



MARIN MUNICIPAL WATER DISTRICT

Water Supply Conveyance Improvements Project



TECHNICAL MEMORANDUM 2

Screening Criteria and Evaluation Framework

DRAFT FINAL / May 2024





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Abbreviations

\$M	dollars in millions
AACE	Association for the Advancement of Cost Engineering
AFY	acre-feet per year
BPS	booster pump station
Carollo	Carollo Engineers, Inc.
COTATI	Cotati Tanks to Reservoirs
District	Marin Municipal Water District
ESA	Environmental Science Associates
fps	feet per second
HGL	hydraulic grade line
mgd	million gallons per day
N/A	not applicable
NMWD	North Marin Water District
PETA	North Marin Aqueduct to Reservoirs
Petaluma	City of Petaluma
Project	Water Supply Conveyance Improvements Project
psi	pounds per square inch
SCADA	supervisory control and data acquisition
STAF	Stafford Lake to Reservoirs
STS	South Transmission System
SWSA	Strategic Water Supply Assessment
TM	technical memorandum
US-101	United States Highway 101
UWMP	Urban Water Management Plan

TM 2 SCREENING CRITERIA AND EVALUATION FRAMEWORK

2.1 Purpose

Carollo Engineers, Inc. (Carollo) is assisting the Marin Municipal Water District (District) with the Water Supply Conveyance Improvements Project (Project). The Project builds on the initial alternatives evaluation performed during the Strategic Water Supply Assessment (SWSA) (Jacobs, 2023) to identify and evaluate improvements to the District's water conveyance infrastructure. The goal of the Project is to enhance the reliability, flexibility, and resiliency of the District's water system to improve service to District customers.

Carollo prepared Technical Memorandum (TM) 1 - Project Goals, Criteria, and Alternatives in January 2024 to summarize the project goals, evaluation criteria, and alternatives. As a next step, Carollo hosted Workshop No. 2 on January 12, 2024, to discuss the screening criteria and evaluation framework to screen the list of project alternatives down to approximately three alternatives.

The purpose of this TM is to summarize the screening criteria and evaluation framework presented during Workshop No. 2 and to identify the preferred alternatives. The preferred alternatives will be evaluated in additional detail during Phase 2 of the Project.

Figure 2.1 provides an overview of the Project workflow.

2.2 Background

The District developed the SWSA in 2023 to assess current and future hydrological conditions, performance of the District's system under these conditions, and to develop potential strategies to achieve a more resilient future water supply. The SWSA identified several potential strategies to improve the District's water supply. One of the key strategies identified was to transfer supplemental water from Sonoma Water during the wintertime. The District hired Carollo in 2023 to further refine water supply alternatives developed during the SWSA as part of this Project, which evaluates project alternatives that convey water from Sonoma Water during the wintertime.

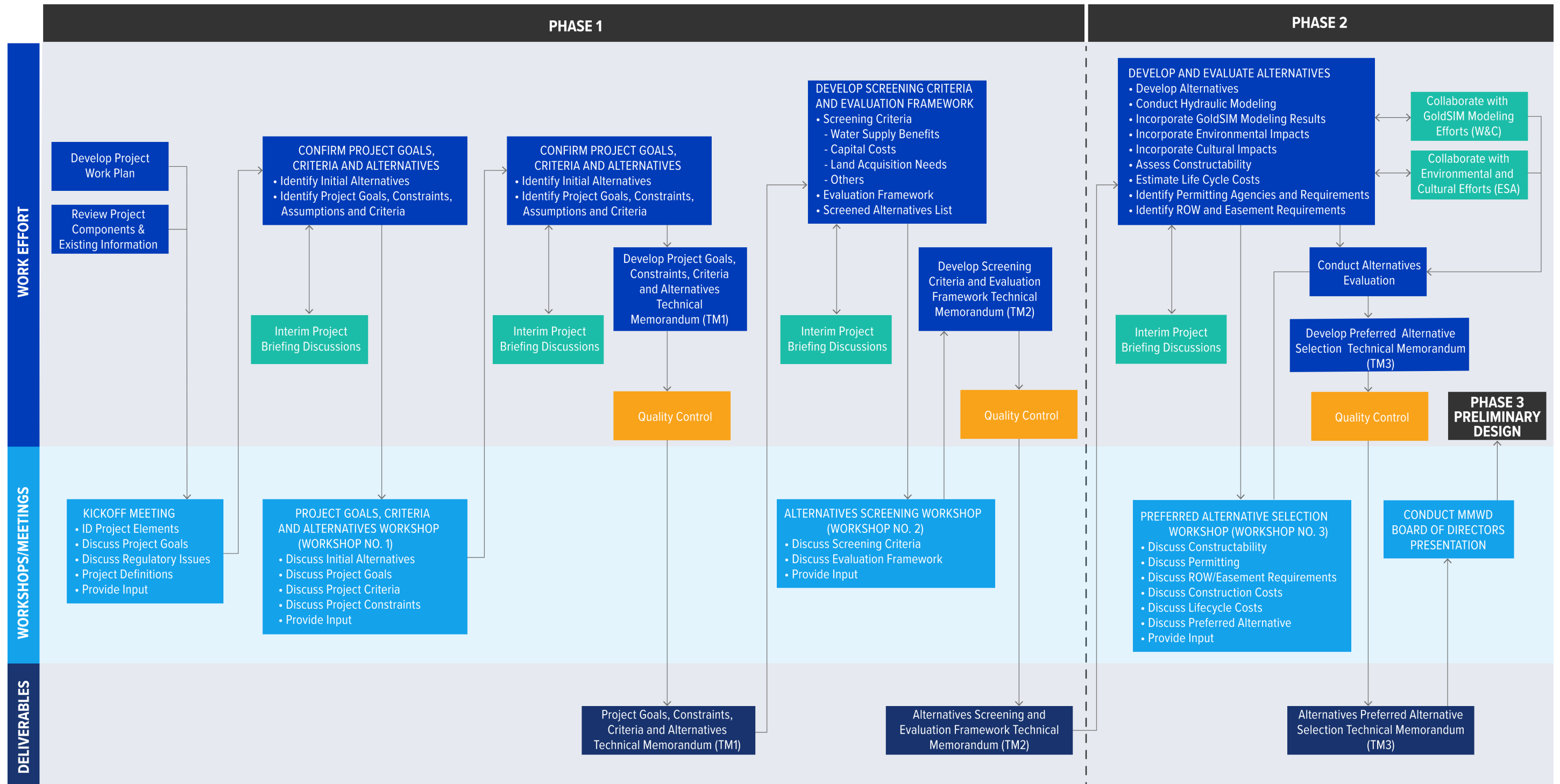


Figure 2.1 Project Workflow

In January 2024, Carollo prepared TM 1 - Project Goals, Criteria, and Alternatives. TM 1 identified the Project goals and criteria to be used to evaluate project alternatives. Additionally, TM 1 identified 13 project alternatives that increase the system's capacity to transfer supplemental water from Sonoma Water during the wintertime, including:

- **STS-1:** Construct a new South Transmission System pipeline along the United States Highway 101 (US-101) corridor to convey additional water from Cotati Tanks to the Kastania Pump Station.
- **STS-2:** Construct a new South Transmission System pipeline through the downtown area of the City of Petaluma (Petaluma) to convey additional water from Cotati Tanks to the Kastania Pump Station.
- **STS-3:** Construct a new South Transmission System pipeline through rural roads in Petaluma to convey additional water from Cotati Tanks to the Kastania Pump Station.
- **STAF-1:** Convey water from the North Marin Aqueduct to Nicasio Reservoir using existing North Marin Water District (NMWD) infrastructure, convey water from the North Marin Aqueduct to Stafford Lake, and construct new facilities to convey water from Stafford Lake to Nicasio Reservoir.
- **STAF-2:** Convey water from the North Marin Aqueduct to Soulajule Reservoir using existing NMWD infrastructure, convey water from the North Marin Aqueduct to Stafford Lake, and construct new facilities to convey water from Stafford Lake to Soulajule Reservoir.
- **STAF-3:** Convey water from the North Marin Aqueduct to Nicasio and Soulajule Reservoirs using existing NMWD infrastructure, convey water from the North Marin Aqueduct to Stafford Lake, and construct new facilities to convey water from Stafford Lake to Nicasio and Soulajule Reservoirs.
- **PETA-1:** Construct new facilities to convey water from North Marin Aqueduct to Nicasio Reservoir.
- **PETA-2:** Construct new facilities to convey water from North Marin Aqueduct to Soulajule Reservoir.
- **PETA-3:** Construct new facilities to convey water from North Marin Aqueduct to Nicasio and Soulajule Reservoirs.
- **PETA-4:** Construct new facilities along San Antonio Road to convey water from North Marin Aqueduct to Nicasio and Soulajule Reservoirs.
- **COTATI-1:** Construct new facilities to convey water from Cotati Tanks to Nicasio Reservoir.
- **COTATI-2:** Construct new facilities to convey water from Cotati Tanks to Soulajule Reservoir.
- **COTATI-3:** Construct new facilities to convey water from Cotati Tanks to Nicasio and Soulajule Reservoirs.

This TM discusses the screening criteria and evaluation framework to screen the list of project alternatives down to approximately three alternatives. This evaluation is the next step towards identifying a preferred alternative to transfer supplemental water from Sonoma Water during the wintertime to the District's facilities.

2.3 Project Goals and Evaluation Criteria Updates

2.3.1 Project Goals

Carollo, the District, and Environmental Science Associates (ESA) worked together to define the Project goals and evaluation criteria. The Project goals and evaluation criteria are summarized in TM 1. There have been no changes to the overall goal of this Project since TM 1 was issued.

The goal of the Project is to enhance the reliability, flexibility, and resiliency of the water system to improve service to the District's customers.

2.3.2 Evaluation Criteria

Based on additional discussions with the District and ESA, there have been several revisions to the evaluation criteria definitions since TM 1 was issued. The following sections summarize the updated evaluation criteria.

2.3.2.1 Water Reliability and Sustainability

This criterion is defined as follows:

- Contribute to a sustainable dry year water supply, consistent with the framework in the SWSA:
 - » In order to constitute contributing to a sustainable dry year water supply, an alternative should be able to increase the system's capacity to take supplemental water from Sonoma Water during the wintertime (October to May) by an amount to be determined by the District.
- Provide reliable water supply, treatment, and transmission infrastructure that meets long-term operational needs under average-day and maximum-day demand conditions.
- Improve the ability of the water system to withstand natural hazards.

2.3.2.2 Flexibility and Resiliency

This criterion is defined as follows:

- Retain and/or improve flexibility of District operations.
- Improve the resilience of District operations from changing conditions, including climate change effects.
- Integrate well with regional water systems.
- Minimize complexities of system operations and hydraulics.

2.3.2.3 Schedule and Implementation

This criterion is defined as follows:

- Implement the project in a timely manner, consistent with District goals.
- Reduce regulatory complexity (e.g., minimize number of permits required, number of agencies with involvement, etc.).

- Preserve options for future conveyance systems between Cotati Tanks and the District's facilities.
- Minimize construction complexities (e.g., alignment minimizes trenchless installation of pipe, avoids crowded utility corridors, etc.).

2.3.2.4 Water Quality

This criterion is defined as follows:

- Design improvements to meet current and foreseeable future drinking water regulations with a margin of safety.

2.3.2.5 Environmental and Social Stewardship

This criterion is defined as follows:

- Minimize long-term environmental impacts relative to other conveyance alternatives.
- Minimize disruption to existing land uses to the extent practical.

2.3.2.6 Economic and Financial

This criterion is defined as follows:

- Minimize capital costs for the District's customers relative to yield.
- Minimize life-cycle costs for the District's customers relative to other conveyance alternatives.
- Integrates well with existing infrastructure.
- Leverage federal and state investments in infrastructure.
- Minimize financial risk.

2.4 Updates to Project Alternatives

TM 1 summarized operation of the District's existing infrastructure that conveys water from the Cotati Tanks to the District's system. It also summarized 13 project alternatives that increase the system's capacity to transfer supplemental water from Sonoma Water during the wintertime.

Based on discussions with the District, there is one additional project alternative that might allow the District to take additional supplemental water from Sonoma Water during the wintertime. This alternative includes 10 individual projects, including pipeline and pump station upgrades, that would increase the capacity of the District's existing distribution system downstream of Ignacio Pump Station. This alternative allows additional water to be conveyed through Ignacio Pump Station, but it does not significantly increase the system's capacity to transfer supplemental water from Sonoma Water to the District's system. As such, this alternative is not included in the alternatives evaluation. However, the project should be considered further by the District in the future as a way to increase the amount of water taken through Ignacio Pump Station. Further discussion of this alternative is included in Appendix 2A for reference.

Additionally, based on further discussions with the District, we have updated our understanding of the existing system operations and refined the estimated water supply benefit of each project alternative. We have also performed a hydraulic analysis of the Petaluma/North Marin Aqueduct System to evaluate hydraulic impacts of the STAF and PETA alternatives to the existing system. A summary of existing system

operations updates, estimated water supply benefit updates, and anticipated hydraulic impacts for alternatives is included below.

2.4.1 Existing System Operation

As discussed in TM 1, approximately 25 percent of the District's water supply is imported from Sonoma Water via an existing transmission system that conveys water from the Russian River to the Cotati Tanks and, ultimately, to the District. TM 1 provided background on the existing system operation and included approximate wintertime demands for customers along the transmission system, including Petaluma, the NMWD, and the District.

Based on recent historical data received, the wintertime demands for Petaluma and NMWD have changed slightly. The assumed demand for the Petaluma turnouts has been updated to 5.0 million gallons per day (mgd) and the assumed demand for NMWD turnouts has been updated to 4.5 mgd. While the assumed demands stated were used in this analysis, it's worth noting that demands for both Petaluma and NMWD may be higher at times. For example, when NMWD is filling Stafford Lake with water from the North Marin Aqueduct, NMWD demands are often higher than 4.5 mgd. The assumed demand at Ignacio Pump Station (which is owned and operated by the District) remains at 8.0 mgd. These updated demands change the water supply benefit of several of the alternatives slightly. Figure 2.2 provides an overview of the facilities used to convey water from Cotati Tanks to Ignacio Pump Station and the updated Petaluma and NMWD demands.

2.4.2 Future System Operation

This section summarizes the evaluation of water supply benefits based on Petaluma and NMWD future wintertime demands. Based on data from the 2020 Sonoma Water Urban Water Management Plan (UWMP), the anticipated future demands for Petaluma and NMWD in 2045 are 6.5 mgd and 6.1 mgd, respectively. We estimated the future wintertime demands by scaling the current demands, discussed above, by the same ratio as the demands between 2020 and 2045 defined in the Sonoma Water UWMP for each agency. Future demands will be further refined as the project progresses. Regardless, the future demands affect the estimated water supply benefit for several alternatives. The estimated water supply benefit for the alternatives based on future demands is included in Section 2.4.9

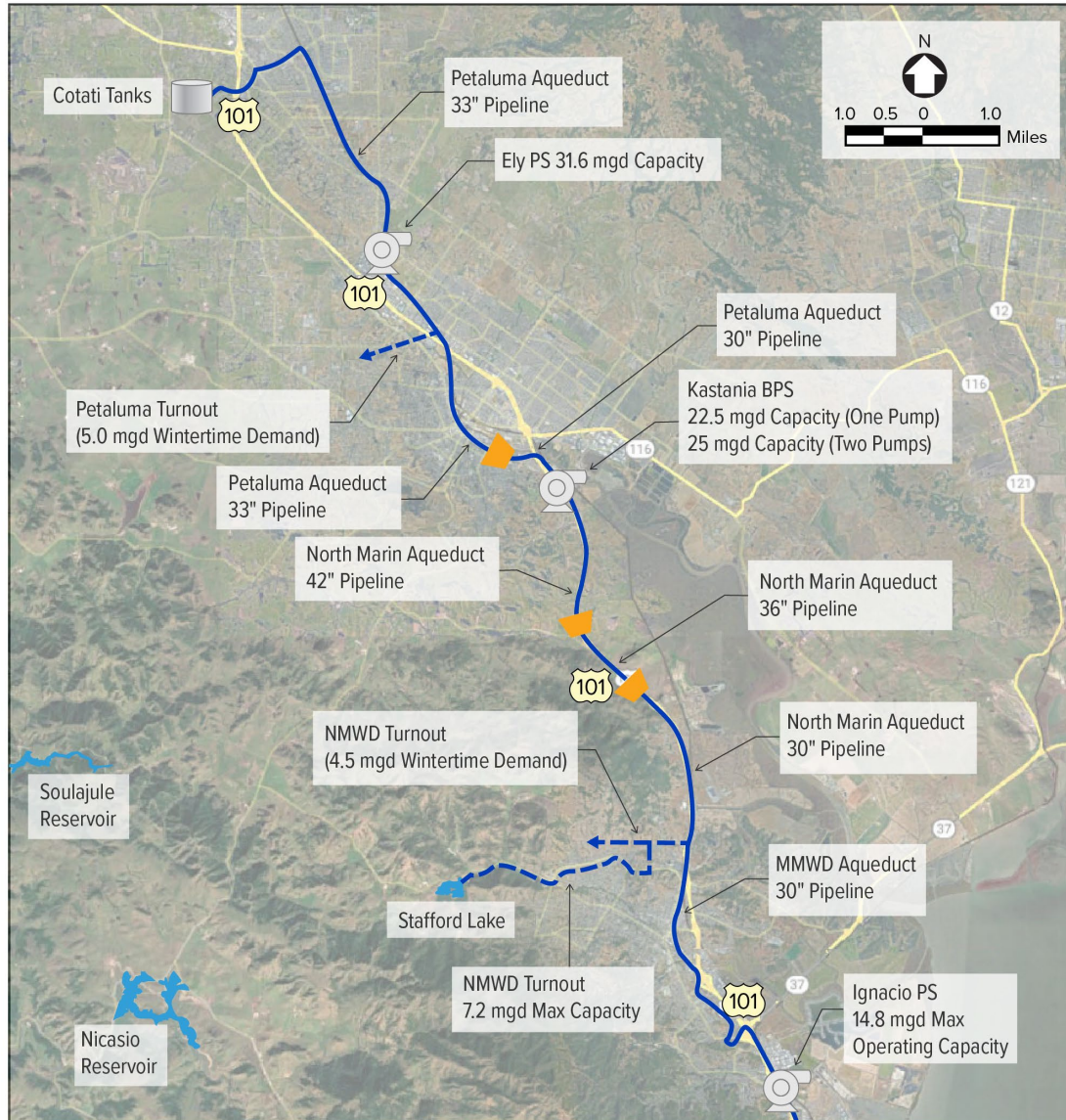


Figure 2.2 Existing Facilities Between Cotati Tanks and Ignacio Pump Station

2.4.3 Hydraulic Analysis of Existing System

Carollo also performed a hydraulic analysis of the Petaluma/North Marin Aqueduct System to evaluate hydraulic impacts to the existing system for the STAF and PETA alternatives. The STS and COTATI alternatives are not anticipated to have a significant impact on the existing system. The purpose of this hydraulic evaluation is to consider impacts to the existing system due to transferring water from Sonoma, through the Petaluma Aqueduct, to a new turnout location.

2.4.3.1 Petaluma/North Marin Aqueduct System Hydraulics

The Petaluma/North Marin Aqueduct System conveys treated surface water from the Cotati Tanks to Petaluma, NMWD, and the District. The Petaluma Aqueduct section is upstream of Kastania Tank, and the

North Marin Aqueduct section is downstream of Kastania Tank and Pump Station. Figure 2.3 shows the hydraulic profile of the aqueduct system.

The Ely Booster Pump Station (BPS) is operated to maintain a level in Kastania Tank between 34 and 38 feet. Under low demand conditions, Ely BPS does not need to turn on since Kastania Tank is at a lower hydraulic grade line (HGL) than the Cotati Tanks. However, when demands increase, the Ely BPS must turn on to overcome headloss through the Petaluma Aqueduct and maintain Kastania Tank levels.

Kastania Tank acts as a pressure break between the Petaluma and North Marin sections of the aqueduct. Hydraulic conditions downstream of Kastania Pump Station are controlled by the level in Kastania Tank and Kastania Pump Station settings. The control system turns pumps on and off at the Kastania Pump Station as needed to maintain minimum pressures at the downstream turnouts. Additional information on the existing Petaluma/North Marin Aqueduct system hydraulics is included in the Kastania Pump Station Rehabilitation Project Basis of Design Report (Carollo, 2021).

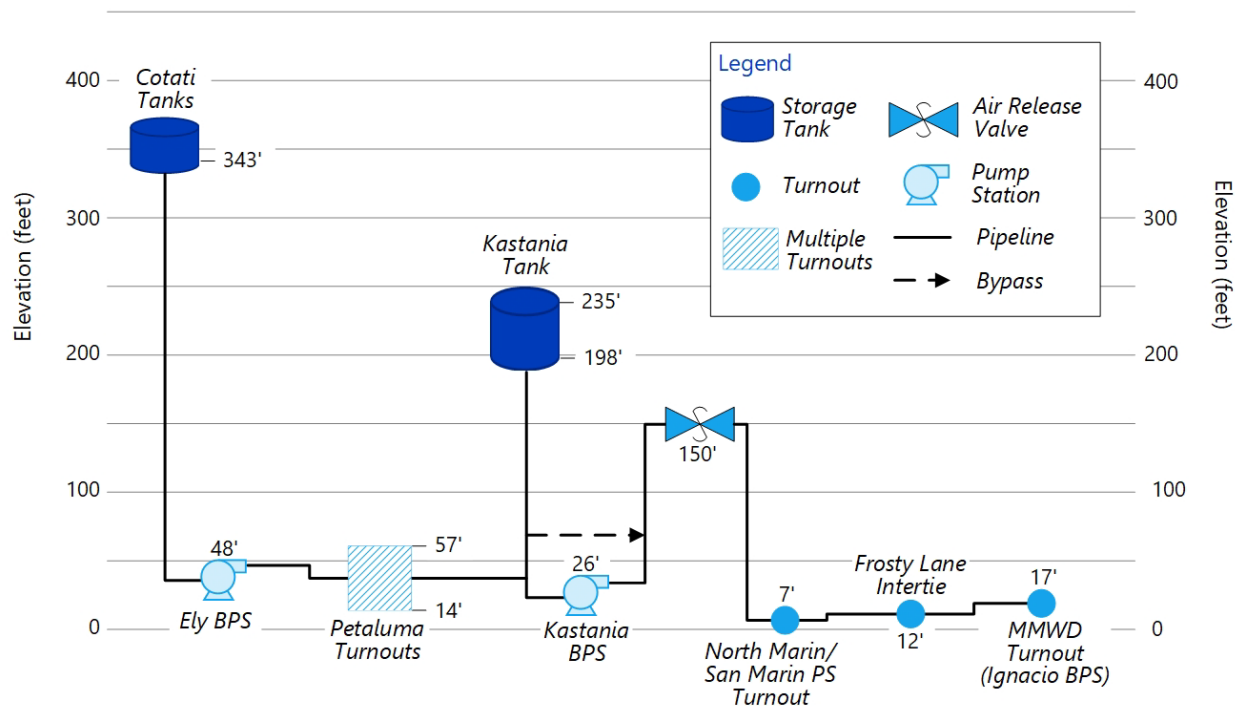


Figure 2.3 Petaluma/North Marin Aqueduct System Hydraulic Profile

2.4.3.2 Hydraulic Model Assumptions and Scenarios

Carollo utilized the hydraulic model developed during the Kastania Pump Station Rehabilitation Project (Carollo, 2021) to evaluate the hydraulic impacts of the water supply conveyance alternatives on the Petaluma/North Marin Aqueduct System. The hydraulic model was developed in Innovyze Inc.'s InfoWater Pro software and was validated during the Kastania Pump Station Rehabilitation Project using supervisory control and data acquisition (SCADA) data from 2020.

The InfoWater Pro model consists of the following components:

- **Cotati Tanks:** The Cotati Tanks are represented in the model using a fixed-head reservoir at an elevation of 343 feet, which is the lowest allowable operating level in the Cotati Tanks. The model assumes unlimited supply from Cotati Tanks to the downstream system.
- **Kastania Tank:** The Kastania Tank is modeled as a cylindrical tank with a diameter of 226 feet, a base elevation of 195 feet, and an operating range of 34 to 38 feet.
- **Ely BPS:** The Ely BPS is modeled with two pumps and a gravity bypass line. Figure 2.4 shows the modeled pump curve for both pumps. The BPS is operated according to levels in Kastania Tank (i.e., the pump station turns on when the tank level falls to 34 feet and turns off once the tank level reaches 38 feet).
- **Kastania Pump Station:** The Kastania Pump Station is modeled with two pumps and a bypass gravity line. Figure 2.4 shows the modeled pump curves for both pumps. The pump station is operated according to downstream demand conditions such that the downstream hydraulic grade does not fall below the minimum required head at each turnout. For this study, hydraulic results were generated with the pump station off, one pump on, and two pumps on under each demand condition to evaluate downstream hydraulics.
- **Turnouts:** Turnouts along the aqueduct are modeled as junctions with fixed demands. The following turnouts were considered in this analysis:
 - » **Petaluma Turnouts:** Petaluma pulls from multiple locations along the aqueduct between the Ely BPS and Kastania Pump Station with elevations ranging from 14 to 57 feet. For this study, all Petaluma demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma boundary.
 - » **North Marin/San Marin Pump Station Turnouts:** NMWD pulls from the aqueduct at the intersection of Redwood Boulevard and Atherton Avenue, which is at an elevation of 7 feet. The turnouts service two zones—Zone 1 and Zone 2. Zone 2, which runs through San Marin Pump Station, is used to convey water to Stafford Lake.
 - » **Ignacio BPS:** The Ignacio BPS, which is at the most downstream point of the aqueduct system, sits at an elevation of 17.5 feet.

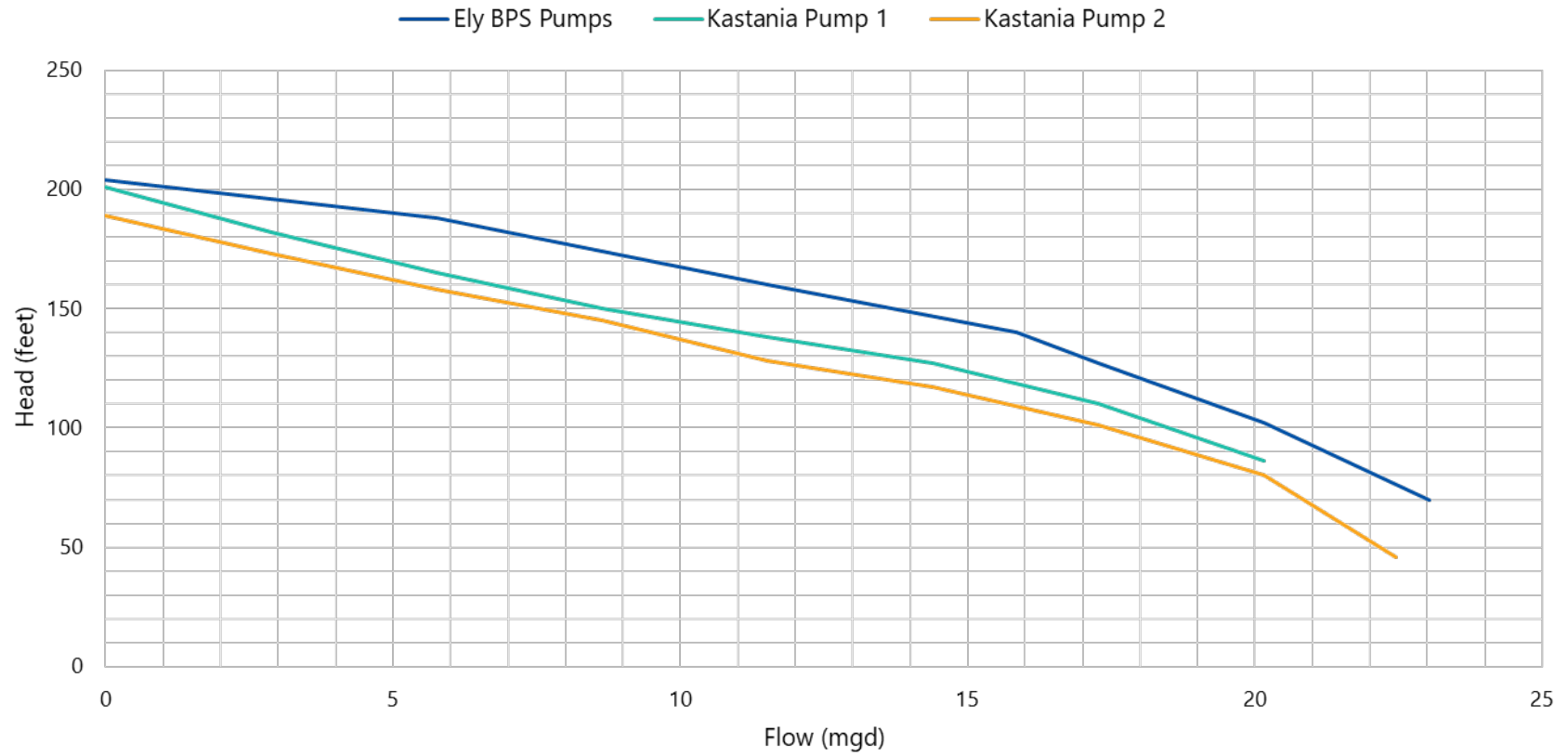


Figure 2.4 Modeled Pump Curves for Ely and Kastania Pump Stations

The hydraulic model was used to evaluate the hydraulic impacts of the STAF-1, STAF-2, and STAF-3 alternatives and PETA-1, PETA-2, PETA-3, and PETA-4 alternatives on the existing Petaluma/North Marin Aqueduct System. Two turnout locations were considered that are downstream of Kastania Pump Station. Table 2.1 describes the primary demand and elevation assumptions for each turnout. Figure 2.5 shows the locations of the two turnouts.

Table 2.1 New Turnout Assumptions

Turnout	Location	Associated Project Alternatives	Elevation (feet)	Low Demand (mgd)	High Demand (mgd)
1	At the intersection of Redwood Boulevard and Atherton Avenue.	STAF-1, 2, and 3	7	7.2	7.2
		PETA-1, 2, and 3	7	10.4	14.1
2	On Petaluma Boulevard approximately 950 feet south of Skinner Road, near San Antonio Road.	PETA-4	33	12.5	30.0



Figure 2.5 Petaluma/North Marin Aqueduct Turnout Alternatives

We also made key hydraulic assumptions for the existing turnouts along the Petaluma/North Marin Aqueduct System. Table 2.2 lists the key assumptions.

Table 2.2 Assumptions for Existing Turnouts

Turnout	Location	Elevation (feet)	Existing Winter Demand (mgd) ⁽¹⁾	Future Winter Demand (mgd) ⁽²⁾
Petaluma	Multiple locations between Ely BPS and Kastania BPS. For this analysis, all demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma boundary.	14 to 57	5.0	6.5
North Marin/ San Marin Pump Station	The intersection of Redwood Boulevard and Atherton Avenue.	7	4.5	6.1
Ignacio BPS	North of Bel Marin Keys Boulevard approximately 1,000 feet east of US-101.	17	8.0	8.0

Notes:

- (1) Existing winter demands were determined in consultation with District staff after reviewing recent water delivery data from Sonoma County.
- (2) Future winter demands are consistent with 2045 demands included in Sonoma County's UWMP.

Based on the new turnout assumptions and assumptions for existing turnouts, several scenarios were considered in the hydraulic analysis. The following lists the key assumptions related to the hydraulic analysis:

- All scenarios were run under steady state conditions (i.e., diurnal variations in demands were not considered).
- Pipes were modeled using nominal diameters. All pipes were assumed to have a Hazen Williams roughness coefficient of 135.
- Minor losses were not included.
- The Kastania Tank initial level was set to the tank's low operating level of 34 feet. It was assumed that the upstream aqueduct system would be upgraded to enable the tank to cycle between 34 and 38 feet for selected alternatives.
- The minimum HGL at the NMWD turnout was assumed to be 170 feet; this requirement was determined during the Kastania Pump Station Rehabilitation Project and was confirmed as part of this study.
- The minimum HGLs at turnouts other than the NMWD turnout were assumed to be the HGL required to maintain 50 pounds per square inch (psi) pressure (i.e., turnout elevation plus 50 psi).

A summary of the anticipated hydraulic impacts of the STAF and PETA alternatives is included in Section 2.4.5 and Section 2.4.6.

2.4.4 South Transmission System (STS) Project Alternatives

There have been no changes to the STS alternatives since TM 1. In general, the STS alternatives include pipeline and pump station improvements to convey additional water from Cotati Tanks to the Kastania Pump Station. The following alternatives are included under the umbrella of the STS alternatives:

- **STS-1:** Cotati Tanks to Kastania Pump Station along the US-101 corridor (10.5 miles of pipeline).
- **STS-2:** Cotati Tanks to Kastania Pump Station through downtown Petaluma (12.1 miles of pipeline).
- **STS-3:** Cotati Tanks to Kastania Pump Station through rural roads (15.5 miles of pipeline).

For each of these alternatives, the supplemental water from Sonoma Water would be conveyed from Cotati Tanks to Kastania Pump Station, from Kastania Pump Station to Ignacio Pump Station, and from Ignacio Pump Station directly into the District's potable water distribution system. These alternatives all provide a benefit of reducing high velocities and flow constrictions in the existing Petaluma Aqueduct. Figure 2.6 shows an overview of the STS alternatives.

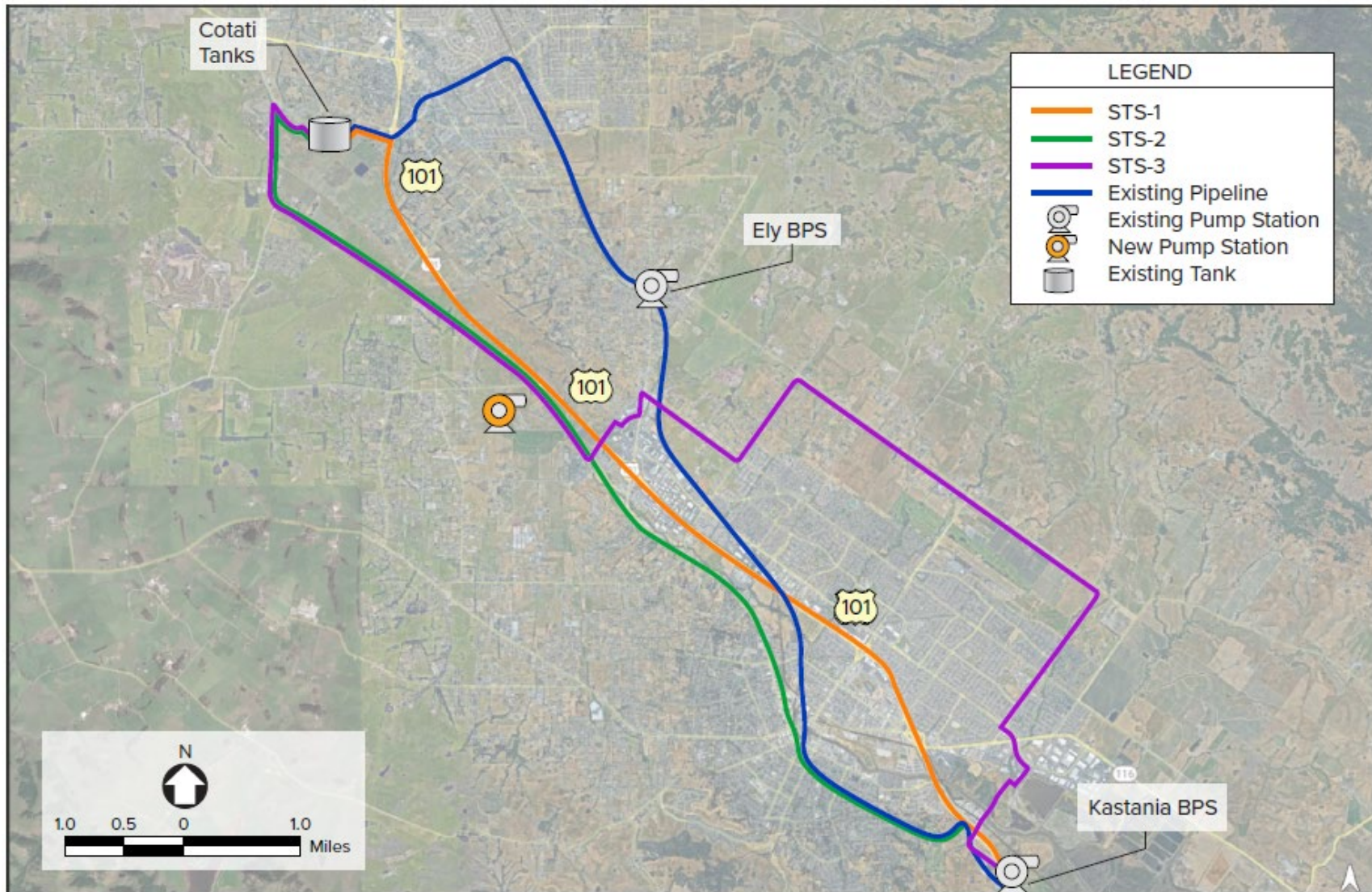


Figure 2.6 STS Alternatives

2.4.4.1 Water System Supply Benefits of STS

Based on current operations, existing infrastructure can convey up to 30.4 mgd of water from Cotati Tanks to Kastania Pump Station, with Petaluma pulling approximately 5.0 mgd of that during wintertime months. As such, up to 25.4 mgd of water can be delivered to Kastania Pump Station during wintertime months. Kastania Pump Station currently has capacity to pump up to 25.0 mgd into the downstream North Marin Aqueduct.

Downstream of Kastania Pump Station, the system demand during wintertime months is approximately 12.5 mgd. As previously discussed, NMWD would pull approximately 4.5 mgd during wintertime months and the District would receive, treat, and distribute approximately 8.0 mgd through Ignacio Pump Station.

Given that the demand downstream of Kastania Pump Station during wintertime months is far less than the current available supply of water at Kastania Pump Station, implementing one of the STS alternatives on its own would not provide any tangible water supply benefits to the District. However, the STS alternatives do provide a water supply benefit to the District and other municipalities in the region by adding a redundant transmission pipeline between Cotati Tanks and Kastania Pump Station.

Figure 2.7 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed project alternative is shown in green.

