

CHAPTER 7

Existing System Evaluation

This chapter presents the evaluation of the City’s existing water system, as described in Chapter 2, and its ability to meet the recommended performance and operational criteria described in Chapter 5 under various existing water demand conditions. This evaluation includes an analysis of water supply capacity, storage capacity, and pumping capacity, as well as the existing water distribution system’s ability to meet recommended operational and design criteria under normal and emergency scenarios.

West Yost conducted this evaluation using the calibrated hydraulic model described in Chapter 6. Recommendations from this evaluation are used to develop a recommended capital improvement program, which is detailed in Chapter 10.

The following sections present the evaluation methodology and results from the existing water system evaluation:

- Existing Water Demands
- Existing Water Supply and Water System Facility Capacity Evaluation
- Existing Water Distribution System Performance Evaluation
- Summary of Findings and Recommendations for the Existing Water System

7.1 EXISTING WATER DEMANDS

The City’s existing baseline water demands are summarized by pressure zone in Table 7-1. As described in Chapter 3, the system-wide baseline average day demand for the purposes of this WMP is approximately 9.0 mgd and represents the average annual water production from 2023. Approximately 78 percent of the City’s overall demand is located within the 375 Pressure Zone.

Chapter 3 describes development of the diurnal patterns for each pressure zone group using consumption and production data from summer of 2023. Maximum day demands were calculated using the maximum day peaking factor developed from the average day and maximum day demands from 2023. Peak hour demands were calculated using the peak hour factor for the City’s entire system based on the summer demand diurnal curves developed using the peak week in summer of 2023.

Table 7-1. Existing Baseline Demands						
Pressure Zone	Average Day Demand ^(a)		Maximum Day Demand ^(b)		Peak Hour Demand ^(c)	
	gpm	mgd	gpm	mgd	gpm	mgd
375	4,895	7.0	9,301	13.4	20,462	29.4
475	398	0.6	756	1.0	1,663	2.0
575	559	0.8	1,062	1.5	2,336	3.3
610	54	0.1	103	0.1	227	0.3
650	199	0.3	378	0.5	832	1.1
750	115	0.2	219	0.3	482	0.6
775	44	0.1	84	0.1	185	0.2
Total Demand	6,264	9.0	11,903	16.9	26,187	36.9
(a) Average day demand is based on 2023 average day demand data (refer to Table 3-6). (b) Maximum day demand is based on the 2023 maximum day demand data (refer to Table 3-6). (c) Peak hour demand is calculated using a peaking factor of 2.2 times the maximum day demand (refer to Table 3-7). gpm = gallons per minute; mgd = million gallons per day						

7.2 EXISTING WATER SUPPLY AND WATER SYSTEM FACILITY CAPACITY EVALUATION

The following capacity evaluations were conducted for the existing water system and are discussed in more detail in subsequent sections:

- Supply Capacity Evaluation
- Pumping Capacity Evaluation
- Storage Capacity Evaluation
- Pressure Regulating Station Capacity Evaluation

7.2.1 Supply Capacity Evaluation

As described in Chapter 5, the recommended supply capacity criterion requires the City to provide firm supply capacity equal to the maximum day demand. For the existing water system, firm groundwater well capacity is defined as the City’s active well capacity with the largest groundwater well offline. Table 7-2 summarizes the results of the supply capacity evaluation and shows that the City has a surplus of existing supply capacity.

Component	Capacity, mgd	Notes
Demand		
[A] Existing Maximum Day Demand	16.9	System-wide maximum day demand (refer to Table 7-1)
Supply		
[B] Surface Water from PCWA	18.9	Entitlement under Contract for Treated Water Supply with PCWA ^(a)
[C] Groundwater	5.9	Existing firm capacity at groundwater wells ^(b)
[D] Total Supply	24.8	[D] = [B] + [C]
[E] Supply Capacity Surplus (Deficit)	7.9	[E] = [D] - [A]
(a) The firm water supply from PCWA is assumed to be the City's maximum delivery entitlement of 18.9 mgd (refer to Table 5-1). (b) Firm groundwater well capacity for the existing system is defined as the City's active well capacity with the largest groundwater well offline. mgd = million gallons per day		

7.2.2 Pumping Capacity Evaluation

Existing pumping capacity in the City’s water system was evaluated to assess its ability to deliver a reliable firm capacity to meet demand conditions outlined in Chapter 5, dependent on whether the pressure zone has gravity storage. The City’s only existing booster pump station is the Catta Verdera BPS serving the 750 Zone which supplies the 610 Zone through pressure regulating stations. Since the 750 Zone does not have gravity storage, pumps at the Catta Verdera BPS need to have sufficient pumping capacity to deliver the greater of either the maximum day demand plus fire flow or the peak hour demand.

Table 7-3 compares the existing firm pumping capacity with required firm pumping capacity for the 750 Zone for existing water demand conditions. As shown in Table 7-3, the 750 Zone has a firm pumping capacity deficit. However, since the unregulated connection at the new PCWA metering station at the Verdera Tank No. 3 site provides adequate supply to the 750 and 610 Zones, the Catta Verdera BPS currently only operates during times of peak demand to provide supplemental supply. The City is also considering upgrading the pump motors with a variable frequency drive. Therefore, no recommendations are made to address the existing pumping capacity deficit.

Table 7-3. Comparison of Required versus Available Existing Pumping Capacity					
Pressure Zone	Supported Zone	Pump Station Name	Required Pumping Capacity, gpm^(a) [A]	Booster Pump Station Firm Capacity^(c) [B]	Existing Pump Capacity Surplus (Deficit), gpm [C] = [B] - [A]
750	610	Catta Verdera Pump Station	1,822	900	(922) ^(c)
<p>(a) Required pumping capacity shown is the MDD plus fire flow for the pressure zone itself and all supported zones. The 750 Zone supplies the 610 Zone; therefore, the required pumping capacity includes the MDD for the 750 Zone and the 610 Zone (refer to Table 7-1). The largest fire flow requirement in the two zones is 1,500 gpm for low density residential land use.</p> <p>(b) Includes the firm capacity of all booster pump stations supplying the pressure zone. Firm pump capacity at booster pump stations is defined as total booster pump station capacity with the largest pump out of service (refer to Table 2-5).</p> <p>(c) The unregulated connection at the PCWA metering station at the Verdera Tank No. 3 site installed in 2021 provides adequate supply to the 750 and 610 Zones. The Catta Verdera BPS currently operates during times of peak demand as supplemental supply. Therefore, no recommendations are made to address the existing pumping capacity deficit.</p> <p>gpm = gallons per minute</p>					

7.2.3 Storage Capacity Evaluation

Water storage provides operational storage to balance differences in demands and supplies, emergency storage in case of a supply failure, and water to fight fires. The City’s water system has two sources of available storage: above-ground storage (i.e., storage tanks) and storage available in the groundwater basin. Together, these two sources of storage must be sufficient to meet the City’s operational, emergency, and fire flow storage criteria. The City’s water storage capacity requirements are further described in Chapter 5.

The existing water storage facilities, along with the available EGWC, were evaluated to determine whether the City’s existing storage is sufficient to meet recommended operational, emergency, and fire flow storage for existing conditions. Table 7-4 summarizes results from the storage capacity evaluation. As shown in Table 7-4, there is a storage capacity surplus in the 575 Zone and storage capacity deficits in the 375, 750, and 775 Zones.

As discussed in Chapter 2, the 375 Zone receives its main source of supply through three pressure regulating stations, two from the 575 Zone (Twelve Bridges and Eastridge) and one from the 475 Zone (Wildomar), and is supplemented with supply from its own groundwater wells. Therefore, the required operational storage for the 375 Zone is assigned to the 575 Zone, while the required storage capacity for the 375 Zone is composed of the remaining fire and emergency storage components. The 475, 610, and 650 Zones are pressure regulated zones (i.e., pressure zones served solely by pressure regulating stations without a booster pump station or storage tank) and are grouped with the pressure zone they receive supply from.

Additionally, the 375 Zone is the only pressure zone that can use EGWC since it is the only pressure zone with groundwater wells. The EGWC equals the firm capacity of the active groundwater wells that can be reliably accessed (i.e., well facilities equipped with auxiliary power). The EGWC cannot exceed the emergency storage requirement and wells included for the EGWC also cannot already be relied upon to meet the City's average day demand. Three out of five of the City's active groundwater wells (Well 2, Westwood Well, and Fiddyment Well) have backup power and are not needed to meet average day demands. To obtain the firm capacity of the active groundwater wells that can be reliably accessed, the well capacity of the Fiddyment Well is excluded since it has the largest well capacity out of the three wells.

The storage capacity deficit in the 375 Zone is due to the emergency storage component. It is assumed the 575 Zone can transfer its surplus storage capacity to the 375 Zone via gravity transfer through the existing pressure regulating stations. Therefore, no additional storage tanks are recommended for the 375 Zone. However, it is recommended that the City consider acquiring dedicated backup power sources for the Moore and Nelson Wells, which would improve well reliability and allow these wells to be counted as part of the EGWC. With backup power at the Moore and Nelson Wells, the EGWC would increase by 1.76 MG for a total EGWC of 4.2 MG¹ resulting in a storage capacity surplus of 1.57 MG for the 375 Zone.

The 750 and 775 Zones do not have any existing storage tanks. If the unregulated PCWA connections supplying these zones go offline, the 775 Zone has no alternative water supply source. Although the 750 Zone can be supplied by the Catta Verdera BPS, and subsequently the 650 and 610 Zones through pressure regulating stations, there is a pumping capacity deficit as shown in Table 7-3. To alleviate the storage capacity deficits and provide redundancy, it is recommended that the City construct a two (2) mgd emergency booster pump station at the Verdera Tank No. 3 site for the 750 Zone and a four (4) mgd emergency booster pump station at the Conspiracy Point Tank site for the 775 Zone. A hydraulic evaluation showing the results of a loss of the unregulated PCWA connections with and without these improvements is discussed in Section 7.3.2.

¹ With backup power at the Moore and Nelson Wells, the firm capacity of the active groundwater wells that can be reliably accessed would increase to 5.9 MG. However, since EGWC cannot exceed the emergency storage amount, the EGWC would be equal to the emergency storage amount of 4.2 MG.

Table 7-4. Comparison of Required versus Available Storage Capacity										
Pressure Zone	Supported Pressure Zones	Storage Available	Required Storage Capacity, MG			Available Storage Capacity, MG			Existing Storage Capacity Surplus (Deficit), MG [H] = [G] - [D]	
			Operational ^(a) [A]	Fire Flow ^(b) [B]	Emergency ^(c) [C]	Storage Capacity Requirement [D] = [A] + [B] + [C]	Existing Available Storage ^(d) [E]	Emergency Groundwater Storage Credit ^(e) [F]		Storage Capacity Available [G] = [E] + [F]
375	-	3 MG Tank	-	0.96	4.20	5.16	2.53	2.44	4.97	(0.19)
575	475 375	Verdera Tank No. 3 Conspiracy Point Tank	3.98	0.96	0.82	5.76	8.75	0.00	8.75	2.99
750	610	-	0.10	0.18	0.15	0.43	0.00	0.00	0.00	(0.43)
775	650	-	0.15	0.54	0.21	0.90	0.00	0.00	0.00	(0.90)

(a) Operational storage is 25 percent of 2023 maximum day demand (MDD) data of each pressure zone (refer to Table 7-1).
(b) Fire storage is equal to the volume of the largest fire flow event that could occur in each pressure zone (refer to Table 5-1).
(c) Emergency storage is 60 percent of 2023 average day demand (ADD) data of each pressure zone (refer to Table 7-1).
(d) Available tank storage capacity was calculated taking into account 5 feet of dead storage and 2 feet of high alarm level in each storage tank (refer to Section 2.3.4).
(e) The Emergency Groundwater Storage Credit (EGWC) includes the firm capacity of groundwater supply that can be reliably accessed. In order for groundwater supply to count toward the EGWC it must: (1) be equipped with backup power, (2) not already be relied upon to meet City average day demand (ADD) requirements, and (3) have sufficient distribution facilities available to distribute to demand areas. The EGWC includes the firm capacity of wells with backup power. The EGWC cannot exceed the emergency storage requirement.

7.2.4 Pressure Regulating Station Capacity Evaluation

The existing pressure regulating stations in the City’s water system were evaluated to assess their ability to reliably supply the existing water service area. As described in Chapter 5, the criterion for pressure zones served solely by pressure regulating stations without a booster pump station or storage tank requires the City’s pressure regulating stations to have sufficient capacity to meet the peak hour demand plus fire flow condition.

Table 7-5 compares existing available pressure regulating station capacity with required capacity for pressure zones that are completely dependent on pressure regulating stations for supply. As shown in Table 7-5, the pressure regulating stations for the pressure regulated zones have sufficient capacity to meet the requirements.

Table 7-5. Comparison of Available versus Required Existing Pressure Regulating Station Capacity								
Pressure Zone	Pressure Regulating Station	Supplied By	Valve Diameter, inches	Available PRS Capacity, gpm ^(a) [A]	Required PRS Capacity, gpm			Existing PRS Capacity Surplus (Deficit), gpm [E] = [A] - [D]
					Peak Hour Demand ^(b) [B]	Fire Flow Demand ^(c) [C]	PRS Capacity Requirement [D] = [B] + [C]	
475	Spring Valley #1	575	3	580	1,663	1,500	3,163	18,587
			8	3,900				
	Spring Valley #2	575	3	580				
			8	3,900				
	Stoneridge	575	6	2,250				
			14	10,540				
475 Zone Total				21,750				
650	Village 13	775	4	990	832	3,000	3,832	10,448
			10	6,150				
	Village 17	750	4	990				
			10	6,150				
	650 Zone Total							
610	Village 18	750	3	580	227	1,500	1,727	13,403
			10	6,150				
	Village 19	750	6	2,250				
			10	6,150				
	610 Zone Total							

(a) Valve capacity is estimated based on intermittent maximum flow capacity for ClaVal Model 90-01 pressure reducing valves. However, actual flow capacity will vary depending on system conditions.
 (b) Refer to Table 7-1 for peak hour demand.
 (c) Largest fire flow event that could occur in each pressure zone (refer to Table 5-1).

7.3 EXISTING WATER DISTRIBUTION SYSTEM PERFORMANCE EVALUATION

The water distribution system performance evaluation identifies necessary improvements to support existing water demands while meeting the City’s recommended water system planning and design criteria, presented in Chapter 5. The updated model and calibrated model described in Chapter 6 was used to evaluate the City’s existing water distribution system. The following evaluations were performed to assess system performance under existing demand conditions:

- **Normal Operations:**
 - Average Day Demand Scenario: This scenario evaluated service pressures during an average day demand condition.
 - Maximum Day Demand Scenario: This scenario evaluated service pressures during a maximum day demand condition.
 - Water Age Scenario: This scenario evaluated system water age during a winter demand condition.
- **Emergency Operations:**
 - Maximum Day Demand plus Fire Flow Scenario: This scenario evaluated system fire flow availability under a maximum day demand condition.
 - Additional Emergency Scenarios: These scenarios evaluated system performance under emergency conditions during a maximum day demand condition.

The results presented are based on the maximum and minimum day diurnal demand patterns (i.e., pressure zone groups, irrigation meters, and large users) derived from 2023 SCADA data and previously presented in Chapter 3. These diurnal patterns were incorporated into the hydraulic model for their associated demand conditions as discussed in the following sections. Results are also based on model controls from the calibrated hydraulic model, which were adjusted as needed for each evaluation. For normal (i.e., non-emergency) operations, model controls were adjusted to reflect typical normal operating conditions observed in the 2023 SCADA data provided in Chapter 3.

7.3.1 Normal Operations

7.3.1.1 Average Day Demand

The normal operations of the City’s water distribution system were evaluated under average day demand conditions (i.e., non-fire). An overview of the evaluation and a discussion of the results are presented in the following sections.

7.3.1.1.1 Evaluation Overview

A 72-hour EPS was conducted using the hydraulic model to evaluate system performance under an average day demand condition with the maximum day diurnal patterns incorporated. As shown in Table 7-1, the average day demand is 6,264 gpm (9.0 mgd) for the existing system. The operational criteria applicable during average day demand conditions are detailed in Chapter 5. The existing system analysis assumes the water system demand will be met by a combination of the PCWA metering stations and existing storage tanks. Groundwater wells and the Catta Verdera BPS were assumed to be offline since these are typically only used during maximum day with peak hour demands and/or emergencies.

7.3.1.1.2 Evaluation Results

Approximate tank level ranges under average day demand conditions are as follows: the 3 MG Tank ranges from 11 to 17 feet, the Conspiracy Point Tank ranges from 16 to 19 feet, and Verdera Tank No. 3 ranges from 14 to 17 feet.

Results from the average day demand condition indicate the existing water system generally meets the City's minimum and maximum pressure criterion at most customer service locations. Figure 7-1 presents the minimum instantaneous pressures during the EPS. In general, most areas of the City's distribution system meet the minimum pressure requirement of 40 psi under peak hour demand. The majority of the City's distribution system experiences pressures ranging between 80 to 100 psi. Pockets of pressures ranging from 40 to 60 psi typically occur around areas that are on the high end of a pressure zone's service elevation range and/or are served by a dead-end pipeline. Locations with pressures below 40 psi occur adjacent to major system facilities where the associated pipelines do not have service connections.

Velocities in the majority of the water distribution system do not exceed 7 feet per second (fps), except for 25 linear feet of 8-inch diameter pipeline at the intersection of 1st Street and Joiner Parkway, which experiences a maximum velocity of 10.5 fps. One 24-inch diameter pipeline and three 12-inch diameter pipelines tie into this 8-inch diameter pipeline, which create a bottleneck resulting in high velocities. It is recommended that this 8-inch diameter pipeline be replaced with a new 16-inch diameter pipeline to mitigate high velocities.

7.3.1.2 Maximum Day Demand with Peak Hour

The normal operations of the City's water distribution system were evaluated under maximum day with peak hour demand conditions (i.e., non-fire). An overview of the evaluation and a discussion of the results are presented in the following sections.

7.3.1.2.1 Evaluation Overview

A 72-hour EPS was conducted using the hydraulic model to evaluate system performance under a maximum day with peak hour demand condition with the maximum day diurnal patterns incorporated. As shown in Table 7-1, for the existing system, the maximum day demand is 11,903 gpm (16.9 mgd) and the total system peak hour demand is 26,187 gpm (36.9 mgd). The operational criteria applicable during maximum day with peak hour demand conditions are detailed in Chapter 5. The existing system analysis assumes the water system demand will be met by a combination of the PCWA metering stations, existing storage tanks, two groundwater wells, and if needed, the Catta Verdera BPS.

7.3.1.2.2 Evaluation Results

Approximate tank level ranges under average day demand conditions are as follows: the 3 MG Tank ranges from 13 to 23 feet, the Conspiracy Point Tank ranges from 17 to 21 feet, and Verdera Tank No. 3 ranges from 14 to 18 feet.

Results from the maximum day with peak hour demand condition indicate the existing water system generally meets the City's minimum and maximum pressure criterion at most customer service locations. Figure 7-2 presents the minimum instantaneous pressures during the EPS. In general, pressures slightly decrease compared to the average day demand results; however, most areas of the City's distribution system meet the minimum pressure requirement of 40 psi under peak hour demand. The majority of the City's distribution system experiences pressures ranging between 60 to 80 psi and between 80 to 100 psi.

Pockets of pressures ranging from 40 to 60 psi typically occur around areas that are on the high end of a pressure zone's service elevation range and/or are served by a dead-end pipeline. Locations with pressures below 40 psi occur adjacent to major system facilities where the associated pipelines do not have service connections.

Velocities in the majority of the water distribution system do not exceed 7 fps, except for 69 linear feet of 8-inch diameter pipeline at the intersection of E Street and McBean Park Drive, which experiences a maximum velocity of 7.7 fps, and the previously identified 8-inch diameter pipeline at 1st Street and Joiner Parkway, which experiences an increased maximum velocity of 21 fps.

The 8-inch diameter pipeline at E Street and McBean Park Drive ties into 18-inch, 12-inch, and 10-inch diameter pipelines which create a bottleneck resulting in high velocities. It is recommended that this 8-inch diameter pipeline be replaced with a new 12-inch diameter pipeline to mitigate high velocities.

7.3.1.3 Water Age

A water age evaluation was performed on the City's existing water distribution system to determine areas in the distribution system that may be vulnerable to potential water quality issues. When water stays stagnant in the distribution system for extended periods due to lack of turnover, water age can increase which can lead to taste and odor concerns, increased potential for disinfection byproduct formation, and potential water quality and/or public health risks. Areas identified with older water age may be used to inform development of water management strategies (e.g., targeted flushing programs and operational changes) to improve water quality within the distribution system.

The water age of the City's existing water distribution system during normal operations was evaluated under a typical winter demand condition. An overview of the evaluation and a discussion of the results are presented in the following sections.

7.3.1.3.1 Evaluation Overview

For purposes of this evaluation, water age is assumed to begin upon entry into the City's distribution system at the PCWA metering stations. A 30-day EPS was conducted using the hydraulic model to evaluate water age under a typical minimum day demand condition; however, only results from the last 24 days of the simulation are presented, as these results are not affected by initial conditions. The minimum day demand diurnal patterns were incorporated into the hydraulic model for the water age evaluation. Water age was evaluated under a minimum week demand condition of 3,230 gpm (4.7 mgd), previously used to develop the minimum day demand diurnal in Chapter 3. The existing system analysis assumes the winter demand would be met by a combination of the PCWA metering stations and existing storage tanks. Groundwater wells and the Catta Verdera BPS were assumed to be offline since these are typically only used during maximum day with peak hour demands and/or emergencies.

It is important to note that locations of the oldest water are typically found on dead-end pipelines (i.e., service laterals) with little or no demand assigned in the hydraulic model and are not representative of the overall water age of the distribution system water served to the City's customers.

7.3.1.3.2 Evaluation Results

Water age in storage tanks has an important influence on the water age in the distribution system. The water age in tanks depends on different factors such as inlet/outlet configuration, total volume in the tank, and system demands supplied from the tank. Table 7-6 summarizes the average water age and average tank level of the three tanks during the water age evaluation. Since the three storage tanks in the

City’s water system have a turnover rate of less than 1 foot over a 24-hour (1 day) period, the resulting water age in the three tanks remains constant. The water age in the Conspiracy Point Tank and Verdera Tank No. 3 are both around 1.5 days old since both tanks receive fresh supply directly from the regulated PCWA connections, while the water age in the 3 MG Tank is slightly older at approximately 2.4 days old due to being fed by older water from the distribution system.

Storage Tank Name	Average Water Age, hours	Average Tank Level, feet
Conspiracy Point Tank	34 (1.4 days)	20.7
Verdera Tank No.3	39 (1.6 days)	19.5
3 MG Tank	58 (2.4 days)	9.4

(a) Results are based on the last 24 days of a 30-day EPS.

Figure 7-3 shows the maximum water age results for City’s water system. Model results indicate the majority of the 375 Zone has a maximum water age ranging from 4 to 7 days. Areas in the 375 Zone with younger water age ranging from 2 to 3 days occur closest to the supply sources into the zone (i.e., near a PRS and/or the 3 MG Tank). The remaining zones (475, 575, 610, 750, and 775 Zones) generally have a maximum water age of less than 3 days. Areas in the remaining zones with older water age of 3 to 4 days occur at dead-end pipelines and/or at areas far from the supply sources into the zone.

The oldest water in the overall system (greater than 7 days) is located in the far north and west furthest from the supply sources and/or at dead-end pipelines with minimal demand. Notable locations with the oldest water include the Turkey Creek Estates development in the far east, the developments in the far northeast, and the Airport area in the far northwest. It should be noted the Liberty development shows water age greater than 7 days, however, this development is new and no associated demands have been added to the existing condition model scenario. Only the pipelines for the Liberty development have been constructed and no units have been constructed at the time of this evaluation.

The Turkey Creek Estates development is a newer development with minimal demands and is supplied by a single dead-end 18-inch diameter transmission pipeline. As development continues in the area, a future connection to Village 1 to the south will provide looping and improve water age in the Turkey Creek Estates. The developments in the northeastern extent of City limits are located north of the Auburn Ravine which limits the ability to easily construct looping. This limitation contributes to its older water age. As development occurs in Village 1, a new transmission pipeline is planned to cross the Auburn Ravine and connect to the northeastern developments, which will add looping and improve water age.

The Airport area has minimal demands and is supplied by 12-inch diameter pipelines which were sized to meet large fire flows (i.e., 3,000 to 4,000 gpm). Due to the low demands, there is less water flowing through the larger diameter pipes which can lead to stagnant water and resulting in older water age.

The City may consider updating its flushing program to include parameters to include water quality. No recommendations are made for the turnover in the City’s tanks since City operational staff are able to adjust operations daily to optimize turnover which the hydraulic model is unable to capture.

7.3.2 Emergency Operations

7.3.2.1 Maximum Day Demand Plus Fire Flow

The maximum day demand plus fire flow scenario evaluates the existing fire flow availability in the City's distribution system under a maximum day demand condition. An overview of the evaluation and a discussion of the results are presented in the sections below.

7.3.2.1.1 Evaluation Overview

To evaluate the existing water system fire flow availability, AquaTwin Water's fire flow module was used to determine the available fire flow at all junctions that represent hydrant locations throughout the system, while maintaining a minimum residual system pressure of 20 psi at all customer service locations. The fire flow evaluation assumed that the fire event would occur during the hour where the peaking factor on the maximum day diurnal is closest to 1. Hour 48 from the maximum day demand plus peak hour EPS was chosen to run the fire flow analysis on. The purpose of this assumption is to confirm that storage is sufficient to supply fire flows during a typical maximum day demand. Maximum velocity is not considered in this evaluation because it is a secondary design criterion.

7.3.2.1.2 Evaluation Results

Figure 7-4 summarizes the percent of available fire flow available at each tested location with respect to its fire flow requirement. Results presented on Figure 7-4 are representative of the system's capacity and do not represent available flow from a specific hydrant. Typically, fire flows exceeding 1,500 gpm are met by multiple hydrants.

As shown on Figure 7-4, there are several locations that do not meet the recommended fire flow criteria. The majority of the tested locations that do not meet the recommended fire flow criteria are along older and/or small diameter pipelines (especially in the downtown area), areas with larger fire flow requirements (i.e., 4,000 gpm), or areas with a lack of looping where high head losses limit the ability to provide recommended fire flows while maintaining pressures greater than 20 psi.

Existing pipelines are assumed to meet fire flow standards that were in place at the time of construction, which may have been lower than the current standards. Therefore, the evaluation of the City's water system under existing demand conditions does not recommend specific pipeline improvements to increase existing fire flow capacity. However, a rehabilitation and replacement (R&R) program, described in detail in Chapter 9, is recommended to replace older and smaller diameter pipelines.

7.3.2.2 Additional Emergency Scenarios

In coordination with the City, 11 emergency scenarios were developed to evaluate the performance of the existing water distribution system under emergency conditions. Each emergency scenario listed below was evaluated under maximum day demand with peak hour conditions using a 96-hour EPS, with the emergency event assumed to occur at hour 24. The operational criteria applicable during maximum day demand under peak hour demand conditions are detailed in Chapter 5 (i.e., minimum pressure of 40 psi under peak hour demand at customer service locations and maximum velocity of seven (7) fps in

distribution pipelines). Results are presented for the final 72 hours of each simulation, as these reflect system performance during the emergency and are not influenced by initial conditions. An overview of each evaluation and a discussion of the results are presented in the following sections:

- Emergency Scenario 1: Loss of all PCWA water sources
- Emergency Scenario 2: Unregulated PCWA Source and Catta Verdera BPS Failure
- Emergency Scenario 3: 775 Zone Unregulated PCWA Connection Failure
- Emergency Scenario 4: 750 Zone Unregulated PCWA Connection Failure
- Emergency Scenario 5: Conspiracy Point Tank 30-inch Diameter Pipeline Failure
- Emergency Scenario 6: Three Largest Groundwater Wells Offline
- Emergency Scenario 7: Stoneridge Blvd 24-inch Diameter Pipeline Failure
- Emergency Scenario 8: 3 MG Tank 20-inch Diameter Pipeline Failure
- Emergency Scenario 9: Verdera Tank No. 3 36-inch Diameter Pipeline Failure
- Emergency Scenario 10: Zone Control Valve in the Camino Cielo Walking Path Failure
- Emergency Scenario 11: Zone Control Valve at Anton Lane and Andover Lane Failure

All storage tanks are assumed to start at 60 percent full, as directed by the City, which correspond to initial tank levels of 20 feet in the Conspiracy Point Tank, 19 feet in Verdera Tank No. 3, and 17 feet in the 3 MG Tank. Results described in the following sections are based on this assumption and may vary if actual tank levels are lower or higher at the time of an emergency. No other operational changes are made from normal operating conditions unless otherwise stated.

It should be noted for most of the emergency scenarios the same distribution pipelines identified in the 375 Zone for the normal operations evaluation have a maximum velocity greater than 7 fps. For some emergency scenarios, additional distribution pipelines are greater than 7 fps but remain under 10 fps. No recommendations are made for these pipelines. Only new pipeline locations with velocities greater than 10 fps are identified in the results.

7.3.2.2.1 Emergency Scenario 1: Loss of All PCWA Water Sources

Emergency Scenario 1 assumes loss of all PCWA regulated and unregulated supply sources. The City's five groundwater wells and the Catta Verdera BPS are active for this scenario. As expected, pressures in the upper zones (i.e., 775, 650, 750, and 610 Zones) supplied by the unregulated connections immediately drop below 40 psi when the supply is lost as there are no other available supply facilities to these zones. Also as anticipated, approximately seven hours after loss of supply, the tank levels in both the Conspiracy Point Tank and Verdera Tank No. 3 reach their minimum levels which cause pressures to drop below 40 psi in the 475 and 575 Zones. Since the 375 Zone has groundwater wells as additional supply, the level in the 3 MG Tank reaches its minimum level after 12 hours of supply loss and pressures within the zone drop below 40 psi after 20 hours of supply loss.

The scenario was re-evaluated with the recommended emergency BPSs from the storage capacity evaluation for the 750 and 775 Zones. Pressures in the upper zones drop below 40 psi after seven hours of loss of supply, while values for the rest of the zones remain the same.

To mitigate loss of PCWA supply, the City is recommended to evaluate additional supply sources discussed in Chapter 4 (i.e., ASR wells, groundwater recharge, recycled water) and consider expanding groundwater well capacity. These recommendations are further discussed and evaluated in Chapter 8. Customers would also be required to significantly reduce water use to extend the available supply. Per the City's Water Shortage Contingency Plan, the loss of PCWA supply would result in a shortage stage of level 6 being declared which requires water be used for health and safety purposes only. Additionally, the 750 Zone and 775 Zone emergency BPSs are recommended to be constructed to ensure continued service to the upper zones.

