Prepared for: Bay Area Water Supply & Conservation Agency (BAWSCA), San Francisco Water Power Sewer, California Water Service Co., Redwood City, City of San Mateo, SVCW Silicon Valley Clean Water

July 2022

Potable Reuse Exploratory Plan (PREP) Title XVI Feasibility Study

DRAFT REPORT

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DRAFT
Potable Reuse Exploratory Plan (PREP)
Title XVI Feasibility Study

28 July 2022

Prepared for

Bay Area Water Supply and Conservation Agency
California Water Service Company
City of Redwood City
City of San Mateo
San Francisco Public Utilities Commission
Silicon Valley Clean Water

K/J Project No. 1668011*03

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Acknowledgments

This document has been prepared by Kennedy/Jenks Consultants, Inc. in close collaboration with the Potable Reuse Exploratory Plan (PREP) Parties, to submit to the U.S. Bureau of Reclamation for approval to be eligible to compete for Title XVI Program funding under section 4009(c) of the Water Infrastructure Improvements for the Nation (WIIN) Act. Eligibility is not assumed to be a guarantee of Federal Funding.

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Frequently Used Acronyms and Abbreviations

AS	activated sludge
ADWF	average dry weather flow
AF	acre-feet
AFY	acre-feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
AWS	alternative water supply
AWWA	American Water Works Association
BAC	biological activated carbon
BAF	biologically active filtration
BAWSCA	Bay Area Water Supply and Conservation Agency
BDPL	Bay Division Pipeline
BG	Bear Gulch
BMP	Best Management Practice
BNR	biological nutrient removal
BOD	biochemical oxygen demand
BOR	Bureau of Reclamation
Cal Water	California Water Service
CBOD	carbonaceous biochemical oxygen demand
CCF	Hundred Cubic Feet
CCR	California Code of Regulations
CCWD	Coastside County Water District
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CO_2	carbon dioxide
CSPS	Crystal Springs Pump Station
CSR	Crystal Spring Reservoir
CWA	Clean Water Act
DBP	disinfection by-product
DBPR	Disinfection Byproducts Rule
Dia	diameter
DiPRRA	Direct potable reuse responsible agency
DPR	direct potable reuse
DDW	(California) State Board Division of Drinking Water, also see SBDDW
EIR	Environmental Impact Report
US EPA	United States Environmental Protection Agency
FAT	full advanced treatment
FEF	Flow Equalization Facility
Ft	feet
GIS	Geographic Information System

GW	groundwater
HDPE	high density polyethylene
Hp	horsepower
Hwy	Highway
IAP	Independent Advisory Panel
IPaC	Information for Planning and Consultation
IPR	indirect potable reuse
JPA	Joint Powers Authority
LF	Lineal feet
LRC	log reduction credit
LRV	log removal value
M	million
Max	Maximum
MBR	Membrane bioreactor
MCL	Maximum contaminant limit
MF	microfiltration
mg/L	milligrams per liter
mgd	million gallons per day
MND	Mitigated Negative Declaration
MOU	Memorandum of Understanding
NDN	Nitrification/Denitrification
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NPR	Non-Potable Reuse
NTU	nephelometric turbidity unit
O&M	Operations and Maintenance
O_3	ozone
PREP	Potable Reuse Exploratory Plan
RWA	raw water augmentation
RO	reverse osmosis
ROW	right-of-way
RW	recycled water
ResWA	reservoir water augmentation
RWPS	Recycled Water Pump Station
RWQCB	Regional Water Quality Control Board or Regional Board
RWS	San Francisco Public Utilities Commission Hetch Hetchy Regional Water System
SBDDW	(California) State Board Division of Drinking Water, also see DDW
SF Bay	San Francisco Bay
SFPUC	San Francisco Public Utilities Commission
SHGCC	Sharon Heights Golf and Country Club
SRF	State Revolving Fund
SVCW	Silicon Valley Clean Water
	State Water Resources Control Board or State Board
SWTP	Surface Water Treatment Plant

TDH	Total Dynamic Head
TDS	total dissolved solids
TWA	Treated Water Augmentation
TM	Technical Memorandum
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TSS	Total suspended solids
UF	Ultrafiltration
USFWS	United States Fish and Wildlife Service
UV	Ultraviolet
UWMP	Urban Water Management Plan
Vol	Total volume of the reservoir
V/G/C	Virus, *Giardia*, and *Cryptosporidium*
WC	(California) Water Code
WBSD	West Bay Sanitary District
WDR	Waste Discharge Requirement
WRF	The Water Research Foundation
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

Executive Summary

Development of a Potable Reuse Exploratory Plan (PREP) is an effort initiated by the Bay Area Water Supply and Conservation Agency (BAWSCA), California Water Service (Cal Water), the San Francisco Public Utilities Commission (SFPUC), the City of Redwood City, the City of San Mateo, and Silicon Valley Clean Water (SVCW) (collectively referred to as the PREP parties), to study potable reuse opportunities in the Mid-Peninsula region. Together, the PREP parties recognize that regional collaboration offers opportunities to address multiple water supply and wastewater challenges, while realizing the benefits of shared infrastructure, asset recovery, economies of scale, and a more competitive strategy to pursue funding, in addition to enhancing regional self-reliance through integrated water management.

ES.1 A Phased Approach to Exploring Potable Reuse Opportunities

Development of a Potable Reuse Exploratory Plan (PREP) is a regional effort to study potable reuse opportunities in the San Francisco Mid-Peninsula region.

- PREP Phase 1 began in 2016, to explore a wide range of potable reuse concepts in the region, including a preliminary screening of groundwater replenishment and augmentation of local reservoirs.
- PREP Phase 2 continued in 2018, the focus of which was to further define the concept of reservoir augmentation Crystal Springs Reservoir (CSR) and to explore institutional considerations for implementation of a regional potable reuse program.
- PREP Phase 3 began in 2020 to further evaluate reservoir augmentation at CSR and explore more direct form of augmentation into the drinking water system.

The purpose of this Title XVI Feasibility Study is to identify a preferred project and a path forward for implementing potable reuse in the Mid-Peninsula region.

ES.2 Project Need

The development of new, local drought-resilient water supplies is needed by the PREP Parties to:

1. Enhance local water supply reliability and resiliency for water providers on the San Francisco Peninsula to prepare for the unpredictability of climate change.
2. Reduce wastewater discharge to the San Francisco Bay, helping communities use locally treated wastewater more efficiently and prevent water from becoming a lost resource.
3. Create a multi-agency project with multiple economic, environmental, and social benefits that supports and leverages a multi-barrier approach to resource planning.

In addition, the intensified effects of climate change are becoming evident through California as the State has been experiencing consecutive years of drought and consistent higher-than-average temperatures. These dramatic climate shifts are further stressing water reservoirs and changing demands for residential, agricultural, and commercial water use.

The PREP Parties seek to use multi-agency involvement to find broad mutual benefits and identify alternatives that address regional water supply and discharge challenges through maximizing utility of the available recycled water supplies, to provide a local, drought-resistant, sustainable water supply that benefits the environment and communities in the region.

ES.3 Project Reuse Concepts

The majority of the water supply to the study area is provided by SFPUC's Hetch Hetchy Regional Water System (RWS), which consists of a complex series of reservoirs, tunnels, pipelines, pump stations, and treatment plants to deliver water from the Sierra Nevada and SF Bay Area watersheds to four counties in the SF Bay Area. The water agencies that could potentially receive purified water include SFPUC, Cal Water, the City of Redwood City,the EMID, and Mid-Peninsula Water District.

The potable reuse concepts considered as part of this Title XVI Feasibility Study include:

(1) **Reservoir Water Augmentation (ResWA)** project that purifies water from local wastewater facilities and conveys the purified water to CSR, where it would comingle with water from SFPUC's Hetch Hetchy Regional Water System (RWS) and becomes part of the SF Bay Area water supply.
(2) **Raw Water Augmentation (RWA)** project that purifies water from local wastewater facilities and conveys the purified water to a small reservoir, which would not meet ResWA regulatory requirements, where it would comingle with runoff and streamflow diversions, be treated at a local drinking water treatment plant, and becomes part of the local potable water distribution system.
(3) **Treated Water Augmentation (TWA)** project that purifies water from local wastewater facilities and conveys the purified water to the local potable water distribution system via an existing treated water reservoir or transmission main.

The project area and concepts are illustrated in Figure ES-1.

Benefits of Regional Collaboration Developing a new drought-resistant, local water supply would help address water supply shortfalls during droughts to protect the environment, the quality of life within the local community, and the vital regional economy.

Figure ES-1: Overview of Potential PREP Project Concepts

Various potable reuse alternatives have been developed and evaluated through a collaborative, stakeholder-driven process. In general, source water from (1) tertiary effluent from the SVCW facility and/or (2) tertiary effluent from the San Mateo Wastewater Treatment Plant (WWTP) would undergo additional treatment at a new advanced water purification facility (AWPF) and purified water produced by the AWPF would be conveyed to its place of use.

The proposed AWPF train would consist of low-pressure membrane filtration via microfiltration (MF) or ultrafiltration (UF) as pretreatment prior to reverse osmosis (RO), followed by an ultra-violet light advanced oxidation process (UV-AOP). This combination of treatment processes is assumed to be sufficient for an indirect potable reuse (IPR) project via ResWA, though it is recognized that additional treatment steps may be required based on site specific conditions. Based on the current regulatory thinking, direct potable reuse (DPR) via RWA and TWA would require additional treatment steps, including ozone and biologically activated carbon (BAC), to provide additional log reduction credits (LRCs) to meet the regulatory requirements discussed below. Reject water from the RO membrane, herein referred to as the RO concentrate, would be discharged via connection to an existing outfall to the San Francisco Bay. Purified water would be conveyed indirectly or directly to drinking water users through existing potable water distribution systems.

SVCW currently produces tertiary-treated disinfected recycled water that meets the standards specified in Title 22 of the California Code of Regulations (CCR) for unrestricted non-potable use. Recycled water from SVCW has been used by Redwood City's Recycled Water Program since 2000. Tertiary effluent produced at the San Mateo WWTP will meet Title 22 criteria in 2024 when upgrades to the facility are completed. There are currently no plans by Cal Water's Bayshore District nor the Estero Municipal Improvement District (EMID) to use recycled water supplies.

ES.4 Meeting Regulatory Requirements

ResWA Regulations

The final ResWA regulations, adopted by the State Water Resource Control Board – Division of Drinking Water (DDW) on March 6, 2018, include minimum retention time and dilution requirements:

1. An initial reservoir retention time of 180 days must be demonstrated, with flexibility for an alternative minimum theoretical retention time as low as 60 days on a case-by-case basis with State Board approval. ResWA projects with minimum retention times of less than 120 days must provide an additional 1-log treatment.
2. The dilution requirement in the reservoir is 100:1 (one percent by volume), or 10:1 (ten percent by volume) with an additional 1-log microbial pathogen treatment, to demonstrate the percent of recycled water withdrawn from the reservoir, by volume, during any 24-hour period.

A reservoir operations model (ROM) was developed, which calculated the ability of CSR to meet regulatory requirements for dilution and retention. The results show that the 10:1 minimum dilution and 100:1 preferred dilution criteria are always met.

The retention time evaluation found that the 2-month minimum and 6-month preferred retention requirements can typically be met, except during extreme consecutive wet years, where high outflows to meet the water surface elevation requirements in the reservoir to protect the fountain thistle plant may result in a retention time less than 2-months. Implementation of a ResWA project may require modifications to RWS operations to maintain a retention time of 6-months, while adhering to other reservoir operation requirements, such as meeting required water surface elevations for the fountain thistle. Future studies will need to identify operational practices to avoid dipping below the 6-month minimum. Based on the worst-case historical scenario, in no case would the retention time go below 2 months.

Demonstrated hydrodynamic modeling and tracer studies would need to be conducted as part of the next steps to simulate, then validate, ResWA assumptions. The proposed MF/RO/UV-AOP treatment train should be able to achieve the 9/8/9 removal requirements for virus, *Giardia*, and *Cryptosporidium* (V/G/C), based on a retention time of less than 120 days and dilution ratio of 100:1, though the ultimate inactivation credit achieved for a given process may be based on site-specific performance and/or a validation approach with DDW, determined on a case-by-case basis (WateReuse 2016).

Other CSR Augmentation Considerations

Any discharges into CSR would not only need to comply with ResWA requirements but would also need to meet local SF Bay Basin Plan requirements and match or be compatible with background water quality concentrations in CSR:

- Ammonia concentrations are controlled by the SF Basin Plan limits, and
- Phosphorus concentrations are controlled by the background concentrations in Upper CSR.

Based on the initial analysis, additional treatment would likely be required to reduce nutrient concentrations prior to release into CSR. For this study, it is assumed breakpoint chlorination would be implemented on the purified water to remove ammonia. Phosphorus limits are assumed to be controlled by background CSR concentrations, since there are no Basin Plan limits, but anti-degradation provisions would apply. Thus, the need for phosphorus removal may need to be further evaluated in a future study.

It should be noted that CSR augmentation would provide drought-year benefits by increasing locally sustainable water supplies, reducing imported water demands and maintaining environmental flows in drought stressed rivers and streams. In addition, should the Bay-Delta Plan Amendment be implemented (see Appendix A.1.3), potential instream flow requirements would increase. Hence, this project would help supplement supplies needed in single or multiple dry years.

SFPUC would not be able to provide year-round storage in CSR without modifications to the current operational strategy of the RWS. Impacts to RWS deliveries to accommodate at ResWA project were not evaluated as part of this Study.

RWA and TWA Regulations

The draft DPR regulations currently impose the same requirements for both RWA and TWA projects. The draft DPR regulations require the designation of one direct potable reuse responsible agency (DiPRRA) that will be responsible for complying with the DPR regulations. The criteria currently include a minimum microbial log-removal value (LRV) requirement of 20/14/15 for virus, *Giardia*, and *Cryptosporidium* (V/G/C), which must be achieved using multiple treatment processes, providing multi-barrier protection. As noted earlier, inclusion of an ozone/BAC process prior to the RO/AOP process will likely be required. However, if there is sufficient blending of wastewater with other water (e.g., potable water or raw water) to dilute wastewater contaminants, ozone/BAC may not be necessary. Similar to the final ResWAregulations, the draft DPR criteria includes an alternative clause that allows for an alternative to these stipulated treatment requirements. In addition to the treatment requirements for DPR regulations, drinking water distribution system requirements will also need to be met. These include but are not limited to the lead and copper rule, total coliform rule, surface water treatment rule, disinfectants and disinfection byproduct rules (DBPR) and other regulations governing distribution systems.

The DiPRRA is required to work collaboratively with the public water system receiving purified water to jointly address potential impacts resulting from the introduction of advanced treated water into a water treatment plant and/or introduction of finished water into a drinking water distribution system and submit necessary plans and reports.

Bay Discharge Requirements

The RO concentrate disposal via the SVCW or San Mateo outfall would need to meet existing and future regulations to the San Francisco Bay (SF Bay), which is regulated under three Waste Discharge Requirements (WDRs) and wastewater National Pollutant Discharge Elimination System (NPDES) permits:

(1) SVCW Individual WDR,
(2) San Mateo WWTP individual WDR,
(3) SF Bay Watershed WDR for mercury and PCBs and
(4) SF Bay Watershed WDR for nutrients.

This study looked at anticipated water quality from the average monthly RO concentrate (from a 6 mgd and 12 mgd AWPF) combined with the tertiary effluent discharge remaining in SVCW's outfall for dilution to identify parameters that limit disposal to the SF Bay. This study also looked at anticipated water quality from the average monthly RO concentrate (from a 6 mgd AWPF) combined with the tertiary effluent discharge remaining in the San Mateo WWTP's outfall for dilution to identify parameters that limit disposal to the SF Bay.

In both cases, it was found that the combined discharge would not impact the ability to meet load or mass-based limits, but concentration-based limits may require dilution with tertiary effluent or additional treatment to meet certain targets (e.g., toxicity and ammonia). Given the high-level of analysis performed as part of this study, a more detailed analysis of water quality is warranted in future phases.

ES.5 Alternatives Evaluation to Compare Project Capacities, Source Waters and Place of Use

Five potable reuse alternatives are evaluated to determine the selection of the Proposed Title XVI Project that could be implemented by the PREP Parties:

- **Alternative 1:** 6-mgd ResWA in Crystal Springs Reservoir
- **Alternative 2:** 12-mgd ResWA in Crystal Springs Reservoir
- **Alternative 3:** 6-mgd RWA in Bear Gulch Reservoir
- **Alternative 4:** 6-mgd TWA on the San Francisco Mid-Peninsula
- **Alternative 5:** 12-mgd TWA on the San Francisco Mid-Peninsula

Sub-alternatives were also developed to present variations in source water and conveyance alignments. Each alternative would serve to meet the project objectives to improve local water supply reliability and drought resilience and reduce discharges to the SF Bay. Two hydrologic flow regimes, representing a 6-year drought and 6-year normal/wet period, are used to evaluate available storage in the RWS for purified water augmentation and potable water demands during dry and wet periods.

Conveyance is a critical component of any recycled water system and often accounts for a significant percentage of capital costs for a project. All potable reuse alternatives would involve conveyance of:

1. Tertiary recycled water from SVCW and/or San Mateo at a new AWPF
2. Purified water from the new AWPF to place of use for augmentation.
3. RO concentrate from the new AWPF to an existing outfall to the SF Bay
4. Repurposing existing infrastructure, such as abandoned pipelines, if available.

ResWA Operational Considerations

Reservoir operational considerations for CSR are assessed using existing water supply models used to simulate operations of the RWS and given implementation of a ResWA project. A CSR Reservoir Operations Model (CSR ROM) is developed to:

1) Estimate the available storage in the RWS and the amount of Hetch Hetchy water that would "spill" in the upcountry system as a result of purified water addition to CSR, and
2) Simulate how a potable reuse project that introduces purified water into CSR would meet ResWA regulatory requirements for retention and dilution.

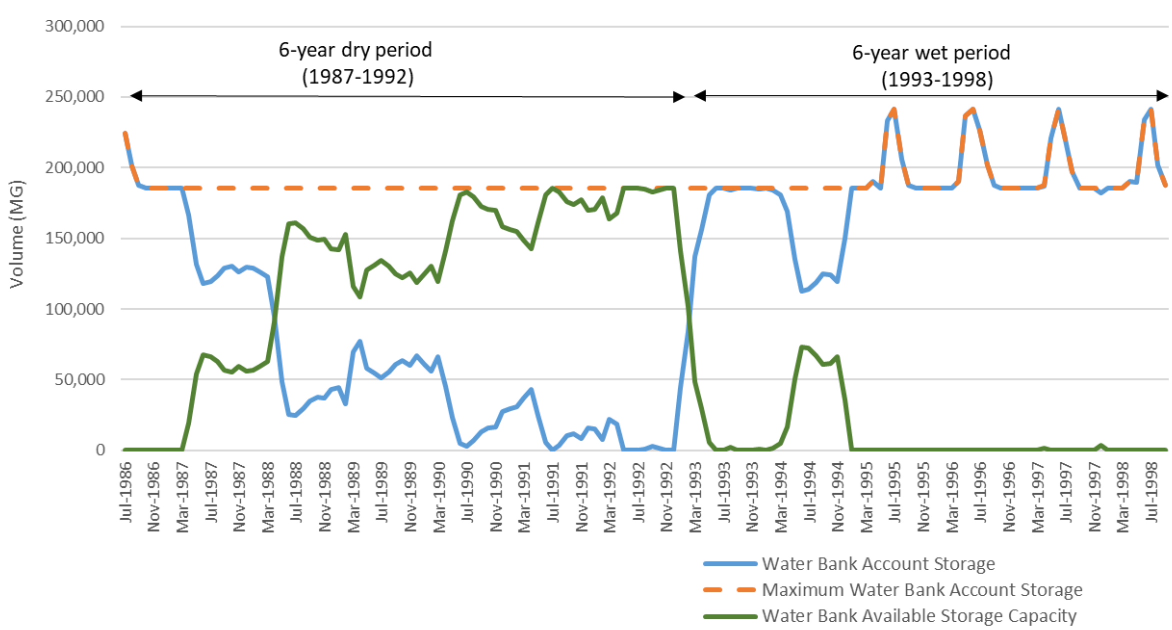
Reservoir augmentation operational scenarios were evaluated to assess the impact of continuous versus seasonal augmentation with purified water, to calculate how reduced production of purified water would reduce the amount of spill from the RWS during wet years to make room for purified water.

The Water Bank storage, which is essentially a storage account for the RWS, under historical operations is illustrated in Figure ES-2. The orange line represents the maximum volume that the Water Bank can store, and the blue line represents the simulated storage in the Water Bank for the 1987-1998 period, which includes the two distinct hydrologic flow regimes.

- During wet years (1993 – 1998) when the Water Bank is primarily full (e.g., there is no additional storage capacity remaining in the water bank), there is no additional storage capacity in the RWS to absorb a new water supply.
- During dry years (1987-1992) the Water Bank has available capacity, and RWS water supply in storage can be augmented if a new water supply is added to the system

The difference between the orange and blue lines in Figure ES-2 reflects the Water Bank account balance (green line), which is the storage volume available to accommodate any water displaced from Crystal Springs or San Andreas Reservoir for purified water as part of a ResWA project.

Figure ES-2: Overview of Water Bank Storage for Historical Operations



The underlying assumption of the CSR ROM is that CSR is maintained full by SFPUC at seasonal target levels, and that there is no physical room in the reservoir to accommodate purified water from the AWPF unless there is additional storage available in the greater RWS system. If the Water Bank storage is full, an equivalent amount of water would have to be "displaced" from the reservoir system to make room for purified water. This displacement would materialize as an upcountry "spill" from the Water Bank because water from the Upcountry system that would have been sent to Crystal Springs is not needed due to the addition of water from the AWPF. So that water remains Upcountry instead, and spills from a full system.

The CSR ROM simulated six sub-alternatives:

- **Alternative 1a/b:** 6-mgd ResWA with continuous operation of AWPF for all years
- **Alternative 1c:** 6-mgd ResWA with seasonal ramp down to 3 mgd in winter months of wet years
- **Alternative 1d:** 6-mgd ResWA with seasonal shutdown to 0 mgd in winter months of wet years
- **Alternative 2a/b:** 12-mgd ResWA with continuous operation of AWPF for all years
- **Alternative 2c:** 12-mgd ResWA with seasonal ramp down to 6 mgd in winter months of wet years
- **Alternative 2d:** 12-mgd ResWA with seasonal shutdown to 0 mgd in winter months of wet years

The CSR ROM analysis found that ramp down operations in wet months of wet years results in a 12.5 percent reduction in purified water deliveries over the 12-year period and shutdown operation in wet months of wet years results in 25 percent reduction in purified water deliveries over the 12-year period. The "spill" analysis found that during most of the dry years, there is generally enough empty storage available for both the 6 mgd and 12 mgd alternatives without creating additional spill. During wet years, when there is less available storage, the addition of purified water results in a small amount of incremental spill relative to the total system baseline spill to make room for storage of purified water.

RWA Operational Considerations

A Bear Gulch Reservoir Operations Model (BG ROM) was developed as a monthly time-step model, with similar operational considerations that were taken into account for the CSR ROM. Historically, the filter plant at Bear Gulch has been operated at partial capacity during wet periods, when local diversions are used to fill the reservoir. To implement a RWA project, the filter plant would be continuously operated at the full capacity (6 mgd) to utilize the augmented purified water. This change in operational practices would require significant upgrades to the treatment plant and reservoir, The BG ROM simulated two sub-alternatives:

- **Alternative 3a:** 6-mgd RWA with continuous operation (year-round), without local streamflow diversions. This alternative would maximize reuse of purified water and could provide an opportunity for other downstream uses of local streamflow.
- **Alternative 3b:** RWA with ramped down operation in winter months to allow local streamflow diversions. Ramping down purified water production would allow historical diversions to continue. Ramping down purified water production to 5 mgd for the 6-year dry period, and 4 mgd for the 6-year wet period, provides space in the reservoir to accommodate 78 percent and 84 percent of historical diversions during dry- and wet-periods, respectively.

Displacing RWS demands, by CalWater – Bear Gulch service area customers, with purified water may result in a "spill" from the RWS similar that which would occur when augmenting CSR, though the impact may only appear as an indirect impact, since it would not directly utilize RWS storage reservoirs.

TWA Operational Considerations

The direct augmentation of purified water, downstream of a treatment plant, considered points of connections directly into the drinking water distribution system using existing storage tanks and transmission pipelines. Several potential TWA points of connection exist in the project vicinity, including Redwood City's and Foster City's storage tanks and CalWater pipelines. To meet the expected flows from the alternatives, multiple tie-in locations to the drinking water distribution system would be needed.

The operational considerations for TWA assumed continuous augmentation of the drinking water system with purified water. Retail water demands and RWS purchases by drinking water suppliers were considered, such that the amount of purified water to augment each system was less than the average day demand during the winter of the 6-year wet period, representing the most conservative example of the lowest demand. The analysis also considered the size of available storage tanks and pipeline capacities. Future studies will further explore and model boundary conditions for augmenting each drinking water system, to further define flow restrictions, infrastructure requirements and operational limitations.

Summary of Alternatives

Table ES-1 provides an overview of alternatives and operational scenarios. Maps for the alternatives are presented in Figures ES-3 to ES-11.

Table ES-1: Overview of Alternatives and Operational Scenarios

Alt	Description	Source Water	Drinking Water System[1]	Ave Annual Water Deliveries (mgd)	Ave Annual Water Deliveries (AFY)
ALTERNATIVE 1 – Reservoir Water Augmentation | 6 mgd to Crystal Springs Reservoir					
1a	ResWA with AWPF near SVCW (continuous operation)	SVCW	SFPUC (CSR)	6	6,720
1b	ResWA with AWPF Hwy 101 Site (continuous operation)	SVCW	SFPUC (CSR)	6	6,720
1c	ResWA with AWPF near SVCW (seasonal ramp down in wet years)	SVCW	SFPUC (CSR)	5.25	5,880
1d	ResWA with AWPF near SVCW (seasonal shutdown in wet years)	SVCW	SFPUC (CSR)	4.5	5,040
ALTERNATIVE 2 – Reservoir Water Augmentation | 12 mgd to Crystal Springs Reservoir					
2a	ResWA with AWPF near SVCW (continuous operation)	SVCW + San Mateo	SFPUC (CSR)	12	13,440
2b	ResWA with AWPF Hwy 101 Site (continuous operation)	SVCW + San Mateo	SFPUC (CSR)	12	13,440
2c	ResWA with AWPF near SVCW (seasonal ramp down in wet years)	SVCW + San Mateo	SFPUC (CSR)	10.5	11,760
2d	ResWA with AWPF near SVCW (seasonal shutdown in wet years)	SVCW + San Mateo	SFPUC (CSR)	9	10,080
ALTERNATIVE 3 – Direct Potable Reuse | 6 mgd Raw Water Augmentation					
3a	RWA at Bear Gulch Reservoir w/ continuous operation	SVCW	Cal Water (BG)	6	6,720
3b	RWA at Bear Gulch Reservoir (seasonal ramp down in all years)	SVCW	Cal Water (BG)	5.25	5,880
ALTERNATIVE 4 – Direct Potable Reuse | 6 mgd Treated Water Augmentation					
4a	TWA with AWPF near SVCW for Local Use	SVCW	Redwood City + Cal Water (SC)	6	6,720
4b	TWA with AWPF at Hwy 101 Site for Local Use	SVCW	Redwood City + Cal Water (SC)	6	6,720
4c	TWA with AWPF near San Mateo WWTP for Local Use	San Mateo	Foster City + Cal Water (SM)	6	6,720
ALTERNATIVE 5 – Direct Potable Reuse | 12 mgd Treated Water Augmentation					
5	TWA with AWPF at Hwy 101 Site for Local Use	SVCW + San Mateo	Redwood City + Cal Water (SC and SM)	12	13,440

[1] CSR = SFPUC customers served via Harry Tracy WTP, BG = Bear Gulch Division customers, SC = San Carlos Division customers, SM = San Mateo Division customers

Figure ES-3: Alternative 1A, 1C and 1D – Reservoir Water Augmentation at Crystal Springs/San Andres Reservoirs (6 MGD)

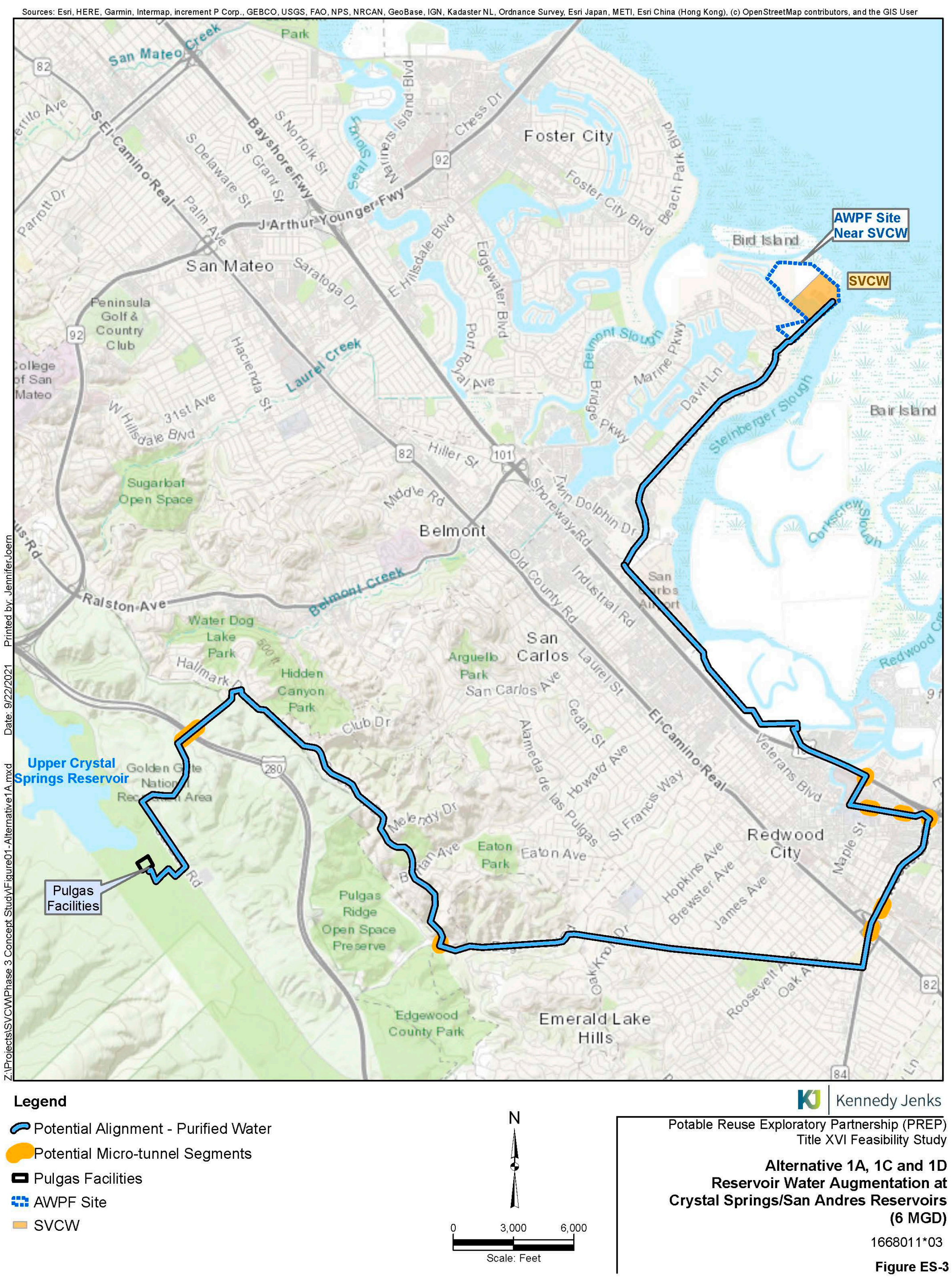


Figure ES-4: Alternative 1B – Reservoir Water Augmentation at Crystal Springs/San Andres Reservoirs (6 MGD)

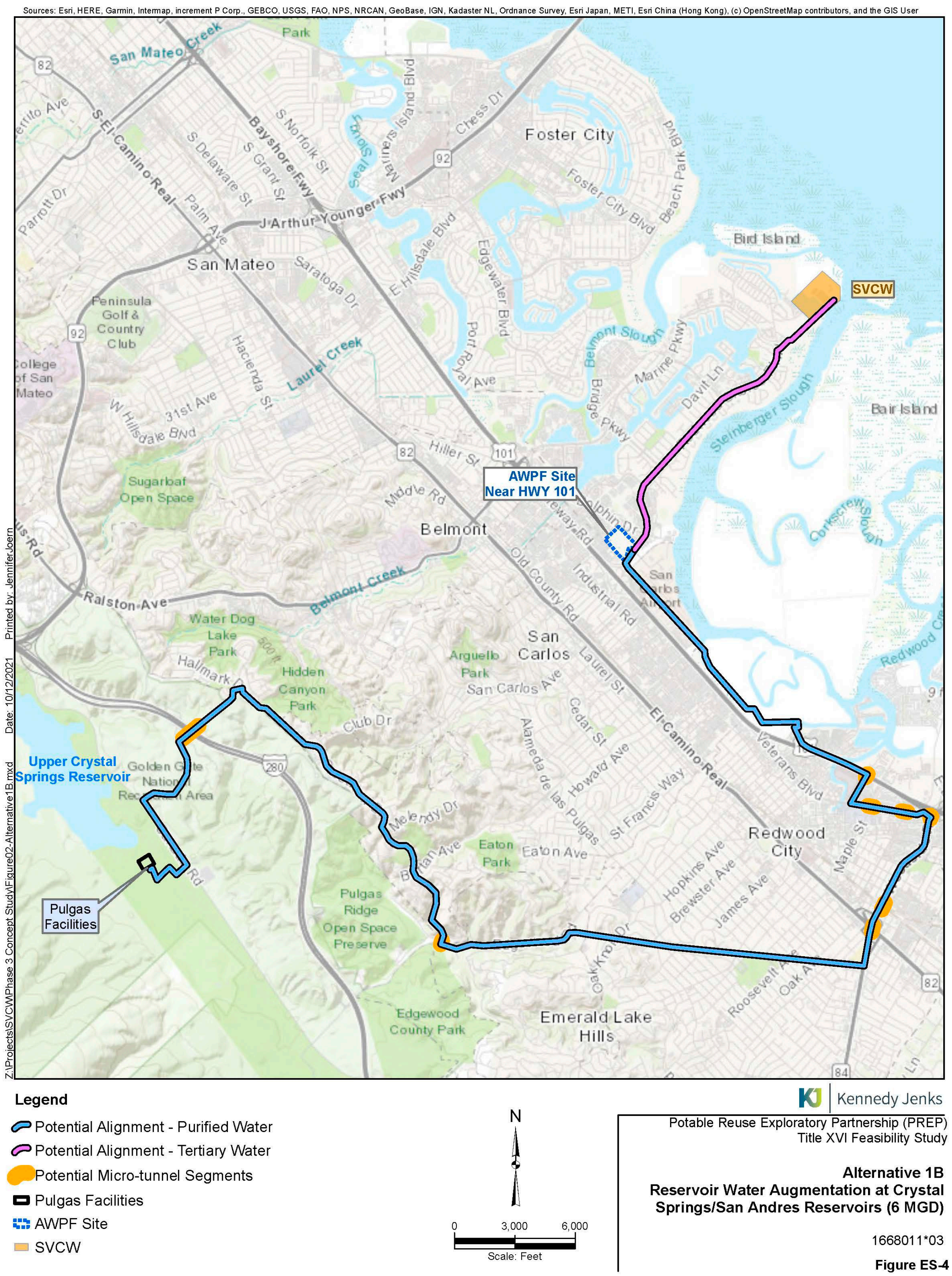


Figure ES-5: Alternative 2A, 2C and 2D – Reservoir Water Augmentation at Crystal Springs/San Andres Reservoirs (12 MGD)

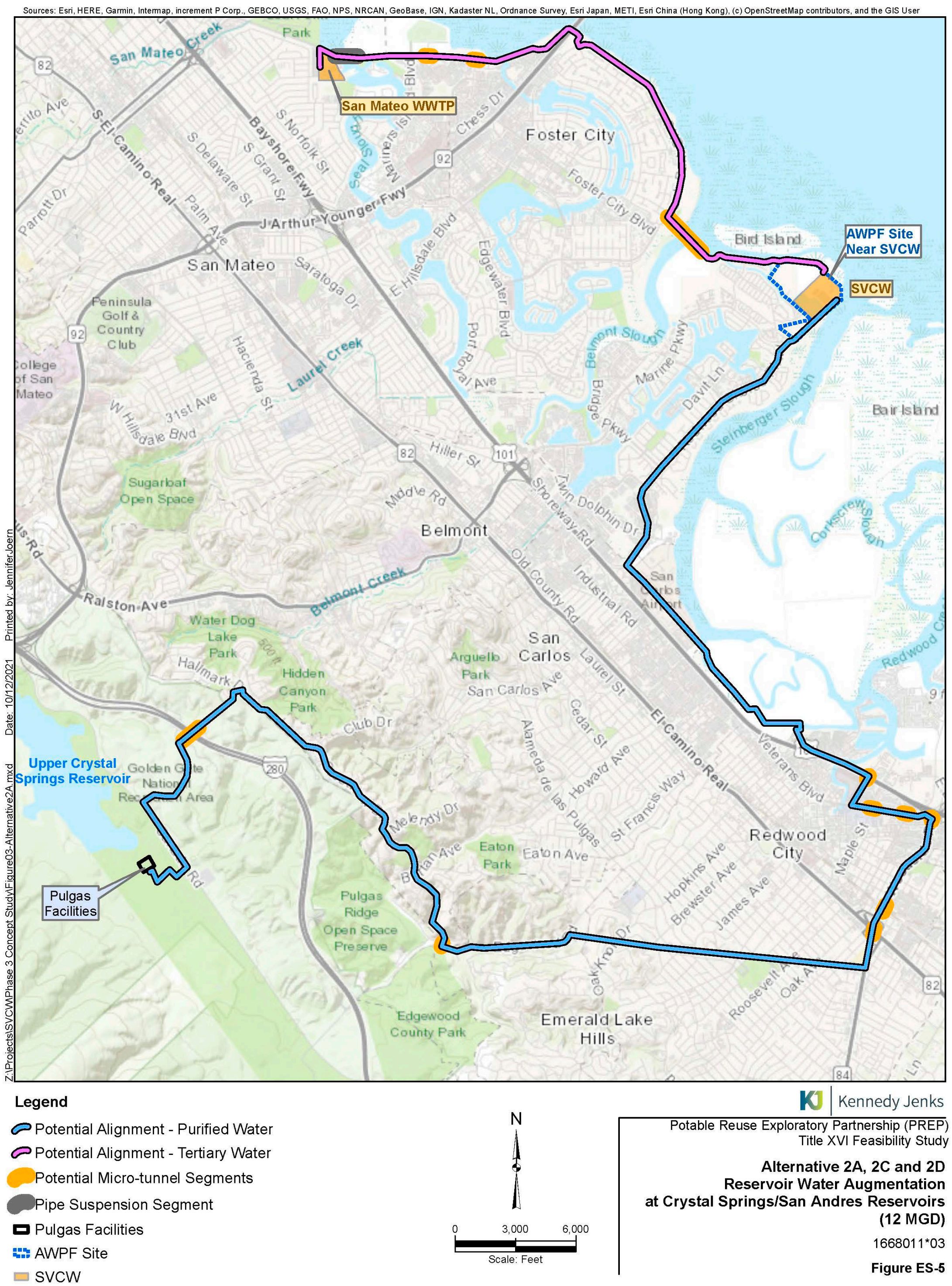


Figure ES-6: Alternative 2B – Reservoir Water Augmentation at Crystal Springs/San Andres Reservoirs (12 MGD)

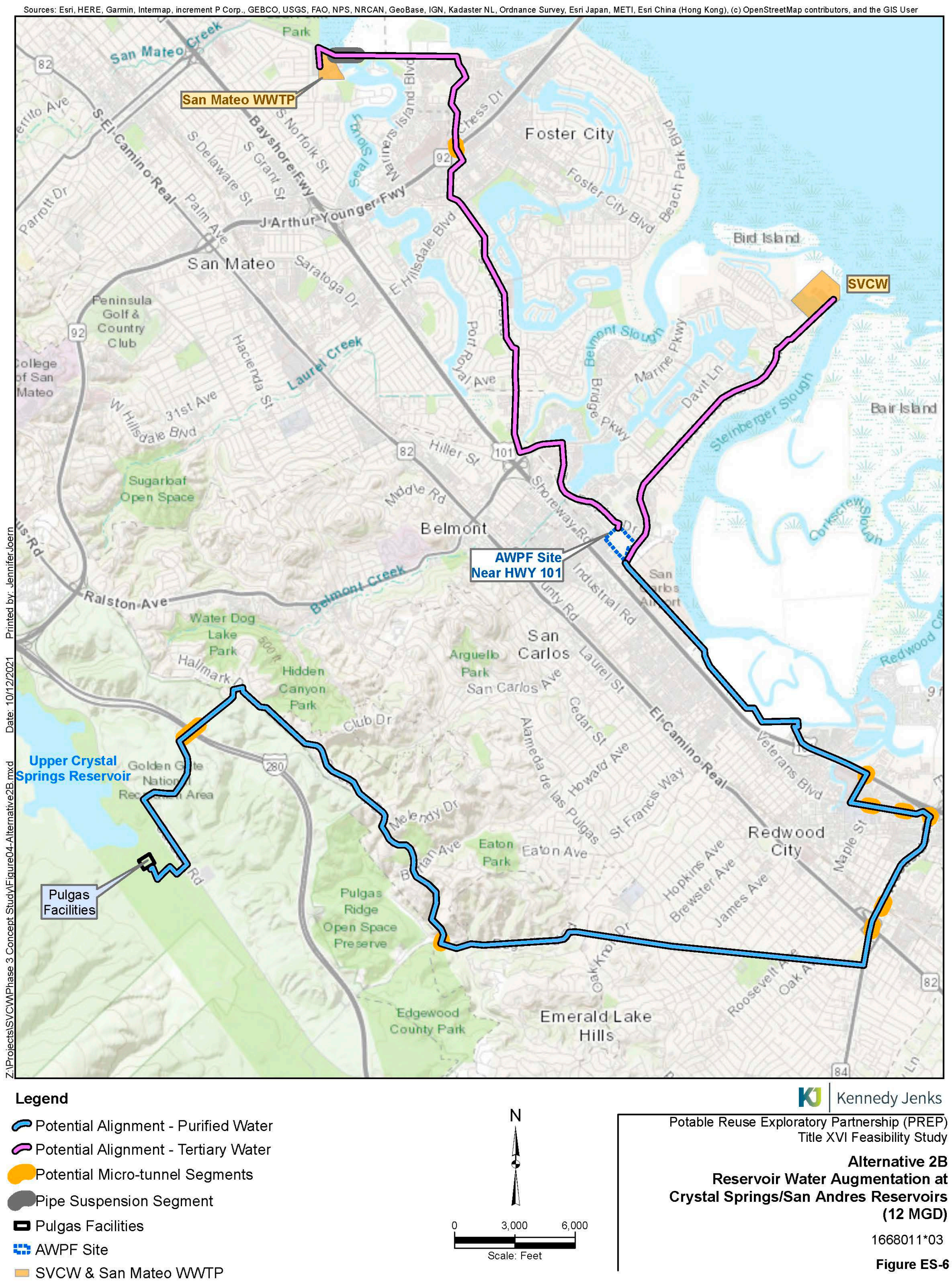
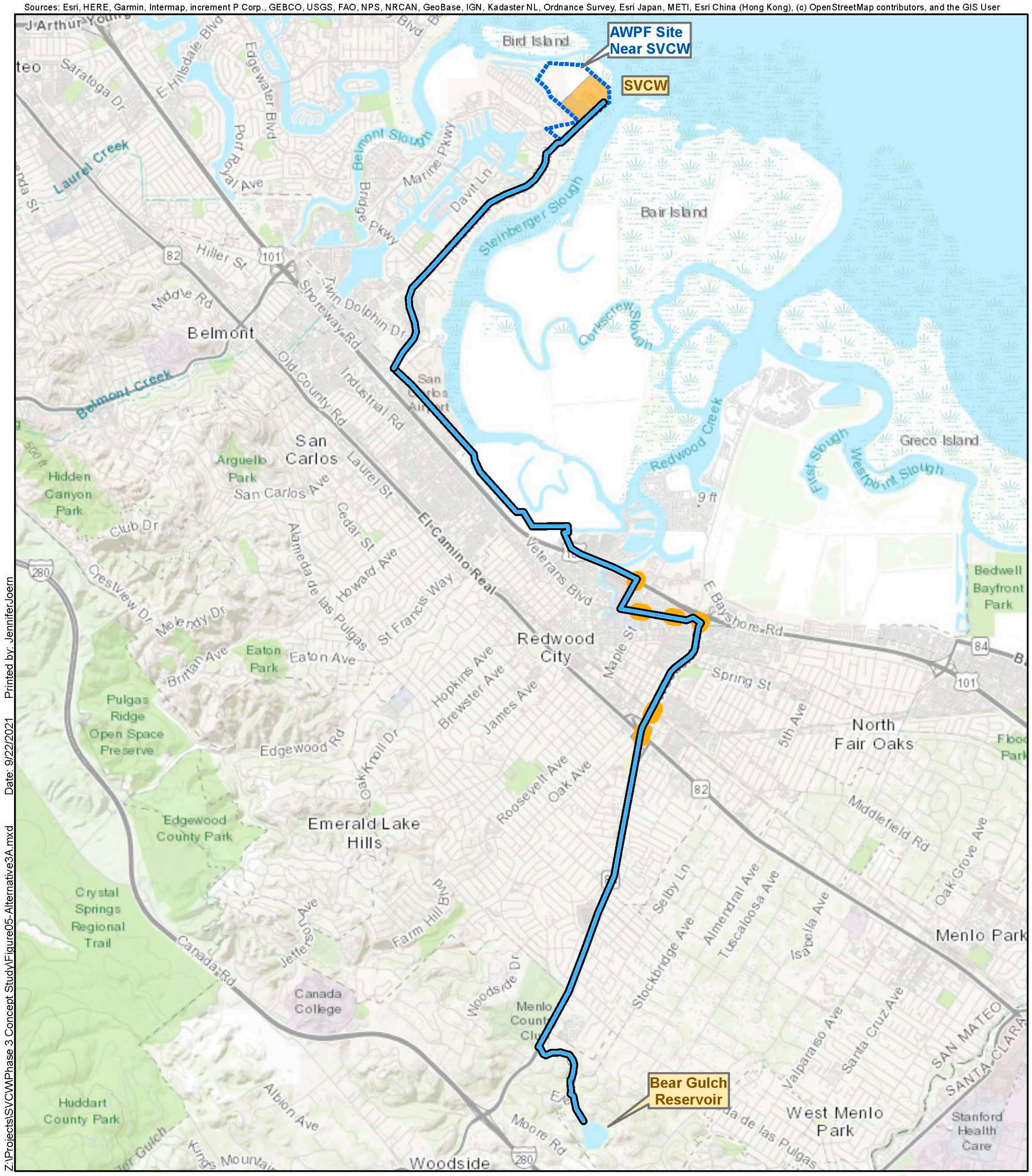