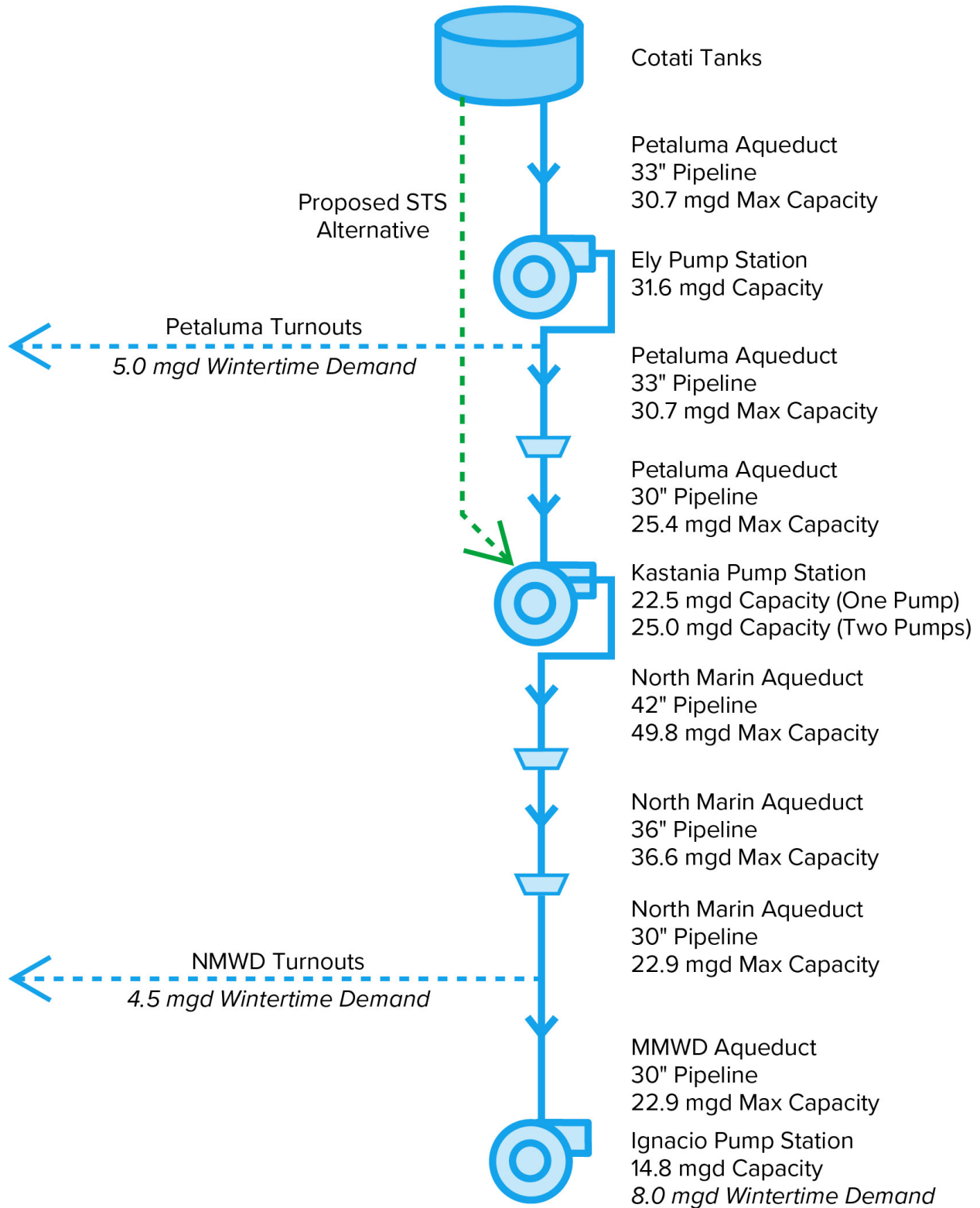


Figure 2.7 STS Schematic

2.4.5 Stafford Lake to Reservoirs (STAF) Project Alternatives

There have been no changes to the STAF alternatives since TM 1. In general, the STAF alternatives include pipeline and pump station improvements to convey additional water from the Stafford Lake area to Nicasio Reservoir, Soulajule Reservoir, or both reservoirs. The following alternatives are included under the umbrella of the STAF alternatives:

- **STAF-1:** Stafford Lake to Nicasio Reservoir (8.0 miles of pipeline).
- **STAF-2:** Stafford Lake to Soulajule Reservoir (6.8 miles of pipeline).
- **STAF-3:** Stafford Lake to Nicasio and Soulajule Reservoirs (11.0 miles of pipeline).

For each of these alternatives, water will be conveyed from the North Marin Aqueduct to Stafford Lake using NMWD's existing pipeline. As previously discussed, the NMWD pipeline has a maximum capacity of 7.2 mgd. Available capacity of the North Marin Aqueduct will be impacted by NMWD's use of the pipeline. At Stafford Lake, a turnout will be constructed along the existing NMWD pipeline before it discharges to Stafford Lake to take water directly out of the pipeline. The turnout will convey water to a new pump station. The new pump station will pump water via a new pipeline to Nicasio Reservoir, Soulajule Reservoir, or both reservoirs. For each of these alternatives, the supplemental water from Sonoma Water will be sent to existing storage reservoirs to be used by the District at a later time. Figure 2.8 shows an overview of STAF alternatives.

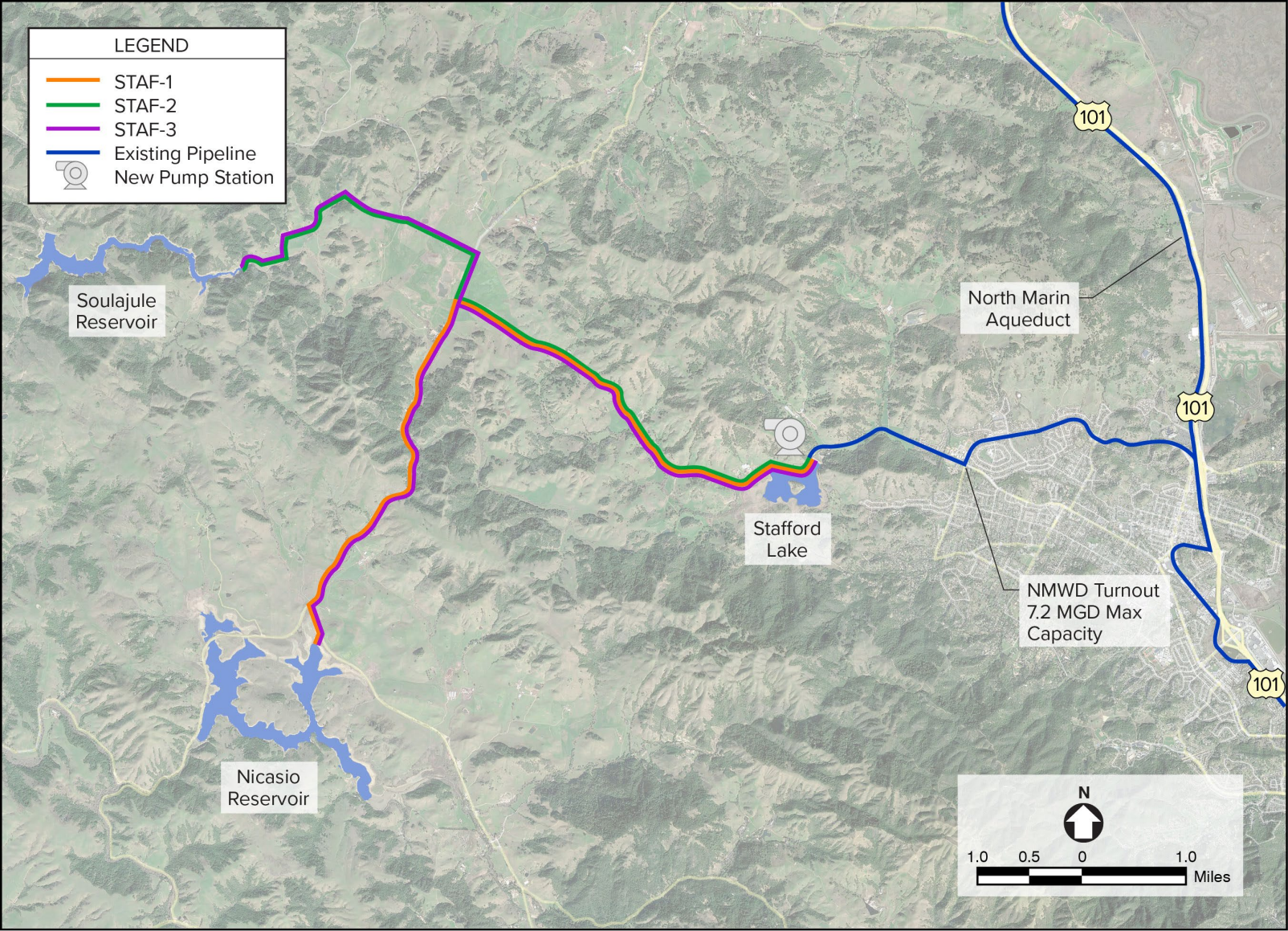


Figure 2.8 STAF Alternatives

2.4.5.1 Water System Supply Benefits of STAF

As previously discussed, the existing NMWD pipeline has a maximum capacity of approximately 7.2 mgd from the North Marin Aqueduct to Stafford Lake. Therefore, new facilities from Stafford Lake to the reservoirs will be sized to convey 7.2 mgd, maximizing the amount of water that can be conveyed through NMWD's pipeline. During certain times, NMWD will utilize a portion or all of the capacity of this existing pipeline that is routed from the North Marin Aqueduct to Stafford Lake. As such, water supply benefits for these alternatives will range from 0.0 to 7.2 mgd, depending on NMWD use of the existing pipeline. No other improvements or upgrades to the existing system are anticipated to be needed to convey up to 7.2 mgd from Stafford Lake to the reservoirs.

Figure 2.9 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed turnout location is shown in green and the largest bottleneck in the existing system is shown in red.

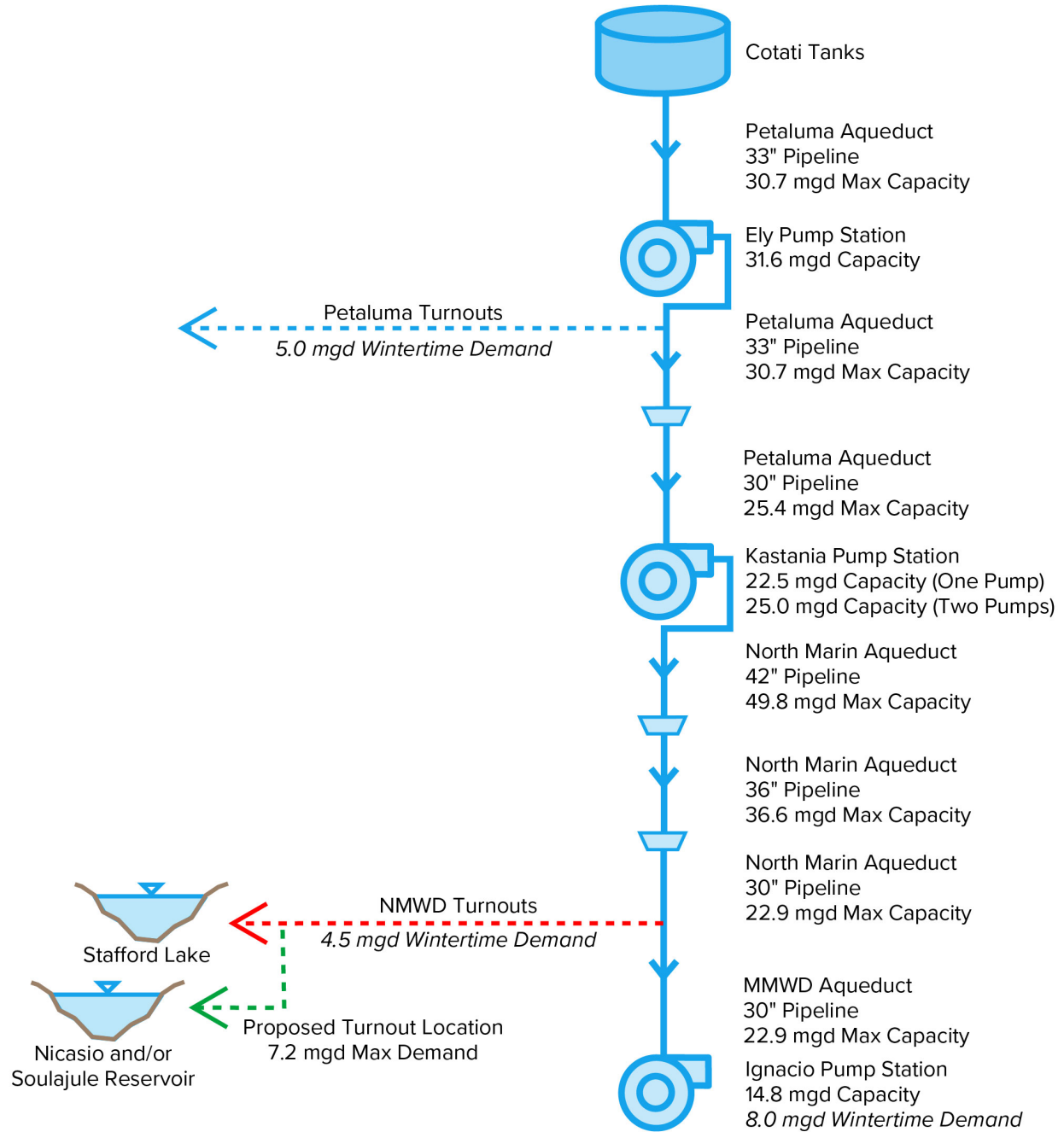


Figure 2.9 STAF Schematic

2.4.5.2 Hydraulic Impacts of STAF

Table 2.3 shows the results of the hydraulic analysis of six scenarios for the STAF alternatives. The scenarios highlighted in red have a HGL at the existing NMWD turnout below the necessary operating HGL of 170 feet. These scenarios are detrimental to the operation of the existing hydraulic system as configured. It may be possible to make other hydraulic improvements to improve the HGL under this scenario, which will be considered in future analyses. However, without other hydraulic improvements, Kastania Pump Station would need to have one or two pumps running to meet HGL requirements at the existing NMWD Turnout based on existing and future demand conditions. Appendix 2B provides more detailed hydraulic results.

Table 2.3 Hydraulic Impacts of STAF

Scenario Number	New Turnout Location ⁽¹⁾	Demand Condition ⁽⁵⁾	Demand at New Proposed Turnout (mgd)	Demands at Other Turnouts (mgd)			Total Sonoma Water Demands (mgd)	Kastania Pump Station Status	HGL at Existing NMWD Turnout ⁽⁴⁾
				Total Petaluma ⁽²⁾	NMWD ⁽³⁾	Ignacio BPS			
1	1	Existing	7.2	5.0	4.5	8.0	24.7	Off	132
2	1	Existing	7.2	5.0	4.5	8.0	24.7	1 pump on	221
3	1	Existing	7.2	5.0	4.5	8.0	24.7	2 pumps on	274
4	1	Future	7.2	6.5	6.1	8.0	27.8	Off	117
5	1	Future	7.2	6.5	6.1	8.0	27.8	1 pump on	192
6	1	Future	7.2	6.5	6.1	8.0	27.8	2 pumps on	254

Notes:

- (1) Turnout 1 is at the intersection of Redwood Boulevard and Atherton Avenue. Turnout 2 is on Petaluma Boulevard approximately 950 feet south of Skinner Road.
- (2) All Petaluma demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma city boundary.
- (3) NMWD demands assumed at all turnouts other than the San Marin Pump Station.
- (4) The values highlighted in red are below the minimum required HGL of 170 feet at the NMWD turnout.
- (5) The future winter demand conditions are based on anticipated future winter demands for Petaluma and NMWD in 2045. 2045 demands are included in Sonoma County's UWMP.

2.4.6 North Marin Aqueduct to Reservoirs (PETA) Project Alternatives

There have been no changes to the PETA alternatives since TM 1. However, there have been some minor revisions to the anticipated water supply benefits. In general, the PETA alternatives include pipeline and pump station improvements to convey additional water from the North Marin Aqueduct to Nicasio Reservoir, Soulajule Reservoir, or both reservoirs. These alternatives are similar to the STAF alternatives, but do not utilize the existing NMWD pipeline that conveys water from the North Marin Aqueduct to Stafford Lake. There is potential to phase the implementation of these alternatives over time, delivering incrementally more capacity with each phase of implementation. Logistics of potential phasing should be

considered further for alternatives that are moved forward. The following alternatives are included under the umbrella of the PETA alternatives:

- **PETA-1:** North Marin Aqueduct to Nicasio Reservoir (13.2 miles of pipeline).
- **PETA-2:** North Marin Aqueduct to Soulajule Reservoir (12.0 miles of pipeline).
- **PETA-3:** North Marin Aqueduct to Nicasio and Soulajule Reservoirs (16.2 miles of pipeline).
- **PETA-4:** North Marin Aqueduct to Nicasio and Soulajule Reservoirs via San Antonio Road (14.8 miles of pipeline).

For each of these four alternatives, water will be conveyed from the North Marin Aqueduct to Nicasio Reservoir, Soulajule Reservoir, or both reservoirs via a new pump station(s) and pipeline. For each of these alternatives, the supplemental water from Sonoma Water will be sent to existing storage reservoirs to be used by the District at a later time. Figure 2.10 shows an overview of PETA alternatives.

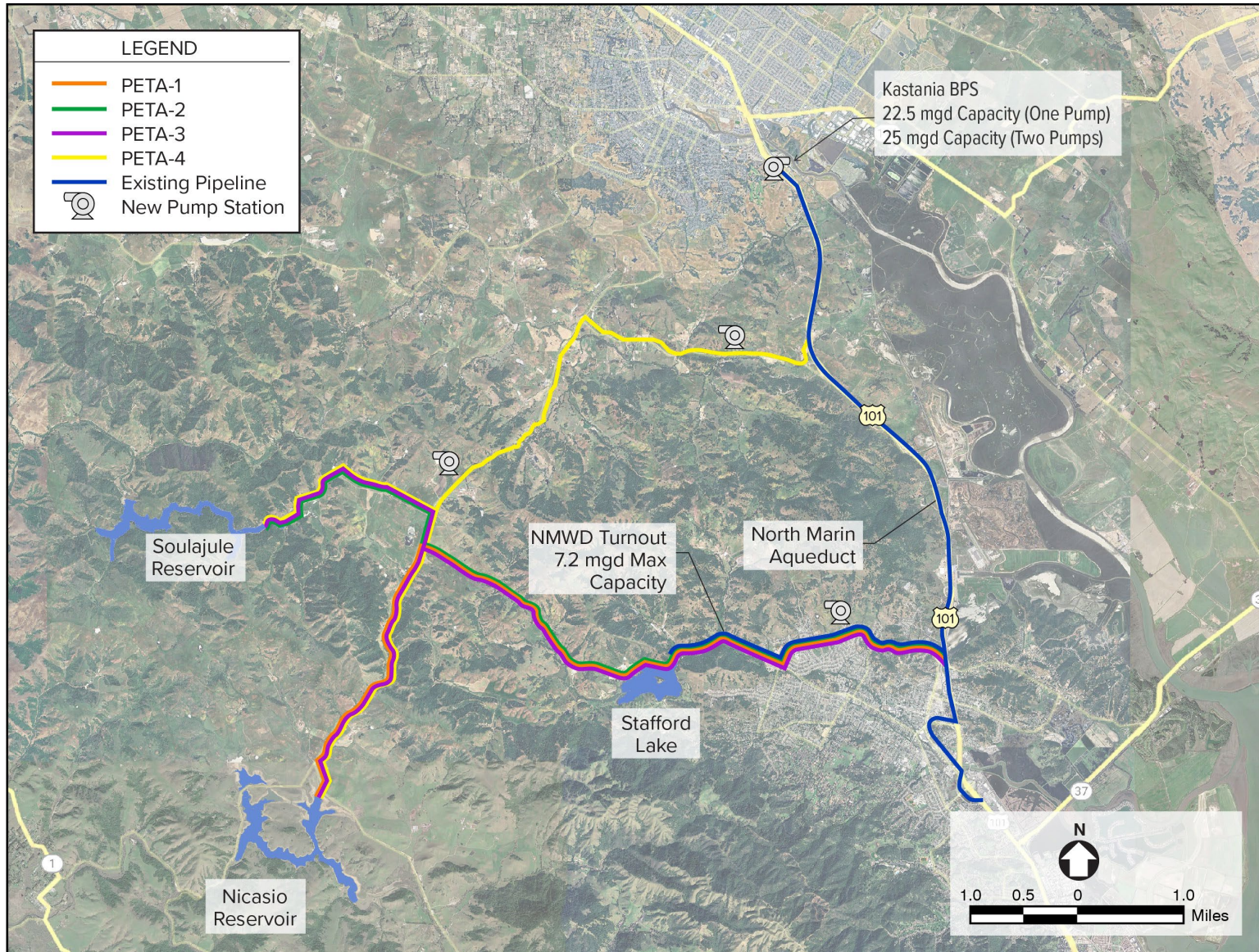


Figure 2.10 PETA Alternatives

2.4.6.1 PETA-1, PETA-2, and PETA-3 Without Upstream Improvements

Water System Supply Benefits

The sizing of the facilities for each of these alternatives is highly dependent upon the capacity of existing infrastructure upstream of the proposed turnout location and upstream demands/diversions along the North Marin Aqueduct. Based on current operations, the existing infrastructure can convey up to 30.4 mgd of water from Cotati Tanks to Kastania Pump Station, with Petaluma diverting approximately 5.0 mgd of that during wintertime months. As such, up to 25.4 mgd of water can be delivered to Kastania Pump Station during wintertime months. Kastania Pump Station has a maximum capacity of 25.0 mgd. Downstream of Kastania Pump Station, for PETA-1, PETA-2, and PETA-3, the proposed turnout location is in Novato, adjacent the existing NMWD pipeline that conveys water from the North Marin Aqueduct to Stafford Lake. At this proposed turnout location, the existing North Marin Aqueduct is 30 inches in diameter and has a maximum capacity of 22.9 mgd, assuming a maximum allowable velocity in the pipeline of 8.0 feet per second (fps). Additionally, downstream of Kastania Pump Station, the system demand during wintertime months is approximately 12.5 mgd. As previously discussed, NMWD would pull approximately 4.5 mgd during wintertime months and the District would receive and distribute approximately 8.0 mgd through Ignacio Pump Station.

Given these capacities and demands, approximately 10.4 mgd of water is available to be conveyed from the North Marin Aqueduct to the reservoirs. The largest bottleneck in the system upstream of the proposed turnout location is the segment of 30-inch pipe in the North Marin Aqueduct. Assuming a maximum capacity of 22.9 mgd of water can be conveyed through this segment of the North Marin Aqueduct, and assuming there is a demand of 12.5 mgd during wintertime operations downstream of this segment of pipe, approximately 10.4 mgd of water is available to be conveyed from the North Marin Aqueduct to the reservoirs.

Figure 2.11 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed turnout location is shown in green and the largest bottleneck in the existing system is shown in red. No other improvements or upgrades to the existing system are anticipated to be needed to convey 10.4 mgd from the North Marin Aqueduct to the reservoirs.

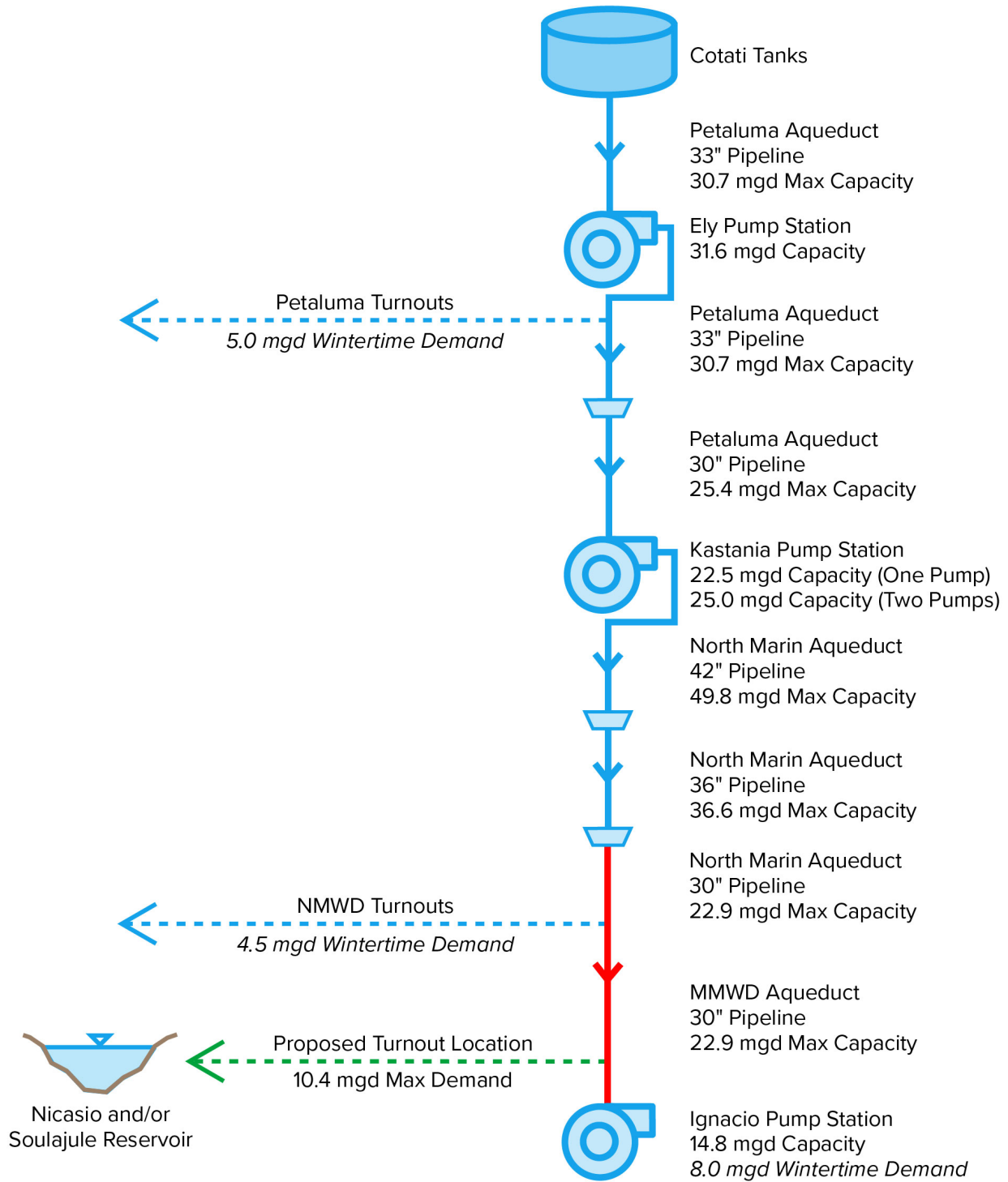


Figure 2.11 PETA-1, 2, and 3 Without Upstream Improvements Schematic

Hydraulic Impacts

Table 2.4 shows the results of the hydraulic analysis of six scenarios for the PETA-1, PETA-2, and PETA-3 alternatives without upstream improvements. The scenarios highlighted in red have a HGL at the existing NMWD turnout below the necessary operating HGL of 170 feet. These scenarios are detrimental to the operation of the existing hydraulic system as configured. It may be possible to make other hydraulic improvements to improve the HGL under this scenario, which will be considered in future analyses. However, without other hydraulic improvements, Kastania Pump Station would need to have two pumps running to meet HGL requirements at the existing NMWD turnout based on existing and future demand conditions. Appendix 2B provides more detailed hydraulic results.

Table 2.4 Hydraulic Impacts of PETA-1, 2, and 3 Without Upstream Improvements

Scenario Number	New Turnout Location ⁽¹⁾	Demand Condition ⁽⁴⁾	Demand at New Proposed Turnout (mgd)	Demands at Other Turnouts (mgd)			Total Sonoma Water Demands (mgd)	Kastania Pump Station Status	HGL at Existing NMWD Turnout ⁽³⁾
				Total Petaluma ⁽²⁾	North Marin/San Marin Pump Station	Ignacio BPS			
1	1	Existing	10.4	5.0	4.5	8.0	27.9	Off	100
2	1	Existing	10.4	5.0	4.5	8.0	27.9	1 pump on	163
3	1	Existing	10.4	5.0	4.5	8.0	27.9	2 pumps on	234
4	1	Future	10.4	6.5	6.1	8.0	31.0	Off	83
5	1	Future	10.4	6.5	6.1	8.0	31.0	1 pump on	132
6	1	Future	10.4	6.5	6.1	8.0	31.0	2 pumps on	213

Notes:

- (1) Turnout 1 is at the intersection of Redwood Boulevard and Atherton Avenue. Turnout 2 is on Petaluma Boulevard approximately 950 feet south of Skinner Road.
- (2) All Petaluma demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma city boundary.
- (3) The values highlighted in red are below the minimum required HGL of 170 feet at the NMWD turnout.
- (4) The future winter demand conditions are based on anticipated future winter demands for Petaluma and NMWD in 2045. 2045 demands are included in Sonoma County's UWMP.

2.4.6.2 PETA-1, PETA-2, and PETA-3 With Upstream Improvements

Water System Supply Benefits

It's possible to increase the water supply benefit of the PETA-1, PETA-2, and PETA-3 alternatives further by implementing improvements to address bottlenecks upstream of the proposed turnout location. Although a wide range of improvements can be implemented to increase the capacity of the system by varying amounts, improvements were selected that maximize the use of existing infrastructure. Required improvements to the existing system that will allow up to 14.1 mgd of water to be conveyed from the North Marin Aqueduct to the reservoirs include:

- Increasing the maximum allowable velocity of the Petaluma Aqueduct pipeline to approximately 8.3 fps, providing a maximum capacity of 31.6 mgd:
 - » No upgrades required to Ely Pump Station.

- » With the increased velocity in the Petaluma Aqueduct, existing infrastructure can convey up to 31.6 mgd of water from Cotati Tanks to Kastania Pump Station, with Petaluma pulling approximately 5.0 mgd of that during wintertime operations.
- » As such, up to 26.6 mgd of water could be delivered to Kastania Pump Station during wintertime months.
- Increasing the capacity of Kastania Pump Station from 25.0 mgd to 26.6 mgd.
- Increasing the maximum allowable velocity of the North Marin Aqueduct pipeline to approximately 9.3 fps, providing a maximum capacity of 26.6 mgd:
 - » Further evaluation of the existing 30-inch North Marin Aqueduct would be required prior to making this change:
 - Need to determine if increasing the velocity over 8.0 fps in the existing pipeline would damage the pipeline.

If the improvements detailed above are included with the Project, the maximum capacity of the system upstream of the turnout location would be increased to 26.6 mgd. Assuming 12.5 mgd of demand during wintertime months downstream of this turnout location, approximately 14.1 mgd of water is available to be conveyed from the North Marin Aqueduct to the reservoirs.

Figure 2.12 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed turnout location is shown in green and the largest bottleneck in the existing system is shown in red with other ancillary improvements described above shown in bold.

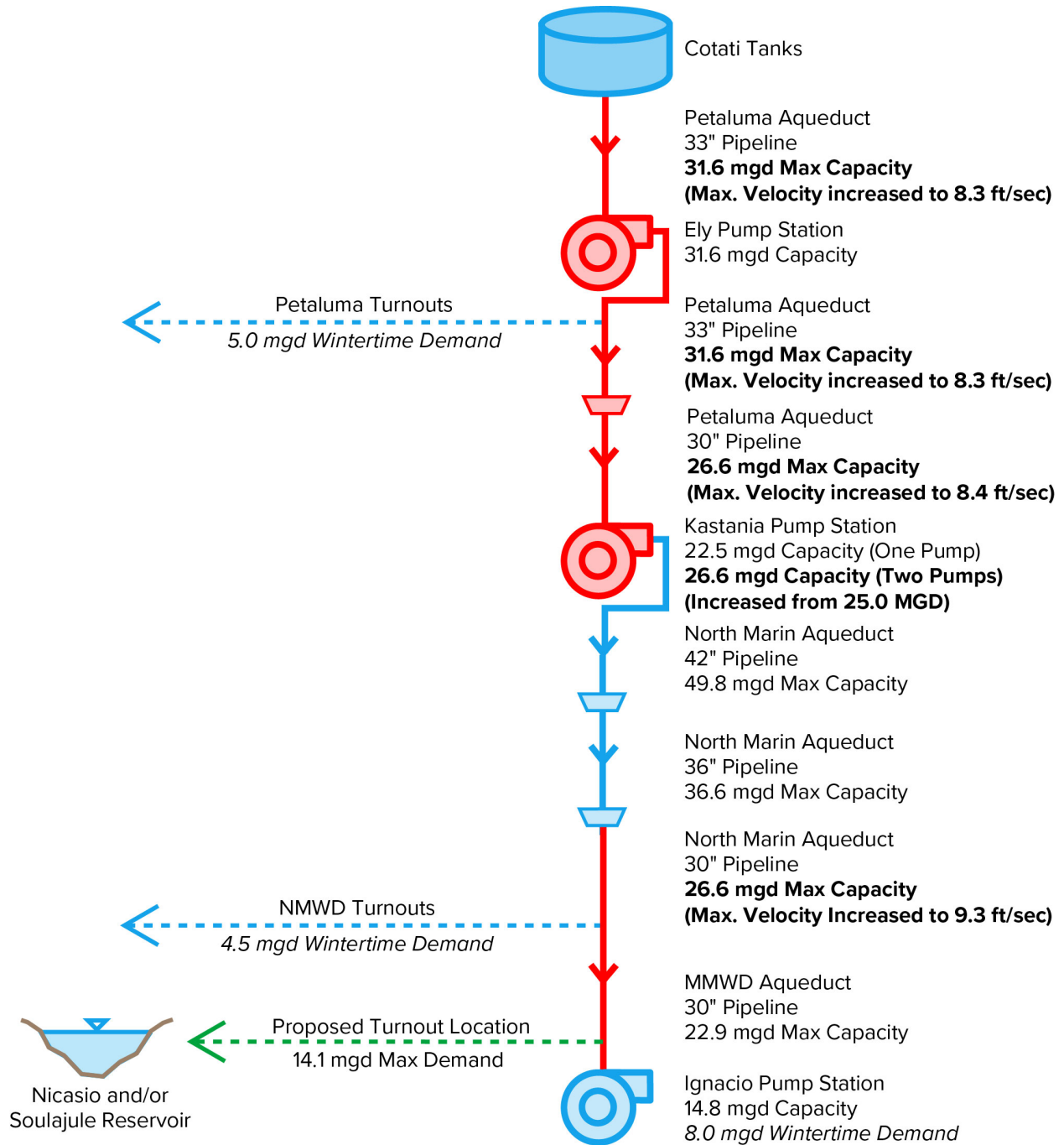


Figure 2.12 PETA-1, 2, and 3 With Upstream Improvements Schematic

Regardless of whether PETA-1, PETA-2, and PETA-3 alternatives include upgrades to existing upstream infrastructure or not, these alternatives also provide a water supply benefit to NMWD. By adding a pipeline parallel to the existing NMWD pipeline from the North Marin Aqueduct to Stafford Lake, these alternatives add a redundant transmission system between North Marin Aqueduct and Stafford Lake.

Hydraulic Impacts

Table 2.5 shows the results of the hydraulic analysis of six scenarios for the PETA-1, PETA-2, and PETA-3 alternatives with upstream improvements. The scenarios highlighted in red have a HGL at the existing NMWD turnout below the necessary operating HGL of 170 feet. These scenarios are detrimental to the operation of the existing hydraulic system as configured. It may be possible to make other hydraulic improvements to improve the HGL under this scenario, which will be considered in future analyses. However, without other hydraulic improvements, Kastania Pump Station would need to have two pumps running to meet HGL requirements at the existing NMWD turnout based on existing demand conditions. Even with two pumps running at Kastania Pump Station, HGL requirements at the existing NMWD turnout would not be able to be met based on future demand conditions. Appendix 2B provides more detailed hydraulic results.

Table 2.5 Hydraulic Impacts of PETA-1, 2, and 3 With Upstream Improvements

Scenario Number	New Turnout Location ⁽¹⁾	Demand Condition ⁽⁴⁾	Demand at New Proposed Turnout (mgd)	Demands at Other Turnouts (mgd)			Total Sonoma Water Demands (mgd)	Kastania Pump Station Status	HGL at Existing NMWD Turnout ⁽³⁾
				Total Petaluma ⁽²⁾	North Marin/ San Marin Pump Station	Ignacio BPS			
1	1	Existing	14.1	5.0	4.5	8.0	31.6	Off	59
2	1	Existing	14.1	5.0	4.5	8.0	31.6	1 pump on	90
3	1	Existing	14.1	5.0	4.5	8.0	31.6	2 pumps on	184
4	1	Future	14.1	6.5	6.1	8.0	34.7	Off	39
5	1	Future	14.1	6.5	6.1	8.0	34.7	1 pump on	57
6	1	Future	14.1	6.5	6.1	8.0	34.7	2 pumps on	160

Notes:

- (1) Turnout 1 is at the intersection of Redwood Boulevard and Atherton Avenue. Turnout 2 is on Petaluma Boulevard approximately 950 feet south of Skinner Road.
- (2) All Petaluma demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma city boundary.
- (3) The values highlighted in red are below the minimum required HGL of 170 feet at the NMWD turnout.
- (4) The future winter demand conditions are based on anticipated future winter demands for Petaluma and NMWD in 2045. 2045 demands are included in Sonoma County's UWMP.

2.4.6.3 PETA-4 Without Upstream Improvements

Water System Supply Benefits

For PETA-4, the proposed turnout location from the North Marin Aqueduct is north of Novato, at San Antonio Road. Based on current operations, the existing infrastructure can convey up to 30.4 mgd of water from Cotati Tanks to Kastania Pump Station, with Petaluma pulling approximately 5.0 mgd of that during wintertime months. As such, up to 25.4 mgd of water can be delivered to Kastania Pump Station during wintertime months. Kastania Pump Station has a maximum capacity of 25.0 mgd. Downstream of Kastania Pump Station, for PETA-4, at the proposed turnout location the existing North Marin Aqueduct is 42 inches and can convey approximately 45.0 mgd, assuming a maximum allowable velocity in the pipeline of 8.0 fps. Additionally, downstream of Kastania Pump Station, the system demand during wintertime months is approximately 12.5 mgd. As previously discussed, NMWD would pull approximately 4.5 mgd during wintertime months and the District will receive and distribute approximately 8.0 mgd through Ignacio Pump Station.

Given these capacities and demands, the largest bottleneck in the system upstream of the proposed turnout location is Kastania Pump Station. Assuming that Kastania Pump Station has a maximum capacity of 25.0 mgd, and assuming there is a demand of 12.5 mgd during wintertime operations downstream of the proposed turnout location, approximately 12.5 mgd of water is available to be conveyed from North Marin Aqueduct to the reservoirs. No other improvements or upgrades to the existing system are anticipated to be needed to convey 12.5 mgd from the North Marin Aqueduct to the reservoirs.

Figure 2.13 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed turnout location is shown in green and the largest bottleneck in the existing system is shown in red. No other improvements or upgrades to the existing system are anticipated to be needed to convey 12.5 mgd from the North Marin Aqueduct to the reservoirs.

