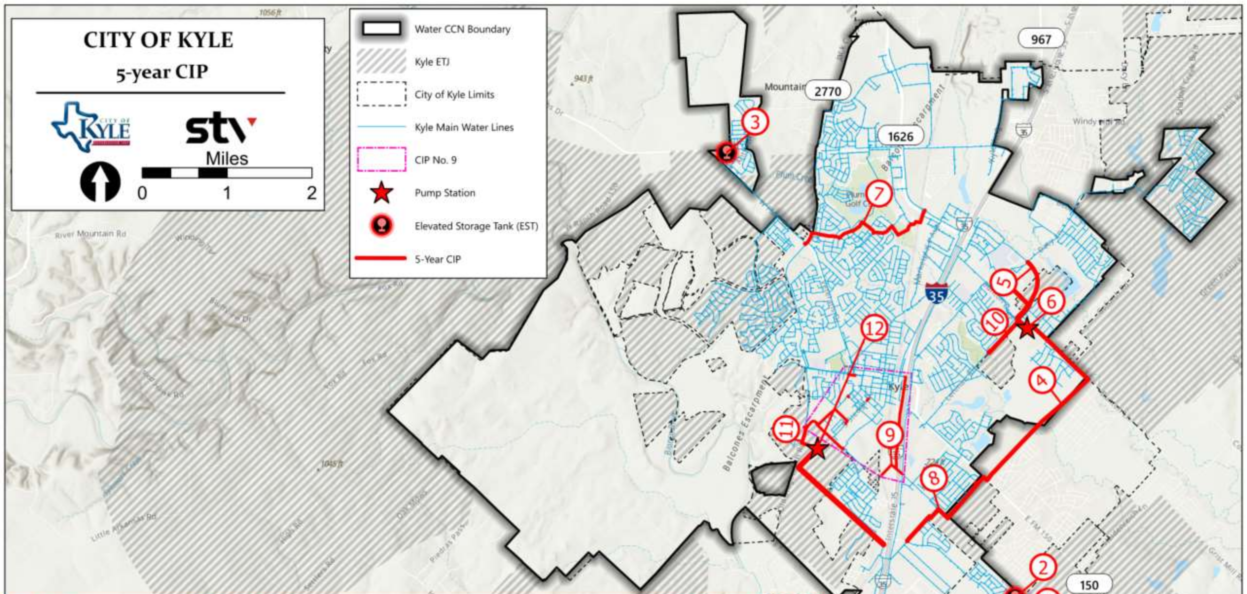
1. Waterstone PS
2. Waterstone EST
3. Hoover EST
4. Lehman to Post Oak Transmission
5. Dacy and Seton Extensions
6. Lehman PS
7. 1626 PS to Veteran's Rd – 16"
8. Waterstone to Post Oak Trans
9. Pressure Plane Modification
10. Lehman Rd Extension
11. ARWA 3 North Transmission
12. ARWA 3 PS</td><td>Population growth planned in 36 developments. 36 Developments planned to be fully built out by 2038. 4 CIP Projects needed to provide system capacity:

13. Nance Tract Transmission Line
14. Old Stagecoach Rd Improvements
15. Nance Tract EST
16. PP4 PS and EST</td><td>Population growth primarily in acreage not identified as specific development to date. Located internal to the water system, not on the edges of the Water CCN:

• Final Expansion of:
  o 1626 PS
  o Waterstone PS
  o Lehman PS
  o ARWA 3 PS
• Connect ARWA 3 PS to PP1
• Additional Ground Storage Tanks at:
  o 1626 PS
  o Waterstone PS
  o Lehman PS
  o ARWA 3 PS
• Additional PP1 EST
• Plum Creek EST Replacement</td></tr>
<tr><td>Total Estimated Cost = $ 137.24M</td><td>Total Estimated Cost = $ 61.87M</td><td></td></tr>
</table>

7.1.1 5-year CIP

Figure 7-1 provides the locations of the proposed capital improvements for the 5-year CIP and the following subsections provide a brief description of the major projects.



Project Name	CIP	Project Limits	Pipeline Size	Start YR	End YR
Waterstone Pump Station	1	New pump station to receive water from ARWA and pump into PP1		25	26
Waterstone EST	2	New EST to provide storage capacity for PP1		25	26
Hoover EST	3	New EST to provide storage capacity for PP3		25	26
Lehman to Post Oak Transmission Line	4	24" transmission line from Post Oak EST to Lehman PS and 30" from Lehman PS to Lehman Rd	24"	25	28
Dacy and Seton Extensions	5	Dual 24" lines from 30" coming off Lehman Rd to Dacy Ln, connecting at Kyle Pkwy and Seton Pkwy	24"	25	28
Lehaman Pump Station	6	New pump station to receive water from ARWA and pump into PP1		25	28
1626 to Veteran's Rd Transmission Line	7	16" connection from 1626 PS to Veteran's Rd	16"	25	28
Waterstone to Post Oak Transmission Line	8	24" from Waterstone Blvd to Post Oak EST	24"	26	29
PP1 to PP2 Boundary Change	9	Pressure Plane boundary change in downtown PP1 to PP2	12"	26	29
Lehamn Rd Extension	10	24" new connection along Lehman Rd from Hallie Dr to 30" on Bunton Creek Rd	24"	28	32
ARWA 3 North Transmission Line	11	16" new connection from ARWA 3 PS to 12" on S Old Stagecoach Rd	16"	27	32
ARWA 3 Pump Station	12	New pump station to receive water from ARWA and a new EST for additional storage capacity		27	32

Figure 7-1 5-year CIP

7.1.1.1 CIP No. 1 Waterstone Pump Station

The Waterstone Pump Station consists of a new pump station with four (4) pumps and a firm pumping capacity of 7.2 MGD. The purpose of this improvement is to receive ARWA water and provide pumping capacity for Pressure Plane 1 (PP1). The project is in construction and is scheduled for completion in FY2026.

7.1.1.2 CIP No. 2 Waterstone EST

The Waterstone Elevated Storage Tank project includes the construction of a new 1 MG elevated storage tank and will provide additional elevated storage capacity for PP1. This EST is included with the Waterstone Pump Station project and is scheduled for completion in FY2026.

7.1.1.3 CIP No. 3 Hoover EST

The Hoover Elevated Storage Tank project includes the construction of a new 1 MG elevated storage tank that will provide elevated storage capacity for Pressure Plane 3 (PP3). The project is in construction and is scheduled for completion in FY2026.

7.1.1.4 CIP No. 4 Lehman to Post Oak Transmission Line

The Lehman to Post Oak Transmission Line is an emergency project started in 2025 to be in place before 2028 which will provide transmission capacity from Post Oak EST to Lehman Pump Station. The project consists of 10,000 ft of 24-inch transmission line installed along future Goforth Road, 5,200 ft of 24-inch transmission line installed along existing Bunton Lane and Bunton Creek Road and 550 ft of 30-inch pipe on Bunton Creek Road. The project is in design and is scheduled for completion in FY2028.

7.1.1.5 CIP No. 5 Dacy and Seton Extensions

The Dacy and Seton Extension is an emergency project beginning in FY2025 and includes dual 24-inch lines connecting Kyle Pkwy and Seton Pkwy to a 30-inch along Bunton Creek Road. This extension provides transmission capacity from Lehman PS to Dacy Lane EST. The project consists of 1275 ft of 30-inch along a future road, 2385 ft of 24-inch to Dacy Ln and Kyle Parkway intersection along a future road, and 2975 ft of 24-inch to Dacy Lane and Seton Parkway intersection along a future road. The project is in design and is scheduled for completion in FY2028.

7.1.1.6 CIP No. 6 Lehman Pump Station

The Lehman Pump Station project will begin in FY2025 and includes the construction of a new pump station with a firm pumping capacity of 5 MGD and further capacity expansion in the future. The pump station receives water from GBRA and pumps into PP1. The new PS will be constructed adjacent to the existing Lehman pump station. The project is in design and is scheduled for completion in FY2028.

7.1.1.7 CIP No. 7 1626 to Veteran's Road 16" Transmission Main

The 1626 to Veteran's Road 16-inch transmission main consists of a water line from 1626 Pump Station to Veteran's Road. This project is needed to provide adequate capacity to the south and west side of Pressure Plane 2 (PP2) and to PP3. This project could be delayed if the ARWA 3 PS were expedited and brought in service by 2028.

7.1.1.8 CIP No. 8 Waterstone to Post Oak Transmission Line

The Waterstone to Post Oak Transmission Line project consists of a 24-inch from Waterstone Blvd to Post Oak EST. This will complete the 24-inch transmission line from Waterstone Blvd in the south to Dacy EST in the north. The total length of new line will be 6,630 ft, including the replacement of 2,800 ft of 12-inch along E Post Road with 24-inch and 3,830 ft of new 24-inch line along future Goforth Road. The project is scheduled for completion in FY2029.

7.1.1.9 CIP No. 9 Pressure Plane Boundary Modification PP1 to PP2

The Pressure Plane Boundary Modification PP1 to PP2 project includes boundary changes and additional lines in targeted areas to improve low pressures in the downtown area. The project consists of improvements in five locations. New transmission lines totaling 7,600 ft of 12-inch along I-35 and County Road 208, including boring under I-35. A total of 5,668 ft of 12-inch Looping along Opal Ln, Scott St, and the northeast edge of the Four Oaks and Bradford Meadows subdivisions which includes new pipe plus 1,320 ft of replacing existing 3-inch pipe. New transmission lines totaling 100 ft of 8-inch Crossing Scott St and along W 3rd St, 125 ft of 8-inch along S Sledge St, and 460 ft of 8-inch along Center St. The project is scheduled to begin design in FY2026.

7.1.1.10 CIP No. 10 Lehman Road Extension

The Lehman Road Extension project includes installation of 2,750 ft of new 24-inch transmission along Lehman Rd from Hallie Dr to connect to the proposed 30-inch on Bunton Creek Rd. The project is scheduled to begin design in FY2028.

7.1.1.11 CIP No. 11 ARWA 3 PS North Transmission Line

The ARWA 3 PS North Transmission Line project consists of a new 16-inch transmission line from ARWA 3 PS to a 12-inch on S Old Stagecoach Rd with a total length of about 2,100 ft. The purpose of this improvement is to provide flow from ARWA 3 PS to PP2. The project is scheduled to begin design in FY2028 provided that the 1626 to Veteran's Road 16" Transmission Main project begins in 2025. It is assumed that the ARWA PS will be constructed with partial capacity in the same timeframe.

7.1.1.12 CIP No. 12 ARWA 3 PS Pump Station and Transmission Line

The ARWA 3 Pump Station project consists of a new pump station at new location (TBD) with a firm pump capacity of 5000 gpm (7.2 MGD) which will be expandable in the future and a 3.5 MG GST with space for another in the future. A 30-inch supply line with about 9,000 LF is also included to deliver water from the ARWA Segment C pipeline to the ARWA 3 PS. The purpose of this improvement is to provide pumping capacity for PP 1 and 2 and receive ARWA water in the southwest side of the system. This project is scheduled to begin design in FY2028 provided that the 1626 to Veteran's Road 16" Transmission Main project begins in 2025.

The below table includes a summary of 5-year CIP projects. All costs included in this Master Plan are in 2025 dollars and future costs should be adjusted for inflation as needed.

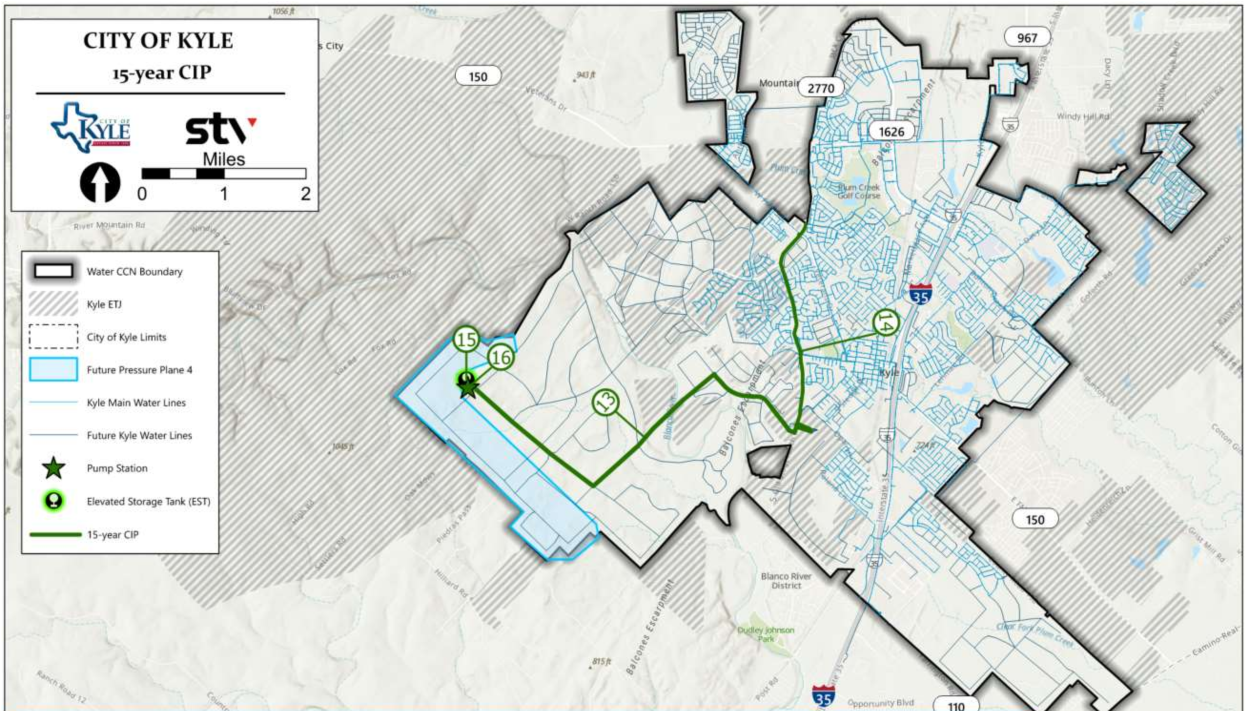
Table 7-2 Summary of 5-Year CIP Projects

CIP No.	Project Title	Status	Begin FY	End FY	Cost Estimate
1	Waterstone Pump Station	Construction	25	25	$11,800,000
2	Waterstone EST	Construction	25	26	$5,900,000
3	Hoover EST	Construction	25	25	$6,243,000
4	Lehman to Post Oak Transmission Line	Design	25	28	$19,343,000
5	Dacy and Seton Extensions	Design	25	28	$8,921,000
6	Lehman Pump Station	Design	25	28	$20,650,000
7	1626 to Veteran's Road 16" Transmission Main	Future	25*	28*	$10,946,000
8	Waterstone to Post Oak Transmission Line	Future	26	29	$6,381,000
9	Pressure Plane Boundary Modification PP1 to PP2	Future	26	29	$10,055,000
10	Lehman Road Extension	Future	28	32	$3,546,000
11	ARWA 3 PS North Transmission Line	Future	27*	32*	$2,784,000
12	ARWA 3 Pump Station and Transmission Line	Future	27*	32*	34,375,000
				5- Year CIP Total	**$137,236,000**

* Assuming 1626 to Veteran's Road 16" Transmission Main begins in 2025, ARWA 3 PS North Transmission Line and ARWA 3 Pump Station can begin in 2027.

7.1.2 15-year CIP

Figure 7-2 provides the locations of the proposed capital improvements for the 15-year CIP and the following subsections provide a brief description of the major projects. These projects are anticipated to be needed within the 6-to-15-year window, and the specific schedules will be driven by development timing and refined as the projects are within the 5-year CIP timeframe.



Project Name	CIP	Project Limits	Start YR	End YR
Nance Tract Transmission Line	13	24" new connection from ARWA 3 PS to the proposed Nance Tract EST	30	38
Old Stagecoach Roach Improvements	14	Improvements to existing 16" from 1626 PS to ARWA 3 PS along Old Stagecoach Rd and new 16" from ARWA 3 PS along Old Stageoach Rd to Veterans Rd	28	38
Nance Tract EST	15	New EST to provide storage capacity for PP2	38	38
Pressure Plane 4 Pump Station and Est	16	New pump station and EST to provide pumping and storage capacity for PP2	34	38

Figure 7-2 15-year CIP

7.1.2.1 CIP No. 13 ARWA 3 PS Nance Tract Transmission Line

The ARWA 3 PS Nance Tract Transmission Line project consists of 28,690 linear feet of new 24-inch transmission line to be installed along future road from ARWA 3 PS to the proposed 1.5 MG Nance Tract EST. The purpose of this improvement is to provide adequate flow capacity to the proposed Nance Tract EST. The project schedule will be driven by development in the Nance Tract.

7.1.2.2 CIP No. 14 Old Stagecoach Road Improvements

The Old Stagecoach Road Improvements project consists of improvements to existing 16-inch line from 1626 PS to ARWA 3 pump station with 10,100 ft of 16-inch from 1626 PS to Veteran's Rd and 12,150 ft of 16-inch along Old Stagecoach Rd from ARWA 3 PS to Veteran's Rd. The purpose of this improvement is to provide adequate flow capacity along Old Stagecoach Rd. The project schedule will be driven by development or as coordinated with road improvement projects.

7.1.2.3 CIP No. 15 Nance Tract EST

The Nance Tract EST project consists of a new 1.5 MG composite EST which will provide elevated storage capacity for PP2. The project schedule will be driven by development in the Nance Tract.

7.1.2.4 CIP No. 16 Pressure Plane 4 Pump Station and EST

The Pressure Plane 4 (PP4) Pump Station and EST project includes a new 2 MGD capacity Pump Station and 300,000-gallon elevated storage tank. The purpose of this improvement is to provide adequate pumping and elevated storage capacity required due to elevation change on western extreme of PP2.The project schedule will be driven by development of the far west edge of the Nance Tract.

Table 7-3 Summary of 15-Year CIP Projects

CIP No.	Project Title	Cost Estimate
13	ARWA 3 PS Nance Tract Transmission Line	$37,629,000
14	Old Stagecoach Road Improvements	$12,672,000
15	Nance Tract EST	$6,939,000
16	Pressure Plane 4 Pump Station and EST	$4,626,000
	15- Year CIP Total	**$61,866,000**

7.1.3 Ultimate Buildout

Population growth after the 15-year timeframe will be primarily in acreage not identified as specific developments to date. The remaining acreage is located internal to the water system, not on the edges of the Water CCN and does not require further piping improvements. The remaining improvements needed will include:

- Final Expansion of existing pump stations with additional pumps and GSTs.
- Connect ARWA 3 PS to PP1.
- Additional EST in PP1.
- Plum Creek EST Replacement.

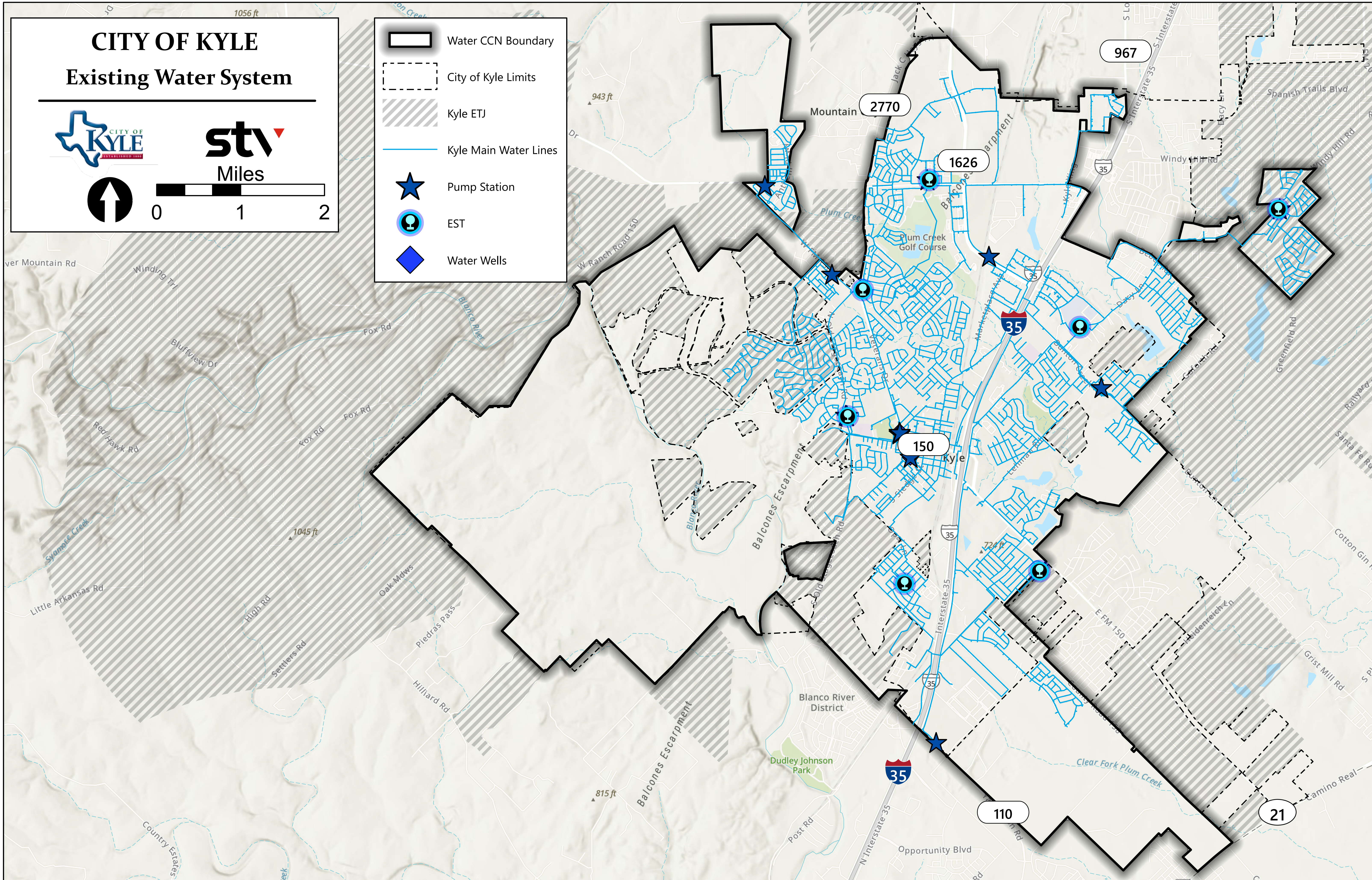
These improvements are not more specifically defined due to the length of time to Ultimate buildout and potential for change. These improvements can be more precise in the next Master Plan update.

8.0 Conclusions and Recommendations

Below is a summary of the recommended next steps based on the above Water Master Plan evaluation.

- Initiate Feasibility study, field testing, demonstration program, and permitting coordination for Aquifer Storage and Recovery (ASR) strategy.
- Amend the Reclaimed Water Master Plan to include a Feasibility Study for Indirect and Direct Potable Reuse strategy to evaluate feasibility of indirect and direct potable reuse, environmental buffers, potential locations, quantities, water quality, public involvement, and develop more detailed cost estimate based on findings.
- Continue coordination with GBRA for participation in the WaterSECURE program, including potential to increase supply share.
- Continue coordination with ARWA Phase 2 project, including Kyle taking a leadership role in advancing this phase and potential to increase supply share.
- Advance Capital Improvement Projects identified in Section 7.
- Update Water Conservation Plan and Drought Contingency Plan.
- Consider Federal and State Funding assistance programs for water supply projects through agencies such as Texas Water Development Board, Environmental Protection Agency, and Bureau of Reclamation.
- Update demand projections annually to confirm water strategies and capital program align with current priorities and schedules.
- Update Water Master Plan periodically (every 3 to 5 years) to review and update overall strategies and update capital improvement plan.

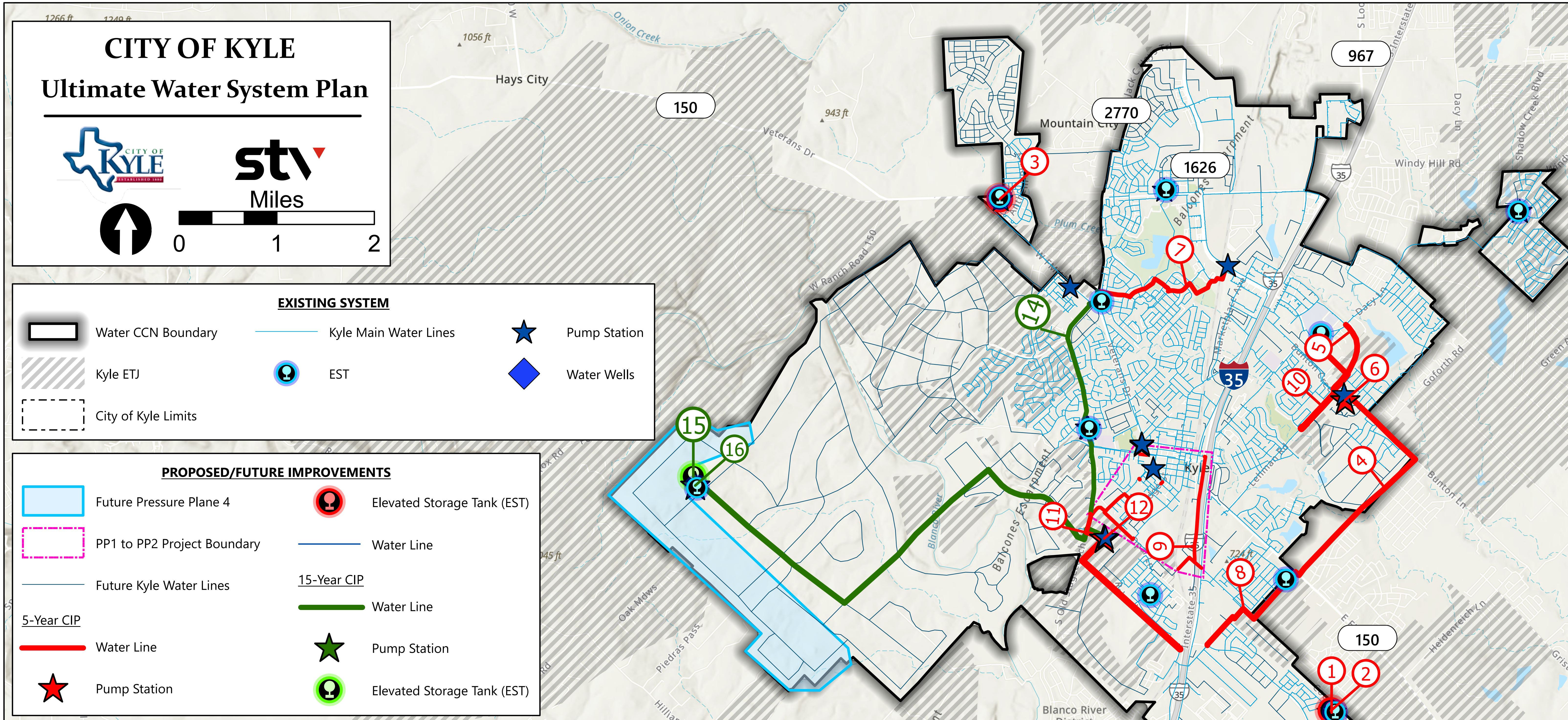
Appendix A
Exhibits



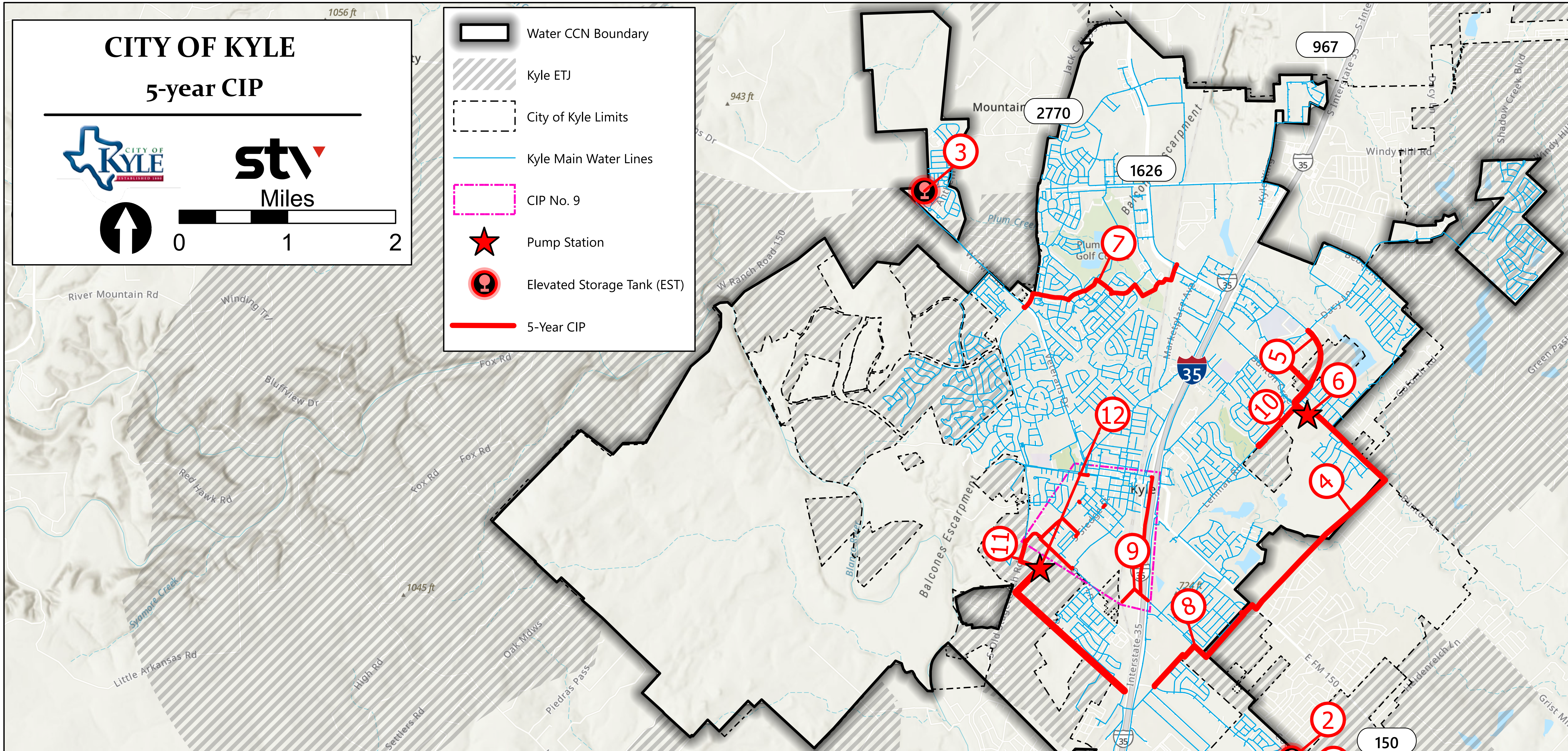
CITY OF KYLE
Existing Water System
CITY OF KYLE
stv
Miles
0
1
2
Water CCN Boundary
City of Kyle Limits
Kyle ETJ
Kyle Main Water Lines
Pump Station
EST
Water Wells
2770
1626
967
150
110
21
35
Mountain
Kyle
Plum Creek Golf Course
Blanco River District
Dudley Johnson Park
Balcones Escarpment
Plum Creek
Clear Fork Plum Creek
Blanco River
Sycamore Creek
W Ranch Road 150
Fox Rd
Bluffview Dr
Winding Trl
Red Hawk Rd
Little Arkansas Rd
High Rd
Settlers Rd
Oak Mdws
Piedras Pass
Hilliard Rd
Country Estates Dr
Post Rd
Opportunity Blvd
N Interstate 35
Interstate 35
S Interstate 35
E FM 150
Windy Hill Rd
Spanish Trails Blvd
Greenfield Rd
Cotton Gin Rd
Grist Mill Rd
Santa Fe Run
Camino Real
1056 ft
943 ft
1045 ft
815 ft
724 ft

CITY OF KYLE

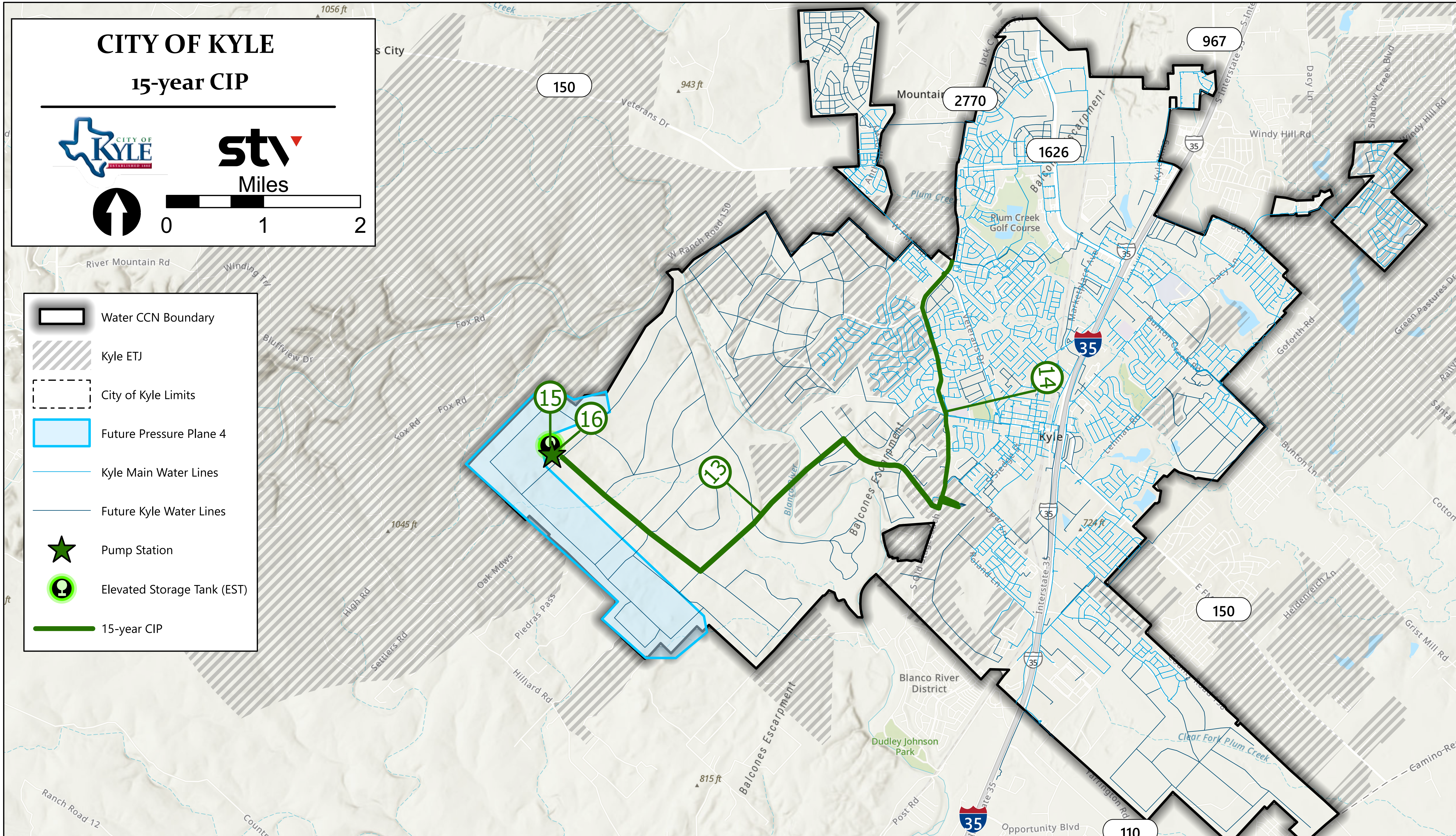
Ultimate Water System Plan



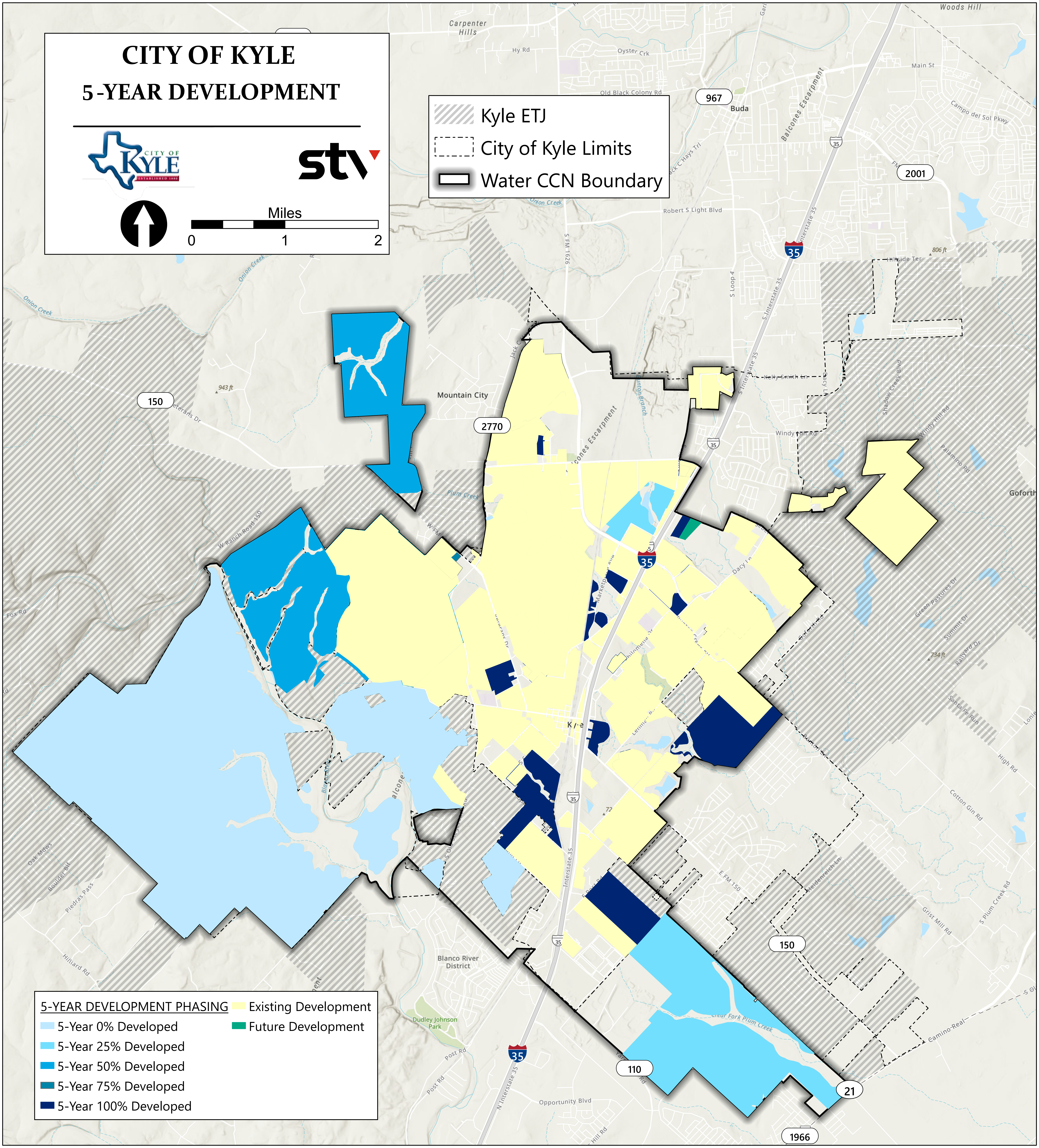
Project Name	CIP	Project Limits	Pipeline Size	Start YR	End YR
Waterstone Pump Station	1	New pump station to receive water from ARWA and pump into PP1		25	26
Waterstone EST	2	New EST to provide storage capacity for PP1		25	26
Hoover EST	3	New EST to provide storage capacity for PP3		25	26
Lehman to Post Oak Transmission Line	4	24" transmission line from Post Oak EST to Lehman PS and 30" from Lehman PS to Lehman Rd	24"	25	28
Dacy and Seton Extensions	5	Dual 24" lines from 30" coming off Lehman Rd to Dacy Ln, connecting at Kyle Pkwy and Seton Pkwy	24"	25	28
Lehaman Pump Station	6	New pump station to receive water from ARWA and pump into PP1		25	28
1626 to Veteran's Rd Transmission Line	7	16" connection from 1626 PS to Veteran's Rd	16"	25	28
Waterstone to Post Oak Transmission Line	8	24" from Waterstone Blvd to Post Oak EST	24"	26	29
PP1 to PP2 Boundary Change	9	Pressure Plane boundary change in downtown PP1 to PP2	12"	26	29
Lehamn Rd Extension	10	24" new connection along Lehman Rd from Hallie Dr to 30" on Bunton Creek Rd	24"	28	32
ARWA 3 North Transmission Line	11	16" new connection from ARWA 3 PS to 12" on S Old Stagecoach Rd	16"	27	32
ARWA 3 Pump Station	12	New pump station to receive water from ARWA and a new EST for additional storage capacity		27	32
Nance Tract Transmission Line	13	24" new connection from ARWA 3 PS to the proposed Nance Tract EST	24"	30	38
Old Stagecoach Roach Improvements	14	Improvements to existing 16" from 1626 PS to ARWA 3 PS along Old Stagecoach Rd and new 16" from ARWA 3 PS along Old Stagecoach Rd to Veterans Rd	16"	28	38
Nance Tract EST	15	New EST to provide storage capacity for PP2		38	38
Pressure Plane 4 Pump Station and Est	16	New pump station and EST to provide pumping and storage capacity for PP2		34	38

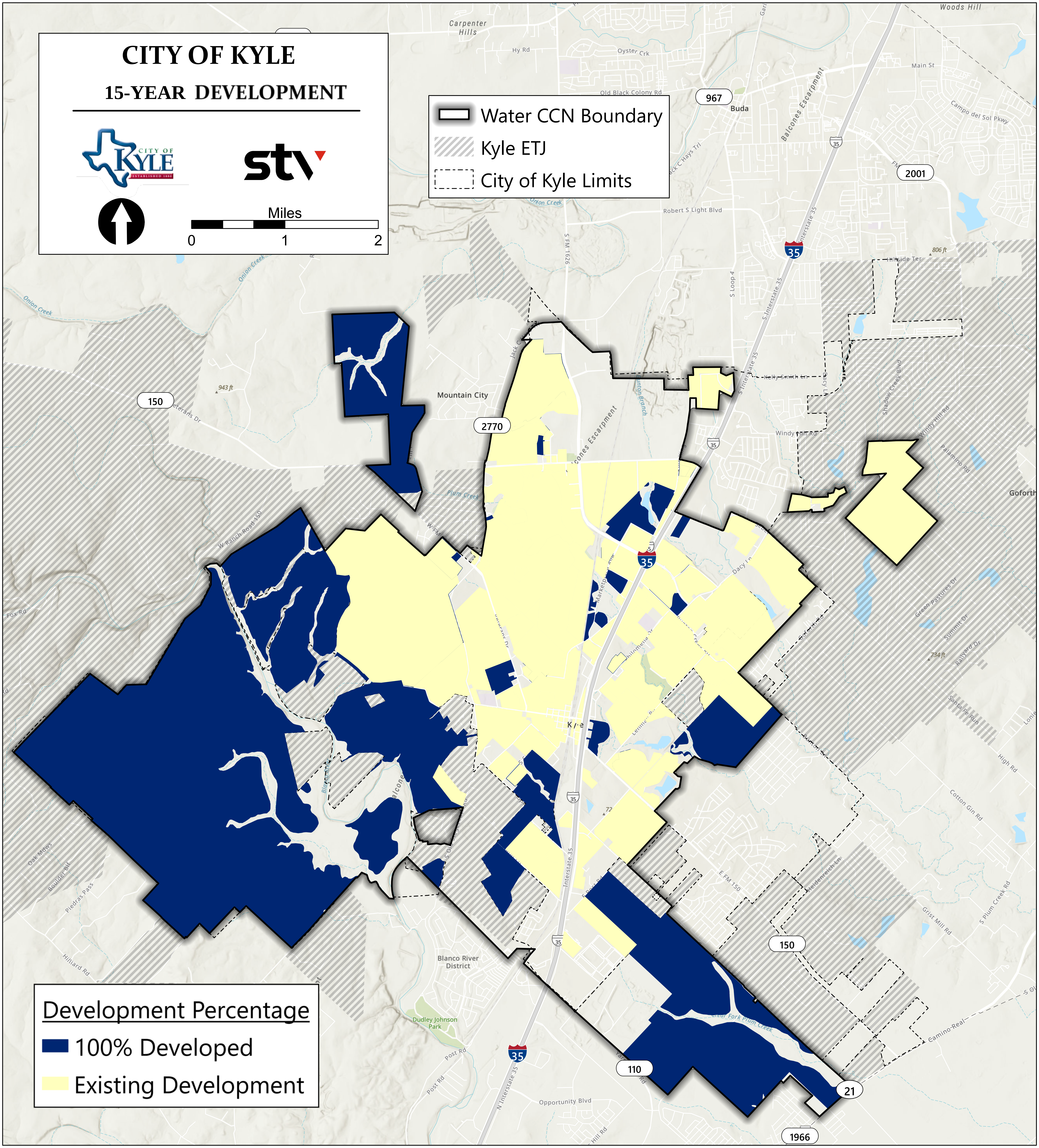


Project Name	CIP	Project Limits	Pipeline Size	Start YR	End YR
Waterstone Pump Station	1	New pump station to receive water from ARWA and pump into PP1		25	26
Waterstone EST	2	New EST to provide storage capacity for PP1		25	26
Hoover EST	3	New EST to provide storage capacity for PP3		25	26
Lehman to Post Oak Transmission Line	4	24" transmission line from Post Oak EST to Lehman PS and 30" from Lehman PS to Lehman Rd	24"	25	28
Dacy and Seton Extensions	5	Dual 24" lines from 30" coming off Lehman Rd to Dacy Ln, connecting at Kyle Pkwy and Seton Pkwy	24"	25	28
Lehaman Pump Station	6	New pump station to receive water from ARWA and pump into PP1		25	28
1626 to Veteran's Rd Transmission Line	7	16" connection from 1626 PS to Veteran's Rd	16"	25	28
Waterstone to Post Oak Transmission Line	8	24" from Waterstone Blvd to Post Oak EST	24"	26	29
PP1 to PP2 Boundary Change	9	Pressure Plane boundary change in downtown PP1 to PP2	12"	26	29
Lehamn Rd Extension	10	24" new connection along Lehman Rd from Hallie Dr to 30" on Bunton Creek Rd	24"	28	32
ARWA 3 North Transmission Line	11	16" new connection from ARWA 3 PS to 12" on S Old Stagecoach Rd	16"	27	32
ARWA 3 Pump Station	12	New pump station to receive water from ARWA and a new EST for additional storage capacity		27	32



Project Name	CIP	Project Limits	Start YR	End YR
Nance Tract Transmission Line	13	24" new connection from ARWA 3 PS to the proposed Nance Tract EST	30	38
Old Stagecoach Roach Improvements	14	Improvements to existing 16" from 1626 PS to ARWA 3 PS along Old Stagecoach Rd and new 16" from ARWA 3 PS along Old Stageoach Rd to Veterans Rd	28	38
Nance Tract EST	15	New EST to provide storage capacity for PP2	38	38
Pressure Plane 4 Pump Station and Est	16	New pump station and EST to provide pumping and storage capacity for PP2	34	38


CITY OF KYLE
5-YEAR DEVELOPMENT
CITY OF KYLE
ESTABLISHED 1880
stv
Miles
0
1
2
Kyle ETJ
City of Kyle Limits
Water CCN Boundary
5-YEAR DEVELOPMENT PHASING
Existing Development
Future Development
5-Year 0% Developed
5-Year 25% Developed
5-Year 50% Developed
5-Year 75% Developed
5-Year 100% Developed
Carpenter Hills
Buda
Mountain City
Kyle
Goforth
Woods Hill
Blanco River District
Dudley Johnson Park
967
2001
150
2770
35
110
21
1966
Interstate 35
Robert S Light Blvd
Old Black Colony Rd
Main St
Campo del Sol Pkwy
Onion Creek
Plum Creek
Balcones Escarpment
W Ranch Road 150
Windy Hill Rd
Kelly Smith Ln
S FM 1626
S Loop 4
Opportunity Blvd
Post Rd
Cotton Gin Rd
Grist Mill Rd
S Plum Creek Rd
Camino Real
E FM 150
Heidenreich Ln
Hilliard Rd
Piedras Pass
Oak Mdws
Boulder Bluff
Fox Rd
Green Pastures Dr
Summit Dr
High Rd
Santa Fe Run
Shadow Creek Blvd
Palamino Rd
Hy Rd
Oyster Crk
806 ft
943 ft
734 ft


CITY OF KYLE
15-YEAR DEVELOPMENT
CITY OF KYLE ESTABLISHED 1880
stv
Miles
0
1
2
Water CCN Boundary
Kyle ETJ
City of Kyle Limits
Development Percentage
100% Developed
Existing Development
Carpenter Hills
Buda
Mountain City
Kyle
Blanco River District
Dudley Johnson Park
Woods Hill
Goforth
967
2001
150
2770
110
21
1966
35
Balcones Escarpment
Onion Creek
Plum Creek
Robert S Light Blvd
Old Black Colony Rd
Main St
Campo del Sol Pkwy
Windy Hill Rd
Kelly Smith Ln
Opportunity Blvd
Post Rd
Hilliard Rd
Cotton Gin Rd
Camino Real
S Plum Creek Rd
Grist Mill Rd
Heidenreich Ln
High Rd
Green Pastures Dr
Summit Dr
E FM 150
W Ranch Road 150
S FM 1626
S Interstate 35
N Interstate 35
Oyster Crk
Hy Rd
Fox Rd
Oak Mdws
Piedras Pass
Boulder Blf
Clear Fork Plum Creek
806 ft
943 ft
734 ft

Appendix B
CIP Summary

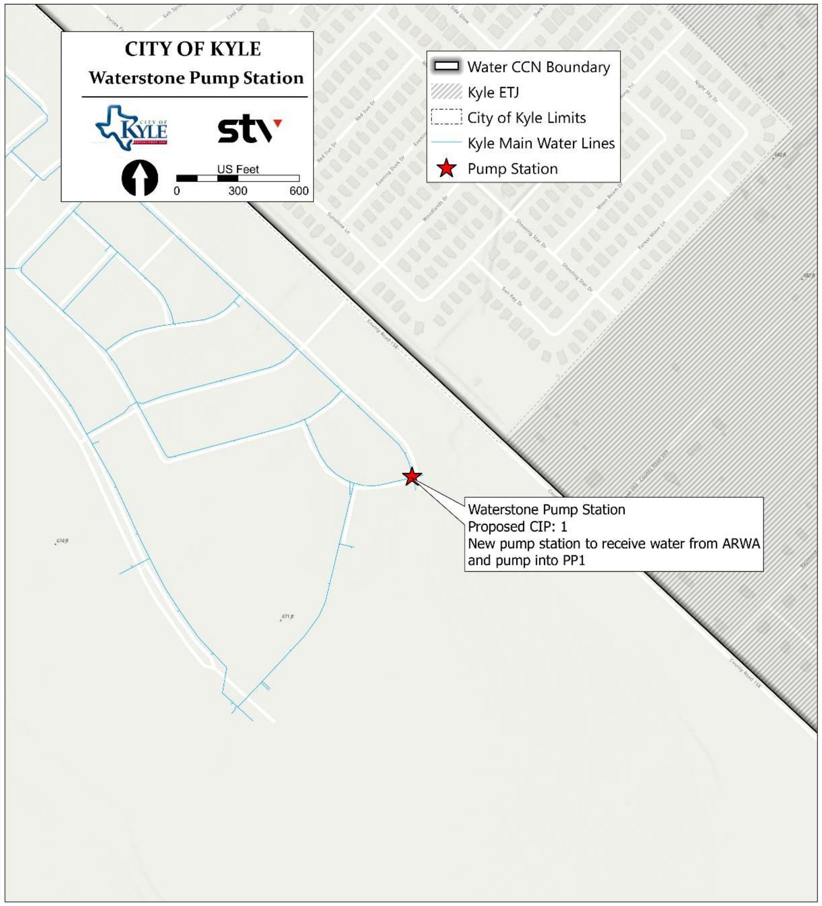
CITY OF KYLE

CIP No. 1 -
Waterstone Pump Station

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The Waterstone Pump Station consists of a new pump station with four (4) pumps and a firm pumping capacity of 7.2 MGD. Waterstone PS will receive water from ARWA and pump into PP1. The project is in construction and is scheduled for completion in FY2026. This project subtotal was provided at $15,000,000 by the City of Kyle and included both the Waterstone Pump Station (CIP No. 1) and Water Stone EST (CIP No. 2). The total cost was split into roughly $10,000,000 for the Pump Station and $5,000,000 for the EST. The subtotal provided is assumed to include construction contingency and mobilization, bonds, and insurance costs.

PROJECT DRIVER:
The purpose of this improvement is to receive ARWA water and provide pumping capacity for PP1.



TIMELINE: FY25 - FY26

CIP No. 1 - Waterstone Pump Station					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	Booster Pump Station (7.2 MGD)	LS	1	$ 10,000,000	$ 10,000,000
				Contingency (30%)	-
				Mobilization/Bonds/Insurance (10%)	-
				Subtotal	**$ 10,000,000**
				Engineering/Survey (18%)	$ 1,800,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 11,800,000**

CITY OF KYLE

CIP No. 2 -
Waterstone Elevated Storage Tank

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:

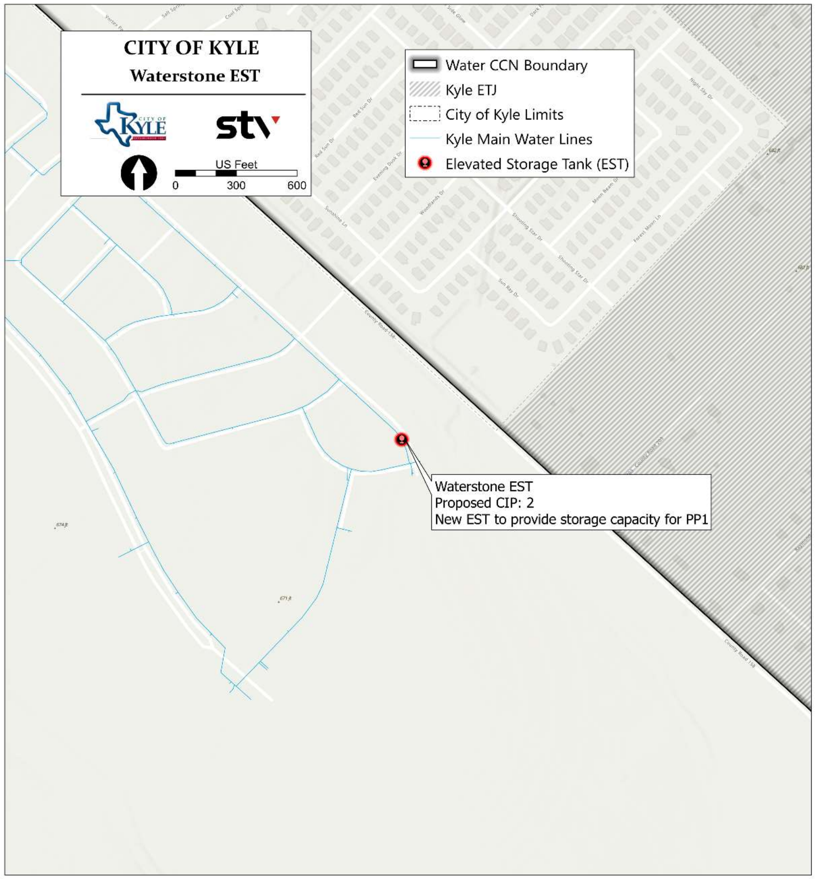
The Waterstone Elevated Storage Tank project includes the construction of a new 1 MG elevated storage tank and will provide additional elevated storage capacity for PP1. This EST is included with the Waterstone Pump Station project and is scheduled for completion in FY2026. This project subtotal was provided at $15,000,000 by the City of Kyle and included both the Waterstone Pump Station (CIP No. 1) and Water Stone EST (CIP No. 2). The total cost was split into roughly $10,000,000 for the Pump Station and $5,000,000 for the EST. The subtotal provided is assumed to include construction contingency and mobilization, bonds, and insurance costs.

PROJECT DRIVER:

The purpose of this improvement is to provide elevated storage capacity for Pressure Plane 1.

