CITY OF EAST PALO ALTO
WATER SYSTEM MASTER PLAN

March 2023
EKI C10082.00

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Water System Master Plan

City of East Palo Alto, CA

March 2023

Prepared for:

City of East Palo Alto
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Prepared by:

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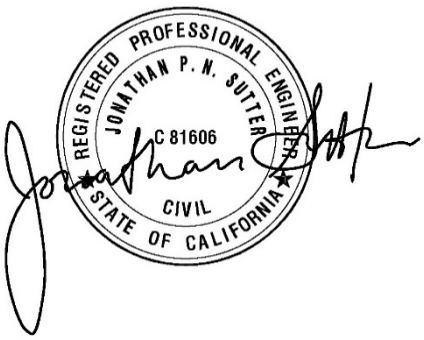

Water System Master Plan

City of East Palo Alto

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ABBREVIATIONS AND ACRONYMS

AC	asbestos cement
ADD	average day demand
BAWSCA	Bay Area Water Supply and Conservation Agency
BPS	Booster Pump Station
CCI	Construction Cost Index
CEQA	California Environmental Quality Act
CI	cast iron
CII	Commercial Industrial and Institutional
CIPs	Capital Improvement Projects
CIP	Capital Improvement Program
COVID	Coronavirus disease
CU	Cupper
DDW	Department of Drinking Water
DEM	digital elevation model
DI	ductile iron
DU	dwelling unit
ENR	Engineering News Record
ETo	reference evapotranspiration
FF	fire flow
ft	feet
FY	fiscal year
FY	fiscal year
GAL	galvanized steel
GPCD	gallons per capita per day
GPD	gallon per day
GPS	Global Positioning System
HDPE	high density polyethylene
ISG	Individual Supply Guarantee
MDD	maximum day demand
MG	million gallon
MGD	million gallons per day
NAVD 88	North American Vertical Datum of 1988
NRW	non-revenue water
OPC	opinion of probable cost
PHD	peak hour demand
PL	plastic
PRV	Pressure reducing valve
PVC	polyvinyl chloride
R&D	research and development
RBD	Ravenswood Business District
RWQCP	Regional Water Quality Control Plant
RWS	Regional Water System
SCADA	supervisory control and data acquisition
SEIR	Supplement Environmental Impact Report
SF	square feet

SFPUC	San Francisco Public Utilities Commission
SWRCB	State Water Resources Control Board
TDH	total dynamic head
TDS	total dissolved solids
TOD	Transit-Oriented Development
UNK	unknown
UWMP	Urban Water Management Plan
VFD	variable frequency drive
WSA	Water Supply Agreement
WSMP	Water System Master Plan

EXECUTIVE SUMMARY

EKI Environment & Water, Inc. (EKI) has prepared this Water System Master Plan (WSMP) Update for the City of East Palo Alto, California (City). This WSMP is intended to provide the City with an overall plan for potable water infrastructure improvements over the next 20 years to maintain water system reliability and support anticipated development within the City's service area.

Service Area Description

The City of East Palo Alto is located in the southeast corner of San Mateo County along the southwestern shore of San Francisco Bay's South Bay. The City of East Palo Alto is bound on the north by the City of Menlo Park, on the west by the City of Palo Alto, on the east by the San Francisco Bay, and on the south by sloughs leading to San Francisquito Creek and the San Francisco Bay. Highway 101, a major north-south highway, bisects the City towards its southwest border.

The City's water system is operated as a public-private partnership between the City and Veolia North America (Veolia). The City serves the majority of the City of East Palo Alto, but other independent water systems located within City limits include: (1) the Palo Alto Park Mutual Water Company and (2) the O'Connor Tract Co-operative Water Company.

The City's service area currently includes a total of 4,065 customer service connections of which 92% serve residential customers and the remainder serve commercial, industrial, institutional, and other accounts. The population in 2022 within the City's service area was estimated to be 23,646 (City of East Palo Alto, 2016 and Department of Finance, 2022). The total projected population within the City's service area is expected to increase to 33,230 by 2045.

The City has several planned development projects including the Ravenswood Business District (RBD)/4 Corners Transit-Oriented Development (TOD) Specific Plan and several other smaller development projects.

Existing Water System Facilities

The City's water supply is primarily purchased and delivered from the San Francisco Public Utilities Commission (SFPUC) Regional Water System (RWS) through three SFPUC turnouts. The City also uses a small amount of groundwater that is produced from the Gloria Way Well, owned by the City. The City owns the potable water distribution system that serves drinking water to its customers. The City's water system is operated as a public-private partnership between the City and Veolia.

The City's water distribution system consists of a single pressure zone with approximately 40 miles of distribution pipelines. Approximately 70% of the existing water mains are either 6 or 8 inches in diameter and approximately 75% are cast iron (CI) pipes. A significant portion of the City's existing distribution network (approximately 16%) consists of 4-inch diameter or smaller pipes. Figure ES-1 shows the City's service area and locations of the City's major water system facilities.

Existing and Future Water Demands

In fiscal year (FY) 2021, the City's total potable water use was 560 million gallons (MG) and per capita water use was 64 gallons per capita per day (GPCD). Since FY 2014 the City has seen significant decreases in demands, which are likely attributable to the severe drought conditions that persisted into FY 2016 and resulted in mandatory state-wide restrictions in urban water use imposed by the State Water Resources Control Board (SWRCB). Water use rebounded slightly in FY 2017 but did not return to pre-drought water use levels. Water use had been relatively stable since FY 2017 but experienced a slight reduction in FY 2022, likely due to the current drought.

Of the total potable water demand in the City's service area between FY 2016 and 2021, the residential sector accounted for approximately 72%, the commercial sector accounted for 18%, loses and other non-revenue water accounted for 9%, and the industrial and institutional/governmental sectors each accounted for approximately 1% of the total water demand. Because irrigation demands are not tracked under a separate water demand sector, water that is used for irrigation is embedded in the residential and commercial, industrial, and institutional (CII) water demands.

The City's future 2045 water demand projections are the sum of the two major components: (1) the 2040 citywide demand projections from the City's 2020 Urban Water Management Plan (UWMP) excluding the 2013 RBD/4 Corners TOD Specific Plan buildout assumptions and (2) the anticipated water demands associated with the updated RBD/4 Corners TOD Specific Plan. The City's total demand in 2045 is estimated to be between 917 MG per year to 1,169 MG per year depending on the selected buildout scenario for the RBD/4 Corners TOD Specific Plan Update.[1] Most of the anticipated increase in water demands in the City's service area is associated with the RBD/4 Corners TOD Specific Plan areas.

Water Distribution System Performance and Sizing Criteria

This section describes the recommended performance and operational criteria by which the City's water system is evaluated herein under existing and future conditions. These criteria are based on California Code of Regulations Title 22 (Title 22) requirements, the City's design and construction standards, recommendations from Menlo Park Fire District, and EKI's recommendations. These criteria are grouped into two categories: (1) criteria used to evaluate the water distribution system's performance and (2) criteria used to evaluate the sizing of the system's water facilities, including pipelines, turnouts, tanks and pump stations.

For long-term planning purposes, the Menlo Park Fire District has indicated that a minimum fire flow of 4,000 gpm for 4 hours should be available in all areas except those designated as low-density residential in the General Plan Zoning Map (City of East Palo Alto, 2017). In low-density residential areas consisting of single-family residential units, a fire flow of 1,000 gpm for 2 hours is required. These fire flows must be available in conjunction with Max Day Demand (MDD) conditions while maintaining a minimum residual pressure of 20 psi at all service connections.

These updated long-term planning fire flow requirements represent a significant increase from those assumed by the City in prior planning efforts and affect the scope and priorities of certain projects currently being planned and designed by the City.

Water Distribution System Hydraulic Model Development

EKI constructed a water system hydraulic model to assess the City's existing and planned infrastructure against the recommended performance criteria. The hydraulic model was used to evaluate capacity needs for current and future demand conditions and to complete the hydraulic assessment portion of the WSMP. As part of the hydraulic model development, EKI validated and calibrated the model by comparing the model results to system operations data and field-testing results and adjusting model parameters to meet calibration criteria.

Water Distribution System Modeling Evaluation

The City's water system was evaluated under existing demand conditions and projected future demand conditions. The future scenario includes upcoming capital improvement projects (CIPs) currently in the

[1] The City is currently preparing the RBD/4 Corners TOD Specific Plan Update and is evaluating three different buildout scenarios.

design or construction phase. These scenarios were evaluated to identify existing and projected future capacity deficiencies.

The City's water distribution system was primarily assessed according to its ability to supply required pressures under peak demand and fire flow conditions. Pipe velocity and head loss criteria were secondary criteria that indicated which pipes could be upsized to increase downstream pressures and improve water movement within the system.

Model results identified portions of the City that require improvements to meet the current fire flow requirements established by Menlo Park Fire District under both existing and future conditions. EKI developed recommended CIPs to improve fire flow availability to meet the requirements.

Water Supply and Storage Capacity Evaluation

EKI assessed the City's existing and future supply capacity, the firm supply capacity from each of its supply sources and storage tanks, to meet both peak hour demands and maximum day demands plus fire flows under existing and future conditions. The supply assessment indicated that no additional supply sources other than those currently planned are needed to meet the supply criteria.

The City currently does not have any storage facilities but is required by the State Water Resources Control Board (SWRCB) Department of Drinking Water (DDW) to add emergency and fire storage. The WSMP established storage criteria to size future storage facilities. Based on the recommended storage criteria, approximately 3.02 MG of storage is needed to support the existing system and a total of 5.20 MG of storage is needed in the future to support planned growth.

Recycled Water Projected Demand and Use Evaluation

The East Palo Alto Sanitary District provides sanitary sewer collection within the City's service area and conveys the wastewater to the City of Palo Alto's Regional Water Quality Control Plant (RWQCP). Recycled water produced by the RWQCP is suitable for non-potable uses such as landscape and agricultural irrigation, cooling towers, industrial process water, and environmental habitat enhancement (e.g., augmentation of a surface water body not used for potable water supply).

EKI identified the most significant potential recycled water users, ranked based on their annual demands. The sites identified are schools and parks that have large irrigated areas, however there may be other potential users such as large apartment complexes and construction contractors that could also utilize recycled water to a lesser degree. The total anticipated demand of the top 11 users is approximately 22 MG per year. Overall, the potential recycled water demand in the City is relatively limited (1.9% of the City's total projected demand in 2045) and would require a significant investment in new pipelines and an agreement with the City of Palo Alto to serve the top users.

Recommended Capital Improvement

Recommended CIPs were developed to support the City's water supply strategy and increase capacity to meet the recommended performance criteria. Projects were prioritized using a risk-based approach and grouped in three priority groups. The City targets completing the Priority 1 projects within the next 5-10 years, with the goal of completing the Priority 1A projects within the next 5 years. Figure ES-2 shows an overview of the recommended improvement project locations and Table ES-1 summarizes all the recommended improvement projects and their estimated planning level opinion of probable costs (OPCs).

Legend

- City of East Palo Alto's Service Area
- W — Gloria Way Well
- Existing SFPUC Turnout
- Emergency Interties
- Existing Pipe

Notes

1. All locations are approximate.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Existing Water System Facilities

City of East Palo Alto
East Palo Alto, CA
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Figure ES-1

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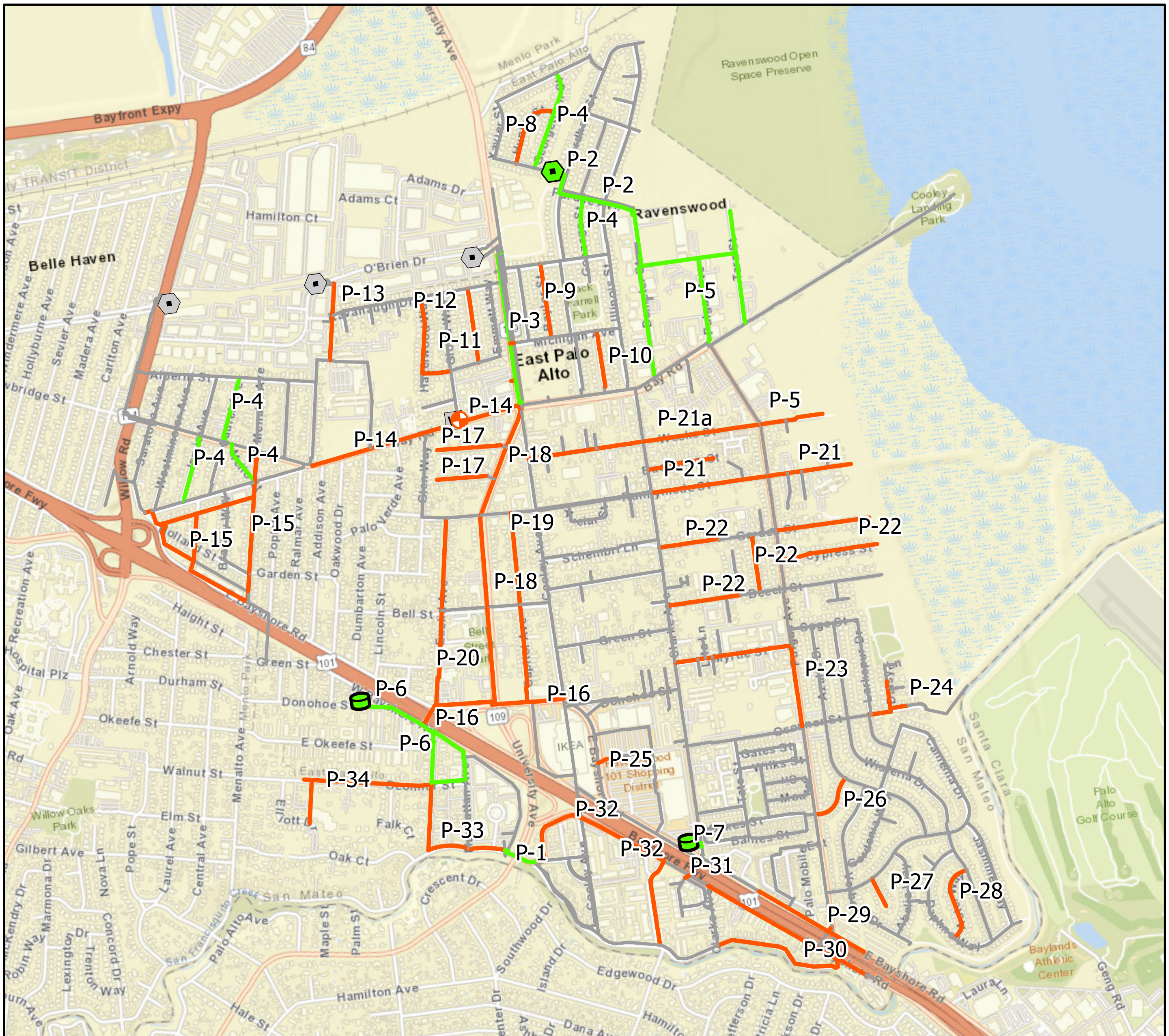

Legend

Existing Infrastructure

- Existing SFPUC Turnout
- Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- Pipe Improvement
- New SFPUC Turnout
- New Tank and Booster Pump Station

Additional Proposed Hydraulic Improvement Projects

- Pipe Improvement
- New Pressure Reducing Valve

Notes

1. All locations are approximate.

N

0 875 1,750 3,500

US Feet

Abbreviations

CIP = Capital Improvement Project

SFPUC = San Francisco Public Utilities Commission

Recommended Water System Improvements

City of East Palo Alto

East Palo Alto, CA

March 2023

EKI C10082.00

Figure ES-2

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Sources

1. Street map provided by ArcGIS online.

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TABLE ES-1
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
WD-05	Water Meter Replacement	Water Meter Replacement Program	--	--	--	Ongoing	8.0	$ 2,167,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WD-06	Hydrant Replacement	Fire Hydrant Replacement Program	--	--	--	Ongoing	12.7	$ 2,200,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WD-07	Water Valve Replacement Program	Water Valve Replacement Program	--	--	--	Ongoing	10.4	$ 1,280,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-01A/P-1	New Pipeline and Interconnection	Woodland Avenue Waterline and City of Palo Alto Interconnect Project - Install new 12" PVC on Woodland Avenue across University Avenue and new City of Palo Alto Interconnection	--	12" PVC	420	Priority 1A	16.6	$ 328,000	
P-2	New Pipeline	16-Inch Water Transmission Main Project - New 16" PVC pipeline on Purdue Avenue near Fordham St, Fordham St between Purdue Ave, and Purdue Avenue between Fordham St and Demeter St.	--	16" PVC	1,240	Priority 1A	15.9	$ 1,423,000	EKI recommends an additional interconnection near Purdue Avenue and Fordham St after the new turnout between the new 16" main and existing 6" main on Purdue Ave.
	New SFPUC Turnout	Planned Fourth Turnout on Purdue Avenue between Georgetown St and Fordham St.	--	--	--				
WS-03A	New Tank	New Storage Tank - East of Highway 101	--	--	--	Priority 1A	15.8	$ 4,700,000	Assumed to be a 1.5 MG tank with a 2 MGD pump station.
P-21a	Pipeline Replacement	Replace existing 8'' AC and 8" CI main on Weeks St between Cooley Avenue and Pulgas St with new 12" PVC main.	8'' AC and 8'' CI	12'' PVC	2,640	Priority 1A	15.8	$ 3,304,000	
WD-04B/WD-04C/P-3	New Pipeline and Pipeline Replacement	12-Inch Water Transmission Main Project (with Proposed Modifications) - Install new 12" PVC transmission main on University Avenue between O'Brien Dr and Bay Rd. Replace existing 8" CI on University Avenue between Bay Road and Donahoe St with new 12" PVC	8" CI	12" PVC	5,250	Priority 1A	15.4	$ 5,230,000	EKI recommends an additional interconnection to the 8" CI mains at Michigan Avenue and reconnection of hydrants along University to new 12" PVC. Instead of continuing on Cooley Ave as currently planned, EKI recommends replacing the existing 8" CI Pipe with new 12" PVC main on University between Bay Road and Donohoe St.
P-29	Pipeline Replacement	Replace existing 6'' CI main on E Bayshore Rd between 1805 E Bayshore (where the 12'' PVC ended) to Pulgas Ave with 12'' PVC main.	6'' CI	12'' PVC	970	Priority 1A	15.4	$ 1,290,000	
	Pipeline Replacement	Replace existing 8'' CI main on E Bayshore Rd between Pulgas Ave and the end of E Bayshore Rd to the east with 12'' PVC main.	8'' CI	12'' PVC	490				
P-32	Pipeline Replacement	Replace existing 6'' CI on Capital Ave and W Bayshore Rd between the intersection of Scofield Ave and Capital Ave to the Intersection of W Bayshore Rd and Newell Rd with 12'' PVC main.	6'' CI	12'' PVC	1,890	Priority 1A	15.4	$ 2,840,000	
	Pipeline Replacement	Replace existing 8'' CI on Newell Rd between W Bayshore Rd and Woodland Ave with 12'' PVC main.	8'' CI	12'' PVC	1,010				
P-33	Pipeline Replacement	Replace existing 8'' CI on Euclid Ave between O'Conner St and Woodland Ave and on Woodland Ave between Euclid Ave and University Ave with 12'' PVC main.	8'' CI	12'' PVC	1,640	Priority 1A	15.4	$ 1,752,000	
P-13	Pipeline Replacement	Replace existing 8" CI, 10" AC, and 10" unknown mains from connection to the 1240 O'Brien turnout on O'Brien Drive through an existing easement to Ralmar Avenue with new 12" PVC main.	8" CI, 10" AC, and 10" Unknown	12" PVC	900	Priority 1	15.4	$ 845,000	

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Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-5	Pipeline Replacement	Replace existing 10" CI main on Demeter St between 351 Demeter St and 255 Demeter St with new 16" PVC main.	10'' CI	16'' PVC	580	Priority 1	15.1	$ 7,850,000	Pipeline Improvements for the Ravenswood Business District Specific Plan
	Pipeline Replacement	Replace existing 6'' CI mains on Demeter St between 255 Demeter St and Bay Rd and on Tara St between Bay Road and North of Bay Rd with new 12" PVC main.	6'' CI	12'' PVC	3,430				
	Pipeline Replacement	Replace existing 8'' CI mains on Pulgas Ave between Bay Rd and North of Bay Rd and on Weeks St between Pulgas Ave to the deadend with new 12" PVC main.	8'' CI	12'' PVC	3,100				
	New Pipeline	Install 12'' PVC main connecting Pulgas Aveand Tara St and replace existing 10'' CI mains connecting Demeter St and Pulgas Ave.	--	12'' PVC	1,070				
P-14	Pipeline Replacement	Replace existing 8" CI main on Bay Rd from University Avenue to Ralmar Avenue with new 12" PVC main.	8" CI	12" PVC	2,450	Priority 1	15.1	$ 2,529,000	EKI recommends a setting of 40 pounds per square inch to maintain the valve closed during normal operating conditions and open during fire flow conditions.
	New Pressure Reducing Valve	Install new 8" pressure reducing valve at Gloria Way and Bay Road at the existing isolation valve that prevents short-circuiting of production from Gloria Way. The PRV would open when pressures drop during fire flow conditions.	--	--	--				
P-6	New Tank	Install new 1.5 MG steel tank at 375 Donohoe Street	--	--	--	Priority 1	Not Ranked	Developer project. No CIP cost estimated	Improvements for the Euclid Improvements Development Project per Option 3 from 23 July 2020 memorandum from BKF to Woodland Park Property Owner, LLC. Pump station recommendations by EKI. EKI Recommends 12" PVC mains instead of 12" and 14" HDPE mains for consistency with City standard pipe material.
	New Pump Station	Install new booster pump station with five new 40-hp (625 gpm) pumps at 375 Donohoe Street	--	--	--				
	Pipeline Replacement	Replace the existing pipes in the loop between W Bayshore Rd (6'' CI), Manhattan Avenue (8'' PVC), O'Connor St (8'' CI), and Euclid Avenue (8''CI) with 12'' PVC main.	6'' CI, 8'' PVC, 8'' CI	12'' PVC	1,710				
	Pipeline Replacement	Replace existing 6'' CI on W Bayshore Rd between Donohoe Avenue and Euclid Avenue with 12'' PVC main.	6'' CI	12'' PVC	470				
	New Pipeline	Install 12'' PVC main to connect the steel tank at 375 Donohoe St and the new replaced pipes in the intersection of Donohoe St and W Bayshore Rd.	--	12'' PVC	540				
P-7	New Tank	Install new 0.15 MG steel tank at the Pad D Site	--	--	--	Priority 1	Not Ranked	Developer project. No CIP cost estimated	New Pad D Fire Suppression System for Light Tree Apartments assumed to be connected to the City's distribution system. Pump station recommendations by EKI.
	New Pump Station	Retrofit booster pump station with two new 30-hp (500 gpm) pumps at Pad D Site and connect to City's distribution system at Clarke Avenue near E Bayshore Rd.	--	--	--				
WS-03B	New Tank	New Storage Tank - West of Highway 101	--	--	--	Priority 2	14.8	$ 4,700,000	Assumed to be a 1.5 MG tank with a 2 MGD pump station.
P-21	Pipeline Replacement	Replace existing 6" CI main on Buchannan Ct from Clark Ave to the deadend to the east with new 8" PVC main.	6'' CI	8'' PVC	750	Priority 2	14.4	$ 2,910,000	
	Pipeline Replacement	Replace existing 8" CI main on Runnymede St between Pulgas Ave and the deadend to the east with new 10" PVC main.	8'' CI	10'' PVC	950				
	Pipeline Replacement	Replace existing 4" CI main on Runnymede St between Clarke Ave and Pulgas Ave with new 8" PVC main.	4" CI	8'' PVC	1,330				
P-16	Pipeline Replacement	Replace existing 8" CI Highway 101 Crossing near Euclid Avenue with new 12" PVC carrier pipe (via jack and bore)	8" CI	12" PVC	250	Priority 2	14.1	$ 2,792,000	Installed via jack and bore under Highway 101.
	Pipeline Replacement	Replace existing 8" CI on Donahoe St between Euclid Avenue and Cooley Avenue with new 12" PVC	8" CI	12" PVC	1,450				

TABLE ES-1
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-30	Pipeline Replacement	Replace existing 6'' CI main on W Bayshore Rd between Clark Avenue and Woodland Ave and existing 8'' PVC on W Bayshore Rd between Woodland and 1982 W Bayshore Rd with 10'' PVC main.	6'' CI, and 8'' PVC	10'' PVC	2,200	Priority 2	13.9	$ 2,949,000	
	Pipeline Replacement	Replace existing 4'' CI and a small section of 4'' PVC main on Woodland Avenue between W Bayshore Rd and Clarke Ave with 10'' PVC main.	4'' CI and 4'' PVC	10'' PVC	1,470				
P-17	Pipeline Replacement	Replace existing 2" GS and 4" CI mains on Weeks St west of University Ave	2" GS and 4" CI	8" PVC	780	Priority 2	13.4	$ 1,148,000	
	Pipeline Replacement	Replace existing 2" GS and 4" CI mains on Sacramento St west of University Ave	2" GS and 4" CI	8" PVC	660				
P-15	Pipeline Replacement	Replace existing 4" CI, 6" CI, and 6" plastic mains on Menalto Avenue between Newbridge St and E Bayshore Road and E Bayshore Rd between Menalto Avenue and Laurel Avenue with new 10" PVC main and install new looped 10" PVC connection on Laurel Avenue between E Bayshore Rd and alley north of E Bayshore Rd.	4" CI, 6" CI, and 6" plastic	10" PVC	2,530	Priority 2	13.1	$ 3,968,000	
	Pipeline Replacement and New Pipeline Connection	Replace existing 4"CI and 6" CI mains along E Bayshore Rd between Bay Rd and alley between E Bayshore Rd and Holland St and on alley between E Bayshore Rd Laurel Avenue with new 8" PVC main.	4" CI, 6" CI, and 6" plastic	8" PVC	920				
	Pipeline Replacement	Replace existing 4" CI main on Laurel Avenue between alley south of Bay Road and alley north of E Bayshore Rd new 8" PVC main.	4" CI	8" PVC	530				
	Pipeline Replacement	Replace existing 4" CI main in alley south of Bay Road between E Bayshore Avenue and Menalto Avenue with new 8" PVC main.	4" CI	8" PVC	1,110				
P-19	Pipeline Replacement	Replace existing 6" CI main on Capital Avenue between Runnymede St and Donahoe St with new 8" PVC main.	6" CI	8" PVC	2,110	Priority 2	12.9	$ 1,852,000	
P-20	Pipeline Replacement	Replace existing 6" CI main on Euclid Avenue between Runnymede St and Donahoe St with new 8" PVC main.	6" CI	8" PVC	2,140	Priority 2	12.9	$ 1,797,000	
P-8	Pipeline Replacement	Replace existing 4" CI main on Hunter Street between Purdue Avenue and Georgetown St with new 8" PVC main.	4" CI	8" PVC	840	Priority 2	12.8	$ 760,000.00	
P-9	Pipeline Replacement	Replace existing 4" CI main on Baylor St between Notre Dame Avenue and Michigan Avenue with new 8" PVC main.	4" CI	8" PVC	910	Priority 2	12.8	$ 760,000.00	
P-10	Pipeline Replacement	Replace existing 4" CI main on Gonzaga St between Michigan Avenue and Bay Rd with new 8" PVC main.	4" CI	8" PVC	640	Priority 2	12.8	$ 556,000.00	
P-11	Pipeline Replacement	Replace existing 4" CI main on Farrington Way between Kavanaugh Dr and Ursula Way with new 8" PVC main.	4" CI	8" PVC	840	Priority 2	12.8	$ 769,000.00	
P-12	Pipeline Replacement	Replace existing 4" CI main on Hazelwood Way between Kavanaugh Dr and Ursula Way and on Ursula Way between Hazelwood Way and Gloria Way with new 8" PVC main.	4" CI	8" PVC	1,190	Priority 2	12.8	$ 1,068,000	
P-27	Pipeline Replacement	Replace existing 4" CI main on Camelia Ct from Camelia Dr to the end of the circle with new 8" PVC main.	4" CI	8" PVC	350	Priority 2	12.8	$ 353,000	

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Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-22	Pipeline Replacement	Replace existing 4" CI main on Garden St between Clarke Ave and 1004 Garden St with new 8" PVC main.	4" CI	8" PVC	690	Priority 3	12.8	$ 3,690,000	
	Pipeline Replacement	Replace existing 4'' CI and 6'' CI main on Garden St between Pulgas Ave to the dead end to the east with new 8" PVC main.	4'' CI and 6'' CI	8" PVC	1,070				
	Pipeline Replacement	Replace existing 4" CI main on Terra Villa St between Garden St and Beech St with new 8" PVC main.	4" CI	8" PVC	840				
	Pipeline Replacement	Replace existing 4" CI main on Beech St between Clarke Ave and Brentwood Ct with new 8" PVC main.	4" CI	8" PVC	620				
	Pipeline Replacement	Replace existing 6'' CI main on Cypress St between Pulgas Ave and the dead end to the east with new 8" PVC main.	6'' CI	8" PVC	1,110				
P-28	Pipeline Replacement	Replace existing 4" CI main on Aster Way between Daphne Way and Wieteria Dr with new 8" PVC main.	4" CI	8" PVC	910	Priority 3	12.8	$ 770,000	
P-26	Pipeline Replacement	Replace existing 4" CI main on Gaillardia Way between Pulgas Ave and Azalia Dr with new 8" PVC main.	4" CI	8" PVC	590	Priority 3	12.8	$ 528,000	
WS-01B	New Interconnection	Emergency Water Connects - Palo Alto Park Mutual	--	--	--	Priority 3	12.5	$ 545,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-01C	New Interconnection	Emergency Water Connects - O'Connor Tract Co-Op	--	--	--	Priority 3	12.5	$ 350,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-01D	New Interconnection	Emergency Water Connects - O'Brien Kavanaugh	--	--	--	Priority 3	12.5	$ 365,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-04	New Source	Second Groundwater Well	--	--	--	Priority 3	12.2	$ 3,100,000	
P-4	Pipeline Replacement	Replace existing 4" CI main on Jervis Avenue between Bay Rd and Newbridge St with new 8" PVC main.	4" CI	8" PVC	790	Priority 3	11.4	$ 2,713,000	P-4 includes the 2015 Water Main replacement Project. New main on Lita Ln assumed not to be included per design plans.
	Pipeline Replacement	Replace existing 4" CI main on Laurel Avenue between Newbridge St and Alberni St with new 8" PVC main.	4" CI	8" PVC	770				
	Pipeline Replacement	Replace existing 2" main on Mello St between Bay Rd and Newbridge St with new 8" PVC main.	2" GS and 4" CI	8" PVC	520				
	Pipeline Replacement	Replace existing 4" CI main on Georgetown St between Purdue Avenue and Tulane Avenue with new 8" PVC main.	4" CI	8" PVC	1,130				
	Pipeline Replacement	Replace existing 4" CI main on Gonzaga St between Purdue Avenue and Notre Dame Avenue with new 8" PVC main.	4" CI	8" PVC	700				
P-34	Pipeline Replacement	Replace existing 8'' CI on O'Conner St between 222 O'Conner St and Euclid Avenue and the 6'' CI main between 222 O'Conner St and the German American International School with 12'' PVC main.	6'' and 8'' CI	12'' PVC	1,930	Priority 3	11.4	$ 1,588,000	Project only required if City is response to provide fire flows to the school. Consider collaboration with City of Palo Alto.
P-24	Pipeline Replacement	Replace existing 6" CI main on O'Conner Rd between Larkspur Dr and 1161 O' Connor St and the 6'' CI main on Daisy Ln from O'Conner St to 421 Daisy Ln with new 8" PVC main.	4" CI	8" PVC	790	Priority 3	11.4	$ 667,000	Only portion up to existing hydrant is included but would likely want to replace entire line.
P-25	Reconnect Hydrant	Connect the two hydrant within the shopping mall at 1721 E Bayshore Rd to the existing 12'' PVC at E Bayshore Rd with a 12'' PVC main.	--	12'' PVC	110	Priority 3	11.0	$ 160,000	

TABLE ES-1
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-23	Pipeline Replacement	Replace existing 8'' CI main on Myrtle St between Clarke Ave and Pulgas Ave and on Pulgas Ave from Myrtle St to O'Conner St with new 8" PVC main.	8'' CI	8" PVC	2,260	Priority 3	8.4	$ 1,882,000	
P-31	New Pipeline Connection	Install 10'' PVC main to connect Mission Dr to W Bayshore Rd.	--	10'' PVC	60	Priority 3	8.4	$ 73,000	
				Grand Total	**9,060**			**$ 80,551,000**	

Abbreviations:
AC = asbestos cement
Ave = avenue
CI = cast iron
Cu = copper
Dr = drive
E = east
ft = feet
GAL = galvanized steel
HDPE = high density polyethylene
PL = unknown plastic
PVC = polyvinyl chloride
Rd = road
W = west

Notes:
(a) See Appendix D for the cost detail, cost includes project construction contingency, design, construction management, permitting, regulatory compliance, CEQA, and project implementation.

1 INTRODUCTION

EKI Environment & Water, Inc. (EKI) has prepared this Water System Master Plan (WSMP) Update for the City of East Palo Alto, California (City). This WSMP is intended to provide the City with an overall plan for potable water infrastructure improvements over the next 20 years to maintain water system reliability and support anticipated development within the City's service area.

1.1 Project Background

The City's prior Water System Master Plan was adopted in 2010 (Integrated Resources Management, 2010), and it identified capital improvement projects (CIPs) that included pipeline replacement, storage tank, water supply, and maintenance projects. The City has implemented a portion of these projects to date. Since the adoption of the 2010 Water Mater Plan, growth projections within the City have been updated and several new development projects have been planned. Additionally, the prior hydraulic model developed for the 2010 Water Master Plan was a skeletonized model that did not include all pipes within the system, and thus was not able to fully assess the City's water system performance.

The City identified the need for a WSMP Update to reevaluate the capacity, resiliency, and reliability of the City's distribution system and supply sources and to develop an updated Capital Improvement Program (CIP) based on the current infrastructure and planning assumptions and with improved modeling tools.

1.2 Project Scope

The scope of the WSMP includes:

- A summary and description of the City's water service area and existing water system;
- An assessment of existing and projected water demands, including a spatial allocation of demands, an assessment of peak demands, and a review of fire flow requirements;
- Establishment of performance, operational, and reliability criteria for evaluating water system capacity, and establishing criteria for identifying rehabilitation and replacement needs;
- An assessment of the City's existing and future water supply and storage capacity requirements;
- Construction, calibration, and evaluation of a new hydraulic model to assess the existing water system's ability to deliver existing and future water demands and fire flows and identify potential capital improvements to improve system operation;
- Preparation of a comprehensive system evaluation that assesses system capacity, redundancy, resiliency, rehabilitation, and replacement needs for the next 20-years;
- Verify the need, sizing, and priority for the planned water system improvements;
- Development of a risk-based capital improvement program that will prioritize future water system improvements based on identified deficiencies and existing and future needs; and
- A Citywide non-potable demand analysis to identify potential opportunities to use recycled water.

1.3 Previous Evaluations and Planning Studies

This WSMP Update updates and builds upon the City's previous planning studies including:

- Water System Master Plan (Integrated Resource Management, 2010)

- Vista 2035, East Palo Alto General Plan (General Plan; City of East Palo Alto, 2017)
- Water Supply Assessment, City of East Palo Alto, General Plan Update (Integrated Resource Management, 2015)
- City of East Palo Alto 2020 Urban Water Management Plan (EKI, 2021)
- Notice of Preparation of Supplement Environmental Impact Report (SEIR) for the Ravenswood Business District (RBD)/4 Corners Transit-Oriented Development (TOD) Specific Plan Update (RBD, 2022)
- Euclid Improvements Water Supply and Fire Flow Systems Report (BKF, 2020)
- Light Tree Apartments, Pad D Fire Suppression Systems Final Plans, prepared by Coleman Engineering (Coleman Engineering, 2021a)
- Summary of Tasks to Transition Storage Tank to City's Drinking Water System (Coleman Engineering, 2021b)
- Review of Eden Housing - Pad D Fire Suppression System Final Plans, East Bayshore Road and Clarke Avenue (EKI, 2021)
- City of East Palo Alto's Woodland Avenue Waterline and City of Palo Alto Interconnect Project, Woodland Avenue Waterline and City of Palo Alto Interconnect Project, 12-Inch Water Transmission Main project, University Ave and Cooley Ave, and 16-Inch Water Transmission Main project, Purdue Ave (Freyer & Laureta, 2014a, 2014b, 2021a, 2021b)
- Ravenswood Business District Water Main Sizing (Wilsey Ham, 2020)
- East Palo Alto Ravenswood Specific Plan Update – Wet Utility Preliminary Impact Analysis Memorandum (Draft) (Schaaf & Wheeler, 2021)
- Draft City of East Palo Alto Asset Management Plan (Harris & Associates, 2021)

1.4 Report Organization

The WSMP is organized into the following sections:

- Section 1 - Introduction
- Section 2 - Service Area Description
- Section 3 - Existing Water System Facilities
- Section 4 - Existing and Future Water Demands
- Section 5 - Water Distribution System Performance and Sizing Criteria
- Section 6 - Water Distribution System Hydraulic Model Development
- Section 7 - Water Distribution System Modeling Evaluation
- Section 8 - Water Supply and Storage Capacity Evaluation
- Section 9 - Recycled Water Projected Demand and Use Evaluation
- Section 10 - Recommended Capital Improvement
- Section 11 - References

2 SERVICE AREA DESCRIPTION

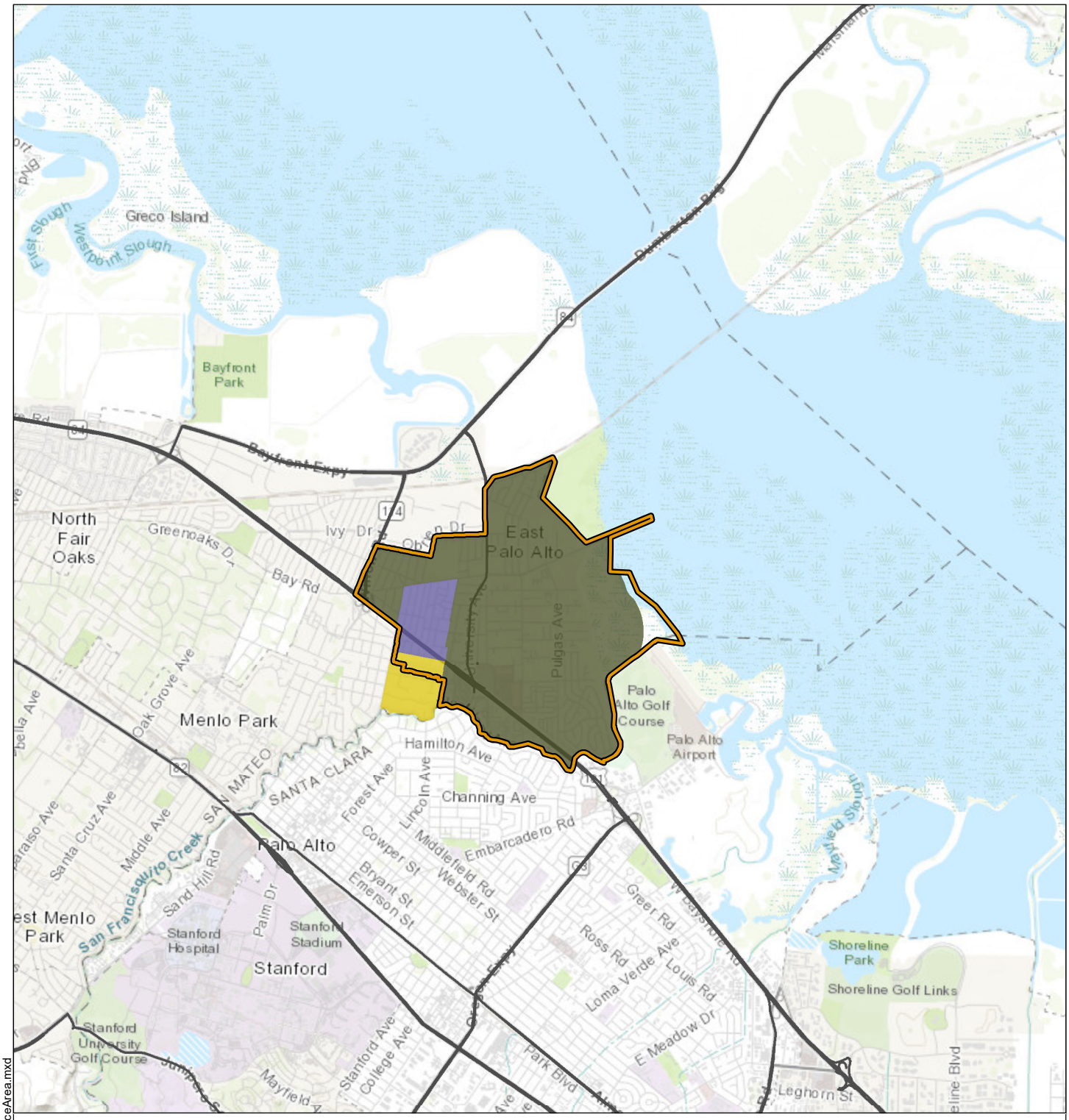
This section describes the physical characteristics of the City's water service area, as well as the current and projected population for the service area.

2.1 City Limits and Water Service Area

The City of East Palo Alto is located in the southeast corner of San Mateo County along the southwestern shore of San Francisco Bay's South Bay (see Figure 2-1). The City of East Palo Alto is bound on the north by the City of Menlo Park, on the west by the City of Palo Alto, on the east by the San Francisco Bay, and on the south by sloughs leading to San Francisquito Creek and the San Francisco Bay. Highway 101, a major north-south highway, bisects the City towards its southwest border.

Founded in 1849, East Palo Alto was part of unincorporated San Mateo County for most of its history and did not have an official boundary until its incorporation in 1983. The City's water system is operated as a public-private partnership between the City and Veolia North America (Veolia).

The City serves the majority of the City of East Palo Alto, but other independent water systems located within City limits include: (1) the Palo Alto Park Mutual Water Company, which serves customers within the western portion of the City using five groundwater production wells located within the City, and (2) the O'Connor Tract Co-operative Water Company, which serves the southwestern portion of the City using two groundwater production wells located in the City of Menlo Park.



Legend

East Palo Alto City Limit

Service Areas

- City of East Palo Alto
- Palo Alto Park Mutual Water Company
- O'Connor Tract Co-operative Water Company

Notes

1. All locations are approximate.
2. Service area data were provided by City of East Palo Alto on 12 April 2016.

Sources

Topographic base map provided by ArcGIS Online.

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Miles

City of East Palo Alto Service Area

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 2-1

eki environment & water

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2.2 Service Area Climate

The City's service area is located within a region characterized by a Mediterranean climate with cool, wet winters and warm, dry summers. As shown in Table 2-1, rainfall in the area averages 15.2 inches per year and is generally confined to the wet season from late October to early May. The average reference evapotranspiration (ETo) for the region is 44 inches per year. The ETo is a standard measurement related to the water demand by plants in a specific region. Because the average annual ETo is approximately 30 inches more than the average annual precipitation and because 90% of the annual precipitation occurs between the months of November and April, growing turf or other plantings in this region requires a significant amount of irrigation during the dry season. Although there is limited landscaping in the City's service area, the City does experience seasonal peaks in demand that are attributable to irrigation.

Table 2-1. Average Monthly Climate Characteristics

Month	Average Temperature (a)		Standard Average ETo (b) (inches)	Average Rainfall (inches)
	Min (°F)	Max (°F)		
January	38.5	57.4	1.4	3.15
February	41.3	61.1	2.0	2.89
March	43.1	64.2	3.3	2.29
April	44.7	68.4	4.4	1.02
May	48.5	72.9	5.4	0.37
June	52.5	77.4	6.0	0.09
July	54.9	78.4	6.2	0.02
August	54.8	78.4	5.4	0.05
September	52.6	78.3	4.4	0.17
October	48.0	73.0	3.1	0.73
November	42.6	64.3	1.7	1.73
December	38.2	57.8	1.2	2.70
Annual	**46.6**	**69.3**	**44**	**15.2**

Abbreviations:
ETo = reference evapotranspiration

Notes:
(a) Temperature and precipitation data are from the Western Regional Climate Center for Station #046646 PALO ALTO from 1 September 1953 to 4 June 2016.
(b) Reference evapotranspiration data for Union City station #171 are from the Department of Water Resources, California Irrigation Management Information System.

2.3 Number of Service Connections

The City's service area currently includes a total of 4,065 customer service connections. Customers in the City's service area are classified by the following categories:

- Residential: Includes single family and multi-family residential customers.
- Commercial: Includes commercial customers.
- Industrial: Includes industrial customers.

- Institutional/Governmental: Includes meters serving City sites and other institutional accounts; and
- Other: Includes fire services and temporary potable meters for construction.

The number of customer service connections in each billing classification are presented in Table 2-2 and Figure 2-2. As shown in Table 2-2 and on Figure 2-2, over 90% of the customer service connections are residential accounts.

Table 2-2. Number of Potable Water Services

Account Type	Count	Percent of Total
Residential	3,744	92%
Government	39	1.0%
Commercial	171	4.2%
Industrial	41	1.0%
Other (Fire Service)	68	1.7%
Other (Portable Meter)	2	0.05%
Total	**4,065**	**100%**

Notes:
Data were obtained from Table 3-2 of the Draft City of East Palo Alto Asset Management Plan (Harris & Associates, 2021).

