FINAL REPORT | APRIL 2023

Russian River County Sanitation District Headworks, Lift Stations, and Force Mains Project Report

PREPARED FOR

Sonoma County Water Agency

Sonoma Water

PREPARED BY

WEST YOST
Water. Engineered.

Russian River County Sanitation District Headworks, Lift Stations, and Force Mains Project Report

Prepared for

Sonoma County Water Agency

West Yost Project No. 798-30-21-03

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LIST OF ACRONYMS AND ABBREVIATIONS

AACE	Advancement of Cost Engineering
ADWF	Average Dry Weather Flow
ATS	Automatic Transfer Switch
AWWF	Average Wet Weather Flow
BEP	Best-Efficiency Points
CCTV	Closed-Circuit Television
CLSM	Controlled Low Strength Material
CML	Cedar-Mortar Lined
CMLC	Cement-Mortar Lines and Coated
CMLCS	Cement-Mortar Lined and Coated Steel
CMLS	Cement-Mortar Lined Steel
CMU	Concrete Masonry Unit
CWSRF	Clean Water State Revolving Fund
DIP	Ductile Iron Pipe
District	Russian River County Sanitation District
FEMA	Federal Emergency Management Agency
H2S	Hydrogen Sulfide Gas
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HP	Horsepower
kV	Kilovolt
KW	Kilowatt
LF	Linear Feet
LHMP	Local Hazard Mitigation Plan
MCC	Motor Control Center
mgd	Million Gallons Per Day
O&M	Operation and Maintenance
PDWF	Peak Dry Weather Flow
PLC	Programmable Logic Controller
Project	Force Mains Rehabilitation and Replacement Project
PVC	Polyvinyl Chloride
PVCO	Molecularly Oriented Polyvinyl Chloride
R&R	Remove and Replace
Regional Board	North Coast Regional Water Quality Control Board
RTU	Remote Telemetry Unit

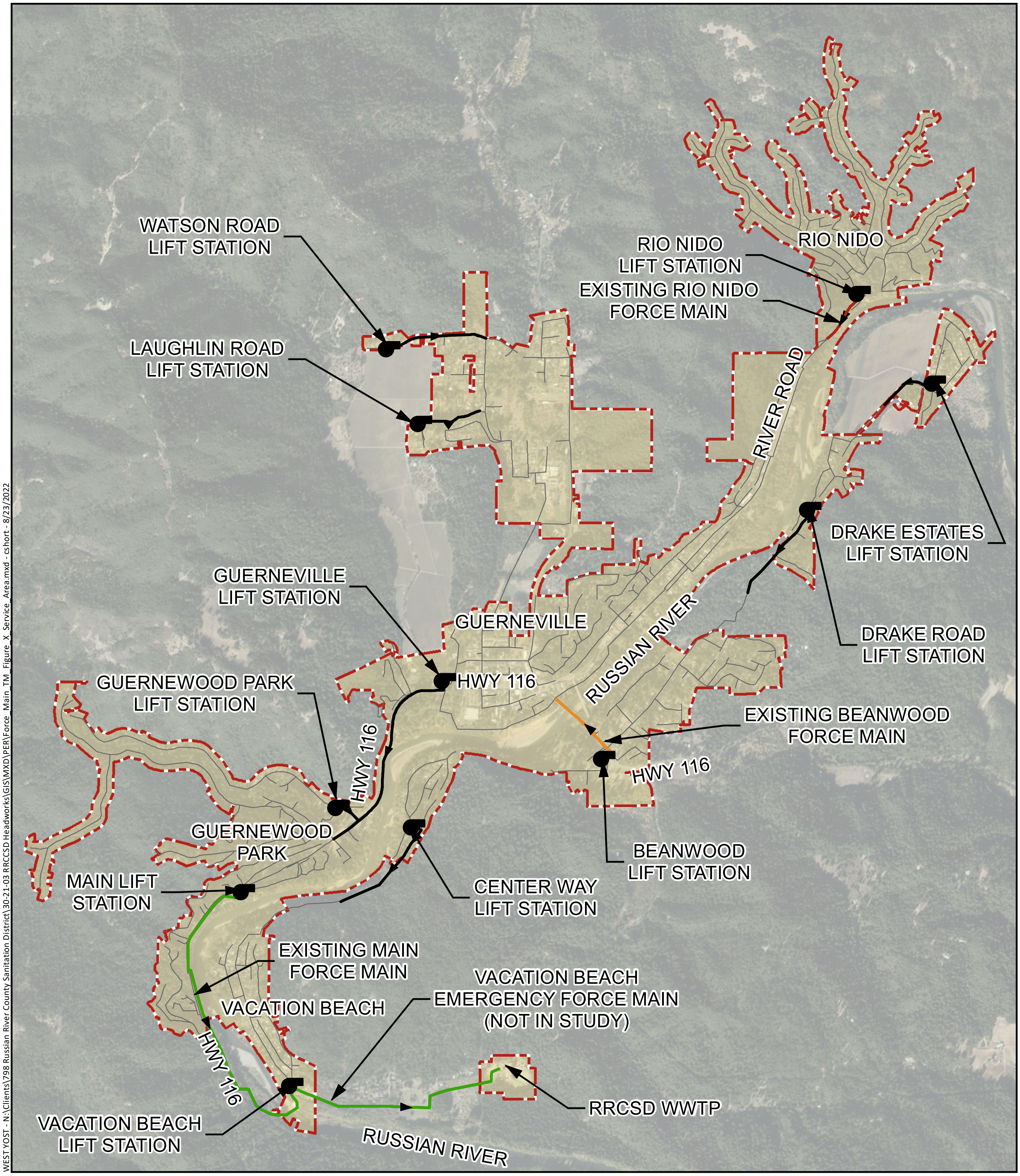
Sonoma Water	Sonoma County Water Agency
SRF	State Revolving Fund
State Water Board	State Water Resources Control Board
Sweetwater	Sweetwater Springs Water District
TM	Technical Memorandum
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION AND BACKGROUND

The Russian River County Sanitation District (District) is one of eight different sanitation zones and districts managed and operated by Sonoma County Water Agency (Sonoma Water). The District services a 2,700 acre area located within the heart of the Russian River watershed near Guerneville, CA. The facilities within the District's service area include a complex gravity and pressurized force main pipeline network, 11 lift stations, and a wastewater treatment plant (WWTP) located just east of Vacation Beach. Figure 1 shows the extents of the District's service area.

The wastewater infrastructure within the District's service area was originally constructed in the 1970's and 1980's, prompting the District to investigate the condition of the lift stations, force mains, and headworks facility at the WWTP. In February 2014, one of the District's force mains ruptured due to internal corrosion and leakage. In November 2021, two additional leaks were discovered - one near the same location of the 2014 failure, and one occurring nearly a mile and a half away on another force main segment. While these leaks were repaired, the District is concerned that other vulnerabilities may exist among the remainder of the infrastructure throughout the wastewater network.

The District has completed an alternatives analysis of three force mains in its network and an extensive condition assessment of all lift stations and the headworks facility. The results of each of the assessments have contributed to the District's understanding of the infrastructure improvements necessary within its service area. Sonoma Water is applying for financial assistance through the Clean Water State Revolving Fund (CWSRF) on behalf of the District to help cover the costs of the Headworks, Lift Stations, and Force Mains Rehabilitation and Replacement Project (Project), which will strengthen its vulnerable infrastructure.



Symbology

- District Service Area
- Existing Lift Stations
- Existing Force Main Network
- Existing Gravity Sanitary Network

N

0 1,000 2,000

Scale in Feet

Sonoma Water

Figure 1

Project Vicinity

Sonoma Water

RRCSD Force Main Rehabilitation and Replacement Project

WEST YOST

2.0 PROJECT AREA

2.1 Vicinity and Service Area

The Russian River County Sanitation District's 2,700 acre service area in Sonoma County, CA encompasses the unincorporated areas of Rio Nido, Guerneville, Guernewood Park, and Vacation Beach. The District provides service to approximately 3,300 parcels, of which the WWTP treats wastewater for approximately 3,200 equivalent single-family dwelling units. The Project area is spread out throughout the District, with three metallic force mains to be replaced at the northern, central, and southern ends of the service area. Most of the District's force mains run parallel to or cross the Russian River. The 11 lift stations to be potentially rehabilitated are evenly distributed throughout the service area and pump flow towards the headworks facility at the WWTP. The Project will be described further in subsequent sections of this report.

2.2 Regional Hydrology, Geology, Topography and Groundwater

The environment in the Project area consists of mountainous redwood ranges surrounding the Russian River which flows through the valley below. The regional topography ranges between approximately 30 feet and 1,200 feet above mean sea level, and a majority of the District's infrastructure exists at approximately 40 to 50 feet above mean sea level. Historically, the Project area has seen frequent flooding as the Russian River can reach elevations above 40 feet.

The subsurface geology in the Project area exists within the Franciscan Complex comprised mostly of sandstone and alluvial and marine deposits near the river. The composition of the geology in the Project area creates risks for liquefaction in the event of seismic activity. According to the Local Hazard Mitigation Plan (LHMP) prepared for the District in 2018 (Appendix A), a majority of the infrastructure in the Project exists within areas classified as "High" to "Very High" liquefaction susceptibility. These zones were based on broad regional scaling and may not portray the exact geologic conditions within the Project area. A geotechnical desktop study produced for the District in 2022 (Appendix B) has indicated that there is likelihood that the liquefaction zone classifications may have downgraded in more recent studies. There is also probability that areas within the Project may have no liquefaction susceptibility due to the presence of bedrock. Nevertheless, the District is planning to mitigate risks of liquefaction by incorporating materials suitable for seismic resiliency.

Groundwater in the Project area is part of the Lower Russian River Valley Groundwater Basin. The groundwater in the basin is hydraulically connected to the river due to it being unconfined; however, large amounts of silt and clay in some areas may confine the groundwater locally. Groundwater levels north of the Russian River in Guerneville were measured at California Department of Water Resources Groundwater Level Station 385141N1229971W001 to be approximately 5 feet below the ground surface in 2001. Groundwater levels at Northwood Golf Club, south of the District WWTP, were measured at California Department of Water Resources Groundwater Level Station 384773N1229923W001 to be approximately 37 feet below the ground surface in 2021. Regional topographic, geologic, and groundwater maps and information can be seen in Appendix C.

2.3 Ground and Surface Water Resources

The Project area is serviced by Sweetwater Springs Water District (Sweetwater). Sweetwater supplies potable water to approximately 3,600 accounts which are 95 percent residential, comprised of nearly 9,000 people. Sweetwater's water supply originates from groundwater wells located near the Russian

River. Distribution facilities for Sweetwater's water network consists of three wells in Guerneville and two wells in the neighboring town of Monte Rio, located just south of the Project area.

As previously mentioned, the Russian River flows directly through the District service area. During large storm events, the Project area is subject to flooding, as shown in the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (Appendix D). The blue outline in these maps represents the inundated zone during a 1-percent annual flood (100-year flood), which represents the flood event that has a 1-percent chance of being equaled or exceeded in any given year. The District and community have experienced similar floods in recent history. During these events, the District facilities are at risk of severe damage, and the inundation of lift stations increases the potential for ground and surface water contamination.

2.4 Existing Force Main Facilities

There are 11 sanitary force main pipelines corresponding to each of the lift stations owned and operated by the District. The force mains make up a total length of nearly five miles of pipe composed of ductile iron pipe (DIP), polyvinyl chloride (PVC), and cement mortar lined and coated steel (CMLCS) ranging in diameter of 1.5 inches to 16 inches. A majority of the force mains flow for a short distance before discharging into the gravity sewer network composed of approximately 35 miles of pipe ranging in diameter from 6 inches to 30 inches.

The existing force mains within the service area were originally constructed approximately 40 years ago and have shown signs of significant depreciation with multiple leaks and ruptures. The force main facilities of largest concern to the District are those composed of either DIP or CMLCS pipe. Through investigation, the District has determined that in multiple locations these pipes are corroding internally. Further corrosion risks additional ruptures throughout the wastewater network and places the District's treatment system in an increasingly vulnerable state. Moreover, wastewater leaks occurring from the force mains puts the soil and groundwater at risk of contamination, a particular concern with the proximity and unconfined nature of the groundwater aquifers and Russian River.

The Project focuses on the three metallic force mains in the network, named after the lift station. They discharge from: Rio Nido force main, Beanwood force main, and Main force main. Rio Nido force main is an 8-inch ductile iron pipe flowing southwest from Rio Nido lift station into the existing gravity sewer network. Beanwood force main is an 8-inch cement mortar lined steel (CMLS) and CMLCS pipe flowing northwest from Beanwood lift station, across the Guerneville Bridge, and into the existing gravity sewer network. Main force main is a 16-inch CMLCS pipe flowing south and east from Main lift station and into the WWTP.

2.5 Existing Lift Station Facilities

The District owns and operates 11 lift stations within the service area, which collect and pump wastewater from the gravity and force main network towards the WWTP. The location of the lift stations and force mains can be seen in Figure 1.

Similar to the force main facilities, many of the lift stations are approaching the end of their useful life, with many of the components being over 40 years old. The current condition of each lift station facility is documented in the condition assessment technical memorandum (TM) in Appendix F.

The existing pumps in each of the lift stations were recently replaced beginning in 2006. Beanwood, Guerneville, Main, and Rio Nido lift stations. Each have three pumps, and the other stations have two pumps. The lift stations that contain two pumps were constructed with circular reinforced concrete wet wells; the lift stations containing three pumps were constructed with rectangular reinforced concrete wet wells. Table 1 summarizes the pump characteristics at each of the lift stations.

Table 1. Existing Lift Station Pump Characteristics

Lift Station	No. Pumps	Horsepower, hp	Firm Capacity[(a)], gpm
Vacation Beach Lift Station	2	10	350
Center Way Lift Station	2	10	120
Beanwood Lift Station	3	10	530
Drake Road Lift Station	2	10	230
Drake Estates Lift Station	2	7.5	125
Rio Nido Lift Station	3	5	330
Watson Road Lift Station	2	2.3	32
Laughlin Road Lift Station	2	2.3	22
Main Lift Station	3	47	2500
Guernewood Park Lift Station	2	7.5 - 10	400
Guerneville Lift Station	3	30	1800

(a) Firm capacity is based on the pump curves obtained by the pump manufacturer and the system curves developed for the analysis, based on the as-built construction drawings.

As part of the District's analysis of the existing lift station facilities, the pump and system curves were reviewed to determine how well the pumps are believed to operate relative to their individual best-efficiency-points (BEP). As noted in Table 1, the pump curves were obtained from the pump manufacturer, and the system curves were developed based on as-built construction drawings for each lift station and associated force main pipeline. The system and pump curves are provided in Appendix F.

A majority of the deficiencies associated with the District lift station facilities relate to, but are not limited to, the site electrical equipment. Two of the lift stations contain a building to house the electrical control centers while the remainder of the lift stations contain the electrical facilities outdoors. The collection system area, including that surrounding the lift stations, has historically been inundated with floodwaters during high water events. The outdoor electrical and motor control centers have been elevated on metal platforms in recent years to avoid the risk of being damaged by water during such flood events.

2.6 Existing Headworks Facilities

The headworks, which is the first point in the treatment train at the District's WWTP, was constructed in approximately 1980 with the rest of the plant. Although there have been minor improvements through the years, including installation of new mechanical spiral screens at the front-end of the headworks, and replacement of various equipment like the grit pumps, the facility currently exhibits many signs of age and is in general need of rehabilitation, as documented in the same condition assessment TM for the lift stations in Appendix F. The following sections discuss the methodology used for conducting the alternatives analysis for the headworks and related facilities. The objective of the analysis is to assist in the selection of a preferred alternative that will provide the necessary improvements to the District's facilities so they may continue to operate well into the future.

Though the District will be making varying levels of improvements to the infrastructure within the facilities discussed, additional flow into the system is not anticipated. Design and current average dry weather flow (ADWF) and average wet weather flow (AWWF) for the headworks and WWTP can be seen in Table 2.

Table 2. Headworks Flow Data

Design ADWF, MGD	Current ADWF, MGD	Design AWWF, MGD	Current AWWF, MGD[(a)]
0.71	0.33	3.5	0.52

(a) Values have been determined based on a 5-year average and do not include flows during Russian River flooding events.

2.7 Current Land Use and Land Use Trends

The current land use for the 3,300 parcels within the District service area consists of residential (both single-family and multi-family), agricultural, and commercial. The sizes of the parcels range from 0.01 to 16.6 acres.

2.8 Current and New Public Sewer Collection System Users

All 3,300 parcels within the District boundary rely on the wastewater system including the gravity sewer pipe network, force mains, lift stations, and WWTP. The largest unincorporated area served by the District is Guerneville, with a population of nearly 5,000 people. The District expects the number of system users to remain the same.

3.0 PROJECT OBJECTIVES

3.1 Reason for the Project

The infrastructure making up the District's wastewater facilities is becoming increasingly more deficient as time goes on. These deficiencies pose risks to the remainder of the network infrastructure, the groundwater basin, the community served, and the employees at the District, as additional hazardous conditions may arise. The information below will highlight the reasons for the Project.

One of the reasons for the Project is to address the liquefiable susceptibility of the subsurface facilities. As mentioned previously, a majority of the Project area is within "High" to "Very High" zones of liquefaction potential as defined in the LHMP. Addressing these concerns will minimize the risk of structural damage to the District's force mains during seismic events. Replacements to the existing infrastructure will be made with materials that are intended for seismic resilience.

A second intention of the Project is to address internal corrosion within the force main network. Naturally occurring sulfur-reducing bacteria in wastewater creates a corrosive hydrogen sulfide gas (H_2S), which can attack concrete and metal materials. It is likely that H_2S corrosion is responsible for the damage that has already occurred within the system at locations where gaps of air are present within the pipeline. Any new pipe materials to be installed for the Project will be composed of corrosion-resistant materials to eliminate the risk of damage due to H_2S.

Both structural damage and corrosion could lead to a force main leak or break which can harm the environment and lead to costly fines and emergency repairs. The potential health effects of a failing system include the following:

- Spread of infectious diseases by mosquitoes and flies that breed in areas where liquid wastewater reaches the surface;
- Contamination of the Russian River;
- Contamination of the groundwater basin; and
- Risk to the public, especially children and animals, who come into contact with surface flows.

