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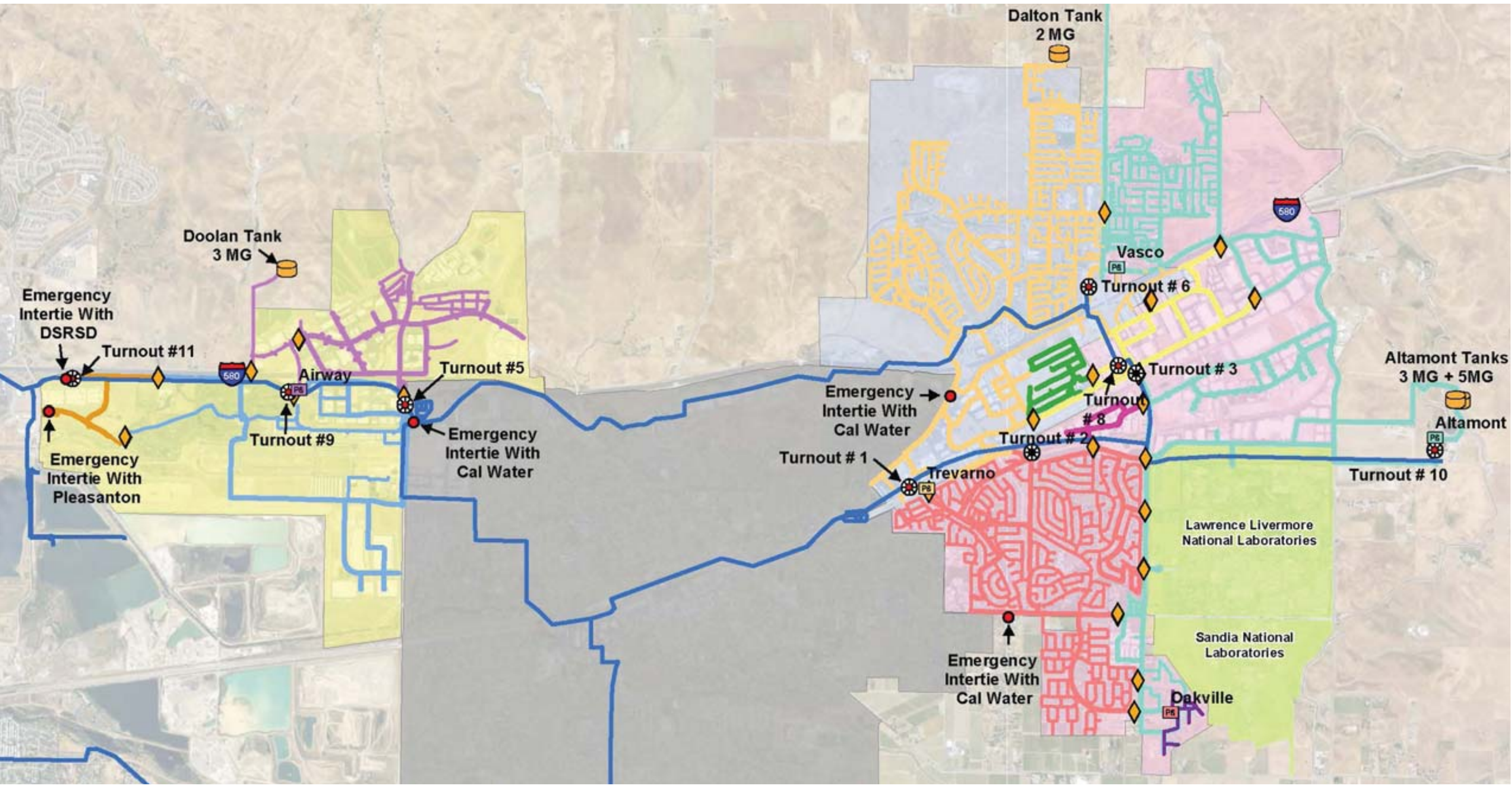

CITY OF LIVERMORE

Water Master Plan

FINAL REPORT

DECEMBER 2017

WEST YOST ASSOCIATES

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FINAL REPORT | DECEMBER 2017

Water Master Plan

Prepared for

City of Livermore

Project No. 438-12-15-05

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2015 UWMP	City of Livermore 2015 Urban Water Management Plan
ACP	Asbestos Cement Pipe
af/yr	Acre Feet Per Year
AWWA	American Water Works Association
BART	Bay Area Rapid Transit
BBID	Byron Bethany Irrigation District
CalWater	California Water Service Company
CI	Cast Iron
CII	Commercial, Industrial and Institutional
CIP	Capital Improvement Program
City	City of Livermore
DDW	Division of Drinking Water
DI	Ductile Iron
DSRSD	Dublin San Ramon Services District
DVWTP	Del Valle Water Treatment Plant
DWR	Department of Water Resources
ft/kft	Feet Per Thousand Feet
ft/s	Feet Per Second
GIS	Geographic Information System
gpcd	Gallons Per Capita Per Day
gpm	Gallon Per Minute
HGL	Hydraulic Grade Line
I-580	Interstate 580
INP	Isabel Neighborhood Plan
ISO	Insurance Service Office
MG	Million Gallons
mgd	Million Gallons Per Day
NRW	Non-Revenue Water
PPWTP	Patterson Pass Water Treatment Plant
PRS	Pressure Regulating Stations
PRV	Pressure Reducing Valve
psi	Pounds Per Square Inch

PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
SBx7-7	Water Conservation Act of 2009
SCADA	Supervisory Control and Data Acquisition
SFPUC	San Francisco Public Utilities Commission
STWSD	Semitropic Water Storage District
SWP	State Water Project
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
USEPA	U.S. Environmental Protection Agency
West Yost	West Yost Associates
Zone 7	Zone 7 Water Agency

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EXECUTIVE SUMMARY

ES.1 OVERVIEW AND NEED FOR WATER MASTER PLAN UPDATE

The City of Livermore (City) municipal water system currently serves a population of approximately 28,000 people in eastern portion of Alameda County. While the City is continually planning and designing water system improvements to ensure a safe and reliable water supply for its existing and future water customers, a comprehensive review of the City's water system facilities has not been completed since 2004. With changes in customer's water use in response to recent on-going drought conditions, and several new development projects proposed throughout the City's water service area, there is a need for an updated Water Master Plan to evaluate the City water system's ability to meet existing and projected buildout water demands and identify improvements needed to address system deficiencies.

ES.2 WATER MASTER PLAN GOALS AND OBJECTIVES

The objective of this Water Master Plan is to clearly define the City's long-term water system infrastructure capacity needs, and to develop a plan that will provide the flexibility and system reliability that the City needs to accommodate changing future capacity needs. Specific objectives are listed in Table ES-1 with references to specific chapters and appendices of this Water Master Plan.

Table ES-1. Water Master Plan Objectives

Water Master Plan Objective	Report Location
Evaluate and summarize the City's water service area and existing water system facilities	**Chapter 2** Water Service Area and Water System Facilities
Prepare water demand projections through buildout of the City's water service area	**Chapter 3** Existing and Future Potable Water Demands
Evaluate, confirm and update, as needed, performance and operational criteria under which the water system will be analyzed and future facilities recommendations will be formulated	**Chapter 4** Water System Planning and Design Criteria
Update and validate the City's water system hydraulic model	Refer to **Appendix A** for information on the update and validation of the City's water system hydraulic model
Evaluate existing and buildout water system conditions to identify the City's existing and future needs	**Chapter 5** Existing Water System Evaluation **Chapter 6** Buildout Water System Evaluation Refer to **Appendix B** for a focused evaluation of water storage requirements in the City's Zone 2 and 3 Water Service Areas and a tank siting study at the City's Altamont Tank site Refer to **Appendix C** for an evaluation of the potential impacts of the proposed Isabel Neighborhood Plan, including an extension of BART to Isabel Avenue, on the City's recommended water system improvements
Develop a plan for recommended existing and buildout water system facilities to meet estimated existing and buildout demands	**Chapter 7** Capital Improvement Program

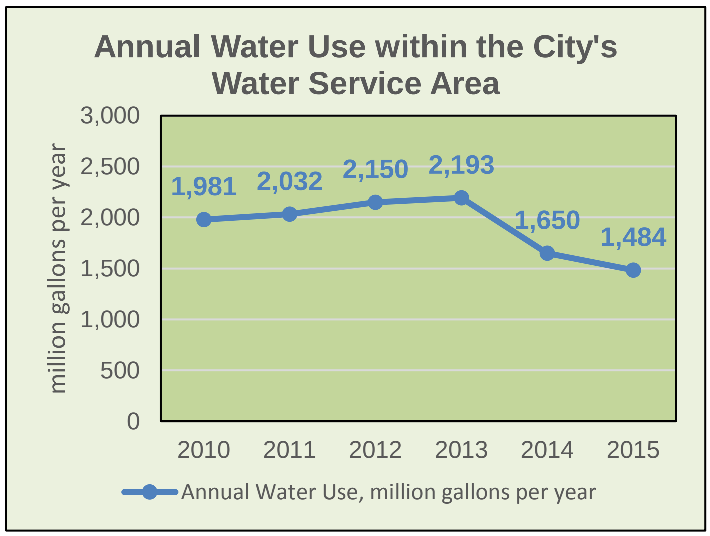
It is important to note that the focus of this Water Master Plan is to recommend capacity-related improvement projects for the City's water system. It is not the intent for this Water Master Plan to be the sole source of all recommended water system projects for inclusion in the City's Capital Improvement Plan (CIP). Other sources include the Water Resource Division's asset management program (which focuses on the renewal or replacement of water system assets based on age and condition), regulations and code compliance, operations and maintenance staff input, and coordination with other roadway improvements. The City utilizes and coordinates all sources in the development of the City's overall CIP for the water system.

The development of this Water Master Plan included working closely with staff from the City's Water Resources Division, Engineering Division and Planning Division to evaluate water use trends and future development plans and their impact on projected buildout water demands and future water system infrastructure needs.

The update of the City's Water Master Plan will guide the City's implementation of required water system improvement projects.

ES.3 EXISTING AND PROJECTED POTABLE WATER DEMANDS

From 2010 to 2015, the average water use in the City's water service area was approximately 5,900 acre feet per year (af/yr), or 1,900 million gallons per year, which is equivalent to an average day demand of approximately 5.2 million gallons per day (mgd). Water use in 2014 and 2015 dropped significantly due to water conservation in response to drought conditions.



Accurate and detailed water demand data and projections are required to develop and calibrate the water system hydraulic model, help identify potential deficiencies in the existing water system, and assist in the assessment of the buildout water system capacity and future capital improvement program based on anticipated future development.

Water demands have been projected for buildout of the City's water service area based on the following three demand components:

- Existing water consumption and estimates of demand rebound for currently developed parcels;
- Projected water demands for reasonably foreseeable development projects; and
- Projected water demands for vacant parcel areas based on current General Plan land use designations.

Although it is unclear when buildout of the City's water service area will actually occur, projected water demands have been estimated for buildout of the City's water service area to provide for the development of a plan to meet the City's future water system needs. The projected water demands at buildout are presented in Table ES-2.

Table ES-2. Projected Water Demand at Buildout

Demand Component	Water Service Area Zone	Annual Demand, AF/YR	Annual Demand, MG/YR	Average Day Demand, mgd
Existing Rebounded Demands	Zone 1	644	210	0.58
	Zone 2	1,743	569	1.56
	Zone 3	3,777	1,233	3.38
	Total	6,164	2,012	5.51
Reasonably Foreseeable Development Project Demands	Zone 1	380	124	0.34
	Zone 2	603	197	0.54
	Zone 3	496	162	0.44
	Total	1,479	483	1.32
Vacant Parcel Demands	Zone 1	109	36	0.10
	Zone 2	215	70	0.19
	Zone 3	259	85	0.23
	Total	583	190	0.52
Total Demands at Buildout	**Zone 1**	**1,133**	**370**	**1.01**
	Zone 2	**2,561**	**836**	**2.29**
	Zone 3	**4,532**	**1,480**	**4.05**
	Total	**8,225**	**2,686**	**7.36**

A complete description of the methodologies used to develop these demand projections is provided in Chapter 3.

It should be noted that the projected water demands for the "Reasonably Foreseeable Development Projects" do not include projected water demands for the proposed Isabel Neighborhood Plan (INP), which has proposed land uses which are different from those included in the City's current General Plan. A description of the INP proposed land uses and projected water demands is provided in Appendix C and summarized in Chapter 7.

ES.4 REVIEW AND CONFIRMATION OF PLANNING AND DESIGN CRITERIA

Water system planning and design criteria previously used in the City's 2004 Water Master Plan were reviewed and confirmed as part of the update of the City's Water Master Plan Update. For the most part, the previous criteria were determined to be applicable and appropriate for use in this Water Master Plan update.

One exception, however, was the volume assumed for operational storage for the City's water storage tanks. The City's 2004 Water Master Plan assumed that the operational storage volume equals 50 percent of the maximum day demand within the tank's service area. This value is quite high. American Water Works Association (AWWA) guidelines for operational storage volume recommend a smaller amount of operational storage, ranging from 15 to about 30 percent of maximum day demand.

West Yost Associates (West Yost) evaluated the maximum day diurnal demand patterns for the City's Zone 1 and Zone 2/3 Water Service Areas for 2012 and 2013 and found that the amount of demand that would need to come out of storage to meet peak demands on the maximum demand day ranged from 11 to 19 percent of the maximum day demand. These amounts are consistent with the AWWA storage guidelines and other agencies' storage volume criteria. As such, for this Water Master Plan, it is recommended that the City's operational storage volume criteria be decreased from 50 percent of the maximum day demand to 25 percent of the maximum day demand. This reduced amount of operational storage volume, while still meeting operational needs, will reduce the required overall volume of recommended future water storage tanks, which will not only reduce costs, but may also reduce water quality issues associated with insufficient turnover of water stored in the City's water storage tanks.

Another difference in criteria from the 2004 Water Master Plan involves operation of the Zone 2 and 3 Water Service Areas under buildout conditions. The 2004 Water Master Plan assumed that the two water service areas would be operated independently (even though they are hydraulically connected through PRVs). As a result, fire flow storage was provided independently for each water service area. For this Water Master Plan, it is assumed that the two water service areas would be operated together (similar to how they are currently operated). This assumption allowed fire flow storage to be provided only within the Zone 3 Water Service Area, but could serve a fire in both water service areas, resulting in a reduction of the required storage volume. This assumption also allowed the Zone 3 Water Service Area to feed the Zone 2 Water Service Area as a way to potentially mitigate capacity issues that the Zone 2 Water Service Area may otherwise experience when operated independently.

The criteria utilized for the update of the City's Water Master Plan are described in Chapter 4.

ES.5 HYDRAULIC MODEL UPDATE AND VALIDATION

The City's previous water system hydraulic model was last updated in 2004. Since 2004, there has been significant new development within the City's water service area, so the previous model was out of date and not suitable to use for analysis for this Water Master Plan. Therefore, as part of the update of the City's Water Master Plan, West Yost updated and validated the City's water system hydraulic model by performing the following tasks:

- Rebuilt the hydraulic model with the City's Geographic Information System (GIS);
- Reviewed connectivity issues in specific locations with the City;
- Allocated 2015 existing water demands by using the City's spatially-located metered account information to distribute water demands within the hydraulic model; and,

- Validated that the hydraulic model system configuration (including pipeline sizes, alignments, connections, and other facility size and locations) is generally representative of the City's current potable water system based on field pressures, flows, and tank elevations recorded in the City's Supervisory Control and Data Acquisition (SCADA) system.

A description of the update and validation of the City's hydraulic model is provided in Appendix A of this Water Master Plan.

Use of the City's updated and validated model for the evaluation of the City's existing and buildout water system is described in further detail in Chapters 5 and 6.

ES.6 RECOMMENDED WATER SYSTEM IMPROVEMENTS

The City's potable water system was evaluated to assess the system's ability to meet the recommended water system planning and design criteria under existing and buildout demand conditions and to identify needed improvements. The findings and recommendations of these evaluations are summarized below. The locations of the recommended water system improvement projects are shown on Figure ES-1. As shown on Figure ES-1, there are no recommended improvements in City's Zone 1 Water Service Area; all recommended improvements are in the City's Zone 2 and 3 Water Service Areas.

ES.6.1 Existing Water System Needs

Chapter 5 of this Water Master Plan presents the evaluation of the City's existing water distribution system, and its ability to meet recommended water system planning criteria under various existing water demand conditions (as described in Chapter 3). The chapter includes both system capacity and hydraulic performance evaluations. The system capacity evaluation includes an analysis of pumping capacity, water storage capacity and pressure reducing station capacity. The hydraulic performance evaluation assesses the existing water distribution system's ability to meet recommended service and performance standards under existing demand conditions.

Findings from the evaluation of the existing water distribution system and the recommended improvements needed to eliminate deficiencies are summarized below. It should be noted that there are no recommended improvements in the City's Zone 1 Water Service Area; all recommended improvements are in the City's Zone 2 and 3 Water Service Areas.

- **Pumping Capacity**:
  - — It is recommended that the firm pumping capacity of the Oakville Pump Station be increased from 140 gpm to 176 gpm. (Project No. EX-CIP-U01)
  - — The City has indicated that some of the existing pumps may not be operating at their nominal capacity. It is recommended that a further investigation be performed to evaluate pump performance under a range of operating conditions to determine if the actual capacity differs from the nominal capacity. The range of operating conditions should include varying reservoir levels, varying upstream pressures in the Zone 7 system and different demand conditions. Pump performance can be evaluated by analyzing available SCADA information.

- **Storage Capacity:**
  - Assuming that Zone 2 water service area fire flow is assigned to the Altamont Tanks, there is an existing storage deficit of 0.39 MG at the Dalton Tank. Based on the analysis of the buildout demands (deficit of 1.41 MG), it is recommended that the 2.0 MG Dalton Tank (already planned to be replaced due to age) be replaced with a 3.41 MG tank. It is recommended that the new tank be equipped with a mixer and provisions for future chlorine addition to address water quality issues.
- **Pressure Reducing Station Capacity:** Three new pressure reducing valves (PRVs) are recommended as follows:
  - Install a PRV station approximately 300 feet west of the intersection of Southfront Road and Commerce Way to supply Pressure Zone 670 from Pressure Zone 744. (Project No. EX-CIP-V01)
  - Install a PRV station at the south end of Lassen Road to supply the north portion of the Pressure Zone 670 from the south portion of the Pressure Zone 670 with a setting of 45 psi if the new PRV station is at an elevation of approximately 533 feet. This project is required only if the City chooses to continue closing the Interstate 580 crossing at Lassen, as this project serves as a bypass of the closed crossing under high demand conditions. (Project No. EX-CIP-V02)
  - Install a PRV at Turnout 1 to allow supply to enter Pressure Zone 670 via gravity under high demand conditions, such as fire flow. The PRV should be set to approximately 45 psi. This project is required only if the City chooses to keep the Trevarno Pump Station bypass line closed. (Project No. EX-CIP-V03)
- **Distribution System Capacity:** As summarized in Chapter 5, pipeline improvements are recommended for the following:
  - Areas with low fire flows, no planned re-development, and where cost-effective improvements could be implemented; and
  - Areas where upsizing or installing new pipelines would add redundancy for fire flow or other needs.

In addition, various operational practices, including operation of Zone 7 turnouts, PRVs, isolation valves, and pipeline crossings of Interstate 580 (I-580), were evaluated to assess their impact on existing water system operations. Recommendations for operational improvements include the following:

- Change the setting for the Kitty Hawk PRV station from 90 psi to approximately 80 psi, and have it available at all times.
- Change the setting for the Scenic/Vasco PRV station from 50 psi to approximately 45 psi, and have it available at all times.

ES.6.2 Buildout Water System Needs

Chapter 6 of this Water Master Plan presents the evaluation of the City's buildout water distribution system, and its ability to meet recommended water system planning criteria under buildout water demand conditions. As documented in Chapter 3, buildout water demand projections include existing water consumption and estimates of demand rebound for currently developed parcels, projected water demands for reasonably foreseeable development projects and projected water demands for vacant parcel areas based on current General Plan land use designations.

Chapter 6 includes both system capacity and hydraulic performance evaluations. The system capacity evaluation includes an analysis of pumping capacity, water storage capacity and pressure reducing station capacity. The hydraulic performance evaluation assesses the buildout water distribution system's ability to meet recommended service and performance standards under buildout demand conditions.

West Yost conducted the buildout system evaluation using an updated hydraulic model that incorporated improvements to eliminate deficiencies identified in the existing water system evaluation (see Chapter 5). In addition, West Yost also conducted a focused water storage evaluation for the City's Zone 2 and 3 Water Service Areas and a storage siting study (see Appendix B).

Findings from the evaluation of the buildout water distribution system and the recommended improvements needed to eliminate deficiencies are summarized below. As for the existing system evaluation, it should be noted that there are no recommended buildout system improvements in the City's Zone 1 Water Service Area; all recommended improvements are in the City's Zone 2 and 3 Water Service Areas. Recommended improvements do not include in-tract pipelines that are required for future development and fully funded by the project proponents.

- **Pumping Capacity:** All pressure zones were found to have surplus pumping capacity in excess of future maximum day demand. However, to mitigate low pressure areas associated with peak hour and fire flow, the following is recommended:
  - Include controls for the high head pumps at the Vasco Pump Station that activate the pumps sequentially when low pressure conditions occur in the following locations:
    - Pressure drops below 35 psi adjacent to the Vineyard/Oakville pressure zone.
    - Pressure drops below approximately 25 to 30 psi in the industrial area southwest of the intersection of East Avenue and Vasco Road.
    - Pressure drops below approximately 35 psi in the industrial area along Las Positas Road between Lawrence Drive and Greenville Road.
    - Pressure drops below 35 psi at the north end of Hillstone Drive.
- **Storage Capacity:** Assuming that the Zone 2 Water Service Area fire flow is assigned to the Altamont Tanks, there is a buildout storage deficit of 1.41 MG at the Dalton Tank. Therefore, it is recommended that the existing 2.0 MG Dalton Tank (already planned to be replaced due to age) be replaced with a new 3.41 MG tank.

- **Distribution System** Capacity**:** The following pipeline improvement is recommended to mitigate low pressure areas associated with peak hour and fire flow:
  - Install 5,500 feet of 16-inch diameter pipeline along Vasco Road between Patterson Pass Road and Emily Way parallel to the existing 16-inch diameter pipeline in this location

ES.6.3 Water System Evaluation for the Isabel Neighborhood Plan

The INP is a proposed development area located in the northwest portion of the City which is contingent upon the extension of Bay Area Rapid Transit (BART) to this location. The INP planning area is entirely within the City's urban growth boundary. A portion of the INP planning area lies within the City's water service area (in the City's Zone 1 Water Service Area) and a portion lies within the California Water Service Company (CalWater) Livermore District service area.

Proposed land uses for the INP are different from those currently included in the City's General Plan, and evaluated in this Water Master Plan. Potable water demands have been projected for the proposed INP land uses to determine if the additional potable water demands associated with the INP trigger additional improvements to the City's potable water system, beyond those improvements identified in this Water Master Plan. However, as described in Appendix C, the additional potable water demands for the INP planning area (with the proposed INP land uses) above those demands based on current General Plan land uses (described in Chapter 3) are relatively small. For the portion of the INP planning area which lies within the City's water service area, the projected potable water demand assuming the INP land uses is 836 af/yr, which is 67 af/yr (or about 9 percent) higher than the potable water demand assuming current General Plan land uses.

Existing water system infrastructure is in place within the INP planning area to serve the existing developed areas. Based on the potable water demand projections for the INP land uses, no additional potable water system improvements would be required, other than potential extension of distribution pipelines to provide service to new development. Additional information on the INP proposed land uses, projected water demands, and potable water system evaluation is provided in Appendix C.

ES.7 OPINION OF PROBABLE PROJECT COSTS

Chapter 7 of this Water Master Plan provides a summary of recommended water system improvements, along with an opinion of probable total project costs for the recommended water system improvements to support the City's existing and buildout water demands. The total project cost is estimated to be $21.9 million; of this amount, approximately $18.2 million is recommended as existing (or near-term) projects, and approximately $3.8 million is required as buildout projects.

Table ES-3 summarizes the opinion of probable project costs by project type to mitigate existing system deficiencies and to meet future growth in the City's water system. It should be noted that any in-tract pipelines required to be installed as part of new development projects will be fully funded and installed by the project proponents. Therefore, these facilities and corresponding costs are not included.

Table ES-3. Opinion of Probable Project Costs for Recommended Water System Capital Improvements by Project Type[(a,b)]

Water System Improvement Type	Existing (Near-Term)	Buildout	Total
Pumping	$298,000	$98,000	**$396,000**
Storage	$7,142,000		**$7,142,000**
Pipelines	$8,949,000	$3,668,000	**$12,617,000**
Pressure Reducing Stations	$1,777,000		**$1,777,000**
Opinion of Probable Project Costs	$18,166,000	$3,766,000	**$21,932,000**

(a) Costs shown are based on the March 2017 SF ENR CCI of 11609.

(b) Total Project Costs include the Estimated Construction Costs which include an estimating contingency of 30 percent of the Base Construction Cost, and Design and Construction Period Services equal to 50 percent of the Estimated Construction Costs.

Existing water system improvements to address existing system deficiencies should be completed as funding permits. The construction of capital improvements for the buildout demand conditions should be coordinated with the proposed schedules of new development to ensure that required water system infrastructure will be in place as needed to serve future customers.

ES.8 CONSIDERATIONS FOR NEXT WATER MASTER PLAN UPDATE

The following lists additional recommendations and observations related to future planning and operations of the City's potable water system:

- The City experienced drought conditions for several years leading up to 2016, when the analysis for this Water Master Plan was performed. Demands within the City dropped significantly in 2014 and 2015, but are expected to increase as the drought ends, as this phenomenon has been observed in other parts of the world when droughts end. The analysis of the system assumed a fairly high level of demand rebound, with demand assumed to rebound to within 90 percent of what the demands were in 2013, before the effects of the drought were observed in the demand data. It is recommended that the City monitor demands within the City using the per capita water use metric calculated as part of the City's 2015 UWMP. Demand rebound for this Water Master Plan was based on the assumption that demands would rebound to a City-wide average of 192 gallons per capita per day (gpcd).
- The City has indicated that the operation of the pumps at its pump stations does not match with what would be expected according to the pump curves for the pumps. This could be an indication of wear and tear on the pumps as they age. It is recommended that the City perform a study of the pump operations to determine the actual capacity of the pumps.
- The prior Water Master Plan included a discussion of a property that was referred to as the former Intel site. This property has a contractual agreement with the City to discharge up to 250,000 gallons per day (gpd). In the prior Water Master Plan, a corresponding water demand of 250,000 gpd was assumed for this property. This

assumption was not used in this Water Master Plan. It is recommended that the City monitor this site for future development that may greatly increase the water demand on this property and within the City's water system.

- In this Water Master Plan, demand factors were calculated or assumed for the various land uses. While it should be understood that demand factors are average values, and that the demand for each parcel with a particular land use will likely not match with the demand factor exactly, it is recommended that the City monitor actual water usage by customers to identify large increases in water demand that may affect the system. In particular, unit water demands should be confirmed for the following land uses:
  - Zone 1 Water Service Area - Residential (UH-4): Unit water demands in this Water Master Plan are much lower than in the 2004 Water Master Plan. Actual unit water use for UH-4 land uses should be compared to the factors used in this Water Master Plan to determine if the estimated factors are appropriate.
  - Zone 2/3 Water Service Area - Point Demands: Actual demands for Intel, McGrath and PG&E should be monitored to determine if estimated demands are appropriate.
  - Zone 2/3 Water Service Area – Commercial/Business and Commercial Park/Industrial: Unit water demands in this Water Master Plan are much lower than in the 2004 Water Master Plan. Actual unit water use for these land uses should be compared to the factors used in this Water Master Plan to determine if the estimated factors are appropriate.
- It is recommended that the City monitor development proposals to confirm and, if needed, update planning assumptions for reasonably foreseeable development projects, including both extent and timing.
- It is recommended that peaking factors be confirmed, particularly the peak hour peaking factor, due to limited data available for this Water Master Plan. In the future, AMI data for individual customers will be available instead of SCADA data at Zone 7 turnouts. AMI data may provide more accurate peaking factors for each water service area zone, as well as individual pressure zones.
- The analysis in this Water Master Plan was based on the hydraulic model developed from the City's pipeline database as of July 8, 2016 (see Appendix A for additional information on the hydraulic model development). The next Water Master Plan update should address and incorporate any changes to the City's water service area zone boundaries, any changes to the Zone 7 turnout supply pressure ranges, any operational configuration changes (i.e., Base Operations Scenario vs. Alternative Scenarios 1 through 4), and any facility changes (i.e., equipment, pipeline modifications). Use of dynamic modeling should be considered for the next Water Master Plan update to allow for more advanced time analysis, in particular, if AMI data is available.
- As described in Chapter 2, the names of the City's water system pressure zones (e.g., Pressure Zone 605) do not necessarily reflect the actual hydraulic grade lines of the pressure zones. The City is considering renaming the pressure zones to be more reflective of actual hydraulic grade lines associated with each pressure zone,

however, to maintain consistency with the pressure zone naming in the 2004 Water Master Plan, the pressure zone names have not been changed for this Water Master Plan. To minimize future confusion regarding pressure zones and their respective hydraulic grade lines, the next Water Master Plan update should incorporate updated pressure zone names which are consistent with their actual hydraulic grade lines.

- If possible, the next Water Master Plan update should be coordinated with the preparation of the City's 2020 Urban Water Management Plan to ensure consistency with water demand projections.

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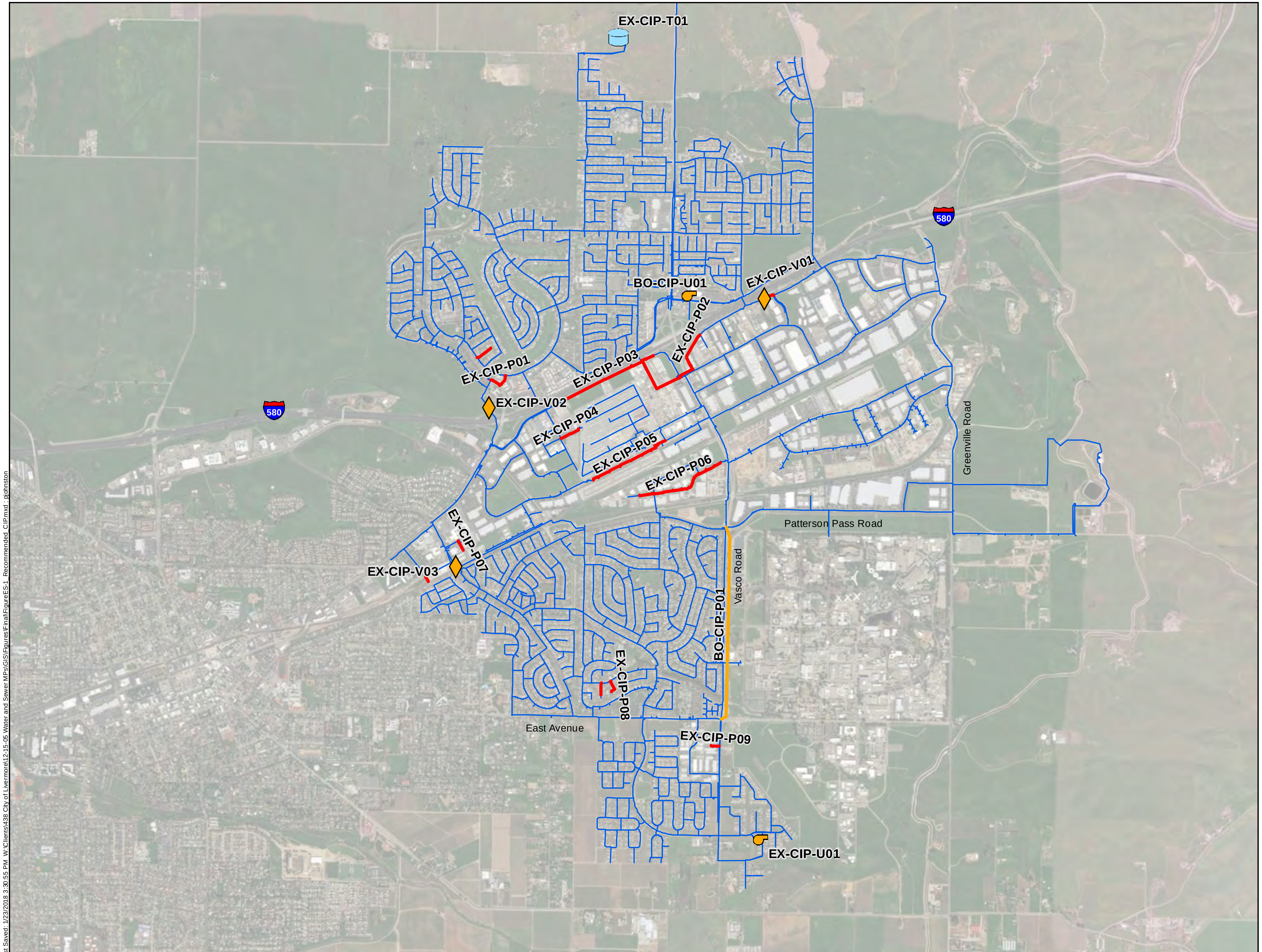

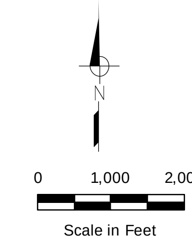

Near-Term Pressure Regulating Station

Near-Term Water Storage Reservoir

Near-Term Pipeline

Buildout Pipeline

Existing Pipeline

Buildout Pump Station Improvement

Note: There are no recommended capital improvement projects in Zone 1.

LIVERMORE CALIFORNIA

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Figure ES-1

Recommended Water System Capital Improvement Program

City of Livermore
Water Master Plan

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1.1 OVERVIEW AND NEED FOR WATER MASTER PLAN

The City of Livermore (City) municipal water system currently serves a population of approximately 28,000 people in the eastern portion of Alameda County. The City's Municipal Water system distributes treated water purchased from a water wholesaler, the Zone 7 Water Agency (Zone 7). The City's water service area includes three water service area zones comprising approximately 13 square miles and including just over 10,000 service connections. The City's water service area zones only cover a portion of the City of Livermore. The balance of the City of Livermore is provided water service by the California Water Service Company. This Water Master Plan covers only the City's water service area zones.

The City's water system consists of over 190 miles of potable water pipelines which deliver water to eleven pressure zones within the City's three water service area zones. The City also has four potable water storage reservoirs and five potable water pump stations.

While the City is continually planning and designing water system improvements to ensure a safe and reliable water supply for its existing and future water customers, a comprehensive review of the City's water supplies and water system facilities has not been completed since 2004. With changes in customer's water use in response to recent on-going drought conditions, and several new development projects proposed throughout the City's water service area, there is a need for an updated Water Master Plan to evaluate the City water system's ability to meet existing and projected future water demands and identify improvements needed to address system deficiencies.

1.2 WATER SYSTEM MASTER PLAN OBJECTIVES AND TASKS

The objective of this Water Master Plan is to clearly define the City's long-term water system infrastructure capacity needs, and to develop a plan that will provide the flexibility and system reliability that the City needs to accommodate changing future needs. The development of this Water Master Plan included working closely with staff from the City's Water Resources Division, Engineering Division and Planning Division to evaluate water use trends and future development plans and their impact on projected future water demands and future water system infrastructure needs. The update of the City's Water Master Plan will guide the City's implementation of required water system improvement projects.

It is important to note that the focus of this Water Master Plan is to recommend capacity-related improvement projects for the City's water system. It is not the intent for this Water Master Plan to be the sole source of all recommended water system projects for inclusion in the City's Capital Improvement Plan (CIP). Other sources include the Water Resource Division's asset management program (which focuses on the renewal or replacement of water system assets based on age and condition), regulations and code compliance, operations and maintenance staff input, and coordination with other roadway improvements. The City utilizes and coordinates all sources in the development of the City's overall CIP for the water system.

To accomplish these objectives, six primary tasks were conducted. These are outlined below:

- Task W1. Data Collection and Review
- Task W2. Evaluate Existing and Future Service Area Characteristics
- Task W3. Develop Potable Water Demand Projections
- Task W4. Evaluate Existing and Future Potable Water System
- Task W5. Develop Capital Improvement Plan
- Task W6. Prepare Water Master Plan

In addition to these primary tasks, the following additional tasks were added during the preparation of this Water Master Plan:

- Evaluation for storage options in the City's Zone 2 and 3 Water Service Areas, including a storage reservoir siting study (discussed in Chapters 5 and 6 and Appendix B); and
- Evaluation of the potential impact on water demands and required infrastructure improvements if the proposed Isabel Neighborhood Plan, including a proposed new Bay Area Rapid Transit (BART) station at Isabel Avenue, is included in the Water Master Plan analysis (discussed in Chapter 7 and Appendix C).

With the completion of these tasks, this resulting Water Master Plan provides a comprehensive road map for the City for future planning for its water system.

1.3 AUTHORIZATION

The City authorized West Yost Associates (West Yost) to prepare this Water Master Plan in November 2015. It should be noted that an update of the City's Sewer Master Plan was also included in the same authorization. An updated Sewer Master Plan was prepared by West Yost in parallel and in coordination with this Water Master Plan, and is included in a separate report.

1.4 REPORT ORGANIZATION

This Water Master Plan is organized into the following chapters:

- Executive Summary
- Chapter 1. Introduction
- Chapter 2. Water Service Area and Water System Facilities
- Chapter 3. Existing and Future Potable Water Demands
- Chapter 4. Water System Planning and Design Criteria
- Chapter 5. Existing Water System Evaluation

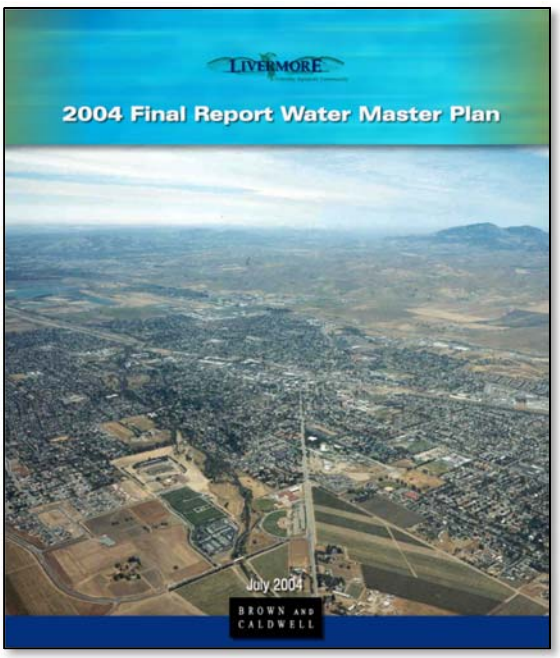
- Chapter 6. Buildout Water System Evaluation
- Chapter 7. Capital Improvement Program

The following appendices to this Water Master Plan contain additional technical information, assumptions and calculations:

- Appendix A: Potable Water System Hydraulic Model Updates
- Appendix B: Additional Storage Evaluation and Tank Siting Study
- Appendix C: Isabel Neighborhood Plan Potable Water System Evaluation Project
- Appendix D: Cost Estimating Assumptions

1.5 RELATED PLANS AND REPORTS

1.5.1 2004 Water Master Plan



The City's last Water Master Plan was completed in 2004[1]. The City's water service area population in 2004 was 25,616, and existing (2003) water demand was estimated at 6 million gallons per day (mgd), and was projected to increase to just over 11 mgd at buildout of the City's water service area. This compares to a current (2015) water service area population of 28,782 and an existing (2015) water demand of 4 mgd, projected to increase to about 7.4 mgd at buildout of the City's water service area. [2]

It is interesting to note that the 2015 water demand is about 30 percent less than the 2003 water demand despite a slight increase in population. It also interesting to note that the current projected buildout water demand is approximately 30 percent less than what was projected in the 2004 Water Master Plan. This is the result of many changes which have occurred both within the City's water service area and throughout California since the 2004 Water Master Plan was completed.

[1] City of Livermore 2004 Final Report Water Master Plan, prepared by Brown and Caldwell, July 2004.

[2] It should be noted that the 2004 Water Master Plan included projected water demands for BART (Greenville BART station and associated Transit Oriented Development (TOD)), while this Water Master Plan does not. A separate analysis of water demands associated with the currently proposed Isabel BART station and associated development of the Isabel Neighborhood Plan is provided in Appendix C of this Water Master Plan, but is not included in the water demands evaluated in this Water Master Plan.

Drought conditions have impacted water resources throughout California from 2007 to 2009, and again from 2011 to 2016. All but two years of the last decade have been dry in California. The most recent prior drought in Water Years 2007 to 2009 was followed by the current five years of drought (Water Years 2012 to 2016), and four of those years set a record for the driest four consecutive water years in California history since record-keeping began. These dry conditions prompted unprecedented State mandates for water conservation and efficient water use.

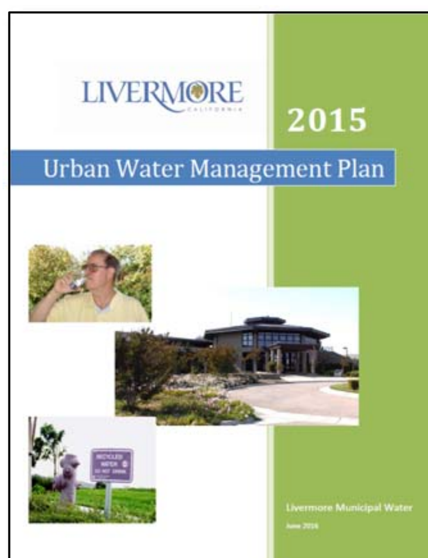
In 2009, the Water Conservation Act of 2009 (SBx7-7) was enacted and required water suppliers to establish per capita water use targets for 2015 and 2020, with an overall goal of reducing urban water use in California by 20 percent. And, in 2015, the State established emergency water conservation regulations to reduce urban potable water use by 25 percent statewide. The City's water customers have responded positively to the call for water conservation and the City has successfully continued operation of its recycled water program to provide recycled water for irrigation and other non-potable uses to offset potable water use in the City's Zone 1 water service area.

As described in Chapter 3, unit water use factors have been reviewed and updated for this Water Master Plan to account for changes in water use for different land uses based on recent water consumption data, and including an assumed demand rebound to account for increases in water use as the City's water customers return to some of their pre-drought water use habits. In many instances, these revised unit water use factors are lower than those used in the City's 2004 Water Master Plan, contributing to the lower water demand projection in this Water Master Plan for buildout of the City's water service area.

Many water system improvements have been implemented since the completion of the 2004 Water Master Plan; however, with many changes in planned new development projects within the City's water service area, and reduced potable water demands projected at buildout, there is a need to re-evaluate the City water system's ability to meet existing and projected future water demands and identify improvements needed to address system deficiencies.

1.5.2 2015 Urban Water Management Plan

The City's 2015 Urban Water Management Plan (2015 UWMP) was completed and adopted by the Livermore City Council in June 2016. The 2015 UWMP provides an evaluation of the availability and reliability of the City's water supplies under various hydrologic conditions through the year 2040 and compares them to projected water demands within the City's service area through 2040. The 2015 UWMP also describes the City's Water Shortage Contingency Plan and water conservation programs and their ability to reduce water demands when water supplies may be limited. The preparation and adoption of the 2015 UWMP is a California Water Code requirement for all urban water suppliers who supply more than 3,000 acre-feet per year of water or who serve more than 3,000 customers.



The water demand projections developed in this Water Master Plan (see Chapter 3) are higher than those included in the City's 2015 UWMP, primarily due to the availability of updated information on future development projects and the use of a more detailed water demand projection approach using water consumption and land use data. The City's 2020 UWMP, when prepared, will include this updated information and resulting water demand projections.

1.5.3 Sewer Master Plan Update

In parallel with this update to the City's Water Master Plan, West Yost has also prepared an update to the City's Sewer Master Plan. While the City's water service area is limited to only a portion of the City of Livermore (remaining portions are served by the California Water Service Company), the City's sewer service area encompasses the entire City of Livermore. Where applicable, the preparation of the City's Water Master Plan and Sewer Master Plan have been coordinated. Areas of coordination have included coordination with future development plans within the City's water service area and coordination between projected water demands and projected return-to-sewer flows within the City's water service area.

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The purpose of this chapter is to describe the City's existing water service area and potable and recycled water system facilities. System information was obtained through the review of previous reports, maps, plans, operating records, and other available data provided to West Yost by the City.

2.1 WATER SERVICE AREA

2.1.1 Water Service Area Description

The City provides potable and recycled water service to portions of the City, located in the eastern portion of Alameda County in the Tri-Valley. The western portion of the City is relatively flat south of the Interstate 580 (I-580), and the eastern portion extends into the hills of the Altamont Pass. Two railroads transect the City south of I-580 from east to west.

The City's Urban Growth Boundary (UGB) is defined in the City's General Plan. The City's UGB was developed in two phases. The South Livermore Urban Growth Boundary Initiative, passed by local voters in March 2000, established the UGB around the southern edge of the City. In December 2002, the City Council passed the North Livermore Urban Growth Boundary Initiative, which completed the UGB around the northern edge of the City. The City's UGB is shown on Figure 2-1.

The City's water service area consists of three water service area zones within the City's UGB: the Zone 1 Water Service Area on the west side of the City which encompasses 2,530 acres, and the Zone 2 and Zone 3 Water Service Areas on the east side of the City which encompass 5,740 acres (see Figure 2-1). The City provides potable water to the residences and businesses within these water service area zones. In total, these water service area zones encompass approximately 8,270 acres, or about 13 square miles.

The remaining residences and businesses within the City's UGB, including those in central Livermore, are served by the California Water Service Company (Cal Water). Lawrence Livermore National Laboratory and Sandia National Laboratories receive water directly from the San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy system.

2.1.2 Existing Number of Services

The City's water system is currently fully metered. The number of water service connections by customer type is summarized in Table 2-1.

Table 2-1. Summary of Existing City Water Service Connections by Customer Type[(a)]

Customer Type	Number of City Water Service Connections[(b)]	Percent of Total City Water Service Connections
Residential	8,301	82%
Commercial	1,131	11%
Irrigation	558	5%
Multi-Family	112	1%
Institutional	23	<1%
City (Domestic and Fire)	24	<1%
Total	**10,149**	**100%**

(a) Source: Service Counts for City of Livermore Municipal Service Department from Utility Billing, dated November 2015.
(b) Includes both active (9,928) and inactive (221) water service connections.

2.1.3 Water Service Area Population

Historical population for the City's water service area is presented in Table 2-2. As shown in Table 2-2, the population of the City's water service area increased from 22,701 people in 2000 to 28,782 people in 2015 according to data received from the City, representing an almost 27 percent increase.

Table 2-2. Historical Water Service Area Population (2000-2015)

Year	City of Livermore Water Service Area Historical Population[(a)]
2000	22,701
2001	23,222
2002	23,835
2003	24,333
2004	25,616
2005	26,085
2006	26,380
2007	26,466
2008	26,525
2009	26,874
2010	27,113
2011	27,394
2012	27,571
2013	28,112
2014	27,113
2015	28,782

(a) 2000-2008 and 2015 population data from the City's 2015 Urban Water Management Plan (Appendix E-1 SBX7-7 Table 3). 2009-2014 population data estimated based on number of residential connections for those years (Source: Population Tool Print Confirmation 15year.pdf provided by City) times the number of persons per residential connection for 2015.

2.1.4 Water Service Area Land Use

The City provided geographic information system (GIS) General Plan land use maps for the entire City. The existing land use map for the City's water service area zones based on General Plan land uses is shown on Figure 2-2. The total acreages by General Plan land use designation for the parcels within the City's water service area in 2015 are summarized in Table 2-3. The land uses are grouped into the same categories that are shown in the City's General Plan.

Chapter 3 provides an evaluation of the water demands for the parcels within the City's water service area which are designated as reasonably foreseeable development projects or vacant parcels to be developed in the future.

2.2 POTABLE WATER SYSTEM

2.2.1 Potable Water Supply

The City purchases its potable water supply from the Zone 7 Water Agency (Zone 7) who also serves the City of Pleasanton, Dublin San Ramon Services District (DSRSD), and Cal Water. Zone 7 acquires over 80 percent of its raw water supply from State Water Project (SWP) surface water entering the South Bay Aqueduct, located on the east side of the system. Surface water is treated at the Patterson Pass Water Treatment Plant (PPWTP) and the Del Valle Water Treatment Plant (DVWTP) and conveyed through a network of Zone 7 transmission pipelines to the City's service areas and other retail customers. The City receives potable water from Zone 7 via seven active turnouts. There are two additional inactive turnouts. Zone 7's conveyance system is illustrated on Figure 2-3.

Zone 7 uses a combination of water supplies and water storage facilities to meet the retailers' water demands, including the City. The combination of water supplies used by Zone 7 includes the following:

- Imported surface water from the SWP;
- Imported surface water transferred from the Byron Bethany Irrigation District (BBID);
- Local surface water runoff captured in Del Valle Reservoir;
- Perennial yield of the Main Basin, quantified by Independent Groundwater Pumping Quotas;
- Local groundwater previously recharged and extracted from the Main Basin;
- Local storage in the future Chain-of-Lakes; and
- Non-local groundwater storage in the Semitropic Water Storage District (STWSD).

The availability and reliability of the City's water supplies is evaluated in the City's 2015 UWMP.

Table 2-3. Existing Land Use[a]

General Plan Land Use	Land Use Code	Total Acreage[b]
Public / Semi-Public / Open Space		
BART	BART	51
Agriculture/Viticulture	AGVT	5
Hillside Conservation	HLCN	195
Parks, Trailways, Recreation Areas	OSP	1012
Large Parcel Agriculture	LPA	21
Limited Agriculture	LDAG	373
Subtotal		1,658
Commercial / Industrial		
Neighborhood Commercial	NC	22
Neighborhood Commercial/Urban High Residential - 3	NC/UH-3	3
Service Commercial	SC	132
Highway Commercial	HC	28
Community Serving General Commercial	CSGC	38
Neighborhood Mixed Medium Density	NMM	0
Neighborhood Mixed High Density	NMH	129
Business and Commercial Park	BCP	665
Business and Commercial Park/Urban High Residential - 3	BCP/UH-3	56
Low Intensity Industrial	LII	375
Low Intensity Industrial/Urban Medium Residential	LII/UM	5
High Intensity Industrial	HII	1,048
High Intensity Industrial/Urban High Residential - 3	HII/UH-3	26
High Intensity Industrial/Urban High Residential - 3/School	HII/UH-3/CF-S	6
Subtotal		2,533
Residential		
Rural Residential (1-5 Acre Site)	RR	29
Urban Low Residential – 1 (1.0 - 1.5 du/acre)	UL-1	119
Urban Low Residential – 2 (1.5 - 2.0 du/acre)	UL-2	26
Urban Low Medium Residential (2.0 - 3.0 du/acre)	ULM	384
Urban Medium Residential (3.0 - 4.5 du/acre)	UM	546
Urban Medium High Residential (4.5 - 6.0 du/acre)	UMH	341
Urban High Residential – 1 (6 - 8 du/acre)	UH-1	35
Urban High Residential – 2 (8 - 14 du/acre)	UH-2	105
Urban High Residential – 4 (18 - 22 du/acre)	UH-4	63
Subtotal		1,647
South Livermore Valley Specific Plan		
Agricultural Preserve	SV-AP	103
Residential Development Area - Area 1	SV-RDA	233
Vineyard Commercial	SV-VC	23
Subtotal		359
Community Facility		
Fire Station	CF	141
Airport	CF-AIR	528
Elementary School	CF-E	46
Intermediate School	CF-I	10
Community College	CF-JC	147
Subtotal		871
Total Acres		**7,068**

[a] Developed based on data received from the City of Livermore on 12/18/2015.

[b] Total acreage does not include street rights-of-way in subdivided areas. Therefore, the total acreage is less than the total area within Water Service Area Zones 1, 2 and 3.

2.2.2 Potable Water Facilities

The City's existing water system facilities are discussed in detail below. The City's potable water distribution system facilities are shown on Figure 2-4 and are color-coded to indicate the City's pressure zones. Figure 2-5 shows the City's potable water facilities schematically.

The evaluation of facility capacities and their ability to meet existing and future water demands is described in Chapters 5 and 6, respectively.

2.2.2.1 Potable Water Turnouts

Water purchased by the City from Zone 7 is delivered through seven active water supply turnout facilities. There are two additional inactive water supply turnout facilities. The turnouts are described as follows:

- LIV 1:
  - Supplies water to the City's Zone 2 Water Service Area
  - Located near Trevarno Road and west of North Mines Road and Railroad intersection
- LIV 2:
  - Inactive, but can supply water to the City's Zone 3 Water Service Area
  - Located near the intersection of Patterson Pass Road and Joyce Street
- LIV 3:
  - Inactive, but can supply water to the City's Zone 3 Water Service Area
  - Located near the intersection of South Vasco Road and Naylor Avenue
- LIV 5:
  - Supplies water to the City's Zone 1 Water Service Area
  - Located near the intersection of East Airway Boulevard and Isabel Avenue
- LIV 6:
  - Supplies water to the City's Zone 2 and 3 Water Service Areas
  - Located near the intersection of North Vasco Road and Northfront Road
- LIV 8:
  - Supplies water to the City's Zone 2 Water Service Area
  - Located near the intersection of Vasco Road and Preston Avenue
- LIV 9:
  - Supplies water to the City's Zone 1 Water Service Area
  - Located near the intersection of Airway Boulevard and Kitty Hawk Road

- LIV 10:
  - Supplies water to the City's Zone 3 Water Service Area
  - Located near Patterson Pass Road, south of the Altamont Pump Station
- LIV 11:
  - Supplies water to the City's Zone 1 Water Service Area
  - Located along Interstate 580, east of El Charro Road

All of the turnouts supply water to one or more of the City's existing water service area zones (Zone 1, Zone 2 and Zone 3) within the City's water distribution system.

The Zone 1 Water Service Area is located in the western portion of the City and primarily receives water from Turnouts 5 and 9 (it can also receive water from Turnout 11). The City also has a recycled water system in the Zone 1 Water Service Area that provides water for non-potable uses, such as irrigation or limited fire protection.

The Zone 2 and 3 Water Service Areas are located in the eastern portion of the City and are hydraulically connected. Neither of these water service area zones is hydraulically connected to the Zone 1 Water Service Area. The combined area is supplied by four individual turnouts (Turnouts 1, 6, 8, and 10). The Zone 2 Water Service Area has one main pressure zone, and a small subzone called McGrath supplied from the Zone 3 Water Service Area. The Zone 3 Water Service Area has a main pressure zone and smaller regulated zones. The Zone 3 Water Service Area also has a small pressure zone that is supplied by the Oakville Pump Station.

Table 2-4 summarizes the existing turnout facilities. As shown, the City's current total meter capacity at the turnouts is 56.59 million gallons per day (mgd). Locations of the turnouts are shown on Figures 2-3 and 2-4. Further description of the City's pressure zones is provided in Section 2.2.2.3 below.

Table 2-4. Potable Water Supply Turnouts

Turnout	Operation Status	Water Service Area Zone	Elevation, feet msl[b]	Typical Hydraulic Grade Line Range, feet[b]	Maximum Meter Design Capacity[a]	
					gpm	mgd
LIV 1	Normal Condition	2	526	644 - 669	5,500	7.92
LIV 2	Inactive	3	540	N/A	1,200	1.73
LIV 3	Inactive	3	538	N/A	600	0.86
LIV 5	Normal Condition	1	400	592 - 636	5,500	7.92
LIV 6	Normal Condition	2 & 3	519	595 - 658	5,500	7.92
LIV 8	Emergency Condition	2	530	611 - 662	2,000	2.88
LIV 9	Normal Condition	1	377	587 - 636	7,000	10.08
LIV 10	Normal Condition	3	669	678 - 685	10,000	14.40
LIV 11	Emergency Condition	1	350	576 - 636	2,000	2.88
				Total	**39,300**	**56.59**

[a] Information for Turnouts 1 through 11 is from the 2016 Zone 7 Transmission System Planning Update (existing normal supply scenario). Refer to Section 5.2 in Chapter 5 for more details.
[b] Datum is NGVD 29.

2.2.2.2 Emergency Water Supply Interties

The City has several interties with the Cal Water distribution system. These interties are for emergency use only and are closed under normal conditions. The City also has emergency interties with DSRSD and the City of Pleasanton. The locations of the interties are shown on Figure 2-4. The interties are described as follows:

- City of Pleasanton Intertie:
  - — Located in the western portion of the City's Zone 1 Water Service Area near the intersection of Jack London Boulevard and El Charro Road.
- DSRSD Intertie:
  - — Located in the western portion of the City's Zone 1 Water Service Area, near Turnout 11 and south of I-580 near Livermore Outlets Drive.
- California Water Service Company Interties (at three locations):
  - — Zone 1 Water Service Area: Near the intersection of East Airway Boulevard and Isabel Avenue,
  - — Zone 2 Water Service Area: Intersection of Southfront Road and First Street, and
  - — Zone 3 Water Service Area: Intersection of East Avenue and Buena Vista Avenue.

2.2.2.3 Potable Water Pressure Zones

There are eleven pressure zones within the City's potable water distribution system. Water purchased from Zone 7, the City's sole potable water supplier, enters the City's water distribution system through Zone 7 turnouts into the City's Pressure Zones 605, 638, 670 and 800, and is then distributed into the City's other pressure zones. The locations of the City's pressure zones are shown on Figure 2-4, and a summary of these pressure zones with their key characteristics is provided in Table 2-5.

It should be noted that the names of the various pressure zones (e.g., Pressure Zone 605) do not necessarily reflect the actual hydraulic grade line of the pressure zones. The City is considering renaming the pressure zones to be reflective of actual hydraulic grade lines associated with each pressure zone; however, to maintain consistency with the pressure zone naming in the 2004 Water Master Plan, the pressure zone names have not been changed for this Water Master Plan.

Table 2-5. Potable Water Pressure Zones

Pressure Zone	Water Service Area Zone	Range of Service Elevations, feet msl[a]	HGL of Reservoir[b] or Pressure Reducing Valve, feet msl	Water Supply Source(s)
605	Zone 1	352 – 374	536	Pressure Zone 638 and Zone 7 Turnout #11
638	Zone 1	362 – 420	618	Pressure Zone 719 and Zone 7 Turnouts #5 and #9
664	Zone 1	391 – 508	600	Pressure Zone 719
719	Zone 1	403 – 480	719	Zone 7 Turnout #9
670	Zone 2	490 – 549	670	Zone 7 Turnouts #1, #6 and #8, Pressure Zone 800, 725, 744
McGrath/ 740	Zone 2	527 – 542	673[c]	Pressure Zone 744
725 North	Zone 3	528 – 594	714	Pressure Zone 800, Pressure Zone 741
725 South	Zone 3	537 - 603	744	Pressure Zone 800
741	Zone 3	540 – 554	717	Pressure Zone 800
744	Zone 3	533 – 563	680	Pressure Zone 800
800	Zone 3	518 – 655	800	Zone 7 Turnouts #6 and #10
875	Zone 3	616 – 671	Pumped	Pressure Zone 800

(a) Based on elevations assigned in the hydraulic model (NGVD 29).
(b) Assumed as the overflow elevation of each reservoir or the highest setting of the pressure reducing valves serving the pressure zone.
(c) Setting from prior master plan model.

2.2.2.4 Potable Water Storage Reservoirs

The City currently operates four potable water storage reservoirs as shown on Figure 2-4. The City has a total storage capacity of approximately 13 million gallons (MG). The storage reservoirs provide storage capacity for the City to meet diurnal demand fluctuations, supply demands during emergency and power outage conditions, and to meet fire flow requirements. A summary of the existing reservoirs with their key characteristics is provided in Table 2-6.

2.2.2.5 Potable Water Pump Stations

The City currently operates five potable water pump stations as shown on Figure 2-4. Pumping stations are required to fill storage tanks and provide adequate pressure within the distribution system by transferring water from the City's Zone 7 turnouts to the various pressure zones. The City operates the pump stations based on the water levels in the storage reservoirs to which they pump. A summary of the existing pump stations with their key characteristics is provided in Table 2-7. It should be noted that the Trevarno Pump Station is normally off-line.

2.2.2.6 Pressure Regulating Valves

The City's water distribution system includes 21 pressure regulating stations (PRS), shown on Figure 2-4, and shown schematically on Figure 2-5. Typically, each pressure regulating station is equipped with pressure reducing valves (PRVs) that regulate the water from higher pressure zones into lower pressure zones, keeping the system pressure from exceeding practical limits. Each pressure regulating station typically consists of one small diameter PRV (for normal operations) and one larger diameter PRV (for fire flow operations). Table 2-8 presents a summary of the existing pressure regulating stations with their key characteristics.

Table 2-6. Potable Water Storage Facilities

Storage Facility ID	Water Service Area Zone Served	Construction Year	Reservoir Type	Bottom Elevation[a], feet msl	Diameter, feet	Height[b], feet	Total Capacity, MG
Dalton	2	1964[c]	Welded Steel	650	130	20	2.00
Altamont	2 & 3	1985[d]	Welded Steel	760	114	40	3.00
Altamont	2 & 3	2003[e]	Welded Steel	760	146	40	5.00
Doolan	1	2008[f]	Welded Steel	695	146	24	3.00
						Total Capacity	**13.00**

[a] Datum is NVGD29
[b] Heights are to overflow elevation
[c] Source file: Dalton Tank Shop Drawing.pdf
[d] Source file: Altamont 3MG Nameplate.JPG
[e] Source file: Altamont 5 Tank Shop Drawings.pdf
[f] Source file: Doolan Potable Tank Shop Drawings.pdf

Table 2-7. Potable Water Pump Stations

Pump Station ID	Source	Pressure Zone	Ground Surface Elevation[d], msl	Type of Pump	Installation Date	Pump Number	Horsepower	Nominal Pump Capacity, gpm	Nominal Pump Capacity, mgd	Rated Total Dynamic Head, feet	Manufacturer and Model
Altamont[a]	Zone 7 (LIV 10 Turnout)	800	673	Vertical Turbine (2 stage)	1985	1	75	1,500	2.16	130	Aurora 12 KHMM
					1985	2	75	1,500	2.16	130	Aurora 12 KHMM
					2003	3	150[c]	2,720	3.92	152	Prime 1405H
					2003	4	150[c]	2,720	3.92	152	Prime 1405H
Airway	Zone 7 (LIV 9 Turnout)	719	385	Horizontal Split Case	2006	1	40	736	1.06	115	Peerless 4AE11
					2006	2	40	736	1.06	115	Peerless 4AE11
					2006	3	40	736	1.06	115	Peerless 4AE11
Oakville/Vinveyard	800	875	623	Vertical Turbine (5 stage)	2012	1	3	70	0.10	76	Floway 6JOL
					2004	2	3	70	0.10	76	Floway 6JOL
					2004	3	3	70	0.10	76	Floway 6JOL
Trevarno[b]	Zone 7 (LIV 1 Turnout)	670	532	Horizontal Split Case	1972	1	50	1,200	1.73	94	Allis Max V
					1972	2	50	1,200	1.73	94	Allis Max V
					2003	3	50	1,000	1.44	154	Allis 8000
					Unknown	4	25	900	1.30	84	Allis Max V
Vasco/ Springtown	Zone 7 (LIV 6 Turnout)	670	532	Vertical Turbine (2 stage)	1997	2-1	75	1,500	2.16	150	Floway 14 DKL
					1997	2-2	75	1,500	2.16	150	Floway 14 DKL
					1997	2-3	75	1,500	2.16	150	Floway 14 DKL
	Zone 7 (LIV 6 Turnout)	800		Vertical Turbine (3 stage)	1997	3-1	100	1,500	2.16	225	Floway 14 DKM
					1997	3-2	100	1,500	2.16	225	Floway 14 DKM
					1997	3-3	100	1,500	2.16	225	Floway 14 DKM
				Vertical Turbine (8 stage)	1997	3-4	20	300	0.43	205	Floway 8 JKM

(a) Source file: Altamont Pump Station.pdf. Data for Pump Nos. 1 and 2 based on assumed performance based on nameplate data; however, does not match SCADA data or pump curve on file.
(b) Source file: Trevarno Pump Station.pdf
(c) Source: Zone 2 and 3 Pumping Schematic.pdf
(d) Source file: Water Infrastructure elevations 2013.pdf

Table 2-8. Pressure Reducing Valve Stations

Location	Diameter(s)[a], in.	From Pressure Zone	To Pressure Zone	Elevation[b], ft.	Pressure Setting[c], psi	Downstream HGL, ft.	Water Service Area Zone
Vasco/Scenic	12 / 4	800	670	531	52	651	Zones 2 & 3
Leisure	8 / 3	744	678	539	60	678	Zones 2 & 3
Las Positas/Lawrence	12 / 6	800	744	564	50	680	Zones 2 & 3
Southfront/Lawrence	16 / 6	800	744	553	55	680	Zones 2 & 3
Vasco/Las Positas	12 / 6	800	744	548	54	673	Zones 2 & 3
Naylor[d]	12 / 4	744	740	544	70	706	Zones 2 & 3
Brisa	12 / 6	800	741	558	69	717	Zones 2 & 3
Patterson Pass/Shelley	12 / 4	800	725 North	549	64	697	Zones 2 & 3
Patterson Pass/Vasco	12 / 6	800	725 North	566	64	714	Zones 2 & 3
Vasco/Daphne	12 / 4	800	725 North	578	53	700	Zones 2 & 3
Vasco/Emily	12 / 6	800	725 North	598	50	714	Zones 2 & 3
East Avenue/Research	12 / 6	800	725 North	592	45	696	Zones 2 & 3
Charlotte/Vasco	12 / 6	800	725 South	603	60	742	Zones 2 & 3
Welch/Vasco	8 / 4	800	725 South	605	60	744	Zones 2 & 3
Trevarno Road	12	725 North	670	536	56	665	Zones 2 & 3
Las Positas/Bennett	12 / 6	744	670	532	53	654	Zones 2 & 3
Kitty Hawk	10 / 4	664	638	410	89	616	Zone 1
Doolan Road	10 / 4	719	638	405	92	618	Zone 1
North Canyons	10 / 4	719	664	452	64	600	Zone 1
Golf Course	12 / 4	638	605	363	75	536	Zone 1
Freisman	12 / 6	638	605	374	70	536	Zone 1

[a] Diameters shown are for Large Diameter PRV/Small Diameter PRVs.
[b] Datum is NGVD 29.
[c] Reflects pressure setting on small diameter PRV. Large diameter PRV set at 5 psi below small diameter PRV.
[d] Setting from prior master plan model.

2.2.2.7 Potable Water Distribution Pipelines

There are approximately 190 miles of distribution pipelines in the City's potable water system that range in size from 2-inches to 24-inches in diameter. The breakdown of miles of potable pipeline by diameter and pipe material is shown in Table 2-9.

Table 2-9. Potable Water Distribution Pipelines by Diameter and Pipe Material

Diameter, inches	Length, miles	Percent of Total	Pipe Material	Length, miles	Percent of Total
2	0.10	<1%	Polyvinyl Chloride (PVC)	89.24	47%
3	0.13	<1%	Cast Iron (CI)	1.80	1%
4	1.05	<1%	Asbestos Cement Pipe (ACP)	58.01	31%
6	26.78	14%	Steel	39.60	21%
8	66.17	35%	Ductile Iron (DI)	0.10	<1%
10	3.70	2%	Plastic	0.17	<1%
12	51.36	27%	Unknown	1.24	1%
14	2.12	1%			
16	15.77	8%			
18	1.45	<1%			
20	18.67	10%			
24	0.62	<1%			
Unknown	2.23	1%			
Total	**~190**	**100%**		**~190**	**100%**

Source: City of Livermore GIS Data, November 2017.

2.3 RECYCLED WATER SYSTEM

2.3.1 Recycled Water Supply

The City produces and distributes recycled water from the Livermore Water Reclamation Plant. Recycled water is provided to commercial and industrial customers within the City's Zone 1 Water Service Area for the following primary uses: landscape and agricultural irrigation, construction, street sweeping, and irrigation use at the Las Positas College and Las Positas Golf Course. In addition, there are some limited fire protection, toilet and urinal flushing uses of recycled water within the City's Zone 1 Water Service Area. The City's recycled water program is relatively well-developed and distributes an average of 2 MG of recycled water per day within the City's Zone 1 Water Service Area.

As described below in Section 2.3.3, it should be noted that the City's existing uses of recycled water will not be discontinued in the future, but future indoor use of recycled water is not assumed in this Water Master Plan.

2.3.2 Existing Recycled Water Facilities

There are approximately 22 miles of distribution pipelines in the City's recycled water system that range in size from 2-inches to 42-inches in diameter. The breakdown of miles of recycled water pipeline by diameter and pipe material is shown in Table 2-10.

Table 2-10. Recycled Water Distribution Pipelines by Diameter and Pipe Material

Diameter, inches	Length, miles	Percent of Total	Pipe Material	Length, miles	Percent of Total
2	0.01	<1%	Polyvinyl Chloride (PVC)	18.76	85%
3	0.30	1%	Asbestos Cement Pipe (ACP)	0.37	2%
4	0.10	<1%	Ductile Iron (DI)	0.08	<1%
6	0.71	3%	Unknown	2.39	11%
8	6.59	31%			
10	0.69	3%			
12	4.49	21%			
14	0.72	3%			
15	0.02	<1%			
16	0.48	2%			
18	5.37	25%			
24	1.38	6%			
42	0.46	2%			
Unknown	0.27	1%			
Total	**~22**	**100%**		**~22**	**100%**

Source: City of Livermore GIS Data, November 2017.

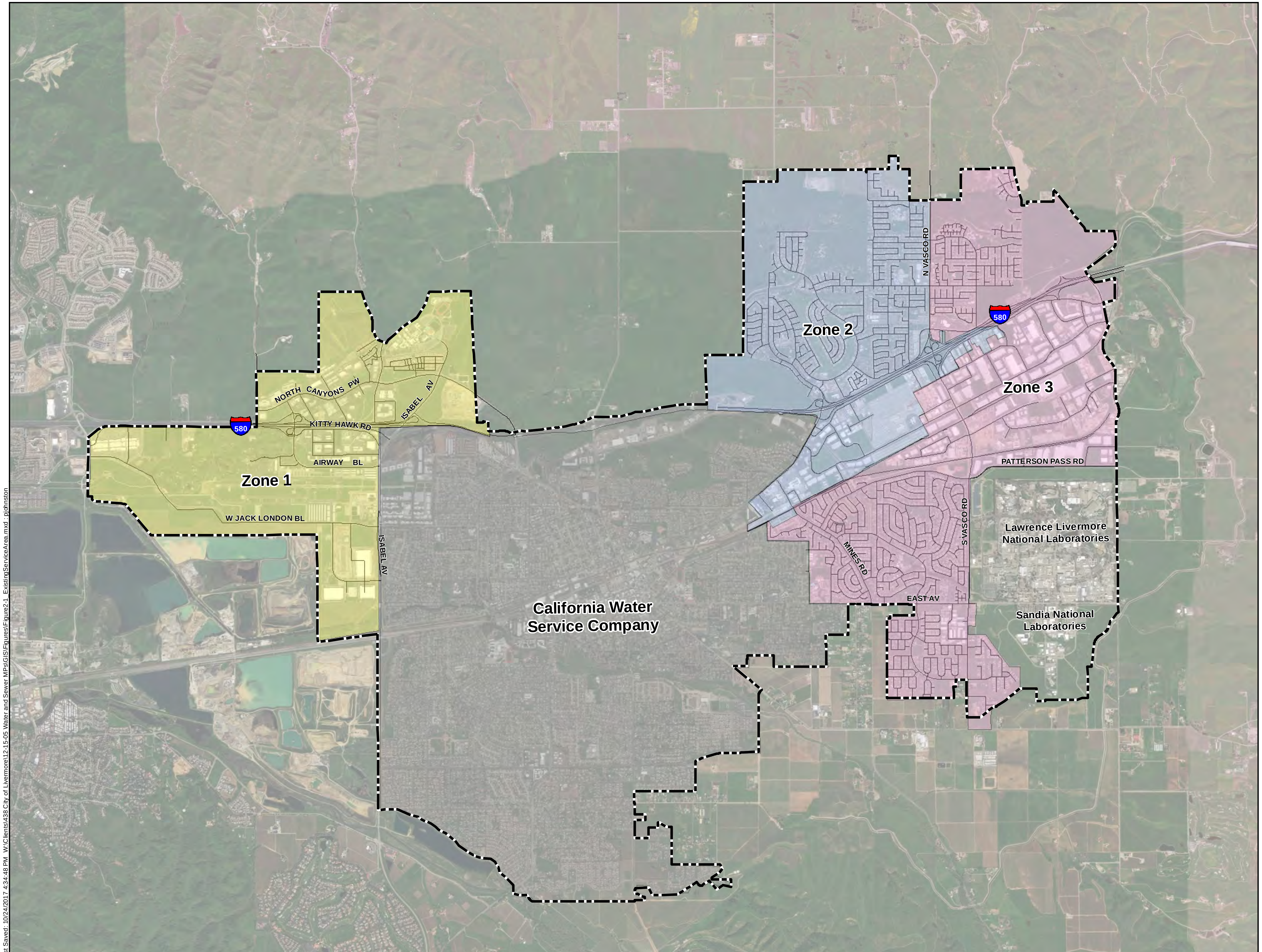
The City's recycled water distribution system includes two recycled water storage tanks. The tanks are located slightly west of the Zone 1 Water Service Area boundary, near Doolan Road, and have a total recycled water storage capacity of approximately 3.8 MG.

2.3.3 Future Recycled Water Facilities

The plan for the recycled water facilities is beyond the scope of this Water Master Plan. However, the City has indicated that future development within the Zone 1 Water Service Area will be supplied with recycled water for landscape irrigation use; however, it is not assumed that recycled water will be used for future toilet and urinal flushing or fire flow. It is assumed that adequate facilities will be developed to support the distribution of recycled water to future development areas in the Zone 1 Water Service Area.

Recycled water is not currently planned to be supplied to the Zone 2 and 3 Water Service Areas in the future. The extensive expansion of the recycled water distribution system required to supply recycled water to the Zone 2 and 3 Water Service Areas was determined to be too much of an investment given the limited number of potential recycled water customers in these zones.

The planning for the potable water system will incorporate the assumption that recycled water will be available for landscape irrigation uses in future development areas in the Zone 1 Water Service Area, and will not be available in the Zone 2 and 3 Water Service Areas.



N

0 2,000 4,000

Scale in Feet

Symbology

- Zone 1 Water Service Area
- Zone 2 Water Service Area
- Zone 3 Water Service Area
- California Water Service Company
- Urban Growth Boundary
- Street

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 2-1

Existing Service Area

City of Livermore
Water Master Plan

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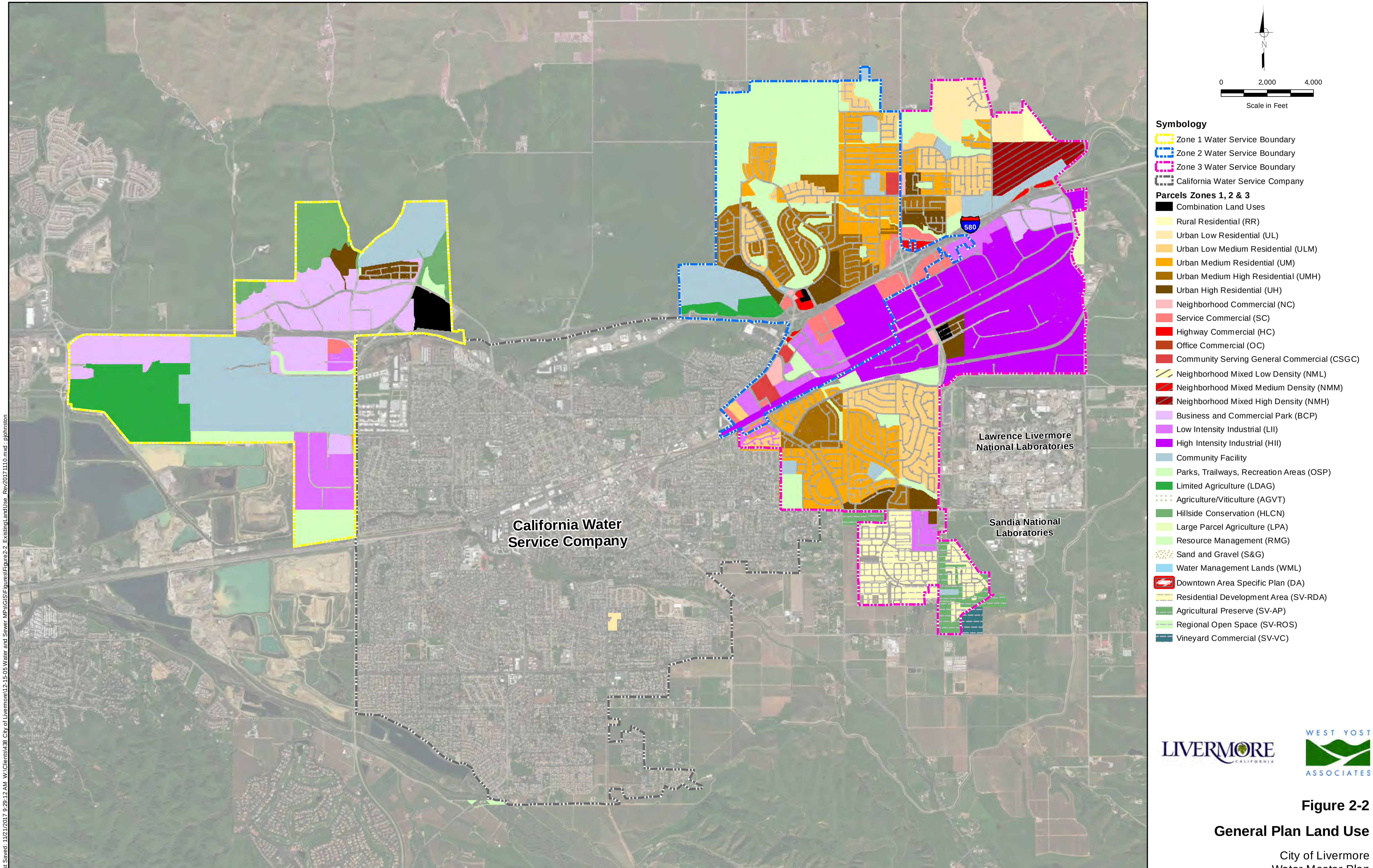

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 2-2

General Plan Land Use

City of Livermore
Water Master Plan

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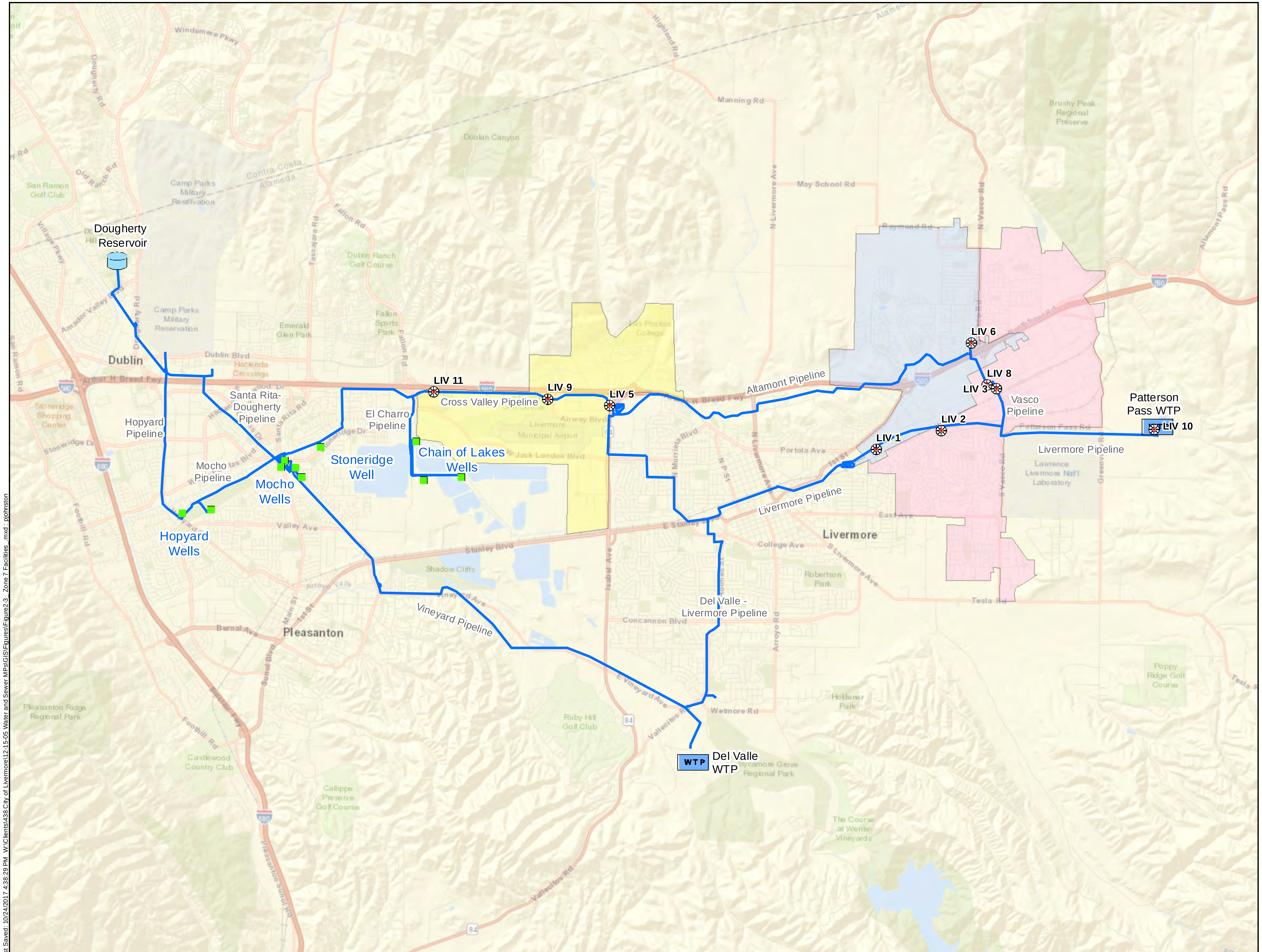

0 3,000 6,000
Scale in Feet

Symbology

- Livermore Zone 7 Turnout
- Zone 7 Distribution Pipeline
- WTP Water Treatment Plant
- Storage Reservoir
- Well
- Zone 1 Water Service Area
- Zone 2 Water Service Area
- Zone 3 Water Service Area

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 2-3

Zone 7 System with Livermore Turnout Locations

City of Livermore
Water Master Plan

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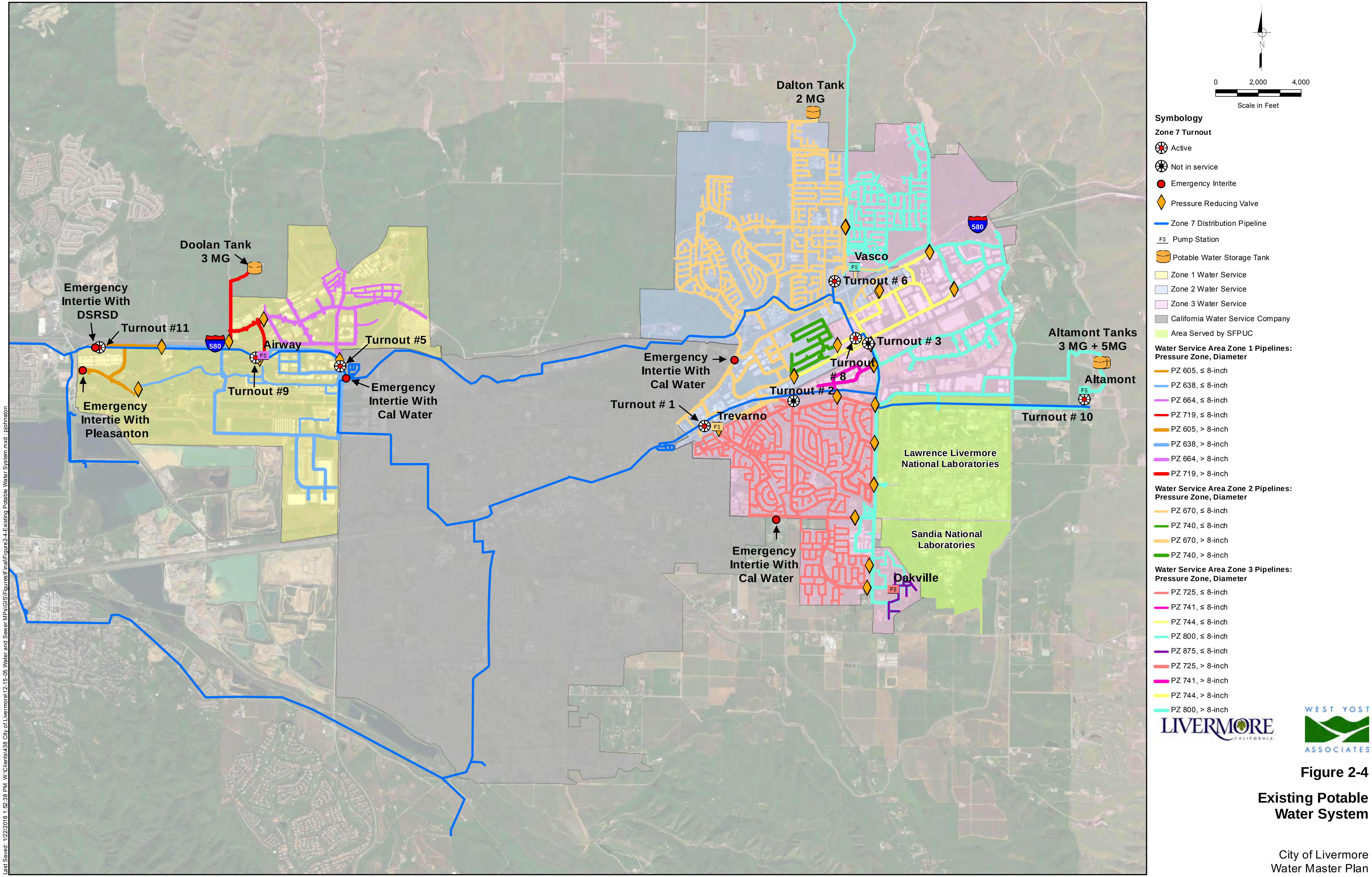

LIVERMORE
CALIFORNIA

WEST YOST
ASSOCIATES

Figure 2-4

Existing Potable Water System

City of Livermore
Water Master Plan

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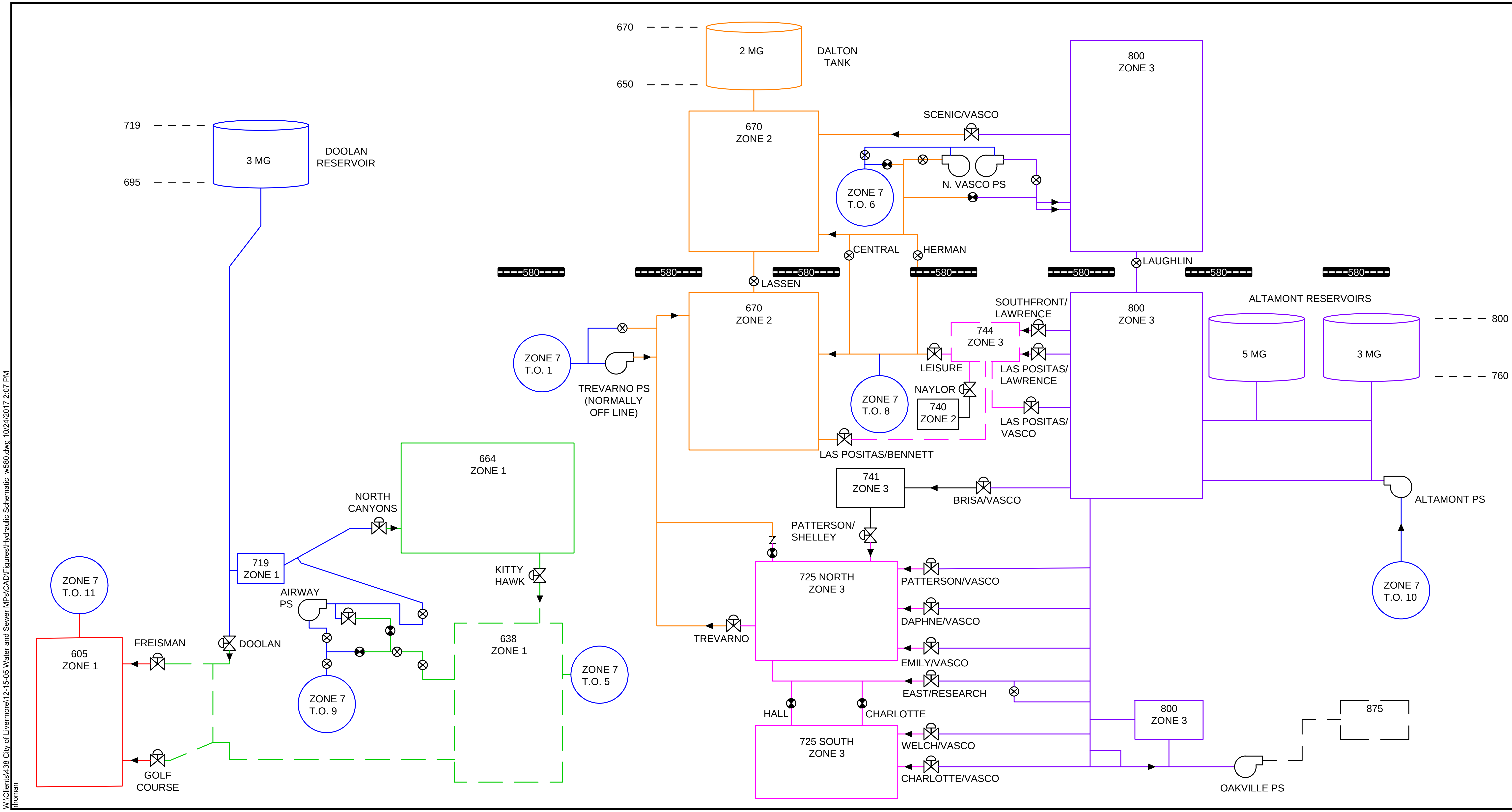

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LEGEND

Pressure Regulating Valve	Zone 7
Open Valve	Pressure Zone 605 (Zone 1)
Closed Valve	Pressure Zone 638 (Zone 1)
Pump Station	Pressure Zone 664 (Zone 1)
Tank	Pressure Zone 719 (Zone 1)
Check Valve	Pressure Zone 670 (Zone 2)
Flow Arrow	Pressure Zone 725 (Zone 3)
	Pressure Zone 740 (Zone 3)
	Pressure Zone 741 (Zone 3)
	Pressure Zone 744 (Zone 3)
	Pressure Zone 800 (Zone 3)
	Pressure Zone 875 (Zone 3)

Notes:
1. Elevations based on NGVD29 datum.
2. Trevarno pump station normally in standby mode.
3. Pressure zone names do not necessarily reflect actual hydraulic grade line of pressure zone.

Figure 2-5
System Schematic

City of Livermore
Water Master Plan

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Existing and Future Potable Water Demands

This chapter presents the existing and projected buildout potable water demands for the City. These water demand estimates were used to identify the required water supply to service the buildout water system. They were also used to update the City's water distribution system model for hydraulic analyses of existing and future water system infrastructure needs.

3.1 OVERVIEW

Accurate and detailed water demand data and projections are required to develop and calibrate the potable water system hydraulic model, help identify potential deficiencies in the existing water system, and assist in the assessment of the buildout water system capacity and future capital improvement program based on anticipated future development. Future water demand projections also play a key role in helping the City identify and secure sufficient water supplies to serve their future customers under various hydrologic conditions.

The following sections of this chapter describe the data and methodology used to determine the City's existing and future water system demands:

- Historical Water Production and Consumption
- Compliance with the Water Conservation Act of 2009 (SBx7-7)
- Adopted Peaking Factors
- Water Demand Projections

3.2 HISTORICAL WATER PRODUCTION AND CONSUMPTION

Water production is the total quantity of water purchased from Zone 7, while water consumption is the quantity of water actually consumed or used by its customers, as measured by the water meters at each customer connection. As will be discussed in Section 3.2.3, the difference between production and consumption is non-revenue water (NRW).

The City currently tracks the water purchased from Zone 7 at the turnouts. The City also compiles monthly reports tracking water usage by billing classes based on water billing data.

3.2.1 Historical Water Production

Annual water production, based on the amount of water purchased from Zone 7, during the six-year period from 2010 to 2015 is summarized in Table 3-1. From 2010 to 2015, the City produced on average approximately 5,900 acre feet per year (af/yr), which is equivalent to an average day demand of approximately 5.2 million gallons per day (mgd).

Table 3-1. Historical Water Production (2010-2015)[a]

Year	Annual Production, af	Annual Production, MG	Average Day Production, mgd
2010	6,078	1,981	5.43
2011	6,235	2,032	5.57
2012	6,598	2,150	5.89
2013	6,731	2,193	6.01
2014	5,064	1,650	4.52
2015	4,556	1,484	4.07
Average	5,877	1,915	5.25

[a] Source: City Record Data, City Water Purchased from Zone 7-updated.xls, containing monthly water purchased from Zone 7 and annual statistics from 1987 to 2015.

Figure 3-1 compares the historical annual water production with historical average annual rainfall for 2010 through 2015. For this relatively short historical period, it is clear that there has been a significant decrease in water production in 2014 and 2015, which corresponds to the last two years of the three-year drought.

Figure 3-2 illustrates the historical monthly water production between 2010 and 2015. The average maximum month production is approximately 285 MG. These data indicate that the City's highest monthly water production has historically occurred in either the month of July or August, which corresponds with high temperatures and minimal rainfall that is experienced in the City during these summer months. The lowest productions are observed during the winter months (December, January and/or February), as expected when there is minimal outdoor water use.

3.2.2 Historical Water Consumption

The City tracks metered consumption by six customer classes, which include Residential, Multi-Family, Commercial, Institutional, Irrigation and City Use. Table 3-2 summarizes the historical metered water consumption by customer class for the period from 2010 through 2015.