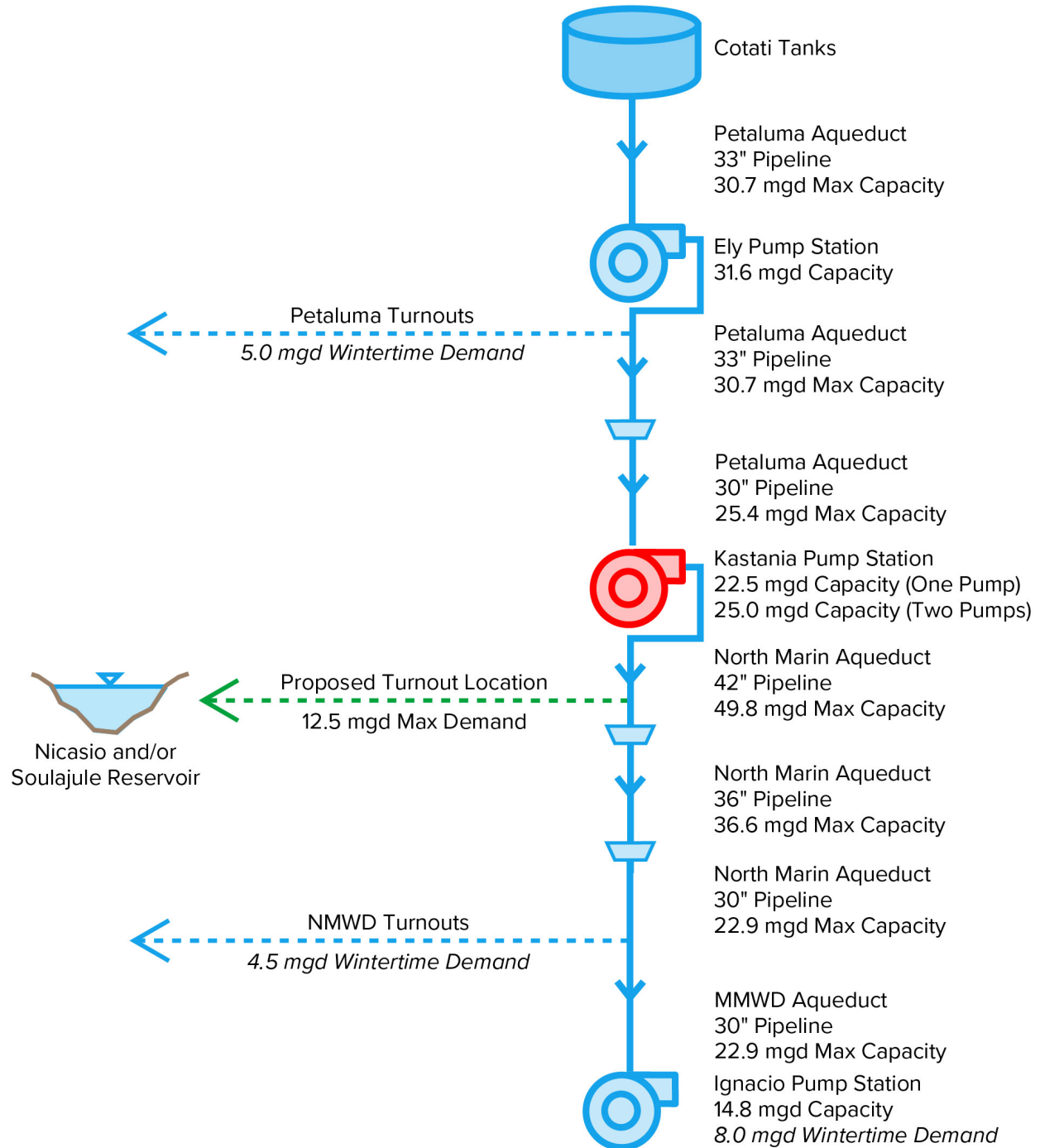


Figure 2.13 PETA-4 Without Upstream Improvements Schematic

Hydraulic Impacts

Table 2.6 shows the results of the hydraulic analysis of six scenarios for the PETA-4 alternatives without upstream improvements. The scenarios highlighted in red have a HGL at the existing NMWD turnout below the necessary operating HGL of 170 feet. These scenarios are detrimental to the operation of the existing hydraulic system as configured. It may be possible to make other hydraulic improvements to improve the HGL under this scenario, which will be considered in future analyses. However, without other hydraulic improvements, Kastania Pump Station would not be able to meet HGL requirements at the existing NMWD turnout based on future demand conditions with no pumps running at Kastania Pump Station. Appendix 2B provides more detailed hydraulic results.

Table 2.6 Hydraulic Impacts of PETA-4 Without Upstream Improvements

Scenario Number	New Turnout Location ⁽¹⁾	Demand Condition ⁽⁴⁾	Demand at New Proposed Turnout (mgd)	Demands at Other Turnouts (mgd)			Total Sonoma Water Demands (mgd)	Kastania Pump Station Status	HGL at Existing NMWD Turnout ⁽³⁾
				Total Petaluma ⁽²⁾	North Marin/ San Marin Pump Station	Ignacio BPS			
1	2	Existing	12.5	5.0	4.5	8.0	30.0	Off	178
2	2	Existing	12.5	5.0	4.5	8.0	30.0	1 pump on	222
3	2	Existing	12.5	5.0	4.5	8.0	30.0	2 pumps on	307
4	2	Future	12.5	6.5	6.1	8.0	33.1	Off	167
5	2	Future	12.5	6.5	6.1	8.0	33.1	1 pump on	197
6	2	Future	12.5	6.5	6.1	8.0	33.1	2 pumps on	292

Notes:

- (1) Turnout 1 is at the intersection of Redwood Boulevard and Atherton Avenue. Turnout 2 is on Petaluma Boulevard approximately 950 feet south of Skinner Road.
- (2) All Petaluma demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma city boundary.
- (3) The values highlighted in red are below the minimum required HGL of 170 feet at the NMWD turnout.
- (4) The future winter demand conditions are based on anticipated future winter demands for Petaluma and NMWD in 2045. 2045 demands are included in Sonoma County's UWMP.

2.4.6.4 PETA-4 With Upstream Improvements

Water System Supply Benefits

It's possible to increase the water supply benefit of the PETA-4 alternative further by implementing improvements to bottlenecks upstream of the proposed turnout location. Although a whole range of upstream improvement projects can be implemented to increase the capacity of the system by varying amounts, improvements were selected that maximize the use of existing infrastructure. Required

improvements to the existing system that will allow up to 30.0 mgd of water to be conveyed from the North Marin Aqueduct to the reservoirs include:

- Constructing an STS alternative that can convey an additional 17.1 mgd from Cotati Tanks to Kastania Pump Station:
 - » As stated above, existing infrastructure can convey up to 30.4 mgd of water from Cotati Tanks to Kastania Pump Station:
 - Petaluma pulls approximately 5.0 mgd of that during wintertime operations. As such, approximately 25.4 mgd of water can currently be delivered to Kastania Pump Station during wintertime months.
 - With the addition of facilities conveying 17.1 mgd from Cotati Tanks to Kastania Pump Station, up to 42.5 mgd of water could be delivered to Kastania Pump Station during wintertime operations:
 - No improvements would need to be made to the existing Petaluma Aqueduct or Ely BPS.
- Increasing the capacity of Kastania Pump Station from 25.0 mgd to 42.5 mgd.

If the improvements detailed above are included with the Project, the maximum capacity of the system upstream of the turnout location will be increased to 42.5 mgd. Assuming 12.5 mgd of demand during wintertime operations downstream of this turnout location, the District should be able to convey up to 30.0 mgd of water from North Marin Aqueduct to the reservoirs.

Figure 2.14 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed turnout location is shown in green, the largest bottleneck in the existing system shown in red, and other ancillary improvements described above shown in bold.

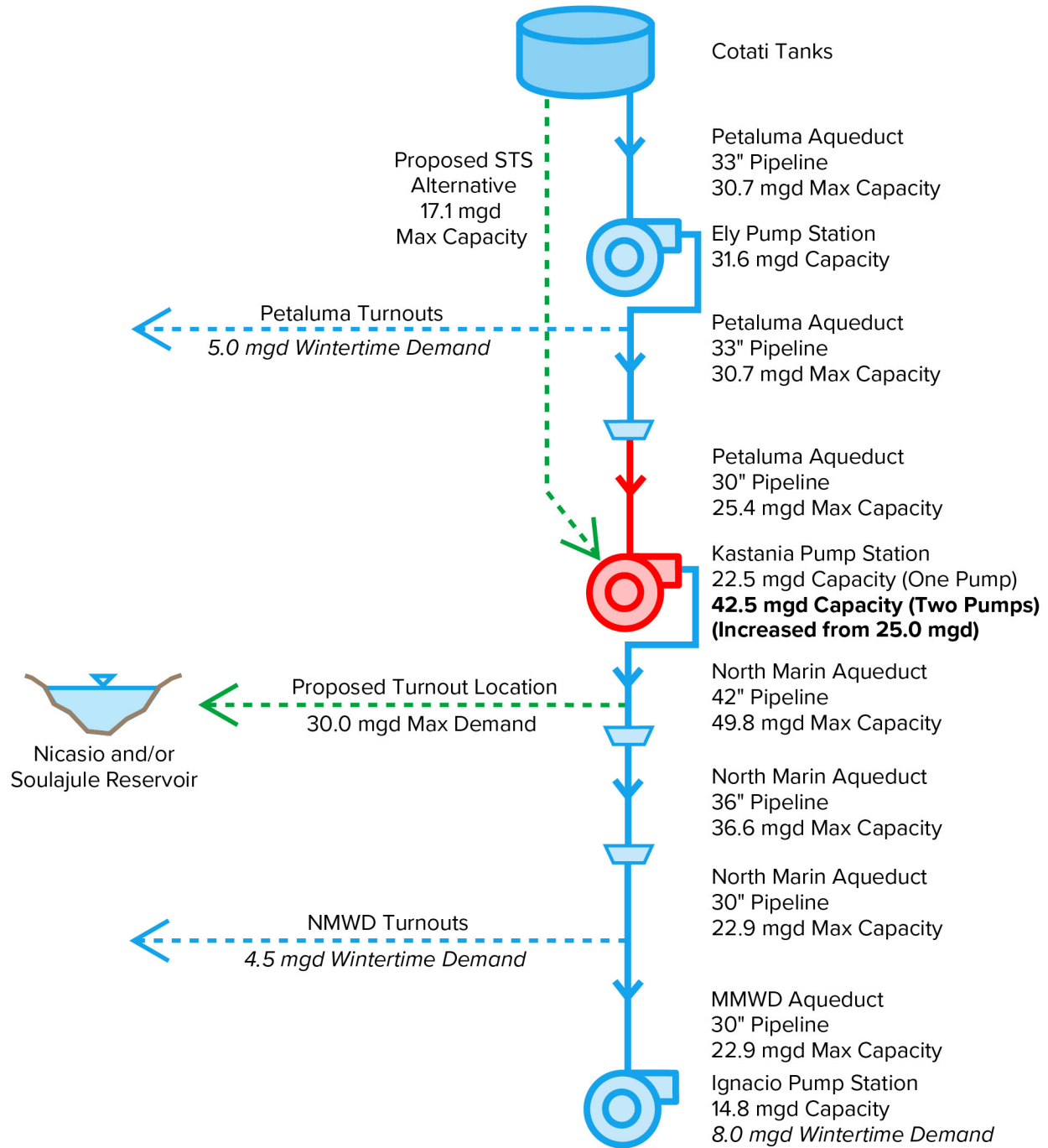


Figure 2.14 PETA-4 With Upstream Improvements Schematic

If PETA-4 includes the upgrades to existing upstream infrastructure detailed above, the alternative does provide a water supply benefit to other municipalities in the region by adding a redundant transmission system between Cotati Tanks and Kastania Pump Station.

Hydraulic Impacts

Table 2.7 shows the results of the hydraulic analysis of six scenarios for the PETA-4 alternatives with upstream improvements. The scenarios highlighted in red have a HGL at the existing NMWD turnout below the necessary operating HGL of 170 feet. These scenarios are detrimental to the operation of the existing hydraulic system as configured. It may be possible to make other hydraulic improvements to improve the HGL under this scenario, which will be considered in future analyses. However, without other hydraulic improvements, Kastania Pump Station would need to have two pumps running to meet HGL requirements at the existing NMWD turnout based on existing and future demand conditions.

Appendix 2B provides more detailed hydraulic results.

Table 2.7 Hydraulic Impacts of PETA-4 With Upstream Improvements

Scenario Number	New Turnout Location ⁽¹⁾	Demand Condition ⁽⁴⁾	Demand at New Proposed Turnout (mgd)	Demands at Other Turnouts (mgd)			Total Sonoma Water Demands (mgd)	Kastania Pump Station Status	HGL at Existing NMWD Turnout ⁽³⁾
				Total Petaluma ⁽²⁾	North Marin/San Marin Pump Station	Ignacio BPS			
1	2	Existing	30.0	5.0	4.5	8.0	47.5	Off	150
2	2	Existing	30.0	5.0	4.5	8.0	47.5	1 pump on	150
3	2	Existing	30.0	5.0	4.5	8.0	47.5	2 pumps on	220
4	2	Future	30.0	6.5	6.1	8.0	50.6	Off	136
5	2	Future	30.0	6.5	6.1	8.0	50.6	1 pump on	136
6	2	Future	30.0	6.5	6.1	8.0	50.6	2 pumps on	197

Notes:

- (1) Turnout 1 is at the intersection of Redwood Boulevard and Atherton Avenue. Turnout 2 is on Petaluma Boulevard approximately 950 feet south of Skinner Road.
- (2) All Petaluma demands were applied at the intersection of Petaluma Boulevard and US-101, which coincides with the southern edge of the Petaluma city boundary.
- (3) The values highlighted in red are below the minimum required HGL of 170 feet at the NMWD turnout.
- (4) The future winter demand conditions are based on anticipated future winter demands for Petaluma and NMWD in 2045. 2045 demands are included in Sonoma County's UWMP.

2.4.7 Cotati Tanks to Reservoirs (COTATI) Project Alternatives

There have been no changes to the COTATI alternatives since TM 1. In general, the COTATI alternatives include pipeline and pump station improvements to convey additional water from Cotati Tanks to Nicasio Reservoir, Soulajule Reservoir, or both reservoirs. The following alternatives are included under the umbrella of the COTATI alternatives:

- **COTATI-1:** Cotati Tanks to Nicasio Reservoir (24.2 miles of pipeline).
- **COTATI-2:** Cotati Tanks to Soulajule Reservoir (20.5 miles of pipeline).
- **COTATI-3:** Cotati Tanks to Nicasio and Soulajule Reservoirs (25.9 miles of pipeline).

For each of these alternatives, water will be conveyed from the Cotati Tanks to Nicasio Reservoir, Soulajule Reservoir, or both reservoirs via a new pump station(s) and pipeline. For each of these alternatives, the supplemental water from Sonoma Water will be sent to existing storage reservoirs to be used by the District at a later time. Figure 2.15 shows an overview of COTATI alternatives.

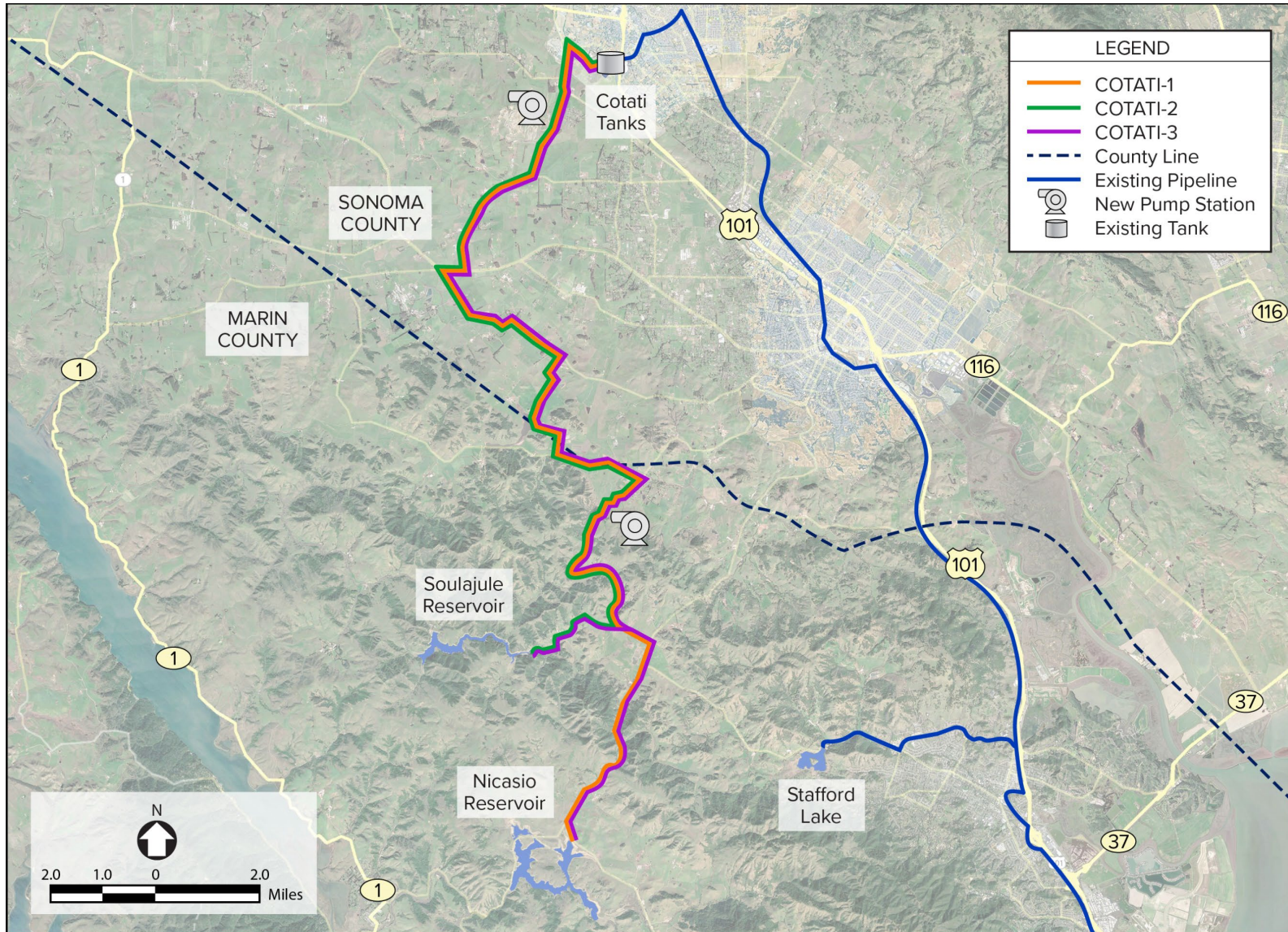


Figure 2.15 COTATI Alternatives

2.4.7.1 Water System Supply Benefits of COTATI

Considering the COTATI alternatives include new infrastructure that is independent of the existing system, the sizing of the facilities and associated water supply benefits can be defined by the District. Based on discussions with the District, these alternatives would likely be sized to convey a maximum flow of approximately 30.0 to 35.0 mgd.

Figure 2.16 shows a schematic of the existing system from Cotati Tanks to Ignacio Pump Station. The schematic is diagrammatic and does not show all existing or proposed facilities. The proposed turnout location is shown in green.

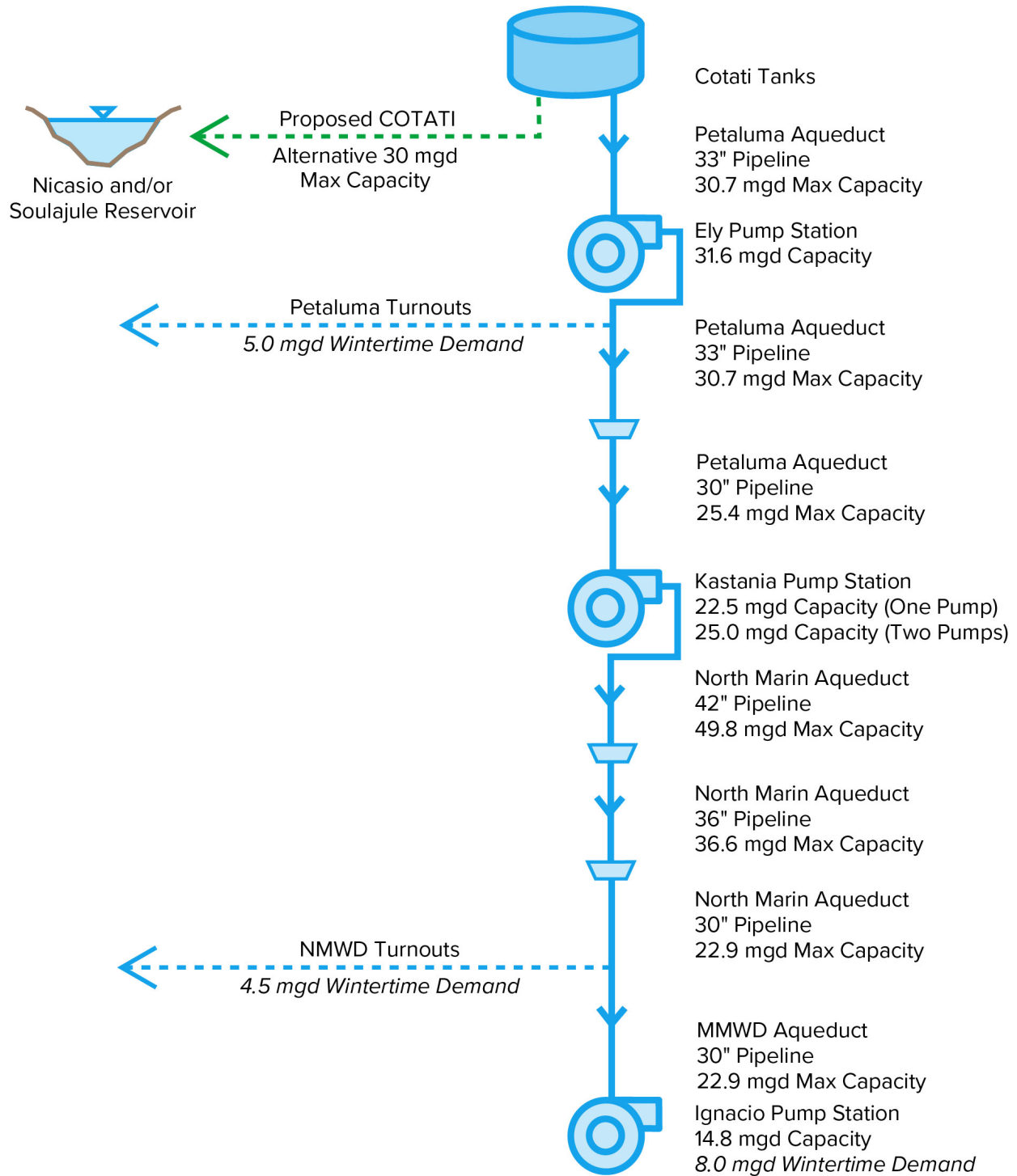


Figure 2.16 COTATI Schematic

2.4.8 Summary of Alternatives

Table 2.8 summarizes the project alternatives, pipeline lengths, anticipated water supply benefits, and anticipated future water supply benefits.

Table 2.8 Summary of Alternatives

Alternative	Description	Pipeline Length (miles)	Potential Water Supply Benefit ⁽¹⁾ (mgd)	Potential Water Supply Benefit in Future ⁽²⁾ (mgd)
STS-1	Cotati Tanks to Kastania Pump Station Along US-101 Corridor	10.5	0.0 ⁽³⁾	0.0 ⁽³⁾
STS-2	Cotati Tanks to Kastania Pump Station Through Downtown Petaluma	12.1	0.0 ⁽³⁾	0.0 ⁽³⁾
STS-3	Cotati Tanks to Kastania Pump Station Through Rural Roads	15.5	0.0 ⁽³⁾	0.0 ⁽³⁾
STAF-1	Stafford Lake to Nicasio Reservoir	8.0	7.2	7.2
STAF-2	Stafford Lake to Soulajule Reservoir	6.8	7.2	7.2
STAF-3	Stafford Lake to Nicasio and Soulajule Reservoirs	11.0	7.2	7.2
PETA-1	North Marin Aqueduct to Nicasio Reservoir	13.2	10.4 ⁽⁴⁾ 14.1 ⁽⁵⁾	8.8 ⁽⁴⁾ 11.0 ⁽⁵⁾
PETA-2	North Marin Aqueduct to Soulajule Reservoir	12.0	10.4 ⁽⁴⁾ 14.1 ⁽⁵⁾	8.8 ⁽⁴⁾ 11.0 ⁽⁵⁾
PETA-3	North Marin Aqueduct to Nicasio and Soulajule Reservoirs	16.2	10.4 ⁽⁴⁾ 14.1 ⁽⁵⁾	8.8 ⁽⁴⁾ 11.0 ⁽⁵⁾
PETA-4	North Marin Aqueduct to Nicasio and Soulajule Reservoirs via San Antonio Road	14.8 ⁽⁷⁾	12.5 ⁽⁴⁾ 30.0 ⁽⁵⁾	10.9 ⁽⁴⁾ 26.9 ⁽⁵⁾
COTATI-1	Cotati Tanks to Nicasio Reservoir	24.2	30.0 ⁽⁶⁾	30.0 ⁽⁶⁾
COTATI-2	Cotati Tanks to Soulajule Reservoir	20.5	30.0 ⁽⁶⁾	30.0 ⁽⁶⁾
COTATI-3	Cotati Tanks to Nicasio and Soulajule Reservoirs	25.9	30.0 ⁽⁶⁾	30.0 ⁽⁶⁾

Notes:

- (1) The water supply benefit listed is in excess of the 8.0 mgd conveyed through the existing system from Cotati Tanks to Ignacio Pump Station during wintertime operations.
- (2) The water supply benefit listed in future is in excess of the 8.0 mgd conveyed through the existing system from Cotati Tanks to Ignacio Pump Station during wintertime operations. This assumes future demands in 2045 for other customers along the existing system from Cotati Tanks to Ignacio Pump Station.
- (3) This alternative improves existing system reliability. However, the alternative does not deliver water to storage, so the additional capacity is estimated as 0 mgd.
- (4) This capacity assumes improvements to the existing system are not made.
- (5) This capacity assumes additional improvements are made to increase the capacity of the existing system to deliver higher flows.
- (6) Since this alternative does not impact existing hydraulic system, the capacity can be designed to meet District preference based on the available water supply.
- (7) Required pipeline length does not include STS. STS is also required if 24.1 mgd is desired.

2.4.8.1 Hydraulic Analysis Results

The STAF and PETA alternatives have the potential of impacting the hydraulics of the existing system. Table 2.9 summarizes the hydraulic analysis results, shows the modeled HGL at the NMWD and Ignacio Pump Station turnouts, and the maximum velocity through the North Marin portion of the aqueduct. The key findings from the analysis are summarized below:

- **Turnout 1 results in more headloss than Turnout 2.** Applying demands at Turnout 1 leads to greater headloss through the North Marin aqueduct compared to applying demands at Turnout 2. As shown on the Turnout 1 HGL plots in Appendix 2B, the greatest headloss downstream of the Kastania Pump Station occurs through the 30-inch diameter section downstream of Turnout 2. The aqueduct reduces down to 30 inches in diameter approximately 5,900 feet downstream of Turnout 2, and Turnout 1 is another 24,700 feet downstream. Consequently, substantial headloss occurs between Turnout 2 and Turnout 1.
- **Diverting water through Turnout 1 or 2 requires operation of the Kastania Pump Station.** Under existing winter conditions, only the Turnout 2 low-demand scenario can be applied while maintaining the minimum HGL of 170 feet at the NMWD turnout when the Kastania Pump Station is turned off. Even for this scenario, the modeled HGL at the NMWD turnout is only 178 feet, which provides little hydraulic buffer. At least one pump must be operated to maintain a minimum 170-foot HGL at the NMWD turnout under future winter conditions when demands are applied at either turnout.
- **The full Kastania Pump Station capacity must be utilized under the high-demand scenario.** Under both existing and future winter demand conditions, two pumps must be operated at the Kastania Pump Station for the high-end demand alternatives associated with either turnout location to meet the minimum HGL of 170 feet at the NMWD turnout.
- **The existing North Marin Aqueduct System does not have sufficient capacity to meet the NMWD HGL requirements when the Turnout 1 high-demand scenario is applied under future winter conditions.** The HGL at the NMWD turnout under future conditions with two pumps on at the Kastania Pump Station is below the minimum 170 feet when the high-end demand for the Turnout 1 alternative is applied.
- **Applying the high-demand scenario at Turnout 1 causes North Marin's maximum aqueduct velocity to be exceeded.** Under both existing and future winter demand conditions, the maximum velocity through the North Marin portion of the aqueduct exceeds 8 fps when the Turnout 1 high-end demand is applied. The maximum velocities through the 30-inch diameter section between Turnout 2 and Turnout 1 are 8.4 and 8.9 fps under existing and future demand conditions, respectively, when the high-end Turnout 1 demand is applied. As previously discussed, this bottleneck leads to increased headloss.

As shown, several scenarios result in HGLs at the NMWD lower than the minimum required HGL of 170 feet. Further evaluation of hydraulic impacts of each alternative on the existing Petaluma/North Marin Aqueduct System is needed in Phase 2.

Table 2.9 Hydraulic Model Scenarios

Scenario	New Turnout Location	Demand Condition ⁽⁴⁾	Demand at New Proposed Turnout (mgd)	Kastania Pump Station Status	HGL at NMWD Turnout (feet) ⁽¹⁾	HGL at Ignacio Pump Station (feet) ⁽²⁾	Maximum Velocity (fps) ⁽³⁾
1	N/A	Existing winter	N/A	Off	191	184	3.9
2	1	Existing winter	7.2	Off	132	125	6.2
3	1	Existing winter	10.4	Off	100	94	7.2
4	1	Existing winter	14.1	Off	59	53	8.4
5	2	Existing winter	12.5	Off	178	172	4.0
6	2	Existing winter	30.0	Off	150	143	6.8
7	N/A	Existing winter	N/A	1 pump on	325	318	3.9
8	1	Existing winter	7.2	1 pump on	221	213	6.2
9	1	Existing winter	10.4	1 pump on	163	156	7.2
10	1	Existing winter	14.1	1 pump on	90	84	8.4
11	2	Existing winter	12.5	1 pump on	222	216	4.0
12	2	Existing winter	30.0	1 pump on	150	144	6.8
13	N/A	Existing winter	N/A	2 pumps on	349	343	3.9
14	1	Existing winter	7.2	2 pumps on	274	266	6.2
15	1	Existing winter	10.4	2 pumps on	234	228	7.2
16	1	Existing winter	14.1	2 pumps on	184	178	8.4
17	2	Existing winter	12.5	2 pumps on	307	300	4.0
18	2	Existing winter	30.0	2 pumps on	220	213	6.8
19	N/A	Future winter	N/A	Off	179	172	4.4
20	1	Future winter	7.2	Off	117	109	6.7
21	1	Future winter	10.4	Off	83	77	7.7
22	1	Future winter	14.1	Off	39	33	8.9
23	2	Future winter	12.5	Off	167	160	4.4
24	2	Future winter	30.0	Off	136	129	7.1
25	N/A	Future winter	N/A	1 pump on	306	300	4.4
26	1	Future winter	7.2	1 pump on	192	184	6.7
27	1	Future winter	10.4	1 pump on	132	125	7.7
28	1	Future winter	14.1	1 pump on	57	50	8.9
29	2	Future winter	12.5	1 pump on	197	191	4.4
30	2	Future winter	30.0	1 pump on	136	130	7.1
31	N/A	Future winter	N/A	2 pumps on	333	327	4.4
32	1	Future winter	7.2	2 pumps on	254	246	6.7
33	1	Future winter	10.4	2 pumps on	213	207	7.7
34	1	Future winter	14.1	2 pumps on	160	154	8.9

Scenario	New Turnout Location	Demand Condition ⁽⁴⁾	Demand at New Proposed Turnout (mgd)	Kastania Pump Station Status	HGL at NMWD Turnout (feet) ⁽¹⁾	HGL at Ignacio Pump Station (feet) ⁽²⁾	Maximum Velocity (fps) ⁽³⁾
35	2	Future winter	12.5	2 pumps on	292	285	4.4
36	2	Future winter	30.0	2 pumps on	197	190	7.1

Notes:

N/A - not applicable

(1) The values highlighted in red are below the minimum required HGL of 170 feet at the NMWD turnout.

(2) The Ignacio Pump Station turnout is the most downstream point of the North Marin/Petaluma Aqueduct System. Lower HGL results at this location indicate greater headloss through the North Marin portion of the aqueduct.

(3) Maximum velocity through the North Marin portion of the aqueduct. Values highlighted red exceed the minimum 8 fps.

(4) The future winter demand conditions are based on anticipated future winter demands for Petaluma and NMWD in 2045. 2045 demands are included in Sonoma County's UWMP.

2.5 Alternatives Evaluation

2.5.1 Alternatives Evaluation Methodology

Carollo and the District discussed the evaluation methodology for screening the 14 alternatives down to approximately 3 alternatives during Workshop No. 2. Figure 2.17 illustrates the evaluation methodology.

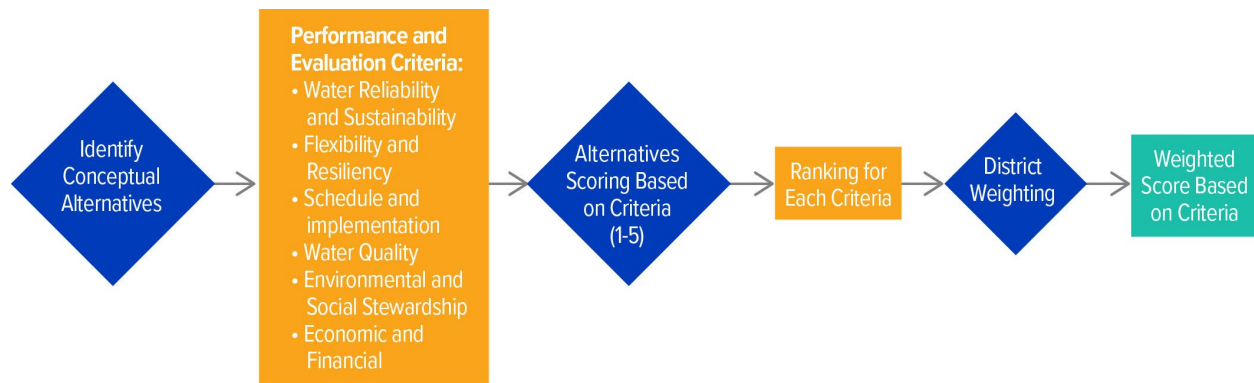


Figure 2.17 Alternatives Screening Methodology

The first step of the evaluation is to identify the conceptual alternatives and corresponding water supply benefits of each alternative. Identification of conceptual alternatives and corresponding water supply benefits was performed in TM 1. As anticipated water supply benefit is the key aspect of this Project, early determination of anticipated benefits was needed. Up to this point, the TM has only discussed anticipated water supply benefits of alternatives in terms of mgd. That is because the allowable duration of water supplied by Sonoma Water is yet to be determined. The allowable duration of water supplied by Sonoma Water will have a significant impact on the total yield for each alternative, which is demonstrated in Table 2.10.

Table 2.10 Example Water Supply Benefit Based on Duration of Water Diversion

Example Water Supply Benefits of Differing Diversion Durations and System Capacity (AFY)								
System Capacity (mgd)	Duration of Water Diversion (Months)							
	1	2	3	4	5	6	7	8
7.2	663	1,326	1,989	2,652	3,314	3,977	4,640	5,303
10.9	1,004	2,007	3,011	4,014	5,018	6,021	7,026	8,028
12.5	1,151	2,302	3,452	4,603	5,754	6,905	8,056	9,207
14.1	1,298	2,596	3,894	5,193	6,491	7,789	9,087	10,385
30.0	2,762	5,524	8,286	11,048	13,810	16,572	19,334	22,096

Notes:

AFY - acre-feet per year; mgd - million gallons per day

The next step is to evaluate each alternative based on the criteria defined in Section 2.3. Table 2.11 defines a score of 1, 3, or 5 for each criteria. It should be noted that the higher scores are better than lower scores (a score of 5 is better than a 1).

Table 2.11 Evaluation Criteria Scoring Definitions

Score	Water Reliability and Sustainability	Flexibility and Resiliency	Schedule and Implementation	Water Quality	Environmental and Social Stewardship	Economic and Financial
5	- Contributes to a sustainable dry year water supply by significantly increasing system's capacity to transfer water from Sonoma Water. - Improves reliability of transmission infrastructure and meets long-term operational needs under maximum- and average-day demand conditions. - Greatly improves the ability of system to withstand natural disasters.	- Greatly improves flexibility of District operations. - Greatly improves the resilience of District operations from changing conditions, including climate change effect. - Integrates well with regional water systems and maximizes regional benefits. - Minimizes complexities of system operations and hydraulics.	- Ability to implement project in the fastest timeline. - Reduce unnecessary regulatory complexity. - Preserves many future conveyance project options. - Minimizes construction complexities.	- Enhances water quality. - Meets current and foreseeable future drinking water regulations with a margin of safety.	- Minimizes long-term environmental effects. - Minimizes disruption to existing land uses to the extent practical.	- Minimizes capital and life cycle costs relative to yield. - Integrates well with existing infrastructure. - Leverage federal and state grant and loan opportunities. - Minimizes financial risk.
3	- Contributes to a sustainable dry year water supply by moderately increasing system's capacity to transfer water from Sonoma Water. - Improves reliability of transmission infrastructure and meets long-term operational needs under average-day demand conditions. - Improves the ability of system to withstand natural disasters.	- Improves flexibility of District operations. - Improves the resilience of District operations from changing conditions, including climate change effect. - Integrates with regional water systems, providing some regional benefits. - Some complexities with system operations and hydraulics.	- Ability to implement project in a reasonable timeline. - Some regulatory complexity. - Preserves some future conveyance project options. - Some construction complexities.	Meets current drinking water regulations.	- Some long-term environmental effects. - Some disruption to existing land uses.	- Moderate capital and life cycle cost relative to yield. - Integrates with some existing infrastructure. - Leverages some federal and state grant and loan opportunities. - Moderate financial risk.
1	- Contributes to a sustainable dry year water supply by minimally increasing system's capacity to transfer water from Sonoma Water. - Doesn't improve reliability of transmission infrastructure that meets long-term operational needs under average-day demand conditions. - Doesn't improve the ability of system to withstand natural disasters.	- Doesn't improve flexibility of District operations. - Doesn't improve the resilience of District operations from changing conditions, including climate change effect. - Doesn't integrate with regional water system, providing minimal regional benefits. - Significant complexities with system operations and hydraulics.	- Project complexities cause project to be implemented in the slowest timeline. - Significant regulatory complexities. - Reduces future conveyance project options. - Significant construction complexities.	Alternative may expose water supply to lower quality surface water during storage.	- Substantial long-term environmental effects. - Substantial disruption to existing land uses.	- High capital and life cycle cost relative to yield. - Does not integrate with existing infrastructure. - Doesn't leverage federal and state grant and loan opportunities. - High financial risk.

After scoring each criteria, the criteria was weighted by the project team based on relative importance on a scale from 1 to 5. If the District considers some of the criteria to be of equal weight, the criteria can be weighted equally in the matrix. The final step of the evaluation is to summarize the results in an Alternative Evaluation Matrix. The three alternatives with the highest total scores will be advanced into Phase 2 of the Project for further evaluation.

2.5.2 Alternatives Screening Results

As discussed in Section 2.5.1, the first step of this evaluation is to identify the conceptual alternatives and corresponding water supply benefits of each alternative. These alternatives were then moved to the next steps of the screening process, which includes scoring and weighting of each alternative based on the evaluation criteria. Table 2.12 shows the Alternative Evaluation Matrix to summarize the scoring and weighting of each alternative. Table 2.13 presents a simplified version of Table 2.12. The score for each criterion (Water Reliability and Sustainability, Flexibility and Resiliency, etc.) was determined by averaging the scores of the subcriteria. The weighting for each criterion was also averaged.