Figure ES-7: Alternative 3A and 3B – Raw Water Augmentation at Bear Gulch Reservoir (6 MGD)

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User



Legend

- Potential Alignment - Purified Water
- Potential Micro-tunnel Segments
- AWPF Site
- SVCW

N

0 3,250 6,500

Scale: Feet

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Alternative 3A and 3B
Raw Water Augmentation at Bear Gulch Reservoir (6 MGD)

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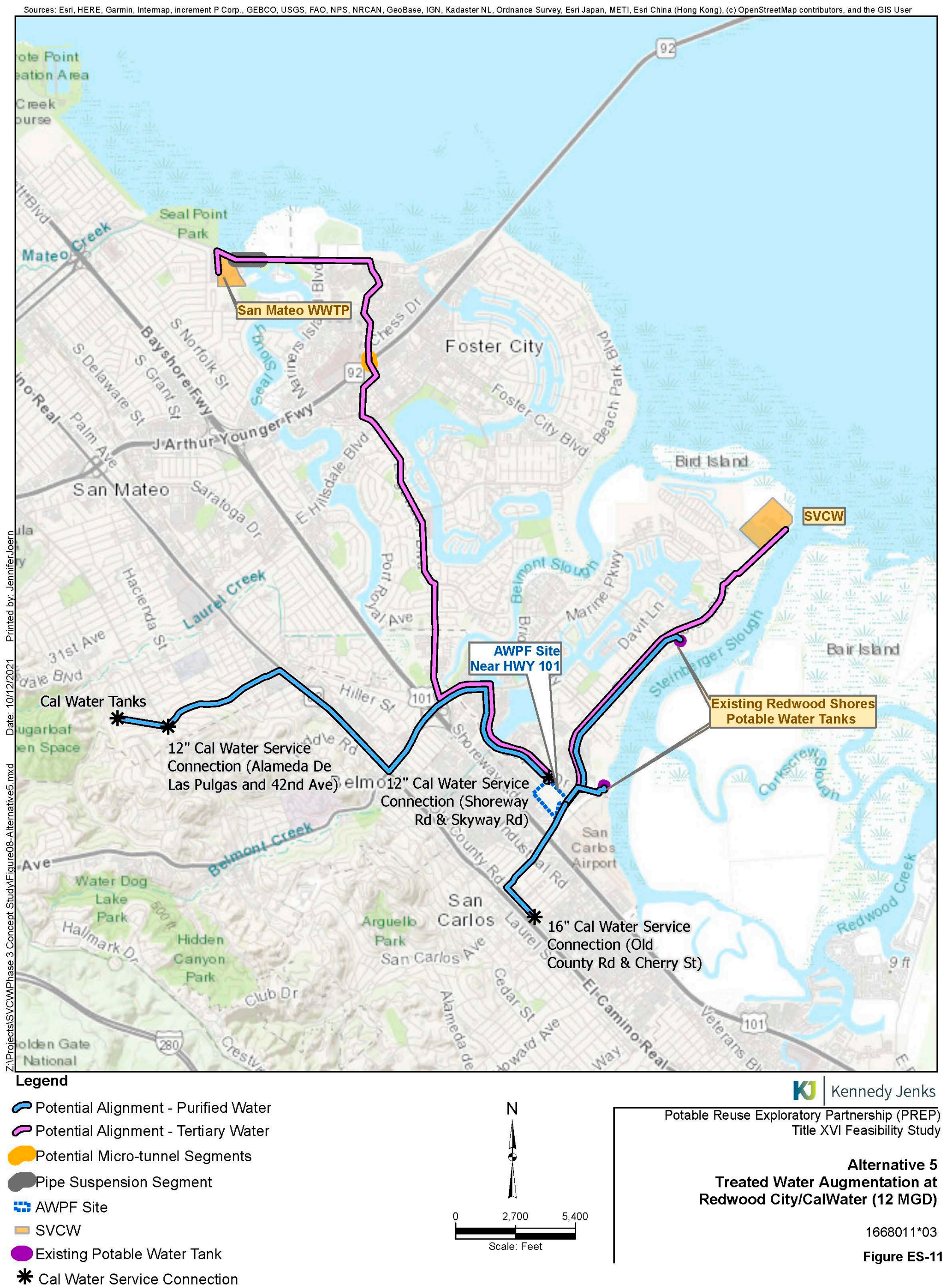
Figure ES-7

Figure ES-8: Alternative 4A – Treated Water Augmentation at Redwood City/CalWater (6 MGD)

Figure ES-9: Alternative 4b – Treated Water Augmentation at Redwood City/CalWater (6 MGD)

Figure ES-10: Alternative 4C – Treated Water Augmentation at Foster City/CalWater (6 MGD)

Figure ES-11: Alternative 5 – Treated Water Augmentation at Redwood City/CalWater (12 MGD)



ES.6 Economic Analysis

An engineer's opinion or probable cost was generated based on the engineering work to allow for an economic and financial analysis of the project alternatives. Costs are broken down for capital and operation and maintenance (O&M) costs in accordance with Title XVI guidelines. Annualized capital costs, annual O&M costs and average project yields are used to estimate the anticipated unit life cycle cost of each project alternative to compare project alternatives. Table ES-2 summarizes the conceptual-level estimate of direct costs to implement the potable reuse alternatives. Key assumptions are as follows:

- Construction costs shown represent loaded facility costs for treatment, pipelines, pump stations, storage tanks, and other facilities necessary to develop each project, including taxes, allowances, contingencies, and escalation to an estimated midpoint of construction.
- Some costs are excluded from the estimate, due to the need for additional information, studies and in many cases, negotiated agreements to provide a reasonable or justifiable unit cost estimate. Excluded costs include land acquisition, reuse of Redwood City facilities, use of SFPUC Pulgas facilities and right-of-ways (ROWs), and future studies.
- Repurposing existing infrastructure was assumed, where possible based on discussion with the PREP Parties, to reduce community disruption during construction and avoid utility conflicts.
- Annual operations and maintenance (O&M) costs include energy, labor, chemicals, maintenance, and repair.
- Unit life cycle costs represent annualized construction costs plus O&M costs divided by the recycled water delivered over the life of the project to obtain a uniformly derived unit cost per volume of water delivered.
- Cost ranges shown represent variations due to the location of the AWPF, pipeline alignments, and pumping requirements.
- A specific monetary value or cost for source water is not included.
- Future studies are needed to assess the full range of conveyance options including the condition of existing assets, availability of ROWs and land for acquisition, subterranean conditions, existing utilities, hydraulic requirements, environmental impacts, alternative alignments, and community outreach.

Table ES-2: Summary of Estimated Probable Costs of Alternatives 1 to 5 (2022 dollars)

Alternative	Alternative 1 6 mgd ResWA	Alternative 2 12 mgd ResWA	Alternative 3 6 mgd RWA	Alternative 4 6 mgd TWA	Alternative 5 12 mgd TWA
Purified Water Delivered (AFY)	5,040 to 6,720	10,080 to 13,440	5,880 to 6,720	6,720	13,440
Loaded Facility Component Cost ($mil)					
Treatment	99 to 105	166 to 184	66 to 66	31 to 47	147
Pipelines	24 to 27	45 to 49	20 to 20	7 to 8	34
Pump Station	4.2 to 4.2	6.4 to 6.4	4.6 to 4.6	4.2 to 4.2	7
Storage	9.6 to 9.6	9.6 to 9.6	80.7 to 80.7	n/a	n/a
Reservoir Facility Improvements	**$348 to $370**	**$577 to $630**	**$630**	**$343 to $349**	**$654**
Total Construction Cost ($)	**$10 to $13**	**$20 to $23**	**$10 to $11**	**$8 to $9**	**$25,430,000**
Annual O&M Cost ($mil/year)	$4040 to $4970	$2980 to $3750	$4110 to $4550	$3480 to $3560	$3,980
Unit Cost ($/AF)	$4,920 to 6,750	$4,720 to $,5080	$4,110 to $4,550	$5,440 to $5,570	$6,290
Unit Cost ($/CCF)	$14.5 to $15.5	$10.8 to $11.7	$13.5 to $14.8	$12.5 to $12.8	$14.4
Unit Cost ($/gal)	$0.019 to $0.021	$0.014 to $0.016	$0.018 to $0.020	$0.017 to $0.017	$0.019

Units: AFY = acre-feet per year, mgd = million gallons per day, $/AF = dollars per acre-foot, $/gal = dollars per gallon, $/CCF = dollars per hundred cubic feet (of purified water delivered).

The completion of this feasibility study is good timing for the **SFPUC's Alternative Water Supply (AWS) Program**, which is evaluating new projects, including the PREP Project, which will help meet future water supply needs in the SFPUC service area. The SFPUC Commission passed a resolution to initiate CEQA by July 2023 for projects in the SFPUC's AWS Program. In order to be "CEQA Ready," a conceptual-level design and completion of an abbreviated CEQA checklist document must be completed for each of the projects, essentially allowing the project to move forward with CEQA and to be compared with other projects. The projects under consideration to meet future supply needs are in various stages of development and there is a wide range in the relative cost and volume of potential new water supplies. At this time there is not a preferred alternative to be implemented in the absence of the PREP Project, and it is likely that multiple projects will be pursued by SFPUC and regional partners to increase drought-year reliability and supplement RWS supplies.

ES.7 Proposed Title XVI Project

A screening approach was developed to compare alternatives in a qualitative manner to identify alternatives to move forward for further consideration. Due the broad set of alternatives and different parties that would be involved in implementation of a potable reuse project on the mid-peninsula, the preferred approach was to use qualitative descriptions and color coding to allow agencies to perform the screening independently, to see where their preferences may lay. Following the screening exercise, each agency answered a series of questions to summarize their perspectives, identify alternatives to eliminate from further consideration and provide input on the next steps for the PREP parties.

The outcomes of screening exercise identified a short-list of projects to move forward for further analysis, which included:

- **Alternative 1 – ResWA | 6 mgd to Crystal Springs Reservoir** (Alternatives 1a, 1b, 1c, 1d)
- **Alternative 4a/b – TWA | 6 mgd with SVCW Supply and Local Use** (Redwood City/Cal Water San Carlos)

The PREP Parties aligned on developing a hybrid project that would deliver purified water for ResWA and TWA in a phased approach, summarized as follows and in Table ES-3:

- Phase 1 – Indirect Potable Reuse (IPR) via ResWA at CSR
- Phase 2 – Direct Potable Reuse (DRP) via TWA for local use by the City of Redwood City, Cal Water and/or potentially the Mid-Peninsula Water District.
- Construction of a new AWPF that meets regulatory requirements for IPR in Phase 1 and DPR for the Phase 2 expansion.
- Conveyance infrastructure to deliver tertiary effluent to the new AWPF, purified water to the place of use and brine for discharge via the SVCW outfall.
- Upgrades at SFPUC's Pulgas Facility to treat and discharge purified water into CSR.
- Source water derived from up to 8 mgd of tertiary effluent from SVCW and 8 mgd of tertiary effluent from the San Mateo WWTP.

- An operational strategy where the new AWPF would produce up to 12 mgd of purified water for potable reuse, with 6 mgd or more delivered to CSR.

Figure ES-12 and Figure ES-13 illustrate the location of major project components for Hybrid A and B, respectively, after construction of Phase 1 and 2.

Table ES-3: Overview of Proposed Title XVI Project – Hybrid A and B

Alt	Description	Source Water[1]	AWPF Location	Drinking Water System Served[2]	Ave Annual Water Deliveries	
					(mgd)	(AFY)
HYBRID A						
Phase 1	Continuous operation ResWA	SVCW	near SVCW (6-mgd TWA train)	SFPUC (CSR)	6	6,720
Phase 2	TWA for Local Use	Blended SVCW + San Mateo	near SVCW (Expand TWA train to 12 mgd)	Redwood City + Cal Water (SC)	6	6,720
				TOTAL	**12**	**13,440**
HYBRID B						
Phase 1	Continuous operation ResWA	SVCW	Hwy 101 Site (6-mgd ResWA train)	SFPUC (CSR)	6	6,720
Phase 2	TWA for Local Use	San Mateo	Hwy 101 Site (6-mgd TWA train)	Redwood City + Cal Water (SC)	6	6,720
				TOTAL	**12**	**13,440**

Figure ES-12: Proposed Title XVI Project – Hybrid A – Phase 1 & 2

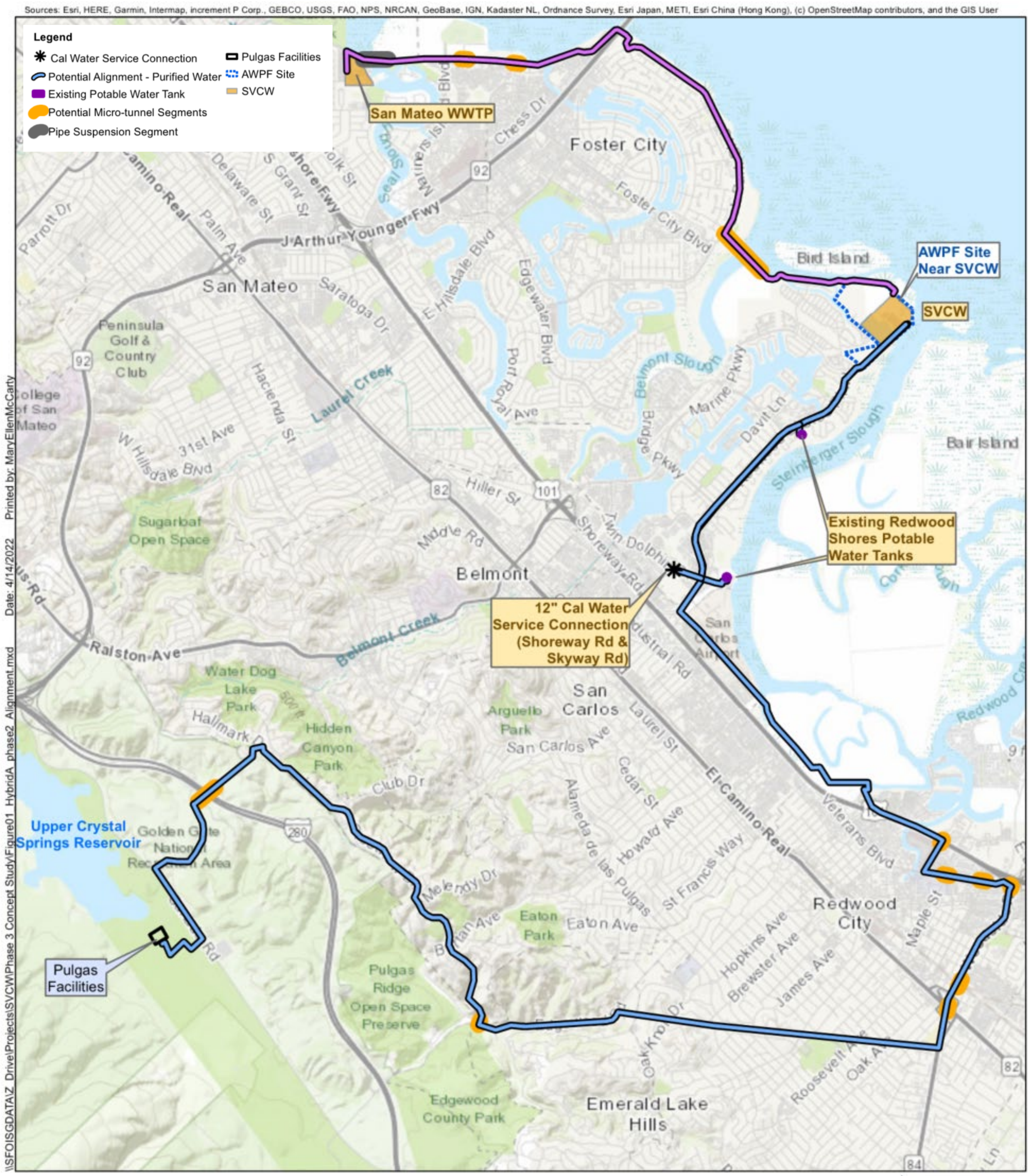


Figure ES-13: Proposed Title XVI Project – Hybrid B – Phase 1& 2

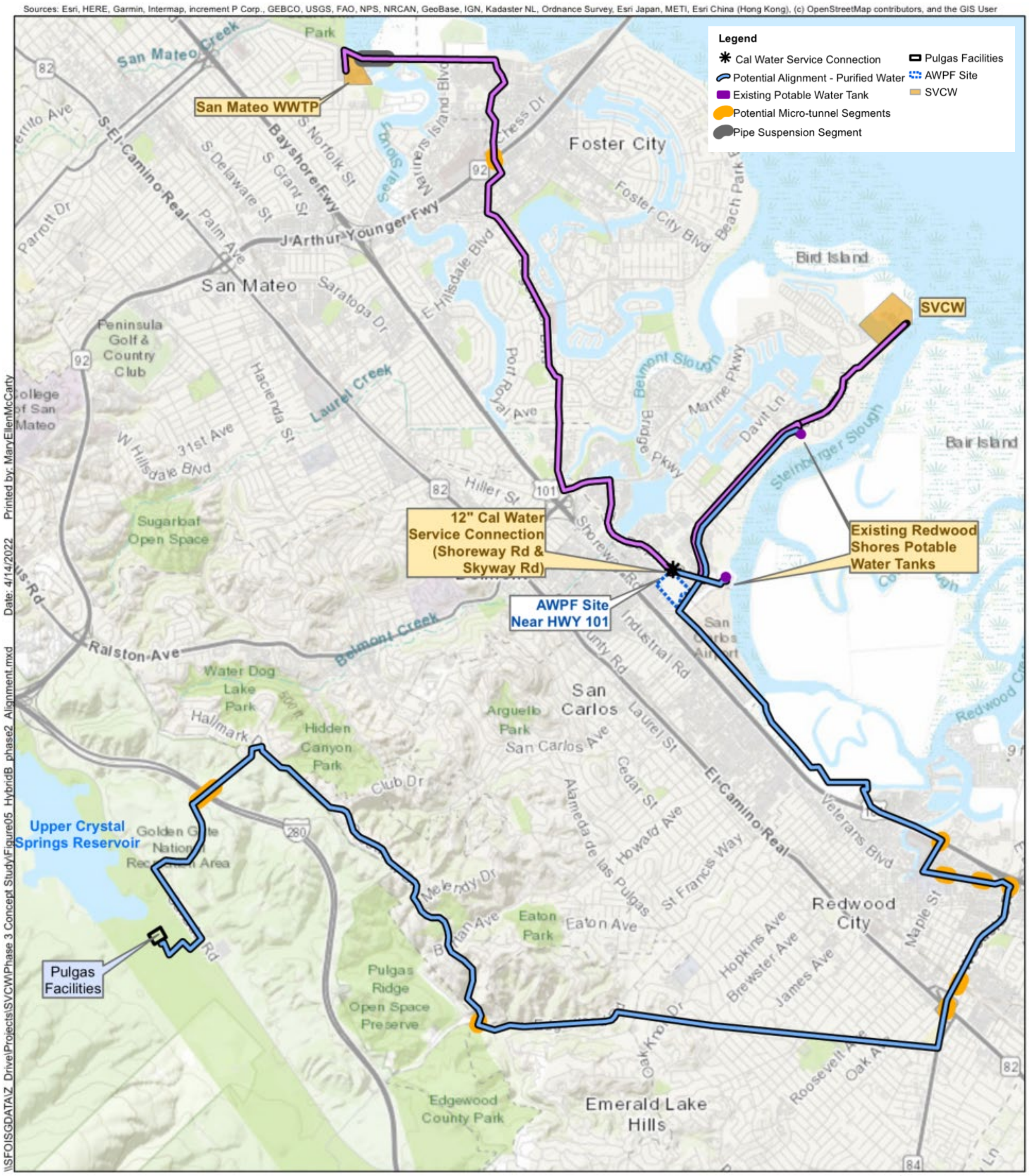


Table ES-4 summarizes capital, annual O&M, and life cycled costs for the Proposed Title XVI Project, by Phases.

Table ES-4: Proposed Title XVI Project – Hybrid A and B Cost Summary Table

Alternative	Hybrid A	Hybrid B
Purified Water Delivered (AFY)	13,440	13,440
Loaded Facility Component ($mil)		
Treatment	$469	$498
Pipelines	$185	$180
Pump Station	$45	$49
Storage	$7	$9
Reservoir Facility Improvements	$11	$10
Total Construction Cost ($mil)	**$717**	**$746**
Annual O&M Cost ($mil/year)	**$30**	**$29**
Unit Cost ($/AF)	$4,620	$4,895
Unit Cost ($/CCF)	$17	$18

The following bullets explain some of the nuances that contributed to the overall costs based on the phasing of each project:

- Hybrid A incurs greater facility costs in Phase 1, because the AWPF building, some treatment processes and storage are sized to meet TWA requirements for the full 12 mgd capacity. The overall treatment costs are lower due to the economy of scale benefits from building one AWPF earlier in the program.
- Hybrid B has a higher overall costs because this option assumes two independent AWPFs, one to treat SVCW effluent to meet ResWA requirements and an independent facility to treat San Mateo WWTP effluent to meet TWA requirements, losing some of the economy of scale.
- Escalation to midpoint of construction – Phase 1 ResWA is assumed to begin construction in 2030 and end in 2033 (43% escalation applied). Phase 2 TWA is assumed to begin construction in 2034 and end in 2036 (56% escalation applied).
- Both Hybrid A and B assume that the pipeline to convey San Mateo WWTP effluent to the AWPF would be constructed during Phase 2.

ES.8 Other Considerations

Environmental Considerations

The Proposed Title XVI Project construction activities are anticipated to have some short-term impacts to endangered or threatened species, water quality, hydrology, natural resources, waters of the United States, and cultural resources. Short-term construction impacts, associated with activities such as grading, excavation, and installation of facilities, can be mitigated by methods such as utilizing trenchless technologies for sensitive areas, performing biological and cultural surveys, and implementing best management practices.

Longer-term operation and maintenance activities would include mechanical and chemical treatment of recycled water to meet ResWA and TWA regulatory requirements, energy, material use, and transportation associated with facility operations, most of which would be conducted at the AWPF. By replacing imported water, the environmental impacts and energy use may be reduced by the generation of local water supplies.

In addition, the Proposed Title XVI Project would augment the supply of water to be stored at the existing CSR and existing drinking water systems. This diversion of wastewater effluent for recycled water production would eliminate discharges of recycled water to the San Francisco Bay, helping SCVW/San Mateo WWTP to meet their NPDES discharge requirements. The water quality discharged into CSR would be treated to match or be compatible with the background levels in CSR to meet the SF Bay Basin Plan.

Legal and Institutional Requirements

The SVCW Joint Powers Authority (JPA) and San Mateo/EMID are the owners of the sourced wastewater for the Proposed Title XVI Project and at this time have made no arrangements nor agreements to transfer jurisdiction of rights to the wastewater. Since the Proposed Title XVI Project involves use of wastewater effluent that is currently directly discharged into the SF Bay, there are no downstream rights to wastewater discharges to compete with the project. The SVCW JPA and San Mateo/EMID, as owners of the sourced wastewater for the Proposed Title XVI Project would seek legal counsel for individual determinations of the use of their supply.

Contractual recycled water supply obligations between SVCW and Redwood City have been accounted for in the supply analysis. There are currently no contractual recycled water supply obligations for San Mateo's effluent. There are no known Indian trust responsibilities or water rights settlements related to the project.

Interagency coordination would be required with local cities for encroachment permits, with the RWQCB and DDW for permitting and between those PREP Parties that partner to implement the Proposed Title XVI Project. There are a number of existing and relevant agreements in place between the PREP Parties that govern the operation of wastewater collection, treatment, and recycled water use, as well as water supply agreements between SFPUC and the wholesale customers. In addition to meeting the stipulations of existing interagency agreements, implementation of the Proposed Title XVI Project will need to meet form new interagency agreements and coordinate with entities across jurisdictional boundaries. The pursuit of a potable reuse project in this region would solicit the interest of numerous stakeholders on the Mid-Peninsula and the surrounding area. An agency specific and regional approach to public outreach would likely be most beneficial for this type of project once a project and its structure are defined.

Implementation of the Title XVI Project will require coordination with various State and Local Agencies to achieve regulatory approvals for potable reuse and obtain the appropriate construction permits.

Financial Capability of Sponsor

The PREP Parties are committed to continuing to work together to define an institutional arrangement and cost-sharing structure to lead a mutually beneficial regional project that is consistent with their legal authorities and the expected value of the benefits they receive. However, the project sponsor has not been defined at this time. Once the project sponsor is identified, a cost allocation framework will be developed, and the appropriate combination of cash contributions identified.

Construction costs are expected to be funded through a combination of grants, loans, and municipal bonds. Potential funding partners may be identified, as-appropriate, depending on the potential for a Regional Consortium to make the Project more cost-effective and/or to reduce risk. The project sponsor will likely pursue funding through available grants, low-interest loan programs and partnerships for the project construction at the appropriate time.

It is anticipated that the project sponsor would fund full operation, maintenance, and ongoing replacement costs through ongoing rates and charges. At this point, a method for allocating costs among the applicable service types (e.g., potable water, recycled water, and sanitation) has not been developed. As the Project moves forward, this allocation method will be developed in order to properly determine cost impacts on each respective customer class.

As part of the next steps for the project, A Basis of Design Report (BODR) will be developed to refine costs and identify potential approaches to fund the project as it moves into construction, irrespective of institutional agreements, cost sharing and ownership framework. The financial plan developed as part of that effort will utilize the updated cost analysis from the BODR effort, identify typical funding sources (financing approaches, bonds, grants/loans) and discuss common pricing policies to identify key considerations for financial planning. Since the project sponsor will not be identified as part of the BODR effort, the financing plan will be at a conceptual level, documenting established vehicles used by the PREP Parties to fund capital projects and recovery annual costs. The intent will be to identify the 30onnectivety between design, environmental/permitting and construction activities on funding (e.g., eligibility for grants/loans to payback considerations).

If Title XVI funding is available and authorized; the Project could seek up to $20 million in federal funding. The remaining non-federal match would be derived from a combination of local contributions, state and local grants, state, or federal loans, and/or municipal bonds. The project sponsor would evaluate available funding options at the appropriate time when project costs and agreements are further refined, and the Title XVI Project is closer to construction.

Research Needs

The Proposed Title XVI Project will use a combination of proven technologies and conventional system components along with the potential to explore innovative areas of research. The AWPF will rely on proven advanced treatment processes to meet regulatory requirements for ResWA and TWA (once finalized). Conveyance of flows to and from the AWPF will consist of conventional conveyance components (e.g., pipelines and pump stations) implemented via industry standard design and construction practices.

Basic research needs include but are not limited to the following topic areas:

- **Reservoir Research Studies at CSR** to assess potential water quality impacts, or benefits, from the addition of purified water. Activities could include water quality sampling and development or use of a reservoir mixing model to answer questions related to reservoir water surface elevations and quality, impacts on vegetation and fisheries and approaches to reservoir operations to minimize risks.
- **Bench Scale Testing to Evaluate Breakpoint Chlorination** at Pulgas Facilities to assess the ability to remove ammonia in the purified water stream, reducing potential to stimulate algae growth and adversely impact water quality in CSR. Activities could include bench and potentially pilot-scale testing is needed at SFPUC's Westside Recycled Water Treatment Facility (RWTF), where start-up of an AWPF is currently underway using similar treatment and wastewater ammonia concentrations. A scope of work for this effort has been submitted to SFPUC.

- **Pilot and/or Demonstration Facility** to support ResWA and TWA treatment concepts through piloting treatment process technologies to demonstrate strategies for compliance and verify treatment process performance. This may be done in phases to support ResWA and TWA and would also be a tool to support public outreach and provide training for treatment plant operators.

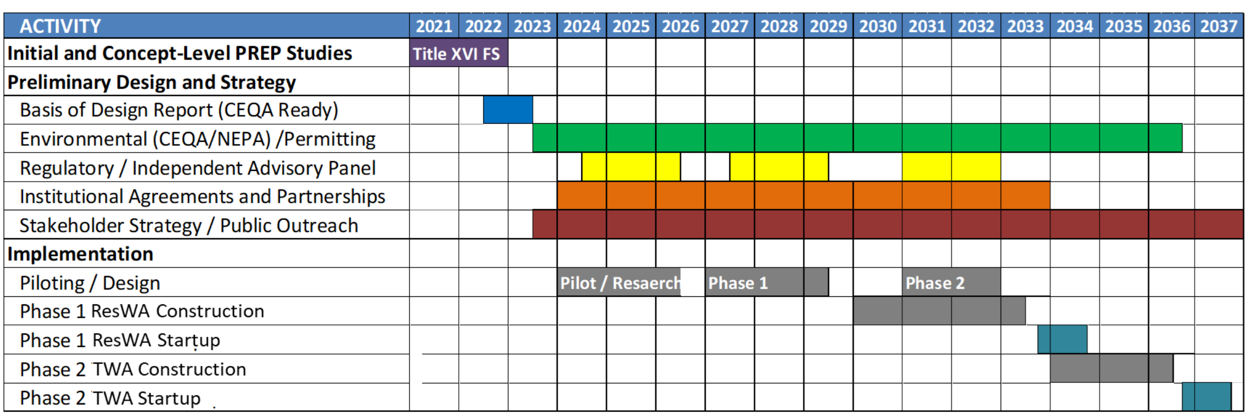
The scope of these areas of research will be further defined as part of discussions with regulators and recommendations by an Independent Advisory Panel (IAP). Research areas related to TWA may not be initiated until Phase 1 activities are underway.

It is assumed that the project sponsor and/or facility owner would administer and lead the research studies teaming with recognized local and national academic and consulting experts in the field of potable reuse. The project sponsor would likely engage local regulatory agencies to share findings and facilitate permitting. The PREP Parties will coordinate with Reclamation as these, and other research opportunities, materialize to identify opportunities for funding and collaboration through Reclamation participation.

ES.9 Proposed Title XVI Project Implementation

A proposed implementation schedule for the Proposed Title XVI Project is shown in Figure ES-14. The intent of this timeline is to provide a general and conservative estimate of when major activities would occur over a 15-year period. The schedule could be reduced by overlapping activities and reducing time between activities, depending on project drivers. This preliminary schedule is based loosely on the duration and schedule for other ResWA projects in progress by East County Advanced Water Purification Program and Pure Water Project Las Virgenes-Triunfo.

Figure ES-14: Potential Timeline for Major Activities to Implement Proposed Title XVI Project



Implementation of the Proposed Title XVI Project, irrespective of which hybrid option is chosen, could benefit the San Francisco Bay Area through:

- ✓ Development of a new locally-controlled, reliable supply of high-quality water that is drought-resilient
- ✓ Reduce dependence on imported water and potential to result in reduced diversions from the Tuolumne River
- ✓ Reduction in discharges to the Bay
- ✓ Treatment of local wastewater more efficiently and prevention of water from becoming a lost resource.
- ✓ Addressing the unpredictability of climate change.
- ✓ Combined resources and regional institution collaboration to maximize water reuse

There are of course inherent risks and uncertainties that accompany project implementation, such as:

- Operational and water quality challenges in Crystal Springs Reservoir
- Ability to reliably meet Bay discharge requirements
- Construction challenges in constructing alignments along the Bay and through Silicon Valley
- Water supply during non-drought years would impact operations and storage availability in the Regional Water System
- Decreasing quantity and quality of source supplies due to conservation
- Uncertainty related to DPR regulatory requirements
- Institutional agreements to share costs and risks
- Equity in distribution of purified water and costs
- Community support and acceptance

These, and other challenges, will be addressed as the project progresses.

Section 1: Introduction

To ensure that a Title XVI feasibility study report complies with Pub. L. 102-575, as amended, other Federal laws, and to otherwise allow Reclamation to assess the feasibility of the proposed Title XVI project, at a minimum the following information shall be included. Introductory Information. Provide the following introductory information. (a) Identification of the non-Federal project sponsor(s). (b) A description of the study area and an area/project map. (c) A definition of the study area in terms of both the site-specific project area where the reclaimed water supply will be needed and developed, and any reclaimed water distribution systems.

This section provides a brief description of the following:

1. Report Organization
2. Project Overview
3. Identification of the Non-Federal Project Sponsor
4. Description of the Study Area

1.1 Report Organization

This report has been prepared in accordance with the Bureau of Reclamation (BOR) Manual Directives and Standards (WTR 11-01). Italicized red text following the section headings represent excerpts from the BOR manual and the ensuing report text addresses the specific topic. This report consists of the following sections:

- Executive Summary
- Section 1: Introduction
- Section 2: Background
- Section 3: Water Reclamation and Reuse Opportunities
- Section 4: Description of Alternatives
- Section 5: Economic Analysis
- Section 6: Selection of the Proposed Title XVI Project
- Section 7: Environmental Consideration and Potential Effects
- Section 8: Legal and Institutional Requirements
- Section 9: Financial Capability of Sponsor
- Section 10: Research Needs
- Section 11: References

The following appendices are included to provide additional detail and supporting materials as needed:

- Appendix A: Climate Change Considerations
- Appendix B: Permitting and Regulatory Requirements
- Appendix C: Treatment Supporting Information
- Appendix D: Conveyance Considerations and Potential Pipeline Alignments
- Appendix E: Water Supply Modeling
- Appendix F: Engineers Opinion of Probable Costs
- Appendix G: Supporting Information for Environmental Review

1.2 Project Overview

Development of a Potable Reuse Exploratory Plan (PREP) is a regional effort to study potable reuse opportunities in California's San Francisco Mid-Peninsula region.

PREP Phase 1 began in 2016, to explore a wide range of potable reuse concepts in the region.

PREP Phase 2 continued in 2018, the focus of which was to further define the concept of a reservoir water augmentation (ResWA) project at Crystal Springs Reservoir (CSR) and explore institutional considerations for implementation of potable reuse.

PREP Phase 3 began in 2020 to further evaluate ResWA at Crystal Springs Reservoir (CSR) and explore direct potable reuse (DPR) in the region through Raw Water Augmentation (RWA) and Treated Water Augmentation (TWA).

The purpose of this Title XVI Feasibility Study is to identify a preferred project and a path forward for implementing potable reuse.

1.3 Identification of the Non-Federal Project Sponsor(s)

Identify the non-Federal project sponsor(s).

The PREP effort has been developed through a regional partnership between water and wastewater agencies on the San Francisco Peninsula. The PREP Parties include the following entities, each with a clear objective for pursuing PREP at this time:

- ***Silicon Valley Clean Water and City of San Mateo (Wastewater Agencies):*** To support local, regional, and State goals for recycled water use and promote the development of recycled water supplies to provide maximum benefit to our service areas.
- ***Bay Area Water Supply and Conservation Agency:*** To identify a potential new water supply to meet the dry-year water supply reliability needs of its member agencies, as documented in BAWSCA's *Long-Term Reliable Water Supply Strategy Phase II Final Report.*

- ***California Water Service (Cal Water):*** To identify potential new local water supply opportunities and capital projects that will deliver water supply reliability to Cal Water's Bayshore District customers.
- ***City of Redwood City:*** To identify potential new water supplies and enhance the quality of recycled water to promote beneficial uses.
- ***San Francisco Public Utilities Commission:*** To identify potential new water supply opportunities to serve existing and new customer demands, including the Cities of San Jose and Santa Clara.

Together, the PREP Parties recognize that regional collaboration offers opportunities to address multiple water supply and wastewater challenges, while realizing the benefits of shared infrastructure, asset recovery, economies of scale, and a more competitive strategy to pursue funding, in addition to enhancing regional self-reliance through integrated water management. The PREP Parties are committed to continuing to work together to define an institutional arrangement and cost-sharing structure to lead a mutually beneficial regional project that is consistent with their legal authorities and the expected value of the benefits they receive.

The Phase 1 Memorandum of Understanding (MOU) between the initial PREP Parties to begin this work was a crucial first step in declaring a regional commitment to exploring potable reuse through integrated water management by proactively reducing wastewater discharges and increasing water supply resiliency. In Phase 1, SVCW, SFPUC, BAWSCA, and Cal Water agreed to conduct regional activities in an inclusive manner that improves water supply reliability in the region. Within months of initiating the study, Redwood City and San Mateo expressed interest in joining the Parties to explore regional solutions that may offer additional economies of scale, and opportunities to share resources and infrastructure.

The MOU was updated to embark on Phase 2, which committed Redwood City and San Mateo to share in the cost to further define a potable reuse concept. As part of Phase 2, the PREP Parties explored institutional considerations, in parallel to an evaluation of technical and financial evaluations, related to the implementation of a project that augments CSR with purified water. Based on the findings from this effort, it appears possible that (1) a potable reuse project could offer benefits for SF Bay Area water and wastewater utilities, and (2) there are viable options to structure the project's implementation.

A Phase 3 Memorandum of Agreement (MOA) was entered into by the PREP Parties to conduct this feasibility study. The MOA defined general roles and responsibilities of all PREP Parties related to conducting the Phase 3 feasibility study and established cost sharing allocations for the study.

Even with the most willing partners, regional projects require the development of partnerships and agreements that guarantee cooperation, coordination, and legal support. Based on the survey questionnaires, interviews and a workshop with the PREP Parties completed as part of Phase 2, collectively, the PREP Parties appear to have the required functional and legal capacity to finance and deliver the project. Therefore, the project is institutionally feasible. Based on these findings, each PREP Party recognized the need to assess the value of their benefits based on their future role on the project at a later stage.

There are a variety of regional non-potable and potable reuse programs in California, in various stages of implementation and development, that have similarities to the project being considered by the PREP Parties. These programs offer some examples of how complex projects like these can be structured based on their drivers, involved parties, and financing approach. Program leadership is typically driven by one or two primary project sponsor(s), supported by a coalition or series of agreements (e.g., MOUs) with a larger group of project partners and/or stakeholders. Getting the institutional and financial arrangements right, up front, is key to the success of most large programs.

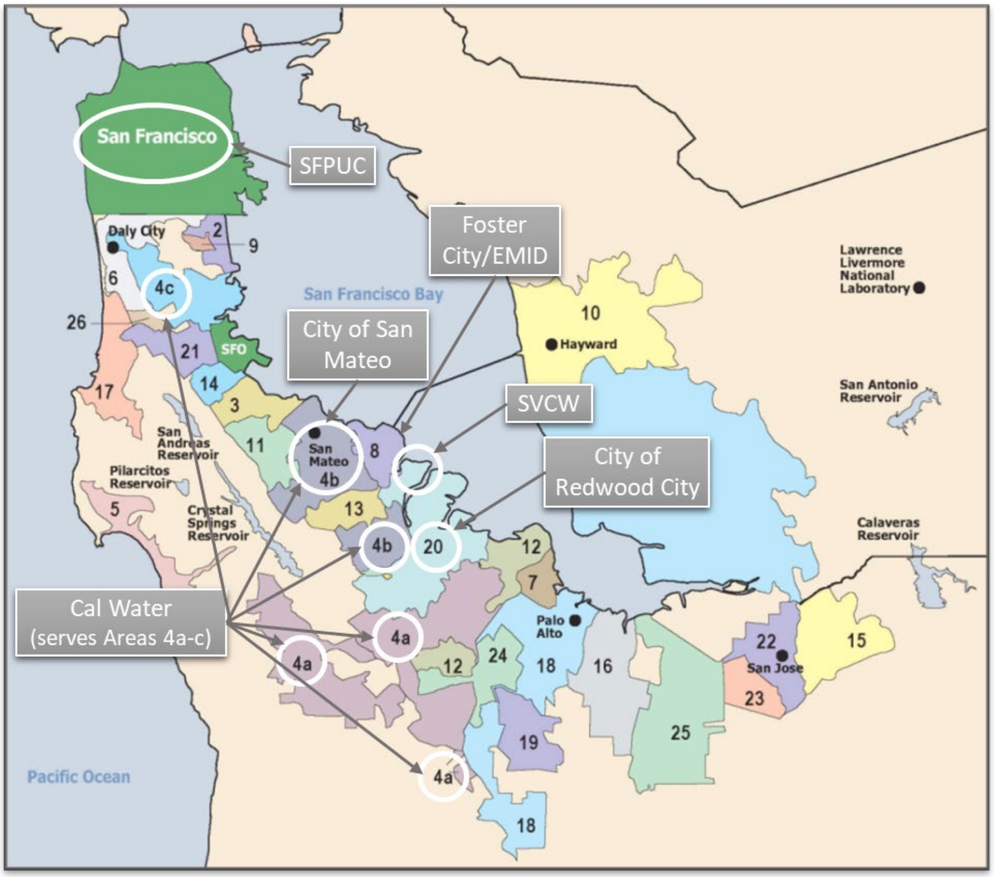
The PREP Parties have the required functional and legal capacity to finance and deliver the project; however, they have not yet developed the partnerships and agreements to define ownership, coordination and legal responsibilities. Thus, the project sponsor, responsible for the planning and development of the project, has not been defined at this time. Potential project sponsors include: (1) SFPUC, as the owner and operator of the Regional Water System (RWS), (2) a joint powers authority (JPA) or (3) similar legal entity, consisting of the water agencies and wastewater agencies that will distribute and supply water for the project (PREP Parties).