The District intends to make improvements to the headworks at the WWTP and the lift stations within the service area in conjunction with the improvements to the associated discharge force mains. A recently compiled condition assessment prepared for the District analyzed the headworks and lift stations using a condition-based and time-based remaining useful life scoring system of 1 to 5 with 5 representing the least remaining useful life and worst condition. Out of 283 total items assessed at the lift stations, over 200 were scored between 3 and 5, indicating that a majority of the District's lift station components will need replacing or rehabilitation in the near future. Part of the improvements intended for the headworks and lift station facilities entails decommissioning the two high-voltage electrical transmission lines that the District maintains, which provide primary power to Main, Vacation Beach, Guerneville, and Guernewood Park Lift Stations. As discussed in Sections 5 and 6, these transmission lines are difficult to maintain and pose a critical safety risk for construction activities that occur within the right-of-way where the lines are located. Accordingly, the District intends to decommission the high-voltage transmission lines and instate new PG&E electrical utility services at each of the affected lift stations.

3.2 Expected Benefits to the Community

The benefits of rehabilitating the public sewer system in the Russian River community are expected to include improved system reliability especially during an earthquake event, reduced District overall sewer operation and maintenance costs, alleviated groundwater and surface water contamination risks, reduced emergency infrastructure repairs, reduced electrical hazards, reduced damages due to flooding, and improvements to public health and safety and the environment.

4.0 FORCE MAIN ALTERNATIVES ANALYSIS

4.1 Planning and Design Parameters and Assumptions

The planning and design parameters for rehabilitating the Rio Nido, Beanwood and Main Force Mains for the District's public sewer system were conducted in accordance with Section 3.2 "Sewer Design Capacity and Structural Calculations," Section 4 "Design Standards," Section 5 "Plan Approval and Permit Issuance" and Section 8 "Control of Work" of the Sonoma Water Design and Construction Standards for Sanitation Facilities dated November 2020 (Sonoma Water Standards). Design requirements generally consisted of pipe size, minimum cover, pipe clearance from existing utilities, and pipe material.

In accordance with the Sonoma Water Standards Section 4.2.B, the minimum pipe diameter for sewer force mains is 3 inches. For the force main replacements for the three alignments, the nominal pipe diameter will be that of the existing diameter in most cases. For Rio Nido and Beanwood Force Mains, the pipe diameter will be 8-inches and for the Main Force Main the pipe diameter will be 14 and 18 inches.

Section 4.2.F of the Sonoma Water Standards specifies a minimum cover of 4.5 feet for pipe within a public street and 3.5 feet for pipe within easements or other rights-of-way not expected to receive traffic loads.

In accordance with the Sonoma Water Standards Section 4.2.H, all sewer pipes must have a minimum 12-inch vertical clearance from all other utilities and a minimum 7.5 feet horizontal clearance from any other structure, unless otherwise approved by the District. Horizontal and vertical clearances between sewer pipes and potable water mains shall be in accordance with the current requirements of California Code of Regulations Title 22 Chapter 16 California Waterworks Standards, which requires 10-foot separation. Sewer pipes must maintain a 5-foot horizontal separation from storm drains and gas mains and a 4-foot horizontal separation from other utilities.

The Sonoma Water Standards Section 4.2.S states that all sewer force main pipe shall be PVC, PVC C-900, PVC C-905, or DIP. However, only PVC and HDPE are being considered for underground force main in this Project to meet one of the Project objectives to replace metallic pipe that is susceptible to corrosion. See section 4.2.4 Pipe Material Alternatives of this report for more information.

4.2 Design Alternatives Considered

A preliminary analysis was conducted describing various construction methods and comparing alternatives by force main segment. Further information discussing these alternatives can be found in the Force Main Alternatives Analysis Technical Memorandum (Appendix E). The multiple alternatives were narrowed to three alternatives discussed in the sections below for further evaluation and full development of construction cost estimates and life cycle cost analyses. The three force mains under consideration in this analysis are shown in Figure 1 and described as follows:

1. Rio Nido Force Main. This force main is approximately 930 feet in length consisting of 8-inch diameter ductile iron pipe with mechanical joints installed in River Road starting at the Rio Nido Lift Station at the intersection of River Road and Rio Nido Road. It continues south on Highway 116 to a discharge manhole, connecting to the gravity sewer system.
2. Beanwood Force Main. This force main is approximately 1,350 feet in length consisting of 8-inch diameter cement-mortar lined (CML) welded steel pipe where exposed on the Guerneville Bridge crossing, and cement-mortar lined and coated (CMLC) steel pipe where buried. The pipe extends from the Beanwood Lift Station near the intersection of Neeley

Road and Drake Road to the Guerneville Bridge where it is suspended from the bridge for a length of 760 feet to traverse the Russian River. The force main ends on the west side of the Russian River at a discharge manhole near River Road.

3. Main Force Main. This force main is approximately 8,560 feet in length consisting of 16-inch diameter CMLC steel pipe from the Main Lift Station on Riverside Drive. The pipe turns onto the State Highway 116 right-of-way for approximately 5,320 feet before it crosses the Russian River via a trenched concrete-encased crossing. The force main then travels approximately 3,230 feet along Vacation Beach Road, Orchard Avenue, and an easement to the headworks of the District's WWTP. It was within this section of the force main that severe corrosion of the main has occurred. An emergency replacement alternatives analysis TM (Alternatives Analysis for the Emergency Force Main Replacement on Orchard Avenue near Vacation Beach Lift Station) was completed by West Yost in May 2022, and construction of improvements was completed in Fall 2022.

A significant factor in the selection of the preferred pipe material is the liquefiable soils throughout the Project area. A flexible pipe is preferred in these conditions to withstand the risk of movement and damage as a result of seismic events.

With the high potential for ongoing corrosion of the metallic pipes and for seismic-induced liquefaction throughout the Project area, an alternatives analysis to compare rehabilitation and replacement methods suitable for restoring approximately 11,000 feet of force main at the above three locations was conducted.

An important aspect of the Project is the necessity to cross the Russian River at two locations. Various construction methods including trenchless and bridge attachment were evaluated in these locations in addition to alternative means of maintaining flow during construction.

Overall, multiple alternatives have been assessed that include both trenchless and open-cut construction methods. The following sections present a comparison of alternatives consisting of various rehabilitation and replacement methods by force main segment and conclude by summarizing the preferred repair method for each project location in Section 7.0.

4.2.1 Rio Nido Force Main

The Rio Nido Force Main is an 8-inch diameter ductile iron force main with mechanical joints beginning at the Rio Nido Lift Station and running south approximately 930 feet along River Road where it discharges into an existing sanitary sewer manhole. This manhole also collects gravity flows from two houses.

The Rio Nido Force Main is mostly located in the "Very Low" liquefaction susceptibility zone, per the District's LHMP. However, the start of the alignment just downstream of the Rio Nido Lift Station where the force main crosses Rio Nido Road is within the limits of the "High" liquefaction zone.

Sliplining, horizontal directional drilling (HDD) and microtunneling were not considered viable construction methods for the Rio Nido Force Main. Further information regarding these methods can be found in the Force Main Alternative Analysis TM (Appendix E).

For analysis purposes, the Rio Nido Force Main alignment is broken up into two segments. Segment 1 includes the portion of the existing force main that is within the "High" liquefaction zone beginning from the lift station and running south, approximately 140 feet. Segment 2 includes the remainder of existing force main, approximately 790 feet, which continues south where it discharges into an existing sanitary sewer manhole. Photo 1 shows a portion of Segment 2 along the viaduct.

Photo 1
Looking south along River Road along a portion of Segment 2 of the existing Rio Nido force main alignment.

4.2.1.1 Alternative 0 – No Action

Due to the age of the Rio Nido Force Main and the potential of corrosion of the existing metallic pipe a “no action” design was not considered a viable option.

4.2.1.2 Alternative 1

Alternative 1 evaluates removing and replacing the existing pipe by open-cut construction in the same trench for Segment 1, defined as the location of the pipe within the “High” liquefaction zone, and using CIPP for Segment 2, which encompasses the remainder of the force main and is within a zone with low risk to liquefaction. Figure 2 displays the proposed force main layout for Alternative 1.

4.2.1.2.1 Segment 1

Alternative 1 includes removing and replacing Segment 1 of the Rio Nido Force Main within the existing alignment with 8-inch diameter force main pipe due to this portion of the pipe being within a “High” liquefaction zone where CIPP lining is not suitable. CIPP lining is not suitable for “High” liquefaction zones because although CIPP liners can accommodate high intensity ground motions during an earthquake, and have lined bell-and-spigot pipe joints that increase deformation capacity due to debonding between the liner and the pipe; the deformation benefit reaches its limit when the joint opening of the pipe increases beyond a half inch, at which point the liner is damaged as it folds into the gap of the joint (“NEESR Summary Report Earthquake Response and Rehabilitation of Critical Lifelines”; Cornell University,

University at Buffalo, and California State University at Los Angeles; 2014). For fused pipe joints, the liner does not provide the benefit of deformation at the joints. Even by designing the CIPP lining to Class 4 (fully structural) level of protection, it is not preferred to rehabilitate the pipe with CIPP in the “High” and “Very High” liquefaction susceptibility zones.

Removal and replacement is a method of open cut construction that involves saw-cutting of pavement (where applicable), then trenching to expose the pipe, followed by the removal of the existing pipe and installation of the new pipe in the same trench. The new pipe will have a similar depth and grade to the existing pipe. Once installed, the trench is then backfilled with material that gets compacted followed by appropriate surface restoration methods. Open-cut construction also helps the contractor to avoid existing utilities due to the contractor’s ability to visually see any obstructions within the trench and possibly make slight adjustments to existing utilities and/or to the force main alignment during installation, thereby avoiding damage to those utilities. Open-cut construction, however, may be more expensive in some cases, and more disruptive than trenchless alternatives due to the high likelihood of needing significantly more traffic control and surface restoration to perform the pipeline installation. In addition, permitting may be more difficult to obtain because of environmental mitigation requirements and traffic flow requirements. Therefore, open-cut construction is only recommended for the portion of the pipe that is within the “High” liquefaction zone.

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Symbology

- Segment 1 - Remove and Replace
- Segment 2 - CIPP
- Flow Bypass Alignment
- Flow Bypass - Buried
- Existing Gravity Network
- Maintenance Hole
- Existing Lift Station
- Parcel

0 150 300
Scale in Feet

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Figure 2

Rio Nido Force Main
Alternative 1

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RRCSD Force Main Rehabilitation
and Replacement Project

4.2.1.2.2 Segment 2

Segment 2 includes CIPP lining the remaining 790 feet of the Rio Nido Force Main. CIPP liner is a resin-impregnated tube that forms a tight fit bond with the interior of the existing pipe. CIPP is inserted into the existing pipe either through a manhole or an access pit. Following insertion, the liner is cured either by circulating hot water or steam, or by heating the pipe with UV light. The total curing phase can be expected to take one to five hours with curing time being dependent on the design parameters, curing method, and surrounding environment.

The CIPP material is composed of an epoxy composite layer reinforced with glass material and/or polyester fiber that creates a jointless, seamless liner that protects from further deterioration, infiltration, and compromised joints, in addition to increasing the structural integrity and restoring or reducing the friction loss which would increase the C-value of the original pipe.

Prior to determining whether to move forward with construction of this trenchless alternative, the existing force main will need to be evaluated by closed-circuit television (CCTV) or other appropriate means to confirm that the existing pipe can accommodate a CIPP liner. An entry pit near the intersection of River Road and Eagle Nest Lane would be required, along with an excavation pit near the discharge location seen on Figure 2 to insert the CIPP liner into the force main.

After exiting the Rio Nido Lift Station, the alignment is expected to be entirely within the paved southbound lane on River Road. Significant traffic impacts would be expected at the intersection of Rio Nido Road and River Road as well as along River Road. Both roads are narrow two-lane roads with a shoulder in each direction. In order to remove and replace (R&R) and CIPP line the pipe, temporary bypassing will need to be conducted.

To bypass the section of pipe under construction, it is necessary to lay temporary pipe placed parallel to the existing alignment in areas protected from traffic. The bypass piping alignment is shown in Figure 2 and would mostly be located above grade in the shoulder of the southbound lane of River Road. For the portions that involve crossing driveways and roadways, a pipe would be temporarily installed below grade in a shallow trench covered by trench plates or used in combination with crossover ramps. The existing pumps could potentially be used for bypassing, though an alternative is inserting pumps into the wet well. Trucking flows instead of bypass is possible. Trucking flows would involve hauling wastewater in trucks from Rio Nido Lift Station to the WWTP. Trucking for a duration longer than 24 hours is not preferred by the District.

Upon discussions with Sonoma County, River Road is planned to be repaved in approximately one year, which would impose a five-year pavement moratorium, likely encompassing the time this project would be constructed. Coordination with the County during design would be necessary to confirm more extensive restoration limits to account for the moratorium.

4.2.1.3 Alternative 2

Alternative 2 evaluates open-cut construction in a parallel alignment for both Segments 1 and 2. Figure 3 displays the proposed force main layout for Alternative 2.

4.2.1.3.1 Segments 1 and 2

Alternative 2 is the construction of a new 8-inch diameter pipe to be laid parallel to the existing alignment for both Segment 1 and Segment 2. Parallel construction of a new force main also involves the same saw-cutting in paved areas (where needed) and open trench excavation described above while leaving the existing force main in operation during the majority of the construction duration. This approach only requires diverting sewer flows while connections are made to the existing system, which would significantly reduce the bypass pumping costs and risk of spilling sewage. The new force main would be designed to maintain required cover over the pipe and tie in on each end at similar elevations to the existing force main. The existing force main would be abandoned in place following installation of the new force main.

The proposed alignment would exit the lift station east of the existing force main into River Road and would run within River Road on the east side of the existing alignment to avoid the gravity sewer main located near the southbound lane shoulder. The new alignment would need to avoid conflict with a viaduct located beneath the northbound lane of the roadway along a portion of this route. To not impact the existing gravity and force main lines, it is likely the new alignment would need to be located at or near the center of the road, which might put the alignment too close to the viaduct to be viable and would also introduce significant traffic issues on an important thoroughfare during the period of construction and surface restoration.

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Symbology

- Alternative 2 - Parallel Alignment
- Existing Gravity Network
- Maintenance Hole
- Existing Lift Station
- Existing Force Main (All)
- Parcel

0 150 300
Scale in Feet

Sonoma Water

WEST YOST

Figure 3

Rio Nido Force Main Alternative 2

Sonoma Water
RRCSD Force Main Rehabilitation and Replacement Project

4.2.2 Beanwood Force Main

The Beanwood Force Main is comprised of approximately 1,350 feet of 8-inch diameter CMLC welded steel force main beginning at the Beanwood Lift Station and extending northeast towards Drake Road then turning northwest towards the Guerneville pedestrian bridge. The force main daylights on the southeast side of the bridge, whereupon it is suspended under the bridge and crosses the Russian River, and then reenters the ground where it discharges at a manhole on the northwest side of the river just north of the pedestrian bridge approach. The alignment is located in a "High" liquefaction susceptible area; therefore, rehabilitation or replacement below ground considers the need to mitigate the risk of damage to the pipeline posed by seismically induced liquefaction.

The Beanwood Force Main alignment is divided into two segments. Segment 1 includes the portion of the existing force main from the lift station to the southeast end of the pedestrian bridge. Segment 2 includes the portion of existing force main that crosses the Russian River from the southeast end to the northwest side of the river, including the relatively short portion that discharges into the gravity system.

Open-cut removal and replacement construction along the existing alignment of Segment 1 of the Beanwood Force Main is considered not viable as a result of the elevated approach to the new Highway 116 bridge that was constructed over the majority of the existing force main leading up to the bridge crossing. This elevated section of road places the existing force main at a substantial depth that renders replacement by open-cut construction unworkable. Microtunneling was also not considered viable for Segment 1 of the Beanwood project site due to space requirements for this trenchless method.

For Segment 1, CIPP lining was not considered as a viable construction method due to the presence of sharp bends. For Segments 1 and 2, Sliplining and HDD were not considered as viable construction methods. For Segment 2, Primus Line liners were not a recommended alternative for crossing the Guerneville Bridge. Further explanation discussing these alternatives can be found in Appendix E. Additionally, after further coordination with Caltrans to hang a new 8-inch diameter force main under the downstream horizontal shoulder wing of the CA State Highway bridge deck, it was determined the Caltrans analysis process would be too complex and lengthy without a guarantee of approval and therefore was not considered further.

The following subsections describe the four alternatives including construction methods and processes under consideration for the Beanwood Force Main.

4.2.2.1 Alternative 0 – No Action

The alignment is located in a "High" liquefaction susceptible area, consisting of metallic pipe at the end of its design life and suspension on a bridge that may be susceptible to earthquakes; therefore, a "no action" design alternative is not a recommended option.

4.2.2.2 Alternative 1

Alternative 1 evaluates constructing an alternative alignment through open-cut construction for Segment 1 and microtunneling for Segment 2. Figure 4 displays the proposed force main layout for Alternative 1.

Symbology

- Segment 1- Alternative Alignment From LS
- Segment 2 - Microtunnel River Crossing
- Flow Bypass Alignment
- Entry and Exit Caisson Shafts
- 20' Permanent Easement Required
- Existing Gravity Network
- Maintenance Hole
- Existing Lift Station
- Existing Force Main
- Caltrans Right of Way
- Parcel

0 150 300
Scale in Feet

Sonoma Water

WEST YOST

Figure 4

Beanwood Force Main Alternative 1

Sonoma Water

RRCSD Force Main Rehabilitation and Replacement Project

4.2.2.2.1 Segment 1

Segment 1 includes the use of open-cut construction for an alternate alignment of the Beanwood Force Main. The force main would run off-pavement until it enters the south end of Drake Road, crossing through a parking lot and running parallel to the west side of Highway 116 along a pedestrian path through Guerneville River Park where it would connect to the start of the Segment 2 alignment. This option would involve some permitting and right-of-entry access needs as well as easement acquisition due to the proposed alignment going through private property, Guerneville River Park (Sonoma County ownership), a CA State Highway right-of-way, and Riverkeeper Stewardship Park (Friends of the Russian River ownership). If this alternative were implemented, it is recommended to obtain permits and permanent easements as soon as possible so that they can be in place before construction. The Caltrans right-of-way for Highway 116 can be seen on Figure 4. The proposed alignment would impose minor traffic impacts to local residences and the park. The existing alignment of the Segment 1 force main would remain in service throughout the open-cut alternative alignment construction and would not require any means of bypassing other than potentially a temporary shut down for connection at the lift station. Once the new alignment is in service, the old force main would be abandoned in place and filled with controlled low strength material (CLSM) or flanged at the ends. Photo 2 shows the location of the existing alignment on Drake Road heading northwest toward the elevated approach.