Table 2.12 and Table 2.13 also include a summation of the total scores for each alternative. As discussed in Section 2.5.1, the three alternatives with the highest total scores will be advanced into Phase 2 of the Project. Based on the total scores included in Table 2.12, the PETA-3, PETA-4, and COTATI-3 alternatives will be advanced into Phase 2 of the Project.

Table 2.12 Alternatives Evaluation Matrix

Criteria	Water Reliability and Sustainability			Flexibility and Resiliency				Schedule and Implementation				Water Quality	Environmental and Social Stewardship		Economic and Financial					Total Score
	Contribute to a sustainable dry year water supply	Provide reliable water supply, treatment and transmission infrastructure that meets long-term operational needs under average- and maximum-day demand conditions	Improve the ability of water system to withstand natural hazards	Retain and/or improve flexibility of District operations	Improve the resilience of District operations from changing conditions, including climate change effects	Integrate well with regional water systems	Minimize complexities of system operations and hydraulics	Implement the project in a timely manner, consistent with framework identified in the SWSA	Reduce regulatory complexity	Preserve options for future conveyance systems between Cotati Tanks and the District's facilities	Minimize construction complexities	Design improvements to meet current and foreseeable future drinking water regulations with a margin of safety	Minimize long-term environmental impacts relative to other conveyance alternatives	Minimize disruption to existing land uses to the extent practical	Minimize capital costs for the District's customers relative to yield	Minimize life-cycle costs for the District's customers relative to other conveyance alternatives	Integrates well with existing infrastructure	Leverage federal and state investments in infrastructure	Minimize financial risk	
Criteria Weighting	5	3	3	3	3	4	4	3	3	3	1	2	2	2	4	4	4	5	2	
STS-1	1	3	1	1	3	3	1	1	3	1	5	5	5	1	1	5	1	3	3	136
STS-2	1	3	1	1	3	3	1	1	3	1	5	5	5	1	1	5	1	3	3	136
STS-3	1	3	1	1	3	3	3	3	3	3	5	5	5	3	1	5	1	3	3	160
STAF-1	1	1	1	3	1	1	3	3	1	1	5	5	3	3	3	5	5	3	3	154
STAF-2	1	1	1	3	1	1	3	3	1	1	5	5	3	3	3	5	5	3	3	154
STAF-3	1	1	3	5	1	1	3	3	3	1	5	5	3	3	3	5	5	3	3	172
PETA-1	3	3	3	3	3	1	3	3	1	3	5	5	3	3	3	3	3	3	3	172
PETA-2	3	3	3	3	3	1	3	3	1	3	5	5	3	3	3	3	3	3	3	172
PETA-3	3	3	5	5	3	5	3	5	3	3	5	5	3	3	3	3	5	3	3	220
PETA-4	5	5	5	5	5	5	1	5	3	3	5	5	3	3	3	1	5	3	3	226
COTATI-1	5	5	5	3	3	3	1	3	3	3	5	3	1	3	1	1	1	3	3	168
COTATI-2	5	5	5	3	3	3	1	3	3	3	5	3	1	3	1	1	1	3	3	168
COTATI-3	5	5	5	5	3	3	1	5	5	3	5	3	1	3	1	1	1	3	3	186

Table 2.13 Alternatives Evaluation Matrix Summary Table

Criteria	Water Reliability and Sustainability	Flexibility and Resiliency	Schedule and Implementation	Water Quality	Environmental and Social Stewardship	Economic and Financial	Total Score
Criteria Weighting	4	4	3	2	2	4	
STS-1	2	2	3	5	3	3	53
STS-2	2	2	3	5	3	3	53
STS-3	2	2	4	5	4	3	58
STAF-1	1	2	3	5	3	4	53
STAF-2	1	2	3	5	3	4	53
STAF-3	2	3	3	5	3	4	61
PETA-1	3	3	3	5	3	3	61
PETA-2	3	3	3	5	3	3	61
PETA-3	4	4	4	5	3	3	72
PETA-4	5	4	4	5	3	3	76
COTATI-1	5	3	4	3	2	2	62
COTATI-2	5	3	4	3	2	2	62
COTATI-3	5	3	5	3	2	2	65

2.6 Project Cost Estimates

In addition to evaluating the alternatives based on their ability to meet project objectives, Carollo developed budgetary construction cost estimates for each alternative. The cost estimates for the alternatives discussed in this TM have differing water supply benefits and will be refined during Phase 2 of this Project.

2.6.1 Basis for Estimate

The Project alternatives are at the preliminary engineering phase with limited design information. The construction cost estimates are consistent with the Association for the Advancement of Cost Engineering (AACE) International Class 4 estimate with an accuracy range of +50 percent to -30 percent of the actual Project cost.

2.6.1.1 Unit Costs

The project cost estimates presented are based on unit costs for the major pipeline and pump station components of the Project. The unit costs for the pipelines are based on information received from pipeline manufacturers for dollars per foot cost of the pipeline material. The pipeline installation costs are based on similar cost estimates on other recent projects. The costs for the pump stations are also based on similar cost estimates on other recent projects.

2.6.1.2 Contingencies

Contingencies are applied to a construction estimate at the design development phase to account for construction items not yet identified and design unknowns. We recommend carrying a 30 to 50 percent contingency during the planning phase of a project considering the design details are not known at this time. The contingency will be reduced as the design is developed. Agencies typically retain contingency within their project budgets, even when construction contract award values are known, to cover the cost or deal with unforeseen conditions.

The cost estimate presented in this TM includes 30 percent contingency, calculated based on the raw construction cost. This is in alignment with the recommendations for a project at an AACE International Class 4 level of development.

2.6.2 Cost Estimates

Table 2.14 presents a summary of cost estimates for each of the 14 alternatives. Detailed breakdowns of the construction cost estimates are included in Appendix 2C.

Table 2.14 Alternatives Cost Estimates

Alternative	Description	Pipeline Length (miles)	Water Supply Benefit (mgd) ⁽¹⁾	Total Estimated Construction Cost (\$M)	Total Estimated Construction Cost Range (\$M) ⁽⁷⁾
STS Alternatives					
STS-1	Cotati Tanks to Kastania Pump Station Along US-101 Corridor	10.5	0.0 ⁽²⁾	\$148	\$104 - \$222
STS-2	Cotati Tanks to Kastania Pump Station Through Downtown Petaluma	12.1	0.0 ⁽²⁾	\$163	\$114 - \$245
STS-3	Cotati Tanks to Kastania Pump Station Through Rural Roads	15.5	0.0 ⁽²⁾	\$200	\$140 - \$300
STAF Alternatives					
STAF-1	Stafford Lake to Nicasio Reservoir	8.0	7.2	\$63	\$44 - \$95
STAF-2	Stafford Lake to Soulajule Reservoir	6.8	7.2	\$56	\$39 - \$84
STAF-3	Stafford Lake to Nicasio and Soulajule Reservoirs	11.0	7.2	\$77	\$54 - \$116
PETA Alternatives					
PETA-1	North Marin Aqueduct to Nicasio Reservoir	13.2	10.4 ⁽³⁾ 14.1 ⁽⁴⁾	\$111 \$144	\$77 - \$167 \$101 - \$217
PETA-2	North Marin Aqueduct to Soulajule Reservoir	12.0	10.4 ⁽³⁾ 14.1 ⁽⁴⁾	\$105 \$135	\$74 - \$158 \$95 - \$203
PETA-3	North Marin Aqueduct to Nicasio and Soulajule Reservoirs	16.2	10.4 ⁽³⁾ 14.1 ⁽⁴⁾	\$129 \$176	\$90 - \$194 \$123 - \$264
PETA-4	North Marin Aqueduct to Nicasio and Soulajule Reservoirs via San Antonio Road	14.8 ⁽⁶⁾	12.5 ⁽³⁾ 30.0 ⁽⁴⁾	\$148 \$378	\$104 - \$222 \$265 - \$567
COTATI Alternatives					
COTATI-1	Cotati Tanks to Nicasio Reservoir	24.2	30.0 ⁽⁵⁾	\$364	\$255 - \$546
COTATI-2	Cotati Tanks to Soulajule Reservoir	20.5	30.0 ⁽⁵⁾	\$322	\$225 - \$483
COTATI-3	Cotati Tanks to Nicasio and Soulajule Reservoirs	25.9	30.0 ⁽⁵⁾	\$380	\$266 - \$571

Notes:

\$M - dollars in millions

- (1) The water supply benefit listed is in excess of the 8.0 mgd conveyed through the existing system from Cotati Tanks to Ignacio Pump Station during wintertime operations.
- (2) This alternative improves existing system reliability. However, the alternative does not deliver water to storage, so the additional capacity is estimated as 0 mgd.
- (3) This capacity assumes improvements to the existing system are not made.
- (4) This capacity assumes additional improvements are made to increase the capacity of the existing system to deliver higher flows.
- (5) Since this alternative does not impact existing hydraulic system, the capacity can be designed to meet District preference based on the available water supply.
- (6) Required pipeline length does not include STS. STS is also required if 24.1 mgd is desired.
- (7) Total Estimated Construction Cost Range assumes an accuracy range of +50 percent to -30 percent.

2.7 Summary

2.7.1 Recommendation

This TM summarizes the criteria and methodology used to evaluate project alternatives and identify the top three alternatives. The PETA-3, PETA-4, and COTATI-3 alternatives ranked the highest and we recommend evaluating these alternatives in additional detail during Phase 2 of the Project.

2.7.2 Next Steps

As shown in Table 2.15, the water supply benefit depends on the system capacity and duration of the water diversion. It is important to determine the available water supply and allowable diversion duration to further advance the conceptual planning of the PETA-3, PETA-4, and COTATI-3 alternatives during Phase 2 of this Project. This will establish the pump station capacity, pipeline sizes, operation, and other details of each alternative.

Table 2.15 Example Water Supply Benefit Based on Duration of Water Diversion

Example Water Supply Benefits of Differing Diversion Durations and System Capacity (AFY)								
System Capacity (mgd)	Duration of Water Diversion (Months)							
	1	2	3	4	5	6	7	8
7.2	663	1,326	1,989	2,652	3,314	3,977	4,640	5,303
10.9	1,004	2,007	3,011	4,014	5,018	6,021	7,026	8,028
12.5	1,151	2,302	3,452	4,603	5,754	6,905	8,056	9,207
14.1	1,298	2,596	3,894	5,193	6,491	7,789	9,087	10,385
30.0	2,762	5,524	8,286	11,048	13,810	16,572	19,334	22,096

APPENDIX 2A

BOTTLENECK TM

TECHNICAL MEMORANDUM: Water Conveyance Bottleneck Investigation

TO: Matthew Steiner, Assistant Engineer
Marin Municipal Water District

PREPARED BY: Nathan Hanson and Chris van Lienden, P.E.

REVIEWED BY: Xavier Irias, P.E.

DATE: January 28, 2022



1. INTRODUCTION

To support the District's Water Conveyance Bottleneck Investigation Woodard & Curran (W&C) updated the District's hydraulic model to incorporate several proposed capacity improvement projects which would improve conveyance of excess winter water from Sonoma County Water Agency (SCWA) into the District's distribution and storage system. A skeletonized system-wide model (steady state) was provided to W&C and used for this analysis. As part of this study, W&C reviewed and updated valve and pump configurations to better match current operations and SCADA readings.

This evaluation allowed the team review specific capacity improvement projects identified by District staff which would allow for conveyance of winter water. The first aspect of this work focused on several projects initially selected by District staff to analyze. Based on meetings with District Staff and preliminary results, these alternatives were redefined into five projects which are presented in Section 2.3 of the Report.

2. DEVELOPMENT AND EVALUATION OF BOTTLENECK IMPROVEMENT PROJECTS

2.1 Background

This TM examines options for providing short term improvements to the District's water conveyance system that would allow excess winter water to be moved from SCWA's system through Marin Water's system to meet demand and fill existing storage. This water would be available episodically after winter storms, in the best case extending for a period of weeks at a time following a major storm or series of storms. The total duration of availability in a given year could vary from zero, or nearly so, to a practical maximum of the entire winter period (October 15 to April 1, a period of 167 days).

It's been estimated that the total volume of water available in a given year might be as little as 1,100 acre-feet, or even less, to as much as 12,500 acre-feet. The study goal is to examine ways to take as much water as possible during periods when winter water is available and flow rates are limited only by Marin Water's ability to convey and use the water.

In discussions with the District, the possibility of additional flows beyond winter water ("summer water") was also identified. While not the subject of this technical memorandum, much of the analysis presented for winter water could be readily extended to model performance of various options with summertime system demands. Summertime demands would also present new project alternatives such as increasing the capacity of the SCWA connection by upgrades to pumping and chemical treatment as needed.

2.2 Assumptions

The analysis assumes that the current upgrades to the Kastania Pump Station are completed and provides a resulting flow rate at Ignacio Pump Station of about 14.8 MGD. This flow rate provides an upper bound on the amount of winter water that could be taken.

While as explained above, the number of winter water pumping days per year is unknown, its upper bound is about 167 days, and the upper bound of annual volume is about 12,500 acre-feet. Taking that volume over a 167-day period would be equal to 24 MGD, a rate well in excess of IPS current capacity, and in excess of total system winter demand (about 14.1 MGD). Thus, there are at least some periods of time during which Marin Water's ability to use the winter water source is limited not by the source availability, but by the lowest of: system demand, IPS capacity, and hydraulic limitations downstream of IPS. The first two constraints could be addressed by options that transfer water to storage and upgrades to IPS. This TM did not explore such options and instead focused on ways to alleviate hydraulic limitations downstream of IPS.

The analysis does *not* consider the possible future East Bay Intertie Project ("Intertie Project"). Some of the system improvements proposed as part of the Intertie Project would potentially help convey winter water as well, so the improvements discussed in this TM could be refined accordingly.

This TM presents various alternatives to relieve bottlenecks and provides estimated component capacity improvements for each alternative project, including selected variants of each major alternative project. In general, the overall SCWA capacity increase that would result from a given portfolio of projects may add up to less than the sum of the capacity increases of the individual projects, since some projects at least partially relieve the same bottleneck as an alternative project.

2.3 Initial Conveyance Improvement Projects

The District initially highlighted potential project locations where improvements could be made, which have been modified and expanded upon during follow-up discussions. An overview figure showing the locations of the proposed Projects is shown in Figure 1 and a brief description of the initial projects is included in Table 1. In the figure, projects that were screened out based on discussions between W&C and the District are shown with grey backgrounds.

Table 1 – Initial Project Evaluated

Project Number	Project Name	Project Description	Alternative Considered in Refinement Phase
1	North Redwood Highway Conveyance Booster Projects	This project proposes a new 24" pipe along Los Gamos Drive to convey flow south from the Redwood Highway Pump Station to the transmission line in Manuel T. Freitas Parkway and parallels the existing 12" pipe with a 24" pipe to bypass the Los Ranchitos Tank and upsizes (or parallels) the existing 14" pipe downstream of the tank with a 24" pipe to convey additional flow South.	Yes
2	Santa Margarita Conveyance Improvements	This project installs a new altitude valve on the 16" line that flows to the Santa Margarita tank and Pump Station. The altitude valve will allow the tank to be filled while the Santa Margarita Pumps operate. This project also proposes a new 30" pipe that bypasses the Hawthorne Hills tank, and allows for additional flow to be conveyed South from the Santa Margarita Pump Station.	Yes
3	Forbes Hill Improvements	This project would install a new pump station at the existing Forbes Hill Reservoir to convey additional flow to the PMT Pressure Zone, and proposes a 24" pipe to bypass the Los Ranchitos Tank and upsizes (or parallels) the existing 14" pipe downstream of the tank to convey additional flow south toward Forbes Hill Reservoir, and can carry flow from either Lucas Valley Pump Station or the North Redwood Drive Booster Station.	Yes
4	San Quentin Conveyance Improvements	This project parallels the existing 12" with a new 24" pipe to reduce pressure and increase flow on the discharge side of the San Quentin pump and adds a new pump to increase flow through the San Quentin Pump Station (the station already has electrical capacity for a new pump).	Yes
5	Federal Works Booster Improvements	Increases capacity at the Federal Works Pump Station to convey flow south	Yes
6	Civic Loop Pipe	This project proposes a new 8" connection between the existing pipes in the utility easement in Civic Center Drive and Scettrini Drive to convey additional flow south from the Redwood Highway Pumps.	No, minimal modeled flow benefit

Project Number	Project Name	Project Description	Alternative Considered in Refinement Phase
7	Greenbrae Tank Pipe Upsizing	This project parallels a section of 8" with a 16" pipe to avoid throttling flow coming from the Greenbrae tank and the San Quentin PS.	No, minimal modeled flow benefit
8	Phoenix Transfer Pump Improvements	Increases capacity at the Phoenix Pump Station to convey flow from Ross Reservoir to Pine Mountain Tunnel and from Pine Mountain Tunnel to Bon Tempe	No, alternative could be reintroduced in a later phase
9	Civic Center San Ventia Intertie	Upsizes (or parallels) a section of 8" pipe to 12" in Peter Behr Drive to increase flow south from the Redwood Highway Pumps.	No, minimal modeled flow benefit
10	Redwood Highway Pipe Upsizing	Upsizes (or parallels) a section of 8" pipe to 14" in the Redwood Highway to increase flow south from the Redwood Highway Pumps.	No, minimal modeled flow benefit

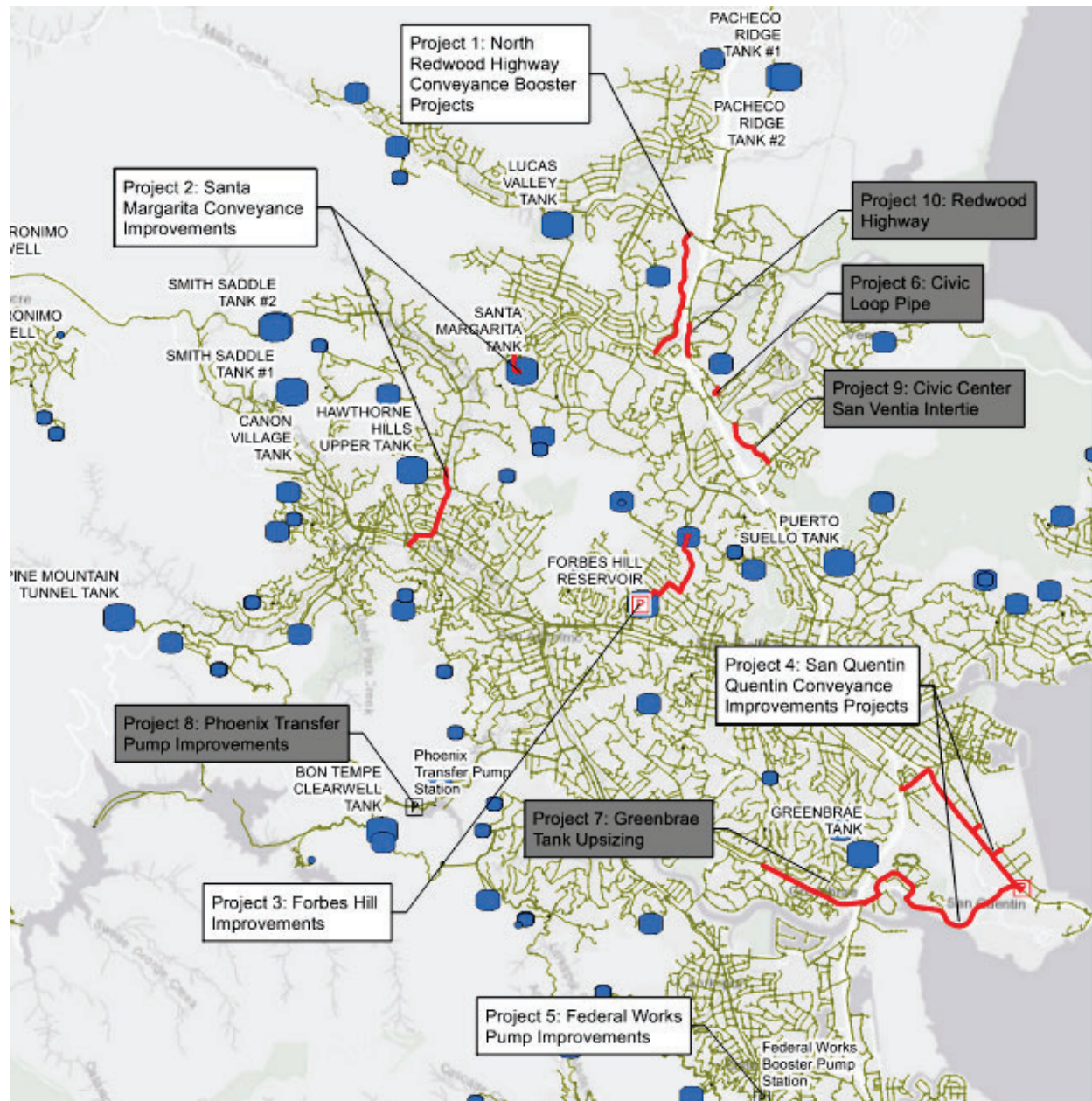


Figure 1 - Overview of Initial Conveyance Improvements Evaluated

2.4 Refined Conveyance Improvement Projects

As part of this study, the following projects were refined to focus on specific conveyance needs:

- Project 1. Conveyance from North Redwood Drive Booster Station to the southwestern part of the distribution system. The current piping from North Redwood Drive Booster Station is effective at conveyance to the Lucas Valley tank but has limited capacity to send flow south. Additional transmission

pipings would provide more flexibility and allow Lucas Valley to convey flow towards Santa Margarita Tank while North Redwood Drive Booster Station conveys flows towards Los Ranchitos Tank and other uses in the southwestern part of the system. This project may be combined with a component of Project 3, specifically with 3C consisting of a Los Ranchitos Bypass that would also allow these pumps to move flow all the way to Forbes Hill Reservoir.

- Project 2. Conveyance from Santa Margarita Tank to Smith Saddle and the Pine Mountain Tunnel (PMT) Zone. The Lucas Valley pumps can send up to about 7.3 mgd to the Santa Margarita tank, but there is less capacity to convey flow from Santa Margarita tank to the western side of the MMWD system. Improvements could increase that conveyance capacity to be more in line with the conveyance capacity from Lucas Valley.
- Project 3. Conveyance from Forbes Hill Reservoir into the PMT Zone. The Lucas Valley pumps can currently pump about 6.2 mgd to Forbes Hill Reservoir. The proposed Los Ranchitos bypass project (element 3C of this project) would improve that conveyance, and, with other improvements, could allow North Redwood Drive Booster Station to fill Forbes Hill Reservoir. However, there are limitations in the demand downstream of Forbes Hill Reservoir. Therefore, using these supplies may require a new pump station that conveys flow from Forbes Hill Reservoir into the PMT Zone.
- Project 4. Conveyance from San Quentin Pump Station into the Ross Valley zone. The San Quentin pump station pumps from the Forbes Hill pressure zone into the Ross Valley zone, where it can serve a much larger set of demands and be conveyed south towards southern Marin. Current pumping capacity is limited by undersized piping both on the suction side of the pump and on the discharge side of the pump station. A series of improvements have been identified to improve potential pumping capacity.
- Project 5. Conveyance from Ross Valley Zone towards the Alto Tanks through Federal Works Booster Station. The improvements described above may increase supply available to the Ross Valley zone but moving that water to Southern Marin requires the use of Federal Works Booster Station. Potential improvements to this pump station to increase that conveyance (which would reduce the need to use Bon Tempe supplies) have been identified.

Figure 2 below shows the general flow path of each alternative. It is recommended that these alternatives be constructed in project bundles or groupings to maximize the flow benefits through areas of the system. Further analysis of these benefits will be analyzed in a future phase of work (See Section 3 for a discussion of next steps). Additional details about these refined alternatives are presented on the following pages with brief project descriptions of all project subprojects, tables summarizing modeled flows and costs, and an overview figure of each alternative.

2.4.1 Basis of Cost

An opinion of probable construction cost (OPCC) with approximate soft costs (design, environmental documentation & permits, project administration, and construction management cost) has been developed based on each of the refined alternatives presented in this section of the report. The cost estimate was prepared consistent with a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International in its Recommended Practice No. 18R-97 with an expected accuracy range of +50 percent to -15 percent to actual costs. To avoid under

predicting the costs for the various conveyance improvement projects, 50 percent contingency has been applied to all project alternatives at this level of Project development to account for design contingencies and unknown conditions. It is suggested that costs be revisited as new information is obtained about various project alternatives.

Costs are reported in October 2021 dollars. The corresponding cost index benchmark is the Engineering News Record Construction Index for the San Francisco area (ENRSF CCI) for October 2021, which is 14,452.

Unit costs were derived from the following sources:

- RS Means 2021 Heavy Construction Cost Data
- The “Sanks Curve” from Pumping Station Design edited by Robert L. Sanks for pump station costs. These curves implicitly assume construction of a new pump station. More detailed studies might find that existing pump stations could be expanded rather than replaced, potentially at a lower cost. Conversely, more detailed studies could find project-specific factors that drive costs up significantly, for example land acquisition, adverse site conditions, or a need for temporary pumps during construction.
- Recently prepared OPCCs:
 - Del Puerto Canyon Reservoir, Patterson, CA
 - Pine Mountain Tanks, MMWD, CA

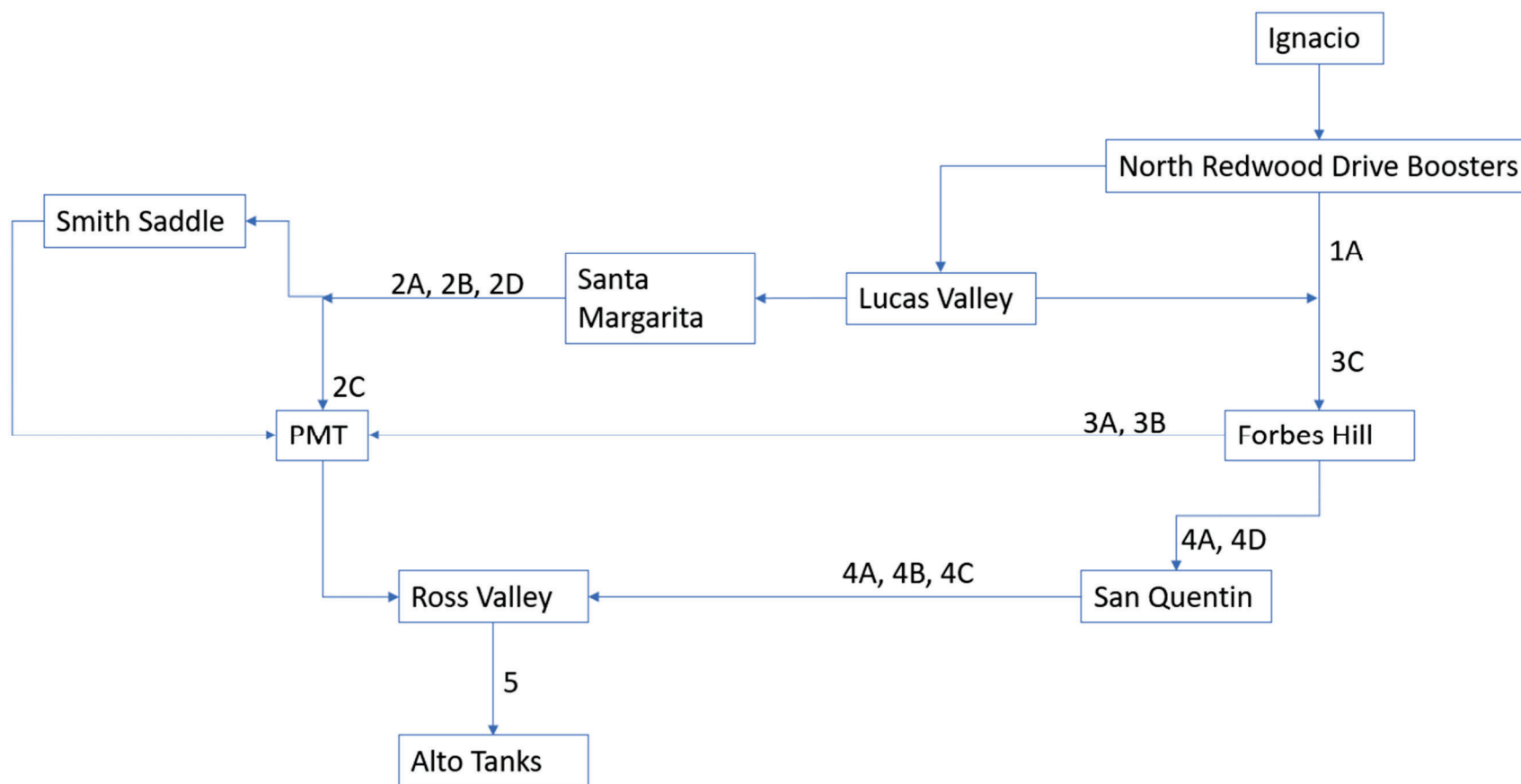


Figure 2 – Schematic of Project Bottleneck Improvement Flow Paths

1 - North Redwood Highway Booster Conveyance Improvements

Project Description: This project aims to increase the amount of flow that can be conveyed to the south from the North Redwood Drive Booster Pumps, towards Los Ranchitos and the Forbes Hill Tank or other customers in the greater San Rafael area. Flow from the booster pumps would be sent through the transmission main in Manuel T. Freitas Parkway (through project 1A) and could continue south to Forbes Hill reservoir (through project 1B).

Note that increasing conveyance to the south would somewhat decrease flows going to Lucas Valley Tank. However, even with the proposed projects implemented, conveyance capacity to Lucas Valley Tank would be approximately 11.1 mgd (with 3 pumps operating), which is more than the combination of the demands served by Lucas Valley Tank and the capacity of the Lucas Valley pump station. This 11.1 mgd would be in addition to the 6.7 mgd flowing to the Forbes Hill and approximately 1 mgd for local demands.

Project Components

- 1A - This project proposes a new 24" pipe along Los Gamos Drive to convey flow south from the Redwood Highway Pump Station to the transmission line in Manuel T. Freitas Parkway. It would increase resiliency by allowing the system to be less reliant on Lucas Valley Pumps and Tanks to move Ignacio Valley water.
- 3C – Part of the Forbes Hill Improvement Project (Project 3). This project would parallel the existing 12" pipe with a 24" pipe to bypass the Los Ranchitos Tank and upsizes (or parallels) the existing 14" pipe downstream of the tank with a 24" pipe to convey additional flow south toward Forbes Hill Reservoir and can carry flow from either Lucas Valley Pump Station or the North Redwood Drive Booster Station.

Table 2 - North Redwood Highway Booster Pump Conveyance Improvements

Conveyance	Flowrate ¹	Notes
No Improvements		
North Redwood Drive Booster Pumps to Los Ranchitos or Forbes Hill Tank	0 mgd	1.7 mgd pumped to demands East of HWY 101.
1A: Los Gamos Drive Project		1A: \$11,000,000
North Redwood Drive Booster Pumps to Los Ranchitos Tank or south towards San Quentin PS via Los Gamos Drive Pipeline	5.5 mgd	Flow can be sent either to Los Ranchitos or to Forbes Hill Tank
North Redwood Drive Booster Pumps to Forbes Hill Tank	3.4 mgd	
1A: Los Gamos Drive Project + 3C: Los Ranchitos Bypass		1A: \$11,000,000 3C: \$8,500,000 Total: \$19,500,000
North Redwood Drive Booster Pumps to Forbes Hill Tank	6.7 mgd	

1. Conveyance to Forbes Hill Tank with 3 pumps operating.

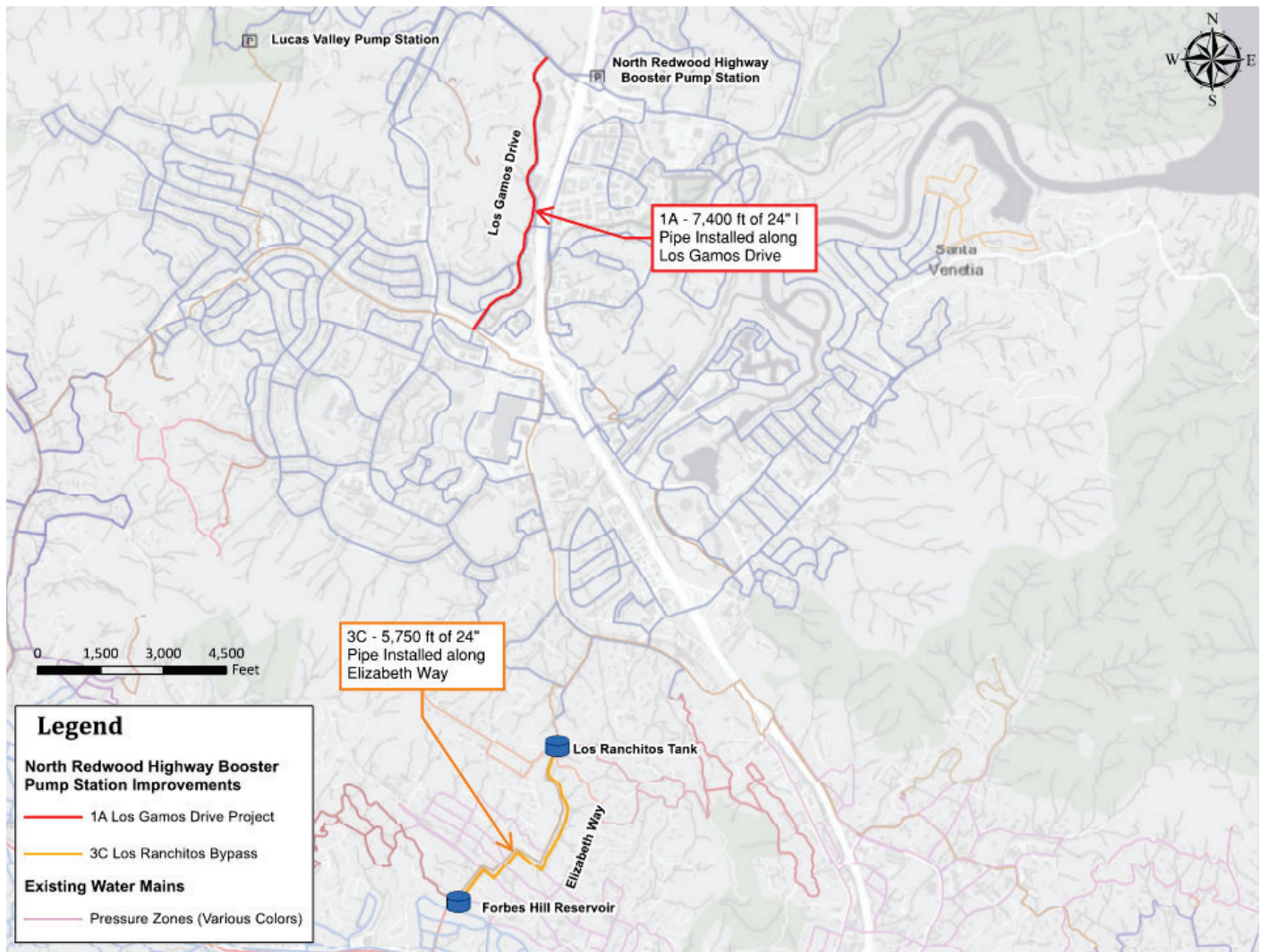


Figure 3 – North Redwood Highway Booster Pump Conveyance Improvements

2 – SANTA MARGARITA CONVEYANCE IMPROVEMENTS

Project Description: This project aims to increase the amount of flow that can be conveyed to the west side of the system from the Santa Margarita Tanks. This flow can either be sent to the Smith Saddle Pressure Zone (where it can flow through the Fairfax Transmission Regulator to the PMT pressure zone) or directly to the PMT pressure zone.

Project Components

- 2A – This project installs a new altitude valve on the 16" line that flows to the Santa Margarita tank and Pump Station. The altitude valve will allow the tank to be filled while the Santa Margarita Pumps operate. This project is in process and will be completed by MMWD Staff.
- 2B – This project parallels the existing 14" pipe with a 20" pipe to reduce headloss in the discharge pipe of the pump station (note this alternative is only required if a new pump is installed- 2D).
- 2C – This project proposes a new 30" pipe that bypasses the Hawthorne Hills tank and allows for additional flow to be conveyed South from the Santa Margarita Pump Station. This component will improve flows from Smith Saddle Tanks to Ross Reservoir and the Pine Mountain Tanks pressure zone. It also increases flexibility for moving water if only Bon Tempe Treatment Plant or SGTP is active.
- 2D – This project proposes a new 10.9 mgd pump station that replaces the existing Santa Margarita pump station. The additional pumps would use VFD's to turn flow down or up as needed for operation flexibility.

