FINAL

Water System Master Plan Report

Prepared for

City of Daly City, California

February 2023

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BC Project No. 154529

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

AC	asbestos cement
ADD	average day demand
AS	alloy steel
BART	Bay Area Rapid Transit
BAWSCA	Bay Area Water Supply & Conservation Agency
BC	Brown and Caldwell
CI	cast iron
CIP	Capital Improvements Program
CMMS	computerized maintenance management system
COF	consequence of failure
CPP	corrugated HDPE
CU	copper
DI	ductile iron
DWR	California Department of Water Resources
EPS	extended period simulation
FCV	flow control valve
ft	feet
fps	feet per second
GI	galvanized iron
GIS	geographic information system
gpcd	gallons per capita day
gpm	gallons per minute
GS	galvanized steel
HDPE	high-density polyethylene
HGL	hydraulic grade line
IAP	InfoAsset planner
in	inch/inches
LOF	likelihood of failure
max	maximum month demands
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
NRW	non-revenue water
PHD	peak hour demand
PRV	pressure-reducing valve
PS	pump station
psi	pounds per square inch
PVC	polyvinyl chloride
RES	reservoir
RRA	Risk and Resiliency Assessment
SCADA	supervisory control and data acquisition
SF	San Francisco
SFPUC	San Francisco Public Utilities Commission
SFRWS	San Francisco Regional Water System
STL	steel
TM	technical memorandum
TO	turnout
UWMP	Urban Water Management Plan
USGS	U.S. Geological Survey
WSMP	Water System Master Plan

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Executive Summary

The City of Daly City (City) last prepared a Water System Master Plan (WSMP) in 1991. Since then, the City has successfully completed a series of improvement projects that addressed many known deficiencies in the system. Additionally, since the last update, water use patterns have changed, and service area populations have increased. With these changes since 1991, the City wanted to update its Water System Master Plan (Plan). In addition, the City recognizes the need to assess the aging facilities to determine potential rehabilitation or replacement projects. This WSMP considers existing operational conditions as well as future anticipated plans provided by City staff and will serve as a strategic planning guide for upgrading, improving, and expanding the City's water system.

Existing Water System

The City's existing water systems consists of approximately 200 miles of pipeline divided into 19 active pressure zones, 16 pumping facilities and 10 storage reservoirs. Existing sources of supply include a groundwater well field with four active wells, which supplements purchased water from the San Francisco Regional Water System (SFRWS). Additionally, the City has interties with several water agencies. Figures ES-1 and ES-2 are hydraulic schematics of the westside and eastside portions of the water system, respectively. These schematics illustrate the relationship between the sources of supply, pumping, and storage facilities.

Water Demands

An important part of the plan is the establishment and projection of water demands. It provides the basis for water supply needs and the determination of required transmission and storage system capacity. Average day demands (ADD), Maximum day demands (MDD) and maximum month demands were calculated for 2018 and 2020 from monthly and daily water production data, shown in Table ES-1.

Table ES-1. Existing Water System Demands

Year	ADD (mgd)	MDD (mgd)[a]	Max Month (mgd)	Peaking Factors (MDD/ADD)
2018	6.11	Not available	6.90	Not available
2020 (used in model)	6.04	8.9	6.85	1.47

a. *MDD was not available for 2018 because only monthly production data was available. MDD date for 2020 was 7/9/2020. Production data for 2019 was not available.*

System Evaluation Criteria

Evaluation and design criteria were developed to confirm the desired level of service within the existing system and to identify future water system needs. Recommendations for criteria are documented in *Appendix E – Water System Evaluation Criteria Technical Memorandum*. A workshop was held to discuss the proposed design and evaluation criteria, and the TM was reviewed by City Staff. An overview of final criteria established are included in Section 6 of this report.

System Evaluation

The City's existing hydraulic model was updated and used to analyze the distribution system. Piping in the model was updated to match the City's latest geographic information system (GIS) piping. The updated model was then analyzed to identify deficiencies for existing and future demand conditions.

There are several locations within 8 pressure zones where the system does not have capacity to meet the fire flow criteria. The pressure zones are primarily included in the older areas within the City's service area that also include smaller diameter pipelines. Based on the analysis performed, 12 FF improvements were identified that included approximately 3.5 miles of pipeline replacements to address the deficiencies. No storage and pump station improvement projects were identified when performing the existing and future capacity analysis. The new improvements were sized to the standards laid out in the evaluation criteria.

In addition, a reliability analysis was performed on the City's pipelines that were 8-inches in diameter or larger that focused on areas with potential corrosion, break history, or that have the potential for critical failure. Based on the results, approximately 12 miles of pipeline were identified for further condition assessment. The City has recognized the need to replace the small diameter pipelines that were installed prior to 1950. Based on City feedback, the most critical small diameter pipeline replacements are within Zone Res 1 and Zone Res 3 due to age and condition. A robust small diameter pipeline replacement strategy is recommended to identify individual projects that the City will need to complete to address replacements in the long-term and build-out phases.

Recommendations

Brown and Caldwell (BC) developed a 10-year Capital Improvements Plan (CIP) for the City system to assist the City in budgeting for improvements needed to provide the required level of service to the City water customers. Projects are categorized as Water System Capacity Improvements, Repair and Rehabilitation Improvements, or as Other Projects. BC has categorized all 10-year CIP projects into near-term (next five years) or longer-term (next six to 10 years). Capital planning for build out projects, i.e., projects with implementation horizons beyond 10 years, was beyond the scope of this master plan. For the build-out improvements, i.e., facilities not in the next 10-year CIP, the City needs to carry out further analyses and cost estimating, to define specific requirements.

BC estimated planning level costs for each project. Cost estimates provided in Table ES-2 are based on a budgetary, planning level, engineer's opinion of probable costs (e.g., AACE International Class 5--order-of-magnitude—estimates). Table ES-2 presents the costs for each recommended improvement in present day value. They were developed based on construction cost information as of Spring 2022, for San Francisco Bay Area. When the City undertakes design, the City will need to update and escalate the costs into then current dollars.

Table ES-2. CIP Summary Table			
		CIP Phasing	
		Near-Term	Long-Term
Project	CIP Cost Estimate	2022-2026	2027-2033
Water System Capacity Improvements	$31,219,000	$12,340,000	$18,879,000
Fire Flow Improvements	$12,602,000	$4,697,000	$7,905,000
Distribution System improvements	$18,617,000	$7,643,000	$10,974,000
Repair and Rehabilitation Projects	$1,119,000		$1,119,000
CIP Total	**$32,338,000**	**$12,340,000**	**$19,998,000**
Average Annual Cost	N/A	$2,468,000	$3,333,000

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Section 1

Introduction

This Water System Master Plan (WSMP) evaluates the capacity of the City of Daly City's (City or Daly City) water system under existing and future conditions through 2045. This WSMP summarizes results and recommendations from Brown and Caldwell's (BC) evaluation of the City's water system.

1.1 Purpose and Objectives

The City's WSMP was last updated in 1991. Since then, the City has implemented several water system upgrades, and water use patterns within the service area have changed. In addition, the City recognizes the need to assess the aging facilities to determine potential rehabilitation or replacement projects. This WSMP considers existing conditions as well as future anticipated plans that City staff provided, and will serve as a strategic planning guide for upgrading, improving, and expanding the City's water system.

1.2 General Overview of Master Plan Elements

The scope of this Master Plan is focused on all assets in the City's water system that have a role in the transmission, storage, and pumping of potable water to and from the City's customers and facilities. An outline of this report by section is given below.

Executive Summary. Summarizes findings, conclusions, and recommendations.

Introduction. Outlines purpose and objectives of master plan, organization of the report, and limitations.

Water System and Facility Information. Outlines existing water supply system including land use, future developments, supply, and system facilities.

Historical and Projected Water Use. Outlines water demands on City water system including existing and future demands, and fire flow requirements.

Model Development. Outlines development and update of the City's hydraulic model. Includes operational calibration description and results, and descriptions of model demand and supply conditions.

Water System Pipe Risk Analysis. Contains desktop risk analysis of the City's water pipelines.

Water System Hydraulic Evaluation. Evaluates water system and Identifies deficiencies.

Capital Improvement Program. Identifies the basis of cost estimates and develops a CIP to mitigate system deficiencies.

1.3 Limitations

This document was prepared solely for the City of Daly City in accordance with professional standards at the time the services were performed and in accordance with the contract between the City of Daly City and Brown and Caldwell dated December 16, 2019. This document is governed by the specific scope of work authorized by the City of Daly City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City of Daly City and other parties, as well as information gathered by Brown and Caldwell over past assignments for the City. Unless otherwise expressly indicated, we have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 2

Water System and Facility Information

This section describes the City's existing potable water system and facilities and the main components of each. Storage capacities and dimensions, well capacities, pump station capacities, pipe diameter and lengths, and pressure zones are also described.

2.1 Service Area

The City service area currently occupies approximately 7.4 square miles in north San Mateo County and served 112,374 customers in Daly City and some unincorporated portions of San Mateo County in 2020 (City of Daly City General Plan, 2013). The City borders the City and County of San Francisco to the north, Pacifica and the Pacific Ocean to the west, South San Francisco to the south, and Brisbane to the southeast. The City's water system includes five areas within the City boundaries that are not in the City's service areas: California Water Service (Cal Water), Franciscan Res, Franciscan Reduced, Master Meter, and Reclaimed. The City's service area is depicted on Figure 2-1.

Since the City completed the 1991 Master Plan, it has undertaken numerous projects to implement major distribution system improvements including greatly improved connectivity between RES 6 and RES 6B and RES 5 and RES 5B, Mission Street corridor upgrades, replacing RES 2 and RES 2B, installing the Sullivan and Junipero Serra wells, and many other improvements recommended in that plan.

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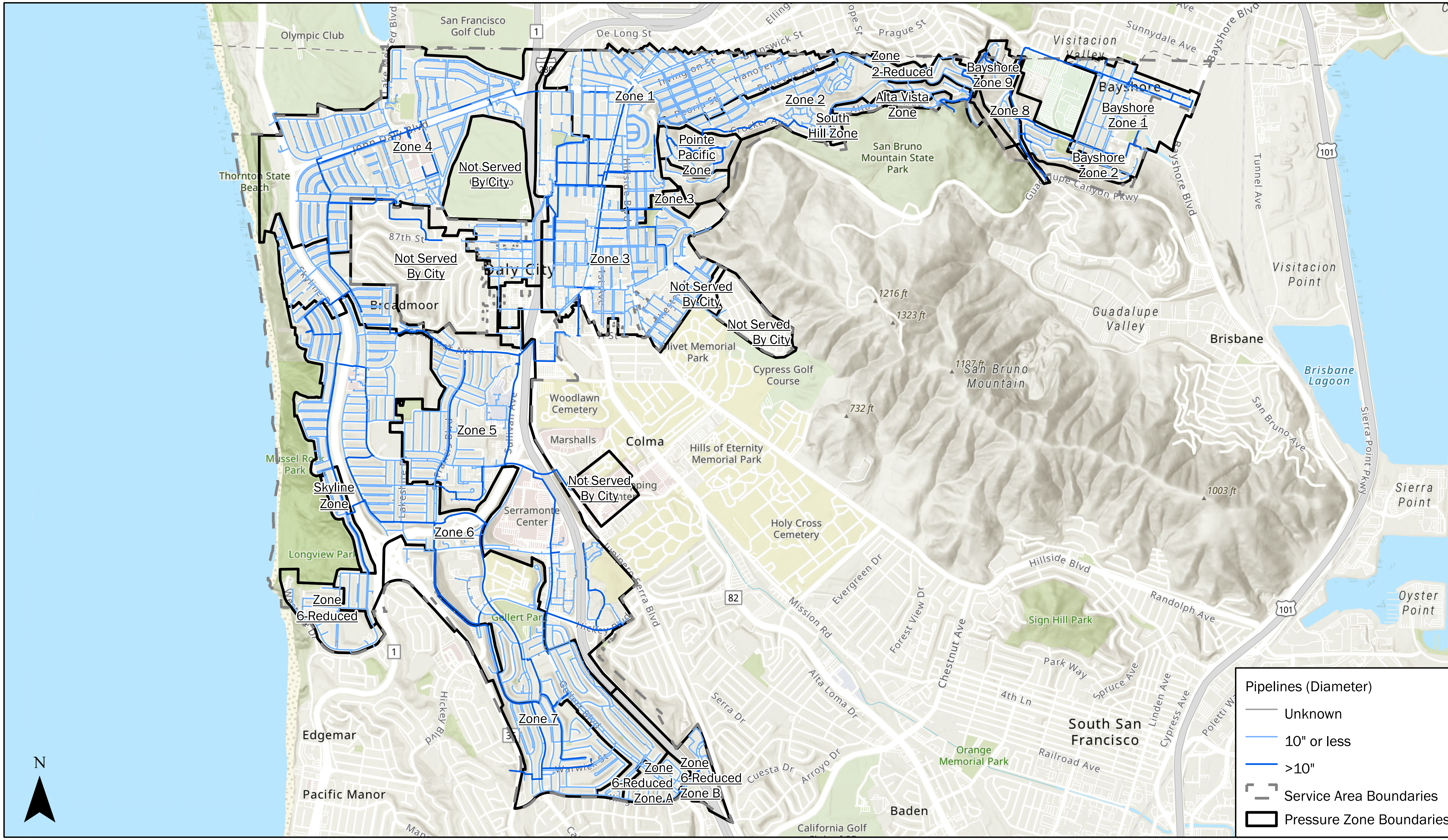

Figure 2-1. Service Area Boundary

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2.2 Land Use

The District's existing and future land use from the 2030 General Plan are described in the 2020 Urban Water Management Plan (UWMP) and summarized below (2020 UWMP, Brown and Caldwell, June 2021).

2.2.1 Current Land Use

The City is predominantly residential with a handful of educational institutions and commercial use areas. The City's commercial use includes primarily home furnishings and appliances, apparel, general merchandise, and eating and drinking establishments. Major shopping areas include Serramonte Shopping Center, Westlake Shopping Center, Pacific Plaza, and the Mission Street retail corridors. The City includes 500 acres of recreation, including a westside area of recreation totaling 400 acres.

2.2.2 Future Land Use

According to the 2030 General Plan, future land use is anticipated to remain largely the same, with the majority remaining low-density residential use.

The following land use updates are projected within the service area:

- The Midway Village located to the east of Cow Palace Arena & Event Center is expected to transform from low-density residential to high-density residential.
- The Broadmoor neighborhood, previously undeveloped, is expected to be developed into low-density residential.
- The Pointe Pacific neighborhood is redeveloped from high density to low density or open space.
- The previously undeveloped lot neighboring the Cow Palace Arena & Event Center in the northeast quadrant of the City is intended for retail and office land use.
- eaves Daly City, an apartment complex in the southwest area of the City, is expected to convert from high- to medium-density residential use.
- Development along Sullivan Avenue and San Pedro Road is expected to be revised according to the Sullivan Corridor Specific Plan and BART Station Area Specific Plan, respectively.
- A recreation area owned by San Mateo County in the northwest boundary is added to the land use map.
- The west recreation area official land use designation was revised from open space to open space preservation.

2.3 Future Developments

The City provided information on 28 developments that are anticipated to be completed by 2045. Of the 28 developments, 11 are anticipated to be redevelopments and four are expansions of existing water service customers. The future developments include commercial, residential, and mixed use. The locations of these major developments are shown on Figure 2-2, and the sizes are summarized in Table 2-1.

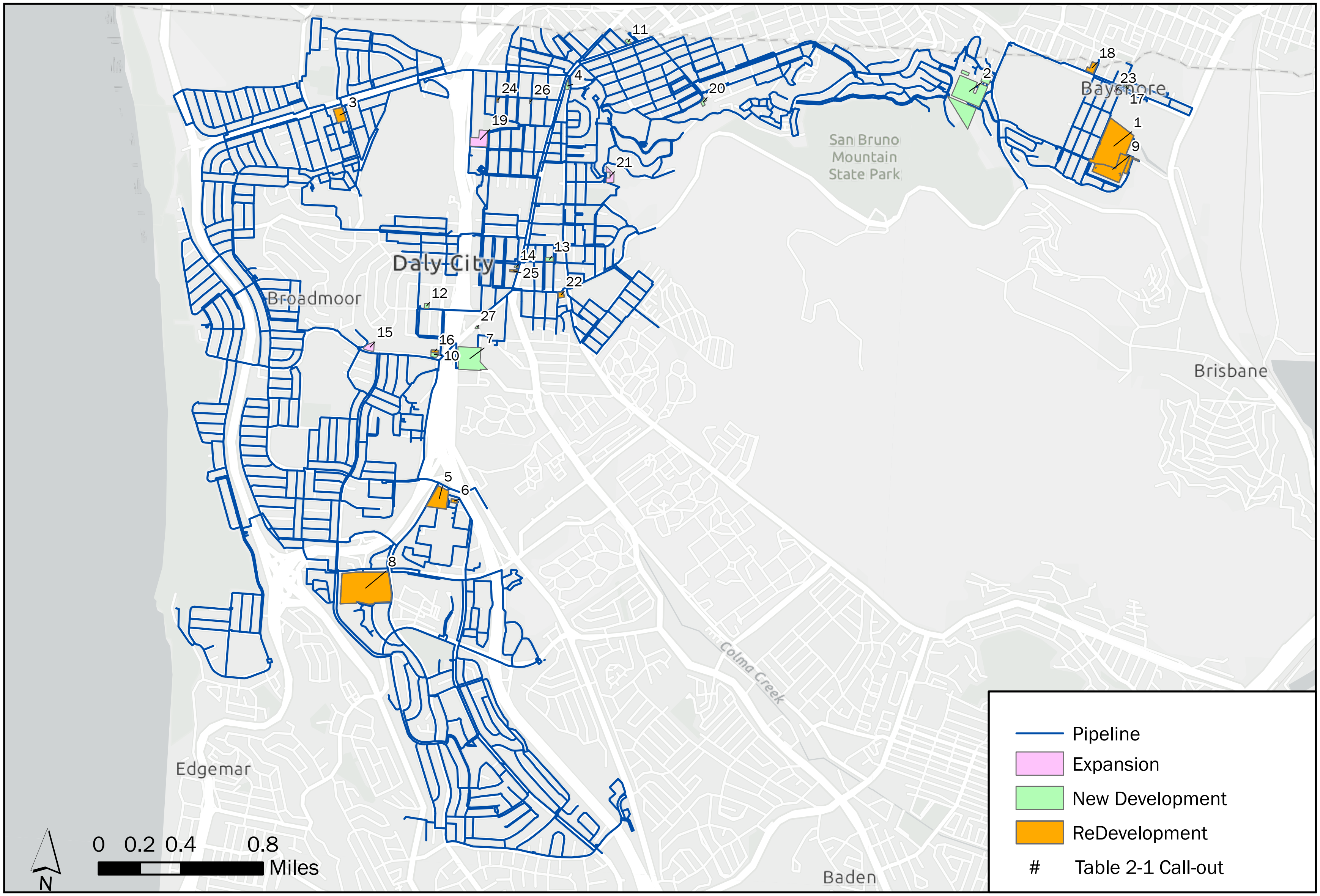

Figure 2-2. Future Developments within Daly City Service Area

Development Name	Development Type	Land Use Type	Corresponding number label on Figure 2-2	Quantity/Size: Dwelling Units	Quantity/Size: Square Footage	Quantity/Size: Number of Hotel Rooms
Midway Village Redevelopment	Redevelopment	Multi-family	1	555	-	-
Point Martin – Phase Two	New	Single-family	2	117	-	-
Westlake Shopping Center Mixed-use Building	Redevelopment	Multi-family, commercial	3	179 -	- 3,644	- -
88 Hillside – Phase II Residential Apartments	New	Multi-family	4	167	-	-
Serramonte Shopping Center Northwest Quadrant (theater, hotel, and retail)	Redevelopment	Commercial, hotel	5	- -	98,000 -	- 137
Serramonte Shopping Center Northeast Quadrant	Redevelopment	Restaurant	6	-	7,262	-
Serra Station Mixed-use Residential/Commercial	New	Single-family, commercial	7	75 -	- 2,300	- -
Jefferson Union High School District Faculty and Staff Housing	Redevelopment	Multi-family	8	116	-	-
Robertson Intermediate School Redevelopment	Redevelopment	Single-family	9	71	-	-
Eastmoor Residential Development	New	Multi-family	10	72	-	-
Mission Street/Goethe Street Mixed-use Building	New	Multi-family, commercial	11	36 -	- 1,568	- -
Bryant Street Mixed Use	New	Multi-family, commercial	12	27 -	- 3,675	- -
Point Martin - Phase One	New	Single-family	2	16	-	-
Woods Condominiums	New	Multi-family	13	20	-	-
Mission Street Mixed Use	New	Multi-family	14	18	-	-
North East Medical Services Building Expansion	Expansion	Institutional	15	-	5,464	-
Sullivan Avenue Apartments (Office Conversion)	Redevelopment	Multi-family	16	12	-	-
Habitat Geneva	New	Single-family	17	6	-	-
Pacific Place Retail Conversion	Redevelopment	Multi-family	18	7	-	-

Table 2-1. Future Development Details						
Development Name	Development Type	Land Use Type	Corresponding number label on Figure 2-2	Quantity/Size		
				Dwelling Units	Square Footage	Number of Hotel Rooms
Duggan's Serra Mortuary Expansion and Carvana Vending Machine Fulfillment Center	Expansion	Commercial	19	-	15,743	-
Templeton Homes	New	Single-family	20	4	-	-
Hilldale School Expansion	Expansion	Institutional	21	-	2,100	-
Popeye's Chicken Drive-through Restaurant	Redevelopment	Commercial	22	-	3,275	-
Geneva Avenue Mixed Use	Expansion	Multi-family	23	4	-	-
Vista Grande Parcel Map	Redevelopment	Single-family	24	2	-	-
7330 Mission Street Mixed Use	Redevelopment	Multi-family	25	3	-	-
Vista Grande Duplex	New	Multi-family	26	1	-	-
San Pedro/Hill Retail Expansion	New	Commercial	27	-	1,204	-

2.4 Existing System Facilities

This section presents an overview of the District's existing water supply, distribution system, and storage facilities. The City water system mainly consists of a groundwater well field with four active wells and one reserve well, approximately 185 miles of water distribution pipelines, 10 storage reservoirs (RES), 16 pumping facilities, 10 San Francisco (SF) turnouts, 11 interties to other systems, pressure-reducing valves (PRV), a centralized supervisory control and data acquisition (SCADA) system, an office building, and three maintenance yards. Figure 2-3 shows the layout of the water system, while Figure 2-4 and Figure 2-5 show a hydraulic schematic of the system for the westside and eastside, respectively. The hydraulic schematics illustrate the relationship among supply, pumping, and storage facilities. Figure 2-5 and Figure 2-4 also present ground elevations for the storage tanks and the range of customer service elevations in each pressure zone.

2.5 Supply

The City receives a large portion of its water supply from San Francisco Regional Water System (SFRWS), which is owned and managed by the San Francisco Public Utilities Commission (SFPUC) and supplements the SFPUC supply with groundwater pumped from local wells. During dry periods, groundwater makes up a larger proportion (up to 45 percent) of Daly City's water supply. If needed, the City also has interties with several water agencies. Wherever feasible, the City uses tertiary recycled water from the North San Mateo County Sanitation District wastewater treatment plant to offset potable/aquifer water demands.

2.5.1 Purchased Water

As stated, the City receives water from the SFRWS, which is operated by SFPUC. The SFRWS draws its supply predominantly from the Sierra Nevada delivered through the Hetch Hetchy aqueducts, but also includes treated water produced by SFPUC from its local watersheds and treatment facilities in Alameda and San Mateo counties. For more information, see the 2020 UWMP.

Table 2-2 summarizes the SFPUC turnout connections.

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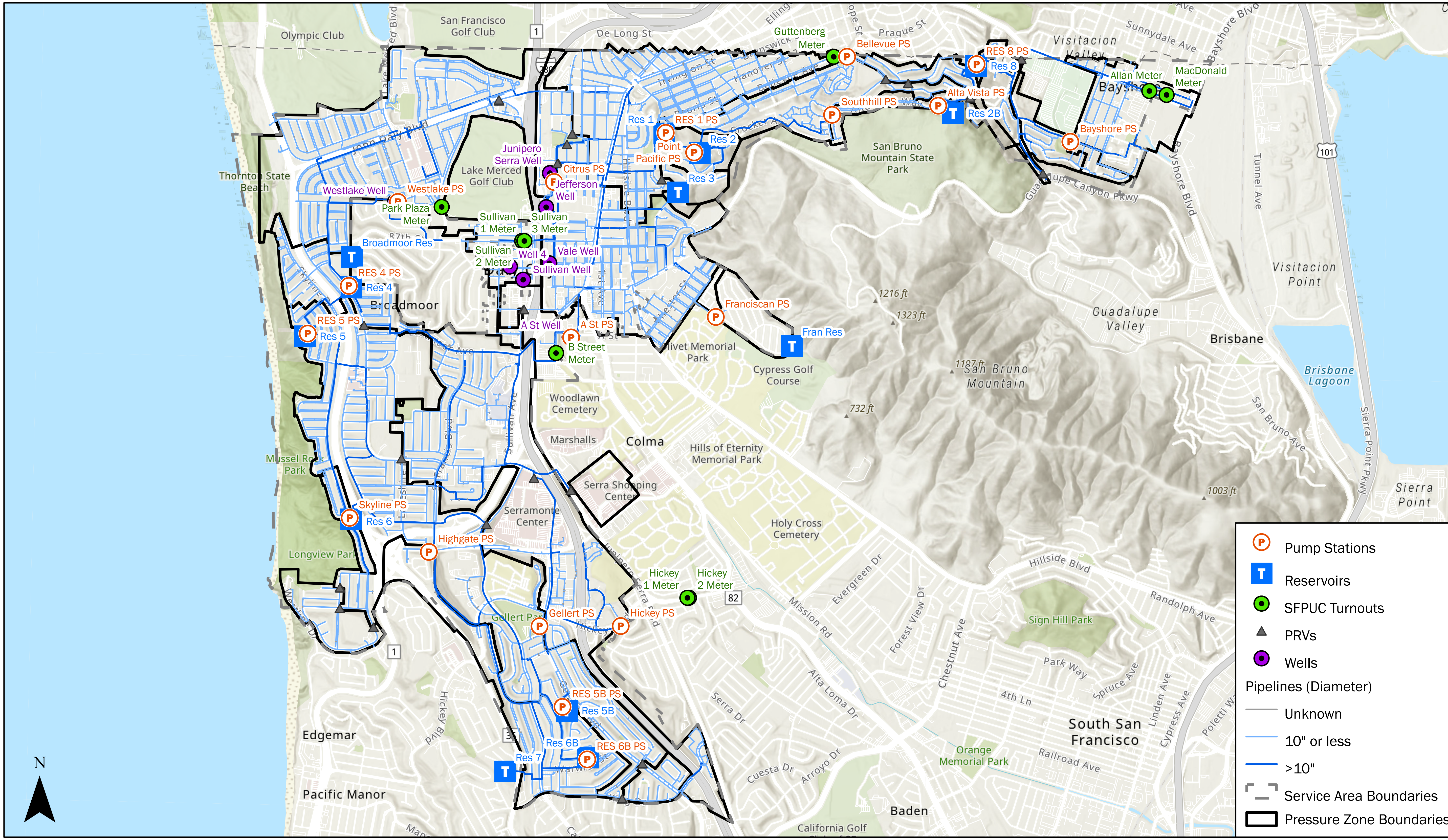

Figure 2-3. Water System Facilities

Brown AND Caldwell

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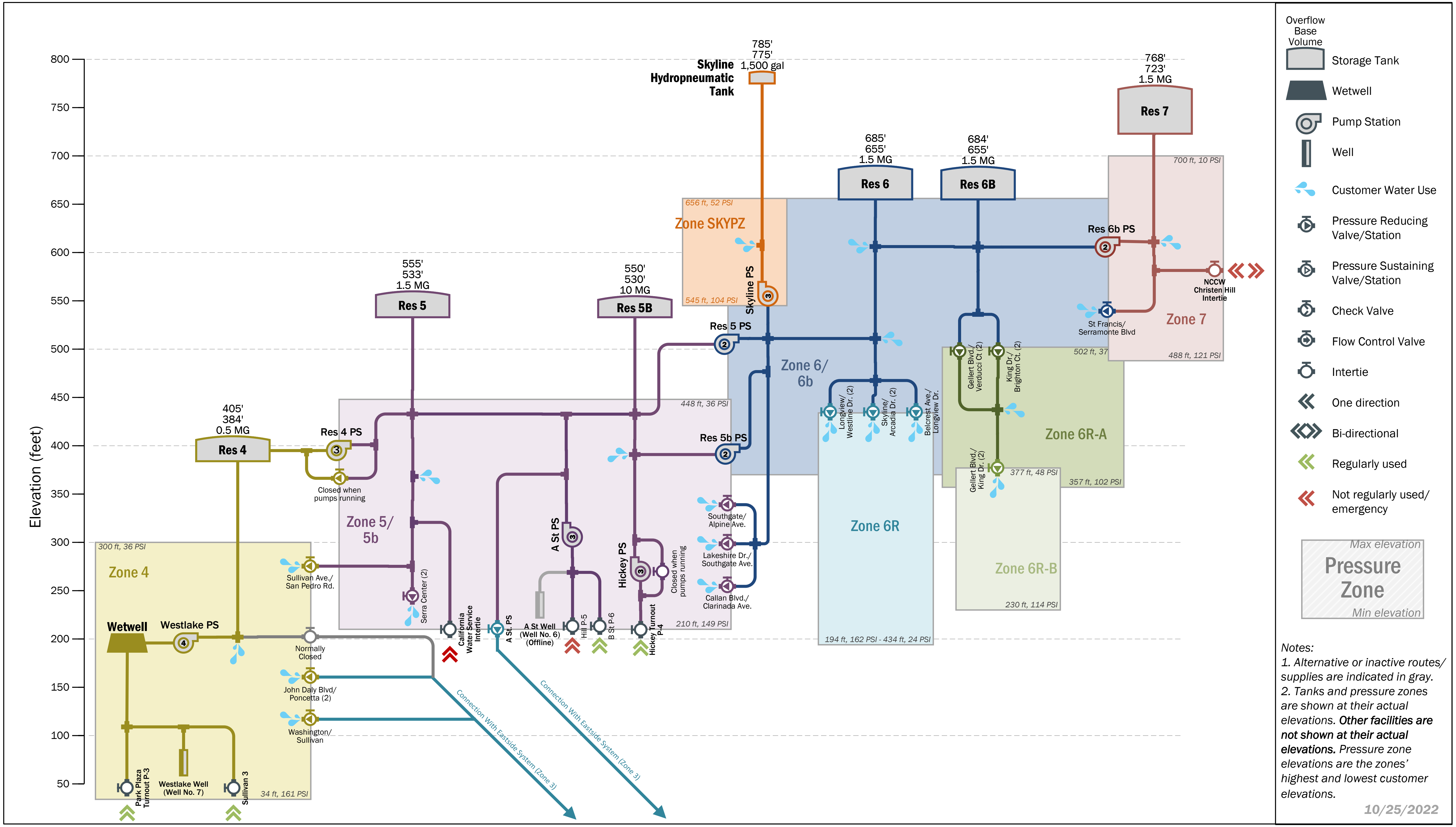

Figure 2-4. Water System Hydraulic Schematic (Westside System)

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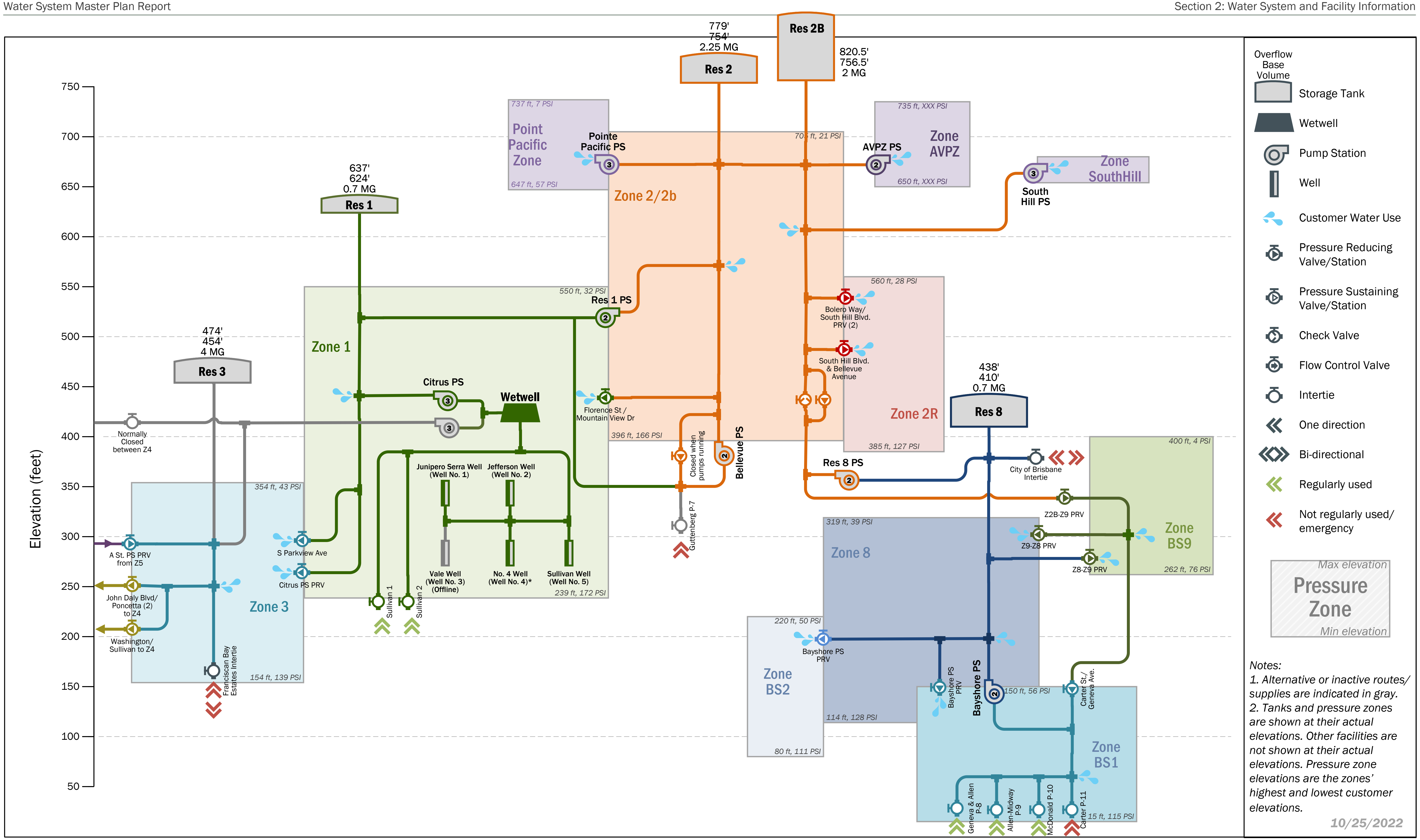

Figure 2-5. Water System Hydraulic Schematic (Eastside System)

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Table 2-2. SFPUC Turnout Connections							
Number	Name	Location	Pressure Zone Served	Pump Station Connection	2020 Flow (gpm)[a]	Minimum HGL (ft)	Maximum HGL (ft)
TO1	Sullivan 1 Meter	Sullivan Avenue/87th Street	Res 1/3	Citrus PS	739	442	380
TO2	Sullivan 2 Meter	Sullivan Avenue/87th Street	Res 1/3	Citrus PS	726	442	380
TO3	Sullivan 3 Meter	Sullivan Avenue/87th Street	Res 1/3	Westlake PS	252	442	380
TO4	Hickey 1 Meter	Near Hickey Pump Station	Res 5/5B	Hickey PS	717	442	380
TO5	Hickey 2 Meter	Near Hickey Pump Station	Res 5/5B	Hickey PS	715	442	380
TO6	Park Plaza Meter	S Park Plaza Drive/Palmcrest Drive	Res 4	Westlake PS	844	--	--
TO7	Macdonald Meter	MacDonald Avenue/Talbert Street	Bayshore Zone 1	Bayshore PS	53	185	185
TO8	Allan Meter (4 meters)	Allan Street/Geneva Avenue	Bayshore Zone 1	Bayshore PS	19, 20, 46, and 61	219	185
TO9	B Street Meter	Hill Street/B Street, Near A Street PS	Res 5/5B (or Res 3)	A St PS	1	--	--
TO10	Guttenberg Meter	Guttenberg Street/Bellevue Avenue	Res 2	Bellevue PS	0	582	536
TO11	Carter	--	Bayshore Zone 1	Bayshore PS	0	--	--
TO12	Hill	--	Res 3	A St PS	0	--	--
Total Consumption (MG)					2,077		

a. Average annual flow
ft – feet
gpm = gallons per minute
HGL = hydraulic grade line
MG = million gallons
PS = pump station
TO = turnout

2.5.2 Groundwater Wells

The City receives a large portion of its drinking water supply from SFPUC and supplements the SFPUC supply with four active local groundwater wells and one reserve groundwater well.

Table 2-3 presents the well name and capacity in gallons per minute (gpm) for each of the currently operable groundwater wells in the City's water system. Citrus Pump Station (PS) draws from Well 4, Jefferson Well, Junipero Serra Well, Sullivan Well, and Vale Well to serve pressure Zones 1 and 3. "A" Street PS draws from "A" Street Well to supply Zone 3. Westlake PS draws from Westlake Well to supply Zone 4. The Ben Franklin and Park Plaza wells have been drilled and will be completed following the completion of Westlake PS GSR improvements. Once in operation, the Ben Franklin and Park Plaza wells will discharge to Westlake PS and support Zone 4. The capacities shown for currently active wells in Table 2-3 are assumed to be typical flow rates rather than well capacity or pump capacity. The wells are operated with manual controls.

Table 2-3. Groundwater Wells

Well Name	Capacity, gpm	Service Zone	Pump Station Connection	Operation Status
Well 4	426	Res 1/3	Citrus PS	Reserve Well
Jefferson Well	340	Res 1/3	Citrus PS	Active
Junipero Serra Well	550	Res 1/3	Citrus PS	Active
Sullivan Well	500	Res 1/3	Citrus PS	Active
Vale Well	693	Res 1/3	Citrus PS	Out of Service
A Street Well	524	Res 3	A Street PS	Not used due to nitrate levels (2015)
Westlake Well	410	Res 4	Westlake PS	Active
Ben Franklin Well (2023)	TBD	Res 4	Westlake PS	Future
Park Plaza Well (2023)	TBD	Res 4	Westlake PS	Future

Source: 2020 BAWSCA workshop feedback

2.5.2.1 Conjunctive Use

The City entered a pilot conjunctive use program with SFPUC to enhance regional water resource management. The project's first phase, which concluded in November 2003, took advantage of available surplus in SFRWS water at a reduced cost. In exchange, the City agreed to use more SFPUC system water and reduce pumping groundwater from the Westside Basin. This action created the opportunity to observe basin response from recharge that takes place from the reduced groundwater pumping. Phase 2 of the conjunctive use program, which began in March 2004 and continued into 2011, had promising results, as discussed below.

The pilot project assessed, in part, the feasibility of a permanent conjunctive use program. As tentatively outlined, the program would:

- Increase groundwater levels in the Westside Basin
- Reduce the potential for seawater intrusion
- Develop increased SFPUC system yield from the overall surface and groundwater system
- Potentially improve water quality conditions at Lake Merced

Initial results from this pilot project showed that groundwater levels increased within the basin. The City has an added benefit of saving its local resource, which results in enhanced emergency and drought protection. With the promising results of the pilot conjunctive use program, SFPUC's Water System Improvement Program (WSIP) groundwater supply and recovery (GSR) project proceeded with the construction of up to 16 new recovery wells and associated facilities, such as pumping systems, pipelines, and chemical treatment equipment. Construction began in April 2015 with construction completion anticipated in spring 2018 (SFPUC 2016a); however, actual construction will conclude in 2023. Figure 2-6 provides an overview of the GSR project groundwater wells.

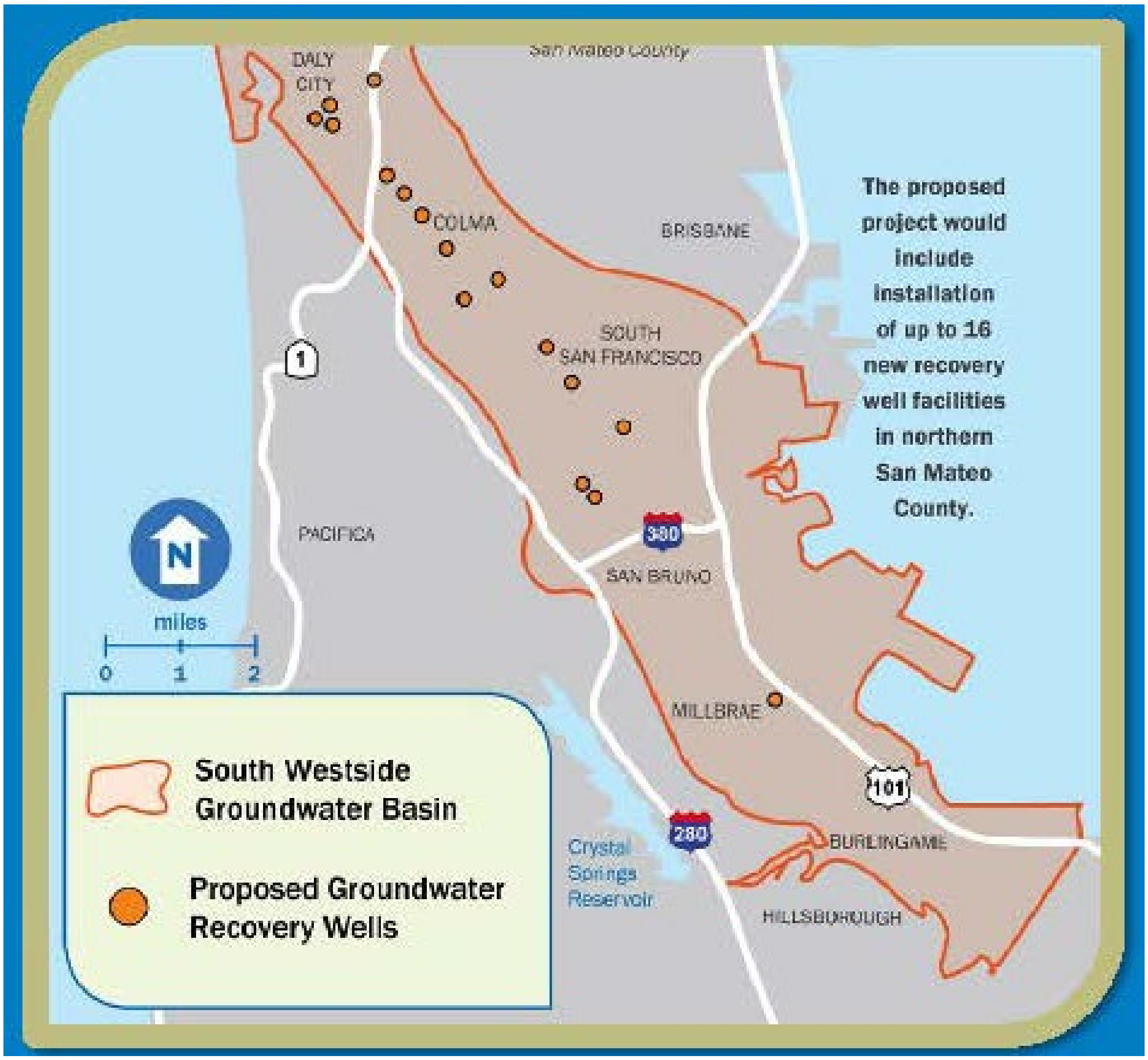

Figure 2-6. GSR project groundwater wells

Source: Bartow 2013

The WSIP GSR not only significantly benefitted the City by providing a water supply insurance policy, but also envisions a systemwide benefit as well. During the pilot program, SFPUC determined that a theoretical storage of about 61,000 acre-feet of additional water is available in the Westside Basin. As it has historically, the City plans to adjust the output of its wells and the flow rate of water it purchases from SFPUC to create a blend of water that consistently meets all water quality standards.

For further detail, see the City's *Permit Amendment to Domestic Water Supply System Number 4110013* (BC, 2016).

For more information, such as constraints and reliability of the GRS project, see the 2020 UWMP.

2.5.3 Emergency Interties

The City has 10 interties with neighboring water systems. These interties, shown in Table 2-4, are normally closed, and used to meet water demand during emergency situations.

Table 2-4. Emergency Interties

Intertie Agency	Address	Zone	Remarks
North Coast County Water District	Arcadia/Skyline	Zone 6	Two-way
North Coast County Water District	204 Kavanaugh, Pacifica	Zone 7	Two-way
North Coast County Water District	Gateway Drive	Zone 6	Two-way
California Water Service Company	Bradley/Southgate	Zone 5	To CWS
California Water Service Company	Second Ave/South of Valley	Zone 3	To CWS
California Water Service Company	Imperial Way/Hickey	Zone 5B	To CWS
Westborough Water District	King/Callan	Zone 7	To WWD
Westborough Water District	Christen Hill	Zone 7	Two-way
City of Brisbane/Guadalupe Valley Municipal Improvement District	Carter St/Guadalupe Valley Parkway	Zone 9	Two-way
City of Brisbane/Guadalupe Valley Municipal Improvement District	Main Street/Linda Vista Drive	Zone 9	To City of Brisbane

CWS: California Water Service Company
NCCWD: North Coast County Water District
WWD: Westborough Water District

2.6 Pressure Zones

The water system is divided into 19 active pressure zones that manage delivery pressures to customers. The zones' service elevations range from 34 feet (ft) to 737 ft. Table 2-5 lists the pressure zones, the hydraulic grade line (HGL) of each zone, and the highest and lowest elevations of customers in each active zone. Figure 2-7 provides the pressure zone map. The service elevations presented in Table 2-5 and the hydraulic profiles are taken from junction elevations retained throughout the hydraulic model. Potential outliers and junctions near PRVs were verified using county elevation contours and topography provided by Google Earth Pro. The City's water system includes five pressure zones within the City boundaries that are not in the City's service areas: Cal Water, Franciscan Res, Franciscan Reduced, Master Meter, and Reclaimed.

Table 2-5. Water System Pressure Zones						
Pressure Zone	HGL (ft) [a]	Service Elevation (ft)		Static Pressures (psi) [b]		Geographic Category
		Low	High	At Low Elev	At High Elev	
Zone 4	405	34	300	161	36	West
Zone 5/5B	555	210	448	149	36	West
Zone 6/6B	685	370	656	136	0	West
Zone 6-Reduced	568	194	434	162	24	West
Zone 6-Reduced Zone A	592	357	502	102	37	West
Zone 6-Reduced Zone B	493	230	377	114	48	West
Zone 7	768	488	700	121	10	West
Skyline Zone	785	545	656	104	52	West
Zone 1	637	239	550	172	32	East
Zone 2/2B	779	396	705	166	21	East
Zone 2-Reduced	711	385	560	127	28	East
Zone 3	474	154	354	139	43	East
Zone 8	438	114	319	128	39	East
Alta Vista Zone	779	650	735	56	21	East
Bayshore Zone 1	311	15	150	115	56	East
Bayshore Zone 2	345	80	220	111	50	East
Bayshore Zone 9	438	262	400	76	4	East
Pointe Pacific Zone	779	647	737	57	35	East
South Hill Zone	-	-	-	-	-	East

a. Based on overflow elevation of the highest tank or the typical pressure of a pump station or PRV serving the zone.

b. Pressures for the low and high elevations calculated from the HGL.

psi = pounds per square inch

The system has several cross connections between the westside and eastside systems connecting Zones 4 and 3 as well as Zones 3 and 5.

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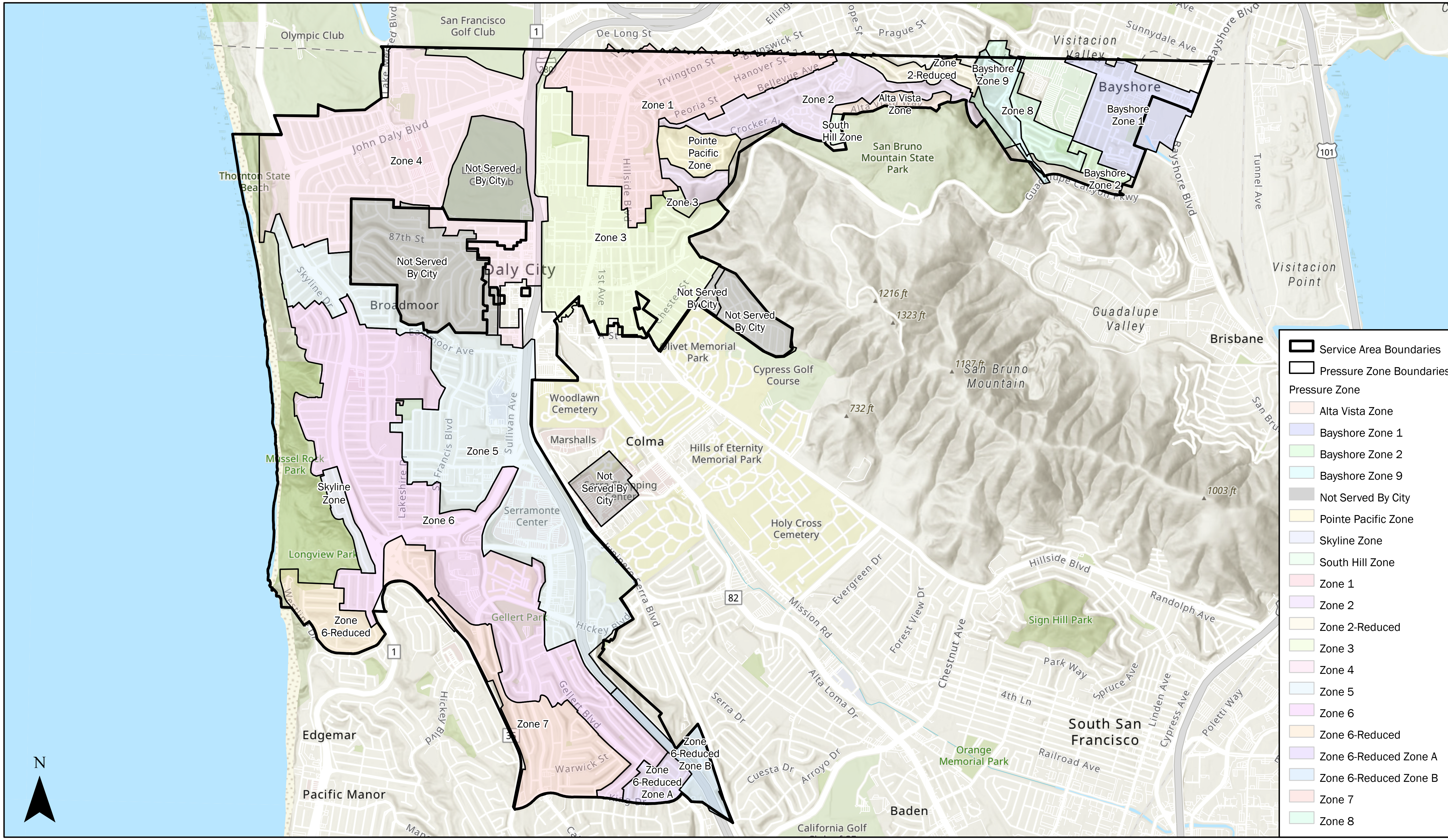

Figure 2-7. City Pressure Zones

Brown AND Caldwell

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2.6.1 Westside Section

The westside system is divided into eight pressure zones supplied by Sullivan Avenue, Park Plaza and Hickey aqueduct turnouts from SFPUC and well water from the Westlake Well at the Westlake PS. SPFUC well water will become available to the Westside section in 2023.

The westside pressure zones include:

- Zone 4
- Zone 5/5B
- Zone 6/6B
- Zone 6 Reduced
- Zone 6B Reduced A
- Zone 6B Reduced B
- Zone 7
- Skyline Hydropneumatic Zone

The westside pressure zones are described in this section.

Zone 4

Zone 4 is located primarily in the Westlake area and includes portions of the Sullivan corridor. The City does not serve the Lake Merced Golf and Country Club located in this area.

The Westlake neighborhood consists of a commercial shopping area along John Daly Boulevard, including the Westlake Shopping Center, and a few schools and surrounding residential development.

The Westlake PS delivers water from the Westlake sump to Zone 4 and RES 4. Westlake sump is supplied with a combination of SFRWS flow and well water. The Westlake well discharges into the Westlake PS sump for disinfection and for blending with water from the SFRWS turnouts. SFRWS has constructed two additional wells (Park Plaza and Ben Franklin), which by 2023 will come online. The SFRWS supply originates from either the Park Plaza turnout (60-inch-diameter Sunset aqueduct) and the Sullivan/87th Street turnout (54-inch-diameter San Andreas #2 aqueduct). The City adds sodium hypochlorite and ammonia to the well water to achieve a chloramine disinfectant residual of 2.0 to 2.8 milligrams per liter (mg/L). The City also adds sodium fluoride to its well water to match the fluoride concentration in SFPUC water (0.6 to 1.2 mg/L). By blending well water with SFRWS water, the City achieves a nitrate concentration of 9 to 19 mg/L (as nitrate), which is well below the maximum contaminant level of 45 mg/L.

RES 4 has a capacity of 1.37 million gallons (MG) and floats off the pressure zone. The four pumps at Westlake PS have a maximum capacity of 3,525 gpm. A second emergency source of SFPUC water can bypass the PS. This flow is drawn from the Sullivan Avenue aqueduct turnout at up to 6.5 mgd but at a lower system pressure. Static pressure from the aqueduct currently brings water to within 15 or 20 feet of the bottom of RES 4 under average conditions. Under the best conditions, water may reach the bottom of the tank.

The backbone of this zone’s distribution system is made up of 12-inch-, 14-inch-, and 16-inch-diameter water mains principally located in South Mayfair Boulevard, Southgate Avenue, and 87th Street. Other distribution lines in the area are mostly 4-inch- and 6-inch-diameter lines.

Pressure Zone 5

Zone 5 includes two distinct areas of the City. The southern section includes Serramonte Shopping Center and the surrounding residential development along Interstate 280. The northern sections of this zone include a medical center, two schools, and surrounding residential development.

Historically, flow from A Street Well, located just north of Woodlawn cemetery, is typically combined with SFPUC flow from the B Street aqueduct turnout (54-inch-diameter San Andreas #2 aqueduct) and Hill aqueduct turnout (out of service). The water is disinfected with chloramine (via addition of sodium hypochlorite and ammonia), fluoridated with sodium fluoride, and then pumped from the A Street Booster Station into Zone 5. The City adds sodium hypochlorite and ammonia to the well water to achieve a chloramine disinfectant residual of 2.0 to 2.8 mg/L. Historically, blending for nitrate reduction yields a blended water concentration of 24 to 38 mg/L (as nitrate). Because of recent elevated nitrate levels, the City has taken the A Street Well offline and is assessing options for nitrate control and/or removal.

SFRWS water from the Hickey Boulevard aqueduct meter turnout provides water for Zone 5; water is stored at RES 5 (1.481 MG capacity) and RES 5B (10.3 MG capacity). The turnout feeds Hickey PS, which provides a maximum capacity of 3,452 gpm. Additionally, RES 4 PS provides water to Zone 5 from Zone 4. RES 4 PS has a maximum capacity of 1,785 gpm.

Pressure Zones 6, 6-Reduced, 6B-Reduced A, and 6B-Reduced B, Skyline

Zone 6 covers the extreme west and south portions of the City, generally paralleling Skyline Drive. It mainly serves residential neighborhoods and several schools in the west but has commercial development in the south, near King Drive and Gellert Boulevard.

Zones 6 and 6B are geographically distinct but operate at the same hydraulic grades over the same range of elevations. Zone 6 proper covers the northern Skyline Drive area extending south to Serramonte Boulevard. Zone 6B extends south from Serramonte Boulevard generally along Gellert Boulevard.

Zone 6/6b has two main sources of water supply. RES 5 PS (2,030 gpm, maximum capacity) and 5B PS (2,740 gpm, maximum capacity) deliver water to Zone 6/6B. Gellert PS on Gellert Avenue, which could bring water from Zone 5/5B into Zone 6/6B, is currently out of service. RES 6 (1.495 MG capacity) and RES 6B (1.451 MG capacity) provide storage for Zone 6/6B. A connecting water main between the reservoirs maintains Zones 6 and 6B at the same HGL. Skyline Hydropneumatic PS delivers water to the Skyline Zone at a maximum flow of 1,784 gpm.

Water from PRVs in Zones 6/6B serve three reduced-pressure zones. Zone 6-Reduced serves the Roosevelt School area west of Skyline Drive. Zone 6B-Reduced A and Zone 6B-Reduced B serve the southernmost portions of the City. Three PRVs located on Longview Drive, Skyline Drive, and Belcrest Avenue deliver water to Zone 6-Reduced. Two PRVs in King Drive and Gellert Boulevard supply water to Zone 6B-Reduced A. Another PRV in King Drive near the intersection with Gellert Boulevard delivers water from Zone 6B-Reduced A to Zone 6B-Reduced B.

Pressure Zone 7

Zone 7 extends south from Serramonte Boulevard along Skyline Boulevard to the City limits. Zone 7 is a mix of residential and commercial use and includes the Callan Boulevard neighborhood, Skyline School, and King Plaza. RES 6B PS delivers water from Zone 6 to the south portion of Zone 7 at a maximum flow of 1,600 gpm. Reservoir 7, with a storage capacity of 1.487 MG, serves the zone from its location west of Skyline Boulevard near King Plaza.

2.6.2 East Section

The eastside system has 11 active pressure zones supplied by B Street, Sullivan North, Guttenberg, Geneva & Allan, Allan-Midway, and McDonald aqueduct turnouts and well water from Junipero Serra, Jefferson, Well No. 4, and Sullivan wells. The eastside system also has connections to Hill and Carter inactive turnouts, an emergency intertie with Franciscan Bay Estates, and two inactive wells (A Street and Vale). Flow from the Vale Well normally supports East Section demands. Although now out of service, the City plans to re-drill and re-equip Vale Well.

Bayshore Subdivision

Three pressure zones serve the City In the Bayshore subdivision:

- Zone 8
- Bayshore Zone 1
- Bayshore Zone 2
- Zone 9

The Bayshore Subdivision includes the easternmost zones in the City's water system. Zone 8 primarily serves attached single-family residential units. The major commercial street in the area is Geneva Avenue. The Cow Palace, a facility that accommodates major sporting events and shows, is located on Geneva Avenue and receives water directly from SFPUC. Midway Village is privately owned and serviced but also obtains its water through Daly City from the SFPUC turnouts.

Bayshore Heights Booster Station delivers water to Zone 8/Reservoir 8 by two pumps up to RES 8 at a maximum flow of 1,300 gpm. RES 8 provides a storage capacity of 0.63 MG.

Bayshore Zone 1 receives its supply using the head available from the SFPUC Geneva & Allan, Allan-Midway, and McDonald meter turnouts at Bayshore (60-inch-diameter Crystal Springs aqueduct). Bayshore 1 is intended to be served directly, with no pressure reduction, from the SFPUC turnouts; however, Bayshore 1 currently operates under pressure reduction due to unacceptably high pressures that occur in lower areas of the zone.

Bayshore Zone 2 is a pressure-reduced zone of Zone 8. Zone 2B-Reduced (Citrus Section) can supply RES 8 when needed for reserve capacity. RES 8 PS can supply RES 2B and provides the water system's east-to-west redundancy.

Zone 9 draws its water from Reservoir 2B through a PRV in Tank 8 PS. The zone serves an area topographically above and southwest of Zone 8.

Citrus Subdivision

The Citrus Section has eight active pressure zones:

- Zone 1
- Zone 2/2B
- Zone 2/2B-Reduced
- Alta Vista Hydropneumatic Zone
- Pointe Pacific Hydropneumatic Zone
- South Hill Hydropneumatic Zone
- Zone 3
- Zone 9

Pressure Zone 1

Zone 1 consists of schools, commercial development, and surrounding residential areas. RES 1, located on Pointe Pacific Drive above Bellevue Avenue, has a capacity of 0.703 MG. Pumps 1, 2, and 3 in the Citrus PS supply this reservoir. This zone's distribution system includes 12-inch-diameter water mains located in Wellington Avenue, Knowles Avenue, and San Diego Avenue. Other water lines are primarily 6 and 8 inches in diameter.

Citrus PS (5,867 gpm, maximum capacity) pumps directly to both Zone 1 and Zone 3, where RES 1 (0.7 MG capacity) provides storage for Zone 1. Water from Sullivan, Junipero Serra, Jefferson, Well No. 4, and Vale (out of service as of February 2020) wells pumps directly into the Citrus PS sump for disinfection with chloramine (via addition of sodium hypochlorite and ammonia) and blending with SFRWS water from the Sullivan North turnout (54-inch-diameter San Andreas #2 aqueduct). The City adds sodium hypochlorite and ammonia to the well water to achieve a chloramine disinfectant residual of 2.0 to 2.8 mg/L. The City also adds fluoride sufficient to match the fluoride concentration in SFRWS water. Blending for nitrate reduction yields a blended water concentration of 19 to 41 mg/L (as nitrate).