TIMELINE: FY25 - FY26

CIP No. 2 - Waterstone Elevated Storage Tank					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	Elevated Storage Tank (1 MG)	LS	1	$ 5,000,000	$ 5,000,000
				Contingency (30%)	-
				Mobilization/Bonds/Insurance (10%)	-
				Subtotal	**$ 5,000,000**
				Engineering/Survey (18%)	$ 900,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 5,900,000**



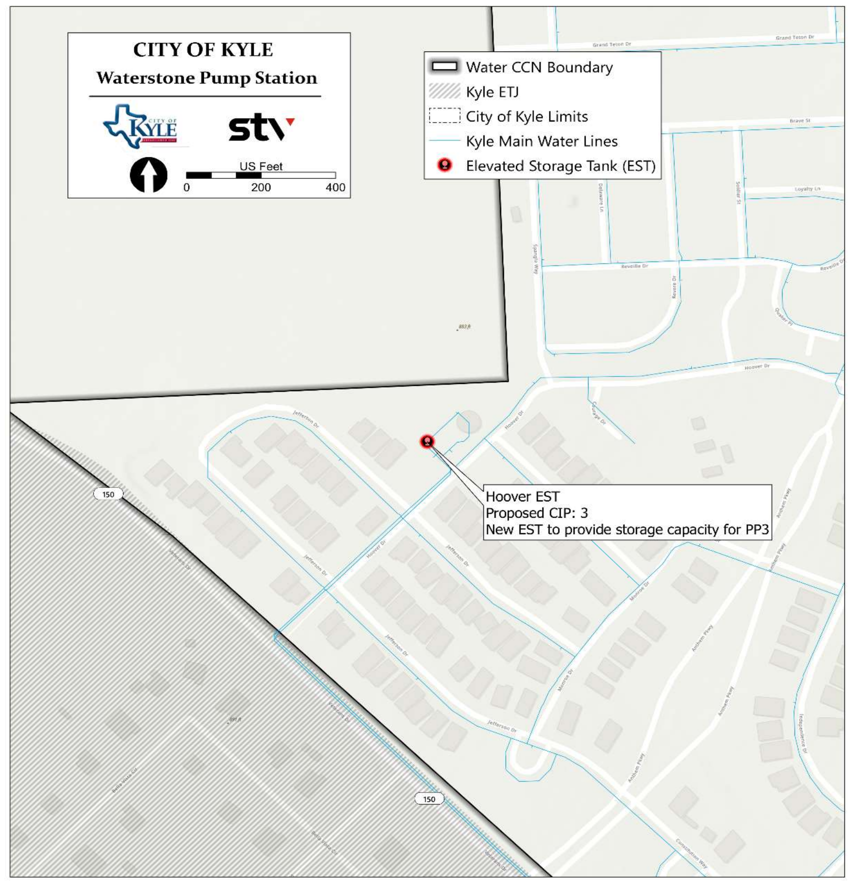
CITY OF KYLE

CIP No. 3 -
Hoover Elevated Storage Tank

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The Hoover Elevated Storage Tank project includes the construction of a new 1 MG elevated storage tank that will provide elevated storage capacity for PP3. The project is in construction and is scheduled for completion in FY2026. This project subtotal was provided by the City of Kyle and is assumed to include construction contingency and mobilization, bonds, and insurance costs.

PROJECT DRIVER:
The purpose of this improvement is to provide elevated storage capacity for Pressure Plane 3.



TIMELINE: FY25 - FY26

CIP No. 3 - Hoover Elevated Storage Tank					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	Elevated Storage Tank (1 MG)	LS	1	$ 5,290,000	$ 5,290,000
				Contingency (30%)	-
				Mobilization/Bonds/Insurance (10%)	-
				Subtotal	**$ 5,290,000**
				Engineering/Survey (18%)	$ 953,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 6,243,000**

CITY OF KYLE

CIP No. 4 -
Lehman to Post Oak Transmission Line

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:

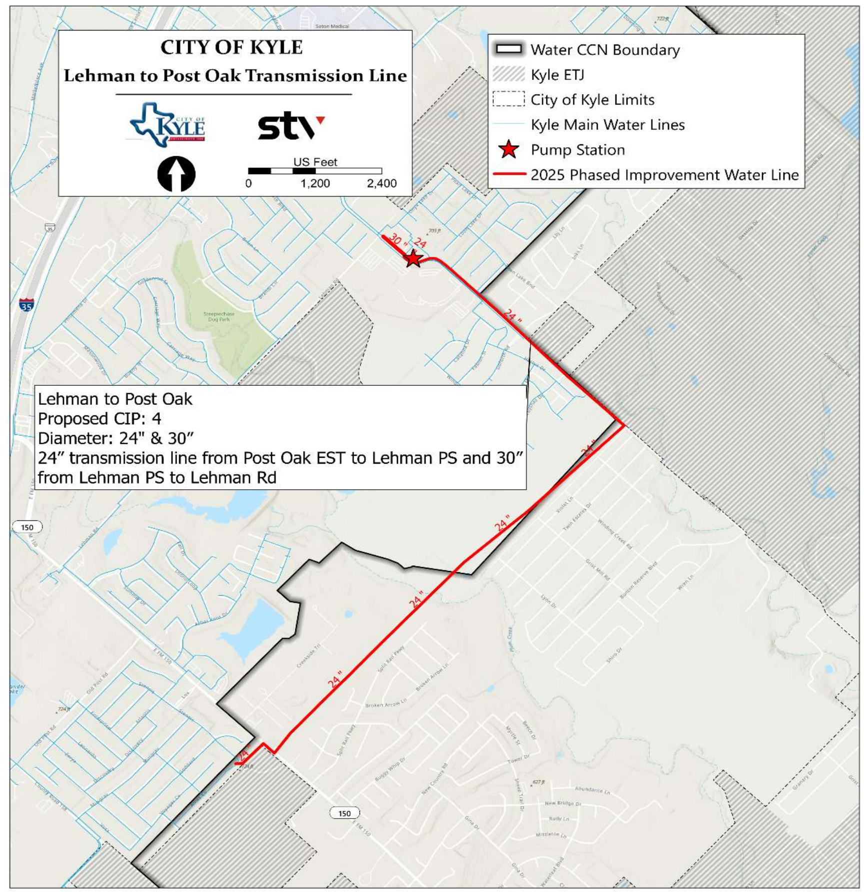
The Lehman to Post Oak Transmission Line is an emergency project started in 2025 to be in place before 2028 which will provide transmission capacity from Post Oak EST to Lehman Pump Station. The project consists of 10,000 ft of 24-inch transmission line installed along future Goforth Road, 5,200 ft of 24-inch transmission line installed along existing Bunton Lane and Bunton Creek Road and 550 ft of 30-inch pipe on Bunton Creek Road. The project is in design and is scheduled for completion in FY2028.

PROJECT DRIVER:

The purpose of this improvement is to provide transmission capacity from Post Oak to Lehman Pump Station.

TIMELINE: FY25 - FY28

CIP No. 4 - Lehman to Post Oak Transmission Line					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	24" Water Line, Open Cut	LF	14,727	$ 614	$ 9,039,433
2	24" Water Line, Trenchless	LF	473	$ 2,000	$ 946,000
3	30" Water Line, Open Cut	LF	500	$ 768	$ 383,900
4	30" Water Line, Trenchless	LF	50	$ 2,450	$ 122,500
5	Pavement Repair	LF	105	$ 110	$ 11,550
6	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 3,151,015
				Mobilization/Bonds/Insurance (10%)	$ 1,050,338
				Subtotal	$ 14,705,000
				Engineering/Survey (18%)	$ 2,647,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	228,405	$ 8	$ 1,828,000
				Project Total	$ 19,180,000



CITY OF KYLE

CIP No. 5 - Dacy and Seton Extensions

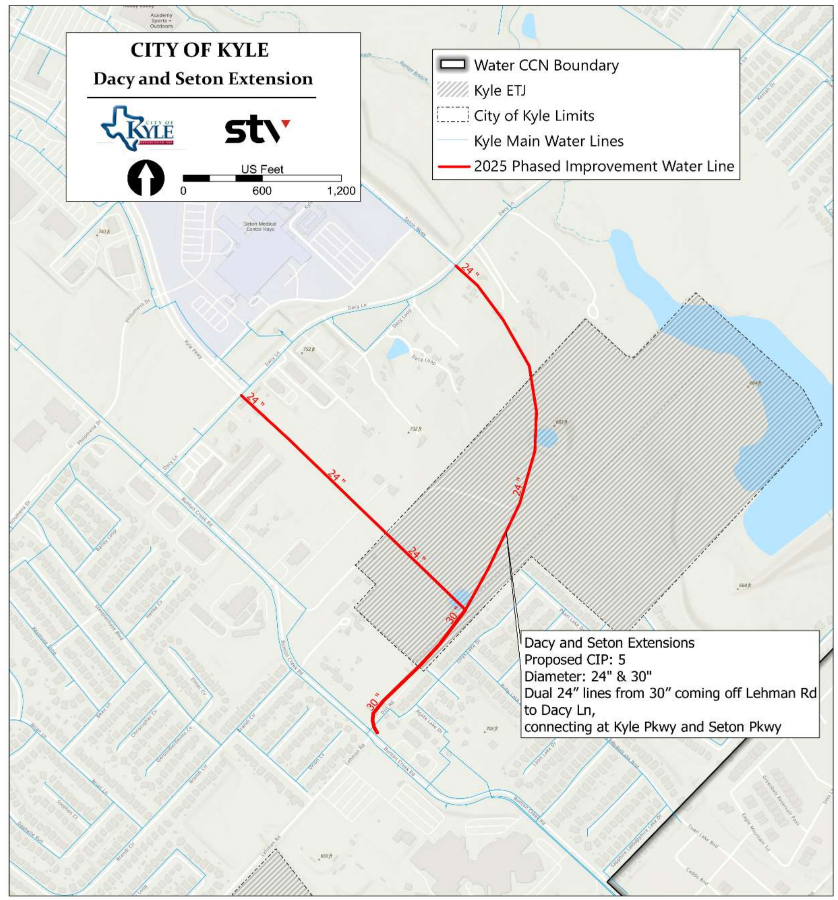
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:

The Dacy and Seton Extension is an emergency project beginning in FY2025 and includes dual 24-inch lines connecting Kyle Pkwy and Seton Pkwy to a 30-inch along Bunton Creek Road. This extension provides transmission capacity from Lehman PS to Dacy Lane EST. The project consists of 1275 ft of 30-inch along a future road, 2385 ft of 24-inch to Dacy Ln and Kyle Parkway intersection along a future road, and 2975 ft of 24-inch to Dacy Lane and Seton Parkway intersection along a future road. The project is in design and is scheduled for completion in FY2028.

PROJECT DRIVER:

The purpose of this improvement is to provide transmission capacity form Lehman to Dacy EST.



TIMELINE: FY25 - FY28

CIP No. 5 - Dacy and Seton Extensions					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	24" Water Line, Open Cut	LF	4870	$ 614	$ 2,989,206
2	24" Water Line, Trenchless	LF	490	$ 2,000	$ 980,000
3	30" Water Line, Open Cut	LF	1275	$ 768	$ 978,945
4	30" Water Line, Trenchless	LF	0	$ 2,450	$ -
5	Pavement Repair	LF	38	$ 110	$ 4,180
6	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 1,485,699
				Mobilization/Bonds/Insurance (10%)	$ 495,233
				Subtotal	**$ 6,934,000**
				Engineering/Survey (18%)	$ 1,249,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	92175	$ 8	$ 738,000
				Project Total	**$ 8,921,000**

CITY OF KYLE

CIP No. 6 -
Lehman Pump Station

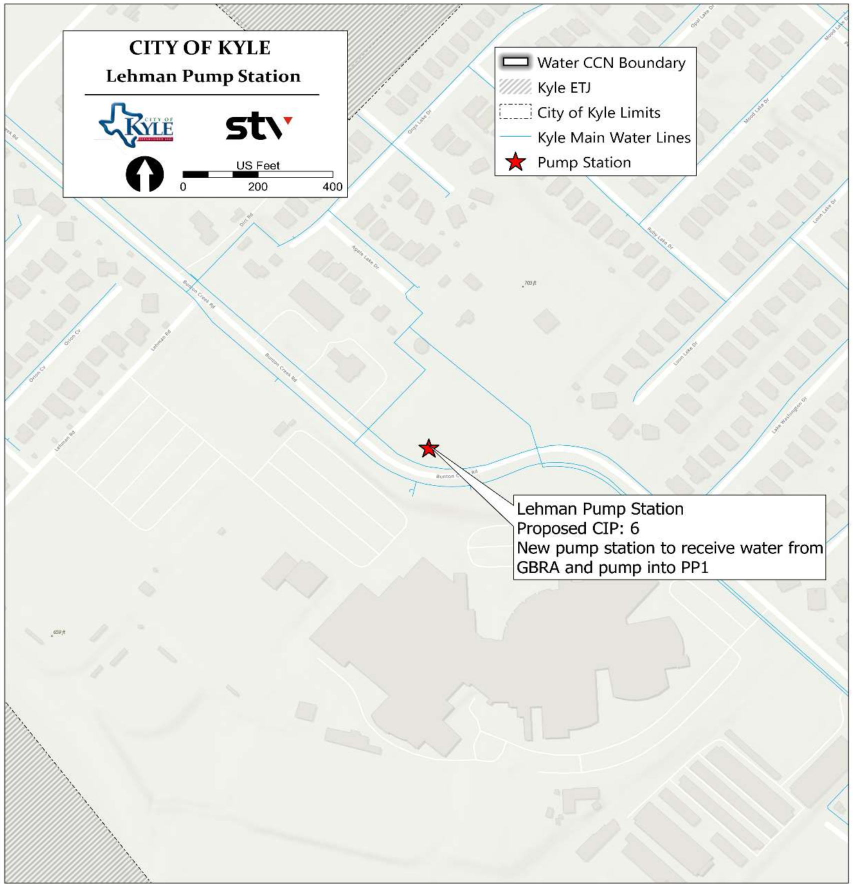
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:

The Lehman Pump Station project will begin in FY2025 and includes the construction of a new pump station with a firm pumping capacity of 5 MGD and further capacity expansion in the future. The pump station receives water from GBRA and pumps into PP1. The new PS will be constructed adjacent to the existing Lehman pump station. The project is in design and is scheduled for completion in FY2028.

PROJECT DRIVER:

The purpose of this improvement is to provide pumping capacity for Pressure Plane 1 and receive GBRA water.



TIMELINE: FY25 - FY28

CIP No. 6 - Lehman Pump Station					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	Pump Station (5 MGD)	LS	1	$ 8,000,000	$ 8,000,000
2	Ground Storage Tank (3.5 MG)	LS	1	$ 4,500,000	$ 4,500,000
				Contingency (30%)	$ 3,750,000
				Mobilization/Bonds/Insurance (10%)	$ 1,250,000
				Subtotal	**$ 17,500,000**
				Engineering/Survey (18%)	$ 3,150,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 20,650,000**

CITY OF KYLE

CIP No. 7 -
1626 to Veteran's Road 16" Transmission Main

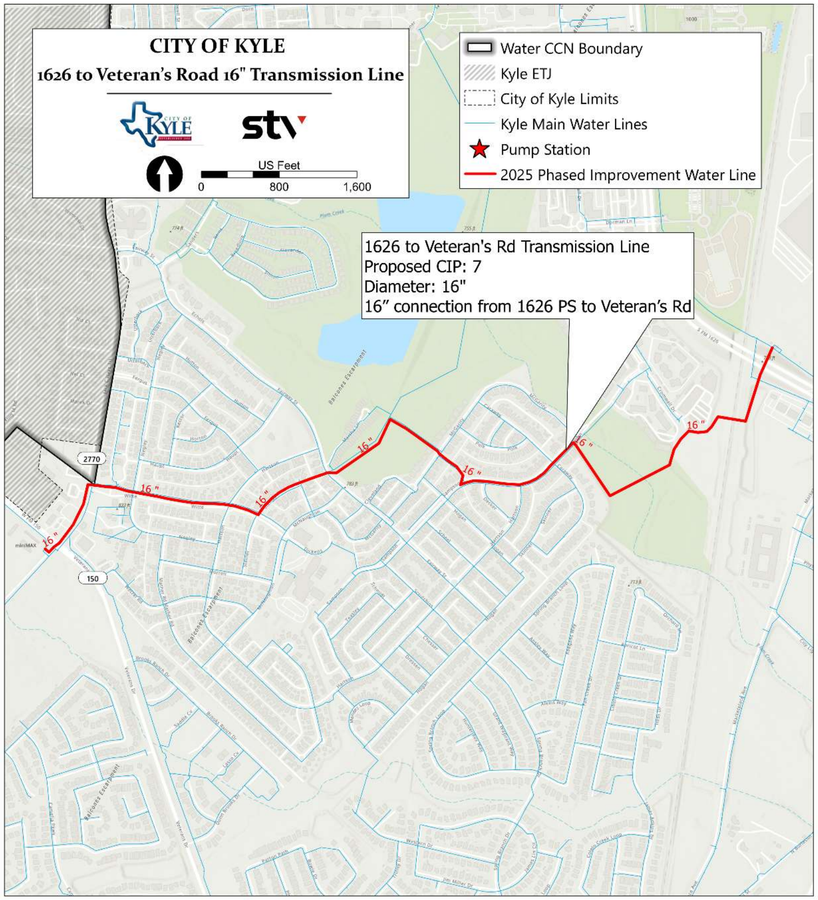
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The 1626 to Veteran's Road 16-inch transmission main consists of a water line from 1626 Pump Station to Veteran's Road. This project is needed to provide adequate capacity to the south and west side of PP2 and to PP3. This project could be delayed if the ARWA 3 PS were expedited and brought in service by 2028.

PROJECT DRIVER:
The purpose of this improvement is to utilize the pump capacity improvements at 1626 Pump Station to serve west side of Pressure Plane 2 and provide water to Pressure Plane 3.

TIMELINE: FY25* - FY28*

CIP No. 7 - 1626 to Veteran's Road 16" Transmission Main					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	16" Water Main Open Cut	LF	9100	$ 504	$ 4,584,580
2	16" Water Main Trenchless	LF	1000	$ 1,600	$ 1,600,000
3	Pavement Repair	LF	1000	$ 110	$ 110,000
4	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 1,888,374
				Mobilization/Bonds/Insurance (10%)	$ 629,458
				Subtotal	**$ 8,813,000**
				Engineering/Survey (18%)	$ 1,587,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	68250	$ 8	$ 546,000
				Project Total	**$ 10,946,000**



CITY OF KYLE

CIP No. 8 -
Waterstone to Post Oak Transmission Line

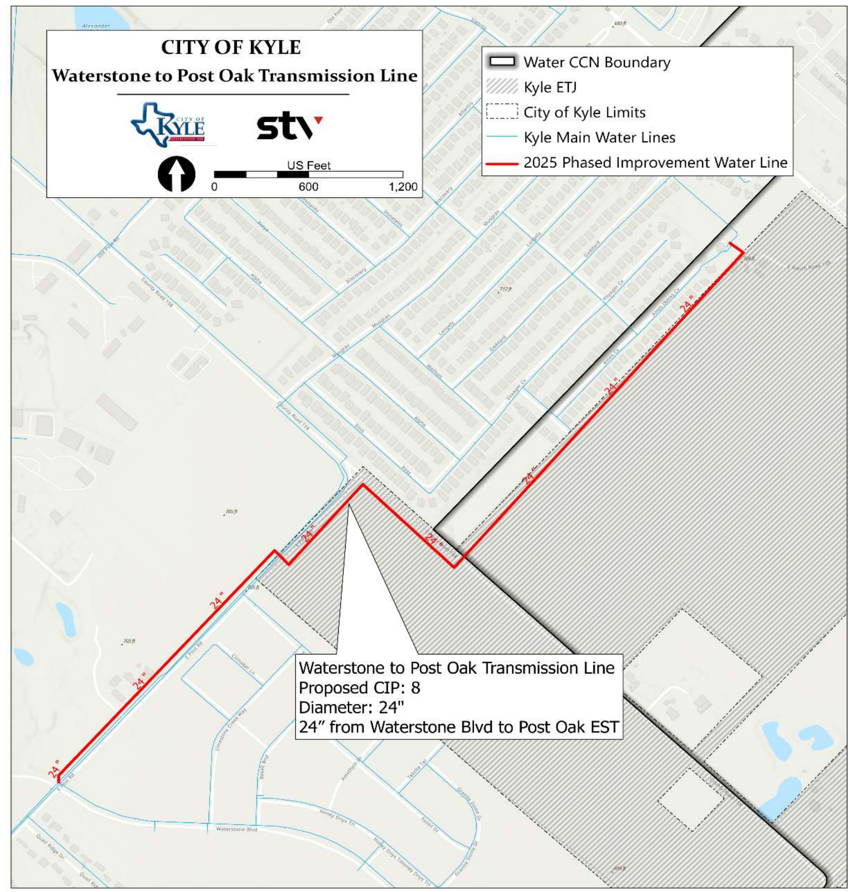
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The Waterstone to Post Oak Transmission Line project consists of a 24-inch from Waterstone Blvd to Post Oak EST. This will complete the 24-inch transmission line from Waterstone Blvd in the south to Dacy EST in the north. The total length of new line will be 6,630 ft, including the replacement of 2,800 ft of 12-inch along E Post Road with 24-inch and 3,830 ft of new 24-inch line along future Goforth Road. The project is scheduled for completion in FY2029.

PROJECT DRIVER:
The purpose of this improvement is to accommodate the new pumping capacity at Waterstone PS to connect to the north.

TIMELINE: FY26 - FY29

CIP No. 8 - Waterstone to Post Oak Transmission Line					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	12" Water Line, Open Cut	LF	2675	$ 339	$ 906,290
2	12" Water Line, Trenchless	LF	125	$ 1,200	$ 150,000
3	24" Water Line, Open Cut	LF	3705	$ 614	$ 2,274,129
4	24" Water Line, Trenchless	LF	125	$ 2,000	$ 250,000
5	Pavement Repair	LF	110	$ 110	$ 12,100
6	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 1,077,756
				Mobilization/Bonds/Insurance (10%)	$ 359,252
				Subtotal	**$ 5,030,000**
				Engineering/Survey (18%)	$ 906,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	55575	$ 8	$ 445,000
				Project Total	**$ 6,381,000**



CITY OF KYLE

CIP No. 9 -
Pressure Plane Boundary Modification PP1 to PP2

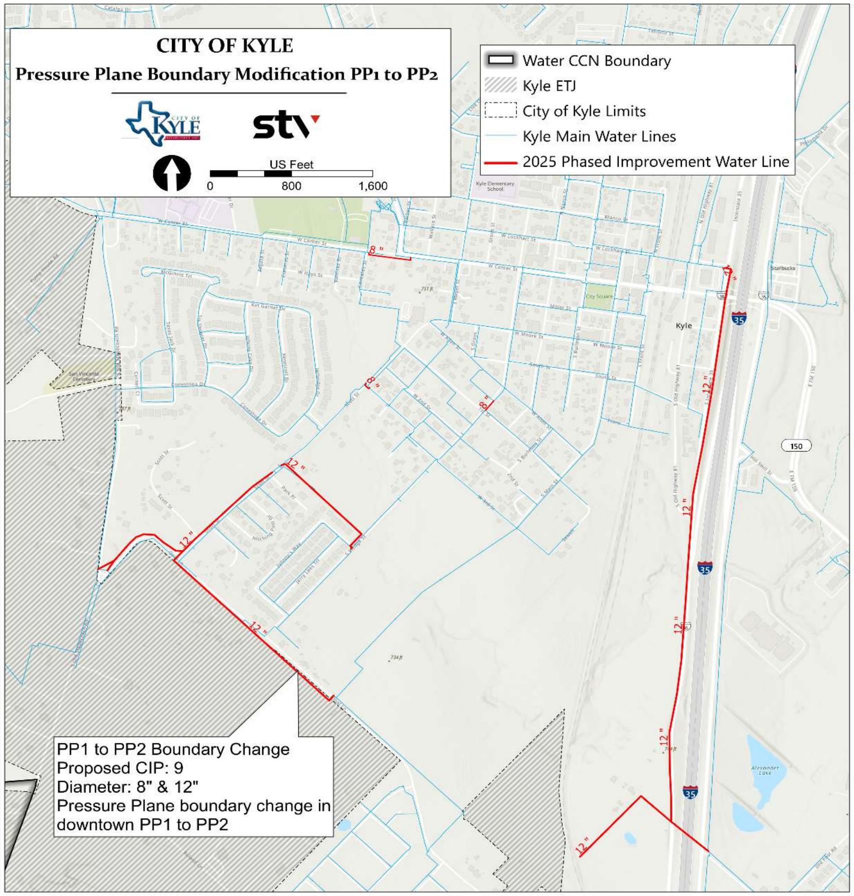
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:

The Pressure Plane Boundary Modification PP1 to PP2 project includes boundary changes and additional lines in targeted areas to improve low pressures in the downtown area. The project consists of improvements in five locations. New transmission lines totaling 7,600 ft of 12-inch along I-35 and County Road 208, including boring under I-35. A total of 5,668 ft of 12-inch Looping along Opal Ln, Scott St, and the northeast edge of the Four Oaks and Bradford Meadows subdivisions which includes new pipe plus 1,320 ft of replacing existing 3" pipe. New transmission lines totaling 100 ft of 8-inch Crossing Scott St and along W 3rd St, 125 ft of 8-inch along S Sledge St, and 460 ft of 8-inch along Center St. A full description of this project can be found in the Pressure Plane Modifications Tech Memo. The project is scheduled to begin design in FY2026.

PROJECT DRIVER:

The purpose of this improvement is to improve persistent low pressures in the downtown area.



TIMELINE: FY26 - FY29

CIP No. 9 - Pressure Plane Boundary Modification PP1 to PP2					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	8" Water Line, Open Cut	LF	460	$ 204	$ 93,610
2	8" Water Line, Trenchless	LF	225	$ 900	$ 202,500
3	12" Water Line, Open Cut	LF	12148	$ 339	$ 4,115,742
4	12" Water Line, Trenchless	LF	1120	$ 1,200	$ 1,344,000
5	Pavement Repair	LF	3000	$ 110	$ 330,000
6	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 1,825,756
				Mobilization/Bonds/Insurance (10%)	$ 608,585
				Subtotal	**$ 8,521,000**
				Engineering/Survey (18%)	$ 1,534,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 10,055,000**

CITY OF KYLE

CIP No. 10 -
Lehman Road Extension

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The Lehman Road Extension project includes installation of 2,750 ft of new 24-inch transmission along Lehman Rd from Hallie Dr to connect to the proposed 30-inch on Bunton Creek Rd. The project is scheduled to begin design in FY2028.

PROJECT DRIVER:
The purpose of this improvement is to complete the loop from Lehman PS discharge to neighborhoods SW of pump station.

TIMELINE: FY28 - FY32

CIP No. 10 - Lehman Road Extension					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	24" Water Line, Open Cut	LF	2562	$ 614	$ 1,572,556
2	24" Water Line, Trenchless	LF	188	$ 2,000	$ 376,000
3	Pavement Repair	LF	100	$ 110	$ 11,000
4	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 587,867
				Mobilization/Bonds/Insurance (10%)	$ 195,956
				Subtotal	$ 2,744,000
				Engineering/Survey (18%)	$ 494,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	38430	$ 8	$ 308,000
				Project Total	$ 3,546,000

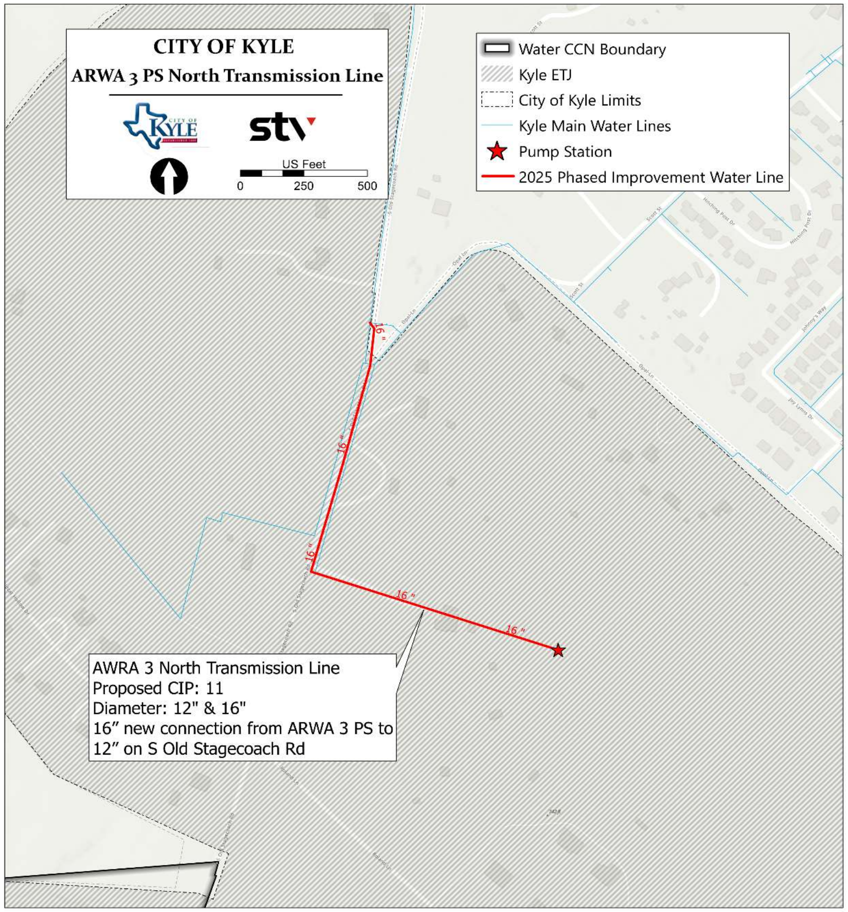
CITY OF KYLE

CIP No. 11 -
ARWA 3 PS North Transmission Line

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The ARWA 3 PS North Transmission Line project consists of a new 16-inch transmission line from ARWA 3 PS to a 12-inch on S Old Stagecoach Rd with a total length of about 2,100 ft. The project is scheduled to begin design in FY2028 provided that the 1626 to Veteran's Road 16" Transmission Main project begins in 2025. It is assumed that the ARWA PS will be constructed with partial capacity in the same timeframe.

PROJECT DRIVER:
The purpose of this improvement is to provide flow from ARWA 3 PS to PP2.



TIMELINE: FY27* - FY32*

CIP No. 11 - ARWA 3 PS North Transmission Line					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	16" Water Main Open Cut	LF	1700	$ 504	$ 856,460
2	16" Water Main Trenchless	LF	400	$ 1,600	$ 640,000
3	Pavement Repair	LF	588	$ 110	$ 64,680
4	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 468,342
				Mobilization/Bonds/Insurance (10%)	$ 156,114
				Subtotal	**$ 2,186,000**
				Engineering/Survey (18%)	$ 394,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	25500	$ 8	$ 204,000
				Project Total	**$ 2,784,000**

CITY OF KYLE

CIP No. 12 -
ARWA 3 Pump Station and Transmision Line

CAPITAL IMPROVEMENT PROJECT SUMMARY

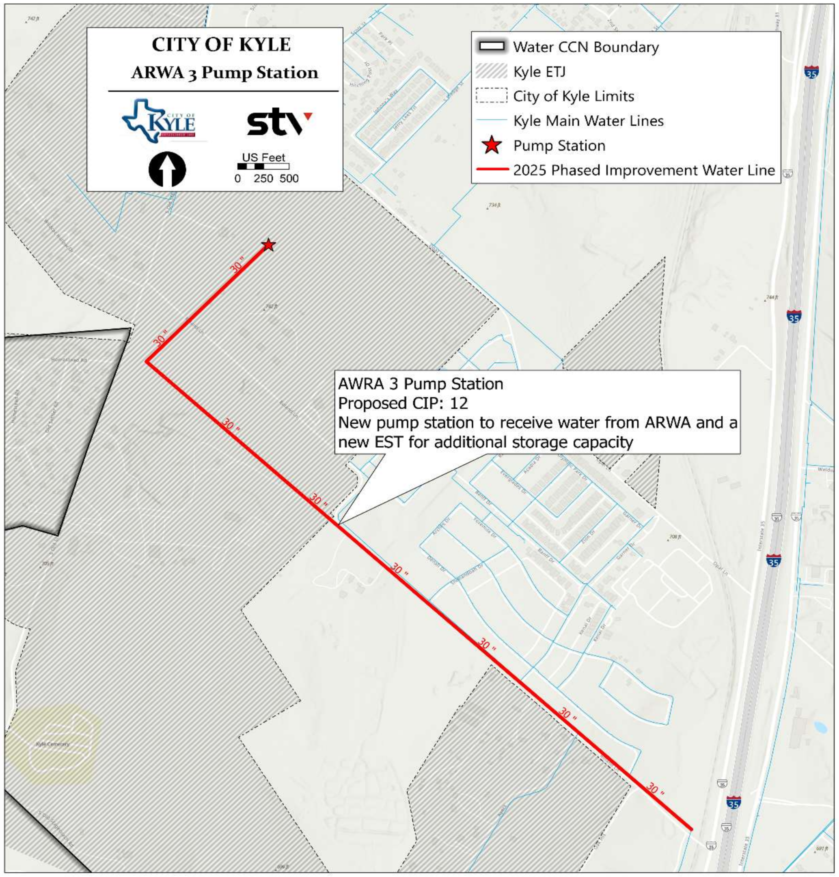
PROJECT DESCRIPTION:
The ARWA 3 Pump Station project consists of a new pump station at new location (TBD) with a firm pump capacity of 5000 gpm (7.2 MGD) which will be expandable in the future and a 3.5 MG GST with space for another in the future. A 30" supply line with length about 9000 ft to deliver ARWA water is also included. This project is scheduled to begin design in FY2027 provided that the 1626 to Veteran's Road 16" Transmission Main project begins in 2025.

PROJECT DRIVER:
The purpose of this improvement is to provide pumping capacity for Pressure Plane 1 and 2 and receive ARWA water in the southwest side of the system.

TIMELINE: FY27* - FY32*

CIP No. 12 - ARWA 3 Pump Station and Transmision Line

ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	4.0 MGD Pump Station and 1.5 MG GST	LS	1	$ 15,000,000	$ 15,000,000
2	30" Water Supply Line from ARWA	LF	9,000	$ 768	$ 6,910,200
				Contingency (30%)	$ 4,500,000
				Mobilization/Bonds/Insurance (10%)	$ 1,500,000
				Subtotal	**$ 27,911,000**
				Engineering/Survey (18%)	$ 5,024,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	180,000	$ 8	$ 1,440,000
				Project Total	**$ 34,375,000**



CITY OF KYLE

CIP No. 13 -
ARWA 3 PS Nance Tract Transmission Line

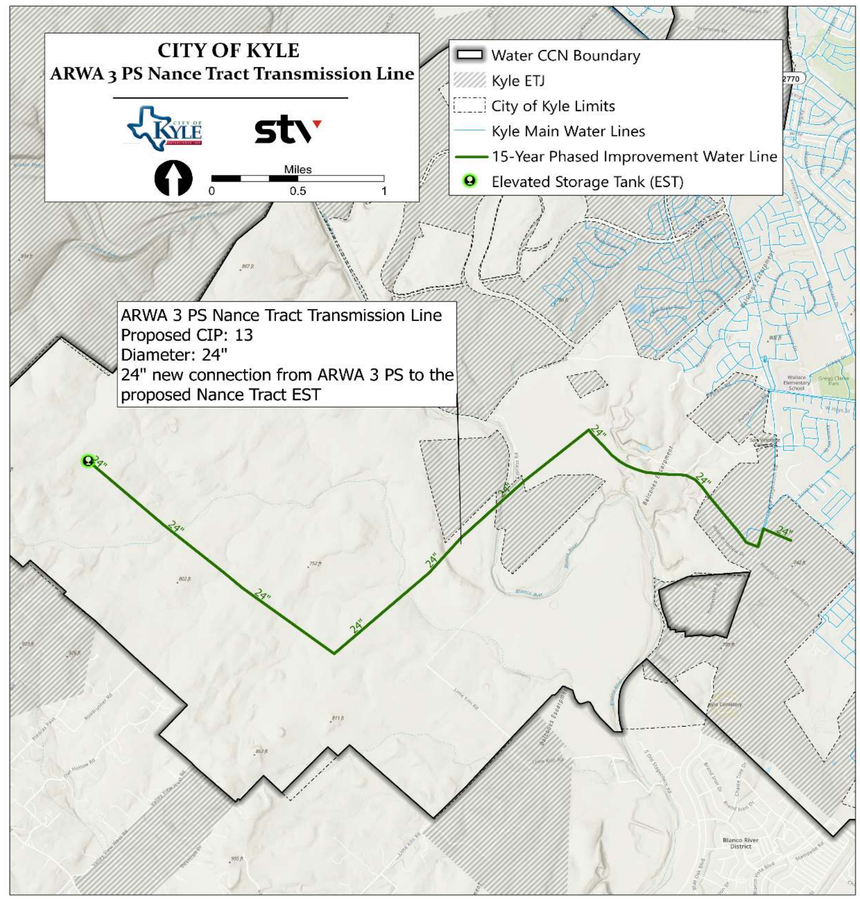
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The ARWA 3 PS Nance Tract Transmission Line project consists of 28,690 linear feet of new 24-inch transmission line to be installed along future road (TBD) from ARWA 3 PS to the proposed 1.5 MG Nance Tract EST. The project is scheduled will be driven by development in the Nance Tract.

PROJECT DRIVER:
The purpose of this improvement is to provide adequate flow capacity to the proposed Nance Tract, BRI McCoy, and Nance Tract EST.

TIMELINE: FY30 - FY38

CIP No. 13 - ARWA 3 PS Nance Tract Transmission Line					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	24" Water Main Open Cut	LF	26400	$ 614	$ 16,204,320
2	24" Water Main Trenchless	LF	2300	$ 2,000	$ 4,600,000
3	Pavement Repair	LF	500	$ 110	$ 55,000
4	Surface Restoration	LF	0	$ 3	$ -
				Contingency (30%)	$ 6,257,796
				Mobilization/Bonds/Insurance (10%)	$ 2,085,932
				Subtotal	**$ 29,204,000**
				Engineering/Survey (18%)	$ 5,257,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	396000	$ 8	$ 3,168,000
				Project Total	**$ 37,629,000**



CITY OF KYLE

CIP No. 14 -
Old Stagecoach Road Improvements

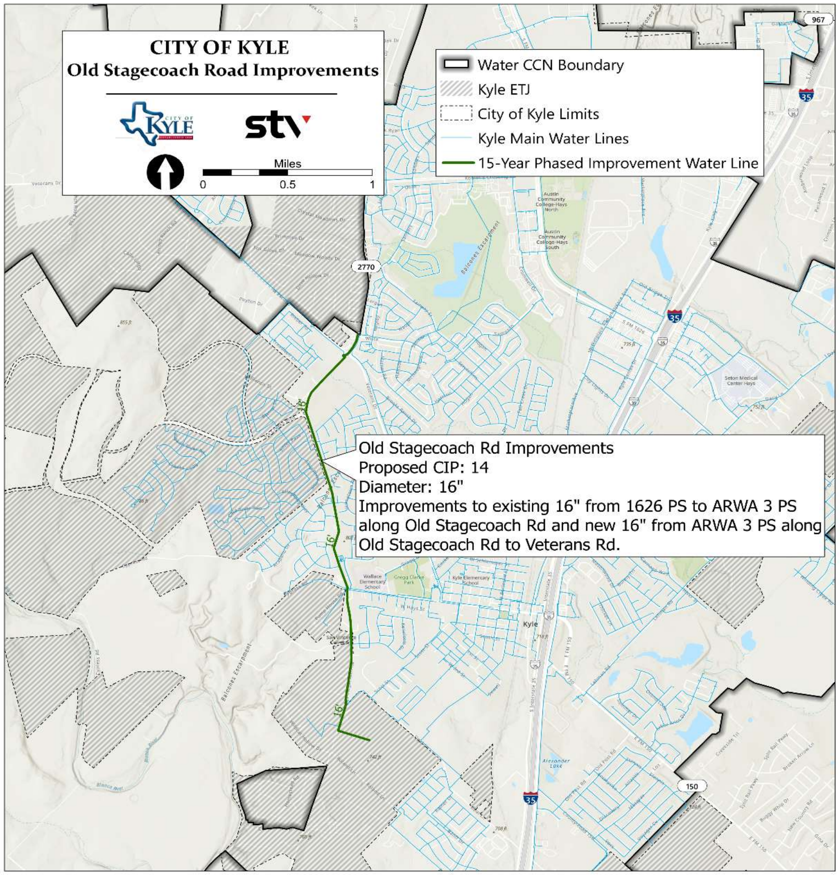
CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:

The Old Stagecoach Road Improvements project consists of improvements to existing 16-inch line from 1626 PS to ARWA 3 pump station with 10,100 ft of 16-inch from 1626 PS to Veteran's Rd and 12,150 ft of 16-inch along Old Stagecoach Rd from ARWA 3 PS to Veteran's Rd. The project schedule will be driven by development or as coordinated with road improvement projects.

PROJECT DRIVER:

The purpose of this improvement is to provide adequate flow capacity along Old Stagecoach Rd. to improve connectivity between the northern and southern portions of Pressure Plane 2.



TIMELINE: FY28 - FY38

CIP No. 14 - Old Stagecoach Road Improvements							
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST		UNIT SUBTOTAL	
1	16" Water Main Open Cut	LF	9047	$	504	$	4,557,879
2	16" Water Main Trenchless	LF	1053	$	1,600	$	1,684,800
3	Pavement Repair	LF	7000	$	110	$	770,000
4	Surface Restoration	LF	0	$	3	$	-
					Contingency (30%)	$	2,103,804
					Mobilization/Bonds/Insurance (10%)	$	701,268
					Subtotal	**$**	**9,818,000**
					Engineering/Survey (18%)	$	1,768,000
Easement/ROW Acqusition							
1	**Property Acquisition**	SF	135705	$	8	$	1,086,000
					Project Total	**$**	**12,672,000**

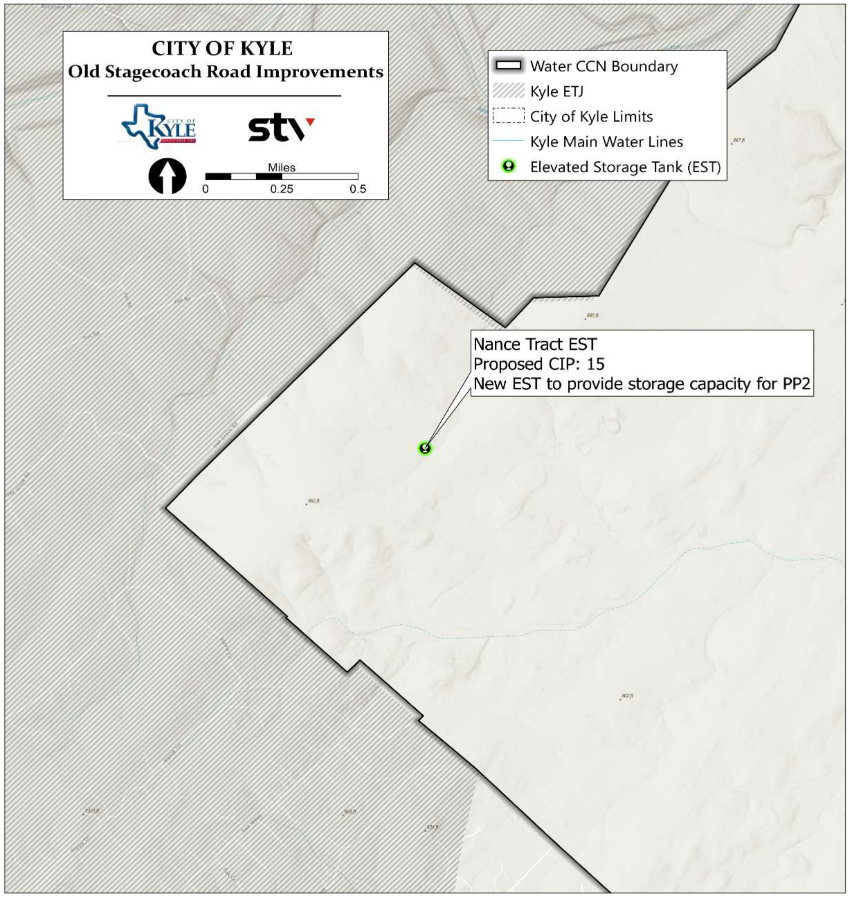
CITY OF KYLE

CIP No. 15 -
Nance Tract EST

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The Nance Tract EST project consists of a new 1.5 MG composite EST which will provide elevated storage capacity for Pressure Plane 2. The project is will be driven by development in the Nance Tract.

PROJECT DRIVER:
The purpose of this improvement is to provide elevated storage capacity for Pressure Plane 2.



TIMELINE: FY30 - FY38

CIP No. 15 - Nance Tract EST					
ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST	UNIT SUBTOTAL
1	Composite Elevated Storage Tank (1.5 MG)	LS	1	$ 4,200,000	$ 4,200,000
				Contingency (30%)	$ 1,260,000
				Mobilization/Bonds/Insurance (10%)	$ 420,000
				Subtotal	**$ 5,880,000**
				Engineering/Survey (18%)	$ 1,059,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 6,939,000**

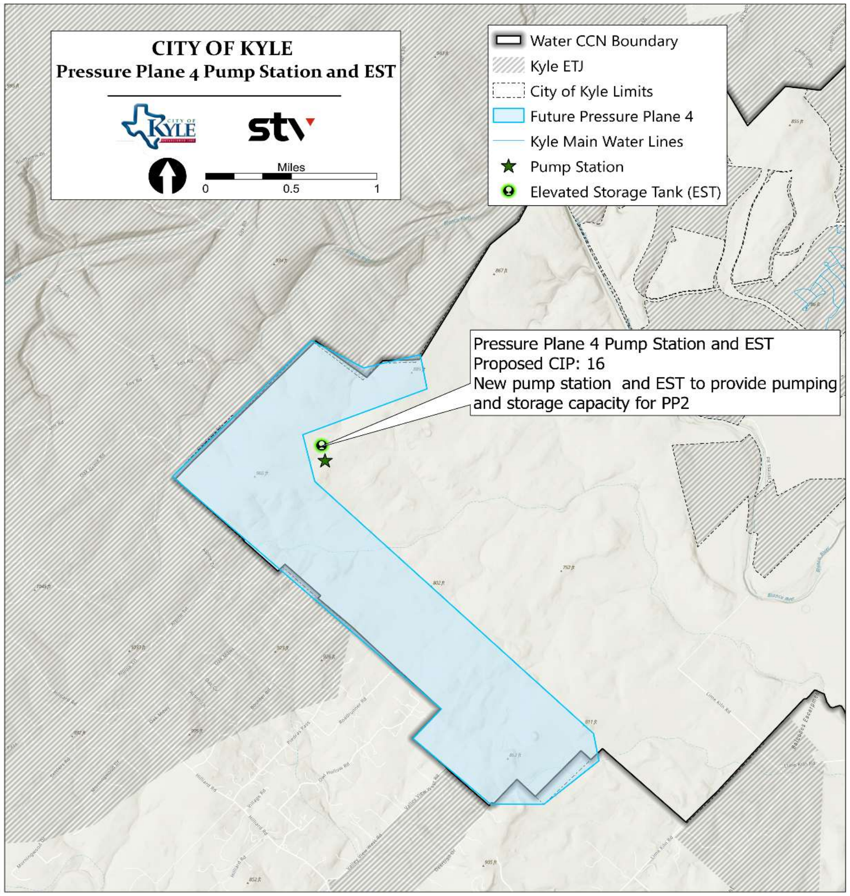
CITY OF KYLE

CIP No. 16 -
Pressure Plane 4 Pump Station and Elevated Storage Tank

CAPITAL IMPROVEMENT PROJECT SUMMARY

PROJECT DESCRIPTION:
The Pressure Plane 4 Pump Station and EST project includes a new 2 MGD capacity Pump Station and 300,000 gallon elevated storage tank. The project schedule will be driven by development in the far west edge of the Nance Tract.

PROJECT DRIVER:
The purpose of this improvement is to provide adequate pumping and elevated storage capacity required due to elevation change on western extreme of Pressure Plane 2.



TIMELINE: FY34 - FY38

CIP No. 16 - Pressure Plane 4 Pump Station and Elevated Storage Tank					
ITEM NO.	**DESCRIPTION**	**UNITS**	**QNTY**	**UNIT COST**	**UNIT SUBTOTAL**
1	Pump Station (2 MGD)	LS	1	$ 1,500,000	$ 1,500,000
2	Elevated Storage Tank (0.3 MG)	LS	1	$ 1,300,000	$ 1,300,000
				Contingency (30%)	$ 840,000
				Mobilization/Bonds/Insurance (10%)	$ 280,000
				Subtotal	**$ 3,920,000**
				Engineering/Survey (18%)	$ 706,000
Easement/ROW Acqusition					
1	**Property Acquisition**	SF	0	$ 8	$ -
				Project Total	**$ 4,626,000**

Appendix C

Existing Water System Technical Memorandum

CITY OF KYLE

WATER DISTRIBUTION SYSTEM ANALYSIS

Existing Water System Technical Memorandum

October 2024

This Technical Memorandum presents the results of the preliminary study of the existing conditions of the City of Kyle water distribution system and presents the development and update of the hydraulic model to be used in further Master Planning activities. This study is intended for planning purposes and does not include final design criteria and recommendations.

FOR REVIEW ONLY
THIS DOCUMENT IS ISSUED FOR INTERIM REVIEW ONLY
AND IS NOT INTENDED FOR CONSTRUCTION, BIDDING,
OR PERMIT PURPOSES.

October 29, 2024
Gil W. Barnett, PE
TX PE No. 108482

CP&Y, Inc. dba STV Infrastructure
TBPELS Registration Number: F-1741

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1.0 Introduction

The City of Kyle is in the Central Texas Innovation Corridor along Interstate 35 in Hays County in an area experiencing significant population growth. The population in 2022 was 57,470 and is currently close to 62,000. Kyle has recently had one of the highest rates in terms of percentage growth for any city in the United States. The City of Kyle Water Utilities provides potable water services to most of the city population; however, there are some areas of the city within the service boundaries of other Certificate of Convenience and Necessity (CCN) holders. Kyle Water Utilities currently receives groundwater from five wells and treated surface water from Guadalupe-Blanco River Authority (GBRA). Surface water will be received from Alliance Regional Water Authority (ARWA) beginning in 2025 and increasing in phases in the near future. Kyle does not treat raw surface water and has no current plans for doing so.

This report provides a review and analysis of the existing water distribution system and the development of the Kyle Hydraulic Model. The hydraulic model has been calibrated to current conditions and will be expanded with future scenarios to include projected water demands and infrastructure improvements. The future scenarios analyzed with the hydraulic model will support the City of Kyle Water Master Plan.

1.1 Data Provided

The City of Kyle has provided data to develop and update the hydraulic model to include:

- Record drawings of ground storage tanks (GSTs) and elevated storage tanks (ESTs)
- Pump capacities, curves, and control settings
- Water production records for 36 months
- Water billing records for 36 months
- GIS layers for system piping, meters, valves, and hydrants
- Previous hydraulic model developed by others

In addition, operations personnel provided answers to specific questions on water system controls and operations. SCADA data and field pressure data from installed data loggers was provided for system review and for model calibration.

2.0 Existing System

The City of Kyle operates and maintains eight pump stations, five groundwater wells, ten ground storage tanks, seven elevated storage tanks, and 218 miles of distribution system piping. The distribution system consists of three (3) separate pressure planes. The system has 16,546 service connections as of the end of 2023 and has been on a recent pace of adding an average of 186 connections per month.

The population served by the water system is currently about 55,000 and is primarily residential and light commercial usage. A system map with facilities and assets labeled is provided in Exhibit 1 of **Appendix A**. A map of the distribution system color coded by pressure plane is shown in Figure 1.

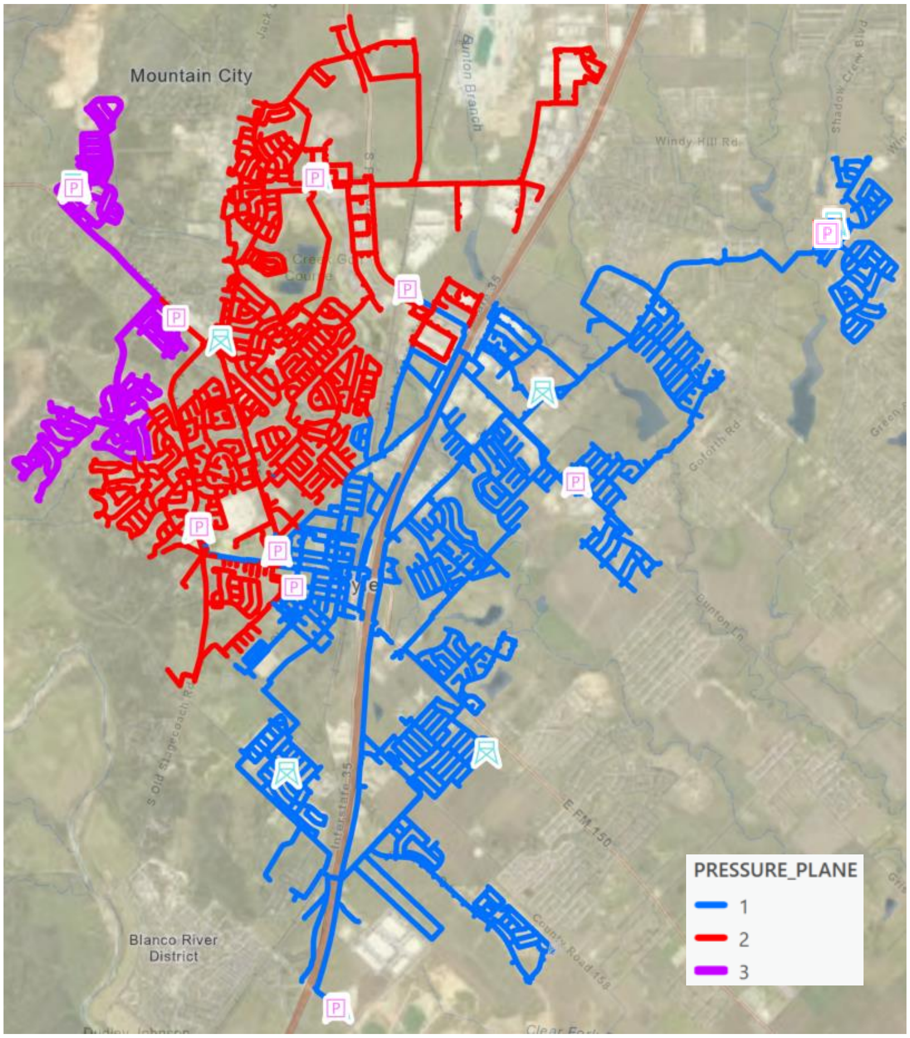


Figure 1 – Kyle Distribution System

The design hydraulic grade line (HGL) of each pressure plane is established by the overflow elevations of the ESTs in pressure planes 1 & 2, and by the hydro-pneumatic tank in Pressure Plane 3. The design HGL of each pressure plane is shown in Table 1.

Table 1 – Pressure Plane Design HGLs

Pressure Plane	HGL (ft)
1	850
2	930
3	1,010

2.1 Facilities

The Kyle System currently operates 8 pump stations and 5 groundwater wells. Current water supplies are provided by the 5 wells and from two connections with Guadalupe-Blanco River Authority. The system also has an emergency connection with San Marcos to the south. A summary of the system facilities is shown in Table 2.

Table 2 – Summary of System Facilities

Facility	Number
Pump Stations	8
Groundwater Wells	5
Water Source Supply Connections	3 with GBRA
Emergency Supply Connections	1 with San Marcos
Pipeline (miles)	218
Fire Hydrants	1,818
Valves	5,156
Pressure Reducing Valves	2
Customer Meters/Connections	16,546

A summary of the pump stations and wells is shown in Table 3.

Table 3 – Summary of Pump Stations

Pump Station	Firm Capacity (gpm)	Pressure Plane	Description
Yarrington PS	1,100	1	Receives water from GBRA. Has three pumps with two providing firm capacity.
Lehman PS	1,500	1	Receives water from GBRA. 2 pumps typically utilized. Has no redundant pump.
Veteran's PS	750	1	Receives water from three wells. Pumps into PP1 but also pumps to transfer water to the GST at Old Stagecoach PS to serve PP2. Has 3 pumps with valving to serve either.
Crosswinds PS	2,100	1	Receives water from GBRA. Has 4 pumps with 3 providing firm capacity.
1626 PS	1,500	2	Receives water into GST from PP1. Transfers from PP1 to PP2. Typically utilizes 2 pumps. Has no redundant pump.
Old Stagecoach PS	1,000	2	Receives water from Well 3 and from Veteran's PS. Pumps into PP2. Has 3 pumps and operates one larger pump alone or two smaller pumps together.
Hoover PS	1,563	3	Serves PP3 with controls based on hydro-pneumatic tank operation. Has 4 pumps with 3 for firm capacity.
RM 150 PS		3	Designed to provide water into GST at Hoover PS to serve PP3. Currently bypassed and not operated. Has 4 pumps with 3 for firm capacity.
Well 1	650	1	Edward's Aquifer. Delivers water to Veteran's PS which serves PP1 but also transfers water to PP2.
Well 2	550	1	Edward's Aquifer. Delivers water to Veteran's PS which serves PP1 but also transfers water to PP2.
Well 3	404	2	Edward's Aquifer. Delivers water into GST at Old Stagecoach PS.
Well 4	800	2	Barton Springs Aquifer. Single well pump delivers water directly into Well 4 EST serving PP2.
Well 5	650	1	Edward's Aquifer. Delivers water to Veteran's PS which serves PP1 but also transfers water to PP2.

Future pump stations include:

1. Expansion of 1626 Pump Station.
2. Waterstone Pump Station.
3. Pump Station for a third ARWA take point on the west side of I35.
4. Well 4 Pump Station

2.2 System Storage

The Kyle System currently has 10 GSTs located at seven pump stations. Total GST volume is 3.2 million gallons. A summary of the ground storage is shown in Table 4.

Table 4 – Summary of Ground Storage

Ground Storage Tank	Volume (gallons)	Pressure Plane
Yarrington GST 1	250,000	1
Yarrington GST 2	500,000	1
Lehman GST	500,000	1
Veteran's GST1	150,000	1
Veteran's GST 2	150,000	1
Crosswinds GST	150,000	1
1626 Station GST	500,000	2
Old Stagecoach GST	500,000	2
Old Stagecoach Standpipe	41,000	2
Hoover GST	540,000	3

Additional ground storage will be added at each of the future pump stations listed in the previous section.

The Kyle System currently has 7 ESTs in operation. Four are located in Pressure Plane 1 and three are in Pressure Plane 2. Pressure Plane 3 has a future EST planned but currently operates with 10,000-gallon and 20,000-gallon hydro-pneumatic tanks. A new EST has been constructed at the Crosswinds PS in PP1 and was recently put into operation yet. A summary of the elevated storage is shown in Table 5.

