October 12, 2023

Mr. Sean Barclay
General Manager
Tahoe City Public Utility District
221 Fairway Drive
Tahoe City, CA 96145

Subject: Infrastructure Improvement Charge Final Report

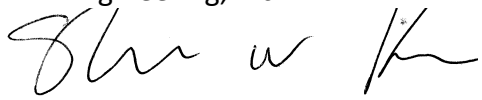
Dear Mr. Barclay:

HDR Engineering, Inc. (HDR) is pleased to present the final Report on the development of the Infrastructure Improvement Charge calculated for the Tahoe City Public Utility District (District) customers in the Tahoe Cedars and Madden Creek water service areas (formerly owned by Mid-Sierra Water Utility). A key objective in developing the Infrastructure Improvement Charge was to determine the methodology and cost-basis for the Infrastructure Improvement Charge based on the cost of reconstructing the two water systems. This Report outlines the approach, methodology, findings, and conclusions related to the development of the Infrastructure Improvement Charge for these water service areas.

This Report was developed utilizing the District's current and historical billing records, recent master plans, Carollo Engineers, Inc. (Carollo) reconstruction estimates, capital budgets, and future projections. HDR has relied on this information to develop the analyses that form our findings, conclusions, and recommendations. The methodology developed for the Infrastructure Improvement Charge is based on generally accepted rate/fee setting principles. The conclusions and recommendations contained within this Report are intended to provide a cost-based Infrastructure Improvement Charge that supports an equitable share of the costs of reconstructing the Tahoe Cedars and Madden Creek water systems.

We appreciate the assistance provided by District staff in the development of this proposed Infrastructure Improvement Charge and Report. More importantly, we appreciate working with District staff, management, and Board on this project.

Sincerely yours,
HDR Engineering, Inc.



Shawn Koorn
Associate Vice President

hdrinc.com

929 108th Ave NE, Suite 1300, Bellevue, WA 98004
T 425-450-6200

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1 Development of the Approach

1.1 Introduction

HDR Engineering, Inc. was retained by the Tahoe City Public Utility District (District) to develop a methodology and approach to establish a cost-based Infrastructure Improvement Charge as a part of the funding strategy for the reconstruction of the Tahoe Cedars and Madden Creek water systems which were formerly owned by Mid-Sierra Water Utility. The District recently completed water system master plans for the Tahoe Cedars and Madden Creek water systems. These water system master plans were formally adopted by the District's Board on February 19, 2021. The master plans for both systems noted significant condition and fire suppression deficiencies and called for complete system reconstruction of both systems. These plans resulted in a proposed capital improvement plan to reconstruct and upgrade the systems to address existing conditions, increase pipe size (i.e., capacity) and add fire hydrants. Given the cost of these infrastructure improvements, the District is moving forward with the development of a long-term funding plan, of which one funding component is the proposed Infrastructure Improvement Charge to be paid by current and future customers within the Tahoe Cedars and Madden Creek water service areas (i.e., the beneficiaries).

1.2 Study Approach Overview

For purposes of developing a cost-based Infrastructure Improvement Charge, the capital costs, financing, and resulting Infrastructure Improvement Charge are the same for all current and future customers of the Tahoe Cedars and Madden Creek water service areas. The results of the master planning process, conducted by Carollo Engineers, Inc., resulted in the identification of the capital improvements needed for the water systems' reconstruction and upgrades to address the condition and fire suppression deficiencies. During this process, District staff has provided information and preliminary cost estimates to the District Board for review, input, and direction.

During Board discussions related to this matter, and consistent with the District's Water System Acquisition Policy (Financial Policy No. 2025), it was determined that the funding of the water systems' reconstruction and upgrades should come from a combination of three revenue sources:

- A direct Infrastructure Improvement Charge from the customers in the Tahoe Cedars and Madden Creek water service areas (the subject of this Report),
- Property tax revenue of the District, and
- Net proceeds from the District's general water rates.

Following the implementation of the subject Infrastructure Improvement Charge, the District will complete its typical 5-year general water rate study, which will account for the revenues from the subject Infrastructure Improvement Charge (assuming it is approved) and Board-designated property tax revenue, to develop a final funding approach and system-wide water

rate impacts to fund the full reconstruction of the Tahoe Cedars and Madden Creek water systems.

1.3 Development of the Study

Through discussion with District staff, it was determined that a methodology would be developed to identify the infrastructure improvements and cost of those infrastructure improvements that directly benefit the customers of the Tahoe Cedars and Madden Creek water service areas. To accomplish this, Carollo prepared an *Engineering Report for the Former Mid-Sierra Water Utility Water Systems Rate Study* (Carollo Report), which compared two water system improvement alternatives to establish the incremental infrastructure improvement costs that directly benefit the customers of the water systems. The Carollo Report is included in the Appendix to this Report. Alternative 1 determined the capital costs associated with reconstructing the systems at their current size and capacity, and without adding any new fire hydrants. Alternative 2, which reflects the upsizing of the systems to meet modern fire protection standards, includes reconstructing the systems with appropriately sized water mains and the installation of a significant number of new fire hydrants.

The incremental cost difference between the two reconstruction alternatives provides the value, or calculation, of the benefit to the customers in the Tahoe Cedars and Madden Creek water services areas. This calculation of the incremental cost provides a reasonable cost-basis to establish the proposed Infrastructure Improvement Charge.

It should be noted that the Carollo Report calculated and compared the total project costs of the Alternatives, which included both a construction contingency and a project delivery contingency. The project delivery contingency estimates costs associated with design and construction-phase professional services. For the purposes of this Study, the project delivery contingency is not included in the cost-basis determinations. All cost estimates in this analysis are construction-only and include a construction contingency.

1.3.1 Alternative 1 - Estimated Reconstruction Cost

To start the analysis, the Carollo Report developed a reconstruction alternative (Alternative 1) based on reconstructing the water systems at their current size and capacity. Alternative 1 includes the relocation of the backyard water mains to the street right-of-ways. However, the new water mains are sized with the same diameters as the existing water mains. Additionally, no new, or additional, hydrants are added as part of Alternative 1. Provided below in Table 1-1 is a summary of the lengths and sizes of water system pipeline and fire hydrants associated with Alternative 1.

Table 1-1 Summary of Alternative 1 Infrastructure (linear feet) [1]							
1-Inch	1.5/2-Inch	3-Inch	4-Inch	6-Inch	8-Inch	12-Inch	Additional Hydrants
3,740 lf	16,990 lf	0 lf	34,850 lf	35,710 lf	0 lf	1,990 lf	0

[1] – Source: Table 2, Carollo, Engineering Report for the Former Mid-Sierra Water Utility Water Systems Rate Study, August 8, 2023.

The next step was to develop a reconstruction cost estimate (i.e., the estimated current construction costs associated with each of the water main sizes) for Alternative 1. Based on current construction costs, as developed in the Carollo Report, the following cost was developed for Alternative 1, assuming the linear lengths by main size summarized in Table 1-1. The estimated reconstruction cost of Alternative 1 is summarized in Table 1-2 below.

Table 1-2 Summary of the Estimated Reconstruction Cost of Alternative 1[1]					
Diameter	Length (Linear Ft) [2]	Replacement Cost ($/LF) [3]	Base Construction Cost	Contingency [4]	Total Reconstruction Cost
1-Inch	3,740	$60	$224,400	$56,100	$280,500
1.5/2-Inch	16,990	65	1,102,485	275,621	1,378,106
3-Inch	0	120	0	0	0
4-Inch	34,850	140	4,879,000	1,219,750	6,098,750
6-Inch	35,710	215	7,674,200	1,918,550	9,592,751
8-Inch	0	235	0	0	0
12-Inch	1,990	290	597,000	149,250	746,250
Fire Hydrant	0	11,040	0	0	0
Total			**$14,477,085**	**$3,619,271**	**$18,096,356**

[1] – Source: Tables 2, 4 and 5, Carollo, Engineering Report for the Former Mid-Sierra Water Utility Water Systems Rate Study, August 8, 2023.
[2] – Source: Table 2, Ibid.
[3] – Source: Table 4, Ibid.
[4] – Source: Table 5, Ibid.

A construction contingency of 25% was added to the base reconstruction cost to result in a total estimated reconstruction cost. As shown above in Table 1-2, the total estimated reconstruction cost for Alternative 1, including construction contingency, was estimated to be approximately $18.1 million.

1.3.2 Alternative 2 - Estimated Reconstruction Cost

Next, the Carollo Report developed a reconstruction alternative (Alternative 2) based on reconstructing the water systems to a size and capacity to meet modern fire protection standards (i.e., reconstructing the systems as proposed in the master plans). Alternative 2 includes relocating existing backyard water mains into street right-of-ways. In this alternative, the new

water mains would be sized to accommodate larger flows consistent with modern fire protection standards. Additionally, 145 new fire hydrants would be added to meet modern fire hydrant spacing standards.

Provided below in Table 1-3 is a summary of the lengths and sizes of water system pipeline and fire hydrants associated with Alternative 2.

Table 1-3
Summary of Alternative 2 Infrastructure (Linear Feet) [1]

1-Inch	1.5/2-Inch	3-Inch	4-Inch	6-Inch	8-Inch	12-Inch	Additional Hydrants
0 lf	0 lf	0 lf	0 lf	0 lf	95,090 lf	5,920 lf	145

[1] – Source: Table 2, Carollo, Engineering Report for the Former Mid-Sierra Water Utility Water Systems Rate Study, August 8, 2023.

As can be seen in Table 1-3, the smaller sized mains have been upsized to an 8" minimum to reflect the capacity necessary to meet modern fire protection standards. In addition, 145 hydrants have been added to the system for purposes of fire protection.

The next step was to develop a reconstruction cost estimate for Alternative 2. The same construction costs assumption developed for Alternative 1 were used to develop the reconstruction cost estimate for Alternative 2 and is summarized below in Table 1-4.

