APPENDIX F
SOUTH CENTRAL SPECIFIC PLAN
WATER AND SEWER
HYDRAULIC ANALYSIS
July 2022

CITY OF FRESNO

SOUTH CENTRAL SPECIFIC PLAN WATER AND SEWER HYDRAULIC ANALYSIS

TECHNICAL MEMORANDUM

Final Draft

July, 2022

Prepared by:

AKEL
ENGINEERING GROUP, INC.

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AKEL
ENGINEERING GROUP, INC.

Final Draft
Smart Planning Our Water Resources

July 19, 2022

City of Fresno
2600 Fresno Street, Suite 3065
Fresno, CA 93721

Attention: Michelle Zumwalt, Architect

Subject: South Central Specific Plan (SCSP) Water and Sewer Hydraulic Analysis (Final Draft)

Dear Summer:

We are pleased to submit this Technical Memorandum to document the water and sewer hydraulic analysis for the South Central Specific Plan land use alternatives. This report is organized into the following sections:

1. Purpose and Scope
2. Land Use Summary
3. Performance and Design Criteria
4. Water Demands and Sewer Flows
5. Water System Evaluation and Recommendations
6. Sewer Collection System Evaluation and Recommendations
7. Summary Conclusions

We are extending our thanks to you, Brock Buche, Interim Director, and other City staff whose courtesy and cooperation were valuable components in completing this study and producing this report.

Sincerely,

AKEL ENGINEERING GROUP, INC.

Tony Akel, P.E., D.WRE
Senior Principal

Enclosure: Report

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1.0 Purpose and Scope

The City of Fresno (City) is currently planning the South Central Specific Plan (SCSP) to facilitate economic growth and improve quality of life for residents. The City has retained Akel Engineering Group, Inc. (Akel) to assess impacts to its water distribution and sewer collection systems due to proposed land use amendments from the SCSP. The overall purpose of this project is to support the buildout of the SCSP and maintain the target level of service for water and sewer utilities.

The scope of work for this project is as follows:

- Review and document land use for the four SCSP development alternatives.
- Summarize the water and sewer system performance and design criteria.
- Project future water demands and sewer flows.
- Evaluate the adequacy of capacity for the water distribution and sewer collection facilities to meet the existing and projected demands and flows.
- Recommend capacity improvements to mitigate observed deficiencies and service growth areas.
- Prepare a Technical Memorandum summarizing findings with tables and exhibits.

Various abbreviations and acronyms were also used in this report to represent relevant terminologies. A list of abbreviations and acronyms is included in **Table 1**.

2.0 Land Use Summary

The SCSP includes four alternatives with varying land uses across the 4,940-acre development area located within the southern portion of the City. The SCSP study area is bound by California Avenue to the North, Peach Avenue to the East, American Avenue to the South, and Fig Avenue to the West. The proposed land uses for each alternative are predominantly industrial as the study area is located near railroad and highways. The primary objective of this project is to expand employment opportunities while reducing impacts to the environment. The four land use alternatives currently under consideration are illustrated in **Appendix A**, and described as follows:

- **Alternative 0: Adopted Proposed Land Use:** This land use alternative includes 30 acres of residential, 4,171 acres of industrial, and 739 acres of other non-residential land uses as documented in **Table 2.**
- **Alternative 1: Blended Proposed Land Use:** This land use alternative includes 270 acres of residential, 3,364 acres of industrial, and 1,305 acres of other non-residential land uses as documented in **Table 2.**
- **Alternative 2: Community Proposed Land Use:** This land use alternative includes 288 acres of residential, 1,511 acres of industrial, and 3,141 acres of other non-residential land uses as documented in **Table 2.**

- **Alternative 3: Business Proposed Land Use:** This land use alternative includes 76 acres of residential, 4,206 acres of industrial, and 658 acres of other non-residential land uses as documented in Table 2.

3.0 Performance and Design Criteria

This section documents the water and sewer design criteria used to evaluate the capacity adequacy of the City's existing systems.

3.1 Water System Performance and Design Criteria

The design criteria documented in Table 3 was established from the City's 2020 Urban Water Management Plan (UWMP) and 2010 Water System Master Plan (WSMP). This design criteria was used to identify deficiencies in the City's existing and future water system. This design criteria includes peaking factors for demands, maximum pipe velocity and friction losses for pipelines, and allowable service pressure ranges for junctions.

3.2 Sewer Collection System Design Criteria

The design criteria documented in Table 4 was established from the City's 2015 Sewer System Master Plan (SSMP) and was used to identify capacity deficiencies in the City's existing sewer system. Additional partial flow criteria for existing dry weather flows were added to the criteria based on Akel experience and standard engineering practices. This design criteria includes partial flow criteria (d/D) for dry weather flows and peak discharge criteria (q/Q) for wet weather flows.

Partial flow in gravity sewers is expressed as maximum pipeline depth to diameter (d/D) ratio. For circular gravity conduits, the highest capacity is generally reached at 92 percent of the full height of the pipe (d/D ratio of 0.92). This is due to the additional wetted perimeter and increased friction of a gravity pipe. When designing sewer pipelines, it is common practice to use variable flow depth criteria that allow higher safety factors in larger sizes. Thus, design d/D ratios may range between 0.5 and 0.92, with the lower values used for smaller pipes. The smaller pipes may experience flow peaks greater than planned or may experience blockages from debris.

During peak dry weather flow (PDWF), the maximum allowable d/D ratio for proposed pipes ranges from 0.50 to 0.75 (Table 4). The maximum allowable d/D ratio for all existing pipes (all diameters) is 0.90. The criterion for existing pipes is relaxed in order to maximize the use of the existing pipes before costly pipe improvements are needed.

For lift stations, the industry standard practice is to provide sufficient capacity to pump the design flow with the largest pump out of service (firm capacity). According to the City's 2015 SSMP, the lift station is considered deficient if the firm capacity is less than the peak wet weather flow (PWWF). The downstream force main from the lift station is also considered deficient if the minimum velocity is below 3 feet per second (ft/s) or the maximum velocity is above 8 ft/s during wet weather conditions.

4.0 Water Demands and Sewer Flows

This section documents the selected land use unit factors, and includes projected water demands and sewer flows for the four SCSP alternatives.

4.1 Water and Sewer Unit Factors

The water and sewer unit factors used for the SCSP alternatives are documented on **Table 5.** These unit factors are based on an analysis of the characteristics of existing users, the ongoing 2020 Metro Water Resources Management Plan, and included additional comparisons of unit factor criteria from other water agencies. The final unit factors for the SCSP alternatives were confirmed by City staff.

Additionally, fire flow requirements for each land use classification are also documented on **Table 5.** The fire flow requirements were developed based on the performance criteria from the 2010 Water Master Plan.

4.2 Projected Water Demands

The projected water demands for the four SCSP alternatives are documented on **Table 6** and described as follows:

- **Alternative 0: Adopted Land Use:** This system demands are estimated at **16.4 million gallons per day (mgd)** for average day demands (ADD), 31.2 mgd for maximum day demands (MDD), and 47.6 mgd for peak hour demands (PHD).
- **Alternative 1: Blended Land Use:** This system demands are estimated at **15.4 mgd** for ADD, 29.3 mgd for MDD, and 44.7 mgd for PHD.
- **Alternative 2: Community Land Use:** This system demands are estimated at **11.3 mgd** for ADD, 21.5 mgd for MDD, and 32.9 mgd for PHD.
- **Alternative 3: Business Land Use:** This system demands are estimated at **15.5 mgd** for ADD, 29.5 mgd for MDD, and 45.0 mgd for PHD.

4.3 Projected Sewer Flows

The projected sewer flows for the four SCSP alternatives are documented on **Table 6** and described as follows:

- **Alternative 0: Adopted Land Use:** This system flows are estimated at **12.8 mgd** for average annual flows (AAF), 14.7 mgd for peak day dry weather flows (PDDWF), and 16.6 mgd for peak month wet weather flows (PMWWF).
- **Alternative 1: Blended Land Use:** This system flows are estimated at **11.6 mgd** for average annual flows, 13.4 mgd for PDDWF, and 15.1 mgd for PMWWF.
- **Alternative 2: Community Land Use:** This system flows are estimated at **7.9 mgd** for average annual flows, 9.0 mgd for PDDWF, and 10.2 mgd for PMWWF.

- **Alternative 3: Business Land Use:** This system flows are estimated at **12.1 mgd** for average annual flows, 13.9 mgd for PDDWF, and 15.7 mgd for PMWWF.

The existing hydraulic model was developed based on 2015 land use data and unit factors shown in Table 5.4 of the 2015 SSMP. As such, the sewer manholes (loading manholes) contained flows that correspond to historical land uses. The following assumptions were made to simulate the SCSP alternatives, including peak dry weather and peak wet weather conditions:

- The sewer unit factors from **Table 5** were used to calculate the projected sewer flows based on the proposed alternatives land use. These projected sewer flows were allocated to the nearest loading manhole in the hydraulic model and the sewershed area for each loading manhole was updated accordingly based on the tributary parcel(s).

- Peak dry weather flow scenarios were simulated based on a maximum day dry weather flow seasonal peaking factor that accounts for diurnal flow variations and flow attenuation within the sewer collection system. The seasonal peaking factor applied in the hydraulic model is consistent with the City's historical WWTP flow data.

- The peak wet weather flow scenarios include groundwater infiltration and inflow (I&I) that is associated with extraneous water entering the sewer through defects in pipelines and manholes. Infiltration occurs when groundwater rises or the soil is saturated due to seasonal factors such as a storm event which causes an increase in flows in the sewer system. Inflow occurs when surface water enters the sewer collection system from storm drain cross connections, manhole covers, or roof/footing drains. The peak wet weather flow scenarios were simulated using a maximum month wet weather flow seasonal peaking factor, existing RTK parameters and rainfall-dependent I&I of a 10-year, 24-hour design storm event. These scenarios also account for diurnal flow variations and flow attenuation within the sewer collection system.

5.0 Water System Evaluation and Recommendations

This section documents the water system evaluation and recommended capacity improvements to mitigate deficiencies and service future growth. The City's existing hydraulic model was used to determine the capacity adequacy of the water distribution system under peak hour and maximum day plus fire flow demand conditions.

5.1 Hydraulic Modeling Assumptions

This section documents the hydraulic modeling assumptions used to evaluate the capacity adequacy of the City's water distribution system. The Southeast Surface Water Treatment Facility currently treats approximately 54 mgd of surface water but has a maximum treatment capacity of 80 mgd. This maximum treatment capacity of 80 mgd was assumed for this hydraulic analysis. Surface water facility production assumptions are documented below.

Surface Water Treatment Facilities Assumptions:

- Northeast Surface Water Treatment Facility: 24 mgd
- Southeast Surface Water Treatment Facility: 80 mgd
- T3 Surface Water Treatment Facility: 3.2 mgd
- **Surface Water Production Total:** 107.2 mgd

The increase in surface water treatment will partially supply the SCSP area due to a solid backbone of Regional/Grid Transmission mains, however a combination of existing and new supply wells may be required to service the SCSP demands. Existing wells will be first utilized to make up the water supply balance, however new wells may be needed within the SCSP boundary to maintain acceptable pressures due to the inadequate number of existing wells within the SCSP boundaries to service the proposed development intensifications.

According to the 2010 WSMP, a Hazen-Williams "C" factor of 130 was applied to new pipelines to estimate friction losses.

5.2 Existing System Fire Flow Analysis (Baseline Conditions)

The fire flow analysis consisted of using the maximum day demand in the hydraulic model and applying hypothetical fire flows. The magnitude of each fire flow was based on the governing land use type within proximity to the fire hydrant location. The criteria for fire flows were also documented on **Table 5**. The existing system fire flow demands within the SCSP boundary are shown graphically on **Figure 1**. **Figure 2** documents the available fire flows at the existing hydrants based on minimum residual pressure of 20 psi and a maximum pipeline velocity of 10 ft/s criteria. **Figure 3** documents the existing fire hydrants within SCSP boundary that are deficient based on the fire flow requirements (fire flow residual pressures less than 20 psi with existing land use).

Since these hydrants are an existing deficiency, no improvements will be recommended unless the proposed land uses increases the fire flow requirement.

5.3 Alternative 0 – Adopted Plan

This section documents the hydraulic analysis results and improvements needed to meet Alternative 0 water demands. New service pipelines, groundwater wells, capacity pipelines and fire flow pipelines improvements were recommended to mitigate deficiencies observed under peak hour and maximum day plus fire flow conditions.

5.3.1 Peak Hour Pressures

PHD scenario indicates pressures ranging from 41 psi to 66 psi within the SCSP boundary. The peak hour pressures are shown graphically on **Figure 4**.

5.3.2 Maximum Day Demand Plus Fire Flow

The MDD scenario was used to estimate maximum available fire flows while maintaining pipeline and service pressure criteria. The hydraulic model indicates additional fire flow deficiencies due to

the Alternative 0 demands. The new deficiencies are located near 1) Jensen Ave and Peach Ave and 2) Cherry Ave and Byrd Ave. These areas will require improvements to mitigate the fire flow deficiencies. The results of this analysis are documented on Figure 5.

5.3.3 Recommended Improvements

The proposed capacity and fire flow improvements for Alternative 0 are shown graphically on Figure 6, which include new wells, new transmission grid mains, capacity pipelines and fire flow pipelines improvements to existing infrastructure. The recommended improvements are documented as follows:

- Install 14.7 miles of new 16-inch transmission grid mains.
- Install 8 new wells, each with a firm capacity of 2,125 gpm.
- Capacity Improvement: Replace approximately 4,250-feet of existing 14-inch pipeline with a new 16-inch pipeline on North Avenue between Maple Avenue and Parkway Drive. This improvement is intended to mitigate a head loss deficiency identified in the analysis.
- Fire Flow Improvement: Replace approximately 2,870-feet of existing 6-inch pipeline with a new 12-inch pipeline along Grove Avenue, Rose Avenue, Nicholas Avenue, and Kaviland Avenue west of Cherry Avenue and Byrd Avenue.
- Fire Flow Improvement: Replace approximately 460-feet of existing 8-inch pipeline with a new 14-inch pipeline along Mary Avenue from Central Avenue to Daleville Avenue.
- Fire Flow Improvement: Replace approximately 1,630-feet of existing 8-inch pipeline with a new 12-inch pipeline along Helm Avenue and Drummond Avenue from Jensen Avenue to Peach Avenue.
- Fire Flow Improvement: Replace approximately 620-feet of existing 10-inch pipeline with a new 12-inch pipeline along Cherry Avenue from Kaviland Avenue to Jensen Avenue.

5.4 Alternative 1 – Blended Plan

This section documents the hydraulic analysis results and improvements needed to meet Alternative 1 water demands. New service pipelines and groundwater well improvements were recommended to mitigate deficiencies observed under peak hour and maximum day plus fire flow conditions.

5.4.1 Peak Hour Pressures

PHD scenario indicates pressures ranging from 48 psi to 68 psi within the SCSP boundary. The peak hour pressures during the PHD scenario are shown graphically on Figure 7.

5.4.2 Maximum Day Demand Plus Fire Flow

The MDD scenario was used to estimate maximum available fire flows while maintaining pipeline and service pressure criteria. The Alternative 1 water demands did not cause additional fire flow deficiencies. The results of this analysis are documented on Figure 8.

5.4.3 Recommended Improvements

The proposed capacity improvements for Alternative 1 are shown graphically on Figure 9, which include new wells and new transmission grid mains. The hydraulic model indicates no capacity (pipeline upsize) or additional fire flow improvements are required. The recommended improvements are documented as follows:

- Install 14.7 miles of new 16-inch transmission grid mains.
- Install 8 new wells, each with a firm capacity of 2,125 gpm.

5.5 Alternative 2 – Community Plan

This section documents the hydraulic analysis results and improvements needed to meet Alternative 2 water demands. New service pipelines, groundwater wells, and capacity pipeline improvements were recommended to mitigate deficiencies observed under peak hour and maximum day plus fire flow conditions.

5.5.1 Peak Hour Pressures

PHD scenario indicates pressures ranging from 51 psi to 70 psi within the SCSP boundary. The peak hour pressures during the PHD scenario are shown graphically on Figure 10.

5.5.2 Maximum Day Demand Plus Fire Flow

The MDD scenario was used to estimate maximum available fire flows while maintaining pipeline and service pressure criteria. The Alternative 2 water demands did not cause additional fire flow deficiencies. The results of this analysis are documented on Figure 11.

5.5.3 Recommended Improvements

The proposed capacity improvements for Alternative 2 are shown graphically on Figure 12, which include new wells, new transmission grid mains, and capacity improvements to existing infrastructure. The hydraulic model indicates no additional fire flow improvements are required. The capacity improvements are documented as follows:

- Install 14.7 miles of new 16-inch transmission grid mains.
- Install 4 new wells, each with a firm capacity of 2,125 gpm.
- Capacity Improvement: Replace approximately 1,700-feet of existing 14-inch pipeline with a new 16-inch pipeline on North Avenue between Cedar Avenue and Parkway Drive. This improvement is intended to mitigate a head loss deficiency identified in the analysis.

5.6 Alternative 3 – Business Plan

This section documents the hydraulic analysis results and improvements needed to meet Alternative 3 water demands. New service pipelines and groundwater well improvements were recommended to mitigate deficiencies observed under peak hour and maximum day plus fire flow conditions.

5.6.1 Peak Hour Pressures

The PHD scenario indicates pressures ranging from 48 psi to 68 psi within the SCSP boundary. The peak hour pressures during the PHD scenario are shown graphically on **Figure 13**.

5.6.2 Maximum Day Demand Plus Fire Flow

The MDD scenario was used to estimate maximum available fire flows while maintaining pipeline and service pressure criteria. The Alternative 3 water demands did not cause additional fire flow deficiencies. The results of this analysis are documented on **Figure 14**.

5.6.3 Recommended Improvements

The proposed capacity improvements for Alternative 3 are shown graphically on **Figure 15**, which include new wells and new transmission grid mains. The hydraulic model indicates no additional fire flow improvements are required. The capacity improvements are documented as follows:

- Install 14.7 miles of new 16-inch transmission grid mains.
- Install 8 new wells, each with a firm capacity of 2,125 gpm.

6.0 Sewer Collection System Evaluation and Recommendations.

This section documents the sewer system evaluation and recommended capacity improvements to mitigate deficiencies and service future growth. The City's existing hydraulic model was used to determine the capacity adequacy of the sewer pipelines and lift stations under peak dry weather and peak wet weather flows. The hydraulic model updates and results are presented in the following sections.