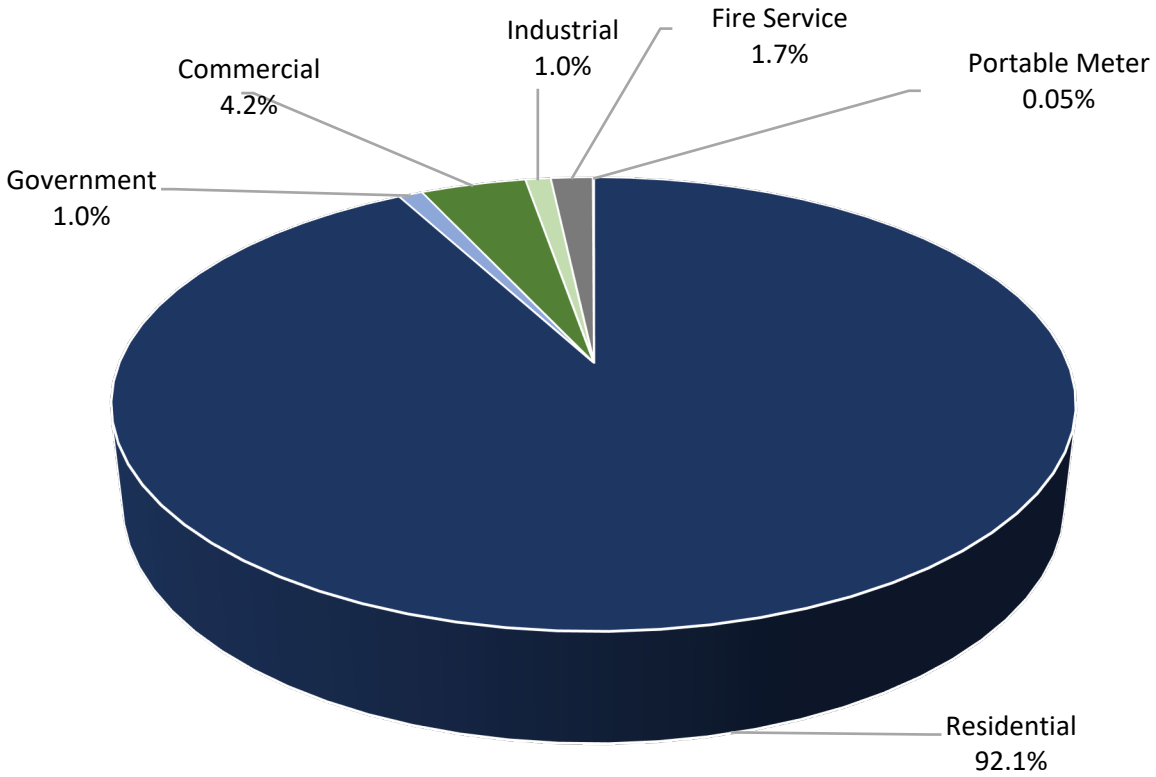

Figure 2-2. Potable Water Services by Customer Category

Table 2-3 includes the breakdown of meter sizes, which range from 5/8-inch to six-inches.

Table 2-3. Number of Potable Water Services by Meter Size

Meter Size (inches)	Count	Percent of Total
5/8	3,280	81%
3/4	257	6.3%
1	307	7.5%
1.5	51	1.3%
2	112	2.8%
3	42	1.0%
4	12	0.30%
6	4	0.10%
Total	**4,065**	**100%**

Notes:
Data were obtained from Table 3-1 of the Draft City of East Palo Alto Asset Management Plan (Harris & Associates, 2021).

2.4 Service Area Demographics

The demographics of the City's customers include a wide range of income, household size, and water demands. The City's average per capita income is lower than those of surrounding jurisdictions (Census Tract, 2021). Similar to many Bay Area cities, there is very little undeveloped land in the City for new development or parks, and therefore new housing and jobs must come from redevelopment, infill, densification, or adaptive building reuse. The City is mostly built out except for open space, marshlands, and vacant land in the Ravenswood industrial area. The densities of new developments are expected to be higher than the existing land uses they replace, which drives the population and employment growth projections presented in Section 2.6. Of the developed areas, residential use is the most common land use in the City. As described in the General Plan, most of the City's land use is residential (50%), while the remaining 50% is split between other uses, including commercial industrial and institutional (CII) (20%), parks and recreation (2%), vacant (9%), and Bayland and marshland (19%).

2.5 Specific Plans and Other Large Planned Development

The City has several approved or pending large development projects. The projects are described below and shown on Figure 2-3:

- Ravenswood Business District (RBD)/4 Corners Transit-Oriented Development (TOD) Specific Plan: The RBD/4 Corners TOD Specific Plan area is approximately 350 acres located in the northeast area of the City and represents the largest opportunity in the City for new development. The current RBD/4 Corners TOD Specific Plan (2013 Specific Plan), adopted by the City Council in 2013, includes development of up to 1.268 million square feet of office uses, 351,820 square feet of industrial or research and development uses, 112,400 square feet of retail uses, 61,000 square feet of civic/community uses, and 835 housing units (816 multifamily, 19 single-family). The City is currently undertaking a targeted update to the 2013 Specific Plan.[2] The proposed update to the 2013 Specific Plan would study increasing the total amount of development within the Specific Plan area by increasing the maximum square footages for office, research and development/life science, light industrial, civic/community, tenant amenity, and the total number of residential

[2] https://www.cityofepa.org/sites/default/files/fileattachments/planning/page/16201/nop_rbd_sp_update_-_full_version_oprcounty_clerk_4.13.22_1.pdf

units to be developed within the Specific Plan area. The updated buildout scenarios that are under consideration include a "No Project Scenario" that includes all development projects described in the 2013 Specific Plan and two additional scenarios with increased development, summarized in Table 2-4, below.

Table 2-4. Ravenswood Business District Buildout Scenarios

Scenarios	Non-Residential (square feet)						Housing Units		
	Office	R&D/ Light Industrial or Flex		Retail	Civic/ Comm	Tenant Amenity	All	Multi-family	Single-Family
Allowed Under Existing Plan	1,268,500	267,967	83,853	112,400	61,000	0	835	816	19
Reallocation	**Office**	**R&D/Lab**	**Industrial**	**-**	**-**	**-**	**-**	**-**	**-**
"No Project" Scenario	1,268,500	175,910	175,910	112,400	61,000	0	835	816	19
Buildout Scenario #1 ("Reduced")	1,835,600	988,400	250,000	112,400	154,700	43,870	1,350	1,270	80
Net Change #1	**567,100**	**812,490**	**74,090**	**0**	**93,700**	**43,870**	**515**	**454**	**61**
Buildout Scenario #2	2,167,750	1,167,250	300,000	112,400	154,700	53,500	1,600	1,472	128
Net Change #2	**899,250**	**991,340**	**124,090**	**0**	**93,700**	**53,500**	**765**	**656**	**109**
Abbreviations: R&D = research and development									

Projected demands associated with each of these scenarios are discussed in Section 6.1.5. Major planned development projects within the 2013 Specific Plan area include:

- 2020 Bay Road - Redevelopment of a 17.2-acre site at the end of Bay Road with five 8-story office buildings (including civic, retail and business support service uses), parking towers, landscaping, plaza and open spaces. The project includes approximately 1,343,292 square feet (sq ft) of retail, office, civic/community, and amenity space.
- Four Corners - Proposed mixed-use development of professional office, residential, commercial/ retail space. The project includes up to 40,000 sq ft of retail, restaurants, and community space, 180 units of mixed-income housing, and 500,000 square feet of life science/laboratory space,
- The Landing (Harvest Properties) - Proposed mixed-use development of office, commercial/ retail space. The development located in 1990 Bay Road and 1175 Weeks Street includes 870,979 sq ft office/life science space, 23,500 sq ft amenities building, and 23,521 sq ft civic/retail area, and the development located in 1103 Weeks Street includes 105,016 sq ft residential space (approximately 95 units), and 12,000 sq ft of civic space.
- East Palo Alto Waterfront Project - proposed mixed-use development of office, residential, commercial/retail space, and open space encompassing multiple sites in the RBD. The project consists of 1,300,000 sq ft of CII and 260 units of residential unit.

Other smaller projects constructed or planned in the 2013 Specific Plan area include the newly constructed East Palo Alto Center Arts, the approved 965 Weeks Street, 1201 Runnymede Street, and 1804 Bay residential developments, and the planned Job Train Office at 2535 Pulgas Ave.

- Other planned development projects outside of the RBD/4 Corners TOD Specific Plan include:
  - Light Tree Apartments at 1805 E Bayshore Rd
  - Clarum Corner at 2331 University Avenue
  - Sobrato Phase II
  - Woodland Apartment Expansion / Euclid Improvements
  - Development at 1788 East Bayshore Road
  - University Circle Phase II located at 2050 University Ave.

Other projected growth within the City's service area is assumed to be consistent with the General Plan. Water demand projections associated with these developments are discussed further in 4.2, and water infrastructure needs for the developments are evaluated in Section 7.2.

Legend

- City of East Palo Alto's Service Area
- Ravenswood Business District Parcels
- Large Planned Development

Notes

1. All locations are approximate.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Specific Plans and Other Large Planned Development

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 2-3

eki environment & water

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2.6 Current and Projected Population

The population in 2022 for the service area within City limits was estimated to be 23,646 based on the City's population and the population ratio of the City's service area and the City's boundary (City of East Palo Alto, 2016 and Department of Finance, 2022). The total projected population within the City's service area is projected to be 33,230 by 2045 according to growth projections assumed in the City's 2020 Urban Water Management Plan (UWMP), which is equivalent to an increase of 40.5% relative to the 2022 population of 23,646 or an average annual increase of approximately 1.5%.

Table 2-5. Population Projections

Population Served	2022	2025	2030	2035	2040	2045
	23,646	27,215	28,589	30,062	31,646	33,230

Notes:

(a) The current population in 2022 is based on the City's population (28,963) and the ratio of the population served by the City (25,935) and the total population within the City (31,767) for 2020 listed in the City's General Plan (City of East Palo Alto, 2016a).

(b) Projected population growth through 2040 based on City's General Plan (City of East Palo Alto, 2016a) and its associated Water Supply Assessment (IRM, 2015). Population projection for 2045 assumes the growth between 2040 and 2045 as projected between 2035 and 2040 in the General Plan (approximately 317 people per year).

Note that these population estimates do not account for the proposed updates to the RBD/4 Corners TOD Specific Plan.

3 EXISTING WATER SYSTEM FACILITIES

The City's water supply is primarily purchased and delivered from the San Francisco Public Utilities Commission (SFPUC) Regional Water System (RWS). The City also uses a small amount of groundwater that is produced from the Gloria Way Well, owned by the City. The City owns the potable water distribution system that serves drinking water to its customers. The City's water system is operated as a public-private partnership between the City and Veolia.

This section summarizes the City's water supply facilities and distribution system. A map of the City's existing water system is shown on Figure 3-1 and a hydraulic profile schematic of the City's water system is shown on Figure 3-2.

Legend

- City of East Palo Alto's Service Area
- W — Gloria Way Well
- Existing SFPUC Turnout
- Emergency Interties
- Existing Pipe

Notes

1. All locations are approximate.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Existing Water System Facilities

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 3-1

eki environment & water

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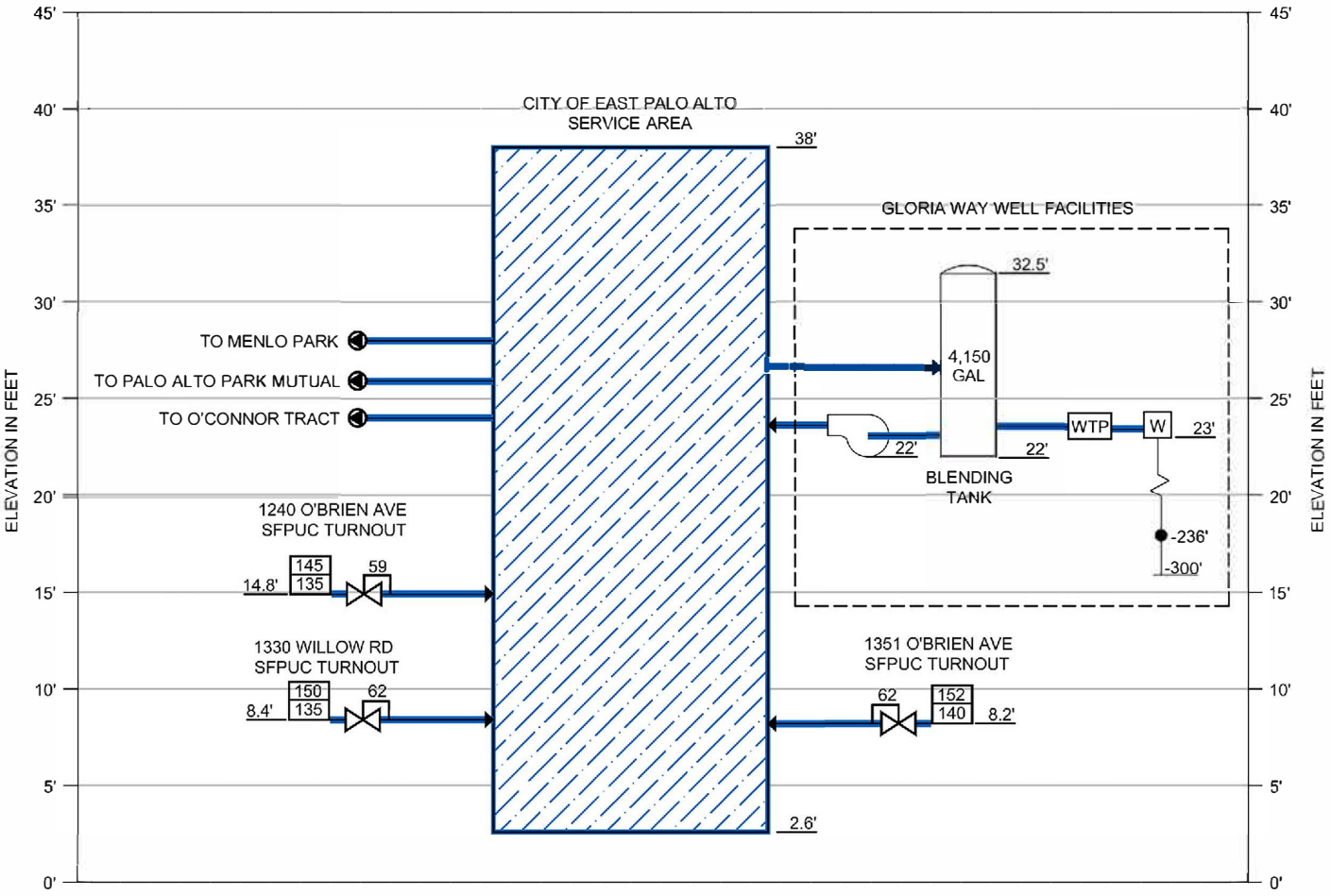

Legend:

- SFPUC Turnout with Elevation and Max. and Min. Pressure Upstream PRV (psi)
- PRV with Elevation and Pressure Settings (psi)
- Pump Station with Max. and Min. Discharge Pressure (psi) and Base Elevation
- Supply Well with Well Head, Pump, and Bottom Elevations
- WTP — Water Treatment Plant
- Tank with Volume, Base and High Water Level Elevation
- Pressure Zone with Highest and Lowest Elevation Served
- Emergency Intertie (Arrow Indicating Flow Direction)

Abbreviations:

EL = elevation
GAL = gallons
NAVD 88 = North American Vertical Datum of 1988
PRV = pressure reducing valve
psi = pounds per square inch
SFPUC = San Francisco Public Utilities Commission

Notes:

1. All elevations are approximate.
2. Elevations are based on NAVD 88.

Existing Water System Hydraulic Profile Schematic

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 3-2

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3.1 Water Supply Facilities

3.1.1 SFPUC RWS and Supply Turnouts

The City purchases most of its potable water from the SFPUC RWS in accordance with the Water Supply Agreement (WSA) between the City and County of San Francisco and Wholesale Customers in Alameda, San Mateo and Santa Clara Counties, that was approved by the SFPUC on 28 April 2009 and amended in November 2018. Approximately 85% of the water supply to the SFPUC RWS originates in the Hetch Hetchy watershed, located in Yosemite National Park, and flows down the Tuolumne River into the Hetch Hetchy Reservoir. Water from the Hetch Hetchy watershed is managed through the Hetch Hetchy Water and Power Project. The remaining 15% of the water supply to the SFPUC RWS originates locally in the Alameda and Peninsula watersheds and is stored in six different reservoirs in Alameda and San Mateo Counties. A map of the SFPUC RWS is shown on Figure 3-3, below.

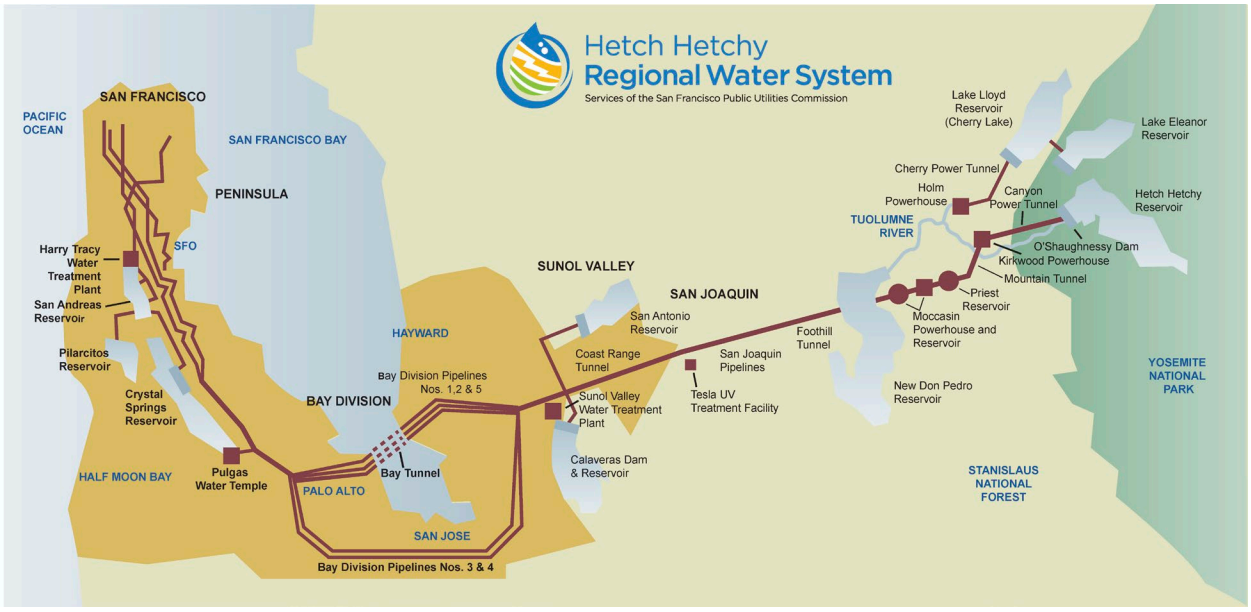


Figure 3-3. SFPUC RWS Map

(Source: Bay Area Water Supply & Conservation Agency Website)

The City receives its supply from the SFPUC RWS from three turnouts off the SFPUC's Bay Division Pipelines. As summarized in Table 3-1 and shown on Figure 3-1, the three turnouts are located at: (1) O'Brien Avenue near University Avenue (1351 O'Brien Avenue), (2) near 1240 O'Brien Avenue, and (3) at 1330 Willow Road. Pressure reducing valves (PRVs) at each SFPUC turnout downstream of the SFPUC meters reduce the pressure from approximately 140 pounds per square inch (psi) to the City's water distribution system pressure of approximately 60 psi. Veolia balances the pressure settings at the PRVs so that each turnout supplies flows during normal operating conditions.

Table 3-1. SFPUC Turnout Information

SFPUC Turnout	Meter Size (in)	Pressure (psi) at SFPUC Meter (a)			PRV (b)		
		Low	Average	High	Size (in)	Elevation (ft NAVD 88)	Setting (psi)
1351 O'Brien Avenue	6	140	146	152	10	8	62
	6						
1240 O'Brien Avenue (c)	8	135	140	145	6	15	59
	8	135	140	145	8	15	54
1330 Willow Road	6	135	144	150	6	8	62

Abbreviations

Ft = feet
In = inches
NAVD 88 =North American Vertical Datum of 1988
psi = inches
PRV = pressure reducing valve

Notes:

(a) Pressure in aqueduct at each turnout location was based on the operation data provided by the City on 22 September 2021. Pressure ranges are approximate.

(b) PRV elevations are per GPS data collected during a field visit on January 18, 2022. Settings for 1240 O'Brien are based on the recorded downstream pressure. Other settings based on calibration because gauges were determined to be inaccurate. Veolia is in process of replacing gauges.

(c) The City switches the settings between the two 1240 O'Brien PRVs on a monthly basis.

3.1.2 Groundwater Wells and Treatment Facilities

The County of San Mateo Department of Public Works constructed a groundwater well at the Gloria Way site in 1979. The well was put into operation by the City as a source of supply in 1981 and used as such until 1989 when it was taken offline due to issues with the quality of the produced groundwater (i.e., high total dissolved solids [TDS], iron, and manganese). In 2018, the City completed a well reactivation project, including pump replacement, installation of a new iron and manganese treatment system, blending system, pump station and surge tank, reconnection to the City's water distribution system, and reactivation of the well from a permitting perspective. Detailed information regarding the Gloria Way Well is included in Table 3-2, and the facility's location is shown on Figure 3-1. Veolia operates the Gloria Way Well twice a week during work hours to supplement SFPUC purchases.

The City has also taken steps towards adding a second standby well at the Pad D site, located at East Bayshore Road and Clarke Avenue. To date the City has drilled and installed a test well and completed design and California Environmental Quality Act (CEQA) documentation for a new production well and treatment system at the site.

Table 3-2. Groundwater Well Information

Well Name	Ground Surface Elevation (ft) (a, d)	Well Pump Elevation (ft)(d)	Bottom of Casing Elevation (ft) (b, d)	Designed Flow Rate (gpm) (a)	Design TDH (ft) (c)	Motor Size and Type (a)	Treatment
Gloria Way Well	23	-236	-300	150	225	25 hp VFD	Iron and manganese treatment (Pyrolusite filter), chloramination, and blending.

Abbreviations:

ft = feet
gpm = gallons per minute
NAVD 88 =North American Vertical Datum of 1988
Hp = horse power
TDH = total dynamic head
VFD = variable frequency drive

Notes:

(a) Information was per the Gloria Way Well Water Treatment Plant Design Plans.
(b) Casing elevation was per the Gloria Way Water Well Production Alternatives Analysis & East Palo Alto Water Security Feasibility Study dated November 2012.
(c) Design head was per the Grundfos pump curves for design flow rate of 100 gpm to 300 gpm, well pump VFD is operated on flow control to produce 150 gpm.
(d) Elevations are in ft NAVD 88.

3.1.3 Emergency Interties

The City has emergency intertie connections with three neighboring water purveyors: (1) Palo Alto Park Mutual Water Company, (2) O'Connor Tract Co-operative Water Company, and (3) the City of Menlo Park (i.e., Menlo Park Municipal). The City has one metered intertie with each agency for a total of three interties.[3] Each of these interties is a one-way intertie that can only deliver water from the City's distribution system to the neighboring system and cannot provide supply to the City.

The City previously had an intertie with the City of Palo Alto and is planning to construct new two-way interties with City of Palo Alto, Palo Alto Park Mutual Water Company, and O'Connor Tract Co-operative Water Company in the future that could serve the City. Two-way emergency interties would assist the City in meeting its supply needs when there is a disruption to its normal supply sources.

3.2 Water Distribution System Facilities

3.2.1 Pressure Zones and Pressure Reducing Valve Stations

The City's distribution system consists of a single pressure zone. System pressures are regulated via the PRVs at the three SFPUC turnouts, described in Section 3.1.1. At the turnouts, pressures are approximately

[3] The City has seven additional unmetered interties with Menlo Park that consist of normally closed isolation valves between the two systems.

60 psi and vary throughout the system depending on elevation and demand conditions. Pressures typically range between approximately 39 psi and 62 psi during normal operating conditions. As shown in Table 3-3 and on Figure 3-2, elevations in the City's distribution system range from 2.6 ft NAVD 88 to 38 ft NAVD 88.

Table 3-3. Pressure Zone Information

Pressure Zone	Service Connection Elevations (ft) (a)	
	Min	Max
1	2.6	38

Abbreviations:
ft = feet NAVD 88 =North American Vertical Datum of 1988

Notes:
(a) Elevations are in ft NAVD 88.

3.2.2 Water Storage Facilities

Potable water storage facilities are typically used within distribution systems to meet peak demands and provide emergency and fire flow storage. The City's distribution system currently does not include any water storage facilities. Peak demands and fire flows are met through supplies from the SFPUC RWS. The City is currently required by the State Water Resources Control Board (SWRCB) Department of Drinking Water (DDW) to install storage facilities to meet emergency and fire flows.[4]

Updated storage criteria were developed as part of this WSMP Update and are summarized in Section 5.2.2. Based on these criteria, an evaluation to determine the required storage volume is presented in Section 8.

3.2.3 Booster Pump Stations

The City's distribution system contains a single booster pump station located at the Gloria Way Well facility. The booster pump station pumps into the distribution system from the facility's blending tank, which is used to blend water from SFPUC and the groundwater produced from the Gloria Way Well. Additional information regarding the booster pump and blending tank is provided in Table 3-4.

[4] State Water Resources Control Board, Division of Drinking Water, 2017 Sanitary Survey, dated 12 October 2017.

Table 3-4. Booster Pump Station and Blending Tank Information

Booster Pump Station	Pump No.	Design Head (ft)(a)	Design Flow (gpm)(a)	Horsepower (Hp) and Type (a)	Pump Station Firm Capacity (gpm) (b)	Elevation (ft) (b)	Backup Power	Blending Tank			
								Volume (gal)	Base Elevation (ft NAVD 88)	Overflow Height (ft)	Dia. (ft)
Gloria Way Well Station (c, d)	1	224	323	30 Hp VFD	646	23	Yes	4,150	22	9.5	8.5
	2	224	323	30 Hp VFD		23					
	3	224	323	30 Hp VFD		23					

Abbreviations:

ft = feet
gal = gallon
gpm = gallons per minute
NAVD 88 =North American Vertical Datum of 1988
Hp = horse power

Notes:

(a) Source: 11211 Packaged Vertical Multi-Stage Inline Pumps data sheet, provided by R.F. MacDonald Co, dated 23 May 2017.
(b) Firm capacity the total capacity with the largest pump out of service. However, Veolia operates the booster pump station with the variable frequency drive to maintain flows at 500 gpm when the Gloria Way Well system is online.
(c) Source: Gloria Way Well Water Treatment Plant Design Plans.
(d) The Booster Pump Station also includes a surge tank on site.

3.2.4 Water Mains and Other Distribution System Features

The City's existing water distribution network consists of approximately 40 miles of pipe ranging from 2-inch diameter and smaller service mains to 16-inch diameter transmission mains. As shown in Table 3-5, approximately 70% of the existing water mains are either 6 or 8 inches in diameter and approximately 75% are cast iron (CI) pipes. The remaining pipes are primarily polyvinyl chloride (PVC), which is the City's current standard pipe material. A significant portion of the City's existing distribution network (approximately 16%) consists of 4-inch diameter or smaller pipes.

Table 3-5 summarizes the City's distribution pipelines by diameter and material. Distribution system pipe sizes are shown on Figure 3-4 and materials are shown on Figure 3-5.

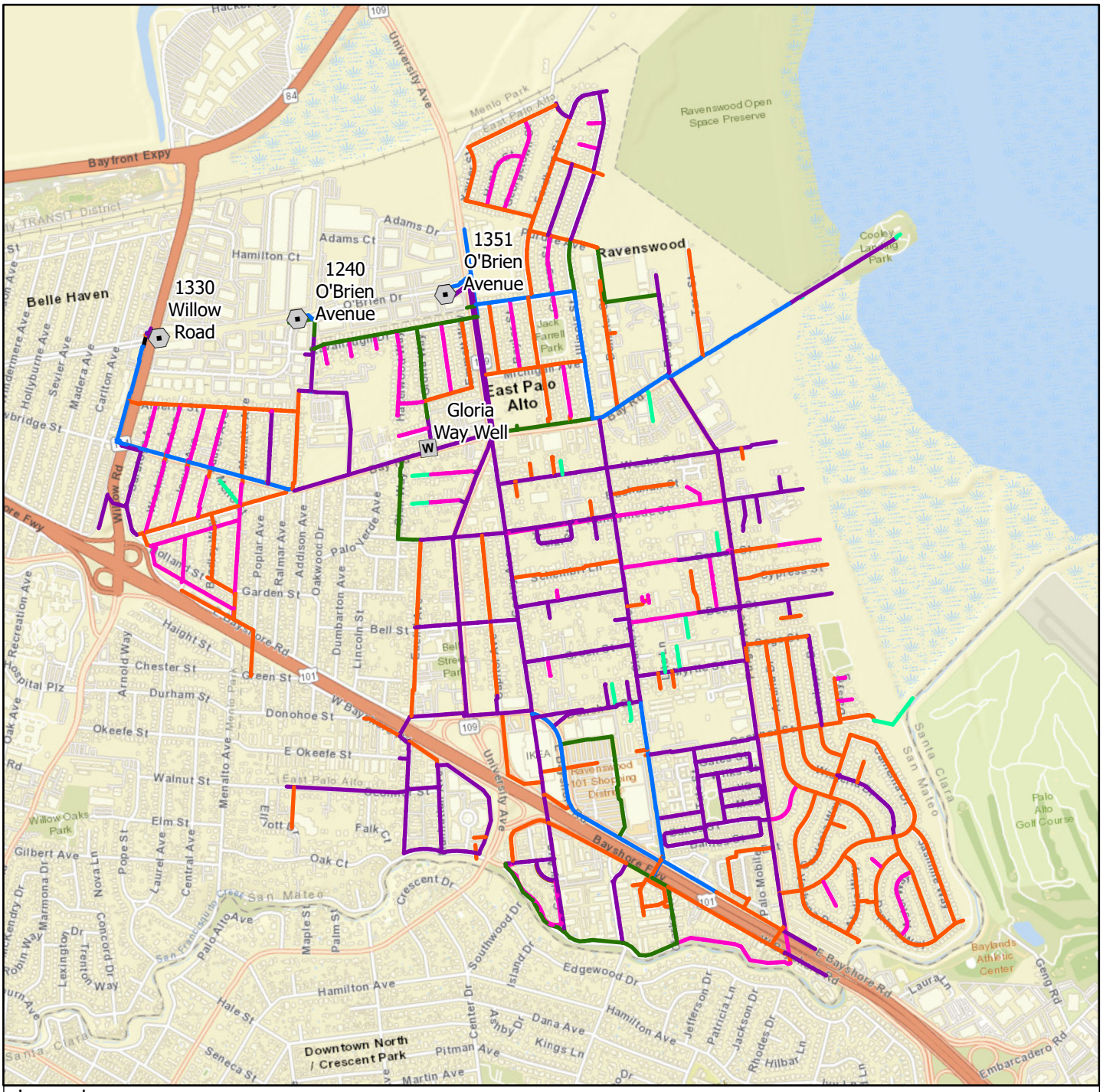
The City's distribution system also contains valves, blow offs, air release valves, hydrants, service connections, meters, and other appurtenances necessary to reliably operate the system.

Table 3-5. Pipeline Lengths by Diameter and Material

Pipe Dia. (in)	Length (ft) (a)									Total Length (miles) (b)	Percent of Water System
	AC	CI	CU	DI	GAL	PL	PVC	HDPE	UNK		
≤2	0	0	1,161	0	1,426	220	58	0	784	0.7	1.7%
3	0	0	0	0	334	0	0	0	0	0.06	0.16%
4	376	29,439	0	79	0	0	242	0	12	5.6	14%
6	483	63,106	0	35	0	1,012	1,267	0	1,402	12.7	32%
8	1,871	50,112	0	224	0	0	25,447	291	1,214	14.6	38%
10	1,518	9,049	0	26	0	0	2,992	0	404	2.4	6.6%
12	2,529	5,935	0	135	0	0	6,345	0	1,375	2.6	7.7%
14	0	0	0	0	0	0	0	0	136	0.03	0.06%
16	0	0	0	40	0	0	0	0	0	0.01	0.02%
Total (miles) (b)	**1.3**	**30**	**0.2**	**0.1**	**0.3**	**0.2**	**6.9**	**0.1**	**1.0**	**40.0**	**-**
Percent	**3.2%**	**75%**	**0.6%**	**0.3%**	**0.8%**	**0.6%**	**17%**	**0.1%**	**2.5%**	**-**	**100%**

Abbreviations:
AC = asbestos cement
CI = cast iron
Cu = copper
DI = ductile iron
ft = feet
GAL = galvanized steel
HDPE = high density polyethylene
in = inches
PL = unknown plastic
PVC = polyvinyl chloride
UNK = unknown

Notes:
(a) Pipeline lengths, diameters, and material includes all active potable water transmission and distribution pipelines are provided by the City and Veolia and updated by EKI based on as-built records.
(b) Totals and percentages may not sum due to rounding.



Legend

- Existing SFPUC Turnout
- Gloria Way Well

Existing Pipe Diameter (inches)

- 1 - 2
- 3
- 4
- 6
- 8
- 10
- 12
- 14-16

Notes

1. All locations are approximate.

Sources

1. Aerial base map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Existing Water Main Sizes

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 3-4

eki environment & water

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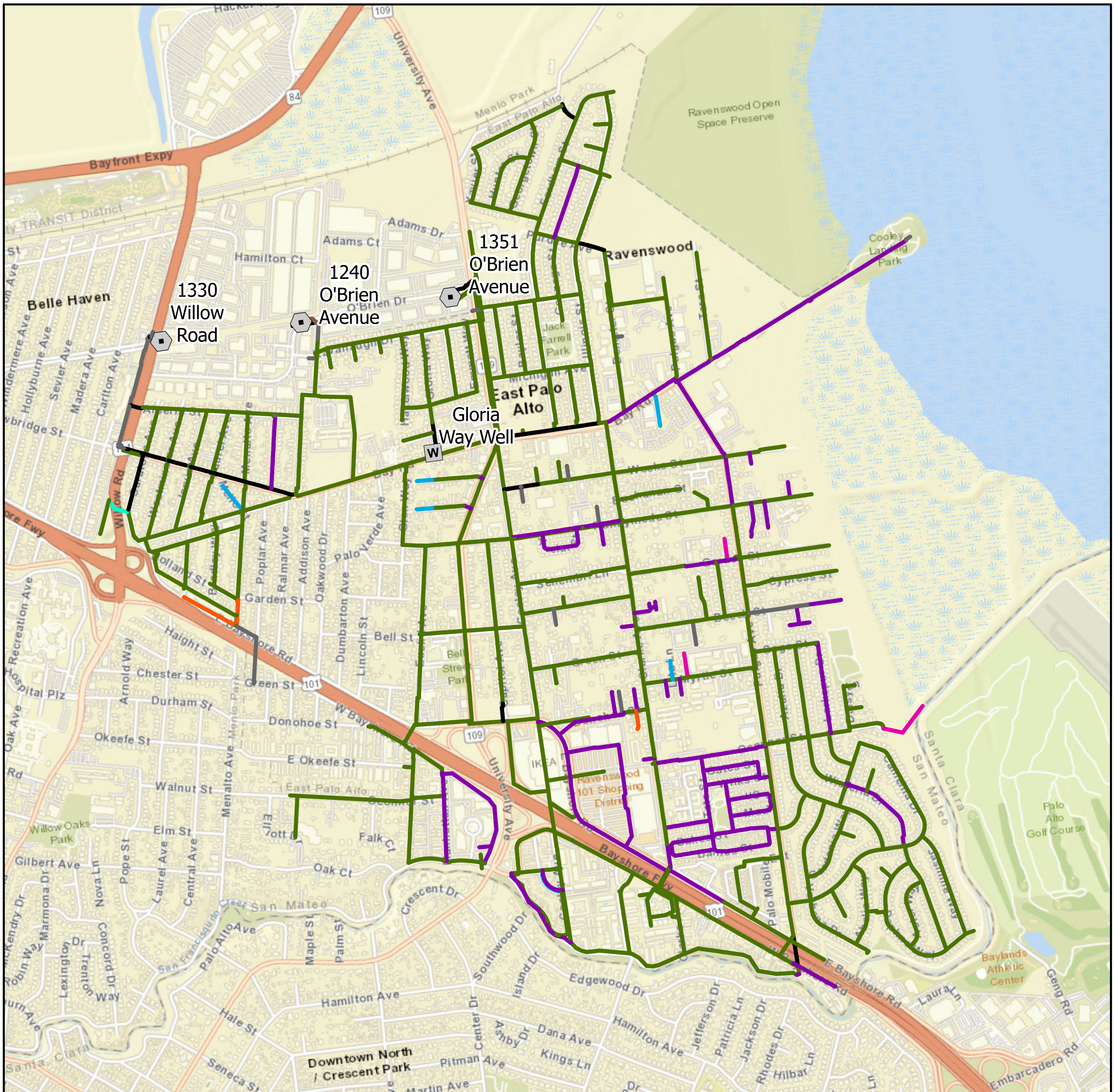

Legend

Existing SFPUC Turnout

Gloria Way Well

Existing Pipe Materials

- Unknown
- Asbestos Cement
- Cast Iron
- Copper
- Ductile Iron
- Galvanized Iron
- High Density Poly Ethylene
- Polyvinyl Chloride
- Plastic

Notes

1. All locations are approximate.

Sources

1. Aerial base map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Existing Water Main Materials

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 3-5

eki environment & water

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3.3 Planned Water System Improvements

The City has several upcoming water system improvement projects currently in the planning, design, or construction phase, including:

- 12-Inch Water Transmission Main Project, University Avenue and Cooley Avenue: Project to install a parallel 12-inch PVC transmission main along University Avenue and Cooley Avenue between O'Brien Drive to Donohoe Street (design completed). This is currently in the City's 2-year CIP.
- Woodland Avenue Waterline and City of Palo Alto Interconnection Project: Project to install a new 12-inch PVC main on Woodland Avenue across University Avenue to connect the east and west portions of the distribution south of Highway 101 and install a new emergency intertie with the City of Palo Alto at Woodland Avenue and University Avenue (design completed). This is currently in the City's 2-year CIP.
- Fourth SFPUC Turnout at Purdue Avenue and 16-Inch Water Transmission Main Project at Purdue Avenue: Project to install a new SFPUC turnout on Purdue Avenue between Georgetown Street and Fordham Street (design and coordination with SFPUC ongoing) and install a new 16-inch PVC transmission main from the proposed fourth SFPUC Turnout on Purdue Avenue near Fordham Street, along Fordham Street between Purdue Avenue, and along Purdue Avenue between Fordham Street and Demeter Street (design completed).
- Pad D Tank and Booster Pump Station: Project to install a new 0.15 MG steel tank and booster pump station at the Pad D Site at East Bayshore Road and Clark Avenue. The tank and booster pump station are currently designed as a dedicated fire suppression system for the new Light Tree Apartments, located on East Bayshore Road east of Clarke Avenue. In the future, after distribution system improvements are completed to improve fire flow availability at the Light Tree Apartments, the facilities will be deeded to the City and the booster pump station will be retrofitted with two new 30-hp (500 gpm) pumps and connect to the City's distribution system (planning completed).
- Water system improvements to support the Euclid Improvements: Several water system improvements have been proposed by the developer of the Euclid Improvements project (planning and design in progress):
  - Install a new 1.5 MG steel tank and a new 4,000 gpm fire pump at 375 Donohoe Street (Donohoe Tank).
  - Replace the existing pipes in the loop between W Bayshore Rd (6-inch CI), Manhattan Avenue (8-inch PVC), O'Connor St (8-inch CI), and Euclid Avenue (8-inch CI) with new 12-inch HDPE mains.
  - Replace existing 6-inch CI on W Bayshore Rd between Donohoe Avenue and Euclid Avenue with 14-inch HDPE mains.
  - Install a new 14-inch HDPE main along Donohoe Street between the new pump station at 375 Donohoe Street and West Bayshore Road.
- Water system improvements to support the RBD/4 Corners TOD Specific Plan: Several water system improvements have been proposed by the developers of the RBD/4 Corners TOD Specific Plan development projects (planning in process):
  - Replace existing 10-inch CI main on Demeter Street between 351 Demeter Street and 255 Demeter Street with a new 16-inch PVC main. This improvement has been designed.

  - Replace existing 6-inch CI mains on Demeter Street between 255 Demeter Street and Bay Road and on Tara Street north of Bay Road with new 12-inch PVC mains.
  - Replace existing 8-inch CI mains on Pulgas Avenue north of Bay Rd and on Weeks St from Pulgas Ave east to the dead end with new 12-inch PVC mains.
  - Install new 12-inch PVC mains to connect the new mains on Demeter Street and Pulgas Avenue North of Bay Road and replace existing 10'' CI mains connecting Demeter St and Pulgas Ave. These improvements are currently being designed as of June 2022.

- 2015 Water Main Replacement Project: The City completed design of a water main replacement project described below in 2015, but construction has not yet been completed:
  - Replace the existing 4-inch CI main on Jervis Avenue between Bay Road and Newbridge Street with a new 8-inch PVC main.
  - Replace the existing 4-inch CI main on Laurel Avenue between Newbridge Street and Alberni Street with a new 8-inch PVC main.
  - Replace the existing 2-inch main on Mello Street between Bay Road and Newbridge Street with a new 8-inch PVC main.
  - Replace the existing 4-inch CI main on Georgetown St between Purdue Avenue and Tulane Avenue with new 8-inch PVC main.
  - Replace the existing 4-inch CI main on Gonzaga Street between Purdue Avenue and Notre Dame Avenue with a new 8-inch PVC main.
- Second Groundwater Well (Pad D Well or other location): Proposed construction of a 500 gallon per minute (gpm) emergency groundwater well and associated iron-manganese treatment system to supplement the City's existing water supply. This project will create an emergency source of water supply for the City by drawing groundwater from the Santa Clara Valley Groundwater Basin and San Mateo Sub-Basin. Treatment of the groundwater would be necessary to enable its use for domestic purposes. The estimated project timeline is currently unknown and expect to occur beyond fiscal year (FY) 2030 (City of East Palo Alto, 2020).
- The City has two projects in its existing CIP to construct new storage tanks east of Highway 101. No tank locations have been identified to date besides the tanks planned for the Euclid Improvements and the Pad D Tank, described above.

As part of the modeling evaluation summarized in Section 7 and the supply and storage evaluations summarized in Section 8, EKI verified the need and proposed sizing and proposed modification, as appropriate, for each of these projects.

4 EXISTING AND FUTURE WATER DEMANDS

The following sections summarize the City's historical and current water demands, water demand projections, and water peaking factors.

4.1 Current and Historical Water Production and Consumption

All demands within the City's service area are currently met with potable water. The current and historical total water demands include the water consumed by metered accounts in the service area (metered water consumption) and the water that is lost within the distribution system or otherwise unaccounted for (i.e., losses).

Table 4-1, Figure 4-1, and Figure 4-2 show the City's potable water demand and per capita water use between FY 2010 and FY 2021. Before the 2013-2016 drought, the City's total per capital potable water use was about 80 gallons per capita per day (GPCD). The drought then caused local and state agencies (i.e., the State Water Resources Control Board [SWRCB]) to issue mandatory water use restrictions which led to a significant decline in water use. The City saw a 28.8% reduction between 2013 and 2016 for the compliance period of June through December.[5] The per capita water demand in 2016 of 57 GPCD was a ten-year low between 2012 and 2021. Water use rebounded slightly in FY 2017 but did not return to pre-drought water use levels. Water use had been relatively stable since FY 2017 but experienced a slight reduction in FY 2022, likely due to the current drought (City of East Palo Alto, 2022a).

[5] SWRCB, Water Conservation Portal - Conservation Reporting; June 2015 - December 2015 Cumulative Savings and Urban Water Supplier Conservation Compliance Dataset and June 2014 - December 2015 Urban Water Supplier Report Dataset: http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml

Table 4-1. Historical and Current Potable Water Demand and Population

Fiscal Year	Potable Water Demand	Service Area Population	Per Capita Potable Water Use (GPCD) (b)
2010	630	22,916	75
2011	646	22,991	77
2012	679	23,170	80
2013	756	23,465	88
2014	607	23,562	71
2015	573	24,424	64
2016	514	24,726	57
2017	550	25,028	60
2018	566	25,331	61
2019	556	25,633	59
2020	572	25,935	60
2021(a)	560	24,021	64

Abbreviations:
GPCD = gallon per capita per day

Notes:
(a) The population in 2021 is based on the City's population (29,423) and the 2020 population ratio of the population served by the City (25,935) and total population within the City (31,767).
(b) Per capita potable water demand is calculated by dividing the total annual potable water demand by the service area population and the number of days in a year.

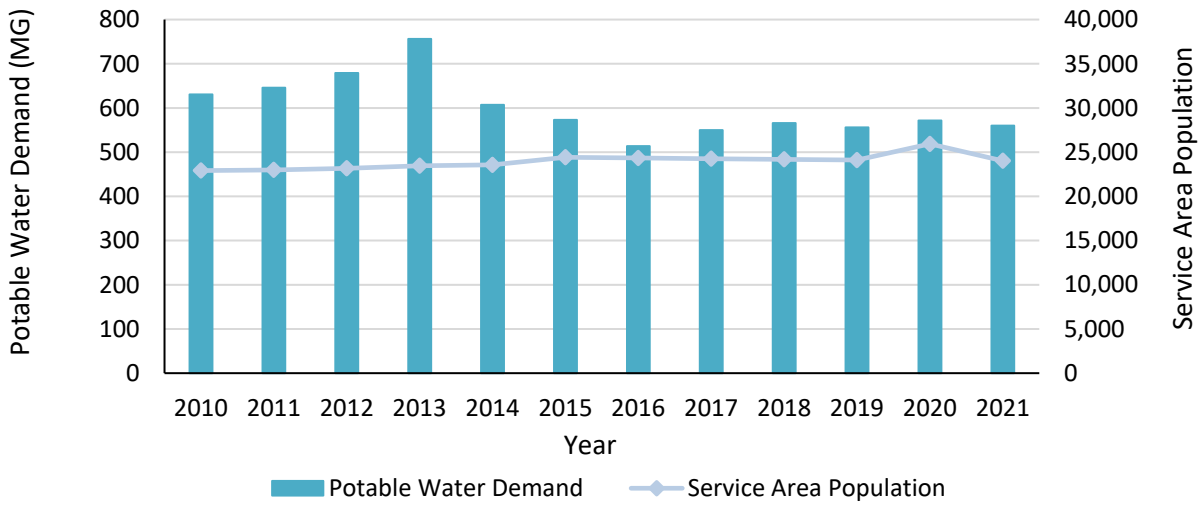


Figure 4-1. Historical and Current Potable Water Demand and Population

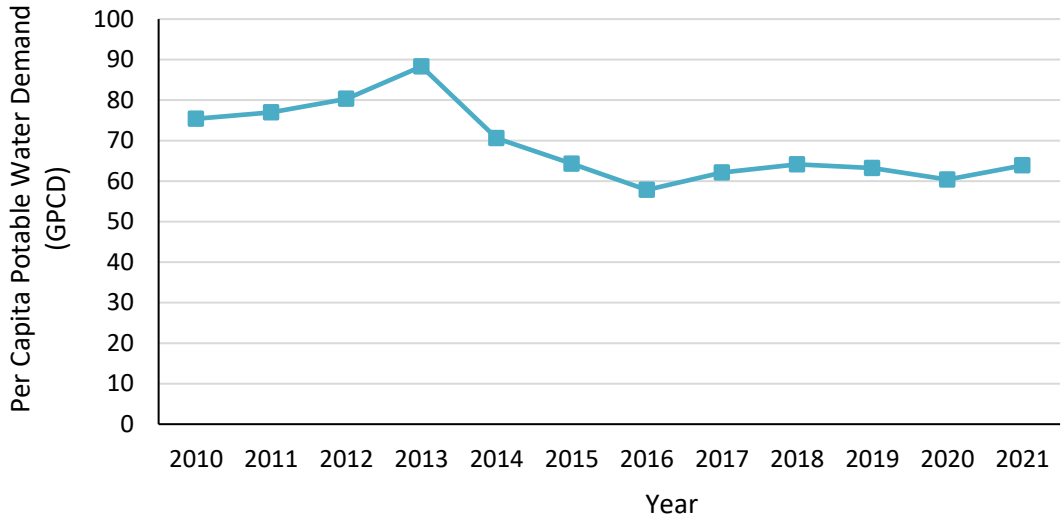


Figure 4-2. Historical and Current Per Capita Potable Water Use

The City's current and historical potable water use between FY 2016 and 2021 is presented Table 4-2, Figure 4-3, and Figure 4-4 by customer sectors. The residential sector accounted for an average of approximately 72% of the potable water demand in the City's service area between FY 2016 and 2021. The City's commercial, industrial, and institutional (CII) accounts accounted for approximately 20% of potable water demand for the 2016-2021 period. The commercial sector accounted for most of the City's CII demand (18% of the total water demand), while the industrial and institutional/governmental sectors each accounted for approximately 1% of the total water demand. Since irrigation demand is not tracked as a separate water demand sector, water that is used for irrigation is embedded in the residential and CII water demands.