Table 3-2. Historical Metered Water Consumption by Customer Class[(a)]

Customer Class	Consumption, MG/year					
	2010	2011	2012	2013	2014	2015
Residential	980	988	1,056	1,117	797	679
Multi-Family	64	87	98	102	88	81
Commercial	316	335	333	352	322	308
Institutional	21	19	22	22	37	21
City Uses	3	3	3	3	2	2
Irrigation	306	269	350	369	310	259
Total Metered Consumption	1,690	1,700	1,862	1,964	1,556	1,349
Total Production	1,981	2,032	2,150	2,193	1,650	1,484
Metered Consumption as a Percent of Total Production	85%	84%	87%	90%	94%	91%
Non-Revenue Water as a Percent of Total Production	15%	16%	13%	10%	6%	9%

(a) Source: City billing data (Monthly Water Usage 1999 to 2015-updated.xls).

3.2.3 Historical Non-Revenue Water

Non-Revenue Water (NRW) is typically the difference between the recorded water production and metered water consumption. NRW includes a combination of various water uses that are not metered, such as water used for hydrant testing, firefighting, and system flushing, or water that is lost from system leaks and water main breaks.

Table 3-2 displays the NRW as a percent of the total production. Based on the data from the last six years, NRW has averaged approximately 11 percent. Water utilities strive to minimize the amount of NRW; however, it is difficult, if not impossible, to eliminate entirely. A survey of water agencies in the United States conducted by the American Water Works Association (AWWA) found that NRW in utilities across the country varied between 7.5 percent to 25 percent[1]. Therefore, the 11 percent NRW is reasonable for the City's water system, and will be assumed to remain constant through buildout.

3.2.4 Historical Per Capita Water Demand

Historical per capita water demands were calculated by dividing the annual water production by the City's annual service area population. Table 3-3 summarizes the historical per capita water demands for the City between 2010 and 2015. As shown in Table 3-3, the historical per capita water demand has averaged approximately 190 gallons per capita per day (gpcd) over the past six years.

1 Survey of State Agency Water Loss Reporting Practices, Final Report to the American Water Works Association, prepared by Janice A. Beecher, Ph.D., Beecher Policy Research, Inc., January 2002.

Table 3-3. Historical Per Capita Water Demand (2010-2015)

Year	Estimated Service Area Population[(a)]	Water Production, MG/yr	Per Capita Water Demand, gpcd
2010	27,113	1,981	200
2011	27,394	2,032	203
2012	27,571	2,150	214
2013	28,112	2,193	214
2014	27,113	1,650	167
2015	28,782	1,484	141
		Average	190

(a) Source: 2015 population from City's 2015 UWMP; 2010-2014 population data estimated based on number of residential connections for those years (Source: Population Tool Print Confirmation 15year.pdf provided by City) times the number of persons per connection for 2015.

Figure 3-3 compares the historical per capita water demand, historical water production and estimated historical population within the City's water service area from 2010 to 2015. Over that time period, the population in the City's water service area generally increased (with the exception of 2014). During that same time period, water production increased through 2013, then decreased significantly in 2014, and decreased further in 2015. These last two years are the second and third years of the on-going drought. As a result, per capita water use declined in 2014 and 2015. The six-year average per capita water use was 190 gpcd, while 2015 per capita water use was 141 gpcd.

3.3 COMPLIANCE WITH THE WATER CONSERVATION ACT OF 2009 (SBX7-7)

A key principle that relates to the Water Master Plan is water conservation. Water conservation may be necessary to meet requirements set by the State under SBx7-7 (Water Conservation Act of 2009, also referred to as the 20 x 2020 Legislation) and other related legislation to reduce the City's water use.

In February 2008, Governor Arnold Schwarzenegger called for a statewide 20 percent reduction in per capita water use by 2020 and asked state and local agencies to develop a more aggressive plan of water conservation to achieve the goal. A team of state and federal agencies (the 20 x 2020 Agency Team) consisting of the Department of Water Resources (DWR), State Water Resources Control Board (SWRCB), California Energy Commission, Public Utilities Commission, Department of Public Health, Air Resources Board, CALFED Program, United States Bureau of Reclamation (USBR), and California Urban Water Conservation Council (CUWCC) was formed to develop a statewide implementation plan for achieving this goal.

On November 10, 2009, Governor Arnold Schwarzenegger signed Senate Bill x7-7 (SBx7-7), known as the Water Conservation Act of 2009, one of several bills passed as part of a comprehensive set of new Delta and water policy legislation. SBx7-7 requires a 20 percent reduction in urban water usage by 2020 and establishes various methodologies for urban water suppliers to establish their interim (2015) and final (2020) per capita water use targets.

Four methods are identified in SBx7-7 for establishing per capita water use targets:

Method 1: A 20 percent reduction from historical baseline per capita water use based on a 10-year running average per capita water use.

Method 2: Per capita water use based on 55 gallons per capita per day water use for residential water use, landscape irrigation use based on water efficiency equivalent to the standards of the Model Water Efficient Landscape Ordinance, and a 10 percent reduction from baseline commercial, industrial and institutional (CII) water use.

Method 3: 95 percent of the State hydrologic region targets as stated in the State's 2010 20 x 2020 Water Conservation Plan.

Method 4: An approach that considers the water conservation potential from: (1) indoor residential savings; (2) metering savings; (3) commercial, industrial and institutional savings; and (4) landscape and water loss savings.

The City adopted Method 1 to calculate its 2015 interim and 2020 final per capita water use targets. Under Method 1, the City's baseline water use was calculated to be 240 gpcd (based on a 10-year average from 1999 to 2008). Therefore, using Method 1, the City's 2015 interim target is 216 gpcd (90 percent of 240 gpcd), and the City's 2020 final target is 192 gpcd (80 percent of 240 gpcd). These per capita water use targets are further described in the City's 2015 UWMP.

Based on the City's 2015 per capita water use of 141 gpcd, the City met its 2015 target per capita water use, and also is currently meeting its 2020 target per capita water use (if this level of water use can be sustained). However, recent reductions in per capita water use are likely influenced by the economic downturn and multiple dry years, and may not be sustainable once economic and hydrologic conditions improve.

3.4 WATER DEMAND PROJECTIONS

Water demands are projected for buildout of the City's Water Service Area by using data from the following:

- Existing water consumption and estimates of demand rebound for currently developed parcels;
- Projected water demands for reasonably foreseeable development projects; and
- Projected water demands for vacant parcel areas.

The methodologies to project these water demands are described in the following sections.

3.4.1 Existing and Rebounded Water Demands for Currently Developed Parcels

3.4.1.1 Historical Billing Data Processing

Water billing data was available for 2011 through 2015. As stated previously, there has been a decrease in demands in 2014 and 2015, which correspond to the last two years of the three-year drought. While it is not known if demands will rebound after the drought ends, or how much they might rebound, the City decided not to base the current Water Master Plan on demands from 2014 or 2015, as these represent a low level of demands that may not be sustained. Instead, the City chose to develop a set of demands that represents an estimate of what demands may be after a certain level of demand rebound occurs. This set of demands will be referred to as the existing rebounded demand projections. Following is a discussion of the process of developing the existing rebounded demand projections.

Through discussions with the City, demands from 2013 and 2015 were selected to develop the existing rebounded demand projections. 2013 was selected as it reflected pre-drought demands. 2015 was selected as the most current year, reflecting current drought conditions, with a spatial distribution of demands that most closely matches current level of development.

Each billing account within each set of demands was joined to the appropriate water meter using the account number. Each water meter was then joined to the appropriate parcel. In some instances, there is more than one meter for a parcel. For these locations, the demands for all meters for a parcel were summed to produce a total demand for the parcel. For both the 2013 and 2015 billing data, 92 percent of the demand from each year was assigned to parcels. The remaining 8 percent of the demands represent billing accounts with issues, such as meters that are not located within a parcel (such as a median strip) or meters located outside the boundary of the parcel map. To account for the demand that could not be spatially located by joining it to a parcel, the joined demands were scaled up by 8 percent.

The totals of the billing data for 2013 and 2015 were then compared to the totals of potable water purchased from Zone 7 to estimate the NRW for each year. The NRW calculated for 2013 and 2015 was 10 percent and 9 percent, respectively. To account for the NRW in the hydraulic model, the joined demands were scaled up by the appropriate factor for each year.

The result of this is two sets of spatially allocated demands, one each for 2013 and 2015.

3.4.1.2 Demand Rebound

Demand rebound refers to increases in demands after a prolonged drought. In the on-going three-year drought, total demands within the City's water service area have decreased approximately 25 to 30 percent from their high in 2013. The decreases have likely been due to conservation-oriented behavioral changes, such as irrigating less frequently, as well as more permanent changes, such as installation of low-flow toilets or removal of lawns. While the permanent changes can be expected to remain in place after the drought ends, whether or not the behavioral changes continue is less certain.

There are limited precedents from which to draw conclusions regarding demand rebound. The Gold Coast area of Australia experienced a severe drought between June 2002 and January 2004. Demands decreased significantly during the drought as a result of water restrictions, but after the drought ended, the demands rebounded 90 percent (to within 10 percent of what they were prior to the drought). The same drought affected northern New South Wales, where demands also decreased significantly during the drought, but rebounded 84 percent (to within 16 percent of what they were prior to the drought).

While the level to which demands in the City's water service area will rebound is unknown, the City decided to include an assumption of some level of demand rebound into the planning process. The assumed level of rebound will be documented so that demand rebound can be monitored and measured against what was assumed in this Water Master Plan. The level of rebound is discussed in the following section.

3.4.1.3 Existing Rebounded Demand Projections

As described above, the City recently completed and adopted its 2015 UWMP, which included revised per capita water use targets in compliance with SBx7-7 requirements. As indicated in Section 3.3, the City's 2020 per capita water use target is 192 gpcd. The City decided to use this value to develop a set of demands with which to evaluate the system. This is expected to be a more conservative evaluation of the system than would take place if the 2015 demands were used, as these are unusually low due to the prolonged drought. This assumption provides a more conservative water demand estimate to account for typical water use patterns during normal hydrologic conditions.

The per capita water demands for 2013 and 2015 are 214 and 141 gpcd, respectively. The 2020 target of 192 gpcd is 90 percent of the 2013 per capita water use of 214 gpcd. This would indicate a rebound in demands up to 90 percent of what demands were prior to the current drought. This compares favorably to the demand rebound values of 84 percent and 90 percent that were observed in the New South Wales and Gold Coast areas of Australia that were discussed in Section 3.4.1.2.

The City's 2020 per capita water use target of 192 gpcd is 36 percent higher than the 2015 per capita water use of 141 gpcd. This would represent an increase of 36 percent. Therefore, the final step in creating a spatially-allocated set of demands to represent the 2020 final target was to increase the 2015 demands by 36 percent. This increase was applied uniformly to all 2015 demands, and is presented in Table 3-4 which shows the City's 2015 demands by land use designation and by water service area zone, and the estimated existing rebounded demands for currently developed parcels.

Table 3-4. Total Existing and Rebounded Potable Water Demands by Land Use Category

			2015 Demands, MG/YR				Rebounded Demands, MG/YR			
			Water Service Area Zone				Water Service Area Zone			
Land Use Category	Land Use Designation	Land Use Code	Zone 1	Zone 2	Zone 3	Total	Zone 1	Zone 2	Zone 3	Total
Residential	Urban Low Residential – 1	UL-1	-	-	0.64	0.64	-	-	0.88	0.88
	Urban Low Residential – 2	UL-2	-	-	10.18	10.18	-	-	14.01	14.01
	Urban Low Medium Residential	ULM	-	49.23	155.41	204.63	-	67.74	213.84	281.58
	Urban Medium Residential	UM	-	111.06	171.43	282.49	-	152.82	235.89	388.71
	Urban Medium High Residential	UMH	-	103.34	73.09	176.42	-	142.19	100.57	242.76
	Urban High Residential – 1	UH-1	-	9.37	14.48	23.85	-	12.89	19.92	32.82
	Urban High Residential – 2	UH-2	-	30.64	48.76	79.40	-	42.16	67.10	109.26
	Urban High Residential – 4	UH-4	32.45	-	6.52	38.97	44.66	-	8.97	53.63
	Residential Mixed	ULM/UH-2	-	-	0.26	0.26	-	-	0.36	0.36
	Residential Mixed	UMH/UH-2	-	3.14	-	3.14	-	4.32	-	4.32
Commercial	Neighborhood Commercial	NC	-	8.83	2.37	11.20	-	12.16	3.26	15.41
	Service Commercial	SC	1.04	18.04	8.44	27.53	1.44	24.82	11.62	37.88
	Highway Commercial	HC	-	8.30	4.00	12.30	-	11.41	5.51	16.92
	Community Serving General Commercial	CSGC	-	16.21	0.31	16.53	-	22.31	0.43	22.74
Industrial	Business and Commercial Park	BCP	102.53	-	46.93	149.46	141.08	-	64.57	205.65
	Low Intensity Industrial	LII	3.79	22.85	13.23	39.87	5.22	31.44	18.21	54.86
	High Intensity Industrial	HII	-	9.25	169.39	178.64	-	12.72	233.08	245.81
Community Facility	Elementary School	CF-E	-	5.75	9.60	15.35	-	7.91	13.21	21.13
	Intermediate School	CF-I	-	-	-	-	-	-	-	-
	Community College	CF-JC	8.85	-	-	8.85	12.18	-	-	12.18
	Research and Development	CF-R&D	-	-	4.08	4.08	-	-	5.61	5.61
	Government Services	CF	-	0.21	-	0.21	-	0.28	-	0.28
	Airport	CF-AIR	4.05	-	-	4.05	5.58	-	-	5.58
	BART Station Parking	BART	-	-	0.29	0.29	-	-	0.40	0.40
Open Space	Parks, Trailways, Recreation Areas	OSP	0.06	16.30	24.72	41.08	0.08	22.43	34.02	56.53
	Large Parcel Agriculture	LPA	-	1.05	0.40	1.44	-	1.44	0.55	1.99
South Livermore Valley SP	Residential Development Area	SV-RDA	-	-	-	-	-	-	-	-
	Agricultural Preserve	SV-AP	-	-	0.87	0.87	-	-	1.20	1.20
	Agricultural Preserve	SV-1-AP	-	-	0.46	0.46	-	-	0.63	0.63
	Residential Development Area	SV-1-RDA	-	-	26.97	26.97	-	-	37.12	37.12
	Agricultural Preserve	SV-2-AP	-	-	4.72	4.72	-	-	6.50	6.50
	Residential Development Area	SV-2-RDA	-	-	90.77	90.77	-	-	124.89	124.89
	South Livermore Valley SP	SV-RDA/SV-AP	-	-	0.34	0.34	-	-	0.46	0.46
Mixed	Neighborhood Mixed Medium Density	NMM	-	-	0.07	0.07	-	-	0.09	0.09
	Industrial/Residential Mixed	HII/UH-3	-	-	0.89	0.89	-	-	1.22	1.22
	Industrial/Residential Mixed	HII/UH-3/CF-S	-	-	0.49	0.49	-	-	0.68	0.68
	Industrial/Residential Mixed	LII/UM	-	-	4.81	4.81	-	-	6.61	6.61
	Industrial/Residential Mixed	LII/ULM	-	-	1.27	1.27	-	-	1.75	1.75
	Commercial/Residential Mixed	NC/UH-4	-	0.03	-	0.03	-	0.04	-	0.04
		Total	**153**	**414**	**896**	**1,463**	**210**	**569**	**1,233**	**2,012**

3.4.2 Projected Future Water Demands

3.4.2.1 Development of Unit Water Demand Factors

Unit water demand factors were estimated for various land use types based on water consumption and land use data. These factors are typically expressed in annual water use per acre, and are multiplied by land use area data to calculate a water demand estimate.

Unit water demand factors were calculated using the City's existing General Plan land use categories and City parcel information in GIS format, which were correlated to the City's existing metered water use data in Excel format. This process was completed using tools available in GIS software as discussed and illustrated below.

The unit water demand factors were calculated using the rebounded demand data. The total water use was divided by the total parcel area for each land use designation. Separate unit water demand factors were calculated for areas where recycled water is currently being used versus where recycled water is not currently being used. Recycled water is currently supplied to a portion of the Zone 1 Water Service Area only. Recycled water is not currently served in the Zone 2 and 3 Water Service Areas.

It is assumed that new development in the Zone 1 Water Service Area will be supplied with recycled water (for irrigation uses), and that new development in the Zone 2 and 3 Water Service Areas will not receive recycled water.

Table 3-5 summarizes the unit demand factors developed for this Water Master Plan in units of gallons per acre per day (gpad). Not all land use designations were represented in the areas with current billing data. Unit water demand factors were calculated only for the land use designations for which current billing data was available.

3.4.2.2 Reasonably Foreseeable Development Projects

The City's Planning Department provided information on 38 separate locations within the City's water service area for which they have received information on the development that has been proposed at the site. For purposes of this Water Master Plan, these future developments are referred to as "Reasonably Foreseeable Development Projects." Information provided by the City Planning Department included the number of proposed housing units and the type or size of the proposed non-residential development. Table 3-6 shows a summary of the information that was provided for each location. The 38 locations are shown on Figures 3-4 and 3-5.

For residential locations, a housing density was calculated by dividing the number of housing units by the area of the parcels. An appropriate land use was then selected based on the corresponding housing densities. For non-residential planned developments, an appropriate land use was selected based on the type of developed being proposed.

Table 3-5. Unit Water Demand Factors Developed for the Water Master Plan

Land Use Category	Land Use Designation	Land Use Code	Unit Water Demand Factor, gpad	
			With RW Use[a]	Without RW Use[b]
Residential	Urban Low Residential – 2	UL-2	-	2,270
	Urban Low Medium Residential	ULM	-	2,240
	Urban Medium Residential	UM	-	2,190
	Urban Medium High Residential	UMH	-	2,400
	Urban High Residential – 1	UH-1	-	2,930
	Urban High Residential – 2	UH-2	-	3,080
	Urban High Residential – 4	UH-4	1,880	3,910
Commercial	Neighborhood Commercial	NC	-	2,680
	Service Commercial	SC	-	940
	Highway Commercial	HC	-	520
	Community Serving General Commercial	CSGC	-	1,180
Industrial	Business and Commercial Park	BCP	690	2,890
	Low Intensity Industrial	LII	-	1,150
	High Intensity Industrial	HII	-	850
Community Facility	Elementary School	CF-E	-	1,830
	Research and Development	CF-R&D	-	60
Open Space	Parks, Trailways, Recreation Areas	OSP	-	910
South Livermore Valley SP	Residential Development Area	SV-RDA	-	2,540
	Agricultural Preserve	SV-AP	-	530

(a) From areas in Zone 1 Water Service Area where recycled water is used.

(b) From Zone 2 and 3 Water Service Areas, and areas in Zone 1 Water Service Area where recycled water is not used.

gallon per acre per day, see Table 3-5

Table 3-6. Potable Water Demand Projections for Reasonably Foreseeable Development Projects

Planning Areas	Name	Water Service Area Zone	Recycled Water is Available?	Parcel Area, acres	Planned Dwelling Units, DU	Housing Density, DU/acre	Land Use Code	Demand Factor, gpad [a]	Total Demand gpd	Total Demand MG/YR	Increase from Existing Demand [b] gpd	Increase from Existing Demand [b] MG/YR	Note [c]
1a	Outlets - Phase II	1	Yes	17			BCP	N/A	14,237	5	14,237	5	Assume full occupancy and same demand/sf as Phase I
1b	Outlets - Phase I	1	Yes	46			BCP	N/A	40,316	15	1,112	0.4	Assume full occupancy
2.00	The Shoppes	1	Yes	12			BCP	1,500	17,718	6	17,718	6	Assume 1,500 gpad, as this is expected to have more restaurant-oriented businesses.
3.00	CrossWinds	1	Yes	25			BCP	1,500	37,952	14	37,952	14	Assume 1,500 gpad, as this is expected to have more restaurant-oriented businesses.
4.00	Sywest Driving Range	1	Yes	21			BCP	690	14,209	5	14,209	5	Use BCP demand factor for Zone 1 Water Service Area
5a	Oaks Business Park: Gillig	1	Yes	38			LII	1,000	38,420	14	38,420	14	Assume 1,000 gpad per prior master plan
5b	Oaks Business Park: Trammel Crow	1	Yes	69			LII	1,000	69,404	25	69,404	25	Assume 1,000 gpad per prior master plan
5c	Oaks Business Park: Remaining Area	1	Yes	62			LII, BCP	1,000	61,816	23	61,816	23	Assume 1,000 gpad per prior master plan
6a	Airport Master Plan (Hangars/Admin)	1	Yes	23			CF-AIR	450	16,128	6	7,713	3	Assume full occupancy per master plan and same demand/sf as existing
7a	Livermore Valley Charter School: K-8	1	Yes	10			BCP	N/A	5,848	2	-	-	Assume existing demand with rebound since it is greater than textbook values for schools with recycled water
7b	Livermore Valley Charter School: Athletics	1	Yes	12			BCP	N/A	-	-	-	-	Assume all use is recycled water
7c	Livermore Valley Charter School: High School	1	Yes	6			BCP	N/A	9,489	3	-	-	Assume existing demand with rebound since it is greater than textbook values for schools with recycled water
8.00	Las Positas College	1	Yes	147			CF-JC	N/A	45,158	16	11,779	4	Scale up existing 2015 rebounded demand of 23.18 gpm from 8,870 current student population to estimated 12,000 future student population
9.00	Shea Homes, Sage	1	Yes	35	476	14	UH-3	1,880	65,800	24	65,800	24	35 acres per Planning Department. Use UH-4 demand factor, since no demand factor available for UH-3.
10.00	Ponderosa	2	No	6	26	5	UMH	2,400	13,336	5	11,562	4	Use UMH demand factor
11.00	KB Home	2	No	3	58	17	UH-3	3,910	13,084	5	13,084	5	Use UH-4 demand factor, since no demand factor available for UH-3.
12.00	Central Crossing	2	No	5	49	10	UH-2	3,080	15,619	6	13,633	5	Proposal includes a General Plan amendment from SC&UM to UH-2
13.00	Garaventa Hills	3	No	32	42	1	UL-1	2,270	71,899	26	71,899	26	Use UL-2 demand factor, since no demand factor available for UL-1.
14.00	Open Space	3	No	40			OSP-NA	150	5,985	2	5,985	2	Use OSP demand factor
15.00	12 Single-Family Homes	3	No	10	12	1	UL-1	2,270	22,020	8	22,020	8	Use UL-2 demand factor, since no demand factor available for UL-1.
16.00	Open Space	3	No	66			OSP-NA	150	9,896	4	9,896	4	Use OSP demand factor
17a	BART Site: 300 SF Homes	3	No	56	300	5	UMH	2,400	133,348	49	131,147	48	Use UMH demand factor
17b	Open Space	3	No	129			NMH	150	19,349	7	19,349	7	Use OSP demand factor
18.00	Intel Site	2	No	9			LII	1,150	10,249	4	4,977	2	Use LII demand factor
19.00	Arroyo Vista Neighborhood Plan	2	No	29	495	17	UH-3	3,910	113,047	41	113,047	41	Use UH-4 demand factor, since no demand factor available for UH-3.
20.00	Bennett Drive	2	No	13	436	34	UH-5b	5,000	64,231	23	64,231	23	Use 5,000 gpad demand factor, since no demand factor available for UH-3.
21.00	McGrath Rent Corp	2	No	112			HII	850	94,894	35	77,878	28	Use HII demand factor
22a	Brisa Neighborhood: 465 units	3	No	34	465	14	UH-3	3,080	104,081	38	51,450	19	Use UH-2 demand factor, since no demand factor available for UH-3.
22b	Brisa Neighborhood: 46 units	3	No	1.4	46	34	UH-5b	5,000	6,805	2	6,805	2	Use 5,000 gpad demand factor, since no demand factor available for UH-3.
23.00	PG&E Training Site	3	No	44			HII	850	37,566	14	35,904	13	Use HII demand factor
24.00	6877 Brisa	3	No	7			HII	850	5,647	2	5,647	2	Use HII demand factor
25.00	7600 Hawthorne	3	No	13			HII	850	10,840	4	10,840	4	Use HII demand factor
26.00	7600 Patterson Pass	3	No	10			HII	850	8,418	3	8,418	3	Use HII demand factor
27.00	Mines Road, South of First	3	No	16	58	4	UM	2,190	35,938	13	24,156	9	Use UM demand factor
28.00	Ponderosa Vines	3	No	5	49	10	UH-2	3,080	14,809	5	14,809	5	Landuse amended from NMM to UH-2 in 2014
29.00	Unnamed Development	3	No	10	20	2	SV-RDA	2,540	25,236	9	25,236	9	Use SV-RDA demand factor
30.00	New Private School	2	No	122			CF-E	1,830	223,731	82	223,731	82	Use CF-E demand factor
31.00	32 Single-Family Homes	2	No	9	32	4	UM	2,190	18,734	7	17,202	6	Use UM demand factor
	Total			**1,303**	**2,564**				**1,515,255**	**553**	**1,323,064**	**483**	

(a) N/A indicates demands were not calculated with a demand factor, but with a different method as indicated in the Note field.

(b) These columns remove any existing demands from the project areas so that they are not double-counted.

(c) Residential land use code housing density ranges, in units of dwelling units per acre, include: UL-1, 1-1.5; UL-2, 1.5-2; ULM, 2-3; UM, 3-4.5; UMH, 4.5-6; UH-1, 6-8; UH-2, 8-14; UH-3, 14-18; UH-4, 18-22; UH-5, 22-38; UH-5a, 22-30; UH-5b, 30-38; UH-6, 38-55.

Using the selected land use category with its corresponding unit water demand factor and the area of the parcels, a water demand was estimated for each of the 38 planning areas. It should be noted that while most of the "Reasonably Foreseeable Development Projects" are on parcels that are currently vacant, some of the parcels have already been partially developed and have existing water meters and existing water demands. For those parcels, existing water demands are accounted for under "Existing and Rebounded Water Demands for Currently Developed Parcels", as described above, and the incremental additional planned demands are included under the potable water demand projections for the "Reasonably Foreseeable Development Projects".

It should be noted that the projected water demands for the "Reasonably Foreseeable Development Projects" do not include projected water demands for the proposed Isabel Neighborhood Plan, which has proposed land uses which are different from those included in the City's current General Plan. A description of the Isabel Neighborhood Plan proposed land uses and projected water demands is provided in Appendix C and summarized in Chapter 7.

The water demand estimate for the "Reasonably Foreseeable Development Projects" is presented in Table 3-6.

3.4.2.3 Vacant Parcels

Based on the City's water meter database and the latest aerial photography of the City, the parcels within the City's service area that are currently vacant were identified. From this set of parcels, those parcels that were identified by the Planning Department as the "Reasonably Foreseeable Development Projects" described in Section 3.4.2.2 were removed. The remaining vacant parcels in the City's Zone 1 and Zone 2 and 3 Water Service Areas are shown on Figures 3-4 and 3-5, respectively.

Using the General Plan land use categories assigned to each of the vacant parcels in the City's GIS parcel layer[2] and the water demand factors developed for each land use, a demand was estimated for each of the vacant parcels from among the land use designations for which a unit water demand factor was calculated. The appropriate demand factors were used depending on if the parcels are in the Zone 1 Water Service Area (where recycled water will be supplied) or in the Zone 2 and 3 Water Service Areas (where recycled water will not be supplied). If an applicable unit water demand factor was not available (i.e., metered water use data for that specific land use type is not available), then specific assumptions for the buildout water demand for that parcel have been made and documented. Estimated demands for the vacant parcels, by land use designation and by water service area zone, are presented in Table 3-7.

[2] It should be noted that some parcels in the City's GIS parcel layer have a -9 land use assignment. Supplemental information was provided by the City and utilized to assign land uses to these parcels based on the General Plan.

Table 3-7. Potable Water Demand Projections for Vacant Areas

Land Use Category	Land Use Designation	Land Use Code	Unit Water Demand Factor, gpad		Parcel Area, acres Water Service Area Zone			Demand, MG/YR Water Service Area Zone				Notes
			With RW Use	Without RW Use	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Total	
Residential	Urban Medium Residential	UM	-	2,190	-	1.0	-	-	0.8	-	0.8	
	Urban Medium High Residential	UMH	-	2,400	-	25.6	-	-	22.5	-	22.5	
	Urban High Residential – 4	UH-4	1,880	3,910	-	-	1.3	-	-	1.9	1.9	
Commercial	Neighborhood Commercial	NC	-	2,680	-	-	3.6	-	-	3.5	3.5	
	Service Commercial	SC	-	940	-	15.0	5.2	-	5.1	1.8	6.9	
	Highway Commercial	HC	-	520	-	1.1	3.2	-	0.2	0.6	0.8	
Industrial	Business and Commercial Park	BCP	690	2,890	124.7	-	19.3	31.4	-	20.4	51.8	
	Business and Commercial Park/Hospital	BCP/CF-HOSP	690	2,890	16.3	-	-	4.1	-	-	4.1	
	Low Intensity Industrial	LII	-	1,150	-	3.1	13.1	-	1.3	5.5	6.8	
	High Intensity Industrial	HII	-	850	-	26.3	102.7	-	8.2	31.9	40.0	
Community	Elementary School	CF-E	-	1,830	-	-	5.0	-	-	3.3	3.3	
Open Space	Parks, Trailways, Recreation Areas	OSP	0	910	-	0.2	1.6	-	0.1	0.5	0.6	
	Natural Areas	OSP-NA	0	150	136.9	526.5	65.2	0	28.8	3.6	32.4	Assume potable irrigation demand of 150 gpad for Zone 2 & 3 Water Service Areas. Assume zero potable irrigation demand in Zone 1 Water Service Area.
	Agriculture/Viticulture	AGVT	-	150	-	-	3.0	-	-	0.2	0.2	
	Limited Agriculture	LDAG	0	150	218.2	57.1	-	0	3.1	-	3.1	
	Large Parcel Agriculture	LPA	-	150	-	-	2.8	-	-	0.2	0.2	
	Hillside Conservation	HLCN	0	150	44.6	-	-	0	-	-	-	
South	Residential Development Area	SV-RDA	-	2,540	-	-	12.1	-	-	11.2	11.2	
				Total	**541**	**656**	**238**	**36**	**70**	**85**	**190**	

3.4.2.4 Buildout Potable Water Demand Projections

Buildout potable water demand projections were developed by combining the existing rebounded demand projections, the demands estimated for the reasonably foreseeable development projects and the demands for the vacant parcels. These demands are summarized in Table 3-8.

Table 3-8. Projected Water Demand at Buildout

Demand Component	Water Service Area Zone	Annual Demand, AF/YR	Annual Demand, MG/YR	Average Day Demand, mgd
Existing Rebounded Demands (see Table 3-4)	Zone 1	644	210	0.58
	Zone 2	1,743	569	1.56
	Zone 3	3,777	1,233	3.38
	Total	6,164	2,012	5.51
Reasonably Foreseeable Development Project Demands (see Table 3-6)	Zone 1	380	124	0.34
	Zone 2	603	197	0.54
	Zone 3	496	162	0.44
	Total	1,479	483	1.32
Vacant Parcel Demands (see Table 3-7)	Zone 1	109	36	0.10
	Zone 2	215	70	0.19
	Zone 3	259	85	0.23
	Total	583	190	0.52
Total Demands at Buildout	**Zone 1**	**1,133**	**370**	**1.01**
	Zone 2	**2,561**	**836**	**2.29**
	Zone 3	**4,532**	**1,480**	**4.05**
	Total	**8,225**	**2,686**	**7.36**

3.5 ADOPTED PEAKING FACTORS

Demand peaking factors are multiplication factors used to calculate water demands expected during high demand conditions. The most commonly used demand conditions for water supply and system evaluations include maximum day and peak hour demands. These demands are generally used to evaluate and size water transmission pipelines, pumping facilities and storage facilities, and to define water supply needs and capacity requirements.

Table 3-9 shows the historical average day and maximum day demand for the City's water system compiled from 2010 to 2015 production data. For this period, the maximum day demand peaking factor varies from 1.85 to 2.52, and averages 2.07. It was decided, based on discussions with City staff, to use an average day to maximum day demand factor of 2.07 for this Water Master Plan.

Table 3-9. Historical Maximum Day Peaking Factors[a]

Year	Average Day Demand, mgd	Maximum Day Demand, mgd	Peaking Factor[b]
2011	5.57	10.45	1.88
2012	5.89	10.89	1.85
2013	6.01	11.50	1.91
2014	4.52	10.00	2.21
2015	4.07	10.25	2.52
		Average	2.07

(a) All data from City's operational records.
(b) Maximum day peaking factor is the Maximum Day Demand divided by the Average Day Demand.

To evaluate hourly usage trends and peak hour usage, data from the Zone 7 turnouts was analyzed. This data was from 2005 through 2008, 2012, and 2013[3]. For each year, the data included hourly flow readings at each Zone 7 turnout, and was for the one-week period in which the maximum demand day for the Zone 7 system occurred.

The City frequently operates their system in a variety of ways, many of which entail intentionally relying on storage to supply peak demands in the City distribution system. The result of this is that the sum of the flow rates through the Zone 7 turnouts at any point in time does not necessarily equal the total system demands at that same point in time. For a more accurate estimate of the system demands, the change in storage must be included. Therefore, the City provided Supervisory Control and Data Acquisition (SCADA) information for tank levels during the same weeks for which the hourly information for the Zone 7 turnouts was available. However, only data for the weeks in 2012 and 2013 was available.

Using these two sets of information, West Yost constructed diurnal demand curves for the days in 2012 and 2013 on which the peak Zone 7 demands occurred. For each year, one curve was developed for the Zone 1 Water Service Area, where recycled water is used, and another curve was developed for the Zone 2 and 3 Water Service Areas, where recycled water is not available. The curves were normalized by dividing the computed hourly flow by the average daily flow, representing the ratio of the hourly flow to the average daily flow. The data for the Zone 1 Water Service Area in 2013 appeared to show unreasonable changes in demand throughout the day, resulting in peaking factors that are higher than expected, especially for an area where much of the peak irrigation demands are supplied by recycled water. Therefore, the 2012 data was used to determine appropriate peak hour peaking factors as follows:

- For the Zone 1 Water Service Area, the peak usage occurs at 3:00 AM and is 1.56 times the average usage for that maximum demand day.

[3] Data for 2009 through 2011 was excluded from the evaluation due to the economic downturn, and data for 2014 and 2015 was excluded from the evaluation due to drought conditions.

- For the Zone 2 and 3 Water Service Areas, the peak usage occurs at 6:00 AM and is 1.96 times the average usage for that maximum demand day.

Figure 3-6 shows the computed hourly diurnal curve for the Zone 7 maximum demand day for 2012. These peak hour peaking factors were selected for use in this Water Master Plan for the evaluation and sizing of water system facilities, and are summarized in Table 3-10.

Table 3-10. Adopted Peaking Factors

Demand Condition/Water Service Area Zone	Peaking Factor
Average Day to Maximum Day Demand (for all Water Service Area Zones)	2.07
Maximum Day to Peak Hour Demand for Zone 1 Water Service Area	1.56
Maximum Day to Peak Hour Demand for Zone 2 & 3 Water Service Areas	1.96

Figure 3-1. Historical Annual Water Production (2010-2015)

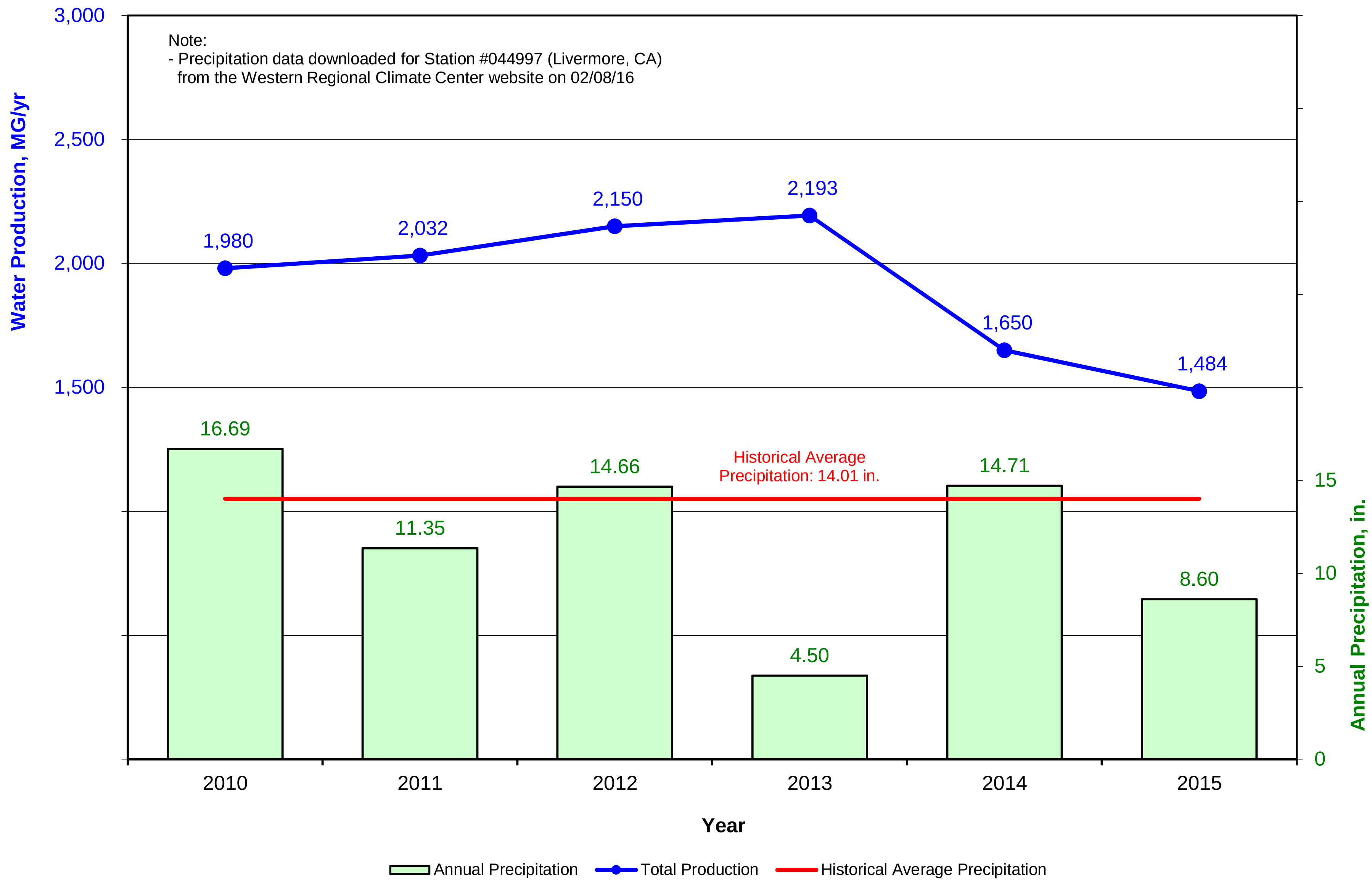

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Figure 3-2. Historical Monthly Water Production (2010-2015)

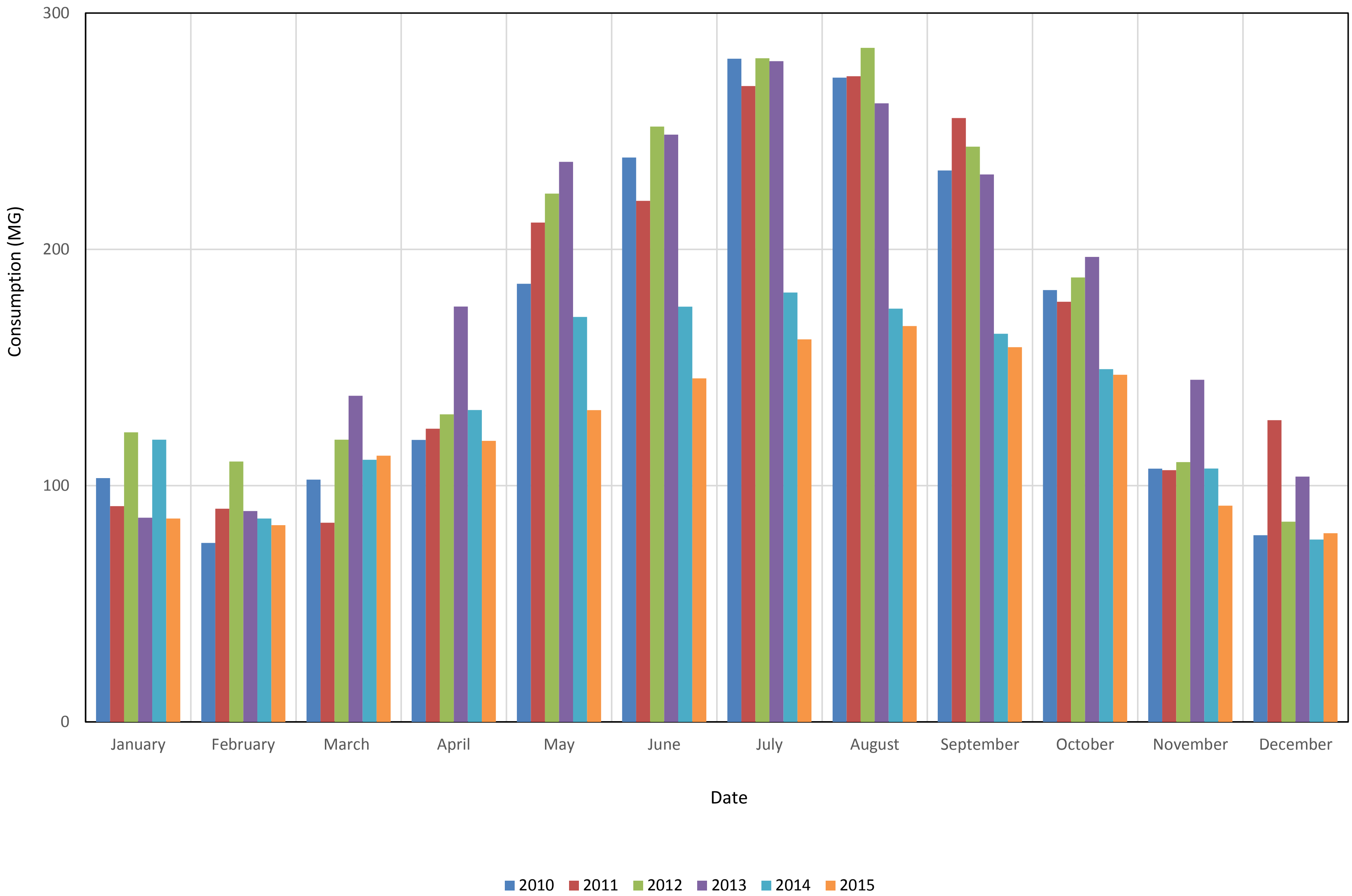

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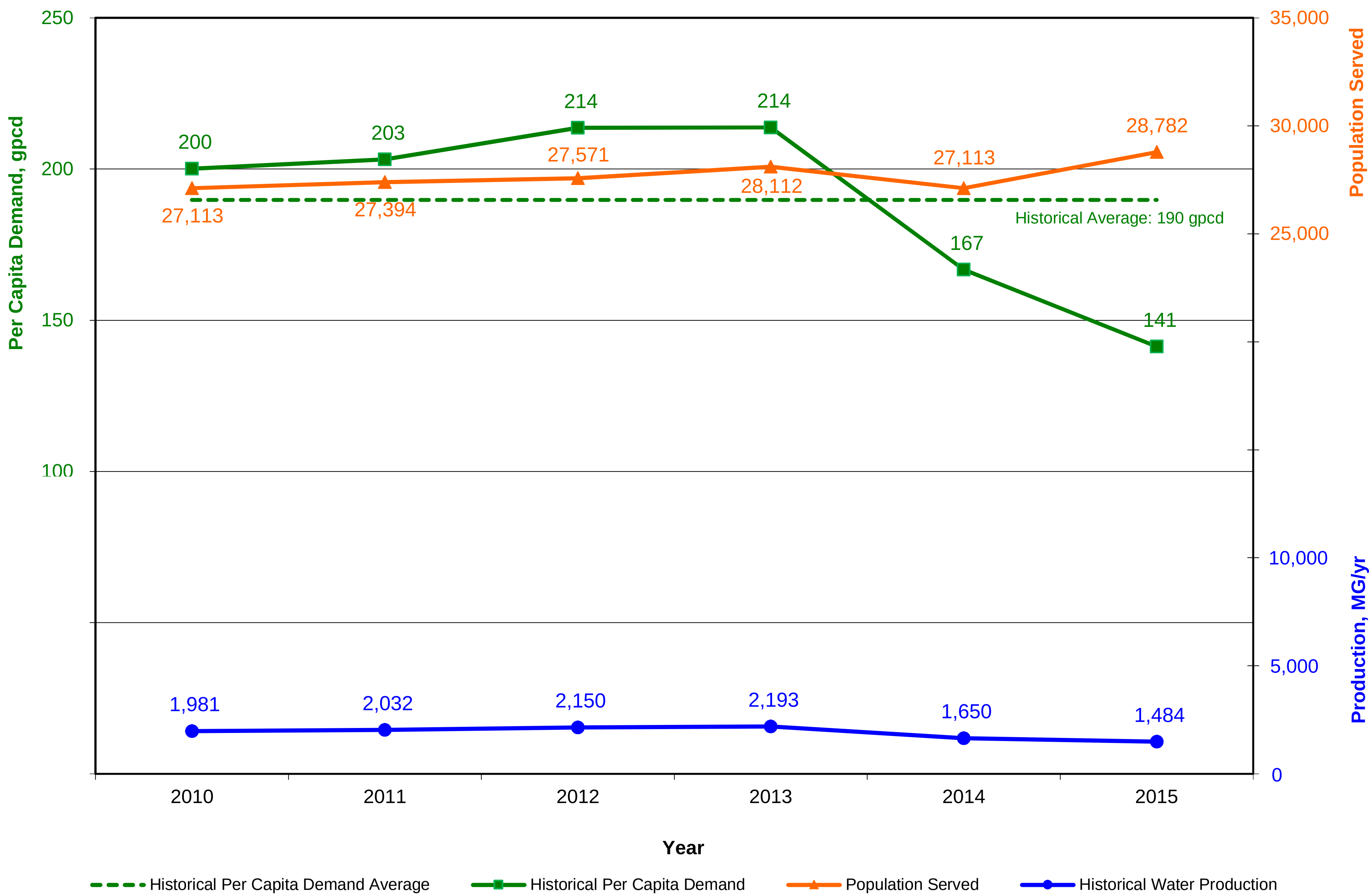
Figure 3-3. Comparison of Historical Per Capita Water Demand, Production and Population



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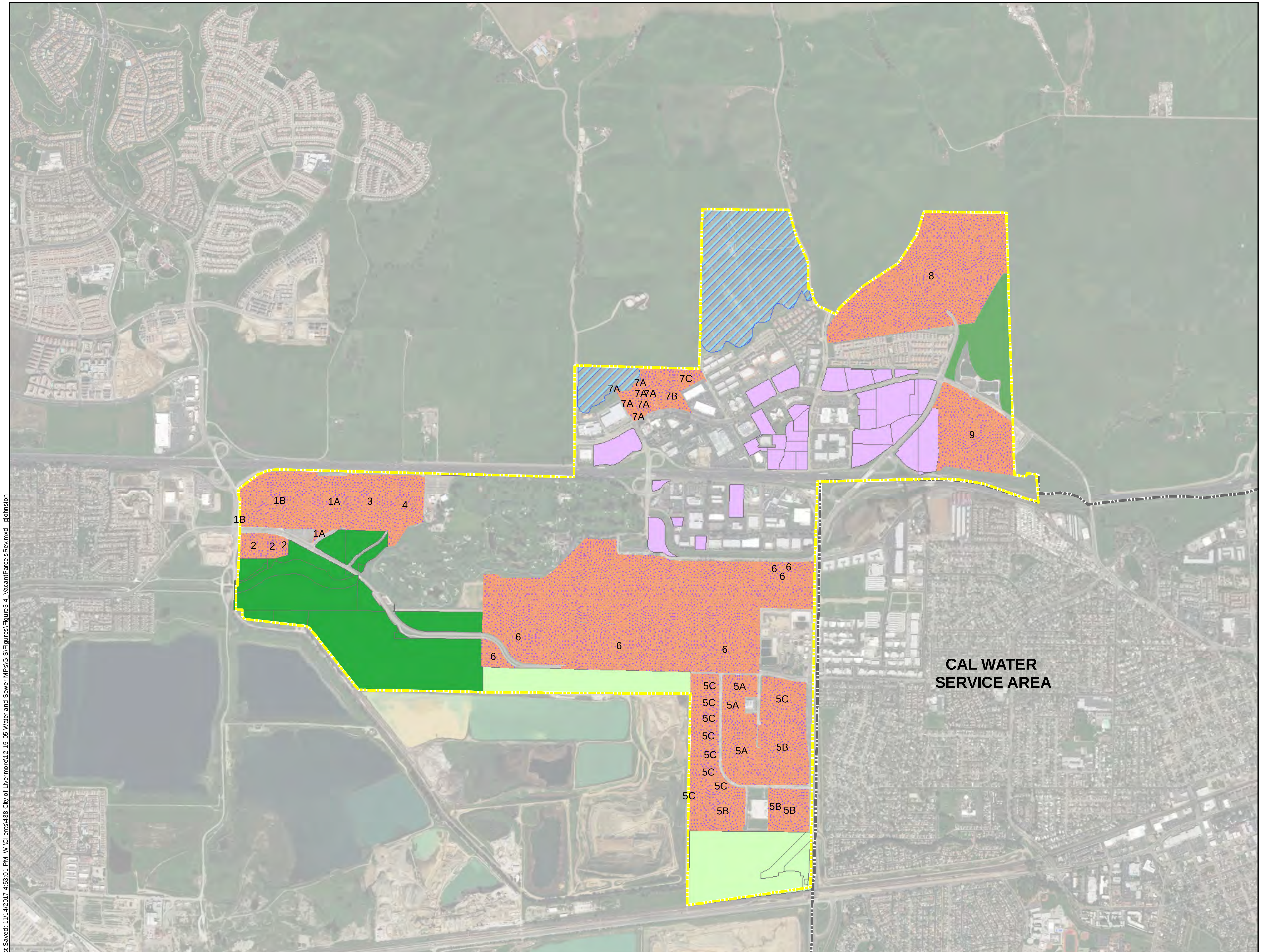

N

0 1,000 2,000

Scale in Feet

Symbology

California Water Service Company

Zone 1 Water Service Boundary

Water Well Supply (Note 4)

Reasonably Foreseeable Development Projects (Notes 1 & 2)

Reasonably Foreseeable Development Projects

Vacant Parcels (Note 3)

Business and Commercial Park (BCP)

Parks, Trailways, Recreation Areas (OSP)

Limited Agriculture (LDAG)

Hillside Conservation (HLCN)

Notes:
1. Refer to Table 3-6 for corresponding water demand assumptions for reasonably foreseeable development projects.
2. Developed parcels with a reasonably foreseeable development project number reflect a change in water demand in the future. See Table 3-6.
3. Refer to Table 3-7 for corresponding water demand assumptions for vacant parcels.
4. Water not supplied by City.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 3-4

Planning and Vacant Parcels - Zone 1 Water Service Area

City of Livermore
Water Master Plan

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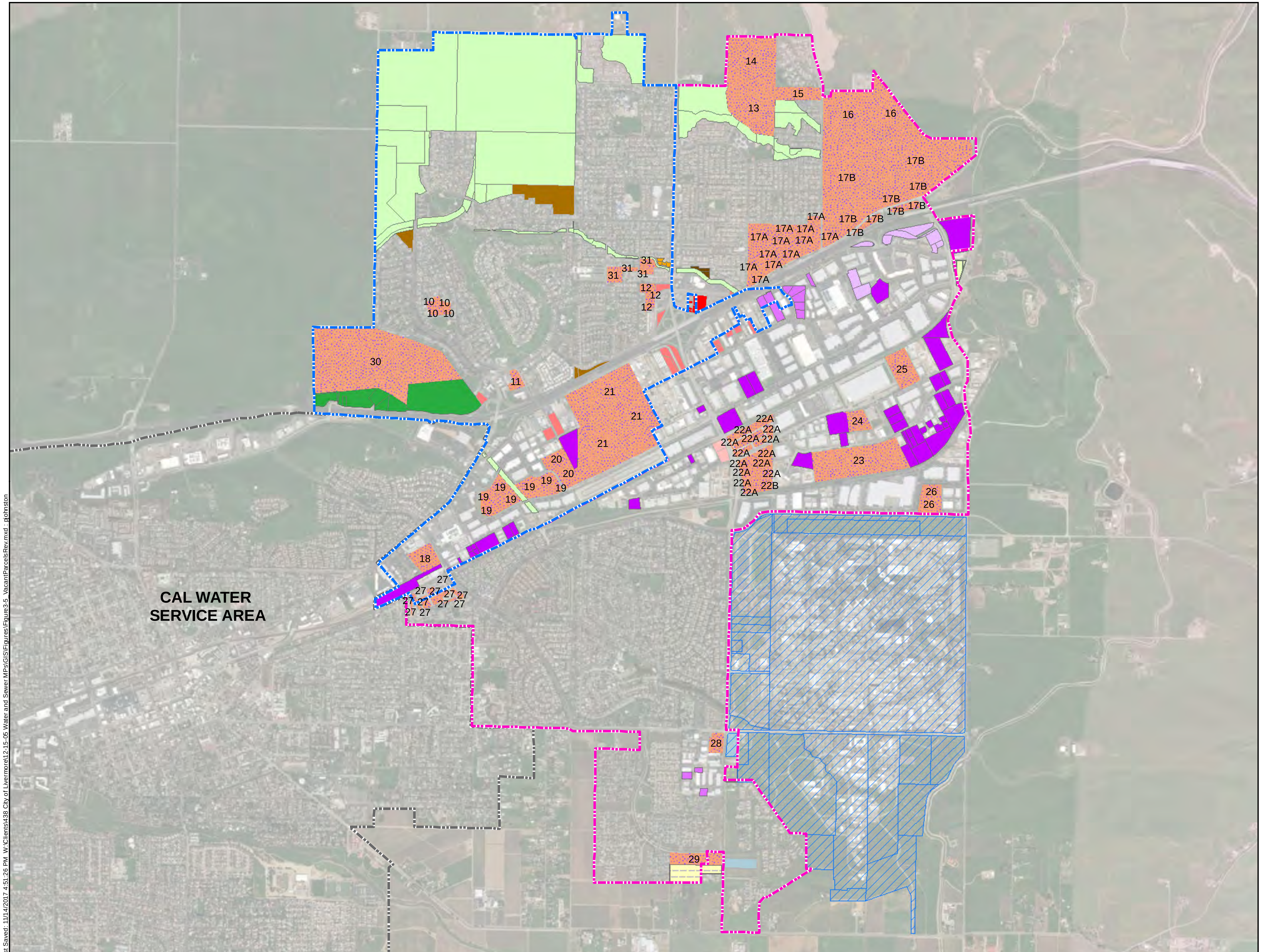

0 1,000 2,000
Scale in Feet

Symbology

Zone

- Zone 2 Water Service Boundary
- Zone 3 Water Service Boundary
- California Water Service Company
- Lawrence Livermore & Sandia National Labs (Note 4)

Reasonably Forseeable Development Projects (Notes 1 & 2)

- Reasonably Forseeable Development Projects

Vacant Parcels (Note 3)

- Urban Medium Residential (UM)
- Urban Medium High Residential (UMH)
- Urban High Residential (UH-4)
- Neighborhood Commercial (NC)
- Service Commercial (SC)
- Highway Commercial (HC)
- Business and Commercial Park (BCP)
- Low Intensity Industrial (LII)
- High Intensity Industrial (HII)
- Elementary School (CF-E)
- Research and Development (CF-R&D)
- Parks, Trailways, Recreation Areas (OSP)
- Limited Agriculture (LDAG)
- Agriculture/Viticulture (AGVT)
- Large Parcel Agriculture (LPA)
- Residential Development Area (SV-RDA)

Notes:
1. Refer to Table 3-6 for corresponding water demand assumptions for reasonably forseeable development projects.
2. Developed parcels with a reasonably foreseeable development project number reflect a change in water demand in the future. See Table 3-6.
3. Refer to Table 3-7 for corresponding water demand assumptions for vacant parcels.
4. Water not supplied by City.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 3-5

Planning and Vacant Parcels - Zone 2 and 3 Water Service Areas

City of Livermore
Water Master Plan

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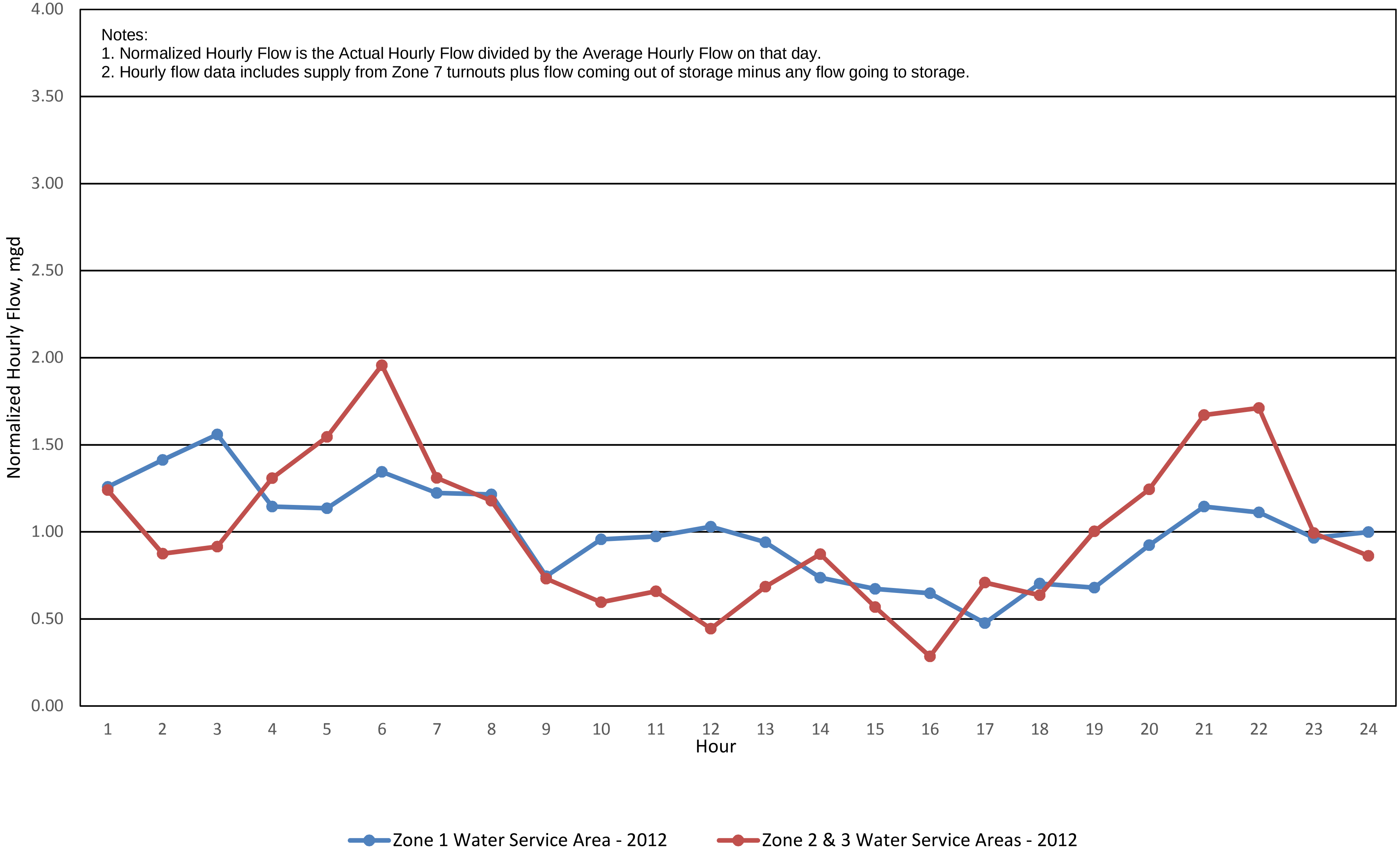
Figure 3-6. 2012 Diurnal Patterns on the Maximum Demand Day



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The purpose of this chapter is to define the recommended water system planning and performance criteria to be used for evaluating the required capacity and performance of the City's potable water system. Key water system planning and performance criteria from the City's 2004 Water Master Plan have been reviewed and incorporated into this chapter as applicable.

4.1 NEED FOR WATER SYSTEM PLANNING AND DESIGN CRITERIA

Establishment of water system planning and design criteria serves two key purposes:

- To provide guidelines for evaluating the capability and reliability of existing system facilities; and
- To provide guidelines for the sizing of new water system facilities to meet projected demands for new or proposed development projects.

Potable water system facilities located within the City's water service area should meet the recommended water system service and performance standards (e.g., minimum and maximum system pressures) discussed in the following sections and as summarized in Table 4-1. Adherence with these planning and design criteria improves system and facility reliability and improves water quality.

Potable water system reliability is achieved through a number of water system features including:

- Appropriately sized pumping, storage and pipeline facilities;
- Looped distribution systems;
- Redundant or "firm" pumping facilities;
- Alternate or backup power supplies for pump stations to keep facilities operational in the event of a power outage; and
- Proper valve placement to allow for water system isolation to maintain reliable and flexible system operation under normal and abnormal operating conditions.

Water system reliability and water quality are also improved by designing looped water distribution pipeline system configurations and avoiding dead-end distribution mains whenever possible. Looping pipeline configurations provide increased reliability for the City's potable water supply system, and reduce the potential for stagnant water and associated taste and odor problems, and low disinfectant residuals.

As a water purveyor, the City is responsible for ensuring that the applicable water quality standards and regulations are met at all times. The U.S. Environmental Protection Agency (USEPA) and the California SWRCB Division of Drinking Water (DDW) are the agencies responsible for establishing water quality standards for drinking water. The USEPA and the SWRCB prescribe regulations that limit the amount of certain constituents and contaminants in water provided by a public water system.

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Table 4-1. Summary of Recommended Water System Service and Performance Standards

Component	Criteria	Note(s)
POTABLE WATER SYSTEM PERFORMANCE		
Fire Flow Requirements [(a,b,c)]		
BART	5,000 gpm @ 5 hours	These are general requirements for master planning purposes, and may not be indicative of requirements for specific developments or buildings. Fire flow requirements and design of fire suppression systems for specific buildings and proposed development should be evaluated on a case-by-case basis.
Heavy Industrial (Zone 2 & 3 Water Service Area)		
Light Industrial (Zone 1 Water Service Area)	4,000 gpm @ 4 hours	
Commercial	3,500 gpm @ 3 hours	
Mixed-Use		
Business and Commercial Park (BCP)		
Community	2,500 gpm @ 2 hours	
Urban High Residential #1 (UH-1)		
Urban High Residential #2 (UH-2)		
Urban High Residential #3 (UH-3)		
Urban High Residential #4 (UH-4)		
South Valley (SV)	1,500 gpm @ 2 hours	
Urban Low Medium Residential (ULM)		
Urban Low Residential #1 (UL-1)		
Urban Low Residential #2 (UL-2)		
Urban Medium Residential (UM)		
Urban Medium High Residential (UMH)		
Peak Supply Capacity		
Normal Operating Conditions	Provide firm supply capacity equal to maximum day demand; meet peak hour demand from a combination of supply sources and storage.	Although storage varies daily and seasonally, for conservative planning purposes, it is assumed that storage reservoirs are 75 percent full at the start of hydraulic evaluations.
Fire Flow Conditions	Meet maximum day demand plus fire flow from a combination of supply sources and storage.	Although storage varies daily and seasonally, for conservative planning purposes, it is assumed that storage reservoirs are 50 percent full at the start of hydraulic evaluations.
Distribution System Pressures		
Minimum Pressure - Normal Operating Conditions	35 psi at customer service connection @ Peak Hour Demand	
Minimum Pressure - Fire Flow Conditions	20 psi	
Maximum Pressure	100 psi	Customers outside of normal service elevations may experience higher pressures. Per Plumbing Code, new services with pressure greater than 80 psi require an individual pressure regulating device.
POTABLE WATER FACILITIES SIZING		
Pumping Facility Capacity		
Pumping Capacity	For pump stations serving pressure zones that are hydraulically connected to storage tanks, firm pumping capacity shall meet the maximum day demand. Peak pumping capacity (with all pumps operating at the same time) shall be capable of refilling fire storage within a 24-hour period with maximum day demands. For pump stations serving pressure zones with no storage, firm capacity shall meet peak hour demand and maximum day demand plus fire flow.	Firm pumping capacity defined as the total capacity of all operational pumps minus the capacity of the largest pumping unit.
Backup Power	Equal to the firm capacity of the pumping facility.	
Water Storage Capacity		
Operational Storage	25 percent of the maximum day demand	This volume is needed to equalize the demand fluctuations on maximum demand days.
Fire Storage	Fire flow demand for the most severe fire flow requirement in the water service area zone multiplied by the recommended fire flow duration.	This volume is needed to fight a fire even if the pumping facilities or turnouts are not operational.
Emergency Storage	50 percent of the maximum day demand	Emergency storage is needed in emergency conditions such as power outages and unforeseen interruptions in supply such as earthquakes.
Total Water Storage Capacity	Operational Storage + Fire Storage + Emergency Storage	
Pressure Regulating Station Capacity		
Valve Capacity	For pressure zones with dedicated storage (operational, emergency and fire), valve capacity must meet maximum day demand. For pressure zones with no dedicated storage (i.e., flow from storage must go through a PRV), valve capacity must meet peak hour demand and maximum day demand plus fire flow.	These criteria are based on valve capacity for each pressure zone, rather than for each water service area zone.
Water Transmission and Distribution Pipelines		
Minimum Pipeline Diameter	8-inch	Criteria based on requirements for sizing new pipelines to serve new development. Evaluation of existing pipelines to be on a case-by-case basis, based on age, material type, velocity, head loss and pressure. Locate new transmission/distribution pipelines within designated utility corridors wherever possible.
Maximum Velocity - Normal Operating Conditions	5 ft/s for pipelines greater than 12-inch diameter 8 ft/s for pipelines less than or equal to 12-inch diameter	
Maximum Velocity - Fire Flow Conditions	12 ft/s	
Maximum Head Loss - Normal Operating	5 ft/1,000 ft	
Maximum Head Loss - Fire Flow Conditions	10 ft/1,000 ft	
Hazen Williams "C" Factor for new pipelines	120 for Ductile Iron (DIP) 120 for Mortar-lined and Mortar-coated Steel (MLCSP) 130 for Polyvinyl Chloride (PVC)	For consistency in hydraulic modeling.
Pipeline Material for Recommended New Pipelines[(d)]	Greater than 12-inch diameter: Polyvinyl Chloride (PVC) pressure pipe (Mortar-lined and Mortar-coated Steel MLCSP), or Ductile Iron (DIP) Less than or equal to 12-inch diameter: Polyvinyl Chloride (PVC) pressure pipe, or Ductile Iron (DIP)	For consistency in hydraulic modeling.

(a) As established for the City of Livermore 2004 Water Master Plan (Table 4-7) by the Livermore-Pleasanton Fire Department based on the guidelines developed by National Insurance Underwriters Association – Insurance Service Office (ISO).

(b) Unique projects or projects with alternate materials may require higher fire flows and should be reviewed by the Fire Marshal on a case-by-case basis (e.g., proposed commercial/industrial areas and schools).

(c) Average spacing between fire hydrants shall be between 200 to 500 feet as determined by the recommended fire flow requirements and shall not exceed values listed in Table C105.1 of the 2013 California Fire Code.

(d) Pipeline material for recommended new pipelines based on City of Livermore Standard Detail No. G-4A Schedule of Acceptable Pipe Materials (dated May 2013).

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4.2 OPERATIONAL CONDITIONS

Maximum day demand, maximum day demand plus fire flow and peak hour demand conditions are used to assess the adequacy of the City's potable water system facilities and transmission/distribution pipelines. The following sections discuss the assumptions and recommended performance standards for different water system operating conditions.

4.2.1 Maximum Day and Peak Hour Demand -- Normal Operation

Generally, in accordance with California Title 22 requirements and typical potable water system demand criteria, the City's potable water system should have the capability to meet the average demand during a maximum day demand condition without using storage. Peak hour demand during a maximum day demand condition will be assumed to be met from a combination of supply sources (i.e., water supplied from Zone 7 and delivered via pump stations, and water stored in storage tanks). Although the quantity of water in storage varies daily and seasonally, for conservative hydraulic modeling purposes, it is assumed that storage reservoirs are 75 percent full at the start of the hydraulic evaluation.

Evaluations of maximum day demand and peak hour demand conditions will be conducted assuming the largest pump unit at each pump station is in standby mode (i.e., firm pumping capacity). This assumption ensures the reliability and flexibility of the City's potable water system to provide sufficient supply.

4.2.2 Fire Flow Conditions

This Water Master Plan evaluates available fire flows (to assess distribution system adequacy under current and future water demand conditions) by using general land use categories that represent different types of development. It should be noted that the fire flow requirements set forth in this Water Master Plan are intended only for general planning purposes, and may not be reflective of the actual fire flow requirements required by a specific development's size and construction type in accordance with the California Fire Code requirements, and will not identify specific existing non-conforming developments.

The recommended requirements for the Water Master Plan fire flow evaluation are based on general land use designations and values presented in the City's 2004 Water Master Plan which were determined by the Livermore-Pleasanton Fire Department based on National Insurance Underwriters Association – Insurance Service Office (ISO) guidelines. Minimum fire flow requirements (in gallons per minute (gpm)) and their required durations are listed in Table 4-1.

Fire flows are to be met concurrently with a maximum day demand condition while maintaining a minimum residual system pressure of 20 pounds per square inch (psi). These fire flow requirements will be used for the evaluation of the City's potable water system under existing and future water demand conditions. The recommended fire flow criteria are used to determine the appropriate sizing of pipelines to meet current and future water system requirements.

Per typical industry standards, the City's potable water system should have the capability to meet a demand condition equal to the occurrence of a maximum day demand concurrent with a single fire flow event while meeting the recommended transmission and distribution pipeline sizing system performance standards discussed in Section 4.5 below.

Additionally, the recommended fire flows and their expected duration are used to establish the required fire flow storage. Maximum day demand plus fire flow will be met by a combination of supply capacity and storage. For planning purposes, it is assumed that storage reservoirs are 50 percent full at the start of the hydraulic evaluation. Assumptions regarding firm pumping capacity will also apply during a maximum day plus fire flow demand condition.

4.3 PUMPING CAPACITY

Sufficient water system pumping capacity should be provided to meet the following conditions within the potable water system:

- For pump stations serving pressure zones that are hydraulically connected to storage tanks, firm pumping capacity shall meet the maximum day demand and peak pumping capacity (assuming all pumps are on-line) shall be capable of refilling fire storage within a 24-hour period with maximum day demands.
- For pump stations serving pressure zones with no storage, firm pumping capacity shall meet peak hour demand and maximum day demand plus fire flow.

All pump stations should also be equipped with an on-site emergency generator, or, at a minimum, should be equipped with a plug-in adapter to allow for interconnection to a portable generator, which could be brought to the site by City staff as needed during a prolonged power outage.

4.4 RESERVOIR STORAGE CAPACITY

The total potable water storage capacity requirement will be calculated based on the sum of the following three components:

- Operational Storage: Volume of water necessary to meet diurnal peaks observed throughout the day, equal to 25 percent of the maximum day demand;
- Fire Storage: Volume of water necessary to supply a single fire flow event; and
- Emergency Storage: Volume of water necessary to provide emergency supply, assumed to be equivalent to 50 percent of the maximum day demand.

Each of these storage components is discussed below. The recommended water storage capacity for the City's potable water system will be evaluated by water service area zone. For water service area zones that have more than one storage tank, the combined storage volume will be used.

4.4.1 Operational Storage Volume

Typically, operational storage is used to meet the peak hour demands and to meet water demands that exceed the available pump station and/or pressure regulating station supply to the pressure zone. Operational storage is typically replenished during hours when actual demand is less than the water supply available to the pressure zone. Supply is typically provided at a rate equal to the maximum day demand.

The City's 2004 Water Master Plan assumed that the operational storage volume equals 50 percent of the maximum day demand within the tank's service area. This value is quite high. AWWA guidelines for operational storage volume recommend a smaller amount of operational storage, ranging from 15 to about 30 percent of maximum day demand[1]. As described below, many water agencies assume that the operational storage volume is 25 percent of maximum day demand.

West Yost evaluated the City's maximum day diurnal demand patterns for the Zone 1 and Zone 2/3 water service areas for 2012 and 2013 and found that the amount of demand that would need to come out of storage to meet peak demands on the maximum demand day ranged from 11 to 19 percent of the maximum day demand. These amounts are consistent with the AWWA storage guidelines and other agencies' storage volume criteria. As such, for this Water Master Plan, it is recommended that the City's operational storage volume criteria be decreased from 50 percent of the maximum day demand to 25 percent of the maximum day demand.

4.4.2 Fire Storage Volume

Fire storage is the volume of storage water reserved for fire flows. The fire storage volume is determined by multiplying the required maximum fire flow rate by the required duration time as described in Section 4.2.2 and shown in Table 4-1. As noted above, and consistent with the 2004 Water Master Plan requirements for the storage evaluation, it is assumed that no more than one fire flow event would occur in any water service area zone at one time.

4.4.3 Emergency Storage Volume

A reserve of stored water is also required to meet demands during an emergency. An emergency is defined as an unforeseen or unplanned event that may degrade the quality or quantity of potable water supplies available to serve customers. The three types of emergency events that a water utility typically prepares for are as follows:

- Minor Emergency. A fairly routine, normal, or localized event that affects a few customers, such as a distribution or service pipeline break, malfunctioning valve, hydrant break, or a brief power loss. Utilities plan for minor emergencies and typically have staff and materials on-hand and available to mitigate these minor emergencies.

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[1] *AWWA Manual M32, Distribution Network Analysis for Water Utilities* (AWWA, 2012) (page 116) states that for large systems, the equalizing storage requirement is typically 15 to 20 percent of the total maximum day demand over a 24-hour period, but equalizing storage could exceed 30 percent for small service areas or arid climates (page 116). The *AWWA Water Distribution Systems Handbook*, (AWWA, 2000) (Section 3.2.2.2 Storage) states that the volume of operational storage required is a function of the diurnal demand fluctuation in a community and is commonly estimated at 25 percent of the total maximum day demand.

- Major Emergency. A disaster that affects an entire, and/or large portion of a water system, lowers the quantity and quality of the water, or places the health and safety of the community at risk. Examples include water treatment plant failures, raw water contamination or major power grid outages. Water utilities seldom experience major emergencies.
- Natural Disaster. A disaster caused by natural forces or events that create a major water utility emergency. Examples include earthquakes, forest or brush fires, hurricanes, tornados or high winds, floods, and other severe weather conditions such as freezing or drought that damage or cause water system facilities to not be able to operate.

Determination of the required volume of emergency storage is a policy decision based on the assessment of the risk of failures, the desired degree of system reliability, the time for staff to repair damaged infrastructure or facilities and water quality concerns. The amount of required emergency storage is a function of several factors including the diversity of the supply sources, redundancy and reliability of the production facilities, and the anticipated length of the emergency outage. AWWA states that no formula exists for determining the amount of emergency storage required, and that the decision will be made by the individual utility based on a judgment about the perceived vulnerability of the system.

The emergency storage volume for the City is assumed to be equal to 50 percent of the maximum day demand. This is the emergency storage volume criteria utilized in the City's 2004 Water Master Plan, and, as described below, is consistent with emergency storage volumes assumed by other water agencies.

4.4.4 Storage Volume Criteria Comparison with Other Agencies

A comparison of the recommended storage volume criteria with other agencies' criteria is provided in Table 4-2. As shown, the City's storage volume criteria are generally consistent with storage volume criteria utilized by other water agencies.

Table 4-2. Comparison of Potable Water Storage Volume Criteria for Various Water Agencies

	Operational Storage Volume	Fire Flow Storage Volume	Emergency Storage Volume
California Water Service Company (Livermore District and Stockton District)	25% of Maximum Day Demand	As needed based on required fire flows and durations for various land use categories and development/ building types in accordance with the California Fire Code	Average Day Demand
City of Pleasanton	25% of Maximum Day Demand		50% of Maximum Day Demand
Dublin San Ramon Services District	25% of Maximum Day Demand		50% of Maximum Day Demand
City of Stockton	25% of Maximum Day Demand		Average Day Demand
City of Tracy	30% of Maximum Day Demand		2 times the Average Day Demand
Contra Costa Water District	25% of Maximum Day Demand		75% of Maximum Day Demand
City of Livermore	**25% of Maximum Day Demand [(a)]**		**50% of Maximum Day Demand**

(a) For this Water Master Plan, the City's Operational Storage volume criteria has been reduced from 50% of Maximum Day Demand (used in City's 2004 Water Master Plan) to 25% of Maximum Day Demand as discussed above in Section 4.4.1.

4.5 TRANSMISSION AND DISTRIBUTION PIPELINE SIZING

The following criteria will be used as guidelines for sizing potable transmission and distribution system pipelines. Although these criteria and guidelines have been established, and will be used to size new pipelines, the City's existing potable water system will be evaluated using system pressure as the primary criterion. Secondary criteria (such as pipeline velocity, head loss, age, and material type) are also used as indicators to locate and help prioritize where potable water system improvements may be needed. Therefore, the City's existing potable water system will be evaluated on a case-by-case basis. For example, if an existing pipeline experiences velocity or head loss in excess of the criteria described below, this condition, by itself, does not necessarily indicate a problem as long as the minimum system pressure criterion is satisfied. Other conditions such as pipeline age, material type, location and criticality in the system will also be considered.

4.5.1 General Definitions and Standards

The following summarizes the general definitions and City standards for transmission and distribution pipelines:

- New pipelines should a have a minimum diameter of 8 inches, unless specifically reviewed and approved by the City.
- All new pipelines less than or equal to 12-inches in diameter are required to be either PVC pressure pipe or ductile iron pipe.

- All new pipelines larger than 12-inches in diameter are required to be PVC pressure pipe, mortar-line and mortar-coated steel pipe or ductile iron pipe.
- New pipelines should be located within designated utility corridors within public rights-of-way, wherever possible, to minimize or eliminate the need for utility easements over private property.
- Hazen Williams coefficient ("C" factor) shall be assumed equal to 120 for ductile iron pipe and mortar-lined and mortar-coated steel pipe, and 130 for PVC pipe.

4.5.2 Pressure Criteria

Adequate system pressure is a basic indicator of acceptable water distribution system performance. The recommended performance standards for potable water system pressures are:

- Allowable Pressures Under Normal Operating Conditions: 35 psi to 100 psi[2,3]
- Minimum Pressure under Peak Hour Demand: 35 psi
- Minimum System Pressure Under Fire Flow Conditions: 20 psi

These performance standards are applied to all areas that fall within the normal customer service elevation ranges for each pressure zone. Individual services that exceed 80 psi must have an individual pressure regulating device installed on the service line per the California Plumbing Code.

4.5.3 Velocity Criteria

For planning purposes, West Yost recommends the following velocity criteria for water transmission and distribution system pipelines:

- Maximum velocity of 5 feet per second (ft/s) during normal operating conditions in transmission pipelines, defined as greater than 12-inch diameter;
- Maximum velocity of 8 ft/s during normal operating conditions in distribution pipelines, defined as 12-inch diameter or less; and
- Maximum velocity of 12 ft/s during fire flow conditions.

These criteria are primarily used for sizing new transmission and distribution system pipeline facilities. Existing water system pipelines are evaluated on a case-by-case basis, and pipeline velocity criteria are not typically used to identify existing deficient facilities.

[2] Based on minimum and maximum pressure criteria from the City's 2004 Water Master Plan.

[3] Individual services that exceed 80 psi must have an individual pressure regulating device installed on the service line per the California Plumbing Code.

4.5.4 Head Loss Criteria

For planning purposes, West Yost recommends the following head loss criteria for water transmission and distribution system pipelines:

- Maximum head loss of 5 ft/1,000 feet per thousand feet (ft/kft) during normal operating conditions.
- Maximum head loss of 10 ft/1,000 feet per thousand feet (ft/kft) during fire flow conditions.

Similar to the velocity criteria, these criteria are primarily used for sizing new transmission and distribution system pipeline facilities. Existing water system pipelines are evaluated on a case-by-case basis, and head loss criteria are not typically used to identify existing deficient facilities.

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CHAPTER 5
Existing Water System Evaluation

This chapter presents the evaluation of the City's existing water distribution system and its ability to meet the City's recommended planning and design criteria under existing water demand conditions. The existing water system evaluation includes both system capacity and performance evaluations. The system capacity evaluation includes an analysis of pumping, water storage, and pressure regulating station capacity. The system performance evaluation assesses the existing water system's ability to meet recommended planning and design criteria under demand conditions. West Yost conducted the system performance evaluation using the hydraulic model developed for this Water Master Plan, which is described in Appendix A Potable Water System Hydraulic Model Updates. The hydraulic model was used to perform static analyses of the City's existing water distribution system.

Evaluations, findings, and recommendations for addressing any deficiencies identified in the existing water distribution system are included in this chapter. Recommendations are used to develop a Capital Improvement Program (CIP), which includes an estimate of probable construction costs. The recommended CIP is described further in Chapter 7.

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

- Existing Water Demands by Pressure Zone
- Zone 7 Supply Pressures
- Existing Water System Facility Capacity Evaluation
- Existing Water System Performance Evaluation
- Summary of Findings and Recommended Improvements for the Existing Water System

5.1 EXISTING WATER DEMANDS BY PRESSURE ZONE

The water demands used for the existing water system evaluation by pressure zone are summarized in Table 5-1. The existing water demands for the City's water system were first spatially located in the hydraulic model using the water meter data averaged from 2015. These average demands were then scaled to capture non-revenue water, and then scaled again to represent the expected rebounded demands after the current drought has ended, as described in Chapter 3. Maximum day and peak hour demands were subsequently estimated based on the adopted peaking factors (see Chapter 3 for more detail).

Table 5-1. Water Demands for the Existing Water System Evaluation

Pressure Zone	Average Day Demand[a]		Maximum Day Demand[b]		Peak Hour Demand[c]	
	gpm	mgd	gpm	mgd	gpm	mgd
Zone 1 Water Service Area						
605	30	0.04	61	0.09	95	0.14
638	80	0.12	166	0.24	260	0.37
664	260	0.37	539	0.78	841	1.21
719	30	0.04	61	0.09	96	0.14
Zone 1 Total	400	0.58	828	1.19	1,292	1.86
Zone 2 Water Service Area						
670	1,070	1.54	2,214	3.19	4,340	6.25
Zone 2 Total	1,070	1.54	2,214	3.19	4,340	6.25
Zone 3 Water Service Area						
725	1,178	1.70	2,439	3.51	4,780	6.88
740[d]	11	0.02	22	0.03	43	0.06
741	42	0.06	86	0.12	169	0.24
744	145	0.21	300	0.43	588	0.85
800	941	1.35	1,947	2.80	3,817	5.50
875	43	0.06	90	0.13	176	0.25
Zone 3 Total	2,359	3.40	4,884	7.03	9,572	13.78
Zone 1, 2, & 3 Total	**3,829**	**5.51**	**7,926**	**11.41**	**15,203**	**21.89**

[a] Average day demand is based on detailed billing records adjusted to reflect rebound from conservation. Billing records from 2015 were spatially located, scaled for non-revenue water, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Maximum day demand calculated using a peaking factor of 2.07 times the average day demand.

[c] Peak hour demand calculated using a peaking factor of 1.56 times the maximum day demand for the Zone 1 Water Service Area and 1.96 for the Zone 2 and 3 Water Service Areas.

[d] Pressure Zone 740 is physically located in the Zone 2 Water Service Area, but operationally is supplied from the Zone 3 Water Service Area and is included in the Zone 3 Water Service Area storage evaluation.

5.2 ZONE 7 SUPPLY PRESSURES

The City receives its supply from Zone 7 through nine turnouts, although only seven turnouts are active. The pressure in the Zone 7 system varies throughout the course of the day, and can vary seasonally, depending on how Zone 7 is operating their system. The hydraulic model of the Zone 7 system was used to obtain a range of pressures at each of the turnouts to the Livermore system. These values are summarized in Table 5-2. For existing conditions, the Zone 7 hydraulic model has two scenarios, one for "normal supply" and one for "surface water limited". From discussions with Zone 7, the "normal supply" scenario is appropriate for the vast majority of conditions. "Surface water limited" refers to conditions where the Zone 7 Del Valle Water Treatment Plant is off-line, with the Patterson Pass Water Treatment Plant supplying higher pressure to the Zone 7 transmission system, resulting in higher pressures at the Livermore turnouts. As the "surface water limited" conditions rarely occur, it was not included in this analysis.

Table 5-2. Zone 7 Turnout Pressures

Turnout	Existing Demand Conditions				Future Demand Conditions		Elevation, ft
	Normal Supply		Surface Water Limited		Normal Supply		
	Minimum Pressure, psi	Maximum Pressure, psi	Minimum Pressure, psi	Maximum Pressure, psi	Minimum Pressure, psi	Maximum Pressure, psi	
LIV 1	51	62	72	76	46	61	526
LIV 3	41	56	64	70	41	58	538
LIV 5	83	102	96	102	71	81	400
LIV 6	33	60	72	80	46	68	519
LIV 8	35	57	67	74	44	61	530
LIV 9	91	112	107	113	81	90	377
LIV 10	4	7	4	7	3	5	669
LIV 11	98	124	121	126	92	101	350

Note: LIV 2 was not included in the Zone 7 model. Therefore, turnout pressures are not available.

The turnout pressures were used in the hydraulic model to provide input pressures at each turnout. The minimum values for the Existing Demand Conditions Normal Supply alternative were used for the existing system scenarios in the Livermore analysis. These were the lowest pressures for existing demand conditions, and are the most conservative. The minimum values for the Future Demand Conditions were used for the buildout scenarios in the Livermore analysis (described in Chapter 6).

It is important to note that many of the turnouts directly supply the City's pump stations that boost the pressure into the water distribution system and reservoirs. However, some turnouts have the ability to directly feed the City's water system depending on the available hydraulic grade line. In addition, the operational status of the turnouts is frequently changed based upon operational needs. As a result, there are several different configurations of how Zone 7 water supply can enter the City's water system. This Water Master Plan evaluated the more common operational scenarios as summarized in Section 5.4.

5.3 EXISTING WATER SYSTEM FACILITY CAPACITY EVALUATION

To evaluate the capacity of the City's existing water system facilities, the following analyses were conducted:

- Pumping Capacity Evaluation,
- Storage Capacity Evaluation, and
- Pressure Regulating Station Capacity Evaluation.

The results of the existing water system facility capacity evaluation are discussed below.

5.3.1 Pumping Capacity Evaluation

The pumping capacity in the City's existing water system was evaluated to assess its ability to deliver a reliable firm and total capacity to serve the existing water service area. Firm capacity assumes a reduction in total pumping capacity to account for pumps that are out of service at any given time due to mechanical breakdowns, maintenance or other operational issues. At each pump station, firm pumping capacity was defined as the total pump station capacity with the largest pump out of service.

It is important to note that this evaluation compares the nominal (i.e., nameplate) pumping capacity at each pump station with the respective pressure zone's water demand to determine adequacy of the pump stations. The hydraulic model was not used to conduct this evaluation. It is recommended that a future evaluation of each pump station be performed utilizing the hydraulic model and considering varying Zone 7 turnout pressure supply ranges, varying reservoir water levels, and modeled friction loss versus verified pump curves to determine actual operating firm capacity.

Consistent with Chapter 4, the Airway Pump Station shall have a firm pumping capacity that equals or exceeds the maximum day demand for the entire Zone 1 Water Service Area. Note this is a conservative assumption as some pressure zones within the Zone 1 Water Service Area can potentially be supplied directly from Zone 7 Turnouts 5 and 11 based on the available HGL. Additional flows needed for peak hour and fire flow demands are supplied by the Doolan Tank (and potentially Zone 7 Turnouts 5 and 11). The total pumping capacity of Airway Pump Station must equal or exceed the maximum day demand plus the flow required to refill the Doolan Tank fire storage volume within a 24-hour period.

For Zone 2 and 3 Water Service Areas, which are hydraulically connected, the various pump stations were evaluated as follows:

- Zone 2 Water Service Area Analysis – The Vasco Pump Station Low and Trevarno Pump Station serve the Zone 2 Water Service Area. The City has indicated that the Trevarno Pump Station is rarely used and therefore has been excluded from the capacity analysis. Therefore, the Vasco Pump Station Low firm capacity shall equal or exceed the maximum day demand for the entire Zone 2 Water Service Area. Note that this is a conservative assumption as some parts of Zone 2 Water Service Area can be supplied directly from Zone 7 Turnouts 1 and 8 depending on the available HGL or from the Zone 3 Water Service Area through PRVs. The additional flows needed for peak hour demand within the Zone 2 Water Service Area are supplied by the Dalton Tank (and potentially Zone 7 Turnouts 1 and 8 or Water Service Area Zone 3). The additional flows needed for fire flow within the Zone 2 Water Service Area are supplied by the Altamont Tanks located in the Zone 3 Water Service Area through PRVs. Since there is no fire storage volume within Zone 2 Water Service Area, there is no total pumping capacity requirement for Vasco Pump Station Low (refer to Section 5.3.2 for further discussion on fire storage).

- Zone 3 Water Service Area Analysis – The Altamont Pump Station and Vasco Pump Station High serve the Zone 3 Water Service Area. Combined, these pump stations should have a firm capacity that equals or exceeds the maximum day demand of the pressure zones within the Zone 3 Water Service Area. The additional flows needed for peak hour and fire flow within the Zone 3 Water Service Area are supplied by the Altamont Tanks. The total capacity of the pump stations combined shall equal or exceed the maximum day demand plus the flow required to refill the Altamont Tanks fire storage volume within a 24-hour period.

- Zone 2 and 3 Water Service Areas Analysis – Since it is possible to operate the Zone 2 and 3 Water Service Areas with just the Zone 3 Water Service Area pump stations operational, a capacity analysis of this scenario was also performed for conservative purposes. Under this scenario, the Altamont Pump Station and Vasco Pump Station High should have a combined firm capacity that equals or exceeds the maximum day demand of all the pressure zones within the Zone 2 and 3 Water Service Areas. The additional flows needed for peak hour and fire flow within the Zone 2 and 3 Water Service Areas are supplied by the Dalton Tank, Altamont Tanks, or Zone 7 Turnouts 1 and 8. The total capacity of the pump stations combined shall equal or exceed the maximum day demand plus the flow required to refill the Altamont Tanks fire storage volume within a 24-hour period.

- The Oakville Pump Station is located within the Zone 3 Water Service Area and serves as a booster pump station for Pressure Zone 875. This pressure zone has no storage so the firm pumping capacity must be equal to or exceed the peak hour demand. Since the pressure zone does not receive fire flow (fire flow in this area is provided by Pressure Zone 800), there is no total pump station capacity requirement.

Table 5-3 compares the existing firm and total pumping capacity of each pump station with the required firm and total pumping capacity for existing water demand conditions. The left-hand side of the table shows the water service area zones and the corresponding supported pressure zones, their associated water demand, and the pump stations serving each water service area zone. For example, the Airway Pump Station directly serves Pressure Zone 719, but must also have sufficient pumping capacity to supply Pressure Zones 605, 638 and 664 because they are supported by Pressure Zone 719. The right-hand side of the table shows the existing total and firm pumping capacity, the required total and firm pumping capacity based on the pumping capacity criterion, and the difference between the two.

Table 5-3. Comparison of Existing and Required Pumping Supply Capacity

Pressure Zone and Supported Upper Pressure Zones		Existing Maximum Day Demand, gpm	Pump Stations	Existing Pumping Capacity, gpm		Required Total Pumping Capacity, gpm[b]	Required Firm Pumping Capacity, gpm[c]	Total Pumping Capacity Surplus (Deficit), gpm	Firm Pumping Capacity Surplus (Deficit), gpm
				Total, gpm	Firm, gpm[a]				
Zone 1 Water Service Area Analysis									
Pressure Zone	*605*	*61*	Airway	2,208	1,472	1,495	828	713	644
	638	*166*							
	664	*539*							
	719	*61*							
Zone 1 Total		828							
Zone 2 Water Service Area Analysis									
Pressure Zone	*670*	*2,214*	~~Trevarno~~[e]	~~4,300~~	~~3,100~~	N/A	2,214	N/A	786
Zone 2 Total		2,214	Vasco/Springtown, Low	4,500	3,000				
Zone 3 Water Service Area Analysis									
Pressure Zone	*725*	*2,439*	Altamont	8,440	5,720	5,925	4,884	7,315	4,136
	740[d]	*22*							
	741	*86*							
	744	*300*							
	800	*1,947*	Vasco/Springtown, High	4,800	3,300				
	875	*90*							
Zone 3 Total		4,884							
Zones 2 & 3 Water Service Areas Analysis									
Pressure Zone	*670*	*2,214*	~~Trevarno~~[e]	~~4,300~~	~~3,100~~	8,140	7,098	5,100	1,922
	725	*2,439*	Altamont	8,440	5,720				
	740[d]	*22*							
	741	*86*							
	744	*300*	~~Vasco/Springtown, Low~~	~~4,500~~	~~3,000~~				
	800	*1,947*							
	875	*90*	Vasco/Springtown, High[f]	4,800	3,300				
Zones 2 & 3 Total		7,098							
Pressure Zone 875 Analysis									
	875	*90*	Oakville/Vineyard[g]	210	140	N/A	176	N/A	(36)
PZ 875 Total		90							

[a] Firm pumping capacity is defined as the total pumping capacity of each pump station with the largest pump unit at each pump station out of service.
[b] Required total pumping capacity is the flow required to fill the tank fire storage in a 24-hour period plus the maximum day demand.
[c] Required firm pumping capacity is equal to maximum day demand.
[d] Pressure Zone 740 is physically located in the Zone 2 Water Service Area , but operationally is supplied from the Zone 3 Water Service Area and is included in the Zone 3 Water Service Area evaluation.
[e] As Trevarno Pump Station is not generally used, it is excluded from the analysis.
[f] Calculation of firm pumping capacity assumes one pump from High side is out of service.
[g] Pressure Zone 875 has no storage. Therefore, the required Firm pumping capacity shall be equal to Peak Hour demands.