Pressure Zones 2, 2B, 2B-Reduced, Alta Vista, Pointe Pacific, South Hill, and Zone 9

Zones 2 and 2B encompass the Southern Hills area and portions of the Crocker neighborhood. The zones are geographically distinct but operate at the same hydraulic grades over the same range of elevations. The development in these areas is predominantly residential housing.

Zones 2 and 2B include two reservoirs—RES 2 (2.3 MG) and RES 2 (2MG) —and three hydropneumatic tanks. Zone 2B also supplies a reduced-pressure zone, Zone 2B-Reduced. These zones have two sources of supply. The Bellevue PS transfers SFRWS water (Guttenberg turnout) into Zones 2 and 2B at a maximum rate of 395 gpm. The suction valving can be changed to a Zone 1 feed when needed. RES 1 PS is the second source, which pumps from RES 1 for a maximum flow of 1,109 gpm.

Zones 2 and 2B include the Alta Vista hydropneumatic tank and the Alta Vista Booster Pumping Station. These components serve the Alta Vista Zone, along Alta Vista Way, via a 12-inch-diameter water main. The pump station provides a maximum flow of 1,131 gpm.

The Pointe Pacific booster area is southwest of RES 2. The area is supplied by the Pointe Pacific Booster Pumping Station pneumatic tank, which draws flow from RES 2 and lifts flow up to the Pointe Pacific pneumatic tank and out to the service area.

The South Hill booster area along South Hill Boulevard is located south of the Alta Vista booster area. The South Hill Booster Pumping Station delivers water to the area at a maximum flow of 1,900 gpm.

Zone 2B-Reduced is north of the Alta Vista area. PRVs from Zone 2B deliver water to the area. Zone 9 is just east of the South Hill and Alta Vista zones. A PRV from Zone 2B provides water to the area. Additionally, Zone 9 is connected to the City of Brisbane intertie for emergency demand situations.

Pressure Zone 3

Zone 3, located in the original Daly City, Hillside, and Mission Street redevelopment areas, serves a mixed-use occupancy with predominately residential development, but also some schools and retail and commercial areas. RES 3, located near the intersection of Thiers and Orange streets, is currently out of service.

A Street PS includes a PRV that allows transfer of water from Zone 5 into Zone 3. Zone 3 also has connections to Zone 4 at four PRVs on Washington Street/Sullivan Avenue and John Daly Boulevard.

The distribution system in this zone includes major mains located in Reiner Street, Mission Street, Price Street, Bismark Street, Citrus Street, Niantic Avenue, and Junipero Serra Boulevard. Other water lines in this area are primarily 4-inch-diameter lines.

Franciscan Bay Park Reservoir is a private facility serving a mobile home park. It has a capacity of 0.285 MG and is located near Franciscan Drive in the southeast comer of Zone 3. The Franciscan Bay Park PS includes two pumps that supply either the mobile home park or the reservoir and provide a maximum flow of 150 gpm.

2.7 Piping

The water system consists of 200 miles of pipes with diameters ranging from 0.75 inches to 16 inches (in). Table 5-1 and Table 5-2 in Section 5 list the length of modeled piping by diameter and material. Pipe diameters and materials are from the City's GIS as of May 2020. As shown on Figure 2-8 about 38 percent of the pipelines are asbestos cement (AC) pipes and 18 percent are cast iron (CI) pipes. Figure 2-8 also provides a breakdown of the linear feet of each pipe diameter by material type. About 77 percent of the water pipelines are 10-inch diameter or less.

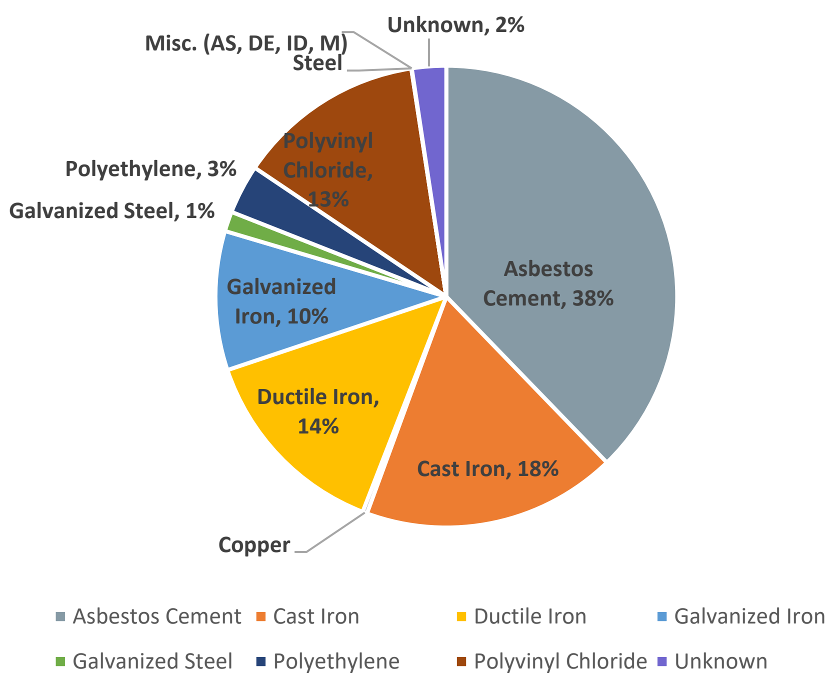

Figure 2-8. Water system piping material summary

2.7.1 Critical Pipes (as identified in the 2020 Risk and Resiliency Assessment)

Pipes critical to the water system typically include pipes that, if isolated, would result in a service outage to a specific area or zone, have limited redundancy, or require complicated repair. For this study, BC used the critical pipes identified as part of the 2020 Risk and Resiliency Assessment (RRA). The RRA assessment identified several pipelines as critical based on a lack of redundancy or potential impacts to customers (such as a complicated repair that may require more than 24 hours to restore service). Section 5 of this report contains the full water system pipe risk analysis.

Table 2-6 identifies the water system's critical pipelines.

Table 2-6. Critical Pipelines

Pipeline	Diameter, in	Length, ft[a]
10-in, 12-in and 16-in discharge pipelines from Citrus PS, up to RES 1 for Zone 1 and up to Mission Street for Zone 3	10 12 16	1,400 5,900 1,400
8-in and 12-in pipelines located between RES 2 and RES 2B	8 12	3,700 5,200
12-in pipeline, RES 2B to RES 8	12	2,900
12-in pipeline connecting RES 6 to RES 6B	12	13,000
12-in discharge pipelines from RES 6B PS and RES 7	12	3,000

a. *Assumed length used for estimated cost replacement purposes only*

2.8 Storage

The City's water system has 10 reservoirs with a total capacity of 23.3 MG. RES 1 and RES 3 are the oldest at 106 and 88 years, respectively. RES 3 has been out of service since 2016. Most of the reservoirs are concrete, but two reservoirs are steel. Table 2-7 summarizes key locations and key characteristics for the City's reservoirs.

2.9 Pump Stations

The City's water system has 19 pump stations, which are summarized in Table 2-8.

2.10 Control Valves

The water system includes PRVs, pressure relief valves, altitude valves, and surge valves described in Table 2-9 through Table 2-12. These tables do not list isolation valves between pressure zones.

Table 2-7. Water System Reservoirs							
Name	Location	Diameter (ft)	Floor Elevation (ft)	Height to Overflow (ft)	Construction	Year Built	Capacity (MG)
Reservoir 1[a]	400 Pointe Pacific Drive (two separate bays)	94	637	624	Concrete	1916	0.7
Reservoir 2	600 Pointe Pacific Drive	125	779	754	Concrete	1995	2.3
Reservoir 2B	57 Alta Vista Way (updated to 2 MG in 2012)	73	756.5	820.5	Concrete	2012	2.0
Reservoir 4	799 Southgate Avenue	105	405	384	Concrete	1955	1.4
Reservoir 5[a]	515 Westmoor Avenue	107	555	533	Concrete	1956	1.5
Reservoir 5B[a]	65 Margate Street	296	550	530	Concrete	1974	10.3
Reservoir 6	815 Skyline Drive (rebuilt In 1994/contains small inner tank)	92	685	655	Concrete	1960, 1994	1.5
Reservoir 6B	7 Nelson Court	92	684	655	Concrete	1996	1.5
Reservoir 7	2300 Skyline Boulevard (repainted interior and exterior in 1997)	75	768	723	Steel	1962	1.5
Reservoir 8	850 Saddleback Drive	64	438	410	Steel	1987	0.6
Total Capacity (gallons)							23.3

a. Reservoirs 1, 5, and 5B are rectangular, but have been converted to equivalent volume circular reservoirs for modeling purposes.

Table 2-8. Pump Stations					
Name	Capacity, gpm		Number of Pumps	Zone[b]	Storage
	Total Capacity	Firm Capacity[a]			
A Street PS	2,250	1500	3	Zone 3	RES 3
Alta Vista PS	1,131	565	2	Alta Vista Zone	RES 2B
Bayshore PS	1,000	500	2	Zone 8, Bayshore Zone 1/2	RES 8
Bellevue PS	395	190	2	Zone 2/2B	RES 2
Citrus PS: Zone 1	3,100	1,600	3	Zone 1	RES 1
Citrus PS: Zone 3	2,767	1,567	3	Zone 3	RES 3
Hickey PS	3,452	2,292	3	Zone 5/5B	RES 5B
South Hill PS	1,900	400	3	South Hill Zone	RES 2B
Westlake PS	3,525	2,580	4	Zone 4	RES 4
RES 1 PS	1, 109	461	2	Zone 1/2	RES 1/2
RES 2 PS or Point Pacific PS	6,000	3,500	3	Pointe Pacific Zone	RES 2
RES 4 PS	1,785	1,190	3	Zone 4/5	RES 4/5
RES 5 PS	2,030	630	2	Zone 5/6	RES 5B/6
RES 5B PS	2,740	1,040	2	Zone 5/6	RES 6B
RES 6 PS or Skyline PS	1,784	234	3	Skyline Zone	RES 6
RES 6B PS	1,600	800	2	Zone 6B/7	RES 6B/7
RES 8 PS	1,300	650	2	Zone 8/2B	RES 8/2B
Gellert PS	605, Standby	276	1	Zone 6/6B	RES 6/6B
Higate PS	560, Standby	280	2	Zone 7	RES 7
Franciscan Bay PS	150, Standby	50	2	Franciscan Zone	Franciscan RES

Source: BC gathered this information from correspondence with City personnel, later verified in the RRA workshop.

a. Capacity with largest pump out of service

b. Number of pumps refers to all pumps including standby pumps.

Table 2-9. Water System Pressure-reducing Valves						
Name	Valve Size (in)	From Zone	To Zone	Pressure Setting (psi) [a]		Valve Status
				Upstream Hydrant	Setting	
S Parkview Avenue/Willits Street	4	1	3	170	83-HYD	Closed
N Parkview Avenue/Woodrow Street	8	1	3	--	80	None
Just north of Citrus PS	8	1	3	175	110	Closed
John Daly Boulevard/Ponetta Drive	8	3	4	155	110	Closed
John Daly Boulevard/Ponetta Drive	3	3	4	155	110	Closed
Washington Street/Sullivan Avenue	8	3	4	--	--	--
St. Francis/Serramonte Boulevard	8	7	6/6B	90	65-HYD	Closed
Bayshore PS	6	8	Bayshore 1	123	70	Closed
Bayshore PS	6	8	Bayshore 2	130	100	None
Bayshore PS #2	2	8	Bayshore 2	130	100	None
BS9-BS1 PRV	12	Bayshore 9	Bayshore 1	--	100	Closed
2B-Reduced to BS9 PRV	10	2B-Reduced	Bayshore 9	--	30	None
Z9-Z8-PRV ALT 801	12	Bayshore 9	8	--	0	Closed
Florence Street/Mountain View Drive	6	2/2B	1	100	60-HYD	Closed
Bellevue PS	6	2/2B	1	145	95-HYD	Closed
"Proposed Project" Lausanne Ave near Bellevue PS	12	1	PPZ	--	35	Closed
South Hill Boulevard and Bellevue Avenue	2	2/2B	2B-Reduced	110	55	Closed
South Hill Boulevard and Bellevue Avenue	6	2/2B	2B-Reduced	110	45	Closed
Bolero Way/South Hill Boulevard	4	2/2B	2B-Reduced	107	50	None
Oakridge Drive/Alta Vista Way	6	2/2B	Z8 PS (Z9 and Z8)	85	38	None
A Street PS, 100 gpm	8	5/5B	3	155	126	Closed
Zone 5-4 Zone Valve, 0 psi Setting, Sullivan Ave/San Pedro Rd	8	5/5B	4	--	--	None
Junipero Serra Boulevard/Serra Center	10	5/5B	Serra Shopping Center	170	68	None
Junipero Serra Boulevard/Serra Center	3	5/5B	Serra Shopping Center	170	70	None

Table 2-9. Water System Pressure-reducing Valves

Name	Valve Size (in)	From Zone	To Zone	Pressure Setting (psi) [a]		Valve Status
				Upstream Hydrant	Setting	
Southgate Avenue and Alpine Avenue	6	6/6B	5/5B	95	50-HYD	Closed
Callan Boulevard/Clarinada Avenue	6	6/6B	5/5B	122	50	Closed
Lakeshire Drive/Southgate Avenue	6	6/6B	5-5B	130	66	Closed
Serravista Ave and Victoria St (ID: 9015)	8	6/6B	5-5B	-	80	None
Skyline Drive/Arcadia Drive	8	6/6B	6 Reduced	110	43	None
Skyline Drive/Arcadia Drive	2	6/6B	6 Reduced	110	32	None
Gellert Boulevard/Verducci Court	6	6/6B	6B-Reduced A	76	38	None
Gellert Boulevard/Verducci Court	3	6/6B	6B-Reduced A	76	38	None
King Drive/Brighton Court	6	6/6B	6B-Reduced A	76	40	None
King Drive/Brighton Court	3	6/6B	6B-Reduced A	76	38	None
Longview Drive/Westline Drive	2	6/6B	6-Reduced	95	45	None
Longview Drive/Westline Drive	6	6/6B	6-Reduced	95	35	None
Longview Drive/Belcrest Avenue	2	6/6B	6-Reduced	115	85-HYD	None
Gellert Boulevard/King Drive	3	6B-RED.A	6B-Reduced B	95	50	None
Gellert Boulevard/King Drive	6	6B-RED.A	6B-Reduced B	95	48	None
Franciscan Pump Station	6	Franciscan	3	90	--	None

Table 2-10. Water System Pressure Relief Valves				
Name	Valve Size (in)	From Zone	To Zone	Setting
RES 4 PS	4	5	4	81
RES 5 PS	4	6	5	65
Skyline PS	6	Skyline	6/6B	60-HYD
Westline Drive and Belcrest Avenue	4	6-Reduced	Drain	125
South Mayfair Avenue at Westlake Shopping Center	4	4	Drain	146
Westlake PS	4	4	Clear Well	138
A Street PS	2	SFPUC	Drain	70
Pointe Pacific PS	8	Point Pacific	2/2B	76
RES 6B PS	6	7	6/6B	65
Gellert Boulevard and Verducci Court	2	6/6B	Drain	80-HYD
King Drive and Brighton Court	3	6/6B	Drain	125
Gellert Boulevard and King Drive	3	6B-Reduced A	Drain	85-HYD
King Drive and Hyde Court	4	6B-Reduced B	Drain	95
South Hill PS	6	South Hill	2B	--
Mira Vista Court	4	2/2B	Drain	125
Alta Vista PS	6	Alta Vista	2/2b	85-HYD
Bayshore PS	2	8	Drain	70
Citrus PS 1	--	1	Clear Well	--
Citrus PS 3	--	3	Clear Well	--

Table 2-11. Water System Altitude Valves					
Name	Valve Size (in)	From Zone	To Zone	Pressure Setting (psi)[a]	Valve Status
RES 8	4	2/2B	8	--	Closed

Table 2-12. Water System Surge Valves					
Name	Valve Size (in)	From Zone	To Zone	Pressure Setting (psi) [a]	Valve Status
"A" Street Pump Station	4	3	Drain	140	Open
"A" Street Pump Station	4	5	Drain	100 - 148	Open
Bayshore Pump Station	4	8	Drain	120 - 175	Closed

Section 3

Historical and Projected Water Use

This section describes the data and steps used to calculate and allocate model demands within the City. BC allocated existing model demands using water billing data and production data. We based future model demands on the City's demand projections for the year 2045, drawn from the 2020 UWMP (BC 2021).

3.1 Land Use Evaluation

This section summarizes current and future land use information provided in the City's General Plan, Specific Plan, and land use maps.

3.1.1 Current Land Use

The 2030 General Plan (City of Daly City, 2013) provides current and future land use maps. The City is predominantly residential with several educational institutions and commercial use areas. The City also has 500 acres of recreation, including a 400-acre area of recreation on the west side of the City. The City is a center for retail trades, primarily home furnishings and appliances, apparel, general merchandise, and eating and drinking establishments. Major shopping areas include the Serramonte Shopping Center, Westlake Shopping Center, Pacific Plaza, and the Mission Street retail corridors.

3.1.2 Future Land Use

According to the 2030 General Plan, the City does not project that future land use will change substantially from existing land use, with most of the land remaining as low-density residential use. The future land use includes the following major changes from existing land use:

- The Midway Village located to the east of Cow Palace Arena & Event Center is expected to transform from low-density residential to high-density residential.
- The Broadmoor neighborhood, previously undeveloped, is expected to be developed into low-density residential.
- The Pointe Pacific neighborhood is redeveloped from high density to low density or open space.
- The previously undeveloped lot neighboring the Cow Palace Arena & Event Center in the northeast quadrant of the City is intended for retail and office land use.
- eaves Daly City, an apartment complex in the southwest area of the City, is expected to convert from high- to medium-density residential use.
- Development along Sullivan Avenue and San Pedro Road is expected to be revised according to the Sullivan Corridor Specific Plan and BART Station Area Specific Plan, respectively.
- A recreation area owned by San Mateo County in the northwest boundary is added to the land use map.
- The west recreation strip official land use designation was revised from open space to open space preservation.

3.2 Existing Demands

BC allocated existing water demands to the InfoWater model from 2019 billing and 2020 production data. The City provided customer billing data for 2017 through 2019 and production data (SFPUC turnout flows) for 2018 and 2020.

3.2.1 Water Production

The City provided monthly SFPUC turnout flows for 2018 and hourly SFPUC turnout meter data for 2020. In 2020, the City drew no water from its wells because it was operating in conjunctive use mode based on its agreement with SFPUC.

Figure 3-1 shows daily water production for 2020.

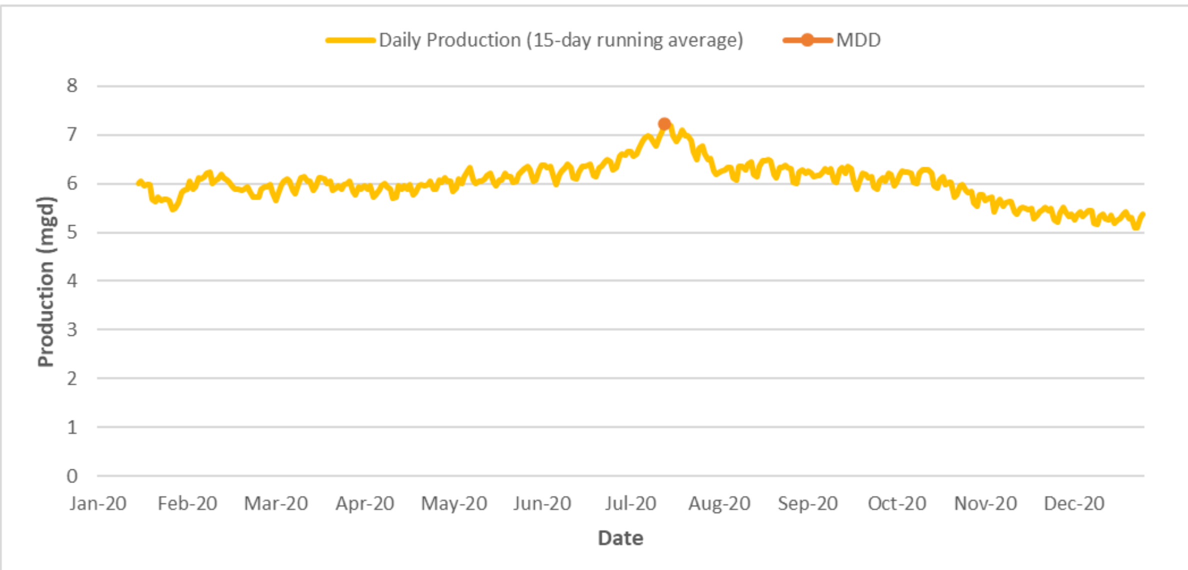

Figure 3-1. Historical water production

Average day demands (ADD), maximum day demands (MDD), and maximum (max) month demands were calculated for 2018 and 2020 from monthly and daily water production data, respectively. Table 3-1 lists ADD, MDD, and max month demands for 2018 and 2020. Appendix H provides detailed tabular information of water demand by pressure zone.

Table 3-1. Existing Water System Demands

Year	ADD (mgd)	MDD (mgd)[a]	Max Month (mgd)	Peaking Factors (MDD/ADD)
2018	6.11	Not available	6.90	Not available
2020 (used in model)	6.04	8.9	6.85	1.47

a. *MDD was not available for 2018 because only monthly production data was available. MDD date for 2020 was 7/9/2020. Production data for 2019 was not available.*

3.2.2 Non-revenue Water

Non-revenue water (NRW) commonly describes the difference between water production and billed water use. NRW includes the "sum of unbilled authorized consumption (water for firefighting, flushing, etc.) plus apparent losses (customer meter inaccuracies, unauthorized consumption, systematic data handling errors) plus real losses (system leakage and storage tank overflows)" (American Water Works Association [AWWA], 2012). Table 3-2 presents the estimated water loss from 2016-2019, taken from the 2020 UWMP. Data for the 2020 Fiscal year was not available for the UWMP and is not included.

Table 3-2. Water Loss Audit Reporting for 2016-2019

	Reporting Period Start Date			
	2016	2017	2018[b]	2019[c]
Volume of water loss, MG[a]	210	142	97	215

a. Volume of water loss from the field "Water Losses" (a combination of apparent and real losses) from the AWWA water audit worksheets.

b. In 2018 the reporting period start date was shifted from January to July, so 2018 shows a much lower loss than preceding and subsequent years.

c. Data from 2019 includes part of 2020.

3.2.3 Model Demand Allocation

BC derived model demands using billing data and NRW, with demand allocation performed using BC's customer demand allocation spreadsheet. The allocation approach assigned customer billing data to the model using the following four steps:

1. Geocode each customer (located geographically) by finding the actual location of each customer's address.
2. Flag model pipes if they could have demands assigned. Pipes that could not have demands assigned included pipes at tanks, pump stations, wells, control valves, and along transmission lines that do not serve customers.
3. Locate the closest pipe (that was flagged to allow demands) to each customer and assign the customer to the closest junction on that pipe, as shown on Figure 3-1.
4. Calculate the total customer demand at each junction as the sum of the demands of all customers assigned to the junction.

The process allocated NRW to the model using the following four steps:

1. Sum the total length of piping for the entire system.
2. Calculate an NRW per foot of pipe for each pressure zone (NRW in each zone divided by the length of pipe in each zone).
3. Calculate an NRW value for each pipe by multiplying the NRW per foot of pipe for the pipe's pressure zone by the length of the pipe.
4. Divide the calculated NRW value for each pipe in half. Assign each half to the pipe endpoint junctions (2 total junctions).

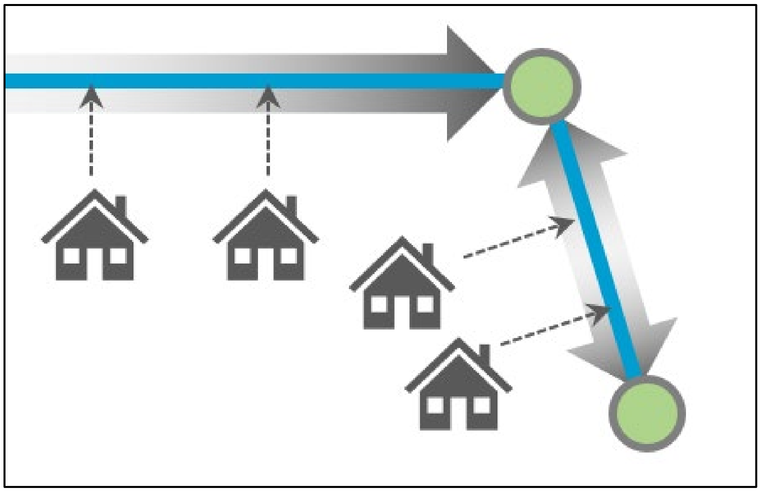

Figure 3-2. Customer demand allocation

BC completed the described demand allocation spreadsheet analysis. The spreadsheet results provided water use values for each of the City's InfoWater hydraulic model demand nodes. BC entered these spreadsheet values into the water system model discussed in Section 6 Water System Hydraulic Evaluation.

3.2.4 Diurnal Patterns

To develop an extended period simulation (EPS) model, a tool often used to more effectively simulate water system operation and component needs, the modeler needs to develop diurnal demand patterns. An EPS model runs for 24 hours or more, simulating changing demands and the operation of pumps and reservoirs. A diurnal pattern is a set of hourly peaking factors that represents fluctuations in demand over a 24-hour period. BC calculated diurnal patterns by adding flows into a zone (from a booster pump station, well, water treatment plant, intertie, or tank draining) minus flows out of a zone (to a booster pump station, intertie, or a tank filling) throughout a day. Typically, flows from PRVs would also be included in these calculations, but were omitted due to lack of PRV SCADA data.

BC opted to use a systemwide diurnal pattern instead of a diurnal pattern for each pressure zone. The patterns for the day used in calibration (June 12, 2020) was very similar to the pattern for the actual day of maximum demand (June 9, 2020). Figure 3-3 shows the selected diurnal pattern following review with the City, and Table 3-3 lists hourly peaking factors. The developed diurnal pattern is characteristic of a community with principally residential and commercial customers.

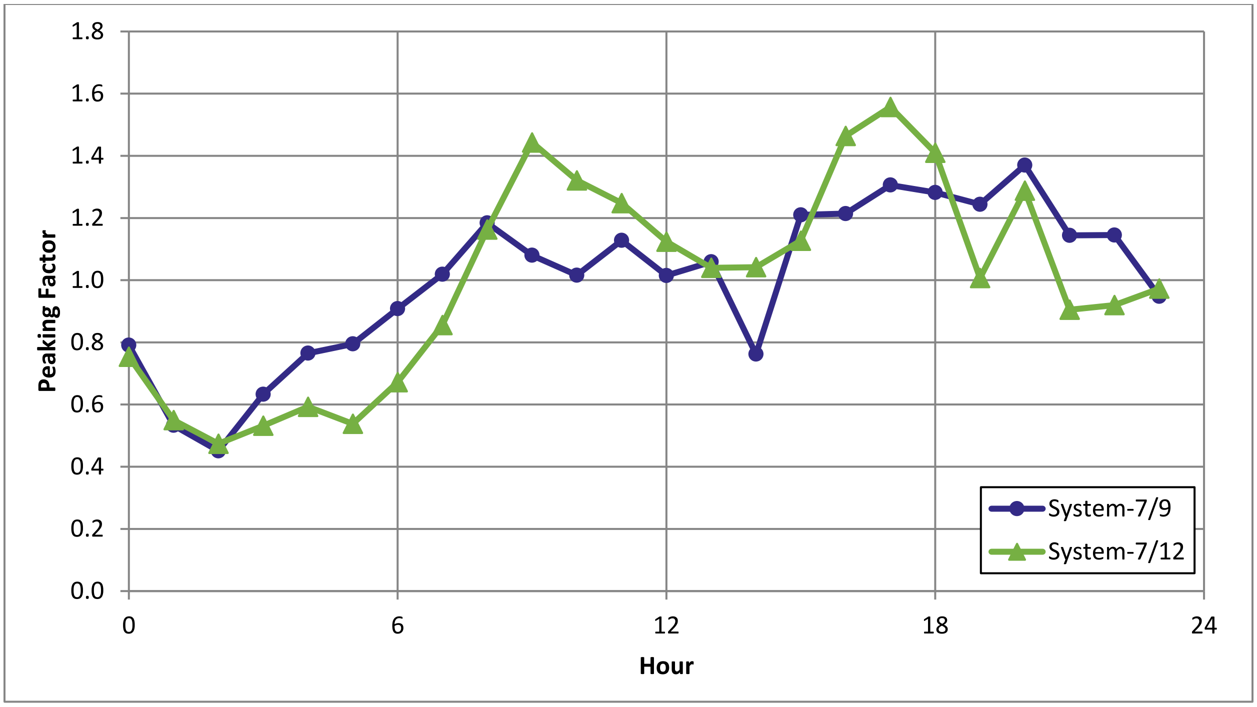

Figure 3-3. Diurnal pattern

Table 3-3. Diurnal Pattern Peaking Factors

Hour	Peaking Factor	Hour	Peaking Factor
1	0.97	13	1.25
2	0.75	14	1.12
3	0.55	15	1.04
4	0.47	16	1.04
5	0.53	17	1.13
6	0.59	18	1.46
7	0.54	19	1.56
8	0.67	20	1.41
9	0.86	21	1.01
10	1.16	22	1.29
11	1.44	23	0.91
12	1.32	24	0.92

3.3 Future Demands

The information presented in this section summarizes the 2020 UWMP future demands, which provide the systemwide overall demand projections. Section 6 Water System Hydraulic Evaluation discusses the methodology of distributing these systemwide overall demand projections from the UWMP onto water user connections represented as demand nodes in the InfoWater hydraulic model.

Table 3-4 presents future demand analysis from the 2020 UWMP (BC, 2021). The City projects future water use from the Bay Area Water Supply & Conservation Agency (BAWSCA) water projections using the BAWSCA-sponsored Decision Support System model that estimates demands through 2045. The projected water demands consider climate change, population growth, on-going water conservation programs, and future reductions in water use due to changing building codes and water efficiency policies. The reader should see the Daly City 2020 UWMP for more details. Owing to projected improved water use efficiency by City residents, annual water demands remain virtually unchanged over the next 20-plus years, even though the City population very likely will increase. From the 2020 UWMP, the City's population is projected to reach approximately 131,037 in 2045, which is approximately a 16 percent increase.

Table 3-4. (UWMP Table 4-1) Projected Potable Water Demands

Use Type	Additional Description	Projected Water Use (MG)[a]				
		2025	2030	2035	2040	2045
Single-family		1,100	1,080	1,073	1,076	1,081
Multi-family		491	481	476	476	477
CII	Commercial, Industrial, Institutional/Governmental	339	340	344	349	355
Landscape		55	56	58	60	61
Losses	Treated water retail distribution system	149	144	144	145	146
Total		2,134	2,101	2,095	2,106	2,120

a. *Demand projections include climate change demand increase and passive and active water savings as described in UWMP Section 4.3.*

3.3.1 DWR Demand Targets

For reader reference, the UWMP presents the anticipated State of California Department of Water Resources (DWR) demand targets compared to actual City water use (2020 UWMP). The City's reported daily per capita water use is well below the target, again demonstrating excellent water efficiency use by City residents.

Table 3-5 summarizes the City's baseline, target, and actual water use.

Table 3-5. Baseline, Target, and Actual Water Use

Baseline Period	Start Year	End Year	Average Baseline Water Use (gpcd)	Confirmed 2020 Target Water Use (gpcd)	Actual 2020 Water Use (gpcd)
10 to15 years	1995	2004	79	124	48
5 year	2003	2007	74		

gpcd = gallons per capita day

The City's actual 2020 water use is 48 gallons per capita day (gpcd) and easily complies with the 2020 DWR target of 124 gpcd. The City's per capita water use is among the lowest in the state.

Section 4

Model Development

This section describes attributes used in the model for six types of model facilities: junctions, pipelines, tanks, pumps, reservoirs, and valves.

The City's previous model was created in Innovyze's H2OMAP Water software. The model was converted to Innovyze's InfoWater software for this model update. The water model was last comprehensively updated in 2007, with partial updates occurring between 2011 and 2017.

4.1 General Model Attributes

Table 4-1 describes model attributes that apply to all facilities. Other tables in this section describe model attributes specific to each facility.

<table>
<tr><th colspan="6">Table 4-1. Common Attributes</th></tr>
<tr><th>Attribute</th><th colspan="5">Value</th></tr>
<tr><td rowspan="9">ID</td><td colspan="5">The Attribute field is a unique alphanumeric identifier for each facility as shown below.</td></tr>
<tr><th>Facility</th><th>Prefix</th><th>Zone</th><th>Unique Number</th><th>Sample ID</th></tr>
<tr><td>Junction</td><td>J</td><td></td><td>Unique number starting at 1</td><td>J-1000</td></tr>
<tr><td>Pipe in GIS</td><td colspan="4">Model ID is the GISID.</td></tr>
<tr><td>Pipe not in GIS (such as at pump stations)</td><td>P</td><td></td><td>Unique number starting at 1</td><td>P-1000</td></tr>
<tr><td>Pump</td><td>PMP</td><td>Pressure zone</td><td>Pump station and pump number, well pump name</td><td>PMP-Z1-DPPS-1</td></tr>
<tr><td>Storage tank</td><td>RES</td><td></td><td>Tank name or zone</td><td>RES-1</td></tr>
<tr><td>Reservoir</td><td>RES</td><td></td><td>Well or intertie name</td><td>RES-MCDONALD</td></tr>
<tr><td>Valve</td><td>FCV
PRV
PSV</td><td>Pressure zone, intertie, or water treatment plant</td><td>Name of valve</td><td>FCV-HICKEYTO
PRV-6-6R</td></tr>
<tr><td>Zone</td><td colspan="5">The pressure zone the facility serves</td></tr>
<tr><td>Year of installation</td><td colspan="5">A query for which facilities are active is based on this field. For the existing system scenario facilities with a construction year <= 2019 or blank are active; facilities with a construction year > 2019 are not active. This value may include:
• Year – The year a facility was constructed, from GIS
• Blank – If the year of construction was not in the GIS
• 2050 – Facilities to be constructed by 2050 (active in 2050 scenario)
• 9999 – Facilities in the GIS that are not active in the model (e.g., raw water piping)</td></tr>
<tr><td>Year of retirement</td><td colspan="5">This field was not used in the model but could be used along with a query to inactivate facilities if they are replaced in a future year.</td></tr>
</table>

PSV = pressure-sustaining valve

4.2 Model Elements

Model facilities were updated based on the system and facility information documented in Section 2. This section describes the attributes related to each model element.

4.2.1 Junctions

Model junctions were created at the ends of all pipes. Table 4-2 lists junction attributes.

Table 4-2. Junction Attributes

Attribute	Value
Elevation	Elevations were assigned from a GIS layer “Elev_Contour” supplied by the City
Demand 1	Existing demands from customer billing data (see Section 5 Water System Pipe Risk Analysis)
Pattern 1	Diurnal (daily water use) pattern based on the systemwide diurnal pattern (see Section 5)
LANDUSE	A field added to the model to store the land use from a City-provided land use shapefile
ZONE	A field added to the model to store the pressure zone in which the junction is located.

4.2.2 Piping

Model piping was updated to match the City’s GIS piping data as of May 2020. Table 4-3 lists pipe attributes. C-factors used take the age of the pipe into account and are reasonable and typical.

<table>
<caption>Table 4-3. Pipe Attributes</caption>
<tr><th>Attribute</th><th colspan="4">Value</th></tr>
<tr><td>Length</td><td colspan="4">Calculated in the model based on the GIS pipe length</td></tr>
<tr><td>Diameter</td><td colspan="4">Diameter from GIS</td></tr>
<tr><td>Material</td><td colspan="4">Pipe material from GIS</td></tr>
<tr><td rowspan="14">Hazen-Williams roughness (C-factor)</td><th colspan="2">Material</th><th>C-factor roughness</th><th>Source</th></tr>
<tr><td colspan="2">AC</td><td>140</td><td>InfoWater help</td></tr>
<tr><td colspan="2">Brass</td><td>130</td><td>Lindeburg</td></tr>
<tr><td rowspan="2">CI</td><td>Before 2015</td><td>100</td><td>Linsley</td></tr>
<tr><td>2015 or newer</td><td>120</td><td>Linsley</td></tr>
<tr><td colspan="2">Concrete</td><td>130</td><td>InfoWater help</td></tr>
<tr><td colspan="2">Copper</td><td>130</td><td>Lindeburg</td></tr>
<tr><td colspan="2">Ductile iron</td><td>130</td><td>Lindeburg</td></tr>
<tr><th colspan="2">Material</th><th>C-factor roughness</th><th>Source</th></tr>
<tr><td colspan="2">Galvanized steel</td><td>120</td><td>InfoWater help</td></tr>
<tr><td colspan="2">Polyethylene</td><td>140</td><td>InfoWater help</td></tr>
<tr><td colspan="2">PVC</td><td>140</td><td>InfoWater help</td></tr>
<tr><td colspan="2">Reinforced concrete cylinder pipe</td><td>130</td><td>InfoWater help</td></tr>
<tr><td colspan="2">Steel</td><td>120</td><td>Linsley</td></tr>
<tr><td>Check valve</td><td colspan="4">Set to “yes” if there is a check valve on a pipe; the check valve direction is the direction of the pipe.</td></tr>
<tr><td>Zone</td><td colspan="4">A field added to the model to store the pressure zone in which the pipe is located.</td></tr>
</table>

4.2.3 Storage Tanks

Table 4-4 lists storage tank attributes.

Table 4-4. Tank Attributes

Attribute	Value
Type[a]	Set to “cylindrical”
Elevation	Tank floor elevation from drawings
Maximum level	Tank overflow depth (or depth to top of tank if overflow not available) from drawings
Initial level	Water depth at the start of a day, set during calibration to match typical water levels
Diameter	Tank internal diameter from drawings
Tank mixing	Complete mixing

a. Reservoirs 1, 5, and 5B are rectangular, but were converted to equivalent volume circular reservoirs for modeling purposes.

4.2.4 Pumps

Each pump at a pump station and well were added to the model. Table 4-5 lists pump attributes.

Table 4-5. Pump Attributes

Attribute	Value
Type	Pump were set using the following, in order of preference: 1. Multiple point curve: the most accurate representation of a pump, used if a pump curve was available 2. Design point curve: pump design head and flow, used when a pump curve was not available 3. Constant power input: pump horsepower, used when the previous two options were not available
Elevation	Pump elevation from drawings or from GIS contours
Diameter	This field was not used and was set to 12 inches
Other attributes	The following attributes were entered depending on the selected pump type: 1. Curve: For multiple point curves, the name of the pump curve 2. Design Head (ft)/Design Flow (gpm): For design point curves, the design head and flow 3. Constant Power (hp): For constant power input, the pump horsepower

4.2.5 Control Valves

Table 4-6 lists model valve attributes. The table only lists PRVs and flow control valves (FCV). Isolation valves were modeled by closing a pipe and were not added to the model as valve features. Check valves were modeled by turning on the check valve option for a pipe.

Table 4-6. Valve Attributes

Attribute	Value
Type	Valves were set to one of the following: 1. PRV 2. FCV
Elevation	Valve elevation from GIS contours
Diameter	This field is for information only and does not affect results
Setting	Pressure (for PRVs) or flow (for FCVs). The settings were initially set based on information from the City, but some values were then adjusted during model calibration to better match recorded flows and pressures.

4.2.6 Reservoirs

Reservoirs were used to model the following:

- Wells – Wells were modeled with a reservoir representing the groundwater level. A pump was added to pump from the well into the distribution system.
- Interties – Interties were modeled with a reservoir representing the HGL of the neighboring agency. A flow control valve was added to control flow from the reservoir between the City and the neighboring agency.

Table 4-7 lists reservoir attributes.

Table 4-7. Reservoir Attributes

Attribute	Value
Type	All reservoirs were set to "Fixed Head"
Head	Elevation of intertie HGL, or well groundwater elevation

4.3 Controls

Two types of controls were used in the model:

- Initial node/pipe status – Sets the status of a feature at the beginning of a model run. Elements in the model have an initial status. In the model, initial status sets the initial setting of a pipe, pump, or valve to be either open or closed. Initial Status Control Settings were used for the following features:
  - Pipes – Model pipes have the option for an initial status option of "open" or "closed". The default pipe initial status value is "Open". In this model, setting a pipe initial status value to "closed" was used to simulate a closed isolation valve, such as at a pressure zone boundary.
  - Pumps – Similarly to pipes, pumps have the option of an initial status of "open" or "closed". Because pumps in this model are typically controlled through node/pipe control (see below), an initial pump status of "closed" means that the pump is closed at the beginning of a run. The pump can be turned on during the run as detailed below.
  - Valves – Set a valve to be closed. For example, FCVs and PRVs were closed in the model at some interties.
- Node/pipe control – Turns a feature on or off based on time or the status of another feature. Controls were set for the following features:
  - Pumps – Pumps were turned on or off based on tank levels or at a specific time of day to match actual operations seen in the SCADA data.

4.4 Calibration Field Work

A field testing plan was created, but no field testing was initially performed due to the ongoing drought conditions. The calibration field plan TM is located in Appendix B.

4.5 Hydrant Flow Calibration

Though no hydrant flow testing was performed because of drought conditions, the City spot checked a few locations based on the results from the fire flow model runs. Typically, hydrant flow tests are conducted to "stress" the distribution system so calibration data would reflect the system's reactions to a range of operating conditions. Results from City-performed tests are provided in Appendix F.

4.6 Operational Calibration

Operational calibration involved comparing model results to SCADA and field data records for July 12, 2020. The City provided SCADA data for tanks, turnouts, and pumps. A partial operational calibration was performed using the following steps:

- Entered tank levels and the status for each pump from SCADA records at 12 a.m. July 12, 2020.
- Scaled system demands to match actual demands for the calibration week.
- Added demands or inflows at interties.
- Ran the model to simulate the period of record.
- Compared model and field data for:
  - Tank levels
  - Pump on/off status and flows
- Adjusted model settings until model results matched SCADA and logger data. Model settings that were adjusted include:
  - Pump on/off settings based on tank levels
  - Pump variable-frequency drive settings if applicable
  - PRV/pressure sustaining valve pressure settings
  - Pipe roughness coefficients

The model calibration comparison plots of all SCADA and pressure logger points used for the model calibration are included in Appendix C. For facilities not listed in Appendix C, calibration could not be done because SCADA data was not available, or the facility was not active.

4.7 Model Calibration Conclusions and Recommendations

Overall, the model calibrated well for the operational calibration, and model results correlate well with actual field results. The calibration gives a good level of confidence that the model will be a good predictor of the actual water system performance over a wide range of operating conditions. Additionally, BC's previous work with modeling the City's water system supports this model calibration effort and overall modeling approach. Previous modeling efforts showed good to very good alignment between City field testing and model results, which supports key assumptions made throughout the modeling process in this model calibration effort.

Efforts that could be implemented to further improve calibration include:

- Performing a full calibration.
- Collecting additional data points, including intermediate valve flows (between pressure zones)
- Providing pressure data for pump stations
- Providing flow data for PRVs at zone boundaries to better quantify diurnal patterns vs. using a single system diurnal.
- Verifying quantity of flow feeding RES 3 Zone from RES 1 Zone.

- Verifying PRV status at Zone 1 and Zone 3 boundaries, including flow measurements if possible.

General items that may further improve calibration include:

- Verifying that pump curves accurately reflect current pump performance.
- Verifying pipe roughness coefficients through field testing.
- Verifying flow rates through PRVs on zone boundaries.

4.8 Demand Conditions

Table 4-8 lists the demand conditions that were used in the model scenarios. The existing and future demands are described in Section 3. Note that peak hour demand (PHD) was not modeled with a separate scenario but is included in the MDD scenarios as the hour of the highest peaking factor from the diurnal patterns. Section 6.3 provides a summary of each scenario.

Table 4-8. Demand Conditions

Scenario	Existing (2020) Scenarios		Future Scenarios		Notes
	(mgd)	(gpm)	(mgd)	(gpm)	
ADD	5.5	3,851	5.46	3,795	Existing: See Table 3-1 Future: Table 3-4
MDD	8.2	5,721	8.15	5,659	

4.9 Supply Conditions

Table 4-9 lists the City's existing and planned wells. Existing well information is from Table 2-3. The capacity shown in Table 2-3 is assumed to be typical flow rate rather than well capacity or pump capacity.

Table 4-9. Existing and 2050 Groundwater Wells

Well Name	Capacity, gpm	Service Zone	Pump Station Connection	Operation Status
Well 4	426	RES 1/3	Citrus PS	Active
Jefferson Well	340	RES 1/3	Citrus PS	Active
Junipero Serra Well	550	RES 1/3	Citrus PS	Active
Sullivan Well	500	RES 1/3	Citrus PS	Active
Vale Well	693	RES 1/3	Citrus PS	Out of Service
A Street Well	524	RES 3	A Street PS	Not used due to nitrate levels (2015)
Westlake Well	410	RES 4	Westlake PS	Active
Ben Franklin Well (2023)	600	RES 4	Westlake PS	Future
Park Plaza Well (2023)	600	RES 4	Westlake PS	Future

Source: 2020 BAWSCA workshop feedback

The wells in the system were modeled based on the capacities and operational status given in table 2.3, which includes the well service zone and pump station connection. Well flows were calibrated based on SCADA flow data, when available. SCADA was used to match existing system conditions for the day of calibration.

4.10 Model Scenarios

Three existing system scenarios and three future system scenarios were set up in the model. Each scenario represents a different combination of demand conditions and operational settings. Each scenario, except for the fire flow scenarios, were created as 24-hour dynamic EPSs. Both the existing and future evaluation scenarios included MDD, MDD and Fire Flow, and ADD scenarios. PHD was not modeled with a separate scenario but is included in the MDD scenarios as the hour of the highest peaking factor from the diurnal patterns.

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Section 5

Water System Pipe Risk Analysis

In this desktop risk analysis, BC analyzed the relative risk of failure for the City's water pipelines by performing a likelihood of failure (LOF) and consequence of failure (COF) analysis. Understanding the relative risk of failure for various water pipeline sections is critical to plan water pipe Capital Improvement Program (CIP) projects effectively by prioritizing the highest-risk projects. BC worked with City staff to develop an appropriate failure ranking and weighting system to predict risk of failure. In general, pipe characteristics (age, material, break history, proximity to natural hazards, etc.), and criticality of the pipe or service location (large diameter, critical customer, hospital service, etc.) determine overall risk of failure. Sections 5.1 through 5.8 discuss methodology. Sections 5.9 and 5.10 provides the results, i.e., risk map, high-risk pipelines map, and a table of the highest risk pipelines. The CIP section will list and discuss the final recommendations further. In addition to pipe risk, other considerations for CIP development include a hydraulic capacity evaluation and City/BC team discussions of operational opportunities.

5.1 Objectives

The Water System Pipe Risk Analysis provides the City with applicable water pipe condition and risk information to support prioritization of CIP projects. Figure 5-1 shows the objectives associated with this pipe risk analysis section.

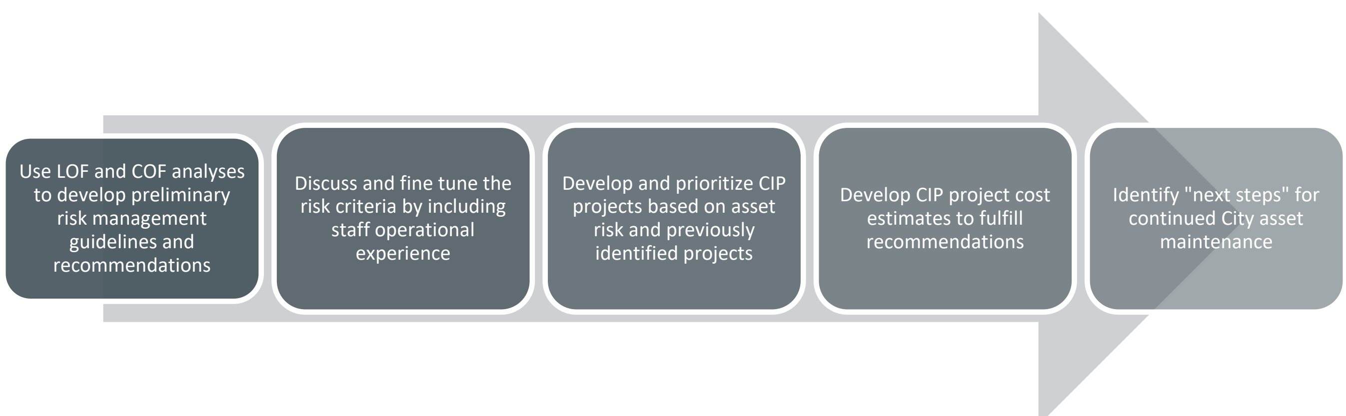

Figure 5-1. Pipe risk analysis objectives

5.2 Desktop Condition Assessment Task

BC prepared a desktop condition assessment analysis to assess asset risk for all pipe segments. The overall risk of pipeline failure considers both the *likelihood* that an asset is unable to provide its intended function, as well as the *consequence* or impacts resulting from an asset's failure.

Overall LOF and COF scores considered both factor ratings and factor weightings. The LOF factor rating predicts how likely an asset is to fail. The consequence factor rating predicts how consequential an asset failure would be. Assigned factor ratings range between 1 and 5, with 1 being the least likely to fail/least consequential and 5 being the most likely to fail/most consequential.

BC assigned the likelihood/consequence factor weighting value, which reflects the relative importance of a specific factor category compared to other factor categories. More-critical factors naturally receive greater weighting values than less-critical factors.

Figure 5-2 shows equations that provide a basis for determining risk scores.

Risk = LOF Score x COF Score

LOF Score = ∑ (LOF Rating x LOF Weighting)

COF Score = ∑ (COF Rating x COF Weighting)

Figure 5-2. Risk equations

∑ represents a sum of each factor.

5.3 Likelihood of Failure

The LOF analysis predicts the likelihood that an asset is unable to provide its intended function, determined by assigned ratings and weightings. BC evaluated the City water pipelines using factors typical for desktop risk analysis, and eliminated factors not relevant to the City.

The evaluation considered asset characteristics, asset condition, and asset location during the LOF analysis. In all cases, BC designated items with unknown data as medium risk. Specifically, BC used the following factors; the data was provided via City GIS:

- **Pipe Age** - In general, as a pipe ages, it has a higher likelihood to fail
- **Pipe Material** – Different pipe material has different life expectancy and failure modes

Table 5-1 and Table 5-2 describe the miles of water main by diameter and material in summary and in detail, respectively. Overall, the City has excellent data, with unknown pipe material accounting for just 1 percent of the data.

Table 5-1. Miles of Water Main by Diameter and Material - Summary

Pipe Diameter, (in)	AC	CI	DI	GI	STL	Misc.	PE	PVC	Total, miles	Percentage
2 or smaller	0	0	0	19	3	1	8	0	31	14
2.5 - 4	18	14	1	1	1	2	-	-	37	18
6	37	15	5		-	1	-	-	57	27
8 or 10	20	11	16	-	-	-	-	-	47	22
12 or greater	11	3	14	-	-	-	-	9	38	18
Unknown	0	0	0	0		2	0		2	1
Total	**86**	**42**	**36**	**21**	**4**	**5**	**8**	**10**	**212**	100
Percentage	**40**	**20**	**17**	**10**	**2**	**3**	**4**	**5**	**100**	-

Table 5-2. Miles of Water Main by Diameter and Material - Detail										
Pipe Diameter, inches	AC	CI	DI	GI	STL	Misc.	HDPE	PVC	Total, miles	Percentage
1.5	-	-	-	-	-	0.1	7	-	7	4
2	-	-	-	19	3	1	-	-	23	11
3	4	0.4	0.3	1	1	2	-	-	8	4
4	14	14	1	-	-	0.1	-	0.1	29	14
6	37	15	5	-	-	0.5	-	0.3	57	27
8	15	9	14	-	0.1	0.3	-	0.3	39	19
10	4	1	2	-	-	-	-		8	4
12	10	2	12	-	-	-	-	9	34	16
14	1	1	-	-	-	-	-	-	2	1
16	1	-	2	-	0.3	0.1	-	-	3	1
Unknown	-	-	-	-	-	2	-	-	2	1
Total	86	42	36	21	4	5	8	10	212	100
Percentage	40	20	17	10	2	3	4	5	100	-

AC = asbestos-cement
CI = cast iron
DI = ductile iron
GI = galvanized iron
STL = steel
HDPE = high-density polyethylene
Misc. = Miscellaneous (Unknown/DE/GP/ID/M)

Table values round the miles of water main displayed for lengths greater than 1 mile up to the nearest mile. The table excludes pipes with diameters of 0.75 inches, 1 inch, 1.25 inches, and 2.5 inches because the length of pipe is insignificant. Figure 5-3 provides the timeline of pipe material installation by decade. Figure 5-4 provides the pipe material map.

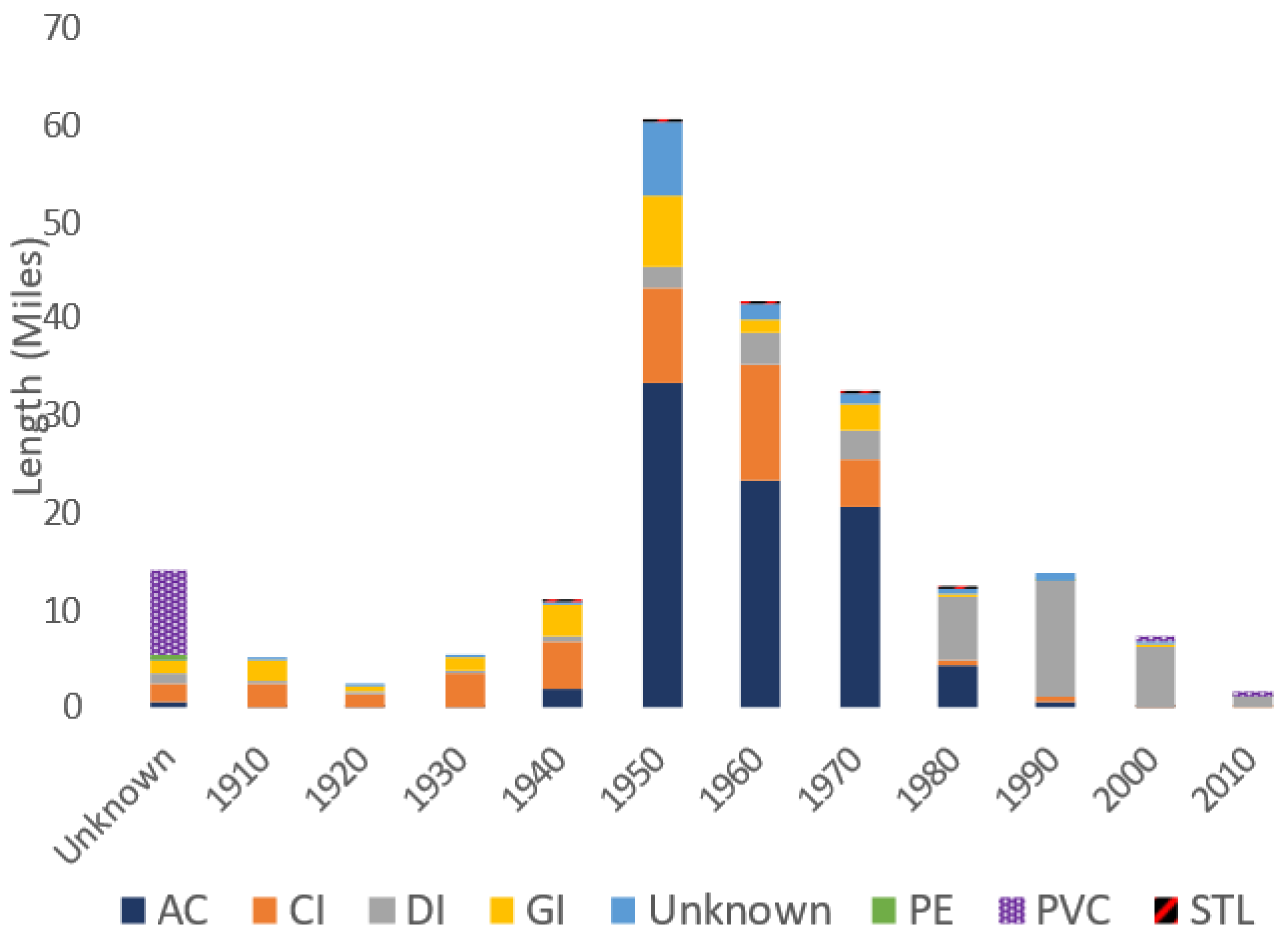

Figure 5-3. Timeline of pipe material installation by decade

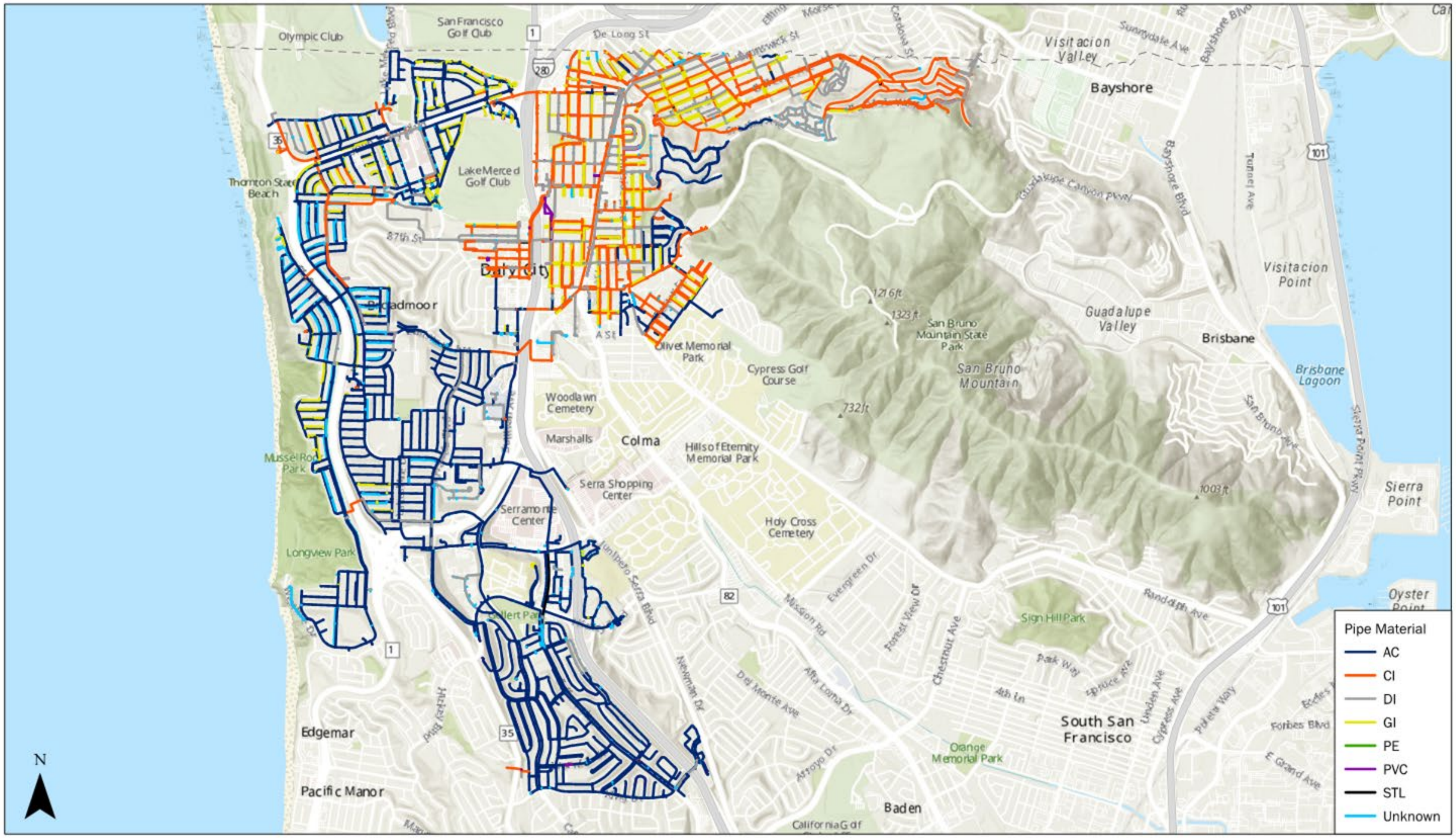

Figure 5-4. Pipe material map

Table 5-3 summarizes the pipeline materials.