Photo 2
Looking northwest along Drake Road at the location of existing Segment 1 of the Beanwood Force Main and existing road conditions.

4.2.2.2.2 Segment 2

Segment 2 includes open-cut construction from Segment 1 under the Guerneville pedestrian bridge to the microtunneling shaft. Microtunneling is a trenchless construction technique used for pipe installation that does not require a host pipe. It entails excavating a borehole, boring along a selected alignment, and inserting a casing pipe through the borehole. A microtunneling boring machine mounted on a jacking frame that is moved forward using jacks is controlled by remote guidance. The system utilizes advanced technology such as gyroscope, laser guidance, and CCTV cameras that help remotely control the system accurately over long distances that may follow a straight or curved alignment.

Microtunneling for Segment 2 would involve creating entry and exit excavation shafts slightly deeper than the recommended crossing depth on each side of the river for the new pipe to be installed beneath the surface. The pipe will be constructed no less than 15 feet below the bed of the river, 30 feet preferred to limit liquefaction concerns, with an estimated casing pipe diameter of 60 inches to accommodate cobbles that are expected to be up to 12 inches in diameter. This casing size is approximate, as 36 inches could be sufficient, though 48 inches and 60 inches have been recommended based on similar projects in the area. To accommodate for lateral spread at the riverbanks, the elevation of the pipe would remain low for an appropriate distance beyond the extents of the river. It is important to note that open-cut construction pipe installation would need to take place from where Segments 1 and 2 meet to the entry excavation shaft and from the exit excavation shaft to the existing manhole west of the Russian River.

A benefit to this construction method is the existing force main would remain in service throughout construction eliminating full bypass costs. The existing pipe along the bridge would be abandoned once the new alignment is in service, but it is likely that it would need to be removed from the bridge structure. However, if the existing force main along the bridge is abandoned in place, it would be blind-flanged at the ends.

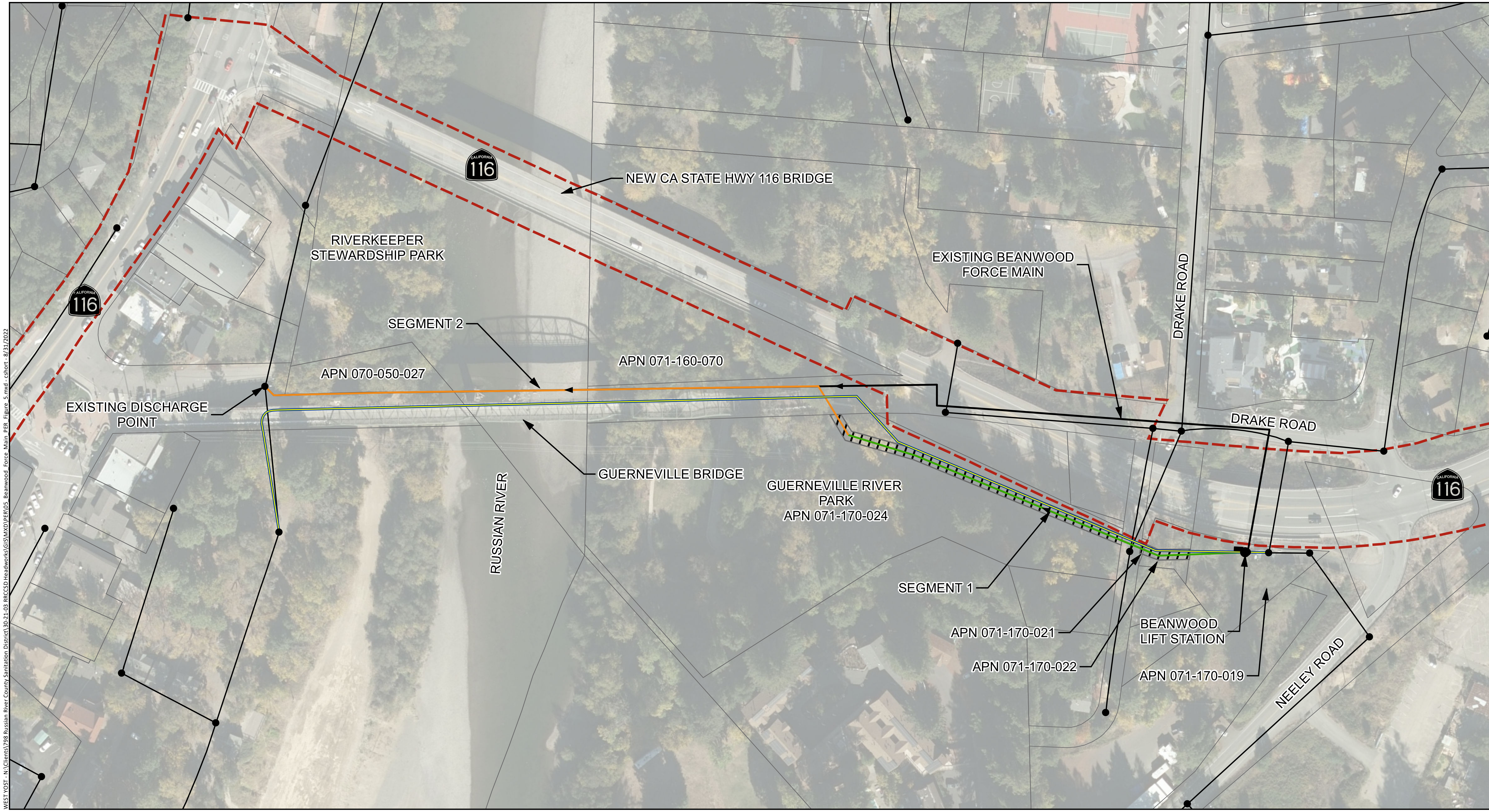
Although microtunneling requires large diameter caissons to be installed for boring access which require adequate clear space at the Project site and add significant expense; microtunneling has the ability to work through more geologic material as opposed to other methods such as HDD. An updated geotechnical desktop study (Appendix E) was conducted, and it was discovered from the reference borings that gravel is present up to at least 100 feet below the riverbed. Microtunneling can be used for deep installation satisfying the significant concern of liquefaction, can be used to tunnel through gravel, unlike HDD, and can overcome large material. Further geotechnical analysis will be needed to confirm the requirements of the Microtunneling alternative.

4.2.2.3 Alternative 2

Alternative 2 evaluates constructing an alternative alignment through open-cut construction for Segment 1 and removal and replacement of the existing pipe along the Guerneville Bridge for Segment 2. Figure 5 displays the proposed force main layout for Alternative 2.

4.2.2.3.1 Segment 1

Similar to Alternative 1, Segment 1 of Alternative 2 uses open-cut construction for an alternate alignment of the Beanwood Force Main along the west side of Highway 116 through Guerneville River Park where it would connect to the start of the Segment 2 alignment. Permitting, traffic control and bypass methods and requirements are the same as discussed above for Alternative 1, Segment 1.



Symbology

- Segment 1- Alternative Alignment From LS
- Segment 2 - Remove and Replace Bridge River Crossing
- Flow Bypass Alignment
- 20' Permanent Easement Required
- Existing Gravity Network
- Existing Force Main
- Maintenance Hole
- Existing Lift Station
- Caltrans Right of Way
- Parcel

0 150 300
Scale in Feet

Figure 5

Beanwood Force Main Alternative 2

Sonoma Water

RRCSD Force Main Rehabilitation and Replacement Project

4.2.2.3.2 Segment 2

Segment 2 includes removing and replacing the existing 8-inch diameter CML force main that is suspended on the bridge with new 8-inch diameter pipe. Replacement pipe material options are discussed in the Materials Alternatives section below. Additional and/or replacement of pipe supports and brackets would be included depending on the pipe material. Photo 3 shows the existing force main hanging underneath the Guerneville Bridge.

Temporary flow bypassing would need to be in place for the duration of construction. The bypassing would consist of setting up a temporary pipe that would be laid on the walkway of the Guerneville Bridge and be restrained and protected to accommodate foot and bicycle traffic.

The Guerneville Bridge is located within the floodplain and may not be seismically resilient. Accordingly, the structural condition of the bridge is not known, and potentially high flood levels put any suspended utilities at risk. To mitigate this, the pipe could either be ductile iron or be contained within a steel casing.

Photo 3
Looking northwest under the Guerneville Bridge at the existing force main hanging on the underside.

4.2.2.4 Alternative 3

Alternative 3 evaluates constructing an alternative alignment through open-cut construction for Segment 1 and CIPP lining the existing pipe along the Guerneville Bridge for Segment 2. Figure 6 displays the proposed force main layout for Alternative 3.

4.2.2.4.1 Segment 1

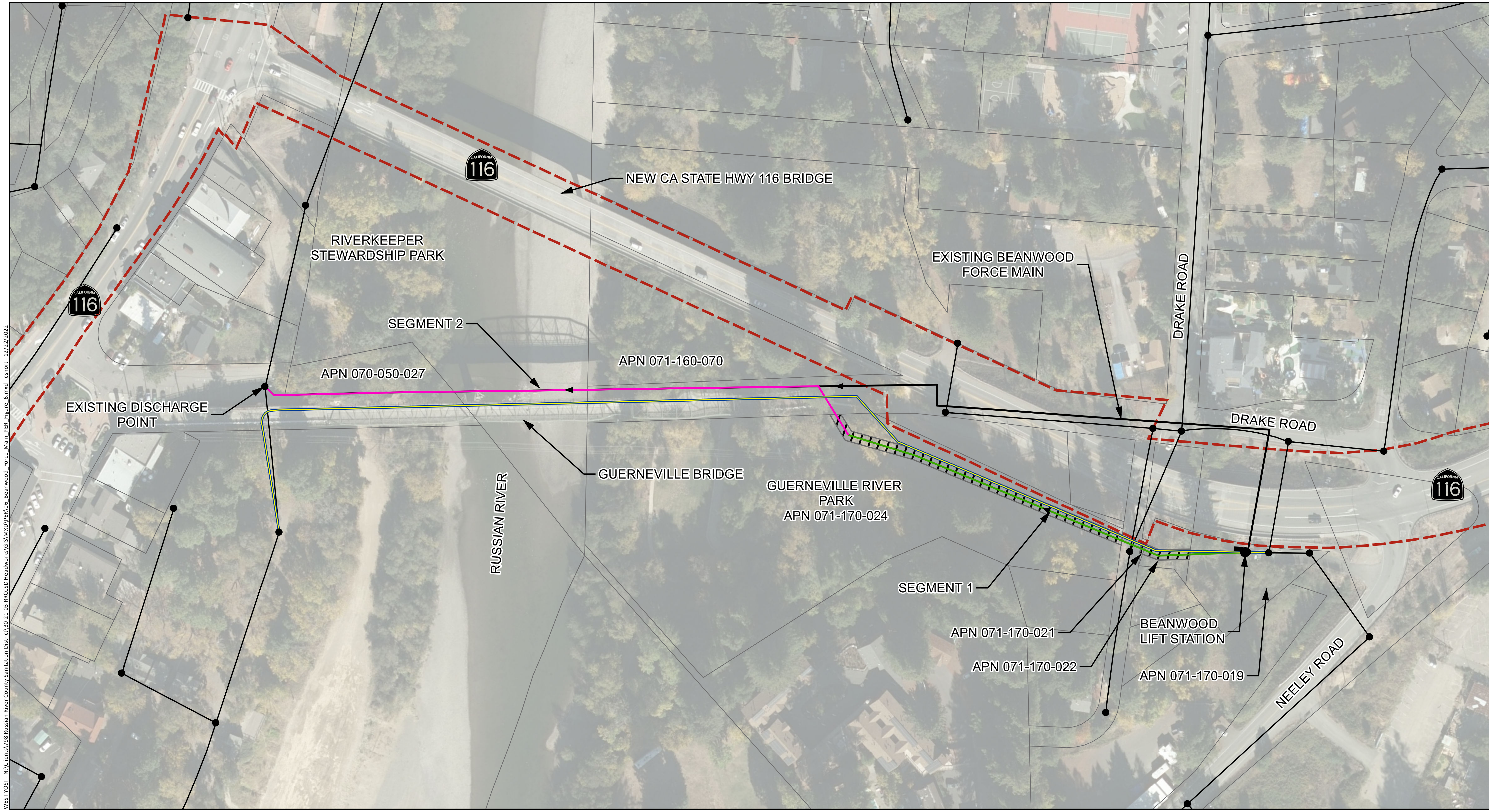
Similar to Segment 1 of both Alternative 1 and Alternative 2, Segment 1 of Alternative 3 uses open-cut construction for an alternate alignment of the Beanwood Force Main along the west side of Highway 116 through Guerneville River Park where it would connect to the start of the Segment 2 alignment. Permitting, traffic control and bypass methods and requirements are the same as discussed above for Alternatives 1 and 2, Segment 1.

4.2.2.4.2 Segment 2

Segment 2 includes CIPP lining the section of existing 8-inch diameter pipe that is suspended on the Guerneville Bridge. Prior to determining whether to move forward with construction of this alternative, the existing force main will need to be evaluated by CCTV or other appropriate means to confirm that the existing pipe can accommodate a CIPP liner. Access to insert the CIPP liner into the force main would be difficult. Options for access are either through the bridge deck or by constructing scaffolding under the bridge. The CIPP liner would either enter on the south side of the bridge after most of the bends or on the north side of the bridge after the vertical pipe. There is risk involved with lining through the 45-degree bends on the bridge, which are located near the piers and difficult to access. It is preferred that these bends be replaced after installation. Other concerns and points of risk include expansion and contraction, weight, stiffness of liner for installation success, and interest for bidding.

Temporary flow bypassing would need to be in place for the duration of construction. The bypassing would consist of setting up a temporary pipe that would be laid on the walkway of the Guerneville Bridge and be restrained and protected to accommodate foot and bicycle traffic.

As mentioned in Alternative 2 Section 4.2.2.3.2 the Guerneville Bridge is located within the floodplain and may not be seismically resilient and any suspended utilities are at risk.



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- Segment 1- Alternative Alignment From LS
- Segment 2 - CIPP Lining Bridge River Crossing
- Flow Bypass Alignment
- 20' Permanent Easement Required
- Existing Gravity Network
- Existing Force Main
- Maintenance Hole
- Existing Lift Station
- Caltrans Right of Way
- Parcel

0 150 300

Scale in Feet

Sonoma Water

WEST YOST

Figure 6

Beanwood Force Main Alternative 3

Sonoma Water

RRCSD Force Main Rehabilitation and Replacement Project

4.2.3 Main Force Main

The Main Force Main consists of a 16-inch diameter CMLC steel pipe conveying wastewater from Guernewood Park area to the WWTP. The force main begins at the south end of the Main Lift Station, where it proceeds along Riverside Drive before turning southwest on CA State Highway 116. Approximately halfway between Riverside Drive and Summer Bridge Road, the force main is suspended from a viaduct along Highway 116. The force main then continues south on Highway 116, turns east onto Summer Bridge Road, crosses beneath the Russian River and heads north into Vacation Beach, where additional wastewater is pumped into the force main from the Vacation Beach Lift Station. The force main then continues east toward the WWTP where it runs within the roadway then an easement and finally discharges into the WWTP headworks. An encroachment permit will be required to perform any work on the District's facilities within Caltrans right-of-way along Highway 116, which can be seen on Figure 7, Figure 8 and Figure 9.

The start of the existing alignment at Main Lift Station is in an area of "High" liquefaction susceptibility and soon after turning onto the highway, susceptibility categorization changes to "Very Low". Midway through the viaduct, the force main again enters an area of "Very High" susceptibility to liquefaction and remains so all the way to the WWTP.

The alignment of the Main Force Main is shown on Figure 7, Figure 8 and Figure 9. For purposes of this analysis, the Main Force Main is subdivided into seven segments due to the complexity of the alignment and the different construction methods applicable for each segment. The following subsections describe the alternatives under consideration for rehabilitation/ replacement of each of these segments.

Segment 5 is split into two parts (west and east sides of the river) with Segment 6 between these. Downstream of the portion of Segment 5 on the east side of the river and upstream of Segment 7, the force main has recently undergone emergency repair of approximately 900 feet of pipe between the park at Vacation Beach Lift Station, Orchard Avenue, and the existing District easement east of Orchard Avenue. The emergency repair was in response to severe corrosion and previous ruptures within the CMLC steel pipe, as described previously. Construction of the replacement force main is considered permanent and consisted of an 18-inch diameter DR17 HDPE pipe aligned adjacent to the existing force main. For this analysis, the emergency repair segment is only relevant in terms of the upstream and downstream connection points of adjacent repairs.

CIPP lining was not considered viable for all segments within the Main Force Main due to the majority of the alignment being within "High" and "Very High" liquefaction zones, in which CIPP is not recommended.

4.2.3.1 Alternative 0 – No Action

Due to the majority of the alignment being located in "High" and "Very High" liquefaction susceptibility areas, the potential of corrosion on the existing metallic pipe, and the age of the pipe a "no action" design alternative was not considered a viable option.

4.2.3.2 Alternative 1

The following is a list by segment of the construction methods selected for Alternative 1 which are shown in Figure 7.