Table 1-4
Summary of the Estimated Reconstruction Cost for the Water Systems Assuming Replacement Upgrades for Capacity and Fire Protection [1]

Diameter	Length (Linear Ft) [2]	Replacement Cost ($/LF) [3]	Reconstruction Cost	Contingency [4]	Total Estimated Cost
1-Inch	0	$60	$0	$0	$0
1.5/2-Inch	0	65	0	0	0
3-Inch	0	120	0	0	0
4-Inch	0	140	0	0	0
6-Inch	0	215	0	0	0
8-Inch	95,090	235	22,377,340	5,594,335	27,971,674
12-Inch	5,920	290	1,776,000	444,000	2,220,000
Fire Hydrant	145	11,040	1,600,800	400,200	2,001,000
Total			**$25,754,140**	**$6,438,535**	**$32,192,674**

[1] – Source: Tables 2, 4 and 5, Carollo, Engineering Report for the Former Mid-Sierra Water Utility Water Systems Rate Study, August 8, 2023.
[2] – Source: Table 2, Ibid.
[3] – Source: Table 4, Ibid.
[4] – Source: Table 5, Ibid.

As shown above in Table 1-4, the total estimated reconstruction cost for Alternative 2, including construction contingency, was estimated to be approximately $32.2 million.

1.4 Cost-Basis for the Infrastructure Improvement Charge

As can be seen in Tables 1-2 and 1-4, the estimated cost for the reconstruction of the water systems varies depending on the degree to which the reconstruction meets the modern fire protection standards for the Tahoe Cedars and Madden Creek water service areas. The incremental construction cost difference of approximately $14.1 million ($32,192,674 versus $18,096,356) associated with reconstructing the water systems to meet modern fire protection standards, as determined in the Carollo Report, is the cost identified as specifically benefitting the customers in the Tahoe Cedars and Madden Creek water service areas.

The engineering and economic analyses performed by HDR, Carollo, and the District, provide the cost-basis for the development and assessment of the Infrastructure Improvement Charge. The customers in the Tahoe Cedars and Madden Creek water service areas directly benefit from these infrastructure improvements. Therefore, the corresponding cost and resulting Infrastructure Improvement Charge should be paid by all the customers within these water service areas.

1.5 Summary of the Approach

Based on the approach outlined above, the cost-basis for the Infrastructure Improvement Charge has been established. The identified incremental cost difference between reconstructing the water systems at their current capacity, versus increasing the systems' capacities to meet modern fire protection standards, provides the specific benefit to the customers of the Tahoe Cedars and Madden Creek water service areas. Given this approach, the proposed Infrastructure Improvement Charge can be calculated.

2 Calculation of the Infrastructure Improvement Charge

2.1 Introduction

In the previous section, the approach to establish the cost-basis for the Infrastructure Improvement Charge was presented, developed, and summarized. Establishing the estimated reconstruction cost and the cost-basis for the Infrastructure Improvement Charge provides the starting point for calculating the cost-based Infrastructure Improvement Charge for the Tahoe Cedars and Madden Creek water service area customers. The proposed Infrastructure Improvement Charge developed within this section of the Report reflects the specific benefit of the fire protection improvements to the Tahoe Cedars and Madden Creek water systems.

2.2 Summary of the Cost-Basis

The estimated incremental cost of the reconstruction of the systems that reflects the specific benefit of meeting modern fire protection standards was evaluated and summarized in the previous section of this Report. This analysis resulted in an estimated incremental reconstruction cost difference of approximately $14.1 million ($32,192,674 versus $18,096,356). This $14.1 million is the calculated benefit to the Tahoe Cedars and Madden Creek water service areas from the upsizing of the water systems to meet modern fire protection standards. It also becomes the starting point or cost input for the calculation of the cost-based Infrastructure Improvement Charge.

2.3 Projection of Future Construction Cost

The approximate incremental cost of $14.1 million identified within this Report was based on current costs (e.g., 2023 costs). However, the improvements to the water systems are projected to occur over a 10-year period (2023 – 2033). Given this, it is prudent when calculating a charge of this type to include the future-value incremental cost of these improvements. To accomplish this, the District provided a schedule of incremental costs over the next ten-year period for the reconstruction of the water systems. The approximate $14.1 million, when adjusted over a ten-year period by an annual construction cost escalation of 2.7%, results in a future incremental construction cost of approximately $16.4 million. Provided in Table 2-1 is a summary of the escalation of the 2023 incremental cost.

Table 2-1 Escalation of 2023 Incremental Project Costs			
Year	**2023 $'s**	**Escalation %**	**Escalated $'s**
2023	$0	2.7%	$0
2024	0	2.7%	0
2025	1,999,600	2.7%	2,109,036
2026	1,625,519	2.7%	1,760,773
2027	2,417,257	2.7%	2,689,086
2028	1,467,679	2.7%	1,676,808
2029	1,415,790	2.7%	1,661,198
2030	1,407,477	2.7%	1,696,033
2031	1,339,915	2.7%	1,658,214
2032	1,313,017	2.7%	1,668,800
2033	1,110,065	2.7%	1,448,948
Total	**$14,096,318**		**16,368,896**

This future incremental construction cost estimate of $16.4 million now provides the anticipated total incremental construction cost, considering the assumed ten-year construction period.

2.4 Estimation of Financing Costs

As noted, the incremental cost associated with the reconstruction of the water systems escalated to future projected cost is approximately $16.4 million. Given the magnitude of this cost and the likelihood of most project costs being financed, it is recommended that the recovery of the incremental costs be spread over a long-term time period to minimize impacts to existing and future customers, maintain a reasonable fee level and better match the District's repayment of any project financing. To accomplish this, it was determined that the calculation of the Infrastructure Improvement Charge would be based on the equivalent of a long-term debt payment. It was presumed to be reasonable to base the calculation on the current 2023 California Drinking Water State Revolving Fund (DWSRF) loan terms and conditions. The current annual interest rate and term for a DWSRF loan repayment are 2.1% for a 30-year repayment period. As a point of reference, a DWSRF loan is most likely the lowest cost long-term debt financing available to the District. Given the assumed long-term borrowing terms noted above, and the future-value incremental construction cost of approximately $16.4 million, the annual debt service payment on a loan of $16.4 million was calculated to be $740,958. As noted, this has assumed a 30-year repayment term at an annual interest rate of 2.1%. Given the calculation of the fee was based on a 30-year repayment period, it is recommended that the proposed Infrastructure Improvement Charge would also be in place for a 30-year period at the calculated level. In other words, no change in the Infrastructure Improvement Charge over the 30-year period.

2.5 Development of Cost-Based Rates and Charges

Developing cost-based and proportional rates and charges is of paramount importance in developing proposed water rates, fees, and charges in California. The District's proposed Infrastructure Improvement Charge has been developed to meet the legal requirements of California Constitution article XIII C, section 1 (Article XIII C), which is commonly referred to as Proposition 218. Article XIII C defines a tax as a levy, charge, or exaction of any kind imposed by a local government, except for levies, charges, or exactions that fall under one of seven express exemptions. Of particular relevance is the second exemption – charges imposed for a specific government service or product provided directly to the payor that is not provided to those not charged, and which does not exceed the reasonable cost to the local government of providing the service or product.

In addition, Article XIII C requires the local government imposing the fee or charge to prove, with evidence, that a levy, charge, or other exaction is not a tax, that the amount is no more than necessary to cover the reasonable cost of the governmental activity, and that the manner in which that cost is allocated to a payor bears a fair or reasonable relationship to the payor's burdens on, or benefits received from, the governmental activity. A fundamental part of this analysis, therefore, is to demonstrate that a fee or charge recovers sufficient revenue to provide the government service, is proportional to the burdens on the system placed by each payor, and generates revenue to be used for the purpose of providing such service.

HDR is of the opinion that the proposed Infrastructure Improvement Charge meets the legal requirements of Article XIII C. HDR reaches this conclusion based upon the following:

- ✓ **The Infrastructure Improvement Charge is imposed for a specific government service.** The District, via the Carollo Report, has identified the cost-basis of providing service to the customers of the Tahoe Cedars and Madden Creek water service areas.
- ✓ **The government service is provided directly to the payor and is not provided to those not charged.** The calculation of the Infrastructure Improvement Charge is for the specific costs (i.e., incremental costs of upsizing water mains and adding fire hydrants to the Tahoe Cedars and Madden Creek water service areas) benefiting the customers of the Tahoe Cedars and Madden Creek water service areas.
- ✓ **The rates do not exceed the reasonable cost to the Agency of providing the service.** The proposed Infrastructure Improvement Charge reflects only a portion of the overall total costs of reconstructing the Tahoe Cedars and Madden Creek water systems and does not exceed the reasonable cost to provide the service.

2.6 Proposed Infrastructure Improvement Charge

As noted in this Report, in this particular instance, the cost-basis and proportionality of the proposed Infrastructure Improvement Charge is that specific incremental cost associated with the water systems' reconstruction to meet modern fire protection standards. These incremental improvements to the Tahoe Cedars and Madden Creek water systems directly benefit the customers in these water service areas. This cost-basis is clearly documented and explained in the Carollo Report, which provided the engineering cost estimates and assumptions for this

Report. Given the methodology and approach as described previously in this Report, Table 2-2 provides a summary of the calculation of the proposed Infrastructure Improvement Charge.

Table 2-2
Proposed Infrastructure Improvement Charge

Present Value Incremental Construction Cost	Future Value Incremental Construction Cost	DWSRF Terms	Annual Incremental Debt Service Payment	Number of Customers (Current 7/24/23)	Annual Infrastructure Improvement Charge	Monthly Infrastructure Improvement Charge
$14,096,318	$16,368,896	2.1%, 30 years	$740,958	1,417	$522.91	$43.58

As shown in Table 2-2, the proposed Infrastructure Improvement Charge is $43.58 per month for the current and future customers in the Tahoe Cedars and Madden Creek water service areas. This Infrastructure Improvement Charge is in addition to the District's water rates as adopted through the previous Proposition 218 process. The proposed Infrastructure Improvement Charge should be applied to all current and future customers within the Tahoe Cedars and Madden Creek water service areas for a period of 30 years.