Table 3 – Santa Margarita Conveyance Improvements¹

Conveyance	Flowrate	Notes
No Improvements		
Santa Margarita Tank to Smith Saddle	3.6 mgd @ 70% operation ² = 2.5 mgd	
Santa Margarita Tank to PMT Zone	3.6 mgd @ 70% mgd = 2.5 mgd	
2A: Santa Margarita Altitude Valve		2A: \$150,000
Santa Margarita Tank to Smith Saddle	3.6 mgd ³	
Santa Margarita Tank to PMT Zone	3.6 mgd ³	
2B: Discharge Piping Improvements (From 14-inch to 20-inch)		2B: \$1,400,000
Santa Margarita Tank to Smith Saddle	3.9 mgd ³	
Santa Margarita Tank to PMT Zone	3.9 mgd ³	
2B: Discharge Piping Improvements + 2C Hawthorne Hills Bypass Pipe		2B: \$1,400,000 2C: \$6,900,000 Total: \$8,300,000
Santa Margarita Tank to Smith Saddle	3.9 mgd ³	
Santa Margarita Tank to PMT Zone	4.1 mgd ³	
2B: Discharge Piping Improvements (20-inch) 2D: Santa Margarita Pumping Improvements (130 psi discharge pressure)		2B: \$1,400,000 2D: \$13,000,000 Total: \$14,400,000
Santa Margarita Tank to Smith Saddle	10.9 mgd ^{1,3}	
Santa Margarita Tank to PMT Zone	8.8 mgd ^{1,3}	
2B: Discharge Piping Improvements (20-inch) 2C: Hawthorne Hills Bypass Pipe 2D: Santa Margarita Pumping Improvements (130 psi discharge pressure)		2B: \$1,400,000 2C: \$6,900,000 2D: \$13,000,000 Total: \$21,300,000
Santa Margarita Tank to Smith Saddle	10.9 mgd ^{1,3}	
Santa Margarita Tank to PMT Zone	10.9 mgd ^{1,3}	

- Note that Lucas Valley to Santa Margarita conveyance capacity is approximately 7.3 mgd with 2 pumps active.
- The Santa Margarita Tank does not currently have a dedicated discharge line for the pump, so the pump must be turned off while the tank is being refilled. Based on review of SCADA data, the pump is typically turned off for 30% of the time to allow the tank to refill.
- Flow can be directed either to Smith Saddle or the PMT Zone

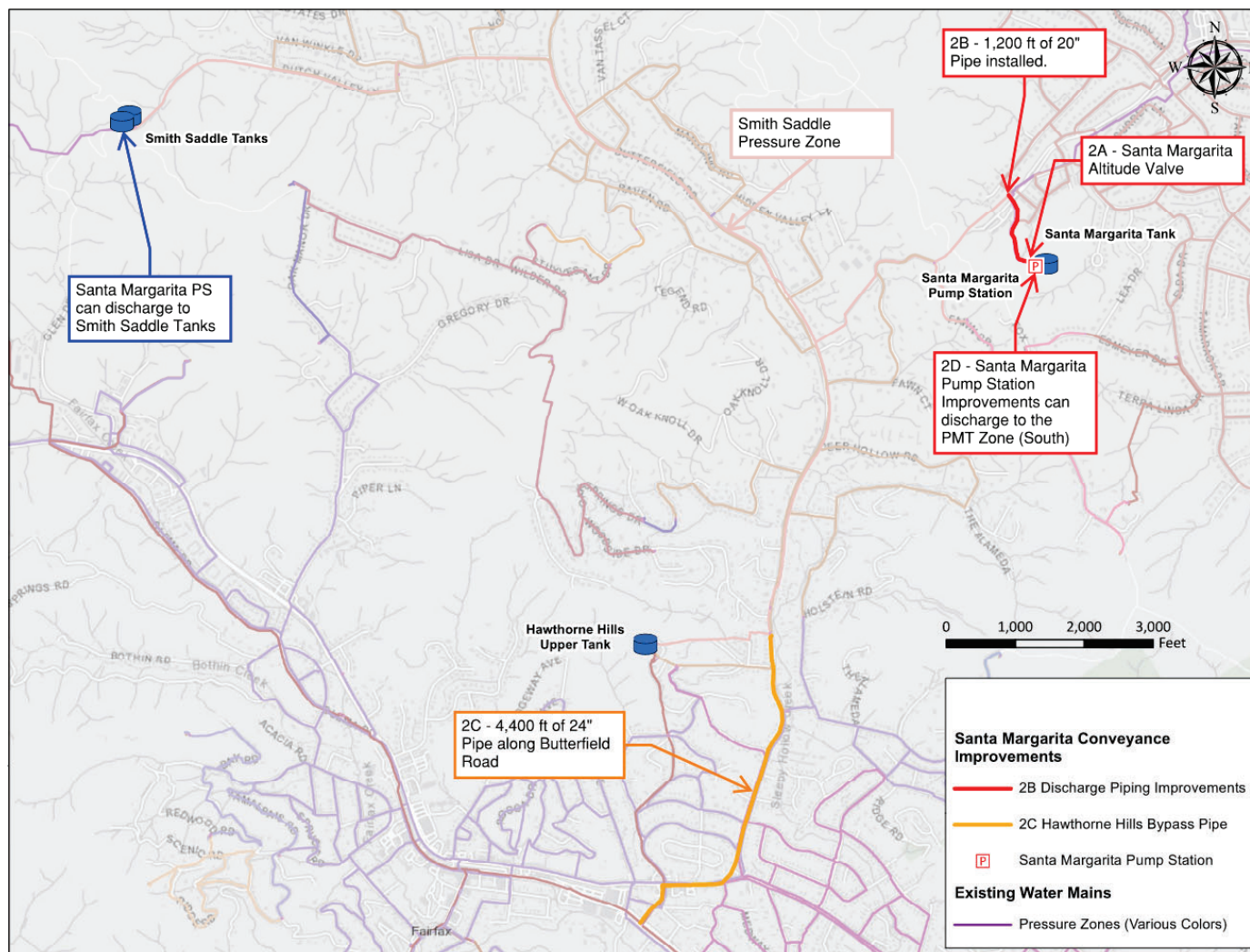


Figure 4 – Santa Margarita Conveyance Improvements

3 - FORBES HILL IMPROVEMENTS

Project Description: This project would install a new pump station at the existing Forbes Hill Reservoir to convey additional flow to the PMT Pressure Zone. It would include Project 1A as well.

Project Components

- 1A - Described above, this project proposes a new 24" pipe along Los Gamos Drive to convey flow south from the Redwood Highway Pump Station to the transmission line in Manuel T. Freitas Parkway
- 3A - This project would install a new 3 mgd pump station at the existing Forbes Hill Reservoir.
- 3B - This project installs a new 4.3 mgd pump station at the existing Forbes Hill Reservoir.
- 3C - This project would parallel the existing 12" pipe with a 24" pipe to bypass the Los Ranchitos Tank and upsizes (or parallels) the existing 14" pipe downstream of the tank with a 24" pipe to convey additional flow south toward Forbes Hill Reservoir, and can carry flow from either Lucas Valley Pump Station or the North Redwood Drive Booster Station.

Table 4 – Conveyance to Forbes Hill Improvements

Conveyance	Flowrate	Notes
No Improvements		
Lucas Valley to Forbes Hill	6.2 mgd ¹	Assumes zero flow from Redwood Drive Booster Pump Station to Forbes Hill
North Redwood Drive Booster Pumps to Forbes Hill Tank	0 mgd ²	Assumes zero flow from Lucas Valley Pump Station to Forbes Hill
1A: Los Gamos Drive Project		1A: \$11,000,000
Lucas Valley to Forbes Hill	6.2 mgd	See notes above
North Redwood Drive Booster Pumps to Forbes Hill Tank	3.1 mgd	See notes above
3C: Los Ranchitos Bypass		1B: \$8,500,000
Lucas Valley to Forbes Hill	9.2 mgd	See notes above
North Redwood Drive Booster Pumps to Forbes Hill Tank	0 mgd	See notes above
1A: Los Gamos Drive Project + 3C: Los Ranchitos Bypass		1A: \$11,000,000 3C: \$8,500,000 Total: \$19,500,000
Lucas Valley to Forbes Hill	9.2 mgd	See notes above
North Redwood Drive Booster Pumps to Forbes Hill Tank	6.7 mgd	See notes above

1. Pumping capacity with 2 pumps operating.
2. Conveyance to Forbes Hill Tank with 3 pumps operating.

Table 5 – Forbes Hill Pump Station Improvements

Conveyance	Flowrate	Notes
No Improvements		
Forbes Hill Tank to PMT Zone	0 mgd	no existing pumping capacity
3A: Forbes Hill Tank Pump Station (130 psi discharge pressure)		3A: \$3,500,000
Forbes Hill Tank to PMT Zone	3.0 mgd	
3B: Forbes Hill Tank Pump Station (150 psi discharge pressure)		3B: \$4,300,000
Forbes Hill Tank to PMT Zone	4.3 mgd	

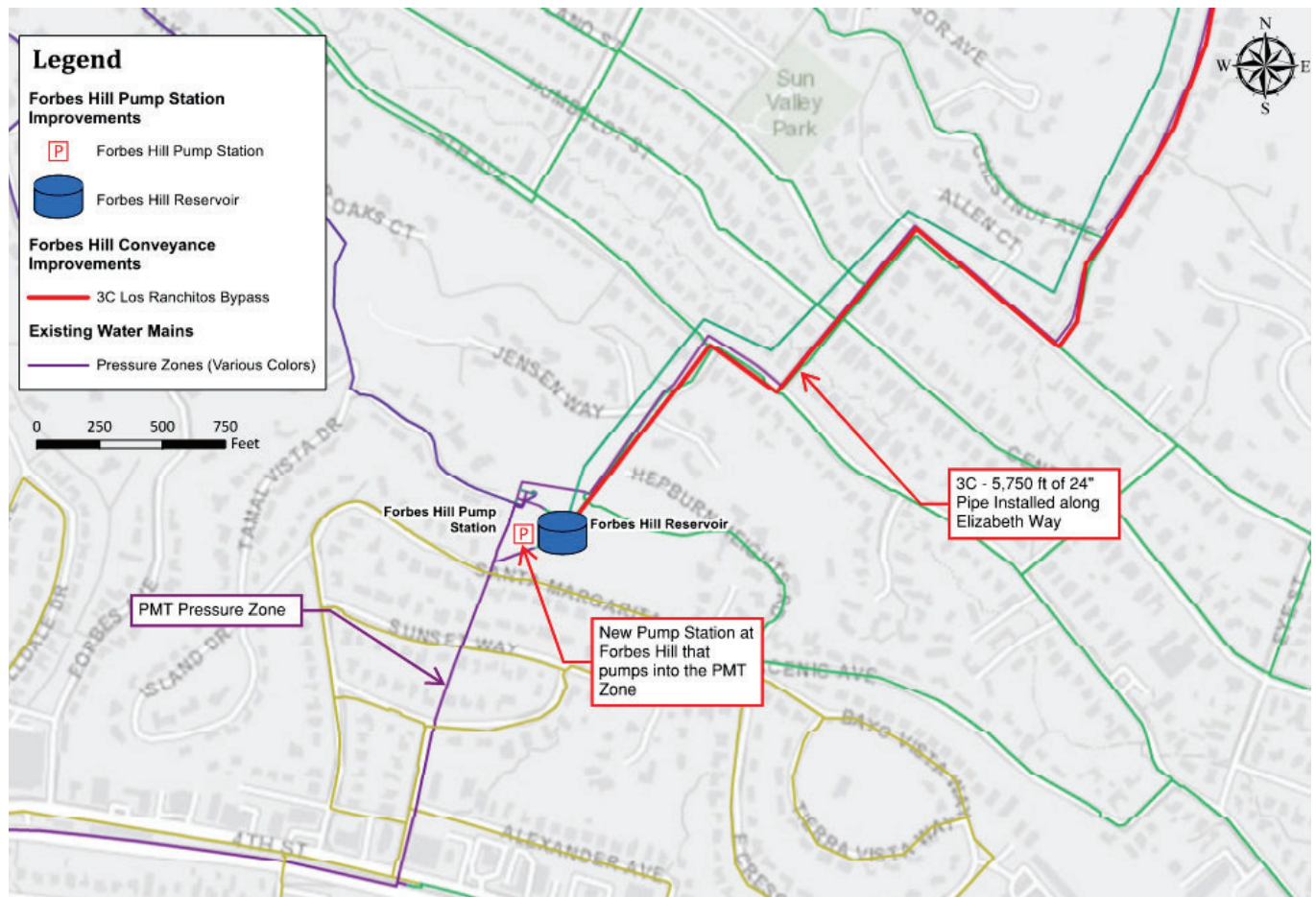


Figure 5- Forbes Hill Pump Station Improvements

4- SAN QUENTIN CONVEYANCE IMPROVEMENTS

Project Description: This project includes several measures to increase flow from the San Quentin Pump Station to the federal works pump station and the Ross Reservoir Pressure Zone. The measures can be implemented singly or in combinations.

- 4A - This project parallels the existing 12" with a new 24" pipe to reduce pressure and increase flow on the discharge side of the San Quentin pump station and parallels the existing 8" and 12" pipes in Francisco Blvd and Shoreline Parkway with new 12", 18", and 24" pipes to improve flow to the pump station.
- 4B - This project replaces the existing San Quentin Pump Station with a new station capable of conveying 6.25 mgd.
- 4C – This Project proposes additional discharge piping along Sir Francis Drake Blvd. to parallel the existing main (8200 feet of 24") and extends a 20" line under Highway 101 along Sir Francis Drake Blvd. to tie into the existing 20" main on Sir Francis Drake Blvd.
- 4D – This project parallels existing mains in Francisco Blvd. and Bellam Blvd. with a 24" and 18" pipeline to reduce headloss and increase flow on the suction side of the San Quentin Pump Station

Table 6– San Quentin Pump Station Conveyance Alternatives

Conveyance	Flowrate (85 psi suction side pressure limit)	Flowrate (variable suction and discharge pressure limits)	Notes (variable suction and discharge pressure limits)
No Improvements			
Existing San Quentin Pump Station (2 Pumps)	3.47 mgd	NA	
4A: San Quentin Pump Station Suction and Discharge Pipe Improvements (Parallel Pipe)	4A: \$4,800,000		
San Quentin Pump Station	4.14 mgd	4.14 mgd	Suction pressure model result equals 62.2 psi and discharge pressure model result equals 161 psi
4A: San Quentin Pump Station Suction and Discharge Pipe Improvements 4B: Upgraded San Quentin Pump Station	4A: \$4,800,000 4B: \$6,500,000 Total: \$11,300,000		
San Quentin Pump Station	4.48 mgd	5.8 mgd	Suction pressure model result equals 66.9 psi and discharge pressure set at 200 psi
4A: San Quentin Pump Station Suction and Discharge Pipe Improvements 4B: Additional Pump at the San Quentin Pump Station 4C: San Quentin Pump Station Additional Discharge Piping along Sir Francis Drake Blvd.	4A: \$4,800,000 4B: \$6,500,000 4C: \$18,000,000 Total: \$29,300,000		
San Quentin Pump Station	4.48 mgd	6.12 mgd	Suction pressure model result equals 62.2 psi and discharge pressure model result equals 161 psi
4A: San Quentin Pump Station Suction and Discharge Pipe Improvements	4A: \$4,800,000 4B: \$6,500,000		

Conveyance	Flowrate (85 psi suction side pressure limit)	Flowrate (variable suction and discharge pressure limits)	Notes (variable suction and discharge pressure limits)
4B: Additional Pump at the San Quentin Pump Station 4D: San Quentin Pump Station Additional Suction Piping along Francisco Blvd. and Bellam Blvd.	4D: \$8,500,000 Total: \$19,800,000		
San Quentin Pump Station	5.00 mgd	5.8 mgd	Suction pressure model result equals 88 psi and discharge pressure set at 200 psi
4A: San Quentin Pump Station Suction and Discharge Pipe Improvements 4B: Additional Pump at the San Quentin Pump Station (Matches Existing Pumps) 4C: San Quentin Pump Station Additional Discharge Piping along Sir Francis Drake Blvd. 4D: San Quentin Pump Station Additional Suction Piping along Francisco Blvd. and Bellam Blvd.	4A: \$4,800,000 4B: \$6,500,000 4C: \$18,000,000 4D: \$8,500,000 Total: 37,800,000		
San Quentin Pump Station	6.25 mgd	8.82 mgd	Suction pressure set to 60 psi and discharge pressure model result equals 175 psi



5 - FEDERAL WORKS BOOSTER IMPROVEMENTS

Project Description: This project replaces the existing Federal Works pump station to convey additional flow to southern Marin, including the Alto Tanks.

Project Components

- 5A - This project replaces the existing Federal Works Pump Station with a new 9 mgd pump station to convey additional flow South.

Table 7 – Federal Works Booster Improvements

Conveyance	Flowrate	Notes
No Improvements		
PMT Zone to Alto Tanks (Federal Works Booster)	5.1 mgd ¹	~130 psi discharge pressure
5A: Federal Works Booster Improvements (150 psi discharge pressure)		4A: \$10,000,000
PMT Zone to Alto Tanks	8.9 mgd ¹	

- Pumping capacity with 2 pumps operating.

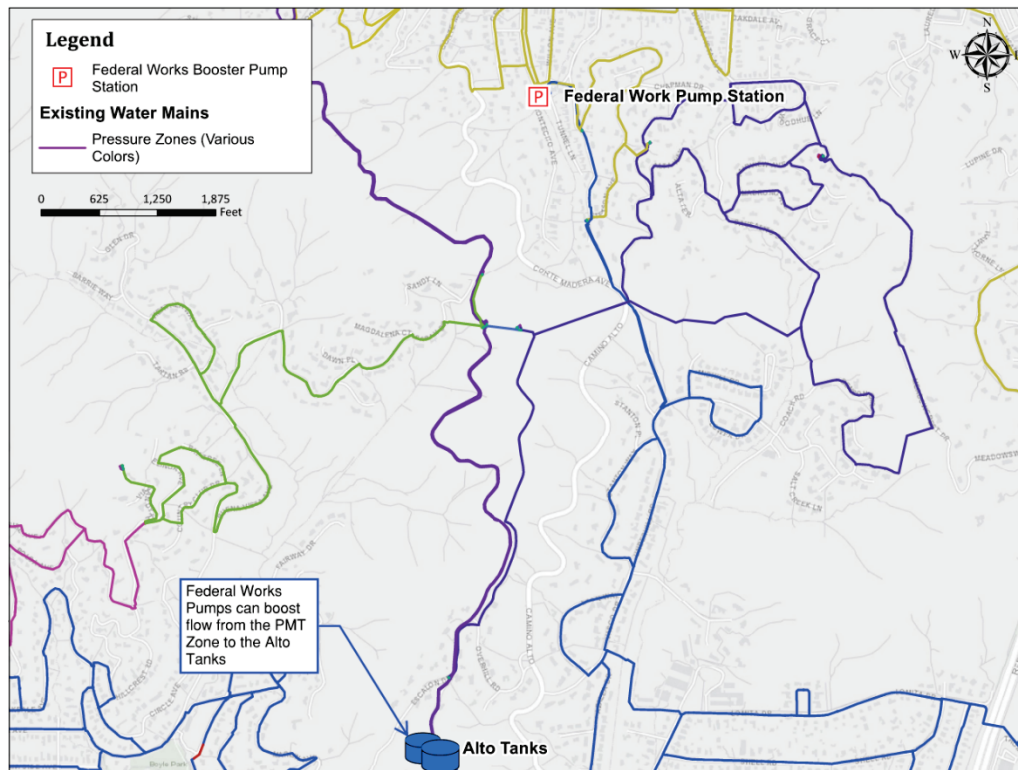


Figure 7 – Federal Works Booster Pump Improvements

3. NEXT STEPS

The projects included here are described at a level intended for project screening only, based on cost of improvements and the incremental benefit in increased conveyance capacity. Several of these projects may require other projects to also be implemented in order to provide significant benefit. The schematic shown in Figure 2 indicates how the different project can work together. For example, Project 1 synergizes with Project 2A-2D because Project 1 allows the North Redwood Drive Booster pumps to move water south while Project 2 allows better conveyance from the Lucas Valley pumps to the western side of the system. Given 16 mgd of available capacity from Ignacio pump station, flow from both Lucas Valley and North Redwood Drive booster pumps would likely be needed. Likewise, multiple paths will likely be needed to convey the available supply from Ignacio to the Ross Valley and southern Marin parts of the system, so Projects 2A-2D, 3A-3C, and 4A-4D improve different flow paths from the eastern part of the system to Ross Valley, while project 5 improves conveyance from Ross Valley to southern Marin.

Woodard & Curran recommend that these alternative projects be compiled into alternative project portfolios. These project portfolios will show the additive benefits of the combining the various alternative projects listed in this TM. These projects can also be evaluated for additional benefits such as operation flexibility, ease of maintenance, replacing old infrastructure, or other benefits as determined by future analysis. A set of three example project portfolios are shown below in Figures 8, 9, and 10. Those portfolios are not necessarily the “best” portfolios but are shown only to illustrate how portfolios might be packaged and assessed. The choice of a best portfolio for the District should weigh many factors beyond capacity increase and capital cost, such as benefits to operational flexibility or resilience, timeline for implementation, performance against a suite of credible demand scenarios, and synergy with other planned or potential projects.

Alternative A

Total Conveyance from Ignacio to Ross: 3.6 mgd + 3.0 + 3.5 mgd = 10.1 mgd

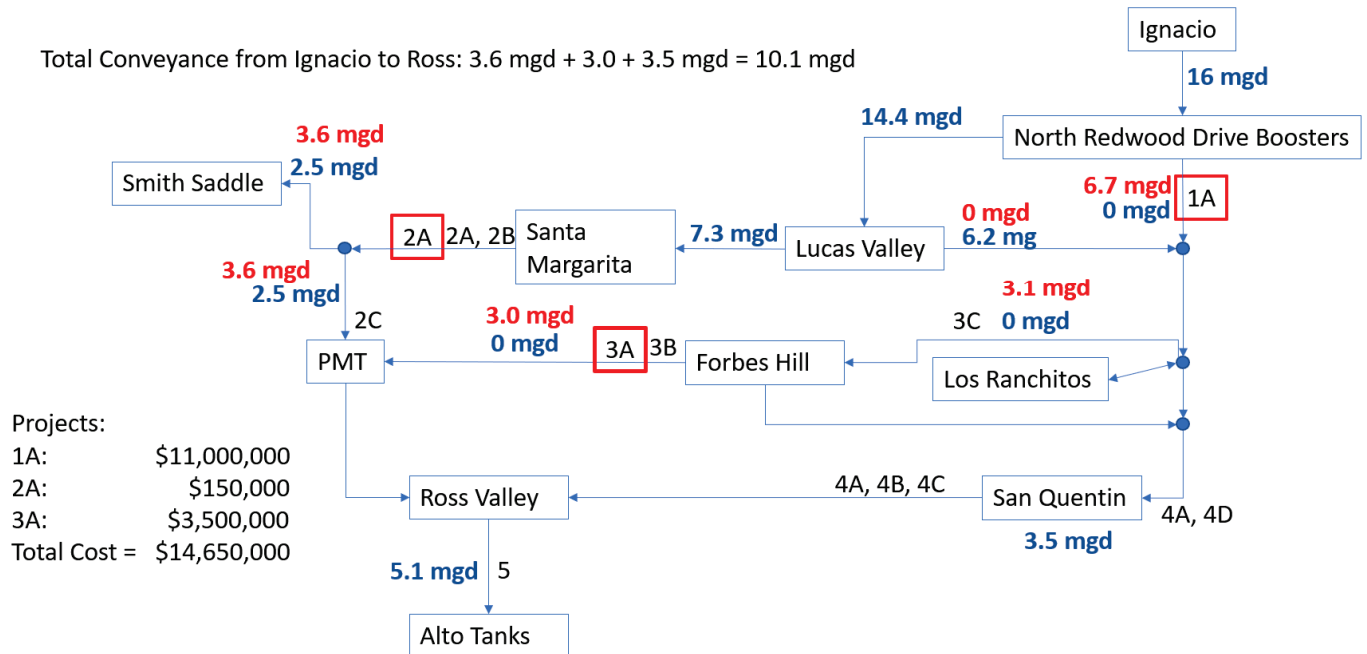


Figure 8- Example Project Portfolio "Alternative A"

Alternative B

Total Conveyance from Ignacio to Ross: 7.3 mgd + 3.5 mgd = 10.8 mgd

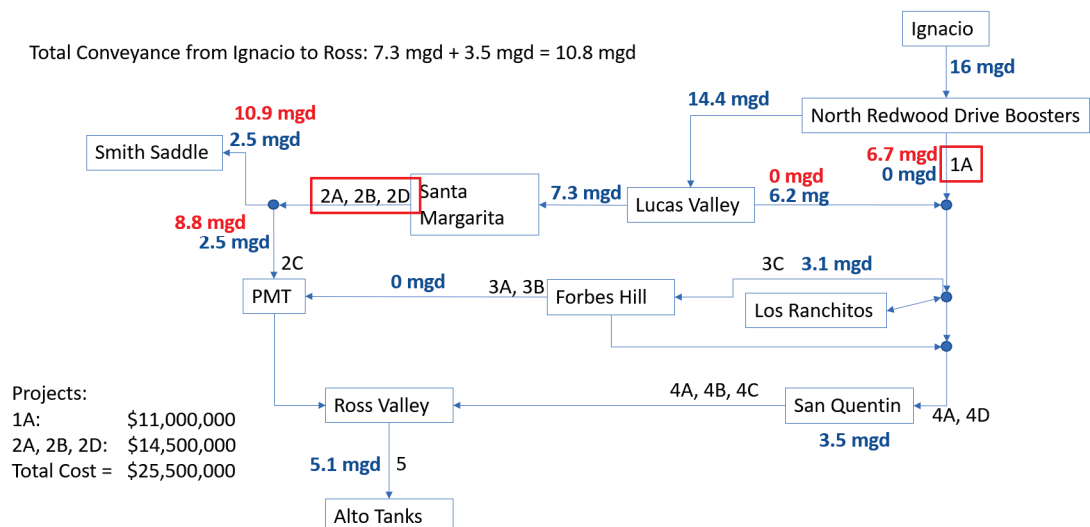


Figure 9 – Example Project Portfolio "Alternative B"

Alternative C

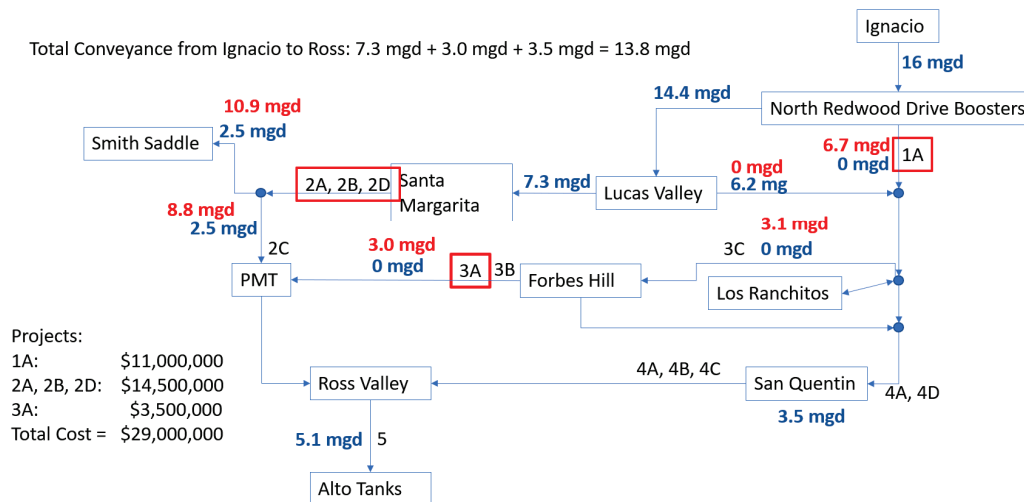


Figure 10 – Example Project Portfolio “Alternative C”

As shown in the sample portfolios, even a handful of project alternatives can produce a wide range of costs and benefits at the portfolio level, even considering only a single demand scenario as for the current work. The following steps are suggested to allow an appropriate range of portfolios to be considered and evaluated before the District chooses a specific portfolio for implementation.

- Consider adding additional projects consistent with the expanded project goals and constraints. I.e., instead of considering only short-term projects focused on winter water, longer-term projects that provide benefits year-round might be considered. Examples of such projects include expansion of IPS as well as pipelines to convey SCWA water to storage, e.g., via a repurposed Pine Mountain Tunnel or via a new pipeline.
- Assemble a "top ten" or similar sized list of portfolios for further exploration. While the theoretical number of portfolios is large (8,192 portfolios, based on 13 projects that could each in theory be part of a portfolio, or not), a top ten could be chosen based on judgment and-or screening criteria such as a cost ceiling, capacity/cost ranking, compatibility with other planned work, etc.
- Model performance of each top-ten portfolio against a range of supply and demand conditions, e.g., using a time-stepped model such as MarinSim to capture a range of hydrologic conditions. This modeling work should at minimum estimate the likely benefit of each modeled portfolio on an annual *volumetric* basis for different hydrologic year types.

The modeling can also consider the water system with and without other potential future projects such as the East Bay Intertie. For example, projects 4A-4D overlap with part of that project.

- Refine estimates of project scopes and costs for each top-ten portfolio. This exercise could generate important variants to a portfolio, and a need to model performance of those variants, if “inflection points” are identified as the project scope is explored.

For example, a pumping plant may be a candidate for a slight increase in flow by changing pumps and motors, without a major rehab or replacement; the cost and performance of that option should be compared to the cost and performance of a more comprehensive rehab or replacement. The tradeoffs between cost and performance depend on operating scenarios, for example, permissible pressures in the suction and discharge piping. As various scope variants are identified, cost and constructability issues can be assessed for each variant. Example issues include land acquisition needs, need for temporary facilities during construction, site constraints, etc.

As a portfolio is fine-tuned, the hydraulic modeling underpinning the relevant capacity estimates should be revisited as needed. The findings in this study are based on model results, but the model has undergone only limited recent validation. Pressure and flow representing existing conditions should be compared to model results to ensure model accuracy at all critical facilities, under multiple different operating scenarios. Similarly, the assumed future conditions should be verified since in some cases they will significantly impact the benefit of a given portfolio; an example of this is the assumed permissible system pressure on the suction side of San Quentin Pump Station.

After the above steps are done the District will be able to select a final portfolio for implementation considering a range of benefits and drawbacks. Benefits include not only flow increases but also synergy with other planned or potential projects including the East Bay Intertie, enhanced operational flexibility, increased system resilience, and performance against a wide range of future conditions. Drawbacks include not only cost, but environmental impacts, community concerns, and regulatory constraints.

Once a portfolio of projects has been selected, conceptual design of the projects should begin to confirm the constructability of the proposed improvements and refine the cost estimates. This could include land survey of the area, utility research, and preparation of base drawings to a 10% design level.

APPENDIX A: ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST



Project: 1A - Los Gamos Drive
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project proposes a new 24" pipe along Los Gamos Drive to convey flow south from the Redwood Highway Pump Station to the transmission line in Manuel T. Freitas Parkway

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	584,000	
2 - Sitework	\$	4,163,000	
Raw Construction Subtotal	\$	4,747,000	
Contractor Overhead & Profit	10%	\$ 470,000	
Sales Tax	8.125%	\$ 190,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost	\$	5,400,000	
Estimating Contingency	50%	\$ 2,700,000	
Estimated Construction Cost with Contingency	\$	8,100,000	
Environmental Documentation & Permits	5%	\$ 410,000	
Design Cost	15%	\$ 1,200,000	
Project Administration and Construction Management Cost	15%	\$ 1,200,000	
Estimated Total Capital Cost	\$	11,000,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							\$ 584,000	
	Mobilization	10%		1	LS	\$416,300	\$ 417,000	10% of Division 2
	Traffic Control	4%		1	LS	\$166,520	\$ 167,000	Light Urban

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework							\$ 4,163,000	
Sitework								
	Surface Restoration of Paved Areas, Full Lane			7,400	LF	\$132	\$ 977,000	Engineer's Estimate based potential utility conflicts on residential streets
	Utility Relocation			1	LS	\$15,000	\$ 15,000	
Open Cut Pipelines								
	24-inch Mortar Lined Steel Pipe	24 inch		7,400	LF	\$389	\$ 2,882,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1	LS	\$288,200	\$ 289,000	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances



Project: 2A - Santa Margarita Altitude Valve
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project installs a new altitude valve on the 16" line that flows to the Santa Margarita tank and Pump Station. The altitude valve will allow the tank to be filled while the Santa Margarita Pumps operate.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	10,000	
11 - Equipment	\$	73,000	
Raw Construction Subtotal		\$ 83,000	
Contractor Overhead & Profit	10%	\$ 8,300	
Sales Tax	8.125%	\$ 670	
Estimated Total Construction Cost		\$ 92,000	
Estimating Contingency	50%	\$ 46,000	
Estimated Construction Cost with Contingency		\$ 140,000	
Environmental Documentation & Permits	5%	\$ -	NA (District has performed the Design Work and will perform the Construction)
Design Cost	15%	\$ -	NA (District has performed the Design Work and will perform the Construction)
Project Administration and Construction Management Cost	5%	\$ 7,000	District will Perform this task
Estimated Total Capital Cost		\$ 150,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements	District Labor/Inspection			1	LS	\$10,000	\$ 10,000	10% of Division 2

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment	Altitude Valve						\$ 73,000	
	Construction of the Valve			1	LS	\$ 73,000	\$ 73,000	District estimate for the cost of the valve



Project: 2B - Santa Margarita Discharge Piping
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project parallels the existing 14" pipe with a 20" pipe to reduce headloss in the discharge pipe of the pump station.

Estimate Type: Concept Level

Process Cost Summary by Division									
Spec. Division	Subtotal						Notes		
1 - General Requirements	\$ 83,000								
2 - Sitework	\$ 584,000								
	Raw Construction Subtotal						\$ 667,000		
		Contractor Overhead & Profit	10%	\$	67,000		Overhead/profit already included in unit cost for well		
		Sales Tax	8.125%	\$	27,000		Assumes this applies to 50% of Raw Constr. Cost		
	Estimated Total Construction Cost						\$ 760,000		
		Estimating Contingency	50%	\$	380,000				
	Estimated Construction Cost with Contingency						\$ 1,100,000		
		Environmental Documentation & Permits	5%	\$	55,000				
		Design Cost	10%	\$	110,000				
		Project Administration and Construction Management Cost	10%	\$	110,000				
	Estimated Total Capital Cost						\$ 1,400,000		
Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes	
1 - General Requirements							\$ 83,000		
	Mobilization	10%		1	LS	\$58,360	\$ 59,000	10% of Division 2 and 16	
	Traffic Control	4%		1	LS	\$23,344	\$ 24,000	4% of Division 2	
2 - Sitework							\$ 583,600		
	Sitework								
	Surface Restoration of Paved Areas, Full Lane			1,200	LF	\$132	\$ 159,000		
	Piping and Appurtenances								
	20-inch Mortar Lined Steel Pipe	20 inch		1,200	LF	\$321	\$ 386,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.	
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1	LS	\$38,600	\$ 38,600	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances	



Project: 2C - Hawthorne Hills Tank Bypass
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project proposes a new 30" pipe that bypasses the Hawthorne Hills tank, and allows for additional flow to be conveyed South from the Santa Margarita Pump Station.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	373,000	
2 - Sitework	\$	2,656,000	
Raw Construction Subtotal	\$	3,029,000	
Contractor Overhead & Profit	10%	\$ 300,000	
Sales Tax	8.125%	\$ 120,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost	\$	3,400,000	
Estimating Contingency	50%	\$ 1,700,000	
Estimated Construction Cost with Contingency	\$	5,100,000	
Environmental Documentation & Permits	5%	\$ 260,000	
Design Cost	15%	\$ 770,000	
Project Administration and Construction Management Cost	15%	\$ 770,000	
Estimated Total Capital Cost	\$	6,900,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						\$	373,000	
	Mobilization	10%		1	LS	\$265,600	\$ 266,000	10% of Division 2
	Traffic Control	4%		1	LS	\$106,240	\$ 107,000	Light Urban

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework						\$	2,656,000	
	Sitework							
	Surface Restoration of Paved Areas, Full Lane			4,400	LF	\$132	\$ 581,000	
	Utility Relocation			1	Allow	\$15,000	\$ 15,000	Engineer's Estimate based potential utility conflicts on residential streets
	Open Cut Pipelines							
	30-inch Mortar Lined Steel Pipe	30 inch		4,400	LF	\$425	\$ 1,872,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1	LS	\$187,200	\$ 188,000	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances



Project: 3A - Forbes Station Alt A
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project installs a new 3 mgd pump station at the existing Forbes Hill Reservoir.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	138,000	
2 - Sitework	\$	45,000	
11 - Equipment	\$	1,323,000	
16 - Electrical	\$	-	
Raw Construction Subtotal		\$ 1,506,000	
Contractor Overhead & Profit	10%	\$ 150,000	
Sales Tax	8.125%	\$ 61,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost		\$ 1,700,000	
Estimating Contingency	50%	\$ 850,000	
Estimated Construction Cost with Contingency		\$ 2,600,000	
Environmental Documentation & Permits	5%	\$ 130,000	
Design Cost	15%	\$ 390,000	
Project Administration and Construction Management Cost	15%	\$ 390,000	
Estimated Total Capital Cost		\$ 3,500,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements								
	Mobilization	10%		1	LS	\$136,800	\$ 137,000	10% of Division 2
	Traffic Control	2%		1	LS	\$900	\$ 1,000	Rural

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework								
Open Cut Pipelines								
	Piping Allowance			1	LS	\$20,000	\$ 20,000	Engineer's Estimate. To be confirmed in more detailed design
	Misc. Pipe Appurtenances and valving			1	LS	\$25,000	\$ 25,000	Engineer's Estimate. To be confirmed in more detailed design

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment								
Pump Station Improvements								
	3 MGD Pump Station			1	LS	\$ 1,322,804	\$ 1,323,000	Sanks Curve for 3 MG Pump Station. To be confirmed in more detailed design. Assumes a new pump station will be installed.



Project: 3B - Forbes Station Alt B
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project installs a new 4.3 mgd pump station at the existing Forbes Hill Reservoir.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	171,000	
2 - Sitework	\$	45,000	
11 - Equipment	\$	1,654,000	
16 - Electrical	\$	-	
Raw Construction Subtotal		\$ 1,870,000	
Contractor Overhead & Profit	10%	\$ 190,000	
Sales Tax	8.125%	\$ 76,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost		\$ 2,100,000	
Estimating Contingency	50%	\$ 1,100,000	
Estimated Construction Cost with Contingency		\$ 3,200,000	
Environmental Documentation & Permits	5%	\$ 160,000	
Design Cost	15%	\$ 480,000	
Project Administration and Construction Management Cost	15%	\$ 480,000	
Estimated Total Capital Cost		\$ 4,300,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements								
	Mobilization	10%		1	LS	\$169,900	\$ 170,000	10% of Division 2
	Traffic Control	2%		1	LS	\$900	\$ 1,000	Rural

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework								
Open Cut Pipelines								
	Piping Allowance			1	LS	\$20,000	\$ 20,000	Engineer's Estimate. To be confirmed in more detailed design
	Misc. Pipe Appurtenances and valving			1	LS	\$25,000	\$ 25,000	Engineer's Estimate. To be confirmed in more detailed design

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment								
Pump Station Improvements								
	4.3 MGD Pump Station			1	LS	\$ 1,653,505	\$ 1,654,000	Sanks Curve for 4.3 MG Pump Station. To be confirmed in more detailed design. Assumes a new pump station will be installed.



Project: 3C- Los Ranchitos Tank Bypass
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project parallels the existing 12" pipe with a 24" pipe to bypass the Los Ranchitos Tank and upsizes (or parallels) the existing 14" pipe downstream of the tank with a 24" pipe to convey additional flow South.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	\$ 454,000	
2 - Sitework	\$ 3,238,000	
Raw Construction Subtotal	\$ 3,692,000	
Contractor Overhead & Profit 10%	\$ 370,000	
Sales Tax 8.125%	\$ 150,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost	\$ 4,200,000	
Estimating Contingency 50%	\$ 2,100,000	
Estimated Construction Cost with Contingency	\$ 6,300,000	
Environmental Documentation & Permits 5%	\$ 320,000	
Design Cost 15%	\$ 950,000	
Project Administration and Construction Management Cost 15%	\$ 950,000	
Estimated Total Capital Cost	\$ 8,500,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							\$ 454,000	
	Mobilization	10%		1	LS	\$323,800	\$ 324,000	10% of Division 2
	Traffic Control	4%		1	LS	\$129,520	\$ 130,000	Light Urban

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework							\$ 3,238,000	
	Sitework							
	Surface Restoration of Paved Areas, Full Lane			5,750	LF	\$132	\$ 759,000	
	Utility Relocation			1	LS	\$15,000	\$ 15,000	Engineer's Estimate based potential utility conflicts on residential streets
	Open Cut Pipelines							
	24-inch Mortar Lined Steel Pipe	24	inch	5,750	LF	\$389	\$ 2,240,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1	LS	\$224,000	\$ 224,000	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances



Project: 4A - San Quentin Pump Station Discharge Piping Improvements

Aspect: Short Term CIP Improvements

Notes: This project parallels the existing 12" with a new 24" pipe to reduce pressure and increase flow on the discharge side of the San Quentin pump station and parallels the existing 8" and 12" pipes in Francisco Blvd and Shoreline Parkway with 12", 18", and 24" pipes to improve flow to the pump station.