1.4 Description of the Study Area

Describe study area in terms of both the site-specific project area where the reclaimed water supply will be needed and developed, and any reclaimed water distribution systems.

The study area includes the San Francisco Mid-Peninsula region, focused on the service areas and facilities of the PREP Parties, which includes the Bay Area Water Supply and Conservation Agency (BAWSCA), California Water Service Company (Cal Water), the San Francisco Public Utilities Commission (SFPUC), the City of Redwood City, the City of San Mateo, and Silicon Valley Clean Water (SVCW). The group will be referred collectively herein as the “Parties” and singularly as a “Party.” A map showing the service areas of the Parties is shown in Figure 1-1.

Figure 1-1: Study Area and PREP Parties' Service Areas



Legend

1	Alameda County Water District	13	Mid-Peninsula Water District
2	City of Brisbane	14	City of Millbrae
3	City of Burlingame	15	City of Milpitas
4a	CWS – Bear Gulch	16	City of Mountain View
4b	CWS – Mid-Peninsula	17	North Coast County Water District
4c	CWS – South San Francisco	18	City of Palo Alto
5	Coastside County Water District	19	Purissima Hills Water District
6	City of Daly City	20	City of Redwood City
7	City of East Palo Alto	21	City of San Bruno
8	Estero Municipal Improvement District	22	San Jose Municipal Water System
9	Guadalupe Valley MID	23	City of Santa Clara
10	City of Hayward	24	Stanford University
11	Town of Hillsborough	25	City of Sunnyvale
12	City of Menlo Park	26	Westborough Water District

Sources: BAWSCA, San Mateo County General Plan

The majority of the water supply to the study area is provided by SFPUC's Hetch Hetchy Regional Water System (RWS), which consists of a complex series of reservoirs, tunnels, pipelines, pump stations, and treatment plants to deliver water from the Sierra Nevada and SF Bay Area watersheds to four counties in the SF Bay Area (see Section 2.2.1). The water agencies that could potentially receive purified water include SFPUC, CalWater, the City of Redwood City, the EMID, and MPWD. The PREP water suppliers and their systems are further described in Section 2.2.2).

This Title XVI Feasibility Study presents the evaluation of alternatives performed in Phase 3, incorporating relevant elements of the Phase 1 and Phase 2 studies. The project area and concepts considered as part of the PREP Phase 3 efforts are illustrated in Figure 1-2.

Figure 1-2: Overview of Potential PREP Project Concepts

Various potable reuse alternatives have been developed and evaluated through a collaborative, stakeholder-driven process. In general, source water from (1) tertiary effluent from the SVCW facility and/or (2) tertiary effluent from the San Mateo Wastewater Treatment Plant (WWTP) would undergo additional treatment at an advanced water purification facility (AWPF) and purified water produced by the AWPF would be conveyed to its place of use. Reject water from the RO membrane, herein referred to as the RO concentrate, would be discharged via connection to an existing outfall to the San Francisco Bay. Purified water would be conveyed indirectly or directly to drinking water users through existing potable water distribution systems.

The SVCW and San Mateo WWTP currently produce tertiary-treated disinfected recycled water that meets the standards specified in Title 22 of the California Code of Regulations (CCR) for unrestricted non-potable use. Recycled water from SVCW has been used by Redwood City's Recycled Water Program since 2000. Tertiary effluent produced at the San Mateo WWTP is not currently being reused, nor are there plans by Cal Water's Bayshore District nor the Estero Municipal Improvement District (EMID) to use recycled water supplies.

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Section 2: Background

Describe key water resource management problems and needs for which water reclamation and reuse may provide a solution, including the following information. All projections shall be reasonable and for a minimum of 20 years.

The **PREP Parties** have been collaborating for the last five years on a multi-phased concept-level analysis to explore opportunities for potable reuse on the San Francisco Mid-Peninsula. This effort was initiative in 2016 as part of SVCW's Long Term Strategic Recycled Water Planning Efforts. At that time, SVCW was anticipating new effluent regulations from the San Francisco Regional Water Quality Control Board (RWQCB) to reduce the concentration of nutrients in SVCW's effluent. To address these new regulations, SVCW recognized the potential to reduce effluent discharges and nutrient concentrations by developing recycled water as a potable water supply. Indirect Potable Reuse (IPR) was seen as an opportunity to help lower wastewater treatment costs, reduce discharges of nutrients to the SF Bay, and create a new water supply source for the region. To explore this new opportunity for recycled water, SVCW began discussions with local Water Agencies to understand the mutual benefits that could be gained from a regional potable reuse program.

In Phase 1, a subset of PREP worked collaboratively to develop a Draft PREP Initial Study, herein referred to as the ***PREP Phase 1 Initial Study***, which documents the first step by the PREP Parties to consider potable reuse alternative concepts in the San Francisco Mid-Peninsula area. Overall, the PREP Phase 1 Initial Study found that an IPR project could provide an integrated water management approach to:

1. Enhance local water supply reliability and resiliency for water and wastewater providers on the San Francisco Peninsula to prepare for the unpredictability of climate change.
2. Reduce discharge to the San Francisco Bay – helping communities use locally treated water more efficiently and prevent water from becoming a lost resource.

Based on the findings from the PREP Phase 1 Initial Study, a potable reuse project via reservoir water augmentation (ResWA) appeared to offer benefits for SF Bay Area water and wastewater utilities, the environment, local communities, and the regional economy.

The ***PREP Phase 2 Concept Study***, built on the PREP Phase 1 Initial Study to further define the preferred reservoir augmentation site identified in Phase 1, confirm the ability to meet regulatory requirements and revisit alignment and facility siting options. A parallel study, ***PREP Institutional Considerations*** (Kennedy Jenks 2019), explored institutional benefits, limitations, and possible frameworks for implementation.

This ***PREP Phase 3 Title XVI Feasibility Study,*** initiated in 2020, further simulates the impact of reservoir augmentation on the regional water system and explores direct potable reuse opportunities through raw water augmentation and treated water augmentation. This work builds on the Phase 2 PREP Concept Study to further assess issues related to mixing and achieving sufficient retention times, optimizing reservoir operations and other implementation considerations for ResWA at CSR. The DPR alternatives consider both RWA and TWA, representing augmentation of a drinking water system upstream and downstream of a drinking water treatment plant, respectively. The intent of Phase 3 is to provide sufficient information for the PREP Parties to determine which project(s) to proceed with further development.

This section provides a brief description of the following:

1. Project Description
2. Current and Projected Water Supplies
3. Current and Projected Water Demands
4. Water quality
5. Existing and Future Resources

Additional supporting information for this section is included in **Appendix A**: Climate Change Considerations for Water Suppliers

2.1 Project Description

The problem and need for a Water Reclamation and Reuse Project

The development of new, local drought-resilient water supplies is needed by the PREP Parties to:

1. Enhance local water supply reliability and resiliency for water and wastewater providers on the San Francisco Peninsula to prepare for the unpredictability of climate change.
2. Reduce discharge to the San Francisco Bay – helping communities use locally treated water more efficiently and prevent water from becoming a lost resource.
3. Create a multi-agency project with multiple economic, environmental, and social benefits.

The intensified effects of climate change are becoming evident through California as the State has been experiencing consecutive years of drought and consistent higher-than-average temperatures. These dramatic climate shifts are stressing water reservoirs and changing demands for residential, agricultural, and commercial water use. The lowest water storage levels have been recorded through the State, and reduced river and stream flows is harming water quality and threatening aquatic life. These factors are now being considered in urban water management planning for water districts in Northern California. As a component of this, several efforts are in the works to identify and assess the risks of climate change and water shortages, and to plan out solutions to avoid severe damage to water systems, human life, and the economy. **Appendix A** further discusses how the intensified effects of climate change are influencing water supplies for the PREP Parties.

The PREP Parties recognize that releasing the unused discharge water to the San Francisco Bay is not a sustainable practice. Future regulations from the San Francisco Bay RWQCB) to reduce the concentration of nutrients in effluent are anticipated to impact all wastewater discharges to the San Francisco Bay. Recycled water offers a pathway to reduce the quantity of effluent discharged and potentially reduce future capital expenditures for nutrient compliant treatment facilities. Section 4.8 summarizes current requirements for bay discharges to the San Francisco Bay.

The power of a regional program makes it more successful in sharing assets, garnering large grants and loans, or sharing costs and benefits over a greater service area. The PREP Parties seek to use multi-agency involvement to find broad mutual benefits and identify alternatives that address regional water supply and discharge challenges through maximizing utility of the available recycled water supplies, to provide a local, drought-resistant, sustainable water supply that benefits the environment and communities in the region.

2.2 Current and Projected Water Supplies

Include water rights, potential sources of additional water (other than the Proposed Title XVI Project) and plans for new facilities.

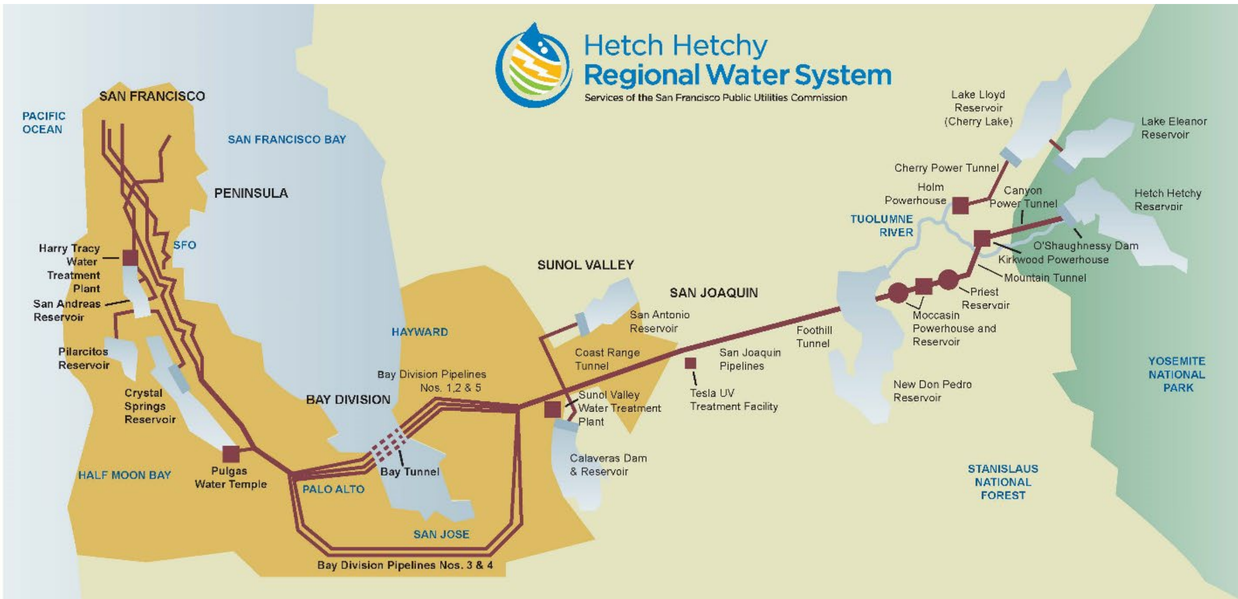
This section describes the primary water supply components that the PREP Parties rely upon and introduces hydrologic flow regime scenarios used to assess how regional water system operations and potable water demands change under a range of hydrologic conditions.

2.2.1 Hetch Hetchy Regional Water System

The City and County of San Francisco hold the water rights to store and deliver water from the Tuolumne River watershed stored in the Hetch Hetchy Reservoir and local reservoirs in the Alameda and Peninsula watersheds, which collectively constitute the water supply for the Hetch Hetchy Regional Water System (RWS). An average of 85 percent of the water supply for the RWS is collected from the Tuolumne River, and the remaining 15 percent of the water supply is drawn from local watersheds in Alameda and the Peninsula (SFPUC, 2021).

The Hetch Hetchy RWS, illustrated in Figure 2-1, consists of a complex series of reservoirs, tunnels, pipelines, pump stations, and treatment plants. The RWS delivers water from the Sierra Nevada and SF Bay Area watersheds to four counties in the SF Bay Area. The RWS originates in the Hetch Hetchy Valley of Yosemite National Park at the O'Shaughnessy Dam and Hetch Hetchy Reservoir. The O'Shaughnessy Dam impounds water along the main stem of the Tuolumne River, thereby creating Hetch Hetchy Reservoir. The reservoir collects water from the surrounding 459 square miles of watershed for the purpose of providing potable water to 2.7 million residential, commercial, and industrial customers in San Francisco, Santa Clara, Alameda, San Mateo, and Tuolumne Counties.

Figure 2-1: Schematic of the Hetch Hetchy Regional Water System



The Hetch Hetchy RWS is owned and operated by the SFPUC and serves both Retail and Wholesale Customers in four counties in the SF Bay Area. Together, the BAWSCA agencies account for two-thirds of water consumption from the system and pay for two-thirds of its upkeep. The RWS accounts for 97 percent of the SFPUC's retail water supply while the remaining 3 percent are from (a) locally produced groundwater from the Westside Groundwater Basin and Castlewood Well System and (b) recycled water from the Southeast Water Pollution Control Plant, Harding Park Recycled Water Project, and Pacifica Recycled Water Project. The SFPUC's 2020 Urban Water Management Plan (UMWP) documents currently available supplies and predict planned future supplies for the RWS for a 25-year period, as summarized in Table 2-1.

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Table 2-1:Current and Projected SFPUC Water Supplies (mgd)

Water Supply Source	2020	2025	2030	2035	2040	2045
RWS Supply [a]						
Retail Customers [b, c, d]	66.5	67.2	67.5	68.6	70.5	73.7
Wholesale Customers [e, f]	132.1	146.0	147.9	151.9	156.3	162.8
Groundwater Retail Supply	2.2	1.4	2.4	3.4	4.4	4.4
Recycled Water Retail Supply	0.1	2.1	2.5	2.5	2.5	2.5
Total SFPUC Supplies	**200.9**	**216.7**	**220.3**	**226.4**	**233.7**	**243.4**

Source: 2020 UWMP for the City and County of San Francisco

(a) In the context of this document, normal year RWS supply is defined as the supply that will be used to meet the full demands on the RWS in a normal year.

(b) Groundwater and recycled water are assumed to be used before RWS supplies to meet retail demand. However, if these alternative supplies are not available, up to 81 mgd of RWS supply could be used in normal years.

(c) Groveland CSD is reported as a wholesale customer for the purposes of this 2020 UWMP, but it is considered a retail customer of the SFPUC solely for purposes of allocating RWS supplies between retail customers and Wholesale Customers. Its demands would be met by the retail supply allocation of 81 mgd.

(d) Projected RWS supplies to be used by Wholesale Customers are based on the purchase request projections provided to the SFPUC by BAWSCA in January 2021. These purchase requests are subject to change in each individual agency's UWMP.

(e) Projected Wholesale Customer deliveries are limited to 184 mgd. 184 mgd includes the demands of the Cities of San Jose and Santa Clara, which are supplied on a temporary and interruptible basis, with their total supply not exceeding 9 mgd assuming supply is available (decision to be made by end of 2028).

(f) Cordilleras MWC is not a party to the WSA, and it is not included in the wholesale supply allocation of 184 mgd. The demands of Cordilleras MWC are minor (projected to be less than 0.01 mgd) and are anticipated to be met with RWS supplies through 2045.

2.2.2 PREP Water Suppliers and their Systems

This section briefly summarizes the potable water systems for the PREP Parties and those that could potentially receive purified water from one of the potable reuse projects explored in PREP Phase 3. A map showing the service areas is shown in Figure 1-1. Additional information about each water supplier and their systems can be found in their 2020 UWMP.

The SFPUC's System

The SFPUC's water system includes the RWS, an in-City distribution system to serve the City of San Francisco, retail and wholesale service areas on the San Francisco Peninsula and East Bay. The In-City Distribution System is owned and operated by the SFPUC and serves a population of nearly 900,000 in San Francisco. In-City retail customers are primarily served with RWS supply, but a few customers also receive groundwater and recycled water. Similarly, the SFPUC's suburban retail customers outside of San Francisco, including the Peninsula System, are primarily served with RWS supply, but some customers also receive groundwater (SFPUC, 2021).

The **Peninsula System** includes conveyance facilities connecting the Bay Division Pipelines (BDPL) to the in-City distribution system and to other customers on the Peninsula. Two reservoirs, Crystal Springs Reservoir and San Andreas Reservoir, collect runoff from the San Mateo Creek watershed. Crystal Springs Reservoir also receives water from the Hetch Hetchy System. A third reservoir, Pilarcitos Reservoir, collects runoff from the Pilarcitos Creek watershed and directly serves one of the Wholesale Customers, the Coastside County Water District (which includes the City of Half Moon Bay), along with delivering water to Crystal Springs and San Andreas Reservoirs. The Harry Tracy Water Treatment Plant (WTP) filters and disinfects water supplied from Crystal Springs Reservoir and San Andreas Reservoir before it is delivered to customers on the Peninsula and the in-City distribution system (SFPUC, 2021).

The **In-City Distribution System** receives RWS supply from several major pipelines from the Peninsula System to the City of San Francisco. Water to the eastside of the in-City distribution system is fed by two pipelines that terminate at University Mound Reservoir. Water to the westside of the in-City distribution is fed by two pipelines that terminate at Sunset Reservoir and one that terminates at Merced Manor Reservoir. The in-City distribution system also includes ten reservoirs and eight water tanks that store water supplied by the RWS. Seventeen pump stations and approximately 1,250 miles of pipelines move water throughout the system and deliver water to homes and businesses in the City (SFPUC, 2021).

Cal Water's Bayshore and Bear Gulch Districts

California Water Service Company (Cal Water) is an investor-owned public utility supplying water service to approximately 1.8 million Californians through over 481,000 connections. Its 25 districts serve 63 communities spanning from the Chico-Hamilton City District in the northern portion of the state to the Palos Verdes District in southern California. On the San Francisco Peninsula, the Bayshore and Bear Gulch Districts purchase water from the RWS, are members of the BAWSCA, and could potentially receive purified water from as part of a PREP Project (CalWater, 2021). Cal Water does not currently distribute recycled water in the San Francisco Mid-Peninsula region and Bear Gulch Districts but are considering planned potable reuse projects to benefit customers.

The **Cal Water Bayshore District** serves the public water systems of South San Francisco, San Mateo, San Carlos, and Town of Colma. In the early 2000's the South San Francisco District merged with the Mid-Peninsula District (San Mateo and San Carlos systems) to form Cal Water's Bayshore District. The Mid-Peninsula system comprise of 35 storage tanks, 54 booster pumps, and 383 miles of pipelines delivering about 12 million gallons per day to over 35,000 service connections. The City of Belmont, served by the Mid-Peninsula Water District, separates the Cities of San Carlos and San Mateo, and divides the Mid-Peninsula into two systems (CalWater, 2021b). The South San Francisco system comprise of 12 storage tanks, 21 booster pumps, and 144 miles of pipelines delivering about 6 million gallons per day to over 16,000 service connections (CalWater, 2021c). The Bayshore District water supply is purchased from the SFPUC RWS and delivers water to residential, commercial, industrial, and governmental customers in the Mid-Peninsula and South San Francisco service area.

The **Cal Water Bear Gulch District** serves the communities of Portola Valley, Woodside, Atherton, and portions of Menlo Park, Redwood City, and San Mateo County. The Bear Gulch District's water supply is primarily from water purchased from the SFPUC RWS, however local surface water supplements approximately nine percent of annual deliveries. The District delivers roughly 12 million gallons of water per day to more than 18,000 service connections, which includes residential, commercial, industrial, and governmental customers (CalWater, 2021a).

City of Redwood City System

The City of Redwood City serves water to customers within the incorporated limits of the City as well as portions of San Mateo County, including parts of the Town of Woodside and the City of San Carlos. Water distribution, water conservation and maintenance of water quality are the City's main water resource functions, as treated water purchased from the SFPUC RWS does not require further water treatment. The water service area serves approximately 89,000 people, covers approximately 17 square miles, and includes the Redwood Shores area, which is non-contiguous but included within the City of Redwood City service area. The City of Redwood City is a member of BAWSCA, and all the service area's water is purchased from the SFPUC RWS for distribution through 259 miles of pipelines, 13 storage reservoirs, and 10 pump stations. The City of Redwood City also has a recycled water project that delivered just over 850 AF of tertiary recycled water from SVCW for non-potable reuse in 2020 (Redwood City, 2021).

Estero Municipal Improvement District and the City of Foster City System

The Estero Municipal Improvement District (EMID) is located on the San Francisco Bay Peninsula between San Francisco and San Jose. EMID serves the incorporated limits of the City of Foster City and a portion of the City of San Mateo called Mariners Island, located immediately west of Foster City. EMID purchases all its potable water from the SFPUC RWS and is a member of the BAWSCA. The distribution system consists of four above ground storage tanks, a pump station, and 135 miles of pipeline to serve a population of approximately 36,500. EMID does not have historical or current water demands that are met with non-potable water supplies, such as recycled water or untreated surface water or groundwater (Foster City, 2021).

Mid-Peninsula Water District System

The Mid-Peninsula Water District (MPWD) is a "Special District" and a public agency directly providing water for municipal purposes in east central San Mateo County on the San Francisco Peninsula, about 30 miles south of San Francisco. The MPWD is a retail customer of the SFPUC RWS, and a BAWSCA member, connected at two points to the SFPUC system at a low elevation in Redwood City and a high elevation in the vicinity of the Pulgas Water Temple. The MPWD currently supplies water to approximately 27,500 customers in an area slightly larger than the city limits of the City of Belmont. The distribution system includes 20 pumps, 11 water tanks, and 94 miles of pipeline. The MPWD is not a PREP Party; however, due the service area location, there could be a potential opportunity to deliver purified water through the MPWD system in the future.

2.2.3 Plans for New Facilities

The SFPUC is leading a broader **Alternative Water Supply Program** to evaluate all potential sources of future water supply and the facilities to bring new projects online to develop supplemental supplies for the coming decades (SFPUC, 2022). SFPUC recognizes that the most significant water supply vulnerability right now is due to new flow requirements on the Tuolumne River through the State Water Resources Control Board (State Board) adopted amendments to the Bay Delta Water Quality Control Plan. For SFPUC, the effect of these requirements is that at current demand, the Regional Water System would need to find an additional water to meet its current water obligations, particularly in drought years. While the SFPUC and their partners work with the State of California on a Voluntary Settlement Agreement to protect the Bay Delta ecosystem, they continue to plan based on the current adopted amendment.

SFPUC is studying the feasibility of eight SF Bay Area and three Sierra Nevada (upcountry) area projects, the majority of which will require partnerships with multiple other entities to accomplish. SFPUC is also evaluating three projects within San Francisco. These projects are described in Section 4.3.

SFPUC has made a commitment to the SFPUC Commission to present project(s) that are ready for analysis under the California Environmental Quality Act (CEQA) by July 2023. Plans for new facilities will be driven by the outcomes of the Alternatives Water Supply Program and Bay Delta instream flow requirements.

2.3 Current and Projected Water Demands

Table 2-2 summarizes current and projected water demands for the Hetch Hetchy RWS for a 25-year period, based on information provided in the SFPUC's 2020 UWMP. The difference between the supply and demand constitutes a shortfall, which could be reduced by a potable reuse or other alternative water supply project.

Table 2-2: Current and Projected SFPUC Water Demands (average, mgd)

Demands	2020[a]	2025	2030	2035	2040	2045
Retail Demands[b]	68.8	70.7	72.4	74.5	77.4	80.6
RWS Wholesale Demands[c]	132.1	146.0	147.9	151.9	156.3	162.7
Total SFPUC Demands	**200.9**	**216.7**	**220.3**	**226.4**	**233.7**	**243.3**
Total SFPUC Supplies [d]	**200.9**	**216.7**	**220.3**	**226.4**	**233.7**	**243.4**
Difference (Supply - Demand)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Source: 2020 UWMP for the City and County of San Francisco

(a) Actual consumption data are obtained from customer billing data
(b) Single family residential and multi-family residential demand projections are from an econometric model developed for the SFPUC. Non-residential demands include commercial/industrial demands, which are also from an econometric model, as well as municipal and irrigation demands, which are assumed to remain constant at the previous five-year average level.
(c) Purchase requests for RWS supplies as anticipated to be reported in each agency's individual 2020 UWMP if one is to be prepared (estimates are subject to change). Projections were provided to the SFPUC by BAWSCA in January 2021. See each agency's 2020 UWMPs for their most up to date purchase request projections.
(d) See Table 2-1

The central planning objective of the Alternatives Supply Planning Program, discussed in Section 2.2.3, is to meet anticipated water supply needs in drought years in the SFPUC's retail and wholesale service areas through the 2045 planning horizon (SFPUC 2022). Future resource needs must account for:

1) the potential instream flow requirements that would affect available water supplies.
2) the SFPUC's contractual obligations to retail and wholesale customers, and an additional 9 mgd for the two interruptible customers (Cities of San Jose and Santa Clara)[1].

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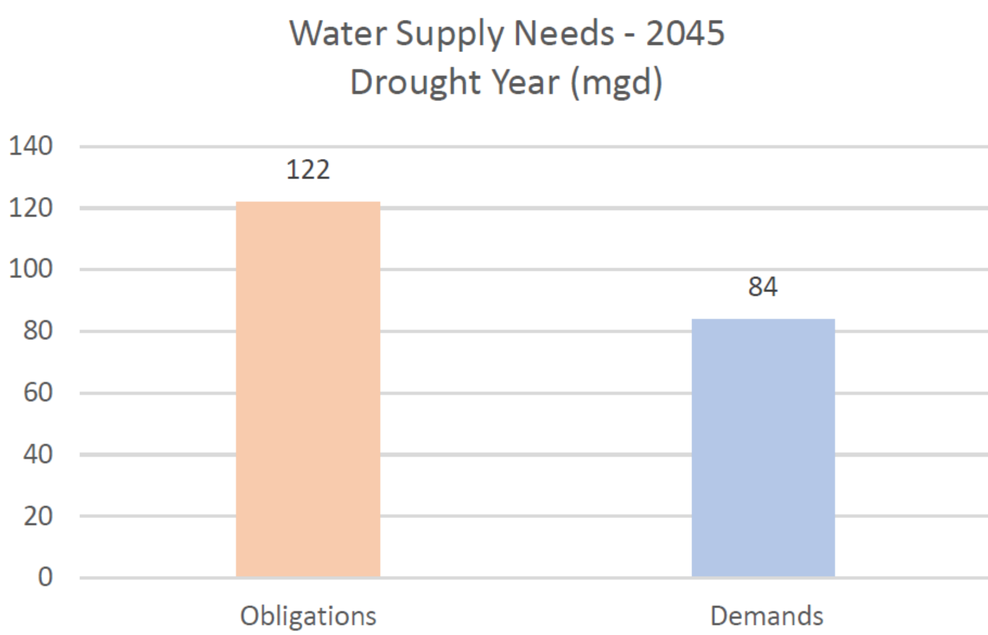
[1] The SFPUC is contractually obligated to making a decision about whether to make San Jose and Santa Clara permanent customers by December 31, 2028.

Based on the difference between the SFPUC's anticipated total obligations and expected supply availability in the RWS, the additional water supply need in a drought year would be 122 mgd, by 2045. However, demands over the planning horizon are projected to be lower than the obligations[2]. Comparing demand projections to water supply availability in 2045, the water supply need would be 84 mgd (Figure 2-2).

Figure 2-2: Anticipated RWS Supply Needs in 2045 – Drought Year



Source: Alternatives Supply Planning Program – Quarterly Update (SFPUC, 2022)

Water from the SF RWS comprise a substantial portion of the water supply for BAWSCA's twenty-six member agencies. Table 2-3 summarizes current and projected water demands for the BAWSCA member agencies for a 25-year period, based on information provided in BAWSCA FY 2020-21 Annual Survey.

[2] Demands for supply from the RWS account for savings from conservation and offsets from non-RWS water supplies and onsite water recycling.

Table 2-3: Current and Projected Water Demands for PREP Parties (average, mgd)

Demands	2020	2025	2030	2035	2040	2045
SF RWS Purchase	139.76	153.91	153.54	157.53	161.95	172.81
Groundwater	17.29	30.59	30.91	32.39	35.37	41.88
Recycled Water	7.71	10.84	12.48	13.99	15.83	17.47
Surface Water	0.82	6.62	6.62	6.62	6.62	6.62
Other Sources	39.81	45.41	43.47	45.05	48.40	44.19
Total BAWSCA Demands	**205.39**	**247.39**	**247.02**	**255.58**	**268.17**	**282.97**

Source: BAWSCA FY 2020-2021 Annual Survey

A summary of system demands for the PREP water agencies, Cal Water, Redwood City and EMID, are provided in Table 2-4

Table 2-4: Water Demands and RWS Purchases by PREP Parties (average, mgd)

Demands	Average Day Demand	Ave Day Purchased from RWS	% Demand Met with RWS Supplies
Redwood City	9.22	8.48	92%
Cal Water Bayshore - Mid-Peninsula	12.99	12.99	100%
Cal Water Bayshore - South San Francisco	5.92	4.55	77%
Cal Water Bear Gulch	11.96	11.96	100%
EMID	4.31	4.31	100%

Source: BAWSCA Member Agencies Profiles https://bawsca.org/members/profiles

2.4 Water Quality

Water Quality Concerns for the Current and Projected Water Supplies

The SFPUC meets much of its existing potable water demands with imported water from the Hetch Hetchy RWS, which is derived from rain and snow from Hetch Hetchy in Yosemite National Park and conveyed via a system of natural and artificial channels and pipelines. Imported Hetch Hetchy water is generally of high quality with low levels of TDS, sulfate, hardness, iron, and manganese, and consistently meets all federal and state water quality standards as reported in the annual Water Quality Report (SFPUC 2020).

As previously noted, the water service areas for this study primarily receive water from Hetch Hetchy, and a small portion of water from local SF Bay Area water. Water from the Hetch Hetchy Reservoir only requires primary disinfection and pH adjustment for corrosion control in the pipelines and undergoes UV disinfection at the Tesla Treatment Facility; water from Hetch Hetchy is not required to undergo filtration prior to distribution. However, local RWS flows from the Alameda System reservoirs are filtered and treated at the Sunol Valley WTP and water from the Peninsula System reservoirs are treated at Harry Tracy WTP. The filtered and treated water from the local watersheds is blended with water from the Hetch Hetchy reservoir, and most customers receive this blended water supply. A summary of constituents in the regional water supply is provided in Table 2-5.

Table 2-5: SFPUC Water Quality

Parameter	Unit	State MCL	Public Health Goals (NL)	Reported	Value
Turbidity	NTU	5	N/A	Highest	1.3[a]
Nitrate (as nitrogen)	ppm	10	10	Range Average	ND
Chloride	ppm	200	N/A	Range Average	<3-15 9
Chlorate	ppb		800	Range Average	67-1200 262
Sulfate	ppm	500	N/A	Range Average	1-34 17
Total Dissolved Solids (TDS)	ppm	1,000	N/A	Range Average	<20-137 72
Hardness (as $CaCO_3$)	ppm	N/A	N/A	Range Average	8-79 45
Total Organic Carbon	ppm	N/A	N/A	Range Highest RAA	1.7-3.4 2.9
N-Nitrosodimethylamine (NDMA)	ppt	N/A	3 (10)	Range	ND

Source: SFPUC annual Water Quality Report (SFPUC 2020)

(a) Maximum turbidity measured from unfiltered Hetch Hetchy water.

2.5 Existing and Future Resources

Current and Projected Wastewaters and Disposal Options Other Than the Proposed Title XVI Project. Include plans for new wastewater facilities, including projected costs.

The SVCW Wastewater Conveyance System takes wastewater from each of the Joint Powers Authority (JPA) member agencies' (Belmont, San Carlos, Redwood City, and West Bay Sanitary District) collection systems, serving 220,000 customers. The WWTP has a permitted capacity of 24 mgd for average dry weather flow (ADWF) and 68 mgd for peak wet weather flow (PWWF). The wastewater at the SVCW WWTP is treated to disinfected tertiary recycled water standards, and excess treated water effluent is discharged to the San Francisco Bay. Discharges from the SVCW WWTP are regulated under an NPDES permit (Order No. R2-2018-0005; National Pollutant Discharge Elimination System (NPDES) permit No. CA 0038369) from the San Francisco Bay RWQCB.

The San Mateo WWTP is jointly owned by the cities of San Mateo and Foster City/Estero Municipal Improvement District and operated by the City of San Mateo. The San Mateo WWTP serves more than 150,000 people and businesses in the City of San Mateo's service area. The WWTP has a permitted capacity of 15.7 mgd for ADWF and 60 mgd for peak wet weather flow (PWWF). The wastewater at the San Mateo WWTP is treated to secondary standards, and the effluent is discharged to the San Francisco Bay. Discharges from the San Mateo WWTP are regulated under an NPDES permit (Order No. R2-2012-0006; NPDES No. CA 0037541) from the RWQCB.

Current and future wastewater flow projections area summarized in Table 2-6. New wastewater treatment facilities are not planned at this time.

Table 2-6: Current and Projected Wastewater Flows (AFY)

Wastewater	2020	2025	2030	2035	2040	2045
Wastewater Flows[a]						
Influent to SCVW WWTP	14,623	n/a	n/a	n/a	n/a	n/a
Influent to San Mateo WWTP[b]	7,834	n/a	n/a	n/a	n/a	n/a
Recycled Water Demands [c]						
Redwood City	856	1,286	1,426	1,686	1,701	1,716
Cal Water Bayshore	0	0	0	0	0	0
Cal Water Bear Gulch	0	0	0	0	0	0
EMID	0	0	0	0	0	0

Source: 2020 UWMP for Redwood City, Cal Water Mid-Peninsula, Cal Water South San Francisco, Cal Water Bear Gulch, and EMID

(a) Wastewater flows were not projected as part of the UWMPs.
(b) Wastewater flows from City of San Mateo and EMID are combined.
(c) Discharges were not projected as part of the UWMPs.

The PREP Parties have explored long-range plans to beneficially use the recycled water from the SVCW WWTP and the San Mateo WWTP and to effectively discontinue discharges to the San Francisco Bay. The Alternatives Supply Planning Program, discussed in Section 2.2.3, includes exploration of several recycled water projects, including the Crystal Springs Purified Water project that is the focus of this Title XVI Feasibly Study.

Section 3: Water Reclamation and Reuse Opportunities

Address the opportunities for water reclamation and reuse in the study area, and identify the sources of water that could be reclaimed

Several agencies on the San Francisco Mid-Peninsula are producing tertiary treated recycled water for non-potable irrigation, commercial, and industrial uses. However, the only existing potable reuse project in northern California is Monterey One Water's recently implemented groundwater replenishment program.

In terms of reuse by the PREP Parties, the SFPUC began recycling wastewater in the early 1930s to irrigate Golden Gate Park, but the facility was eventually decommissioned in 1981 due to stricter standards for recycled water treatment. Over the years the SFPUC has supported recycled water projects throughout the Regional Water System's services area, and most recently the SFPUC is implementing the Westside Enhanced Water Recycling Project in the City of San Francisco, which will utilize up to 4 mgd of recycled water from the Oceanside Water Pollution Control Plant for non-drinking purposes. The City of Redwood City has also been supplying up to 0.75 mgd of recycled water produced at Silicon Valley Clean Water (SVCW), to its customers since 2000. CalWater and San Mateo are currently not producing water for reuse.

For the PREP Project, two potential sources of treated wastewater are evaluated for potable reuse: (1) effluent from the SVCW facility; and (2) effluent from the San Mateo Wastewater Treatment Plant (WWTP).

This section provides a brief description of the following:

1. identified uses for reclaimed water,
2. the water market,
3. potential project challenges,
4. stakeholders,
5. potential sources of water to be reclaimed,
6. source water facilities,
7. existing water reuse,
8. water reclamation and reuse technology.

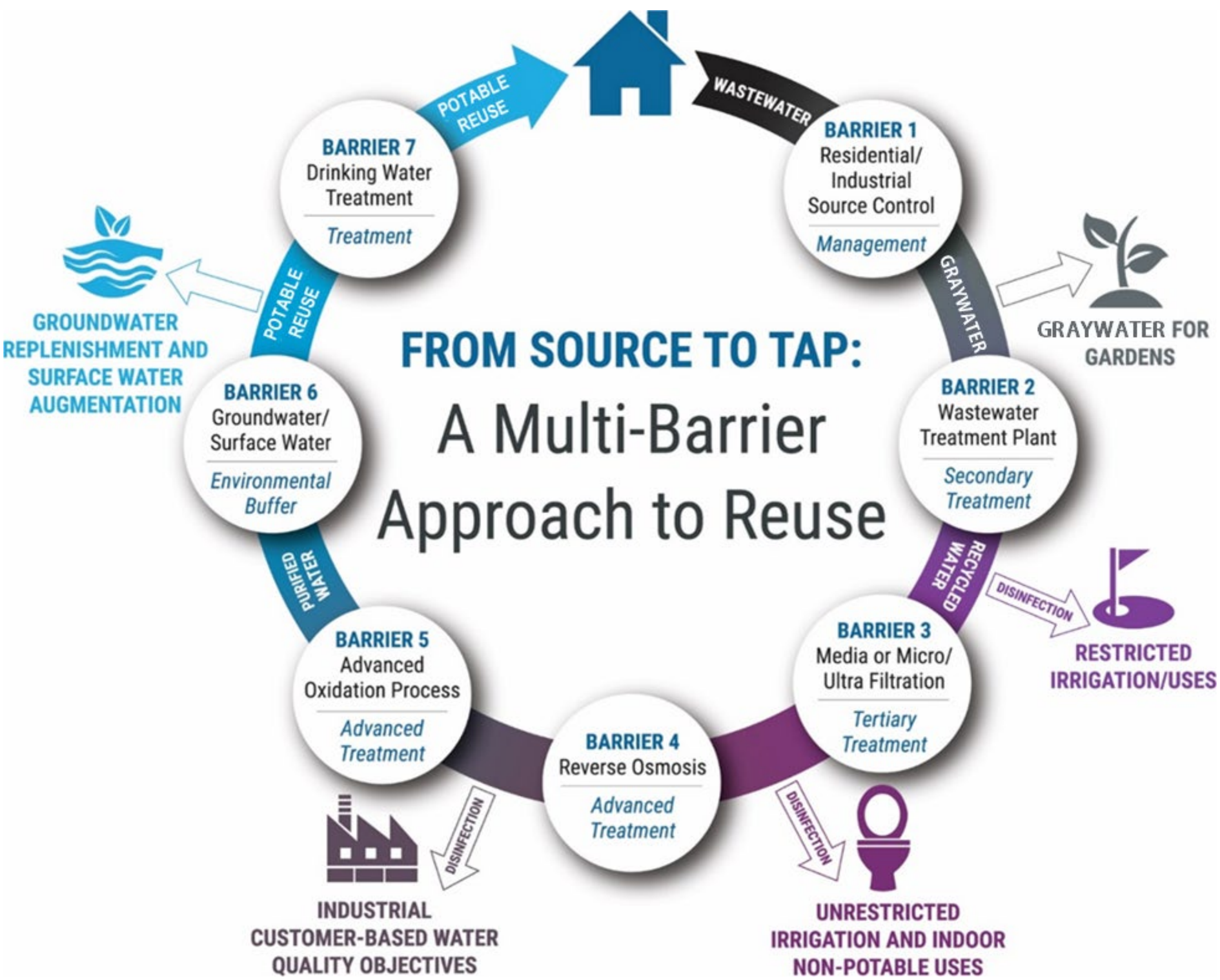
Additional supporting information for this section is included in **Appendix B**: Permitting and Regulatory Requirements

3.1 Identified Uses for Reclaimed Water

Description of all uses for reclaimed water or categories of potential uses. Environmental restoration, fish and wildlife, groundwater recharge, municipal, domestic, industrial, agricultural, power generation, and recreation. Identify any associated water quality, and associated treatment requirements.

Recycled water begins as wastewater that undergoes a series of treatment steps using a multi-barrier approach to remove organic matter and pollutants. The production and use of recycled water must adhere to strict regulations stipulating the levels of treatment, allowable types of reuse, and water quality requirements. Figure 3-1 illustrates the multi-barrier approach to reuse, highlighting the increasing level of treatment necessary to produce the right quality of water for the right use.

Figure 3-1: Multi-Barrier Approach to Reuse



Non-potable reuse has many applications but for purposes of this document, refers to the use of tertiary treated municipal wastewater for a specific purpose other than drinking, such as landscape irrigation, industrial uses, agriculture, or for environmental benefits. In general, water for non-potable reuse does not require the same level of treatment as potable reuse (AWWA, 2016). Centralized non-potable reuse requires dedicated pipe networks and pumping systems, or an alternative delivery system such as trucking (WRF, 2014b). Throughout California, NPR has been ongoing for the last century, and regulations for NPR have been in place since the 1970s. As previously noted, SVCW has been producing recycled water for Redwood City's recycled water program since 2000 for current non-potable customers.

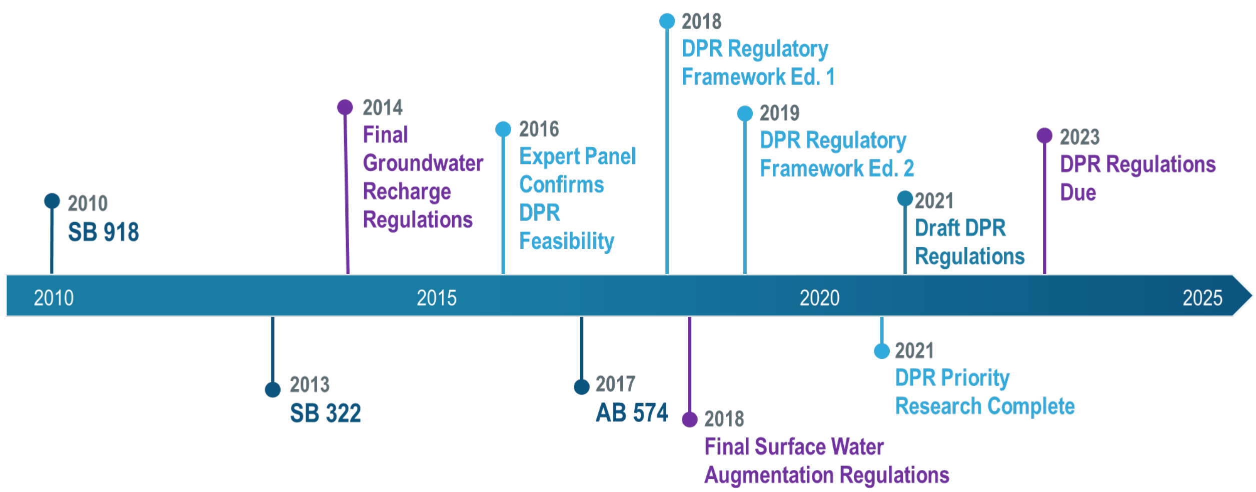
Potable reuse refers to the intended use of highly treated or purified municipal wastewater to augment a water supply that is used for drinking and all other purposes. Unplanned potable reuse, where one community draws raw water supplies downstream from wastewater treatment plant discharges, is regulated by state and federal discharge requirements for WWTPs. Implementing planned potable reuse involves a more formal public process and regulatory consultation, and the regulations in California for indirect and direct potable reuse are at varying stages of development. AB 292, introduced in January 2019, aims to eliminate the distinctions of "indirect potable reuse" and "direct potable reuse" and define "potable reuse" to include groundwater augmentation, ResWA, RWA, and treated water augmentation.