Table 5 – Summary of Elevated Storage

Elevated Storage Tank	Volume	Overflow Elevation (ft)	Pressure Plane
Dacy EST	300,000	850	1
Post Oak EST	750,000	850	1
Yosemite EST	300,000	850	1
Crosswinds EST	150,000	850	1
Plum Creek EST	200,000	931	2
Well 4 EST	500,000	931	2
Old Stagecoach EST	150,000	931	2

Additional elevated storage will be added at the Hoover PS and near the area of the proposed Waterstone PS.

2.3 Service Connections

The number of active water service connections are reported on the Monthly Operating Report. As of December 2023, there were 16,546 active connections reported. The growth in connections from 2021 to the first quarter of 2024 is shown in Figure 2.

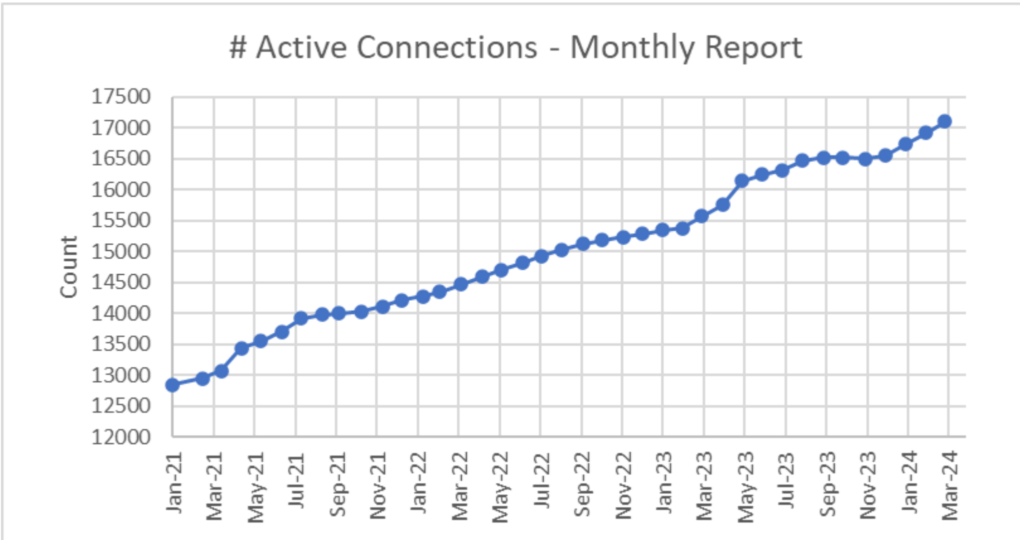


Figure 2 – Number of Connections

- 12,840 connections in Jan 2021 to 16,546 connections in Dec 2023. (17,106 – March 2024).
- Growth of 4,266 connections in 39 months. (33% growth).
- Average of 109 connections per month added during the three-year period.
- Average of 186 connections per month in the most recent quarter.

The connections are further broken down by pressure plane and compared to the available storage in each plane. TCEQ requirements are 200 gallons per connection of total storage and 100 gallons per connection of elevated storage in each separate pressure plane. Pressure plane 3 currently utilizes a 10,000-gallon and a 20,00-gallon hydro-pneumatic tanks in lieu of an elevated tank. A pressure tank must provide a capacity of 20 gallons per connection per TCEQ requirements.

A review of storage volumes and the number of connections in each pressure plane is shown in Table 6.

Table 6 – Storage Volumes and Allowed Connections

	EST Vol (MG)	GST Vol (MG)	Pressure Tank Volume (gal)	Connections Allowed by EST Vol	Current Connections
PP1	1.35	1.55	NA	13,500	8,399
PP2	0.85	1.0	NA	8,500	7,612
PP3	NA	0.54	30,000	2,500	1,095

2.4 Pipe Inventory

The Kyle System has 218 miles of pipe with size ranging from 1” to 24” diameter. The amount of pipe in the system for each pipe size is shown in Figure 3 and Table 7.

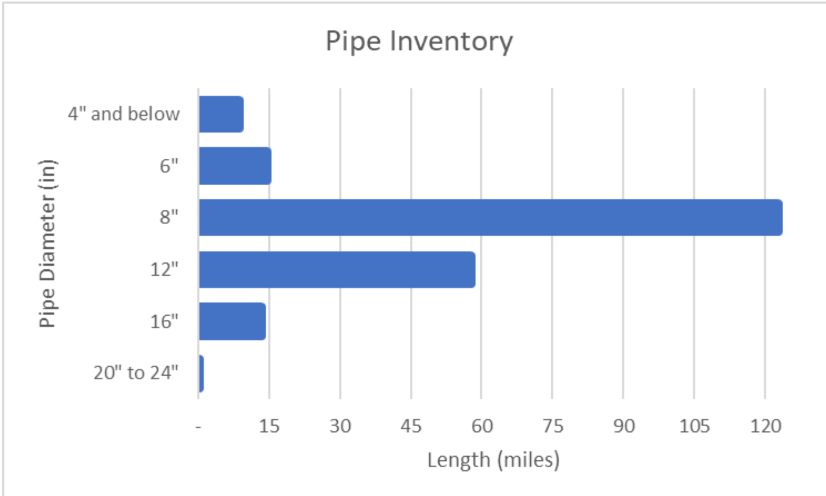


Figure 3 – Pipe Inventory

Table 7 – Pipe Inventory

Diameter	Length (ft)	Length (miles)
4" and below	45,811	8.68
6"	76,559	14.50
8"	648,741	122.87
12"	304,886	57.74
16"	70,767	13.40
20" & 24"	1,701	0.32
Total	1,148,465	218

The prevalent pipe material is PVC, but a detailed inventory of pipe materials is not available. A map of the pipe diameters throughout the system is provided in Exhibit 2 of **Appendix A**.

2.5 Fire Hydrants

The Kyle distribution system has about 1,818 fire hydrants, with additional hydrants being added as new development continues. The City of Kyle GIS layer for hydrants was used to identify the fire hydrants installed throughout the system.

A system map showing the installed fire hydrant locations is provided in Exhibit 3 of **Appendix A**.

2.6 Pressure Reducing Valves

Two PRVs are present on the boundary between Pressure Planes 1 and 2 and are shown in Exhibit 1 of **Appendix A**. The PRVs are located on the western side of I35 along Marketplace Ave. and James Adkins Drive. These PRVs allow flow and pressure from Pressure Plane 2 to prevent operating pressure from dropping below a desired value in Pressure Plane 1. The set points of the valves will open and allow flow to maintain a minimum 40 psi in Pressure Plane 1. During typical operating conditions, the valves are closed.

2.7 Terrain

The terrain where the City of Kyle is located has its lowest elevations on the east side of I35 and generally increases in elevation on the west side of I35 to the highest point in the far northwest of the city. The lowest ground elevation in the existing distribution system is 625 ft on the eastern edge of the system. The highest elevation is 892 ft in the northwest area of the system. This is a 267 ft elevation differential across the system and is the driving factor for establishing the current three pressure planes.

3.0 Water Production and Demands

A study of the past 3 years water usage and water billing records was conducted. Water production records indicate the daily water usage. This data establishes the average day demand (ADD) and maximum day demand (MDD). Billing records provide the volume of water accounted for and billed to users. The difference between water production and water billed shows the amount of water losses in the system.

3.1 Water Production

Water production records were reviewed for the previous 3-year period, 2021 to 2023. Water production represents water usage and water demand. The terms are synonymous. Most of the water used in this period is the water purchased from GBRA. A lesser amount of water is supplied through the 5 groundwater wells. The yearly volume of water produced for the recent 3-year period is shown in Figure 4.

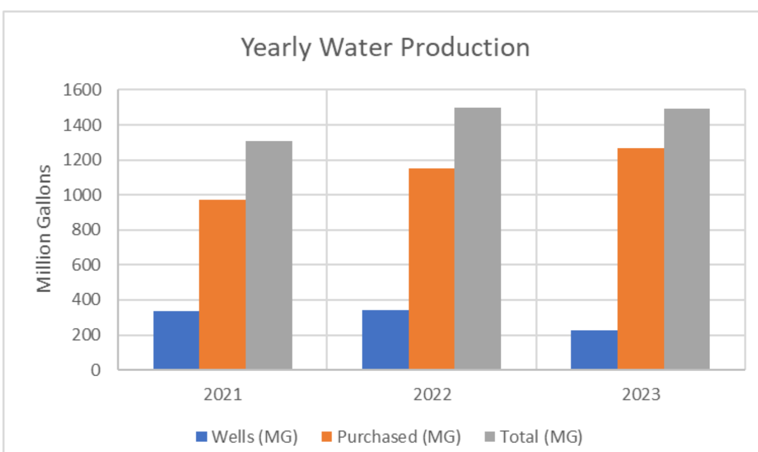


Figure 4 – Yearly Water Production

Together, the purchased water and well water make up the total water production. The daily water volumes produced are shown in Figure 5.

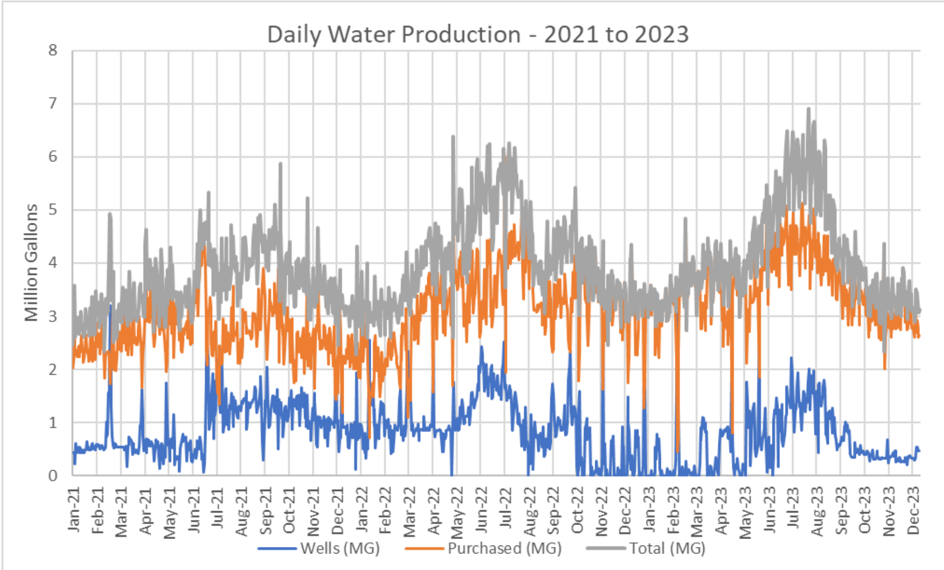


Figure 5 – Daily Water Production 2021 to 2023

The daily water production is used to calculate the ADD and MDD for each year. From 2021 to 2022, the ADD grew by 14%, but from 2022 to 2023, the ADD was unchanged. The ADD in 2023 was impacted by significant watering restrictions implemented by the city. Population in the service area did grow but the water demand was leveled by the restrictions. The overall production and the ADD and MDD for the three-year period are shown in Table 8.

Table 8 – Three year ADD and MDD Data

Year	Production (MG)	ADD (MGD)	ADD (gpm)	MDD (MGD)	MDD (gpm)
2021	1,309	3.59	2,490	5.88	4,084
2022	1,493	4.09	2,841	6.38	4,429
2023	1,494	4.09	2,842	6.90	4,792

3.2 Current Water Demand

The most recent full year data, 2023, is utilized in the current hydraulic model. The ADD and MDD are calculated from the full year data; however, there is insufficient intra-day data to calculate the actual peak hour demand (PHD). Therefore, an assumption was made that the PHD would be equal to 1.4 times the MDD. This is a typical ratio applicable to a residential and light commercial population. The existing water demands utilized in the model are shown in Table 9.

Table 9 – Existing Water Demand

Demand	(gpm)	(MGD)
ADD	2,842	4.1
MDD	4,792	6.9
PHD	6,709	9.7

3.3 Water Billing Records

Billing records for all customers for the 3-year period, 2021 to 2023, were reviewed. The total usage for each year and average daily usage of each customer were determined. The physical address of each customer was used to input the water demands into the proper location in the hydraulic model. This ensures accurate water demand distribution across the system matching the model to the actual system. The total water billed for each year is shown in Table 10.

Table 10 – Three Year Billed Water Data

Year	Average Day Billed (gpm)	Average Day Billed (MGD)
2021	2,169	3.1
2022	2,533	3.6
2023	2,526	3.6

The top 12 water users in the Kyle System accounted for 11.74% of total water billed in 2023. The top users were commercial, apartments, and multi-family developments. The top water users from 2023 are listed in Table 11.

Table 11 – Top Water Users

	Name	Type	Avg Daily Usage (gpm)
1	KYLE CORRECTIONAL CENTER	Commercial	47.1
2	SETON MEDICAL CENTER	Commercial	37.8
3	ALSCO CORPORATION	Commercial	35.6
4	KYLE DACY APARTMENTS	Apartments	28.9
5	PLUM CREEK APARTMENTS	Apartments	23.4
6	KYLE BLUEBONNET MHC	Multifamily	22.8
7	HAYS JUNCTION APARTMENTS	Apartments	21.5
8	HIDDEN TRAILS ON ROLAND	Multifamily	19.8
9	PLUM CREEK APARTMENTS, No. 2	Apartments	16.8
10	GEMSTONE PALACE	Commercial	14.6
11	KYLE CAR WASH SERVICE	Commercial	14.5
12	THE GREEN AT PLUM CREEK APTS	Multifamily	13.8

3.4 Compare Water Production and Billing Data

All distribution systems experience water losses due to numerous reasons to include leaks from pipes and fittings, pipe breakages, line flushing, fire hydrant operation, and other events. Comparing total water produced with total water billed shows the overall amount of water unbilled or lost. Production and billing data for the three-year period 2021 to 2023 were compared to determine the amount of unbilled or lost water experienced by the Kyle System. The unbilled water ranges from 11% to 13% for Kyle. This amount is in the typical range seen for many Texas cities and is not unusual. The comparison of water produced and billed is shown in Table 12.

Table 12 – Unbilled Water

	Production (MG)	Billed (MG)	ADD Produced (gpm)	ADD Billed (gpm)	Unbilled Percentage	Number of Billing Records
2021	1,309	1,139	2,490	2,169	**13%**	13,621
2022	1,493	1,331	2,841	2,533	**11%**	14,922
2023	1,494	1,327	2,842	2,526	**11%**	16,365

4.0 Model Development

The hydraulic model for the City of Kyle water distribution system was completely updated and rebuilt to existing conditions. Information from the previous model developed by others was reviewed as well as record drawings and the city GIS layers for piping, facilities, valves, etc. Both steady state and extended period simulations (EPS) were developed to include ADD, MDD, and PHD. The model was developed in InfoWater Pro 2024.2 operating in a GIS environment under ArcGIS Pro 3.3.1. A screenshot of the hydraulic model is provided in Exhibit 4 of **Appendix A**.

For the extended period simulations, a 24-hour diurnal pattern is required to simulate the change in water demand throughout the day. There was insufficient intra-day data available to precisely determine the diurnal pattern for the Kyle System, so a typical pattern associated with similar customer bases of residential and light commercial users was assumed. A morning peak and evening peak are typical for these users. The peak hour demand is assumed to be 1.4 times the average demand and occurs in the early evening hours. A second lower peak typically occurs in the morning as people are preparing to go to work or school. The diurnal pattern assumed for the Kyle System and utilized in the model is shown in Figure 6.

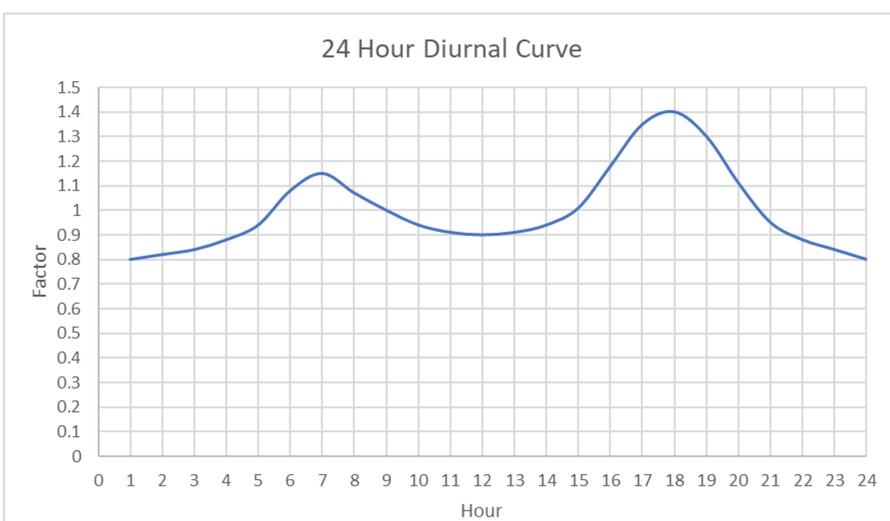


Figure 6 – Assumed Diurnal Pattern

Elevations for the piping system were determined by using publicly available LIDAR data from the Texas Natural Resources Information System. Pipes were assumed to have three feet of cover. Pump station and tank elevations were taken from record drawings.

Pump controls and valve settings were provided by Operations. Typical tank levels were provided by SCADA data. Demand data was placed into the model by using billing data and GIS address geolocation tools.

5.0 Model Calibration

Hydraulic models are essentially mathematical representations of water system hydraulics. Models are only as good as the accuracy of their predictions of actual water system performance. "Calibration" is the process of comparing the results of model simulations to actual field data and then making corrections and adjustments to the model in order to achieve agreement between the two.

Following model development and updates, vetting of the available SCADA data, and identification of sites for data logger installation, the calibration exercise was planned and completed. The Kyle System does not have permanently installed pressure monitoring sites throughout the system so data loggers were prepared and installed on existing fire hydrants to collect pressure data for the calibration exercise. Operations obtained 10 data loggers to collect pressure data. In order to include enough pressure data locations for a thorough calibration, each pressure plane was calibrated separately. This allowed up to 10 pressure monitoring locations per pressure plane. SCADA data is available for pump operation and tank levels. The SCADA data and data logger data provided sufficient information for model calibration.

Data was collected in each pressure plane for a weeklong period from 7/16/2024 to 8/5/2024. A single day in each week of data was selected as the calibration day for each pressure plane. The data collection periods, and the calibration days are summarized in Table 13.

Table 13 – Calibration Day

Pressure Plane	Pressure Data Collected	Calibration Day
1	7/23/2024 to 7/29/2024	7/26/2024
2	7/30/2024 to 8/5/2024	8/4/2024
3	7/16/2024 to 7/22/2024	7/17/2024

One helpful tool available in the InfoWater PRO software is the Calibrator Module. This tool allows for entry of the actual SCADA and field data for pressure and runs an analysis to best fit pipe roughness coefficients and demand adjustments. Calibration is an iterative process and using this tool as part of the process is beneficial and improves efficiency and accuracy. The Calibrator tool interface is shown in Figure 7.

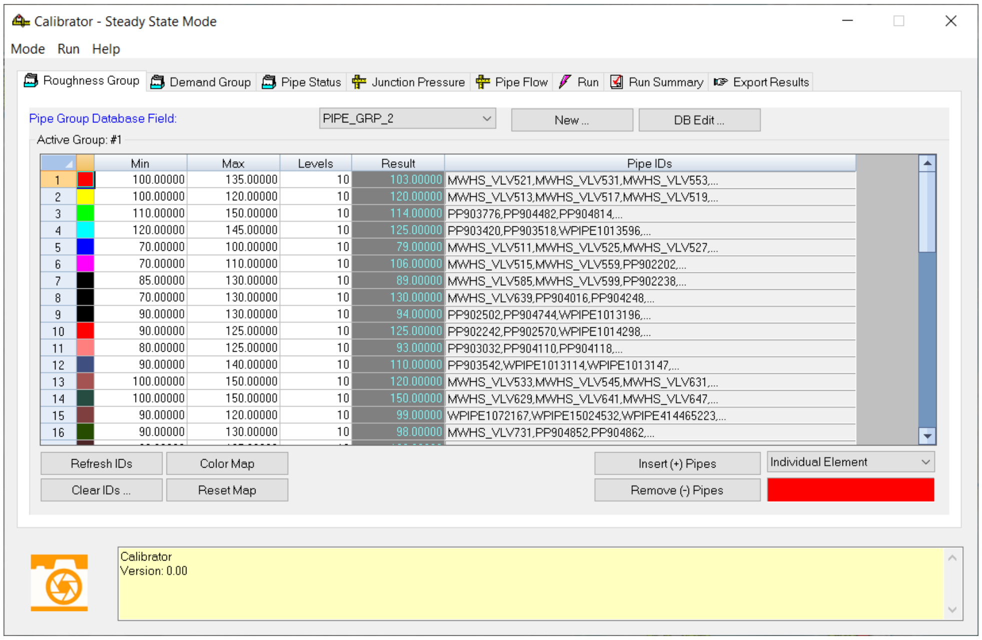


Figure 7 – InfoWater Calibrator Tool

The calibration process determined C values on the piping of each pressure plane that brought the model results into close agreement with actual system pressures. Pressures between the model results and the field data agreed within 2 to 3 psi, most often within a fraction of a psi.

A full description and details of the calibration plan and calibration exercise with results for each pressure plane are presented in **Appendix B**.

6.0 System Evaluation

The calibrated model was utilized to evaluate the existing system. This section reviews the existing system for:

1. Minimum Pressures.
2. Fire flow analysis.
3. Water Age.
4. Velocities.
5. Identified bottleneck.

6.1 Minimum System Pressures

The existing system was evaluated for a MDD in an EPS which includes the peak hour demand. The system minimum pressures generally occur during the peak hour. The model indicates that under some conditions minimum pressures can drop below 35 psi in a part of Pressure Plane 1 which is on the boundary with Pressure Plane 2 and has the highest elevations for this plane. Minimum pressure in all other parts of the system is adequate. Some low pressures can occur in transmission lines that convey water from one pump station to another, but these lines are not distribution lines. A map of the minimum pressures in the distribution system is provided in Exhibit 5 of **Appendix A**.

Modification of the boundary between PP1 and PP2 is recommended to mitigate the low-pressure potential in PP1. The city has considered this boundary change in the past due to the persistent low pressures in the downtown area. The model was utilized to identify the area and develop options. The area with minimum pressures below 35 psi is shown in Figure 8.

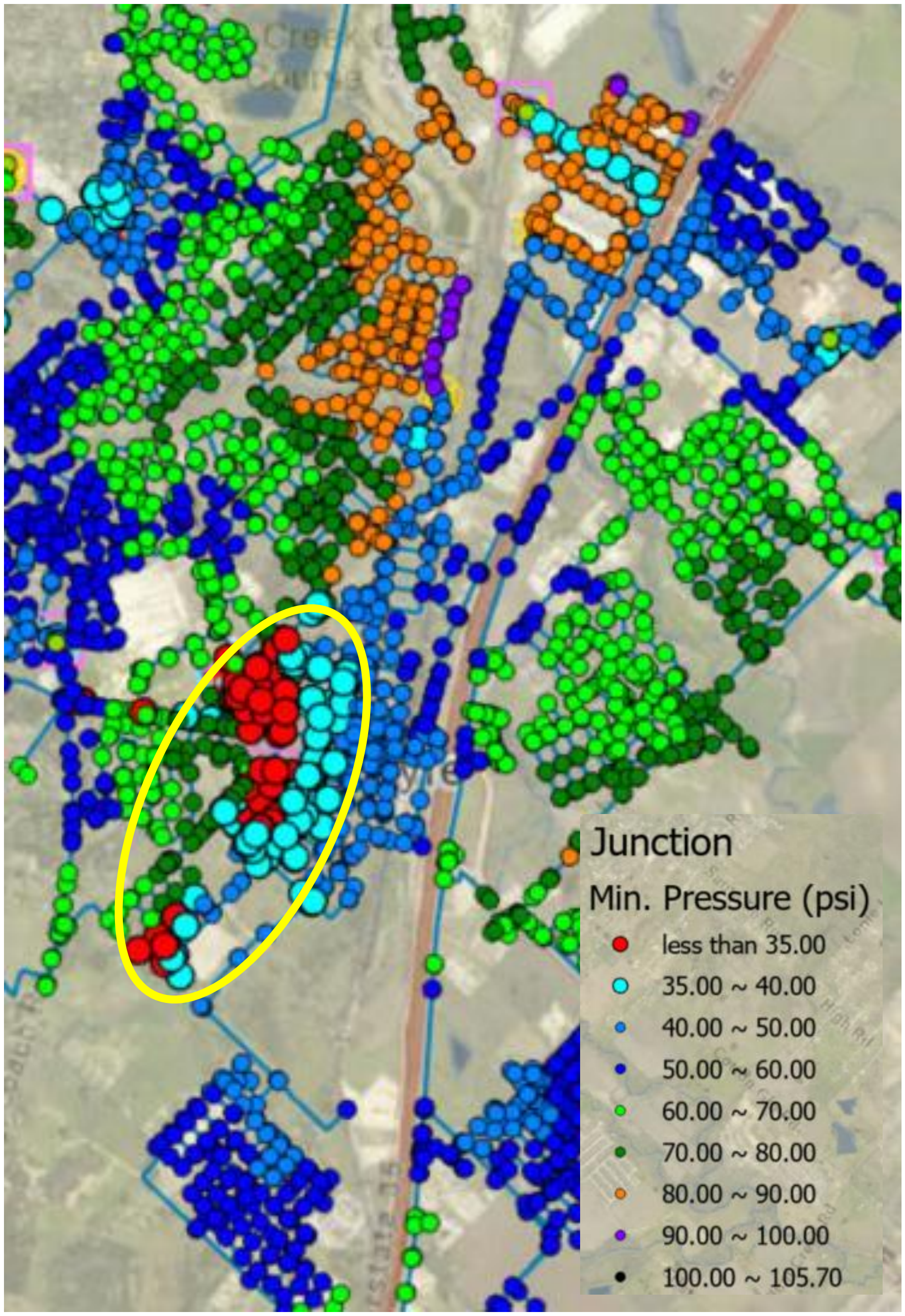


Figure 8 – Area with Minimum Pressures Identified for Improvement

The recommended pressure plane modification is detailed in **Appendix C**.

6.2 Fire Flow Analysis

A fire flow analysis was run with the model considering maximum day and peak hour demands with model nodes nearest to each fire hydrant in the system. The fire flow available at each hydrant was determined and shown in Exhibit 6 of **Appendix A**.

The available fire flows were determined given 20 psi delivery pressure and ranged from 160 gpm to above 6000 gpm. Fire flows of 1500 gpm or higher are considered adequate for typical residential areas; however, city code may require higher fire flows for some commercial or other property types.

Four areas in the Kyle System were identified with available fire flows under 1500 gpm. All of these areas are within Pressure Plane 1. Three areas identified have model predicted available fire flows below 1000 gpm and the fourth area has some available fire flows above 1000 gpm but below 1500 gpm. The three areas with values under 1000 gpm are recommended for network improvements to increase the available fire flow.

Details showing and describing the areas with low available fire flow and the recommended improvements are provided in **Appendix D**.

6.3 Water Age Analysis

Water age is the time water spends in the distribution system prior to use. A common average water age for typical distribution systems is 1 to 3 days; however, this can vary between systems and even within segments of the same distribution system. Water age can become longer than desired due to low water usage periods, if piping and storage are oversized, or when connections and circulation are poor such as in dead ends and behind closed valves.

Water age for the Kyle System was evaluated in the hydraulic model with an extended period simulation covering a 24-day period. The system was run at the ADD for 24 consecutive days and the age of the water in the system piping was predicted at nodes throughout the system. The ADD gives a conservative prediction for water age. During MDD the water age would be lower as water turns over in the system more quickly. Water Age for all parts of the distribution system is shown in Exhibit 7 of **Appendix A**.

6.3.1 Water Age of Pressure Planes

Pressure plane 1 had the lowest water age with 1 to 3 days typical. There are some locations on the edges of the plane that have water age of 4 or more days due to the newer developments that have full water piping in place but only a few homes built to date. The demands are low because the planned homes are not there yet, which increases the time water spends in the local piping. But otherwise, water age in PP1 is low because all purchased water is received in PP1. Water Age in PP1 is shown in Figure 9.

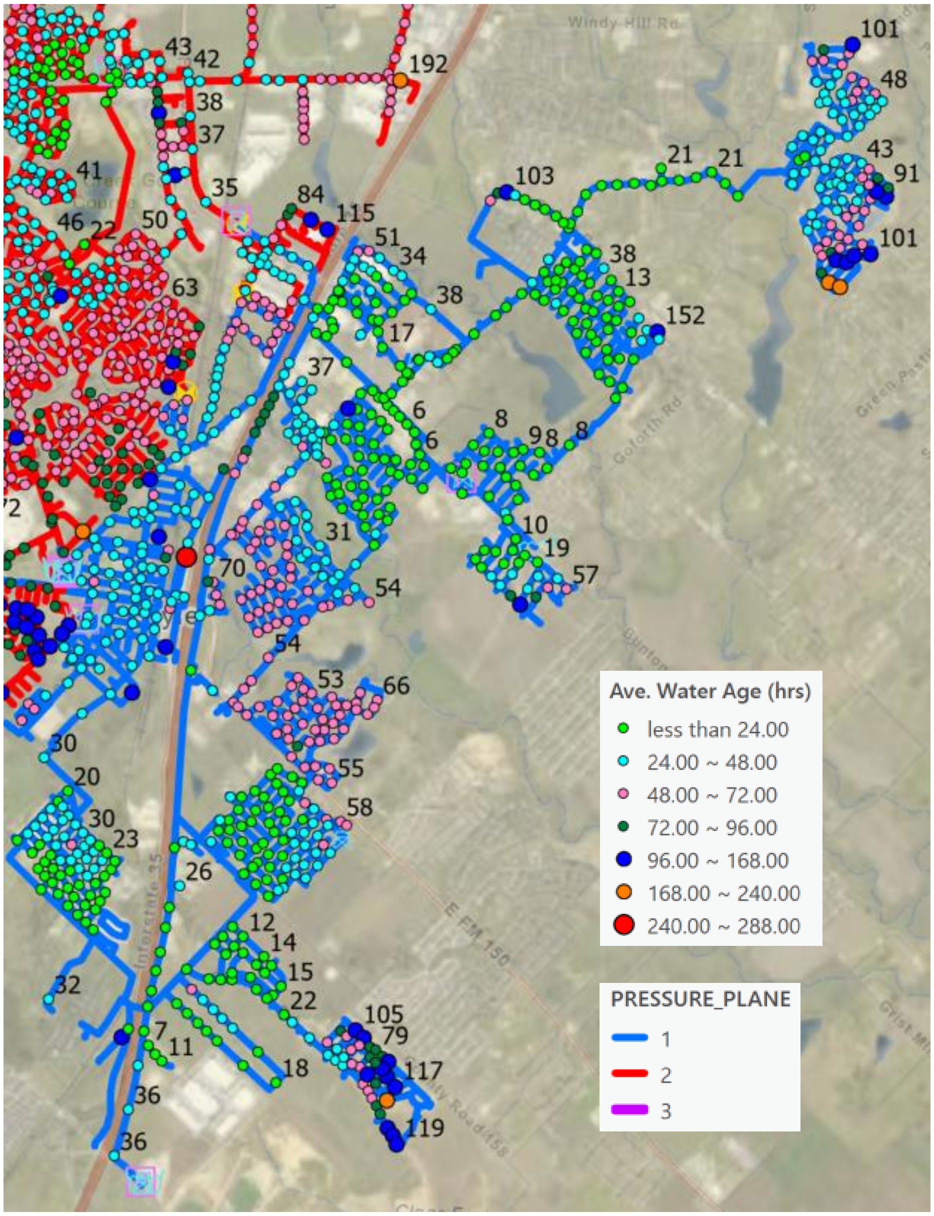


Figure 9 – Water Age in Pressure Plane 1

Pressure Plane 2 has water ages ranging from 1 to 7 days. Purchased water is delivered from PP1 to PP2 at 1626 PS. Therefore, the water has already aged before delivery to PP2, and additional time is spent in the GST at 1626 PS. Water may receive a chlorination boost in some locations if needed, which would make the effective age of the water less. However, the model is measuring the age of the water since delivery from GBRA. The water age in PP2 may not be analogous with the chlorine residual present in the water.

The water is the youngest in PP2 around Well 4 EST. The well water fed into the EST provides water age of less than 1 day to the immediate area and 1 to 2 days in the vicinity. Water is the oldest in PP2 to the south and around Old Stagecoach PS. GBRA water takes some time to get to this area. Well water is supplied from Old Stagecoach PS but is a blend of local Well 3 and the other well water that is transferred from Veteran's PS. The model measures age from the time the water is pumped from the wells and some time passes before the well water is pumped out of Old Stagecoach GSTs into the system. A mixture of well water and GBRA water in the southern region of PP2 gives a water age from 3 to 7 days. Water Age in PP2 is shown in Figure 10.

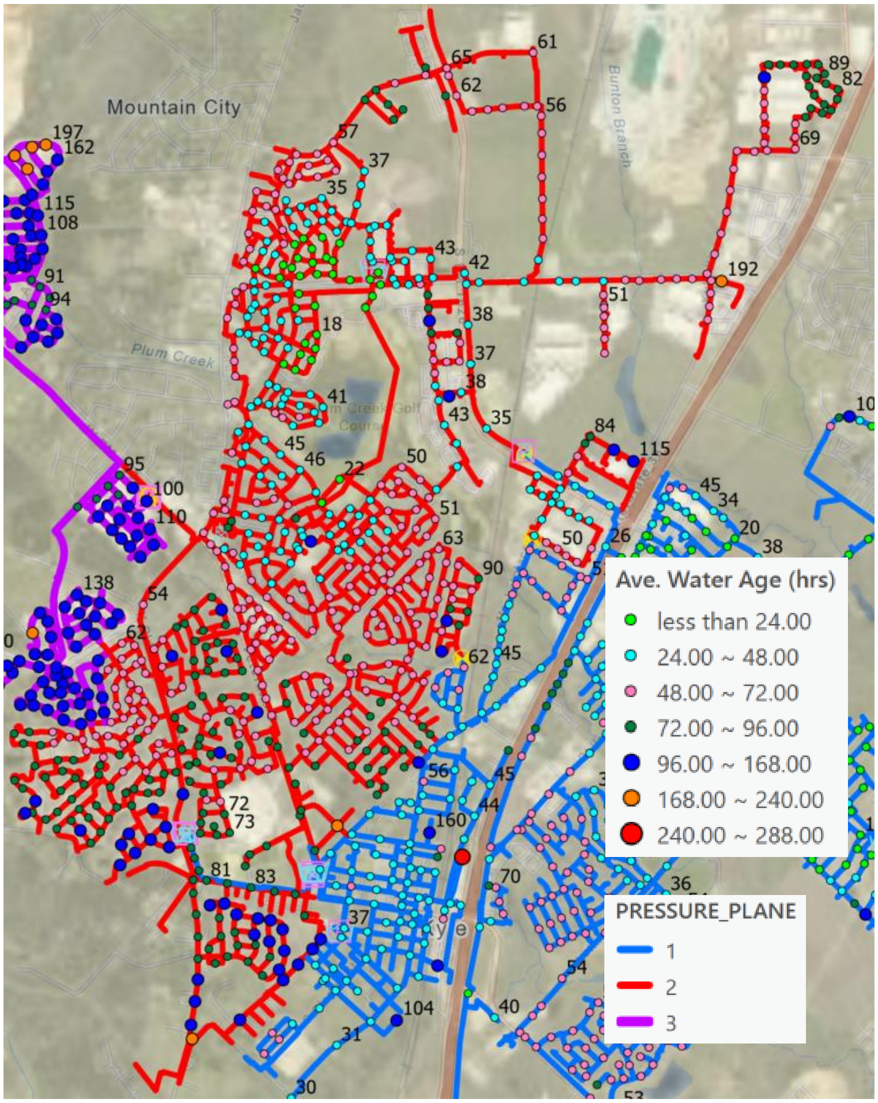


Figure 10 – Water Age in Pressure Plane 2

Pressure Plane 3 has water ages from 4 to 10 days. PP3 receives water from PP2 which is already aged. Water supplied to PP3 is delivered to the Hoover GST and the chlorine residual is boosted. Therefore, the effective age of water in PP3 is not analogous to the calculated age in the model. The model calculates the water age from the time it is delivered from GBRA or pumped from a well. Water Age in PP3 is shown in Figure 11.

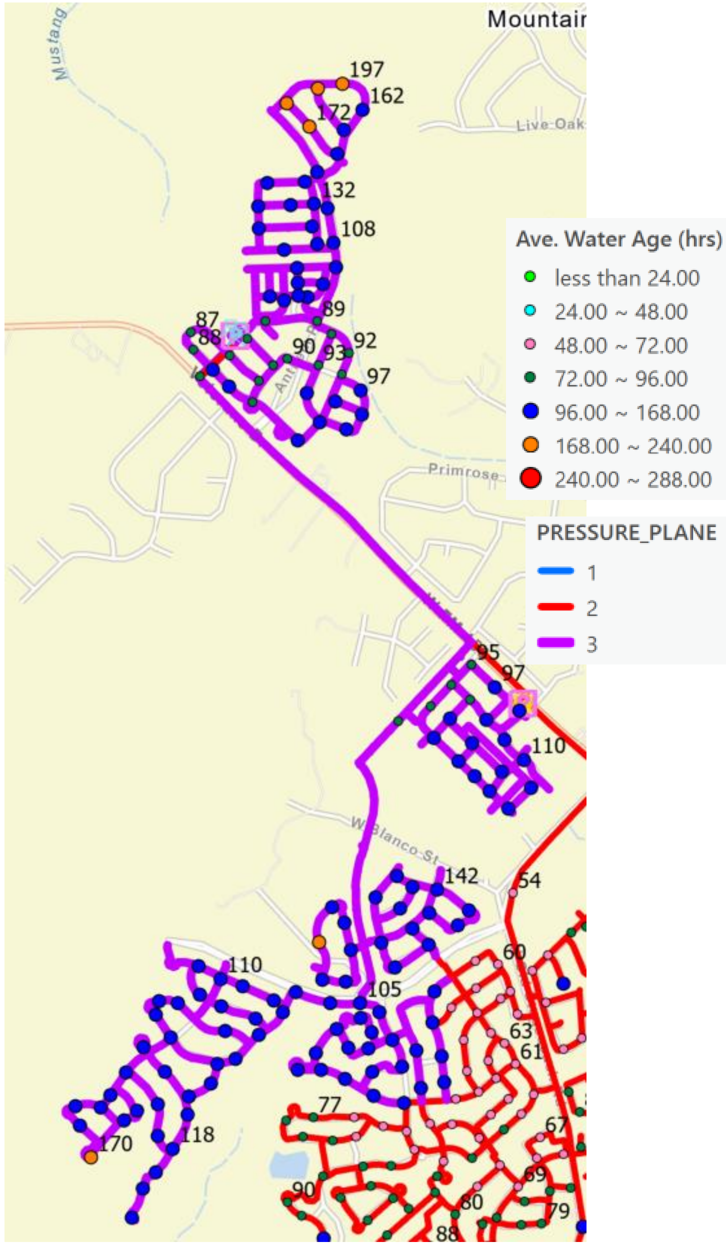


Figure 11 – Water Age in Pressure Plane 3

An overall map showing water age throughout the Kyle System is provided in Exhibit 7 of **Appendix A**.

6.3.2 Dead Ends Identified

Water age was found to be very high at some locations that are effectively dead ends with limited water demand and no path to circulate. Three areas noted that would benefit from installing a circulation path are shown below.

Example 1 is shown in Figure 12. The 12" water line running south down Old Stagecoach Road may develop a water age of near 8 days because of very small diameter lines connected to the southern end and limited water demand in that vicinity. Replacing the 2- and 3-inch piping to create a 12" loop would improve the circulation.

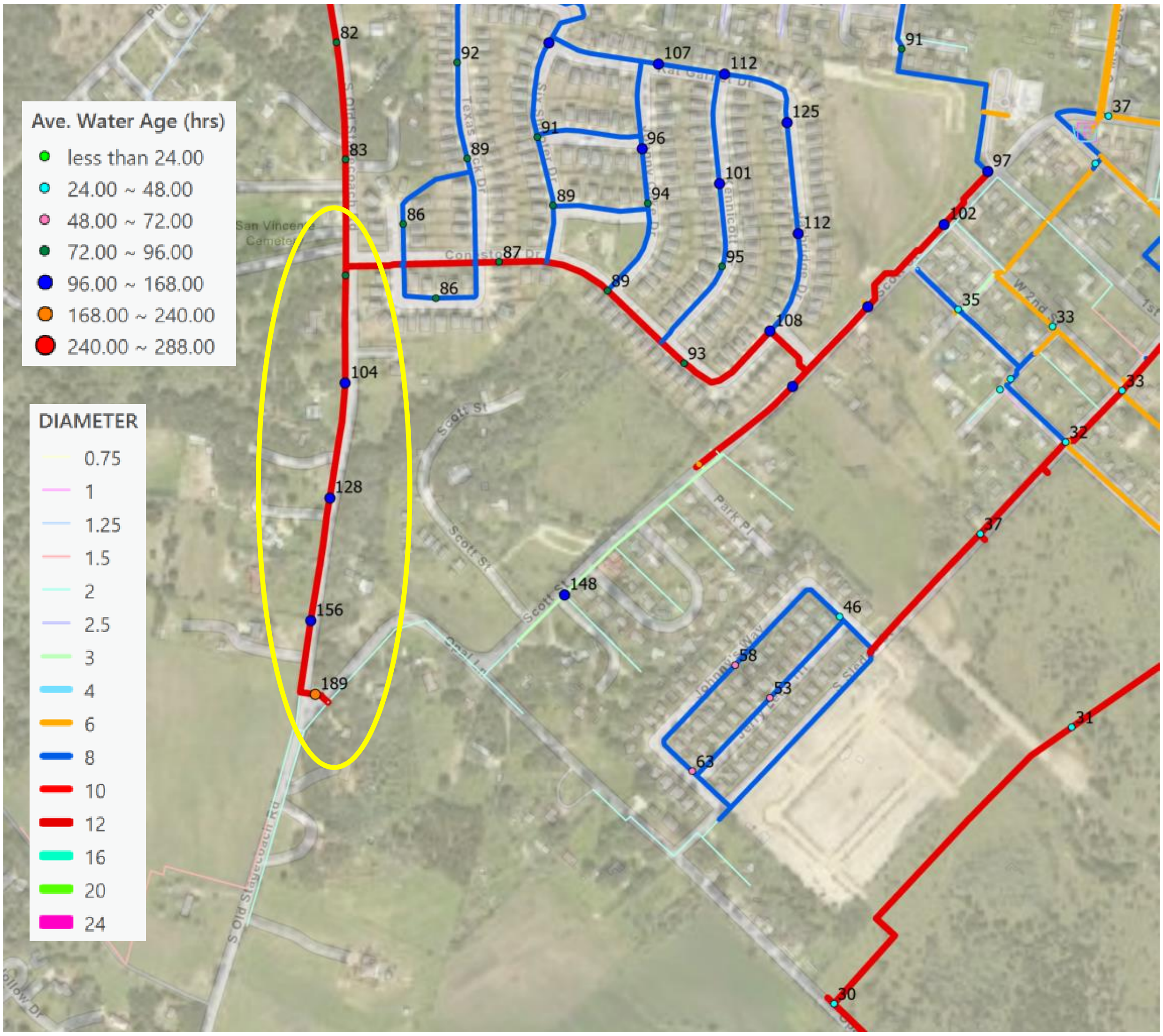


Figure 12 – Dead End Example 1

The site with the longest water age in the Kyle system was found in the hydraulic model to be an 8" line on the east side of North Old Highway Drive that terminates at a fire hydrant. The average water age calculated was 12 days but could be much longer in this segment of pipe since it terminates at a hydrant. The business that are supplied from this line appear to have a water age of 2 to 3 days, so the impact of this dead-end line may be insignificant. This area is shown in Figure 13.

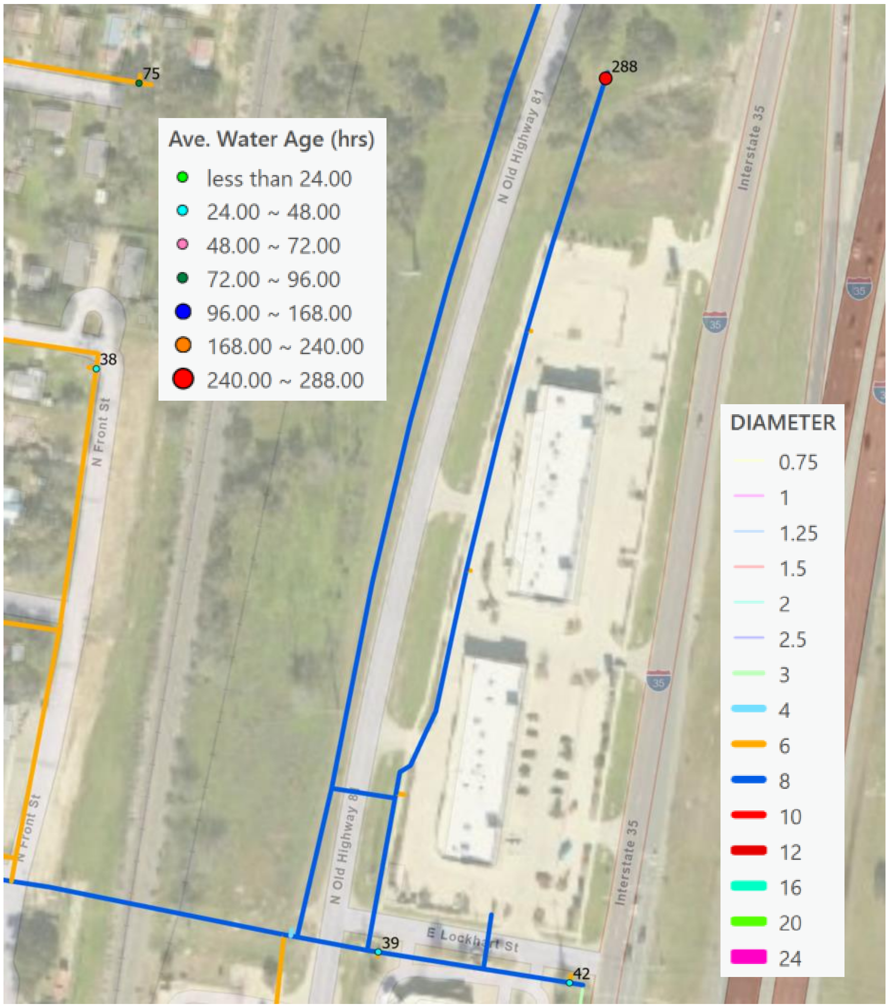


Figure 13 – Dead End Example 2

Example 3 is an area that has average water age of 2 to 3 days which is acceptable. However, there is an opportunity to make a connection to improve the network. Installing a pipe length of about 560 ft would provide a new looping connection along E FM 150 as shown in Figure 14. This would add a flow path between two parts of PP1 that are somewhat isolated even though they are close in proximity.

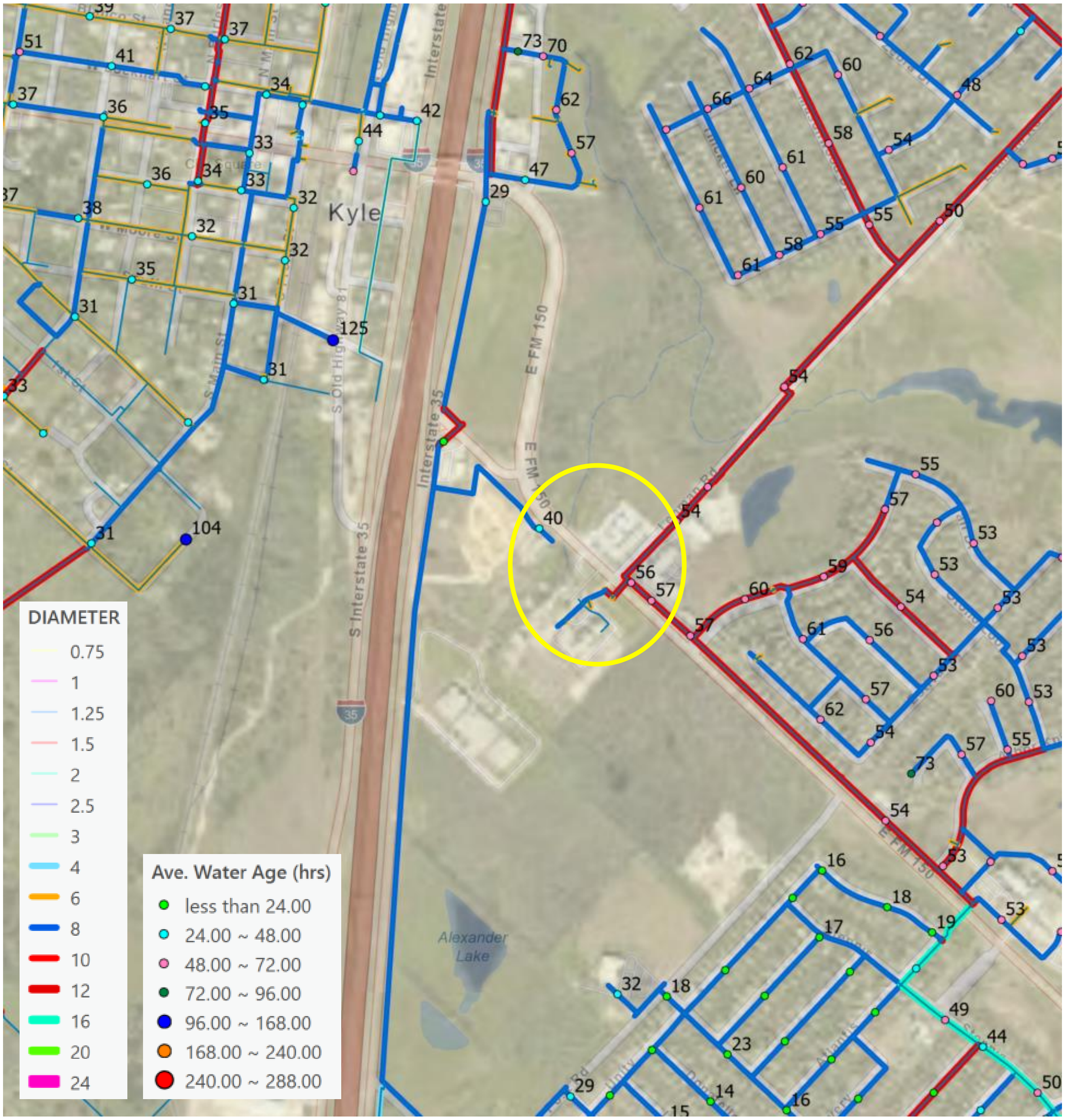


Figure 14 – Dead End Example 3

6.4 Velocities

The maximum velocity recommended within the distribution system is 5 fps provided that sufficient pressure is maintained. In the current Kyle system, maximum velocities are under 5 fps in the distribution system during a maximum day and peak hour. There are some cases in transfer piping between wells and GSTs where velocities may exceed 5 fps; however, that does not impact the distribution system.

The majority of pipe in the distribution system experiences maximum flow velocities of under 1.5 fps. The maximum velocities are from 4.6 to 4.2 fps in some 12” transmission lines at the discharge of Yarrington and Lehman pump stations. Well #2 provides water to a GST at Veteran’s PS through a 6” line. Velocity in the 6” line can exceed 6 fps but does not impact the distribution system. Water is transferred between the GSTs at Veteran’s PS and Old Stagecoach PS prior to pumping into the distribution system. The transfer piping between the pump stations is generally 8” diameter pipe but has a 650 ft length of 6” pipe in the line. Velocity in the 6” segment can go above 9 fps generating significant head loss, but the distribution system is not affected. A review of the highest velocities in the system is shown in Table 14.

Table 14 – Existing System Maximum Velocities

Pipe Description	Maximum Velocity	Function
750 ft length segment of 12” pipe along Bunton Creek Road between Lehman Road and Brandi Circle transmitting discharge from Lehman PS to the northwest	4.6	Distribution
12” pipe along the I35 access road transmitting flow from Yarrington PS to the north	4.2	Distribution
6” pipe transferring Well #2 water to Veteran’s PS	6.3	Transfer
8” pipe in transfer line between Veteran’s PS and Old Stagecoach PS	5.4	Transfer
650 ft length segment of 6” pipe in transfer line between Veteran’s PS and Old Stagecoach PS	9.6	Transfer

Maximum velocities throughout the Kyle System during a MDD are shown in Exhibit 8 of **Appendix A**.

6.5 Identified Bottleneck

A bottleneck in Pressure Plane 1 has been identified that inhibits the filling and operation of the Dacy EST. Pumping at Yarrington PS and Lehman PS is controlled by the level in Post Oak EST. Because of the bottleneck in the pressure plane between Dacy EST and Post Oak EST, the tank levels will not rise and fall in a similar pattern when water demands increase as projected for 2026 and beyond. Dacy EST will become more difficult to fill and may potentially empty during a peak hour demand or a significant fire flow event. Dacy EST could fall below minimum levels and the pumps will not be called because Post Oak EST would not lower at the same rate. To date, with existing water demands, the impact of the bottleneck has not been a problem. As water demands grow, the impact can become significant.

The bottle neck is due to a single 12” connection between the southern and northern parts of PP1. At higher system demands, Post Oak and Dacy ESTs will not rise and fall together as expected in the same pressure plane. Large volumes may be taken from Dacy EST to supply 1626 PS in PP2 at peak demand and the tank may empty rapidly. Because of the 12” bottleneck, additional flow cannot be supplied as quickly as needed to stop the tank from dropping below minimum levels.

The PP1 bottleneck is shown and described and the recommended improvements are provided in **Appendix F**.

7.0 Summary of Recommended System Improvements

Evaluation of the distribution system utilizing the calibrated hydraulic model has resulted in identification and verification of some system issues. Improvements are recommended including a pressure plane boundary change, pipe network improvements to address available fire flow, elimination of dead ends, and elimination of a system bottleneck. Also, valve operation issues at 2 ESTs were found.

7.1 Pressure Plane Boundary Change

Persistent low pressures on the west side of I35 in the downtown area of the City of Kyle are a consequence of the existing boundary between Pressure Plane 1 and Pressure Plane 2. Portions of Pressure Plane 1 have been identified that would be better served if moved into Pressure Plane 2. The railroad on the west side and parallel to I35 defines an ideal break between the two pressure planes.

A Technical Memorandum dated 4/26/2024 was submitted to the City of Kyle describing the recommended boundary changes between PP1 and PP2. This TM is included in **Appendix C**.

7.2 Fire Flow Improvements

Areas of the distribution system were identified with inadequate fire flows in Section 6.2. Three areas are recommended for improvements to increase the fire flow available. These areas and recommended improvements are presented in **Appendix D**.

7.3 Eliminate Dead Ends

During the water age analysis for the distribution system in Section 6.3, three dead end areas were identified with excessive water ages. These areas were shown in Figure 12, Figure 13, and Figure 14. Proposed improvements for these three areas are presented in **Appendix E**.

7.4 Eliminate Bottleneck in Pressure Plane 1

A system bottleneck in Pressure Plane 1 was identified as described in Section 6.5. This bottleneck creates a separation between the north and south parts of the pressure plane and will impair the normal operations of Dacy Lane EST as system demands increase in the next couple of years. Recommended improvements to mitigate the bottleneck are presented in **Appendix F**.

7.5 Storage Volume Compliance

The available storage volume and number of connections in each pressure plane were reviewed in Section 2.3. Pressure Plane 3 utilizes 10,000-gallon and 20,000-gallon hydropneumatic tanks in lieu of elevated storage. The current number of connections in PP3 is well below the 2,500 that is allowed by rule for the existing pressure tanks.

Texas Administrative Code Title 30 Chapter 290.45 (30 TAC 290.45) defines the minimum water system capacity requirements for public water systems. Section 290.45 (b)(D) applies to groundwater systems with more than 250 connections. The rule requires an EST capacity of 100 gallons per connection or a pressure tank capacity of 20 gallons per connection. However, a maximum 30,000 gallons of tank capacity allows up to 2,500 connections.

PP3 currently has about 1,095 connections and is growing. An elevated storage tank is planned for PP3 located at the Hoover PS site. It is recommended to move forward with the EST project or install additional pressure tank volume for the short term until the EST is constructed.

7.6 Discovery of Valve Issues

During collection and review of system operating data in preparation for model calibration, it was revealed that the control valves and check valves at Dacy Lane EST and Yosemite EST are not functioning as intended and may be sticking in a closed position at times. SCADA data on EST levels and field pressure data show that these ESTs do not fill and empty as expected. Not always but often, the tanks do not change level when the nearby pressures indicate the tanks should be filling or emptying. The valves that are intended to close to prevent overflowing the tanks close at unintended times, isolating the stored water volume, and preventing cycling of the tanks.

It is recommended that the control valving at Dacy Lane and Yosemite ESTs be inspected, serviced, repaired, or replaced, to allow proper operation and cycling of the tanks.

The data and analysis showing the unexpected operation of Dacy Lane EST and Yosemite EST are presented in **Appendix G**.

8.0 Water Supply Improvements

Currently all purchased water is received from GBRA in Pressure Plane 1 on the east side of I35. Moving water through PP1 and additional pumping is required to get water supply to PP2 and PP3 on the west side of I35. Receiving all purchased water on the east side if I35 has been inefficient and adds stress to the distribution system. ARWA water supply will be introduced in 2025.

Two take points for ARWA water are planned and in the design stage with a third take point under consideration. The planned ARWA take point #1 at 1626 PS is on the west side of I35 in the northern part of PP2 while take point #2 will be at Waterstone PS on the east side of I35. The third take point being considered will provide a second take point on the west side of I35.