Table 5-3. Summary of Pipeline Materials		
Material	Approximate Years When Installed in Daly City (Using GIS info)	Typical Service Life, years
AC	1940s to 1990s, but primarily in 1950s to early 1970s.	90 +
CI	System inception (1910s) to 1960s	100 to 150 +
DI	1950s to present day, but primarily in 1980+	75 +
GI	System inception (1910s) to 1970s	50
High-density polyethylene	2000s to present	50
PVC	1980s to present	75 +
Steel	1910 to 1980s, but primarily the '30s and '40s.	50
Gray iron	1920s to 1960s	100 +
Welded steel	1980s to present	50 +
Concrete cylinder	1960s (raw water), and 1960s and 1980s (treated water)	100 +

Likelihood of Failure Factors (Continued):

- **Breaks** - Pipes with computerized maintenance management system (CMMS) break repair work orders are more likely to fail. The City provided CMMS work orders for the past 2 years, as shown in Table 5-4.

Table 5-4. Linear Feet of Breaks - Diameter Vs Material										
Pipe Diameter, in	AC	CI	DI	GI	Misc. [a]	HDPE	PVC	STL	Total, feet	Percentage
2 or smaller				11,920	438	2,320		2,002	16,680	60
2.5 - 4	1,111	2,882			4			625	4,622	17
6	1,137	874	1,465						3,477	13
8 or 10	360	697	14						1,072	4
12 or greater	415		218				1,284		1,917	7
Total, feet	3,024	4,453	1,698	11,920	441	2,320	1,284	2,628	27,768	100
Percentage	11	16	6	43	2	8	5	9	100	

a. *This column combines materials with piping less than 50 pipe segments and include alloy steel (AS), unknown (DE), unknown (ID), and metal (M) pipe.*

The water system saw 80 breaks over the past two years; 5.3 miles of pipes had breaks. Of these 5 miles, eight pipes had two breaks totaling 1.2 miles). The length of breaks is assumed to be the full length of the failing pipe. Pipes with one CMMS work order will receive a rating of 4 out of 5 (more likely to fail), while pipes with two CMMS work orders will receive a rating of 5 (most likely to fail). We used these breaks to calibrate the Pipe Material likelihood of failure factor.

The 2-inch-diameter GI pipes (ranks 1st in most problematic pipe material, 43 percent of all breaks in past 2 years per Table 5-4)

The 2-inch-diameter GI pipe is the City's most problematic pipe type. Even though GI pipes only make up 10 percent of the water system in Daly City (Table 5-1), it breaks the most by a substantial margin (i.e., 43 percent of all breaks vs. CI, which experiences the second highest number of breaks at 16 percent, and AC pipe, which experiences the third highest number of breaks at 11 percent). In fact, the three zones with the highest proportion of GI pipes also are the zones with the most breaks.

GI Pipe Risk conclusions – For the *Pipe Material* factor, GI pipes received the most severe likelihood of failure rating (5 of 5). The overall LOF score of a given pipe still will depend on other LOF factors (e.g., pipe attributes, natural hazards); the overall risk will consider COF.

GI Pipe CIP considerations – In the CIP section, BC explores the City's existing 2-inch-diameter pipe replacement program and determines how to best schedule the replacement of the 19 miles of 2-in-diameter GI pipe.

Likelihood of Failure Factors (Continued):

- **Proximity to Earthquake Faults** – Pipes located within 500 feet of the San Andreas or Serra fault zones are rated higher likelihood to fail. The proximity to earthquake faults also accounts for the impact of smaller seismic events on pipe structural integrity. Per California Geological Survey's Fault Evaluation and Zoning Program's policy, the policy since 1977 is to position fault zone boundaries about 500 feet away from major active faults and about 200 to 300 feet away from well-defined, minor faults. While the Serra Fault Zone is not active and San Andreas Fault zone is active, both are given a buffer of 500 feet in this analysis to remain conservative. BC downloaded the quaternary fault zone GIS layer from the United States Geological Survey (USGS) website. Figure 5-5 provides the earthquake fault map which shows the water system facilities overlayed with the quartenary fault zone GIS layer from USGS.

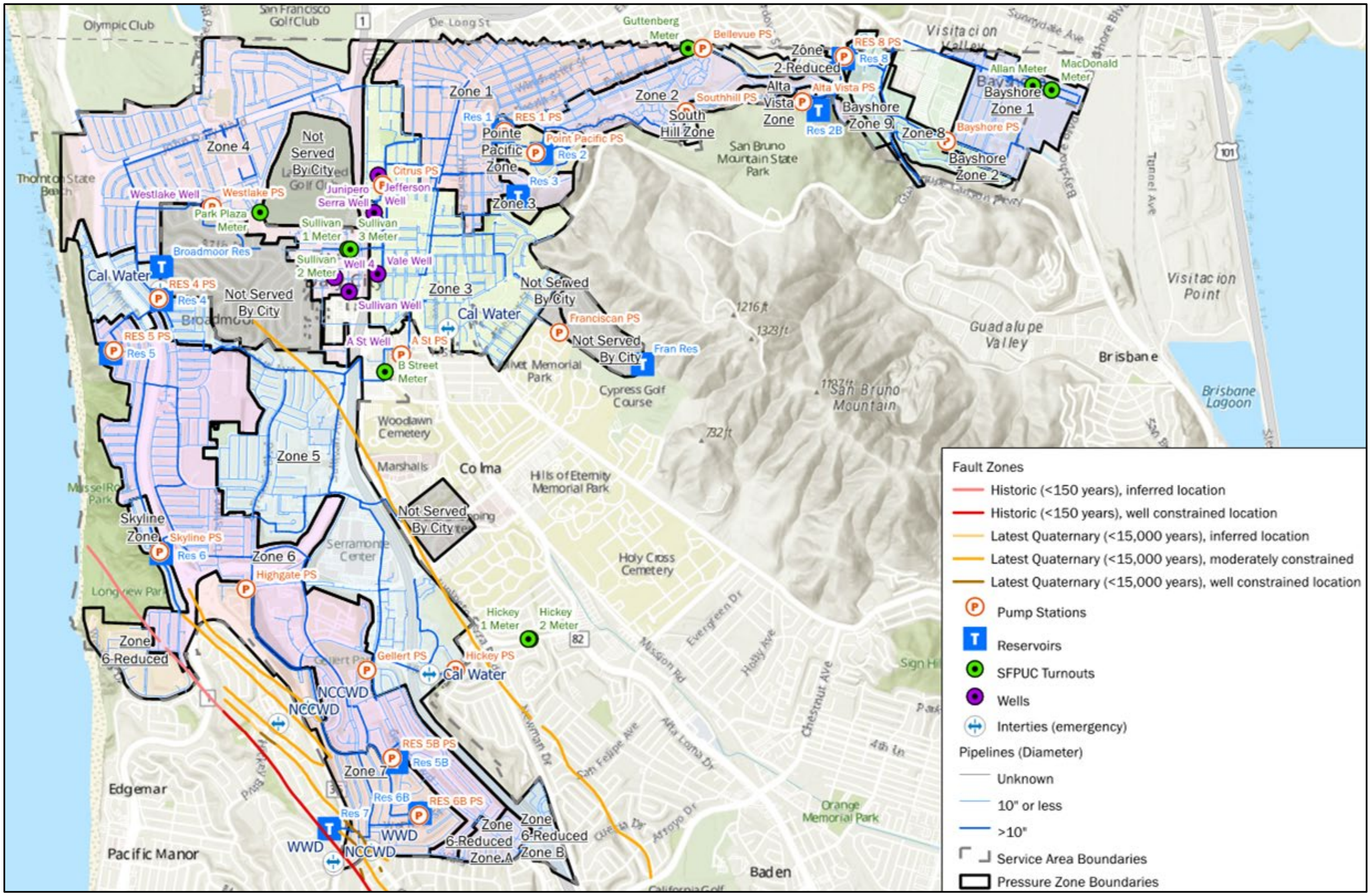

Figure 5-5. Earthquake fault map

- **Local Geology (Liquefaction)** – A liquefaction layer from USGS provides soil resiliency ratings to seismic events. This factor also accounts for the impact of smaller seismic events on pipe structural integrity.

As described by the USGS Earthquake Hazards Program, liquefaction is a phenomenon where saturated sand and silt take on the characteristics of a liquid during the intense shaking of an earthquake. The highest hazard areas are concentrated in regions of man-made landfill, especially fill that was placed many decades ago in areas that were once submerged Bay floor. Such areas along the Bay margins are found in San Francisco, Oakland, and Alameda Island, as well as other places around San Francisco Bay. Other potentially hazardous areas include larger stream channels, which produce the loose young soils that are particularly susceptible to liquefaction.

BC reviewed the USGS hazard maps. The City has “very low” or “low” susceptibility to liquefaction, and most of the City is not in the earthquake fault zones.

- **External Corrosion by Soil:** The water industry typically considers the USGS soil survey data the most comprehensive publicly available U.S. soil data source, but unfortunately most of the Daly City area has no rated corrosion potential. However, City staff provided corrosion hotspots, and BC incorporated the corrosion data into the analysis.

BC also looked at the following LOF factors but decided not to include them in this risk evaluation for the reasons stated:

- Soil Erosion: Occasionally, desktop pipe risk analyses will consider soil erosion; however, most of the City has a soil erosion rating of “unrated,” which we assume means no data.
- Landslide and Corrosion Threats: BC considered these; however, available data show no significant landslide threat.
- Pipe Capacity: Typically, a hydraulic model analysis identifies pipes that require upsizing. BC will evaluate pipe risk and pipe capacity side by side when preparing the CIP.

One factor for which the City may have information and BC did not evaluate is:

- Internal Corrosion (water quality) of Pipe: Per City staff observations, internal corrosion is present in GI pipe only, but GI pipe will be replaced and, as such, is not considered a factor in this analysis.

5.4 LOF Factors and Ratings for the Water System

Table 5-5 captures details and scoring basis for each LOF factor. A given pipe is assigned an LOF rating (1 through 5) for each factor.

Table 5-5. Daly City Water System LOF Factors and Ratings

Broad Category	LOF Factor	LOF Rating: 1 (Least Likely to Fail)	2	3	4	5 (Most Likely to Fail)	Factor Weighting (percent)
Asset Characteristics	Age	Installed on/after 2000	Installed between 1985 and 1999	Installed between 1970 and 1984[a]	Installed between 1955 and 1969	Installed in/before 1954	20
	Pipe Material	AS	PVC, HDPE	CU, DI, CPP	AC, UNK	GI, CI, GS, STL	20
Asset Condition	Break History	No breaks	-	-	1 Break	2 breaks	30
Natural Hazards	Proximity to Earthquake Faults	Not within fault area	-	-	-	Crossing or within 500 ft of fault line	10
	Likelihood of Liquefaction	Very low	Low	Medium	High	Very high	10
Soil Conditions	Corrosion	Not in hotspot				In hotspot	10

a. If characteristic is unknown, classify as this rating.
AC = asbestos-cement
AS = alloy steel
CI = cast iron
CPP = corrugated HDPE
CU = copper
DI = ductile iron
GI = galvanized iron
GS = galvanized steel
HDPE = high-density polyethylene
PVC = polyvinyl chloride
STL = steel
UNK = unknown/DE/GP/ID/M

Table 5-6 shows, as an example, the ratings (in grey-filled cells) a 1940 AC pipe with two breaks would receive:

Table 5-6. Example LOF Rating - 1940 AC Pipe with 2 Breaks and No Natural Hazard Threats

Broad Category	LOF Factor	LOF Rating					Factor Weighting (percent)
		1 (Least Likely to Fail)	2	3	4	5 (Most Likely to Fail)	
Asset Characteristics	Age	Installed on/after 2000	Installed between 1985 and 1999	Installed between 1970 and 1984[1]	Installed between 1955 and 1969	Installed in/before 1954	25
	Pipe Material	AS	PVC, HDPE	CU, DI, CPP	AC, UNK	GI, CI, GS, STL	25
Asset Condition	Break History	No Breaks	-	-	1 Break	2 breaks	10
Natural Hazards	Proximity to Earthquake Faults	Not within fault area	-	-	-	Crossing or within 500 ft of fault line	20
	Likelihood of Liquefaction	Very low	Low	Medium	High	Very high	20

5.5 Consequence of Failure

The COF analysis predicts via assigned rating and weightings, the impact resulting from the failure of an asset. COF categories capture both community impacts and cost of replacement.

In a similar fashion to the LOF analysis, BC evaluated COF factors typical for desktop risk analysis and eliminated factors irrelevant to the City. Additional COF factor descriptions and data include:

- **Pipe Size (diameter)** – Larger-diameter pipes are more expensive to replace, serve a greater area, provide a greater service area than smaller diameter pipes, result in greater water loss when broken, and draw more publicity upon failure (pipe diameter provided by City GIS).
- **Critical Pipes** – Pipes critical to the water system typically include pipes that, if isolated, would result in a service outage to a specific area or zone, have limited redundancy, or require complicated repair. For this analysis, BC used the critical pipes identified as part of the 2020 RRA. The RRA assessment identified several pipelines as critical based on a lack of redundancy or potential impacts to customers (such as a complicated repair that may require more than 24 hours to restore service). Table 5-7 presents critical pipelines identified in the RRA.

Table 5-7. Critical Pipelines	
Pipeline	**Length (approx.), ft**
10-in, 12-in, and 16-in discharge pipelines from Citrus PS, up to RES 1 for Zone 1 and up to Mission Street for Zone 3	10-in, 1,400 12-in, 5,900 16-in, 1,400
8-in and 12-in pipelines located between RES 2 and RES 2B	8-in, 3,700 12-in, 5,200
12-in pipeline, RES 2B to RES 8	2,900
12-in pipeline connecting RES 6 to RES 6B	13,000
12-in discharge pipelines from RES 6B PS and RES 7	3,000
12-in pipeline connecting RES 5 to RES 5B **Added after RRA based on discussion with Bill Faisst*	

- **Critical customers** – The 2020 RRA identified only the Kaiser Medical Center and a dialysis center as critical customers.
  - Kaiser Medical Center: 395 Hickey Blvd, Daly City, CA 94015
  - DaVita Westlake Daly City Dialysis Center: 2201 Junipero Serra Blvd, Daly City, CA 94014
- **Road type** – Some road types, such as arterial or highway, will impact more people than a neighborhood street; therefore, BC identified pipe intersections with major traffic conveyance routes, such as the Bay Area Rapid Transit (BART) Daly City station, freeways, state routes, arterial streets, or major roads. BC downloaded the GIS for major roads from the San Mateo County GIS and the BART GIS from the BART website, and applied a buffer of 800 feet to the geocoded coordinate point to capture the frontage and adjacent segments adjacent. Similarly, BC applied a buffer of 35 feet to the major roads layer to capture potential leak or breakage impact and GIS alignment differences between the road type and pipe layers.
- **Access restriction** – Access restrictions may apply to pipes that are difficult to repair due to access limitations, far from customer service center, or are on private property.

BC also looked at the following COF factors but elected not to include them in this risk evaluation for the stated reasons:

- **Land use**: Upon investigation, the intersection of land use and City water pipes produced a vast majority of "road" land use, which would be inaccurate and skew the analysis. While land use typically captures water use tendencies and critical areas, pipe diameter, road type, and critical customers also cover these areas of consideration.
- **Pipe depth:** Although depth could provide information on pipe replacement cost, these data currently are unavailable. If there are significant differences in pipe depth, or pipes that are otherwise difficult to access due to pipe depth, then the City can update the pipe GIS accordingly. In the meantime, diameter and road type drivers of the risk analysis offer similar insight on correlations with pipe replacement cost.
- **SFPUC large-diameter aqueducts, right of way** – There is no readily available data for this factor. This factor can be considered in future analyses when data is available.

Table 5-8 COF Factors and Ratings for the Water System elaborates on details and scoring basis for each factor.

Table 5-8. COF Factors and Ratings for the Water System

Broad Category	COF Factor	COF Rating 1 (Negligible Consequence)	2 (Minimal Consequence)	3 (Moderate Consequence)	4 (Severe Consequence)	5 (Critical Consequence)	Factor Weighting
Service Interruptions and Overflow Potential	Diameter	Less than or equal to 1.5 inches	2 to 4 inches	6 inches	8 to 10 inches	Greater than 12 inches	25%
	Critical Pipelines	Not critical or has redundancy (based on 2020 RRA)	-	-	-	No redundancy or otherwise critical (based on 2020 RRA)	25%
	Critical Customers	Not affecting a critical customer (based on 2020 RRA)	-	-	-	Within 500 ft of critical customers (based on 2020 RRA)	15%
Transportation/Transit	Road Type [a,b]	Neighborhood streets (< 30 mph)	Collector streets (30-45 mph)	Arterial streets (46-60 mph)	Expressway or state routes	Freeway crossing or within 50 feet of BART track	20%
Response Time	Difficult Access	Not difficult to access				Known difficult access	15%

Note:

a. The Roads layer doesn't necessarily coincide with pipes. Selected "intersection" with a 50-ft buffer in InfoAsset.

b. Speed limit used as a proxy for impacts to transportation given data limitations; assumed neighborhood streets = <30 mp; collector streets =<45 mph; arterial streets =<60 mph; expressways, state routes, and freeways as identified in road name.

mph = miles per hour

5.6 Asset Risk

After the LOF and COF rating and weighting were determined for individual factors, an overall LOF score and overall COF score was determined by summing the factor scores. Combining the two overall scores determines the overall asset risk (Risk = LOF x COF).

BC performed a desktop risk assessment using Innovyze's IAP program, a GIS extension tool. Using the criteria described previously, the tool predicts the relative probability that each asset could fail (LOF) and the relative consequence of its failure (COF) based on its GIS data and spatial interaction with other GIS layers.

For example, for the assessment of earthquake fault threat, the tool computed pipe proximity to faults for each of the 13,941 District pipes (212 miles) and assigned a score of 5 if it was within 500 feet of a fault (per the California Fault program's policy described in Section 5.3) or a score of 1 if it was not within the threat area. Likewise, COF analysis determines the severity of each asset if it fails. The tool scores each pipe for COF based on asset data such as diameter and proximity to other GIS layers such as road type. Once the user defines the rating (1 through 5) for each factor and weighting of these factors relative to one another, the tool produces a holistic risk score for each pipe GIS asset. This risk score is adjusted so that the lowest-scoring pipes receive a 1 out of 5 (least at risk) and the highest-scoring pipes receive a 5 out of 5 (most at risk).

5.7 Daly City Staff Input

This section describes input provided by City staff at two risk assessment workshops.

Risk Workshop 1

On June 17, 2021, BC conducted a risk assessment workshop with City staff to provide an overview of the risk assessment approach, present preliminary results, and receive City input regarding specific risk assessment criteria and weighting as well as input on the preliminary results map. Following the workshop, the City provided responses to questions developed during the workshop.

Risk Workshop 2

On September 14, 2021, BC conducted a risk assessment workshop with City staff to review the risk analysis section of the technical memorandum. During the call, the City provided input on risk assessment criteria, pipe material description, and historical performance, and identified remaining data items that could improve the analysis. After the call, City staff provided BC with PDF map markups that indicated planned pipe replacement projects, pipes with difficult access, and corrosion hotspots. After the workshop, BC updated the analysis accordingly.

5.8 Sensitivity Analysis

With the LOF and COF criteria finalized and preliminary weighting of the relative impact of each factor determined, BC conducted a sensitivity analysis. The factor weightings were adjusted using engineering judgment to evaluate pipe risk against various weighting scenarios to determine which weighting scenario is most sensible. The final weighting scenarios are presented in Section 5.4 and 5.5.

5.9 Risk Assessment Results

BC's modeling determined overall LOF and COF score assignments for all pipe segments, based on the criteria outlined previously. Evaluation then determined a total risk score from the product of the overall LOF and COF scores, normalized within the dataset from 1 (negligible risk) to 5 (extreme risk). The tool imported this GIS dataset to an ArcGIS Online dashboard (see Figure 5-6 and Figure 5-7).

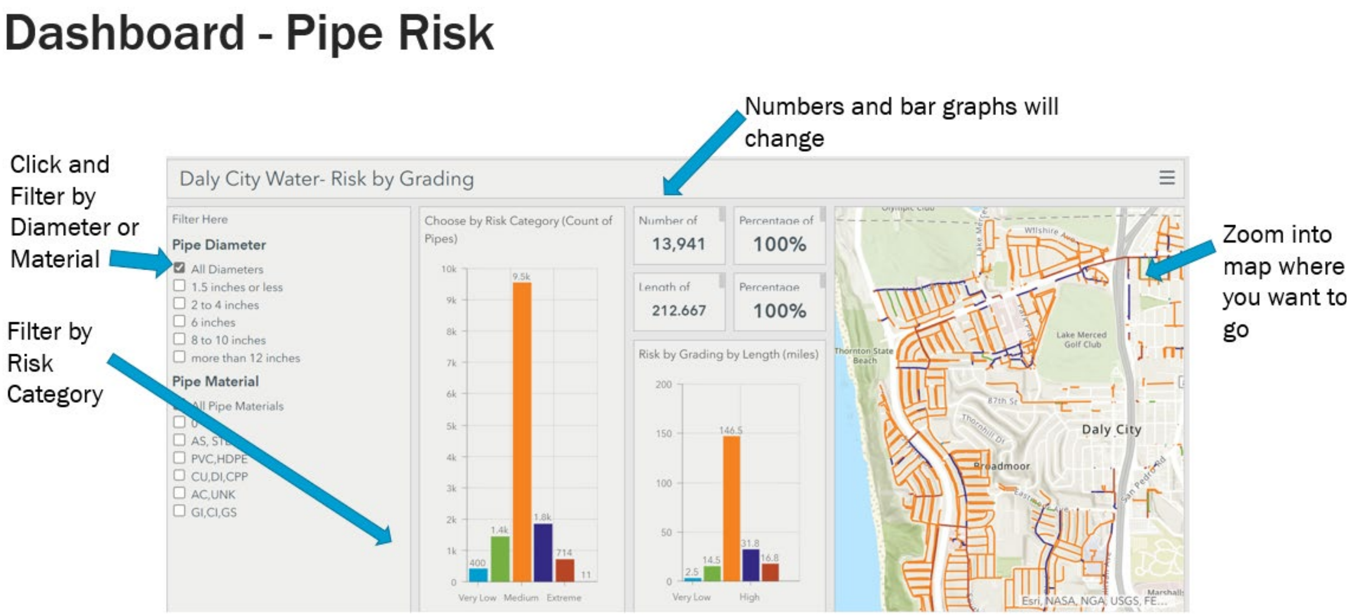

Figure 5-6. ArcGIS online dashboard guide

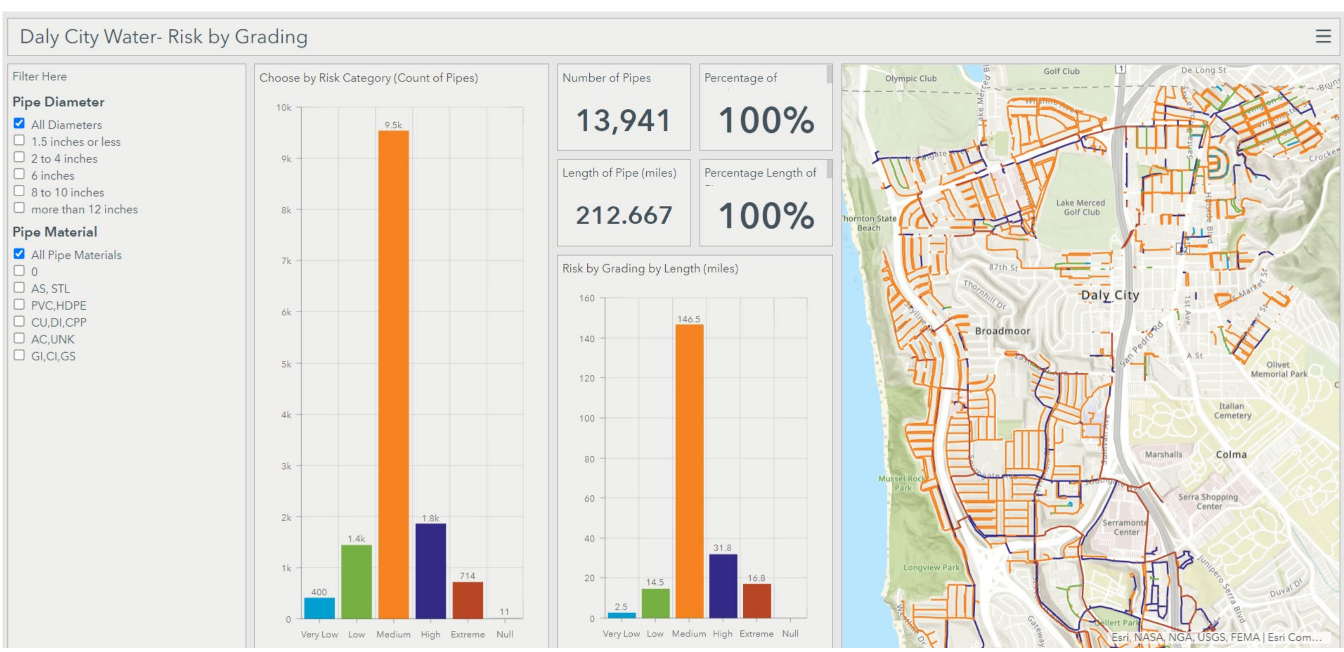

Figure 5-7. ArcGIS online dashboard

Figure 5-8 presents the risk scores for all water pipelines on ArcMap.

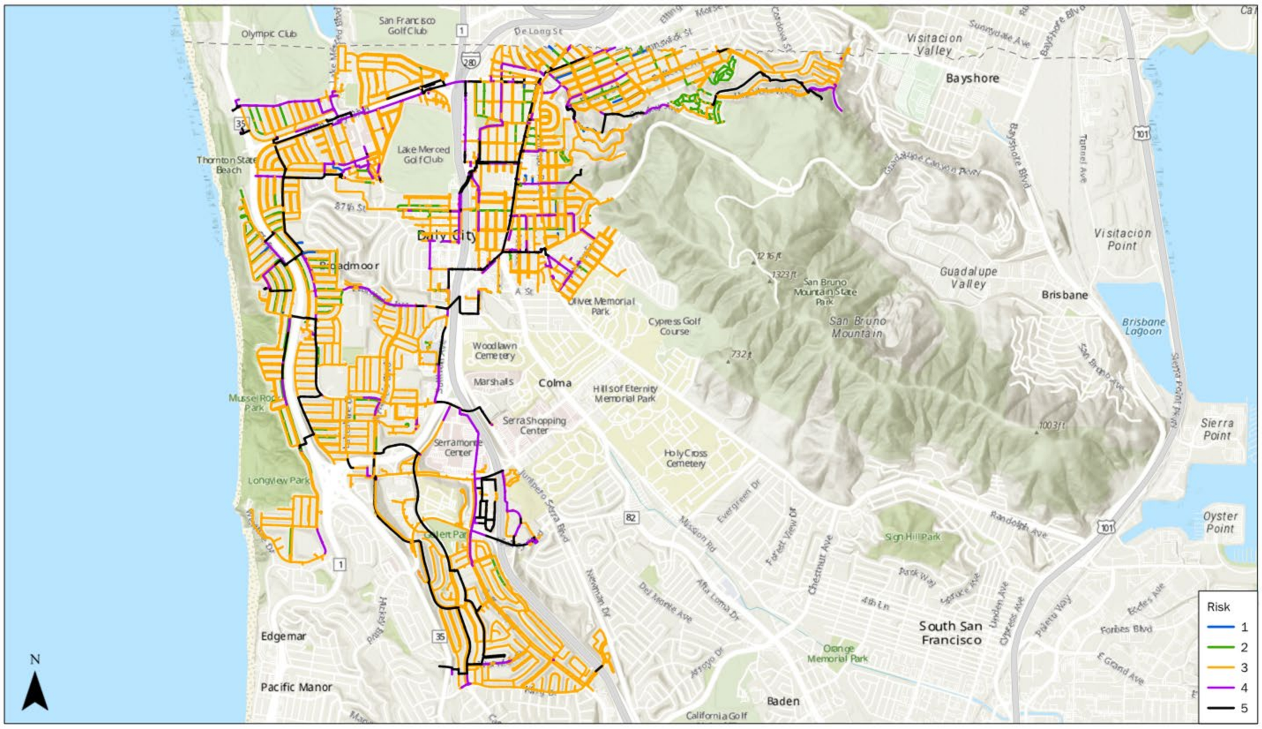

Figure 5-8. Asset risk rating; a higher number indicates greater risk

From a systemwide standpoint, a pipe cohort analysis of material-age-diameter groupings revealed that high risk groups include:

- AC pipes 35 to 65 years old of 8-in or more diameter
- CI pipes 50+ years old of 8-in or more diameter
- 2- to 4-in-diameter GI pipes

Low risk groups include DI pipes. In fact, all pipes that have a risk score of 1 and 2 are DI pipes, despite all DI pipes receiving an assignment Pipe Material rating factor of 3. That means the other likelihood factors (such as age, breaks, natural hazard proximity) and consequence factors (diameter, criticality, nearby road type) had low values as a whole.

Pipe segments considered an extreme risk are at the greatest likelihood of deterioration and/or have the highest consequence of failing. As such, the CIP (Section 7) prioritizes pipe replacement for these pipelines.

Figure 5-9 provides the risk distribution for the pipe segments. Most of the pipe segments have negligible or low risk; 12 percent are medium- to extreme-risk pipe segments.

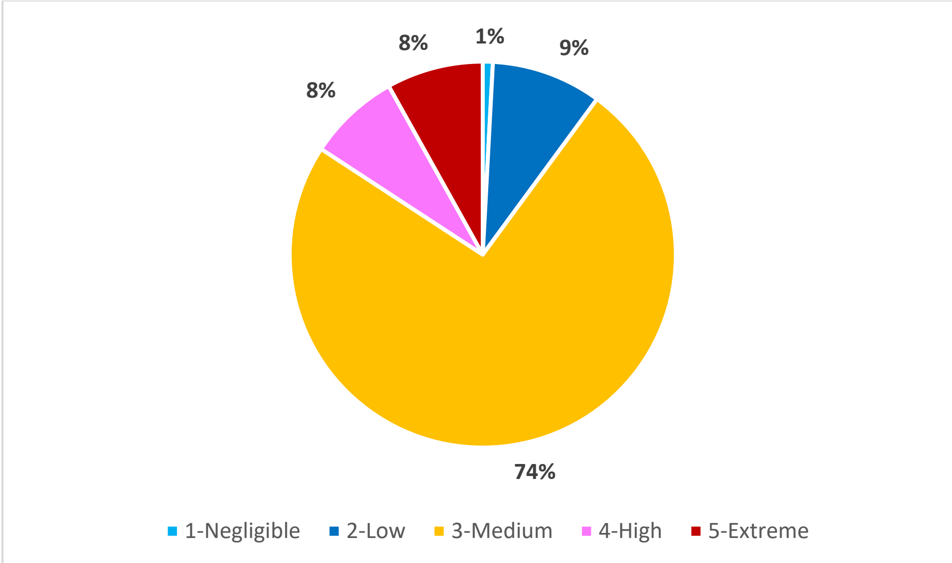

Figure 5-9. Pipeline risk distribution

Appendix D provides the risk scores for all pipe segments. BC calculated LOF and COF scores based on the equation figure at the beginning of Section 5 and the rating and weighting criteria described previously. BC calculated the risk score column by multiplying the LOF score and COF score, then normalized from 1 through 5 in the last column (1- negligible, 2-low, 3- medium, 4- high or 5-extreme), with the table sorted by descending risk score.

5.10 Conclusion

The results of the water system pipe risk analysis helped to inform project prioritization for CIP development. Critical pipes and pipes with break and corrosion issues were separated into a CIP line item and prioritized based on their location within the system. Small-diameter pipes were identified in the CIP in addition to pipes identified in the risk analysis. Because most of the pipelines identified in this section are either newer or do not have ongoing issues, it is recommended to do more routine non-destructive pipeline testing to verify condition. This recommendation is included in Section 7 as a CIP line item. In general, pipe replacements in the CIP are small diameter pipes that are older (installed prior to 1930) or have both condition and capacity related deficiencies.

Aside from CIP, other efforts that can be implemented to further improve risk assessment include:

- Continue to collect work order information in GIS format.
- If there are pipes buried much deeper than the average pipe in the system, and are more difficult to repair, adding pipe depth to the pipe GIS may be beneficial.

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Section 6

Water System Hydraulic Evaluation

This section presents criteria used for hydraulic evaluation of the City distribution system under current and future conditions, identifies system deficiencies, and includes existing and future pump station and storage capacity analyses.

6.1 Evaluation Criteria Overview

The hydraulic model developed for this project was used to evaluate the water distribution system facilities. The following model scenarios were analyzed:

- MDD
- PHD
- MDD and Fire Flow

The system was evaluated for pressure, velocity, fire flow, storage capacity, pump capacity, supply capacity, and reliability under existing demand conditions using the calibrated hydraulic model. The evaluation criteria used to evaluate the City's water system are summarized in the tables below (Tables 6-1 through 6-3). Fire flow requirements are summarized in Table 6-4. Detailed descriptions for each evaluation criteria are provided in the Water Distribution System Evaluation Criteria TM in Appendix E.

Table 6-1. Pipe Criteria

Criterion		Value	Reference
Pressure	Desired Operating Range	60-80 psi	GLUMRB[a]
	Maximum Operating	100 psi	GLUMRB
	Minimum During PHD	40 psi	CWWS[b]
	Minimum During MDD + Fire Demands	20 psi	CWWS
Maximum Velocity	MDD	5 fps	AWWA
	PHD or MDD + Fire Demand	10 fps	
Maximum Headloss	Transmission (≥12-inch diameter)	3 ft/1,000 ft	City
	Distribution (<12-inch diameter)	10 ft/1,000 ft	
Required Minimum Size	Minimum (without hydrants)	3 in	City
	Minimum (serving hydrants)	8 in	

a. Great Lakes-Upper Mississippi River Board
b. California Water Works Standards

Since the last master plan, the City agreed to a pump criteria change for zones with no elevated storage. Pumped zones with no elevated storage should meet fire flow requirements. Any deficiencies as a result of this criterion change are mitigated with the use of a designated fire flow pump. This pump criteria change is reflected in the pump evaluation criteria, given below in Table 6-2.

Table 6-2. Pump Criteria			
Criterion		**Value**	**Reference**
Minimum Capacity	Booster Pump Station (zone served by single PS) Booster Pump Station (zone served with no elevated storage)	Meets MDD with the largest pump out of service Meets MDD + fire flow with largest pump out of service	City
Reliability	Redundancy Redundant Pump Sizing	Each pump station should have a minimum of 2 supply pumps Pumps should be sized to meet the minimum capacity requirement with the largest pump out of service	GLUMRB
Operations	Minimum Suction Pressure Control Settings	Maintain positive gauge pressure if suction piping is not above ground Provide adequate range between high/low pressure or tank-level settings to prevent excessive cycling of the pump	GLUMRB

Table 6-3. Storage Criteria			
Criterion		**Value**	**Reference**
Capacity	Equalization Fire Emergency	Volume to serve demand in excess of supply to the system for MDD conditions. Calculated as 25 percent of MDD Volume required to supply the largest needed fire flow in the system (or pressure zone) for the required fire flow duration 33 percent of fire flow and equalization combined storage	City GLUMRB City

Fire flow criteria was confirmed by the North County Fire Authority (NFCA) fire marshal and is given below in Table 6-4.

Table 6-4. Fire Flow Requirements by Land Use		
Land Use	**Fire Flow, gpm**	**Duration, hours**
Low-density Residential[a]	1,000 (with automated sprinkler system)	1
	1,500 (without automated sprinkler system)	2
Multi-family	2,500	3
School/Church	2,500	3
Public/Institutional	2,500	3
Commercial/Industrial	4,000	4

Source: 1991 Master Plan and recent guidance from the fire marshal for newer projects

a. Based on feedback from NCFA based on the 2019 California Fire Code, Appendix B, the Fire Flow requirement of 1,500 gpm for 2 hours was used in this analysis for all Low-Density Residential land use

6.2 Existing Systems Evaluation

Based on the evaluation criteria described in Section 6.1, the distribution system was evaluated under existing demand conditions. The hydraulic model was used to identify pressure, velocity, capacity, and fire flow deficiencies. Areas in the existing system that did not meet the criteria are identified as deficiencies that should be addressed. The proposed improvements to mitigate the deficiencies are identified in Section 7.

6.2.1 Existing Pressure Analysis

The City's system pressures were evaluated using the hydraulic model. Results of the computer model evaluation indicate that, with a few minor exceptions, the water system has adequate water pressure; however, there are several areas where pressure exceeds the maximum allowable limit of 100 psi.

6.2.1.1 Low Pressures

The evaluation criteria state that the minimum allowable pressure at PHD is 40 psi. Figure 6-1 shows that there are isolated locations where water pressure drops below 40 psi. In most instances, these locations are located at the end of small pipes at a high elevation relative to the pressure zone, or may be a result of low static pressures (located in close proximity to a storage tank). For these reasons, these isolated incidents will not be addressed in this master plan.

6.2.1.2 High Pressures

High pressures may result in increased unaccounted water losses, high billed water use, and frequent and catastrophic pipe failures. The pressure class of pipe in the system is typically 150 psi, and water pressure greater than 150 psi presents a high risk of failure with pressure surges in the pipe. The majority of the high-pressure areas occur along pressure zone boundaries or in areas lower in elevation where there are significant changes in elevation over short distances. A majority of the maximum system pressures were between 40 and 150 psi. Figure 6-2 shows the areas where pressures exceeded the established criteria.

6.2.2 Existing Velocity Analysis

The hydraulic model was used to evaluate pipeline velocities in the existing system under MDD and PHD conditions. Based on the criteria listed in Section 6.1, the maximum velocity under MDD conditions is 5 fps. The water model did indicate existing piping with excess velocities, as shown on Figure 6-3. The area of concern contains pipelines exceeding velocities of 10 fps, and occurs in 4-inch piping located in Zone 1. This area is included in Zone 1 piping improvement projects for the

6.2.3 Existing Fire Flow Analysis

The model was used to evaluate the capacity of the existing distribution system to deliver the fire flows listed in Table 6-4. Hydrants were assigned a fire flow demand corresponding to the highest land use within 200 ft. Fifteen locations in the system were unable to meet the required flow at 20 psi. Table 6-5 lists all fire hydrants in the water system that do not meet the flow and residual pressure criteria.

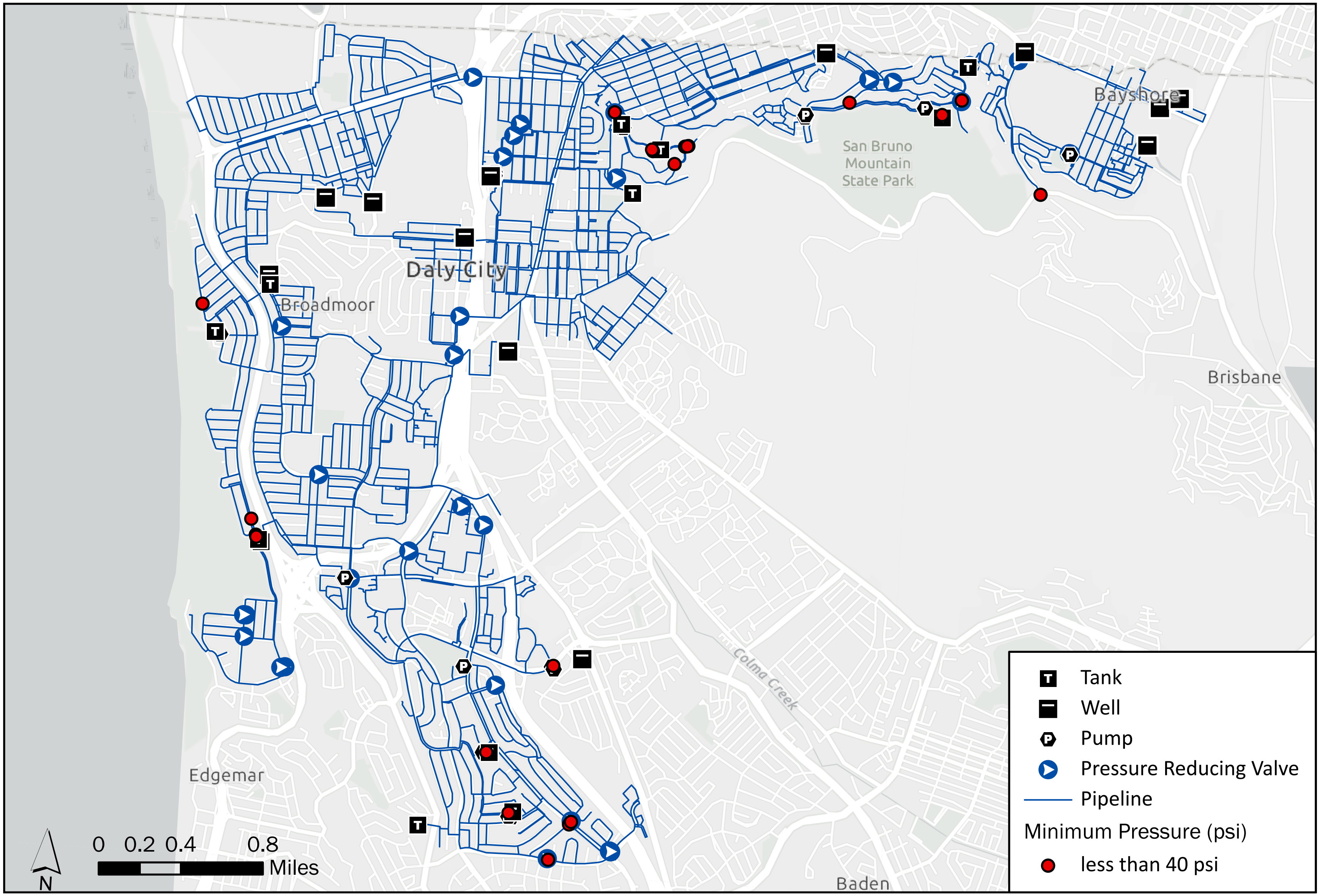

Figure 6-1. Existing System Low Pressure Deficiencies

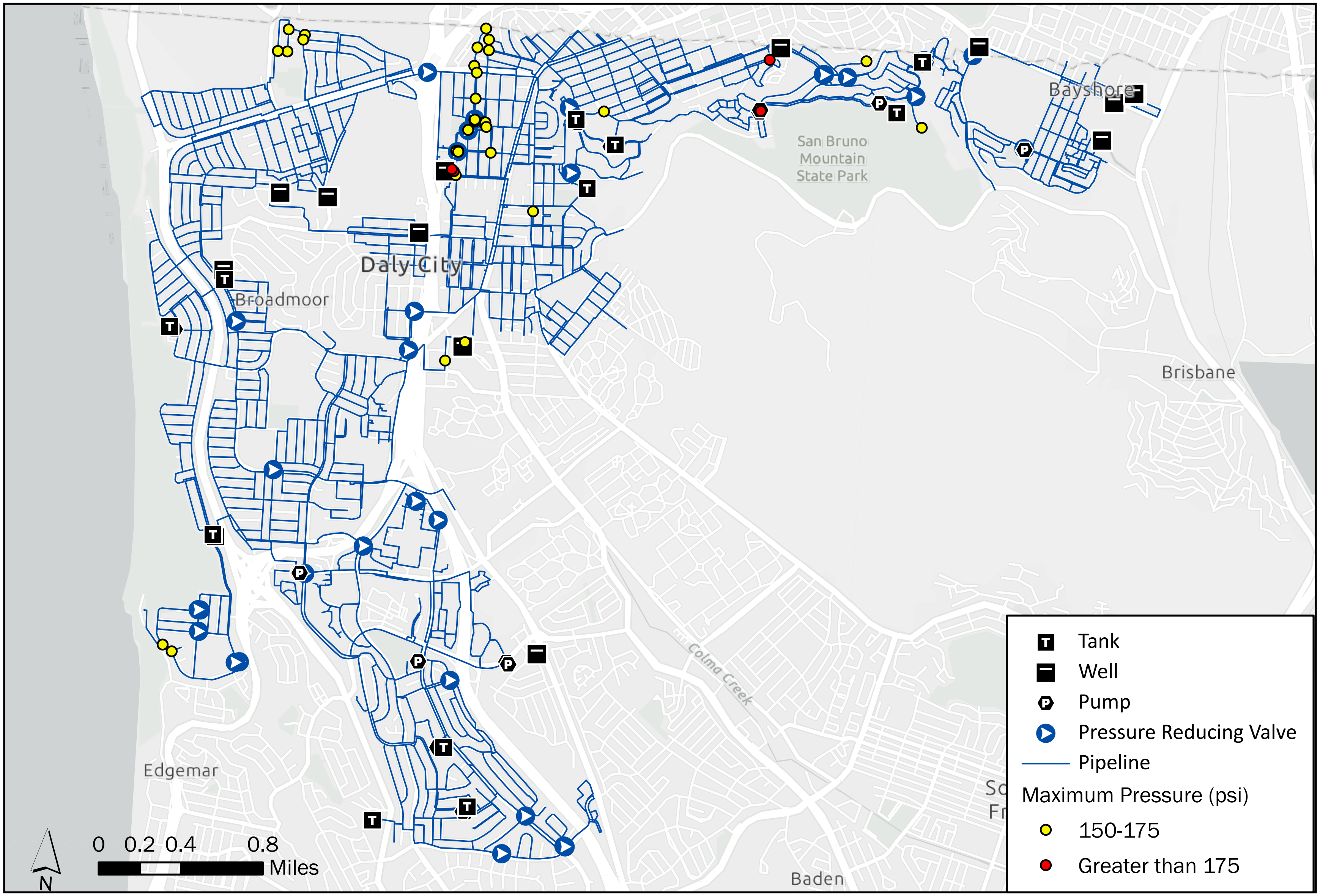

Figure 6-2. Existing System High Pressure Deficiencies

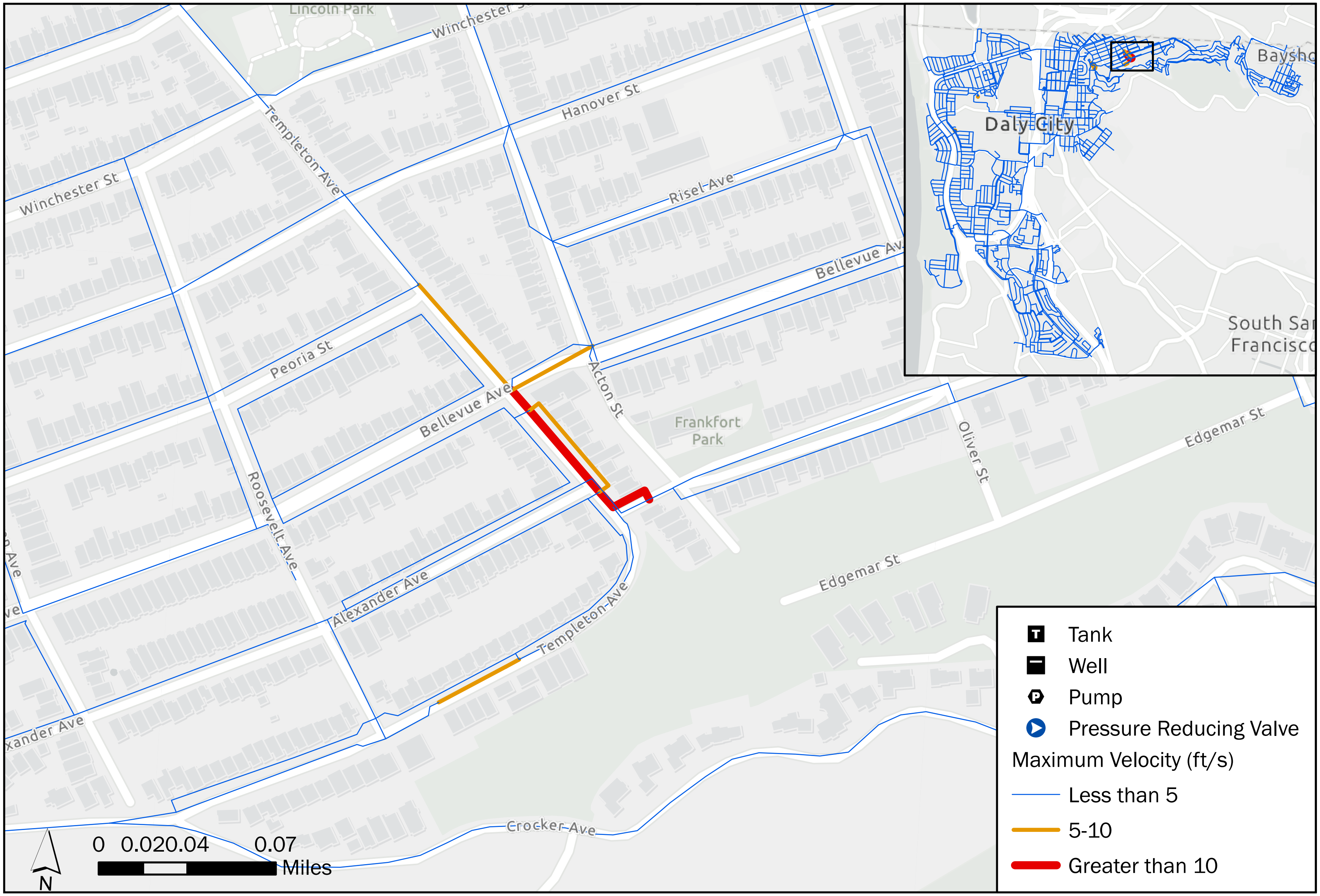

Figure 6-3. Existing System Pipe Velocities

Table 6-5. Fire Flow Analysis				
Fire Hydrant Model ID	Required Fire Flow Demand (gpm)	Available Flow at Hydrant at 20 psi (gpm)	Available Fire Flow (%)	Deficient Hydrant Location Description
8-J12	4,000	3,283	82	Carter St. and Alexis Cir
7-J806	1,500	1,223	82	End of Wessix Ct.
262	1,500	1373	91	Intersection of Wembley Dr. and Morton Dr.
5-J559	1,500	1,415	94	End of Olcese Ct.
5-J511	1,500	1,299	87	Located on Crestview Ave
6-J608	1,500	1,392	93	Skyline Drive, between Palisades Dr. and Upland Ave
J-4540	4,000	3,551	89	Intersection of Pierce St. and Edgeworth Ave
J-100	2,500	862	35	End of Tallwood Dr
J-97	3,000	2,053	68	End of Garwood Drive
J-325	2,500	2,248	90	Intersection of Westlake Ave and Woodrow St
J-263	1,500	1,394	93	Bellevue Ave and Waverly Way
J-278	1,500	651	43	End of Caroline way
J-509	1,500	1,284	86	S. Hill Blvd and Oakridge Dr.
J-556	1,500	1,319	88	Alta Vista Way and S. Hill Blvd Intersection
J-137	3,000	1,140	38	Intersection of Bellevue Ave and Lowell Street

6.2.3.1 Fire Flow Improvements

The model was used to identify fire flow improvements, shown in Table 6-6 and Figure 6-5, that will alleviate the deficiencies listed in Table 6-5 These improvements include constructing new pipelines, completing pipeline loops, or rezoning existing pressure zones with new pipe connections.

Table 6-6. Fire Flow Improvements

CIP ID	Pressure Zone	Improvement Location Description	Description	Diameter (in)	Pipeline Length[a] (ft)
FF-1	Bayshore 9	Carter St. and Steve Courter Way, Martin Trl to Carter St.	New pipe	12	170
FF-2	Res 7	Dennis Drive and Warwick Street, to end of Wessix Ct	New pipe	8	1,160
FF-3	Res 6	Wembley Drive connection to Hickey Blvd	New pipe connection/looping	6	230
FF-4	Res 5	Olcesse Ct and El Dorado Drive to end of Olcesse Court	New pipe	8	660
FF-5	Res 5	Crestview Ave and Skyline Drive to end of Crestview Ave	Rezone, new pipe connection	6	70
FF-6	Res 6	Skyline Drive	New pipe	8	390
FF-7	Res 4	Pierce Street and Edgeworth Ave	New pipe	10, 12	760, 1,380
FF-8	Res 1	Tallwood Drive	New pipe	8	470
FF-9	Res 1	End of Garwood Drive	New pipe	6	460
FF-10	Res 2	Westlake Avenue and Woodrow Street	New pipe	8	1,270
FF-11	Res 2	Bellevue Ave and Waverly Way	New pipe	8	440
FF-12	Res 2	Caroline way	Rezone, new pipe connection	6	70
FF-13	Res 2R	S. Hill Blvd	New pipe	8	560
FF-14	Alta Vista	Alta Vista Way	Rezone, new pipe connection	8	3,050
FF-15	Res 1	Bellevue Ave and Lowell Street	New pipe	8	5,400

a. *Pipe lengths rounded to nearest 10 ft*

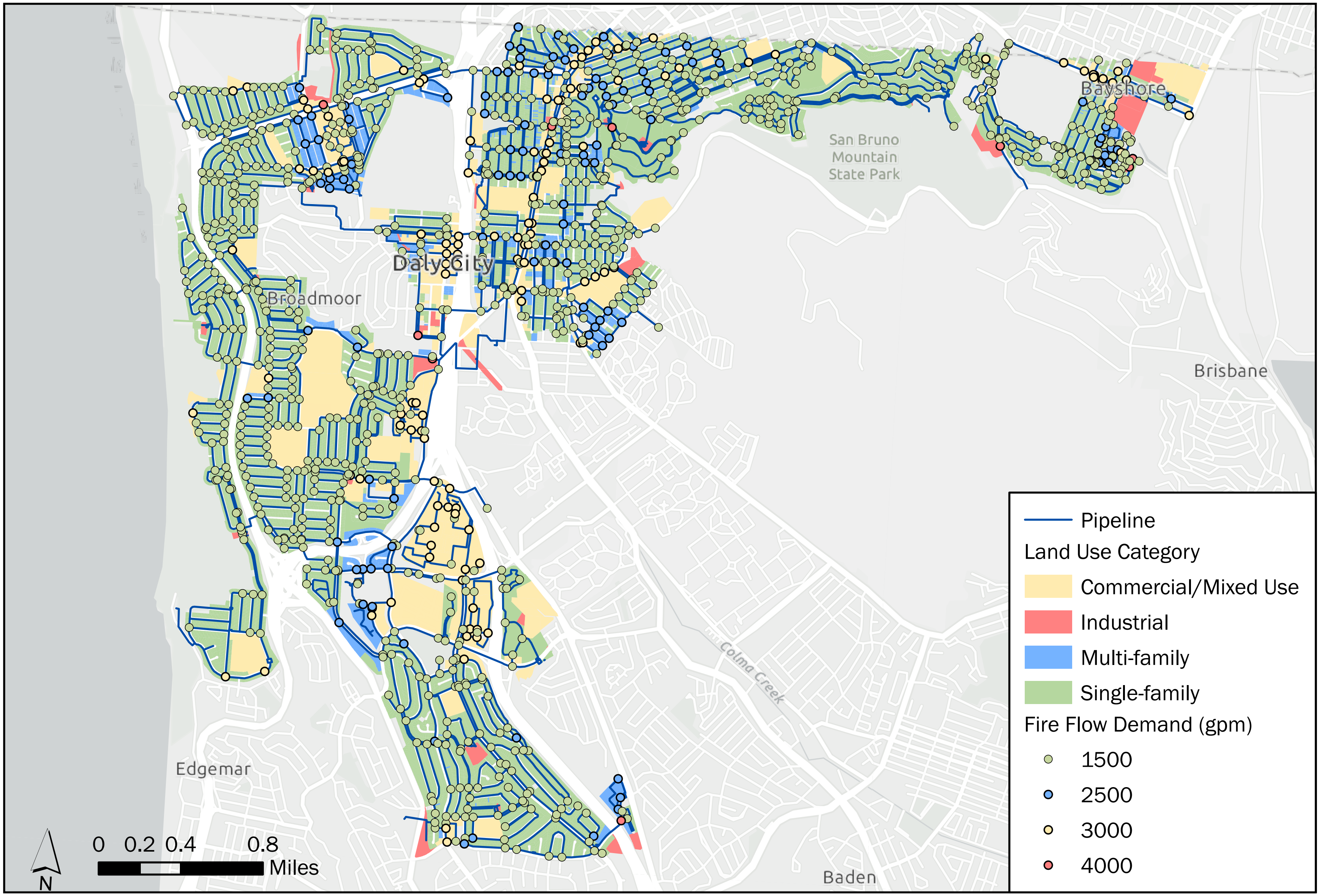

Figure 6-4. Fire Flow Demand Allocation by Land Use Category

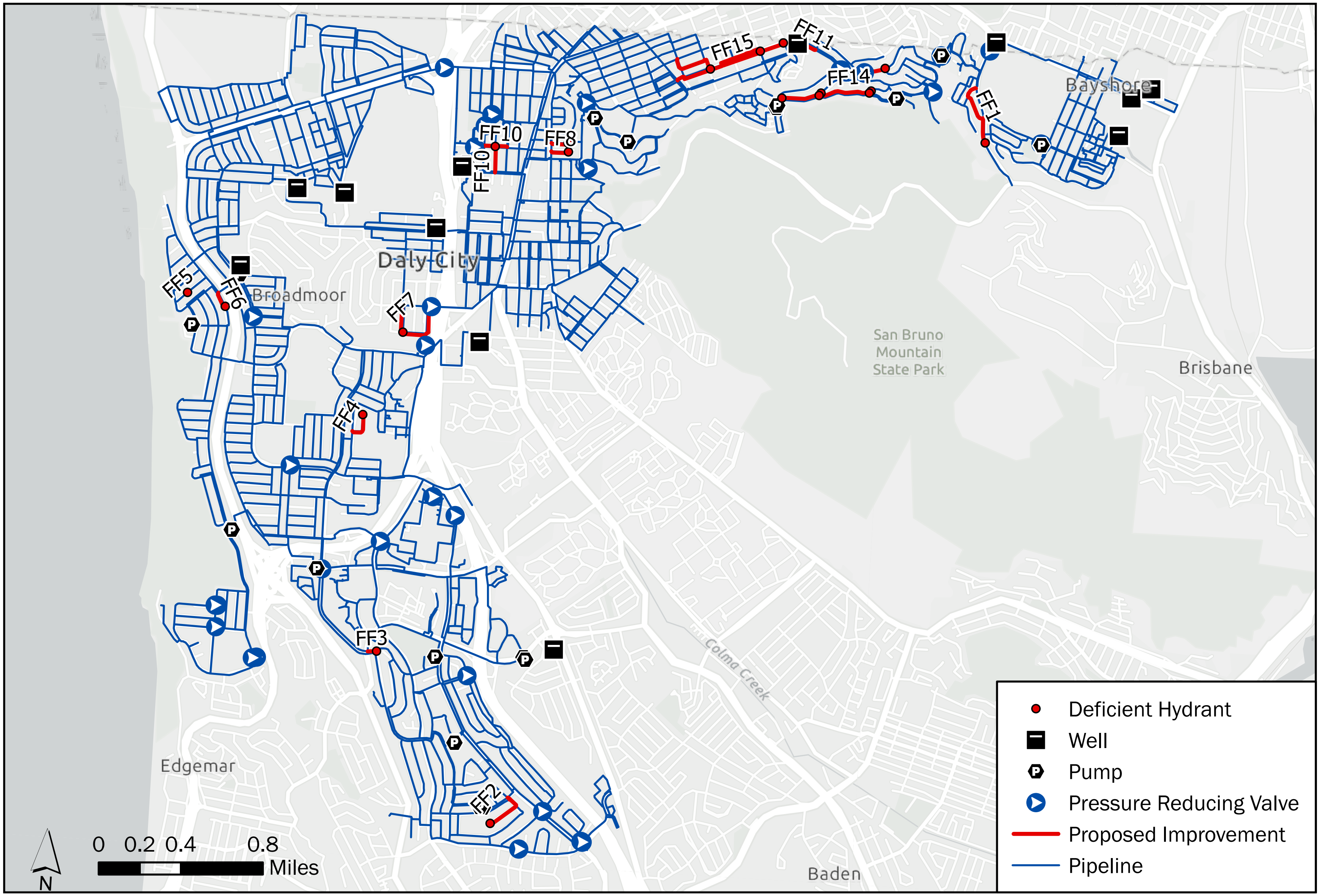

Figure 6-5. Recommended fire flow improvement projects

6.3 Existing Pump Station Analysis

The City's water system has 19 pump stations operating. The pump station analysis evaluates the existing pump station capacities based on the evaluation criteria in Section 6.1. The results of the analysis are summarized in Table 6-7.