The definitions herein reflect the proposed language in AB 292 and references the terms used in existing law.

- **"Groundwater augmentation"** means the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system, as defined in Section 116275 of the Health and Safety Code. *(Previously referred to as IPR via groundwater replenishment reuse)*
- **"Reservoir water augmentation"** means the planned placement of recycled water into a raw surface water reservoir used as a source of domestic drinking water supply for a public water system, as defined in Section 116275 of the Health and Safety Code, or into a constructed system conveying water to such a reservoir. *(Previously referred to as IPR via surface water augmentation (SWA))*
- **"Raw water augmentation"** means the planned placement of recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system, as defined in Section 116275 of the Health and Safety Code. *(Previously referred to as direct potable reuse (DPR) into a raw water supply upstream of a drinking water treatment plant)*
- **"Treated drinking water augmentation"** means the planned placement of recycled water directly into a finished water distribution system of a public water system, as defined in Section 116275 of the Health and Safety Code. *(Previously referred to as DPR into a potable water supply distribution system downstream of a drinking water treatment plant)*

Figure 3-2 illustrates the progression of potable reuse regulations and legislation. Regulations for groundwater augmentation became effective on June 18, 2014. Final recycling criteria for ResWA were adopted by the State Board on March 6, 2018 and became effective on October 1, 2018.

Figure 3-2: Progression of California Potable Reuse Regulations and Legislation



Currently, RWA and TWA are not yet included as allowable uses in California, though a report released by the State Board on December 26, 2016, concluded that it is feasible to regulations for RWA and TWA, provided that certain research and key knowledge gaps are addressed (State Board 2016).

- AB 574, signed on July 5, 2017, further required the State Board to adopt uniform water recycling criteria for potable reuse through RWA on or before December 31, 2022.
- The State Board published a proposed framework for regulating DPR (State Board 2018), which evaluated how public health threats, risk management opportunities and permitting options vary between the range of potable reuse forms and how public health must and will be protected in all cases.
- The Framework also set forth a schedule for completing the recommended research from the prior investigation of developing raw water augmentation criteria (WateReuse 2016).
- In March 2021, the State Board released a DPR Framework Addendum that included an early draft of the anticipated criteria for DPR.
- In August 2021, an updated DPR Framework 2nd edition Addendum was released that included an updated early draft of the anticipated criteria for DPR and an updated schedule for completing research and development of a regulatory framework that is protective of public health.
- To comply with state mandates, the DDW has also established an expert panel to review the draft DPR criteria and provide inputs by the end of 2023. Details on the draft DPR criteria are discussed in **Appendix B**.

3.2 Water Market

Water Market Available to Utilize Recycled Water to be Produced

The PREP Project focused on the market for potable reuse, which included augmentation of drinking water reservoirs and distribution systems on the San Francisco Mid-Peninsula. Once intermingled with the drinking water system, the market for RWS drinking water will be relevant.

The market for non-potable reuse was not a focus of the PREP Project.

3.2.1 Description of the market assessment procedures used

A summary of the market assessment for the three PREP Phases is provided herein to provide a reference to the approach used to assess the market for different types of potable reuse.

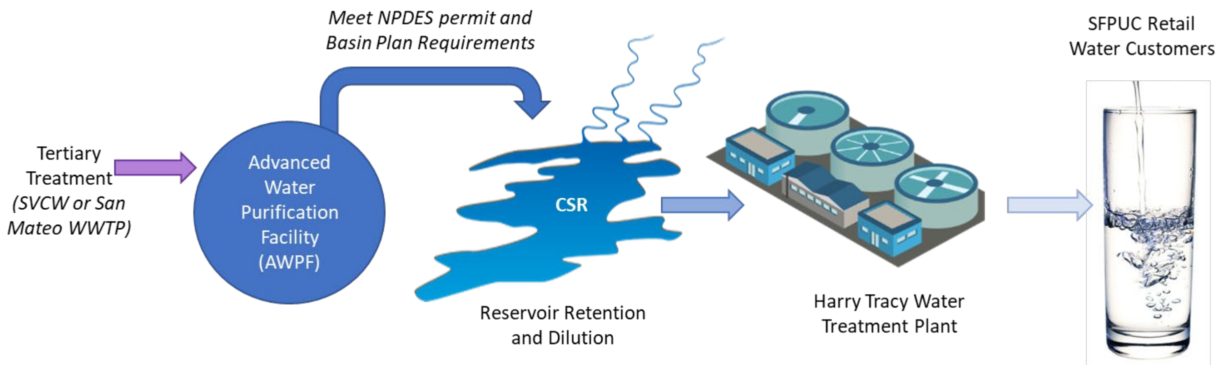
- The PREP Phase 1 Initial Study evaluated project alternatives for groundwater augmentation in the San Mateo Plain Basin, and ResWA at CSR and at Bear Gulch Reservoir. RWA or TWA alternatives were not considered as part of the Initial Study. Groundwater augmentation was deemed not viable for further study due to uncertainty about groundwater basin capacity and well siting limitations. It was also determined the use of Bear Gulch Reservoir for
- For Phase 2, the PREP Parties agreed to proceed with the evaluation of ResWA at CSR to confirm the ability to meet finalized ResWA regulations, further explore institutional issues, evaluate pipeline alignments, and refine costs.
- For Phase 3, the PREP Parties agreed to proceed with the evaluation ResWA at CSR and develop direct potable reuse alternatives to explore RWA at Bear Gulch Reservoir and TWA on the San Francisco Mid-Peninsula Region. Thus, the following sections focus on regulatory and treatment requirements for potable reuse via ResWA, RWA and TWA.

The following sections describe the identified potential uses for purified water for the PREP Phase 3 Project.

3.2.1.1 Reservoir Water Augmentation (ResWA)

A potable reuse project via reservoir augmentation, also referred to as indirect potable reuse (IPR), involves the use advanced treated recycled water for augmenting a reservoir that is designated as a source of municipal water supply. According to the finalized Surface Water Augmentation (also referred to Res WA in this report) regulations, the viability of a ResWA project depends on the dilution ratio and the retention time achievable in the reservoir. No RWA projects currently exist in California, although three are moving forward in southern California: (1) Pure Water San Diego (San Diego 2022); (2) East County Advanced Water Purification Program (East County 2022);, and (3) Pure Water Project Las Virgenes-Triunfo (LVT JPA 2022). The PREP Phase 3 RWA concept is depicted in Figure 3-3.

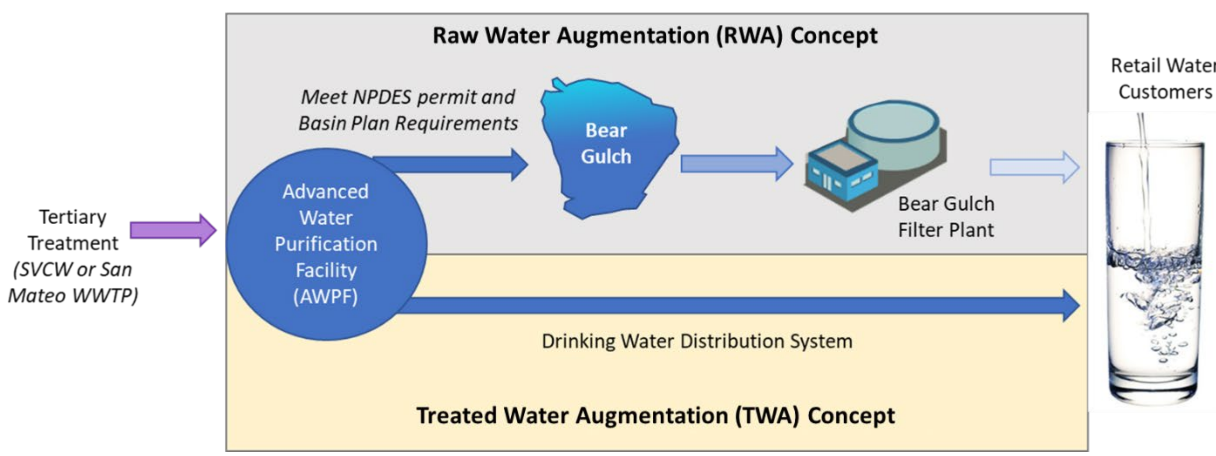
Figure 3-3: ResWA Concept



3.2.1.2 Raw Water and Treated Water Augmentation

DDW defines direct potable reuse as, "the planned introduction of recycled water either directly into a public drinking water system, or into a raw water supply immediately upstream of a drinking water treatment plant." As illustrated in Figure 3-4, RWA and TWA both involve the use of advanced treated recycled water for augmenting a municipal water supply. For the RWA concept, Bear Gulch reservoir is unable to meet the dilution ratio and the retention time required for ResWA, but the Bear Gulch Filter Plant still provides an additional treatment buffer. For the TWA concept there is no additional environmental or treatment buffer, and the purified water would directly augment the drinking water distribution system via and storage tank or transmission pipeline.

Figure 3-4: RWA and TWA Concepts



3.2.2 Identification of potential users

Define the expected use, peak use, on-site conversion costs, and desire to use recycled water for each potential user, including letters of intent if available. Consultation with Potential Recycled Water Customers

The PREP Project does not identify non-potable users for recycled water, thus there are no on-site conversion costs, letters of intent from potential users or consultations with potential recycled water customers conducted as part of this effort.

The primary users of purified water from the PREP Project would be existing customers served by the PREP water agencies, which includes the SFPUC, CalWater, Redwood City, EMID/Foster City and potentially other BAWSCA agencies. An overview of each party and infrastructure relevant to the PREP is provided in Section 3.4.

3.3 Potential Project Challenges

Inhibitors may be physical, monetary, converting systems for reused water, or public acceptance. Identify methods or community incentives to stimulate recycled water demand, and methods to eliminate obstacles.

There are inherent challenges associated with the introduction of a potable reuse program. Some of the potential project challenges for implementing a potable reuse on the San Francisco Mid-Peninsula include:

- **High Costs and Construction Impacts:** Infrastructure associated with an AWPF, new pipelines, and a new brine line would be expensive to construct. Construction impacts to the local community, environmental permitting (CEQA), right-of-way acquisitions, and easements would be challenging given the amount of above and below ground facilities that would be constructed as part of the project. The PREP Parties have dealt with many of the issues through other capital improvement projects and would apply similar methods to address obstacles as they arise.

- **Institutional Agreements:** Interagency coordination would be a significant effort due to the number of state and local agencies required to implement the project. Entities include wastewater agencies who own and operate the wastewater treatment plans that would supply the source water, water agencies that would receive purified water, local cities for encroachment permits, and regulatory agencies (including DDW and the RWQCB) for implementation of potable reuse. The PREP Parties, as stakeholders, have already initiated discussions internally, and as the project develops conversations with regulators and local agencies will continue to address issues and negotiate agreements.

- **Public Outreach:** Public perception regarding a potable reuse project can be a significant barrier to overcome. The PREP Parties will take a proactive approach to stakeholder engagement, retaining a communication firm specializing in water programs to involve the community, NGOs, and local leaders to help navigate the political, social, and technical hurdles that will need to be overcome in order to implement a successful surface water augmentation project.

- **Implementation:** Potable reuse projects are complex, with many technical, regulatory, and operational challenges to overcome.
    - For ResWA at CSR, additional project challenges include management of operations of CSR reservoir (e.g., meeting lake level requirements, environmental releases and overall Regional Water System operational constraints) and demonstrating that the purified water will meet and exceed ambient water quality without causing degradation.
    - For RWA at Bear Gulch, similar reservoir management and water quality challenges would apply with the additional challenge of the need for considerable upgrades at the existing water treatment plant and dam.
    - For TWA, the potential for purified water to dominate the local water supplies and integration of flows with current operations are challenges that would need to be addressed.

Over the last 5 years, the PREP Parties have evaluated a range of potable reuse projects, removed from further considerations projects that had insurmountable obstacles, and identified implementation challenges and potential solutions along the way. The PREP Parties are committed to working together, to meet regulatory requirements using innovative technologies and operational expertise to implement the best project for the region.

3.4 Stakeholders

Identification of all the water and wastewater agencies that may have jurisdiction in the potential service area or over the sources of reclaimed water that are desired.

The pursuit of a potable reuse project in the region would solicit the interest of numerous stakeholders on the San Francisco Mid-Peninsula and the surrounding area. An initial list of potential stakeholders that may be interested in future developments of a PREP Project is provided in Table 3-1.

Table 3-1: List of Potential Stakeholders

Category	Organization Name
Water Agency	SFPUC, BAWSCA, Cal Water
Wastewater Agencies	SVCW, City of Redwood City and City of San Mateo
Hetch Hetchy Regional Water System Members	City and County of San Francisco BAWSCA 26 Member Agencies
Direct Connections to CSR	Coastside County Water District City of Daly City, South San Francisco, City and County of San Francisco, City of San Bruno, Westborough, North Coast County Water District,
Other Direct Connections to CSR or Harry Tracy WTP	Agencies/cities that may receive flows from the Sunset Branch pipeline during emergencies/outages
Cities or other entities in ROW or Party to Existing JPAs/Agreements	Redwood City, Belmont, Foster City, San Carlos, City of San Mateo, San Mateo County, West Bay Sanitary District, Estero Municipal Improvement District
Environmental groups	Natural Resources Defense Council, Sierra Club, California Coastkeepers Alliance, Surfrider Foundation, Pacific Institute, San Francisco Baykeeper, Save the Bay, Tuolumne River Trust Open the SF Watershed, Bay Institute, Wholly H2O
Universities/Schools (if interested)	San Francisco Universities: UC San Francisco, San Francisco State University, University of San Francisco, Golden Gate University, Silicon Valley Universities: Stanford University, San Jose State University, Santa Clara University, others. Local schools
Community Groups	Sustainable Silicon Valley, Sustainable San Mateo County, Silicon Valley Leadership Group, Silicon Valley Joint Venture, Redwood Shores, Concerned Citizens, Green County San Mateo
Other Groups	**Medical Groups** – Santa Clara County, San Mateo County, and other Medical Associations **Industry/Business Groups** – Bay Area Council, Bay Area Council Economic Institute, Association of Bay Area Governments (ABAG), Silicon Valley Leadership Group **Water-Related Associations/Organizations** – WateReuse, AWWA, CWEA, ACWA, BACWA, San Francisco Estuary Institute, ReNUWit
Governmental/Regulatory Jurisdiction	SWRCB /DDW, San Francisco Bay RWQCB County Health Departments, California Public Utilities Commission, California EPA and US EPA, US Bureau of Reclamation (Title XVI)

The following sections provide an overview of each party and infrastructure relevant to the PREP.

3.4.1 Silicon Valley Clean Water (SVCW)

SVCW is a Joint Powers Authority (JPA) governed by four member agencies (City of Redwood City, West Bay Sanitary District, San Carlos, and Belmont). SVCW's Wastewater Conveyance System takes wastewater from each of the JPA member agencies' collection systems and delivers it to the SVCW wastewater treatment plant (WWTP) located adjacent to San Francisco Bay at the northeast end of Redwood Shores. The individual members of the JPA own and operate the sanitary sewer collection systems within their respective jurisdictions. SVCW owns and operates the WWTP, as well as the conveyance system force main and pump stations that convey the raw wastewater to the treatment plant. SVCW produces recycled water for Redwood City for unrestricted non-potable uses.

3.4.2 City of San Mateo

The City of San Mateo provides stormwater, sewer, and wastewater treatment services to more than 150,000 people and businesses in the City of San Mateo's service area. The San Mateo WWTP, located north of the San Mateo Bridge and east of Hwy 101, is jointly owned by the cities of San Mateo and Foster City/Estero Municipal Improvement District and operated by the City of San Mateo. The treated effluent is discharged to a deep-water channel of the San Francisco Bay. The City of San Mateo, through it's Clean Water Program is upgrading the existing WWTP to eliminate sanitary sewer overflows, meet current and future regulatory requirements, ensure wet-weather capacity, and explore water reuse opportunities.

3.4.3 Bay Area Water Supply and Conservation Agency (BAWSCA)

BAWSCA was created in 2003 to represent the interests of cities, water districts, and private utilities in Alameda, Santa Clara and San Mateo counties that purchase water on a wholesale basis from the San Francisco Regional Water System (RWS). BAWSCA is governed by a 26-member Board of Directors comprised of a representative from 24 cities and water districts that are member agencies of BAWSCA, and two private utilities that also have appointees to the board, Stanford University and California Water Service Company. BAWSCA has the authority to directly represent the needs of the cities, water districts, and private utilities (wholesale customers) that depend on the RWS.

3.4.4 California Water Service (Cal Water)

Cal Water, formed in 1926, is a San Jose-based company that serves 484,900 customer connections through 28 Customer and Operations Centers throughout the state. The Cal Water Bayshore District serves the SF Bay Area Region, including San Carlos, San Mateo, South San Francisco, and the Town of Colma. The Bear Gulch District serves the communities of Atherton, Portola Valley, Woodside, parts of Menlo Park, parts of unincorporated Redwood City, and adjacent unincorporated portions of San Mateo County including West Menlo Park, Ladera, North Fair Oaks, and Menlo Oaks. Cal Water purchases potable water from SFPUC, pumps supplemented by local groundwater wells, and delivers it to customers via a system of drinking water pipelines, storage tanks, and booster pump stations.

3.4.5 City of Redwood City

The City of Redwood City is the third largest city in San Mateo County, with 82,881 residents. Redwood City is a member agency of the SVCW JPA and owns and operates two 2-million-gallon storage tanks, a 1-million-gallon chlorine contact tank, a distribution pump station at the SVCW facility, and 17 miles of distribution pipelines to serve tertiary recycled water to non-potable reuse customers in the City's service area.

3.4.6 The San Francisco Public Utilities Commission (SFPUC)

The SFPUC provides retail drinking water & wastewater services to the City of San Francisco, wholesale water to three SF Bay Area counties, green hydroelectric & solar power to Hetch Hetchy electricity customers, and power to the residents & businesses of San Francisco through the CleanPowerSF program. The SFPUC is the third largest municipal utility in California, serving 2.7 million residential, commercial, and industrial customers in the SF Bay Area. The SFPUC owns and operates the Hetch Hetchy Regional Water System (Figure 2-1), which includes Crystal Springs Reservoir (CSR) and the Harry Tracy WTP, where stored water from CSR is treated before being supplied to drinking water customers.

3.5 Potential Sources of Water to be Reclaimed

All potential sources including impaired surface and groundwater sources.

The primary source of water to be reclaimed is municipal wastewater from the SVCW JPA member agencies' (Belmont, San Carlos, Redwood City, and West Bay Sanitary District) collection systems, which is treated at the SVCW facility and/or municipal wastewater from the City of San Mateo's and Foster City's service area, which is treated at the San Mateo WWTP. The SVCW and San Mateo WWTP facilities are further discussed in the next sections.

3.6 Source Water Facilities

Description and location of the source water facilities, including capacities, existing flows, treatment processes, design criteria, plans for future facilities, and quantities of impaired water available to meet new reclaimed and reused water demands.

The SVCW facility and the San Mateo WWTP are the two source water facilities in consideration and are located approximately four miles apart in the cities of Redwood City and San Mateo, respectively, as depicted in Figure 3-5.

Figure 3-5: Potential Sources of Treated Wastewater

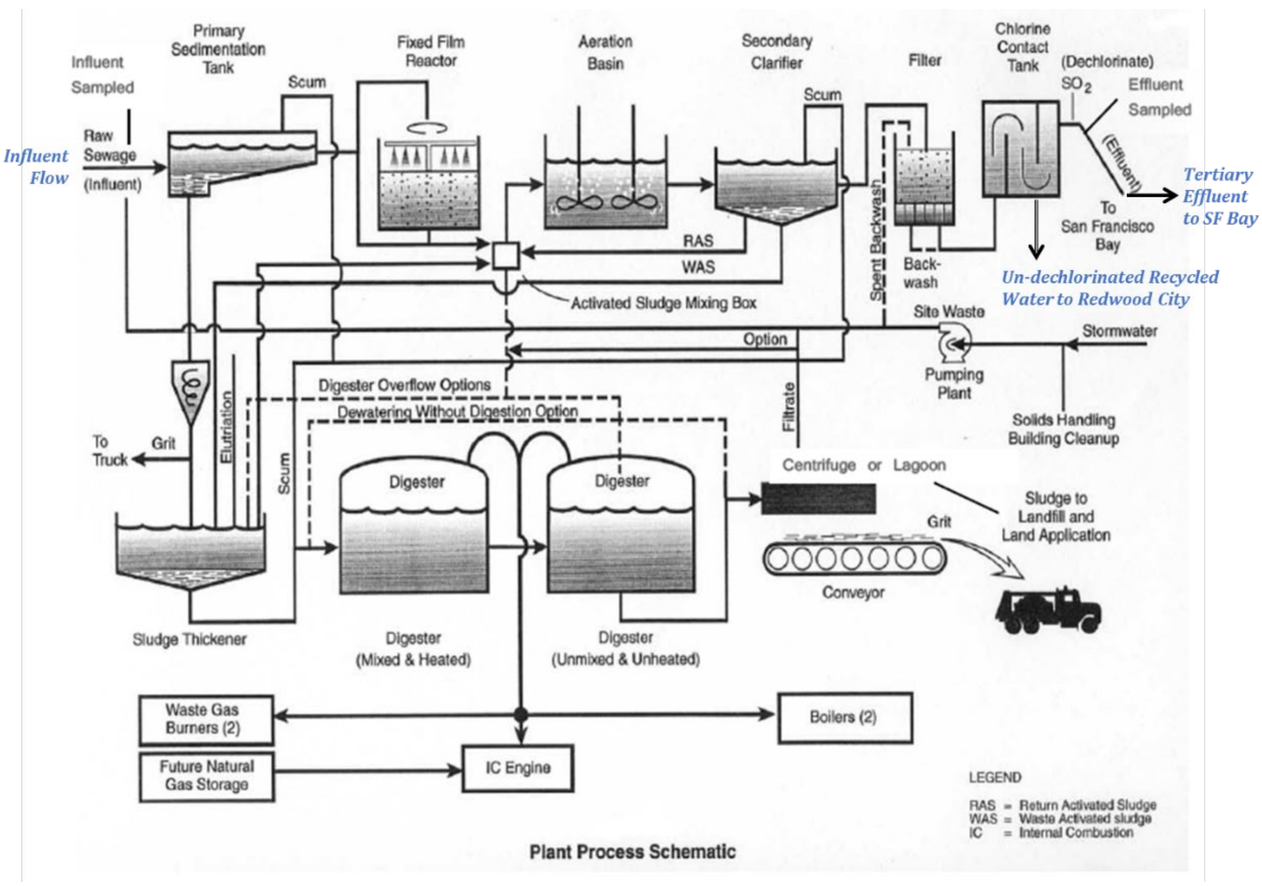
3.6.1 Silicon Valley Clean Water (SVCW)

The SVCW's Wastewater Conveyance System takes wastewater from each of the JPA member agencies' (Belmont, San Carlos, Redwood City, and West Bay Sanitary District) collection systems, serving 220,000 customers. The wastewater is pumped to its wastewater treatment plant located adjacent to San Francisco Bay at the northeast end of Redwood Shores. The individual members of the JPA own and operate the sanitary sewer collection systems within their respective jurisdictions, and West Bay Sanitary District (WBSD) also owns the existing Flow Equalization Facility (FEF), which can be used to store its wastewater during wet weather conditions. SVCW owns and operates the facility, as well as the conveyance system force main and pump stations that convey the raw wastewater to the treatment plant.

SVCW is a water resource recovery facility that meets all stringent federal and state regulations. Built in 1980, the SVCW facility enables wastewater to be recycled and the fragile ecosystem of the San Francisco Bay to be protected for current and future generations to enjoy (SVCW 2022). The SVCW facility uses an advanced, two-stage biological treatment facility where wastewater passes through physical and biological processes, which result in high-quality effluent being discharged to the deep-water channel of the San Francisco Bay (SF Bay). The facility has a peak wet weather flow capacity of 71 mgd. The SVCW treatment process schematic is shown in Figure 3-6.

SVCW is successfully producing recycled water for Redwood City's Phase 1 Recycled Water Project that meets Title 22 of the CCR for unrestricted non-potable uses. The facilities constructed on SVCW's site include tertiary treatment and disinfection, pumping, and storage. Future filtration and storage improvements are planned for the Phase 2 expansion of Redwood City's recycled water system.

Figure 3-6: The Silicon Valley Clean Water Treatment Process Schematic



3.6.1.1 SVCW Available Flow

SVCW has a permitted Average Dry Weather Flow (ADWF) capacity of 29 mgd and a peak wet weather flow capacity of 71 mgd. As shown in Figure 3-6, un-dechlorinated tertiary effluent is supplied to Redwood City to meet recycled water demands, and the remaining tertiary effluent is discharged into SF Bay. From 2013 to 2020, the average monthly effluent flow discharged to SF Bay was approximately 13.7 mgd.

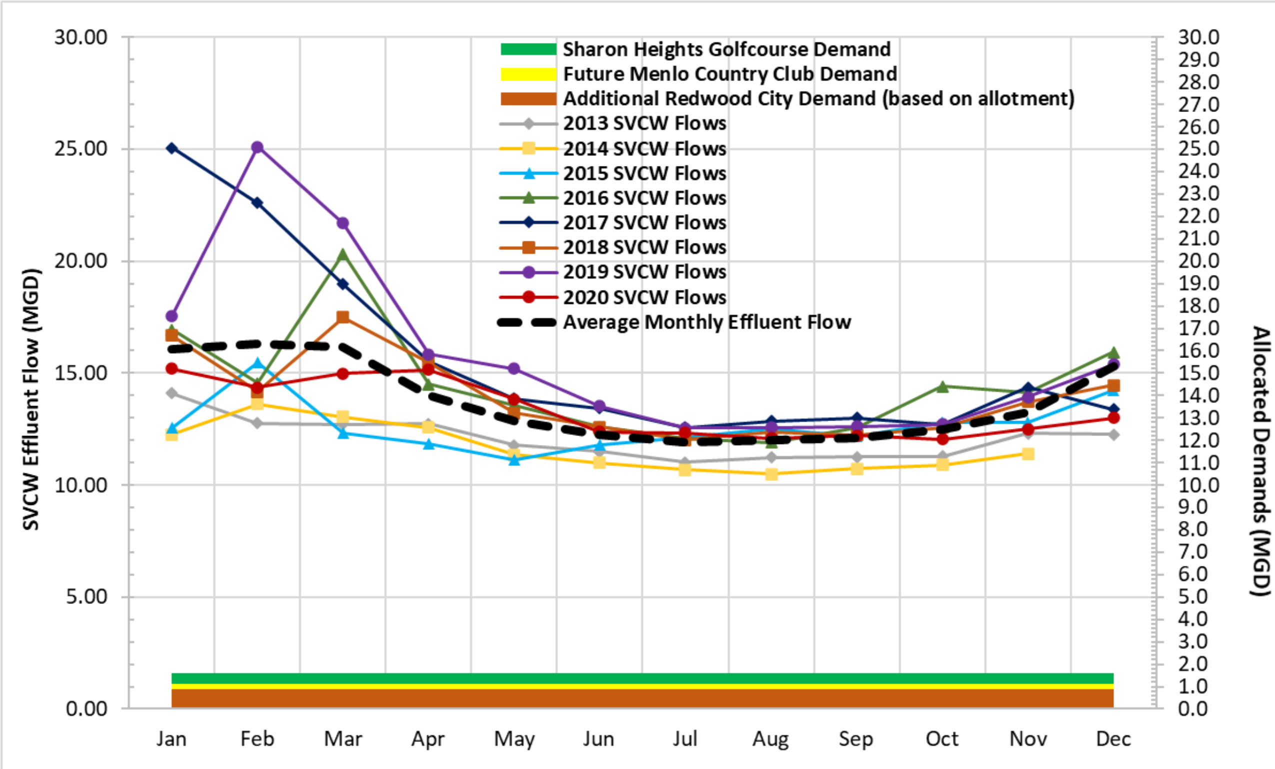
During the 2013-2020 period, the average monthly flow during the dry-weather months (May – October) was approximately 12.3 mgd. This flow was used to provide a conservative estimate of the amount of effluent available for reuse.

- Sharon Heights Golf and Country Club (SHGCC) and WBSD have a newly constructed recycled water facility, where SHGCC pumps and treats raw wastewater from the WBSD collection system and uses it for irrigation at the golf course. This project diverts up to 0.5 mgd of influent from SVCW.
- Redwood City has a total allotment of 2.9 mgd of tertiary recycled water. During this same period of record, Redwood City has used 0.72 mgd on an average annual basis and the highest monthly average use (in July 2020) was about 1.3 mgd. Redwood City reserves the right to the remaining 2.18 mgd of effluent.
- Menlo Country Club (Menlo CC) is in the SVCW wastewater service area and currently receives potable water from the SFPUC. Menlo CC has expressed interest in switching to recycled water. For this study, it is assumed that Menlo CC's 0.2 mgd of demand would be met by a satellite recycled water facility, hence reducing the amount of influent to SVCW.

Based on the above allotments and demands, an daily average of approximately 9 mgd to 11 mgd of effluent could be available for source water supply. It is recognized that continued water conservation, recycled water allocations and the demand for non-potable recycled water may compete with the availability of source water for the project. It is also recognized that influent flow from the wastewater conveyance system follows a diurnal curve that is typically at its minimum values during the early morning hours. Diurnal storage equalization and/or coordination with future tunnel operations would be required to maintain consistent flows for further purification. The availability of source water and need for storage will be further evaluated in future design phases.

The average monthly effluent flows into SF Bay for 2013 to 2020 are shown in Figure 3-7.

Figure 3-7: SVCW Average Monthly Effluent Flows (2013 – 2020)



Note: hourly dry-weather flows were not evaluated as part of this effort and should be further assessed in conjunction with equalization storage to estimate the minimum potential daily supply of available effluent.

For the purpose of this Study, it is assumed that 8 mgd would be conveyed to an Advanced Water Purification Facility (AWPF) and the remaining flow would serve to dilute the reject water, or reverse osmosis (RO) concentrate, which is returned to the outfall. During the dry weather months there may only be 2.7 mgd available for dilution, however during the wet weather months there will be additional flow available for mixing, which may vary based on the amount of inflow and infiltration (I&I) during storm events.

Assuming a 75 percent recovery rate for the AWPF that consists of low-pressure membrane filtration, via microfiltration (MF) or ultrafiltration (UF) as pretreatment prior to reverse osmosis (RO), the amount of purified water available for potable reuse would be about approximately 6 mgd. Additional discussion of treatment requirements and AWPF processes are provided in **Appendices B** and **C**, respectively.

3.6.1.2 SVCW Wastewater Water Quality

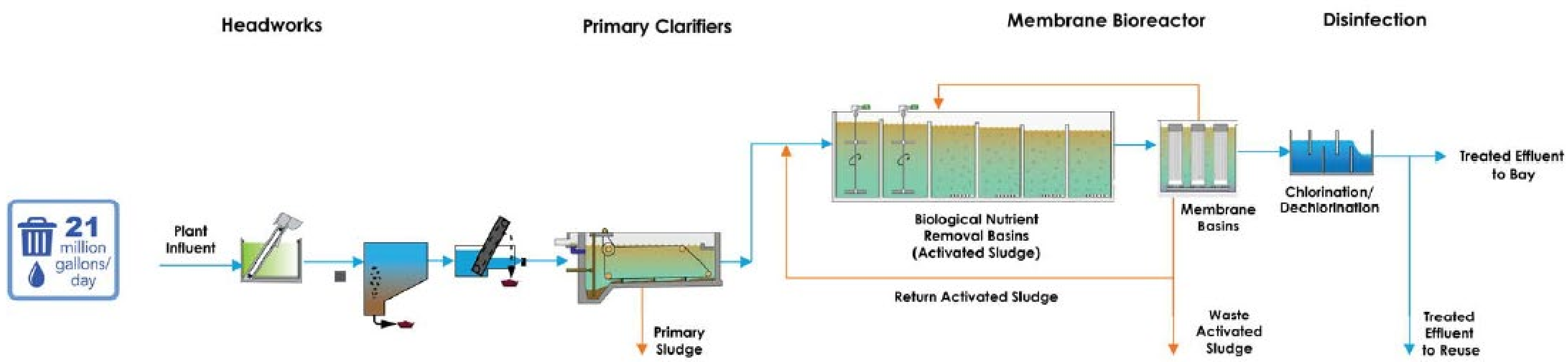
SVCW effluent consistently meets the requirements set forth in their discharge permit (Order No. R2-2018-0005; National Pollutant Discharge Elimination System (NPDES) permit No. CA 0038369) from the San Francisco Bay RWQCB (RWQCB 2013). SVCW could provide tertiary effluent, or Title 22 water depending on the desired water quality to facilitate efficient operation of an AWPF. Table 3-2 lists average water quality for some constituents of interest used to evaluate the potable reuse alternatives, based on available data at the time of this study. Future data collection efforts will be necessary to understand the water quality of the influent to the AWPF and estimate the anticipated water quality of the resulting purified water.

3.6.2 City of San Mateo

The San Mateo WWTP is jointly owned by the cities of San Mateo and Foster City/Estero Municipal Improvement District and operated by the City of San Mateo. The San Mateo WWTP serves more than 150,000 people and businesses in the City of San Mateo's service area. The current treatment plant uses bacteria to remove organic material and toxins from the wastewater it treats. Wastewater arrives at the plant through a series of pipelines and pump stations, which then passes through a series of physical and biological processes. The resulting high-quality effluent is discharged to the deep-water channel of the SF Bay.

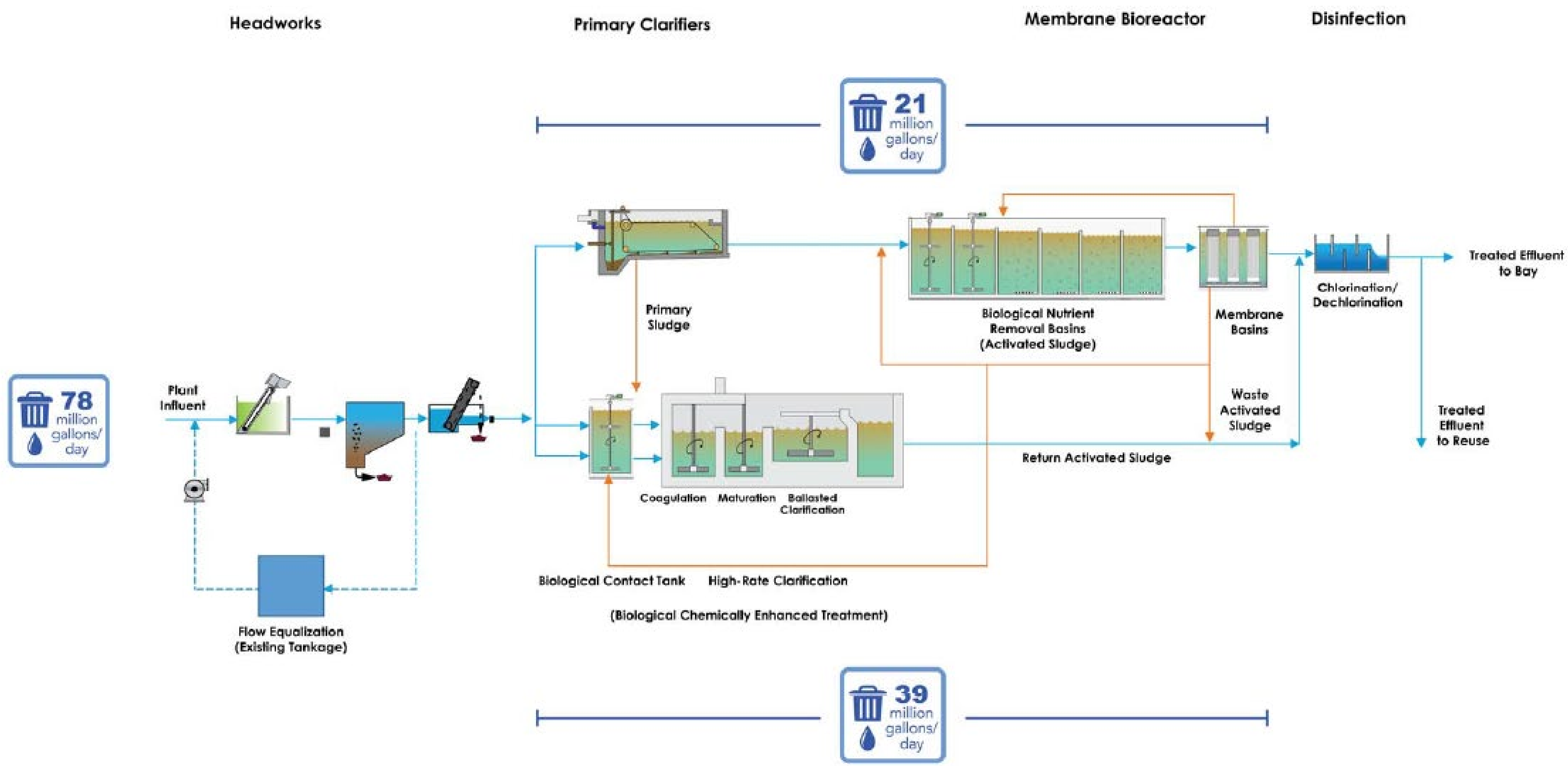
As part of the City of San Mateo's Clean Water Program, the City has pursued a project to upgrade the existing secondary treatment facilities. to replace aging infrastructure, meet current and future regulatory requirements, and ensure wet-weather capacity (San Mateo 2019). This program aligns with the City's sustainability goals to explore water reuse, recover resources, and incorporate sustainable materials into future construction projects. The planned WWTP improvements include new Biological Nutrient Removal (BNR) Basins and a new Membrane Bioreactor (MBR) system, in addition to other supporting treatment processes. By effectively treating wastewater at an advanced biological treatment facility, the future plant will help keep SF Bay environmentally clean and safe. The planned WWTP will have a peak wet weather flow capacity of 78 mgd. A schematic of the proposed treatment approach is shown in Figure 3-8 and Figure 3-9 for average and peak wet weather flows, respectively.

Figure 3-8: San Mateo WWTP Proposed Treatment Process Schematic – Average Flow



Source: San Mateo, 2019

Figure 3-9: San Mateo WWTP Proposed Process Schematic – Peak Wet Weather Flow



Source: San Mateo, 2019

3.6.2.1 City of San Mateo Available Flow

The San Mateo WWTP has a planned average annual flow of 16 mgd and a planned peak wet weather flow of 78 mgd. Currently, the facility treats an average annual flow of 10.6 mgd with an ADWF of approximately 9.6 mgd from 2018-2020 flow data and a maximum wet weather flow of 60 mgd.

The City does not currently have a recycled water program. Since San Mateo has a similar dry weather flow to SVCW, it is assumed that the new MBR facility could provide 8 mgd tertiary effluent, with the potential to contribute an additional 6 mgd of purified water for a regional potable reuse project with 75 percent water recovery through the AWPF. This study assumes that any available effluent from San Mateo that is not used for the AWPF will be used to dilute the RO concentrate if the AWPF is located at San Mateo; however, no additional effluent from San Mateo w be used to dilute the RO concentrate if the AWPF is located at SVCW. Should additional dilution be needed to meet future SF Bay discharge requirements, the conveyance of additional flows from the San Mateo WWTP to the AWPF could be considered.

3.6.2.2 San Mateo WWTP's Water Quality

The City of San Mateo's WWTP's effluent consistently meets the requirements set forth in their discharge permit (Order No. R2-2012-0006; NPDES No. CA 0037541) from the RWQCB (RWQCB 2013). The City has embarked on a project to upgrade the existing secondary treatment facilities to replace aging infrastructure, meet current and future regulatory requirements, and ensure wet-weather capacity and is currently in the design phase, which includes BNR and MBR facilities. Thus, there are no reported water quality data for the future facility. Table 3-2 lists anticipated water quality for some constituents of interest used to evaluate potable reuse alternatives.

3.6.3 Summary of Source Water Options

Table 3-2 summarizes the available flows and assumed water quality for the SVCW source water, the San Mateo WWTP source water, and source water from both facilities combined.

Table 3-2: Summary of Source Water Options

Parameter	Units	SVCW Tertiary Effluent[1]	San Mateo Anticipated Tertiary Effluent[2]	SVCW + San Mateo Combined Tertiary Effluent
Tertiary Flow to AWPF	mgd	8	8	16
Est. Purified Flow	mgd	6	6	12
TDS[3, 4]	mg/L	1,000	1,900	1,450
TSS[4]	mg/L	3.6	9.8	6.7
Turbidity	NTU	3.0	0.25	1.61
CBOD/BOD[5]	mg/L	4 (CBOD)	5 (BOD)	N/A
Total Ammonia (as N)	mg/L	48.0	1	24.5
Total Nitrogen	mg/L	49.4	6.0	27.7
Total Phosphorus	mg/L	4.7	1.0	2.8

[1] SVCW Commonly analyzed parameters from 2012-2021 provided to the RWQCB by City to fulfill NPDES general reporting requirements.
[2] Water quality data for San Mateo is from PREP Phase 2 study (as of September 2019).
[3] TDS data for SVCW is from PREP Phase 2 study (as of September 2019).
[4] TDS and TSS for combined tertiary effluent is shown as an average but is likely to vary based on blending timing and water chemistry.
[5] CBOD = carbonaceous biochemical oxygen demand; BOD = biochemical oxygen demand

3.7 Existing Water Reuse

Description of the current water reuse taking place. Include a list of reclaimed water uses, types and amount of reuse, and a map of existing pipelines and use sites.

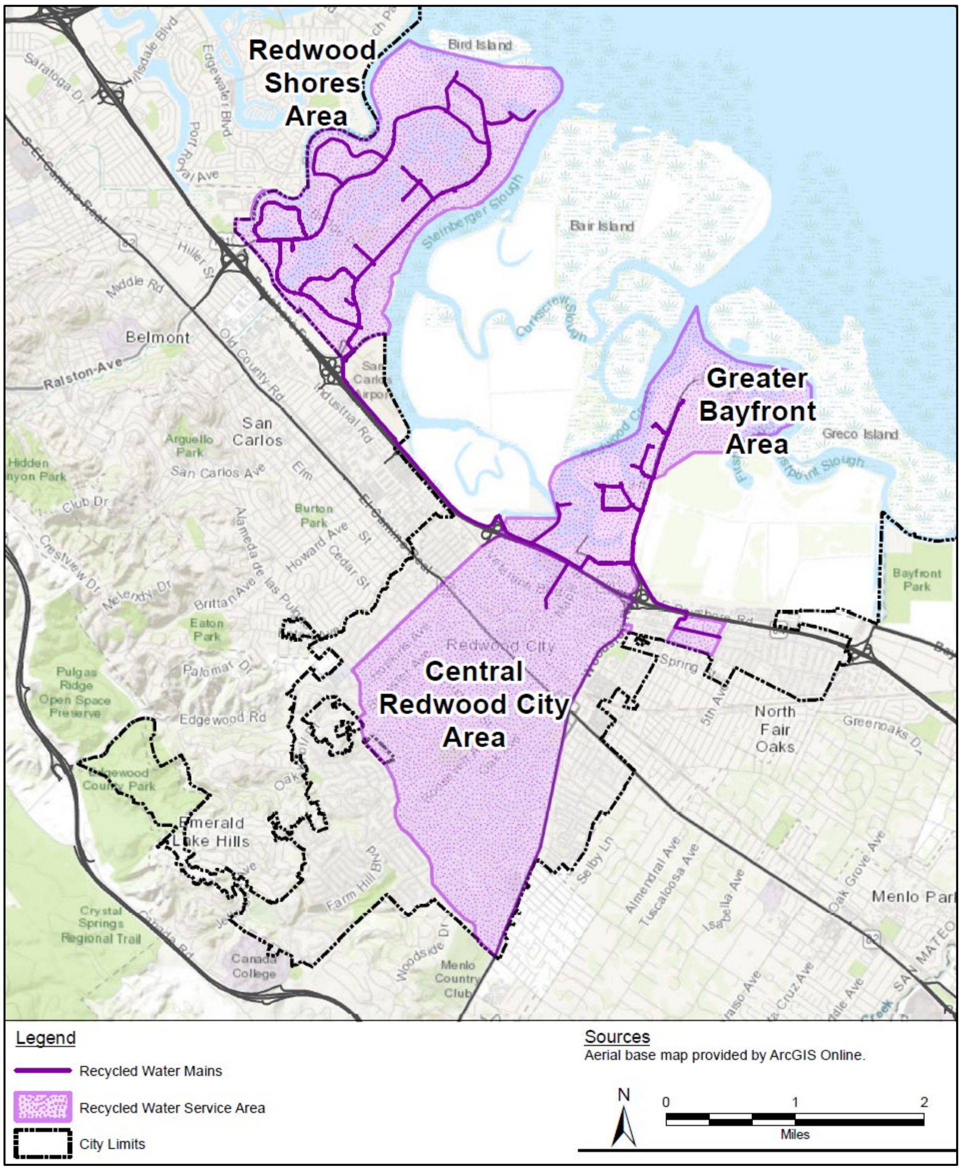
3.7.1 Current Uses

The SVCW currently produces tertiary-treated disinfected recycled water that meets the standards specified in Title 22 of the CCR for unrestricted non-potable use. Once the upgrades at the San Mateo WWTP are completed, the facility will produce recycled water.