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	\$ 272,000	
2 - Sitework	\$ 1,935,000	
Raw Construction Subtotal	\$ 2,207,000	
Contractor Overhead & Profit 10%	\$ 220,000	Overhead/profit already included in unit cost for well
Sales Tax 8.125%	\$ 90,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost	\$ 2,500,000	
Estimating Contingency 50%	\$ 1,300,000	
Estimated Construction Cost with Contingency	\$ 3,800,000	
Environmental Documentation & Permits 5%	\$ 190,000	
Design Cost 10%	\$ 380,000	
Project Administration and Construction Management Cost 10%	\$ 380,000	
Estimated Total Capital Cost	\$ 4,800,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							\$ 272,000	
	Mobilization	10%		1	LS	\$193,440	\$ 194,000	10% of Division 2 and 16
	Traffic Control	4%		1	LS	\$77,376	\$ 78,000	4% of Division 2

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework							\$ 1,934,400	
	Sitework							
	Surface Restoration of Paved Areas, Full Lane			3,700 LF		\$132	\$ 489,000	
	Piping and Appurtenances							
	12-inch Mortar Lined Steel Pipe	12 inch		780	LF	\$299	\$ 234,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	18-inch Mortar Lined Steel Pipe	18 inch		850	LF	\$321	\$ 273,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	24-inch Mortar Lined Steel Pipe	24 inch		2,070	LF	\$389	\$ 807,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1	LS	\$131,400	\$ 131,400	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances



Project: 4B - Santa Margarita PS Improvments

Aspect: Short Term CIP Improvements

Date: 12/22/2021

Project Number: 0012036.00

Prepared By: Nathan Hanson

Checked By: Tony Valdivia

Check Date: 12/22/2021

Notes: This project proposes a new 10.9 mgd pump station that replaces the existing Santa Margarita pump station.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	309,000	
11 - Equipment	\$	3,087,000	
16 - Electrical	\$	-	
Raw Construction Subtotal		\$ 3,396,000	
Contractor Overhead & Profit	10%	\$ 30,000	Overhead/profit already included in unit cost for well
Sales Tax	8.125%	\$ 140,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost		\$ 3,600,000	
Estimating Contingency	50%	\$ 1,800,000	
Estimated Construction Cost with Contingency		\$ 5,400,000	
Design Cost	10%	\$ 540,000	
Project Administration and Construction Management Cost	10%	\$ 540,000	
Estimated Total Capital Cost		\$ 6,500,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							\$ 309,000	
	Mobilization	10%		1	LS	\$308,700	\$ 309,000	10% of Division 2 and 16
11 - Equipment							\$ 3,087,000	

San Quentin Pump Station Improvements

6.25 MGD Pump Station	1	LS	\$ 3,086,543	\$ 3,087,000	Sanks Curve for a 6.25 MG Pump Station (based on model). To be confirmed in more detailed design. Assumes a new pump station will be installed.
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Project: 4C- San Quentin Pump Station Suction Improvements

Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project parallels the existing 8" and 12" pipes in Francisco Blvd and Shoreline Parkway to 12", 18", and 24" pipes to improve flow to the pump station.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	975,000	
2 - Sitework	\$	6,957,000	
	Raw Construction Subtotal	\$ 7,932,000	
	Contractor Overhead & Profit 10%	\$ 790,000	Overhead/profit already included in unit cost for well
	Sales Tax 8.125%	\$ 320,000	Assumes this applies to 50% of Raw Constr. Cost
	Estimated Total Construction Cost	\$ 9,000,000	
	Estimating Contingency 50%	\$ 4,500,000	
	Estimated Construction Cost with Contingency	\$ 14,000,000	
	Environmental Documentation & Permits 5%	\$ 700,000	
	Design Cost 10%	\$ 1,400,000	
	Project Administration and Construction Management Cost 10%	\$ 1,400,000	
	Estimated Total Capital Cost	\$ 18,000,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						\$	975,000	
	Mobilization	10%		1	LS	\$695,660	\$ 696,000	10% of Division 2 and 16
	Traffic Control	4%		1	LS	\$278,264	\$ 279,000	4% of Division 2

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework						\$	6,956,600	
	Sitework							
	Surface Restoration of Paved Areas, Full Lane			13,065 LF		\$132	\$ 1,725,000	
	Piping and Appurtenances							
	20-inch Mortar Lined Steel Pipe	20 inch		4,865 LF		\$321	\$ 1,562,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	24-inch Mortar Lined Steel Pipe	24 inch		8,200 LF		\$389	\$ 3,194,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1 LS		\$475,600	\$ 475,600	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances



Project: 4D - San Quentin Pump Station Suction Improvements

Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: This project parallels the existing 8" and 12" pipes in Francisco Blvd and Shoreline Parkway to 12", 18", and 24" pipes to improve flow to the pump station.

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal		Notes
1 - General Requirements	\$	481,000	
2 - Sitework	\$	3,426,000	
	Raw Construction Subtotal	\$ 3,907,000	
	Contractor Overhead & Profit 10%	\$ 390,000	Overhead/profit already included in unit cost for well
	Sales Tax 8.125%	\$ 160,000	Assumes this applies to 50% of Raw Constr. Cost
	Estimated Total Construction Cost	\$ 4,500,000	
	Estimating Contingency 50%	\$ 2,300,000	
	Estimated Construction Cost with Contingency	\$ 6,800,000	
	Environmental Documentation & Permits 5%	\$ 340,000	
	Design Cost 10%	\$ 680,000	
	Project Administration and Construction Management Cost 10%	\$ 680,000	
	Estimated Total Capital Cost	\$ 8,500,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							\$ 481,000	
	Mobilization	10%		1	LS	\$342,520	\$ 343,000	10% of Division 2 and 16
	Traffic Control	4%		1	LS	\$137,008	\$ 138,000	4% of Division 2

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework							\$ 3,425,200	
	Sitework							
	Surface Restoration of Paved Areas, Full Lane			6,765 LF		\$132	\$ 893,000	
	Piping and Appurtenances							
	18-inch Mortar Lined Steel Pipe	18 inch		4,865	LF	\$321	\$ 1,562,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	24-inch Mortar Lined Steel Pipe	24 inch		1,900	LF	\$389	\$ 740,000	Assumes 7ft deep trench excavation with 1 ft of clearance between trench walls and pipe. Assumes average soil conditions, shoring costs are included. Assumes backfill is imported and native material is off hauled. Assumes 1 pothole per 100 linear feet of pipe installed.
	Misc. Pipe Appurtenances (valves, joints, tees, etc.) Allowance	10%		1	LS	\$230,200	\$ 230,200	Assumed 10% of Pipeline cost for Isolation Valves, Other Appurtenances



Project: 5A - Federal Works Pump Improvements
Aspect: Short Term CIP Improvements

Date: 12/22/2021
 Project Number: 0012036.00
 Prepared By: Nathan Hanson
 Checked By: Tony Valdivia
 Check Date: 12/22/2021

Notes: Increases capacity at the Federal Works Pump Station to convey flow south

Estimate Type: Concept Level

Process Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	\$ 403,000	
2 - Sitework	\$ 45,000	
11 - Equipment	\$ 3,969,000	
16 - Electrical	\$ -	
Raw Construction Subtotal	\$ 4,417,000	
Contractor Overhead & Profit 10%	\$ 440,000	
Sales Tax 8.125%	\$ 180,000	Assumes this applies to 50% of Raw Constr. Cost
Estimated Total Construction Cost	\$ 5,000,000	
Estimating Contingency 50%	\$ 2,500,000	
Estimated Construction Cost with Contingency	\$ 7,500,000	
Environmental Documentation & Permits 5%	\$ 380,000	
Design Cost 15%	\$ 1,100,000	
Project Administration and Construction Management Cost 15%	\$ 1,100,000	
Estimated Total Capital Cost	\$ 10,000,000	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							\$ 403,000	
	Mobilization	10%		1	LS	\$401,400	\$ 402,000	10% of Division 2
	Traffic Control	2%		1	LS	\$900	\$ 1,000	Rural

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework							\$ 45,000	
	Open Cut Pipelines							
	Piping Allowance			1	LS	\$20,000	\$ 20,000	Engineer's Estimate. To be confirmed in more detailed design
	Misc. Pipe Appurtenances and valving			1	LS	\$25,000	\$ 25,000	Engineer's Estimate. To be confirmed in more detailed design

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment							\$ 3,969,000	
	Pump Station Improvements							
	8.9 MGD Pump Station			1	LS	\$ 3,969,000	\$ 3,969,000	Sanks Curve for 8.9 MG Pump Station. To be confirmed in more detailed design. Assumes a new pump station will be installed.

APPENDIX 2B

HYDRAULIC ANALYSIS RESULTS

Figures 2B.1 through 2B.7 show the model hydraulic grade line profiles under existing winter demand conditions for the baseline (i.e., no new turnout demands) alternative as well as the low- and high-end demand options for the two turnout alternatives. Results are shown with the Kastania Pump Station off and with one and two pumps on. Figures 2B.8 through 2B.14 show results for similar scenarios but under future demand conditions.

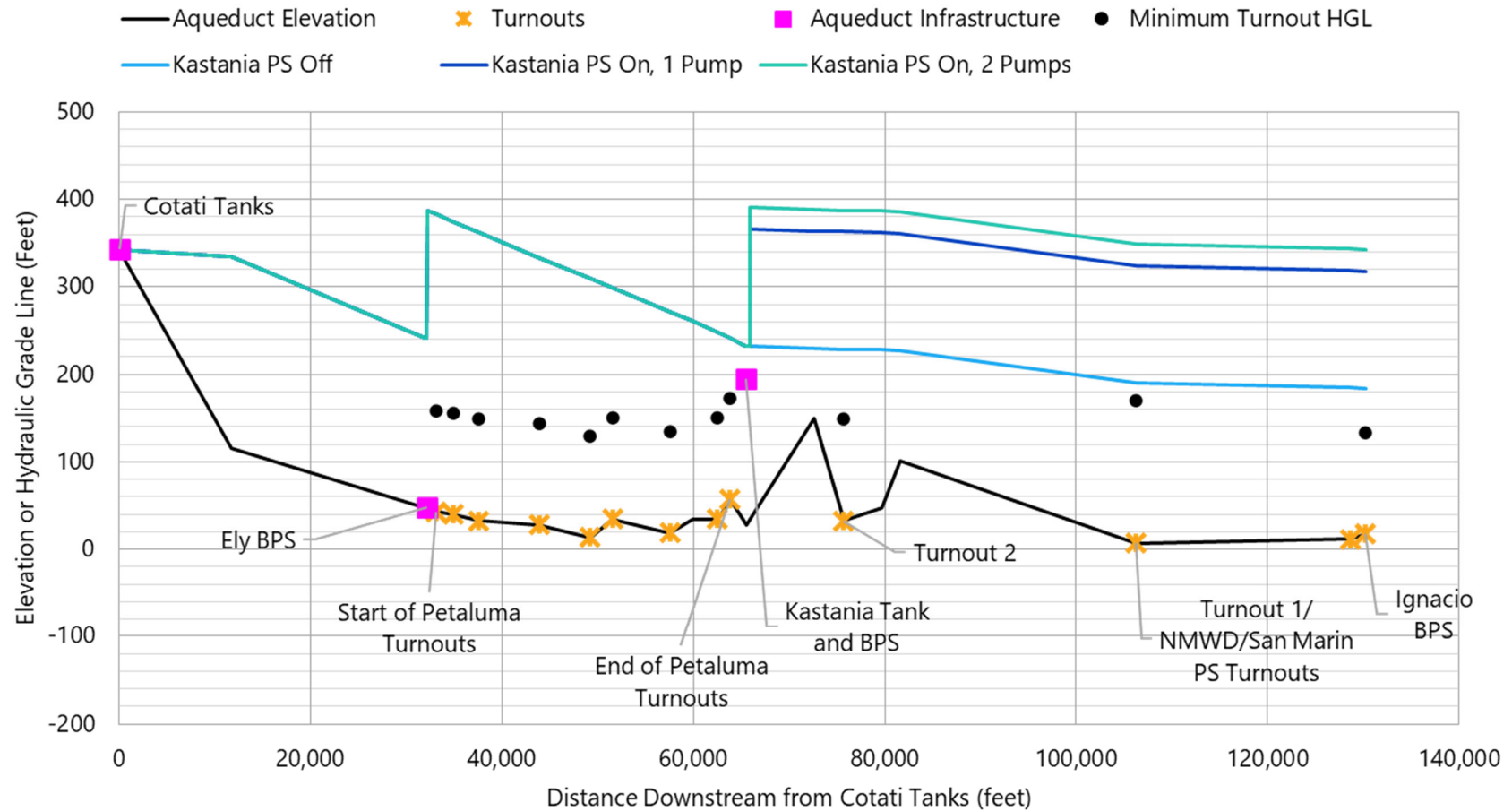


Figure 2B.1 Aqueduct System Hydraulic Profile - Existing Winter Baseline Scenarios

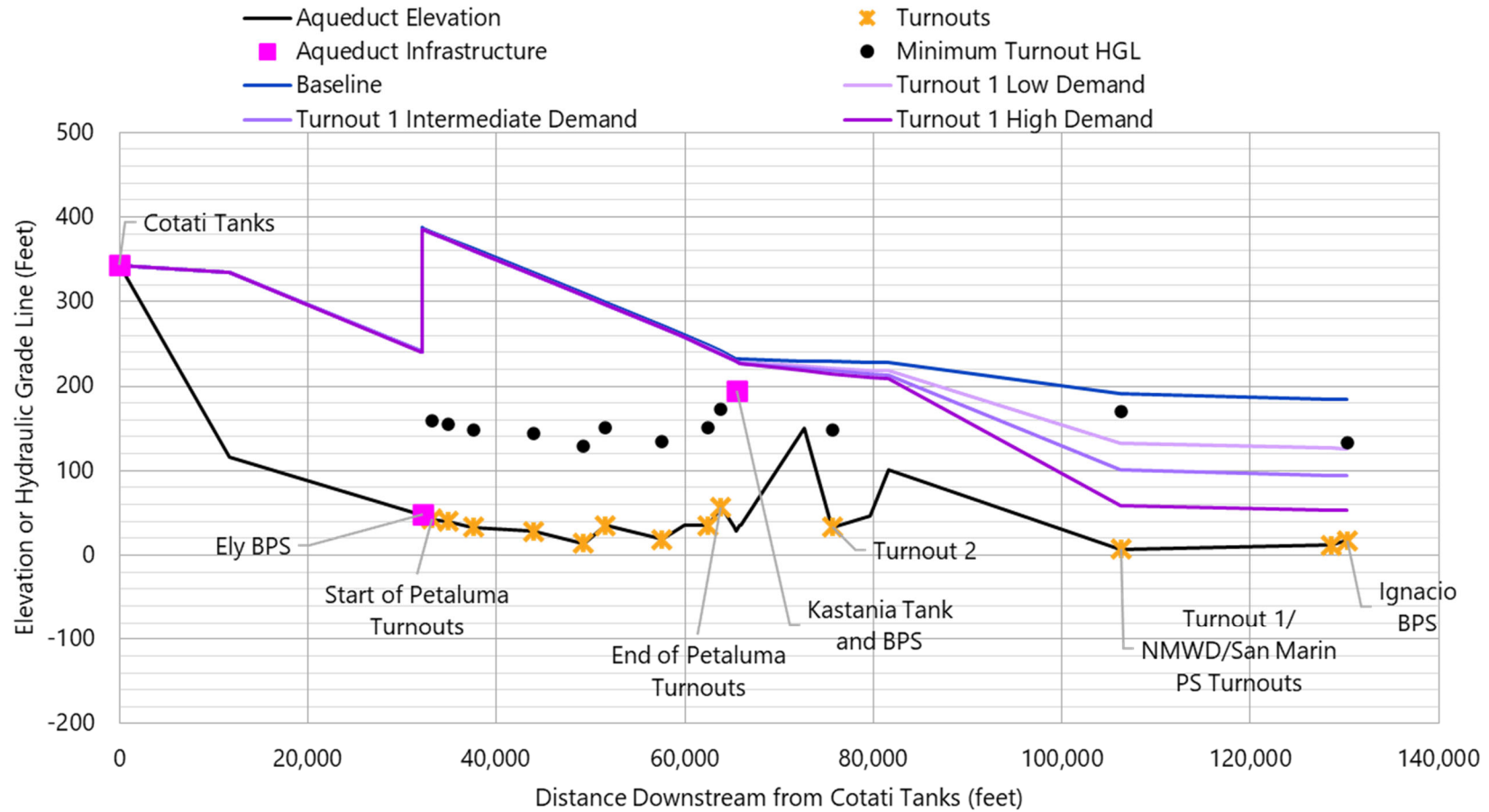


Figure 2B.2 Aqueduct System Hydraulic Profile - Existing Winter, Kastania Pump Station Off, Turnout 1 Demands

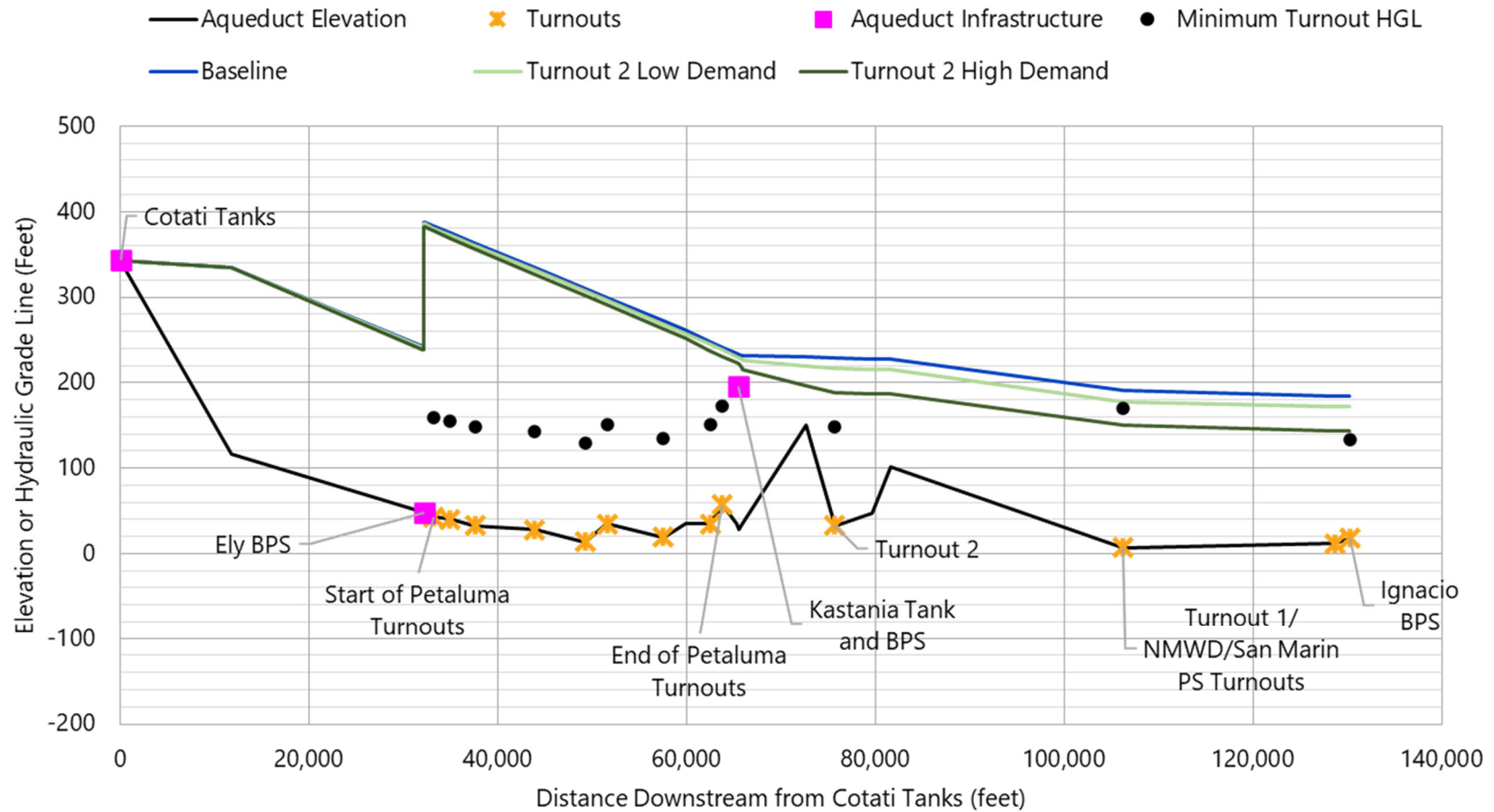


Figure 2B.3 Aqueduct System Hydraulic Profile - Existing Winter, Kastania Pump Station Off, Turnout 2 Demands

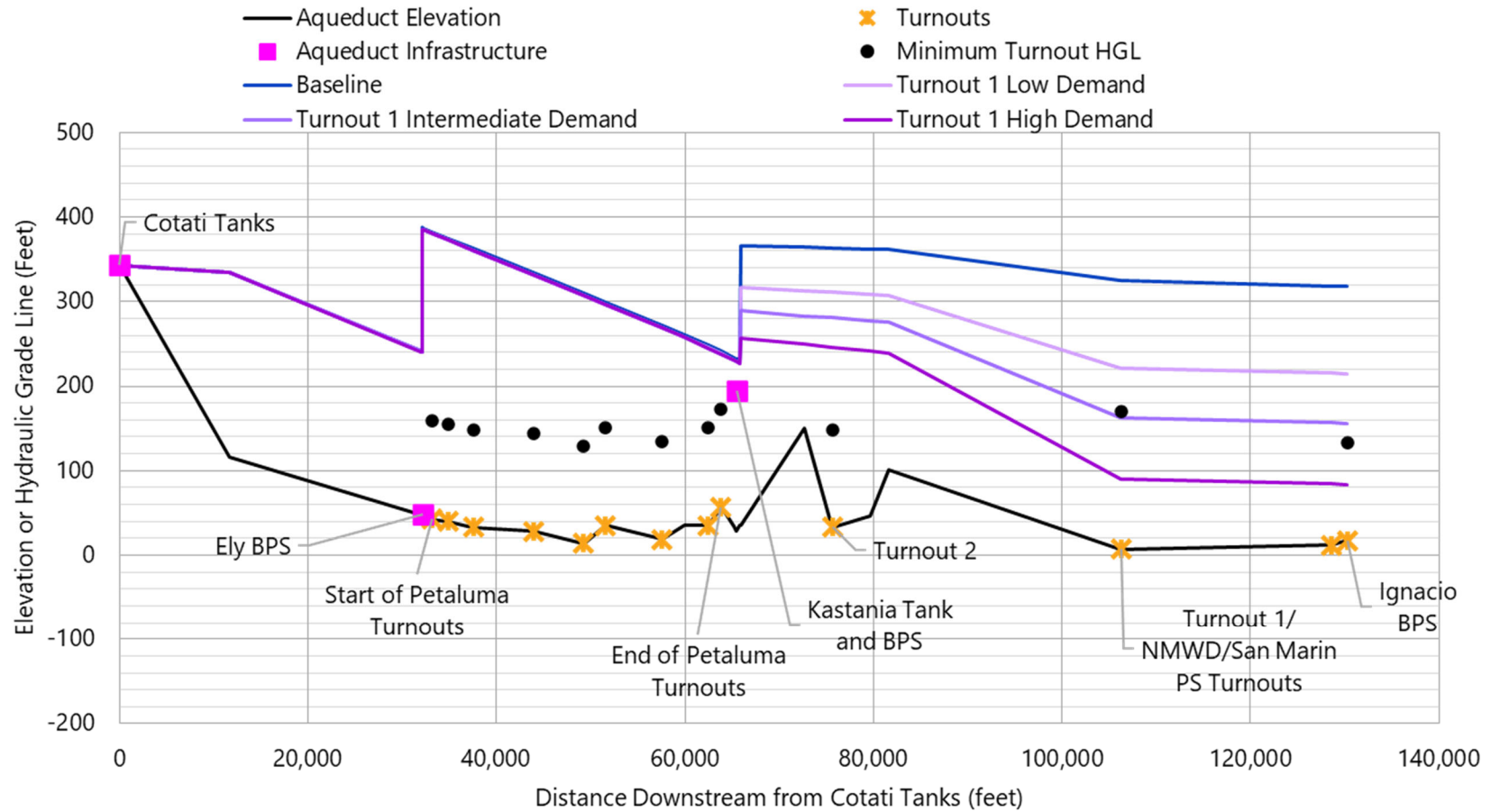


Figure 2B.4 Aqueduct System Hydraulic Profile - Existing Winter, Kastania Pump Station On (1 Pump), Turnout 1 Demands

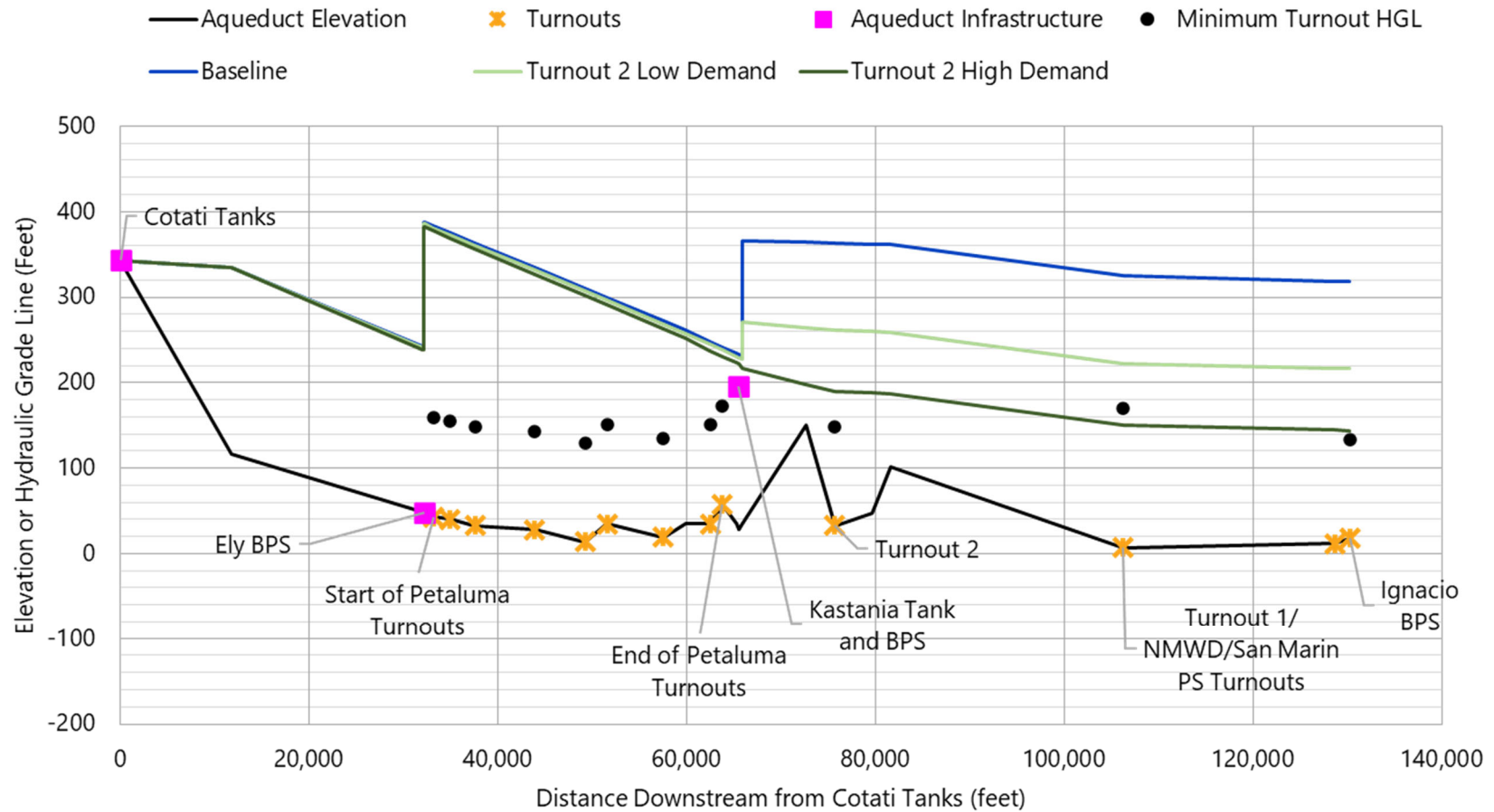


Figure 2B.5 Aqueduct System Hydraulic Profile - Existing Winter, Kastania Pump Station On (1 Pump), Turnout 2 Demands

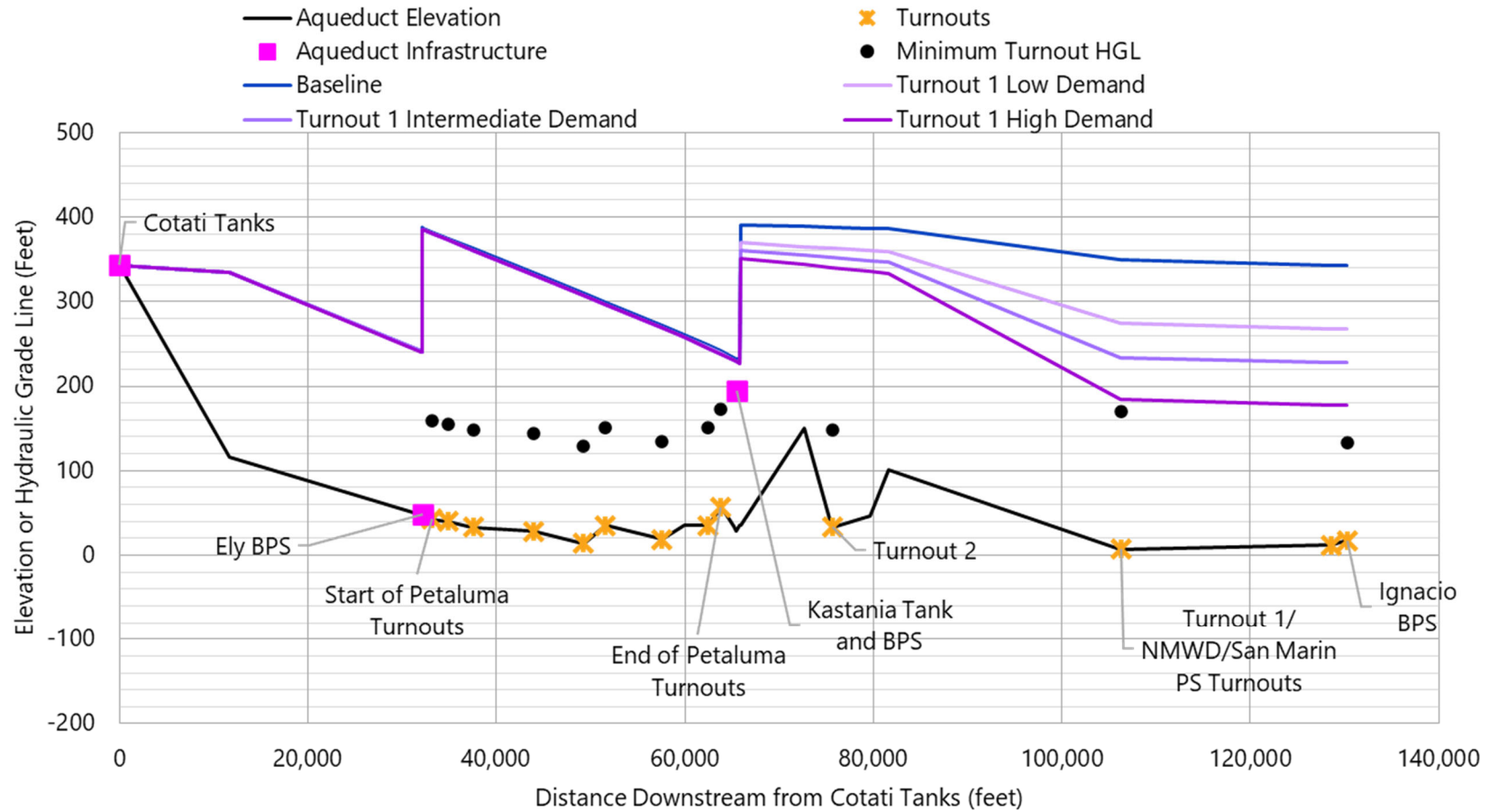


Figure 2B.6 Aqueduct System Hydraulic Profile - Existing Winter, Kastania Pump Station On (2 Pumps), Turnout 1 Demands

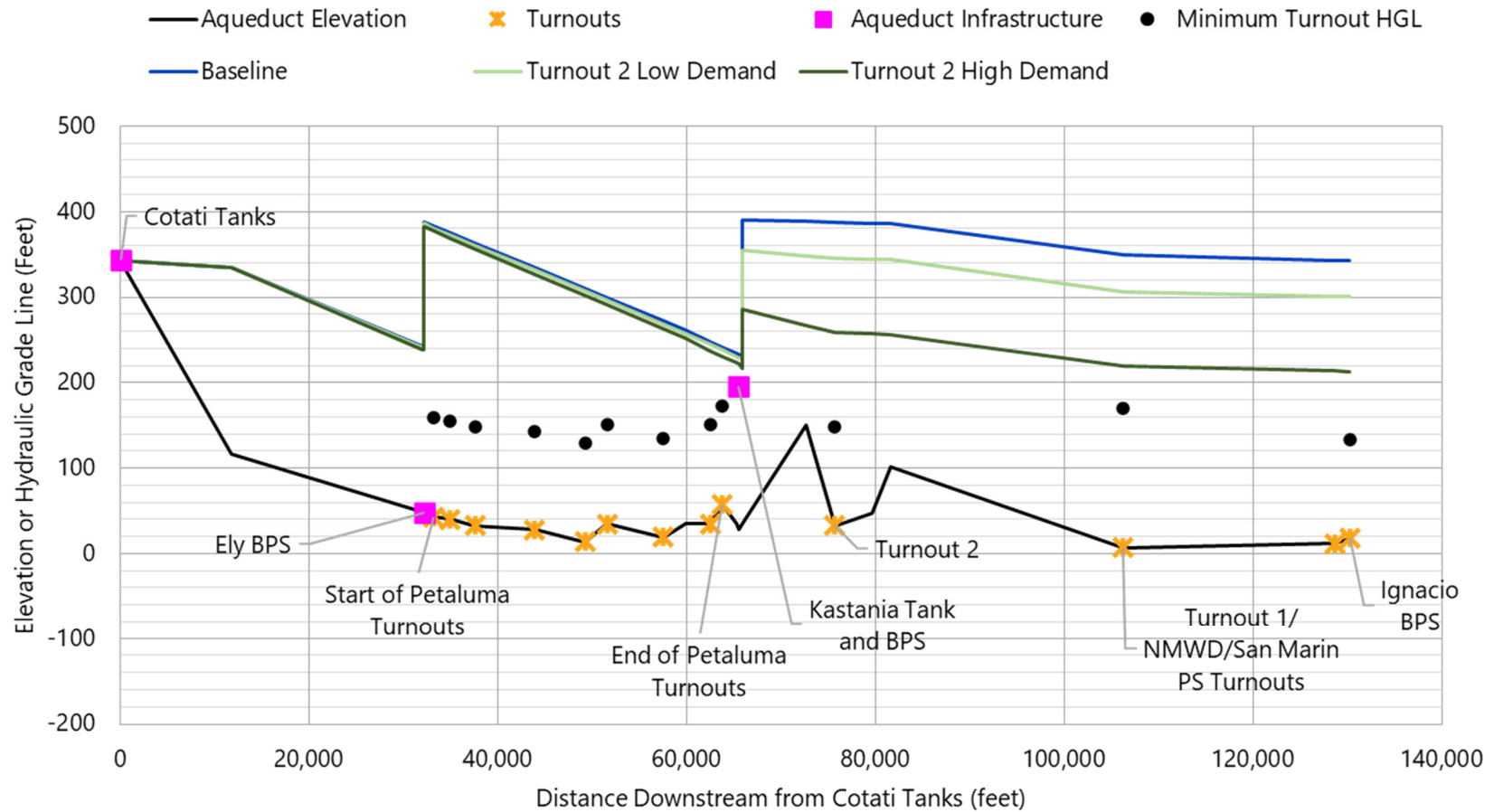


Figure 2B.7 Aqueduct System Hydraulic Profile - Existing Winter, Kastania Pump Station On (2 Pumps), Turnout 2 Demands