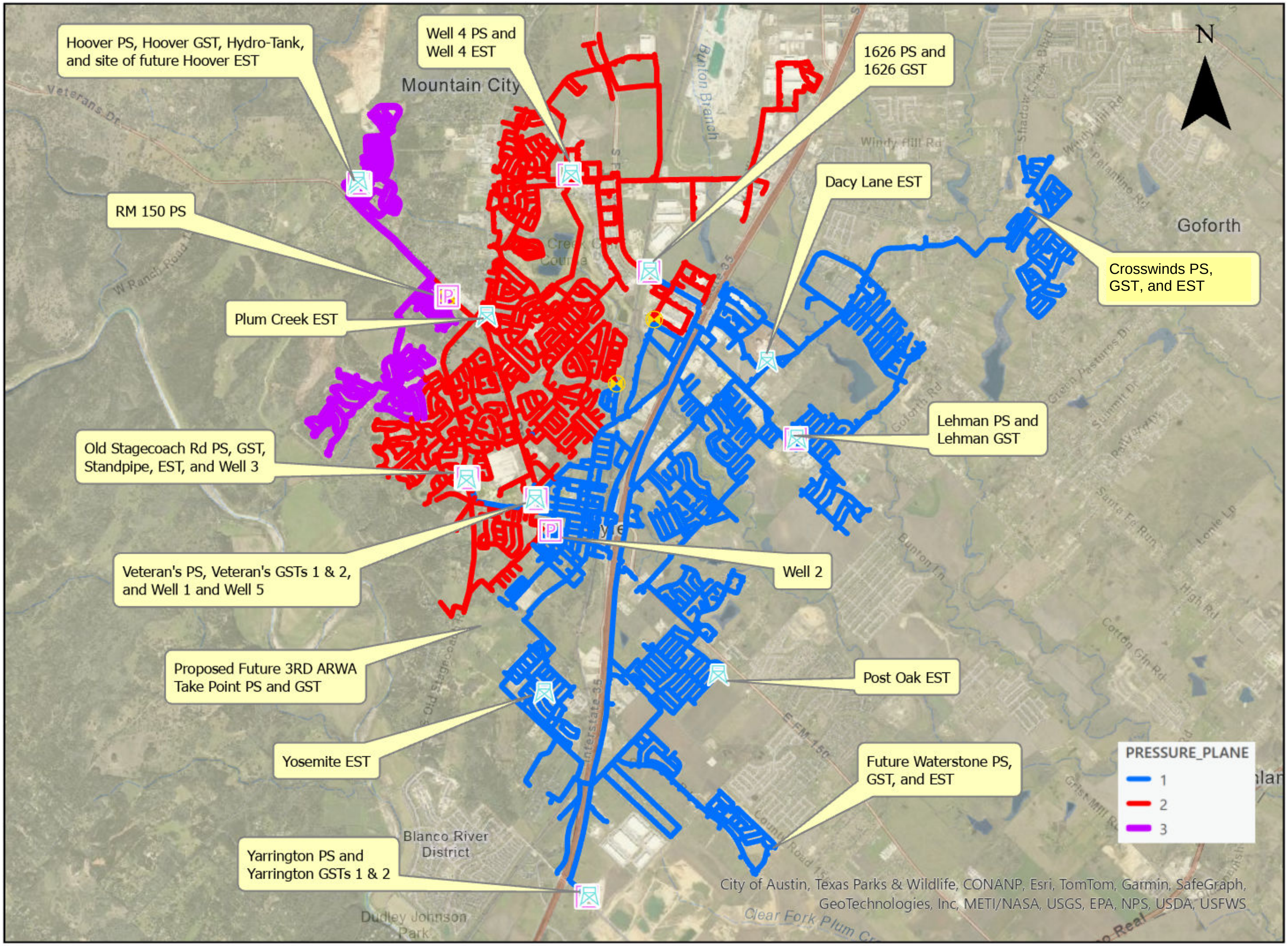
A second supply point on the west side of I35, in the southern part of PP2, will more efficiently supply the distribution system. This will provide two supply points into PP2 so that water is not required to travel through PP1 to get to the other pressure planes. The recommended location for the third ARWA take point and pump station is presented in **Appendix H**.

Appendix A

System Maps

Kyle Distribution System Map

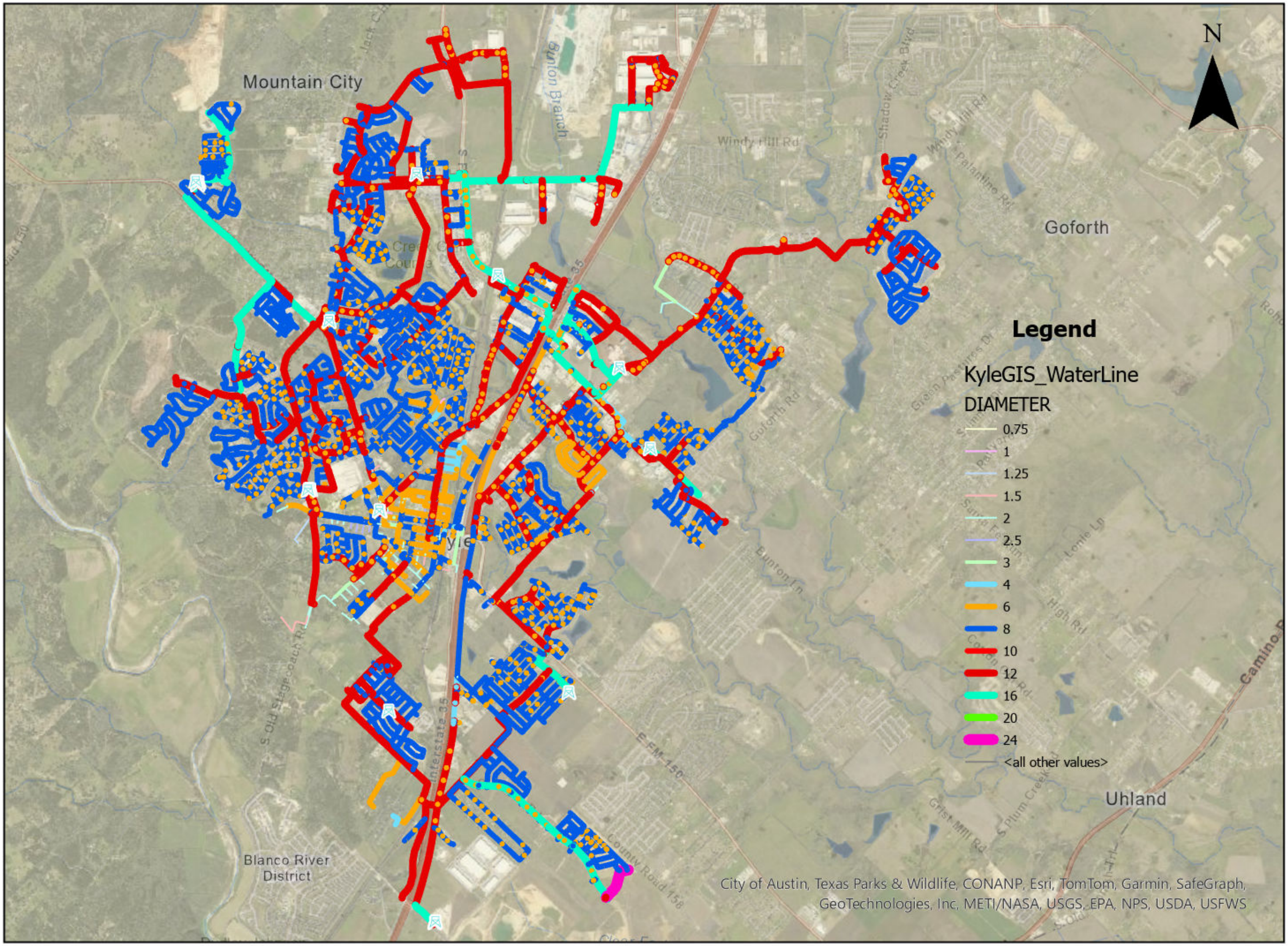
EXHIBIT 1



0 0.5 1 2 Miles

Pipe Diameters

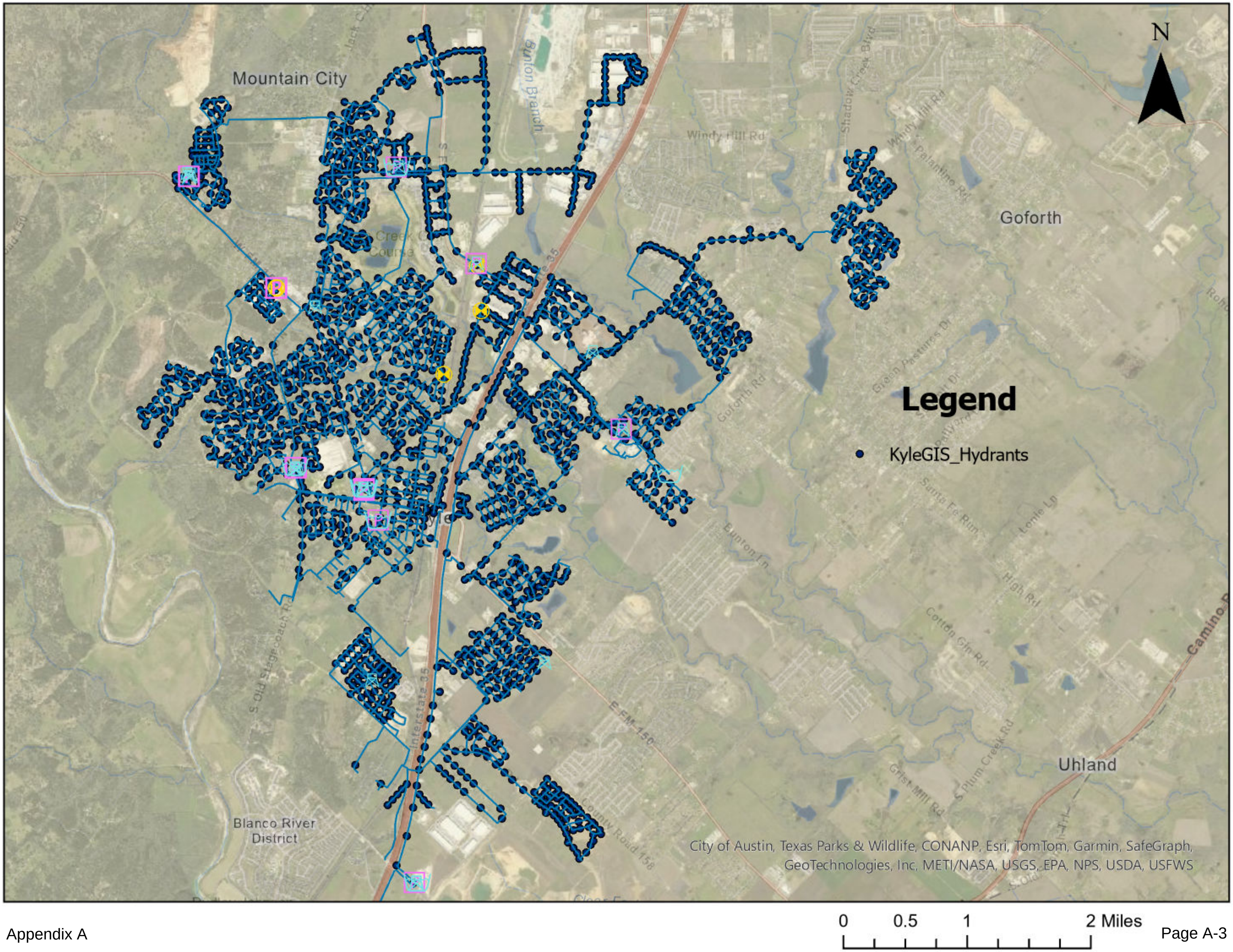
EXHIBIT 2



0 0.5 1 2 Miles

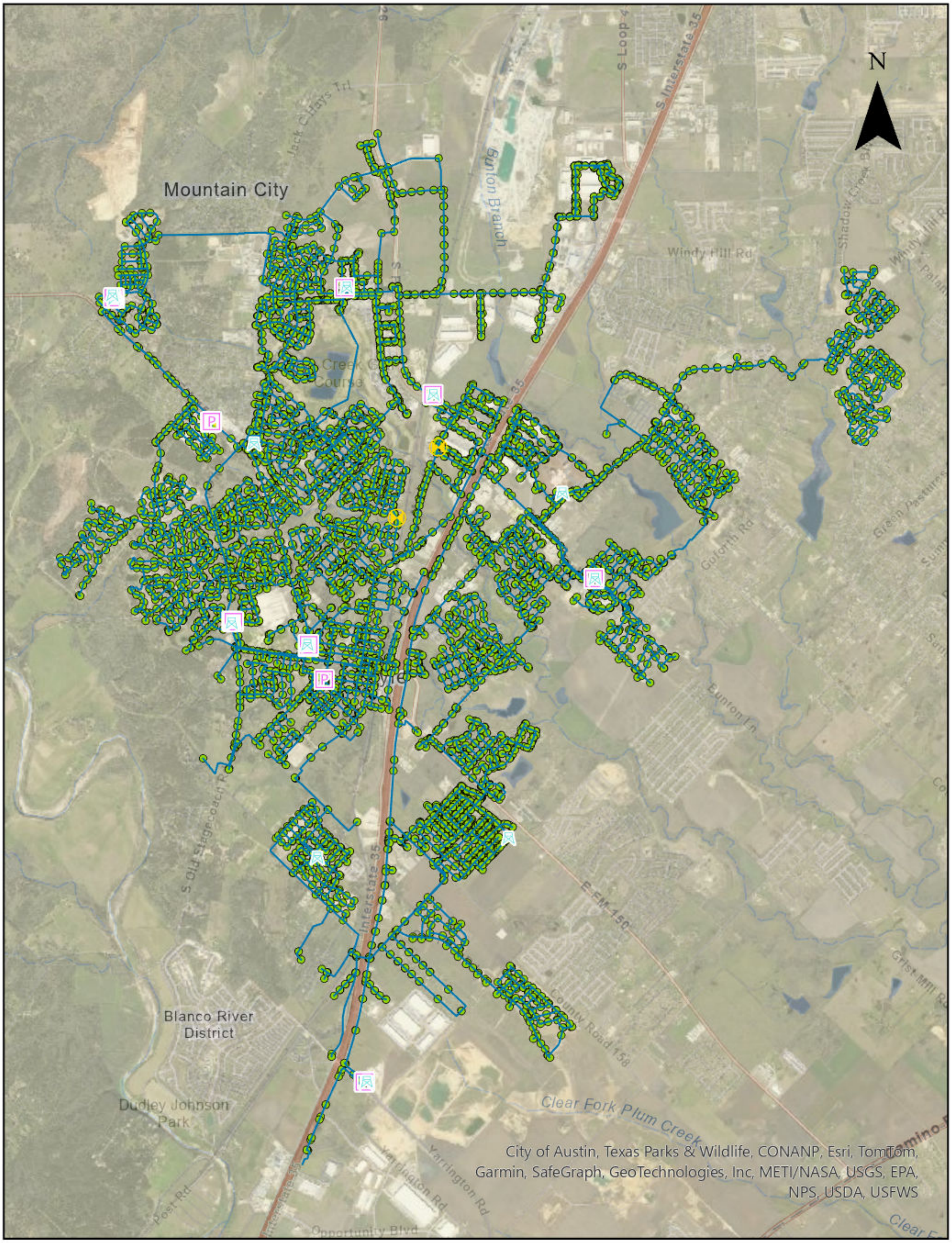
Fire Hydrants

EXHIBIT 3



Kyle Hydraulic Model

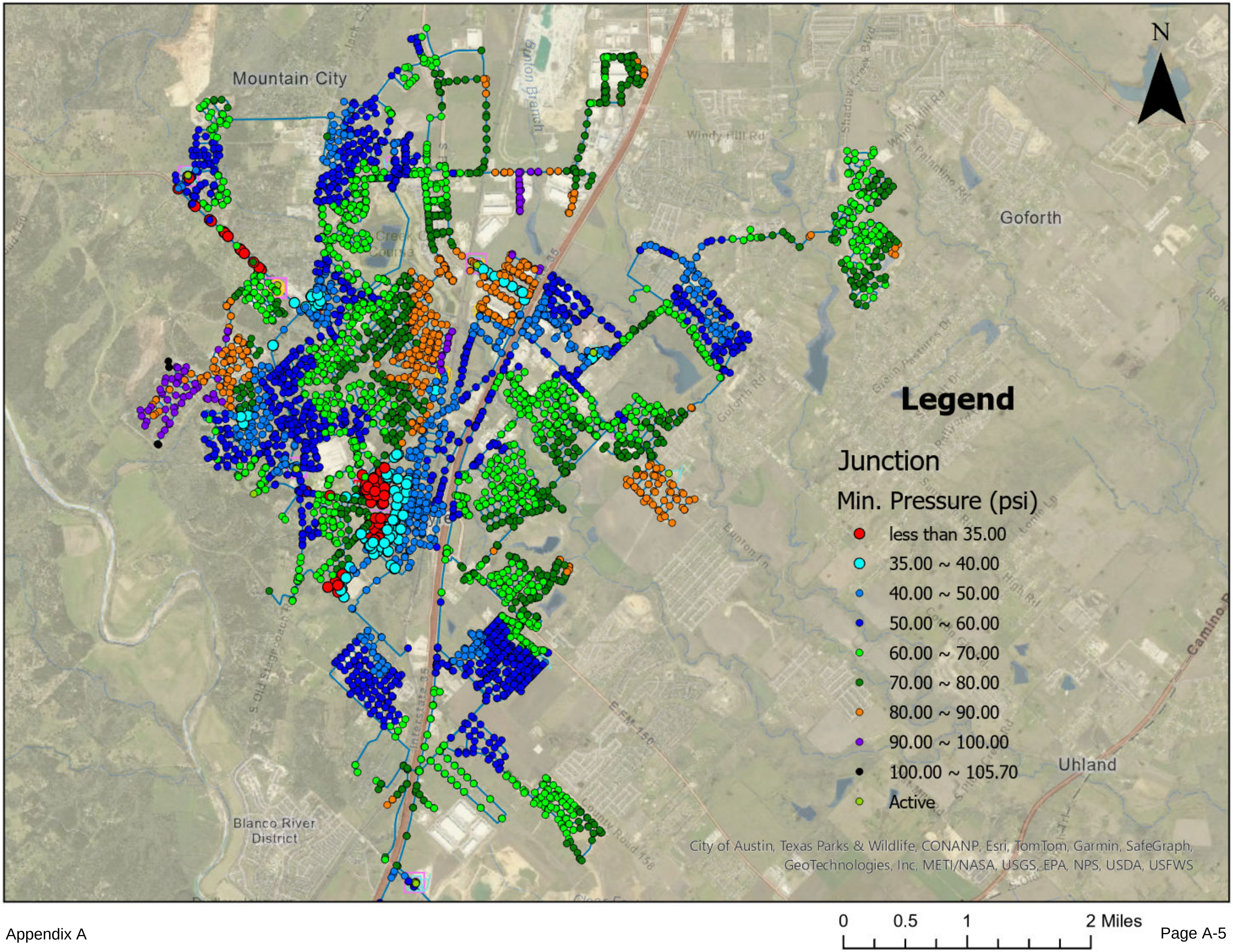
EXHIBIT 4



0 0.5 1 2 Miles

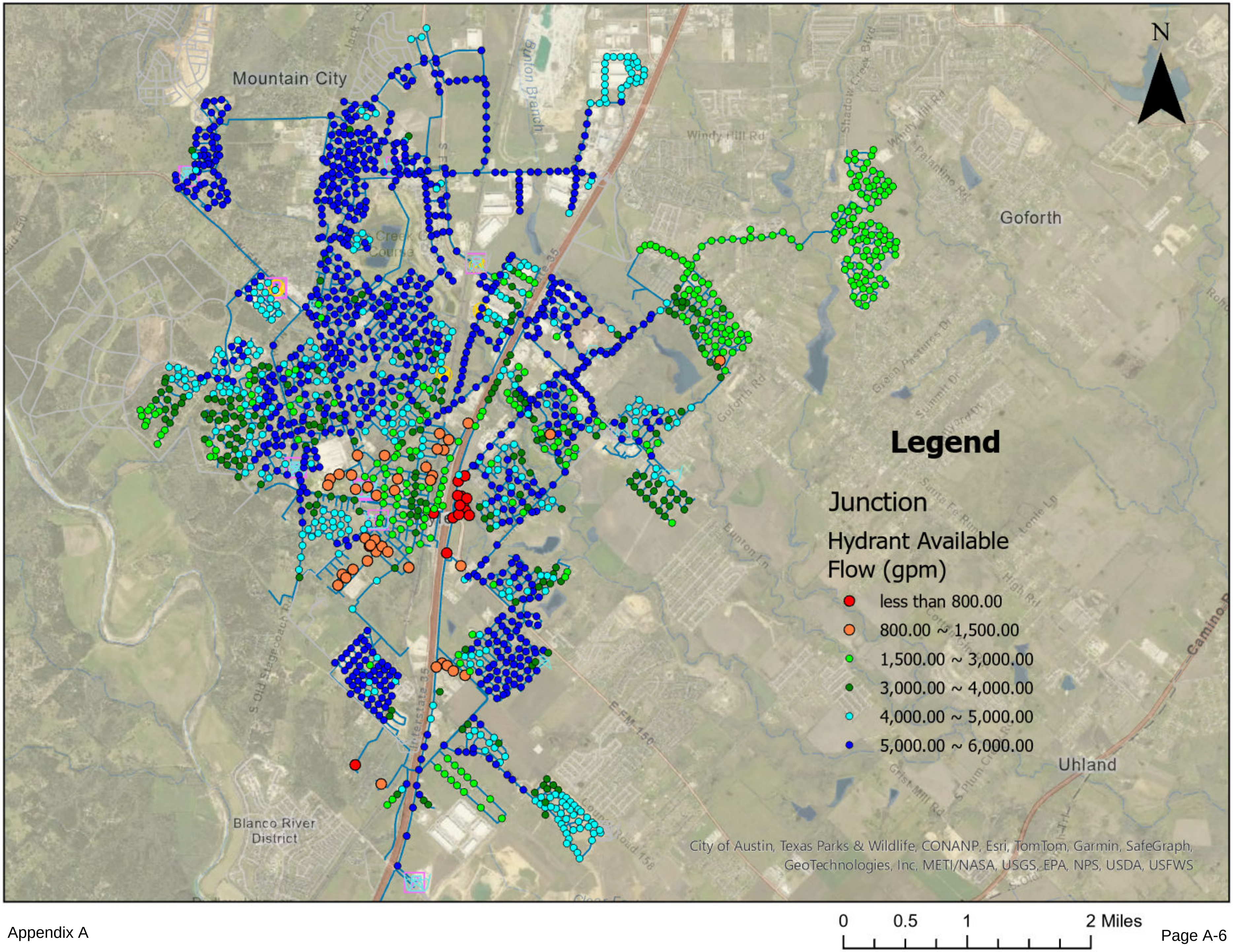
Minimum Pressures - MDD and Peak Hour

EXHIBIT 5



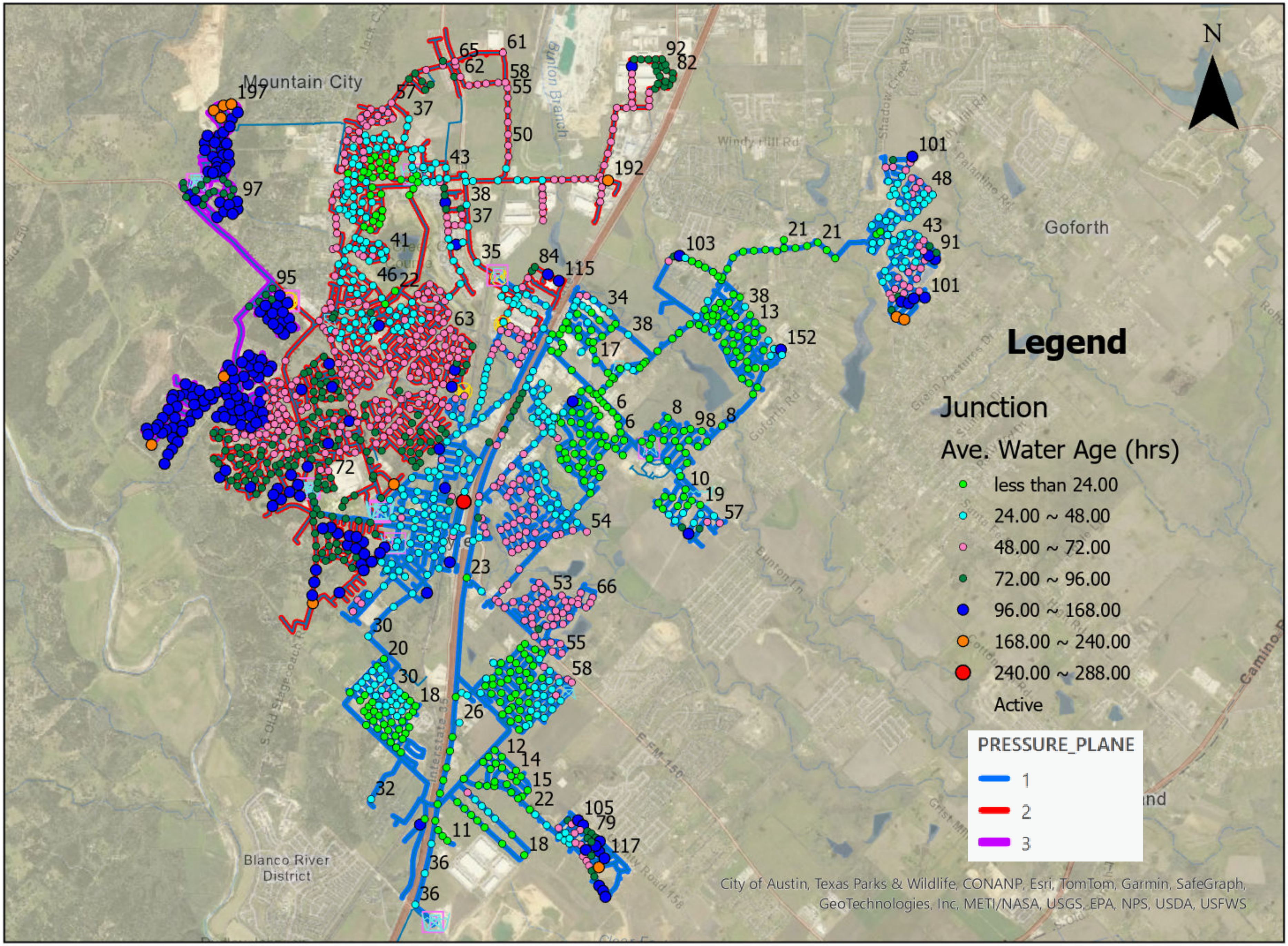
AVAILABLE FIRE FLOW

EXHIBIT 6



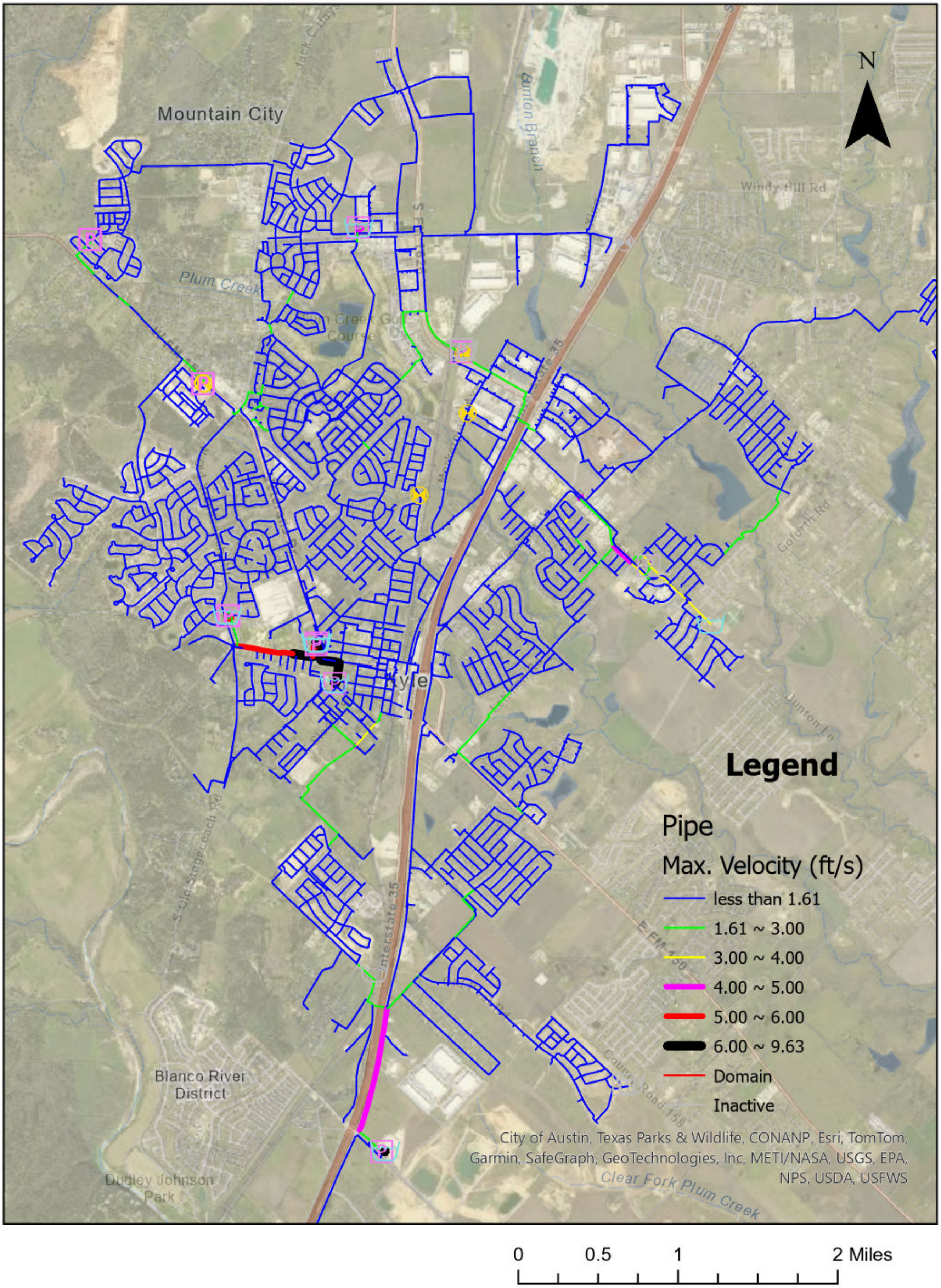
Water Age

EXHIBIT 7



Maximum Velocities

EXHIBIT 8



Appendix B

Model Calibration

APPENDIX B

Model Calibration

Model calibration was conducted individually for each of the three pressure planes over a three-week period. The final calibration dates are as shown in Table B1.

Table B1 – Calibration Dates

Pressure Plane	Pressure Data Collected	Calibration Day
1	7/23/2024 to 7/29/2024	7/26/2024
2	7/30/2024 to 8/5/2024	8/4/2024
3	7/16/2024 to 7/22/2024	7/17/2024

The calibration plan is described in the following pages. The calibration results are then presented.

Contents

Calibration Plan B2

Calibration Results B8

Kyle Hydraulic Model

Calibration Procedure

Due to limited number of data loggers that can be deployed to collect system pressure data, it is recommended to calibrate one pressure zone at a time to ensure enough pressure data points are included in the calibration run.

Data loggers will be installed on fire hydrants across the pressure plane. Pressure data should be collected in 1-minute intervals.

SCADA Data will be collected in 1-minute intervals for:

1. EST and GST levels
2. Pump status – on/off, Flow in gpm
3. Pressure Transmitters

Data loggers to be run for one week in each pressure zone. (Collect minimum 3 full 24-hour periods).

Schedule:

One 24-hour period in each week will be selected as 'calibration day' for each pressure zone. Model calibration will be conducted on each pressure zone the week following the data capture.

Time and effort are needed to install loggers, collect data from loggers at end of week, and relocate the loggers to the next pressure zone. The goal is to get 3 to 4 complete days of data in each zone. A day or two will be lost to installing/relocating loggers and other issues.

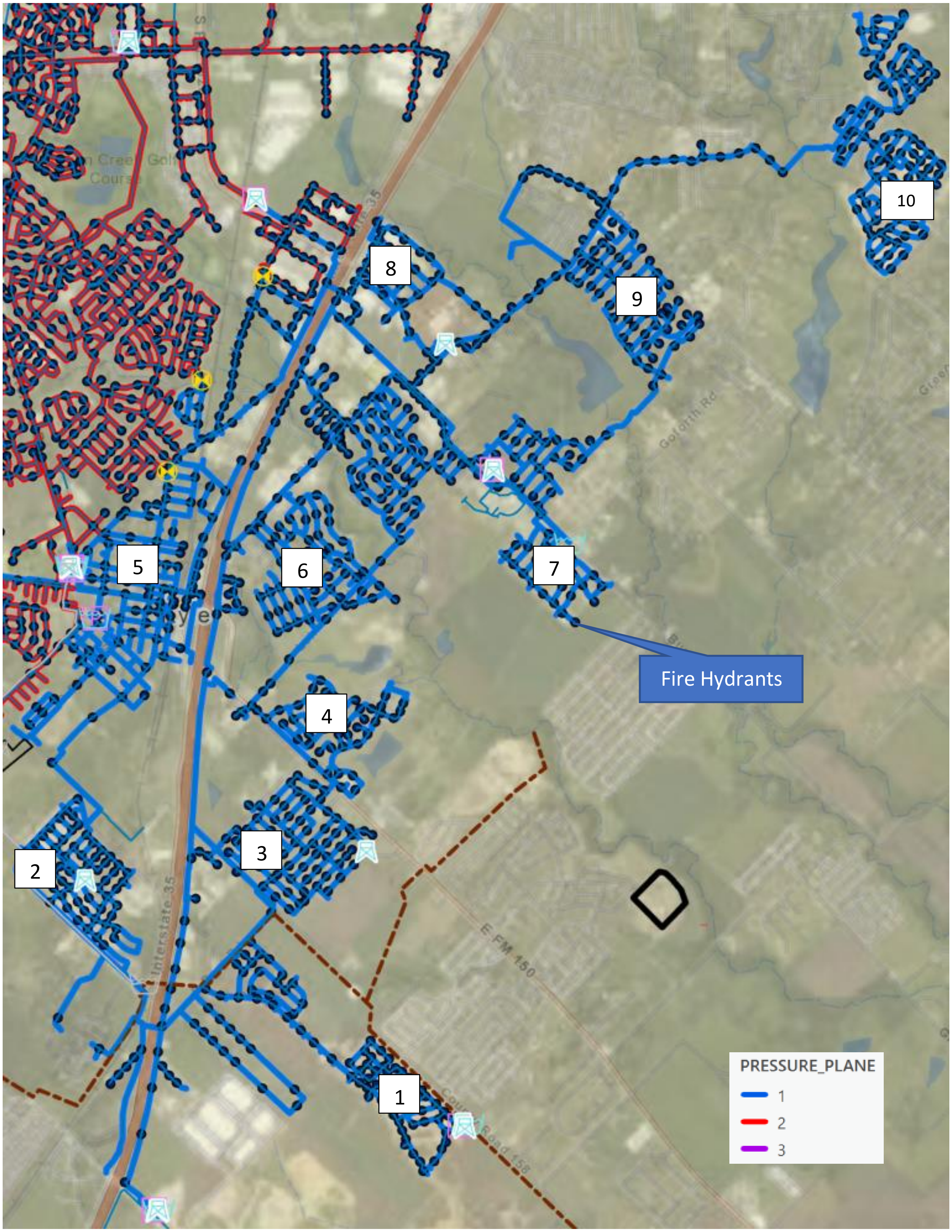
1. Week 1 – collect pressure data with loggers in PP1. Download all SCADA data for the week. Provide production data for the week.
2. Week 2 - collect pressure data with loggers in PP2. Download all SCADA data for the week. Provide production data for the week. (Calibration exercise in model completed for PP1).
3. Week 3 - collect pressure data with loggers in PP3. Download all SCADA data for the week. Provide production data for the week. (Calibration exercise in model completed for PP2).
4. Week 4 - Calibration exercise in model completed for PP3. Begin Calibration TM.
5. Week 5 – Complete Calibration Draft TM, QA/QC calibration process. (Submit Draft).
6. Week 6 – Final Calibration results. Model calibration complete. Issue Calibration TM.
7. The Calibration TM will be stand-alone but also attached to the Existing Water System Hydraulic TM.

(Note: The order of pressure planes may be adjusted to sync with irrigation weeks so that PP2 and PP3 occur during irrigation weeks.)

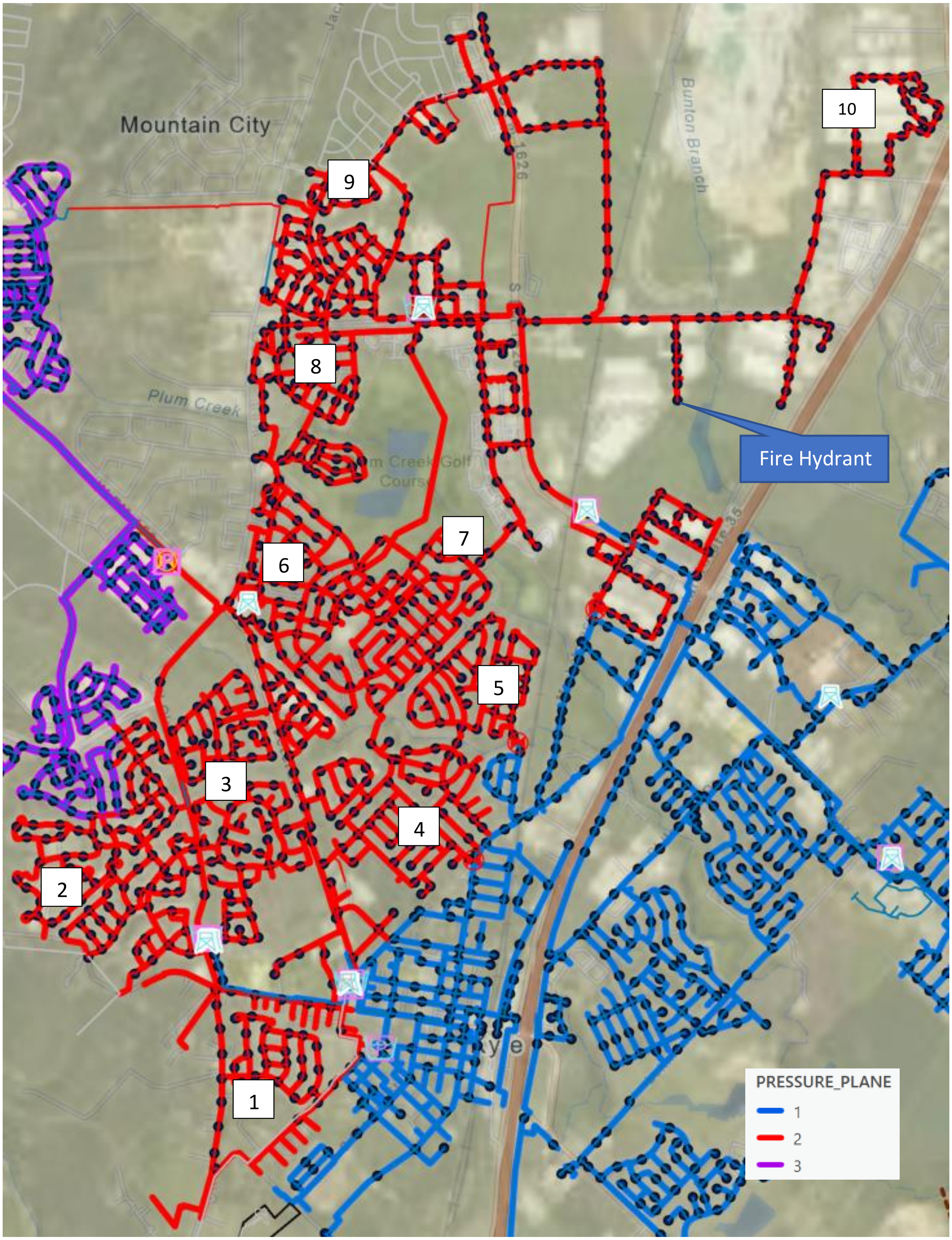
Before the first week of data collection, the loggers will need to be tested, adjusted, inspected to ensure operation and accuracy. Record time between the loggers and SCADA needs to be in sync. We need to be accurate when SCADA says 1:31 pm and the logger says 1:31 pm, that they are in sync with the same time.

Fire hydrant locations by pressure plane:

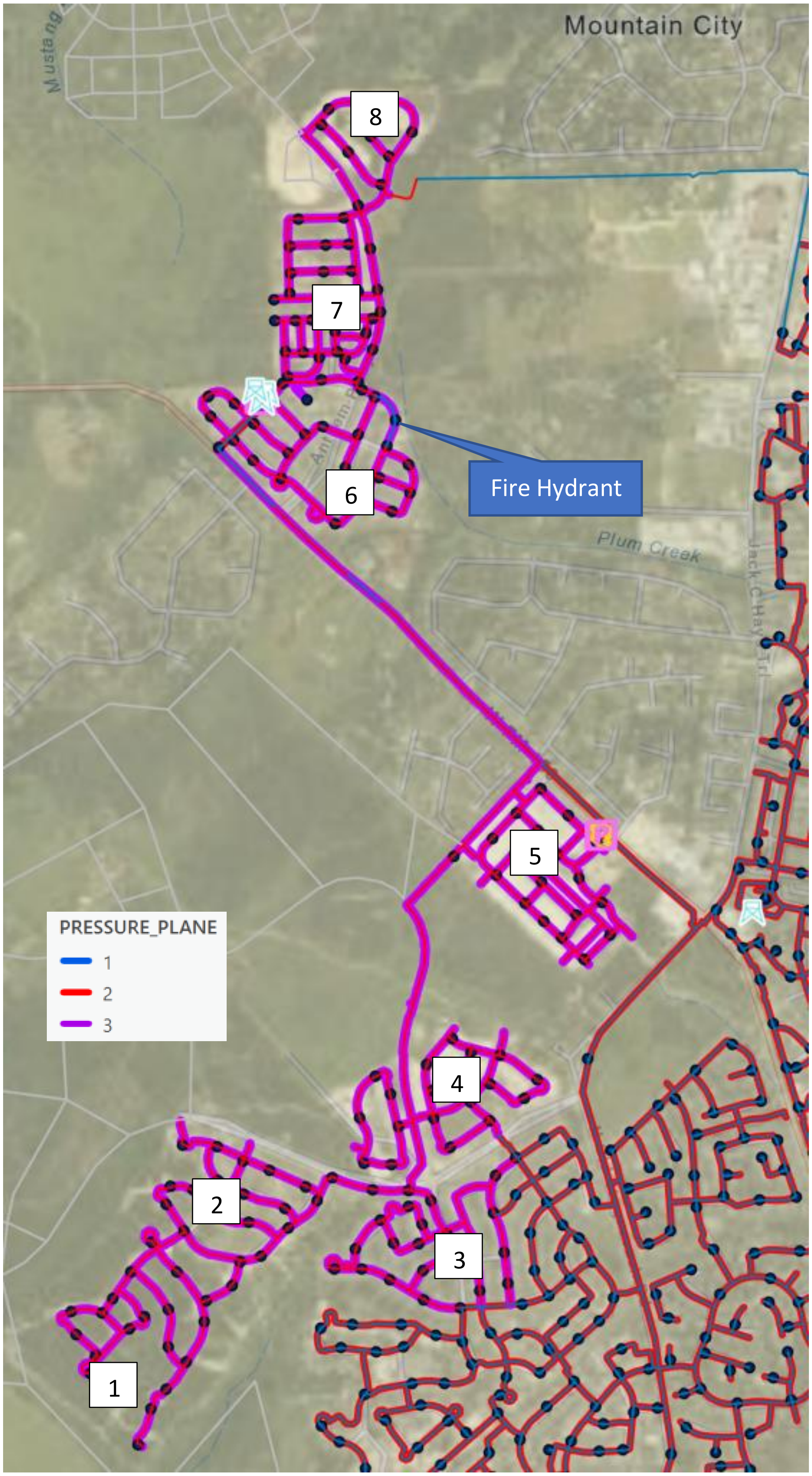
PP1 (10 Pressure Recording Sites)



PP2 (10 Pressure Recording Sites)



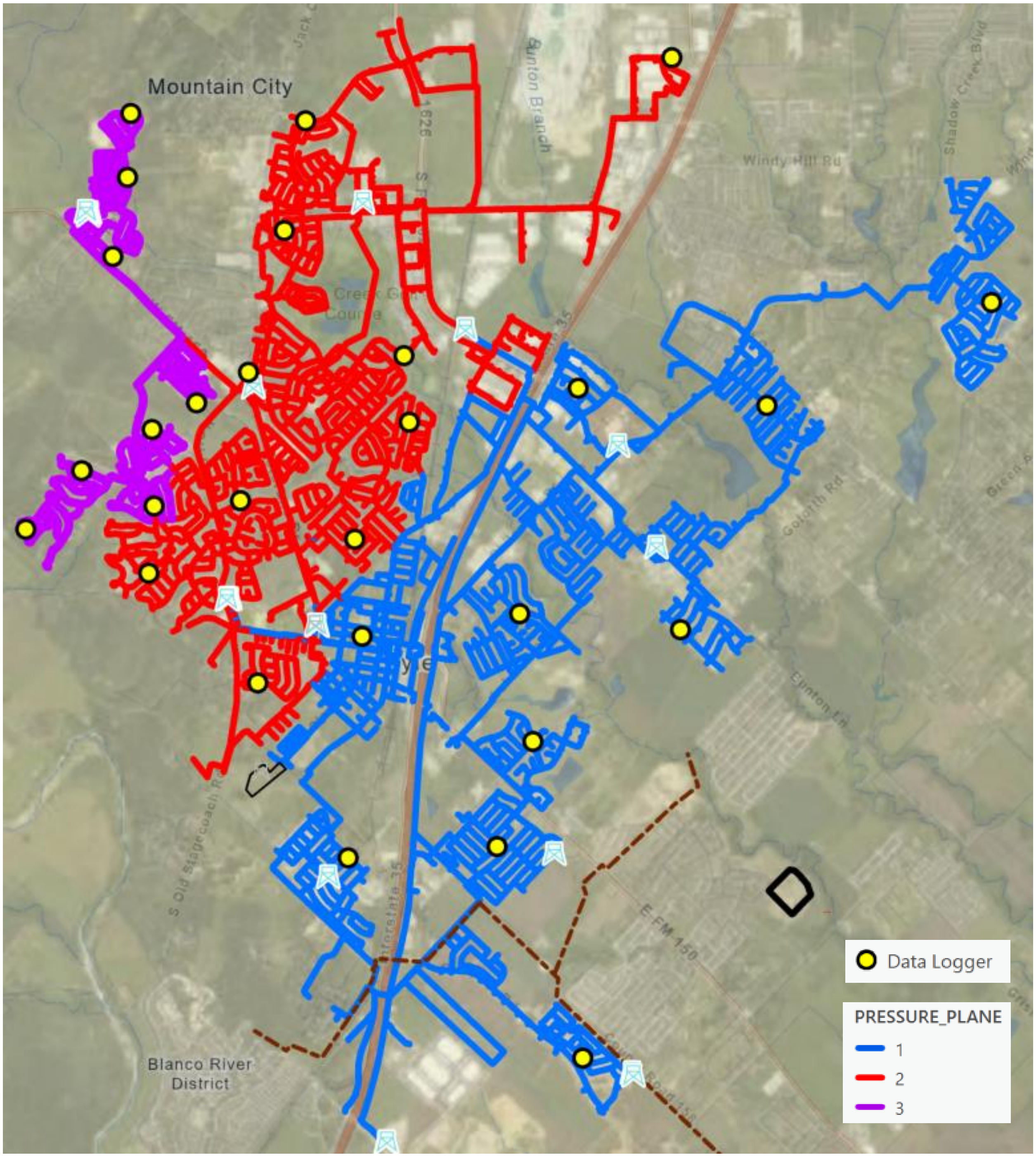
PP3 (8 Pressure Recording Sites)



Fire Hydrant List

Pressure Plane	Hydrant Site	Hydrant ID	Hydrant Location (Nearest Intersection)	Model Junction
1	1	WD-HY-4113	Avre Loop & Yuba Path	J386
1	2	WD-HY-1854	Olympic Park Dr & Mammoth Dr	61282
1	3	WD-HY-248	Discovery & Enterprise	276
1	4	WD-HY-373	Estival Dr & Otono Loop	401
1	5	WD-HY-1731	W Lockhart St & N Sledge St	61166
1	6	WD-HY-209	Primrose Blvd & Prairie Crossing	237
1	7	WD-HY-1923	Winding Creek Rd & Fabion St	61337
1	8	WD-HY-658	Kyle Pkwy & Horvath Dr	686
1	9	WD-HY-396	Downing Way & Marquitos Dr	424
1	10	WD-HY-2752	Hurley St & James Caird Dr	J1172
2	1	WD-HY-1121	Conestoga Dr & Texas Jack Dr	J1174
2	2	WD-HY-3752	Five Mile Crk Wy & Left Frk Dr	J1176
2	3	WD-HY-451	Camelia Pkwy & Hometown Pkwy	479
2	4	WD-HY-258	Remington Dr & San Jacinto Dr	286
2	5	WD-HY-471	Apricot Ln & Fall Creek Dr	499
2	6	WD-HY-78	Jack C Hays Trl & Witte Rd	106
2	7	WD-HY-639	Sampson & McGarity	667
2	8	WD-HY-630	Kirby Ln & Dorn	658
2	9	WD-HY-5264	Rioja & Mountain City Dr	J1178
2	10	WD-HY-1042	Gateway Blvd & Chula Hill Dr	47868
3	1	WD-HY-3708	Seaside Sparrow Wy & Lily Pad Ln	J1180
3	2	WD-HY-2193	Milam Creek Dr & Six Creeks Blvd	61386
3	3	WD-HY-1790	Rio Blanco Wy & Painted Crk Wy	61221
3	4	WD-HY-3788	Tumbling Creek Run	J1182
3	5	WD-HY-3591	Treadwell Ln	J1184
3	6	WD-HY-1943	Constitution Way	61357
3	7	WD-HY-3663	Anthem Pkwy & Grand Teton Dr	J1186
3	8	WD-HY-5231	Tubman Dr	J1188

Data Logger Nodes in Hydraulic Model



Calibration Results

Calibration results are presented for each pressure plane. The calibration exercise was assisted by utilizing the Calibration Tool in InfoWater Pro. The Calibration tool calculates the best fit Friction Coefficient or "C" value for the system piping to match model pressure results with the actual field data collected. Field data and model results should agree within 2 or 3 psi or about 5% to be considered well calibrated.

Pressure Plane 1

Data collection nodes included 10 fire hydrants in PP1 where pressure data was collected. SCADA data collected included all tank levels and pump flow measurements. Model parameters were set to match the SCADA data at the calibration time. The pressure data collection sites are shown in Figure B1.

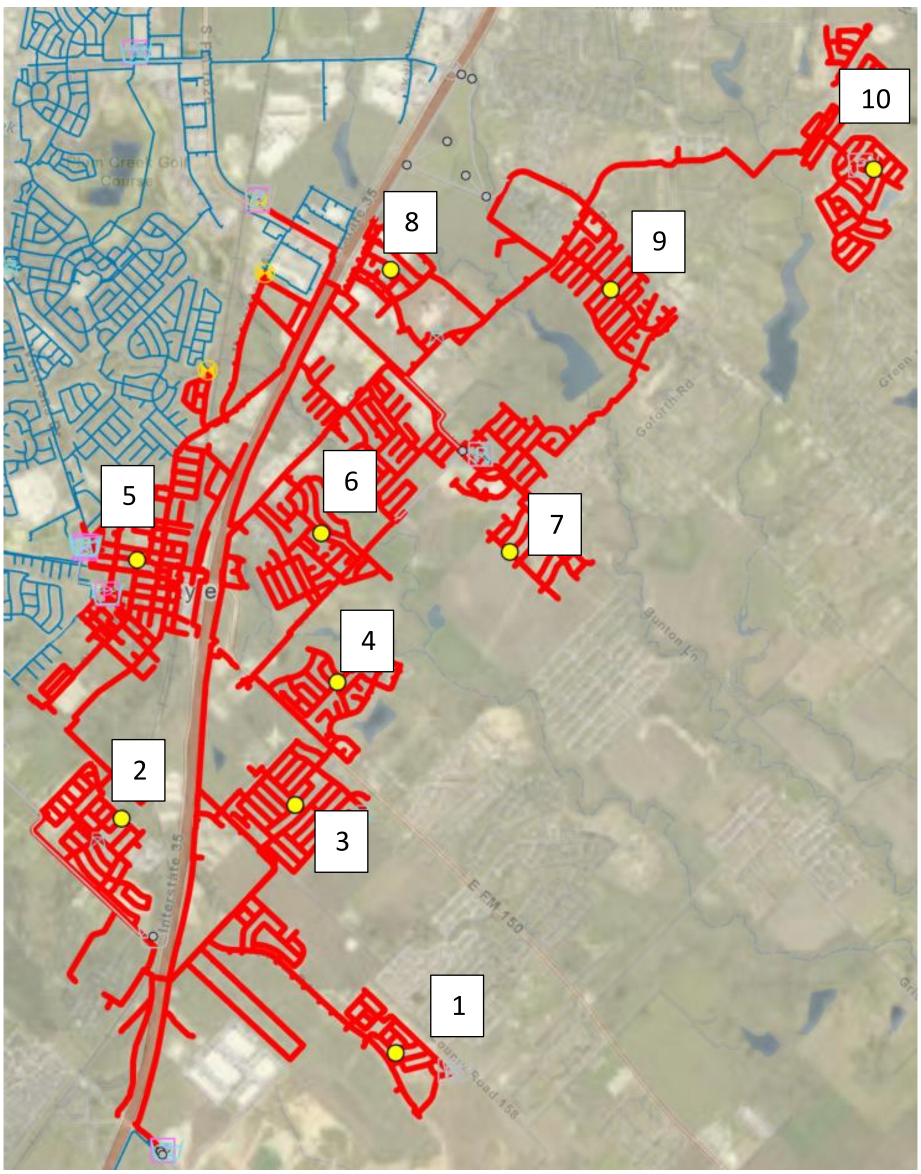


Figure B1 – Pressure Plane 1 Data Collection Sites

The calibration date and time selected for PP1 was 7/26/2024 at 10:00 am. The observed pressures in PP1 at that time are shown in Table B2.

Table B2 – Observed Pressures for Calibration

Logger Data	
	PSI Observed
PP1DATA_LOGGER_01	69.40
PP1DATA_LOGGER_02	51.30
PP1DATA_LOGGER_03	55.13
PP1DATA_LOGGER_04	70.80
PP1DATA_LOGGER_05	40.20
PP1DATA_LOGGER_06	68.70
PP1DATA_LOGGER_07	81.96
PP1DATA_LOGGER_08	59.46
PP1DATA_LOGGER_09	54.23
PP1DATA_LOGGER_10	74.77

Tank levels and pump flow rates in the model were set to match SCADA data for this same day and hour and the calibration tool was run to determine C values for all piping. Eleven Pipe groups were selected for use in the calibration tool based on pipe diameter and geographic area. Most of the pipe material in the Kyle system is PVC with limited information on other materials, so pipe groups were not selected based on material. The pipe groups used in the calibrator tool with calculated C values are shown in Figure B2.

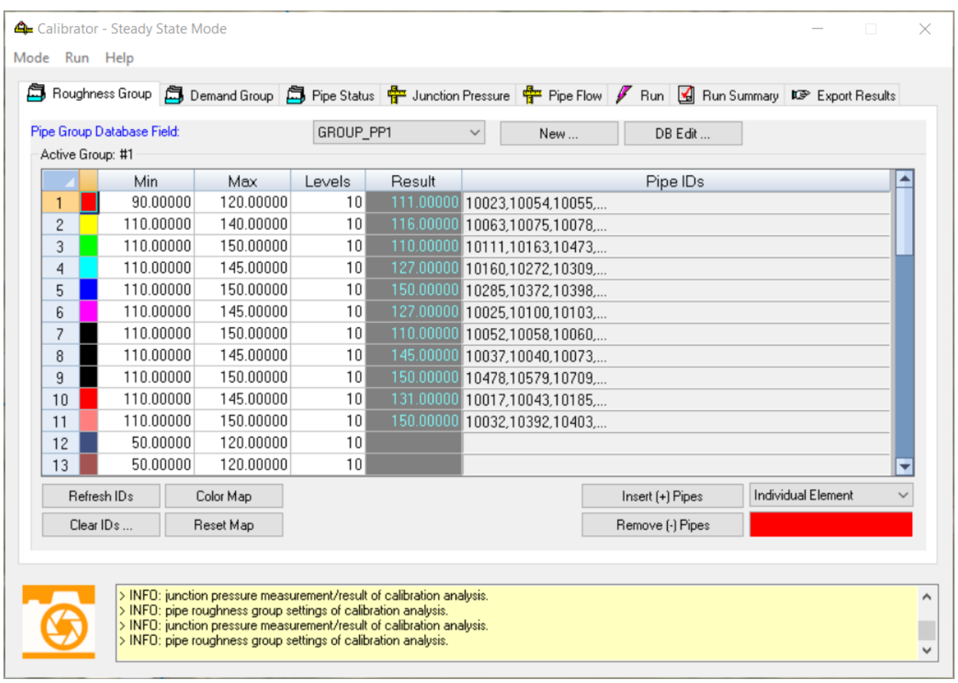


Figure B2 – C Value Results

The calibration run determines the pipe C values that give pressure results at the fire hydrants that best fit the observed values. The model results for the pressures at each fire hydrant/data logger are shown in Figure B3.

	ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	PP1DATA_LOGGER_01	0.00	677.74	838.18	69.38
2	PP1DATA_LOGGER_02	0.00	719.74	841.23	52.54
3	PP1DATA_LOGGER_03	0.00	709.73	837.38	55.20
4	PP1DATA_LOGGER_04	0.00	672.74	837.41	71.21
5	PP1DATA_LOGGER_05	0.00	739.53	839.40	43.19
6	PP1DATA_LOGGER_06	0.00	673.76	838.06	71.05
7	PP1DATA_LOGGER_07	0.00	646.01	838.98	83.45
8	PP1DATA_LOGGER_08	0.00	699.04	840.04	60.97
9	PP1DATA_LOGGER_09	0.00	710.29	839.25	55.76
10	PP1DATA_LOGGER_10	0.00	662.00	838.50	76.32

Figure B3 – Model Results

Comparing the model results for expected pressure at the 10 fire hydrants with the observed values measured by the data loggers shows a very close match. The model simulation predicts pressures within 3 psi of the observed pressures. Pressure plane 1 in the model produces results accurately matching the real system. The comparison of model results and observed data for pressures in PP1 are shown in Table B3.

Table B3 – Compare Observed Data and Model Simulation Results

Data				
	Observed psi	Simulated psi	difference psi	difference %
PP1DATA_LOGGER_01	69.40	69.38	-0.02	-0.03%
PP1DATA_LOGGER_02	51.30	52.54	1.24	2.42%
PP1DATA_LOGGER_03	55.13	55.2	0.07	0.12%
PP1DATA_LOGGER_04	70.80	71.21	0.41	0.58%
PP1DATA_LOGGER_05	40.20	43.19	2.99	7.44%
PP1DATA_LOGGER_06	68.70	71.05	2.35	3.42%
PP1DATA_LOGGER_07	81.96	83.45	1.49	1.81%
PP1DATA_LOGGER_08	59.46	60.97	1.51	2.53%
PP1DATA_LOGGER_09	54.23	55.76	1.53	2.82%
PP1DATA_LOGGER_10	74.77	76.32	1.55	2.08%

The C values for pipes in PP1 were updated in the model based on the calibrator tool calculations. C values ranged from 110 to 150. These C values are typical of PVC piping in distribution systems with a variety of pipe ages and conditions. Multiple pipe groups for 8” and 12” piping were used because these are the most numerous pipe sizes in the system and different geographic areas may generally have different pipe ages. Newer area of the city and older area of the city may not have the same C values; therefore, multiple groups were defined for these pipes. The C values determined during the calibration run are shown in Table B4.

Table B4 – C Values Updated in Model

Pipe Diameter	Group	C Value
4" and under	1	111
6"	2	116
8"	4	127
	6	127
	8	145
	10	131
12"	5	150
	7	110
	9	150
	11	150
16"	3	110

Pressure Plane 2

Data collection nodes included 10 fire hydrants in PP2 where pressure data was collected. SCADA data collected included all tank levels and pump flow measurements. Model parameters were set to match the SCADA data at the calibration time. The pressure data collection sites are shown in Figure B4.

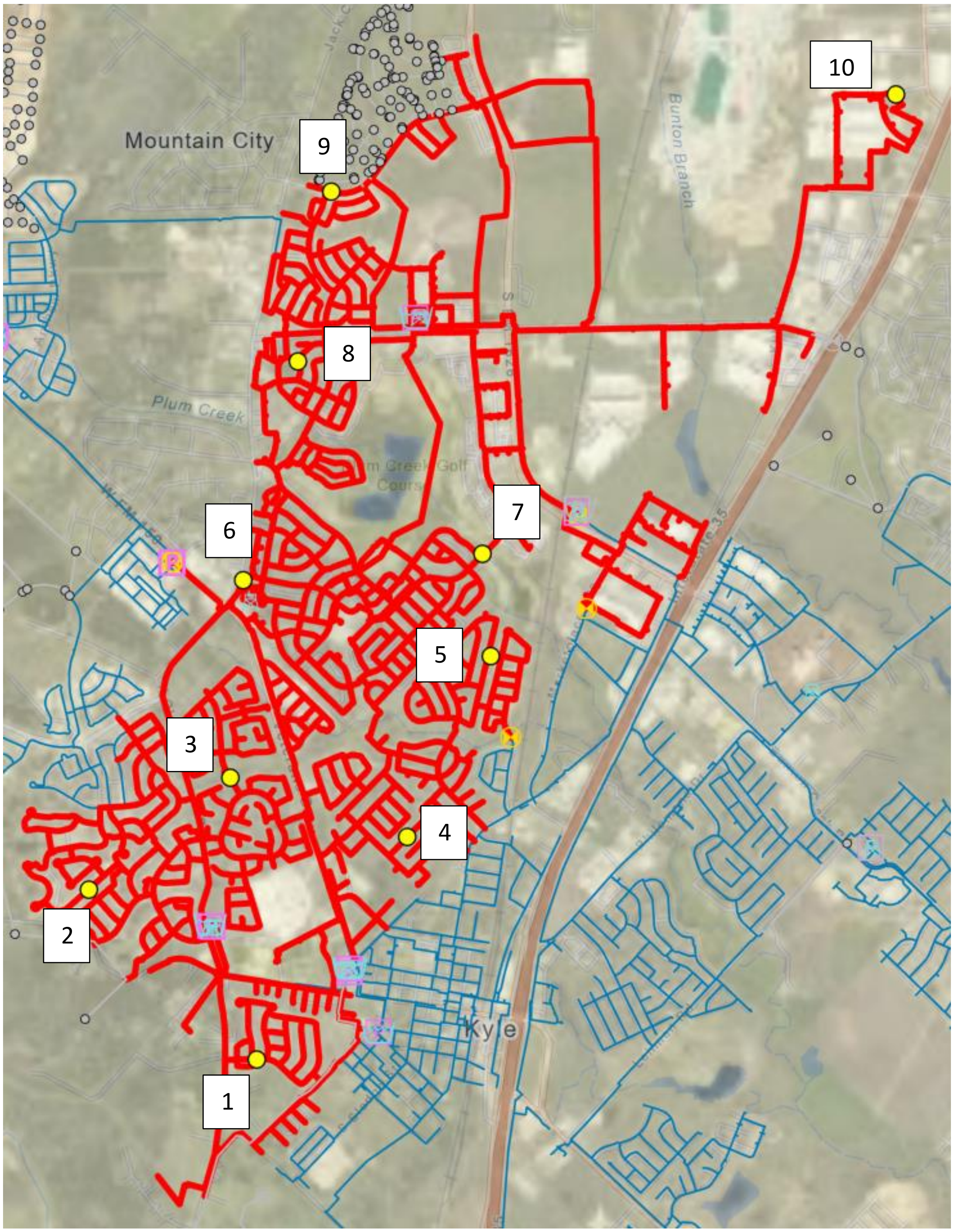


Figure B4 – Pressure Plane 2 Data Collection Sites

The calibration date and time selected for PP2 was 8/4/2024 at 8:30 pm. The observed pressures in PP2 at that time are shown in Table B5.

Table B5 – Observed Pressures for Calibration

Logger Data	
	PSI Observed
PP1DATA_LOGGER_01	59.50
PP1DATA_LOGGER_02	56.00
PP1DATA_LOGGER_03	62.80
PP1DATA_LOGGER_04	73.20
PP1DATA_LOGGER_05	88.50
PP1DATA_LOGGER_06	40.60
PP1DATA_LOGGER_07	86.50
PP1DATA_LOGGER_08	56.40
PP1DATA_LOGGER_09	53.00
PP1DATA_LOGGER_10	80.10

Tank levels and pump flow rates in the model were set to match SCADA data for this same day and hour and the calibration tool was run to determine C values for all piping. Six pipe groups were selected for use in the calibration tool based on pipe diameter. Most of the pipe material in the Kyle system is PVC with limited information on other materials, so pipe groups were not selected based on material. The pipe groups used in the calibrator tool with calculated C values are shown in Figure B5.

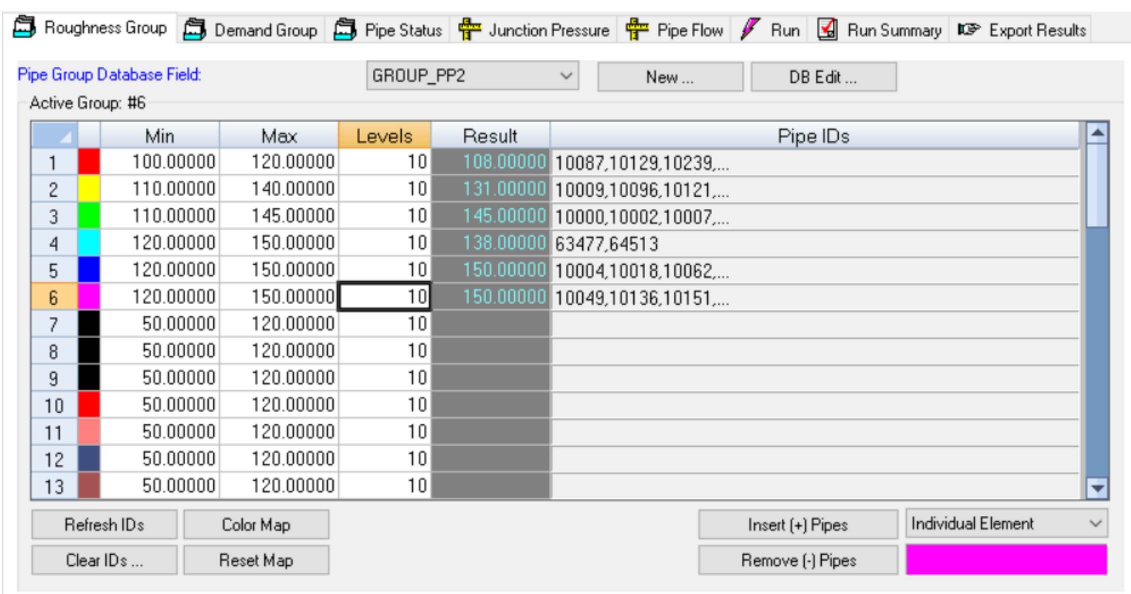


Figure B5 – C Value Results

The calibration run determines the pipe C values that give pressure results at the fire hydrants that best fit the observed values. The model results for the pressures at each fire hydrant/data logger are shown in Figure B6.

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	PP2DATA_LOGGER_01	0.00	782.00	919.58	59.50
2	☐	PP2DATA_LOGGER_02	0.00	790.00	919.55	56.02
3	☐	PP2DATA_LOGGER_03	0.00	775.60	919.59	62.27
4	☐	PP2DATA_LOGGER_04	0.00	750.30	919.69	73.25
5	☐	PP2DATA_LOGGER_05	0.00	717.37	920.03	87.64
6	☐	PP2DATA_LOGGER_06	0.00	828.12	920.01	39.74
7	☐	PP2DATA_LOGGER_07	0.00	720.41	921.02	86.75
8	☐	PP2DATA_LOGGER_08	0.00	791.94	922.43	56.42
9	☐	PP2DATA_LOGGER_09	0.00	801.00	923.19	52.84
10	☐	PP2DATA_LOGGER_10	0.00	737.82	923.43	80.27

Figure B6 – Model Results

Comparing the model results for expected pressure at the 10 fire hydrants with the observed values measured by the data loggers shows a very close match. The model simulation predicts pressures within 1 psi of the observed pressures. Pressure plane 2 in the model produces results accurately matching the real system. The comparison of model results and observed data for pressures in PP2 are shown in Table B6.

Table B6 – Compare Observed Data and Model Simulation Results

Data				
	Observed psi	Simulated psi	difference psi	difference %
PP1DATA_LOGGER_01	59.50	59.50	0.00	0.00%
PP1DATA_LOGGER_02	56.00	56.02	-0.02	-0.04%
PP1DATA_LOGGER_03	62.80	62.27	0.53	0.84%
PP1DATA_LOGGER_04	73.20	73.25	-0.05	-0.07%
PP1DATA_LOGGER_05	88.50	87.64	0.86	0.97%
PP1DATA_LOGGER_06	40.60	39.74	0.86	2.12%
PP1DATA_LOGGER_07	86.50	86.75	-0.25	-0.29%
PP1DATA_LOGGER_08	56.40	56.42	-0.02	-0.04%
PP1DATA_LOGGER_09	53.00	52.84	0.16	0.30%
PP1DATA_LOGGER_10	80.10	80.27	-0.17	-0.21%

The C values for pipes in PP2 were updated in the model based on the calibrator tool calculations. C values ranged from 108 to 150. These C values are typical of PVC piping in distribution systems with a variety of pipe ages and conditions. The C values determined during the calibration run are shown in Table B7.

Table B7 – C Values Updated in Model

Pipe Diameter	Group	C Value
4" and under	1	108
6"	2	131
8"	3	145
10”	4	138
12”	5	150
16”	6	150

Pressure Plane 3

Data collection nodes included 8 fire hydrants in PP3 where pressure data was collected. SCADA data collected included all tank levels and pump flow measurements. Model parameters were set to match the SCADA data at the calibration time. The pressure data collection sites are shown in Figure B7.

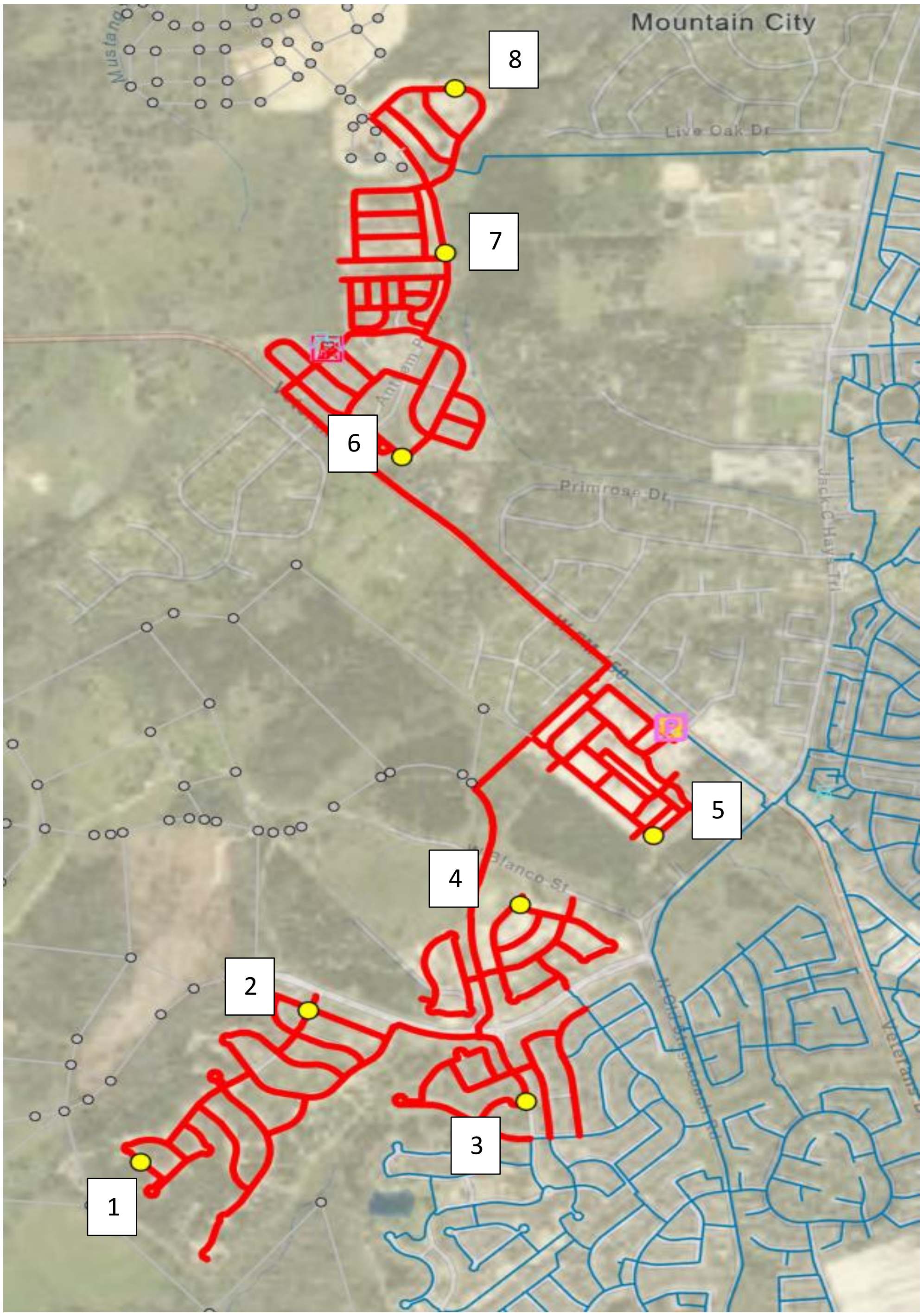


Figure B7 – Pressure Plane 3 Data Collection Sites

The calibration date and time selected for PP3 was 7/17/2024 at 8:00 pm. The observed pressures in PP2 at that time are shown in Table B8.

Table B8 – Observed Pressures for Calibration

Logger Data	
	PSI Observed
PP1DATA_LOGGER_01	97.40
PP1DATA_LOGGER_02	92.00
PP1DATA_LOGGER_03	74.50
PP1DATA_LOGGER_04	87.30
PP1DATA_LOGGER_05	71.00
PP1DATA_LOGGER_06	65.90
PP1DATA_LOGGER_07	59.20
PP1DATA_LOGGER_08	73.70

Tank levels and pump flow rates in the model were set to match SCADA data for this same day and hour and the calibration tool was run to determine C values for all piping. Five Pipe groups were selected for use in the calibration tool based on pipe diameter. Most of the pipe material in the Kyle system is PVC with limited information on other materials, so pipe groups were not selected based on material. The pipe groups used in the calibrator tool with calculated C values are shown in Figure B8.

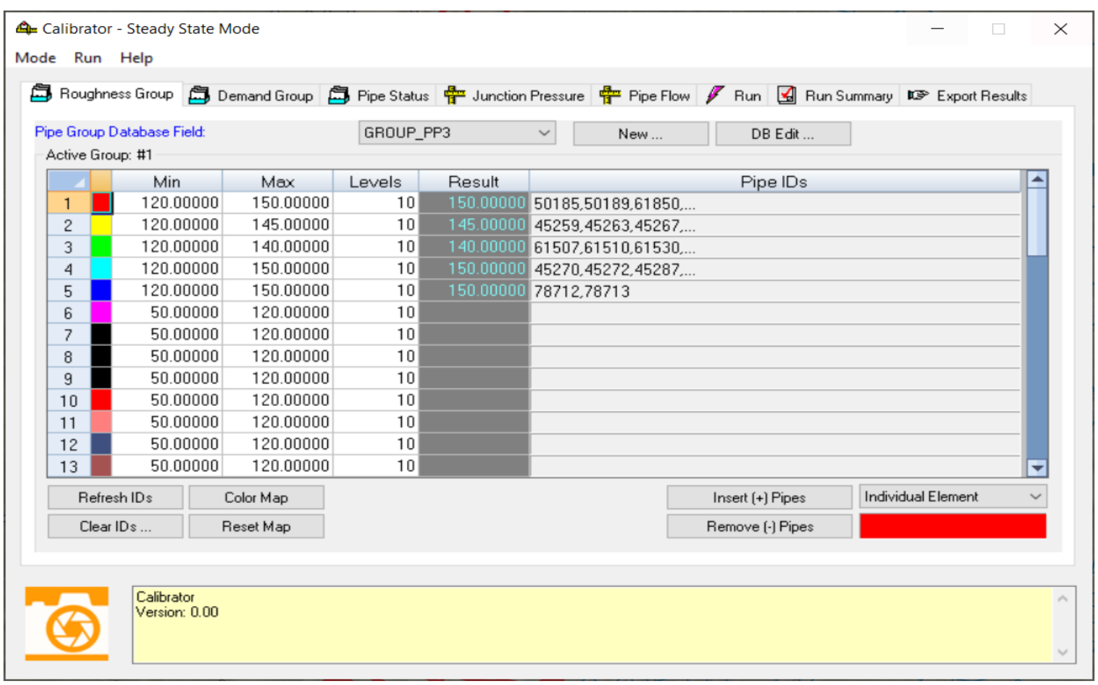


Figure B8 – C Value Results

The calibration run determines the pipe C values that give pressure results at the fire hydrants that best fit the observed values. The model results for the pressures at each fire hydrant/data logger are shown in Figure B9.

[Dom] Junction Report: PP3DATA_LOGGER_3,PP3DATA_LOGGER_6,...,PP3DATA_

00:00 hrs

	ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	PP3DATA_LOGGER_1	0.00	773.33	999.72	97.90
2	PP3DATA_LOGGER_2	0.00	788.18	999.74	91.49
3	PP3DATA_LOGGER_3	0.00	827.44	999.75	74.51
4	PP3DATA_LOGGER_4	0.00	799.50	999.77	86.61
5	PP3DATA_LOGGER_5	0.00	837.00	999.83	70.41
6	PP3DATA_LOGGER_6	0.00	850.82	1,000.00	64.51
7	PP3DATA_LOGGER_7	0.00	866.00	1,000.00	57.95
8	PP3DATA_LOGGER_8	0.00	830.50	1,000.00	73.30

Figure B9 – Model Results

Comparing the model results for expected pressure at the 8 fire hydrants with the observed values measured by the data loggers shows a very close match. The model simulation predicts pressures within 1.5 psi of the observed pressures. Pressure plane 3 in the model produces results accurately matching the real system. The comparison of model results and observed data for pressures in PP3 are shown in Table B9.

Table B9 – Compare Observed Data and Model Simulation Results

Data				
	Observed psi	Simulated psi	difference psi	difference %
PP1DATA_LOGGER_01	97.40	97.90	-0.50	0.51
PP1DATA_LOGGER_02	92.00	91.49	0.51	-0.56
PP1DATA_LOGGER_03	74.50	74.51	-0.01	0.02
PP1DATA_LOGGER_04	87.30	86.61	0.69	-0.8
PP1DATA_LOGGER_05	71.00	70.41	0.59	-0.83
PP1DATA_LOGGER_06	65.90	64.51	1.39	-2.11
PP1DATA_LOGGER_07	59.20	57.95	1.25	-2.12
PP1DATA_LOGGER_08	73.70	73.30	0.40	-0.54

The C values for pipes in PP3 were updated in the model based on the calibrator tool calculations. C values ranged from 140 to 150. These C values are typical of PVC piping in distribution systems with relatively new pipe ages. The area served by PP3 is relatively new developments in the City of Kyle and is expected to have all newer pipig. The C values determined during the calibration run are shown in Table B10.

Table B10 – C Values Updated in Model

Pipe Diameter	Group	C Value
6"	1	150
8"	2	145
12”	3	140
16”	4	150
20”	5	150

Appendix C

Recommended Pressure Plane 1 Boundary Revisions

To: City of Kyle Water Utilities

Date: April 26, 2024

Subject: Proposed Pressure Plane 1 and Pressure Plane 2 Boundary Modification

BACKGROUND

Persistent low pressures on the west side of I35 in the downtown area of the City of Kyle are a consequence of the existing boundary between pressure plane 1 and pressure plane 2. Portions of Pressure Plane 1 have been identified that would be better served if moved into Pressure Plane 2. The existing boundary can be modified to eliminate the low pressures currently experienced in pressure plane 1. The railroad on the west side and parallel to I35 defines an ideal break between the two pressure planes. The following data and figures show the recommended modification to the pressure plane boundary.

The area identified and outlined in yellow in Figure 1 has typical pressures in the mid 40's psi down to the TCEQ minimum of 35 psi with the ESTs at 80% full in pressure plane 1. The goal is to adjust the pressure plane boundary so that all areas are provided a typical target of 50 psi or greater. The area identified in Figure 1 is recommended for conversion to pressure plane 2.

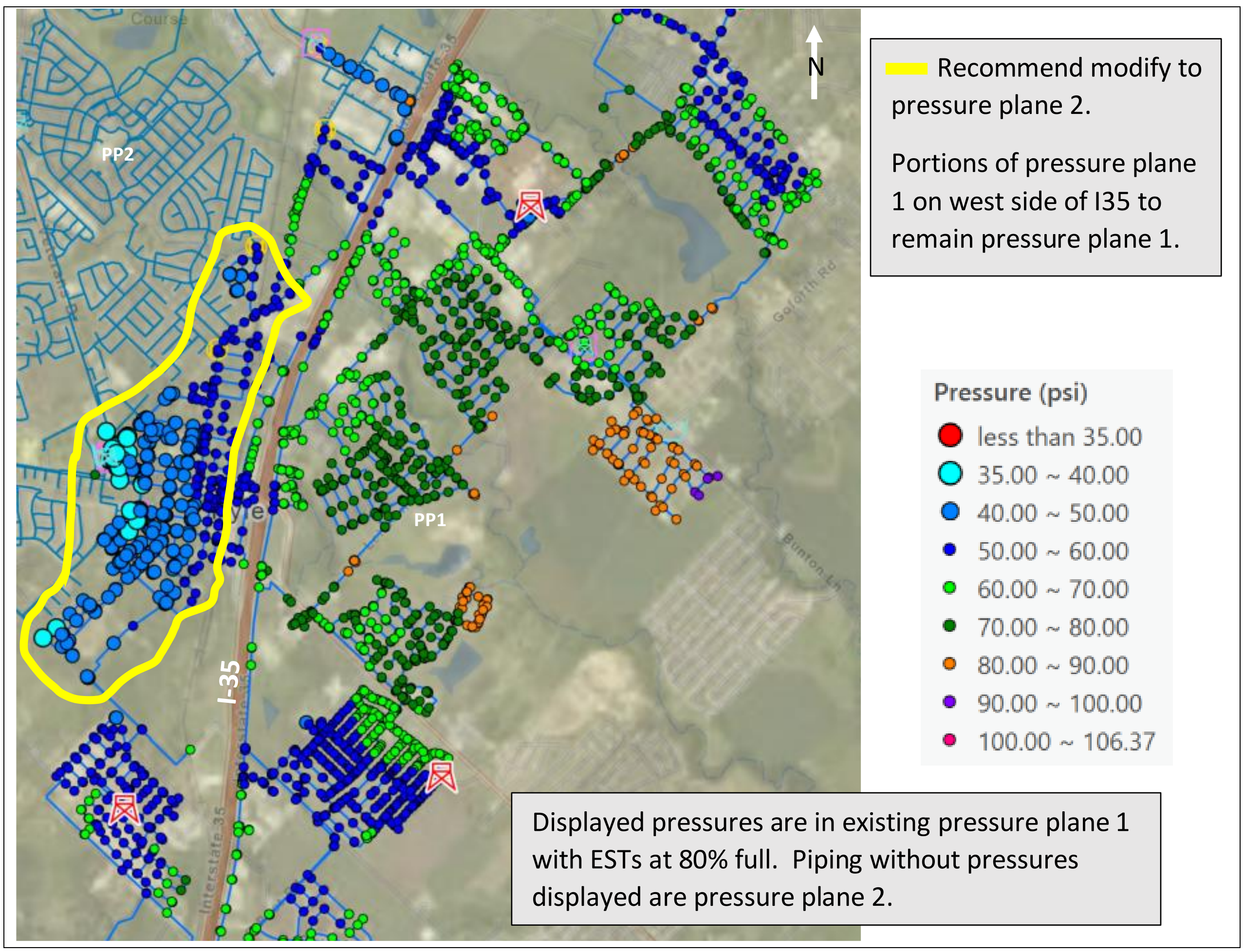


Figure 1 – Low Pressure Area of Existing Pressure Plane 1

An enlargement of the area identified for modification to pressure plane 2 is shown in Figure 2.

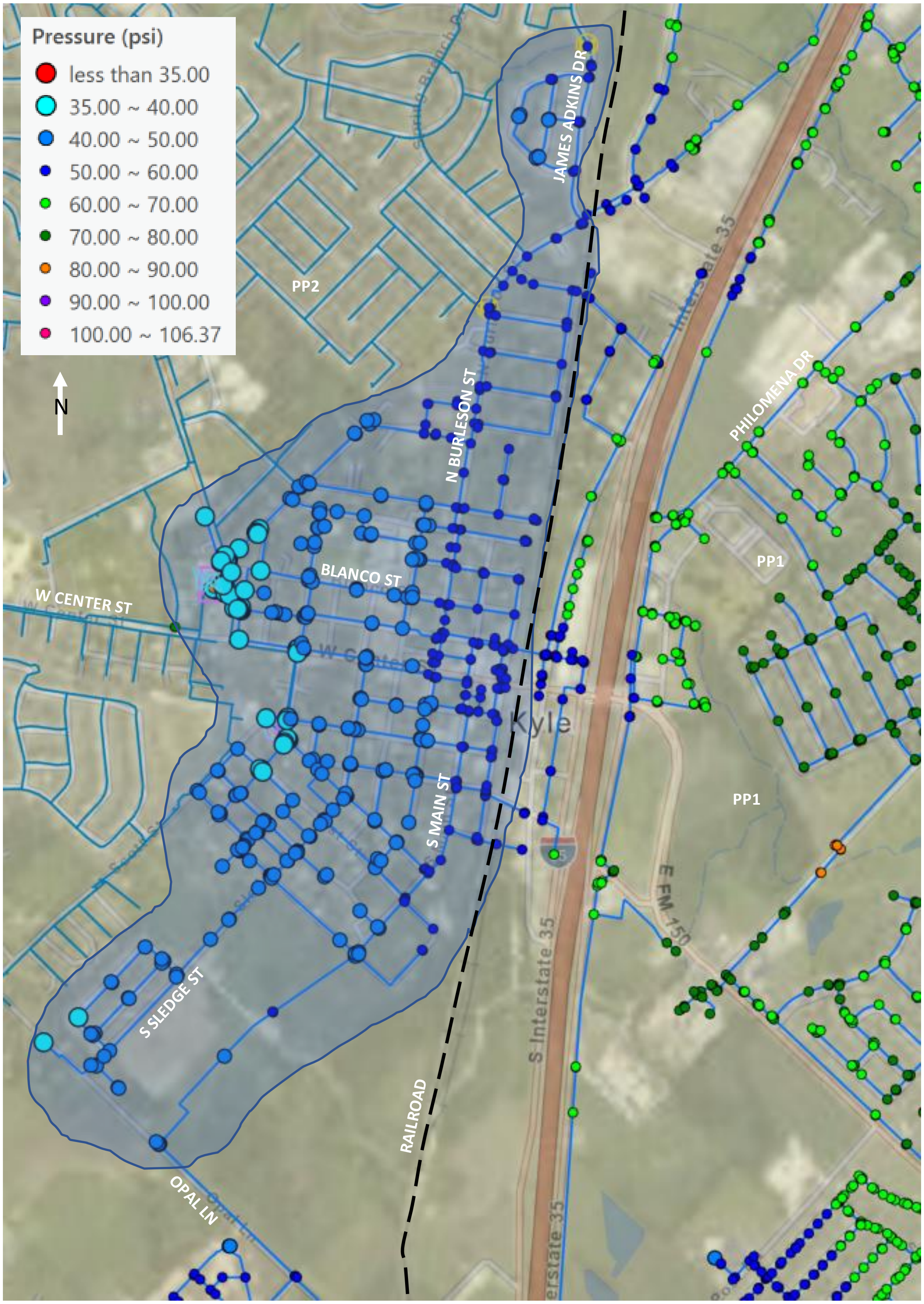


Figure 2 – Addition to Pressure Plane 2

EVALUATION

The area on the west side of I35 recommended to remain on pressure plane 1 would experience maximum pressures above 100 psi if moved to pressure plane 2. To prevent these high pressures, a narrow area along I35 should remain on pressure plane 1. This narrow area will require new piping to connect the south including the Roland EST, to the north around Marketplace Ave. Two sections of piping are needed to provide adequate connections within pressure plane 1 as shown by the yellow piping in Figure 3.

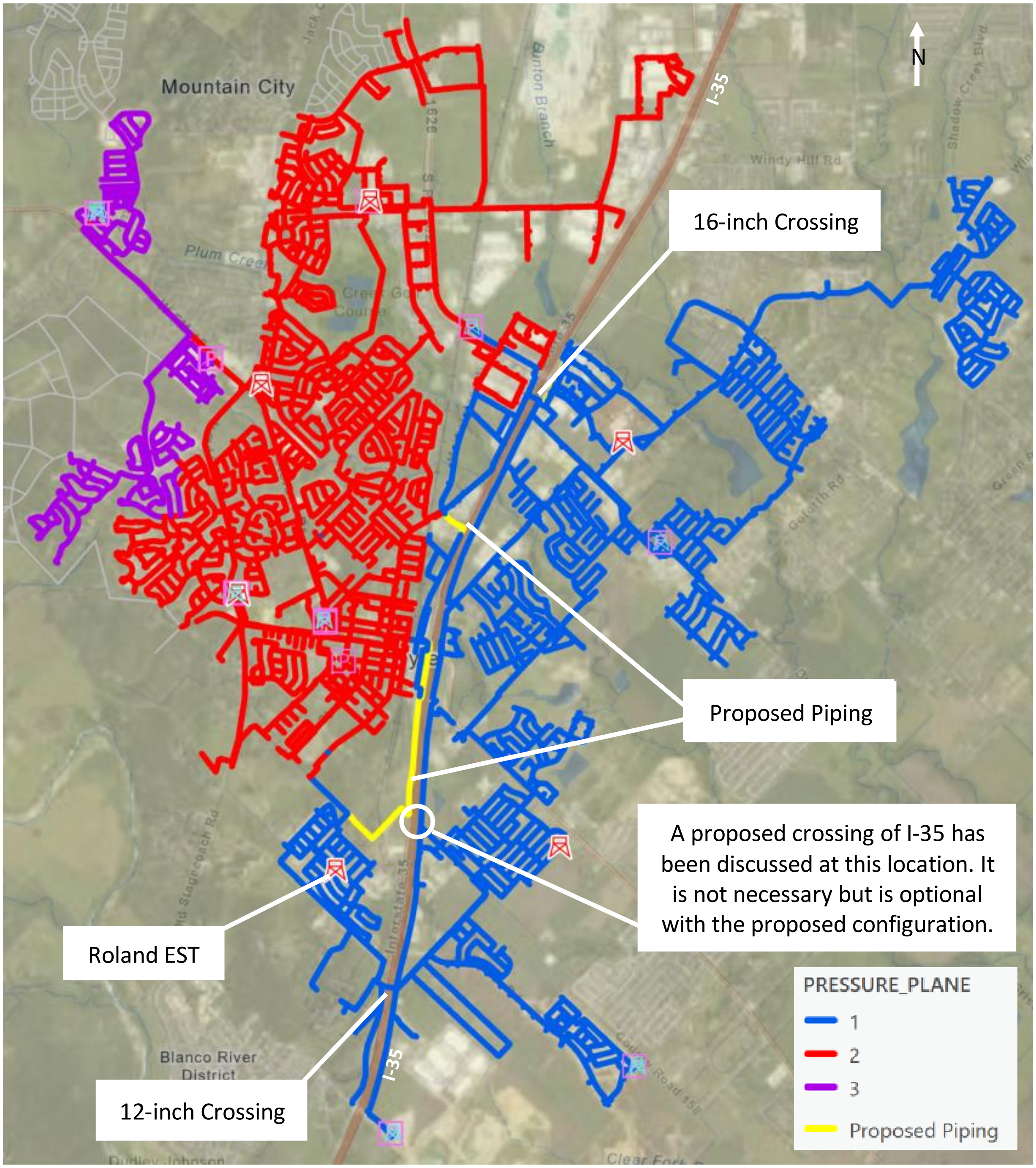


Figure 3 – Proposed Pressure Planes & New Piping for Pressure Plane 1

An enlarged view of the area requiring new piping to establish pressure plane 1 on the west side of I35 is shown in Figure 4.

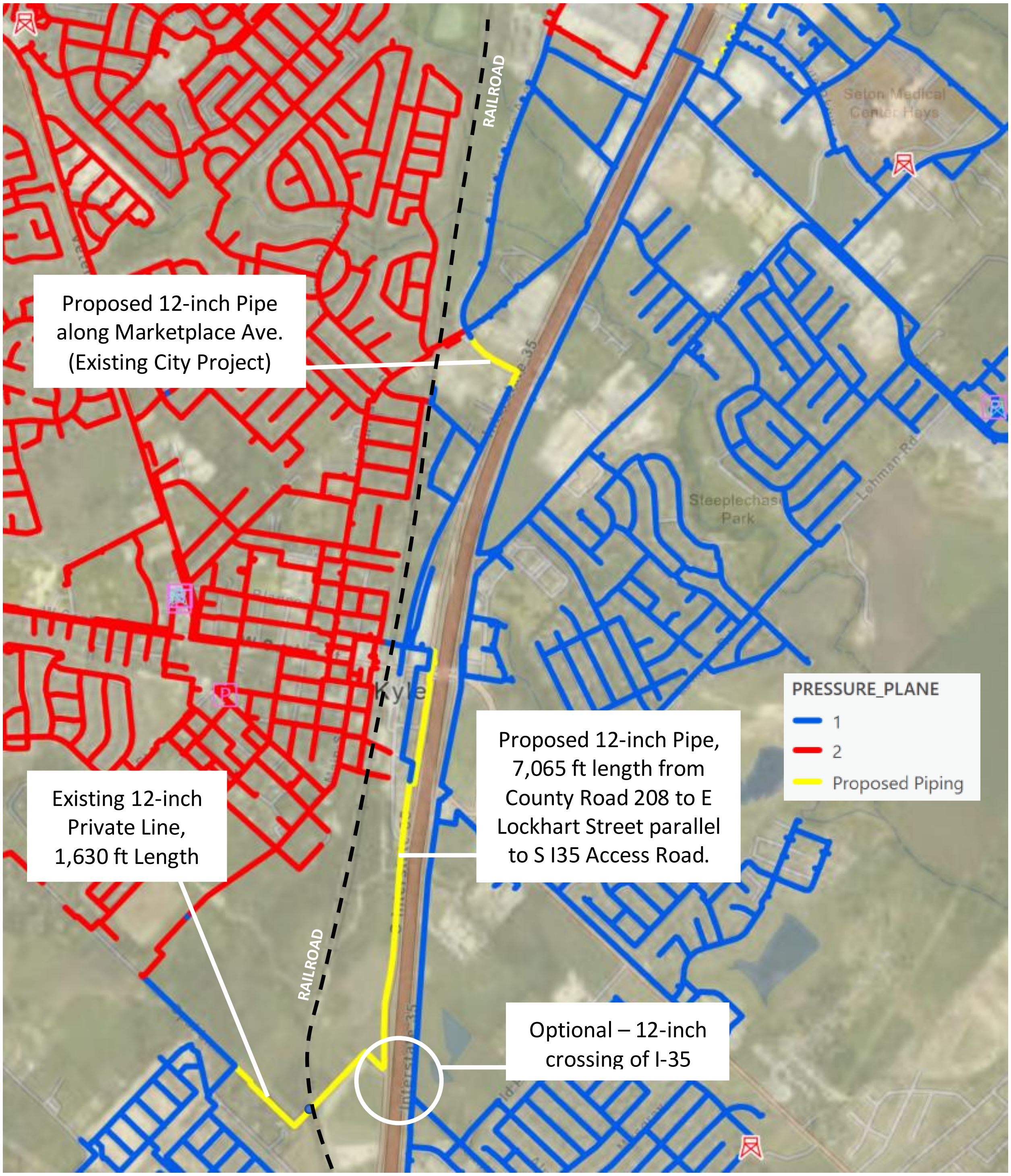


Figure 4 – Recommended Piping for Pressure Plane 1

Typical pressures for the modified pressure plane 1 are not changed from current conditions. The portions of pressure plane 1 remaining on the west side of I35 are above 50 psi. Portions of pressure plane 1 with historically low pressures are now shown in pressure plane 2. The model predicted pressures for pressure plane 1 are shown in the following figures.

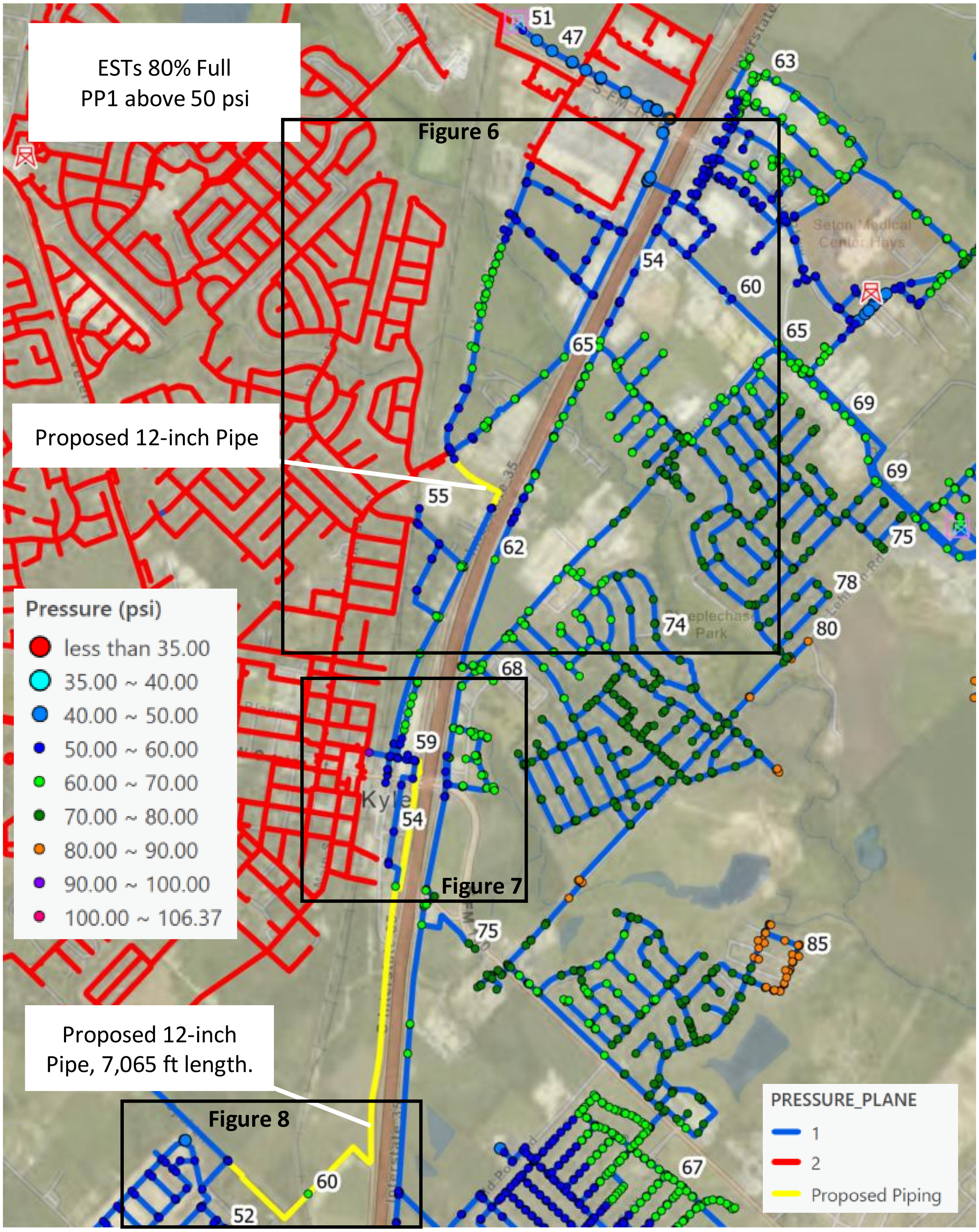


Figure 5 – Typical Pressures in Pressure Plane 1

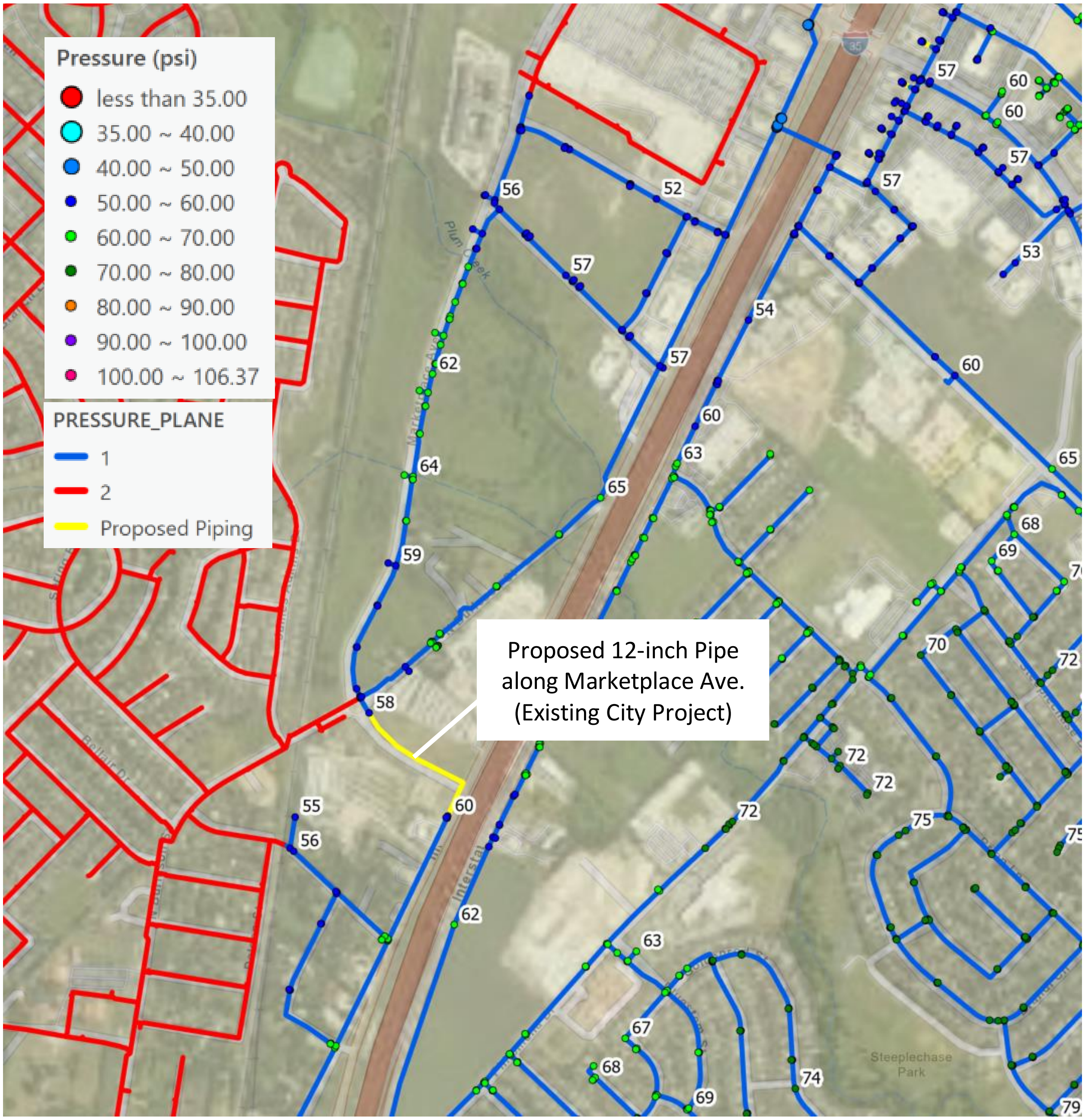


Figure 6 – Enlarged View 1 (North Area)

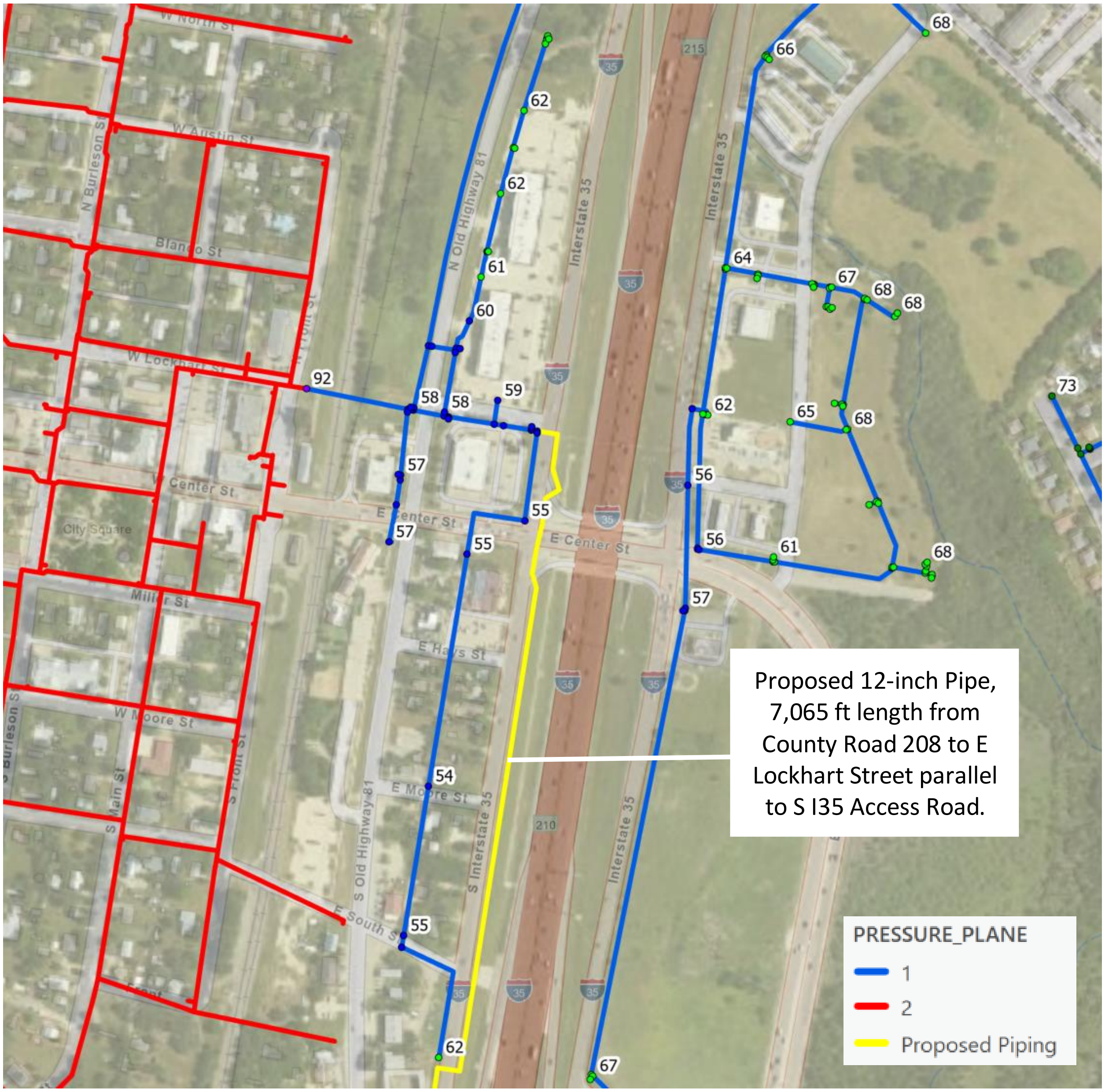


Figure 7 – Enlarged View 2 (Middle Area)

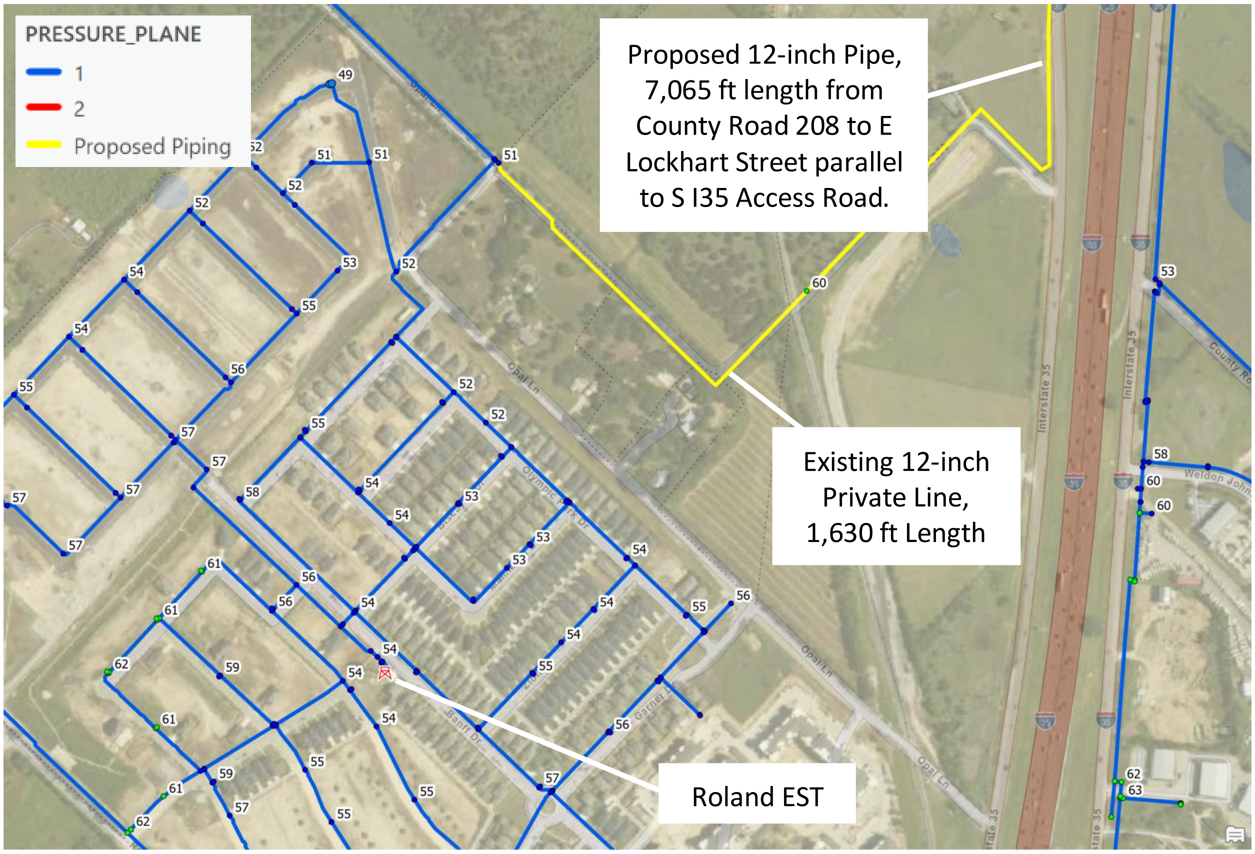


Figure 8 – Enlarged View 3 (South Area)

Pressures in the portions of existing pressure plane 1 that are recommended to be moved to pressure plane 2 will generally have pressures raised by 35 psi. The downtown sites that previously had 40 psi to 50 psi pressures will increase to 75 psi to 85 psi pressures. The converted sections of pressure plane 1 will experience higher pressures than in the past but the piping in this area is considered in good condition by operations and is not expected to have significant breakage or failures with the higher pressures. Typical pressures with the ESTs 80% full for pressure plane 2 are shown in the following figures.