- **Segment 1**: Open-Cut Construction – Removal and Replacement
- **Segment 2**: Open-Cut Construction – Parallel Alignment

- **Segment 3**: Trenchless Construction – Sliplining
- **Segments 4 and 5**: Open-Cut Construction – Parallel Alignment
- **Segment 6**: Trenchless Construction – Connect to Existing Force Main
- **Segment 7**: Open-Cut Construction – Removal and Replacement

Symbology

- Force Main
- Flow Bypass Alignment
- Existing Gravity Network
- Maintenance Hole
- 20' Permanent Easement Required
- Existing Lift Station
- Caltrans Right of Way
- Parcel

Alternative 1 Force Main Segments

- 1 - Remove and Replace
- 2 - Parallel Alignment
- 3 - Slipline with HDPE
- 4 - Parallel Alignment
- 5 - Parallel Alignment
- 6 - Ex. Force Main River Crossing
- 7 - Remove and Replace
- Ex. Emergency Replacement
- Proposed Emergency Replacement

0 500 1,000
Scale in Feet

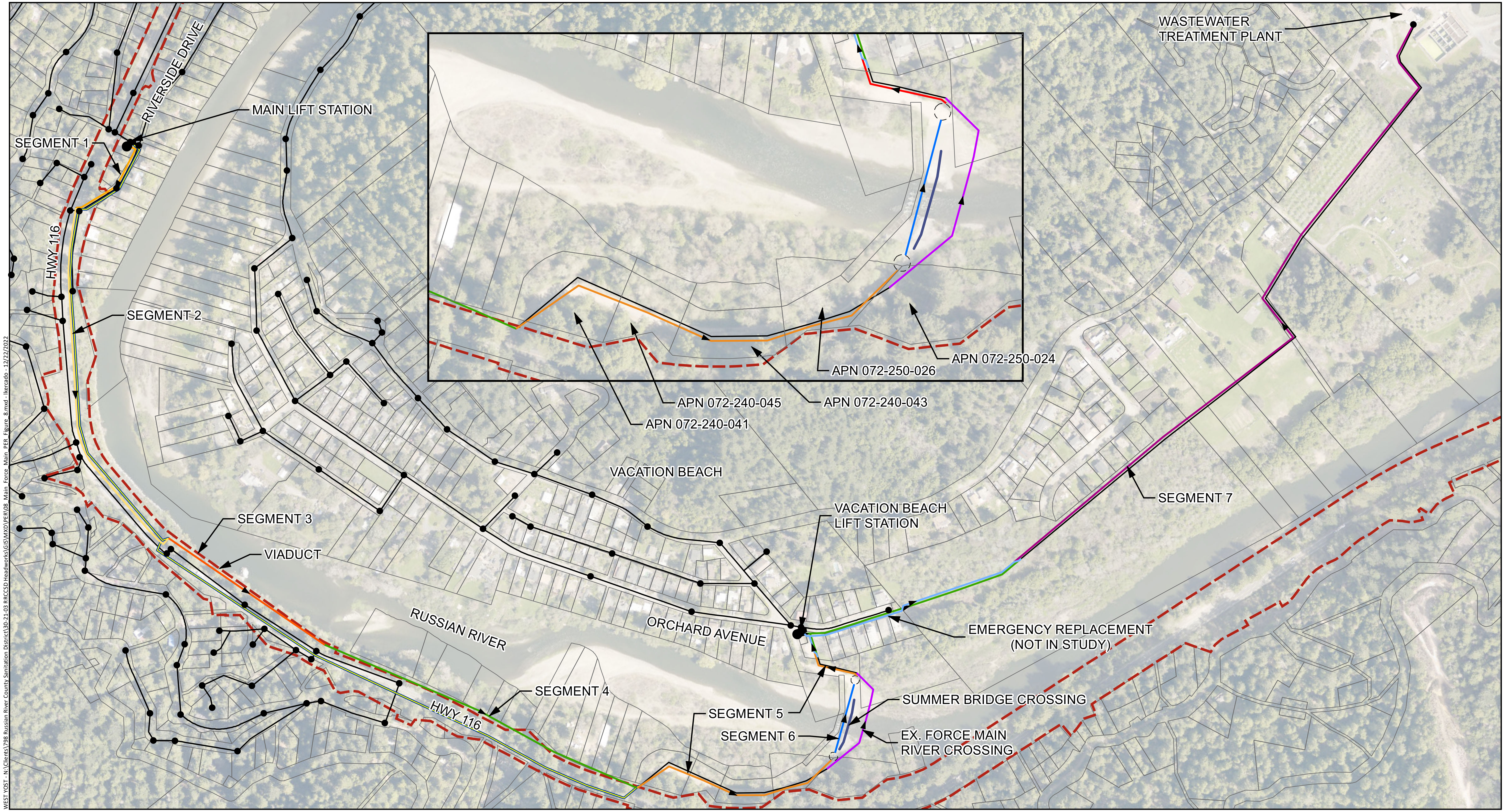
Sonoma Water

WEST YOST

Figure 7

Main Lift Station to WWTP Force Main Alternative 1

Sonoma Water
RRCSD Force Main Rehabilitation and Replacement Project



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Symbology

- Force Main
- Flow Bypass Alignment
- Summer Bridge
- Existing Gravity Network
- Maintenance Hole
- Existing Lift Station
- Caltrans Right of Way
- Entry and Exit Caisson Shafts
- Parcel

Alternative 2 Force Main Segments

- 1 - Remove and Replace
- 2 - Remove and Replace
- 3 - Slipline with HDPE
- 4 - Remove and Replace
- 5 - Parallel Alignment
- 6 - Microtunneling
- 7 - Parallel Alignment
- Ex. Emergency Replacement
- Ex. Force Main River Crossing
- Proposed Emergency Replacement

0 500 1,000
Scale in Feet

Sonoma Water

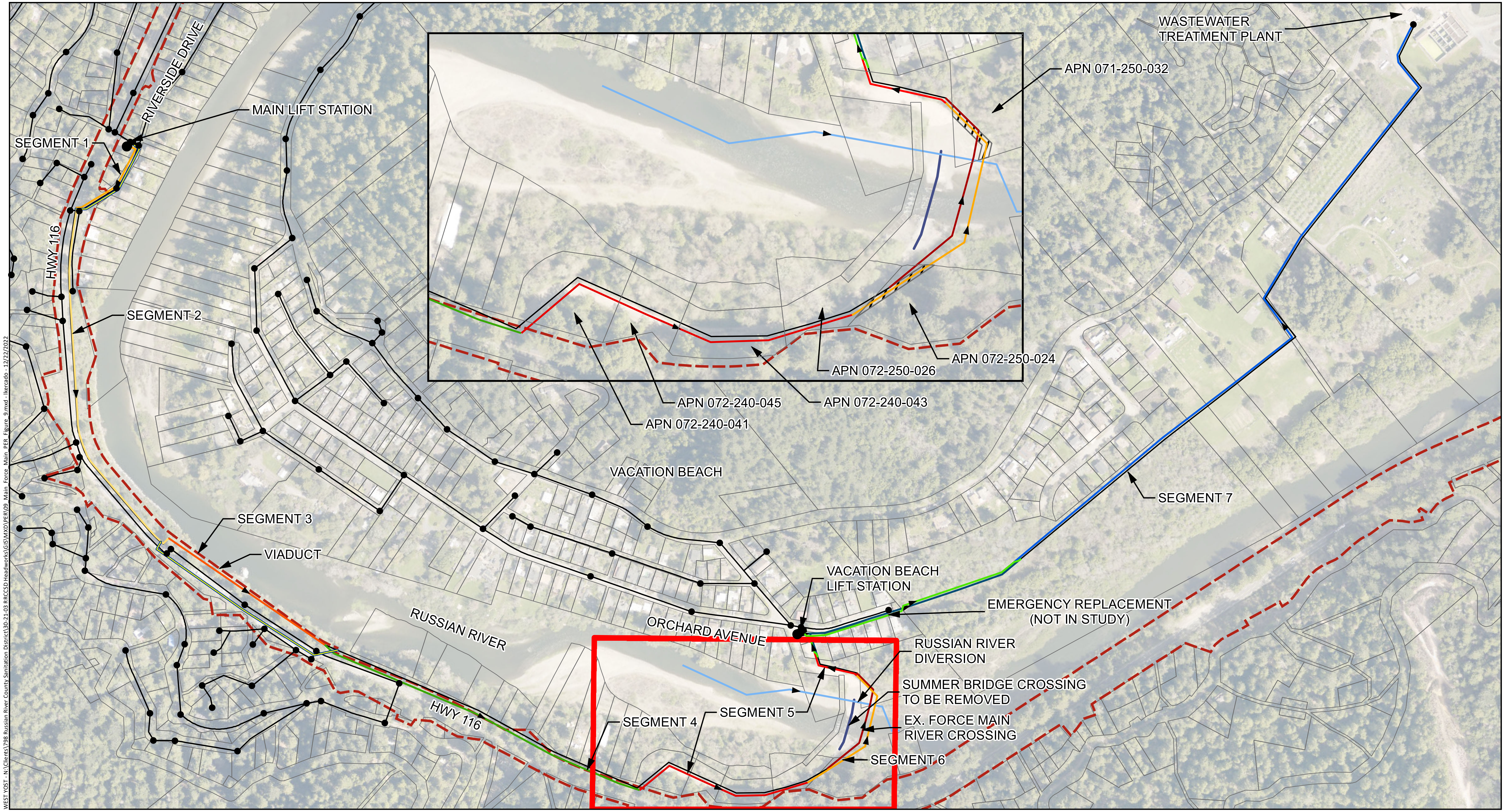
WEST YOST

Figure 8

Main Lift Station to WWTP Force Main Alternative 2

Sonoma Water

RRCSD Force Main Rehabilitation and Replacement Project



Symbology

- Force Main
- Russian River Diversion
- Flow Bypass Alignment
- Summer Bridge
- Existing Gravity Network
- Maintenance Hole
- 20' Permanent Easement Required
- Existing Lift Station
- Caltrans Right of Way
- Parcel

Alternative 3 Force Main Segments

- 1 - Remove and Replace
- 2 - Parallel Alignment
- 3 - Slipline with HDPE
- 4 - Parallel Alignment
- 5 - Parallel Alignment
- 6 - Parallel Alignment
- 7 - Parallel Alignmnet
- Ex. Force Main River Crossing
- Ex. Emergecy Repair
- Proposed Emergency Replacement

0 500 1,000
Scale in Feet

Figure 9

Main Lift Station to WWTP
Force Main Alternative 3

Sonoma Water
RRCSD Force Main Rehabilitation
and Replacement Project

4.2.3.2.1 Segment 1

Segment 1 represents the portion of Main Force Main in Guernewood Park within Riverside Drive (shown in Photo 4) to the intersection of Highway 116. At this location, construction may be slightly challenging due to spatial constraints and the existence of various subsurface utilities, including water and gravity sewer lines. In addition to existing subsurface utilities, large redwood trees constrict the width available for construction and pose a risk for constructing outside of the existing force main trench if tree roots extend into the project area. For these reasons, replacing the existing force main in an alternate, parallel alignment is not recommended. Sliplining is also possible for Segment 1, but it is not recommended, as it would permanently decrease the pipe capacity while still requiring bypass piping for construction.

Open-cut construction in the same trench is the only viable option for Segment 1. The existing force main would be taken offline, removed from the existing trench, and replaced with a pipe of superior material. Because the force main would need to be offline during the entire construction process, flow bypass measures would need to be in operation for the same duration of construction. In addition to bypass operations, open-cut construction activity may limit vehicular access to the west side of Riverside Drive for the duration of construction.

Photo 4
Facing northwest towards Highway 116 on Riverside Drive showing redwood tree obstructions.

4.2.3.2.2 Segment 2

Segment 2 of the Main Force Main begins at the intersection of Riverside Drive and Highway 116. The existing force main at this location lies in the west side of the highway and flows south for approximately 1,440 feet, where it bends 90 degrees toward the east side of the highway and connects to Segment 3. Photo 5 shows a portion of Segment 2 along Highway 116. According to the original design documents, the force main has an approximate cover depth of 5 feet and is adjacent to an 8-inch diameter sanitary sewer gravity pipe.

For this alternative, Segment 2 includes installing the new force main in a parallel alignment which would provide flexibility in operation, eliminate the need for full alignment flow bypassing, minimize traffic disruption and potentially lower construction costs. The subsurface conditions below Highway 116 may introduce construction-related concerns because of the likelihood that the bedrock and redwood tree stumps beneath the surface are shallow, though the depth may increase from west to east. The subsurface conditions should be evaluated when considering how deep the new force main would be installed.

According to as-built documents and maps received from utility agencies, there are both gravity sewer and water main lines to the west, in the shoulder, of the existing force main. Therefore, any new parallel alignment would be constructed to the east of the existing force main or in the southbound lane between the existing force main alignment and the existing gravity sewer and water main lines. Following installation of the new force main, the existing CMLC steel pipe would be removed due to Caltrans requiring the removal of non-operating utilities within their right-of-way.

Photo 5
Looking southeast along Highway 116 at the location of the Segment 2 pipeline alignment.

4.2.3.2.3 Segment 3

Segment 3 of the Main Force Main is the location where the pipe is exposed and suspended along the highway viaduct. At this point, both the force main and an 8-inch diameter gravity pipe are exposed, with the gravity pipe aligned approximately one foot above the force main as shown in Photo 6.

Because of the circumstances of the existing force main and any uncertainty in the conditions below grade within the viaduct, pipe rehabilitation is a preferred over replacement. The constructability in this area would be difficult, as slopes are steep and much vegetation would need to be cleared for access. Also, depending on the type of pipe chosen for replacement, additional supports may be required.

Therefore, the replacement method for Segment 3 is sliplining of the existing pipe. Sliplining involves inserting a new, smaller-diameter liner pipe into an existing pipe and grouting the annular space in-between the two. This method of pipe repair offers a full structural rehabilitation that functions as an entirely new pipe and is useful where open cut construction or repositioning is unavailable. Sliplining would decrease the flow capacity of the larger pipe that was originally in place, though the new liner pipe will often decrease friction losses as compared to those of the host pipe. The method of installing a sliplined pipe requires an excavation pit or access manhole where the new liner pipe would either be winched and pulled through the existing force main from the receiving end or pushed into the existing force main from a pneumatic or hydraulically powered pushing machine at the entry pit. The pipe materials available for sliplining include HDPE and segmented PVC. In addition, the outer diameter of the liner pipe must be 5 percent to 10 percent smaller than the inside diameter of the host pipe. Lengths of up to 1,000 feet can be installed during a single slipline insertion. With the required parameters, it is recommended that a 14-inch diameter IPS DR17 HDPE (ID=12.25”) pipe be used to slipline the existing 16-inch diameter CMLC steel force main throughout the duration of exposure along the Highway 116 viaducts.

An assessment of the pump capabilities at Main Lift Station was conducted to determine if downsizing the pipe for this portion of the Main Force Main to the above specification is possible. The difference in head at average flows of 1,500 gallons per minute is minor. Bypass operations would be required for the duration of rehabilitation.

Photo 6
The existing 16-inch diameter CMLC steel force main and 8-inch diameter gravity sanitary sewer suspended along the Hwy 116 viaduct.

4.2.3.2.4 Segment 4

Segment 4 of Main Force Main begins at the point where the pipe reenters the ground downstream of the viaduct. The existing force main continues along the east side of Highway 116 for approximately 1,320 feet, where it bends toward Summer Bridge Road.

Segment 4 includes parallel construction. It requires crossing the existing force main at least once for the purpose of avoiding existing utilities. At the start of this segment, the existing force main is located on the east side of the existing gravity sewer line for approximately 360 feet. As the force main nears the intersection of Highway 116 and Summer Bridge Road, there may be a potential conflict with the water main pipe alignment. For this reason, it is recommended that the proposed force main cross over to the west side of the existing force main prior to the water main location near Summer Bridge Road. The parallel alignment would be constructed to the next point of connection. As mentioned in Segment 2 Section 4.2.3.2.2 above, the existing CMLC steel pipe will be removed per the Caltrans requirements.

4.2.3.2.5 Segment 5

Segment 5 of Main Force Main begins at the intersection of Highway 116 and Summer Bridge Road. At this intersection, a tee with a blind flange directed south on the highway is recommended for future expansion and bypass connections. The force main continues toward Summer Bridge, a temporary bridge structure that is constructed and deconstructed every year for summer season recreational activity. The force main follows the road towards the Russian River, crosses the river beneath the riverbed within an encasement (see Segment 6 below), and continues up Vacation Beach Road within an easement towards Vacation Beach Lift Station. Segment 5 is located in a “Very High” liquefaction susceptible area.

For Segment 5, in an attempt to keep the existing force main in operation throughout construction on the southwest side of the Russian River, open cut construction via a parallel alignment along Summer Bridge Road gives the District the opportunity to limit bypass pumping and bypass trucking activity from the Main Lift Station to the WWTP. The parallel alignment would be constructed on both the west and east sides of the river to the connection to the emergency repair project parallel alignment in the Vacation Beach park.

4.2.3.2.6 Segment 6

Segment 6 is located between the two parts of Segment 5 where the existing force main crosses beneath the Russian River within an unconfirmed 20-foot-wide District easement. Nearly 800 feet from the intersection of Highway 116 and Summer Bridge Road, the existing force main crosses the river in a concrete encasement, common to both the force main and electrical conduits, at a depth of approximately 17 to 20 feet below the riverbed. The force main stays encased in concrete for approximately 460 linear feet (LF), where it then exits the casing and continues up Vacation Beach Road toward the Vacation Beach lift station, as noted in Segment 5.

Segment 6 includes leaving the existing concrete encased force main in place, remaining in service, while the new pipe upstream and downstream of the existing river crossing connect on either end as close as possible to the encasement. This would require a condition assessment of the existing force main at this location to be performed as the first task of construction to confirm the feasibility of keeping this existing segment in service. The assessment cannot be performed until construction since the force main cannot be taken out of service. Completing the assessment at the start of construction would determine as early as possible the method of construction to move forward with so the contractor could plan schedule, subcontractors, and costs. The design documents would contain microtunneling as an alternative design with a bid alternate in the case that the existing pipe cannot be utilized. However, this would be difficult to plan funding needed since the costs, as described further in this report, are different for these two methods.

In order to secure the pipe leading into and out of the connections, and to minimize seismic vulnerabilities, the upstream and downstream segments of pipe within the riverbank would be backfilled with controlled low-strength material. This backfill will improve the soil conditions and reduce the risk of pipe exposure and unexpected lateral movement and settlement where the pipe within the encasement remains rigid. The connections can be made with flex couplings, but these have the potential to fail if subject to rapid movement.

Connection to the existing force main is not the preferred alternative, as it ultimately keeps the force main in the liquefaction susceptibility area (within 30 feet of depth from the riverbed), and therefore this is not the alternative that best meets the needs of this Project.

4.2.3.2.7 Segment 7

Segment 7 of the Main Force Main begins approximately 500 feet east of the dead end at Orchard Avenue in Vacation Beach and extends for the remainder of the distance to the WWTP. Pipeline installation would occur within an existing 20-foot-wide District easement. Additional temporary construction easements and/or right-of-entry permits may be needed to support construction within this location. The majority of the existing force main is located in an area with “High” liquefaction susceptibility. Due to this and to the connections at both the headworks facility and the emergency repair segment, pipe lining is not recommended for this segment.