6.1 Hydraulic Modeling Updates

The hydraulic model was updated to include recently constructed sewer manhole structures and 11,600 feet of gravity mains located with the SCSP boundary. The City of Fresno's iView platform was used to extract physical model parameters such as manhole connectivity, pipe length, invert elevations, and ground elevations.

6.2 Existing System Review

The existing sewer system was analyzed during PDWF conditions to determine if any existing pipelines were deficient under existing flow conditions. Additionally, the hydraulic model was also

analyzed during PWWF conditions to determine if any existing lift stations were deficient under current conditions.

The PDWF hydraulic modeling results for the existing system are displayed on **Figure 16**. This figure provides a plan view of the study area with color-coded maximum pipeline d/D ratios for each pipe. According to the results, there are approximately 3 pipes within the SCSP boundary that exceed the maximum allowable d/D ratio of 0.90. Generally, PDWF results are acceptable and indicate the study area has sufficient capacity to service existing users. The PWWF hydraulic modeling results indicated the lift station within the SCSP boundary also has adequate capacity to meet the City's design criteria.

6.3 Alternative 0 – Adopted Plan

This section documents the hydraulic analysis results and improvements needed to accommodate Alternative 0 flows. Existing gravity main and lift station improvements were recommended to mitigate deficiencies observed under the PDWF and PWWF conditions, respectively.

6.3.1 Gravity Mains

The PDWF scenario was used to evaluate pipeline capacity for Alternative 0 flows. Pipelines exceeding a d/D value of 0.9 were identified as deficient and are shown graphically on **Figure 17**. The hydraulic evaluation predicted the following deficiencies:

- 12-inch Gravity Main along Cherry Avenue, downstream of Lift Station (LS)-20.
- 18-inch Gravity Main along Central Avenue, between Orange Avenue and Cedar Avenue.
- 10-inch Gravity Main along Central Avenue, adjacent to Cedar Avenue.
- 10-inch Gravity Main along Jensen Avenue, between Chestnut Avenue and Willow Avenue.

6.3.2 Lift Station

The PWWF scenario was used to evaluate LS-20 capacity for Alternative 0 flows. The hydraulic evaluation predicted the following deficiency:

- Existing LS-20 firm capacity of 1.0 mgd is below the required firm capacity of **7.2** mgd.

6.3.3 Recommended Improvements

The proposed capacity improvements for the Alternative 0 are shown graphically on **Figure 18**, which include existing gravity main replacements and lift station capacity improvements. The recommended improvements are documented as follows:

- P-1 diameter increased from 12-inches to 30-inches to mitigate d/D deficiencies.
- P-2 diameter increased from 18-inches to 24-inches to mitigate d/D deficiencies.
- P-3 diameter increased from 10-inches to 18-inches to mitigate d/D deficiencies.

- P-4 diameter increased from 10-inches to 15-inches to mitigate d/D deficiencies.
- LS-20 capacity increased to **7.2 mgd** to handle increased sewer flows.

6.4 Alternative 1 – Blended Plan

This section documents the hydraulic analysis results and improvements needed to accommodate Alternative 1 flows. Existing gravity main and lift station improvements were recommended to mitigate deficiencies observed under the PDWF and PWWF conditions, respectively.

6.4.1 Gravity Mains

The PDWF scenario was used to evaluate pipelines conditions for Alternative 1 flows. Pipelines exceeding a d/D value of 0.9 were identified as deficient and are shown graphically on **Figure 19**. The hydraulic evaluation predicted the following deficiencies:

- 12-inch Gravity Main along Cherry Avenue, downstream of LS-20.
- 10-inch Gravity Main along Central Avenue, adjacent to Cedar Avenue.
- 10-inch Gravity Main along Jensen Avenue, between Chestnut Avenue and Willow Avenue.

6.4.2 Lift Station

The PWWF scenario was used to evaluate LS-20 capacity for Alternative 1 flows. The hydraulic evaluation predicted the following deficiency:

- Existing LS-20 firm capacity of 1.0 mgd is below the required firm capacity of **5.4** mgd.

6.4.3 Recommended improvements

The proposed capacity improvements for Alternative 1 are shown graphically on **Figure 20**, which include existing gravity main replacements and lift station capacity improvements. The recommended improvements are documented as follows:

- P-1 diameter increased from 12-inches to 24-inches to mitigate d/D deficiencies.
- P-2 diameter increased from 10-inches to 18-inches to mitigate d/D deficiencies.
- P-3 diameter increased from 10-inches to 15-inches to mitigate d/D deficiencies.
- LS-20 capacity increased to **5.4** mgd to handle increased sewer flows.

6.5 Alternative 2 – Community Plan

This section documents the hydraulic analysis results and improvements needed to accommodate Alternative 2 flows. Existing gravity main and lift station improvements were recommended to mitigate deficiencies observed under the PDWF and PWWF conditions, respectively.

6.5.1 Gravity Mains

The PDWF scenario was used to evaluate pipelines conditions for Alternative 2 flows. Pipelines exceeding a d/D value of 0.9 were identified as deficient and are shown graphically on **Figure 21**. The hydraulic evaluation predicted the following deficiencies:

- 12-inch Gravity Main along Cherry Avenue, downstream of LS-20.
- 10-inch Gravity Main along Central Avenue, adjacent to Cedar Avenue.
- 10-inch Gravity Main along Jensen Avenue, between Chestnut Avenue and Willow Avenue.

6.5.2 Lift Station

The PWWF scenario was used to evaluate LS-20 capacity for Alternative 2 flows. The hydraulic evaluation predicted the following deficiency:

- Existing LS-20 firm capacity of 1.0 mgd is below the required firm capacity of **4.2** mgd.

6.5.3 Recommended Improvements

The proposed capacity improvements for Alternative 2 are shown graphically on **Figure 22**, which include existing gravity main replacements and lift station capacity improvements. The recommended improvements are documented as follows:

- P-1 diameter increased from 12-inches to 24-inches to mitigate d/D deficiencies.
- P-2 diameter increased from 10-inches to 18-inches to mitigate d/D deficiencies.
- P-3 diameter increased from 10-inches to 12-inches to mitigate d/D deficiencies.
- LS-20 capacity increased to **4.2** mgd to handle increased sewer flows.

6.6 Alternative 3 – Business Plan

This section documents the hydraulic analysis results and improvements needed to accommodate Alternative 3 flows. Existing gravity main and lift station improvements were recommended to mitigate deficiencies observed under the PDWF and PWWF conditions, respectively.

6.6.1 Gravity Mains

The PDWF scenario was used to evaluate pipelines conditions for Alternative 3 flows. Pipelines exceeding a d/D value of 0.9 were identified as deficient and are shown graphically on **Figure 23**. The hydraulic evaluation predicted the following deficiencies:

- 12-inch Gravity Main along Cherry Avenue, downstream of LS-20.
- 10-inch Gravity Main along Central Avenue, adjacent to Cedar Avenue.
- 10-inch Gravity Main along Jensen Avenue, between Chestnut Avenue and Willow Avenue.

6.6.2 Lift Station

The PWWF scenario was used to evaluate LS-20 capacity for Alternative 3 flows. The hydraulic evaluation predicted the following deficiency:

- Existing LS-20 firm capacity of 1.0 mgd is below the required firm capacity of **5.9** mgd.

6.6.3 Recommended Improvements

The proposed capacity improvements for Alternative 3 are shown graphically on **Figure 24**, which include existing gravity main replacements and lift station capacity improvements. The recommended improvements are documented as follows:

- P-1 diameter increased from 12-inches to 24-inches to mitigate d/D deficiencies.
- P-2 diameter increased from 10-inches to 18-inches to mitigate d/D deficiencies.
- P-3 diameter increased from 10-inches to 15-inches to mitigate d/D deficiencies.
- LS-20 capacity increased to **5.9** mgd to handle increased sewer flows.

6.7 Preliminary Sewer Routing

A small portion of the SCSP boundary extends beyond the City's current service area and therefore requires extension of the existing wastewater collection system. Preliminary sewer routing alignments were analyzed separately as they are applicable to each alternative with minimal differences in tributary catchments flows.

The preliminary sewer routing alignments are illustrated on **Figure 25** with a total proposed length of approximately 7.3 miles along the right-of-way. The proposed sizing recommendations should be investigated during subsequent design phases of the SCSP development as they may change contingent on geotechnical investigations, potential cross-utility conflicts, and site-specific conditions. This analysis was conducted using elevation information obtained from Google Earth and assumed typical cover of 5 to 10 feet.

7.0 SUMMARY AND CONCLUSIONS

The projected buildout of each SCSP land use alternative will introduce increased water demands and sewer flows to the City's existing utilities. The hydraulic model results indicate that the water distribution system will require additional supply and pipelines to handle the increased water demands, and the sewer collection system will require capacity improvements to both the impacted pipelines and LS-20 to handle the increased sewer flows. Additionally, the sewer system will also require new pipelines to extend service to SCSP areas located beyond the City's current service area.

The recommended improvements for each alternative are document on **Table 7** and summarized as follows:

Alternative 0 – Adopted Plan:

Water System Infrastructure	Sewer System Infrastructure
14.7 miles transmission grid mains	1.4 miles of upsized gravity mains
1.9 miles of capacity improvements	7.2 mgd LS capacity upgrade
8 number of wells at 2,125 gpm	7.3 miles of new gravity mains
1.1 miles of fire flow improvements	

Alternative 1 – Blended Plan:

Water System Infrastructure	Sewer System Infrastructure
14.7 miles transmission grid mains	0.9 miles of upsized gravity mains
8 number of wells at 2,125 gpm	5.4 mgd LS capacity upgrade
	7.3 miles of new gravity mains

Alternative 2 – Community Plan:

Water System Infrastructure	Sewer System Infrastructure
14.7 miles transmission grid mains	0.9 miles of upsized gravity mains
0.3 miles of capacity improvements	4.2 mgd LS capacity upgrade
4 number of wells at 2,125 gpm	7.3 miles of new gravity mains

Alternative 3 – Business Plan:

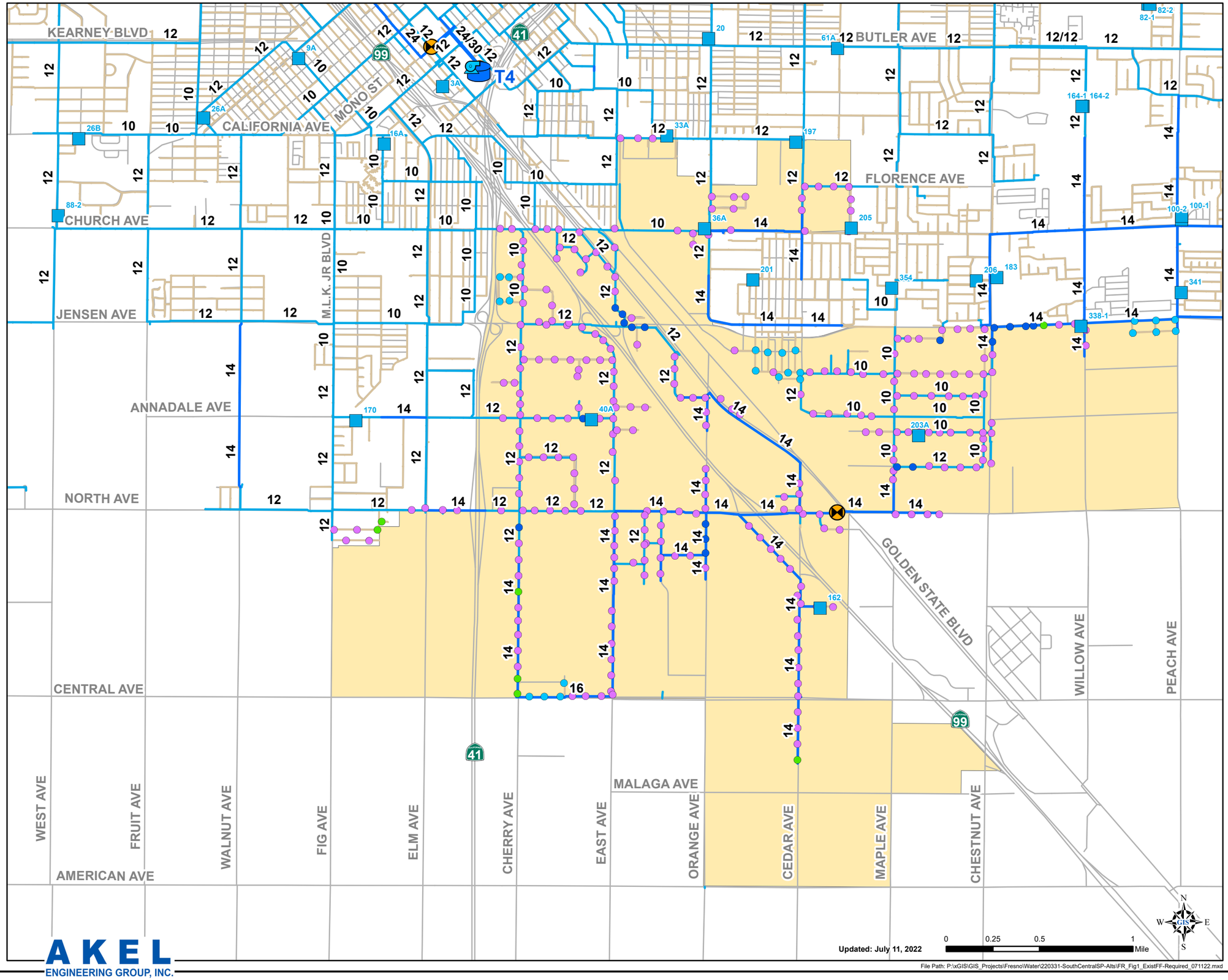
Water System Infrastructure	Sewer System Infrastructure
14.7 miles transmission grid mains	0.9 miles of upsized gravity mains
8 number of wells at 2,125 gpm	5.9 mgd LS capacity upgrade
	7.3 miles of new gravity mains

Sincerely,

AKEL ENGINEERING GROUP, INC.

Tony Akel, P.E., D. WRE
Senior Principal

FIGURES



Legend

Existing Fire Hydrant Minimum Fire Flow Requirements

- 2,000 gpm for 2 Hours
- 3,000 gpm for 3 Hours
- 3,500 gpm for 4 Hours
- 4,500 gpm for 4 Hours

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8" or Smaller
- 10" - 12"
- 14" and Larger

Other

- South Central Specific Plan
- Streets

PRELIMINARY

Figure 1
Existing Fire Flow Requirement

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

KEARNEY BLVD
CALIFORNIA AVE
CHURCH AVE
JENSEN AVE
ANNADALE AVE
NORTH AVE
CENTRAL AVE
AMERICAN AVE
MONO ST
M.L.K. JR BLVD
BUTLER AVE
FLORENCE AVE
GOLDEN STATE BLVD
WILLOW AVE
PEACH AVE
MALAGA AVE
WEST AVE
FRUIT AVE
WALNUT AVE
FIG AVE
ELM AVE
CHERRY AVE
EAST AVE
ORANGE AVE
CEDAR AVE
MAPLE AVE
CHESTNUT AVE
T4

Legend

Existing Fire Hydrant Available Fire Flow

- < 2,000 gpm
- 2,000 - 3,500 gpm
- 3,500 - 4,500 gpm
- > 4,500 gpm

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8" or Smaller
- 10" - 12"
- 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation results shown reflect Maximum Day Demand + Fire Flow conditions.
2. Available fire flow based on minimum pressure of 20 psi or maximum velocity of 10 ft/s.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

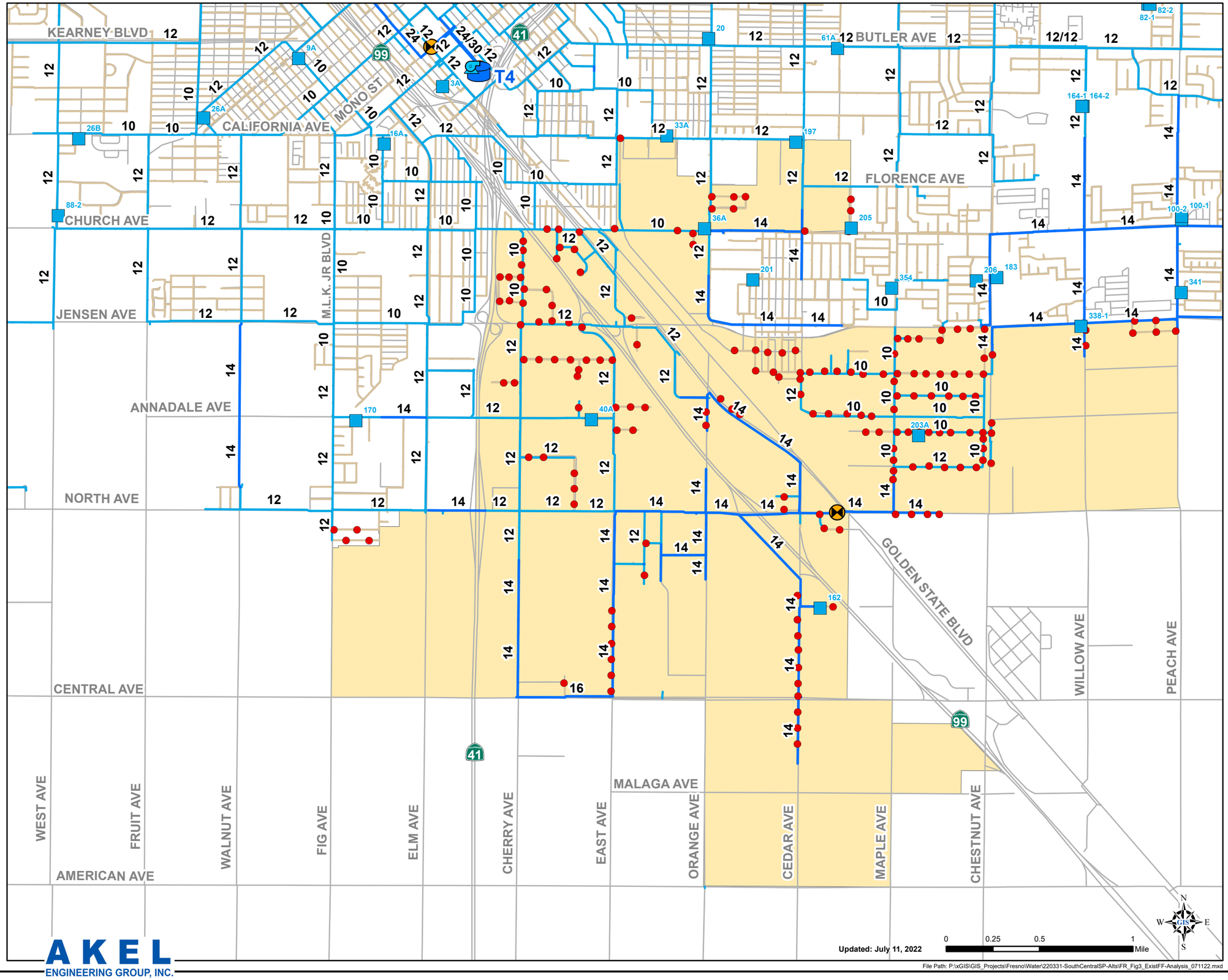
File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig2_ExistAvailFF_071122.mxd

Figure 2
Existing System Available Fire Flow

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.