Table 6-7. Existing System Pump Station Capacity Analysis

Pressure Zone	Pump Station	Total Capacity (gpm)	Firm[a] Capacity (gpm)	Required Capacity		Deficit/ Surplus (gpm)
				Description	Flow (gpm)	
West System						
Zone 7	Res 6b PS	1,600	800	Zone 7 MDD	260	540
Skyline Zone	Skyline PS	1,784	234	Skyline MDD	31	203
Zone 6/6b Group	Res 5 PS, Res 5b PS	4,770	1,670	Zone 6/6b MDD	1,401	269
Zone 5/5b	Res 4 PS, A St PS, Hickey PS	7,487	4,982	Zone 5/5b MDD	2,414	2,568
Zone 4	Westlake PS	3,525	2,580	Zone 4 MDD	3,466	-886
East System						
Zone Bayshore 1	Allen TOs, Macdonald TO	238	238	Bayshore Zone 1 MDD	1,203	-965
Zone 8, Zone Bayshore 2, Zone Bayshore 9	Bayshore PS	1,000	500	Zone 8, Bayshore 2, Bayshore 9 MDD	123	377
Zone Alta Vista	Alta Vista PS	1,131	565	Alta Vista MDD + Alta Vista FF demand	1,518	-953
Zone Pointe Pacific	Pointe Pacific PS	6,000	3,500	Pointe Pacific MDD + Pointe Pacific FF demand	4,016	-516
Zone South Hill	South Hill PS	1,900	400	Southhill MDD + SouthHill FF demand	1,507	-1,107
Zone 2/2b group	Res 1 PS, Bellevue PS, Res 8 PS	2,804	1,301	Zone 2/2b MDD	300	1,001
Zone 1	Citrus PS to Zone 1	3,100	1,600	Zone 1 MDD	1,051	549
Zone 3	Citrus PS to Zone 3[b]	2,767	0	Zone 3 MDD	218	-218

a. *Capacity with the largest pump out of service*

b. *Reservoir 3 pumps remain off at Citrus due to the City not having the reservoir in service, and pressurizing the zone through the zone 1-3 PRV valve at Citrus P/S and the PRV valve at A street. To better reflect this operating condition, the Citrus PS to Zone 3 firm capacity is assumed as 0 gpm. Additionally, the City has undergone a study to replace the Citrus PS, which would presumably make up any shortfall in pumping capacity.*

6.4 Existing Storage Capacity Analysis

As discussed in Section 2, the City's water system has 14 reservoirs with a total of 24.7-MG capacity. The storage criteria, described in Section 6.1, consist of three components: equalization, fire, and emergency storage. The equalization storage criteria were set at 25 percent of MDD, the emergency storage was set at 33 percent of fire flow and equalization combined storage, and the fire flow storage was set at the volume required to supply the largest needed fire flow in the system for the required fire flow duration, typically supplied by pressure zone. The highest fire flow requirement in the City's service area is 4,000 gpm for 4 hours.

A summary of the required and available storage volumes is presented in Table 6-8; details of this analysis are presented in Appendix G.

In Table 6-8, red text indicates a zone deficit, with associated recommended storage or zone transfers also shown in red text in the "Zone Transfer Description/Recommended Storage" column.

Table 6-8. Existing System Storage Analysis

Zone	Tank	Existing Operational Capacity (MG)	MDD (mgd)	Equalization Storage (MG)	Maximum Fireflow Required in Zone (gpm)	Fireflow Duration (hour)	Fire Storage (MG)	Emergency Storage (MG)	Zone Deficit/Surplus (MG)	Zone Transfer Description/Recommended Storage
West System										
Zone 7	RES 7	1.5	0.4	0.1	4,000	4	1.0	0.3	0.1	
Zone 6/6b, Zone 6-Reduced, Zone Reduced A, Zone Reduced B, Zone Skyline	RES 6, RES 6B	2.9	1.6	0.4	4,000	4	1.0	0.5	1.1	
Zone 5/5b	RES 5, RES 5b	11.8	1.5	0.4	4,000	4	1.0	0.4	10	PRV to Zone 3 (A Street PRV), PRV to Zone 4 (Sullivan Avenue/San Pedro Rd PRV)
Zone 4	RES 4	1.37	1.5	0.4	4,000	4	1.0	0.4	-0.4	PRV from Zone 5/5b (Sullivan Ave/San Pedro Rd PRV)
East System										
Zone 2/2b, Zone 2R, Zone Alta Vista, Zone Pointe Pacific, Zone South Hill	RES 2, RES 2b	2.1	0.4	0.1	4,000	4	1.0	0.4	0.6	PRV to Zone 8 group
Zone 8, Zone Bayshore 1, Zone Bayshore 2, Zone Bayshore 9	RES 8	0.6	0.4	0.1	4,000	4	1.0	0.3	-0.8	PRV from Zone 2/2b, Pump from Bayshore PS
Zone 1	RES 1	0.7	1.1	0.3	4,000	4	1.0	0.4	-0.9	Pump from Citrus PS
Zone 3	RES 3	0	1.3	0.3	4,000	4	1.0	0.4	-1.7	PRV from Zone 5 (A Street PRV)

The deficiencies and recommended storage improvements are:

- **Zone 4**: With a maximum day demand of 1.5 mgd, the total required storage is 1.8 MG; however, only 1.37 MG is available, giving a zone deficiency of 0.4 MG. To resolve this deficit, a zone transfer from Zone 5/5b through the Sullivan Ave/San Pedro Rd PRV is proposed.
- **Zone 8 Group:** With a combined maximum day demand of 0.4 mgd, the total required storage is 1.4 MG; however, only 0.6 MG of storage is available, giving a zone deficiency of 0.8 MG. To resolve this deficiency, a zone transfer from Zone 2/2b through a PRV is proposed, along with pumping from Bayshore PS.
- **Zone 1**: With a maximum day demand of 1.1 mgd, the total required storage is 1.6 MG. Only 0.7 MG is available, giving a zone deficiency of 0.9 MG. To resolve this deficiency, pump from Citrus PS.
- **Zone 3**: With a maximum day demand of 1.3 mgd, the required storage is 1.7 mgd. In order to determine whether the system can function with Reservoir 3 offline, the storage analysis was performed with the assumption that Reservoir 3 is offline. This gives Zone 3 0 MG of storage. Therefore, the zone deficiency is 1.7 MG. To resolve this deficit, a zone transfer from Zone 5 through A Street PRV is proposed.

6.5 Future Systems Evaluation

This section summarizes the model analysis of a future scenario. Future conditions are representative of the year 2045 and represent build-out of the master plan study area. The existing system hydraulic model was used as the basis for development. Water demand used for each scenario is described in Section 3.

6.5.1 Piping Improvements

Based on the modeling analysis under future ADD and MDD conditions, no new areas with high- or low-pressure deficiencies were identified.

6.5.1.1 Fire Flow Improvements

As the future system expansions in the hydraulic model are limited to a backbone system of new developments, no additional fire flow deficiencies and improvements were identified. It was also assumed that the distribution systems of the future developments will be adequately sized to the land-use based fire flow criteria used in the Master Plan. Hence, no fire flow improvements projects are recommended.

6.6 Future Storage and Pump Station Capacity Analysis

The City's distribution system includes connectivity between pressure zones through PRVs; therefore, surplus storage in the District's pressure zones with supplies can often supplement the storage deficit in lower pressure zones if gravity flow through PRV is available.

Table 6-9 summarizes the required and available storage volume under future demand conditions, and Table 6-10 presents the available and required pump capacities under future demand conditions. In Table 6-9, red text indicates a zone deficit, with associated recommended storage or zone transfers also shown in red text in the "Zone Transfer Description/Recommended Storage" column.

Table 6-9. Future System Storage Analysis

Zone	Tank	Existing Operational Capacity (MG)	MDD (mgd)	Equalization Storage (MG)	Maximum Fireflow Required in Zone (gpm)	Fireflow Duration (hour)	Fire Storage (MG)	Emergency Storage MG)	Zone Deficit/Surplus (MG)	Zone Transfer Description/ Recommended Storage
West System										
Zone 7	RES 7	1.5	0.4	0.1	4,000	4	1.0	0.3	0.1	
Zone 6/6b, Zone 6-Reduced, Zone Reduced A, Zone Reduced B, Zone Skyline	RES 6, RES 6B	2.9	1.9	0.5	4,000	4	1.0	0.5	1.0	
Zone 5/5b	RES 5, RES 5b	11.8	1.5	0.4	4,000	4	1.0	0.4	10	PRV to Zone 3 (A Street PRV), PRV to Zone 4 (Sullivan Avenue/San Pedro Rd PRV)
Zone 4	RES 4	1.37	1.5	0.4	4,000	4	1.0	0.4	-0.4	PRV from Zone 5/5b (Sullivan Ave/San Pedro Rd PRV)
East System										
Zone 2/2b, Zone 2R, Zone Alta Vista, Zone Pointe Pacific, Zone South Hill	RES 2, RES 2b	2.1	0.4	0.1	4,000	4	1.0	0.4	0.6	PRV to Zone 8 group
Zone 8, Zone Bayshore 1, Zone Bayshore 2, Zone Bayshore 9	RES 8	0.6	0.4	0.1	4,000	4	1.0	0.3	-0.8	PRV from Zone 2/2b, Pump from Bayshore PS
Zone 1	RES 1	0.7	1.1	0.3	4,000	4	1.0	0.4	-0.9	Pump from Citrus PS
Zone 3	RES 3	0	1.3	0.3	4,000	4	1.0	0.4	-1.7	PRV from Zone 5 (A Street PRV)

Table 6-10. Future System Pump Station Capacity Analysis

Pressure Zone	Pump Station	Total Capacity (gpm)	Firm Capacity[a] (gpm)	Required Capacity		Deficit/Surplus (gpm)
				Description	Flow (gpm)	
West System						
Zone 7	RES 6b PS	1,600	800	Zone 7 MDD	260	540
Skyline Zone	Skyline PS	1,784	234	Skyline MDD	31	203
Zone 6/6b Group	RES 5 PS, RES 5b PS	4,770	1,670	Zone 6/6b MDD	1,323	347
Zone 5/5b	RES 4 PS, A St PS, Hickey PS	7,487	4,982	Zone 5/5b MDD	2,365	2,617
Zone 4	Westlake PS	3,525	2,580	Zone 4 MDD	3,441	-861
East System						
Zone Bayshore 1	Allen TOs, Macdonald TO	238	238	Bayshore Zone 1 MDD	1,309	-1,071
Zone 8, Zone Bayshore 2, Zone Bayshore 9	Bayshore PS	1,000	500	Zone 8, Bayshore 2, Bayshore 9 MDD	139	361
Zone Alta Vista	Alta Vista PS	1,131	565	Alta Vista MDD + Alta Vista FF demand	1,522	-957
Zone Pointe Pacific	Pointe Pacific PS	6,000	3,500	Pointe Pacific MDD + Pointe Pacific FF demand	4,015	-515
Zone South Hill	South Hill PS	1,900	400	Southhill MDD + SouthHill FF demand	1,507	-1,107
Zone 2/2b group	RES 1 PS, Bellevue PS, RES 8 PS	2,804	1,301	Zone 2/2b MDD	303	998
Zone 1	Citrus PS to Zone 1	3,100	1,600	Zone 1 MDD	1,082	518
Zone 3	Citrus PS to Zone 3	2,767	0	Zone 3 MDD	217	-217

a. Capacity with the largest pump out of service
FF = fire flow

Section 7

Capital Improvement Program

This section presents the recommended CIP for the Daly City water system. The proposed CIP presents improvement projects based on the water system evaluations described in Section 6.

This section starts with a summary of the cost-estimating assumptions. Subsequently, the potable water CIP is presented with a summary of recommendations on project prioritization.

7.1 Cost Estimating

The cost estimates presented in this Master Plan are developed from bid tabulations, cost curves, information obtained from previous studies, and BC's experience on similar projects.

7.1.1 Capital Cost Development

Capital costs developed for this master plan are estimated by multiplying the estimated construction cost with various markups. The various cost components used in the development of capital cost estimates are described below.

7.1.1.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvement projects. Pipeline construction costs were developed based on planning-level unit costs and preliminary pipeline lengths and diameters. Planning-level unit costs were developed from bid tabs from recent pipeline construction projects, details of which are given in Section 7.1.2. Baseline construction costs are calculated by multiplying the estimated number of units by the unit cost (such as length of pipeline times the average cost of linear foot of pipeline). The unit construction costs used for this master plan are presented in Section 7.1.2.

7.1.1.2 Estimated Construction Cost

Contingency costs were added to the planning budget as a percentage of the total construction cost, divided into two categories: estimated construction cost and capital improvement cost. A 35 percent contingency was applied to the baseline construction cost to account for unforeseen events and unknown conditions. This contingency accounts for unknown site conditions and other unknowns and is typical for master planning projects. The estimated construction cost for the proposed water system improvements consists of the baseline construction cost plus the 35 percent construction contingency. Construction costs are based on AACE International Class 5 estimates.

7.1.1.3 Capital Improvement Cost

Other project construction contingency costs include costs associated with engineering, construction-phase professional services, and project administration. As shown in the following sample calculation of the capital improvement cost in Table 7-1, the total cost of select project construction contingencies is 77 percent of the baseline construction cost. The calculation of the 77 percent is the overall markup on the baseline construction cost to arrive at the capital improvement cost. It is not an additional contingency.

Table 7-1. Sample Capital Improvement Cost Calculation	
Baseline Construction Cost	**$1,000,000**
Construction Contingency (35%)	$350,000
Estimated Construction Cost	**$1,350,000**
Engineering Cost (15%)	$202,500
Construction Management (8%)	$108,000
Project Administration (8%)	$108,000
Capital Improvement Cost	**$1,768,500**

7.1.2 Unit Construction Cost

Construction costs were developed based on planning-level unit costs. Planning level unit costs were developed from bid tabs from recent construction projects, details of which can be found in Appendix I. Assumptions made for these costs are also included in Appendix I. The costs in Appendix I do not include engineering or contingency costs, which were added separately as detailed in Section 7.1.1.

7.2 Water System CIP

BC developed a 10-year Capital Improvements Plan (CIP) for the City system to assist the City in budgeting for improvements needed to provide the required level of service to the City water customers. Projects are categorized as Water System Capacity Improvements, Repair and Rehabilitation Improvements, or as Other Projects. BC has categorized all 10-year CIP projects into near-term (next five years) or longer-term (next six to 10 years). Capital planning for build out projects, i.e., projects with implementation horizons beyond 10 years, was beyond the scope of this master plan. For the build-out improvements, i.e., facilities not in the next 10-year CIP, the City needs to carry out further analyses and cost estimating, to define specific requirements.

BC estimated planning level costs for each project. Cost estimates provided in Table ES-2 are based on a budgetary, planning level, engineer's opinion of probable costs (e.g., AACE International Class 5--order-of-magnitude—estimates). Table ES-2 presents the costs for each recommended improvement in present day value. They were developed based on construction cost information as of Spring 2022, for San Francisco Bay Area. When the City undertakes design, the City will need to update and escalate the costs into then current dollars.

The Water System CIP is summarized by project category, facility type, and phase in Table 7-2 and a breakdown of costs by improvement and phase is shown on Figure 7-1. Project locations are shown on Figure 7-3. A detailed CIP table is included in Appendix I. As listed in Table 7-2 and shown in Figure 7-2, the majority of the proposed improvements consist of pipeline improvements, at 82 percent of the total CIP cost.

Table 7-2. CIP Summary Table

Project	CIP Cost Estimate	CIP Phasing	
		Near-Term 2022-2026	Long-Term 2027-2033
Water System Capacity Improvements	$31,219,000	$12,340,000	$18,879,000
Fire Flow Improvements	$12,602,000	$4,697,000	$7,905,000
Distribution System improvements	$18,617,000	$7,643,000	$10,974,000
Repair and Rehabilitation Projects	$1,119,000		$1,119,000
CIP Total	**$32,338,000**	**$12,340,000**	**$19,998,000**
Average Annual Cost	N/A	$2,468,000	$3,333,000

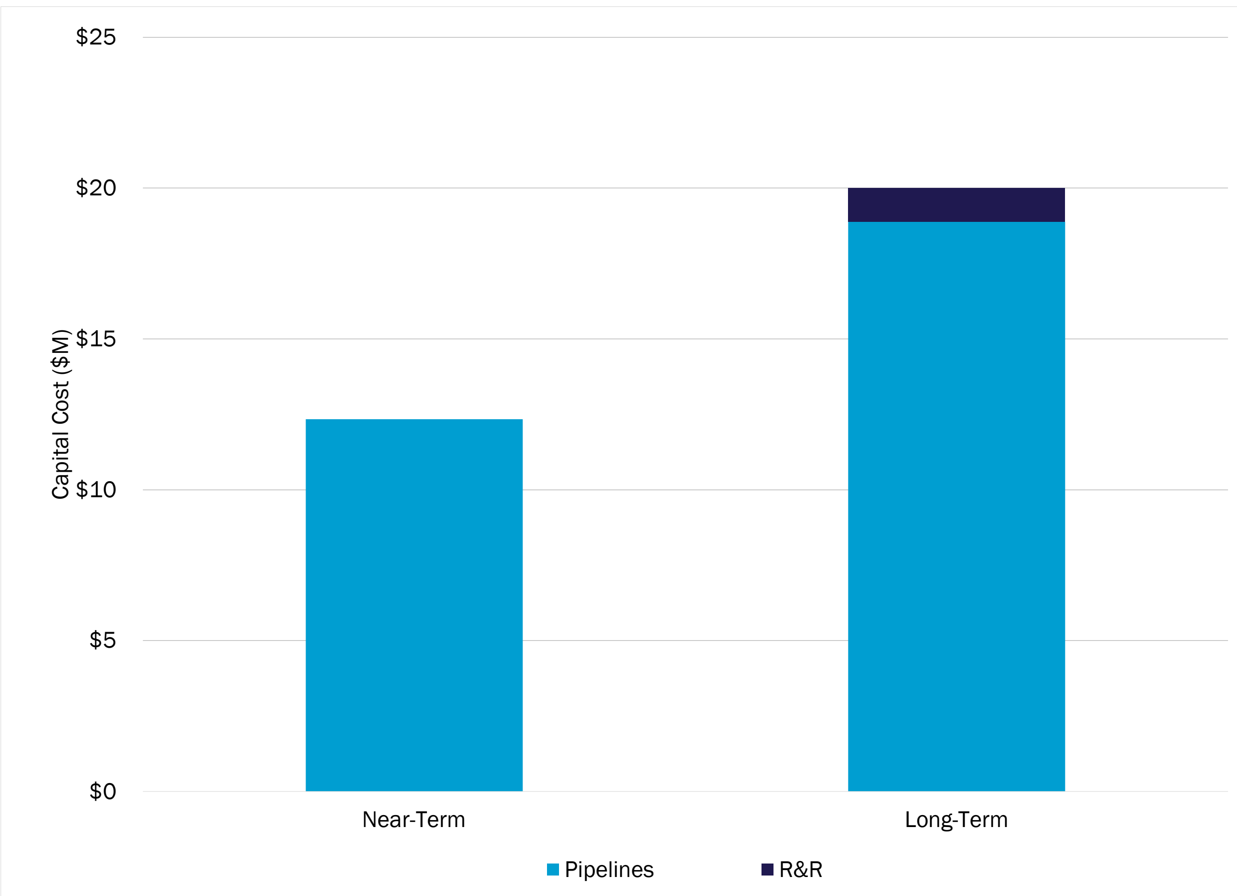

Figure 7-1. Water CIP by Improvement Category and Phase

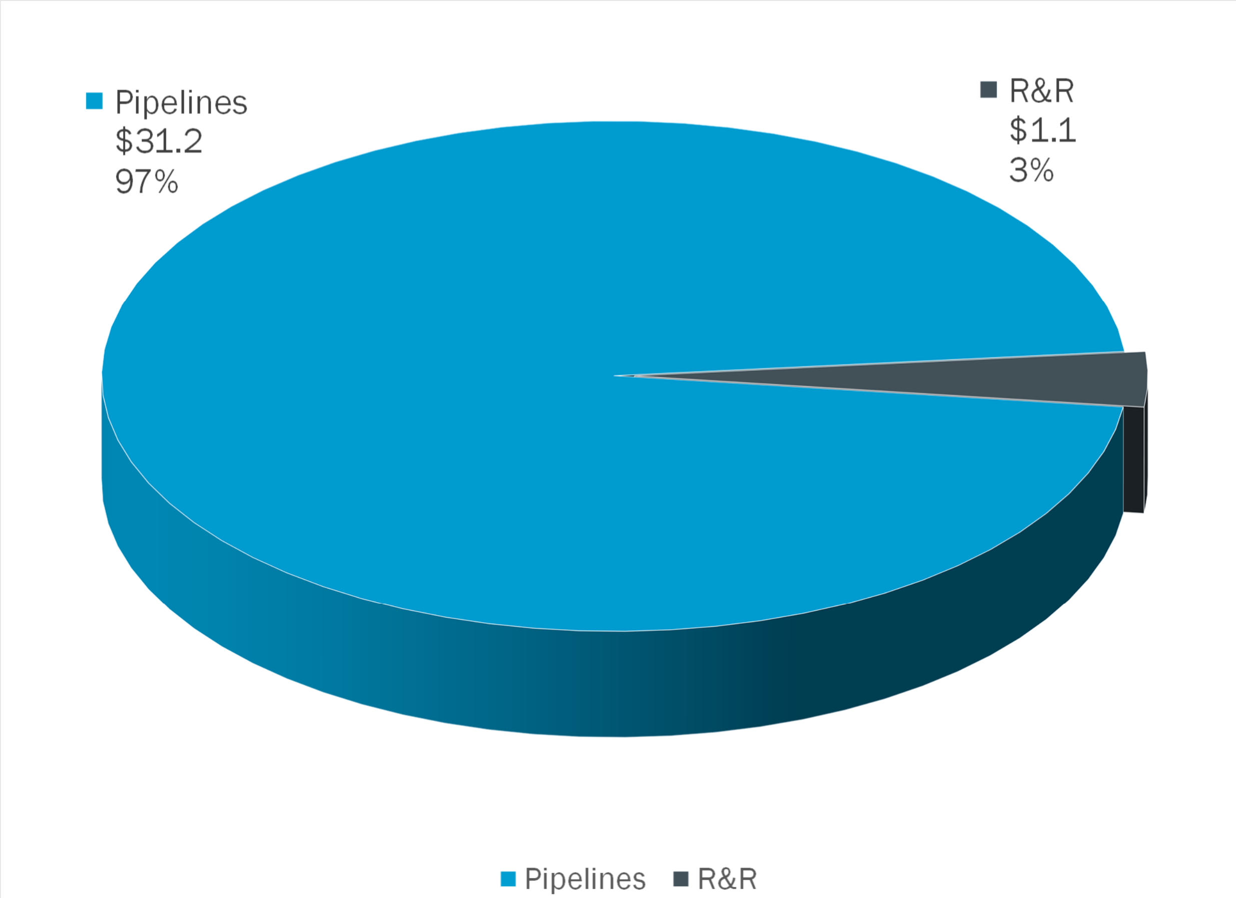

Figure 7-2. Water CIP by Project Type

7.2.1 Water System Project Prioritization

The improvement projects were divided into the following project categories:

- Water System Capacity Improvements
  - Distribution System Improvements (piping)
  - Fire Flow Improvements
- Repair and Rehabilitation Projects
  - Recommended Condition Assessments
  - SCADA upgrades

The proposed capital improvements are prioritized based on their urgency to mitigate existing deficiencies and to provide service for future growth. Fire flow improvements were ranked based on the existing percentage of the fire flow demand they are currently providing, and the criticality of the pressure zone they are located in. Within each improvement category, projects were prioritized into a near-term, long-term, or build-out phases. The near-term phases extend from 2022 to 2026, the long-term phases extend from 2027 to 2033, and build-out is from 2033 and beyond. Figure 7-3 summarizes project locations for each phase.

7.2.1.1 Near-term

As summarized in Table 7-4 and shown on Figure 7-1, the cost for near-term-related improvement projects is approximately $12.3 million, which includes $12.3 million in capacity-related improvements. Projects include four fire flow improvement projects, and 2.2 miles of small diameter pipeline improvements. Based on feedback from the City, small diameter pipeline improvements were targeted to begin in the oldest parts of the City as well as along Crocker Ave, and work their way south and east. Small-diameter pipelines in Zone 1 were the highest priority and were assigned within the near-term and proximity to fire flow improvement projects, where applicable. Priority was given to pipeline replacement projects with existing pipelines built prior to 1930, and that were classified as small diameter pipelines (4 inches and below).

7.2.1.2 Long-term

As summarized in Table 7-4 and shown on Figure 7-1, the cost for long-term-related improvement projects is approximately $19.9 million, which includes $18.8 million for capacity-related improvement, and approximately $1.1 million for annual condition assessments. The remaining fire flow projects are included in the long-term timeframe. Annual ongoing condition assessments for critical pipelines as identified in Section 5 are included in the long-term timeframe, in order to inform the prioritization of further distribution system improvements in the build-out timeframe. Small diameter pipeline improvement cost estimates do not account for reconnecting of service lines and are assuming a one-to-one replacement. A robust small diameter pipeline replacement strategy should be prioritized for the long-term and build-out phases. Therefore, individual pipeline replacement projects should be assessed as part of future planning studies.

7.2.1.3 Build-out

Build-out projects include the remaining small diameter pipes in Zone 1, with installation dates after 1930. Additionally, all Zone 2 and Zone 3 small diameter pipelines are included in the build-out timeframe. Repair and Rehabilitation build-out projects include general water distribution SCADA upgrades. For the build-out improvements, the City needs to carry out further analyses and cost estimating, to define specific requirements.

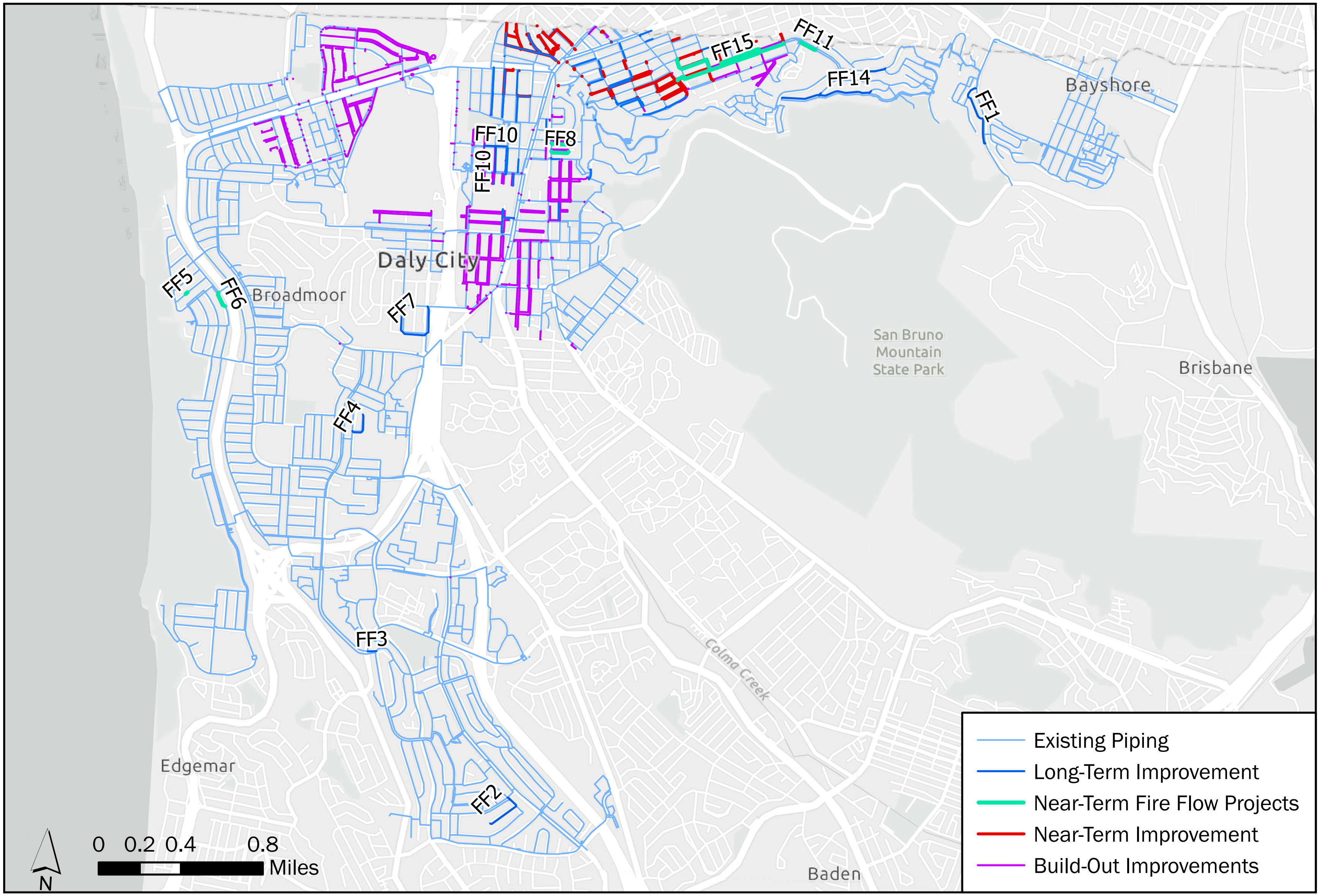

Figure 7-3. Capital Improvement Projects

Section 8

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Appendix A: One-Page Summaries for Near-Term CIP recommendations

Appendix A includes one-page summary sheets for each year in the near-term CIP phase (2022 through 2026).

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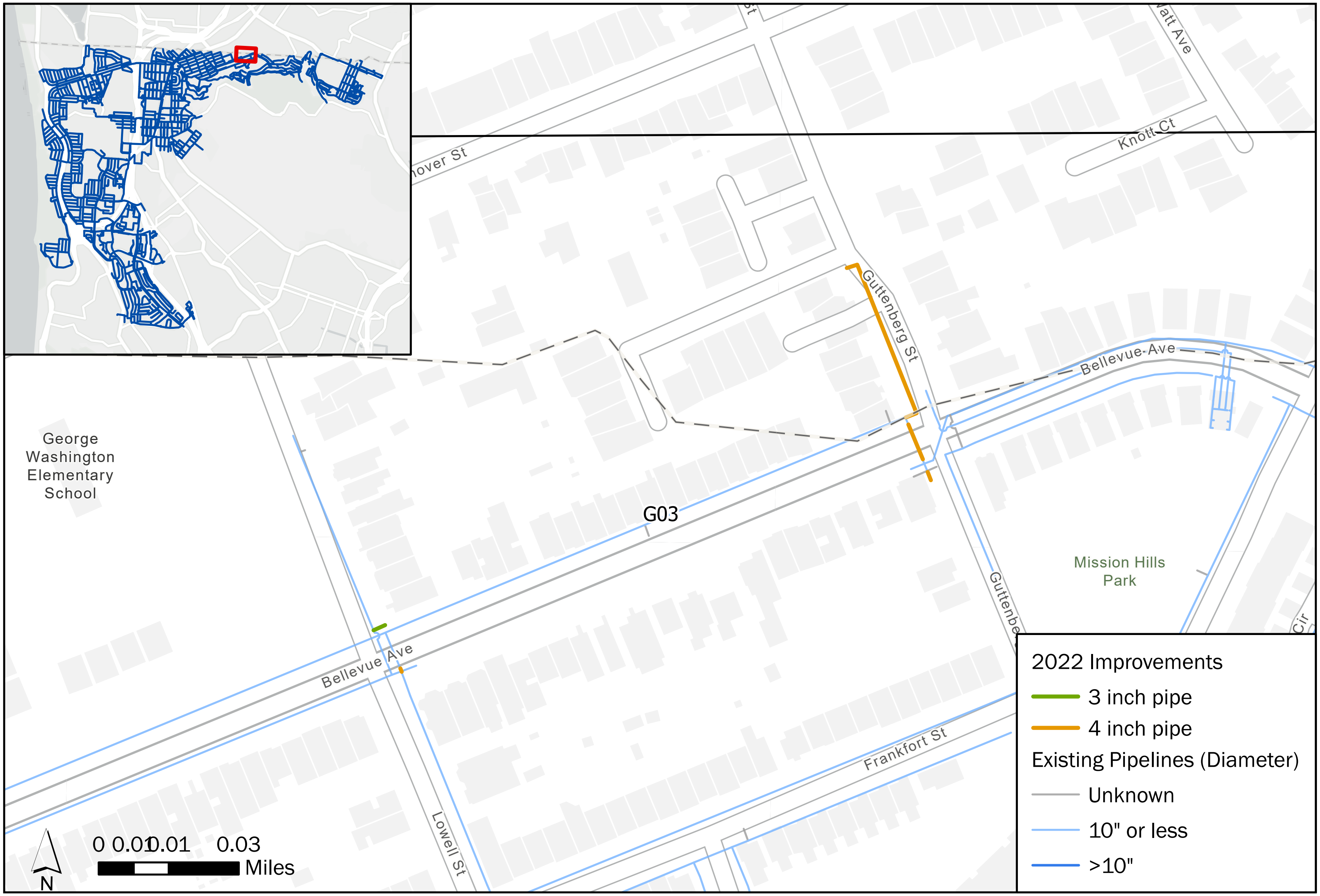
City of Daly City
Integrated Master Plan
CAPITAL IMPROVEMENT PLAN

Project Identification: 2022
Project Name: CIP Improvements in 2022
System Type: Potable Water
System Deficiency: Fire-Flow, Small Diameter Pipes
Project Justification: Alleviates fire-flow deficiencies, provides additional capacity and improves quality of service in areas with small diameter piping
Project Description:
Improvement projects in 2022. Includes all of FF-11, portions of FF-15 in grid G03, and portions of small diameter pipe replacements (Zone 1) in grid G03.

Pipe Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Estimated Construction Cost 135%	Capital Improvement Cost 177%	Project Schedule
FF-15	Pipe	4	8	Replace	740	$ 389	$ 288,016	$ 388,821	$ 509,000	2022
FF-15	Pipe	6	8	Replace	1,036	$ 389	$ 403,191	$ 544,307	$ 713,000	2022
FF-15	Pipe	7	8	Replace	629	$ 389	$ 244,494	$ 330,067	$ 432,000	2022
Res 1 SD pipe installed prior to 1930	Pipe	4	8	Replace	286	$ 389	$ 111,428	$ 150,428	$ 197,000	2022



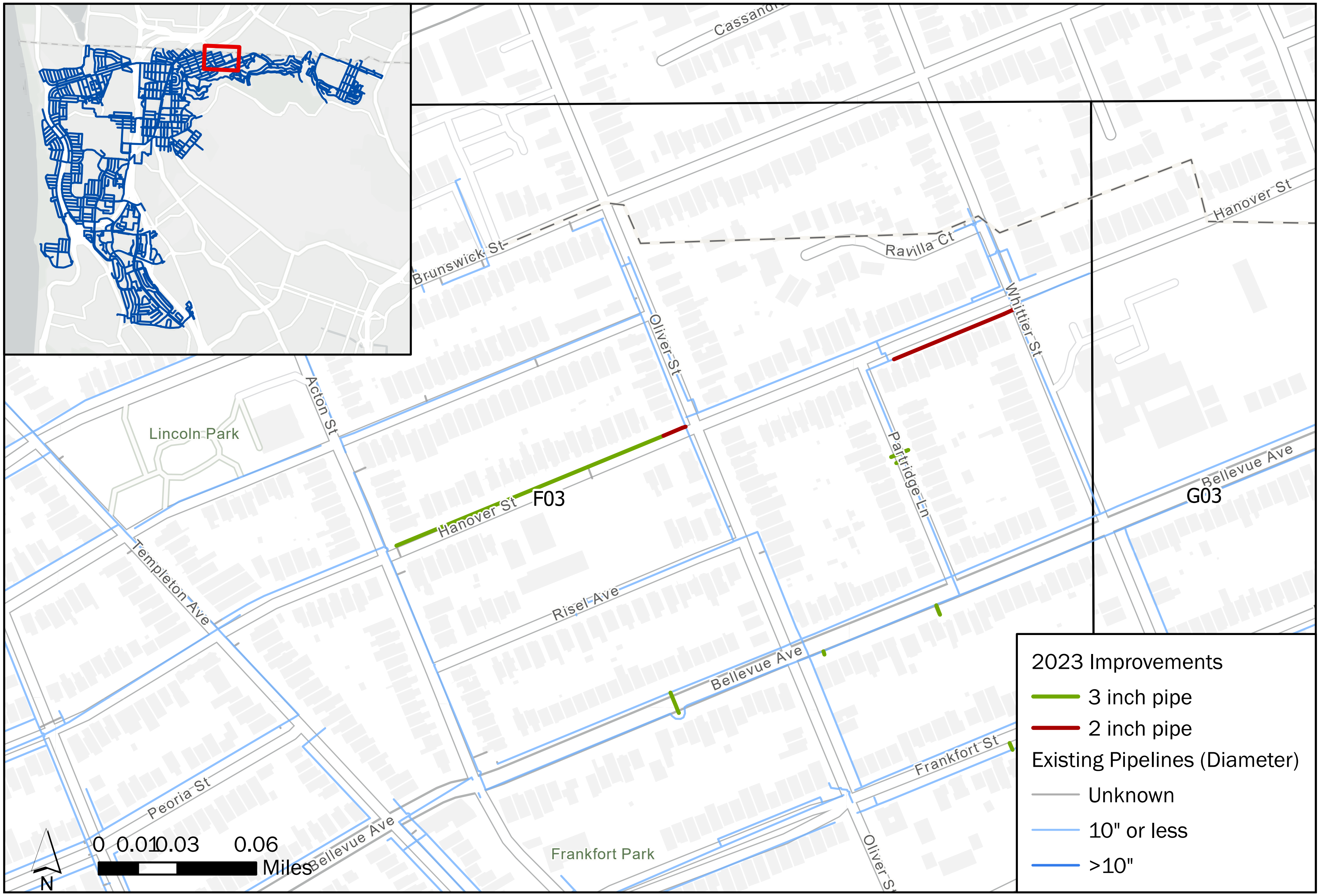
2022 Capital Improvement Projects

Brown AND Caldwell

City of Daly City
Integrated Master Plan
CAPITAL IMPROVEMENT PLAN

Project Identification: 2023
Project Name: Near Term-2023
System Type: Potable Water
System Deficiency: Fire-Flow, Small Diameter Pipes
Project Justification: Alleviates fire-flow deficiencies, provides additional capacity and improves quality of service in areas with small diameter piping
Project Description:
Improvement projects in 2023. Includes portions of FF-15 in zone F03. Remaining projects include amount of 2" and 3" small diameter pipe in grid F03 until total cost approches recommended budget of $2.5M.

Pipe Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Estimated Construction Cost 135%	Capital Improvement Cost 177%	Project Schedule
FF-15	Pipe	4	8	Replace	1,590	$ 389	$ 618,646	$ 835,172	$ 1,094,000	2023
FF-15	Pipe	7	8	Replace	1,064	$ 389	$ 413,709	$ 558,508	$ 732,000	2023
Res 1 SD pipe installed prior	Pipe	3	8	Replace	677	$ 389	$ 263,384	$ 355,569	$ 466,000	2023
to 1930 located in Grid F03	Pipe	2	8	Replace	303	$ 389	$ 117,867	$ 159,120	$ 208,000	2023



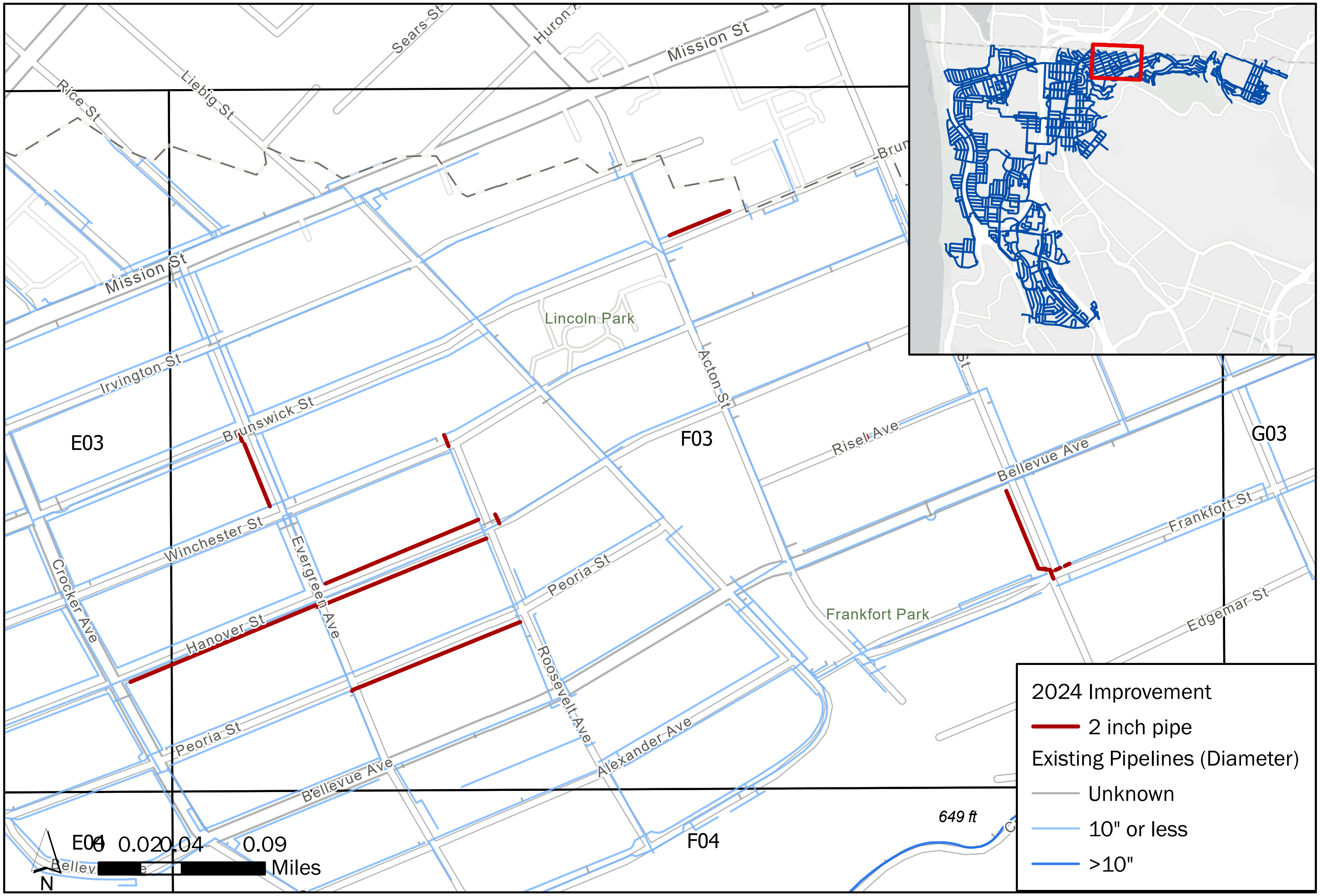
2023 Capital Improvement Projects

Brown AND Caldwell

City of Daly City
Integrated Master Plan
CAPITAL IMPROVEMENT PLAN

Project Identification: 2024
Project Name: Near Term-2024
System Type: Potable Water
System Deficiency: Fire-Flow, Small Diameter Pipes
Project Justification: Alleviates fire-flow deficiencies, provides additional capacity and improves quality of service in areas with small diameter piping
Project Description:
Improvement projects in 2024. Includes FF-8 and FF-9. Remaining projects include amount of 2" small diameter pipe in grid F03 until total cost approaches recommended budget of $2.5M.

Pipe Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Estimated Construction Cost 135%	Capital Improvement Cost 177%	Project Schedule
FF-8	Pipe	4	8	New	474	$ 389	$ 184,573	$ 249,173	$ 326,000	2024
FF-9	Pipe	4	6	New	460	$ 339	$ 156,093	$ 210,725	$ 276,000	2024
Res 1 SD pipe installed prior to 1930	Pipe	2	8	Replace	2,699	$ 389	$ 1,049,911	$ 1,417,380	$ 1,857,000	2024

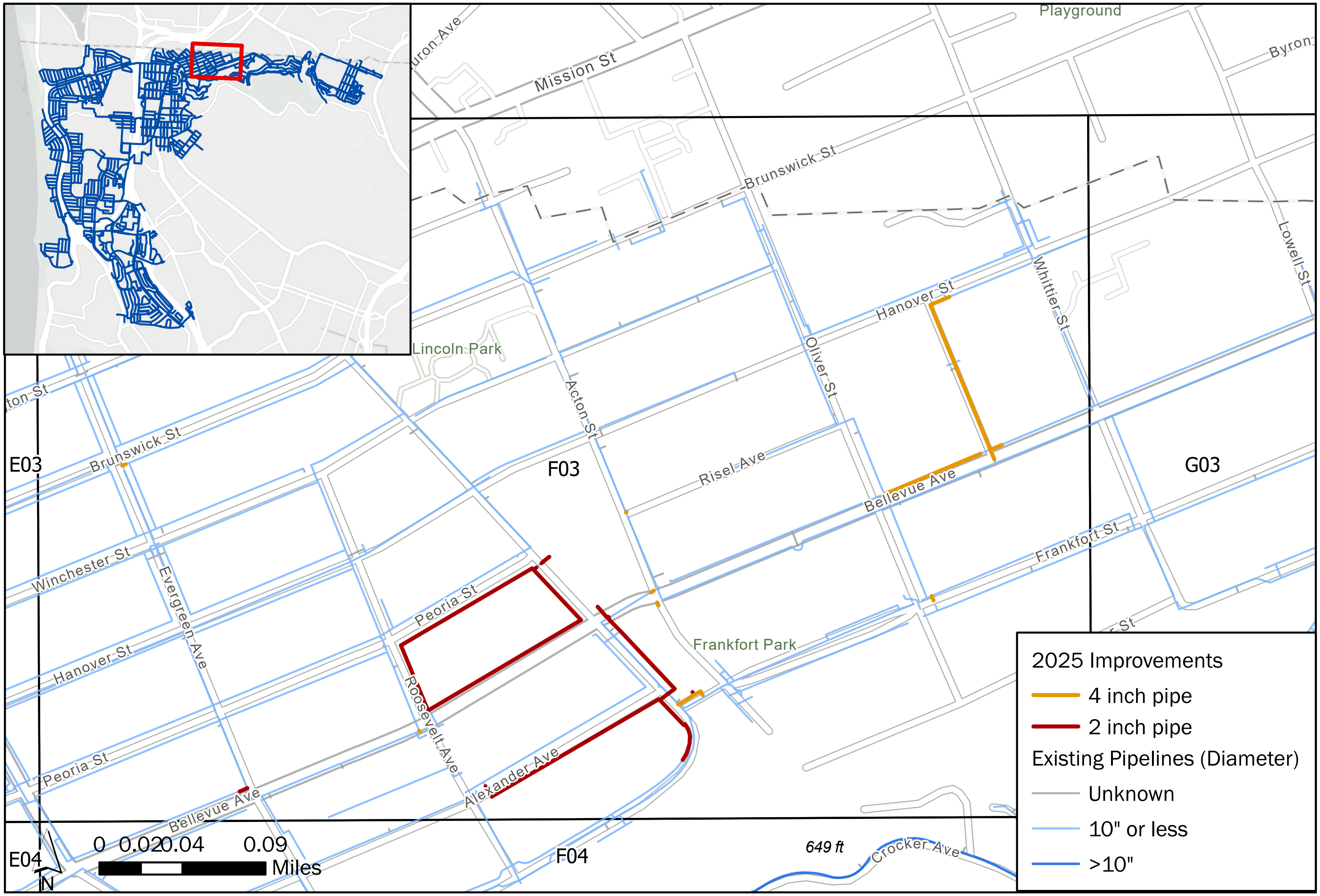


2024 Capital Improvement Projects

City of Daly City
Integrated Master Plan
CAPITAL IMPROVEMENT PLAN

Project Identification: 2025
Project Name: Near Term-2025
System Type: Potable Water
System Deficiency: Small Diameter Pipes
Project Justification: Provides additional capacity and improves quality of service in areas with small diameter piping
Project Description:
Improvement projects in 2025. Includes remaining 2" and 4" small diameter pipe installed prior to 1930 in grid F03.

Pipe Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Estimated Construction Cost 135%	Capital Improvement Cost 177%	Project Schedule
Res 1 zone SD pipe prior to 1930	Pipe	4	8	Replace	2,353	$ 389	$ 915,392	$ 1,235,779	$ 1,619,000	2025
	Pipe	2	8	Replace	1,602	$ 389	$ 623,206	$ 841,329	$ 1,102,000	2025

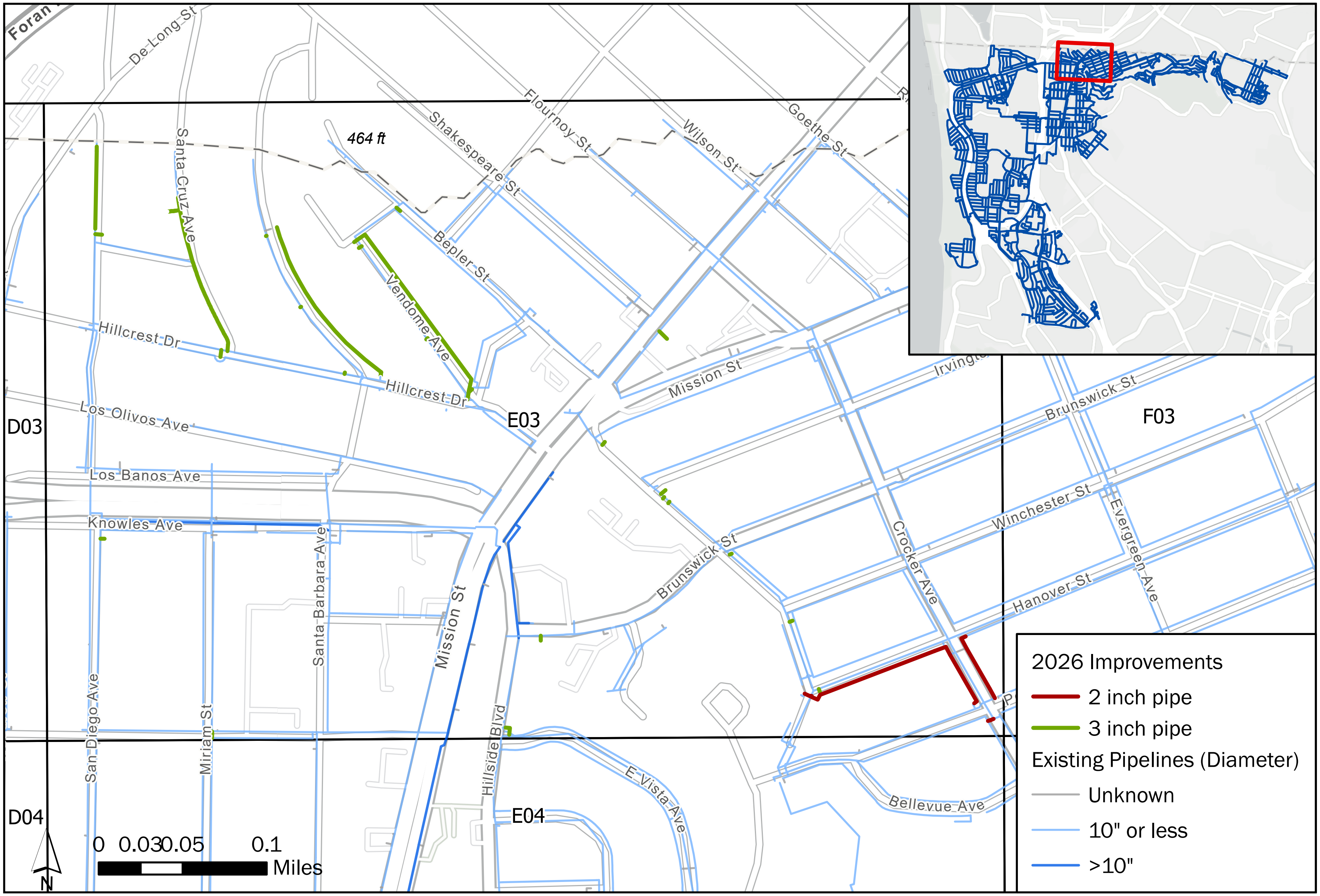


2025 Capital Improvement Projects

City of Daly City
Integrated Master Plan
CAPITAL IMPROVEMENT PLAN

Project Identification: 2026
Project Name: Near Term-2026
System Type: Potable Water
System Deficiency: Fire-Flow, Small Diameter Pipes
Project Justification: Alleviates fire-flow deficiencies, provides additional capacity and improves quality of service in areas with small diameter piping
Project Description:
Improvement projects in 2026. 2" and 3" small diameter pipe installed prior to 1930 in grid E03.

Pipe Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Estimated Construction Cost 135%	Capital Improvement Cost 177%	Project Schedule
FF-5	Pipe		6	New	70	$ 339	$ 23,730	$ 32,036	$ 41,970	2026
FF-6	Pipe	6	8	Replace	394	$ 389	$ 153,336	$ 207,004	$ 271,170	2026
Res 1 zone SD pipe prior to 1930	Pipe	2.00	8	Replace	808	$ 389	$ 314,312	$ 424,321	$ 555,860	2026
	Pipe	3.00	8	Replace	2,361	$ 389	$ 918,611	$ 1,240,125	$ 1,624,560.00	2026



2026 Capital Improvement Projects

Brown AND Caldwell

Appendix B: Calibration Plan

The calibration plan in this appendix explains the calibration field work. The plan was developed to guide the field calibration explained in Section 4.1. The calibration plan included the following six attachments that are not included in this appendix for the reasons stated below:

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201 North Civic Drive, Suite 300
Walnut Creek, CA 94596
T: 925.937.9010

Technical Memorandum

Prepared for: City of Daly City

Project Title: 10-Year Water System Master Plan

Project No.: 154529

Technical Memorandum

Subject: Field Calibration Plan

Date: May 10, 2021

To: Thomas Piccolotti, Director

From: Shem Liechty, Brown and Caldwell

Section 1: Introduction

This technical memorandum (TM) describes field testing for calibration of the City of Daly City (City) water system model. The City will perform field testing and Brown and Caldwell (BC) will use the results to calibrate the model. This TM discusses testing procedures, locations, required personnel, and equipment for flow testing and pressure data collection.

Field testing will consist of the following three types of tests:

1. Hydrant flow tests will be performed at various sites within the water system. These are not the same as hydrant fire flow tests performed to determine available flow from a hydrant. The calibration flow tests are done to “stress” the distribution system so that the calibration data will reflect the system’s reactions to a range of operating conditions. Before, after, and during the tests, pressure data will be recorded at select hydrants within the distribution system. The flow and pressure data will be used in conjunction with the City’s SCADA data during the same period to calibrate the hydraulic model.
2. Pressure monitoring devices will be installed throughout the system to monitor pressures during normal operation and during hydrant flow tests.
3. Pump performance will be tested by gathering operating head and flow for each pump for comparison with pump curves.

The proposed testing schedule is listed in Table 1-1. This includes time to install and remove monitoring equipment from the system.

Table 1-1. Proposed Field Testing Schedule

Date	Approximate Time	Activity Description
November 30, 2020	7:00am – 4:00pm	• Install 8 pressure loggers in water system
December 1, 2020	7:00am – 4:00pm	• Perform 8 hydrant flow tests
December 2, 2019	7:00am – 4:00pm	• Perform 8 hydrant flow tests
December 3, 2020	7:00am – 4:00pm	• Perform 4 hydrant flow tests, retest any sites if necessary • City staff and a representative from BC will identify specific locations for installing strap-on flow meters for Reservoir 3 fire flow tests
December 4, 2020	7:00am – 4:00pm	• Perform 4 Reservoir 3 fire flow tests
December 7, 2020	7:00am – 4:00pm	• Collect pump performance data
December 8, 2020	7:00am – 4:00pm	• Collect pump performance data
December 17, 2020	7:00am – 4:00pm	• Remove pressure loggers from system

1.1 Field Work Health and Safety Awareness

Brown and Caldwell prepares a Field Work Safety Plan (FWSP) for its personnel when BC personnel perform or assist with flow testing. Although BC personnel are not required for this testing plan, the FWSP is provided in Attachment A for City reference.

1.2 Collection of SCADA Data

Prior to field testing, the City should ensure that all flows, pressures, and tank levels are being recorded and stored in the SCADA system. A list of the data points needed from SCADA are provided in Table 1-2. After the field flow testing, City staff will provide SCADA data for the water system for June 1, 2020 to the present. Including the testing period. The SCADA data should be provided at 1-hour intervals or less, at a minimum. Data at 5-minute intervals or less is preferred.

Table 1-2. SCADA Data Points

Storage Tank Water Level	Pump Station flowrate or pump status for all pumps (on/off)	Turnout flowrate (SFPUC)
Reservoir 1	A Street PS	T01 - Sullivan 1 Meter
Reservoir 2	Alta Vista PS	T02 - Sullivan 2 Meter
Reservoir 2B	Bayshore PS	T03 - Sullivan 3 Meter
~~Reservoir 3~~	Bellevue PS	T04 - Hickey 1 Meter
Reservoir 4	Citrus PS	T05 - Hickey 2 Meter
Reservoir 5	Hickey PS	T06 - Park Plaza Meter
Reservoir 5B	South Hill PS	T07 - Macdonald Meter
Reservoir 6	Westlake PS	T08 - Allen Meter 1
Reservoir 6B	RES 1 PS	Allen Meter 2
Reservoir 7	RES 2 PS or Point Pacific PS	Allen Meter 3
Reservoir 8	RES 4 PS	Allen Meter 4
Citrus Sump	RES 5 PS	T09 - B Street Meter
Westlake Sump	RES 5B PS	~~T010 - Guttenberg Meter~~
Franciscan Res.	RES 6 PS or Skyline PS	T011 - Carter
	RES 6B PS	T012 - Hill
	RES 8 PS	Citrus Valve TO
	~~Gellert PS~~	
	~~Higate PS~~	
	Franciscan Bay PS	

Section 2: Hydrant Flow Tests

The personnel and equipment needed for the hydrant flow tests are described in this section.

2.1 Personnel

Table 2-1 lists the number of personnel needed from each organization and their respective duties. The flow testing is expected to be completed in two days.

Table 2-1. Personnel Requirements

Organization	Number of personnel	Duties
City	2 at a minimum, 3 preferred	• Conduct flow tests • Collect data • Operate hydrants for flow tests • Provide vehicle to transport City staff and equipment to each test location

2.2 Preparation

Prior to the testing, the City should ensure the following:

- It is requested that the City check the hydrant flow test locations (described in Section 2.5) prior to the day of testing to ensure that each location is suitable.
- During field inspection or calibration testing, if any of the locations are found to be unsuitable or if a hydrant is inoperable, an alternate site will be selected and documented.
- On the day of testing, compare the SCADA clock time to the clock times being used for the testing record and for the pressure loggers. Note any differences.

2.3 Equipment

Table 2-2 lists the equipment needed for the calibration testing. Equipment should be checked prior to the day of testing to verify that it is functional and accurate.

Table 2-2. Required Equipment for Calibration Testing

Item	Quantity	Provided By
Hydrant wrench	2	City
Valve key	1	City
Hydrant flow diffusers	2	BC
Dechlorination tablets for flow diffuser and storm drain inlet curb bags	As needed for 24 hydrant flow tests	City
Calibrated 200 psi pressure gauge	3	BC
Calibrated pressure loggers, 300 psi rated	11	BC
Strap-on Flow Meters	3	BC

2.4 Hydrant Flow Testing

Each hydrant flow test should follow the general procedures listed in Table 2-3. Each flow test involves two hydrants, one "flow" hydrant with a diffuser where flow is measured and one "pressure" hydrant equipped with a pressure gauge where pressure is monitored, before, during, and following the flow test. City personnel will record all data and comments for each test. During the testing period, any valves in the system that are known, or suspected, to be closed as well as any pipe breaks or other water system emergency should be noted and reported to a BC representative.

Table 2-3. Flow Test Procedures

Step	General Description	Detailed Description
1.	City will verify test location	City will verify that the test locations match the locations on the map. If other hydrants are used, mark the test hydrants on the map. Alternatively, the test location may be skipped and noted for BC personnel to identify an alternative test location.
2.	City will attach the pressure gauge and logger to the pressure hydrant	City will flush the pressure hydrant and attach the pressure gauge and logger to the pressure hydrant as shown in Figure 2-1 with the hydrant valve fully opened so that the pressure gauge is reading the distribution system pressure.
3.	City will attach diffuser to the flow hydrant.	City will flush the flow hydrant and attach a hydrant diffuser to the hydrant with a pressure gauge and logger as shown in Figure 2-2.
4.	City Personnel #1 will record the pressure and time at the pressure hydrant	
5.	City Personnel #2 will open the flow hydrant	By mobile phone or hand signal, City Personnel #1 at the pressure hydrant will instruct City Personnel #2 at the flow hydrant to start flowing the hydrant. The hydrant is opened SLOWLY until a minimum 5 psi pressure (10 psi if possible) drop is observed at the pressure hydrant. If a sufficient pressure drop cannot be obtained, turn the hydrant off SLOWLY, add another diffuser to the other hydrant nozzle or a nearby hydrant (record which hydrant is used), and re-start the test at step 4.
6.	City Personnel #1 will record the pressure at the pressure hydrant and City Personnel #2 will record the flow from the flow hydrant	When the pressure at the pressure hydrant stabilizes (usually one to five minutes), City Personnel #1 at the pressure hydrant will record the time and pressure and will signal City Personnel #2 at the flow hydrant to record the flow.
7.	City Personnel #2 will close the flow hydrant	City Personnel #1 will instruct the flow hydrant to be closed SLOWLY.
8.	City Personnel #1 will record the pressure and time again at the pressure hydrant	
9.	City will remove the pressure gauges and hydrant diffusers	The bleed valve on the pressure gauge/pressure logger assembly will be opened before the hydrant valve is fully closed to prevent drawing a suction on and thereby damaging the equipment.