7.3.2.2.2 Emergency Scenario 2: Unregulated PCWA Source and Catta Verdera BPS Failure

Emergency Scenario 2 assumes the loss of unregulated PCWA supply and the failure of the Catta Verdera BPS. As discussed in the previous scenario, the 775 Zone has no alternative supply source besides supply from PCWA. Without the Catta Verdera BPS, the 750, 650, and 610 Zones would also have no supply.

The scenario was re-evaluated with the inclusion of the 750 Zone and 775 Zone BPSs, which allowed the upper zones to be supplied from the 575 Zone tanks. Inflow from the regulated PCWA connections were slightly increased, but remained within the contracted amount, to account for the demands in the upper zones. Without this adjustment, after three days of supply loss, the levels in the Conspiracy Point Tank and Verdera Tank No. 3 would drop to approximately 13 feet and 9 feet, respectively. This drop in the 575 Zone tank levels would cause minimum pressures in the 475 and 575 Zones to decrease but remain above 40 psi during peak hour.

Although the Catta Verdera BPS is currently equipped with a portable generator, installation of a permanent generator is recommended. Construction of the 775 Zone emergency BPS is also recommended, as the zone lacks backup supply. While complete failure of the Catta Verdera BPS is considered unlikely, construction of the 750 Zone emergency BPS is recommended to further enhance system redundancy and reliability.

7.3.2.2.3 Emergency Scenario 3: 775 Zone Unregulated PCWA Connection Failure

Emergency Scenario 3 assumes the failure of the unregulated PCWA connection supplying the 775 and 650 Zones with Catta Verdera BPS online. As previously discussed, the 775 Zone has no alternative supply source. However, the 650 Zone can receive supply from the 750 Zone via the Village 17 PRS. The Catta Verdera BPS operates and provides additional supply into the 750 Zone to support the 650 Zone demands.

The scenario was re-evaluated assuming construction of the 775 Zone emergency BPS. In this case, the Catta Verdera BPS did not operate, as the 775 Zone BPS also supplied the 650 Zone. Similar to Emergency Scenario 2, inflow from the regulated PCWA connections were slightly increased; if not adjusted, after three days of supply loss, the levels in the Conspiracy Point Tank and Verdera Tank No. 3 drop to approximately 15 feet and 12 feet, respectively. This drop in the 575 Zone tank levels would cause minimum pressures in the 475 and 575 Zones to decrease but remain above 40 psi during peak hour. As with Emergency Scenario 2, it is recommended the emergency 775 Zone emergency BPS be constructed.

7.3.2.2.4 Emergency Scenario 4: 750 Zone Unregulated PCWA Connection Failure

Emergency Scenario 4 assumes the failure of the unregulated PCWA connection supplying the 750 and 610 Zones with the Catta Verdera BPS online. As discussed in Chapter 2, prior to the installation of the unregulated PCWA connection, the Catta Verdera BPS historically provided supply to these zones. In the

event of an unregulated PCWA connection failure, the Catta Verdera BPS is capable of meeting zone demands which was confirmed when this scenario was evaluated in the model.

In the event of the 750 Zone unregulated connection failure, the Catta Verdera BPS becomes a critical pumping facility as defined by the criteria in Chapter 5. Therefore, it is recommended to install a permanent generator at the facility to ensure reliable operation. The construction of the 750 Zone emergency BPS is not required for this emergency scenario as the Catta Verdera BPS can provide adequate supply to the 750 and 610 Zones.

7.3.2.2.5 Emergency Scenario 5: Conspiracy Point Tank 30-inch Diameter Pipeline Failure

Emergency Scenario 5 assumes a break in the 30-inch diameter transmission pipeline downstream of the Conspiracy Point Tank into the distribution system. Assuming the outflow from the Conspiracy Point Tank is shut off after the pipeline break, the Conspiracy Point Tank levels would continuously increase. However, City operations staff continuously monitor tank levels through SCADA and would make an immediate adjustment to the inflow into the Conspiracy Point Tank to prevent the tank from overflowing. The 3 MG Tank reaches its minimum level after six hours, and Verdera Tank No. 3 reaches its minimum level after 10 hours. Minimum pressures in the majority of the system drop below 40 psi five hours after the pipeline break.

Adjustments to model controls were made to identify operational recommendations. Within four hours after the pipeline break (i.e., before pressures drop below 40 psi and the Conspiracy Point Tank overflows), it is recommended City operations staff make the following adjustments to maintain adequate service during repairs:

- Shut off valve for the 30-inch diameter transmission pipeline downstream of the Conspiracy Point Tank
- Shut off supply into the Conspiracy Point Tank
- Increase supply through the regulated PCWA connection at the metering station at the Verdera Tank No. 3 site
- Turn on all groundwater wells
- Reduce inflow significantly into the 3 MG Tank

With these adjustments, the levels in the active tanks are generally lower than levels during normal operations; Verdera Tank No. 3 ranges from approximately 7 to 14 feet, while the 3 MG Tank ranges from approximately 9 to 20 feet. Figure 7-5 shows the change in minimum pressures compared to normal operations under maximum day demand (Figure 7-2). Pressures in the western portion of the 375 Zone increase by 5 to 10 psi, while pressures in the 575 Zone decrease by 5 to 10 psi north of Stonebridge Boulevard and by more than 10 psi south of Stonebridge Boulevard. However, almost all customer service locations remain above 40 psi under peak hour demand, with the exception of three locations near Rossi Lane, where minimum pressures are approximately 35 to 36 psi, as shown on Figure 7-5.

7.3.2.2.6 Emergency Scenario 6: Three Largest Groundwater Wells Offline

Emergency Scenario 6 assumes the City's three largest capacity groundwater wells (i.e., Nelson, Fiddymont, and Moore Road Wells) are offline. Operations remain the same as the normal operations under maximum day demand evaluation except the two wells that are operating are the two smallest capacity wells: Well 2 (800 gpm) and Westwood Well (900 gpm). Results of the evaluation indicate that

there are minimal effects on the system if the three largest capacity wells are offline. Pressures drop minimally (0 to 1.5 psi) compared to the pressures from the normal operations under maximum day demand. There are no customer service locations that experience pressures below 40 psi during peak hour. No recommendations are made for this scenario.

7.3.2.2.7 Emergency Scenario 7: Stoneridge Blvd 24-inch Diameter Pipeline Failure

Emergency Scenario 7 assumes a break in the 24-inch diameter transmission pipeline in Stonebridge Boulevard west of the Catta Verdera BPS. Figure 7-6 shows the change in minimum pressures compared to normal operations under maximum day demand (Figure 7-2). As shown on Figure 7-6, minimum pressures in the 575 Zone north of Twelve Bridges Drive decrease by five (5) to more than 15 psi, with the greatest impacts occurring in neighborhoods north and south of Stonebridge Boulevard (i.e., along Hidden Hills Lane, Monument Drive, Winding Way, Blue Heron Loop, Kingfisher Lane, and Spring Valley Parkway). Minimum pressures in the 575 Zone south of Twelve Bridges Drive increase slightly by 0 to 5 psi, while pressures in the rest of the system decrease minimally by 0 to 5 psi. However, no customer service locations in the entire system drop below 40 psi under peak hour demand. No recommendations are made for this scenario.

7.3.2.2.8 Emergency Scenario 8: 3 MG Tank 20-inch Diameter Pipeline Failure

Emergency Scenario 8 assumes a break in the 20-inch diameter transmission pipeline downstream of the 3 MG Tank into the distribution system. Assuming the outflow from the 3 MG Tank is shut off after the pipeline break, the 3 MG Tank levels would continuously increase. However, City operations staff continuously monitor tank levels through SCADA and would make an immediate adjustment to the inflow into the 3 MG Tank to prevent the tank from overflowing. The Conspiracy Point Tank reaches its minimum level after 33 hours, and Verdera Tank No.3 reaches its minimum level after 32 hours. Minimum pressures in the Turkey Creek Estates and Lincoln Meadows developments drop below 40 psi five hours after the pipeline break.

Similar to Emergency Scenario 5, adjustments to model controls were made to identify operational recommendations. Within four hours after the pipeline break (i.e., before pressures drop below 40 psi), it is recommended City operations staff make the following adjustments to maintain adequate service to customers while the pipeline is being repaired:

- Shut off valve for the 20-inch diameter transmission pipeline downstream of the 3 MG Tank
- Reduce inflow into the 3 MG Tank
- Turn on two groundwater wells
- Decrease supply through the regulated PCWA connection at the metering station at the Conspiracy Point Tank site
- Decrease supply through the regulated PCWA connection at the metering station at the Verdera Tank No. 3 site

With these adjustments, tank levels are generally lower than levels during normal operations; the 3 MG Tank ranges from approximately 11 to 16 feet, the Conspiracy Point Tank ranges from approximately 11 to 19 feet, while Verdera Tank No. 3 ranges from approximately 8 to 16 feet. Figure 7-7 shows the change in minimum pressures compared to normal operations under maximum day demand (Figure 7-2). As shown on Figure 7-7, the Esplanade and Turkey Creek Estates developments in the 375 Zone experience the largest minimum pressure decrease by more than 10 psi and pressures southwest of Esplanade decrease

by 10 to 15 psi. Majority of pressures in the remaining 375 Zone decrease by 5 to 10 psi, while pressures in the remainder of the system decrease minimally by 0 to 5 psi. However, most customer service locations remain above 40 psi under peak hour demand, with the exception of Turkey Creek Estates, where minimum pressures are approximately 35 to 39 psi, as shown on Figure 7-7.

The City may consider installing a temporary emergency BPS to help boost pressures in Turkey Creek Estates in the event of emergency. However, it should be noted, within the next five years, the 20-inch diameter transmission pipeline is planned to be replaced by a 30-inch diameter transmission pipeline and a new pressure zone (450 Zone) will be created to serve Village 1 developments located in high elevations. This transmission pipeline replacement and new 450 Zone are planned to be completed as part of the Leavell Ranch Project in Village 1 and West Yost is currently conducting a water system hydraulic evaluation to assess the impacts of this development on the City's water system. The proposed 450 Zone will be supplied through a PRS from the 575 Zone with a secondary PRS from the 610 Zone. Additionally, as part of the Leavell Ranch development, an emergency PRS from the 450 to 375 Zone near Turkey Creek Estates is recommended to be constructed which will provide a secondary supply avenue for the 375 Zone. This emergency PRS would help alleviate low pressures in the event of the 20-inch diameter pipeline (or new 30-inch diameter pipeline) failure. Recommendations associated with the Leavell Ranch Project are further evaluated and discussed in Chapter 8.

7.3.2.2.9 Emergency Scenario 9: Verdera Tank No. 3 36-inch Diameter Pipeline Failure

Emergency Scenario 9 assumes a break in the 36-inch diameter transmission pipeline downstream of Verdera Tank No. 3 into the distribution system. Assuming the outflow from Verdera Tank No. 3 is shut off after the pipeline break, Verdera Tank No. 3 tank levels would continuously increase. However, City operations staff continuously monitor tank levels through SCADA and would make an immediate adjustment to the inflow into Verdera Tank No. 3 to prevent the tank from overflowing. The Conspiracy Point Tank reaches its minimum level after seven hours, and the 3 MG Tank reaches its minimum level after 11 hours. Minimum pressures at several locations in the system drop below 40 psi five hours after the pipeline break.

Similar to Emergency Scenario 5, adjustments to model controls were made to identify operational recommendations. Within four hours after the pipeline break (i.e., before pressures drop below 40 psi), it is recommended City operations staff make the following adjustments to maintain adequate service to customers while the pipeline is being repaired:

- Shut off valve for the 36-inch diameter transmission pipeline downstream of Verdera Tank No. 3
- Shut off supply into Verdera Tank No. 3
- Increase supply through the regulated PCWA connection at the metering station at the Conspiracy Point Tank site
- Turn on all groundwater wells
- Reduce inflow significantly into the 3 MG Tank

With these adjustments, the levels in the active tanks are generally lower than levels during normal operations; Conspiracy Point Tank ranges from approximately 7 to 15 feet, while the 3 MG Tank ranges from approximately 9 to 20 feet. Figure 7-8 shows the change in minimum pressures compared to normal operations under maximum day demand (Figure 7-2). Pressures in the western portion of the 375 Zone

increase by 5 to 10 psi, while pressures in the 575 Zone decrease by more than 10 psi north of Twelve Bridges Drive and by 5 to 10 psi south of Twelve Bridges Drive. However, almost all customer service locations remain above 40 psi under peak hour demand, with the exception of three locations near Rossi Lane, where minimum pressures are approximately 36 to 38 psi, as shown on Figure 7-8.

7.3.2.2.10 Emergency Scenario 10: Zone Control Valve in the Camino Cielo Walking Path Failure

Emergency Scenario 10 assumes failure of the normally closed 12-inch diameter zone control valve located in the Camino Cielo walking path, which separates the 610 and 575 Zones. For this scenario, the valve is assumed to fail fully open, resulting in an average flow of 1,050 gpm and a maximum flow of 1,400 gpm from the 610 Zone to the 575 Zone.

With the 610 Zone supplying the 575 Zone, flow from the unregulated PCWA connection in the 750 Zone increases substantially to meet the additional 575 Zone demands and significantly exceeds the contracted maximum deliverable amount by 226 percent. The Catta Verdera BPS also operates continuously to support demands in the 750 and 610 Zones, but because it draws from the 575 Zone it is effectively pumping in a loop. Additionally, the 575 Zone tanks continuously fill and reach overflow levels about three days after the valve failure, while the level in the 3 MG Tank is approximately 23 feet.

The main concern with a sudden failure of a zone control valve is the resulting pressure changes and high velocities. In the 610 Zone, minimum pressures decrease on average by six (6) psi; however, no customer service locations drop below 40 psi. In the 575 Zone, maximum pressures increase by four (4) to five (5) psi, with most locations remaining below 120 psi. Figure 7-9 shows the maximum pressures under maximum day demand in the 575 Zone. As shown on Figure 7-9, a few customer service locations north and south of Stonebridge Boulevard (i.e., along Winding Way, Blue Heron Loop, and Monument Drive) and at the southeastern border of the 575 Zone exceed the maximum pressure criterion, however, pressures remain at or below 125 psi. Areas with known maximum pressures near 135 psi along Hidden Hills Lane increase to approximately 136 to 139 psi. Pressures in the remainder of the system remain similar to normal conditions.

It is recommended City consider the following to maintain adequate service to customers while the zone control valve is being repaired:

- Shut off the Catta Verdera BPS to prevent pumping in a circle
- Close valves feeding the 12-inch diameter pipeline connected to the zone control valve to isolate the valve for repair
- Install motor-operated valves upstream and downstream of the 12-inch diameter pipelines to be able to quickly isolate the valve for repair

7.3.2.2.11 Emergency Scenario 11: Zone Control Valve at Anton Lane and Andover Lane Failure

Emergency Scenario 11 assumes the failure of the normally closed 8-inch diameter zone control valve located at the intersection of Anton Lane and Andover Lane, which separates the 475 and 375 Zones. For this scenario, the valve is assumed to fail fully open, resulting in an average flow of 2,224 gpm and a maximum flow of 2,400 gpm from the 475 Zone to the 375 Zone. Due to the increase in supply from the 475 Zone, supply from the 3 MG Tank would decrease and tank levels would continuously increase. However, City operations staff continuously monitor tank levels through SCADA and would make an

immediate adjustment to the inflow into the 3 MG Tank to prevent the tank from overflowing. Tank levels in the Conspiracy Point Tank and Verdera Tank No. 3 are at 10 feet and 4 feet, respectively.

As previously discussed, the main concern with a sudden failure of a zone control valve is the resulting pressure changes and high velocities. Figure 7-10 shows the change in minimum pressures compared to normal operations under maximum day demand (Figure 7-2) and locations of maximum velocity exceedances. In the 475 Zone, minimum pressures near the valve decrease by five (5) to more than 15 psi, while the remainder of the zone experiences minimal decreases of 0 to 1 psi; no customer service locations drop below 40 psi during peak hour. In the 375 Zone, maximum pressures closest to the valve increase by 2 to 3 psi, with no locations exceeding 120 psi.

As shown on Figure 7-10, the largest pressure decreases and highest velocities occur upstream of the valve along the 8-inch diameter pipelines in Anton Lane and in Beckwith Lane between Anton Lane and Monument Drive. This segment experiences extremely high velocities, with an average of 14.3 fps and maximum values ranging from 10 to 15 fps. These high velocities for long-sustained periods can lead to pipeline breaks. Pressures and velocities in the remainder of the system remain similar to normal conditions. No recommendations are made for this scenario, however, the City should be aware of the pipelines in this location if the valve failure were to occur.

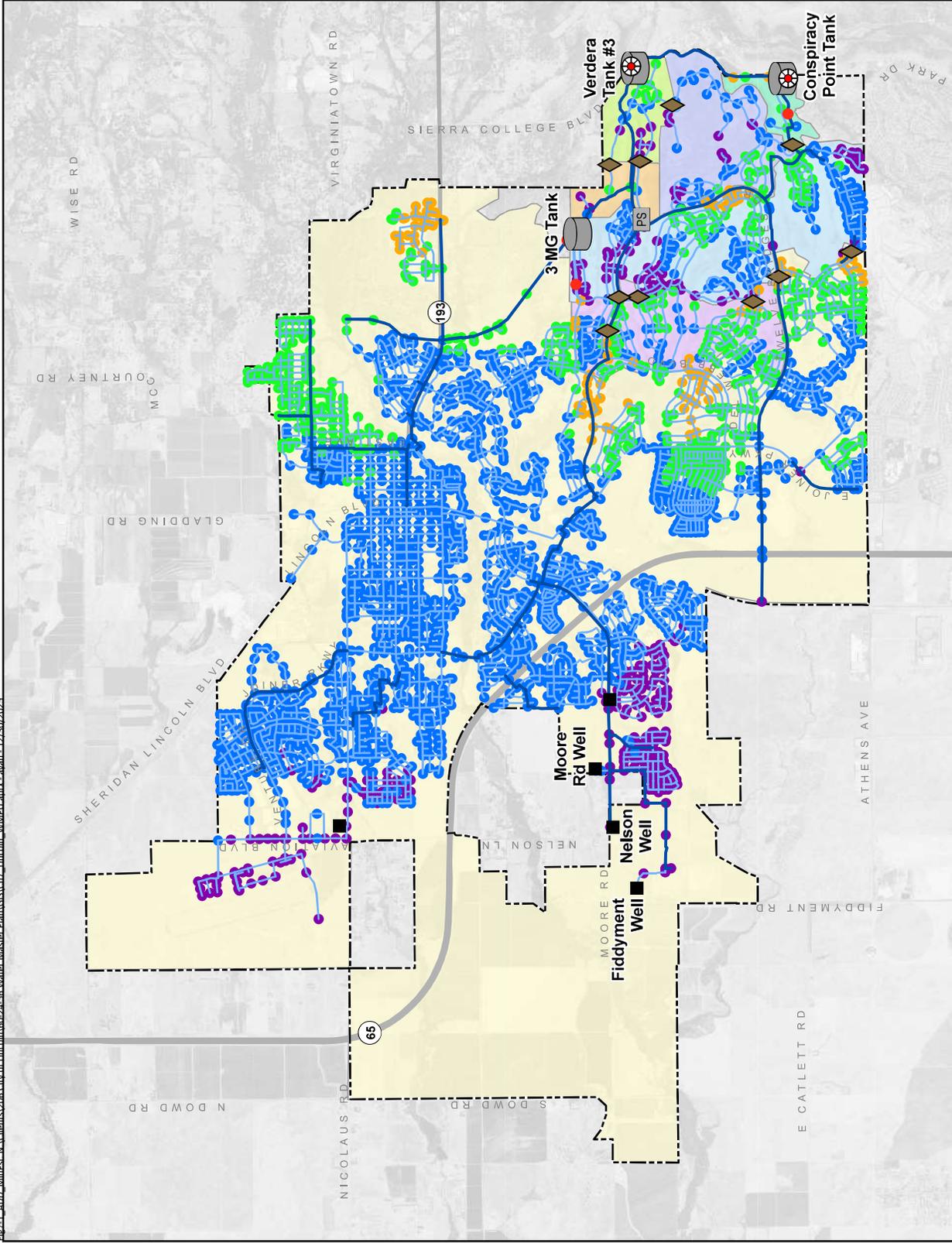
7.4 SUMMARY OF FINDINGS AND RECOMMENDATIONS FOR THE EXISTING WATER SYSTEM

Findings and recommended improvements for the existing water system are summarized below. Figure 7-11 summarizes all recommended improvements for the existing water system. These recommendations are used to develop a recommended capital improvement program, which is further described in Chapter 10.

- Supply
 - No supply-related improvements are recommended.
- Storage and Pumping
 - Address the existing storage deficit in the 375 Pressure Zone through installation of dedicated on-site backup power at the Nelson and Moore Wells to provide 1.76 MG of EGWC and improve system reliability.
 - Address the existing storage deficit in the 750 Pressure Zone through construction of a new emergency booster pump station at the Verdera Tank No. 3 tank site with a minimum capacity of two (2) mgd.
 - Address the existing storage deficit in the 775 Pressure Zone through construction of a new emergency booster pump station at the Conspiracy Point Tank site with a minimum capacity of four (4) mgd.
- Pipelines
 - Replace 8-inch diameter pipeline at intersection of 1st Street and Joiner Parkway with a new 16-inch diameter pipeline to mitigate velocity exceedance.
 - Replace 8-inch diameter pipeline at intersection of E Street and McBean Park Drive with a new 12-inch diameter pipeline to mitigate velocity exceedance.

- Rehabilitation and Replacement
 - Enhance the City’s existing pipeline R&R program to accelerate the replacement of aging and undersized distribution pipelines on a proactive and programmatic basis before they fail and require emergency repair and replacement. A recommended program is described in Chapter 9. Upsizing many of the smaller diameter pipelines would improve fire flow in the downtown area of the City.
- Other Recommendations
 - Update flushing program to include water quality parameters to improve water quality in the developments in northeastern extent of City limits, the Turkey Creek Estates development, and the Airport Area.

Fig2_1_ADD_MinPsi: \\N:\Clients\2015_City of Lincoln\60-24-56_Water Master Plan\GIS\City of Lincoln_WM\BLL.aprx - numn - 12/30/2015



Prepared by:



Prepared for:

City of Lincoln
Water Master Plan Update

Minimum Pressure at Average Day Demand Existing Water System
Figure 7-1

- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- Existing System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Catta Verdera Pump Station
 - ◆ Pressure Regulating Station
 - ⊕ Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)

- Existing Boundaries**
- 375 Zone
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - 650 Zone
 - 750 Zone
 - 775 Zone
 - City Limit

Notes:
 1. Total system average day demand is 9.0 million gallons per day (refer to Table 7-1).
 2. Velocities in the entire system are less than 7 feet per second.

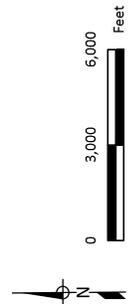
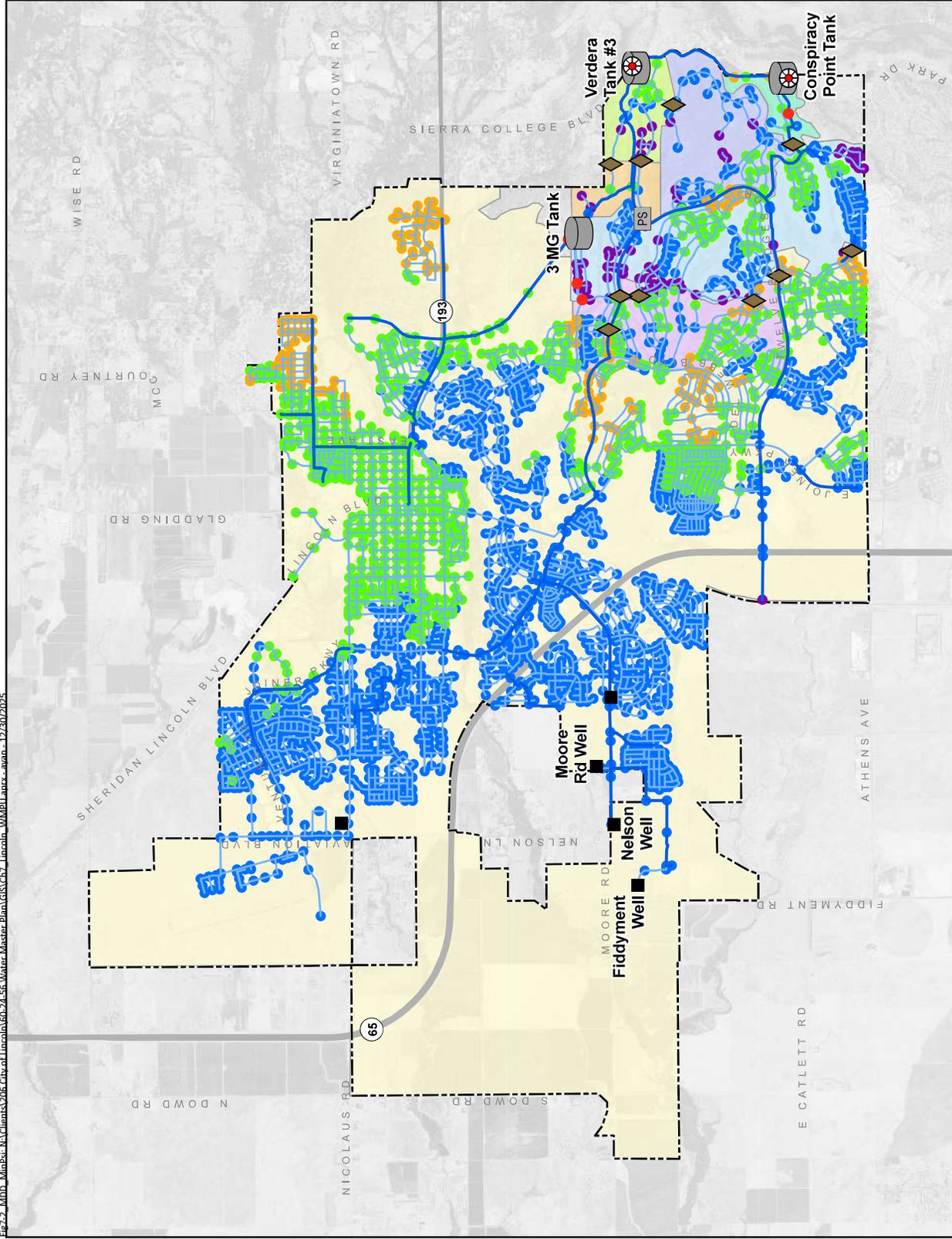


Fig2.2_MDD_Micro: \\N:\Clients\2006_City of Lincoln\602456_Water Master Plan\GIS\CBZ_Lincoln_WMPLU.aprx - splan - 12/30/2025



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- Existing System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Catta Verdera Pump Station
 - ◆ Pressure Regulating Station
 - ⊂ Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)

- Existing Boundaries**
- 375 Zone
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - 650 Zone
 - 750 Zone
 - 775 Zone
 - City Limit

Notes:

1. Total system maximum day demand is 16.9 mgd and peak hour demand is 36.9 mgd (refer to Table 7-1).
3. Velocities in the entire system are less than 7 fps.