Table 4-2. Current and Historical Potable Water Use by Customer Category

Use Type	Volume (MG) (b)					
	FY2016	FY2017	FY2018	FY2019	FY2020	2021
Single Family (a)	460	374	369	366	400	400
Commercial	51	89	96	157	98	89
Industrial	0	6	6	5	5	2
Institutional/Governmental	0	7	7	11	10	8
Losses (c)	3	73	84	16	58	60
Fire Service	0	1	0	0	1	1
Other	0	0	4	1	0	1
TOTAL	**514**	**550**	**566**	**556**	**572**	**560**

Abbreviations:
FY = fiscal year MG = million gallon

Notes:
(a) Single-family demand includes total residential water demand. The City's projected water demands do not specify demands between single-family and multi-family.
(b) Water demand was provided through various City records. Water demand for FY 16, 17, and 18 was recorded in the DSS Model and water demand for FY19, 20 and 21 were provided by Veolia.
(c) Losses are estimated as the difference between total demand and metered consumption, and thus includes unmetered water consumption and distribution system water losses.

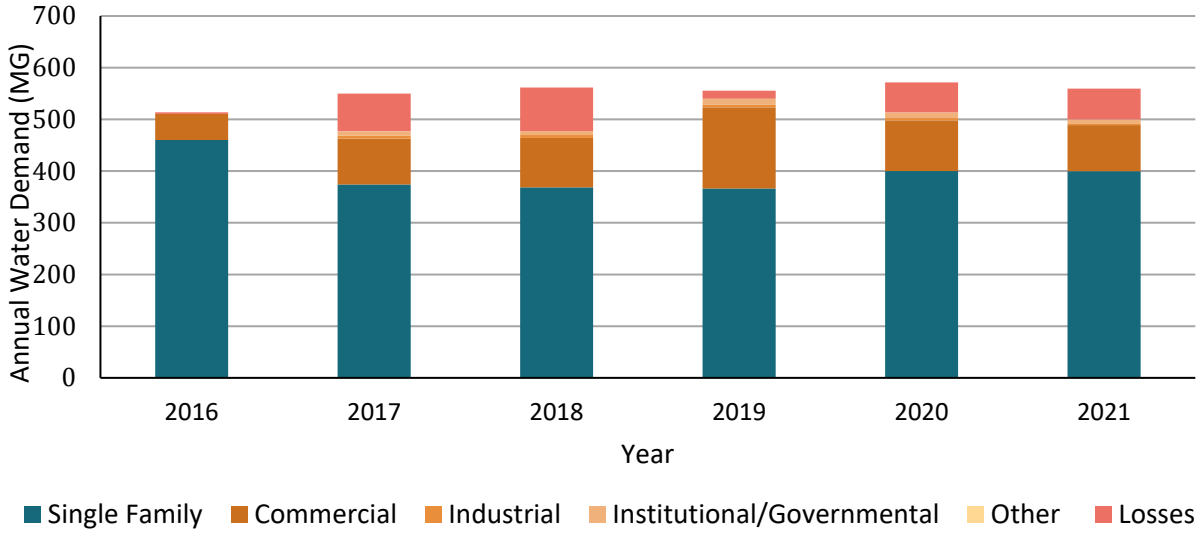


Figure 4-3. Annual Water Demand by Sector

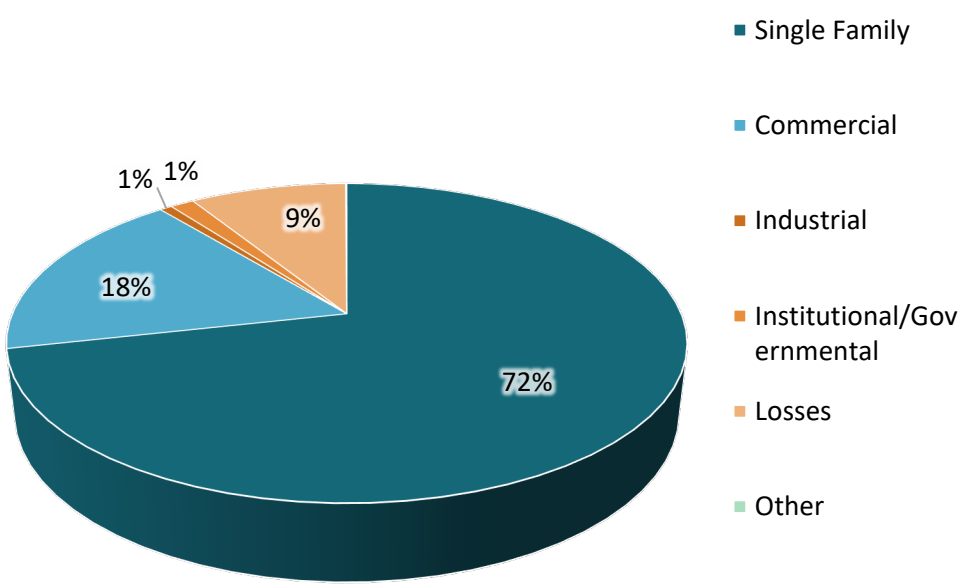


Figure 4-4. Percentage of Total Water Demand by Sector from 2016 to 2021

Overall, as shown in Table 4-3, the City's residential per capita water use (R-GPCD) is significantly lower than the average R-GPCD across all Bay Area Water Supply and Conservation Agency (BAWSCA) agencies and throughout the state.

Table 4-3. Residential Per Capita Water Demand Comparison for FY 2021

	Baseline Residential Per Capita Water Demand (R-GPCD)
City of East Palo Alto	44
BAWSCA Agencies (a)	66
Statewide Average (b)	90

Abbreviations:
BAWSCA = Bay Area Water Supply and Conservation Agency
FY = fiscal year
R-GPCD = residential gallon per capita per day

Notes:
(a) Average BAWSCA R-GPCD calculated from data provided in BAWSCA Annual Survey FY 2020-21 (BAWSCA, 2020).
(b) State-wide R-GPCD for 2021 obtained from data provided at California State Water Resources Control Board Water Conservation Portal - Conservation Reporting, http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml, accessed March 2021.

4.2 Water Demand Projections

The City recently prepared water demand projections as part of the 2020 UWMP planning effort. The land use and population assumptions that underpin the water use projections were based on the City's General Plan (City of East Palo Alto, 2017). However, as noted in Section 2.5, additional development has been identified as part of the RBD/4 Corners TOD Specific Plan that is not incorporated into the 2020 UWMP demand projections. Additionally, for master planning purposes, it is necessary to develop spatial distributions of existing and future demand estimates to apply to the water system hydraulic model and evaluate distribution system performance.

The following subsections discuss the City's current projected water demands. The methodology used to allocate existing and projected water demands in the hydraulic model is discussed further in Section 6.1.5.

4.2.1 Existing Water Demands

To determine the representative existing water demands for the WSMP, EKI reviewed monthly billing data provided by Veolia and SFPUC production data. Average water use from FY 2018 to 2020 was selected as the basis for existing demands and is assumed to represent "normal" conditions after a partial rebound from the recent (2013-2016) drought and economic downturn during the great recession. As shown in Table 4-1, water use was stable between FY 2018 and 2020. Consumption patterns during FY 2021 appear to have been affected from the COVID-19 pandemic and were thus excluded from the estimate of existing demands.

As shown in Table 4-4, the existing annual average consumption of 982 gpm was calculated by totaling the FY 2018-2020 average for each individual billing account, excluding all portable meters and fire services. Years with incomplete records were excluded from these averages. To calculate the total existing annual demand of 1,080 gpm (568 MG), EKI applied a non-revenue water (NRW)/portable meter factor of 1.1 to all consumption data based on the maximum calculated NRW/portable meter factor between FY 2018 and 2020. The allocation of the existing demands in the hydraulic model is discussed in Section 6.1.5.

Table 4-4. Water Consumption and Demand from FY 2018 to 2020 and WSMP Existing Demands

	FY2018	FY2019	FY2020	Existing Demands
Total Annual Average Consumption w/o Portable Meters and Fire Services (gpm)	1,000	982	1,073	**982 (a)**
Annual Average Total Demand (gpm)	1,099	1,060	1,110	**1,080**
NRW/Portable Meter Factor (-) (b)	1.10	1.08	1.03	**1.10**

Abbreviations:
FY = fiscal year
gpm = gallon per minute
NRW = Non-Revenue Water

Notes:
(a) The existing demands are the sum of the FY 2018-2020 average for each individual billing accounts. For accounts with incomplete records of annual billing data, the years without data are excluded from the average. Thus, the assumed existing demands are not an exact average of total annual consumption for FY 2018-2020.
(b) The NRW/Portable Meter Factor for each fiscal year is equal to the Annual Average Total Demand (equal to total production) divided by the Total Annual Average Consumption (based on billing records) excluding portable meter and fire service consumption. A factor of 1.1 was assumed for existing demands to be conservative.

4.2.2 Future Water Demand Projections

The City's water demands were projected through 2045 in the 2020 UWMP. The demand projections through 2040 reflected the growth projections included in the City's General Plan (City of East Palo Alto, 2017), inclusive of the 2013 RBD/4 Corners TOD Specific Plan buildout assumptions. Demand projections beyond 2040 in the 2020 UWMP assume growth within the City's service area would continue at the same rate between 2040 and 2045 as projected between 2035 and 2040. This additional growth beyond 2040 attempted to account for additional development in the RBD/4 Corners TOD Specific Plan area beyond what was assumed in the 2013 RBD/4 Corners TOD Specific Plan and the General Plan. Since the adoption of the 2020 UWMP, the City has formally initiated preparation of an RBD/4 Corners TOD Specific Plan Update (see Section 2.5).

Future demand projections for this WSMP were updated from those presented in the 2020 UWMP to better account for the development scenarios under consideration as part of the RBD/4 Corners TOD Specific Plan Update. To update the demand projections and allocate those demands spatially within the City's water system, EKI projected demands both within and outside the RBD/4 Corners TOD Specific Plan area. The follow sections describe the updated demand projections.

4.2.2.1 Future Water Demand Projections for RBD/4 Corners TOD Specific Plan Area

As discussed in Section 2.4, planned projects within the RBD/4 Corners TOD Specific Plan currently exceed the development studied by the 2013 RBD/4 Corners TOD Specific Plan. As shown in Table 2-4, the City is considering three scenarios: a "No Project Scenario" that includes all development projects in the Specific Plan Area currently in the planning pipeline and two scenarios with additional development.

Based on demand factors used in the Draft East Palo Alto Ravenswood Specific Plan Update – Wet Utility Preliminary Impact Analysis Memorandum (Schaaf & Wheeler, 2021) listed in Table 4-5, projected demands were calculated for the 2013 Specific Plan land use assumptions and the buildout projections

for each development scenario considered as part of the Specific Plan Update. Total demands for each scenario are listed in Table 4-6.

Table 4-5. Water Use Factors

Use Type	Water Demand Factor (a)	Units
Industrial	110	GPD/1,000 SF
Industrial R&D	375	GPD/1,000 SF
Commercial – Office	110	GPD/1,000 SF
Retail/Restaurant	160	GPD/1,000 SF
Civic/Amenities	110	GPD/1,000 SF
Residential – Single Family	260	GPD/DU
Residential – Multi-family	160	GPD/DU

Abbreviations:
DU = dwelling unit
GPD = gallons per day
SF = square feet
R&D = research and development

Notes:
(a) Source: Draft East Palo Alto Ravenswood Specific Plan Update – Wet Utility Preliminary Impact Analysis Memorandum (Schaaf & Wheeler, 2021).

Table 4-6. Projected Annual Demands for the RBD/4 Corners TOD Specific Plan Update

Scenarios	Non-Residential Demands (MG) (a)						Residential Demands (MG) (a)		Water Loss (MG) (b)	Total (MG) (c)
	Office	R&D Lab	Light Industrial or Flex	Retail	Civic/ Comm	Tenant Amenity	Multi-family	Single-Family		
2013 Specific Plan Demand	51	37	3.4	6.6	2.4	-	48	1.8	14	**163**
RBD/4 Corners TOD Specific Plan Update Scenarios										
"No Project" Scenario	51	24	7.1	6.6	2.4	-	48	1.8	13	**153**
Buildout Scenario #1	74	135	10	6.6	6.2	1.8	74	7.6	29	**344**
Buildout Scenario #2	87	160	12	6.6	6.2	2.1	86	12.1	34	**406**

Abbreviations:
GPD = gallons per day
MG = million gallon
R&D = Research and development
RBD = Ravenswood Business District
TOD = Transit-Oriented Development

Notes:
(a) Water demands for each land use equal the development projections listed in Table 2-4 multiplied by the water use factors listed in Table 4-5.
(b) Water loss is estimated to be 8.3% of total demands based on 2020 UWMP projections.
(c) Totals may not sum due to rounding.

4.2.2.2 Future Water Demands Projections for Areas Outside of the RBD/4 Corners TOD Specific Plan Area

Water demand projections within the portions of the City's service area outside of the RBD/4 Corners TOD Specific Plan Area were assumed to reflect the General Plan growth projections, excluding the 2013 RBD/4 Corners TOD Specific Plan development. The total annual demand projections for these areas were calculated to be 764 MG and were calculated by subtracting the annual demand projections for the 2013 Specific Plan (163 MG) from the 2040 demand projections listed in the 2020 UWMP (927 MG). This represents an increase of 196 MG per year above the City's existing annual demand of 568 MG. Table 4-7 lists the total and incremental demand projections for each customer sector for areas outside of the RBD/4 Corners TOD Specific Plan Area.

Table 4-7. Projected Annual Demands for Areas Outside of the RBD/4 Corners TOD Specific Plan Area

Sector	[A] 2040 UWMP Citywide Projections (MG)	[B] 2013 Specific Plan Projections (MG)	[C] Existing Demands (MG)	[D] Future Demands Outside RBD [D] = [A]-[B]-[C]	[E] Total Projected Demand Outside RBD (MG) [E] = [C] + [D]
Residential	500	49	404	47	**451**
Commercial	334	97	107	130	**237**
Industrial	16	3	5	8	**13**
Losses (a)	77	14	52	11	**63**
Sum	**927**	**163**	**568**	**196**	**764**

Abbreviations:
MG = million gallon RBD = Ravenswood Business District/4 Corners TOD

Notes:
For the 2040 UWMP Citywide Projections and the 2013 Specific Plan Projections, the water loss factor was based on the ratio of water loss and total demand in the 2040 demand projection in 2020 UWMP (8.3%).

4.2.2.3 Total Future Water Demand Projections

Total future water demands represent the sum of the water demands projections for the RBD/4 Corners TOD Specific Plan Area and remaining areas in the service area. Total future water demands are calculated in Table 4-8 for each RBD/4 Corners TOD Specific Plan scenario and range from 917 MG per year for the "No Project Scenario" to 1,169 MG per year for Scenario 2.

To evaluate system performance for purposes of this WSMP, total demands for Scenario 2 are assumed for the future water demands for 2045.

Table 4-8. Total Projected Demands for each RBD/4 Corners TOD Specific Plan Scenario

Sector	Total 2045 Projected Demands (MG) (a)		
	"No Project Scenario"	Scenario 1	Scenario 2
Residential	500	533	549
Commercial	321	461	499
Industrial	20	23	25
Losses (a)	76	91	97
Sum	**917**	**1,108**	**1,169**

Abbreviations:
MG = million gallon

Notes:
(a) Total 2045 demand projections equal the sum of the projected demand inside and outside the RBD/4 Corner TOD.

4.2.3 Comparison of Projected Demand and Available Supply

As discussed in Section 3.1.1, the City purchases most of its potable water from the SFPUC RWS in accordance with the WSA between the City and County of San Francisco and Wholesale Customers in Alameda, San Mateo and Santa Clara Counties, that was approved by the SFPUC on 28 April 2009 and amended in November 2018. The City also uses a small amount of groundwater that is produced at the Gloria Way Well that is owned and operated by the City. The City's contractual allocation of SFPUC supplies (known as its Individual Supply Guarantee [ISG]) is 3.46 million gallons per day (MGD), or approximately 1,264 MG per year, which is guaranteed during normal supply years. During normal years, the City expects to produce 7 MG per year from groundwater.

As shown in Table 4-9, the total projected demands under the "No Project Scenario", Scenario 1, and Scenario 2 will be within the City's normal year supply projections.

Table 4-9. Total Projected Future Demand and Supply Comparison

	"No Project Scenario"	Scenario 1	Scenario 2
Projected Future Demand (MG)			
Existing Demand	568	568	568
Future Demand Outside of RBD	196	196	196
Future Demand within RBD	153	344	406
Total Projected Demand	**917**	**1,108**	**1,169**
Projected Normal Year Supply (MG)			
SFPUC	1,264	1,264	1,264
Groundwater	7	7	7
Total Available Normal Year Supply	*1,271*	*1,271*	*1,271*
Normal Year Supply Surplus/Deficit (MG)	**354**	**163**	**102**

Abbreviations:
MG = million gallon

4.3 Peak Demands

Peaking factors are used to calculate water demands expected under varying demand conditions to account for seasonal and diurnal variations in demands. Maximum day demand (MDD) and peak hour demand (PHD) peaking factors are used to calculate demands under these peak conditions to evaluate system performance and size pipelines, storage facilities, and supply capacities.

The 2010 Water System Master Plan assumed a MDD peaking factor of 1.5 times average day demand (ADD) and a PHD peaking factor of 3.0 times ADD. However, the basis for those factors was unclear. EKI developed new MDD and PHD peaking factors based on FY 2018-2021 hourly data from the City's SFPUC meters at each turnout.

The water use patterns during FY 2018-2021 are summarized in Table 4-10, and maximum demand day diurnal patterns during this period are shown on Figure 4-5. Based on this analysis, the systemwide peaking factors have been updated to 1.3 times ADD for MDD and 1.5 times MDD for PHD (or 1.95 times ADD for PHD), as shown in Table 4-11. These updated peaking factors are lower than those assumed in the 2010 Water System Master Plan and reflect the City's current water use patterns. The recommended peaking factors are applied uniformly across system ADD consumption data to estimate the peak demands within the City's service area.

Table 4-10. Water Use Patterns in the City's Service Area

FY	2018	2019	2020	2021
Demands (gpm)				
Average Day Demand (ADD)	1,099	1,060	1,110	1,037
Max Day Demand (MDD)	1,401	1,351	1,443	1,233
Max Day	7/6/2018	6/10/2019	6/30/2020	6/18/2021
Peak Hour Demand (PHD) on Max Day	1,758	1,980	1,920	1,509
Peaking Factors (-)				
MDD/ADD Peaking Factor	*1.27*	*1.28*	*1.30*	*1.19*
PHD/MDD Peaking Factor	*1.25*	*1.47*	*1.33*	*1.22*
Abbreviations:				
FY = fiscal year		gpm = gallon per minute		

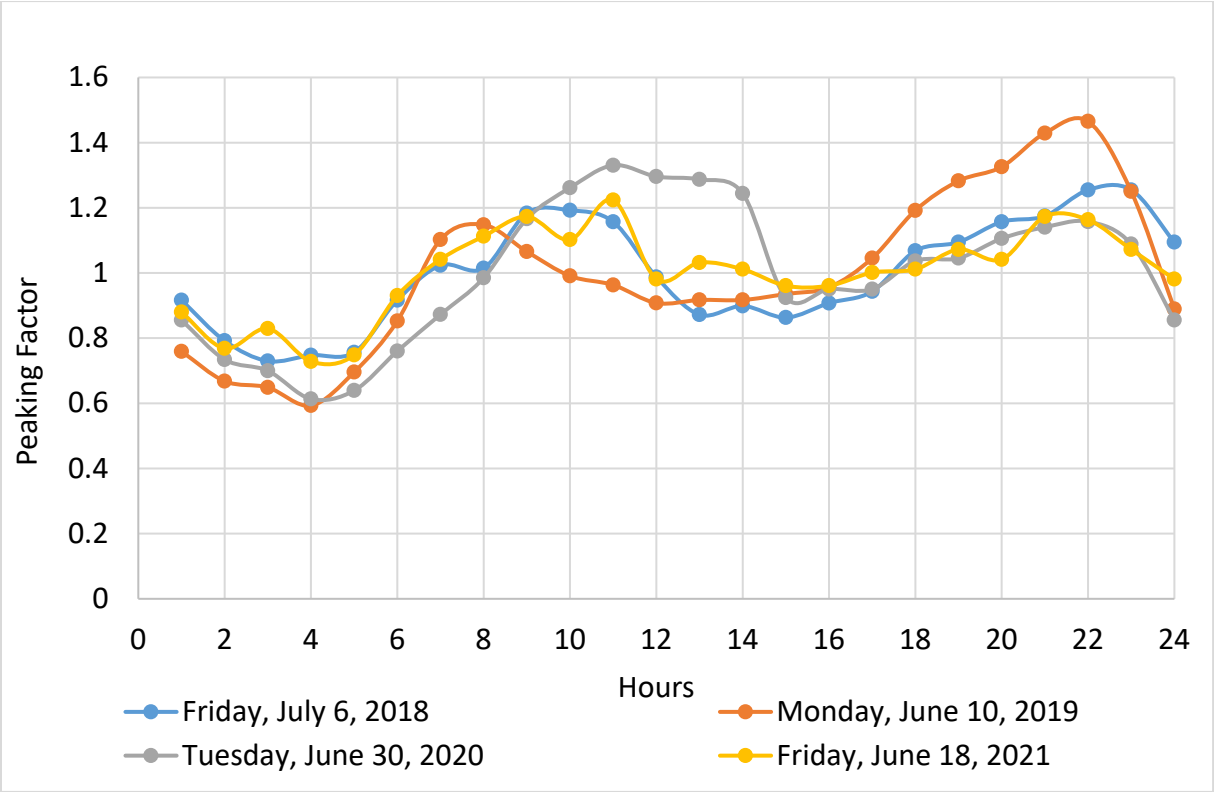


Figure 4-5. Max Day Diurnal Curves

Table 4-11. Recommended Peaking Factors

	Recommended Peaking Factors (a)
NRW/Portable Meter Factor (b)	1.1
MDD/ADD	1.3
PHD/ADD	1.95
PHD/MDD	1.5

Abbreviations:
ADD = average day demand
MDD = maximum day demand
NRW = non-revenue water
PHD = peak hour demand

Notes:
(a) Recommended peaking factors are the maximum peaking factors observed between FY 2018 and FY 2021.
(b) The NRW/Portable Meter Factor is applied to annual average actual or projected consumption to account for water loss and portable meter use to calculate ADD.

5 WATER DISTRIBUTION SYSTEM PERFORMANCE AND SIZING CRITERIA

This section describes the recommended performance and operational criteria by which the City's water system is evaluated herein under existing and future conditions. These criteria are based on California Code of Regulations Title 22 (Title 22) requirements, the City's design and construction standards, recommendations from Menlo Park Fire District, and EKI's recommendations. These criteria can be grouped into two categories: (1) criteria used to evaluate the water distribution system's performance (Section 5.1) and (2) criteria used to evaluate the sizing of the systems water facilities, including pipelines, turnouts, tanks and pump stations (Section 5.2).

These criteria are summarized in Table 5-1 and described in further detail in the following section.

Table 5-1. System Performance and Sizing Criteria

Component	Criteria	Remarks
WATER SYSTEM PERFORMANCE		
Fire Flow Requirements		
Single Family Residential and Parks	1,000 gpm for 2 hours.	Based on review and approval by the Menlo Park Fire District Fire Marshal for master planning. These criteria are general requirements for master planning purposes and may not be indicative of requirements for specific developments.
Multi-Family Residential, General Commercial and Office, Heavy Commercial, Industrial	4,000 gpm for 4 hours.	
Peaking Factors for System Analysis		
Water Loss (Non-Revenue Water) Factor	10% increase to average day demands for unaccounted for water.	Recommendation based on demand evaluation.
Max Day to Average Day Peaking Factor	1.3 times average day demand.	
Peak Hour to Average Day Peaking Factor	1.95 times average day demand.	
Water System Supply Requirement		
Demand Condition to Be Met	All Conditions: Provide firm water supply and storage capacity to meet maximum day demand and the maximum fire flow requirement, or peak hour demands, whichever is larger.	-

Component	Criteria	Remarks
Distribution System Pressures		
Maximum Pressure	80 psi at customer service connections (without individual service pressure reducing valves)	California Plumbing Code requirement.
Minimum Pressure - Normal Operating Conditions for System Expansions	40 psi at customer service connections excluding fire flow	Title 22 requirements for system expansions that expand the number of existing system service connections by 20 percent or more.
Minimum Pressure - Max Day Plus Fire Flow Conditions	20 psi	Title 22 requirement for minimum allowable pressure.
FACILITIES SIZING		
Pipelines		
New Distribution Main Diameter	General: 8-inch diameter or larger Cul-de-sacs and dead end runs: 6-inch diameter acceptable within cul-de-sacs and dead end runs of less than 400 feet where future extensions will not occur and no fire hydrants are located. Commercial, Industrial, and High-Density Residential: 10-inch diameter.	Recommendation based on industry practice.
Maximum Velocity	6 ft/s, all system mains, peak hour demand 10 ft/s, all system mains, maximum day plus fire flow	Recommendation based on industry practice.
Maximum Head Loss	3 ft per 1,000 ft, mains ≥ 16", peak hour demands 7 ft per 1,000 ft, mains <16", peak hour demands 10 ft per 1,000 ft, all system mains, maximum day plus fire flow	
Hazen Williams "C" Factor	New Piping = 145 Existing System Piping per model calibration	New Piping C-factor based on installation of PVC pipe. Existing system piping C-factors confirmed by EKI calibration.
Pipeline Material	PVC C900 or C905 Class 235 (DR 18)	City Standard

Component	Criteria	Remarks
Water Storage Capacity		
Operational (Equalization)	Equal to 25 percent of maximum day demand calculated.	-
Fire	Supply flow for maximum fire flow requirement (4,000 gpm for 4 hours).	
Emergency	Equal to 100 percent of average day demand calculated.	
Emergency Groundwater Credit	Equal to the groundwater supply capacity that can be reliably pumped (facilities equipped with auxiliary power) over an 18-hour period.	-
Total Water Storage Capacity	100 percent of max day demand plus fire volume minus emergency groundwater credit.	Summation of operational, fire, and emergency storage

5.1 Distribution System Performance Criteria

5.1.1 Fire Flow Requirements

Fire protection for the City is provided by Menlo Park Fire District. The Menlo Park Fire District establishes minimum fire flow requirements and durations based on the California Fire Code, which the City is responsible for providing in its water distribution system. Required fire flows are based on land use designations and are designed to be conservative for long-term planning. For long-term planning purposes, the Menlo Park Fire District has indicated that a minimum fire flow of 4,000 gpm for 4 hours should be provided in all areas except those designated as low-density residential in the General Plan Zoning Map (City of East Palo Alto, 2017). In low-density residential areas consisting of single-family residential units, a fire flow of 1,000 gpm for 2 hours is required. These fire flows must be available for a minimum of two hours in conjunction with MDD conditions while maintaining a minimum residual pressure of 20 psi at all service connections.

It should be noted that these fire flow requirements are intended to be used for long-term planning purposes to support potential future redevelopment and are likely greater than fire flow requirements for existing land uses. Thus, locations where fire flow availability does not meet the long-term planning fire flow requirements may still have sufficient fire flow to meet existing fire flow requirements.

These fire flow requirements for land uses other than low density residential represent a significant increase from those assumed in the 2010 WSMP and subsequent planning efforts performed by the City prior to this WSMP Update. In the 2010 WSMP, most commercial and industrial areas had a minimum fire flow requirement of 2,500 gpm, with select properties having requirements as high as 3,500 gpm. These updated fire flow requirements present a major change to prior planning assumptions and affect the projects currently under planning and design, as discussed in Section 7.

5.1.2 Peaking Factors

The WSMP uses peaking factors to estimate MDDs and PHDs for purposes of evaluating the distribution system performance under peak demand conditions. As discussed in Section 4.2.3, the updated peaking factors are as follows:

- MDD Peaking Factor = 1.5 x ADD
- PHD Peaking Factor = 1.95 x ADD

In addition, a NRW/portable meter factor of 1.1 is applied to the water consumption projections to estimate ADD.

5.1.3 Water System Supply Requirement

The recommended water supply capacity criterion is to provide firm water supply and storage capacity to meet (1) maximum day demand and the maximum fire flow requirement or (2) peak hour demands, whichever is larger, under all conditions.

5.1.4 Distribution System Pressures

The distribution system's ability to maintain adequate system pressures is the primary indicator of acceptable system performance. System performance is evaluated against the following pressure criteria:

- A minimum pressure of 40 psi at all service connections is targeted at all service line connections during normal operating conditions (PHD conditions).
- A minimum pressure of 20 psi is required at all service line connections at all times, including fire flow conditions, to comply with Title 22 requirements.
- A maximum pressure of 80 psi is required at all service connections where there are not individual service PRVs installed per the California Plumbing Code.

5.2 Water Facility Sizing Criteria

The following sections describe the performance and sizing criteria for City water facilities.

5.2.1 Water Transmission and Distribution Pipeline Sizing Criteria

The following pipeline velocity and head loss criteria are used for sizing new transmission and distribution pipelines. However, when evaluating the existing system, velocity and head loss criteria are secondary to the system pressure criteria described above.

For example, if system pressures are satisfied under PHD and MDD plus fire flow conditions, an existing pipe that exceeds maximum velocity or head loss criteria is not necessarily indicative of a problem that requires system improvements. Any identified exceedances have been reviewed on a case-by-case basis to determine if they are influencing any deficient system pressures or if improving these pipes to meet velocity or head loss criteria would benefit the water movement within the system. In certain cases, upsizing deficient upstream piping near supply sources where flow and head loss are greatest can effectively address multiple downstream pressure deficiencies.

5.2.1.1 Velocity Criteria

The following velocity criteria, in conjunction with head loss criteria described below, are recommended for sizing new water mains:

- PHD conditions: Maximum velocity of 6 feet per second (fps) for all mains

- MDD plus fire flow conditions: Maximum velocity of 10 fps for all mains

As discussed above, for existing infrastructure these criteria are secondary to pressure criteria and are evaluated to identify potential bottlenecks in the system that could be upsized to address pressure deficiencies.

5.2.1.2 Headloss Criteria

In addition to velocity criteria, the following head loss criterion is recommended for sizing new water mains:

- PHD conditions: Maximum head loss of 3 feet per 1,000 feet (ft/k-ft) of pipe with a diameter not greater than 16 inches (in)
- PHD conditions: Maximum head loss of 7 ft/k-ft of pipe with a diameter greater than 16 in
- PHD with fire flow conditions: Maximum head loss of 10 ft/k-ft of pipe

For existing pipelines this criterion is used to identify bottlenecks in the system that if upsized could relieve downstream pressure to meet pressure criteria and improve connectivity of major supply sources and storage facilities to outlying areas.

5.2.2 Water Storage Capacity

Treated water storage capacity includes equalization storage, fire storage, and emergency storage. The following sections explain the recommended requirement for each storage component in detail.

As discussed in Section 3.2.2, the City does not currently have any treated storage in its distribution system. Required storage based on existing and future demand conditions based on the following criteria is evaluated in Section 8.

5.2.2.1 Equalization Storage

As discussed above, peaking factors were developed to capture varying water demand conditions. Higher water demand periods occur during summer months when irrigation demands are higher. Over a day, usage typically peaks in the early morning when people are preparing for their day and at night when people return home and begin irrigating their landscapes.

Treated water storage is typically used to meet peak demands and then is refilled during low demand periods when the water supply is greater than water demand. The storage volume used to meet these high demand periods is called operational or equalization storage. Recommended equalization storage is equal to 25% of MDD.

5.2.2.2 Emergency Storage

Emergency storage is required to supply demands during various emergencies, such as natural disasters, pipeline failures, treatment failures, power outages or pump station failures. No standard requirements exist for determining the appropriate amount of emergency storage, and each utility establishes these requirements based on their judgement and risk tolerance. EKI recommends an emergency storage requirement of 100% of ADD. EKI believes this requirement is appropriately conservative given that the City's system is a single, gravity-fed pressure zone fed by a highly-reliability source and that peak season irrigation would be curtailed during emergency conditions.

5.2.2.3 Fire Storage

As discussed in Section 5.1.1, fire flow and duration requirements were established for long-term planning purposes by the City and local fire department. EKI recommends fire storage to meet a commercial fire (4,000 gpm for 4 hours), which is equivalent to 0.96 MG.

5.2.2.4 Groundwater Storage Credit

The City's groundwater basin can account for a portion of the City's emergency storage requirement. Groundwater credit for emergency storage is defined as the quantity of groundwater which can reliably be produced in the event of an emergency over an 18-hour period. The groundwater credit is calculated based on the groundwater supply of facilities equipped with backup power.

6 WATER DISTRIBUTION SYSTEM HYDRAULIC MODEL DEVELOPMENT

This section describes the development, validation, and calibration of the City's new water system hydraulic model. A hydraulic model simulates the operations of water facilities and distribution systems in a mathematical model under various demand and operational conditions. The hydraulic model generates information on pressures, flows, velocities, and head losses that can be used to assess system performance and identify deficiencies. The hydraulic model can also be used to develop and verify the adequacy of recommended or proposed system improvements.

To develop the hydraulic model, EKI completed the following tasks:

- Updated the City's distribution system geodatabase;
- Created a hydraulic model of the City's distribution system based on the updated geodatabase;
- Inventoried pumping and PRV characteristics and settings and populated the model accordingly;
- Spatially allocated demands using the City's billing data and meter locations and distributed these demands to nodes in the model;
- Validated the hydraulic model to check the accuracy of the model's representation of real system operations; and
- Calibrated the hydraulic model using flow and pressures observed in the field during hydrant flow testing on 25, 26, and 28 January 2022.

EKI worked closely with City staff to obtain and review data required to develop the model. Development of the hydraulic model is discussed in more detail, below.

6.1 Model Construction

EKI constructed the model in Innovyze's InfoWater Pro software package using the City's existing water system geodatabase, available as-built records, SFPUC production data, and water billing records to populate the network of nodes (i.e., pumps, valves, hydrants, reservoirs, and pipe junctions) and pipes that comprise the model. The steps completed to populate information for each of these elements are discussed below.

6.1.1 Pipelines and Junctions

As an initial model construction step, EKI reviewed and updated the City's water system geodatabase by comparing it against the City's prior hydraulic model, available as built records, and input from City and Veolia staff. After these updates, EKI imported the pipe layers from the geodatabase into the InfoWater Pro software. After importing, EKI used the InfoWater Append Nodes tool to create and assign beginning and end nodes to each pipe segment and used software tools to check pipe and node connectivity.

For each pipe segment, a roughness factor (i.e., Hazen-Williams coefficient of friction or "C-factor") was assigned to represent the frictional losses along the pipe section. The City did not have any information regarding the roughness factors associated with its water mains. EKI assigned preliminary C-factors based on typical values for various materials and diameters. These preliminary C-factors were evaluated during model calibration (see Appendix A).

6.1.2 SFPUC Turnouts and PRVs

After adding the pipes and junction to the model, EKI added the following information for the SFPUC turnouts and their associated PRV settings to the model based on information inventoried in Section 3:

- SFPUC Turnouts (modeled as reservoirs)

  - Hydraulic grade level
  - Elevation

- PRVs
  - Valve size and associated minor loss coefficient based on manufacturers data
  - Pressure settings
  - Elevations, which were verified in the field using a GPS unit during calibration testing

The hydraulic grade of the SFPUC turnout was determined by the Veolia operational pressure data. PRV settings were provided by Veolia and were verified as part of the calibration effort.

6.1.3 Other Water System Facilities

After adding the pipes, junction, SFPUC turnouts, and PRVs to the model, EKI added the following information for each existing system facility to the model based on information inventoried in Section 3:

- Blending Tank near the Gloria Way Well
  - Base elevation
  - Diameter
  - Height
  - Volume
- Booster Pump Station (BPS) near the Gloria Way Well
  - Pump curves
  - Elevation
  - Variable frequency drive settings

For the Future Scenario (see Section 6.3), EKI added the Pad D and Donohoe tanks and booster pump stations (see Section 3.3) based on information included in planning studies prepared by the developers for the Light Tree Apartments and Euclid Improvements, respectively (Coleman Engineering, 2021a and BKF, 2020). EKI refined the planned pump design points and settings as part of the model development such that the pumps would turn on during peak demand conditions and remain off during ADD conditions. Pump station characteristics are as described below:

- Pad D Booster Pump Station
  - Configuration: 2 x 500 gpm (30 hp) variable frequency drive (VFD) pumps (1+1 configuration)
  - Settings:
    - On setting: discharge pressure drops to 51 psi
    - VFD setting: target 54 psi
- 375 Donohoe Booster Pump Station
  - Configuration: 5 x 625 gpm (40 hp) VFD pumps (4+1 configuration)
  - Settings:
    - Lead On setting: discharge pressure drops to 50 psi

- Lead VFD setting: target 500 gpm
- Lag On setting: discharge pressure drops to 45 psi
- Lag setting: 4 pumps running at 100% speed.

6.1.4 System Elevations

EKI populated elevation data for each of the model junctions and facilities based on a San Mateo County 2017 digital elevation model (DEM). Elevations in the DEM were extracted and assigned to each node in the hydraulic model. Elevations are based on North American Vertical Datum of 1988 (NAVD 88). Tank, PRV, and pump station elevations were spot checked against available records and GPS data. Precise elevations and locations of hydrants tested during the calibration testing were measured using a GPS unit and updated in the model.

6.1.5 Water Demand Allocations

As discussed in Section 4, EKI allocated existing water demands in the model by geocoding average FY 2018-2020 billing data with the City's meter location shapefile. These water demands were allocated to the appropriate nodes in the model using modeling software tools and peaking factors were applied to create each demand scenario.

The future demand was allocated per the methodologies described below:

- Future demand within the RBD/4 Corners TOD Specific Plan Areas:
  - The demand associated with the five smaller projects that are either constructed or planned (see Table 6-1 for details) were assigned to the junctions adjacent to those developments.
  - The demands for the four major projects (i.e., 2020 Bay Road, Four Corners, The Landing, and the Waterfront Project) were assumed to equal the total demand RBD/4 Corners TOD Specific Plan Areas minus the demands for the five smaller projects listed above or 383 MG per year (see Table 6-1 for details). These demands were distributed proportionally to the area of each parcel associated with these projects, shown on Figure 2-3, and assigned to junctions adjacent to the parcels.
- Future demand from planned projects outside of the RBD/4 Corners TOD Specific Plan Areas:
  - The demands from the six projects that are either constructed or planned (see Table 6-2- for details) were assigned to the nearby junction(s).
  - The remaining future demands totaling 153 MG (Table 6-2) were allocated uniformly across the junctions near the University Avenue Corridor, where it is assumed the majority of future development will occur.

Table 6-1. Anticipated Development Projections within of the RBD

Project Name	Type	Size	Net Demand Increase (MG) (a)
965 Weeks Street	Residential	136 units	9.2
1201 Runnymede Street	Residential	32 units	2.2
1804 Bay Road Residential Development	Residential	66 units	4.5
The Sobrato Office Project at 2519 Pulgas Ave	Office	62,500 sq ft	2.5
JobTrain Office Project at 2535 Pulgas Ave	Office	110,000 sq ft	4.4
Total Demand from the Projects Listed Above			**23**
Remaining Demand to be allocated to the four major developments (b)			**383**

Abbreviations:
gpm = gallons per minute
sq ft = square feet

Notes:
(a) The demand projections are based on water use factors shown in Table 4-5 and include assumed water loss.
(b) Remaining demand to be allocated to the four major developments equals the total demand associated with the RBD/4 Corners TOD Specific Plan Update Scenario 2 from Table 4-6 (406 MG) minus the demand for the smaller projects listed above.

Table 6-2. Anticipated Development Projections outside of the RBD

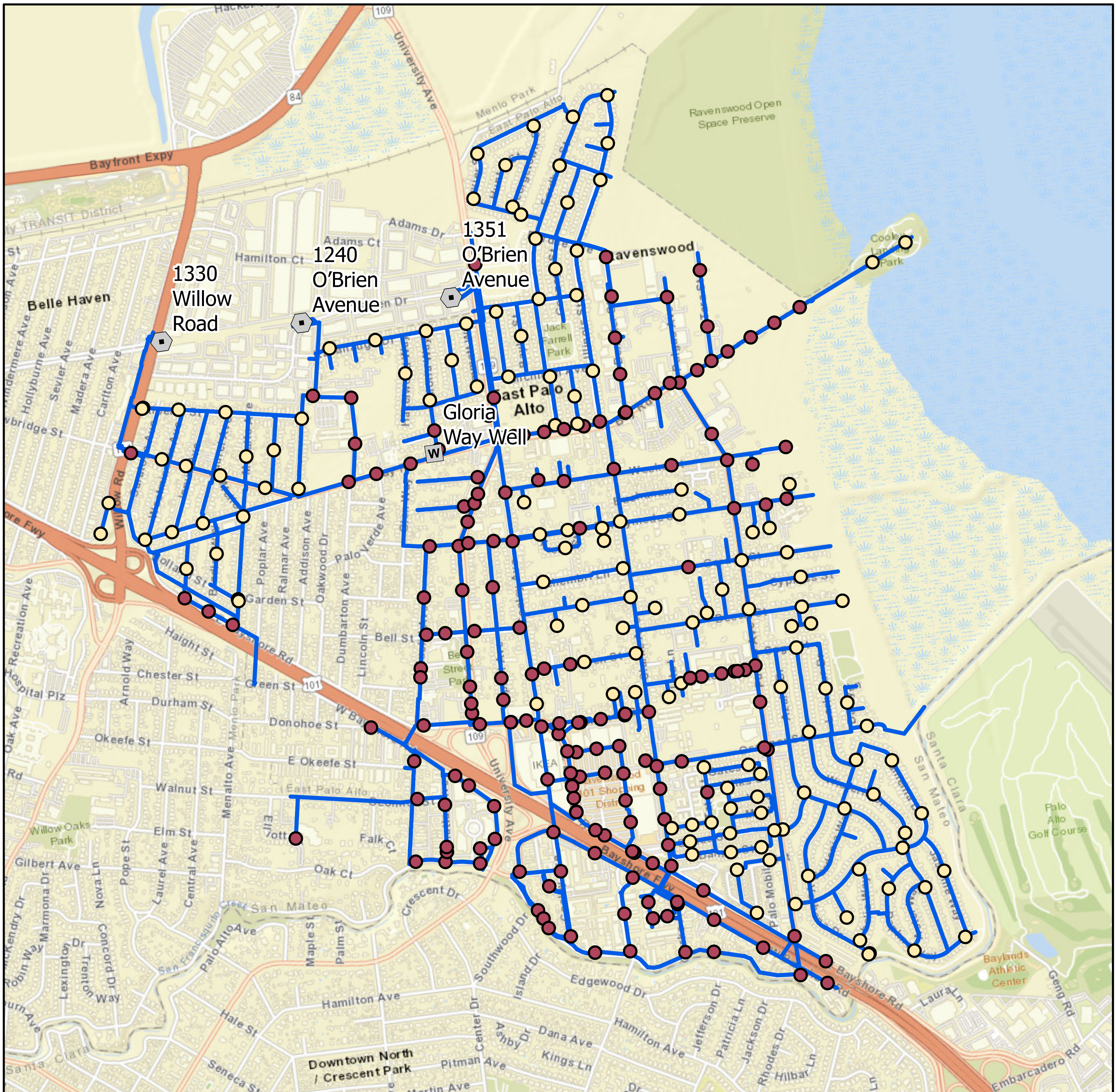
Project Name	Type	Size	Net Demand Increase (MG) (a)
Light Tree Apartments	Residential	185 units	13
Clarum Corner	Mixed-Use	33 units	2.1
Sobrato Phase II	Office	233,000 sq ft	9.3
Woodland Apartment Expansion / Euclid Improvements (b)	Residential	605 units (net increase of 444 units)	11
Development at 1788 East Bayshore Road	Office	16,000 sq ft	0.6
University Circle Phase II located at 2050 University Ave.	Office	180, 000 sq ft	7.2
Total Demand from the Projects above (include water loss)			**43**
Remaining Demand to be allocated the University Avenue Corridor			**153**

Abbreviations:
gpm = gallons per minute Sq ft = square feet

Notes:
(a) The demand projection is based on demand factor of 170 gallons per day per unit for the residential unit and 0.10 gallons per day per square feet for office areas for consistency (based on recent Water Supply Assessment's prepared by EKI).
(b) Demand projection for the Woodland Apartment Expansion / Euclid Improvements is per the information provided by the developer.

6.1.6 Fire Flow Allocations

Within the model, EKI added fire hydrant modeling nodes at the location where each hydrant lateral connects to the main as shown on Figure 6-1. At each fire hydrant modeling node, land-use specific fire flow requirements were assigned according to Table 5-1. Establishing nodes at the actual hydrant lateral locations, as opposed to only at pipe intersections like in the City's prior model, allows for more accurate analysis of fire flow availability and assists in model calibration efforts.



Legend

- Existing Pipe
- Gloria Way Well
- Existing SFPUC Turnout

Fire Flow Requirement (gpm)

- 1,000
- 4,000

Abbreviations

gpm = gallons per minute
SFPUC = San Francisco Public Utilities Commission

Notes

1. All locations are approximate.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500
US Feet

Fire Flow Requirements

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 6-1

eki environment & water

Path: X:\C10082.00\Map\EPA_WSMP_Figures.aprx

6.2 Model Validation and Calibration

After model construction, EKI performed steady-state model validation and calibration to verify model construction, controls, and other model variables. EKI conducted model validation runs to check the accuracy of the model's representation of real system operations. EKI verified the results of these validation runs against hourly SFPUC production data and operational and prior fire flow testing data provided by the City. During the validation step, EKI made minor modifications to system facility settings and pipe connectivity to confirm modeled system pressures were generally consistent with actual system pressures.