2.5 Reservoir 3 Fire Flow Testing

Fire flow tests will be performed at critical locations in Pressure Zone 3 to determine if the removal of Reservoir 3 has compromised the capacity of the water distribution system to deliver adequate fire flow. The tests will be performed will be performed using the same procedures as the hydrant flow testing listed in Table 2-3. However, Step 5 will be modified as follows:

> *By mobile phone or hand signal, the City Personnel at the pressure hydrant will instruct the City person operating the flow hydrant to start flowing the hydrant. The hydrant is opened SLOWLY until pressure observed at the pressure hydrant reads 20 psi. If a reading of 20 psi cannot be obtained, turn the hydrant off SLOWLY, add another diffuser to the other hydrant nozzle or a nearby hydrant (record which hydrant is used), and re-start the test at step 4. If 20 psi still cannot be obtained with flow from two diffusers, proceed to step 6 and complete the test.*

Figure 2-1. Pressure gauge and logger connected to the pressure hydrant

Figure 2-2. One or two flow diffusers connected to the flow hydrant

Fire flow testing will be performed at each site under the following three operating conditions:

1. Citrus Pump Station on, A Street Pump Station off (flow through PRV)
2. Citrus Pump Station on, A Street Zone 5 – 3 Pump Station on
3. Citrus Pump Station off, A Street Zone 5 – 3 Pump Station on

During the fire flow tests, flow data will be collected from the regulator at B Street, from the A Street Pump Station (from the pumps and from the regulator), and from the regulator at the Citrus Pump Station. City will confirm that the pressure relief valve to the clearwell at the Citrus Pump Station is operating so that the testing does not over-pressurize the distribution system when the fire flow tests end. It is assumed that we will need to install strap-on flow meters at each of the 3 regulators. The strap-on meters should be installed one day prior to fire flow testing.

2.6 Test Locations

Figure 2-3 shows the location of the 20 flow tests related the hydraulic model calibration. Attachment B contains a figure for each field test identifying the proposed hydrants for each test. Figure 2-4 shows the location of the 4 flow tests related to Reservoir 3 fire flow testing.

2.7 Data Collection

Field data collected during the field flow tests will be recorded using printed hydrant testing forms provided by BC.

Section 3: Pressure Loggers

Field data will also be collected from pressure loggers placed on hydrants throughout the system. Figure 3-1 shows the 8 locations where pressure loggers are to be placed in the system. A map of each pressure logger location is provided in Attachment C. Procedures for pressure logger installation are provided in Table 3-1.

Table 3-1. Pressure Logger Test Procedures

Step	General Description	Detailed Description
1.	City will verify test location	City will verify that the test locations match the locations on the map. If other hydrants are used, mark the test hydrants on the map. Alternatively, the test location may be skipped and noted for BC personnel to identify an alternative test location. If there are no nearby alternative test location, ensure the new test location meets the following requirements: • The location is far from reservoirs, turnouts, and pressure reducing valves. • The pipe is 8-inch diameter or smaller. 12-inch diameter pipes would require 2 hydrants.
2.	City will attach the pressure logger to the test hydrant	At the beginning of the test period identified in Table 1-1, City will install all pressure loggers. At each location, City will flush the test hydrant and attach the hydrant cap/pressure logger assembly to one of the 2 ½ - inch nozzles of the test hydrant. After installing the pressure logger assembly, the hydrant valve nut will be operated to the fully open position so that the pressure gauge is reading the distribution system pressure. Check for leaks around the caps and the hydrant barrel. Tighten caps as necessary to eliminate leaks. If water is observed rising from the ground around the hydrant, operate the hydrant nut and return to the fully open position. If this does not eliminate the leak, make a note and a new location shall be identified by BC staff. Alternatively, a new location may be identified by City staff with the requirements described in Step 1.
3.	City will remove the pressure logger assemblies	At the end of the testing period identified in Table 1-1, City will remove the pressure logger assemblies. At each test hydrant, City will operate the hydrant valve nut to the fully closed position. The bleed valve on the pressure logger assembly will be opened before the hydrant valve is fully closed to prevent drawing a suction on and thereby damaging the equipment. City will remove the pressure logger assembly and replace the hydrant cap. The pressure logger assembly will be returned to BC for data download within one working day of removal.

Section 4: Pump Tests

Pump testing involves collecting data relative to pump performance as represented by total discharge head (TDH) and flowrate. The collected TDH and flowrate for each pump will be compared with manufacturer's pump curves. These curves will be adjusted to match the collected data.

While some or all of the required data may already be collected and recorded by the SCADA system, it is important at a minimum to confirm the accuracy of the recorded values through comparison with data collected by calibrated testing equipment. Calibration of flowmeters is not included in the scope of this effort so flowrate measured and recorded by SCADA will be used. However, TDH will be confirmed by measurement of suction and discharge pressure. These pressure measurements will be performed using calibrated pressure gages provided by BC. A protocol for the testing of each pump in the distribution system is provided in Table 4-1.

Table 4-1. Pump Test Procedures

Step	General Description	Detailed Description
1.	City will confirm SCADA function	Before testing begins, City will confirm that SCADA is reading and recording suction pressure (if available), discharge pressure, and flowrate for each pump or pump station.
2.	City will install calibrated pressure gages	City will install calibrated pressure gages, provided by BC, on the suction and discharge manifolds of each pump station. This may be done at an existing port or location of an existing pressure gage if present. A proper wrench shall be used to tighten the gage by its fitting rather than twisting the face of the dial to avoid damaging the pressure gage.
3.	City will record static flow and pressure	City will record the suction and discharge pressure of the pump station with no pumps operating as well as the time that the reading was recorded.
4.	City will record pressure and flow while operating each pump	City will operate each pump in the pump station, one at a time. While each pump is operating, City personnel will record the flowrate, suction pressure, discharge pressure and the time the reading was recorded.
5.	City will remove the pressure gages	At the end of the testing at each pump station, City will remove the calibrated pressure gages used for testing and return the pump station to normal operation.

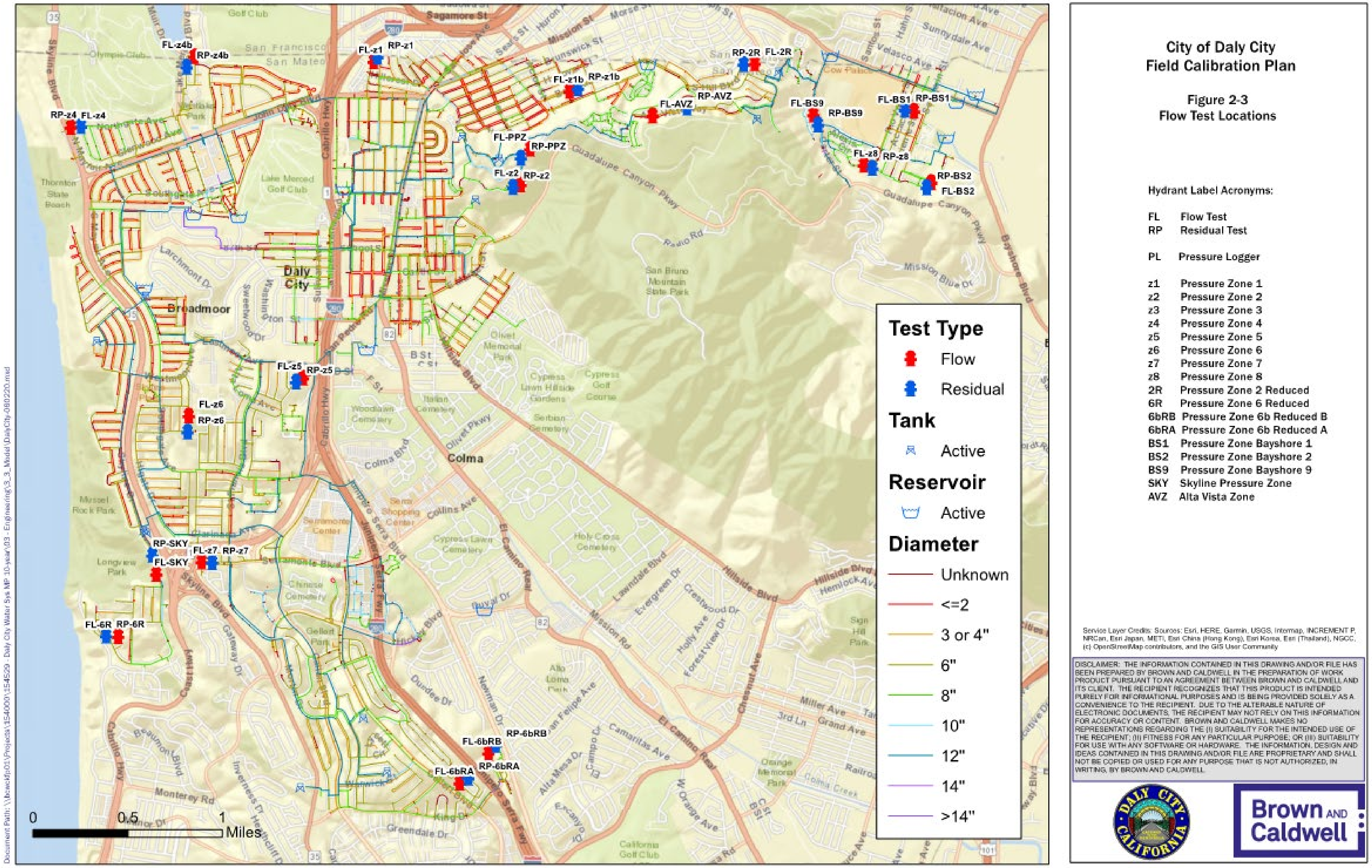

Figure 2-3. Field Test Locations Overview

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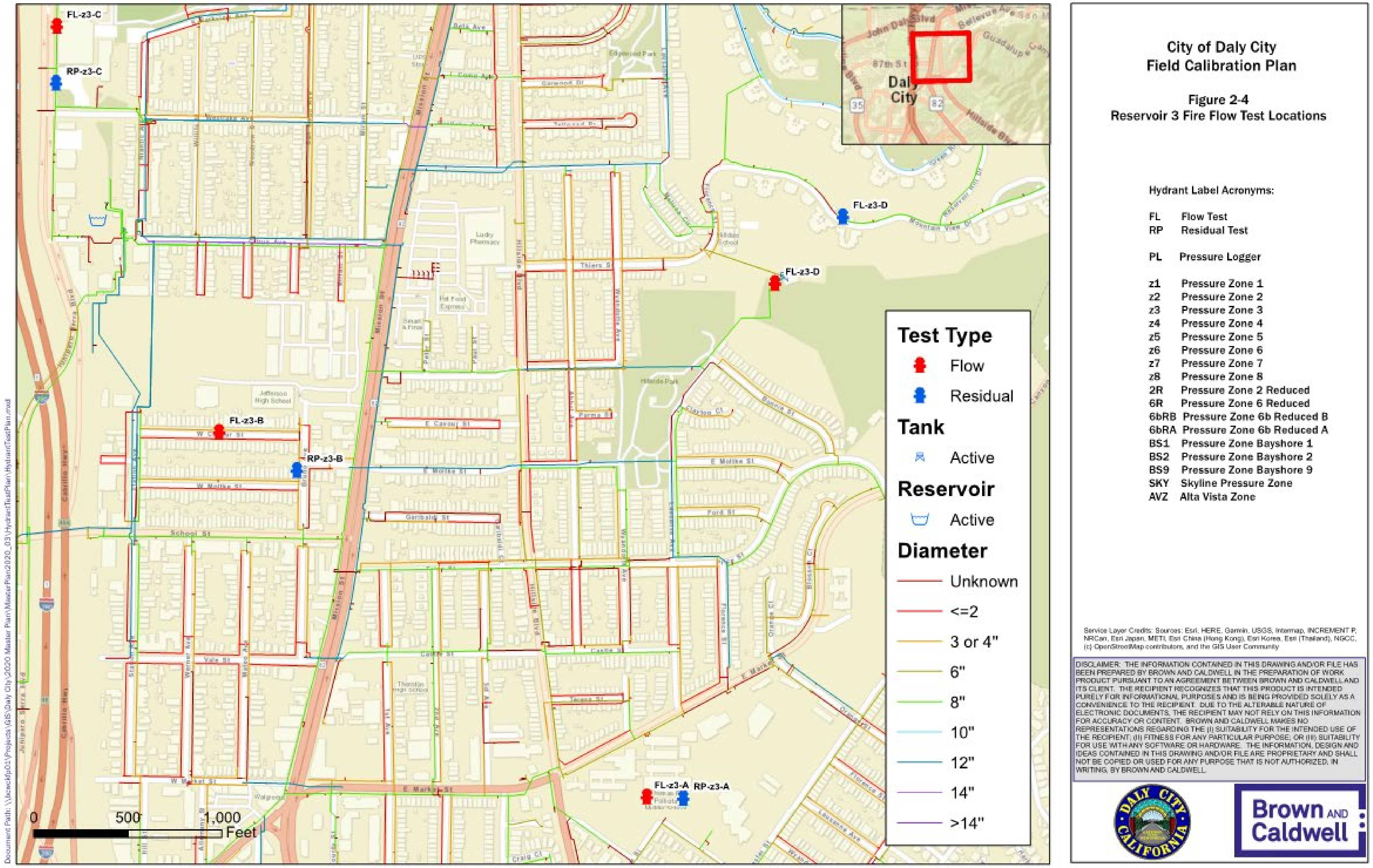

Figure 2-4. Reservoir 3 Fire Flow Test Locations

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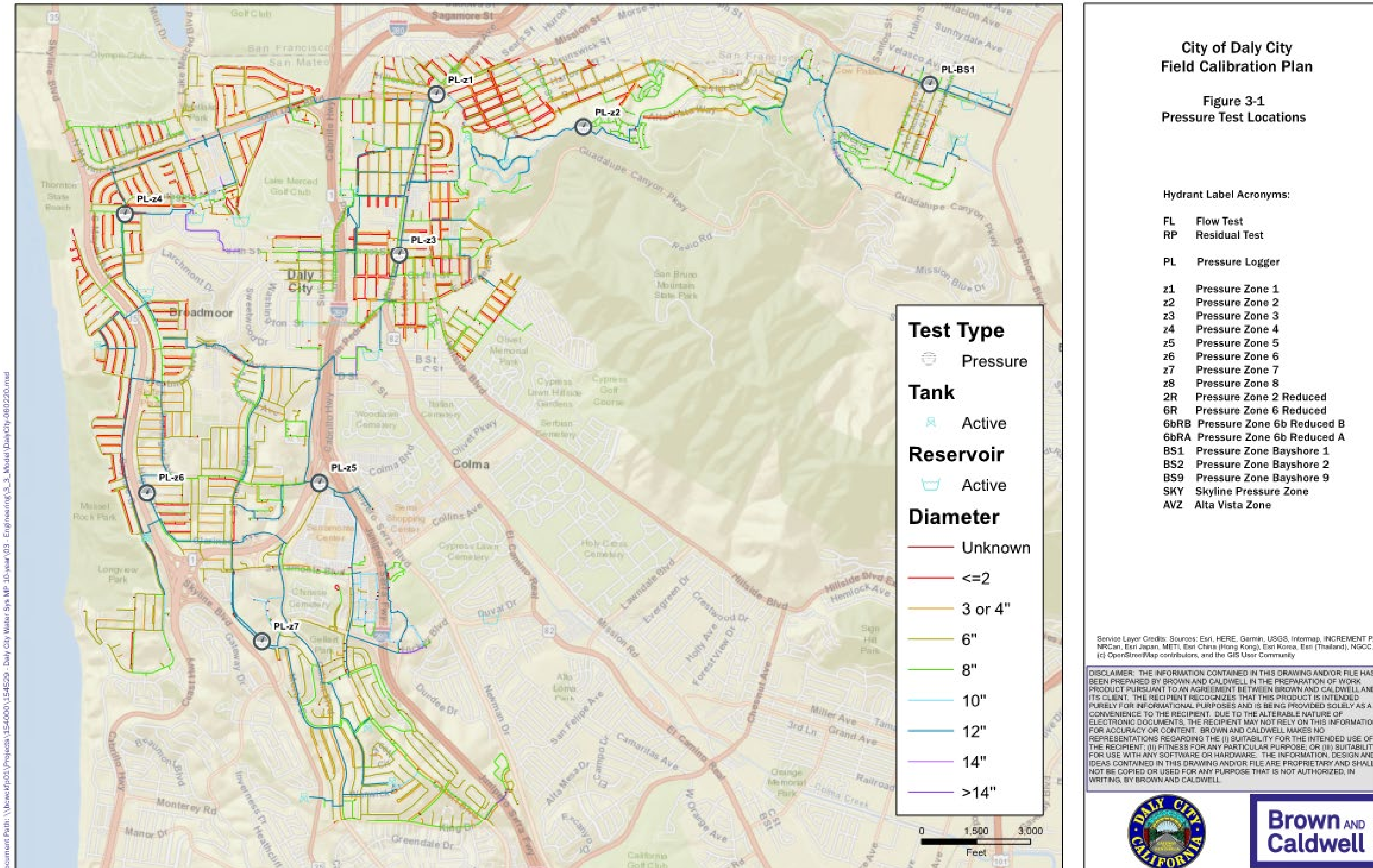

Figure 3-1. Pressure Monitoring Locations Overview

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Attachment B: Flow Test Locations

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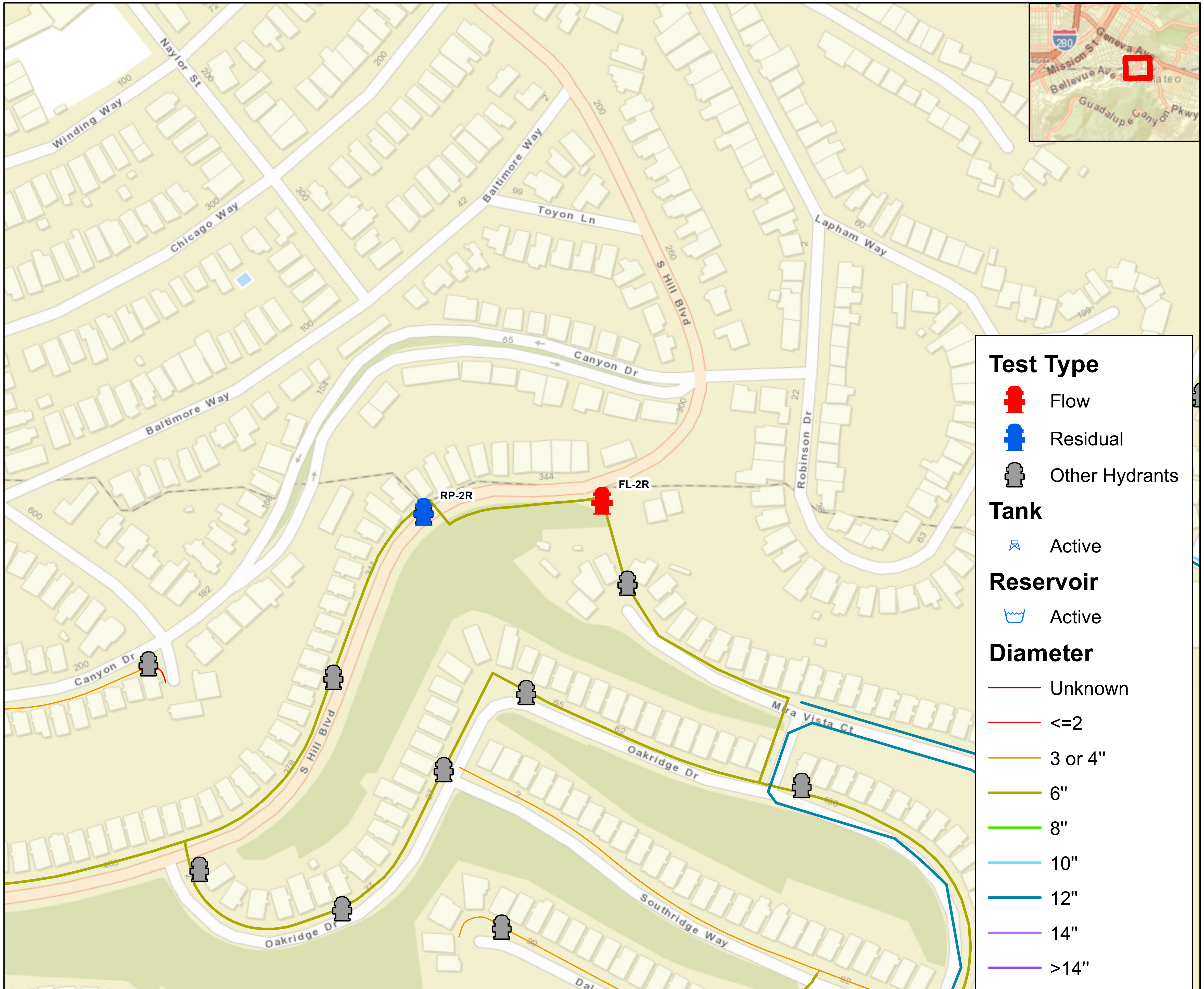

City of Daly City
Field Calibration Plan

Appendix B
Flow Test Locations

Hydrant Label Acronyms:

FL	Flow Test
RP	Residual Test
PL	Pressure Logger
z1	Pressure Zone 1
z2	Pressure Zone 2
z3	Pressure Zone 3
z4	Pressure Zone 4
z5	Pressure Zone 5
z6	Pressure Zone 6
z7	Pressure Zone 7
z8	Pressure Zone 8
2R	Pressure Zone 2 Reduced
6R	Pressure Zone 6 Reduced
6bRB	Pressure Zone 6b Reduced B
6bRA	Pressure Zone 6b Reduced A
BS1	Pressure Zone Bayshore 1
BS2	Pressure Zone Bayshore 2
BS9	Pressure Zone Bayshore 9
SKY	Skyline Pressure Zone
AVZ	Alta Vista Zone

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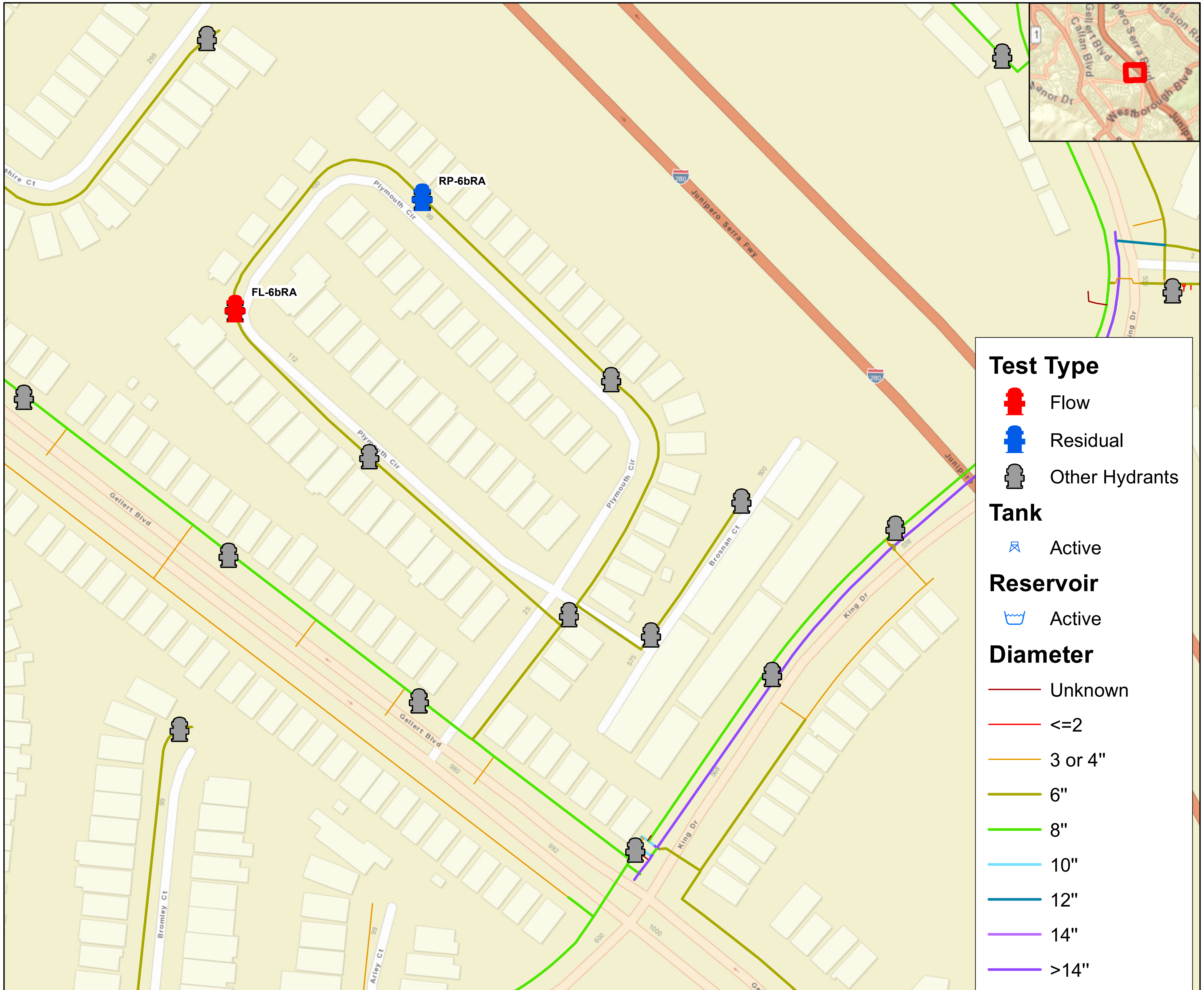

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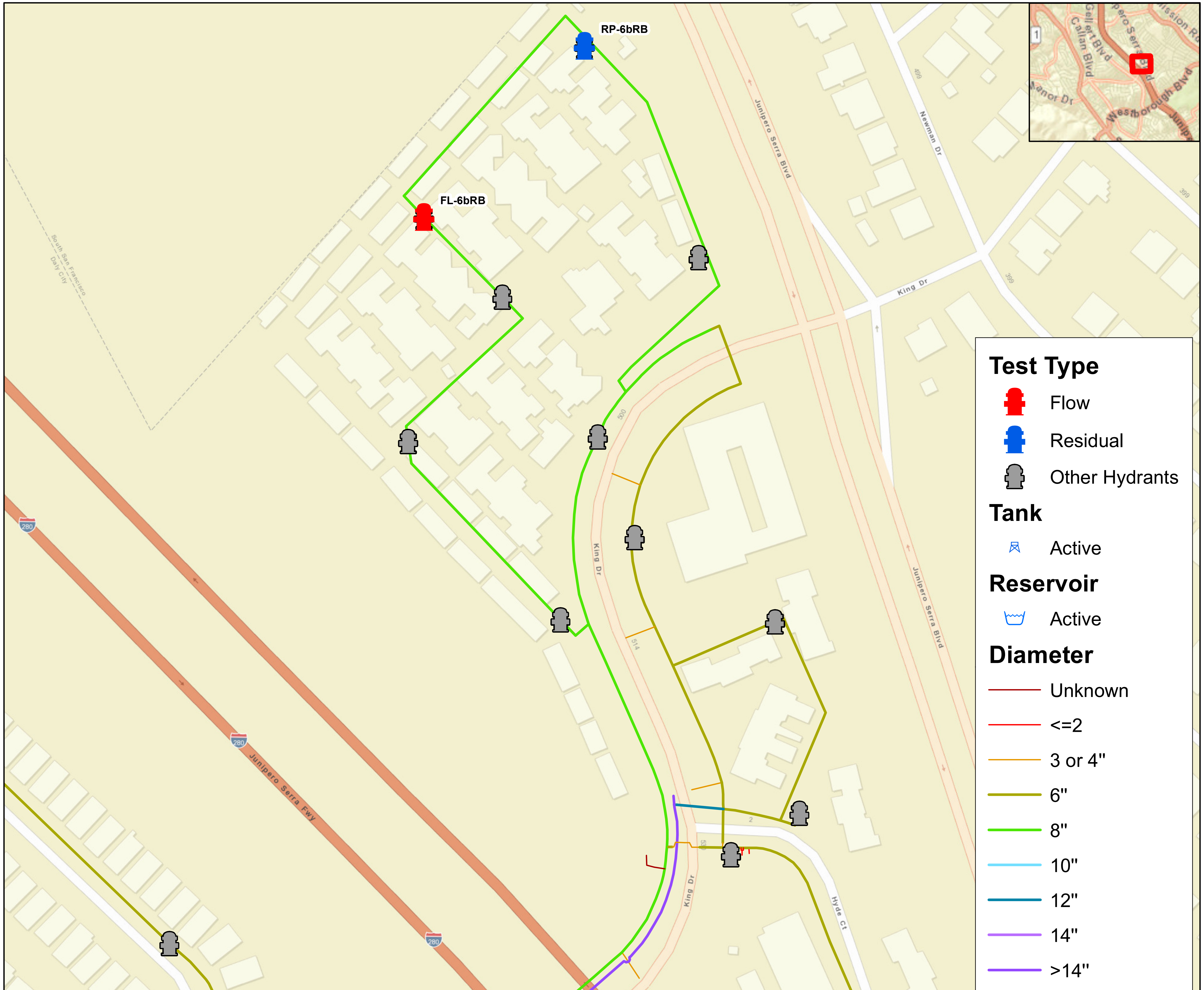

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Brown AND Caldwell

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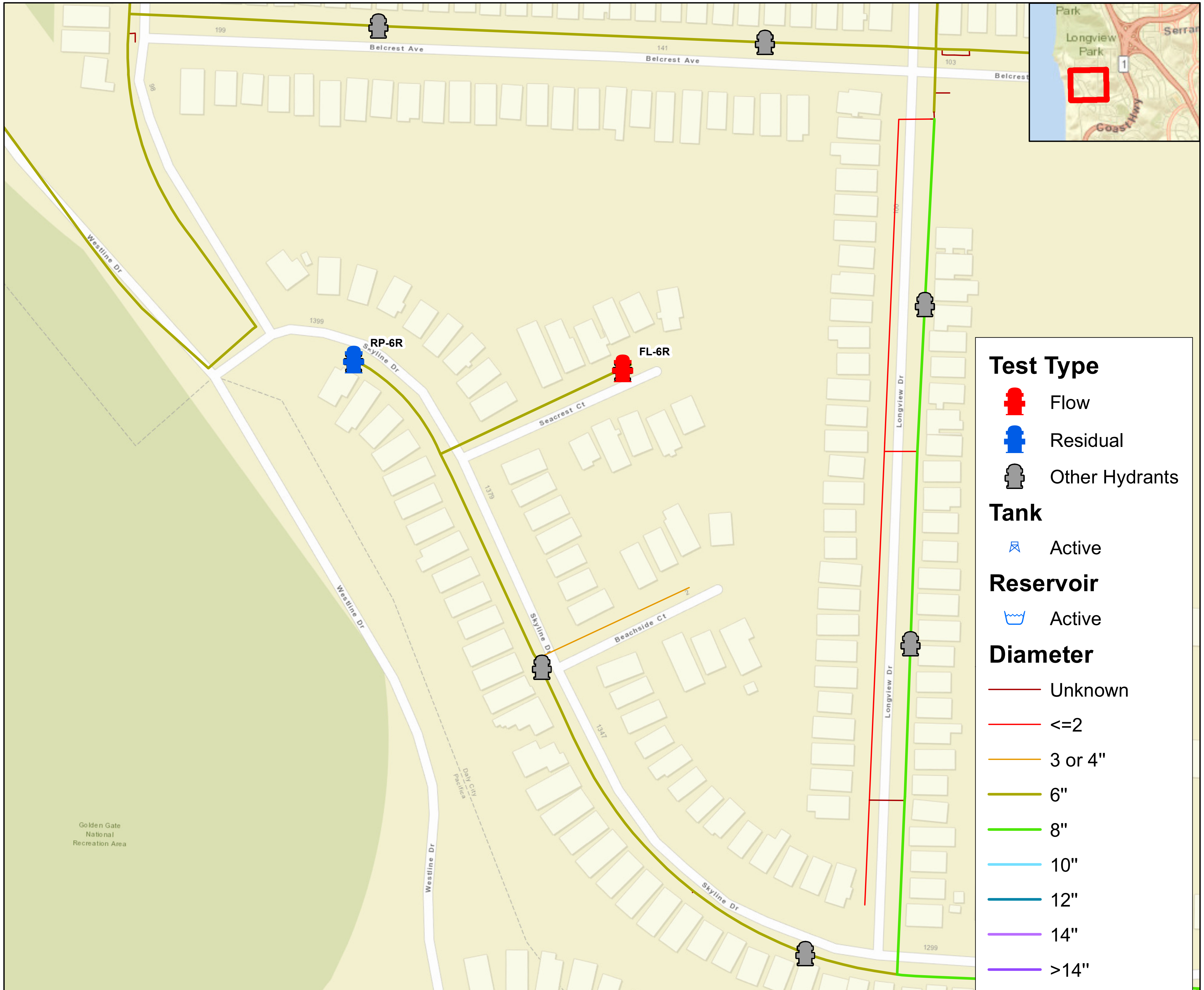

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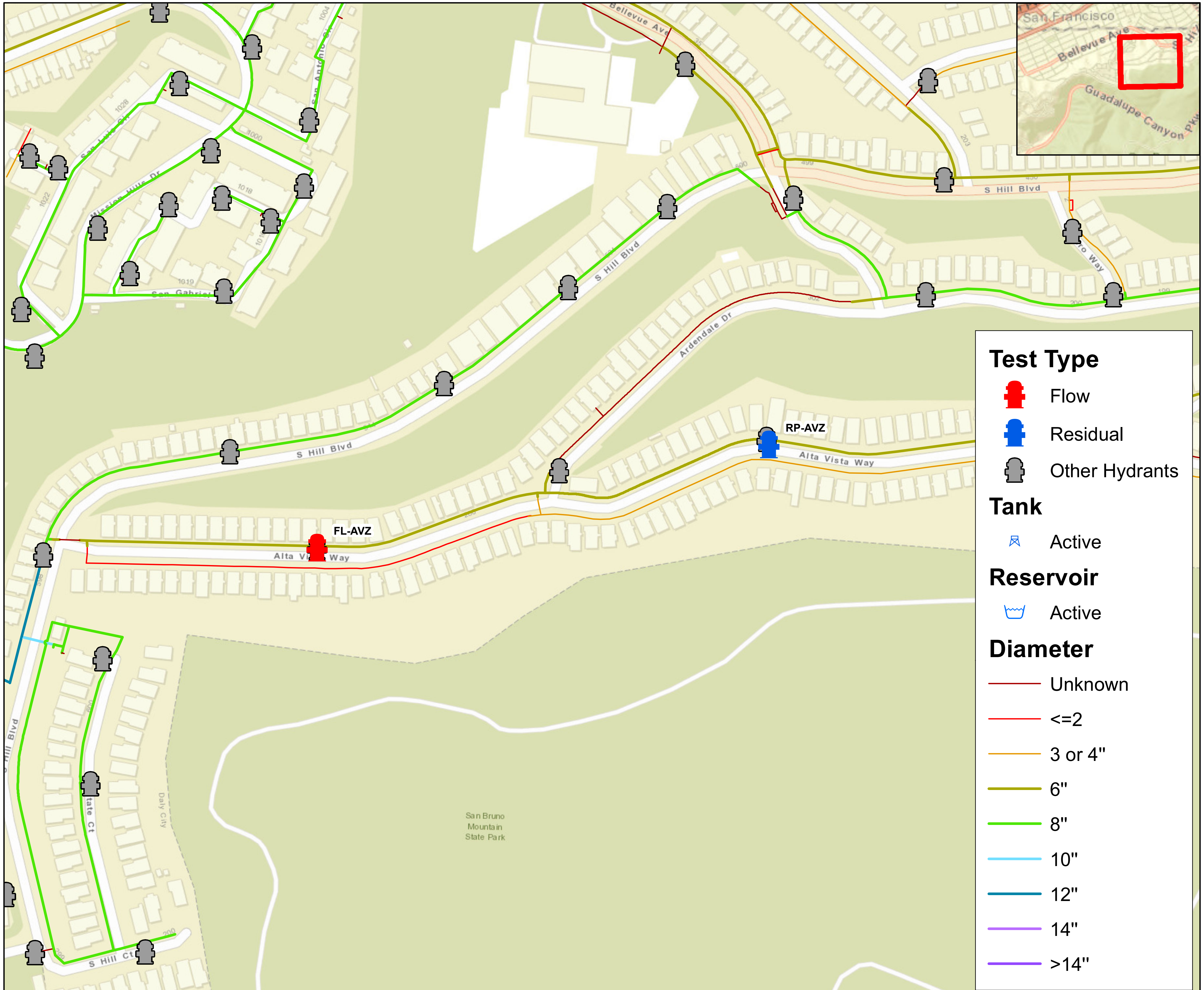

City of Daly City Field Calibration Plan

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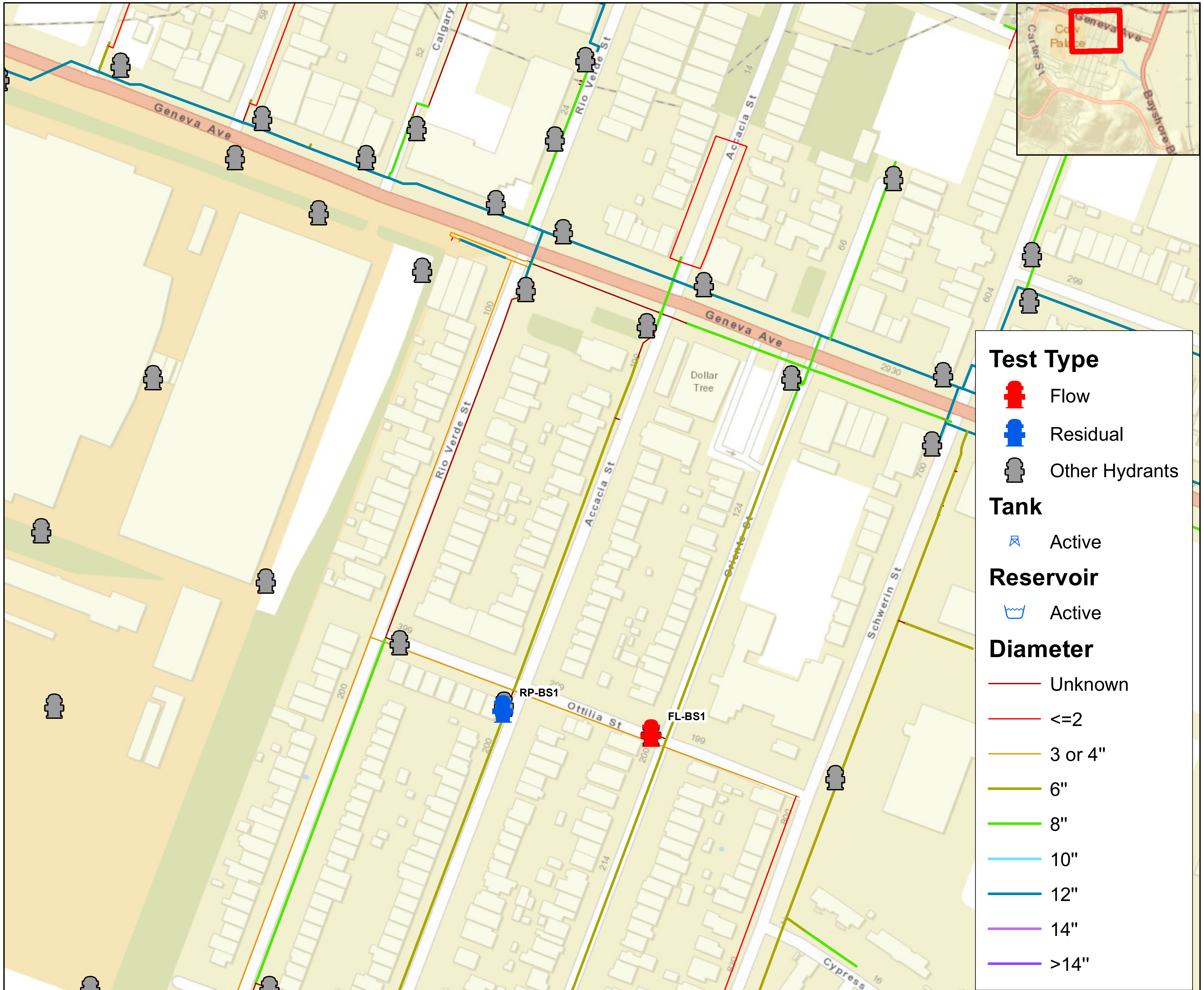

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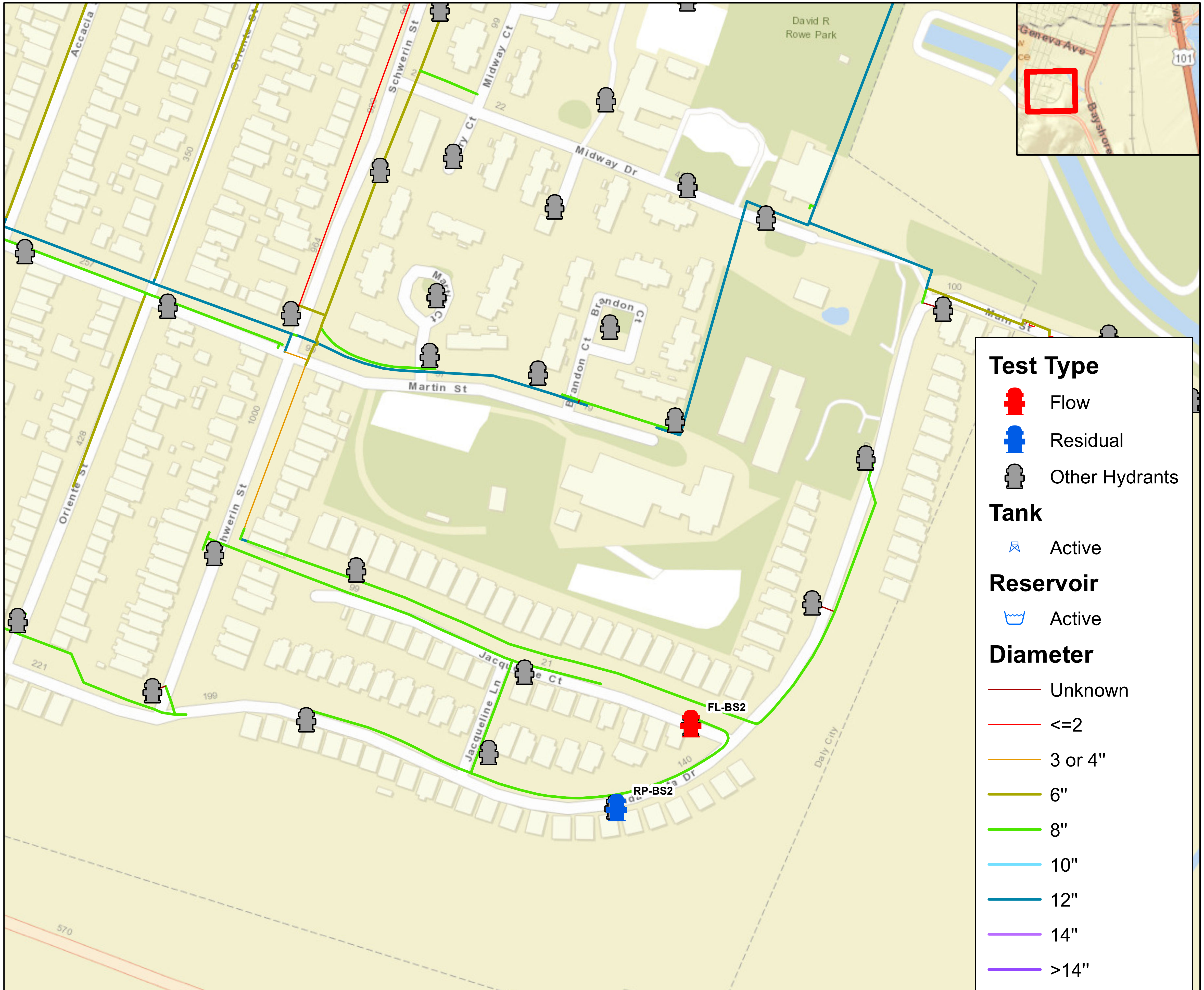

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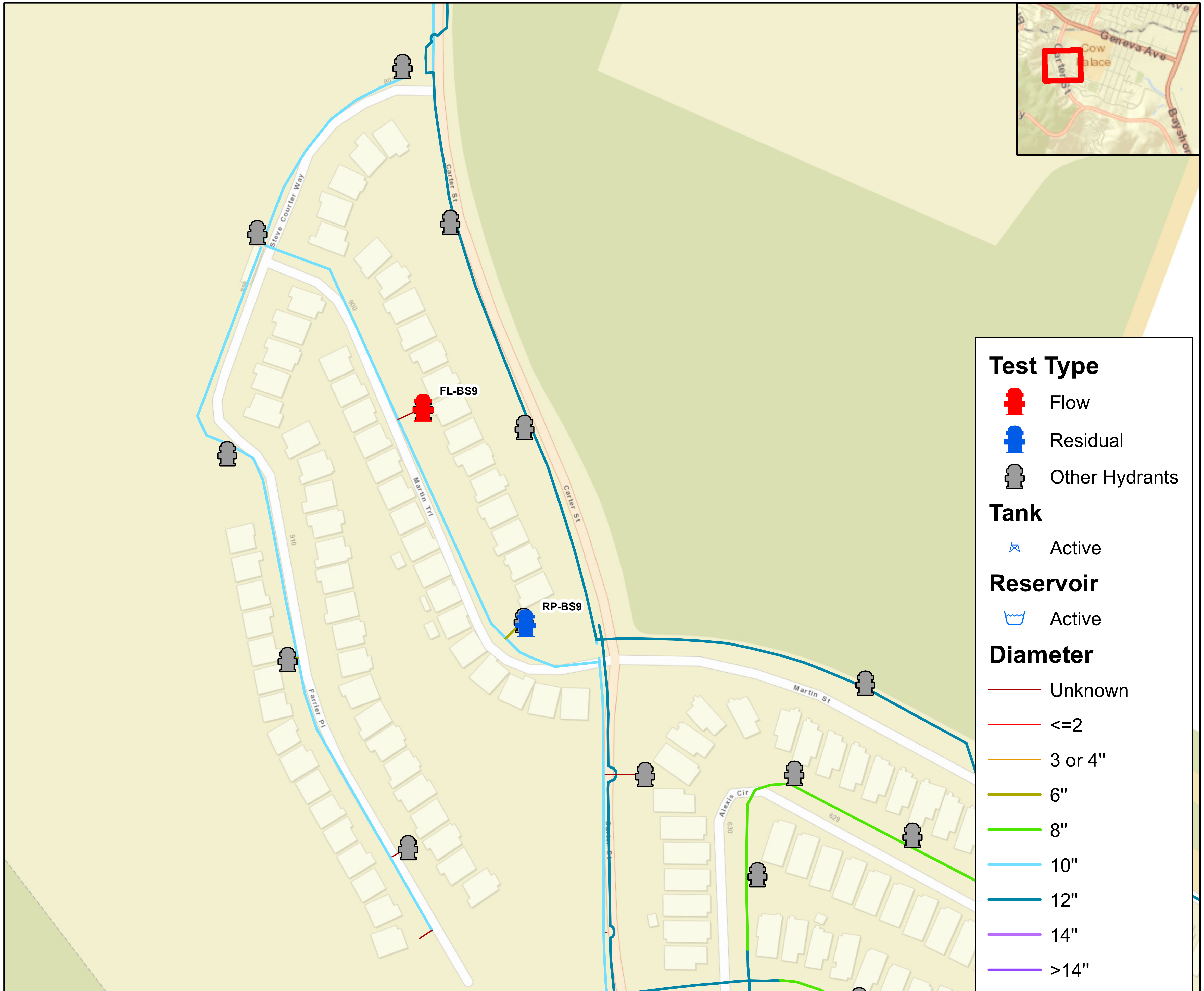

City of Daly City
Field Calibration Plan

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Flow Test Locations

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RP Residual Test

PL Pressure Logger

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SKY Skyline Pressure Zone
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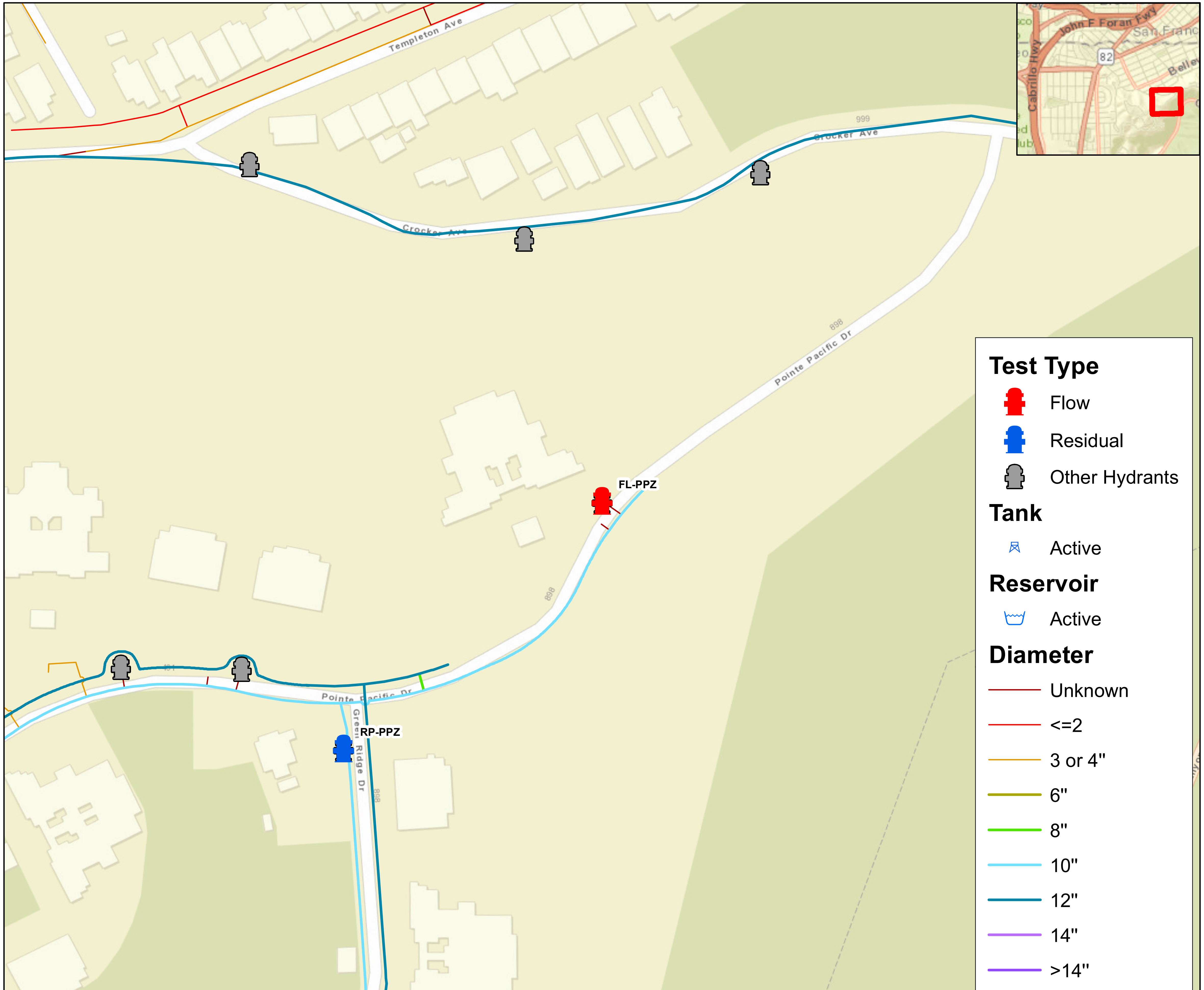

City of Daly City
Field Calibration Plan

Appendix B
Flow Test Locations

Hydrant Label Acronyms:

FL Flow Test
RP Residual Test

PL Pressure Logger

z1 Pressure Zone 1
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z3 Pressure Zone 3
z4 Pressure Zone 4
z5 Pressure Zone 5
z6 Pressure Zone 6
z7 Pressure Zone 7
z8 Pressure Zone 8
2R Pressure Zone 2 Reduced
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BS1 Pressure Zone Bayshore 1
BS2 Pressure Zone Bayshore 2
BS9 Pressure Zone Bayshore 9
SKY Skyline Pressure Zone
AVZ Alta Vista Zone

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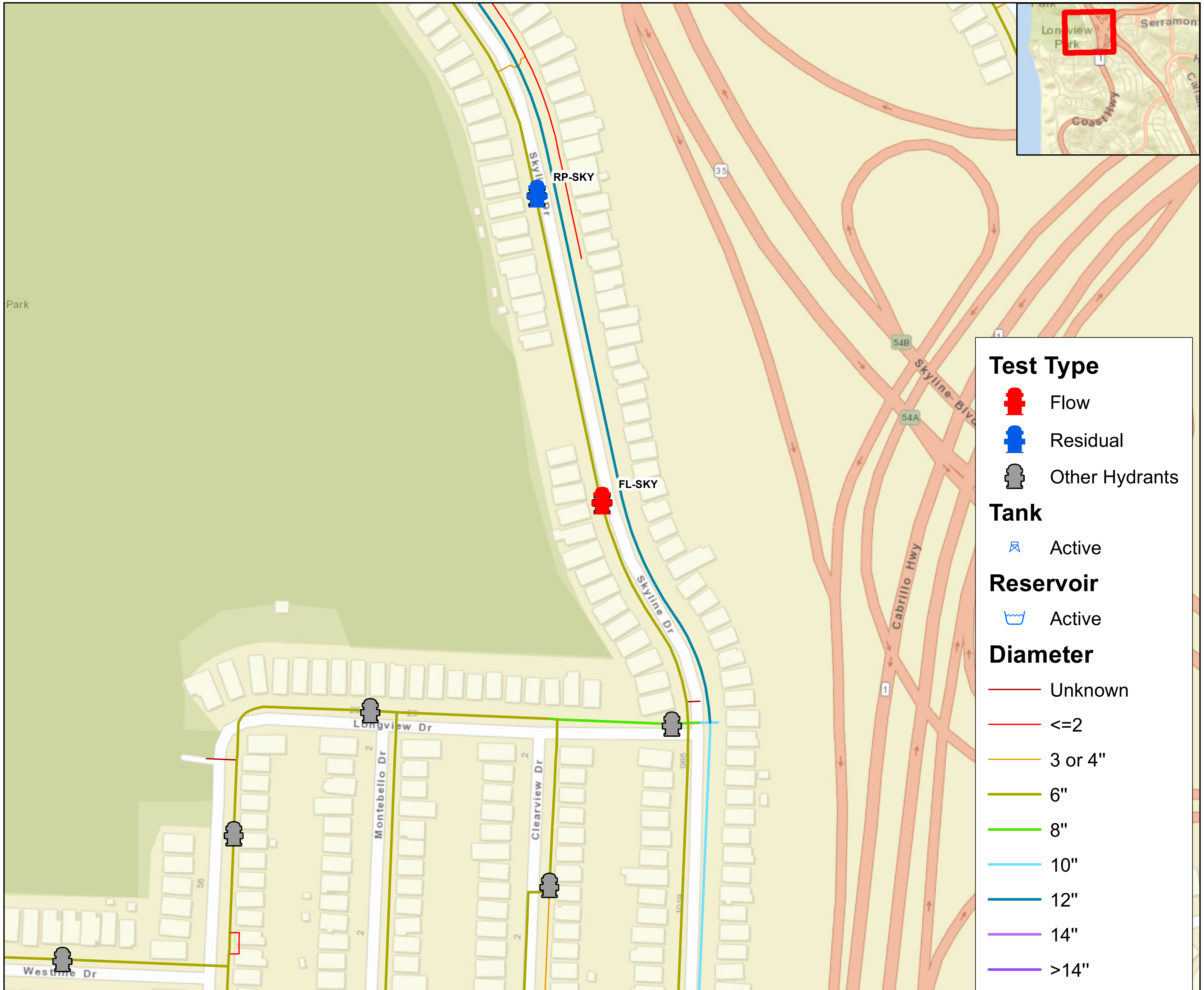

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City of Daly City
Field Calibration Plan

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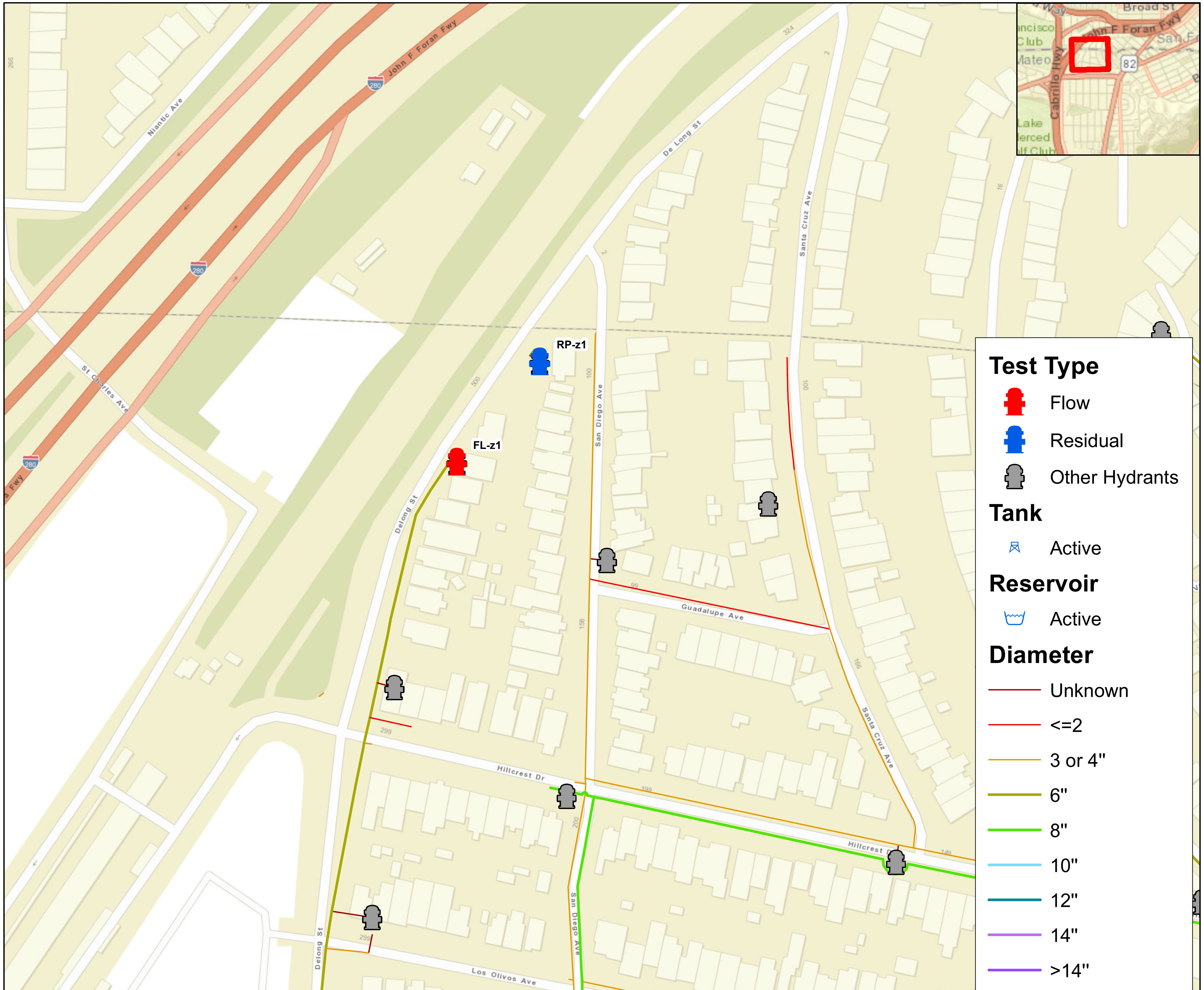