It is important to note and understand that the proposed Infrastructure Improvement Charge is not intended or designed to fund/collect the total cost necessary to fund the complete reconstruction and upgrades of the water systems. The Infrastructure Improvement Charge will provide total revenue of approximately $741,000 annually for the 30-year period. For perspective, the District as a part of its long-term financial planning efforts has estimated that the annual debt service payment for the systems' total reconstruction is approximately $2.5 million for 30-years, using the same financing assumptions noted above in this Report. This means that the Infrastructure Improvement Charge will provide approximately 30% of the total revenue required to fund the reconstruction and upgrade project. The remainder will be funded by the District's general water rates and other available funding sources including property taxes.

2.7 Summary of the Study

This completes the summary of the proposed Infrastructure Improvement Charge applicable to the customers of the Tahoe Cedars and Madden Creek water service areas. It is recommended that the Infrastructure Improvement Charge be implemented through a Proposition 218 process and established for a 30-year period.

Technical Appendix

PROJECT MEMORANDUM

TAHOE CITY PUBLIC UTILITY DISTRICT

Mid-Sierra Water Utility Rate Study

Project No.: 11727A00
Date: August 8, 2023
Prepared By: Julia Semmens
Reviewed By: Coral Taylor, P.E. and Tim Loper, P.E.
Subject: Engineering Report for the Former Mid-Sierra Water Utility Water Systems Rate Study

Introduction

In January 2018, the Tahoe City Public Utility District (TCPUD) acquired the Mid-Sierra Water Utility (MSWU), which includes two physically separate water systems: the Tahoe Cedars and the Madden Creek water systems. These water systems require substantial reconstruction to address condition and capacity deficiencies, in particular the provision of adequate fire protection flows and hydrant coverage. TCPUD is investigating several funding opportunities to finance these reconstruction projects, including the use of TCPUD water rate revenues, water capital reserves, and property tax revenues along with grants and financing options.

In conjunction with the above, the TCPUD is conducting a Rate Study to determine what infrastructure improvement costs are unique to the Tahoe Cedars and Madden Creek water systems' reconstruction projects and could be paid for by the customers within those water systems. The Rate Study will determine an Infrastructure Improvement Charge (Charge) to be charged to developed parcels within the former service area of the MSWU. The specific Charge would represent the incremental cost of upsizing pipelines and adding fire hydrants to the Tahoe Cedars and Madden Creek water systems' reconstruction projects from the systems' current sizing to a size and corresponding capacity that would meet modern fire protection standards. Figure 1 shows the location and overview of the Tahoe Cedars and Madden Creek water systems.

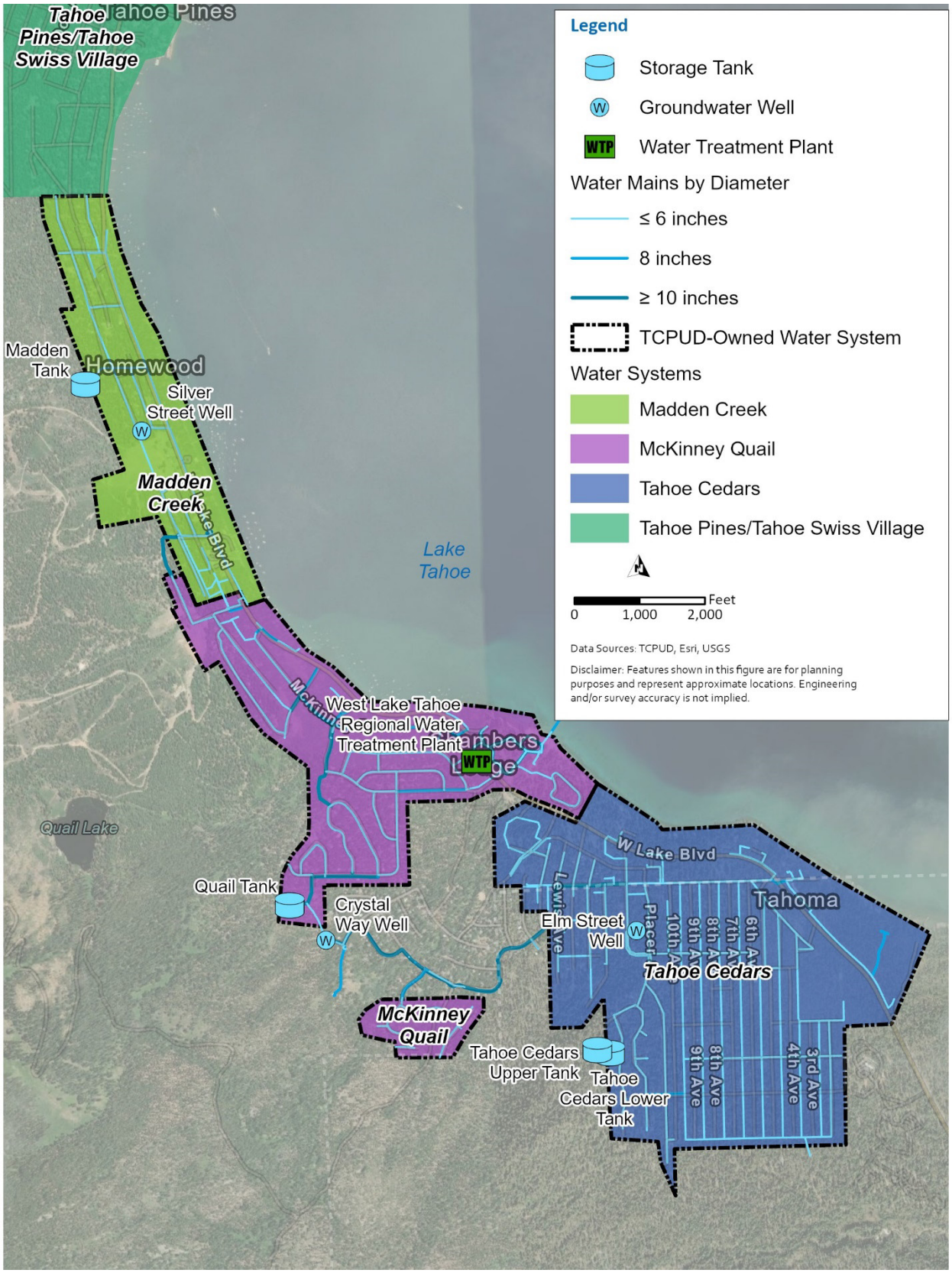

Figure 1 Overview of Water Systems

This project memorandum (PM) documents the hydraulic and economic analyses conducted to determine both the necessity and the incremental cost of upsizing pipelines and adding fire hydrants to the Tahoe Cedars and Madden Creek water systems. This PM is intended to support the Cost-of-Service analysis being performed for the Rate Study. The PM is organized as follows:

- **Introduction:** This section explains the purpose of the Rate Study and the PM and provides an overview of the Tahoe Cedars and Madden Creek water systems.
- **Background:** This section summarizes recent studies, including master plans, completed for, or related to the Tahoe Cedars and Madden Creek water systems, and describes modern fire protection standards.
- **Water System Improvements Alternatives:** This section describes the two water system improvement alternatives considered in this PM.
- **Alternatives Analysis:** This section describes comparative hydraulic and economic analyses conducted as part of this PM.
- **Conclusion:** This section summarizes the findings of this PM.

Background

After acquiring the MSWU, the TCPUD contracted with Carollo Engineers, Inc. (Carollo) to develop water system master plans for both systems. Completed in March 2021, the Tahoe Cedars Water Master Plan and the Madden Creek Water Master Plan (2021 Master Plans) evaluated the existing water systems' condition and hydraulic capacity. These studies identified capital improvements to mitigate identified deficiencies and to meet regulatory, industry, local, and TCPUD water system standards. The 2021 Master Plans recommended a series of projects to completely reconstruct both water distribution systems (i.e., the Tahoe Cedars and Madden Creek water systems reconstruction projects), which address the identified deficiencies and meet hydraulic performance criteria. The Master Plans recommended full reconstruction of the water distribution systems for several reasons:

- The distribution pipelines and appurtenances are well past their useful life and are actively failing.
- Fire hydrants are sparse within both water systems and do not meet modern spacing requirements.
- Many of the water mains in the Tahoe Cedars system are located in backyards (i.e., within back-of-lot alignments), which contribute to operational challenges due to maintenance and repair access and customer nuisances.
- The water distribution pipelines sizes and layouts are insufficient to meet modern fire protection standards.

While not legally obligated to do so, most California public utilities, including TCPUD, design and construct their water distribution systems to meet modern fire protection standards. Such standards are primarily defined by the California Fire Code (California Code of Regulations, Title 24) and the codes and regulations of the local fire protection agency (North Tahoe Fire Protection District and Meeks Bay Fire Protection District in the study area). These codes are established to provide minimum standards for the protection of built structures from structure fires. The 2021 Master Plans established the TCPUD's criteria to meet modern fire protection standards for the Tahoe Cedars and Madden Creek water distribution systems as follows:

- For residential land use areas, minimum system flow rate of 1,500 gallons per minute (gpm) at a residual pressure of 20 pounds per square inch (psi) after 2 hours of flow at that rate.
- For commercial land use areas, minimum system flow rate of 3,000 gpm at a residual pressure of 20 psi after 3 hours of flow at that rate.
- Minimum hydrant spacing of 500 feet in residential land use areas and 450 feet in commercial land use areas.

The above criteria are minimum values established to enable water systems to achieve sufficient flows for fighting localized structure fires at a single location. When feasible, utilities strive to exceed these values to provide a more robust water system capable of supplying flows at multiple points. Given climatic factors that contribute to elevated fire risks for customers within the Lake Tahoe basin, TCPUD is particularly interested in increasing system resiliency and robustness to achieve fire flows beyond the minimum criteria wherever economically feasible.

In addition to the 2021 Master Plans, the TCPUD has been advancing other projects and studies that are related to the Tahoe Cedars and Madden Creek water systems. Table 1 summarizes these projects and studies that were considered in this PM.