After initial model validation, calibration field testing and model runs were performed to confirm the finer accuracy of model settings and evaluate appropriate C-factors for various pipe size, materials, ages, and locations. Field testing was performed by Veolia, City, and EKI staff at 11 test locations on 25, 26 and 28 January 2022. Field testing helped identify several unexpected issues in the distribution system, such as inadvertently closed or partially valves and valves that would not properly seal when closed. EKI applied adjustments to C-Factors during the calibration effort and achieved a ±10% calibration criteria at eight of 11 locations with valid test results. Validation and calibration efforts and results are described in more detail in Appendix A.

Table 6-3. Fire Hydrant Testing Locations

Location No.	Flow Hydrant Location	Tests	Pipe Diameter, Material, and Assumed Year Installed	No. of Closed Valves during C-Factor Test	No. of Observation Hydrants
1	1626 Tulane Ave	2 Tests: Hydrant Flow Test and C-Factor Test	6'' Cast Iron (CI) – 1950s	4	3
2	1600 Bay Rd	2 Tests: Hydrant Flow Test and C-Factor Test	10" Asbestos Cement (AC) – UNK	4	4
3	1351 Bay Rd	2 Tests: Hydrant Flow Test and C-Factor Test	8" CI – 1940s	3	3
4	2386 Ralmar Ave	2 Tests: Hydrant Flow Test and C-Factor Test	6'' CI – 1940s	8	3
5	2101 University Ave	2 Tests: Hydrant Flow Test and C-Factor Test	8''CI – 1940s	3	4
6	2125 Capitol Ave	2 Tests: Hydrant Flow Test and C-Factor Test	6'' AC – UNK	3	2
7	735 Green St	2 Tests: Hydrant Flow Test and C-Factor Test	8''CI – 1950s	1	3
8	911 Oakes St	2 Tests: Hydrant Flow Test and C-Factor Test	8'' Polyvinyl Chloride (PVC) - UNK	3	3
9	1805 E Bayshore Rd	2 Tests: Hydrant Flow Test and C-Factor Test	6'' CI – 1960s	2	3
10	1898 E Clarke Ave	2 Tests: Hydrant Flow Test and C-Factor Test	10'' CI – 1950s	4	3
11	258 Daphne Way	2 Tests: Hydrant Flow Test and C-Factor Test	6'' CI – 1950s	4	3

6.3 Modeling Scenarios

Two modeling scenarios were developed as part of the Water System Master Plan Update:

- Existing Scenario:
  - Existing demand conditions
  - Existing infrastructure
- Future Scenario:
  - Projected 2045 demand conditions (i.e., demand from Scenario 2)
  - Existing infrastructure with planned water system improvements described in Section 3.3

In each scenario, Gloria Way Well was assumed to be offline because Veolia operates Gloria Way Well manually on a set schedule, and the facility may not be available to supply peak demand and fire flow requirements. In the Future Scenario, the Pad D and 375 Euclid Booster Pump Stations initial conditions

were set to off but were allowed to turn on based on the settings described in Section 6.1.3. Additional details are discussed in Section 7.

7 WATER DISTRIBUTION SYSTEM MODELING EVALUATION

To evaluate distribution system performance against performance criteria, EKI conducted steady-state model simulations of (1) PHD and (2) MDD plus fire flow (MDD+FF) for both the Existing and Future Scenarios (see Section 6.3).

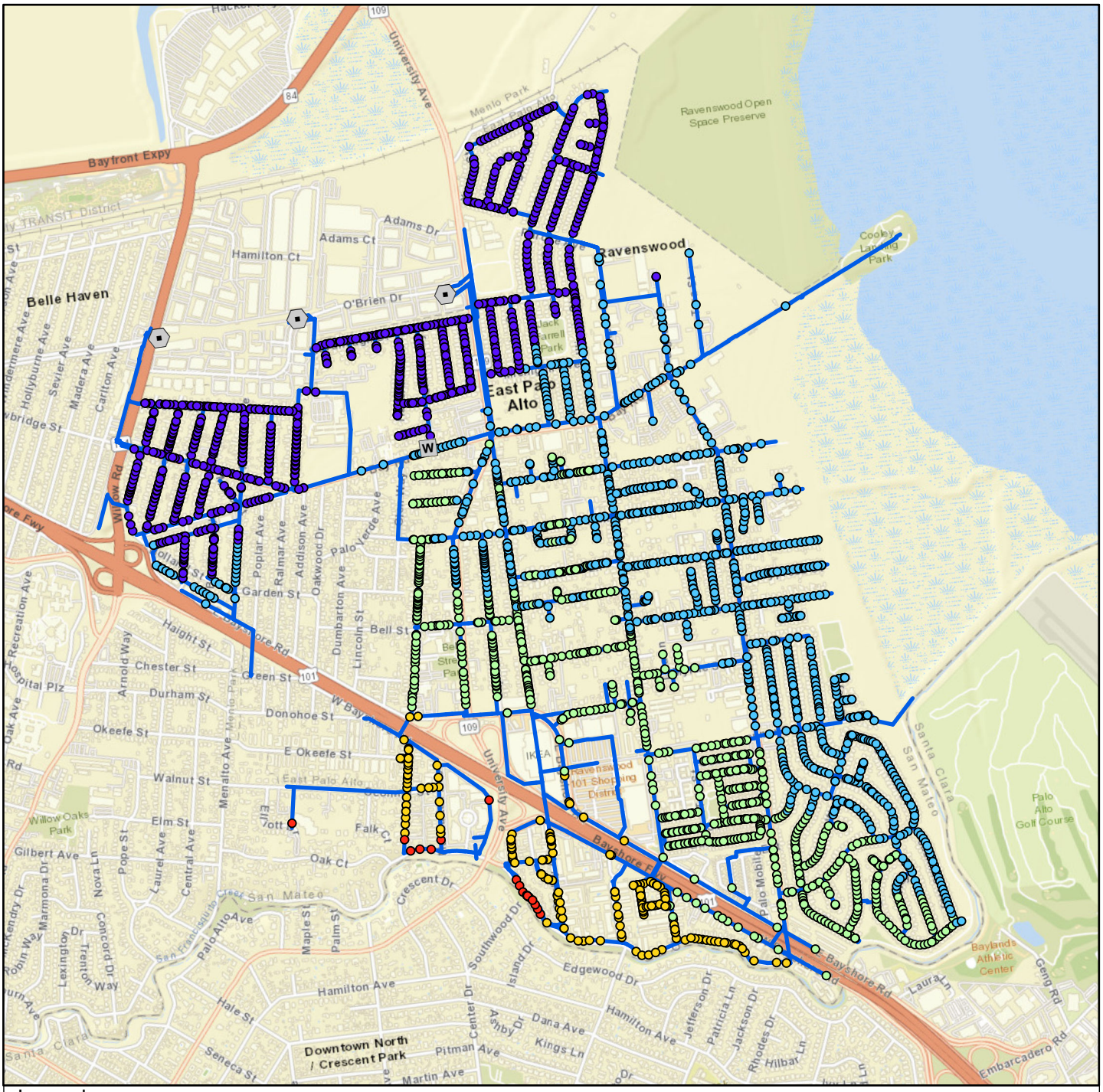
Model outputs from the PHD scenario include junction pressures and pipeline head loss and velocity under PHD conditions. These results were compared against the PHD performance criteria.

The MDD+FF simulations determine the available fire flow at each hydrant while maintaining a minimum of 20 psi everywhere in the system. These results were compared to fire flow requirements to determine which hydrants are not meeting the required planning-level criteria. To identify bottlenecks in the system and test potential system improvements, additional fire flow analyses were conducted under MDD conditions on a case-by-case basis by manually applying fire demands on individual hydrant nodes to assess pipeline head loss and velocity.

7.1 Existing Scenario Evaluation

7.1.1 PHD Results

Model results indicate that the existing system can meet minimum pressure criteria of 40 psi under PHD conditions in most of the City's service area except for three nodes the area south of Highway 101 and west of University Avenue. Modeled system pressures ranged from 39 psi to 61 psi, as shown on Figure 7-1. Results show that velocities are elevated near the three turnouts, but velocities do not exceed the maximum 6 fps criterion in any pipe (Figure 7-2). As shown on Figure 7-3, head losses exceed criterion of 7 ft per 1,000 ft for mains less than 16-inches near the three turnouts and on Bay Road between Dumbarton Avenue and Glen Way. As discussed in Section 5.2.1, these exceedances do not necessarily indicate there is a problem unless the head loss is contributing to pressure deficiencies.



Legend

- Existing SFPUC Turnout
- W — Gloria Way Well
- Existing Pipe

Junction Pressure (psi)

- 37 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60

Notes

1. All locations are approximate.
2. Only nodes located at customer service connections are shown.

Sources

1. Aerial base map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Junction Pressure with Peak Hour Demands Existing Scenario

Abbreviations

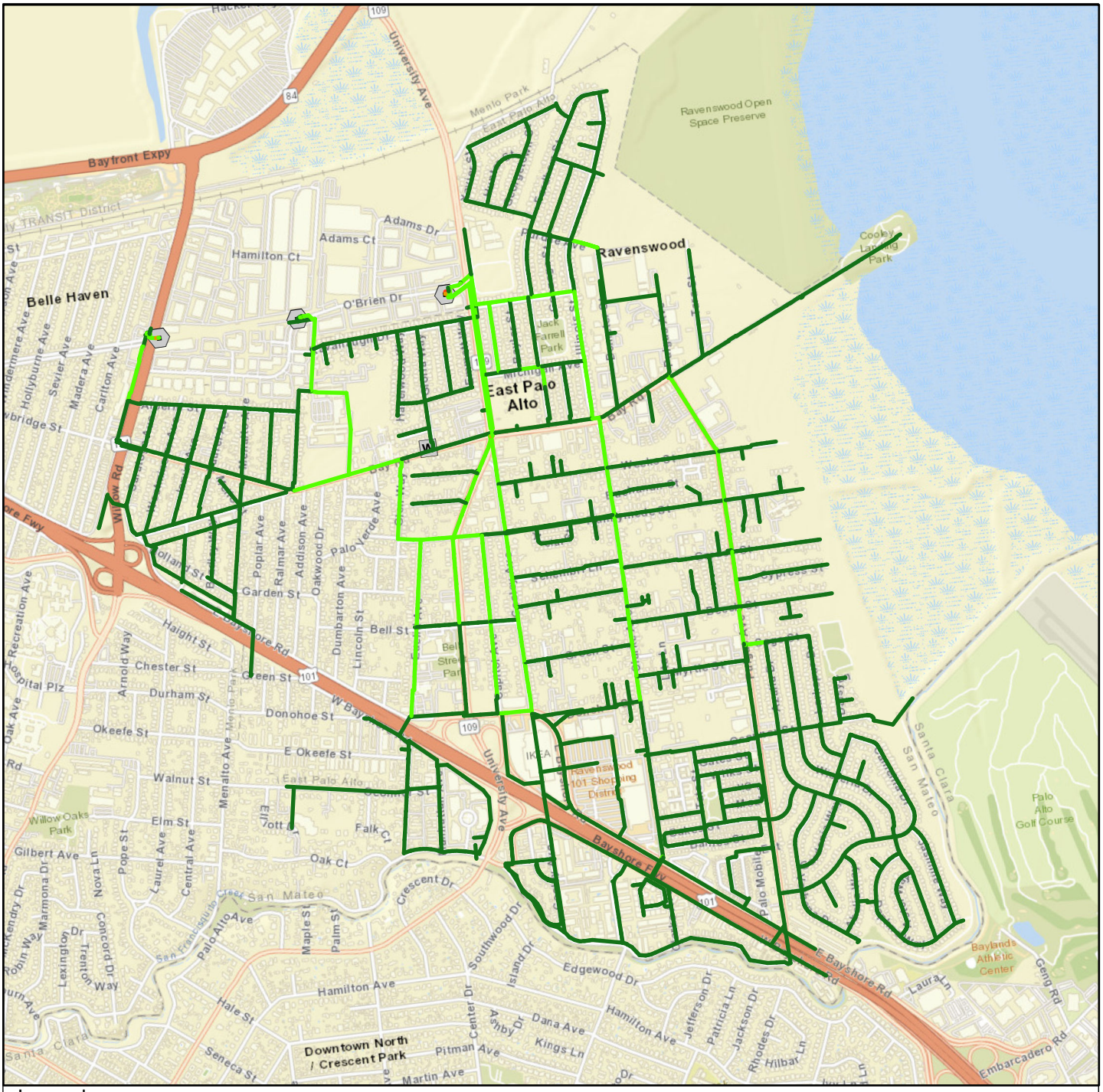
psi = pounds per square inch

SFPUC = San Francisco Public Utilities Commission

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-1

Path: C:\Users\qzhang\InfoWater\C10082.00\Map\EPA_WSMP_Figures.aprx



Legend

- W — Gloria Way Well
- Existing SFPUC Turnout

Velocity in Water Mains (ft/s)

- < 1
- 1 - 3
- 3 - 5
- 5 - 6

Notes

1. All locations are approximate.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Abbreviations

ft/s = foot per second

SFPUC = San Francisco Public Utilities Commission

Pipe Velocity with Peak Hour Demands Existing Scenario

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-2

eki environment & water

Path: X:\C10082.00\Map\EPA_WSMP_Figures.aprx

Legend

- W — Gloria Way Well
- Existing SFPUC Turnout

Headloss per Thousand Feet in Water Mains (ft/k-ft)

- <3
- 3 - 7
- 7 - 10
- 10 - 15
- >15

Notes

1. All locations are approximate.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Abbreviations

ft/k-ft = foot per kilo-foot

SFPUC = San Francisco Public Utilities Commission

Headloss per Thousand Feet with Peak Hour Demands Existing Scenario

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-3

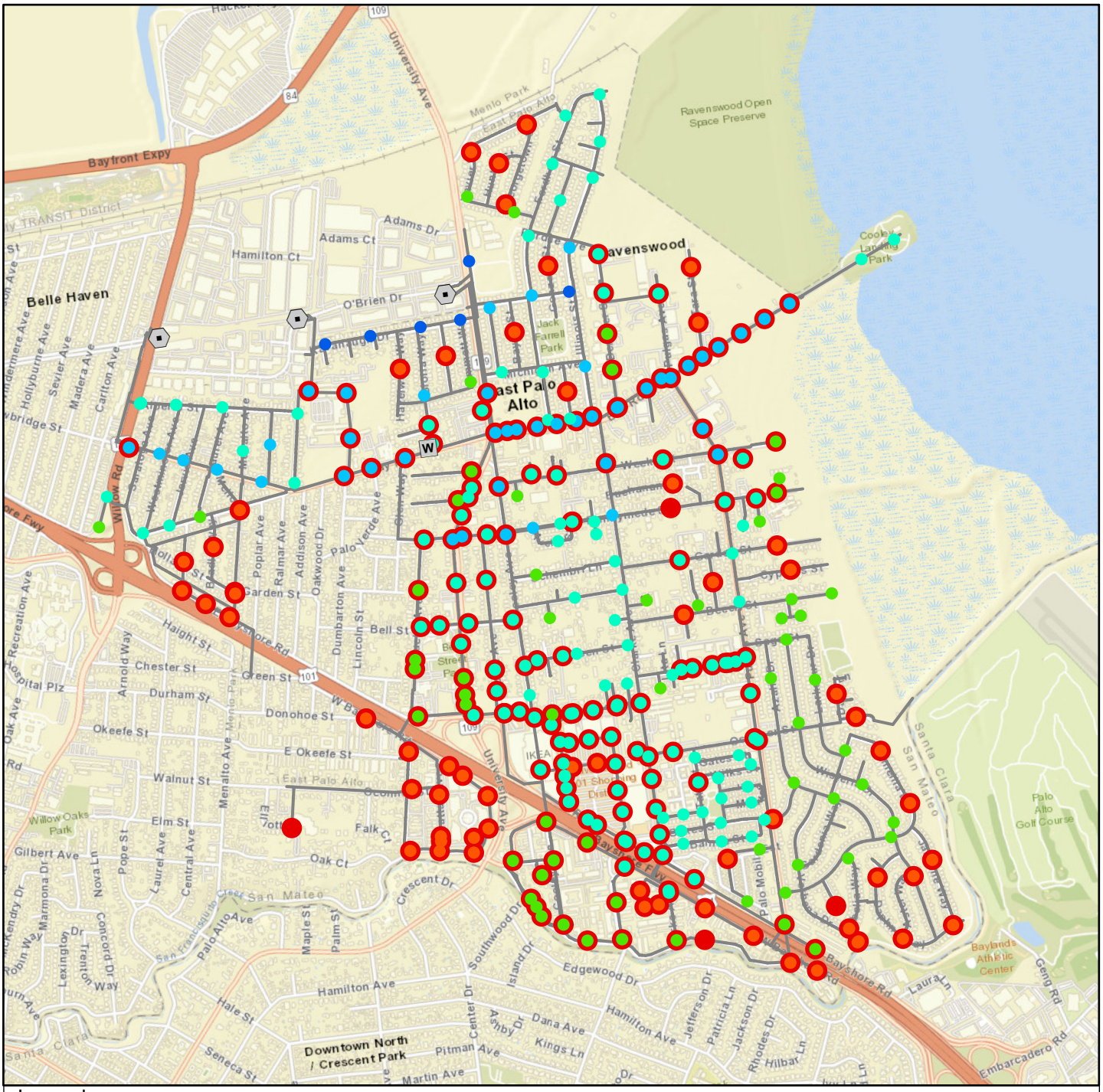
eki environment & water

Path: X:\C10082.00\Map\EPA_WSMP_Figures.aprx

7.1.2 MDD Plus Fire Flow Results

Modeled fire flow availability under existing conditions is shown on Figure 7-4. Large areas of the system cannot meet the enhanced fire flow requirements established by Menlo Park Fire District with existing infrastructure.

As noted in Section 5.1.1, the modeled fire flow requirements are intended to be used for long-term planning purposes to support potential future land uses and in most cases are greater than the current fire flow requirements for existing land uses. Thus, locations where fire flow availability does not meet the long-term planning fire flow requirements may still have sufficient fire flow availability to meet existing fire flow requirements. In addition, as noted in Section 5.1.1, the long-term planning fire flow requirements proposed by Menlo Park Fire District and presented herein are significantly greater than those assumed by the City during prior planning efforts.



Legend

- W — Gloria Way Well
- Existing SFPUC Turnout
- Existing Pipe

Available Fire Flow (gpm)

- < 500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,500
- 2,500 - 4,000
- >4,000
- Available Fire Flow Below Requirement

Abbreviations

gpm = gallons per minute
psi = pounds per square inch
SFPUC = San Francisco Public Utilities Commission

Notes

1. All locations are approximate.
2. Available fire flow is the flow at the hydrant that does not cause pressures to drop below 20 psi at any other service connection locations.
3. Gloria Way Well is assumed to be offline.

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Available Fire Flow with Maximum Day Demands Existing Scenario

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-4

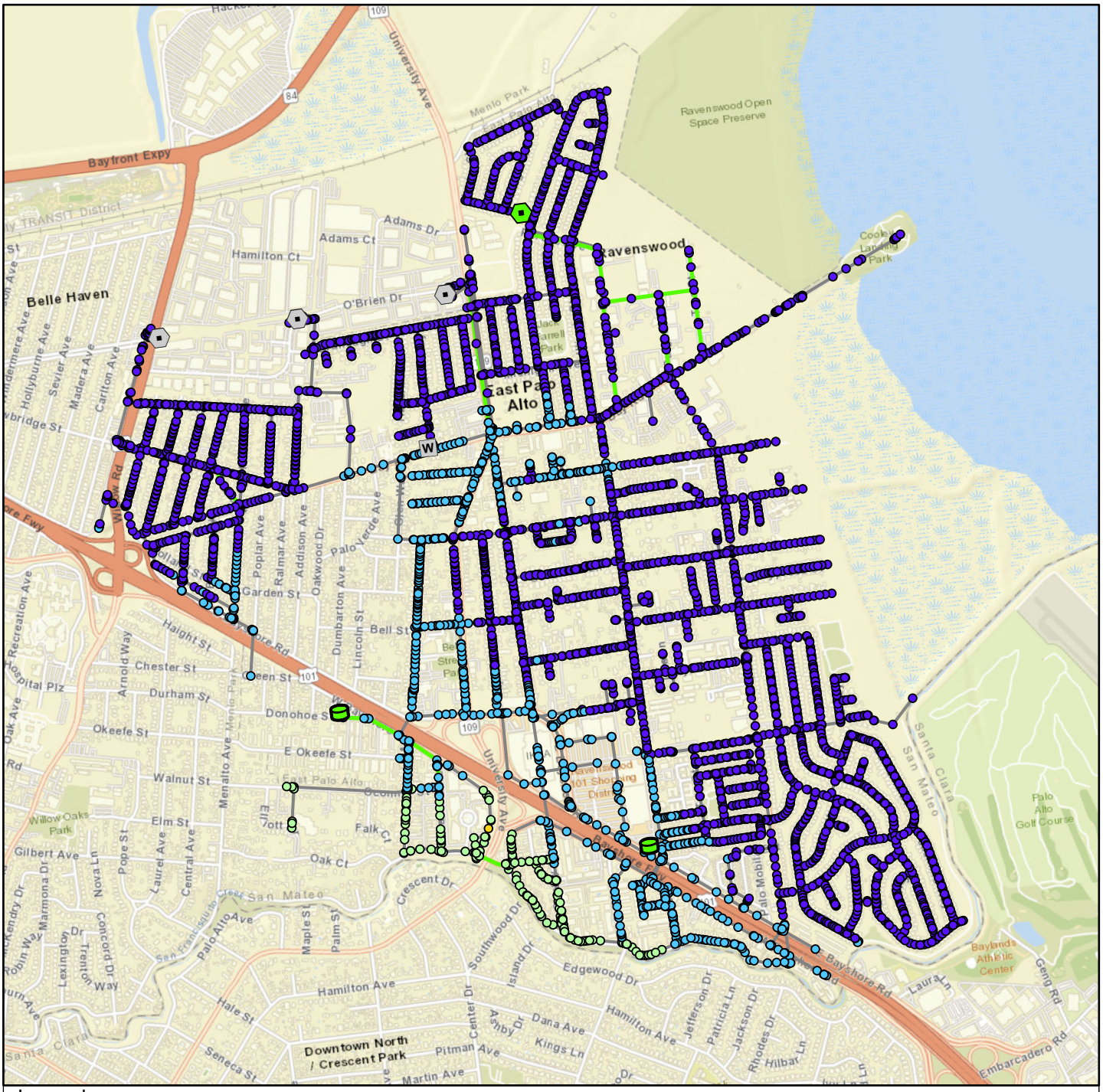
eki environment & water

Path: X:\C10082.00\Map\EPA_WSMP_Figures.aprx

7.2 Future Scenario Evaluation

7.2.1 PHD Results

Model results indicate that with the planned improvement, the system can meet minimum pressure criteria of 40 psi system-wide under PHD conditions. Modeled system pressures ranged from 45 psi to 61 psi, as shown on Figure 7-5. Results show that velocities are elevated near the four turnouts but none exceed the maximum 6 fps criteria (Figure 7-6). As shown on Figure 7-7, head losses exceed criteria near the four turnouts. As discussed in Section 5.2.1, these exceedances do not necessarily indicate there is a problem unless the head loss is contributing to pressure deficiencies.



Legend

Existing Infrastructure

- Existing SFPUC Turnout
- W Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- Pipe Improvement
- New SFPUC Turnout
- New Tank and Booster Pump Station

Junction Pressure (psi)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- >55

Notes

1. All locations are approximate.
2. Only nodes located at customer service connections are shown.
3. Gloria Way Well is assumed to be offline.

N

0 875 1,750 3,500

US Feet

Abbreviations

psi = pounds per square inch
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

Junction Pressure with Peak Hour Demands Future Scenario with Planned Projects

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-5

eki environment & water

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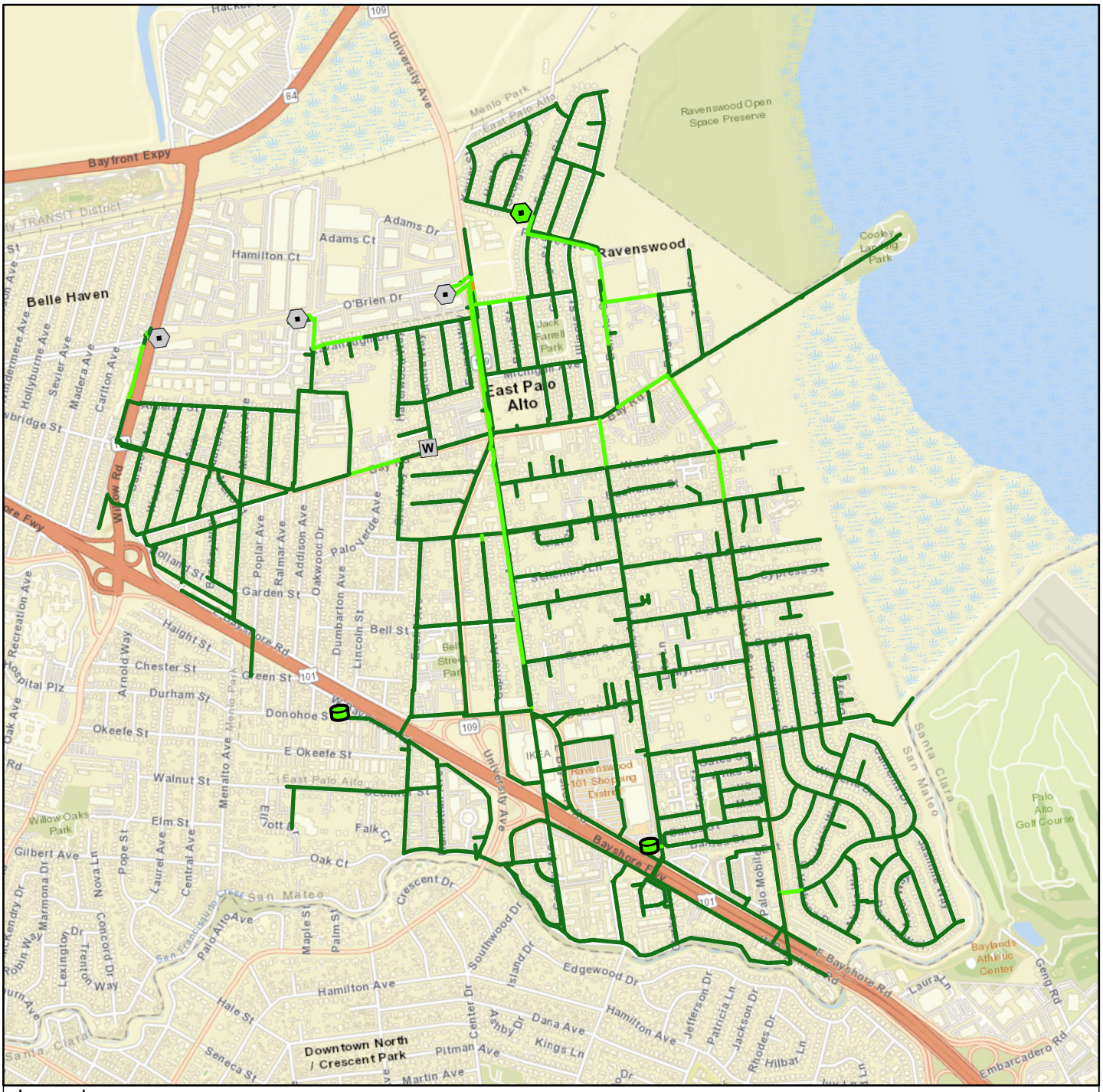


Legend

Existing Infrastructure

- Existing SFPUC Turnout
- W Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- New SFPUC Turnout
- New Tank and Booster Pump Station

Velocity in Water Mains (ft/s)

- < 1
- 1 - 3
- 3 - 5
- 5 - 6

Notes

1. All locations are approximate.
2. Gloria Way Well is assumed to be offline.

N

0 875 1,750 3,500

US Feet

Abbreviations

psi = pounds per square inch

SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

Pipe Velocity with Peak Hour Demands Future Scenario with Planned Projects

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-6

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_Fig_part1.aprx

Legend

Existing Infrastructure

- Existing SFPUC Turnout
- W Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- New SFPUC Turnout
- New Tank and Booster Pump Station

Headloss per Thousand Feet in Water Mains (ft/k-ft)

- <3
- 3 - 7
- 7 - 10
- 10 - 15
- >15

Notes

1. All locations are approximate.
2. Gloria Way Well is assumed to be offline.

N

0 875 1,750 3,500

US Feet

Abbreviations

ft/k-ft = foot head loss per 1,000 feet of pipe
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

Headloss with Peak Hour Demands
Future Scenario with Planned Projects

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 7-7

eki environment & water

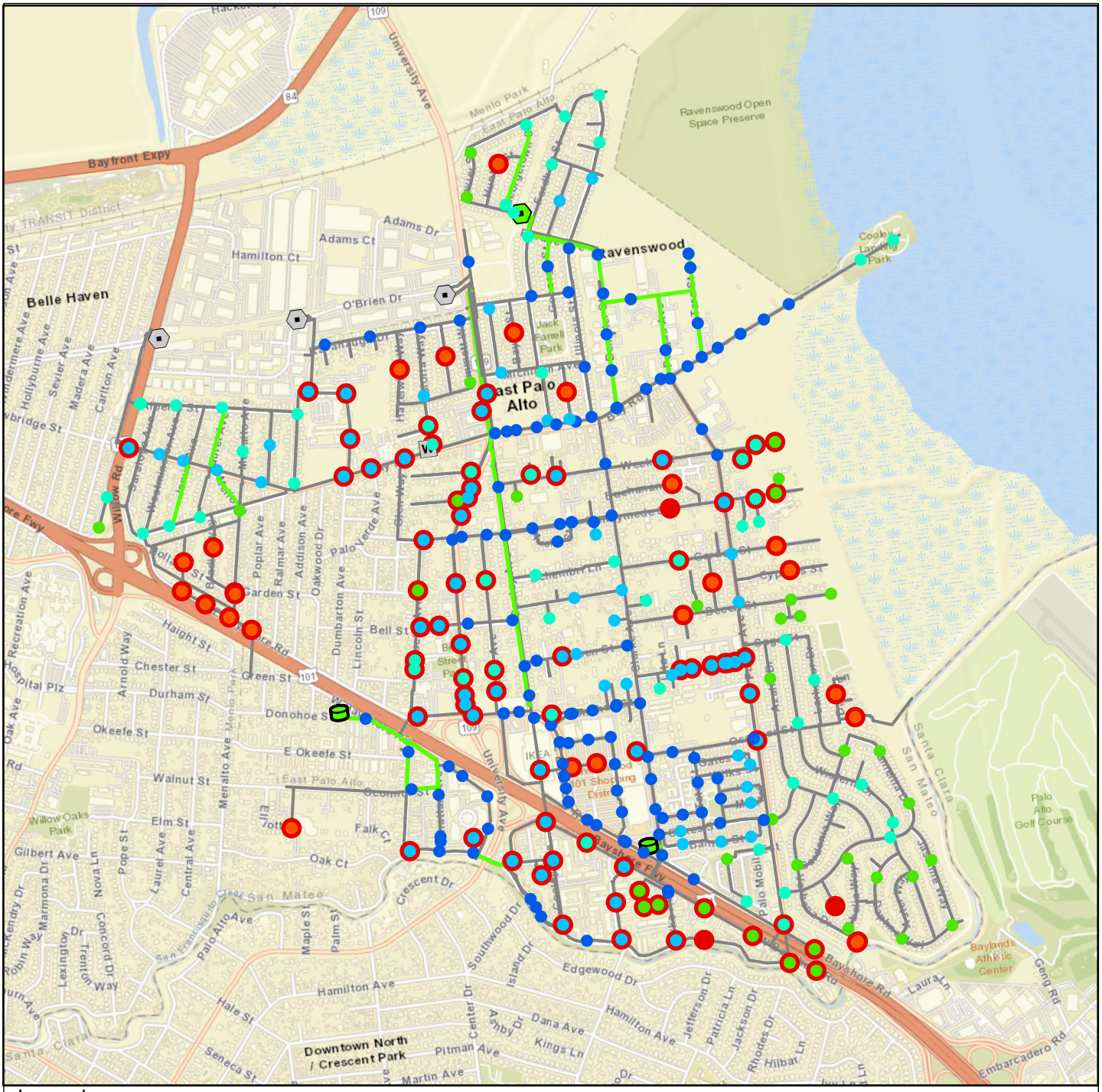
Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_Fig_part1.aprx

7.2.2 MDD Plus Fire Flow Results

Modeled fire flow availability is shown on Figure 7-8. Several areas cannot meet the enhanced long-term planning fire flow requirements, including:

- Bay Road
- University Corridor where the commercial accounts are located
- Areas near Ikea
- South of Highway 101
- The neighborhood near East Bayshore Road near Willow Road
- Other areas near Weeks Street and Schools near the intersection of Myrtle Street and Pulgas Avenue

As noted in 7.1.2, as the fire flow requirements are intended for long-term planning purposes, and locations where the requirements are not met are not necessarily reflective of an existing deficiency.



Legend

Existing Infrastructure

- Existing SFPUC Turnout
- W Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- Pipe Improvement
- New Tank and Booster Pump Station

Available Fire Flow (gpm)

- <500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,500
- 2,500 - 4,000
- > 4,000
- Available Fire Flow Below Requirement

Abbreviations

CIP = Capital Improvement Project
gpm = gallons per minute
psi = pounds per square inch
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Notes

1. All locations are approximate.
2. Available fire flow is the flow at the hydrant that does not cause pressures to drop below 20 psi at any other service connection locations.
3. Gloria Way Well is assumed to be offline.

Available Fire Flow with Maximum Day Demands Future Scenario with Planned Projects

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00
Figure 7-8

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_Fig_part1.aprx

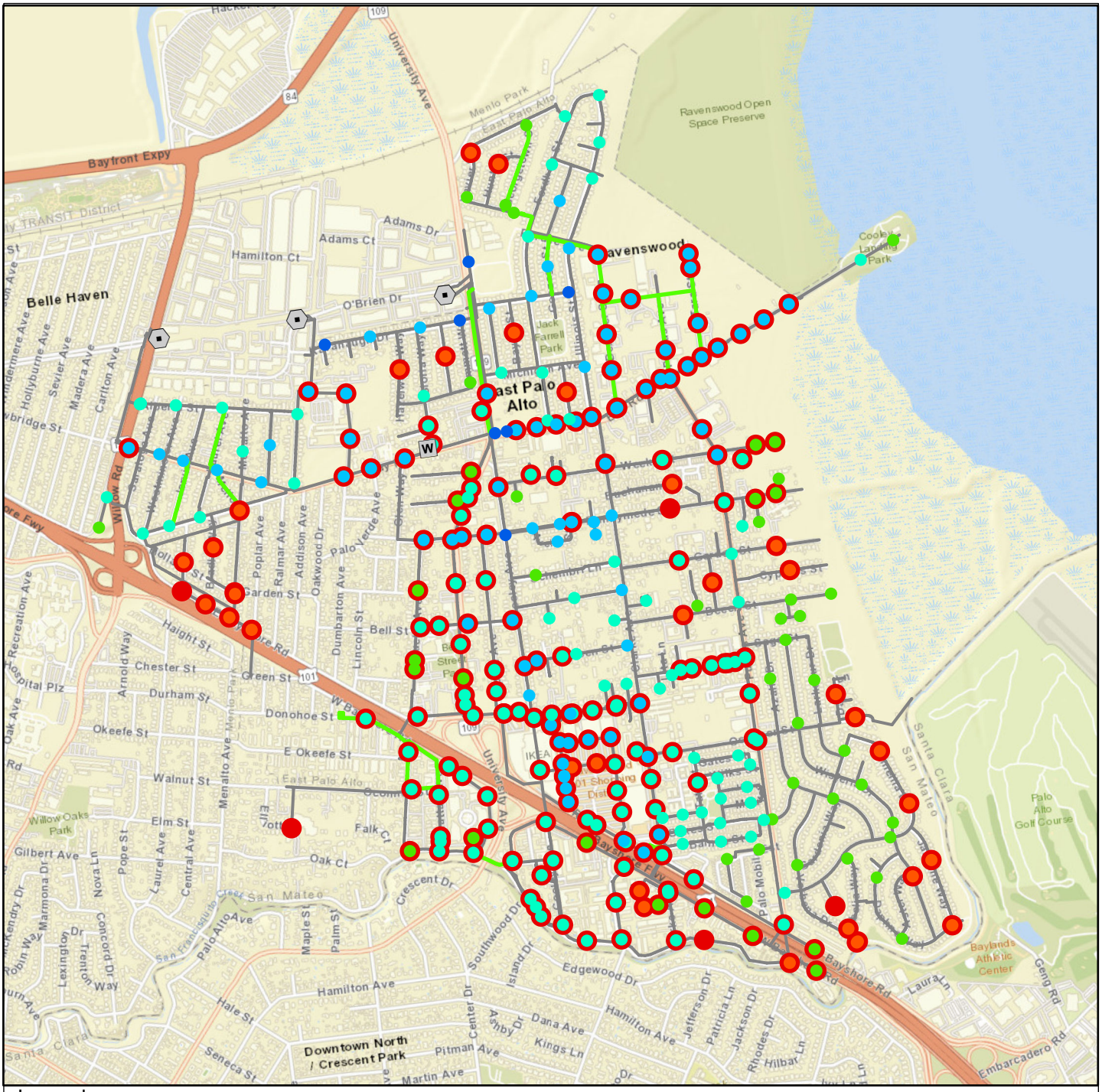
7.3 Modeling Evaluation of Fourth SFPUC Turnout

As discussed in Section 3.3, the City has proposed and is currently designing a fourth turnout off of SFPUC's Bay Division Pipeline on Purdue Avenue between Georgetown Street and Fordham Street to improve fire flows within the City and to support the future RBD/4 Corners TOD Specific Plan. SFPUC provided the City a letter of commitment to construct a fourth turnout on 25 October 2021 (SFPUC, 2021) and requested that this WSMP analyze the need for and benefits of the fourth turnout.

The future scenario described in Section 7.2 included the fourth turnout in addition to the other planned projects identified in Section 3.3. To specifically show the impact of the fourth turnout, EKI has prepared two additional modeling scenarios: (1) the future scenario without the Donohoe and Pad D Tanks/Booster Pump Stations or fourth turnout and (2) the future scenario with the fourth turnout but without the Donohoe and Pad D Tanks/Booster Pump Stations. Fire flow availability under future MDD conditions was modeled for each scenario, as shown in Figure 7-9 and Figure 7-10, respectively.

As shown in Figure 7-9, only 36% of the hydrants in the City would meet long-term planning fire flow requirements under the future demand scenario (116 of 324 hydrants) without either the Donohoe and Pad D Tanks or the fourth turnout in place. Adding the fourth turnout increases the number of hydrants systemwide that would meet fire flow by 34% such that approximately 48% of all hydrants (154 of 324) and all of the hydrants in the RBD/4 Corners TOD Specific Plan area would meet the requirements after construction of the turnout (Figure 7-10). Adding the Donohoe and Pad D Tanks/Booster Pump Stations, as shown on Figure 7-8, would increase the number of hydrants that meet the required fire flow by an additional 42% such that 68% of hydrants citywide (219 of 324) would meet requirements. These results indicate that adding the fourth turnout is able to provide the necessary increase in fire flow availability to support planned development in the RBD/4 Corners TOD Specific Plan area. Additionally, the fourth turnout adds redundancy to the City's system by increasing its firm supply capacity, as shown in Section 8, below.

The fourth turnout represents a cost-effective solution to significantly improve the system hydraulics and supply redundancy. Given that the City has already initiated the design of the fourth SFPUC turnout and 16-inch transmission line and coordination with SFPUC, the project could be completed on an accelerated schedule. Therefore, EKI recommends that the City prioritize the installation of the fourth turnout as part of its CIP (see Section 10).



Legend

Existing Infrastructure

- Existing SFPUC Turnout
- Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- Pipe Improvement

Available Fire Flow (gpm)

- <500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,500
- 2,500 - 4,000
- > 4,000
- Available Fire Flow Below Requirement

Abbreviations

CIP = Capital Improvement Project
gpm = gallons per minute
psi = pounds per square inch
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Notes

1. All locations are approximate.
2. Available fire flow is the flow at the hydrant that does not cause pressures to drop below 20 psi at any other service connection locations.
3. Gloria Way Well, Pad D Tank, Donohoe Tank, and Fourth Turnout are assumed to be offline.

Available Fire Flow with Maximum Day Demands
Future Scenario without the Pump Stations or the Fourth Turnout

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00
Figure 7-9

eki environment & water

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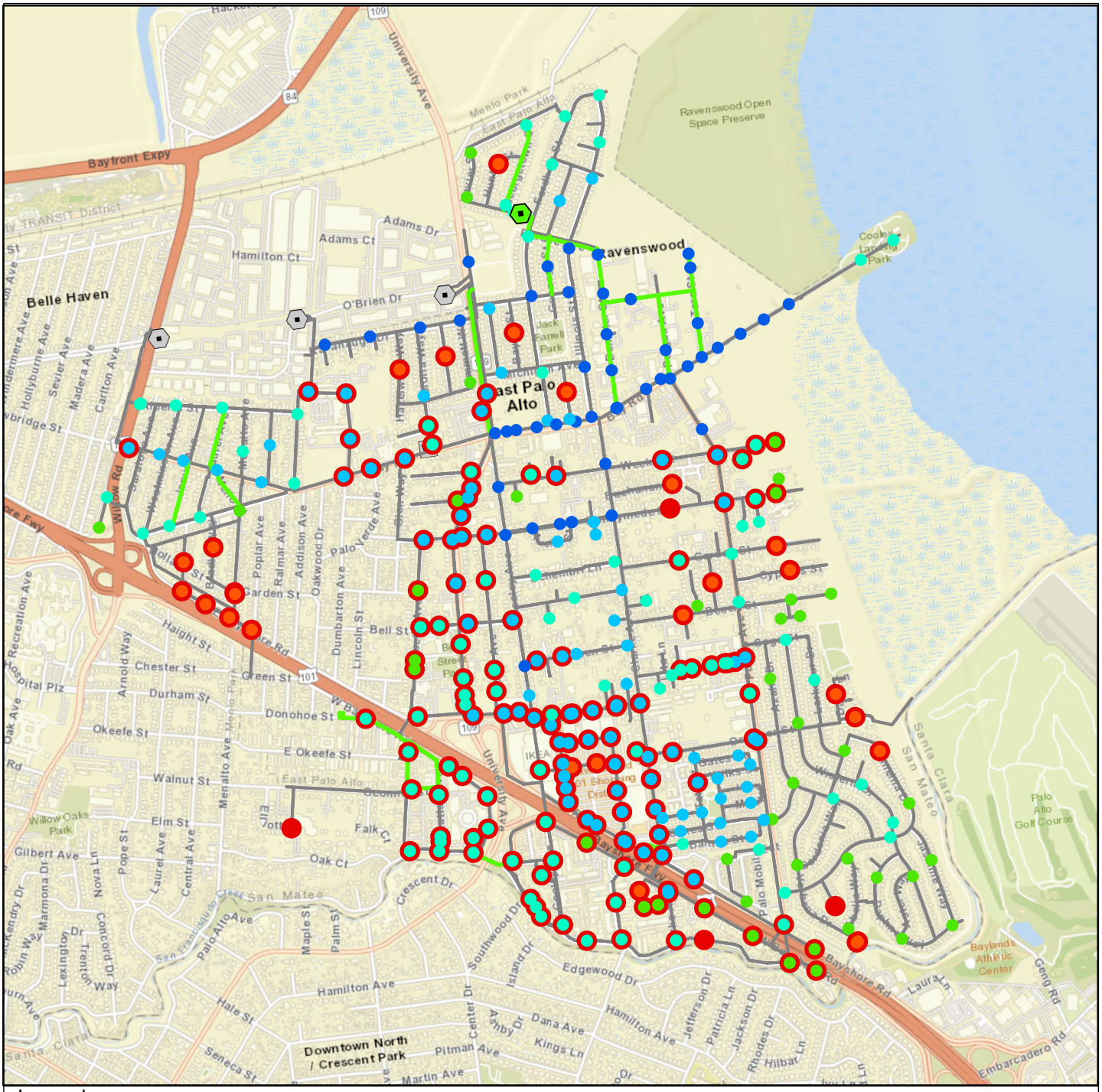

Legend

Existing Infrastructure

- Existing SFPUC Turnout
- W Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- Pipe Improvement

Available Fire Flow (gpm)

- <500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,500
- 2,500 - 4,000
- > 4,000
- Available Fire Flow Below Requirement

Abbreviations

CIP = Capital Improvement Project
gpm = gallons per minute
psi = pounds per square inch
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Notes

1. All locations are approximate.
2. Available fire flow is the flow at the hydrant that does not cause pressures to drop below 20 psi at any other service connection locations.
3. Gloria Way Well, Pad D Tank, and Donohoe Tank are assumed to be offline.

Available Fire Flow with Maximum Day Demands Future Scenario with the Fourth Turnout and without the Pump Stations

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00
Figure 7-10

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_Fig_part1.aprx

7.4 Recommended Distribution System Capacity Improvements

EKI developed improvement projects to address parts of the system identified in the hydraulic modeling evaluation that could not meet the performance criteria in the future scenario. The projects largely consistent of pipeline projects to improve system pressures. In general, transmission pipelines from supply sources that exhibited higher velocities and head losses in modeling results were targeted first, because upsizing these pipelines can significantly assist downstream pressure issues. Remaining fire flow deficiencies were addressed by upsizing distribution mains, adding new pipe connections, relocating hydrant laterals to a larger nearby pipe, or adding control valves that would open during low pressure conditions (e.g., fire flow conditions).

As part of the recommend improvements, EKI has proposed modifications to certain projects currently planned or designed (see Section 3.3), discussed below:

- 16-Inch Water Transmission Main Project at Purdue Avenue: EKI recommends an additional 8-inch interconnection near Purdue Avenue and Fordham Street downstream of the new fourth turnout between the new 16-inch main and the existing 6-inch main on Purdue Avenue to improve fire flow availability in the residential areas located northeast of Purdue Avenue.
- 12-Inch Water Transmission Main Project, University Avenue and Cooley Avenue: Instead of installing the new transmission main on Cooley Avenue south of Bay Road, EKI recommends replacing the existing 8-inch CI Pipe on University between Bay Road and Donohoe St with a new 12-inch PVC main. These modifications would largely provide all the benefits of the original project but would also improve fire flow availability on University Avenue above the required 4,000 gpm. EKI also recommends an additional interconnection to the 8-inch CI mains at Michigan Avenue and reconnection of hydrants along University Avenue north of Bay Road to the new 12" PVC main.
- Water system improvements to support the Euclid Improvements: EKI Recommends 12" PVC mains be installed instead of the planned 12" and 14" HDPE mains for consistency with City standard pipe material. In addition, instead of installing a 4,000-gpm fire pump at the 375 Donohoe Pump Station, EKI recommends that five 625-gpm (40 hp) pumps with VFDs be installed to better supply the system during normal and fire flow conditions.