Recycled water from SVCW has been utilized by Redwood City's Recycled Water Program, which was first introduced to the community in 2000, with a small trial in Redwood Shores. The program later expanded along the eastern edge of Hwy 101 from Redwood Shores to the Greater Bayfront Area, as shown in Figure 3-10. Redwood City owns and operates two 2-MG storage tanks, a 1-MG chlorine contact tank and a distribution pump station at the SVCW facility, and 17 miles of distribution pipelines to serve non-potable reuse customers.

Over the last five years, Redwood City's recycled water demand increased from 647 AFY in 2016 to 856 AFY in 2020. During this period, recycled water demand as a percentage of total water demand increased from 7.3 percent to 8.0 percent. Almost all recycled water is currently used for landscape irrigation with some indoor uses for toilet and urinal flushing, and a small portion dedicated to industrial, and construction uses. (EKI, 2021)

Figure 3-10: Redwood City Recycled Water Service Area and Distribution System



Source: City of Redwood City 2020 UWMP (EKI, 2021)

Cal Water's Bayshore District nor EMID have plans to reuse the tertiary effluent that will be produced at the San Mateo WWTP once the upgrade is completed in 2025.

3.8 Water Reclamation and Reuse Technology

Summary of water reclamation and reuse technology currently in use, and opportunities for development of improved technologies.

The current tertiary treatment process at SVCW is illustrated in Figure 3-6 and a schematic of the proposed treatment approach at the San Mateo WWTP is shown in Figure 3-8 and Figure 3-9, for average and peak wet weather flows, respectively.

Implementation of a potable reuse project would require advanced treatment processes to achieve the necessary levels of public health required for potable reuse via ResWA, RWA and TWA. Table 3-3 summarizes treatment processes considered for potable reuse. The AWPF treatment processes assumed for implementation of each type of potable reuse to meet the regulatory requirements discussed in **Appendix B** is detailed in the following sections.

Table 3-3: Summary of Relevant Treatment Technologies

Treatment Process	Description
Tertiary Filtration	A wastewater post-treatment process that provides filtration to remove the majority of the remaining suspended solids and other pollutants using sand or media filtration.
Microfiltration (MF) or Ultrafiltration (UF)	A membrane-based, low-pressure-driven separation process that provides a barrier to the passage of solids and microorganisms. MF and/or UF does not remove salts (i.e., Total Dissolved Solids [TDS]) or other dissolved constituents like ammonia. For potable reuse applications, the primary goal of MF/UF is to provide pre-treatment for the reverse osmosis (RO) membranes, and to remove suspended particulate matter and larger microorganisms.
Membrane Bioreactors (MBR)	An MBR combines a bioreactor and microfiltration into one-unit process. The microfiltration membrane (cassette) is submerged in the bioreactor and water flows through the membrane either by vacuum or by gravity.
Reverse Osmosis (RO)	A membrane-based, high-pressure-driven separation process that provides a barrier to the passage of particles, colloids, organics, bacteria and pathogens, and the vast majority of dissolved salts. RO produces a very low-TDS product stream and a high-TDS concentrate stream. Initially, RO was considered completely effective at removing all pathogens and chemicals; however, with improving analytical methods, select trace organic compounds have been detected in the RO permeate. This gave rise to the required advanced oxidation process following RO (discussed below).

Treatment Process	Description
Chlorine-based Disinfection	The most common disinfection technology in wastewater treatment and reuse. Chlorine inactivates a diverse group of pathogens, including viruses, and residual chlorine prevents pathogen re-growth during storage and distribution. Free chlorine disinfection can be implemented to achieve virus and *Giardia* credits at multiple places in a potable reuse treatment train. Currently, California water recycling regulations do not differentiate between free and combined chlorine disinfection.
Ultraviolet (UV) Disinfection	Treatment by applying a broad spectrum of radiation with intense peaks at certain wavelengths. UV light penetrates an organism's cell walls and disrupts the cell's genetic material, making reproduction impossible. With the proper dosage, UV irradiation has proven to be an effective disinfectant for bacteria, protozoa, and virus in water, while not contributing to the formation of disinfection byproducts (DBPs).
UV-based Advanced Oxidation Process (AOP)	Treatment by applying light in the presence of an auxiliary oxidant that has been added to the wastewater, such as hydrogen peroxide, ozone, or chlorine. Photo-excited oxidants quickly degrade to form highly-reactive free radicals, which are strong oxidants capable of degrading most natural and synthetic organic compounds present in wastewater. The design of a UV-AOP typically requires UV doses in great excess of those needed for disinfection alone.
Ozone	To generate ozone (O_3), energy is added to oxygen (O_2), splitting the molecules into individual atoms which then collide with oxygen forming ozone. Ozone is then bubbled into water where it oxidizes compounds directly or forms hydrogen peroxyl (HO_2) and hydroxyl (OH) radicals, which oxidize certain contaminants.
Biological activated carbon (BAC)	A biologically enhanced granular activated carbon (GAC) process that removes dissolved organics through adsorption by the activated carbon and biodegradation by bacteria attached on the activated carbon. Biologically activated carbon (BAC) has not been used in a full-scale potable reuse project in California to date but is currently being pursued for the City of San Diego's ResWA project. BAC filtration is often used after ozonation.
Breakpoint Point Chlorination	Breakpoint chlorination is a method to remove ammonia by adding high concentrations of chlorine to oxidize ammonia to nitrogen gas. A theoretical weight ratio of 7.6:1 chlorine to ammonia nitrogen is needed to convert ammonia nitrogen to ammonia gas. Greater ratios may be required in practice.

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Section 4: Description of Alternatives

Description of other water supply alternatives considered to accomplish the objectives to be addressed by the Proposed Title XVI Project. Include benefits to be gained by each alternative, total project cost, life cycle cost, and corresponding cost of the project water produced expressed in dollars per million gallons (MG), and/or dollars per acre-foot. An appraisal level cost estimate, or better, is acceptable for these alternatives.

This section describes the potable reuse alternatives evaluated to determine the selection of the Proposed Title XVI Project that could be implemented by the PREP Parties.

- **Alternative 1:** 6-mgd ResWA in Crystal Springs Reservoir
- **Alternative 2:** 12-mgd ResWA in Crystal Springs Reservoir
- **Alternative 3:** 6-mgd RWA in Bear Gulch Reservoir
- **Alternative 4:** 6-mgd TWA on the San Francisco Mid-Peninsula
- **Alternative 5:** 12-mgd TWA on the San Francisco Mid-Peninsula

Various sub alternatives were also developed to present variations in source water and conveyance alignments. Each alternative would serve to meet the project objectives to improve local water supply reliability and drought resilience and reduce discharges to the San Francisco Bay. The economic analysis is covered in Section 5 and the description of the proposed Title XVI is covered in Section 6.

This section provides a description of the following:

1. Non-Federal Funding
2. Project Objectives and Design Requirements
3. Other Water Supply Alternatives
4. Potable Reuse Alternative Concepts
5. Potential Alignments and Pump Stations
6. Waste-Stream Discharge Treatment and Disposal Water Quality Requirements

Additional supporting information for this section is included in:

- Appendix B: Permitting and Regulatory Requirements
- Appendix C: Treatment Supporting Information
- Appendix D: Conveyance Considerations and Potential Pipeline Alignments
- Appendix E: Water Supply Modeling

4.1 Non-Federal Funding

Description of the non-Federal funding condition. The reasonably foreseeable future actions that the non-Federal project sponsor would take if Federal funding were not provided for the proposed water reclamation and reuse project, including estimated costs.

The project sponsor, responsible for the planning and development of the project, has not been defined at this time. Candidates for project sponsor include the SFPUC, as the owner and operator of the Regional Water System (RWS), or a joint powers authority (JPA) or similar legal entity, consisting of the water agencies and wastewater agencies that will distribute and supply water for the project (PREP Parties).

The project sponsor would be responsible for non-Federal funding and would manage and operate the proposed Project. The project sponsor and project partners would actively seek funding from a variety of sources including local, state, and Federal funding. Should Federal funding not be provided for the selected Project, the project sponsor and project partners would rely on alternative funding vehicles at a state and local level, including grants and low-interest loans. A portion of the project would be financed through rates and revenues from the project sponsor's customers.

The PREP Parties recognize that successful implementation of the project will require all financial and project delivery responsibilities to be accounted for and executable. This means that PREP Parties must agree upon their respective roles in the integrated system and recover the costs associated with their participation, directly or indirectly.

4.2 Project Objectives and Design Requirements

Statement of the objectives all alternatives are designed to meet.

The Project would seek to address two over-arching objectives:

1) Enhance local water supply reliability and resiliency for water providers on the San Francisco Peninsula to prepare for the unpredictability of climate change.
2) Reduce discharge to the San Francisco Bay – helping communities use locally treated water more efficiently and prevent water from becoming a lost resource.

The potable reuse alternatives evaluated herein were developed to take a technically innovative approach, leveraging regional multi-agency cooperation, to solve the ever-growing water shortage and discharge compliance issues in the Parties' service areas. Specified project objectives and design requirements are discussed in this section.

4.2.1 Hydrologic Flow Regimes

Hydrologic flow regime scenarios are defined for the purpose of the Phase 3 PREP to assess how regional water system operations and potable water demands change under a range of hydrologic conditions. Two 6-year hydrologic periods are identified to showcase a range of wet/normal to critically dry operations to represent modeling years to use throughout the analysis. A 6-year drought would realize the maximum benefit of a potable reuse project because in this hydrologic period the RWS has available storage in the system. A 6-year normal/wet period would show the minimum benefit because the RWS has little to no available storage and would result in releases in the upcountry system to make room for purified water.

Based on discussions with the PREP Parties, the following bookend scenarios were selected:

- **6-Year Drought** (*1987-1992), commonly referred to as the* "drought of record in CA", this is the longest sequence of very dry years in recorded history. During this period there was no spill from the RWS to the Tuolumne system.
- **6-Year Normal/Wet** (*1993-1998),* a period with very wet big spill years (1993, 1995-1998) and on extremely dry year (1994), which captures historical spills at CSR, years with physical available storage in the RWS, as well as ripple effect where water will spill in upcountry.

The hydrologic flow regimes are used to evaluate available storage in the RWS for purified water augmentation and potable water demands during dry and wet periods. Monthly potable demands for the PREP water suppliers for the two hydrologic flow regime periods in the winter (October through March) and summer (April through September) months are summarized in Table 4-1. For comparison, annual average demands for the year are also summarized and Table 4-1 and were based on water use presented in each agencies' 2020 UWMP.

Table 4-1: Summary of Potable Demand Analysis for Hydrologic Flow Regimes (mgd)

PREP Water Suppliers	6-year dry period (1987-1992)	6-year wet period (1993 to 1998)	Annual Average[4] (2020)
San Francisco Harry Tracy WTP Deliveries[1]			
Winter	22.5	42.0	32.2
Summer	21.0	22.1	
Cal Water Bear Gulch District			
Winter	7.0	7.3	11.6
Summer	12.5	14.3	
Cal Water Bayshore District – San Mateo[2]			
Winter	9.5	9.4	9.8
Summer	12.9	13.9	
Cal Water Bayshore District – San Carlos[2]			
Winter	3.0	3.0	3.2
Summer	4.2	4.6	
Foster City/EMID			
Winter	3.7	4.0	4.0
Summer	5.4	6.2	
Redwood City[3]			
Winter	7.6	8.7	8.7
Summer	10.5	12.6	

1. SFPUC Annual Average based on 2020-2021 data provided by SFPUC. Historical dry and wet period data from HHLSM Model representing San Andres Reservoir Releases to HTWP, where the maximum release was 86 mgd.
2. Cal Water Bayshore District's Mid-Peninsula Annual Average demand based on 2020 UWMP gross water use (13.0 mgd) with an estimated split of 75:25 between San Mateo and San Carlos.
3. Data for 6-year dry period was not available, values shown represent Redwood City demand over the prior of record provided 1997 to 2020. Redwood Shores recent demand ranges from 1.1 mgd in the winter to 1.5 mgd in the summer based on the period of record from 2013 to 2020. Annual average in 2020 does not include recycled water use.
4. Average annual demands as reported in UWMPs

4.2.2 Source Water Flow Projections

The supply objective for the project is to increase water supply reliability by producing up to 12 mgd of new, local, drought-resilient water supplies through potable reuse. To meet this objective, it is assumed that 16 mgd if tertiary treated effluent would be conveyed to an Advanced Water Purification Facility (AWPF) with 4 mgd of reject water, or reverse osmosis (RO) concentrate, returned to the outfall.

SVCW and San Mateo would each contribute 8 mgd of dry weather flow to the project, with the remaining effluent flow serving to dilute the RO concentrate discharged through the outfall. Should additional dilution be needed to meet future SF Bay discharge requirements, the reduction of purified water production during dry period or the conveyance of additional flows from the San Mateo WWTP to the AWPF could be considered. Available source water flow from SVCW and the City of San Mateo are described in further detail in Section 3.6.

4.2.3 Regulatory Requirements

A potable reuse project would enable the PREP Parties to:

- **Reduce the annual volume of effluent discharged** to San Francisco Bay.

- **Comply with applicable potable reuse regulatory requirements** adopted by the State Water Resource Control Board – Division of Drinking Water (DDW). For ResWA, compliance would include minimum retention time, dilution, and advanced treatment requirements. For RWA and TWA, the draft DPR regulations currently impose the same requirements and are currently being reviewing by the DPR expert panel. The final recommendations are expected to be released in December 2023. The draft DPR regulations include additional treatment processes to the advanced treatment requirements for ResWA and the designation of one direct potable reuse responsible agency (DiPRRA) that will be responsible for complying with the DPR regulations. **Appendix B** provides additional detail about regulatory and treatment requirements for potable reuse.

- **Comply with Bay discharge NPDES permit requirements.** In particular, the RO concentrate disposal via SVCW's outfall would need to meet existing and future regulations at the SVCW outfall to the San Francisco Bay (SF Bay), which is regulated under three Waste Discharge Requirements (WDRs) / National Pollutant Discharge Elimination System (NPDES) permits: (1) SVCW Individual WDR, (2) SF Bay Watershed WDR for mercury and PCBs and (3) SF Bay Watershed WDR for nutrients. **Appendix C** provides additional detail about RO Concentrate disposal considerations.

- **Comply with SF Bay Basin Plan regulations** and match or be compatible with background water quality concentrations in receiving water reservoirs. For CSR, this includes un-ionized ammonia concentrations controlled by the SF Bay Basin Plan limits at 0.025 mg/L as ammonia and phosphorus concentrations controlled by the background concentrations in Upper CSR. For Bear Gulch Reservoir, similar quantitative limits on un-ionized ammonia and dissolved oxygen and qualitative limits on bioaccumulation, biostimulatory substances, population, and community ecology, etc. must be met. **Appendix B** provides additional detail CSR and Bear Gulch Reservoir regulatory considerations.

Appendices B and C describe potable reuse regulations and the associated treatment requirements to protect public health and provides an overview of regulatory considerations to discharge to the San Francisco Bay, CSR, and Bear Gulch Reservoir.

4.2.4 Treatment Capacity and Process

As discussed in Section 3.6, it is assumed that a potable reuse project would receive up to 8 mgd of tertiary effluent from the SVCW facility and up to 8 mgd from the City of San Mateo's future BNR/MBR facility, for a total of up to 16 mgd (approximately 18,000 AFY). The AWPF process assumes the following recovery rates:

- MF/UF Recovery Rate = 90 percent
- RO Recovery Rate = 85 percent
- Overall Recovery Rate = 77 percent
- RO Concentrate Disposal Rate = 13 percent

Thus, 8 mgd of tertiary effluent would yield 6 mgd of purified water (approximately 6,720 AFY) and 16 mgd of tertiary effluent would yield 12 mgd of purified water (approximately 13,500 AFY). Considerations for operating the AWPF year-round, seasonally or at a reduced rate are discussed in Section 4.2.6.

All reuse alternatives including ResWA at CSR, RWA at Bear Gulch, and TWA would require Full Advanced Treatment (FAT), which include MF, RO, and UV-AOP. However, RWA and TWA would require additional LRCs attained through the addition of ozone and biologically activated carbon (BAC) to FAT. Because reuse alternative ResWA at CSR is considered indirect potable reuse, ozone and BAF are not expected to be required, but could be added if additional LRCs are desired. An in-depth discussion of potable reuse treatment concepts is provided **Appendix D**.

Additional ammonia removal will likely be required to meet SF Bay Basin Plan Limits for reuse alternatives ResWA at CSR and RWA at Bear Gulch. While RO can be conservatively assumed to remove ionized ammonia at 95 percent efficacy, ionized ammonia will still be present in the purified water discharged to CSR or Bear Gulch. Ammonia may exist as an ionized (e.g., ammonium) or un-ionized (e.g., ammonia) form depending on pH. Around neutral pH, such as those expected for the AWPF and CSR, ammonia is primarily in the ionized form. The SF Bay Basin Plan sets limits for un-ionized ammonia; however, it is conservative to assess removal of total ammonia (ionized and un-ionized ammonia) to levels below those required for the SF Bay Basin Plan.

Breakpoint chlorination is a promising treatment method that can remove ammonia at low cost and leverage existing infrastructure at Pulgas. Additional ammonia removal may not be required for TWA because the recycled water is not discharged to surface water. Treatment alternatives and methods are summarized in Table 4-2. Additional discussion on breakpoint chlorination can be found in **Appendix C**.

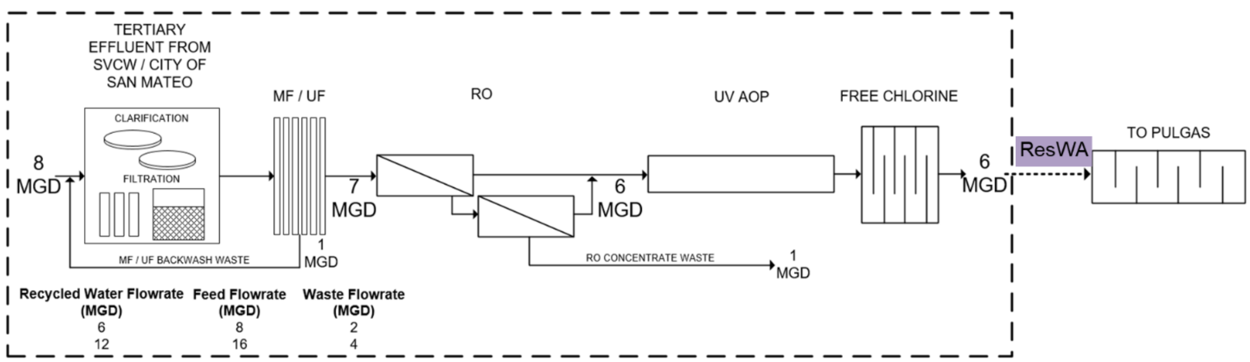
Table 4-2: Summary of Treatment Process for Alternatives

Use	Nutrient Removal Strategy[1]	AWPF	Disinfection Residual	Disinfection Removal
Alt 1 & 2 ResWA @ CSR	Breakpoint Chlorination	MF/RO/UV/AOP	Match RWS inflow to Pulgas	Pulgas Dechloramination
Alt 3 RWA @ Bear Gulch	Breakpoint Chlorination	MF/RO/UV/AOP + O3 + BAC	N/A	New Dechlorination station
Alt 4 & 5 TWA	Chloramination	O3 + BAC + MF/RO/UV/AOP	Match Potable Water Distribution	None

[1] Nutrient removal drivers include meeting SF Bay Basin Plan requirements or match background concentrations for CSR and Bear Gulch Reservoir and meeting potable water distribution requirements for TWA.

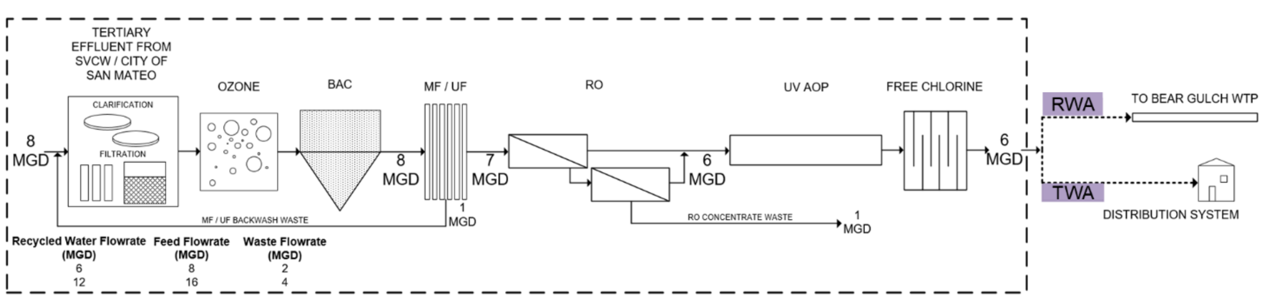
The AWPF process assumed for implementation of ResWA is illustrated in Figure 4-1.

Figure 4-1: Potential AWPF Treatment Processes for ResWA



The AWPF process assumed for implementation of RWA or TWA is illustrated in Figure 4-2.

Figure 4-2: Potential AWPF Treatment Processes for RWA or TWA



Further evaluation of additional treatment requirements and processes would be performed in future phases of a potable reuse program to assure the appropriate level of treatment and to optimize treatment process design.

Appendix C further describes the advance treatment processes removal rates to achieve anticipated pathogen removal credits to meet regulatory requirements.

4.2.5 Conveyance Considerations

Conveyance is a critical component of any recycled water system and often accounts for a significant percentage of capital costs for a project. All potable reuse alternatives would involve conveyance of:

1. Tertiary recycled water from SVCW and/or San Mateo at a new AWPF
2. Purified water from the new AWPF to place of use for augmentation.
3. RO concentrate from the new AWPF to an existing outfall to the SF Bay
4. Repurposing existing infrastructure, such as abandoned pipelines, if available.

Design criteria for conveyance include the following:

- Pipeline maximum velocity = 6 feet per second
- Pipeline minimum velocity = 2 feet per second
- Hazen-Williams Coefficient = 130
- Pump Efficiency = 80 percent
- Variable speed pumps and typical wet-well are assumed for pump stations, with pumps and controls located outside.

A detailed discussion of conveyance considerations is included in **Appendix D**.

4.2.6 Operational Considerations

Appendix E describes the existing water supply models used to simulate operations of the RWS and reservoir operations for CSR and Bear Gulch Reservoir, the two surface water reservoirs being considered for potable reuse. This section summarizes operational considerations for augmentation with purified water.

Hetch Hetchy Local Simulation Model (HHLSM): The SFPUC has developed and maintained a monthly timestep water balance model called the HHLSM, which runs historical hydrology on the entire RWS from 1920 to 2017. HHLSM can be used to simulate the way that different combinations of RWS infrastructure and operational requirements would perform through the historical hydrology. For this effort, the HHLSM model was primarily used to understand the amount of available storage space for purified water in the RWS in dry years, the associated water supply benefits for the RWS, and conversely to evaluate the amount of water that would "spill" from the RWS to make room for purified water when the reservoir system is full (e.g., primarily in wet years).

BAWSCA Regional Water Reliability Model: This model provides member agency perspective on frequency, magnitude and timing of shortages based on each agencies demand and regional supplies. Hazen and Sawyer provided the PREP Parties output of modeled shortages from July 1986-2011 to identify shortages by the PREP Parties during the defined hydrologic flow regimes. This served to inform the benefit of a potable reuse project to supplementing supplies during dry years.

CSR Reservoir Operation Model: A CSR Reservoir Operations Model (CSR ROM) for Reservoir Water Augmentation was developed for this study using a monthly time-step based on outputs from SFPUC's HHLSM model (described in **Appendix E.1**). The purpose of the CSR ROM is to:

1) Estimate the available storage in the RWS and the amount of Hetch Hetchy water that would "spill" in the upcountry system as a result of purified water addition to CSR, and
2) Simulate how a potable reuse project that introduces purified water into CSR would meet ResWA regulatory requirements for retention and dilution (**Appendix B.2**).

Together, these models were utilized to develop operational scenarios to assess the impact of continuous, ramped down and seasonal production of purified water, to understand how augmentation of CSR, Bear Gulch Reservoir and drinking water distribution systems would impact the RWS, in terms of the benefits during dry years and increased spills in the upcountry during wet periods.

4.3 Other Water Supply Alternatives

Description of other water supply alternatives considered to accomplish the objectives to be addressed by the Proposed Title XVI Project. Include benefits to be gained by each alternative, total project cost, life cycle cost, and corresponding cost of the project water produced expressed in dollars per million gallons (MG), and/or dollars per acre-foot. An appraisal level cost estimates, or better, is acceptable for these alternatives.

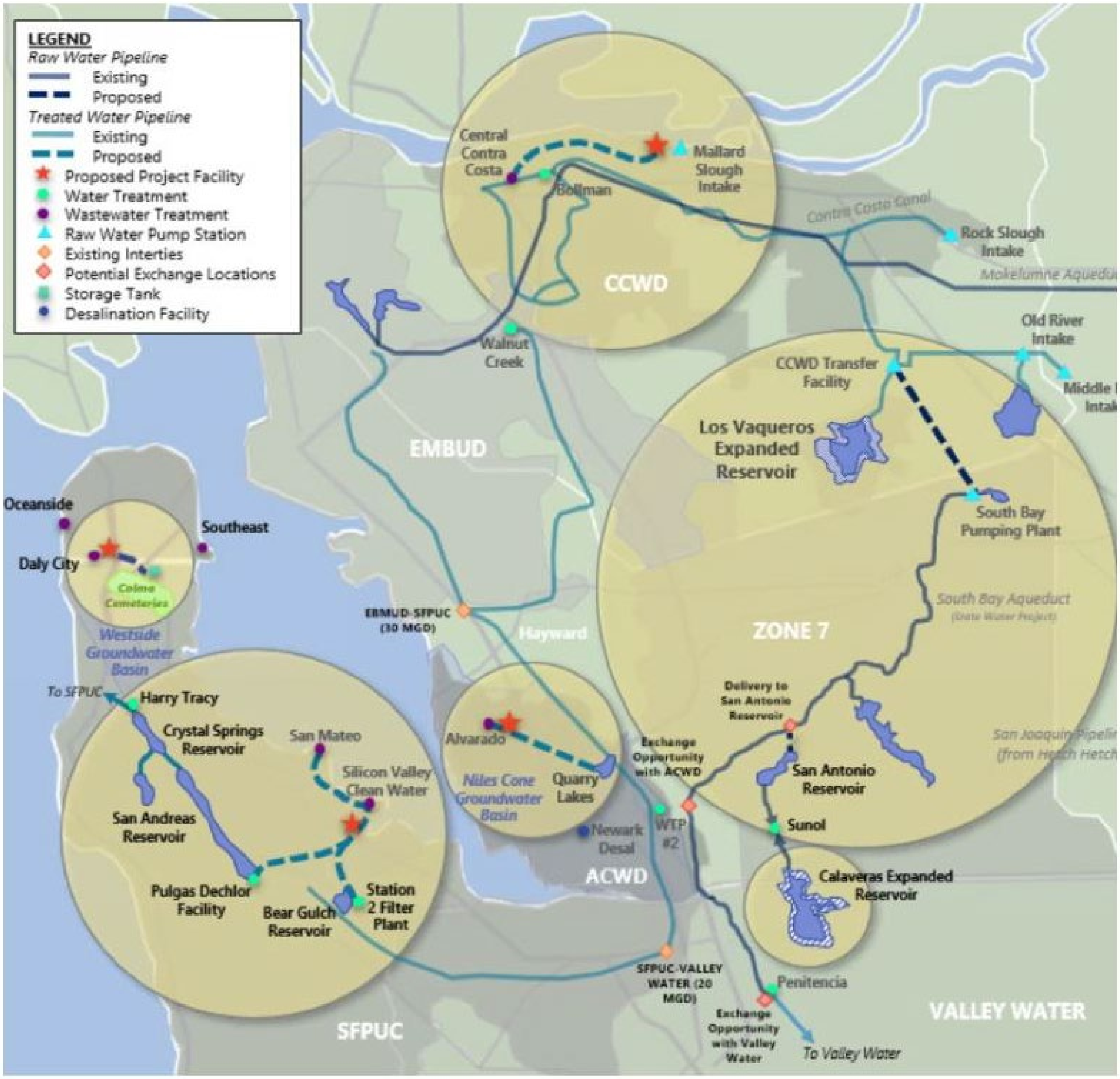
The PREP Parties have considered various other supply and effluent management alternatives to address water supply needs and discharge reduction goals.

- **Conservation** – Ongoing conservation and Demand Management Measures (DMM) implemented by the SFPUC, Cal Water, Redwood City and Foster City contribute to meeting demand reduction goals and maintaining high levels of water use efficiency. These drinking water suppliers each have a robust DMM program that includes implementation of water waste prevention ordinances, metering, conservation pricing, public education and outreach, programs to assess and manage distributions system real loss, and water conservation program coordination and staffing support. The PREP drinking water supply agencies are committed to implementing water conservation to maximize sustainability in meeting future water needs for their customers.
- **Imported Water Supply and Redundancy –** The SFPUC and the 26 BAWSCA member agencies will continue to import water from the RWS directly and through interconnections with regional agencies. The SFPUC maintains interconnections to potable supplies that can be utilized during emergencies or planned outages within the RWS and continues to seek new regional projects that may be mutually beneficial.
- **Capital Improvement Projects (CIP) –** Each of the PREP Parties continue to implement system improvements to enhance system operations and reliability.

As previously discussed in Section 2.2.3, the SFPUC is leading a broader Alternative Water Supply Program to evaluate all potential sources of future water supply and the facilities to bring new projects online to develop supplemental supplies for the coming decades. These include reservoir and recycled water expansion projects, brackish water desalination projects, potable reuse project, groundwater banking, dry year transfers and inter-basin collaborations, as shown in Figure 4-3 and described in Table 4-3

While many of the projects under consideration to meet future supply needs are in various stages of development, the most recent Alternative Water Supply Program Quarterly Report (SFPUC, Mar 2022) provides a graphical illustration of the relative volume and cost of these projects, Figure 4-4.

Figure 4-3: Regional Alternative Water Supply Program Activities

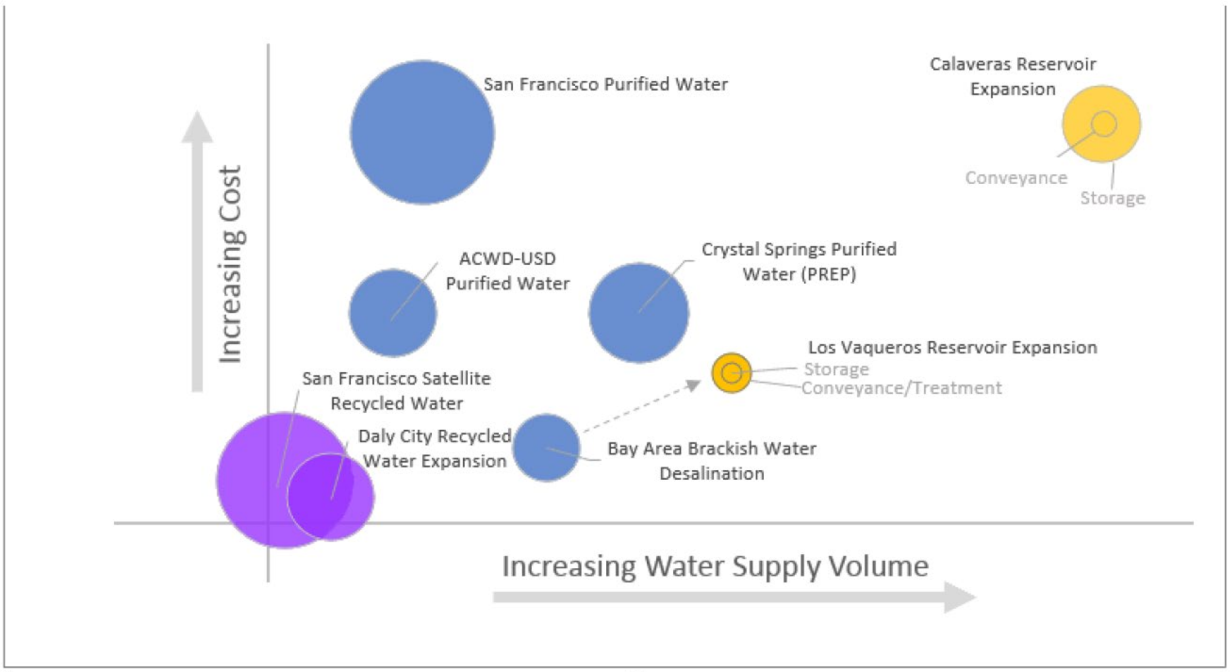


Source: Alternative Water Supply Program Quarterly Report, SFPUC, March 2022

Table 4-3: Summary of SFPUC's Alternative Water Supply Program

Project	Drought/ Dry Year Reliability	Reduce Discharges	Develop New Local Supplies	Offset Imported Water	Operational Benefits	Env Benefits	Availability	Supply Type
Los Vaqueros Reservoir Expansion	☑				☑	☑	Drought and/or All Years	Storage
Calaveras Reservoir Expansion	☑				☑		Drought Years and/or All Years	Local Storage
Daly City RW Expansion/ Satellite RW	☑	☑	☑				Drought and/or All Years	RW/ GW Offsets
Bay Area Regional Reliability (BARR) Shared Water Access Program (SWAP)	☑			☑	☑		Drought Years	Conveyance/ Transfer
Bay Area Brackish Water Desalination	☑		☑	☑	☑		Dry Years (with storage) and/or All Years	Desalination/ Transfer
ACWD -USD Purified Water Partnership	☑	☑	☑	☑			All Years	Purified Water
Crystal Springs Purified Water (this PREP Project)	☑	☑	☑	☑			All Years	Purified Water
PureWaterSF Exploration	☑	☑	☑	☑			All Years	Purified Water
Satellite Recycled Water	☑	☑	☑	☑			All Years	Recycled Water
Groundwater Banking	☑				☑		Drought Years	GW / Storage
Dry Year Transfers	☑				☑		Drought Years	Transfers
Inter-Basin Collaborations	☑				☑	☑	Varies	Storage of Exchanges

Figure 4-4: Relative Volume and Cost of Alternative Water Supply Projects



Dot size is an indicator of relative $/AF costs. The sizes are intended for illustrative purposes only, as project-specific costs are still being developed.

Purple dots represent non-potable supply projects. **Blue dots** are for potable supply projects. **Yellow dots** represent storage projects.

Source: Alternative Water Supply Program Quarterly Report, SFPUC, March 2022

The PREP Parties are committed to continuing to explore the benefits of a variety of projects to augment potable supply and effectively manage effluent. This feasibility focuses on the viability of potable reuse on the San Francisco Mid-Peninsula to create a local, sustainable, and resilient supply to add to this growing portfolio of projects.

4.4 Potable Reuse Alternative Concepts

Description of at least two alternative measures, or technologies available for water reclamation, distribution, and reuse for the project under consideration. These alternatives must be approvable by the state(s) or tribal authorities in which the project will be located.

This study evaluates and compares three types of potable reuse projects:

(4) **Reservoir Water Augmentation (ResWA)** project that purifies water from local wastewater facilities and conveys the purified water to CSR, where it would comingle with water from SFPUC's Hetch Hetchy Regional Water System (RWS) and becomes part of the SF Bay Area water supply.

(5) **Raw Water Augmentation (RWA)** project that purifies water from local wastewater facilities and conveys the purified water to a small reservoir, which would not meet ResWA regulatory requirements, where it would comingle with runoff and streamflow diversions, be treated at a local drinking water treatment plant, and becomes part of the local potable water distribution system.

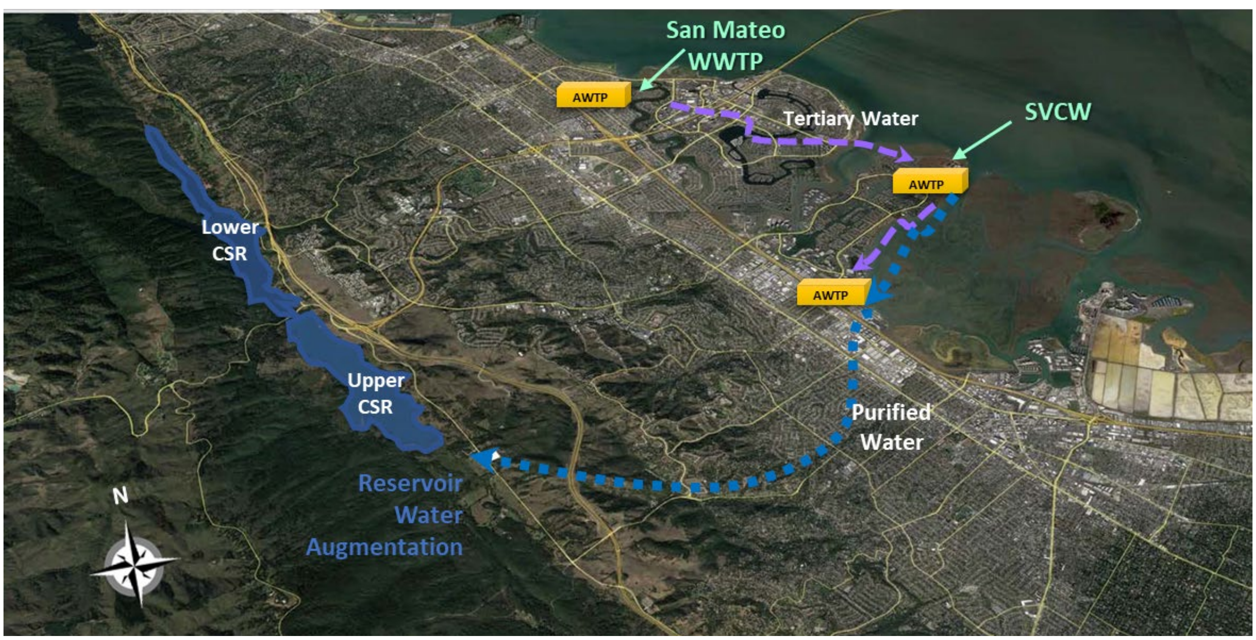
(6) **Treated Water Augmentation (TWA)** project that purifies water from local wastewater facilities and conveys the purified water to the local potable water distribution system via an existing treated water reservoir or transmission main.

The following sections describe each concept, key infrastructure, and purified water operational scenarios.

4.4.1 CSR Reservoir Water Augmentation Project Concept

The CSR ResWA project concept would treat tertiary effluent from SVCW and/or San Mateo WWTP at an AWPF and convey purified water to CSR where it would be combined with surface water in the reservoir (Figure 4-5). After the required storage retention, water would be transported downstream to Harry Tracy WTP for treatment and conveyed to drinking water users through the existing RWS potable water distribution system.

Figure 4-5: ResWA Project Concept



The Crystal Springs/San Andres Integrated Reservoir System consists of Upper CSR, Lower CSR, and San Andreas Reservoir. Upper and Lower CSR are hydraulically connected via two culverts and are operated as a single reservoir. Lower CSR is connected to San Andreas Reservoir in the north via the Crystal Springs Pump Station (CSPS) and Crystal Springs-San Andreas pipeline. The two-reservoir system (CSR and San Andreas Reservoir) is owned and operated as part of the RWS. An overview of the Crystal Springs/San Andrews Integrated Reservoir System, including an illustration of all inflows and outflows, is provided in **Appendix E**.

The following sections describe the analysis of the suitability of CSR to meet the anticipated ResWA requirements discussed in **Appendix B.2**.

4.4.1.1 CSR Reservoir Operation Model

As part of the PREP Phase 3 effort, a CSR Reservoir Operations Model (CSR ROM) for Reservoir Water Augmentation was developed using a monthly time-step based on outputs from SFPUC's HHLSM model (described in **Appendix E**). The purpose of the CSR ROM is to:

1) Estimate the available storage capacity in the RWS and the amount of Hetch Hetchy water that would "spill" in the upcountry system as a result of purified water addition to CSR, and
2) Simulate how a potable reuse project that introduces purified water into CSR would meet ResWA regulatory requirements for retention and dilution (**Appendix B**).

The ROM uses HHLSM data from 1987 to 1998 to represent the 12-year flow regime selected for the evaluation to represent both an extended 6-year dry period (1987 – 1992) and extended 6-year wet period (1993 – 1998). Model parameters include inflows, storage volumes, and outflows to Upper CSR, Lower CSR and San Andres reservoir, available storage in the RWS and releases to Harry Tracy WTP. A flow diagram for the CSR ROM is provided in **Appendix E**.

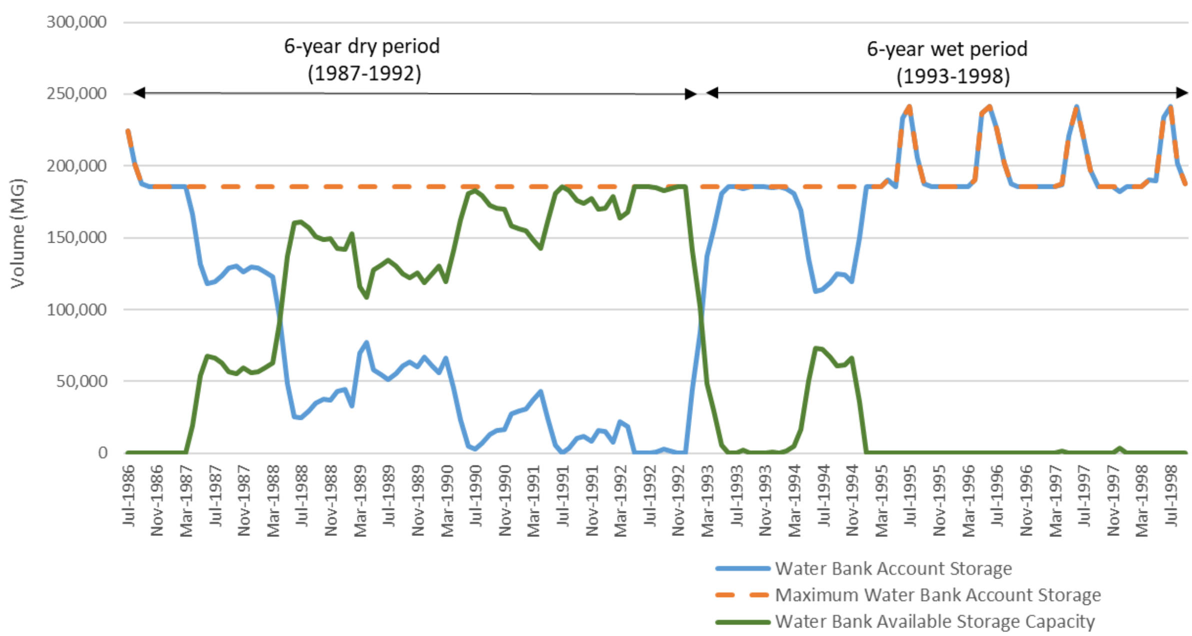
The following sections describes the evaluation of "spill" or displaced water in the RWS, retention and dilution evaluation to meet ResWA regulatory requirements, and other water quality considerations.