Table 1 Summary of Previous and Ongoing Efforts related to the Tahoe Cedars and Madden Creek Water Systems

Effort	Description
WLTRWTP	TCPUD is constructing the WLTRWTP to address water supply deficiencies within the water systems along the west shore of Lake Tahoe between Timberland and Tahoma, including the Tahoe Cedars and Madden Creek water systems. Phase 1 of the WLTRWTP, which will increase available water supplies by 695 gpm, is expected to be completed in 2024.
2021 Master Plans	The 2021 Master Plans evaluated the Tahoe Cedars and Madden Creek water systems against regulatory, industry, and TCPUD's water system planning criteria and identified capital improvements to address system needs through 2040. As part of this effort, Carollo developed an InfoWater Pro hydraulic model of the Tahoe Cedars and Madden Creek water systems to evaluate hydraulic performance. The 2021 Master Plans proposed completely reconstructing both systems and realigning all water mains to be within street ROWs.
WSSA study	The WSSA study is an ongoing planning study investigating strategies to augment water storage within the water systems supplied by the planned WLTRWTP. To support this study, Carollo updated the hydraulic model developed for the 2021 Master Plans to incorporate the entire WLTRWTP service area. The WSSA study has examined various alternatives for improving storage and transmission within the study area. It is envisioned that the storage and transmission improvements will be integrated with other distribution system improvements to improve overall water system hydraulic performance.

Abbreviations:
WLTRWTP - West Lake Tahoe Regional Water Treatment Plant; gpm - gallons per minute; ROW - right-of-way;
WSSA - West Shore Storage Augmentation

This PM uses data, modeling, and recommendations from the 2021 Master Plans and the projects and studies listed in Table 1 to estimate the above-described incremental cost in support of the Rate Study.

Water System Improvement Alternatives

This study considered the following two water system improvement alternatives:

- **Alternative 1: Reconstruct system at current size.** This alternative consists of reconstructing both water systems, including relocating existing backyard water mains into street ROWs. The new water mains would be sized with the same diameters as the existing water mains. No new hydrants would be added as part of this alternative. This alternative is not recommended and is not included in the 2021 Master Plans. It is included in the PM for comparative purposes.
- **Alternative 2: Reconstruct system to meet modern fire protection standards.** This alternative would also reconstruct both water systems and relocate existing backyard water mains into street ROWs. In this alternative, the new water mains would be sized to accommodate larger flows consistent with the above-described modern fire protection standards. Additionally, 145 new hydrants would be added to meet the above-described minimum hydrant spacing requirements. This alternative is similar to the water system reconstruction projects recommended in the 2021 Master Plans, with the exception of minor alignment and sizing changes for certain projects.

Table 2 summarizes the two alternatives, Figure 2 and Figure 3 show overview of the water system improvements under Alternatives 1 and 2, respectively.

Table 2 Overview of Water System Reconstruction Alternatives

Item	Proposed Improvements[1]	
	Alternative 1	Alternative 2
1-inch diameter water main	3,740 lf	0 lf
2-inch diameter water main	16,990 lf	0 lf
3-inch diameter water main	0 lf	0 lf
4-inch diameter water main	34,850 lf	0 lf
6-inch diameter water main	35,710 lf	0 lf
8-inch diameter water main	0 lf	95,090 lf
12-inch diameter water main	1,990 lf[2]	5,920 lf[2][3]
Fire hydrant	0 hydrants	145 hydrants

Notes:
(1) Proposed Alternative 2 improvements are consistent with the recommended project in the 2021 Tahoe Cedars and Madden Creek Water Master Plans, with the exception of minor alignment and sizing changes for certain projects. Projects completed since the Master Plans, which include the Madden Creek Phase 2 improvements and the Second Avenue Replacement Project, are included only for Alternative 2.
(2) Both alternatives include 1,990 lf of 12-inch diameter water main that TCPUD already replaced as part of a previous interconnection project.
(3) In Alternative 2, 3,800 lf of existing 6-inch diameter water main from the Elm Street Well to the Tahoe Cedars tanks is replaced with 12-inch instead of 8-inch diameter water main.