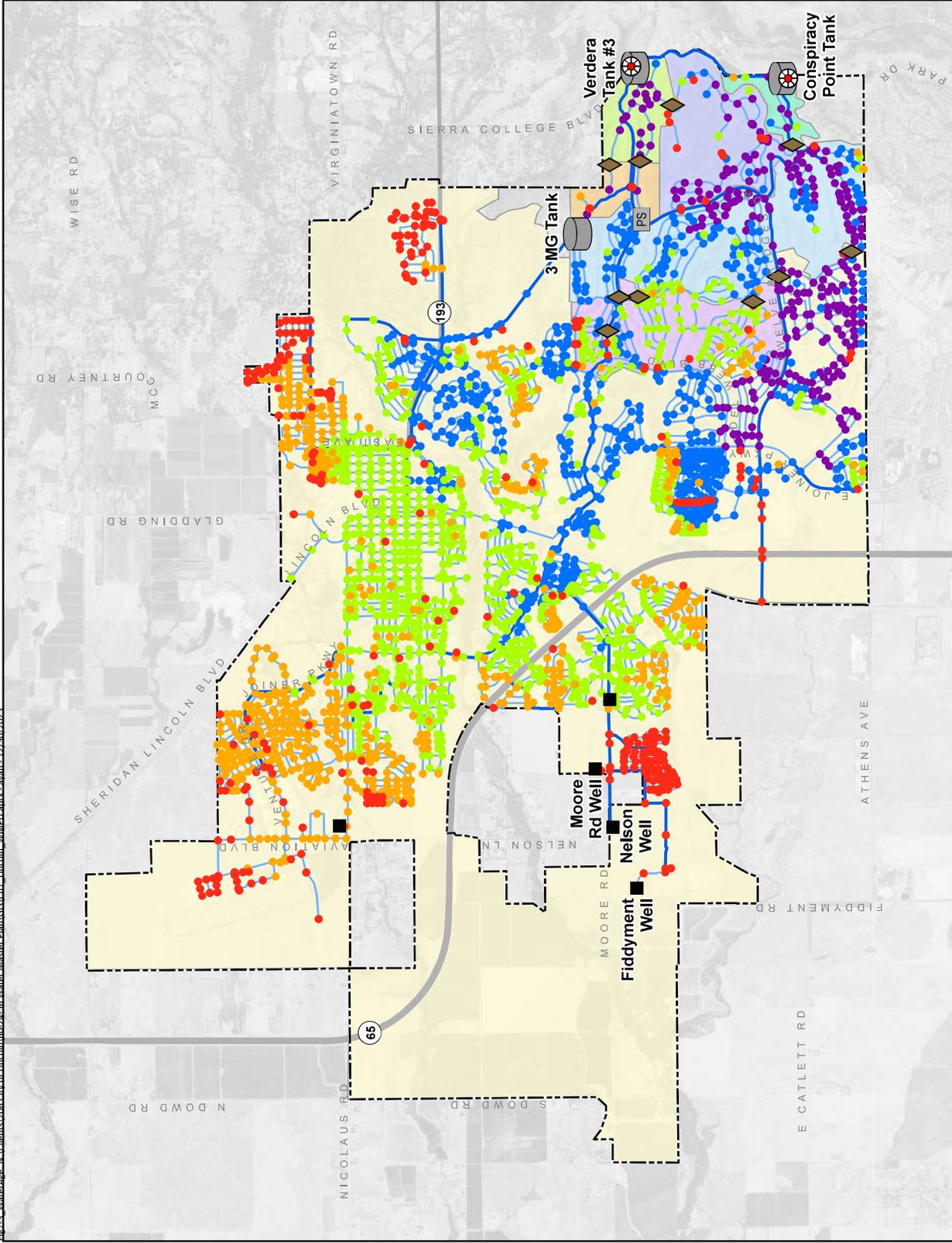
Minimum Pressure at Maximum Day Demand Existing Water System
Figure 7-2

Prepared by: **WEST YOST**

Prepared for: **City of Lincoln**
 Water Master Plan Update

City of Lincoln
 Live Life Lincoln

Scale: 0, 3,000, 6,000 Feet



- Maximum Water Age**
- Less than 2 days
 - 2 - 3 days
 - 3 - 4 days
 - 4 - 7 days
 - Greater than 7 days

Existing System Facilities

- ⊗ Placer County Water Agency Metering Station
- Groundwater Well
- PS Catta Verdera Pump Station
- ◆ Pressure Regulating Station
- ⊂ Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Existing Boundaries

- 375 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- City Limit

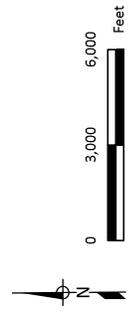
Notes:

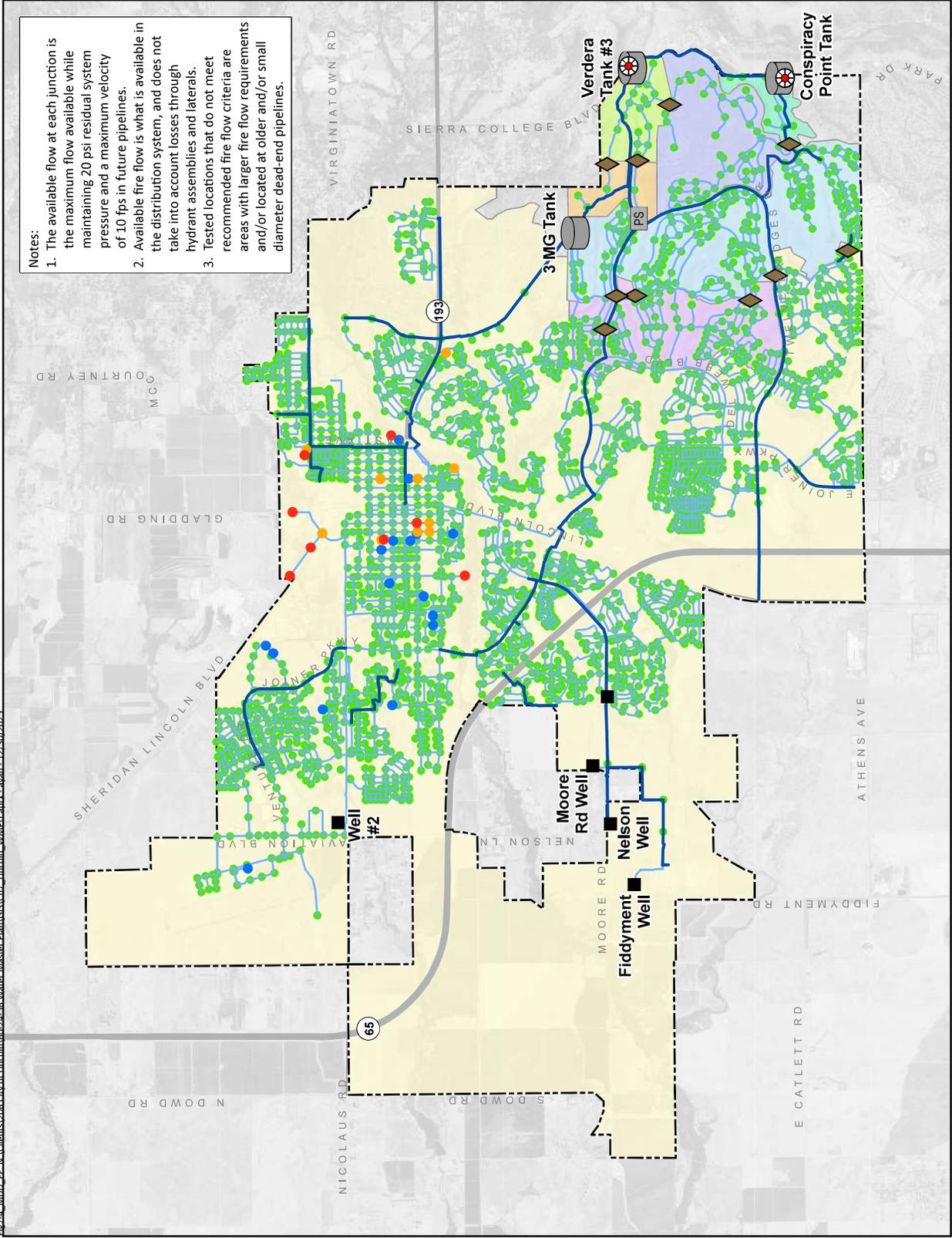
1. Total system minimum day demand is 4.7 mgd which was used to develop the minimum day diurnal in Chapter 3.
2. Water age was evaluated over a 30-day period.

Maximum Water Age at Minimum Day Demand Existing Water System
Figure 7-3

Prepared for:

City of Lincoln
 Water Master Plan Update





Notes:

1. The available flow at each junction is the maximum flow available while maintaining 20 psi residual system pressure and a maximum velocity of 10 fps in future pipelines.
2. Available fire flow is what is available in the distribution system, and does not take into account losses through hydrant assemblies and laterals.
3. Tested locations that do not meet recommended fire flow criteria are areas with larger fire flow requirements and/or located at older and/or small diameter dead-end pipelines.

Percent of Available Fire Flow

- ≥ 100% of Criteria
- 75 - 100% of Criteria
- 50 - 75% of Criteria
- < 50% of Criteria

Existing System Facilities

- ⊕ Placer County Water Agency Metering Station
- Groundwater Well
- PS Catta Verdera Pump Station
- ◆ Pressure Regulating Station
- ⊕ Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (>18-inch)

Existing Boundaries

- 375 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- City Limit

Prepared by:

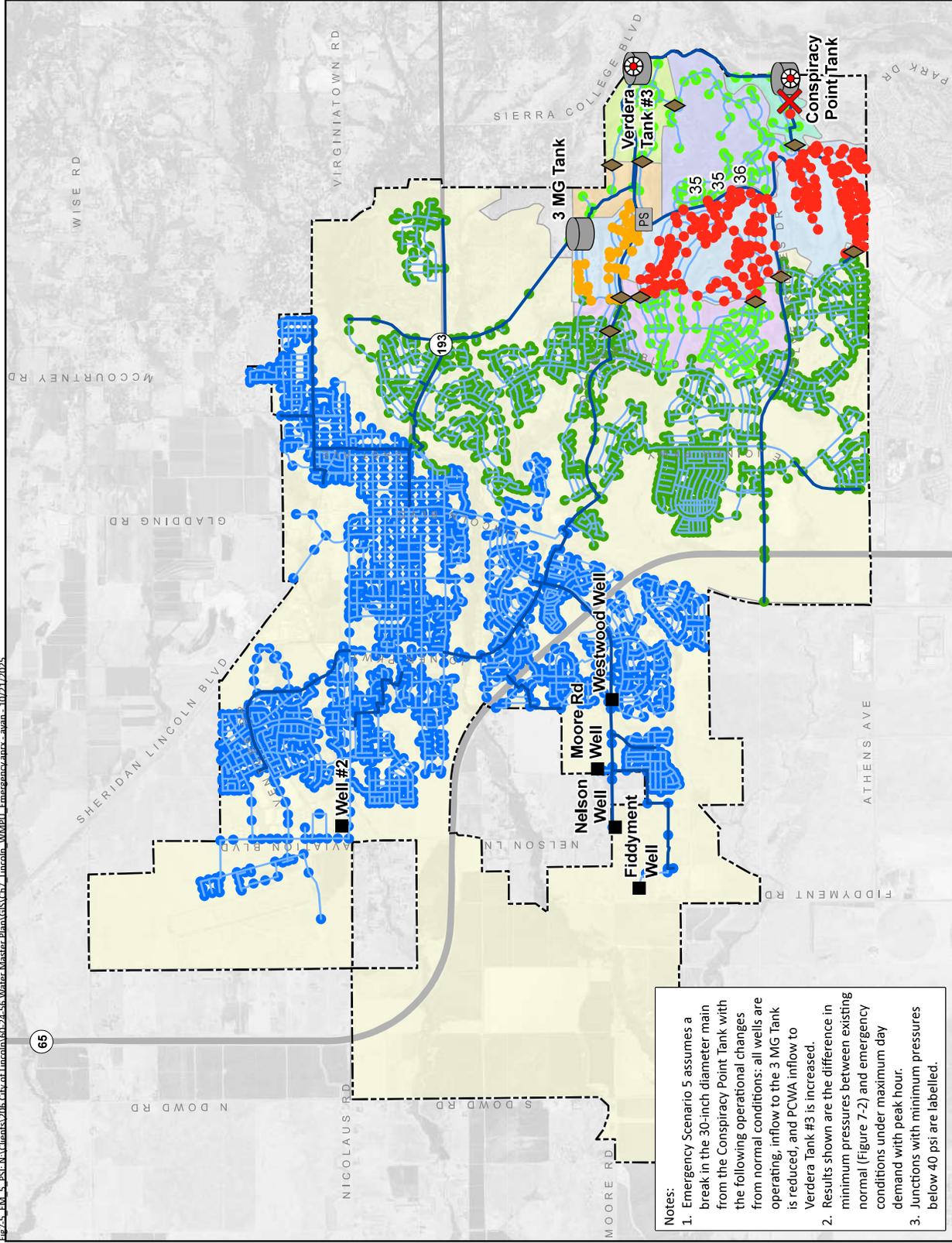


Prepared for:

City of Lincoln
Water Master Plan Update



Percent of Fire Flow Requirement Available Existing Water System
Figure 7-4



Change in Pressure

- Transmission Main Break
- Greater than -10 psi
- 10 to -5 psi
- 5 to 0 psi
- 0 to 5 psi
- 5 to 10 psi
- Greater than 10 psi

System Facilities

- Placer County Water Agency Metering Station
- Catta Verdera Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit

Notes:

- Emergency Scenario 5 assumes a break in the 30-inch diameter main from the Conspiracy Point Tank with the following operational changes from normal conditions: all wells are operating, inflow to the 3 MG Tank is reduced, and PCWA inflow to Verdera Tank #3 is increased.
- Results shown are the difference in minimum pressures between existing normal (Figure 7-2) and emergency conditions under maximum day demand with peak hour.
- Junctions with minimum pressures below 40 psi are labelled.

Change in Minimum Pressures Emergency Scenario 5
Figure 7-5

Transmission Main Break

Change in Pressure

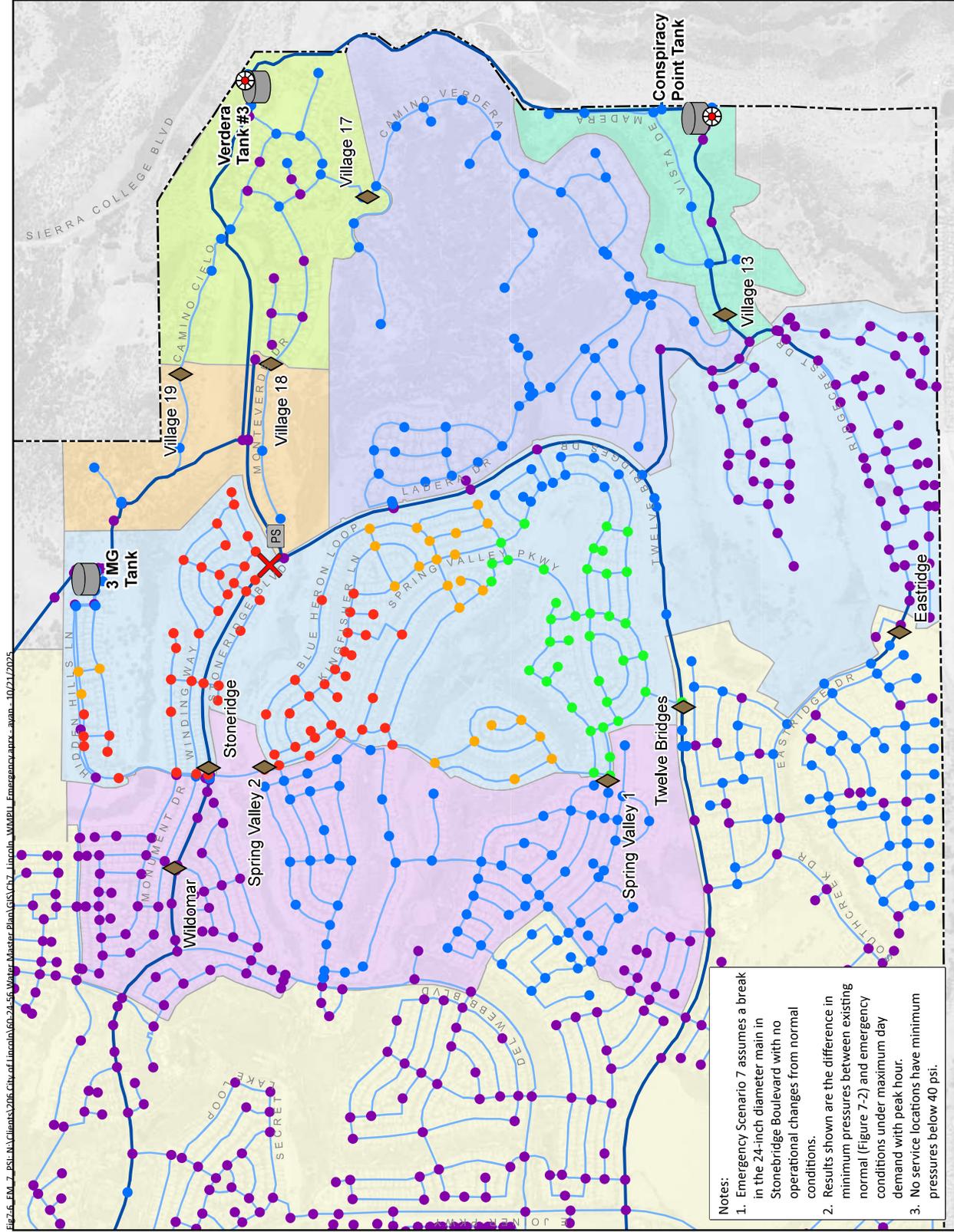
- Greater than -15 psi
- 15 to -10 psi
- 10 to -5 psi
- 5 to 0 psi
- 0 to 5 psi

System Facilities

- Placer County Water Agency Metering Station
- Catta Verdera Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit

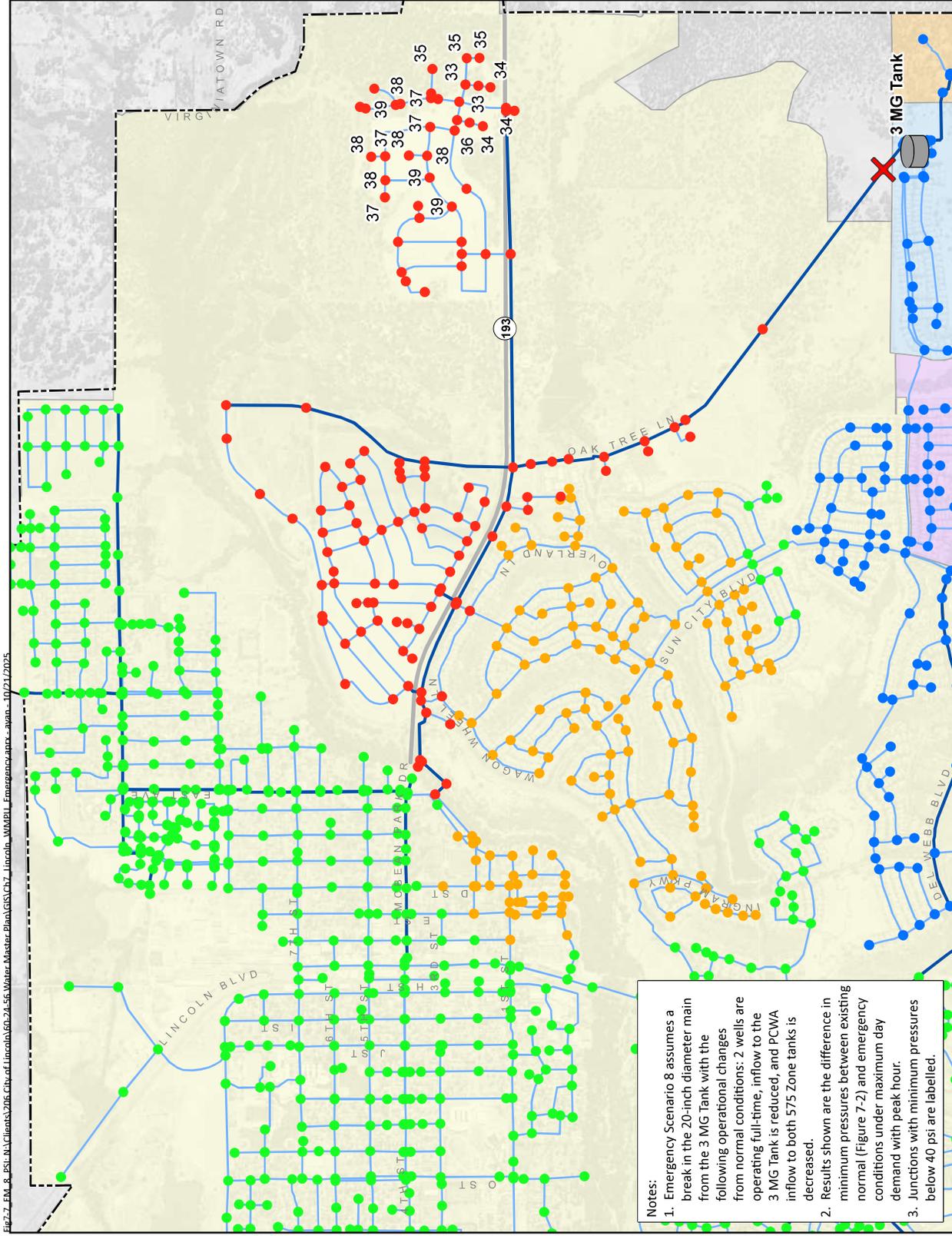


Notes:

1. Emergency Scenario 7 assumes a break in the 24-inch diameter main in Stonebridge Boulevard with no operational changes from normal conditions.
2. Results shown are the difference in minimum pressures between existing normal (Figure 7-2) and emergency conditions under maximum day demand with peak hour.
3. No service locations have minimum pressures below 40 psi.

Change in Minimum Pressures Emergency Scenario 7
Figure 7-6

Fig 7-6_EM_7_PSI - R:\Clients\2016_City of Lincoln\602456_Water Master Plan\GIS\CBZ_Lincoln_WMPL_Emergency\apex - apax - 10/21/2025

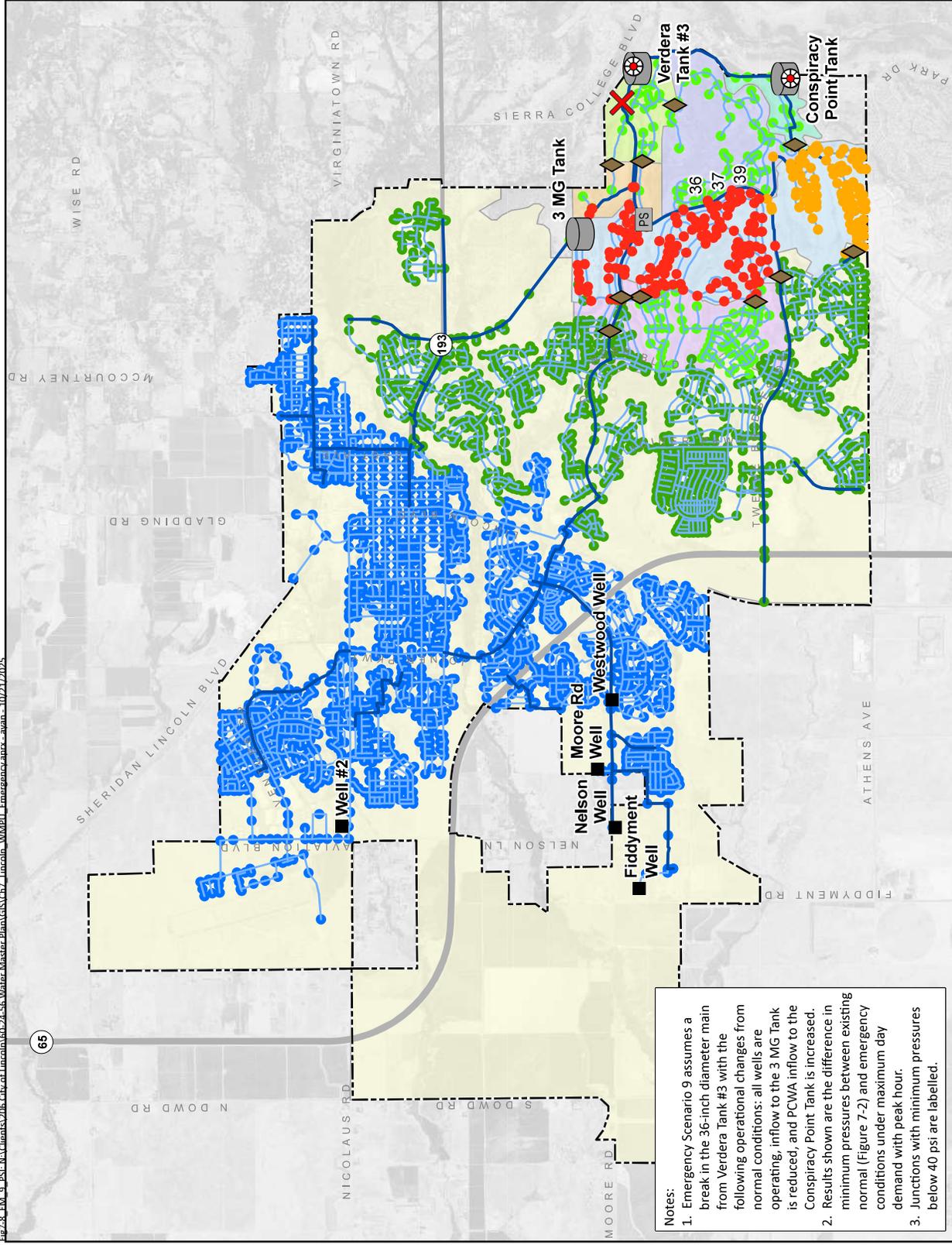


- ✗ Transmission Main Break
- Change in Pressure**
 - Greater than -15 psi
 - -15 to -10 psi
 - -10 to -5 psi
 - -5 to 0 psi
 - 0 to 5 psi
- System Facilities**
 - Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)
- Boundaries**
 - 375 Zone
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - Existing City Limit

Notes:

1. Emergency Scenario 8 assumes a break in the 20-inch diameter main from the 3 MG Tank with the following operational changes from normal conditions: 2 wells are operating full-time, inflow to the 3 MG Tank is reduced, and PCWA inflow to both 575 Zone tanks is decreased.
2. Results shown are the difference in minimum pressures between existing normal (Figure 7-2) and emergency conditions under maximum day demand with peak hour.
3. Junctions with minimum pressures below 40 psi are labelled.

Fig2_8_E_M_9_PSI - 1/11/2016 Client: 2016 City of Lincoln, 6024156 Water Master Plan\GIS\CBZ_Lincoln_WM\PIU_Emergency\apex - apax - 10/21/2025



Notes:

- Emergency Scenario 9 assumes a break in the 36-inch diameter main from Verdera Tank #3 with the following operational changes from normal conditions: all wells are operating, inflow to the 3 MG Tank is reduced, and PCWA inflow to the Conspiracy Point Tank is increased. Results shown are the difference in minimum pressures between existing conditions under maximum day demand with peak hour.
- Junctions with minimum pressures below 40 psi are labelled.

Change in Pressure

- Transmission Main Break
- Greater than 10 psi
- 10 to -5 psi
- 5 to 0 psi
- 0 to 5 psi
- 5 to 10 psi
- Greater than 10 psi

System Facilities

- Placer County Water Agency Metering Station
- Catta Verdera Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit

Prepared by:

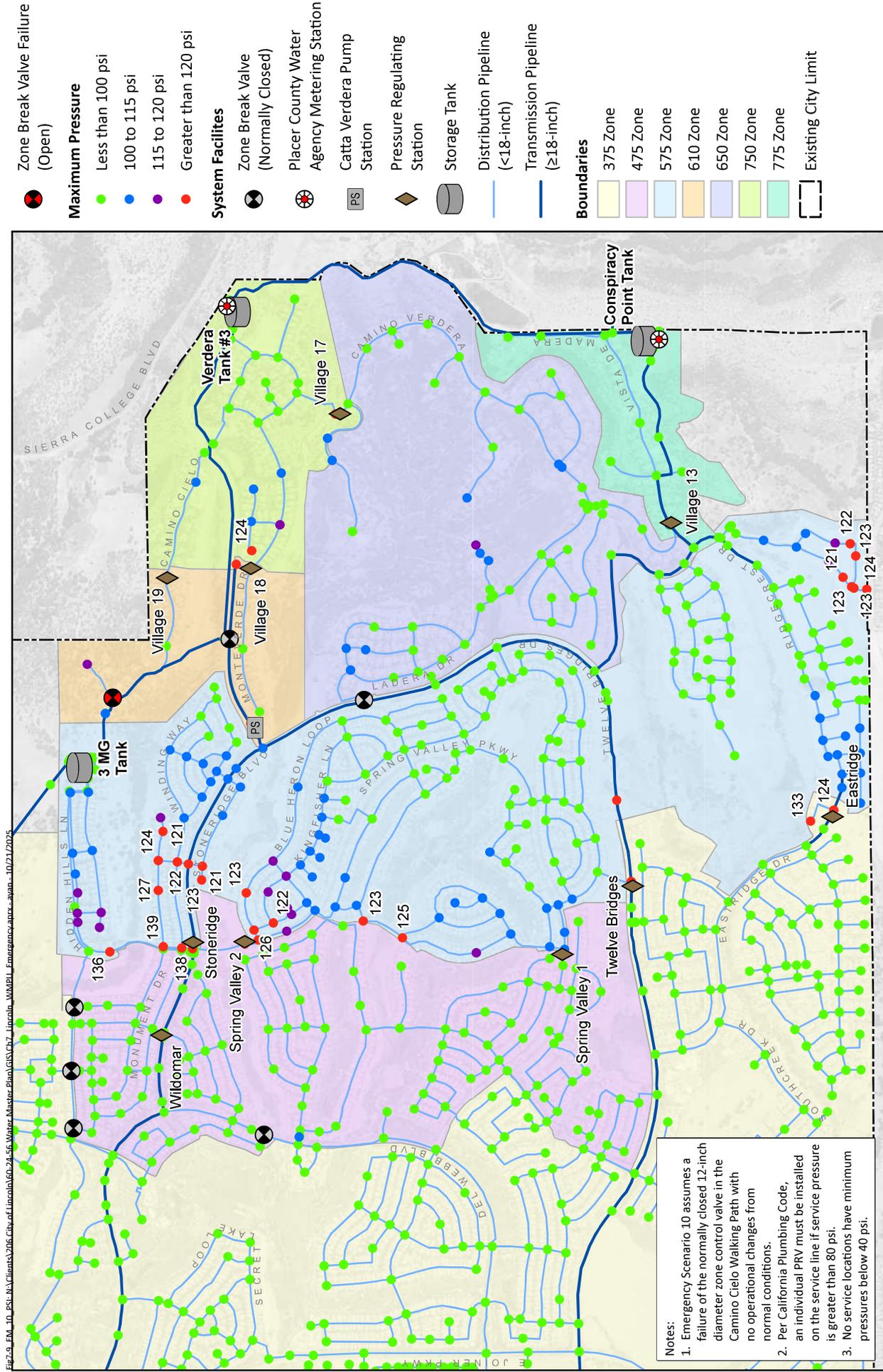


Prepared for:

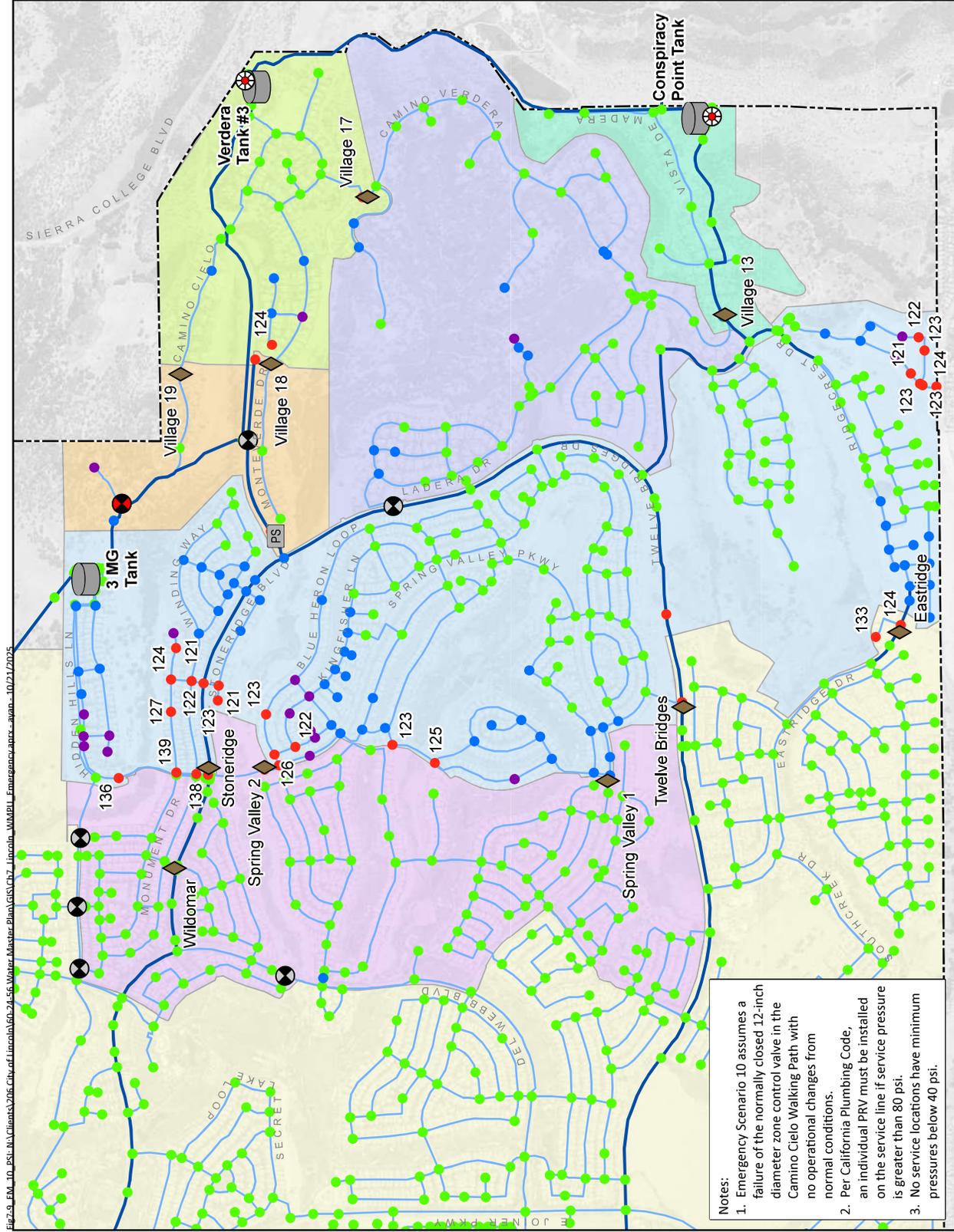
City of Lincoln
Water Master Plan Update