4.4.1.2 RWS "Spill" (Displaced Water) Evaluation

The HHLSM model tracks available storage in the RWS, including in the Water Bank. The Water Bank is essentially a storage account on Don Pedro Reservoir, which is located on the Tuolumne River in the upcountry region of the RWS system that begins with the Hetch Hetchy Reservoir in Yosemite National Park. The RWS is operated such that all reservoirs are filled first and maintained full to the extent possible, and the Water Bank is typically the last to be filled.

The Water Bank storage under historical operations, based on HHLSM outputs, is illustrated in Figure 4-6. The orange line represents the maximum volume that the Water Bank can store, and the blue line represents the actual storage in the Water Bank for the 1987-1998 period. During wet years (1993 – 1998) when the Water Bank is primarily full (e.g., there is no additional storage capacity remaining in the water bank), there is no available storage capacity in the RWS to absorb water supply from a new source. During dry years (1987-1992) the Water Bank has available capacity. The difference between the orange and blue lines in Figure 4-6 reflects the remaining available storage capacity in the Water Bank account (green line), which is the storage volume available to accommodate any water displaced from Crystal Springs or San Andreas Reservoir for purified water as part of a ResWA project.

Figure 4-6: Overview of Water Bank Storage for Historical Operations



The underlying assumption of the CSR ROM is that CSR is maintained full at seasonal storage targets by SFPUC, and that there is no physical room in the reservoir to accommodate purified water from the AWPF unless there is additional storage available in the greater RWS system. If the Water Bank storage is full, an equivalent amount of water would have to be "displaced" from the reservoir system to make room for purified water. This displacement would materialize as an upcountry "spill" from the Water Bank because water from the Upcountry system that would have been sent to Crystal Springs is not needed due to the addition of water from the AWPF. So that water remains Upcountry instead, and spills from a full system.

The HHLSM model could be used to further refine the estimated amount of “spill” with a ResWA project, by performing a more complex simulation of operational adjustments to accommodate purified water. However, based on an initial assessment by SFPUC’s modeling group, the refinements would not noticeably change the outcome of this analysis, thus the CSR ROM’s estimation of “spill” is used for this analysis.

4.4.1.3 ResWA Operational Scenarios

Three ResWA operational scenarios were evaluated to assess the impact of continuous versus seasonal augmentation with purified water, to calculate how reduced production of purified water would reduce the amount of spill during wet years. The three ResWA scenarios include:

1) **Continuous AWPF Operational Scenario** – the AWPF operates at the design capacity consistently during the 12-year period.

2) Seasonal Ramp Down **Operational Scenario –** the AWPF would operate at full capacity during the summer months (May to October) and ramp down purified water production to half its capacity during the wet year winter months (November to April). Under this operational mode, membranes and other equipment would be rotated to minimize operational complexity associated with a full shutdown.
~

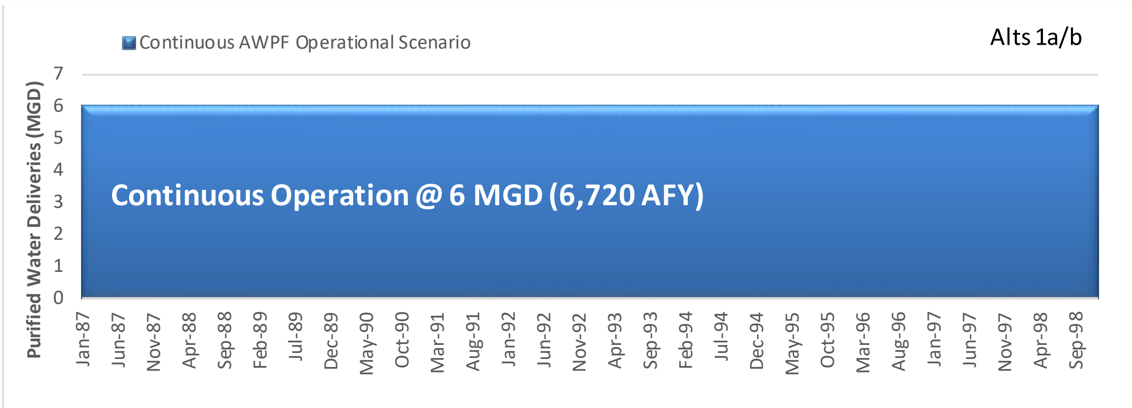
3) Seasonal Shut Down **Operational Scenario –** the AWPF would operate at full capacity during summer months (May to October) and shut down during wet year winter months. During the shutdown period, the membranes will be fully preserved.

Figure 4-7 illustrates the amount of purified water produced under the three operational scenarios for the 6-year dry period (1987-1992) and the 6-year wet period (1993-1998). Alternatives 1 and 2, are broken down into the following operational scenarios:

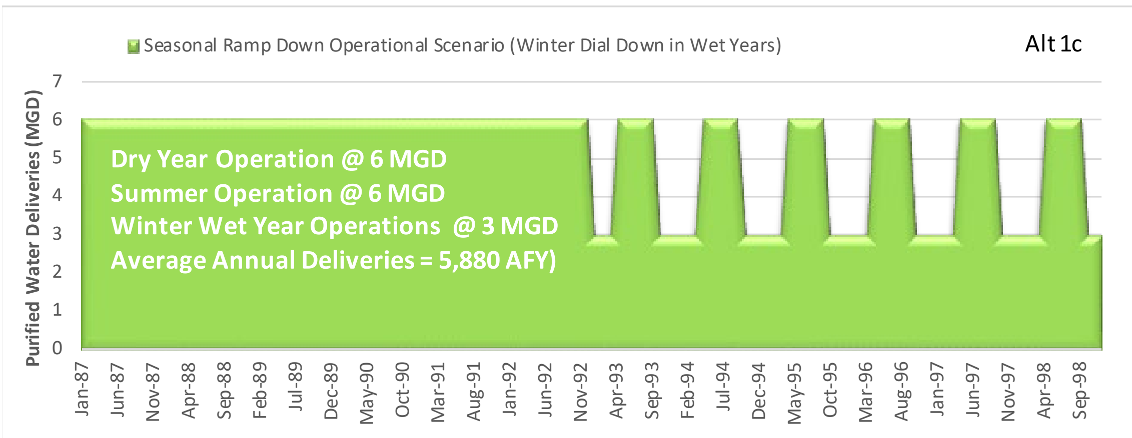
- **Alternative 1a/b:** 6-mgd ResWA with continuous operation of AWPF for all years
- **Alternative 1c:** 6-mgd ResWA with seasonal ramp down to 3 mgd in winter months of wet years and no seasonal ramp down in dry years
- **Alternative 1d:** 6-mgd ResWA with seasonal shutdown to 0 mgd in winter months of wet years
- **Alternative 2a/b:** 12-mgd ResWA with continuous operation of AWPF for all years
- **Alternative 2c:** 12-mgd ResWA with seasonal ramp down to 6 mgd in winter months of wet years and no seasonal ramp down in dry years
- **Alternative 2d:** 12-mgd ResWA with seasonal shutdown to 0 mgd in winter months of wet years

Ramp down operations results in a 12.5 percent reduction in purified water deliveries over the 12-year period and shutdown operation results in 25 percent reduction in purified water deliveries over the 12-year period.

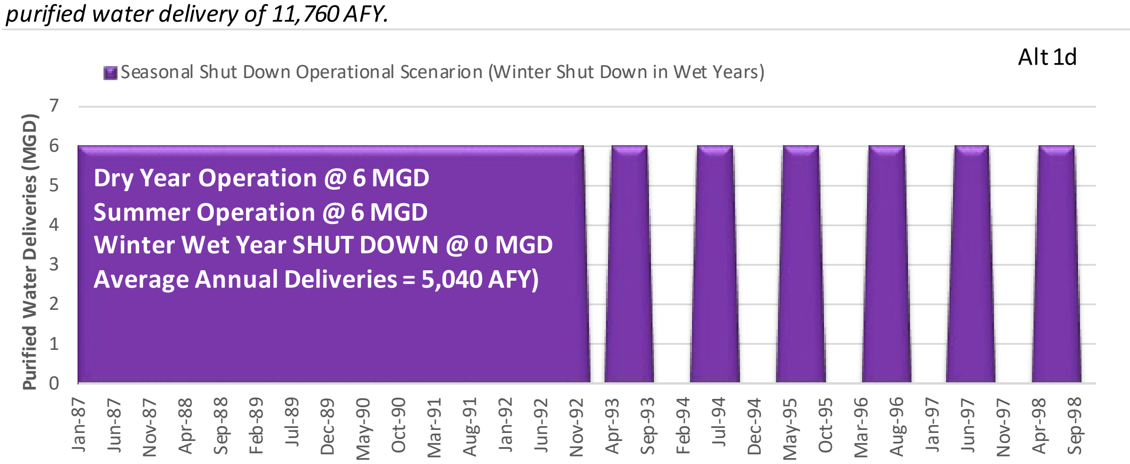
Figure 4-7: CSR ResWA Operational Scenarios



Alt 2a/b would look similar with monthly flows at 12 MGD and average annual purified water delivery of 13,440 AFY.



Alt 2c would look similar with monthly winter flows at 6 MGD, summer flows at 12 MGD and average annual purified water delivery of 11,760 AFY.



Alt 2d would look similar with monthly summer flows at 12 MGD and avernage annual purified water delivery of 10,080 AFY.

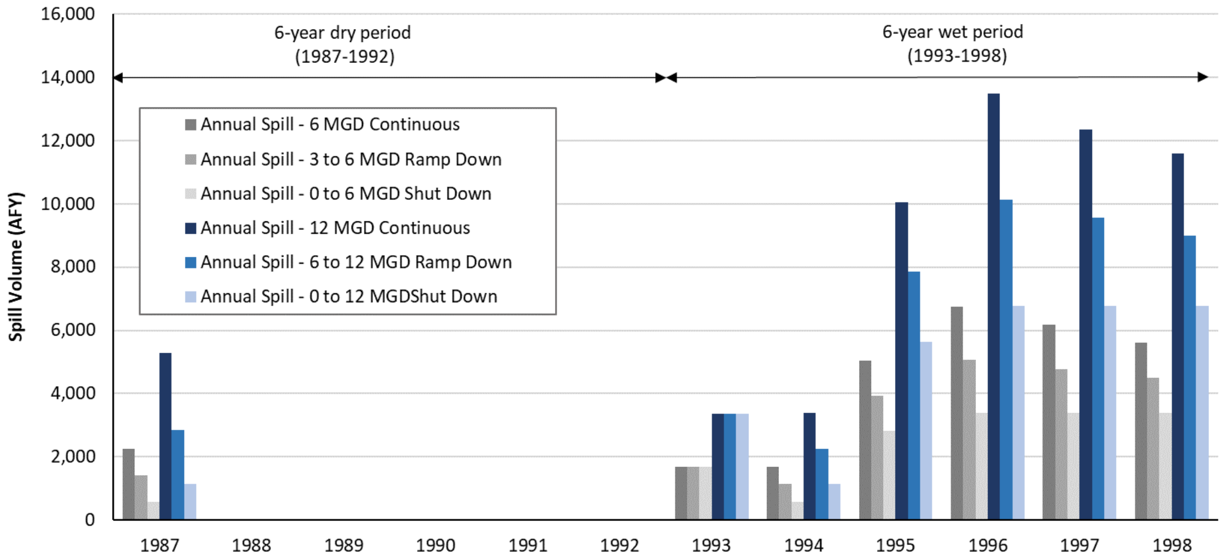
The CSR ROM was used to evaluate the impact of a 6 mgd and a 12 mgd ResWA project on upcountry spill under the three operational scenarios. The “spill” analysis found that:

- During most of the dry years, there is generally enough empty storage available for both the 6 mgd and 12 mgd alternatives without creating additional spill. The only year in the 6-year dry period that resulted in additional spill was 1987, likely due to the prior year being a wet year.
- During wet years, when there is less available storage, the addition of purified water results in increased spill as shown in Figure 4-8..
- Historical operations during this same 12-year period, without the introduction of any purified water, resulted in a total volume of uncapturable water of approximately 6,350,000 AF. This could be considered the “baseline spill.”
- For the 6 mgd alternatives, the incremental spill volume (to make room for purified water) over the 12-year period was 15,000 AF to 30,000 AF, which amounts to a slight increase of 0.25 percent to 0.5 percent over the baseline spill.
- For the 12 mgd alternatives, the incremental spill volume over the 12-year period was 30,000 to 60,000 AF, which amounts to an increase of 0.5 percent to 1 percent over the baseline spill.

Water supply shortages occurred in the RWS during the 6-year drought. The water supply from this project could be used to alleviate some of these shortages during similar future dry periods. Additionally, though it is beyond the scope of this analysis, it is noted that the ResWA project alternatives would increase the storage capacity within the RWS and would allow for capture of water generated in wet years.

This “spill” analysis results are summarized in Figure 4-8 and Table 4-4.

Figure 4-8: Annual "Spill" Evaluation for ResWA Operational Scenarios



Note: In 1993, the spill is the same for the continuous ramp down and shutdown scenarios primarily because during this very wet year, spills occurred during the summer period (June to Sept) when the AWPF is operating at full capacity for all scenarios, hence there was no difference in spill between the scenarios.

Table 4-4: Summary of CSR ROM Spill Analysis

Water Year	Flow Regime	Baseline Spill	Annual Increase in "Spill" Over Baseline (AFY)					
			Alt 1a/b 6 mgd Continuous	Alt 1c 6 mgd Winter Ramp Down	Alt 1d 6 mgd Winter Shut Down	Alt 2a/b 12 mgd Continuous	Alt 2c 12 mgd Winter Ramp Down	Alt 2d 12 mgd Winter Shut Down
1987	Dry	11,016	2,266	1,418	571	5,279	2,837	1,142
1988	Dry	0	0	0	0	0	0	0
1989	Dry	0	0	0	0	0	0	0
1990	Dry	0	0	0	0	0	0	0
1991	Dry	0	0	0	0	0	0	0
1992	Dry	0	0	0	0	0	0	0
1993	Wet	328,881	1,676	1,676	1,676	3,352	3,352	3,352
1994	Dry	10,572	1,695	1,133	571	3,389	2,266	1,142
1995	Wet	1,891,538	5,029	3,923	2,818	10,057	7,847	5,637
1996	Wet	874,616	6,742	5,066	3,389	13,483	10,131	6,779
1997	Wet	1,543,330	6,171	4,780	3,389	12,341	9,560	6,779
1998	Wet	1,690,893	5,600	4,494	3,389	11,599	8,989	6,779
Total (AF)		**6,350,845**	**17,407**	29,177	22,491	15,804	59,502	44,982
Increase Over Baseline Spill		**n/a**	**0.3%**	0.5%	0.4%	0.2%	0.9%	0.7%
Purified Water Augmented to CSR (AFY)			6,720	5,880	5,040	13,440	11,760	10,080
Annual Average Spill (AFY)			2,431	1,874	1,317	4,958	3,748	2,634
Dry Year Average Spill (AFY)			378	236	95	880	473	190
Wet Year Average Spill (AFY)			4,485	3,512	2,539	9,037	7,024	5,078
Annual Average Water Purified Water Delivery (AFY)			6,720	5,880	5,040	13,440	11,760	10,080
Percent of Purified Water that creates a "spill"			36%	32%	26%	37%	32%	26%

4.4.1.4 CSR ResWA Retention Time Evaluation

Per the Final ResWA Regulations, an initial reservoir retention time of 180 days (6 months) must be demonstrated, with flexibility for an alternative minimum theoretical retention time as low as 60 days (2 months) on a case-by-case basis with State Board approval. ResWA projects with minimum retention times of less than 120 days (4 months) must provide an additional 1-log treatment. A theoretical retention time of no less than 60 days may be considered for approval.

Reservoir retention time is defined as the total volume of the reservoir (V) divided by the total flow out of the reservoir (Q) during a given time period. Retention times are to be calculated at the end of each month based on the reservoir conditions for that month. The CSR ROM was used to calculate retention time on a monthly basis for the 12-year period, reflecting historical dry- and wet- year operations. Inflows into the reservoir (i.e., purified water production rates) are not required or used for this analysis. The ResWA Scenarios were combined with two reservoir system configurations, to anticipate a combination of scenarios that the DDW may be interested in seeing to ensure that the minimum retention criteria could be met. The two cases are as follows:

A. **Upper CSR** as a standalone reservoir, which includes one outflow from the Cahill Ridge Pump Station that goes directly to a water treatment plant (CCWD's Nunes WTP) as well as reservoir evaporation, and

B. **Integrated Reservoir System,** as a combined system with Upper CSR + Lower CSR + San Andreas, which includes three outflows to CCWD's Nunes WTP, San Mateo Creek discharges and SFPUC's Harry Tracy WTP, as well as reservoir evaporation.

Upper and Lower CSR were not evaluated as a standalone system because there is no new outflow to a water treatment plant. An argument could be made to assume Upper and Lower CSR essentially act as one reservoir because they are hydraulically connected; however, this study considers Upper CSR a standalone reservoir to be conservative. Modeling outflows from the HHLSM on a monthly time-step basis were used as inputs into the CSR ROM for this evaluation.

Table 4-5 summarizes the average, maximum and minimum retention time values, in months, for the Upper CSR and Integrated Reservoir System, based on historical reservoir volumes and outflow values.

Table 4-5: CSR ResWA Retention Time Evaluation

Retention (months) = $\text{Volume}_{\text{reservoir}} / \text{Outflow}_{\text{total}}$					
Upper CSR Retention Time (months)			Integrated Reservoir System Retention Time (months)		
Average	Max	Min	Average	Max	Min
128	467	36	23	30	3

The retention time evaluation found that:

- Upper CSR always meets the 2-month minimum and 6-month preferred retention requirements, primarily because the maximum outflow to the Cahill Ridge Pump Station is only 6 mgd.
- For the Integrated Reservoir System, the retention is 2 years on average, and stays above the 2-month minimum requirement for the period of simulation.

- There were two months within the entire 12-year period during which the retention time for the Integrated Reservoir System dropped below the 6-month preferred criteria. This occurs during consecutive wet year periods (January 1997 and February 1998). Both timeframes coincide with the high outflows observed in the overall CSR + San Andreas system, when the majority of those outflow conditions were attributed to higher releases in the San Mateo Creek. These higher releases to San Mateo Creek are required to meet WSE in the reservoir for Fountain Thistle.

Implementation of a ResWA project may require modifications to RWS operations to maintain a retention time of 6-months, while adhering to other reservoir operation requirements, such as meeting required water surface elevations for the fountain thistle. The ability to modify outflows at times when there are high local inflows from stormwater runoff in the CSR reservoir will be limited. One option may be to utilize predictive analysis tools may be useful to anticipate high local inflow events and preemptively release water from CSR or reduce inflows from the RWS to provide a buffer in the reservoir. Future studies will include hydrodynamic modeling of the reservoir and an assessment of operational practices to avoid dipping below the 6-month minimum. Based on the worst-case historical scenario, in no case would the retention time go below 2 months.

In comparison to other ongoing ResWA projects, the City of San Diego is pursuing a 30 mgd ResWA project in the 5,800-AF-capacity Miramar Reservoir, which would have an average retention time of just over two months. The City of San Diego was active in the legislative and regulatory efforts to reduce the minimum required retention time to 2 months (60 days) so that ResWA at Miramar would be viable for Phase 1. For the East County Advanced Water Purification Program, Padre Dam Municipal Water District (MWD) is exploring a 15 mgd ResWA project in Lake Jennings (capacity of approximately 9,800 AF), which would have an average retention time of just over 200 days, but a minimum retention time between 1.4 and 2.1 months. Padre Dam MWD is working with the DDW to demonstrate their ability to meet ResWA criteria with specific operational accommodations during emergencies. The Pure Water Project Las Virgenes-Triunfo is moving forward with an 8,840 AF volume reservoir, and their initial simulations of minimum retention time demonstrate the ability to achieve greater than 2 months retention.

A ResWA project may also need to demonstrate that the risk of short-circuiting in the reservoir would be minimal or could be controlled. Given the geometry of CSR, with a long fetch between the inlet and outlet, it appears there would be a significant period for purified flows to travel from the point of augmentation to the San Andreas Reservoir and then to Harry Tracy WTP, minimizing the risk of short circuiting. Future studies would be performed to evaluate dispersion, mixing characteristics, and water quality in the reservoir, using hydrodynamic mixing analyses and/or modeling to refine the ResWA scenarios and confirm the ability to meet regulations.

4.4.1.5 CSR ResWA Dilution Evaluation

Per the Final ResWA Regulations, pathogen removal requirements are also dependent on a reservoir's ability to dilute off-spec discharge flows. As discussed in **Appendix B**, standard pathogen removal requirements (i.e., 8/7/8 log removal for V/G/C) are based on achieving a 100:1 (or 1 percent) dilution of a 24-hour discharge of purified water and maintaining greater than 120 days retention time. If a reservoir achieves only 10:1 (10 percent) dilution of a 24-hour discharge of purified water, pathogen removal requirements are increased by a factor of 10 (i.e., 9/8/9 log removal for V/G/C).

The actual capacity of a reservoir to dilute off-spec discharge flows is dependent on several factors:

- Discharge facility location and depth,
- Design of the discharge facility,
- Reservoir hydrodynamics (i.e., mixing), and
- Weather (i.e., wind and runoff) conditions.

Reservoir modeling and tracer studies would be required to determine the practical amount of dilution provided by CSR in a 24-hour period. Discharge facility alternative design studies may also be needed if enhanced initial mixing is required.

For the purpose of this analysis, The CSR ROM was used to calculate the monthly theoretical dilution ratios by dividing the monthly reservoir volume by the quantity of purified water delivered during the prior 24-hour period. Table 4-6 summarizes the theoretical dilution ratios at purified water flow rates of 6 mgd and 12 mgd considering (1) Upper CSR only and (2) the Integrated Reservoir System for each of the three operational scenarios.

The results show that for both reservoir systems, the 10:1 minimum dilution and 100:1 preferred dilution criteria are always met. Assuming complete mixing (i.e., 100 percent dispersion of purified water throughout the entire reservoir volume), dilution ratios equal to or greater than 400:1 would be possible. In comparison, the City of San Diego's ResWA at Miramar Reservoir and Padre Dam MWD's project at Lake Jennings would have estimated high dilution ratios of about 70:1 and 200:1, respectively. A ResWA at CSR would allow at least 5 times and 2 times more dilution as compared to the San Diego and Padre Dam MWD projects, respectively.

Inversely, the maximum theoretical purified water augmentation rates possible while still achieving dilution ratios of 100:1 and 10:1 could be over 180 mgd for the Full Reservoir System and over 50 mgd for Upper CSR. This is well above the assumed available purified flow of 6 and 12 mgd being considered for PREP Phase 3.

Table 4-6: CSR ResWA Minimum Monthly Dilution

Purified Water Deliveries (mgd)	Upper CSR	Integrated Reservoir System
Alt 1a/b: 6 mgd Continuous	860 : 1	3,130 : 1
Alt 1c: 6 mgd Seasonal Ramp Down	1,000 : 1	3,520 : 1
Alt 1d: 6 mgd Seasonal Shut Down	1,000 : 1	3,520 : 1
Alt 2a/b: 12 mgd continuous	430 : 1	1,560 : 1
Alt 2c: 12 mgd Seasonal Ramp Down	500 : 1	1,760 : 1
Alt 2d: 12 mgd Seasonal Shut Down	500 : 1	1,760 : 1

In operation, purified water released directly in the southern end of the reservoir during any 24-hour period could mix with a smaller portion of the reservoir volume, so actual dilution of a 24-hour pulse discharge would be less than the theoretical dilutions computed under these assumed complete mixing conditions. Although actual dilution ratios are anticipated to be somewhat lower than the theoretical dilution ratios presented in Table 4-6, it should be possible to design a dispersal/release system capable of achieving dilution ratios of at least 100:1 under all operating conditions because proposed purified flows are so small relative to CSR's large reservoir storage volumes.

Based on the conservative retention time and dilution evaluations, it is possible that a ResWA project would need to meet pathogen removal requirements of 9/8/9 (v/c/g), based on a retention time of less than 4 months and dilution ratio of 100:1. However, upon modification to RWS operations, SFPUC may be able to adjust CSR operations to avoid the peak outflows that occurred during the consecutive wet years of 1997 and 1998, thus maintaining a retention time of more than 4 months, thereby reducing the pathogen removal requirements to 8/7/8. Hydrodynamic modeling and tracer studies would need to be conducted as part of the next steps to simulate then validate these assumptions.

4.4.1.6 CSR ResWA Water Quality Considerations

As described in **Appendix B**, water quality considerations for discharges into CSR will be governed by the SF Bay Basin Plan and the background water quality in CSR. Specifically, maximum ammonia concentrations are controlled by the basin plan limits and maximum phosphorus concentrations are controlled by the background concentrations in Upper CSR. For constituents that do not have a basin plan limit, discharge limits would be governed by drinking water maximum contaminant levels (MCLs), or secondary MCLs. In addition to these quantitative limits, beneficial uses for Upper and Lower CSR also drive water quality objectives which would inform effluent limitations for discharge to CSR. The Basin Plan defines CSR beneficial uses, which include consumptive, recreational as well as ecological.

Table 4-7 compares the anticipated purified water concentrations of some of the main constituents of interest for CSR ResWA, to corresponding Basin Plan limits, as well as background CSR levels. The concentrations listed here correspond to the concentrations in Lower CSR based on available data.

Table 4-7 Main Constituents of Interest for ResWA

Constituent	Basin Plan Limit	Units	AWPF Removal Rate	Anticipated Purified Water Concentration (SVCW only)	Background CSR Concentration[1]
Un-ionized ammonia	Annual median = 0.025 Maximum = 0.4	mg/L as N	95%	2.40	0.100
Nitrate [2]	-	mg/L as N	90%	0.04	0.000
Nitrate + Nitrite	10	mg/L as N	90%	0.05	0.000
Nitrite	1	mg/L as N	90%	0.04	0.000
Total P	Depends on N : P limits	mg/L	99%	0.05	0.100
PO_4	N/A	mg/L	99%	0.25	0.100
Temperature	No change; or up to +5 F from background concentrations	C		21.97	21.8

[1] 2016-2020 Median Values from the SFPUC 2020 Peninsula Watershed Sanitary Survey (Stantec, 2021).
[2] There is a 10 mg/L MCL for Nitrate

As shown in Table 4-7 anticipated purified water levels for constituents other than ammonia are well within their respective basin plan limits or MCLs. However, ambient CSR levels are still not being met, and thus additional treatment would likely be required to reduce nutrient concentrations prior to release into CSR. As described in Section 4.2.4, the AWPF train is assumed to consist of MF or UF, followed by RO and UV-AOP. Phosphorus removal by RO is typically more than 99 percent, while nitrogen removal, particularly ionized ammonia nitrogen, is typically between 95-97 percent. Nutrients are not well removed by UV-AOP; thus, additional treatment may be needed for purified water to meet standards for discharge into CSR. Closer examination of nutrient concentrations and loading limitations would be needed to determine if further treatment is required, and if so, what level of treatment would be required.

In addition to the nutrients listed above, other constituents of interest evaluated for the ResWA project include compounds that fall under California Toxics Rule (NDMA, Bromodichloromethane and Dibromochloromethane), mercury, chlorinated pesticides as well as some PFAS compounds. However, effluent data from SVCW and San Mateo reported negligible or non-detect quantities of these constituents, and as a result, they do not pose a concern to anticipated quality of the purified water from the AWPF.

Table 4-8 compares nutrient levels present in SVCW effluent and San Mateo WWTP effluent before, and after RO treatment against existing nutrient levels present in CSR. Actual nutrient limits for a CSR ResWA project would depend on site-specific conditions.

Table 4-8: CSR ResWA Water Quality Considerations

Nutrient	Source Water Quality				Potential WQ Limits	
	Source	Purified Flow Rate (mgd)	Dry Season Average (mg/L)	Estimated RO Permeate (mg/L)*	Lower CSR Existing Conditions	Basin Plan Limits
Ammonia as N (mg/L)	SVCW	6	48	2.4	0.0 to 0.3	Annual median = 0.025 mg/L as N Maximum = 0.4 mg/L as N
	SVCW and San Mateo	12	25	1.3		
Total P (mg/L)	SVCW	6	4.7	0.05	0.1 to 0.4	
	SVCW and San Mateo	12	2.8	0.03		

Sources: SVCW effluent water quality (Phase 2/eSMR reports 2019-2021); Crystal Springs data obtained from 2020 Peninsula Watershed Sanitary Survey (provided by SFPUC on June 29, 2021); San Mateo estimated effluent source water Ammonia at 1 mg/L and Total P at 1 mg/L per CH2M (data from Phase 2).
*** RO Product:** Conservatively assumes 95 percent removal of Ammonia and 99 percent removal of Total P. Previous membrane modeling software (Toray DS2) indicated rejection of ammonia by RO for a MF-RO reuse treatment train to be >97 percent.

Based on the data presented in Table 4-8 and as discussed previously in Section 4.2.4, augmentation of CSR without additional nutrient removal would contribute mass loading to the reservoir. For example, conservatively assuming dry season SVCW effluent as source water with an ammonia concentration of 48 mg/L ammonia as N, the RO permeate ammonia concentration would be 2.4 mg/L ammonia as N conservatively assuming 95 percent rejection by RO. Although the ammonia would largely exist as ionized ammonia, which is not limited by the SF Bay Basin Plan, it is conservative to assume removal of total ammonia (ionized and un-ionized) to meet SF Bay Basin Plan discharge limits. This is one order of magnitude higher than the existing median CSR conditions of 0 to 0.3 mg/L. Assuming 6 mgd of purified water augmentation on average over the year, this could add around 20,000 kg of ammonia (as nitrogen) to CSR annually if there were no additional nutrient removal.

At this level of planning, it would be conservative to assume that the water quality of augmented water would need to match or be compatible with the background levels in CSR. Preliminary observations are:

- Treatment would be required to reduce nitrogen concentrations in purified water to or below reservoir concentrations.
- Blending SVCW source water with San Mateo WWTP's anticipated source water quality would reduce nutrient concentrations and could decrease the amount of nutrient reduction required.
- With RO treatment, total phosphorus loading for either a 6-mgd or 12-mgd AWPF would likely remain below background conditions in CSR.

- Even with RO treatment, ammonia levels in the purified discharge to the reservoir are estimated to be approximately one to two orders of magnitude higher than existing reservoir conditions.
- Modification of the biological treatment process at SVCW to full or partial denitrification would further reduce nitrogen concentrations in the purified water. However, upstream nutrient reduction modifications may still be unable to achieve the low ammonia concentrations required in the final purified water without additional treatment.
- Further treatment of purified water effluent, such as breakpoint chlorination, may be a more cost-effective approach to reduce nutrient concentrations post-RO. This approach is further discussed in **Appendix C**.

4.4.2 Bear Gulch Raw Water Augmentation Project Concept

The Phase 3 RWA project concept would treat tertiary effluent from SVCW at an AWPF and convey purified water to Bear Gulch Reservoir (Figure 4-9) where it would be combined with surface water in the reservoir, extracted for treatment at the adjacent Filter Plant and conveyed to drinking water users through Cal Water's existing potable water distribution system. As previously discussed, a project that delivers recycled water to a surface water reservoir, with the reservoir providing some benefits, but lacking the full complement of benefits (e.g., dilution and retention) provided by ResWA, would be considered DPR via RWA, signifying no environmental buffer of significance.

Figure 4-9: RWA Project Concept

Bear Gulch is a small reservoir located in a residential area in Atherton, owned and operated by the Cal Water. The reservoir provides 20 percent of the water supply for the cities of Menlo Park, Atherton, Portola Valley, and Woodside. Bear Gulch is filled via runoff from the Santa Cruz Mountains and diversions from local creeks. Stored water is conveyed from the reservoir outlet to the Station 2 Filter Plant, which is also owned by Cal Water. The outflow is through the Filter Plant or drain is used for wet-weather emergencies only. Treated water is then distributed via a potable water transmission pipeline to 18,000 customer connections in the Bear Gulch System (Tenera Environmental, 2011).

An overview of the Bear Gulch Reservoir System, including a map illustrating the location of the reservoir outlet and Station 2 Filter Plant is provided in **Appendix E.**

4.4.2.1 Bear Gulch Reservoir Operations Model

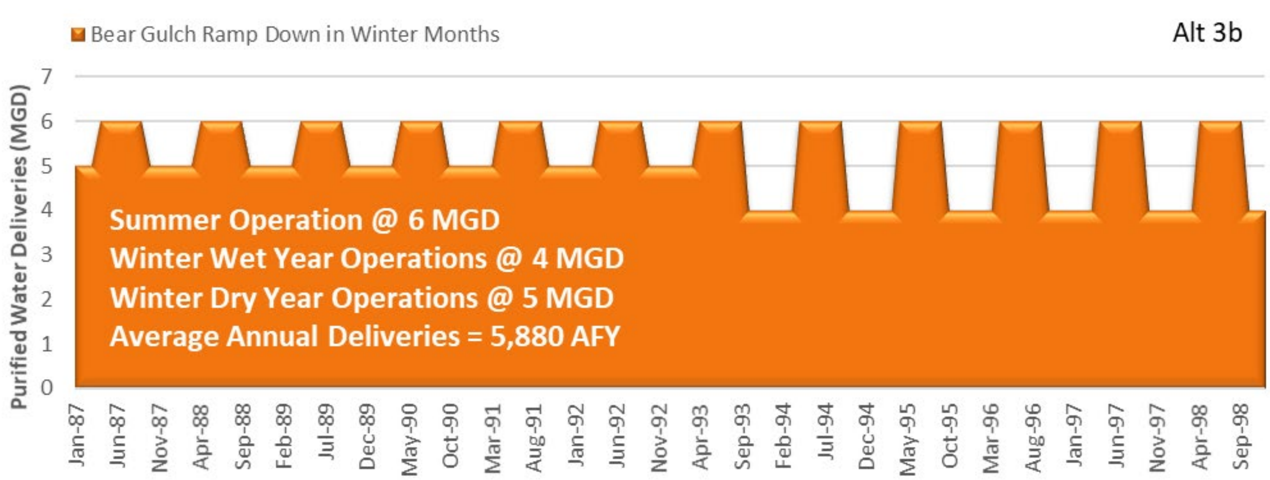
A Bear Gulch Reservoir Operations Model (BG ROM) was developed as a monthly time-step model, with similar operational considerations that were taken into account for the CSR ROM. Monthly data from 1987 to 1998, provided by Cal Water, was used to evaluate a RWA project at Bear Gulch Reservoir. Model parameters include inflows, storage volume, and outflows to the filter plant. An overview of the Bear Gulch Reservoir System and a flow diagram for the BG ROM is provided in **Appendix E**.

As previously discussed, historically, the filter plant at Bear Gulch has been operated at partial capacity during wet periods, when local diversions are used to fill the reservoir. For any RWA, the filter plant would be continuously operated at the full capacity (6 mgd) to utilize the augmented purified water. This change in operational practices would require significant upgrades to the treatment plant and reservoir, which is discussed in the following section.

Two alternatives were simulated for the RWA project:

a. **Alternative 3a:** 6-mgd RWA with continuous operation (year-round), without local streamflow diversions. This alternative would maximize reuse of purified water and could provide an opportunity for other downstream uses of local streamflow.
b. **Alternative 3b:** RWA with ramped down operation in winter months to allow local streamflow diversions. Ramping down purified water production would allow historical diversions to continue. Historical data revealed that the average rate of local diversions during the 6-year dry period and 6-year wet period was 0.84 mgd during 1.63 mgd, respectively. Based on this data, a constant, ramped down purified water production rate identified for the winter months was set at 5 mgd for the 6-year dry period, and 4 mgd for the 6-year wet period, as illustrated in Figure 4-10 to allow space in the reservoir to accommodate available diversions from local streamflow.

Figure 4-10: Purified Water Ramped Down Approach for Bear Gulch RWA Project



For Alternative 3b, the BG ROM estimated that Bear Gulch would be able to capture 78 percent of historical diversions during the 6-year dry period and 84 percent of historical diversions during the 6-year wet period. The annual BG ROM results summarized in Figure 4-11 and Table 4-9.

Figure 4-11: Summary of Alt 3b Streamflow

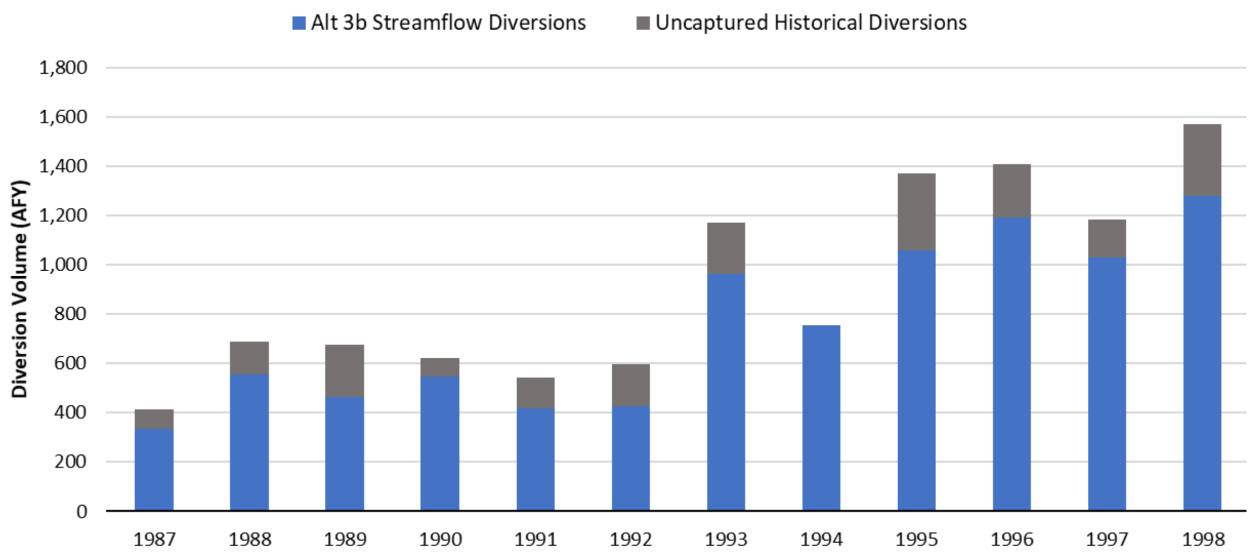


Table 4-9: Summary of BG ROM Analysis

Year	Flow Regime	Historical Diversions (AFY)	Alt 3a - 6-mgd RWA Continuous with No Diversions		Alt 3b - 6-mgd RWA Winter Ramp Down with Capped Diversions			
			Purified Water Production (AFY)	Filter Plant Production (AFY)	Purified Water Production (AFY)	Capped Streamflow Diversions (AFY)	Filter Plant Production (AFY)	Reduction in Diversions (%)
1987	Dry	412	6,721	6,721	6166	336	6501	18%
1988	Dry	687	6,740	6,740	6181	557	6738	19%
1989	Dry	675	6,721	6,721	6166	462	6628	32%
1990	Dry	621	6,721	6,721	6166	548	6713	12%
1991	Dry	543	6,721	6,721	6166	418	6584	23%
1992	Dry	598	6,740	6,740	6181	424	6605	29%
1993	Wet	1,171	6,721	6,721	5610	961	6572	18%
1994	Dry	753	6,721	6,721	5610	753	6363	0%
1995	Wet	1,369	6,721	6,721	5610	1059	6669	23%
1996	Wet	1,406	6,740	6,740	5623	1191	6814	15%
1997	Wet	1,183	6,721	6,721	5610	1028	6638	13%
1998	Wet	1,570	6,721	6,721	5610	1278	6888	19%
Total		**916**	**6726**	**6726**	**5892**	**751**	**6643**	**18%**
Ave DRY years		**613**	**6727**	**6727**	**6091**	**499**	**6590**	**19%**
Ave WET years		**1340**	**6725**	**6725**	**5613**	**1103**	**6716**	**18%**

4.4.2.2 Reservoir Dam, Intake Structure and Filtration Plant Considerations

The existing facilities at Bear Gulch Reservoir need significant infrastructure upgrades in order to store and treat 6 mgd of purified water year-round. Cal Water has and continues to explore some preliminary planning level recommendations to support an estimate of the capital infrastructure that would be required to implement a Bear Gulch RWA project as part of its larger water supply reliability portfolio. A summary of short-, mid- and long-term needs are listed below. Additional study would be needed to further evaluate these recommendations.

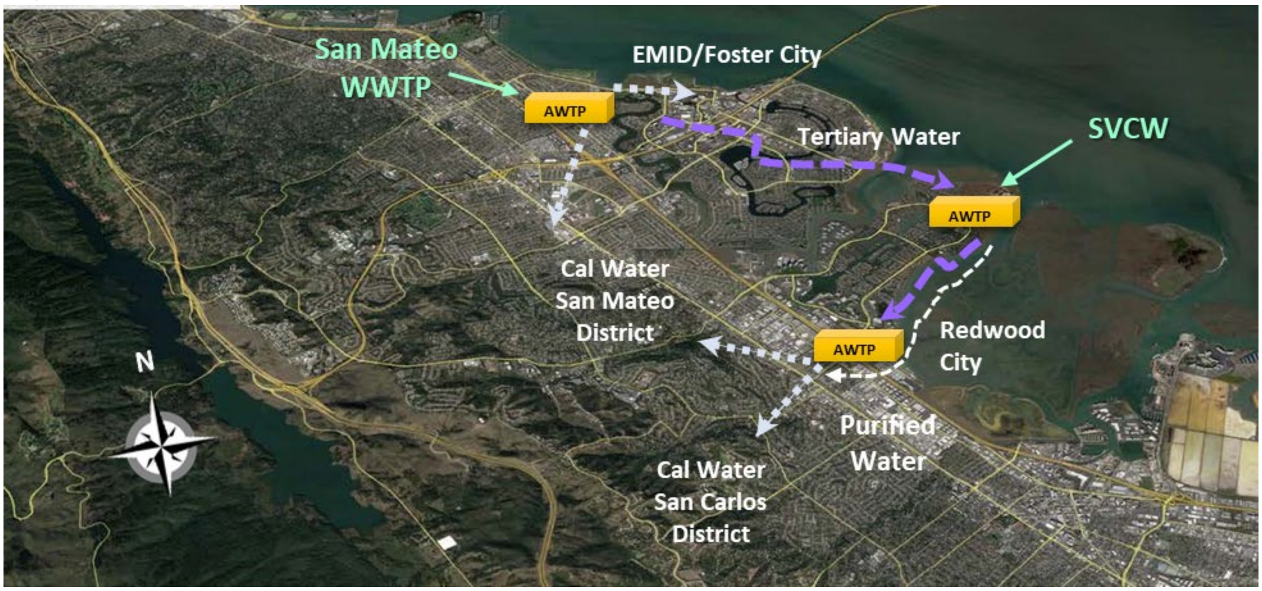
- **Short Term Needs (within next 2 to 3 years):** upgrades to the Reservoir Dam and Intake Structure, new Raw Water Supply Booster Pumping / Clarifier Flushing, new redundant In-line mixer, improved Valve Automation.
- **Mid-Term Needs (within 5 to 10 years):** continue maintenance and repair activities on process and mechanical equipment, replacement the plant HVAC system, add variable frequency drive (VFD) to Vertical Turbine Pumps, streamline current monitors,

- **Long Term Needs – Full Plant Replacement (30 to 40 years in the future):** should a 6-mgd RWA project be implemented, it is assumed that a full plant replace would be required.