Abbreviation:
lf - linear feet

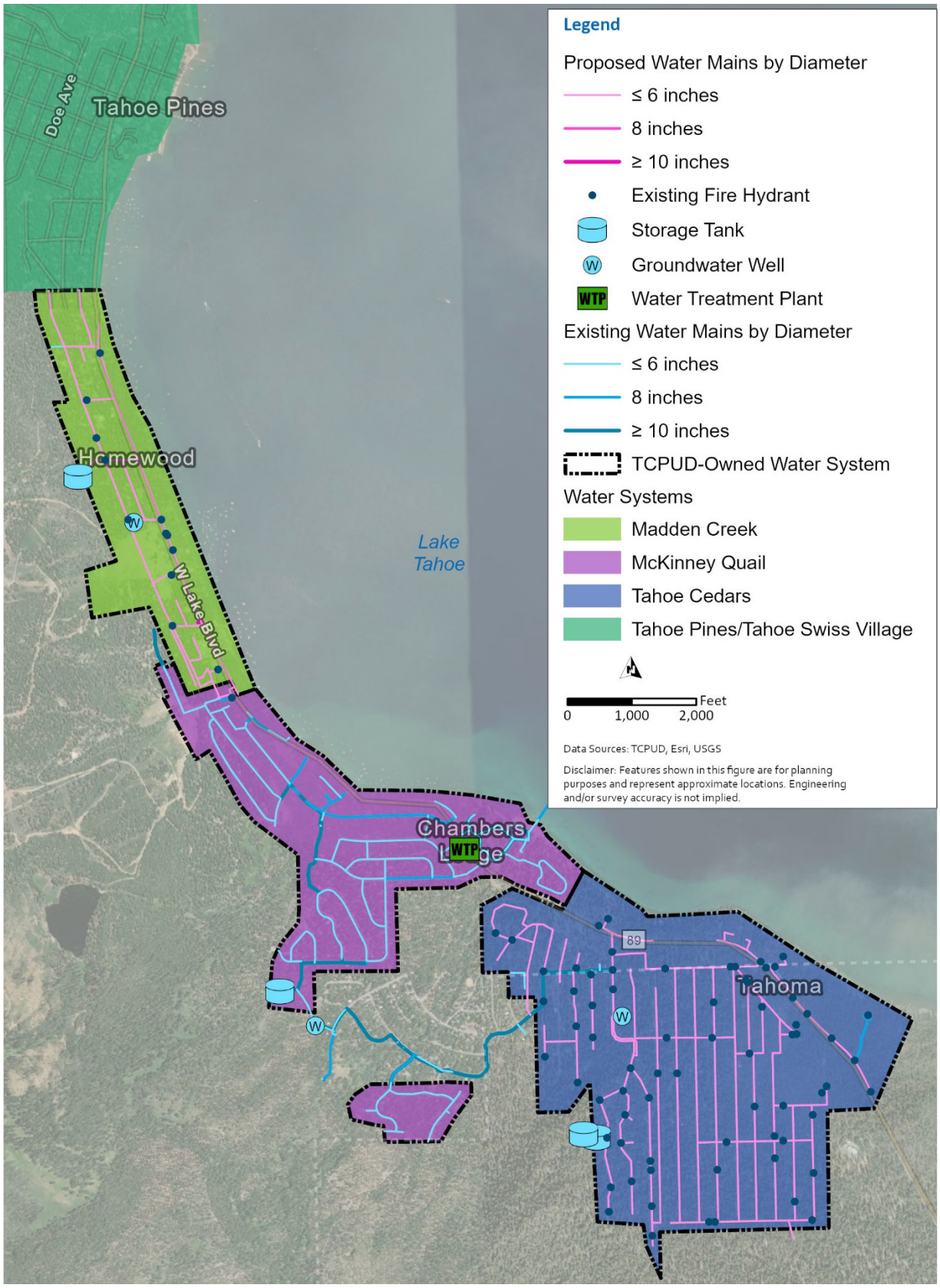

Figure 2 Overview of Alternative 1 Water System Improvements

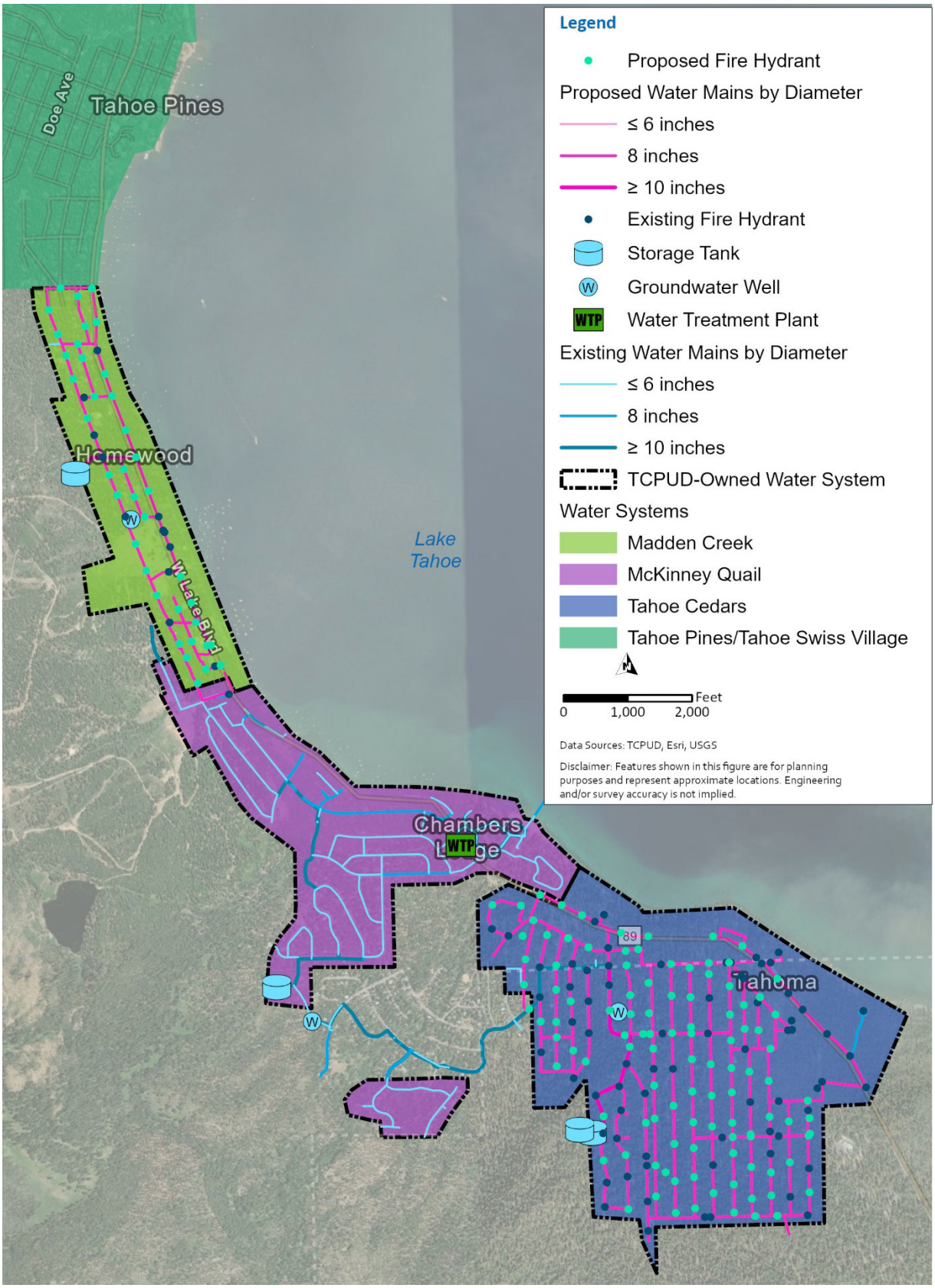

Figure 3 Overview of Alternative 2 Water System Improvements

Alternatives Analysis

This section describes the analyses conducted to compare the two water system reconstruction alternatives. The alternatives analysis consisted of the following three components:

- Hydraulic analysis: This component focused on the differences in fire flow availability provided by the two alternatives.
- Fire hydrant coverage analysis: This component focused on the differences in hydrant coverage provided by the two alternatives.
- Economic component: This component investigated the capital cost differences between the alternatives.

Hydraulic Analysis

A hydraulic analysis was conducted to evaluate the hydraulic performance differences between the two reconstruction alternatives. This evaluation utilized the InfoWater Pro hydraulic model developed as part of the 2021 Master Plans and updated for the WSSA study. The hydraulic analysis consisted of calculating available fire flows at the existing and proposed hydrant locations while maintaining 20 psi residual pressure. The model performs a steady-state calculation to determine available fire flows according to the initial conditions defined within the model run. The following lists the main assumptions incorporated into the model for this study:

- Phase 1 of the WLTRWTP was assumed to be completed.
- System demands were assumed to be equal to those under existing summer maximum day demand (MDD) conditions.
- Storage tank initial levels were set at a level below the maximum operating levels (MOLs) equal to 75 percent of the MDD volume for the system consistent with the operational storage criteria utilized in the 2021 Master Plans.
- All pipelines identified for replacement were assumed to have Hazen-Williams roughness coefficients equal to 140, which is consistent with the planning criteria in the 2021 Master Plans for Polyvinyl Chloride pipelines.

The model was used to calculate available fire flow throughout the Tahoe Cedars and Madden Creek water systems for both alternatives under two operational conditions:

- WLTRWTP on and all other supplies off.
- WLTRWTP off and all other supplies on.

Table 3 summarizes the fire flow results after 2 hours while maintaining 20 psi residual pressure under the above two operational conditions for both alternatives, and Figure 4 and Figure 5 show the results for Alternative 1 and Alternative 2, respectively. The model results suggest that implementing Alternative 2 over Alternative 1 would substantially increase available fire flows throughout the system. Under Alternative 2, the majority of the system has modeled fire flows greater than 3,000 gpm, and over 95 percent of the hydrants have modeled flows greater than 1,500 gpm. In contrast, over 65 percent of the existing hydrants are unable to achieve a fire flow of 1,000 gpm while maintaining 20 psi residual pressure under Alternative 1.

Under both Alternatives 1 and 2, existing tank elevations limit the maximum potential available fire flow at each hydrant. Hydrants located close to the existing tanks are at higher elevations and have relatively low static pressures. Additional tank improvements not considered in this analysis are required to mitigate hydraulic performance deficiencies at these hydrants.

The model results presented for Alternative 1 in Table 3 and on Figure 4 differ from the existing system fire flow results in the 2021 Master Plans as well as the May 2022 Tahoe Cedars Fire Flow Analysis due to the following reasons:

- Increased Hazen-Williams roughness coefficients assigned to pipelines identified for replacement substantially improved hydraulic performance compared to past fire flow analyses assuming existing pipeline conditions. Hazen-Williams roughness coefficients are inversely correlated with pressure loss, so increasing roughness coefficients enables model hydrants to achieve greater flows while maintaining 20 psi residual pressure.
- Although no specific looping was added for Alternative 1, realigning the pipelines into street ROWs led to increased hydraulic performance in certain areas, particularly in the grid neighborhood section of Tahoe Cedars, since some looping is required to connect the new pipelines in the street ROWs.

Table 3 Summary of Fire Flow Alternatives Analysis

Alternative/ Supply Condition	Number of Model Hydrants by Available Fire Flow(1)			
	1,000 gpm or less	1,000 to 1,500 gpm	1,500 to 3,000 gpm	> 3,000 gpm
WLTRWTP On, Other Supplies Off				
Alternative 1 – Reconstruct system at current size	59	19	6	0
Alternative 2 – Reconstruct system to meet fire protection standards	6	5	46	172
WLTRWTP Off, Other Supplies On				
Alternative 1 – Reconstruct system at current size	56	21	7	0
Alternative 2 – Reconstruct system to meet fire protection standards	6	2	49	172

Note:
(1) Available fire flow was calculated under summer maximum day demand conditions while maintaining 20 psi residual pressure.

Hydrant Coverage Analysis

A hydrant spacing analysis was performed in the 2021 Master Plans to assess compliance with the hydrant spacing criteria defined above of 500 feet minimum in residential land use areas and 450 feet minimum in commercial land use areas. Alternative 2 is designed to comply with these criteria.

Figure 6 through Figure 9 show buffers around each existing and proposed fire hydrant in the Madden Creek and Tahoe Cedars water system under each alternative to indicate areas that lack adequate hydrant coverage. Figure 6 and Figure 7 show the hydrant coverage under Alternative 1 for Tahoe Cedars and Madden Creek, respectively, and Figure 8 and Figure 9 show the coverage under Alternative 2 for Tahoe Cedars and Madden Creek, respectively. Table 4 summarizes the number of developed, developable, and undevelopable parcels within and not within the maximum allowable distance from existing and proposed fire hydrants per the spacing requirements for each alternative.

Under Alternative 1, a total of 626 out of 1,742 developed or developable parcels in the Tahoe Cedars and Madden Creek water systems are not within a hydrant buffer. Alternative 2 reduces the number of developed or developable parcels outside a hydrant buffer to 59.

Table 4 Summary of Hydrant Coverage Analysis

Parcel Status	Alternative 1 – Reconstruct System at Current Size		Alternative 2 – Reconstruct System to Meet Fire Protection Standards	
	Within Allowable Hydrant Spacing Buffer	Not within Allowable Hydrant Spacing Buffer	Within Allowable Hydrant Spacing Buffer	Not within Allowable Hydrant Spacing Buffer
Number of Developed Parcels	944	512	1,407	49
Number of Developable Parcels	172	114	276	10
Subtotal Developed or Developable	**1,116**	**626**	**1,683**	**59**
Number of Undevelopable Parcels	265	281	529	17
Total	**1,381**	**907**	**2,212**	**76**