Legend

Deficient Existing Fire Hydrants

- Residual Pressure <20 psi

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 — 8" or Smaller
- 10 — 10" - 12"
- 14 — 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation results shown reflect Maximum Day Demand + Fire Flow conditions.

PRELIMINARY

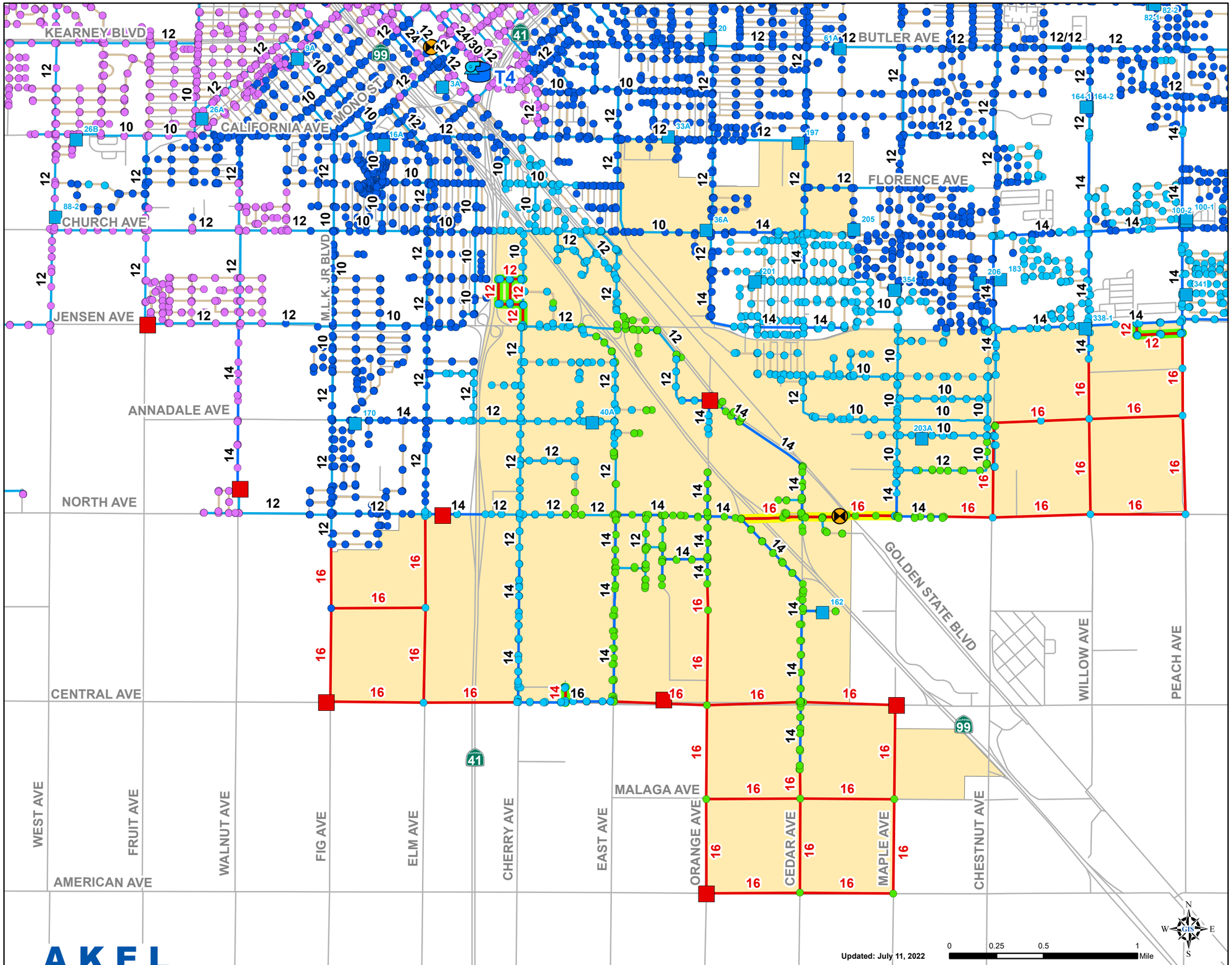
Figure 3
Existing System Fire Flow Analysis

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig3_ExistFF-Analysis_071122.mxd



Legend

Peak Hour Pressures

Service Connections and Junctions

- 40 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- 70 - 79 psi

Future Water System

- Wells
- 16 New Pipeline
- Capacity Improvement
- Fire Flow Improvement

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Peak Hours Pressures reflect Peak Hour Demand conditions.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig4_Alt1-PeakHrPressures_071122.mxd

Figure 4
Alternative 0: Adopted Peak Hour Pressures

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

KEARNEY BLVD
CALIFORNIA AVE
MONO ST
BUTLER AVE
FLORENCE AVE
CHURCH AVE
M.L.K. JR BLVD
JENSEN AVE
ANNADALE AVE
NORTH AVE
CENTRAL AVE
MALAGA AVE
AMERICAN AVE
GOLDEN STATE BLVD
WILLOW AVE
PEACH AVE
WEST AVE
FRUIT AVE
WALNUT AVE
FIG AVE
ELM AVE
CHERRY AVE
EAST AVE
ORANGE AVE
CEDAR AVE
MAPLE AVE
CHESTNUT AVE
T4

Legend

Existing Fire Hydrant Available Fire Flow

- < 2,000 gpm
- 2,000 - 3,500 gpm
- 3,500 - 4,500 gpm
- > 4,500 gpm

Future Water System

- Wells
- 16 New Pipeline
- Capacity Improvement
- Fire Flow Improvement

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation results shown reflect Maximum Day Demand + Fire Flow conditions.
2. Available fire flow based on minimum pressure of 20 psi or maximum velocity of 10 ft/s.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

N W GIS E S

Figure 5
Alternative 0: Adopted Available Fire Flow

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

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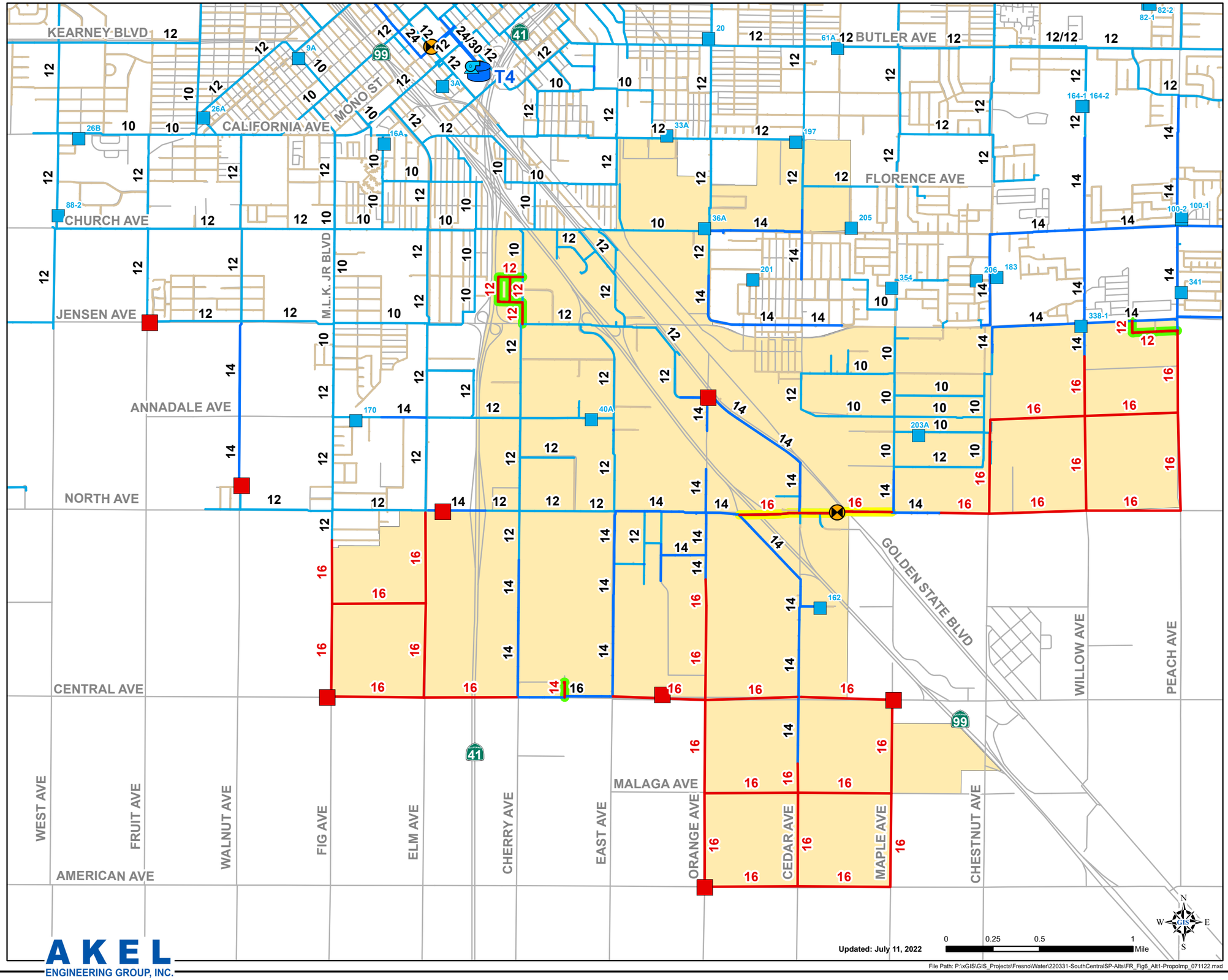


Legend

Future Water System

- Wells
- 16 — New Pipeline
- Capacity Improvement
- Fire Flow Improvement

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 — 8" or Smaller
- 10 — 10" - 12"
- 14 — 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:

1. Evaluation assumed SESWTF at maximum capacity of 80 mgd.
2. Evaluation assumed proposed wells operate with design flow of 2,125 gpm.

PRELIMINARY

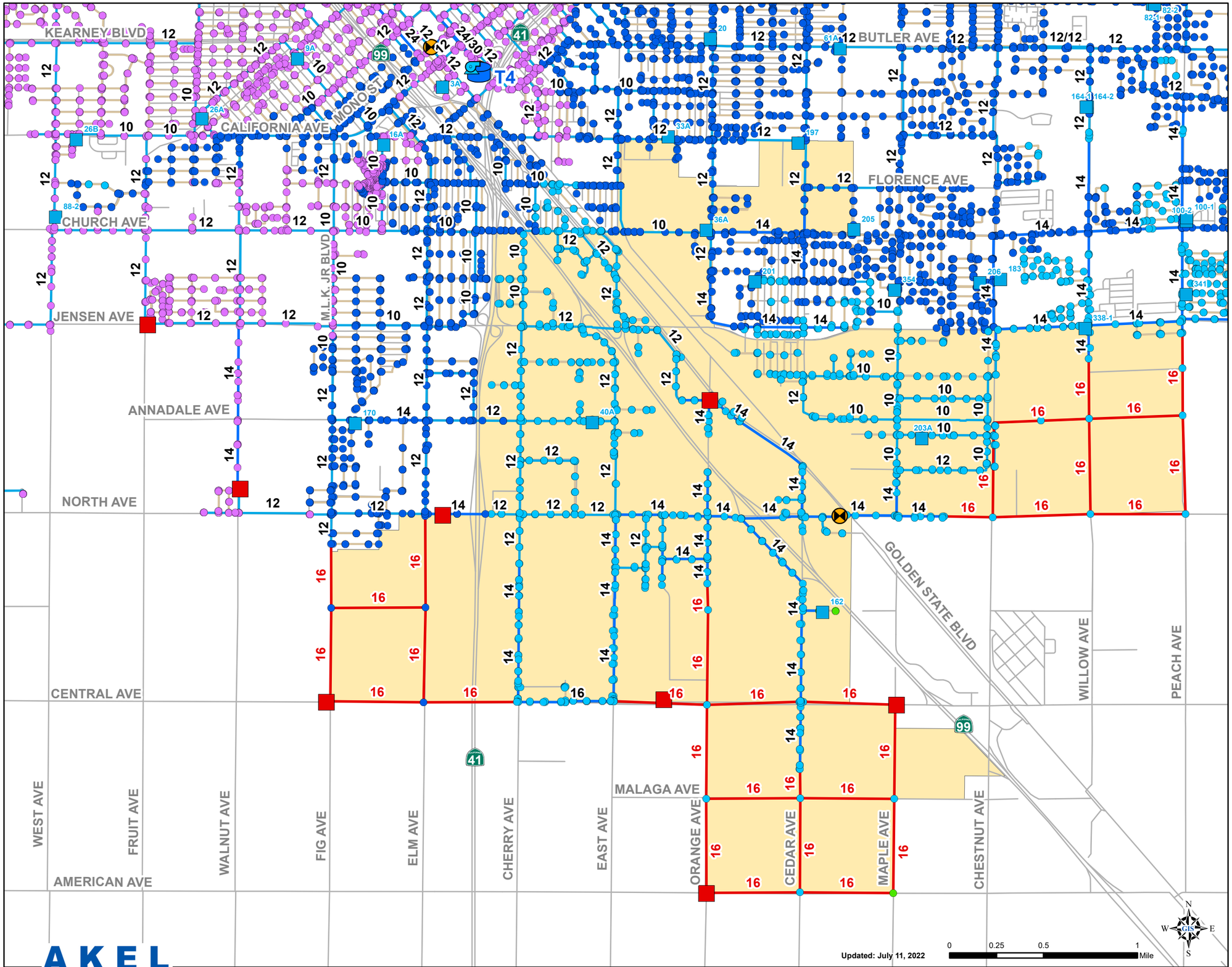
Figure 6
Alternative 0: Adopted Proposed Improvements

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig6_Alt1-Propolmp_071122.mxd



Legend

Peak Hour Pressures

Service Connections and Junctions

- 40 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- 70 - 81 psi

Future Water System

- Wells
- 16 New Pipeline

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Peak Hours Pressures reflect Peak Hour Demand conditions.

PRELIMINARY

Figure 7
Alternative 1: Blended Peak Hour Pressures

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

KEARNEY BLVD
CALIFORNIA AVE
MONO ST
BUTLER AVE
FLORENCE AVE
CHURCH AVE
M.L.K. JR BLVD
JENSEN AVE
ANNADALE AVE
NORTH AVE
CENTRAL AVE
MALAGA AVE
AMERICAN AVE
GOLDEN STATE BLVD
WILLOW AVE
PEACH AVE
WEST AVE
FRUIT AVE
WALNUT AVE
FIG AVE
ELM AVE
CHERRY AVE
EAST AVE
ORANGE AVE
CEDAR AVE
MAPLE AVE
CHESTNUT AVE
T4

Legend

Existing Fire Hydrant Available Fire Flow

- < 2,000 gpm
- 2,000 - 3,500 gpm
- 3,500 - 4,500 gpm
- > 4,500 gpm

Future Water System

- Wells
- 16 New Pipeline

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation results shown reflect Maximum Day Demand + Fire Flow conditions.
2. Available fire flow based on minimum pressure of 20 psi or maximum velocity of 10 ft/s.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

N W GIS E S

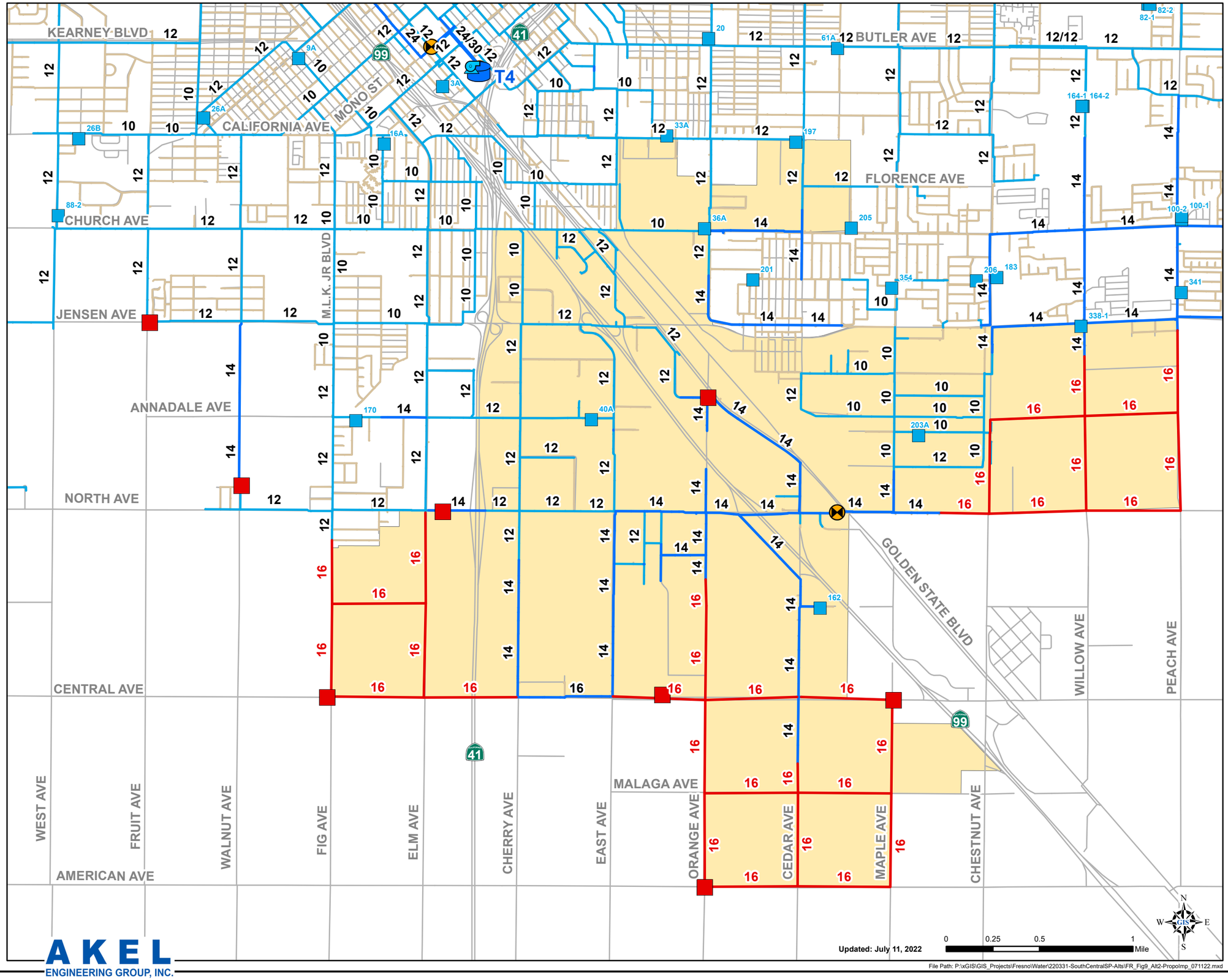
Figure 8
Alternative 1: Blended Available Fire Flow

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig8_Alt2-AvailFF_071122.mxd



Legend

Future Water System

- Wells
- 16 — New Pipeline

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 — 8" or Smaller
- 10 — 10" - 12"
- 14 — 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:

1. Evaluation assumed SESWTF at maximum capacity of 80 mgd.
2. Evaluation assumed proposed wells operate with design flow of 2,125 gpm.

