



DRAFT Evaluation of Options to Improve Fire Flow Infrastructure in Los Altos Hills County Fire District

Los Altos Hills

DRAFT

November 2017

EKI B70079.00

TABLE OF CONTENTS

TABLE OF CONTENTS	I
1. INTRODUCTION	1-1
1.1 Scope of Work.....	1-1
1.2 Report Organization.....	1-2
2. CRITERIA FOR PRIORITIZING FIRE FLOW IMPROVEMENT PROJECTS	2-3
3. EVALUATION OF PHWD FIRE FLOW IMPROVEMENT OPTIONS	3-4
3.1 PHWD Infrastructure Information Gathering and Review	3-4
3.2 Assessment of PHWD’s Fire Flows	3-4
3.3 Prioritization of PHWD Projects and Cost-Sharing Framework.....	3-4
4. EVALUATION OF CAL WATER FIRE FLOW IMPROVEMENT OPTIONS.....	4-1
4.1 Cal Water Information Gathering and Review	4-1
4.2 Assessment of Cal Water’s Fire Flows	4-1
4.3 Development of the Conservative EKI Simplified Hydraulic Model of Fire Flows During MDD	4-2
4.4 Fire Flow Modeling Results from EKI Simplified Model.....	4-3
4.4.1 <i>Evaluation of Cal Water’s Existing Infrastructure.....</i>	<i>4-3</i>
4.4.2 <i>Evaluation of Cal Water’s Proposed Fire Flow Improvements Using EKI Simplified Model</i>	<i>4-3</i>
4.4.3 <i>Alternative CIPs Proposal.....</i>	<i>4-4</i>
4.4.4 <i>Comparison of Cal Water CIP Project Costs and Benefits.....</i>	<i>4-4</i>
5. RECOMMENDATIONS.....	5-6
6. REFERENCES	6-1

LIST OF TABLES

Table 1 PHWD Available Fire Flow at Hydrants in Zones 2, 3, and 4

Table 2A PHWD Comparison of Fire Flow Pipeline Improvements

Table 2B PHWD Comparison of Fire Flow Pipeline Improvements

Table 3 Cal Water Extrapolated Available Fire Flow at 20 PSI

Table 4 EKI Simplified Modeling of MDD Fire Flows in Cal Water Mora Area

Table 5 EKI Simplified Modeling of MDD Fire Flows with Cal Water's Proposed CIPs

Table 6 EKI Simplified Modeling of MDD Fire Flows with EKI's Fire Flow CIPs

Table 7A Comparison of Fire Flow CIP Costs in Cal Water Mora Area

Table 7B Comparison of Fire Flow CIP Costs in Cal Water Mora Area

Table 8A Recommended Project Prioritization

Table 8B Recommended Project Prioritization

LIST OF FIGURES

Figure 1 LAHCFD Proposed Improvements Under Evaluation

Figure 2 PHWD ZONE 4 WATER MAIN CIP PROJECTS

Figure 3 PHWD Zone 4 Markup with EKI's CIPs

Figure 4 EKI Simplified Model -- Existing Infrastructure Cal Water Mora Area

Figure 5 EKI Simplified Model -- MDD Fire Flow Availability -- Cal Water Mora Area with Existing Infrastructure

Figure 6 EKI Simplified Model -- MDD Fire Flow Availability -- Cal Water Mora Area with Cal Water's Proposed CIPs

Figure 7 EKI Simplified Model -- MDD Fire Flow Availability -- Cal Water Mora Area with EKI's Proposed CIPs

Figure 8 Recommended Project Prioritization - Cal Water Mora Area

LIST OF APPENDICIES

Appendix A Information from PHWD

Appendix B Information from Cal Water

1. INTRODUCTION

EKI Environment & Water, Inc. (“EKI”) is pleased to submit this evaluation of options to improve fire flow infrastructure to the Los Altos Hills County Fire District (“LAHCFD” or “District”). The District has received proposals for capital improvement projects to improve fire flow availability in the District from the two water agencies located within its boundaries, Purissima Hills Water District (“PHWD”) on the west side and California Water Service Company – Los Altos District (“Cal Water”) on the east side (see Figure 1). Proposed project locations are shown on Figure 1. EKI has been retained by LAHCFD to assist in evaluating the proposals, engaging key stakeholders, identifying cost-sharing strategies, and providing recommendations for implementation.

The District requires that sufficient water flow and pressure is available for fire protection throughout the District. To achieve adequate fire protection, LAHCFD has identified a target fire flow of 1,250 gallons per minute (“gpm”) for all fire hydrants within the District, while maintaining a system pressure of at least 20 pounds per square inch (“psi”). Each water supplier that serves the District’s residents has identified hydrants that currently do not meet this standard and has proposed capital projects to address these deficiencies. Proposed projects include upsizing several water mains and other system upgrades to achieve the flow and pressure requirements. The projects are potentially multi-year and multi-million-dollar capital projects, and each water agency would procure the design, engineering and construction services for their respective, agreed-upon projects. The District’s goals are to responsibly fund effective fire flow improvement projects and increase public safety in the District.

1.1 Scope of Work

The scope of work for the evaluation included the following primary tasks:

- Request and gather information from the District and key stakeholders, including the PHWD, Cal Water, and the Santa Clara County Fire Department (“SCCFD”) regarding the water systems, proposed projects, and priorities.
- Perform a high-level review of the agencies’ analyses to check that the methods of analysis are reasonable.
- Confirm that the predicted fire flow improvements are expected to be achieved by the proposed capital improvement projects.
- Assess project benefits and costs.
- Prioritize projects.
- Develop cost-sharing strategies.
- Develop recommended implementation plan.
- Provide regular progress updates to the LAHCFD Board.
- Prepare a final report.

1.2 Report Organization

The WSMP is organized into the following sections:

- Section 1 - Introduction
- Section 2 – Criteria for Prioritizing Fire Flow Improvement Projects
- Section 3 – Evaluation of PHWD Fire Flow Improvement Options
- Section 4 – Evaluation of Cal Water Fire Flow Improvement Options
- Section 5 - Recommendations
- Section 6 - References

2. CRITERIA FOR PRIORITIZING FIRE FLOW IMPROVEMENT PROJECTS

In consultation with John Justice, the Deputy Fire Chief of the Santa Clara County Fire Department, and with George Tyson and Mark Warren, commissioners of the LAHCFD, EKI determined that LAHCFD has primary and secondary criteria for prioritizing fire flow improvement projects. The primary criterion is the quantity of fire flow available up to the goal of 1250 gpm while a minimum of 20 psi residual pressure is maintained in the zone in which the fire flow is being provided, during any given day of the year. The most demanding conditions occur during the maximum day demand conditions, which typically occurs in the summer time. Fire flow availability should be evaluated under maximum day conditions.

The secondary criterion that LAHCFD weighs is the proximity of houses to the open space of the Foothills Preserve running along the southern and southwestern border of LAHCFD (see Figure 1), a region with lots of vegetation which can be susceptible to wild fires. If competing projects serve the same number of hydrants, the projects which improve the fire flows along the border with the Foothills Preserve should be prioritized.

LAHCFD seeks to fund projects that meet their criteria as cost-effectively as possible. Therefore, in the following sections projects are evaluated according to how much “bang for the buck” they provide.

Where information was not readily available or provided to weigh proposed projects against these criteria, EKI has proposed next steps for the District to obtain the necessary information to prudently prioritize spending.

3. EVALUATION OF PHWD FIRE FLOW IMPROVEMENT OPTIONS

EKI evaluated and prioritized the PHWD fire flow improvement options according to the criteria established in Section 2, and developed cost sharing-strategies.

3.1 PHWD Infrastructure Information Gathering and Review

After reviewing PHWD’s DRAFT PROPOSAL TO IMPROVE HYDRANT FIRE FLOWS IN ZONE 4, we held an initial phone call with Patrick Walter, General Manager of the PHWD, to discuss the objectives of the evaluation, our basic understanding of the proposal, and the types of information we were seeking. PHWD provided a number of documents and files with detailed information on the water system and its fire flows. EKl held an in person meeting with Patrick Walter and Erik Walter, GIS/Operation staff on 22 August 2017 in which the system maps, system schematics, and fire flow model analyses were reviewed in detail. PHWD provided further documents by email after the meeting.