Within Segment 7, open cut removal and replacement may include benefits such as providing some assurance that the existing bedrock, if any, has previously been removed; however, the proximity of the existing electrical conduits to the location of the existing force main may increase the complexity of the replacement process. Additionally, the time spent protecting this utility and the need for flow bypassing during construction may increase the cost and duration of the project. Finally, connection to the emergency repair project upstream is set up for a parallel alignment. Therefore, replacement in the same alignment for Segment 7 would require bends in the force main that are not otherwise needed. For these reasons, open cut removal and replacement is not preferred for Segment 7 of the Main Force Main.

4.2.3.2.8 Temporary Flow Bypassing

There are three segments within Alternative 1 along the Main Force Main that would require bypass pumping during the duration of construction. These sections include Segment 1, Segment 3 and Segment 7. Segment 6 may need bypassing during the condition assessment. The Main Lift Station would need to be shut offline periodically to make the necessary bypass connections and permanent connections on either end of Segment 6.

Bypassing Segment 1 would involve connecting to the Main Lift Station and laying temporary pipe placed parallel to the existing alignment in areas protected from traffic. The bypass piping alignment is shown in both Figure 7 and Figure 8 and would mostly be located above grade along Riverside Drive where it would connect to the existing Segment 2 force main outside of Caltrans right-of-way. For the portions that involve crossing driveways and roadways, a pipe would be temporarily installed below grade in a shallow trench covered by trench plates or used in combination with crossover ramps.

Segment 3 bypassing would involve connecting to the existing Segment 2 force main, just upstream of Segment 3, and laying above-grade piping along the northbound shoulder of Highway 116 where it will connect to the existing Segment 4 force main.

For Segment 7 on the east side of Russian River, connections for bypass piping would be available on the emergency repair segment of force main and at the WWTP. Additional bypassing will only be needed for a short duration for connecting to Segment 6.

The emergency project repair in Vacation Beach has permanent bypass tees with valves built into the force main to accommodate bypass piping flowing into the force main within the park, flowing out of the 6-inch diameter discharge force main at Vacation Beach Lift Station, and flowing out of the force main within the easement at the east end of the emergency repair segment. These tees can be utilized while connecting Segments 5 and 7 into the emergency repair segment.

4.2.3.3 Alternative 2

The following is a list by segment of the construction methods selected for Alternative 2 which are shown in Figure 8. Based on our preliminary alternatives analysis, three of the force main segments have clearly preferred construction methods. Therefore, other alternatives were not further investigated for those segments.

- **Segment 1**: Open-Cut Construction – Removal and Replacement (same as Alternative 1)
- **Segment 2**: Open-Cut Construction – Removal and Replacement
- **Segment 3**: Trenchless Construction – Sliplining (same as Alternative 1)
- **Segment 4**: Open-Cut Construction – Removal and Replacement
- **Segment 5**: Open-Cut Construction – Parallel Alignment (same as Alternative 1)

- **Segment 6**: Trenchless Construction – Microtunneling
- **Segment 7**: Open-Cut Construction – Parallel Alignment

4.2.3.3.1 Segment 1

Similar to Alternative 1, Segment 1 for Alternative 2 includes the replacement of the existing pipe in the same trench. Refer to Section 4.2.3.2.1 for more information regarding removing and replacing the existing pipe.

4.2.3.3.2 Segment 2

Segment 2 includes removing and replacing the existing force main on the same alignment. This would provide some benefits compared to constructing a new parallel alignment, though flow bypass measures would need to be operational for the duration of construction. Given the potential for challenging subsurface conditions, removing and replacing the existing force main in the same trench provides some assurance that any existing bedrock or unknown dense material has previously been excavated, which potentially decreases the construction duration and cost and reduces conflicts with existing utilities. If desired and if possible, modifications to the new force main elevation could be made during the design process.

4.2.3.3.3 Segment 3

Similar to Alternative 1, Segment 3 would be rehabilitated by sliplining the existing force main. Refer to Section 4.2.3.2.3 for more information regarding sliplining the existing pipe.

4.2.3.3.4 Segment 4

Segment 4 of the Main Force Main involves the open cut removal and replacement in place method. It may include similar benefits to what was described in Segment 2 of this alternative; however, the proximity of the existing gravity sewer and water lines to the location of the existing force main may increase the complexity of the replacement process. Additionally, the time spent protecting these utilities and the need for flow bypassing during construction may increase the cost and duration of the project.

4.2.3.3.5 Segment 5

Similar to Alternative 1, Segment 5 of Alternative 2 includes open-cut construction via a parallel alignment along Summer Bridge Road. Refer to Section 4.2.3.2.5 for more information regarding open cut construction via a parallel alignment along Summer Bridge Road.

4.2.3.3.6 Segment 6

Segment 6 includes crossing the Russian River with a new pipe at the Summer Bridge location which would require trenchless construction to insert a casing beneath the riverbed. Microtunneling would require entry and exit excavated shafts at a slightly greater depth to the recommended pipe crossing depth on each side of the river for the new pipe to be installed beneath the riverbed. For preliminary planning purposes, the new pipe will be placed no less than 15 feet below the bed of the river, 30 feet preferred to limit liquefaction concerns, with an estimated casing pipe diameter of 60 inches to accommodate cobbles that are expected to be up to 12 inches in diameter. Similar to Beanwood, this casing size is approximate as 48 inches and 60 inches have been recommended based on similar projects in the area to minimize microtunneling interruptions. The pipe would either be vertical at the shafts to reach minimum cover, or to accommodate for lateral spread at the riverbanks, the elevation of the pipe would remain deeper for an appropriate distance beyond the extents of the river.

The replacement pipe for the force main along this segment would likely be 16- to 18-inch diameter plastic pipe. Therefore, the 60-inch diameter pipe, which would be jacked through the ground during the microtunneling process, would act as a casing pipe for the force main.

4.2.3.3.7 Segment 7

Open-cut construction via a parallel alignment for Segment 7 offers a relatively straightforward method of repair within the 20-foot wide existing District easement. Since the emergency repair project upstream of Segment 7 ends with an alignment north of the original CMLC steel force main, a parallel alignment for Segment 7 would also be installed north of the existing main and run adjacent to the existing pipe until connecting to the headworks inlet. Similar to construction on the emergency repair segment, the existing force main would be abandoned in place by draining and capping the ends with mechanical plugs, thus potentially allowing the abandoned line to be used as a future electrical conduit.

4.2.3.3.8 Temporary flow bypassing

There are four segments within Alternative 2 along the Main Force Main that would require bypass pumping during the duration of construction. These sections include Segment 1 through Segment 4.

Flow bypassing could be phased by segment or length to accommodate flow during construction of Segments 1 through 4. This would require bypass to be set up and running during construction of the first length then demobilized and set up again on the next sequential length. In this scenario, the Main Lift Station may need to be shut offline periodically to make the necessary bypass connections.

Alternatively, bypass operations can be set up to pump flows from the Main Lift Station all the way to Summer Bridge along the side of Highway 116. At this location, bypass piping connections can tie into the existing force main of Segment 5 for the duration of construction on the west side of the Russian River.

The emergency repair project in Vacation Beach has permanent bypass tees with valves built into the force main to accommodate bypass piping flowing into the force main within the park. For additional bypass information see Section 4.2.3.2.8 Temporary Flow Bypassing for Alternative 1.

4.2.3.4 Alternative 3

The following is a list by segment of the construction methods selected for Alternative 3 which are shown in Figure 9.

- **Segment 1**: Open-Cut Construction – Removal and Replacement (same as Alternative 1)
- **Segment 2**: Open-Cut Construction – Parallel Alignment (same as Alternative 1)
- **Segment 3**: Trenchless Construction – Sliplining (same as Alternative 1)
- **Segments 4 and 5**: Open-Cut Construction – Parallel Alignment (same as Alternative 1)
- **Segment 6**: Open-Cut Construction – Parallel Alignment
- **Segment 7**: Open-Cut Construction – Parallel Alignment (same as Alternative 2)

4.2.3.4.1 Segments 1 through 5 and Segment 7

Segments 1 through 5 utilize the same construction methods and processes as presented in Alternative 1 in Section 4.2.3.2 above. Segment 7 utilizes the same construction method and process as presented in Alternative 2 in Section 4.2.3.3.7.

4.2.3.4.2 Segment 6

Segment 6 involves the use of open-cut construction to install a new concrete encased 18-inch force main in a parallel alignment that would cross below the Russian River. The portion of the pipe leading up to the river on the east side would be constructed during the summer months while the dam and bridge are in place. Construction of the pipe that crosses beneath the river would take place after the removal of Summer Bridge. There is a large portion of open area to the east of Russian River that is utilized for the abutment of Summer Bridge when it is in service during the summer months. Once Summer Bridge is taken down, and the river depth has not reached its winter peak, the open land would provide space to divert the river to the east through the open space and around the project location that crosses the river. The approximate alignment of the diversion is shown in Figure 9. A temporary coffer dam would be installed to create the diversion. A benefit of this method is mitigating bypass cost by keeping the existing pipe in service until the connection to the new pipe is made. An important thing to note is that open cut construction within the river would require a longer environmental review that would extend the schedule by approximately a year.

4.2.4 Pipe Material Alternatives

Due to the high potential of corrosivity within the existing force main and the high susceptibility to liquefaction in most of the project area, the District has decided to avoid metallic pipe options, although the use of ductile iron pipe will be considered for exposed locations. A thorough analysis of potential pipe materials was conducted and is documented in the Force Main Alternatives Analysis TM (Appendix E). The material preferences are the following:

- AWWA C909 PVCO
- AWWA C906 DR17 HDPE
- Ductile Iron Pipe with Seismic Restrained Joints

The pipe material needs to perform well during seismic events since a majority of the Project is within liquefiable soils and needs to address future proofing for pump and hydraulic changes which would increase the pressure. Table 3 summarizes material details for the availability of molecularly oriented PVC Molecularly Oriental {Polyvinyl Chloride (PVCO), HDPE pipe, and ductile iron pipe.

Table 3. Pipe Material Comparison				
Pipe Type	Pressure Class, psi	Size, inches	Lead Time[a]	Price/ft[b], dollars
PVCO with Restrained Joints (AWWA C909)	235	8	2 to 3 weeks	20.56
PVCO with Restrained Joints (AWWA C909)	305	8	2 to 3 weeks	25.77
PVCO with Restrained Joints (AWWA C909)	165	16	6 to 8 weeks	56.70
HDPE (DR17, PE 4710 , AWWA C906)	125	8	3 to 4 weeks	12.00
HDPE (DR17, PE 4710 , AWWA C906)	125	18	3 weeks	36.38
Ductile Iron Pipe with Seismic Restrained Joints	350	8	6 months	65.68

(a) Lead time derived from discussions with JM Eagle, Performance Pipe, and US Pipe from Spring 2022.
(b) Values represent the cost of material only from Spring 2022 and do not include transport or labor/install costs.

4.3 Alternatives Analysis

4.3.1 Capital Costs

Project cost estimates were developed for Alternatives 1 and 2 for the Rio Nido Force Main, and Alternatives 1, 2, and 3 for the Beanwood and Main Force Mains. The full breakdown of each estimate is included in Appendix H.

The factors considered in the cost analysis include:

1. **Construction Duration**: This is intended to portray total construction duration in the field and includes mobilization, bypass installation and removal where required, pipe installation, connections, testing, cleanup, and restoration. Pipe installation duration is based on typical installation rates dependent on construction method and location of the alignment. The longer the construction duration, the more general and administrative costs increase.
2. **Construction Cost**: This is total estimated cost for pipe installation based on standard installation costs by pipe size and material.
3. **Geotechnical Factors**: A geotechnical risk factor was added as a percentage of the capital construction costs of the project alignments that would be in either open-cut or tunneling construction in conditions that include the presence of cobbles and hard rock.
4. **Traffic Control**: Traffic control costs include approximate costs for the necessary traffic control dependent on the segment’s construction method, alignment location, and duration of installation.
5. **Bypass Cost**: Bypass costs are for full segment bypass and include localized bypass or wastewater trucking costs required for connections.
6. **Restoration Cost**: Restoration costs include both pavement and environmental/ landscape restoration.
7. **Special Structures Cost**: Special structures include caissons for microtunneling and connection to existing manholes.
8. **Mobilization**: Mobilization cost includes contractor mobilization and demobilization, including potholing and initial site observations and photos.

9. **Contingency**: A 20 percent contingency has been added to the total construction cost, covering any unexpected items that may need to be addressed.
10. **Easement Acquisition**: Easement acquisition costs are dependent on the location of the alignment and are estimates using a 20-foot width for permanent easements. The actual easement cost will depend on the value of each property.
11. **Soft Costs**: Finally, soft costs include costs borne by the District which have been estimated as percentages of the total construction cost for planning, design, administration, CEQA, construction management, value engineering, and construction contingency.

Table 4 summarizes the project capital costs for Alternative 1 and Alternative 2 in each area of the Project, in addition to Alternative 3 for Beanwood and Main Force Mains. Further cost investigation and development has been conducted for the selected alternatives in Section 7.0 below.

Table 4. Capital Costs for Force Main Improvements (2022 dollars)

Rio Nido	670,300	887,700	NA
Beanwood	14,440,900	1,191,100	1,092,300
Main	13,905,400	21,590,900	15,498,500

4.3.2 Maintenance Costs

Table 5 lists the estimated overall life-cycle costs associated with the annual maintenance expenditures for each force main. The values represent the net present worth for a life-cycle duration of 50 years, a nominal five percent interest rate and a two percent market discount rate are incorporated into the estimates. To approximate the annual expenditures listed in Table 5, the annual expenditures are estimated to be $200 per 100 LF of 8-inch pipe and $400 per 100 LF of 14-inch and 18-inch pipe for each alternative.

Table 5. Maintenance Costs for Force Main Improvements (2022 dollars)

Force Main	Alternative 1	Alternative 2	Alternative 3
Rio Nido	208,800	212,300	NA
Beanwood	313,800	296,000	296,000
Main	3,476,400	3,476,400	3,476,400

4.3.3 Life-Cycle Cost

Table 6 show the life-cycle costs prepared for the alternatives considered for the Rio Nido, Beanwood and Main Force Mains. Life-cycle costs include total upfront capital and operation and maintenance (O&M) costs over the life of the project. It was assumed that the force main pipeline will have a useful life of 50 years.

Table 6. Life-Cycle Costs for Force Main Improvements (2022 dollars)			
Force Main	Alternative 1	Alternative 2	Alternative 3
Rio Nido	879,100	1,100,000	NA
Beanwood	14,754,700	1,487,100	1,388,300
Main	17,381,800	25,071,700	18,974,900

4.3.4 Planning and Design Parameters

The planning and design parameters for Rio Nido, Beanwood and Main Force Main meet the Sonoma Water Standards and are summarized in Table 7, Table 8 and Table 9 below.

Table 7. Rio Nido Force Main Planning and Design Parameters Summary		
Item Description	Alternative 1	Alternative 2
Pipe Diameter	8-inch	8-inch
Pipe Material	DR17 HDPE & CIPP liner	DR17 HDPE
Total Rehabbed/Replaced Pipe Length	915 LF	930 LF

Table 8. Beanwood Force Main Planning and Design Parameters Summary			
Item Description	Alternative 1	Alternative 2	Alternative 3
Pipe Diameter	8-inch	8-inch	8-inch
Pipe Material	DR17 HDPE	DR17 HDPE and DIP	DR17 HDPE and CIPP liner
Total Rehabbed/Replaced Pipe Length	1,375 LF	1,297 LF	1,297 LF

Table 9. Main Force Main Planning and Design Parameters Summary			
Item Description	Alternative 1	Alternative 2	Alternative 3
Pipe Diameter	14-inch & 18-inch	14-inch and 18-inch	14-inch and 18-inch
Pipe Material	DR17 HDPE	DR17 HDPE	DR17 HDPE
Total Rehabbed/Replaced Pipe Length	7,616 LF	7,616 LF	7,616 LF

4.3.5 State Planning Priorities

The Rio Nido, Beanwood and Main Force Main alternatives address the State environmental planning priorities in Section 65041.1 of the California Government Code (Appendix G), which are intended to promote public health and safety in the state, including in urban, suburban, and rural communities. Improvements to the existing sewer infrastructure will assist in protecting the environment and promote public health and safety. Alternatives 1 and 2 of the Rio Nido Force Main, and Alternatives 1, 2, and 3 of Beanwood and Main Force Mains equally meet the State planning priorities in regards to O&M because the ongoing costs to taxpayers are similar. However, the capital costs are higher for Alternative 1 for Beanwood Force Main and Alternative 2 for Main Force Main because of the microtunneling.

4.3.6 Climate Change Consideration

Replacing and rehabilitating the sewer system will reduce the risk of groundwater and surface water contamination from force main leaks, which may be attributable to climate change. These alternatives have no appreciable impact on climate change.

4.3.7 Opportunities for Water and Energy Efficiency

Alternative 2 for Rio Nido, Alternative 1 for Beanwood, and Alternatives 2 and 3 for Main are more energy efficient than operating the existing force mains due to reduced friction loss with the use of new HDPE pipe. Alternative 1 would have a slightly higher reduction of friction losses due to the greater length of new plastic pipe. Also, the “no action” alternatives (Alternative 0), would potentially continue to require emergency O&M whenever a failure occurs. Eliminating these emergency repairs decreases the need for cleanup, service and construction equipment. Routine maintenance on the new pipe would require less energy than pipeline emergency replacement activity.

5.0 LIFT STATION ALTERNATIVES ANALYSIS

As previously mentioned, the condition of the District's lift station facilities is generally beyond the respective useful life and is in need of major repairs, upgrades, and/or overhauls. The following sections discuss the methodology used for conducting the alternatives analysis for the eleven lift stations included in the project. The objective of the analysis is to assist in the selection of a preferred alternative that will provide the necessary improvements to the District's facilities so they may continue to operate well into the future.

5.1 Planning and Design Parameters and Assumptions

The main planning and design parameters considered for the lift stations include capacity, primary power, and flow equalization. Each of these parameters are discussed in the following sections.

5.1.1 Capacity

Based on historical sanitary flow patterns in the District's collection system, coupled with little anticipation for local population growth, additional flow is not anticipated at the lift stations. Accordingly, it is assumed that improvements considered for the lift stations would be designed to maintain and not increase existing station capacities.