PRELIMINARY

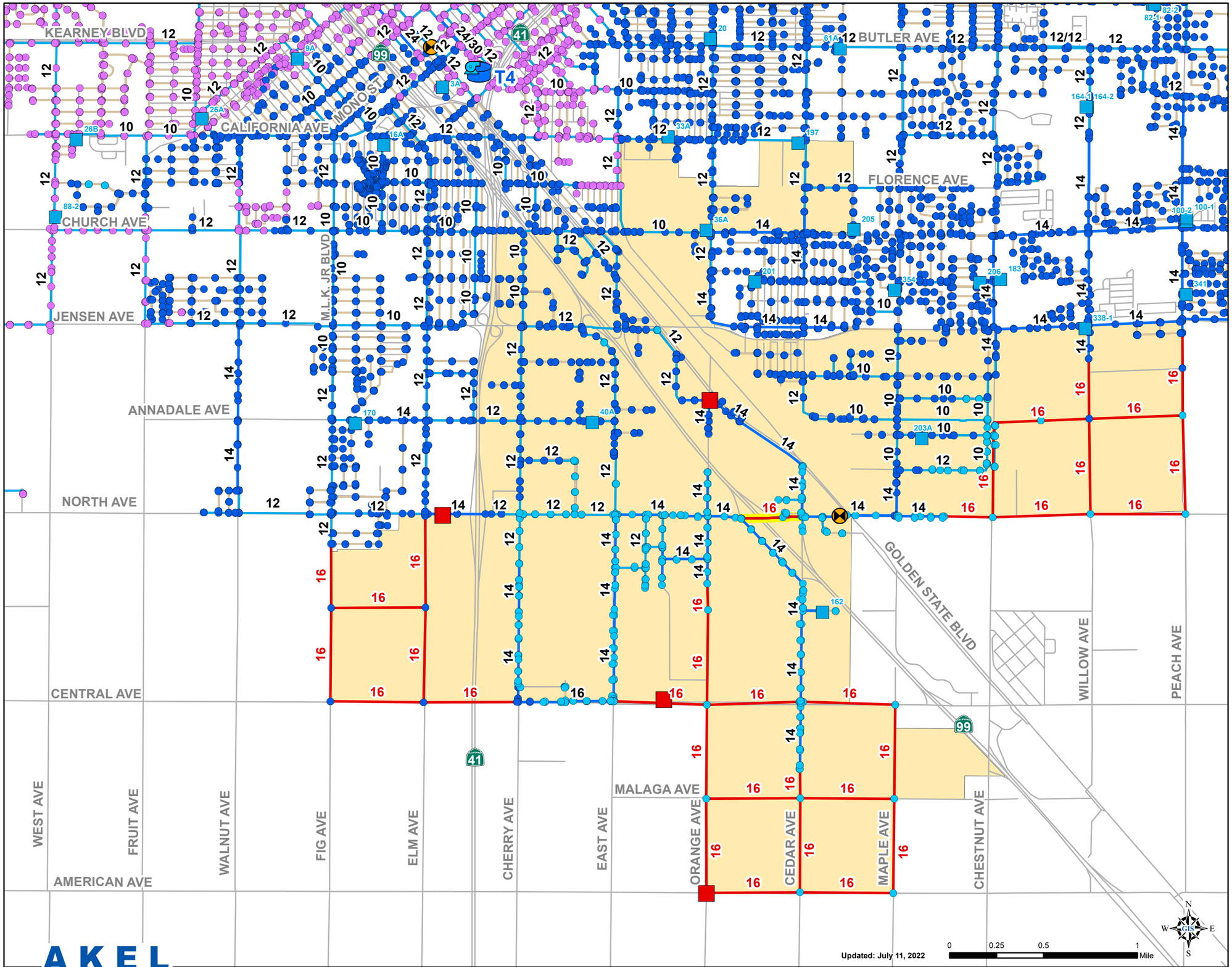
Figure 9
Alternative 1: Blended Proposed Improvements
Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

Updated: July 11, 2022

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig9_Alt2-Propolmp_071122.mxd



Legend

Peak Hour Pressures

Service Connections and Junctions

- 40 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- 70 - 79 psi

Future Water System

- Wells
- 16 New Pipeline
- Capacity Improvement

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Peak Hours Pressures reflect Peak Hour Demand conditions.

PRELIMINARY

Figure 10
Alternative 2: Community Peak Hour Pressures

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

KEARNEY BLVD
CALIFORNIA AVE
MONO ST
BUTLER AVE
FLORENCE AVE
CHURCH AVE
M.L.K. JR BLVD
JENSEN AVE
ANNADALE AVE
NORTH AVE
CENTRAL AVE
MALAGA AVE
AMERICAN AVE
GOLDEN STATE BLVD
WILLOW AVE
PEACH AVE
WEST AVE
FRUIT AVE
WALNUT AVE
FIG AVE
ELM AVE
CHERRY AVE
EAST AVE
ORANGE AVE
CEDAR AVE
MAPLE AVE
CHESTNUT AVE
T4

Legend

Existing Fire Hydrant Available Fire Flow

- < 2,000 gpm
- 2,000 - 3,500 gpm
- 3,500 - 4,500 gpm
- > 4,500 gpm

Future Water System

- Wells
- 16 New Pipeline
- Capacity Improvement

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation results shown reflect Maximum Day Demand + Fire Flow conditions.
2. Available fire flow based on minimum pressure of 20 psi or maximum velocity of 10 ft/s.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

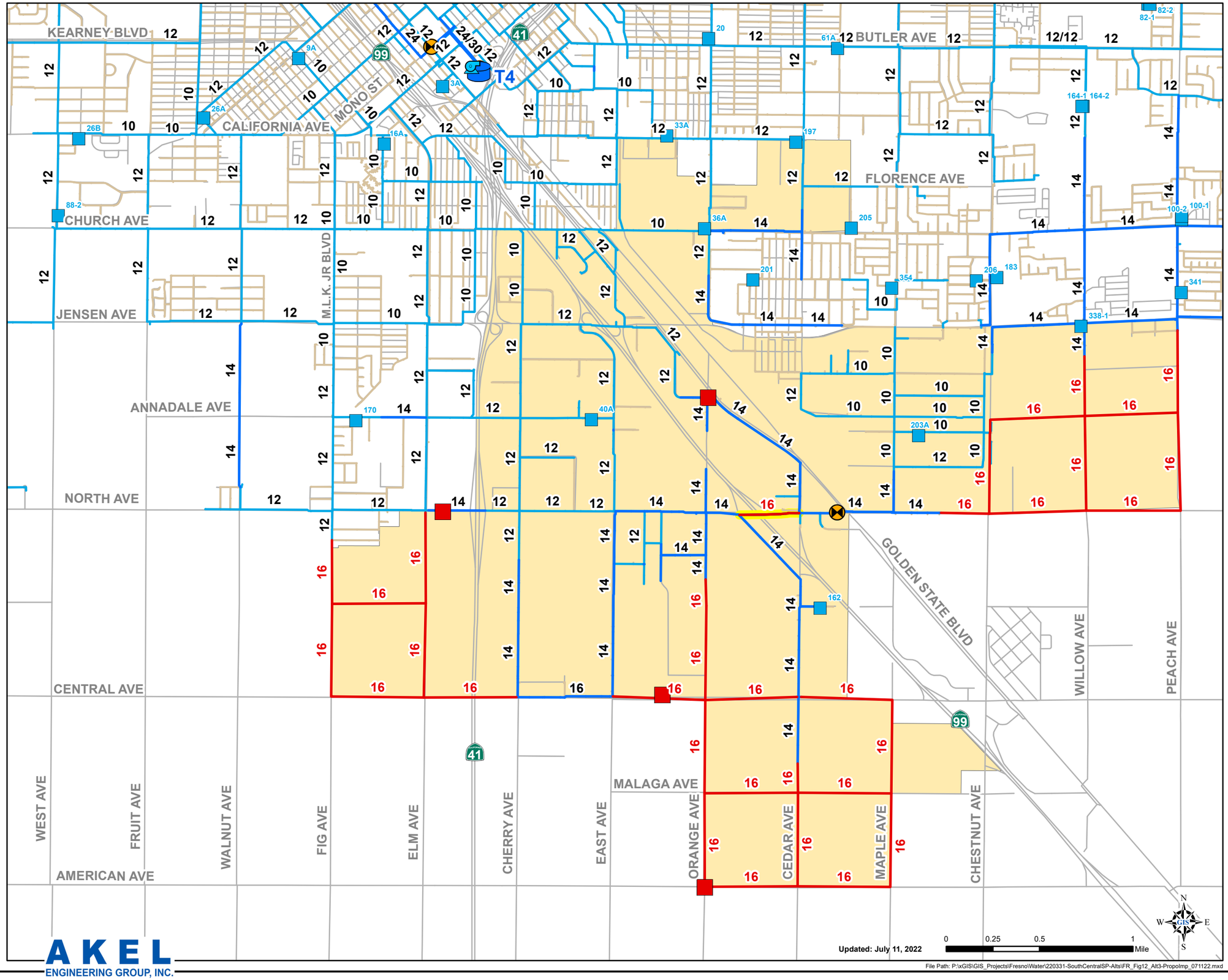
File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig11_Alt3-AvailFF_071122.mxd

Figure 11
Alternative 2: Community Available Fire Flow

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.



Legend

Future Water System

- Wells
- 16 New Pipeline
- Capacity Improvement

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:

1. Evaluation assumed SESWTF at maximum capacity of 80 mgd.
2. Evaluation assumed proposed wells operate with design flow of 2,125 gpm.

PRELIMINARY

Figure 12
Alternative 2: Community Proposed Improvements

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

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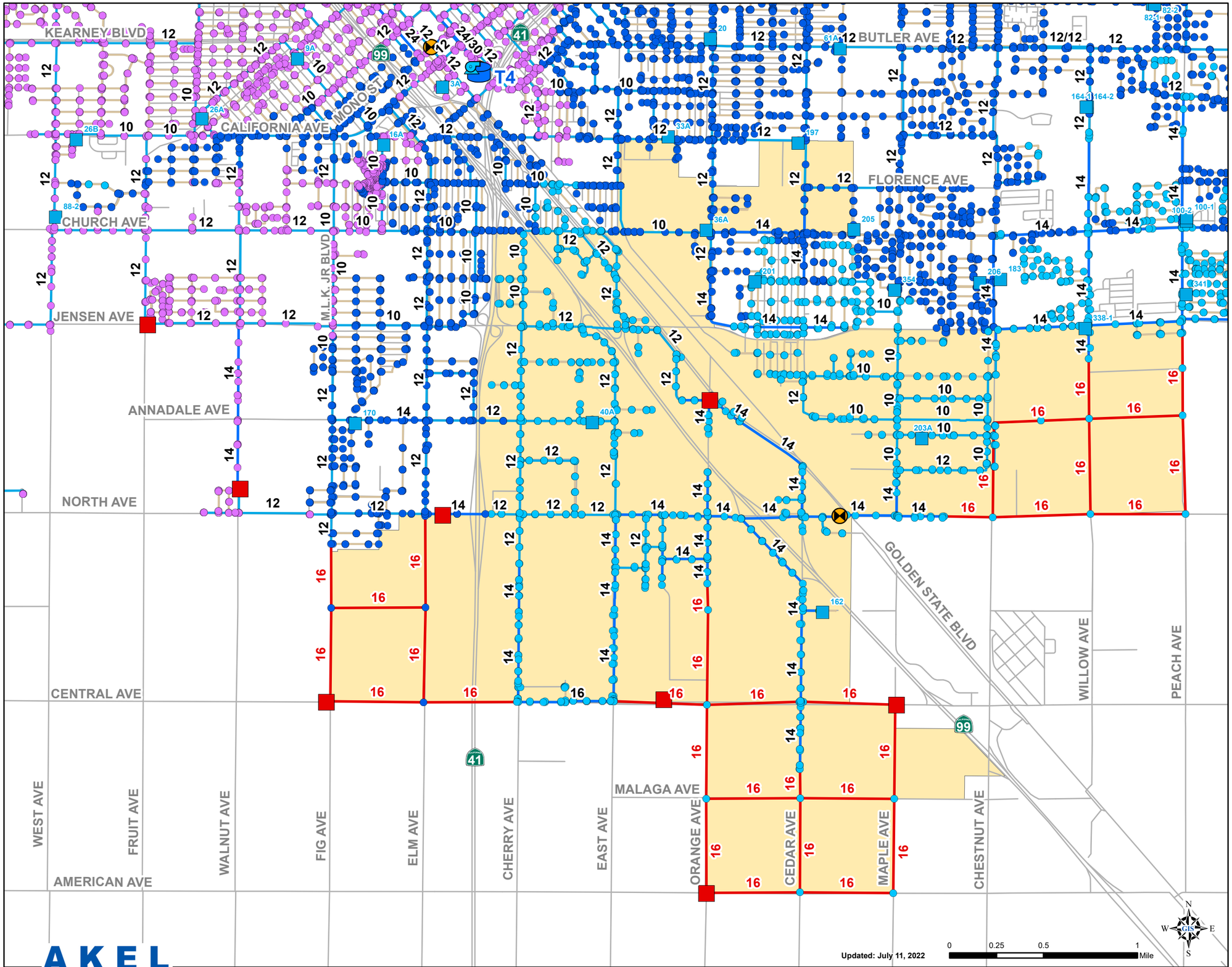


Legend

Peak Hour Pressures

Service Connections and Junctions

- 40 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- 70 - 81 psi

Future Water System

- Wells
- 16 New Pipeline

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Peak Hours Pressures reflect Peak Hour Demand conditions.

PRELIMINARY

Figure 13
Alternative 3: Business Peak Hour Pressures

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig13_Alt4-PeakHrPressures_071122.mxd

KEARNEY BLVD
CALIFORNIA AVE
MONO ST
BUTLER AVE
FLORENCE AVE
CHURCH AVE
M.L.K. JR BLVD
JENSEN AVE
ANNADALE AVE
NORTH AVE
CENTRAL AVE
AMERICAN AVE
MALAGA AVE
GOLDEN STATE BLVD
WILLOW AVE
PEACH AVE
WEST AVE
FRUIT AVE
WALNUT AVE
FIG AVE
ELM AVE
CHERRY AVE
EAST AVE
ORANGE AVE
CEDAR AVE
MAPLE AVE
CHESTNUT AVE
T4

Legend

Existing Fire Hydrant Available Fire Flow

- < 2,000 gpm
- 2,000 - 3,500 gpm
- 3,500 - 4,500 gpm
- > 4,500 gpm

Future Water System

- Wells
- 16 New Pipeline

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation results shown reflect Maximum Day Demand + Fire Flow conditions.
2. Available fire flow based on minimum pressure of 20 psi or maximum velocity of 10 ft/s.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig14_Alt4-AvailFF_071122.mxd

Figure 14
Alternative 3: Business Available Fire Flow
Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

KEARNEY BLVD
CALIFORNIA AVE
CHURCH AVE
JENSEN AVE
ANNADALE AVE
NORTH AVE
CENTRAL AVE
AMERICAN AVE
MONO ST
M.L.K. JR BLVD
BUTLER AVE
FLORENCE AVE
GOLDEN STATE BLVD
MALAGA AVE
WEST AVE
FRUIT AVE
WALNUT AVE
FIG AVE
ELM AVE
CHERRY AVE
EAST AVE
ORANGE AVE
CEDAR AVE
MAPLE AVE
CHESTNUT AVE
WILLOW AVE
PEACH AVE
T4

Legend

Future Water System

- Wells
- 16 New Pipeline

Existing Water System

- Tank
- Wells
- Booster Pumps
- PRVs

Pipes by Diameter

- 8 8" or Smaller
- 10 10" - 12"
- 14 14" and Larger

Other

- South Central Specific Plan
- Streets

Notes:
1. Evaluation assumed SESWTF at maximum capacity of 80 mgd.
2. Evaluation assumed proposed wells operate with design flow of 2,125 gpm.