These hydraulic capacity projects are discussed in Section 9.0. EKI modeled the proposed improvements under future demand conditions to confirm the performance criteria were met systemwide. These results are presented in Appendix B.

8 WATER SUPPLY AND STORAGE CAPACITY EVALUATION

This section evaluates the City's water system storage and supply capacity to meet the recommended performance and operational criteria (Section 5) under existing and future scenarios described in Section 4.2.

8.1 Supply Capacity Evaluation

As discussed in Section 5.1.3, the City's required firm supply capacity from each of its supply sources and storage tanks must be greater than MDD plus fire flows or PHD, whichever is greater. The firm supply capacity was calculated to be the total supply capacity of each supply source, assuming the highest capacity source is offline. As shown in Table 8-1, the firm capacity of the City's existing supply sources exceeds the supply criteria based on existing demands and the firm capacity of the planned supply sources exceed the supply criteria based on future demands. Thus, no additional supply sources are needed to meet the supply criteria.

Table 8-1 . Projected Supply Requirements

Available or Required Capacity		Existing		Future	
		gpm	mgd	gpm	mgd
Available Supply Capacity	SFPUC Turnout - 1351 O'Brien Ave (10") (a)	6,150	8.9	6,150	8.9
	SFPUC Turnout - 1240 O'Brien Ave PRV 1 (6") (a)	2,250	3.2	2,250	3.2
	SFPUC Turnout - 1240 O'Brien Ave PRV 2 (8") (a)	3,900	5.6	3,900	5.6
	SFPUC Turnout - 1330 Willow Road (6") (a)	2,250	3.2	2,250	3.2
	Future 4th SFPUC Turnout - PRV1 (6") (a)	-	-	2,250	3.2
	Future 4th SFPUC Turnout - PRV2 (8") (a)	-	-	3,900	5.6
	Gloria Way Well (b)	150	0.2	150	0.2
	Future Pad D Tank BPS (c)	-	-	500	0.7
	Future 375 Donohoe Tank BPS (c)	-	-	2,500	3.6
	Total Available Firm Supply Capacity (d)	**8,550**	**21**	**17,700**	**34**
Criteria 1: Max Day Plus Fire Flow	MDD+FF	5,404	7.8	8,338	12.0
	MDD+FF Supply Capacity Surplus	**3,146**	**13.4**	**9,362**	**22.3**
Criteria 2: Peak Hour Demands	PHD	2,106	3.0	4,338	6.2
	PHD Supply Capacity Surplus	**6,444**	**18.1**	**13,362**	**28.1**
Supply Capacity Surplus (e)		**3,146**	**13.4**	**9,362**	**22.3**

Abbreviations:

BPS = booster pump station
gpm = gallons per minute SFPUC
MDD+FF = maximum day demand plus fire flow
mgd = million gallons per day
PHD = peak hour demand
SFPUC = San Francisco Public Utilities Commission

Notes:

(a) Capacities of the SFPUC Turnouts are based on the rated maximum intermittent flow for the associated PRVs (https://www.cla-val.com/wp-content/uploads/2021/03/E-90-01.pdf).
(b) Capacity of Gloria Way Well assumed to be the current flow setting of 150 gpm.
(c) Capacity of the planned booster pump stations assumed to be the firm capacity with the largest pump out of service.
(d) Total available firm capacity is assumed to be the sum of the available supply capacities with the largest capacity supply source out of service.
(e) Supply capacity surplus or deficit equals the minimum of the MDD+FF Capacity Surplus or PHD Supply Capacity Surplus.

8.2 Storage Evaluation

As discussed in Section 5.2.2, the City's required storage capacity is comprised of equalization (25% of MDD), fire (0.96 MG based on a commercial fire flow requirement of 4,000 gpm with a duration of four hours), and emergency storage (100% of ADD). Total existing required storage is equal to 3.02 MG and the future required storage is 5.20 MG.

The City currently does not have any storage tanks within its system but is working with local developers to construct 1.65 MG of storage (Pad D and Donohoe Tanks). The City does have a groundwater credit of 0.16 MG (see Section 5.2.2.4) and is planning for an additional 0.54 MG of groundwater credit for total future credit of 0.7 MG. Thus, the City currently has a storage deficit of 2.86 MG and a future deficit of 2.85 MG (assuming planned tank and groundwater well projects are constructed). Table 8-2 provides a summary of existing and future storage requirements and capacity.

Table 8-2. Projected Storage Requirements

Storage Component		Existing	Future
Available Storage Capacity (MG)	Existing Storage Capacity	-	-
	Groundwater Credit (a)	0.16	0.16
	Planned Groundwater Credit (a)	-	0.54
	Planned Storage Capacity (b)	-	1.65
	Total Existing and Planned Storage Capacity	0.16	2.35
Required Storage Capacity (MG)	Operational	0.51	1.04
	Emergency	1.56	3.20
	Fire Storage	0.96	0.96
	Total Projected Required Storage Capacity	3.02	5.20
Total Projected Storage Capacity Surplus (Deficit)		**(2.86)**	**(2.85)**

Abbreviations:
MG = million gallons

Notes:
(a) Groundwater credit is calculated as the capacity of the wells with backup power over an 18-hour period.
(b) Planned storage capacity includes the 1.5 MG Tank at 375 Donohoe and the 0.15 MG Pad D Tank.

8.3 Preliminary Water Storage Siting Evaluation

Based on the supply and storage evaluations presented above, it is recommended that the City plan for installation of an additional 3.0 MG of storage within the system to meet the storage requirements of the future scenario (in addition to the developer funded tanks at Pad D and 375 Donohoe). The additional storage could be distributed at multiple locations in the City or at a single centralized facility.[6] A booster pump station would be required at each tank site to deliver stored water to the distribution system.

EKI has identified two sites that are either owned by the City or designated for a future park that appear to be amenable for installation of future tanks (See Figure 8-1): (1) a vacant parcel at the corner of

[6] The City currently assumes two new storage tanks in its existing 10-year CIP.

University Avenue and Bay Road (APN 063-111-230) owned by the City, and (2) a vacant parcel located north of Martin Luther King Jr Park (APN 063-600-060) currently owned by San Mateo County.

Based on its limited footprint, the property at the Corner of University Avenue and Bay Road would only be able to accommodate a small portion of the total required storage (i.e., less than 1 MG). Also, the site is located at a prominent intersection adjacent to the planned 4 Corners TOD project. Thus, a large storage tank is not ideally suited for this location and the property was determined not to be a feasible tank site.

The City is currently in discussions with San Mateo County to acquire the parcel located north of Martin Luther King Jr Park. The site is approximately 2.28 acres and would likely be large enough to accommodate a 3.0 MG storage tank and booster pump station. However, the City currently has plans to use the site as part of an expansion and renovation of Martin Luther King Jr Park (City of East Palo Alto, 2022b), which would exclude or significantly limit the size of a potential storage facility at the site. EKI recommends that this site be retained for future study.

Additional study is required to select one or more storage sites. As described in Section 10, EKI recommends that the City retain the two storage projects in the City's existing 10-year CIP to meet the 3.0 MG of required storage. Under the CIP budget for these projects, EKI recommends that the City perform a detailed tank siting study as an initial planning step.

Because the siting of the tanks is uncertain, the water system modeling and resulting recommended hydraulic improvements were developed without adding storage other than the Pad D and 375 Donohoe Tanks. However, adding additional tanks and booster pump stations to the system may reduce the extent of required piping improvements in the areas nearby the tanks.

Legend

- City of East Palo Alto's Service Area
- Potential Future Tank Sites

Sources

1. Street map provided by ArcGIS online.

N

0 875 1,750 3,500

US Feet

Potential Future Tank Sites

Notes

1. All locations are approximate.

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 8-1

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9 RECYCLED WATER PROJECTED DEMAND AND USE EVALUATION

This section presents a Citywide non-potable demand analysis that identifies potential opportunities to use recycled water within the City.

9.1 Potential Source of Recycled Water

The East Palo Alto Sanitary District provides sanitary sewer collection within the City's service area and conveys the wastewater to the City of Palo Alto's Regional Water Quality Control Plant (RWQCP). The RWQCP treats wastewater from the City, as well as Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford University, and produces title 22 recycled water that can be used for many non-potable applications. The RWQCP is located approximately half a mile from the City's south-east corner, however there are currently no recycled water pipelines to convey recycled water from the RWQCP to the City.

The RWQCP is a tertiary wastewater treatment plant that treats approximately 20 MGD of wastewater and has the capability to produce approximately 4.5 MGD of recycled water that meets the Title 22 unrestricted use standard (City of Palo Alto, 2021).[7] Current annual production of recycled water is approximately 14% of the 4.5 MGD capacity. The City of Palo Alto plans to expand the recycled water distribution system and increase the recycled water demands in the future.

9.2 Recycled Water Market Analysis

Recycled water produced by the RWQCP meets title 22 unrestricted reuse standards and is suitable for non-potable uses such as landscape and agricultural irrigation, cooling towers, industrial process water, and environmental habitat enhancement (e.g., augmentation of a surface water body not used for potable water supply). Given the lack of heavy industry and agriculture that could utilize the recycled water in the City's service area, this market analysis focused on recycled water use for landscape irrigation.

Water use by the City's customers is metered and billed monthly by account; however, the City does not have dedicated irrigation accounts. To estimate irrigation demand, a unit demand factor has been applied to estimated landscaped areas. Several parks and schools have been identified as large irrigation water users due to their large areas of green space and water use data that show seasonal water use patterns (e.g., more water use in the summer months when irrigation primarily occurs). Additionally, the City is currently developing a Parks Master Plan and have identified sites for potential future parks. Irrigation demands for these parcels were estimated based on the potential irrigated area and an irrigation water use factor of 0.78 MG per acre per year (or 29 inches per acre), which is based on water use at three City parks.[8]

The result of the market assessment is presented in Table 9-1, which lists the most significant potential recycled water users ranked based on the estimated annual demands. The sites identified are schools and parks that have large irrigated areas, however there may be other potential users such as large apartment complexes and construction contractors that could also utilize recycled water to a lesser degree. The total anticipated demand of the top 11 users is approximately 22 MG per year.

[7] Regional Water Quality Control Board, San Francisco Bay Region Order No. 93-160 lists the capacity as 9 MG.
[8] Martin Luther King Jr. Park, Jack Farrell Park, and University Square Park.

Table 9-1. Top Potential Recycled Water Users

Ranks	User Name/Description	User Type	area (ac)	Annual Demand (MG)
1	Cesar Chavez Ravenswood Middle School	School	5.3	4.1
2	Martin Luther King Jr Park (a)	Park	3.5	3.9
3	Potential RBD Turf Irrigated Area (b)	Park	5.0	3.8
4	Costano Elementary School	School	3.4	2.6
5	Jack Farrell Park (a)	Park	2.3	2.0
6	Bell Street Park	Park	2.4	1.9
7	University Square Park (a)	Park	1.5	1.7
8	Euclid Improvements Park (c)	School	1.0	0.8
9	Eastside College Preparatory School Field	School	0.9	0.7
10	Ravenswood Elementary School District Football Field	Park	0.7	0.6
11	Ravenswood City SCH DIST - Garden St	School	0.6	0.5
Total	-	-	**26**	**22**

Abbreviations:

ac = acre
DIST = district
MG = million gallon
RBD = Ravenswood Business District
SCH = school
St = street

Notes:

(a) Average annual demands from Fiscal Year 2018 to 2020 per account billing data were available in the Martin Luther King Jr. Park, Jack Farrell Park, and University Square Parks and are presented herein. Other demands were estimated per the irrigation water use factor of 0.78 MG per acre per year (or 29 inches per acre), which is based on water use at three City parks.

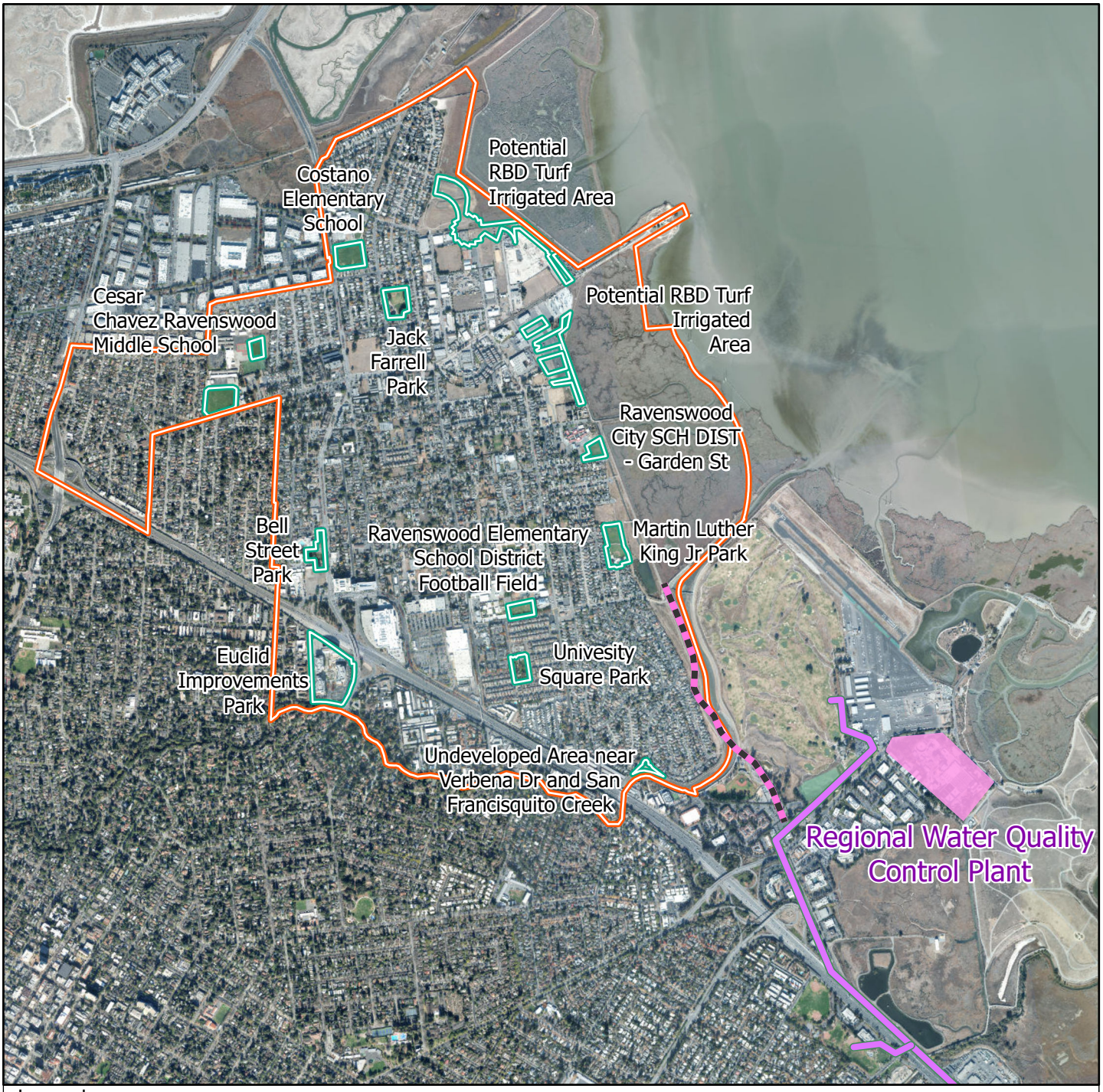
(b) A total of 23 acres of land were designated as “usable open space” and “private public open space” within the RBD development in the draft East Palo Alto Parks Master Plan. For this analysis EKI assumed that a quarter of the area would be irrigated turf.

(c) The exact location and size of the Euclid Improvements Park was not discussed in the draft East Palo Alto Parks Mater Plan. Thus 1 acre of land was assumed to be irrigated turf for this recycled water analysis.

Figure 9-1 shows the spatial distribution of these potential recycled water users in the service area in relation to the RWQCP and existing and proposed recycled water distribution lines. As shown on Figure 9-1, the potential recycled water users are distributed throughout the City, although the eastern portion of the City does contain many of the top potential users. The potential users clustered on the eastern side of the City are nearest to the proposed RW pipeline located west of the Baylands Golf Links. The City could potentially extend this pipeline approximately 1 mile north to Bay Road to serve these potential users.

Overall, the potential recycled water demand in the City is relatively limited (1.9% of the City’s total projected demand in 2045) and would require a significant investment in new pipelines and an agreement with the City of Palo Alto to serve the top users. Additionally, each of the potential users would need to perform onsite improvements to separate all potable water systems from irrigation systems in order to

use recycled water. Additional study is required to assess the feasibility and economics of supplying recycled water to the identified potential users.



Legend

- Potential Recycled Water Irrigation Customers
- City of East Palo Alto's Service Area
- Palo Alto Existing Recycled Water Pipeline
- Palo Alto Proposed Future Recycled Water Pipeline

Sources

1. Street map provided by ArcGIS online.
2. Palo Alto's existing and proposed recycled water pipeline alignments were obtained from the City of Palo Alto website. https://www.cityofpaloalto.org/Departments/Public-Works/Watershed-Protection/Recycled-Water-Pipeline-Strategic-Plan

N

0 1,125 2,250 4,500

US Feet

Top Potential Recycled Water Users

Notes

1. All locations are approximate.

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 9-1

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10 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

This section summarizes the recommended CIPs including (1) hydraulic capacity improvement projects based on the modeling evaluation presented in Sections 7, (2) storage facility improvements recommended in Section 8, and (3) improvements identified previously by the City that are included in the City's existing CIP budget. EKI has developed opinions of probable cost (OPC) and recommended priorities for each project.

10.1 CIP Costs

Cost for capacity improvement projects have been estimated based on recent bid results and EKI's experience with similar projects.

These costs are conceptual level estimates (Association for the Advancement of Cost Engineering [AACE] Class 5 estimates) with an estimated accuracy range of -30% to +50%, suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed to design and construction. An OPC for construction of each project has been developed using unit cost factors discussed below and are presented in September 2022 dollars based on an Engineering News Record (ENR) Construction Cost Index (CCI) of 15,083.26 (San Francisco).

The total CIP OPC also includes allowances equal to 60% of the construction OPC for project construction contingency, design, construction management, permitting, regulatory compliance, CEQA, and project implementation:

- Project Construction Contingency: 30%
- Design: 15%
- Construction Management: 5%
- Permitting, Regulatory Compliance, CEQA: 5%
- Project Implementation: 5%

10.1.1 Pipeline Project Costs

Unit costs for water pipeline projects are presented in Table 10-1. These costs vary by diameter and assume open-trench construction and installation of C900 or C905 PVC pipe for all projects. The unit construction costs presented below generally include pipeline materials, trenching, placing and joining pipe, placing imported pipe bedding and backfill material, and partial asphalt pavement replacement, if required. These costs are representative of pipeline construction under normal conditions and would be higher for difficult cases.

Table 10-1. Unit Construction Cost for Pipeline Projects

Pipe Diameter (inches)	Estimated Cost ($/linear foot)
6	270
8	330
10	390
12	470
16	640

In addition to the unit construction cost for length of pipe installed, Table 10-2 presents additional unit costs that have been included to better estimate total project costs.

Table 10-2. Miscellaneous Costs for Pipeline Projects

Item	Estimated Cost ($/ea)
Hydrant Replacements	16,500
New Services/ Replacements (≤2”)	5,000
New Services/ Replacements (>2”)	10,000
Main Connections	10,000

10.1.2 Treated Water Storage Tank Costs

Treated water storage tank costs are based on unit-volume cost factors which include the installation of above-grade steel storage tank, site piping, earthwork, paving, instrumentation, and all related sitework. Note that these costs are representative of construction conducted under normal excavation and foundation conditions and would be significantly higher for special or difficult foundation requirements.

10.1.3 Booster Pump Station Costs

The booster pump station OPCs conservatively assume new installation of the booster pump stations at the flow rates specified. It has been assumed that each new tank will require a new booster pump station. Costs include installation of the booster pumps, pump station building, site piping, earthwork, paving, on-site backup/standby power generator, SCADA, and related sitework.

10.1.4 Groundwater Supply Well Costs

The new groundwater supply well OPC assumes the project will consist of pilot hole drilling, geophysical logging, water quality/soil sampling, pilot hole reaming, well construction, well development, and installation of the necessary housing, pump, motor, electrical equipment, backup generator, SCADA equipment, discharge piping, hydropneumatic tank, and disinfection equipment. The construction OPC for a new 500 gpm well is estimated to be approximately $3,100,000 based on the estimate from the Pad D Well design documents, escalated to September 2022 dollars. The OPC assumes that no additional wellhead treatment will be required.

10.1.5 Miscellaneous Costs

In addition to the costs presented above, other cost factors are presented in Table 10-3.

Table 10-3. Miscellaneous Costs

Item	Estimated Cost ($/ea)
PRV Installation	130,000
SFPUC Turnout	150,000

PRV Station cost assumes a pre-assembled packaged PRV station that includes a 6-inch PRV and a 2-inch low-flow bypass PRV, a precast utility vault, and required connection piping, valves, and fittings.

10.2 Recommended Priorities

EKI has developed recommended priorities for each of the proposed improvements based on a risk-based scoring system. Two main categories were considered (1) condition of the improvement, which includes physical condition (pipe material, age, and size) and hydraulic performance, and (2) consequence of failure of the improvement, which includes service requirements, environmental/public impact, safety, and supply impact. Descriptions for the scoring system used is shown in Appendix C, along with how each category is weighted. The consequence of failure scoring matrix is based on the asset criticality table included in the City's Draft Asset Management Plan (Harris, 2021).

EKI has assumed the following description and weighting of each category:

- Condition (Total score out of 10)
  - Physical Condition
    - Description: Score represents the pipe material, age, and whether the pipe is under 6" diameter, which are proxies for the condition of the pipe. It is the City's goal to remove all small diameter pipes from its system and they are currently undertaking a condition assessment program to further evaluate pipe conditions.
    - Weighting (25%): This category was weighted less because the vast majority of pipelines within the City are old (50+ years) and in generally poor condition. Therefore, condition generally does not represent whether a project is high priority. The City and its contract operator Veolia are currently investigating asset condition in more detail, so condition scores may be adjusting as more information is gathered.
  - Hydraulic Performance
    - Description: Score represents the level of hydraulic benefit improvement on the City's system.
    - Weighting (75%): This category was weighted more because improving hydraulic performance within the City is a key priority of the CIP and much of the system is undersized, as discussed in Section 7.
- Consequence (Total score out of 10)
  - Service Requirements
    - Description: Score represents whether the improvement meets minimum Department of Drinking Water (DDW) requirements, such as maintaining minimum system pressures, emergency storage, or pipe size)

    - Weighting (35%): This category and the supply impact category were weighted the same to prioritize projects that involve transmission mains that may affect large portions of the City if they were to fail.

- Environmental/Public Impacts: 15% weighting
    - Description: Score represents the level of impacts to the environment or public that would occur if the improvement were to fail or not be implemented.
    - Weighting (15%): This category was weighted less because the City is generally built out and failure of water improvements are unlikely to cause major impacts to the environment or the public. However, failure of large water lines or tanks may impact the public from a supply perspective, which is captured in the Supply Impact category.
- Safety: 15% weighting
    - Description: Score represents the potential safety issues that would occur if the improvement were to fail or not be implemented.
    - Weighting (15%): This category was weighted less because failure of water infrastructure is unlikely to results in direct safety concerns, other than supply impacts.
- Supply Impact: 35% weighting
    - Description: Score represents the impacts to the City's water supply that would occur if the improvement were to fail or not be implemented.
    - Weighting (35%): This category and the supply impact category were weighted the same to prioritize projects that involve transmission mains that may affect large portions of the City if they were to fail.

The weighted totals of each category (condition and consequence) were then added together to determine an overall score with a maximum of 20 (higher numbers indicating that the project is of higher priority).

Finally, projects were then grouped into three priority groups according to their risk scores. A portion of the Priority 1 projects were designated as Priority 1A. The City is targeting to complete all of the Priority 1 projects within the next 5-10 years, with the goal of completing the Priority 1A projects within the next 5 years. Priority 2 and 3 projects are intended to be completed after the Priority 1 projects on a schedule that will depend upon available funding, among other considerations. Detailed project prioritization scores are included in Appendix C.

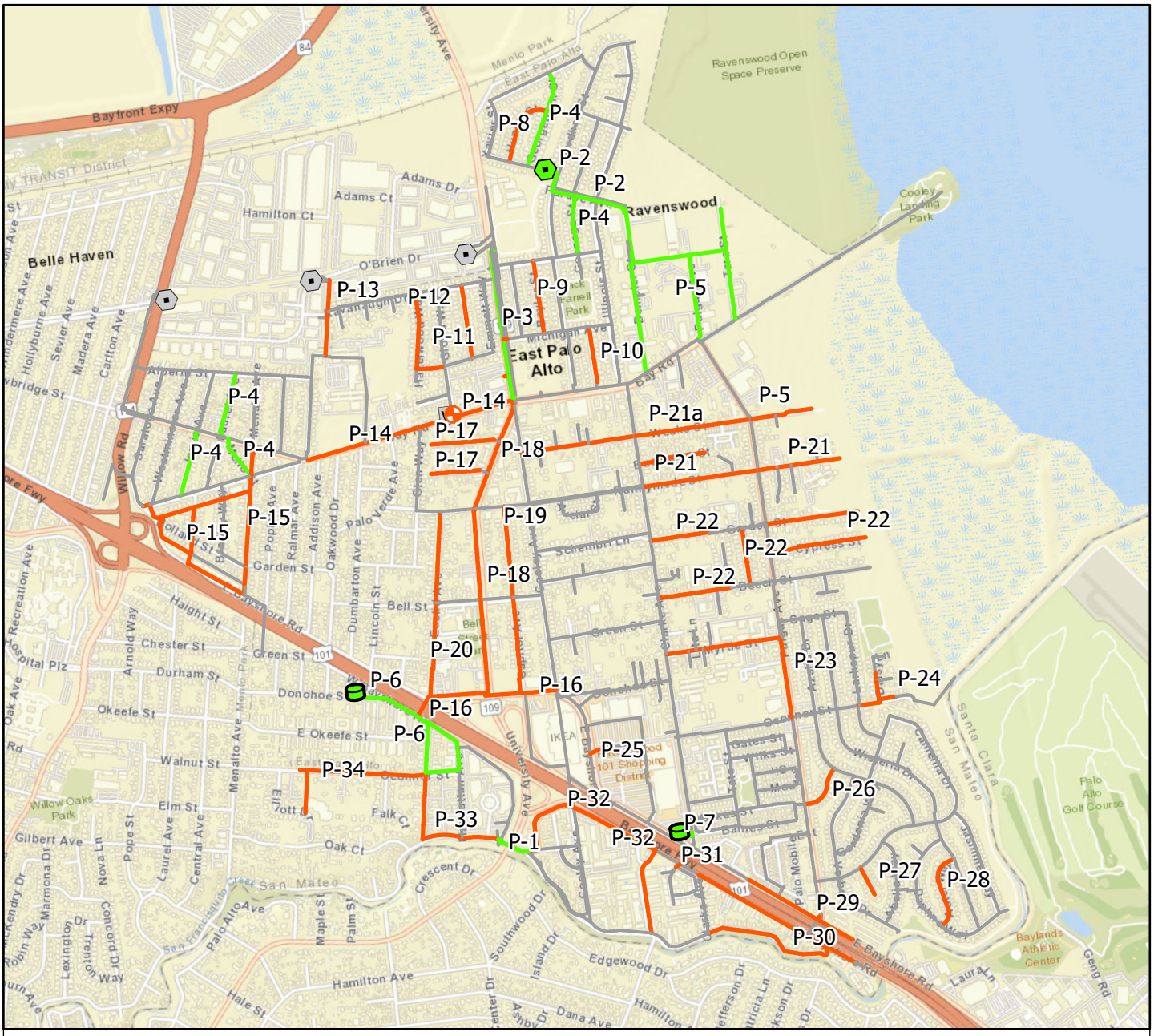
10.3 Capital Improvements Projects

Figure 10-1 shows an overview of the recommended improvements P-1 through P-34. A summary of the recommended improvements, as well the CIPs included in the City's existing 10-year CIP budget, are presented in Table 10-4. As shown in Table 10-4, the total OPC for all of the proposed CIPs in September 2022 dollars is approximately $80.6 million, including the water infrastructure projects currently in the City's 10-year CIP budget (some of which have been revised based on EKI recommendations, as described in Table 10-4). It should be noted that the recommended CIPs only identify improvements at a master plan level and do not constitute designs of such improvements. Subsequent detailed design is required to determine the exact sizes and locations of these proposed improvements.

In addition to the identified CIPs, there are 101,000 linear feet (or 19 miles) of additional CI pipes within the City's system that do not currently require hydraulic improvements. EKI suggests that the City focus on completing the hydraulic improvements identified herein, and then work on replacing the remaining

101,000 linear feet of CI pipe unless future condition assessments reveal the need for replacement of any other specific pipelines.

Project summary sheets are provided for each project in Appendix D. Each summary sheet includes a location map, a description of and justification for the proposed improvements, recommended priority, and estimated planning level OPC (summarized in Table 10-4).



Legend

Existing Infrastructure

- Existing SFPUC Turnout
- W Gloria Way Well
- Existing Pipes

Planned CIPs and Development Improvement Projects

- Pipe Improvement
- New SFPUC Turnout
- New Tank and Booster Pump Station

Additional Proposed Hydraulic Improvement Projects

- Pipe Improvement
- New Pressure Reducing Valve

Notes

1. All locations are approximate.

N

0 875 1,750 3,500

US Feet

Abbreviations

CIP = Capital Improvement Project
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

Recommended Water System Improvements

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure 10-1

eki environment & water

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TABLE 10-4
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
WD-05	Water Meter Replacement	Water Meter Replacement Program	--	--	--	Ongoing	8.0	$ 2,167,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WD-06	Hydrant Replacement	Fire Hydrant Replacement Program	--	--	--	Ongoing	12.7	$ 2,200,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WD-07	Water Valve Replacement Program	Water Valve Replacement Program	--	--	--	Ongoing	10.4	$ 1,280,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-01A/P-1	New Pipeline and Interconnection	Woodland Avenue Waterline and City of Palo Alto Interconnect Project - Install new 12" PVC on Woodland Avenue across University Avenue and new City of Palo Alto Interconnection	--	12" PVC	420	Priority 1A	16.6	$ 328,000	
P-2	New Pipeline	16-Inch Water Transmission Main Project - New 16" PVC pipeline on Purdue Avenue near Fordham St, Fordham St between Purdue Ave, and Purdue Avenue between Fordham St and Demeter St.	--	16" PVC	1,240	Priority 1A	15.9	$ 1,423,000	EKI recommends an additional interconnection near Purdue Avenue and Fordham St after the new turnout between the new 16" main and existing 6" main on Purdue Ave.
	New SFPUC Turnout	Planned Fourth Turnout on Purdue Avenue between Georgetown St and Fordham St.	--	--	--				
WS-03A	New Tank	New Storage Tank - East of Highway 101	--	--	--	Priority 1A	15.8	$ 4,700,000	Assumed to be a 1.5 MG tank with a 1.75 MGD pump station.
P-21a	Pipeline Replacement	Replace existing 8'' AC and 8" CI main on Weeks St between Cooley Avenue and Pulgas St with new 12" PVC main.	8'' AC and 8'' CI	12'' PVC	2,640	Priority 1A	15.8	$ 3,304,000	
WD-04B/WD-04C/P-3	New Pipeline and Pipeline Replacement	12-Inch Water Transmission Main Project (with Proposed Modifications) - Install new 12" PVC transmission main on University Avenue between O'Brien Dr and Bay Rd. Replace existing 8" CI on University Avenue between Bay Road and Donahoe St with new 12" PVC	8" CI	12" PVC	5,250	Priority 1A	15.4	$ 5,230,000	EKI recommends an additional interconnection to the 8" CI mains at Michigan Avenue and reconnection of hydrants along University to new 12" PVC. Instead of continuing on Cooley Ave as currently planned, EKI recommends replacing the existing 8" CI Pipe with new 12" PVC main on University between Bay Road and Donohoe St.
P-29	Pipeline Replacement	Replace existing 6'' CI main on E Bayshore Rd between 1805 E Bayshore (where the 12'' PVC ended) to Pulgas Ave with 12'' PVC main.	6'' CI	12'' PVC	970	Priority 1A	15.4	$ 1,290,000	
	Pipeline Replacement	Replace existing 8'' CI main on E Bayshore Rd between Pulgas Ave and the end of E Bayshore Rd to the east with 12'' PVC main.	8'' CI	12'' PVC	490				
P-32	Pipeline Replacement	Replace existing 6'' CI on Capital Ave and W Bayshore Rd between the intersection of Scofield Ave and Capital Ave to the Intersection of W Bayshore Rd and Newell Rd with 12'' PVC main.	6'' CI	12'' PVC	1,890	Priority 1A	15.4	$ 2,840,000	
	Pipeline Replacement	Replace existing 8'' CI on Newell Rd between W Bayshore Rd and Woodland Ave with 12'' PVC main.	8'' CI	12'' PVC	1,010				
P-33	Pipeline Replacement	Replace existing 8'' CI on Euclid Ave between O'Conner St and Woodland Ave and on Woodland Ave between Euclid Ave and University Ave with 12'' PVC main.	8'' CI	12'' PVC	1,640	Priority 1A	15.4	$ 1,752,000	
P-13	Pipeline Replacement	Replace existing 8" CI, 10" AC, and 10" unknown mains from connection to the 1240 O'Brien turnout on O'Brien Drive through an existing easement to Ralmar Avenue with new 12" PVC main.	8" CI, 10" AC, and 10" Unknown	12" PVC	900	Priority 1	15.4	$ 845,000	

TABLE 10-4
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-5	Pipeline Replacement	Replace existing 10" CI main on Demeter St between 351 Demeter St and 255 Demeter St with new 16" PVC main.	10'' CI	16'' PVC	580	Priority 1	15.1	$ 7,850,000	Pipeline Improvements for the Ravenswood Business District Specific Plan
	Pipeline Replacement	Replace existing 6'' CI mains on Demeter St between 255 Demeter St and Bay Rd and on Tara St between Bay Road and North of Bay Rd with new 12" PVC main.	6'' CI	12'' PVC	3,430				
	Pipeline Replacement	Replace existing 8'' CI mains on Pulgas Ave between Bay Rd and North of Bay Rd and on Weeks St between Pulgas Ave to the deadend with new 12" PVC main.	8'' CI	12'' PVC	3,100				
	New Pipeline	Install 12'' PVC main connecting Pulgas Aveand Tara St and replace existing 10'' CI mains connecting Demeter St and Pulgas Ave.	--	12'' PVC	1,070				
P-14	Pipeline Replacement	Replace existing 8" CI main on Bay Rd from University Avenue to Ralmar Avenue with new 12" PVC main.	8" CI	12" PVC	2,450	Priority 1	15.1	$ 2,529,000	EKI recommends a setting of 40 pounds per square inch to maintain the valve closed during normal operating conditions and open during fire flow conditions.
	New Pressure Reducing Valve	Install new 8" pressure reducing valve at Gloria Way and Bay Road at the existing isolation valve that prevents short-circuiting of production from Gloria Way. The PRV would open when pressures drop during fire flow conditions.	--	--	--				
P-6	New Tank	Install new 1.5 MG steel tank at 375 Donohoe Street	--	--	--	Priority 1	Not Ranked	Developer project. No CIP cost estimated	Improvements for the Euclid Improvements Development Project per Option 3 from 23 July 2020 memorandum from BKF to Woodland Park Property Owner, LLC. Pump station recommendations by EKI. EKI Recommends 12" PVC mains instead of 12" and 14" HDPE mains for consistency with City standard pipe material.
	New Pump Station	Install new booster pump station with five new 40-hp (625 gpm) pumps at 375 Donohoe Street	--	--	--				
	Pipeline Replacement	Replace the existing pipes in the loop between W Bayshore Rd (6'' CI), Manhattan Avenue (8'' PVC), O'Connor St (8'' CI), and Euclid Avenue (8''CI) with 12'' PVC main.	6'' CI, 8'' PVC, 8'' CI	12'' PVC	1,710				
	Pipeline Replacement	Replace existing 6'' CI on W Bayshore Rd between Donohoe Avenue and Euclid Avenue with 12'' PVC main.	6'' CI	12'' PVC	470				
	New Pipeline	Install 12'' PVC main to connect the steel tank at 375 Donohoe St and the new replaced pipes in the intersection of Donohoe St and W Bayshore Rd.	--	12'' PVC	540				
P-7	New Tank	Install new 0.15 MG steel tank at the Pad D Site	--	--	--	Priority 1	Not Ranked	Developer project. No CIP cost estimated	New Pad D Fire Suppression System for Light Tree Apartments assumed to be connected to the City's distribution system. Pump station recommendations by EKI.
	New Pump Station	Retrofit booster pump station with two new 30-hp (500 gpm) pumps at Pad D Site and connect to City's distribution system at Clarke Avenue near E Bayshore Rd.	--	--	--				
WS-03B	New Tank	New Storage Tank - West of Highway 101	--	--	--	Priority 2	14.8	$ 4,700,000	Assumed to be a 1.5 MG tank with a 2 MGD pump station.
P-21	Pipeline Replacement	Replace existing 6" CI main on Buchannan Ct from Clark Ave to the deadend to the east with new 8" PVC main.	6'' CI	8'' PVC	750	Priority 2	14.4	$ 2,910,000	
	Pipeline Replacement	Replace existing 8" CI main on Runnymede St between Pulgas Ave and the deadend to the east with new 10" PVC main.	8'' CI	10'' PVC	950				
	Pipeline Replacement	Replace existing 4" CI main on Runnymede St between Clarke Ave and Pulgas Ave with new 8" PVC main.	4" CI	8'' PVC	1,330				
P-16	Pipeline Replacement	Replace existing 8" CI Highway 101 Crossing near Euclid Avenue with new 12" PVC carrier pipe (via jack and bore)	8" CI	12" PVC	250	Priority 2	14.1	$ 2,792,000	Installed via jack and bore under Highway 101.
	Pipeline Replacement	Replace existing 8" CI on Donahoe St between Euclid Avenue and Cooley Avenue with new 12" PVC	8" CI	12" PVC	1,450				

TABLE 10-4
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-30	Pipeline Replacement	Replace existing 6'' CI main on W Bayshore Rd between Clark Avenue and Woodland Ave and existing 8'' PVC on W Bayshore Rd between Woodland and 1982 W Bayshore Rd with 10'' PVC main.	6'' CI, and 8'' PVC	10'' PVC	2,200	Priority 2	13.9	$ 2,949,000	
	Pipeline Replacement	Replace existing 4'' CI and a small section of 4'' PVC main on Woodland Avenue between W Bayshore Rd and Clarke Ave with 10'' PVC main.	4'' CI and 4'' PVC	10'' PVC	1,470				
P-17	Pipeline Replacement	Replace existing 2" GS and 4" CI mains on Weeks St west of University Ave	2" GS and 4" CI	8" PVC	780	Priority 2	13.4	$ 1,148,000	
	Pipeline Replacement	Replace existing 2" GS and 4" CI mains on Sacramento St west of University Ave	2" GS and 4" CI	8" PVC	660				
P-15	Pipeline Replacement	Replace existing 4" CI, 6" CI, and 6" plastic mains on Menalto Avenue between Newbridge St and E Bayshore Road and E Bayshore Rd between Menalto Avenue and Laurel Avenue with new 10" PVC main and install new looped 10" PVC connection on Laurel Avenue between E Bayshore Rd and alley north of E Bayshore Rd.	4" CI, 6" CI, and 6" plastic	10" PVC	2,530	Priority 2	13.1	$ 3,968,000	
	Pipeline Replacement and New Pipeline Connection	Replace existing 4"CI and 6" CI mains along E Bayshore Rd between Bay Rd and alley between E Bayshore Rd and Holland St and on alley between E Bayshore Rd Laurel Avenue with new 8" PVC main.	4" CI, 6" CI, and 6" plastic	8" PVC	920				
	Pipeline Replacement	Replace existing 4" CI main on Laurel Avenue between alley south of Bay Road and alley north of E Bayshore Rd new 8" PVC main.	4" CI	8" PVC	530				
	Pipeline Replacement	Replace existing 4" CI main in alley south of Bay Road between E Bayshore Avenue and Menalto Avenue with new 8" PVC main.	4" CI	8" PVC	1,110				
P-19	Pipeline Replacement	Replace existing 6" CI main on Capital Avenue between Runnymede St and Donahoe St with new 8" PVC main.	6" CI	8" PVC	2,110	Priority 2	12.9	$ 1,852,000	
P-20	Pipeline Replacement	Replace existing 6" CI main on Euclid Avenue between Runnymede St and Donahoe St with new 8" PVC main.	6" CI	8" PVC	2,140	Priority 2	12.9	$ 1,797,000	
P-8	Pipeline Replacement	Replace existing 4" CI main on Hunter Street between Purdue Avenue and Georgetown St with new 8" PVC main.	4" CI	8" PVC	840	Priority 2	12.8	$ 760,000.00	
P-9	Pipeline Replacement	Replace existing 4" CI main on Baylor St between Notre Dame Avenue and Michigan Avenue with new 8" PVC main.	4" CI	8" PVC	910	Priority 2	12.8	$ 760,000.00	
P-10	Pipeline Replacement	Replace existing 4" CI main on Gonzaga St between Michigan Avenue and Bay Rd with new 8" PVC main.	4" CI	8" PVC	640	Priority 2	12.8	$ 556,000.00	
P-11	Pipeline Replacement	Replace existing 4" CI main on Farrington Way between Kavanaugh Dr and Ursula Way with new 8" PVC main.	4" CI	8" PVC	840	Priority 2	12.8	$ 769,000.00	
P-12	Pipeline Replacement	Replace existing 4" CI main on Hazelwood Way between Kavanaugh Dr and Ursula Way and on Ursula Way between Hazelwood Way and Gloria Way with new 8" PVC main.	4" CI	8" PVC	1,190	Priority 2	12.8	$ 1,068,000	
P-27	Pipeline Replacement	Replace existing 4" CI main on Camelia Ct from Camelia Dr to the end of the circle with new 8" PVC main.	4" CI	8" PVC	350	Priority 2	12.8	$ 353,000	

TABLE 10-4
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-22	Pipeline Replacement	Replace existing 4" CI main on Garden St between Clarke Ave and 1004 Garden St with new 8" PVC main.	4" CI	8" PVC	690	Priority 3	12.8	$ 3,690,000	
	Pipeline Replacement	Replace existing 4'' CI and 6'' CI main on Garden St between Pulgas Ave to the dead end to the east with new 8" PVC main.	4'' CI and 6'' CI	8" PVC	1,070				
	Pipeline Replacement	Replace existing 4" CI main on Terra Villa St between Garden St and Beech St with new 8" PVC main.	4" CI	8" PVC	840				
	Pipeline Replacement	Replace existing 4" CI main on Beech St between Clarke Ave and Brentwood Ct with new 8" PVC main.	4" CI	8" PVC	620				
	Pipeline Replacement	Replace existing 6'' CI main on Cypress St between Pulgas Ave and the dead end to the east with new 8" PVC main.	6'' CI	8" PVC	1,110				
P-28	Pipeline Replacement	Replace existing 4" CI main on Aster Way between Daphne Way and Wieteria Dr with new 8" PVC main.	4" CI	8" PVC	910	Priority 3	12.8	$ 770,000	
P-26	Pipeline Replacement	Replace existing 4" CI main on Gaillardia Way between Pulgas Ave and Azalia Dr with new 8" PVC main.	4" CI	8" PVC	590	Priority 3	12.8	$ 528,000	
WS-01B	New Interconnection	Emergency Water Connects - Palo Alto Park Mutual	--	--	--	Priority 3	12.5	$ 545,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-01C	New Interconnection	Emergency Water Connects - O'Connor Tract Co-Op	--	--	--	Priority 3	12.5	$ 350,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-01D	New Interconnection	Emergency Water Connects - O'Brien Kavanaugh	--	--	--	Priority 3	12.5	$ 365,000	Cost based on City's 2020 Ten-Year Capital Improvement Program FY 2020-21 Capital Budget
WS-04	New Source	Second Groundwater Well	--	--	--	Priority 3	12.2	$ 3,100,000	
P-4	Pipeline Replacement	Replace existing 4" CI main on Jervis Avenue between Bay Rd and Newbridge St with new 8" PVC main.	4" CI	8" PVC	790	Priority 3	11.4	$ 2,713,000	P-4 includes the 2015 Water Main replacement Project. New main on Lita Ln assumed not to be included per design plans.
	Pipeline Replacement	Replace existing 4" CI main on Laurel Avenue between Newbridge St and Alberni St with new 8" PVC main.	4" CI	8" PVC	770				
	Pipeline Replacement	Replace existing 2" main on Mello St between Bay Rd and Newbridge St with new 8" PVC main.	2" GS and 4" CI	8" PVC	520				
	Pipeline Replacement	Replace existing 4" CI main on Georgetown St between Purdue Avenue and Tulane Avenue with new 8" PVC main.	4" CI	8" PVC	1,130				
	Pipeline Replacement	Replace existing 4" CI main on Gonzaga St between Purdue Avenue and Notre Dame Avenue with new 8" PVC main.	4" CI	8" PVC	700				
P-34	Pipeline Replacement	Replace existing 8'' CI on O'Conner St between 222 O'Conner St and Euclid Avenue and the 6'' CI main between 222 O'Conner St and the German American International School with 12'' PVC main.	6'' and 8'' CI	12'' PVC	1,930	Priority 3	11.4	$ 1,588,000	Project only required if City is response to provide fire flows to the school. Consider collaboration with City of Palo Alto.
P-24	Pipeline Replacement	Replace existing 6" CI main on O'Conner Rd between Larkspur Dr and 1161 O' Connor St and the 6'' CI main on Daisy Ln from O'Conner St to 421 Daisy Ln with new 8" PVC main.	4" CI	8" PVC	790	Priority 3	11.4	$ 667,000	Only portion up to existing hydrant is included but would likely want to replace entire line.
P-25	Reconnect Hydrant	Connect the two hydrant within the shopping mall at 1721 E Bayshore Rd to the existing 12'' PVC at E Bayshore Rd with a 12'' PVC main.	--	12'' PVC	110	Priority 3	11.0	$ 160,000	

TABLE 10-4
Summary of Planned CIPs, Development Projects, and Additional Proposed Hydraulic Improvement Projects

Project #	Improvement Type	Improvement Description	existing Pipe Size and Material	Proposed Pipe Size and Material (in)	Approx. Pipe Length (Linear Feet)	Project Priority	Risk Score	Budget Level Cost (September 2022 dollars)	Notes
P-23	Pipeline Replacement	Replace existing 8'' CI main on Myrtle St between Clarke Ave and Pulgas Ave and on Pulgas Ave from Myrtle St to O'Conner St with new 8" PVC main.	8'' CI	8" PVC	2,260	Priority 3	8.4	$ 1,882,000	
P-31	New Pipeline Connection	Install 10'' PVC main to connect Mission Dr to W Bayshore Rd.	--	10'' PVC	60	Priority 3	8.4	$ 73,000	
				Grand Total	**9,060**			**$ 80,551,000**	

Abbreviations:
AC = asbestos cement
Ave = avenue
CI = cast iron
Cu = copper
Dr = drive
E = east
ft = feet
GAL = galvanized steel
HDPE = high density polyethylene
PL = unknown plastic
PVC = polyvinyl chloride
Rd = road
W = west

Notes:
(a) See Appendix D for the cost detail, cost includes project construction contingency, design, construction management, permitting, regulatory compliance, CEQA, and project implementation.