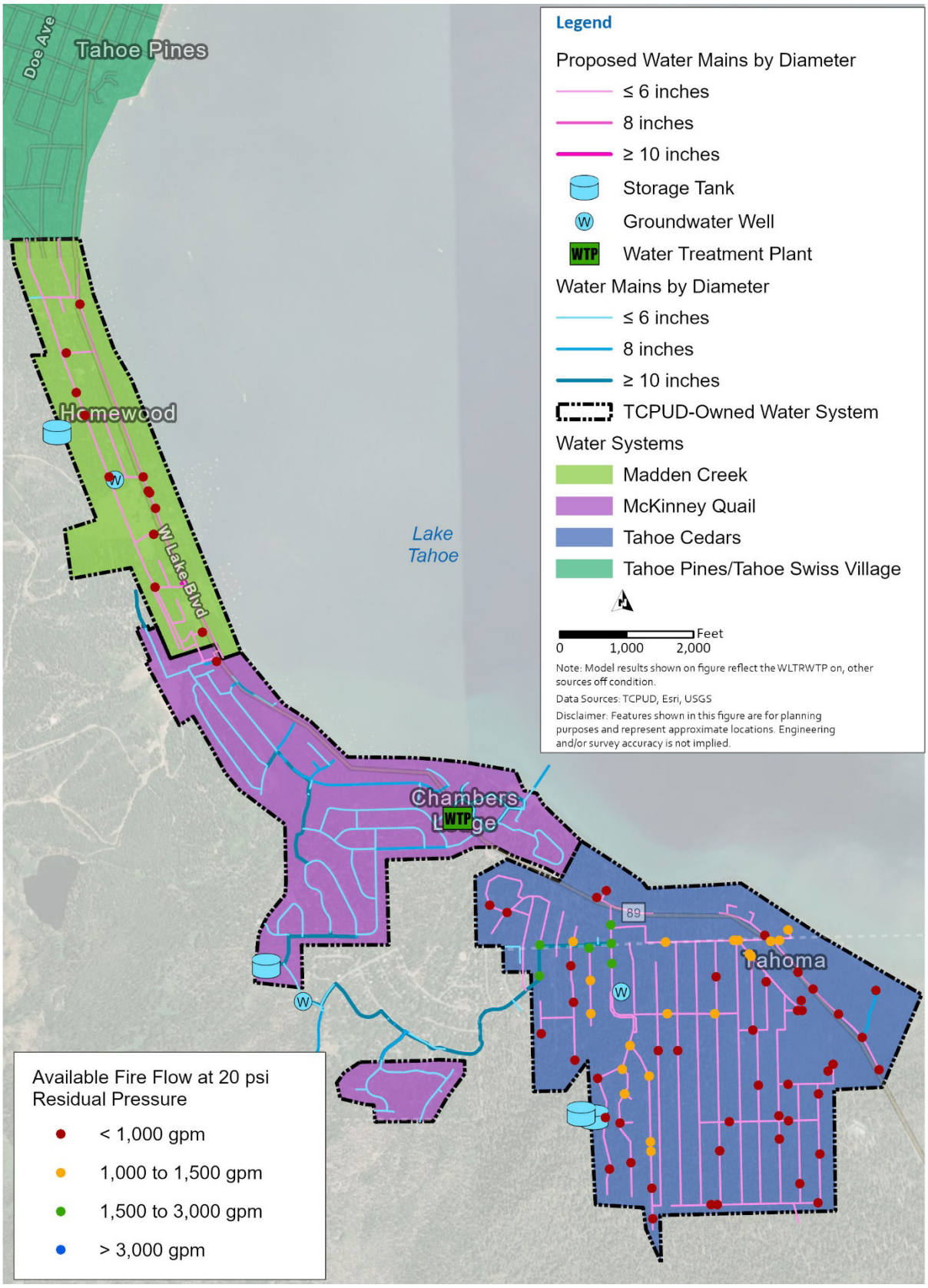

Figure 4 Available Fire Flow after 2 Hours while Maintaining 20 psi Residual Pressure – Alternative 1

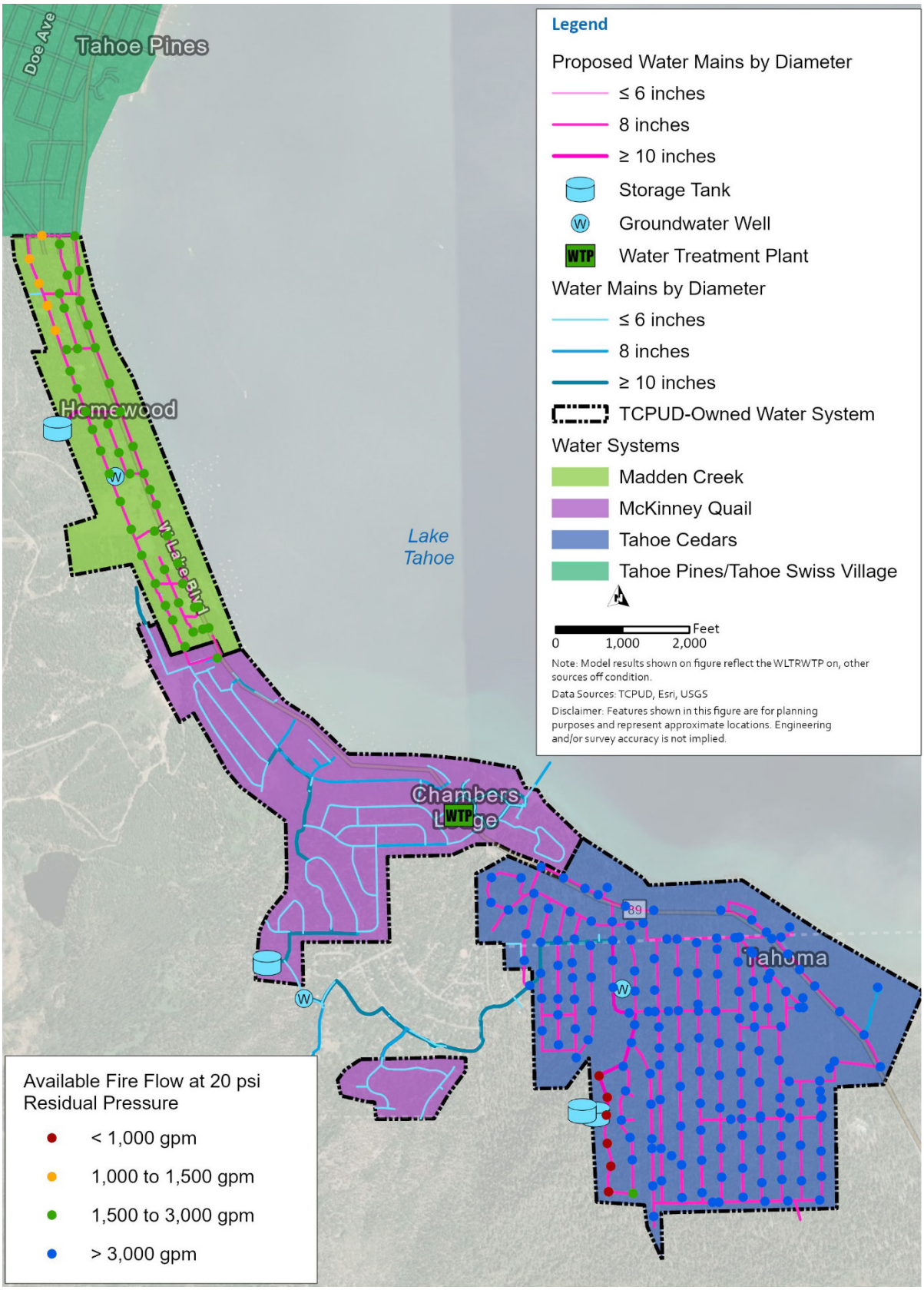

Figure 5 Available Fire Flow after 2 Hours while Maintaining 20 psi Residual Pressure – Alternative 2