PRELIMINARY

Updated: July 11, 2022

0 0.25 0.5 1 Mile

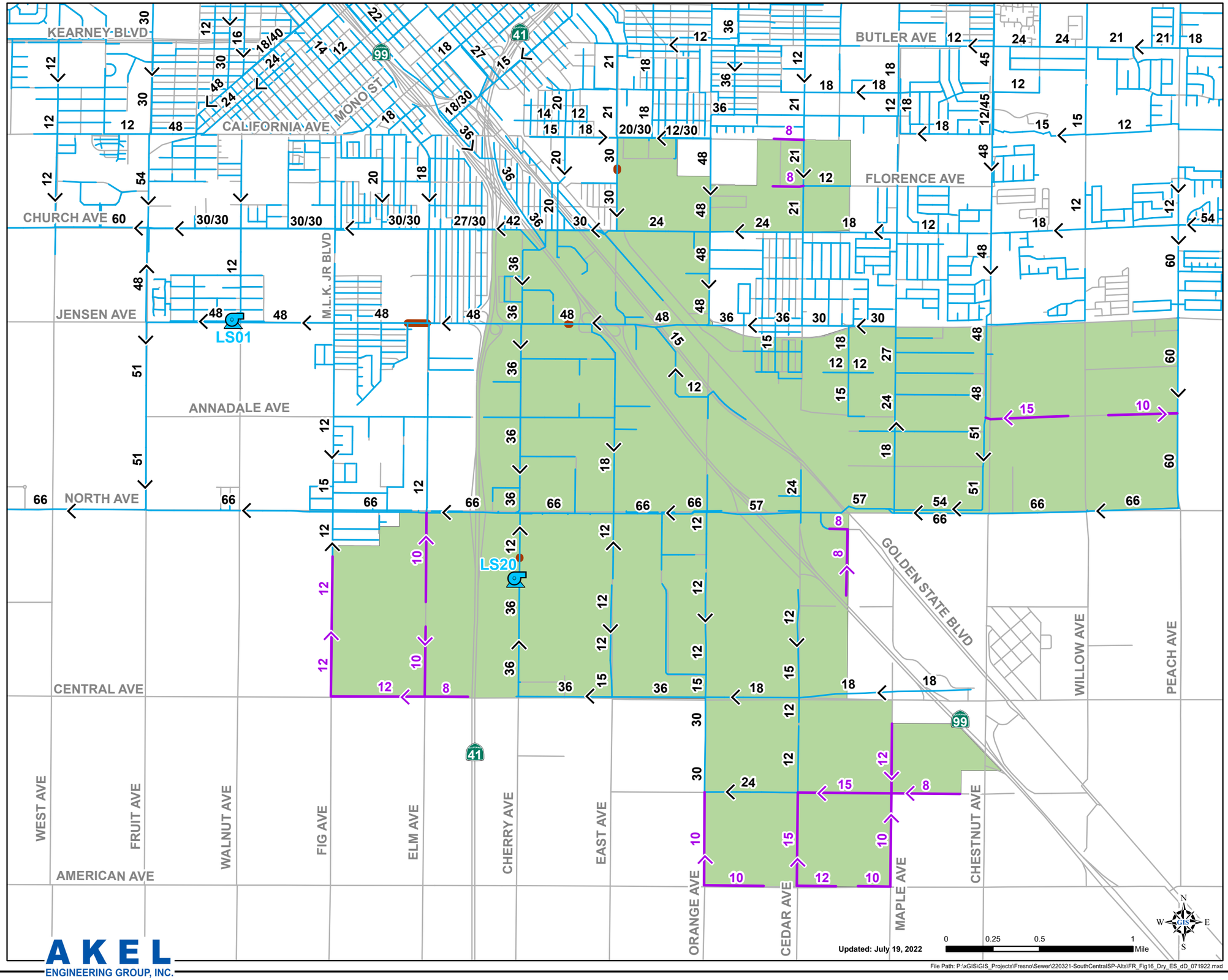
File Path: P:\xGIS\GIS_Projects\Fresno\Water\220331-SouthCentralSP-Alts\FR_Fig15_Alt4-PropoImp_071122.mxd

Figure 15
Alternative 3: Business Proposed Improvements

Water Distribution System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.



Legend

Proposed Sewer Improvements

12 Pipes for Sewer Routing

Deficient Gravity Mains

d/D > 0.90 (Count: 5)

Existing Sewer System

Lift Stations

12 Pipes

Other

South Central Specific Plan

Streets

Notes:

1. Deficient pipes include pipelines with maximum depth of flow exceeding 90 percent of pipeline diameter.

PRELIMINARY

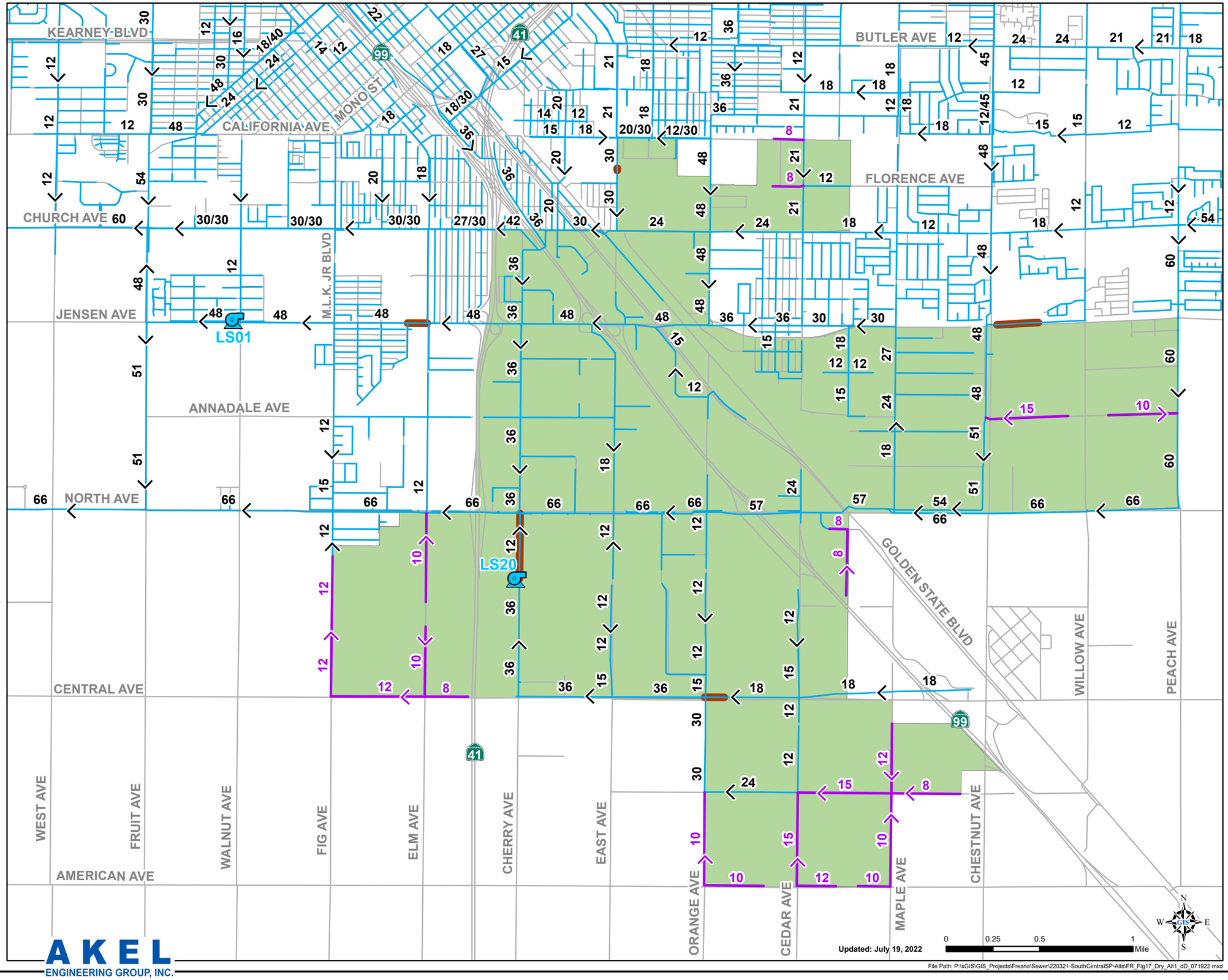
Figure 16
Existing System Analysis for PDWF

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig16_Dry_ES_dD_071922.mxd



Legend

Proposed Sewer Improvements

12 Pipes for Sewer Routing

Deficient Gravity Mains

d/D > 0.90 (Count: 13)

Existing Sewer System

Lift Stations

12 Pipes

Other

South Central Specific Plan

Streets

Notes:

1. Deficient pipes include pipelines with maximum depth of flow exceeding 90 percent of pipeline diameter.

PRELIMINARY

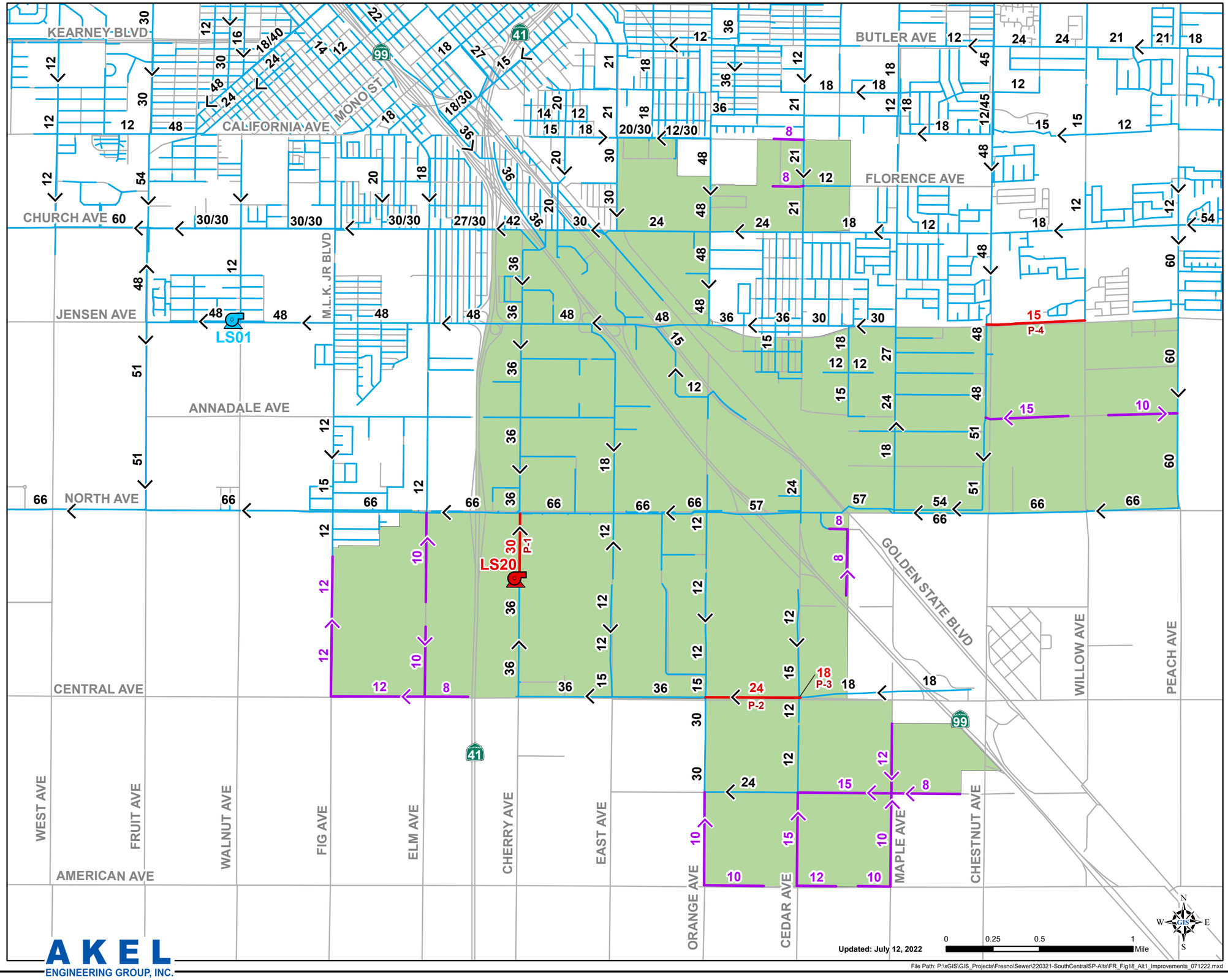
Figure 17
Alternative 0: Adopted Analysis for PDWF

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig17_Dry_Alt1_dD_071922.mxd



Legend

Proposed Sewer Improvements

- 12 — Pipes for Sewer Routing

Existing Sewer Improvements

- Lift Station
- 24 — Pipes

Existing Sewer System

- Lift Stations
- 12 — Pipes

Other

- South Central Specific Plan
- Streets

Notes:
Recommended LS-20 capacity = **7.2 mgd**

PRELIMINARY

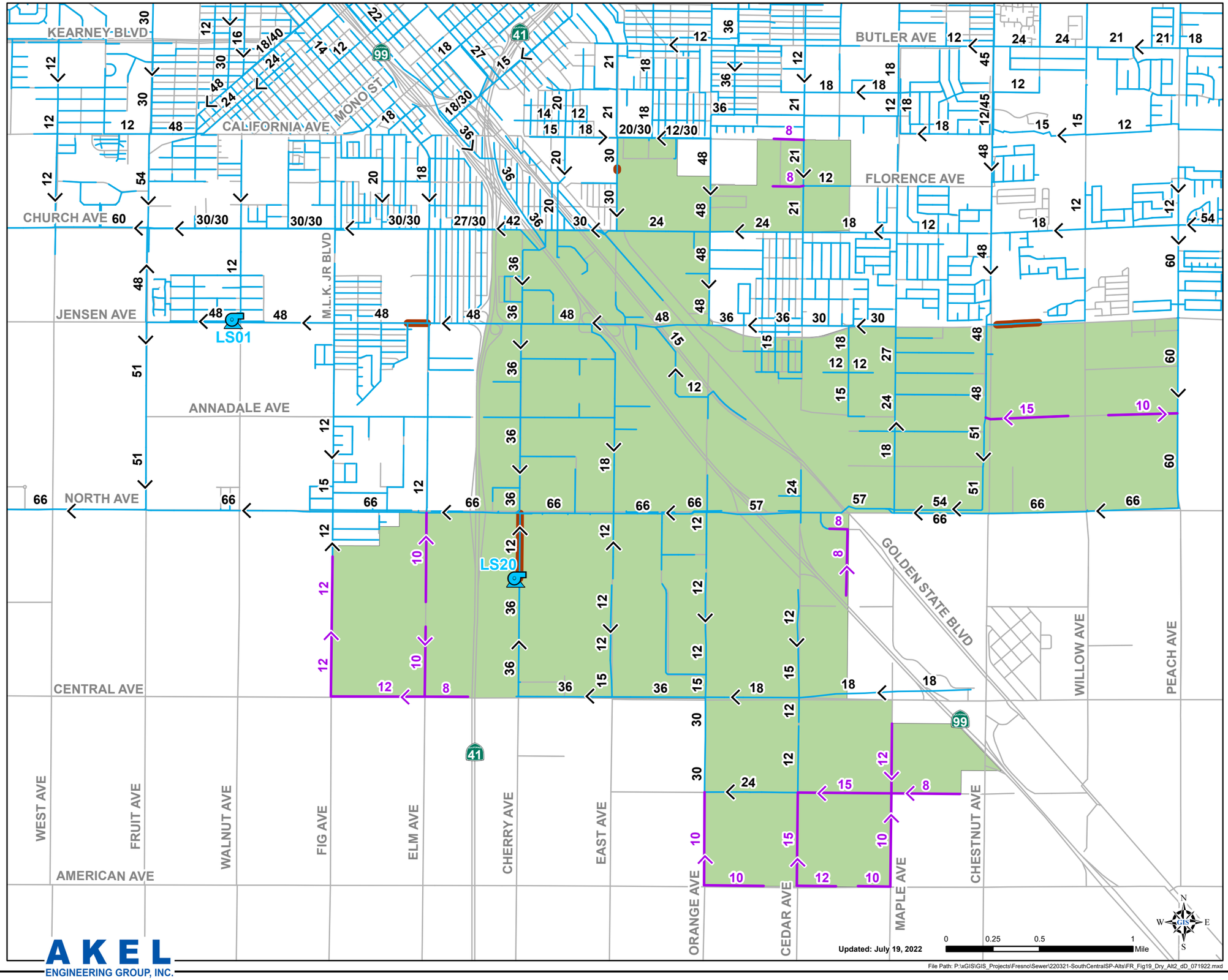
Figure 18
Alternative 0: Adopted System Improvements

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig18_Alt1_Improvements_071222.mxd



Legend

Proposed Sewer Improvements

12 Pipes for Sewer Routing

Pipe d/D

d/D > 0.90 (Count: 11)

Existing Sewer System

Lift Stations

12 Pipes

Other

South Central Specific Plan

Streets

Notes:

1. Deficient pipes include pipelines with maximum depth of flow exceeding 90 percent of pipeline diameter.

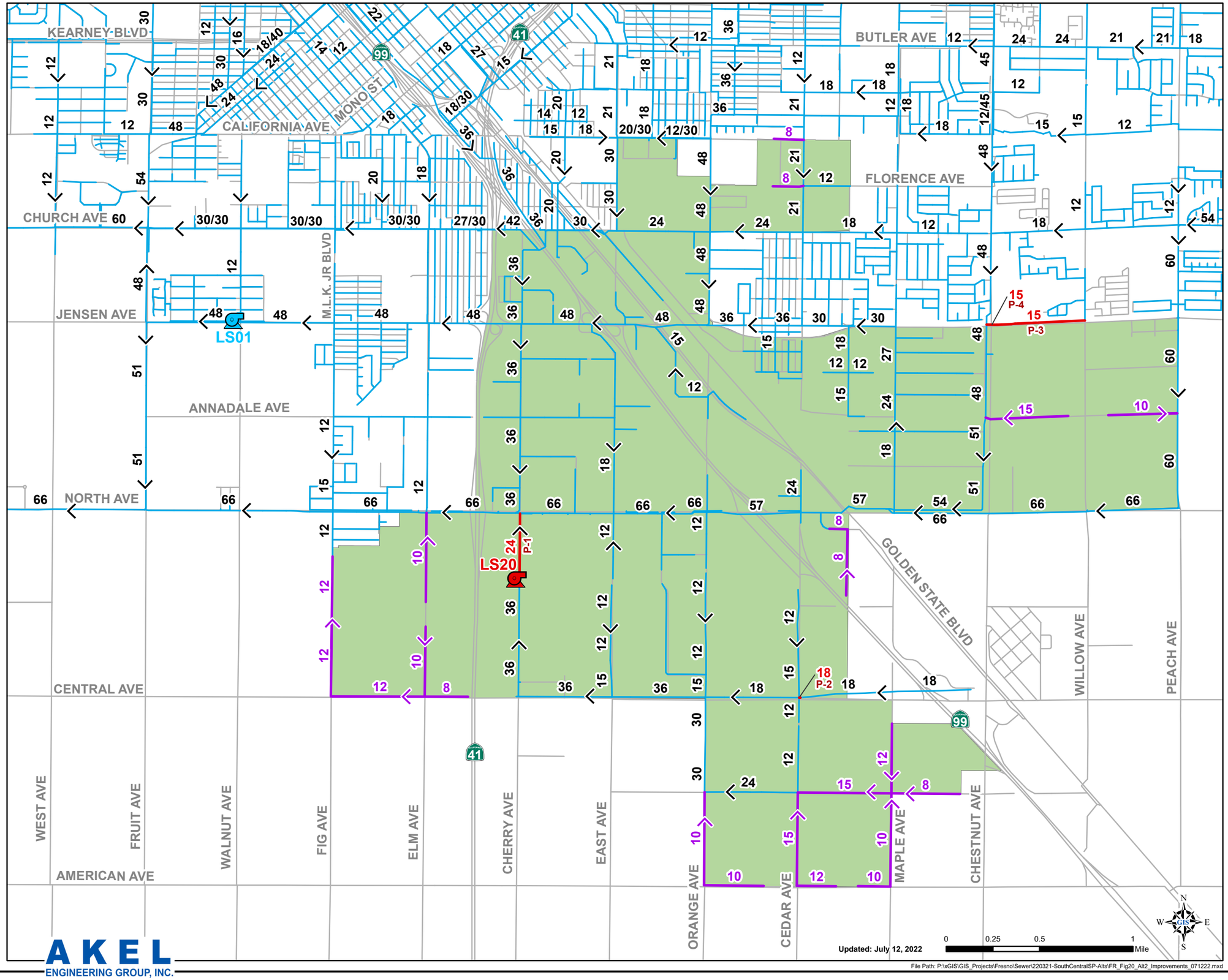
PRELIMINARY

Figure 19
Alternative 1: Blended Analysis for PDWF

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.