Table 5-3 indicates that all pump stations, except Oakville Pump Station, have a surplus in total and firm pumping capacity for existing demands. Oakville Pump Station has a firm pumping capacity deficit of 36 gpm. It is recommended that additional firm pumping capacity be added at the Oakville Pump Station to address the deficiency.

Currently all existing pump stations have on-site backup power generators, except Trevarno Pump Station. Because Trevarno Pump Station is a facility that provides water from a supply turnout, the City may want to consider backup power for this facility. However, it is recognized that the Trevarno Pump Station is rarely used, so no formal recommendation has been included in this Water Master Plan.

5.3.2 Storage Capacity Evaluation

The primary advantages that storage provides for the water system are to provide: (1) operational storage to balance differences in demands and supplies; (2) emergency storage in case of supply failure; and (3) water to fight fires. As described in Chapter 4, the City's water storage capacity requirement is to provide an operational storage component equal to 25 percent of a maximum day demand, an emergency storage component equal to 50 percent of a maximum day demand (the required volume depends on the pressure zone), and a fire flow storage component equal to the highest fire flow and duration recommended in a particular pressure zone based on land uses within the pressure zone.

Table 5-4 compares the City's available water storage capacity with the required storage capacity by pressure zone. Existing storage capacities reported in the table are based on nominal storage capacities calculated from tank geometry.

For the Zone 1 Water Service Area, the comparison between the City's available and required storage capacities indicates that there is a surplus of 1.15 MG.

Since the Zone 2 and 3 Water Service Areas are hydraulically connected through PRVs, the City requested that the use of combined storage for both water service area zones be investigated to determine its feasibility and the potential to reduce capital costs for needed improvements. In the analysis summarized in Appendix B, the following storage criteria and improvements for the Zone 2 and 3 Water Service Areas were recommended:

- The Dalton Tank (located in the Zone 2 Water Service Area) shall be sized to contain operational and emergency storage for pressure zones within the Zone 2 Water Service Area, but not be sized to contain fire storage for pressure zones within the Zone 2 Water Service Area.
- The Altamont Tanks (located in the Zone 3 Water Service Area) shall be sized to contain operational and emergency storage for pressure zones within the Zone 3
- Water Service Area, and fire flow storage for a single fire within the Zone 2 and 3 Water Service Areas.

- Based on existing demand conditions and the above criteria, there is an existing storage deficit in the Zone 2 Water Service Area Dalton Tank of 0.39 MG. However, it is recommended that the existing 2.0 MG Dalton Tank be replaced with a new 3.41 MG storage facility, with the recommended sizing based on the additional capacity required based on the analysis of buildout demands (see Chapter 6 for additional discussion).
- It is important to note that there are some differences in the storage criteria for existing conditions versus that included in the 2004 Master Plan. For operational volume, this Water Master Plan reduces the 2004 Master Plan criteria from 50 percent of maximum day demand to 25 percent of maximum day demand as previously discussed in Chapter 4. For emergency storage, the 2004 Master Plan had the emergency storage for both the Zone 2 and 3 Water Service Areas located at the Altamont Tanks. In this Water Master Plan the location of emergency storage resides at the tanks within the respective water service areas zone. Doing so reduces the storage volume at the Altamont Tank site (which is built out and where it would be expensive to construct additional improvements) and shifts the storage improvements to the Dalton Tank site (which is an aging facility already requiring replacement and thus more economical). For fire volume, both master plans assume storage at Altamont only and for a single fire flow event within the Zone 2 or 3 Water Service Areas. These differences in criteria, and the reduction in maximum day demand estimates from that in the 2004 Master Plan, result in a total storage volume reduction from 14.2 MG in the 2004 Master Plan to 11 MG in this Water Master Plan for existing conditions.
- It is also important to note that since fire storage for the Zone 2 Water Service Area will be located at the Altamont Tanks, sufficient connection between the Zone 2 and 3 Water Service Areas must be maintained to allow fire flows to be transmitted from the Altamont tanks to the Zone 2 Water Service Area. For this reason, the PRVs that connect the Zone 2 and 3 Water Service Areas should remain operational at all times. These PRVs include Vasco/Scenic, Trevarno, Las Positas/Bennett and Leisure, which all directly serve the Zone 2 Water Service Area. Additionally, PRVs upstream from these four PRVs, which serve pressure zones that supply these four PRVs should also remain operational at all times. These include Southfront/Lawrence, Las Positas/Lawrence, Las Positas/Vasco, Patterson/Vasco, Daphne/Vasco, Emily/Vasco and East/Research.

Table 5-4. Required Storage Capacity Under Existing Demand Conditions

Water Service Area Zone[a]	Pressure Zone	Storage Facility	Available Storage Capacity, MG		Maximum Day Demand, mgd	Required Storage Capacity, MG						Storage Surplus (Deficit), MG
						Operational Criteria[b]		Emergency Criteria				
			Reservoir Capacity	Total Available Storage		Percent of Maximum Day Demand	Operational	Percent of Maximum Day Demand	Emergency	Fire Flow[c]	Total Required Storage	
Zone 1	*605* *638* *664* *719*	Doolan	3.00	3.00	1.19	25%	0.30	50%	0.60	0.96	1.85	1.15
Zone 2	*670*	Dalton	2.00	2.00	3.19	25%	0.80	50%	1.59	0[d]	2.39	(0.39)
Zone 3	*725* *740*[e] *741* *744* *800* *875*	Altamont	8.00	8.00	7.03	25%	1.76	50%	3.52	1.50	6.77	1.23

(a) Average day demand is based on detailed billing records and adjusted to reflect rebound from conservation. Billing records from 2015 were spatially located, scaled to include non-revenue water, scaled to reflect expected demand rebound. and then aggregated by pressure zone.

(b) Based on 25 percent of maximum day demand (see Table 5-1).

(c) Based on demand for the most severe fire recommended in the pressure zone multiplied by the corresponding recommended fire flow duration.

(d) Fire flow storage for single fire in Water Service Area Zones 2 or 3 to be at Altamont.

(e) Pressure Zone 740 is physically located in the Zone 2 Water Service Area, but operationally is supplied from the Zone 3 Water Service Area and is included in the Zone 3 Water Service Area evaluation.

5.3.3 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. This is a nominal analysis that evaluates PRV capacity by pressure zone, comparing the total nominal PRV supply capacity to the demands for each pressure zone.

Consistent with Chapter 4, the PRVs feeding pressure zones within the Zone 1 and 3 Water Service Areas must have capacity to meet peak hour demand and maximum day demand plus fire flow because all flow (regardless of source) must go through the PRVs to feed the respective pressure zone. For Pressure Zone 670 in the Zone 2 Water Service Area, depending on the operational configuration, the peak hour demand can normally be supplied from a combination of sources within the pressure zone (i.e., not flowing through PRVs) and from outside the pressure zone (i.e., flowing through PRVs). However, for conservative purposes, this analysis assumes Pressure Zone 670 is being fed from sources outside the pressure zone. Therefore, PRVs feeding the Zone 2 Water Service Area must also meet peak hour demand and maximum day demand plus fire flow. The analysis of all pressure regulating station capacities also assumes pressure zones are not supplied by any turnouts.

Table 5-5 compares existing available pressure regulating station capacity with that required per the above criteria. The table shows that all of these pressure zones have sufficient pressure regulating station capacity to meet the required flows.

For pressure zones which are supplied by more than one regulating station, the capacity requirement for the pressure zone was also compared to the valve capacity of each regulating station supplying the pressure zone to determine if each regulating station could supply the pressure zone on its own. Each regulating station does have sufficient valve capacity to meet the valve capacity requirement on its own, except for the following regulating stations:

- The Golf Course regulating station has a valve capacity of 3,900 gpm, which cannot meet the valve capacity requirement of 4,061 gpm for Pressure Zone 605. Therefore, it is recommended that the Freisman regulating station remain operational.
- The Leisure regulating station has a valve capacity of 3,900 gpm, which cannot meet the valve capacity requirement of 7,214 gpm for Pressure Zone 670. Therefore, it is recommended that at least one of the other three regulating stations that supply Pressure Zone 670 remain operational.
- Each of the five regulating stations supplying Pressure Zone 725 North has a valve capacity of 8,720 gpm, which cannot meet the valve capacity requirement of 9,142 pm for Pressure Zones 725 North and 670. Therefore, it is recommended that at least two of these five valves remain operational.
- The Welch/Vasco regulating station has a valve capacity of 3,900 gpm, which cannot meet the valve capacity requirement of 5,511 gpm for Pressure Zone 725 South. Therefore, it is recommended that the Charlotte/Vasco regulating station remain operational.

In addition, the flows through the PRVs under existing peak hour demand and maximum day demand plus fire flow scenarios in the hydraulic model were compared to valve capacities to confirm that the flows were lower than the valve capacities. This is true in all cases, indicating that the existing valves are adequately sized to accommodate the existing demand conditions.

Table 5-5. Comparison of Existing and Required Pressure Regulating Station Capacity

Pressure Zone	Maximum Day Demand, gpm	Peak Hour Demand, gpm	Fire Flow Requirement, gpm[(a)]	Regulating Station	Valve Diameter, inches	Existing Valve Capacity, gpm[(b)]	Valve Capacity Requirement, gpm[(c)]	Valve Capacity Surplus (Deficit), gpm
605	61	95	4,000	Freisman	12	8,720	4,061	8,559
				Golf Course	8	3,900		
					Total	12,620		
638 (+605)	228	355	4,000	Kitty Hawk	10	6,150	4,228	8,072
				Doolan	10	6,150		
					Total	12,300		
664 (+605 & 638)	767	1,196	4,000	North Canyon	10	6,150	4,767	1,383
					Total	6,150		
670	2,214	4,340	5,000	Trevarno	12	8,720	7,214	22,846
				Vasco/Scenic	12	8,720		
				Las Positas/Bennet	12	8,720		
				Leisure	8	3,900		
					Total	30,060		
725 North (+670)	4,142	8,118	5,000	Patterson Pass/Shelley	12	8,720	9,142	34,458
				Patterson Pass/Vasco	12	8,720		
				Daphine/Vasco	12	8,720		
				East/Research	12	8,720		
				Emily/Vasco	12	8,720		
					Total	43,600		
725 South	511	1,002	4,000	Welch/Vasco	8	3,900	4,511	8,109
				Charlotte/Vasco	12	8,720		
					Total	12,620		
740	22	43	5,000	Naylor	12	8,720	5,022	3,698
					Total	8,720		
741 (+725 North)	2,014	169	5,000	Brisa/Vasco	12	8,720	7,014	1,706
					Total	8,720		
744 (+740 & 670)	2,536	4,971	5,000	Southfront/Lawrence	16	10,540	7,536	20,444
				Las Positas/Lawrence	12	8,720		
				Vasco/Las Positas	12	8,720		
					Total	27,980		

(a) Based on demand for the most severe fire recommended in the pressure zone.
(b) Based on the intermittent maximum flow capacity for ClaVal model 90-01 PRV valves. However, actual flow capacity will vary depending on system conditions.
(c) Regulating stations must supply maximum day plus fire flow or peak hour demand, whichever is larger.

5.4 EXISTING WATER SYSTEM PERFORMANCE EVALUATION

This section discusses the hydraulic performance evaluation of the existing water distribution system. The following evaluations were performed to assess distribution system performance under existing water demand conditions:

- Peak Hour Demand Scenario: This scenario evaluates the potential for low customer service pressures in the system during a peak hour demand condition.
- Maximum Day Scenario: This scenario evaluates the potential for high customer service pressures in the system during a maximum day demand condition.
- Fire Operations – Maximum Day plus Fire Flow Scenario: This scenario evaluates fire flow availability in the system under a maximum day demand condition.

These three scenarios used the hydraulic model developed for this Water Master Plan to evaluate the existing water system performance. The existing water system is expected to deliver flow within the acceptable pressure, velocity and head loss ranges as identified in the planning and design criteria presented in Chapter 4.

The purpose of the existing water system performance evaluation is to identify necessary improvements to support the City's existing water demands while meeting the City's recommended water system planning and design criteria.

The City operates its water distribution system in a variety of ways to achieve different goals at different times. The system was evaluated using operational alternatives, which represent the primary system operational configurations that the City employs. Table 5-6 summarizes the facilities that are adjusted when changing between the operational alternatives.

For the Zone 1 Water Service Area, the variation involves the Zone 7 Turnout 5 and the Kitty Hawk PRV. When Zone 7 Turnout 5 is open, the hydraulic grade line from the turnout can be high enough to feed portions of the Zone 1 Water Service Area directly from the turnout. As a result, this leads to a decrease in supply from the Doolan Tank (in conjunction with Airway Pump Station and Zone 7 Turnout 9). In order to encourage more turnover of the water stored in the Doolan Tank, Turnout 5 is sometimes closed. However, this can cause an increase in flows from Pressure Zone 664 to Pressure Zone 638 via the Kitty Hawk PRV, which can result in lower pressures in Pressure Zone 664. To prevent this concern, the Kitty Hawk PRV is sometimes closed, which forces Pressure Zone 638 to be fed from Pressure Zone 719 via the Doolan PRV.

Table 5-6. Summary of Operational Alternatives

Zone 1 Water Service Area Facility[(a)]	Base	Alternative 1 – TO 5 Impact	Alternative 2 – Kitty Hawk PRV Impact	Alternative 3 – TO 5 and Kitty Hawk Impact	
Zone 7 – Turnout 5	Open	Closed	Open	Closed	
PRV – Kitty Hawk	Closed	Closed	Operational	Operational	
Zone 2 & 3 Water Service Area Facility[(b)]	**Base**	**Alternative 1 – Central Impact**	**Alternative 2 – Lassen Impact**	**Alternative 3 – Vasco Bypass Impact**	**Alternative 4 – Hall / Charlotte Impact**
Herman Crossing	Open	Open	Open	Open	Open
Central Crossing	Closed	Open	Closed	Closed	Closed
Lassen Crossing	Closed	Closed	Open	Closed	Closed
PRV – Scenic/ Vasco	Closed	Operational	Operational	Operational	Closed
N. Vasco Pump Station Bypass	Closed	Closed	Closed	Open	Closed
Isolation – Hall	Closed	Closed	Closed	Closed	Open
Isolation – Charlotte	Closed	Closed	Closed	Closed	Open

(a) For all alternatives: Zone 7 Turnout 11 is assumed to be closed. Zone 7 Turnout 9 is assumed to be opened and supplying Airway Pump Station. Airway Pump Station and Doolan Tank are operational.

(b) For all alternatives: Zone 7 Turnout 1 and Turnout 8 are assumed to be closed. Zone 7 Turnout 6 and Turnout 10 are assumed to be opened and feeding their respective pump stations. Trevarno Pump Station is not operational. North Vasco PS Low and High, Altamont Pump Station, and Oakville Pump Station are operational. Dalton Tank and Altamont Tanks are operational.

For the Zone 2 and 3 Water Service Areas, the analysis assumes the two zones are hydraulically connected (i.e., all PRVs operational except Scenic/Vasco which varies based on the alternative). The variation between the Base Alternative and Alternatives 1 and 2 primarily involves the separation of the Zone 2 Water Service Area by Interstate 580 into a north portion and a south portion. There are three crossings that join the north and south portions, consisting of the Herman Crossing, the Central Crossing and the Lassen Crossing. The City frequently closes one or more of these crossings to limit flow between the north and south to encourage turnover of the water stored in the Dalton Tank. When flow is limited between the two portions, the south portion is primarily supplied by PRVs from upper pressure zones and partially from Zone 7 Turnout 1 and Turnout 8 if open (for the purposes of this analysis they are conservatively assumed to be closed). The north portion is supplied by the Dalton Tank (in conjunction with Vasco Pump Station Low and Zone 7 Turnout 6) and the Scenic/Vasco PRV (depending on its operational status). The base option is an operational arrangement that allows the most turnover at Dalton Tank as only the Herman Crossing is open and the Scenic/Vasco PRV is closed. This limits the amount of flow from the Zone 3 Water Service Area into the northern part of the Zone 2 Water Service Area. Alternatives 1 and 2 are operational arrangements that allow less turnover at Dalton Tank as two crossings are opened and the Scenic/Vasco PRV is operational. This increases the amount of flow from the Zone 3 Water Service Area into the northern part of the Zone 2 Water Service Area.

The Alternative 3 variation involves the bypass at Vasco Pump Station. When this bypass is opened, flow from Zone 7 Turnout 6 can be fed directly into the Zone 2 Water Service Area rather than via the Vasco Pump Station Low.

The Alternative 4 operational variation involves Pressure Zone 725 in the Zone 3 Water Service Area. The City isolates the portion of Pressure Zone 725 south of East Avenue by closing valves on Charlotte Way and Hall Circle. This helps to prevent lower pressures in the portion of Pressure Zone 725 south of East Avenue.

5.4.1 Peak Hour Demand Scenario

5.4.1.1 Evaluation Overview

A steady-state hydraulic analysis was conducted using the hydraulic model to evaluate system performance under an existing peak hour demand condition for each of the alternatives listed in Table 5-6. As shown in Table 5-1, the peak hour demand for the existing water service area was calculated to be 15,203 gpm (21.89 mgd). This analysis assumed that storage reservoirs are 75 percent full for conservative purposes. As a result, although the pump stations and corresponding supply turnouts are operational in the model, they are not flowing under this static condition due to the reservoir fill level.

As described in Chapter 4, during a peak hour demand scenario, a minimum pressure of 35 psi must be maintained at service connections throughout the entire water system. In addition, for pipelines, it is recommended that maximum velocities should not exceed 5 ft/s in transmission pipelines (greater than 12-inch diameter) or 8 ft/s in distribution pipelines (less than or equal to 12-inch diameter) during normal demand conditions, to help minimize energy (pumping) costs and excessive head loss due to undersized pipelines.

5.4.1.2 Evaluation Results

Results of the existing system peak hour analyses for the City's Zone 1 Water Service Area for each operational alternative are shown on Figures 5-1A through 5-4A.[1] Results of the existing system peak hour analyses for the City's Zone 2 and 3 Water Service Areas for each operational alternative are shown on Figures 5-1B through 5-5B.

Results from the peak hour demand simulations indicate that the existing water system could adequately meet the City's minimum pressure criterion of 35 psi at all customer services, except for the locations in the Zone 2 and 3 Water Service Areas shown in red on Figures 5-1B through 5-5B. The areas that do not meet the pressure criterion vary somewhat between the different operational alternatives. The figures also show the pipelines in the system that do not meet the velocity criteria. The areas that do not meet the velocity criteria vary between the different operational alternatives. Although there are smaller areas that do not meet the velocity criteria, the major areas include:

- The two pipelines between the Altamont Tanks and Greenville Road;
- The pipeline along Patterson Pass Road between Greenville Road and Vasco Road;

[1] Because there is no Operational Alternative 4 for the Zone 1 Water Service Area, there is no Figure 5-5A. There is a Figure 5-5B to show results for Operational Alternative 4 for the Zone 2 and 3 Water Service Areas.

- The pipeline along Greenville Road between Marathon Drive and Las Positas Road; and
- The pipeline along Vasco Road between Patterson Pass Road and Daphne Drive.

The low pressures indicated near the Vasco Pump Station are in the pipelines upstream from the Vasco Pump Station and do not need to be addressed.

In the Zone 3 Water Service Area, in the southern-most portion of Pressure Zone 800 east of Vasco Road, low pressures occur beyond the extent of the Vineyard 875 Pressure Zone. These are slightly more widespread when either the Lassen Crossing or the Central Crossing of Interstate 580 is open and the Scenic/Vasco PRV is operational and transmitting flow, which increases the pipe friction losses within Pressure Zone 800 and exacerbates the low pressures at the south end of Vasco Road.

In the Zone 2 Water Service Area on the north side of the Lassen Crossing, a small area of low pressures occurs when both of the Interstate 580 crossings at Central and Lassen are closed, and the PRV at Scenic/Vasco is closed, such as in the Base Operational Alternative and in Operational Alternatives 3 and 4.

These two situations are related, as resolving the Zone 2 Water Service Area pressure issues by increasing flow from the Zone 3 Water Service Area to the Zone 2 Water Service Area by opening the Interstate 580 crossings, or making the PRV at Scenic/Vasco operational, exacerbates the pressure issues in the southern portion of the Zone 3 Water Service Area. This occurs by the increased flows from the Altamont Tanks and creates greater head loss in the distribution system and lower pressures. The analysis determined that activating the high head pumps at the Vasco Pump Station during high demand periods would reduce the extent of the area at the south end of Vasco Road with low pressures. However, the results indicate that there will still be a small area outside the 875 Vineyard Pressure Zone that does not meet the criteria, even with three high head pumps at the Vasco Pump Station operating.

A summary of the areas with low pressures is provided below, along with recommended options for mitigation:

- The low pressures on the north side of the Lassen Crossing occur because supply is limited to the north portion of the Zone 2 Water Service Area.
  - To allow supply under high demand conditions, it is recommended that the PRV at Scenic/Vasco always be operational, but with a setting of approximately 45 psi for the small valve and 40 psi for the larger valve. With this setting, the PRV will provide supply only during peak hour demands, but not during other parts of high demand days.
  - Additionally, it is recommended that two of the three Interstate 580 crossings at Lassen, Central and Herman should remain open, as is the case in Operational Alternatives 1 and 2.

- The low pressures at the south end of Vasco Road occur under high demand conditions, and are more widespread when supply to the Zone 2 Water Service Area is limited to the Altamont Tanks.
  - Including controls at the high head pumps at the Vasco Pump Station that activate pumps when pressures near the Vineyard Pump Station fall below 35 psi will allow the pumps to help mitigate the low pressures. However, this will not completely mitigate the low pressures.
  - To completely mitigate the low pressures, it is recommended to install approximately 5,500 feet of 16-inch diameter parallel pipeline along Vasco Road between Patterson Pass Road and Emily Way. The recommended parallel pipeline, in conjunction with the low pressure controls on the high head pumps at the Vasco Pump Station, will mitigate the low pressure issues at the south end of Vasco Road near the Vineyard Pump Station pressure zone. However, because the areas that do not meet the criteria are small, it is recommended that these mitigation projects be deferred until demand conditions approach buildout demands.

Because pipeline velocity is a secondary criterion, no improvements for pipelines exceeding the velocity criteria in the existing water system are recommended unless the primary criterion (pressure) is not met. Therefore, no mitigation is recommended at this time based on the velocity criteria alone. However, the alternative to install a parallel pipeline along Vasco Road between Patterson Pass Road and Emily Way will resolve the high velocity issues that occur here.

Refer to Section 6.4.1.2 for a discussion of the usage of operational storage within the Zone 2 Water Service Area.

5.4.2 Maximum Day Demand Scenario

5.4.2.1 Evaluation Overview

A steady-state hydraulic analysis was conducted using the hydraulic model to evaluate system performance under an existing maximum day demand condition for each of the alternatives listed in Table 5-6. As shown in Table 5-1, the maximum day demand for the existing water service area was calculated to be 7,926 gpm (11.4 mgd). This analysis assumed that storage reservoirs are 75 percent full. In addition, in order to evaluate the system for high pressure, it was conservatively assumed that one pump was operating at the Airway Pump Station, one low head pump was operating at the Vasco Pump Station and one high head pump was operating at the Vasco Pump Station. No pumps were set to operate at the Trevarno Pump Station, as this pump station is almost never operated. No pumps were set to operate at the Altamont Pump Station, as SCADA shows that the Altamont Pump Station and the Vasco High Pump Station do not operate at the same time.

As described in Chapter 4, the maximum desired pressure in the distribution system is 100 psi.

5.4.2.2 Evaluation Results

Results of the existing system maximum day analyses for the Zone 1 Water Service Area for each operational alternative are shown on Figures 5-6A through 5-9A.[2] Results of the existing system maximum day analyses for the Zone 2 and 3 Water Service Areas for each operational alternative are shown on Figures 5-6B through 5-10B.

Results from the maximum day demand simulations indicate that the existing water system has pressures that exceed 100 psi at some locations when pumps are operating. In the Zone 1 Water Service Area, these pressures are as high as 137 psi at the outlet of the Airway Pump Station. In the Zone 2 and 3 Water Service Areas, these pressures are as high as 111 psi in the area of the Vasco Pump Station.

No recommendations are suggested for the distribution system based on the maximum criteria, as the system is currently capable of handling pressures exceeding 100 psi in the areas where they occur. However, it is recommended that the City investigate the developed properties in these areas to verify that there are individual PRVs on the service laterals and consider having them installed where they do not already exist. Per the Plumbing Code, new services with pressure greater than 80 psi require an individual pressure regulating device. Therefore, for properties in these areas that are developed in the future, it is recommended that the City require individual PRVs on the service laterals.

5.4.3 Fire Operations – Maximum Day Demand plus Fire Flow Scenario

5.4.3.1 Evaluation Overview

To evaluate the existing water system under the maximum day demand plus fire flow scenario, H2OMap Water's "*Available Fire Flow Analysis*" tool was used to determine the available fire flow at a minimum residual pressure of 20 psi and a maximum velocity constraint of 12 ft/s. For the existing system fire flow analysis, key junctions that represent hydrant locations were evaluated to determine the available flow that can be provided, in addition to meeting the maximum day demand. The analysis assumed that storage reservoirs are 50 percent full, that no pump stations are operating and that no flow is entering the system from the turnouts.

5.4.3.2 Evaluation Results

Figures 5-11A through 5-14A summarize the available fire flow at each tested hydrant location in the Zone 1 Water Service Area while meeting the minimum residual pressure criterion of 20 psi and/or a maximum pipeline velocity of 12 ft/s.[3] Figures 5-11B through 5-15B summarize the available fire flow at each tested hydrant location in the Zone 2 and 3 Water Service Areas while meeting the same criteria. The results presented are representative of the system capacity and do not represent available flow from a specific hydrant. Typically, fire flows exceeding 1,500 gpm

[2] Because there is no Operational Alternative 4 for the Zone 1 Water Service Area, there is no Figure 5-10A. There is a Figure 5-10B to show results for Operational Alternative 4 for the Zone 2 and 3 Water Service Areas.

[3] Because there is no Operational Alternative 4 for the Zone 1 Water Service Area, there is no Figure 5-15A. There is a Figure 5-15B to show results for Operational Alternative 4 for the Zone 2 and 3 Water Service Areas.

are met by multiple hydrants. Figures 5-16A and 5-16B show the available fire flow at each key junction location for the base operational alternative.

For the fire flow analysis, available fire flows were reviewed, and improvements were identified for: (1) areas with low fire flows, no planned re-development, and where cost-effective improvements could be implemented; and (2) areas where upsizing or installing new pipelines would add redundancy for fire flow or other needs.

West Yost conducted additional analysis in areas described above and the following projects are recommended, which are displayed in Chapter 7 on Figure 7-1:

Zone 1 Water Service Area:

1. As seen in Alternative 1, when Kitty Hawk PRV and Zone Turnout 5 are closed, residual pressure issues under fire conditions exist in the southern portion of the zone. Therefore, it is recommended that Kitty Hawk PRV be operational, but with a lower setting so that it is available for high demand periods such as fire flow conditions. The current setting of 90 psi could be lowered to approximately 80 psi so that it will remain closed during peak hour conditions, but will open for fire flow conditions. It is recommended that the smaller PRV at Kitty Hawk be set at 80 psi and the larger PRV be set at 75 psi.
2. In the northeast corner of the Zone 1 Water Service Area at the east end of Selby Lane, the fire flow deficiency is a result of a fire flow demand of 3,500 gpm for an area that has a land use code of Business and Commercial Park, but is actually a public park area. As this pipeline has sufficient fire flow capacity for the adjacent residential land uses with fire flow demands of 2,500 gpm, no improvement project is recommended.
3. For the Base Operational Alternative, the hydrant near the intersection of Dovecote Lane and Quarry Hill Avenue shows a fire flow deficiency resulting from a fire flow demand of 3,500 gpm for an area that has a land use code of Business and Commercial Park, but is actually a public park area. As this pipeline has sufficient fire flow capacity for the adjacent residential land uses with fire flow demands of 2,500 gpm, no improvement project is recommended.

Zone 2 and 3 Water Service Areas:

1. As seen in the Base Alternative vs. Alternatives 1 through 3, when the Scenic/Vasco PRV is operational, the residual pressure issues under fire conditions just north and south of the Lassen Crossing are significantly reduced. Since this Water Master Plan already recommends that the Scenic/Vasco PRV remain operational at all times (refer to Sections 5.3.2 and 5.4.1.2), only the below improvements are needed to address the remaining issues in the subject area.
   a. Replace approximately 500 feet of 6-inch diameter pipe with 8-inch diameter pipe along Zinnia Court. (Project No. EX-CIP-P01).

b. Replace approximately 650 feet of 6-inch diameter pipe with 12-inch diameter pipe along Springtown Boulevard between Lassen Road and Bluebell Drive, and along Bluebell Drive between Springtown Boulevard and Larkspur Drive. (Project No. EX-CIP-P01).

c. Install a PRV at the south end of Lassen Road to allow supply from the south portion to the north portion of Pressure Zone 670 under high demand conditions, such as fire flow demands. The PRV should be set at approximately 45 psi, with an assumed elevation of 533 feet (Project No. EX-CIP-V02). This project is required only if the City chooses to continue closing the Interstate 580 crossing at Lassen, as this project serves as a bypass of the closed crossing under high demand conditions.

d. Install a PRV at Turnout 1 to allow supply to enter directly into Pressure Zone 670 via gravity under high demand conditions, such as fire flow, enabling the system to meet fire flow demands west of the Trevarno Pump Station. The PRV should be set to approximately 45 psi (Project No. EX-CIP-V03). This project is required only if the City chooses to keep the Trevarno Pump Station bypass line closed.

e. Replace approximately 50 feet of 6-inch diameter pipe with 12-inch diameter pipe at the intersection of Contractors Place and Mines Road. (Project No. EX-CIP-P07).

f. Replace approximately 310 feet of 8-inch diameter pipe with 12-inch diameter pipe on Technology Drive east of North Mines Road (Project No. EX-CIP-P07).

g. Replace approximately 170 feet of 8-inch diameter pipe with 12-inch diameter pipe near the intersection of Trevarno Road and Contractors Place. (Project No. EX-CIP-P07).

h. Replace approximately 600 feet of 12-inch diameter pipe with 18-inch diameter pipe along Preston Avenue east of McGraw Avenue. (Project No. EX-CIP-P04).

i. On Southfront Road, approximately 700 feet east of Bennet Road, hydrant 4G1WFH-504 is shown to be connected to an 8-inch diameter pipeline, which does not have sufficient capacity to meet the fire flow demand of 3,500 gpm. Nearby hydrants along Southfront Road are shown to be connected to a 12-inch diameter pipeline parallel to the 8-inch diameter pipeline that does have sufficient capacity to meet the fire flow demands. The City can rely on nearby hydrants for fire flow supply in this area, or hydrant 4G1WFH-504 can be reconnected to the 12-inch diameter pipeline.

2. Replace approximately 300 feet of 12-inch diameter pipe with 16-inch diameter pipe along Southfront Road extending from Commerce Way to the west. At the west end of the new 16-inch diameter pipe install a PRV station approximately 300 feet west of the intersection of Southfront Road and Commerce Way to supply Pressure Zone 670 from Pressure Zone 744. There is currently no connection at this location between Pressure Zones 670 and 744. (Project No. EX-CIP-V01).

3. Replace approximately 1,600 feet of 8-inch diameter pipe with 12-inch diameter pipe along Preston Avenue from the western part of Southfront Road to the eastern part of Southfront Road, and along the eastern part of Southfront Road between Preston Avenue and Waxlax Way. (Project No. EX-CIP-P02).
4. Install approximately 4,400 feet of 12-inch diameter pipe. A portion is to install approximately 700 feet of new 12-inch diameter pipeline along Preston Avenue from Turnout 8 west to the intersection of Franklin Lane and Preston Avenue. A second portion is to install approximately 900 feet of new 12-inch diameter pipeline along Franklin Lane from Preston Avenue to Southfront Road. A third portion is to replace approximately 400 feet of 8-inch diameter pipe with 12-inch diameter pipe from the intersection of Southfront Road and Franklin Lane to approximately 400 feet to the east along Southfront Road. A fourth portion is to install approximately 2,300 feet of new 12-inch diameter pipeline parallel to the existing 8-inch diameter pipeline from the intersection of Southfront Road and Franklin Lane to approximately 2,300 feet to the west, connecting to the existing 12-inch diameter pipeline. (Project No. EX-CIP-P03).
5. Replace approximately 2,500 feet of 12-inch diameter pipe with 18-inch diameter pipe along Las Positas Road from the Las Positas/Bennet PRV Station near Bennet Drive to Capitol Street. (Project No. EX-CIP-P05).
6. Replace approximately 2,800 feet of 12-inch diameter pipe with 18-inch diameter pipe along Brisa Street from the PRV station near Vasco Road to the last hydrant on the west end of Brisa Street, west of La Ribera Street. (Project No. EX-CIP-P06).
7. Replace approximately 350 feet of 6-inch diameter pipe with 8-inch diameter pipe along Juliet Court from Kathy Way to the hydrant on Juliet Court. (Project No. EX-CIP-P08).
8. Replace approximately 400 feet of 6-inch diameter pipe with 8-inch diameter pipe along Kathy Court from Kathy Way to the hydrant on Kathy Way. (Project No. EX-CIP-P08).
9. Replace approximately 250 feet of 8-inch diameter pipe with 12-inch diameter pipe along Graham Court from South Vasco Road to the hydrant on Graham Court. (Project No. EX-CIP-P09).
10. The fire flow deficiencies identified on Calistoga Court, Oakville Lane, Yountville Court were for hydrants that were shown in the City GIS to be connected to the Oakville Pressure zone. Subsequent field investigations by City staff revealed that these hydrants are actually connected to pipelines in Pressure Zone 800, as they should be. Therefore, no improvement projects are recommended. The hydraulic model should be updated after the City updates the GIS.
11. The fire flow deficiency identified on Kisa Court was minor; therefore, no improvement project is recommended.
12. The fire flow deficiency identified on Research Drive was minor; therefore, no improvement project is recommended.

13. The fire flow deficiency identified on Jayhawk Lane is due to the 3,500 gpm fire flow demand of the adjacent school. However, since the area near the end of Jayhawk Lane is an athletic field, and the pipeline has sufficient capacity to meet the fire flow demands of the residential parcels along Jayhawk Lane, no improvement project is recommended.

These projects were included in the City's near-term CIP, which is discussed in Chapter 7.

5.5 SUMMARY OF FINDINGS AND RECOMMENDED IMPROVEMENTS FOR THE EXISTING WATER SYSTEM

Findings from the evaluation of the existing water distribution system and the recommended improvements needed to eliminate deficiencies are summarized below. These recommendations are included in the recommended capital improvement program described in Chapter 7 (see Table 7-1 and Figure 7-1).

5.5.1 Pumping Capacity

- It is recommended that the firm pumping capacity of the Oakville Pump Station be increased from 140 gpm to 176 gpm. (Project No. EX-CIP-U01).
- The City has indicated that some of the existing pumps may not be operating at their nominal capacity. It is recommended that a further investigation be performed to evaluate pump performance under a range of operating conditions to determine if the actual capacity differs from the nominal capacity. The range of operating conditions should include varying reservoir levels, varying upstream pressures in the Zone 7 system and different demand conditions. Pump performance can be evaluated by analyzing available SCADA information (Project No. EX-CIP-U02).

5.5.2 Storage Capacity

- There is an existing storage deficit of 0.39 MG at the Dalton Tank. Based on the analysis of the buildout demands (deficit of 1.41 MG), it is recommended that the 2.0 MG tank be replaced with a 3.41 MG tank (see Chapter 6 for additional discussion). It is recommended that the new tank be equipped with a mixer and provisions for future chlorine addition to address water quality issues. (Project No. EX-CIP-T01).

5.5.3 Pressure Reducing Stations

- Install a PRV station approximately 300 feet west of the intersection of Southfront Road and Commerce Way to supply Pressure Zone 670 from Pressure Zone 744. (Project No. EX-CIP-V01).
- Install a PRV station at the south end of Lassen Road to supply the north portion of the Pressure Zone 670 from the south portion of the Pressure Zone 670 with a setting of 45 psi if the new PRV station is at an elevation of approximately 533 feet. This project is required only if the City chooses to continue closing the Interstate 580 crossing at Lassen, as this project serves as a bypass of the closed crossing under high demand conditions. (Project No. EX-CIP-V02).

- Install a PRV at Turnout 1 to allow supply to enter Pressure Zone 670 via gravity under high demand conditions, such as fire flow. The PRV should be set to approximately 45 psi. This project is required only if the City chooses to keep the Trevarno Pump Station bypass line closed. (Project No. EX-CIP-V03).

5.5.4 Pipelines

The following pipeline improvements are recommended to address existing system fire flow needs:

- Replace approximately 300 feet of 12-inch diameter pipe with 16-inch diameter pipe along Southfront Road extending from Commerce Way to the west (included in Project No. EX-CIP-V01).
- Replace approximately 500 feet of 6-inch diameter pipe with 8-inch diameter pipe along Zinnia Court. (Project No. EX-CIP-P01).
- Replace approximately 650 feet of 6-inch diameter pipe with 16-inch diameter pipe along Springtown Boulevard between Lassen Road and Bluebell Drive, and along Bluebell Drive between Springtown Boulevard and Larkspur Drive. (Project No. EX-CIP-P01).
- Replace approximately 1,600 feet of 8-inch diameter pipe with 12-inch diameter pipe along Preston Avenue from the western part of Southfront Road to the eastern part of Southfront Road, and along the eastern part of Southfront Road between Preston Avenue and Waxlax Way. (Project No. EX-CIP-P02).
- Install approximately 4,400 feet of 12-inch diameter pipe. A portion is to install approximately 700 feet of new 12-inch diameter pipeline along Preston Avenue from Turnout 8 west to the intersection of Franklin Lane and Preston Avenue. A second portion is to install approximately 900 feet of new 12-inch diameter pipeline along Franklin Lane from Preston Avenue to Southfront Road. A third portion is to replace approximately 400 feet of 8-inch diameter pipe with 12-inch diameter pipe from the intersection of Southfront Road and Franklin Lane to approximately 400 feet to the east along Southfront Road. A fourth portion is to install approximately 2,300 feet of new 12-inch diameter pipeline parallel to the existing 8-inch diameter pipeline from the intersection of Southfront Road and Franklin Lane to approximately 2,300 feet to the west, connecting to the existing 12-inch diameter pipeline. (Project No. EX-CIP-P03).
- Replace approximately 600 feet of 12-inch diameter pipe with 18-inch diameter pipe along Preston Avenue east of McGraw Avenue. (Project No. EX-CIP-P04).
- Replace approximately 2,500 feet of 12-inch diameter pipe with 18-inch diameter pipe along Las Positas Road from the Las Positas/Bennet PRV Station near Bennet Drive to Capitol Street. (Project No. EX-CIP-P05).
- Replace approximately 2,800 feet of 12-inch diameter pipe with 18-inch diameter pipe along Brisa Street from the PRV station near Vasco Road to the last hydrant on the west end of Brisa Street, west of La Ribera Street. (Project No. EX-CIP-P06).
- Replace approximately 50 feet of 6-inch diameter pipe with 12-inch diameter pipe at the intersection of Contractors Place and Mines Road. (Project No. EX-CIP-P07).

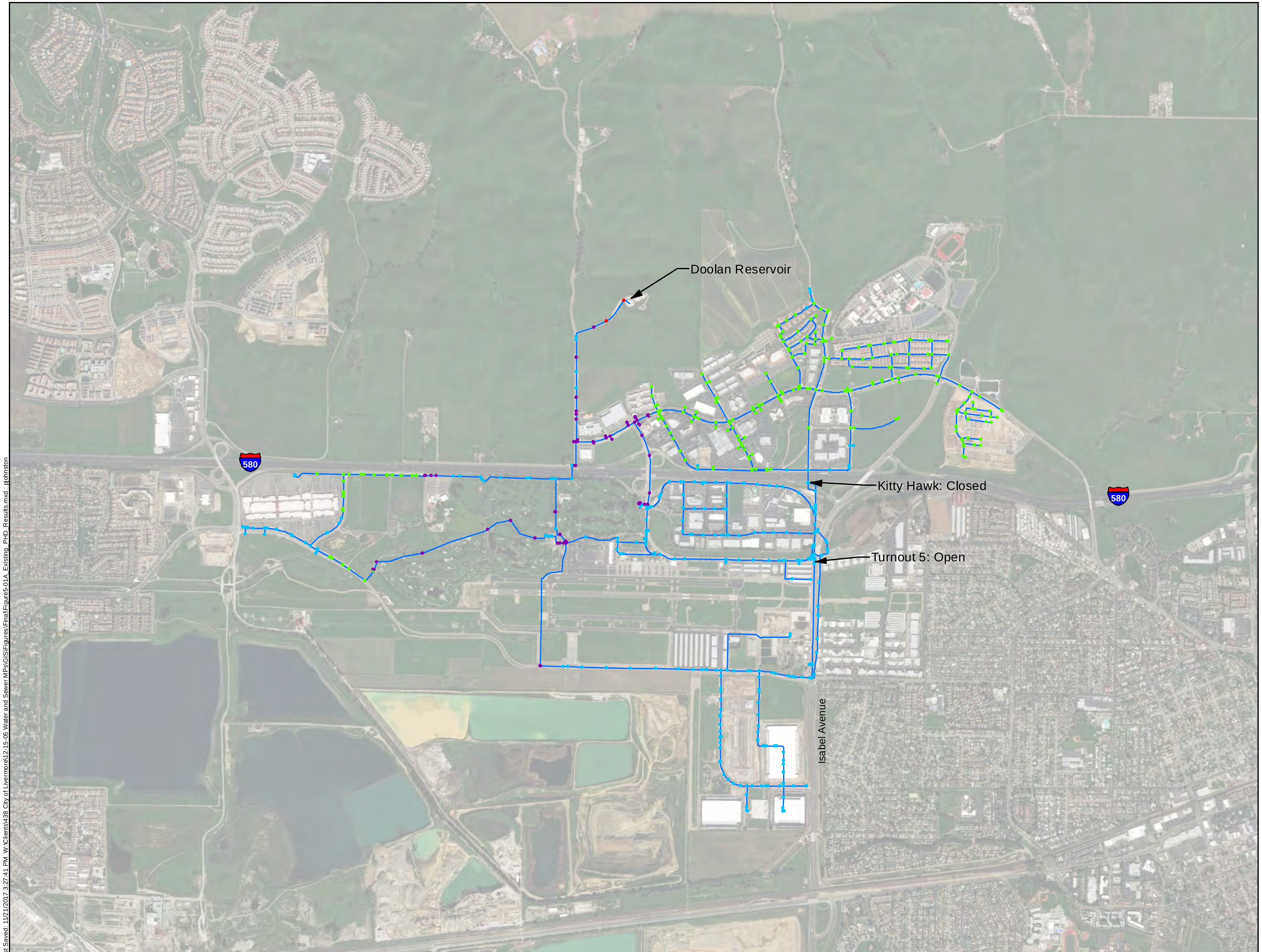
- Replace approximately 170 feet of 8-inch diameter pipe with 12-inch diameter pipe near the intersection of Trevarno Road and Contractors Place. (Project No. EX-CIP-P07).
- Replace approximately 310 feet of 8-inch diameter pipe with 12-inch diameter pipe on Technology Drive east of North Mines Road. (Project No. EX-CIP-P07).
- Replace approximately 350 feet of 6-inch diameter pipe with 8-inch diameter pipe along Juliet Court from Kathy Way to the hydrant on Juliet Court. (Project No. EX-CIP-P08).
- Replace approximately 400 feet of 6-inch diameter pipe with 8-inch diameter pipe along Kathy Court from Kathy Way to the hydrant on Kathy Way. (Project No. EX CIP-P08).
- Replace approximately 250 feet of 8-inch diameter pipe with 12-inch diameter pipe along Graham Court from South Vasco Road to the hydrant on Graham Court. (Project No. EX-CIP-P09).

5.6 FINDINGS AND RECOMMENDED OPERATIONAL IMPROVEMENTS FOR THE EXISTING WATER SYSTEM

The following operational improvements are recommended for the existing water system:

- The City's practice of closing the Zone 7 Turnout 5 to induce more turnover in the Doolan Tank does not prevent the system from meeting the demand and the performance criteria and can be continued as long as the Kitty Hawk PRV remains operational.
- The City's practice of closing the Kitty Hawk PRV to boost pressures in Pressure Zone 664 does prevent the system from meeting the criteria for fire flow when Zone 7 Turnout 5 is also closed. It is recommended that the Kitty Hawk PRV be available with a setting of approximately 80 psi. With this setting, the Kitty Hawk PRV should supply water to the lower pressure zone only during fire flow events.
- For the Zone 1 Water Service Area, it is recommended that the City use Operational Alternatives 2 or 3, which entail keeping the Kitty Hawk PRV operational and available, and opening or closing Zone 7 Turnout 5 as desired.
- The City's practice of closing the PRV at Scenic/Vasco to induce more turnover in the Dalton Tank can prevent the system from meeting the performance criteria under periods of high demand. It is recommended that the PRV at Scenic/Vasco always be available with a setting of approximately 45 psi. With this setting, the PRV should supply water to the lower pressure zone only during periods of high demand, which
- The City's practice of opening the bypass at the Vasco Pump Station appears to have no effect on system operation under the operational alternatives analyzed. In the peak hour and fire flow analyses, the hydraulic grade in the Zone 7 transmission system under Normal Supply conditions as listed in Table 5-2 is lower than the hydraulic grade in the City's 670 Pressure Zone.

- The City's practice of closing the Central and the Lassen Crossings of Interstate 580 to increase turnover in the Dalton Tank can prevent the system from meeting the performance criteria on the north side of Interstate 580 in the Zone 2 Water Service Area. However, the practice can be continued if a PRV station is installed at the south end of Lassen Road, as mentioned above.
- The City's practice of closing isolation valves at Hall and Charlotte is intended to assist in maintaining higher pressures below East Avenue in the 725 Pressure Zone during high demand conditions. The analysis showed that under peak hour demand conditions, the pressures in the adjacent portion of the 800 Pressure Zone that supplies the 725 Pressure Zone do not meet the performance criteria and are not resolved by closing the isolation valves at Hall and Charlotte. However, closing these valves is not detrimental to system performance, and can be continued. This allows the City to create a sub zone south of East Avenue and west of Vasco Road in which the City can adjust pressures by changing the settings of the PRVs supplying this area.
- Note that fire storage for the Zone 2 Water Service Area is located at the Altamont tanks. Therefore, it is recommended that all PRVs that connect to the Zone 2 Water Service Area be operational at all times. This includes the Trevarno, Vasco/Scenic, Las Positas/Bennet and Leisure PRVs. The current settings are sufficient, except for Vasco/Scenic, which should be set at approximately 45 psi.
- As has been mentioned previously, this Water Master Plan analysis assumed the Zone 2 and 3 Water Service Areas are hydraulically connected. When the Zone 2 Water Service Area is not being supplied by either the Vasco Low Pump Station, or directly from turnouts, it can be supplied through turnouts by the Zone 3 Water Service Area. This results in energy loss through the PRVs, and can negatively affect water quality by reducing turnover in the Dalton Tank. The City should consider a follow-up study that analyzes the feasibility of operating the two water service area zones independently for normal operations, while still maintaining connections for fire flow conditions. The study could evaluate energy savings and water quality issues and could evaluate the costs associated with enabling the Zone 2 Water Service Area to reliably supply peak hour demands without depending on supply from the Zone 3 Water Service Area PRVs.
- For the Zone 2 and 3 Water Service Areas, if Project EX-CIP-V02 is constructed, Operational Alternatives 1, 2 and 3 are all acceptable.
- As the pressures in the Zone 7 system can vary, depending on how the Zone 7 system us operated, it is recommended that the City investigate the need for PRVs at all turnouts to protect the system (pumps, pipes, reservoirs) from abnormally high pressures from Zone 7.



N

0 1,000 2,000

Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:

1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

LIVERMORE CALIFORNIA

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Figure 5-1A

Existing System
Peak Hour Demand Results
Base Operational Alternative
(Zone 1)

City of Livermore
Water Master Plan

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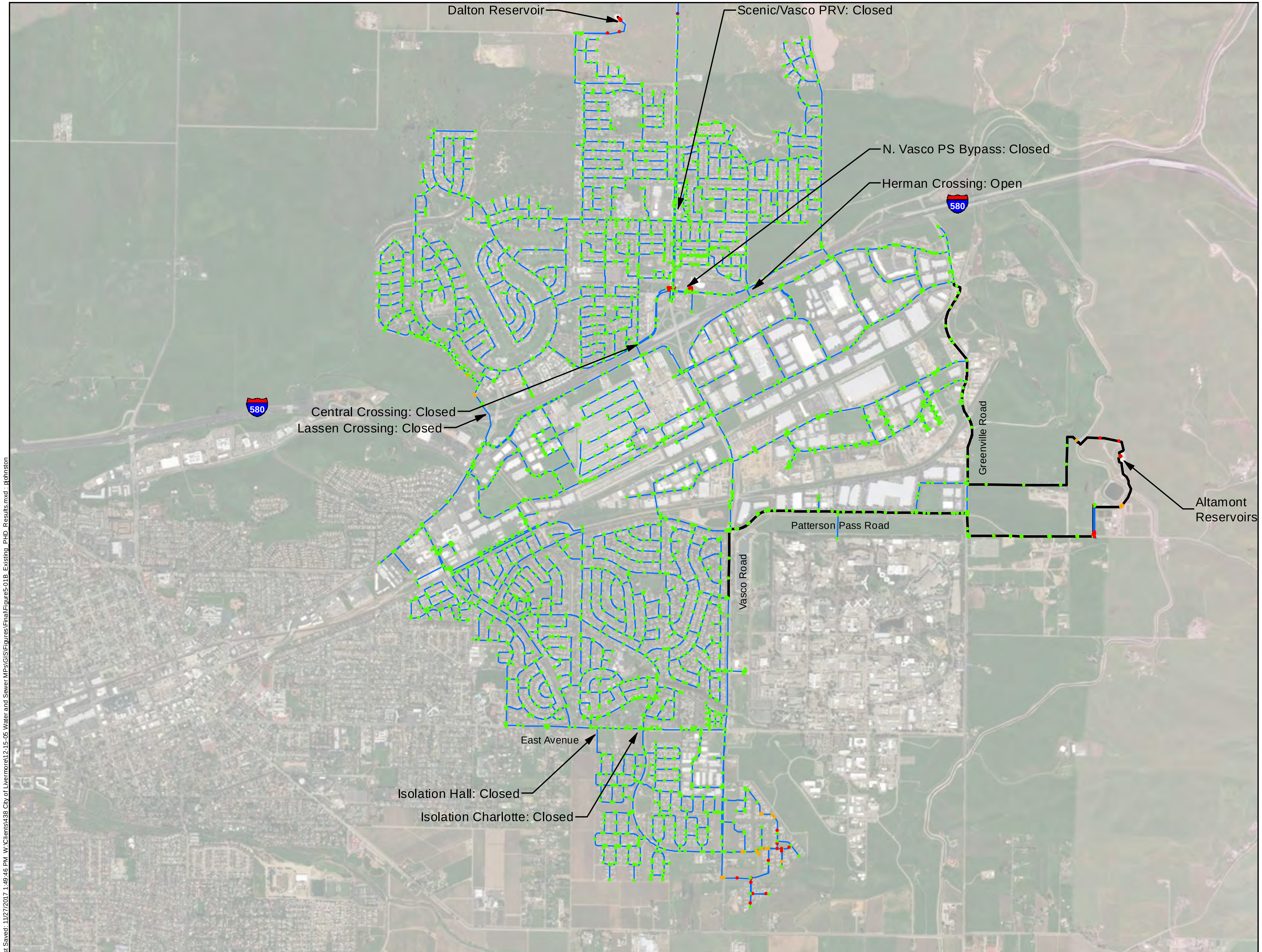

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0 1,000 2,000

Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:

1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-1B

Existing System Peak Hour Demand Results Base Operational Alternative (Zones 2 & 3)

City of Livermore
Water Master Plan

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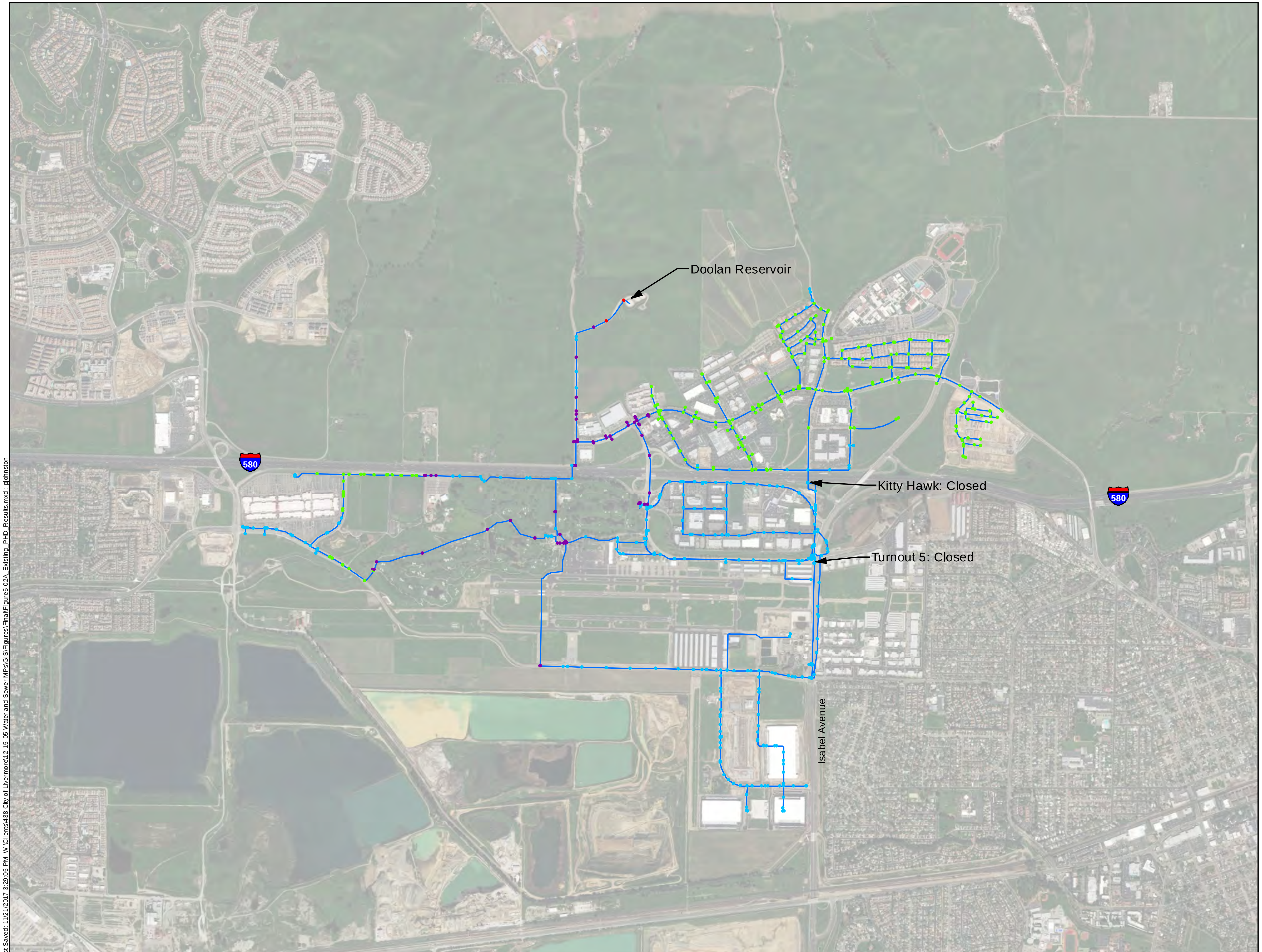

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-2A

Existing System Peak Hour Demand Results Operational Alternative 1 (Zone 1)

City of Livermore
Water Master Plan

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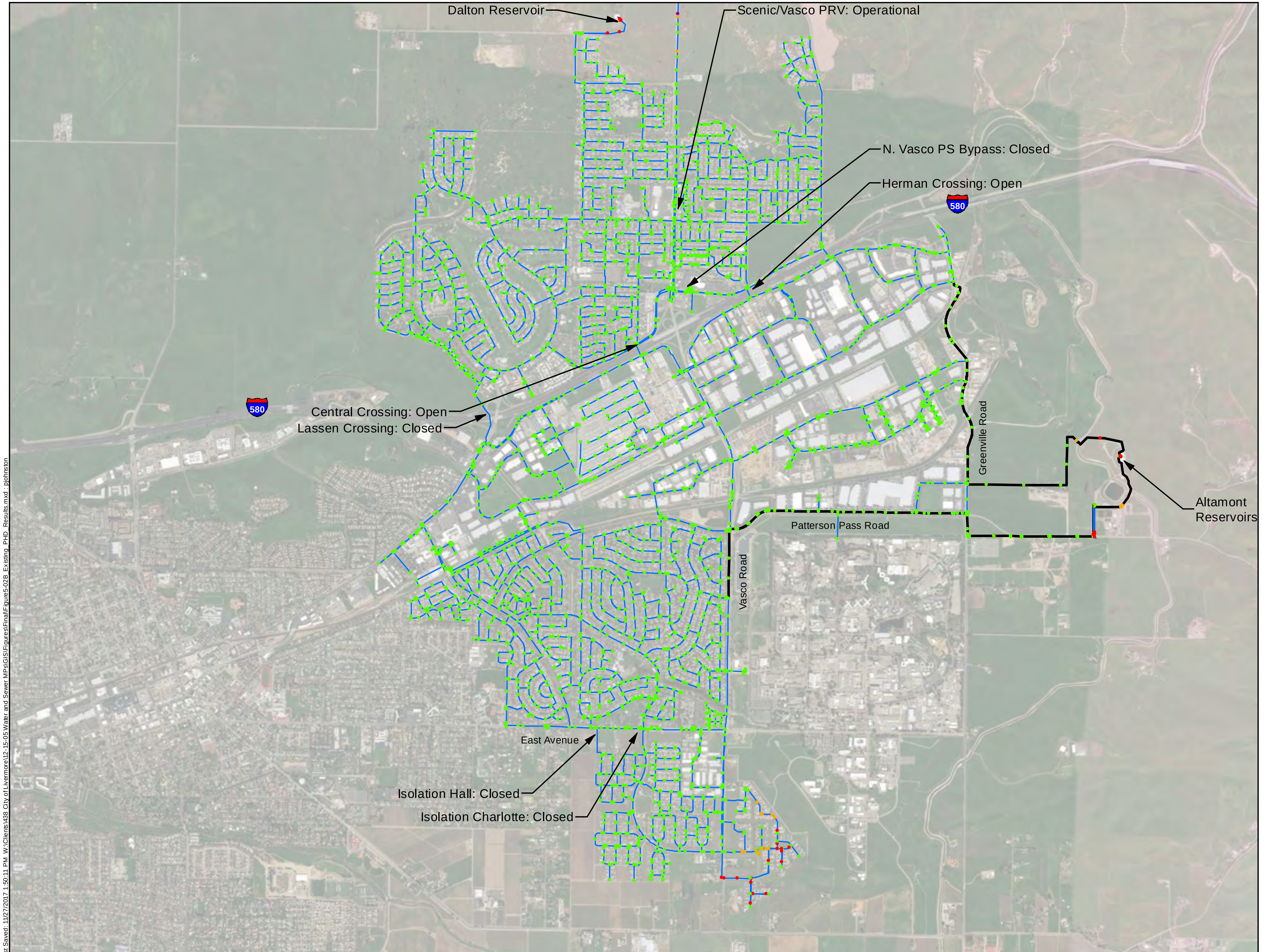

N

0 1,000 2,000

Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-2B

Existing System Peak Hour Demand Results Operational Alternative 1 (Zones 2 & 3)

City of Livermore
Water Master Plan

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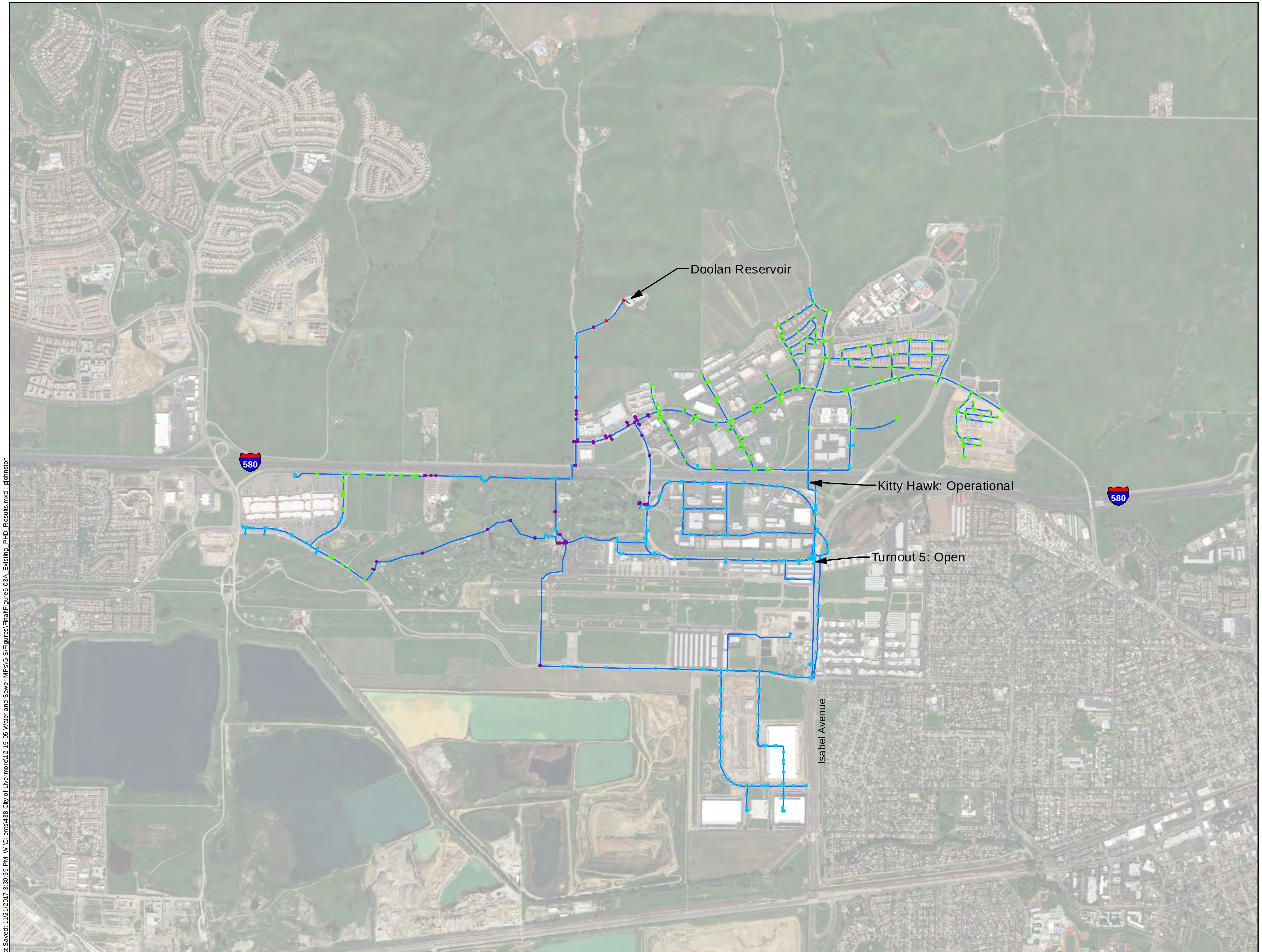

N
0 1,000 2,000
Scale in Feet

Pressure
- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)
- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-3A

Existing System Peak Hour Demand Results Operational Alternative 2 (Zone 1)

City of Livermore
Water Master Plan

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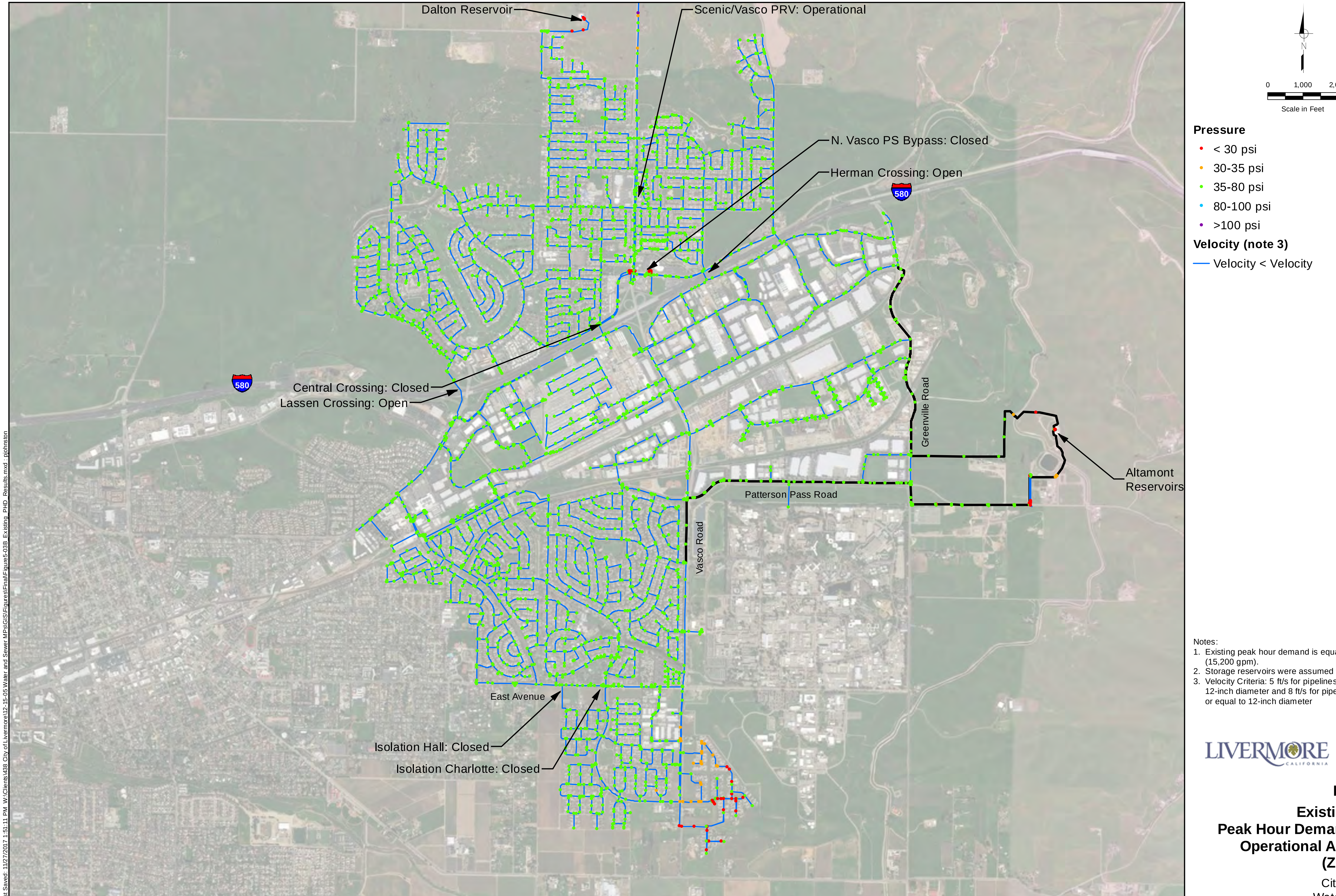

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-3B

Existing System Peak Hour Demand Results Operational Alternative 2 (Zones 2 & 3)

City of Livermore
Water Master Plan

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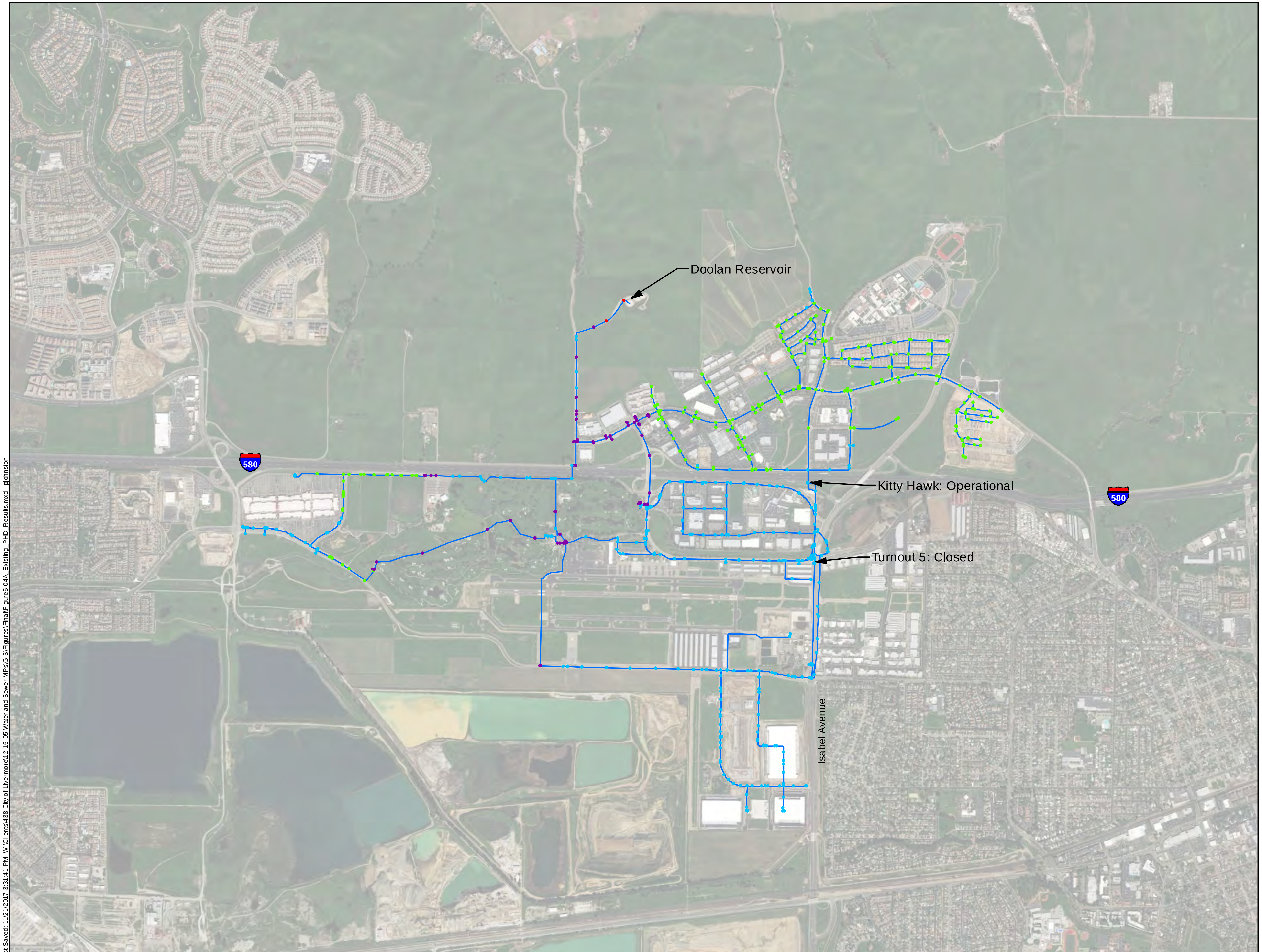

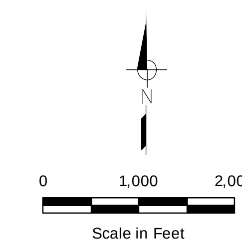

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:

1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-4A

Existing System Peak Hour Demand Results Operational Alternative 3 (Zone 1)

City of Livermore
Water Master Plan

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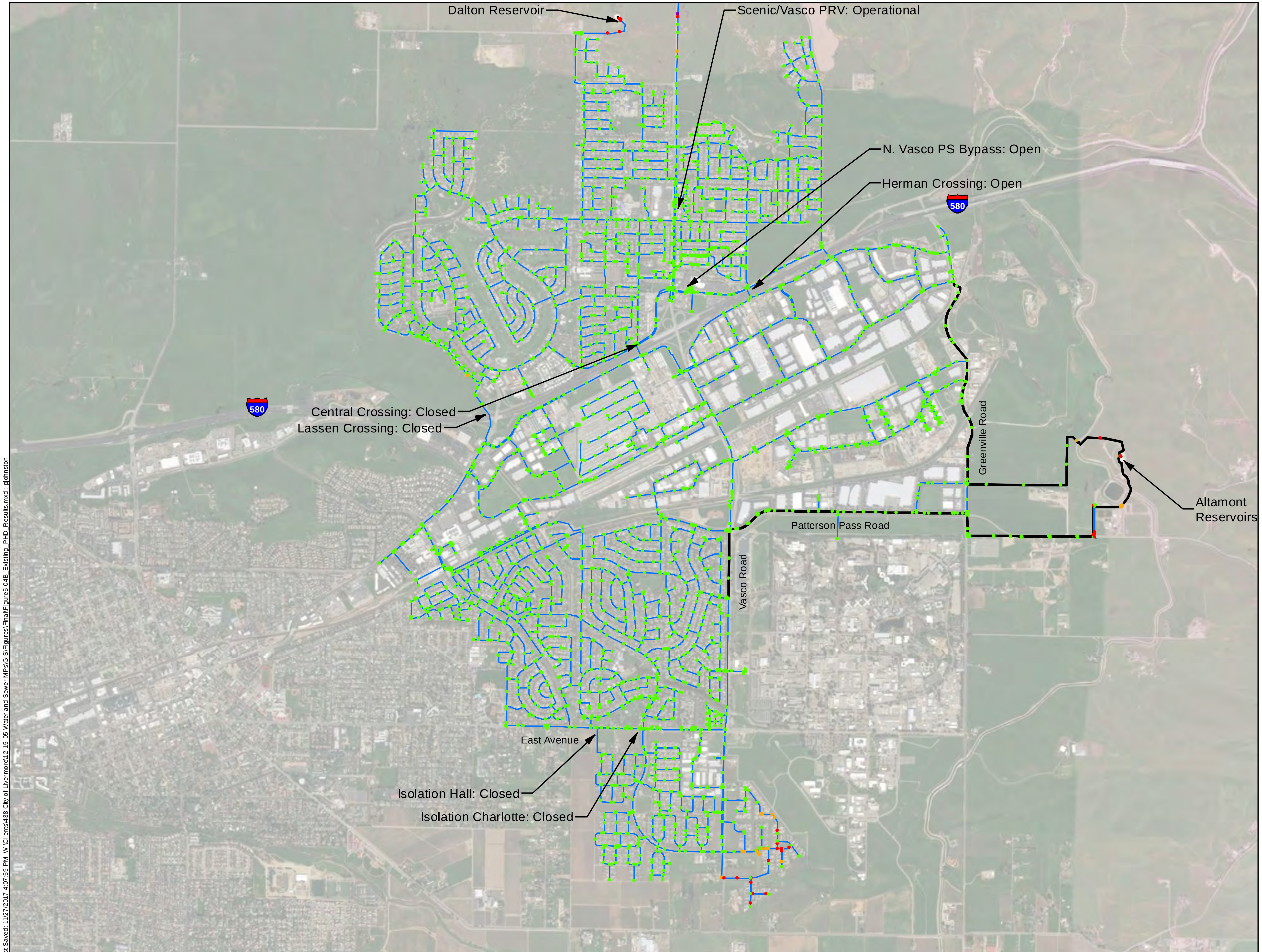

N

0 1,000 2,000

Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-4B

Existing System Peak Hour Demand Results Operational Alternative 3 (Zones 2 & 3)

City of Livermore
Water Master Plan

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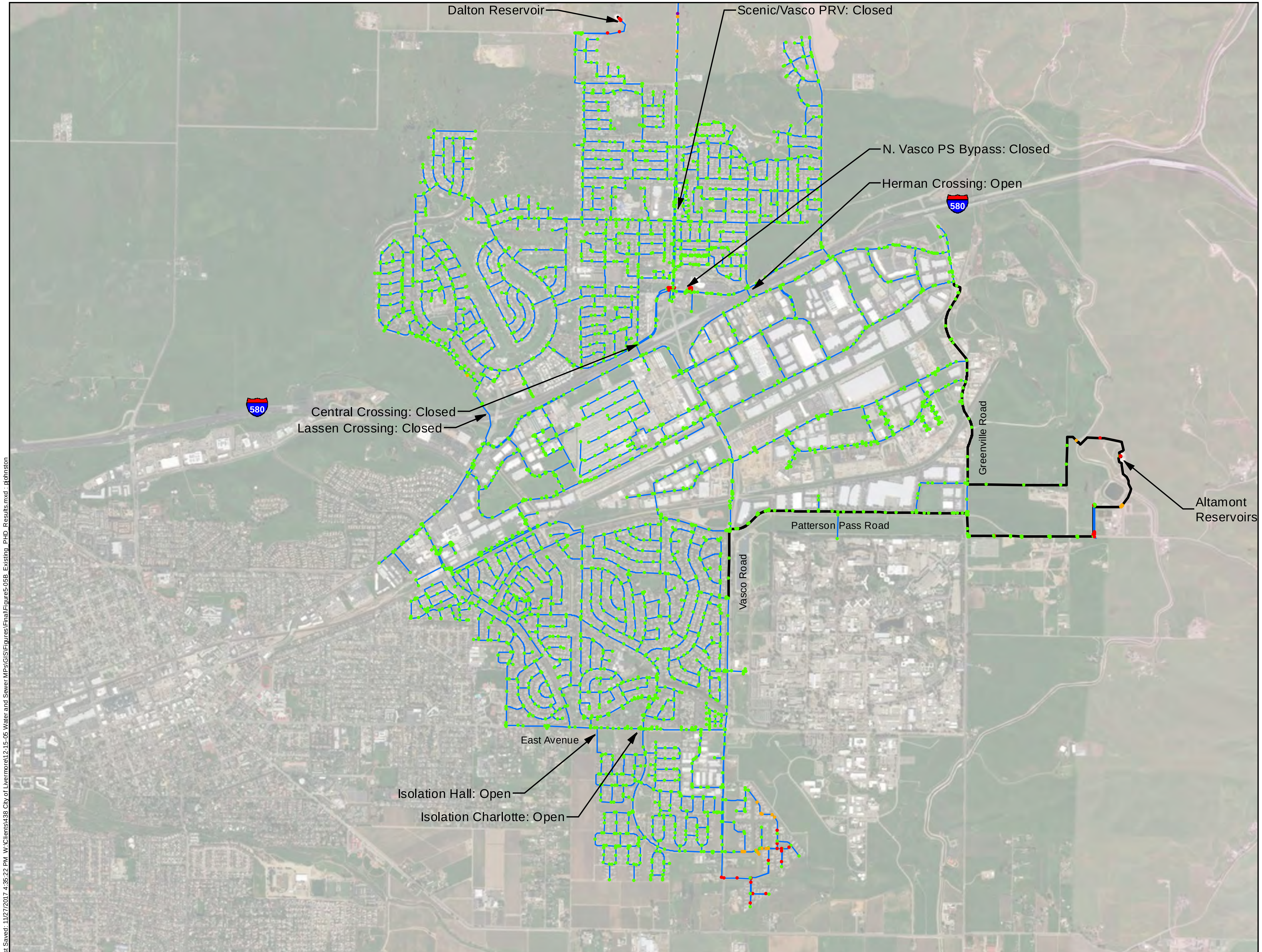

Pressure
- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)
- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter

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Figure 5-5B

Existing System Peak Hour Demand Results Operational Alternative 4 (Zones 2 & 3)

City of Livermore
Water Master Plan

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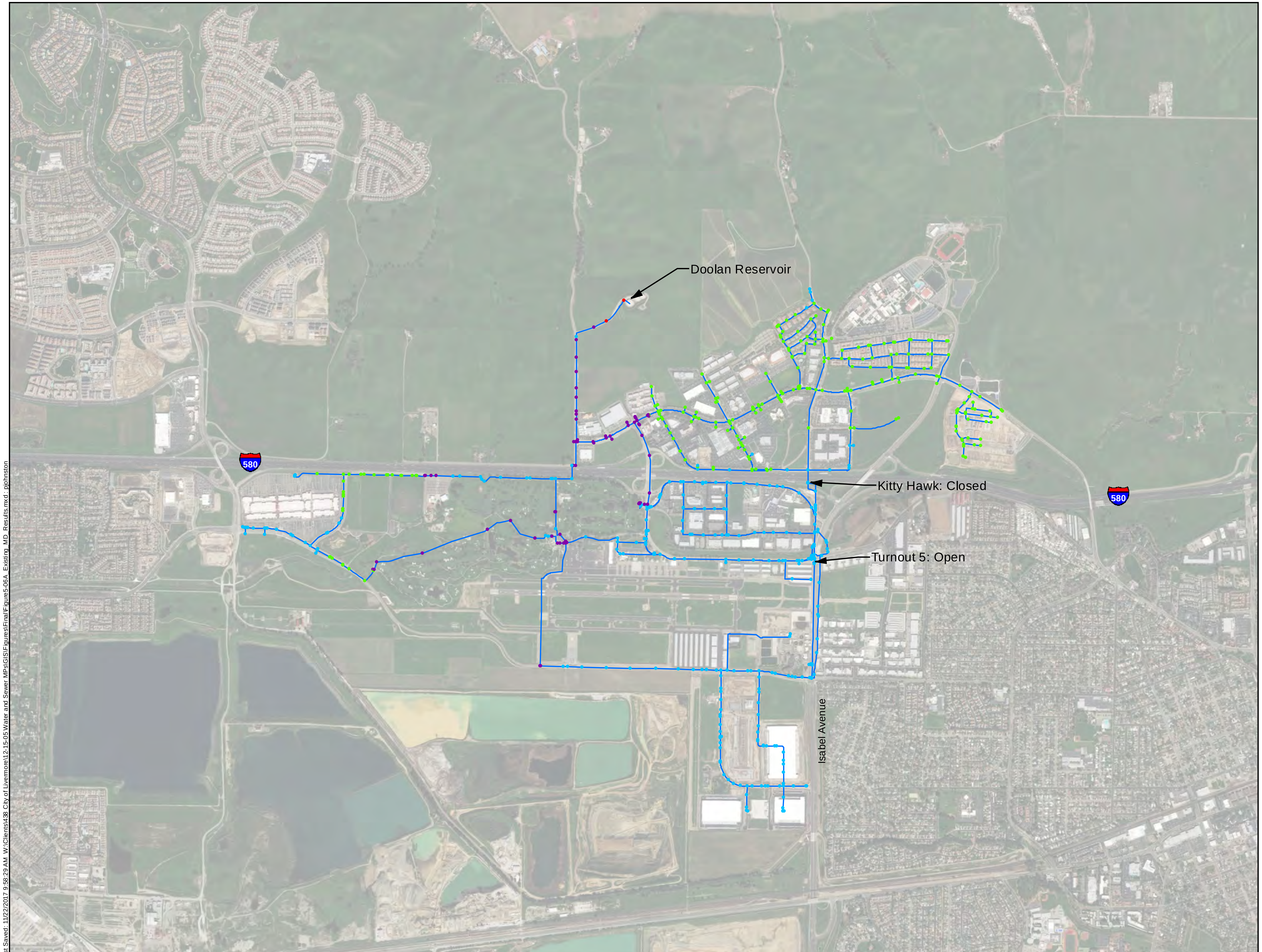

0 1,000 2,000
Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.

LIVERMORE CALIFORNIA

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Figure 5-6A

Existing System Maximum Day Demand Results Base Operational Alternative (Zone 1)

City of Livermore
Water Master Plan

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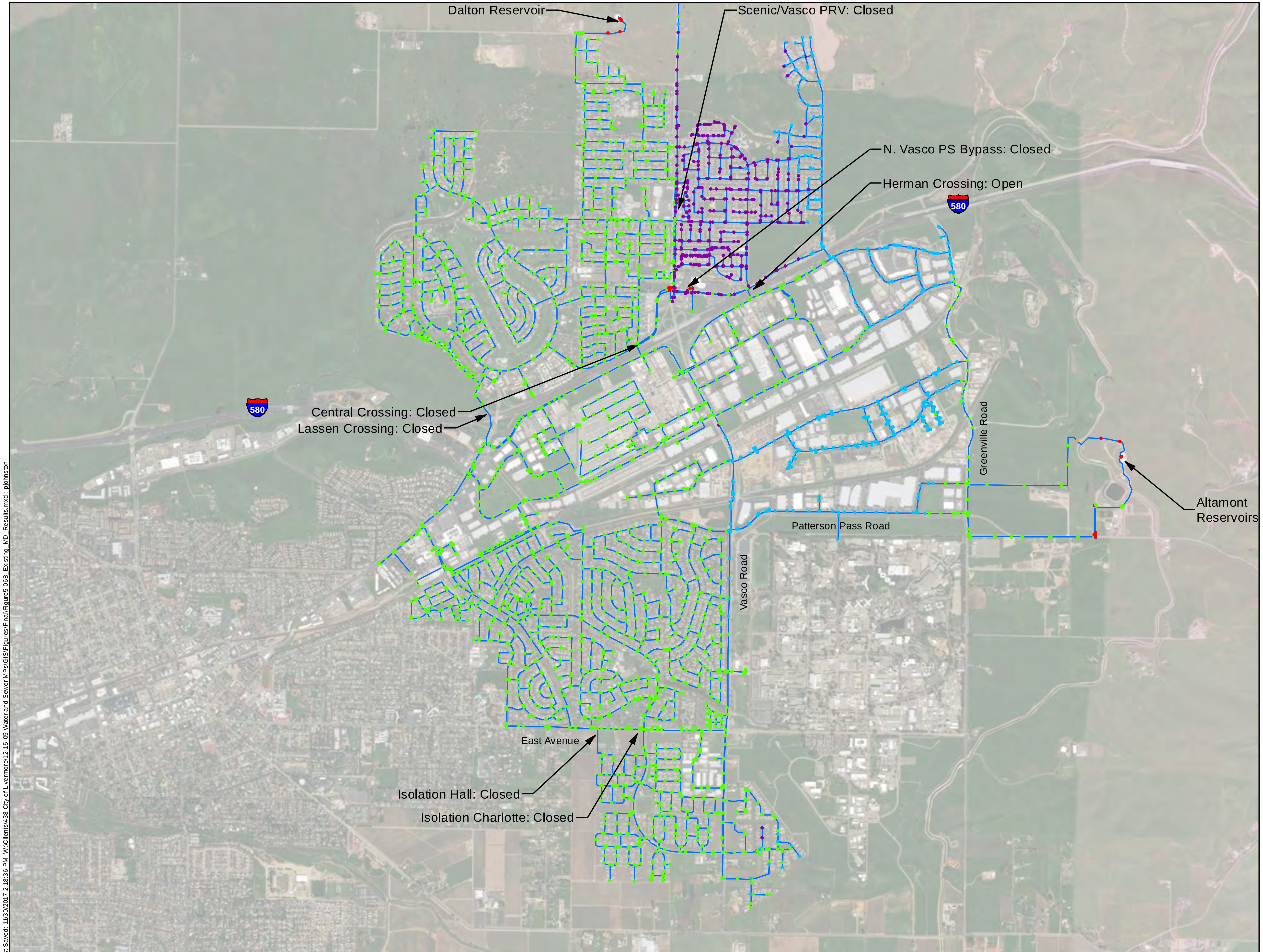

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.

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Figure 5-6B

Existing System Maximum Day Demand Results Base Operational Alternative (Zones 2 & 3)

City of Livermore
Water Master Plan

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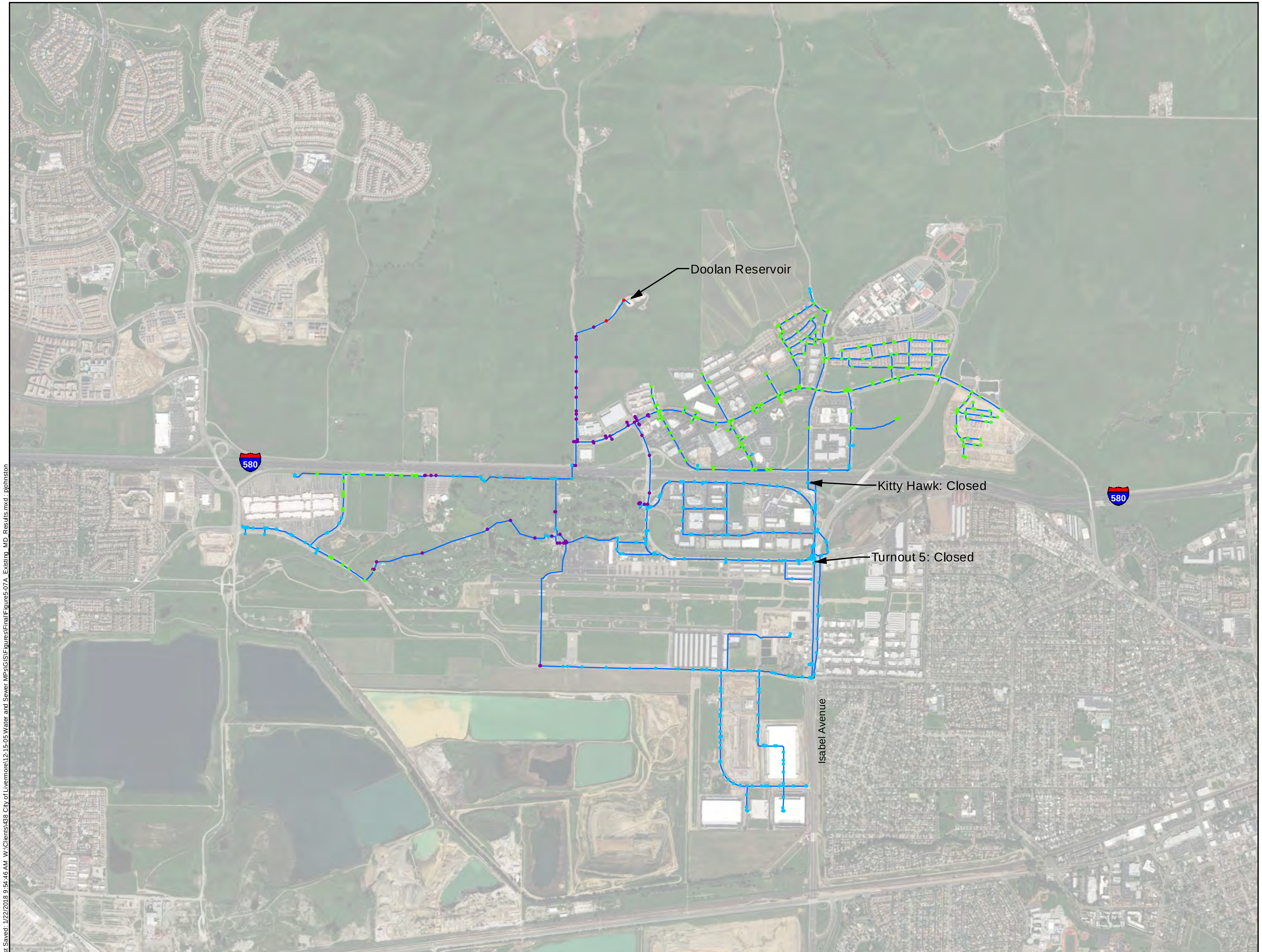

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.

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Figure 5-7A

Existing System Maximum Day Demand Results Operational Alternative 1 (Zone 1)

City of Livermore
Water Master Plan

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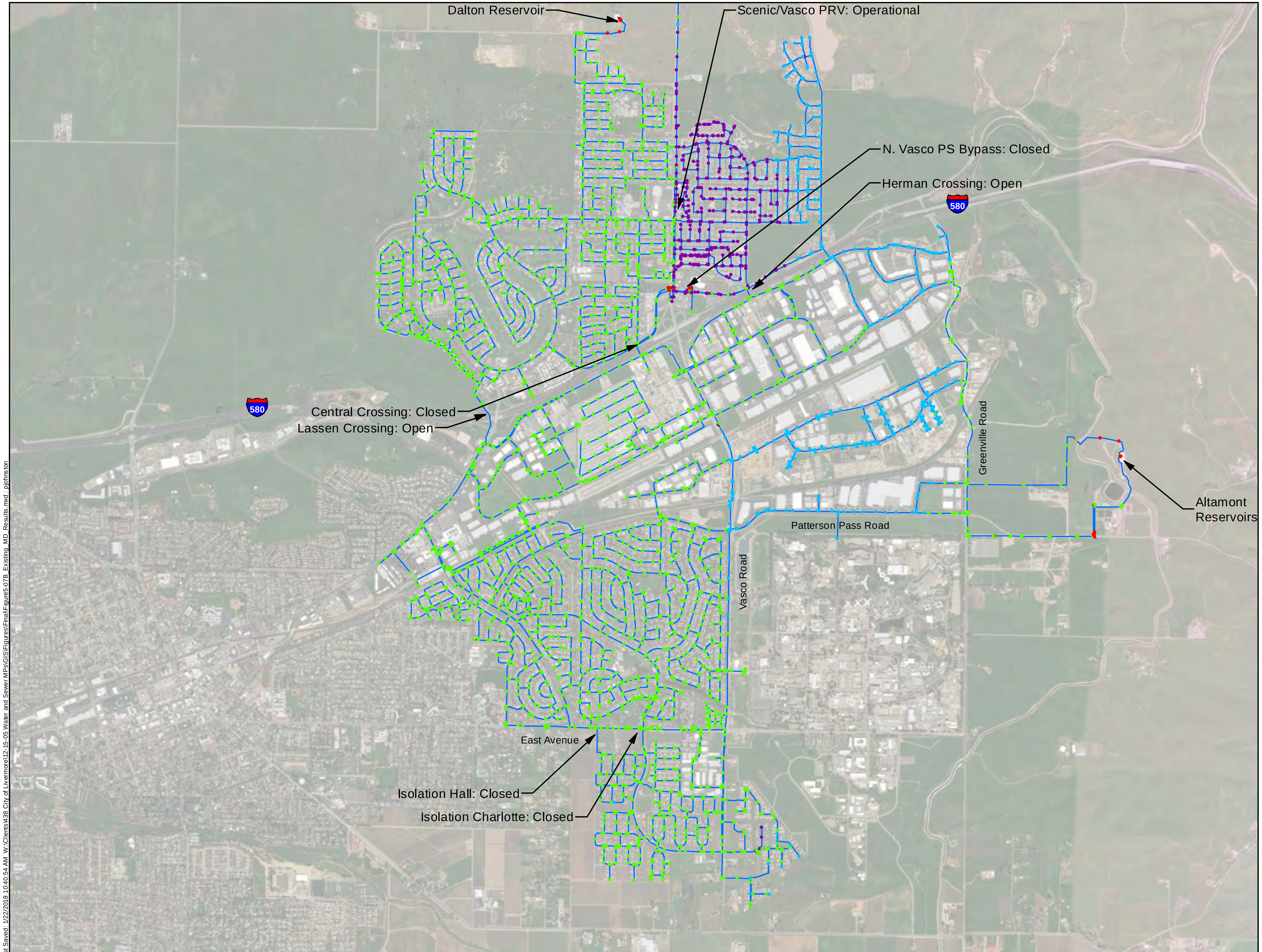

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:

1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.