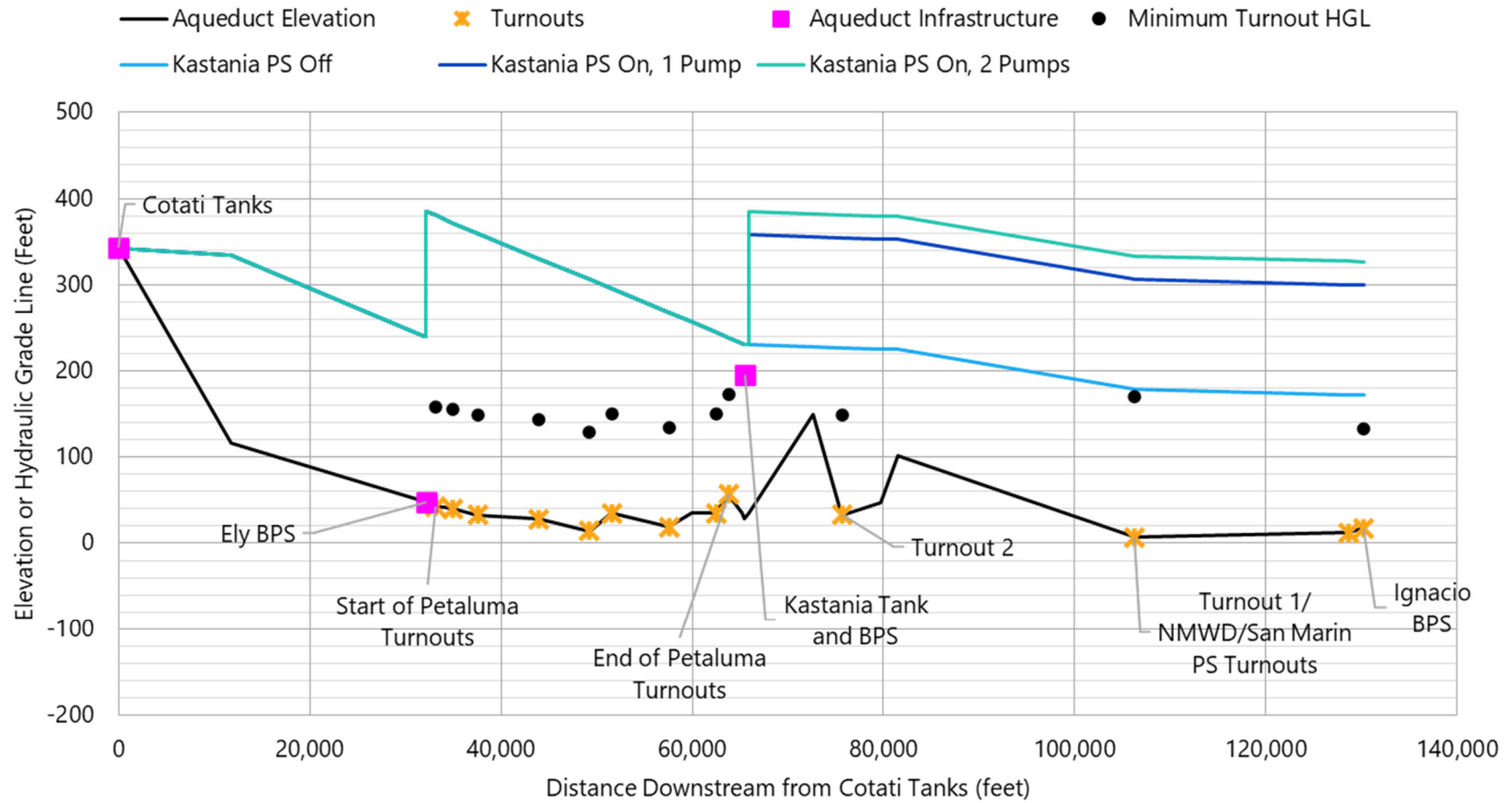


Figure 2B.8 Aqueduct System Hydraulic Profile - Future Winter Baseline Scenarios

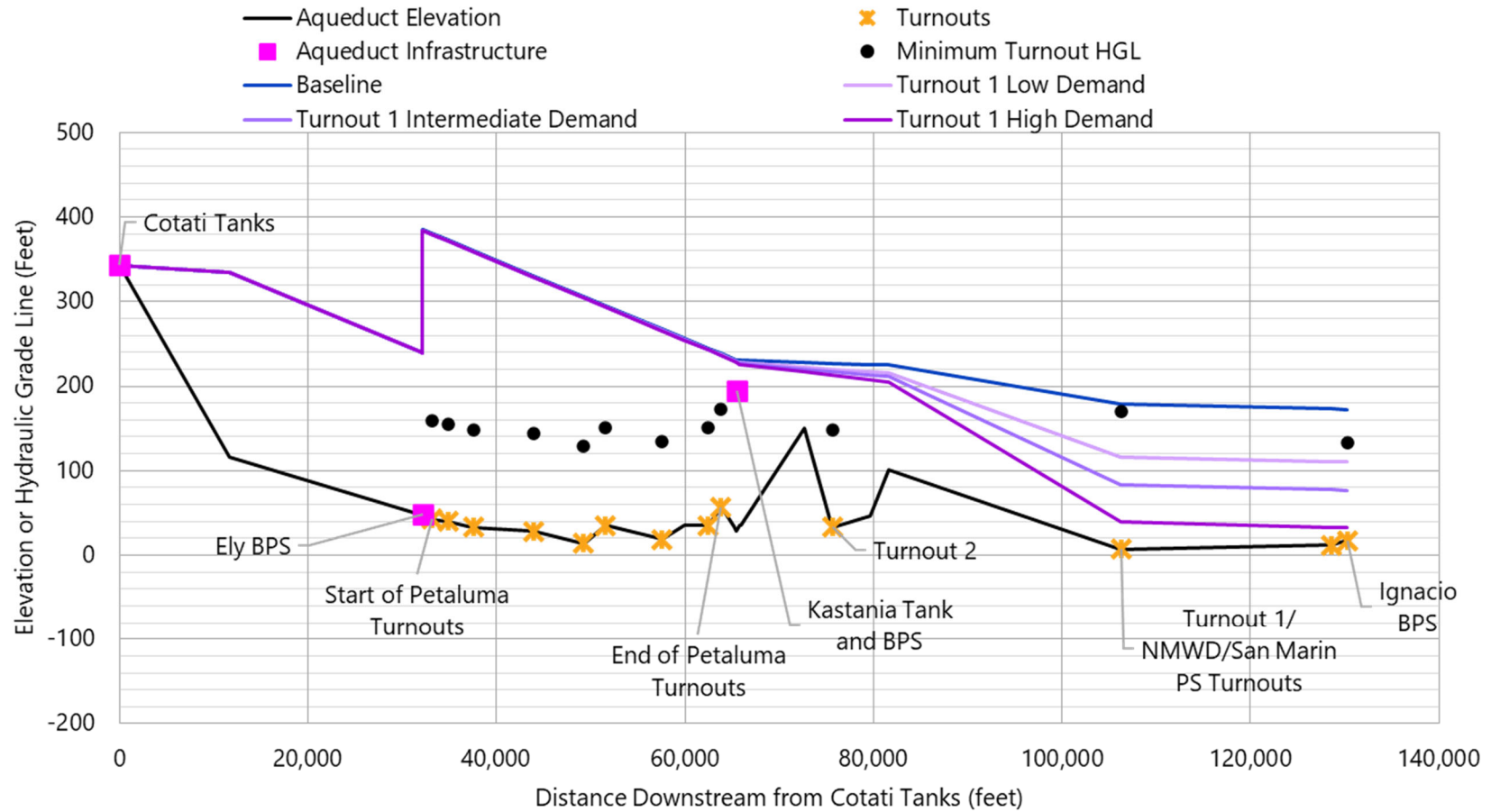


Figure 2B.9 Aqueduct System Hydraulic Profile - Future Winter, Kastania Pump Station Off, Turnout 1 Demands

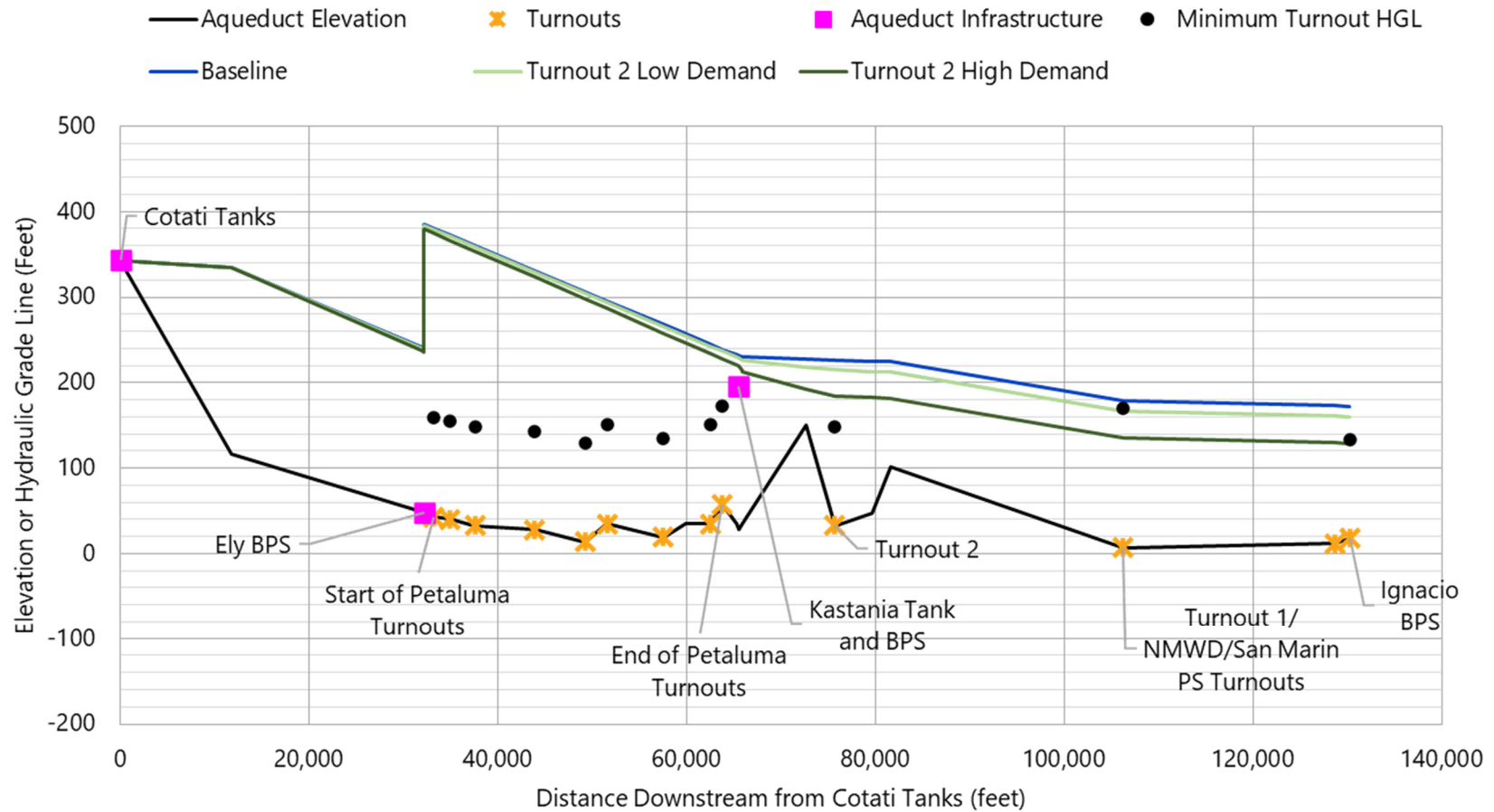


Figure 2B.10 Aqueduct System Hydraulic Profile - Future Winter, Kastania Pump Station Off, Turnout 2 Demands

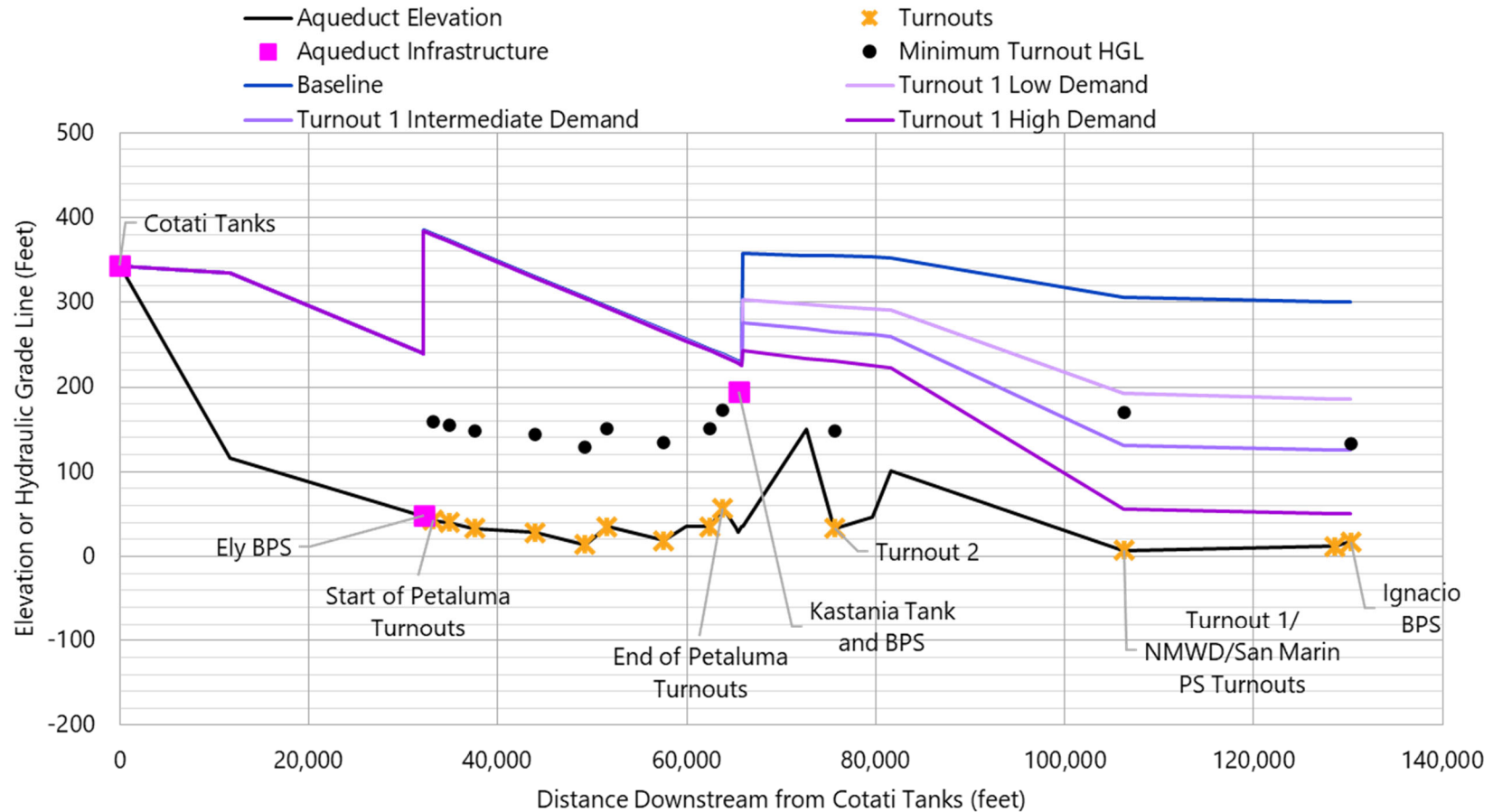


Figure 2B.11 Aqueduct System Hydraulic Profile - Future Winter, Kastania Pump Station On (1 Pump), Turnout 1 Demands

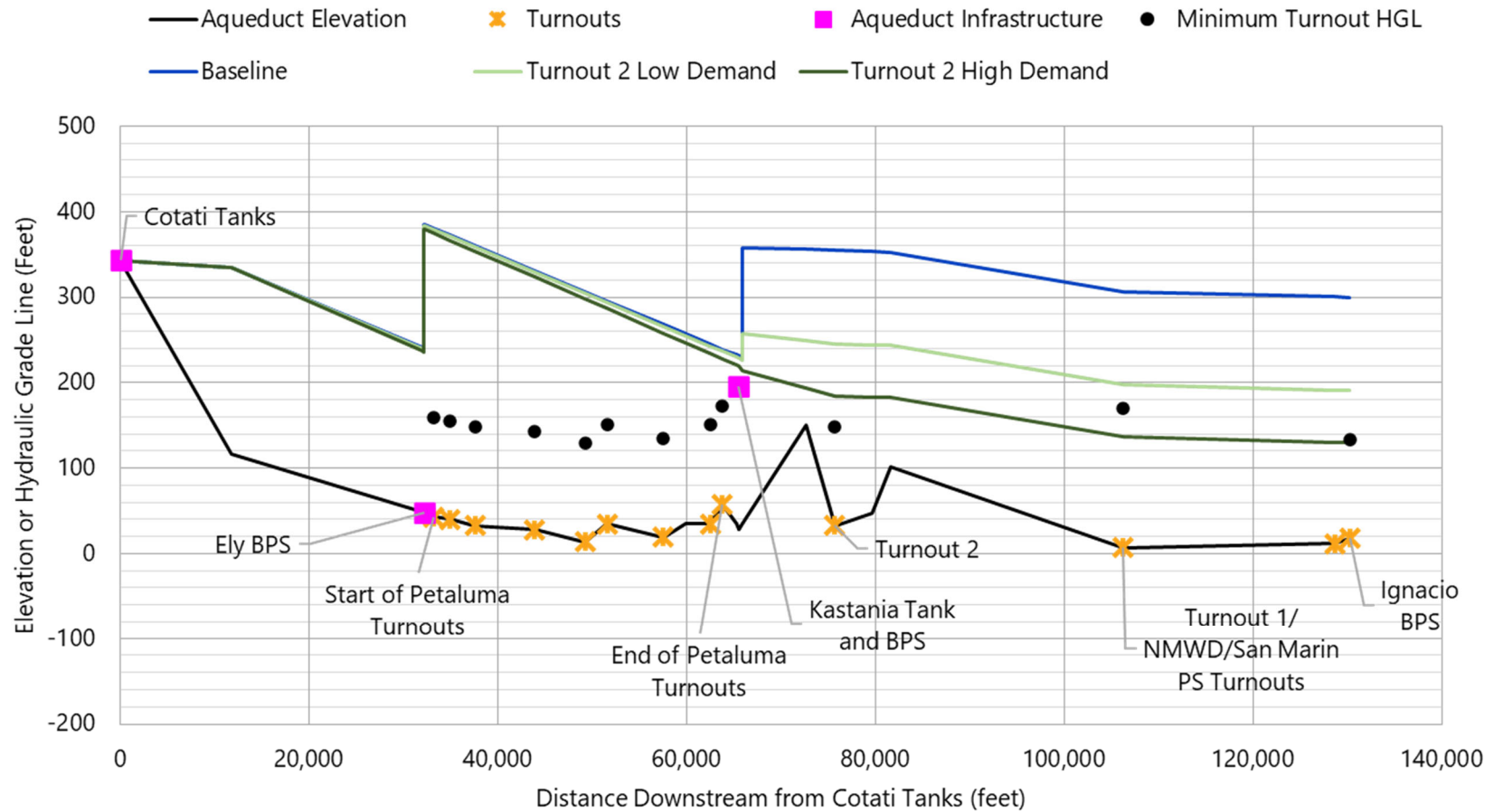


Figure 2B.12 Aqueduct System Hydraulic Profile - Future Winter, Kastania Pump Station On (1 Pump), Turnout 2 Demands

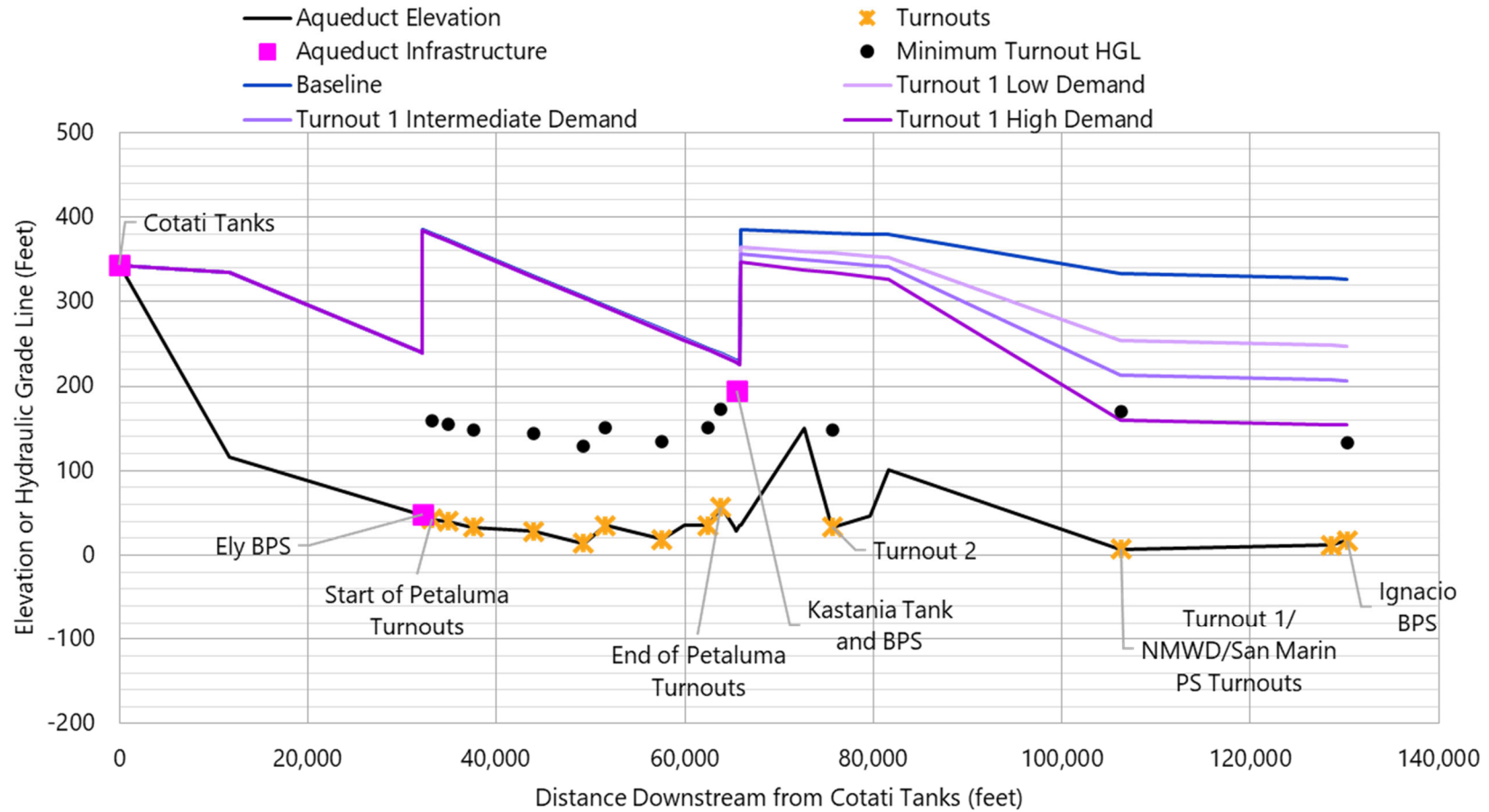


Figure 2B.13 Aqueduct System Hydraulic Profile - Future Winter, Kastania Pump Station On (2 Pumps), Turnout 1 Demands

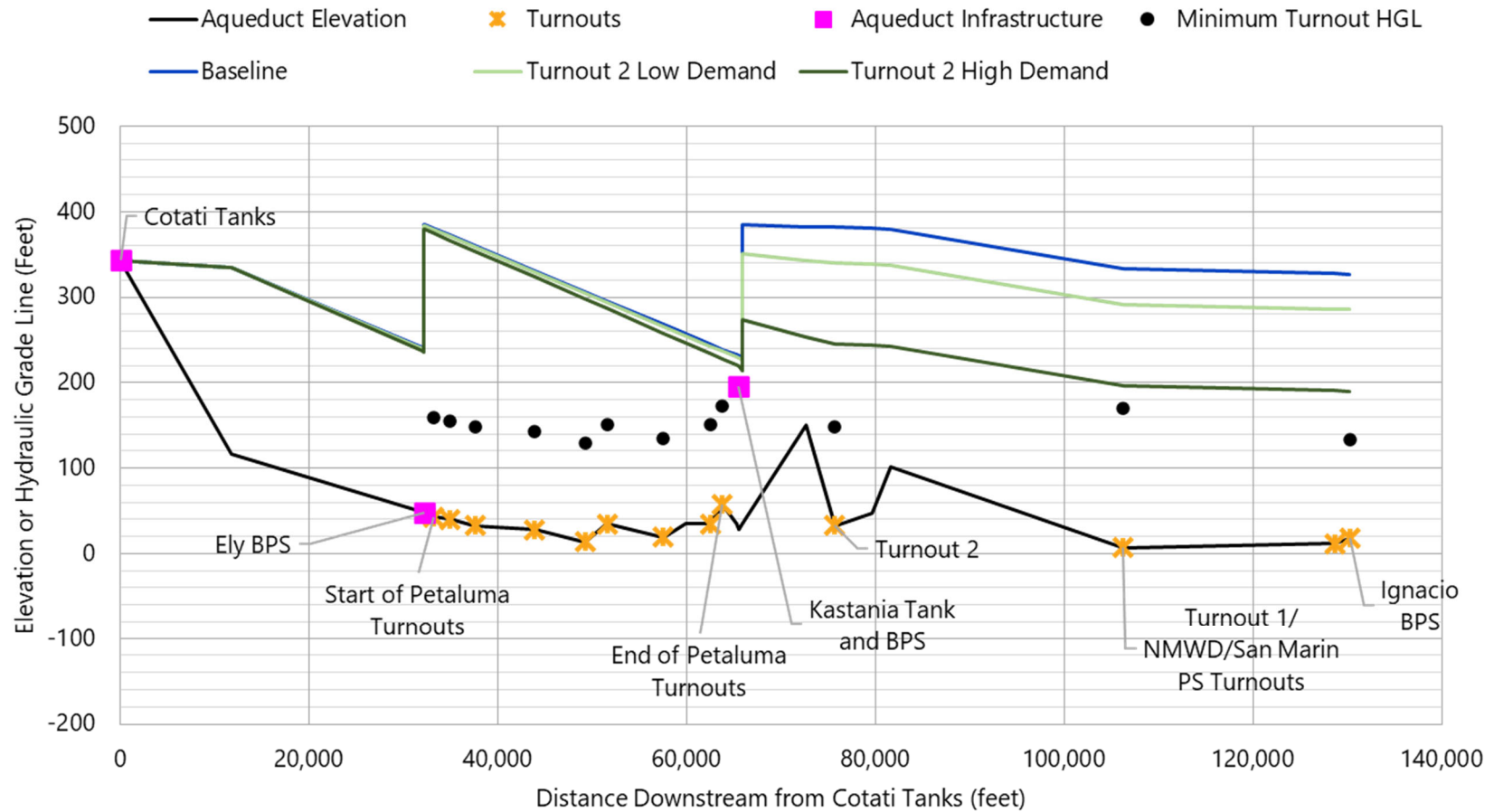


Figure 2B.14 Aqueduct System Hydraulic Profile - Future Winter, Kastania Pump Station On (2 Pumps), Turnout 2 Demands

APPENDIX 2C

BUDGETARY COST ESTIMATES



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: STS-1: Cotati Tanks to Kastani Pump Station Along US-101 Corridor

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$3,813,500
02	Pipeline	\$49,270,000
03	Pump Station	\$27,000,000
04	Ancillary Items	\$7,627,000
TOTAL DIRECT COST		\$87,710,500
	Contingency 30.0%	\$26,313,150
	Subtotal	\$114,023,650
	General Contractor Overhead, Profit & Risk 12.0%	\$13,682,838
	Subtotal	\$127,706,488
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$14,366,980
	Subtotal	\$142,073,468
	Sales Tax (8.25% on half the direct cost) 8.3%	\$5,860,531
	Subtotal	\$147,933,998
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$147,933,998
	Engineering, Legal & Administration Fees 15.0%	\$22,190,100
	Owner's Reserve for Change Orders 5.0%	\$7,396,700
TOTAL ESTIMATED PROJECT COST		\$177,520,798
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: STS-2: Cotati Tanks to Kastani Pump Station Through Downtown Petaluma

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$4,189,384
02	Pipeline	\$56,787,674
03	Pump Station	\$27,000,000
04	Ancillary Items	\$8,378,767
TOTAL DIRECT COST		\$96,355,825
	Contingency 30.0%	\$28,906,747
	Subtotal	\$125,262,572
	General Contractor Overhead, Profit & Risk 12.0%	\$15,031,509
	Subtotal	\$140,294,081
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$15,783,084
	Subtotal	\$156,077,165
	Sales Tax (8.25% on half the direct cost) 8.3%	\$6,438,183
	Subtotal	\$162,515,348
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$162,515,348
	Engineering, Legal & Administration Fees 15.0%	\$24,377,302
	Owner's Reserve for Change Orders 5.0%	\$8,125,767
TOTAL ESTIMATED PROJECT COST		\$195,018,417
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: STS-3: Cotati Tanks to Kastani Pump Station Through Rural Roads

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$5,152,500
02	Pipeline	\$71,550,000
03	Pump Station	\$31,500,000
04	Ancillary Items	\$10,305,000
TOTAL DIRECT COST		\$118,507,500
	Contingency 30.0%	\$35,552,250
	Subtotal	\$154,059,750
	General Contractor Overhead, Profit & Risk 12.0%	\$18,487,170
	Subtotal	\$172,546,920
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$19,411,529
	Subtotal	\$191,958,449
	Sales Tax (8.25% on half the direct cost) 8.3%	\$7,918,286
	Subtotal	\$199,876,735
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$199,876,735
	Engineering, Legal & Administration Fees 15.0%	\$29,981,510
	Owner's Reserve for Change Orders 5.0%	\$9,993,837
TOTAL ESTIMATED PROJECT COST		\$239,852,081
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: STAF-1: Stafford Lake to Nicasio Reservoir

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$1,564,000
02	Pipeline	\$22,480,000
03	Pump Station	\$8,800,000
04	Ancillary Items	\$4,692,000
TOTAL DIRECT COST		\$37,536,000
Contingency	30.0%	\$11,260,800
Subtotal		\$48,796,800
General Contractor Overhead, Profit & Risk	12.0%	\$5,855,616
Subtotal		\$54,652,416
Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026)	7.5%	\$6,148,397
Subtotal		\$60,800,813
Sales Tax (8.25% on half the direct cost)	8.3%	\$2,508,034
Subtotal		\$63,308,846
Bid Market Allowance	0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$63,308,846
Engineering, Legal & Administration Fees	15.0%	\$9,496,327
Owner's Reserve for Change Orders	5.0%	\$3,165,442
TOTAL ESTIMATED PROJECT COST		\$75,970,616
The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: STAF-2: Stafford Lake to Soulajule Reservoir

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$1,395,500
02	Pipeline	\$19,110,000
03	Pump Station	\$8,800,000
04	Ancillary Items	\$4,186,500
TOTAL DIRECT COST		\$33,492,000
	Contingency 30.0%	\$10,047,600
	Subtotal	\$43,539,600
	General Contractor Overhead, Profit & Risk 12.0%	\$5,224,752
	Subtotal	\$48,764,352
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$5,485,990
	Subtotal	\$54,250,342
	Sales Tax (8.25% on half the direct cost) 8.3%	\$2,237,827
	Subtotal	\$56,488,168
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$56,488,168
	Engineering, Legal & Administration Fees 15.0%	\$8,473,225
	Owner's Reserve for Change Orders 5.0%	\$2,824,408
TOTAL ESTIMATED PROJECT COST		\$67,785,802
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: STAF-3: Stafford Lake to Nicasio and Soulajule Reservoir

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$1,905,500
02	Pipeline	\$30,910,000
03	Pump Station	\$7,200,000
04	Ancillary Items	\$5,716,500
TOTAL DIRECT COST		\$45,732,000
	Contingency 30.0%	\$13,719,600
	Subtotal	\$59,451,600
	General Contractor Overhead, Profit & Risk 12.0%	\$7,134,192
	Subtotal	\$66,585,792
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$7,490,902
	Subtotal	\$74,076,694
	Sales Tax (8.25% on half the direct cost) 8.3%	\$3,055,664
	Subtotal	\$77,132,357
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$77,132,357
	Engineering, Legal & Administration Fees 15.0%	\$11,569,854
	Owner's Reserve for Change Orders 5.0%	\$3,856,618
TOTAL ESTIMATED PROJECT COST		\$92,558,829
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		

PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-1: North Marin Aqueduct to Nicasio Reservoir without Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$2,759,500
02	Pipeline	\$37,190,000
03	Pump Station	\$18,000,000
04	Ancillary Items	\$8,278,500
TOTAL DIRECT COST		\$66,228,000
	Contingency 30.0%	\$19,868,400
	Subtotal	\$86,096,400
	General Contractor Overhead, Profit & Risk 12.0%	\$10,331,568
	Subtotal	\$96,427,968
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$10,848,146
	Subtotal	\$107,276,114
	Sales Tax (8.25% on half the direct cost) 8.3%	\$4,425,140
	Subtotal	\$111,701,254
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$111,701,254
	Engineering, Legal & Administration Fees 15.0%	\$16,755,188
	Owner's Reserve for Change Orders 5.0%	\$5,585,063
TOTAL ESTIMATED PROJECT COST		\$134,041,505
The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-1: North Marin Aqueduct to Nicasio Reservoir with Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$3,576,500
02	Pipeline	\$48,530,000
03	Pump Station	\$18,000,000
04	Kastania Pump Station Improvements	\$5,000,000
05	Ancillary Items	\$10,729,500
TOTAL DIRECT COST		\$85,836,000
	Contingency 30.0%	\$25,750,800
	Subtotal	\$111,586,800
	General Contractor Overhead, Profit & Risk 12.0%	\$13,390,416
	Subtotal	\$124,977,216
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$14,059,937
	Subtotal	\$139,037,153
	Sales Tax (8.25% on half the direct cost) 8.3%	\$5,735,283
	Subtotal	\$144,772,435
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$144,772,435
	Engineering, Legal & Administration Fees 15.0%	\$21,715,865
	Owner's Reserve for Change Orders 5.0%	\$7,238,622
TOTAL ESTIMATED PROJECT COST		\$173,726,922
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		

PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-2: North Marin Aqueduct to SoulaJule Reservoir without Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$2,590,718
02	Pipeline	\$33,814,368
03	Pump Station	\$18,000,000
04	Ancillary Items	\$7,772,155
TOTAL DIRECT COST		\$62,177,242
	Contingency 30.0%	\$18,653,172
	Subtotal	\$80,830,414
	General Contractor Overhead, Profit & Risk 12.0%	\$9,699,650
	Subtotal	\$90,530,064
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$10,184,632
	Subtotal	\$100,714,696
	Sales Tax (8.25% on half the direct cost) 8.3%	\$4,154,481
	Subtotal	\$104,869,177
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$104,869,177
	Engineering, Legal & Administration Fees 15.0%	\$15,730,377
	Owner's Reserve for Change Orders 5.0%	\$5,243,459
TOTAL ESTIMATED PROJECT COST		\$125,843,013
The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.		

PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-2: North Marin Aqueduct to SoulaJule Reservoir with Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$3,356,295
02	Pipeline	\$44,125,904
03	Pump Station	\$18,000,000
04	Kastania Pump Station Improvements	\$5,000,000
05	Ancillary Items	\$10,068,886
TOTAL DIRECT COST		\$80,551,085
	Contingency 30.0%	\$24,165,325
	Subtotal	\$104,716,410
	General Contractor Overhead, Profit & Risk 12.0%	\$12,565,969
	Subtotal	\$117,282,379
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$13,194,268
	Subtotal	\$130,476,647
	Sales Tax (8.25% on half the direct cost) 8.3%	\$5,382,162
	Subtotal	\$135,858,809
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$135,858,809
	Engineering, Legal & Administration Fees 15.0%	\$20,378,821
	Owner's Reserve for Change Orders 5.0%	\$6,792,940
TOTAL ESTIMATED PROJECT COST		\$163,030,571
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		

PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-3: North Marin Aqueduct to Nicasio and Soulajule Reservoir without Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$3,181,000
02	Pipeline	\$45,620,000
03	Pump Station	\$18,000,000
04	Ancillary Items	\$9,543,000
TOTAL DIRECT COST		\$76,344,000
	Contingency 30.0%	\$22,903,200
	Subtotal	\$99,247,200
	General Contractor Overhead, Profit & Risk 12.0%	\$11,909,664
	Subtotal	\$111,156,864
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$12,505,147
	Subtotal	\$123,662,011
	Sales Tax (8.25% on half the direct cost) 8.3%	\$5,101,058
	Subtotal	\$128,763,069
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$128,763,069
	Engineering, Legal & Administration Fees 15.0%	\$19,314,460
	Owner's Reserve for Change Orders 5.0%	\$6,438,153
TOTAL ESTIMATED PROJECT COST		\$154,515,683
The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.		

PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-3: North Marin Aqueduct to Nicasio and Soulajule Reservoir with Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$4,351,000
02	Pipeline	\$59,520,000
03	Pump Station	\$22,500,000
04	Kastania Pump Station Improvements	\$5,000,000
05	Ancillary Items	\$13,053,000
TOTAL DIRECT COST		\$104,424,000
	Contingency 30.0%	\$31,327,200
	Subtotal	\$135,751,200
	General Contractor Overhead, Profit & Risk 12.0%	\$16,290,144
	Subtotal	\$152,041,344
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$17,104,651
	Subtotal	\$169,145,995
	Sales Tax (8.25% on half the direct cost) 8.3%	\$6,977,272
	Subtotal	\$176,123,268
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$176,123,268
	Engineering, Legal & Administration Fees 15.0%	\$26,418,490
	Owner's Reserve for Change Orders 5.0%	\$8,806,163
TOTAL ESTIMATED PROJECT COST		\$211,347,921
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-4: North Marin Aqueduct to Nicasio and Soulajule Reservoir via San Antonio Rd without Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$3,654,500
02	Pipeline	\$41,590,000
03	Pump Station	\$31,500,000
04	Ancillary Items	\$10,963,500
TOTAL DIRECT COST		\$87,708,000
	Contingency 30.0%	\$26,312,400
	Subtotal	\$114,020,400
	General Contractor Overhead, Profit & Risk 12.0%	\$13,682,448
	Subtotal	\$127,702,848
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$14,366,570
	Subtotal	\$142,069,418
	Sales Tax (8.25% on half the direct cost) 8.3%	\$5,860,364
	Subtotal	\$147,929,782
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$147,929,782
	Engineering, Legal & Administration Fees 15.0%	\$22,189,467
	Owner's Reserve for Change Orders 5.0%	\$7,396,489
TOTAL ESTIMATED PROJECT COST		\$177,515,738
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: PETA-4: North Marin Aqueduct to Nicasio and Soulajule Reservoir via San Antonio Rd with Upstream Improvements

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$9,347,500
02	Pipeline	\$66,270,000
03	Pump Station	\$58,500,000
04	Kastania Pump Station Improvements	\$10,000,000
05	STS Alternative	\$52,180,000
06	Ancillary Items	\$28,042,500
TOTAL DIRECT COST		\$224,340,000
	Contingency 30.0%	\$67,302,000
	Subtotal	\$291,642,000
	General Contractor Overhead, Profit & Risk 12.0%	\$34,997,040
	Subtotal	\$326,639,040
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$36,746,892
	Subtotal	\$363,385,932
	Sales Tax (8.25% on half the direct cost) 8.3%	\$14,989,670
	Subtotal	\$378,375,602
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$378,375,602
	Engineering, Legal & Administration Fees 15.0%	\$56,756,340
	Owner's Reserve for Change Orders 5.0%	\$18,918,780
TOTAL ESTIMATED PROJECT COST		\$454,050,722

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: COTATI-1: Cotati Tanks to Nicasio Reservoir

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$8,994,500
02	Pipeline	\$107,890,000
03	Pump Station	\$72,000,000
04	Ancillary Items	\$26,983,500
TOTAL DIRECT COST		\$215,868,000
	Contingency 30.0%	\$64,760,400
	Subtotal	\$280,628,400
	General Contractor Overhead, Profit & Risk 12.0%	\$33,675,408
	Subtotal	\$314,303,808
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$35,359,178
	Subtotal	\$349,662,986
	Sales Tax (8.25% on half the direct cost) 8.3%	\$14,423,598
	Subtotal	\$364,086,585
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$364,086,585
	Engineering, Legal & Administration Fees 15.0%	\$54,612,988
	Owner's Reserve for Change Orders 5.0%	\$18,204,329
TOTAL ESTIMATED PROJECT COST		\$436,903,902
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: COTATI-2: Cotati Tanks to Soulajule Reservoir

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$7,963,474
02	Pipeline	\$91,769,488
03	Pump Station	\$67,500,000
04	Ancillary Items	\$23,890,423
TOTAL DIRECT COST		\$191,123,386
	Contingency 30.0%	\$57,337,016
	Subtotal	\$248,460,401
	General Contractor Overhead, Profit & Risk 12.0%	\$29,815,248
	Subtotal	\$278,275,649
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$31,306,011
	Subtotal	\$309,581,660
	Sales Tax (8.25% on half the direct cost) 8.3%	\$12,770,243
	Subtotal	\$322,351,903
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$322,351,903
	Engineering, Legal & Administration Fees 15.0%	\$48,352,786
	Owner's Reserve for Change Orders 5.0%	\$16,117,595
TOTAL ESTIMATED PROJECT COST		\$386,822,284
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		



PROJECT SUMMARY

Project: Water Supply Conveyance Improvements Project
Client: Marin Municipal Water District
Location: Marin/Sonoma County
Zip Code: 94952
Carollo Job # 202554
Project Alt: COTATI-3: Cotati Tanks to Nicasio and Soulajule Reservoir

Estimate Class: 4
PIC: TT
PM: DGB
Date: May 2, 2024
By: AC
Reviewed: DGB

NO.	DESCRIPTION	TOTAL
01	General Conditions	\$9,397,500
02	Pipeline	\$115,950,000
03	Pump Station	\$72,000,000
04	Ancillary Items	\$28,192,500
TOTAL DIRECT COST		\$225,540,000
	Contingency 30.0%	\$67,662,000
	Subtotal	\$293,202,000
	General Contractor Overhead, Profit & Risk 12.0%	\$35,184,240
	Subtotal	\$328,386,240
	Escalation to Mid-Point (Assumes Mid-Point in Aug. 2026) 7.5%	\$36,943,452
	Subtotal	\$365,329,692
	Sales Tax (8.25% on half the direct cost) 8.3%	\$15,069,850
	Subtotal	\$380,399,542
	Bid Market Allowance 0.0%	\$0
TOTAL ESTIMATED CONSTRUCTION COST		\$380,399,542
	Engineering, Legal & Administration Fees 15.0%	\$57,059,931
	Owner's Reserve for Change Orders 5.0%	\$19,019,977
TOTAL ESTIMATED PROJECT COST		\$456,479,450
<i>The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.</i>		

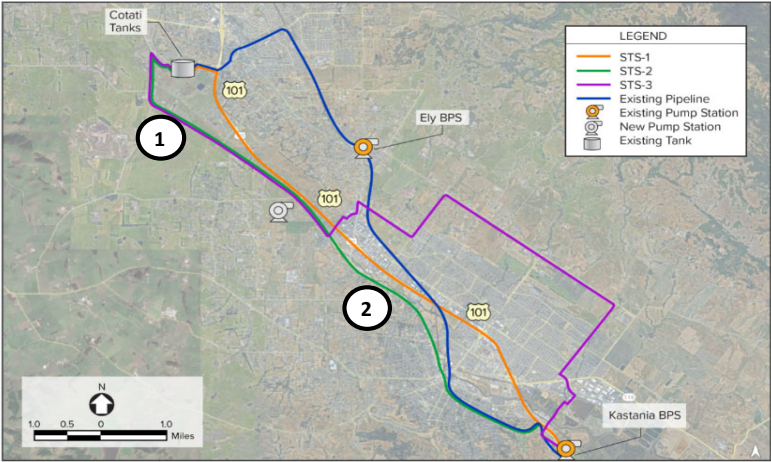
MMWD Water Supply Conveyance Improvements Project - STS Pipeline Sizing																		
Project Alternative	Segment	From	To	Length (miles)	Length (feet)	Flow (MGD)	Flow (gpm)	Flow (cfs)	Max Design Velocity (ft/sec)	Minimum Pipe Diameter (in)	Design Pipe Diameter (in)	Actual Pipe Velocity (ft/sec)	Hazen Williams C factor ⁽¹⁾	Friction Headloss (ft) ⁽²⁾	Minor Losses (ft) ⁽³⁾	Starting Elevation	Max Elevation	Finish Elevation
STS-1	1	Cotati Tanks	Pump Station	4.5	23,760	30	20833.33	46.42	7	34.87	36	6.57	135	74.29	7.43	343	343	40
	2	Pump Station	Kastania Pump Station	6.0	31,680	30	20833.33	46.42	7	34.87	36	6.57	135	99.06	9.91	40	250	250
STS-2	1	Cotati Tanks	Pump Station	6.0	31,680	30	20833.33	46.42	7	34.87	36	6.57	135	99.06	9.91	343	343	40
	2	Pump Station	Kastania Pump Station	6.1	32,208	30	20833.33	46.42	7	34.87	36	6.57	135	100.71	10.07	40	250	250
STS-3	1	Cotati Tanks	Pump Station	5.5	29,040	30	20833.33	46.42	7	34.87	36	6.57	135	90.80	9.08	343	343	40
	2	Pump Station	Kastania Pump Station	10.0	52,800	30	20833.33	46.42	7	34.87	36	6.57	135	165.09	16.51	40	250	250

(1) - Assumes a C Factor for Cement Mortar Lined Welded Steel Pipe

(2) - Headloss Calculated Using Hazen-Williams Equation

$$h_f = \frac{10.44 * L * Q^{1.85}}{C^{1.85} * d^{4.8655}}$$

(3) - Minor losses assumed to be 10% of friction headloss



STS Alternative Pump Stations											
STS-1			<---- Includes minor losses <---- 20 psi at Kastania Tank	STS-2			<---- Includes minor losses <---- 20 psi at Kastania Tank	STS-3			<---- Includes minor losses <---- 20 psi at Kastania Tank
Friction head loss	109.0	ft		Friction head loss	110.8	ft		Friction head loss	181.6	ft	
Pressure head	46.2	ft		Pressure head	46.2	ft		Pressure head	46.2	ft	
Elevation head	210	ft		Elevation head	210	ft		Elevation head	210	ft	
Total Dynamic Head	365.2	ft		Total Dynamic Head	367.0	ft		Total Dynamic Head	437.8	ft	
TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$			
Flow	20840.00	gpm		Flow	20840.00	gpm		Flow	20840.00	gpm	
TDH	365.2	ft		TDH	367.0	ft		TDH	437.8	ft	
whp	1921.71	hp		whp	1931.27	hp		whp	2303.99	hp	
bhp	2562.28	hp		bhp	2575.02	hp		bhp	3071.99	hp	
Rounded bhp	3000	hp	Rounded bhp	3000	hp	Rounded bhp	3500	hp			
<---- Assuming 75% pump efficiency			<---- Assuming 75% pump efficiency			<---- Assuming 75% pump efficiency					

MMWD Water Supply Conveyance Improvements Project - STAF Pipeline Sizing																	
Project Alternative	From	To	Length (miles)	Length (feet)	Flow (MGD)	Flow (gpm)	Flow (cfs)	Max Design Velocity (ft/sec)	Minimum Pipe Diameter (in)	Design Pipe Diameter (in)	Actual Pipe Velocity (ft/sec)	Hazen Williams C factor ⁽¹⁾	Friction Headloss (ft) ⁽²⁾	Minor Losses (ft) ⁽³⁾	Starting Elevation	Max Elevation	Finish Elevation
STAF-1	Stafford Lake	Nicasio Reservoir	8.0	42,240	7.3	5069.44	11.30	7	17.20	24	3.60	135	69.51	6.95	200	551	169
STAF-2	Stafford Lake	Soulajule Reservoir	6.8	35,904	7.3	5069.44	11.30	7	17.20	24	3.60	135	59.09	5.91	200	509	330
STAF-3	Stafford Lake	Nicasio and Soulajule Reservoir	11.0	58,080	7.3	5069.44	11.30	7	17.20	24	3.60	135	95.58	9.56	200	551	330

(1) - Assumes a C Factor for Cement Mortar Lined Welded

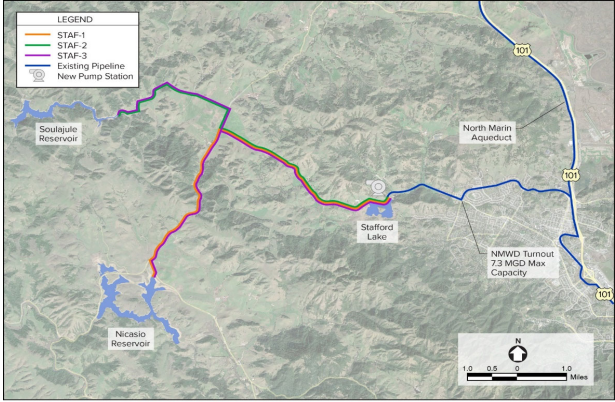
(2) - Headloss Calculated Using Hazen-Williams Equation

10.44 * L * Q^{1.85}

h_f =

C^{1.85} * d^{4.8655}

(3) - Minor losses assumed to be 10% of friction headloss



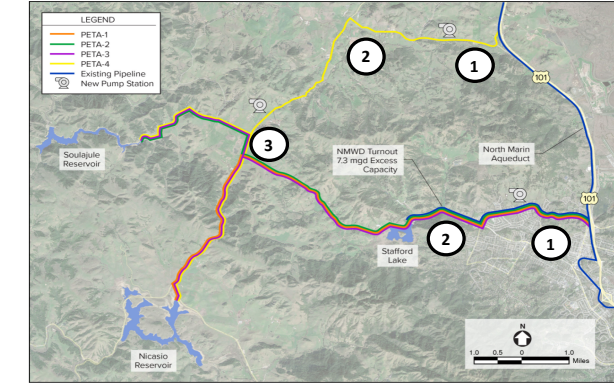
STAF Alternative Pump Stations																	
STAF-1			<---- Includes minor losses <---- Open Discharge at Reservoir <---- Assuming 75% pump efficiency	STAF-2			<---- Includes minor losses <---- Open Discharge at Reservoir <---- Assuming 75% pump efficiency	STAF-3			<---- Includes minor losses <---- Open Discharge at Reservoir <---- Assuming 75% pump efficiency						
Friction head loss	76.5	ft		Friction head loss	65.0	ft		Friction head loss	105.1	ft							
Pressure head	0.0	ft		Pressure head	0.0	ft		Pressure head	0.0	ft							
Elevation head	351	ft		Elevation head	309	ft		Elevation head	351	ft							
Total Dynamic Head	427.5	ft		Total Dynamic Head	374.0	ft		Total Dynamic Head	456.1	ft							
TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$									
Flow	5070.00	gpm		Flow	5070.00	gpm		Flow	5070.00	gpm							
TDH	427.5	ft		TDH	374.0	ft		TDH	456.1	ft							
whp	547.28	hp		whp	478.83	hp		whp	584.00	hp							
bhp	729.71	hp		bhp	638.44	hp		bhp	778.66	hp							
Rounded bhp	800	hp	Rounded bhp	800	hp	Rounded bhp	800	hp									

MMWD Water Supply Conveyance Improvements Project - PETA Pipeline Sizing w/o Upstream Improvements																		
Project Alternative	Segment	From	To	Length (miles)	Length (feet)	Flow (MGD)	Flow (gpm)	Flow (cfs)	Max Design Velocity (ft/sec)	Minimum Pipe Diameter (in)	Design Pipe Diameter (in)	Actual Pipe Velocity (ft/sec)	Hazen Williams C factor ⁽¹⁾	Friction Headloss (ft) ⁽²⁾	Minor Losses (ft) ⁽³⁾	Starting Elevation	Max Elevation	Finish Elevation
PETA-1	1	North Marin Aqueduct	Pump Station	1.0	5,280	10.4	7222.22	16.09	7	20.53	24	5.12	135	16.72	1.67	36	80	80
	2	Pump Station	Nicasio Reservoir	12.2	64,416	10.4	7222.22	16.09	7	20.53	24	5.12	135	204.03	20.40	80	551	169
PETA-2	1	North Marin Aqueduct	Pump Station	1.0	5,280	10.4	7222.22	16.09	7	20.53	24	5.12	135	16.72	1.67	36	80	80
	2	Pump Station	Soulajule Reservoir	11.0	58,080	10.4	7222.22	16.09	7	20.53	24	5.12	135	183.96	18.40	80	509	330
PETA-3	1	North Marin Aqueduct	Pump Station	1.0	5,280	10.4	7222.22	16.09	7	20.53	24	5.12	135	16.72	1.67	36	80	80
	2	Pump Station	Nicasio and Soulajule Reservoir	15.2	80,256	10.4	7222.22	16.09	7	20.53	24	5.12	135	254.20	25.42	80	551	330
PETA-4	1	North Marin Aqueduct	Pump Station A	1.5	7,920	12.5	8680.56	19.34	7	22.51	24	6.16	135	35.25	3.53	30	50	50
	2	Pump Station A	Pump Station B	4.2	22,176	12.5	8680.56	19.34	7	22.51	24	6.16	135	98.71	9.87	50	350	350
	3	Pump Station B	Nicasio and Soulajule Reservoir	9.1	48,048	12.5	8680.56	19.34	7	22.51	24	6.16	135	213.87	21.39	350	656	330

(1) - Assumes a C Factor for Cement Mortar Lined Welded Steel Pipe
(2) - Headloss Calculated Using Hazen-Williams Equation

$$h_f = \frac{10.44 * L * Q^{1.85}}{C^{1.85} * d^{4.8655}}$$

(3) - Minor losses assumed to be 10% of friction headloss



PETA Alternative Pump Stations w/o Upstream Improvements																				
PETA-1						PETA-2						PETA-3						PETA-4: Pump Station A		
Friction head loss	224.4	ft	<---- Includes minor losses <---- Open Discharge at Reservoir	Friction head loss	202.4	ft	<---- Includes minor losses <---- Open Discharge at Reservoir	Friction head loss	279.6	ft	<---- Includes minor losses <---- Open Discharge at Reservoir	Friction head loss	108.6	ft						
Pressure head	0.0	ft		Pressure head	0.0	ft		Pressure head	0.0	ft		Pressure head	30.0	ft						
Elevation head	471	ft		Elevation head	429	ft		Elevation head	471	ft		Elevation head	300	ft						
Total Dynamic Head	695.4	ft		Total Dynamic Head	631.4	ft		Total Dynamic Head	750.6	ft		Total Dynamic Head	438.6	ft						
TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$								
Flow	7230.00	gpm		Flow	7230.00	gpm		Flow	7230.00	gpm		Flow	8690.00	gpm						
TDH	695.4	ft		TDH	631.4	ft		TDH	750.6	ft		TDH	438.6	ft						
whp	1269.70	hp		whp	1152.71	hp		whp	1370.46	hp		whp	962.44	hp						
bhp	1692.93	hp	<---- Assuming 75% pump efficiency	bhp	1536.95	hp	<---- Assuming 75% pump efficiency	bhp	1827.28	hp	<---- Assuming 75% pump efficiency	bhp	1283.26	hp						
Rounded bhp	2000	hp		Rounded bhp	2000	hp		Rounded bhp	2000	hp		Rounded bhp	1500	hp						

PETA-4: Pump Station B	
Friction head loss	235.3 ft
Pressure head	0.0 ft
Elevation head	306 ft
Total Dynamic Head	541.3 ft
TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960	
Flow	8690.00 gpm
TDH	541.3 ft
whp	1187.76 hp
bhp	1583.68 hp
Rounded bhp	2000 hp
<---- Includes minor losses <---- Open Discharge at Reservoir	
<---- Assuming 75% pump efficiency	

MMWD Water Supply Conveyance Improvements Project - PETA Pipeline Sizing w/ Upstream Improvements																		
Project Alternative	Segment	From	To	Length (miles)	Length (feet)	Flow (MGD)	Flow (gpm)	Flow (cfs)	Max Design Velocity (ft/sec)	Minimum Pipe Diameter (in)	Design Pipe Diameter (in)	Actual Pipe Velocity (ft/sec)	Hazen Williams C factor ⁽¹⁾	Friction Headloss (ft) ⁽²⁾	Minor Losses (ft) ⁽³⁾	Starting Elevation	Max Elevation	Finish Elevation
PETA-1	1	North Marin Aqueduct	Pump Station	1.0	5,280	14.1	9791.67	21.82	7	23.91	30	4.44	135	9.92	0.99	36	80	80
	2	Pump Station	Nicasio Reservoir	12.2	64,416	14.1	9791.67	21.82	7	23.91	30	4.44	135	120.98	12.10	80	551	169
PETA-2	1	North Marin Aqueduct	Pump Station	1.0	5,280	14.1	9791.67	21.82	7	23.91	30	4.44	135	9.92	0.99	36	80	80
	2	Pump Station	Soulajule Reservoir	11.0	58,080	14.1	9791.67	21.82	7	23.91	30	4.44	135	109.08	10.91	80	509	330
PETA-3	1	North Marin Aqueduct	Pump Station	1.0	5,280	14.1	9791.67	21.82	7	23.91	30	4.44	135	9.92	0.99	36	80	80
	2	Pump Station	Nicasio and Soulajule Reservoir	15.2	80,256	14.1	9791.67	21.82	7	23.91	30	4.44	135	150.73	15.07	80	551	330
PETA-4	1	North Marin Aqueduct	Pump Station A	1.5	7,920	30	20833.33	46.42	7	34.87	36	6.57	135	24.76	2.48	30	50	50
	2	Pump Station A	Pump Station B	4.2	22,176	30	20833.33	46.42	7	34.87	36	6.57	135	69.34	6.93	50	350	350
	3	Pump Station B	Nicasio and Soulajule Reservoir	9.1	48,048	30	20833.33	46.42	7	34.87	36	6.57	135	150.24	15.02	350	656	330
Added STS Alt for PETA-4 w/Imps	1	Cotati Tanks	Pump Station	4.5	23,760	17.1	11875.00	26.46	7	26.33	30	5.39	135	63.76	6.38	343	343	40
	2	Pump Station	Kastania Pump Station	6.0	31,680	17.1	11875.00	26.46	7	26.33	30	5.39	135	85.02	8.50	40	250	250

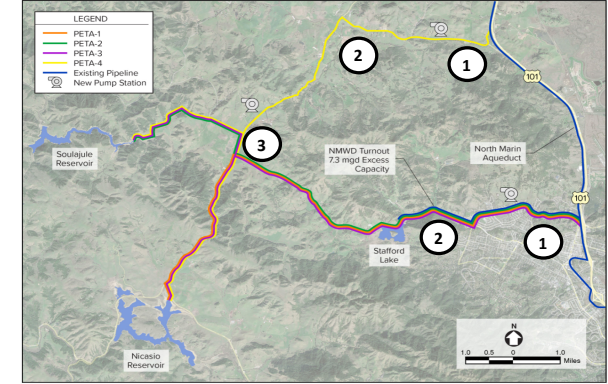
(1) - Assumes a C Factor for Cement Mortar Lined Welded Steel Pipe
(2) - Headloss Calculated Using Hazen-Williams Equation

Notes

Kept Pipeline Larger than Needed to Eliminate PS
Kept Pipeline Larger than Needed to Eliminate PS
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Kept Pipeline Larger than Needed to Eliminate PS

$$h_f = \frac{10.44 * L * Q^{1.85}}{C^{1.85} * d^{4.8655}}$$

(3) - Minor losses assumed to be 10% of friction headloss



PETA Alternative Pump Stations w/ Upstream Improvements														
PETA-1			<---- Includes minor losses <---- Open Discharge at Reservoir	PETA-2			<---- Includes minor losses <---- Open Discharge at Reservoir	PETA-3			<---- Includes minor losses <---- Open Discharge at Reservoir	PETA-4: Pump Station A		
Friction head loss	133.1	ft		Friction head loss	120.0	ft		Friction head loss	165.8	ft		Friction head loss	76.3	ft
Pressure head	0.0	ft		Pressure head	0.0	ft		Pressure head	0.0	ft		Pressure head	30.0	ft
Elevation head	471	ft		Elevation head	429	ft		Elevation head	471	ft		Elevation head	300	ft
Total Dynamic Head	604.1	ft		Total Dynamic Head	549.0	ft		Total Dynamic Head	636.8	ft		Total Dynamic Head	406.3	ft
TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$				TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$		
Flow	9800.00	gpm		Flow	9800.00	gpm		Flow	9800.00	gpm		Flow	20840.00	gpm
TDH	604.1	ft		TDH	549.0	ft		TDH	636.8	ft		TDH	406.3	ft
whp	1494.95	hp		whp	1358.62	hp		whp	1575.94	hp		whp	2138.06	hp
bhp	1993.27	hp		bhp	1811.49	hp		bhp	2101.25	hp		bhp	2850.75	hp
Rounded bhp	2000	hp	Rounded bhp	2000	hp	Rounded bhp	2500	hp	Rounded bhp	3000	hp			
<---- Assuming 75% pump efficiency			<---- Assuming 75% pump efficiency			<---- Assuming 75% pump efficiency			<---- Assuming 75% pump efficiency					

PETA-4: Pump Station B	
Friction head loss	165.3 ft
Pressure head	0.0 ft
Elevation head	306 ft
Total Dynamic Head	471.3 ft
TDH to HP (equation 1) $\text{whp} = \frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$	
Flow	20840.00 gpm
TDH	471.3 ft
whp	2480.06 hp
bhp	3306.75 hp
Rounded bhp	3500 hp

Added STS PS for PETA-4 w/lmps	
Friction head loss	93.5/ft
Pressure head	46.2/ft
Elevation head	210/ft
Total Dynamic Head	349.7/ft
TDH to HP (equation 1) whp = $\frac{\text{gpm} \times \text{TDH (ft)}}{3,960}$	
Flow	11880.00/gpm
TDH	349.7/ft
whp	1049.16/hp
bhp	1398.88/hp
Rounded bhp	1500/hp

MMWD Water Supply Conveyance Improvements Project - COTATI Pipeline Sizing																		
Project Alternative	Segment	From	To	Length (miles)	Length (feet)	Flow (MGD)	Flow (gpm)	Flow (cfs)	Max Design Velocity (ft/sec)	Minimum Pipe Diameter (in)	Design Pipe Diameter (in)	Actual Pipe Velocity (ft/sec)	Hazen Williams C factor ⁽¹⁾	Friction Headloss (ft) ⁽²⁾	Minor Losses (ft) ⁽³⁾	Starting Elevation	Max Elevation	Finish Elevation
COTATI-1	1	Cotati Tanks	Pump Station A	1.0	5,280	30	20833.33	46.42	7	34.87	36	6.57	135	16.51	1.65	343	343	165
	2	Pump Station A	Pump Station B	14.0	73,920	30	20833.33	46.42	7	34.87	36	6.57	135	231.13	23.11	165	361	300
	3	Pump Station B	Nicasio Reservoir	9.1	48,048	30	20833.33	46.42	7	34.87	36	6.57	135	150.24	15.02	300	735	169
COTATI-2	1	Cotati Tanks	Pump Station A	1.0	5,280	30	20833.33	46.42	7	34.87	36	6.57	135	16.51	1.65	343	343	165
	2	Pump Station A	Pump Station B	14.0	73,920	30	20833.33	46.42	7	34.87	36	6.57	135	231.13	23.11	165	361	300
	3	Pump Station B	Soulajule Reservoir	5.5	29,040	30	20833.33	46.42	7	34.87	36	6.57	135	90.80	9.08	300	735	330
COTATI-3	1	Cotati Tanks	Pump Station A	1.0	5,280	30	20833.33	46.42	7	34.87	36	6.57	135	16.51	1.65	343	343	165
	2	Pump Station A	Pump Station B	14.0	73,920	30	20833.33	46.42	7	34.87	36	6.57	135	231.13	23.11	165	361	300
	3	Pump Station B	Nicasio and Soulajule Reservoir	10.9	57,552	30	20833.33	46.42	7	34.87	36	6.57	135	179.95	18.00	300	735	330

(1) - Assumes a C Factor for Cement Mortar Lined Welded Steel Pipe

(2) - Headloss Calculated Using Hazen-Williams Equation

10.44 * L * Q^{1.85}

h_f =

c

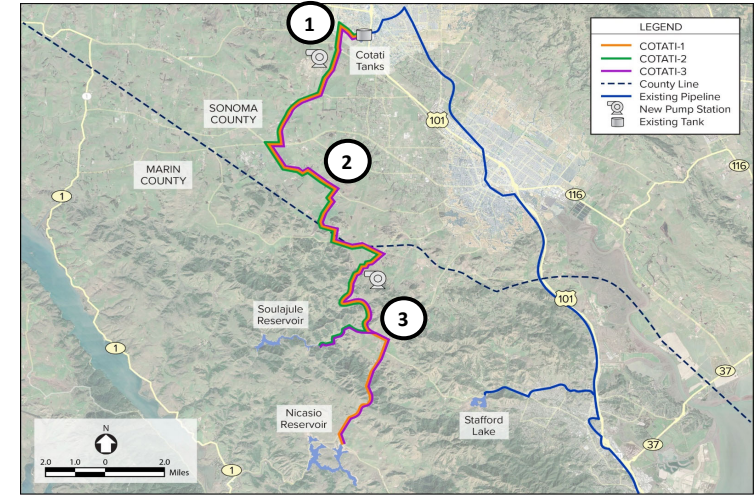
1.85

*

d

4.8655

(3) - Minor losses assumed to be 10% of friction headloss



COTATI Alternative Pump Stations											
COTATI-1: Pump Station A				COTATI-2: Pump Station A				COTATI-3: Pump Station A			
Friction head loss	254.2	ft	<---- Includes minor losses	Friction head loss	254.2	ft	<---- Includes minor losses	Friction head loss	254.2	ft	<---- Includes minor losses
Pressure head	30.0	ft	<---- Discharge to Pump Suction Header	Pressure head	30.0	ft	<---- Discharge to Pump Suction Header	Pressure head	30.0	ft	<---- Discharge to Pump Suction Header
Elevation head	196	ft		Elevation head	196	ft		Elevation head	196	ft	
Total Dynamic Head	480.2	ft		Total Dynamic Head	480.2	ft		Total Dynamic Head	480.2	ft	
TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960				TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960				TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960			
Flow	20840.00	gpm		Flow	20840.00	gpm		Flow	20840.00	gpm	
TDH	480.2	ft		TDH	480.2	ft		TDH	480.2	ft	
whp	2527.35	hp	<---- Assuming 75% pump efficiency	whp	2527.35	hp	<---- Assuming 75% pump efficiency	whp	2527.35	hp	<---- Assuming 75% pump efficiency
bhp	3369.80	hp		bhp	3369.80	hp		bhp	3369.80	hp	
Rounded bhp	3500	hp		Rounded bhp	3500	hp		Rounded bhp	3500	hp	
COTATI-1: Pump Station B				COTATI-2: Pump Station B				COTATI-3: Pump Station B			
Friction head loss	165.3	ft	<---- Includes minor losses	Friction head loss	99.9	ft	<---- Includes minor losses	Friction head loss	197.9	ft	<---- Includes minor losses
Pressure head	0.0	ft	<---- Open Discharge at Reservoir	Pressure head	0.0	ft	<---- Open Discharge at Reservoir	Pressure head	0.0	ft	<---- Open Discharge at Reservoir
Elevation head	435	ft		Elevation head	435	ft		Elevation head	435	ft	
Total Dynamic Head	600.3	ft		Total Dynamic Head	534.9	ft		Total Dynamic Head	632.9	ft	
TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960				TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960				TDH to HP (equation 1) whp = gpm x TDH (ft) 3,960			
Flow	20840.00	gpm		Flow	20840.00	gpm		Flow	20840.00	gpm	
TDH	600.3	ft		TDH	534.9	ft		TDH	632.9	ft	
whp	3158.94	hp	<---- Assuming 75% pump efficiency	whp	2814.88	hp	<---- Assuming 75% pump efficiency	whp	3330.97	hp	<---- Assuming 75% pump efficiency
bhp	4211.92	hp		bhp	3753.18	hp		bhp	4441.29	hp	
Rounded bhp	4500	hp		Rounded bhp	4000	hp		Rounded bhp	4500	hp	

STS Pipeline Cost Estimate												
Project Alternative	Segment	From	To	Type of area where pipeline will be placed	Length (miles)	Length (feet)	Flow (MGD)	Design Pipe Diameter (in)	Pipe Cost (\$/LF) (1)	Installation Cost (\$/LF)(2)	Pipe & Installation Unit Cost (\$/LF)	Total Pipeline Segment Cost
STS-1	1	Cotati Tanks	Pump Station	US-101 Corridor	4.50	23,760	30	36	\$ 407.00	\$ 481.50	\$ 888.50	\$ 21,120,000
	2	Pump Station	Kastania Pump Station	US-101 Corridor	6.00	31,680	30	36	\$ 407.00	\$ 481.50	\$ 888.50	\$ 28,150,000
STS-2	1	Cotati Tanks	Pump Station	Rural	6.00	31,680	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 26,860,000
	2	Pump Station	Kastania Pump Station	Downtown Area	6.10	32,208	30	36	\$ 407.00	\$ 522.20	\$ 929.20	\$ 29,927,674
STS-3	1	Cotati Tanks	Pump Station	Rural	5.50	29,040	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 24,630,000
	2	Pump Station	Kastania Pump Station	Residential	10.00	52,800	30	36	\$ 407.00	\$ 481.50	\$ 888.50	\$ 46,920,000

(1) - Estimate includes cost for WSP. 10% added to pipe costs to account for valves/fittings

(2) - Installation cost assumes 40% for rural areas, 50% for residential/Caltrans corridor and 60% for downtown areas, \$8/LF for traffic control and \$270/LF for paving (Paving includes 15' width of full roadway reconstruction and 15' width of 2" grind and overlay)

STS Pump Station Cost Estimate		
Project Alternative	Estimated Horsepower	Total Pump Station Cost
STS-1	3000	\$ 27,000,000.00
STS-2	3000	\$ 27,000,000.00
STS-3	3500	\$ 31,500,000.00

Booster Pump Station Unit Cost Assumptions		
Station Size	Unit Construction Cost (\$/hp)	Capital Cost (\$/hp)
30 hp and smaller	\$15,000	\$25,000
30-125 hp	\$12,950	\$21,500
125-500 hp	\$7,775	\$13,000
600-1,000 hp	\$6,475	\$11,000
1,000 hp and larger	\$5,175	\$9,000
Notes: Unit costs were taken from Mtn View Recycled Water Feasiblity Study		

STAF Pipeline Cost Estimate												
Project Alternative	Segment	From	To	Type of area where pipeline will be placed	Length (miles)	Length (feet)	Flow (MGD)	Design Pipe Diameter (in)	Pipe Cost (\$/LF) (1)	Installation Cost (\$/LF)(2)	Pipe & Installation Unit Cost (\$/LF)	Total Pipeline Segment Cost
STAF-1	1	Stafford Lake	Nicasio Reservoir	Rural	8.00	42,240	7.30	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 22,480,000
STAF-2	1	Stafford Lake	Soulajule Reservoir	Rural	6.80	35,904	7.30	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 19,110,000
STAF-3	1	Stafford Lake	Nicasio and Soulajule Reservoir	Rural	11.00	58,080	7.30	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 30,910,000

(1) - Estimate includes cost for WSP. 10% added to pipe costs to account for valves/fittings

(2) - Installation cost assumes 40% for rural areas, 50% for residential/Caltrans corridor and 60% for downtown areas, \$8/LF for traffic control and \$270/LF for paving (Paving includes 15' width of full roadway reconstruction and 15' width of 2" grind and overlay)

STAF Pump Station Cost Estimate		
Project Alternative	Estimated Horsepower	Total Pump Station Cost
STAF-1	800	\$ 8,800,000.00
STAF-2	800	\$ 8,800,000.00
STAF-3	800	\$ 7,200,000.00

Booster Pump Station Unit Cost Assumptions		
Station Size	Unit Construction Cost (\$/hp)	Capital Cost (\$/hp)
30 hp and smaller	\$15,000	\$25,000
30-125 hp	\$12,950	\$21,500
125-500 hp	\$7,775	\$13,000
600-1,000 hp	\$6,475	\$11,000
1,000 hp and larger	\$5,175	\$9,000
Notes: Unit costs were taken from Mtn View Recycled Water Feasiblity Study		

PETA Pipeline Cost Estimate w/o Upstream Improvements												
Project Alternative	Segment	From	To	Type of area where pipeline will be placed	Length (miles)	Length (feet)	Flow (MGD)	Design Pipe Diameter (in)	Pipe Cost (\$/LF) (1)	Installation Cost (\$/LF)(2)	Pipe & Installation Unit Cost (\$/LF)	Total Pipeline Segment Cost
PETA-1	1	North Marin Aqueduct	Pump Station	Residential	1.00	5,280	10.4	24	\$ 181.50	\$ 368.75	\$ 550.25	\$ 2,910,000
	2	Pump Station	Nicasio Reservoir	Rural	12.20	64,416	10.4	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 34,280,000
PETA-2	1	North Marin Aqueduct	Pump Station	Residential	1.00	5,280	10.4	24	\$ 181.50	\$ 368.75	\$ 550.25	\$ 2,910,000
	2	Pump Station	Soulajule Reservoir	Rural	11.00	58,080	10.4	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 30,904,368
PETA-3	1	North Marin Aqueduct	Pump Station	Residential	1.00	5,280	10.4	24	\$ 181.50	\$ 368.75	\$ 550.25	\$ 2,910,000
	2	Pump Station	Nicasio and Soulajule Reservoir	Rural	15.20	80,256	10.4	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 42,710,000
PETA-4	1	North Marin Aqueduct	Pump Station A	Rural	1.50	7,920	12.5	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 4,220,000
	2	Pump Station A	Pump Station B	Rural	4.20	22,176	12.5	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 11,800,000
	3	Pump Station B	Nicasio and Soulajule Reservoir	Rural	9.10	48,048	12.5	24	\$ 181.50	\$ 350.60	\$ 532.10	\$ 25,570,000

(1) - Estimate includes cost for WSP. 10% added to pipe costs to account for valves/fittings

(2) - Installation cost assumes 40% for rural areas, 50% for residential/Caltrans corridor and 60% for downtown areas, \$8/LF for traffic control and \$270/LF for paving (Paving includes 15' width of full roadway reconstruction and 15' width of 2" grind and overlay)

PETA Pump Station Cost Estimate w/o Upstream Improvements		
Project Alternative	Estimated Horsepower	Total Pump Station Cost
PETA-1	2000	\$ 18,000,000.00
PETA-2	2000	\$ 18,000,000.00
PETA-3	2000	\$ 18,000,000.00
PETA-4: Pump Station A	1500	\$ 13,500,000.00
PETA-4: Pump Station B	2000	\$ 18,000,000.00

Booster Pump Station Unit Cost Assumptions		
Station Size	Unit Construction Cost (\$/hp)	Capital Cost (\$/hp)
30 hp and smaller	\$15,000	\$25,000
30-125 hp	\$12,950	\$21,500
125-500 hp	\$7,775	\$13,000
600-1,000 hp	\$6,475	\$11,000
1,000 hp and larger	\$5,175	\$9,000
Notes: Unit costs were taken from Mtn View Recycled Water Feasiblity Study		

PETA Pipeline Cost Estimate w/ Upstream Improvements												
Project Alternative	Segment	From	To	Type of area where pipeline will be placed	Length (miles)	Length (feet)	Flow (MGD)	Design Pipe Diameter (in)	Pipe Cost (\$/LF) (1)	Installation Cost (\$/LF)(2)	Pipe & Installation Unit Cost (\$/LF)	Total Pipeline Segment Cost
PETA-1	1	North Marin Aqueduct	Pump Station	Residential	1.00	5,280	14.1	30	\$ 297.00	\$ 426.50	\$ 723.50	\$ 3,830,000
	2	Pump Station	Nicasio Reservoir	Rural	12.20	64,416	14.1	30	\$ 297.00	\$ 396.80	\$ 693.80	\$ 44,700,000
PETA-2	1	North Marin Aqueduct	Pump Station	Residential	1.00	5,280	14.1	30	\$ 297.00	\$ 426.50	\$ 723.50	\$ 3,830,000
	2	Pump Station	Soulajule Reservoir	Rural	11.00	58,080	14.1	30	\$ 297.00	\$ 396.80	\$ 693.80	\$ 40,295,904
PETA-3	1	North Marin Aqueduct	Pump Station	Residential	1.00	5,280	14.1	30	\$ 297.00	\$ 426.50	\$ 723.50	\$ 3,830,000
	2	Pump Station	Nicasio and Soulajule Reservoir	Rural	15.20	80,256	14.1	30	\$ 297.00	\$ 396.80	\$ 693.80	\$ 55,690,000
PETA-4	1	North Marin Aqueduct	Pump Station A	Rural	1.50	7,920	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 6,720,000
	2	Pump Station A	Pump Station B	Rural	4.20	22,176	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 18,810,000
	3	Pump Station B	Nicasio and Soulajule Reservoir	Rural	9.10	48,048	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 40,740,000
Added STS Alt for PETA-4 w/Imps	1	Cotati Tanks	Pump Station	US-101 Corridor	4.50	23,760	17.1	30	\$ 256.43	\$ 406.22	\$ 662.65	\$ 15,750,000
	2	Pump Station	Kastania Pump Station	US-101 Corridor	6.00	31,680	17.1	30	\$ 297.00	\$ 426.50	\$ 723.50	\$ 22,930,000

(1) - Estimate includes cost for WSP. 10% added to pipe costs to account for valves/fittings

(2) - Installation cost assumes 40% for rural areas, 50% for residential/Caltrans corridor and 60% for downtown areas, \$8/LF for traffic control and \$270/LF for paving (Paving includes 15' width of full roadway reconstruction and 15' width of 2" grind and overlay)

PETA Pump Station Cost Estimate w/ Upstream Improvements		
Project Alternative	Estimated Horsepower	Total Pump Station Cost
PETA-1	2000	\$ 18,000,000.00
PETA-2	2000	\$ 18,000,000.00
PETA-3	2500	\$ 22,500,000.00
PETA-4: Pump Station A	3000	\$ 27,000,000.00
PETA-4: Pump Station B	3500	\$ 31,500,000.00
Added STS PS for PETA-4 w/Imps	1500	\$ 13,500,000.00

Booster Pump Station Unit Cost Assumptions		
Station Size	Unit Construction Cost (\$/hp)	Capital Cost (\$/hp)
30 hp and smaller	\$15,000	\$25,000
30-125 hp	\$12,950	\$21,500
125-500 hp	\$7,775	\$13,000
600-1,000 hp	\$6,475	\$11,000
1,000 hp and larger	\$5,175	\$9,000
Notes: Unit costs were taken from Mtn View Recycled Water Feasiblity Study		

COTATI Pipeline Cost Estimate												
Project Alternative	Segment	From	To	Type of area where pipeline will be placed	Length (miles)	Length (feet)	Flow (MGD)	Design Pipe Diameter (in)	Pipe Cost (\$/LF) (1)	Installation Cost (\$/LF) (2)	Pipe & Installation Unit Cost (\$/LF)	Total Pipeline Segment Cost
COTATI-1	1	Cotati Tanks	Pump Station A	Rural	1.00	5,280	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 4,480,000
	2	Pump Station A	Pump Station B	Rural	14.00	73,920	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 62,670,000
	3	Pump Station B	Nicasio Reservoir	Rural	9.10	48,048	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 40,740,000
COTATI-2	1	Cotati Tanks	Pump Station A	Rural	1.00	5,280	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 4,480,000
	2	Pump Station A	Pump Station B	Rural	14.00	73,920	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 62,669,376
	3	Pump Station B	Soulajule Reservoir	Rural	5.50	29,040	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 24,620,112
COTATI-3	1	Cotati Tanks	Pump Station A	Rural	1.00	5,280	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 4,480,000
	2	Pump Station A	Pump Station B	Rural	14.00	73,920	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 62,670,000
	3	Pump Station B	Nicasio and Soulajule Reservoir	Rural	10.90	57,552	30	36	\$ 407.00	\$ 440.80	\$ 847.80	\$ 48,800,000

(1) - Estimate includes cost for WSP. 10% added to pipe costs to account for valves/ittings
(2) - Installation cost assumes 40% for rural areas, 50% for residential/Caltrans corridor and 60% for downtown areas, \$8/LF for traffic control and \$270/LF for paving (Paving includes 15' width of full roadway reconstruction and 15' width of 2" grind and overlay)

COTATI Pump Station Cost Estimate		
Project Alternative	Estimated Horsepower	Total Pump Station Cost
COTATI-1: Pump Station A	3500	\$ 31,500,000.00
COTATI-1: Pump Station B	4500	\$ 40,500,000.00
COTATI-2: Pump Station A	3500	\$ 31,500,000.00
COTATI-2: Pump Station B	4000	\$ 36,000,000.00
COTATI-3: Pump Station A	3500	\$ 31,500,000.00
COTATI-3: Pump Station B	4500	\$ 40,500,000.00

Booster Pump Station Unit Cost Assumptions		
Station Size	Unit Construction Cost (\$/hp)	Capital Cost (\$/hp)
30 hp and smaller	\$15,000	\$25,000
30-125 hp	\$12,950	\$21,500
125-500 hp	\$7,775	\$13,000
600-1,000 hp	\$6,475	\$11,000
1,000 hp and larger	\$5,175	\$9,000
Notes: Unit costs were taken from Mtn View Recycled Water Feasiblity Study		