Change in Minimum Pressures Emergency Scenario 9
Figure 7-8

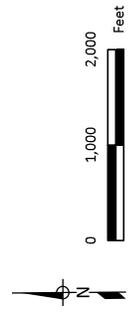


**Maximum Pressures at Maximum Day Demand
Emergency Scenario 10**
Figure 7-9



Prepared for:

City of Lincoln
Water Master Plan Update



Prepared by:



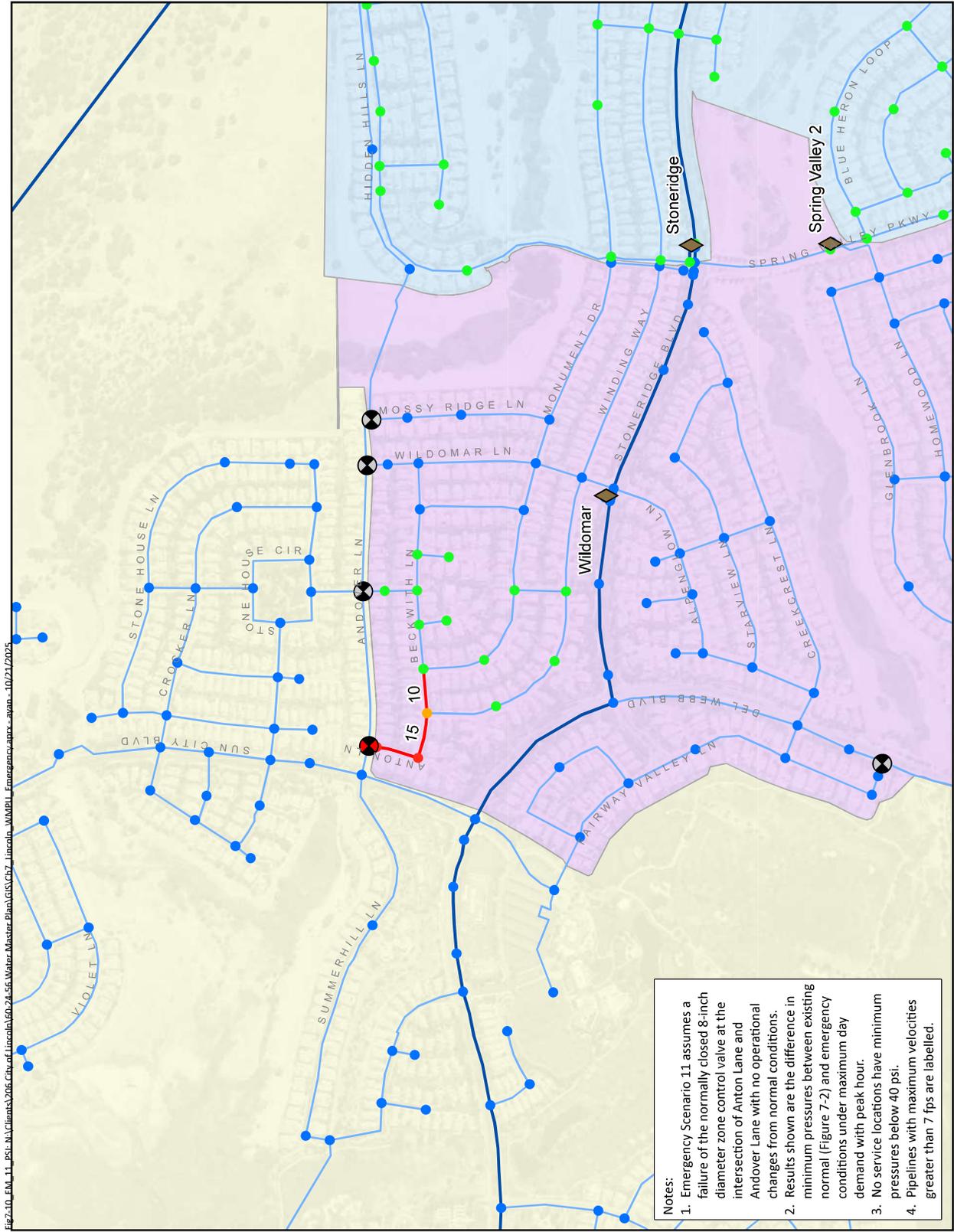


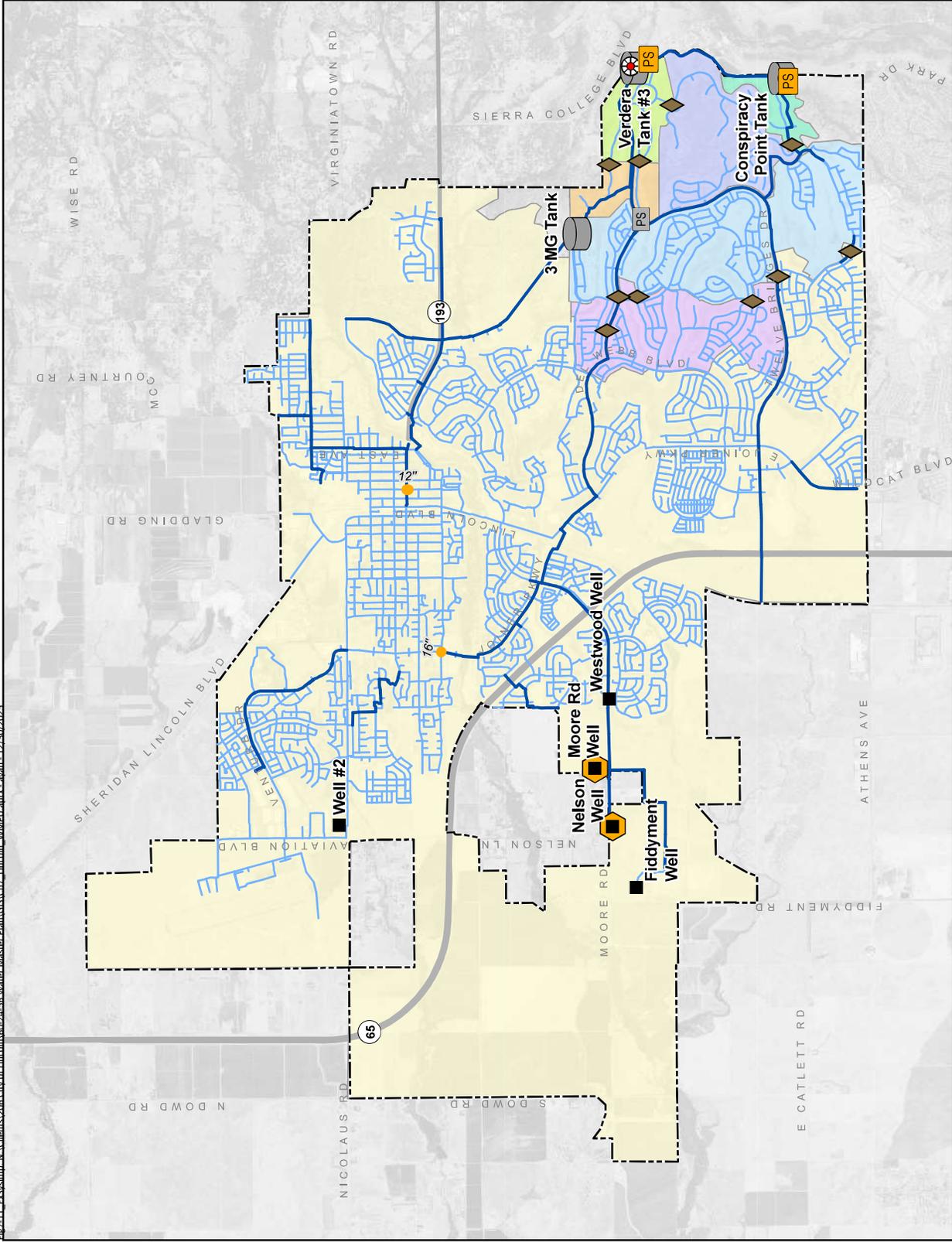
Fig 7-10_EM_11_PSI - N:\Clients\2106_City of Lincoln\626-24-56_Water Master Plan\GIS\Caz_Lincoln_MMRII_Emergency.sppr - April - 10/21/2025

Notes:

1. Emergency Scenario 11 assumes a failure of the normally closed 8-inch diameter zone control valve at the intersection of Anton Lane and Andover Lane with no operational changes from normal conditions.
2. Results shown are the difference in minimum pressures between existing normal (Figure 7-2) and emergency conditions under maximum day demand with peak hour.
3. No service locations have minimum pressures below 40 psi.
4. Pipelines with maximum velocities greater than 7 fps are labelled.

Change in Minimum Pressures
Emergency Scenario 11
Figure 7-10

Fig 7-11_E:\Systems\206_City of Lincoln\60_24_56_Water Master Plan\GIS\Gbz_Lincoln_WMPL.aprx - 12/30/2025



Recommended Improvements

- Backup Power
- New Pump Station
- Pipeline Improvement

Existing System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Catta Verdera Pump Station
- Pressure Regulating Station
- Storage Tank

- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

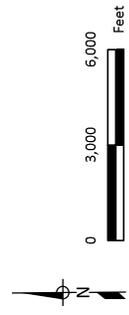
Existing Boundaries

- 375 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- City Limit

Recommended Improvements
Existing Water System
Figure 7-11

Prepared for:

City of Lincoln
Water Master Plan Update



CHAPTER 8

Future System Evaluation

This chapter presents the evaluation of the City’s future water system, and its ability to support projected phasing and buildout demands (described in Chapter 3) while meeting the recommended performance and operational criteria (described in Chapter 5).

This evaluation includes an analysis of water supply capacity, storage capacity, and pumping capacity, as well as the distribution system’s ability to meet recommended operational and design criteria under 5-Year, 10-Year, 15-Year, and Buildout average day demand, maximum day demand (including peak hour), and maximum day demand plus fire flow scenarios. West Yost conducted this evaluation using the calibrated hydraulic model described in Chapter 6. The hydraulic model was subsequently updated to include recommended improvements developed as part of the existing water system evaluation (see Chapter 7) and assumes the recommended existing system improvements are completed for the phasing and buildout scenarios. Recommendations from this evaluation are used to develop a recommended Capital Improvement Program (CIP), which is detailed in Chapter 10.

The following sections present the evaluation methodology and results from the future water system analysis:

- Future Water System Description
- Future Water Demand
- Future Water Supply and Water System Facility Capacity Evaluation
- Future Water Distribution System Performance Evaluation
- Summary of Findings and Recommendations for the Future Water System

8.1 FUTURE WATER SYSTEM DESCRIPTION

Figure 8-1 shows the backbone water distribution system network recommended for the future system. The backbone pipelines shown on Figure 8-1 serve as a basis for supplying future development in the Villages and Special Use Districts (SUDs) described in Chapter 3. Pipelines are color coded to indicate the anticipated timing they are needed to support future demands. Recommended future groundwater wells and storage tanks are also shown on Figure 8-1. As discussed in Chapter 4, future groundwater wells are recommended to be equipped with ASR capability. Sizing and layout of future wells and storage tanks are preliminary and based on the data used for the WMPU. As future development plans are refined, infrastructure needs may change, and the City should require Project proponents to confirm the proposed infrastructure meets all design criteria presented in Chapter 5.

In addition, the recommended existing system improvements (i.e., emergency booster pump stations at the Conspiracy Point Tank and Verdera Tank No. 3 tank sites) detailed in Chapter 7 are included on Figure 8-1. These existing system improvements were assumed to be constructed but inactive for the normal operation of the future system.

Currently, West Yost is conducting a water system hydraulic evaluation to assess the impacts of the Leavell Ranch Project within Village 1. Due to high elevations in parts of the development, a new 450 Zone is recommended to be created to be able to meet the City’s minimum system criteria. The 450 Zone is shown on Figure 8-1 in the southeast area of the City. The 450 Zone will be supplied through a PRS from the 575 Zone with a secondary PRS from the 610 Zone to provide required system supply redundancy. In addition, emergency PRSs from the 450 Zone will be added to support the 375 Zone.

- Notes:
1. Most of the future development is anticipated in the western and northern part of the 375 Zone, referred to as "375 Zone West." 375 Zone West is part of the overall 375 Zone and not a separate zone. The 450 Zone will be active with the 10 Year Phase.
 2. Future facilities and pipelines are preliminary and will require further study and refinement by Project proponents as future developments move forward.
 3. Future facilities and pipelines are preliminary and will require further study and refinement by Project proponents as future developments move forward.

Phasing Color Legend

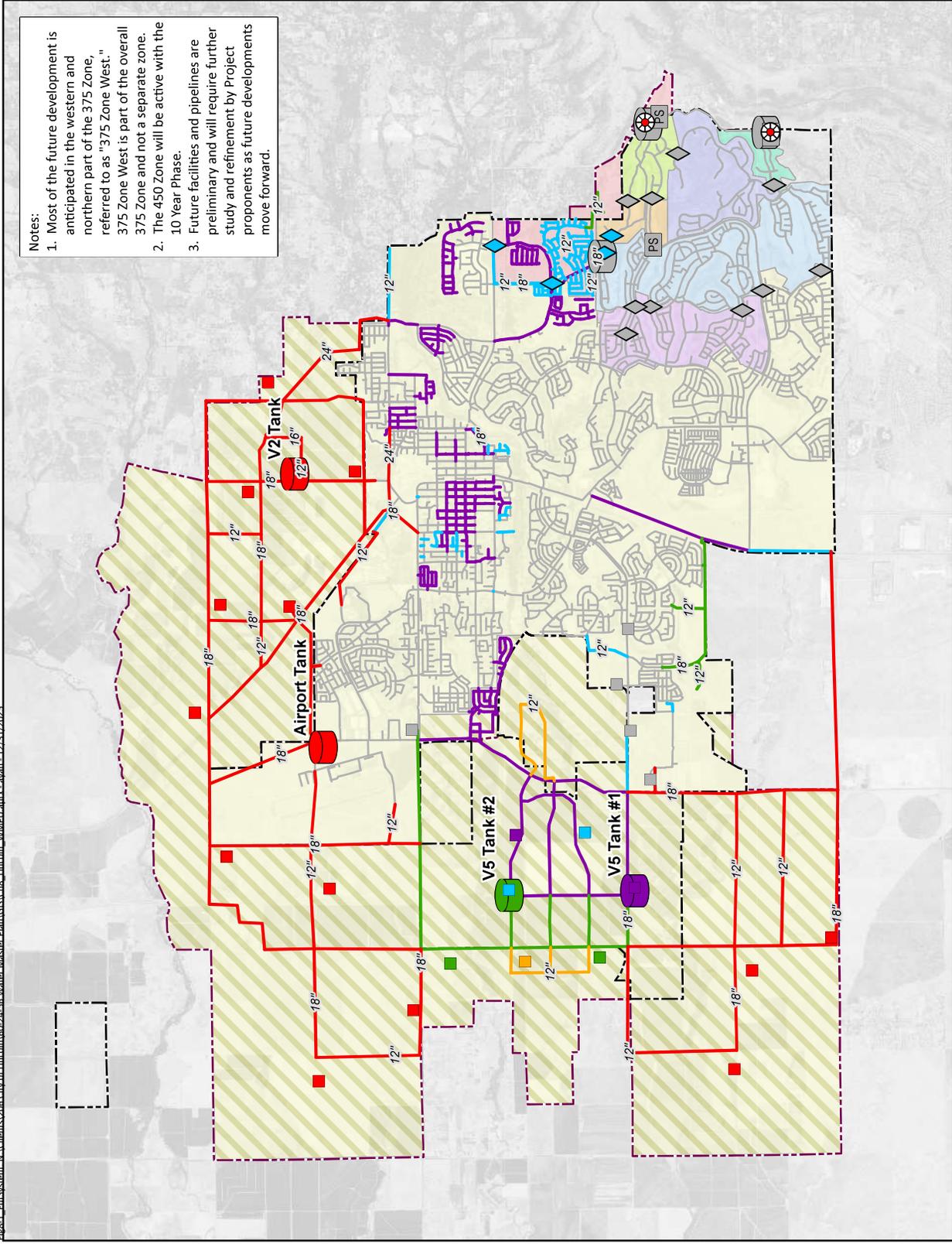
- Existing
- 5 Year
- 10 Year
- 15 Year
- 20 Year
- Buildout

System Facilities

- Groundwater Well
- Placer County Water Agency Metering Station
- Pump Station
- Pressure Reducing Station
- Storage Tank
- Pipeline

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

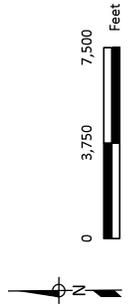


Prepared by:



Prepared for:

City of Lincoln
Water Master Plan Update



Most of the future development within the City’s service area is anticipated to occur in the western and northern part of the 375 Zone. These future developments are referred to as “375 Zone West” in the tables for the future demand projections and facility capacity evaluations in the subsequent sections. However, it should be noted that 375 Zone West is part of the overall 375 Zone and not a separate zone.

8.2 FUTURE WATER DEMAND

Future demand conditions used in the water system evaluation are based on projected land uses and water use factors discussed in Chapter 3. Projected future demands were added to the existing baseline demands (described in Chapter 3 and Chapter 7) to develop projected 5-Year, 10-Year, 15-Year, 20-Year, and Buildout baseline water demands. The future water demands were spatially located in the hydraulic model based on the future development land use areas. Tables 8-1 to 8-5 summarize the City’s future water demands for each of the pressure zones over the five phases. As discussed in Section 8.1, the majority of the future development occurs in the western and northern 375 Zone, which is separated out as 375 Zone West for identification purposes.

The City’s 5-Year water demands are summarized in Table 8-1. Maximum day demands were calculated based on the recommended peaking factor of 1.9 times the average day demand. Peak hour demands were calculated based on the recommended peaking factor of 2.2 times the maximum day demand. The 5-Year baseline average day demands are expected to be 10.9 mgd, or a 20 percent increase over existing baseline demands (previously presented in Table 7-1). As shown in Table 8-1, approximately 82 percent of the City’s overall 5-Year demand is located within the 375 and 375 West Zones. The proposed 450 Zone is assumed to not be active in the 5-Year Phase, and therefore, no demands are projected.

Table 8-1. 5-Year Future Baseline Demands

Pressure Zone	Average Day Demand ^(a)		Maximum Day Demand ^(b)		Peak Hour Demand ^(c)	
	gpm	mgd	gpm	mgd	gpm	mgd
375 Zone^(d)						
Existing 375	5,692	8.2	10,815	15.6	23,793	34.3
375 West	462	0.7	877	1.3	1,929	2.8
<i>375 Zone Subtotal</i>	<i>6,154</i>	<i>8.9</i>	<i>11,692</i>	<i>16.9</i>	<i>25,722</i>	<i>37.1</i>
Remaining Zones						
450	0	0.0	0	0.0	0	0.0
475	398	0.6	756	1.1	1,663	2.4
575	559	0.8	1,062	1.5	2,336	3.4
610	54	0.1	103	0.1	227	0.3
650	199	0.3	378	0.5	832	1.2
750	115	0.2	219	0.3	482	0.7
775	44	0.1	84	0.1	185	0.3
<i>Remaining Zone Subtotal</i>	<i>1,369</i>	<i>2.0</i>	<i>2,602</i>	<i>3.6</i>	<i>5,725</i>	<i>8.3</i>
Total Demand	7,523	10.9	14,294	20.5	31,447	45.4
<p>(a) Average day demand is based on 2023 average day demand data (refer to Table 3-6) plus projected 5-Year demands (refer to Table 3-11).</p> <p>(b) Maximum day demand is calculated using a peaking factor of 1.9 times the average day demand (refer to Table 3-7).</p> <p>(c) Peak hour demand is calculated using a peaking factor of 2.2 times the maximum day demand (refer to Table 3-7).</p> <p>(d) Most of the future development within the City is anticipated to occur in the western and northern part of the 375 Zone, referred to as 375 Zone West. It should be noted 375 Zone West is part of the overall 375 Zone and not a separate zone.</p> <p>gpm = gallons per minute; mgd = million gallons per day</p>						

The City’s 10-Year baseline demands are summarized in Table 8-2. The 10-Year baseline average day demands are expected to be 14.0 mgd, or a 54 percent increase over existing baseline demands (previously presented in Table 7-1). Approximately 81 percent of the City’s 10-Year baseline demand is located within the 375 and 375 West Zones.

Table 8-2. 10-Year Future Baseline Demands						
Pressure Zone	Average Day Demand ^(a)		Maximum Day Demand ^(b)		Peak Hour Demand ^(c)	
	gpm	mgd	gpm	mgd	gpm	mgd
375 Zone^(d)						
Existing 375	6,348	9.2	12,061	17.4	26,534	38.2
375 West	1,550	2.2	2,945	4.2	6,479	9.3
<i>375 Zone Subtotal</i>	<i>7,898</i>	<i>11.4</i>	<i>15,006</i>	<i>21.6</i>	<i>33,013</i>	<i>47.5</i>
Remaining Zones						
450	444	0.6	844	1.2	1,857	2.7
475	398	0.6	756	1.1	1,663	2.4
575	559	0.8	1,062	1.5	2,336	3.4
610	54	0.1	103	0.1	227	0.3
650	199	0.3	378	0.5	832	1.2
750	115	0.2	219	0.3	482	0.7
775	44	0.1	84	0.1	185	0.3
<i>Remaining Zone Subtotal</i>	<i>1,813</i>	<i>2.6</i>	<i>3,446</i>	<i>4.8</i>	<i>7,582</i>	<i>11.0</i>
Total Demand	9,711	14.0	18,452	26.4	40,595	58.5
(a) Average day demand is based on 2023 average day demand data (refer to Table 3-6) plus projected 10-Year demands (refer to Table 3-11). (b) Maximum day demand is calculated using a peaking factor of 1.9 times the average day demand (refer to Table 3-7). (c) Peak hour demand is calculated using a peaking factor of 2.2 times the maximum day demand (refer to Table 3-7). (d) Most of the future development within the City is anticipated to occur in the western and northern part of the 375 Zone, referred to as 375 Zone West. It should be noted 375 Zone West is part of the overall 375 Zone and not a separate zone. gpm = gallons per minute; mgd = million gallons per day						

The City’s 15-year baseline demands are summarized in Table 8-3. The 15-Year baseline average day demands are expected to be 16.9 mgd, or an 86 percent increase over existing baseline demands (previously presented in Table 7-1). Approximately 85 percent of the City’s 15-year baseline demand is located within the 375 and 375 West Zones.

Table 8-3. 15-Year Future Baseline Demands						
Pressure Zone	Average Day Demand ^(a)		Maximum Day Demand ^(b)		Peak Hour Demand ^(c)	
	gpm	mgd	gpm	mgd	gpm	mgd
375 Zone^(d)						
Existing 375	6,540	9.4	12,426	17.9	27,337	39.4
375 West	3,345	4.8	6,355	9.2	13,981	20.1
<i>375 Zone Subtotal</i>	<i>9,885</i>	<i>14.2</i>	<i>18,781</i>	<i>27.1</i>	<i>41,318</i>	<i>59.5</i>
Remaining Zones						
450	444	0.6	844	1.2	1,857	2.7
475	398	0.6	756	1.1	1,663	2.4
575	559	0.8	1,062	1.5	2,336	3.4
610	54	0.1	103	0.1	227	0.3
650	199	0.3	378	0.5	832	1.2
750	115	0.2	219	0.3	482	0.7
775	44	0.1	84	0.1	185	0.3
<i>Remaining Zone Subtotal</i>	<i>1,813</i>	<i>2.7</i>	<i>3,446</i>	<i>4.8</i>	<i>7,582</i>	<i>11.0</i>
Total Demand	11,698	16.9	22,227	31.9	48,900	70.5
<p>(a) Average day demand is based on 2023 average day demand data (refer to Table 3-6) plus projected 15-Year demands (refer to Table 3-11).</p> <p>(b) Maximum day demand is based on the 2023 maximum day demand data (refer to Table 3-6).</p> <p>(c) Peak hour demand is calculated using a peaking factor of 2.2 times the maximum day demand (refer to Table 3-7).</p> <p>(d) Most of the future development within the City is anticipated to occur in the western and northern part of the 375 Zone, referred to as 375 Zone West. It should be noted 375 Zone West is part of the overall 375 Zone and not a separate zone.</p> <p>gpm = gallons per minute; mgd = million gallons per day</p>						

The City’s 20-year baseline demands are summarized in Table 8-4. The 20-Year baseline average day demands are expected to be 18.9 mgd, or a 109 percent increase over existing baseline demands (previously presented in Table 7-1). Approximately 86 percent of the City’s 20-year baseline demand is located within the 375 and 375 West Zones.

Table 8-4. 20-Year Future Baseline Demands						
Pressure Zone	Average Day Demand ^(a)		Maximum Day Demand ^(b)		Peak Hour Demand ^(c)	
	gpm	mgd	gpm	mgd	gpm	mgd
375 Zone^(d)						
Existing 375	6,666	9.6	12,665	18.3	27,863	40.1
375 West	4,596	6.6	8,732	12.6	19,210	27.7
<i>375 Zone Subtotal</i>	<i>11,262</i>	<i>16.2</i>	<i>21,397</i>	<i>30.9</i>	<i>47,073</i>	<i>67.8</i>
Remaining Zones						
450	444	0.6	844	1.2	1,857	2.7
475	398	0.6	756	1.1	1,663	2.4
575	559	0.8	1,062	1.5	2,336	3.4
610	54	0.1	103	0.1	227	0.3
650	199	0.3	378	0.5	832	1.2
750	115	0.2	219	0.3	482	0.7
775	44	0.1	84	0.1	185	0.3
<i>Remaining Zone Subtotal</i>	<i>1,813</i>	<i>2.7</i>	<i>3,446</i>	<i>4.8</i>	<i>7,582</i>	<i>11.0</i>
Total Demand	13,075	18.9	24,843	35.7	54,655	78.8
(a) Average day demand is based on 2023 average day demand data (refer to Table 3-6) plus projected 20-Year demands (refer to Table 3-11). (b) Maximum day demand is based on the 2023 maximum day demand data (refer to Table 3-6). (c) Peak hour demand is calculated using a peaking factor of 2.2 times the maximum day demand (refer to Table 3-7). (d) Most of the future development within the City is anticipated to occur in the western and northern part of the 375 Zone, referred to as 375 Zone West. It should be noted 375 Zone West is part of the overall 375 Zone and not a separate zone. gpm = gallons per minute; mgd = million gallons per day						

The City’s buildout baseline demands are summarized in Table 8-5. The Buildout baseline average day demands are expected to be 35.3 mgd, or a 292 percent increase over existing baseline demands (previously presented in Table 7-1). Approximately 93 percent of the City’s buildout baseline demand is located within the 375 and 375 West Zones.

Table 8-5. Buildout Future Baseline Demands						
Pressure Zone	Average Day Demand ^(a)		Maximum Day Demand ^(b)		Peak Hour Demand ^(c)	
	gpm	mgd	gpm	mgd	gpm	mgd
375 Zone^(d)						
Existing 375	6,733	9.7	12,793	18.4	28,145	40.5
375 West	15,976	23.0	30,354	43.8	66,779	96.2
<i>375 Zone Subtotal</i>	<i>22,709</i>	<i>32.7</i>	<i>43,147</i>	<i>62.2</i>	<i>94,924</i>	<i>136.7</i>
Remaining Zones						
450	444	0.6	844	1.2	1,857	2.7
475	398	0.6	756	1.0	1,663	2.4
575	559	0.8	1,062	1.5	2,336	3.4
610	54	0.1	103	0.1	227	0.3
650	199	0.3	378	0.5	832	1.2
750	115	0.2	219	0.3	482	0.7
775	44	0.1	84	0.1	185	0.3
<i>Remaining Zone Subtotal</i>	<i>1,813</i>	<i>2.6</i>	<i>3,446</i>	<i>4.7</i>	<i>7,582</i>	<i>11.0</i>
Total Demand	24,522	35.3	46,593	66.9	102,506	147.7
(a) Average day demand is based on 2023 average day demand data (refer to Table 3-6) plus projected buildout demands (refer to Table 3-11). (b) Maximum day demand is based on the 2023 maximum day demand data (refer to Table 3-6). (c) Peak hour demand is calculated using a peaking factor of 2.2 times the maximum day demand (refer to Table 3-7). (d) Most of the future development within the City is anticipated to occur in the western and northern part of the 375 Zone, referred to as 375 Zone West. It should be noted 375 Zone West is part of the overall 375 Zone and not a separate zone. gpm = gallons per minute; mgd = million gallons per day						

8.3 FUTURE WATER SUPPLY AND WATER SYSTEM FACILITY CAPACITY EVALUATION

The following capacity evaluations were conducted for the existing water system and are discussed in more detail in subsequent sections:

- Supply Capacity Evaluation
- Pumping Capacity Evaluation
- Storage Capacity Evaluation
- Pressure Regulating Station Capacity Evaluation

8.3.1 Supply Capacity Evaluation

As described in Chapter 5, the recommended supply capacity criterion requires the City to provide firm supply capacity equal to the maximum day demand. For the future water system, firm groundwater well capacity is defined as 50 percent of the City’s maximum day demand with the largest well pump out of service. As discussed in Chapter 4, future PCWA supply assumptions are based on the existing agreements in effect at the time of preparation of this WMPU and the City will need to construct new groundwater ASR wells to achieve the firm groundwater well capacity criterion. Each new well is assumed to have a capacity of 1.7 mgd (1,200 gpm) and will be equipped with backup power or plug-in adaptors to provide additional credit toward the EGWC discussed in Section 8.3.3. Tables 8-6 to 8-10 summarize the results of the five phases. The tables show the comparison of projected maximum day demands to the recommended firm supply.