Legend

Proposed Sewer Improvements

- 12 — Pipes for Sewer Routing

Existing Sewer Improvements

- Lift Station
- 24 — Pipes

Existing Sewer System

- Lift Stations
- 12 — Pipes

Other

- South Central Specific Plan
- Streets

Notes:
Recommended LS-20 capacity = **5.4 mgd**

PRELIMINARY

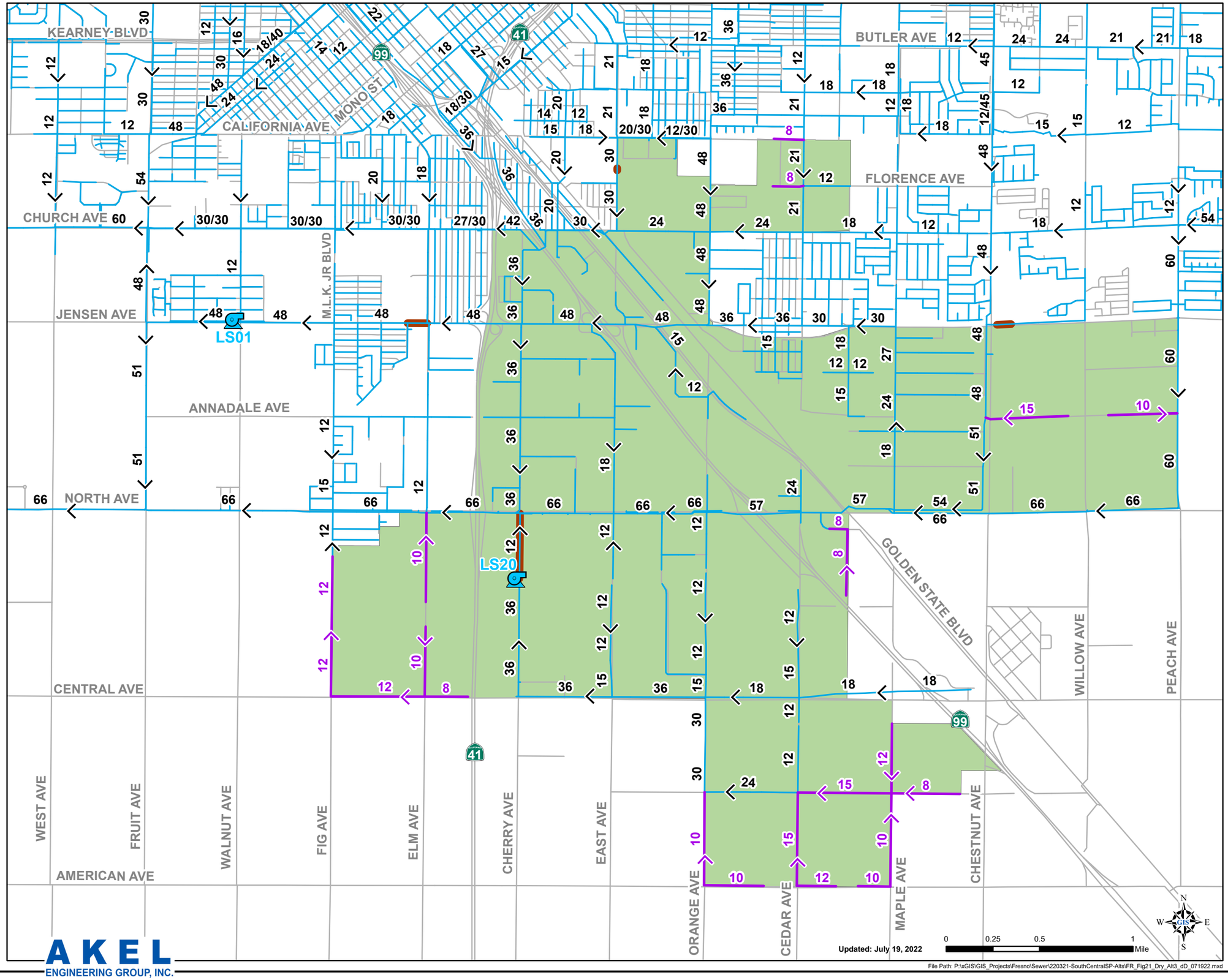
Figure 20
Alternative 1: Blended System Improvements

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig20_Alt2_Improvements_071222.mxd



Legend

Proposed Sewer Improvements

12 Pipes for Sewer Routing

Deficient Gravity Mains

d/D > 0.90 (Count: 9)

Existing Sewer System

Lift Stations

12 Pipes

Other

South Central Specific Plan

Streets

Notes:

1. Deficient pipes include pipelines with maximum depth of flow exceeding 90 percent of pipeline diameter.

PRELIMINARY

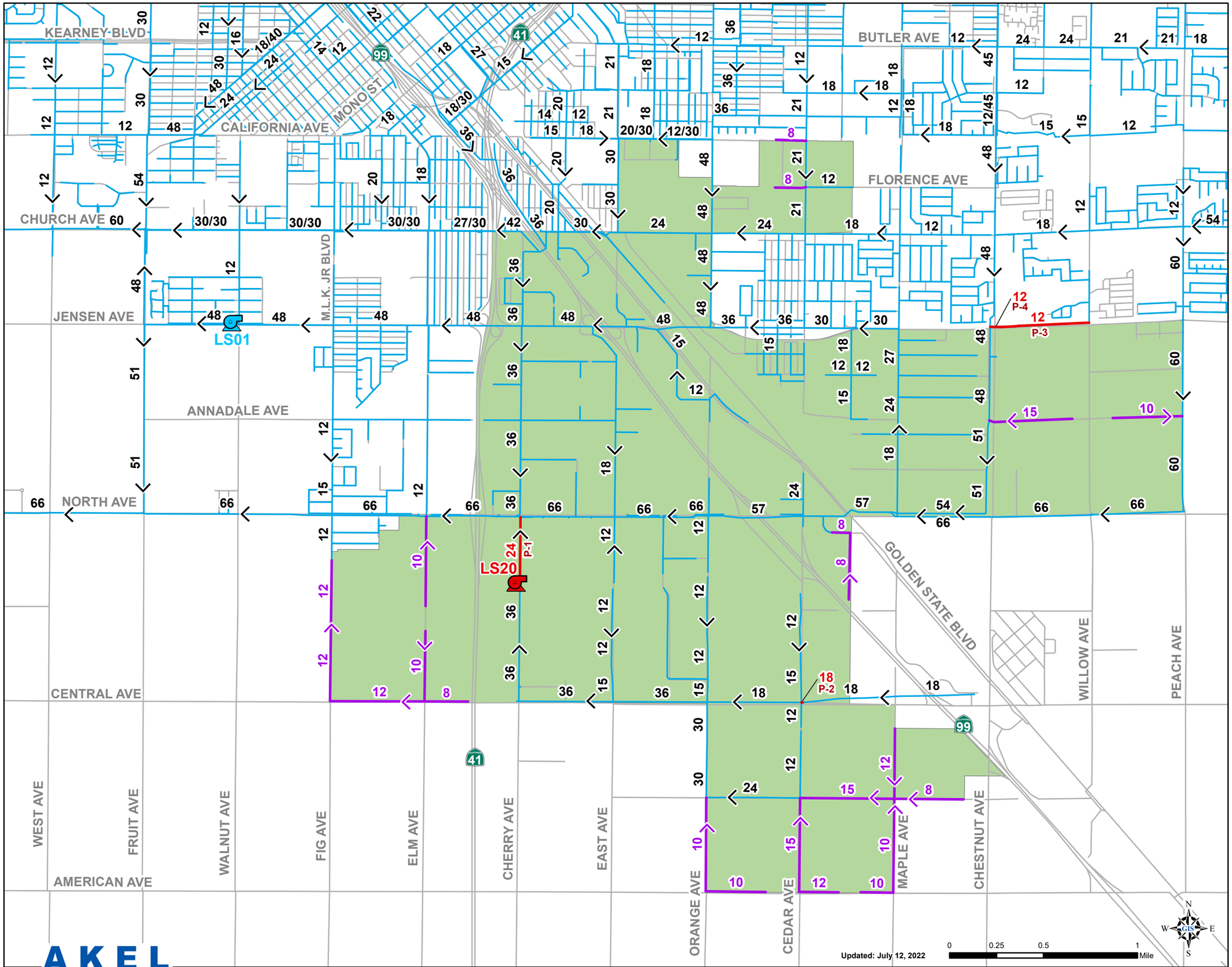
Figure 21
Alternative 2: Community Analysis for PDWF

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig21_Dry_Alt3_dD_071922.mxd



Legend

Proposed Sewer Improvements

- 12 — Pipes for Sewer Routing

Existing Sewer Improvements

- Lift Station
- 24 — Pipes

Existing Sewer System

- Lift Stations
- 12 — Pipes

Other

- South Central Specific Plan
- Streets

Notes:
Recommended LS-20 capacity = **4.2 mgd**

PRELIMINARY

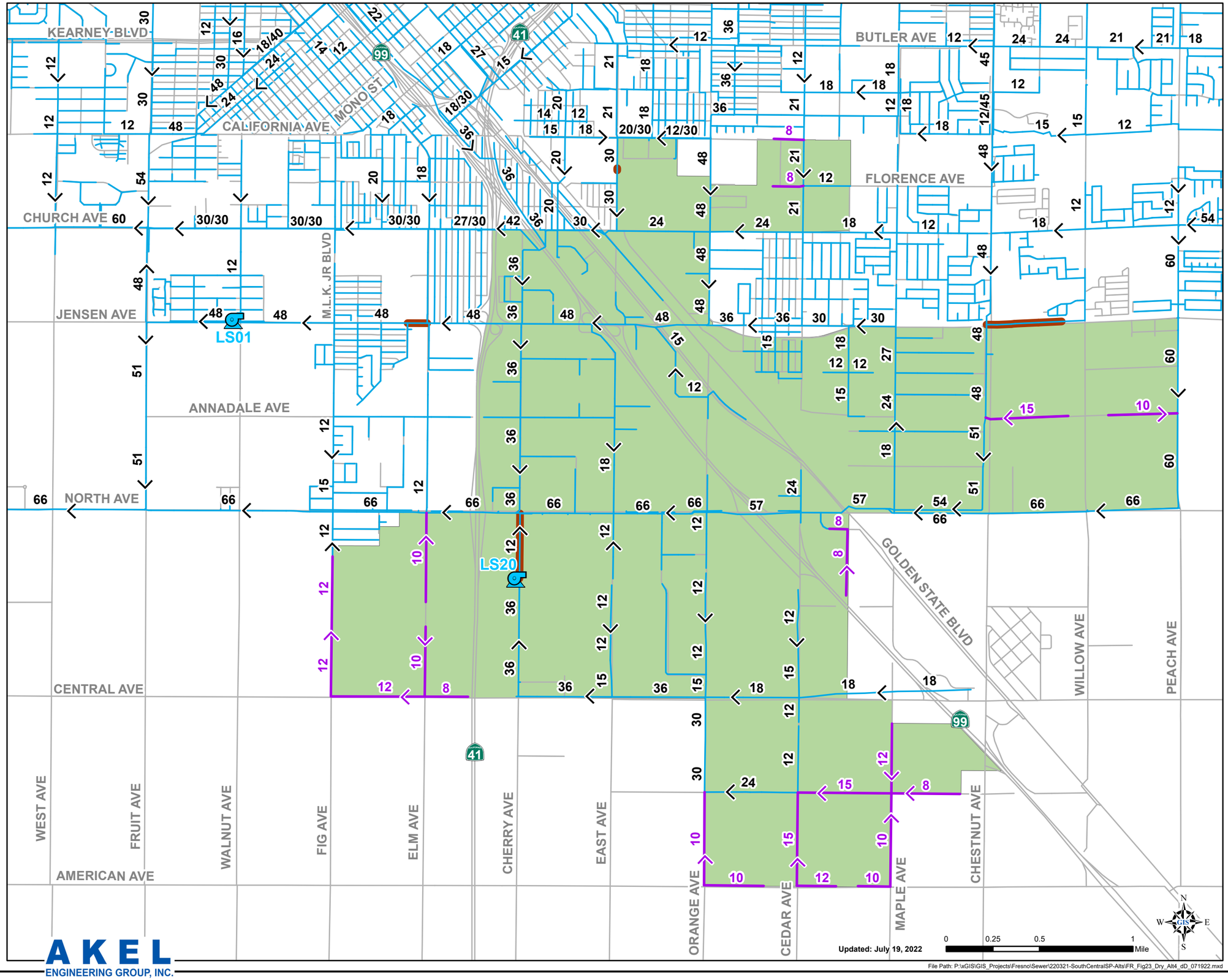
Figure 22
Alternative 2: Community System Improvements

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig22_Alt3_Improvements_071222.mxd



File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig23_Dry_Alt4_dD_071922.mxd

Legend

Proposed Sewer Improvements

12 Pipes for Sewer Routing

Deficient Gravity Mains

d/D > 0.90 (Count: 13)

Existing Sewer System

Lift Stations

12 Pipes

Other

South Central Specific Plan

Streets

Notes:

1. Deficient pipes include pipelines with maximum depth of flow exceeding 90 percent of pipeline diameter.

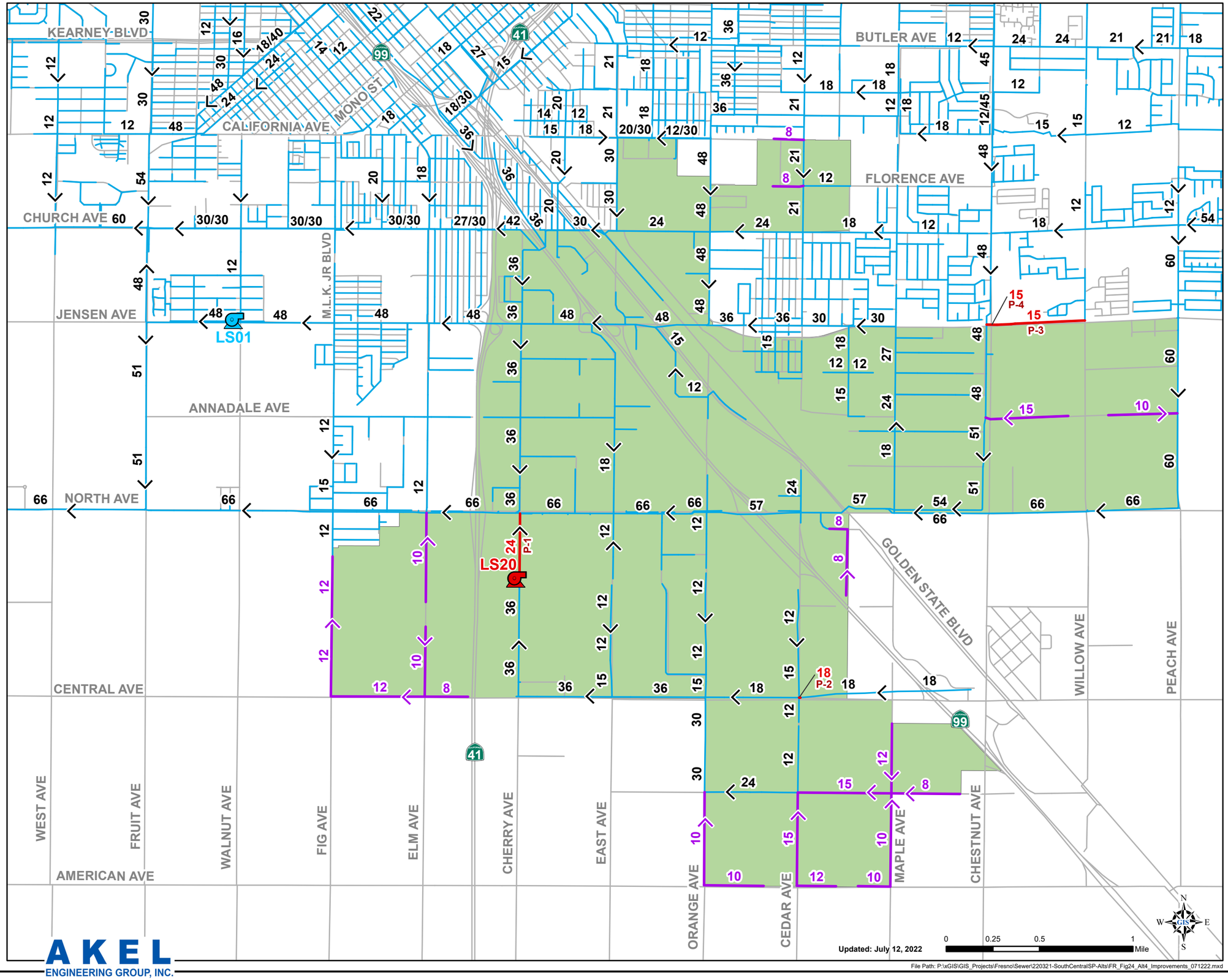
PRELIMINARY

Figure 23
Alternative 3: Business Analysis for PDWF

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.