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Figure 5-7B

Existing System Maximum Day Demand Results Operational Alternative 1 (Zones 2 & 3)

City of Livermore
Water Master Plan

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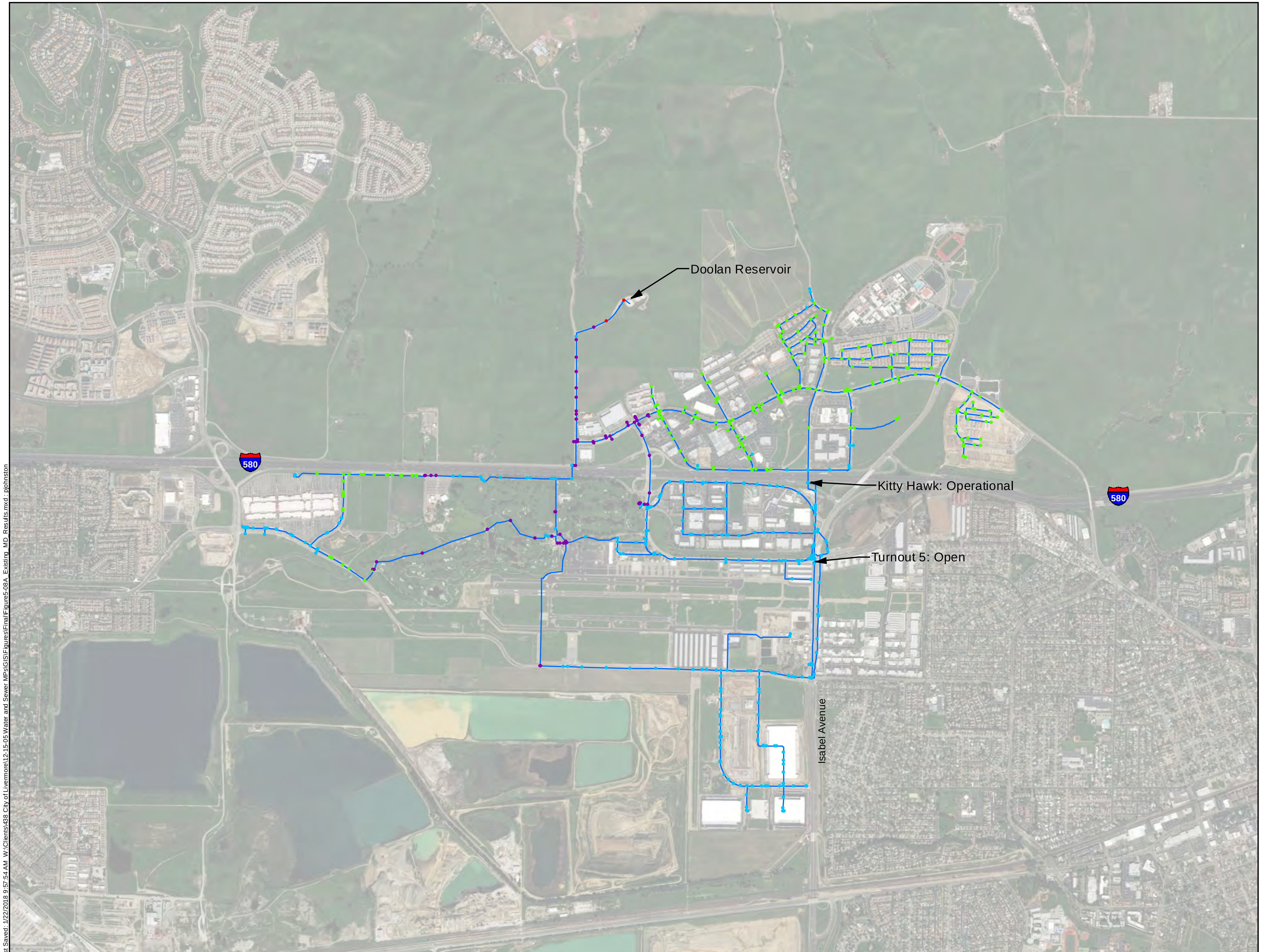

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.

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Figure 5-8A

Existing System Maximum Day Demand Results Operational Alternative 2 (Zone 1)

City of Livermore
Water Master Plan

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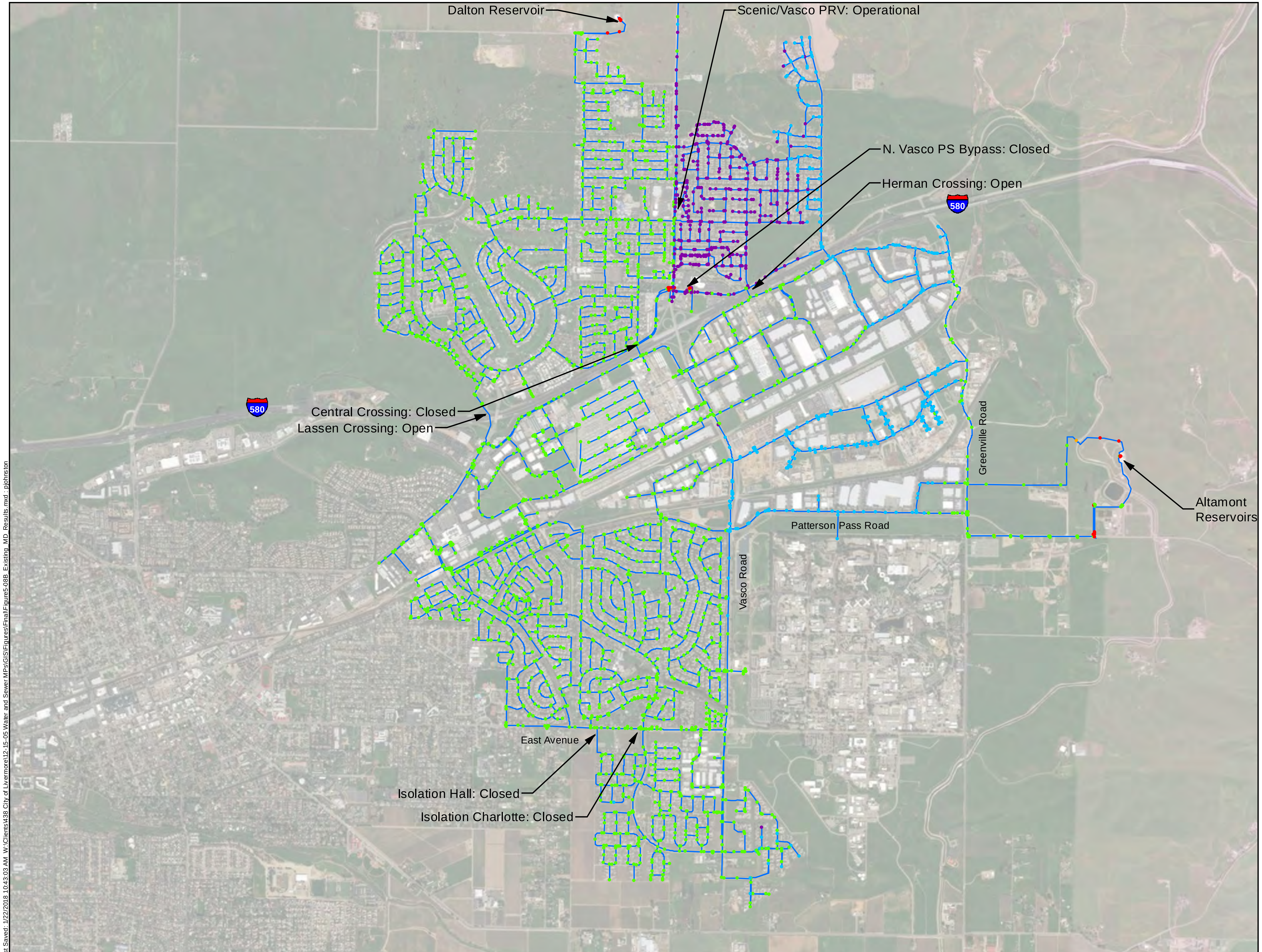

0 1,000 2,000
Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.

LIVERMORE CALIFORNIA

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Figure 5-8B

Existing System Maximum Day Demand Results Operational Alternative 2 (Zones 2 & 3)

City of Livermore
Water Master Plan

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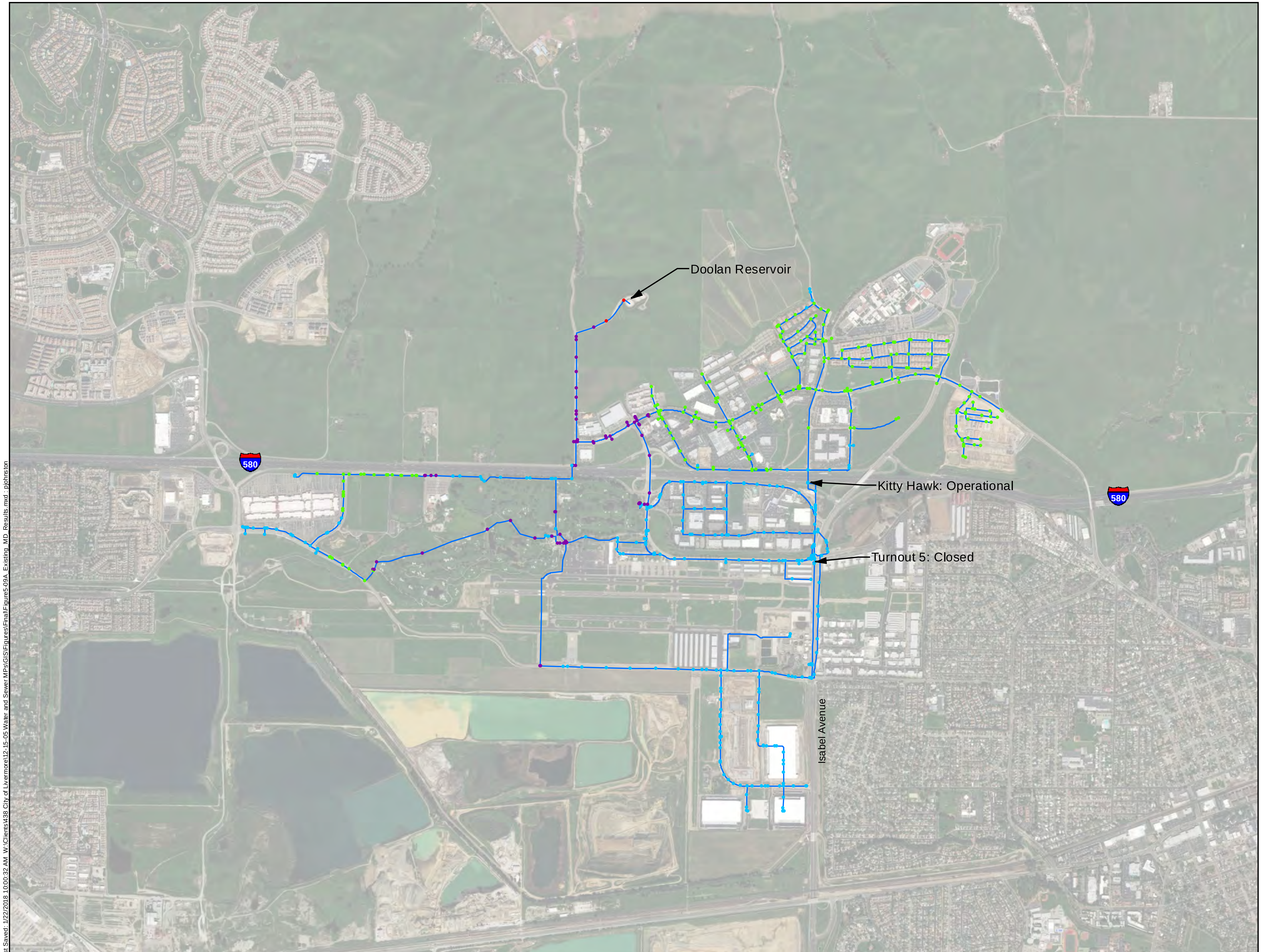

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.

LIVERMORE CALIFORNIA

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Figure 5-9A

Existing System Maximum Day Demand Results Operational Alternative 3 (Zone 1)

City of Livermore
Water Master Plan

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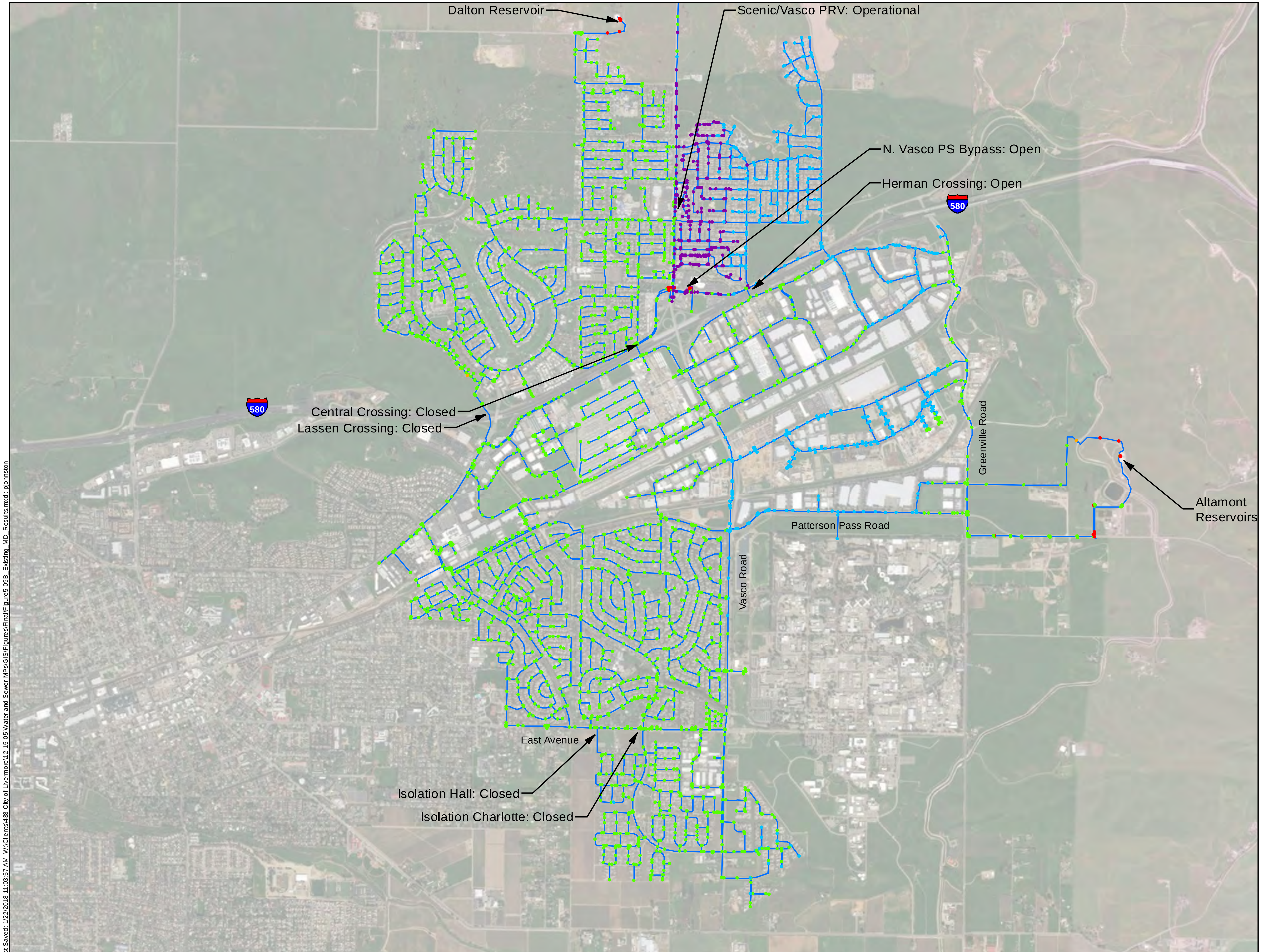

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:

1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.

LIVERMORE CALIFORNIA

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Figure 5-9B

Existing System Maximum Day Demand Results Operational Alternative 3 (Zones 2 & 3)

City of Livermore
Water Master Plan

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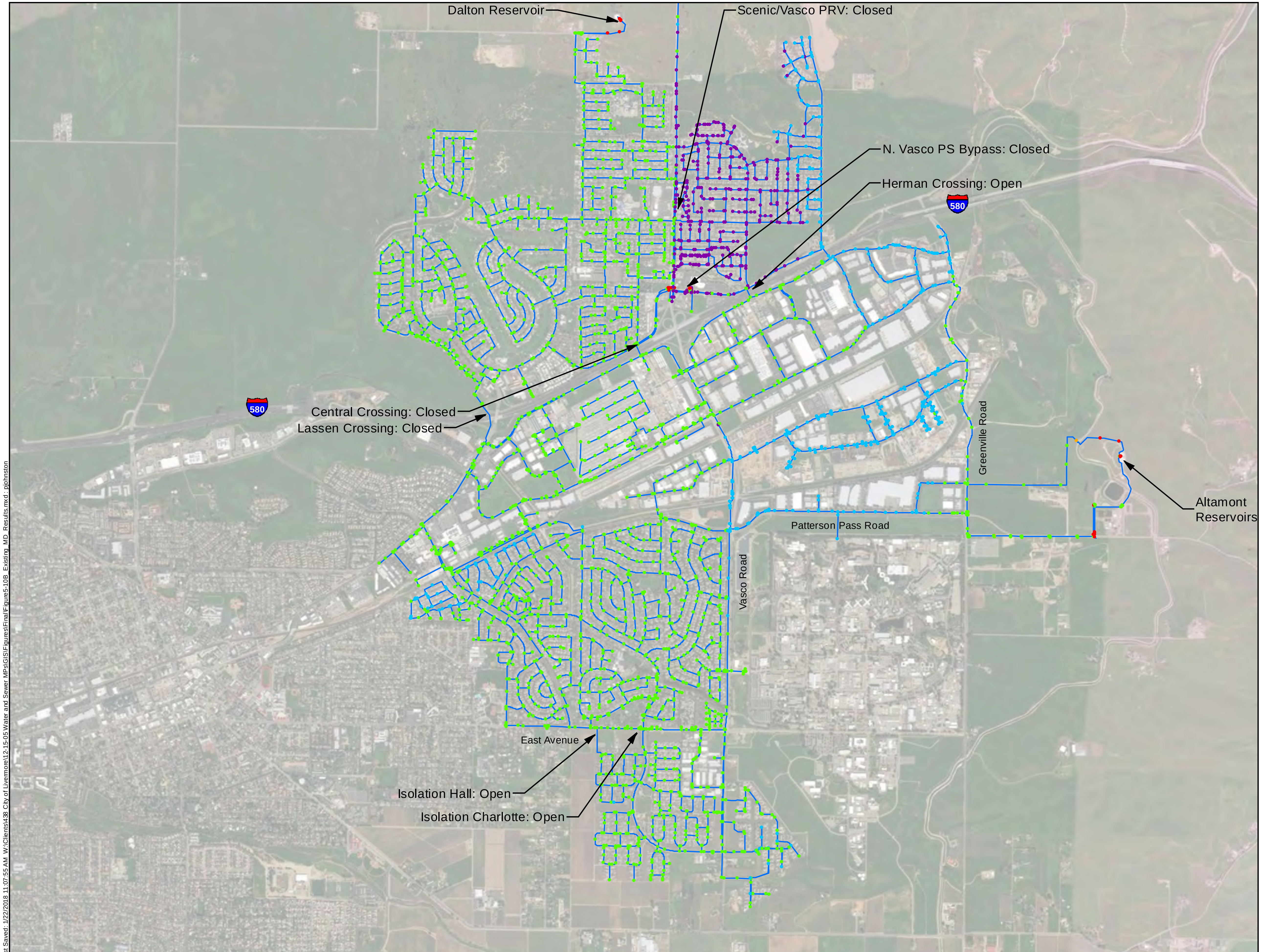

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:

1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.

LIVERMORE CALIFORNIA

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Figure 5-10B

Existing System Maximum Day Demand Results Operational Alternative 4 (Zones 2 & 3)

City of Livermore
Water Master Plan

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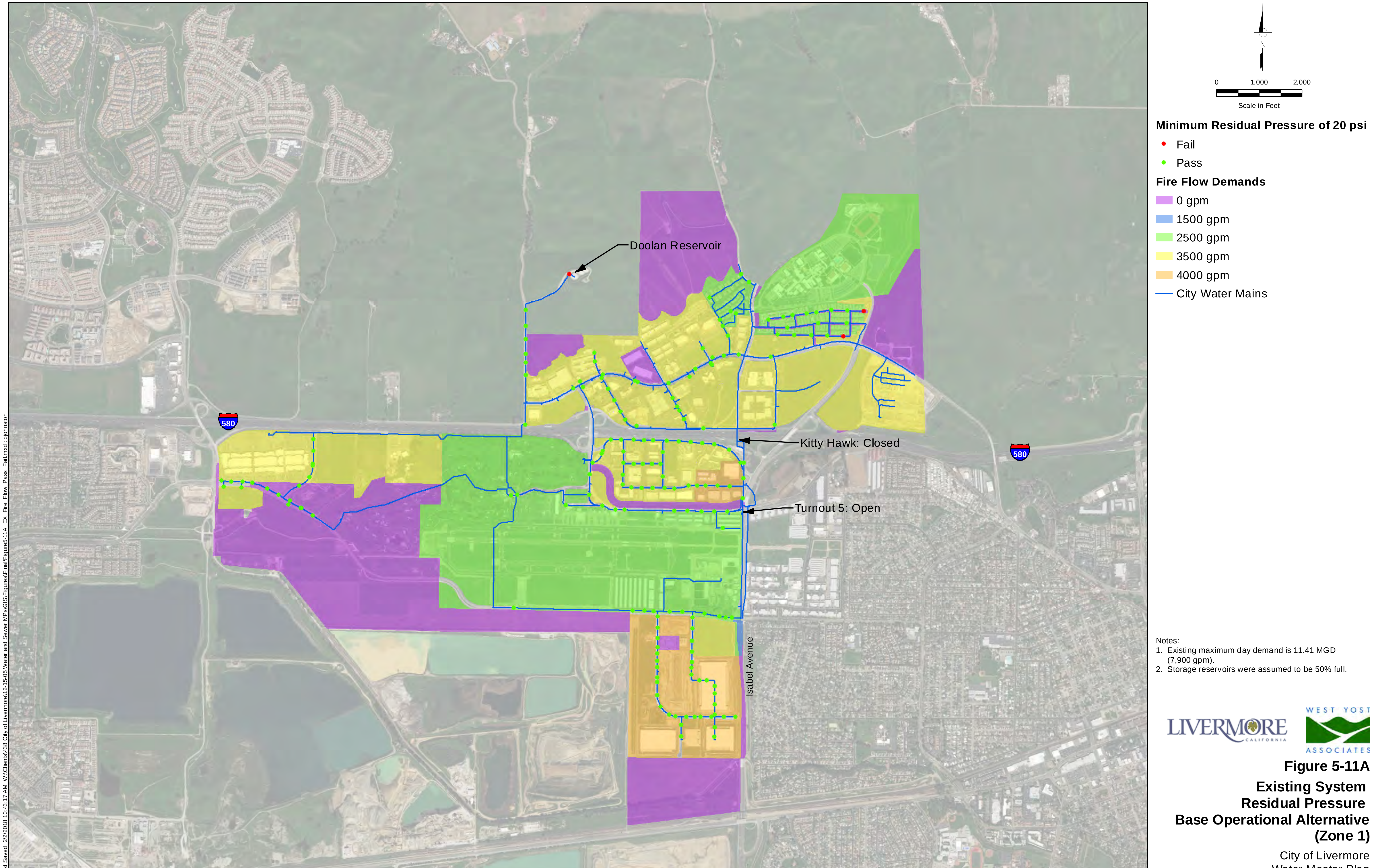

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-11A

Existing System Residual Pressure Base Operational Alternative (Zone 1)

City of Livermore
Water Master Plan

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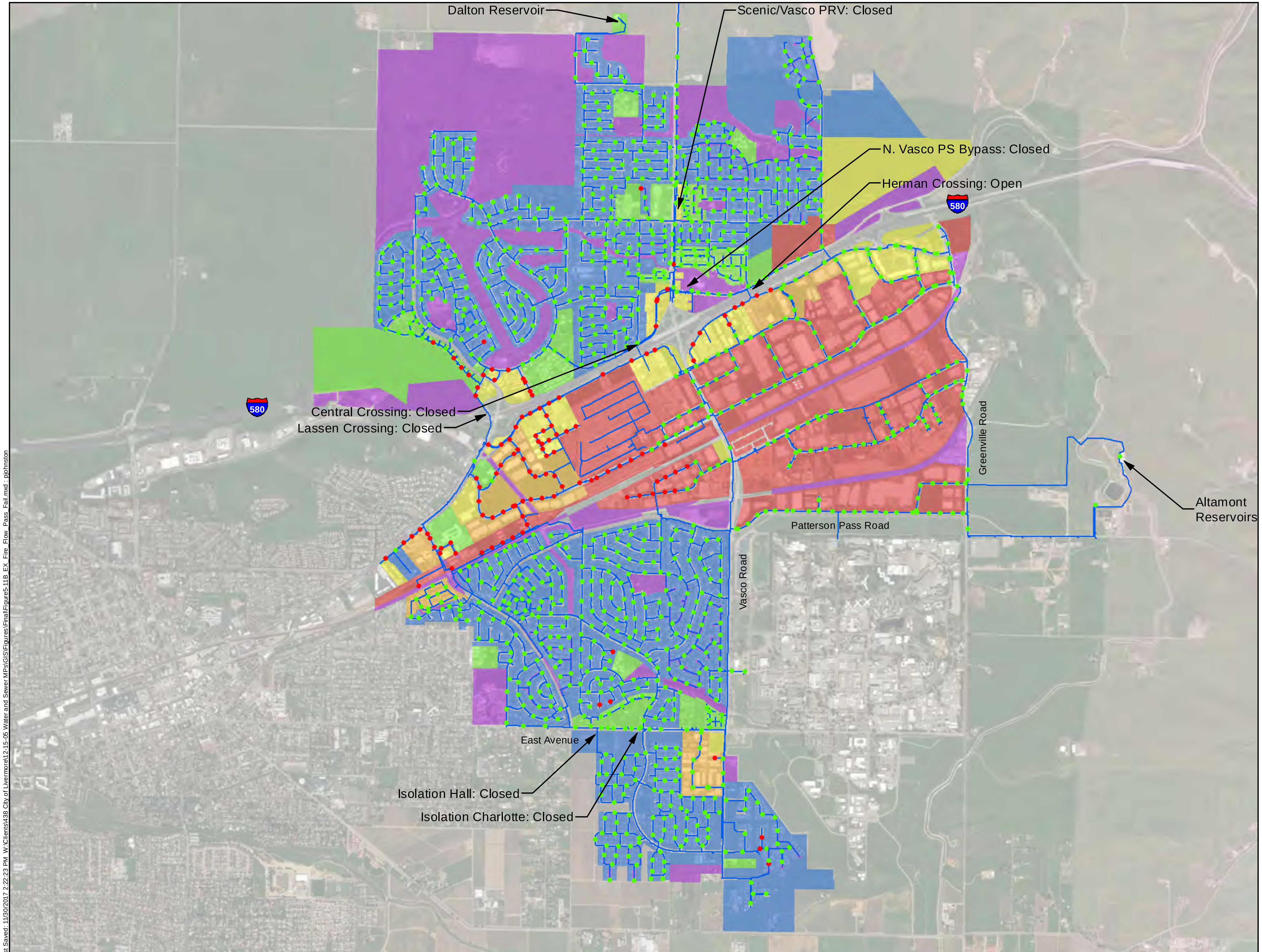

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-11B

Existing System Residual Pressure Base Operational Alternative (Zones 2 & 3)

City of Livermore
Water Master Plan

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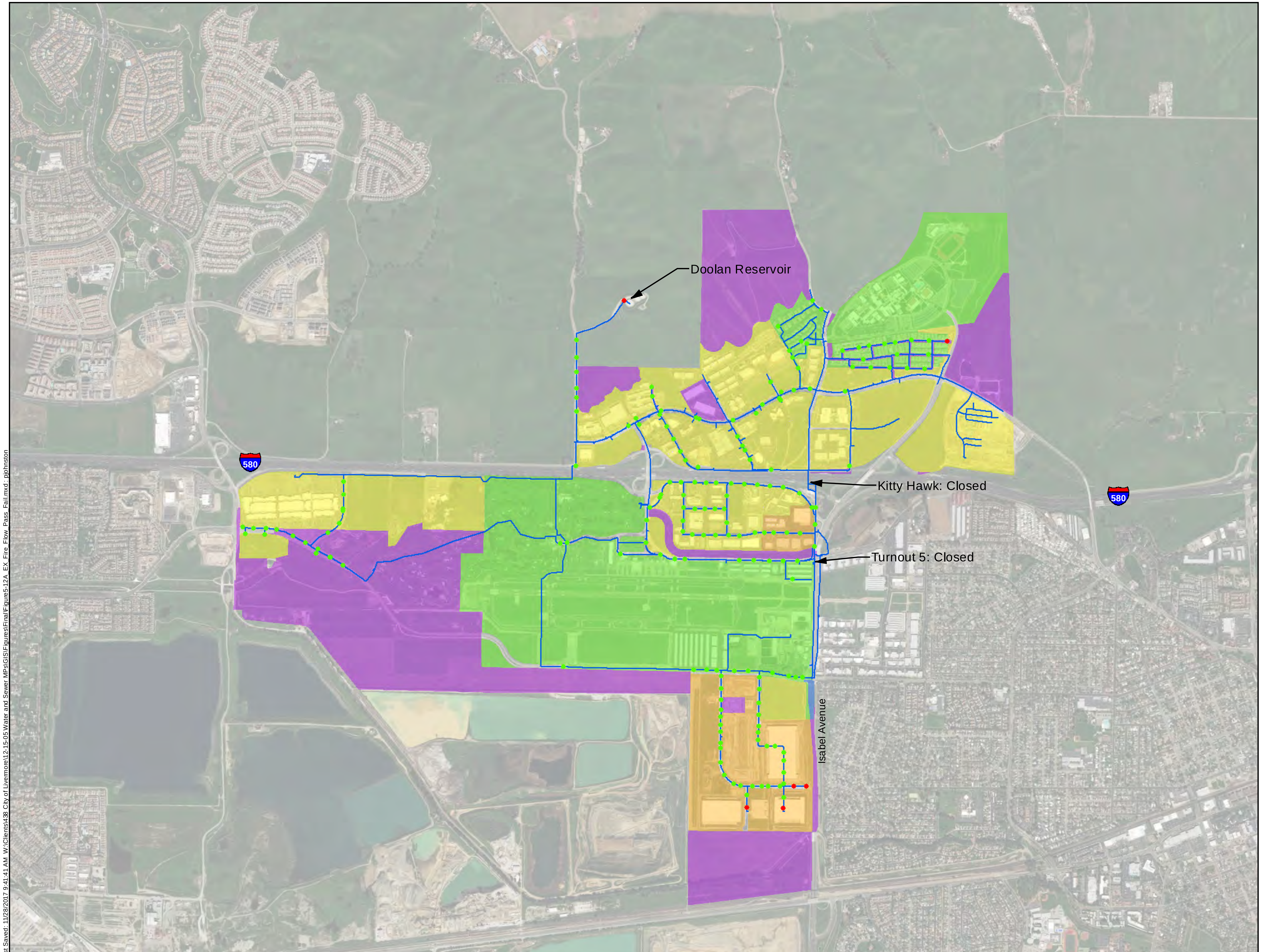

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- City Water Mains

Notes:

1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-12A

Existing System Residual Pressure Operational Alternative 1 (Zone 1)

City of Livermore
Water Master Plan

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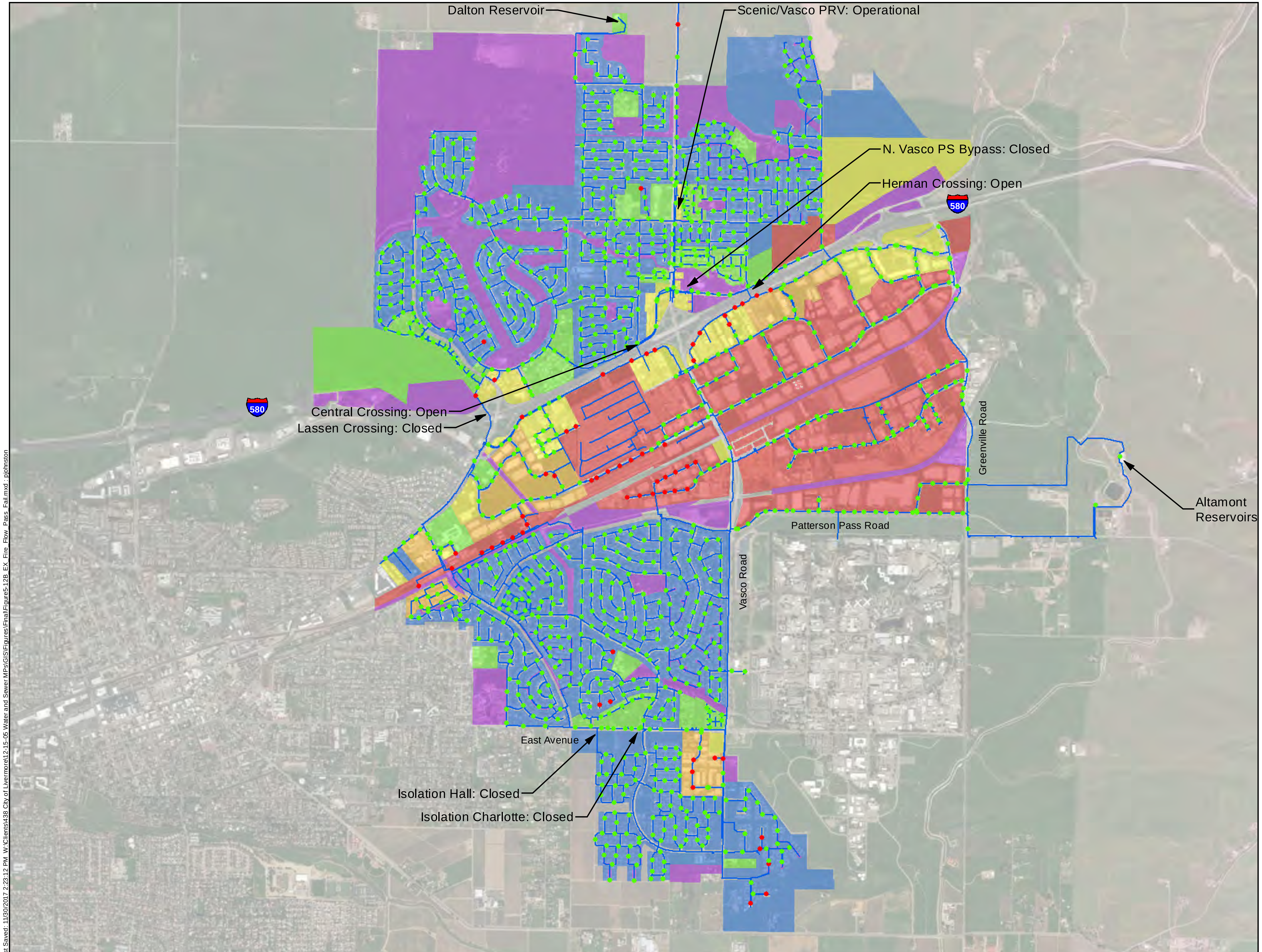

N

0 1,000 2,000
Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA
WEST YOST ASSOCIATES

Figure 5-12B

Existing System Residual Pressure Operational Alternative 1 (Zones 2 & 3)

City of Livermore
Water Master Plan

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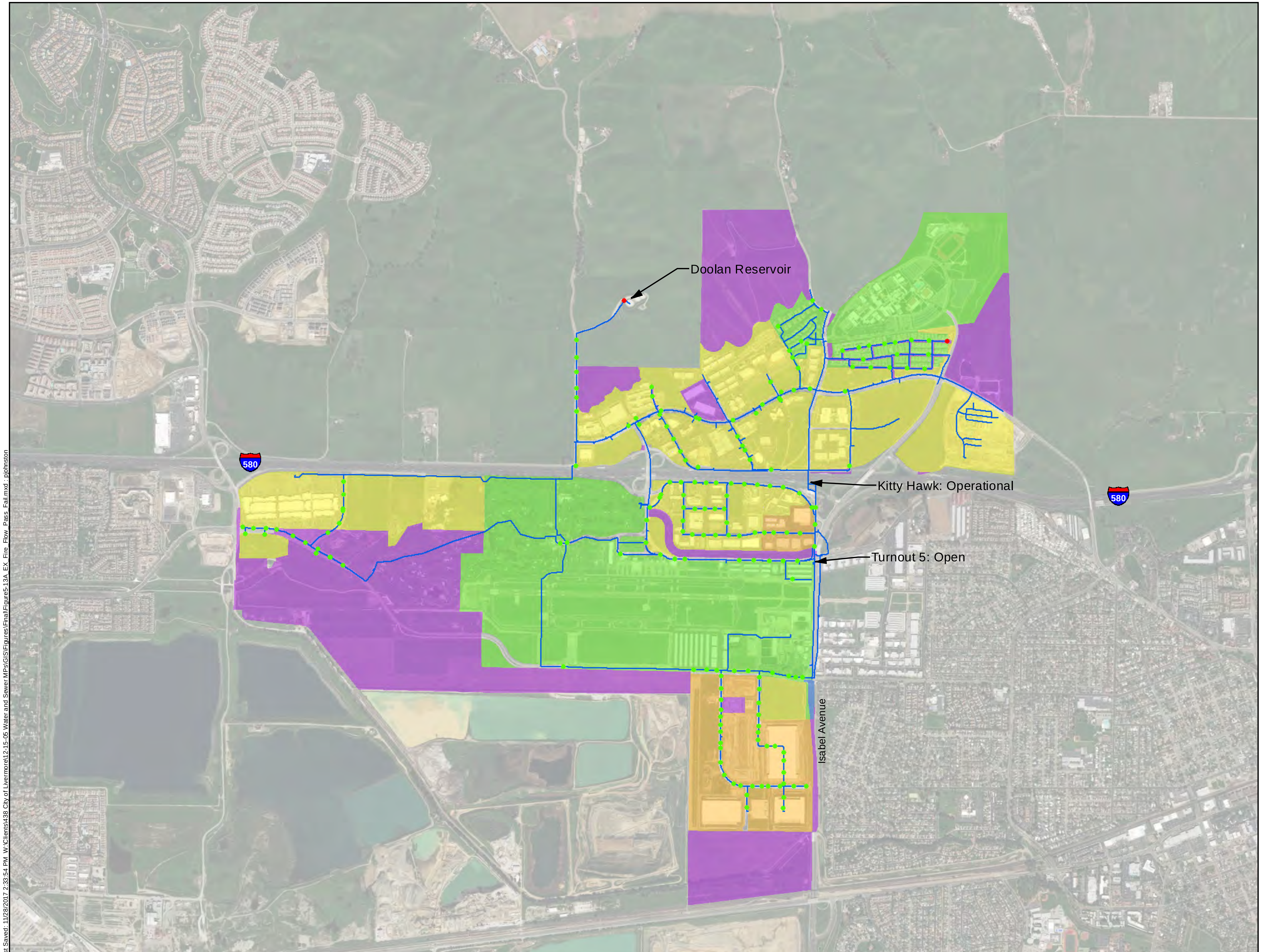

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-13A

Existing System Residual Pressure Operational Alternative 2 (Zone 1)

City of Livermore
Water Master Plan

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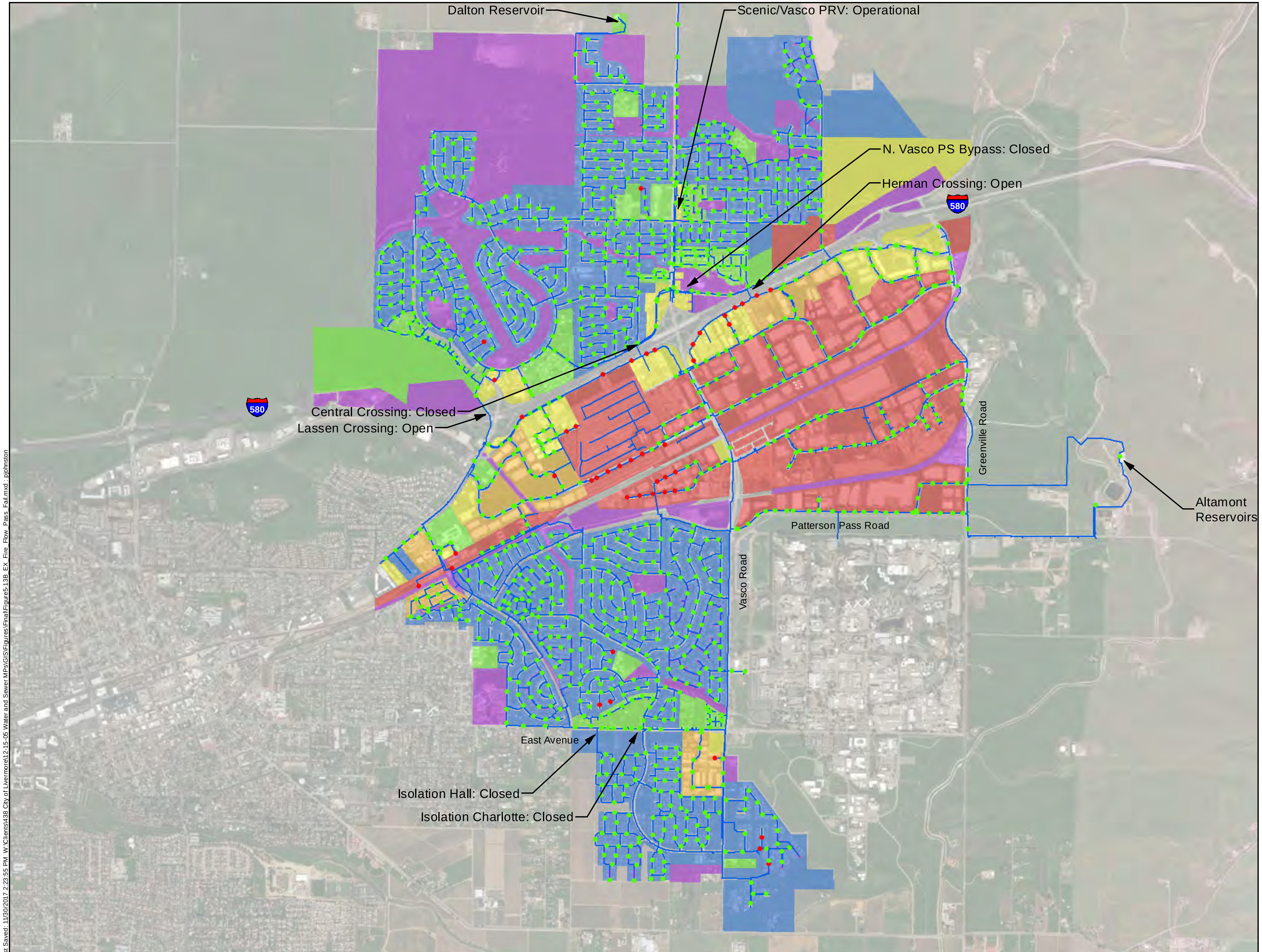

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

Pass/Fail

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-13B

Existing System Residual Pressure Operational Alternative 2 (Zones 2 & 3)

City of Livermore
Water Master Plan

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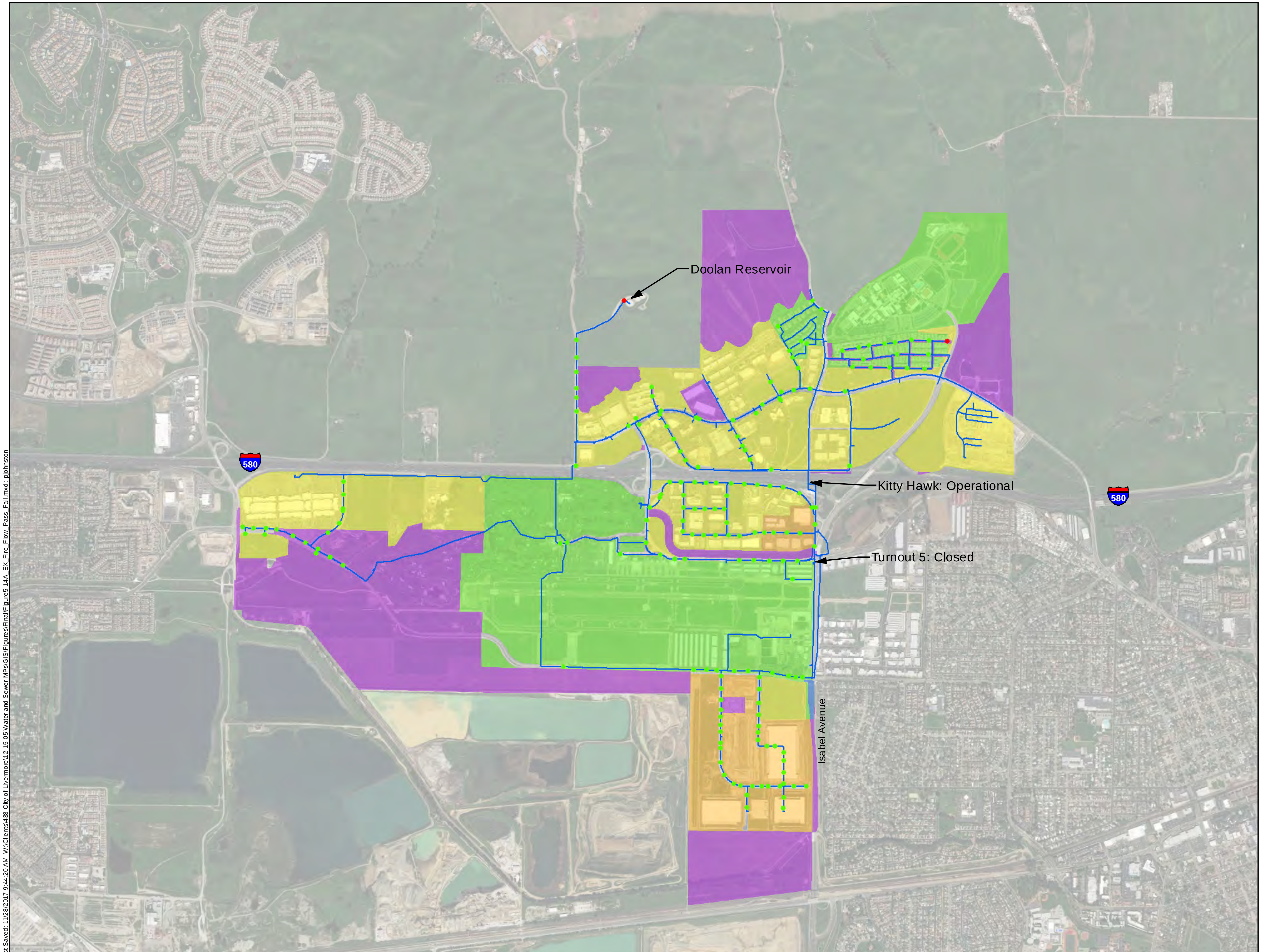

Minimum Residual Pressure of 20 psi

Pass/Fail

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-14A

Existing System Residual Pressure Operational Alternative 3 (Zone 1)

City of Livermore
Water Master Plan

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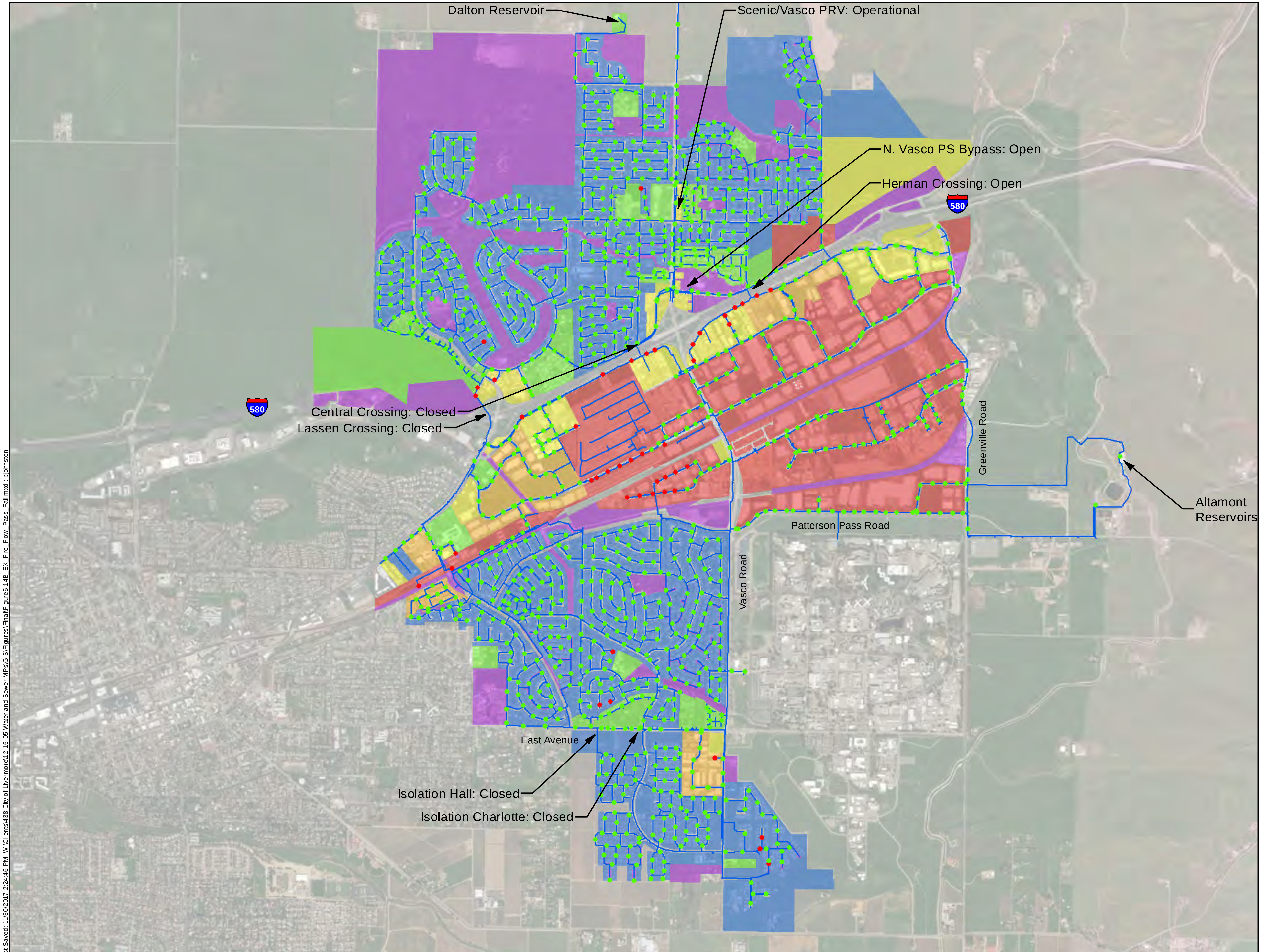

Minimum Residual Pressure of 20 psi

Pass/Fail

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-14B

Existing System Residual Pressure Operational Alternative 3 (Zones 2 & 3)

City of Livermore
Water Master Plan

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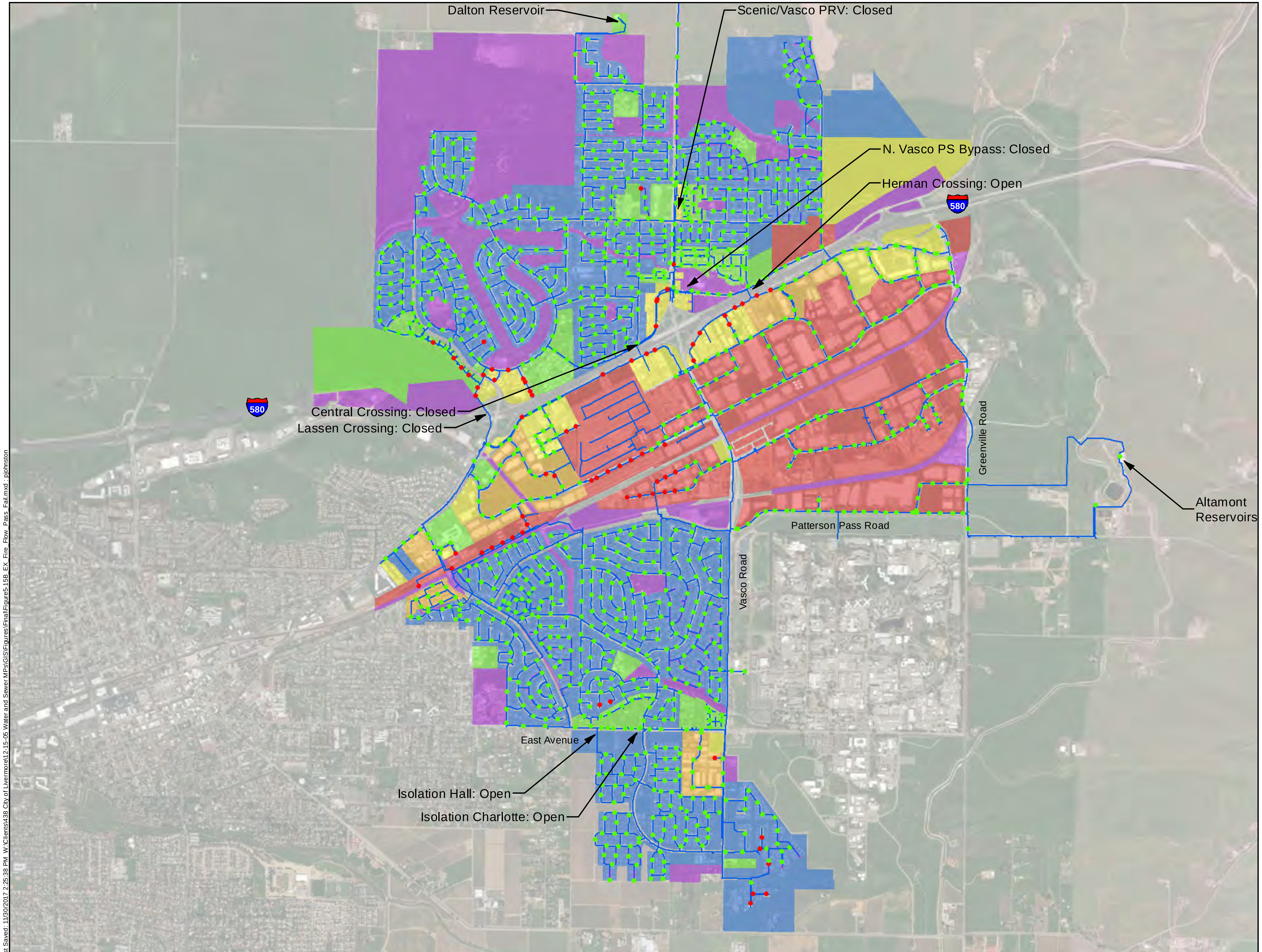

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

Pass/Fail

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.

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Figure 5-15B

Existing System Residual Pressure Operational Alternative 4 (Zones 2 & 3)

City of Livermore
Water Master Plan

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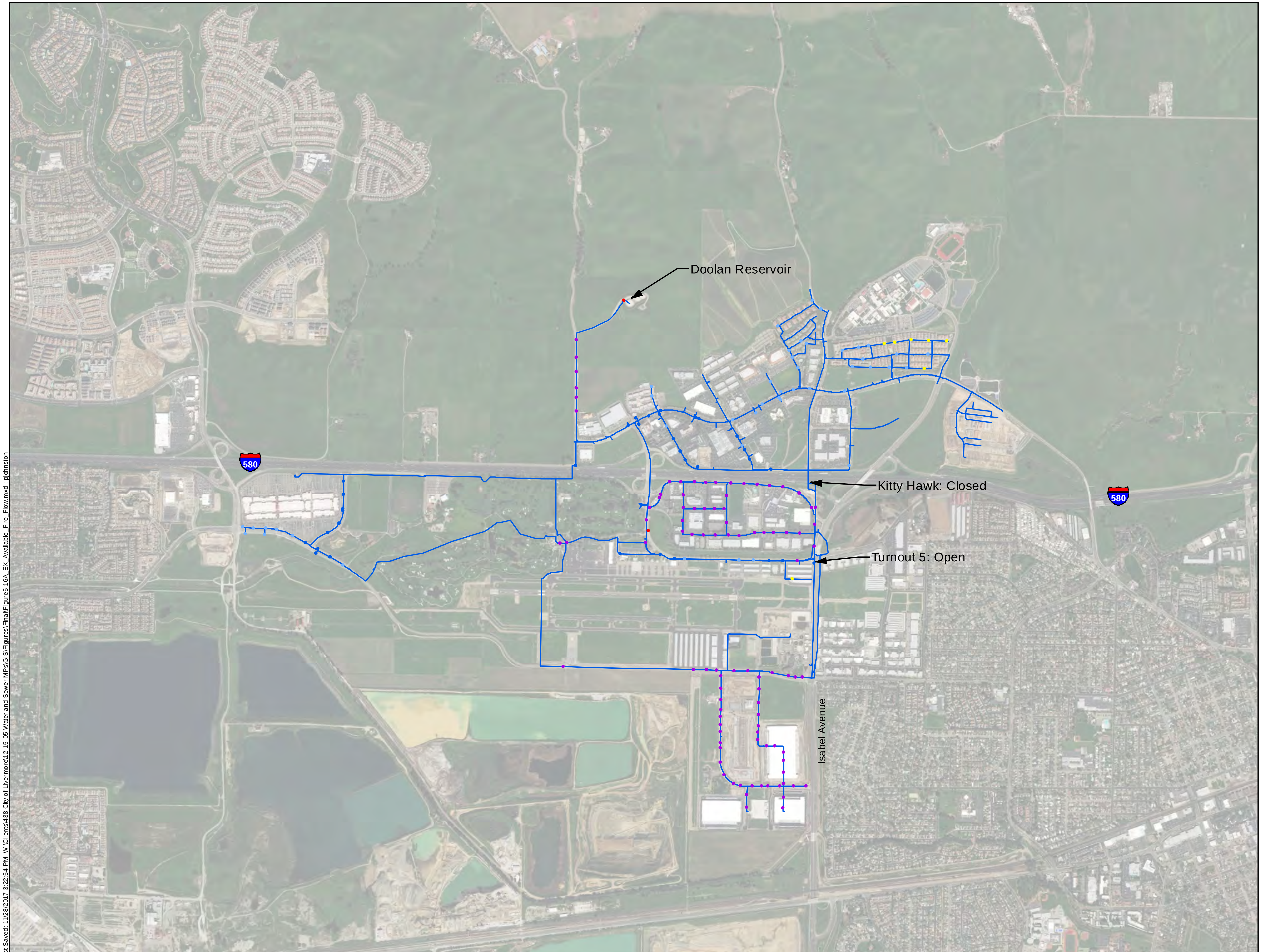

N

0 1,000 2,000

Scale in Feet

Available Flow at 20 psi

- Less than 500 gpm
- 500 to 1,000 gpm
- 1,000 to 1,500 gpm
- 1,500 to 2,000 gpm
- 2,000 to 2,500 gpm
- 2,500 gpm to 3,500 gpm
- 3,500 gpm to 4,500 gpm
- 4,500 gpm to 5,500 gpm
- Greater than 5,500 gpm
- City Water Mains

Notes:

1. Existing maximum day demand is 11.4 MGD (7,926 gpm).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 5-16A

Existing System Available Fire Flow at 20 psi Base Operational Alternative (Zone 1)

City of Livermore
Water Master Plan

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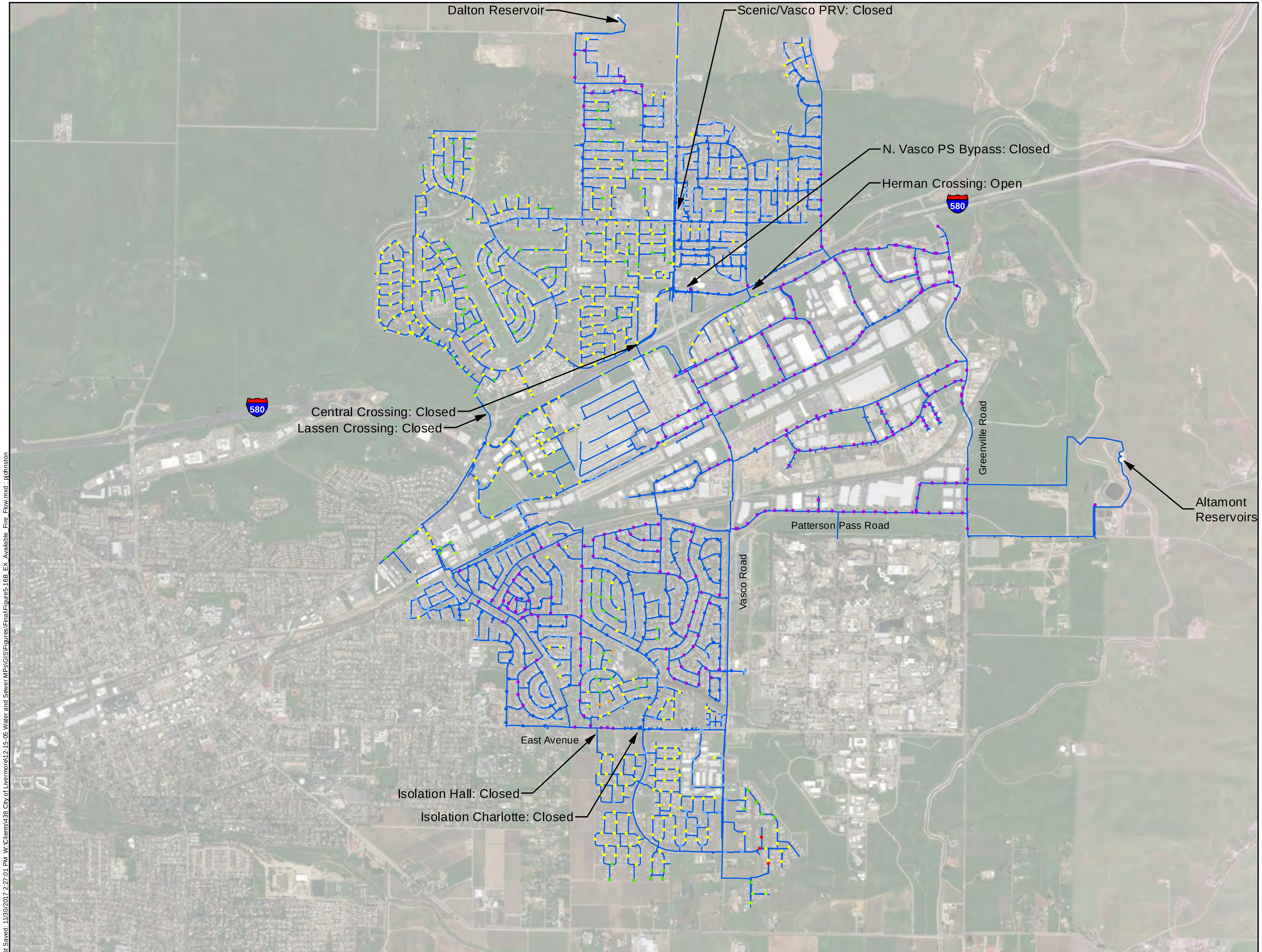

N

0 1,000 2,000

Scale in Feet

Available Flow at 20 psi

- Less than 500 gpm
- 500 to 1,000 gpm
- 1,000 to 1,500 gpm
- 1,500 to 2,000 gpm
- 2,000 to 2,500 gpm
- 2,500 gpm to 3,500 gpm
- 3,500 gpm to 4,500 gpm
- 4,500 gpm to 5,500 gpm
- Greater than 5,500 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.4 MGD (7,926).
2. Storage reservoirs were assumed to be 50% full.

LIVERMORE CALIFORNIA

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Figure 5-16B

Existing System
Available Fire Flow at 20 psi
Base Operational Alternative
(Zones 2 & 3)

City of Livermore
Water Master Plan

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CHAPTER 6
Buildout Water System Evaluation

This chapter presents the evaluation of the City's buildout water distribution system and its ability to meet the City's recommended planning and design criteria under buildout water demand conditions. West Yost conducted this evaluation using an updated hydraulic model that incorporated improvements to eliminate deficiencies identified in the existing water system evaluation (see Chapter 5).

The buildout water system evaluation includes both system capacity and performance evaluations. The system capacity evaluation includes an analysis of pumping, water storage, and pressure regulating station capacity. The system performance evaluation assesses the buildout water system's ability to meet recommended planning and design criteria under buildout demand conditions. West Yost conducted the system performance evaluation using the hydraulic model developed for this Water Master Plan, which is described in Appendix A Potable Water System Hydraulic Model Updates. The hydraulic model was used to perform static analyses of the City's buildout water distribution system.

Evaluations, findings, and recommendations for addressing any deficiencies identified in the buildout water distribution system are included in this chapter. Recommendations are used to develop a CIP, which includes an estimate of probable construction costs. The recommended CIP is described further in Chapter 7.

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

- Projected Water Demands by Pressure Zone
- Zone 7 Supply Pressures
- Buildout Water System Facility Capacity Evaluation
- Buildout Water System Performance Evaluation
- Summary of Findings and Recommended Improvements for the Buildout Water System

6.1 PROJECTED WATER DEMANDS BY PRESSURE ZONE

The water demands used for the buildout water system evaluation by pressure zone are summarized in Table 6-1. As discussed in Chapter 3, buildout demands were developed from a combination of rebounded existing demands, demand estimates for a group of Reasonably Foreseeable Development Projects provided by the City Planning Department, and demand estimates for currently vacant parcels. The buildout water demands for the City's water system were spatially located in the hydraulic model using the parcel information. The City's buildout average day demands are expected to increase by approximately 33 percent over existing rebounded water demands. These growth projections are long-term projections that assume complete buildout of the area within the City's water service area zones.

Table 6-1. Water Demands for the Buildout Water System Evaluation

Pressure Zone	Average Day Demand[a]		Maximum Day Demand[b]		Peak Hour Demand[c]	
	gpm	mgd	gpm	mgd	gpm	mgd
Zone 1 Water Service Area						
605	89	0.13	184	0.26	287	0.41
638	211	0.30	437	0.63	682	0.98
664	369	0.53	764	1.10	1,191	1.72
719	35	0.05	73	0.10	113	0.16
Zone 1 Total	704	1.01	1,457	2.10	2,273	3.27
Zone 2 Water Service Area						
670	1,524	2.19	3,155	4.54	6,183	8.90
Zone 2 Total	1,524	2.19	3,155	4.54	6,183	8.90
Zone 3 Water Service Area						
725	1,235	1.78	2,556	3.68	5,009	7.21
740[d]	65	0.09	134	0.19	263	0.38
741	43	0.06	89	0.13	175	0.25
744	163	0.24	338	0.49	662	0.95
800	1,330	1.91	2,752	3.96	5,394	7.77
875	43	0.06	90	0.13	176	0.25
Zone 3 Total	2,879	4.15	5,959	8.58	11,679	16.82
Zone 1, 2, & 3 Total	**5,106**	**7.36**	**10,570**	**15.22**	**20,135**	**28.99**

[a] Average day demand is based on detailed billing records adjusted to reflect rebound from conservation and estimated demands for future buildout. Billing records from 2015 were spatially located, scaled for non-revenue water, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Maximum day demand calculated using a peaking factor of 2.07 times the average day demand.

[c] Peak hour demand calculated using a peaking factor of 1.56 times the maximum day demand for the Zone 1 Water Service Area and 1.96 for the Zone 2 and 3 Water Service Areas.

[d] Pressure Zone 740 is physically located in the Zone 2 Water Service Area, but operationally is supplied from the Zone 3 Water Service Area and is included in the Zone 3 Water Service Area storage evaluation.

6.2 ZONE 7 SUPPLY PRESSURES

As discussed in Section 5.2, the City receives its supply from Zone 7 through nine turnouts, although only seven turnouts are active. Table 5-2 summarizes the pressures at each turnout for future demand conditions, which are the values that were used for the evaluation of the buildout water system. Similar to the existing system analysis described in Chapter 5, the buildout analysis evaluated the more common operational scenarios for how Zone 7 water is fed into the City's water system as summarized in Section 5.4.

6.3 BUILDOUT WATER SYSTEM FACILITY CAPACITY EVALUATION

To evaluate the capacity of the City's buildout water system facilities, the following analyses were conducted:

- Pumping Capacity Evaluation,
- Storage Capacity Evaluation, and
- Pressure Regulating Station Capacity Evaluation.

The results of the buildout water system facility capacity evaluation are discussed below.

6.3.1 Pumping Capacity Evaluation

The pumping capacity in the City's buildout water system was evaluated to assess its ability to deliver a reliable firm and total capacity to serve the buildout water service area. Firm capacity assumes a reduction in total pumping capacity to account for pumps that are out of service at any given time due to mechanical breakdowns, maintenance, water quality, or other operational issues. At each pump station, firm pumping capacity was defined as the total pump station capacity with the largest pump out of service.

Similar to the existing system analysis described in Chapter 5, this evaluation uses the nominal pump capacity at each pump station to perform the analysis. The hydraulic model was not used to conduct the pumping capacity analysis. The criteria for evaluation of the pump stations for buildout conditions is consistent with Chapter 4 and is as described in Chapter 5.

Table 6-2 compares the existing firm and total pumping capacity of each pump station with the required firm and total pumping capacity for buildout water demand conditions. The left-hand side of the table shows the water service area zones and the corresponding supported pressure zones, their associated water demand, and the pump stations serving each water service area zone. For example, the Airway Pump Station directly serves Pressure Zone 719, but must also have sufficient pumping capacity to supply Pressure Zones 605, 638 and 664 because they are supported by Pressure Zone 719. The right-hand side of the table shows the existing total and firm pumping capacity, the required firm pumping capacity based on the pumping capacity criterion, and the difference between the two.

Table 6-2 indicates that all water service area zones have surplus pumping capacity in excess of the buildout required total and firm pumping capacity, except as discussed below.

Table 6-2. Comparison of Buildout and Required Pumping Supply Capacity

Pressure Zone and Supported Upper Pressure Zones		Buildout Maximum Day Demand, gpm	Pump Stations	Existing Pumping Capacity, gpm: Total, gpm	Existing Pumping Capacity, gpm: Firm, gpm[a]	Required Total Pumping Capacity, gpm[b]	Required Firm Pumping Capacity, gpm[c]	Total Pumping Capacity Surplus (Deficit), gpm	Firm Pumping Capacity Surplus (Deficit), gpm
Zone 1 Water Service Area Analysis									
Pressure Zone	*605*	*184*	Airway	2,208	1,472	2,124	1,457	84	15
	638	*437*							
	664	*764*							
	719	*73*							
Zone 1 Total		1,457							
Zone 2 Water Service Area Analysis									
Pressure Zone	*670*	*3,155*	~~Trevarno~~[e]	~~4,300~~	~~3,100~~	N/A	3,155	N/A	(155)
Zone 2 Total		3,155	Vasco/Springtown, Low	4,500	3,000				
Zone 3 Water Service Area Analysis									
Pressure Zone	*725*	*2,556*	Altamont	8,440	5,720	7,000	5,959	6,240	3,061
	740[d]	*134*							
	741	*89*							
	744	*338*							
	800	*2,752*	Vasco/Springtown, High	4,800	3,300				
	875	*90*							
Zone 3 Total		5,959							
Zones 2 & 3 Water Service Areas Analysis									
Pressure Zone	*670*	*3,155*	~~Trevarno~~[e]	~~4,300~~	~~3,100~~	10,155	9,113	3,085	(93)
	725	*2,556*	Altamont	8,440	5,720				
	740[d]	*134*							
	741	*89*							
	744	*338*	~~Vasco/Springtown, Low~~	~~4,500~~	~~3,000~~				
	800	*2,752*							
	875	*90*	Vasco/Springtown, High[f]	4,800	3,300				
Zones 2 & 3 Total		9,113							
Pressure Zone 875 Analysis									
	875	*90*	Oakville/Vineyard[g]	210	140	N/A	176	N/A	(36)
PZ 875 Total		90							

[a] Firm pumping capacity is defined as the total pumping capacity of each pump station with the largest pump unit at each pump station out of service.
[b] Required total pumping capacity is the flow required to fill the tank fire storage in a 24-hour period plus the maximum day demand.
[c] Required firm pumping capacity is equal to maximum day demand.
[d] Pressure Zone 740 is physically located in the Zone 2 Water Service Area , but operationally is supplied from the Zone 3 Water Service Area and is included in the Zone 3 Water Service Area evaluation.
[e] As Trevarno Pump Station is not generally used, it is excluded from the analysis.
[f] Calculation of firm pumping capacity assumes one pump from High side is out of service.
[g] Pressure Zone 875 has no storage. Therefore, the required Firm pumping capacity shall be equal to Peak Hour demands.

When the Zone 2 Water Service Area is analyzed separately, and when the Trevarno Pump Station is not considered, since it is not generally used, the Zone 2 Water Service Area shows a small firm pumping capacity deficiency. However, since Trevarno Pump Station can be operated, since there is excess capacity in the Zone 3 Water Service Area pump stations that can hydraulically feed demand in the Zone 2 Water Service Area, and since Zone 7 Turnouts 1 and 8 can feed water by gravity directly into the Zone 2 Water Service Area, no recommendation is being made to address the small deficiency.

Under the conservative analysis where all of the Zone 2 and 3 Water Service Area demands are supplied by Vasco Pump Station High and Altamont Pump Station (i.e., the Zone 2 Water Service Area pump stations are offline), a small firm pumping capacity deficiency is identified. However, since the likelihood of both the Zone 2 Water Service Area pump stations being out of service at the same time both Altamont Pump Station and Vasco Pump Station standby pumps are unavailable is extremely low, no recommendation is being made to address the small deficiency.

The analysis shows a firm pumping capacity deficiency at the Oakville/Vineyard Pump Station. The firm pumping capacity of 140 gpm is not sufficient to meet the peak hour demand of 176 gpm. This same deficiency was identified in Chapter 5 for existing demand conditions and does not require additional improvements beyond that already recommended.

Currently all existing pump stations have on-site backup power generators except Trevarno Pump Station. Because Trevarno Pump Station is a facility that provides water from a supply turnout, the City may want to consider backup power for this facility. However, it is recognized that the Trevarno Pump Station is rarely used, so no formal recommendation has been included in this Water Master Plan.

6.3.2 Storage Capacity Evaluation

The primary advantages that storage provides for the water system are to provide: (1) operational storage to balance differences in demands and supplies; (2) emergency storage in case of supply failure; and (3) water to fight fires. As described in Chapter 4, the City's water storage capacity requirement is to provide an operational storage component equal to 25 percent of a maximum day demand, an emergency storage component equal to 50 percent of a maximum day demand (the required volume depends on the pressure zone), and a fire flow storage component equal to the highest fire flow and duration recommended in a particular pressure zone based on land uses within the pressure zone.

Table 6-3 compares the City's available water storage capacity with the required storage capacity by pressure zone under buildout demand conditions. Existing storage capacities reported in the table are based on nominal storage capacities calculated from tank geometry.

The comparison between the City's available and required buildout storage capacities indicates that there is a surplus of 0.47 MG in the Zone 1 Water Service Area.

Table 6-3. Required Storage Capacity Under Buildout Demand Conditions

Water Service Area Zone[a]	Pressure Zone	Storage Facility	Available Storage Capacity, MG		Maximum Day Demand, mgd	Required Storage Capacity, MG						Storage Surplus (Deficit), MG
						Operational Criteria[b]		Emergency Criteria				
			Reservoir Capacity	Total Available Storage		Percent of Maximum Day Demand	Operational	Percent of Maximum Day Demand	Emergency	Fire Flow[c]	Total Required Storage	
Zone 1	605, 638, 664, 719	Doolan	3.00	3.00	2.10	25%	0.52	50%	1.05	0.96	2.53	0.47
Zone 2	670	Dalton	2.00	2.00	4.54	25%	1.14	50%	2.27	0[d]	3.41	(1.41)
Zone 3	725, 740[e], 741, 744, 800, 875	Altamont	8.00	8.00	8.58	25%	2.15	50%	4.29	1.50	7.94	0.06

[a] Average day demand is based on detailed billing records adjusted to reflect rebound from conservation and estimated demands for future buildout. Billing records from 2015 were spatially located, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Based on 25 percent of maximum day demand (see Table 6-1).

[c] Based on demand for the most severe fire recommended in the pressure zone multiplied by the corresponding recommended fire flow duration.

[d] Fire flow storage for single fire in Water Service Area Zones 2 or 3 to be at Altamont.

[e] Pressure Zone 740 is physically located in the Zone 2 Water Service Area, but operationally is supplied from the Zone 3 Water Service Area and is included in the Zone 3 Water Service Area evaluation.

Since the Zone 2 and 3 Water Service Areas are hydraulically connected through PRVs, the City requested that the use of combined storage for both zones be investigated to determine its feasibility and the potential to reduce capital costs for needed improvements. In the analysis summarized in Appendix B, the following storage criteria and improvements for the Zone 2 and 3 Water Service Areas were recommended:

- The Dalton Tank (located in the Zone 2 Water Service Area) shall be sized to contain operational and emergency storage for pressure zones within the Zone 2 Water Service Area, but not be sized to contain fire storage for pressure zones within the Zone 2 Water Service Area; and
- The Altamont Tanks (located in the Zone 3 Water Service Area) shall be sized to contain operational and emergency storage for pressure zones within the Zone 3 Water Service Area, and fire flow storage for a single fire within the Zone 2 and 3 Water Service Areas.
- Based on buildout demand conditions and the above criteria, there is a storage deficit in the Zone 2 Water Service Area Dalton Tank of 1.41 MG. Therefore, it is recommended that the existing 2.0 MG Dalton Tank be replaced with a new 3.41 MG storage facility.
- It is important to note that there are some differences in the storage criteria for buildout conditions versus that included in the 2004 Master Plan. For operational volume, this Water Master Plan reduces the 2004 Master Plan criteria from 50 percent of maximum day demand to 25 percent of maximum day demand as previously discussed in Chapter 4. For emergency storage for future conditions, both master plans have the storage reside at the tanks within the respective zone. For fire volume, the 2004 Master Plan has fire storage residing at both the Dalton and Altamont sites and sized independently for individual fires within the respective zones. This Water Master Plan assumes fire storage at Altamont only and for a single fire flow event within the Zone 2 or 3 Water Service Areas. This Water Master Plan's fire storage criteria for buildout is consistent with the criteria for existing conditions from both master plans. and reduces the overall storage volume required in the system. These differences in criteria, and the reduction in maximum day demand estimates from that in the 2004 Master Plan, results in a total storage volume reduction from the 2004 Master Plan of 25.5 MG to 13.9 MG for buildout conditions.
- It is also important to note that since fire storage for the Zone 2 Water Service Area will be located at the Altamont Tanks, sufficient connection between the Zone 2 and 3 Water Service Areas must be maintained to allow fire flows to be transmitted from the Altamont Tanks to the Zone 2 Water Service Area. For this reason, the PRVs that connect the Zone 2 and 3 Water Service Areas should remain operational at all times. These PRVs include Vasco/Scenic, Trevarno, Las Positas/Bennett and Leisure, which all directly serve the Zone 2 Water Service Area. Additionally, PRVs upstream from these four PRVs, which serve pressure zones that supply these four PRVs, should also remain operational at all times. These include Southfront/Lawrence, Las Positas/Lawrence, Las Positas/Vasco, Patterson/Vasco, Daphne/Vasco, Emily/Vasco and East/Research.

6.3.3 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 buildout demand conditions. This is a nominal analysis that evaluates PRV capacity by pressure zone, comparing the total nominal PRV supply capacity to the demands for each pressure zone. The criteria for evaluation of the PRVs for buildout conditions is consistent with Chapter 4 and is as described in Chapter 5.

Table 6-4 compares existing available pressure regulating station capacity with the required buildout pressure regulating station capacity for the pressure zones that are completely dependent on pressure regulating stations for supply. The table shows that all of the pressure zones have sufficient pressure regulating station capacity to meet the required flows.

For pressure zones which are supplied by more than one regulating station, the valve capacity requirement for the pressure zone was compared to the valve capacity of each regulating station supplying the pressure zone to determine if each regulating station could supply the pressure zone on its own. Each regulating station does have sufficient valve capacity to meet the valve capacity requirement on its own, except for the following regulating stations:

- The Golf Course regulating station has a valve capacity of 3,900 gpm, which cannot meet the valve capacity requirement of 4,184 gpm for Pressure Zone 605. Therefore, it is recommended that the Freisman regulating station remain operational.
- The Leisure regulating station has a valve capacity of 3,900 gpm, which cannot meet the valve capacity requirement of 8,155 gpm for Pressure Zone 670. Therefore, it is recommended that at least one of the other three regulating stations that supply Pressure Zone 670 remain operational.
- Each of the five regulating stations supplying Pressure Zone 725 North has a valve capacity of 8,720 gpm, which cannot meet the valve capacity requirement of 10,174 gpm for Pressure Zones 725 North and 670. Therefore, it is recommended that at least two of these five valves remain operational.
- The Welch/Vasco regulating station has a valve capacity of 3,900 gpm, which cannot meet the valve capacity requirement of 4,536 gpm for Pressure Zone 725 South. Therefore, it is recommended that the Charlotte/Vasco regulating station remain operational.

In addition, the flows through the PRVs under buildout peak hour demand and maximum day demand plus fire flow scenarios in the hydraulic model were compared to valve capacities to confirm that the flows were lower than the valve capacities. This is true in all cases, indicating that the existing valves are adequately sized to accommodate the buildout demand conditions.

Table 6-4. Comparison of Existing and Required Pressure Regulating Station Capacity

Pressure Zone	Maximum Day Demand, gpm	Peak Hour Demand, gpm	Fire Flow Requirement, gpm[a]	Regulating Station	Valve Diameter, inches	Existing Valve Capacity, gpm[b]	Valve Capacity Requirement, gpm[c]	Valve Capacity Surplus (Deficit), gpm
605	184	287	4,000	Freisman	12	8,720	4,184	8,436
				Golf Course	8	3,900		
					Total	12,620		
638 (+605)	621	968	4,000	Kitty Hawk	10	6,150	4,621	7,679
				Doolan	10	6,150		
				Total		12,300		
664 (+605 & 638)	1,384	2,159	4,000	North Canyon	10	6,150	5,384	766
					Total	6,150		
670	3,155	6,183	5,000	Trevarno	12	8,720	8,155	21,905
				Vasco/Scenic	12	8,720		
				Las Positas/Bennet	12	8,720		
				Leisure	8	3,900		
					Total	30,060		
725 North (+670)	5,174	10,142	5,000	Patterson Pass/Shelley	12	8,720	10,174	33,426
				Patterson Pass/Vasco	12	8,720		
				Daphine/Vasco	12	8,720		
				East/Research	12	8,720		
				Emily/Vasco	12	8,720		
					Total	43,600		
725 South	536	1,050	4,000	Welch/Vasco	8	3,900	4,536	8,084
				Charlotte/Vasco	12	8,720		
					Total	12,620		
740	134	263	5,000	Naylor	12	8,720	5,134	3,586
					Total	8,720		
741 (+725 North)	2,109	175	5,000	Brisa/Vasco	12	8,720	7,109	1,611
					Total	8,720		
744 (+740 & 670)	3,626	7,107	5,000	Southfront/Lawrence	16	10,540	8,626	19,354
				Las Positas/Lawrence	12	8,720		
				Vasco/Las Positas	12	8,720		
					Total	27,980		

[a] Based on demand for the most severe fire recommended in the pressure zone.

[b] Based on the intermittent maximum flow capacity for ClaVal model 90-01 PRV valves. However, actual flow capacity will vary depending on system conditions.

[c] Regulating stations must supply maximum day plus fire flow or peak hour demand, whichever is larger.

6.4 BUILDOUT WATER SYSTEM PERFORMANCE EVALUATION

This section discusses the hydraulic performance evaluation of the buildout water distribution system. The following evaluations were performed to assess distribution system performance under buildout water demand conditions:

- Peak Hour Demand Scenario: This scenario evaluates the potential for low customer service pressures in the system during a peak hour demand condition.
- Maximum Day Scenario: This scenario evaluates the potential for high customer service pressures in the system during a maximum day demand condition.
- Fire Operations – Maximum Day plus Fire Flow Scenario: This scenario evaluates fire flow availability in the system under a maximum day demand condition.

These three scenarios used the hydraulic model developed for this Water Master Plan to evaluate the buildout water system performance. The buildout water system is expected to deliver flow within the acceptable pressure, velocity and head loss ranges as identified in the planning and design criteria presented in Chapter 4.

The purpose of the buildout water system performance evaluation is to identify necessary improvements to support the City's buildout projected water demands while meeting the City's recommended water system planning and design criteria.

As described in Chapter 5, the City operates its water distribution system in a variety of ways to achieve different goals at different times. The buildout water system was analyzed using the same operational alternatives, which represent the primary system operational configurations that the City employs (see Table 5-6 in Chapter 5 for a summary of the operational alternatives).

It is important to note that like the existing demand conditions, the buildout conditions analysis assumes Zones 2 and 3 Water Service Areas are hydraulically connected (i.e., all PRVs are operational except Scenic/Vasco which varies based on the alternative). This is a different assumption from the 2004 Master Plan where for build out conditions the water service area zones were assumed to be independent.

6.4.1 Peak Hour Demand Scenario

6.4.1.1 Evaluation Overview

A steady-state hydraulic analysis was conducted using the hydraulic model to evaluate system performance under a buildout peak hour demand condition for each of the operational alternatives listed in Table 5-6. As shown in Table 6-1, the peak hour demand for the buildout water service area was calculated to be 20,135 gpm (28.99 mgd). This analysis assumed that storage reservoirs are 75 percent full for conservative purposes. As a result, although the pump stations and corresponding supply turnouts are operational in the model, they are not flowing under this static condition due to the reservoir fill level.

As described in Chapter 4, during a peak hour demand scenario, a minimum pressure of 35 psi must be maintained at service connections throughout the entire water system. In addition, for pipelines, it is recommended that maximum velocities should not exceed 5 ft/s in transmission pipelines (greater than 12-inch diameter) or 8 ft/s in distribution pipelines (less than or equal to 12-inch diameter) during normal demand conditions, to help minimize energy (pumping) costs and excessive head loss due to undersized pipelines.

6.4.1.2 Evaluation Results

Results of the buildout system peak hour analyses for the City's Zone 1 Water Service Area are shown on Figures 6-1A through 6-4A[1]. Results of the buildout system peak hour analyses for the City's Zone 2 and 3 Water Service Areas for each operational alternative are shown on Figures 6-1B through 6-5B. It should be noted that the results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described below.

Results from the peak hour demand simulation indicate that the buildout water system could adequately meet the City's minimum pressure criterion of 35 psi at all customer services, except for the locations shown in red on the figures. The areas that do not meet the pressure criterion vary somewhat between the operational alternatives. The figures also show the pipelines in the system that do not meet the velocity criteria. Although there are smaller areas that do not meet the velocity criteria, the major areas include:

- The two pipelines between the Altamont Tanks and Greenville Road;
- The pipeline along Patterson Pass Road between Greenville Road and Vasco Road;
- The pipeline along Greenville Road between Marathon Drive and Las Positas Road; and
- The pipeline along Vasco Road between Patterson Pass Road and Daphne Drive.

In the Zone 3 Water Service Area, as in the existing system analysis, in the southern-most portion of Pressure Zone 800 east of Vasco Road, low pressures occur beyond the extent of the Vineyard 875 Pressure Zone. Additionally, for the buildout system analysis, the area with low pressures extends into the southern portion of Pressure Zone 725. These are more widespread when either the Lassen or the Central Crossing of Interstate 580 is open and the Scenic/Vasco PRV is operational, which increases the demand on Pressure Zone 800 and exacerbates the low pressures at the south end of Vasco Road. Use of the Interstate 580 crossings also extends the area of low pressures in Pressure Zone 725 farther to the north. In all of the operational alternatives, the area of low pressures in Pressure Zone 725 includes most or all of the area south of East Avenue.

[1] Because there is no Operational Alternative 4 for the Zone 1 Water Service Area, there is no Figure 6-5A. There is a Figure 6-5B to show results for Operational Alternative 4 for the Zone 2 and 3 Water Service Areas.

In the Zone 3 Water Service Area Zone, low pressures also occur at the north end of Pressure Zone 800 along Hillstone Drive and Laughlin Road with Operational Alternatives 1, 2 and 3 when the PRV at Scenic/Vasco is operational. Low pressures also occur along Greenville Road near Las Positas Road and Southfront Road with all operational alternatives. The area of low pressures along Greenville Road is greater with Operational Alternatives 1, 2 and 3 when the PRV at Scenic/Vasco is operational, with the low pressures extending onto Southfront Road, Las Positas Road, Mountain Vista Parkway and Longard Road.

In the Zone 2 Water Service Area on the north side of the Lassen Crossing and the Central Crossing, low pressures occur when both of the Interstate 580 crossings are closed, and the PRV at Scenic/Vasco is closed, such as in the Base Operational Alternative and in Operational Alternative 4. When the PRV at Scenic/Vasco is operational (i.e. Operational Alternatives 1, 2, and 3) the low pressure areas are significantly reduced. However, there is still an area of low pressure on the north side of the Lassen Crossing, as shown on Figures 6-1B through 6-5B.

All of these areas of low pressure are related, as resolving the Zone 2 Water Service Area pressures by opening the Interstate 580 crossings, or making the PRV at Scenic/Vasco operational exacerbates the pressure issues in the Zone 3 Water Service Area. This increases flows from the Altamont tanks and creates greater head loss in the distribution system and lower pressures. The analysis determined that activating the high head pumps at the Vasco Pump Station during high demand periods would reduce the extent of the area at the south end of Vasco Road with low pressures. However, the results indicate that there will still be a small area outside the 875 Vineyard Pressure Zone that does not meet the criteria, even with three high head pumps at the Vasco Pump Station operating. Activating the high head pumps at the Vasco Pump Station does resolve the areas with low pressures on Hillstone Drive, Laughlin Road, Greenville Road, Southfront Road, Las Positas Road, Mountain Vista Parkway and Longard Road.

Activating the high head pumps at the Vasco Pump Station during high demand periods also resolves the areas of low pressure within the Zone 2 Water Service Area, as this allows the Zone 3 Water Service Area to provide sufficient support to the Zone 2 Water Service Area to resolve the areas of low pressure.

A summary of the areas with low pressures is provided below, along with recommended options for mitigation:

- The low pressures on the north side of the Lassen Crossing occur because supply is limited to the north portion of the Zone 2 Water Service Area. The recommendations for this area are the same as for the analysis of the existing system.
  - As recommended in the existing system analysis, to allow supply under high demand conditions, the PRV at Scenic/Vasco should be always operational, but with a setting of approximately 45 psi.
  - As recommended in the existing system analysis, additionally, a new PRV should be installed at the south end of Lassen Road that allows supply from the south portion to the north portion of the Zone 2 Water Service Area under high demand conditions. While the setting for this PRV depends on the elevation, at an elevation of approximately 533 feet, the setting should be approximately 45 psi.

This project is required only if the City chooses to continue closing the Interstate 580 crossing at Lassen, as this project serves as a bypass of the closed crossing under high demand conditions.

- The low pressures at the south end of Vasco Road occur under high demand conditions, and are more widespread when supply to the Zone 2 Water Service Area is limited to the Altamont Tanks. Both of the following are recommended:
  - Including controls at the high head pumps at the Vasco Pump Station that activate pumps when pressures near the Vineyard Pump Station fall below 35 psi will allow the pumps to help mitigate the low pressures. However, this will not completely mitigate the low pressures.
  - As recommended in the existing system analysis, to further mitigate the low pressures, it is recommended to install approximately 5,500 feet of 16-inch diameter parallel pipeline along Vasco Road between Patterson Pass Road and Emily Way. The recommended parallel pipeline, in conjunction with the low pressure controls on the high head pumps at the Vasco Pump Station, will mitigate the low pressure issues at the south end of Vasco Road near the Vineyard Pump Station Pressure Zone.
- The low pressures at the north end of Greenville Road occur under high demand conditions and are more widespread when supply to the Zone 2 Water Service Area is allowed through the Scenic/Vasco PRV.
  - Including controls at the high head pumps at the Vasco Pump Station that activate pumps when pressures in this area fall below 35 psi will allow the pumps to mitigate the low pressures.
- The low pressures at the north end of Laughlin Road and Hillstone Drive occur under high demand conditions.
  - Including controls at the high head pumps at the Vasco Pump Station that activate pumps when pressures in this area fall below 35 psi will allow the pumps to mitigate the low pressures.

Because pipeline velocity is a secondary criterion, no improvements for pipelines exceeding the velocity criteria in the buildout water system are recommended unless the primary criterion (pressure) is not met. Therefore, no mitigation is recommended at this time based on the velocity criteria alone. However, the alternative to install a parallel pipeline along Vasco Road between Patterson Pass Road and Emily Way will resolve the high velocity issues that occur here.