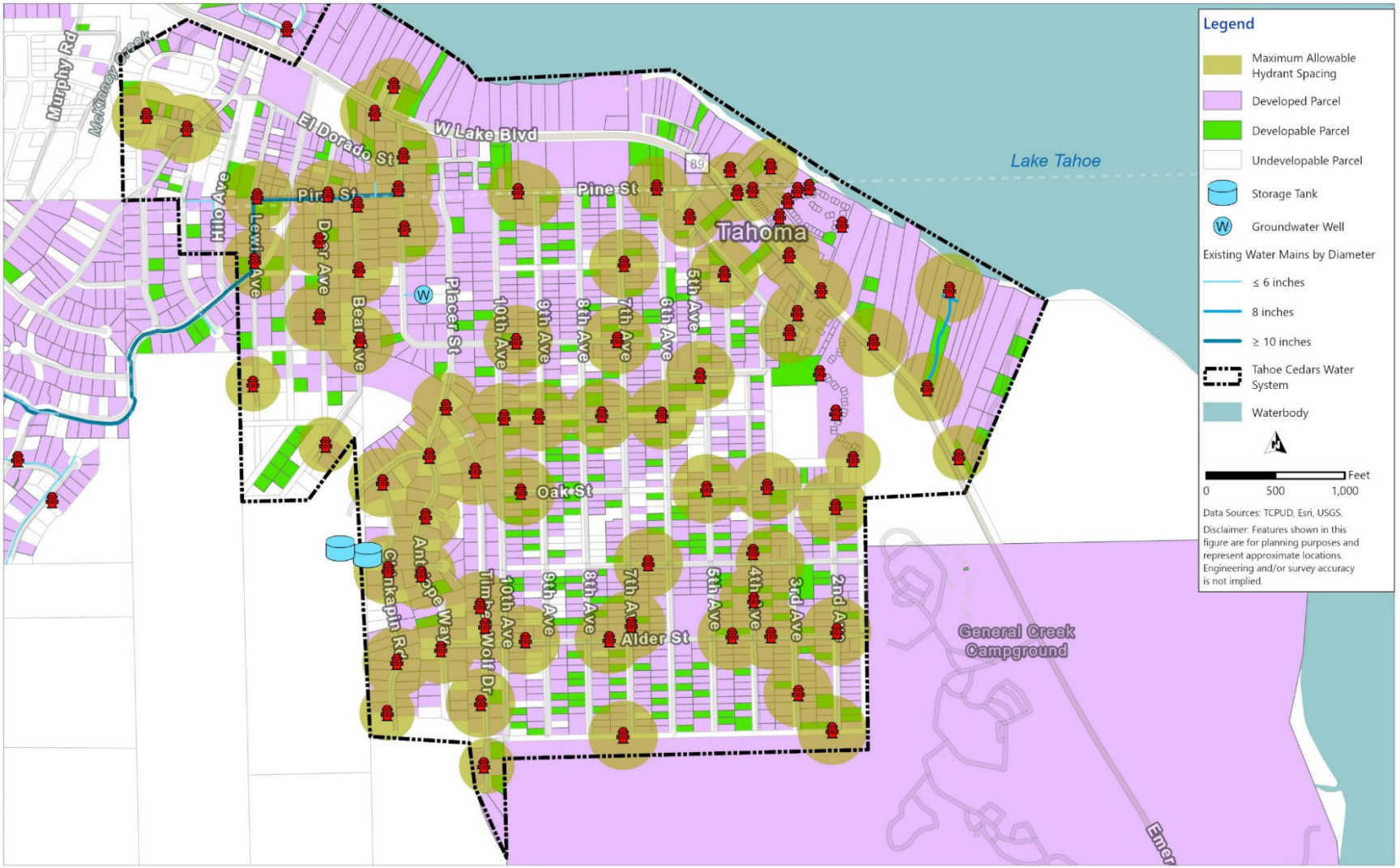

Figure 6 Tahoe Cedars Fire Hydrant Spacing - Alternative 1

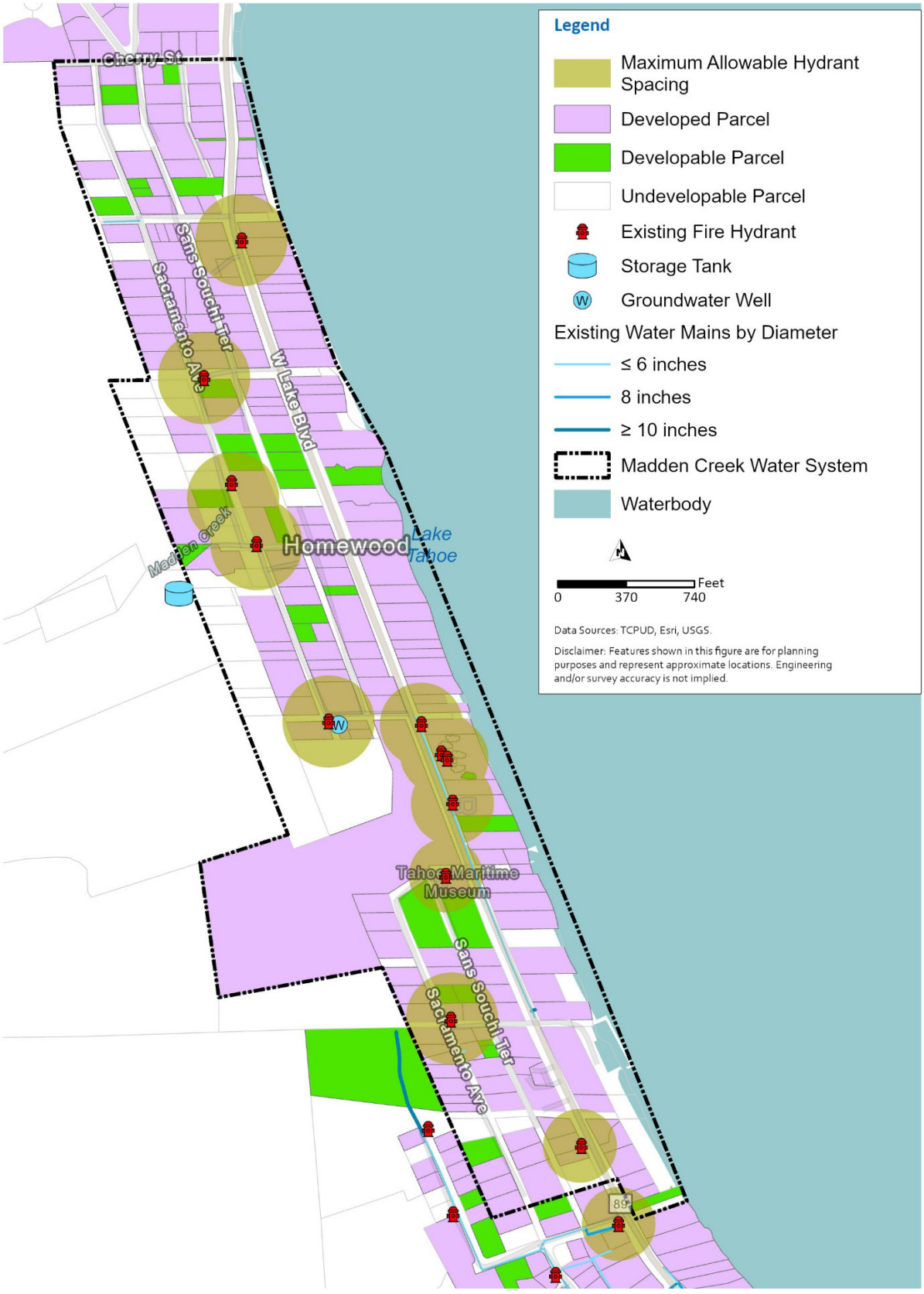

Figure 7 Madden Creek Fire Hydrant Spacing - Alternative 1

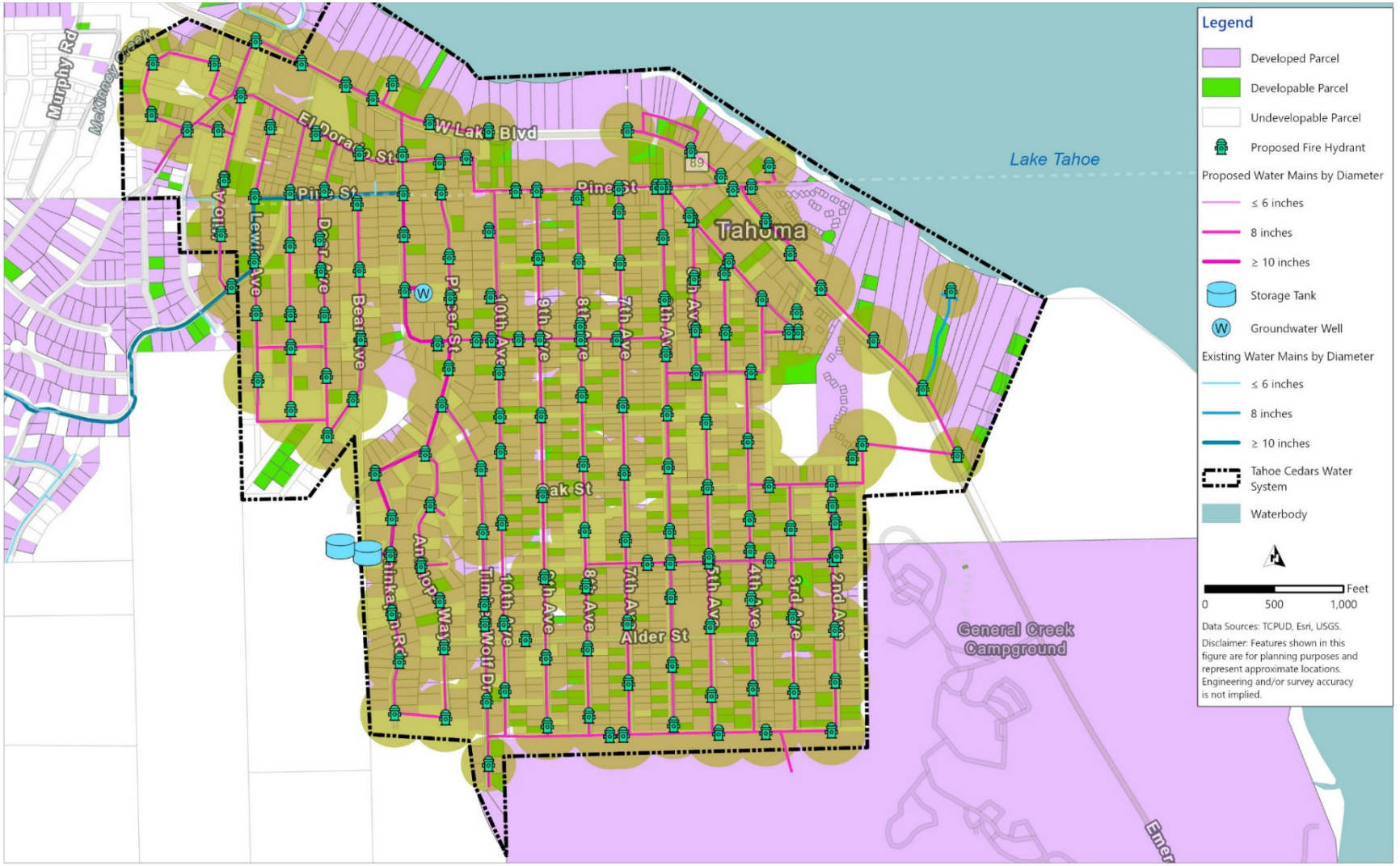

Figure 8 Tahoe Cedars Fire Hydrant Spacing - Alternative 2

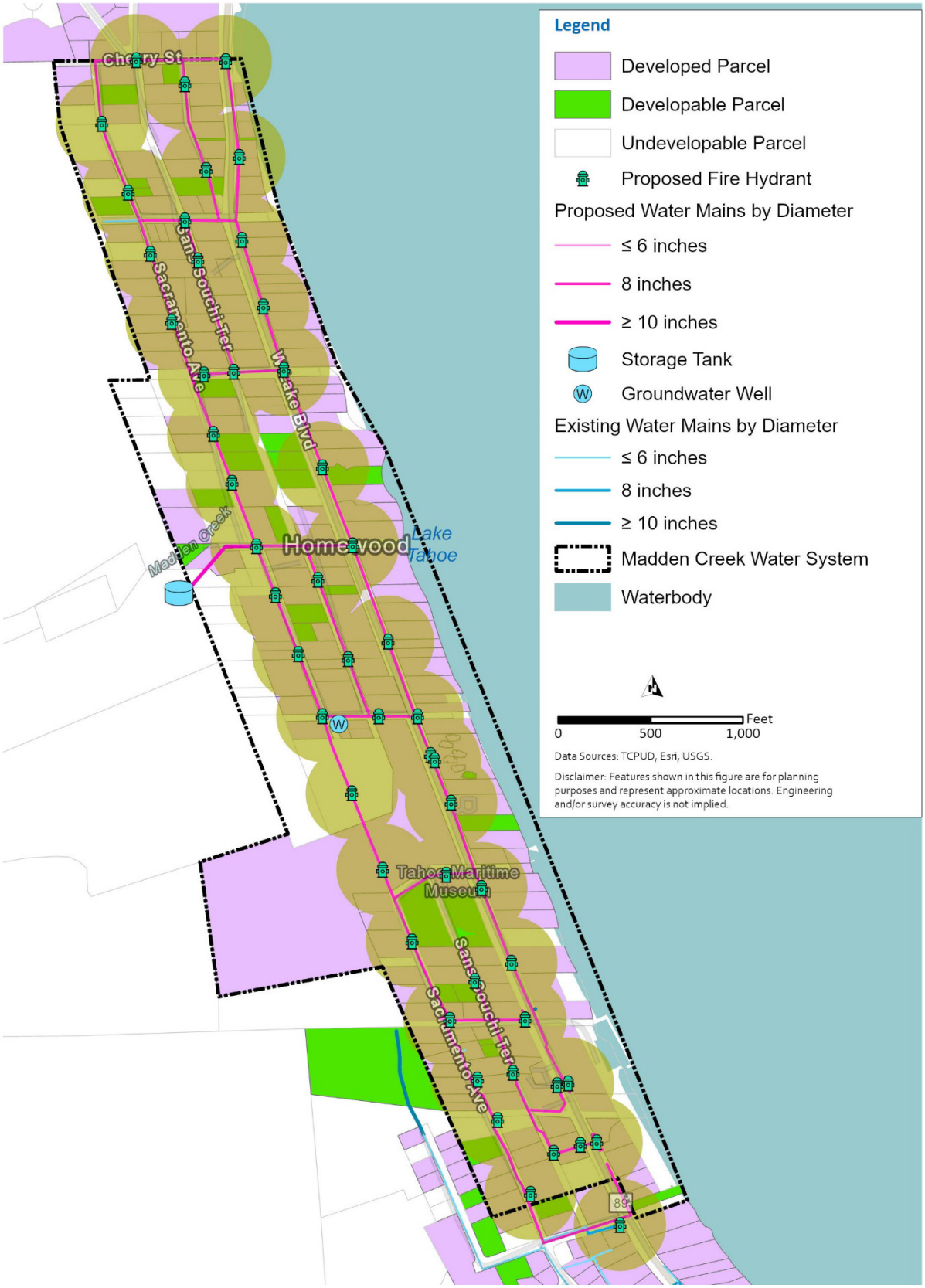

Figure 9 Madden Creek Fire Hydrant Spacing - Alternative 2

Economic Analysis

An economic analysis was performed to estimate each alternative's capital cost and determine the cost difference between the two alternatives. This analysis considered differences in capital costs as well as other potential cost variations. The following sections describe the methodology used to estimate capital costs and present the total project costs for each alternative.

Cost Estimating Methodology

Capital project costs consist of baseline construction costs, estimating contingencies, and other contingencies consistent with a Class 5 estimate as defined by the American Association of Cost Estimating (AACE). Class 5 estimates have a range of accuracy of -50 percent to +100 percent and are typically used for cost screening and analysis related to project feasibility. The following sections outline the assumptions used to estimate baseline construction, total construction, and total project costs.

Baseline Construction Costs

The baseline construction cost is the estimated construction cost, in dollars, of the proposed improvements. Construction costs used for this study are representative of water system facilities under normal construction conditions and schedules.

Baseline construction costs were developed by multiplying the number of units to be reconstructed or newly installed by the unit cost. Table 5 shows the assumed unit costs for each asset. The costs used in this study are consistent with those in the 2021 Master Plans. In order to escalate the unit costs based on inflation from 2021 to 2023, the unit costs in the 2021 Master Plans were multiplied by a factor of 1.16 and rounded to the nearest 5 or 0. This factor is based on the ratio of the Engineering News Record (ENR) 20-City Average Construction Cost Index (CCI) for May 2023 of 13,288 to the ENR 20-City Average CCI for July 2020 of 11,439. (The 2021 Master Plans used the July 2020 ENR 20-City Average CCI). Unit costs for water mains smaller than 8 inches in diameter were not included in the 2021 Master Plans and were extrapolated for this study.

Table 5 Unit Cost Assumptions

Item	Unit	Assumed Baseline Unit Cost(1)
1-inch diameter water main	lf	$60
2-inch diameter water main	lf	$65
3-inch diameter water main	lf	$120
4-inch diameter water main	lf	$140
6-inch diameter water main	lf	$215
8-inch diameter water main	lf	$235
12-inch diameter water main	lf	$300
Fire hydrant	each	$11,040

Note:
(1) Unit costs are based on the unit costs in the 2021 Master Plans which used the ENR 20-City Average CCI for July 2020 of 11,439, and have been scaled up, using the ENR 20-City Average CCI for May 2023 of 13,288. Unit costs for items not in the 2021 Master Plans (i.e., water mains smaller than 8 inches in diameter) were extrapolated.

Contingency Costs

Construction and project delivery contingency costs were added to the baseline construction costs as percentages to account for additional requirements associated with individual projects. Actual cost percentages will vary for each individual project depending on specific factors such as location and complexity. However, this study assumed typical construction and project delivery contingency percentages, which are consistent with those used in the 2021 Master Plans.

Given that site-specific conditions of the proposed improvements are unknown at this time, a 25 percent construction contingency was applied to the baseline construction costs, resulting in the estimated construction cost. This 25 percent construction contingency is used to account for unknown site conditions such as rock, poor soils, unforeseen conditions, environmental mitigations, and other unknowns, which is consistent with the 2021 Master Plans and is typical for this level of planning estimates.

Additionally, a 20 percent project delivery contingency cost was applied to the estimated construction cost, resulting in the total project cost estimate. The project delivery contingency costs include, but are not limited to, costs associated with project engineering, construction phase professional services, and project administration. Engineering services associated with new facilities include preliminary investigations and reports, ROW acquisition, preparation of drawings and specifications for construction, surveying and staking, sampling and testing of materials, and start-up services, all of which may vary depending on specific project requirements. Construction phase professional services cover items such as construction management, engineering services, materials testing, and inspection during construction. Finally, there are project administration costs, which cover items such as legal fees, environmental compliance requirements, permitting compliance, financing expenses, administrative costs, and interest during construction.