5.1.2 Primary Power

Four of the eleven lift stations currently rely on one of two long-distance 5 kilovolt (kV) transmission lines owned and operated by the District for primary power. These stations are Vacation Beach, Guernewood Park, Guerneville, and Beanwood Lift Stations. The high-voltage transmission lines are in use as an alternative to dedicated utility services for each facility. One of the transmission lines originates at the District's WWTP and conveys power to Vacation Beach Lift Station; the other transmission line originates at Main Lift Station and conveys power to the other three lift stations stated above. To convey utility power from Main Lift Station to Guernewood Park, Guerneville, and Beanwood lift Stations, a transformer at Main Lift Station steps the incoming 480V PG&E utility power up to 4160V, and a transformer at each of the receiving lift stations steps the power back down to 480V. A similar setup is in place between the WWTP and Vacation Beach Lift Station, wherein voltage is stepped up at the WWTP for conveyance to Vacation Beach, and a stepdown transformer reduces the voltage for use at the station.

An objective of the District is to decommission the two high-voltage transmission lines described above since they pose a safety hazard, are difficult to maintain, and because more reliable service would be achieved if dedicated utility services are provided. Therefore, new electrical services will be provided at Guernewood Park, Guerneville, and Beanwood Lift Stations.

5.1.3 Flow Equalization and VFD Analysis

Operation of the WWTP is negatively affected by the rapid fluctuations in inflow rates coming into the plant from the Main and Vacation Beach Lift Station flow and the other lift stations that send flow to the Main Lift Station. The pumps at these lift stations operate in a fill-and-draw mode where constant speed pumps are called to operate when the liquid level reaches a certain set level and shut down once the liquid has receded to a set low level. Depending on the inflow to the lift station, the pumps are estimated to cycle on and off many times per day, causing the treatment plant to experience the significant flow rate fluctuations mentioned above. It has been concluded that the most effective solution is to install VFDs at Main, Vacation Beach, Beanwood, Drake Road, Rio Nido, Guernewood Park, and Guerneville Lift Stations.

Applying these improvements would not only optimize operations at the WWTP but would reduce any hydraulic transients occurring within all related force mains, diminishing risks of fatigue failures during operation. A more detailed discussion of the flow equalization analysis is provided in the Force Main Alternatives Analysis TM (Appendix E).

5.2 Design Alternatives Considered

For each lift station, the alternatives that were considered include one with no major improvements, one involving significant rehabilitation, and one involving reconstruction of the entire facility. Routine maintenance over the next 50 years is included as part of all three alternatives. Descriptions are provided below for each alternative:

- **Alternative 0 – No Major Improvements:** This alternative for each lift station entails replacing individual pieces of equipment and infrastructure over time as failures occur, instead of making improvements on a preemptive basis. Accordingly, it is expected that the District would need to deal with emergency failures on an increasingly more frequent basis, which would be more expensive overall compared to making major improvements up front. In addition, since some of the existing components at the lift stations have either failed or pose a safety risk due to the nature of the construction, particularly the electrical facilities, replacement of these key components is also included as part of Alternative 0.
- **Alternative 1 – Facility Rehabilitation:** The rehabilitation alternatives generally entail replacing items that either have reached or are approaching the end of useful life, including pumps, piping, valves, electrical equipment, instrumentation, and other miscellaneous components of each facility as described in the sections below. While the pumps are typically replaced as part of this alternative due to age, various lift stations will require pumps with different operating points, as it has been determined through analysis that the existing pumps are currently operating inefficiently at certain locations.
- **Alternative 2 – Facility Reconstruction:** This alternative entails demolishing the existing lift station and constructing a new station. A typical new lift station facility will consist of a wet well with either 2 or 3 submersible pumps depending on the inflow patterns at the station; valve vault with all new valves and other mechanical appurtenances; new primary electrical utility service if one does not currently exist; stationary generator for standby power if one currently exists at the station; all new electrical, instrumentation and controls equipment; flow meter; and other miscellaneous elements required to meet acceptable operating standards as well as Sonoma Water design and construction standards.

The following sections provide site-specific descriptions of the existing lift stations, highlighting key features that have been determined to be deficient based on the condition assessment performed in January 2022. Following the description for each lift station, the individual no-action, rehabilitation, and reconstruction alternatives outlined above are summarized.

5.2.1 Rio Nido Lift Station

Rio Nido Lift Station is located at the crossing of Rio Nido Road and River Road. Inflow to the station is from a 12-inch gravity pipe located about 21 feet below ground. Historical ADWF is approximately 238 gpm, including infiltration. Three 5-horsepower (HP) submersible pumps operate in a lead-lag-standby configuration and discharge flow away from the station through an 8-inch force main. The firm capacity at the lift station with two of the three pumps operating is 330 gpm. The pumps are located inside a rectangular concrete wet well, approximately 28 feet deep. The primary power source for Rio Nido Lift Station is a 240V 3-phase PG&E utility service. Standby power is provided by a stationary 30-kilowatt (KW) propane generator, which is located with all the electrical panels and controls on site in a 12'x12' concrete masonry unit (CMU) building.

Three alternatives considered for Rio Nido Lift Station are described in the following sections.

5.2.1.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.1.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps in kind or with similar models. Pumps will be equipped with VFDs to improve the flow equalization in the downstream collection system and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning within the building to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- R&R the building ceiling
- Pavement restoration
- Construct new chain link access gate
- Demolish the existing electrical and motor controls. RTU will be reused or new one provided by District.
- Meter/main breaker panel, ATS and generator will remain.
- New motor control panel will be provided for the three pumps.
- Existing Local pump and instrumentation termination box will be reused.
- Submersible level transmitter and float switches will be reused.
- Install new flowmeter and emergency site lighting.

5.2.1.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed on the same site and with the same 330 gpm firm capacity as the existing station. The space on site is likely sufficient for a new wet well, valve vault and building to be constructed adjacent to the existing, allowing operation of the District's existing pumping facilities at Rio Nido Lift Station to continue largely uninterrupted through construction.

5.2.2 Beanwood Lift Station

Beanwood Lift Station is located at Highway 116 and Neeley Road. Inflow to the station is from a 12-inch gravity pipe located about 25-feet below ground. ADWF is approximately 211 gpm, including infiltration. Three 10-HP submersible pumps operate in a lead-lag-standby configuration and discharge flow away from the station through an 8-inch force main. The firm capacity at the lift station with two of the three pumps operating is 530 gpm. The pumps are located inside a rectangular concrete wet well, approximately 31 feet deep. As previously mentioned, Beanwood Lift Station is one of the three stations that draws its primary electrical power from Main Lift Station. To convey utility power from Main to Beanwood Lift Station, a transformer at Main Lift Station steps up the incoming power from 480V to 4160V and a transformer at Beanwood Lift Station steps the power back down to 480V. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

Three alternatives considered for Beanwood Lift Station are described in the following sections.

5.2.2.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.2.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point. Pumps will be equipped with VFDs to improve the flow equalization downstream and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault
- Replace all isolation valves, check valves, and combination air valves.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches
- Pavement restoration
- Provide new PG&E primary utility service. The existing high-voltage service from Main Lift Station will be decommissioned, and a new PG&E electric utility service will be instated for station primary power.
- Demolish existing electrical and motor controls. The remote telemetry unit (RTU) will be reused or a new one will be provided by District.
- New meter/main breaker panel will be provided, and utility power will be routed to the new meter location. New PG&E transformer, meter/main panel, automatic transfer switch (ATS) and portable generator will be located near the site frontage close to the existing gate. The motor control center (MCC) can be installed next to the gate or on the existing platform.

- A three or four section MCC with weather wrap will house:
  - ATS
  - Motor starters for three pumps
  - Small 120VAC panelboard and transformer
  - RTU section
  - Miscellaneous electrical and instrumentation equipment
- New Local pump and instrumentation termination box will be installed at the lift station on the existing platform.
- Existing float switches will be reused. Submersible level element will be replaced with new ultrasonic level element to match the other existing sites. The instrumentation wires will be routed through the new termination panel.
- Install weather overhang above outdoor electrical panels.
- Install new flowmeter and emergency site lighting.
- Install sump pump and/or clear clogged drain in the valve vault.

5.2.2.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed on the same site and with the same firm capacity as the existing station. The space on site is likely sufficient for a new wet well, valve vault and electrical controls to be constructed adjacent to the existing, allowing operation of the District's existing pumping facilities at Beanwood Lift Station to continue largely uninterrupted through construction.

5.2.3 Main Lift Station

Main Lift Station is located near the intersection of Highway 116 and Riverside Drive. Inflow to the station is from a 21-inch gravity pipe located about 21-feet below ground. ADWF is approximately 1,245 gpm, including infiltration. Three 47-HP submersible pumps operate in a lead-lag-standby configuration and discharge flow away from the station through a 16-inch force main. The firm capacity at the lift station with two of the three pumps operating is 2500 gpm. The pumps are located inside a rectangular concrete wet well, approximately 30-feet deep.

The primary power source for Main Lift Station is a 480V 3-phase PG&E utility service. Standby power is provided by a 200KW diesel generator, which is located with all the electrical panels and controls on site in a 22'-8"x18' CMU building. As previously mentioned, Main Lift Station provides primary electrical power to Guernewood Park, Guerneville, and Beanwood Lift Stations via a high-voltage transmission line. The transmission line is energized by the PG&E electrical utility and can also be energized by the standby generator at Main Lift Station upon utility power outage.

5.2.3.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.3.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point. Pumps will be equipped with VFDs to improve the flow equalization in the downstream collection system and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning within the building to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault
- Replace all isolation valves, check valves, and combination air valves.
- Demolish existing wet well top concrete slab and access hatches. Reconstruct a new reinforced concrete top with three new replacement access hatches.
- Replace odor control equipment.
- R&R existing building ceiling.
- Provide new springs and miscellaneous hardware for the valve vault hatches.
- Demolish the existing electrical and motor controls. The existing step-up transformer will also be demolished. The RTU will be reused or a new one will be provided by District.
- The existing generator may be reused or replaced with a smaller generator based on new loads.
- New meter/main switchboard with ATS, and motor controls be provided.
- Panelboard will be replaced in kind or wires will be routed to a new panelboard and panelboard transformer located in the MCC section.
- A new local pump and instrumentation termination box will be installed at the lift station above the flood plain.
- The existing ultrasonic level element and float switches will be reused. The instrumentation wires will be routed through the new Termination Panel.
- A new flowmeter and emergency site lighting will be installed.
- Construct an additional wet well and valve vault and install new low-flow pumps. The wet well will be a 6’ diameter precast concrete structure and deep enough to provide additional storage; the exact depth, which is expected to be deeper than the existing wet well, will be determined in the next phase of the project. Two new pumps will be provided to accommodate the PDWF when both pumps are operating. Additional piping, isolation valves, and check valves will be installed, in addition to a separate flow meter and connection to the main force main. The new wet well system will allow the District to bypass the existing wet well for maintenance activities, which is important as Main Lift Station is a critical facility that needs to remain online to greatest extent possible.

5.2.3.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed with the same firm capacity as the existing station. An analysis needs to be conducted to determine if there is sufficient space on site for a new wet well, valve vault and building to be constructed adjacent to the existing, which would allow operation of the District's existing pumping facilities at Main Lift Station to continue largely uninterrupted through construction.

5.2.4 Drake Estates Lift Station

Drake Estates Lift Station is located off Western Avenue. Inflow to the station comes from a 6-inch gravity pipe located about 20-feet below ground. ADWF is approximately 42 gpm, including infiltration. Two submersible pumps at 7.5-HP and 7.6-HP operate in a duty-standby configuration and discharge flow away from the station through a 4-inch force main. The firm capacity at the lift station with one of the two pumps operating is 125 gpm. The pumps are located inside a circular concrete wet well, approximately 24.5 feet deep. The primary power source for Drake Estates Lift Station is a 240V 1-phase PG&E utility service. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.4.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.4.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point. Pumps will be equipped with VFDs to improve the flow equalization in the downstream collection system and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- Construct new chain link access gate.
- Demolish the existing electrical and motor controls. The existing RTU will be reused or new one will be provided by District.
- New meter/main breaker panel will be provided. Utility power will be routed to the new meter location.
- The new meter/main breaker panel and ATS will be located outside of the Electrical Control Panel. This will allow removing power to the electrical panel without opening the doors.
- A large NEMA 4X rated electrical control panel will house:
    - Motor control panel
    - Small 120VAC panelboard
    - RTU
    - Miscellaneous electrical and instrumentation equipment

- New local pump and instrumentation termination box will be installed at the lift station above the flood plain.
- The existing float switches will be reused. The existing submersible level element will be replaced with a new ultrasonic level element, matching other existing sites. The instrumentation wires will be routed through the new Termination Panel.
- A new flowmeter and emergency site lighting will be installed.

5.2.4.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed with the same firm capacity as the existing station. The amount of space available on site is insufficient for constructing a new wet well, valve vault and electrical controls adjacent to the existing, which would allow for largely uninhibited operation of the existing station throughout construction. Therefore, an analysis would need to be conducted to determine a suitable location for a replacement lift station under this alternative.

5.2.5 Drake Road Lift Station

Drake Road Lift Station is located off Drake Road and Leasowe Lane. Inflow to the station comes from two 6-inch gravity pipes located 2.5 feet and 18 feet below ground as well as one 8-inch gravity pipe located 12 feet below ground. ADWF is approximately 100 gpm, including infiltration. Two 10-HP submersible pumps operate in a duty-standby configuration and discharge flow away from the station through a 6-inch force main. The firm capacity at the lift station with one of the two pumps operating is 230 gpm. The pumps are located inside a circular concrete wet well, approximately 24 feet deep. The primary power source for Drake Road Lift Station is a 240V 3-phase PG&E utility service. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.5.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.5.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point.
- Replace all exposed piping inside the valve vault.
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- Demolish the existing electrical and motor controls. The existing RTU will be reused or a new one will be provided by District.
- New meter/main breaker panel will be provided. Utility power will be routed to the new meter location.
- The new meter/main breaker panel and ATS will be located outside of the electrical control panel. This will allow removing power to the electrical panel without opening the doors.

- A large NEMA 4X rated electrical control panel will house:
  - Motor control panel
  - Small 120VAC panelboard
  - RTU
  - Miscellaneous electrical and instrumentation equipment
- New local pump and instrumentation termination box will be installed at the lift station above the flood plain.
- Existing float switches will be reused. The existing submersible level element will be replaced with a new ultrasonic level element, matching existing sites. The instrumentation wires will be routed through the new termination panel.
- A new flowmeter and emergency site lighting will be installed.
- Install sump pump and/or clear clogged drain in the valve vault.

5.2.5.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed on the same site and with the same firm capacity as the existing station. Because the existing lift station is constructed within a residential driveway, coordination with the neighboring homeowners would need to be conducted and a temporary street closure would potentially need to be implemented during construction.

5.2.6 Watson Road Lift Station

Watson Road Lift Station is located off Watson Road. Inflow to the station comes from a 6-inch gravity pipe located 6 feet below ground. ADWF is approximately 11.2 gpm, including infiltration. Two 2.3-HP submersible pumps operate in a duty-standby configuration and discharge flow away from the station through a 2-inch force main. The firm capacity at the lift station with one of the two pumps operating is 32 gpm. The pumps are located inside a circular concrete wet well, approximately 10 feet deep. The primary power source for Watson Road Lift Station is a 240V 1-phase PG&E utility service. Standby power is provided by a stationary 9 KW propane generator. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.6.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.6.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point.
- Replace all exposed piping inside the wet well and valve vault.
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well hatch.
- Repair corrosion on electrical platform.

- Demolish the existing electrical and motor controls. The existing RTU will be reused or a new one will be provided by the District.
- New meter/main breaker panel will be provided. Utility power will be routed to new meter location.
- Existing ATS / panelboard may be reused.
- A large NEMA 4X rated electrical control panel will house:
  - Motor control panel
  - RTU
  - Miscellaneous electrical and instrumentation equipment
- The new meter/main breaker panel and ATS will be located outside of the electrical control panel. This will allow removing power to the electrical panel without opening the doors.
- New local pump and instrumentation termination box will be installed at the lift station above the flood plain.
- Submersible level transmitter and float switches will be reused. The instrumentation wires will be routed through the new termination panel.
- A new flowmeter and emergency site lighting will be installed.

5.2.6.3 Alternative 2 - Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed on the same site and with the same firm capacity as the existing station. Because the existing lift station is constructed within the right-of-way, coordination with the neighboring homeowners would need to be conducted and a temporary street closure would potentially need to be implemented during construction.

5.2.7 Laughlin Road Lift Station

Laughlin Road Lift Station is located off Laughlin Road. Inflow to the station comes from a 6-inch gravity pipe located 10 feet below ground. ADWF is approximately 12.8 gpm, including infiltration. Two 2.3HP submersible pumps operate in a duty-standby configuration and discharge flow away from the station through a 1.5-inch force main. The firm capacity at the lift station when one of the two pumps is operating is 22 gpm. The pumps are located inside a circular concrete wet well, approximately 14 feet deep. The primary power source for Laughlin Road Lift Station is a 240V 1-phase PG&E utility service. Standby power is provided by a stationary 9KW propane generator. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.7.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.7.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point.
- Replace all exposed piping inside the wet well and valve vault.
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well hatch.
- Demolish the existing electrical and motor controls. The existing RTU will be reused or a new one will be provided by the District.
- New meter/main breaker panel will be provided. Utility power will be routed to new meter location.
- Existing ATS / panelboard may be reused.
- A large NEMA 4X rated electrical control panel will house:
  - Motor control panel
  - RTU
  - Miscellaneous electrical and instrumentation equipment
- The new meter/main breaker panel and ATS will be located outside of the electrical control panel. This will allow removing power to the electrical panel without opening the doors.
- New local pump and instrumentation termination box will be installed at the lift station above the flood plain.
- Submersible level transmitter and float switches will be reused. The instrumentation wires will be routed through the new termination panel.
- A new flowmeter and emergency site lighting will be installed.

5.2.7.1 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed on the same site and with the same firm capacity as the existing station. Because the existing lift station is constructed within the right-of-way, coordination with the neighboring homeowners would need to be conducted and a temporary street closure would potentially need to be implemented during construction.