3.2 Assessment of PHWD’s Fire Flows

EKI used the results of hydraulic modeling analyses conducted by PHWD’s engineering consultant Pakpour Consulting Group to analyze PHWD’s fire flows during maximum day demand conditions, with pumps off. The PHWD is composed of four pressure zones fed entirely from SFPUC in Zone 1. Table 1 shows a breakdown of available fire flows during maximum day demand (MDD), with pumps off, by pressure zone (see Appendix A for more detailed fire flow tables). PHWD Zone 4, the uppermost hydraulic grade line zone, and Zone 2 each have a total of 20 hydrants with fire flow under 1250 gpm, while Zone 3 has nine hydrants with fire flows under 1250 gpm. Although Zone 4 and Zone 2 have the same number of deficient hydrants, the deficient Zone 4 hydrants are clustered more closely together (see hydrant fire flow maps in Appendix A) and mostly occur relatively close to the main “backbone” of the water system, running from the Page Mill Tank Site to the west, up along Page Mill, and east along Altamont Rd (see Figure 2). Therefore, we saw that upsizing the Zone 4 backbone provided a cost-effective means of boosting fire flows in many downstream deficient clusters on branches off the backbone just by reducing head losses along the backbone.

3.3 Prioritization of PHWD Projects and Cost-Sharing Framework

The construction costs and fire flow benefits of implementing capital improvement projects (“CIPs”) along the Page Mill Road and Altamont Rd backbone as well as the other proposed CIPs in PHWD’s proposal are listed in two different cost-sharing approaches in Table 2A and Table 2B. The number of hydrants fully improved to fire flows exceeding 1250 gpm and total number of hydrants improved (these are the hydrants that will experience an increase in their flow because of the planned improvements but that increase may not exceed 1250 gpm; detailed modeling will be required to be more specific) are shown, as well as the number of parcels

served by the improved hydrants. The estimated costs shown in the tables are based on PHWD's recent construction costs (these costs only include construction costs and not other project costs, e.g., design, permitting, construction management). Shown in Table 2A are the costs to replace the smaller diameter pipe with a larger diameter pipe to accommodate the increase in flow required to meet the goal of 1,250 gpm with a 20 psi residual from each fire hydrant. Shown in Table 2B is the incremental cost of installing a larger diameter pipe, assuming that the water supplier is paying the portion of the cost share that would be spent if the pipe were just replaced with another pipe of the same diameter.

In Table 2A, clearly Zone 4 backbone improvements show the lowest cost per hydrant improved. In addition, Zone 4 borders the Foothill Preserve, so is considered a higher risk zone.

Because the original Altamont CIP was designed to meet a fire flow target of 1500 gpm, which is a more conservative criterion than 1250 gpm, less pipe can be upsized to meet the 1250 gpm criterion that LAHCFD is using than is shown on Figure 2. In addition, as the CIP extends from the source water to the west along the backbone to the east side of Zone 4, it provides diminishing returns, as CIPs further from the source impact fewer hydrants downstream. As stated in the notes, Figure 2A also makes clear that the existing water main is cast iron and susceptible to severe damage during seismic events. Thus, PHWD's desire to replace the cast iron pipe with ductile iron pipe serves two purposes: 1) provide enhanced reliability of water service and 2) improve the fire flow from nearby hydrants. Because these improvements have a two-fold benefit, EKI suggests two potential cost sharing strategies:

1. LAHCFD proposes to share costs of the improvements with PHWD by offering to pay for the upper backbone portions of the CIP, which has the greatest impacts on fire flows, as their budgets allow (refer to Table 2A); or
2. LAHCFD proposes to share costs of the improvements with PHWD by offering to pay for the incremental cost (refer to Table 2B) of CIPs.

Recommendations for CIP prioritization and cost sharing will be discussed in Section 5.

4. EVALUATION OF CAL WATER FIRE FLOW IMPROVEMENT OPTIONS

4.1 Cal Water Information Gathering and Review

After reviewing Cal Water’s presentation LAHCFD 2017-2018 Budget proposal from Cal Water: for Los Altos Hills County Fire District, EKI held an initial phone call with Ronald Richardson, District Manager of Cal Water Los Altos, and Devi Prasanna, Senior Engineer of Cal Water, to discuss the objectives of the evaluation, our basic understanding of the proposal, and the types of information we were seeking. Mr. Richardson requested that EKI provide a formal signed request for information and to execute a liability and confidentiality agreement. EKI complied with this request. As a result, there is some information that has been used in these analyses the details of which cannot be published in this document.

Cal Water did not have a model of its distribution system. After review of the information that Cal Water provided, EKI determined that in order to evaluate the fire flows as a result of Cal Water’s proposed improvements, at least a simple hydraulic model should be developed. EKI developed a simplified hydraulic model of the Mora Tank area of the system where Cal Water proposed CIPs, relying partly on fire hydrant testing records provided by Cal Water, and partly on publicly available GIS maps. EKI used the model and other information provided by Cal Water to evaluate and prioritize the proposed fire flow improvement options as well as our own proposed alternative options for the District’s consideration.

4.2 Assessment of Cal Water’s Fire Flows

A confidential figure provided by Cal Water shows the estimated fire flow from hydrants with a residual pressure of 20 psi in the Cal Water service area. Where pressures are estimated to be less than 20 psi the hydrant has been highlighted. The method Cal Water used to estimate the fire flow availabilities was a simple extrapolation calculation from observed hydrant testing data from pairs of flow hydrants and residual pressure measurement hydrants. The extrapolation does not take into account other variables such as changing boundary conditions of tank elevations and domestic water demand conditions, and therefore EKI does not consider these extrapolated values to be conservative estimates of fire flows at 20 psi during maximum day conditions (“MDD”) conditions. However, these fire flow estimates are still useful for identifying low fire flow regions worthy of CIPs, but they should be considered in a separate context from fire flows modeled during MDD conditions, such as with the PHWD model.

Table 3 shows a breakdown of Cal Water’s estimated available fire flows at 20 psi, by pressure zone. The Price Zone, which is the zone where Cal Water has proposed \$1-million dollars in CIPs, has clusters of hydrants shown with under 1250 gpm fire flow, some of which are in close proximity to the bordering Foothills Preserve. Downstream of the proposed pipelines in the D-1 pressure zone, separated from the Price Zone by a PRV, are four hydrants where fire flows have not yet been calculated, so the proposed CIPs may also contribute to those four hydrants

in D-1. The Price Zone also has 18 hydrants where fire flows have not yet been calculated, so many more hydrants may be deficient than are highlighted on the table.

The Loyola Zone has 60 hydrants without calculated fire flows. So, in Section 5 Recommendations, EKI proposes that a study should be performed on fire flows in the Loyola Zone, to assess the fire flow availability and develop appropriate CIPs as necessary.

The new southwest zone, formed from a combination of Sta 28, Sta 37, and the Olive Tree zones has not yet undergone fire hydrant testing. Cal Water provided a description of some modeling they conducted of the new southeast zone and asserted that with the improvements they have put in place the prior fire flow deficiencies should be rectified. To confirm the available fire flows, fire hydrants should be tested.

In order to evaluate the Cal Water proposed pipeline CIPs in the Price zone in a conservative manner and perform an apples-to-apples comparison to the modeled PHWD projects, we built in InfoWater a simplified hydraulic model of the Cal Water CIP pipelines and ran the model during conservative MDD conditions. This simplified model is not meant to fully represent the true operations of the system, but rather, is meant to evaluate the costs and benefits of the proposed CIPs, consider conservative alternative solutions, and probe the potential benefits of developing models of Cal Water's fire flows.

4.3 Development of the Conservative EKI Simplified Hydraulic Model of Fire Flows During MDD

The water system piping was digitized with diameter and hydrant locations using the confidential Cal Water Los Altos Hills District and Los Altos Hills Fire Protection District Fire Flow Exhibit Map. Although the Fire Flow Exhibit Map is confidential, Cal Water approved for EKI to publicly present the pipeline diameters in this specific Mora Tank study area where Cal Water has proposed CIPs. Pipe materials were assigned per Cal Water's CIP proposal where possible, or otherwise logically assumed based on the neighboring pipe types.

To calibrate the model, EKI followed methods outlined in the American Water Works Associations Computer Modeling of Water Distribution System Manual (Robinson, 2012). These methods describe how to calibrate a model using fire hydrant testing data. Cal Water provided EKI with five fire flow testing data sets which EKI used to calibrate the model's pressure reducing valve settings and pipe roughness coefficients. These fire flow data were taken at different times of year, and at different times of the day. To conservatively calibrate C-factors during unknown tank and demand conditions under which hydrant testing occurred, EKI made boundary condition assumptions which would conservatively result in lower C-factors (rougher pipes) during calibration:

1. EKI set the initial tank setting at a full level; therefore, pressure losses would all need to be born through the piping and PRV.

2. EKI calibrated the PRV setting to match the hydrant testing static pressure downstream of the PRV.
3. EKI then assigned flow rates consistent with hydrant testing data and calibrated the C-factors to produce head losses resulting in the residual pressures observed during actual hydrant testing (see Appendix B for actual hydrant testing records).