Table 6 lists the continency cost assumptions used for this study.

Table 6 Contingency Assumptions

Item	Assumption
Construction contingency	25 percent of baseline construction cost
Estimated construction cost as percentage of baseline cost	**125 percent**
Project delivery contingency(1)	20 percent of total construction cost
Total project cost as percent of baseline construction cost(2)	**150 percent**

Notes:
(1) Project delivery contingency consists of project and construction management, permitting, engineering, services during construction, commissioning, close-out, and legal and administrative fees.
(2) Total project cost consists of all costs associated with implementing the project except preliminary design.

Estimated Capital Improvement Costs

The total project cost is the sum of the baseline construction cost and the contingencies costs. Table 7 shows the total estimated capital costs for the two alternatives. As shown in Table 7, Alternative 2 was estimated to cost approximately $16.9 million more than Alternative 1.

Table 7 Estimated Capital Costs for Water System Improvement Alternatives

Alternative	Total Project Cost(1) ($ million)
Alternative 1 – Replace system at current size	$21.7
Alternative 2 – Replace system to meet fire protection standards	$38.6

Note:
(1) Costs are in 2023 dollars.

Other Economic Considerations

In addition to the estimated capital improvement costs, TCPUD must consider other potential factors that could increase one alternative's operations and maintenance (O&M) costs over the other. In particular, Alternative 1's lower hydraulic performance could lead to long-term increased O&M costs. Smaller diameter water mains experience greater velocities, which can contribute to substantial pressure surges under high-demand conditions, such as fire flow conditions. When these pressure surges occur, they can increase asset degradation rates and may cause pipeline appurtenances to fail. In addition, smaller mains reduce a system's ability to supply adequate flow during fire flow and emergency conditions, which increases the risk to system users.

Over time, lower hydraulic performance can increase capital and labor requirements. Due to increased degradation rates, assets must be replaced more often, and operational issues produced by inefficient hydraulics can lead to higher maintenance requirements. In combination, these factors could increase Alternative 1's long-term cost relative to Alternative 2 and consequently decrease Alternative 1's economic favorability.

Conclusion

Based on the analyses performed in this PM, the incremental cost of upsizing pipelines and adding fire hydrants to the Tahoe Cedars and Madden Creek water systems reconstruction projects from the systems' current sizing to a size/capacity that would meet modern fire protection standards is $16.9 million (in 2023 dollars).

Appendix A PROJECT COST CALCULATIONS

Table A.1 and Table A.2 show the planning level cost estimates for Alternatives 1 and 2, respectively.

Table A.1 Alternative 1 Capital Cost Estimate

Item No.	Description	Units	Quantity	Unit Price[1]	Budget[2] (million dollars)
1	1-inch diameter water main	lf	3,740	$60	$0.2
2	2-inch diameter water main	lf	16,990	$65	$1.1
3	3-inch diameter water main	lf	0	$120	$0.0
4	4-inch diameter water main	lf	34,850	$140	$4.9
5	6-inch diameter water main	lf	35,710	$215	$7.7
6	8-inch diameter water main	lf	0	$235	$0.0
7	12-inch diameter water main	lf	1,990	$300	$0.6
8	Fire Hydrant	ea	0	$11,040	$0.0
				Baseline Construction Cost	**$14.5**
				Estimated Construction Cost[3]	**$18.1**
				Capital Improvement Cost[4]	**$21.7**

Notes:
(1) Unit costs are in May 2023 dollars.
(2) Costs are rounded to the nearest $0.1 million unless otherwise noted.
(3) Estimated construction cost is 125 percent of the baseline construction cost.
(4) Capital improvement cost is 120 percent of the total construction cost.

Table A.2 Alternative 2 Capital Cost Estimate

Item No.	Description	Units	Quantity	Unit Price[1]	Budget[2]
1	1-inch diameter water main	lf	0	$60	$0
2	2-inch diameter water main	lf	0	$65	$0
3	3-inch diameter water main	lf	0	$120	$0
4	4-inch diameter water main	lf	0	$140	$0
5	6-inch diameter water main	lf	0	$215	$0
6	8-inch diameter water main	lf	95,090	$235	$22.4
7	12-inch diameter water main	lf	5,920	$300	$1.8
8	Fire Hydrant	ea	145	$11,040	$1.6
				Baseline Construction Cost	**$25.8**
				Estimated Construction Cost[3]	**$32.2**
				Capital Improvement Cost[4]	**$38.6**

Notes:
(1) Unit costs are in May 2023 dollars.
(2) Costs are rounded to the nearest $0.1 million unless otherwise noted.
(3) Estimated construction cost is 125 percent of the baseline construction cost.
(4) Capital improvement cost is 120 percent of the total construction cost.