Legend

Proposed Sewer Improvements

- 12 — Pipes for Sewer Routing

Existing Sewer Improvements

- Lift Station
- 24 — Pipes

Existing Sewer System

- Lift Stations
- 12 — Pipes

Other

- South Central Specific Plan
- Streets

Notes:
Recommended LS-20 capacity = **5.9 mgd**

PRELIMINARY

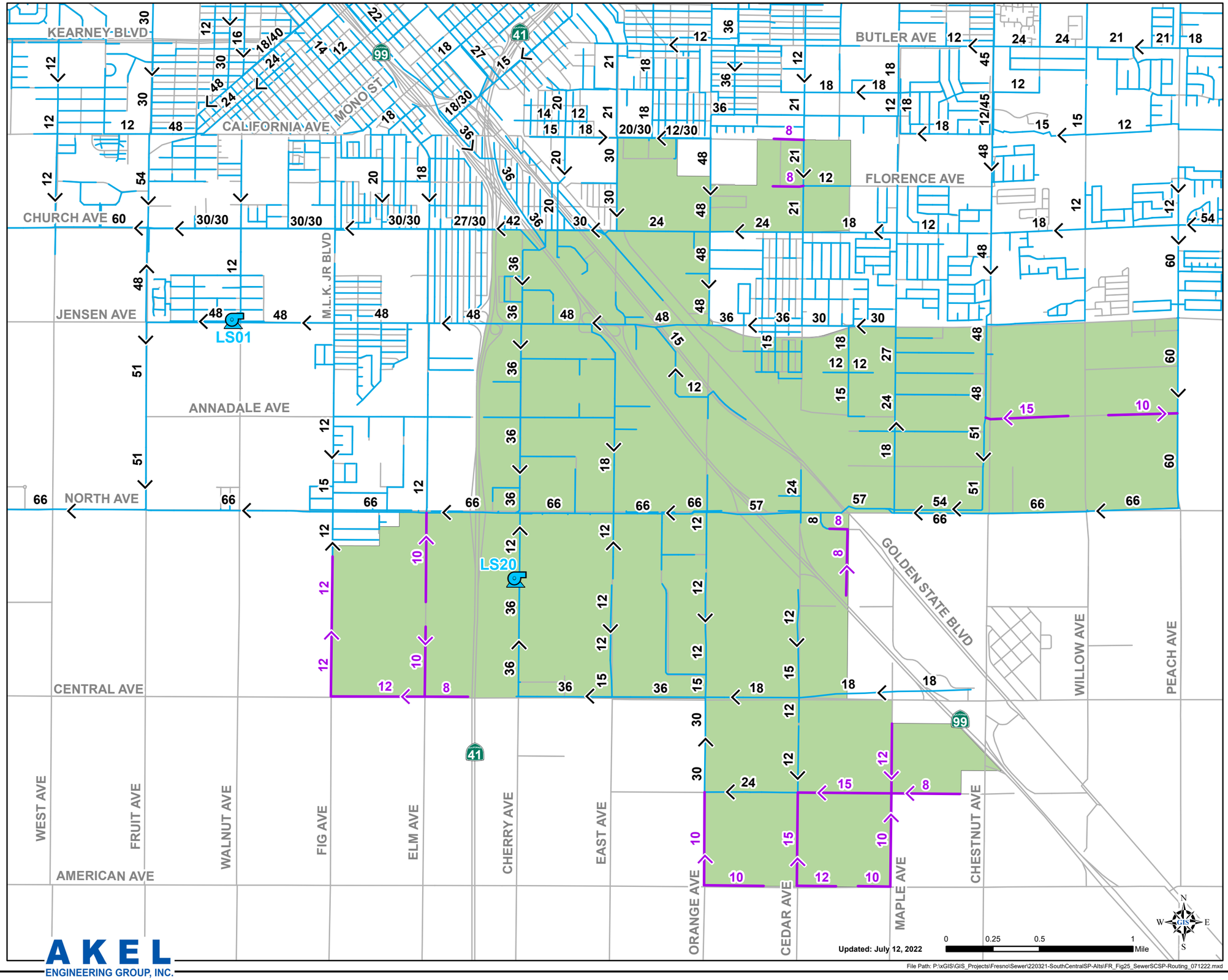
Figure 24
Alternative 3: Business System Improvements

Sewer Collection System
South Central Specific Plan
Alternatives Analysis

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig24_Alt4_Improvements_071222.mxd



Legend

Proposed Sewer Improvements

- 12 — Pipes for Sewer Routing

Existing Sewer System

- Lift Stations
- 12 — Pipes

Other

- South Central Specific Plan
- Streets

PRELIMINARY

Figure 25
Preliminary Sewer Routing for SCSP

South Central Specific Plan
Alternatives Analysis
City of Fresno

City of FRESNO

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Fresno\Sewer\220321-SouthCentralSP-Alts\FR_Fig25_SewerSCSP-Routing_071222.mxd

TABLES

Table 1 Abbreviation and Acronyms

South Central Specific Plan Alternatives Analysis

City of Fresno

PRELIMINARY

Abbreviation	Expansion	Abbreviation	Expansion
WSMP	Water System Master Plan	MDD	Maximum Day Demand
SSMP	Sewer System Master Plan	mgd	Million Gallons per Day
UWMP	Urban Water Management Plan	PDDWF	Peak Day Dry Weather Flow
Akel	Akel Engineering Group, Inc.	PDWF	Peak Day Dry Weather Flow
City	City of Fresno	PHD	Peak Hour Demand
d/D	Depth of flow to pipe diameter	PMWWF	Peak Month Wet Weather Flow
ft/s	Feet per Second	PMWWF	Peak Month Wet Weather Flow
gpd	Gallons per Day	q/Q	Peak flow to maximum flow
gpm	Gallons per Minute	SCSP	South Central Specific Plan
LS	Lift Station	WWTP	Wastewater Treatment Plant

AKEL ENGINEERING GROUP, INC.

7/5/2022

Table 2 Alternative Land Use Summary

South Central Specific Plan Alternatives Analysis

City of Fresno

PRELIMINARY

	Land Use Classifications	Alternative 0: Adopted Plan (acre)	Alternative 1: Blended Plan (acre)	Alternative 2: Community Plan (acre)	Alternative 3: Business Plan (acre)
RESIDENTIAL					
11	**Single-Family Residential**	30	270	288	76
6	**Neighborhood Mixed Use**	0.25	0.25	0.25	0.25
NON-RESIDENTIAL					
1	**Business Park**	144	653	581	40
2	**General Commercial**	10	47	2,092	13
3	**Regional Business Park**	351	334	247	334
4	**Heavy Industrial**	3,486	2,650	22	3,059
5	**Light Industrial**	685	715	1,489	1,146
7	**Open Space - Ponding Basin**	158	158	158	158
8	**Open Space - Neighborhood Park**	2	2	2	2
9	**Public**	42	78	29	78
10	**Rail**	32	32	32	32
TOTAL					
	Total	**4,940**	**4,940**	**4,940**	**4,940**

AKEL ENGINEERING GROUP, INC.

7/13/2022

Notes:

1. Proposed plan acreage for each alternative based on GIS data received from City on June 24, 2022.

Table 3 Water System Performance and Design Criteria

South Central Specific Plan Alternatives Analysis

City of Fresno

PRELIMINARY

Design Parameter	Criteria	
Transmission Grid Mains **14 to 20-inch**	Transmission grid main should be designed to meet the greater of:	
	1) Average Day Demands	
	Maximum pipe velocity of 3 feet per second	
	Maximum friction losses of 2 feet / 1,000 feet	
	2) Maximum Day Demand	
	Maximum pipe velocity of 5 feet per second	
	Maximum friction losses of 3 feet / 1,000 feet	
	3) Peak Hour Demands	
	Maximum pipe velocity of 5 feet per second	
	Maximum friction losses of 3 feet / 1,000 feet	
Distribution Mains **12-inch or smaller**	Distribution mains should be designed to meet the greater of:	
	1) Average Day Demands	
	Maximum pipe velocity of 5 feet per second	
	Maximum friction losses of 5 feet / 1,000 feet	
	2) Maximum Day Demand plus Fire Flows	
	Maximum pipe velocity of 10 feet per second	
	Maximum friction losses of 10 feet / 1,000 feet	
	3) Peak Hour Demands	
	Maximum pipe velocity of 7 feet per second	
	Maximum friction losses of 10 feet / 1,000 feet	
Service Pressures	***Transmission Grid Mains***	
	Maximum Pressure	80 psi
	Minimum Pressure (during Average Day)	50 psi
	Minimum Pressure (during Maximum Day)	40 psi
	Minimum Pressure (during Peak Hour)	40 psi
	Distribution Mains	
	Maximum Pressure	80 psi
	Minimum Pressure (during Average Day)	40 psi
	Minimum Residual Pressure (during Fires)	20 psi
	Minimum Pressure (during Peak Hour)	40 psi
Demand Peaking Factors	Maximum Day Demand	**1.90** x Average Day Demand
	Peak Hour Demand	**2.90** x Average Day Demand
Fire Flows	See Land Use/Unit Factor table for for details of Fire Flow Requirements	

AKEL ENGINEERING GROUP, INC.

1/26/2022

Notes:

1. Design criteria established from the City's 2020 Urban Water Management Plan and 2010 Water System Master Plan

Table 4 Sewer System Performance and Design Criteria

South Central Specific Plan Alternatives Analysis
City of Fresno

PRELIMINARY

Pipeline Criteria[1]

Peak Wet Weather Flow Criteria

Existing Sewer Pipelines[1]:

Maximum **q/Q of 1.15**

Existing Sewer Forcemains[1]:

Minimum Velocity: **3 ft/sec**

Maximum Velocity: **8 ft/sec**

Peak Dry Weather Flow Criteria

Existing Sewer Pipelines[2]:

Maximum **d/D of 0.90**

Proposed Sewer Pipelines[1]:

Less than 12 inches: maximum **d/D of 0.50**

12 - 18 inches: maximum **d/D of 0.67**

Larger than 18 inches: maximum **d/D of 0.75**

AKEL ENGINEERING GROUP, INC.

4/28/2022

Notes:

1. Sewer pipeline criteria from 2015 Sewer System Master Plan
2. Maximum PDWF d/D criteria selected by Akel Engineering based on standard practices

Table 5 Unit Factors and Fire Flow Requirements

South Central Specific Plan Alternatives Analysis

City of Fresno

PRELIMINARY

	Land Use Classifications[1]	Unit Factors[2]		Fire Flow Requirements[3]
		Water (gpd/acre)	Sewer (gpd/acre)	
1	Business Park	2,800	1,960	3,500 gpm for 4 hours
2	General Commercial	2,500	1,750	3,500 gpm for 4 hours
3	Regional Business Park	2,000	1,400	3,500 gpm for 4 hours
4	Heavy Industrial	3,900	3,120	4,500 gpm for 4 hours
5	Light Industrial	1,900	1,520	4,500 gpm for 4 hours
6	Neighborhood Mixed Use	2,900	2,030	3,500 gpm for 4 hours
7	Open Space - Ponding Basin	1,300	-	-
8	Open Space - Neighborhood Park	3,500	-	-
9	Public	1,900	1,520	3,500 gpm for 4 hours
10	Rail	-	-	-
11	Single-Family Residential	2,800	1,200	2,000 gpm for 2 hours

AKEL ENGINEERING GROUP, INC.

2/28/2022

Notes:

1. Land Use Classifications received from City on January 10, 2022.
2. Unit Factors updated from 2010 Water System Master Plan and 2015 Sewer System Master Plan to reflect localized demands and flows, and confirmed by City Staff on February 17, 2022
3. Fire Flow Requirements follow 2010 Water System Master Plan, and are matched to closest applicable land use.

Table 6 Alternative Flow Summary

South Central Specific Plan Alternatives Analysis

City of Fresno

PRELIMINARY

Land Use Classifications		Factors		Alternative 0: Adopted Alternative			Alternative 1: Blended Plan[2]			Alternative 2: Community Plan			Alternative 3: Business Plan		
		Water	Sewer	Proposed Plan Area	Estimated Water Demands	Estimated Sewer Flows	Proposed Plan Area	Estimated Water Demands	Estimated Sewer Flows	Proposed Plan Area	Estimated Water Demands	Estimated Sewer Flows	Proposed Plan Area	Estimated Water Demands	Estimated Sewer Flows
		(gpd/acre)	(gpd/acre)	(acre)	(mgd)	(mgd)	(acre)	(mgd)	(mgd)	(acre)	(mgd)	(mgd)	(acre)	(mgd)	(mgd)
RESIDENTIAL															
11	Single-Family Residential	2,800	1,200	30	0.08	0.04	270	0.76	0.32	288	0.81	0.35	76	0.21	0.09
6	Neighborhood Mixed Use	2,900	2,030	0.25	0.00	0.00	0.25	0.00	0.00	0.25	0.00	0.00	0.25	0.00	0.00
NON-RESIDENTIAL															
1	Business Park	2,800	1,960	144	0.40	0.28	653	1.83	1.28	581	1.63	1.14	40	0.11	0.08
2	General Commercial	2,500	1,750	10	0.02	0.02	47	0.12	0.08	2,092	5.23	3.66	13	0.03	0.02
3	Regional Business Park	2,000	1,400	351	0.70	0.49	334	0.67	0.47	247	0.49	0.35	334	0.67	0.47
4	Heavy Industrial	3,900	3,120	3,486	13.59	10.88	2,650	10.33	8.27	22	0.09	0.07	3,059	11.93	9.54
5	Light Industrial	1,900	1,520	685	1.30	1.04	715	1.36	1.09	1,489	2.83	2.26	1,146	2.18	1.74
7	Open Space - Ponding Basin	1,300	-	158	0.20	-	158	0.20	-	158	0.20	-	158	0.20	-
8	Open Space - Neighborhood Park	3,500	-	2	0.01	-	2	0.01	-	2	0.01	-	2	0.01	-
9	Public	1,900	1,520	42	0.08	0.06	78	0.15	0.12	29	0.05	0.04	78	0.15	0.12
10	Rail	-	-	32	-	-	32	-	-	32	-	-	32	-	-
TOTAL															
	Total			4,940	16.40	12.81	4,940	15.43	11.63	4,940	11.34	7.87	4,940	15.50	12.07

AKEL ENGINEERING GROUP, INC.

7/13/2022

Notes:

1. Proposed plan acreage for each alternative based on GIS data received from City on June 24, 2022.

Table 7 Water System and Sewer System Improvements Summary

South Central Specific Plan Alternatives Analysis
City of Fresno

PRELIMINARY

Improv. No.	Type of Improvement	Improvements Details			
		Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)
Alternative 0 - Adopted Plan					
Water System Improvements					
TGM	Transmission Grid Main	-	New	16	77,470
C	Capacity	14	Replace	16	4,250
FF	Fire Flow	6	Replace	12	2,870
FF	Fire Flow	8	Replace	14	460
FF	Fire Flow	8	Replace	12	1,630
FF	Fire Flow	10	Replace	12	620
W	Well	-	New	8 @ 2,125 gpm	
Sewer System Improvements					
GME-1	Gravity Main Extension	-	New	8	7,269
GME-2	Gravity Main Extension	-	New	10	14,318
GME-3	Gravity Main Extension	-	New	12	9,684
GME-4	Gravity Main Extension	-	New	15	7,628
P-1	Gravity Main	12	Replace	30	1,850
P-2	Gravity Main	18	Replace	24	2,700
P-3	Gravity Main	10	Replace	18	50
P-4	Gravity Main	10	Replace	15	2,800
LS-20	Lift Station	1.0 mgd	Capacity Improvement	7.2 mgd	
Alternative 1 - Blended Plan					
Water System Improvements					
TGM	Transmission Grid Main	-	New	16	77,470
W	Well	-	New	8 @ 2,125 gpm	
Sewer System Improvements					
GME-1	Gravity Main Extension	-	New	8	7,269
GME-2	Gravity Main Extension	-	New	10	14,318
GME-3	Gravity Main Extension	-	New	12	9,684
GME-4	Gravity Main Extension	-	New	15	7,628

Table 7 Water System and Sewer System Improvements Summary

South Central Specific Plan Alternatives Analysis
City of Fresno

PRELIMINARY

Improv. No.	Type of Improvement	Improvements Details			
		Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)
P-1	Gravity Main	10	Replace	24	1,850
P-2	Gravity Main	10	Replace	18	50
P-3	Gravity Main	10	Replace	15	2,800
LS-20	Lift Station	1.0 mgd	Capacity Improvement	5.4 mgd	
Alternative 2 - Community Plan					
Water System Improvements					
TGM	Transmission Grid Main	-	New	16	77,470
C	Capacity	14	Replace	16	1,700
W	Well	-	New	4 @ 2,125 gpm	
Sewer System Improvements					
GME-1	Gravity Main Extension	-	New	8	7,269
GME-2	Gravity Main Extension	-	New	10	14,318
GME-3	Gravity Main Extension	-	New	12	9,684
GME-4	Gravity Main Extension	-	New	15	7,628
P-1	Gravity Main	10	Replace	24	1,850
P-2	Gravity Main	10	Replace	18	50
P-3	Gravity Main	10	Replace	15	2,800
LS-20	Lift Station	1.0 mgd	Capacity Improvement	4.2 mgd	
Alternative 3 - Business Plan					
Water System Improvements					
TGM	Transmission Grid Main	-	New	16	77,470
W	Well	-	New	8 @ 2,125 gpm	
Sewer System Improvements					
GME-1	Gravity Main Extension	-	New	8	7,269
GME-2	Gravity Main Extension	-	New	10	14,318
GME-3	Gravity Main Extension	-	New	12	9,684
GME-4	Gravity Main Extension	-	New	15	7,628
P-1	Gravity Main	10	Replace	24	1,850