EKI determined that C-factors of 75 for cast iron pipe and 140 for transite pipe produced residual pressures at or below those shown in hydrant testing. It is understood from Cal Water that existing pipes could have been installed as early as the 1940s. These C-factors are within the expected range of pipes of these materials and age (Robinson 2012) (Lindberg 2015).

For fire flow modeling under MDD conditions, MDD demands were determined by applying a peaking factor of two to the average day demands (ADDs) based on Title 22 standards. ADDs for 2015 were determined based on the Cal Water 2015 Urban Water Management Plans per capita water usage during the 2015 drought. ADD demands were scaled up to 2013 non-drought demands to better represent future non-drought year demands. The MDD demands were applied on a parcel by parcel basis to the nearest node for the modeled infrastructure, and the demands for the remainder of the Price pressure zone were applied at a point node representing the western portion of the Price zone.

During fire flow modeling, the Mora Tank was set at an initial condition of half full, to conservatively estimate its drawdown at the end of a maximum demand day before pumps could refill it. Based on the Cal Water Fire Flow exhibit, the D-2 PRV was set at a hydraulic grade line of 560 feet, equivalent to a 91 psi pressure given the PRV's elevation.

4.4 Fire Flow Modeling Results from EKI Simplified Model

The following sections describe the results of fire flow modeling of the Cal Water Mora Tank area using the EKI Simplified Model.

4.4.1 Evaluation of Cal Water's Existing Infrastructure

As seen in Table 4 and on Figure 5, the fire flows of the ten hydrants shown along Mora Drive, Mora Glen Dr, Mora Heights Way, and Eastbrook Ave do not meet the 1250-gpm fire flow requirement at any hydrant. The conservative modeling methodology has resulted in a prediction of hydrant 1312, located upstream of Cal Water's CIPs, to have a fire flow of 1,158 gpm during MDD, whereas Cal Water's fire flow exhibit shows a fire flow of 1,738 gpm at 20 psi (Figure 4). As a result, hydrant 1312 was added to the list of hydrants whose fire flows we propose to improve in an alternative CIP proposal.

4.4.2 Evaluation of Cal Water's Proposed Fire Flow Improvements Using EKI Simplified Model

As seen in Table 5 and on Figure 6, the proposed CIPs significantly improve fire flows. Because hydrant 1312 is upstream of the proposed CIPs, its fire flow is unchanged by the CIPs. This CIP

addresses the downstream fire flow concerns with an adequate level of safety without modifying PRV settings. Though, at a minimum EKI recommends upsizing pipes upstream to meet fire flow at hydrant 1312.

4.4.3 Alternative CIPs Proposal

EKI conducted additional modeling to consider more cost-effective alternatives for meeting fire flow goals during the EKI Simplified Model's MDD scenario. Figure 8 shows where pipelines along Mora Drive, Eastbrook Avenue, and Mora Glen Drive are proposed to be upsized with new ductile iron pipe (DIP). The effects of these alternative CIPs are summarized in Table 6 and described below.

Five Mora Drive CIPs are proposed:

1. To meet fire flow at hydrant 1312, EKI proposes that the northern intertie between the 10" and 6" parallel pipelines along Mora Drive be upsized to 10". This intertie has large head losses due to velocities as high as 12 ft/sec when transferring water to the downstream network during fire flow conditions.
2. From hydrant 1312 to hydrant 1266 a 1,000-ft section of 8" DIP termed "Mora Dr. upstream" is proposed.
3. From hydrant 1266 to Eastbrook Ave a 1,240-ft section of 8" DIP termed "Mora Dr. downstream" is proposed.
4. Along Eastbrook from Mora Dr to Mora Glen Dr a 140-ft section of 8" DIP is proposed.
5. For 340 feet of Mora Glen Dr an 8" DIP pipe is proposed. This is 430 less feet of pipe than was proposed by Cal Water.

In Table 6, the ten modeled hydrants show fire flows exceeding 1250 gpm during MDD with these five CIPs instantiated. In addition, four hydrants in the downstream D-1 pressure zone are also improved (but they were not modeled, as they were not evaluated in the Cal Water CIP, and no hydrant testing data were shown on the Cal Water exhibit). The model also shows that increasing the D-2 PRV setting can increase fire flow. With the CIPs in place, the D-2 pressure zone PRV is seen to significantly reduce pressure from 102 psi down to 91 psi, limiting available fire flows downstream of the PRV. By modifying the D-2 pressure zone PRV to a setting of approximately 102 psi, significantly less upsizing would be required on Mora Glen Drive to meet fire flow requirements at hydrant 1304, which is seen to be the most difficult hydrant to produce 1250 gpm due to its elevation. These preliminary results indicate that there could be potential cost-savings by increasing the setpoint of the D-2 pressure zone PRV and installing less CIP pipeline. However, increasing the PRV setpoint could cause excessive pressure if domestic connections lack pressure reducers.

4.4.4 Comparison of Cal Water CIP Project Costs and Benefits

Presented in Tables 7A and 7B is a comparison of the Cal Water proposed improvements and EKI's proposed pipeline improvements in the Price zone. As discussed for the PHWD proposals

Shown in Table 7A are the costs to replace the smaller diameter pipe with a larger diameter pipe to accommodate the increase in flow required to meet the goal of 1,250 gpm with a 20 psi residual from each fire hydrant. Shown in Table 7B is the incremental cost of installing a larger diameter pipe.

The Cal Water proposed improvements are estimated to cost \$1,040,000 dollars (Table 7A - \$160,000 if the incremental cost sharing approach is used shown in Table 7B) and fully improve the fire flows of 9 of the 10 hydrants analyzed. The EKI recommended improvements are estimated to cost \$901,750 (Table 7B - \$140,000) and fully improve the fire flows of all the 10 hydrants analyzed. This alternative option should be considered in cost-sharing discussions with Cal Water.

Recommendations for CIP prioritization and cost sharing are discussed in the next section.

5. RECOMMENDATIONS

Using the criteria established in Section 2, EKI prioritized implementation of proposed CIPs to improve fire flows, investigations of fire flows in areas lacking fire flow information, and development of future CIP proposals to improve fire flows in other low fire flow areas in LAHCFD. Priorities are assigned from one being highest priority to five being lowest priority, in Table 8A and Table 8B, which reflect different philosophies of cost sharing.

Table 8A reflects a “going-it-alone” independent philosophy, in which LAHCFD would pay the complete costs of specific sections of pipe replacement that LAHCFD deems high bang-for-the-buck based on how many hydrant fire flows are improved by the contemplated CIP. Under this philosophy, not all projects proposed by water providers are prioritized in the table; projects which impact less than three hydrants are not placed in the top four priority levels in Table 8A. Only the upstream section of the Altamont Rd CIP makes the top four priority level list in Table 8A, since the downstream section has a very high cost per hydrant improved.

Table 8B reflects a cost sharing perspective, in which it is understood that the District’s objective is to have 1250 gpm fire flows available by increasing pipe diameters, whereas the water provider’s objective is to provide reliable water service by replacing aged or brittle pipes, irrespective of pipe diameters. Therefore, the water supplier can pay the cost of replacing the pipe at the same diameter, and the District can pay the incremental cost between the cost of upsizing the pipe and the cost of replacing a pipe at the same diameter.

EKI recommends that the district starts implementing the Priority 1 projects using the incremental cost sharing philosophy.

6. REFERENCES

California Water Service, 2016. Los Altos Suburban District 2015 Urban Water Management Plan, June 2016.

Lindeburg, M. R. 2015. *Civil engineering reference manual for the PE exam*, Professional Publications, Inc. 2015.

Robinson, Laredo 2012. *Computer Modeling of Water Distribution Systems*, American Water Works Association, 2012.

Title 22 California Drinking Water-Related Regulations, 22 CCR § 64554 (b)(3)(D), September 2017.

TABLE 1
PHWD Available Fire Flows Under MDD Conditions
 Los Altos Hills County Fire District, Los Altos Hills, California

Pressure Zone	Hydrants shown with under 1250 gpm fire flow		Hydrants without calculated fire flows	Maximum potential number of hydrants with under 1250 gpm fire flow	
	< 950 gpm	950 <Q< 1250 gpm		< 950 gpm	950 <Q< 1250 gpm
Zones Bordering Foothills Preserve					
PHWD Zone 4	2	18	0	2	18
PHWD Zone 3	3	6	0	3	6
Zones that Do Not Border Foothills Preserve					
PHWD Zone 2	8	12	0	8	12
PHWD Zone 1	Upper zones overlap geography with Zone 1 and provide fire flows in Zone 1 areas.				