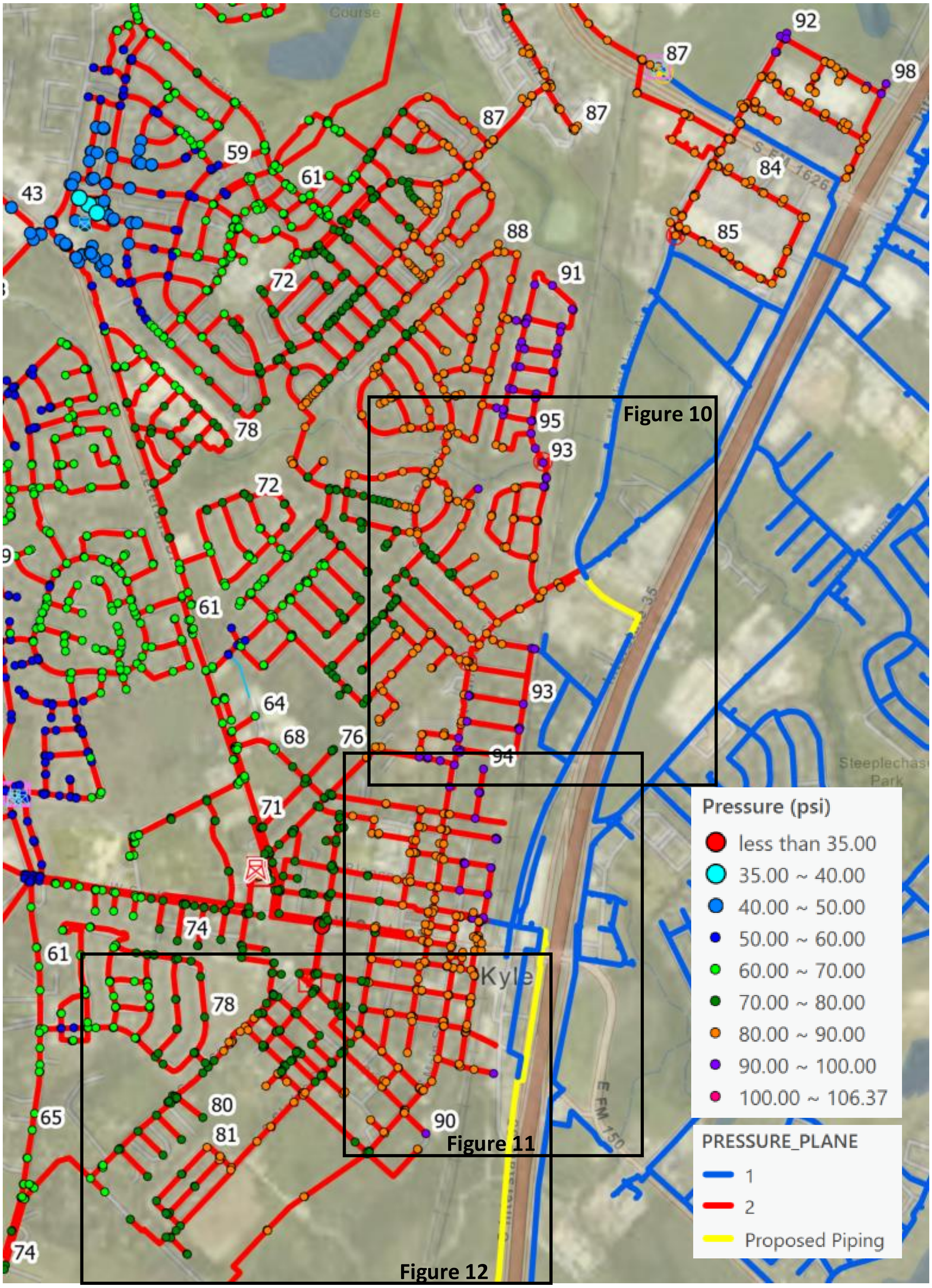


Figure 9 – Typical Pressures in Pressure Plane 2

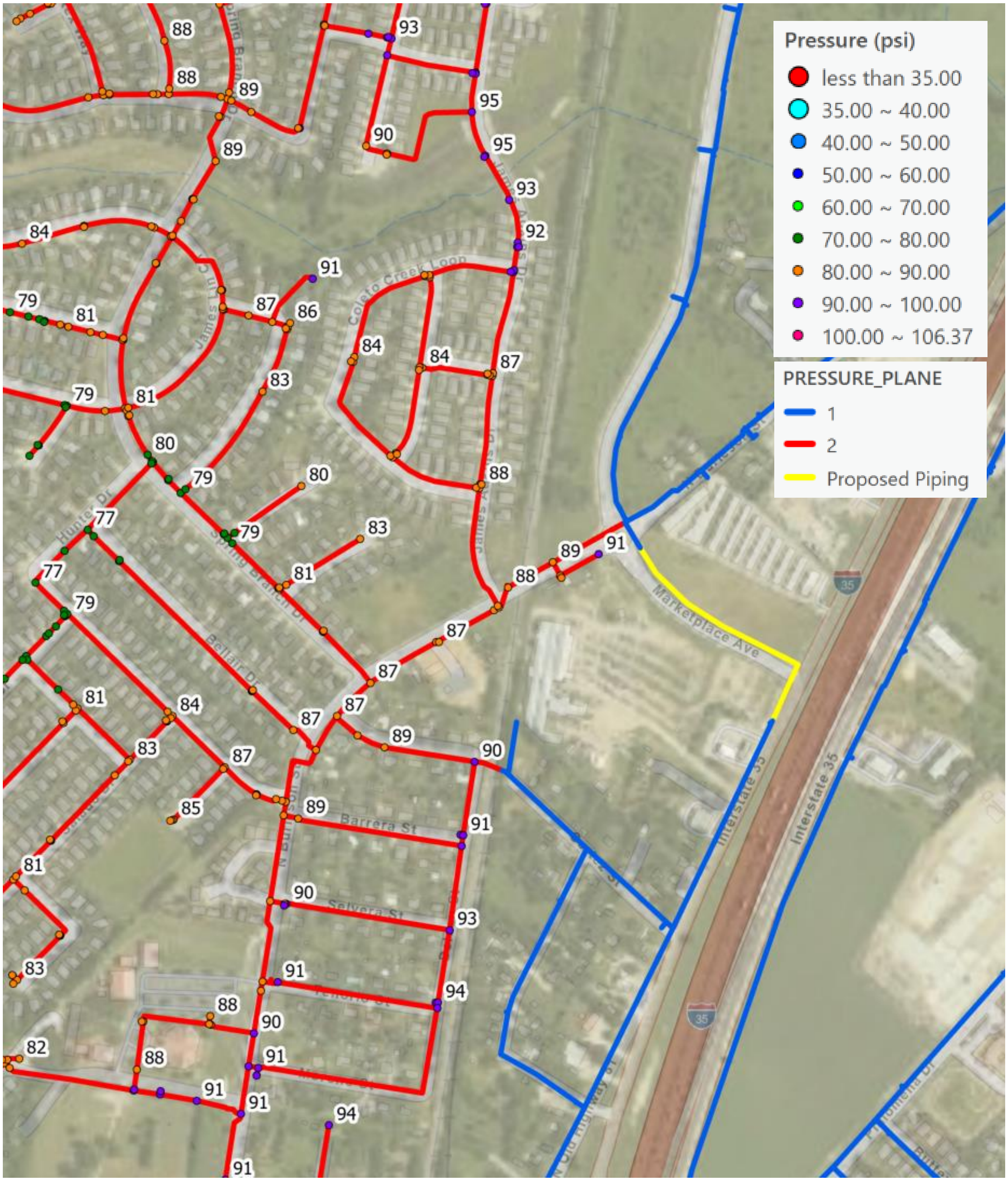


Figure 10 – Enlarged View 1 (North Area)

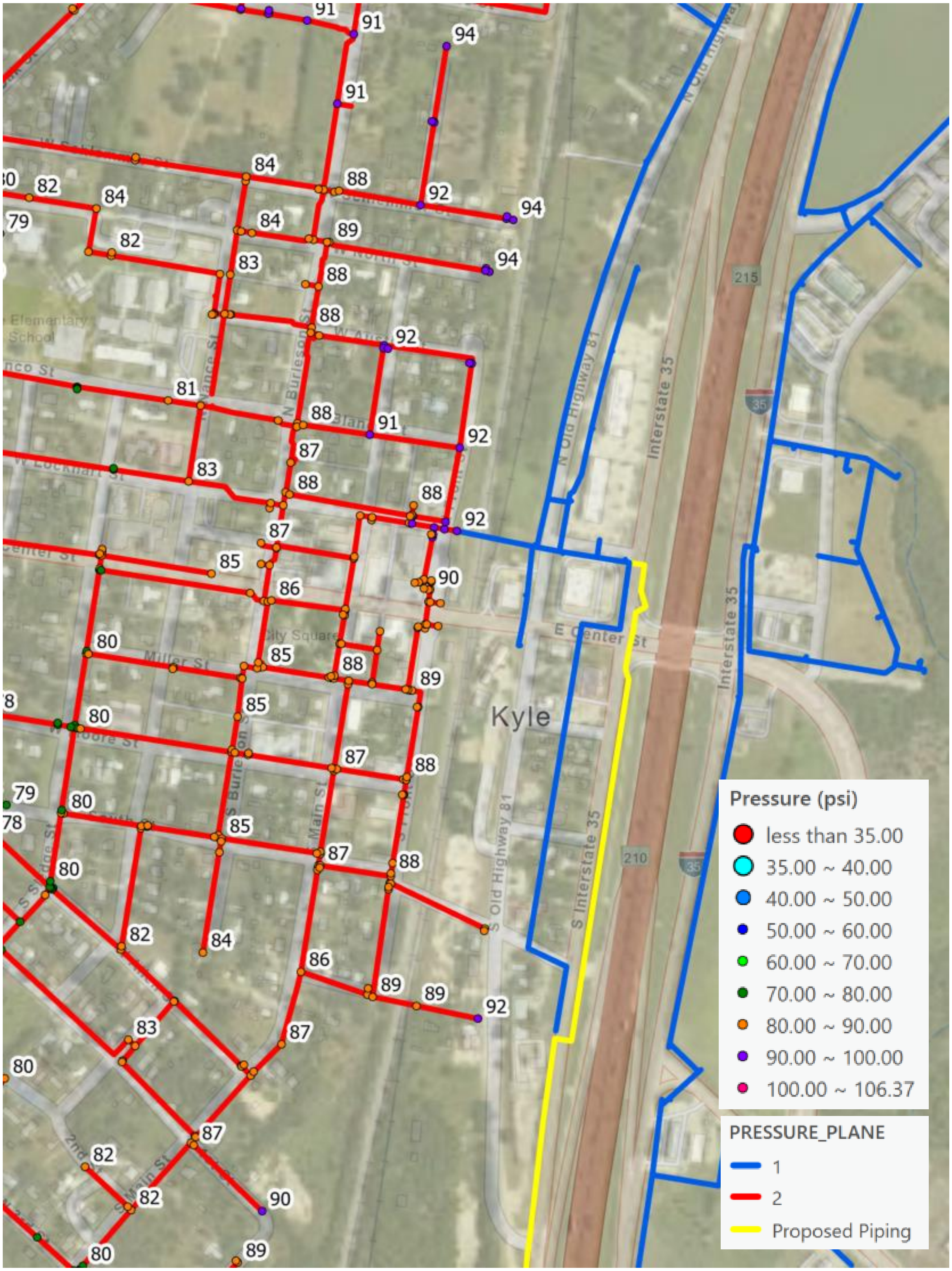


Figure 11 – Enlarged View 2 (Middle Area)

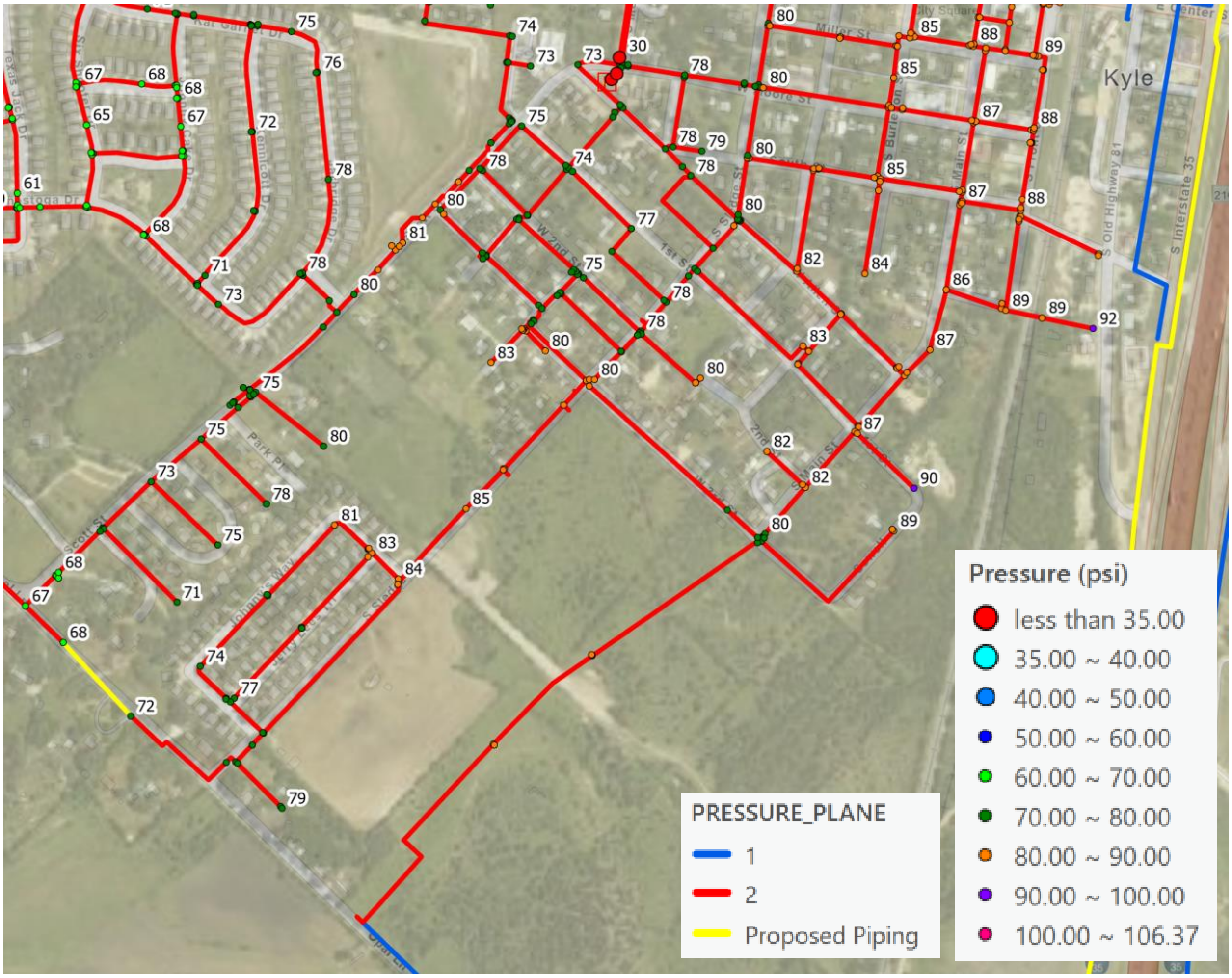


Figure 12 – Enlarged View 3 (South Area)

RECOMMENDATIONS

The portions of pressure plane 1 as shown in the preceding figures are recommended for conversion to pressure plane 2. This conversion will mitigate the historically low service pressures in the downtown area on the west side of I-35. Some portions of pressure plane 1 on the west side of I-35 that have acceptable pressures above 50 psi are recommended to remain in pressure plane 1. Including these areas in pressure plane 2 would result in typical pressures above 100 psi.

Recommendations for modifying the boundary between pressure plane 1 and pressure plane 2 involve opening some existing boundary valves and closing specific valves that become the new boundary valves. The locations to open boundary valves and for valve/pipe closure to establish the revised boundary are shown in Figure 13, Figure 14, Figure 15, and Figure 16.

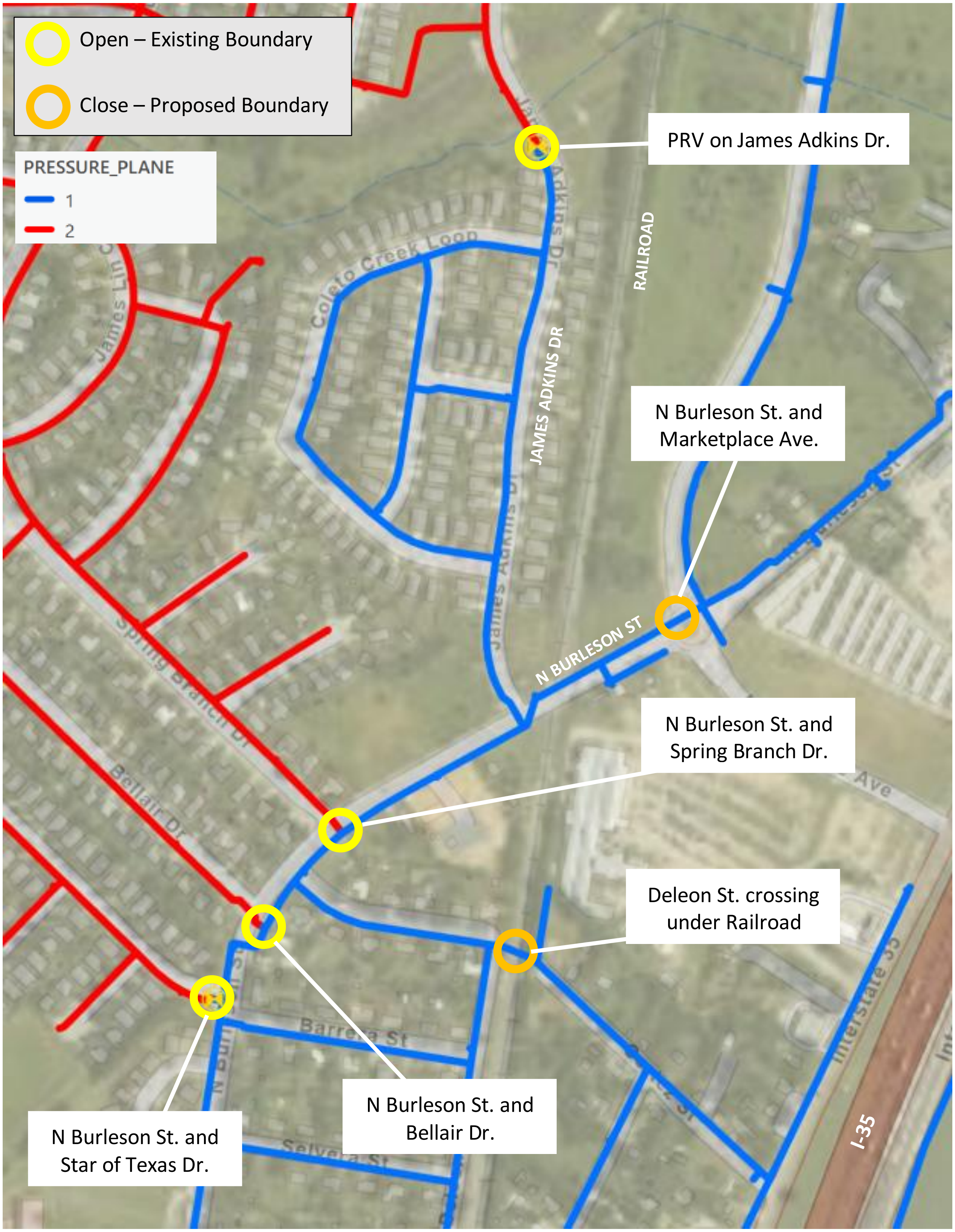


Figure 13 – Boundary Valve Modifications Part 1

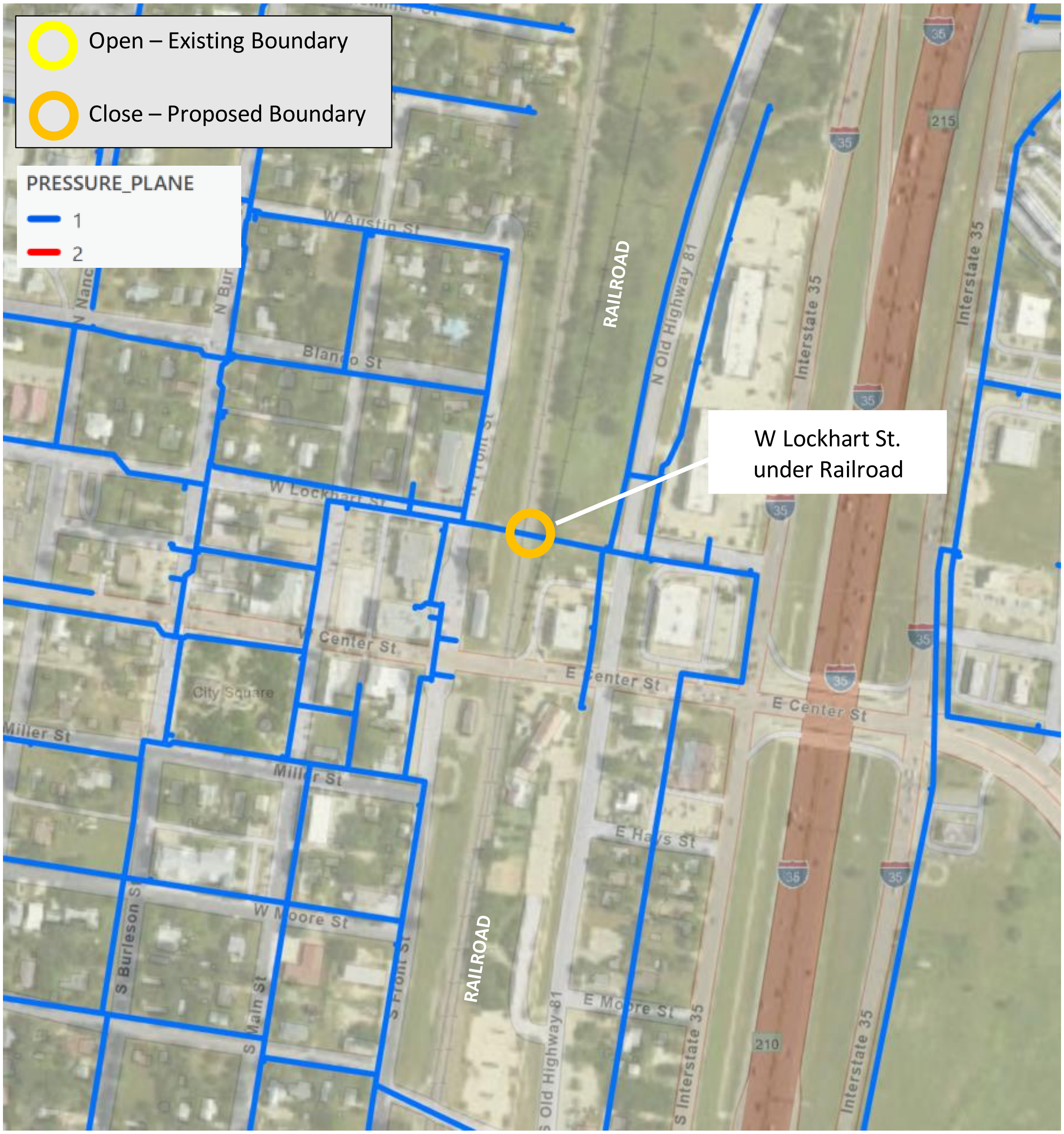


Figure 14 - Boundary Valve Modifications Part 2

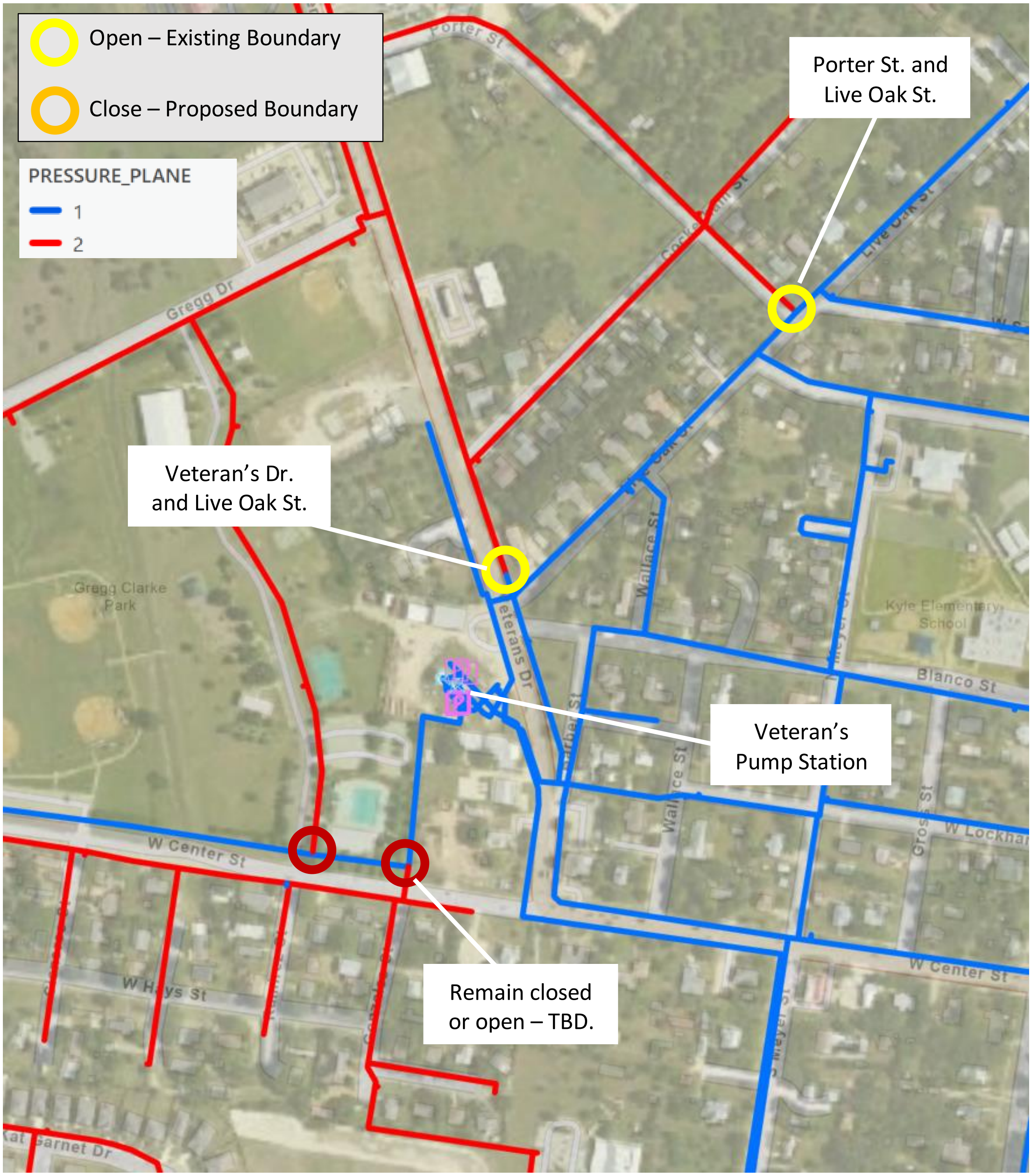


Figure 15 - Boundary Valve Modifications Part 3

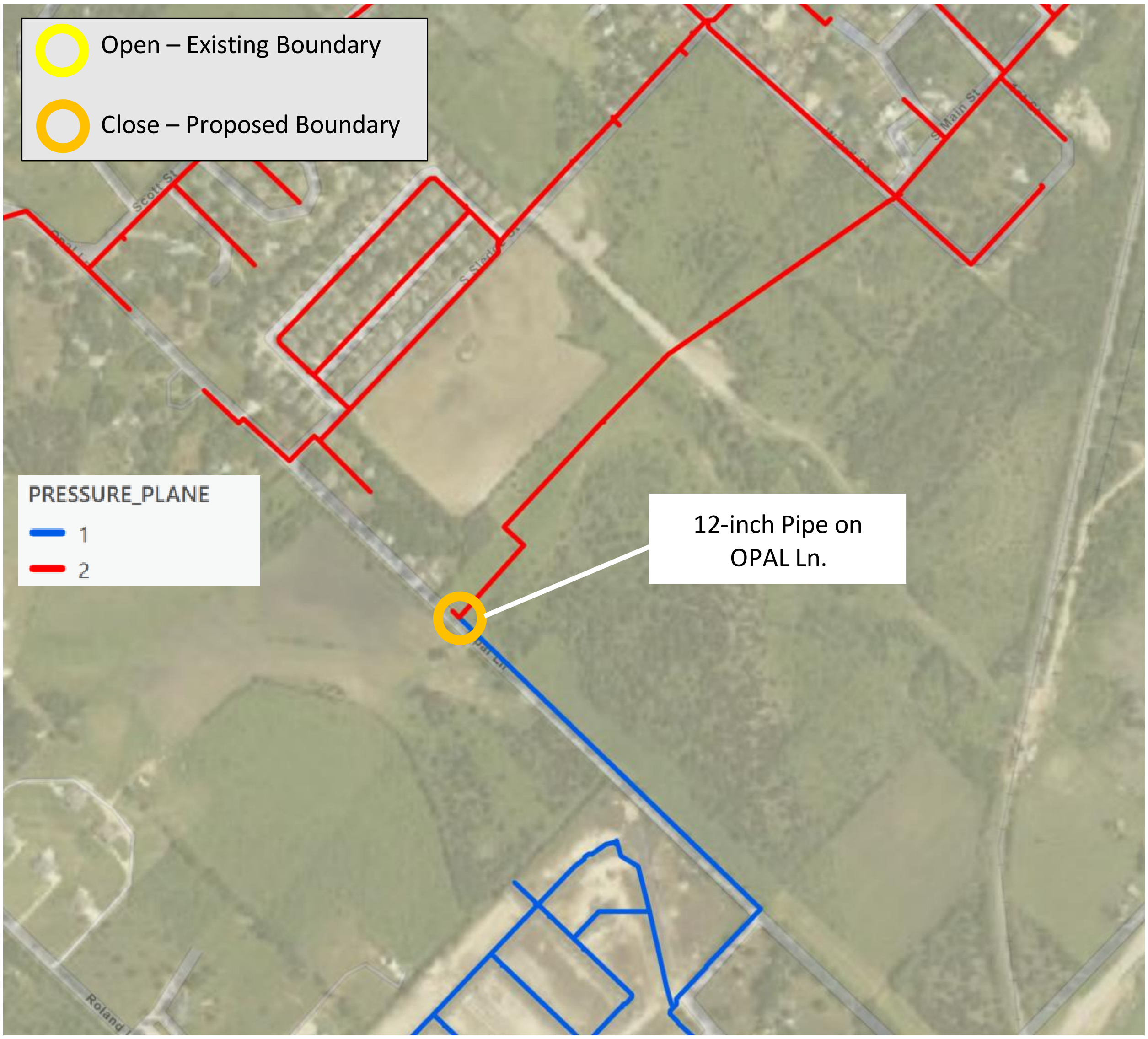


Figure 16 - Boundary Valve Modifications Part 4

Additional pipe connections are recommended within the modified pressure plane 2. Parts of pressure plane 1 that are moved to pressure plane 2 but currently have no connection to pressure plane 2 with a closed boundary valve, would benefit from a new connection to provide looping and better connectivity within the revised pressure plane 2. Locations for proposed connections within the revised pressure plane 2 are shown in Figure 17 and Figure 18.

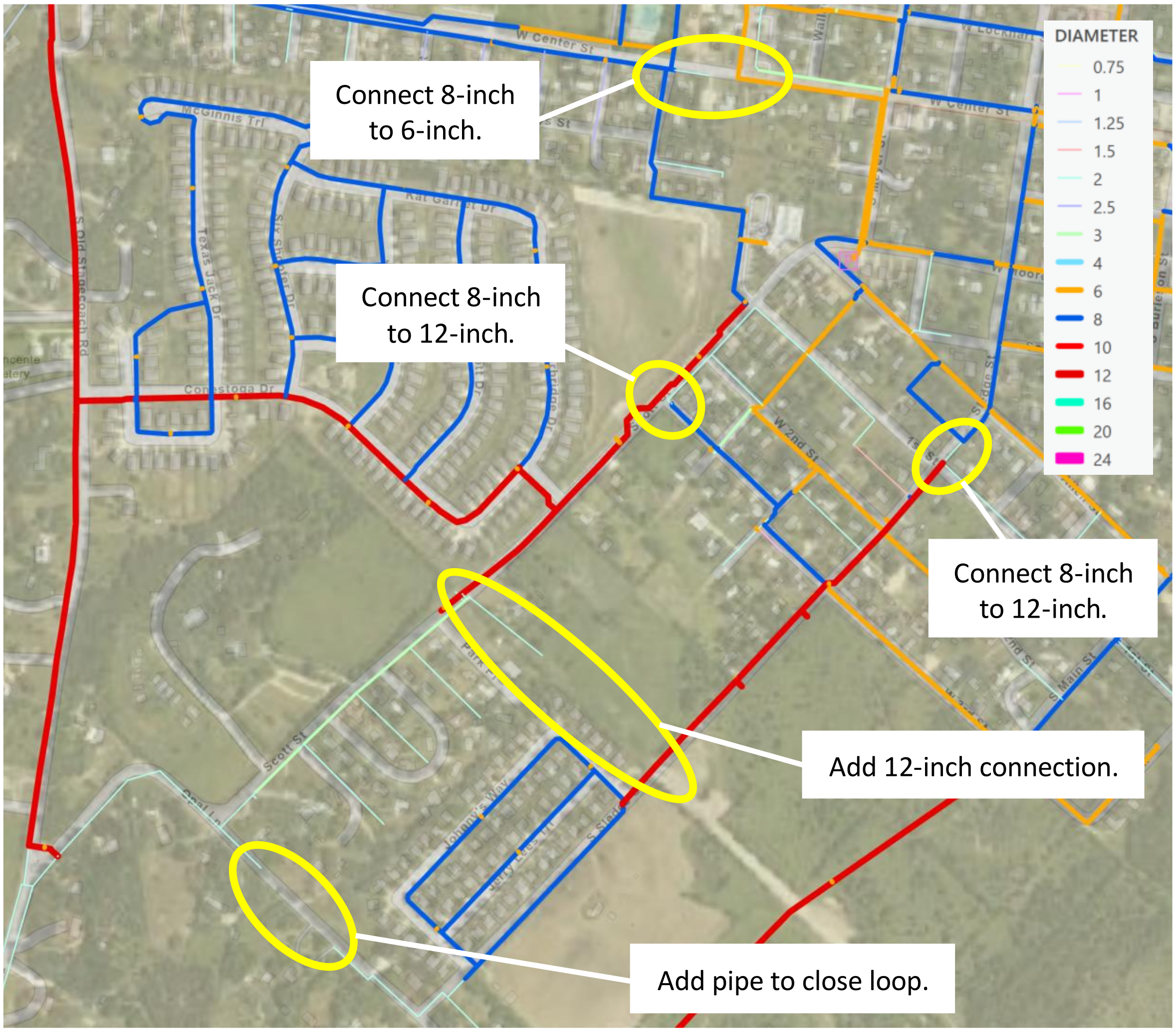


Figure 17 – Recommended New Connections within Modified Pressure Plane 2

Figure 18 - Recommended New Connections within Modified Pressure Plane 2 (Part 2)

Prepared by:

Gil Barnett, P.E.
STV

Appendix D

Recommended Fire Flow Improvements

Appendix D

Recommended Fire Flow Improvements

Four areas within PP1 are identified with available fire flows under 1500 gpm. These areas are shown in this appendix with recommendations to improve the fire flows.

Area 1:

Fire flow available was initially predicted to be under 1000 gpm in an area on the east side of I35 near the E Center Street overpass. This area is shown in Figure D1.

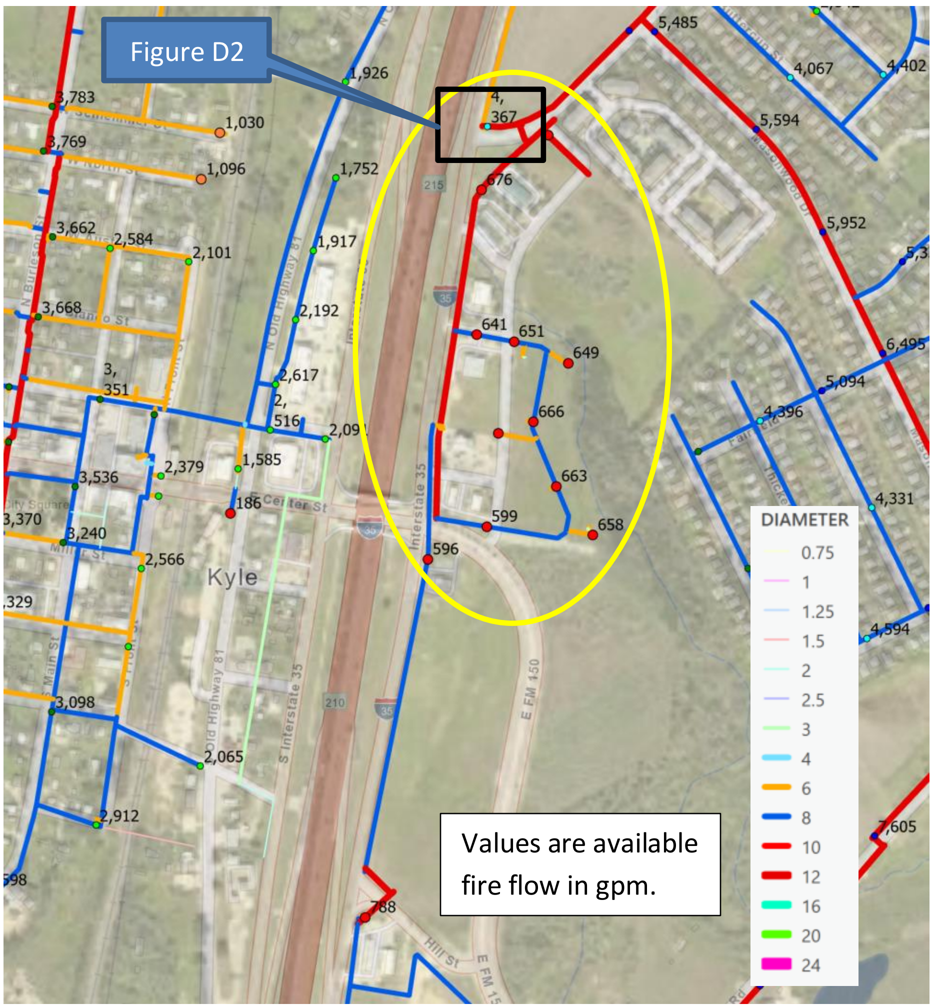


Figure D1 – Inadequate Fire Flow Area

The primary cause of the low fire flows is the lack of a network connection in the 12" piping identified in the black box in the north part of the circled area in the above figure. A zoomed in view of this area showing the pipe network and the 'missing' connection is shown in Figure D2. Further investigation by city staff found that this connection with 12" piping does exist. The GIS data showing no connection at this location was not correct. With the network connection here, fire flows are in excess of 1500 gpm.

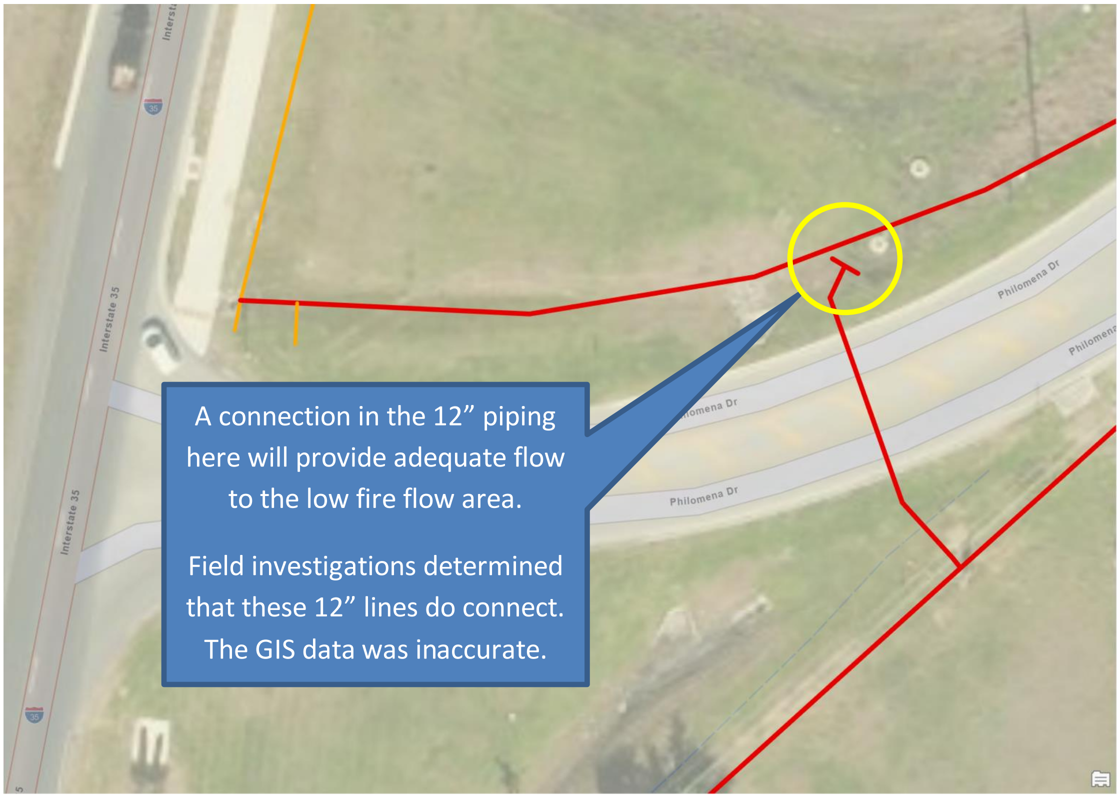


Figure D2 – Zoomed in View of 12” Piping

Area 2:

Also on the west side of this area is a hydrant on a dead-end line bottlenecked by a short run of 2” pipe. The dead-end line runs along N Old Highway 81 from E Lockhart St. to just south of E Center St. The 2” pipe segment significantly limits flow to this fire hydrant. This area is shown in Figure D2.

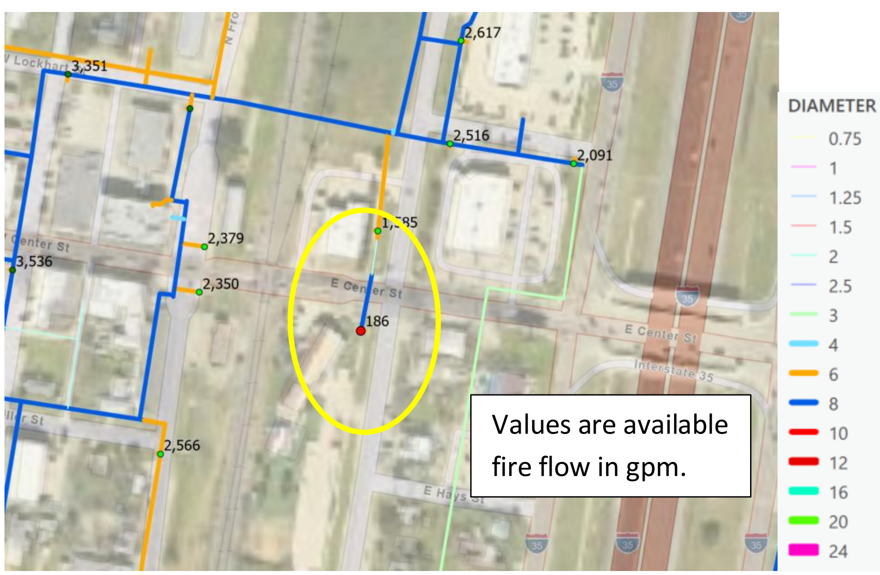


Figure D2 - Bottlenecked Fire Hydrant

This low fire flow can be improved to above 1500 gpm by replacing the 6” and 2” pipe segments with an 8” pipe segment. Field investigations determined that this piping was previously replaced with all 8” piping. Therefore the fire flow at this point is adequate as the recommended improvements have already been completed.

Area 3:

Another area with marginal fire flow available is near the intersection of S Sledge St. and Opal Ln. Fire flow can drop just below 1000 gpm and is limited due to the lack of network looping. This area is a dead end in the system as shown in Figure D3.

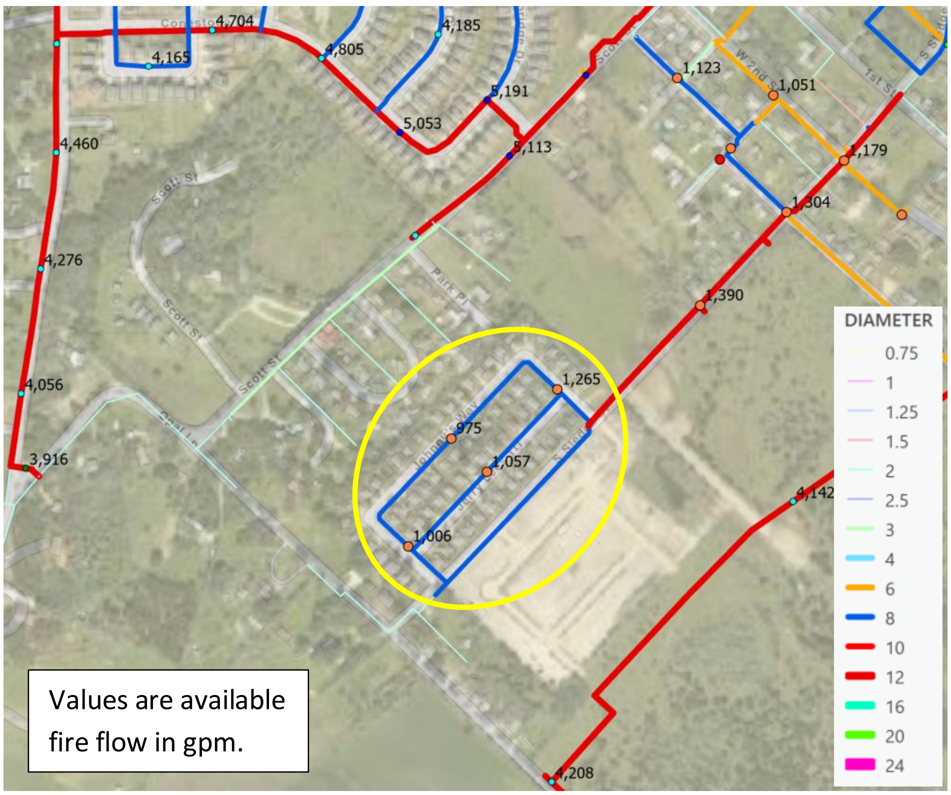


Figure D3 - Low Fire Flow Area

Completing a 12” loop on the south side of the circled area will improve flow capacity to this area and provide higher available fire flows. This will be accomplished when the pressure plane boundary modification is completed as described previously in this report and for dead end remediation as shown in Appendix E.

Area 4:

A portion of the Kyle downtown area has a large amount of 6” diameter piping in the network. 6” Piping limits the available fire flow but can be adequate as long as flow can be supplied from two directions to the hydrant. Fire flows in this downtown area are above 1000 gpm but in some locations are not at or above 1500 gpm as shown in Figure D4.

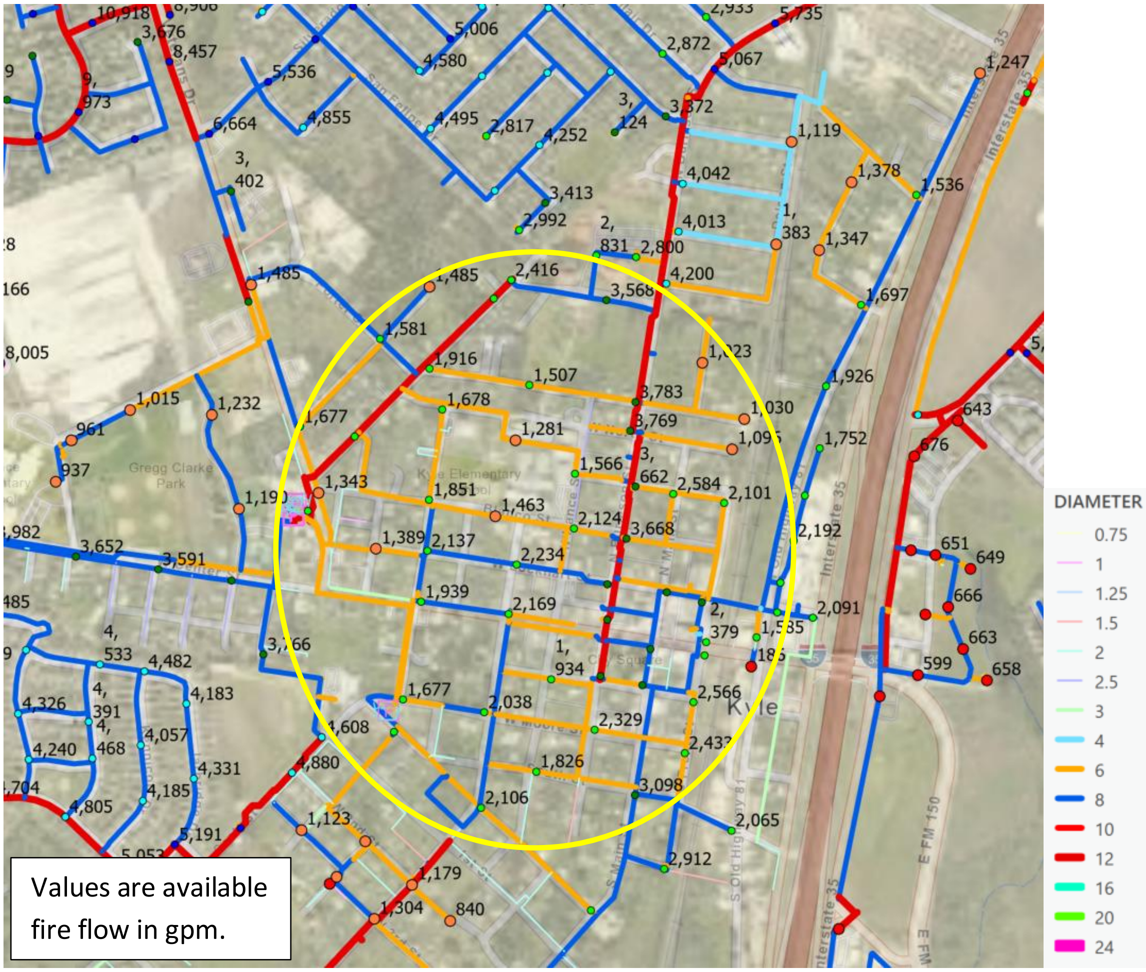


Figure D4 - Low Fire Flow Area - Part 2

Appendix E

Network Improvements to Remove Dead Ends

Appendix E

Removing Network Dead Ends

A water age analysis identified some area with very high water age indicating potential dead ends with limited water demand and no path to circulate. Three areas noted that would benefit from installing a circulation path were shown in Section 6.3.2. Recommended improvements to improve the water age and eliminate dead end areas are presented in this appendix.

Example 1

The 12" line running south down Old Stagecoach Road may develop a water age of near 8 days because of very small diameter lines connected to the southern end and limited water demand in that vicinity. Improved pipe diameters and new pipe to complete the looping is recommended as shown in Figure E1.

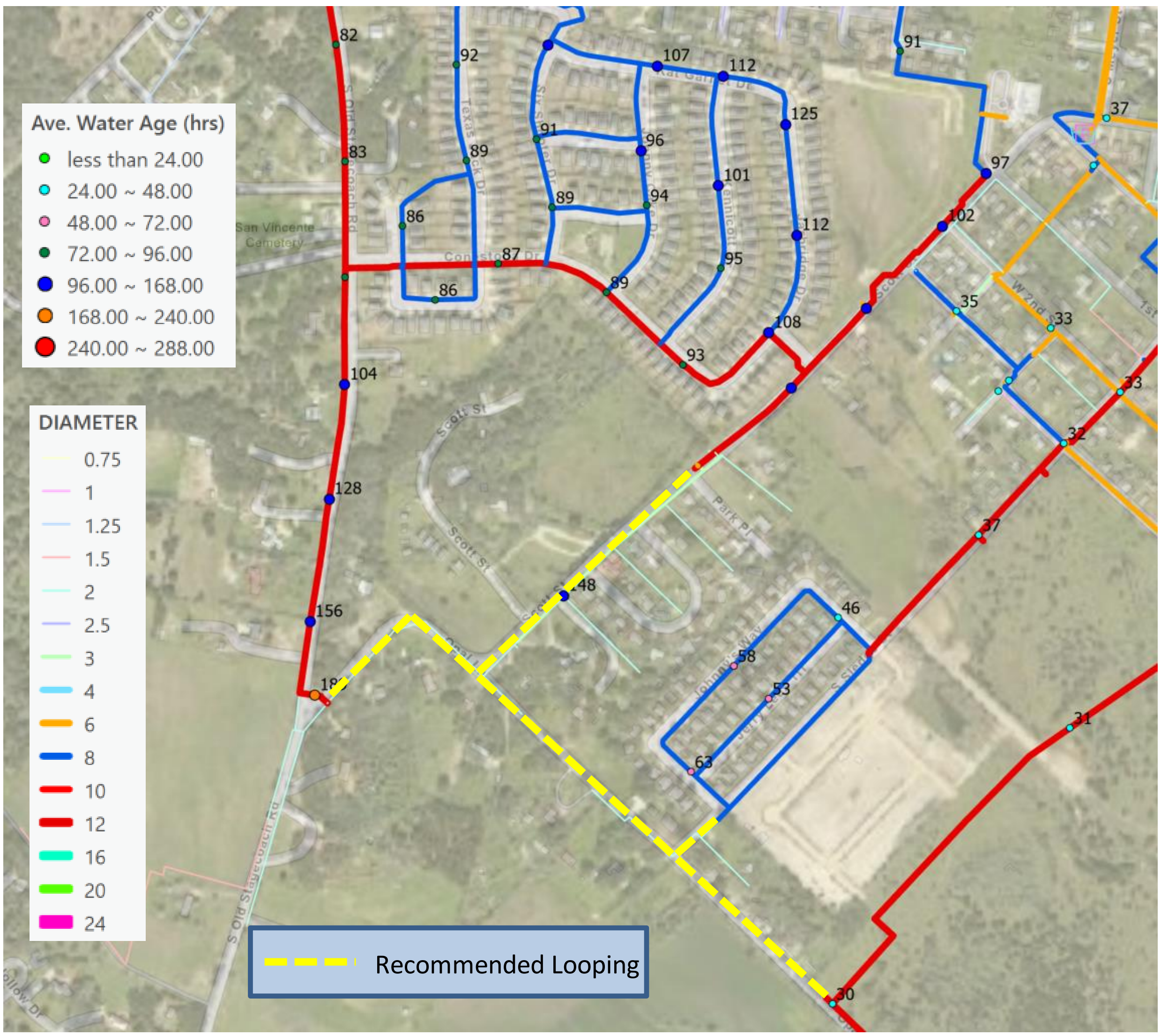


Figure E1 – Dead End Example 1

Example 2

An 8" line on the east side of North Old Highway Drive terminates at a fire hydrant. The average water age calculated was 12 days but could be much longer in this segment of pipe since it terminates at a hydrant. A looping connection under N Old Highway Drive is recommended to eliminate the dead end, as shown in Figure E2. Alternatively, routine line flushing can be conducted in lieu to the pipe improvement.

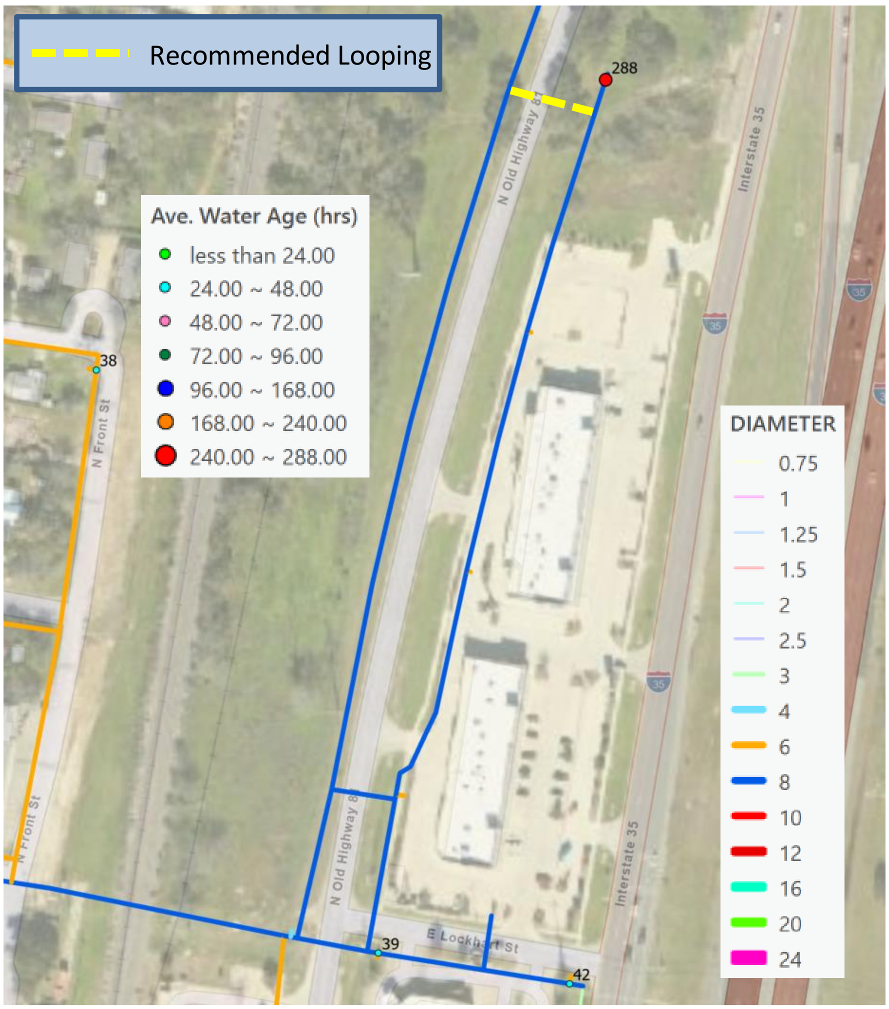


Figure E2 – Dead End Example 2

Example 3

An area in PP1 on the east side of I35 near the crossing of E FM 150, has acceptable water age but has an opportunity to make a connection and improve the overall network in the area. A short length of pipe could provide a looping connection adding a flow path between two parts of PP1 that are somewhat isolated even though they are close in proximity. The recommended pipe network improvement is shown in Figure E3.