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Appendix A

Model Validation and Calibration

Appendix A
Model Validation and Calibration

This Appendix describes the initial pipe roughness assignment and adjustments to the roughness factor (i.e., C-factor) based on the field results from the hydrant flow testing conducted by EKI and Veolia on 25, 26, and 28 January 2022.

1. Initial C-Factor Assignment

The initial roughness factor[1] (i.e., Hazen-Williams coefficient of friction or "C-factor") was assigned based on the American Water Works Associations (AWWA) Manual M32, Table 2-1. Figure 1 below shows the excerpt of the Table 2-1 from the AWWA Manual. The ages of the CI pipes were estimated based on the nearby building's construction date per the City of East Palo Alto's (City's) parcel data provided by the City on 20 October 2021. The estimated cast iron (CI) pipes ages within the City service area ranges from 50 to 80 years, and therefore the initial roughness assignment was estimated based on the C-factor of "moderate impact" to reflect the aging and degrading of the CI pipes.

[1] Roughness factor is the correction factor used in fluid-flow calculations to allow for flow resistance caused by the roughness of the surface over which the fluid must flow. A higher C-factor suggests a smoother pipe.

Table 2-1 Pipe roughness Hazen–Williams *C*-factors for discrete pipe diameters

Type of Pipe	1.0 in. (2.5 cm)	3.0 in. (7.6 cm)	6.0 in. (15.2 cm)	12 in. (30 cm)	24 in. (61 cm)	48 in. (122 cm)
Uncoated cast iron—smooth and new,		121	125	130	132	134
30 years old						
Trend 1—slight impact		100	106	112	117	120
Trend 2—moderate impact		83	90	97	102	107
Trend 3—appreciable impact		59	70	78	83	89
Trend 4—severe impact		41	50	58	66	73
60 years old						
Trend 1—slight impact		90	97	102	107	112
Trend 2—moderate impact		69	79	85	92	96
Trend 3—appreciable impact		49	58	66	72	78
Trend 4—severe impact		30	39	48	56	62
100 years old						
Trend 1—slight impact		81	89	95	100	104
Trend 2—moderate impact		61	70	78	83	89
Trend 3—appreciable impact		40	49	57	64	71
Trend 4—severe impact		21	30	39	46	54
Miscellaneous						
Newly scraped mains		109	116	121	125	127
Newly brushed mains		97	104	108	112	115
Coated spun iron—smooth and new		137	142	145	148	148
Old—take as coated cast iron of same age						
Galvanized iron—smooth and new	120	129	133			
Wrought iron—smooth and new	129	137	142			
Coated steel—smooth and new	129	137	142	145	148	148
Uncoated steel—smooth and new	134	142	145	147	150	150
Coated asbestos cement—clean		147	149	150	152	
Uncoated asbestos cement—clean		142	145	147	150	
Spun cement-lined and spun		147	149	150	152	153
bitumen-lined—clean						
Smooth pipe (including lead, brass, copper,	140	147	149	150	152	153
polyethylene, and polyvinyl chloride)						
—clean						
Polyvinyl chloride wavy—clean	134	142	145	147	150	150
Concrete—Scobey's coefficient (C_s)						
Class 1—C_s = 0.27; clean		69	79	84	90	95
Class 2—C_s = 0.31; clean		95	102	106	110	113
Class 3—C_s = 0.345; clean		109	116	121	125	127
Class 4—C_s = 0.37; clean		121	125	130	132	134
Best—C_s = 0.40; clean		129	133	138	140	141
Tate relined pipes—clean		109	116	121	125	127
Prestressed concrete pipes—clean				147	150	150

Source: Lamont (1981).

Figure 1. Ranges of Cast Iron Pipe Roughness (Source

2. Hydrant Flow Testing and Model Validation and Calibration

After the initial roughness assignment, EKI and Veolia conducted hydrant flow testing across the City's service area to validate and calibrate those C-factor. Hydrant flow testing consisted of flowing hydrants and measuring the flow and residual pressures upstream of the flowing hydrant prior to and during the flow testing. These flow and pressure data are recorded and compared against the model results for calibration purposes.

Two types of hydrant tests were conducted:

1. Hydrant flow tests; and
2. C-factor tests.

During hydrant flow tests, all valves are left open to mimic normal operating conditions. This test measures the system's ability to produce required fire flows at a given location and can illuminate macro-level issues in the model's settings such as pump controls, pipe diameter, demand conditions, or pipe connectivity issues. Additionally, this test can illuminate other real-world operating issues such as partially closed valves.

For C-factor tests, certain valves are closed to isolate and measure flow and pressure along a single line. This test allows for determination of frictional losses along the isolated pipeline. Based on these measurements, the modeled C-factors can be compared to and calibrated to observed data. Test locations along a single dead-end line only require a single test to capture both hydrant flow and C-factor test information.

3. Field Testing

EKI selected 11 test locations, as listed in Table 1 and shown on Figure 1. These locations were selected to ensure that data was collected for a wide range of pipeline sizes, ages, and materials and pressure zones. Additionally, these tests were located sufficiently distant from tanks and pumps to avoid unintended influences and to ensure sufficient pressure drop in the tested pipeline to allow for more accurate calibration.

Table 1. Fire Hydrant Testing Locations

Location No.	Flow Hydrant Location	Tests	Pipe Diameter, Material, and Assumed Year Installed	No. of Closed Valves during C-Factor Test	No. of Observation Hydrants
1	1626 Tulane Ave	2 Tests: Hydrant Flow Test and C-Factor Test	6'' Cast Iron (CI) – 1950s	4	3
2	1600 Bay Rd	2 Tests: Hydrant Flow Test and C-Factor Test	10" Asbestos Cement (AC) – UNK	4	4
3	1351 Bay Rd	2 Tests: Hydrant Flow Test and C-Factor Test	8" CI – 1940s	3	3
4	2386 Ralmar Ave	2 Tests: Hydrant Flow Test and C-Factor Test	6'' CI – 1940s	8	3
5	2101 University Ave	2 Tests: Hydrant Flow Test and C-Factor Test	8''CI – 1940s	3	4
6	2125 Capitol Ave	2 Tests: Hydrant Flow Test and C-Factor Test	6'' AC – UNK	3	2
7	735 Green St	2 Tests: Hydrant Flow Test and C-Factor Test	8''CI – 1950s	1	3
8	911 Oakes St	2 Tests: Hydrant Flow Test and C-Factor Test	8'' Polyvinyl Chloride (PVC) - UNK	3	3
9	1805 E Bayshore Rd	2 Tests: Hydrant Flow Test and C-Factor Test	6'' CI – 1960s	2	3
10	1898 E Clarke Ave	2 Tests: Hydrant Flow Test and C-Factor Test	10'' CI – 1950s	4	3
11	258 Daphne Way	2 Tests: Hydrant Flow Test and C-Factor Test	6'' CI – 1950s	4	3

The EKI and Veolia performed testing on 25, 26 and 28 January 2022. At all locations, both hydrant tests and C-factor tests were performed. Figure 2 through 11 show for each location the flow hydrant, test hydrants (where residual pressures were measured), which valves were closed to perform the C-factor tests, and test results.

To ensure the accuracy of the testing, EKI supplied three pressure transducers to continuously record pressures at each test hydrant and used GPS equipment to accurate locate the horizontal

location and elevation of each hydrant. The Veolia flowed the hydrants with a 2 ½" diffuser with a built-in pitot gauge to measure flows.

The following issues were identified during the field testing:

- After shutting the valves to perform the Test 2A C-Factor Test, the static pressures at the observation hydrants dropped by approximately 8 pounds per square inch (psi). Veolia's operation team examined the status of nearby valves on a few occasions but could not identify the potential closed valve(s) in the systems that could cause the significant drop in static pressure along this line.
- After shutting the valves to perform the Test 4A C-Factor Test, no flow was available in the flow hydrant located at 2386 Ralmar Ave. Follow-up field work identified that an isolation valve at Alberni Street near the intersection of Jervis Avenue and Alberni St.
- Static pressures at the observation hydrants located along the Palo Mobile Estate at during Test 9 were measured to be approximately 10 psi lower than the normal static pressures in the area. The City later found that there were two back flow valves near the intersections of East Bayshore Road and Palo Mobile Estate and Pulgas Avenue and Palo Mobile Estate.
- The static pressures and the residual pressures of the observation hydrants at Location 10 were very similar at both tests. The static pressures dropped by 3 psi along Woodland Avenue and Clarke Avenue, and the exact cause was not identified.

4. Calibration Criterion

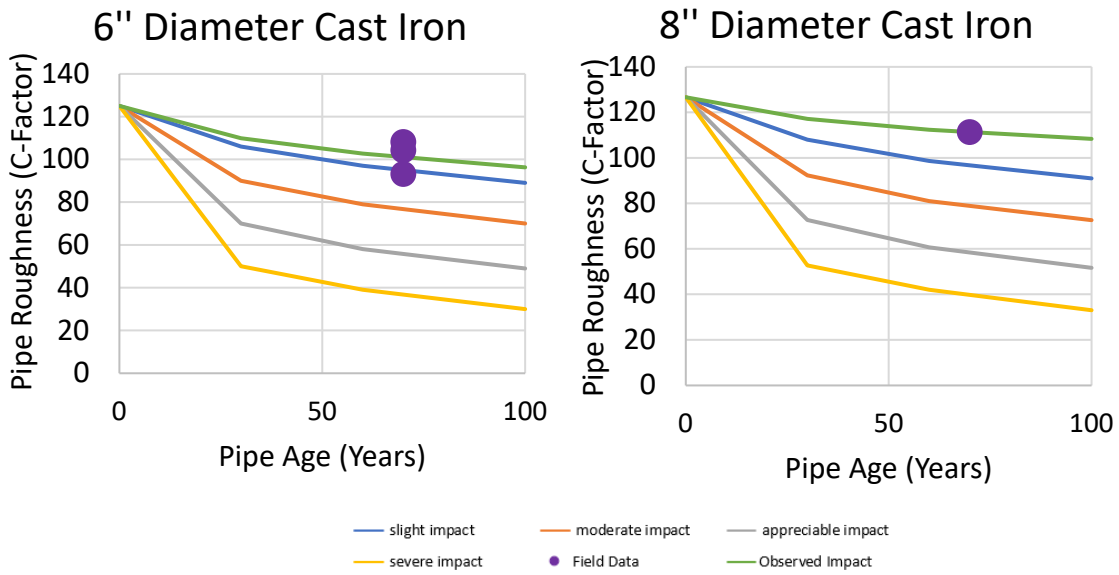
Various criteria exist to calibrate hydraulic models based on the quality and quantity of available data and intended model use. For purposes of long-range planning, EKI uses a calibration criterion ±10% (i.e., the modeled and observed system pressures must agree to within ±10%).

5. Calibration Results

EKI created model simulations to compare model results against field data. EKI used Eye on Water provided by the City to adjust SFPUC turnouts and system demands in the model to mimic actual operations during each test. Complete results for each hydrant test are included in Table 1.

As shown in the Table 1, EKI was able to successfully calibrate all but two of the hydrant tests (Tests 5 and 8) to within the ±10% calibration criteria, with adjustment to C-factor assignments and modifying PRV operations. EKI was able to calculate the observed C-factors along the test lines based on the C-factor test data. The observed C-factors for each C-factor test are shown in Table 2. As shown in Table 2, eight of the locations were affected by various issues and resulted

in an abnormal C-factor values. Only three[2] locations (all CI pipes) yielded C-factors that were within the C-factor ranges between new CI pipes and slight impact CI pipes (Figure 2). Based on the C-factors calculated from the C-factor test data, EKI updated the C-factors for the pipes tested. However, based on the feedback from City staff and Veolia's system operator who have observed the poor condition of old CI pipes removed from the ground as well as the overall system performance during the hydrant flow testing days, the C-Factor test results were assumed to not be representative of the system-wide C-factors for the CI pipes. System-wide, CI pipes were assumed to fall between "moderate impact" and "appreciable impact". Thus, as shown in Table 3, the C-factors for all pipes (excluding PVC pipes and pipes where the testing occurred) were adjusted to reflect the pipe condition.



Note: 6-in CI pipes at Location 1, 6, and 11 and 8-in CI pipes at Location 7 were included as field data above.

Figure 2. Ranges of Cast Iron Pipe Roughness

[2] Pipes along Location 6 appeared to be CI pipes.

Table 1. Calibration Results

Hydrant	Field Data				Modeled Data			Static Pressures	Residual Pressures
	Elevation (ft)	Static Pressure (psi)	Residual Pressure (psi)	Differential (psi)	Static Pressure (psi)	Residual Pressure (psi)	Differential (psi)	Percent Difference Between Field and Model	
Hydrant Flow Test 1 1626 Tulane Ave - Flow = 550 gpm									
1A	9	60	50	11	60	48	12	-0.7%	-3.4%
1B	12	60	53	7	59	51	8	-1.9%	-4.1%
1C	13	60	55	5	58	52	6	-2.6%	-4.4%
Hydrant Flow Test 2 1600 Bay Rd - Flow = 700 gpm									
2A	25	53	49	4	53	49	4	-0.4%	-0.1%
2B	22	55	51	4	54	50	4	-0.6%	-0.7%
2D	20	56	52	4	55	52	4	-0.5%	-1.0%
Hydrant Flow Test 3 1351 Bay Rd - Flow = 815 gpm									
3A	19	56	53	3	56	52	4	-0.1%	-2.1%
3B	17	57	55	2	57	54	3	0.5%	-1.8%
3C	14	59	57	1	58	56	3	-0.4%	-3.0%
Hydrant Flow Test 4 2386 Ralmar Ave - Flow = 660 gpm									
4A	15	58	55	4	59	56	3	0.4%	1.6%
4B	14	58	55	3	59	57	2	0.9%	3.1%
4C	15	59	56	3	58	56	2	-1.4%	0.2%
Hydrant Flow Test 5 2101 University Ave - Flow = 490 gpm									
5A	21	54	41	13	53	47	6	-1.1%	15.4%
5C	20	55	45	10	54	50	4	-1.5%	10.7%
5D	17	58	47	11	56	52	4	-3.8%	10.9%
Hydrant Flow Test 6 2125 Capitol Ave - Flow = 580 gpm									
6A	18	55	44	10	55	48	7	0.6%	8.6%
6B	16	56	49	7	56	51	5	-0.1%	4.6%

Hydrant	Field Data				Modeled Data			Static Pressures	Residual Pressures
	Elevation (ft)	Static Pressure (psi)	Residual Pressure (psi)	Differential (psi)	Static Pressure (psi)	Residual Pressure (psi)	Differential (psi)	Percent Difference Between Field and Model	
Hydrant Flow Test 7 735 Green St - Flow = 710 gpm									
7A	17	54	44	10	54	45	9	1.2%	2.5%
7B	15	55	45	10	55	45	10	0.2%	-0.2%
7C	13	56	46	9	56	47	9	0.2%	2.2%
Hydrant Flow Test 8 911 Oakes St - Flow = 580 gpm									
8A	18	54	40	14	54	48	6	0.6%	19.5%
8B	16	55	41	14	56	49	6	1.0%	19.0%
8C	13	57	43	14	57	50	6	0.2%	17.4%
Hydrant Flow Test 10 1898 E Clarke Ave - Flow = 700 gpm									
10A	20	53	42	11	53	44	10	0.8%	4.1%
10B	28	51	40	11	50	41	9	-1.6%	1.6%
10C	32	50	40	11	48	39	9	-3.9%	-1.0%
Hydrant Flow Test 11 258 Daphne Way - Flow = 560 gpm									
11A	11	57	43	15	57	45	12	0.6%	6.0%
11B	10	58	44	14	58	46	12	-0.6%	4.0%
11C	7	59	46	14	59	48	11	-0.7%	4.0%

Abbreviations:

ft = feet

psi = pounds per square inch

gpm = gallons per minute

Notes:

(a) Differential was obtained by subtracting the residual pressure from the static pressure.

(b) Values highlighted in blue were from field values.

Table 2. Estimated C-Factors from Hydrant Flow Testing

Test Location	Pipe Size / Material	Calculated C-Factor			Notes
		Hyd C to B	Hyd B to A	Hyd C to A	
1	6” CI	96	89	93	-
2	10” AC	84	75	81	Potential closed valves
3	8” CI	86	148	108	The pipes are likely not isolated
4	6” CI	NA	NA	NA	No flow due to closing valve
5	8” CI	NA	35	52	Potential closed valves
6	6” AC	NA	108	NA	Assumed to be CI pipe in the model
7	8” CI	129	80	111	-
8	8” PVC	84	125	101	Pressure drop not significant
9	6” CI	NA	NA	NA	Results affected by backflow
10	10” CI	79	134	112	The pipes are likely not isolated
11	6” CI	109	99	104	-

Abbreviations:

AC = asbestos cement
CI = cast iron
Hyd = hydrant
PVC = polyvinyl chloride
NA = not available

Table 3. Global C-Factors in the System

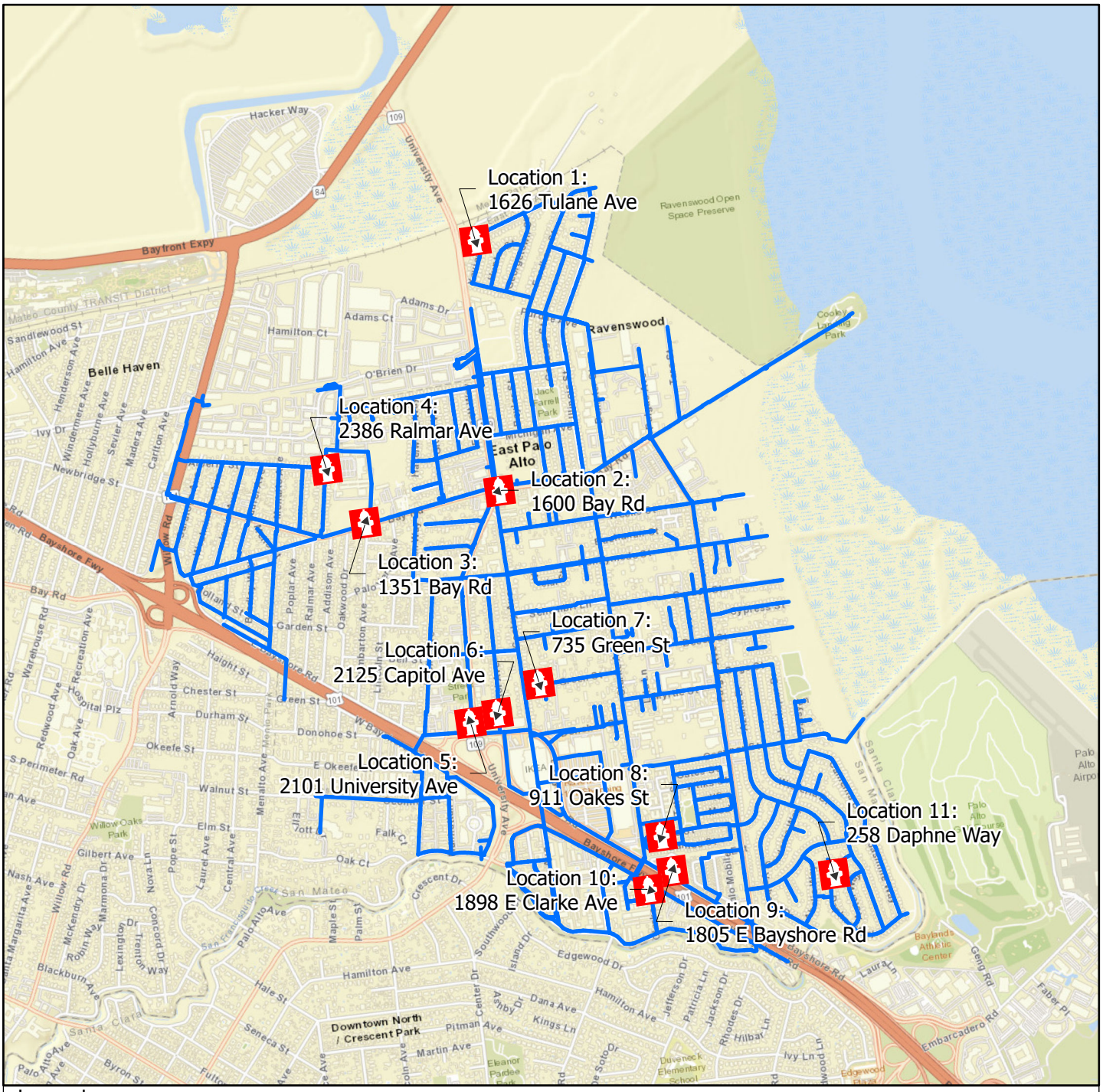
Pipe Dia.(in)	AC	CI	CU	DI	GAL	HDPE	PL	PVC	UNK
<2	-	-	100	-	87	-	101	138	70
3	-	-	-	-	90	-	-	-	-
4	100	68	-	135	-	-	-	143	70
6	102	72	-	136	-	-	104	145	70
8	102	73	-	136	-	140	-	146	70
10	102	74	-	137	-	-	-	146	70
12	103	75	-	137	-	-	-	147	70
14	-	-	-	-	-	-	-	-	70
16	-	-	-	137	-	-	-	-	-

Abbreviations:

AC = asbestos cement
CI = cast iron
Cu = copper
DI = ductile iron
GAL = galvanized iron
HDPE = high density polyethylene
In = inches
PL = unknown plastic
PVC = polyvinyl chloride
UNK = unknown

Notes:

(a) The C-factors of CI pipes were affected by the age of the pipe, and the assumed CI pipe ages ranges from 50 to 80 year estimated from the building ages within the City's service area.



Legend

- Flow Fire Hydrant
- Existing Water Line

N

0 1,000 2,000 4,000

US Feet

Notes

1. All locations are approximate.
2. Locations 11-12 should only be tested if needed.

DRAFT

Overview Map
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 1

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx

Legend

- Open Gate Valve
- Closed Gate Valve
- Flow Fire Hydrant
- Observation Fire Hydrant
- Existing Water Line
- Lateral
- Tested Water Line

N

0 100 200 400

US Feet

Abbreviations

CI = cast iron
PVC = polyvinyl chloride

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

DRAFT

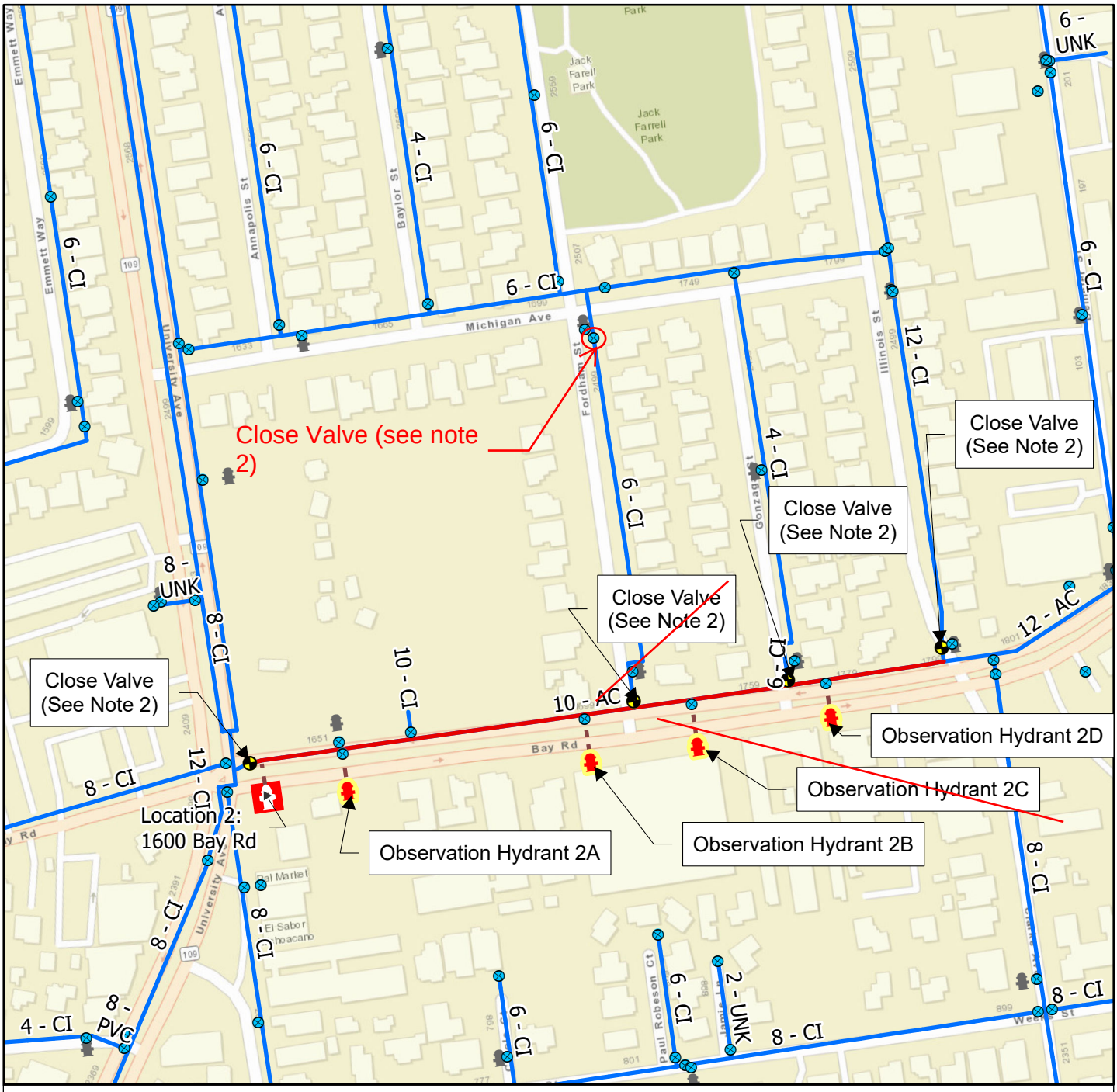
Location 1:
1626 Tulane Ave
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 2

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve
- Lateral

N

0 125 250 500

US Feet

Abbreviations

CI = cast iron
PVC = polyvinyl chloride

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

DRAFT

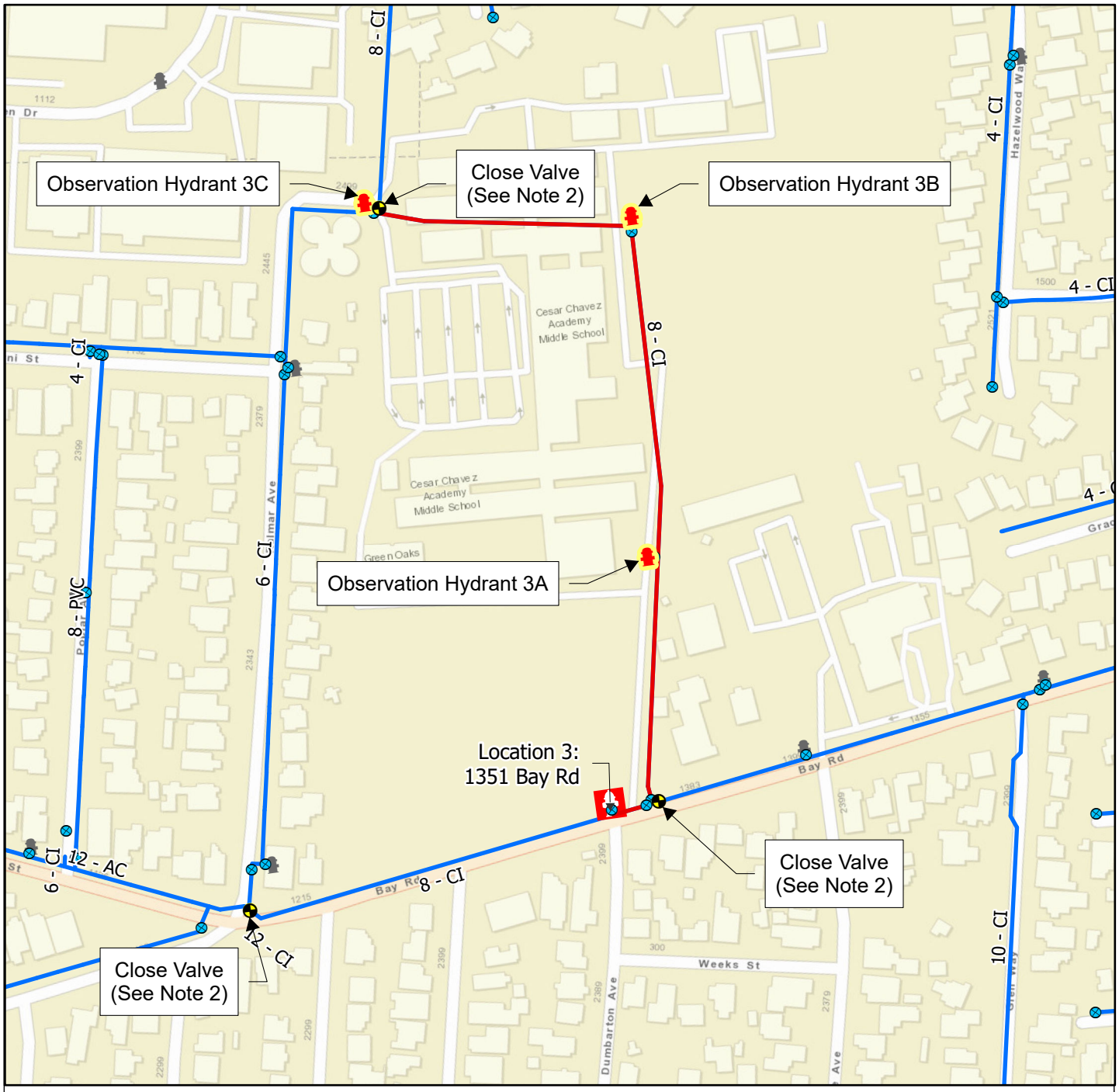
Location 2: 1600 Bay Rd
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 3

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve

N

0 125 250 500

US Feet

Abbreviations

CI = cast iron
PVC = polyvinyl chloride

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

DRAFT

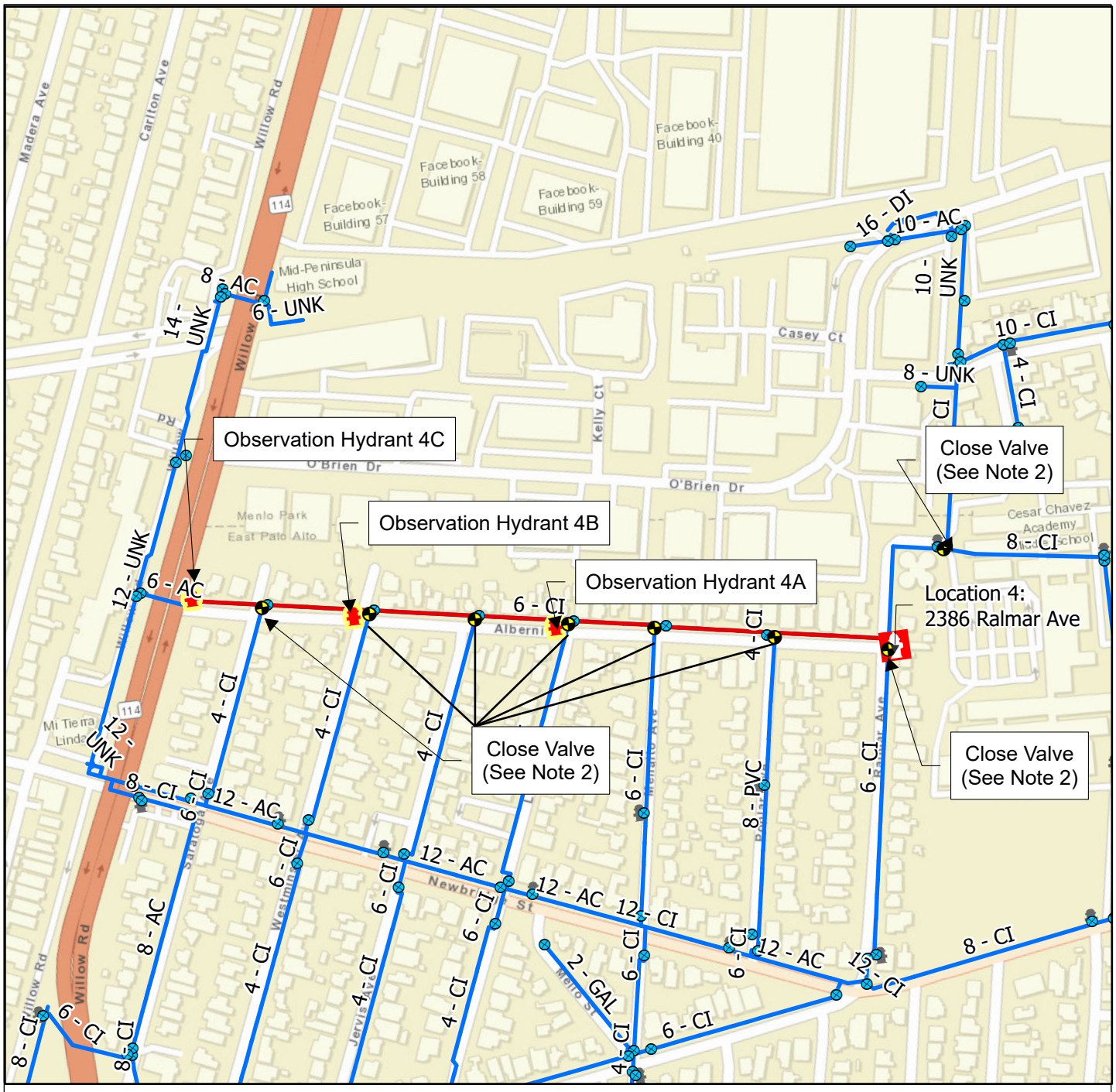
Location 3:
1351 Bay Rd
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 4

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Open Gate Valve
- Closed Gate Valve
- Observation Fire Hydrant
- Flow Fire Hydrant
- Fire Hydrant
- Tested Water Line
- Existing Water Line

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 200 400 800

US Feet

Abbreviations

AC = asbestos cement
CI = cast iron
UNK = unknown

DRAFT

Location 4: 2386 Ralmar Ave Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 5

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx

Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve
- Lateral

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 200 400 800

US Feet

Abbreviations

AC = asbestos cement
CI = cast iron
PVC = polyvinyl chloride

DRAFT

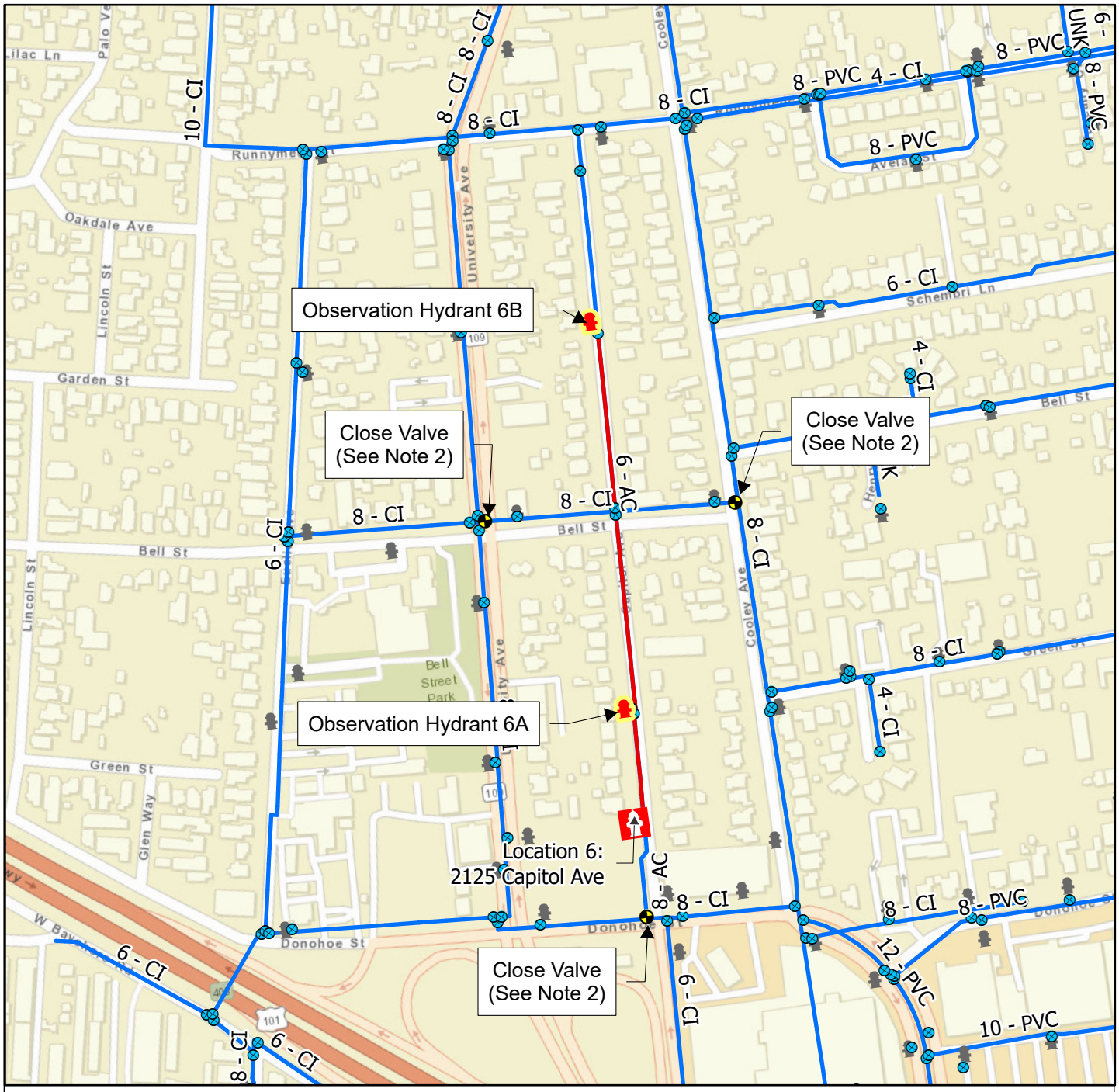
Location 5:
2101 University Ave
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 6

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 200 400 800

US Feet

Abbreviations

AC = asbestos cement
CI = cast iron
PVC = polyvinyl chloride
UNK = unknown

DRAFT

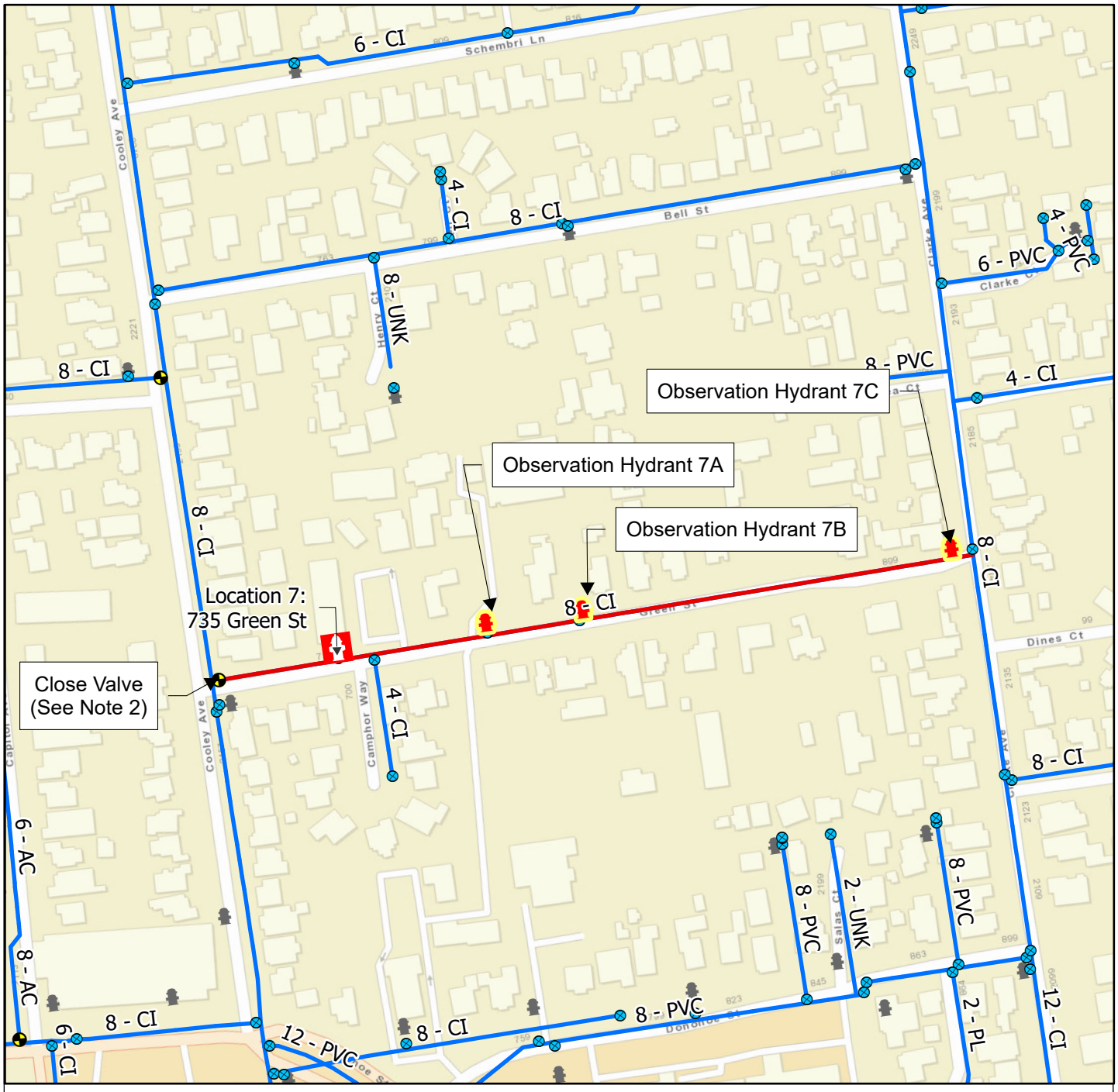
Location 6: 2125 Capitol Ave Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 7

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 125 250 500

US Feet

Abbreviations

CI = cast iron
PVC = polyvinyl chloride
PL = plastic

DRAFT

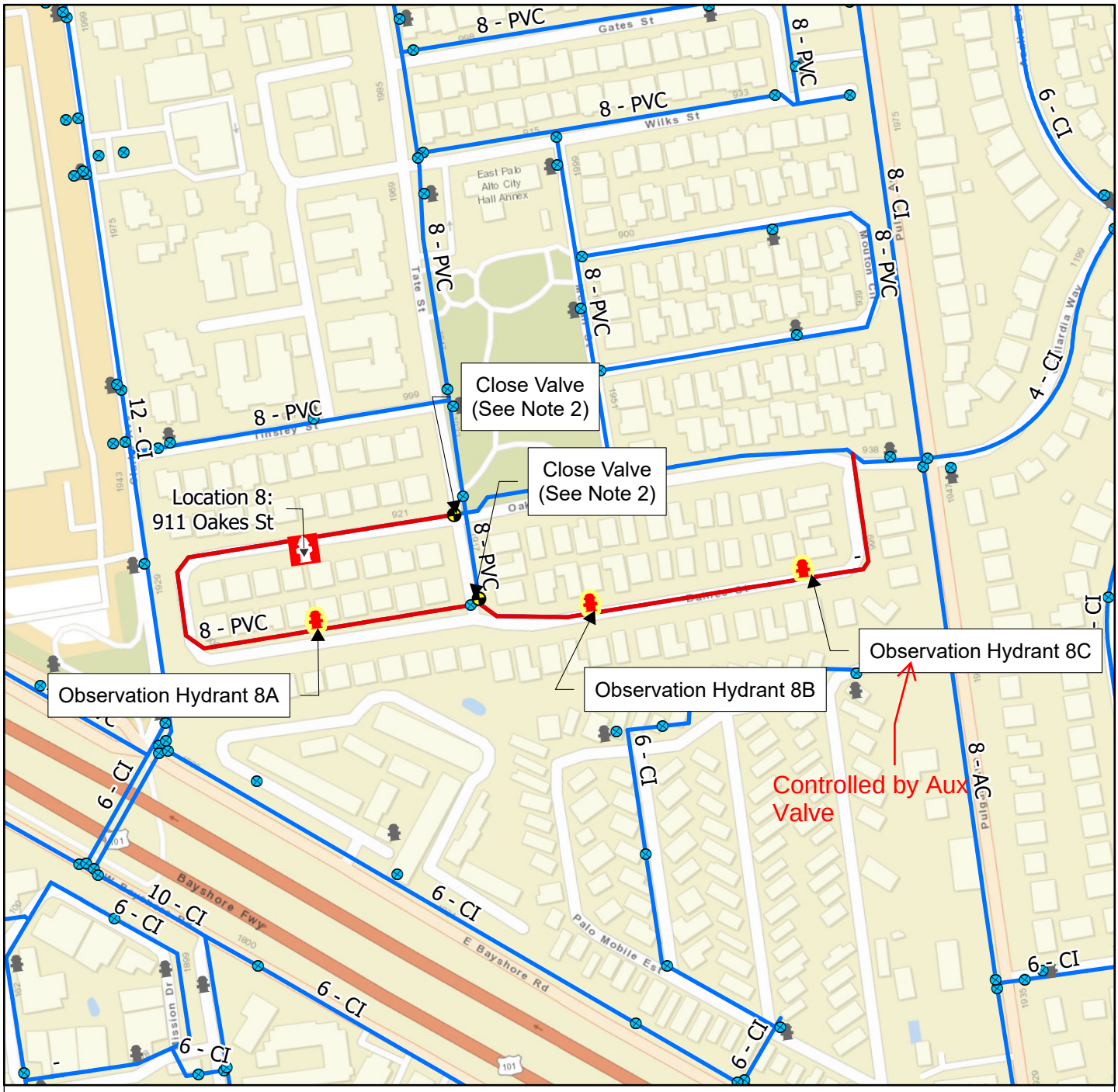
Location 7:
735 Green St
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 8