Abbreviations

gpm: gallons per minute

MDD: maximum day demand

PHWD: Purissima Hills Water District

Q: fire flow rate in gpm

TABLE 2A
PHWD Comparison of Fire Flow Pipeline Improvements
 Los Altos Hills County Fire District, Los Altos Hills, California

Improvement (a)	Pipe Size		Cost for New Pipe per foot (\$)	Pipe Length (feet)	Cost (\$)	Hydrants Fully Improved (b)	Total Hydrants Improved (c)	Cost per Hydrant Improved (\$)
	Original (inches)	New (inches)						
PHWD Zone 2								
La Paloma Rd	6"	10"	\$ 375	611	\$ 229,125	2 to 5	5	\$ 45,825
PHWD Zone 3								
Black Mountain Rd	6"	8"	\$ 325	1357	\$ 441,025	1 to 2	2	\$ 220,513
PHWD Zone 4								
Page Mill Rd	8"	12"	\$ 425	1335	\$ 567,375	6 to 20	20	\$ 28,369
Altamont Rd Upstream Portion	6"	8"	\$ 325	750	\$ 243,750	0 to 14	14	\$ 17,411
Altamont Rd Downstream Portion	6"	8"	\$ 325	5000	\$ 1,625,000	0 to 6	6	\$ 270,833
Briones Way	6"	8"	\$ 325	300	\$ 97,500	0 to 1	1	\$ 97,500
Menalto Drive Cross Country	2"	8"	\$ 325	300	\$ 97,500	0 to 1	1	\$ 97,500
Zone 4 PHWD Total	2", 6", & 8"	8" & 12"	--	600	\$ 2,631,125	18 to 20	20	\$ 131,556

Notes

- (a) Improvements assume abandoning existing pipe in place and installing new ductile iron pipe with open trench construction.
 (b) Hydrants fully improved are hydrants that will have fire flow exceeding 1,250 gpm after the improvement.
 (c) Hydrants improved may or may not have fire flow exceeding 1,250 gpm after the improvement; they may require more than one improvement project. Modeling is required to demonstrate the effect of individual improvements.

Abbreviations

PHWD: Purissima Hills Water District

TABLE 2B
PHWD Comparison of Fire Flow Pipeline Improvements
 Los Altos Hills County Fire District, Los Altos Hills, California

<i>Improvement (a)</i>	<i>Pipe Size</i>		<i>Cost for New Pipe per foot</i>	<i>Cost for Original Pipe Size Pipe per foot</i>	<i>Pipe Length</i>	<i>Incremental Cost</i>	<i>Hydrants Fully Improved</i>	<i>Total Hydrants Improved</i>	<i>Incremental Cost per Hydrant Improved</i>
	<i>Original</i>	<i>New</i>							
	<i>(inches)</i>	<i>(inches)</i>	<i>(\$)</i>	<i>(\$)</i>	<i>(feet)</i>	<i>(d) (\$)</i>	<i>(b)</i>	<i>(c)</i>	<i>(\$)</i>
PHWD Zone 2									
La Paloma Rd	6"	10"	\$ 375	\$ 275	611	\$ 61,100	2 to 5	5	\$ 12,220
PHWD Zone 3									
Black Mountain Rd	6"	8"	\$ 325	\$ 275	1357	\$ 67,850	1 to 2	2	\$ 33,925
PHWD Zone 4									
Page Mill Rd	8"	12"	\$ 425	\$ 325	1335	\$ 133,500	6 to 20	20	\$ 6,675
Altamont Rd Upstream Section	6"	8"	\$ 325	\$ 275	750	\$ 37,500	0 to 14	14	\$ 2,679
Altamont Rd Downstream Section	6"	8"	\$ 325	\$ 275	5000	\$ 250,000	0 to 6	6	\$ 41,667
Briones Way	6"	8"	\$ 325	\$ 275	300	\$ 15,000	0 to 1	1	\$ 15,000
Menalto Drive Cross Country (e)	2"	8"	\$ 325	\$ 275	300	\$ 15,000	0 to 1	1	\$ 15,000
<i>Zone 4 PHWD Total</i>	<i>2", 6", & 8"</i>	<i>8" & 12"</i>	<i>--</i>	<i>--</i>	<i>600</i>	<i>\$ 451,000</i>	<i>18 to 20</i>	<i>20</i>	<i>\$ 22,550</i>

Notes

- (a) Improvements assume abandoning existing pipe in place and installing new ductile iron pipe with open trench construction.
- (b) Hydrants fully improved are hydrants that will have fire flow exceeding 1,250 gpm after the improvement.
- (c) Hydrants improved may or may not have fire flow exceeding 1,250 gpm after the improvement; they may require more than one improvement project. Modeling is required to demonstrate the effect of individual improvements.
- (d) Difference between cost of replacing pipe with upsized pipe versus with same sized pipe.
- (e) Pipe replacement cost presented are for 6" pipe, which is assumed to be the minimum diameter which would be installed.

Abbreviations

Cal Water: California Water Service Los Altos
 PHWD: Purissima Hills Water District

TABLE 3
Cal Water Available Fire Flows

Los Altos Hills County Fire District, Los Altos Hills, California

Pressure Zone	Hydrants shown with under 1250 gpm fire flow		Hydrants without calculated fire flows	Maximum potential number of hydrants with under 1250 gpm fire flow	
	< 950 gpm	950 <Q< 1250 gpm		< 950 gpm	950 <Q< 1250 gpm
Zones Bordering Foothills Preserve					
Price	5	13	18	23	31
New southwest zone from combination of Sta 28, Sta 37, and Olive Tree zones	Untested since new zoning		10	10	10
D-2	2	2	1	3	3
Blandor	0	1	5	5	6
Zones that Do Not Border Foothills Preserve					
Loyola	6	6	60	66	66
STA 113	1	4	0	1	4
Robleda Heights (535)	2	6	6	8	12
Robleda Heights Subzone	1	1	2	3	3
Low	3	6	5	8	11
Sta 112	0	0	8	8	8
D-1	0	0	4	4	4
D-3	0	0	4	4	4
STA 118	0	0	1	1	1

Abbreviations

Cal Water: California Water Service

gpm: gallons per minute

Q: fire flow rate in gpm

Table 4
EKI Simplified Modeling of MDD Fire Flows in Cal Water Mora Area
 Los Altos Hills County Fire District, Los Altos Hills, California

<i>Hydrant</i>	<i>Modeled Fire Flow</i>	<i>Hydrant Meeting Fire Flow Requirement</i>
	<i>(gpm)</i>	
1250	736	No
1252	869	No
1266	700	No
1269	777	No
1272	826	No
1284	737	No
1290	780	No
1304	585	No
1312	1,158	No
1319	790	No

Notes:

(a) This scenario represents worst-case fire flows.

Abbreviations:

gpm : gallons per minute

Table 5
EKI Simplified Modeling of MDD Fire Flows with Cal Water's Proposed CIPs
 Los Altos Hills County Fire District, Los Altos Hills, California

<i>Hydrant</i>	<i>Modeled Flow Before CIP</i>	<i>Modeled Flow After CIP</i>	<i>Hydrant Meeting Fire Flow Requirement Before CIP</i>	<i>Hydrant Meeting Fire Flow Requirement After CIP</i>
	<i>(gpm)</i>	<i>(gpm)</i>		
1250	736	1,302	No	Yes
1252	869	2,455	No	Yes
1266	700	2,072	No	Yes
1269	777	2,326	No	Yes
1272	826	1,905	No	Yes
1284	737	2,017	No	Yes
1290	780	1,881	No	Yes
1304	585	1,309	No	Yes
1312	1,158	1,158	No	No
1319	790	1,663	No	Yes

Notes:

- (a) This scenario represents conservative fire flows while upsizing approximately 3200 LF on Mora Drive, Eastbrook Avenue, and Mora Glen Drive from 6" to 8".

Abbreviations:

gpm : gallons per minute

CIPs: capital improvement projects

Table 6
EKI Simplified Modeling of MDD Fire Flows with EKI's Fire Flow CIPs
 Los Altos Hills County Fire District, Los Altos Hills, California

<i>Hydrant</i>	<i>Modeled Flow Before CIP</i>	<i>Modeled Flow After CIP</i>	<i>Hydrant Meeting Fire Flow Requirement Before CIP</i>	<i>Hydrant Meeting Fire Flow Requirement After CIP</i>
	<i>(gpm)</i>	<i>(gpm)</i>		
1250	736	1,325	No	Yes
1252	869	2,555	No	Yes
1266	700	2,202	No	Yes
1269	777	2,458	No	Yes
1272	826	1,952	No	Yes
1284	737	1,863	No	Yes
1290	780	2,020	No	Yes
1304	585	1,261	No	Yes
1312	1,158	1,257	No	Yes
1319	790	1,545	No	Yes

Notes:

- (a) This scenario represents conservative fire flows while upsizing approximately 2740 LF on Mora Drive, Eastbrook Ave, and Mora Glen drive from 6" to 8", upsizing 30 LF on Mora Drive from 6" to 10", and setting the D-2 pressure zone PRV to 102 PSI.