4.4.3 Treated Water Augmentation Project Concept

The TWA project concept would treat tertiary effluent from SVCW and/or San Mateo WWTP at an AWPF and convey purified water to the existing drinking water distribution systems operated by Cal Water, the City of Redwood City and/or EMID where it would be combined with drinking water in a storage tank or transmission pipeline (Figure 4-12). There would be no additional downstream water treatment, and the purified water would blend with RWS and local supplies as it is conveyed to drinking water users through the existing potable water distribution system.

Figure 4-12: TWA Project Concept



4.4.3.1 Point of Connection to Drinking Water Distribution System

Water from the AWPF could be directly introduced into the drinking water distribution system for local distribution. Potential tie-in locations would consist of potable water storage tanks, distribution lines, and transmission lines. Several points of connection to the water distribution system in the project vicinity exist as potential options for treated water augmentation.

- Redwood City and Foster City have water storage tanks that could serve as potential tie-in locations. The Redwood City tanks have a combined storage capacity of 6.2 million gallons (MG). Foster City has three 4MG tanks and one 8MG tank.
- Cal Water has various locations within its distribution system that could serve as potential tie-in locations in San Mateo and San Carlos. Cal Water is planning to add additional storage tanks that could potentially be an additional tie-in.

To meet the expected flows from the alternatives, multiple tie-in locations to the distribution system would be needed. Potential points of connection for each TWA are identified in Section 8.

4.4.4 Key Infrastructure

All the potable reuse alternatives would involve advanced treatment of tertiary recycled water from SVCW and/or San Mateo at a new AWPF and conveyance of purified water to place of use for augmentation. Key infrastructure components for alternatives are summarized below.

- **Treatment Facilities:** AWPF near SVCW, the Hwy 101 AWPF Site, or near San Mateo WWTP employing full advanced treatment with MF, RO, and UV/AOP for ResWA, with the addition of ozone and BAC for RWA and TWA.
  - Nutrient removal before advanced treatment.
  - Dechloramination prior to discharge into CSR via the Pulgas Facilities.
  - Dechlorination prior to discharge into Bear Gulch, and
  - Post treatment prior to discharge into existing potable water distribution systems.
- **Brine Discharge:** the RO concentrate discharge via connection to SVCW's outfall to the SF Bay or San Mateo's outfall to the SF Bay, depending on the AWPF location.
- **Pump Stations:**
  - SVCW to AWPF (tertiary effluent),
  - San Mateo WWTP to the AWPF (tertiary effluent)
  - AWPF to CSR (purified water), and
  - AWPF to SVCW Outfall (the RO concentrate)
- **Pipelines:**
  - SVCW to AWPF (tertiary effluent),
  - San Mateo WWTP to the AWPF (tertiary effluent)
  - AWPF to place of use (purified water), and
  - AWPF to SVCW/San Mateo Outfall (the RO concentrate)
- **Storage:** Convert RWC tank at SVCW for use as equalization prior to AWPF and new steel storage tank(s) for product water tank prior to conveyance to CSR
- **Reservoir Discharge Facility:** Connect to Pulgas Facilities and use the existing Pulgas Discharge Channel (no expansion or modification assumed), or new discharge facility at Bear Gulch Reservoir.
- **Potable Water System Tie-ins:** the point of augmentation to the drinking water system for a TWA would be to an existing reservoir or transmission main.

Appendix C provides additional details about treatment processes. **Appendix D** provides additional details on conveyance considerations and potential pipeline alignments. Details about estimated capital and O&M costs for selected sub-alternatives are provided in Section 5.

4.5 Overview of Alternatives

The five project alternatives evaluated in Phase 3 include:

- <u>**Alternative 1:**</u> 6-mgd ResWA in Crystal Springs Reservoir
- <u>**Alternative 2:**</u> 12-mgd ResWA in Crystal Springs Reservoir
- <u>**Alternative 3:**</u> 6-mgd RWA in Bear Gulch Reservoir
- <u>**Alternative 4:**</u> 6-mgd TWA on the San Francisco Mid-Peninsula
- <u>**Alternative 5:**</u> 12-mgd TWA on the San Francisco Mid-Peninsula

Table 4-10 provides and overview of alternatives and operational scenarios. Average annual deliveries of purified water are based on the operational scenarios introduced in Sections 4.4.1 and 4.4.2 for CSR and Bear Gulch, respectively, where AWPF operations would ramp down or shut down in wet and normal years. Purified water production for TWA is assumed to be consistent year-round.

Table 4-10: Overview of Alternatives and Operational Scenarios

Alt	Description	Source Water	Drinking Water System	Ave Annual Water Deliveries	
				(mgd)	(AFY)
ALTERNATIVE 1 - Reservoir Water Augmentation | 6 mgd to Crystal Springs Reservoir					
1a	ResWA with AWPF near SVCW (continuous operation)	SVCW	SFPUC (CSR)	6	6,720
1b	ResWA with AWPF Hwy 101 Site (continuous operation)	SVCW	SFPUC (CSR)	6	6,720
1c	ResWA with AWPF near SVCW (seasonal ramp down in wet years)	SVCW	SFPUC (CSR)	5.25	5,880
1d	ResWA with AWPF near SVCW (seasonal shutdown in wet years)	SVCW	SFPUC (CSR)	4.5	5,040
ALTERNATIVE 2 - Reservoir Water Augmentation | 12 mgd to Crystal Springs Reservoir					
2a	ResWA with AWPF near SVCW (continuous operation)	SVCW + San Mateo	SFPUC (CSR)	12	13,440
2b	ResWA with AWPF Hwy 101 Site (continuous operation)	SVCW + San Mateo	SFPUC (CSR)	12	13,440
2c	ResWA with AWPF near SVCW (seasonal ramp down in wet years)	SVCW + San Mateo	SFPUC (CSR)	10.5	11,760
2d	ResWA with AWPF near SVCW (seasonal shutdown in wet years)	SVCW + San Mateo	SFPUC (CSR)	9	10,080
ALTERNATIVE 3 - Direct Potable Reuse | 6 mgd Raw Water Augmentation					
3a	RWA at Bear Gulch Reservoir w/ continuous operation	SVCW	Cal Water (BG)	6	6,720
3b	RWA at Bear Gulch Reservoir (seasonal ramp down in all years)	SVCW	Cal Water (BG)	5.25	5,880
ALTERNATIVE 4 - Direct Potable Reuse | 6 mgd Treated Water Augmentation					
4a	TWA with AWPF near SVCW for Local Use	SVCW	Redwood City + Cal Water (SC)	6	6,720
4b	TWA with AWPF at Hwy 101 Site for Local Use	SVCW	Redwood City + Cal Water (SC)	6	6,720
4c	TWA with AWPF near San Mateo WWTP for Local Use	San Mateo	Foster City + Cal Water (SM)	6	6,720
ALTERNATIVE 5 - Direct Potable Reuse | 12 mgd Treated Water Augmentation					
5	TWA with AWPF at Hwy 101 Site for Local Use	SVCW + San Mateo	Redwood City + Cal Water (SC and SM)	12	13,440

4.6 Potential Treatment Locations

It is assumed that the AWPF facility would be located near the SVCW facility, at the Hwy 101 Site or near the San Mateo WWTP, as shown in Figure 4-13. **Appendix D** describes some of the opportunities for repurposing assets depending on the treatment facility location.

Figure 4-13: Potential AWPF Locations

AWPF at Site near SVCW: This site would involve coordination with SVCW to identify available space at or near the SVCW treatment facility. The AWPF at this location could be supplied with the tertiary effluent from SVCW and/or the San Mateo WWTP. Should an AWPF Site Near SVCW be selected, the RO concentrate would be sent a short distance to the SVCW facility for blending prior to discharge. ResWA, RWA and TWA could be served from an AWPF at this location.

AWPF at Highway 101 Site: This site would involve coordination with San Mateo County. The AWPF at this location could be supplied with the tertiary effluent from SVCW and/or the San Mateo WWTP. Should the Highway 101 AWPF Site be selected, the RO concentrate would need to be sent back to the SVCW facility for blending prior to discharge. ResWA, RWA and TWA could be served from an AWPF at this location.

AWPF at Site near San Mateo WWTP: This site would involve coordination with the City of San Mateo to identify available space at or near the San Mateo WWTP. The AWPF would be supplied with the tertiary effluent from the San Mateo WWTP. Only TWA would be served from an AWPF at this location. Should an AWPF Site near San Mateo WWTP be selected, the RO concentrate would be sent a short distance to the San Mateo WWTP for blending prior to discharge.

4.7 Potential Alignments and Pump Stations

This section summarizes the potential alignments by water type, starting and ending locations, and associated pump stations. Table 4-11 provides an overview of the pipeline alignments, sizing for each alternative, and Table 4-12 provides an overview of the associated pump station requirements. A description and map of each alignment is included in the sections that follow.

Appendix D discusses opportunities to repurpose or use existing infrastructure to convey tertiary water to the AWPF, the RO concentrate from the AWPF for discharge, and purified water to the place of use. **Appendix D** also discusses pipeline separation considerations.

Table 4-11: Summary of Pipe Lengths and Pipe Diameters for Sub-Alternatives

Alternative	Alt #	TOTAL	Tertiary		Purified		Brine	
		Pipe Length (miles)[1]	Length (miles)	Diameter (in)	Length (miles)	Diameter (in)	Length (miles)	Diameter (in)
Alternative 1 – Reservoir Water Augmentation (ResWA) 6 mgd to Crystal Springs Reservoir	1a	17.0	0.6	20.0	15.9	18.0	0.5	10.0
	1b	18.8	2.9	20.0	13.0	18.0	2.9	10.0
	1c	17.0	0.6	20.0	15.9	18.0	0.5	10.0
	1d	17.0	0.6	20.0	15.9	18.0	0.5	10.0
Alternative 2 – Reservoir Water Augmentation (ResWA) 12 mgd to Crystal Springs Reservoir	2a	22.6	6.1	20.0	15.9	24.0	0.5	14.0
	2b	24.6	8.7	20.0	13.0	24.0	2.9	14.0
	2c	22.6	6.1	20.0	15.9	24.0	0.5	14.0
	2d	22.6	6.1	20.0	15.9	24.0	0.5	14.0
Alternative 3 – Raw Water Augmentation (RWA) 6 mgd to Bear Gulch Reservoir	3a	11.0	0.6	20.0	9.8	18.0	0.5	10.0
	3b	11.0	0.6	20.0	9.8	18.0	0.5	10.0
Alternative 4 – Treated Water Augmentation (TWA) 6 mgd to Local Drinking Water Systems	4a	6.9	0.6	20.0	2.8	18.0	0.5	10.0
	4b	2.4	2.9	20.0	1.9	18.0	2.9	10.0
	4c	3.2	0.0	-	2.7	18.0	0.0	-
Alternative 5 – Treated Water Augmentation (TWA) 6 mgd to Local Drinking Water Systems	5	18.3	8.7	20.0	6.7	24.0	2.9	14.0

[1]Pipe Length estimated from Google Earth®.

Table 4-12: Summary of Pump Station Requirements for Sub Alternatives

Alternative	Alt #	Tertiary		Purified		Brine	
		TDH (ft)[1]	Total Pump Horsepower (hp)	TDH (ft)	Total Pump Horsepower (hp)	TDH (ft)	Total Pump Horsepower (hp)
Alternative 1 – Reservoir Water Augmentation (ResWA) 6 mgd to Crystal Springs Reservoir	1a	28	50	1258	1700	49	40
	1b	101	200	1033	1400	128	200
	1c	28	50	1258	1700	49	40
	1d	28	50	1258	1700	49	40
Alternative 2 – Reservoir Water Augmentation (ResWA) 12 mgd to Crystal Springs Reservoir	2a	186	350	1223	3300	37	50
	2b	273	500	1158	3100	128	200
	2c	186	350	1223	3300	37	50
	2d	186	350	1223	3300	37	50
Alternative 3 – Raw Water Augmentation (RWA) 6 mgd to Bear Gulch Reservoir	3a	28	50	520	785	49	40
	3b	28	50	520	785	49	40
Alternative 4 – Treated Water Augmentation (TWA) 6 mgd to Local Drinking Water Systems	4a	28	50	100	200	49	40
	4b	101	200	67	90	49	40
	4c	28	50	51	95	49	40
Alternative 5 – Treated Water Augmentation (TWA) 6 mgd to Local Drinking Water Systems	5	276	340	475	1300	128	200

1: TDH calculated using pipeline length and diameter and elevation data from Google Earth®.

4.7.1 Tertiary Alignment from SVCW to AWPF

The following assumptions are made to estimate the conveyance requirements to deliver tertiary or Title 22 water from SVCW to an AWPF.

- **AWPF Site Near SVCW:** Tertiary water from the repurposed Redwood City tank would be conveyed to the inlet of the AWPF via a new open trench pipeline. Since an exact location and layout for the AWPF has not been determined at this time, a conservative estimate of the required alignment length within the boundary shown in Figure 4-13 for the AWPF near SVCW site is assumed. A small tertiary pump station would be required to convey tertiary water from the tank to the AWPF.
- **Hwy 101 AWPF Site:** Tertiary water from the repurposed Redwood City tank would be conveyed to the inlet of the AWPF by repurposing Redwood City's recycled water pipeline. Since an exact location and layout for the AWPF has not been determined at this time, a conservative estimate of the required alignment length within the boundary shown in Figure 4-13 for the Hwy 101 AWPF site is assumed.

4.7.2 Tertiary Alignment from San Mateo to AWPF

Two tertiary alignments from the San Mateo WWTP to AWPF are evaluated, Option A and B. Potential non-potable recycled water customers in San Mateo and Foster City could be served along the way with a focus on landscape irrigation uses. The potential alignments and non-potable demands were developed based on the outcomes of the San Mateo Recycled Water Facilities Planning Study (RWFPS; HydroScience 2017) and discussions with the Cities of San Mateo and Foster City. Non-potable reuse (NPR) demand estimates are listed in Table 4-13.

Table 4-13: Summary of Tertiary Alignments from San Mateo WWTP to AWPF

Tertiary Alignment San Mateo to AWPF	AWPF	Pipe Length (miles)	Static Head (feet)	Adjacent NPR Annual Demand (AFY)	Adjacent NPR Peak Flow[4] (mgd)
Option A – Beach Park [1]	Near SVCW	5.3	7	200	0.4
	Hwy 101 Site	Not evaluated			
Option B – Edgewater Blvd[2]	Near SVCW[3]	8.7	9	360	0.7
	Hwy 101 Site	5.8	9	360	0.7

[1] Option A includes estimated demands for golf course on East 3rd Ave, parks and schools along Beach Park Blvd, and potential residential customers at the end of Foster City Blvd.

[2] Option B includes estimated demands for commercial, industrial, schools and business park customers, as well as medium- and high-density residential customers along Vintage Park Dr. and Edgewater Blvd. The assumed "Hwy 92 Crossing" may not be viable due to improvements that were made to the overpass in 2016.

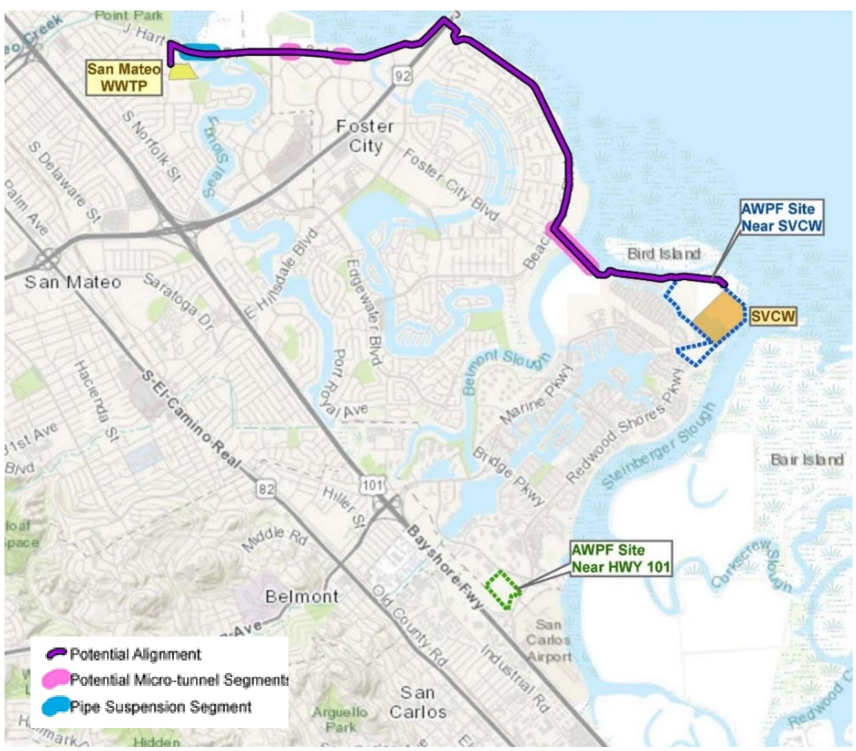
[3] Assume open trench from the Hwy 101 Site to the recycled water tank at SVCW.

[4] Assume peak flows would need to be available in the summer months during irrigation period.

Option A: Beach Park Alignment to AWPF Site near SVCW would be constructed primarily along the Beach Park Blvd., parallel to the levee, to the existing Redwood City storage tank at SVCW as shown in Figure 4-14. The most challenging section would be the crossing under Belmont Slough, which would require modified microtunnel construction due to the long crossing distance (>1000 ft) and deep jacking and receiving pits (~100 ft) due to subsurface geotechnical conditions (soil stratigraphy, groundwater level, etc.). Special shoring methods may be required for the open cut sections along the Bay to provide required lateral support associated with less stable soil, such as young bay mud. Pipe suspension would be required when passing the bridge on East 3rd Ave, the constructability of which depends on future detailed review of the bridge design. Option A included estimated demands for adjacent NPR customers identified by Foster City, using similar unit demands from the San Mateo RWFPS.

A Beach Park Alignment to Hwy 101 AWPF Site was not evaluated because the alignment prior to the existing Redwood City storage tank at SVCW would be the same as the above option. The San Mateo tertiary water, combined with SVCW tertiary water, would be delivered to the Hwy 101 AWPF site by reusing the existing Redwood City recycled water pipeline, as discussed in Section 4.6.2.

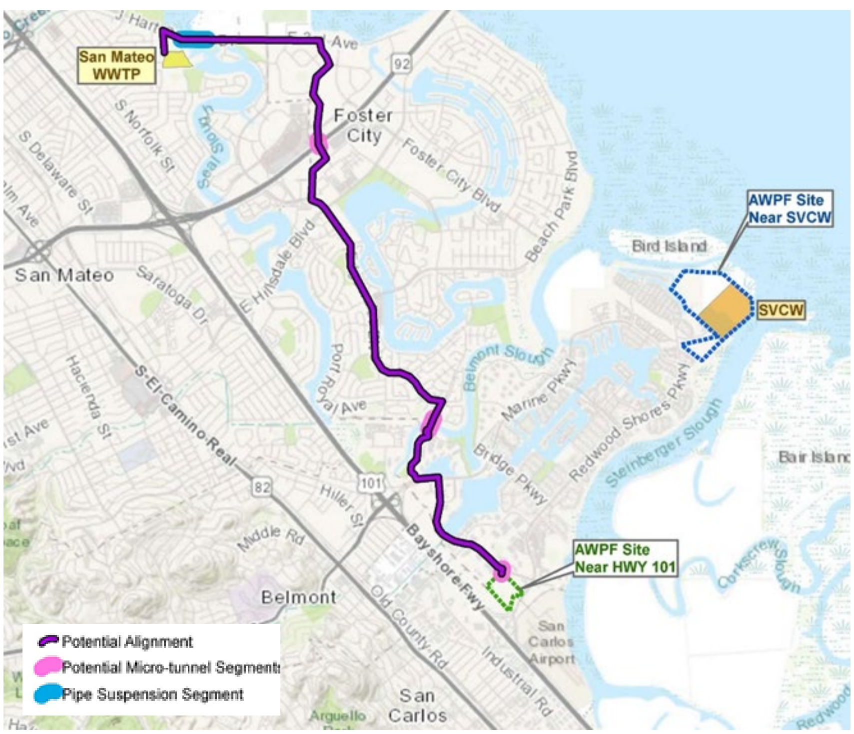
Figure 4-14: Option A- Beach Park Alignment



Option B: Edgewater Blvd Alignment to Hwy 101 AWPF Site would be constructed primarily in the roadway, as shown in Figure 4-15 . This alignment crosses Belmont Slough at the end of Buffin Street and would also require modified microtunnel construction due to the long crossing distance (>1000ft) and bad soil conditions. However, this alignment is potentially not as challenging and costly as Option A. Regular microtunnel construction is assumed at the Hwy 92 crossing and the end of the alignment to connect to the Hwy 101 AWPF site to protect wetlands around the potential AWPF site. Note that a Hwy 92 crossing at the location shown may not be viable due to improvements that were made to the overpass in 2016. Like Option A, pipe suspension would be required when passing the bridge on East 3rd Ave. Higher open trench unit costs are applied considering busy traffic and commercial areas along the alignment. Option B considers the adjacent NPR customers and demands identified in the San Mateo RWFPS that could be served tertiary RW in route to the AWPF.

An Edgewater Blvd Alignment to AWPF Site near SVCW would be similar to the alignment to the Hwy 101 AWPF with the addition of an open trench pipeline along Redwood Shores to the AWPF site near SVCW. Note that the abandoned SVCW influent 54”-dia pipeline could not be used because a purified water pipeline from the AWPF is assumed to be slip-lined into the pipeline in this case, and there are risks co-locating the pipelines due to potential separation requirements as discussed in Section 4.6.5.

Figure 4-15: Option B – Edgewater Blvd Alignment



The tertiary pipeline alignment from the San Mateo WWTP to an AWPF Site Near San Mateo was assumed to include 2,500 feet of 20"-dia pipeline within the boundary of the AWPF site and is not shown separately.

4.7.3 RO Concentrate Alignment from AWPF to SVCW Outfall

The following alignments are evaluated to deliver the RO concentrate from the AWPF site to existing SVCW ocean outfall at the northeast corner of SVCW.

- **AWPF Site near SVCW:** A short open trench pipeline would be constructed along the SF Bay to the SVCW outfall. Special shoring methods may be required to provide extra lateral support due to poor soil stability.
- **Hwy 101 AWPF Site:** A pipeline from Hwy 101 AWPF Site to the SVCW outfall would be slip-lined in the existing 54"-dia SVCW force main along Redwood Shores Pkwy. It is assumed that eight (8) access and eight (8) receiving pits would be required at horizontal or vertical bends to slip-line pipeline segments. Future study would be needed to refine exact pit locations and confirm cost implications and risks.

4.7.4 RO Concentrate Alignment from AWPF to San Mateo Outfall

Outfall drawing maps were reviewed as part of this effort and it was assumed that the RO Concentrate alignment form the AWPF to the San Mateo outfall would be approximately 2,500 feet of 10" diameter pipe. A specific alignment was not determined as part of this effort and assumptions were made to create reasonable comparisons to the other alternatives.

4.7.5 Purified Alignment to CSR

Three alignment options from the AWPF to CSR were evaluated in the Phase 2 Concept Study to explore options to reuse infrastructure, avoid construction disruption in public ROWs through residential areas of the valley, use SFPUC ROWs, avoid the Pulgas Tunnel, and minimize pipeline length and total lift. Each alignment option meets one or more, but not all, of these objectives.

The Phase 2 Concept Study found that the alignment option that minimized utility conflicts while retaining reasonable pipeline length and total lift is the Woodside Road – SFPUC ROW option. A summary of the alignment is provided in Table 4-14 and illustrated in Figure 4-16. The two additional options for pipeline alignments evaluated in Phase 2 went through San Carlos and Redwood City along San Carlos/Club Drive and Edgewood Road. These options were identified to reduce the pipeline length and static head requirements, though they have the potential for increased utility conflicts and the need for more open trenching and micro-tunneling.

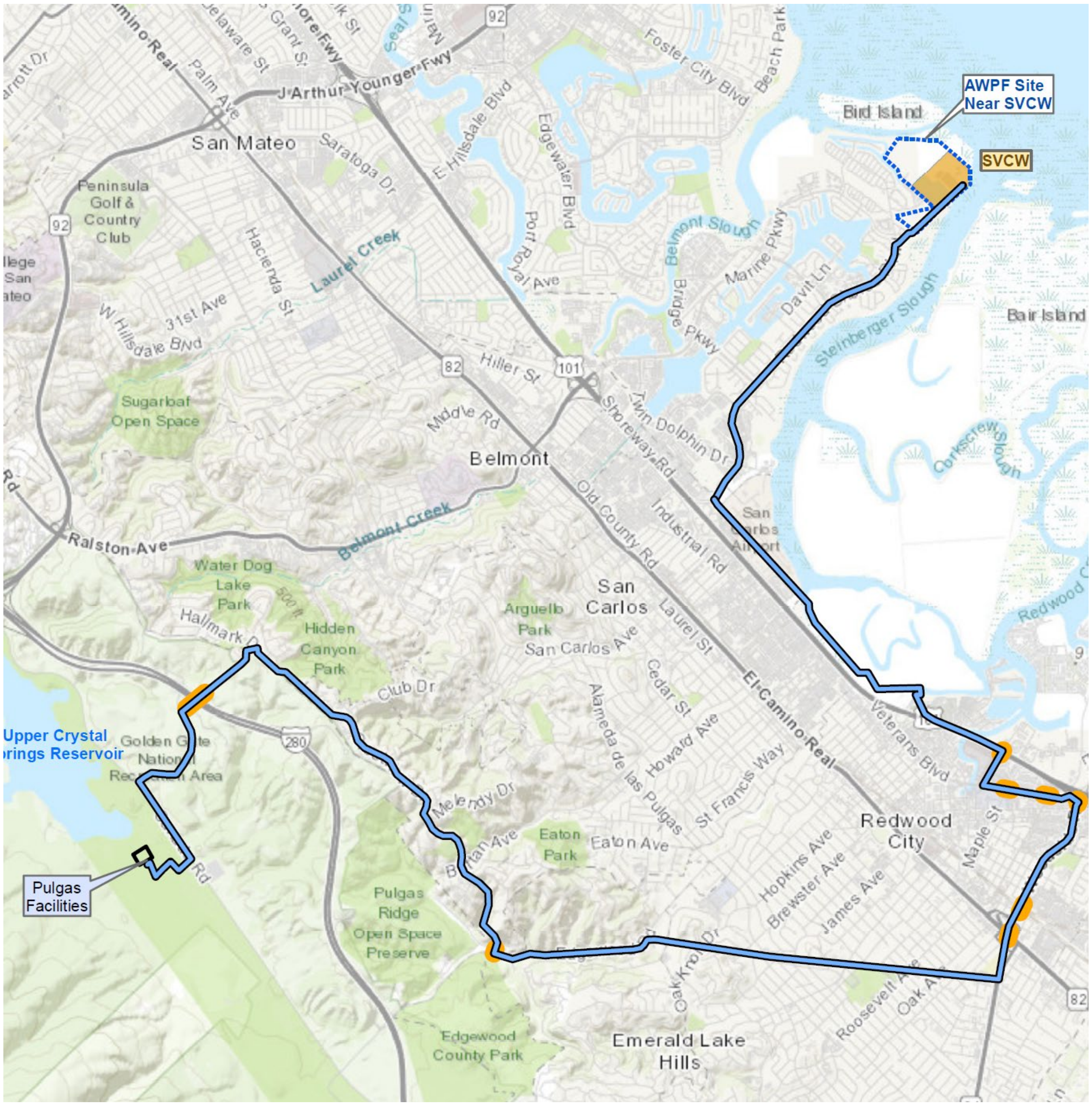
For the PREP Phase 3 effort, it was agreed to focus on the Woodside Road – SFPUC ROW alignment (shown in Figure 4-16) to be conservative in terms of costs (e.g., this was the highest cost alignment identified in Phase 2) and to minimize the number of alternatives evaluated for this effort. Future studies would revisit the three alignments to identify a preferred alternative.

Table 4-14: Summary of Purified Water Alignment from AWPF to CSR

Purified Water Alignment	HWY AWPF 101 Site		*AWPF Site Near SVCW*	
	Pipe Length	Static Head	*Pipe Length*	*Static Head*
Woodside Road - SFPUC ROW	13.5 miles	910 feet	16.4 miles	910 feet

Notes: Pipeline lengths include alignment along sections that could potentially repurpose existing assets (i.e., abandoned pipelines from SVCW as discussed in Section 8.1.3)

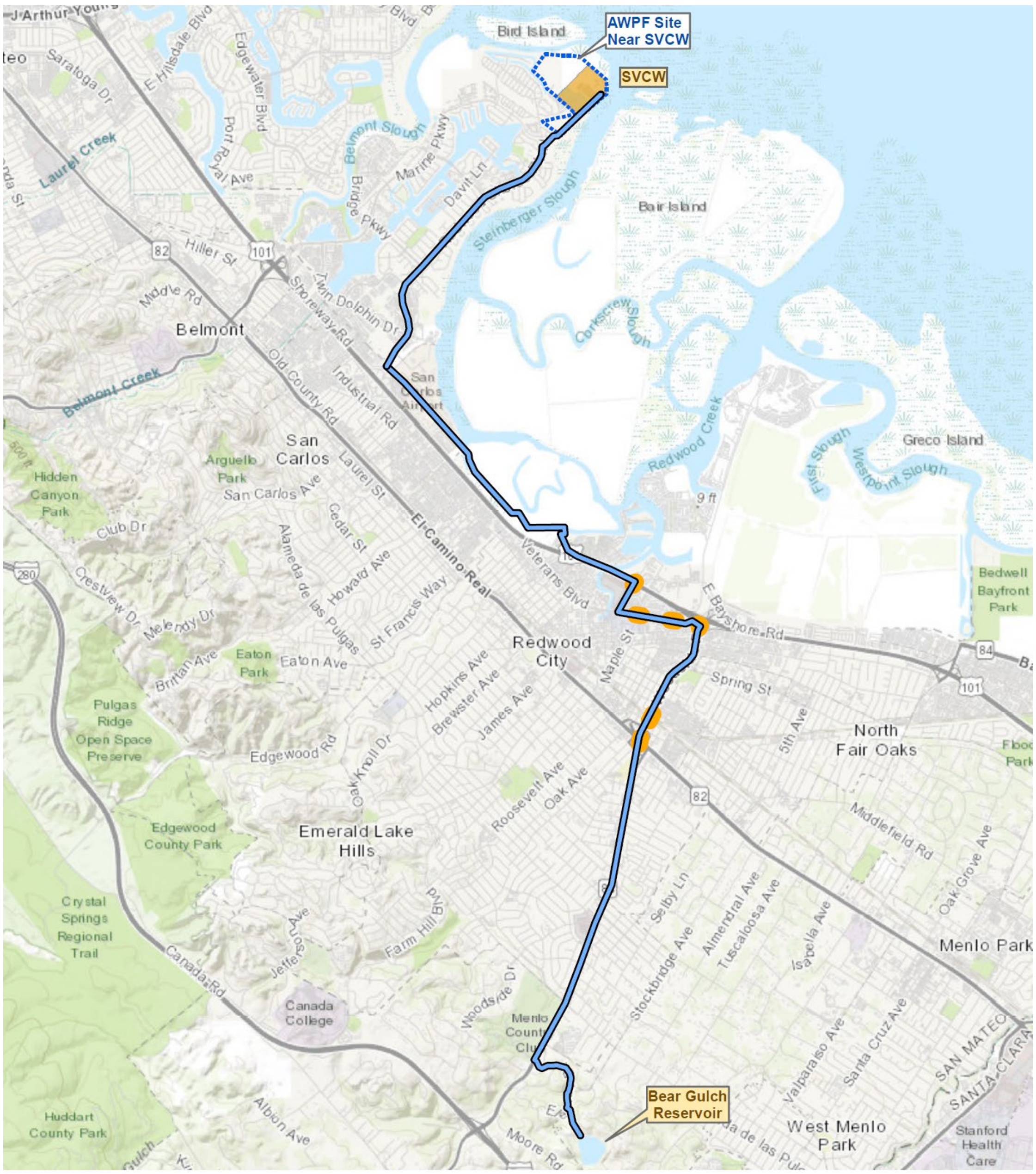
Figure 4-16: Purified Water Alignment to Crystal Springs Reservoir



4.7.6 Purified Alignment to Bear Gulch

The alignment to Bear Gulch Reservoir repurposes existing infrastructure along HWY 101 and considers ease of future construction. The alignment includes the possibility of reusing existing infrastructure along HWY 101 and continues along Woodside Road to reach the Bear Gulch Facilities, as illustrate in Figure 4-17.

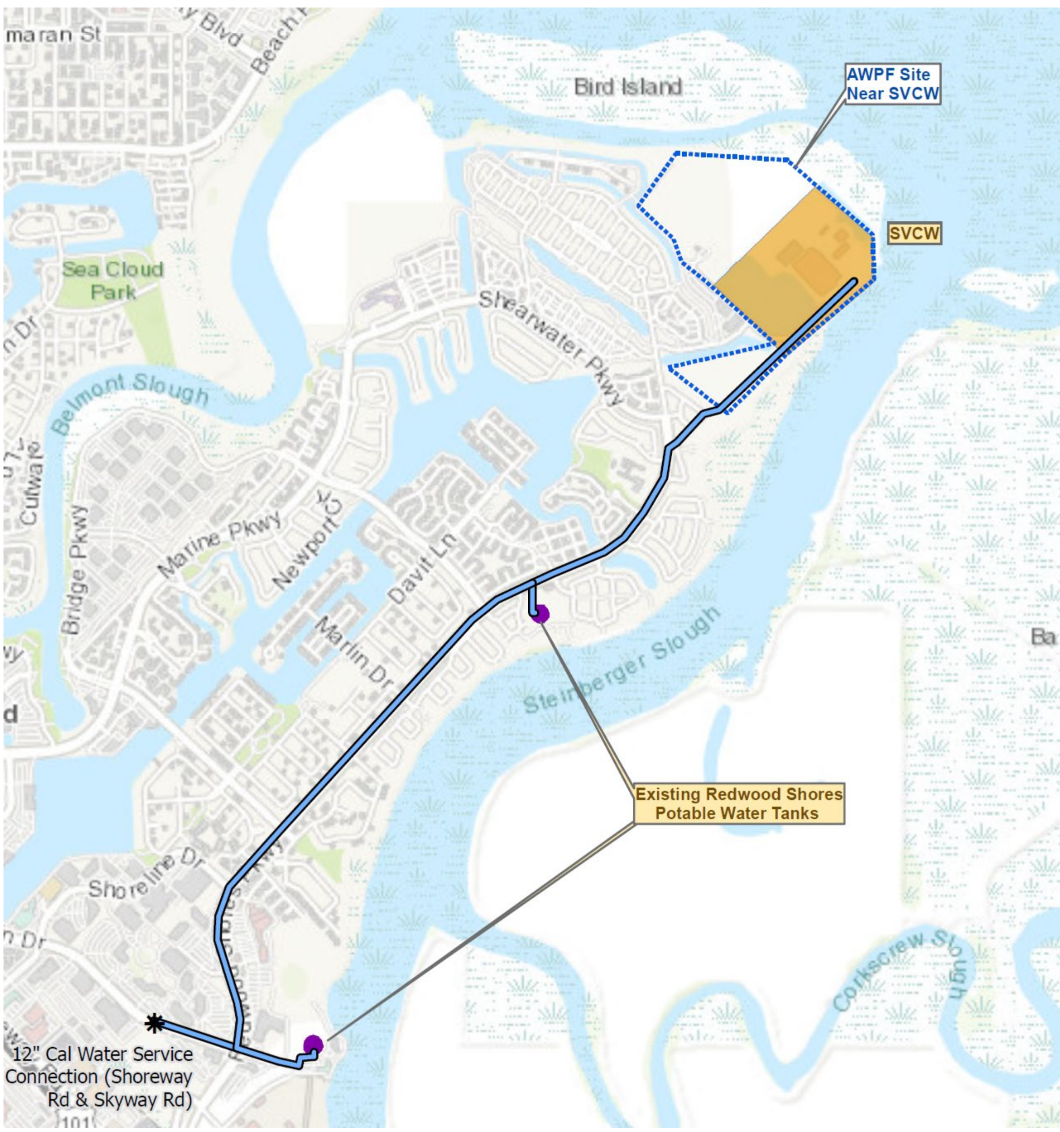
Figure 4-17: Purified Water Alignment to Bear Gulch Reservoir



4.7.7 Purified Alignment to Potable Water Distribution Systems

Various potable water distribution system tie-ins are within the vicinities of the proposed AWPF locations. Redwood City has two existing storage tanks off Redwood Shores Parkway with a combined storage capacity of 6.2 million gallons. These tanks are near both SVCW and the potential AWPF location near HWY 101. Purified water produced at the AWPF site near SVCW could be delivered to the Redwood Shores tanks as shown in Figure 4-18. Purified water from the AWPF site near SVCW could also be delivered to Cal Water's San Carlos Transmission System at the intersection of Shoreway Rd and Skyway Rd (12"), also shown in Figure 4-18. This tie-in would provide the purified water direct access to the distribution system.

Figure 4-18: Purified Water Alignment to Redwood City and Cal Water San Carlos



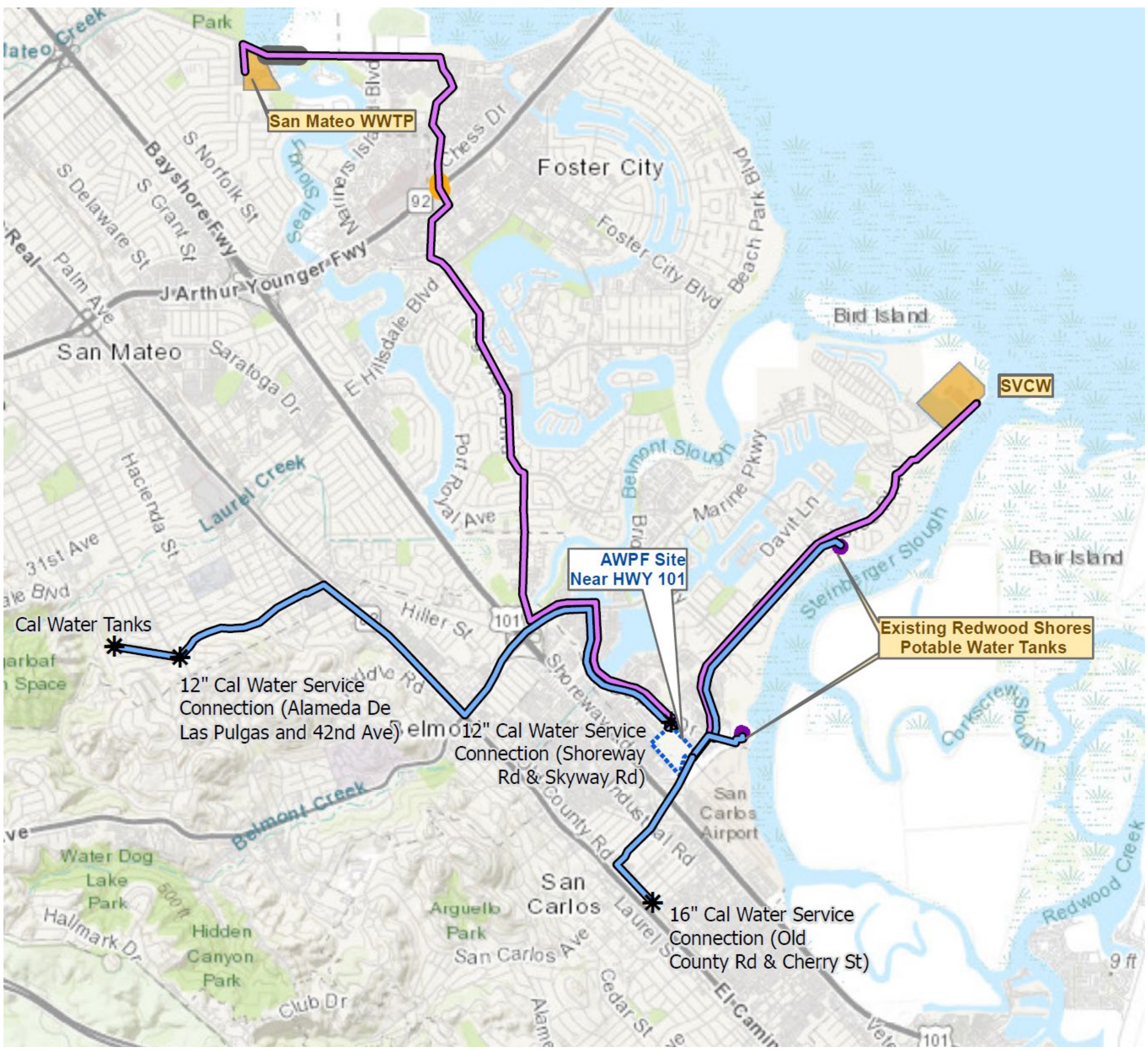
Foster City has multiple storage tanks along E 3rd Ave near the San Mateo WWTF. The tanks have a combined capacity of 20 million gallons. The Foster City Tanks could be augmented with purified water produced at an AWPF near the San Mateo WWTF, see Figure 4-19.

Purified water from the AWPF site near San Mateo could also be delivered to Cal Water's San Mateo Transmission System at the intersections of Newbridge Ave and S Norfolk St (12") and the intersection of Newbridge Ave and S Delaware St (24"). These tie-ins would provide the purified water direct access to the distribution system.

Figure 4-19: Purified Water Alignment to Foster City and Cal Water San Mateo

A 12 mgd purified water project would need to tie into multiple drinking water system locations to distribute purified water to a broader set of customers. As shown in Figure 4-20, purified water could be distributed from the AWPF site near Hwy 101 to the Redwood Shores tanks, two tie-in locations to Cal Water's San Carlos Transmission System at the intersection of Shoreway Rd and Skyway Rd (12") and the intersection of Old County Rd and Cherry St (16"), a tie-in location to Cal Water's San Mateo Transmission system at Alameda de Las Puglas and 42nd avenue and existing tanks nearby. Further evaluation of the capacity and operation of each drinking water system would be performed as part of a future study to confirm the preferred points of connection.

Figure 4-20: Purified Water Alignment to Redwood City, Cal Water San Carlos, and Cal Water San Mateo



4.7.8 Summary of Potential Alignments

Potential alignments explored as part of this study focused on:

- Reusing pipelines owned and abandoned by SVCW,
- Using existing recycled water pipeline owned by the City of Redwood City,
- Using existing recycled water storage tanks owned by the City of Redwood City,
- Leveraging existing SFPUC facilities and the right-of-way for their BDPL,
- Using existing Pulgas discharge facilities,
- Identifying potential alignments to deliver the RO concentrate from an AWPF to the SVCW outfall, located in the SF Bay deep water shipping channel,
- Identifying two (2) potential alignments to deliver tertiary water from the San Mateo WWTP through San Mateo and Foster City to an AWPF, and
- Identifying three (3) potential alignments to deliver purified water from an AWPF through the valley to CSR.
- Identifying a potential alignment to deliver purified water from an AWPF to Bear Gulch Reservoir
- Identifying potential distribution system tie-in locations.