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 125 250 500

US Feet

Abbreviations

CI = cast iron
PVC = polyvinyl chloride
PL = plastic

DRAFT

Location 8:
911 Oakes St
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 9

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx

Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve
- Lateral

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 100 200 400

US Feet

Abbreviations

CI = cast iron
PVC = polyvinyl chloride

DRAFT

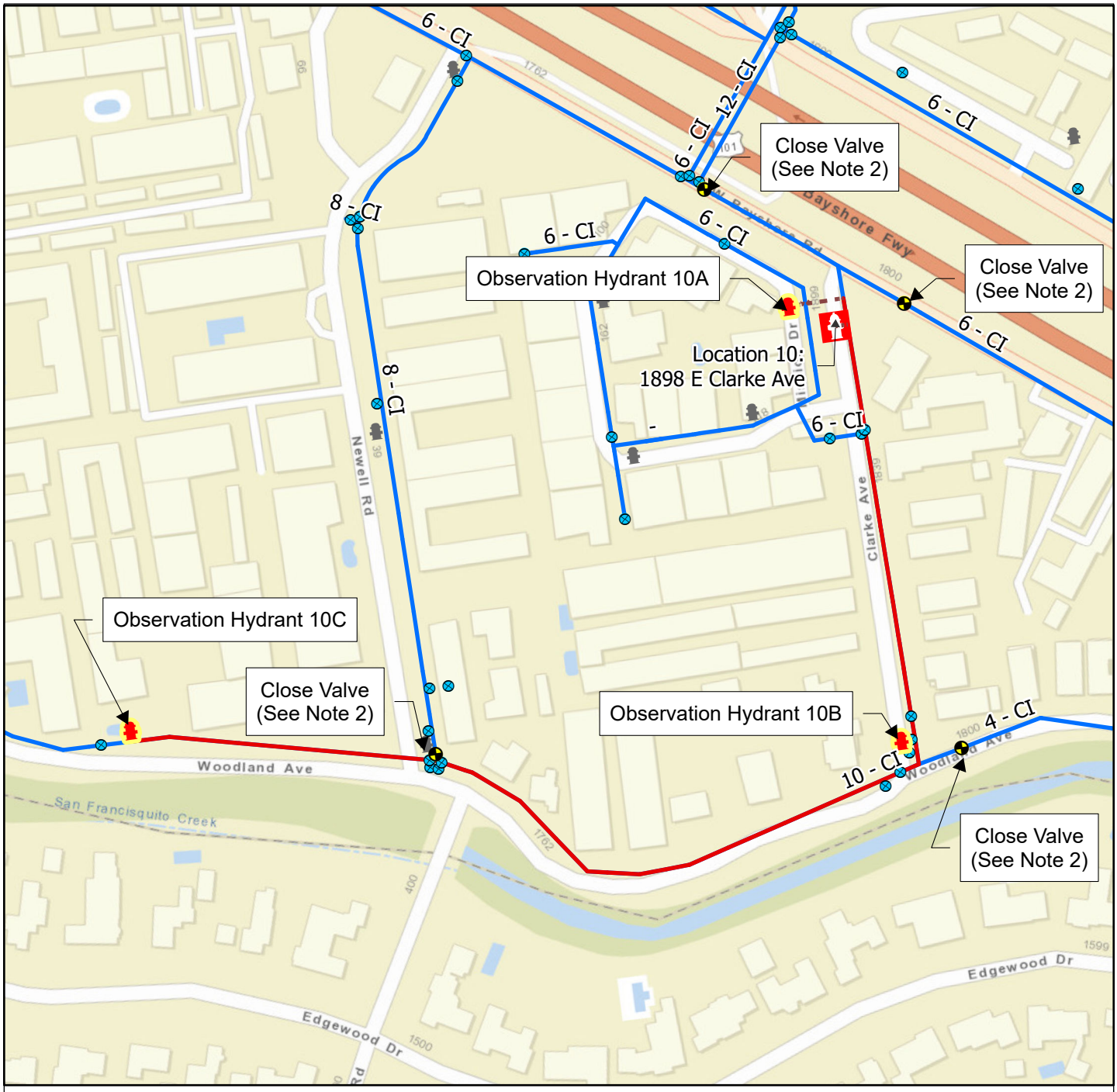
Location 9:
1805 E Bayshore Rd
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 10

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve
- Lateral

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 100 200 400

US Feet

Abbreviations

CI = cast iron

DRAFT

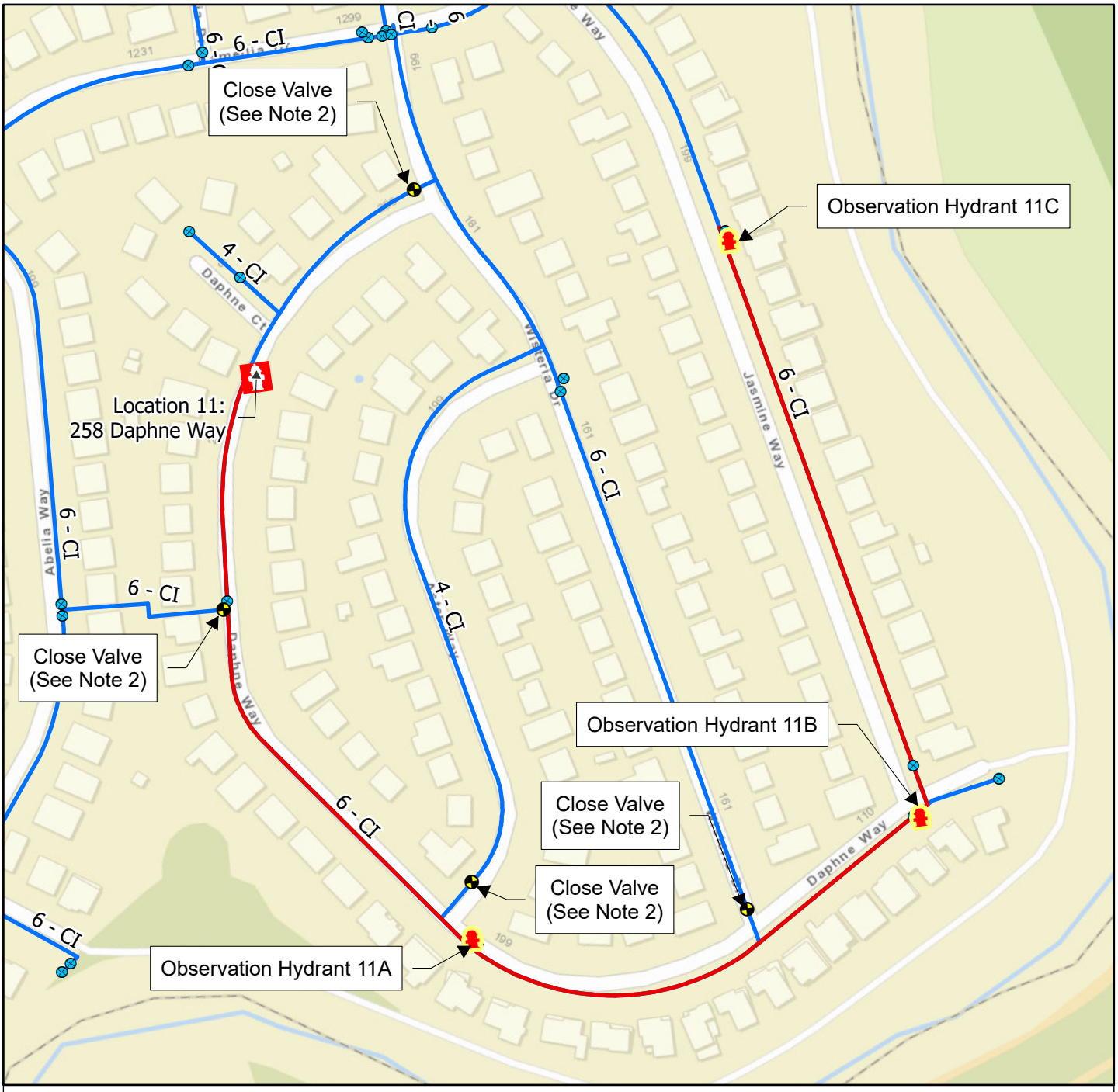
Location 10:
1898 E Clarke Ave
Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

Figure 11

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Model.aprx



Legend

- Existing Water Line
- Tested Water Line
- Fire Hydrant
- Flow Fire Hydrant
- Observation Fire Hydrant
- Open Gate Valve
- Closed Gate Valve

Notes

1. All locations are approximate.
2. All valves will be left open during the hydrant test. Indicated valves will only be closed during the C-Factor test.

N

0 100 200 400

US Feet

Abbreviations

CI = cast iron

DRAFT

Location 11: 258 Daphne Way Fire Hydrant Test Plan

City of East Palo Alto
East Palo Alto, CA
November 2021
EKI C10082.00

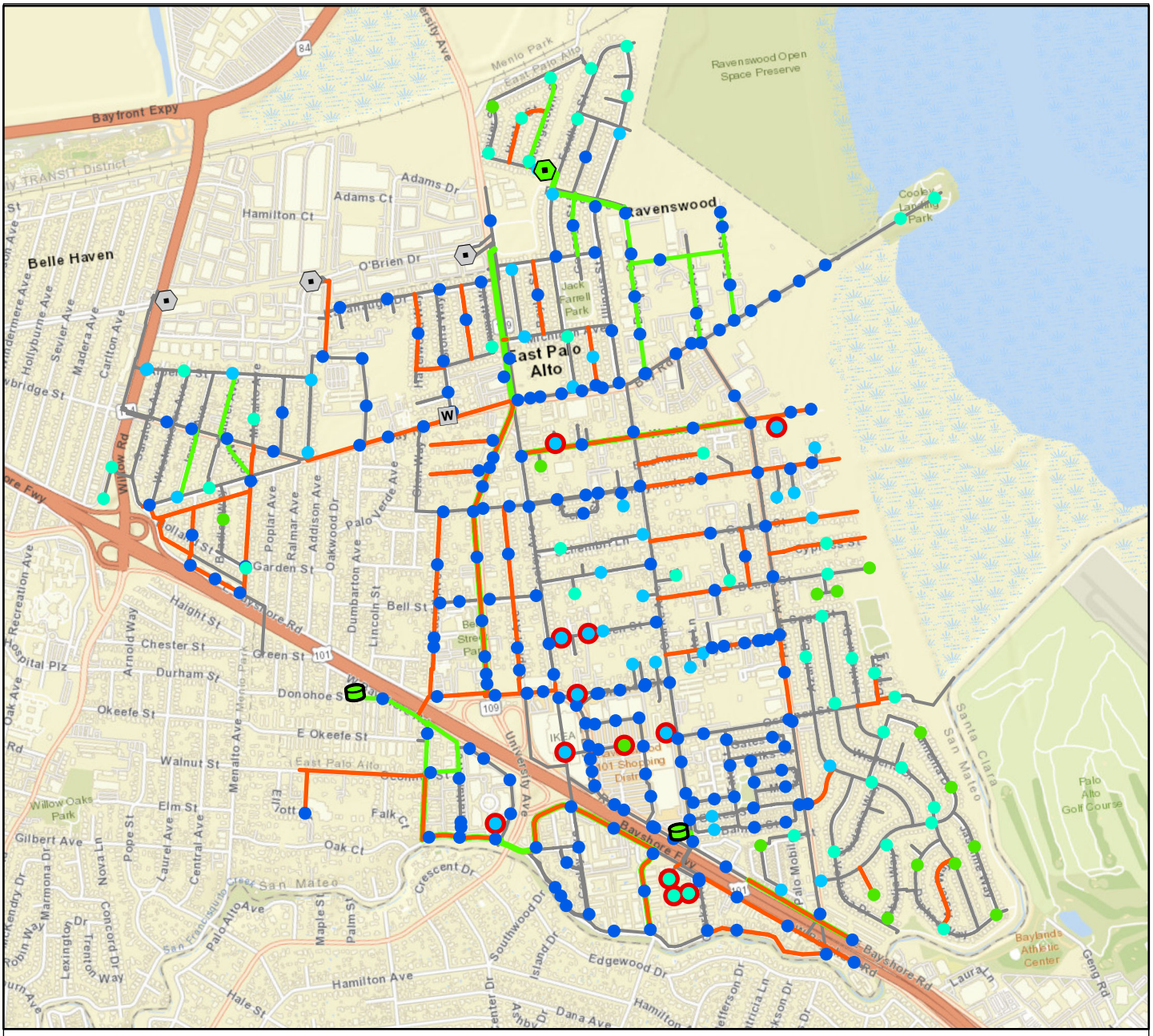
Figure 12

eki environment & water

Path: C:\Users\qzhang\InfoWater\C10082.00\Map\EPA_WSMP_Model.aprx

Appendix B

Modeled Water System Performance with Recommended Capacity Improvement Projects



Legend

Existing Infrastructure

- Existing SFPUC Turnout
- Gloria Way Well
- Existing Pipes

Priority 1A Improvement Projects

- Pipe Improvement
- New SFPUC Turnout
- New Tank and Booster Pump Station

Additional Proposed Hydraulic Improvement Projects

- Pipe Improvement
- New Pressure Reducing Valve

Available Fire Flow (gpm)

- <500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,500
- 2,500 - 4,000
- > 4,000
- Available Fire Flow Below Requirement

Notes

1. All locations are approximate.
2. Available fire flow is the flow at the hydrant that does not cause pressures to drop below 20 psi at any other service connection locations.
3. Gloria Way Well is assumed to be offline.
4. Additional hydraulic improvement projects have been designed to meet fire flow requirements and performance criteria on all mains. Remaining fire flow deficiencies shown are generally located on laterals and are within close proximity of hydrants that meet the fire flow requirements (<500 feet).

N

0 875 1,750 3,500

US Feet

Abbreviations

CIP = Capital Improvement Project
SFPUC = San Francisco Public Utilities Commission

Sources

1. Street map provided by ArcGIS online.

Available Fire Flow with Maximum Day Demands Future Scenario with Proposed CIPs

City of East Palo Alto
East Palo Alto, CA
March 2023
EKI C10082.00

Figure B-1

eki environment & water

Path: C:\Users\qzhang\Info\Water\C10082.00\Map\EPA_WSMP_Figures.aprx

Appendix C

Detailed Project Prioritization Scores

Table C-1
Capital Improvement Program Scoring Matrix

Category	Scoring					Weighting
	1	2	3	4	5	
Condition						
Physical Condition (Pipe Material/Size)	Pipe that is less than 20 years old or installation of new pipe alignment		Pipe that is 50+ year old and not CI or new pipeline/facility essential (e.g., no existing redundancy)		Pipe that is less than 6" or 50+ year old CI	25%
Hydraulic Performance	Replacement of main with same size pipe		Upsize of main to 8" or 10" or improves a limited area of system. Or provides emergency interconnect/source.		Improvement or transmission main that will affect large parts of system (i.e., large tank or 12" main and higher)	75%
Consequence (a)						
Service Requirements	Asset meets or exceeds all DDW requirements		Asset marginally meets DDW requirements and may go out of compliance from time to time (e.g., periodic non-compliance with minimum pressures)		Asset does not meet DDW requirements (e.g., minimum pressures, storage capacities, or pipe size)	35%
Environmental/Public	Loss of Asset will not cause Environmental damage	Loss of asset will cause minimal environment damage, very little press or public notice, <$1000 fine	Loss of asset will cause moderate environmental damage, public may be affected, and press will notice, <$10,000 fine	Loss of asset will cause heavy environmental damage, public will be heavily affected, press will take notice for an extended period, <$100,000 fine	Loss of asset will cause severe environmental damage, public will be severely affected over a long term, press will notice for long term, >$100,000 fine, possible prison sentences	15%
Safety	No injury or illness	Minor injury or illnesses, can be treated with onsite first aide	Moderate injury or illness results in loss time injury, injuries and illness will require from medical staff	Severe injury or illness results in extend loss time injuries, injuries will require extended in patient care by medical staff	Fatal injury or illness to one or more persons.	15%
Supply	Supply to all customers is unaffected	Supply to customers is affected to a limited area and a limited time. Typically loss of 8" looped water main	Supply to customers is affected to an extended area for moderate period. Typically a loss of a 12 inch looped water main or undersized main unable to meet peak hour flows	Supply to customers is affected to a wide area for extended periods, Typically a loss of a transmission water main (not looped), or undersized main unable to meet daily water demands or fire fl ow	Supply to the entire district is affected for extended periods. Typically in adequate storage to meet peak demands, loss of supply from wholesaler, or unable to meet peak hour, fire flow, or daily demands for extended periods	35%

Notes:
(a) Asset consequence matrix based on the draft City of East Palo Alto Asset Management Plan (Harris, 2021).

Table C-2
CIP Project Scoring

Project #	WS-01B	WS-01C	WS-01D	WS-03A	WS-03B	WS-04	WD-05	WD-06	WD-07
Description	**Emergency Water Connects - Palo Alto Park Mutual**	**Emergency Water Connects - O'Connor Tract Co-Op**	**Emergency Water Connects - O'Brien Kavanaugh**	**New Storage Tank - East of Highway 101**	**New Storage Tank - West of Highway 101**	**Second Groundwater Well**	**Water Meter Replacement Program**	**Fire Hydrant Replacement Program**	**Water Valve Replacement Program**
Physical Condition Score	3	3	3	3	1	1	3	3	3
Hydraulic Performance Score	3	3	3	5	5	3	3	3	3
Weighted Condition Score (out of 10)	6	6	6	9	8	5	6	6	6
Service Score	3	3	3	5	5	5	1	5	3
Environmental Score	1	1	1	2	2	1	1	3	2
Safety Score	2	2	2	2	2	2	1	3	1
Supply Score	5	5	5	3	3	4	1	2	2
Weighted Consequence Score (of out 10)	6.5	6.5	6.5	6.8	6.8	7.2	2	6.7	4.4
Total Score (out of 20)	**12.5**	**12.5**	**12.5**	**15.8**	**14.8**	**12.2**	**8**	**12.7**	**10.4**

Table C-2
CIP Project Scoring

Project #	WS-01A/P-1	P-2	WD-04B/WD-04C/P-3	P-4	P-5	P-6	P-7	P-8	P-9
Description	**Woodland Avenue Waterline and City of Palo Alto Interconnect**	**Planned Fourth Turnout and 16-Inch Water Transmission Main at Purdue Ave**	**12-Inch Water Transmission Main on University**	**Pipeline Replacements related to 2015 Water Main Replacement Project**	**Ravenswood Busiiness District Specific Plan Projects - Not City Projects**	**Improvements for the Euclid Improvements Development Project - Not a City Project**	**Pad D Fire Suppression System for Light Tree Apartments - Not a City Project**	**Replace existing 4" CI main on Hunter Street with new 8" PVC main**	**Replace existing 4" CI main on Baylor St with new 8" PVC main**
Physical Condition Score	3	3	5	5	5	N/A	N/A	5	5
Hydraulic Performance Score	5	5	5	3	5	N/A	N/A	3	3
Weighted Condition Score (out of 10)	9	9	10	7	10	--	--	7	7
Service Score	5	5	3	3	3	N/A	N/A	5	5
Environmental Score	1	1	3	2	2	N/A	N/A	2	2
Safety Score	1	1	1	1	1	N/A	N/A	1	1
Supply Score	5	4	3	2	3	N/A	N/A	2	2
Weighted Consequence Score (of out 10)	7.6	6.9	5.4	4.4	5.1	--	--	5.8	5.8
Total Score (out of 20)	**16.6**	**15.9**	**15.4**	**11.4**	**15.1**	**--**	**--**	**12.8**	**12.8**

Table C-2
CIP Project Scoring

Project #	P-10	P-11	P-12	P-13	P-14	P-15	P-16	P-17	P-19
Description	**Replace existing 4" CI main on Gonzaga St with new 8" PVC main**	**Replace existing 4" CI main on Farrington Way with new 8" PVC main**	**Replace existing 4" CI main on Hazelwood Way and on Ursula Way with new 8" PVC main**	**Replace existing 8" and 10" mains along O'Brien Drive and existing easement with new 12" PVC main**	**Replace existing 8" CI main on Bay Rd with new 12" PVC main. Install new 8" PRV.**	**Various pipeline replacements between Newbridge St., Menalto Ave, E Bayshore Road, and Bay Road**	**Replace 8" CI Highway 101 Crossing near Euclid Ave with new 12" PVC carrier pipe. Replace 8" CI on Donahoe St with new 12" PVC**	**Replace 2" GS and 4" Mains on Week St and Sacramento St West of University Ave**	**Replace existing 6" CI main on Capital Ave with new 8" PVC main**
Physical Condition Score	5	5	5	5	5	5	5	5	5
Hydraulic Performance Score	3	3	3	5	5	3	3	3	4
Weighted Condition Score (out of 10)	7	7	7	10	10	7	7	7	8.5
Service Score	5	5	5	3	3	5	3	5	3
Environmental Score	2	2	2	3	2	3	4	2	2
Safety Score	1	1	1	1	1	1	1	3	1
Supply Score	2	2	2	3	3	2	5	2	2
Weighted Consequence Score (of out 10)	5.8	5.8	5.8	5.4	5.1	6.1	7.1	6.4	4.4
Total Score (out of 20)	**12.8**	**12.8**	**12.8**	**15.4**	**15.1**	**13.1**	**14.1**	**13.4**	**12.9**

Table C-2
CIP Project Scoring

Project #	P-20	P-21	P-21a	P-22	P-23	P-24	P-25	P-26	P-27
Description	**Replace existing 6" CI main on Euclid Ave with new 8" PVC main**	**Various pipeline replacements along Weeks St., Buchannan Ct, and Runnymede St.**	**Replace existing 8" AC and 8" CI main on Weeks St between Cooley Avenue and the deadend east of Pulgas St.**	**Various pipeline replacements along Garden St., Terra Villa St., Beech St., and Cypress St.**	**Replace existing 8" CI main on Myrtle St and on Pulgas Ave with new 8" PVC main**	**Replace existing 6" CI main on O'Conner Rd and the 6" CI main on Daisy Ln with new 8" PVC main**	**Connect the two hydrants within the shopping mall at 1721 E Bayshore Rd to the 12" PVC at E Bayshore Rd with a 12" PVC main.**	**Replace existing 4" CI main on Gaillardia Way with new 8" PVC main**	**Replace existing 4" CI main on Camelia Ct with new 8" PVC main**
Physical Condition Score	5	5	5	5	5	5	1	5	5
Hydraulic Performance Score	4	5	5	3	1	3	3	3	3
Weighted Condition Score (out of 10)	8.5	10	10	7	4	7	5	7	7
Service Score	3	3	5	5	3	3	5	5	5
Environmental Score	2	2	2	2	2	2	3	2	2
Safety Score	1	1	1	1	1	1	3	1	1
Supply Score	2	2	2	2	2	2	1	2	2
Weighted Consequence Score (of out 10)	4.4	4.4	5.8	5.8	4.4	4.4	6	5.8	5.8
Total Score (out of 20)	**12.9**	**14.4**	**15.8**	**12.8**	**8.4**	**11.4**	**11**	**12.8**	**12.8**

Table C-2
CIP Project Scoring

Project #	P-28	P-29	P-30	P-31	P-32	P-33	P-34
Description	Replace existing 4" CI main on Aster Way with new 8" PVC main	Replace existing 6" CI and 8" CI mains on E Bayshore Rd with 12" PVC main	Replace 6" CI main on W Bayshore Rd and 8" PVC on W Bayshore Rd with 10" PVC main. Replace 4" CI and a section of 4" PVC main on Woodland Ave with 10" PVC main.	Install 10" PVC main to connect Mission Dr to W Bayshore Rd.	Replace existing 6" CI on Capital Ave and W Bayshore Rd with 12" PVC main. Replace existing 8" CI on Newell Rd with 12" PVC main.	Replace existing 8" CI on Euclid Ave and on Woodland Ave with 12" PVC main.	Replace existing 8" CI on O'Conner St and the 6" CI main between 222 O'Connor St and the German American International School with 12" PVC main.
Physical Condition Score	5	5	5	1	5	5	5
Hydraulic Performance Score	3	5	4	3	5	5	3
Weighted Condition Score (out of 10)	7	10	8.5	5	10	10	7
Service Score	5	3	3	3	3	3	3
Environmental Score	2	3	3	1	3	3	2
Safety Score	1	1	1	1	1	1	1
Supply Score	2	3	3	1	3	3	2
Weighted Consequence Score (of out 10)	5.8	5.4	5.4	3.4	5.4	5.4	4.4
Total Score (out of 20)	**12.8**	**15.4**	**13.9**	**8.4**	**15.4**	**15.4**	**11.4**

Appendix D

Project Summary Sheets

Project Name	**Woodland Avenue Waterline and City of Palo Alto Interconnect Project**		
CIP Project No.	WS-01A/P-1	**Priority Level**	Priority 1A
Project Type	New Pipeline and Interconnection		
Location	Woodland Avenue and University Avenue		

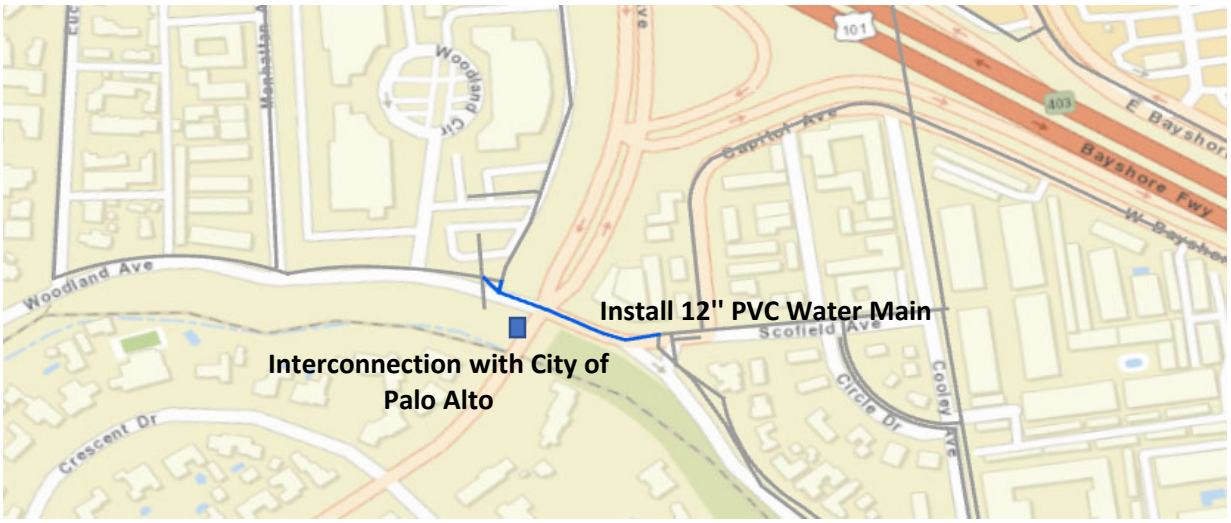
PROJECT DESCRIPTION

1) New 12" PVC water main on Woodland Avenue across University Avenue.
2) New City of Palo Alto Interconnection.

PROJECT JUSTIFICATION

Improves system redundancy and addresses enhanced Menlo Park Municipal Fire Department fire flow requirements west of Highway 101.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	420	LF	$ 470	$ 197,000
Tie-ins	3	EA	$ 10,000	$ 30,000
New Interconnection	1	EA	$ 25,000	$ 25,000
			Contingency (30%)	$ 76,000
			Construction OPC	$ 328,000
			Engineering, CM, Admin., and Permitting Costs (15%) (Design Complete)	$ 49,000
			Total OPC	**$ 328,000**

Project Name	**16-Inch Water Transmission Main Project**		
CIP Project No.	P-2	**Priority Level**	Priority 1A
Project Type	New SFPUC turnout and transmission main		
Location	Purdue Avenue, Fordham Street, and Demeter Street		

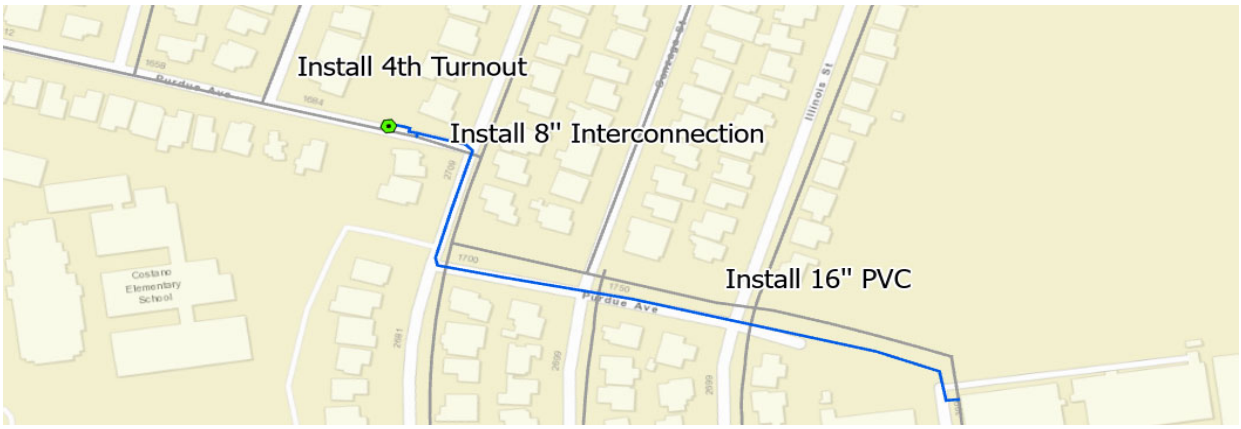
PROJECT DESCRIPTION

1) New SFPUC Turnout on Purdue Ave between Georgetown St and Fordham St.
2) New 16" PVC pipeline on Purdue Ave near Fordham St, Fordham St between Purdue Ave, and Purdue Avenue between Fordham St and Demeter St, with 12" intertie between 16" main and existing 6" main on Purdue Ave.

PROJECT JUSTIFICATION

Improves system redundancy and addresses fire flow requirements systemwide.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	60	LF	$ 330	$ 20,000
12" PVC Water Main	10	LF	$ 470	$ 5,000
16" PVC Water Main	1,120	LF	$ 640	$ 717,000
New SFPUC Turnout	1	LS	$ 150,000	$ 150,000
Tie-ins	2	EA	$ 10,000	$ 20,000
			Contingency (30%)	$ 274,000
			Construction OPC	$ 1,186,000
			Engineering, CM, Admin., and Permitting Costs (20%) (90% Design Complete)	$ 237,000
			Total OPC	**$ 1,423,000**

Project Name	**12-Inch Water Transmission Main Project (with Proposed Modifications)**		
CIP Project No.	WD-04B/WD-04C/P-3	**Priority Level**	Priority 1A
Project Type	New Pipeline and Pipeline Replacement		
Location	University Avenue		

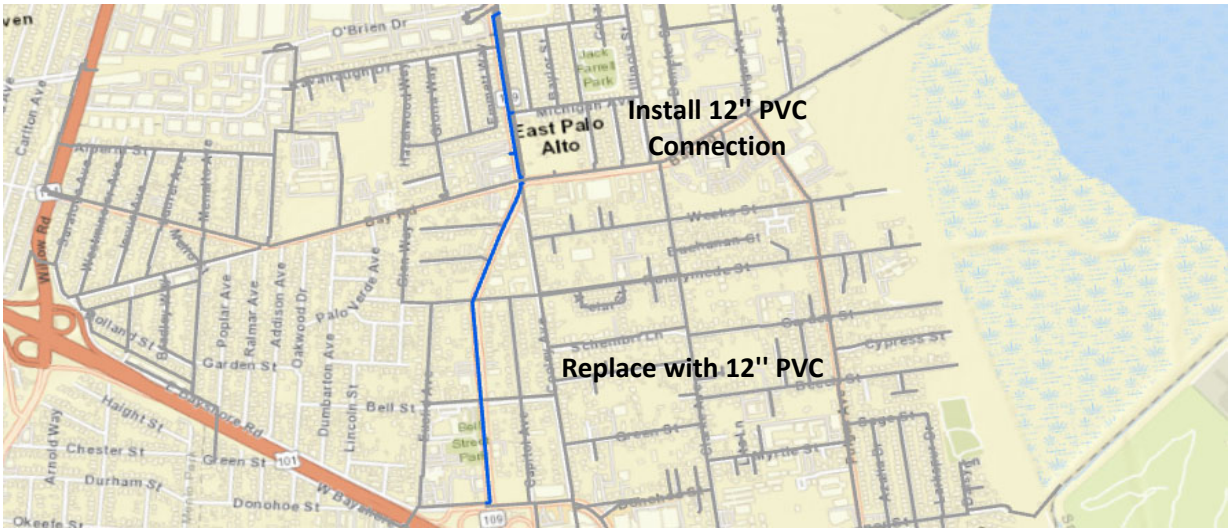
PROJECT DESCRIPTION

1) Install new 12" PVC transmission main on University Avenue between O'Brien Dr and Bay Rd.
2) Replace existing 8" CI on University Avenue between Bay Road and Donahoe St with new 12" PVC.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements for the commercial areas along University Avenue and East Bayshore Road and replaces aging mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC	57	LF	$ 330	$ 19,000
12" PVC Water Main	5,232	LF	$ 470	$ 2,459,000
Tie-ins	11	EA	$ 10,000	$ 110,000
Service Replacement	58	EA	$ 5,000	$ 290,000
Hydrants	14	EA	$ 16,500	$ 231,000
			Contingency (30%)	$ 933,000
			Construction Total	$ 4,023,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 1,207,000
			Total	$ 5,230,000

Project Name	**Various Pipeline Replacement for 4" or Smaller Existing Pipes**		
CIP Project No.	P-4	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	Jervis Ave, Laurel Ave, Mello St, Georgetown St, and Gonzaga St.		

PROJECT DESCRIPTION

1) Replace existing 4" CI main on Laurel Ave between Newbridge St and Alberni St with new 8" PVC main.
2) Replace existing 2" main on Mello St between Bay Rd and Newbridge St with new 8" PVC main.
3) Replace existing 4" CI main on Georgetown St between Purdue Avenue and Tulane Avenue with new
4) 8" PVC main.
5) Replace existing 4" CI main on Gonzaga St between Purdue Avenue and Notre Dame Avenue with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

Replace with 8" PVC

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	3,830	LF	$ 330	$ 1,264,000
Tie ins	10	EA	$ 10,000	$ 100,000
<2" Meters	24	EA	$ 5,000	$ 120,000
Hydrants	20	EA	$ 16,500	$ 330,000
			Contingency (30%)	$ 545,000
			Construction Total	$ 2,359,000
			Engineering, CM, Admin., and Permitting Costs (15%) (Design Complete)	$ 354,000
			Total	$ 2,713,000

Project Name	**Pipeline Improvements for the Ravenswood Business District Specific Plan**		
CIP Project No.	P-5	**Priority Level**	Priority 1
Project Type	New Pipeline and Pipeline Replacement		
Location	Ravenswood Business District		

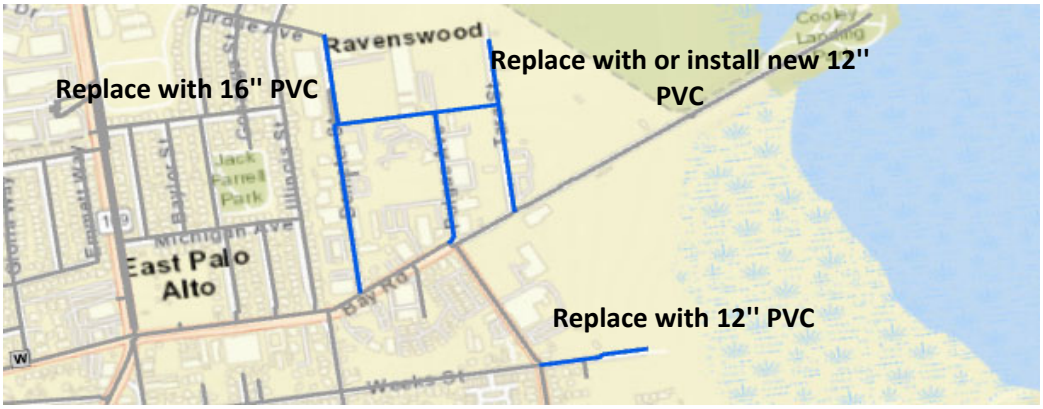
PROJECT DESCRIPTION

1) Replace existing 10" CI main on Demeter St between 351 Demeter St and 255 Demeter St with new 16" PVC main.
2) Replace existing 6'' CI mains on Demeter St between 255 Demeter St and Bay Rd and on Tara St between Bay Road and North of Bay Rd with new 12" PVC main.
3) Replace existing 8'' CI mains on Pulgas Ave between Bay Rd and North of Bay Rd and on Weeks St between Pulgas Ave to the deadend with new 12" PVC main.
4) Install 12'' PVC main connecting Pulgas Aveand Tara St and replace existing 10'' CI mains connecting Demeter St and Pulgas Ave.

PROJECT JUSTIFICATION

Improvements to supply required fire flows for the Ravenswood Business District development and replaces aging mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	8,183	LF	$ 470	$ 3,846,000
16" PVC Water Main	580	LF	$ 640	$ 371,000
Tie ins	6	EA	$ 10,000	$ 60,000
<2" Meters	25	EA	$ 5,000	$ 125,000
Large Commercial/Fire Meters	6	EA	$ 10,000	$ 60,000
Hydrants	11	EA	$ 16,500	$ 182,000
			Contingency (30%)	$ 1,394,000
			Construction Total	$ 6,038,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 1,812,000
			Total	$ 7,850,000

Project Name	**Install a 1.5 MG Steel Tank at 375 Donohoe Street and Pump Station**		
CIP Project No.	P-6	**Priority Level**	Priority 1
Project Type	New Tank, Pump Station, and Pipeline Installation and Replacement		
Location	375 Donohoe St		

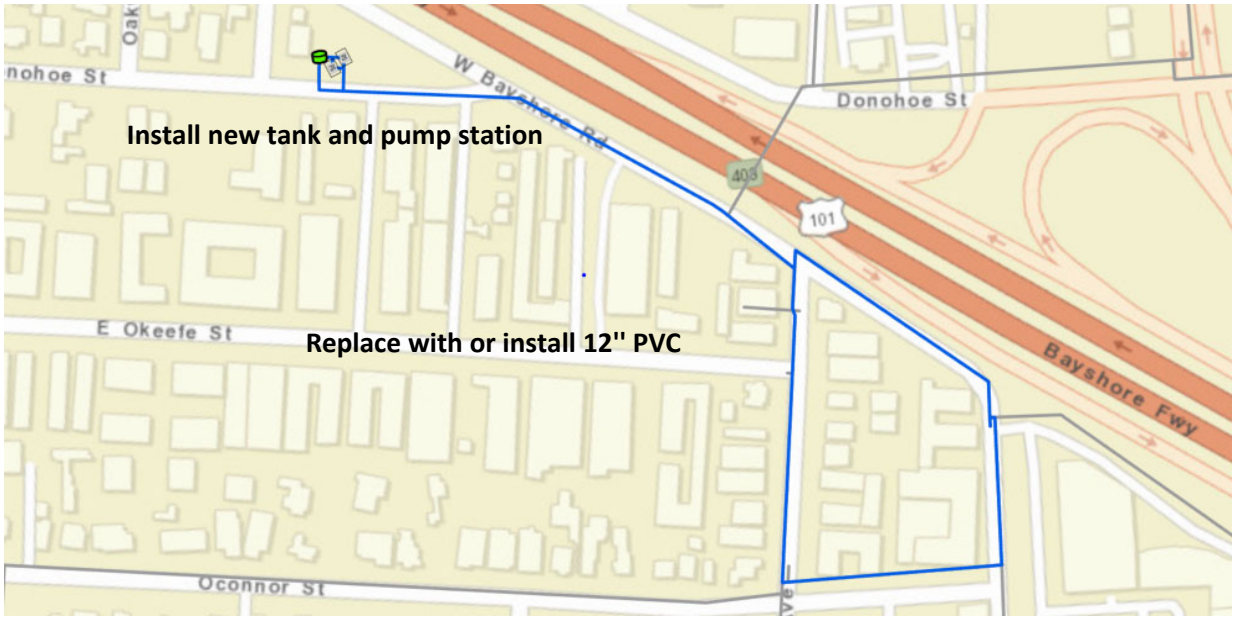
PROJECT DESCRIPTION

1) Install new 1.5 MG steel tank at 375 Donohoe Street.
2) Install new booster pump station with five new 40-hp (625 gpm) pumps at 375 Donohoe Street.
3) Replace the existing pipes in the loop between W Bayshore Rd (6'' CI), Manhattan Avenue (8'' PVC), O'Connor St (8'' CI), and Euclid Avenue (8''CI) with 12'' PVC main.
4) Replace existing 6'' CI on W Bayshore Rd between Donohoe Avenue and Euclid Avenue with new 12'' PVC main.
5) Install 12'' PVC main to connect the steel tank at 375 Donohoe St and the new replaced pipes in the intersection of Donohoe St and W Bayshore Rd.

PROJECT JUSTIFICATION

Improvements to supply storage and required fire flow for the Euclid Improvements development.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Project will be developer funded and paid. No OPC provided

Project Name	**Install a 0.15 MG Steel Tank at a Pad D Site**		
CIP Project No.	P-7	**Priority Level**	Priority 1
Project Type	New Tank, Pump Station, and Pipeline Installation		
Location	Pad D Site		

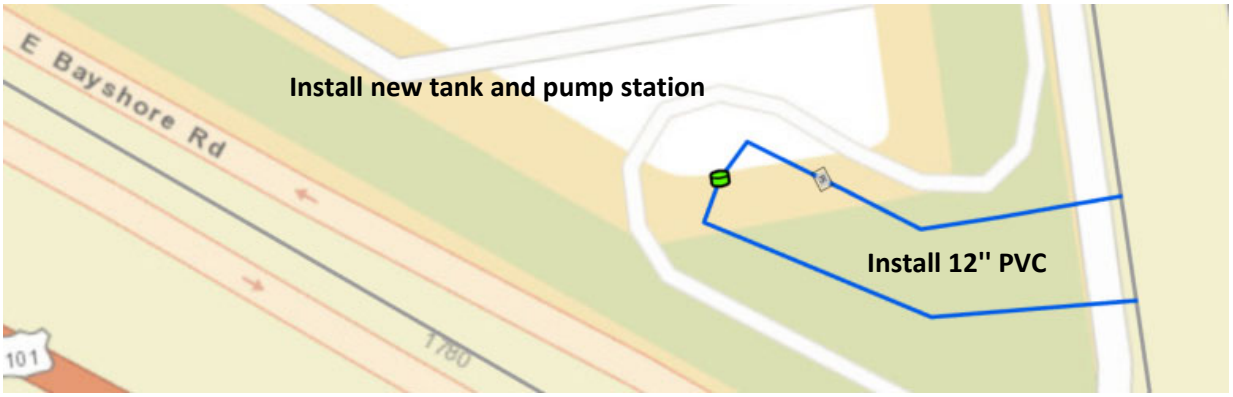
PROJECT DESCRIPTION

1) Install new 0.15 MG steel tank at the Pad D Site.
2) Retrofit booster pump station with two new 30-hp (500 gpm) pumps at Pad D Site and connect to City's distribution system at Clarke Avenue near E Bayshore Rd.