During Peak Hour demand conditions, as much as 50 percent of the demands in the Zone 2 Water Service Area can be supplied by the Zone 3 Water Service Area through PRVs, with the remaining 50 percent of the demands supplied by the operational storage at Dalton. Although the Zone 3 Water Service Area storage analysis did not consider that the Zone 3 Water Service Area would need to supply the Zone 2 Water Service Area, the excess pumping capacity available in the Zone 3 Water Service Area ensures that the Zone 2 Water Service Area can be adequately supplied without inappropriately drawing from Zone 3 Water Service Area operational storage.

6.4.2 Maximum Day Demand Scenario

6.4.2.1 Evaluation Overview

A steady-state hydraulic analysis was conducted using the hydraulic model to evaluate system performance under a buildout maximum day demand condition. As shown in Table 6-1, the maximum day demand for the buildout water service area was calculated to be 10,570 gpm (15.2 mgd). This analysis assumed that storage reservoirs are 75 percent full. In addition, in order to evaluate the system for high pressure, it was conservatively assumed that one pump was operating at the Airway Pump Station, one low head pump was operating at the Vasco Pump Station and one high head pump was operating at the Vasco Pump Station. No pumps were set to operate at the Trevarno Pump Station, as this pump station is almost never operated. No pumps were set to operate at the Altamont Pump Station, as SCADA shows that the Altamont Pump Station and the Vasco High Pump Station do not typically operate at the same time.

As described in Chapter 4, the maximum desired pressure in the distribution system is 100 psi.

6.4.2.2 Evaluation Results

Results of the buildout system maximum day analyses for the Zone 1 Water Service Area for each operational alternative are shown on Figures 6-6A through 6-9A[2]. Results of the buildout system maximum day analyses for the Zone 2 and 3 Water Service Areas for each operational alternative are shown on Figures 6-6B through 6-10B. It should be noted that the results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described below.

Results from the maximum day demand simulations indicate that the buildout water system has pressures that exceed 100 psi at some locations when pumps are operating. In the Zone 1 Water Service Area, these pressures are as high as 132 psi at the outlet of the Airway Pump Station. In the Zone 2 and 3 Water Service Areas, these pressures are as high as 109 psi in the area of the Vasco Pump Station.

No recommendations are suggested based on the maximum criteria, as the system is currently capable of handling pressures exceeding 100 psi in the areas where they occur. However, it is recommended that the City investigate the developed properties in these areas to verify that there are individual PRVs on the service laterals and consider having them installed where they do not already exist. Per the Plumbing Code, new services with pressure greater than 80 psi require an individual pressure regulating device. Therefore, for properties in these areas that are developed in the future, it is recommended that the City require individual PRVs on the service laterals.

[2] Because there is no Operational Alternative 4 for the Zone 1 Water Service Area, there is no Figure 6-10A. There is a Figure 6-10B to show results for Operational Alternative 4 for the Zone 2 and 3 Water Service Areas.

6.4.3 Fire Operations – Maximum Day Demand plus Fire Flow Scenario

6.4.3.1 Evaluation Overview

To evaluate the buildout water system under the maximum day demand plus fire flow scenario, H2OMap Water's "*Available Fire Flow Analysis*" tool was used to determine the available fire flow at a minimum residual pressure of 20 psi and a maximum velocity constraint of 12 ft/s. For the buildout system fire flow analysis, key junctions that represent hydrant locations were evaluated to determine the available flow that can be provided, in addition to meeting the maximum day demand. The analysis assumed that storage reservoirs are 50 percent full, that no pump stations are operating and that no flow is entering the system from the turnouts.

For buildout fire flow analysis, fire flow rates were assigned to each model future input node based on the land use designation in the node's tributary basin. As noted in the 2004 Water Master Plan, recycled water does provide fire flow to some portions of the Zone 1 Water Service Area. However, for the hydraulic analysis of the Zone 1 Water Service Area potable water distribution system, it was assumed that potable water would be used to provide fire flow throughout the distribution system. In the future, this will provide the City with flexibility to convert the portion of the Zone 1 Water Service Area from recycled water to potable water for fire protection.

6.4.3.2 Evaluation Results

Figures 6-11A through 6-14A[3] summarize the available fire flow at each tested hydrant location in the Zone 1 Water Service Area while meeting the minimum residual pressure criterion of 20 psi and/or a maximum pipeline velocity of 12 ft/s. Figures 6-11B through 6-15B summarize the available fire flow at each tested hydrant location in the Zone 2 and 3 Water Service Areas while meeting the same criteria. It should be noted that the results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described below.

The results presented are representative of the system capacity and do not represent available flow from a specific hydrant. Typically, fire flows exceeding 1,500 gpm are met by multiple hydrants. The results shown are for the existing distribution system with the buildout demands. Figures 6-16A and 6-16B show the available fire flow at each key junction location for the base operational alternative.

Available fire flows are similar but slightly lower than available fire flows under existing maximum day conditions, indicating that the system is well looped and capable of providing similar fire flows to existing conditions, even with a 33 percent increase in system demand.

[3] Because there is no Operational Alternative 4 for the Zone 1 Water Service Area, there is no Figure 6-15A. There is a Figure 6-15B to show results for Operational Alternative 4 for the Zone 2 and 3 Water Service Areas.

When the improvement projects recommended for existing conditions are incorporated into the system, there are still some areas in the system with insufficient capacity to support fire flow demands as described below.

Zone 1 Water Service Area:

1. As mentioned in the evaluation of the existing system, in Alternative 1, when Kitty Hawk PRV and Zone Turnout 5 are closed, residual pressure issues under fire conditions exist in the southern portion of the zone. Therefore, it is recommended that Kitty Hawk PRV be operational, but with a lower setting so that it is available for high demand periods such as fire flow conditions. The current setting of 90 psi could be lowered to approximately 80 psi so that it will remain closed during peak hour conditions, but will open for fire flow conditions. It is recommended that the smaller PRV at Kitty Hawk be set at 80 psi and the larger PRV be set at 75 psi.
2. As mentioned in the evaluation of the existing system, in the northeast corner of the Zone 1 Water Service Area at the east end of Selby Lane, the fire flow deficiency is a result of a fire flow demand of 3,500 gpm for an area that has a land use code of Business and Commercial Park, but is actually a public park area. As this pipeline has sufficient fire flow capacity for the adjacent residential land uses with fire flow demands of 2,500 gpm, no improvement project is recommended.
3. Similar to the evaluation of the existing system, for the Base Operational Alternative, the hydrants along Dovecote Lane shows fire flow deficiency resulting from a fire flow demand of 3,500 gpm for areas that have a land use code of Business and Commercial Park, but is actually a public park area, or is currently undeveloped. As this pipeline has sufficient fire flow capacity for the adjacent residential land uses with fire flow demands of 2,500 gpm, no improvement project is recommended. However, when the undeveloped area is developed, this area should be analyzed again as there will likely be additional piping within the undeveloped area.
4. Near the intersection of Jack London Boulevard and El Charro Road there is one hydrant with a fire flow deficiency in all alternatives and a second hydrant with a fire flow deficiency in the Base Alternative. These deficiencies are minor and there is a nearby hydrant located within 250 feet that can provide the required fire flow. Therefore, no improvement project is recommended.

Zone 2 and 3 Water Service Areas:

1. At the area near the intersection of East Avenue and Vasco Road, the fire flow deficiencies can be resolved in two ways that relate to the analysis of the Peak Hour demands. Both of the following are recommended:
   - Activate at least two high head pumps at the Vasco Pump Station to allow the system to meet the minimum pressure criteria for fire flows.
   - To resolve the low pressure issues, install new parallel 5,500 feet of 16-inch diameter pipeline along Vasco Road between Patterson Pass Road and East Avenue. (Project No. BO-CIP-P01)

2. At the area near the intersection of Greenville Road and Las Positas Road, the fire flow deficiencies can be resolved by activating at least two high head pumps at the Vasco Pump Station allows the system to meet the minimum pressure criteria for fire flows.

6.5 SUMMARY OF FINDINGS AND RECOMMENDED IMPROVEMENTS FOR THE BUILDOUT WATER SYSTEM

Findings from the evaluation of the buildout water distribution system and the recommended improvements needed to eliminate deficiencies are summarized below. These recommendations are included in the recommended capital improvement program described in Chapter 7 (see Table 7-1 and Figure 7-1).

6.5.1 Pumping Capacity

- All pumping capacity improvements recommended in the existing conditions analysis are also recommended for the buildout conditions analysis. Project No. EX-CIP-U01 will address capacity issues at Oakville Pump Station which are the same for both existing and buildout conditions.
- To assist in addressing the additional pressure issues related to peak hour demand and maximum day plus fire flow demand for buildout conditions, it is recommended that the City implement a control strategy for the high head pumps at Vasco Pump Station to activate when the following pressure conditions occur (Project No. BO-CIP-U01):
  - Pressure drops below 35 psi adjacent to the Vineyard/Oakville Pressure Zone (see peak hour demand analysis)
  - Pressure drops below approximately 25 to 30 psi in the industrial area southwest of the intersection of East Avenue and Vasco Road (see fire flow demand analysis)
  - Pressure drops below approximately 35 psi in the industrial area along Las Positas Road between Lawrence Drive and Greenville Road (see peak hour demand and fire flow demand analysis)
  - Pressure drops below 35 psi at the north end of Hillstone Drive (see peak hour demand analysis)
- Since the high head pumps at the Vasco Pump Station will be relied upon to resolve additional pressure issues related to peak hour demand and maximum day plus fire flow demand under buildout conditions, the City should verify that the generators at this pump station are equipped with automatic transfer switches.

6.5.2 Storage Capacity

- All storage capacity improvements recommended in the existing conditions analysis are also recommended for the buildout conditions analysis. Project No. EX-CIP-T01 requires replacement of the existing 2.0 MG Dalton tank with a new 3.41 MG tank, which is sized to accommodate the buildout deficit of 1.41 MG.

6.5.3 Pipelines

- All pipeline improvements recommended in the existing conditions analysis are also recommended for the buildout conditions analysis.
- To assist in addressing the additional pressure issues related to peak hour demand and maximum day plus fire flow demand for buildout conditions, it is recommended that the City implement the following:
  - — Install 5,500 feet of 16-inch diameter pipeline along Vasco Road between Patterson Pass Road and East Avenue parallel to the existing 16-inch diameter pipeline in this location. (Project No. BO-CIP-P01)

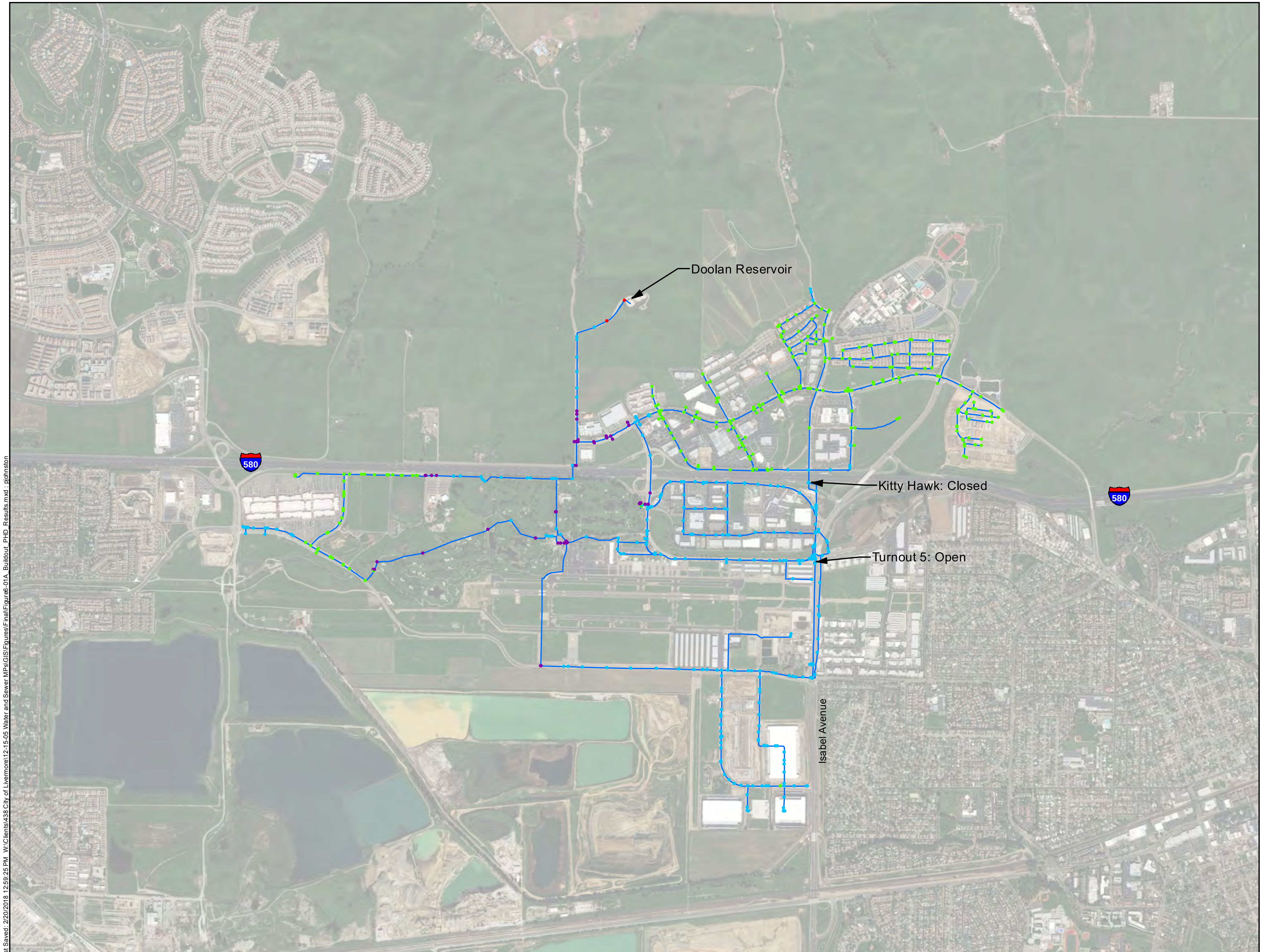
6.5.4 Pressure Reducing Stations

- All pressure reducing station improvements recommended in the existing conditions analysis are also recommended for the buildout conditions analysis.

6.6 FINDINGS AND RECOMMENDED OPERATIONAL IMPROVEMENTS FOR THE BUILDOUT WATER SYSTEM

The following operational improvements are recommended for the buildout water system:

- Operational changes recommended in the existing analysis (described in Chapter 5) are also recommended for buildout conditions.
- As described previously, this Water Master Plan analysis assumed the Zone 2 and 3 Water Service Areas are hydraulically connected. When the Zone 2 Water Service Area is not being supplied by either the Vasco Low Pump Station, or directly from turnouts, it can be supplied through turnouts by the Zone 3 Water Service Area. This results in energy loss through the PRVs, and can negatively affect water quality by reducing turnover in the Dalton Tank. The City should consider a follow-up study that analyzes the feasibility of operating the two water service area zones independently for normal operations, while still maintaining connections for fire flow conditions. The study could evaluate energy savings and water quality issues and could evaluate the costs associated with enabling the Zone 2 Water Service Area to reliably supply peak hour demands without depending on supply from the Zone 3 Water Service Area PRVs.
- For the Zone 1 Water Service Area, Operational Alternatives 2 or 3 are recommended, as these involve the Kitty Hawk PRV being operational.
- For the Zone 2 and 3 Water Service Areas, if Project No. EX-CIP-V02 is constructed, Operational Alternatives 1, 2 and 3 are all acceptable.



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Notes:

1. Future peak hour demand is equal to 28.99 mgd (20,135 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-1A

Buildout System Peak Hour Demand Results Base Operational Alternative (Zone 1)

City of Livermore
Water Master Plan

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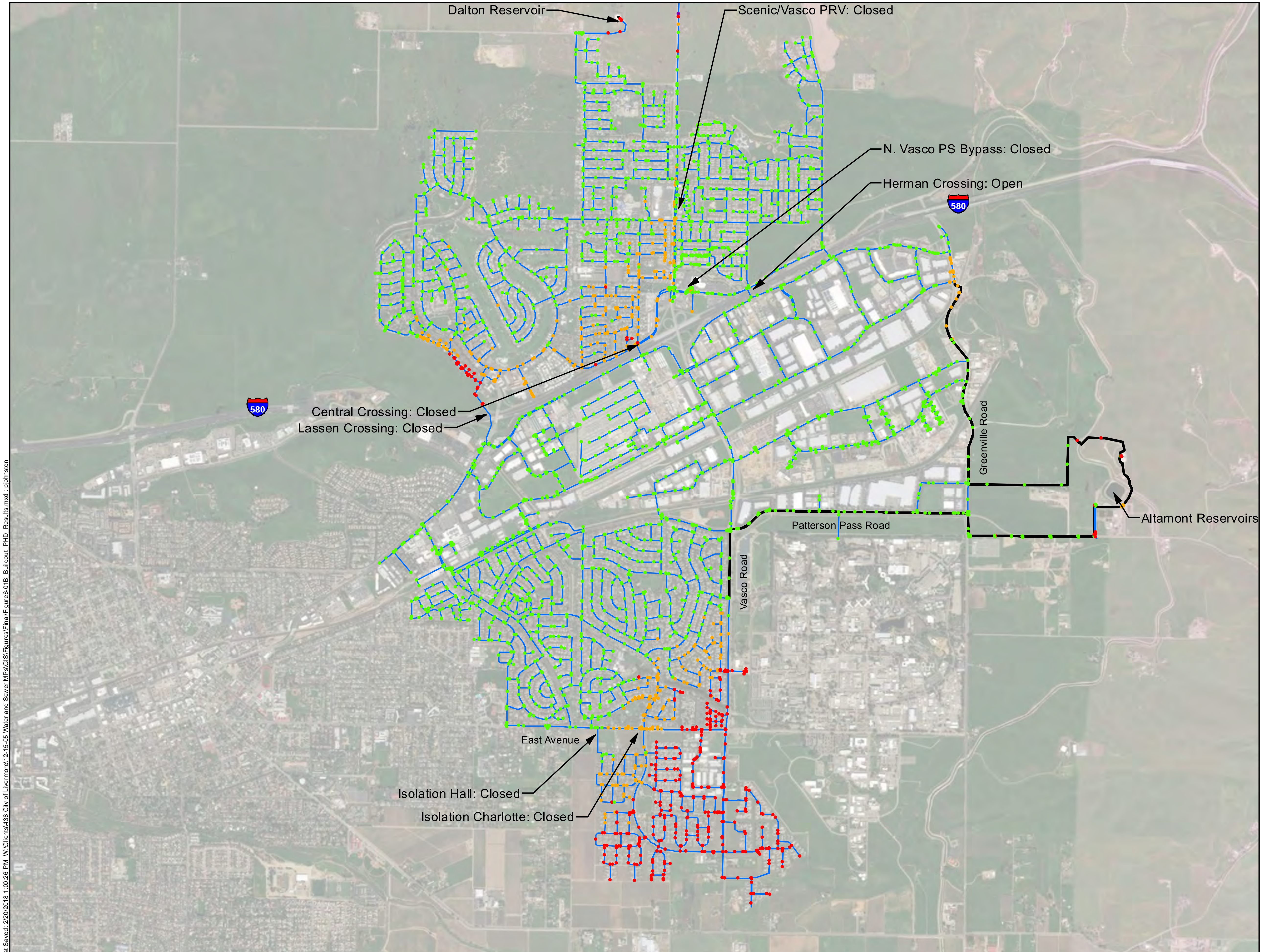

Notes:
1. Future peak hour demand is equal to 28.99 mgd (20,135 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-1B

Buildout System Peak Hour Demand Results Base Operational Alternative (Zones 2 & 3)

City of Livermore
Water Master Plan

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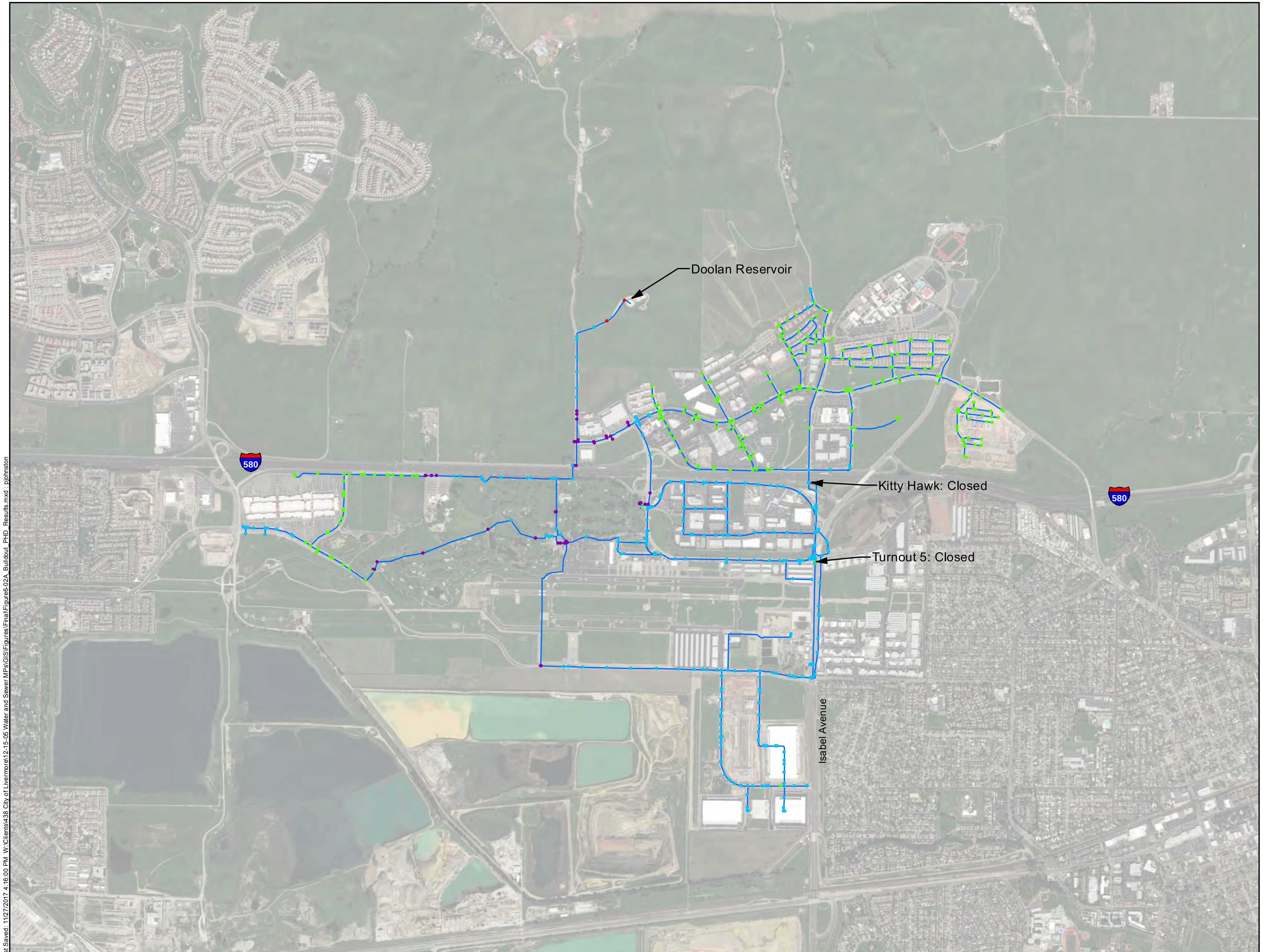

N

0 1,000 2,000
Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-2A

Buildout System Peak Hour Demand Results Operational Alternative 1 (Zone 1)

City of Livermore
Water Master Plan

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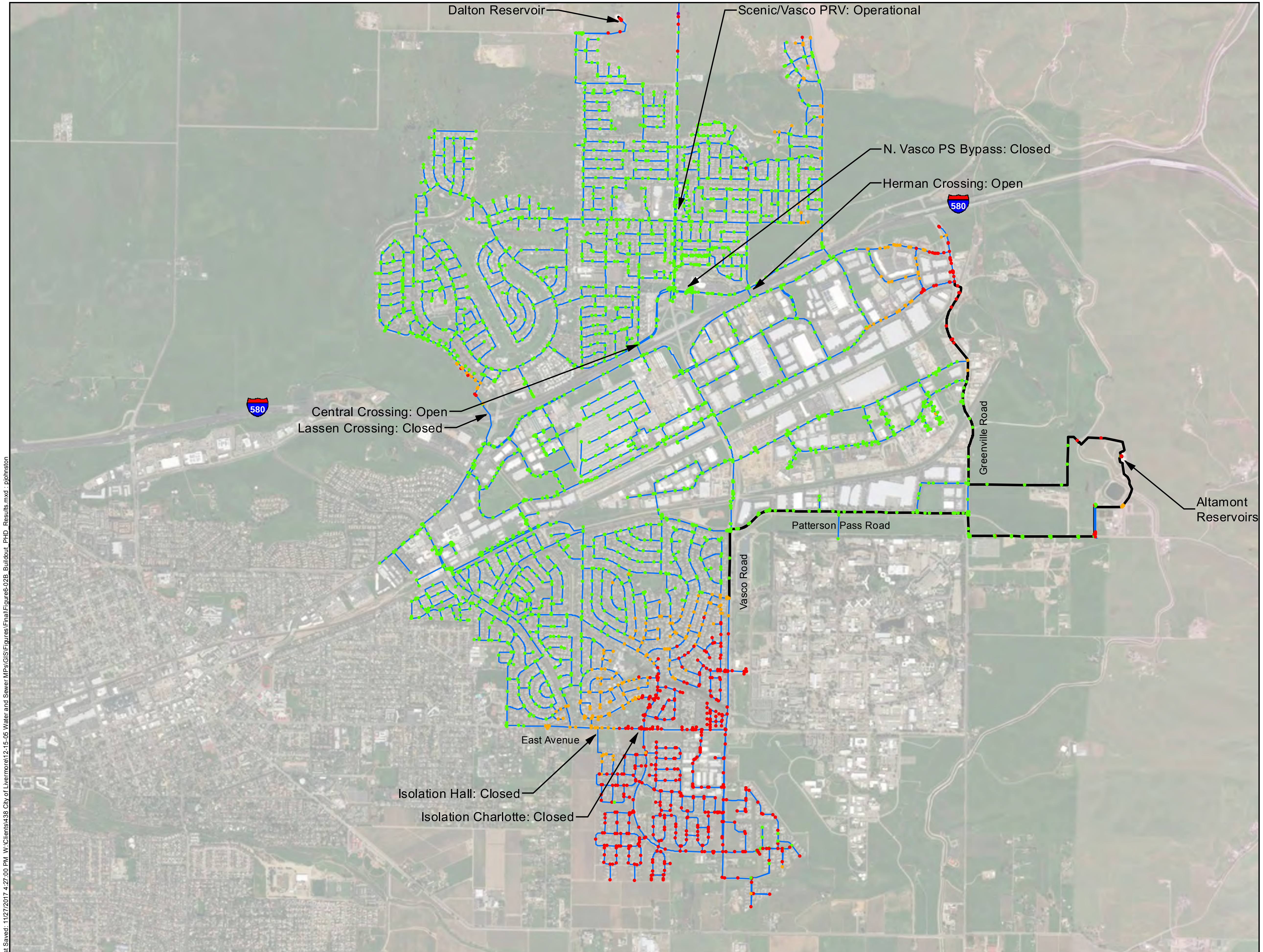

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:

1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-2B

Buildout System
Peak Hour Demand Results
Operational Alternative 1
(Zones 2 & 3)

City of Livermore
Water Master Plan

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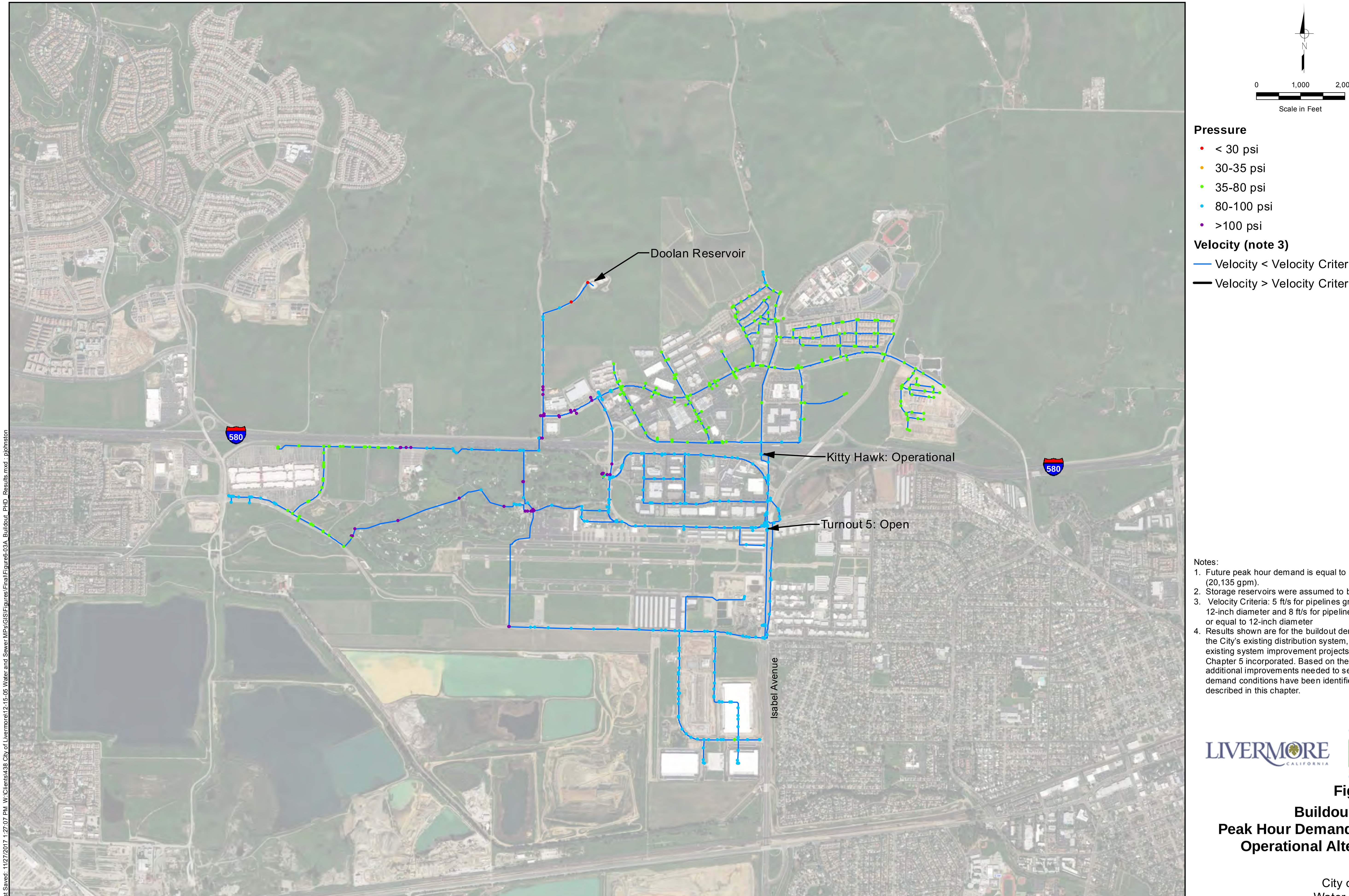

Notes:
1. Future peak hour demand is equal to 28.99 mgd (20,135 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-3A

Buildout System Peak Hour Demand Results Operational Alternative 2 (Zone 1)

City of Livermore
Water Master Plan

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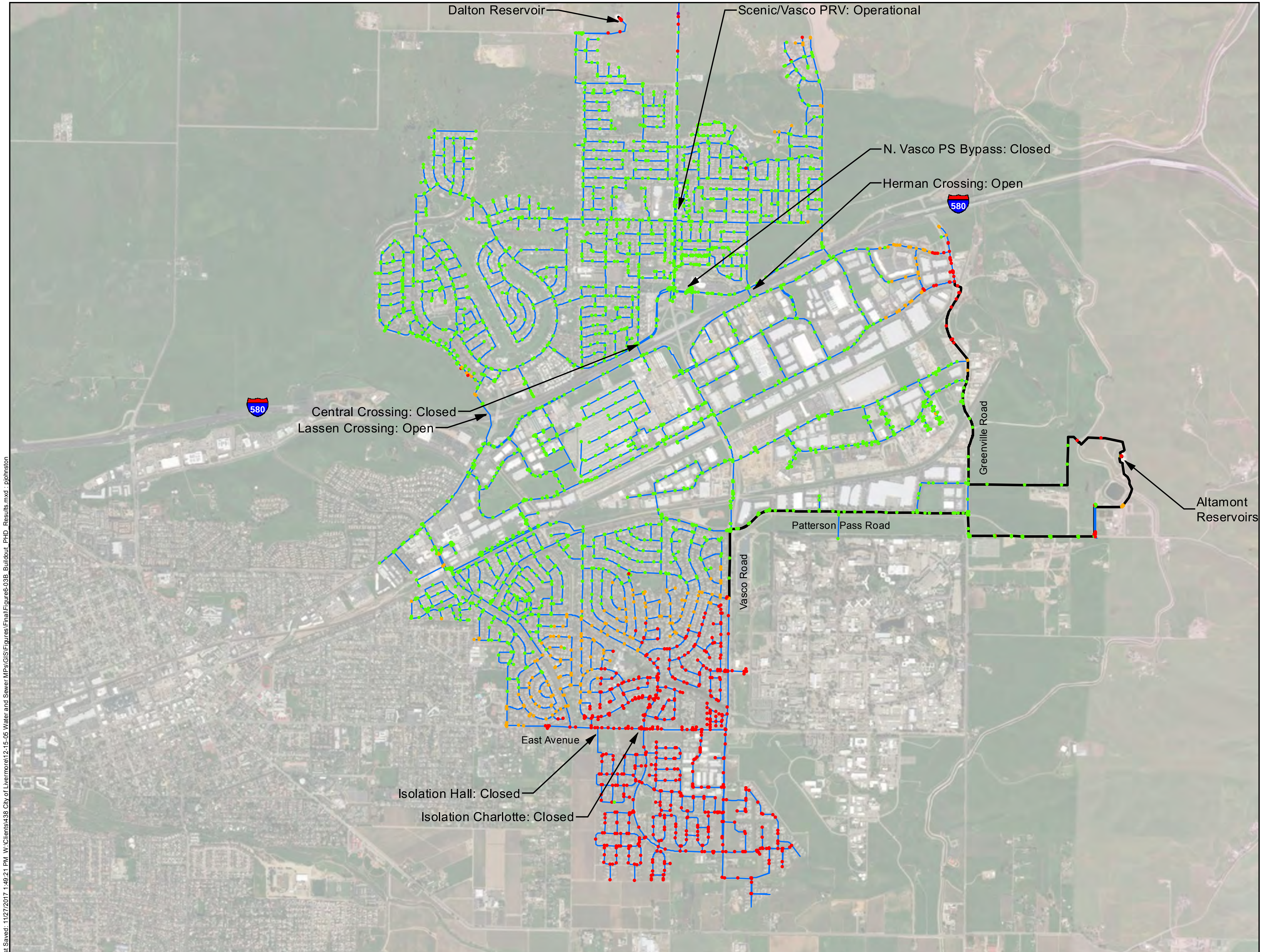

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0 1,000 2,000

Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- >100 psi

Velocity (note

- Velocity < Velocity
- Velocity > Velocity

Notes:

1. Future peak hour demand is equal to 28.99 mgd (20,135 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-3B

Buildout System Peak Hour Demand Results Operational Alternative 2 (Zones 2 & 3)

City of Livermore Water Master Plan

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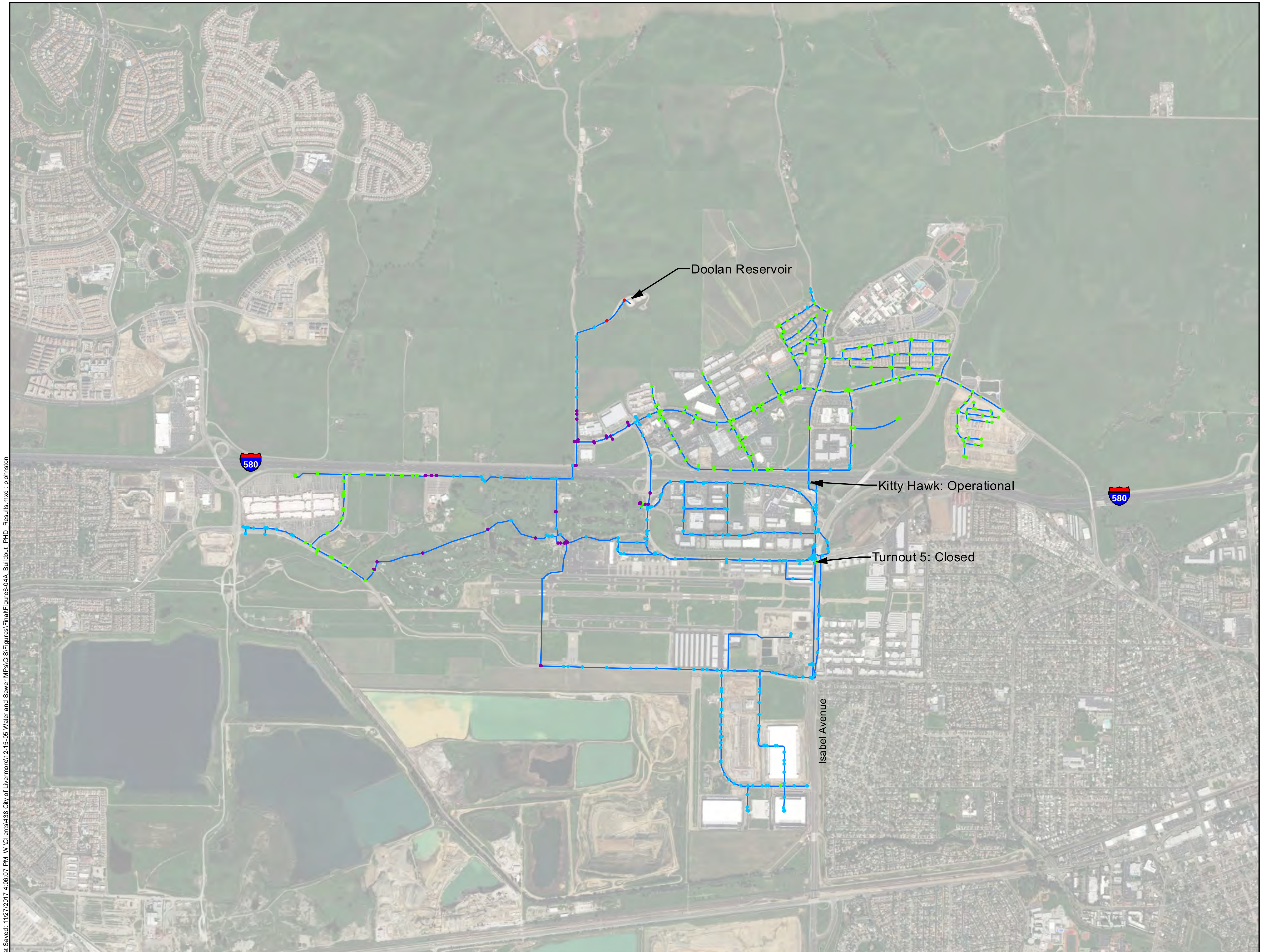

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Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-4A

Buildout System Peak Hour Demand Results Operational Alternative 3 (Zone 1)

City of Livermore
Water Master Plan

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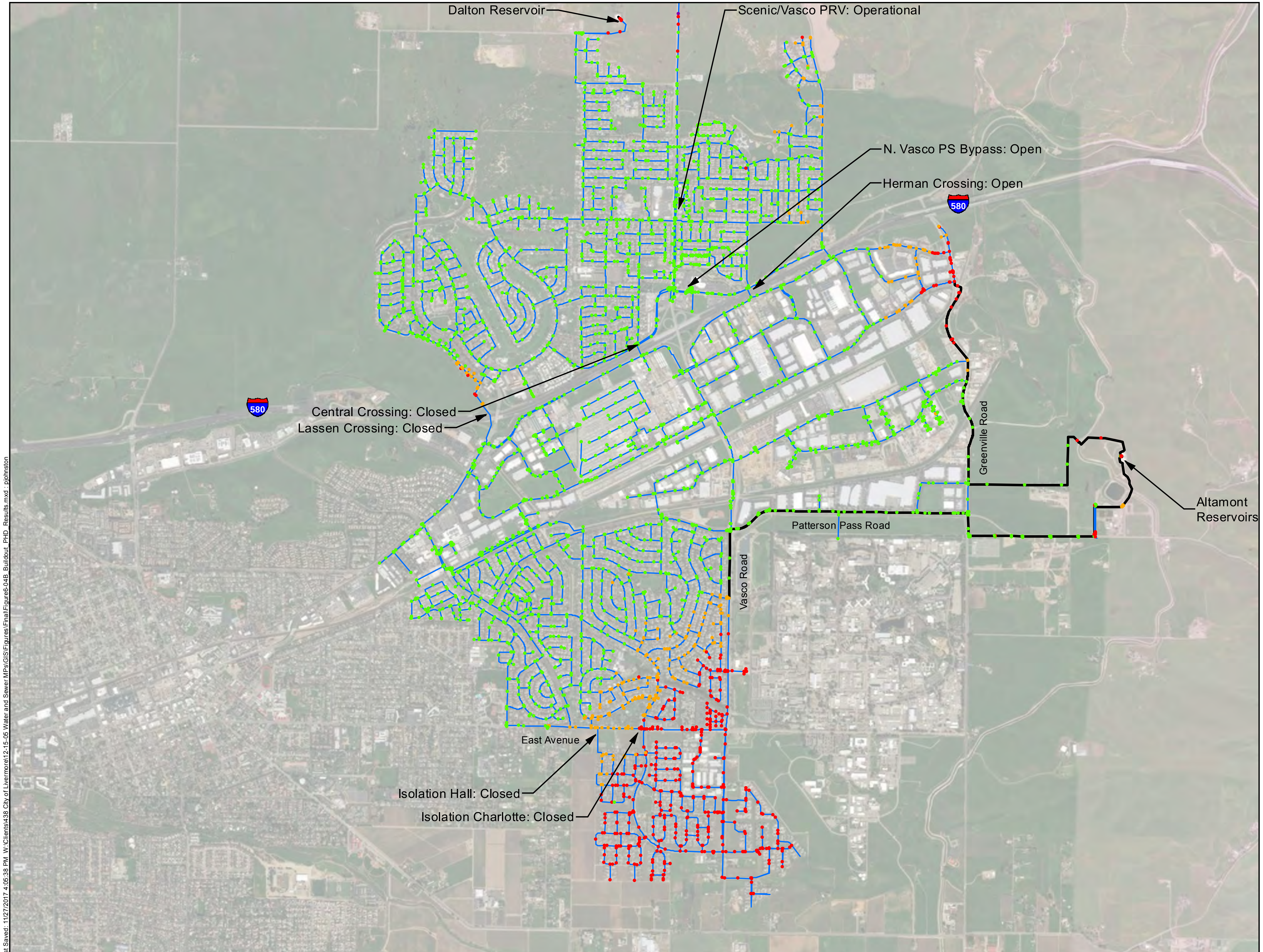

N

0 1,000 2,000

Scale in Feet

Pressure

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)

- Velocity < Velocity
- Velocity > Velocity

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-4B

Buildout System Peak Hour Demand Results Operational Alternative 3 (Zones 2 & 3)

City of Livermore
Water Master Plan

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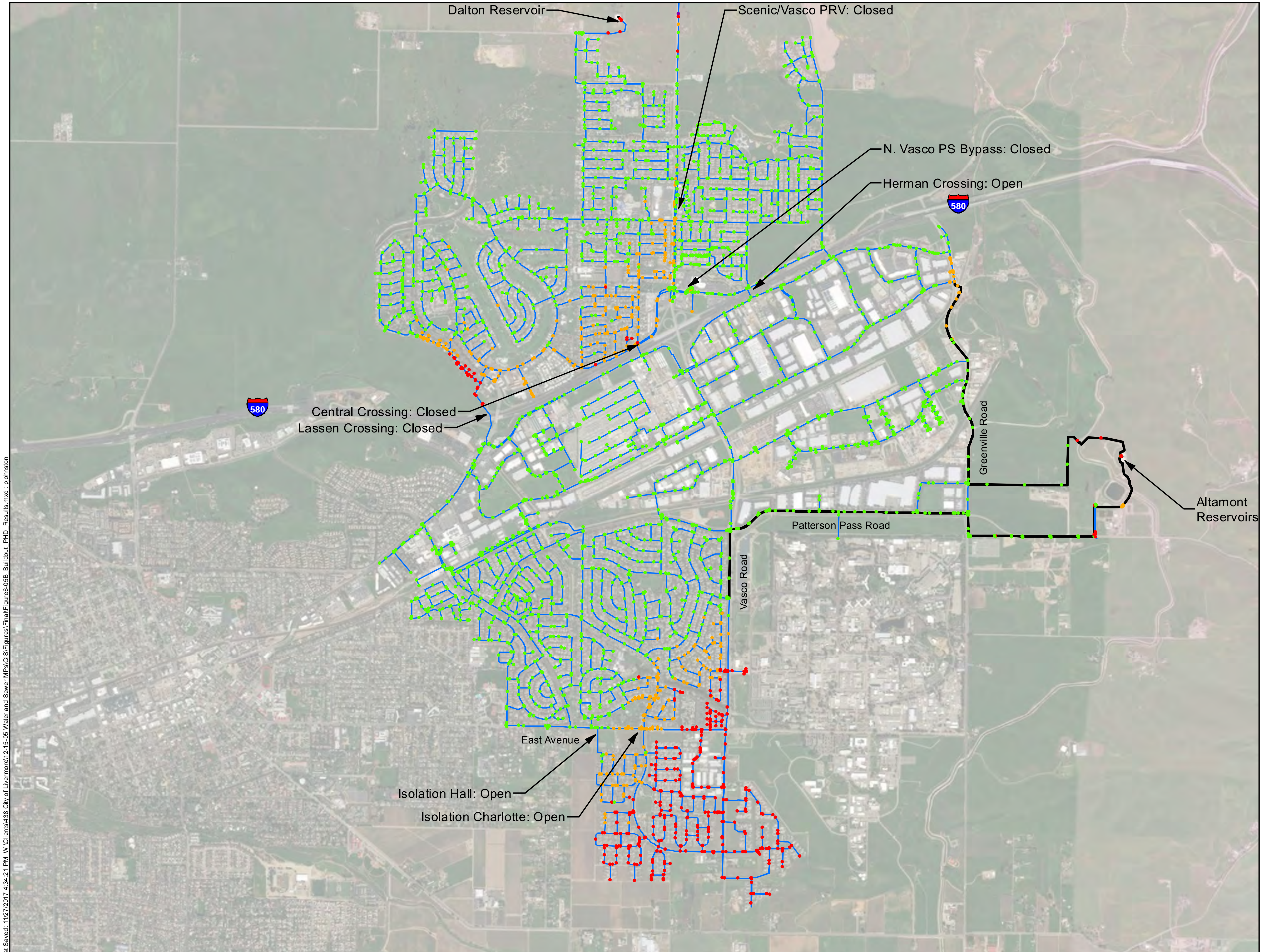

N

0 1,000 2,000
Scale in Feet

Pressure
- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi

Velocity (note 3)
- Velocity < Velocity Criteria
- Velocity > Velocity Criteria

Notes:
1. Existing peak hour demand is equal to 21.89 mgd (15,200 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. Velocity Criteria: 5 ft/s for pipelines greater than 12-inch diameter and 8 ft/s for pipelines less than or equal to 12-inch diameter
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-5B

Buildout System Peak Hour Demand Results Operational Alternative 4 (Zones 2 & 3)

City of Livermore
Water Master Plan

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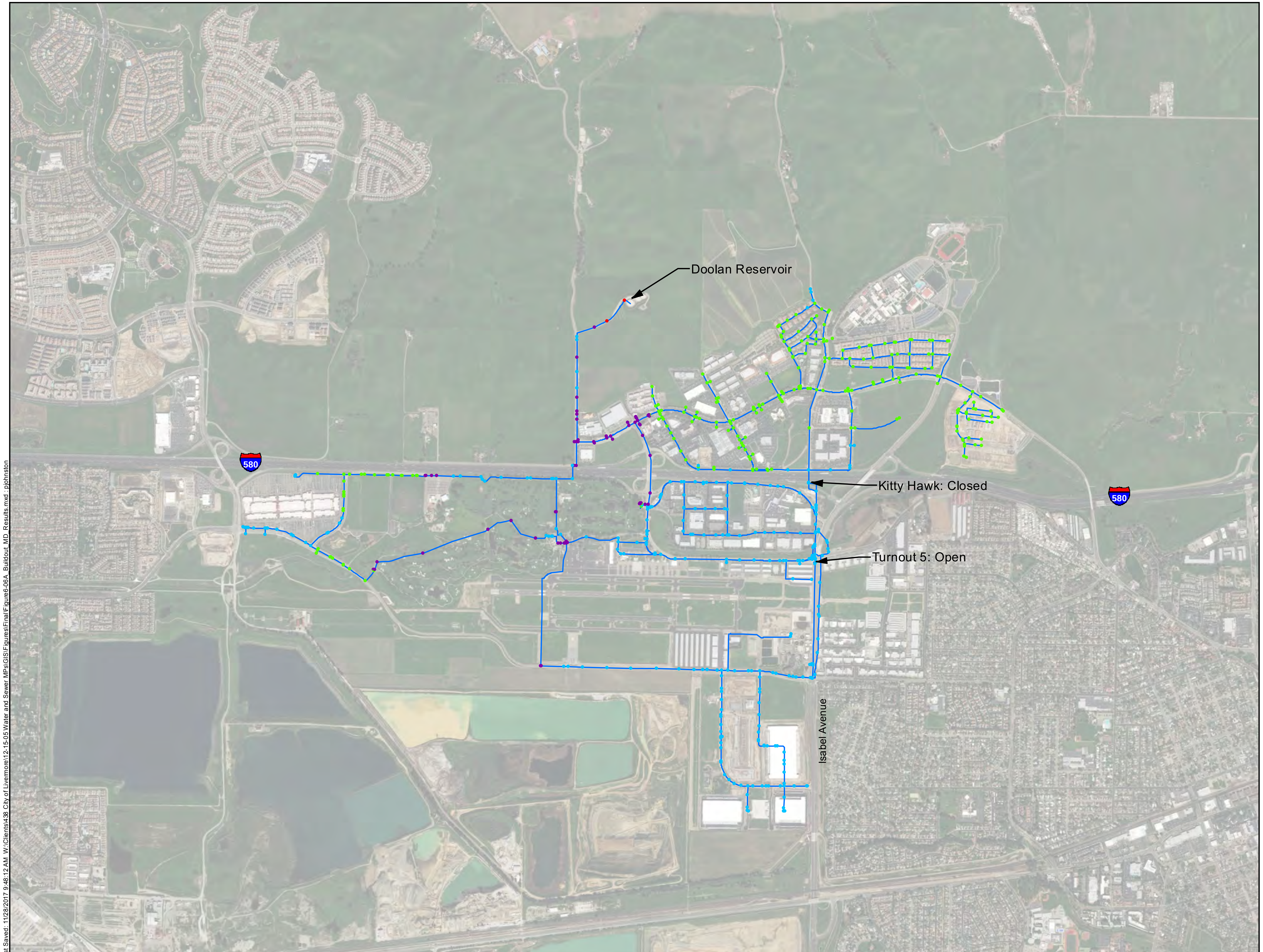

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-6A

Buildout System Maximum Day Demand Results Base Operational Alternative (Zone 1)

City of Livermore
Water Master Plan

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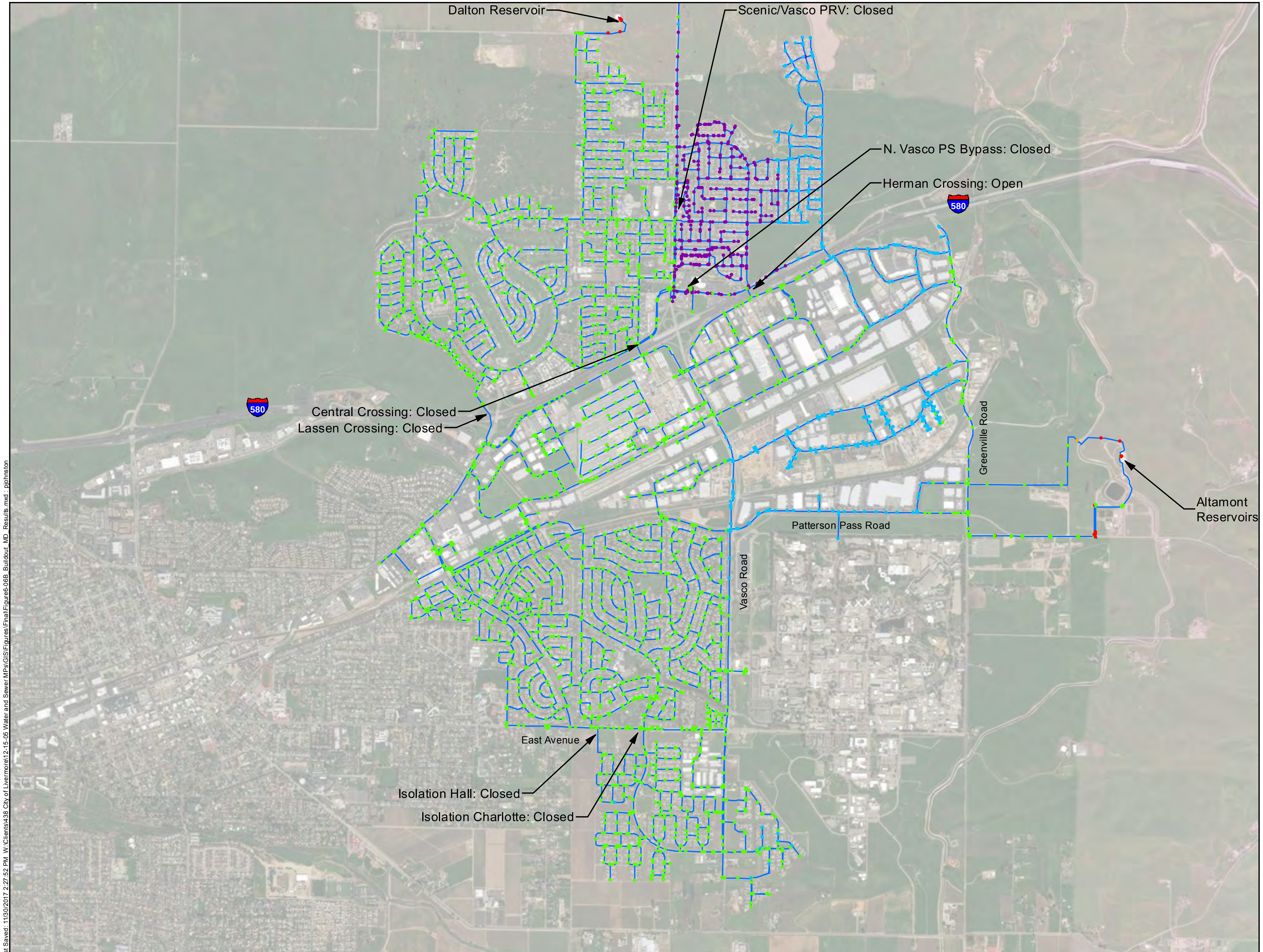

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:

1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-6B

Buildout System Maximum Day Demand Results Base Operational Alternative (Zones 2 & 3)

City of Livermore
Water Master Plan

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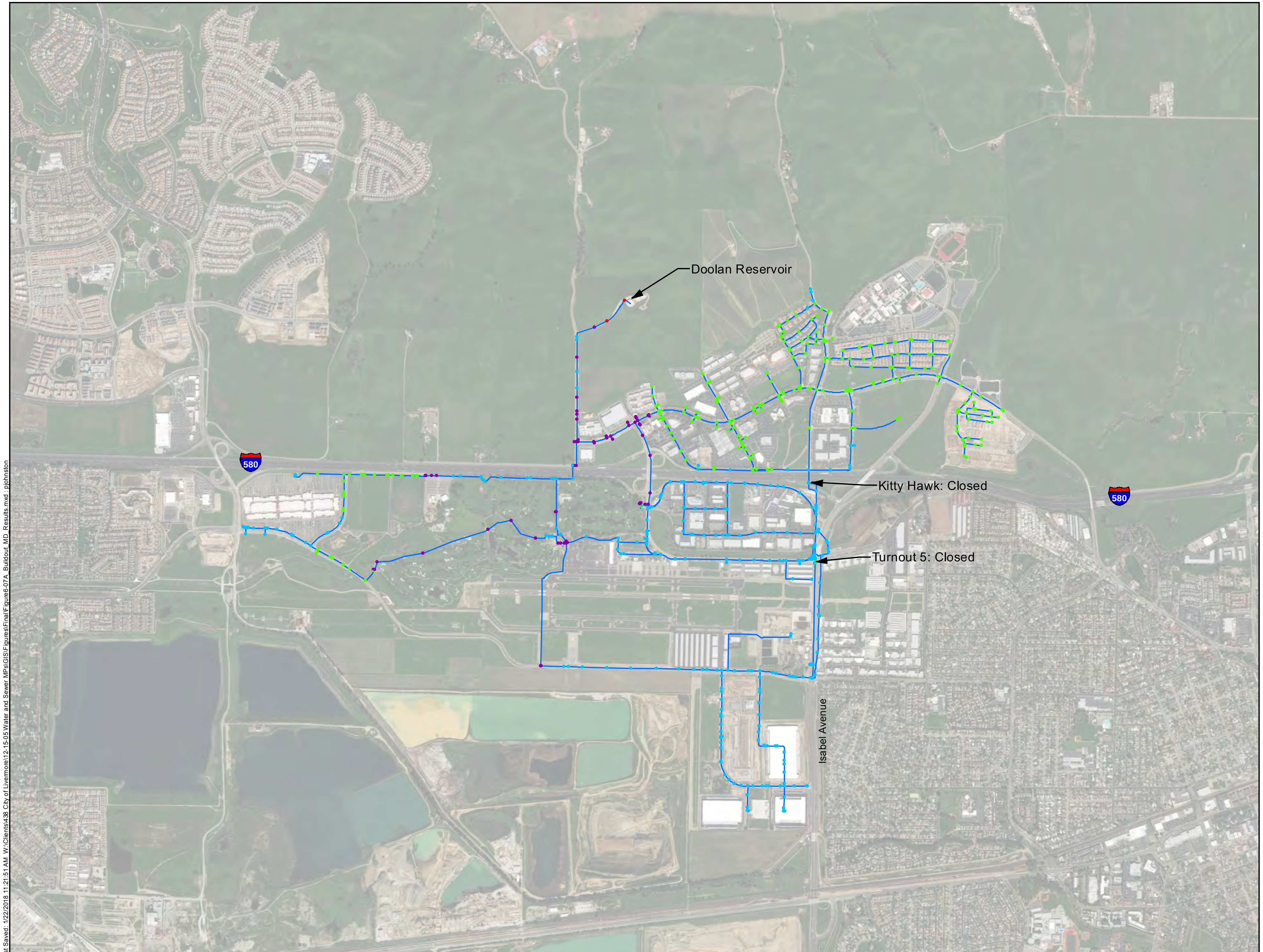

N

0 1,000 2,000
Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-7A

Buildouit System
Maximum Day Demand Results
Operational Alternative 1
(Zone 1)

City of Livermore
Water Master Plan

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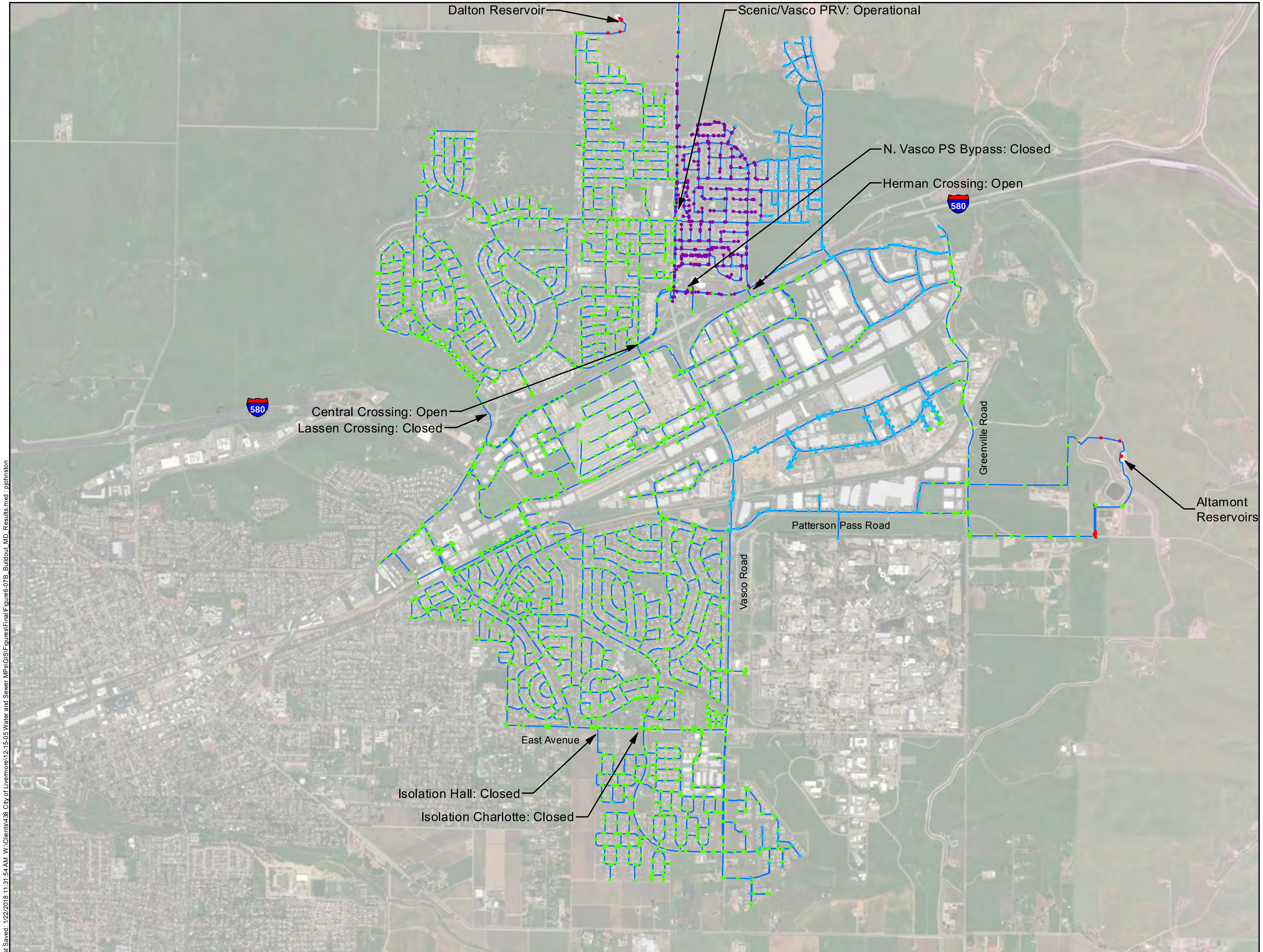

0 1,000 2,000
Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:

1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

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Figure 6-7B

Buildout System Maximum Day Demand Results Operational Alternative 1 (Zones 2 & 3)

City of Livermore
Water Master Plan

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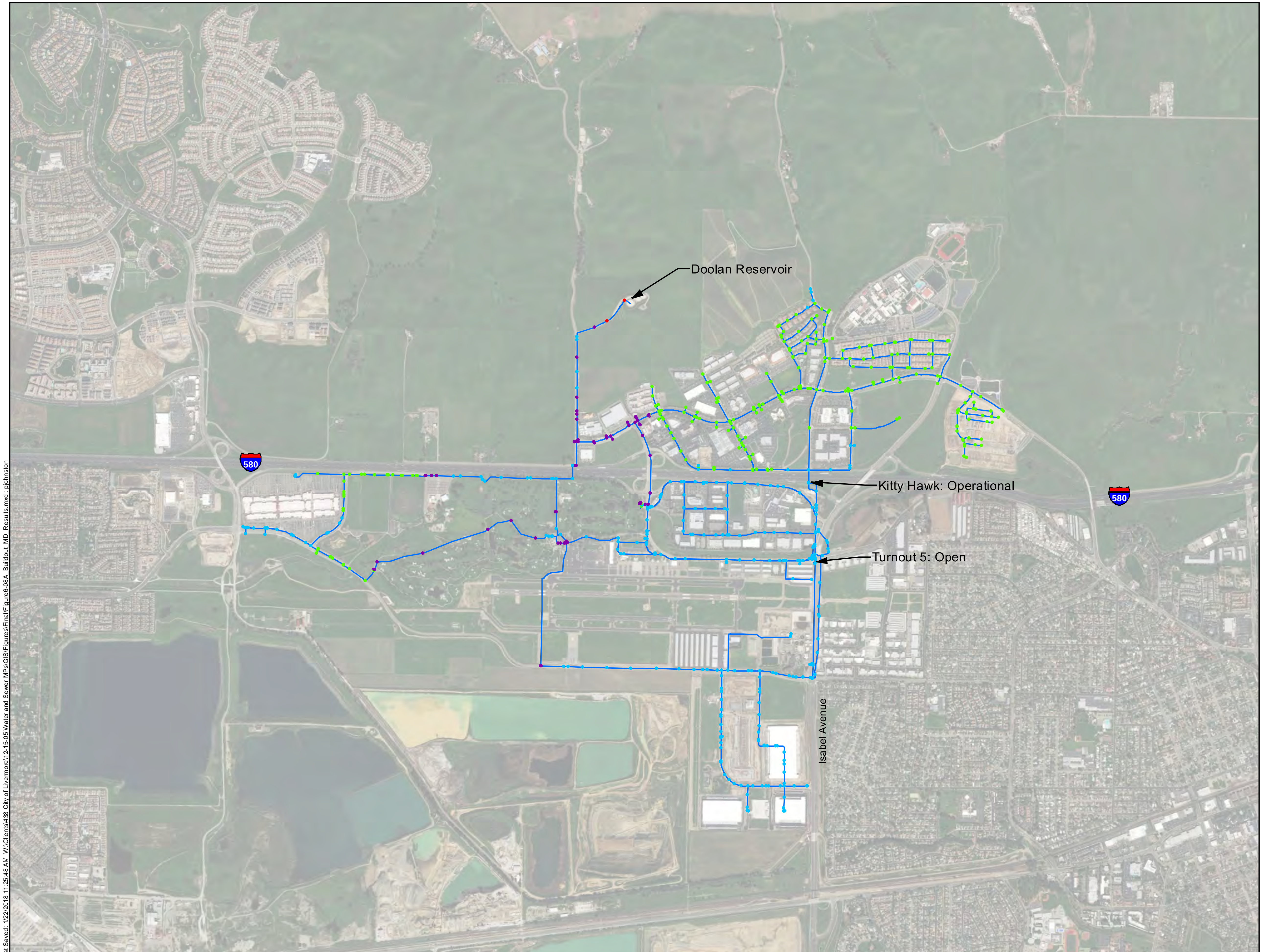

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

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Figure 6-8A

Buildout System Maximum Day Demand Results Operational Alternative 2 (Zone 1)

City of Livermore
Water Master Plan

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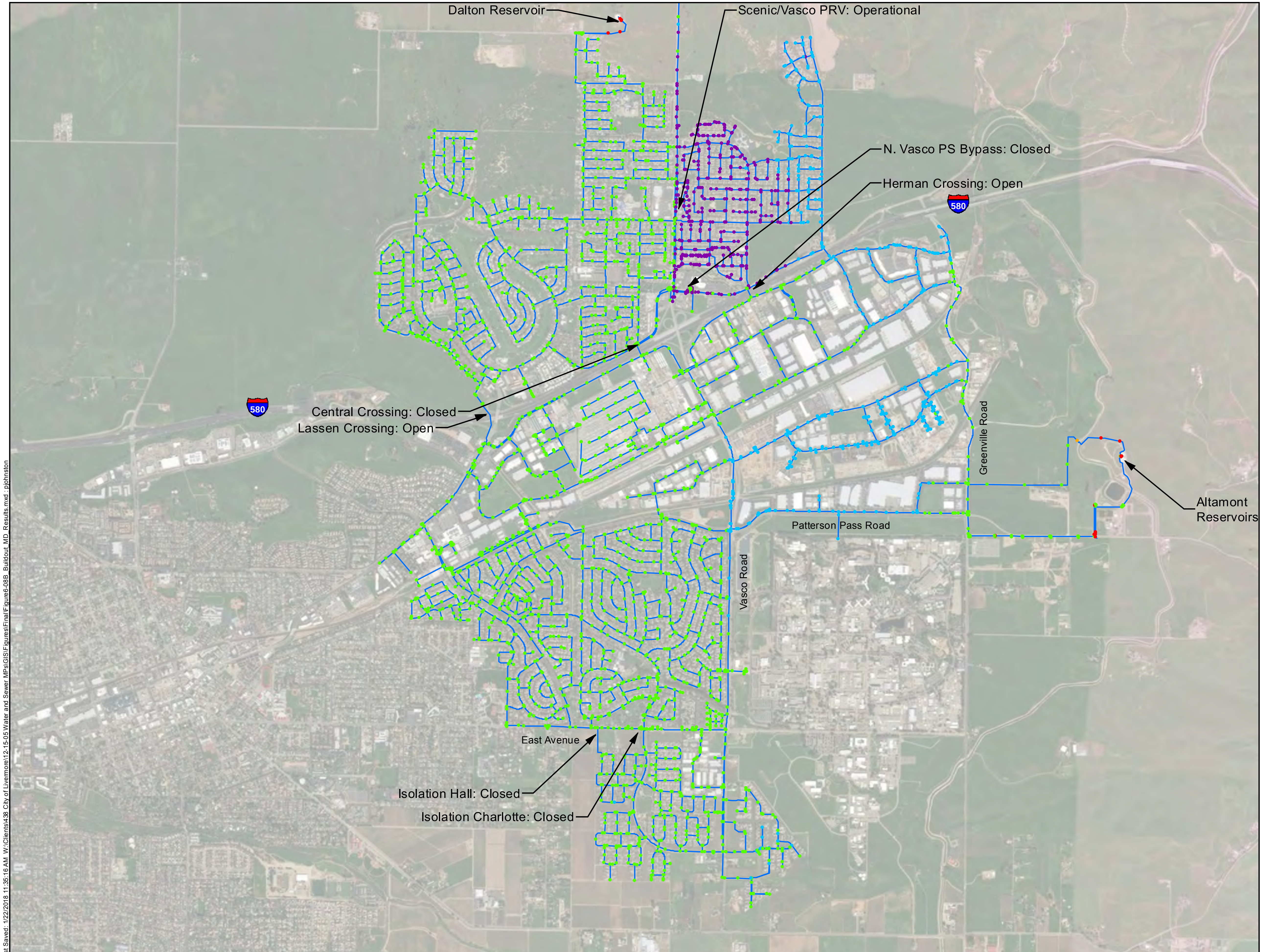

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:

1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

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Figure 6-8B

Buildout System Maximum Day Demand Results Operational Alternative 2 (Zones 2 & 3)

City of Livermore
Water Master Plan

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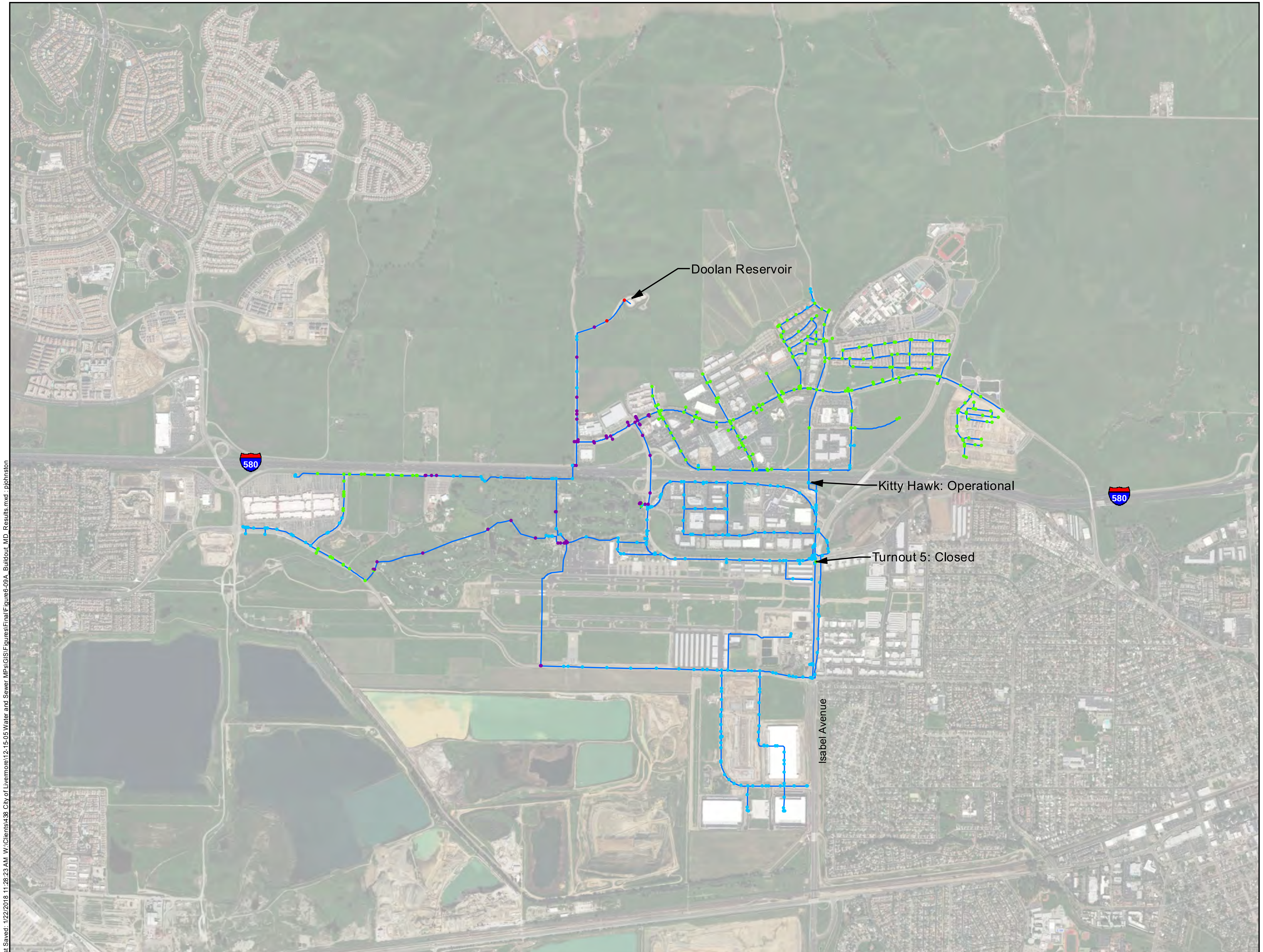

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One Pump at Airway PS operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

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Figure 6-9A

Buildout System Maximum Day Demand Results Operational Alternative 3 (Zone 1)

City of Livermore
Water Master Plan

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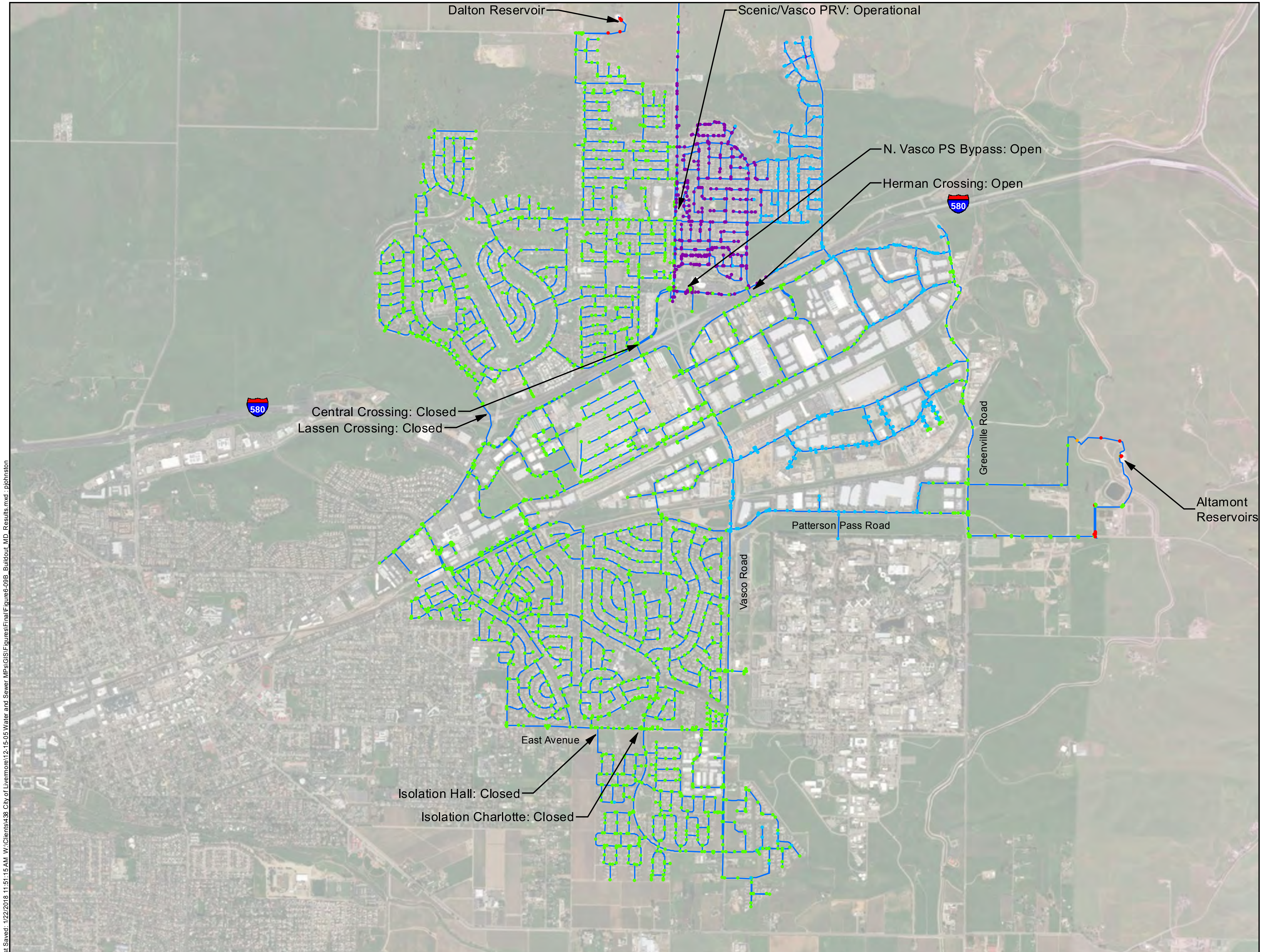

N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-9B

Buildout System Maximum Day Demand Results Operational Alternative 3 (Zones 2 & 3)

City of Livermore
Water Master Plan

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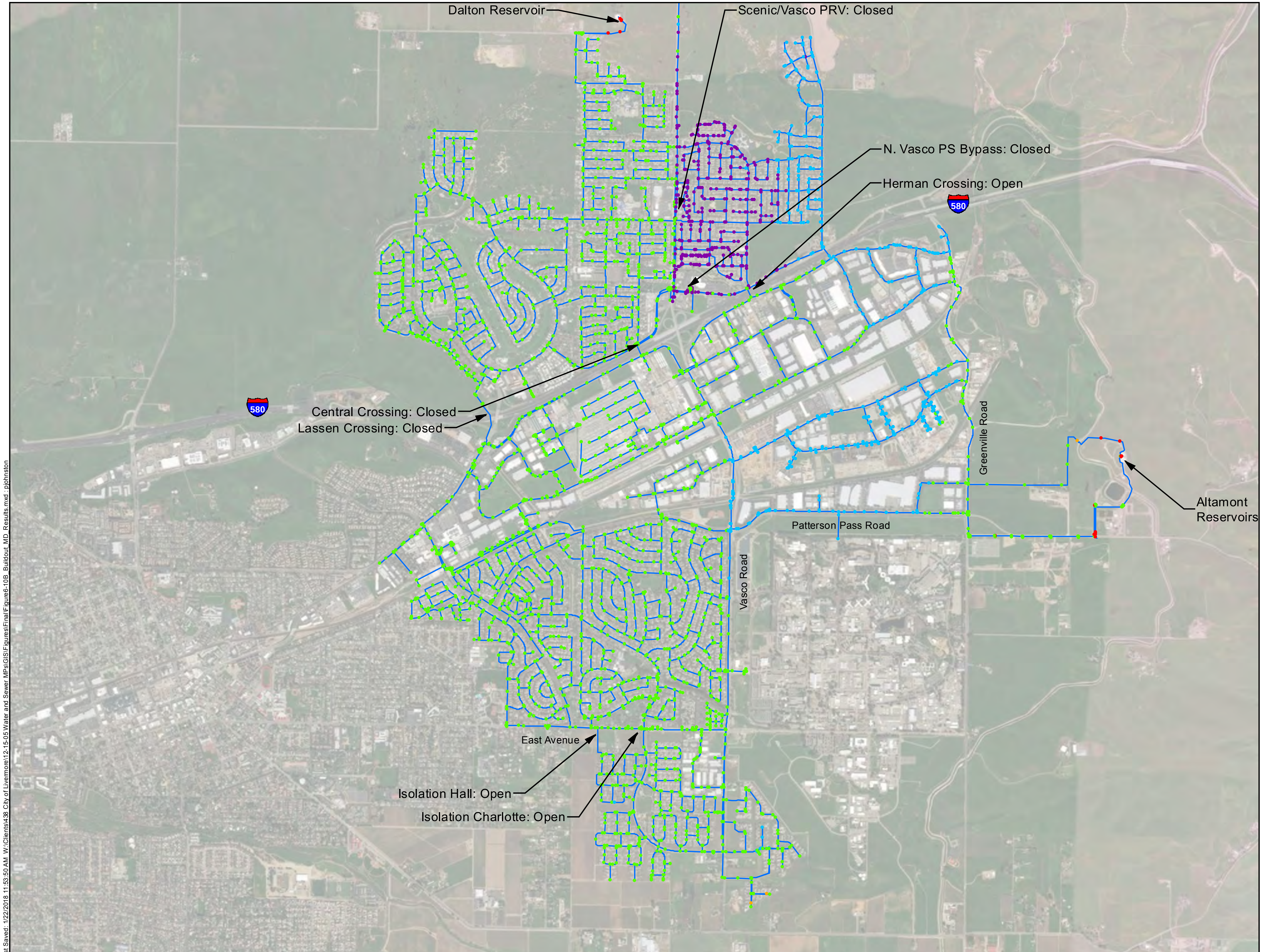

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N

0 1,000 2,000

Scale in Feet

Maximum Pressure (psi)

- < 30 psi
- 30-35 psi
- 35-80 psi
- 80-100 psi
- >100 psi
- Pipelines

Notes:
1. Existing maximum day demand is equal to 11.41 mgd (7,900 gpm).
2. Storage reservoirs were assumed to be 75% full.
3. One low head pump and one high head pump at Vasco PS are operating.
4. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

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Figure 6-10B

Buildout System Maximum Day Demand Results Operational Alternative 4 (Zones 2 & 3)

City of Livermore
Water Master Plan

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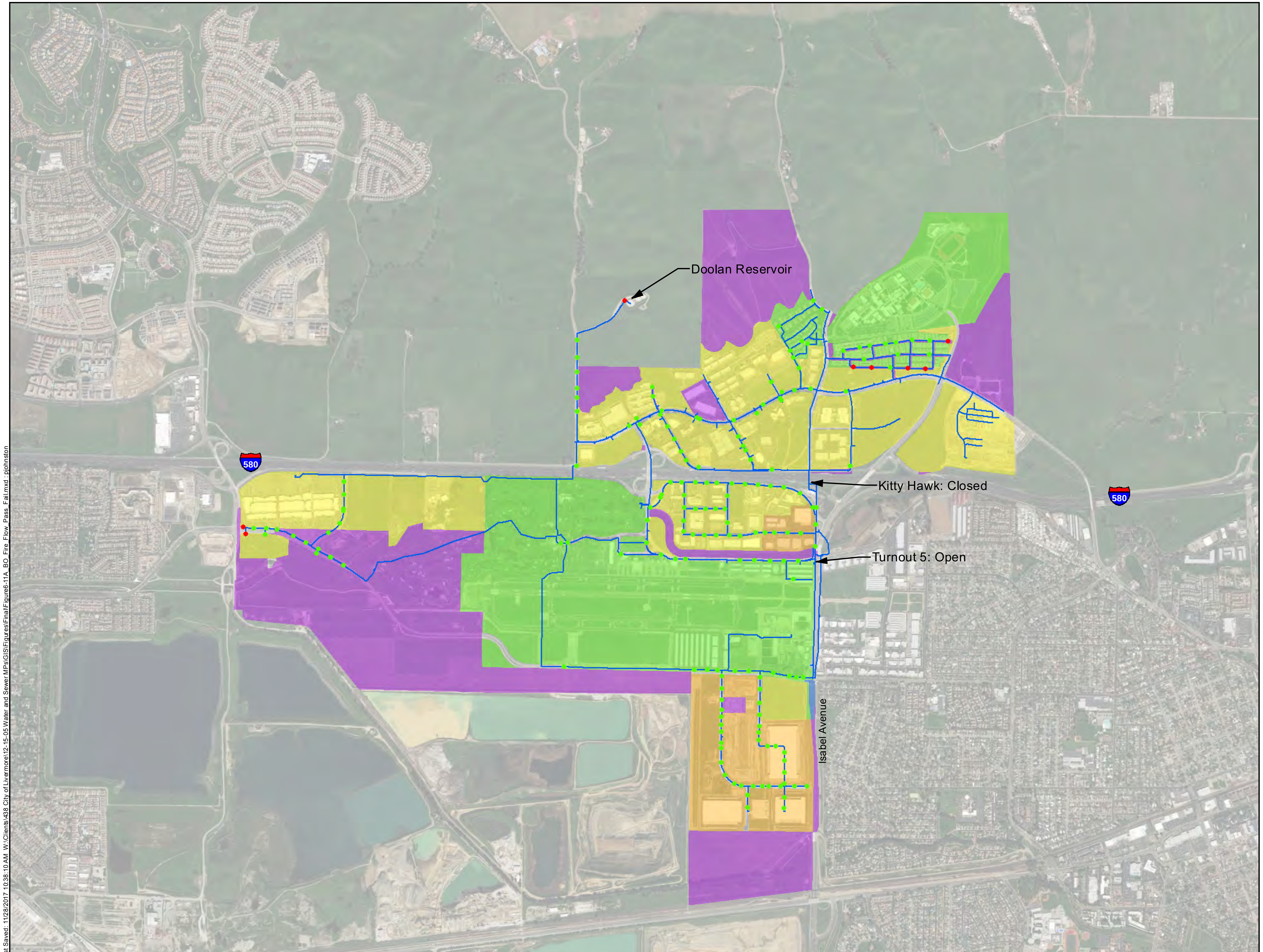

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA
WEST YOST ASSOCIATES

Figure 6-11A

Buildout System Residual Pressure Base Operational Alternative (Zone 1)

City of Livermore
Water Master Plan

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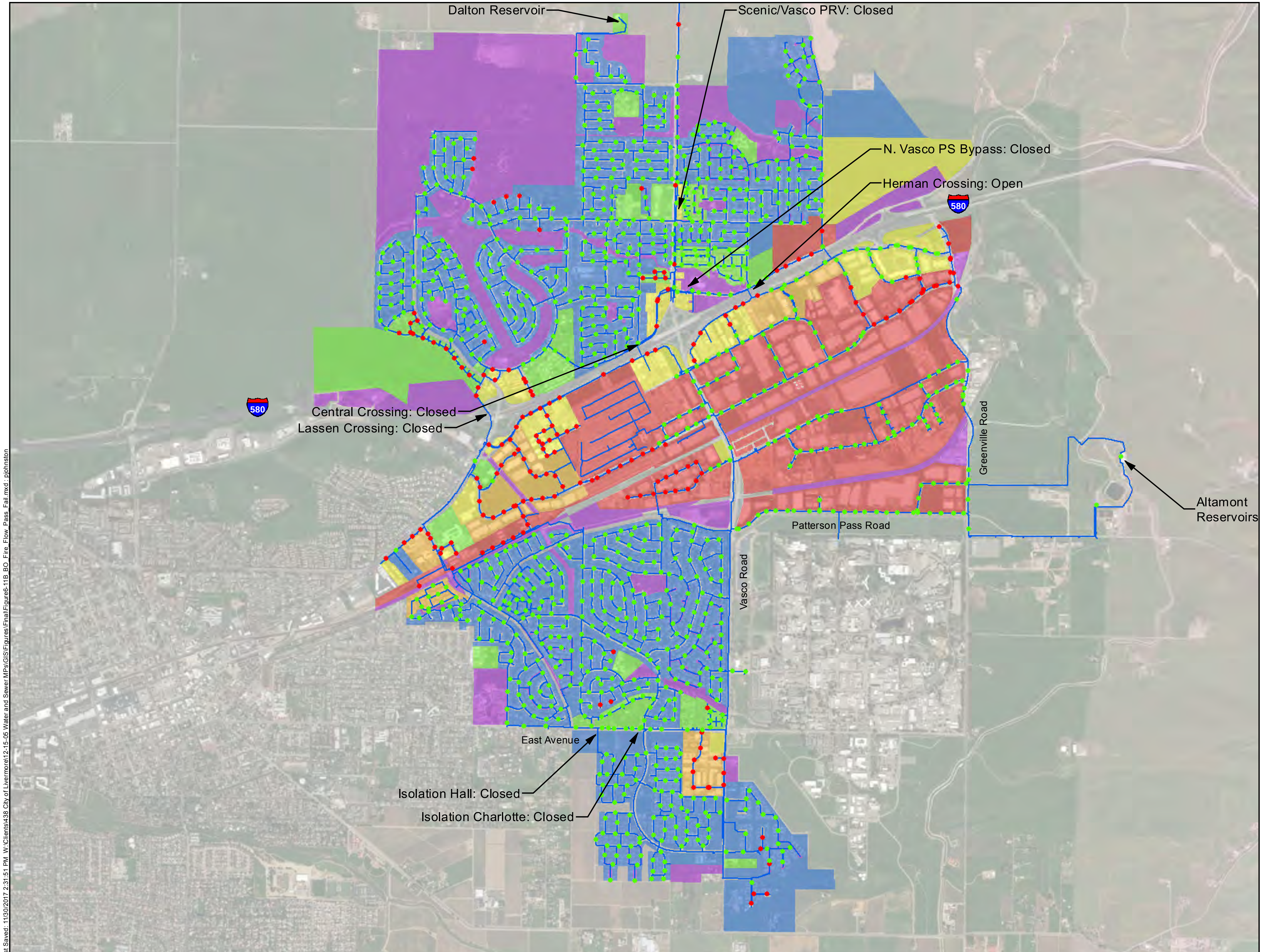

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:

1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

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Figure 6-11B

Buildout System Residual Pressure Base Operational Alternative (Zones 2 & 3)

City of Livermore
Water Master Plan

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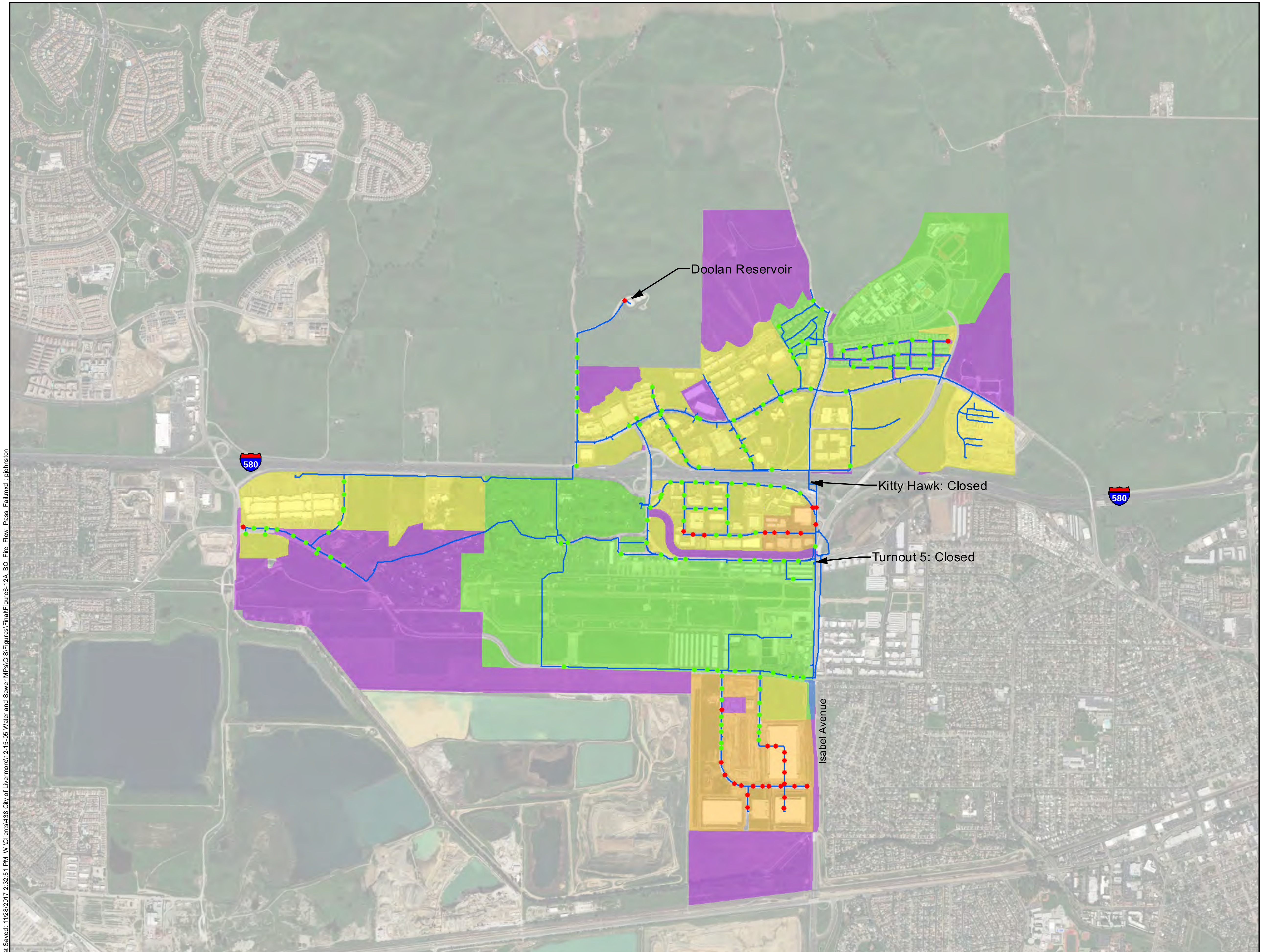