Abbreviations:

gpm : gallons per minute

CIPs: capital improvement projects

Table 7A
Comparison of Fire Flow CIP Costs in Cal Water Mora Area
 Los Altos Hills County Fire District, Los Altos Hills, California

<i>Improvement (a)</i>	<i>Pipe Size</i>		<i>Cost for New Pipe per foot</i>	<i>Pipe Length</i>	<i>Cost</i>	<i>Hydrants Fully Improved</i>	<i>Total Hydrants Improved</i>	<i>Cost per Hydrant Improved</i>
	<i>Original</i>	<i>New</i>						
	(inches)	(inches)	(\$)	(feet)	(\$)	(b)	(c)	(\$)
EKI's Proposed Improvements								
Mora Dr	6"	10"	\$ 375	30	\$ 11,250	1 to 14	14	\$ 804
Mora Dr. Upstream	6"	8"	\$ 325	1000	\$ 325,000	3 to 13	13	\$ 25,000
Mora Dr. Downstream	6"	8"	\$ 325	1240	\$ 403,000	0 to 10	10	\$ 40,300
Eastbrook Ave.	6"	8"	\$ 325	160	\$ 52,000	0	5	\$ 10,400
Mora Glen Dr.	6"	8"	\$ 325	340	\$ 110,500	0	3	\$ 36,833
Total	6"	8" & 10"	--	2740	\$ 901,750	10 to 14	14	\$ 64,411
Cal Water's Proposed Improvements								
Mora Dr., Eastbrook Ave. & Mora Glen Dr.	6"	8"	\$ 325	3200	\$ 1,040,000	9 to 13	13	\$ 80,000

Notes:

- (a) Improvements assume abandoning existing pipe in place and installing new ductile iron pipe with open trench construction.
- (b) Hydrants fully improved are hydrants that will have fire flow exceeding 1,250 gpm after the improvement.
- (c) Hydrants improved may or may not have fire flow exceeding 1,250 gpm after the improvement; they may require more than one improvement project. Modeling is required to demonstrate the effect of individual improvements.

Abbreviations:

Cal Water: California Water Service Los Altos

Table 7B
Comparison of Fire Flow CIP Costs in Cal Water Mora Area
 Los Altos Hills County Fire District, Los Altos Hills, California

Improvement (a)	Pipe Size		Cost for New Pipe per foot (\$)	Cost for Original Pipe Size Pipe per foot (\$)	Pipe Length (feet)	Icremental Cost (d) (\$)	Hydrants Fully Improved (b)	Hydrants Improved (c)	Incremental Cost per Hydrant Improved (\$)
	Original (inches)	New (inches)							
EKI's Proposed Improvements									
Mora Dr	6"	10"	\$ 375	\$ 275	30	\$ 3,000	1 to 14	14	\$ 214
Mora Dr. Upstream	6"	8"	\$ 325	\$ 275	1000	\$ 50,000	3 to 13	13	\$ 3,846
Mora Dr. Downstream	6"	8"	\$ 325	\$ 275	1240	\$ 62,000	0 to 10	10	\$ 6,200
Eastbrook Ave.	6"	8"	\$ 325	\$ 275	160	\$ 8,000	0	5	\$ 1,600
Mora Glen Dr.	6"	8"	\$ 325	\$ 275	340	\$ 17,000	0	3	\$ 5,667
Total	6"	8" & 10"			2740	\$ 140,000	10 to 13	14	\$ 10,000
Cal Water's Proposed Improvements									
Mora Dr., Eastbrook Ave. & Mora Glen Dr.	6"	8"	\$ 325	\$ 275	3200	\$ 160,000	9 to 13	13	\$ 12,308

Notes:

- (a) Improvements assume abandoning existing pipe in place and installing new ductile iron pipe with open trench construction.
- (b) Hydrants fully improved are hydrants that will have fire flow exceeding 1,250 gpm after the improvement.
- (c) Hydrants improved may or may not have fire flow exceeding 1,250 gpm after the improvement; they may require more than one improvement project. Modeling is required to demonstrate the effect of individual improvements.
- (d) Difference between cost of replacing pipe with upsized pipe versus with same sized pipe.

Abbreviations:

Cal Water: California Water Service Los Altos

TABLE 8A
Recommended Project Prioritization
 Los Altos Hills County Fire District, Los Altos Hills, California

Priority	Zone	Improvement (a)	New Pipe Size	Pipe Length (feet)	Total Hydrants Improved (b)	Zone borders Foothills Preserve	Cost per Hydrant Improved	Cost (%)
1	Cal Water Price	Mora Dr tie	10"	30	14	yes	\$ 804	\$ 11,250
1	Cal Water Price	Mora Dr Upstream Section	8"	1000	13	yes	\$ 25,000	\$ 325,000
1	PHWD Zone 4	Page Mill Rd	12"	1335	20	yes	\$ 28,369	\$ 567,375
1	PHWD Zone 4	Altamont Rd Upstream Section	8"	750	11	yes	\$ 22,159	\$ 243,750
2	Cal Water Price	Mora Dr Downstream Section	8"	1240	10	yes	\$ 40,300	\$ 403,000
2	Cal Water D-2	Eastbrook Ave	8"	160	5	yes	\$ 10,400	\$ 52,000
2	Cal Water D-2	Mora Glen Dr	8"	340	3	yes	\$ 36,833	\$ 110,500
2	Cal Water	Perform a fire flow reliability study across Cal Water, including evaluating proposal for 2 control valves			NA	yes	TBD	TBD/RFP
3	Cal Water D-1	Perform fire flow availability modeling in D-1			NA	no	TBD	TBD/RFP
3	Cal Water Loyola	Perform modeling study on available fire flows in Loyola Zone during maximum day demand conditions			9	no	TBD	TBD/RFP
4	PHWD Zone 2	La Paloma Rd	10"	611	5	no	\$ 45,825	\$ 229,125
4	Cal Water New	Perform hydrant testing in newly rezoned Olive Tree Zone			9	no	TBD	TBD

Notes

- (a) Improvements assume abandoning existing pipe in place and installing new ductile iron pipe with open trench construction.
- (b) Hydrants improved may or may not have fire flow exceeding 1,250 gpm after the improvement; they may require more than one improvement project. Modeling is required to demonstrate the effect of individual improvements.

Abbreviations

Cal Water: California Water Service Los Altos

PHWD: Purissima Hills Water District

TABLE 8B
Recommended Project Prioritization
 Los Altos Hills County Fire District, Los Altos Hills, California

Priority	Zone	Improvement (a)	Pipe Size		New Pipe Cost per foot (\$)	Original Size Cost per foot (\$)	Pipe Length (feet)	Total Hydrants Improved (c)	Zone borders Foothills Preserve	Incremental Cost per Hydrant	Incremental Cost Share (b) (\$)
			Original (inches)	New (inches)							
1	PHWD Zone 4	Page Mill Rd	8"	12"	\$ 425	\$ 325	1335	20	yes	\$ 6,675	\$ 133,500
1	PHWD Zone 4	Altamont Rd Upstream Section	6"	8"	\$ 325	\$ 275	750	11	yes	\$ 3,409	\$ 37,500
1	Cal Water Price	Mora Dr tie	6"	10"	\$ 375	\$ 275	30	14	yes	\$ 214	\$ 3,000
1	Cal Water Price	Mora Dr Upstream Section	6"	8"	\$ 325	\$ 275	1000	13	yes	\$ 3,846	\$ 50,000
2	Cal Water Price	Mora Dr Downstream Section	6"	8"	\$ 325	\$ 275	1240	10	yes	\$ 6,200	\$ 62,000
2	Cal Water D-2	Eastbrook Ave	6"	8"	\$ 325	\$ 275	160	5	yes	\$ 1,600	\$ 8,000
2	Cal Water D-2	Mora Glen Dr	6"	8"	\$ 325	\$ 275	340	3	yes	\$ 5,667	\$ 17,000
2	Cal Water	Perform a fire flow reliability study across Cal Water, including evaluating proposal for 2 control valves						NA	yes	TBD	\$ -
3	Cal Water D-1	Perform fire flow availability modeling in D-1						NA	no	TBD	\$ -
3	Cal Water Loyola	Perform modeling study on available fire flows in Loyola Zone during maximum day demand conditions						9	no	TBD	\$ -
4	PHWD Zone 2	La Paloma Rd	6"	10"	\$ 375	\$ 275	611	5	no	\$ 12,220	\$ 61,100
4	Cal Water New	Perform hydrant testing in newly rezoned Olive Tree Zone						9	no	TBD	\$ -
4	PHWD Zone 4	Briones Way	6"	8"	\$ 325	\$ 275	300	1	no	\$ 15,000	\$ 15,000
4	PHWD Zone 4	Menalto Drive Cross Country	2"	8"	\$ 325	\$ 275	300	1	no	\$ 15,000	\$ 15,000
5	PHWD Zone 4	Altamont Rd Downstream Section	6"	8"	\$ 325	\$ 275	5000	6	yes	\$ 41,667	\$ 250,000