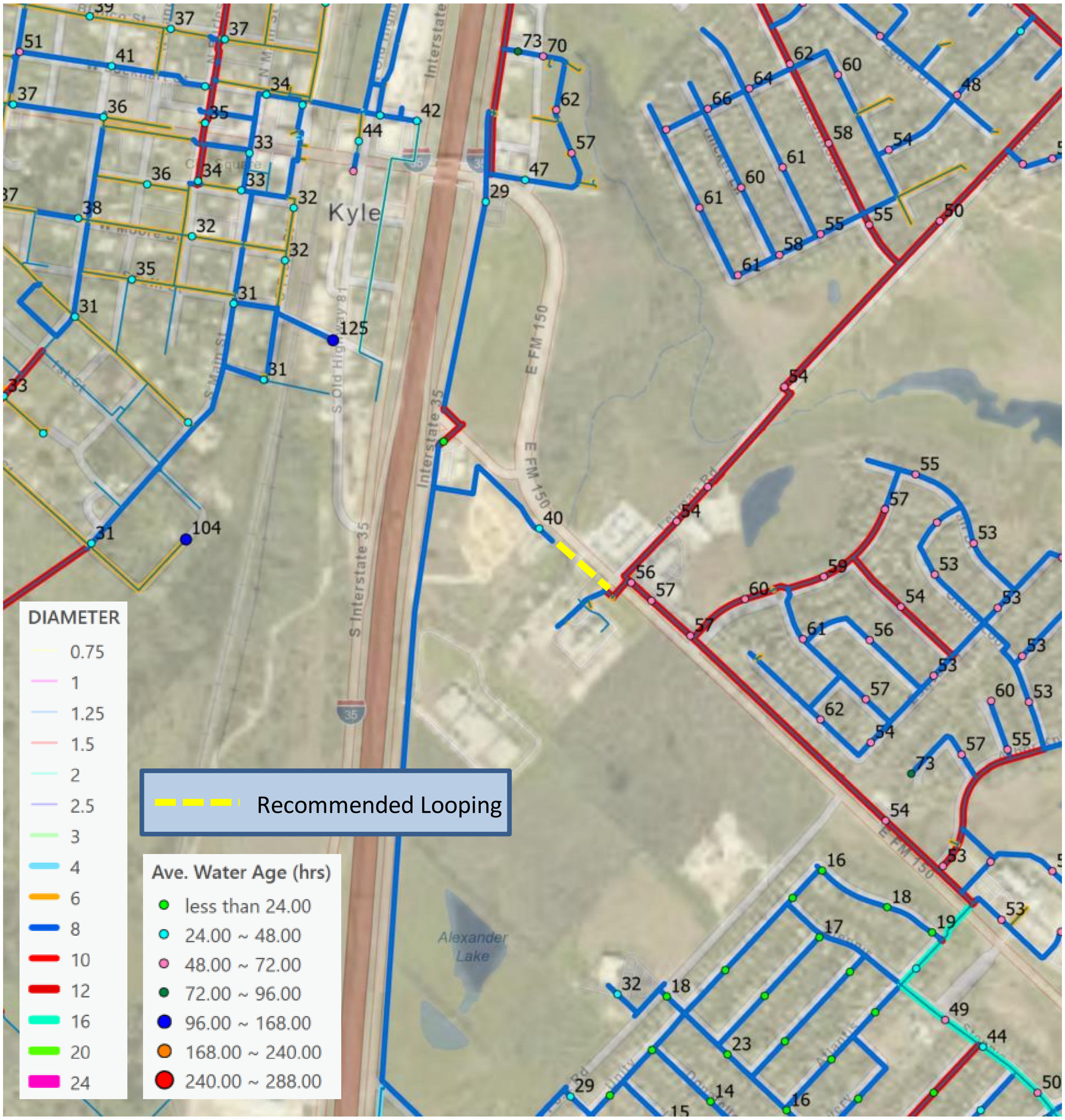


Figure E3 – Dead End Example 3

Appendix F

Network Improvements to Remove Bottleneck in Pressure Plane 1

City of Kyle

Water Master Plan

Pressure Plane 1 Improvement Plan – Short Term

Pipe Improvements

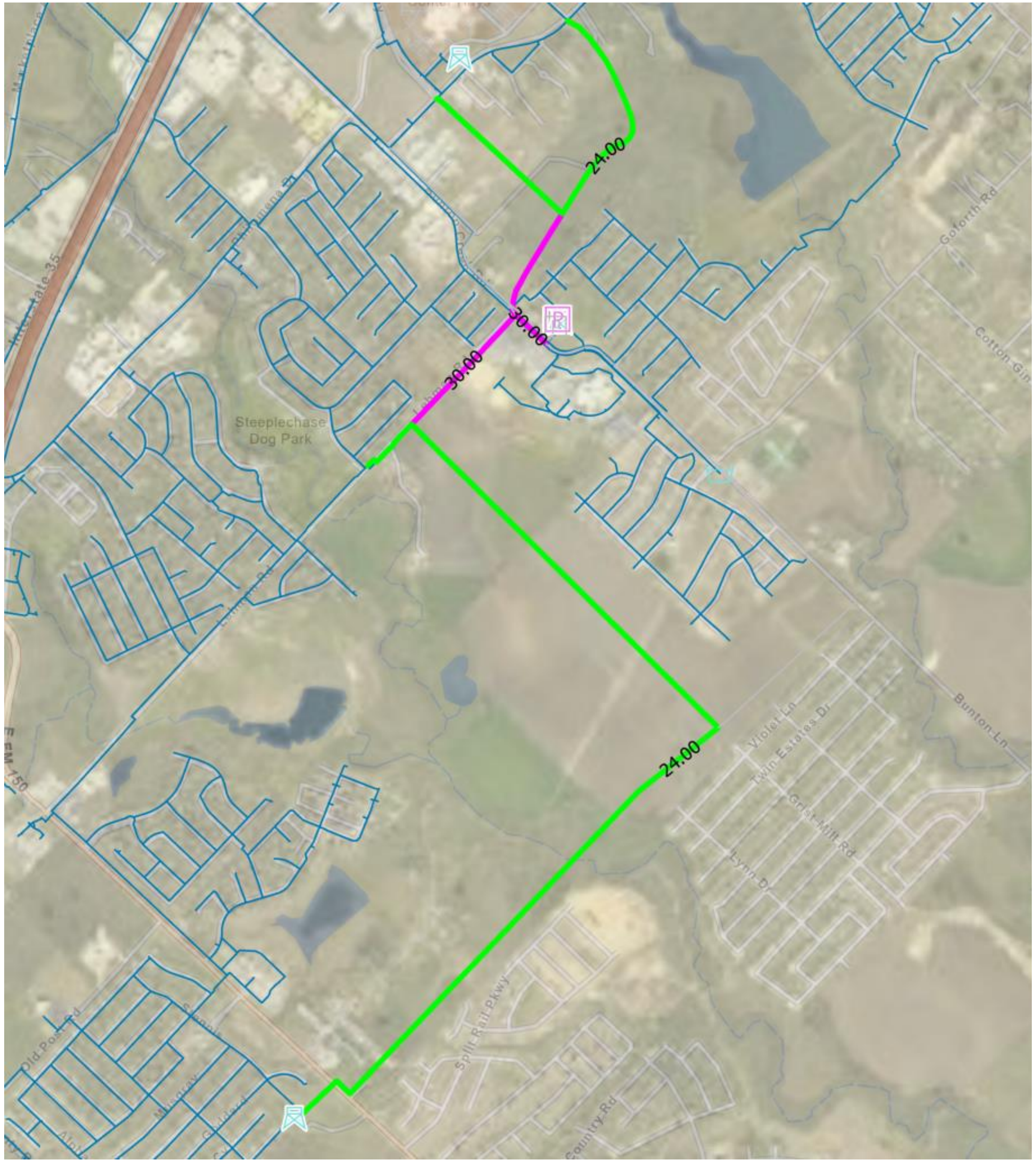
Improvements to support system capacity for 2026 projected Kyle Demands and Caraway Demands

Piping Improvements:

- Part 1 – 30” and 24” from Lehman Pump Station to Kyle Parkway and Dacy Lane
- Part 1A – 24” line to Seton Parkway and Dacy Lane
- Part 2 – 30” and 24” line along Lehman Rd 2,700 ft, from Bunton Creek Rd to Hallie Dr
- Part 3 – 24” parallel line from Post Oak EST to Lehman Rd

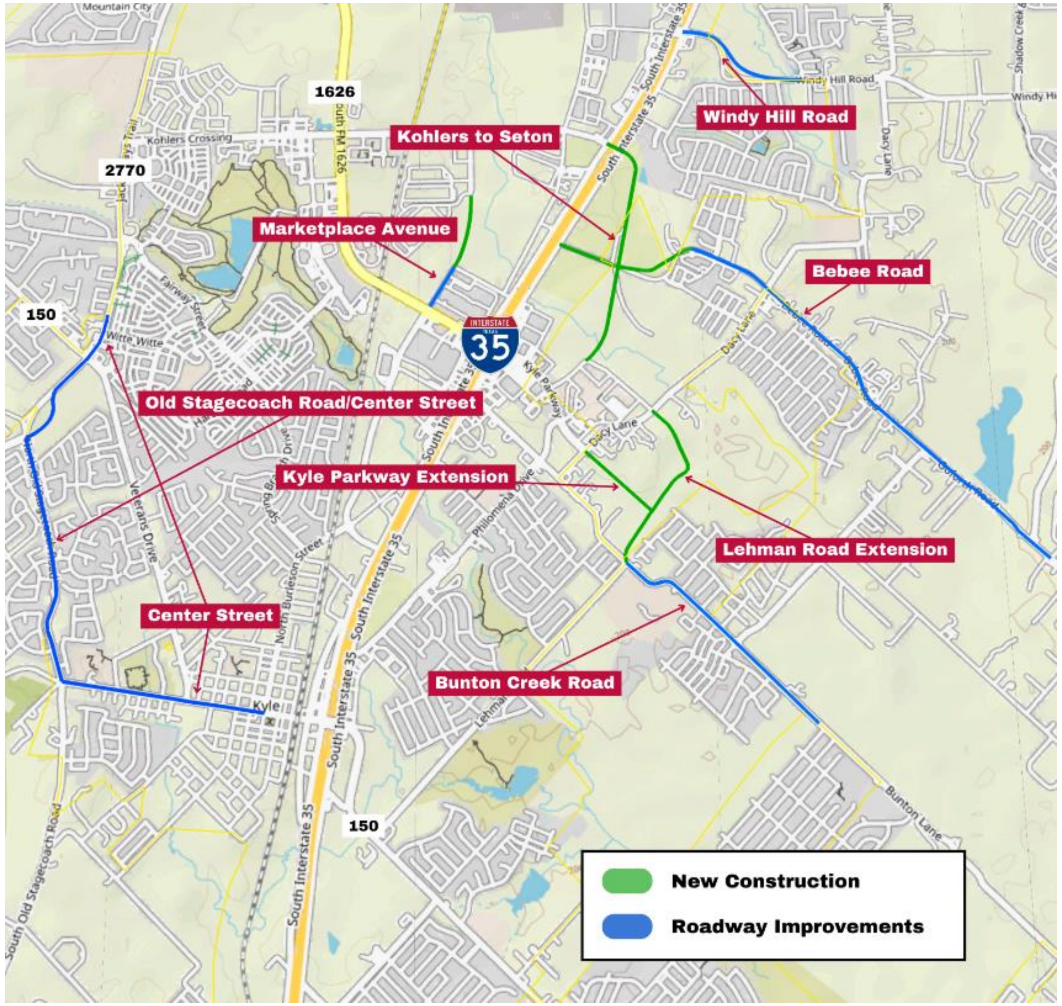
Overall

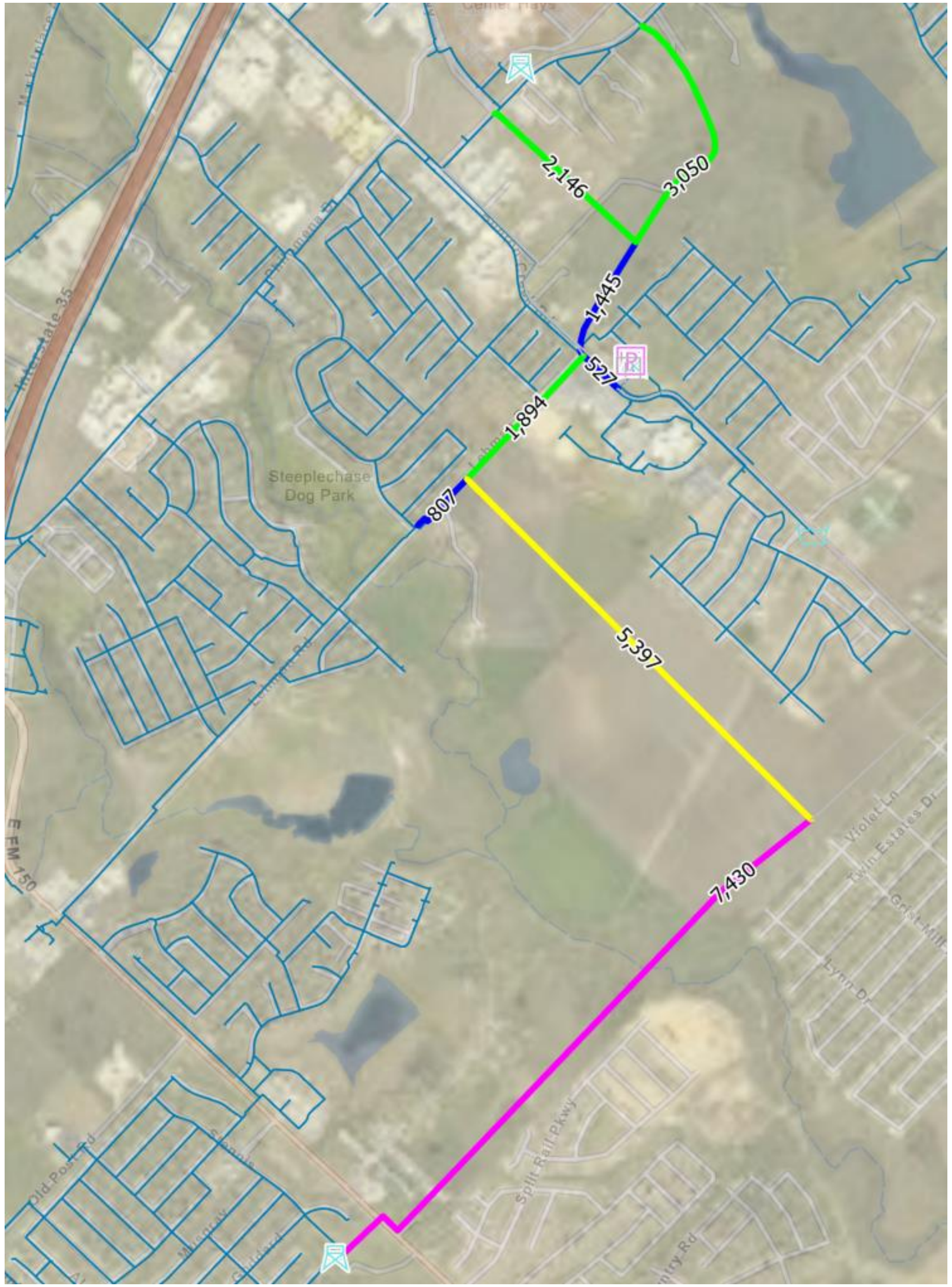
- Overall pipe improvements
- Follows Transportation Master Plan Routes
- 30” and 24” diameters sized for future growth
- 22,700 ft of pipe
  - 3,870 ft of 30” pipe
  - 18,830 ft of 24” pipe



Segment Lengths

- Utilizes Transportation Project Routes

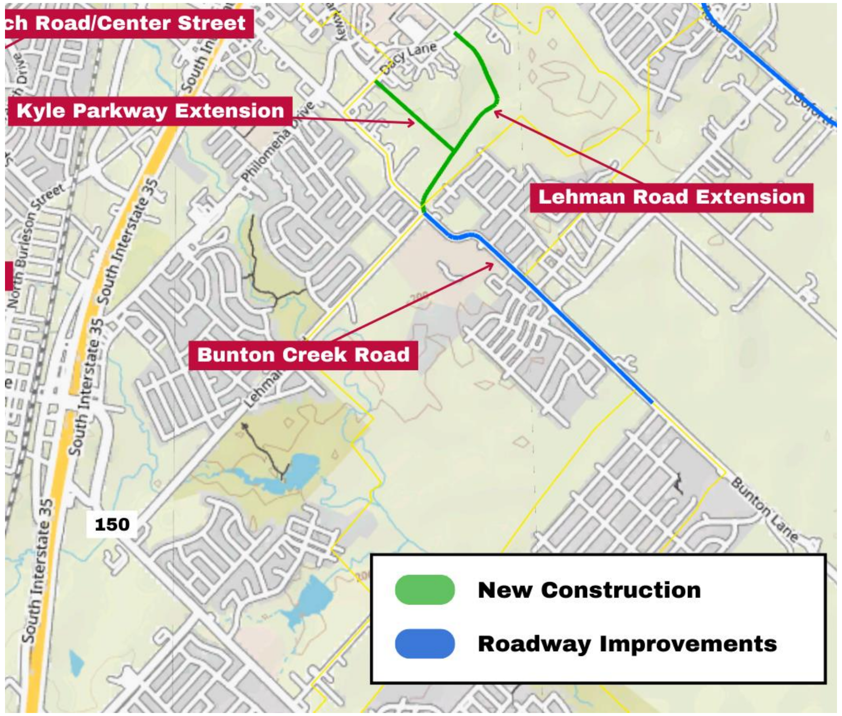




stv

Part 1 and 1A

- Part 1 – Needed by Mid 2026
  - 1,972 ft of 30”
  - 2,146 ft of 24”
- Part 1A – Completion date not as critical
  - 3,050 ft of 24”

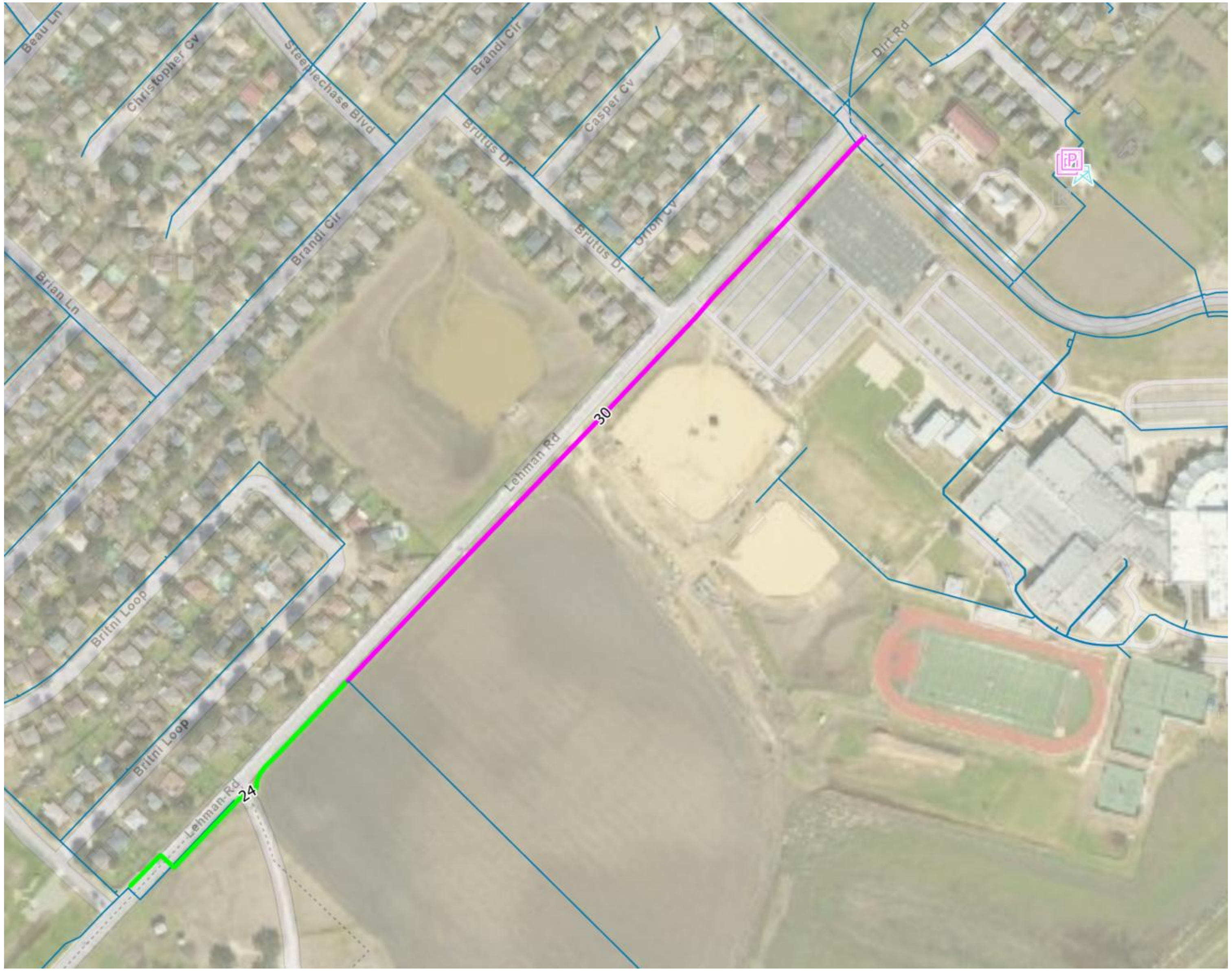


Part 2

- Part 2 follows Lehman Rd from Bunton Creek Rd to Hallie Dr.
  - 1,895 ft of 30”
  - 807 ft of 24”

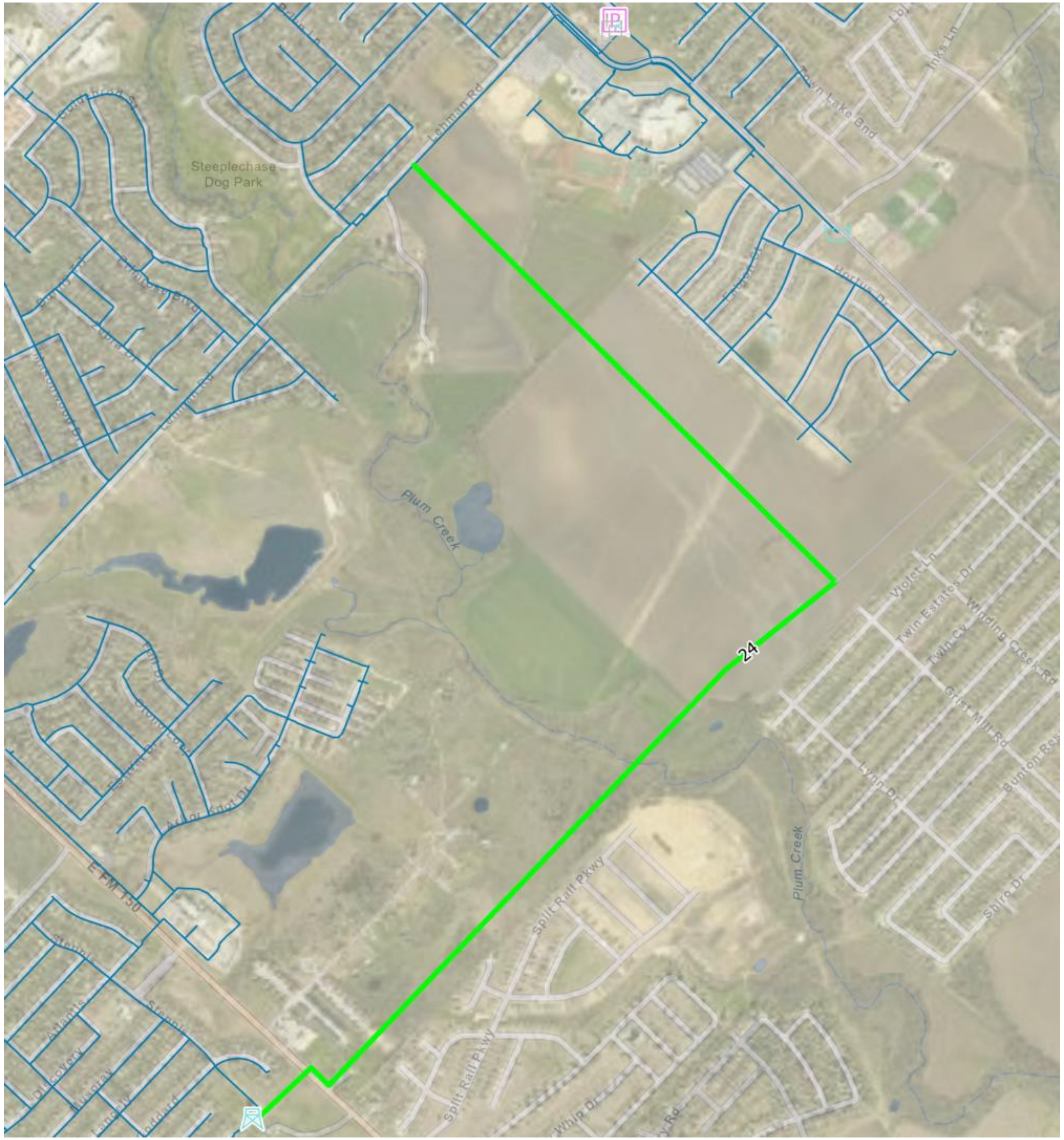
- TEE connection with Part 1
- TEE connection with Part 3
- Connect to 12” at Lehman Rd and Hallie Dr

- Completion not critical for 2026, but target 2027 to 2028



Part 3

- Part 3 provides a parallel connection from Post Oak EST to Lehman PS
- 12,830 ft of 24”
- Alternative to pipe replacement along Lehman Rd and FM 150. All new piping, no existing pipe replacement
- Follows Transportation planning routes
- Completion not critical for 2026, but target 2027 to 2028



OPCC

Pipe Improvements, Parts 1 to 3

Segment	OPCC $	Note	Target Date
Part 1 & 1A	7.2 M	Part 1 = $4.6 M, Part 1A = $2.6 M	Mid 2026 for Part 1
Part 2	3.1 M	Assumes pipe installed along side of road, not significant road repair	2027 to 2028
Part 3	10.4 M	Installation is mostly in open fields	2027 to 2028
Total	20.7 M	Pipe improvements support future Kyle water demands plus Caraway.	

OPCC details on following pages

OPCC

Part 1 and 1A

- $7.2 M
- 30% Contingency
- Part 1
  - 1,972 ft of 30”
  - 2,146 ft of 24”
  - $ 4.6 M
- Part 1A
  - 3,050 ft of 24
  - Adds $2.6 M overall

City of Kyle - Pressure Plane 1 Pipe Improvements (Parts 1 and 1A)
Opinion of Probable Construction Cost
DRAFT PLANNING LEVEL OPCC

ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST[1]	UNIT SUBTOTAL[2]
1	Pavement Repair	SY	1600	$ 200	$ 320,000
2	Seeding/Hydromulch	SY	32000	$ 2	$ 64,000
3	Upgrade Pipe (30") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	530	$ 575	$ 304,800
4	New Pipe (30") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	1445	$ 575	$ 830,900
5	New Pipe (24") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	2146	$ 450	$ 965,700
6	New Pipe (24") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	3050	$ 450	$ 1,372,500
7	Demolition of 12" line	LF	600	$ 20	$ 12,000
8	Valve (Gate)(24")	EA	4	$ 60,000	$ 240,000
9	Valve (Gate)(30")	EA	3	$ 90,000	$ 270,000
10	Drain Valve Assemblies	EA	4	$ 15,000	$ 60,000
11	Erosion Control	LS	2%	$ 88,798	$ 88,800
12	Traffic Control	LS	2%	$ 88,798	$ 88,800
13	Mobilization	LS	5%	$ 221,995	$ 222,000
				Project Subtotal	**$ 4,839,500**
				Contingency (30% of Subtotal)	$ 1,451,900
				Project Subtotal[4]	**$ 6,291,400**
				Engineering/Survey (15% of subtotal)	**$ 943,710**
				Estimated Total Project Cost*	**$ 7,235,110**

[1]The 'Unit Cost' is the manufacturer's supplied cost plus installation, unless otherwise noted.

[2]Unit Subtotal and Adder Subtotals are rounded to the nearest $100.

[4]These costs have been developed from prior bid tabulations, industry standards and coordination with material / equipment manufacturers. The items included herein are based on STV’s perception of current conditions at the project location. The OPCC is considered a Class 4 Estimate per the Association for the Advancement of Cost Engineering (AACE). STV has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor’s means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. STV cannot warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs included in the OPCC herein.

OPCC

Part 2

- $3.1 M
- 30% Contingency
- Part 2
  - 1,895 ft of 30”
  - 807 ft of 24”

City of Kyle - Pressure Plane 1 Pipe Improvements (Part 2)
Opinion of Probable Construction Cost
DRAFT PLANNING LEVEL OPCC

ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST[1]	UNIT SUBTOTAL[2]
1	Pavement Repair	SY	550	$ 200	$ 110,000
2	Seeding/Hydromulch	SY	12000	$ 2	$ 24,000
4	New Pipe (30") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	1895	$ 575	$ 1,089,700
5	New Pipe (24") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	807	$ 450	$ 363,200
8	Valve (Gate)(24")	EA	2	$ 60,000	$ 120,000
9	Valve (Gate)(30")	EA	2	$ 90,000	$ 180,000
10	Drain Valve Assemblies	EA	2	$ 15,000	$ 30,000
11	Erosion Control	LS	2%	$ 38,338	$ 38,400
12	Traffic Control	LS	2%	$ 38,338	$ 38,400
13	Mobilization	LS	5%	$ 95,845	$ 95,900
	Project Subtotal				**$ 2,089,600**
	Contingency (30% of Subtotal)				$ 626,900
	Project Subtotal[4]				**$ 2,716,500**
	Engineering/Survey (15% of subtotal)				**$ 407,475**
	Estimated Total Project Cost*				**$ 3,123,975**

[1]The 'Unit Cost' is the manufacturer's supplied cost plus installation, unless otherwise noted.

[2]Unit Subtotal and Adder Subtotals are rounded to the nearest $100.

[4]These costs have been developed from prior bid tabulations, industry standards and coordination with material / equipment manufacturers. The items included herein are based on STV’s perception of current conditions at the project location. The OPCC is considered a Class 4 Estimate per the Association for the Advancement of Cost Engineering (AACE). STV has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor’s means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. STV cannot warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs included in the OPCC herein.

OPCC

Part 3

- $10.4 M
- 30% Contingency
- Part 3
  - 12,830 ft of 24”

City of Kyle - Pressure Plane 1 Pipe Improvements (Part 3)
Opinion of Probable Construction Cost
DRAFT PLANNING LEVEL OPCC

ITEM NO.	DESCRIPTION	UNITS	QNTY	UNIT COST[1]	UNIT SUBTOTAL[2]
1	Pavement Repair	SY	550	$ 200	$ 110,000
2	Seeding/Hydromulch	SY	57000	$ 2	$ 114,000
5	New Pipe (24") DIP AWWA C151 (all depths), including excavation, backfill, & fittings	LF	12830	$ 450	$ 5,773,500
8	Valve (Gate)(24")	EA	6	$ 60,000	$ 360,000
10	Drain Valve Assemblies	EA	3	$ 15,000	$ 45,000
11	Erosion Control	LS	2%	$ 128,050	$ 128,100
12	Traffic Control	LS	2%	$ 128,050	$ 128,100
13	Mobilization	LS	5%	$ 320,125	$ 320,200
				Project Subtotal	**$ 6,978,900**
				Contingency (30% of Subtotal)	$ 2,093,700
				Project Subtotal[4]	**$ 9,072,600**
				Engineering/Survey (15% of subtotal)	**$ 1,360,890**
				Estimated Total Project Cost*	**$ 10,433,490**

[1]The 'Unit Cost' is the manufacturer's supplied cost plus installation, unless otherwise noted.

[2]Unit Subtotal and Adder Subtotals are rounded to the nearest $100.

[4]These costs have been developed from prior bid tabulations, industry standards and coordination with material / equipment manufacturers. The items included herein are based on STV’s perception of current conditions at the project location. The OPCC is considered a Class 4 Estimate per the Association for the Advancement of Cost Engineering (AACE). STV has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor’s means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. STV cannot warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs included in the OPCC herein.

Thank You

Appendix G

Valve Operation Issue for Dacy Lane and Yosemite ESTs

Appendix G

Valving for Dacy Lane and Yosemite ESTs

During data collection and analysis for model calibration, some anomalies were identified in the operation of Dacy Lane EST and Yosemite EST. From the SCADA data and the Data Logger pressure information collected over a three-week period, it is clear that the valving which controls flow into and out of these two ESTs is not opening and closing as intended. It appears the vales intended to function as altitude valves are often closed when the ESTs are not full and check valves installed for the ESTs are sticking. Data collected and analyzed is presented below. A photo of the valve vault for the Yosemite EST is shown in Figure G1. The valve set up for Dacy Lane EST is the same as for Yosemite EST.

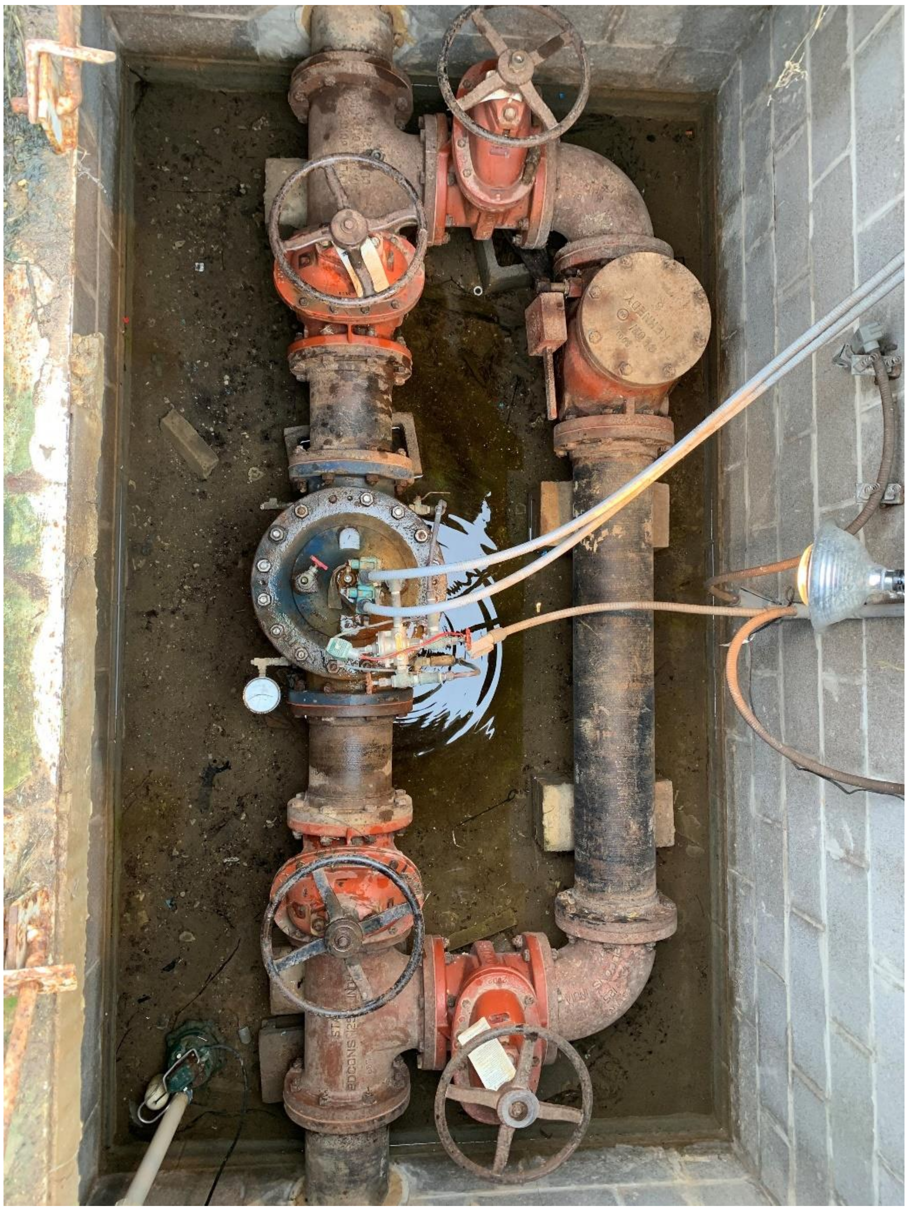


Figure G1 – Yosemite EST Valve Vault

System SCADA data from 7/26/2024 for Pressure Plane 1

1. Post Oak EST cycles as expected with the pumping at Yarrington and Lehman.
2. Yosemite EST does not respond to pumping as expected. Only one pump cycle fills the tank. Otherwise, the tank is almost stagnant.
3. Dacy sometimes responds to pumping and sometimes not.
4. Full ESTs have HGL of 850 ft. Tanks are not typically filled all the way.

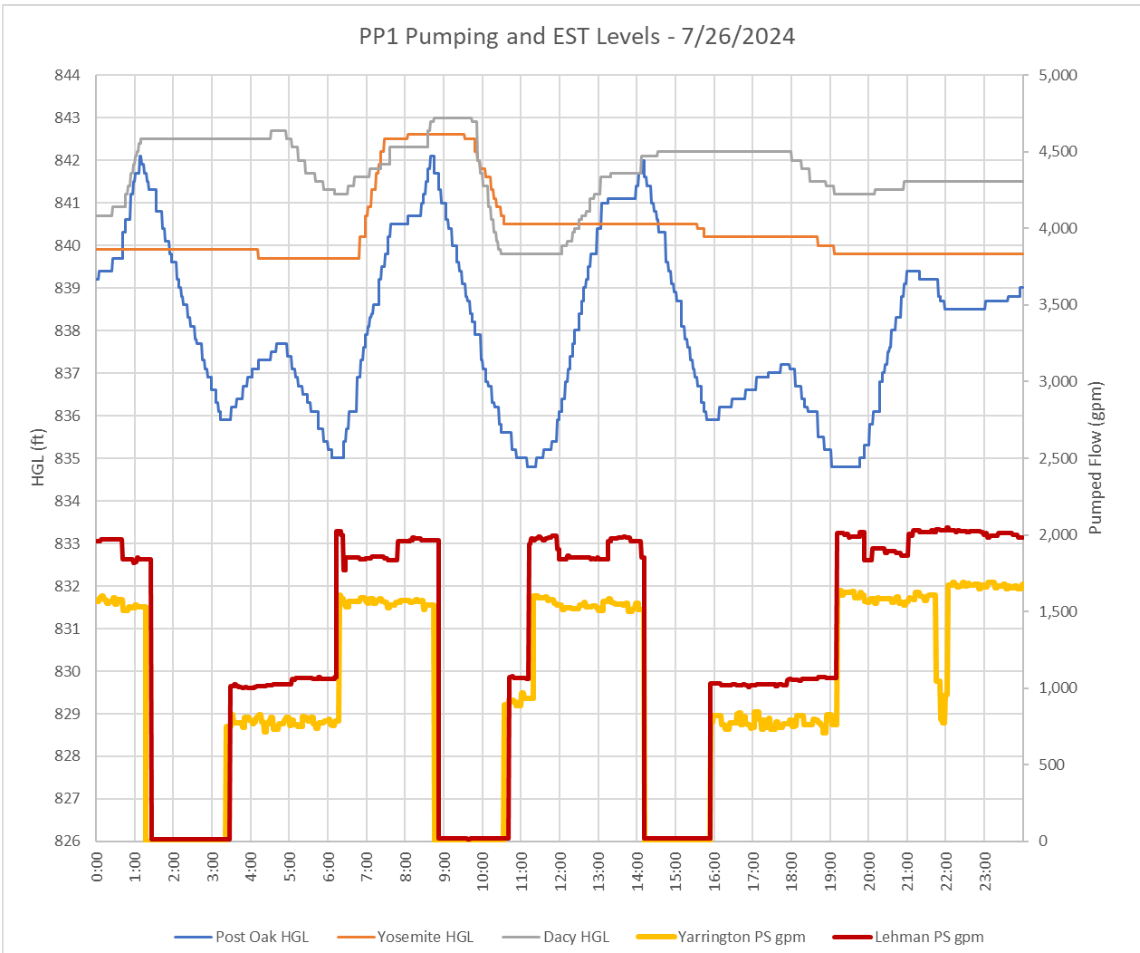


Figure G2 – PP1 Pump and EST Data on 7/26/2024

Pumping is off at three times; <u>2:00 to 3:00</u>, <u>9:00 to 10:00</u>, and <u>15:00 to 16:00</u>.

Yosemite and Dacy ESTs do not supply water from 2:00 to 3:00 or from 15:00 to 16:00. But they do supply water from 9:00 to 10:00. This does not seem to make sense. Both Dacy and Yosemite ESTs should generally be supplying water at times when Post Oak is dropping quickly, and no pumps are on.

When pumps are on, Post Oak responds immediately and fills significantly. Yosemite only fills during one pump cycle, from 7:00 to 8:00. Yosemite should have inflows all the other times pumping is maxed out. Dacy has some inflows during the first 3 pump cycles but not in the last from 19:00 to 24:00.

Yosemite EST has several days where it does not cycle but stays at about the same level the entire day or most of the day. The EST is sometimes isolated and not cycled throughout the day.

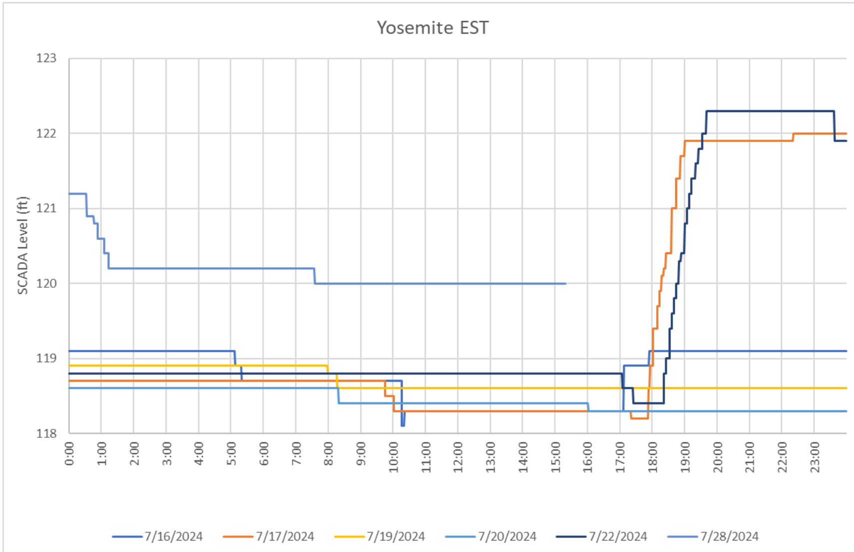


Figure G3 – Yosemite ESTs Level

Dacey EST also has days where the tank level is relatively unchanged through the day. Sometimes it seems to be isolated or all bad SCADA data.

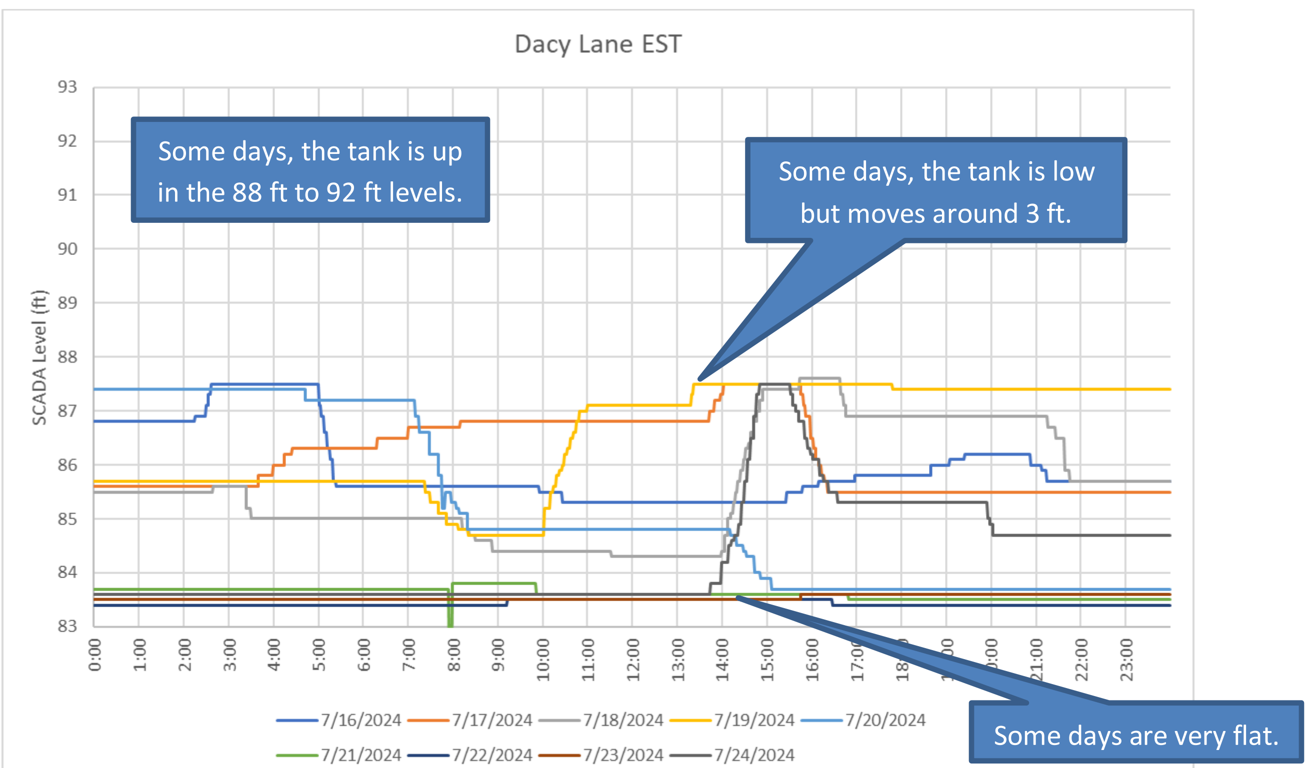


Figure G4 – Dacy Lane EST Level

Post Oak remains in sync with the pumping data and is very consistent through the 3 weeks of data collected (7/16/2024 to 8/5/2024).

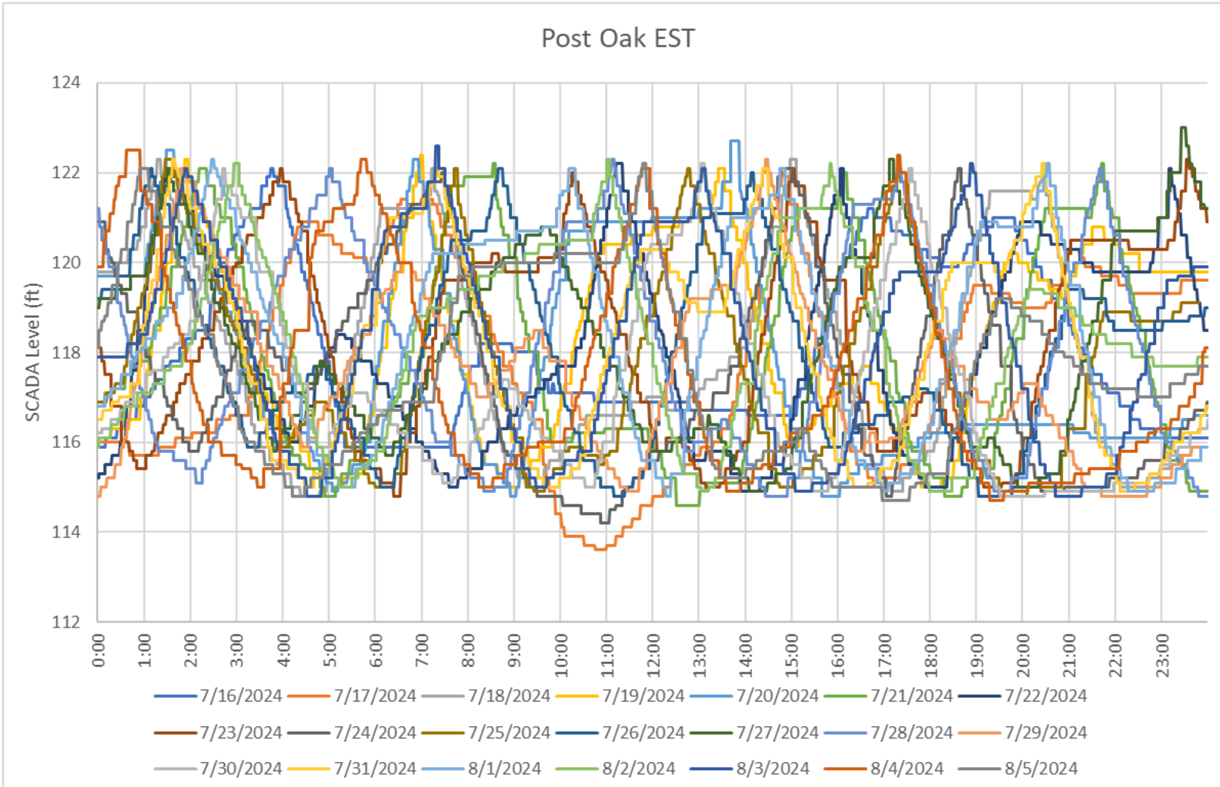


Figure G5 – Post Oak EST Level

Yosemite and Dacy data are not as consistent as Post Oak. The filling and emptying of these two tanks do not align well with pumping and seem to be isolated from the system at different times with no perceptible schedule.

System SCADA data from 7/16/2024 for Pressure Plane 1

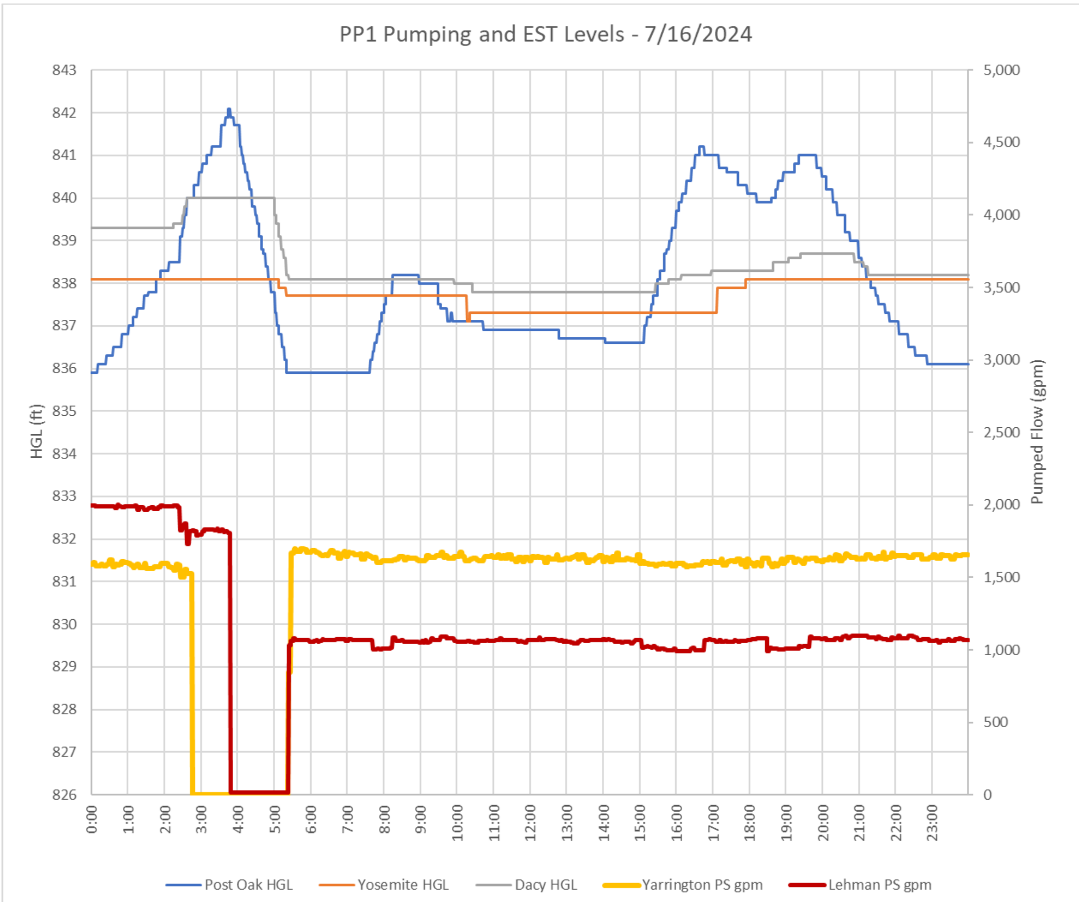


Figure G6 – PP1 Pump and EST Data on 7/16/2024

In the morning 0:00 to 4:00, pumps are on and Post Oak fills. Yosemite does not fill and Dacy only fills 1 ft. Demands should be low this time of day. The two ESTs should fill.

In the evening 15:00 to 20:00, Post Oak EST fills. This is also around the evening peak hour. For Post Oak to fill, it seems like the second Lehman pump should have come on. Yosemite and Dacy ESTs have very little movement throughout the day. There is a lot of movement in Post Oak but relatively none in Yosemite and Dacy, indicating they are isolated from the system.

Yosemite EST and Data Logger 2

The HGL should be very close between Yosemite and FH2. The HGL deviates as shown in Figure G7.

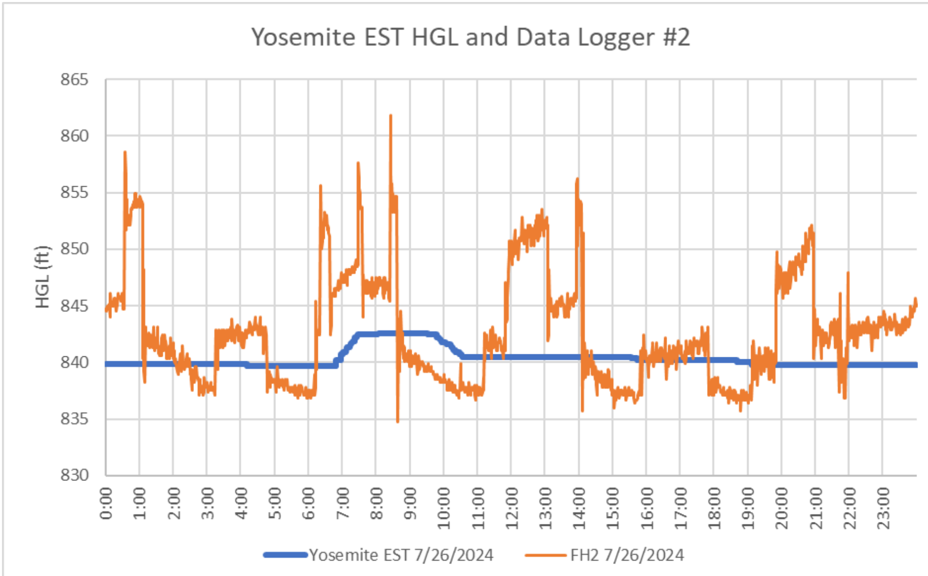


Figure G7 – HGL of Yosemite EST and nearby FH2

HGL at Logger 2 is recorded above the EST level and there is no inflow into the EST. EST is isolated from the system except at small timeframes when the tank inflows or outflows. This is typical of most days in the data. The local pressures at Data Logger 2 were often high enough to fill Yosemite EST to 130.3 ft (850ft HGL) which is a full tank. The stagnant level in Yosemite EST shows that the tank is isolated from the system. It neither fills nor empties as it should. The intermittent performance of Yosemite is shown over a 3 week period in Figure G8.

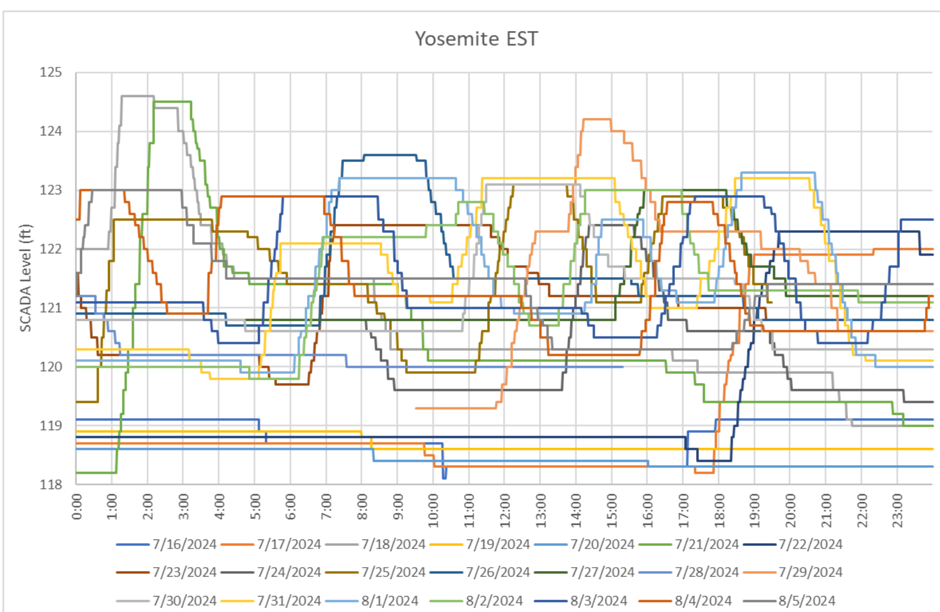


Figure G8 – Yosemite EST Level over 3 Weeks

Dacy Lane EST and Data Loggers 8 & 9

The HGL should be close between Dacy EST and the two nearby Fire Hydrants. The HGLs deviate as shown in Figure G9.

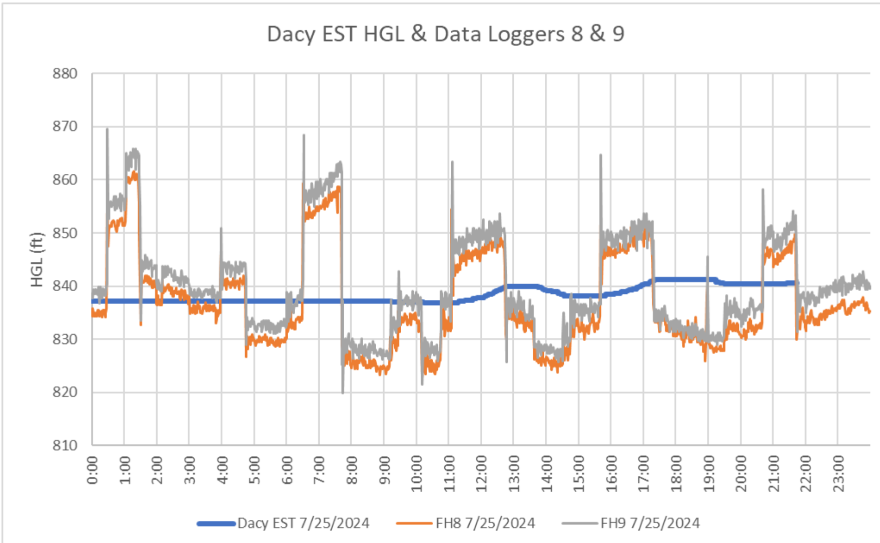


Figure G9 – HGL of Dacy EST and two Nearby FHs

Dacy EST does not fill when nearby HGL is above the tank level. On this day, 7/25/2024, the tank appears to be isolated from the system. Some days have a different response, where the tank does fill and empty. The full range of tank levels over a three-week period is shown in Figure G10.