Table 8-6 summarizes the results of the 5-Year supply capacity evaluation and shows that the City has a supply surplus of 10.1 mgd. Two new wells are assumed to be added to the system by the end of the 5-Year Phase.

Table 8-6. Comparison of Projected Demand versus 5-Year Future Supply Capacity		
Component	Capacity, mgd	Notes
Demand		
[A] Maximum Day Demand	20.5	System-wide maximum day demand (refer to Table 8-1)
Firm Supply		
[B] Surface Water from PCWA	20.4	Entitlement under Contract for Treated Water Supply with PCWA ^(a)
[C] Groundwater	10.2	Firm capacity at groundwater wells ^(b)
[D] Total Supply	30.6	[D] = [B] + [C]
[E] Supply Capacity Surplus (Deficit)	10.1	[E] = [D] - [A]
(a) The firm water supply from PCWA is assumed to be the City's maximum delivery entitlement of 20.4 mgd and based on existing agreements at the time of preparation of this WMPU (refer to Figure 4-3). (b) Firm groundwater well capacity is assumed to be 50 percent of MDD with the largest well out of service. mgd = million gallons per day; gpm = gallons per minute		

Table 8-7 summarizes the results of the 10-Year supply capacity evaluation and shows that the City has a supply surplus of 9.4 mgd. Two new wells are assumed to be added to the system by the end of the 10-Year Phase in addition to the two new wells previously added in the 5-Year Phase.

Table 8-7. Comparison of Projected Demand versus 10-Year Future Supply Capacity		
Component	Capacity, mgd	Notes
Demand		
[A] Maximum Day Demand	26.4	System-wide maximum day demand (refer to Table 8-2)
Firm Supply		
[B] Surface Water from PCWA	22.7	Entitlement under Contract for Treated Water Supply with PCWA ^(a)
[C] Groundwater	13.1	Firm capacity at groundwater wells ^(b)
[D] Total Supply	35.8	[D] = [B] + [C]
[E] Supply Capacity Surplus (Deficit)	9.4	[E] = [D] - [A]
(a) The firm water supply from PCWA is assumed to be the City's maximum delivery entitlement of 22.7 mgd and based on existing agreements at the time of preparation of this WMPU (refer to Figure 4-3). (b) Firm groundwater well capacity is assumed to be 50 percent of MDD with the largest well out of service. mgd = million gallons per day; gpm = gallons per minute		

Table 8-8 summarizes the results of the 15-year supply capacity evaluation and shows that the City has a supply surplus of 9.0 mgd. Two new wells are assumed to be added to the system by the end of the 15-Year Phase in addition to the four new wells added in the previous phases.

Table 8-8. Comparison of Projected Demand versus 15-Year Future Supply Capacity		
Component	Capacity, mgd	Notes
Demand		
[A] Maximum Day Demand	31.9	System-wide maximum day demand (refer to Table 8-3)
Firm Supply		
[B] Surface Water from PCWA	25.0	Entitlement under Contract for Treated Water Supply with PCWA ^(a)
[C] Groundwater	15.9	Firm capacity at groundwater wells ^(b)
[D] Total Supply	40.9	[D] = [B] + [C]
[E] Supply Capacity Surplus (Deficit)	9.0	[E] = [D] - [A]
(a) The firm water supply from PCWA is assumed to be the City's maximum delivery entitlement of 25.0 mgd and based on existing agreements at the time of preparation of this WMPU (refer to Figure 4-3). (b) Firm groundwater well capacity is assumed to be 50 percent of MDD with the largest well out of service. mgd = million gallons per day; gpm = gallons per minute		

Table 8-9 summarizes the results of the 20-Year supply capacity evaluation and shows that the City has a supply surplus of 9.3 mgd. One new well is assumed to be added to the system by the end of the 20-Year Phase in addition to the six new wells added in the previous phases.

Table 8-9. Comparison of Projected Demand versus 20-Year Future Supply Capacity		
Component	Capacity, mgd	Notes
Demand		
[A] Maximum Day Demand	35.7	System-wide maximum day demand (refer to Table 8-4)
Firm Supply		
[B] Surface Water from PCWA	27.3	Entitlement under Contract for Treated Water Supply with PCWA ^(a)
[C] Groundwater	17.7	Firm capacity at groundwater wells ^(b)
[D] Total Supply	45.0	[D] = [B] + [C]
[E] Supply Capacity Surplus (Deficit)	9.3	[E] = [D] - [A]
(a) The firm water supply from PCWA is assumed to be the City's maximum delivery entitlement of 27.3 mgd and based on existing agreements at the time of preparation of this WMPU (refer to Figure 4-3). (b) Firm groundwater well capacity is assumed to be 50 percent of MDD with the largest well out of service. mgd = million gallons per day; gpm = gallons per minute		

Table 8-10 summarizes the results of the buildout supply capacity evaluation and shows that the City has a supply deficit of 4.5 mgd based on the assumptions for firm supply. Nine new wells are assumed to be added to the system by buildout in addition to the seven new wells added in the previous phases to achieve 50 percent of maximum day demands. A total of 16 new groundwater wells would be added to the City's future water system by Buildout.

Additional water supply sources would be required by buildout. Evaluation of future supply alternatives to meet buildout demands should be conducted. It is recommended the City perform the following:

- Conduct a study to evaluate obtaining additional capacity from PCWA facilities, such as potential modifications and/or expansions to metering stations, and additional PCWA water supply sources in western Placer County (e.g., RiverArc Project).¹
- Conduct an evaluation on groundwater replenishment, including ASR and basin recharge.
- Conduct a study within the next five years to explore buildout supply options which would be used as a framework for developers to provide supply solutions since the increase in water demands are driven by development.
- Conduct a feasibility and reliability study to evaluate how the City can utilize the water supply from NID.
- Conduct an evaluation on the impacts of increased use of recycled water on potable water demand offsets.
- Monitor system demands to verify water conservation impacts on future consumption.

¹ As discussed in Chapter 4, additional agreements between the City and PCWA would be required to obtain additional supply capacity.

Component	Capacity, mgd	Notes
Demand		
[A] Maximum Day Demand	66.9	System-wide maximum day demand (refer to Table 8-5)
Firm Supply		
[B] Surface Water from PCWA	29.0	Entitlement under Contract for Treated Water Supply with PCWA ^(a)
[C] Groundwater	33.4	Firm capacity at groundwater wells ^(b)
[D] Total Supply	62.4	[D] = [B] + [C]
[E] Supply Capacity Surplus (Deficit)	(4.5)	[E] = [D] - [A]
(a) The firm water supply from PCWA is assumed to be the City's maximum delivery entitlement of 29.0 mgd and based on existing agreements at the time of preparation of this WMPU (refer to Figure 4-3). (b) Firm groundwater well capacity is assumed to be 50 percent of MDD with the largest well out of service. mgd = million gallons per day; gpm = gallons per minute		

8.3.2 Pumping Capacity Evaluation

Future pumping capacity in the City’s water system was evaluated to assess its ability to deliver a reliable firm capacity to meet demand conditions outlined in Chapter 5, dependent on whether the pressure zone has gravity storage.

The City’s future system will incorporate at grade storage tanks with pump stations in the 375 Zone West area of the City to support the proposed developments as well as new ASR wells to provide additional supply to the area. The pump stations for the at grade storage tanks are intended to support the system during peak demands and emergency conditions. The maximum day demands are anticipated to be met through the supply capacity. Therefore, the pumping capacity evaluation for the 375 Zone West area of the City assumes the required pumping capacity is the difference between maximum day demands and peak hour demands plus the maximum fire flow requirement. The existing area in the 375 Zone is expected to continue to be supported through gravity storage from the 3 MG Tank and from the PRSs feeding the zone.

Table 8-11 shows the results for the pumping capacity evaluation of the 375 Zone West area for the five phases. For the Buildout phase, there is a slight pumping capacity deficit. This deficit is a result of the projected supply capacity deficit discussed in Section 8.3.1 and shown in Table 8-10.

Existing water storage facilities, in conjunction with the available EGWC², were evaluated to determine whether the City’s existing storage capacity is sufficient to meet future demands. Tables 8-12 to 8-16 summarize the results of the storage capacity evaluations on the five phases of the City’s future water system. Recommended storage improvements for each phase are incorporated into the storage capacity evaluation for the subsequent phase.

² Available EGWC includes the firm capacity of groundwater supply that can be reliably accessed, which includes the existing wells and new future wells from the supply capacity evaluation.

The 750 and 775 Zones were previously identified in the existing system storage capacity evaluation as having a deficit. These zones are supplied through the unregulated connections from PCWA which accounts for the operational storage serving these zones. As the unregulated supply currently does not include local distribution system storage for the 750 and 775 Zones, it was identified that the construction of emergency pump stations could provide redundant backup fire flow and a more resilient emergency supply to the zones from the Verdera Tank No.3 and Conspiracy Point Tank, in the unlikely scenario that the PCWA unregulated water supply becomes temporarily unavailable. Since there is no growth projected for these zones, they are not included in the storage tables for the future system.

Table 8-12 summarizes results from the 5-Year storage capacity evaluation. As shown in Table 8-12, there is a storage capacity surplus in the 375 and 575 Zones and deficit in the 375 West Zone. The deficit in the 375 West Zone can be alleviated through the construction of the planned 2 MG storage tank in Village 5.

Table 8-13 summarizes results from the 10-Year storage capacity evaluation. As shown in Table 8-13, there is a storage capacity surplus in the 375 and 575 Zones and minor deficit in the 375 West Zone. No recommendations are made for the 375 West Zone since the deficit is minor (0.01 mgd) and will be resolved by the recommended 15-Year storage improvement.

Table 8-14 summarizes results from the 15-year storage capacity evaluation. As shown in Table 8-14, there is a storage capacity surplus in the 375 and 575 Zones and deficit in the 375 West. The deficit in the 375 West Zone can be alleviated through the construction of an additional 2 MG storage tank in Village 5.

Table 8-15 summarizes results from the 20-Year storage capacity evaluation. As shown in Table 8-15, there is a storage capacity surplus in the 375 and 575 Zones and deficit in the 375 West. No recommendations are made for the 375 West Zone since the deficit is minor (0.11 mgd) and will be resolved by the recommended Buildout storage improvement.

Table 8-16 summarizes results from the buildout storage capacity evaluation. As shown in Table 8-16, there is a storage capacity surplus in the 375 and 575 Zones and deficit in the 375 West. The deficit in the 375 West Zone can be alleviated through the construction of a 5 MG storage Tank in Village 2 and a 3 MG storage tank in the Airport area.

8.3.3 Storage Capacity Evaluation

Water storage provides operational storage to balance differences in demands and supplies, emergency storage in case of a supply failure, and water to fight fires. The City's water system has two sources of available storage: above-ground storage (i.e., storage tanks) and storage available in the groundwater basin. Together, these two sources must be sufficient to meet the City's operational, emergency, and fire flow storage criteria. The City's water storage capacity requirements are further described in Chapter 5.

Table 8-11. Comparison of Required versus Available Pumping Capacity for 375 Zone West

Pumping Station/Well Name ^(a)	Required Pumping Capacity, gpm ^(b) [A]	Booster Pump Stations Firm Capacity ^(c) [B]	Groundwater Wells Firm Capacity ^(d) [C]	Total Available Pumping Capacity [D] = [B] + [C]	Pump Capacity Surplus (Deficit), gpm [E] = [D] - [A]
5-Year					
Village 5 Tank #1 Pump Station 2 Future Wells 5 Existing Wells	5,052	2,250	6,500	8,750	3,698
10-Year					
Village 5 Tank #1 Pump Station 4 Future Wells 5 Existing Wells	7,534	2,250	8,900	11,150	3,616
15-Year					
Village 5 Tank #1 Pump Station Village 5 Tank #2 Pump Station 6 Future Wells 5 Existing Wells	11,626	4,500	11,300	15,800	4,174
20-Year					
Village 5 Tank #1 Pump Station Village 5 Tank #2 Pump Station 7 Future Wells 5 Existing Wells	14,478	4,500	12,500	17,000	2,522
Buildout					
Village 5 Tank #1 Pump Station Village 5 Tank #2 Pump Station Village 2 Tank Pump Station Airport Tank Pump Station 16 Future Wells 5 Existing Wells	40,425	13,000	23,300	36,300	(4,125)
<p>(a) All future wells are assumed to be equipped with ASR capability.</p> <p>(b) Required pumping capacity for the 375 Zone West assumes the required pumping capacity is the difference between maximum day demands and peak hour demands (refer to Tables 8-1 to 8-5) plus the maximum fire flow requirement which is 4,000 gpm for schools.</p> <p>(c) Includes the firm capacity of all booster pump stations supplying the pressure zone. Firm pump capacity at booster pump stations is defined as total booster pump station capacity with the largest pump out of service.</p> <p>(d) Groundwater wells firm capacity is total groundwater well capacity with the largest well out of service.</p> <p>gpm = gallons per minute</p>					

Table 8-12. Comparison of Required versus 5-Year Future Storage Capacity

Pressure Zone	Supported Pressure Zone	Storage Available	Required Storage Capacity, mg				Available Storage Capacity, mg			Recommended Improvements		New Storage Capacity Surplus (Deficit), mg [K] = [J] + [I]	
			Operational ^(a) [A]	Fire Flow ^(b) [B]	Emergency ^(c) [C]	Storage Capacity Requirement [D] = [A] + [B] + [C]	Available Storage ^(d) [E]	Emergency Groundwater Storage Credit ^(e) [G]	Storage Capacity Available [H] = [E] + [F] + [G]	Storage Capacity Surplus (Deficit), mg [J] = [H] - [D]	Recommended Storage		Recommended Storage Capacity, mg [I]
375 ^(f)	-	- 3 MG Tank (3 MG)	-	0.96	4.92	5.88	2.53	4.92	7.45	1.57	-	-	-
375 West ^(g)	-	-	0.33	0.96	0.42	1.71	0.00	0.42	0.42	(1.29)	Village 5 Tank #2 (2 MG)	2.00	0.71
575	475 and 375	- Verdera Tank No.3 (5 MG) - Conspiracy Point Tank (5 MG)	4.55	0.96	1.18	6.69	8.75	0.00	8.75	2.06	-	-	-

(a) Operational storage is 25 percent of maximum day demand (MDD) (refer to Table 8-1).

(b) Fire storage is equal to the volume of the largest fire flow event that could occur in each pressure zone (refer to Table 5-1).

(c) Emergency storage is 60 percent of average day demand (ADD) of each pressure zone (refer to Table 8-1).

(d) Available tank storage capacity was calculated as useable storage which assumes 5 feet of dead storage and 2 feet below high alarm level in each storage tank (refer to Section 2.3.4).

(e) The Emergency Groundwater Storage Credit (EGWC) includes the firm capacity of groundwater supply that can be reliably accessed. The EGWC cannot exceed the emergency amount.

(f) Operational storage for the 375 Zone is assigned to the 575 Zone which supplies normal operation to the 375 Zone through multiple pressure reducing stations.

(g) 375 Zone West represents new development on the west side of the City, including Village 5.

Table 8-13. Comparison of Required versus 10-Year Future Storage Capacity

Pressure Zone	Supported Pressure Zone	Storage Available	Required Storage Capacity, mg				Available Storage Capacity, mg			Recommended Improvements		New Storage Capacity Surplus (Deficit), mg [K] = [I] + [J]
			Operational ^(a) [A]	Fire Flow ^(b) [B]	Emergency ^(c) [C]	Storage Capacity Requirement [D] = [A] + [B] + [C]	Available Storage ^(d) [E]	Emergency Groundwater Storage Credit ^(e) [G]	Storage Capacity Available [H] = [E] + [F] + [G]	Storage Capacity Surplus (Deficit), mg [I] = [H] - [D]	Recommended Storage	
375 ^(f)	-	- 3 MG Tank (3 MG)	-	0.96	5.46	6.42	2.53	5.46	7.99	1.57	-	-
375 West ^(g)	-	- Village 5 Tank #1 (2 MG)	1.05	0.96	0.42	2.43	2.00	0.42	2.42	(0.01)	-	-
575	475 and 375	- Verdera Tank No.3 (5 MG) - Conspiracy Point Tank (5 MG)	5.30	0.96	1.18	7.44	8.75	0.00	8.75	1.31	-	-

(a) Operational storage is 25 percent of maximum day demand (MDD) (refer to Table 8-2).

(b) Fire storage is equal to the volume of the largest fire flow event that could occur in each pressure zone (refer to Table 5-1).

(c) Emergency storage is 60 percent of average day demand (ADD) of each pressure zone (refer to Table 8-2).

(d) Available tank storage capacity was calculated as useable storage which assumes 5 feet of dead storage and 2 feet below high alarm level in each storage tank (refer to Section 2.3.4).

(e) The Emergency Groundwater Storage Credit (EGWC) includes the firm capacity of groundwater supply that can be reliably accessed. The EGWC cannot exceed the emergency amount.

(f) Operational storage for the 375 Zone is assigned to the 575 Zone which supplies normal operation to the 375 Zone through multiple pressure reducing stations.

(g) 375 Zone West represents new development on the west side of the City, including Village 5.

Table 8-14. Comparison of Required versus 15-Year Future Storage Capacity

Pressure Zone	Supported Pressure Zone	Storage Available	Required Storage Capacity, mg				Available Storage Capacity, mg			Recommended Improvements		New Storage Capacity Surplus (Deficit), mg [K] = [I] + [J]	
			Operational ^(a) [A]	Fire Flow ^(b) [B]	Emergency ^(c) [C]	Storage Capacity Requirement [D] = [A] + [B] + [C]	Available Storage ^(d) [E]	Emergency Groundwater Storage Credit ^(e) [G]	Storage Capacity Available [H] = [E] + [F] + [G]	Storage Capacity Surplus (Deficit), mg [I] = [H] - [D]	Recommended Storage		Recommended Storage Capacity, mg [J]
375 ^(f)	-	- 3 MG Tank (3 MG)	0.00	0.96	5.64	6.60	2.53	5.64	8.17	1.57	-	-	
375 West ^(g)	-	- Village 5 Tank #1 (2 MG)	2.30	0.96	2.88	6.14	2.00	2.88	4.88	(1.26)	- Village 5 Tank #2 (2 MG)	2.00	0.74
575	475 and 375	- Verdera Tank No.3 (5 MG) - Conspiracy Point Tank (5 MG)	5.45	0.96	1.54	7.95	8.75	0.00	8.75	0.80	-	-	-

(a) Operational storage is 25 percent of maximum day demand (MDD) (refer to Table 8-3).

(b) Fire storage is equal to the volume of the largest fire flow event that could occur in each pressure zone (refer to Table 5-1).

(c) Emergency storage is 60 percent of average day demand (ADD) of each pressure zone (refer to Table 8-3).

(d) Available tank storage capacity was calculated as useable storage which assumes 5 feet of dead storage and 2 feet below high alarm level in each storage tank (refer to Section 2.3.4).

(e) The Emergency Groundwater Storage Credit (EGWC) includes the firm capacity of groundwater supply that can be reliably accessed. The EGWC cannot exceed the emergency amount.

(f) Operational storage for the 375 Zone is assigned to the 575 Zone which supplies normal operation to the 375 Zone through multiple pressure reducing stations.

(g) 375 Zone West represents new development on the west side of the city, including Village 5.

Table 8-15. Comparison of Required versus 20-Year Future Storage Capacity

Pressure Zone	Supported Pressure Zone	Storage Available	Required Storage Capacity, mg				Available Storage Capacity, mg			Recommended Improvements		New Storage Capacity Surplus (Deficit), mg [K] = [I] + [J]
			Operational ^(a) [A]	Fire Flow ^(b) [B]	Emergency ^(c) [C]	Storage Capacity Requirement [D] = [A] + [B] + [C]	Available Storage ^(d) [E]	Emergency Groundwater Storage Credit ^(e) [G]	Storage Capacity Available [H] = [E] + [F] + [G]	Storage Capacity Surplus (Deficit), mg [I] = [H] - [D]	Recommended Storage	
375 ^(f)	-	- 3 MG Tank (3 MG)	-	0.96	5.76	6.72	2.53	5.76	8.29	1.57	-	-
375 West ^(g)	-	- Village 5 Tank #1 (2 MG) - Village 5 Tank #2 (2 MG)	3.15	0.96	3.96	8.07	4.00	3.96	7.96	(0.11)	-	-
575	475 and 375	- Verdera Tank No.3 (5 MG) - Conspiracy Point Tank (5 MG)	5.53	0.96	1.54	8.03	8.75	0.00	8.75	0.72	-	-

(a) Operational storage is 25 percent of maximum day demand (MDD) (refer to Table 8-4).

(b) Fire storage is equal to the volume of the largest fire flow event that could occur in each pressure zone (refer to Table 5-1).

(c) Emergency storage is 60 percent of average day demand (ADD) of each pressure zone (refer to Table 8-4).

(d) Available tank storage capacity was calculated as useable storage which assumes 5 feet of dead storage and 2 feet below high alarm level in each storage tank (refer to Section 2.3.4).

(e) The Emergency Groundwater Storage Credit (EGWC) includes the firm capacity of groundwater supply that can be reliably accessed. The EGWC cannot exceed the emergency amount.

(f) Operational storage for the 375 Zone is assigned to the 575 Zone which supplies normal operation to the 375 Zone through multiple pressure reducing stations.

(g) 375 Zone West represents new development on the west side of the city, including Village 5.

Table 8-16. Comparison of Required versus Buildout Future Storage Capacity													
Pressure Zone	Supported Pressure Zone	Storage Available	Required Storage Capacity, mg			Available Storage Capacity, mg			Recommended Improvements		New Storage Capacity Surplus (Deficit), mg [K] = [I] + [J]		
			Operational ^(a) [A]	Fire Flow ^(b) [B]	Emergency ^(c) [C]	Storage Capacity Requirement [D] = [A] + [B] + [C]	Available Storage ^(d) [E]	Emergency Groundwater Storage Credit ^(e) [G]	Storage Capacity Available [H] = [E] + [F] + [G]	Storage Capacity Surplus (Deficit), mg [I] = [G] - [D]		Recommended Storage	Recommended Storage Capacity, mg [J]
375 ^(f)	-	- 3 MG Tank (3 MG)	-	0.96	5.82	6.78	2.53	5.82	8.35	1.57	-	-	-
375 West ^(g)	-	- Village 5 Tank #1 (2 MG) - Village 5 Tank #2 (2 MG)	10.95	0.96	13.80	25.71	4.00	13.80	17.80	(7.91)	- Village 2 Tank (5 MG) - Airport Tank (3 MG)	8.00	0.09
575	475 and 375	- Verdera Tank No.3 (5 MG) - Conspiracy Point Tank (5 MG)	5.58	0.96	1.54	8.08	8.75	0.00	8.75	0.67	-	-	-

(a) Operational storage is 25 percent of maximum day demand (MDD) (refer to Table 8-5).

(b) Fire storage is equal to the volume of the largest fire flow event that could occur in each pressure zone (refer to Table 5-1).

(c) Emergency storage is 60 percent of average day demand (ADD) of each pressure zone (refer to Table 8-5).

(d) Available tank storage capacity was calculated as useable storage which assumes 5 feet of dead storage and 2 feet below high alarm level in each storage tank (refer to Section 2.3.4).

(e) The Emergency Groundwater Storage Credit (EGWC) includes the firm capacity of groundwater supply that can be reliably accessed. The EGWC cannot exceed the emergency amount.

(f) Operational storage for the 375 Zone is assigned to the 575 Zone which supplies normal operation to the 375 Zone through multiple pressure reducing stations.

(g) 375 Zone West represents new development on the west side of the city, including Village 5.

8.3.4 Pressure Regulating Station Capacity Evaluation

The future pressure regulating stations in the City’s water system were evaluated to assess their ability to reliably supply the future water service area. As described in Chapter 5, the criterion for pressure zones served solely by pressure regulating stations without a booster pump station or storage tank requires the City’s pressure regulating stations to have sufficient capacity to meet the peak hour demand plus fire flow conditions.

The 475, 610, and 650 Zones were evaluated in Chapter 7 (see Table 7-5 for results) and no new demands are projected for these zones. The required pressure regulating station capacity to serve the new 450 Zone described in Section 8-1 was evaluated. Table 8-17 compares future available pressure regulating station capacity with required capacity for the 450 Zone.

Pressure Regulating Station	Supplied By	Valve Diameter, inches	Available PRS Capacity, gpm ^(b) [A]	Required PRS Capacity, gpm			PRS Capacity Surplus (Deficit), gpm [E] = [D] - [A]
				Peak Hour Demand ^(c) [B]	Fire Flow Demand ^(d) [C]	PRS Capacity Requirement [D] = [B] + [C]	
450 Main	575	3	580	1,857	4,000	5,857	3,103
	575	8	3,900				
450 Emergency	610	3	580				
	610	8	3,900				
450 Zone Total			8,960				

(a) The 450 Zone will be active starting in the 10-Year Phase. No new demands will be added in the subsequent phases, therefore, the required PRS capacity is assumed to be the same for 10-Year, 15-year, 20-Year, and Buildout.

(b) Valve capacity is estimated based on intermittent maximum flow capacity for ClaVal model 90-01PRV valves. However, actual flow capacity will vary depending on system conditions.

(c) Refer to Table 8-1 for peak hour demand.

(d) The largest fire flow requirement for the 450 Zone is 4,000 gpm for schools.

gpm = gallons per minute

8.4 FUTURE WATER DISTRIBUTION SYSTEM PERFORMANCE EVALUATION

The water distribution system performance evaluation identifies necessary improvements to the City's water distribution system to support the City's future water demands while meeting the City's recommended water system planning and design criteria presented in Chapter 5 under normal and emergency conditions. A hydraulic performance evaluation was carried out for each of the five phases: 5-Year, 10-Year, 15-Year, 20-Year, and Buildout. The following scenarios were evaluated as part of the future water distribution system performance evaluation:

- **Normal Operations:**
 - Average Day Demand Scenario: This scenario evaluated service pressures during an average day demand condition
 - Maximum Day Demand Scenario: This scenario evaluated service pressures during a maximum day demand condition
- **Emergency Operations:**
 - Maximum Day Demand plus Fire Flow Scenario: This scenario evaluated system fire flow availability under a maximum day demand condition

The water system hydraulic model, updated with the proposed improvements to the existing system from Chapter 7, was used to evaluate the water system performance for each of the five phases. Additional facilities (i.e., pipes, new PRSs, new tanks, and new wells) to provide service to projected future development areas were also included in the hydraulic model, as shown on Figure 8-1. In addition, recommended improvements identified in the facility capacity evaluation above were incorporated into the hydraulic model and are also shown on Figure 8-1. As previously mentioned, sizing and locations of future pipelines and facilities are preliminary and will require further study and refinement by Project proponents as future developments move forward.

As discussed in Section 8.3.1, the City will have insufficient supply by the Buildout Phase. For purposes of the hydraulic evaluation, it is assumed that four additional groundwater ASR wells are added into the system to mitigate the supply deficit and to support maximum day plus peak hour demand conditions. However, the City is recommended to conduct the supply studies recommended in Section 8.3.1 to determine the most viable additional water supply source.

Table 8-18 summarizes the assumptions for each modeling scenario before incorporating recommended improvements from the performance evaluation. Sections 8.4.1 and 8.4.2 provide an overview and general discussion of results of the evaluated scenarios. Table 8-19 in Section 8.4.3 summarizes the specific results for each phase.

Table 8-18. Summary of Phasing Assumptions^(a,b)

Phase	Capacity Evaluation Improvements	Additional Assumptions
5-Year	5-Year: <ul style="list-style-type: none"> 1 storage tank: Village 5 Tank #1 (2 MG) 2 wells 	<ul style="list-style-type: none"> Includes recommendations from the existing system evaluation in Chapter 7 (i.e., pipeline improvements and emergency BPSs for the 750 and 775 Zones). Planned replacement of 20-inch transmission main from the 3 MG Tank with a 30-inch transmission main is active. Planned extension of 24-inch transmission main in Oak Tree Lane crossing the Auburn Ravine to existing 18-inch transmission main in Virginiatown Road is active. Pipelines within the 5-Year timeline identified in the 10-Year Pipeline R&R from Chapter 9 are replaced.
10-Year	10-Year: <ul style="list-style-type: none"> 2 wells Total (Previous and Current Phases): <ul style="list-style-type: none"> 1 storage tank 4 wells 	<ul style="list-style-type: none"> Includes recommendations from previous phases All pipelines identified in the 10-Year Pipeline R&R from Chapter 9 are replaced. New Pressure Zone (450 Zone) is created with associated PRSs.
15-Year	15-Year: <ul style="list-style-type: none"> 1 storage tank: Village 5 Tank #2 (2 MG) 2 wells Total (Previous and Current Phases): <ul style="list-style-type: none"> 2 storage tanks 6 wells 	<ul style="list-style-type: none"> Includes recommendations from previous phases.
20-Year	20-Year: <ul style="list-style-type: none"> 1 well Total (Previous and Current Phases): <ul style="list-style-type: none"> 2 storage tanks 7 wells 	<ul style="list-style-type: none"> Includes recommendations from previous phases.
Buildout	Buildout: <ul style="list-style-type: none"> 2 storage tanks: Village 2 Tank (5 MG) Airport Tank (3 MG) 9 wells 4 wells to address supply deficit for purposes of the performance evaluation^(c) Total (Previous and Current Phases): <ul style="list-style-type: none"> 4 storage tanks 20 wells 	<ul style="list-style-type: none"> Includes recommendations from previous phases.

(a) Sizing and locations of future pipelines and facilities are preliminary and will require further study and refinement by Project proponents as future developments move forward.

(b) All future wells are assumed to be equipped with ASR capability.