0 1,000 2,000
Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-12A

Buildout System Residual Pressure Operational Alternative 1 (Zone 1)

City of Livermore
Water Master Plan

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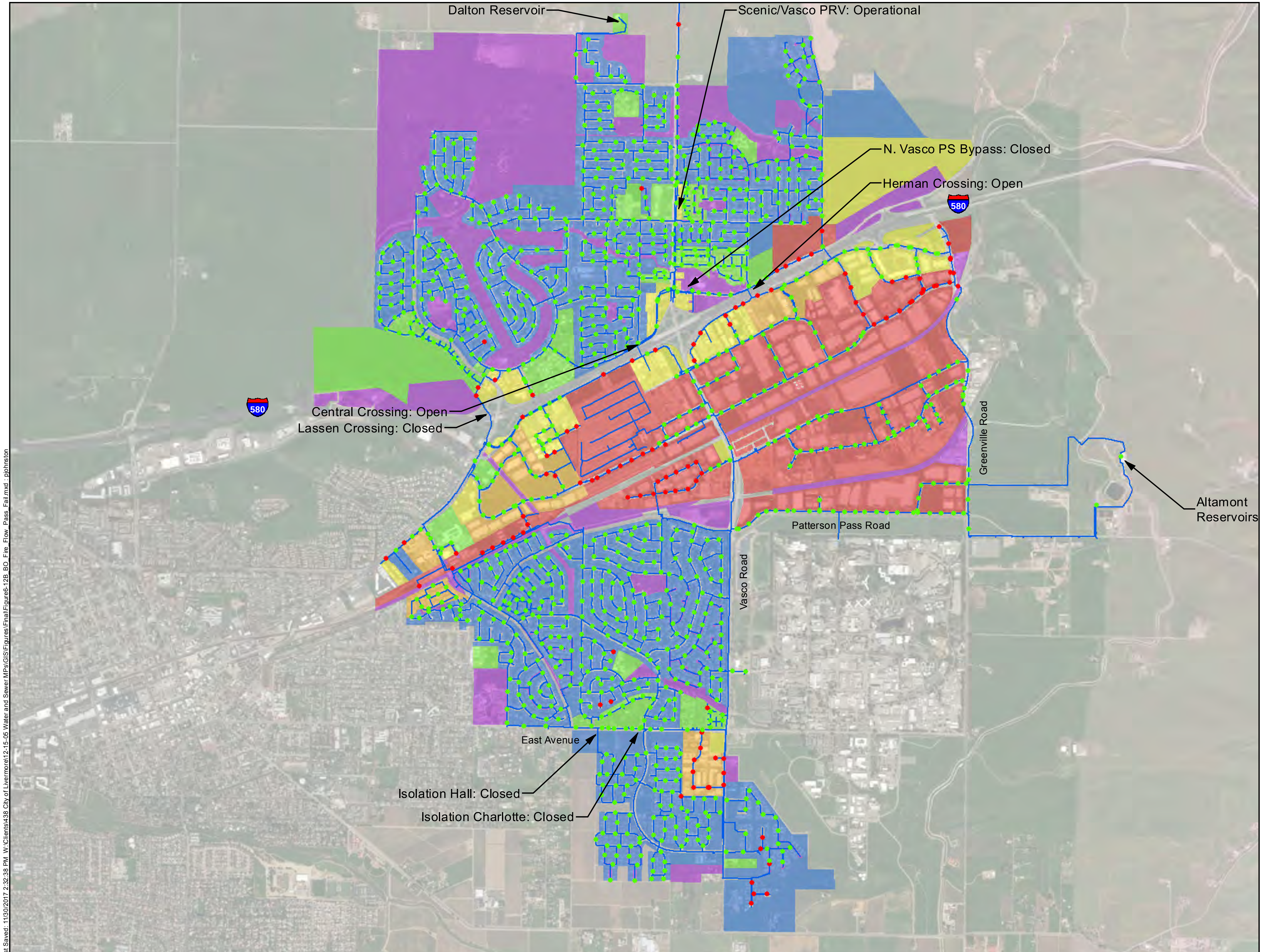

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:

1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

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Figure 6-12B

Buildout System Residual Pressure Operational Alternative 1 (Zones 2 & 3)

City of Livermore
Water Master Plan

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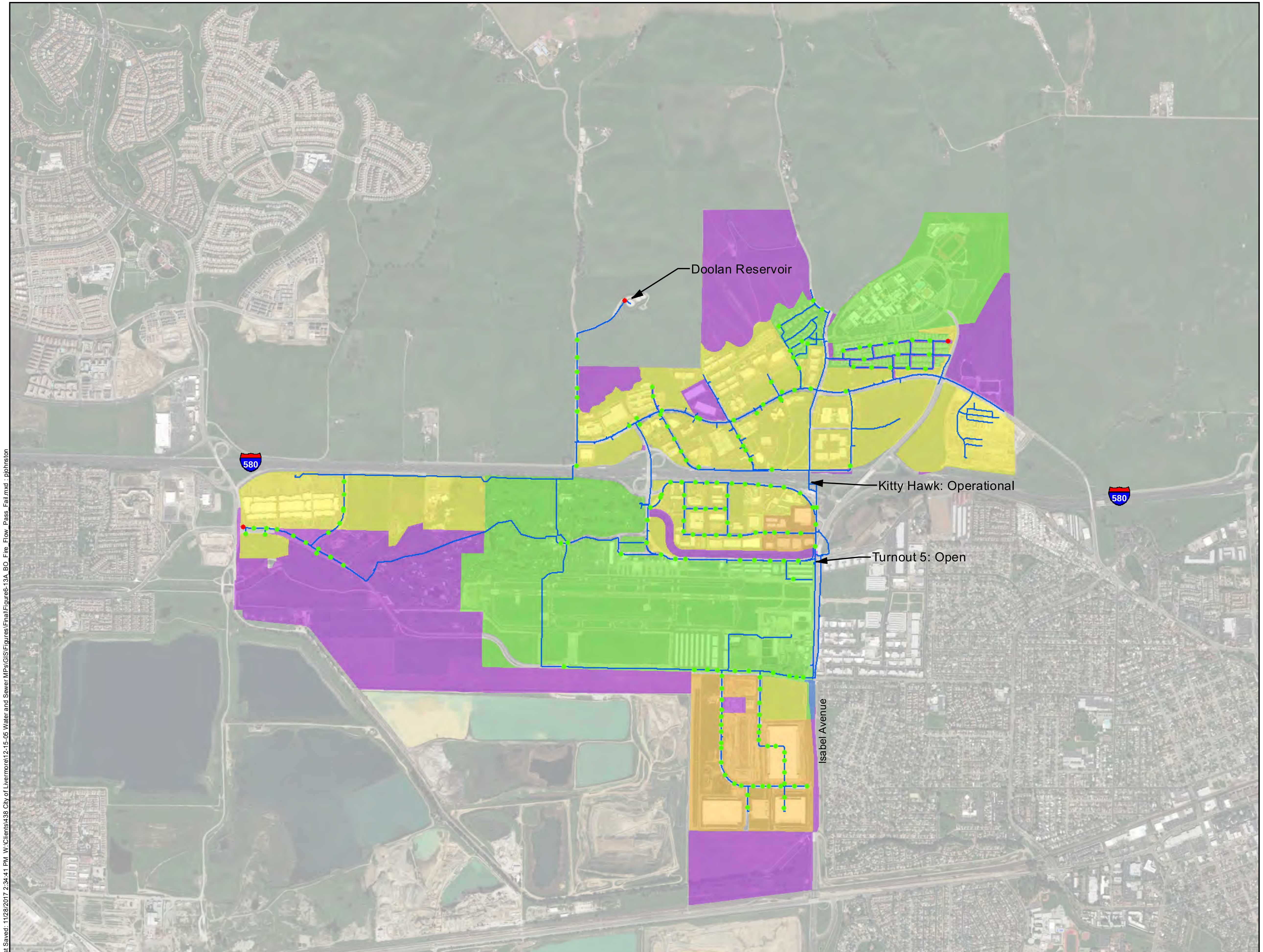

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-13A

Buildout System Residual Pressure Operational Alternative 2 (Zone 1)

City of Livermore
Water Master Plan

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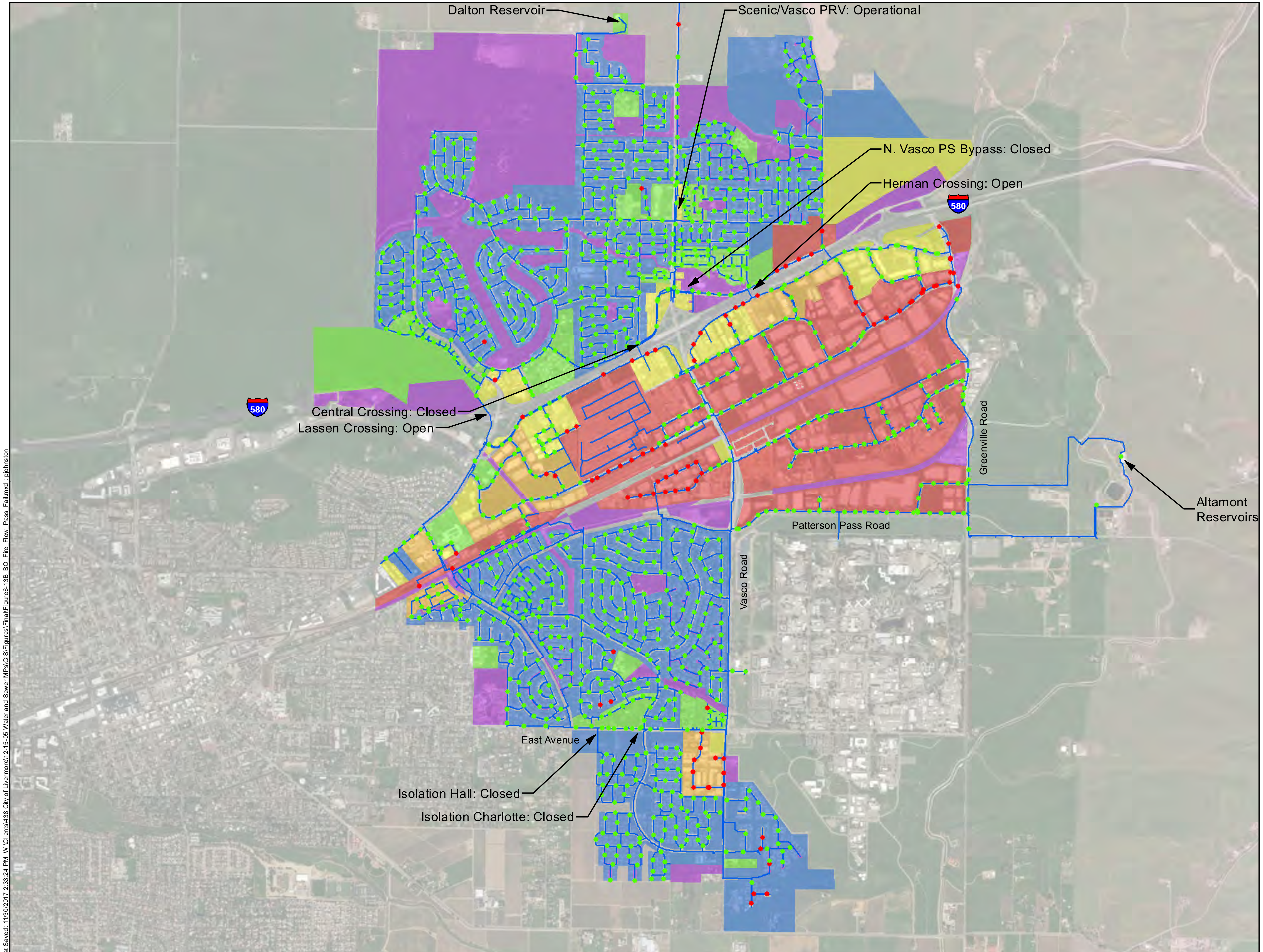

0 1,000 2,000
Scale in Feet

Minimum Residual Pressure of 20 psi
- Fail
- Pass

Fire Flow Demands
- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA
WEST YOST ASSOCIATES

Figure 6-13B

Buildout System Residual Pressure Operational Alternative 2 (Zones 2 & 3)

City of Livermore
Water Master Plan

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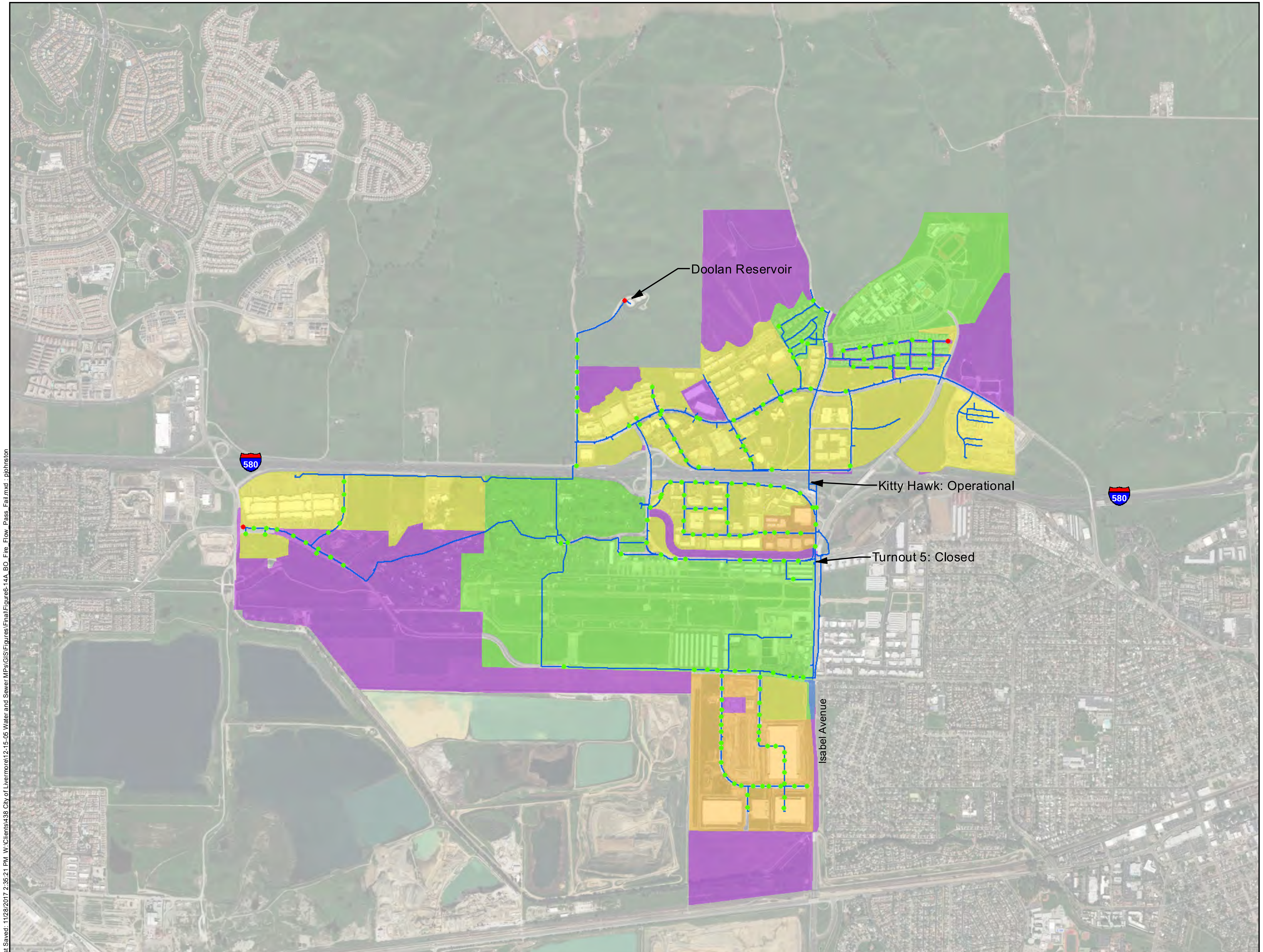

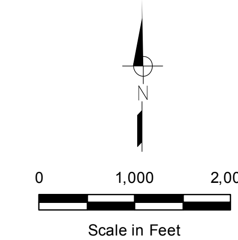

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-14A

Buildout System Residual Pressure Operational Alternative 3 (Zone 1)

City of Livermore
Water Master Plan

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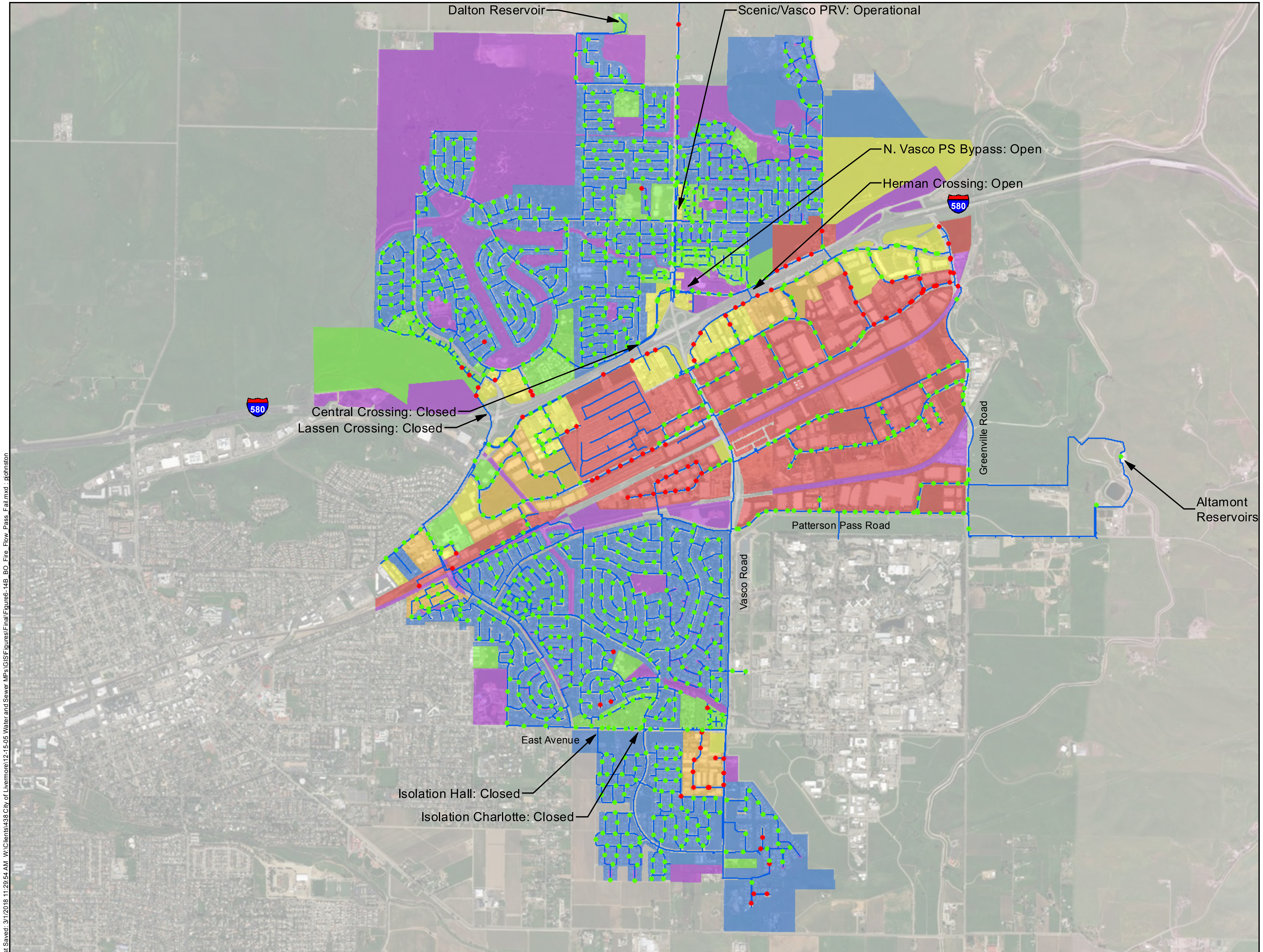

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:

1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-14B

Buildout System Residual Pressure Operational Alternative 3 (Zones 2 & 3)

City of Livermore
Water Master Plan

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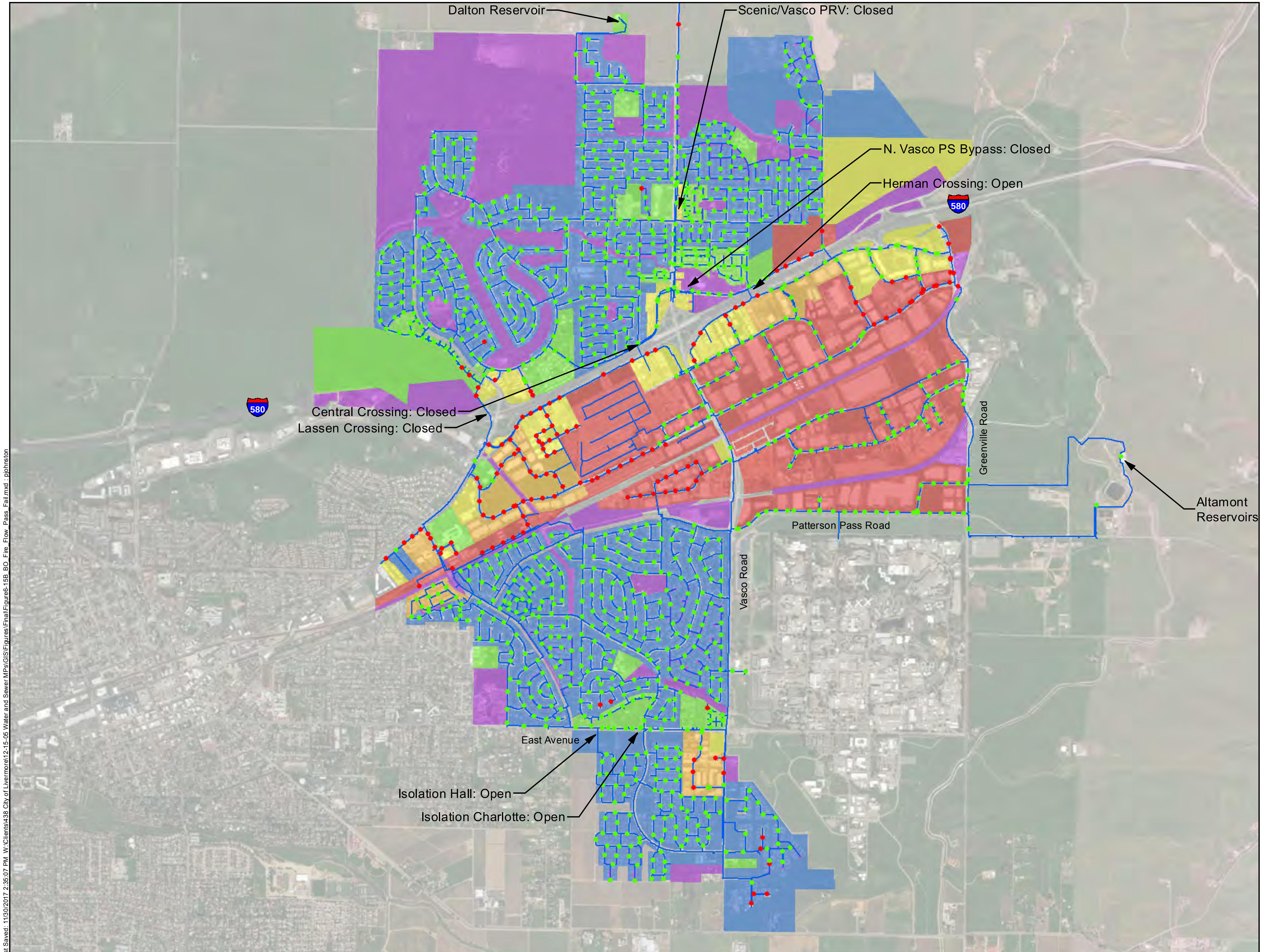

N

0 1,000 2,000

Scale in Feet

Minimum Residual Pressure of 20 psi

- Fail
- Pass

Fire Flow Demands

- 0 gpm
- 1500 gpm
- 2500 gpm
- 3500 gpm
- 4000 gpm
- 5000 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.41 MGD (7,900 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-15B

Buildout System Residual Pressure Operational Alternative 4 (Zones 2 & 3)

City of Livermore
Water Master Plan

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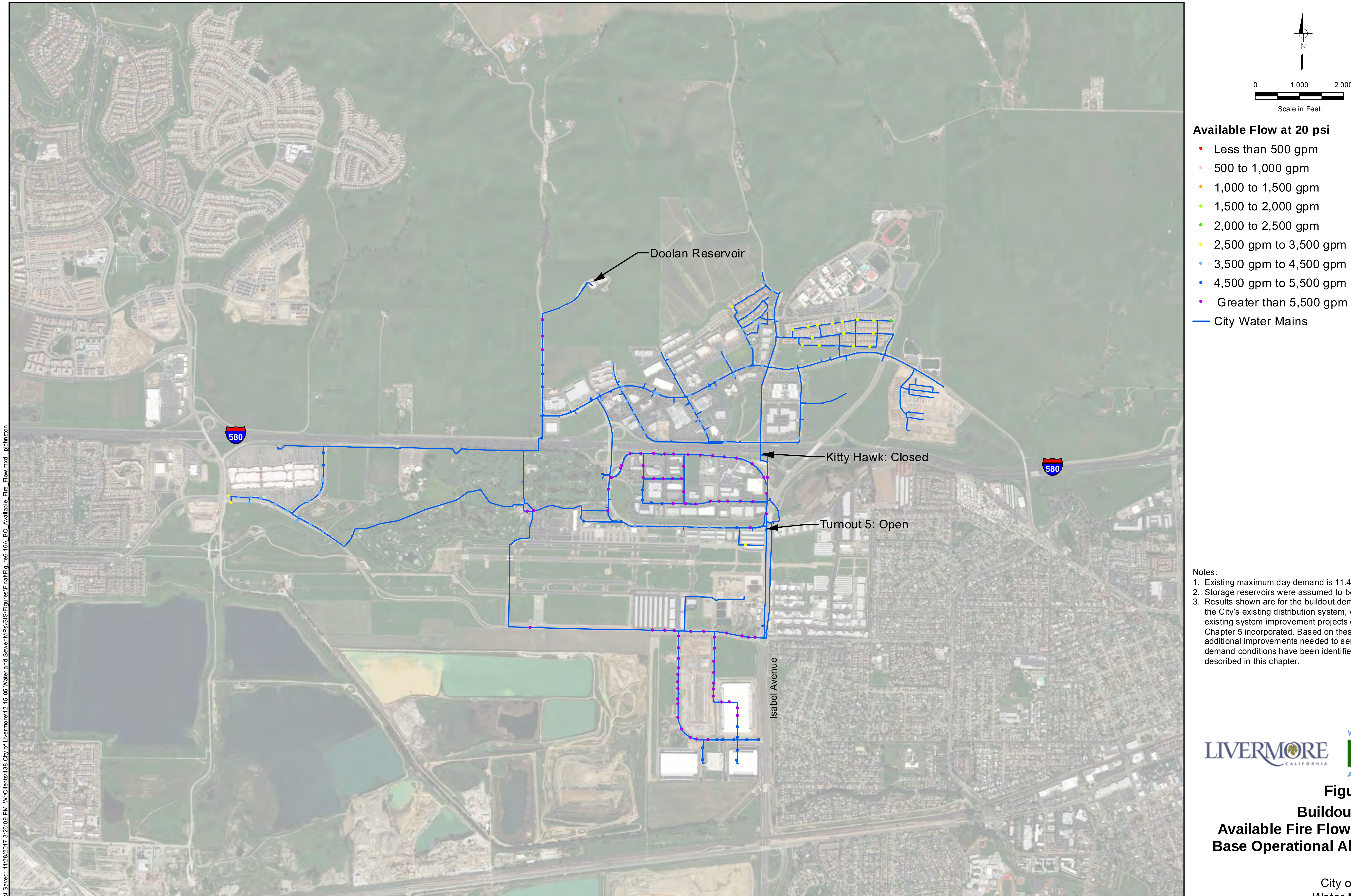

Notes:
1. Existing maximum day demand is 11.4 MGD (7,926 gpm).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-16A

Buildout System
Available Fire Flow at 20 psi
Base Operational Alternative
(Zone 1)

City of Livermore
Water Master Plan

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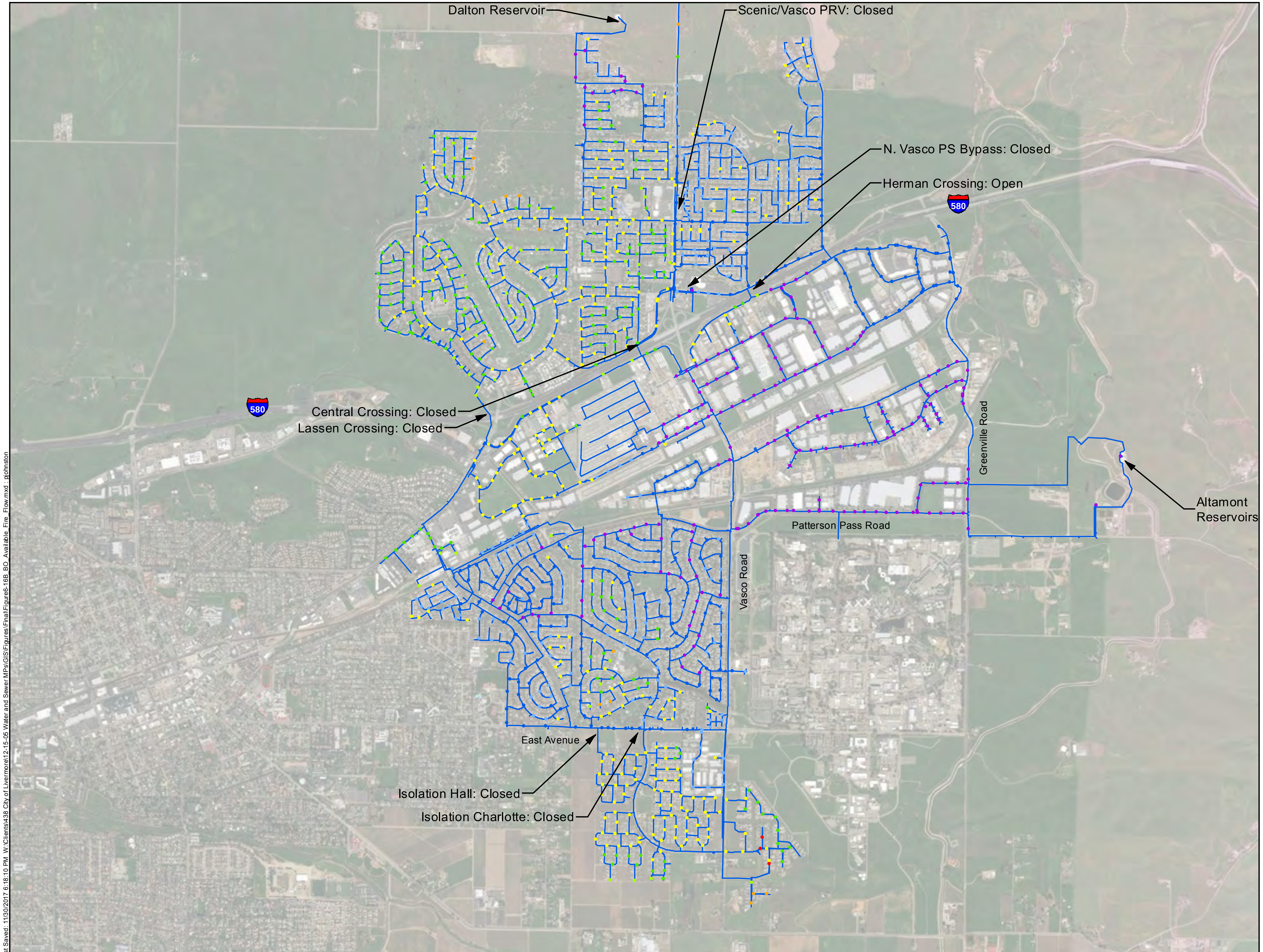

N

0 1,000 2,000

Scale in Feet

Available Flow at 20 psi

- Less than 500 gpm
- 1,000 to 1,500 gpm
- 1,500 to 2,000 gpm
- 2,000 to 2,500 gpm
- 2,500 gpm to 3,500 gpm
- 3,500 gpm to 4,500 gpm
- 4,500 gpm to 5,500 gpm
- Greater than 5,500 gpm
- City Water Mains

Notes:
1. Existing maximum day demand is 11.4 MGD (7,926).
2. Storage reservoirs were assumed to be 50% full.
3. Results shown are for the buildout demands applied to the City's existing distribution system, without the existing system improvement projects described in Chapter 5 incorporated. Based on these results, the additional improvements needed to serve buildout demand conditions have been identified and are described in this chapter.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 6-16B

Buildout System
Available Fire Flow at 20 psi
Base Operational Alternative
(Zones 2 & 3)

City of Livermore
Water Master Plan

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This chapter presents the recommended improvements to be included in the City's Capital Improvement Program (CIP) for the City's existing and buildout water system based on the evaluations described in Chapters 5 and 6 of this Water Master Plan. The chapter provides a summary of the recommended capital improvement projects, along with estimates of probable construction costs. Probable construction cost estimates are developed individually for each proposed improvement project.

It is important to note that the focus of this Water Master Plan is to recommend capacity-related improvement projects for the City's water system. It is not the intent for this Water Master Plan to be the sole source of all recommended water system projects for inclusion in the City's Capital Improvement Plan (CIP). Other sources include the Water Resource Division's asset management program (which focuses on the renewal or replacement of water system assets based on and age and condition), regulation and code compliance, operations and maintenance staff input, and coordination with other roadway improvements. The City utilizes and coordinates all sources in the development of the City's overall CIP for the water system.

This chapter also briefly describes an evaluation of the potential need for additional potable water system improvements beyond those identified in Chapters 5 and 6 of this Water Master Plan to serve the City's proposed Isabel Neighborhood Plan, which is proposed to develop in conjunction with the proposed future extension of BART to Isabel Avenue. As described in Section 7.1.3 below, it was determined that no additional potable water system improvements would be required to serve the proposed Isabel Neighborhood Plan. A complete description of the potable water system evaluation to serve the proposed Isabel Neighborhood Plan is provided in Appendix C.

7.1 RECOMMENDED WATER SYSTEM CAPITAL IMPROVEMENT PROGRAM

The recommended water system capital improvement projects are described below, listed in Table 7-1 and shown on Figure 7-1. It should be noted that there are no recommended capital improvements in the City's Zone 1 water service area; all recommended improvements are in the Zone 2 and 3 water service areas as shown on Figure 7-1.

It should also be noted that the recommended CIP only identifies improvements at a Master Planning level and does not constitute a design of such improvements. Subsequent detailed design will be required to determine the exact sizes and locations of these proposed improvements and to refine the opinion of probable construction cost.

Table 7-1. Summary of Recommended Capital Improvement Projects and Estimated Cost[a]									
								Cost Allocation	
CIP ID	Improvement Type	Reason for Improvement	Was this a project in the 2004 WMP?	Improvement Description	Pressure Zone	Base Construction Cost[a]	Total Project Cost (includes mark-ups)[a]	Existing Users	Future Users
Near-Term Improvements (Near-Term Improvements)									
Pipeline Improvements									
EX-CIP-P01	Pipeline Replacement	Fire Flow	No	Replace 480 feet of existing 6-inch diameter pipeline with 8-inch pipeline on Zinnia Court. Replace 670 feet of existing 6-inch diameter pipeline with 16-inch pipeline on Springtown from Lassen to Bluebell and along Bluebell from Springtown to Larkspur.	670	$ 331,000	$ 645,000	$ 645,000	
EX-CIP-P02	Pipeline Replacement	Fire Flow	Yes, but not constructed	Replace 1570 feet of existing 8-inch diameter pipeline with 12-inch pipeline on Preston from Southfront west to Southfron east and along Southfront east from Preston to Waxlax.	670	$ 439,000	$ 856,000	$ 856,000	
EX-CIP-P03	Pipeline Replacement	Fire Flow	Yes, but not constructed	Construct 4,400 feet of new 12-inch diameter pipeline, which includes 700 feet of new 12-inch diameter pipeline along Preston Avenue from Turnout 8 west to the intersection of Franklin Lane and Preston Avenue, 900 feet of new 12-inch diameter pipeline along Franklin Lane from Preston Avenue to Southfront Road, 400 feet of 8-inch diameter pipe with 12-inch diameter pipe from the intersection of Southfront Road and Franklin Lane to approximately 400 feet to the east along Southfront Road and 2,300 feet of new 12-inch diameter pipeline parallel to the existing 8-inch diameter pipeline from the intersection of Southfront Road and Franklin Lane to approximately 2,300 feet to the west, connecting to the existing 12-inch diameter pipeline.	670	$ 1,233,000	$ 2,404,000	$ 2,404,000	
EX-CIP-P04	Pipeline Replacement	Fire Flow	No	Replace 580 feet of existing 12-inch diameter pipeline with 18-inch pipeline on Preston east from McGraw.	670	$ 220,000	$ 429,000	$ 429,000	
EX-CIP-P05	Pipeline Replacement	Fire Flow	Yes, constructed, but still deficient	Replace 2490 feet of existing 12-inch diameter pipeline with 18-inch pipeline on Las Positas from the Las Positas/Bennet PRV near Bennet Drive to Capitol Street.	744	$ 946,000	$ 1,845,000	$ 1,845,000	
EX-CIP-P06	Pipeline Replacement	Fire Flow	No	Replace 2760 feet of existing 12-inch diameter pipeline with 18-inch pipeline on Brisa Street from the PRV station near Vasco Road to the west end of Brisa near La Ribera Street.	741	$ 1,048,000	$ 2,044,000	$ 2,044,000	
EX-CIP-P07	Pipeline Replacement	Fire Flow	No	Replace 170 feet of existing 8-inch diameter pipeline with 12-inch pipeline at the intersection of Trevarno and Contractors Place, Replace 50 feet of 6-inch diameter pipeline with 12-inch pipeline at the intersection of Contractors Place and Mines Road, and replace 310 feet of 8-inch diameter pipeline with 12-inch pipeline on Technology Drive.	670	$ 149,000	$ 291,000	$ 291,000	
EX-CIP-P08	Pipeline Replacement	Fire Flow	No	Replace 730 feet of existing 6-inch diameter pipeline with 8-inch pipeline on Juliet Court and Kathy Way.	725	$ 154,000	$ 300,000	$ 300,000	
EX-CIP-P09	Pipeline Replacement	Fire Flow	No	Replace 240 feet of existing 8-inch diameter pipeline with 12-inch diameter pipeline on Graham Court.	800	$ 69,000	$ 135,000	$ 135,000	
						Subtotal	$ 8,949,000	$ 8,949,000	$ -
Pressure Reducing Valve Station Improvements									
EX-CIP-V01	New PRV Station and Pipeline Replacement	Fire Flow	No	Construct new PRV station at Commerce Way and Southfront Road. Replace 300 feet of existing 12-inch diameter pipeline with 16-inch pipeline along Southfront Road.	744 to 670	$ 371,000	$ 723,000	$ 723,000	
EX-CIP-V02	New PRV Station	Fire Flow	No	Construct new PRV station at south end of Lassen Road	670	$ 270,000	$ 527,000	$ 527,000	
EX-CIP-V03	New PRV Station	Fire Flow	No	Construct a PRV at Turnout 1	670	$ 270,000	$ 527,000	$ 527,000	
						Subtotal	$ 1,777,000	$ 1,777,000	$ -
Pumping Improvements									
EX-CIP-U01	New Pump Capacity	Peak Hour	No	Increase firm pumping capacity in the Oakville/Vineyard Pump Station	800	$ 50,000	$ 98,000	$ 98,000	
EX-CIP-U02	Pump Performance Study	Peak Hour	No	Evaluation of pump performance under a range of operating conditions	Several	$ 200,000	$ 200,000	$ 200,000	
						Subtotal	$ 298,000	$ 298,000	$ -
Storage Improvements									
EX-CIP-T01	Replace Reservoir	Storage Deficiency	Yes	Replace the existing Dalton Tank with a new 3.4 MG storage reservoir at the Dalton site (cost per City CIP Project No. 201619)	670		$ 7,142,000	$ 5,006,000	$ 2,136,000
						Subtotal	$ 7,142,000	$ 5,006,000	$ 2,136,000
				Existing System Improvement Projects (Near-Term Projects) Total			**$ 18,166,000**	**$ 16,030,000**	**$ 2,136,000**
Buildout Improvements (2040 Improvements)									
Pipeline Improvements									
BO-CIP-P01	Pipeline Replacement	Peak Hour and Fire Flow	No	Construct 5,500 feet of new 16-inch pipeline parallel to the existing 16-inch pipeline along Vasco Road between Patterson Pass Road and East Avenue.	800	$ 1,881,000	$ 3,668,000		$ 3,668,000
						Subtotal	$ 3,668,000	$ -	$ 3,668,000
Pumping Improvements									
BO-CIP-U01	Adjust Controls and Verify Automatic Transfer Switches	Peak Hour and Fire Flow	No	Adjust controls to activate high head pumps at Vasco Pump Station when low pressures occur in various locations in Pressure Zone 800. Verify automatic transfer switches on generators.	800	$ 50,000	$ 98,000		$ 98,000
						Subtotal	$ 98,000	$ -	$ 98,000
						Buildout Improvement Projects Total	**$ 3,766,000**	**$ -**	**$ 3,766,000**
						Total Capital Improvement Plan	**$ 21,932,000**	**$ 16,030,000**	**$ 5,902,000**

[a] Costs shown are based on the March 2017 SF ENR CCI of 11609.

7.1.1 Existing Water System Capital Improvement Program

Chapter 5 provided a summary of the evaluation of the City's existing water system and its ability to meet the recommended water system planning and design criteria described in Chapter 4. Based on the existing water system evaluations, improvements were recommended in the Zone 2 and 3 water service areas to eliminate existing system deficiencies. No existing system improvements are recommended in the Zone 1 water service area.

The recommended existing water system improvements in the Zone 2 and 3 water service areas are as follows:

- Pumping Capacity Improvements
  - Increase the firm pumping capacity of the Oakville Pump Station from 140 gpm to 176 gpm. (Project No. EX-CIP-U01)
  - Perform a pump station evaluation to evaluate pump performance under a range of operating conditions to determine if the actual capacity differs from the nominal capacity. (Project No. EX-CIP-U02).
- Storage Capacity Improvements
  - Replace the existing 2.0 MG Dalton Tank with a new 3.41 MG tank, with the sizing of the new facility based on buildout demand requirements (see Chapter 6 and Section 7.1.2 below for further discussion). (Project No. EX-CIP-T01).
- Pressure Reducing Station Improvements
  - Install a new PRV station approximately 300 feet west of the intersection of Southfront Road and Commerce Way to supply Pressure Zone 670 from Pressure Zone 744. (Project No. EX-CIP-V01).
  - Install a new PRV station at the south end of Lassen Road to supply the north portion of Pressure Zone 670 from the south portion of Pressure Zone 670 when the Lassen Crossing is closed. This project is required only if the City chooses to continue closing the Interstate 580 crossing at Lassen, as this project serves as a bypass of the closed crossing under high demand conditions. (Project No. EX-CIP-V02).
  - Install a PRV at Turnout 1 to allow supply to enter Pressure Zone 670 via gravity under high demand conditions, such as fire flow. The PRV should be set to approximately 45 psi. This project is required only if the City chooses to keep the Trevarno Pump Station bypass line closed. (Project No. EX-CIP-V03).
- Pipeline Improvements for Fire Flow and System Reliability
  - Replace approximately 300 feet of 12-inch diameter pipe with 16-inch diameter pipe along Southfront Road extending from Commerce Way to the west. (included in Project No. EX-CIP-V01).
  - Replace approximately 500 feet of 6-inch diameter pipe with 8-inch diameter pipe along Zinnia Court. (Project EX-CIP-P01).

- Replace approximately 650 feet of 6-inch diameter pipe with 16-inch diameter pipe along Springtown Boulevard between Lassen Road and Bluebell Drive, and along Bluebell Drive between Springtown Boulevard and Larkspur Drive. (Project EX-CIP-P01).
- Replace approximately 1,600 feet of 8-inch diameter pipe with 12-inch diameter pipe along Preston Avenue from the western part of Southfront Road to the eastern part of Southfront Road, and along the eastern part of Southfront Road between Preston Avenue and Waxlax Way. (Project No. EX-CIP-P02).
- Install approximately 4,400 feet of 12-inch diameter pipe. A portion is to install approximately 700 feet of new 12-inch diameter pipeline along Preston Avenue from Turnout 8 west to the intersection of Franklin Lane and Preston Avenue. A second portion is to install approximately 900 feet of new 12-inch diameter pipeline along Franklin Lane from Preston Avenue to Southfront Road. A third portion is to replace approximately 400 feet of 8-inch diameter pipe with 12-inch diameter pipe from the intersection of Southfront Road and Franklin Lane to approximately 400 feet to the east along Southfront Road. A fourth portion is to install approximately 2,300 feet of new 12-inch diameter pipeline parallel to the existing 8-inch diameter pipeline from the intersection of Southfront Road and Franklin Lane to approximately 2,300 feet to the west, connecting to the existing 12-inch diameter pipeline. (Project No. EX-CIP-P03).
- Replace approximately 600 feet of 12-inch diameter pipe with 18-inch diameter pipe along Preston Avenue east of McGraw Avenue. (Project No. EX-CIP-P04)
- Replace approximately 2,500 feet of 12-inch diameter pipe with 18-inch diameter pipe along Las Positas Road from the Las Positas/Bennet PRV station near Bennet Drive to Capitol Street. (Project No. EX-CIP-P05).
- Replace approximately 2,800 feet of 12-inch diameter pipe with 18-inch diameter pipe along Brisa Street from the PRV station near Vasco Road to the last hydrant on the west end of Brisa Street, west of La Ribera Street. (Project No. EX-CIP-P06).
- Replace approximately 170 feet of 8-inch diameter pipe with 12-inch diameter pipe near the intersection of Trevarno Road and Contractors Place. (Project No. EX-CIP-P07).
- Replace approximately 50 feet of 6-inch diameter pipe with 12-inch diameter pipe at the intersection of Contractors Place and Mines Road. (Project No. EX-CIP-P07).
- Replace approximately 310 feet of 8-inch diameter pipe with 12-inch diameter pipe on Technology Drive east of North Mines Road. (Project No. EX-CIP-P07).
- Replace approximately 350 feet of 6-inch diameter pipe with 8-inch diameter pipe along Juliet Court from Kathy Way to the hydrant on Juliet Court. (Project No. EX-CIP-P08).
- Replace approximately 400 feet of 6-inch diameter pipe with 8-inch diameter pipe along Kathy Court from Kathy Way to the hydrant on Kathy Way. (Project No. EX-CIP-P08).

— Replace approximately 250 feet of 8-inch diameter pipe with 12-inch diameter pipe along Graham Court from South Vasco Road to the hydrant on Graham Court. (Project No. EX-CIP-P09).

The recommended existing system improvements should be implemented in the near-term. The locations of the recommended existing water system improvement projects are shown on Figure 7-1.

Recommended operational improvements for the existing water system that do not require capital improvements are described in Chapter 5 (see Section 5.6).

7.1.2 Buildout Water System Capital Improvement Program

Chapter 6 provided a summary of the evaluation of the City's buildout water system and its ability to meet the recommended water system planning and design criteria described in Chapter 4. Based on the buildout water system evaluation, improvements were recommended in the Zone 2 and 3 water service areas to eliminate future system deficiencies and to meet future demand at buildout. No system improvements are recommended for buildout in the Zone 1 water service area.

The recommended buildout water system improvements in the Zone 2 and 3 water service areas are in addition to those listed for existing conditions and are as follows:

- Pumping Improvements
  - — Implement a control strategy for the high head pumps at Vasco Pump Station to activate when low pressure conditions occur at the various locations within the Zone 3 Water Service Area as described in Chapter 6. (Project No. BO-CIP-U01).
- Storage Improvements
  - — Replace the existing 2.0 MG Dalton Tank with a new 3.41 MG tank, with the sizing of the new facility based on buildout demand requirements. This improvement project to be constructed as an existing improvement. (Project No. EX-CIP-T01).
- Pipeline Improvements for Peak Hour, Fire Flow and System Reliability
  - — Install 5,500 feet of 16-inch diameter pipeline along Vasco Road between Patterson Pass Road and Emily Way parallel to the existing 16-inch diameter pipeline in this location. (Project No. BO-CIP-P01).

The construction of recommended improvements for buildout conditions should be coordinated with the proposed schedules of new development to ensure that required infrastructure will be in place to serve future customers. The locations of the recommended buildout water system improvement projects are shown on Figure 7-1.

Recommended operational improvements for the buildout water system that do not require capital improvements are described in Chapter 6 (see Section 6.6).

7.1.3 Additional Improvements to Serve the Isabel Neighborhood Plan

The Isabel Neighborhood Plan (INP) is a proposed development area located in the northwest portion of the City. The INP planning area covers approximately 1,138 acres, and is entirely within the City's urban growth boundary. A portion of the INP planning area lies within the City's water service area (in the Zone 1 Water Service Area) and a portion lies within the California Water Service Company (CalWater) Livermore District service area. The INP will guide future development of the area surrounding the proposed BART station in the Interstate 580 median, just east of Isabel Avenue and is contingent upon the extension of BART to this location.

The INP planning area includes both existing developed areas and proposed new development areas. Proposed land uses for the INP are different from those currently included in the City's General Plan. The INP includes new residential areas both north and south of Interstate 580, as well as non-residential, employment generating, uses including ground floor retail, office and commercial. Three new neighborhood parks and open space buffers along the creeks are also proposed to provide recreational opportunities and access to natural areas.

Potable water demands have been projected for the proposed INP land uses to determine if the additional potable water demands associated with the INP trigger required improvements to the City's potable water system. However, as described in Appendix C, the incremental potable water demands for the INP planning area with the proposed INP land uses above those demands based on current General Plan land uses (described in Chapter 3) are relatively small. For the portion of the INP planning area which lies within the City's water service area, the projected potable water demand assuming the INP land uses is 836 af/yr, which is 67 af/yr (or about 9 percent) higher than the potable water demand assuming current General Plan land uses.

Existing water system infrastructure is in place within the INP planning area to serve the existing developed areas. Based on the potable water demand projections for the INP land uses, no additional potable water system improvements would be required, other than potential extension of distribution pipelines to provide service to new development.

The only deficiency identified by the analysis is a small pumping capacity deficiency at the Airway Pump Station when all supply into the Zone 1 Water Service Area is from the Airway Pump Station. However, Turnouts 5 and 11 are capable of supplying Pressure Zones 638 and 605 by gravity. Therefore, no increase in pumping capacity is recommended. However, when the pumps at the Airway Pump Station are replaced in the future, an increase in pumping capacity should be considered.

Additional information on the INP proposed land uses, projected water demands, and potable water system evaluation is provided in Appendix C.

7.2 CAPITAL IMPROVEMENT PROGRAM COSTS AND IMPLEMENTATION

7.2.1 Cost Assumptions

The opinion of probable project cost for recommended water system improvements is presented in March 2017 dollars based on an Engineering News Record (ENR) Construction Cost Index (CCI) of 11609 (San Francisco Average). Base construction costs were developed based on bids on other water facilities design projects and from standard cost estimating guides. The total project cost includes a mark-up equal to 95 percent of the base construction costs, which includes an estimating contingency of 30 percent, and markups of 20 percent for design period services and 30 percent for construction period services. Refer to Appendix D (Table 5) for an example application of project cost markups.

For this Water Master Plan, it is assumed that new distribution system facilities will be developed in public rights-of-way or on public property; therefore, land acquisition costs have not been included. The opinion of probable project cost does not include costs for annual operation and maintenance. A complete description of the assumptions used in the development of the opinion of probable project cost is provided in Appendix D.

7.2.2 Opinion of Probable Project Costs

The opinion of probable project costs for the recommended existing and buildout water system improvements is presented in Table 7-1.

Table 7-2 summarizes the planning-level opinion of probable project costs by project type to mitigate existing system deficiencies, and to meet future growth in the City's potable water system. As described above, no additional potable water system improvements would be required if the proposed INP were to develop. It should be noted that any in-tract pipelines that may be required as part of new development projects will be fully funded and installed by the project proponents. Therefore, these facilities and corresponding costs are not included.

Table 7-2. Opinion of Probable Project Costs for Recommended Potable Water System Capital Improvements by Project Type[a,b]

Water System Improvement Type	Existing (Near-Term)	Buildout	Total
Pumping	$298,000	$98,000	**$396,000**
Storage	$7,142,000		**$7,142,000**
Pipelines	$8,949,000	$3,668,000	**$12,617,000**
Pressure Reducing Stations	$1,777,000		**$1,777,000**
Opinion of Probable Project Costs	$18,166,000	$3,766,000	**$21,932,000**

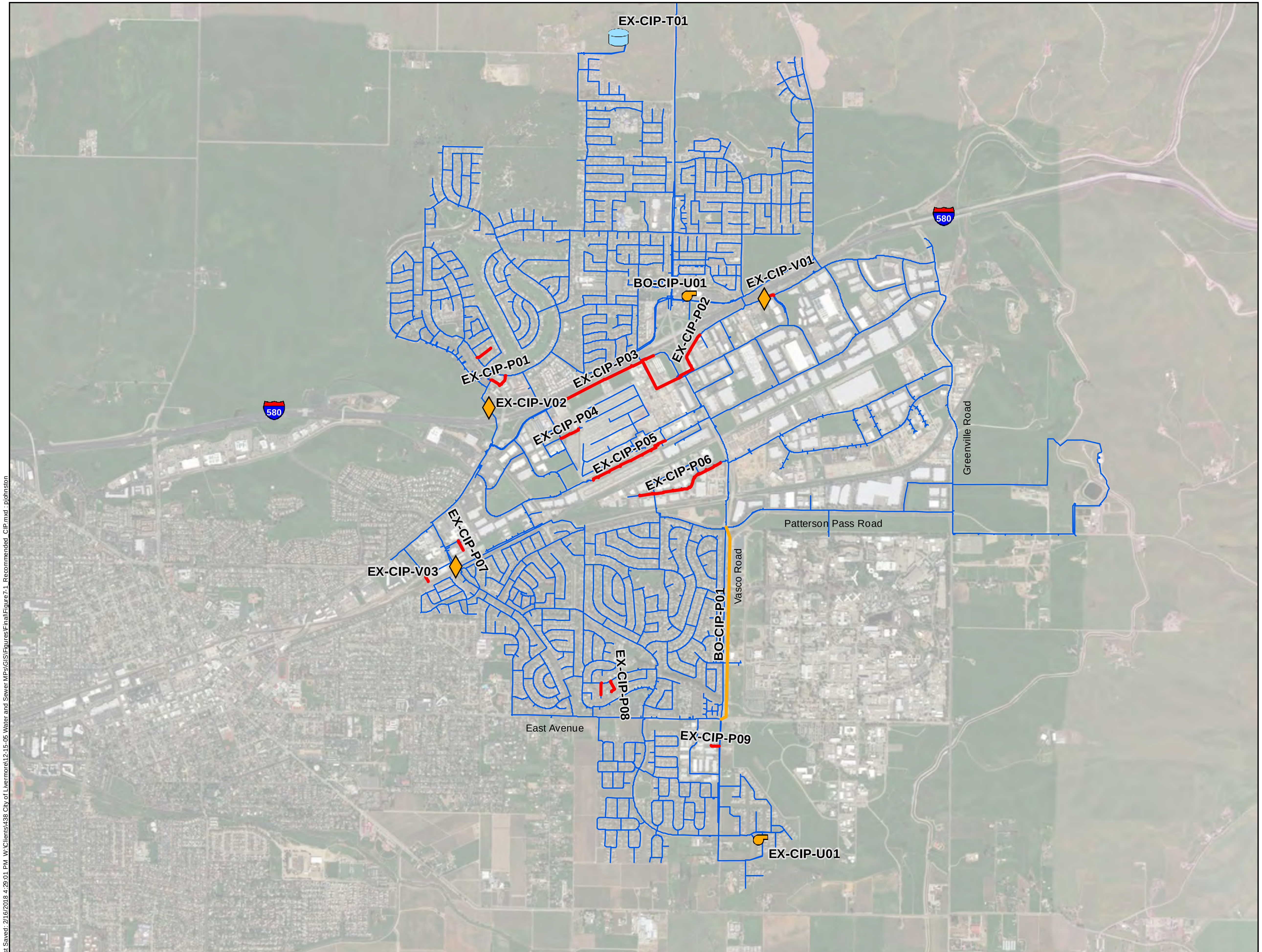
(a) Costs shown are based on the March 2017 SF ENR CCI of 11609.

(b) Total Project Costs include the Estimated Construction Costs which include an estimating contingency of 30 percent of the Base Construction Cost, and Design and Construction Period Services equal to 50 percent of the Estimated Construction Costs.

As shown, the total opinion of probable project costs for water system improvements to support the City's existing and buildout water demands is approximately $21.9 million. Of this amount, approximately $18.2 million is required to address existing system deficiencies, and approximately $3.8 million is required to support buildout.

Existing water system improvements to address existing system deficiencies should be completed as funding permits. The construction of capital improvements for buildout demand conditions should be coordinated with the proposed schedules of new development to ensure that required infrastructure will be in place to serve future customers.

Table 7-1 also shows the proposed cost allocation of the recommended improvements to existing and future water system customers. Total capital costs allocated to existing users are approximately $16 million, and total capital costs allocated to future users are approximately $5.9 million. As shown, most of the recommended capital improvements specific provide benefits to either existing water customers or future water customers. The only improvement which provides benefits to both existing and future customers is the replacement of the Dalton Tank. Costs for the Dalton Tank replacement have been allocated based on the capacity needed to serve existing customers (2.39 MG) vs. the additional capacity needed to serve future customers (1.02 MG).



N

0 1,000 2,000

Scale in Feet

- Near-Term Pressure Regulating Station
- Near-Term Water Storage Reservoir
- Near-Term Pipeline
- Buildout Pipeline
- Existing Pipeline
- Buildout Pump Station Improvement

Note: There are no recommended capital improvement projects in Zone 1.

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure 7-1

Recommended Water System Capital Improvement Program

City of Livermore
Water Master Plan

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APPENDIX A

Potable Water System Hydraulic Model Updates

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This appendix describes the update of the City's potable water system hydraulic model and provides a "Modeler's Notebook" to document the structure and components of the City's hydraulic model, including facility data and evaluation scenarios included in the hydraulic model.

HYDRAULIC MODEL UPDATE

The following sections describe West Yost's review, update and validation of the City's potable water system hydraulic model, which was used for the Water Master Plan to evaluate the adequacy of the City's existing and proposed future water system:

- Hydraulic Model Background
- Model Update Methodology
- Review and Update of the Hydraulic Model
- Hydraulic Model Validation

Hydraulic Model Background

In 2004, the City completed the development of an operational potable water system hydraulic model during the completion of the Water Master Plan. The 2004 operational potable water hydraulic model was developed for the City's Zone 1 water service area from a prior model developed during the City's West Side Potable Water System Study and for the City's Zone 2 and 3 water service areas from the City's GIS database. The 2004 model was calibrated with hydrant test results.

Since 2004, there has been enough new development within the City's water service area that it was determined to be more efficient to rebuild the hydraulic model with the City's current GIS database. The information for facilities (such as valves, pumps and tanks) was based on the 2004 model, but updated with the most current information provided by the City.

Model Update Methodology

West Yost completed the following tasks to update the City's hydraulic model:

- Rebuilt the hydraulic model with the City's GIS;
- Reviewed connectivity issues in specific locations with the City;
- Allocated 2015 existing water demands by using the City's spatially-located metered account information to distribute water demands within the hydraulic model; and,
- Validated that the hydraulic model system configuration (including pipeline sizes, alignments, connections, and other facility size and locations) is generally representative of the City's current potable water system based on field pressures, flows, and tank elevations recorded in the City's Supervisory Control and Data Acquisition (SCADA) system.

To accomplish these tasks, West Yost worked closely with City staff to obtain and review the following available data:

- Information regarding existing transmission and distribution mains, storage tanks, and booster pump stations;
- Metered account water consumption data; and
- Historical SCADA system data.

The updated hydraulic model was validated with hydrant test results. The hydraulic model update and validation are described in the following sections.

Update of the Hydraulic Model

The following sections describe the findings of West Yost's model review and the specific updates made to the potable water hydraulic model.

Pipeline Network

As part of this Water Master Plan, West Yost reviewed the network connectivity in the City's hydraulic model using H2OMap Water's Network Review/Fix tools. A number of fixes were made to establish appropriate pipeline connectivity. It should be noted, that where pipes were split, the original Livermore pipe ID was retained in each section of the split pipe.

Pipeline Roughness Characteristics

Typically, C-factors are assigned to pipelines based on the characteristics of the pipeline (e.g., age, material type and size). Based on review of the City's GIS pipeline database, the pipeline material information and the installation year are available in the GIS database. Therefore, both material and year installation information were transferred from the GIS database to the potable water hydraulic model. After the pipeline characteristics were imported into the hydraulic model, C-factors based on pipeline material, age and size were adjusted through the calibration process. Table 1 presents the final C-factor values that were included in the hydraulic model based on pipeline material, age and size.

Table 1. Pipeline C-factors

Pipeline Material	C-factor
Asbestos Cement (AC)	120
Cast Iron (CI)	100
Ductile Iron (DI)	108
Polyvinyl Chloride (PVC)	134
Steel	138
Unknown	110

As part of the development of the hydraulic model, West Yost conducted hydrant testing where pressures were recorded at specific locations in the system while a selected hydrant was flowed at a rate that was also recorded. System parameters were recorded for the day of the testing. The plan for the hydrant testing is included as an attachment to Appendix A. The data from the hydrant testing was then included in the model to test the performance of the model. After settings for facilities such as tank levels and PRV settings were matched with available information, C-factors were adjusted to improve agreement between the hydraulic model results and the field data. The results from the hydrant testing calibration effort are summarized in Table 2.

Model Element Identifications

West Yost developed a specific naming scheme for network elements in the hydraulic model, which is presented in Table 3.

Spatially-Located Meter Accounts

City staff provided West Yost with a spatially-located meter shapefile to be used for demand allocation in the hydraulic model. A total of 9,841 customer accounts were linked to the spatially-located meter shapefile.

Potable Water Demand Allocation

The City's billing information for 2015 was linked to the spatially-located meter shapefile (described above), and 2015 water consumption data were allocated in the potable water hydraulic model using the spatially-located meter demand data. The Demand Allocator tool automatically assigns the spatially-located demand point to the closest junction to its position in the water system. West Yost staff then reviewed the allocated water demand to confirm that the demands were allocated properly.

Table 2. Summary of Hydrant Test Calibration Results

Hydrant[a]	Field Data: Static Pressure, psi	Field Data: Residual Pressure, psi	Field Data: Differential Pressure, psi (Static - Residual)	Modeled Data: Static Pressure, psi	Modeled Data: Residual Pressure, psi	Modeled Data: Differential Pressure, psi (Static - Residual)	Comparison of Differential Pressures between Field and Modeled Data[b]
Hydrant Flow Test No. 1 [Jack London Boulevard]							
Flowing 1	78	38	40	79	50	29	N/A
1A	78	45	33	78	52	26	7
1B	76	46	30	77	56	21	9
1C	77	52	25	76	60	16	9
1D	78	60	18	75	65	10	8
Hydrant Flow Test No. 2 [Discovery Drive]							
Flowing 2	97	49	48	94	71	23	N/A
2A	96	58	38	95	72	22	16
2B	97	64	33	97	78	18	15
2C	98	72	26	99	86	12	14
2D	103	80	23	100	92	8	15
Hydrant Flow Test No. 3 [Lindbergh Avenue]							
Flowing 3	102	27	75	103	61	42	N/A
3A	105	52	53	103	66	37	16
3B	103	60	43	104	72	32	11
3C	107	78	29	104	82	22	7
3D	103	85	18	102	91	11	7
Hydrant Flow Test No. 4 [Haggin Oaks Avenue]							
Flowing 4	65	29	36	61	51	10	N/A
4A	65	52	13	62	54	7	6
4B	66	56	10	62	56	6	4
4C	70	64	6	63	60	3	3
Hydrant Flow Test No. 5 [Joyce Street]							
Flowing 5	71	35	36	73	60	13	N/A
5A	68	58	10	71	65	6	4
5B	66	56	10	70	66	4	6
5C	68	60	8	70	68	2	6
5D	64	57	7	70	69	1	6
Hydrant Flow Test No. 6 [Las Positas Road]							
Flowing 6	67	33	34	49	38	12	N/A
6A	64	46	18	49	39	11	7
6B	64	47	17	49	39	10	7
6C	68	54	14	50	43	8	6
6D	67	55	12	51	45	6	6
Hydrant Flow Test No. 7 [Norma Way]							
Flowing 7	56	21	35	59	31	28	N/A
7A	55	18	37	60	35	25	12
7B	56	24	32	61	43	18	14
7C	57	30	27	62	49	13	14
Hydrant Flow Test No. 8 [Felicia Avenue]							
Flowing 8	65	23	42	69	47	22	N/A
8A	65	45	20	70	58	12	8
8B	67	50	17	71	64	7	10
8C	71	62	9	75	73	2	7
Hydrant Flow Test No. 9 [Foxtail Drive]							
Flowing 9	102	45	57	96	38	58	N/A
9A	102	61	41	96	51	45	-4
9B	100	64	36	96	58	38	-2
9C	103	76	27	97	71	25	2
9D	100	81	19	95	82	13	6
Hydrant Flow Test No. 10 [Buckskin Road]							
Flowing 10	77	15	62	66	33	34	N/A
10A	74	23	51	65	36	29	22
10B	72	28	44	65	40	25	19
10C	75	40	35	64	46	18	17
10D	74	54	20	66	55	11	9

[a] Location of hydrants can be found in Attachment 4 to Appendix.

[b] The goal of the calibration effort is to achieve a differential pressure comparison within 5 psi for observed hydrants.

[c] Test 1 was cancelled due to insufficient drainage at the test site. Static pressures were recorded for model verification.

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Table 3. Naming Scheme for Hydraulic Model Network Elements

Model Component	Naming Scheme
Pipelines	P21000 "1000" = Sequential Number "2" = Zone 2 "P" = Pipeline
Junctions	J21000 "1000" = Sequential Number "2" = Zone 2 "J" = Junction
Tanks	T10B "10B" = Reservoir 10B "T" = Tank
Reservoirs	TURNOUT4 "4" = Turnout number 4 "TURNOUT" = Zone 7 Supply Turnout Station
Booster Pumps	PS20A_1 "1" = Pump Number 1 "20A" = Station 20A "PS" = Pump Station
Pressure Reducing Valves/General Valve/Float Valve	20APRV_1 "1" = Valve Number 1 "PRV" = Pressure Reducing Valve "VALVE" = General Valve or Float Valve "20A" = Station 20A "TURNOUT1" = Turnout 1 Station

MODELER'S NOTEBOOK

Overview

The modeler's notebook and associated facility database were compiled from the information available at the time of the hydraulic model development. West Yost's intent with the modeler's notebook is to provide City staff with a means to evaluate the information that West Yost has incorporated into the hydraulic model, and also to provide the City with a "living" reference for either in-house use by City staff and/or to provide to outside parties that will be using the City's potable water system hydraulic model. The modeler's notebook and associated facility database should be updated as often as necessary to keep up with the construction of new facilities so that this resource remains as up-to-date as possible.

Hydraulic Model Software

The City's potable water system hydraulic model was developed using H2OMap Water Version 10.0 Update #6.

Facility Database

An electronic Microsoft Access database of the existing potable water system facilities that are currently in the hydraulic model is included as part of the modeler's notebook. This facility database contains the data sheets for each PRV, pump facility, and storage facility included in the hydraulic model. These data sheets are included as attachments to Appendix A.

Each data sheet in the modeling notebook contains "general information", which includes information provided from available as-built drawings and/or pump curves, and "modeling information", which documents how the general information was used to populate the facilities' properties in the hydraulic model.

Facility Information Date

The City provided updates to its pipeline database throughout the development of the hydraulic model. The final update to the pipeline database that was incorporated into the hydraulic model was received from the City in July 2016.

Evaluation Scenarios

H2OMap Water software allows the user to create unique scenarios to differentiate between different evaluation conditions within the same hydraulic model (e.g., maximum day demand vs. peak hour demand). The scenarios developed by West Yost and included in the City's potable water system hydraulic model are summarized in Table 4.

Each scenario in the hydraulic model is developed using various data sets, query sets, simulation options, and simulation time settings as defined below.

- Data sets are used to describe specific system facilities and system conditions. Data sets can be common to multiple scenarios or they can be unique to a specific scenario.
- Facility sets are used to define the active facilities for a specific scenario. Query sets that select facilities using query statements are typically used to define the facility set.
- Simulation options contain the hydraulic simulation criteria necessary for the hydraulic engine to run (e.g., flow and pressure units, number of trials, etc.).
- Simulation time contains the hydraulic simulation time-step information (e.g., steady state or extended period simulation).

Table 4 also summarizes the data sets, facility sets, simulation options, and simulation time assigned to each scenario in the hydraulic model.

Table 4. Organization of Evaluation Scenarios

Scenario Name	Scenario Status	Demand Set	Tank Set	Reservoir Set	Pump Set	Valve Set	Pipe Set	Control Set	Fire Flow Set	Simulation Option	Simulation Time	Facility Set
BASE	**Not Used**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
BUILDOUT_2040	**Not Used**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
MAXDAY_2040	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAXDAY_2040_ALT1	Active							ALT1				
MAXDAY_2040_ALT1_ISABEL	Active	2040-ISABEL						ALT1				
MAXDAY_2040_ALT2	Active	2040						ALT2				
MAXDAY_2040_ALT3	Active							ALT3				
MAXDAY_2040_ALT4	Active							ALT4				
MAXDAY_2040_BASE	Active							BASE				
MAXDAYFF_2040	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAXDAYFF_2040_ALT1	Not Used	2040	2040FF	BASE	BASE	BASE	BASE	ALT1	FF_LU	Fire Flow	N/A	FUTURE
MAXDAYFF_2040_ALT1_Z1	Active							ALT1				FUTURE_Z1
MAXDAYFF_2040_ALT1_Z23	Active							ALT1				FUTURE_Z23
MAXDAYFF_2040_ALT2	Not Used							ALT2				FUTURE
MAXDAYFF_2040_ALT2_Z1	Active							ALT2				FUTURE_Z1
MAXDAYFF_2040_ALT2_Z23	Active							ALT2				FUTURE_Z23
MAXDAYFF_2040_ALT3	Not Used							ALT3				FUTURE
MAXDAYFF_2040_ALT3_Z23	Active							ALT3				FUTURE_Z23
MAXDAYFF_2040_ALT4	Not Used							ALT4				FUTURE
MAXDAYFF_2040_ALT4_Z23	Active							ALT4				FUTURE_Z23
MAXDAYFF_2040_BASE	Active							BASE				FUTURE
PEAKHOUR_2040	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PEAKHOUR_2040_ALT1	Active	2040PH	2040	BASE	BASE	BASE	BASE	ALT1	N/A	OPT1	STEADYSTATE	FUTURE
PEAKHOUR_2040_ALT1_ISABEL	Active	2040PH-ISABEL						ALT1				
PEAKHOUR_2040_ALT2	Active	2040PH						ALT2				
PEAKHOUR_2040_ALT2_ISABEL	Active	2040PH-ISABEL						ALT2				
PEAKHOUR_2040_ALT3	Active	2040PH						ALT3				
PEAKHOUR_2040_ALT3_ISABEL	Active	2040PH-ISABEL						ALT3				

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<table>
<tr><th colspan="13">Table 4. Organization of Evaluation Scenarios</th></tr>
<tr><th>Scenario Name</th><th>Scenario Status</th><th>Demand Set</th><th>Tank Set</th><th>Reservoir Set</th><th>Pump Set</th><th>Valve Set</th><th>Pipe Set</th><th>Control Set</th><th>Fire Flow Set</th><th>Simulation Option</th><th>Simulation Time</th><th>Facility Set</th></tr>
<tr><td>PEAKHOUR_2040_ALT4</td><td>Active</td><td rowspan="2">2040PH</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>ALT4</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>PEAKHOUR_2040_BASE</td><td>Active</td><td>BASE</td></tr>
<tr><td>PEAKHOUR_2040_BASE_ISABEL</td><td>Active</td><td>2040PH-ISABEL</td><td>BASE</td></tr>
<tr><td>BUILDOUT_2040_CIP</td><td>Not Used</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
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<tr><td>MAXDAY_2040_CIP_ALT1_NOD</td><td>Active</td><td>ALT1_NODALTON</td></tr>
<tr><td>MAXDAY_2040_CIP_ALT2</td><td>Active</td><td>ALT2</td></tr>
<tr><td>MAXDAY_2040_CIP_ALT2_NOD</td><td>Active</td><td>ALT2_NODALTON</td></tr>
<tr><td>MAXDAY_2040_CIP_ALT3</td><td>Active</td><td>ALT3</td></tr>
<tr><td>MAXDAY_2040_CIP_ALT3_NOD</td><td>Active</td><td>ALT3_NODALTON</td></tr>
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<tr><td>MAXDAY_2040_CIP_BASE</td><td>Active</td><td>BASE</td></tr>
<tr><td>MAXDAYFF_2040_CIP</td><td>Not Used</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>MAXDAYFF_2040_CIP _ALT1</td><td>Not Used</td><td rowspan="2">2040</td><td rowspan="13">2040FF</td><td rowspan="13">BASE</td><td rowspan="13">BASE</td><td rowspan="13">BASE</td><td rowspan="13">BASE</td><td>ALT1</td><td rowspan="13">FF_LU</td><td rowspan="13">Fire Flow</td><td rowspan="13">N/A</td><td>FUTURE_CIP</td></tr>
<tr><td>MAXDAYFF_2040_CIP _ALT1_Z1</td><td>Active</td><td>ALT1</td><td>FUTURE_CIP_Z1</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT1_Z1_ISABEL</td><td>Active</td><td>2040-ISABEL</td><td>ALT1</td><td>FUTURE_CIP_Z1</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT1_Z23</td><td>Active</td><td rowspan="3">2040</td><td>ALT1_CIP</td><td>FUTURE_CIP_Z23</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT1_Z23_NOD</td><td>Active</td><td>ALT1_NODALTON</td><td>FUTURE_CIP_Z23</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT2</td><td>Active</td><td>ALT2</td><td>FUTURE_CIP</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT2_ISABEL</td><td>Active</td><td>2040-ISABEL</td><td>ALT2</td><td>FUTURE_CIP</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT2_NOD</td><td>Active</td><td rowspan="3">2040</td><td>ALT2_NODALTON</td><td>FUTURE_CIP_Z23</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT3</td><td>Not Used</td><td>ALT3</td><td>FUTURE_CIP_Z23</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT3_Z1</td><td>Active</td><td>ALT3</td><td>FUTURE_CIP</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT3_Z1_ISABEL</td><td>Active</td><td>2040-ISABEL</td><td>ALT3</td><td>FUTURE_CIP_Z1</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT3_Z23</td><td>Active</td><td rowspan="2">2040</td><td>ALT3_CIP</td><td>FUTURE_CIP_Z23</td></tr>
<tr><td>MAXDAYFF_2040_CIP_ALT3_Z23_NOD</td><td>Active</td><td>ALT3_NODALTON</td><td>FUTURE_CIP_Z23</td></tr>
</table>

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Table 4. Organization of Evaluation Scenarios

Scenario Name	Scenario Status	Demand Set	Tank Set	Reservoir Set	Pump Set	Valve Set	Pipe Set	Control Set	Fire Flow Set	Simulation Option	Simulation Time	Facility Set
MAXDAYFF_2040_CIP_ALT4	Not Used							ALT4				FUTURE_CIP
MAXDAYFF_2040_CIP_ALT4_Z1	Active							ALT4				FUTURE_CIP_Z1
MAXDAYFF_2040_CIP_ALT4_Z23	Active							ALT4				FUTURE_CIP_Z23
MAXDAYFF_2040_CIP_BASE	Active							BASE				FUTURE_CIP
MAXDAYFF_2040_CIP_BASE_ISABEL	Active	2040-ISABEL						BASE				FUTURE_CIP
PEAKHOUR_2040_CIP	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PEAKHOUR_2040_CIP_ALT1	Active							ALT1_CIP_BO				
PEAKHOUR_2040_CIP_ALT1_NO24	Active							ALT1_NO24				
PEAKHOUR_2040_CIP_ALT2	Active							ALT2_CIP_BO				
PEAKHOUR_2040_CIP_ALT2_NO24	Active							ALT2_NO24				
PEAKHOUR_2040_CIP_ALT3	Active	2040PH	2040	BASE	BASE	BASE	BASE	ALT3_CIP_BO	N/A	OPT1	STEADYSTATE	FUTURE_CIP
PEAKHOUR_2040_CIP_ALT3_NO24	Active							ALT3_NO24				
PEAKHOUR_2040_CIP_ALT4	Active							ALT4				
PEAKHOUR_2040_CIP_BASE	Active							BASE_CIP_BO				
PEAKHOUR_2040_CIP_BASE_NO24	Active							BASE_NO24				
EXISTING_2020	**Not Used**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
MAXDAY_2020	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAXDAY_2020_ALT1	Active							ALT1				
MAXDAY_2020_ALT2	Active							ALT2				
MAXDAY_2020_ALT3	Active	2020	2016	BASE	BASE	BASE	BASE	ALT3	N/A	OPT1	STEADYSTATE	EXISTING
MAXDAY_2020_ALT4	Active							ALT4				
MAXDAY_2020_BASE	Active							BASE				
RUN104	Active							BASE_PRV				
MAXDAYFF_2020	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAXDAYFF_2020_ALT1	Active							ALT1				
MAXDAYFF_2020_ALT2	Active	2020	2016FF	BASE	BASE	VALVEFF	BASE	ALT2	FF_LU	Fire Flow	N/A	EXISTING
MAXDAYFF_2020_ALT3	Active							ALT3				

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Table 4. Organization of Evaluation Scenarios

Scenario Name	Scenario Status	Demand Set	Tank Set	Reservoir Set	Pump Set	Valve Set	Pipe Set	Control Set	Fire Flow Set	Simulation Option	Simulation Time	Facility Set
MAXDAYFF_2020_ALT4	Active							ALT4				
MAXDAYFF_2020_BASE	Active							BASE				
MAXDAYFF_2020_BASE_PRV	Active							BASE_PRV				
PEAKHOUR_2020	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PEAKHOUR_2020_ALT1	Active							ALT1				
PEAKHOUR_2020_ALT2	Active							ALT2				
PEAKHOUR_2020_ALT3	Active	2020PH	2016	BASE	BASE	BASE	BASE	ALT3	N/A	OPT1	STEADYSTATE	EXISTING
PEAKHOUR_2020_ALT4	Active							ALT4				
PEAKHOUR_2020_BASE	Active							BASE				
EXISTING_2020_CIP	**Not Used**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
MAXDAY_2020_CIP	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAXDAY_2020_CIP_ALT1	Active							ALT1				
MAXDAY_2020_CIP_ALT2	Active							ALT2				
MAXDAY_2020_CIP_ALT3	Active	2020	2016	BASE	BASE	BASE	BASE	ALT3	N/A	OPT1	STEADYSTATE	EXISTING_CIP
MAXDAY_2020_CIP_ALT4	Active							ALT4				
MAXDAY_2020_CIP_BASE	Active							BASE				
MAXDAYFF_2020_CIP	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MAXDAYFF_2020_CIP_ALT1	Active							ALT1				
MAXDAYFF_2020_CIP_ALT2	Active							ALT2				
MAXDAYFF_2020_CIP_ALT3	Active	2020	2016FF	BASE	BASE	VALVEFF	BASE	ALT3	FF_LU	Fire Flow	N/A	EXISTING_CIP
MAXDAYFF_2020_CIP_ALT4	Active							ALT4				
MAXDAYFF_2020_CIP_BASE	Active							BASE				
PEAKHOUR_2020_CIP	Not Used	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PEAKHOUR_2020_CIP_ALT1	Active							ALT1				
PEAKHOUR_2020_CIP_ALT2	Active							ALT2				
PEAKHOUR_2020_CIP_ALT3	Active	2020PH	2016	BASE	BASE	BASE	BASE	ALT3	N/A	OPT1	STEADYSTATE	EXISTING_CIP
PEAKHOUR_2020_CIP_ALT4	Active							ALT4				
PEAKHOUR_2020_CIP_BASE	Active							BASE				

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ATTACHMENT 1

PRV Data Sheets

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Storage Facility Data Sheet

Facility Name:	A. Trevarno PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	684
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9037
Component	
Type:	
Elevation	534.8
Diameter	12
Setting	50
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name:	B. Leisure PRV		
Facility Type:	0: Pressure Reducing Valve	**Pressure Zone:**	
Location:			

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	678
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9009
Component	
Type:	
Elevation	543
Diameter	8
Setting	50
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name:	C. Vasco/Scenic PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	660-670
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9001
Component	
Type:	
Elevation	531
Diameter	12
Setting	50
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name:	D. Patterson Pass/Shelly PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	740
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9013
Component	
Type:	
Elevation	553.7
Diameter	12
Setting	73
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name: E. Patterson Pass/ South Vasco PRV

Facility Type:

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft) 718

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID

Component

Type:

Elevation

Diameter

Setting

Minor Loss

Curve ☐

Control Tank

Upper Level

Lower Level

Notes

Last Updated

Storage Facility Data Sheet

Facility Name: F. Daphine/Vasco PRV

Facility Type: 0: Pressure Reducing Valve

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft) 705

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID V-PRV-9015

Component

Type:

Elevation 579.7

Diameter 12

Setting 55

Minor Loss 10

Curve ☐

Control Tank

Upper Level

Lower Level

Notes

Last Updated

Storage Facility Data Sheet

Facility Name:	G. East Research PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	714
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9019
Component	
Type:	
Elevation	592.7
Diameter	12
Setting	
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name:	H. Emily/Vasco PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	725
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9017
Component	
Type:	
Elevation	597.1
Diameter	12
Setting	55
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name:	I. Las Positas/Lawrence PRV		
Facility Type:	0: Pressure Reducing Valve	**Pressure Zone:**	
Location:			

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	744
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9005
Component	
Type:	
Elevation	564
Diameter	12
Setting	78
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name: J. Southfront/Lawrence PRV

Facility Type: 0: Pressure Reducing Valve

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft) 738

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID V-PRV-9003

Component

Type:

Elevation 553.8

Diameter 16

Setting 80

Minor Loss 10

Curve ☐

Control Tank

Upper Level

Lower Level

Notes

Last Updated

Storage Facility Data Sheet

Facility Name:	K. Vasco/Las Positas PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	733
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9011
Component	
Type:	
Elevation	551.9
Diameter	12
Setting	80
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name: L. Naylor PRV

Facility Type:

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft) 740

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID

Component

Type:

Elevation

Diameter

Setting

Minor Loss

Curve ☐

Control Tank

Upper Level

Lower Level

Notes

Last Updated

Storage Facility Data Sheet

Facility Name:	M. Brisa/Vasco PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	741
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9043
Component	
Type:	
Elevation	555.1
Diameter	12
Setting	80
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name: N. Welch/Vasco v

Facility Type:

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft) 717

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID

Component

Type:

Elevation

Diameter

Setting

Minor Loss

Curve

Control Tank

Upper Level

Lower Level

Notes

Last Updated

Storage Facility Data Sheet

Facility Name:	O. Charlotte/Vasco PRV
Facility Type:	
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	719
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	
Component	
Type:	
Elevation	
Diameter	
Setting	
Minor Loss	
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name:	McGrath PRV
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-20028
Component	
Type:	
Elevation	544.5
Diameter	12
Setting	70
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	
Last Updated	

Storage Facility Data Sheet

Facility Name: New Valve

Facility Type: 0: Pressure Reducing Valve

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft)

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID V-PRV-5555

Component

Type:

Elevation 602.1

Diameter 12

Setting 50

Minor Loss 10

Curve ☐

Control Tank

Upper Level

Lower Level

Notes 800 to 725, On Welch at Vasco

Last Updated

Storage Facility Data Sheet

Facility Name: PRV

Facility Type: 0: Pressure Reducing Valve

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft)

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID V-PRV-9035

Component

Type:

Elevation 565

Diameter 12

Setting 66

Minor Loss 10

Curve ☐

Control Tank

Upper Level

Lower Level

Notes 800 to 725, On Patterson Pass at Vasco

Last Updated

Storage Facility Data Sheet

Facility Name:	New Valve
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9050
Component	
Type:	
Elevation	535.9
Diameter	12
Setting	0
Minor Loss	0
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	744 to 670, on Las Positas near Bennet
Last Updated	

Storage Facility Data Sheet

Facility Name: New Valve

Facility Type: 0: Pressure Reducing Valve

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft)

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID V-PRV-9052

Component

Type:

Elevation 453.4

Diameter 12

Setting 80

Minor Loss 0

Curve ☐

Control Tank

Upper Level

Lower Level

Notes 719 to 638, Valve for new Zone 1 PZ

Last Updated

Storage Facility Data Sheet

Facility Name:	New Valve
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9054
Component	
Type:	
Elevation	405.5
Diameter	12
Setting	100
Minor Loss	0
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	719 to 638, Valve for new Zone 1 PZ
Last Updated	

Storage Facility Data Sheet

Facility Name:	New Valve
Facility Type:	0: Pressure Reducing Valve
Pressure Zone:	
Location:	

General Information

Year Built:	
Status:	
Elevation (ft)	
Setting (ft)	
Valve Type:	
Diameter (in)	
Make	
Model	
Serial Number	

Modeling Information

ID	V-PRV-9856
Component	
Type:	
Elevation	606.5
Diameter	12
Setting	50
Minor Loss	10
Curve	☐
Control Tank	
Upper Level	
Lower Level	
Notes	800 to 725, On Charlotte at Vasco
Last Updated	

Storage Facility Data Sheet

Facility Name: Backflow Prevention Valve

Facility Type: 5: General Purpose Valve

Pressure Zone:

Location:

General Information

Year Built:

Status:

Elevation (ft)

Setting (ft)

Valve Type:

Diameter (in)

Make

Model

Serial Number

Modeling Information

ID: V-GPV-9023

Component

Type:

Elevation: 449.7

Diameter: 8

Setting: 0

Minor Loss: 0

Curve

Control Tank

Upper Level

Lower Level

Notes

Last Updated

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ATTACHMENT 2

Pumps Data Sheets

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Storage Facility Data Sheet

Facility Name: Oakville/Vineyard Pump Station

Facility Type: Pump **Pressure Zone** 725

Facility Location Near Oakville Lane and Calistoga Court

General Information

Number of Pumps 4 **Elevation (ft):** **Backup Power** ☐

Pump Name	P1	P2	P3	P4?
Pump Status	Active	Active	Active	Active
Pump Supply	Potable	Potable	Potable	Potable
Install Date	2004-03-01			
Make				
Model				
Serial Number				
Pump Type				
Diameter (in)	0			3.72
Rated Power (hp)	3.33	3.32	3.47	1.15
Pump RPM				1760
Design Flow (gpm	117	117	117	70
Design TDH (ft)	75.08	75.08	75.08	77
Pump Test	**Date**	**Date**	**Date**	**Date**
	Q	**Q**	**Q**	**Q**
	H	**H**	**H**	**H**
	Eff.	**Eff.**	**Eff.**	**Eff.**
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID	21178			
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Continued

Facility Name: Oakville/Vineyard Pump Station

Pump Name				
Pump Status				
Pump Supply	Potable	Potable	Potable	
Install Date				
Make				
Model				
Serial Number				
Pump Type				
Diameter (in)				
Rated Power (hp)				
Pump RPM				
Design Flow (gpm				
Design TDH (ft)				
Pump Test	**Date**	**Date**	**Date**	**Date**
	Q	**Q**	**Q**	**Q**
	H	**H**	**H**	**H**
	Eff.	**Eff.**	**Eff.**	**Eff.**
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID				
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Storage Facility Data Sheet

Facility Name:	Airway Pump Station		
Facility Type:	Pump	**Pressure Zone**	719
Facility Location	Intersection of Airway Boulevard and Kitty Hawk Road		

General Information

Number of Pumps	3	**Elevation (ft):**		**Backup Power** ☐	

Pump Name	1	2	3	
Pump Status	Active			
Pump Supply	Potable	Potable	Potable	Potable
Install Date	2000-10-01			
Make	Peerless Pump	Peerless Pump	Peerless Pump	
Model	4AE11	4AE11	4AE11	
Serial Number				
Pump Type	AE	AE	AE	
Diameter (in)	10.75	10.75	10.75	
Rated Power (hp)	40	40	40	
Pump RPM	1780	1780	1780	
Design Flow (gpm				
Design TDH (ft)				
Pump Test	**Date**	**Date**	**Date**	**Date**
	Q	**Q**	**Q**	**Q**
	H	**H**	**H**	**H**
	Eff.	**Eff.**	**Eff.**	**Eff.**
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID	23109			
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Continued

Facility Name: Airway Pump Station

Pump Name				
Pump Status				
Pump Supply	Potable	Potable	Potable	
Install Date				
Make				
Model				
Serial Number				
Pump Type				
Diameter (in)				
Rated Power (hp)				
Pump RPM				
Design Flow (gpm				
Design TDH (ft)				
Pump Test	Date	Date	Date	Date
	Q	Q	Q	Q
	H	H	H	H
	Eff.	Eff.	Eff.	Eff.
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID				
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Storage Facility Data Sheet

Facility Name:	Altamont Pump Station
Facility Type:	Pump
Pressure Zone	800
Facility Location	Near Patterson Road and Patterson Reservoir

General Information

Number of Pumps 4 **Elevation (ft):** **Backup Power** ☐

Pump Name	Number 1	Number 2	Number 3	Number 4
Pump Status	Active	Active	Active	Active
Pump Supply	Potable	Potable	Potable	Potable
Install Date				
Make				
Model	5KS6268XH1A	5KS6268XH1A	1405H-2stage	1405H-2stage
Serial Number	AYJ 0109100	EXJ523111	0303943-1	0303943-2
Pump Type	KS	KS		
Diameter (in)				
Rated Power (hp)	75	75		
Pump RPM	1780	1785	1770	1770
Design Flow (gpm	1500	1500	2720	2720
Design TDH (ft)	130	130	152	152
Pump Test	Date	Date	Date	Date
	Q	Q	Q	Q
	H	H	H	H
	Eff.	Eff.	Eff.	Eff.
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID	23323			
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Continued

Facility Name: Altamont Pump Station

Pump Name				
Pump Status				
Pump Supply	Potable	Potable	Potable	
Install Date				
Make				
Model				
Serial Number				
Pump Type				
Diameter (in)				
Rated Power (hp)				
Pump RPM				
Design Flow (gpm				
Design TDH (ft)				
Pump Test	**Date**	**Date**	**Date**	**Date**
	Q	**Q**	**Q**	**Q**
	H	**H**	**H**	**H**
	Eff.	**Eff.**	**Eff.**	**Eff.**
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID				
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Storage Facility Data Sheet

Facility Name: Vasco Pump Station

Facility Type: Pump **Pressure Zone** 800

Facility Location Near Intersection of Northfront Road and Pleasant Avenue

General Information

Number of Pumps 7 **Elevation (ft):** **Backup Power** ☐

Pump Name	Pump 2-1	Pump 2-2	Pump 2-3	Pump 3-1
Pump Status	Active	Active	Active	Active
Pump Supply	Potable	Potable	Potable	Potable
Install Date	1995-04-01			
Make				
Model				
Serial Number	25232-3-1	25232-3-2	25232-3-3	25232-5-1
Pump Type	DLK	DLK	DLK	DKL
Diameter (in)	14	14	14	14
Rated Power (hp)	75	75	75	100
Pump RPM	1800	1800	1800	1800
Design Flow (gpm	1500	1500	1500	1500
Design TDH (ft)				
Pump Test	Date	Date	Date	Date
	Q	Q	Q	Q
	H	H	H	H
	Eff.	Eff.	Eff.	Eff.
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID	23340			
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Continued

Facility Name: Vasco Pump Station

Pump Name	Pump 3-2	Pump 3-3	Pump 3-4	
Pump Status	Active	Active	Active	
Pump Supply	Potable	Potable	Potable	
Install Date				
Make				
Model				
Serial Number	25232-5-2	25232-6-1	25232-8-1	
Pump Type	DKL	DKL	JKM	
Diameter (in)	14	14	8	
Rated Power (hp)	100	100	20	
Pump RPM	1800	1800	1800	
Design Flow (gpm	1500	1500	300	
Design TDH (ft)				
Pump Test	**Date**	**Date**	**Date**	**Date**
	Q	**Q**	**Q**	**Q**
	H	**H**	**H**	**H**
	Eff.	**Eff.**	**Eff.**	**Eff.**
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID				
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐
Notes				
Last Updated				

Storage Facility Data Sheet

Facility Name: Trevarno Pump Station

Facility Type: Pump **Pressure Zone** 670

Facility Location Trevarno Road

General Information

Number of Pumps 4 **Elevation (ft):** **Backup Power** ☐

Pump Name	Number 1	Number 2	Number 3	Number 4
Pump Status	Active	Active	Active	Active
Pump Supply	Potable	Potable	Potable	Potable
Install Date				
Make				
Model			Model 100	5000 Series
Serial Number	1-04989-1-2	1-049891-1	831-48643-01-1	1-04989-2-1
Pump Type	Max. V	Max. V	8000	Max. V
Diameter (in)	12.88	12.88	12.80	10.12
Rated Power (hp)	50	50	50	25
Pump RPM	1770	1770	1750	1770
Design Flow (gpm	1200	1200	1000	900
Design TDH (ft)	94	94	154	84
Pump Test	Date	Date	Date	Date
	Q	Q	Q	Q
	H	H	H	H
	Eff.	Eff.	Eff.	Eff.
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID	23363			
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐

Notes

Last Updated

Continued

Facility Name: Trevarno Pump Station

Pump Name				
Pump Status				
Pump Supply	Potable	Potable	Potable	
Install Date				
Make				
Model				
Serial Number				
Pump Type				
Diameter (in)				
Rated Power (hp)				
Pump RPM				
Design Flow (gpm				
Design TDH (ft)				
Pump Test	Date	Date	Date	Date
	Q	Q	Q	Q
	H	H	H	H
	Eff.	Eff.	Eff.	Eff.
Pump Curve	☐	☐	☐	☐
Station Capacity				

Modeling Information

ID				
Component				
Type				
Elevation				
Diameter				
Constant Power				
Shutoff Head				
Design Head				
Design Flow				
High Head				
High Flow				
Pump Curve	☐	☐	☐	☐
NPSH Curve	☐	☐	☐	☐
Notes				
Last Updated				

ATTACHMENT 3

Tank Data Sheets

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Storage Facility Data Sheet

Facility Name:	Doolan
Facility Type:	Tank
Facility Location:	North of Zone 1, off Doolan Road

General Information

Tank Name	Doolan	
Year Built		
Tank Status:	Active	
Tank Supply:	Recycled	
Pressure Zone:	638	
Zone Served:		
Volume (MG):	1.9	
Material:		
Tank Height (ft):		
Diameter (ft):	18	
Bottom Elevation (ft):		
Overflow Elevation (ft):		

Modeling Information

ID	470	
Component		
Type		
Bottom Elevation		
Minimum Level		
Maximum Level		
Initial Level		
Diameter		
Minimum Volume (cf)		
Variable Area Tank Curve	☐	

Notes:	
Last Updated	

Storage Facility Data Sheet

Facility Name: Dalton

Facility Type: Tank

Facility Location: North of Zone 2, near Raymond Road

General Information

Tank Name	2 MG Dalton	
Year Built	1964	
Tank Status:	Active	
Tank Supply:	Potable	
Pressure Zone:	670	
Zone Served:	2	
Volume (MG):	2	
Material:		
Tank Height (ft):		
Diameter (ft):	-9	
Bottom Elevation (ft):	650	
Overflow Elevation (ft):	670	

Modeling Information

ID	21548	
Component		
Type		
Bottom Elevation	650	
Minimum Level		
Maximum Level		
Initial Level		
Diameter		
Minimum Volume (cf)		
Variable Area Tank Curve	☐	

Notes:

Last Updated

Storage Facility Data Sheet

Facility Name:	Altamont
Facility Type:	Tank
Facility Location:	West of Zone 3, off Patterson Road

General Information

Tank Name	3 MG Altamont	
Year Built	1985	
Tank Status:	Active	
Tank Supply:	Potable	
Pressure Zone:	800	
Zone Served:	3/2	
Volume (MG):	3	
Material:		
Tank Height (ft):	38.6	
Diameter (ft):	18	
Bottom Elevation (ft):	760	
Overflow Elevation (ft):	800	

Modeling Information

ID	21513	
Component		
Type		
Bottom Elevation	750	
Minimum Level		
Maximum Level		
Initial Level		
Diameter		
Minimum Volume (cf)		
Variable Area Tank Curve	☐	

Notes:

Last Updated

Storage Facility Data Sheet

Facility Name: Altamont

Facility Type: Tank

Facility Location: West of Zone 3, off Patterson Road

General Information

Tank Name	5 MG Altamont	
Year Built	2003	
Tank Status:	Active	
Tank Supply:	Potable	
Pressure Zone:	800	
Zone Served:	3/2	
Volume (MG):	5	
Material:		
Tank Height (ft):		
Diameter (ft):	18	
Bottom Elevation (ft):	760	
Overflow Elevation (ft):	800	

Modeling Information

ID	21515	
Component		
Type		
Bottom Elevation	750	
Minimum Level		
Maximum Level		
Initial Level		
Diameter		
Minimum Volume (cf)		
Variable Area Tank Curve	☐	

Notes:

Last Updated

Storage Facility Data Sheet

Facility Name:	Doolan
Facility Type:	Tank
Facility Location:	North of Zone 1, off Doolan Road

General Information

Tank Name	3 MG Doolan	
Year Built		
Tank Status:	Active	
Tank Supply:	Potable	
Pressure Zone:	0	
Zone Served:		
Volume (MG):	3	
Material:		
Tank Height (ft):		
Diameter (ft):	18	
Bottom Elevation (ft):		
Overflow Elevation (ft):		

Modeling Information

ID	23073	
Component		
Type		
Bottom Elevation		
Minimum Level		
Maximum Level		
Initial Level		
Diameter		
Minimum Volume (cf)		
Variable Area Tank Curve	☐	
Notes:		
Last Updated		

Storage Facility Data Sheet

Facility Name: Doolan

Facility Type: Tank

Facility Location: North of Zone 1, off Doolan Road

General Information

Tank Name	1.9 MG Doolan	
Year Built		
Tank Status:	Active	
Tank Supply:	Recycled	
Pressure Zone:	638	
Zone Served:		
Volume (MG):	1.9	
Material:		
Tank Height (ft):		
Diameter (ft):	18	
Bottom Elevation (ft):		
Overflow Elevation (ft):		

Modeling Information

ID	23074	
Component		
Type		
Bottom Elevation		
Minimum Level		
Maximum Level		
Initial Level		
Diameter		
Minimum Volume (cf)		
Variable Area Tank Curve	☐	

Notes:

Last Updated

ATTACHMENT 4

Hydrant Testing for Hydraulic Model Calibration

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MEMORANDUM

DATE: June 28, 2016 — Project No.: 438-12-15-05

SENT VIA: EMAIL

TO: Todd Yamello, City of Livermore

FROM: Patrick Johnston, RCE #59028

REVIEWED BY: Roberto Vera, RCE #83500

SUBJECT: City of Livermore—Water Master Plan
Hydrant Testing for Hydraulic Model Calibration

This memorandum summarizes the proposed hydrant tests and testing procedures required to calibrate the hydraulic model of the City of Livermore's (City) existing water distribution system. This work is being conducted as part of the Water Master Plan project, and provides a plan for the collection of the necessary field data. West Yost Associates' (West Yost) recommended program for hydrant testing is summarized below and provided for your review and comment.