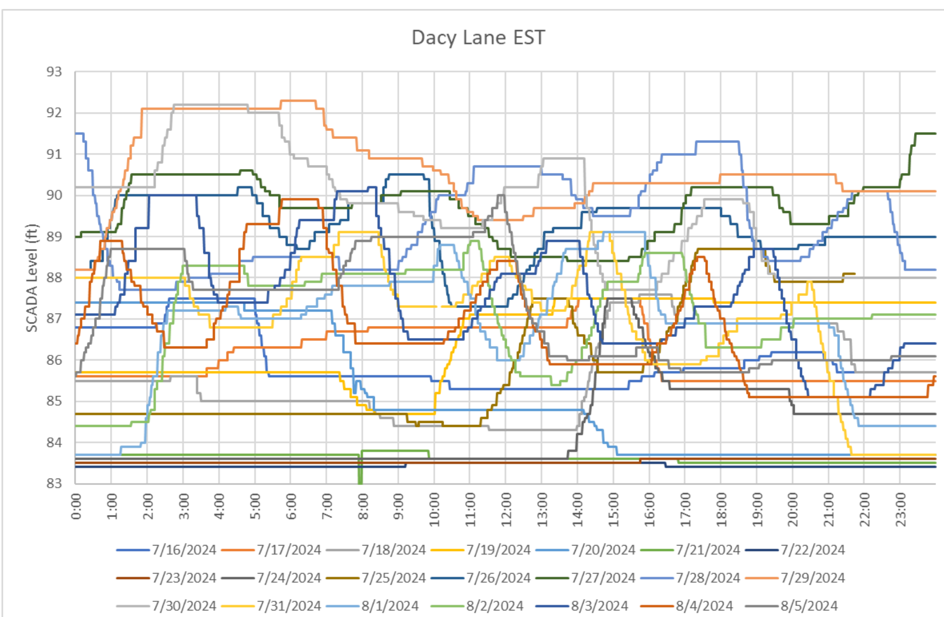


Figure G10 – Dacy Lane EST Levels over 3 Weeks

Appendix H

Proposed 3RD ARWA Take Point

Appendix H

Proposed Third ARWA Take Point

The purpose of a third ARWA take point is to provide another water supply point on the west side of I35 and in PP2. Currently, all surface water supplies are delivered into PP1 on the east side of I35 and must be pumped across the highway and lifted to supply PP2. A delivery point on the west side of I35 will bypass the flow restrictions caused by having to send water through PP1 to get to the west. The preferred location of the take point and pump station are shown below.

Pump Station Site:

Figure H1 – Proposed Location and Connection of Third ARWA Take Point

Transmission line length is 8,895 ft. The ground elevation is 671 ft at the ARWA pipeline take point. The bottom of the proposed GST to receives water is 751 ft, the full tank level is 799, and the mid-point is 775 ft. The maximum flow will be 13.5 MGD.

The proposed design parameters for the transmission line are shown in Table H1. The HGL from the take point to the GST is shown in Figure H2.

Table H1 – Transmission Line Parameters

Item	Unit		Max
FLOW	(MGD)		**13.5**
DIAMETER	(IN)		**30**
VELOCITY	(FPS)		**4.3**
HEAD LOSS	(FT)		**19**
HGL at Take Point	(FT)		**794**
PRESSURE at Take Point	(PSI)		**53**

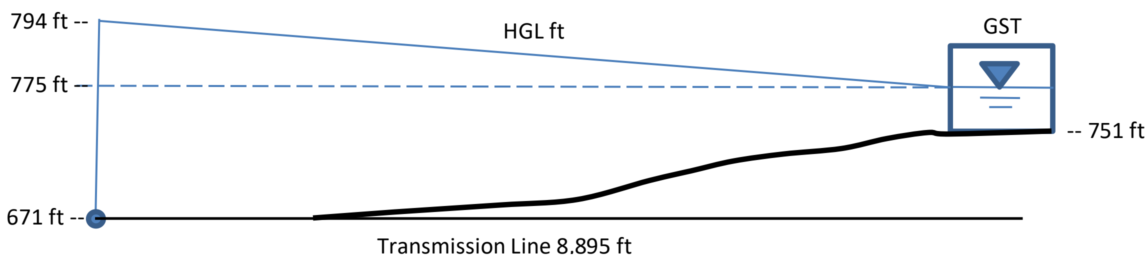


Figure H2 – HGL from Take Point to GST

Full ARWA supply in the future is 13.5 MGD or 9,380 gpm. City of Kyle needs the flexibility to take all of the supply at the proposed third take point if needed.

The preliminary recommendation for the pipe diameter from the ARWA connection to the proposed pump station is 30-inch. At full capacity, the flow velocity is 4.3 fps and the head/pressure required in the ARWA system is 794 ft / 53 psi.

Consider piping out of the pump station – supplying Pressure Plane 2.

To support a maximum 13.5 MGD (9,380 gpm) pumped out from Take Point 3 Pump Station, sufficient pipe capacity will be required. The proposed pump station can have one supply line going to PP1, and two lines supplying directly into PP2. With a maximum flow velocity of 5 fps, the possible pipe sizes at the pump station discharge are reviewed in Table H1.

Table H1 – Pipe sizes and Flow Capacity

Diameter (inches)	Flow (gpm)	Velocity (fps)
6	440	5
8	790	5
12	1,760	5
16	3,140	5
20	4,900	5
24	7,100	5
30	11,000	5

To support at least 9,380 gpm, piping on the pump station discharge requires at least:

1. Three 16-inch pipes
2. Three pipes; 20-inch, 16-inch, and 12-inch
3. Two 20-inch pipes
4. Two pipes; 24-inch and 16-inch

Appendix D

Aquifer Storage and Recovery (ASR) Technical Memorandum

Technical Memorandum

TO: Ryan Owens, P.E.
STV, Inc.
Vía Email: Ryan.Owen@stvinc.com

FROM: Bill Stein, P.G., James Beach, P.G. and Jordan Vega

SUBJECT: Preliminary ASR Evaluation for the City of Kyle

DATE: February 28, 2025

Executive Summary

Aquifer storage and recovery (ASR) systems can be a useful strategy for storing water underground that can be retrieved later. This preliminary evaluation of ASR for the City of Kyle (the City) assumed that their main ASR objective is to store water for short periods to help meet peak water demands during the summer. The strategy assumes that the City would use its Edwards Aquifer wells as a supply to recharge water into the Trinity Aquifer during the winter when demands are lower and retrieve the water that is stored through new wells when demands are higher in the summer. The City's historic data for average daily water demand by month indicates the maximum peak demand of about 4.5 million gallons per day (MGD) occurs in August and is about 1 million MGD above the annual average of 3.5 MGD. Therefore, the preliminary ASR concept presented in this technical memorandum is to develop a system that could provide up to 1 MGD of additional supply during the summer months based on available water for recharge during the winter months.

Potential target aquifers in the City for water storage include the Trinity and Edwards Aquifers. For this preliminary assessment, the Trinity Aquifer was selected for storage. We believe there less potential for migration of the stored water and less potential for other pumpers to capture the stored water. Even though the middle and lower Trinity Aquifer are deeper than the Edwards Aquifer, they are reasonable target aquifers for an ASR project. Depths of the middle Trinity Aquifer are up to about 2,000 feet and depths for the lower Trinity Aquifer may be up to about 3,000 feet within the City. Preliminary estimates for well capacity could be up to a few hundred gallons per minute (gpm), or about 0.4 MGD. The City would need to drill three to four new wells to develop a 1 MGD supply during summer recovery. Ideally, the ASR wells would be located close to existing Edwards Aquifer supply wells, ground storage tanks, and other infrastructure. A preliminary cost estimate for a well completed to these depths is in the range of about $3 to $4 million per well. This cost does not include the cost of pumps and other infrastructure required for the ASR system. Test wells need to be completed to confirm production capacity and water quality.

For permitting, the City's area is complicated with multiple groundwater conservation districts and permitting through the TCEQ, so additional legal clarification will need to be done before ASR wells are permitted and constructed. It appears that Texas Administrative Code (TAC) Chapter 331.19 would currently only allow ASR wells within the Edwards Aquifer regulated portion of the Barton Creek Edwards Aquifer Conservation District area.

Introduction

ASR systems recharge water from various sources into an aquifer and provide for recovery of the water later for beneficial use. For the ASR system conceptualized for the City, the injection (recharge), and extraction (recovery), of water are accomplished through wells. Water can be recharged into an aquifer at various intervals and may be stored from months to decades. The stored water can be recovered when normal supplies run low or when demand is higher than normal. Depending on the characteristics of the aquifer and the native groundwater in the aquifer, ASR projects may suffer some loss of recharged water to the aquifer. For example, when the native water in the aquifer is brackish, the mixing of native and recharged water during initial injection period results in a loss of some recharged water due to reduced water quality. However, these losses can be minimized with proper operation and management of recharged water.

The cities of El Paso, Kerrville and San Antonio have used ASR systems to increase water supplies. The San Antonio Water System (SAWS) recharges permitted Edwards Aquifer water into the Carrizo Aquifer at the H_2Oaks facility south of San Antonio during wetter periods. SAWS has stored over 200,000 acre-feet of Edwards water and has successfully recovered 40-50 million gallons per day (MGD) during the dry summers of 2022 and 2023.

The 2022 State of Texas Water Plan contains 27 ASR water management strategies for 10 of the 16 regional water planning areas. The results of a 2010 Texas Water Development Board (TWDB) survey of Texas water utilities indicated four primary concerns related to the use of ASR systems in other parts of Texas: legal and physical limitations, the quality of the recovered water, cost-effectiveness, and the potential for other pumpers to capture the utility's stored water.

Hydrogeology

Figure 1 shows a stratigraphic column showing the various geologic units in the area. The Edwards and Trinity Group are geologic layers within the lower Cretaceous System. Stratigraphically, the Edwards Group is composed of the Kainer and Person Formations, and along with the overlying Georgetown Formation, they collectively compose the Edwards Aquifer (Maclay and Small, 1986). The Edwards Aquifer is located between an upper confining unit consisting of the Del Rio Clay, Buda Limestone, and Eagle Ford Formation, and the underlying lower confining unit consisting of the upper member of the Glen Rose Limestone of the Trinity Group.

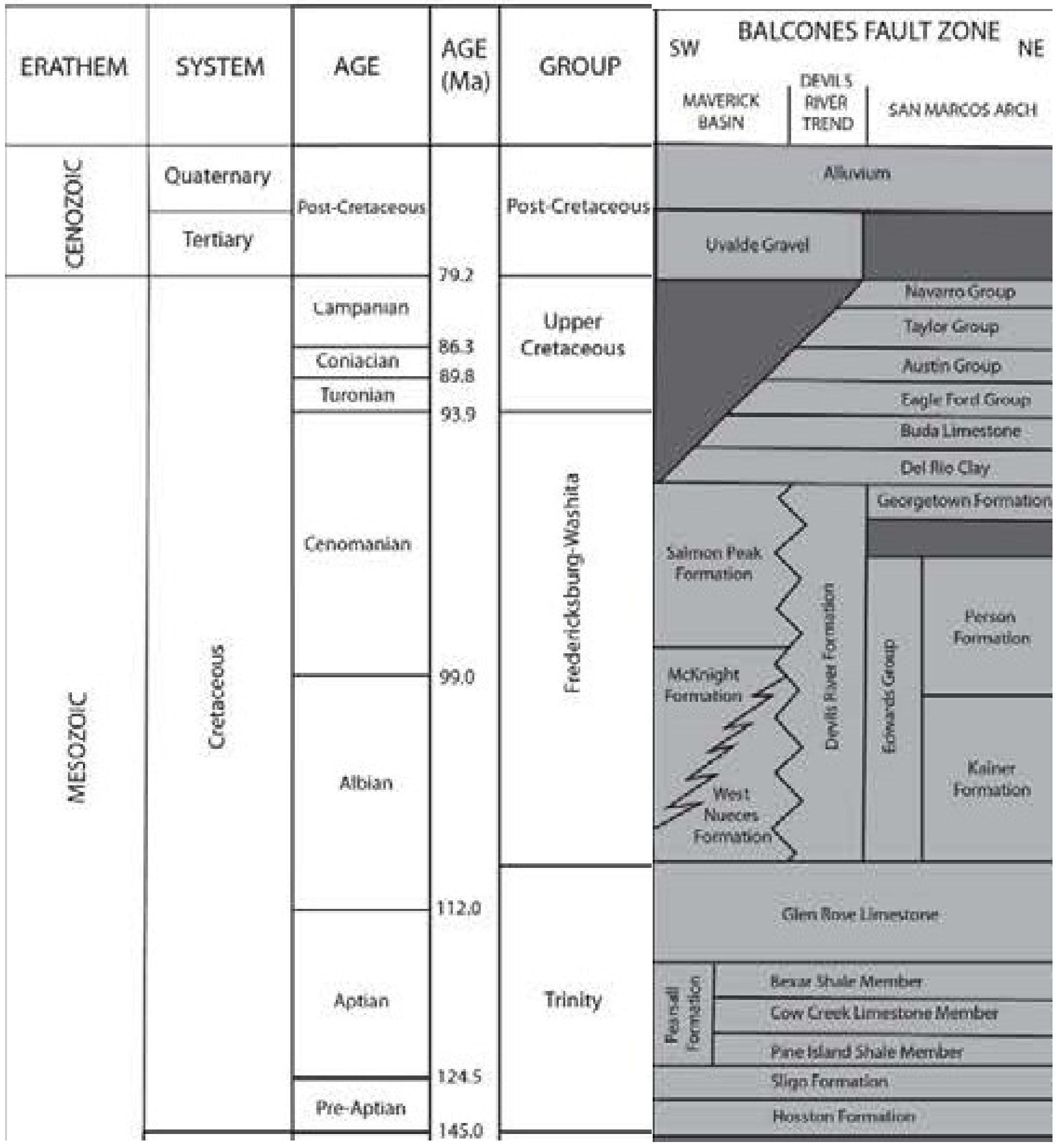


Figure 1. Stratigraphy in the Kyle area (modified from Toll et al, 2018)

Figure 2 shows the surface geology in the vicinity of the City of Kyle. Wells in the area generally have Austin Chalk at the surface and the Edwards Limestone outcrops in the western portion of the City. The map also shows several southwest to northeast oriented faults of the Balcones Fault Zone that occur in the area.

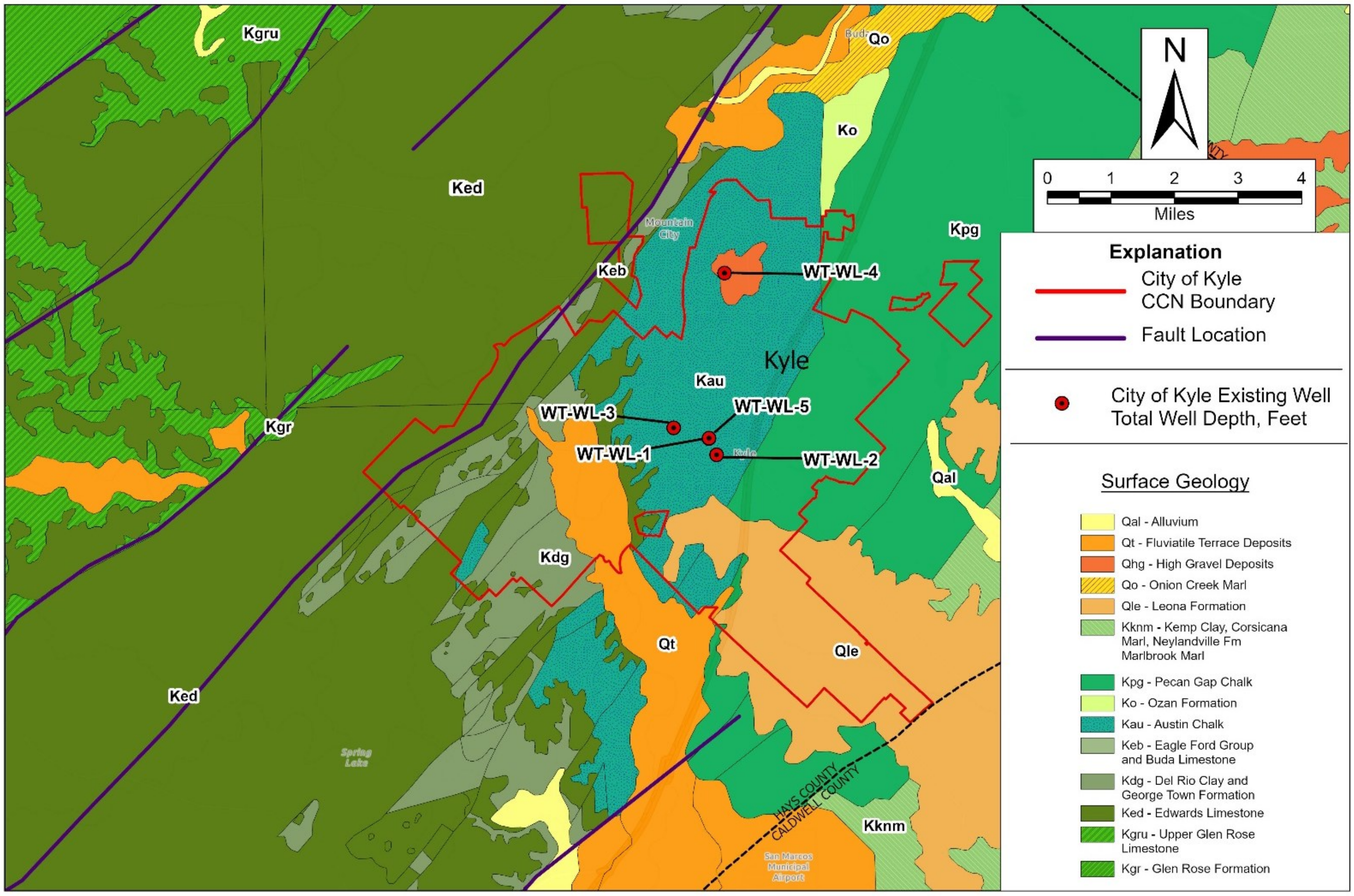


Figure 2. Surface Geology near City of Kyle (Texas Water Science Center)

The Trinity Group is divided into the following formations, in order from the shallowest to deepest: Glen Rose and Travis Peak (also known as the Pearsall). The Glen Rose Formation is divided informally into the lower and upper members. The Travis Peak Formation is further subdivided into the following members in order from shallowest to deepest: Bexar Shale or Hensell Sand, Cow Creek Limestone, Hammett Shale, Sligo Limestone, and Hosston Sand. Based on their hydrologic relationships, the water-bearing rocks of the Trinity Group, collectively referred to as the Trinity Group Aquifer, are divided into the following aquifer units (Ashworth, 1983):

upper Trinity	Consists of the upper Glen Rose Limestone.
middle Trinity	Consists of the lower member of the Glen Rose Limestone, and the Bexar Shale/Hensell Sand, and Cow Creek Limestone members of the Travis Peak Formation.
lower Trinity	Consists of the Hosston Sand and Sligo Limestone members of the Travis Peak Formation.

The Hammett Shale (sometimes referred to as the Pine Island Shale) is relatively impermeable and acts as a confining bed that divides the producing units of the lower and middle Trinity Aquifer units. The upper and middle Trinity Aquifer units are divided because of their water-quality differentiations. Water in the upper member of the Glen Rose Limestone, which forms the upper Trinity Aquifer unit, can contain relatively high concentrations of sulfate.

Because of fractures, faults, and other hydrogeologic factors, the upper, middle, and lower Trinity Aquifer units are often in hydraulic communication with one another and collectively considered to be a leaky-aquifer system. Recharge to the aquifers is from rainfall over the outcrop areas and some leakage can occur vertically between these units.

Figure 3 shows the boundary of the City of Kyle's Certificate of Convenience and Necessity (CCN), the City's wells and other nearby wells**.** TWDB aquifer designations and production capacities are also shown on the map for reference. Publicly available data do not indicate any active Trinity wells within the Kyle CCN and to the east. Historically, this portion of the aquifer has not been used because it is deeper and more brackish than the portions of the Trinity Aquifer to the west.

Trinity well production capacity ranges from tens to several hundred gallons per minute (gpm). Edwards well production capacity ranges from tens to over a thousand gallons per minute.

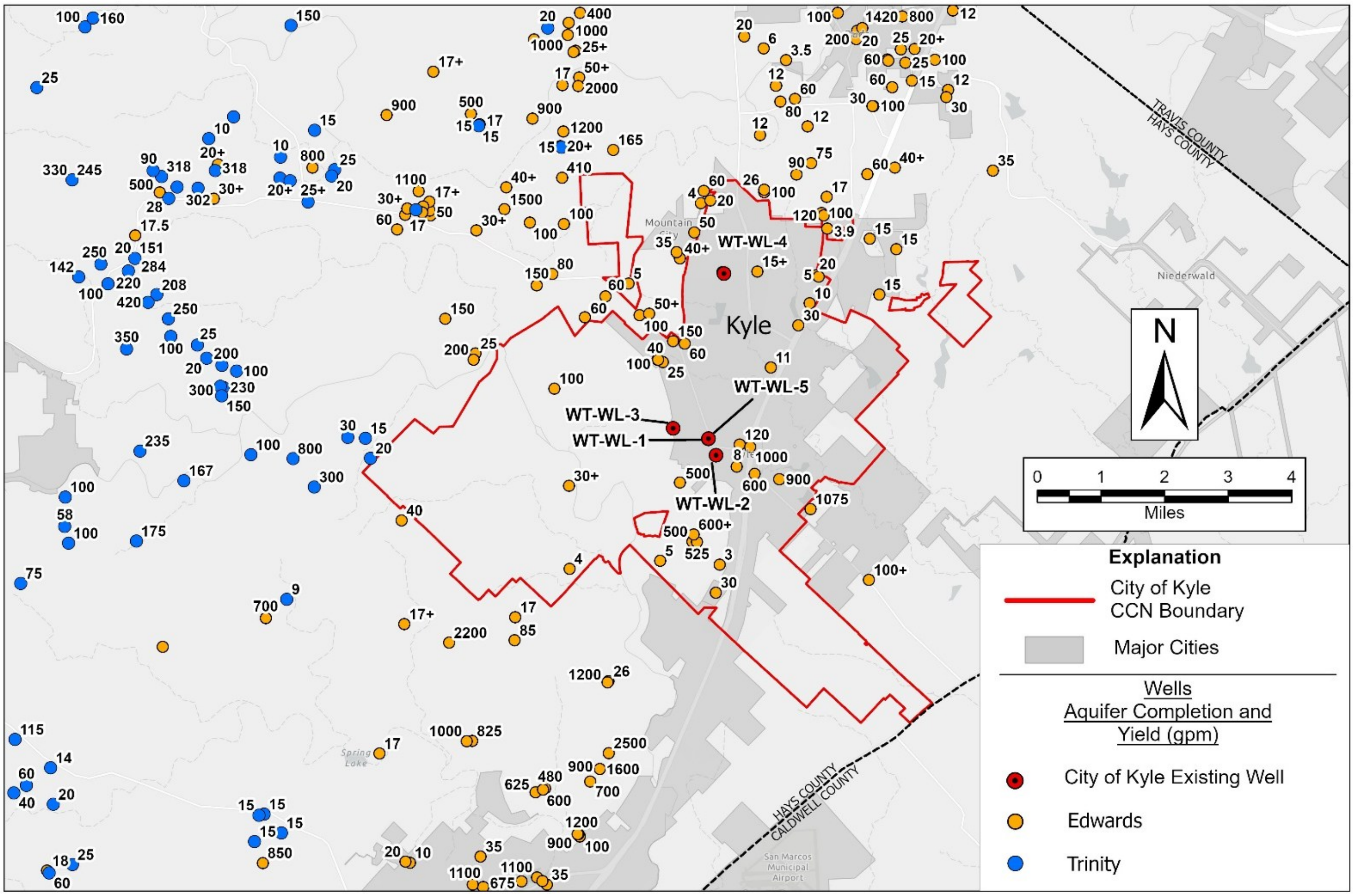


Figure 3. City of Kyle CCN boundary and wells, and other nearby wells

Figure 4 shows a generalized cross section of the Balcones Fault Zone in central Texas oriented from northwest to southeast. This cross-section transects the area south of the City of Kyle, but like New Braunfels (as shown in Figure 4), the City sits on the Balcones Fault Zone. All the geologic formations increase in depth from the northwest to the southeast, and significant faults occur in the area.

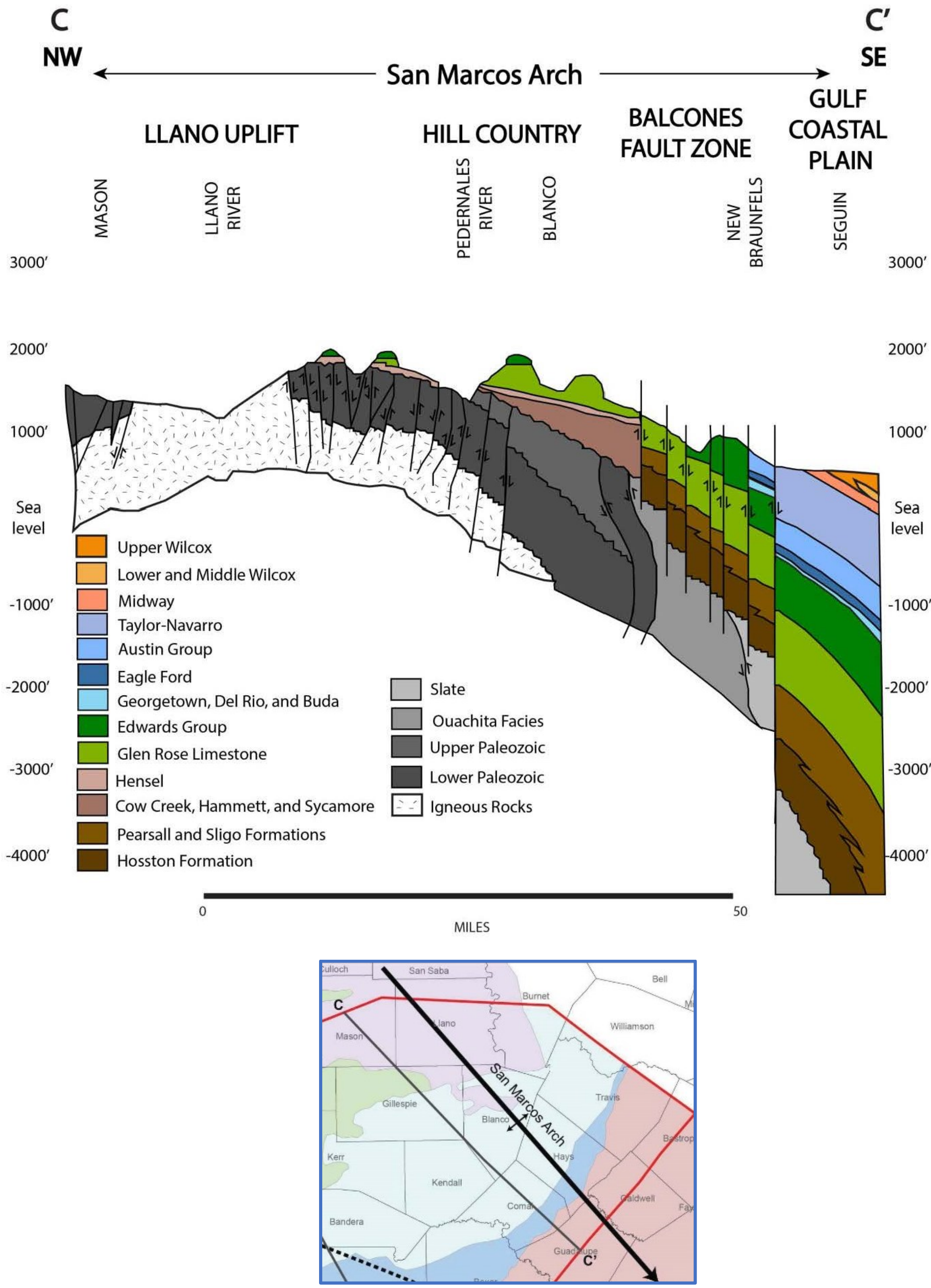


Figure 4. Generalized Cross Section in Central Texas (modified Toll et al, 2018).

The most productive aquifers in the area are the Edwards, the lower Glen Rose, and Cow Creek limestones of the Middle Trinity Aquifer, and the Hosston formation of the Lower Trinity Aquifer. Although the Edwards Aquifer could be used for ASR, our preliminary evaluation indicates that the Edwards Aquifer may not be the best target for multiple reasons. First, there are many other Edwards wells near the City, which may increase the risk of losing stored water to other pumpers. Secondly, the karst nature of the Edwards near the City may allow stored water to flow away from wells quickly. The saline zone of Edwards Limestone might be a storage candidate if the wells are located far enough to the southeast, like the wells for the ASR project being developed by New Braunfels Utilities. The middle or lower portions of the Trinity Aquifer might be more favorable in the City of Kyle. Public records do not show any existing Trinity wells in the City or east of the City.

Figure 5 shows the depth to the bottom of the Glen Rose Limestone based on the TWDB Brackish Resources Aquifer Characterization System (BRACS) data sets. Although not shown in Figure 5, the lower Glen Rose is about 300 feet in total thickness. There is often a reef in the lower Glen Rose and when present that is the most productive portion of the Glen Rose Limestone. Figure 6 shows the depth to the top of the Cow Creek Limestone based on the BRACS data sets. Although not shown in Figure 6, the total thickness of the Cow Creek is about 80 to 90 feet. Typically, the top 30 feet of the Cow Creek is the most productive part of this formation. The contours lines in these two figures also show the potential depth of middle Trinity Aquifer wells.

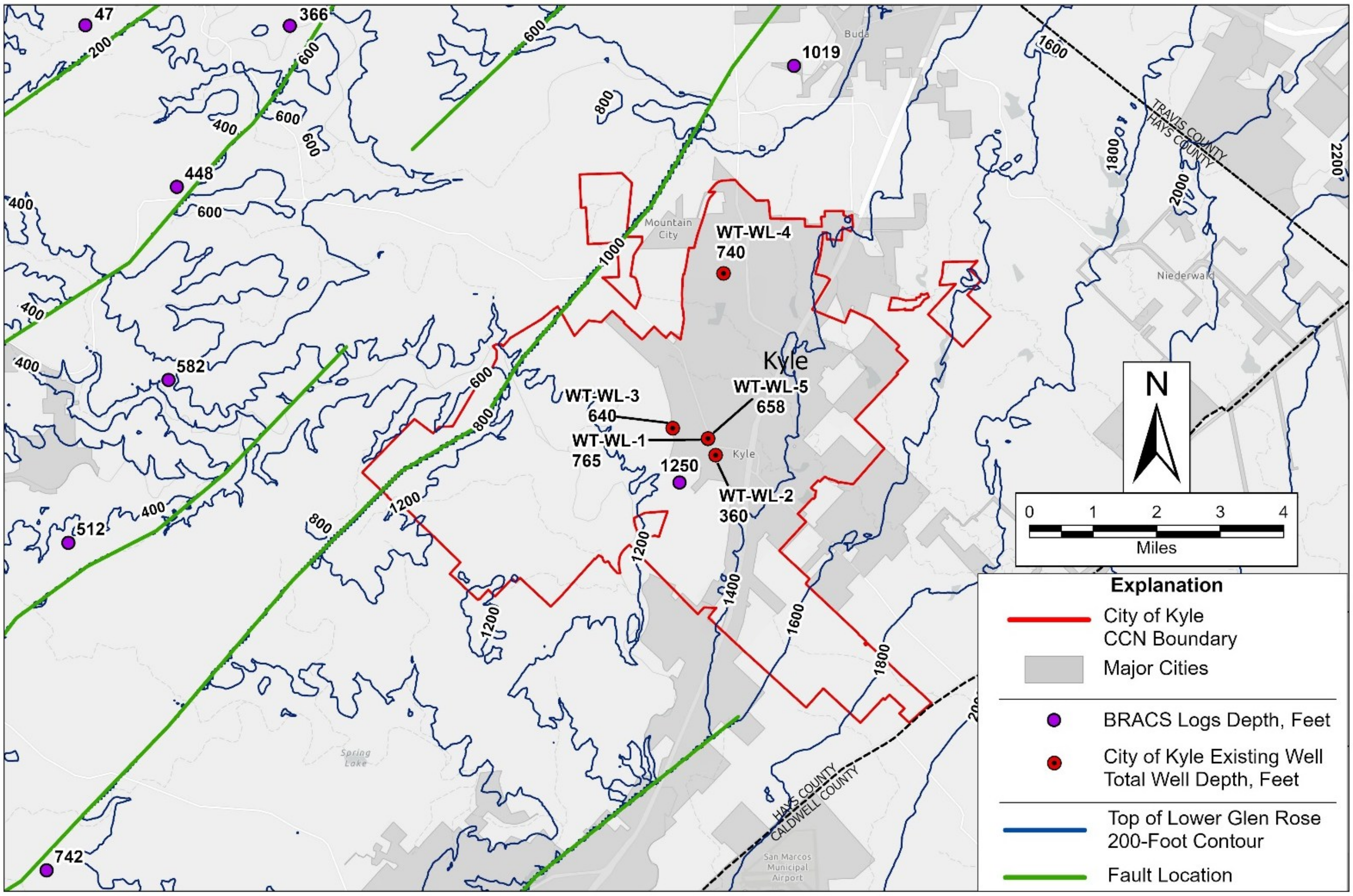


Figure 5. Depth to bottom of Glen Rose Limestone

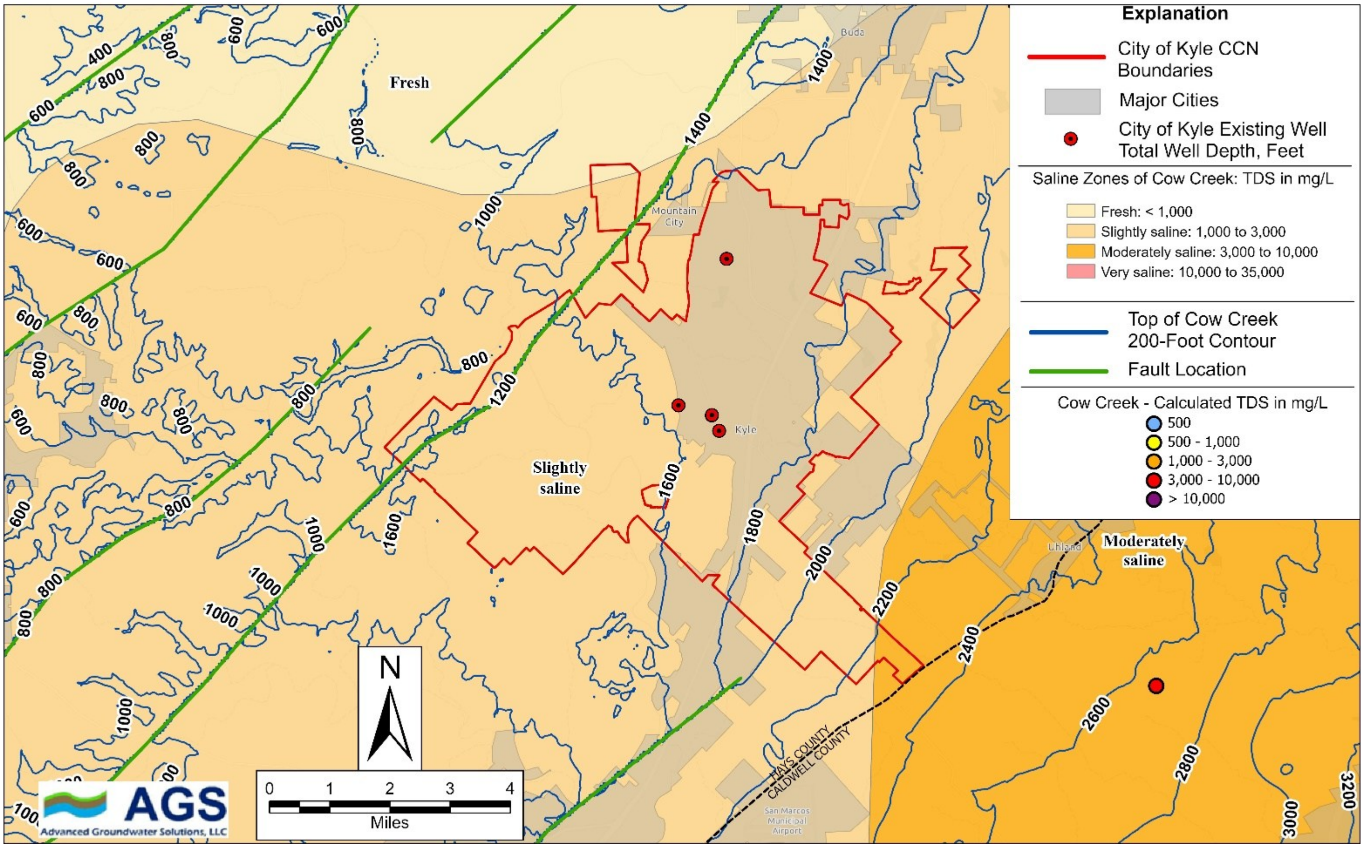


Figure 6. Depth to top of Cow Creek Limestone

Figure 7 contains contour lines indicating the depth to the bottom of the lower Trinity (Hosston formation) based on the BRACS data sets. Although not shown in Figure 7, the Hosston is about 500 feet thick total. Usually, the best producing interval of the lower Trinity is the bottom 50 to 100 feet of the formation that is often composed of a coarser sand to gravel conglomerate.

Additionally, both Figure 6 for the Cow Creek Limestone and Figure 7 for the Hosston/Lower Trinity (Figure 7) show the estimated total dissolved solids (TDS) levels. According to the BRACS calculations, these formations in the Kyle area are slightly brackish, with TDS levels ranging from 1,000 to 3,000 milligrams per liter (mg/L).

Drilling for test wells will need to be completed to characterize both units if the Trinity Aquifer is selected for the City's ASR system because there are no wells completed in the middle or lower Trinity Aquifer in the Kyle area and to the east.

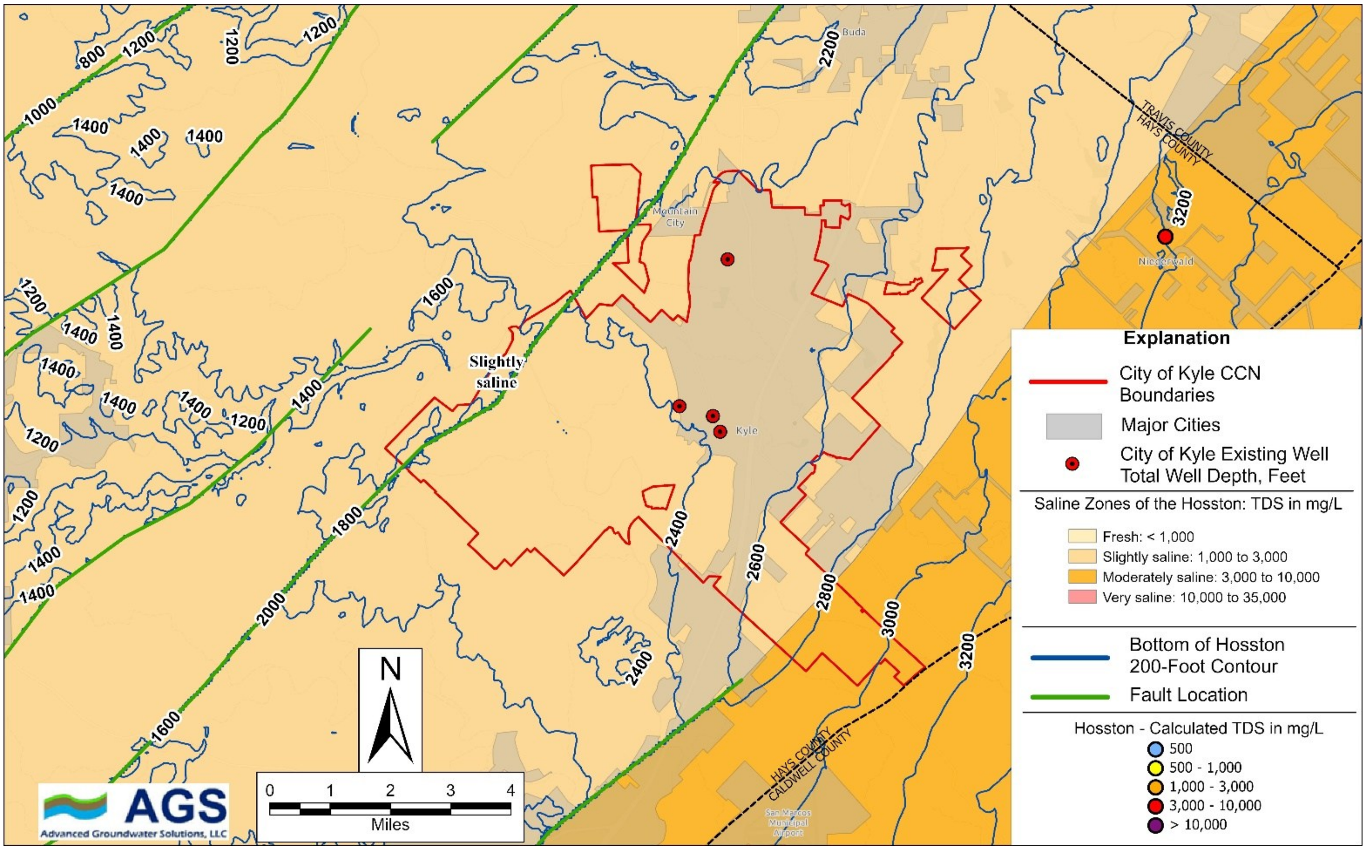


Figure 7. Depth to bottom of Hosston (Lower Trinity)

Conceptual ASR System

Figure 8 shows the estimated the recent average daily water demand by month for the City calculated by STV. The data indicates that there are 5 months when the demand is lower than average, 2 months when the demand is about equal to the average, and 5 months when the demand is above average. The maximum peak demand is about 1 MGD above average, and the peak months are July and August. Therefore, the preliminary ASR concept for the City is to develop a system to provide up to 1 MGD of additional supply during the summer months.

Preliminary estimates for Trinity Aquifer well capacity could be up to a few hundred gpm, or about 0.4 MGD. AGS estimates that 3 to 4 new wells may be needed to develop 1 MGD of additional supply. Ideally, the ASR wells would be located close to the City's existing Edwards Aquifer supply wells, ground storage tanks, and other infrastructure. Well spacing would be determined by several factors, including aquifer transmissivity and storativity, porosity, water levels in the aquifer, proximity to other wells, and total production capacity required for summer peak demand.

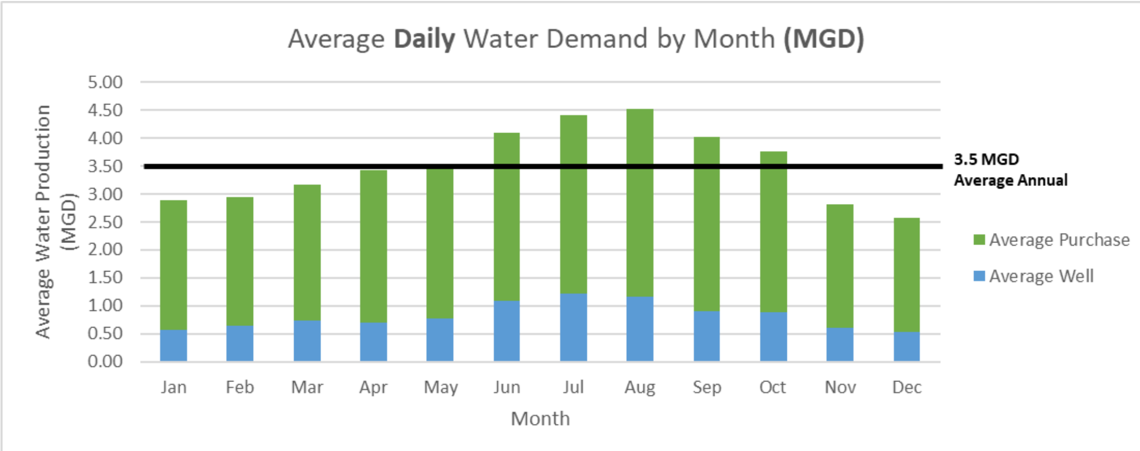


Figure 8. Average daily water demand by month for City of Kyle.

Figure 9 illustrates an idealized cross-section of an ASR well in an aquifer where water has been injected, and a buffer zone has developed in the area where native and stored water have mixed in the aquifer. The stored water in the illustration can by produced without pulling in any of the native water. The concept for the City is to store fresh water in a brackish groundwater aquifer. Therefore, the water in the buffer zone cannot be recovered unless the City has a plan to treat the water that has higher TDS due to mixing with the native groundwater. Generally, ASR systems in brackish aquifers develop a buffer zone over time and then do not recover that water. The loss of this buffer zone may reduce the efficiency of recovering stored water in the early years of ASR operation.

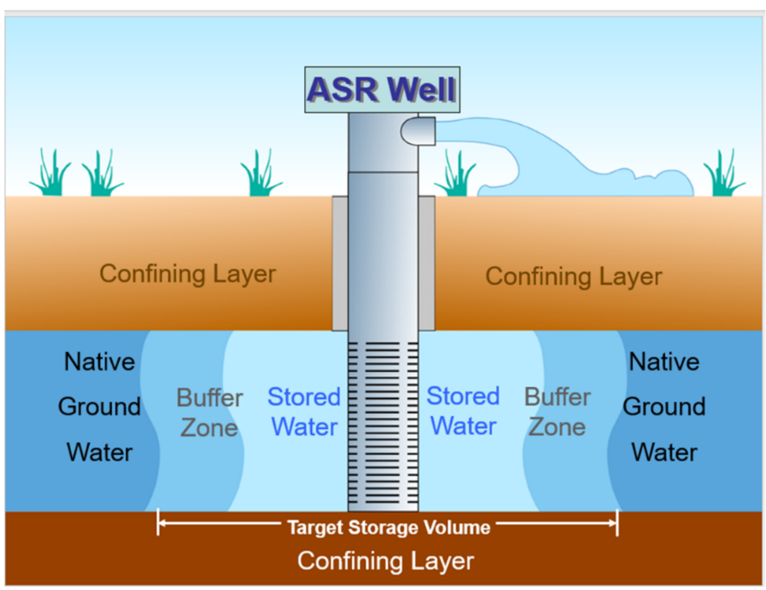


Figure 9. Illustration of idealized cross-section of an ASR well and the native groundwater, the buffer zone, and stored water zones

Recharged water will create a "bubble" around the well screen into the aquifer that will grow over time. Figure 10 shows the estimated radius of the recharge water bubble around a well assuming a well recharges for 4 months of the year at a rate of 250 gpm in a 200-foot-thick aquifer with 20% porosity. This radius does not account for mixing in the aquifer or potential native groundwater flow but does provide a rough estimate of the footprint of injected water around a well as a bubble is developed during the initial storage phases.

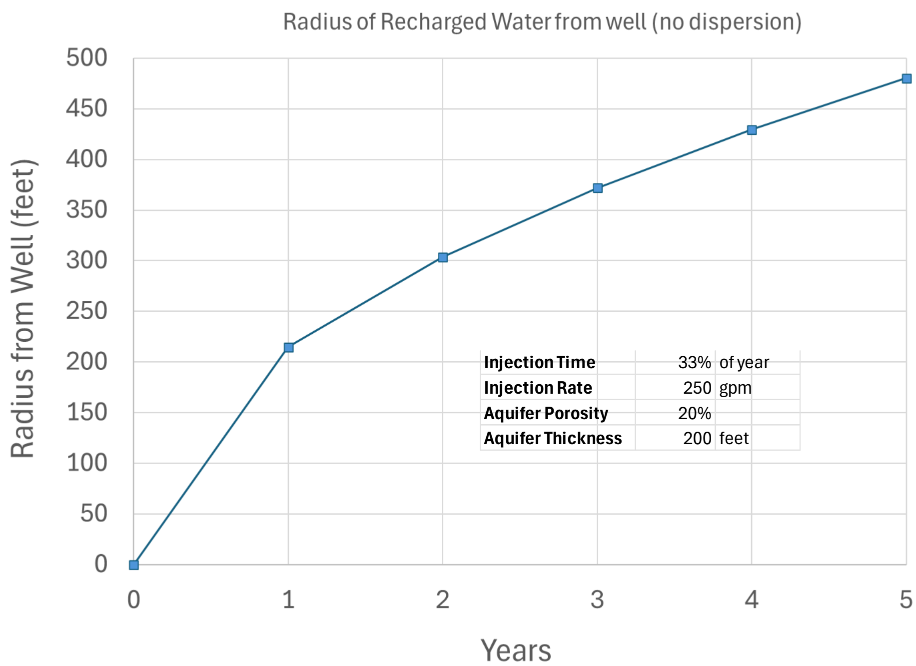


Figure 10. Estimate of recharge water radius around a well when initially creating a storage bubble

Based on experience from other operating systems, it is usually necessary to develop a sizable bubble around ASR wells in brackish aquifers prior to production so that the buffer zone will not be pumped into the well. The total volume of injected water can never be completely recovered due to the mixing of native brackish water and stored water. Depending on water availability for storage during winter months, AGS estimates it will take 2-4 years of recharging water prior to recovering it in the summer months to avoid pulling in water from the buffer zone.

A preliminary cost estimate for a well completed in the lower Trinity Aquifer is in the range of about $3 to $4 million per well. This estimate does not include pumps and motors, or any other infrastructure associated with the ASR system. Wells need to be constructed to confirm production capacity and water quality.

Regulatory Considerations

The injection wells used in ASR systems are permitted through the Texas Commission on Environmental Quality (TCEQ). Our understanding based on review of Texas Administrative Code (TAC) Chapter 331, Subchapter A, Section 19 and discussions with TCEQ and the Edwards Aquifer Authority (EAA) and Barton Springs Edwards Aquifer Conservation District (BSEACD), ASR wells into or through the Edwards Aquifer are not currently legislatively allowed within Hays County that is also within the EAA or Plum Creek district area. The BSEACD has an approved amendment to this statue that allows for Injection wells within their boundaries. In order to have ASR wells outside of the BSEACD Edwards area, an amendment to Chapter 331 would need to be done and passed in the legislature. New Braunfels Utility has a recent one approved and other entities are currently trying to do the same in other areas of the Balcones Fault Zone Edwards Aquifer.

The wells would also need to be registered with the local groundwater conservation district (GCD) or other GCD permits may have to obtained for well construction or production permits as well. The boundaries of the GCDs or other groundwater districts in the area around Kyle are illustrated in Figure 11. These districts are the BSEACD, EAA, Plum Creek GCD and Hays Trinity Groundwater Conservation District. The City area is complicated with multiple GCDs and permitting through the TCEQ, so additional legal clarification will need to be done before ASR wells are permitted and constructed.

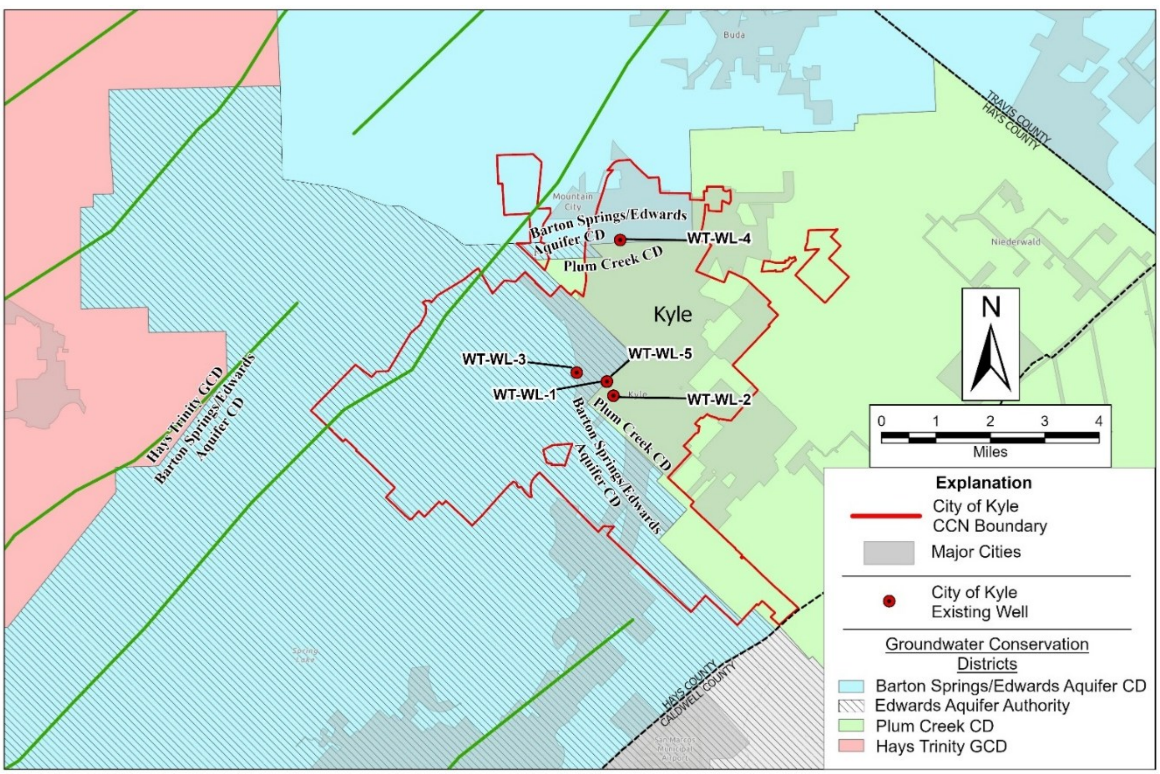


Figure 11. Groundwater Districts in vicinity of the City of Kyle

Potential Future Work

The typical phases of an ASR project include:

- Conceptual Planning
- Feasibility Study
- Field Testing and Demonstration Program
- Design and Construction
- Pilot Testing
- Implementation and Operation
- Potential Expansion

If the City decides to explore the ASR concept further, a more thorough feasibility study and field-testing program would be the next phases.

After identifying potential properties for locating test wells, the next phase will be to explore the Trinity Aquifer with test well drilling and construction. Depending on the timeline for the potential project and other factors, either a temporary test well or a full-size production well could be used to characterize the aquifer. Because there are no Trinity wells in the City from which to obtain water quality information from various potential target intervals, it might be best for the City to complete an exploratory borehole that could be geologically characterized, geophysically logged, and in which temporary wells could be constructed to sample groundwater from one or more intervals to help characterize the water quality in different formations.

This phase would entail drilling a small diameter test or pilot hole(s) at one or more locations, perform geophysical logging, collect geologic samples for analyses, install temporary test well casing and screen, pump the small diameter test well(s), and collect water samples for water quality analyses.

The geophysical logs performed should include dual induction, spontaneous potential (SP), gamma ray, density porosity, and neutron porosity logs. The geophysical logs will be evaluated to assess the depths and thicknesses of the aquifer layers and then to select the depths for any test well screen(s) for water sampling. A relatively short length of temporary well screen can be attached to 4-or 6-inch diameter drill pipe and a small gravel pack installed around the temporary well for interval sampling purposes.

The water sampling should be planned and completed in multiple depths in each test hole using a temporary, small diameter test well sampling method. A test well can be installed in the test hole for development pumping operations, and collecting water samples for laboratory analyses. If desired, one or more temporary test wells can be installed in the test hole at the deepest sampling depth first so that water samples can be collected for laboratory analyses. Then, if more than one test well sampling depth is selected, the temporary casing sections can be partially removed or pulled from the test well material string and another temporary test well can be installed in the same test hole at one or more additional shallower sampling depths to test well development pumping collect additional water samples at these shallower sampling depth(s). At a minimum, water quality analysis would include water quality constituents regulated by the TCEQ for public water systems.

If desired, after completion of all of the temporary test well sampling operations, the temporary test well casing and screen materials can be removed from the test hole and the test hole can be plugged and abandoned or it can be reamed to a larger diameter to accommodate construction of a larger diameter well. The smaller diameter test wells could also be used to collect water level data and complete smaller capacity pumping tests. The site-specific geophysical logs and test well water sampling will provide hydrogeologic, aquifer, and water quality data to assess the prospects for evaluating the Trinity Aquifer. If the results of the test well sampling are favorable, then constructing a full-sized production well can be completed with subsequent pumping tests conducted to determine well performance, aquifer properties, and potential well production rate or capacity. Well design should include appropriate pumps and motors to perform well pumping tests to determine aquifer capacities and yield.

Scheduling will be mainly dictated by the availability and schedule of the drilling contractor. Once on-site, the process of drilling the pilot hole and installing the temporary casing, screen, and gravel pack to sample multiple zones, may take 2 to 3 months. If reaming and constructing larger diameter production wells may take another 2 to 4 months. All of this work is also contingent on permitting through TCEQ and the local groundwater districts, which should be determined and factored into the project schedule.

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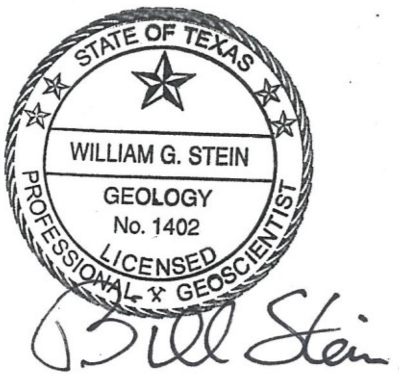

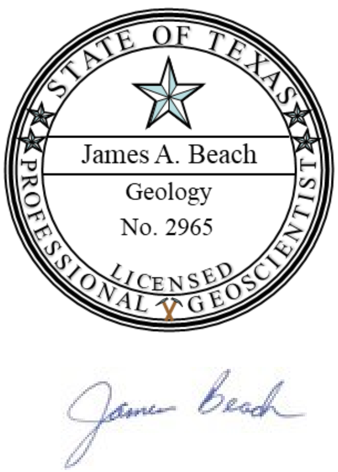

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