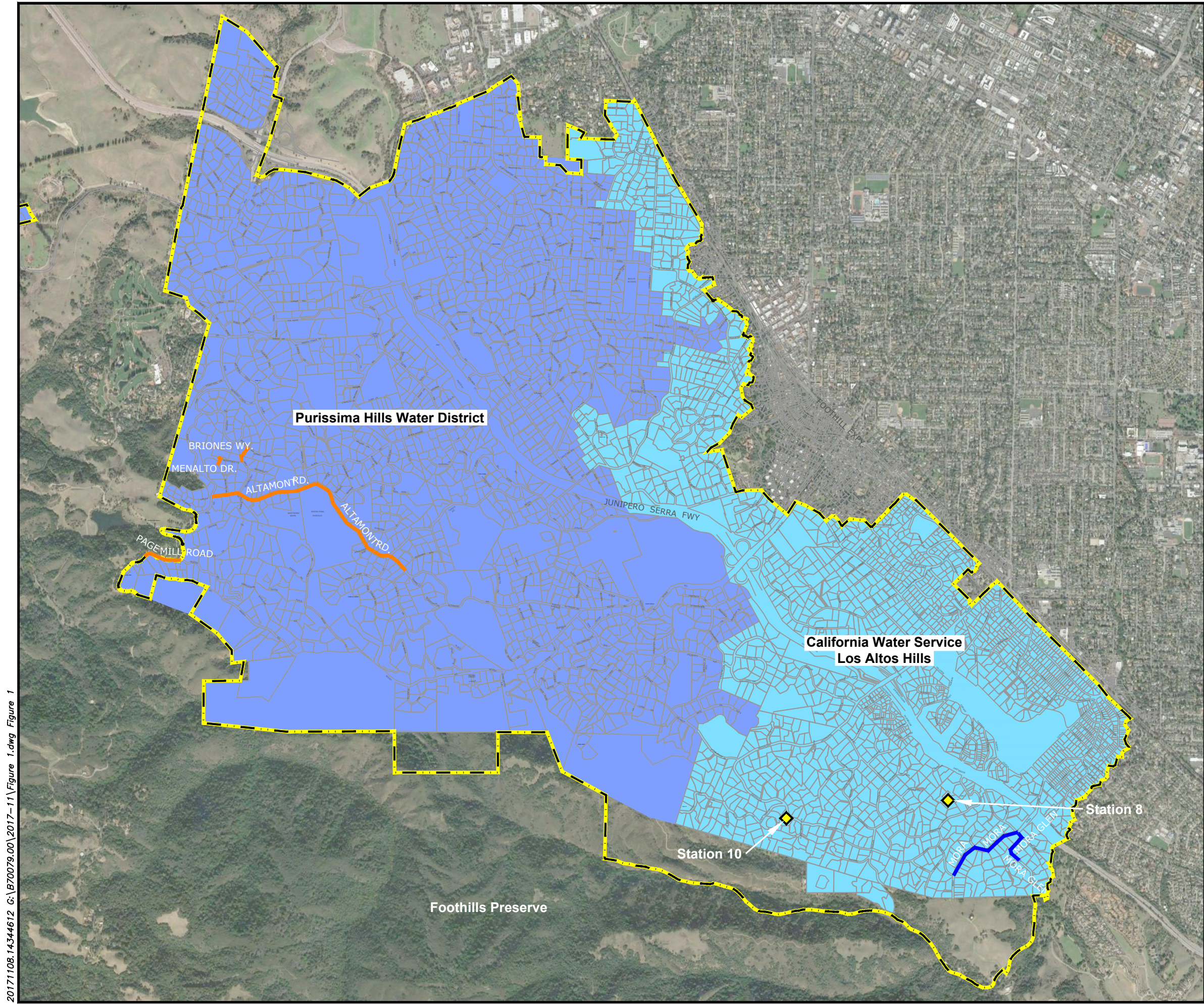
Notes

- (a) Improvements assume abandoning existing pipe in place and installing new ductile iron pipe with open trench construction.
 (b) Difference between cost of replacing pipe with upsized pipe versus with same sized pipe.
 (c) Hydrants improved may or may not have fire flow exceeding 1,250 gpm after the improvement; they may require more than one improvement project. Modeling is required to demonstrate the effect of individual improvements.

Abbreviations

Cal Water: California Water Service Los Altos
 PHWD: Purissima Hills Water District

20171108.14344612 G:\B70079.00\2017-11\Figure 1.dwg Figure 1



Legend:

- LAHCFD Boundary Line
- Purissima Hills Water District Proposed Pipeline Improvements
- California Water Service Los Altos Hills Proposed Pipeline Improvements
- Cal Water Proposed Control Valve Improvements
- PHWD - Los Altos Hills
- Cal Water

Abbreviations:

Cal Water = California Water Service Los Altos Hills
LAHCFD = Los Altos Hills County Fire District
PHWD = Purissima Hills Water District

Notes:

- All locations are approximate.
- Basemap sources: Mailing Zone Drawing acquired from Los Altos County Fire District; Google Earth Pro, date of imagery 2 November 2016.

N

0 2,500 5,000

(Scale in Feet)

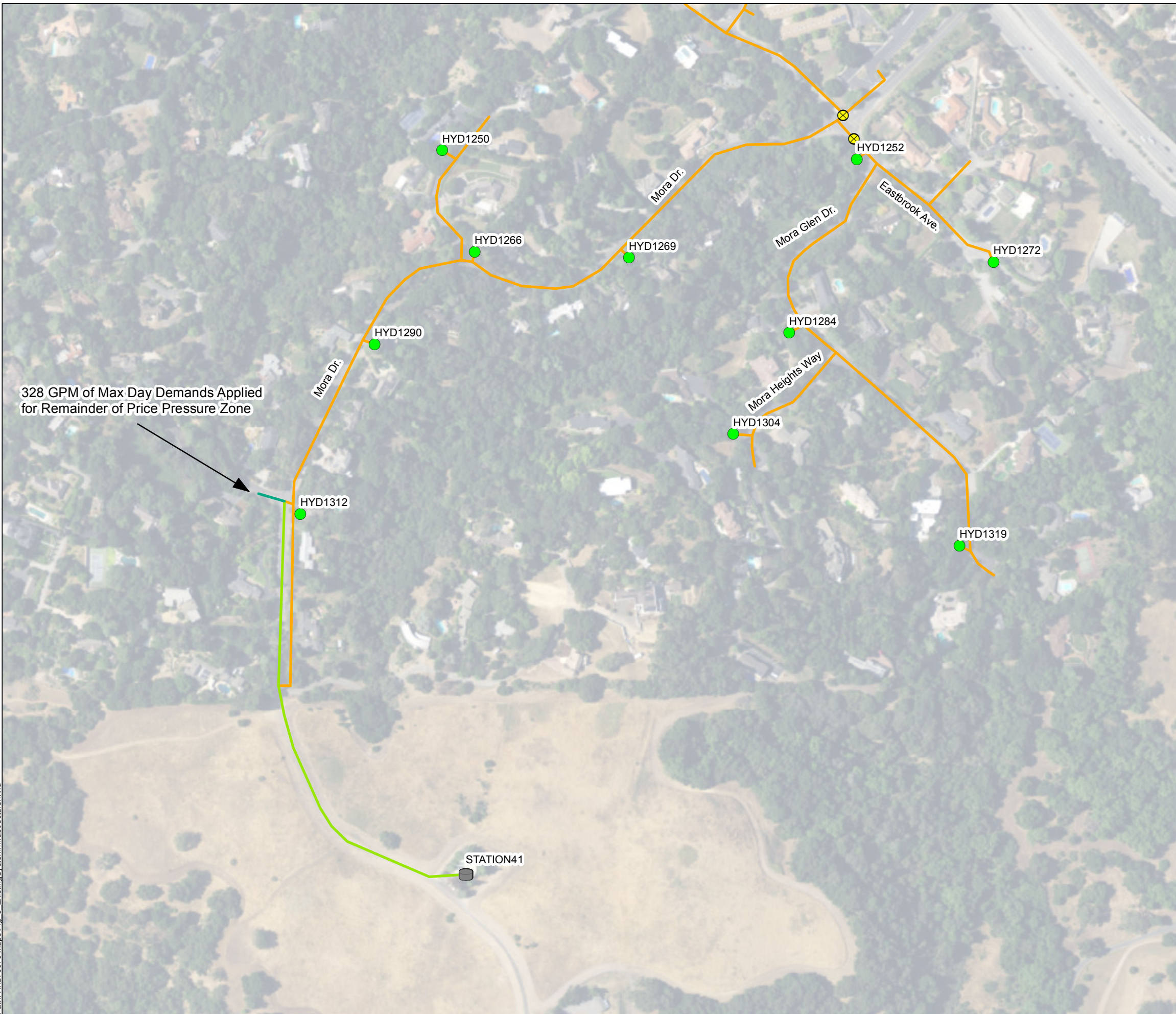
LAHCFD Proposed Improvements Under Evaluation