HYDRANT TESTING PROGRAM

The hydrant testing program will be used to confirm and "spot-check" the roughness factors (C-factors) that are assigned to pipelines in the City's hydraulic model. West Yost will use data collected directly through hydrant testing to verify if the current pipeline C-factors assigned in the City's hydraulic model are appropriate. Depending on this field testing to determine representative C-factors by pipeline material type and pipeline age, pipeline C-factors may be adjusted in the hydraulic model to better reflect field conditions.

Details related to the hydrant testing program are divided into the following four separate categories and are discussed in more detail below:

- Personnel and System Data Requirements
- Hydrant Testing Schedule
- Testing Requirements and Procedure
- City Responsibilities

Personnel and System Data Requirements

West Yost would like to request the following City personnel, system data, and supporting documents to accomplish the recommended hydrant testing program under West Yost's direction:

- A minimum of four City staff members (with vehicles and radio communications) that will be available during regular working hours to assist with, but not limited to, the following:
  - Closing and re-opening valves, as needed before and after hydrant testing:
  - Reading and recording hydrant pressure data;
  - De-chlorination at the flowing test hydrant;
  - Flowing the test hydrant;
  - Directing and controlling traffic, and hydrant flows, as necessary, to ensure safety during these hydrant flow tests, and collect this discharged water into a vac truck during each test; and
  - Public outreach and interface, as necessary.
- System information before and during the hydrant testing period that includes the following:
  - Zone 7 Turnouts (flows and downstream pressures, if available from City's SCADA or from Zone 7 Supervisory Control and Data Acquisition (SCADA), if not available control settings will need to be confirmed for these facilities)
  - City's SCADA system information for:
    - Tank levels (water surface elevations);
    - Booster Pump Stations (pump operational status, speed settings, discharge pressures, and flows); and
  - If the City's SCADA system does not provide for historical archiving of these data, or it is not possible to get this information in digital format, then manual readings at key zone facilities that affect zone supply will need to be taken before, during, and immediately after each hydrant test.
- One copy of the City's Health and Safety Plan for testing hydrants.

Hydrant Testing Schedule

The hydrant testing is scheduled to occur over a two-day period on July 13th and 14th. The testing period is to occur between 8:00 AM and 5:00 PM. West Yost will meet with City staff at 8:00 AM at the City's Wastewater Treatment Plant to have a brief field coordination meeting to review hydrant testing procedures and protocol (*i.e.*, where to go and what to do). West Yost will also use this coordination meeting to distribute pressure gauges (hydrant wrenches to be provided by the City) necessary to complete the hydrant testing program. **Hydrant testing should continue until completion of the proposed 10 hydrant tests.**

Testing Requirements and Procedure

West Yost would like to conduct approximately ten (10) hydrant flow tests within the City's existing service area. Table 1 lists the 10 proposed hydrant test locations, which are also illustrated on Figure 1. As shown on Figure 1, the selected hydrants are distributed throughout the existing water service area and were selected based on a specific pipeline diameter, age, and material type, as summarized in Table 1. Table 1 also includes additional details specific to each hydrant test related to the number of closed valves and the number of observation hydrants required to conduct the test.

Each hydrant test will involve maintaining flow from a single hydrant, while monitoring the residual pressures at three to four observation hydrants located near the flowing hydrant. The field observed static and residual pressure readings will then be used to confirm or adjust pipeline C-factors to calibrate the hydraulic model to observed field conditions. Hydrant test locations have been selected to isolate pipelines of a particular material type, diameter, and age and some tests will require that City personnel close one or more isolation valves prior to the test and re-open these isolation valves following the test.

The general testing procedure at each of the hydrant test locations is outlined below and illustrated on Figure 2. In addition, if GPS equipment is available, provided either by the City or by West Yost, record the spatial location (XY coordinates and elevation) at the base (*i.e.* ground elevation) of the flowing hydrant. Spatial location is important during the calibration effort because it confirms the location and elevation at the flowing hydrant.

Step 1. Before the test, flush the test (flowing) hydrant and each observation hydrant before attaching the pressure gage. (This allows sediments, which might damage the gage or cause faulty readings, to be flushed out from the hydrant.)

Step 2. Attach the pressure gage to the hydrant with the gage's test cock valve **open**. Slowly open the hydrant and bleed off the gage with the gage's test cock until the hydrant is fully pressurized.

Step 3. Close the gage test cock valve, and then measure the static pressures at the designated test hydrant and each observation hydrant.

Step 4. Flow the designated test hydrant and measure the discharge flow and pressure.

Step 5. Measure the residual pressures at the designated test hydrant and at each observation hydrant while the test hydrant is flowing.

Step 6. Continue monitoring pressure until the "all clear" is given by a West Yost employee. Record the static pressure and then detach the pressure gage. ***IMPORTANT****: Before closing the hydrant, be sure the gage's test cock valve is open and bleeding while the hydrant is being closed*.

At least one City staff member will be required at the flowing test hydrant and up to three (3) additional City personnel will be required in the field to measure static and residual pressures at the observation hydrants (refer to Attachment A). West Yost will provide three staff members to direct, oversee, and assist in the field data collection work effort.

It is anticipated that each hydrant test will take approximately one half hour and that each hydrant will be flowing for no more than 10 minutes during a test.

Testing Equipment

West Yost will provide 2.5-inch and 4.5-inch diameter Swivel Piezo Diffusers and pressure gages during the hydrant testing program. It is our recommendation that the 4.5-inch diameter Swivel Piezo Diffuser be used for all proposed hydrant tests. For any hydrant test where it is not possible to use this type of diffuser due to drainage or traffic control issues, an alternative method will need to be further evaluated and confirmed before the day of field testing.

City Responsibilities

The City will be responsible for providing the following hydrant testing equipment:

- Hydrant wrenches; and
- Two-way portable communication for each of the testing personnel.

The City is also responsible for notifying other City staff and residents about the scheduled hydrant testing, obtaining any approvals that may be required, providing proper drainage of the hydrant flow, and providing equipment for de-chlorinating[1] test water and personnel for traffic control, if required.

West Yost requests that City Operations staff review and inspect each of the proposed test locations before the testing date to identify any potential problems or hazards with the selected locations. Of particular concern will be the potential for flooding landscaping, building basements, or creating hazardous traffic conditions. Location and status of valves that will be closed during the hydrant testing should be checked. Detailed figures, which illustrate the flowing hydrant, observation hydrants and valves to be closed are provided in Attachment A.

SUMMARY OF HYDRANT TESTING PROGRAM

Hydrant testing will be performed as described above during regular Operations staff working hours. The City is responsible for notifying other City staff and local residents/businesses about the hydrant testing program and coordinating with the City's Fire Department, as needed.

West Yost requests a conference call or meeting with City staff approximately one week before the scheduled testing day to review and identify any potential issues that may occur during hydrant testing such as unavailable SCADA system data. An Outlook meeting request will be sent to City staff to schedule a suitable meeting date and time. In the meantime, please feel free to contact Patrick Johnston at (925) 949-5818 if you have any questions or comments.

---

[1] Handling of water released from each hydrant test will need to comply with the City Operations procedures and be consistent with the City's NPDES permit for planned releases from hydrant tests.

Table 1. Hydrant Test Locations

Test No.	Pipeline Material	Installation Year	Pipeline Diameter, inches	Location	No. of Residual Hydrants	No. of Closed Valves	Comments
1	PVC	Assume 1980's or later	12	Along West Jack London Blvd.	4	1	-
2	PVC	2006	12	Along Discovery Dr.	4	1	-
3	ACP	1997	8	Along Nissen Dr. and Lindbergh Ave.	4	2	-
4	ACP	1965	8	Along Aster Ln. and Primrose Ln.	4	3	-
5	CI	1962-64	10	Along Lucille St. and Lillian St.	4	4	-
6	ACP	1993	12	Along Las Positas Rd.	4	1	-
7	ACP	1970	8	Along Norma Way	3	2	-
8	ACP	1965	8	Along Hazel St.	4	2	-
9	PVC	2009	8	Along North Vasco Road	4	0	-
10	ACP	1962	6	Along Hibiscus Way	3	1	-
11-ALT	ACP	1965	8	Along Haggin Oaks Ave.	3	1	Alternative Test

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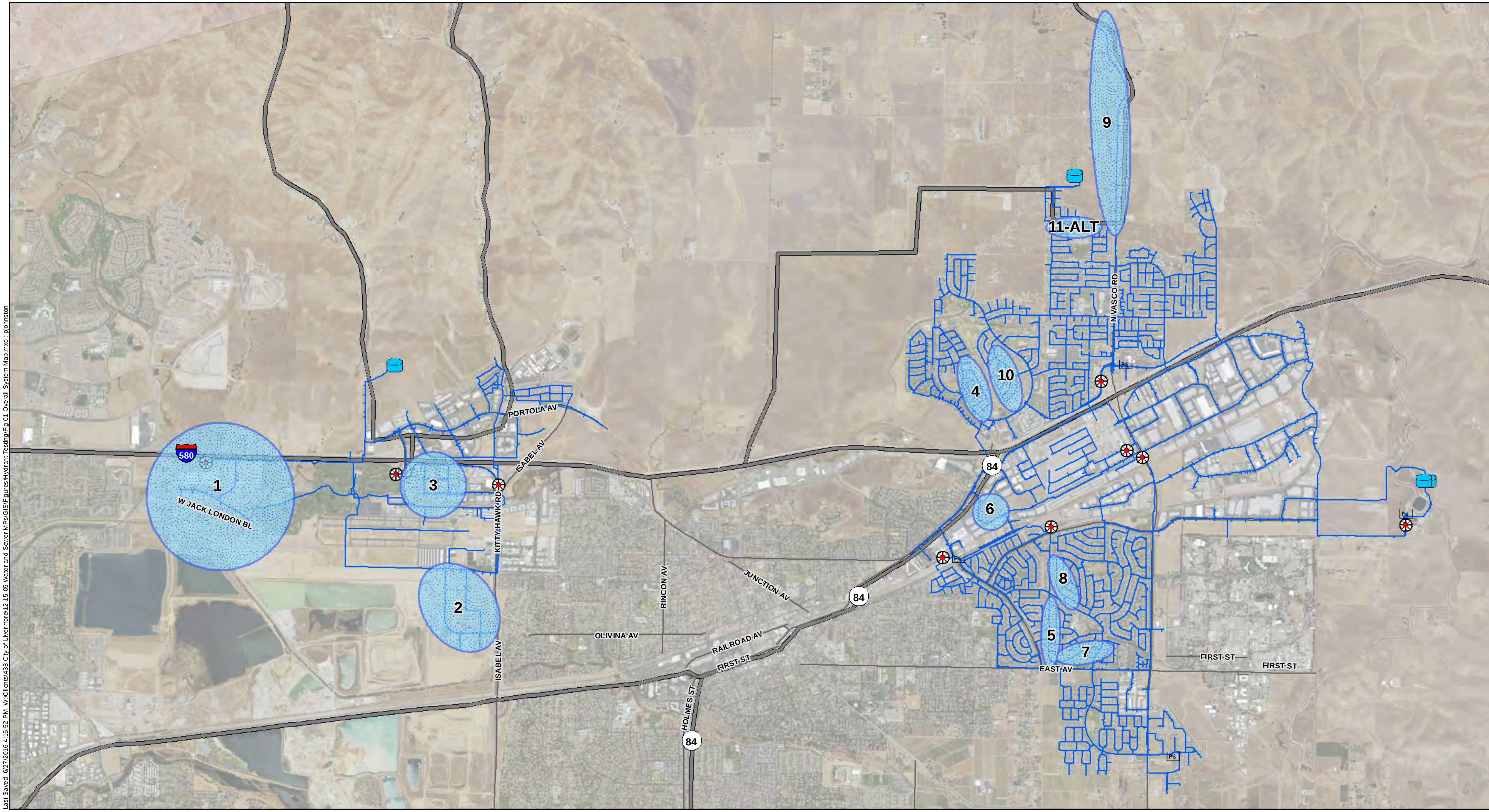

Last Saved: 6/27/2016 4:15:52 PM W:\Clients\438 City of Livermore\12-15-05 Water and Sewer MP\GIS\Figures\Hydrant Testing\Fig 01 Overall System Map.mxd : pjohnston

Project_Locations
Turnout
Pump Station
Potable Water Storage Tank
Pipeline

N

0 1,800 3,600
Scale in Feet

Figure 1

Proposed Hydrant Test Location Map

City of Livermore
Water and Sewer Master Plan
Hydrant Test Plan

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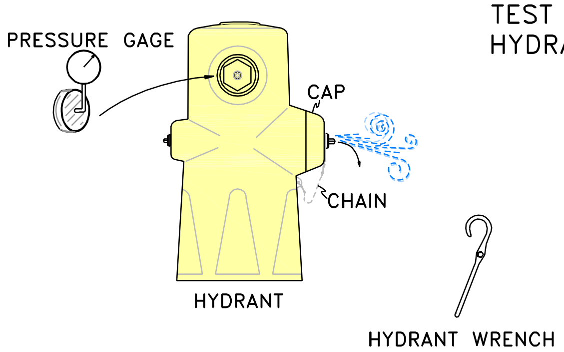
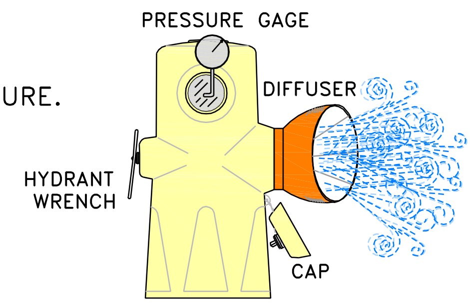
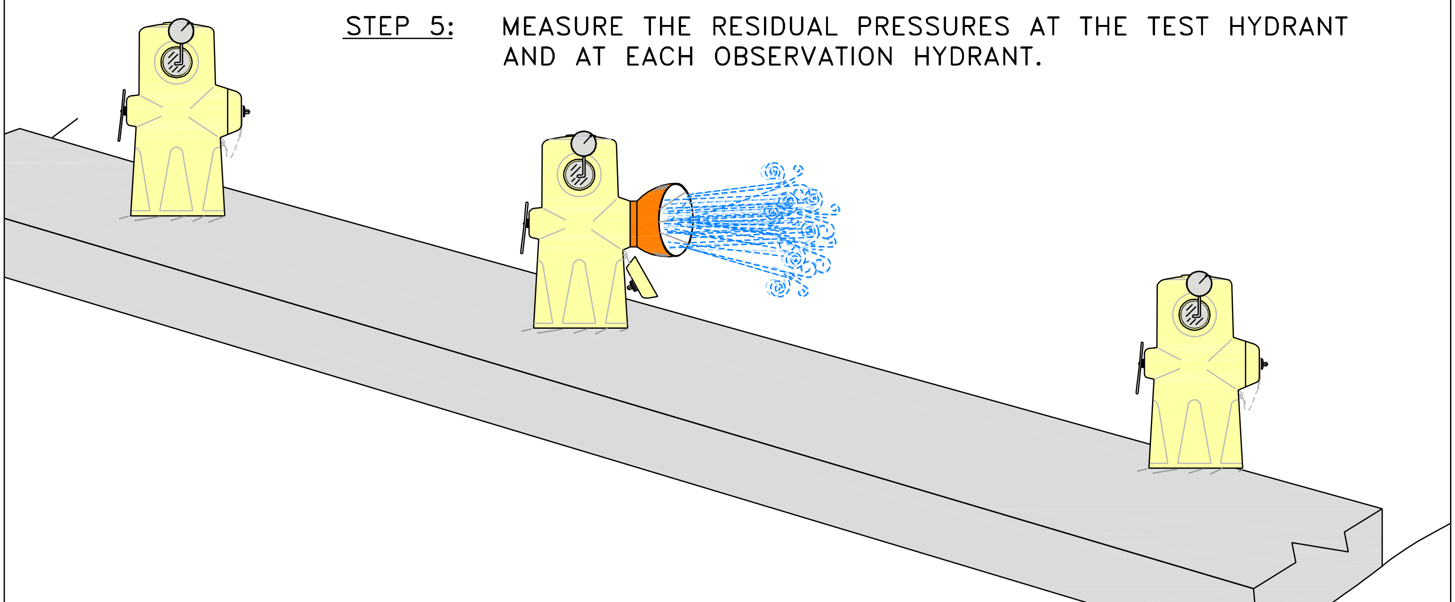
STEPS 1, 2 & 3: REMOVE HYDRANT CAP, FLUSH OUT HYDRANT AND MEASURE THE STATIC PRESSURES AT THE TEST HYDRANT AND AT EACH OBSERVATION HYDRANT.



STEP 4: FLOW THE DESIGNATED TEST HYDRANT AND MEASURE THE DISCHARGE FLOW AND PRESSURE.



STEP 5: MEASURE THE RESIDUAL PRESSURES AT THE TEST HYDRANT AND AT EACH OBSERVATION HYDRANT.



LEGEND:

NOT TO SCALE

LIVERMORE CALIFORNIA

CITY OF LIVERMORE
SEWER & WATER MASTER PLAN

FIGURE 2
HYDRANT TEST PROCEDURE

1777 Botelho Drive, Suite 240
Walnut Creek, California 94596
(925) 949-5800
FAX (530) 756-5991
WEST YOST ASSOCIATES

CAD FILE: w:/C/438/12-15-05/CAD/Figures/FIG 2_Hydrant Test.dwg DATE: 06-23-16 4:25pm DBarksdale

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ATTACHMENT A

Hydrant Test Location Sheets

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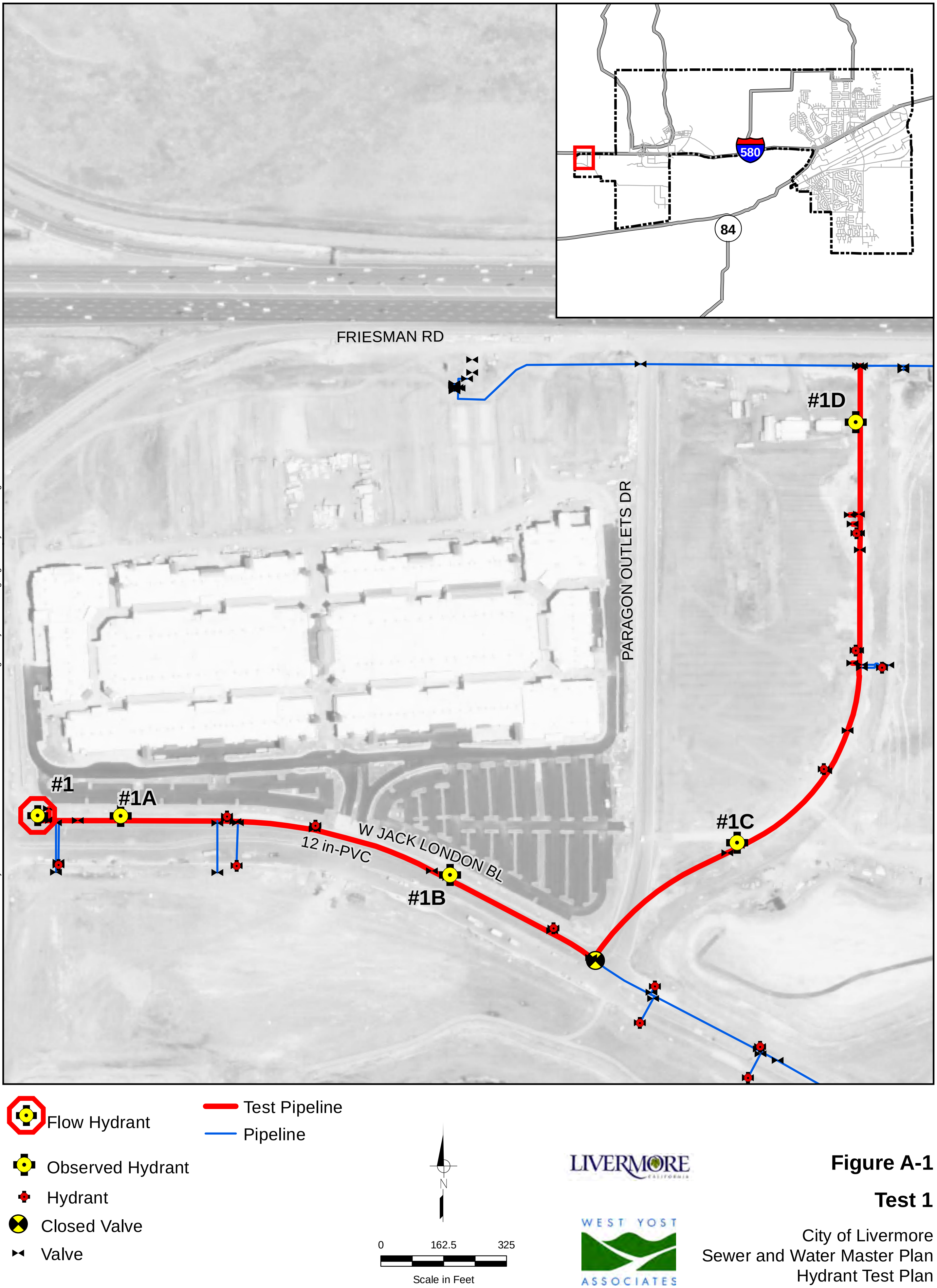

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Figure A-1

Test 1

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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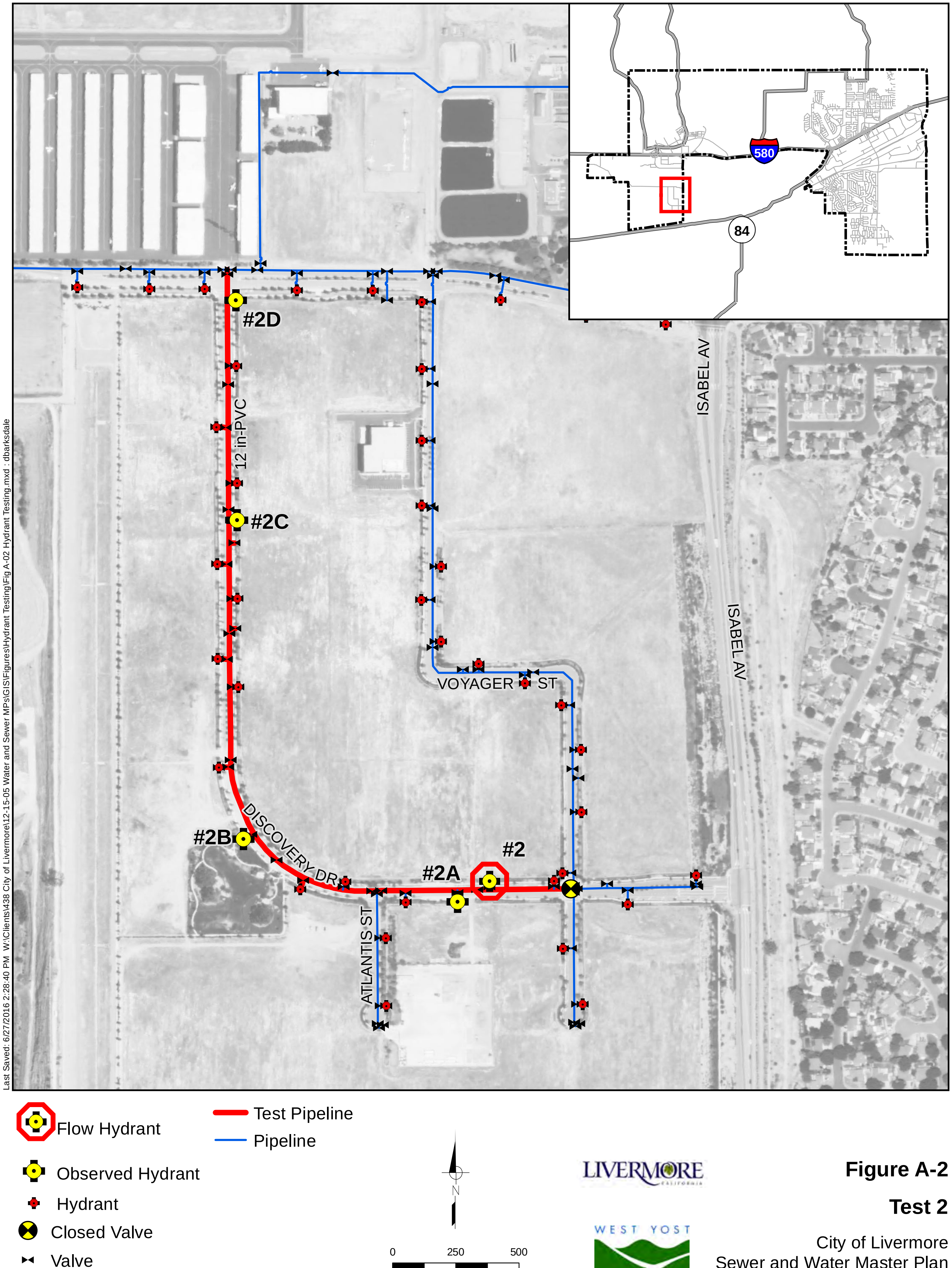

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-2

Test 2

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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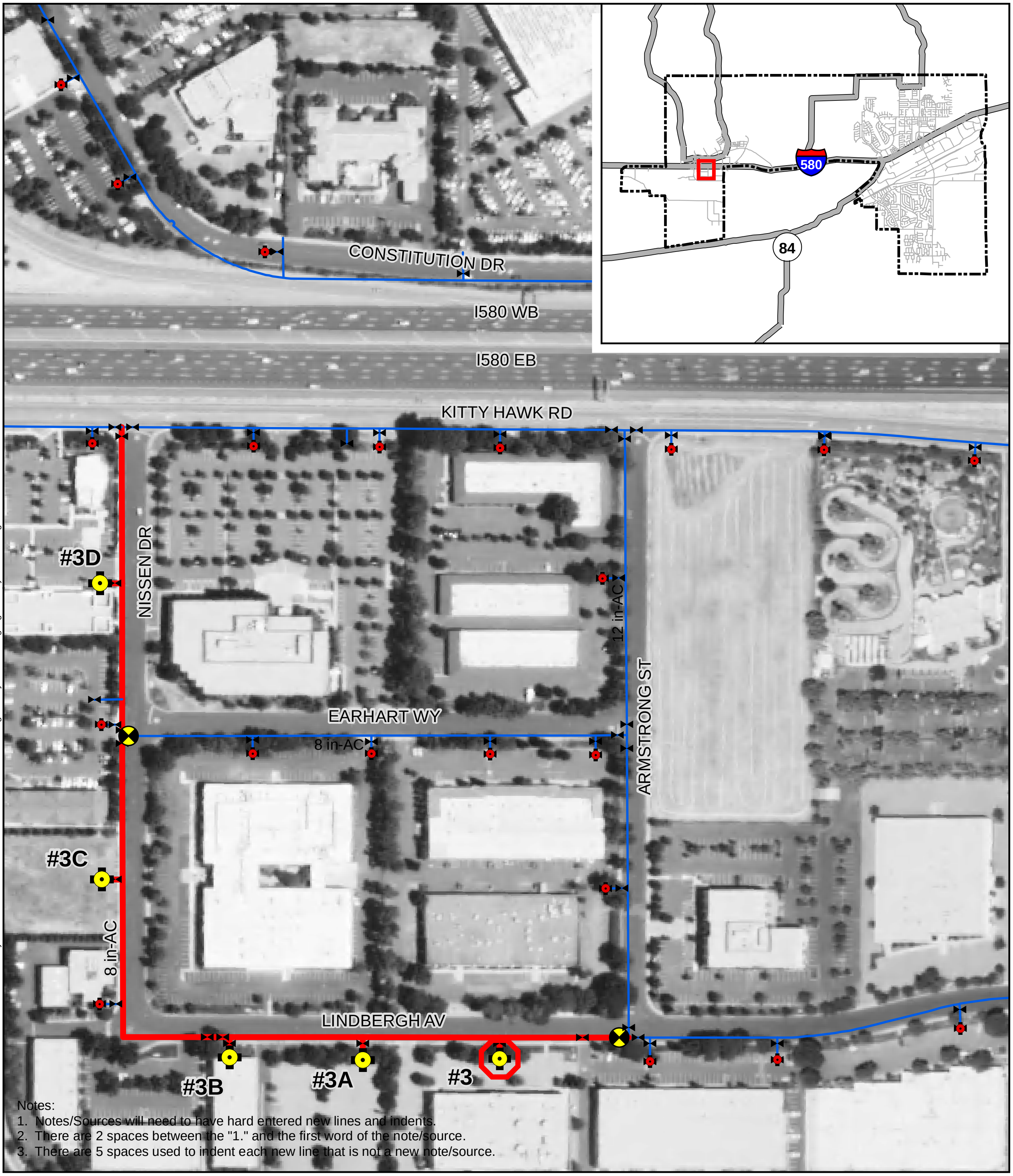

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Flow Hydrant
Observe Hydrant
Hydrant
Close Valve
Valve
Test Pipeline
Pipeline

N

0 125 250
Scale in Feet

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-3

Test 3

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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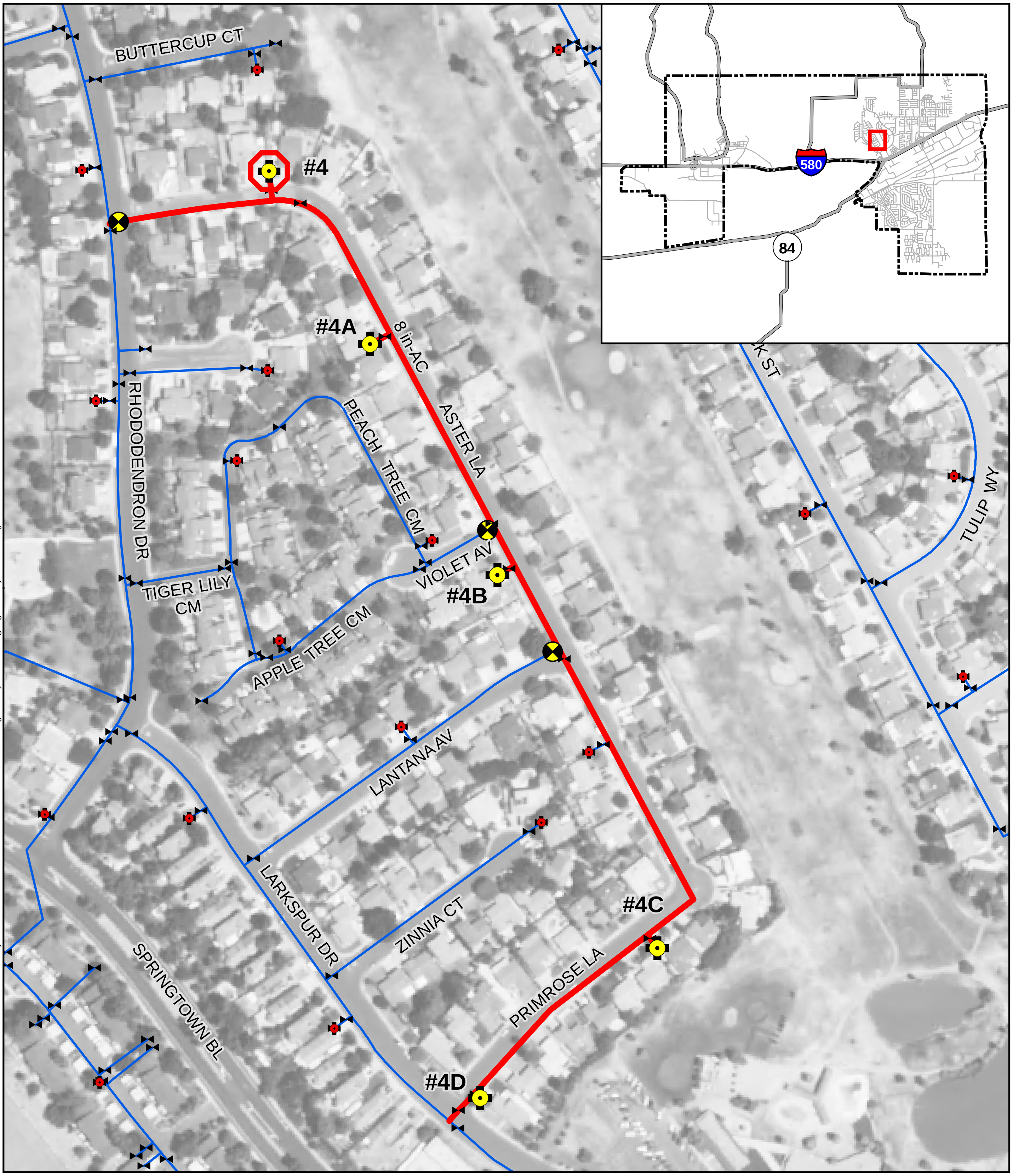

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Flow Hydrant
Test Pipeline
Pipeline
Observed Hydrant
Hydrant
Closed Valve
Valve

N

0 125 250
Scale in Feet

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-4

Test 4

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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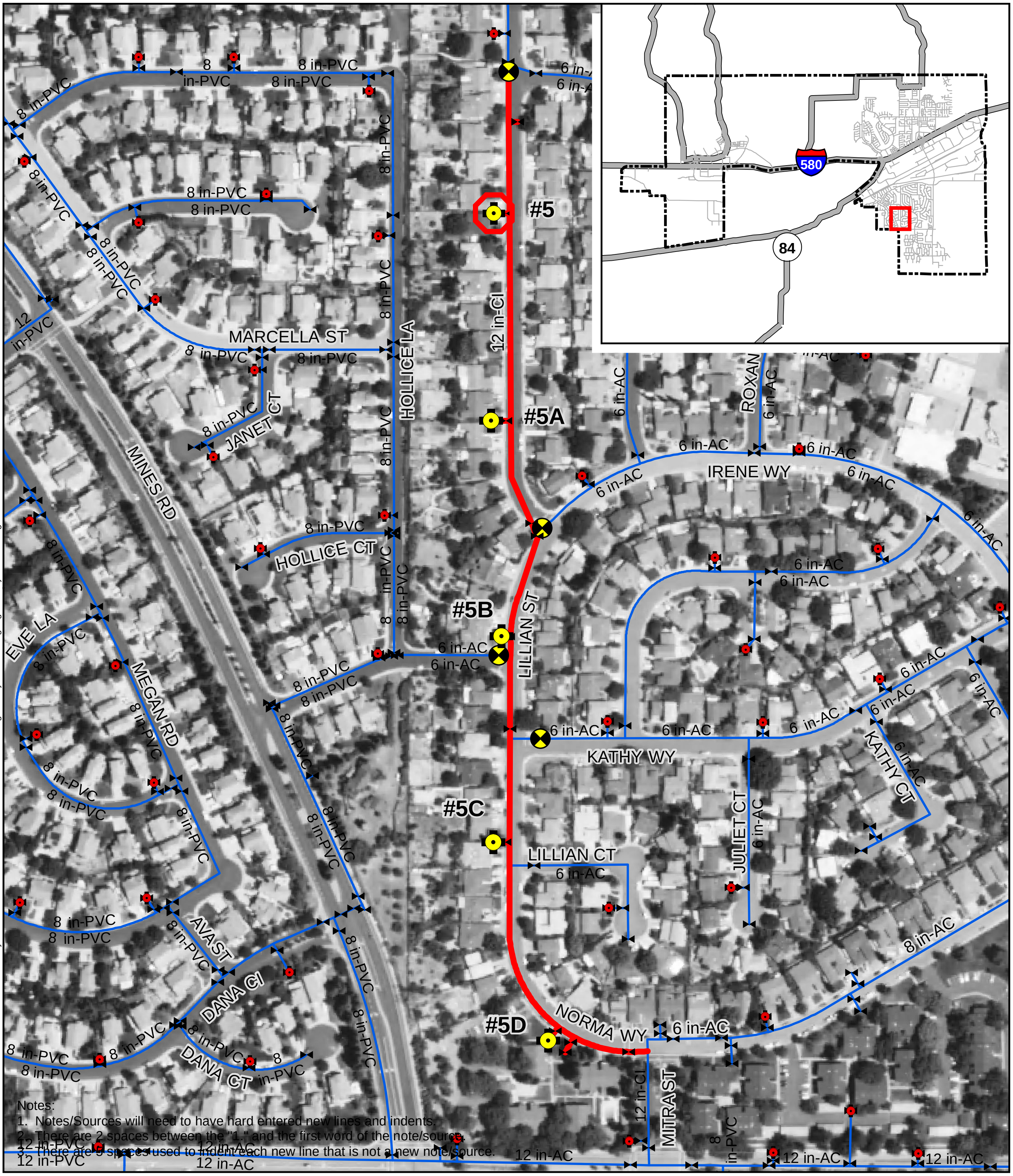

Flow Hydrant

Test Pipeline

Pipeline

Observe Hydrant

Hydrant

Close Valve

Valve

N

0 150 300

Scale in Feet

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-5

Test 5

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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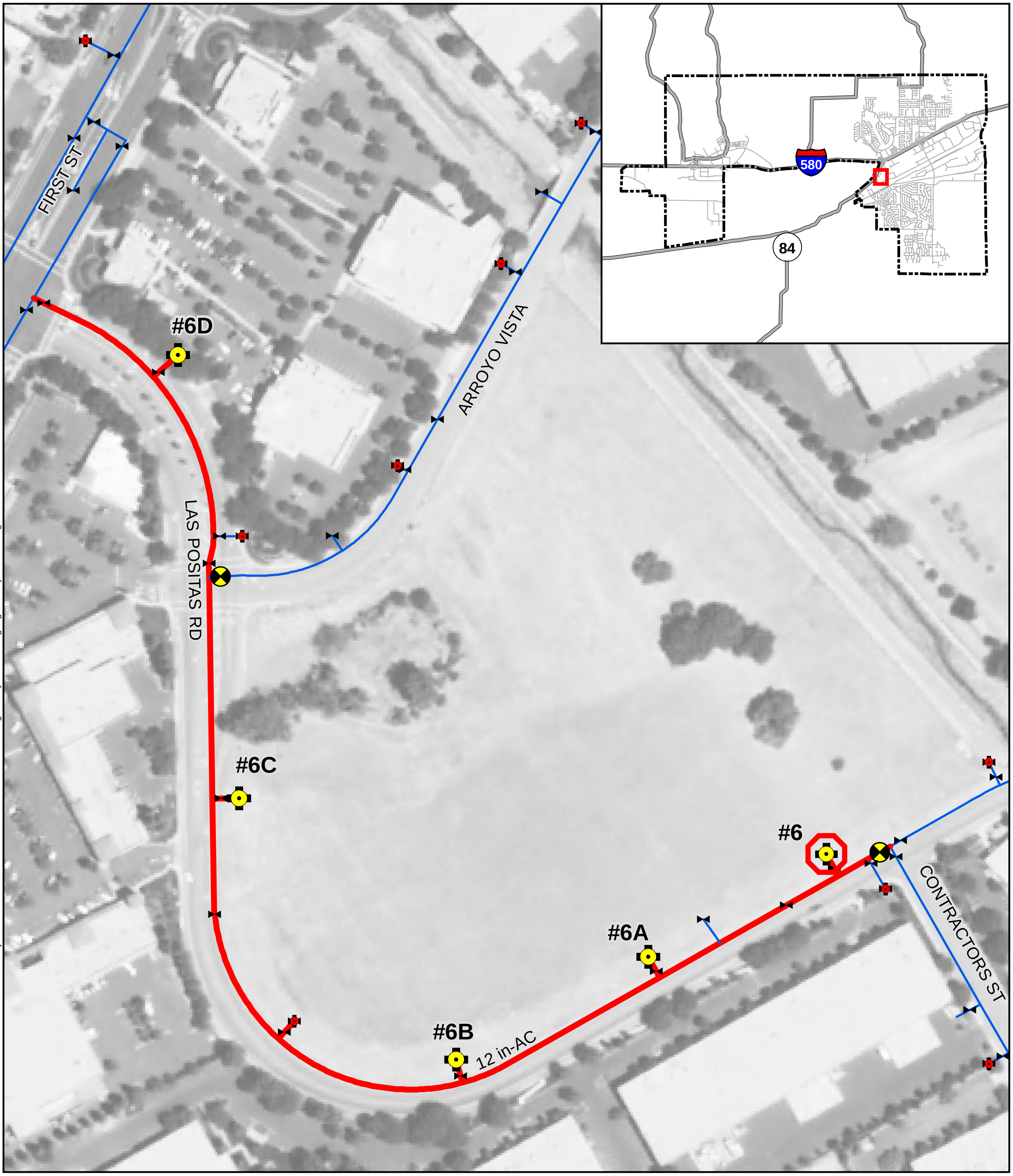

Flow Hydrant
Test Pipeline
Pipeline
Observed Hydrant
Hydrant
Closed Valve
Valve

0 100 200
Scale in Feet

Figure A-6

Test 6

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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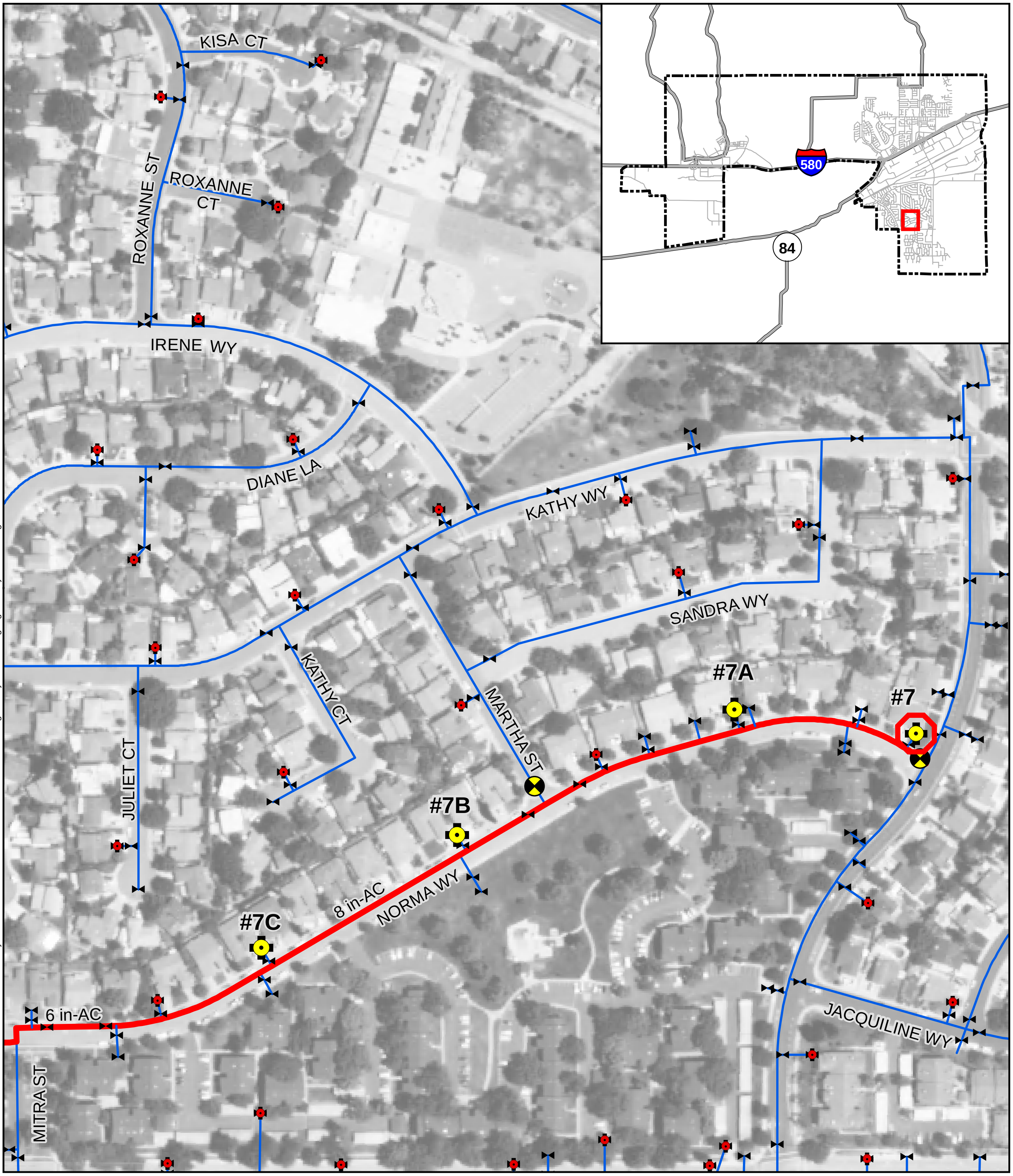

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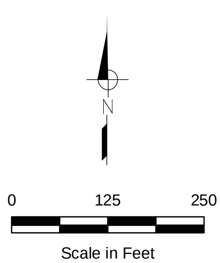
Flow Hydrant
Test Pipeline
Pipeline
Observed Hydrant
Hydrant
Closed Valve
Valve



LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-7

Test 7

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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Flow Hydrant
Observed Hydrant
Hydrant
Closed Valve
Valve
Test Pipeline
Pipeline

N

0 150 300
Scale in Feet

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-8

Test 8

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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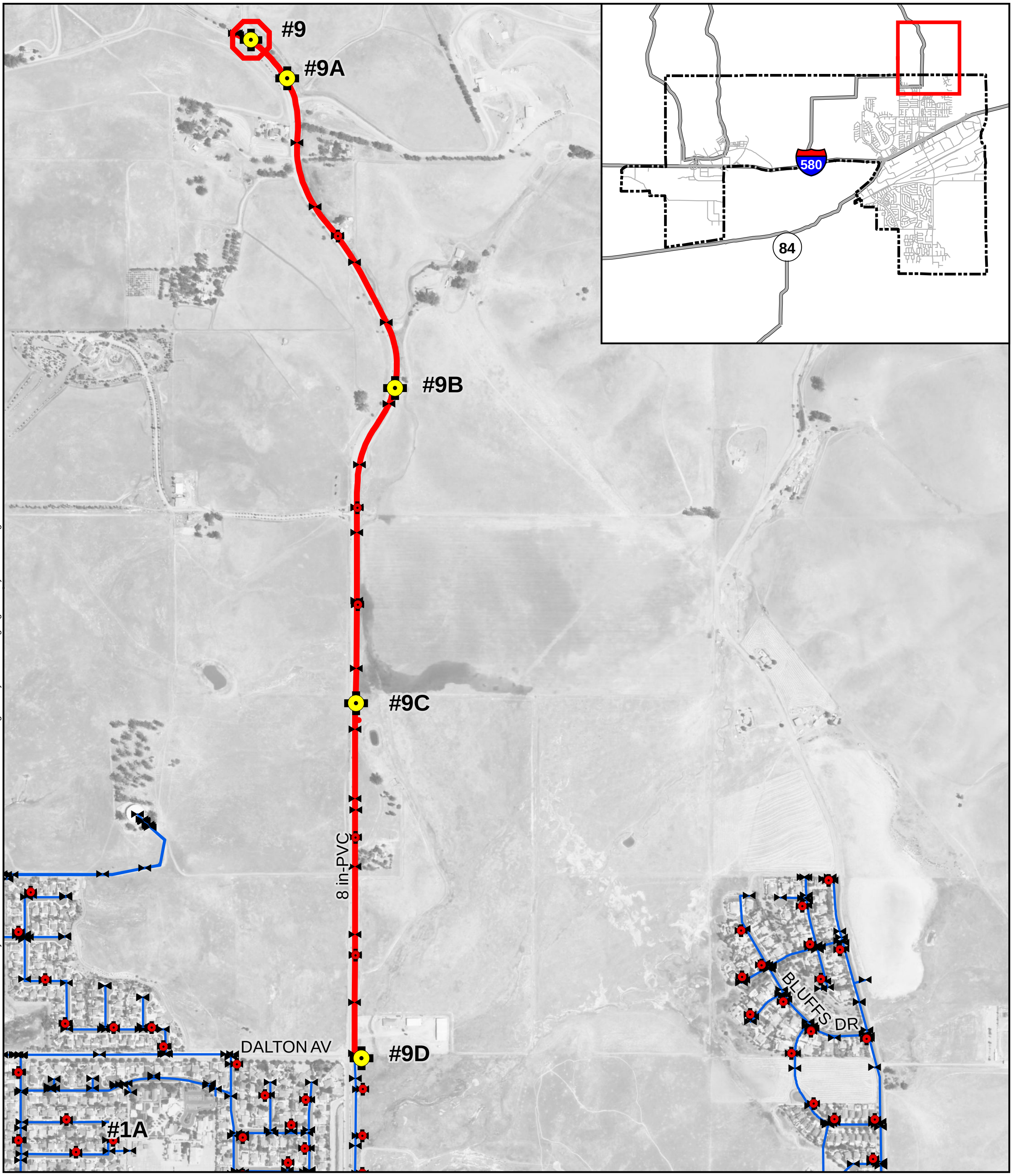

Flow Hydrant

Observed Hydrant

Hydrant

Closed Valve

Valve

Test Pipeline

Pipeline

N

0 500 1,000

Scale in Feet

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-9

Test 9

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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Flow Hydrant
Observed Hydrant
Hydrant
Closed Valve
Valve

Test Pipeline
Pipeline

N

0 125 250
Scale in Feet

LIVERMORE CALIFORNIA

WEST YOST ASSOCIATES

Figure A-10

Test 10

City of Livermore
Sewer and Water Master Plan
Hydrant Test Plan

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APPENDIX B

Additional Storage Evaluation and Tank Siting Study

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WEST YOST ASSOCIATES
Consulting Engineers

REGISTERED PROFESSIONAL ENGINEER
PATRICK A. JOHNSTON
No. C59028
Exp. 6-30-17
CIVIL
STATE OF CALIFORNIA

TECHNICAL MEMORANDUM

DATE: February 1, 2017 Project No.: 438-12-16-06
SENT VIA: EMAIL

TO: Todd Yamello, City of Livermore

FROM: Patrick Johnston, PE, RCE #C59028
Jim Connell, PE, RCE #C63052

REVIEWED BY: Elizabeth Drayer, PE, RCE #C46872

SUBJECT: City of Livermore Water Master Plan – Additional Storage Evaluation and Tank Siting Study

The purpose of this technical memorandum (TM) is to discuss the findings of an additional hydraulic evaluation of the City of Livermore (City) potable water storage options within Zones 2 and 3. In October 2016, the City requested the assistance of West Yost Associates (West Yost) to evaluate if potable water storage in Zone 2 in the Dalton Tank and in Zone 3 in the Altamont Tanks can be analyzed collectively when determining the potable water storage requirements for these two zones. Previously, these two zones were analyzed independently, and it was assumed that each zone would need to have sufficient operational, emergency, and fire flow storage on its own. However, given that the City's distribution system has the capability to transmit water by gravity from Zone 3 into Zone 2, the City would like to determine if the storage requirements for Zone 2 could be met by storage within Zone 3.

The City currently experiences water quality challenges in Zone 2 during low demand periods and occasionally needs to manually dose chlorine at the Dalton Tank to address water quality issues. If additional storage is built at Dalton Tank, a more permanent and automatic chlorine dosing system may be required. Currently, the City can better accommodate additional water storage in Zone 3 as it experiences fewer water quality issues and has greater operational flexibility than Zone 2.

The City also wanted to investigate the cost ramifications of this decision in terms of the estimated construction cost for additional storage facilities. The City is currently in the planning process for replacing the Dalton Tank, as it has reached the end of its useful life. Expanding the size of this tank while replacing it is possible, and may be a relatively inexpensive way to add additional storage to Zone 2; however, as discussed above, a permanent chlorine dosing system may also need to be added. In comparison, moving storage to the Altamont site offers the advantage of a reduction in fire flow storage, as one fire flow storage volume could be used to meet the requirements of both zones, reducing the overall amount of additional storage required system-wide. However, the Altamont site is limited in terms of the amount and availability of space in which to construct new storage facilities.

This TM addresses the concerns described above through the following topics:

- Storage Evaluation
- Hydraulic Modeling
- Dalton Tank Siting Study
- Altamont Tank Siting Study
- Conclusions
- Recommendations

These topics are described in greater detail below.

STORAGE EVALUATION

The City's potable water storage criteria require that storage be provided for operational, fire flow and emergency uses within each of the City's water distribution system pressure zones. This storage is to be provided from the City's potable water storage tanks (not supplemented with supplies from Zone 7). These storage components are defined as follows:

- Operational Storage: Volume of water necessary from storage to meet diurnal peaks observed throughout the day, equal to 25 percent of the maximum day demand;
- Fire Storage: Volume of water necessary from storage to supply a single fire flow event during maximum day demand conditions; and
- Emergency Storage: Volume of water necessary from storage to provide emergency supply, assumed to be equivalent to 50 percent of the maximum day demand.

The City requested an evaluation of storage requirements for Pressure Zones 2 and 3 to determine if storage between the two pressure zones could be shared. Specifically, the City wanted to investigate the possibility of having a single fire flow storage reserve volume at Altamont to serve a fire occurring in either Zone 2 or Zone 3. In addition, the City wanted to investigate the possibility of physically shifting the buildout emergency storage requirements for Zone 2 from Dalton to Altamont.

Three storage scenarios were evaluated under both existing and buildout demand conditions:

- Scenario 1: Three Zones Analyzed Independently
- Scenario 2: With Zone 2 Fire Flow Storage Assigned to Altamont
- Scenario 3: With Zone 2 Emergency and Fire Flow Storage Assigned to Altamont

Results are summarized in Table 1 based on the buildout demand conditions. Additional details on existing and buildout water demands and associated storage requirements are provided in Attachment A.

Table 1. Summary of Storage Evaluation Results based on Buildout Demand Conditions

Pressure Zone	Storage Facility	Available Storage, MG	Required Operational Storage, MG	Required Fire Flow Storage, MG	Required Emergency Storage, MG	Total Required Storage, MG	Storage Surplus (Deficit), MG
Storage Scenario 1: Three Zones Analyzed Independently							
Zone 1	Doolan	3.0	0.52	0.96	1.05	2.53	0.47
Zone 2	Dalton	2.0	1.14	1.50	2.27	4.91	(2.91)
Zone 3	Altamont	8.0	2.15	1.50	4.29	7.94	0.06
Storage Scenario 2: With Zone 2 Fire Flow Storage Assigned to Altamont							
Zone 1	Doolan	3.0	0.52	0.96	1.05	2.53	0.47
Zone 2	Dalton	2.0	1.14	Shared with Zone 3 at Altamont	2.27	3.41	(1.41)
Zone 3	Altamont	8.0	2.15	1.50	4.29	7.94	0.06
Storage Scenario 3: With Zone 2 Emergency and Fire Flow Storage Assigned to Altamont							
Zone 1	Doolan	3.0	0.52	0.96	1.05	2.53	0.47
Zone 2	Dalton	2.0	1.14	Shared with Zone 3 at Altamont	At Altamont	1.14	0.86
Zone 3	Altamont	8.0	2.15	1.50	6.56	10.21	(2.21)
MG = Million Gallons							

As shown in Table 1, under Storage Scenario 1, with all three zones analyzed independently, 2.91 MG of additional storage would need to be provided in Zone 2. Under Storage Scenario 2, with Zone 2 fire flow storage shared with Zone 3 at Altamont, the amount of additional storage required in Zone 2 (at Dalton) would be 1.41 MG, while the storage requirement for Zone 3 (at Altamont) remains the same. Under Storage Scenario 3, with Zone 2 fire flow and emergency storage assigned to Altamont, no additional storage would be required in Zone 2 (at Dalton); however, 2.21 MG of additional storage would be required in Zone 3 (at Altamont).

HYDRAULIC MODELING

The City requested West Yost to analyze the technical feasibility of shared storage between Pressure Zones 2 and 3 by verifying that the distribution system has sufficient transmission capacity to move the required volume of water for fire flows and emergency storage from the Altamont storage facilities in Zone 3 into Zone 2. West Yost used the recently-developed and calibrated hydraulic model to determine if the distribution system has sufficient transmission capacity.

Criteria and Assumptions

The criteria used to evaluate the distribution system are the same as those that have been developed during the on-going Water Master Plan effort, and are summarized as follows for the fire flow and emergency conditions evaluated:

- Fire Flow:
  - — Minimum pressure of 20 psi during Maximum Day Demand (MDD) plus Fire Flow (FF) conditions;
  - — Maximum FF demand for both Zone 2 and Zone 3 is 5,000 gallons per minute (gpm) for five hours; and
  - — Buildout MDD plus FF demand conditions are used to evaluate the system's ability to adequately transmit fire flow storage.
- Emergency:
  - — Minimum pressure of 35 pounds per square inch (psi) during Maximum Day and Peak Hour demand conditions; and
  - — Buildout MDD conditions are used to evaluate the system's ability to adequately transmit emergency storage.

The buildout demand scenarios that were analyzed were assumed to include the improvement projects that have been preliminarily proposed for the Water Master Plan.

Each storage scenario was evaluated for the five operational alternatives evaluated in the Water Master Plan. The five operational alternatives evaluated are summarized in Table 2 along with key operational assumptions.

Table 2. Summary of Operational Alternatives

Zone 2 & 3 Facility	Base	Alternative 1 Central Impact	Alternative 2 Lassen Impact	Alternative 3 Vasco Bypass Impact	Alternative 4 Hall/Charlotte Impact
N. Vasco Pump Station Bypass	Closed	Closed	Closed	Open	Closed
Herman Crossing	Open	Open	Open	Open	Open
Central Crossing	Closed	Open	Closed	Closed	Closed
Lassen Crossing	Closed	Closed	Open	Closed	Closed
PRV – Scenic/ Vasco	Closed	Operational	Operational	Operational	Closed
Isolation - Hall	Closed	Closed	Closed	Closed	Open
Isolation - Charlotte	Closed	Closed	Closed	Closed	Open

PRV = Pressure Reducing Valve

Storage Scenario 1: Three Zones Analyzed Independently

For Storage Scenario 1, Zones 2 and 3 each have emergency and fire flow (FF) storage in the storage facilities within their respective zones, at Dalton in Zone 2 and at Altamont in Zone 3.

Interstate 580 (I-580) passes through Zone 2, dividing it into a north portion and a south portion. There are three crossings that join the north and south portions, consisting of the Herman Crossing, the Central Crossing and the Lassen Crossing. The City frequently closes one or more of these crossings to limit flow between the north and south to encourage turnover of the water stored in the Dalton tank. When flow is limited between the two portions, the south portion is primarily supplied by Zone 7 turnouts or PRVs from upper pressure zones, while the north portion is supplied by the Dalton Tank, the PRV at Scenic/Vasco or the Zone 7 Turnout 6 (either directly or through the Vasco Pump Station).

In the south portion of Zone 2, the highest fire flow demands are 5,000 gpm for five hours. During fire flow events, the fire flow demands in the south portion of Zone 2 are supplied primarily from PRVs from upper pressure zones in Zone 3. To clarify, what this means is that the hydraulic model shows that when a fire flow demand is assigned to a junction in the south portion of Zone 2, the flows to meet that fire flow demand come primarily from the PRVs from Zone 3, rather than from the Dalton Tank in Zone 2. This is true for all of the five operational alternatives that were analyzed. This is also true for all of the three storage scenarios analyzed. The maximum fire flow demands in Zone 3 are 5,000 gpm for five hours, as in the south portion of Zone 2. Therefore, there is sufficient fire flow storage in Zone 3 to supply the fire flow demands in the south portion of Zone 2 through the PRVs.

In the north portion of Zone 2, the highest fire flow demands are 3,500 gpm for three hours. During FF events, when the Vasco Pump Station is not operating, the FF demands in the north portion of Zone 2 are supplied primarily from the Dalton Tank and the PRV at Scenic and Vasco. FF demands can be adequately supplied from these two sources. However, when the PRV at Scenic and Vasco is not operational, as in the Base and Alternative 4 operational alternatives, pressures in the north portion of Zone 2 fall well below the criteria of 20 psi. Therefore, it is recommended that the PRV at Scenic and Vasco always be available to support FF events. The PRV station at Scenic and Vasco contains two pressure reducing valves, a smaller one for normal operating conditions, and a larger one for high flows such as those that occur during a FF event. While the smaller valve may continue to be closed for operational purposes, as in the Base and Alternative 4 operational alternatives, it is recommended that the larger valve always be operational with a setting of approximately 45 psi. At this setting, the valve will open during FF events to help maintain adequate pressures in the north portion of Zone 2, while remaining closed during normal operational demand conditions.

Storage Scenario 2: With Zone 2 Fire Flow Storage Assigned to Altamont

For Storage Scenario 2, Zones 2 and 3 each have emergency storage within their respective zones, at Dalton in Zone 2 and at Altamont in Zone 3. FF storage for both zones is assumed to be at Altamont in Zone 3.

As with the analysis of Storage Scenario 1, when FF events occur in the south portion of Zone 2, flows to meet the FF demand come primarily from the PRVs from Zone 3. Therefore, for these FF events, moving FF storage from Dalton to Altamont is acceptable, as this is the way the system already operates.

As with the analysis of Storage Scenario 1, when FF events occur in the north portion of Zone 2, flows to meet the demand come primarily from the Dalton Tank, and also from the PRV at Scenic and Vasco when it is operational, as in Operational Alternatives 1, 2 and 3. The analysis shows that the PRV at Scenic and Vasco is needed to prevent pressures from falling below 20 psi during fire flow events. Therefore, the recommendation that the large valve at the PRV at Scenic and Vasco always be available with a setting of approximately 45 psi remains the same for Storage Scenario 2.

As stated above, for Storage Scenario 2, the FF storage for Zone 2 is located at Altamont in Zone 3. However, during FF events, the hydraulic model shows that flow to supply a FF demand does come partially from the Dalton Tank in some situations. It was determined that this was acceptable after analyzing the storage at Dalton and Altamont together. Specifically, the emergency storage requirement of 2.27 MG for Zone 2 at Dalton was considered along with the FF storage requirement of 1.5 MG for Zones 2 and 3 at Altamont. The analysis showed that the emergency storage for Zone 2 at Dalton and the FF storage for Zone 2 at Altamont are interchangeable. If a portion of the emergency storage at Dalton is used to supply a fire flow event in Zone 2, as the model shows will happen, the unused FF storage at Altamont will, in effect, become replacement emergency storage for Zone 2 until it can be replenished. As will be discussed for Storage Scenario 3 below, the model analysis shows that locating emergency storage for Zone 2 at Altamont is acceptable, as the system can adequately maintain system pressures in Zone 2 using emergency storage at Altamont. Therefore, considering emergency storage for Zone 2 at Dalton and FF storage for Zone 2 at Altamont to be interchangeable is acceptable. This approach of considering the Dalton and Altamont storage together is necessary because when the Dalton Tank is removed entirely to force the system to supply fire flow demands only from the Altamont tank, the system cannot maintain a pressure of 20 psi in many parts of Zone 2 during a FF event.

Storage Scenario 3: With Zone 2 Emergency and Fire Flow Storage Assigned to Altamont

For Storage Scenario 3, the emergency and FF storage for Zones 2 and 3 are located at Altamont in Zone 3.

The ability to use storage at Altamont to serve FF events in Zone 2 is described in Storage Scenario 2 above and the same recommendations apply to Storage Scenario 3.

For Storage Scenario 3, the system was also analyzed for emergency conditions when the system is experiencing Buildout MDD demands. For a conservative approach, the system was analyzed using the assumption that the Dalton Tank is completely empty to ensure that the system is supplied only from the emergency storage at Altamont, and not from the Dalton Tank. No supply is provided from the Zone 7 turnouts in these analyses. In this situation, the system can maintain a minimum pressure of 35 psi throughout Zone 2. However, the PRV at Scenic and Vasco is critical to maintaining pressure in the northern portion of Zone 2. Therefore, the recommendation that the large valve at the PRV at Scenic and Vasco always be available with a setting of approximately 45 psi remains the same for Storage Scenario 3 for these demand conditions.

For emergency conditions, if the PRV at Scenic and Vasco is not available, and the Dalton Tank is completely removed from the system, the other supply sources that can adequately maintain pressure in the north portion of Zone 2 include the Lassen Crossing and the Vasco Pump Station bypass. Assuming the Herman Crossing is available, as it is in all of the operational alternatives, opening the Central Crossing is not sufficient to maintain pressures in the north portion of Zone 2. Operating the Lassen Crossing in conjunction with the Herman Crossing does allow the system to maintain pressures in the north portion of Zone 2. Opening the Vasco Pump Station bypass in conjunction with the Herman Crossing does allow the system to maintain pressures in the north portion of Zone 2. However, the Vasco Pump Station bypass is fed from Zone 7, and would not likely be available under emergency conditions.

Summary

The following provides a summary of the hydraulic analysis results for fire flow and emergency storage:

- Fire Flow Storage
  - All three storage scenarios satisfy the fire flow evaluation criteria.
  - For Storage Scenarios 2 and 3, the fire flow storage is at Altamont. Altamont will supply fire flow for Zone 3 and the south side of Zone 2. However, the north side of Zone 2 will continue to rely on the storage in Dalton (borrowing from Dalton's emergency storage under Storage Scenario 2 and Dalton's excess operational storage under Storage Scenario 3), to be replenished by the fire/emergency storage in Altamont.
  - The analysis shows that the PRV at Scenic and Vasco is needed to prevent pressures from falling below 20 psi during fire flow events. Therefore, it is recommended that the large valve at the PRV at Scenic and Vasco always be available with a setting of approximately 45 psi.

- Emergency Storage
  - All three storage scenarios satisfy the emergency storage evaluation criteria.
  - Even under Storage Scenario 3, emergency storage at Altamont can be a sole source of water for Zone 2 and 3 without the use of water from Dalton or from Zone 7.
  - The PRV at Scenic and Vasco is critical to maintaining pressure in the northern portion of Zone 2. Therefore, it is recommended that the large valve at the PRV at Scenic and Vasco always be available with a setting of approximately 45 psi.

DALTON TANK SITING STUDY

In parallel with this evaluation, Carollo Engineers has been retained by the City to evaluate the potential to replace existing storage and add additional storage at the Dalton site. The existing 2.0 MG Dalton Tank is planned to be replaced due to its age and condition, and it is possible to replace the Dalton Tank with a larger tank. Specifically, Carollo has evaluated the following:

- Replacement of the existing 2 MG Dalton Tank with a 2 MG tank;
- Replacement of the existing 2 MG Dalton Tank with a new 4.91 MG tank to provide an additional 2.91 MG of storage capacity as needed for Storage Scenario 1; and
- Replacement of the existing 2 MG Dalton Tank with a new 3.41 MG tank to provide an additional 1.41 MG of storage capacity as needed for Storage Scenario 2.

For each tank size, Carollo developed several options for height and diameter based on AWWA D100 seismic design requirements. For the 2 MG size, the existing tank diameter was used. For the 3.41 MG and 4.91 MG sizes, Carollo selected the most cost-effective height/diameter based on the panel sizes that are used by tank manufacturers. The most cost-effective sizes were also the shortest, which minimizes the effect on the pumps. The selected tank dimensions and preliminary cost estimates are shown in Table 3.

Table 3. Dalton Tank Replacement Options

Tank Size, MG	Tank Height, feet	Tank Diameter, feet	Freeboard, feet	Preliminary Construction Cost Estimate[a]
2.00	28	130	7.5	$2.6M
3.41	32	155	8.0	$3.6M
4.91	40	162	9.0	$4.2M

[a] Preliminary construction cost estimates include the new tank (including coatings and foundation) and site improvements. It does not included mechanical, electrical and instrumentation components, which are common to all options.

To accommodate the larger tank sizes on the site, Carollo recommends expanding the site to the north, keeping the existing piping and electrical connections in the same place. Some fill will be required on the northern slope to create an even grade for the larger tanks and new paved access road around the perimeter, though the slope on the northern side is relatively shallow.

Additional details of regarding Carollo's preliminary cost estimates for the Dalton Tank options are provided in Attachment B.

ALTAMONT TANK SITING STUDY

Under Storage Scenario 3, an additional 2.21 MG of storage is required at Altamont. West Yost has conducted a tank siting study for the Altamont site to evaluate the potential for providing an additional 2.21 MG of storage at the Altamont site.

There are currently two potable water storage tanks at the Altamont site: a 3 MG tank constructed in 1985, and a 5 MG tank constructed in 2003. The existing 5 MG tank at Altamont has a base elevation of 760 feet and a maximum water depth of 40 feet to the overflow (total height of 43 feet). Any new storage at that location should match that base elevation and water depth.

Because the existing site is steeply sloped, locating additional storage would be challenging. Two alternative tank configurations were investigated:

- Alternative 1: Construct a new 2.21 MG storage tank
- Alternative 2: Demolish the existing 3 MG tank and construct a new 5.21 MG tank

Both alternatives would be constructed within the existing property line and easement. Possible site layouts, required site grading, construction challenges, and an Engineer's Opinion of Relative Costs for the two alternatives are discussed below.

Alternative 1: Construct a New 2.21 MG Storage Tank

Under Alternative 1, a new 2.21 MG storage tank (approximately 97 feet in diameter) would be constructed to the southeast of the existing 5 MG storage tank. Construction at this location would require a substantial amount of fill material (over 30 feet at the southeast edge) and a steep slope to recover site topography by the east property line. This alternative would also require relocating an existing storm drain and foundation drain.

A possible site layout is shown in Attachment C in Figure C-1. The existing 21-inch diameter storm drain and 6-inch diameter drain line would be removed or grouted, with a new alignment constructed between the existing 5 MG tank and the new 2.21 MG tank or downslope to the property line, then south along the property line. An additional drain inlet may be required at the toe of slope/property line to prevent erosion of the fill material.

Site grading will require excavation of the existing overburden to expose bedrock and approximately 21,200 cubic yards (cy) of fill material to bring the slope to a base elevation of 760 feet. A 2:1 slope will be required to transition from the tank base elevation to the existing grade at the east property line.

The geotechnical aspects of this project would be the most challenging. Not only must fill material be brought in, but the fill material will be at varying depth, ranging from very little fill on the northwest side, to over 30 feet of fill on the southwest side. The risk of differential settling and slope instability, particularly during seismic events, will have to be mitigated. The details of the required mitigation measures have not been developed at this level of study. Once the geotechnical issues are resolved, construction should be fairly standard.

To compare alternatives, an Engineer’s Opinion of Relative Cost (EORC) at this level of project understanding has been developed, and is shown in Attachment C. So that the several tank siting options at both Dalton and Altamont can be evaluated, the EORC uses the same basic assumptions and unit costs as was used for the Dalton siting study. Equipment and features common to all alternatives, such as mechanical, electrical, and instrumentation, are not included in the EORC. Therefore, the EORC does not reflect an actual construction cost estimate. The EORC for Alternative 1 is $5.4 million.

Alternative 2: Demolish the Existing 3 MG Tank and construct a New 5.2 MG Tank

Under Alternative 2, the existing 3 MG storage tank would be demolished and a new 5.21 MG tank (approximately 149 feet in diameter) would be constructed at that location. It should be noted that demolishing the existing 3 MG tank would mean early replacement of an existing asset with significant remaining life.

Constructing the new 5.21 MG tank would require cutting into the existing berm and reconstructing the berm slope to approximately 1:1, as was completed for the 5 MG tank in 2003. The total height of the berm, and hence the screening capability, would not be affected.

A possible site layout is shown in Attachment C in Figure C-2. The existing 20-inch diameter fill pipe would be removed. The existing valve pit may be reusable, but for purposes of this study, it is assumed to be removed and replaced. Site grading will be much less than for Alternative 1. Some fill will be required on the northeast side and some cut will be needed on the north and east.

The height of the berm can be preserved by constructing a 1:1 slope, similar to the modifications completed during construction of the 5 MG tank.

Although geotechnical considerations are important for Alternative 2, they are more easily mitigated than for Alternative 1.

To compare alternatives, an EORC at this level of project understanding has been developed, and is shown in Attachment C. So that the several tank siting options at both Dalton and Altamont can be evaluated, the EORC uses the same basic assumptions and unit costs as was used for the Dalton siting study. Equipment and features common to all alternatives, such as mechanical, electrical, and instrumentation, are not included in the EORC. Therefore, the EORC does not reflect an actual construction cost estimate. The EORC for Alternative 2 is $4.7 million.

CONCLUSIONS

Storage Scenario 1: Three Zones Analyzed Independently

The results for Storage Scenario 1 indicate that an additional 2.91 MG of storage would be required at the Dalton site under buildout demand conditions. This additional storage would be in addition to the existing 2 MG storage currently provided at the Dalton site, thus requiring a new 4.91 MG tank at the Dalton site. This storage scenario does not take advantage of the ability to share storage between Zones 2 and 3, and a larger tank at Dalton would be more expensive and may lead to water quality issues. Under this storage scenario, a new larger tank at Dalton should be designed with provisions to possibly add a permanent chlorine injection system in the future in the event that the increased storage volume leads to water quality issues.

The storage evaluation determined that no additional storage would be needed at the Zone 3 Altamont site if the Zone 2 fire flow storage and emergency storage were to remain in Zone 2.

Storage Scenario 2: With Zone 2 Fire Flow Storage Assigned to Altamont

Under Storage Scenario 2, an additional 1.41 MG of storage would be required at the Dalton site if Zone 2 fire flow storage was assigned to Altamont. This additional storage would be in addition to the existing 2 MG storage currently provided at the Dalton site, thus requiring a new 3.41 MG tank at the Dalton site. The hydraulic analysis described above determined that fire flows in the northern part of Zone 2 would continue to be served from storage available in the Dalton Tank, borrowing from the emergency storage, which would then be replenished from the Altamont Tank. Therefore, Storage Scenario 2 is hydraulically feasible.

As discussed above, the City is currently in the planning process for replacing the Dalton Tank, as it has reached the end of its useful life. As described above, the potential to replace existing storage and add additional storage at the Dalton site is being evaluated separately for the City by Carollo Engineers. Expanding the size of this tank while replacing it is possible, and may be a relatively inexpensive way to add additional storage to Zone 2. Under this storage scenario, a new larger tank at Dalton should be designed with provisions to possibly add a permanent chlorine injection system in the future in the event that the increased storage volume leads to water quality issues.

Under Storage Scenario 2, no additional storage would be needed at the Zone 3 Altamont site, as the fire flow storage already provided by Altamont would be shared by the two zones.

Storage Scenario 3: With Zone 2 Emergency and Fire Flow Storage Assigned to Altamont

Under Storage Scenario 3, an additional 2.21 MG would be needed at the Altamont site if both the Zone 2 emergency and fire flow storage were to be located there. The hydraulic analysis described above determined that fire flows and emergency water in the northern part of Zone 2 would continue to be served from storage available in the Dalton Tank, borrowing from excess operational storage, which would then be replenished from the Altamont Tank. Therefore, Storage Scenario 3 is hydraulically feasible.

However, siting the additional storage at the Altamont tank site does present challenges. Two alternatives were evaluated:

- Alternative 1: Construct a New 2.21 MG Storage Tank would be very difficult to construct due to the substantial amount of fill required.
- Alternative 2: Construct a New 5.21 MG Storage Tank would be easier to construct, but requires a much larger storage volume to compensate for the removal of the existing 3 MG tank.

Therefore, if Storage Scenario 3 is selected, Alternative 2: Construct a 5.21 MG Storage Tank at Altamont, seems more feasible, and is the less costly alternative even though it requires the construction of a larger tank and it means the early replacement of an existing asset with significant remaining life.

The relative costs of the three Storage Scenarios are presented in Table 4.

Table 4. Relative Cost of Tank Siting Alternatives

Storage Scenario	Tank Siting Alternative	Engineer's Opinion of Relative Cost[a,b]
1	4.91 MG Tank at Dalton (replacement of existing 2 MG tank + 2.91 MG additional storage capacity)	$4.2M
	No New Tank at Altamont	$0.0M
	Total Storage Scenario 1	**$4.2M**
2	3.41 MG Tank at Dalton (replacement of existing 2 MG tank + 1.41 MG additional storage capacity)	$3.6M
	No New Tank at Altamont	$0.0M
	Total Storage Scenario 2	**$3.6M**
3 (Alternative 1)	2.0 MG Tank at Dalton (replacement of existing 2 MG tank)	$2.6M
	2.21 MG Tank at Altamont (new tank)	$5.4M
	Total Storage Scenario 3 (Alternative 1)	**$8.0M**
3 (Alternative 2)	2.0 MG Tank at Dalton (replacement of existing 2 MG tank	$2.6M
	5.21 MG Tank at Altamont (replacement of existing 3 MG tank + 2.21 MG additional storage capacity)	$4.7M
	Total Storage Scenario 3 (Alternative 2)	**$7.3M**

(a) The EORC uses the same basic assumptions and unit costs for both the Dalton and Altamont tank alternatives. Equipment and features common to all alternatives, such as mechanical, electrical, and instrumentation, are not included in the EORC. Therefore, the EORC does not reflect an actual construction cost estimate.

(b) See Attachments B and C for detailed cost information.

RECOMMENDATIONS

Overall, based on the three storage scenarios evaluated, Storage Scenario 2, with a new 3.4 MG tank at Dalton with Zone 2 fire flow storage assigned to Altamont, appears to be the best option, both from a cost standpoint and an operations standpoint, as the existing Dalton tank is already planned for replacement and the additional storage volume required (1.41 MG) is less than for the other storage scenarios evaluated. As described above, the other storage scenarios evaluated would require the construction of larger tanks to replace and provide additional required storage, which would be more expensive and may lead to water quality issues.

ATTACHMENT A

Storage Evaluation Tables

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Table 5-1. Water Demands for the Existing Water System Evaluation

Pressure Zone	Average Day Demand[a]		Maximum Day Demand[b]		Peak Hour Demand[c]	
	gpm	mgd	gpm	mgd	gpm	mgd
Zone 1						
605	30	0.04	61	0.09	95	0.14
638	80	0.12	166	0.24	260	0.37
664	260	0.37	539	0.78	841	1.21
719	30	0.04	61	0.09	96	0.14
Zone 1 Total	400	0.58	828	1.19	1,292	1.86
Zone 2						
670	1,070	1.54	2,214	3.19	4,340	6.25
Zone 2 Total	1,070	1.54	2,214	3.19	4,340	6.25
Zone 3						
725	1,178	1.70	2,439	3.51	4,780	6.88
740[d]	11	0.02	22	0.03	43	0.06
741	42	0.06	86	0.12	169	0.24
744	145	0.21	300	0.43	588	0.85
800	941	1.35	1,947	2.80	3,817	5.50
875	43	0.06	90	0.13	176	0.25
Zone 3 Total	2,359	3.40	4,884	7.03	9,572	13.78
Zone 1, 2, & 3 Total	**3,829**	**5.51**	**7,926**	**11.41**	**15,203**	**21.89**

[a] Average day demand is based on detailed billing records adjusted to reflect rebound from conservation. Billing records from 2015 were spatially located, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Maximum day demand calculated using a peaking factor of 2.07 times the average day demand.

[c] Peak hour demand calculated using a peaking factor of 1.56 times the maximum day demand for Zone 1 and 1.96 for Zones 2 and 3.

[d] Zone 740 is physically located in Zone 2, but operationally is supplied from Zone 3 and is included in the Zone 3 storage evaluation.

Table 6-1. Water Demands for the Buildout Water System Evaluation

Pressure Zone	Average Day Demand[a]		Maximum Day Demand[b]		Peak Hour Demand[c]	
	gpm	mgd	gpm	mgd	gpm	mgd
Zone 1						
605	89	0.13	184	0.26	287	0.41
638	211	0.30	437	0.63	682	0.98
664	369	0.53	764	1.10	1,191	1.72
719	35	0.05	73	0.10	113	0.16
Zone 1 Total	704	1.01	1,457	2.10	2,273	3.27
Zone 2						
670	1,524	2.19	3,155	4.54	6,183	8.90
Zone 2 Total	1,524	2.19	3,155	4.54	6,183	8.90
Zone 3						
725	1,235	1.78	2,556	3.68	5,009	7.21
740[d]	65	0.09	134	0.19	263	0.38
741	43	0.06	89	0.13	175	0.25
744	163	0.24	338	0.49	662	0.95
800	1,330	1.91	2,752	3.96	5,394	7.77
875	43	0.06	90	0.13	176	0.25
Zone 3 Total	2,879	4.15	5,959	8.58	11,679	16.82
Zone 1, 2, & 3 Total	**5,106**	**7.36**	**10,570**	**15.22**	**20,135**	**28.99**

[a] Average day demand is based on detailed billing records adjusted to reflect rebound from conservation and estimated demands for future buildout. Billing records from 2015 were spatially located, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Maximum day demand calculated using a peaking factor of 2.07 times the average day demand.

[c] Peak hour demand calculated using a peaking factor of 1.56 times the maximum day demand for Zone 1 and 1.96 for Zones 2 and 3.

[d] Zone 740 is physically located in Zone 2, but operationally is supplied from Zone 3 and is included in the Zone 3 storage evaluation.

Table 5-4. Required Storage Capacity Under Existing Demand Conditions

Water Service Area Zone[a]	Pressure Zone	Storage Facility	Available Storage Capacity, MG		Maximum Day Demand, mgd	Required Storage Capacity, MG						Storage Surplus (Deficit), MG
						Operational Criteria[b]		Emergency Criteria				
			Reservoir Capacity	Total Available Storage		Percent of Maximum Day Demand	Operational	Percent of Maximum Day Demand	Emergency	Fire Flow[c]	Total Required Storage	
WSA Zone 1	605 638 664 719	Doolan	3.00	3.00	1.19	25%	0.30	50%	0.60	0.96	1.85	1.15
WSA Zone 2	670	Dalton	2.00	2.00	3.19	25%	0.80	50%	1.59	0[d]	2.39	(0.39)
WSA Zone 3	725 740[e] 741 744 800 875	Altamont	8.00	8.00	7.03	25%	1.76	50%	3.52	1.50	6.77	1.23

[a] Average day demand is based on detailed billing records and adjusted to reflect rebound from conservation. Billing records from 2015 were spatially located, scaled to include non-revenue water, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Based on 25 percent of maximum day demand (see Table 5-1).

[c] Based on demand for the most severe fire recommended in the pressure zone multiplied by the corresponding recommended fire flow duration.

[d] Fire flow storage for single fire in Water Service Area Zones 2 or 3 to be at Altamont.

[e] Pressure Zone 740 is physically located in Water Service Area Zone 2, but operationally is supplied from Water Service Area Zone 3 and is included in the Water Service Area Zone 3 evaluation.

Table 6-3. Required Storage Capacity Under Buildout Demand Conditions

Water Service Area Zone[a]	Pressure Zone	Storage Facility	Available Storage Capacity, MG: Reservoir Capacity	Available Storage Capacity, MG: Total Available Storage	Maximum Day Demand, mgd	Required Storage Capacity, MG: Operational Criteria[b]: Percent of Maximum Day Demand	Operational Criteria[b]: Operational	Emergency Criteria: Percent of Maximum Day Demand	Emergency Criteria: Emergency	Fire Flow[c]	Total Required Storage	Storage Surplus (Deficit), MG
WSA Zone 1	*605* *638* *664* *719*	Doolan	3.00	3.00	2.10	25%	0.52	50%	1.05	0.96	2.53	0.47
WSA Zone 2	*670*	Dalton	2.00	2.00	4.54	25%	1.14	50%	2.27	0[d]	3.41	(1.41)
WSA Zone 3	*725* *740*[e] *741* *744* *800* *875*	Altamont	8.00	8.00	8.58	25%	2.15	50%	4.29	1.50	7.94	0.06

[a] Average day demand is based on detailed billing records adjusted to reflect rebound from conservation and estimated demands for future buildout. Billing records from 2015 were spatially located, scaled to reflect expected demand rebound and then aggregated by pressure zone.

[b] Based on 25 percent of maximum day demand (see Table 5-1).

[c] Based on demand for the most severe fire recommended in the pressure zone multiplied by the corresponding recommended fire flow duration.

[d] Fire flow storage for single fire in Water Service Area Zones 2 or 3 to be at Altamont.

[e] Pressure Zone 740 is physically located in Water Service Area Zone 2, but operationally is supplied from Water Service Area Zone 3 and is included in the Water Service Area Zone 3 evaluation.