City of Daly City
Field Calibration Plan

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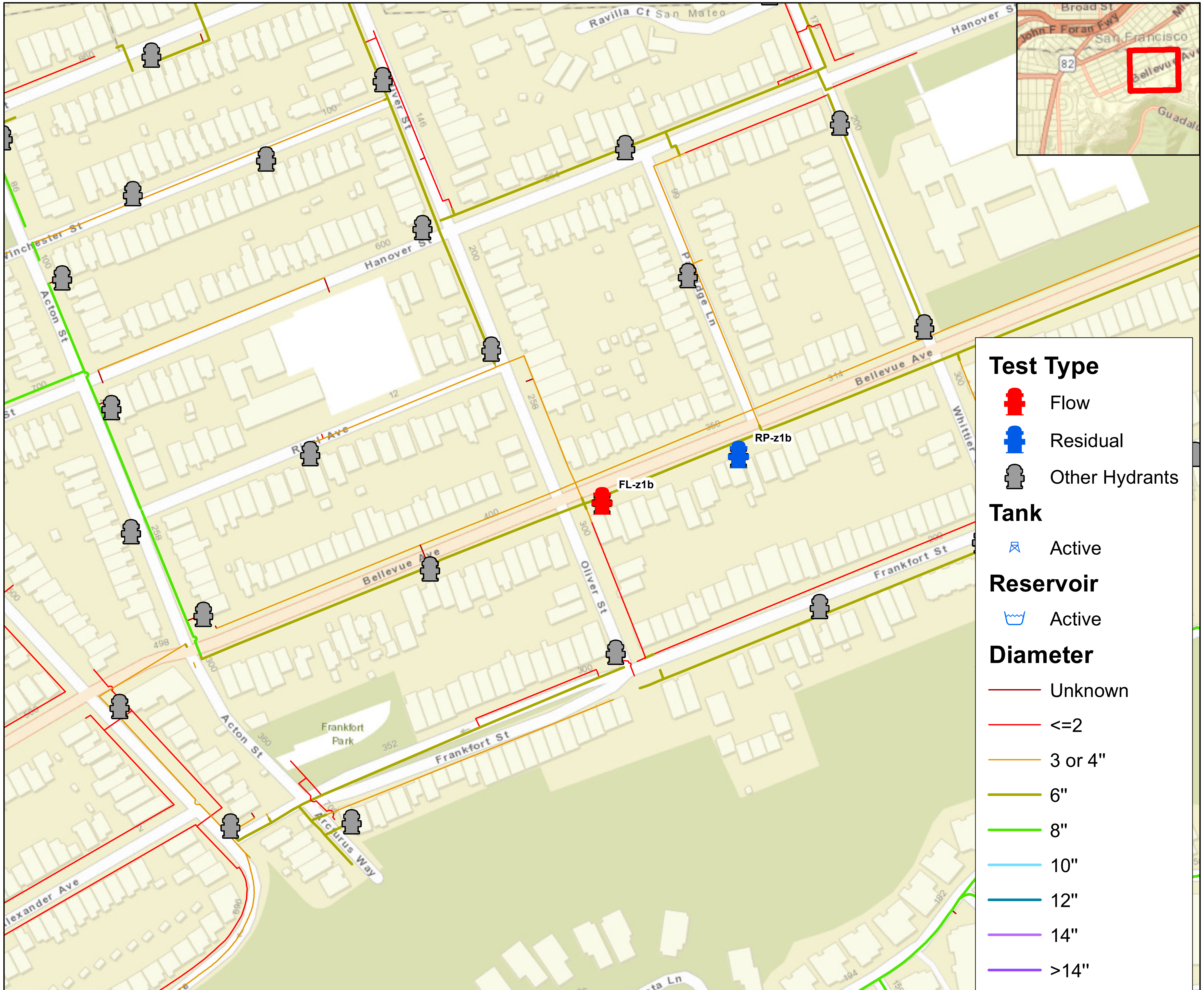

City of Daly City
Field Calibration Plan

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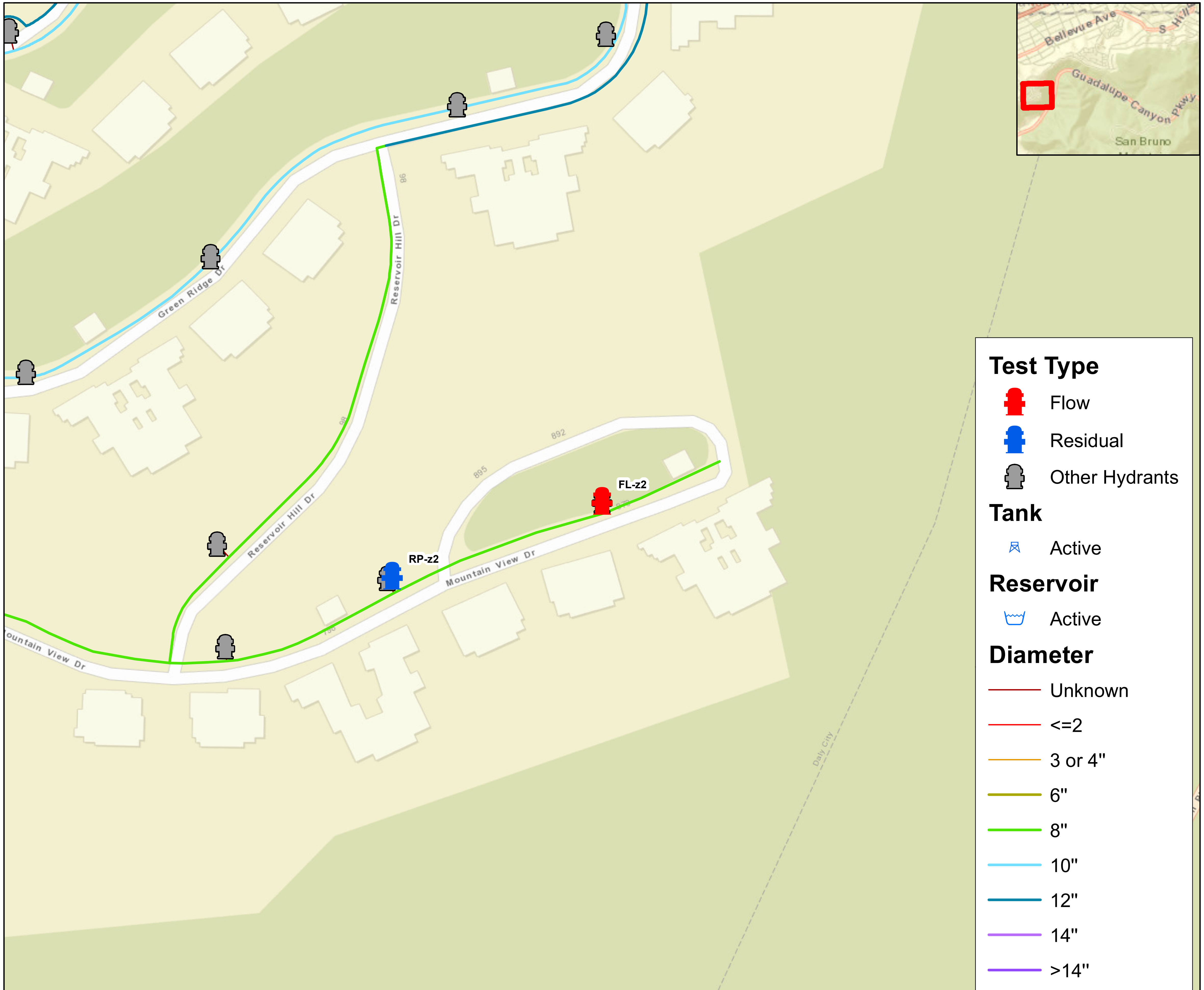

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City of Daly City
Field Calibration Plan

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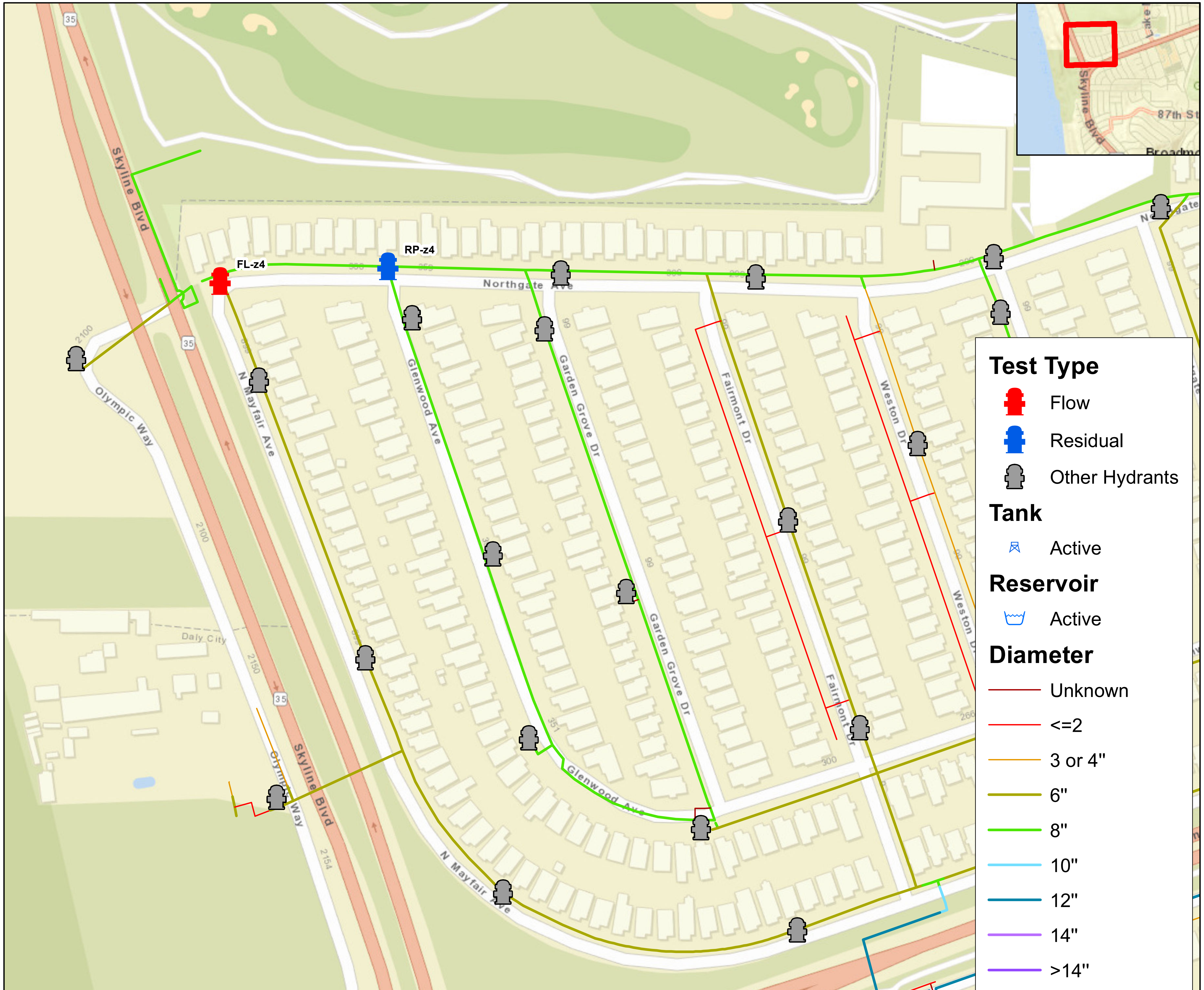

City of Daly City
Field Calibration Plan

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City of Daly City
Field Calibration Plan

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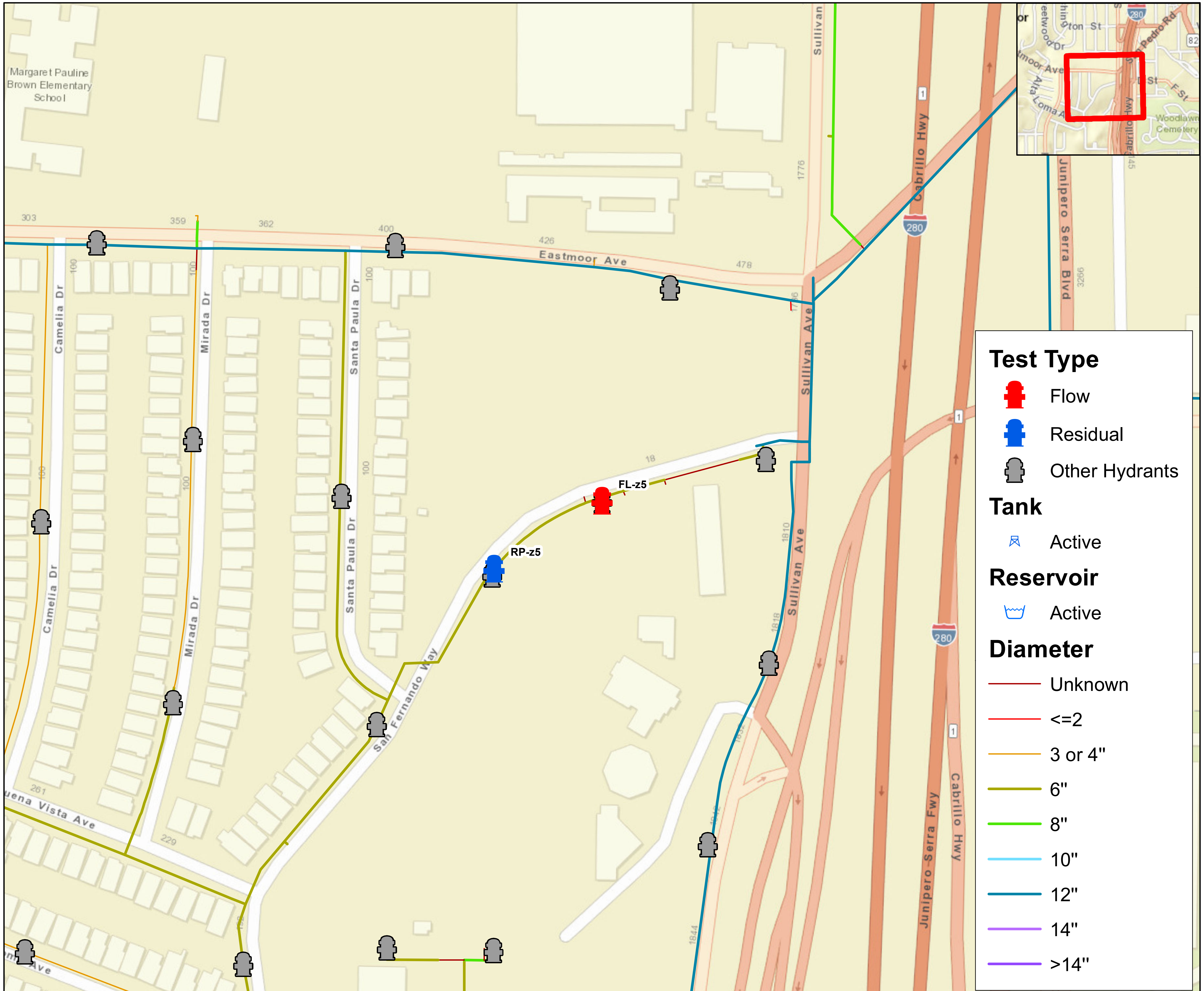

City of Daly City
Field Calibration Plan

Appendix B
Flow Test Locations

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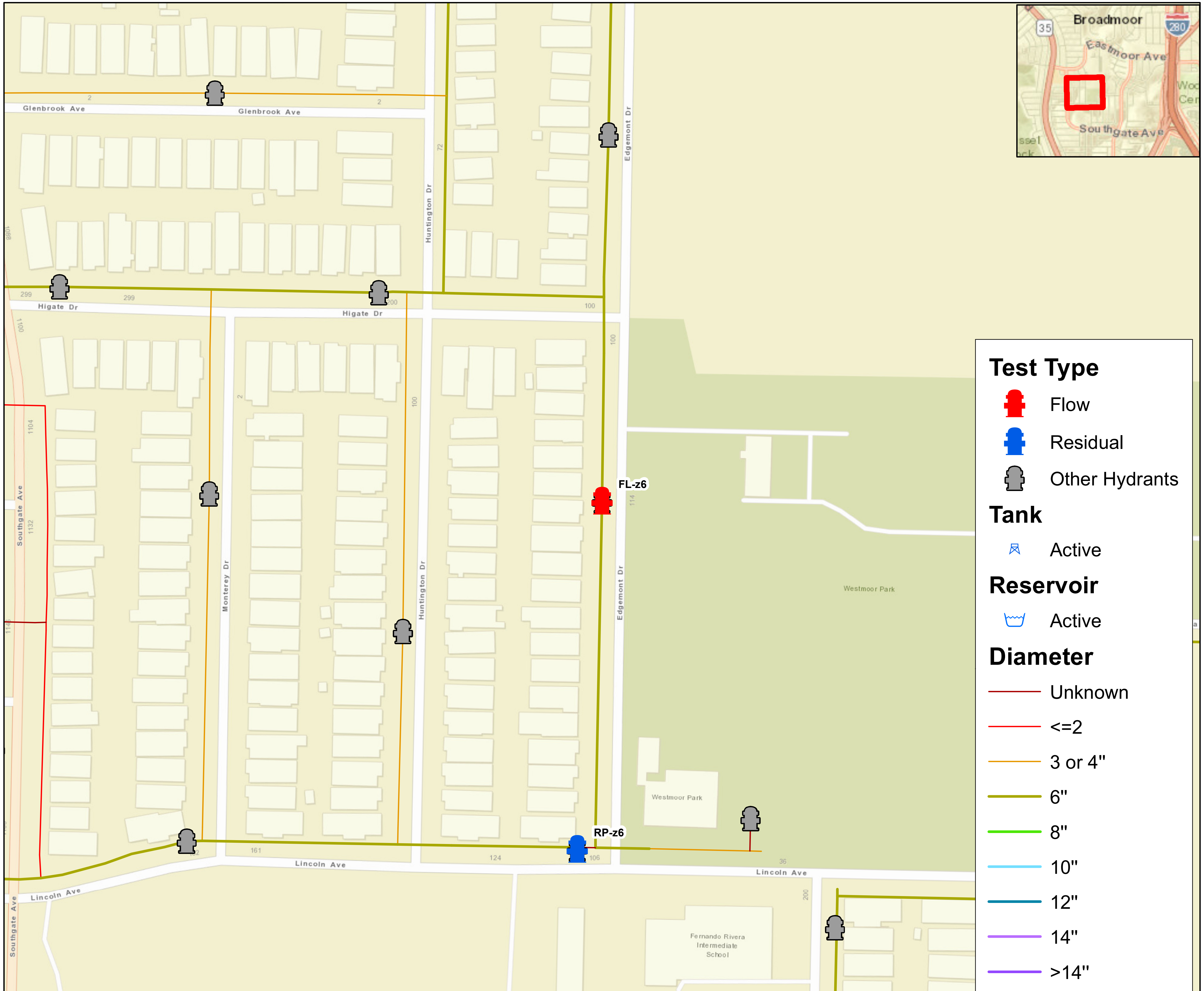

City of Daly City
Field Calibration Plan

Appendix B
Flow Test Locations

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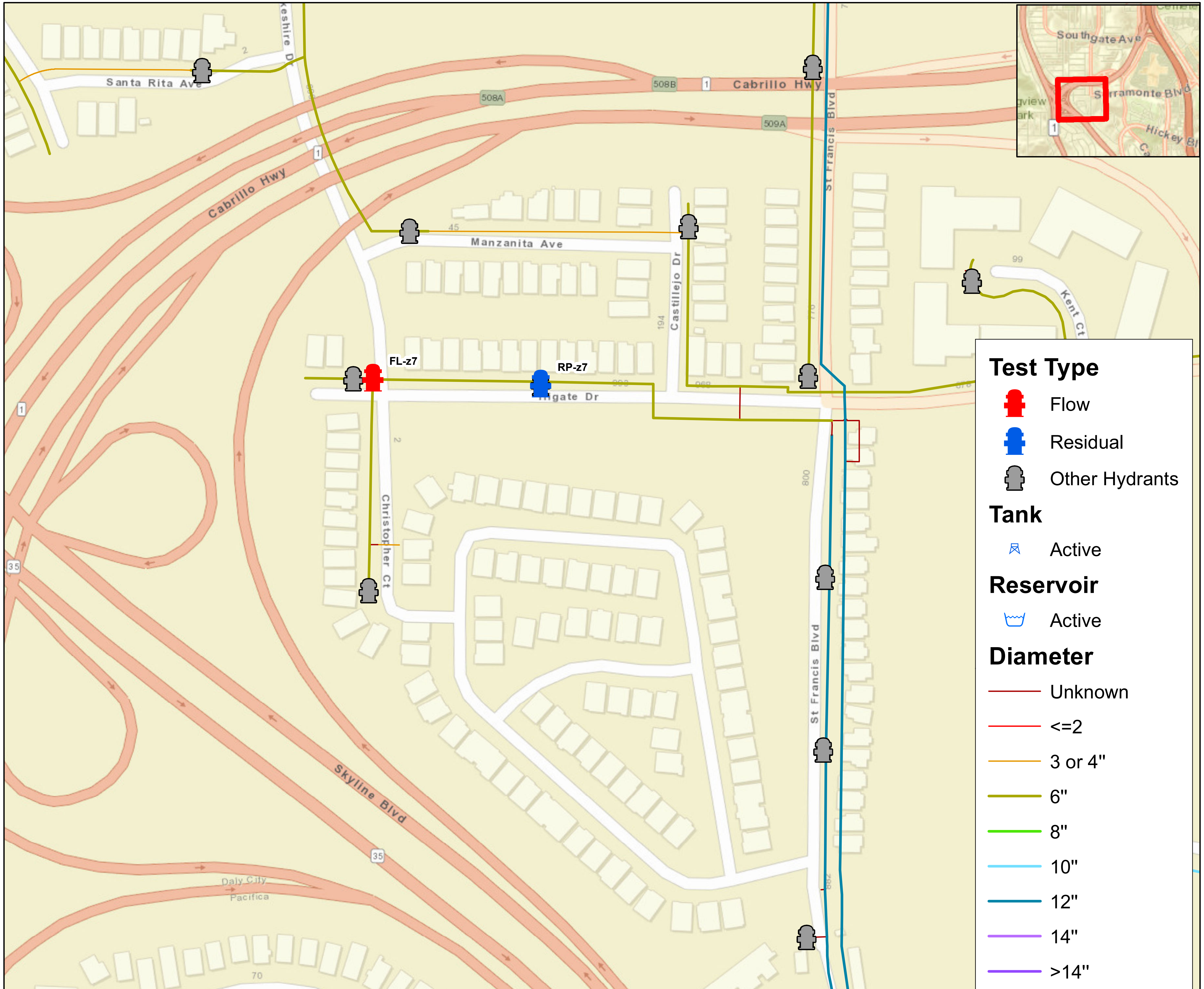
City of Daly City
Field Calibration Plan

Appendix B
Flow Test Locations



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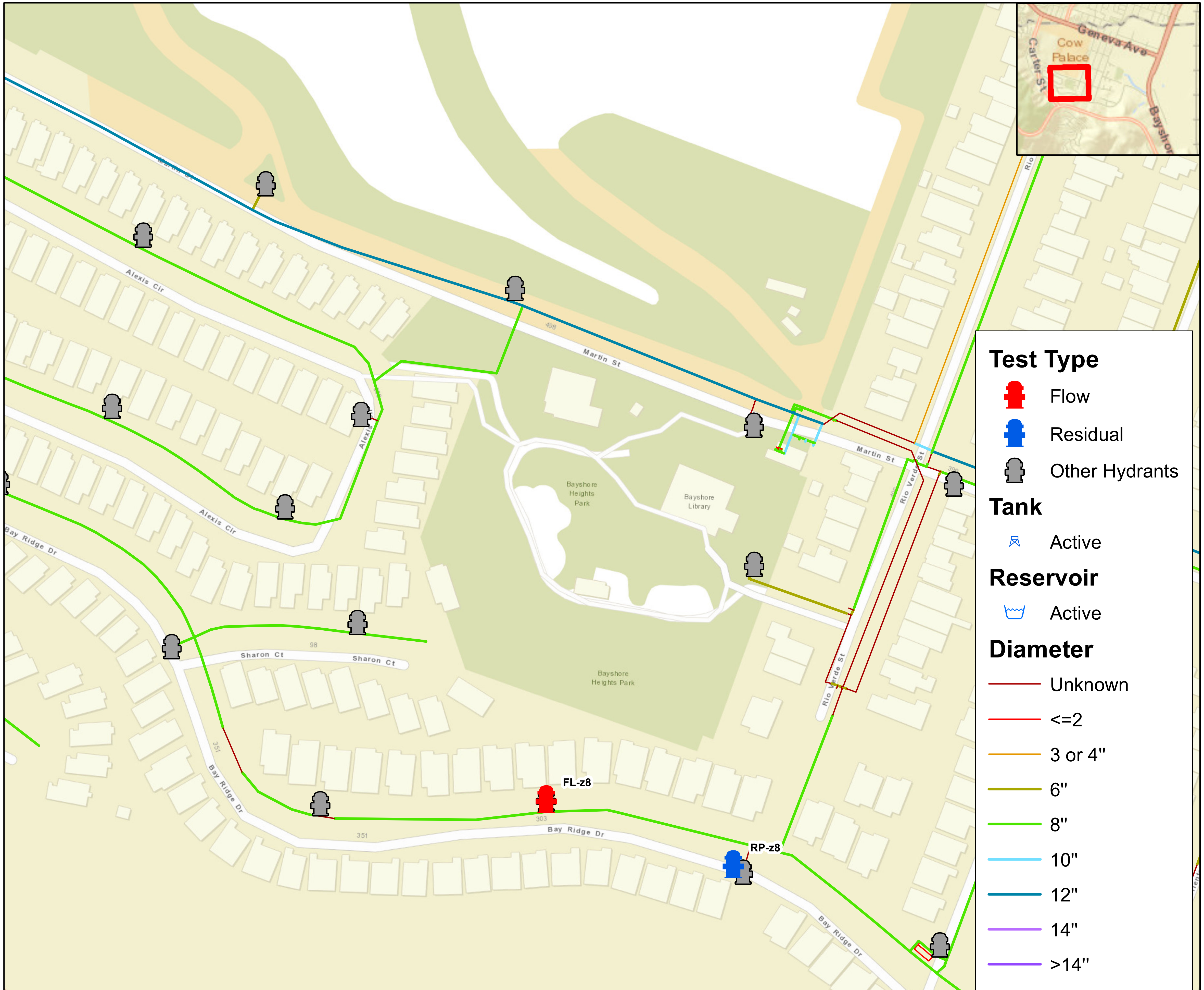

City of Daly City
Field Calibration Plan

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Attachment C: Pressure Logger Locations

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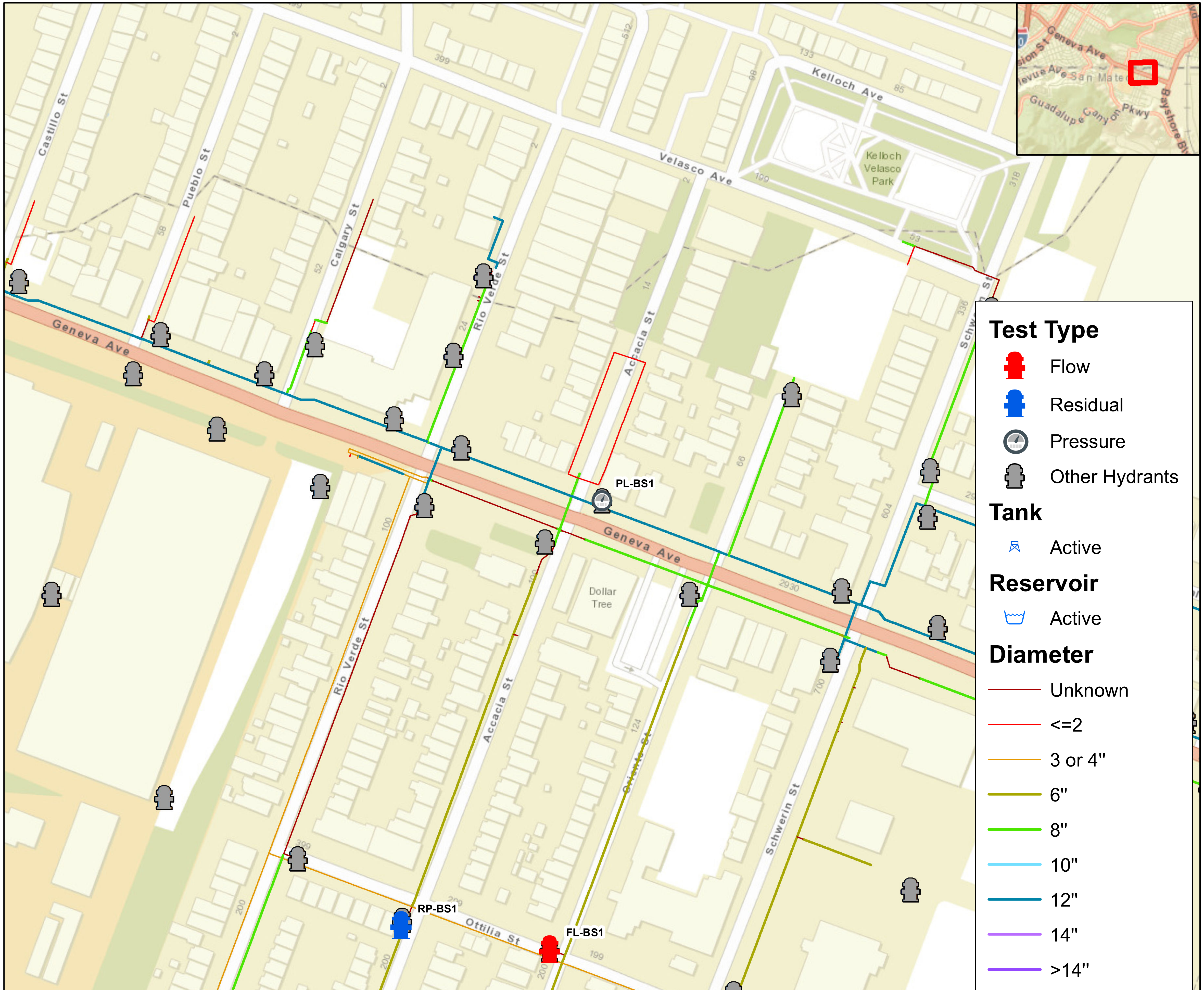

City of Daly City
Field Calibration Plan

Appendix C
Pressure Logger Locations

Hydrant Label Acronyms:

FL Flow Test
RP Residual Test

PL Pressure Logger

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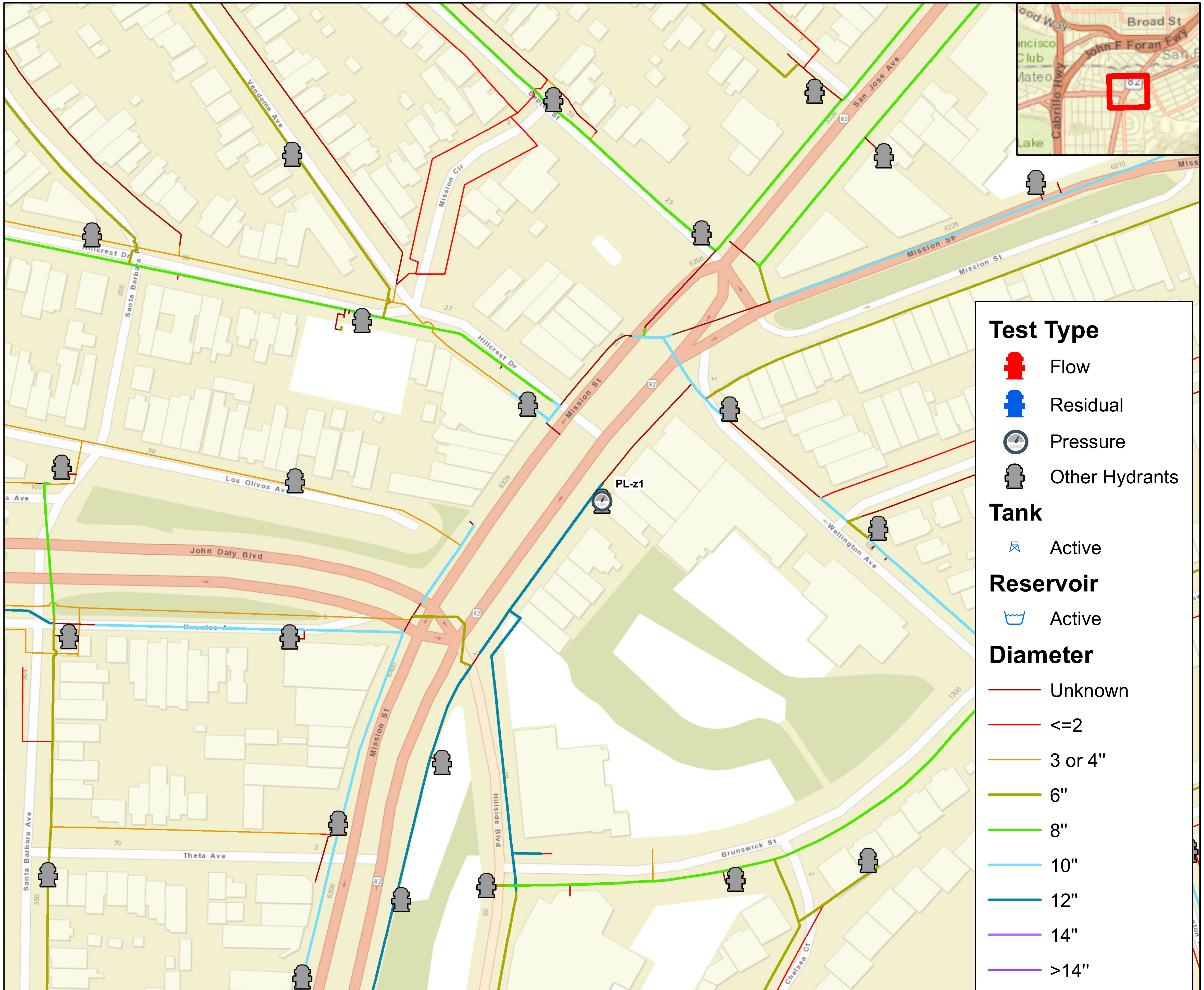

City of Daly City
Field Calibration Plan

Appendix C
Pressure Logger Locations

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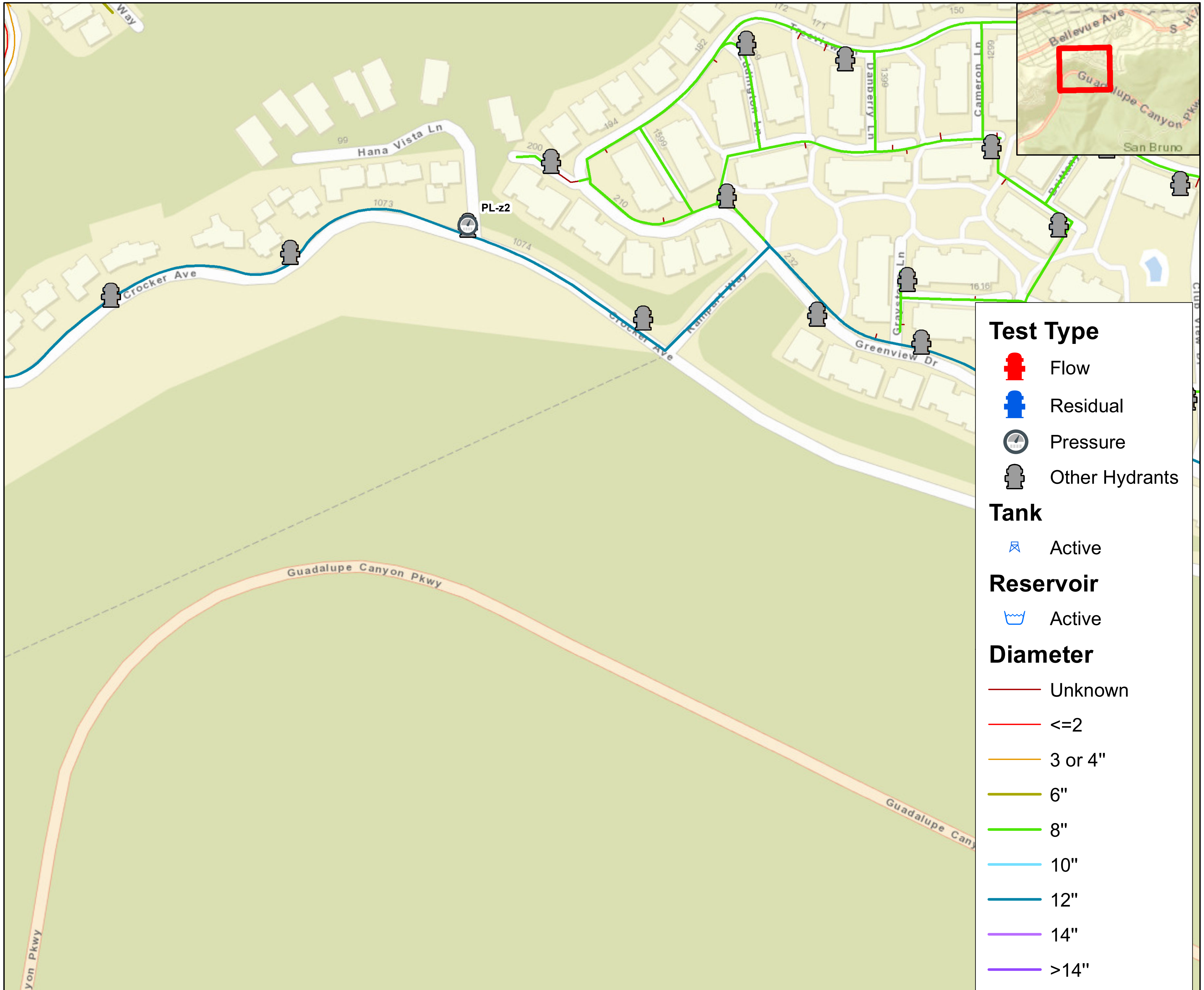

City of Daly City
Field Calibration Plan

Appendix C
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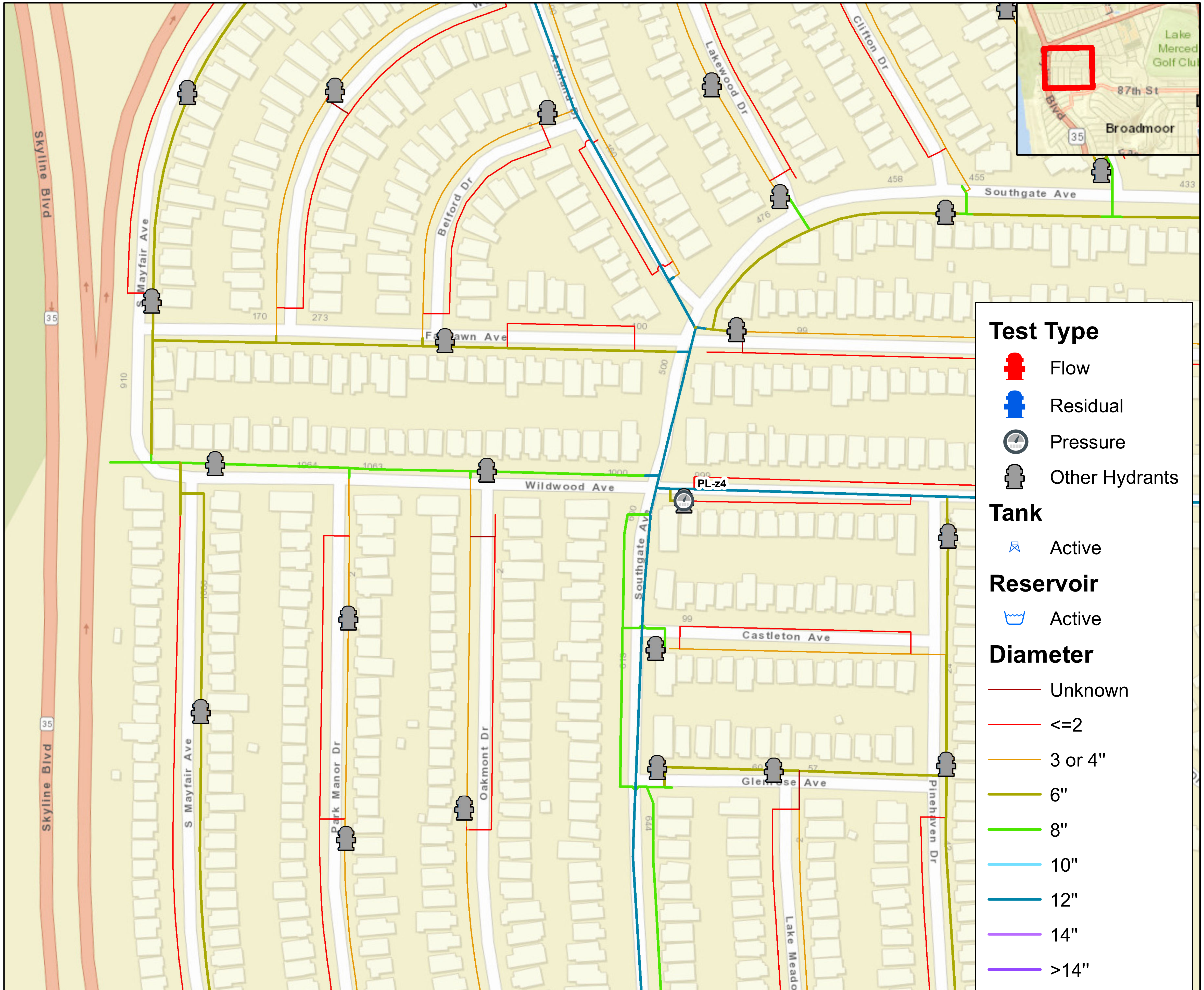

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City of Daly City
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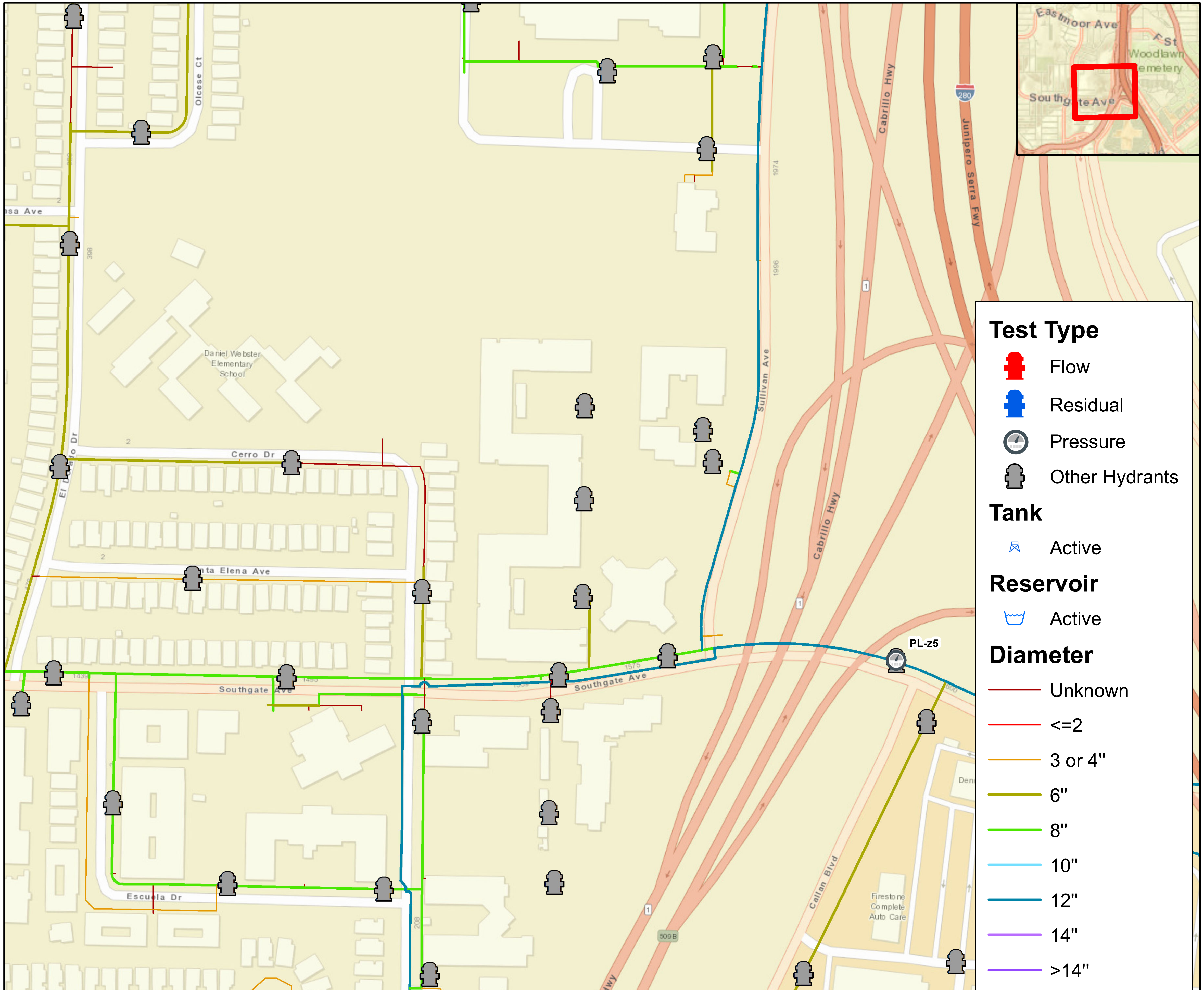

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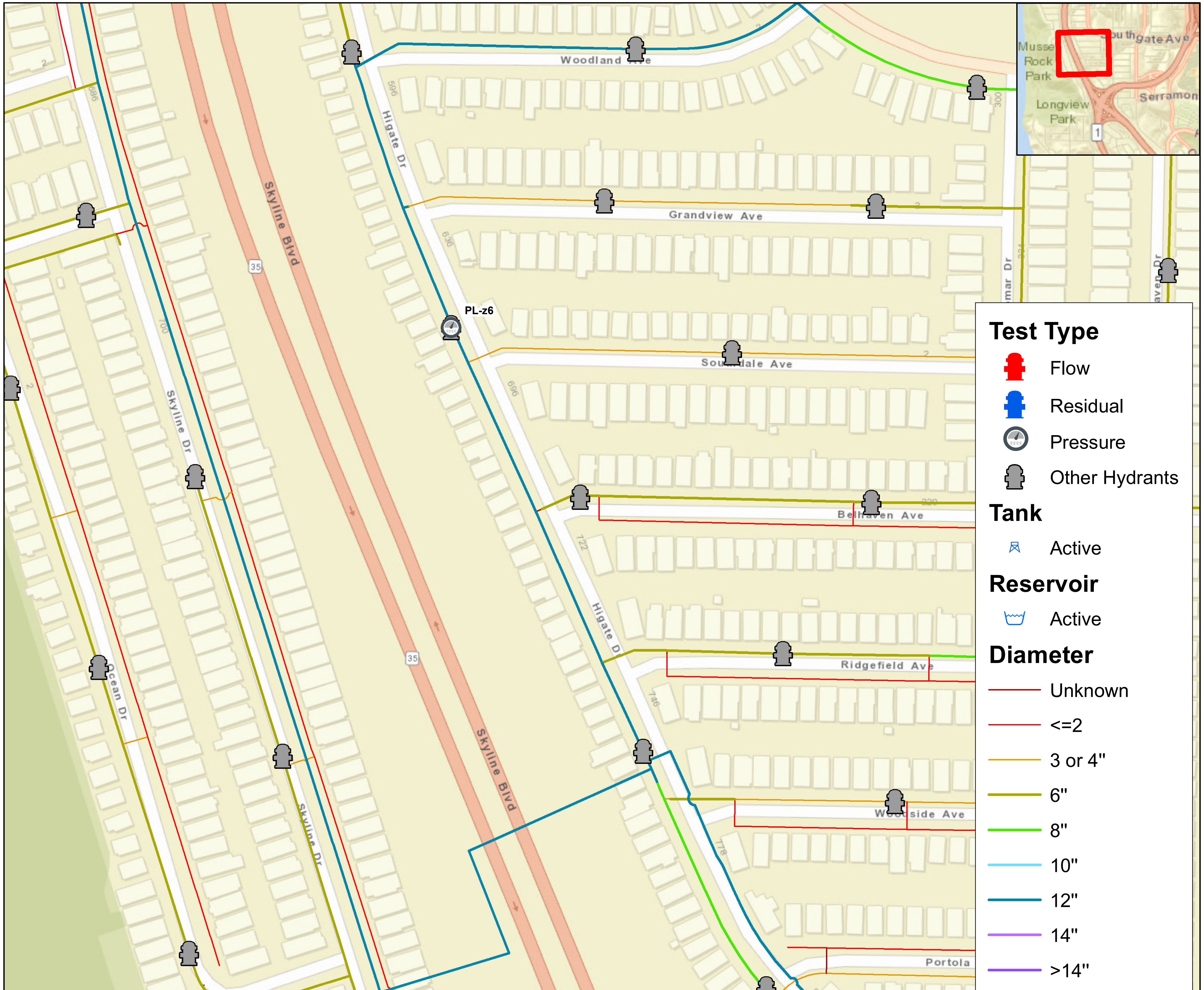

City of Daly City
Field Calibration Plan

Appendix C
Pressure Logger Locations

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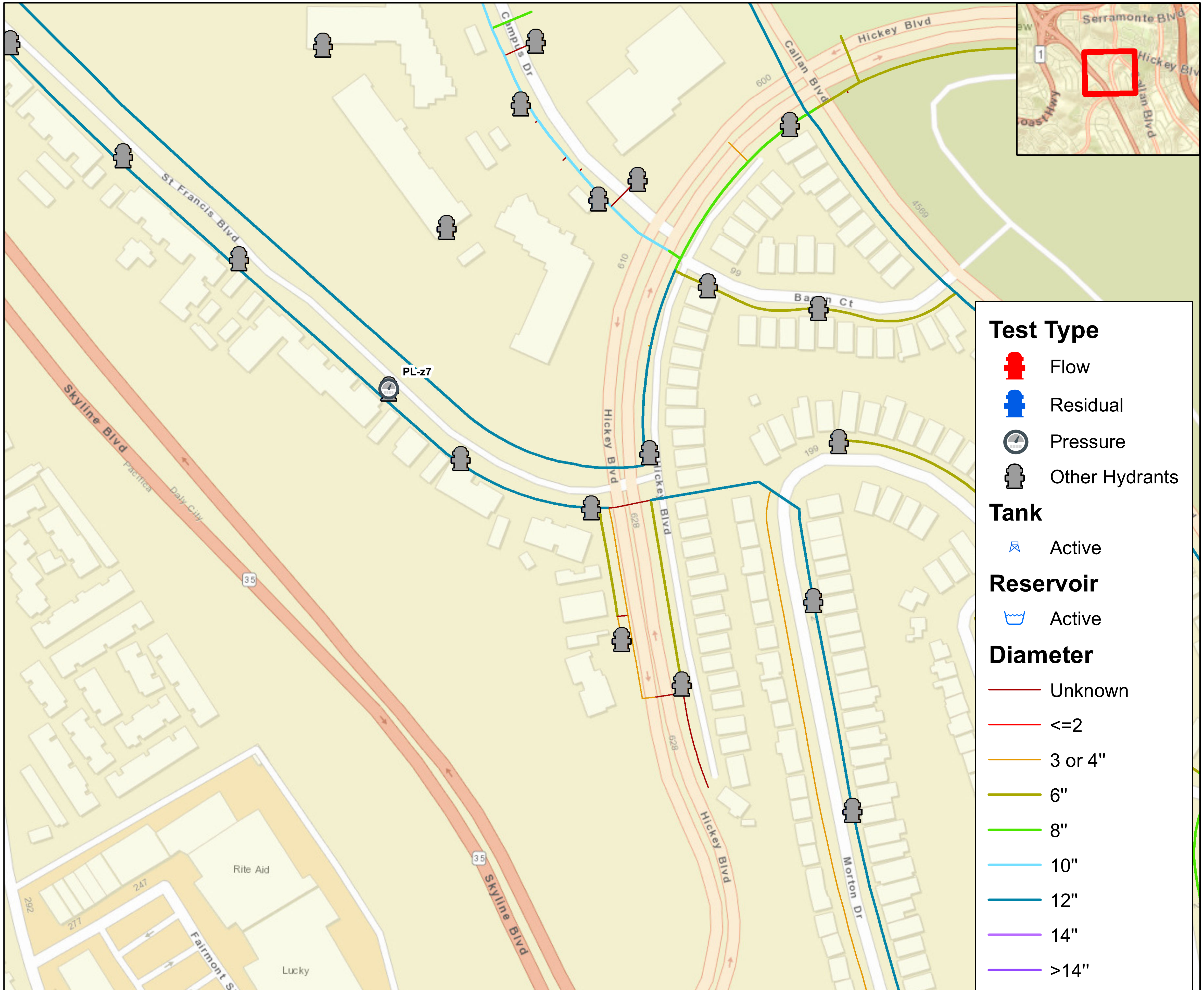

City of Daly City
Field Calibration Plan

Appendix C
Pressure Logger Locations

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Appendix C: Operational Calibration Results

The graphs in the following pages show a comparison of actual water system tank levels, pressures, and flows versus model results. The curves labeled as SCADA in the graphs include data obtained from the City's SCADA system and from pressure loggers placed during field work.