Los Altos Hills County Fire District
Los Altos Hills, CA
November 2017
EKI B70079.00

Figure 1

eki environment & water

Path: X:\B70079\Maps\Fig. 5 ExistingSystemInfrastructure.mxd



Legend

Existing City Infrastructure

- Enclosed Storage Facility
- Hydrant
- Pressure Reducing Valve

Existing Pipe Diameter, Inches

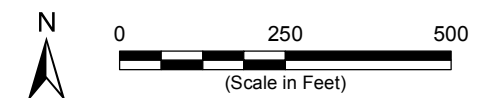
- 6
- 8
- 10
- 12

Notes

- All locations are approximate.

Sources

- Aerial photograph provided by ESRI's ArcGIS Online, 14 November 2017.



EKI Simplified Model - Existing Infrastructure Cal Water Mora Area

DRAFT
eki environment
& water

Los Altos Hills County Fire District
Los Altos Hills, CA
November 2017
B70079.00

Figure 4

Path: X:\B70079\Maps\Fig. 6 ExistingFireFlow.mxd



Legend

Existing City Infrastructure

- Enclosed Storage Facility
- Pressure Reducing Valve
- Pipe

Hydrant Flow

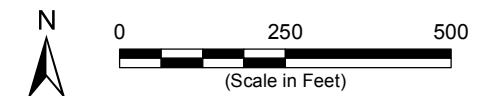
- Unable to Meet Requirement
- Meeting Requirement

Notes

- All locations are approximate.

Sources

- Aerial photograph provided by ESRI's ArcGIS Online, 14 November 2017.



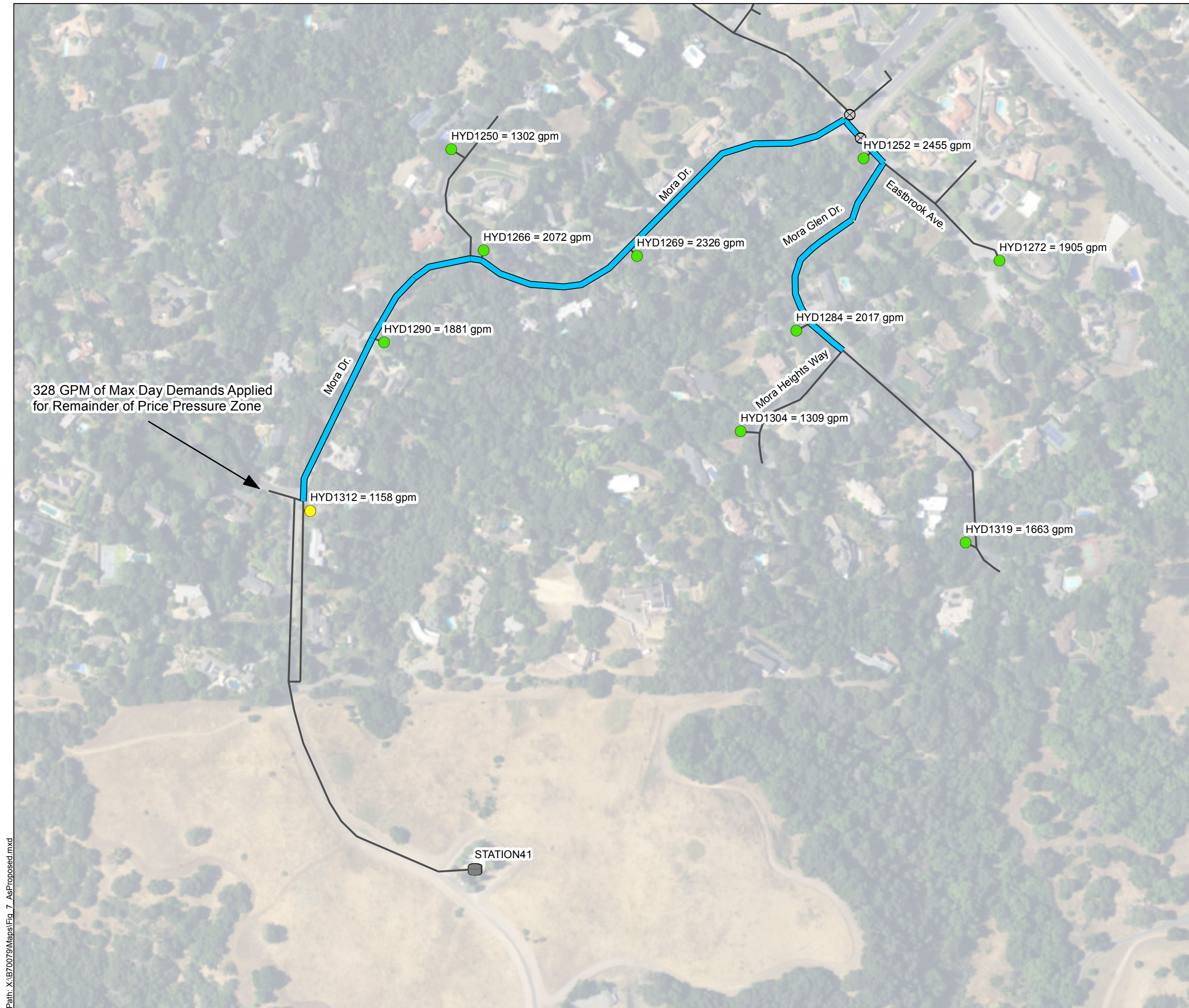
EKI Simplified Model - MDD Fire Flow Availability Cal Water Mora Area with Existing Infrastructure

DRAFT
eki environment
& water

Los Altos Hills County Fire District
Los Altos Hills, CA
November 2017
B70079.00

Figure 5

Path: X:\B70079\Maps\Fig. 7. AsProposed.mxd



Legend

- Enclosed Storage Facility
- Pressure Reducing Valve
- Pipe
- Replacement Pipe 6" to 8"

Hydrant Flow

- Unable to Meet Requirement
- Meeting Requirement

Notes

1. All locations are approximate.

Sources

1. Aerial photograph provided by ESRI's ArcGIS Online, 14 November 2017.

N

0250500

(Scale in Feet)