5.2.8 Guerneville Lift Station

Guerneville Lift Station is located off River Road and Brookside Lane. Inflow to the station comes from a 15-inch gravity pipe located 29 feet below ground. ADWF is approximately 933 gpm, including infiltration. Three 30HP submersible pumps operate in a lead-lag-standby configuration and discharge flow away from the station through a 12-inch force main. The firm capacity at the lift station when two of the three pumps are in operation is 1800 gpm. The pumps are located inside a rectangular concrete wet well, approximately 37 feet deep. Guerneville Lift Station is one of the three stations that draws its primary electrical power from Main Lift Station. As previously mentioned, to convey utility power from Main to Guerneville Lift Station, a transformer at Main Lift Station steps up the incoming power from 480V to 4160V and a transformer at Guerneville Lift Station steps the power back down to 480V. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.8.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.8.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point. Pumps will be equipped with VFDs to improve the flow equalization in the downstream collection system and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning within the building to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- Provide new PG&E primary utility service. The existing high-voltage service from Main Lift Station will be decommissioned, and a new PG&E electric utility service will be instated for station primary power.
- Demolish the existing electrical and motor controls. The existing RTU will be reused or a new one will be provided by the District.
- New meter/main breaker panel will be provided. Utility power will be routed to the new meter location.
- The new meter/main breaker panel will be located outside of the electrical control panel.
- A three section MCC with weather wrap will house:
  - ATS
  - Motor starters for the pumps
  - Small 120VAC panelboard and transformer
  - RTU section
  - Miscellaneous electrical and instrumentation equipment
- New local pump and instrumentation termination box will be installed at the lift station on the platform.
- Existing ultrasonic level element and float switches will be reused. The instrumentation wires will be routed through the new termination panel.
- A new flowmeter and emergency site lighting will be installed.

5.2.8.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed with the same firm capacity as the existing station. An analysis needs to be conducted to determine if there is sufficient space on site for a new wet well, valve vault and electrical controls to be constructed adjacent to the existing, which would allow operation of the District's existing pumping facilities at Guerneville Lift Station to continue largely uninterrupted through construction.

5.2.9 Guernewood Park Lift Station

Guernewood Park Lift Station is located off Old Cazadero Road. Inflow to the station comes from two 8-inch gravity pipes located 20 feet and 21 feet below ground. ADWF is approximately 168 gpm, including infiltration. Two submersible pumps at 10-HP and 7.5-HP operate in a duty-standby configuration and discharge flow away from the station through a 12-inch force main. The firm capacity at the lift station when the 7.5-HP pump is in operation is 400 gpm. The pumps are located inside a rectangular concrete wet well, approximately 28 feet deep. Guernewood Park Lift Station one of the three stations that draws its primary electrical power from Main Lift Station. As previously mentioned, to convey utility power from Main to Guernewood Park Lift Station, a transformer at Main Lift Station steps up the incoming power from 480V to 4160V and a transformer at Guernewood Park Lift Station steps the power back down to 480V. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.9.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.9.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point. Pumps will be equipped with VFDs to improve the flow equalization in the downstream collection system and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- Regrade the site to minimize the heightened slope that currently leads up to the wet well and valve vault hatches.
- Provide new PG&E primary utility service. The existing high-voltage service from Main Lift Station will be decommissioned, and a new PG&E electric utility service will be instated for station primary power.
- Demolish the existing electrical and motor controls. The existing RTU will be reused or a new one will be provided by the District.
- New meter/main breaker panel will be provided. Utility power will be routed to the new meter location.

- The new meter/main breaker panel and ATS will be located outside of the electrical control panel. This will allow removing power to the electrical panel without opening the doors.
- A large NEMA 4X rated electrical control panel will house:
  - Motor control panel
  - Small 120VAC panelboard
  - RTU
  - Miscellaneous electrical and instrumentation equipment
- New local pump and instrumentation termination box will be installed at the lift station on the platform.
- Existing float switches will be reused. The existing submersible level element will be replaced with a new ultrasonic level element, matching existing sites. The instrumentation wires will be routed through the new termination panel.
- A new flowmeter and emergency site lighting will be installed.

5.2.9.3 Alternative 2 - Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed with the same firm capacity as the existing station. An analysis needs to be conducted to determine if there is sufficient space on site for a new wet well, valve vault and building to be constructed adjacent to the existing, which would allow operation of the District's existing pumping facilities at Guernewood Park Lift Station to continue largely uninterrupted through construction.

5.2.10 Center Way Lift Station

Center Way Lift Station is located off Guernewood Road and Neeley Road. Inflow to the station comes from a 6-inch gravity pipe located 12 feet below ground. ADWF is approximately 43 gpm, including infiltration. Two 10-HP submersible pumps operate in a duty-standby configuration and discharge flow away from the station through a 4-inch force main. The firm capacity at the lift station when one of the two pumps is in operation is 120 gpm. The pumps are located inside a circular concrete wet well, approximately 24 feet deep. The primary power source for Center Way Lift Station is a 240V 3-phase PG&E utility service. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.10.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.10.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point.
- Replace all exposed piping inside the wet well and valve vault.
- Replace all isolation valves and check valves.

- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- Demolish the existing electrical and motor controls. The existing RTU will be reused or a new one provided by the District.
- New meter/main breaker panel will be provided. Utility power will be routed to the new meter location.
- The meter/main breaker panel and ATS will be located outside of the electrical control panel. This will allow removing power to the electrical panel without opening the doors.
- A large NEMA 4X rated electrical control panel will house:
  - Motor control panel
  - Small 120VAC panelboard
  - RTU
  - Miscellaneous electrical and instrumentation equipment
- New local pump and instrumentation termination box will be installed at the lift station above the flood plain.
- Existing float switches will be reused. Existing submersible level element will be replaced with a new ultrasonic level element, matching existing sites. The instrumentation wires will be routed through the new termination panel.
- A new flowmeter and emergency site lighting will be installed.

5.2.10.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed on the same site and with the same firm capacity as the existing station. The space on site is likely sufficient for a new wet well, valve vault and electrical controls to be constructed adjacent to the existing, allowing operation of the District's existing pumping facilities at Center Way Lift Station to continue largely uninterrupted through construction.

5.2.11 Vacation Beach Lift Station

Vacation Beach Lift Station is located off Vacation Beach Road and Orchard Avenue. Inflow to the station comes from a 6-inch gravity pipe located 19 feet below ground, and an 8-inch gravity pipe located 18 feet below ground. ADWF is approximately 130 gpm, including infiltration. Two 10-HP submersible pumps operate in a duty-standby configuration and discharge flow away from the station through a 4-inch force main. The firm capacity at the lift station when one of the two pumps is in operation is 350 gpm. The pumps are located inside a circular concrete wet well, approximately 26 feet deep. As previously mentioned, Vacation Beach Lift Station draws its primary electrical power from the WWTP by use of a step-up transformer at the WWTP followed by a step-down transformer at the lift station. A connection point is located on site for the District to connect a portable generator for use as standby power. The electrical controls and transformer are located above the flood elevation on an elevated metal platform.

5.2.11.1 Alternative 0 – No Major Improvements

No major improvements are to be completed up front as part of this alternative other than addressing safety concerns and replacing equipment that may have already failed. Routine maintenance over the course of the next 50 years is also included.

5.2.11.2 Alternative 1 – Facility Rehabilitation

The following work is included as part of Alternative 1:

- Replace pumps with different models to better fit the design operating point. Pumps will be equipped with VFDs to improve the flow equalization in the downstream collection system and ultimately at the WWTP headworks. Based on the climate profile in the area, it is anticipated that the temperature is not warm enough to necessitate air conditioning to regulate the VFD operating temperature.
- Replace pump discharge elbows, guide rails and brackets.
- Replace all exposed piping inside the wet well and valve vault.
- Replace all isolation valves and check valves.
- Provide new springs and miscellaneous hardware for the wet well and valve vault hatches.
- Regrade the site to minimize the heightened slope that currently leads up to the wet well and valve vault hatches.
- Construct new chain link access gate.
- Demolish existing electrical (step-up transformer at WWTP, step-down transformer at the lift station, and motor controls).
- Existing RTU panel and radio system will be turned over to the District. I/O associated with the lift station will be monitored at a programmable logic controller (PLC) designated by the District.
- Motor controls, including the new VFDs, will be relocated to the WWTP. New 480V power wires will be routed from the WWTP to the lift station.
- Since VFDs will be provided for the motors, harmonic mitigation measures will be reviewed due to the distance between the new VFD and the motors.
- New ultrasonic level element and float switches will be located at the lift station. The new instrumentation wires will be run back to the WWTP.
- Since power is coming from the WWTP, local disconnect will be provided. Local disconnect switches and pump termination box will be installed at the lift station above the flood plain.
- A new flowmeter will be installed.

5.2.11.3 Alternative 2 – Facility Reconstruction

As part of Alternative 2, a new lift station would be constructed with the same firm capacity as the existing station. An analysis needs to be conducted to determine if there is sufficient space on site for a new wet well, valve vault and building to be constructed adjacent to the existing, which would allow operation of the District's existing pumping facilities at Vacation Beach Lift Station to continue largely uninterrupted through construction.

5.3 Alternatives Analysis

To compare the relative suitability between alternatives considered, the cumulative maintenance expenditures and initial capital cost were estimated to determine an approximate life-cycle cost. The main objective was to determine which alternatives would be less costly, and therefore more preferable, over time. Accordingly, a life-cycle present worth analysis was conducted for all three alternatives for each lift station. The useful life used in the analysis is 50 years, and the discount and inflation rates are estimated to be 2 percent and 5 percent, on average, over the course of the 50-year useful life.

The following sections describe the methodology for approximating the overall life-cycle cost for the lift stations. The estimated costs have been prepared at a Class 5 level, which is defined by the Association for the Advancement of Cost Engineering (AACE) as corresponding to a project at approximately the 0 percent to 2 percent of its complete definition. The costs were developed based on a combination of quotes from vendors, historical data, and prior experience with similar projects.

5.3.1 Capital Costs

The capital costs estimated for all three alternatives for each lift station are summarized in Table 10. For Alternative 0, the costs represent the work to replace existing failed components that are required for facility operation and also to replace components that have been determined to pose an immediate safety hazard. The majority of these components are related to the existing electrical infrastructure.

Table 10. Capital Costs for Lift Station Improvements (2022 dollars)

Lift Station Facility	Alternative 0 No Action, dollars	Alternative 1 Rehabilitation, dollars	Alternative 2 Reconstruction, dollars
Rio Nido	636,000	1,164,000	1,288,800
Beanwood	955,000	1,727,000	1,964,400
Main	1,120,000	5,103,000	6,015,800
Drake’s Estates	582,000	1,271,000	1,417,200
Drake Road	582,000	1,289,000	1,438,800
Watson	491,000	1,108,000	1,221,600
Laughlin	491,000	1,070,000	1,176,000
Guerneville	830,000	2,118,000	2,433,600
Guernewood Park	667,000	1,360,000	1,524,000
Center Way	582,000	1,243,000	1,383,600
Vacation Beach	830,000	1,621,000	1,837,200
Total	**$7,766,000**	**$19,074,000**	**$21,701,000**

The totals listed in Table 10 were developed using the following specific factors:

1. **Direct Cost**: These represent the costs required for a complete installation, rehabilitation, or replacement for a given element of work. The costs are borne specifically by the contractor, and include costs such as materials, labor, shipping and taxes, preparation and submittal of shop drawings, overhead, profit, mobilization and demobilization. The costs account for work being completed at the present time.
2. **Estimating and Construction Contingency (50 percent)**: Due to the inherent uncertainty related to potential construction efforts and the limited information available at the current stage of the Project, a contingency of +50 percent was applied. Typical estimating contingency values for Class 5 estimates range from -20 percent to -50 percent on the low side, and +30 percent to +100 percent on the high side, depending on the project. The

+50 percent was applied to the sum of the Direct Costs defined above to yield a Total Construction Cost.

3. **Soft Costs (50 percent of Total Construction Cost)**: These are costs borne by the District in relation to the administration of the construction work, including engineering fees, legal, environmental, permitting, taxes, insurance, construction management, etc. A 50 percent allowance was assumed for the soft costs and was applied to the Total Construction Cost defined above to yield a Total Construction and Administration Cost.
4. **Inflation Adjustment (5 percent per year)**: A market inflation rate of 5 percent per year for 5 years was applied to the improvement costs. This market inflation rate timeframe is assumed to extend to the midpoint of the associated construction. The rate was applied to the Total Construction and Administration Cost defined above to yield the values listed in Table 10.

5.3.2 Maintenance Costs

Table 11 lists the estimated overall costs associated with the annual maintenance expenditures for each lift station throughout the entire life-cycle. The values represent the net present worth, and, as previously mentioned, a life-cycle duration of 50 years, a nominal 5 percent inflation rate and a 2 percent market discount rate are incorporated into the estimates.

Table 11. Maintenance Costs for Lift Station Improvements (2022 dollars)

Lift Station Facility	Alternative 0 No Major Improvements, dollars	Alternative 1 Rehabilitation, dollars	Alternative 2 Reconstruction, dollars
Rio Nido	4,451,000	3,081,000	2,967,200
Beanwood	6,733,000	4,679,000	4,450,600
Main	20,541,000	14,379,000	13,694,000
Drake's Estates	4,907,000	3,423,000	3,194,800
Drake Road	4,907,000	3,423,000	3,309,200
Watson	4,222,000	2,967,000	2,738,400
Laughlin	3,994,000	2,853,000	2,739,000
Guerneville	8,330,000	5,820,000	5,591,400
Guernewood Park	5,249,000	3,652,000	3,423,000
Center Way	4,793,000	3,309,000	3,195,400
Vacation Beach	6,276,000	4,451,000	4,221,800
Total:	**$74,403,000**	**$52,037,000**	**$49,525,000**

To approximate the annual expenditures listed above in Table 11, the annual expenditures are estimated to be 3.0 percent of the cost of a new facility for Alternative 0, 2.1 percent is estimated for Alternative 1, and 2.0 percent for Alternative 2. The higher rate for Alternative 0 is assumed since significant initial improvements would not be completed as part of this alternative, leading to more expected maintenance required overall. Alternative 1 has a slightly higher rate assumed for maintenance costs compared to Alternative 2 to account for recoating the existing concrete wet wells periodically over the next 50 years, approximately once per 15 years; this effort is assumed to also apply to Alternative 0, but not assumed for Alternative 2.

5.3.3 Life-Cycle Costs

The initial capital costs are added to the maintenance costs presented above in Table 10 and Table 11, respectively, to determine the overall life-cycle cost for each alternative. Table 12 below summarizes the life-cycle costs associated with each facility and alternative.

Table 12. Life-Cycle Costs for Lift Station Improvements (2022 dollars)

Lift Station Facility	Alternative 0 No Major Improvements, dollars	Alternative 1 Rehabilitation, dollars	Alternative 2 Reconstruction, dollars
Rio Nido	5,087,000	4,245,000	4,256,000
Beanwood	7,688,000	6,406,000	6,415,000
Main	21,661,000	19,482,000	19,710,000
Drake's Estates	5,489,000	4,694,000	4,612,000
Drake Road	5,489,000	4,712,000	4,748,000
Watson	4,713,000	4,075,000	3,960,000
Laughlin	4,485,000	3,923,000	3,915,000
Guerneville	9,160,000	7,938,000	8,025,000
Guernewood Park	5,916,000	5,012,000	4,947,000
Center Way	5,375,000	4,552,000	4,579,000
Vacation Beach	7,106,000	6,072,000	6,059,000
Total	**$82,169,000**	**$71,111,000**	**$71,226,000**

5.3.4 Planning and Design Parameters

The planning and design parameters for improvements to the lift stations include maintaining existing capacity, providing exclusive primary electrical utility power for individual facilities, and equalization of the flow into the WWTP, as described in Section 5.1 of this report. Alternatives 1 and 2 satisfy all of these objectives, while Alternative 0 only maintains the existing capacity.

5.3.5 State Planning Priorities

Alternatives 1 and 2 considered for the lift stations will adhere to the same priorities as previously described for the force main improvements in Section 4 of this report, and will assist in protecting the environment and promote public health and safety. The same can not be said about Alternative 0.

5.3.6 Climate Change Consideration

The improvements considered for the lift stations are not anticipated to have an appreciable impact on climate change.

5.3.7 Opportunities for Water and Energy Efficiency

The work included as part of Alternative 0 for each lift station are not anticipated to offer opportunities to improve energy efficiency. Alternatives 1 and 2, however, would improve the District's energy efficiency related to operating the facilities. The specific improvements that would help increase efficiency include the installation of VFDs, efficient motors, and more modern lighting. Additionally, pumping control strategies will be developed to optimize efficiency. No opportunities for increasing water efficiency are anticipated, since there are no major water uses related to the operation of the lift station facilities.

6.0 HEADWORKS ALTERNATIVES ANALYSIS

The headworks facility at the WWTP consists of a primary bar screen, two mechanical spiral intake screens, each rated for 5.5-mgd capacity, a concrete Parshall flume for measuring flow rate, and a grit chamber equipped with two submersible 7.5-HP grit handling pumps located in a basement pumping room. Based on as-built information, the piping system for the grit pumping station consists of approximately 220 LF of 4-inch diameter pipe that discharges into the grit classifier on the second floor of the mechanical building, where the grit is dewatered and separated. The grit classifier is difficult for the District to maintain and operate since it is relatively far away from the headworks where the grit pumps are located. The current condition and inventory of equipment and other facilities at the headworks are documented in the condition assessment TM in Appendix F.

6.1 Planning and Design Parameters and Assumptions

The main planning and design parameters considered for the headworks include capacity, equalization of flow through the WWTP, and improvement of the primary grit removal process. These parameters are discussed in the following sections.

6.1.1 Capacity

As previously described, additional capacity is not anticipated for the overall system, and therefore no additional capacity is anticipated at the headworks. Accordingly, improvements will be made such that the existing capacity will be maintained.

6.1.2 Equalization and VFD Analysis

As previously discussed in relation to the lift stations, operation of the WWTP is negatively affected by the rapid fluctuations in inflow rates coming into the plant from the Main and Vacation Beach Lift Station flow and the other lift stations that send flow to the Main Lift Station. In addition to providing VFDs for pumps at various lift stations, flow equalization through the WWTP can be improved by using the existing Aeration Basin 3 for additional storage and release. The District considered incorporating this improvement to the WWTP as part of the Project, but ultimately decided that the benefit to operations would not justify the added cost and maintenance required for the improvement. Therefore, additional flow equalization measures will not be incorporated into the project at the WWTP; flow equalization will be adequately accomplished with the VFDs being incorporated at the lift stations described previously.