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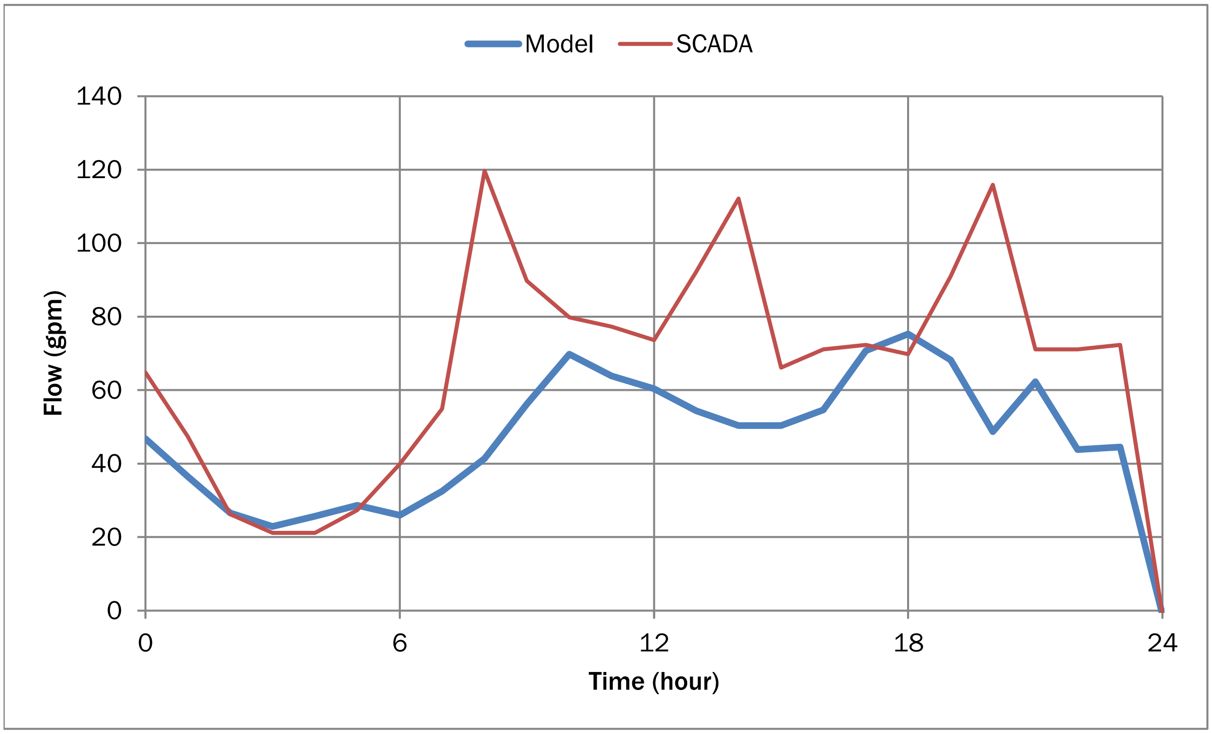

Figure C-1. Allen Meter 2 flow (gpm)

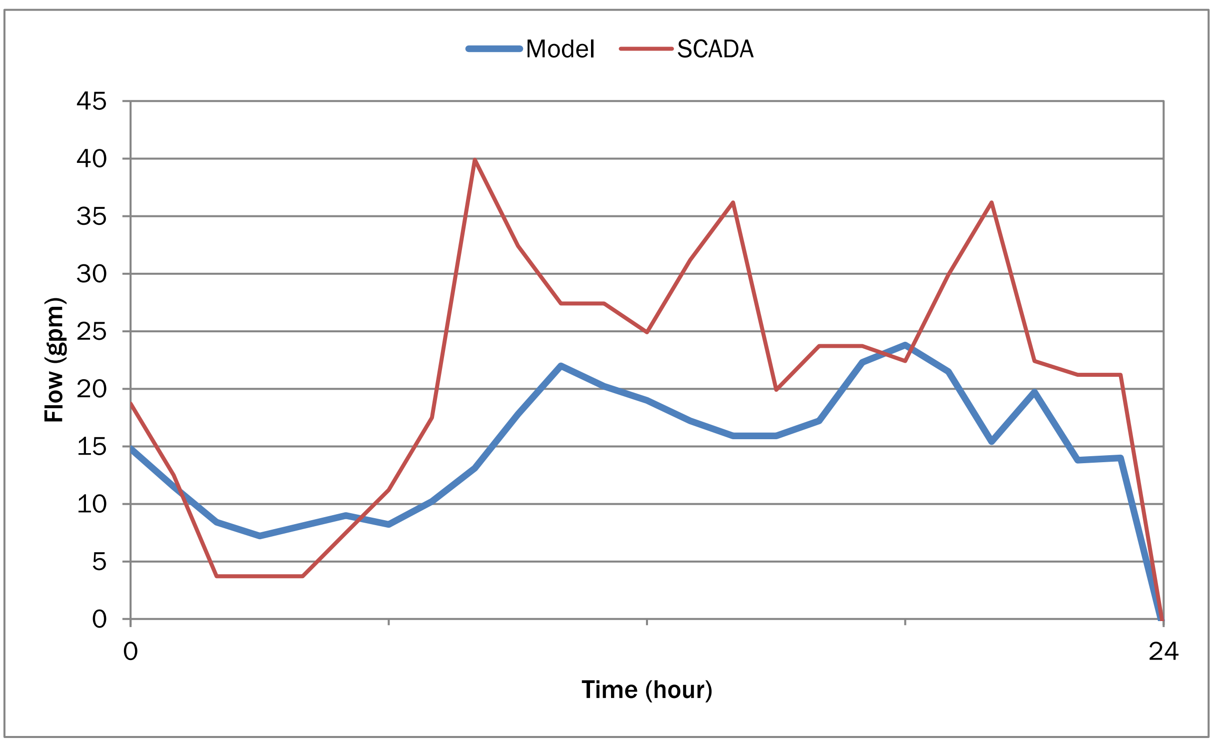

Figure C-2. Allen meter 3 flow (gpm)

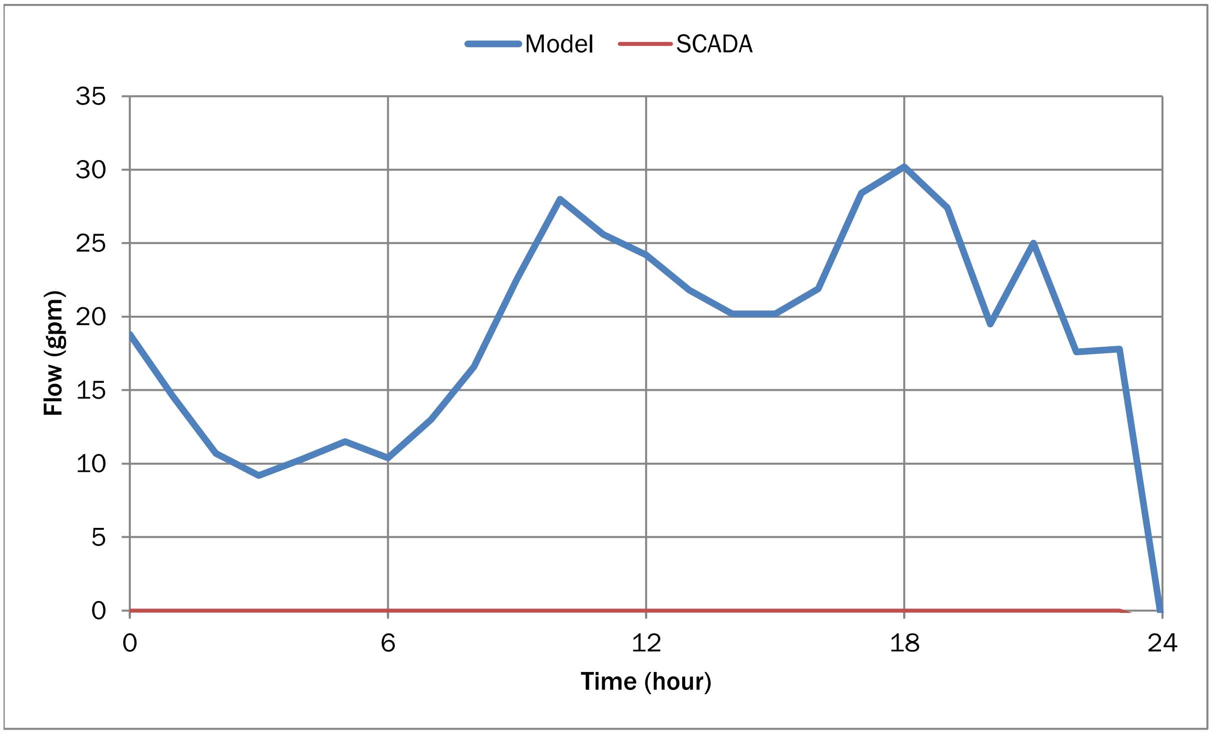

Figure C-3. Alta Vista PS flow (gpm)

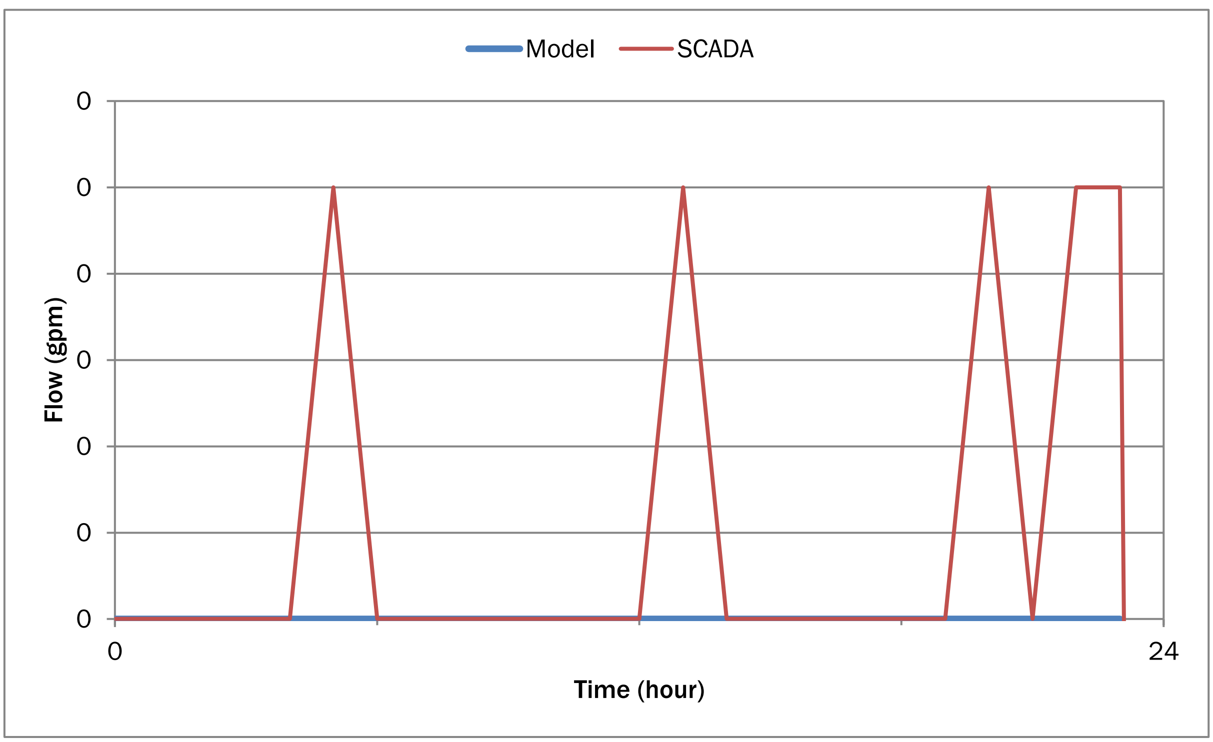

Figure C-4. Bayshore PS flow (gpm)

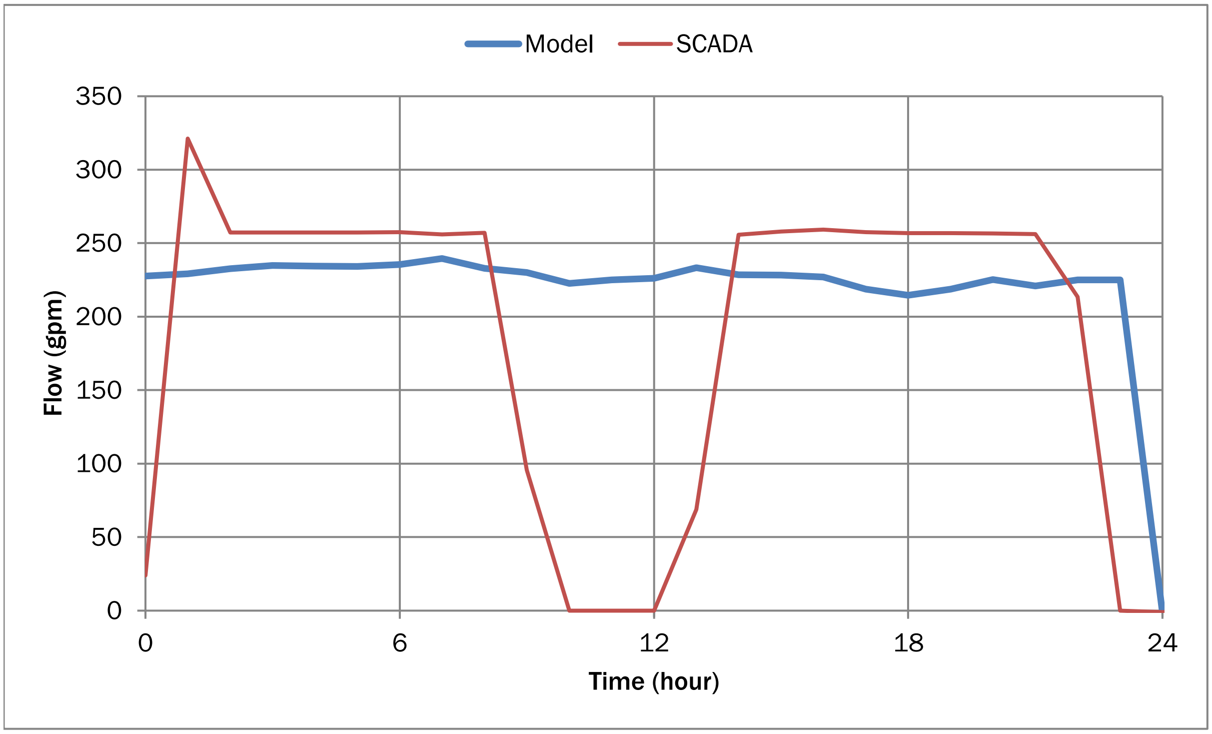

Figure C-5. Bellevue PS flow (gpm)

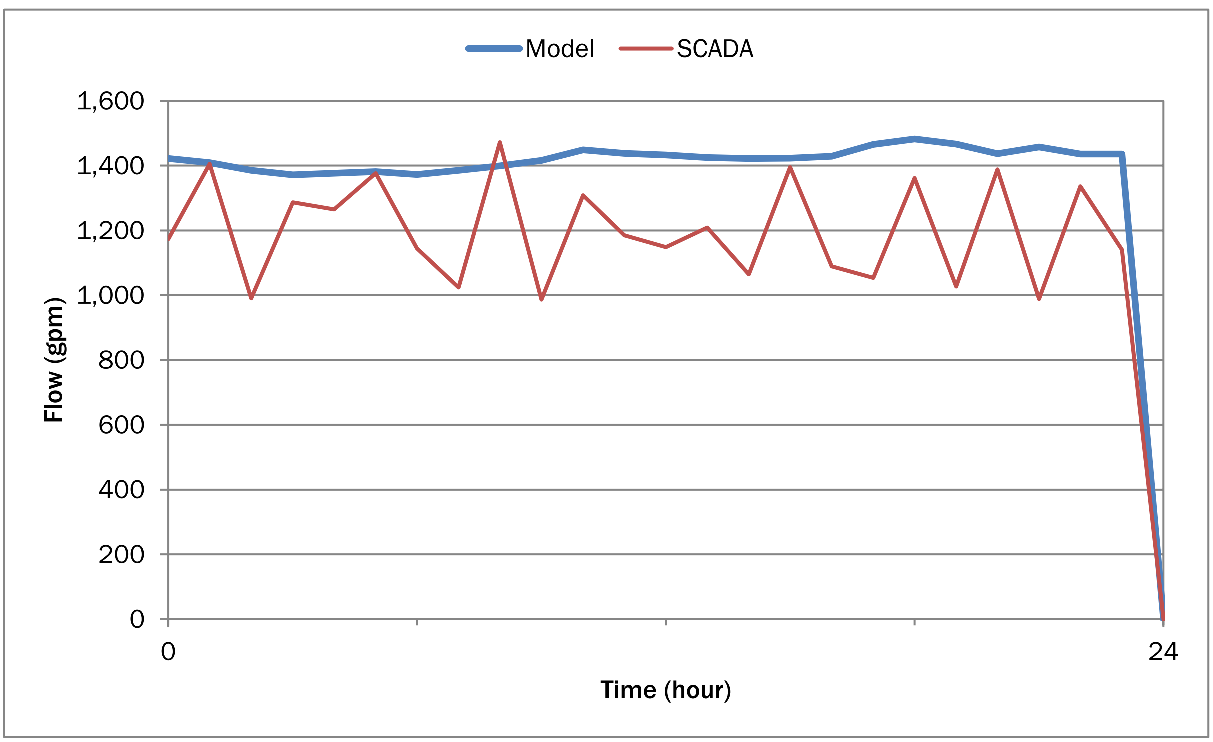

Figure C-6. Citrus PS Zone 1 flow (gpm)

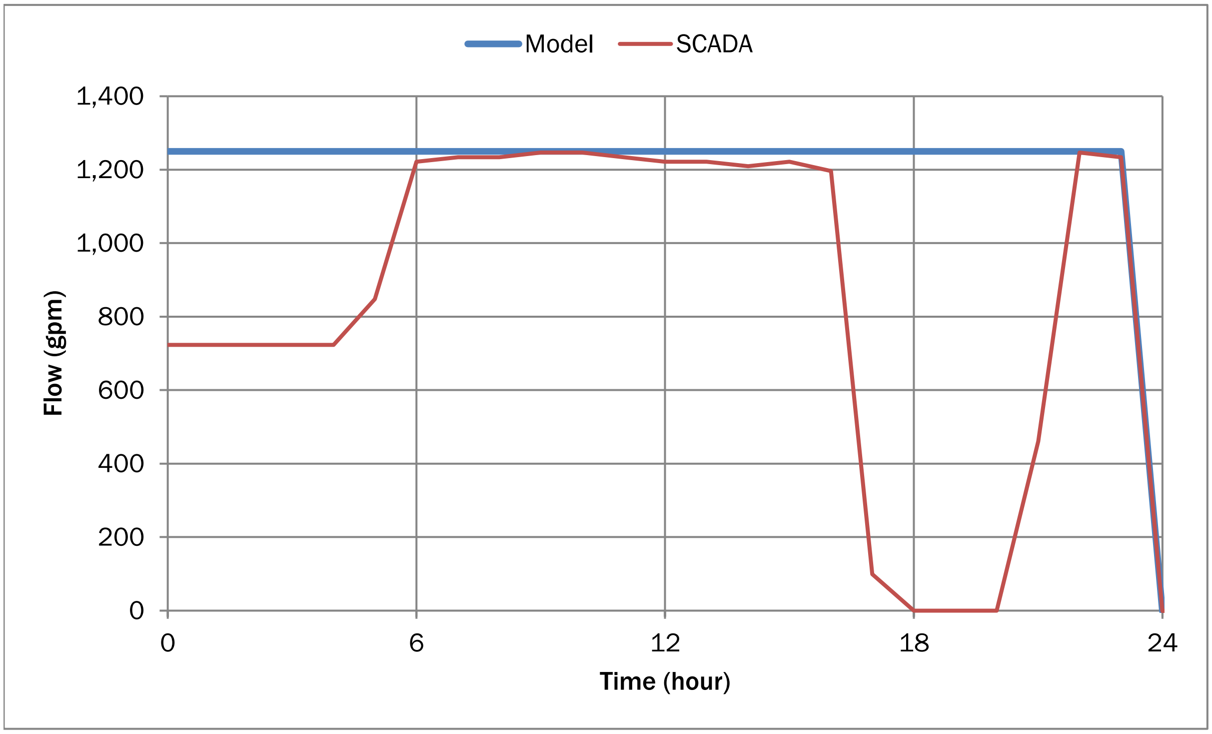

Figure C-7. Hickey 1 TO Meter flow (gpm)

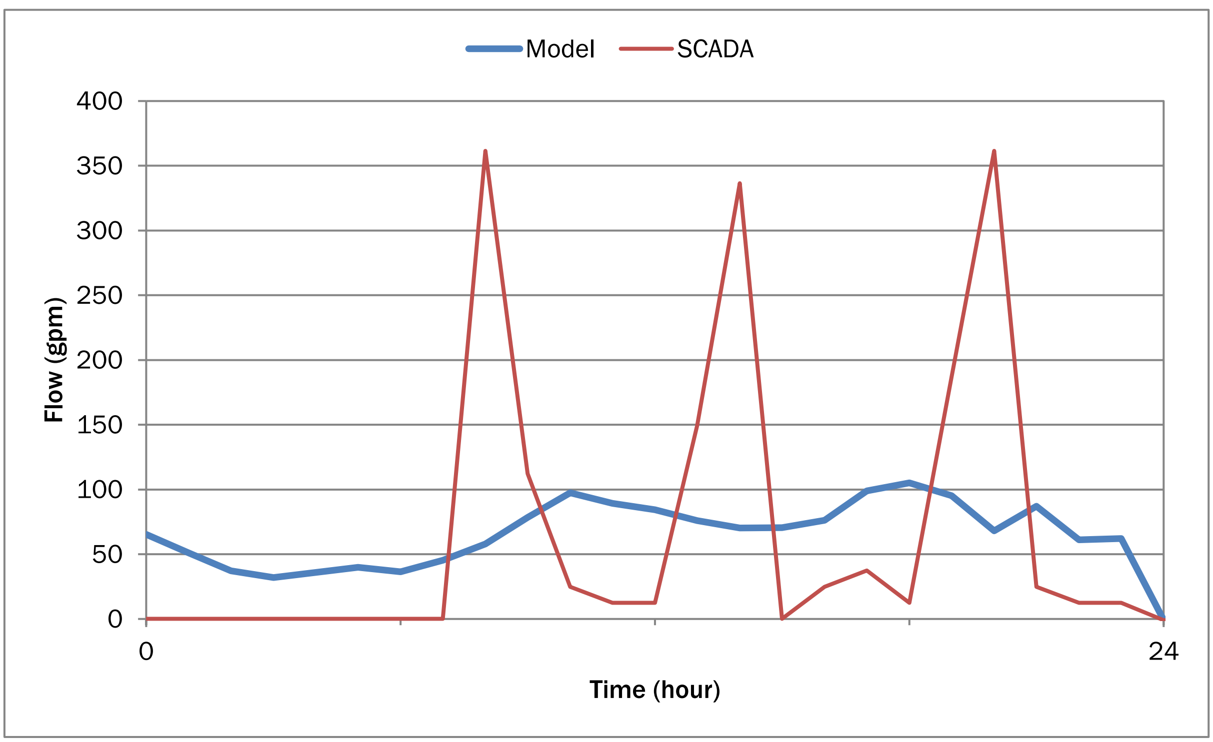

Figure C-8. Macdonald Meter flow (gpm)

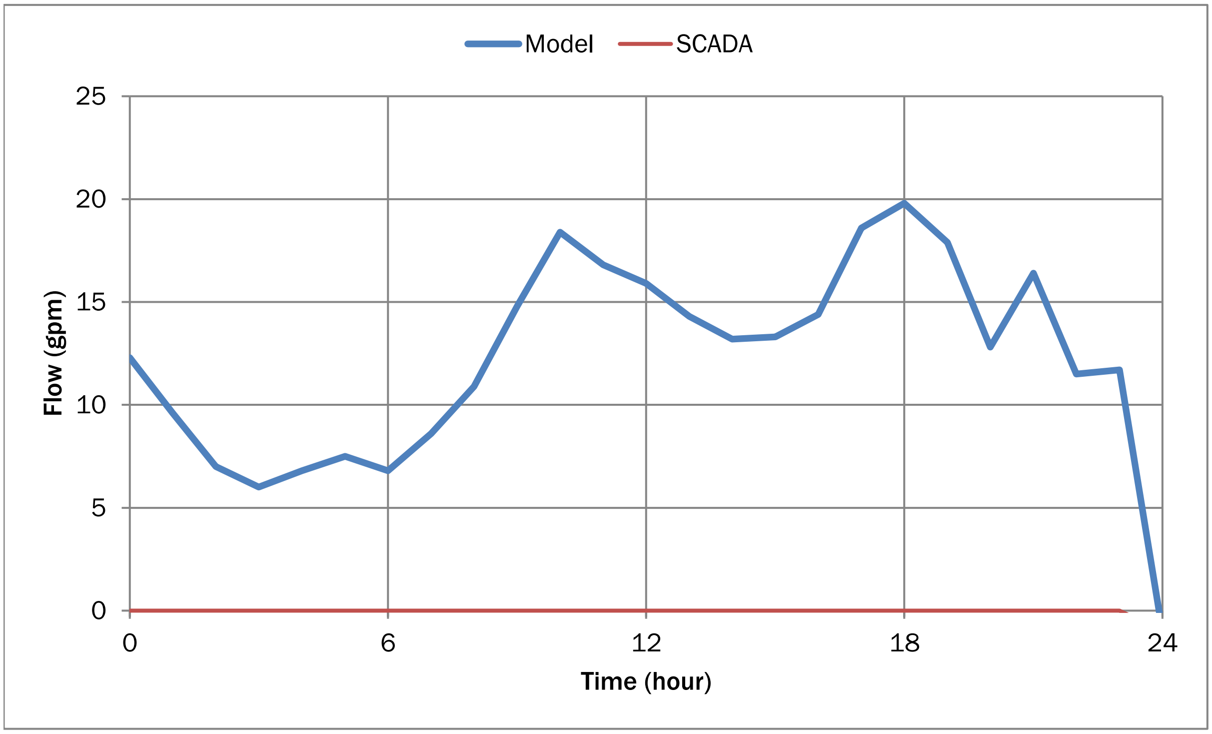

Figure C-9. Pointe Pacific BPS flow (gpm)

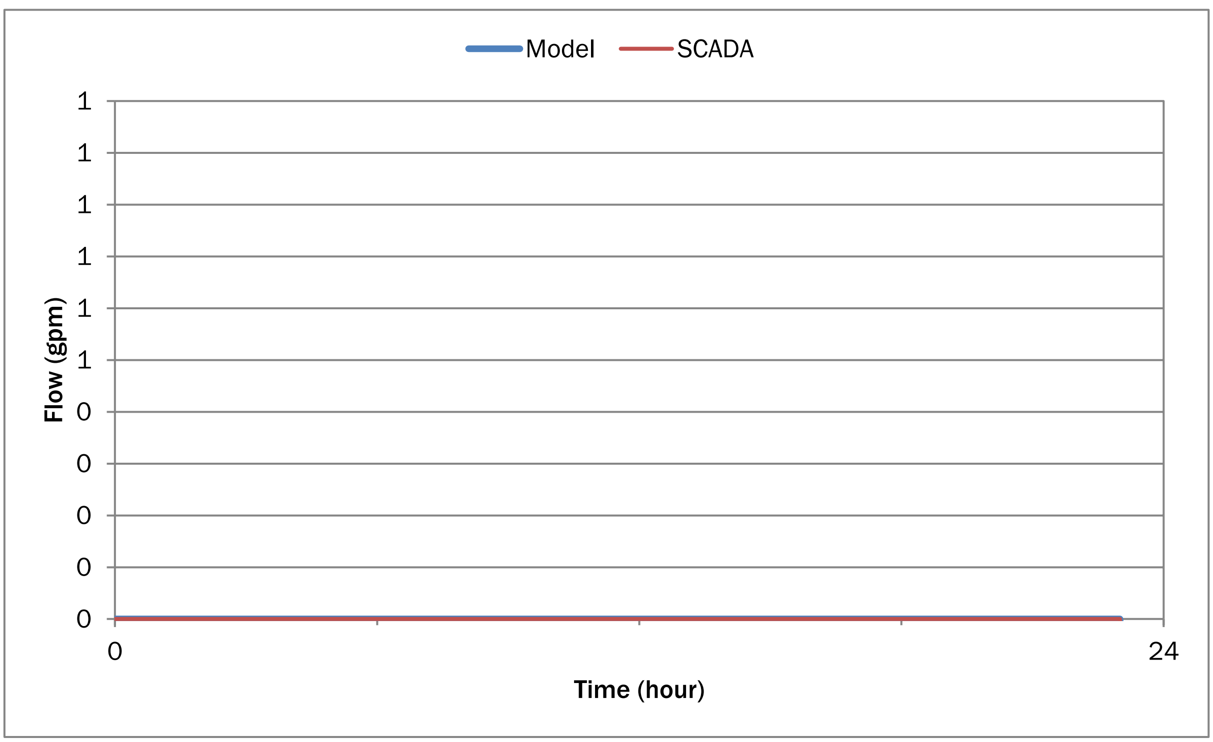

Figure C-10. Res 1 PS flow (gpm)

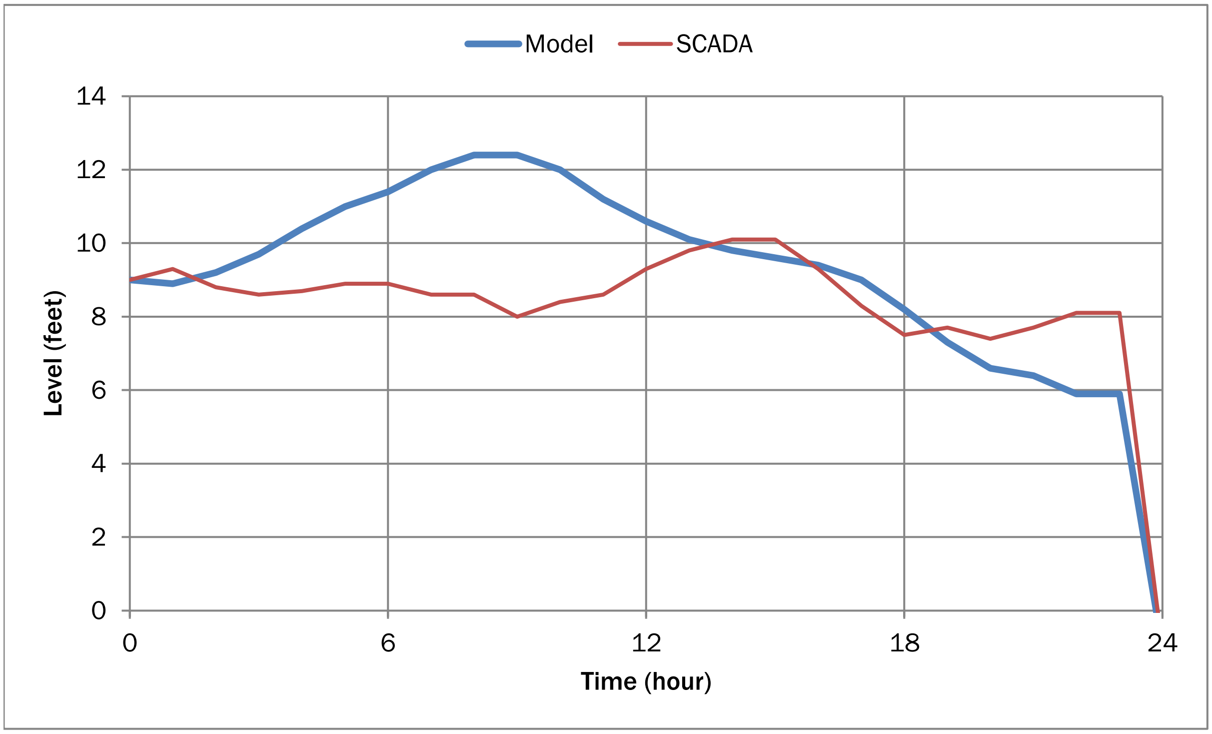

Figure C-11. Res 1 tank level

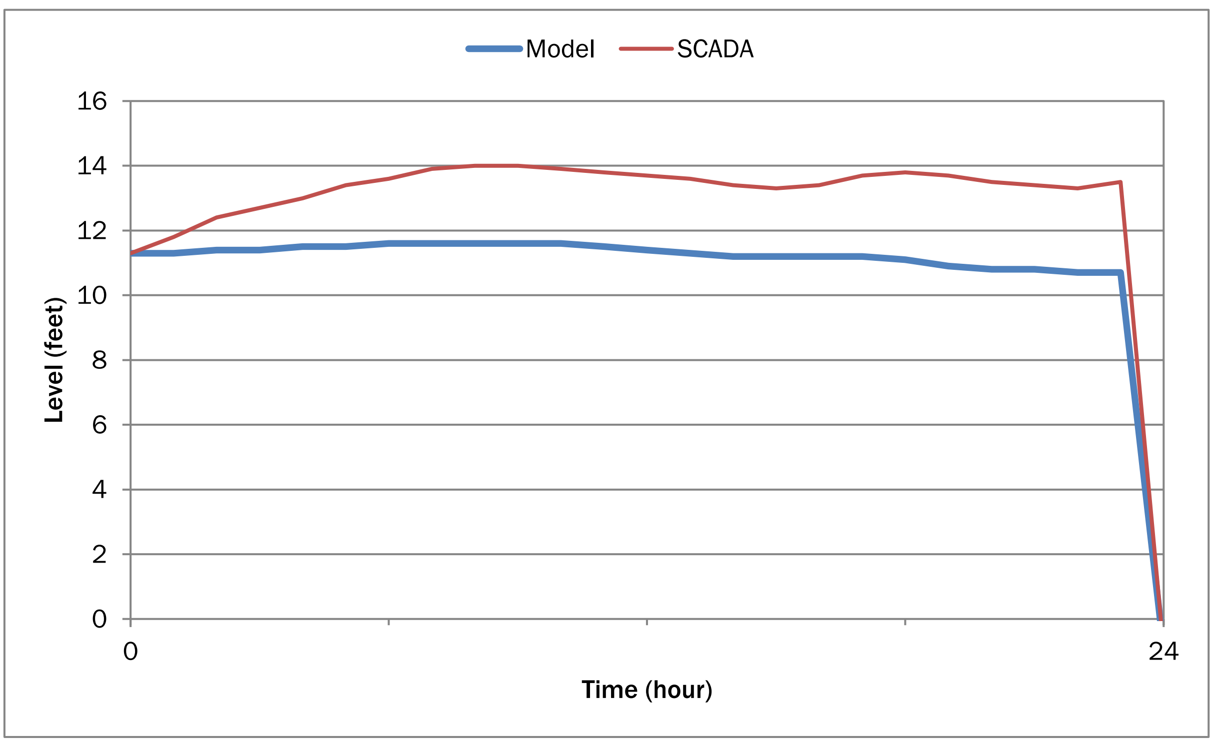

Figure C-12. Res 2 tank level

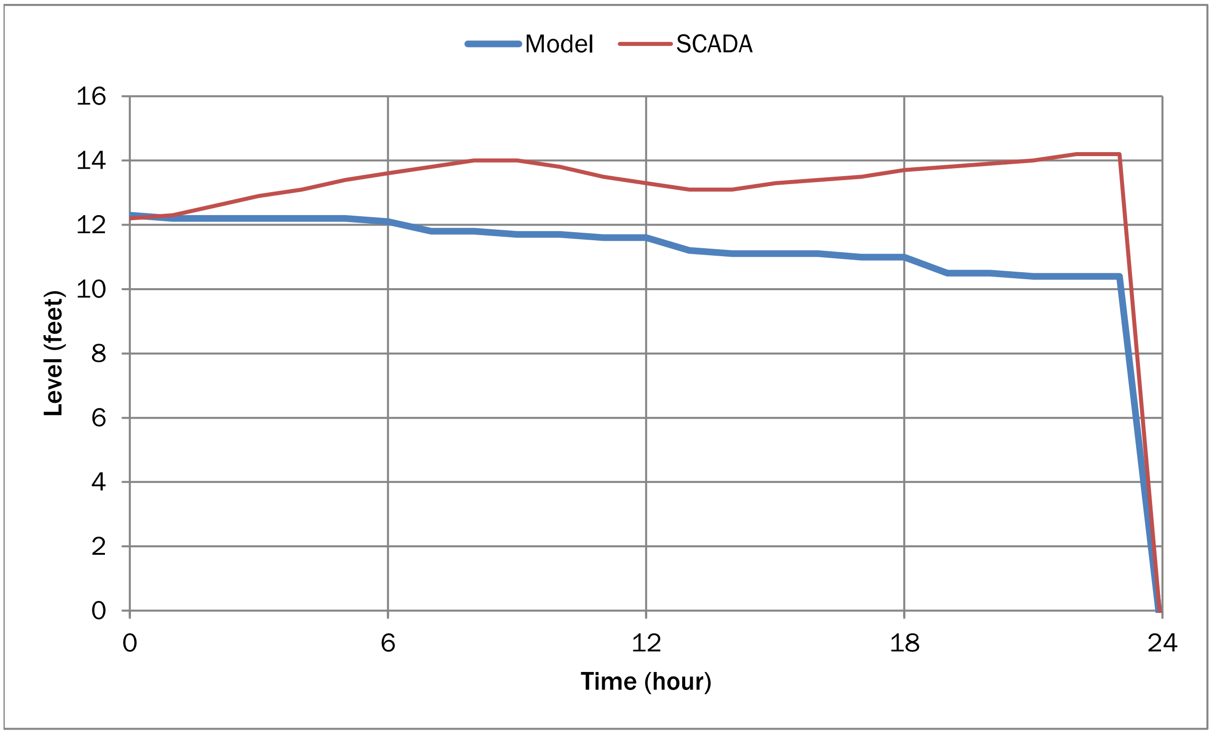

Figure C-13. Res 2b tank level

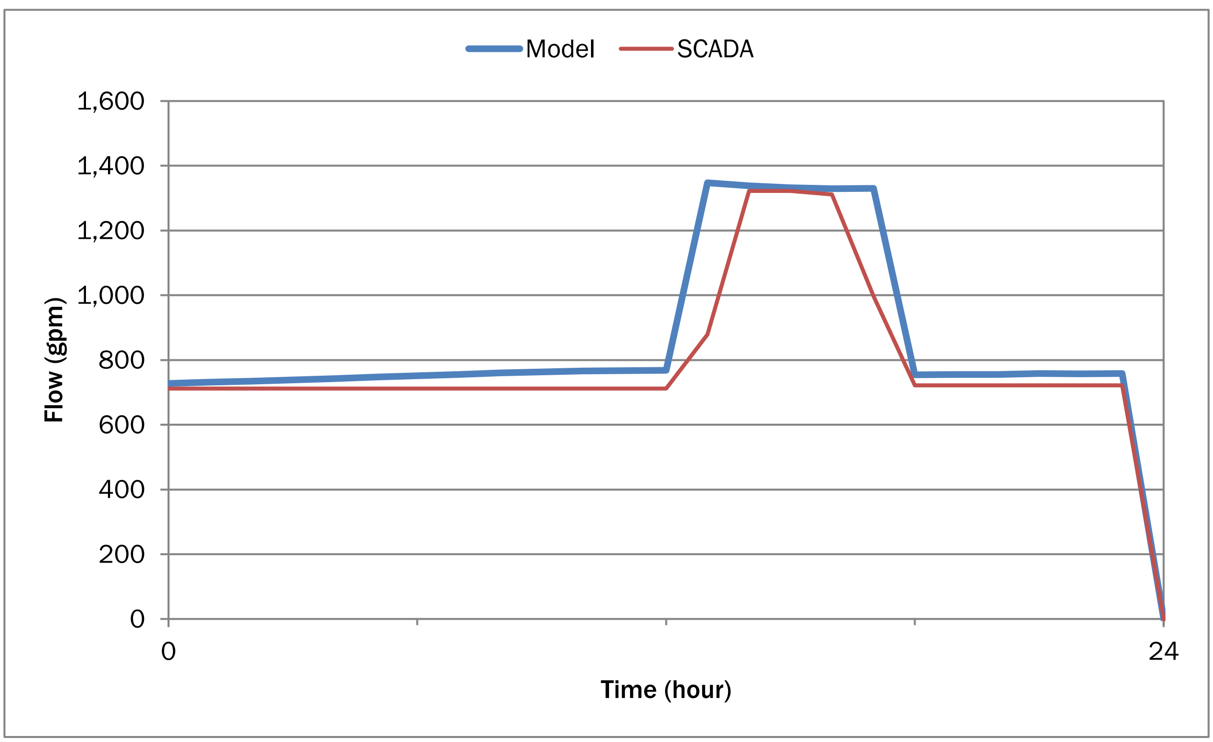

Figure C-14. Res 4 PS flow (gpm)

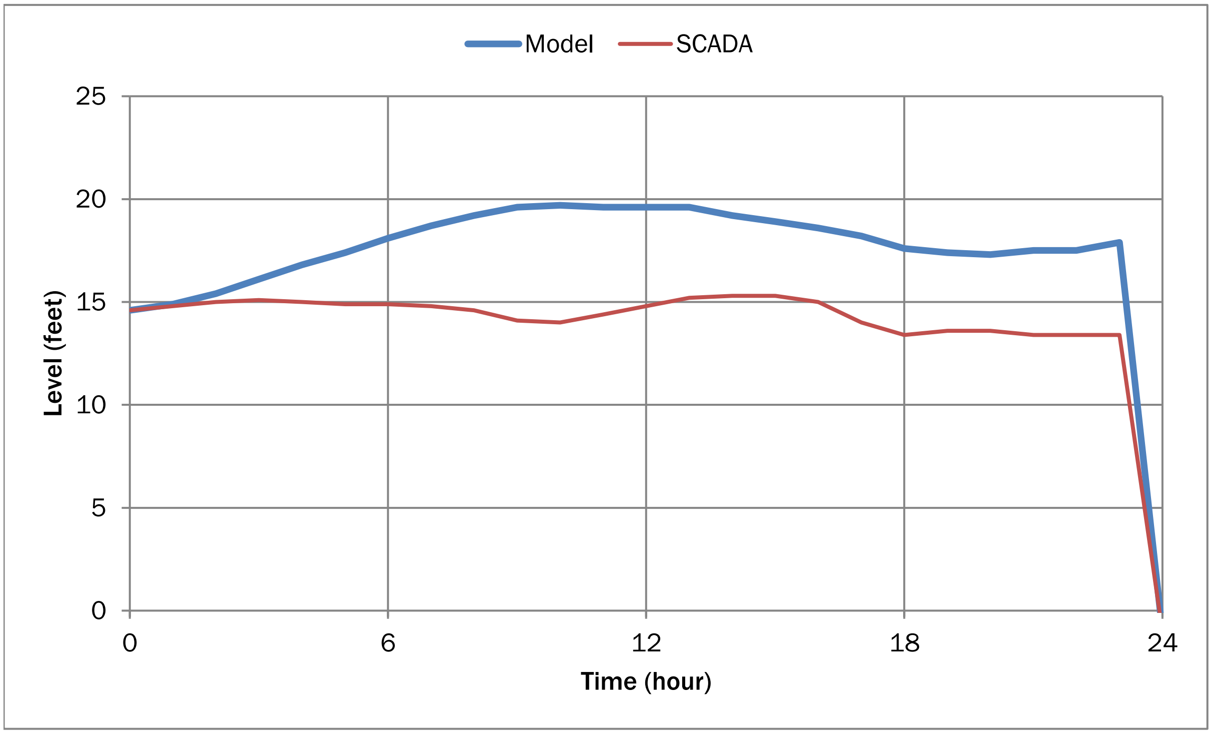

Figure C-15. Res 4 tank level

Figure C-16. Res 5 PS flow (gpm)

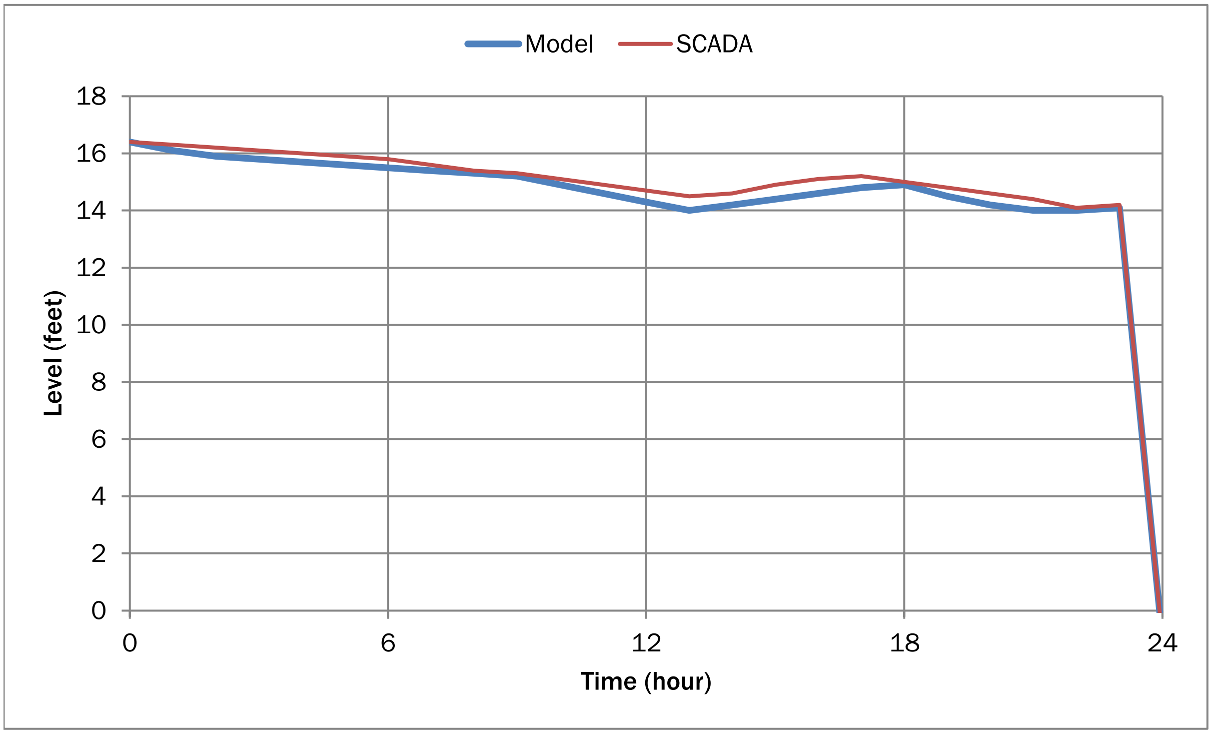

Figure C-17. Res 5 tank level

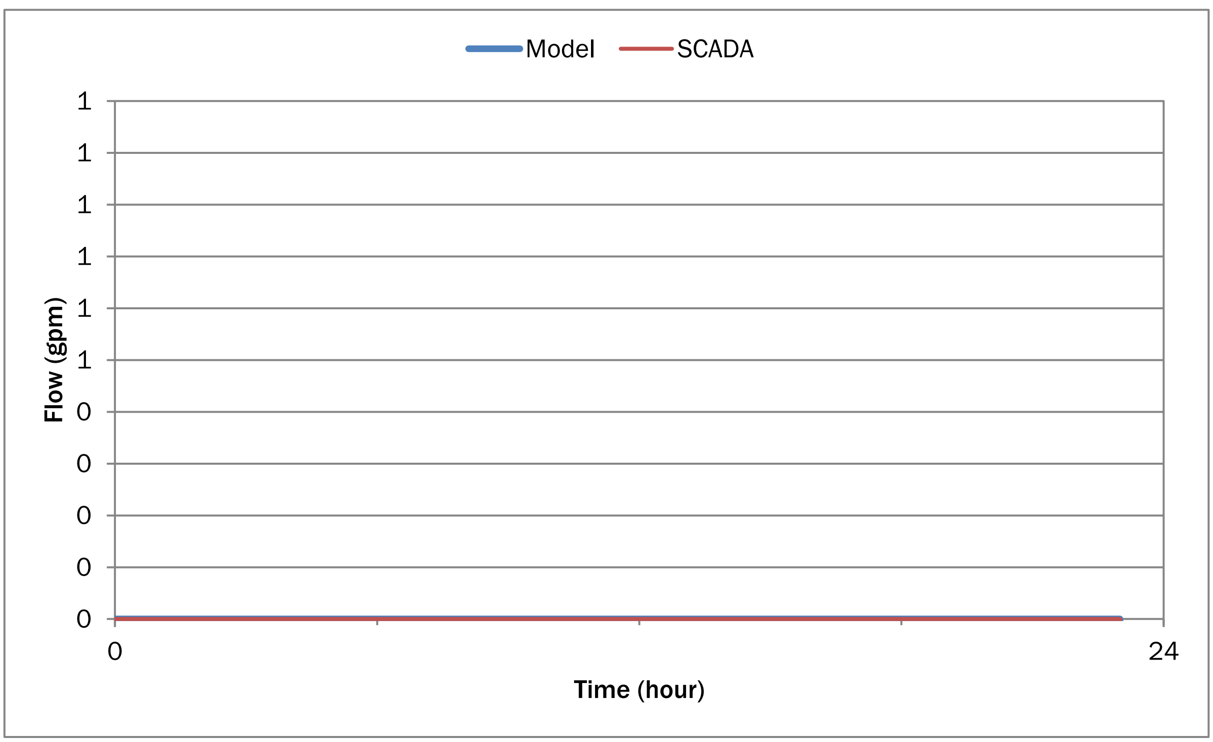

Figure C-18. Res 5b PS flow (gpm)

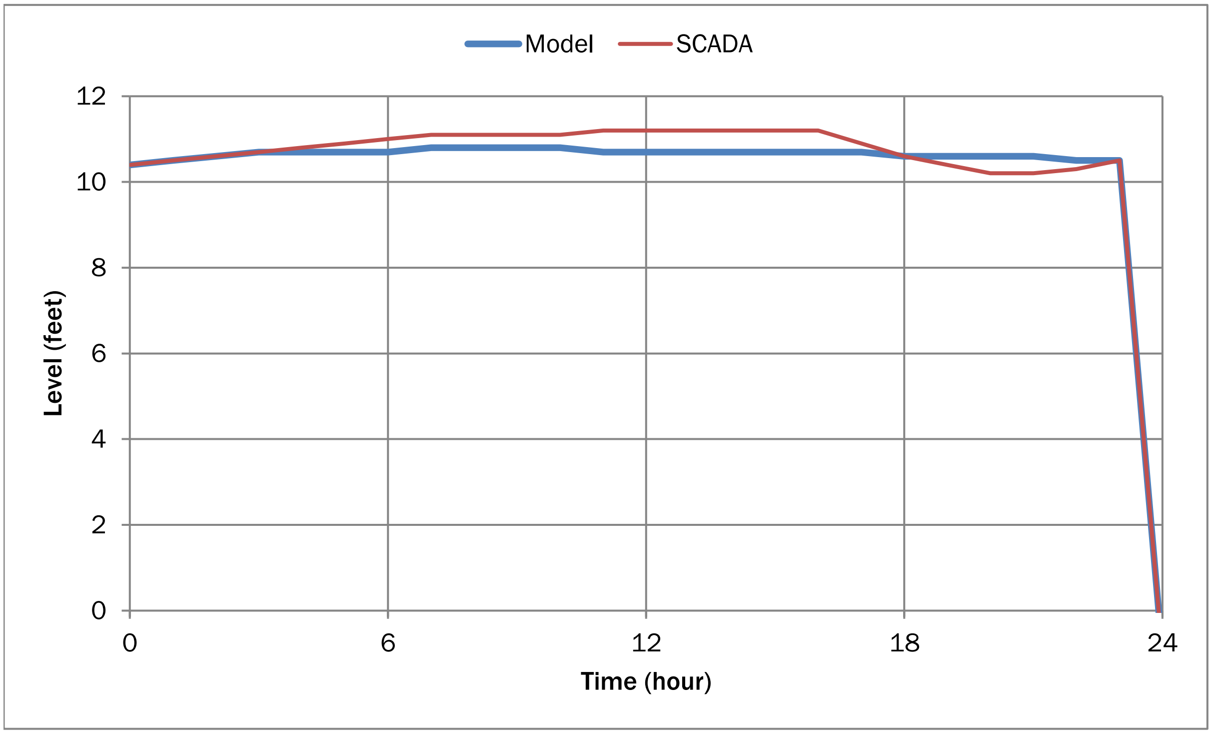

Figure C-19. Res 5b tank level

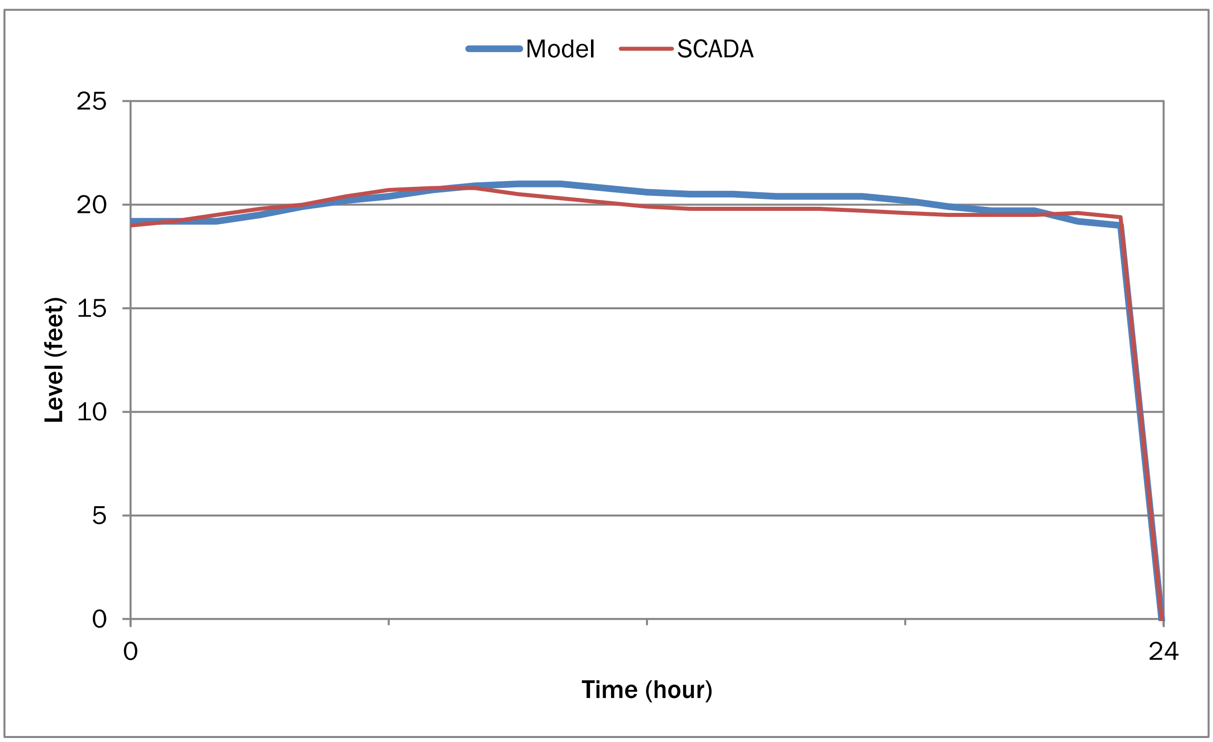

Figure C-20. Res 6 tank level

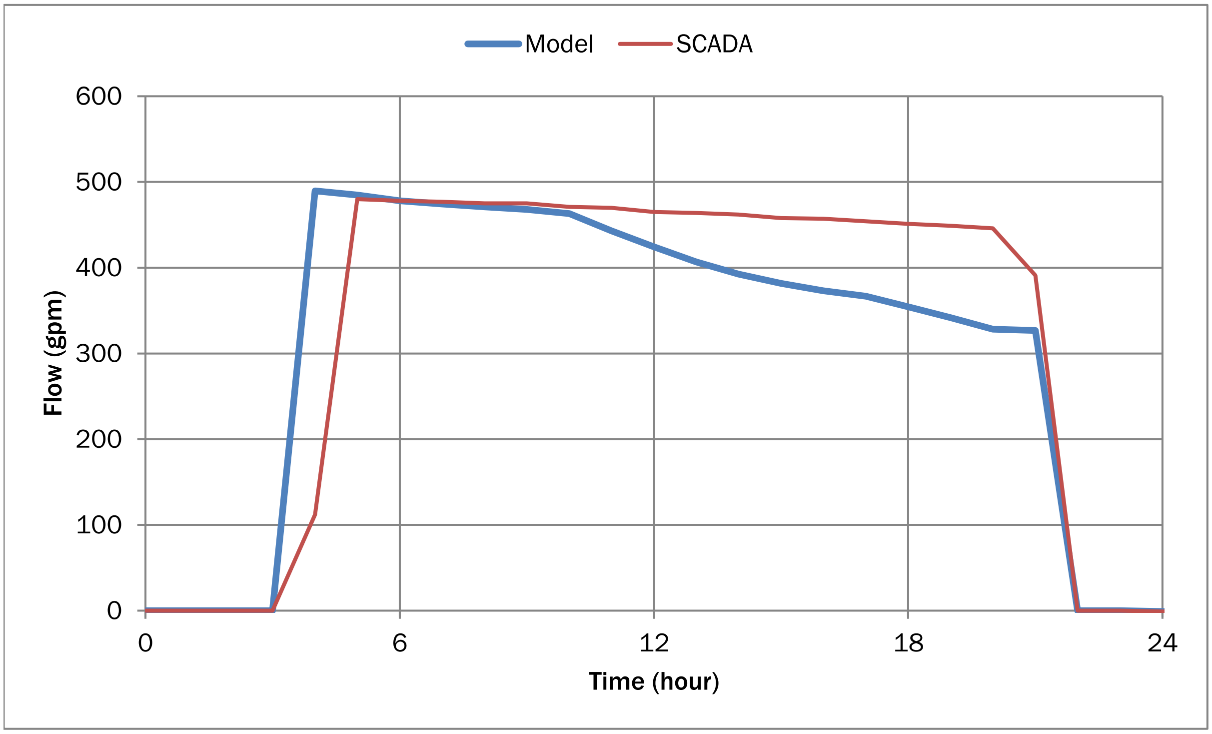

Figure C-21. Res 6b PS Pump 1

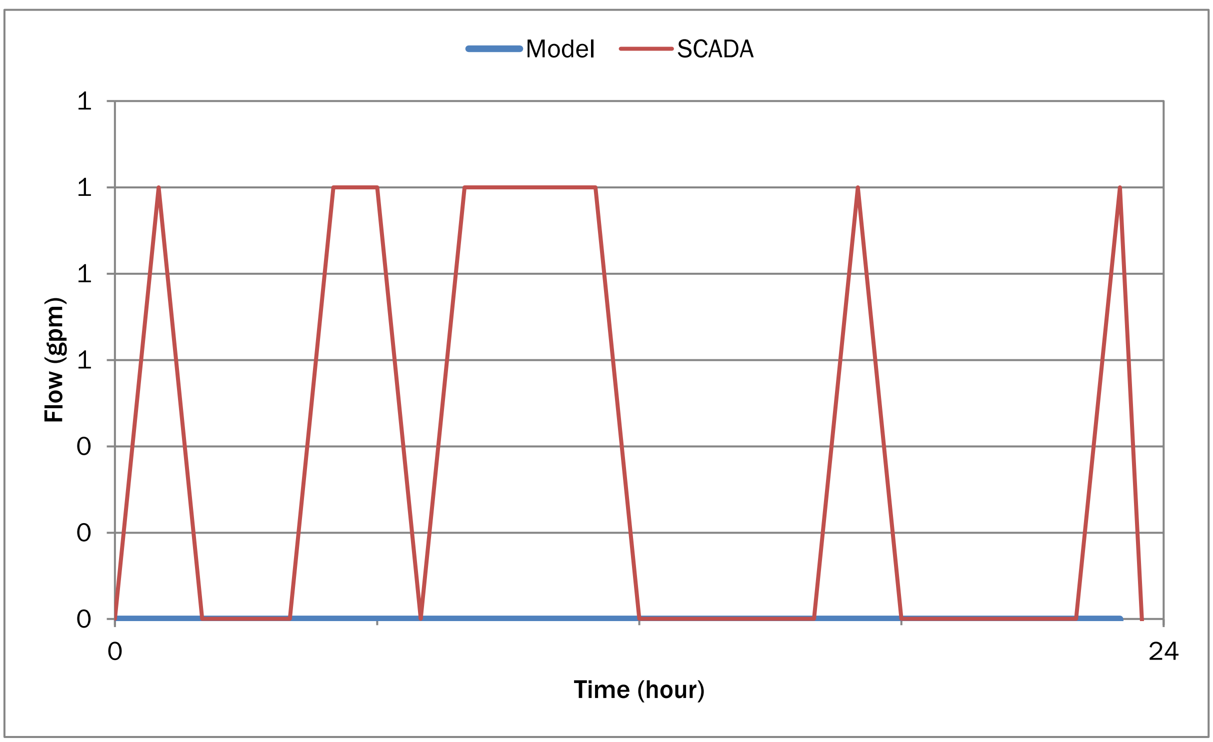

Figure C-22. Res 6b PS Pump 2

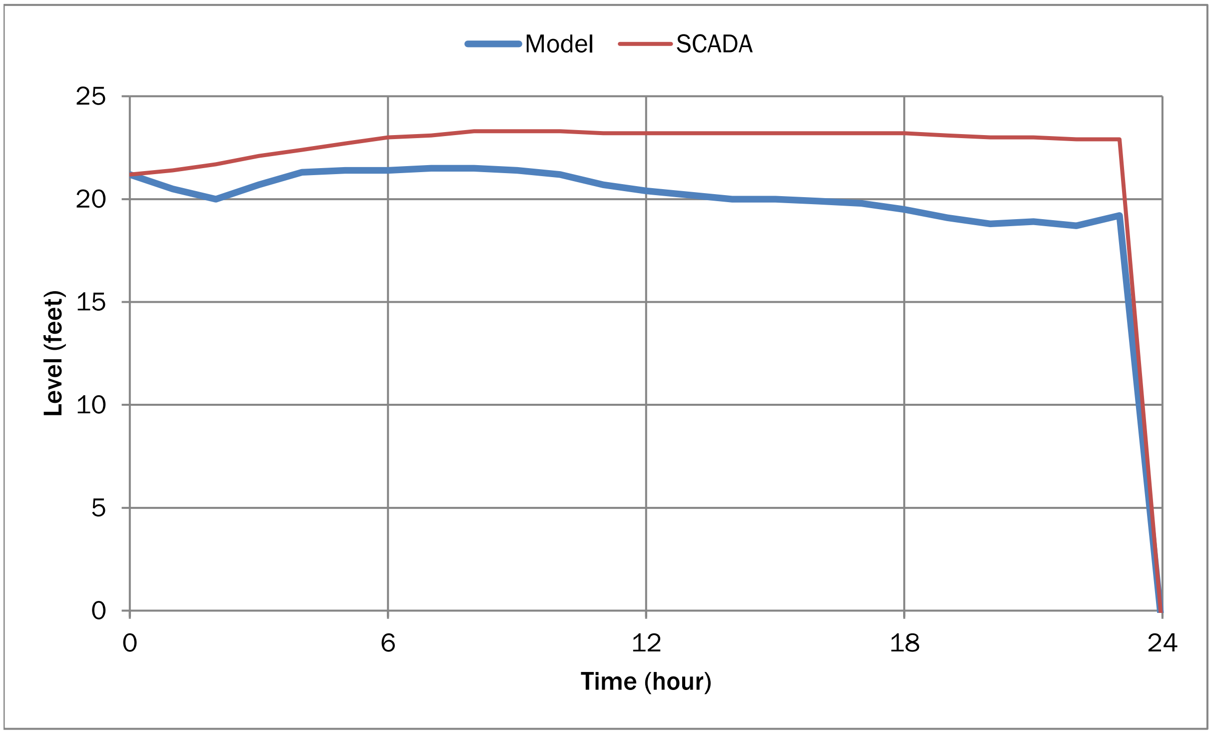

Figure C-23. Res 6b tank level

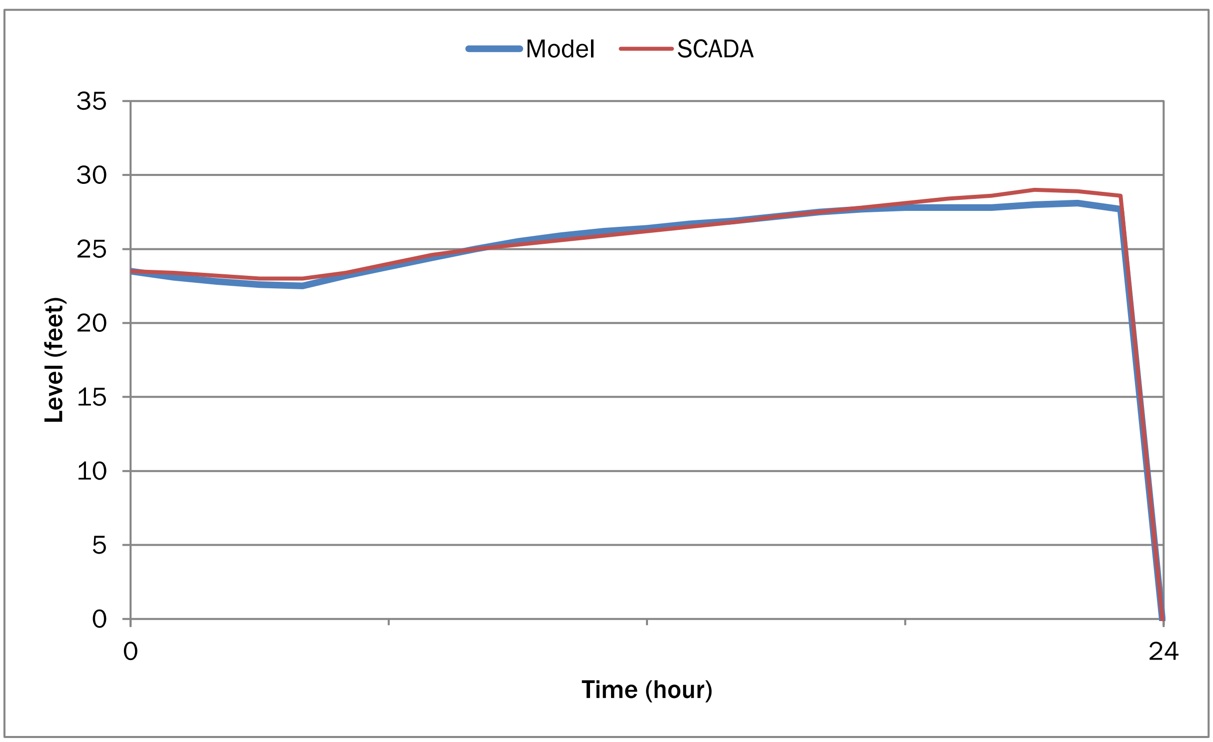

Figure C-24. Res 7 tank level

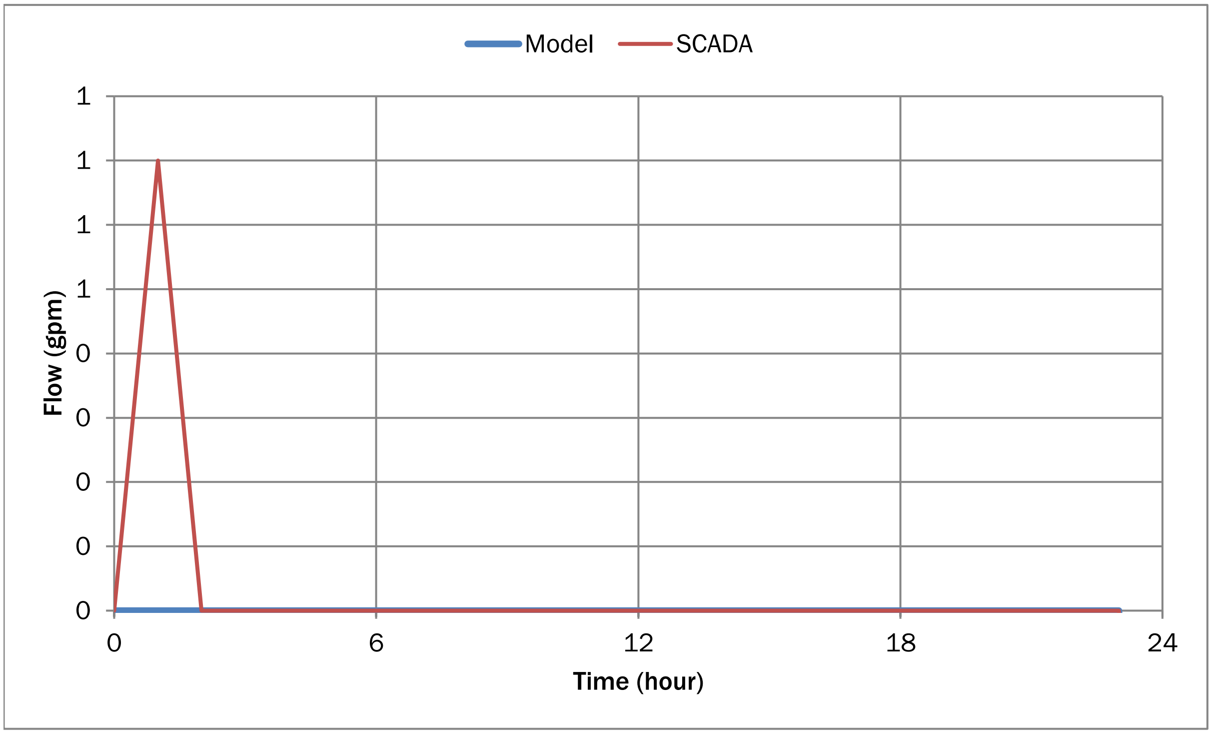

Figure C-25. Res 8 PS

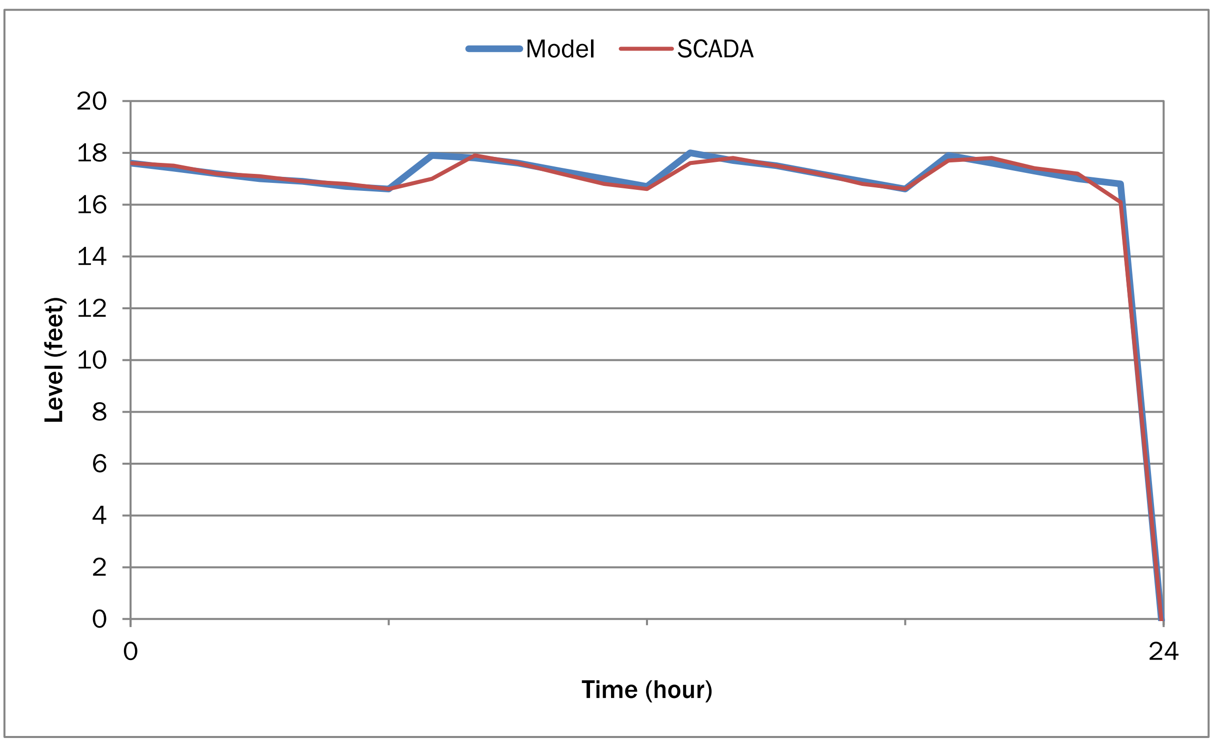

Figure C-26. Res 8 tank level

Figure C-27. Skyline PS

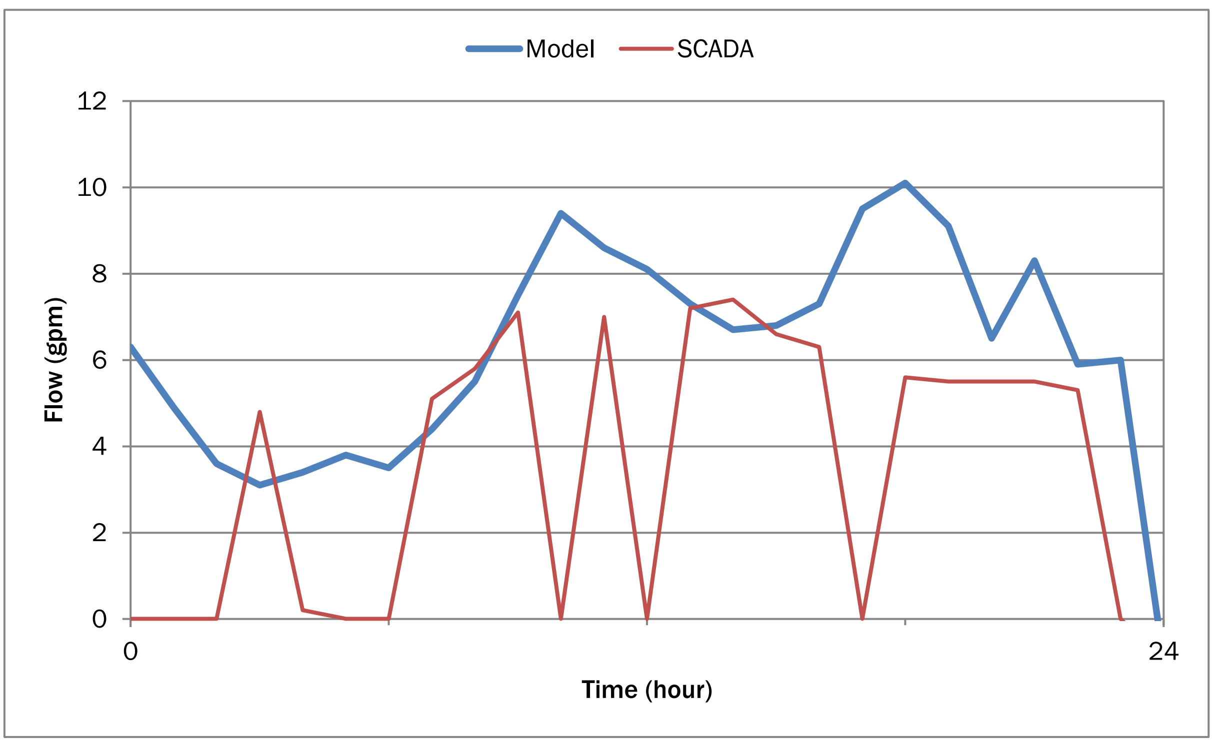

Figure C-28. Southhill PS

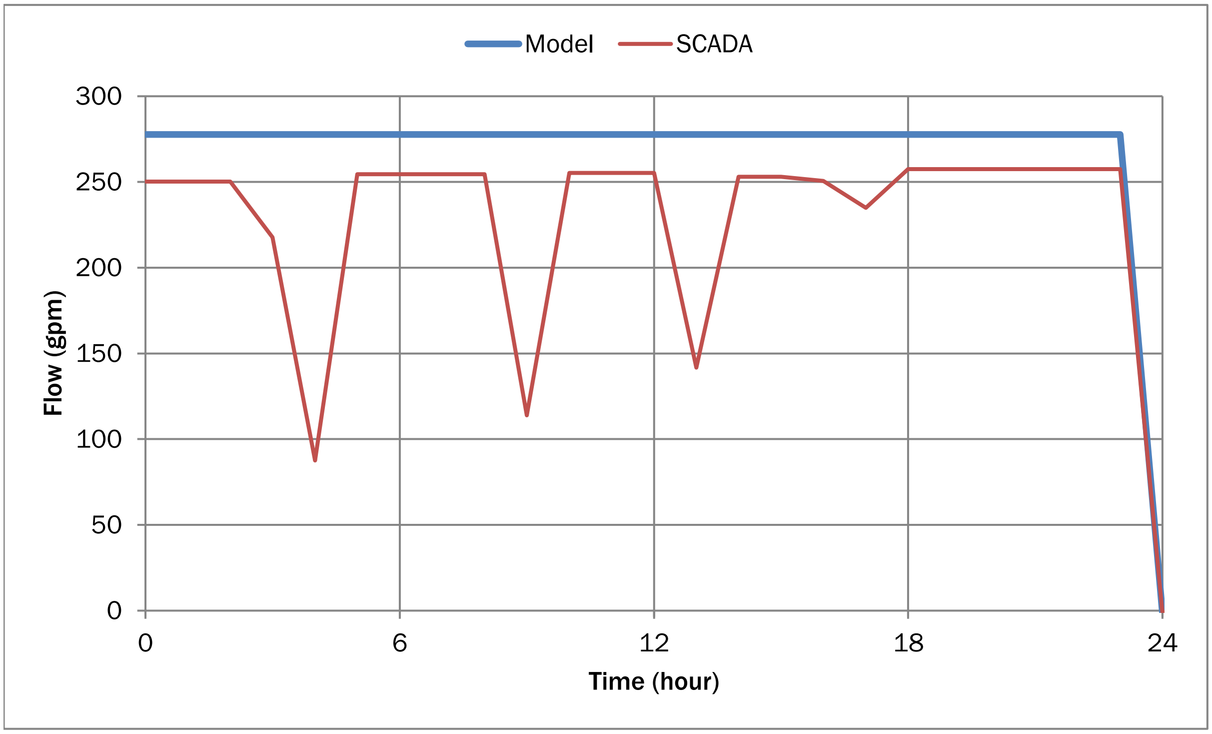

Figure C-29. Westlake PS pump 2 (109)