ATTACHMENT B

Dalton Tank Site Evaluation by Carollo Engineers

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DALTON TANK REPLACEMENT PROJECT
LIVERMORE WATER RECLAMATION PLANT

TASK :	DALTON TANK REPLACEMENT PROJECT		
JOB # :	8145I.10	**LOCATION FACTOR :**	1.13
	LIVERMORE WATER RECLAMATION PLANT	**ESTIMATED MIDPOINT OF CONSTRUCTION :**	12/1/2017
LOCATION :	LIVERMORE, CA	**COST ESTIMATE PREPARATION DATE :**	12/22/2016
ELEMENT # :	1	**BY :**	DDC/MK
ELEMENT :	Dalton Tank Replacement	**2.0** million gallon tank **REVIEWED BY:**	ZMS

DIVISION	DESCRIPTION	QTY	UNIT	UNIT COST	LOCATION FACTOR	SUBTOTAL	TOTAL
2	**SITEWORK**						
	Demolish Asphalt Pavement	6,833	SF	$1	1.13	$6,708	
	Demolish Tank and Tank Foundation (incl lead abatement)	1	LS	$100,000	1.00	$100,000	
	Demolish Valve Vault	0	LS	$7,500	1.00	$0	
	Fill and Grading	292	CY	$39	1.13	$12,805	
	4" Paving on 8" ABC	6,833	SF	$4	1.13	$30,885	
	Tank Foundation Backfill	983	CY	$75	1.00	$73,740	
	Total						$224,138
3	**CONCRETE**						
	Tank Foundation (3' x 4' x 130' Diameter Ring)	182	CY	$750	1.13	$153,833	
	Tank Foundation Formwork	408	LF	$45	1.13	$20,796	
	Valve Vault	0	LS	$15,000	1.00	$0	
	Total						$174,629
4	**MASONRY**						
	None						
	Total						$0
5	**METALS**						
	2 MG, 130' Diameter Welded Steel Tank, Shop Primed - Installed	1	EA	$1,114,250	1.00	$1,114,250	
	Total						$1,114,250
6	**WOOD AND PLASTICS**						
	NONE						
	Total						$0
7	**THERMAL AND MOISTURE PROTECTION**						
	None						
	Total						$0
8	**DOORS AND WINDOWS**						
	None						
	Total						$0
9	**FINISHES**						
	Interior and Exterior Field Coatings	1	LS	$792,105	1.00	$792,105	
	Total						$792,105

DALTON TANK REPLACEMENT PROJECT
LIVERMORE WATER RECLAMATION PLANT

TASK :	DALTON TANK REPLACEMENT PROJECT		
JOB # :	8145I.10	**LOCATION FACTOR :**	1.13
	LIVERMORE WATER RECLAMATION PLANT	**ESTIMATED MIDPOINT OF CONSTRUCTION :**	12/1/2017
LOCATION :	LIVERMORE, CA	**COST ESTIMATE PREPARATION DATE :**	12/22/2016
ELEMENT # :	1	**BY :**	DDC/MK
ELEMENT :	Dalton Tank Replacement — **2.0** million gallon tank	**REVIEWED BY:**	ZMS

DIVISION	DESCRIPTION	QTY	UNIT	UNIT COST	LOCATION FACTOR	SUBTOTAL	TOTAL
10	**SPECIALTIES**						
	None						
	Total						$0
11	**EQUIPMENT**						
	None						
	Total						$0
12	**FURNISHING**						
	None						
	Total						$0
13	**SPECIAL CONDITIONS**						
	None						
	Total						$0
14	**CONVEYING SYSTEMS**						
	None						
	Total						$0
15	**MECHANICAL**						
	Pipes and supports, mixer, valves	0	LS	$250,000	1.00	$0	
	Total						$0
16	**ELECTRICAL**						
	Electrical Allowance (% of Div 11-15)	15	%			$0	
	Total						$0
17	**INSTRUMENTATION**						
	Instrumentation Allowance (% of Div 11-15)	10	%			$0	
	Total						$0
	SUBTOTAL - (TANK & FIELD COATINGS)						**$398,767**
	INDIRECT COSTS (NOT APPLIED TO TANK OR FIELD COATINGS)						
	Estimating Contingency	30	%				$119,630.12
	SUBTOTAL						**$518,397**
	Sales Tax on 50% of Subtotal Above	9.50	%				$24,624
	SUBTOTAL						**$543,021**
	General Conditions	12	%				$65,162.52
	SUBTOTAL						**$608,184**
	Contractor Overhead and Profit	13	%				$79,063.86
	SUBTOTAL						**$687,247**
	Rate of Annual Inflation	3	%				$19,415
	ELEMENT CONSTRUCTION COST (INCL/ TANK & COATINGS)						**$2,613,000**

DALTON TANK REPLACEMENT PROJECT
LIVERMORE WATER RECLAMATION PLANT

TASK :	DALTON TANK REPLACEMENT PROJECT		
JOB # :	8145I.10	**LOCATION FACTOR :**	1.13
	LIVERMORE WATER RECLAMATION PLANT	**ESTIMATED MIDPOINT OF CONSTRUCTION :**	12/1/2017
LOCATION :	LIVERMORE, CA	**COST ESTIMATE PREPARATION DATE :**	12/22/2016
ELEMENT # :	1	**BY :**	DDC/MK
ELEMENT :	Dalton Tank Replacement — **3.4** million gallon tank	**REVIEWED BY:**	ZMS

DIVISION	DESCRIPTION	QTY	UNIT	UNIT COST	LOCATION FACTOR	SUBTOTAL	TOTAL
2	**SITEWORK**						
	Demolish Asphalt Pavement	6,833	SF	$1	1.13	$6,708	
	Demolish Tank and Tank Foundation (incl lead abatement)	1	LS	$100,000	1.00	$100,000	
	Demolish Valve Vault	0	LS	$7,500	1.00	$0	
	Fill and Grading	838	CY	$39	1.13	$36,695	
	4" Paving on 8" ABC	8,011	SF	$4	1.13	$36,210	
	Tank Foundation Backfill	1,398	CY	$75	1.00	$104,829	
	Total						$284,441
3	**CONCRETE**						
	Tank Foundation (3' x 4' x 155' Diameter Ring)	216	CY	$750	1.13	$183,417	
	Tank Foundation Formwork	487	LF	$45	1.13	$24,795	
	Valve Vault	0	LS	$15,000	1.00	$0	
	Total						$208,212
4	**MASONRY**						
	None						
	Total						$0
5	**METALS**						
	3.4 MG, 155' Diameter Welded Steel Tank, Shop Primed - Installed	1	EA	$1,597,000	1.00	$1,597,000	
	Total						$1,597,000
6	**WOOD AND PLASTICS**						
	NONE						
	Total						$0
7	**THERMAL AND MOISTURE PROTECTION**						
	None						
	Total						$0
8	**DOORS AND WINDOWS**						
	None						
	Total						$0
9	**FINISHES**						
	Interior and Exterior Field Coatings	1	LS	$1,109,874	1.00	$1,109,874	
	Total						$1,109,874

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DALTON TANK REPLACEMENT PROJECT
LIVERMORE WATER RECLAMATION PLANT

TASK :	DALTON TANK REPLACEMENT PROJECT		
JOB # :	8145I.10	**LOCATION FACTOR :**	1.13
	LIVERMORE WATER RECLAMATION PLANT	**ESTIMATED MIDPOINT OF CONSTRUCTION :**	12/1/2017
LOCATION :	LIVERMORE, CA	**COST ESTIMATE PREPARATION DATE :**	12/22/2016
ELEMENT # :	1	**BY :**	DDC/MK
ELEMENT :	Dalton Tank Replacement	**3.4** million gallon tank **REVIEWED BY:**	ZMS

DIVISION	DESCRIPTION	QTY	UNIT	UNIT COST	LOCATION FACTOR	SUBTOTAL	TOTAL
10	**SPECIALTIES**						
	None						
	Total						$0
11	**EQUIPMENT**						
	None						
	Total						$0
12	**FURNISHING**						
	None						
	Total						$0
13	**SPECIAL CONDITIONS**						
	None						
	Total						$0
14	**CONVEYING SYSTEMS**						
	None						
	Total						$0
15	**MECHANICAL**						
	Pipes and supports, mixer, valves	0	LS	$250,000	1.00	$0	
	Total						$0
16	**ELECTRICAL**						
	Electrical Allowance (% of Div 11-15)	15	%			$0	
	Total						$0
17	**INSTRUMENTATION**						
	Instrumentation Allowance (% of Div 11-15)	10	%			$0	
	Total						$0
	SUBTOTAL - (TANK & FIELD COATINGS)						**$492,653**
	INDIRECT COSTS (NOT APPLIED TO TANK OR FIELD COATINGS)						
	Estimating Contingency	30	%				$147,795.92
	SUBTOTAL						**$640,449**
	Sales Tax on 50% of Subtotal Above	9.50	%				$30,421
	SUBTOTAL						**$670,870**
	General Conditions	12	%				$80,504.44
	SUBTOTAL						**$751,375**
	Contractor Overhead and Profit	13	%				$97,678.72
	SUBTOTAL						**$849,053**
	Rate of Annual Inflation	3	%				$23,986
	ELEMENT CONSTRUCTION COST (INCL/ TANK & COATINGS)						**$3,580,000**

DALTON TANK REPLACEMENT PROJECT
LIVERMORE WATER RECLAMATION PLANT

TASK :	DALTON TANK REPLACEMENT PROJECT		
JOB # :	8145I.10	**LOCATION FACTOR :**	1.13
	LIVERMORE WATER RECLAMATION PLANT	**ESTIMATED MIDPOINT OF CONSTRUCTION :**	12/1/2017
LOCATION :	LIVERMORE, CA	**COST ESTIMATE PREPARATION DATE :**	12/22/2016
ELEMENT # :	1	**BY :**	DDC/MK
ELEMENT :	Dalton Tank Replacement — **4.9** million gallon tank	**REVIEWED BY:**	ZMS

DIVISION	DESCRIPTION	QTY	UNIT	UNIT COST	LOCATION FACTOR	SUBTOTAL	TOTAL
2	**SITEWORK**						
	Demolish Asphalt Pavement	6,833	SF	$1	1.13	$6,708	
	Demolish Tank and Tank Foundation (incl lead abatement)	1	LS	$100,000	1.00	$100,000	
	Demolish Valve Vault	0	LS	$7,500	1.00	$0	
	Fill and Grading	1,004	CY	$39	1.13	$43,955	
	4" Paving on 8" ABC	8,341	SF	$4	1.13	$37,701	
	Tank Foundation Backfill	1,527	CY	$75	1.00	$114,511	
	Total						$302,874
3	**CONCRETE**						
	Tank Foundation (3' x 4' x 162' Diameter Ring)	226	CY	$750	1.13	$191,700	
	Tank Foundation Formwork	509	LF	$45	1.13	$25,915	
	Valve Vault	0	LS	$15,000	1.00	$0	
	Total						$217,615
4	**MASONRY**						
	None						
	Total						$0
5	**METALS**						
	4.9 MG, 162' Diameter Welded Steel Tank, Shop Primed - Installed	1	EA	$1,941,900	1.00	$1,941,900	
	Total						$1,941,900
6	**WOOD AND PLASTICS**						
	NONE						
	Total						$0
7	**THERMAL AND MOISTURE PROTECTION**						
	None						
	Total						$0
8	**DOORS AND WINDOWS**						
	None						
	Total						$0
9	**FINISHES**						
	Interior and Exterior Field Coatings	1	LS	$1,292,448	1.00	$1,292,448	
	Total						$1,292,448

DALTON TANK REPLACEMENT PROJECT
LIVERMORE WATER RECLAMATION PLANT

TASK :	DALTON TANK REPLACEMENT PROJECT		
JOB # :	8145I.10	**LOCATION FACTOR :**	1.13
	LIVERMORE WATER RECLAMATION PLANT	**ESTIMATED MIDPOINT OF CONSTRUCTION :**	12/1/2017
LOCATION :	LIVERMORE, CA	**COST ESTIMATE PREPARATION DATE :**	12/22/2016
ELEMENT # :	1	**BY :**	DDC/MK
ELEMENT :	Dalton Tank Replacement	**4.9** million gallon tank — **REVIEWED BY:**	ZMS

DIVISION	DESCRIPTION	QTY	UNIT	UNIT COST	LOCATION FACTOR	SUBTOTAL	TOTAL
10	**SPECIALTIES**						
	None						
	Total						$0
11	**EQUIPMENT**						
	None						
	Total						$0
12	**FURNISHING**						
	None						
	Total						$0
13	**SPECIAL CONDITIONS**						
	None						
	Total						$0
14	**CONVEYING SYSTEMS**						
	None						
	Total						$0
15	**MECHANICAL**						
	Pipes and supports, mixer, valves	0	LS	$250,000	1.00	$0	
	Total						$0
16	**ELECTRICAL**						
	Electrical Allowance (% of Div 11-15)	15	%			$0	
	Total						$0
17	**INSTRUMENTATION**						
	Instrumentation Allowance (% of Div 11-15)	10	%			$0	
	Total						$0
	SUBTOTAL - (TANK & FIELD COATINGS)						**$520,489**
	INDIRECT COSTS (NOT APPLIED TO TANK OR FIELD COATINGS)						
	Estimating Contingency	30	%				$156,146.80
	SUBTOTAL						**$676,636**
	Sales Tax on 50% of Subtotal Above	9.50	%				$32,140
	SUBTOTAL						**$708,776**
	General Conditions	12	%				$85,053.16
	SUBTOTAL						**$793,830**
	Contractor Overhead and Profit	13	%				$103,197.84
	SUBTOTAL						**$897,027**
	Rate of Annual Inflation	3	%				$25,341
	ELEMENT CONSTRUCTION COST (INCL/ TANK & COATINGS)						**$4,157,000**

ATTACHMENT C

Altamont Tank Site Evaluation by West Yost Associates

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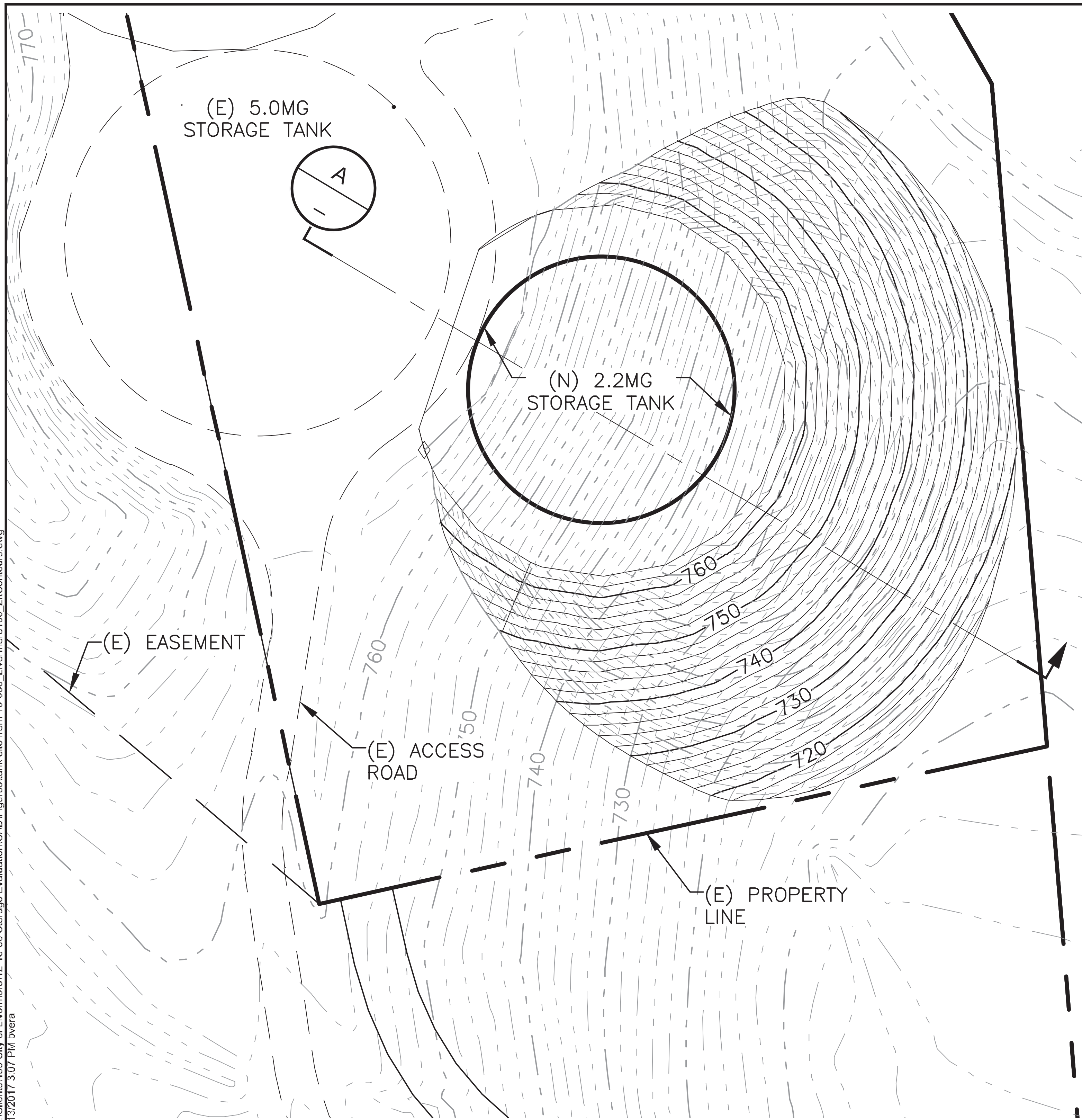

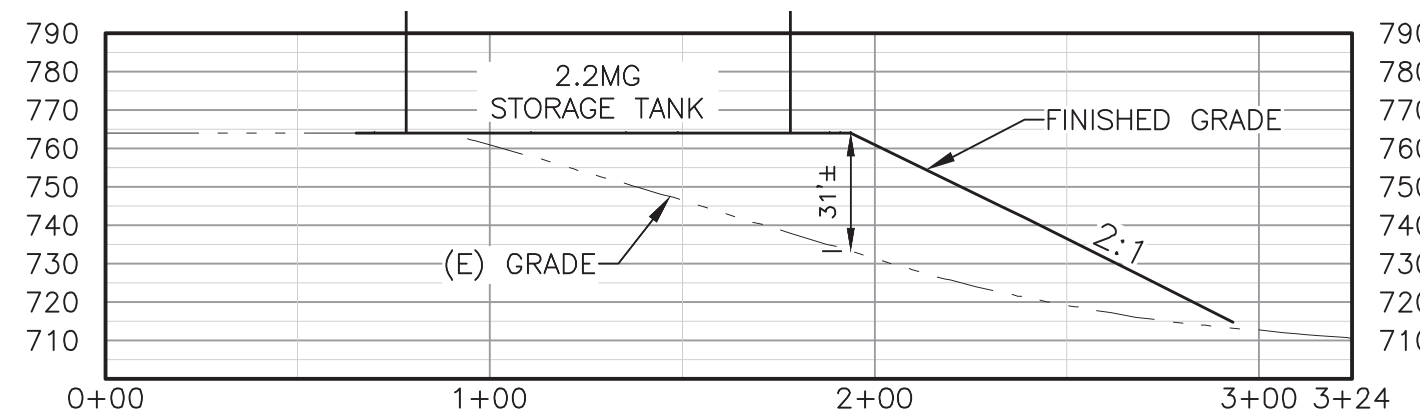

SECTION A

LEGEND

— - — - —	(E) CONTOUR
————	(N) CONTOUR
MG	MILLION GALLON
(E)	EXISTING
(N)	NEW

N

0 25 50
SCALE IN FEET

WEST YOST ASSOCIATES

Figure C-1

Alternative 1
2.2 MG Storage Tank

CITY OF LIVERMORE
Additional Storage Evaluation
and Tank Siting Study

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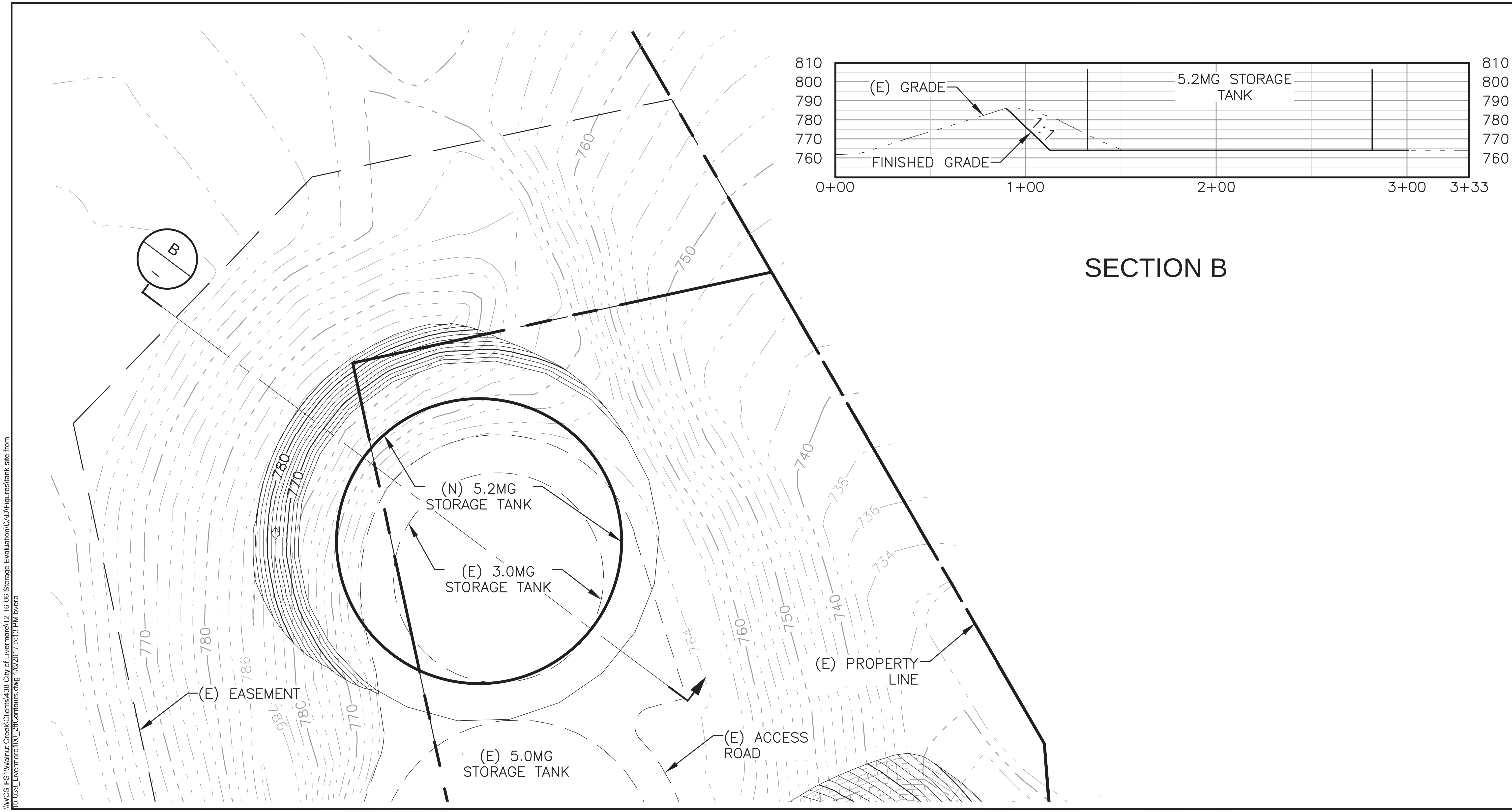

LEGEND

— - - - —	(E) CONTOUR
———	(N) CONTOUR
MG	MILLION GALLON
(E)	EXISTING
(N)	NEW

N

0 25 50
SCALE IN FEET

WEST YOST ASSOCIATES

Figure C-2

Alternative 2
Demolish Existing Tank
and Construct 5.2MG tank

CITY OF LIVERMORE
Additional Storage Evaluation
and Tank Siting Study

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Table C-1. Engineer's Opinion of Relative Cost[(a)]
Altamont Alternative 1: Construct a New 2.2 MG Tank

Description	Quantity	Unit	Unit Cost	Location Factor[(b)]	Cost
Division 2 Sitework					
Demolish Asphalt Pavement	0	SF	$ 1	1.13	$ -
Demolish 3 MG Tank and foundation	0	LS	$ 100,000	1.00	$ -
Demolish Valve Vault	0	LS	$ 7,500	1.00	$ -
Fill and Grading	1	LS	$ 1,350,000	1.00	$ 1,350,000
4" Paving on 8" ABC	7,600	SF	$ 4	1.13	$ 34,352
Tank Foundation Backfill	582	CY	$ 75	1.00	$ 43,650
Remove and Replace 21-inch Storm Drain	460	LF	$ 420	1.00	$ 193,200
Sight Berm Construction	0	LS	$ 228,200	1.00	$ -
				Subtotal	$ 1,621,202
Division 3 Concrete					
Tank Foundation (3 x 4 x 100 Diameter Ring)	140	CY	$ 750	1.13	$ 118,650
Tank Foundation Formwork	314	LF	$ 45	1.00	$ 14,130
Valve Vault	1	LS	$ 15,000	1.00	$ 15,000
				Subtotal	$ 147,780
Division 5 Metals					
2.2 MG 100' Diameter Welded Steel Tank, Shop Primed - Installed	1	LS	$ 1,225,000	1.00	$ 1,225,000
				Subtotal	$ 1,225,000
Division 9 Finishes					
Interior and Exterior Field Coatings	1	LS	$ 871,315	1.00	$ 871,315
				Subtotal	$ 871,315
				Subtotal Division 2 and 3	$ 1,768,982
				Estimating Contingency, 30% (Division 2 and 3 only)	$ 530,695
				Subtotal	$ 2,299,677
				Sales Tax on 50% of work (9.5%)	$ 218,469
				Subtotal	$ 2,518,146
				General Conditions (12%)	$ 302,178
				Subtotal	$ 2,820,323
				Contractor Overhead and Profit (13%)	$ 366,642
				Subtotal	$ 3,186,965
				Annual Rate of Inflation (2.8%)	$ 89,235
				Construction Total	**$ 5,373,000**

(a) Relative costs do not include those items common to all alternatives. Costs are tied to the December 2016 ENR CCI of 10531.
(b) Location factors are based on Carollo estimates for the Dalton Tank Replacement Project.

Table C-2. Engineer's Opinion of Relative Cost[a] Altamont Alternative 2: Demolish the Existing 3 MG Tank and Construct a New 5.2 MG Tank					
Description	Quantity	Unit	Unit Cost	Location Factor[b]	Cost
Division 2 Sitework					
Demolish Asphalt Pavement	8,200	SF	$ 1	1.13	$ 9,266
Demolish 3 MG Tank and foundation	1	LS	$ 100,000	1.00	$ 100,000
Demolish Valve Vault	1	LS	$ 7,500	1.00	$ 7,500
Fill and Grading	0	LS	$ 1,350,000	1.13	$ -
4" Paving on 8" ABC	10,600	SF	$ 4	1.13	$ 47,912
Tank Foundation Backfill	1,310	CY	$ 75	1.00	$ 98,250
Remove and Replace 21-inch Storm Drain	0	LF	$ 420	1.00	$ -
Sight Berm Construction	1	LS	$ 228,200	1.00	$ 228,200
				Subtotal	$ 491,128
Division 3 Concrete					
Tank Foundation (3 x 4 x 150 Diameter Ring)	210	CY	$ 750	1.13	$ 177,975
Tank Foundation Formwork	471	LF	$ 45	1.00	$ 21,195
Valve Vault	1	LS	$ 15,000	1.00	$ 15,000
				Subtotal	$ 214,170
Division 5 Metals					
5.2 MG 150' Diameter Welded Steel Tank, Shop Primed - Installed	1	LS	$ 2,059,200	1.00	$ 2,059,200
				Subtotal	$ 2,059,200
Division 9 Finishes					
Interior and Exterior Field Coatings	1	LS	$ 1,371,577	1.00	$ 1,371,577
				Subtotal	$ 1,371,577
				Subtotal Division 2 and 3	$ 705,298
				Estimating Contingency, 30% (Division 2 and 3 only)	$ 211,589
				Subtotal	$ 916,887
				Sales Tax on 50% of work (9.5%)	$ 87,104
				Subtotal	$ 1,003,992
				General Conditions (12%)	$ 120,479
				Subtotal	$ 1,124,471
				Contractor Overhead and Profit (13%)	$ 146,181
				Subtotal	$ 1,270,652
				Annual Rate of Inflation (2.8%)	$ 35,578
				Construction Total	**$ 4,737,000**

(a) Relative costs do not include those items common to all alternatives. Costs are tied to the December 2016 ENR CCI of 10531.

(b) Location factors are based on Carollo estimates for the Dalton Tank Replacement Project.

APPENDIX C

Isabel Neighborhood Plan Potable Water System Evaluation Project

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Isabel Neighborhood Plan
Potable Water System Evaluation

Prepared for

City of Livermore

Project No. 438-12-15-05

	5-3-17
Project Manager: Patrick Johnston, PE	Date
	5-3-17
QA/QC Review: Elizabeth T. Drayer, PE	Date

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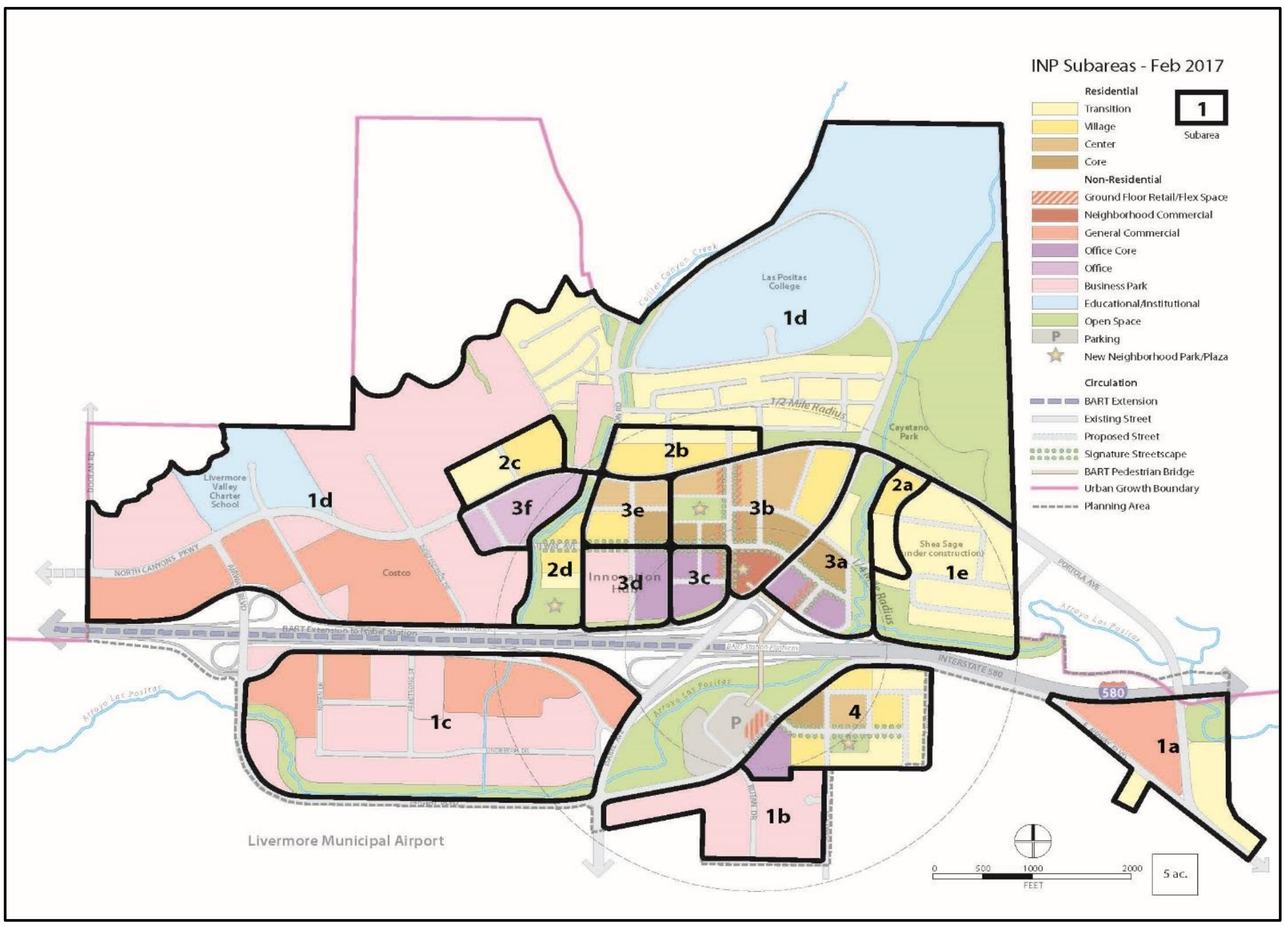
OVERVIEW

The Isabel Neighborhood Plan (INP) is a proposed development area located in the northwest portion of the City. The planning area for the INP covers approximately 1,138 acres, and is entirely within the City's urban growth boundary. The INP will guide future development of the area surrounding the proposed BART station in the Interstate 580 median, just east of Isabel Avenue and is contingent upon the extension of BART to this location.

Proposed land uses for the INP planning area are different from those currently included in the City's current adopted General Plan. The INP includes new residential areas both north and south of Interstate 580, as well as non-residential, employment generating, uses including ground floor retail, office and commercial. Three new neighborhood parks and open space buffers along the creeks are also proposed to provide recreational opportunities and access to natural areas.

Figure 1. Proposed Land Uses



The INP planning area includes both existing developed areas and proposed new development areas. Existing potable water system infrastructure is in place to serve the existing developed areas within the INP planning area. Evaluations were performed for the 2017 Water Master Plan and for the proposed INP to determine what, if any, water system improvements will be needed to serve buildout of the proposed INP planning area, both with and without the proposed INP land uses.

The following describes the INP proposed land uses, projected water demands, and required water system improvements to serve the proposed INP.

LAND USE ASSUMPTIONS

- Proposed INP land uses are based on information provided by the City of Livermore Planning Division.
  - Residential and Non-Residential acres by subarea and land use designation (INP Draft Plan Buildout 02/21/17).
  - Residential dwelling units by subarea (Preferred Plan Buildout – Residential Units INP Draft Plan Buildout by Subarea 02/16/17).
  - INP Subarea Map (February 2017).
- Proposed INP land uses are provided for both Change Areas (i.e., proposed new development) and Non-Change Areas (i.e., existing development).
- The proposed INP planning area lies partially within the City of Livermore water service area and partially within the California Water Service Company-Livermore District (CalWater) water service area.
  - INP Subareas 1a, 1b and 4 are in the CalWater water service area.
  - All other INP Subareas are in the City's water service area.
- The proposed INP land uses by subarea are summarized in Table 1.

Table 1. Proposed Land Uses by Subarea

Subarea	Existing vs. New[a]	Residential, acres: Transition	Village	Center	Core	Total Residential Acres	Residential Dwelling Units (du)	Non-Residential, acres: Ground Floor Retail/ Flex Space	Neighborhood Commercial	General Commercial	Office Core	Office	Business Park	Public/ Institutional	Total Non-Residential Acres	Total Acres	Subarea Total Acres	Notes
1a	New	11.2				11.2	224								-	**11.2**	**25.2**	INP Subarea 1a is in CalWater water service area
	Existing					-				14.0					14.0	**14.0**		
1b	New					-							10.2		10.2	**10.2**	**31.2**	INP Subarea 1b is in CalWater water service area
	Existing					-							21.0		21.0	**21.0**		
1c	New					-				7.0			4.8		11.8	**11.8**	**102.2**	
	Existing					-				30.9			59.5		90.4	**90.4**		
1d	New					-				12.4			7.4		19.8	**19.8**	**294.0**	
	Existing	53.8				53.8	907			59.3			80.9	80.2	220.4	**274.2**		
1e	New					-									-	**-**	**31.1**	Area is currently being developed; this is the Shea Sage development which is already approved and currently under construction; not yet "existing"
	Existing	31.1				31.1	476	(Shea Home)							-	**31.1**		
2a	New	3.5	3.2			6.7	182								-	**6.7**	**6.7**	
	Existing					-									-	**-**		
2b	New	4.6	7.7			12.3	361								-	**12.3**	**13.1**	
	Existing	0.8				0.8									-	**0.8**		
2c	New	5.5	6.2			11.7	328								-	**11.7**	**11.7**	
	Existing					-									-	**-**		
2d	New	1.7	4.0			5.7	174								-	**5.7**	**5.7**	
	Existing					-									-	**-**		
3a	New	2.8			3.8	6.6	507	0.9			6.4				7.3	**13.9**	**13.9**	
	Existing					-									-	**-**		
3b	New		6.4	10.8	7.9	25.1	1,278	2.5	4.1						6.6	**31.7**	**31.7**	
	Existing					-									-	**-**		
3c	New					-		0.5			6.9				7.4	**7.4**	**7.4**	
	Existing					-									-	**-**		
3d	New					-					5.9		8.0		13.9	**13.9**	**13.9**	Area is currently developed; does not reflect existing office buildings proposed to be replaced under INP project
	Existing					-									-	**-**		
3e	New		3.3	4.0	2.7	10.0	488								-	**10.0**	**10.0**	Area is currently developed; does not reflect existing office buildings proposed to be replaced under INP project
	Existing					-									-	**-**		
3f	New					-						6.2			6.2	**6.2**	**12.2**	Area is currently developed; does not reflect replacement of existing office building
	Existing					-						6.0			6.0	**6.0**		
4	New	10.3	7.5	3.1	2.6	23.5	795				5.2				5.2	**28.7**	**28.7**	INP Subarea 4 is in CalWater water service area
	Existing					-									-	**-**		
Outside of Subarea	New					-		0.9							0.9	**0.9**		
	Existing					-									-	**-**	**0.9**	
Totals	**New**	**39.6**	**38.3**	**17.9**	**17.0**	**112.8**	**4,337**	**4.8**	**4.1**	**19.4**	**24.4**	**6.2**	**30.4**	**-**	**89.3**	**202.1**		
	Existing	**85.7**	**-**	**-**	**-**	**85.7**	**1,383**	**-**	**-**	**104.2**	**-**	**6.0**	**161.4**	**80.2**	**351.8**	**437.5**		
	Total	**125.3**	**38.3**	**17.9**	**17.0**	**198.5**	**5,720**	**4.8**	**4.1**	**123.6**	**24.4**	**12.2**	**191.8**	**80.2**	**441.1**	**639.6**	**639.6**	**Does not include Parks and Open Space**

Source: INP Draft Plan Buildout 02/21/2017 (residential and non-residential acreages by subarea) and INP Draft Plan Buildout 02/16/2017 (residential dwelling units by subarea)

[a] "New" corresponds with "Change Areas" in the INP Land Use Plan; "Existing" corresponds with "Non-Change Areas" in the INP Land Use Plan.

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EVALUATION ASSUMPTIONS

- The INP potable water system evaluation will consider the projected water demands for both the Change Areas and the Non-Change Areas to evaluate overall City potable water infrastructure needs at buildout of the portions of the proposed INP which lie within the City's water service area.
- For the potable water system modeling for the INP within the City's water service area, existing metered consumption within the INP planning area will be removed and will be replaced with estimated total potable water demands for the INP project within the City's water service area. This approach has been used to accurately reflect the existing and proposed new development, and, in particular, the proposed redevelopment of existing developed parcels. This approach is different from that used in the 2017 Water Master Plan where existing demands for developed parcels (based on metered consumption) are added to projected demands for planned developments and vacant parcels to determine the total future demands.
- Evaluation of potable water infrastructure needs for the proposed INP planning area within the CalWater water service area will be performed by others.
- Evaluation of recycled water infrastructure needs for the proposed INP planning area within the City's water service area will be performed by others.

POTABLE WATER DEMAND ASSUMPTIONS

Water Service Area

- INP Subareas 1a, 1b and 4 are located in the CalWater water service area and will receive potable water from CalWater.
- All other INP Subareas are located in the City of Livermore water service area and will receive potable water from the City.

Use of Potable Water and Recycled Water Supplies

- City of Livermore water service area:
  - — Potable water will be used to meet interior water uses.
  - — Recycled water will be used to meet exterior/landscape irrigation demands.
  - — There are some existing potable water irrigation accounts within the INP planning area which may or may not be converted to recycled water in the future. To be conservative for the evaluation of potable water infrastructure requirements, the existing potable water irrigation accounts are assumed to continue to be served with potable water.
- CalWater water service area:
  - — Potable water will be used to meet all projected water demands as recycled water is not available within CalWater's water service area.

Potable Water Use Factors

- Potable water demand for INP residential land uses is based on the water use factor for Urban High Residential-4 (UH-4) of 1,880 gallons per acre per day (gpad) (based on the rebounded water use factors established for the 2017 Water Master Plan). This water use factor is equivalent to 94 gallons per day (gpd) per dwelling unit (du), assuming 20 du per acre.
  - This potable water use factor of 94 gpd/du has been assumed for all proposed INP residential land uses regardless of dwelling unit density as the proposed INP residential development has densities which are either equal to the UH-4 density or greater than the UH-4 density.
  - The potable water use factor of 94 gpd/du is considered appropriate for the UH-4 density, as well as higher density development, as the individual dwelling unit square footages and occupancy of the higher density development would be similar to UH-4 development, only with higher Floor Area Ratios (FAR) (e.g., additional stories) to provide for more dwelling units per acre.
- Potable water demand for INP non-residential land uses is based on the water use factor for Business/Commercial Park (BCP) of 690 gpad (based on the rebounded water use factors established for the 2017 Water Master Plan).
  - The proposed non-residential land uses within the proposed INP include Ground Floor Retail/Flex Space, Neighborhood Commercial, General Commercial, Business Park and Public/Institutional, which will have potable water use consistent with the BCP land use category.
  - Proposed Office Core and Office land uses are proposed to have multi-story office buildings (4 to 6 stories for Office Core and 3 to 4 stories for Office). The proposed FAR for Office Core and Office land uses are consistent with the proposed multi-story construction. To account for water use in Office Core and Office land uses, the BCP water use factor is scaled up for Office Core (3 times the BCP factor, or 2,070 gpad) and for Office (2 times the BCP factor, or 1,380 gpad).
- Potable water demand for the residential and non-residential landscaping and proposed parks in Subareas 1a and 4 (to be served by CalWater) are based on the Model Water Efficient Landscape Ordinance (MWELO) Maximum Applied Water Allowance (MAWA) for landscaping in residential and non-residential areas. The formula for calculating the MAWA is as follows:

  MAWA = (ETo) (0.62) [(ETAF x LA) + ((1-ETAF) x (SLA)]

  Where:

  MAWA = Maximum Applied Water Allowance, gallons per year

  ETo = Reference Evapotranspiration, inches (ETo for Livermore is 47.2 inches)

  ETAF = Evapotranspiration Adjustment Factor (maximum of 0.55 for residential areas and 0.45 for non-residential areas)

  LA = Landscape area, square feet (assumed to be 15 percent of the residential and non-residential areas)

  SLA = Special landscape area, square feet

  0.62 = Conversion factor that converts acre-inches per acre per year to gallons per square foot per year

Based on the MAWA formula, the MAWA for residential landscaping is 1,920 gpad (2.15 af/yr) and for non-residential landscaping is 1,570 gpad (1.76 af/yr).

These same factors have also been used to estimate the recycled water demand for residential and non-residential areas and parks in the City of Livermore water service area for discussion in the INP Water Supply Assessment. As for the CalWater water service area, the irrigated area within the City of Livermore water service area is assumed to be 15 percent of the overall residential and non-residential acres plus park acres.

Projected Potable Water Demand

- The projected potable water demand for the INP by subarea is provided in Table 2.
- A summary of the projected potable water demand for the INP is provided below in Table 3. It should be noted that the potable water demands shown below include demands for both existing and proposed land uses within the INP.

Incremental Additional Potable Water Demand for the INP

Potable water demands for the INP planning area with and without the proposed INP land uses are summarized in the table below (Table 4). As shown, the projected potable water demand for the INP planning area with the INP land uses is 67 af/yr (or approximately 9 percent) higher than the projected water demand based on the City's 2017 Water Master Plan assumptions, which are based on developed parcels and projected water demands for planned new development and vacant parcels based on General Plan land uses.

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Table 2. Projected Potable Water Use																		
Subarea	Existing vs. New[(a)]	Residential Demand, gpd	Residential Demand, af/yr	Office Core Demand, gpd	Office Core Demand, af/yr	Office Demand, gpd	Office Demand, af/yr	Other Non-Residential Demand, gpd	Other Non-Residential Demand, af/yr	Residential Landscaping, gpd	Residential Landscaping, af/yr	Non-Residential Landscaping, gpd	Non-Residential Landscaping, af/yr	Parks, gpd	Parks, af/yr	Total Potable Water Demand, gpd	Total Potable Water Demand, af/yr	Notes
Potable Water Use Factor		94		2,070		1,380		690		1920		1570		1570				
Unit		gpd/du		gpad		gpad		gpad		af/ac/yr		af/ac/yr		af/ac/yr				
1a	New	21,056	24	-	-	-	-	-	-	3,226	4	-	-	6,519	7	**30,801**	**35**	Landscaping demands to be met with potable water
	Existing	-	-	-	-	-	-	9,660	11	-	-	3,297	4			**12,957**	**15**	in CalWater service area
1b	New	-	-	-	-	-	-	7,038	8	-	-	2,402	3			**9,440**	**11**	Landscaping demands to be met with potable water
	Existing	-	-	-	-	-	-	14,490	16	-	-	4,946	6			**19,436**	**22**	in CalWater service area
1c	New	-	-	-	-	-	-	8,142	9							**8,142**	**9**	
	Existing	-	-	-	-	-	-	62,376	70							**62,376**	**70**	
1d	New	-	-	-	-	-	-	13,662	15							**13,662**	**15**	
	Existing	85,258	96	-	-	-	-	152,076	170							**237,334**	**266**	
1e	New	-	-	-	-	-	-	-	-							**-**	**-**	Not existing yet; Shea Sage currently under
	Existing	44,744	50	-	-	-	-	-	-							**44,744**	**50**	construction
2a	New	17,108	19	-	-	-	-	-	-							**17,108**	**19**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
2b	New	33,934	38	-	-	-	-	-	-							**33,934**	**38**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
2c	New	30,832	35	-	-	-	-	-	-							**30,832**	**35**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
2d	New	16,356	18	-	-	-	-	-	-							**16,356**	**18**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
3a	New	47,658	53	13,248	15	-	-	621	1							**61,527**	**69**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
3b	New	120,132	135	-	-	-	-	4,554	5							**124,686**	**140**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
3c	New	-	-	14,283	16	-	-	345	0							**14,628**	**16**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
3d	New	-	-	12,213	14	-	-	5,520	6							**17,733**	**20**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	Existing office park
3e	New	45,872	51	-	-	-	-	-	-							**45,872**	**51**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	Existing office park
3f	New	-	-	-	-	8,556	10	-	-							**8,556**	**10**	
	Existing	-	-	-	-	8,280	9	-	-							**8,280**	**9**	Existing office park
4	New	74,730	84	10,764	12	-	-	-	-	6,768	8	1,225	1	2,719	3	**96,206**	**108**	Landscaping demands to be met with potable water
	Existing	-	-	-	-	-	-	-	-	-	-	-	-			**-**	**-**	in CalWater service area
Outside of Subarea	New	-	-	-	-	-	-	621	1							**621**	**1**	
	Existing	-	-	-	-	-	-	-	-							**-**	**-**	
Totals for INP	**New**	**407,678**	**457**	**50,508**	**57**	**8,556**	**10**	**40,503**	**45**	**9,994**	**11**	**3,627**	**4**	**9,239**	**10**	**530,104**	**594**	
	Existing	**130,002**	**146**	**-**	**-**	**8,280**	**9**	**238,602**	**267**	**-**	**-**	**8,243**	**9**	**-**	**-**	**385,127**	**431**	
	Total	**537,680**	**602**	**50,508**	**57**	**16,836**	**19**	**279,105**	**313**	**9,994**	**11**	**11,869**	**13**	**9,239**	**10**	**915,230**	**1,025**	
City Water Service Area	**New**	311,892	349	39,744	45	8,556	10	33,465	37	-	-	-	-	-	-	**393,657**	**441**	
	Existing	130,002	146	-	-	8,280	9	214,452	240	-	-	-	-	-	-	**352,734**	**395**	All INP Subareas except 1a, 1b and 4
	Total	441,894	495	39,744	45	16,836	19	247,917	278	-	-	-	-	-	-	**746,391**	**836**	
CalWater Water Service Area	**New**	95,786	107	10,764	12	-	-	7,038	8	9,994	11	3,627	4	9,239	10	**136,447**	**153**	
	Existing	-	-	-	-	-	-	24,150	27	-	-	8,243	9	-	-	**32,393**	**36**	INP Subareas 1a, 1b and 4
	Total	95,786	107	10,764	12	-	-	31,188	35	9,994	11	11,869	13	9,239	10	**168,839**	**189**	

[(a)] "New" corresponds with "Change Areas" in the INP Land Use Plan; "Existing" corresponds with "Non-Change Areas" in the INP Land Use Plan.

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Table 3. Summary of Projected Potable Water Demand			
		Potable Water Demand	
Service Area	Land Use	gpd	af/yr
City Water Service Area	Residential	441,894	495
	Non-Residential	304,497	342
	Landscaping	--[(a)]	--[(a)]
	Total City Service Area	**746,391**	**836**
CalWater Water Service Area	Residential	95,786	107
	Non-Residential	41,952	47
	Landscaping	31,102	34
	Total CalWater Service Area	**168,839**	**189**
	Overall INP	**915,230**	**1,025**

(a) Landscaping demands within the City's water service area to be met with recycled water. Estimated recycled water demands within the City's water service area are 208,132 gpd, or 233 af/yr.

Table 4. Potable Water Demands without Proposed INP Land Uses			
	Potable Water Demand for INP Planning Area, af/yr		
	City Water Service Area	CalWater Water Service Area	Total INP Area
Potable Water Demand without INP[(a)]	769[(b)]	116[(c)]	885
Potable Water Demand with INP[(d)]	836	189	1,025
Difference in Potable Water Demand with INP	**+67**	**+73**	**+140**

(a) Based on existing metered consumption and estimates of demand rebound for currently developed parcels, projected water demands for reasonably foreseeable development projects (not including the INP) and projected water demands for vacant parcel areas within the INP planning area based on planned land uses as specified in the General Plan.

(b) As included in the City's 2017 Water Master Plan, based on existing metered consumption for developed parcels (rebounded) and projected water demands for planned new development and vacant parcels based on General Plan land uses.

(c) Based on projected demands contained in CalWater's 2007 Water Master Plan and 2015 Urban Water Management Plan for the INP planning area.

(d) Based on proposed INP land uses, which include both developed parcels and planned new development based on the INP.

REQUIRED POTABLE WATER INFRASTRUCTURE TO SERVE THE PROPOSED INP

To evaluate the capacity of the City's future water system facilities to serve the portion of the proposed INP within the City's water service area, the following analyses were conducted:

- Pumping Capacity Evaluation,
- Storage Capacity Evaluation,
- Pressure Regulating Station Capacity Evaluation, and
- Pipeline Capacity Evaluation.

The results of the future water system facility capacity evaluation considering the potable water demands for the proposed INP are discussed below.

As mentioned in the section on Potable Water Demand Assumptions, there are some existing potable water irrigation accounts within the INP planning area which may or may not be converted to recycled water in the future. To be conservative for the evaluation of potable water infrastructure requirements, the existing potable water irrigation accounts are assumed to continue to be served with potable water. These accounts represent approximately 55 gpm of average day demand within the INP planning area. The demands developed separately for the INP planning area were added to the 55 gpm for the irrigation accounts. The total of these demands was then used to perform the pumping, storage and pipeline evaluations for the proposed INP project.

Pumping Capacity Evaluation

The pumping capacity in the City's future water system was evaluated to assess its ability to deliver a reliable firm capacity to serve the water service area. Firm capacity assumes a reduction in total pumping capacity to account for pumps that are out of service at any given time due to mechanical breakdowns, maintenance, water quality, or other operational issues. At each booster pump station (BPS), firm booster pumping capacity was defined as the total booster pump station capacity with the largest pump out of service.

As described in Chapter 4 Water System Planning and Design Criteria of the 2017 Water Master Plan, the firm pumping capacity must equal or exceed the maximum day demand in zones with storage. In zones with storage, maximum day plus fire flow and peak hour demands are met from a combination of zone supply and storage. The total pumping capacity must equal or exceed the flow required to fill the tank storage in a 24-hour period plus the maximum day demand.

Table 5 compares the existing firm capacity with required firm capacity for the future demand conditions developed for the INP. The left-hand side of the table shows the service zones supported by the Airway BPS and their associated water demands. The Airway BPS directly serves Zone 719, but must also have sufficient pumping capacity to supply Zones 605, 638 and 664 because they are supported by Zone 719. The right-hand side of the table shows the existing pumping capacity, the required firm pumping capacity based on the pumping capacity criterion, and the difference between the existing firm pumping capacity and the required firm pumping capacity for buildout with the INP. The analysis shows that when the INP demands are considered the Airway BPS has a capacity deficit of 179 gpm, when it is assumed that all supply into Zone 1 is from the Airway BPS. However, Turnouts 5 and 9 are capable of supplying Zones 638 and 605 by gravity, so the identified capacity deficit does not warrant an increase in the pumping capacity for the Airway BPS, as long as Zones 638 and 605 can be adequately supplied by Turnouts 5 and 9. This is discussed further in the pipeline evaluation

Table 5. Pumping Capacity Evaluation

Service Pressure Zone and Supported Upper Pressure Zones		Buildout Maximum Day Demand, gpm	Pump Stations	Existing Pumping Capacity, gpm		Required Total Pumping Capacity, gpm[b]	Required Firm Pumping Capacity, gpm[c]	Supply Capacity Surplus (Deficit), gpm
				Total, gpm	Firm, gpm[a]			
Zone	605	184	Airway	2,208	1,472	2,317	1,651	(179)
	638	427						
	664	948						
	719	92						
Zone 1 Total		**1,651**						

(a) Firm pumping capacity is defined as the total pumping capacity of each pump station with the largest pump unit at each pump station out of service.
(b) Required total pumping capacity is the flow required to fill the tank fire storage in a 24-hour period plus the maximum day demand.
(c) For pressure zones with available storage, required firm pumping capacity is equal to maximum day demand.

Storage Capacity Evaluation

The primary advantages that storage provides for the water system are to provide: (1) operational storage to balance differences in demands and supplies; (2) emergency storage in case of supply failure; and (3) water to fight fires. The City's water storage capacity requirement is to provide an operational storage component equal to 25 percent of a maximum day demand, an emergency storage component equal to 50 percent of a maximum day demand (the required volume depends on the pressure zone), and a fire flow storage component equal to the highest fire flow and duration recommended in a particular pressure zone based on land uses within the pressure zone.

Table 6 compares the City's available water storage capacity with the required storage capacity for Zone 1 under the future demand conditions developed for the INP. Existing storage capacities reported in the table are based on nominal storage capacities calculated from tank geometry. The comparison between the City's available and required future storage capacities indicates that there is a surplus of 0.26 MG in Zone 1 even when the INP demands are considered.

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 Zone 1 area under the demand conditions developed for the INP. Table 7 compares the existing available pressure regulating station capacity with the required pressure regulating station capacity for the pressure zones within Zone 1 that are completely dependent on pressure regulating stations for supply. The table shows that all of these pressure zones have sufficient pressure regulating station capacity to meet the required flows even when the INP demands are considered. The analysis assumes pressure zones are only supplied via the PRVs, and not directly from Turnouts 5, 9 or 11.

In addition, the flows through the PRVs under the projected future peak hour and maximum day plus fire flow demand scenarios in the hydraulic model were compared with the existing valve capacities to confirm that the flows were lower than the valve capacities. This is true in all cases, indicating that the existing valves are adequately sized to accommodate the future demand conditions developed for the INP.

Table 6. Required Storage Capacity Under Buildout Demand Conditions

		Available Storage Capacity, MG			Required Storage Capacity, MG						
					Operational Criteria[b]		Emergency Criteria				
Pressure Zone[a]	Storage Facility	Reservoir Capacity	Total Available Storage	Maximum Day Demand, mgd	Percent of Maximum Day Demand	Operational	Percent of Maximum Day Demand	Emergency	Fire Flow[c]	Total Required Storage	Storage Surplus (Deficit), MG
Zone 1	Doolan	3.00	3.00	2.38	25%	0.59	50%	1.19	0.96	2.74	0.26

(a) Average day demand is based on detailed billing records adjusted to reflect rebound from conservation and estimated demands for future buildout. Billing records from 2015 were spatially located, scaled to reflect expected demand rebound and then aggregated by pressure zone.

(b) Based on 25 percent of maximum day demand.

(c) Based on demand for the most severe fire recommended in the pressure zone multiplied by the corresponding recommended fire flow duration.

Table 7. Comparison of Existing and Required Pressure Regulating Station Capacity

Zone	Maximum Day Demand, gpm	Peak Hour Demand, gpm	Fire Flow Requirement, gpm[a]	Regulating Station	Valve Diameter, inches	Existing Valve Capacity, gpm[b]	Valve Capacity Requirement, gpm[c]	Valve Capacity Surplus (Deficit), gpm
605	184	287	4,000	Freisman	12	8,720	4,184	8,436
				Golf Course	8	3,900		
					Total	**12,620**		
638 (+605)	611	952	4,000	Kitty Hawk	10	6,150	4,611	7,689
				Doolan	10	6,150		
					Total	**12,300**		
664 (+605 & 638)	1,559	2,432	4,000	North Canyon	10	6,150	5,559	591
					Total	**6,150**		

(a) Based on demand for the most severe fire recommended in the pressure zone.
(b) Based on the intermittent maximum flow capacity for ClaVal model 90-01 PRV valves. However, actual flow capacity will vary depending on system conditions.
(c) For these zones, regulating stations must supply maximum day demand plus fire flow or peak hour demand, whichever is larger.

Pipeline Capacity Evaluation

The hydraulic model was updated with the buildout demands developed for the Isabel analysis, along with the demands for the existing irrigation accounts within the INP. The demands developed for the INP were assigned to the model nodes as shown on Figure 2. The existing water distribution facilities are also shown on Figure 2.

The model was run for peak hour demand conditions and maximum day plus fire flow demand conditions with the INP demands included under the scenarios that were developed for the Water Master Plan. For these scenarios, the system does not have enough hydraulic capacity to supply the fire flow demands for the industrial area south of the wastewater treatment plant when the Kitty Hawk PRV is closed. In the Water Master Plan, it is recommended that the Kitty Hawk PRV remain operational at all times, but with a lower setting so that it is available for high demand periods, such as fire flow conditions. When this recommendation is tested with the INP demands included, the system does have enough hydraulic capacity to supply the fire flow demands for the industrial area south of the wastewater treatment plant. Therefore, this operational recommendation still holds for this analysis. No other pipeline hydraulic issues were identified for either peak hour or maximum day demand plus fire flow conditions.

Regarding the pumping capacity deficit identified in the pumping capacity analysis, an additional analysis of the system using the hydraulic model was required to determine if the domestic demands in Pressure Zones 638 and 605 can be adequately supplied by Turnouts 5 and 9. As with the buildout demand conditions analysis performed for the Water Master Plan, the analysis for supplying Pressure Zones 638 and 605 from Turnouts 5 and 9 assumes that the hydraulic grade lines for these turnouts will be lower in the future. The hydraulic grade lines were obtained from the hydraulic model that was developed for Zone 7 planning work. While it is still recommended that the Kitty Hawk and Doolan PRVs remain operational at all times, as noted in the paragraph above, for the purposes of this analysis, it was also assumed that the Kitty Hawk and Doolan PRVs were closed to force the system to supply Pressure Zones 638 and 605 from Turnouts 5 and 9. Because this additional analysis is concerned with supplying the domestic demands for Pressure Zones 638 and 605 by Turnouts 5 and 9, the system was only tested for peak hour demand conditions. Fire flow storage would still be supplied from the Doolan Tank. When these assumptions are applied to the model, the results show that the system does have adequate capacity to supply Pressure Zones 638 and 605 from Turnouts 5 and 9 for peak hour demand conditions.

Infrastructure Requirements

The only deficiency identified when the system was analyzed with the demands for the INP planning area is the pumping capacity deficiency at the Airway BPS. However, because the system does not actually need to rely on this booster pumping station to adequately supply all of Zone 1, as Pressure Zones 638 and 605 can be adequately supplied by Turnouts 5 and 9, no infrastructure requirements are recommended as a result of the additional demands for the INP planning area.

Regarding the distribution pipelines, the existing distribution pipeline network within the INP planning area was analyzed for its capacity to adequately supply the INP area demands and found to be adequate. As the INP planning area is developed, additional distribution pipelines may be needed to serve new development. However, these additional distribution pipelines were not addressed in this analysis.

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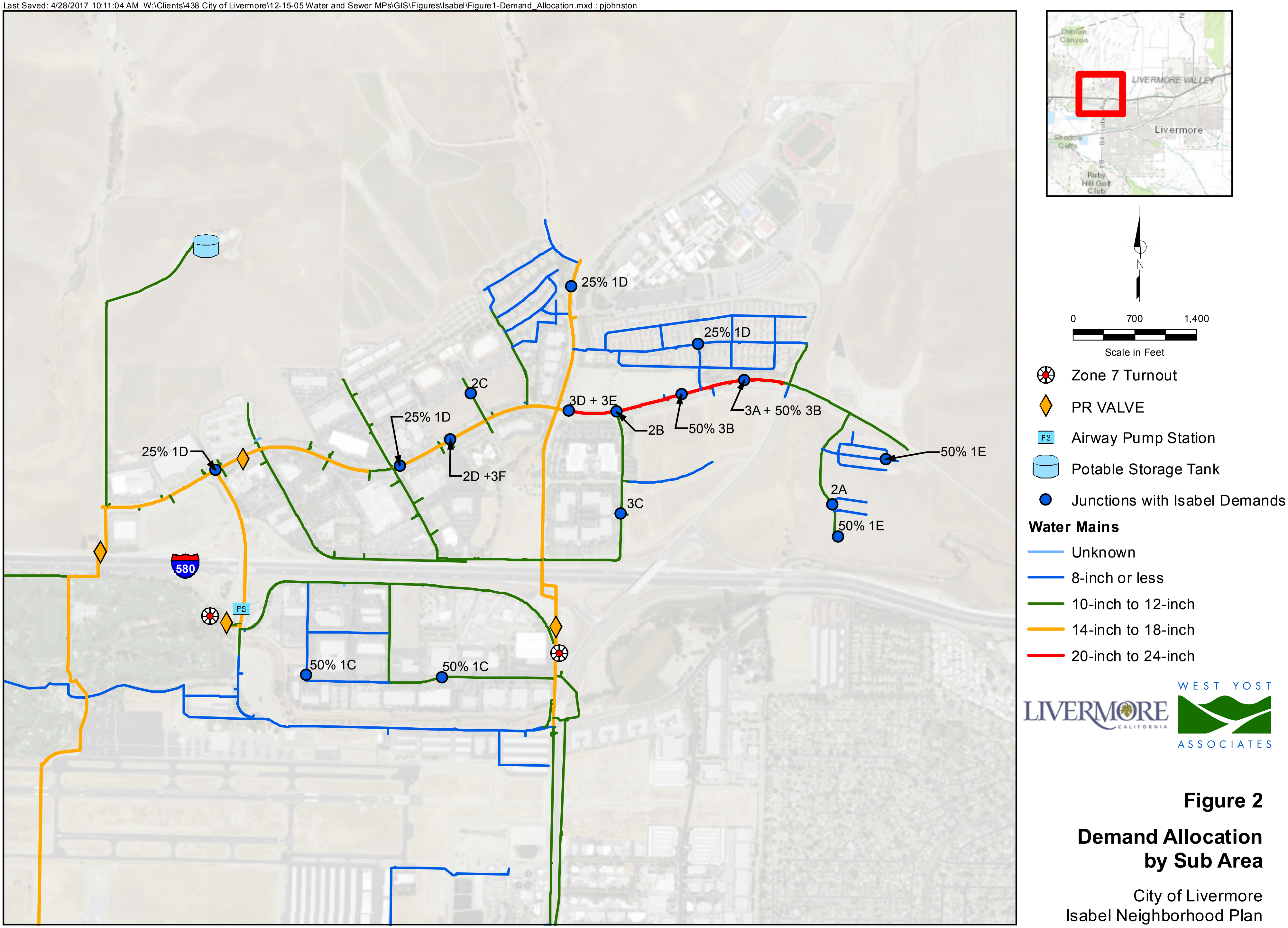

LIVERMORE CALIFORNIA

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Figure 2

Demand Allocation by Sub Area

City of Livermore
Isabel Neighborhood Plan

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APPENDIX D

Cost Estimating Assumptions

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1.1 OVERVIEW

This appendix provides the assumptions used by West Yost to develop an opinion of the probable construction cost for the planning and design of recommended water system facilities for the City's water system. The opinion of probable construction cost was developed based on a combination of data supplied by manufacturers, published industry standard cost data and curves, construction costs for similar facilities built by other public agencies, and construction costs previously estimated by West Yost for similar facilities with similar construction cost indexes.

Additionally, the costs presented in this appendix are for construction only and do not include uncertainties in estimation or unexpected construction costs (e.g., variations in final quantities) or cost estimates for land acquisition, engineering, legal costs, environmental review, soils investigation, surveying, construction management, and inspections and/or contract administration. Some of these additional cost items are referred to as contingency costs or mark-ups, and are further described in the last section of this appendix.

The opinion of probable construction cost has been adjusted to reflect March 2017 costs at an Engineering News Record (ENR) Construction Cost Index (CCI) of 11609 (San Francisco Average). These construction costs are to be used for conceptual cost estimates only, and should be updated regularly. Construction costs presented in this appendix are not intended to represent the lowest prices in the industry for each type of construction; rather they are representative of average or typical construction costs. These planning-level construction costs have been prepared for guidance in evaluating various facility improvement options, and are intended for budgetary purposes only, within the context of this master planning effort.

The following sections of this appendix describe the assumptions used to develop the opinion of probable construction cost for the planning and design of recommended water system facilities for the City's potable water system.

1.2 WATER SYSTEM BASE CONSTRUCTION COSTS

The following sections present the assumptions used to develop the opinion of probable construction cost for base construction costs for recommended facilities in the City's water system and are categorized by improvement project type. These base construction costs include sales tax, overhead and profit and general conditions, but do not include estimating contingency (discussed below in Section 1.3).

1.2.1 Storage Reservoirs

Table 1 summarizes the construction costs for water storage reservoirs for the size range of 0.1 to 6.0 MG. These costs generally include the installation of the storage tank, site piping, earthwork, paving, instrumentation, and all related sitework. Costs do not include land acquisition. It should be noted that these costs are representative of construction conducted under normal excavation and foundation conditions, and would be significantly higher for special or difficult foundation requirements. Costs also assume relatively minor earthwork and grading to level the tank site and does not include significant grading or excavation to clear a site for a tank. Cost assumptions are for above grade welded steel tanks.

Table 1. Base Construction Costs for Welded Steel Water Storage Reservoirs[a]	
Capacity, MG	Estimated Base Construction Cost, million dollars
0.1	1.4
0.5	1.7
1.0	2.1
2.0	2.9
3.0	3.7
4.0	4.5
5.0	5.4
6.0	6.2

[a] Based on March 2017 ENR CCI of 11609 (San Francisco Average).

The demolition cost of an existing storage reservoir is estimated to be approximately $200,000. This cost is representative of demolition conducted under normal conditions and does not include costs associated with hazardous material handling (e.g., lead paint or lead based coatings).

1.2.2 Pump Stations

Pump stations will be required at reservoirs to lift water to the appropriate pressure zones. Average construction costs for distribution pumping stations, shown in Table 2, are based on enclosed stations with architectural and landscaping treatment suitable for residential areas. It should be noted that pump station costs can vary considerably, depending on factors such as architectural design, pumping head, and pumping capacity. Therefore, these costs presented below are representative of construction conducted under common or normal conditions, and would be significantly higher for special or difficult conditions.

Pump station costs include the installation of the pumps, site piping, earthwork, paving, on-site backup/standby power generator, SCADA, and all related sitework.

Table 2. Base Construction Costs for Pump Stations[a]	
Firm Capacity[b], mgd	Estimated Base Construction Cost, million dollars
0.5	1.3
1	1.4
2	1.6
3	1.7
8	2.6
10	2.9

[a] Based on March 2017 ENR CCI of 11609 (San Francisco Average).
[b] Equal to the total pumping capacity with the largest pump assumed out of service or on standby (i.e., firm capacity).

1.2.3 Pipelines

Table 3 presents unit base construction costs for potable water pipelines 8 through 24-inches in diameter. These unit costs are for pipeline construction in developed areas and are representative of pipeline construction conducted under common or normal conditions, which would be significantly higher under special or difficult conditions.

The unit base construction costs presented below generally include pipeline materials, trenching, placing and jointing pipe, valves, fittings, hydrants, service connections, placing imported pipe bedding, native backfill material, and asphalt pavement replacement, if required. However, the costs presented in Table 3 do not include the cost of boring and jacking pipe. Pipeline bore and jack costs are shown in Table 4 and should be added where required for this purpose. Pipeline bore and jack costs were used as representative of micro tunneling or other advanced pipeline costs.

Table 3. Unit Base Construction Costs for Pipelines[a,b]

Pipeline Diameter, inches	Unit Base Construction Cost, $/linear foot
8	201
10	240
12	280
14	310
16	340
20	410
24	480

(a) Costs based on San Francisco Peninsula pipeline cost estimates, scaled up to March 2017 ENR CCI of 11609 (San Francisco Average).
(b) Costs based on ductile iron cement-lined pipe.

Table 4. Unit Base Construction Costs for Bore and Jack[a,b]

Pipeline Size	Unit Base Construction Cost, $/linear foot
8-inch diameter (16-inch diameter casing)	530
12-inch diameter (21-inch diameter casing)	605
16-inch diameter (24-inch diameter casing)	700
20-inch diameter (30-inch diameter casing)	865

(a) Costs based on San Francisco Peninsula pipeline cost estimates, scaled up to March 2017 ENR CCI of 11609 (San Francisco Average).
(b) Conductor pipe is not included in cost.

1.2.4 Pressure or Flow Regulating Stations and Valves

Interconnections (i.e., pressure regulating stations or check valves) are required to provide water supply between pressure zones during peak demands and/or emergency conditions.

- Pressure Regulating Stations:
  - The base construction cost for a new pressure regulating station or an existing pressure regulating station upgrade under normal conditions is estimated to be approximately $270,000.
  - The base construction cost for a new pressure regulating station or an existing pressure regulating station upgrade under special or difficult conditions (e.g., construction in high traffic areas) is estimated to be approximately $340,000.
- Check Valves:
  - The base construction cost for a new check valve connection is estimated to be approximately $6,000.

Base construction costs for a pressure regulating station include the installation of control valve(s), a concrete utility vault, access hatches, site piping, earthwork, paving, SCADA, and related sitework.

1.3 ESTIMATING CONTINGENCY (30 PERCENT)

The base construction costs presented above are representative of the construction of potable water system facilities under normal construction conditions and schedules; consequently, it is appropriate to allow for estimating contingency to account for uncertainties unavoidably associated with the conceptual planning of projects. Factors such as unexpected construction conditions, the need for unforeseen mechanical items, and variations in design and final quantities are only a few of the items that can increase project costs.

1.4 DESIGN AND CONSTRUCTION PERIOD SERVICES (50 PERCENT)

Design and construction period services have been divided into two categories as shown below.

Design Period Services:	20 percent
Construction Period Services:	30 percent
Total:	50 percent

Design period services associated with new facilities include preliminary investigations and reports, right-of-way acquisition, foundation explorations, preparation of drawings and specifications for construction, surveying and staking, sampling of testing material, start-up services, permitting, regulatory and CEQA compliance and City administration, public outreach and legal.

Construction period services covers items such as contract management and inspection during construction. City administration, public outreach and legal covers items such as legal fees, financing expenses, and interest during construction.

1.5 EXAMPLE COST ESTIMATE

An example application of these standard mark-ups to a project with an assumed base construction cost of $1.0 million is shown in Table 5. As shown, the total cost of all project markups is 95 percent of the base construction cost for each construction project.

Table 5. Example Application of Project Cost Mark-ups

Cost Component	Percent	Cost
Base Construction Cost[(a)]		$1,000,000
Estimating Contingency	30%	$300,000
Total Construction Cost		$1,300,000
Design Period Services (Consultant/City to perform design, bid, permitting, CEQA, regulatory, legal, outreach, administration)	20%	$260,000
Construction Period Services (Consultant/City to perform construction management, inspection, testing, programming, engineering support, change order contingency)	30%	$390,000
Total Project Cost		**$1,950,000**

(a) Assumed cost of an example project.

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Appendix E: Growth Assumptions Updated in 2020

Land Use Assumptions for the 2016 Water Master Plan Update
City of Livermore Municipal Water Service Area

Prepared by Lori Parks, with assistance from Steve Stewart and the Planning Division
March 15, 2016
Updated by Steve Stewart on August 28, 2020

The City will commence with a Comprehensive General Plan Update in Fall 2020. Staff anticipates the process will be completed in the Winter of 2023. The project will include community visioning and development of alternatives before determining a final plan.

Isabel Neighborhood Specific Plan – In October and November 2020, the Planning Commission and City Council will review the Draft EIR and Draft Isabel Neighborhood Specific Plan. Table 1 below is the land use program for the Plan Area:

Table 1: Estimated 2040 Net New Development

	Within ½ mile radius of Valley Link station	*Outside ½ mile radius*	*Planning Area Total*
Residential (housing units)	3,525	570	4,095
Non-residential (square feet)			
Office	1,578,000	152,500	1,730,500
Business Park	73,590	106,800	180,390
Neighborhood Commercial	167,185[1]	0	167,185[1]
General Commercial	107,200	189,100	296,300
General Industrial[2]	(270,175)	0	(270,175)
Total	**1,655,800**	**448,400**	**2,104,200**
Jobs	8,000	1,200	9,200

Notes:
1. Includes Ground Floor Retail/Flex Space.
2. As build out of the Planning Area occurs, General Industrial uses will be replaced with Office, Business Park, Neighborhood Commercial, and General Commercial uses.

Source: Dyett & Bhatia, 2020.

First Street Corridor Transition Area: In 2017, the City Council approved a General Plan Amendment to establish the First Street Corridor Transitional Area. The GPA created a dual land use designation permitting continued Commercial Service use or conversion to residential. The area is approximately 24 acres south of First Street from Portola Avenue westward to, but not including, the “Livermore Casino” site.

The project also included, on 7 of the 24 acres, a request to rezone to residential use and approve a subdivision for 100 townhomes. This residential subdivision (Auburn Grove) is constructed and likely 100% occupied

In 2017 the City Council approved the annexation of 79 acres that included the Concannon Winery. The Property contains vineyards, two administration and wine production facilities totaling 44,000± and 55,000± square feet, a 13,500± square foot tasting room and wine bar, 2,250± square foot a caretaker residence, 2,600± square foot historic home, landscaped gardens and patio area, and other visitor serving amenities. Cumulatively, these site improvements equal approximately 12± acres. The remaining 68± acres are vineyards and open space.

In 2017 the City Council approved a residential subdivision on the former Sonoma School site. The project included 5 singe family homes. The homes are completed and occupied.

In 2020 the City Council authorized staff to submit the following proposals to the MTC/ABAG for the Draft Blue Print/Plan Bay Area 2050 effort:

- The future Valley Link Southfront Road Station Area as a new Priority Development Area
- The Oaks Business Park and Eastern Industrial Area as Priority Production Areas

Map 1

1. **Outlets – Phase II:** recommend using existing water use for Phase 1 and assume full occupancy of Phase II - four retail buildings, totaling 192,100 square feet.
   a) Phase II has about 15,000 square feet of vacant space
   b) Phase I has about 15,000 square feet of vacancy (out of 544,000 square feet) – that's from some recent vacancies

   All phases are complete and fully occupied.
2. **The Shops at Livermore:** approved for 124,000 square feet of retail, including several restaurants
   a) Includes 31,000 square feet of "Restaurant/Retail" space. Ben would assume at least 75% (23,000 square feet) of that will be restaurant.

   Project is complete and near full occupancy. Two of the tenant spaces in the pad buildings previously assumed to be restaurants were recently approved for dentist and orthodontist offices – total square footage for those uses combined is about 5,500 square feet.
3. **CrossWinds:** 25-acre site, with potential for 289,000 square feet of commercial development
   a) The current proposal designates 20,500 square feet for restaurant use and 25,800 for "quick-serve retail" (QSR). Ben estimates half the QSR space as fast-food restaurants, resulting in a total of about 33,000 square feet of restaurant space.

   This 23-acre site is now developed with the Republic Square Regional Shopping Center. The project consists of 282,000± square feet of building area, including retail, restaurants, and two hotels. There are still a few pad buildings left to be constructed. Both hotels are complete. Here are the project components:

   Parking lot to accommodate 499 vehicles for the SF Premium Outlets. Five restaurant buildings, ranging in size from 4,360 to 5,750 square feet, two quick-serve-retail buildings measuring 11,650± and 16,375± square feet, and one 9,050± square foot retail building. One three-floor, 112-unit hotel (Residence Inn by Marriott), and one three-floor 104-room hotel (Homewood Suites by Hilton). One retail buildings with floor area of 49,600± square feet.

4. **Sywest Driving Range:** 21.3-acre site with potential for up to 249,000 square feet of commercial development. The City has not had any recent inquiries for potential development.
   Site remains a driving range and City has not had any recent inquiries for development.
5. **Oaks Business Park:**
   a) Gillig: 640,000 square feet on 39 acres, including 65,000 square feet of office and the rest is manufacturing. Water Resources is going to use data on water use at existing Hayward facility.
   b) Trammel Crow: 1,298,000 square feet of warehouse and distribution on 67.8 acres
   These are complete and operating.

   c) Use BCP/LII assumptions for remaining area (about 10% of Oaks Business Park is currently undeveloped.)
   Recently completed warehouse and manufacturing located at the southwest corner of Isabel Avenue and Jack London Boulevard, with one industrial building with a total floor area of approximately 372,500 square feet. The building includes approximately 343,500 square feet of warehouse and distribution use and up to 29,000 square feet of office.

6. **Airport Master Plan:**
   a) Current proposal to add 133,777 sf within two new buildings next to the recently constructed FBO buildings.
   One 25,500 sq. ft. hangar building is complete. A new 42,110 square-foot building was approved by the Planning Commission in June 2020.

7. **Livermore Valley Charter School:**
   a) K-8 grade school on a 11-acre site, with a max enrollment of 932 students
   b) Athletic facility and parking lot on the adjacent 12.4-acre vacant property
   c) Planning for an 1,080-student high school on nearby 5.5-acre site
   The school is no longer operating at this site. Use BCP/LII assumptions for buildings. Uses are a mixture of R&D and Light Industrial. I believe there are still vacant buildings available here.

8. **Las Positas College:** Assume a total student population of 12,000. This is based on conversation with LPC administration in April 2015. They currently have 510 full- and part-time faculty and staff members. The Facilities Master Plan (2012) includes a projection of 10,500 students in 2025.
   Enrollment continues to be between 7,500 and 10,000 students.

9. **Shea Homes, Sage:** 476 townhouses, including a 2.5-acre public park, recreation facilities (a pool and fitness center), on-site landscaping, multi-use trail, and community gardens.

   Project is complete.

Map 2

10. **Ponderosa:** 26 single family houses – approved (construction nearly complete)
    Project is complete and occupied.
11. **KB Home:** 58 townhouses – approved and under construction
    Project is complete and occupied.
12. **Central Crossing:** proposal for 49 small-lot single family detached homes on a 5.2-acre site
    Project is complete and occupied.

13. **Garaventa Hills:** proposal for 42 single-family houses
Approved for 38 single family detached units and six attached townhomes.
14. Assume no development – will likely stay as open space
No Change
15. Assume development of 12 single-family houses – per Residential Land Inventory
No Change
16. Assume no development: owned by EBRPD to maintain as open space
No Change
17. **Greenville BART TOD:** 2010 Program EIR for BART to Livermore alignments found that this site is not viable for a BART station.
    a) Assume development of 300 single-family houses – per assumptions for Plan Bay Area traffic model
    b) Assume no development: outside of UGB – was contingent upon a BART station

    Use same assumptions. However, the land uses of this area will be evaluated in the upcoming General Plan Update commencing in the fall 2020.
18. **Intel Site:** Todd is trying to track down the agreement (Roberta may have it) to see if it has expired or does not transfer to future users. Planning could not identify any changes to the site since 2003 that would indicate a water use has increased (it may have gone down even). This is based on approval of a CUP in 2005 for a self-storage facility in two of the four buildings, when the primary site user determined they did not need as much space since their manufacturing technologies had become more efficient. It is possible that the manufacturing could intensify in the future.
No Change. Self storage use is present and operating.

19. **Arroyo Vista Neighborhood Plan:** allows up to 495 multi-family units per adopted Neighborhood Plan
Entitlements approved for 435 nits including 86 two-story single-family detached houses and 109 three-story row townhomes, 140 single-family attached Garden Court Townhomes (three stories with each building having at least one two-story end unit) and 100 multi-family attached Flats (three stories). The project remains entitled, but no prospective developer.

20. **Bennett Drive:** sites re-designated in 2013 to UH-5b; assume 436 multi-family units, per Residential Land Inventory
No Change
21. **McGrath Rent Corp:** assume standard level of intensification. However, intensification would be contrary to current use which has been consistent over time.
This area to be studied during the forthcoming General Plan Update as a potential Valley Link Station Transit Oriented Development. This area is part of the newly designated Southfront Priority Development Area.
22. **Brisa Neighborhood:**
    a) 465 units (246 single-family dwellings, 48 townhomes, 171 garden apartments) and 2 acres of parkland are under construction – per the Brisa Neighborhood Plan.

    Project is complete and occupied.

    b) City-owned site next to ACE station: capacity for 46 units (UH-5b) – per Residential Land Inventory

    No Change

23. **PG&E training site:** assume standard level of intensification.
No Change

Intensification of eastside Industrial areas: The opposite trend predicted in the 2003 Master Plan has occurred. However, it is reasonable to assume that intensification could occur under future market conditions. Planning recommends re-calculating the existing water demand of typical industrial users (excluding McGrath and PG&E sites for example), in order to determine a more realistic water demand associated with future intensification. Pipeline projects include:

24. **6877 Brisa:** application for 127,374 S.F. building consisting of warehouse/manufacturing space with ancillary office space (SPDRM16-001). Approved and constructed.
25. **7600 Hawthorne:** new 241,545 square foot building consisting of warehouse/manufacturing space with ancillary office space – approved and contstructed
26. **7600 Patterson Pass:** new 86,700 square foot warehouse and distribution building on a 9.9-acre site with 4,000 square feet of office and 73 dock doors – approved and constructed

Map 3

27. **Mines Road, south of first (Grove):** building permits have been issued for all 58 houses approved at that site.

Project completed and occupied.

28. **Ponderosa Vines:** 49 single family houses – approved

Project completed and occupied.

29. Assume development of 20 single-family houses – per Residential Land Inventory

No Change

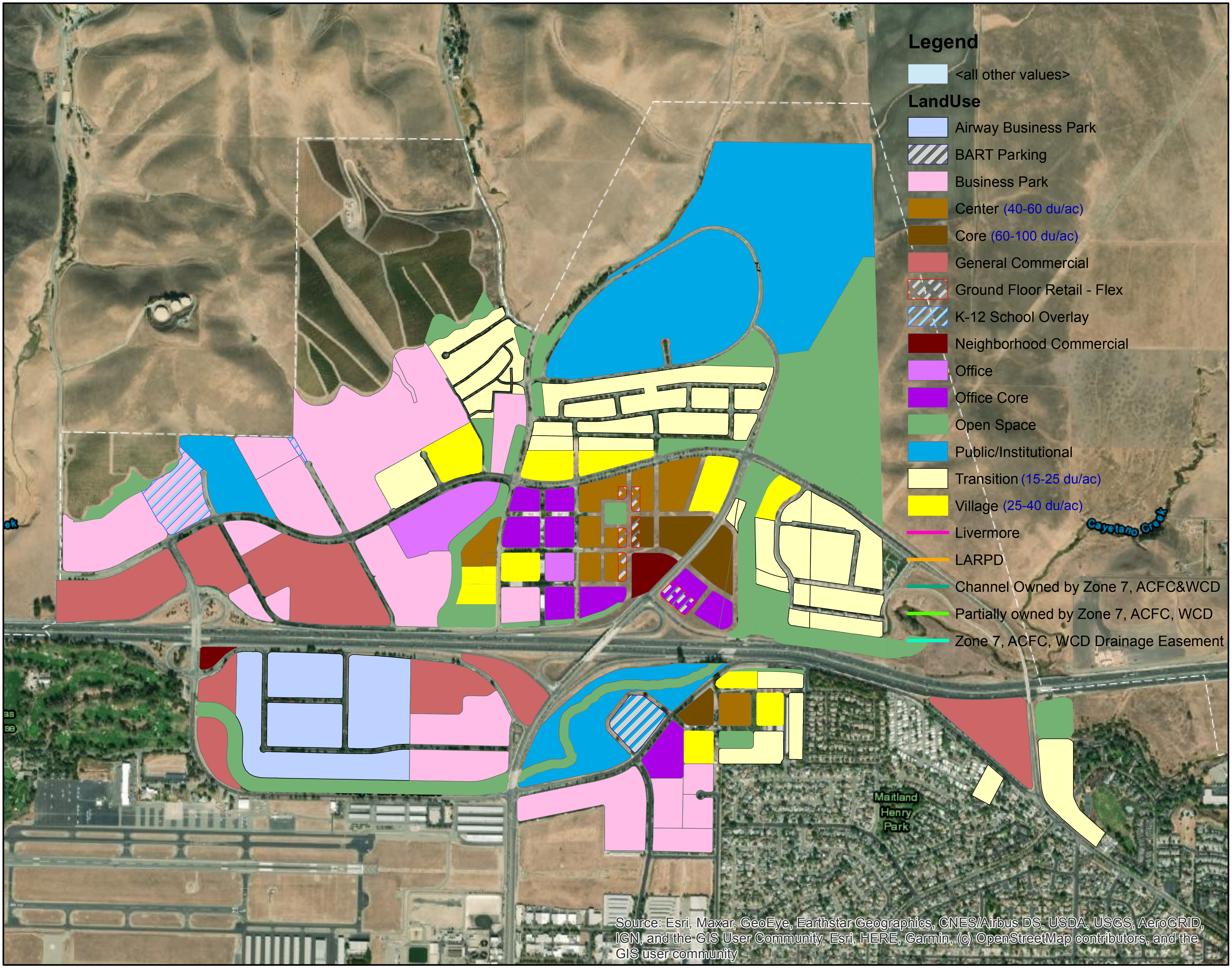
30. **New private school:** include previous assumptions

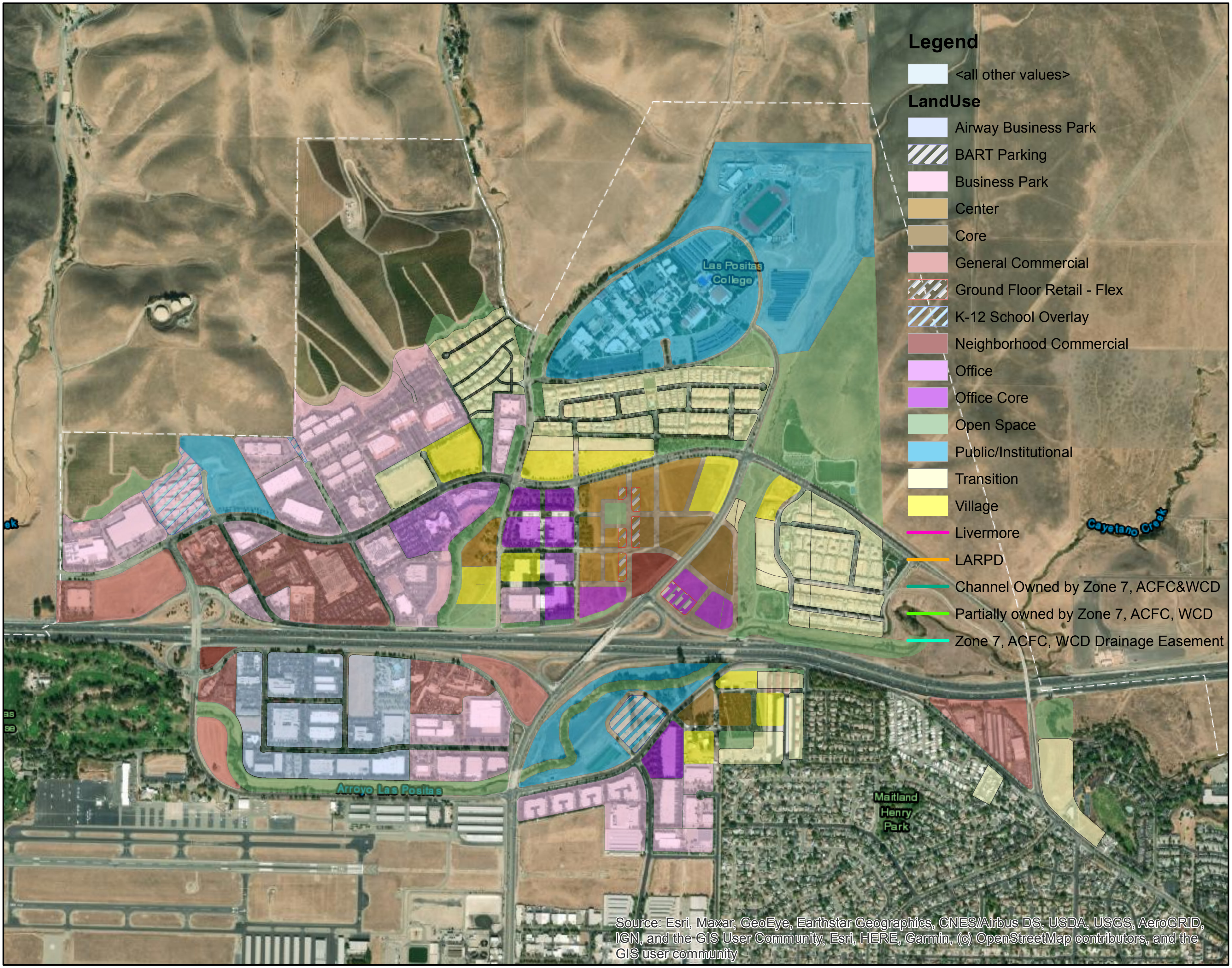
No Change

31. Assume 32 single-family houses – per Residential Land Inventory

No Change

Future public school sites: Assume no new public schools. No Change


Legend
<all other values>
LandUse
Airway Business Park
BART Parking
Business Park
Center (40-60 du/ac)
Core (60-100 du/ac)
General Commercial
Ground Floor Retail - Flex
K-12 School Overlay
Neighborhood Commercial
Office
Office Core
Open Space
Public/Institutional
Transition (15-25 du/ac)
Village (25-40 du/ac)
Livermore
LARPD
Channel Owned by Zone 7, ACFC&WCD
Partially owned by Zone 7, ACFC, WCD
Zone 7, ACFC, WCD Drainage Easement
Cayetano Creek
Maitland Henry Park
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community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Channel Owned by Zone 7, ACFC&WCD
Partially owned by Zone 7, ACFC, WCD
Zone 7, ACFC, WCD Drainage Easement
Las Positas College
Cayetano Creek
Arroyo Las Positas
Maitland Henry Park
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

FIGURE 2-3: SUBAREA DIAGRAM

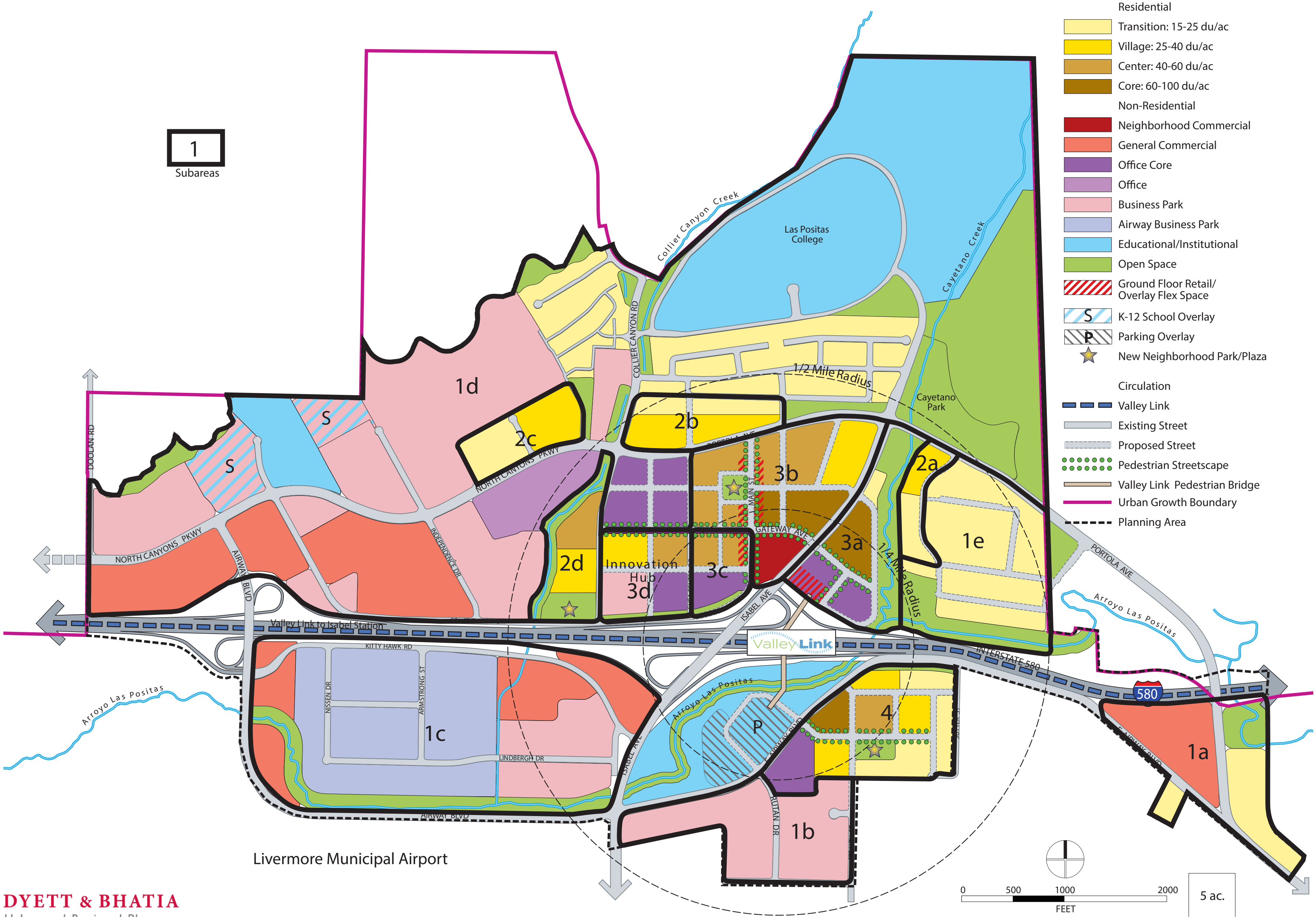

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TABLE 2-6: PERFORMANCE MEASURES BY SUBAREA

Sub-area	*Minimum Housing Units*	*Target Housing Units*[1]	*Maximum Housing Units*	*Performance Measures*
1a	138	184	230	a) Provide at least two residential product types.
2a	163	201	240	a) Provide at least two residential product types.
2b	299	361	422	a) Provide at least two residential product types. b) Limit the building heights of units directly facing the adjacent Montage development to 45 feet above existing grade (three stories). c) Limit building heights on the remainder of the site to 50 feet above existing grade or Scenic Corridor limit, whichever is stricter.
2c	268	327	386	a) Provide at least two residential product types. b) Limit building heights to 50 feet above existing grade or Scenic Corridor limit, whichever is stricter.
2d	200	243	286	a) Provide at least two residential product types. b) Limit building heights to 50 feet above existing grade or Scenic Corridor limit, whichever is stricter.
3a	162	244	326	a) Provide at least two residential product types. b) The exact location of new streets is flexible, as long as they align with the proposed intersections shown on the Plan figures.
3b	1,054	1,267	1,480	a) Provide at least three residential product types. b) Concentrate the tallest buildings along Gateway Avenue and transition downward in scale along Portola. c) With the exception of Gateway Avenue, Shea Center Drive, and Main Street, the exact location of the new streets is flexible.
3c	182	210	237	a) Provide at least two residential product types. b) For sites outside of the Scenic Corridor exception area, limit building heights to 50 feet above existing grade (or Scenic Corridor limit, whichever is stricter). c) Provide the tallest buildings along Gateway Avenue and transition downward in scale for housing along Portola Avenue.
3d	197	238	279	a) Provide at least two residential product types. b) For sites outside of the Scenic Corridor exception area, limit building heights to 40 feet above existing grade (or Scenic Corridor limit, whichever is stricter).
4a	660	793	926	a) Provide at least three residential product types. b) Limit building heights along Sutter Street and adjacent to existing residential uses to three stories. c) Locate the tallest buildings closest to the Valley Link station. d) The exact location of new streets is flexible, as long as they align with the proposed intersection with the Valley Link station and there is at least one connection to Sutter Street. e) If development is phased such that redevelopment of the self-storage site occurs after development of the G&M Farms property, the first phase shall plan for future street connections with the second phase.

Notes:

1. *The target unit count is based on a variety of factors including density averages, development constraints, and market condition.*