PROJECT JUSTIFICATION

Tank and booster pump station currently supplies required fire flows to the Light Tree Apartment and will provide storage to the City after the apartments can meet fire flow requirements with other system improvements.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Project will be developer funded and paid. No OPC provided

Project Name	**Pipeline Replacement for 4'' CI Pipes, Hunter Street**		
CIP Project No.	P-8	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Hunter Street		

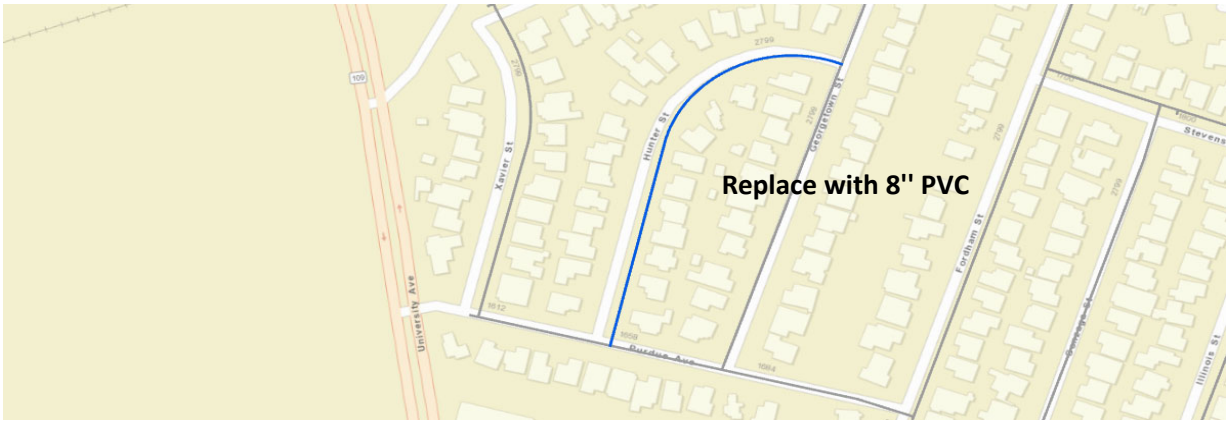
PROJECT DESCRIPTION

1) Replace existing 4" CI main on Hunter Street between Purdue Avenue and Georgetown St with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	840	LF	$ 330	$ 277,000
Tie ins	2	EA	$ 10,000	$ 20,000
Hydrant	1	LS	$ 16,500	$ 17,000
Service Replacement	27	LS	$ 5,000	$ 135,000
			Contingency (30%)	$ 135,000
			Construction Total	$ 584,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 176,000
			Total	$ 760,000

Project Name	**Pipeline Replacement for 4'' CI Pipes, Baylor Street**		
CIP Project No.	P-9	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Baylor Street		

PROJECT DESCRIPTION

1) Replace existing 4" CI main on Baylor St between Notre Dame Ave and Michigan Ave with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	840	LF	$ 330	$ 277,000
Tie ins	2	EA	$ 10,000	$ 20,000
Hydrant	1	LS	$ 16,500	$ 17,000
Service Replacement	27	LS	$ 5,000	$ 135,000
			Contingency (30%)	$ 135,000
			Construction Total	$ 584,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 176,000
			Total	$ 760,000

Project Name	**Pipeline Replacement for 4'' CI Pipes, Gonzaga Street**		
CIP Project No.	P-10	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Gonzaga Street		

PROJECT DESCRIPTION

1) Replace existing 4" CI main on Gonzaga St between Michigan Avenue and Bay Rd with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	640	LF	$ 330	$ 211,000
Tie ins	2	EA	$ 10,000	$ 20,000
Hydrant	1	LS	$ 16,500	$ 17,000
Service Replacement	16	LS	$ 5,000	$ 80,000
			Contingency (30%)	$ 99,000
			Construction Total	$ 427,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 129,000
			Total	$ 556,000

Project Name	**Pipeline Replacement for 4'' CI Pipes, Farrington Way**		
CIP Project No.	P-11	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Farrington Way		

PROJECT DESCRIPTION

1) Replace existing 4" CI main on Farrington Way between Kavanaugh Dr and Ursula Way with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	840	LF	$ 330	$ 277,000
Tie ins	2	EA	$ 10,000	$ 20,000
Hydrant	1	LS	$ 16,500	$ 17,000
Service Replacement	28	LS	$ 5,000	$ 140,000
			Contingency (30%)	$ 137,000
			Construction Total	$ 591,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 178,000
			Total	$ 769,000

Project Name	**Pipeline Replacement for 4'' CI Pipes, Hazelwood Way**		
CIP Project No.	P-12	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Hazelwood Way		

PROJECT DESCRIPTION

1) Replace existing 4" CI main on Hazelwood Way between Kavanaugh Dr and Ursula Way and on Ursula Way between Hazelwood Way and Gloria Way with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	1,190	LF	$ 330	$ 393,000
Tie ins	3	EA	$ 10,000	$ 30,000
Hydrant	2	LS	$ 16,500	$ 33,000
Service Replacement	35	LS	$ 5,000	$ 175,000
			Contingency (30%)	$ 190,000
			Construction Total	$ 821,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 247,000
			Total	$ 1,068,000

Project Name	**Pipe Improvements near the 1240 O'Brien Turnout**		
CIP Project No.	P-13	**Priority Level**	Priority 1
Project Type	Pipeline Replacement		
Location	Near the 1240 O'Brien Turnout		

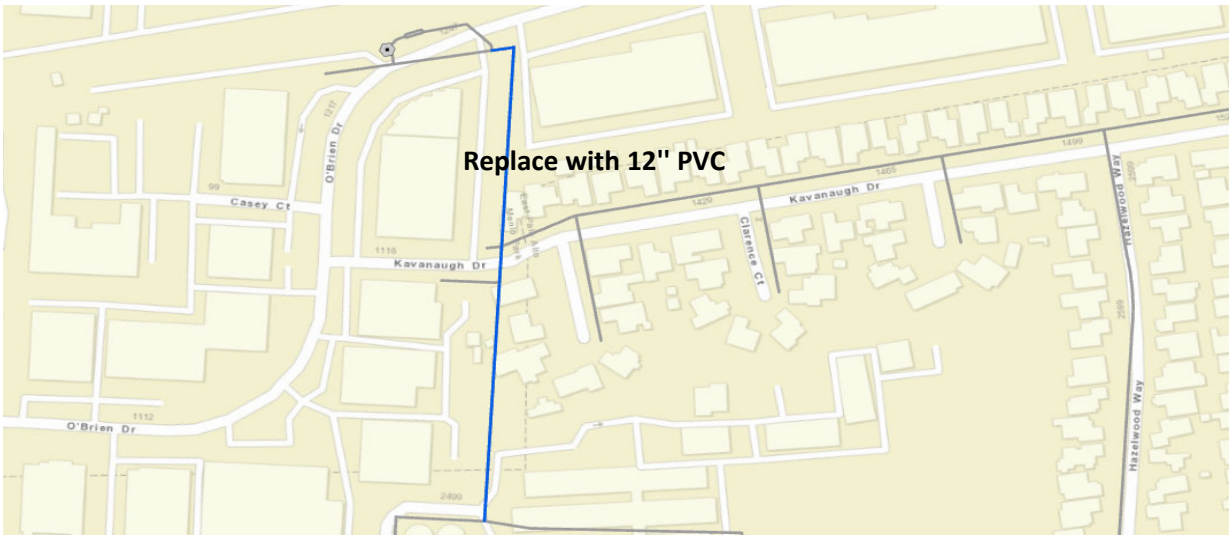
PROJECT DESCRIPTION

1) Replace existing 8" CI, 10" AC, and 10" unknown mains from connection to the 1240 O'Brien turnout on O'Brien Drive through an existing easement to Ralmar Avenue with new 12" PVC main.

PROJECT JUSTIFICATION

Improve transmission from 1240 O'Brien and increase pressures and fire flow availability systemwide.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	900	LF	$ 470	$ 423,000
Tie ins	5	EA	$ 10,000	$ 50,000
Hydrant	1	LS	$ 16,500	$ 17,000
Service Replacement	2	LS	$ 5,000	$ 10,000
			Contingency (30%)	$ 150,000
			Construction Total	$ 650,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 195,000
			Total	$ 845,000

Project Name	**Pipe Improvements on Bay Road**		
CIP Project No.	P-14	**Priority Level**	Priority 1
Project Type	Pipeline Replacement		
Location	Bay Road		

PROJECT DESCRIPTION

1) Replace existing 8" CI main on Bay Rd from University Avenue to Ralmar Avenue with new 12" PVC main.
2) Install new 8" pressure reducing valve (PRV) at Gloria Way and Bay Road at the existing isolation valve that prevents short-circuiting of production from Gloria Way. The PRV would only open when pressures drop during fire flow conditions.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements along Bay Road and Gloria Way in commercial and multi-family residential areas.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	2,460	LF	$ 470	$ 1,156,000
Tie ins	5	EA	$ 10,000	$ 50,000
Service Replacement	22	EA	$ 5,000	$ 110,000
8-inch PRV	1	EA	$ 130,000	$ 130,000
Hydrants	3	EA	$ 16,500	$ 50,000
			Contingency (30%)	$ 449,000
			Construction Total	$ 1,945,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 584,000
			Total	$ 2,529,000

Project Name	**Pipe Improvements Near Willow Road and Highway 101**		
CIP Project No.	P-15	**Priority Level**	Priority 2
Project Type	Pipeline Replacement and New Pipeline Connection		
Location	Multiple streets near Willow Road and Highway 101		

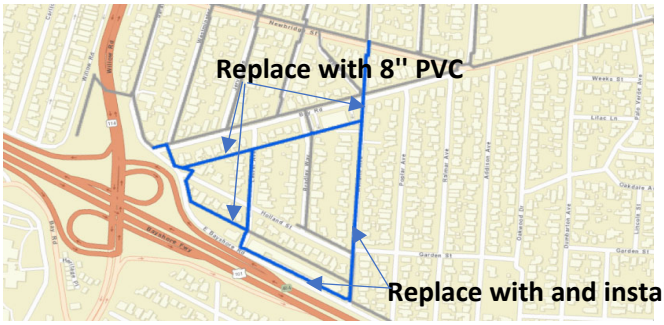
PROJECT DESCRIPTION

1) Replace existing 4" CI, 6" CI, and 6" plastic mains on Menalto Avenue between Newbridge St and E Bayshore Road and E Bayshore Rd between Menalto Avenue and Laurel Avenue with new 10" PVC main and install new looped 10" PVC connection on Laurel Avenue between E Bayshore Rd and alley north of E Bayshore Rd.
2) Replace existing 4"CI and 6" CI mains along E Bayshore Rd between Bay Rd and alley between E Bayshore Rd and Holland St and on alley between E Bayshore Rd Laurel Avenue with new 8" PVC main.
3) Replace existing 4" CI main on Laurel Avenue between alley south of Bay Road and alley north of E Bayshore Rd new 8" PVC main.
4) Replace existing 4" CI main in alley south of Bay Road between E Bayshore Avenue and Menalto Avenue with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements and replaces aging and/or undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
10" PVC Water Main	2,570	LF	$ 390	$ 1,002,000
8" PVC Water Main	2,570	LF	$ 330	$ 848,000
Tie ins	7	EA	$ 10,000	$ 70,000
Service Replacement	59	EA	$ 5,000	$ 295,000
Hydrants	8	EA	$ 16,500	$ 132,000
			Contingency (30%)	$ 705,000
			Construction Total	$ 3,052,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 916,000
			Total	$ 3,968,000

Project Name	**Pipe Improvements on Highway Crossing and Donohoe Street**		
CIP Project No.	P-16	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Donohoe Street and Highway 101		

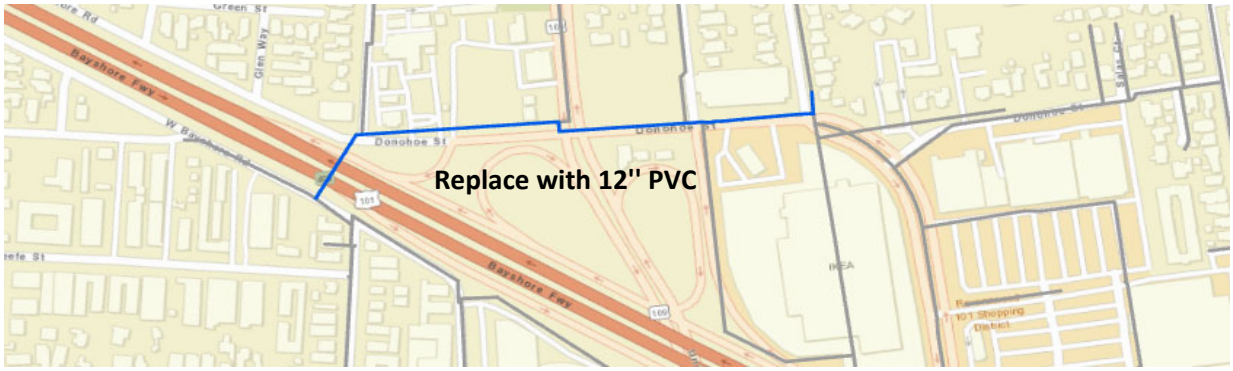
PROJECT DESCRIPTION

1) Replace existing 8" CI Highway 101 Crossing near Euclid Avenue with new 12" PVC carrier pipe (via jack and bore).
2) Replace existing 8" CI on Donahoe St between Euclid Avenue and Cooley Avenue with new 12" PVC.

PROJECT JUSTIFICATION

Improves transmission to areas across Highway 101 between proposed 375 Donohoe Tank and SFPUC turnouts to increase pressures and fire flow availability systemwide; improves system resiliency and replaces aging mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	1,820	LF	$ 470	$ 855,000
24" Steel Casing (Jack and Bore)	250	LF	$ 2,500	$ 625,000
Tie ins	7	EA	$ 10,000	$ 70,000
Service Replacement	7	EA	$ 5,000	$ 35,000
Hydrants	4	EA	$ 16,500	$ 66,000
			Contingency (30%)	$ 496,000
			Construction Total	$ 2,147,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 645,000
			Total	$ 2,792,000

Project Name	**Various Pipeline Replacement for 4" or Smaller Existing Pipes**		
CIP Project No.	P-17	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Weeks St and Sacramento St west of University Avenue.		

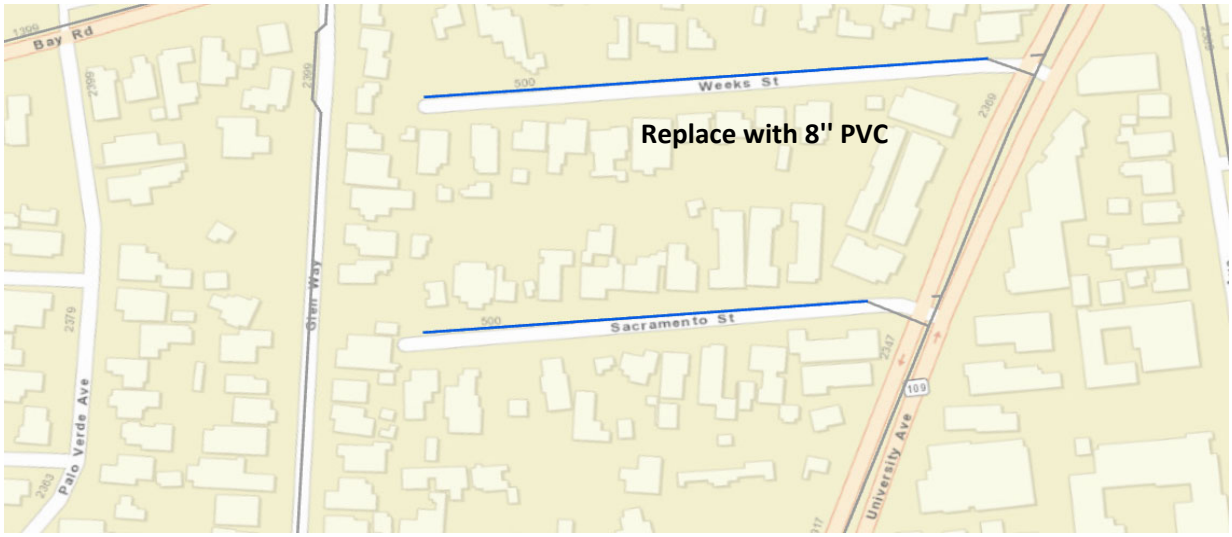
PROJECT DESCRIPTION

1) Replace existing 2" GS and 4" CI mains on Weeks St west of University Ave.
2) Replace existing 2" GS and 4" CI mains on Sacramento St west of University Ave.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	1,290	LF	$ 330	$ 426,000
Tie ins	2	EA	$ 10,000	$ 20,000
Service Replacement	40	EA	$ 5,000	$ 200,000
Hydrants	2	EA	$ 16,500	$ 33,000
			Contingency (30%)	$ 204,000
			Construction Total	$ 883,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 265,000
			Total	$ 1,148,000

Project Name	**Pipeline Replacement on Capital Avenue**		
CIP Project No.	P-19	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Capital Avenue		

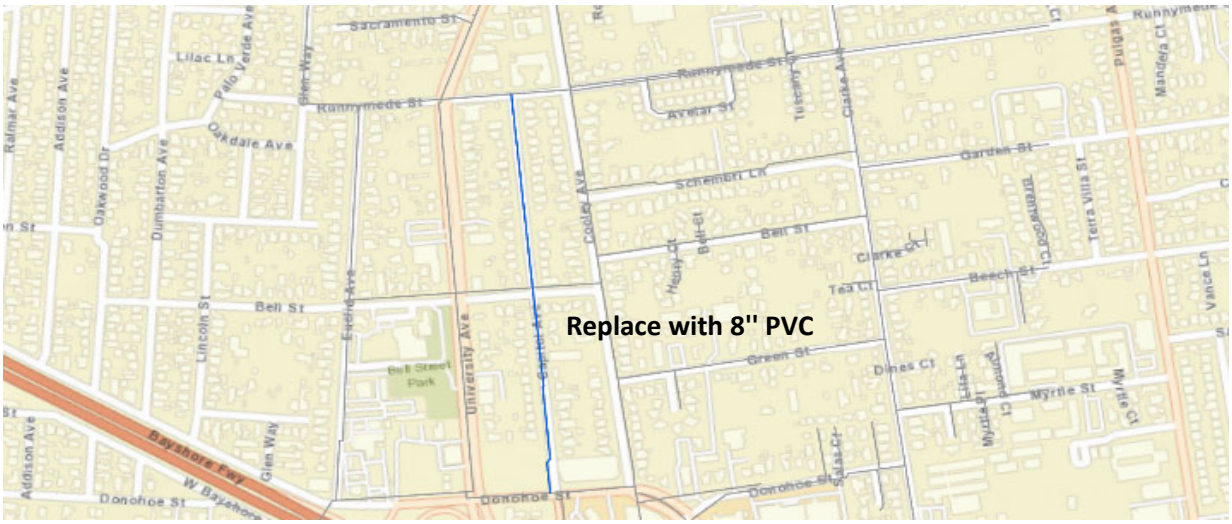
PROJECT DESCRIPTION

1) Replace existing 6" CI main on Capital Avenue between Runnymede St and Donahoe St with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in the commercial area along Capital Ave and replaces aging, undersized main.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	2,150	LF	$ 330	$ 710,000
Tie ins	3	EA	$ 10,000	$ 30,000
Service Replacement	61	EA	$ 5,000	$ 305,000
Hydrants	3	EA	$ 16,500	$ 50,000
			Contingency (30%)	$ 329,000
			Construction Total	$ 1,424,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 428,000
			Total	$ 1,852,000

Project Name	**Pipeline Replacement on Euclid Avenue**		
CIP Project No.	P-20	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Euclid Avenue		

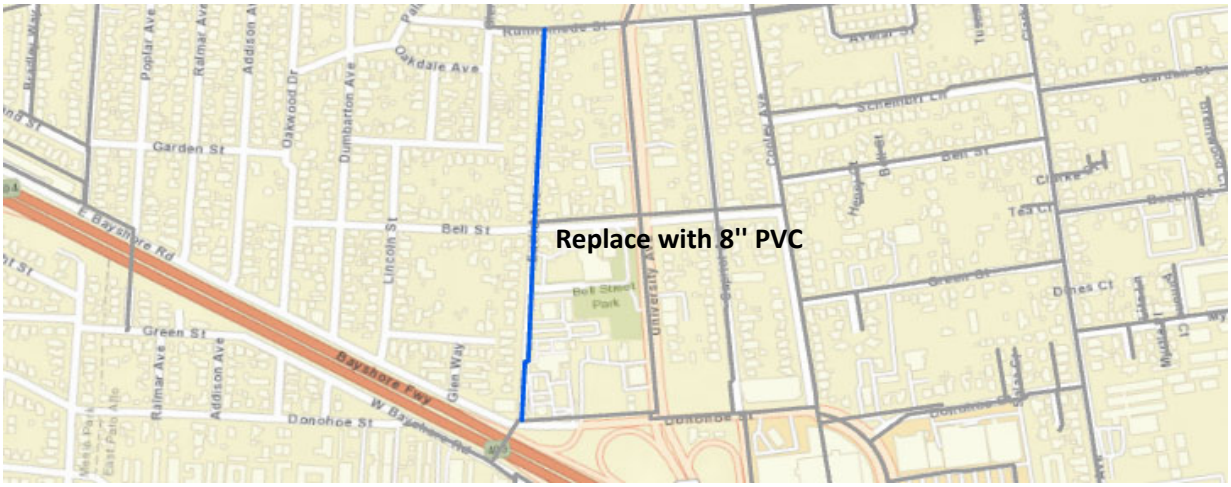
PROJECT DESCRIPTION

1) Replace existing 6" CI main on Euclid Avenue between Runnymede St and Donahoe St with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in commercial area along Euclid Ave and replaces aging, undersized main.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	2,130	LF	$ 330	$ 703,000
Tie ins	3	EA	$ 10,000	$ 30,000
Service Replacement	56	EA	$ 5,000	$ 280,000
Hydrants	3	EA	$ 16,500	$ 50,000
			Contingency (30%)	$ 319,000
			Construction Total	$ 1,382,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 415,000
			Total	$ 1,797,000

Project Name	**Pipeline Replacement on Clarke Avenue and Runnymede Street**		
CIP Project No.	P-21a	**Priority Level**	Priority 1A
Project Type	Pipeline Replacement		
Location	Clarke Avenue, Runnymede Street		

PROJECT DESCRIPTION

1) Replace existing 8'' AC and 8" CI main on Weeks St between Cooley Avenue and Pulgas St with new 12" PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements for commercial customers along Weeks Street.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	2,640	LF	$ 470	$ 1,241,000
Tie ins	9	EA	$ 10,000	$ 90,000
Service Replacement	85	EA	$ 5,000	$ 425,000
Hydrants	12	EA	$ 16,500	$ 198,000
			Contingency (30%)	$ 587,000
			Construction Total	$ 2,541,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 763,000
			Total	$ 3,304,000

Project Name	**Pipeline Replacement on Clarke Avenue and Runnymede Street**		
CIP Project No.	P-21	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Clarke Avenue, Runnymede Street		

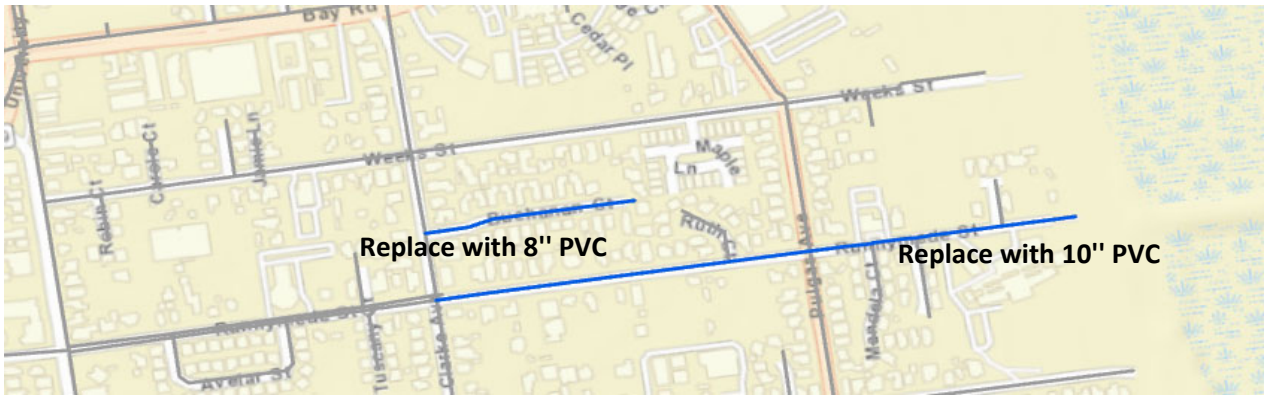
PROJECT DESCRIPTION

1) Replace existing 6" CI main on Buchannan Ct from Clark Ave to the deadend to the east with new 8" PVC main.
2) Replace existing 8" CI main on Runnymede St between Pulgas Ave and the deadend to the east with new 10" PVC main.
3) Replace existing 4" CI main on Runnymede St between Clarke Ave and Pulgas Ave with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
10" PVC Water Main	940	LF	$ 390	$ 367,000
8" PVC Water Main	2,080	LF	$ 330	$ 686,000
Tie ins	8	EA	$ 10,000	$ 80,000
Service Replacement	78	EA	$ 5,000	$ 390,000
Hydrants	12	EA	$ 16,500	$ 198,000
			Contingency (30%)	$ 517,000
			Construction Total	$ 2,238,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 672,000
			Total	$ 2,910,000

Project Name	**Various Pipeline Replacement for 4'' CI and 6'' CI Pipes**		
CIP Project No.	P-22	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	Garden St, Terra Villa St, Beach St, Cypress St		

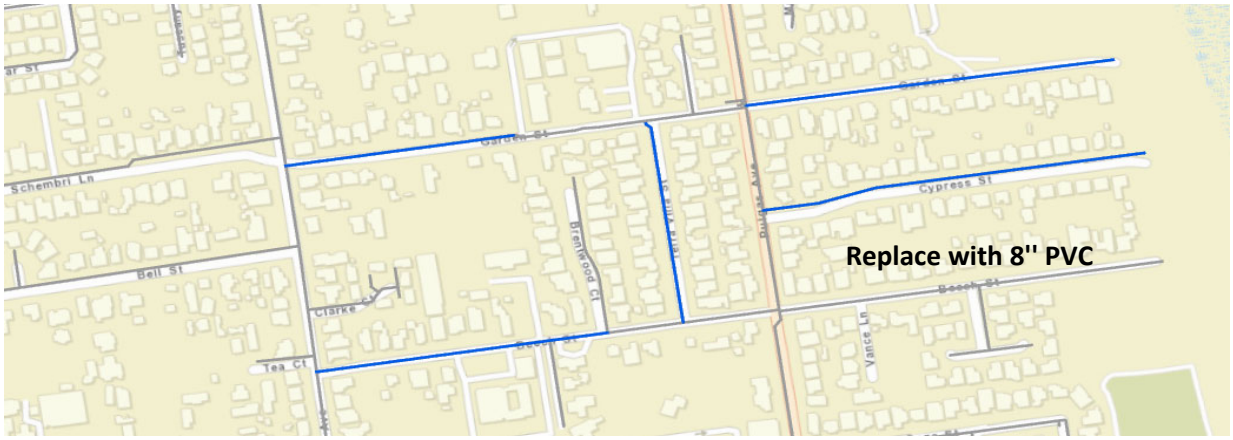
PROJECT DESCRIPTION

1) Replace existing 4" CI main on Garden St between Clarke Ave and 1004 Garden St with new 8" PVC main.
2) Replace existing 4'' CI and 6'' CI main on Garden St between Pulgas Ave to the dead end to the east with new 8" PVC main.
3) Replace existing 4" CI main on Terra Villa St between Garden St and Beech St with new 8" PVC main.
4) Replace existing 4" CI main on Beech St between Clarke Ave and Brentwood Ct with new 8" PVC main.
5) Replace existing 6'' CI main on Cypress St between Pulgas Ave and the dead end to the east with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	4,340	LF	$ 330	$ 1,432,000
Tie ins	9	EA	$ 10,000	$ 90,000
Hydrants	4	EA	$ 16,500	$ 66,000
Service Replacement	119	EA	$ 5,000	$ 595,000
			Contingency (30%)	$ 655,000
			Construction Total	$ 2,838,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 852,000
			Total	$ 3,690,000

Project Name	**Pipeline Replacement for Nearby Schools**		
CIP Project No.	P-23	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	Myrtle Street and Pulgas Avenue		

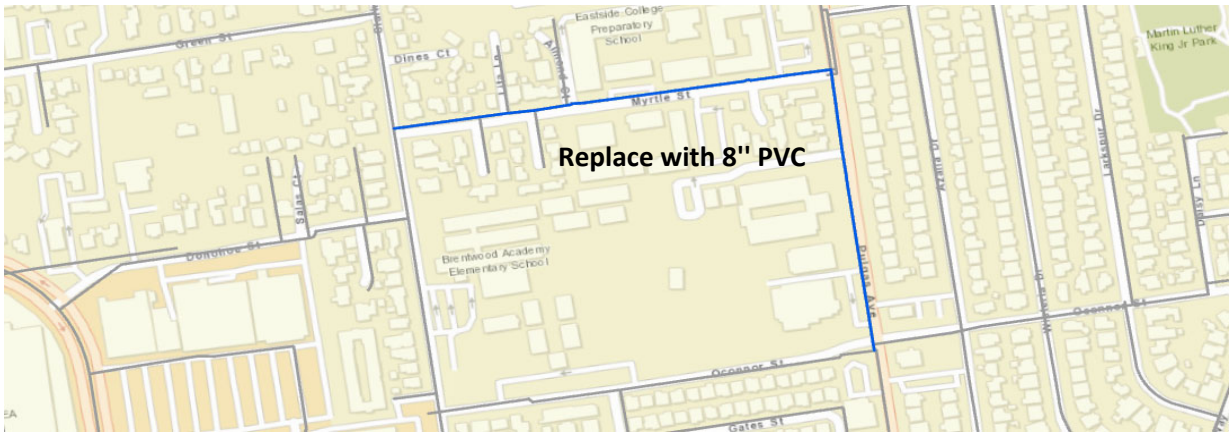
PROJECT DESCRIPTION

1) Replace existing 8'' CI main on Myrtle St between Clarke Ave and Pulgas Ave and on Pulgas Ave from Myrtle St to O'Conner St with new 8" PVC main.

PROJECT JUSTIFICATION

Address enhanced Menlo Park Municipal Fire Department fire flow requirements near school.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	2,260	LF	$ 330	$ 746,000
Tie ins	8	EA	$ 10,000	$ 80,000
Hydrants	8	EA	$ 16,500	$ 132,000
Service Replacement	31	EA	$ 5,000	$ 155,000
			Contingency (30%)	$ 334,000
			Construction Total	$ 1,447,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 435,000
			Total	$ 1,882,000

Project Name	**Pipeline Replacement on O'Conner Road and Daisy Lane**		
CIP Project No.	P-24	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	O'Conner Road and Daisy Lane		

PROJECT DESCRIPTION

1) Replace existing 6" CI main on O'Conner Rd between Larkspur Dr and 1161 O' Connor St and the 6'' CI main on Daisy Ln from O'Conner St to 421 Daisy Ln with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	790	LF	$ 330	$ 261,000
Tie ins	5	EA	$ 10,000	$ 50,000
Hydrants	2	EA	$ 16,500	$ 33,000
Service Replacement	10	EA	$ 5,000	$ 50,000
			Contingency (30%)	$ 119,000
			Construction Total	$ 513,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 154,000
			Total	$ 667,000

Project Name	**Connect the Two Hydrants at Shopping Mall**		
CIP Project No.	P-25	**Priority Level**	Priority 3
Project Type	Reconnect Hydrant		
Location	1721 E Bayshore Road		

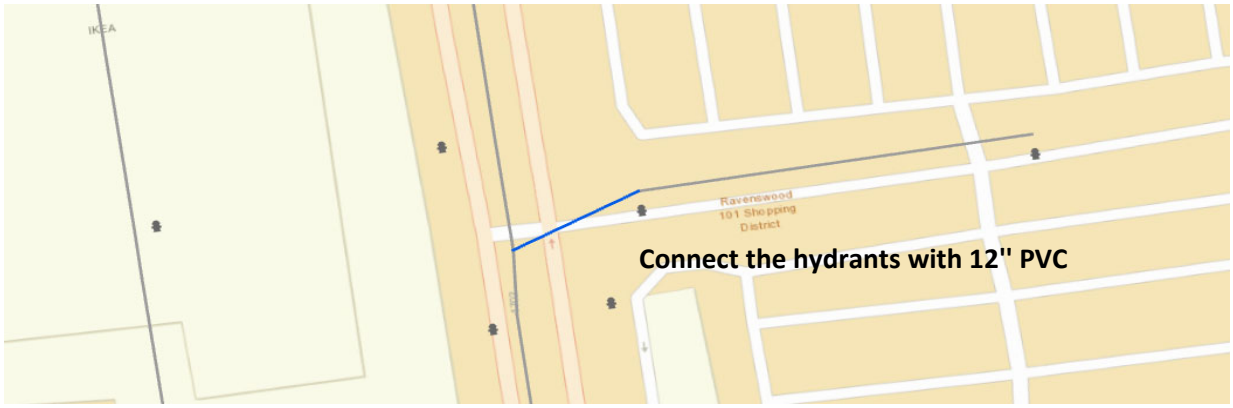
PROJECT DESCRIPTION

1) Connect the two hydrant within the shopping mall at 1721 E Bayshore Rd to the existing 12'' PVC at E Bayshore Rd with a 12'' PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in the shopping center.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	110	LF	$ 470	$ 52,000
Tie ins	2	EA	$ 10,000	$ 20,000
Hydrants	1	EA	$ 16,500	$ 17,000
Service Replacement	1	EA	$ 5,000	$ 5,000
			Contingency (30%)	$ 29,000
			Construction Total	$ 123,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 37,000
			Total	$ 160,000

Project Name	**Pipeline Replacement on Gaillardia Way**		
CIP Project No.	P-26	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	Gaillardia Way		

PROJECT DESCRIPTION

1) Replace existing 4" CI main on Gaillardia Way between Pulgas Ave and Azalia Dr with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	590	LF	$ 330	$ 195,000
Tie ins	2	EA	$ 10,000	$ 20,000
Hydrants	1	EA	$ 16,500	$ 17,000
Service Replacement	16	EA	$ 5,000	$ 80,000
			Contingency (30%)	$ 94,000
			Construction Total	$ 406,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 122,000
			Total	$ 528,000

Project Name	**Pipeline Replacement on Camelia Drive**		
CIP Project No.	P-27	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	Camelia Drive		

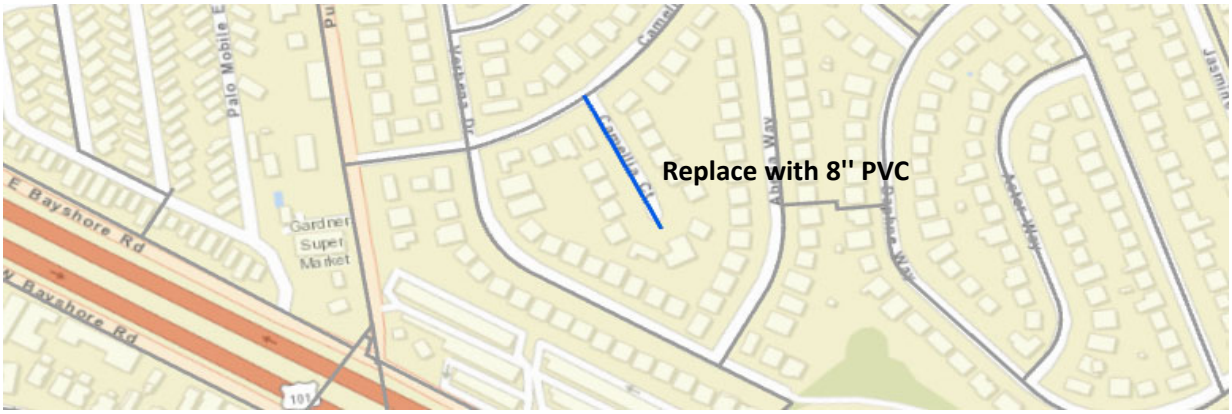
PROJECT DESCRIPTION

1) Replace existing 4" CI main on Camelia Ct from Camelia Dr to the end of the circle with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	350	LF	$ 330	$ 116,000
Tie ins	1	EA	$ 10,000	$ 10,000
Hydrants	1	EA	$ 16,500	$ 17,000
Service Replacement	13	EA	$ 5,000	$ 65,000
			Contingency (30%)	$ 63,000
			Construction Total	$ 271,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 82,000
			Total	$ 353,000

Project Name	**Pipeline Replacement on Aster Way**		
CIP Project No.	P-28	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	Aster Way		

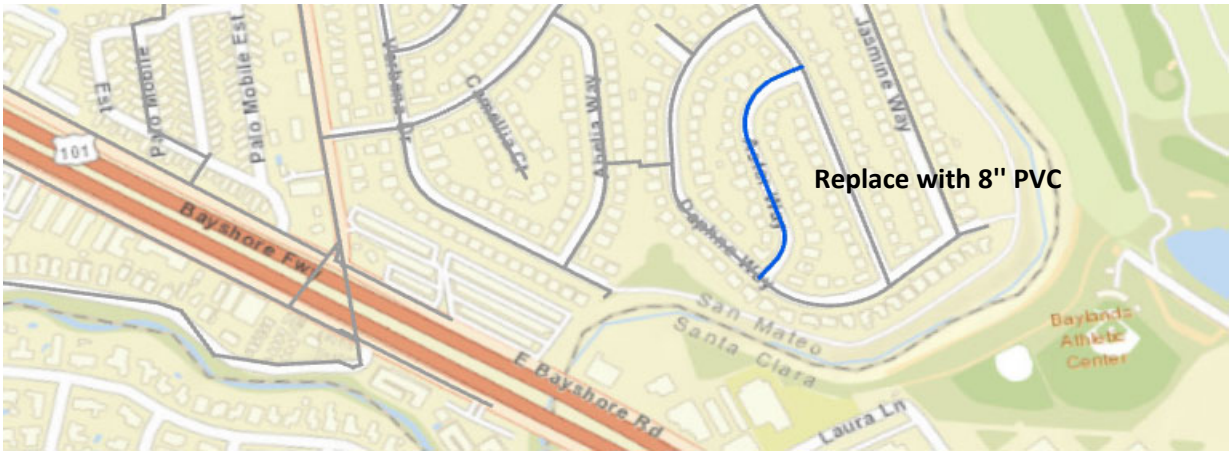
PROJECT DESCRIPTION

1) Replace existing 4" CI main on Aster Way between Daphne Way and Wieteria Dr with new 8" PVC main.

PROJECT JUSTIFICATION

Addresses existing fire flow requirements in the residential neighborhoods and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
8" PVC Water Main	910	LF	$ 330	$ 300,000
Tie ins	2	EA	$ 10,000	$ 20,000
Service Replacement	27	EA	$ 5,000	$ 135,000
			Contingency (30%)	$ 137,000
			Construction Total	$ 592,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 178,000
			Total	$ 770,000

Project Name	**Pipeline Replacement on East Bayshore Road**		
CIP Project No.	P-29	**Priority Level**	Priority 1A
Project Type	Pipeline Replacement		
Location	East Bayshore Road		

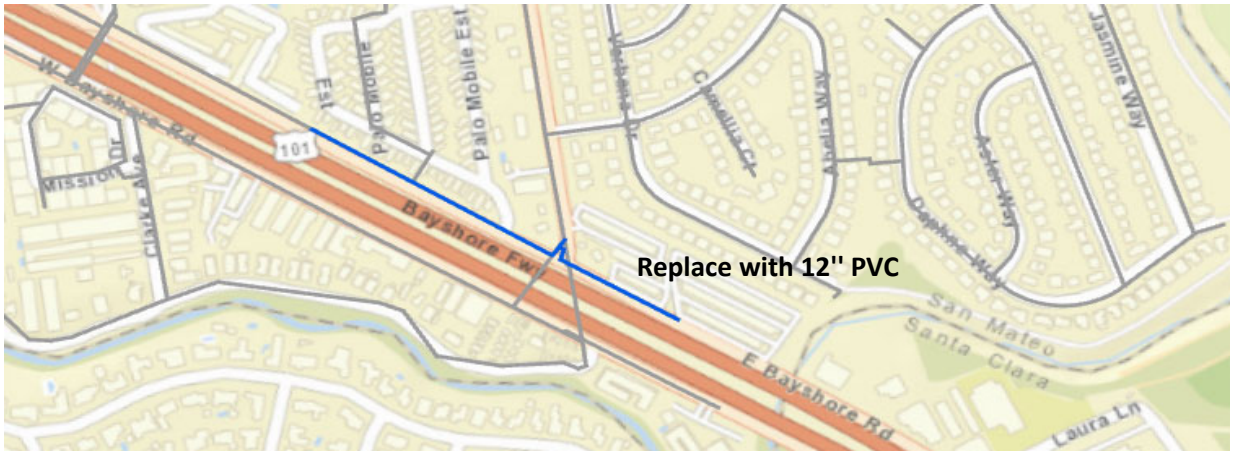
PROJECT DESCRIPTION

1) Replace existing 6'' CI main on E Bayshore Rd between 1805 E Bayshore (where the new 12'' PVC ended) to Pulgas Ave with 12'' PVC main.
2) Replace existing 8'' CI main on E Bayshore Rd between Pulgas Ave and the end of E Bayshore Rd to the east with 12'' PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	1,460	LF	$ 470	$ 686,000
Tie ins	4	EA	$ 10,000	$ 40,000
Hydrants	1	EA	$ 16,500	$ 17,000
Service Replacement	4	EA	$ 5,000	$ 20,000
			Contingency (30%)	$ 229,000
			Construction Total	$ 992,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 298,000
			Total	$ 1,290,000

Project Name	**Various Pipeline Replacement West of Highway 101**		
CIP Project No.	P-30	**Priority Level**	Priority 2
Project Type	Pipeline Replacement		
Location	West Bayshore Road, Woodland Avenue		

PROJECT DESCRIPTION

1) Replace existing 6'' CI main on W Bayshore Rd between Clark Avenue and Woodland Ave and existing 8'' PVC on W Bayshore Rd between Woodland and 1982 W Bayshore Rd with 10'' PVC main.
2) Replace existing 4'' CI and a small section of 4'' PVC main on Woodland Avenue between W Bayshore Rd and Clarke Ave with 10'' PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in multi-family residential areas and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
10" PVC Water Main	3,670	LF	$ 390	$ 1,431,000
Tie ins	6	EA	$ 10,000	$ 60,000
Hydrants	5	EA	$ 16,500	$ 83,000
Service Replacement	34	EA	$ 5,000	$ 170,000
			Contingency (30%)	$ 524,000
			Construction Total	$ 2,268,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 681,000
			Total	$ 2,949,000

Project Name	**New Pipeline Connection at Mission Drive and West Bayshore Road**		
CIP Project No.	P-31	**Priority Level**	Priority 3
Project Type	New Pipeline Connection		
Location	Mission Drive and West Bayshore Road		

PROJECT DESCRIPTION

1) Install 10'' PVC main to connect Mission Dr to W Bayshore Rd.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in multi-family residential areas.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
10" PVC Water Main	60	LF	$ 390	$ 23,000
Tie ins	2	EA	$ 10,000	$ 20,000
			Contingency (30%)	$ 13,000
			Construction Total	$ 56,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 17,000
			Total	$ 73,000

Project Name	**Pipeline Replacement West of Highway 101 and East of University Ave**		
CIP Project No.	P-32	**Priority Level**	Priority 1A
Project Type	Pipeline Replacement		
Location	Capital Avenue, West Bayshore Road, and Newell Road		

PROJECT DESCRIPTION

1) Replace existing 6'' CI on Capital Ave and W Bayshore Rd between the intersection of Scofield Ave and Capital Ave to the Intersection of W Bayshore Rd and Newell Rd with 12'' PVC main.
2) Replace existing 8'' CI on Newell Rd between W Bayshore Rd and Woodland Ave with 12'' PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in multi-family residential areas and replaces aging, undersized mains.

PROJECT DETAIL MAP

TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	2,970	LF	$ 470	$ 1,396,000
Tie ins	7	EA	$ 10,000	$ 70,000
Hydrants	6	EA	$ 16,500	$ 99,000
Service Replacement	23	EA	$ 5,000	$ 115,000
			Contingency (30%)	$ 504,000
			Construction Total	$ 2,184,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 656,000
			Total	$ 2,840,000

Project Name	**Pipeline Replacement West of Highway 101 and West of University Ave**		
CIP Project No.	P-33	**Priority Level**	Priority 1A
Project Type	Pipeline Replacement		
Location	Euclid Avenue and Woodland Avenue		

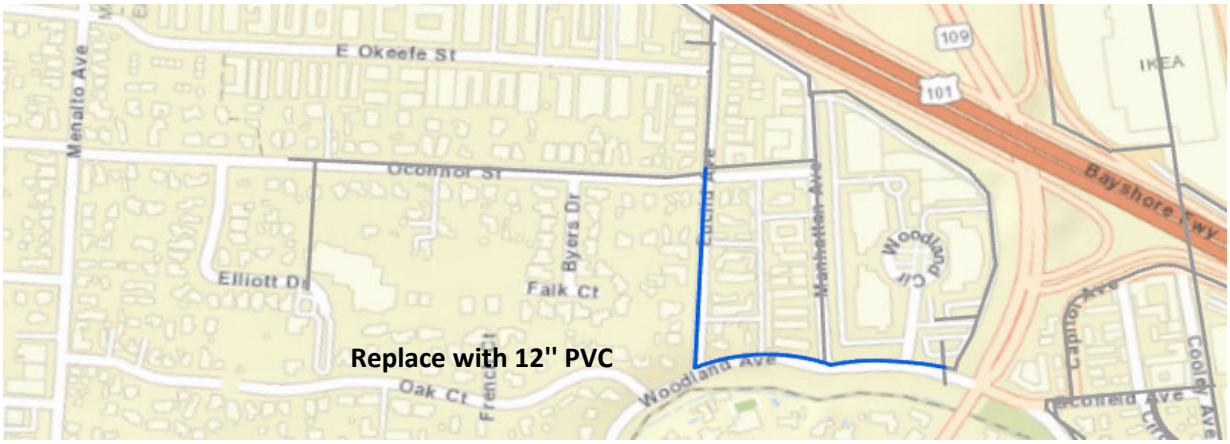
PROJECT DESCRIPTION

1) Replace existing 8'' CI on Euclid Ave between O'Conner St and Woodland Ave and on Woodland Ave between Euclid Ave and University Ave with 12'' PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements in multi-family residential areas and replaces aging, undersized mains.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	1,640	LF	$ 470	$ 771,000
Tie ins	5	EA	$ 10,000	$ 50,000
Hydrants	3	EA	$ 16,500	$ 50,000
Service Replacement	33	EA	$ 5,000	$ 165,000
			Contingency (30%)	$ 311,000
			Construction Total	$ 1,347,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 405,000
			Total	$ 1,752,000

Project Name	**Pipeline Replacement near German American International School**		
CIP Project No.	P-34	**Priority Level**	Priority 3
Project Type	Pipeline Replacement		
Location	Near German American International School		

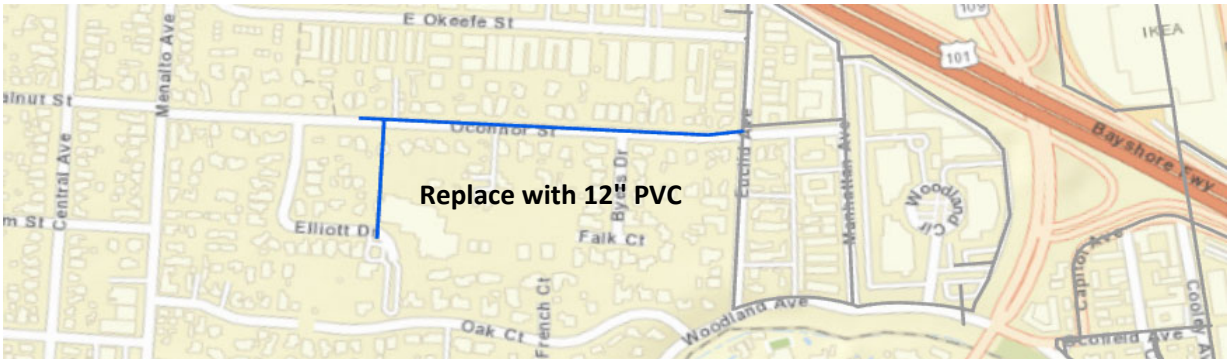
PROJECT DESCRIPTION

1) Replace existing 8'' CI on O'Conner St between 222 O'Conner St and Euclid Avenue and the 6'' CI main between 222 O'Conner St and the German American International School with 12'' PVC main.

PROJECT JUSTIFICATION

Addresses enhanced Menlo Park Municipal Fire Department fire flow requirements at German American International School.

PROJECT DETAIL MAP



TOTAL OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost	Total Cost
12" PVC Water Main	1,930	LF	$ 470	$ 907,000
Tie ins	1	EA	$ 10,000	$ 10,000
Hydrants	1	EA	$ 16,500	$ 17,000
Service Replacement	1	EA	$ 5,000	$ 5,000
			Contingency (30%)	$ 282,000
			Construction Total	$ 1,221,000
			Engineering, CM, Admin., and Permitting Costs (30%)	$ 367,000
			Total	$ 1,588,000