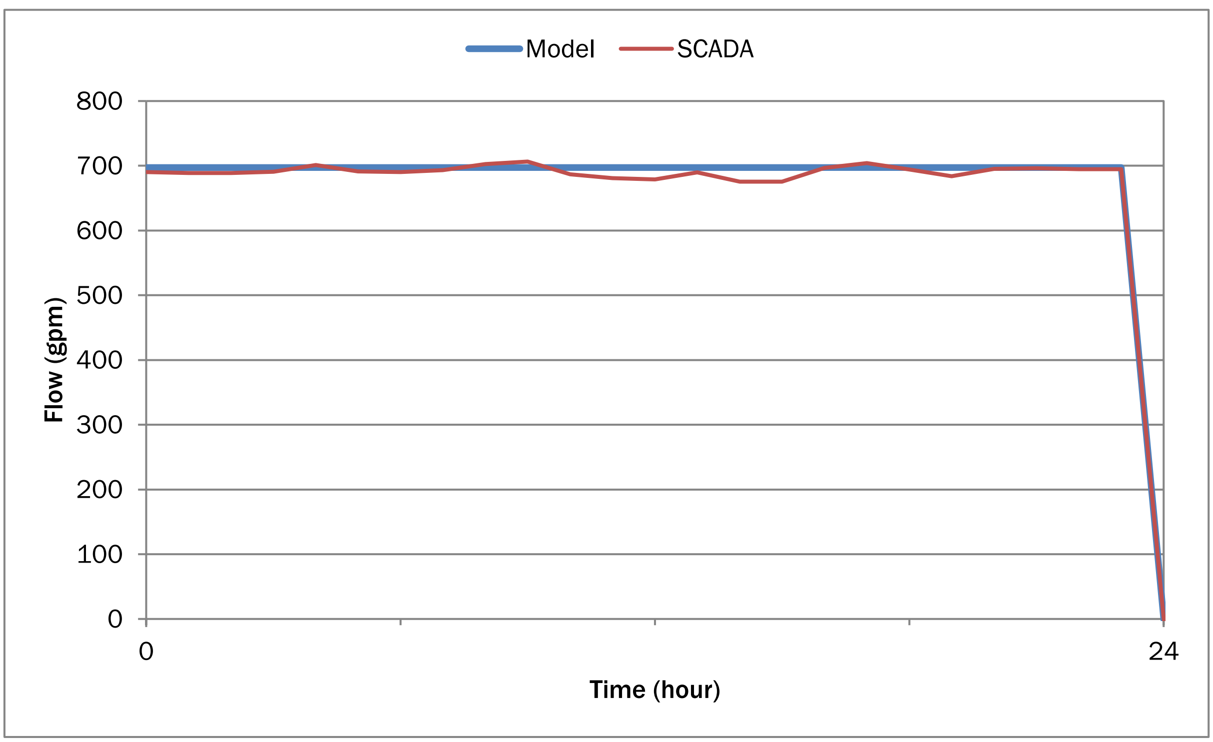

Figure C-30. Westlake PS pump 3 (5001)

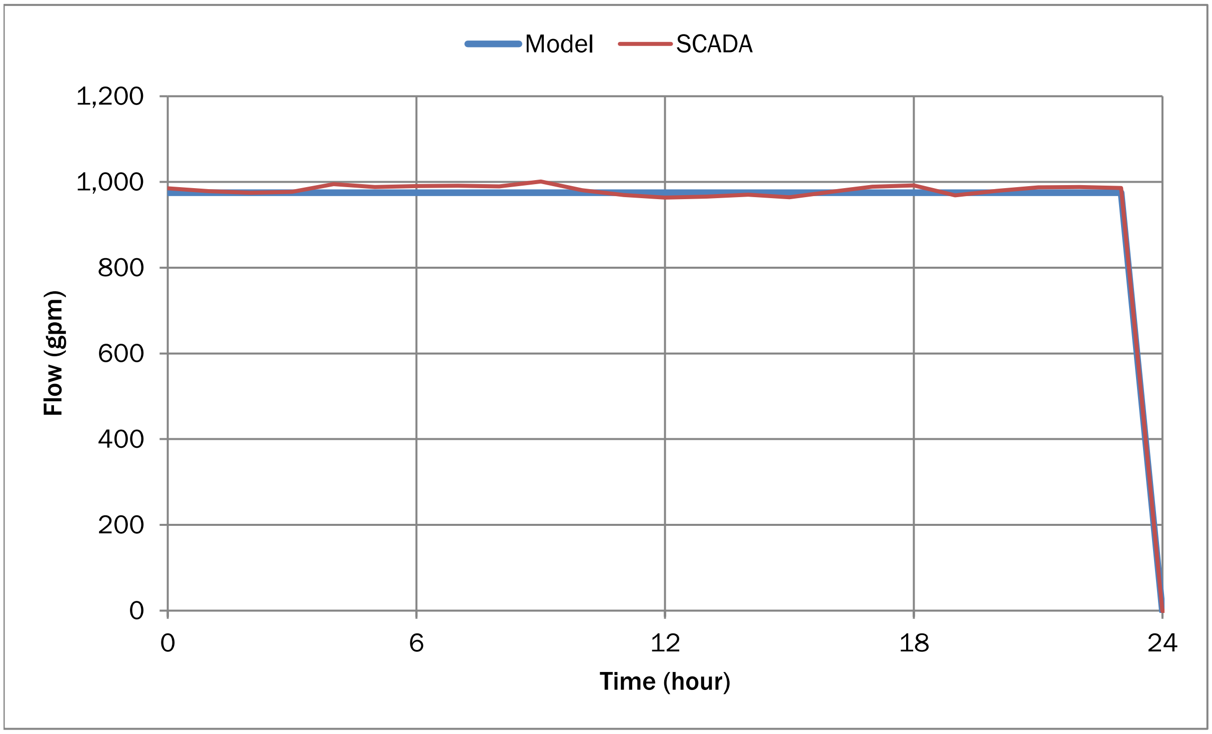

Figure C-31. Westlake PS pump 4 (113)

Figure C-32. Westlake PS pump 5 (111)

Appendix D: Pipe Risk Scores (Excel Spreadsheet and GIS)

Appendix D provides pipe risk scores based on the criteria described in Section 5. The spreadsheet is sorted by descending risk score from high to low, then by material (Z to A), then by diameter (smallest to largest), and lastly by grid (A to Z).

The GIS shapefile builds upon the City's water pipe GIS and provides risk score, grid location, in addition to the water pipe attributes previously present in the GIS (diameter, material, age, length).

Note: This will be provided electronically with the final report.

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Appendix E: Water Distribution System Evaluation Criteria TM

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Brown AND Caldwell

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Technical Memorandum

Prepared for: City of Daly City

Project Title: 10-Year Water System Master Plan

Project No: 154529

Technical Memorandum

Subject: Water Distribution System Evaluation Criteria

Date: December 1, 2021

To: Gregory M. Krauss, City of Daly City

Kenneth Alasandro, City of Daly City

Joshua Cosgrove, City of Daly City

From: Chris Peters, Brown and Caldwell

Bill Faisst, Brown and Caldwell

Aimee Zhao, Brown and Caldwell

Prepared by: ______________________________
Aimee Zhao

Reviewed by: ______________________________
William K. Faisst, Ph.D., P.E.

Reviewed by: ______________________________
Jacob Young

Table of Contents

List of Tables

List of Abbreviations

AWWA	American Water Works Association
CCR	California Code of Regulations
CWWS	California Water Works Standards
fps	Feet Per Second
ft	feet
gpm	Gallons Per Minute
GLUMRB	Water Supply Committee of the Great Lakes--Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers
hr	hour
IFC	International Fire Code
MDD	Average of Maximum Day Demand
mgd	million gallons per day
NCFA	North County Fire Authority
NFPA	National Fire Protection Association
PHD	Peak Hour Demand
psi	Pounds Per Square Inch
TM	technical memorandum

Section 1: Introduction

This technical memorandum (TM) describes the criteria Brown and Caldwell (BC) used for evaluating the existing drinking water system and to size future system improvements for the City of Daly City (City). BC developed the criteria to provide the desired level of service to each customer and to maximize the future system efficiency. BC used the documents listed below to develop these criteria. The criteria listed meet state regulations and conform with industry standards.

- California Code of Regulations (CCR) [CAOAL, 2019] – BC used the rules and regulations for water systems specified in primarily in CCR Title 17 and CCR Title 22 as the basis for these criteria.
- Recommended Standards for Water Works [GLUMRB, 2012] – This document is a guidance document containing criteria for transmission, supply, pumping, and storage facilities, produced by the Water Supply Committee of the Great Lakes--Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, commonly referred to as the "10 States Standards." The water industry widely accepts the 10 States Standards for basic water system planning and design guidance.
- Daly City Design Standards (Section 6.02.C)
- 2019 California Fire Code (CFC)
- Manual of Water Supply Practices, M32, Computer Modeling of Water Distribution Systems [AWWA, 2017] – BC defaulted to this document when we found no applicable criteria in the documents listed above.

The criteria include the specific capacity, operations, and reliability requirements for supply, piping, pumping, and storage facilities in the water system.

Section 2: Supply Criteria

The City relies on purchased water the City and County of San Francisco's Regional Water System (RWS), which is operated by SFPUC, and local groundwater to supply. The RWS draws supply predominantly from the Sierra Nevada, delivered through the Hetch Hetchy aqueducts, but also includes treated water produced by SFPUC from its local watersheds and treatment facilities in the Alameda and San Mateo counties. SFPUC has a perpetual commitment (Supply Assurance) to deliver 184 million gallons per day (mgd) to the 24 permanent wholesale customers collectively. SFPUC has allocated the Supply Assurance among the 24 permanent wholesale customers through Individual Supply Guarantee (ISG), which represent each wholesale customer's allocation of the 184 mgd Supply Assurance. Daly City's ISG is 4.292 mgd, or 4,807 acre-feet per year (afy). Table 2-1 summarizes criteria for the evaluation and design of groundwater sources.

Table 2-1. Supply Criteria

Criteria	Value\Description	Reference
Capacity		
SFPUC Individual Supply Guarantee (ISG)	4.292 mgd (or 4,807 afy)	2020 UWMP
Groundwater Well Pumping Limit [a]	3.43 mgd (or 3,842 afy)	2020 UWMP
Well Reliability		
Redundant Well Capacity	Meet capacity requirements with the largest producing well from each well field out of service	[GLUMRB]
Power Supply	Each water source should have at least two independent sources or a standby/auxiliary source (e.g. generator)	[GLUMRB]

a. Groundwater Storage and Recovery (GSR) Agreement with City of Daly City, SFPUC, City of San Bruno, and California Water Service Company (CWS) limits the pumping within the aquifer at no more than 6.9 mgd from which City's aggregated designated quantity is an average rate of 3.43 mgd..

Section 3: Piping and Appurtenances Criteria

BC used piping and appurtenances criteria to:

1. Identify existing pipes that have inadequate capacity
2. Determine the appropriate size for future piping
3. Identify pipes that the City should modify for reliability purposes.

Table 3-1 lists the capacity, operations, and reliability criteria for evaluating and designing the water system piping.

Table 3-1. Pipe Criteria

Criteria	Value\Description	Reference
Diameter		
Required size	As calculated based on flow demand to satisfy pressure, velocity, and head loss requirements listed below	[GLUMRB]
Required minimum size[a]		
Minimum (Without Hydrants)	6 inch	[GLUMRB]
Minimum (Serving Hydrants)	8 inch	City
System Pressures		
Desired Operating Range	60-80 psi	[GLUMRB]
Minimum		
At Peak Hour Demand (PHD)	40 psi	CWWS[b]
MDD with Fire Demand	20 psi	CWWS[c]
Fire Sprinkler Demand and MDD	55 psi	NFPA
Velocity (Transmission and Distribution)		
Maximum for MDD[a]	5 fps	[AWWA]
Maximum Headloss for MDD[a]		
Transmission Pipe (≥16-inch in diameter)	3 feet/1000 feet	City[d]
Distribution Pipe (<16-inch in diameter)	10 feet/1000 feet	City[d]
Reliability		
Transmission Piping (≥12-inch in diameter)	Redundant supply lines to isolated areas hydraulically wherever feasible	[GLUMRB]
Distribution Piping (<12-inch in diameter)	Looping wherever feasible	[GLUMRB]

a. *This master plan uses this criterion for proposed improvements. It is not an independent justification to replace existing facilities.*

b. *The latest edition of the California Water Works Standards (Section 64602) requires a peak-hour pressure of 40 pounds per square inch gage (psig).*

c. *Fire flow demand at the model junction varies, with a minimum residual pressure of at least 20 pounds per square inch gage (psig) except for mains directly adjacent to reservoirs.*

d. *AWWA recommends this criterion to avoid high operating costs. The cost of adding piping to meet it may exceed the benefit; therefore, it is a recommendation rather than requirement.*

e. *AWWA recommends a maximum velocity of 10 fps for fire flow with MDD due to the potential to damage pipes through water hammer and cavitation at velocities greater than 10 fps.*

Section 4: Fire Flow Criteria

The North county Fire Authority (NFCA) fire marshal determines specific fire flow requirements by building square footage and material, referencing the CFC, with requirement modified by the fire marshal at his/her discretion. However, because this information is unavailable for all existing buildings, BC assumed fire flow requirements based on discussions with the fire marshal and land use..

In the 1991 Master Plan, the fire marshal provided a map with fire flow areas ranging from 1,500 gpm to 4,000 gpm. As part of this Master Plan, BC updated that map as originally prepared, adding in Zone 9 and provided the map to the fire marshal to confirm and update any changes since the previous master plan. Where information was not available, we assumed the fire flow based on land use type as presented in Table 4-1.

Table 4-1. Fire Flow Requirements by Land Use[a]

Land Use	Fire Flow, gpm	Duration, hours
Low-Density Residential	1,000[b] (with automated sprinkler system)	1
	1,500[b] (without automated sprinkler system)	2
Multi-family	2,500	2
School/Church	3,000	3
Public/Institutional	3,000	3
Commercial/Industrial	4,000	4

Source: 1991 Master Plan and recent guidance from the fire marshal for newer projects

Section 5: Pump Station Criteria

Booster pump stations boost pressures on the discharge side of the station during specified demand conditions. Table 5-1 summarizes the pump station capacity, operations, and reliability criteria.

Table 5-1. Pump Station Criteria

Criteria	Value\Description	Reference
Minimum Capacity		
Booster Pump Station (Zone Served by Single PS)	Meets MDD with the largest pump out of service	City
Booster Pump Station (Zone Served by Multiple PSs)	Meets MDD with the single largest pump out of service	City
Reliability		
Redundancy	Each pump station should have a minimum of 2 supply pumps.	[GLUMRB]
Operations		
Minimum Suction Pressure	Maintain positive gauge pressure if suction piping is not above ground	[GLUMRB]
Control Settings	Provide adequate range between high/low pressure or tank level settings to prevent excessive cycling of the pump	[GLUMRB]

Section 6: Storage Criteria

The volume of required storage for a service area consists of three components: equalization, fire, and emergency storage. Equalization storage capacity will meet demands when they exceed supply to the system (e.g. during peak demand periods). Fire storage capacity is a reserve to supply fire demand for the duration of a fire event. Emergency storage capacity is a reserve to provide water during events such as power outages, standard maintenance procedures, natural disasters, facility failures, etc.

Table 6-1 summarizes the standards for determining the total volume needed to meet the three required components of storage capacity and guidance on storage tank operations and siting.

Table 6-1. Storage Criteria

Criteria	Value\Description	Reference
Capacity		
Equalization	25 percent of maximum day demand	City
Fire	Volume required to supply the largest needed fire flow in the system for the required fire flow duration, typically supplied by pressure zone	City
Emergency	33 percent of fire flow and equalization combined storage	City
Operations		
Water Quality	Excessive storage capacity should be avoided to prevent water quality issues	[GLUMRB]
Controls	Adequate control to maintain levels in storage tanks (e.g., pump controls, altitude valves)	[GLUMRB]

References

American Water Works Association (AWWA). (2017). AWWA Manual of Water Supply Practices, M32 Computer Modeling of Water Distribution Systems, Fourth Edition.

Building Standards Commission. (2019). California Code of Regulations (CCR).

North County Fire Authority. (2021). Daly City Fire Flow Map.

Water Supply Committee of the Great Lakes--Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (GLUMRB). (2012). Recommended Standards for Water Works, 2012 Edition.

Appendix F: Hydrant Test Results

Appendix F includes copies of hydrant test results supplied by the City.

F

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Daly City Water and Wastewater Resources
Water Operations
Fire Hydrant Flow Data

Test date:	5/1/22
Test time:	21:50
Test conducted by:	MP
Test witnessed by:	HA

Test Location

		Static psi	Pitot psi	Orifice Size
		86	42	2.5"
Permit Number	ws-			
Grid Map Series	1999	Static psi	Pitot psi	Orifice Size
Grid Map #	E-04			2.5"
Hydrant #	29			
Water Main Diameter (in.)	4" CI			
Address	90 Garwood Dr.			

Supply Zone

Reservoir #:	1
Lower pump station:	CPS
Pumps on during test:	0
Maximum storage level:	11
Minimum storage level:	8
Storage level during test:	7.5

Static /Residual Location

		Static psi	Residual psi
Grid Map Series	1999		
Grid Map #	E-04	115	112
Hydrant #	28		
Water Main Diameter (in.)	6" CI		
Address	299 Hillside Blvd		

Observed Flow At Hydrant Tested	Observed GPM Flow Flow @ 20 PSI
906	5855

Qr= Qf x (Hr^0.54/Hf^0.54)

Qr= Flow available at desired residual pressure (20 PSI).

Qf= Observed Flow= $29.83cd^2\sqrt{p}$ Where **c**=coefficient of 0.75, $\mathbf{d^2}$=orfice diameter in inches squared, and $\sqrt{\mathbf{p}}$=square root of the pitot pressure.
(Calculated observed flow during test uses a pitot diffuser conversion for back pressure equal to a 0.75 coefficient.) *See note below.

Hr= Difference between static and desired residual pressure (20 PSI).

Hf= Difference between static and actual residual pressure.

STATIC	RESIDUAL	PITOT	OBSERVED Q	Q AT 20 PSI	Hr		Hf
115	112	42	906	5855	11.69		1.81

Note: Fire systems are to be designed based on a public water main supply pressure not greater than sixty five (65) psi, regardless of the static pressures found to be greater. In cases where a fire flow is performed and the static presures are found to be lower than sixty five (65) psi then the lower pressure shall be used in the design of the fire systen. DWWR, in consultation with the Fire Department, shalll review designs not in keeping with this section.

Methods and formulas used in determining fire flow data conform to NFPA291 Recommended Practice for Fire Flow Testing and Marking of Hydrants, 1995 Edition.

Note: Observed flows were measured with a pitot diffuser and calculated to real flow based on the formula presented in the Journal of the AWWA, July, 1990, which calculates the internal diffuser pressure into flow.

Regardless of the result of the test, the City of Daly City Water/Wastewater Division assumes no liability beyond that stated in the following:

"The information was taken at a specific time and date and the utility water system varies in it's capability to meet the above criteria as a result of it's normal operation."

Greg Krauss, Chief of Operatioins

DWWR (12-9-2002 AQG) Updated (1-18-2017 AQG)

Daly City Water and Wastewater Resources
Water Operations
Fire Hydrant Flow Data

Test date:	2/12/22
Test time:	6:40
Test conducted by:	DS
Test witnessed by:	TP

Test Location

		Static psi	Pitot psi	Orifice Size
		95	35	2.5"
Permit Number				
Grid Map Series	1999	Static psi	Pitot psi	Orifice Size
Grid Map #	F-03			2.5"
Hydrant #	25			
Water Main Diameter (in.)	4"			
Address	435 Bellevue Ave			

Supply Zone

Reservoir #:	1
Lower pump station:	CPS
Pumps on during test:	None
Maximum storage level:	13
Minimum storage level:	6
Storage level during test:	10.03

Static /Residual Location

		Static psi	Residual psi
Grid Map Series	1999		
Grid Map #	F-03	102	95
Hydrant #	26		
Water Main Diameter (in.)	6"		
Address	399 Bellevue Ave		

Observed Flow At Hydrant Tested	Observed GPM Flow Flow @ 20 PSI
827	3124

Qr= Qf x (Hr^0.54/Hf^0.54)
Qr= Flow available at desired residual pressure (20 PSI).
Qf= Observed Flow= $29.83cd^2\sqrt{p}$ Where **c**=coefficient of 0.75, d^2=orfice diameter in inches squared, and $\sqrt{p}$=square root of the pitot pressure.
(Calculated observed flow during test uses a pitot diffuser conversion for back pressure equal to a 0.75 coefficient.) *See note below.
Hr= Difference between static and desired residual pressure (20 PSI).
Hf= Difference between static and actual residual pressure.

STATIC	RESIDUAL	PITOT	OBSERVED Q	Q AT 20 PSI	Hr		Hf
102	95	35	827	3124	10.80		2.86

Note: Fire systems are to be designed based on a public water main supply pressure not greater than sixty five (65) psi, regardless of the static pressures found to be greater. In cases where a fire flow is performed and the static presures are found to be lower than sixty five (65) psi then the lower pressure shall be used in the design of the fire systen. DWWR, in consultation with the Fire Department, shalll review designs not in keeping with this section.

Methods and formulas used in determining fire flow data conform to NFPA291 Recommended Practice for Fire Flow Testing and Marking of Hydrants, 1995 Edition.

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“The information was taken at a specific time and date and the utility water system varies in it’s capability to meet the above criteria as a result of it’s normal operation.”

Greg Krauss, Chief of Operatioins

DWWR (12-9-2002 AQG) Updated (1-18-2017 AQG)

Appendix G: Storage and Pump Station Analysis

Appendix G provides expanded analyses of the City Storage and Pump station analyses presented in Section 6.

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Table G-1. Existing System Storage Analysis															
Pressure Zone	Existing Storage Facilities	Existing Operational Capacity (MG)	Existing ADD (mgd)	Existing MDD (mgd)	Equalization Storage (MG)	Maximum Fireflow Required in Zone (gpm)	Fireflow Duration (hr)	Fire Storage (MG)	Emergency Storage (MG)	Total Storage Required (MG)	Zone Deficit/ Surplus (MG)	Zone Transfer Description / Recommended Storage	Zone Transfer (MG)	Proposed Storage Capacity (MG)	Surplus with Improvements and Transfers
West System															
Zone 7	Reservoir 7	1.5	0.3	0.4		4,000	4								
Zone 7 Subtotal	n/a	1.5	0.3	0.4	0.1	4,000	4	1.0	0.3	1.4	0.1				
Zone 6/6B	Reservoir 6	1.5	0.9	1.4		3,000	3								
	Reservoir 6B	1.5													
Zone 6 Reduced			0.1	0.1		3,000	3								
Zone Reduced A			0.0	0.1		1,500	2								
Zone Reduced B			0.0	0.1		4,000	4								
Zone Skyline			0.0	0.0		1,500	2								
Zone 6/6B Group Subtotal	n/a	2.9	1.1	1.6	0.4	4,000	4	1.0	0.5	1.8	1.1				
Zone 5/5B	Reservoir 5	1.5	1.0	1.5		4,000	4					PRV to Zone 3 (A St. PRV)	-1.7		
	Reservoir 5B	10.3										PRV to Zone 4 (Sullivan Ave./San Pedro Rd. PRV)	-0.4		
Zone 5/5B Subtotal	n/a	11.8	1.0	1.5	0.4	4,000	4	1.0	0.4	1.8	10.0	n/a	-2.1	0.0	7.9
Zone 4	Reservoir 4	1.4	1.0	1.5		4,000	4					PRV from Zone 5/5B (Sullivan Ave./San Pedro Rd. PRV)	0.4		
Zone 4 Subtotal	n/a	1.37	1.0	1.5	0.4	4,000	4	1.0	0.4	1.8	-0.4		0.4	0.0	0.0
East System															
Zone 2/2B	Reservoir 2	1.1	0.3	0.4		3,000	3					PRV to Zone 8 group	-0.6		
	Reservoir 2B	1.0													
Zone 2R			0.0	0.0		1,500	2								
Zone Alta Vista			0.0	0.0		1,500	2								
Zone Point Pacific			0.0	0.0		4,000	4								
Zone South Hill			0.0	0.0		1,500	2								
Zone 2/2B Group Subtotal	n/a	2.1	0.3	0.4	0.1	4,000	4	1.0	0.4	1.4	0.6	n/a	-0.6	0.0	0.1
Zone 8	Reservoir 8	0.6	0.1	0.1		4,000	4					PRV from Zone 2/2B	0.6		
Zone Bayshore 1			0.1	0.2		4,000	4					Pump from Bayshore PS	0.2		
Zone Bayshore 2			0.0	0.0		1,500	2								
Zone Bayshore 9			0.0	0.0		4,000	4								
Zone 8 Group Subtotal	n/a	0.6	0.3	0.4	0.1	4,000	4	1.0	0.3	1.4	-0.8	n/a	0.8	0.0	0.0
Zone 1	Reservoir 1	0.7	0.7	1.1		4,000	4					Pump from Citrus PS	0.9		
Zone 1 Subtotal	n/a	0.7	0.7	1.1	0.3	4,000	4	1.0	0.4	1.6	-0.9	n/a	0.9	0.0	0.0
Zone 3	Reservoir 3	0.0	0.9	1.3		4,000	4					PRV from Zone 5 (A St. PRV)	1.7		
Zone 3 Subtotal	n/a	0.0	0.9	1.3	0.3	4,000	4	1.0	0.4	1.7	-1.7	n/a	1.7	0.0	0.0
Grand Total	n/a	21.0	5.5	8.2	2.0	n/a	n/a	7.7	3.2	12.9	8.1	n/a	1.1	0.0	8.0

Table G-2. Future System Storage Analysis															
Pressure Zone	Existing Storage Facilities	Existing Operational Capacity (MG)	Future ADD (mgd)	Future MDD (mgd)	Equalization Storage (MG)	Maximum Fireflow Required in Zone (gpm)	Fireflow Duration (hr)	Fire Storage (MG)	Emergency Storage (MG)	Total Storage Required (MG)	Zone Deficit/ Surplus (MG)	Zone Transfer Description / Recommended Storage	Zone Transfer (MG)	Proposed Storage Capacity (MG)	Surplus with Improvements and Transfers
West System															
Zone 7	Reservoir 7	1.5	0.3	0.4		4,000	4								
Zone 7 Subtotal	n/a	1.5	0.3	0.4	0.1	4,000	4	1.0	0.3	1.4	0.1				
Zone 6/6B	Reservoir 6	1.5	1.0	1.5		3,000	3								
	Reservoir 6B	1.5													
Zone 6 Reduced			0.1	0.1		3,000	3								
Zone Reduced A			0.1	0.1		1,500	2								
Zone Reduced B			0.0	0.1		4,000	4								
Zone Skyline			0.0	0.0		1,500	2								
Zone 6/6B Group Subtotal	n/a	2.9	1.3	1.9	0.5	4,000	4	1.0	0.5	1.9	1.0				
Zone 5/5B	Reservoir 5	1.5	1.0	1.5		4,000	4					PRV to Zone 3 (A St. PRV)	-1.7		
	Reservoir 5B	10.3										PRV to Zone 4 (Sullivan Ave./San Pedro Rd. PRV)	-0.4		
Zone 5/5B Subtotal	n/a	11.8	1.0	1.5	0.4	4,000	4	1.0	0.4	1.8	10.0	n/a	-2.1	0.0	7.9
Zone 4	Reservoir 4	1.4	1.1	1.5		4,000	4					PRV from Zone 5/5B (Sullivan Ave./San Pedro Rd. PRV)	0.4		
Zone 4 Subtotal	n/a	1.37	1.1	1.5	0.4	4,000	4	1.0	0.4	1.8	-0.4		0.4	0.0	0.0
East System															
Zone 2/2B	Reservoir 2	1.1	0.2	0.4		3,000	3					PRV to Zone 8 group	-0.8		
	Reservoir 2B	1.0										Pump from Bayshore PS?	0.1		
Zone 2R			0.0	0.0		1,500	2								
Zone Alta Vista			0.0	0.0		1,500	2								
Zone Point Pacific			0.0	0.0		4,000	4								
Zone South Hill			0.0	0.0		1,500	2								
Zone 2/2B Group Subtotal	n/a	2.1	0.3	0.4	0.1	4,000	4	1.0	0.4	1.4	0.6	n/a	-0.6	0.0	0.0
Zone 8	Reservoir 8	0.6	0.1	0.1		4,000	4					PRV from Zone 2/2B	0.8		
Zone Bayshore 1			0.2	0.2		4,000	4								
Zone Bayshore 2			0.0	0.0		1,500	2								
Zone Bayshore 9			0.0	0.0		4,000	4								
Zone 8 Group Subtotal	n/a	0.6	0.4	0.4	0.1	4,000	4	1.0	0.3	1.4	-0.8	n/a	0.8	0.0	0.0
Zone 1	Reservoir 1	0.7	0.8	1.1		4,000	4					Pump from Citrus PS	0.9		
Zone 1 Subtotal	n/a	0.7	0.8	1.1	0.3	4,000	4	1.0	0.4	1.6	-0.9	n/a	0.9	0.0	0.0
Zone 3	Reservoir 3	0.0	0.8	1.2		4,000	4					PRV from Zone 5 (A St. PRV)	1.7		
Zone 3 Subtotal	n/a	0.0	0.8	1.2	0.3	4,000	4	1.0	0.4	1.7	-1.7	n/a	1.7	0.0	0.0
Grand Total	n/a	21.0	5.9	8.4	2.1	n/a	n/a	7.7	3.2	13.0	8.0	n/a	1.1	0.0	7.9

Pressure Zone	Existing Pumping Facilities	Pump Station Capacity (gpm)	Firm Pump Station Capacity (gpm)	Existing ADD (gpm)	Existing MDD (gpm)	Capacity Required for FF (Zones Without storage), (gpm)	Capacity Required Including Downstream Zones MDD (gpm)	Zone Deficit/ Surplus (gpm)	Zone Transfer Description / Recommended Pump Station	Zone Transfer (gpm)	Proposed Future Total Capacity (gpm)	Proposed Future Total Firm Capacity (gpm)	Surplus with Improvements and Transfers
Table G-3. Existing System Pump Station Analysis													
West System													
Zone 7	Res 6b PS	1,600	800	177	260								
Zone 7 Subtotal		1,600	800	177	260		260	540					
Zone Skyline	Skyline PS	1,784	234	21	31								
Zone Skyline Subtotal		1,784	234	21	31		31	203					
Zone 6/6B	Res 5 PS	2,030	630	653	960								
	Res 5B PS	2,740	1,040										
Zone 6 Reduced				37	55								
Zone Reduced A				34	50								
Zone Reduced B				31	45								
Zone 6/6B Group Subtotal		4,770	1,670	755	1,110		1,401	269					
Zone 5/5B	Res 4 PS	1,785	1,190	689	1,012				PRV to Zone 4 (Sullivan Ave./ San Pedro Rd.)	-886			
	A St PS	2,250	1,500						PRV to Zone 3 (A St. PS)	-218			
	Hickey PS	3,452	2,292										
Zone 5/5B Subtotal			4,982	689	1,012		2,414	2,568		-1,103			1,465
Zone 4	Westlake PS	3,525	2,580	716	1,052				PRV from Zone 5 (Sullivan Ave./ San Pedro Rd.)	886			
Zone 4 Subtotal			2,580	716	1,052		3,466	-886		886			0
East System													
Zone Bayshore 1	Allen TOs	150	150	103	151				PRV from Zone 8 (Bayshore PS PRV)	965			
	MacDonald TO	88	88										
Zone Bayshore 1 Subtotal		238	238	819	1,203		1,203	-965		965			0
Zone 8	Bayshore PS	1,000	500	48	71				PRV to Zone BSZ1 (Bayshore PS PRV)	-965			
Zone Bayshore 2				22	32				PRV from Zone 2/2B	588			
Zone Bayshore 9				13	20								
Zone 8 Subtotal		1,000	500	83	123		123	377		-377			0
Zone Alta Vista	Alta Vista PS	1,131	565	12	18	1,500	1,518						
Zone Alta Vista Subtotal		1,131	565	12	18	1,500	1,518	-953	Additional capacity required - 1000 gpm	1000			47
Zone Point Pacific	Pointe Pacific PS	6,000	3,500	11	16	4,000	4,016						
Zone Point Pacific Subtotal		6,000	3,500	11	16	4,000	4,016	-516	Deficient with firm capacity by 550 gpm. Surplus with total capacity by 2000 gpm	550			34
Zone South Hill	South Hill PS	1,900	400	5	7	1,500	1,507						
Zone South Hill Subtotal		1,900	400	5	7	1,500	1,507	-1,107	Deficient with firm capacity by 1150 gpm. Surplus with total capacity by 400 gpm	1150			43
Zone 2/2B	Res 1 PS	1,109	461	175	257				PRV to BSZ9	-588			
	Bellevue PS	395	190										
	Res 8 PS	1,300	650										
Zone 2R				1	2								
Zone 2/2B Subtotal		2,804	1,301	176	259		300	1,001		-588			413
Zone 1	Citrus PS to Zone 1	3,100	1,600	511	751								
Zone 1 subtotal			1,600	511	751		1,051	549					
Zone 3	Citrus PS to Zone 3	2,767	0	592	870				PRV from Zone 5 (A St. PS)	218			
Zone 3 subtotal[1]			0	592	870		218	-218		218			0
Grand Total	n/a	21,227	18,370	4,567	6,713		n/a	862	n/a	2,700			

Note:
[1] Citrus PS to Zone 3 is out of service and the firm capacity is 1,567 gpm, but set to 0 since out of service.

Table G-4. Future System Pump Station Analysis												
Pressure Zone	Existing Pumping Facilities	Pump Station Capacity (gpm)	Firm Pump Station Capacity (gpm)	Future MDD (gpm)	Capacity Required for FF (Zones Without storage), (gpm)	Capacity Required Including Downstream Zones MDD (gpm)	Zone Deficit/ Surplus (gpm)	Zone Transfer Description / Recommended Pump Station	Zone Transfer/ Capacity Increase (gpm)	Proposed Future Total apacity (gpm)	Proposed Future Total Firm Capacity (gpm)	Surplus with Improvements and Transfers
West System												
Zone 7	Res 6b PS	1,600	800	260								
Zone 7 Subtotal		1,600	800	260		260	540					
Zone Skyline	Skyline PS	1,784	234	31								
Zone Skyline Subtotal		1,784	234	31		31	203					
Zone 6/6B	Res 5 PS	2,030	630	887								
	Res 5b PS	2,740	1,040									
Zone 6 Reduced				50								
Zone Reduced A				50								
Zone Reduced B				45								
Zone 6/6B Group Subtotal		4,770	1,670	1,032		1,323	347					
Zone 5/5B	Res 4 PS	1,785	1,190	1,042				PRV to Zone 4 (Sullivan Ave./ San Pedro Rd.)	-861			
	A St PS	2,250	1,500					PRV to Zone 3 (A St. PS)	-217			
	Hickey PS	3,452	2,292									
Zone 5/5B Subtotal			4,982	1,042		2,365	2,617		-1,077			1,540
Zone 4	Westlake PS	3,525	2,580	1,075				PRV from Zone 5 (Sullivan Ave./ San Pedro Rd.)	861			
Zone 4 Subtotal			2,580	1,075		3,441	-861		861			0
East System												
Zone Bayshore 1	Allen TOs	150	150	234				PRV from Zone 8 (Bayshore PS PRV)	1,071			
	MacDonald TO	88	88									
Zone Bayshore 1 Subtotal		238	238	1,309		1,309	-1,071		1,071			0
Zone 8	Bayshore PS	1,000	500	71				PRV to Zone BSZ1 (Bayshore PS PRV)	-1,071			
Zone Bayshore 2				33				PRV from Zone 2/2B	710			
Zone Bayshore 9				36								
Zone 8 Subtotal		1,000	500	139		139	361		-361			0
Zone Alta Vista	Alta Vista PS	1,131	565	22	1,500	1,522						
Zone Alta Vista Subtotal		1,131	565	22	1,500	1,522	-957	Additional capacity required - 1000 gpm	1000			43
Zone Point Pacific	Pointe Pacific PS	6,000	3,500	15	4,000	4,015	-515					
Zone Point Pacific Subtotal		6,000	3,500	15	4,000	4,015	-515	Deficient with firm capacity by 550 gpm. Surplus with total capacity by 2000 gpm	550			35
Zone South Hill	South Hill PS	1,900	400	7	1,500	1,507	-1,107					
Zone South Hill Subtotal		1,900	400	7	1,500	1,507	-1,107	Deficient with firm capacity by 1150 gpm. Surplus with total capacity by 400 gpm	1150			43
Zone 2/2B	Res 1 PS	1,109	461	214				PRV to BSZ9	-710			
	Bellevue PS	395	190									
	Res 8 PS	1,300	650									
Zone 2R				45								
Zone 2/2B Subtotal		2,804	1,301	259		303	998		-710			288
Zone 1	Citrus PS to Zone 1	3,100	1,600	778								
Zone 1 subtotal			1,600	778		1,082	518					
Zone 3	Citrus PS to Zone 3	2,767	0	867				PRV from Zone 5 (A St. PS)	217			
Zone 3 subtotal[1]			0	867		217	-217		217			0
Grand Total	n/a	21,227	18,370	6,837		n/a	857	n/a	2,700			

Note:

[1] Citrus PS to Zone 3 is out of service and the firm capacity is 1,567 gpm, but set to 0 since out of service.

Appendix H: Water Demand by Pressure Zone

Appendix H provides detailed tabular information of water demand by pressure zone showing average annual, maximum day, minimum and maximum month, and peak hour demands.

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Table H-1. Demand By Zone, Scaled (gpm)						
Area	Demand by Condition (gpm)					
	Average Annual (2018)	Max Month	Min Month	Maximum Day	Peak Hour	East or West Side
City						
Unknown	41	52	34	66	102	-
Alta Vista Zone	18	20	16	25	39	Eastside
Bayshore Zone 1	120	140	109	175	273	Eastside
Bayshore Zone 2	20	22	19	28	43	Eastside
CalWater	1	1	-	1	2	-
Franciscan Reduced Zone	60	67	57	83	130	-
Pointe Pacific Booster	20	22	18	28	43	Eastside
Reclaimed	-	-	-	-	-	-
Res 1	554	616	454	770	1,202	Eastside
Res 2	150	165	137	206	322	Eastside
Res 2-Reduced	36	40	35	50	78	Eastside
Res 3	569	673	344	841	1,313	Eastside
Res 4	750	875	609	1,094	1,706	Westside
Res 5	731	949	580	1,187	1,851	Westside
Res 6	729	827	639	1,033	1,612	Westside
Res 6 Red Zone A	43	47	40	59	92	Westside
Res 6 Red Zone B	34	40	31	50	79	Westside
Res 6 Reduced	44	47	43	59	92	Westside
Res 7	211	230	204	288	449	Westside
Res 8	77	91	71	114	178	Eastside
Skyline Booster	29	31	29	39	61	Westside
South Hill HydroPneumatic	5	6	5	7	11	Eastside
Total Westside	2,571	3,048	2,176	3,810	5,943	Westside
Zone 3	569	673	344	841	1,313	Westside
Total Westside + Zone 3	3,141	3,721	2,520	4,651	7,256	
Total Eastside	1,569	1,796	1,209	2,245	3,502	Eastside
Eastside + Westside	4,141	4,844	3,385	6,054	9,445	
Unknown	41	52	34	66	102	-
Other Agencies	61	68	57	85	132	-

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Appendix I: Basis of Cost Assumptions and CIP Summary Table

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In accordance with AACE International (formerly Association for the Advancement of Cost Estimating International), this is a Class 5 estimate. Expected accuracy for Class 5 estimates typically ranges from -50 to +100 percent, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown. All costs are current for the San Francisco Bay Area Spring 2022.

I.1 Pipe

Table I-1 presents Ductile Iron pipe costs used in the analysis in dollars per linear feet ($/LF). The costs shown on the table below reflect asphalt demo/replace, dewatering, and traffic control. All pipe trenches are assumed to be backfilled with crushed rock. Pipes 8" to 12" include a hydrant every 300 feet. Costs do not include any trenchless portions or any elevated/bridge crossings.

The costs in the table do not include engineering or contingency costs, which were added separately as detailed in Section 7.1.1.

Table I-1. Unit Construction Costs – Ductile Iron Pipe Installed Cost

Pipe Size	Unit Construction Cost ($/LF)[a]
6-inch	$261
8-inch	$367
10-inch	$388
12-inch	$420

a. Assumes CL350 DI pipe, restrained. Used quote pricing from mid-2021, which is lower than current pricing but probably more realistic over the long term. (DI Pipe pricing went up 15% in 2021 per the PPI.)

I.2 CIP Summary Table

A detailed CIP summary table with cost estimates broken down by project is shown in Table I-2.

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Table I-2. CIP Summary Table

Project		Proposed Size/Diameter	Pipe Length	CIP Cost Estimate	CIP Phasing					
					Near-Term					Long-Term
					2022	2023	2024	2025	2026	2027-2033
Water system capacity improvements				$ 31,219,000	$ 2,167,000	$ 2,500,000	$ 2,459,000	$ 2,721,000	$ 2,493,000	$ 18,879,000
Fire Flow Improvements		Diameter (in)	Length (ft)	$ 12,602,000						
FF-1	Upsize 738 ft of existing 8" and 965 ft of 10" pipe to 12" diameter from Steve Couter Way to Martin Trl and Carter St.	12	1,703	$ 1,397,000	$ -	$ -	$ -	$ -	$ -	$ 1,397,000
FF-2	Upsize 1,159 ft of 6" pipe to 8" pipe on Dennis Dr. to Wessix Ct.	8	1,159	$ 797,000	$ -	$ -	$ -	$ -	$ -	$ 797,000
FF-3	Loop pipeline and connect pipe on Wembley Dr. to pipe on Hickey Blvd. Requires 225 ft of 6" pipe.	6	225	$ 135,000	$ -	$ -	$ -	$ -	$ -	$ 135,000
FF-4	Upsize 664 ft of 6" pipe to 8" pipe from El Dorado Dr. and Olcese Ct to the end of Olcese Ct.	8	664	$ 456,000	$ -	$ -	$ -	$ -	$ -	$ 456,000
FF-5-6	Rezone pipeline along Crestview Avenue and add 70 ft of 6" pipe to loop lines on Crestview ave. Upsize 394 feet of 6" pipe to 8" on Skylne Dr.	6	464	$ 313,000	$ -	$ -	$ -	$ -	$ 313,000	$ -
FF-7	Further investigation needed for this improvement project. Confirm if this particular hydrant is served by Cal-Water or Daly City.	10	2,135	$ 1,711,000	$ -	$ -	$ -	$ -	$ -	*$ 1,711,000*
FF-8-9	Combined FF-8 and FF-9. Upsize 4" pipe on Garwood Dr to 6", upsize 4" pipe on Tallwood Dr to 8".	8	935	$ 602,000	$ -	$ -	$ 602,000	$ -	$ -	$ -
FF-10	Upsize 4" pipe to 8" diameter on Westlake Ave from Willits St to San Diego Ave, and on Woodrow st. from Citrus Ave to Westlake ave.	8	1,265	$ 870,000	$ -	$ -	$ -	$ -	$ -	$ 870,000
FF-11	Upsize 6" pipe on Bellevue ave from Pope St to Waverly way to 8" pipe.	8	438	$ 301,000	$ 301,000	$ -	$ -	$ -	$ -	$ -
FF-14	Upsize 3,048 feet of 6" and 7" pipe to 8" diameter and hydrant at Ardendale Dr. and Alta Vista Way Intersection Rezone end of Ardendale Dr to be in Alta Vista zone.	8	3,129	$ 2,152,000	$ -	$ -	$ -	$ -	$ -	$ 2,152,000
FF-13	Upsize 563 ft of 6" pipe to 8" pipe on S. Hill blvd from Bloero way to Oakridge dr.	8	563	$ 387,000	$ -	$ -	$ -	$ -	$ -	$ 387,000
FF-15	5,400 ft of 4" and 6" pipe upsized to 8" diameter.	8	629	$ 3,481,000	$ 1,655,000	$ 1,826,000	$ -	$ -	$ -	$ -
Distribution system improvements		Diameter (in)	Length (ft)	$ 18,617,000						
Zone 1-update	CIP Improvements in 2022	8	85,244	$ 18,563,000	$ 211,000	$ 674,000	$ 1,857,000	$ 2,721,000	$ 2,180,000	$ 10,920,000
Zone 3-all	All zone 3 pipe improvements (excluding FF)	8	90,192	$ 54,000	$ -	$ -	$ -	$ -	$ -	$ 54,000
P-1	Break/Corrosion pipes in entire system (excluding zones 1 and 3)	8	19,337	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PSD-1930	Zone 2 small diameter pipe installed pipe prior to 1930	8	4,514	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Repair and Rehabilitation Improvements				$ 1,119,000	$ -	$ -	$ -	$ -	$ -	$ 1,119,000
PWO-2	Water distribution SCADA upgrades	n/a		$ -	$ -	$ -	$ -	$ -	$ -	$ -
PWO-3	Bayshore Zone Condition Assessment	n/a		$ 408,000	$ -	$ -	$ -	$ -	$ -	$ 408,000
PWO-4	Condition assessment on critical pipelines	n/a		$ 711,000	$ -	$ -	$ -	$ -	$ -	$ 711,000
CIP Total				$ 32,338,000	$ 2,167,000	$ 2,500,000	$ 2,459,000	$ 2,721,000	$ 2,493,000	$ 19,998,000
Annual Cost				N/A	$ 2,167,000	$ 2,500,000	$ 2,459,000	$ 2,721,000	$ 2,493,000	$ 3,333,000

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I.3 Replacement Pipe Tables

Tables I-3 and I-4 provide the lengths and diameters of existing pipes, and the corresponding sizes and lengths for the proposed replacement pipes, and their included costs for Zones Res 1 and Res 3. The costs come from Table I-1, and include the same assumptions provided in Section I.1. All lengths are rounded up to the nearest foot. Fire Flow improvement projects are not included in these tables and are given in the Fire Flow improvement project section of Table I-2.

Table I-3. Zone Res 1 Replacement Pipes

Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Capital Improvement Cost 177%	Project Schedule
Res 1 zone SD pipe prior to 1930	Pipe	3	8	20	$389	$7,901	$13,974	2022
Res 1 zone SD pipe prior to 1930	Pipe	4	8	286	$389	$111,428	$197,061	2022
Res 1 zone SD pipe prior to 1930	Pipe	2	8	303	$389	$117,867	$208,448	2023
Res 1 zone SD pipe prior to 1930	Pipe	3	8	677	$389	$263,384	$465,795	2023
Res 1 zone SD pipe prior to 1930	Pipe	2	8	2,699	$389	$1,049,911	$1,856,768	2024
Res 1 zone SD pipe prior to 1930	Pipe	2	8	1,602	$389	$623,206	$1,102,140	2025
Res 1 zone SD pipe prior to 1930	Pipe	4	8	2,353	$389	$915,392	$1,618,870	2025
Res 1 zone SD pipe prior to 1930	Pipe	2	8	808	$389	$314,312	$555,861	2026
Res 1 zone SD pipe prior to 1930	Pipe	3	8	2,361	$389	$918,611	$1,624,564	2026
Subtotal (Near-Term)				**11,109**			**$7,643,481**	
BREAK	Pipe	2	8	4,136	$389	$1,608,845	$2,845,242	2027-2033
BREAK	Pipe	3	8	629	$389	$244,651	$432,666	2027-2033
BREAK	Pipe	4	8	498	$389	$193,566	$342,322	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	2	8	3,458	$389	$1,345,299	$2,379,162	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	2	8	271	$389	$105,461	$186,507	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	2	8	644	$389	$250,441	$442,904	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	3	8	1,223	$389	$475,936	$841,694	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	3	8	1,272	$389	$494,878	$875,192	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	4	8	2,361	$389	$918,330	$1,624,067	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	4	8	606	$389	$235,629	$416,711	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	4	8	339	$389	$131,693	$232,899	2027-2033
Res 1 zone SD pipe prior to 1930	Pipe	4	8	437	$389	$170,059	$300,749	2027-2033

Table I-3. Zone Res 1 Replacement Pipes								
Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Capital Improvement Cost 177%	Project Schedule
Subtotal (Long-Term)				**15,874**			**$10,920,115**	
Res 1 zone SD pipe 1930-1950	Pipe	1	8	181	$389	$70,362	$124,434	2033 & Beyond
Res 1 zone SD pipe 1930-1950	Pipe	2	8	204	$389	$79,473	$140,548	2033 & Beyond
Res 1 zone SD pipe 1930-1950	Pipe	2	8	11,118	$389	$4,325,002	$7,648,766	2033 & Beyond
Res 1 zone SD pipe 1930-1950	Pipe	3	8	981	$389	$381,483	$674,653	2033 & Beyond
Res 1 zone SD pipe 1930-1950	Pipe	3	8	2,587	$389	$1,006,439	$1,779,888	2033 & Beyond
Res 1 zone SD pipe 1930-1950	Pipe	4	8	9,117	$389	$3,546,511	$6,272,004	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	1	8	107	$389	$41,677	$73,706	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	1	8	115	$389	$44,792	$79,215	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	2	8	45	$389	$17,427	$30,820	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	2	8	16,197	$389	$6,300,750	$11,142,877	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	3	8	63	$389	$24,358	$43,077	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	3	8	3,828	$389	$1,488,972	$2,633,247	2033 & Beyond
Res 1 zone SD pipe after 1950	Pipe	4	8	13,717	$389	$5,336,000	$9,436,716	2033 & Beyond
Subtotal (Buildout)				**58,260**			**$40,079,951**	

Table I-4. Zone Res 3 Replacement Pipes								
Description	Project Element	Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Length (ft)	Unit Cost ($/Unit)	Baseline Construction Cost	Capital Improvement Cost 177%	Project Schedule
Res 3 zone SD pipe prior to 1930	Pipe	0.75	8	78	$389	$30,397	$53,757	2027-2033
Subtotal (Long-Term)				**78**			**$53,757**	
BREAK	Pipe	2	8	4,708	$389	$1,831,524	$3,239,050	2033 & Beyond
BREAK	Pipe	4	8	1,039	$389	$404,253	$714,921	2033 & Beyond
BREAK	Pipe	6	8	710	$389	$276,014	$488,130	2033 & Beyond
BREAK	Pipe	8	8	137	$389	$53,153	$94,001	2033 & Beyond
Res 3 zone SD pipe prior to 1930	Pipe	2	8	7,851	$389	$3,054,038	$5,401,066	2033 & Beyond
Res 3 zone SD pipe prior to 1930	Pipe	3	8	208	$389	$80,822	$142,933	2033 & Beyond
Res 3 zone SD pipe prior to 1930	Pipe	4	8	6,803	$389	$2,646,243	$4,679,880	2033 & Beyond
Res 3 zone SD pipe 1930-1950	Pipe	0.75	8	78	$389	$30,397	$53,757	2033 & Beyond
Res 3 zone SD pipe 1930-1950	Pipe	1.25	8	151	$389	$58,644	$103,712	2033 & Beyond
Res 3 zone SD pipe 1930-1950	Pipe	2	8	19,192	$389	$7,465,730	$13,203,144	2033 & Beyond
Res 3 zone SD pipe 1930-1950	Pipe	3	8	1,293	$389	$503,053	$889,649	2033 & Beyond
Res 3 zone SD pipe 1930-1950	Pipe	4	8	16,761	$389	$6,519,975	$11,530,575	2033 & Beyond
Res 3 zone SD pipe AFTER 1950	Pipe	0.75	8	121	$389	$46,956	$83,042	2033 & Beyond
Res 3 zone SD pipe AFTER 1950	Pipe	1.5	8	191	$389	$74,450	$131,664	2033 & Beyond
Res 3 zone SD pipe AFTER 1950	Pipe	2	8	12,190	$389	$4,741,861	$8,385,982	2033 & Beyond
Res 3 zone SD pipe AFTER 1950	Pipe	3	8	1,736	$389	$675,254	$1,194,187	2033 & Beyond
Res 3 zone SD pipe AFTER 1950	Pipe	4	8	16,946	$389	$6,592,095	$11,658,121	2033 & Beyond
Subtotal (Buildout)				**90,115**			**$61,993,814**	

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