EKI Simplified Model - MDD Fire Flow Availability

Cal Water Mora Area with Cal Water's Proposed CIPs

DRAFT

eki environment & water

Los Altos Hills County Fire District

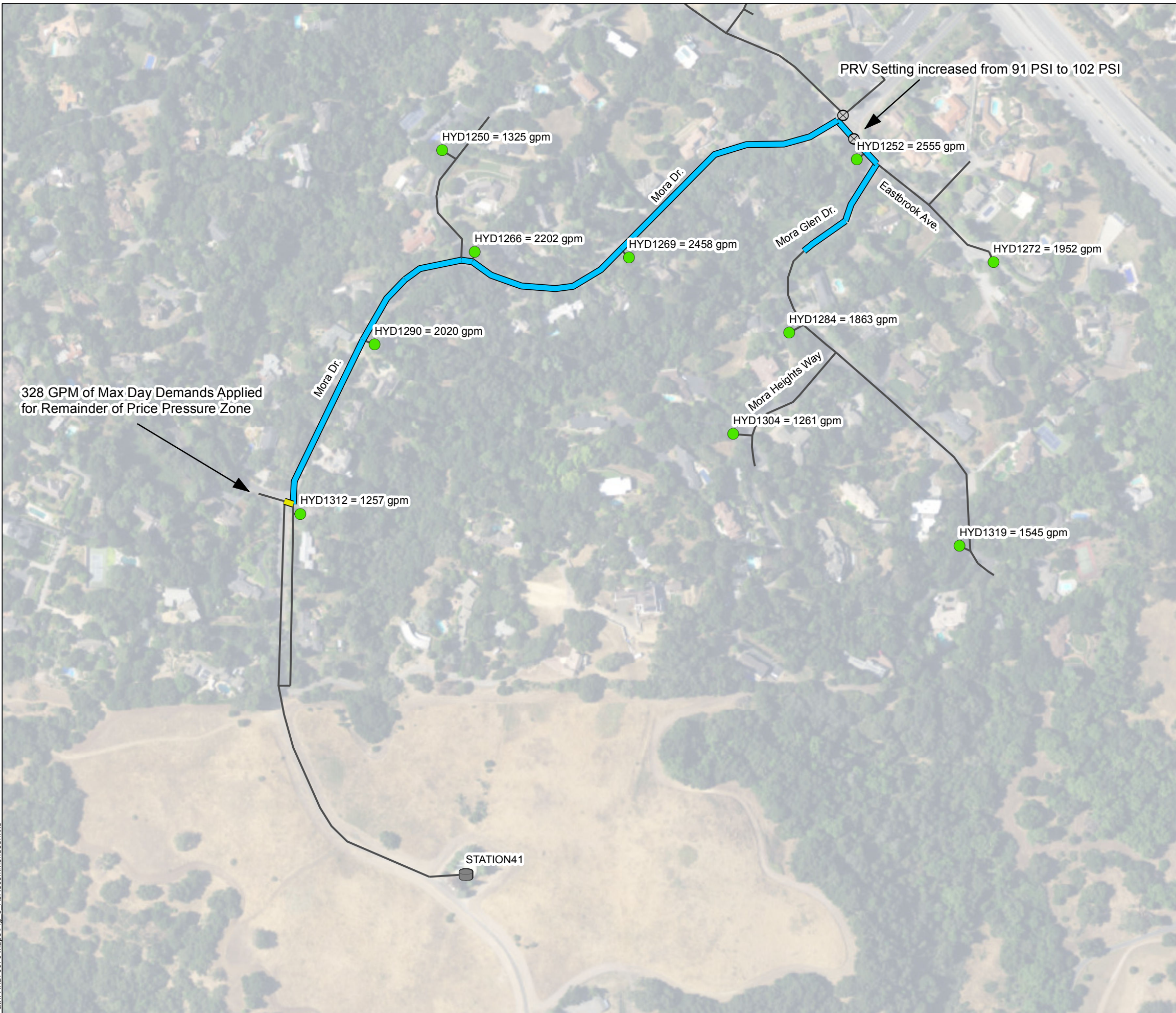
Los Altos Hills, CA

November 2017

B70079.00

Figure 6

Path: X:\B70079\Maps\Fig. 8_AsRecommended.mxd



Legend

- Enclosed Storage Facility
- Pressure Reducing Valve
- Pipe
- Replacement Pipe 6" to 8"
- Replacement Pipe 6" to 10"

Hydrant Flow

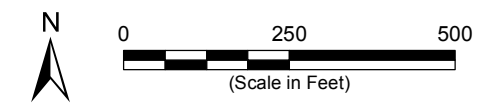
- Unable to Meet Requirement
- Meeting Requirement

Notes

- All locations are approximate.

Sources

- Aerial photograph provided by ESRI's ArcGIS Online, 14 November 2017.



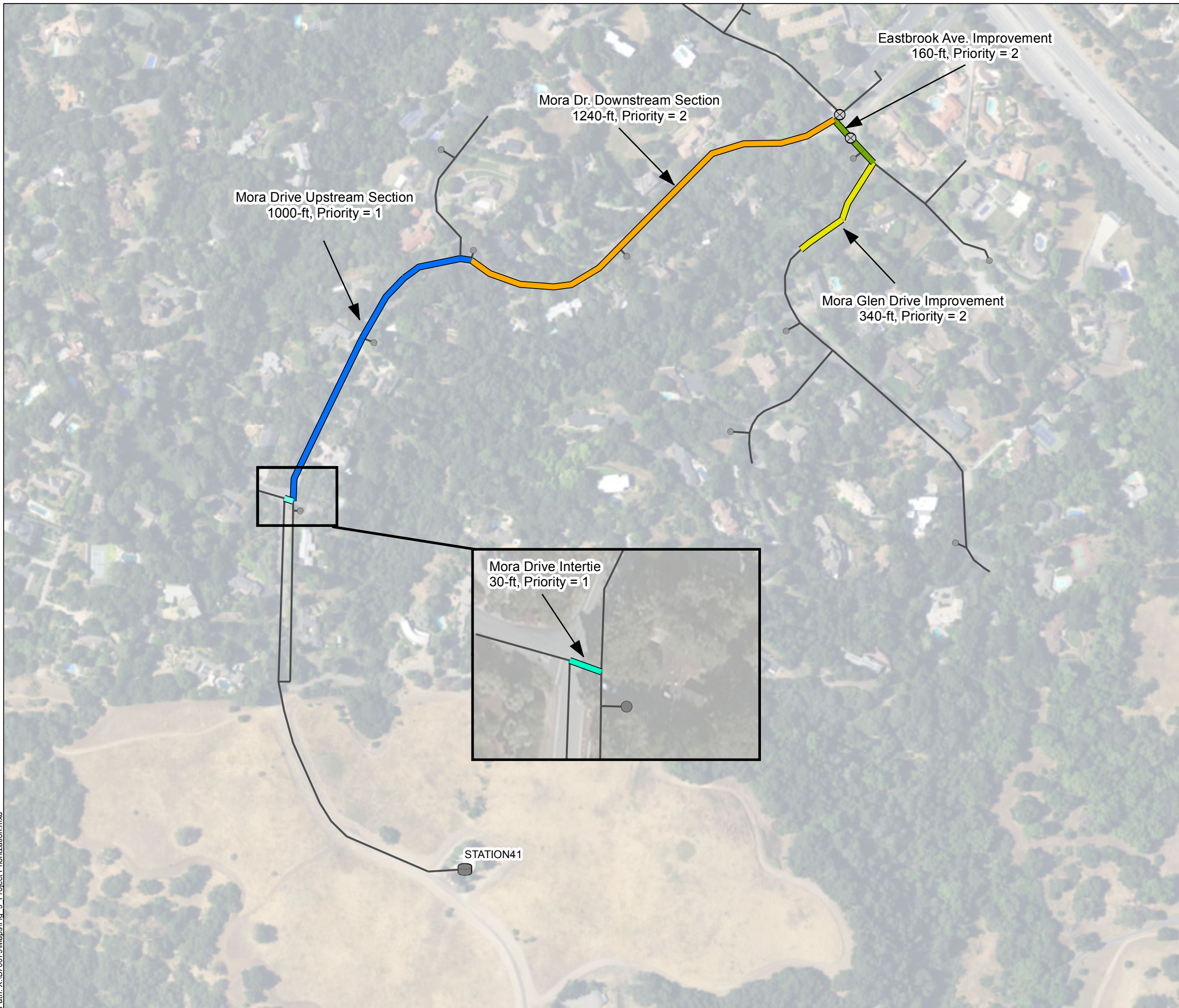
EKI Simplified Model - MDD Fire Flow Availability Cal Water Mora Area with EKI's Proposed CIPs

DRAFT
eki environment
& water

Los Altos Hills County Fire District
Los Altos Hills, CA
November 2017
B70079.00

Figure 7

Path: X:\B70079\Maps\Fig. 9 - Project Prioritization.mxd



Legend

Existing City Infrastructure

- Enclosed Storage Facility
- Pressure Reducing Valve
- Pipe
- Hydrant

Projects

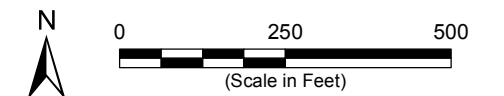
- Mora Drive Intertie, Replace with 10"
- Mora Drive Upstream, Replace with 8"
- Mora Drive Downstream, Replace with 8"
- Eastbrook Ave. Improvement, Replace with 8"
- Mora Glen Drive Improvement, Replace with 8"

Notes

- All locations are approximate.

Sources

- Aerial photograph provided by ESRI's ArcGIS Online, 14 November 2017.



Recommended Project Prioritization Cal Water Mora Area

DRAFT
eki environment
& water

Los Altos Hills County Fire Department
Los Altos Hills, CA
November 2017
B70079.00

Figure 8