(c) As discussed in Section 8.3.1, the City will have insufficient supply by the Buildout Phase. For purposes of the hydraulic evaluation, it is assumed four additional groundwater wells are added into the system to mitigate the supply deficit. However, the City is recommended to conduct the supply studies recommended in Section 8.3.1 to determine the most feasible additional water supply source.

8.4.1 Normal Operations Overview

The normal operations of the City’s water distribution system were evaluated under average day and maximum day with peak hour demand conditions (i.e., non-fire). For each phase, a 72-hour extended period simulation (EPS) was conducted using the hydraulic model to evaluate system performance under average day and maximum day with peak hour demand conditions. However, only results from the last two days of the simulation were used, as these results are not affected by initial conditions.

Tables 8-1 to 8-5 summarize the average day and maximum day system demands for each phase. The maximum day diurnal patterns (i.e., pressure zone groups, irrigation meters, and large users) previously presented in Chapter 3 and previously incorporated into the hydraulic model in Chapter 7, were used. The operational criteria applicable during normal operating conditions are detailed in Chapter 5.

The normal operations evaluation assumes the water system demand will be met by a combination of the PCWA metering stations, storage tanks, and groundwater wells as needed. Firm groundwater capacity is assumed (i.e., the largest existing well is offline). Catta Verdera BPS was assumed to be offline for the future water system.

8.4.1.1 Normal Operations Results: 5-Year, 10-Year, 15-Year, and 20-Year Phases

For the 5-Year, 10-Year, 15-Year, and 20-Year Phases, no wells operate during average day demand, however, during maximum day demand, various wells operate either full-time or during peak hour only (refer to Table 8-19 for the number of wells operating per phase).

Table 8-19 summarizes the specific results for each phase and subsequent recommendations. Figures 8-2 to 8-5 present the minimum instantaneous pressures during the EPS for average day demand for each phase. Figures 8-7 to 8-10 present the minimum instantaneous pressures during the EPS for maximum day demand for each phase. The following discussion is a general summary of results for the 5-Year, 10-Year, 15-Year, and 20-Year Phases. These results assume the recommended improvements from Table 8-18 have been constructed in the system.

Results from the normal operations evaluation (i.e., average day and maximum day demand with peak hour conditions) indicate the 5-Year, 10-Year, 15-Year, and 20-Year phasing of the future water system generally meets the City’s minimum and maximum pressure criterion at most customer service locations.

In general, most areas of the City’s distribution system meet the minimum pressure requirement of 40 psi for each phase. For the average day demand condition for each phase, the majority of the City’s distribution system experiences pressures ranging between 80 to 100 psi or greater than 100 psi. For the maximum day demand condition for each phase, the majority of the City’s distribution system experiences pressures ranging between 60 to 100 psi. Lower pockets of pressures (refer to Table 8-19 for specific pressure ranges for each phase) typically occur around areas that are on the high end of a pressure zone’s service elevation range and/or are served by a dead-end pipeline. Locations with pressures below 40 psi occur adjacent to major system facilities where the associated pipelines do not have service connections, and therefore, no recommended improvements are made. Velocities in the water distribution system for both average day and maximum day demand conditions do not exceed 7 feet per second (fps).

8.4.1.2 Normal Operations Results: Buildout Phase

For Buildout Phase, six wells (three full-time and three during peak hour) operate during average day demand. During maximum day demand, 24 wells (20 full-time and four during peak hour) operate while one well does not operate. To mitigate the potential for high use of groundwater supply to meet peaking demands, the City endeavors to leverage use of reclaimed water supply and partner with PCWA and/or NID to provide additional surface water supplies.

Table 8-19 summarizes the specific results for the Buildout Phase and subsequent recommendations. Figure 8-6 presents the minimum instantaneous pressures during the EPS for average day demand. Figure 8-11 presents the minimum instantaneous pressures during the EPS for maximum day demand. The following discussion is a general summary of results for the Buildout Phase.

Results from the normal operations evaluation (i.e., average day and maximum day demand with peak hour conditions) indicate the buildout phase of the water system generally meets the City's minimum and maximum pressure criterion at most customer service locations.

In general, most areas of the City's buildout distribution system meet the minimum pressure requirement of 40 psi. For the average day demand condition, the majority of the City's distribution system experiences pressures ranging between 80 to 100 psi. For the maximum day demand condition, the majority of the City's distribution system experiences pressures ranging between 60 to 80 psi. Lower pockets of pressures (refer to Table 8-19 for ranges) and locations with pressures below 40 psi typically occur around areas that are on the high end of a pressure zone's service elevation range and/or are served by a dead-end pipeline. No recommendations are made to mitigate these areas of low pressure since velocity criterion in pipelines are met in these areas. Additionally, there are locations with pressures below 40 psi that occur adjacent to major system facilities where the associated pipelines do not have service connections, and therefore, no recommended improvements are made.

For the average day demand condition, maximum velocities in the buildout water distribution system pipelines do not exceed 7 fps. Figure 8-12 shows the maximum velocities in the buildout water system for the maximum day demand condition. As shown on Figure 8-11, maximum velocities range from 7 to 8 fps in the following transmission mains near storage tanks and pressure reducing stations:

- 24-inch diameter main in Twelve Bridges from Verdera Tank No.3
- 30-inch diameter main from the 3 MG Tank to Oak Tree Lane
- 30-inch diameter main from the Conspiracy Point Tank
- Portions of the 24-inch diameter main in Stonebridge Boulevard (near the Stoneridge pressure reducing station), Del Webb Boulevard (near the Wildomar pressure reducing station), and East Joiner Parkway
- 8-inch diameter pipeline in Chesapeake Way near the Eastridge pressure reducing station

While these velocities exceed maximum recommended velocities, improvements are not recommended at these locations as they do not impact the primary criterion, customer service pressure.

8.4.2 Emergency Operations Overview

To evaluate the existing water system fire flow availability, AquaTwin Water’s fire flow module was used to determine the available fire flow at junctions that represent hydrant locations throughout the system, while maintaining a minimum residual system pressure of 20 psi at all customer service locations and new development areas. In addition, a maximum velocity of 10 fps should be maintained in new development pipelines. Pipelines in existing areas are evaluated without a maximum velocity constraint because these pipelines were sized to meet standards at the time of their construction.

The fire flow evaluation assumed that the fire event would occur during the hour where the peaking factor on the maximum day diurnal is closest to 1. Hour 48 from the maximum day demand plus peak hour EPS was chosen to run the fire flow analysis on. The purpose of this assumption is to confirm that storage is sufficient to supply fire flows during a typical maximum day demand.

As discussed in Chapter 7, recommended fire flow criteria presented in Table 5-1 are established for future development land use types. The fire flow evaluation presents the system-wide available fire flow compared to recommended fire flow criteria for future water service areas for comparison purposes only. As previously mentioned in Chapter 7, because much of the City’s system is older, a R&R Program detailed in Chapter 9 is recommended to replace smaller diameter (i.e., less than 8-inch diameter) distribution pipelines (which are typically older). As the City proceeds with the program, fire flow availability in these areas will improve. Therefore, the evaluation of the City’s future water system does not recommend specific pipeline improvements to existing pipelines to increase existing fire flow capacity as it is assumed they will be included in the City’s R&R program.

For new development areas, fire flow availability is evaluated to confirm sizing of recommended future system improvements for new developments. As development plans in future areas are refined, infrastructure is expected to change, and the City should require Project proponents to size infrastructure to meet all design criteria presented in Chapter 5, unless criteria are superseded by a future standard adopted by the City.

8.4.2.1 Emergency Operation Results

Figures 8-13 to 8-17 summarizes the percent of available fire flow available for each phase at each tested location with respect to its fire flow requirement. Results presented in these figures are representative of the system’s capacity and do not represent available flow from a specific hydrant.

As shown on Figures 8-13 to 8-17, most tested locations in the model for each phase meet or exceed the City’s fire flow requirements, and a few locations meet at least 75 percent of the criteria. Most locations that do not meet the recommended fire flow criteria are existing known deficiencies in the model as identified in Chapter 7. These are locations with larger fire flow requirements (i.e., 3,000 and 4,000 gpm) and/or located at small diameter (i.e., 6-inch) dead-end distribution pipelines. Typically, fire flow requirements exceeding 1,500 gpm are expected to be met by multiple hydrants and as described in Chapter 7, existing pipelines are assumed to meet fire flow standards that were in place at the time of construction. All tested locations within future development areas meet the required fire flow. Therefore, no specific pipeline improvements to increase fire flow capacity are recommended.

8.4.3 Future Water Distribution System Performance Evaluation Results Summary

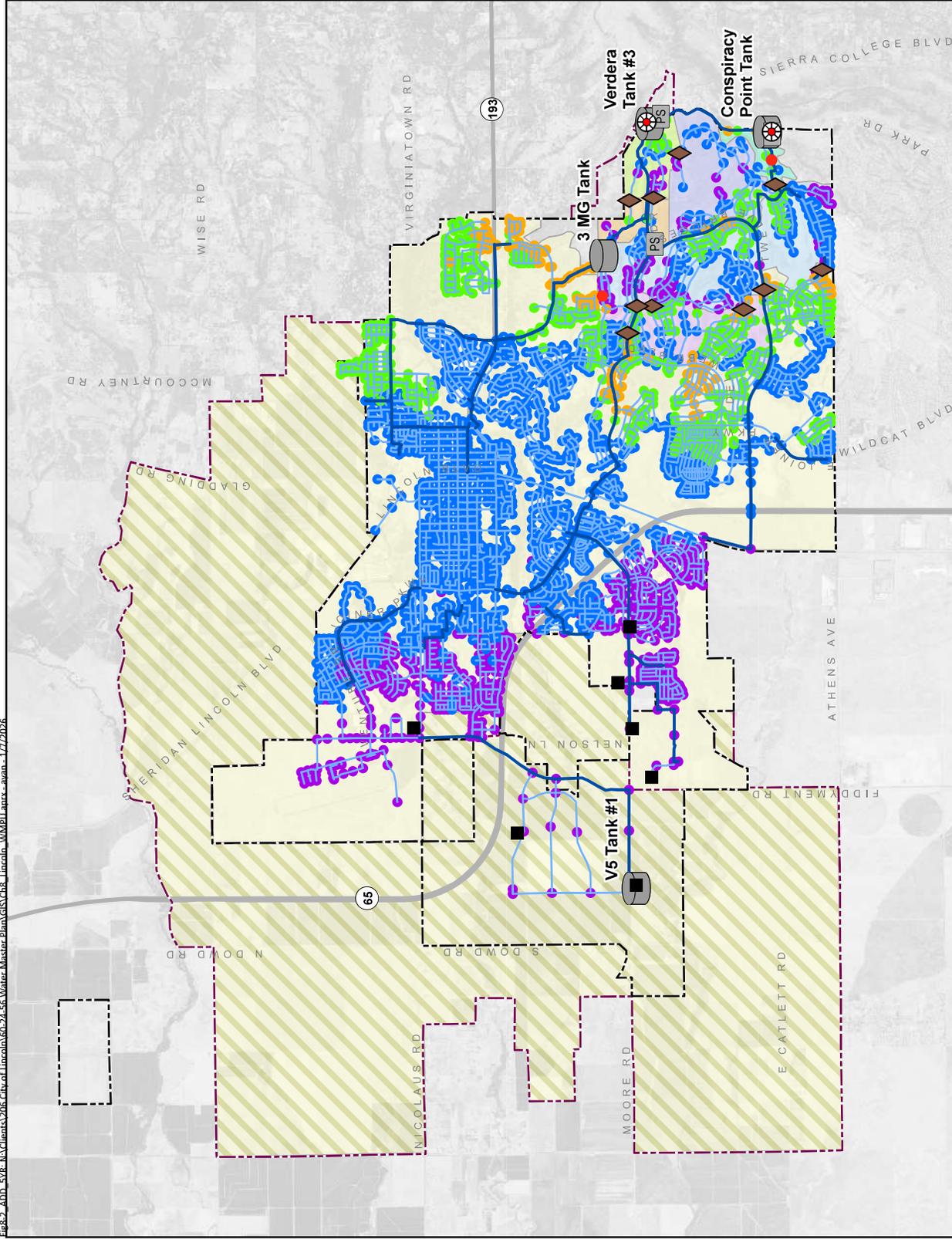
Table 8-19 details the specific performance evaluation results for each of the five phases.

Table 8-19. Future System Evaluation Results Summary

Phase	Average Day Demand Results	Maximum Day Demand Results	Maximum Day Demand Plus Fire Flow Results	Recommended Performance Evaluation Improvements
5-Year	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 80 - greater than 100 psi. Some locations in the east, northeast, and Village 1 (i.e., Turkey Creek and Stardust) range from 40 - 80 psi due to high elevations. Pressures below 40 psi occur adjacent to major system facilities where the associated pipelines do not have service connections. Velocity exceedance (8 fps) in existing 8-inch diameter pipe at intersection of 1st Street and Joiner Ranch. No wells operating. 	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 60 to 100 psi. Some locations in the east and Village 1 (i.e., Turkey Creek and Stardust) range from 40 - 60 psi due to high elevations. Pressures below 40 psi occur adjacent to major system facilities where the associated pipelines do not have service connections. Velocity exceedance (20 fps) in existing 8-inch diameter pipe at intersection of 1st Street and Joiner Ranch. 3 wells operating (1 well operating full-time and 2 wells during peak hour). 	<ul style="list-style-type: none"> Most existing tested locations meet the required fire flow. Existing tested locations in the model that do not meet the required fire flow are existing known deficiencies (i.e., areas with larger fire flow requirements which require multiple hydrants [i.e., 3,000 and 4,000 gpm] and/or located at small diameter [(i.e., 6-inch)] dead-end distribution pipelines). All tested future development locations meet the required fire flow. 	<ul style="list-style-type: none"> No recommended improvements for normal operations. Known existing fire flow deficiencies not located on dead-end pipelines will be addressed with the R&R Program described in Chapter 9. No recommended improvements for other existing fire flow deficiencies.
10-Year	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 80 to greater than 100 psi similar to 5-Year Phase. Some locations in the east, northeast, and Village 1 range from 40 - 80 psi due to high elevations. Pressures improve and range from 80 - 100 psi in Stardust of Village 1 due to being served by the new 450 Zone. Pressures below 40 psi occur at the same locations as the 5-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. No wells operating. 	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 60 to 100 psi with an increase in areas with 80 to 100 psi to the north compared to the 5-Year Phase. Some locations served in the east and Village 1 range from 40 - 60 psi due to high elevations. Pressures improve and range from 80 - 100 psi in Stardust of Village 1 due to being served by the new 450 Zone. Pressures below 40 psi occur at the same locations as the 5-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. 3 wells operating (1 well operating full-time and 2 wells during peak hour). 	<ul style="list-style-type: none"> Most existing tested locations meet the required fire flow. One existing deficient fire flow location is alleviated by the R&R Program. Existing tested locations in the model that do not meet the required fire flow are existing known deficiencies (i.e., areas with larger fire flow requirements which require multiple hydrants [i.e., 3,000 and 4,000 gpm] and/or located at small diameter [(i.e., 6-inch)] dead-end distribution pipelines). All tested future development locations meet the required fire flow. 	<ul style="list-style-type: none"> No recommended improvements for normal operations. No recommended improvements for existing fire flow deficiencies.
15-Year	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 80 to greater than 100 psi with a slight decrease in pressures to the west compared to the 10-Year Phase. Pressures ranging from 40 to 80 psi are at the same locations as the 10-Year Phase due to high elevations. Pressures below 40 psi occur at the same locations as the 10-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. No wells operating. 	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 60 to 100 psi with a slight decrease in pressures to the north compared to the 10-Year Phase. Pressures ranging from 40 to 80 psi are at the same locations as the 10-Year Phase due to high elevations. Pressures below 40 psi occur at the same locations as the 10-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. 6 wells operating (3 wells operating full-time and 3 wells during peak hour). 	<ul style="list-style-type: none"> Most existing tested locations meet the required fire flow. Existing tested locations in the model that do not meet the required fire flow are existing known deficiencies (i.e., areas with larger fire flow requirements which require multiple hydrants [i.e., 3,000 and 4,000 gpm] and/or located at small diameter [(i.e., 6-inch)] dead-end distribution pipelines). All tested future development locations meet the required fire flow. 	<ul style="list-style-type: none"> No recommended improvements for normal operations. No recommended improvements for existing fire flow deficiencies.
20-Year	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 80 to 100 psi with a slight decrease in pressures to the west compared to the 15-Year Phase. 	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 60 to 100 psi with a slight decrease in pressures to the north compared to the 15-Year Phase. 	<ul style="list-style-type: none"> Most existing tested locations meet the required fire flow. Existing tested locations in the model that do not meet the required fire flow are existing known deficiencies (i.e., areas with larger fire flow requirements which 	<ul style="list-style-type: none"> No recommended improvements for normal operations. No recommended improvements for existing fire flow deficiencies.

Table 8-19. Future System Evaluation Results Summary				
Phase	Average Day Demand Results	Maximum Day Demand Results	Maximum Day Demand Plus Fire Flow Results	Recommended Performance Evaluation Improvements
Buildout	<ul style="list-style-type: none"> Pressures ranging from 40 to 80 psi are at the same locations as the 15-Year Phase due to high elevations. Pressures below 40 psi occur at the same locations as the 15-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. No wells operating. 	<ul style="list-style-type: none"> Pressures ranging from 40 to 80 psi are at the same locations as the 15-Year Phase due to high elevations. Pressures below 40 psi occur at the same locations as the 15-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. 8 wells operating (3 wells operating full-time and 5 wells during peak hour). 	<ul style="list-style-type: none"> Pressures ranging from 40 to 80 psi are at the same locations as the 15-Year Phase due to high elevations. Pressures below 40 psi occur at the same locations as the 15-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. 8 wells operating (3 wells operating full-time and 5 wells during peak hour). 	<ul style="list-style-type: none"> Require multiple hydrants (i.e., 3,000 and 4,000 gpm) and/or located at small diameter [(i.e., 6-inch)] dead-end distribution pipelines. All tested future development locations meet the required fire flow.
	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 80 to 100 psi with a slight decrease in pressures to the west compared to the 20-Year Phase. Pressures ranging from 40 to 80 psi are at the same locations as the 20-Year Phase due to high elevations. Pressures below 40 psi occur at the same locations as the 20-Year Phase, adjacent to major system facilities where the associated pipelines do not have service connections. No velocity exceedances in distribution system pipelines. No wells operating. 	<ul style="list-style-type: none"> Meets pressure criteria at most customer service locations. Majority of system ranges from 60 to 80 psi which is an overall decrease in pressures compared to the 20-Year Phase. Pressures ranging from 40 to 80 psi are at the same locations as the 20-Year Phase with additional locations in the east and northeast due to high elevations. Pressures below 40 psi occur at the same locations as the 20-Year Phase, with additional locations located at high elevations and/or end of dead-end pipes. Borderline velocity exceedances in transmission mains near storage tanks and pressure reducing stations (7 to 8 fps). 24 wells operating (20 wells operating full-time and 4 wells during peak hour). 	<ul style="list-style-type: none"> Most existing tested locations meet the required fire flow. Existing deficiencies in the north by Village 2 are resolved. Existing tested locations in the model that do not meet the required fire flow are existing known deficiencies (i.e., areas with larger fire flow requirements which require multiple hydrants (i.e., 3,000 and 4,000 gpm) and/or located at small diameter [(i.e., 6-inch)] dead-end distribution pipelines). All tested future development locations meet the required fire flow. 	<ul style="list-style-type: none"> No recommended improvements for normal operations since velocity exceedances are borderline. Four new wells to meet peak demands during maximum day. No recommended improvements for existing fire flow deficiencies.

Fig8_2_ADD_SVR: \\A:\Clients\206_City of Lincoln\60-2A-56_Water Master Plan\GIS\Ca8_Lincoln_WM\B1.aprx - 1/7/2026



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Pump Station
 - ◆ Pressure Regulating Station
 - Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)

- Boundaries**
- 375 Zone
 - 375 Zone West
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - 650 Zone
 - 750 Zone
 - 775 Zone
 - Existing City Limit
 - City Sphere of Influence

Notes:
 1. Velocities in majority of the distribution system are less than 7 feet per second.

Minimum Pressure at Average Day Demand 5-Year Water System Figure 8-2

Prepared for:

City of Lincoln
 Water Master Plan Update

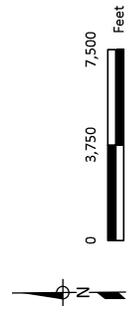
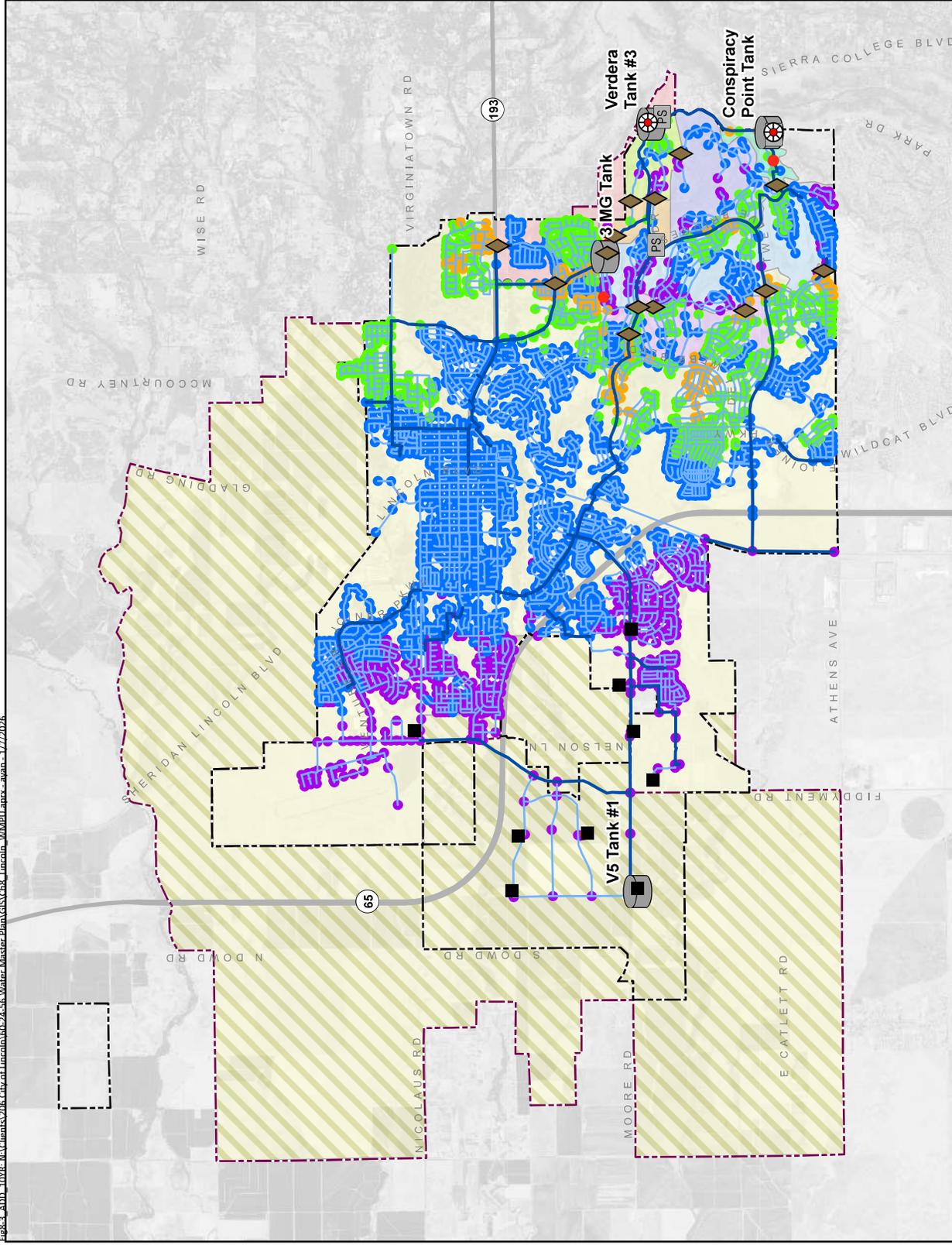


Fig8_3_ADD_10XB_NA\Clients\206_City of Lincoln\GIS\CB8_Lincoln_WMBU\aparc-aparc_1/17/2026



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

System Facilities

- ⊗ Placer County Water Agency Metering Station
- Groundwater Well
- PS Pump Station
- ◆ Pressure Regulating Station
- ⊕ Storage Tank

- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone

- Existing City Limit
- City Sphere of Influence

Notes:

1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Average Day Demand 10-Year Water System Figure 8-3

Prepared by:



Prepared for:

City of Lincoln
Water Master Plan Update

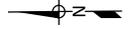
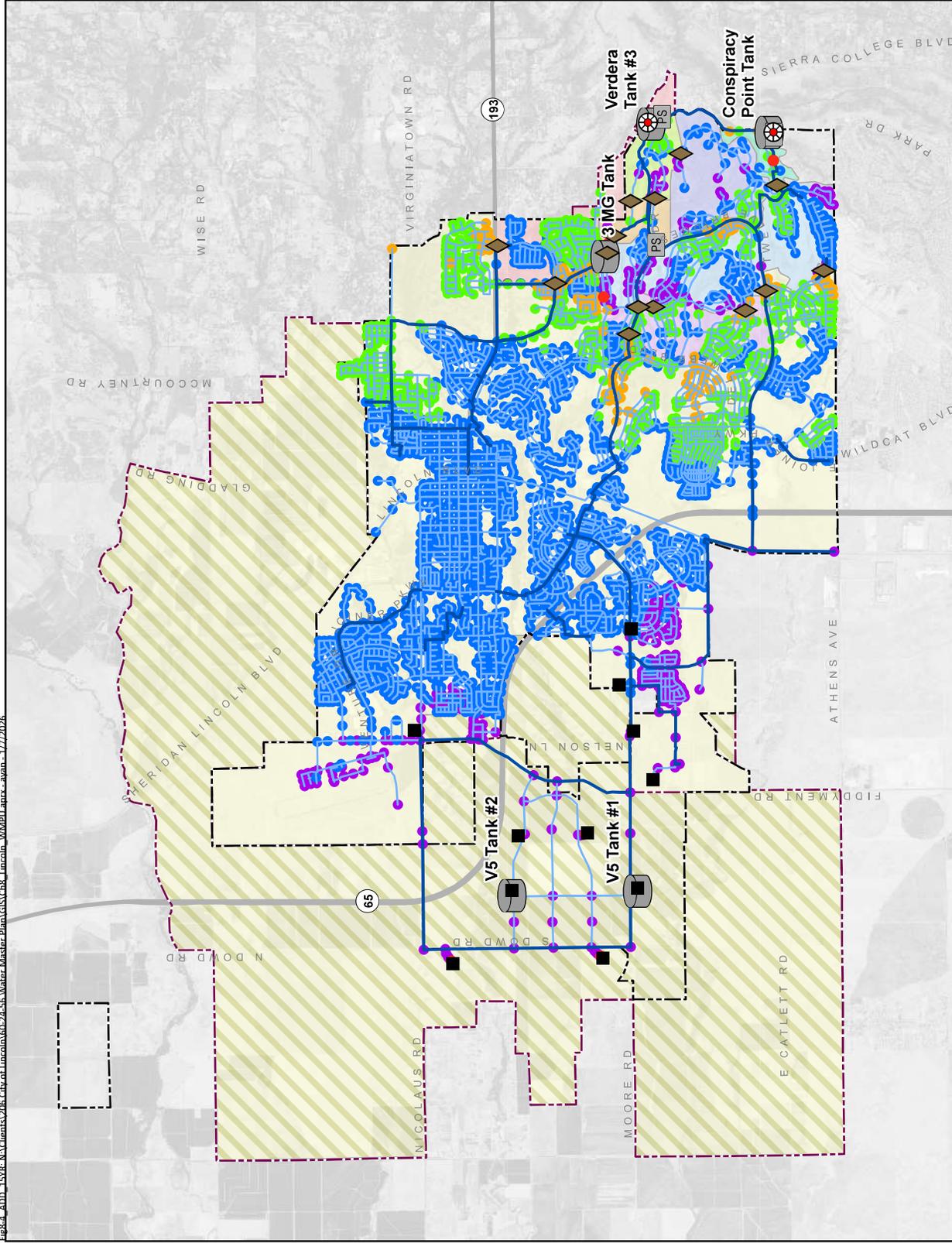


Fig8.4_ADD_15XB_NA\Clients\206_City of Lincoln\602456_Water Master Plan\GIS\C8_Lincoln_WMBU.aprx - splan - 1/7/2026



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

System Facilities

- ⊗ Placer County Water Agency Metering Station
- Groundwater Well
- PS Pump Station
- ◆ Pressure Regulating Station
- ⊕ Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Notes:

1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Average Day Demand 15-Year Water System Figure 8-4

Prepared by:



Prepared for:



City of Lincoln
Water Master Plan Update

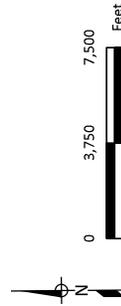
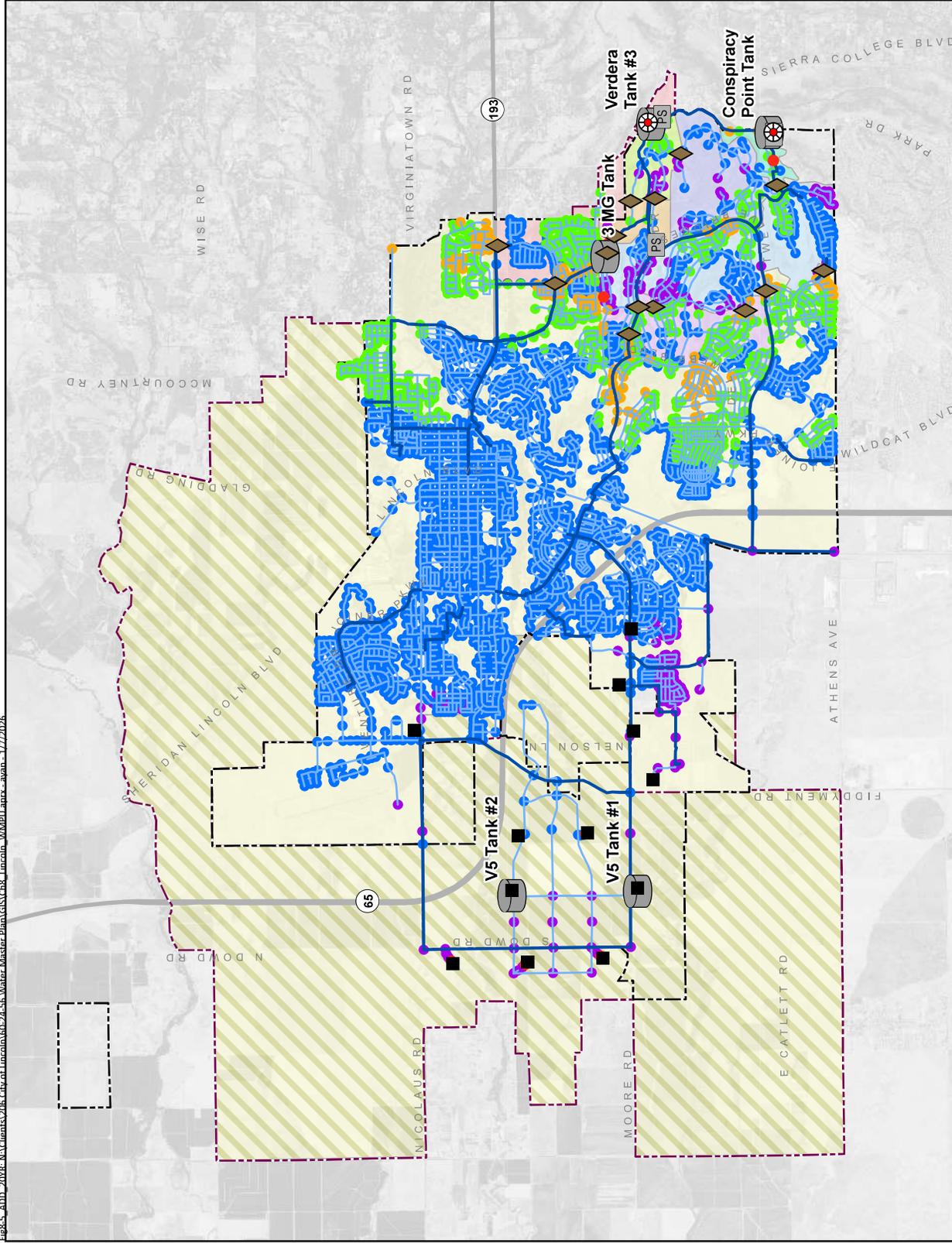


Fig8.5_ADD_20X8_NA\Clients\206_City of Lincoln\602456_Water Master Plan\GIS\C8_Lincoln_WMBL.aprx - splan - 1/7/2026



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Pump Station
 - ◆ Pressure Regulating Station
 - ⊕ Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)

- Boundaries**
- 375 Zone
 - 375 Zone West
 - 450 Zone
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - 650 Zone
 - 750 Zone
 - 775 Zone
 - Existing City Limit
 - City Sphere of Influence

Notes:
 1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Average Day Demand 20-Year Water System
Figure 8-5

Prepared for:
City of Lincoln
 Water Master Plan Update

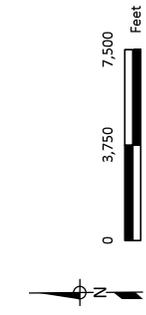
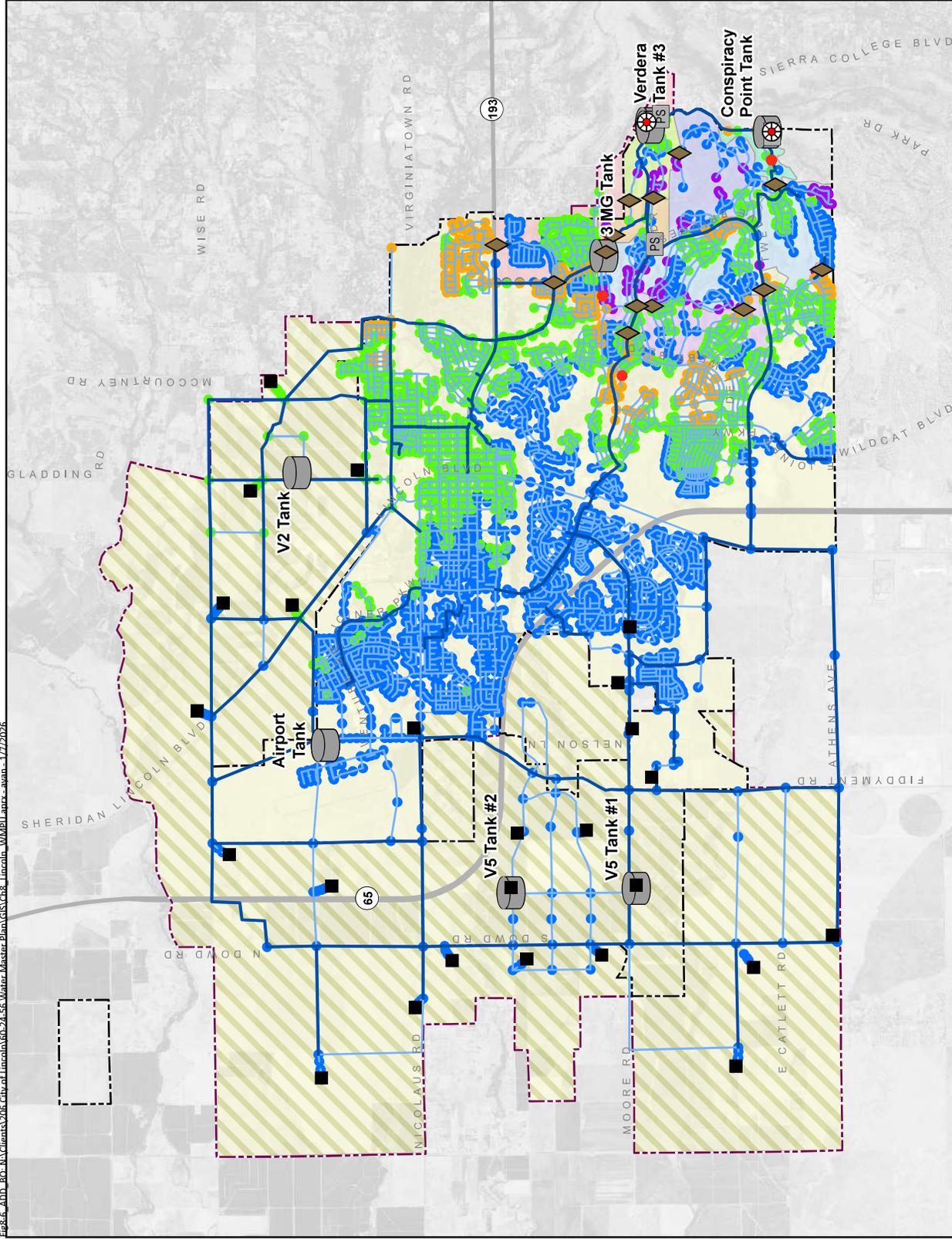


Fig8.6_ADD_B0_NA\Clients\2016_City of Lincoln\60-2A56-Water-Master-Plan\GIS\CH8_Lincoln_MM\B1.aprx -- plan -- 1/7/2026



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Pump Station
 - ◆ Pressure Regulating Station
 - ⊕ Storage Tank

- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

- Boundaries**
- 375 Zone
 - 375 Zone West
 - 450 Zone
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - 650 Zone
 - 750 Zone
 - 775 Zone
 - Existing City Limit
 - City Sphere of Influence

Notes:
 1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Average Day Demand
Buildout Water System
Figure 8-6

Prepared for:

City of Lincoln
 Water Master Plan Update

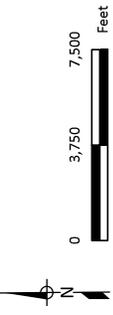
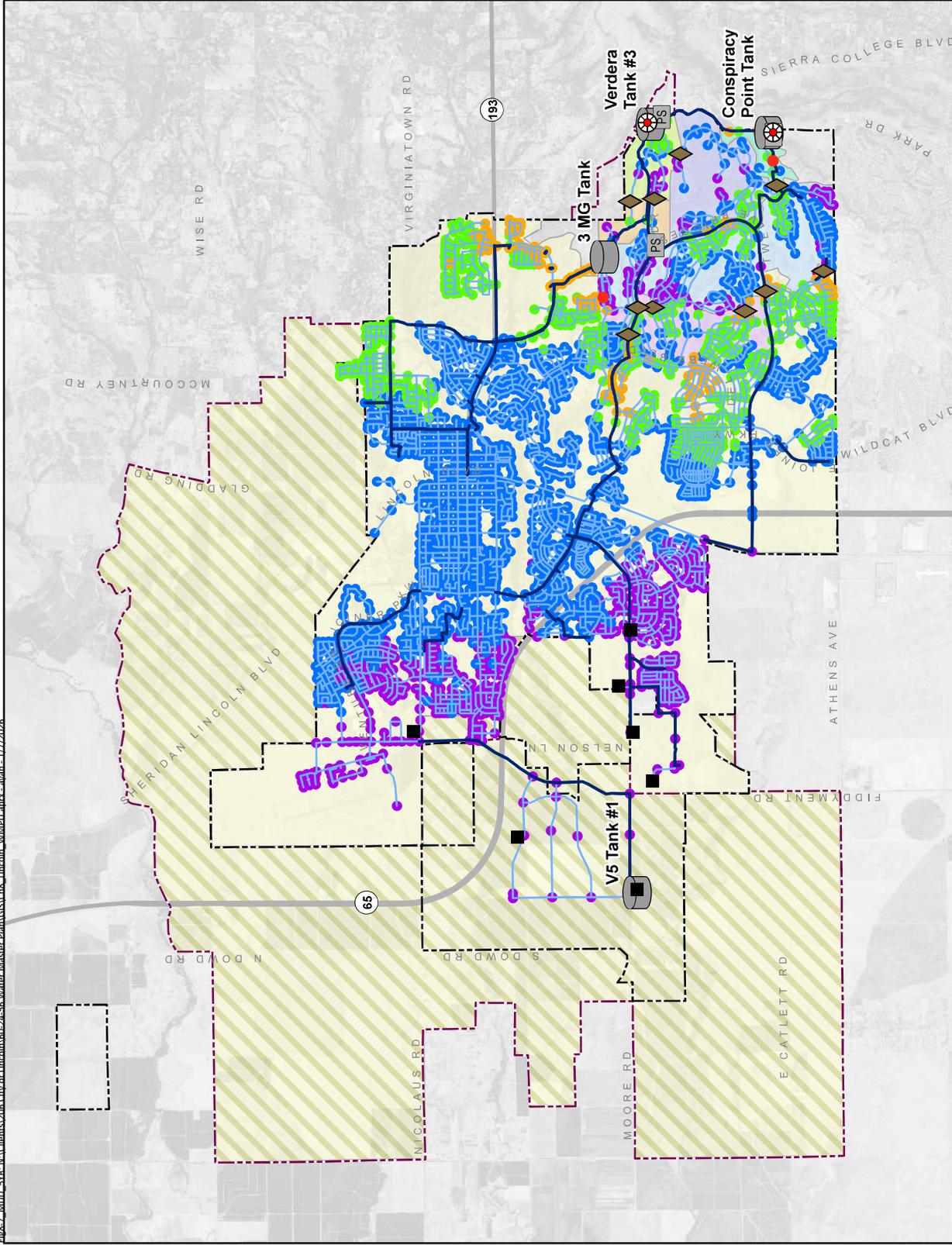


Fig8_7_MDD_SVB: \\N:\Clients\2006_City of Lincoln\602456_Water Master Plan\GIS\Ch8_Lincoln_WMPLU.aprx - splan - 1/7/2026



Minimum System Pressure

- Less than 40 psi
- 40 - 60 psi
- 60 - 80 psi
- 80 - 100 psi
- Greater than 100 psi

System Facilities

- ⊗ Placer County Water Agency Metering Station
- Groundwater Well
- PS Pump Station
- ◆ Pressure Regulating Station
- ⊠ Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Notes:

1. Velocities in majority of the distribution system are less than 7 feet per second.

Minimum Pressure at Maximum Day Demand 5-Year Water System Figure 8-7

Prepared by:



Prepared for:

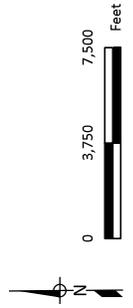
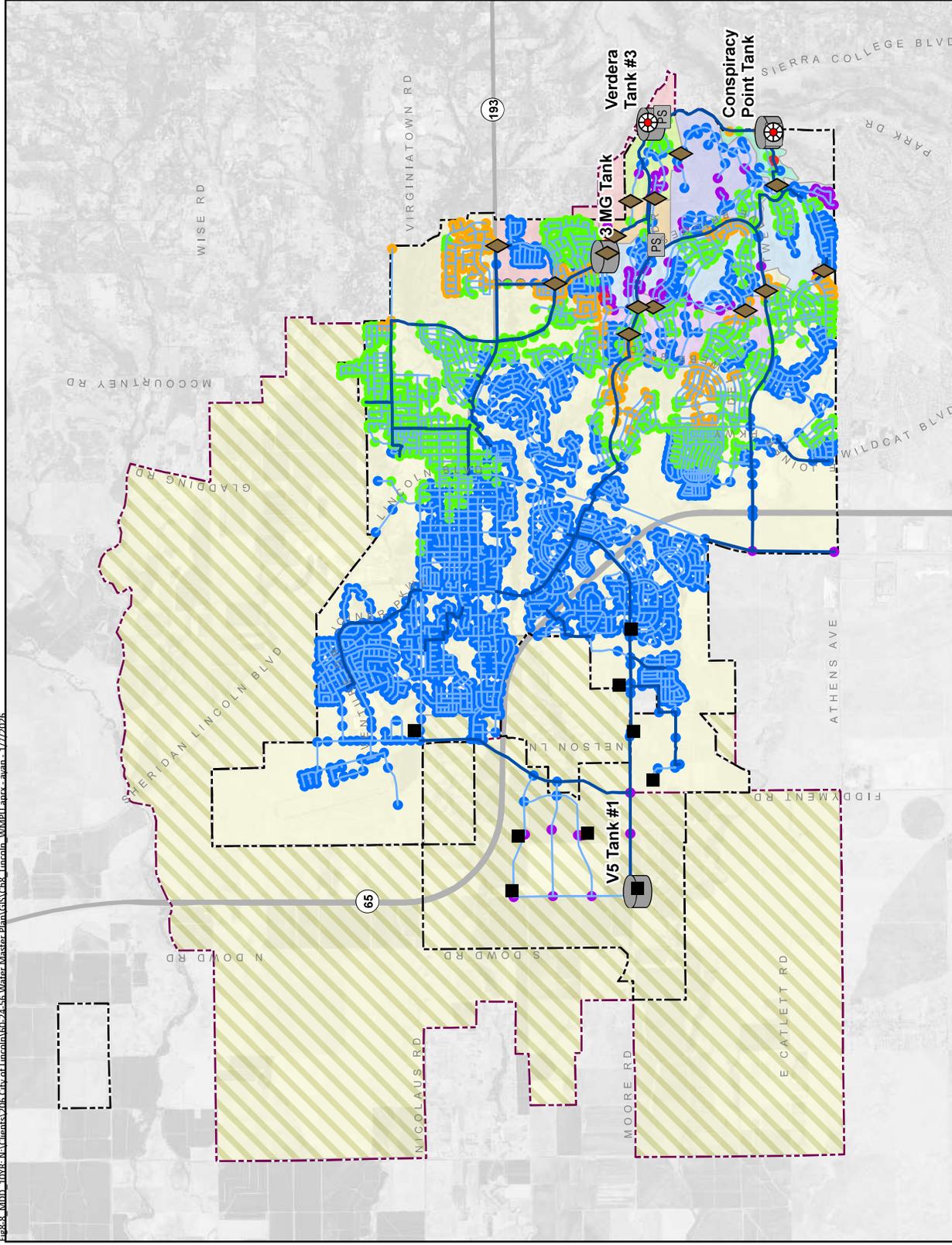


Fig8_8_MDD_10VE_NA\Clients\2016 Ctr of Lincoln\60-24-56 Water Master Plan\GIS\CH8_Lincoln_WMPL.aprx --Jan_17/2016



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

System Facilities

- ⊗ Placer County Water Agency Metering Station
- Groundwater Well
- PS Pump Station
- ◆ Pressure Regulating Station
- ⊞ Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Notes:

1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Maximum Day Demand 10-Year Water System Figure 8-8

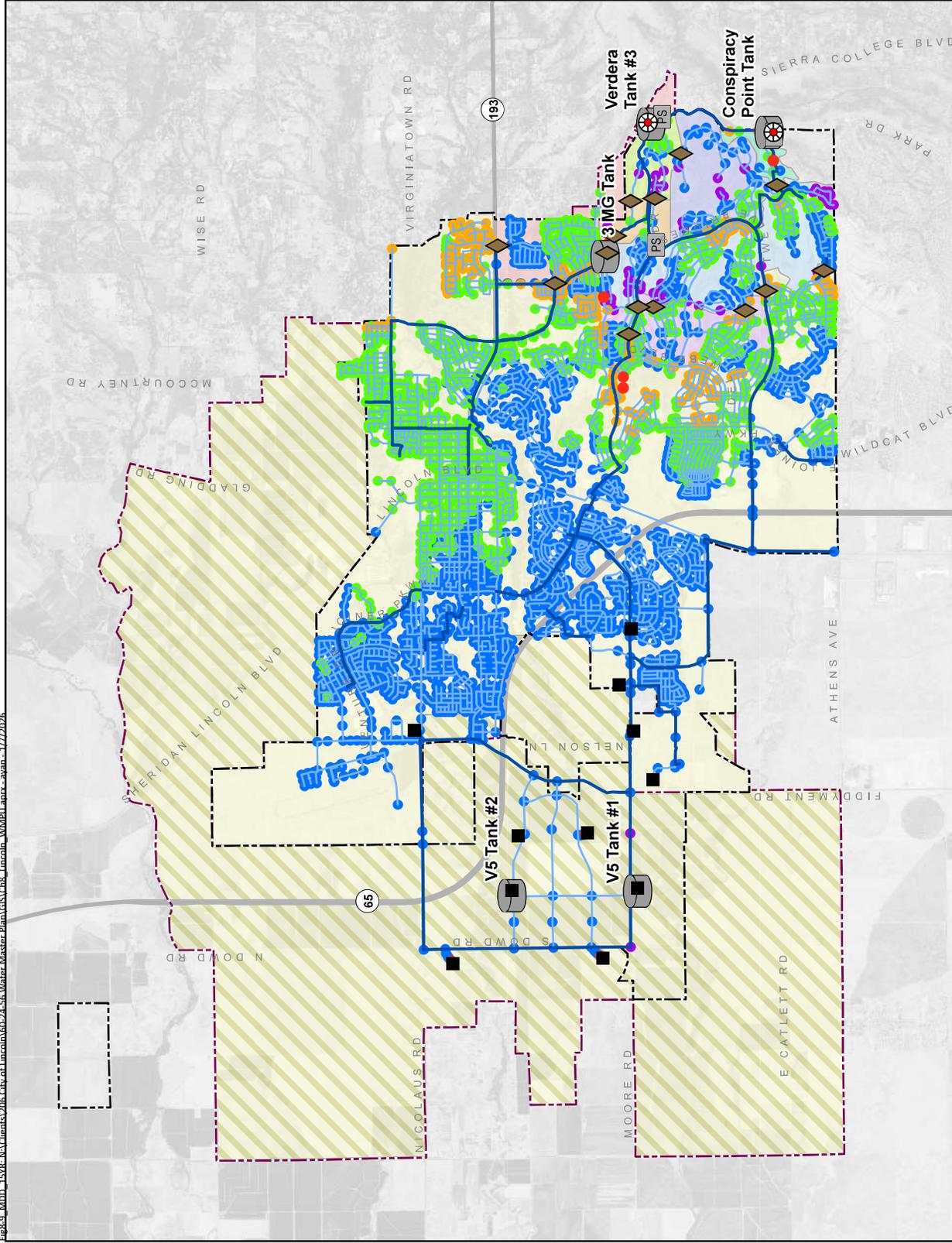
Prepared by:



Prepared for:



Fig8_9_MDD_15VE_NA\Clients\2016 Ctr of Lincoln\60-24-56 Water Master Plan\GIS\CH8_Lincoln_WMPL.aprx --Jan_17/2016



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Pump Station
 - ◆ Pressure Regulating Station
 - ⊕ Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Notes:

1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Maximum Day Demand 15-Year Water System Figure 8-9

Prepared by:

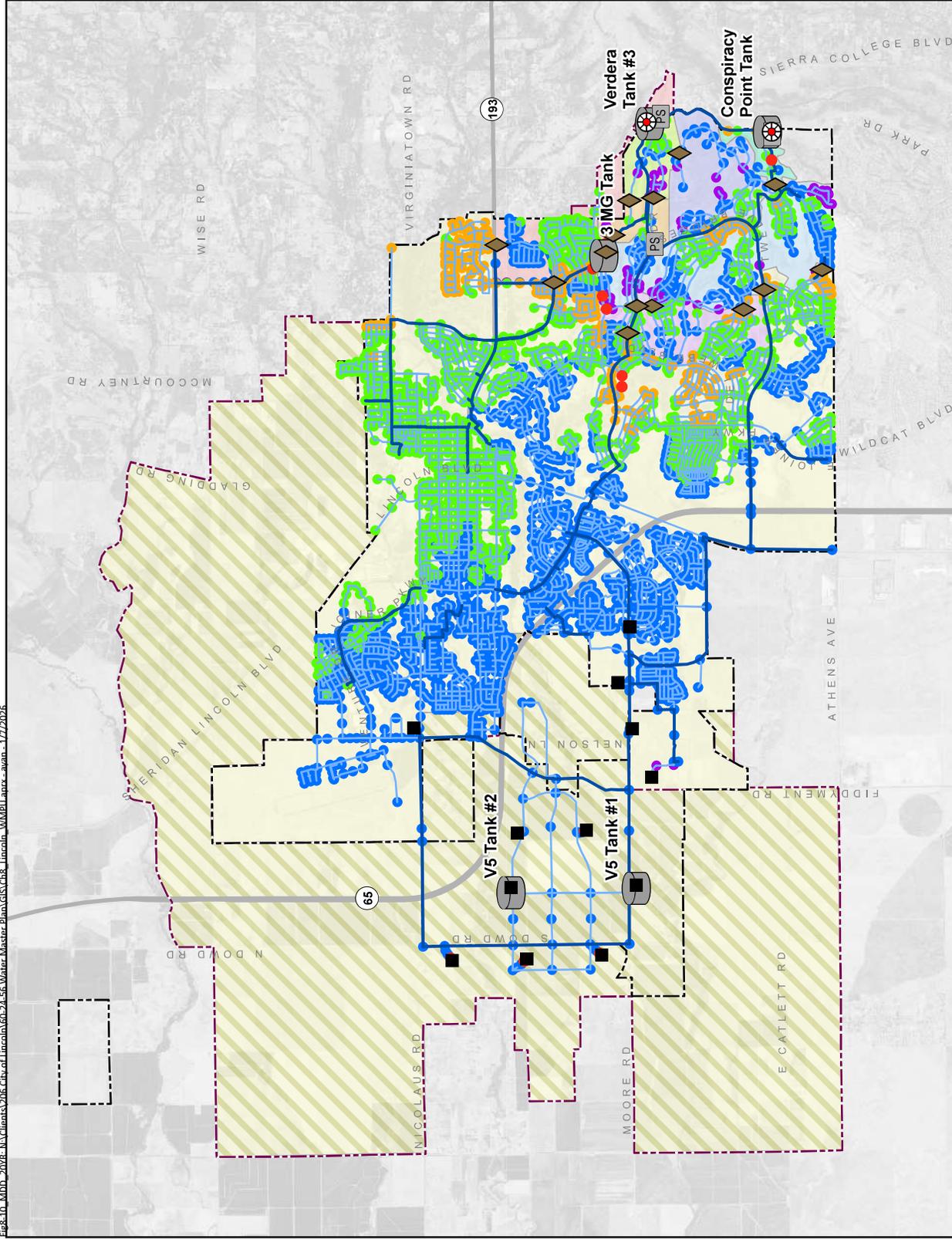


Prepared for:

City of Lincoln
Water Master Plan Update



Fig8-10_MDD_2018 - A:\Clients\2016_City of Lincoln\602-24-56_Water Master Plan\GIS\C88_Lincoln_WMPL.aprx - 1/7/2016



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

- System Facilities**
- ⊗ Placer County Water Agency Metering Station
 - Groundwater Well
 - PS Pump Station
 - ◆ Pressure Regulating Station
 - ⊕ Storage Tank
 - Distribution Pipeline (<18-inch)
 - Transmission Pipeline (≥18-inch)

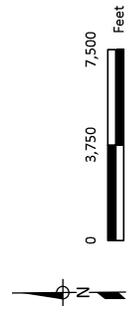
- Boundaries**
- 375 Zone
 - 375 Zone West
 - 450 Zone
 - 475 Zone
 - 575 Zone
 - 610 Zone
 - 650 Zone
 - 750 Zone
 - 775 Zone
 - Existing City Limit
 - City Sphere of Influence

Notes:
 1. Velocities in the distribution system are less than 7 feet per second.

Minimum Pressure at Maximum Day Demand 20-Year Water System
Figure 8-10

Prepared for:

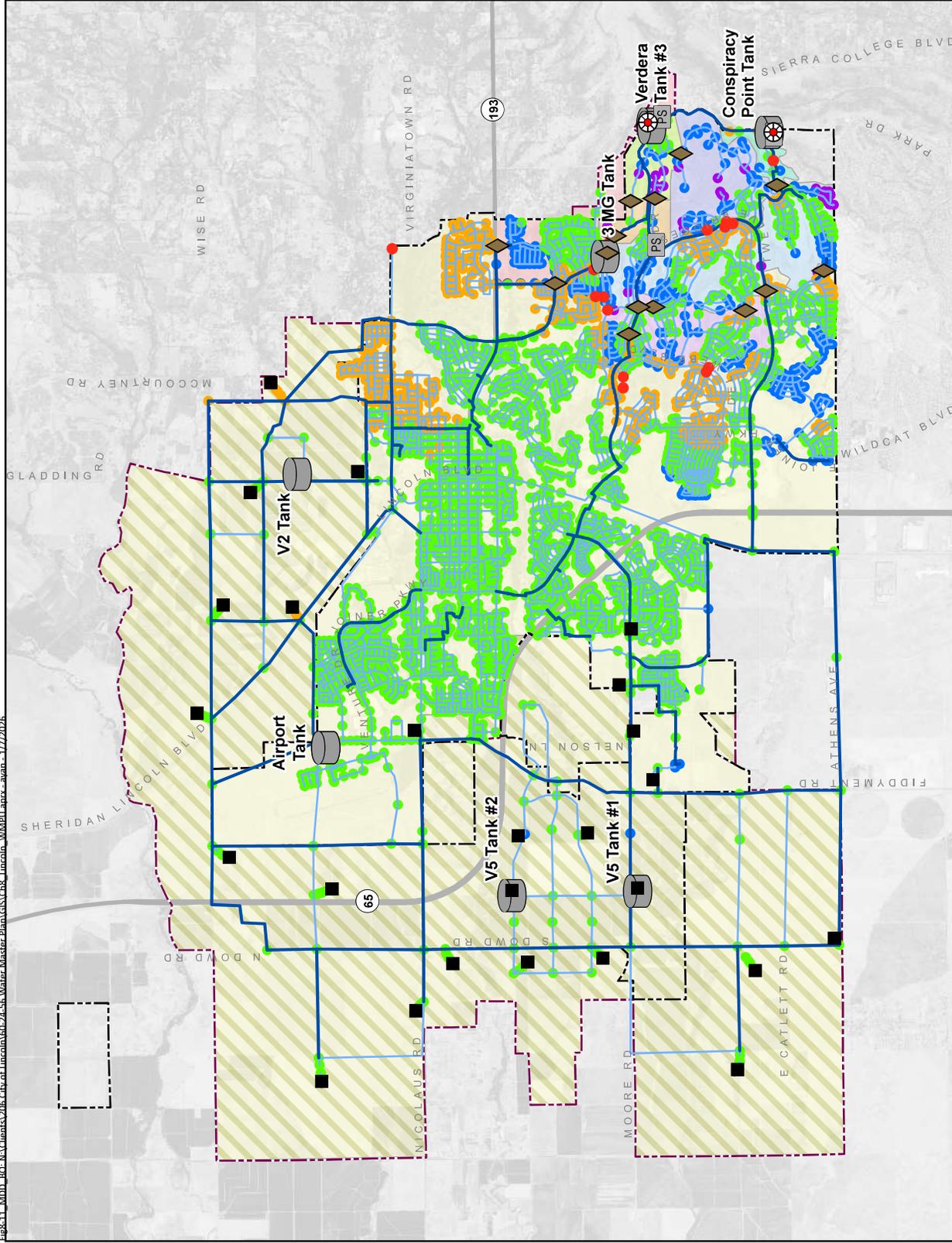
City of Lincoln
 Water Master Plan Update



Prepared by:
WEST YOST



Fig8-11_MDD_80_NA\Clients\206_City of Lincoln\602456_Water Master Plan\GIS\CBS_Lincoln_WMPL\apex-apex_1/7/2026



Prepared by:



Prepared for:

City of Lincoln
Water Master Plan Update



- Minimum System Pressure**
- Less than 40 psi
 - 40 - 60 psi
 - 60 - 80 psi
 - 80 - 100 psi
 - Greater than 100 psi

System Facilities

- ⊗ Placer County Water Agency Metering Station
- Groundwater Well
- PS Catta Verdera Pump Station
- ◆ Pressure Regulating Station
- ⊕ Storage Tank

- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone

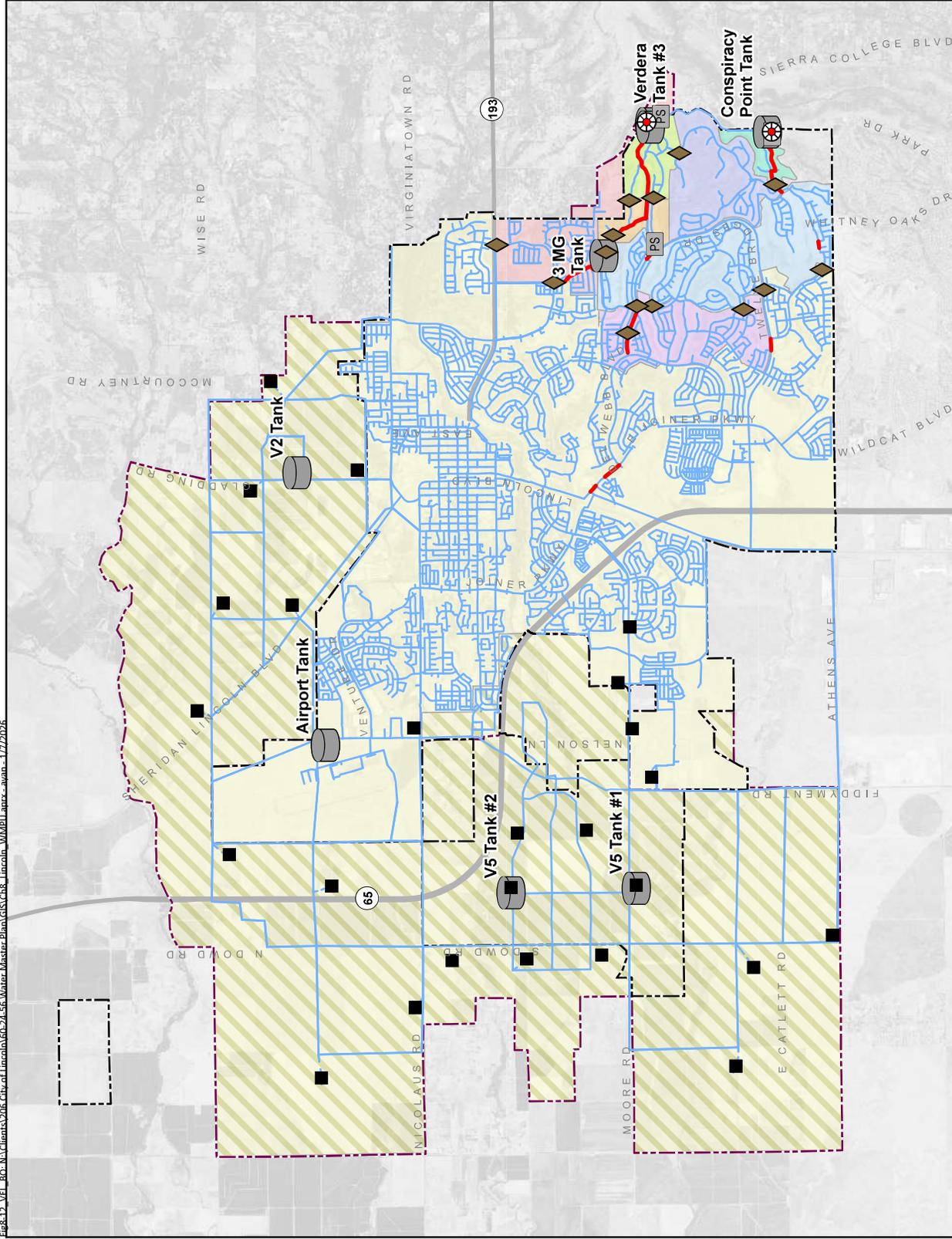
- Existing City Limit
- City Sphere of Influence

Notes:

1. Velocities in the most of the system are less than 7 feet per second.

Minimum Pressure at Maximum Day Demand Buildout Water System
Figure 8-11

Fig8.12_VEL_BD-AU\Clients\206_City of Lincoln\60-24-56-Water Master Plan\GIS\Ch8_Lincoln_WMAPBL.mxd -- appn_11712006



Maximum Velocity

- Less than or equal to 7 fps
- Greater than 7 fps

System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Pump Station
- Pressure Regulating Station
- Storage Tank

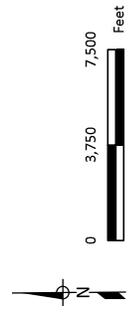
Boundaries

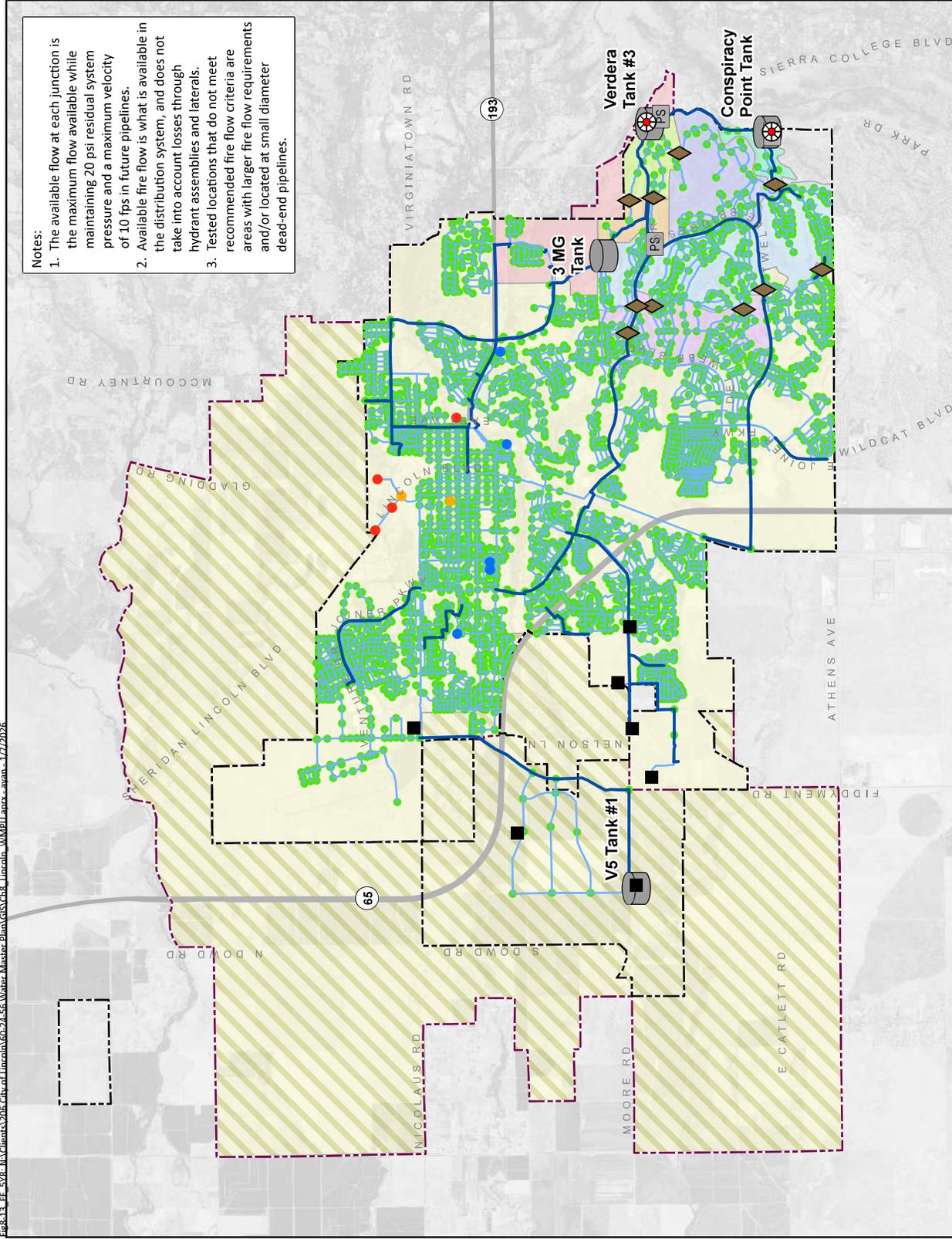
- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Notes:
 1. Maximum velocities exceeding the velocity criterion range from 7 to 8 feet per second.

Maximum Velocities at Maximum Day Demand
Buildout Water System
Figure 8-12

Prepared for:
City of Lincoln
 Water Master Plan Update





Notes:

1. The available flow at each junction is the maximum flow available while maintaining 20 psi residual system pressure and a maximum velocity of 10 fps in future pipelines.
2. Available fire flow is what is available in the distribution system, and does not take into account losses through hydrant assemblies and laterals.
3. Tested locations that do not meet recommended fire flow criteria are areas with larger fire flow requirements and/or located at small diameter dead-end pipelines.

Percent of Available Fire Flow

- $\geq 100\%$ of Criteria
- 75 - 100% of Criteria
- 50 - 75% of Criteria
- $< 50\%$ of Criteria

System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (>18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Percent of Fire Flow Requirement Available
5-Year Water System
Figure 8-13

Prepared for:

Prepared by:

Notes:

1. The available flow at each junction is the maximum flow available while maintaining 20 psi residual system pressure and a maximum velocity of 10 fps in future pipelines.
2. Available fire flow is what is available in the distribution system, and does not take into account losses through hydrant assemblies and laterals.
3. Tested locations that do not meet recommended fire flow criteria are areas with larger fire flow requirements and/or located at small diameter dead-end pipelines.

Percent of Available Fire Flow

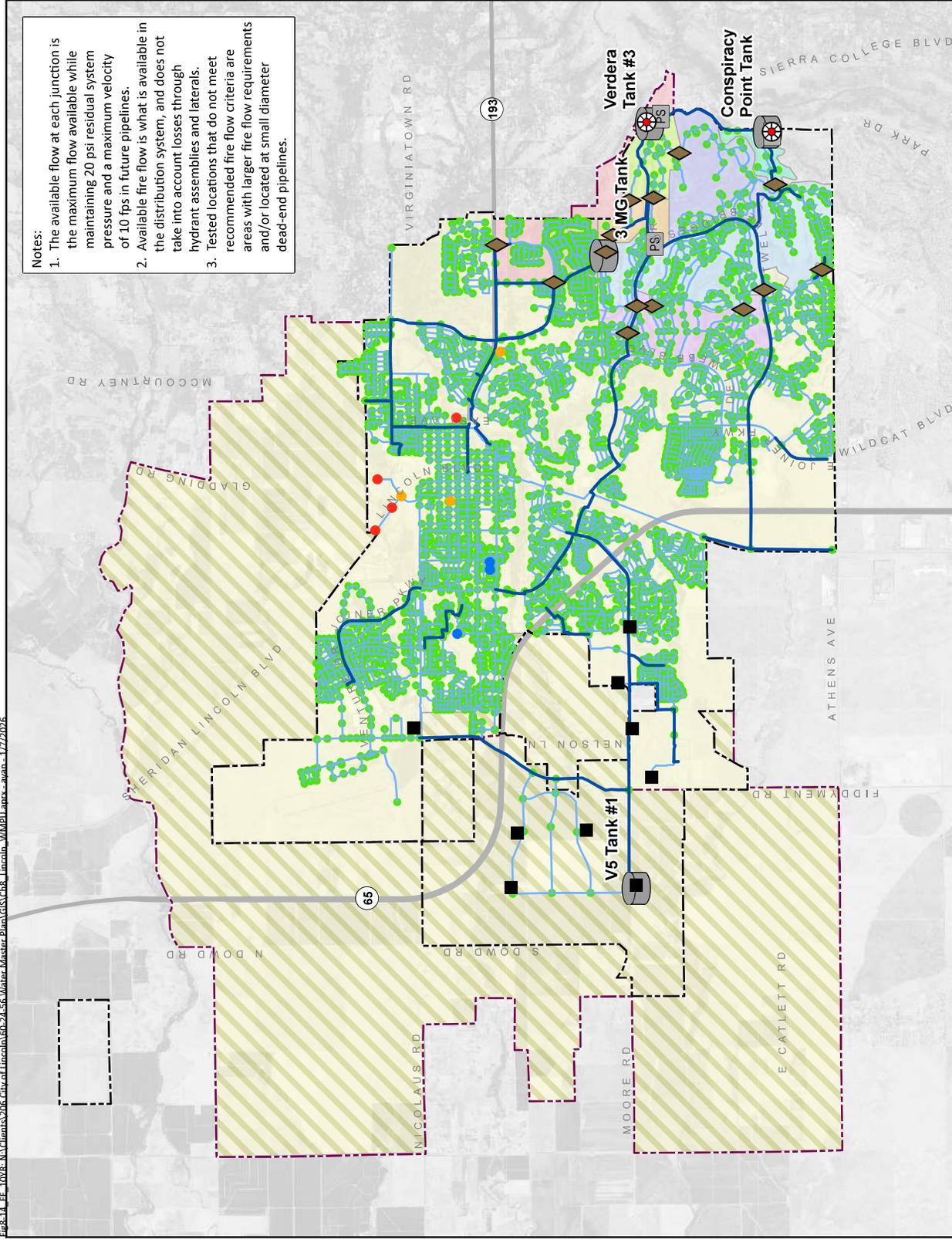
- ≥ 100% of Criteria
- 75 - 100% of Criteria
- 50 - 75% of Criteria
- < 50% of Criteria

System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥18-inch)

Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence



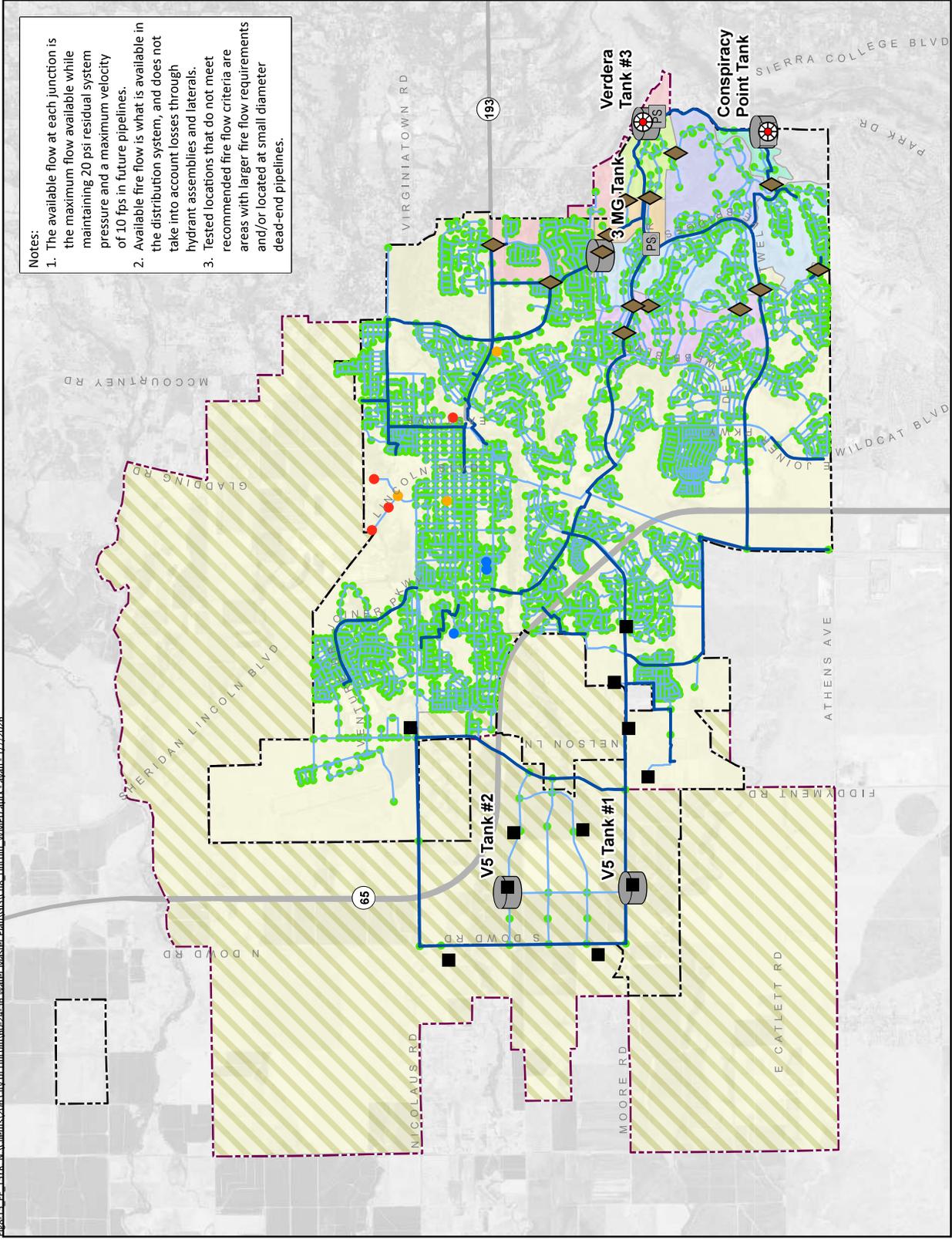
Prepared by:



Prepared for:



Percent of Fire Flow Requirement Available
10-Year Water System
Figure 8-14



Notes:

1. The available flow at each junction is the maximum flow available while maintaining 20 psi residual system pressure and a maximum velocity of 10 fps in future pipelines.
2. Available fire flow is what is available in the distribution system, and does not take into account losses through hydrant assemblies and laterals.
3. Tested locations that do not meet recommended fire flow criteria are areas with larger fire flow requirements and/or located at small diameter dead-end pipelines.

Percent of Available Fire Flow

- $\geq 100\%$ of Criteria
- 75 - 100% of Criteria
- 50 - 75% of Criteria
- $< 50\%$ of Criteria

System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (>18-inch)

Boundaries

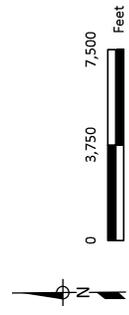
- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

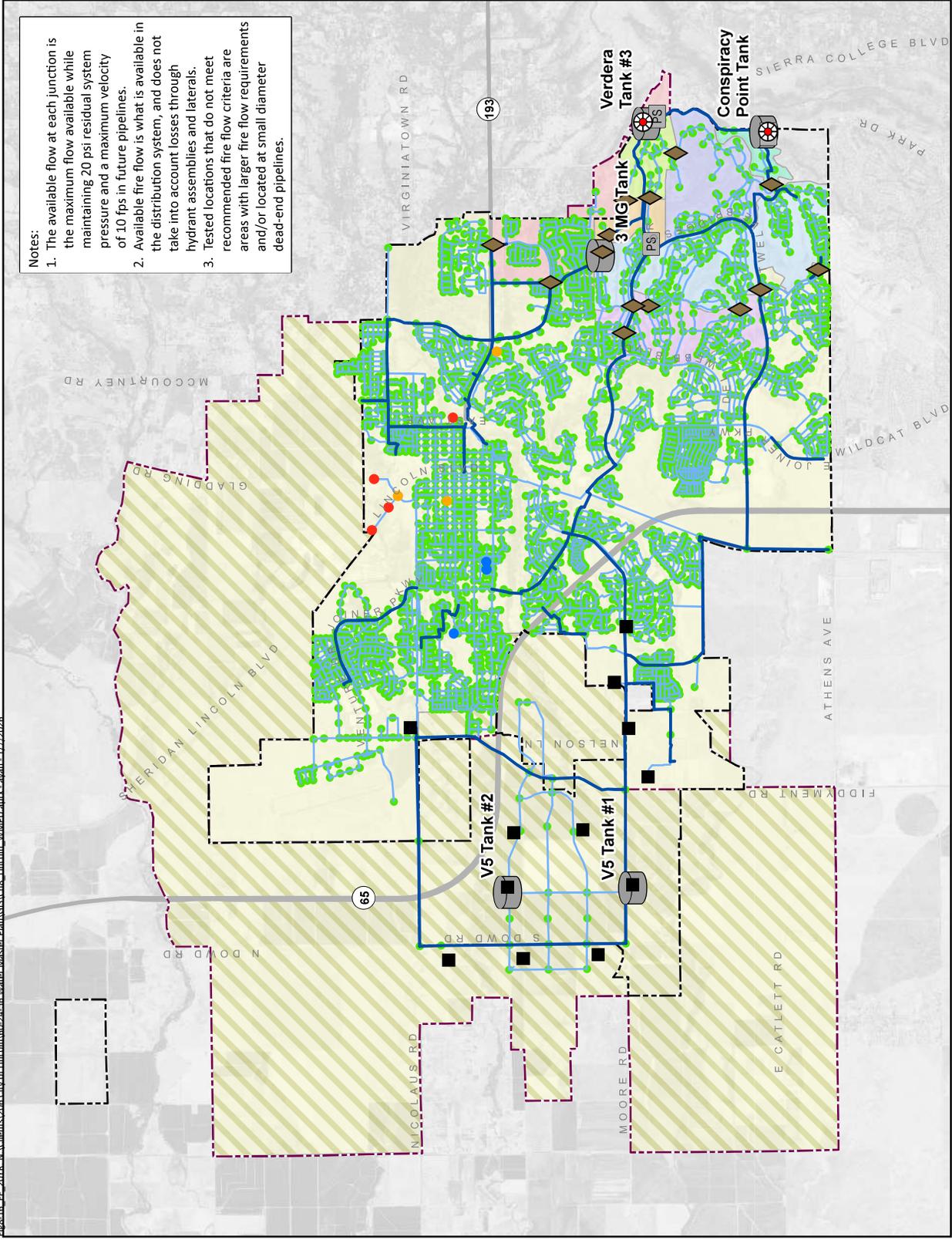
Percent of Fire Flow Requirement Available
15-Year Water System
Figure 8-15

Prepared for:

City of Lincoln
 Water Master Plan Update

Prepared by:





Notes:

1. The available flow at each junction is the maximum flow available while maintaining 20 psi residual system pressure and a maximum velocity of 10 fps in future pipelines.
2. Available fire flow is what is available in the distribution system, and does not take into account losses through hydrant assemblies and laterals.
3. Tested locations that do not meet recommended fire flow criteria are areas with larger fire flow requirements and/or located at small diameter dead-end pipelines.

Percent of Available Fire Flow

- $\geq 100\%$ of Criteria
- 75 - 100% of Criteria
- 50 - 75% of Criteria
- $< 50\%$ of Criteria

System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (>18-inch)

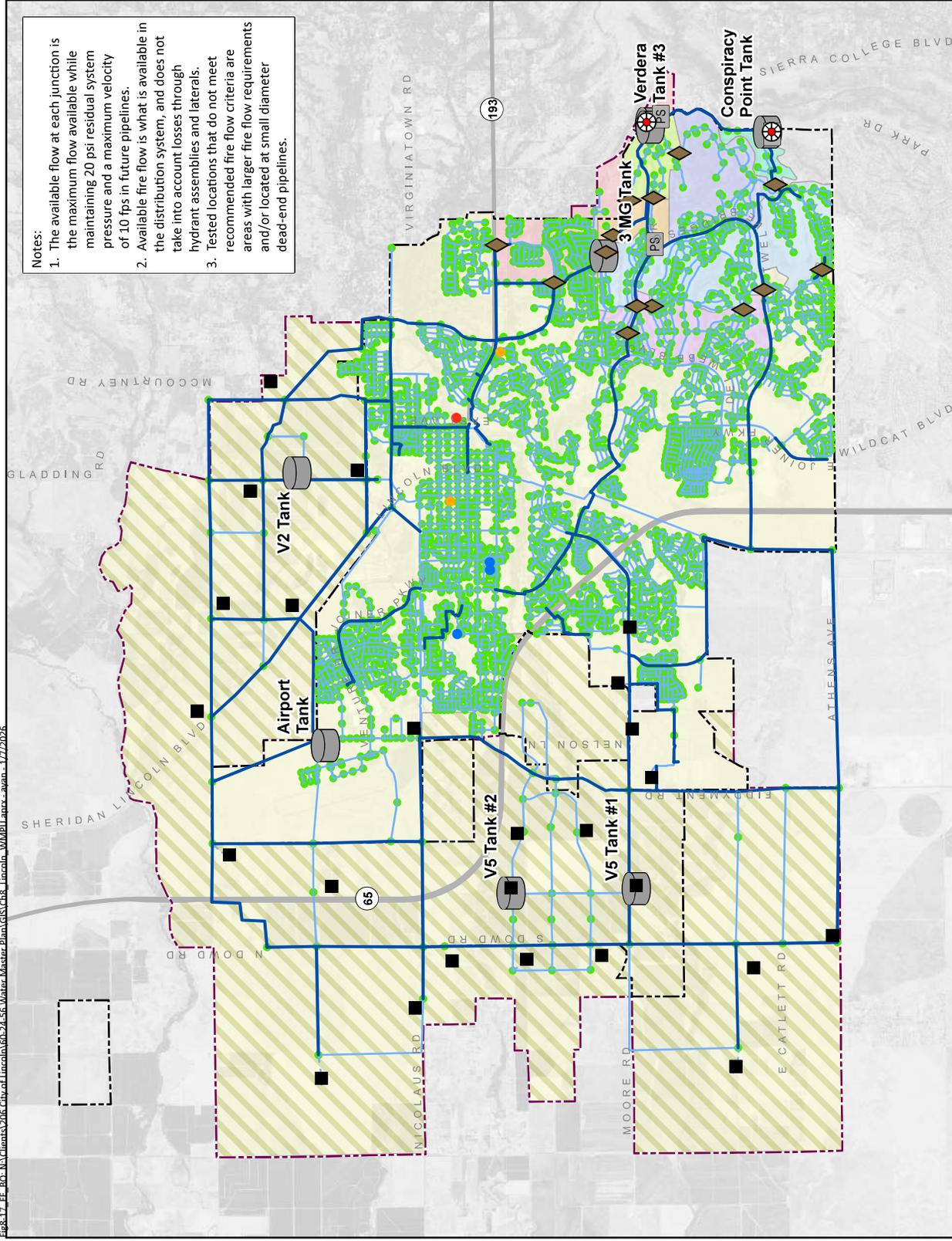
Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Percent of Fire Flow Requirement Available
20-Year Water System
Figure 8-16

Prepared for:

Prepared by:



Notes:

1. The available flow at each junction is the maximum flow available while maintaining 20 psi residual system pressure and a maximum velocity of 10 fps in future pipelines.
2. Available fire flow is what is available in the distribution system, and does not take into account losses through hydrant assemblies and laterals.
3. Tested locations that do not meet recommended fire flow criteria are areas with larger fire flow requirements and/or located at small diameter dead-end pipelines.

Percent of Available Fire Flow

- $\geq 100\%$ of Criteria
- 75 - 100% of Criteria
- 50 - 75% of Criteria
- $< 50\%$ of Criteria

System Facilities

- Placer County Water Agency Metering Station
- Groundwater Well
- Pump Station
- Pressure Regulating Station
- Storage Tank
- Distribution Pipeline (<18-inch)
- Transmission Pipeline (≥ 18 -inch)

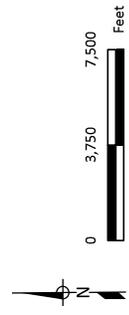
Boundaries

- 375 Zone
- 375 Zone West
- 450 Zone
- 475 Zone
- 575 Zone
- 610 Zone
- 650 Zone
- 750 Zone
- 775 Zone
- Existing City Limit
- City Sphere of Influence

Percent of Fire Flow Requirement Available
Buildout Water System
Figure 8-17

Prepared for:

City of Lincoln
 Water Master Plan Update



8.5 SUMMARY OF FINDINGS AND RECOMMENDATIONS FOR THE FUTURE WATER SYSTEM

Table 8-20 provides a summary of findings and recommended improvements identified by evaluating the 5-Year, 10-Year, 15-Year, 20-Year, and Buildout water systems and is organized by improvement type and phase. These recommendations are used to develop a recommended CIP, which is further described in Chapter 10. Figure 8-1 presents the recommended improvements for the five phases.

8.6 OTHER RECOMMENDATIONS

In addition to the improvements identified in the capacity and performance evaluations, other recommendations were identified through discussions with City staff. These projects are included to improve system and/or water supply reliability and are summarized below.

- **Water Supply Options Study.** A comprehensive water supply study is recommended to investigate feasible water supply sources for Buildout. This study will also explore the feasibility of obtaining additional PCWA and NID water supply. Potential PCWA options to consider include, but are not limited to, new PCWA water supply sources in west Placer County, such as the RiverArc Project, potential expansion and/or modification to metering stations, and the establishment of new agreements to access additional supply. The outcome of the study will be used as a framework for Project proponents to provide supply solutions to meet the increase in water demands for their developments. The supply solutions should be included in the development approval process with the City.
- **Groundwater Recharge Study.** A groundwater recharge study is recommended to perform field investigation and testing on the sites identified in the 2023 groundwater recharge site feasibility study completed by WPGSA. This study will also further evaluate whether implementation of recharge is viable in the City.
- **ASR Wells Study.** An ASR well study is recommended to investigate the feasibility of implementing ASR capabilities in future wells.
- **Recycled Water Feasibility Study.** The City should update the 2019 Reclamation Master Plan and continue to work with developers and Lincoln-Sewer Maintenance District 1 Wastewater Authority (LiSWA) to maximize the future use of recycled water.

Table 8-20. Summary of Recommended Future System Improvements					
Improvement Type	5-Year	10-Year	15-Year	20-Year	
Supply	<ul style="list-style-type: none"> Construct two new ASR wells with backup power to improve supply reliability. 	<ul style="list-style-type: none"> Construct additional two new ASR wells with backup power to improve supply reliability. 	<ul style="list-style-type: none"> Construct additional two new ASR wells with backup power to improve supply reliability. 	<ul style="list-style-type: none"> Construct an additional new ASR well with backup power to improve supply reliability. 	<ul style="list-style-type: none"> Construct additional 13 new ASR wells with backup power to improve supply reliability.
	<ul style="list-style-type: none"> Total (Previous and Current Phases): 2 ASR wells Alternative water supplies will be explored and/or advanced to offset the need for additional groundwater capacity. Refer to Chapter 4 for additional detail. 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 4 ASR wells Construct an additional 2 MG storage tank and pump station in Village 5 to mitigate the storage deficit in the 375 Zone. 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 6 ASR wells Construct an additional 2 MG storage tank and pump station in Village 5 to mitigate the storage deficit in the 375 Zone. 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 7 ASR wells None 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 20 ASR wells Construct a 5 MG storage tank and pump station in Village 2 to mitigate the storage deficit in the 375 Zone. Construct a 3 MG storage tank and pump station in the Airport Area to mitigate the storage deficit in the 375 Zone.
Storage and Pumping					
Pressure Reducing Station	<ul style="list-style-type: none"> Total (Previous and Current Phases): 1 new storage tank 1 new associated pump station None 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 1 new storage tank 1 new associated pump station Construct four new pressure reducing stations for the proposed 450 Zone. 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 2 new storage tanks 2 new pump stations None 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 2 new storage tanks 2 new pump stations 	<ul style="list-style-type: none"> Total (Previous and Current Phases): 4 new storage tanks 4 new pump stations
Pipelines	<ul style="list-style-type: none"> Construct new transmission pipelines to support future development areas. City should continue to rehabilitate and replace older and undersized (i.e., smaller than 8-inch diameter) pipelines, with the R&R previously discussed in Chapter 7 and described in detail in Chapter 9. 				