6.1.3 Improvement of Primary Grit Removal

The District has indicated the grit removal process to be problematic at times, due in part to the grit building up at the bottom of the grit chamber and occasionally clogging the grit removal pumps and piping. To improve the process, the District considered installing a baffle wall system within the grit chamber at the Headworks, and incorporation of an air-burst and grit fluidization system. The baffle walls help with short-circuiting and directing the flow to the grit collection hopper. The air-burst process would provide compressed air to be vigorously introduced at the location of the settled grit to break apart hardened solids, and the grit fluidization process would introduce plant water to the grit suction piping to improve pumping effectiveness.

6.2 Design Alternatives Considered

The three alternatives considered for the headworks are conceptually the same as the lift stations, being comprised of an alternative with no major improvements, one entailing rehabilitation of the facility, and another entailing construction of a new facility. Routine maintenance over the next 50 years is also included for each alternative. Each alternative is described in the following sections.

6.2.1 Alternative 0 – No Major Improvements

Like the corresponding alternative for the lift stations, this alternative mainly entails routine maintenance and also replacing individual pieces of equipment and infrastructure over time as failures occur. In addition to routine maintenance, Alternative 0 for the headworks also includes the following:

- Repair of concrete cracks and corrosion within the flume channel in the.
- Repair of concrete cracks on the channel wall just upstream of the grit chamber. The cracks were documented as part of the condition assessment results in Appendix F to be larger than 1/8-inch in width and penetrate through the thickness of the wall.
- Recoating of the internal concrete within the headworks structure every 15 years

6.2.2 Alternative 1 – Facility Rehabilitation

The rehabilitation alternative entails replacing items that either have reached or are approaching the end of useful life, including pumps, piping, valves, electrical equipment, instrumentation, and other miscellaneous components. This includes work described under Alternative 0, in addition to the following:

- Decommission the step-down transformer and electrical connection that supplies power to Vacation Beach, as described previously in Section 5.

- Replace the two grit pumps with different models to better fit the design operating point.
- Replace the motor starters for the grit pumps.
- Replace exposed grit pump discharge piping and valves inside the pump room and grit chamber.
- Replace exhaust fan and building door in grit pump room.
- Replace various corroded metalwork such as conduit supports, conduits, small-diameter piping.
- Repair corroded concrete in various areas, including within the Parshall flume
- Repair cracked concrete in various areas, including areas with visible water leakage and/or moisture infiltration.
- Replace the three grit-chamber-aeration blowers, which are located in the maintenance building.
- Replace the existing grit classifier, which is located in the maintenance building. The new unit will be a 480VAC, 3-phase unit with a motor less than 7.5 HP, and will be located outside near the headworks structure. The existing grit piping coming out of the grit chamber will need to be redirected to the new classifier location; the portion of the existing piping within the maintenance building will be removed and a portion of the buried piping will be properly abandoned in place. The new piping alignment will be considered in the selection of the new grit pumps stated above.
- Replace two existing screens with multi-rake screens and install a conveyor on the influent screen system so that debris for both screens may be collected in the same bin.

- Install a baffle wall system inside the grit chamber with an air-blast and grit fluidization assembly to improve grit removal.
- Decommission and remove the existing drainage pump used to drain Aeration Basin 3. The existing pump, currently located inside the basement level of the Blower Building, will be replaced with a pair of submersible pumps that will be installed on rail systems within the Aeration Basin 3. The pumps will be equipped with VFDs, and the discharge pipes will be routed into the piping gallery and connected to the existing piping used for the existing drainage pump.

6.2.3 Alternative 2 – Facility Reconstruction

This alternative entails the following:

- Constructing a new facility adjacent to the existing. The space available on site is anticipated to be sufficient to allow construction of the new facility to proceed with minimal interruptions to the existing flow through the existing headworks facility.
- The existing blowers and grit classifier are intended to be replaced. The grit classifier will be relocated to the new headworks location.
- Like Alternative 1, the existing step-down transformer and electrical connection that supplies power to Vacation Beach will be decommissioned.
- Like Alternative 1, the existing Aeration Basin No. 3 will be converted to use for equalization storage with a new VFD-equipped pumping system.

6.3 Alternatives Analysis

To compare the relative suitability between alternatives considered, the cumulative maintenance expenditures and initial capital cost were estimated to determine an approximate life-cycle cost. The main objective was to determine which alternatives would be less costly, and therefore most preferable, over time. Accordingly, a life-cycle present worth analysis was conducted for all three alternatives. The useful life used in the analysis is 50 years, and the discount and inflation rates are estimated to be 2 percent and 5 percent, on average, over the course of the 50-year useful life.

The following sections summarize the overall life-cycle cost for the headworks improvement alternatives. The estimated costs have been prepared at a Class 5 level, which is defined by the Association for the AACE as corresponding to a project at approximately the 0 percent to 2 percent of its complete definition. The costs were developed based on a combination of quotes from vendors, historical data, and prior experience with similar projects.

6.3.1 Capital Costs

The capital costs estimated for all three alternatives are summarized in Table 13. The totals listed were developed using the same specific estimating factors as used for the for the lift station capital costs, discussed previously in Section 5. These factors include direct cost, 50-percent estimating and construction contingency, 50-percent addition for District-borne soft costs, and nominal 5 percent inflation for an assumed 5-year timeframe until the midpoint of construction.

Table 13. Capital Costs for Headworks Improvements (2022 dollars)

WWTP Headworks	604,000	1,600,000	4,354,000

6.3.2 Maintenance Costs

Table 14 lists the estimated overall costs associated with the annual maintenance expenditures for each alternative throughout the entire life-cycle. The values represent the net present worth, and, as previously mentioned, a life-cycle duration of 50 years, a nominal 5 percent inflation rate and a 2 percent market discount rate are incorporated into the estimates.

Table 14. Maintenance Costs for Headworks Improvements (2022 dollars)

WWTP Headworks	14,949,000	10,385,000	9,928,000

To approximate the annual expenditures listed above in Table 14, the annual expenditures are estimated to be 3 percent of the cost of a new facility for Alternative 0, and 2.0 Percent is estimated for Alternatives 1 and 2. The higher rate for Alternative 0 is assumed since significant initial improvements would not be completed as part of this alternative, leading to more expected maintenance required overall. Alternative 1 has a slightly higher rate for anticipated maintenance costs compared to Alternative 2 to account for recoating the existing concrete structures periodically over the next 50 years. This recoating effort is estimated to be $50,000 (2022 dollars), and would occur approximately once per 15 years; the effort is also assumed for Alternative 0 but not for Alternative 2.

6.3.3 Life-Cycle Costs

The initial capital costs are added to the maintenance costs presented above in Table 13 and Table 14, respectively, to determine the overall life-cycle cost for each alternative. Table 15 below summarizes the life-cycle costs associated with each alternative.

Table 15. Life-Cycle Costs for Headworks Improvements (2022 dollars)

WWTP Headworks	$15,553,000	$11,985,000	$14,282,000

6.3.4 Planning and Design Parameters

The planning and design parameters for improvements to the headworks include maintaining existing capacity, and equalization of the flow into the WWTP, as described in Section 6.1 of this report. Alternatives 1 and 2 satisfy both of these objectives, while Alternative 0 only maintains the existing capacity.

6.3.5 State Planning Priorities

Alternatives 1 and 2 considered for the headworks will adhere the same priorities as described for the force main improvements in Section 4 of this report and will assist in protecting the environment and promote public health and safety. The same cannot be said about Alternative 0.

6.3.6 Climate Change Consideration

The improvements considered for the headworks are not anticipated to have an appreciable impact on climate change.

6.3.7 Opportunities for Water and Energy Efficiency

The work included as part of Alternative 0 is not anticipated to offer opportunities to improve energy efficiency. Alternatives 1 and 2, however, would improve the District's energy efficiency related to operating the headworks facilities. The specific improvements that would help increase efficiency include the installation of VFDs, efficient motors, and more modern lighting. Additionally, pumping control strategies will be developed to optimize efficiency. No opportunities for increasing water efficiency are anticipated, since there are no major water uses related to the operation of the lift station facilities.

7.0 SELECTED PROJECT – FORCE MAIN

7.1 Recommended Project Alternative

As mentioned previously, Alternative 0 was dismissed since "no action" was not considered a viable option due to the susceptibility to liquefaction, age of the pipe and the potential for corrosion.

7.1.1 Rio Nido Force Main

Of the two viable alternatives, Alternative 1 was ultimately selected as the preferred alternative for the Rio Nido Force Main because it has a lower life-cycle cost. Considering the relatively short and straight alignment of the Rio Nido Force Main, lining most of the existing 8-inch diameter ductile iron pipe with CIPP liner and replacing the force main with HDPE pipe in place within the "High" liquefaction zone is recommended. The lack of horizontal and vertical 90-degree bends simplifies the installation of the liner and significantly diminishes the variables that can otherwise make CIPP impractical. Additionally, while a main concern with other locations of the Project is liquefaction susceptibility, the Rio Nido Force Main alignment is mostly classified as "Very Low" susceptibility with only a small portion near Rio Nido Road classified as "High". The combination of CIPP with open-cut replacement is also the lowest cost alternative. For these reasons, a fully structural CIPP liner with partial HDPE replacement is recommended for the Rio Nido Force Main repair.

7.1.2 Beanwood Force Main

Of the three viable alternatives, Alternative 2 was selected as the preferred alternative for the Beanwood Force Main. As discussed above, it is recommended to create a new alignment via open-cut construction and install DR17 HDPE from the Beanwood Lift Station, remaining on the west side of Highway 116 to Guerneville River Park. From that point, the existing pipe on the Guerneville Bridge would be replaced with a new pipe in same approximate location.

7.1.3 Main Force Main

Of the three viable alternatives for the Main Force Main, Alternative 2 was ultimately selected as the preferred alternative. Although this alternative has twice the life-cycle cost as the other alternatives, the combination of the various construction methods for Alternative 2 address the different constraints faced for each segment and the susceptibility to liquefaction during a seismic event. Alternative 1 was not selected because of the added construction risks associated with Segment 7 and the seismic risk within Segment 6. Alternative 3 was not selected due to the environmental process that would significantly increase force main failure risks as the construction schedule would be delayed at least one year. While considering the alternatives, an effort was made to consider a recommended pipe material. Material recommendations are based on the known soil conditions along Highway 116, in addition to the material proposed for the emergency replacement project in Vacation Beach.

The recommended repair method for each segment of force main from Main Lift Station to the WWTP is Alternative 1. This recommended repair is summarized as follows:

- Segment 1
  - Open-cut, R&R with 18-inch diameter DR17 HDPE
- Segment 2
  - Open-cut, R&R with 18-inch diameter DR17 HDPE

- Segment 3
    - Slipline the existing force main with 14-inch diameter DR17 HDPE (ID=12.25 inch)
- Segment 4
    - Open-cut, R&R with 18-inch diameter DR17 HDPE
- Segment 5
    - Open-cut, parallel alignment with 18-inch diameter DR17 HDPE
- Segment 6
    - Microtunneling; 60-inch diameter casing pipe sliplined with 18-inch diameter DR17 HDPE
- Segment 7
    - Open-cut, parallel alignment with 18-inch diameter DR17 HDPE

7.2 Design Criteria and Useful Life

Alternative 1 for the Rio Nido, Alternative 2 for Beanwood and Alternative 2 for Main Force Mains meet the design criteria outlined in the Sonoma Water Standards, including pipe size, pipeline minimum cover requirements, and pipe material. The HDPE material is not included in Sonoma Water Standards, but it has been previously approved. The useful life of the pipeline was assumed to be 50 years.

7.3 Life-Cycle Cost

The capital cost breakdown for Alternative 1 for the Rio Nido, Alternative 2 for Beanwood and Alternative 2 for Main Force Mains are shown in Table 4 and summarized in Table 16. The Force Main Project total capital cost is $23,357,900. The life-cycle cost breakdown for Alternative 1 for the Rio Nido, Beanwood and Main Force Mains are shown in Table 6 and summarized in Table 16. The Force Main Project total life-cycle cost is $50,795,800.

Table 16 Life-Cycle Cost for Recommended Force Main Improvements (2022 dollars)

Rio Nido	670,300	208,800	879,100
Beanwood	1,191,100	296,000	1,487,100
Main	21,595,300	3,476,400	25,071,700
Total:	**$23,456,700**	**$3,981,200**	**$27,437,900**

8.0 SELECTED PROJECT – LIFT STATIONS

8.1 Recommended Project Alternative

In general, it is recommended that the District complete the rehabilitation work associated with Alternative 1 for each lift station.

8.2 Design Criteria and Useful Life

For each of the lift stations considered, Alternative 1 meets the design criteria outlined in Section 5 of this report, including maintaining flow capacity, providing dedicated primary electrical utility service for each facility, and equalizing the flow being pumped into the WWTP.

The useful life of each lift station was assumed to be 50 years.

8.3 Life-Cycle Cost

The capital, maintenance, and life-cycle costs for the recommended improvements is summarized in Table 17. The Lift Station Project life-cycle cost is $71,111. While the overall life-cycle cost for Alternative 1 is very close Alternative 2, as indicated in Table 12 each lift station, Alternative 1 is preferable because the capital cost required for is approximately $2.6 million less than Alternative 2. Additionally, land/easement acquisition is not required to rehabilitate the facilities under Alternative 1, which would likely be required for several facilities under Alternative 2 because of the limited space on site and the need to keep facilities active throughout construction.

Table 17. Life-Cycle Costs for Recommended Lift Station Improvements (2022 dollars)

Rio Nido	1,164,000	3,081,000	4,245,000
Beanwood	1,727,000	4,679,000	6,406,000
Main	5,103,000	14,379,000	19,482,000
Drake's Estates	1,271,000	3,423,000	4,694,000
Drake Road	1,289,000	3,423,000	4,712,000
Watson	1,108,000	2,967,000	4,075,000
Laughlin	1,070,000	2,853,000	3,923,000
Guerneville	2,118,000	5,820,000	7,938,000
Guernewood Park	1,360,000	3,652,000	5,012,000
Center Way	1,243,000	3,309,000	4,552,000
Vacation Beach	1,621,000	4,451,000	6,072,000
Total:	**$19,074,000**	**$52,037,000**	**$71,111,000**

9.0 SELECTED PROJECT – HEADWORKS

9.1 Recommended Project Alternative

It is recommended that the District complete the rehabilitation work associated with Alternative 1. Selecting this alternative will ensure effective operation of the headworks facilities into the future with a lower risk of failure compared to Alternative 0 and with less overall costs compared to both Alternatives 0 and 2.

9.2 Design Criteria and Useful Life

Alternative 1 meets the design criteria for the headworks, outlined in Section 6 of this report, including maintaining flow capacity, and equalizing the flow being conveyed through the WWTP.

The useful life for the rehabilitated headworks facility was assumed to be 50 years.

9.3 Life-Cycle Cost

The capital, maintenance, and life-cycle costs for the recommended improvements is summarized in Table 18. The selected Headworks Project estimated life-cycle cost is $11,985,000.

Table 18. Life-Cycle Costs for Recommended Headworks Improvements (2022 dollars)

Facility	Capital Costs, dollars	Maintenance Costs, dollars	Life Cycle Costs, dollars
WWTP Headworks	$1,600,000	$10,385,000	$11,985,000

10.0 SUMMARY

10.1 Project Schedule

Table 19 shows the estimated design, bid, and construction schedule for the Project. This schedule could potentially be accelerated pending funding availability and conducting activities in parallel.

Table 19. Project Schedule

Task	Completion Date
Preliminary Design	December 2022
Complete Construction Application	June 2023
Final Design	August 2023
CEQA Documents Adopted by Board/Notice of Determination	August 2023
Federal Environmental Cross-Cutters	November 2023
Initial Financing Agreement by DFA CWSRF	January 2024
Bid Advertisement	February 2024
Final Budget Approval Package	March 2024
Contract Award	April 2024
Begin Construction	May 2024
Construction Completion	August 2026

10.2 Permits Required

The permits required for Alternative 1 of the Rio Nido, Alternative 2 of the Beanwood and Alternative 2 of the Main Force Mains include an encroachment permit from Caltrans, encroachment permit from Sonoma County, and access permits/easements for various parcels, including the Russian River Recreation and Parks District and private parcels. A National Pollutant Discharge and Elimination System permit will most likely be required due to the project size. This will be obtained by the contractor at the start of construction. A plan review meeting with the County, Caltrans and Recreation and Parks District will be held during the design phase and any requirements will be incorporated into the construction documents.

Depending on the extent of work at various lift stations that are within the public right-of-way, an encroachment permit from Sonoma County may be required. The need for this and other permits required for the lift station work will be determined during the environmental review process and during design.

10.3 Issues to be Resolved

Outstanding issues to be resolved prior to successful implementation include environmental review, geotechnical investigation, coordination with Caltrans and the County, and easement acquisition. These issues will be addressed during project design. Environmental review is in progress. A Geotechnical Investigation will determine more details for the construction method for the river crossings, including types of soils and preferred locations for the microtunneling shafts. Easement needs for the force mains are shown on Figure 2, Figure 4 and Figure 7.

10.4 Conclusion

Presented in Table 20 and Table 21 are the total project costs of the preferred alternatives for the force main, lift station, and headworks portions of the project. The grand total project capital cost is estimated to be $44,130,700.

Table 20 Total Cost for Recommended Project Improvements (2022 dollars)

Force Main	23,456,700	3,981,200	27,437,900
Lift Station	19,074,000	52,037,000	71,111,000
Headworks	1,600,000	10,385,000	11,985,000
Total:	**$44,130,700**	**$67,403,200**	**$110,533,900**

Table 21 Breakdown of Estimated Costs

Item	Description	Total, dollars
1	Force Mains	10,140,00
2	Lift Stations	8,250,000
3	Headworks	694,000
	Direct Cost	9,100,00
	Estimating Contingency – 20%	3,820,000
	Construction Contingency – 10%	1,910,000
	Total Construction Cost	**$28,000,000**
	Escalation to Midpoint of Construction, 5 percent per year	3,230,030
	Total Project Construction Cost – with Inflation	28,000,000
A	Construction Cost	28,000,000
B	Pre-Purchase Material / Equipment	
C	Purchase of Land/Easements	1,000,000
D	Change Order Contingency (10%)	2,800,400
E	Force Account	
F	Allowances (Soft Costs)	12,300,000
	Planning (10%)	2,800,000
	Design (15%)	4,210,000
	Construction Management (10%)	2,480,000
	Administration (10%)	2,800,000
	Total	**$44,130,000**

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