Table 7 Water System and Sewer System Improvements Summary

South Central Specific Plan Alternatives Analysis
City of Fresno

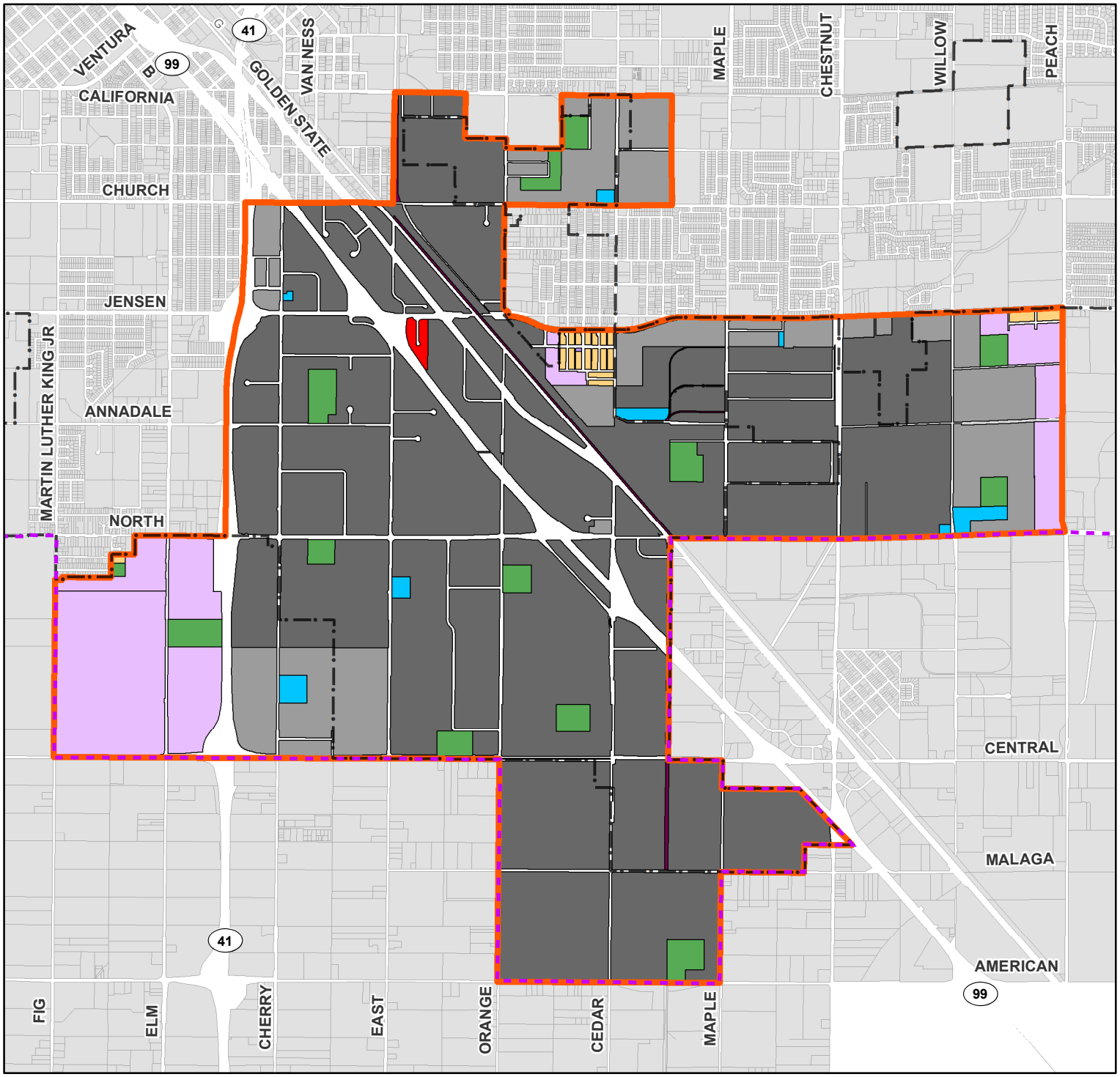
PRELIMINARY

Improv. No.	Type of Improvement	Improvements Details			
		Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)
P-2	Gravity Main	10	Replace	18	50
P-3	Gravity Main	10	Replace	15	2,800
LS-20	Lift Station	1.0 mgd	Capacity Improvement	5.9 mgd	

AKEL ENGINEERING GROUP, INC.

7/12/2022

APPENDIX A
ALTERNATIVE LAND USE MAPS



ALTERNATIVE 0: ADOPTED PLAN LAND USE MAP

RESIDENTIAL
- Low Density (1-3.5 D.U./acre)
- Medium Low Density (3.5-6 D.U./acre)
- Medium Density (5.0-12 D.U./acre)
- Medium High Density (12-16 D.U./acre)
- Urban Neighborhood (16-30 D.U./acre)
- High Density (30-45 D.U./acre)

COMMERCIAL
- Community
- General
- Regional

EMPLOYMENT
- Office
- Business Park
- Regional Business Park
- Light Industrial
- Heavy Industrial
- Rail

MIXED USE
- Neighborhood Mixed Use
- Corridor/Center Mixed Use

OPEN SPACE
- Parks - Open Space

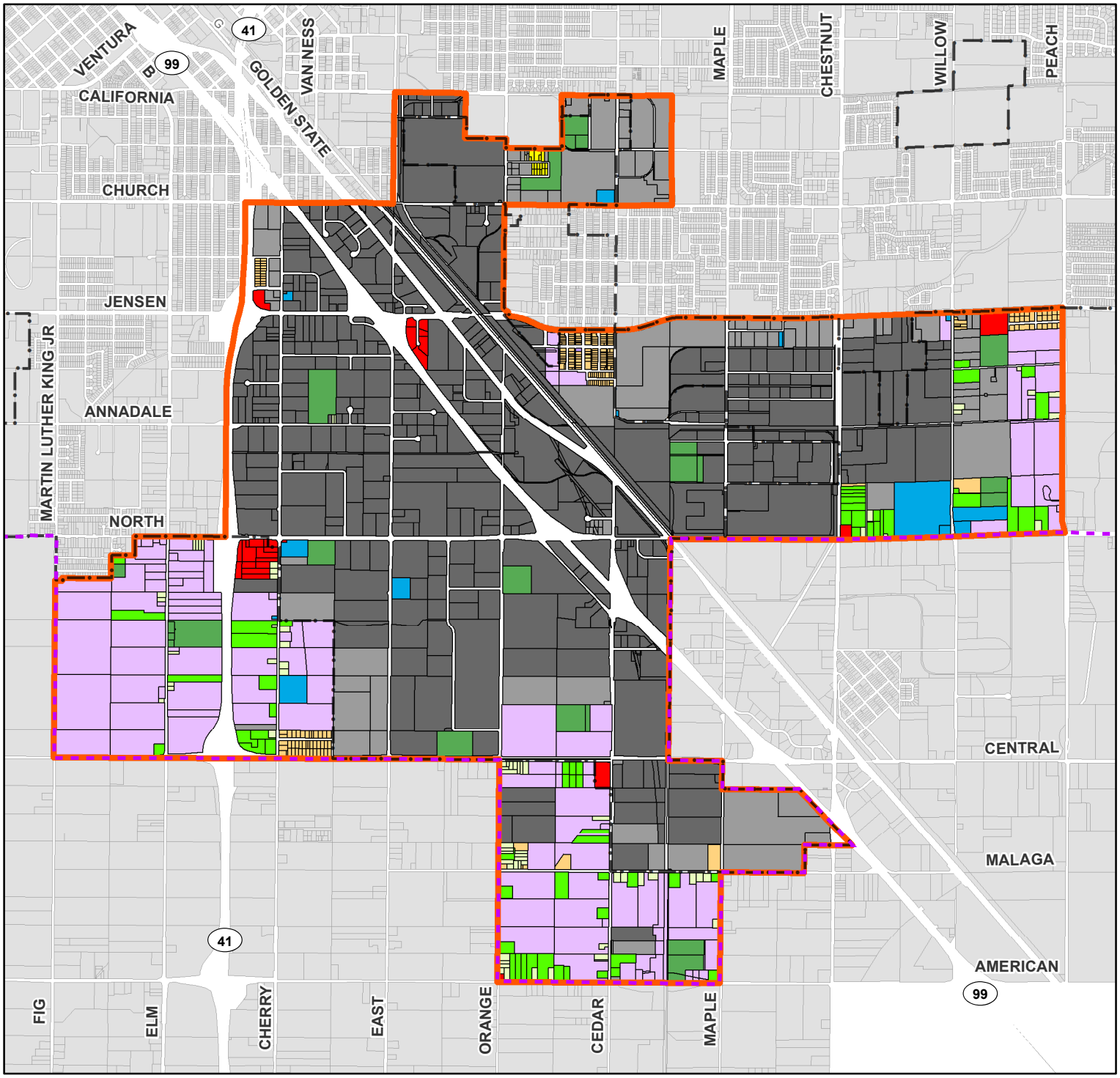
PUBLIC FACILITIES
- Public/Quasi-public Facility
- Fire Station

- Fresno Sphere of Influence
- Fresno City Limits
- South Central Specific Plan (SCSP)

South Central Specific Plan

0 0.5 1 Miles

Source: City of Fresno GIS Data
Prepared by the Planning and Development Department



ALTERNATIVE 1: BLENDED PLAN LAND USE MAP

Legend

RESIDENTIAL
- Residential <= 1 acre
- Residential > 1 acre
- Low Density Residential
- Medium Low Density Residential
- Medium Density Residential

COMMERCIAL
- General Commercial

EMPLOYMENT
- Regional Business Park
- Light Industrial
- Heavy Industrial
- Business Park

MIXED USE
- Neighborhood Mixed Use

OPEN SPACE
- Open Space - Ponding Basin
- Open Space - Neighborhood Park

PUBLIC FACILITIES
- Public Facility

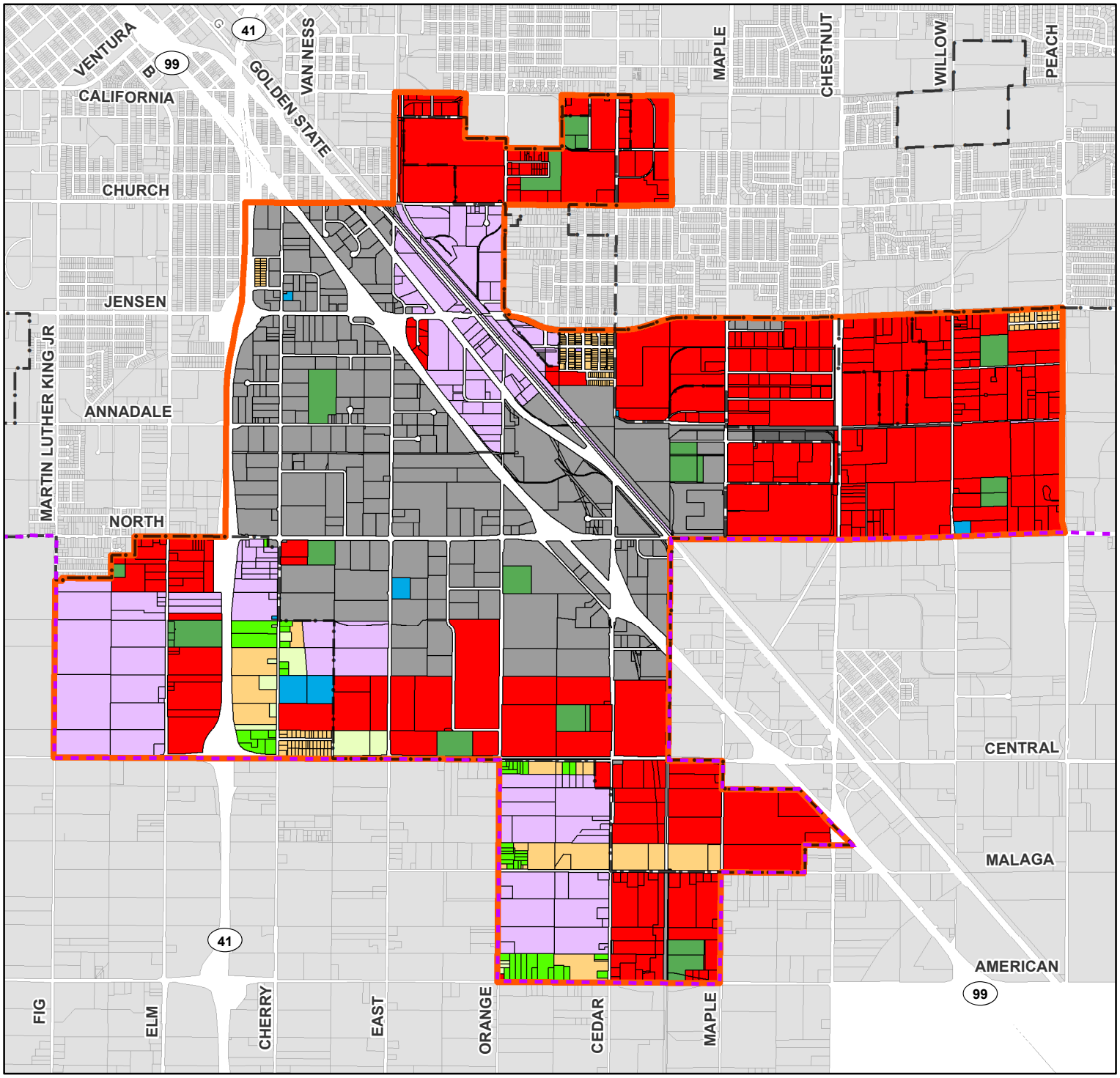
UNDESIGNATED
- Rail

- Fresno Sphere of Influence
- Fresno City Limits
- South Central Specific Plan (SCSP)

South Central Specific Plan

0 0.5 1 Miles

Source: City of Fresno GIS Data
Prepared by the Planning and Development Department



ALTERNATIVE 2: COMMUNITY PLAN LAND USE MAP

Legend

RESIDENTIAL
- Residential <= 1 acre
- Residential > 1 acre
- Medium Density Residential

COMMERCIAL
- General Commercial

EMPLOYMENT
- Regional Business Park
- Light Industrial
- Heavy Industrial
- Business Park

MIXED USE
- Neighborhood Mixed Use

OPEN SPACE
- Open Space - Ponding Basin
- Open Space - Neighborhood Park

PUBLIC FACILITIES
- Public Facility

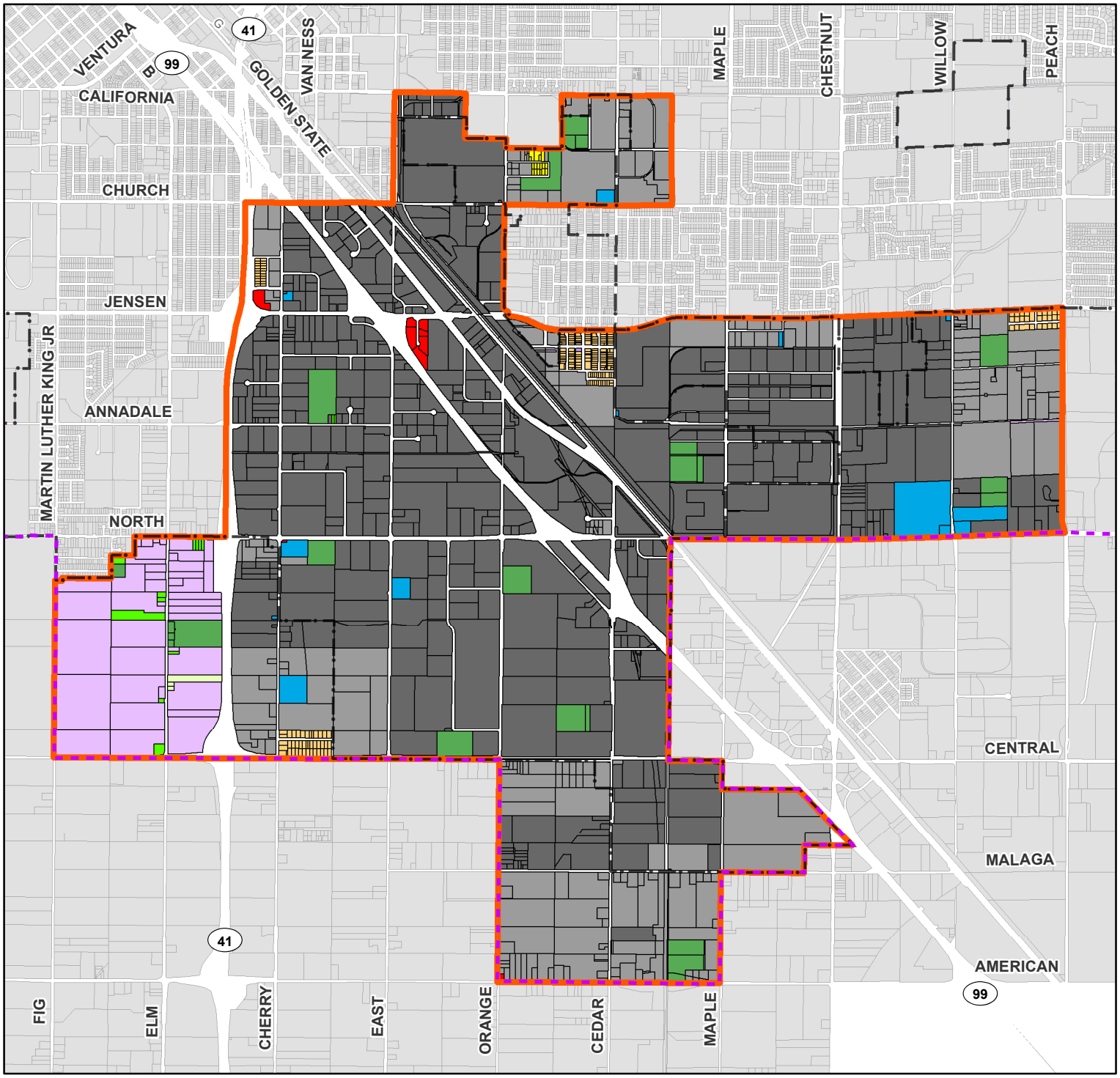
UNDESIGNATED
- Rail

- Fresno Sphere of Influence
- Fresno City Limits
- South Central Specific Plan (SCSP)

South Central Specific Plan

0 0.5 1 Miles

Source: City of Fresno GIS Data
Prepared by the Planning and Development Department



ALTERNATIVE 3: BUSINESS PLAN LAND USE MAP

Legend

RESIDENTIAL
- Residential <= 1 acre
- Residential > 1 acre
- Low Density Residential
- Medium Low Density Residential
- Medium Density Residential

COMMERCIAL
- General Commercial

EMPLOYMENT
- Regional Business Park
- Light Industrial
- Heavy Industrial
- Business Park

MIXED USE
- Neighborhood Mixed Use

OPEN SPACE
- Open Space - Ponding Basin
- Open Space - Neighborhood Park

PUBLIC FACILITIES
- Public Facility

UNDESIGNATED
- Rail

- Fresno Sphere of Influence
- Fresno City Limits
- South Central Specific Plan (SCSP)

South Central Specific Plan

0 0.5 1 Miles

Source: City of Fresno GIS Data
Prepared by the Planning and Development Department

City of
FRESNO