Table 4-15 lists the various sub-alternative pipeline alignment combinations based on source water; AWPF locations; and tertiary, the RO concentrate, and purified water pipe alignments.

Construction of new infrastructure may:

- Provide more flexibility for design,
- Provide more reliable services,
- Disrupt community during construction (particularly in Redwood Shores),
- Require receiving/injection pit every 500-1000 feet for microtunneling segments,
- Require designs to address challenging subterranean conditions and regulatory requirements,
- Encounter utility conflicts associated with new open trench construction,
- Have high costs for design and construction,
- Have a greater environmental impact (particularly near the Bay), and
- Be limited by potential conflicts from other planned or unknown new projects.

Repurposing existing infrastructure may:

- Provide less flexibility for design and shorter lifespan depending on the condition assessment of the existing asset,
- Reduce public disruption during construction,
- Avoid utility conflicts associated with a new open trench construction,

- Require receiving/injection pits to slip-line new pipelines, depending on conditions, locations of horizontal and vertical bends in the existing pipelines, and availability of land for pits,
- Have lower costs for design and construction than new construction,
- Have less environmental impacts from construction, and
- Be limited by other planned or unknown new projects (e.g., the schedule for the SVCW Gravity Pipeline Project would make some existing pipe alignments available 2022-2025).

Some considerations for the alignments along San Carlos Ave, Club Drive and Edgewood Road include the following:

- New pipeline construction between Hwy 101 and El Camino would likely require extensive mitigation for community impact via the CEQA process.
- Heavily travelled residential streets may not have enough lane space and may arouse a vocal response from residents.
- Routes through central business district areas and heavily travelled routes may be more complex in terms of avoiding existing utilities, construction methods, and traffic control.
- Additional permitting time and costs would be incurred to cross under the Caltrain grade separation/overpass, Hwy 101 and I-280, and work near San Carlos Airport.

Table 4-15: Overview of Sub-Alternative Pipeline Alignment Combinations

Alt	Description	AWPF Location	Tertiary Conveyance	RO Concentrate Conveyance	Purified Conveyance
ALTERNATIVE 1 - Indirect Potable Reuse | Reservoir Water Augmentation (RWA) | 6 MGD to Crystal Springs Reservoir					
1a	AWPF near SVCW w/ consistent operation	Near SVCW	Short Alignment	Short Alignment	Woodside Road
1b	AWPF Hwy 101 Site w/ consistent operation	Hwy 101 Site	Repurpose SVCW Pipeline	Repurpose SVCW Pipeline	Woodside Road
1c	AWPF near SVCW w/ seasonal ramp down operation	Near SVCW	Short Alignment	Short Alignment	Woodside Road
1d	AWPF near SVCW w/ optimized ramp down operation	Near SVCW	Short Alignment	Short Alignment	Woodside Road
ALTERNATIVE 2 - Indirect Potable Reuse | Reservoir Water Augmentation (RWA) | 12 MGD to Crystal Springs Reservoir					
2a	AWPF near SVCW w/ consistent operation	Near SVCW	Beach Park, Repurpose SVCW Pipeline	Short Alignment	Beach Park (tertiary) Woodside Road (purified)
2b	AWPF Hwy 101 Site w/ consistent operation	Hwy 101 Site	Edgewater Blvd, Repurpose SVCW Pipeline	Repurpose SVCW Pipeline	Edgewood Blvd (tertiary) Woodside Road (purified)
2c	AWPF near SVCW w/ seasonal ramp down operation	Near SVCW	Beach Park, Repurpose SVCW Pipeline	Short Alignment	Beach Park (tertiary) Woodside Road (purified)
2d	AWPF near SVCW w/ optimized ramp down operation	Near SVCW	Beach Park, Repurpose SVCW Pipeline	Short Alignment	Beach Park (tertiary) Woodside Road (purified)
ALTERNATIVE 3 - Direct Potable Reuse | Raw Water Augmentation (RaWA) | 6 MGD to Bear Gulch Reservoir					
3a	Raw Water Augmentation at Bear Gulch Reservoir w/ consistent operation	Near SVCW	Short Alignment	Short Alignment	Woodside Road
3b	Raw Water Augmentation at Bear Gulch Reservoir w/ ramp down operation	Near SVCW	Short Alignment	Short Alignment	Woodside Road
ALTERNATIVE 4 - Direct Potable Reuse | Treated Water Augmentation (TWA) | 6 MGD to Potable Water System					
4a	Treated Water Augmentation (TWA) SVCW Supply and Local Use	Near SVCW	Short Alignment	Short Alignment	Redwood Shores Shoreway Rd
4b	Treated Water Augmentation (TWA) SVCW Supply and Local Use	Hwy 101 Site	Repurpose SVCW Pipeline	Repurpose SVCW Pipeline	Redwood Shores Shoreway Rd
4c	TWA SVCW Supply and Local Use (Foster City/CalWater)	Near San Mateo WWTF	Beach Park	SM Outfall	J Hart Clinton Drive Newbridge Ave @ S Delaware St
ALTERNATIVE 5 - Direct Potable Reuse | Treated Water Augmentation (TWA) | 12 MGD to Potable Water System					
5	TWA SVCW and San Mateo Supply and Local Use (Redwood City/CalWater)	Hwy 101 Site	Edgewater Blvd, Repurpose SVCW Pipeline	Repurpose SVCW Pipeline	Redwood Shores Shoreway Rd @ Skyway Road Fernwood Street @ Alameda de Las Pulgas

a. Assume 4 and 5.5 acres for 6 and 12 mgd capacity AWPF's, respectively.
Exact footprint location, and land acquisition costs, to be determined in a future study.

b. Short Alignment = connect Redwood City RW Tank to AWPF Inlet.
Repurpose SVCW Pipeline = slip-line in abandoned pipeline along Redwood Shores Parkway
Repurpose RWC pipeline = reuse Redwood City recycled pipeline to deliver tertiary water

c. Short Alignment = AWPF to SVCW outfall.
Repurpose Pipeline = slip-line in abandoned pipeline along Redwood Shores Parkway

Future studies are needed to assess the full range of conveyance options, including the condition of existing assets, availability of ROWs and land for acquisition, subterranean conditions, existing utilities, hydraulic requirements, environmental impacts, community response, and alternative alignments.

4.8 Waste-Stream Discharge Treatment and Disposal Water Quality Requirements

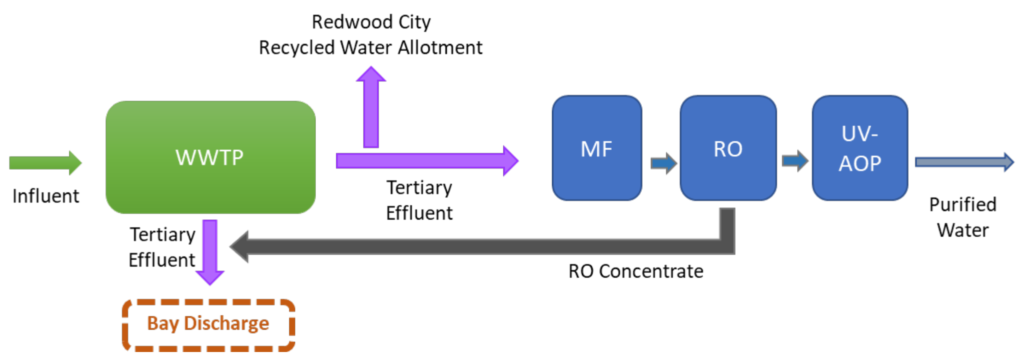
Description of waste-stream discharge treatment and disposal water quality requirements for the Proposed Title XVI Project.

Appendix B details discharge requirements in the San Francisco Bay. Key concepts and considerations related to RO concentrate disposal to the San Francisco Bay are summarized herein.

4.8.1 RO Concentrate Treatment and Disposal Concept

The discharge of treated wastewater from SVCW's outfall is regulated by requirements from three (3) WDRs and NPDES permits. The RO concentrate from the AWPF will be blended with the WWTP's tertiary effluent at the outfall (see Figure 4-21), and this combined effluent will need to meet the same requirements described in the WDR/NPDES permits. The projected combined effluent for both 6 mgd and 12 mgd scenarios show that constituents do not exceed monthly discharge limits, except for $CBOD_5$ in the 12 mgd scenario at SVCW. To meet monthly effluent discharge limits for the 12 mgd scenario, a reduction in recovery during periods of high CBOD flow may be implemented to meet NPDES discharge limits or to increase the tertiary effluent contribution from San Mateo thereby increasing the available tertiary effluent from SVCW for more dilution of the RO concentrate. Because $CBOD_5$ cannot be monitored instantaneously, surrogate monitoring parameters such as total organic carbon (TOC) or chemical oxygen demand (COD) may be used to develop a relationship between $CBOD_5$ and TOC/COD concentrations.

Figure 4-21: Flow Diagram Highlighting Bay Discharge Contributions



4.8.2 Existing Permits for Bay Discharge Requirements

The WDR/NPDES establish requirements for the overall water quality-based effluent limitations, mercury and polychlorinated biphenyls limitations, and nutrients monitoring requirements, respectively. The following permits are in place to regulate the Bay discharge requirements and are described in further detail in **Appendix B.5**:

- SVCW WDR: Order No. R2-2018-0005, NPDES No. CA0038369
- WDR for Mercury and PCBs: ORDER No. R2-2017-0041, NPDES No. CA0038849
- WDR for Nutrients: ORDER No. R2-2014-0014, NPDES No. CA0038873

Individual NPDES Permits

There are existing individual NPDES permits, one specific to SVCW and the other for the City of San Mateo WTP. Both include effluent limitations, monitoring requirements, and discharge specifications/ qualitative limitations on receiving water. In both permits, the limits are generally developed based on the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan). The dry season limitations are more stringent in both permits and were the requirements evaluated in this study. Table 4-16 and Table 4-17 summarize the Dry Season effluent limitations for SVCW and San Mateo, respectively, and **Appendix B.5** describes the permits in further detail.

Table 4-16: Summary of SVCW Dry Season Effluent Limitations

Parameter	Units	Average Monthly	Average Weekly	Max Daily	Inst. Min	Inst. Max
$CBOD_5$	mg/L	8	12	-	-	-
TSS	mg/L	8	12	-	-	-
Oil and Grease	mg/L	10	-	20	-	-
pH	s.u.[1]	-	-	-	6	9
Turbidity	NTU	10	-	20	-	-
Chlorine, Total Residual	mg/L	-	-	-	-	0
Ammonia, Total	mg/L as N	170	-	250	-	-
Copper, Total Recoverable	µg/L	52	-	84	-	-
Cyanide, Total	µg/L	21	-	36	-	-

Notes:
1. s.u. = standard units.

Table 4-17: Summary of SVCW Dry Season Effluent Limitations

Parameter	Units	Average Monthly	Average Weekly	Max Daily	Inst. Min	Inst. Max
$CBOD_5$	mg/L	15	25	-	-	-
TSS	mg/L	20	30	-	-	-
Oil and Grease[2]	mg/L	10	-	20	-	-
pH[2]	s.u.[1]	-	-	-	6	9
Chlorine, Total Residual[2]	mg/L	-	-	-	-	0
Ammonia, Total[2]	mg/L as N	66	-	120	-	-
Copper, Total[2]	µg/L	51	-	72	-	-
Cyanide, Total[2]	µg/L	20	-	38	-	-
Dioxin-TEQ[2]	µg/L	1.4×10^{-8}	-	2.8×10^{-8}	-	-
Nickel, Total[2]	µg/L	30	-	71	-	-

Notes:
[1] s.u. = standard units.
[2] Effluent limitations are applicable year-round.

Mercury and PCBs NPDES Permit

This permit requires monitoring of discharges for mercury and PCBs to comply with concentration and mass loading limits.

Existing and Future Nutrients NPDES Permit

This nutrient watershed permit complements SVCW's individual NPDES permits and stipulates additional nutrient-related requirements. The 2019 permit does not specify effluent limitations for nutrients, but includes effluent monitoring requirements for ammonia, nitrate-nitrite, total inorganic nitrogen, and total phosphorus. It also includes 2024 load targets for inorganic nitrogen based on historical 2014-2017 maximum dry season average loads, escalated to include a 15 percent population growth buffer. The 2024 dry season average load target of 2,900 kg/day is anticipated to be converted to a load cap in the 2024 permit cycle on a sub-embayment basis, with potential for nutrient credit trading to meet compliance. Because these load targets and caps are mass based, the RO concentrate from an AWPF would not negatively impact compliance with a potential new effluent nutrient limit that is load based.

4.9 Additional Receiving Water Quality Requirements for Purified Water Augmentation

Appendix B details discharge requirements in the San Francisco Basin Plan requirements for discharge to CSR and Bear Gulch. Key concepts and considerations related to purified water augmentation to CSR and Bear Gulch are summarized herein.

4.9.1 Reservoir Water Augmentation and Direct Potable Reuse Requirements

A reservoir water augmentation (ResWA) project is defined as having plans to use purified recycled water from a municipal wastewater facility for augmenting a reservoir that is designated as a source of domestic water supply. A ResWA project would likely be implemented within a State Board Division of Drinking Water (SBDDW) drinking water supply permit and a NPDES permit while following the Final ResWA Regulations. The Final ResWA Regulations require 1) an initial minimum theoretical retention time of no less than 180 days with potential for 60 days to be approved; and 2) a dilution requirement in the reservoir of 100:1 or 10:1 with an additional 1-log microbial pathogen treatment. The regulations also include an "alternatives clause" to provide adaptability to offer alternative permitting pathways for innovative projects, with alternative approaches that may apply to the treatment train, monitoring plan, or approaches used to demonstrate meeting minimum retention time. Alternatives must provide equivalent or better performance and receive written approval from the State Board prior to implementation. **Appendix B.1** provides further details on the Final ResWA Regulations.

The treatment requirements for ResWA require recycled water to be treated by RO and an AOP prior to delivery to a reservoir. Table 4-18 summarizes the ResWA criteria and treatment requirements for different ResWA scenarios. These requirements are also described in further detail in **Appendix B.2**.

Table 4-18: ResWA Criteria and Treatment Requirements

Retention Time (days)[1]	Dilution ($Volume:Inflow_{day}$)[2]	Log Removal at AWPF (V/G/C)[3]	# of Treatment Processes
≥ 120	100:1	8/7/8	2
	10:1	9/8/9	3
≥ 60	100:1	≥ 9/8/9	2
	10:1	≥ 10/9/10	3

[1] Retention time is calculated as total volume divided by total outflow

[2] Dilution of 100:1 = one percent, by volume, of purified water delivered to the surface water reservoir during any 24-hour period. Dilution of 10:1 = ten percent, by volume, of purified water delivered to the surface water reservoir during any 24-hour period

[3] Log reductionl credits at a drinking water treatment plant (4/3/2 V/G/C) were previously included in the total log removal values (LRV) requirement in prior versions of the Draft ResWA Regulations but are not included in the Final ResWA Regulations.

The draft DPR regulations currently impose the same requirements for RWA and TWA projects. The DDW states this is because the raw water augmentation is defined as "the planned placement of recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant." Under this description, RWA could refer to recycled water that is introduced into a system and does not have a SWTP. The regulations require the designation of one direct potable reuse responsible agency (DiPRRA) responsible for complying with the DPR regulations. This agency must be a public water system responsible for using the DPR water and will be responsible for the compliance of all treatment processes with regulations, must facilitate inspections of the facilities and operations.

For DPR, the draft criteria include a minimum microbial LRV requirement of 20/14/15 V/G/V which must be achieved using multiple treatment processes, providing multi-barrier protection. The draft DPR pathogen control treatment requirements are summarize below in Table 4-19 and described in more detail in **Appendix B.4**.

Table 4-19: Summary of Draft DPR Pathogen Control Treatment Requirements

Sum of LRVs for DPR Treatment Train at AWPF (V/G/C)	Minimum # of Treatment Processes with >1 log-removal	Minimum # of Diverse Treatment Processes[1]	Minimum Typical Treatment Train Requirements
20/14/15	4	3	• Ozone/BAC • RO • UV-AOP

[1] Includes: UV disinfection, physical separation, chemical disinfection

In addition, any entity considering DPR in the State of California must also comply with the United States Environmental Protection Agencies Safe Drinking Water Act (SDWA) will also need to meet the following requirements as described in **Appendix B.4**:

- Lead and Copper Rule
- Total Coliform Rule
- Surface Water Treatment Rules
- Stage 1 and State 2 Disinfectants and Disinfection Byproducts Rules (DPBR)
- Other regulations governing distribution systems

4.9.2 Overview of Treatment Processes for Potable Reuse

Two potential water sources for the project include tertiary effluent from the SVCW facility and/or the San Mateo WWTP. **Appendix C.1** summarizes the available AWPF treatment processes that may be considered for implementation. The combination of these treatment processes will depend on the quality of the treated wastewater influent and the intended use of the AWPF product water.

To maintain low treatment facility costs, simplify operations, and maximize economic returns, operating the AWPF at a relatively constant flow is preferable, and it will be assumed the project could receive 8 mgd of tertiary influent from the SVCW facility and 8 mgd from the City of San Mateo's BNR/MBR facility, for a total of 16 mgd. Assuming 75 percent recovery, the project will produce up to 12 mgd of new, local water supplies.

For the alternatives evaluation, the AWPF train was assumed to consist of a low-pressure membrane (MF or UF) as pretreatment prior to the RO System. The next step would be an advanced oxidation process (AOP), which typically combines UV treatment with the addition of an oxidant to oxidize most remaining natural and synthetic organic compounds not removed by RO> Ozone and biologically activated carbon (BAC) could be advantageous for ResWA and is anticipated to be required for a RWA or TWA project. The anticipated pathogen removal credits for treatment train processes are listed in Table C-2 of **Appendix C.2**. These values are for planning purposes only and DDW allocates treatment credits on a case-by-case basis based on monitoring and performance.

4.9.3 Nutrient Management via Breakpoint Chlorination

The SF Bay Basin Plan limits the discharge of un-ionized ammonia to receiving waters to < 0.025 mg/L as N (Section 4.2.3). As shown in Table 4-8, 2.4 mg/L as N of ammonia is conservatively expected to be present in the purified water following RO treatment and additional ammonia removal is required to meet SF Bay Basin Plan limits. As discussed previously, while ammonia may exist as ionized or un-ionized depending on pH, it is conservative to reduce total ammonia concentrations to below the basin plan limits. Breakpoint chlorination utilizes chlorine to oxidize ammonia to nitrogen gas through the addition of high concentrations of ammonia to chlorine at a weight ratio of 7.6:1. In practice, greater ratios of chlorine to ammonia may be required to achieve breakpoint chlorination (e.g., 10:1). Breakpoint chlorination to remove ammonia prior to discharge of recycled water to CSR may be performed at Pulgas, which is currently performing breakpoint chlorination. For ammonia removal at Bear Gulch, breakpoint chlorination may be performed in the conveyance pipeline to Bear Gulch or in a newly installed chlorine contactor at Bear Gulch. Additional ammonia removal may not be required for TWA because the recycled water is not discharged to surface water.

4.9.4 Temperature Management

The SF Bay Basin Plan requires that the temperature of any freshwater habitat would not be increased by ± 5°F and the addition of recycled water is not expected to increase background temperatures in CSR. Treatment technologies for the recycled water including MF, RO, UV/UV-AOP, ozone, and BAF are expected to have a negligible increase in water temperature. In addition, the average background temperature from the secondary effluent and CSR are also similar (Table 4-7). Moreover, any potential increases in temperature from the secondary effluent or the treatment system may be mitigated or negated during water conveyance from AWPF to Pulgas, the lengthy breakpoint chlorination contact pipeline used at Pulgas, and the outfall discharge from Pulgas to CSR. Similar assumptions would also apply to discharge at Bear Gulch. Thus, temperature management is not anticipated to be of concern.

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Section 5: Economic Analysis

A Title XVI feasibility study report must include an economic analysis of the Proposed Title XVI Project relative to other water supply alternatives that could be implemented by the non-Federal project sponsor. This assessment needs to identify the degree to which the water recycling and reuse alternative is cost-effective, and the economic benefits that are to be realized after implementation. The study lead must submit the following information for the economic analysis in a Title XVI feasibility study report.

This section describes economic analysis of existing conditions and future projections and provides a cost comparison of the alternatives presented in Section 4. A substitute project cost opinion is provided based on information available from other planning efforts being conducted in the region. A summary of some qualitative benefits and considerations is also described.

This section provides a brief description of the following:

1. Existing Conditions and Future Projections
2. Cost Comparisons of Alternatives
3. Substitute Project Cost Opinion
4. Qualitative Benefits and Considerations

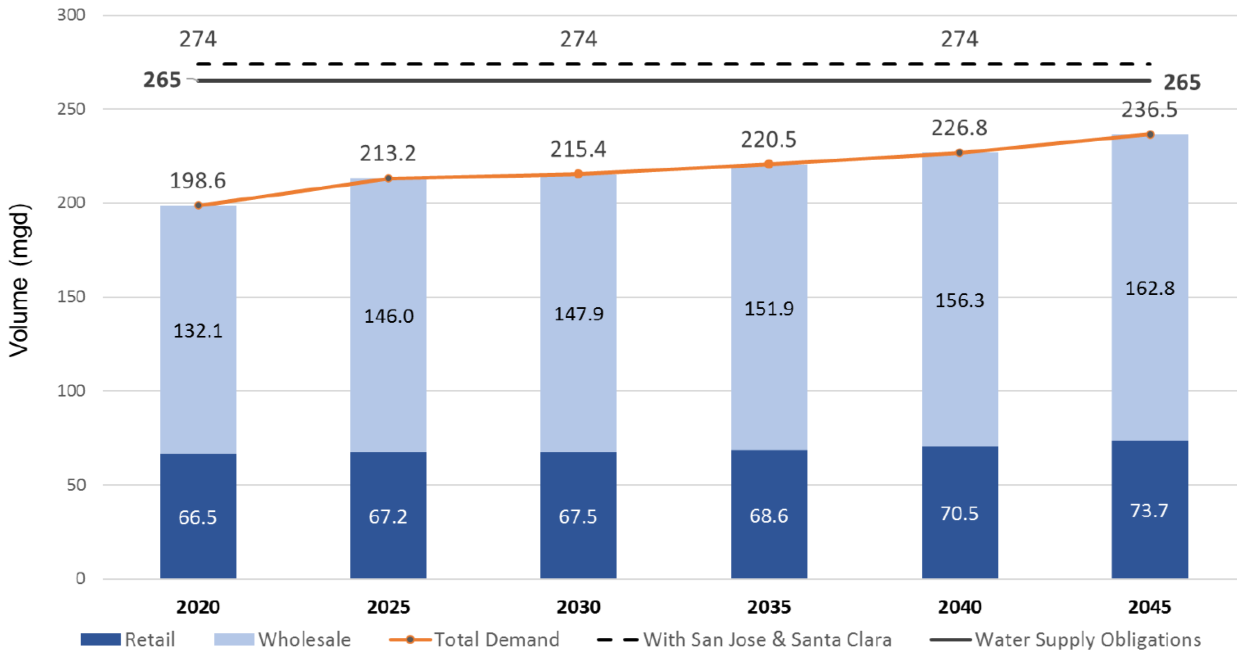
Additional supporting information for this section is included in **Appendix F**: Engineers Opinion of Probable Costs

5.1 Existing Conditions and Future Projections

The economic analysis included in the feasibility study report shall describe the conditions that exist in the area and provide projections of the future with, and without, the project. Emphasis in the analysis must be given to the contributions that the plan could make toward alleviation of economic problems and the meeting of future demand.

The Regional Water System (RWS) faces significant water supply challenges due to climate change and regulatory pressures, which can result in future direct and indirect social economic impacts. On the demand front, the SFPUC has contractual obligations to provide 184 mgd (Supply Assurance) to Wholesale Customers and 81 mgd to retail customers, representing 265 mgd of water supply delivery obligations. San Jose and Santa Clara, interruptible customers of the SFPUC, have requested a minimum permanent supply of 9 mgd and up to 15.5 mgd of dedicated supply, which the SFPUC's Commission will have to make a policy decision by 2028 on whether to provide this new supply assurance (SFPUC, 2022). The planning objective of SFPUC is to meet anticipated water supply needs in drought years in the SFPUC's retail and wholesale service areas through 2045, as shown in Figure 5-1, which is consistent with the SFPUC's 2020 Urban Water Management Plan.

Figure 5-1: SFPUC's Water Supply Obligations and Projected Demands



Source: Alternative Water Supply Program Quarterly Report, (SFPUC, March 2022)

Future planning will evaluate ways of serving new permanent customers and providing additional supply for existing customers; and prepare for future climate effects and other uncertainties through 2045. SFPUC estimates an additional 84 mgd of water supply is required for 2045 projections. This is based on an estimated 274 mgd in planning obligations and 152 mgd of available water supply, assuming implementation of the Bay-Delta Plan and rationing (SFPUC, 2022).

Because of this gap between the projected supply and demand, SFPUC needs to evaluate new and diverse alternative water supply options including expanding storage, groundwater banking, transfers, purified water (potable reuse), desalination, and technological innovations. Exploring these alternative options will diversify water supply sources to meet future demands while increasing reliability of the SFPUC system. SFPUC established the Alternative Water Supply (AWS) Program to evaluate and establish new projects that will help meet future water supply needs and level of service goals. The PREP Project is being considered as one of the supplemental supply projects to fill the gap,

The implementation of this project would help to supplement future water supplies for the SFPUC system and diversify the water supply with a local and reliable source and minimize economic impacts in the region.

5.2 Cost Comparison of Alternatives

The Title XVI feasibility study must include a cost comparison of alternatives that would satisfy the same demand as the Proposed Title XVI Project. Alternatives used for comparison must be likely and realistic, and developed with the same standards with respect to interest rates and period of analysis.

This section describes the engineer's opinion of probable costs developed for the ResWA alternatives described in Section 4. As shown in Table 5-1, 15 sub-alternatives were developed to show all the potential combinations of treatment siting and conveyance. Alternative costs were developed for those indicated with a "*" in Table 5-1 to provide a representative range of costs associated with the location of the AWPF, the size of the AWPF, and the potential to repurpose infrastructure for comparison.

Table 5-1: Overview of Sub-Alternatives

Alt	Description	Source Water[1]	AWPF Location	Drinking Water System Served[2]	Ave Annual Water Deliveries	
					(mgd)	(AFY)
ALTERNATIVE 1 - Reservoir Water Augmentation | 6 mgd to Crystal Springs Reservoir						
1a	Continuous operation	SVCW	near SVCW	SFPUC (CSR)	6	6,720
1b	Continuous operation	SVCW	Hwy 101 Site	SFPUC (CSR)	6	6,720
1c	Seasonal ramp down in wet years	SVCW	near SVCW	SFPUC (CSR)	5.25	5,880
1d	Seasonal shutdown in wet years	SVCW	near SVCW	SFPUC (CSR)	4.5	5,040
ALTERNATIVE 2 - Reservoir Water Augmentation | 12 mgd to Crystal Springs Reservoir						
2a	Continuous operation	SVCW + SM	near SVCW	SFPUC (CSR)	12	13,440
2b	Continuous operation	SVCW + SM	Hwy 101 Site	SFPUC (CSR)	12	13,440
2c	Seasonal ramp down in wet years	SVCW + SM	near SVCW	SFPUC (CSR)	10.5	11,760
2d	Seasonal shutdown in wet years	SVCW + SM	near SVCW	SFPUC (CSR)	9	10,080
ALTERNATIVE 3 - Direct Potable Reuse | 6 mgd Raw Water Augmentation Bear Gulch Reservoir						
3a	Continuous operation	SVCW	near SVCW	Cal Water (BG)	6	6,720
3b	Seasonal ramp down in all years	SVCW	near SVCW	Cal Water (BG)	5.25	5,880
ALTERNATIVE 4 - Direct Potable Reuse | 6 mgd Treated Water Augmentation						
4a	TWA for Local Use near SVCW	SVCW	near SVCW	Redwood City + Cal Water (SC)	6	6,720
4b	TWA for Local Use near SVCW	SVCW	Hwy 101 Site	Redwood City + Cal Water (SC)	6	6,720
4c	TWA for Local Use near San Mateo	SM	Near San Mateo WWTP	Foster City + Cal Water (SM)	6	6,720
ALTERNATIVE 5 - Direct Potable Reuse | 12 mgd Treated Water Augmentation						
5	TWA for Local Use near SVCW	SVCW + SM	Hwy 101 Site	Redwood City + Cal Water (SC and SM)	12	13,440

[1] SM = effluent from San Mateo WWTP

[2] CSR = SFPUC customers served via Harry Tracy WTP, BG = Bear Gulch Division customers, SC = San Carlos Division customers, SM = San Mateo Division customers

All sub-alternatives include the repurpose of infrastructure where appropriate, which may include some or all of the following:

- Use Redwood City storage tanks at SVCW,
- Repurpose SVCW pipelines along Redwood Shores Pkwy,
- Repurpose SVCW pipelines along Shoreway Rd,
- Use Redwood City recycled water pipeline to Hwy 101 AWPF Site,
- Use Pulgas Dechloramination Facility, and
- Use Pulgas Discharge Facility

Appendix F includes additional information about cost assumptions and provides a detailed opinion of probable costs for each sub-alternative.

The engineer's opinion of probable capital, O&M, and annualized unit costs for each sub-alternative are summarized in Table 5-2 and Table 5-3. A graphical comparison of capital costs and annualized unit life cycle costs are presented in Figure 5-2 and Figure 5-3, respectively

- When comparing a 12-mgd ResWA project to a 6-mgd ResWA project, the capital and O&M costs are higher for the larger facility, but not proportionally for the increased flow due to the scalability of treatment and conveyance facilities. Thus, the unit life cycle costs decrease by 28 percent, illustrating the economics of scale that could be realized by a larger project.

As indicated in

- Table 4-4, the average spill volumes during the 6-year wet period are much higher than those during the 6-year dry period, which reduces the net benefit of purified water to RWS during wet years. This approach allows SFPUC, and the other PREP parties, to understand the merits of the project during dry years when it is needed the most. The conceptual cost estimates for the ResWA alternatives are refined to realize the true value of the project in dry vs wet years. This was done by quantifying the cost of producing water without benefit, i.e., the purified water that gets displaced due to lack of available storage in the RWS and creates Upcountry spill which is lost to the system. This cost of spill was estimated for wet and dry periods to highlight the difference in net benefit of the purified water that would be delivered, i.e., total purified water produced less spill. The analysis shows that the overall benefit of the project is much higher during dry years, when higher deliveries of purified water are achieved, and costs of spill are significantly lower. Projects that repurpose SVCW pipelines realize a 10 percent overall project savings from those that assumed construction of all new pipelines.

- The location of the AWPF does not significantly influence the overall cost due to the assumption that the existing Redwood City pipeline in Redwood Shores could be used to convey Title 22 flow, and the abandoned SVCW influent line could be used to slip-line an RO concentrate line. Costs for leasing the Hwy 101 AWPF Site or purchasing land near SVCW are not included and may have a greater influence on the preferred location.

- The overall confidence level for the conceptual-level analysis should be considered to be low across all alternatives, primarily because preliminary design work has not been performed. Even though the project and infrastructure needs have been further defined in Phase 2, alternative alignment studies, hydraulic analysis, and treatment studies (particularly for nutrient removal) have not been conducted, which could influence more than 50 percent of the cost estimate. For this reason, an estimate contingency of 40 percent is included. For the purpose of this study, the cost estimate is appropriate to assess the viability of the program overall, allow for an apples-to-apples of comparison of alternatives based on capacity and key alignments, and to provide an overall distribution of costs for major infrastructure.

- O&M costs for plant shutdown are ~10 percent lower than for ramp down indicating that the energy and chemical costs required to operate a ramped down plant is greater than the estimated costs for membrane preservation during plant shutdown.

As previously noted, the costs provided herein represent planning to feasibility level information with an estimated accuracy range between -30 percent and +50 percent. These are intended to be used for comparison of alternatives within the study and not to be used for budgeting purposes.

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Table 5-2: Summary of Opinion of Probable Costs for ResWA

Sub-Alternative	1a	1b	1c	1d	2a	2b	2c	2d
AWPF Location	AWPF near SVCW	AWPF Near HW 101	AWPF near SVCW	AWPF near SVCW	AWPF near SVCW	AWPF Near HW 101	AWPF near SVCW	AWPF near SVCW
Operations	Continuous Operation	Continuous Operation	Seasonal Ramp Down	Seasonal Shut Down	Continuous Operation	Continuous Operation	Seasonal Ramp Down	Seasonal Shut Down
Receiving Water System	6 mgd CSR (SFPUC)	6 mgd CSR (SFPUC)	6 mgd CSR (SFPUC)	6 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)
Source Water	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)
Average Purified Water Deliveries (Assumed Wet and Dry Years)								
Purified Water Produced (mgd)	6.0	6.0	5.3	4.5	12.0	12.0	10.5	9.0
Purified Water Produced (AFY)	6,720	6,720	5,880	5,040	13,440	13,440	11,760	10,080
Ave Annual Displaced Water or "Spill"	2,430	2,430	1,880	1,320	4,960	4,960	3,750	2,630
Purified Water Benefit (AFY)	4,290	4,290	4,000	3,720	8,480	8,480	8,010	7,450
Dry Year Average Spill (AFY)	378	378	236	95	880	880	473	190
Wet Year Average Spill (AFY)	4,485	4,485	3,512	2,539	9,037	9,037	7,024	5,078
Purified Water Benefit (mgd)	3.8	3.8	3.6	3.3	7.6	7.6	7.2	6.7
Facility Component								
Treatment	$227,000,000	$208,000,000	$227,000,000	$227,000,000	$385,000,000	$346,000,000	$385,000,000	$385,000,000
Pipelines	$105,000,000	$99,000,000	$105,000,000	$105,000,000	$184,000,000	$166,000,000	$184,000,000	$184,000,000
Pump Station	$24,000,000	$27,000,000	$24,000,000	$24,000,000	$45,000,000	$49,000,000	$45,000,000	$45,000,000
Storage	$4,200,000	$4,200,000	$4,200,000	$4,200,000	$6,400,000	$6,400,000	$6,400,000	$6,400,000
Reservoir Facility Improvements	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000
Total Est. Capital Cost ($)	**$369,800,000**	**$347,800,000**	**$369,800,000**	**$369,800,000**	**$630,000,000**	**$577,000,000**	**$630,000,000**	**$630,000,000**
Estimated Capital Cost ($mil)	**$370**	**$348**	**$370**	**$370**	**$630**	**$577**	**$630**	**$630**
Annualized Capital Cost ($mil/yr)	$14.7	$14.2	$14.7	$14.7	$18.3	$17.4	$18.3	$18.3
Annualized Unit Capital Cost for Produced Water ($/AF)	**$2,180**	**$2,110**	**$2,490**	**$2,910**	**$1,360**	**$1,300**	**$1,560**	**$1,820**
Annual O&M Cost ($/yr)	$12,500,000	$13,300,000	$11,400,000	$10,400,000	$23,300,000	$22,600,000	$21,300,000	$19,500,000
Annual Unit O&M Cost for Purified Water Produced/Delivered ($/AF)	**$1,860**	**$1,980**	**$1,940**	**$2,060**	**$1,730**	**$1,680**	**$1,810**	**$1,930**
Annulaized Project Unit Cost for Purified Water Produced/Delivered ($/AF)	**$4,040**	**$4,090**	**$4,430**	**$4,970**	**$3,090**	**$2,980**	**$3,370**	**$3,750**
Unit Cost ($/CCF)	$14.5	$14.7	$15.0	$15.5	$11.3	$10.8	$11.4	$11.7
Unit Cost ($/gal)	$0.019	$0.020	$0.020	$0.021	$0.015	$0.015	$0.015	$0.016
Average Annual Cost of Purified Water Produced/Delivered ($mil)	**$27.1**	**$27.5**	**$26.0**	**$25.0**	**$41.5**	**$40.1**	**$39.6**	**$37.8**
Average Annual Cost of "Spill" ($mil)	**$9.8**	**$9.9**	**$8.3**	**$6.6**	**$15.3**	**$14.8**	**$12.6**	**$9.9**
Dry Year Average Annual Cost of "Spill" ($mil)	**$1.5**	**$1.5**	**$1.0**	**$0.5**	**$2.7**	**$2.6**	**$1.6**	**$0.7**
Wet Year Average Annual Cost of "Spill" ($mil)	**$18.1**	**$18.3**	**$15.6**	**$12.6**	**$27.9**	**$26.9**	**$23.7**	**$19.0**

Assumptions:

1. Use Redwood City storage tanks at SVCW, Pulgas Dechloramination Facility, and Pulgas Discharge Facility for all alternatives.
2. Repurpose SVCW pipeline along Redwood Shores Pkwy for all alternatives.
3. Repurpose SVCW pipeline along Redwood Shores Pkwy for all alternatives except 1a.2.
4. Use RWC RW pipelines from storage tanks at SVCW to Highway 101 for alternative 1b.1 and 2c.1.

Table 5-3: Summary of Opinion of Probable Costs for RWA and TWA

Sub-Alternative	3a	3b	4a	4b	4c	5
AWPF Location	AWPF near SVCW	AWPF near SVCW	AWPF near SVCW	AWPF Near HW 101	AWPF near SM	AWPF Near HW 101
Operations	Continuous Operation	Seasonal Ramp Down	Continuous Operation	Continuous Operation	Continuous Operation	Continuous Operation
Receiving Water System	6 mgd Bear Gulch (CalWater)	6 mgd Bear Gulch (CalWater)	6 mgd DPR (RWC / CalWater SC)	6 mgd DPR (RWC / CalWater SC)	6 mgd DPR (FC / CalWater SM)	6 mgd DPR (RWC / CalWater SC-SM)
Source Water	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)
Average Purified Water Deliveries (Assumed Wet and Dry Years)						
Purified Water Delivered (mgd)	**6**	**5.3**	**6**	**6**	**6**	**12**
Purified Water Delivered (AFY)	**6,720**	**5,880**	**6,720**	**6,720**	**6,720**	**13,440**
Purified Water Delivered (MGs/year)	**2,190**	**1,916**	**2,190**	**2,190**	**2,190**	**4,380**
Facility Component						
Treatment	$459,000,000	$459,000,000	$301,000,000	$290,000,000	$306,000,000	$466,000,000
Pipelines	$66,000,000	$66,000,000	$31,000,000	$47,000,000	$25,000,000	$147,000,000
Pump Station	$20,000,000	$20,000,000	$7,000,000	$8,000,000	$10,000,000	$34,000,000
Storage	$4,600,000	$4,600,000	$4,200,000	$4,200,000	$4,200,000	$7,000,000
Reservoir Facility Improvements	$80,700,000	$80,700,000	n/a	n/a	n/a	n/a
Total Est. Capital Cost ($)	**$630,300,000**	**$630,300,000**	**$343,200,000**	**$349,200,000**	**$345,200,000**	**$654,000,000**
Estimated Capital Cost ($mil)	**$630**	**$630**	**$343**	**$349**	**$345**	**$654**
Annualized Capital Cost ($mil/yr)	$16.3	$16.3	$15.3	$15.0	$15.5	$28.1
Annualized Unit Capital Cost ($/AF)	**$2,430**	**$2,780**	**$2,280**	**$2,240**	**$2,300**	**$2,090**
Annual O&M Cost ($/yr)	$11,300,000	$10,400,000	$8,518,000	$8,850,000	$7,766,000	$25,430,000
Annual Unit O&M Cost ($/AF)	**$1,680**	**$1,770**	**$1,270**	**$1,320**	**$1,160**	**$1,890**
Annulaized Project Unit Cost ($/AF)	**$4,110**	**$4,550**	**$3,550**	**$3,560**	**$3,460**	**$3,980**
Unit Cost ($/CCF)	$9.4	$10.5	$8.2	$8.2	$7.9	$9.1
Unit Cost ($/gal)	$0.013	$0.014	$0.011	$0.011	$0.011	$0.012

Figure 5-2: Summary of Capital Costs

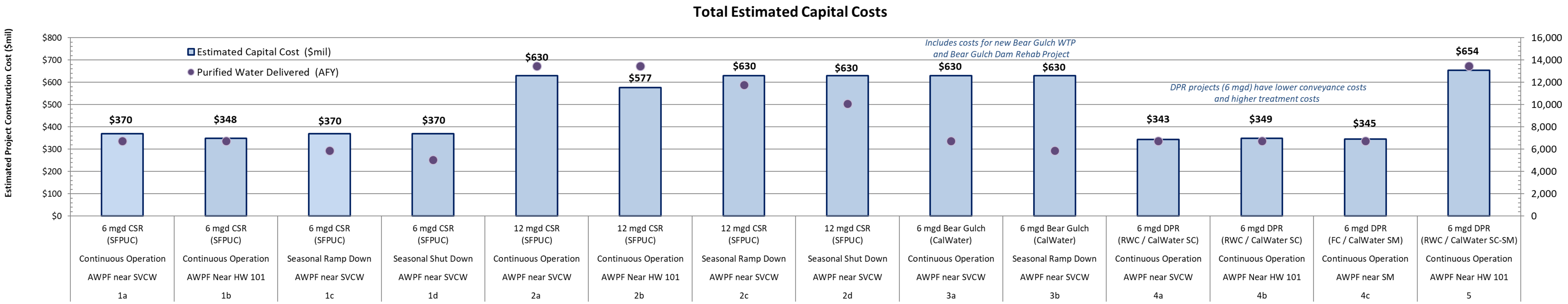
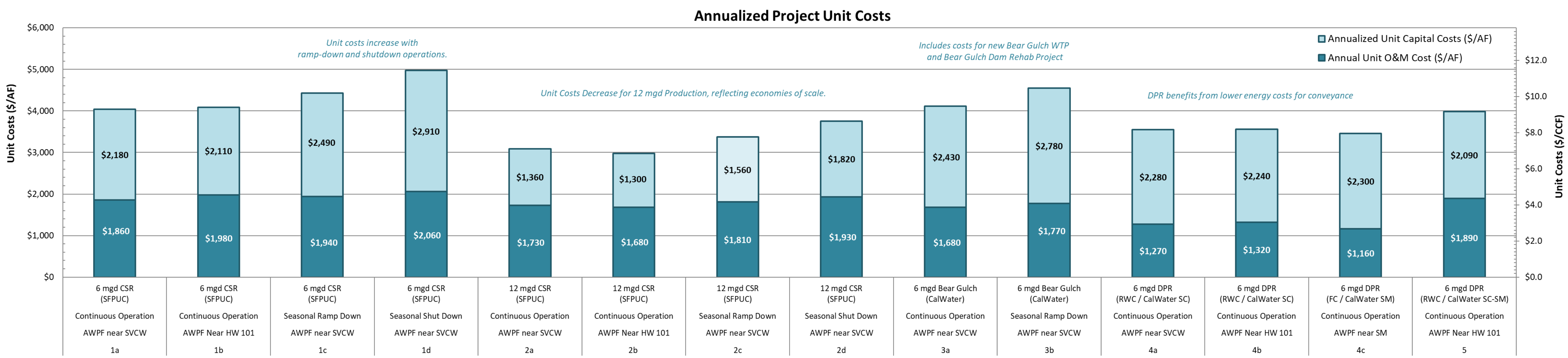


Figure 5-3: Summary of Annual Unit Costs



Notes: 1. The stacked bars represent unit life cycle costs, the sum of annualized construction costs (based on facility life) plus annual O&M costs, divided by the recycled water delivered over the life of the project, to obtain a uniformly derived unit cost per volume of water delivered (left y-axis).
2. Land acquisition costs for siting an AWPF and other above ground facilities, including necessary ROW acquisitions, are not included due to the uncertainly related to the location and market value of available land.
3. Costs for use of Redwood City's capital investments are not included.
4. It is assumed that the SFPUC Pulgas Dechloramination Facility and Pulgas Discharge Channel could be used at no additional cost, though an estimated cost is included for connecting to the Pulgas Facilities.

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5.3 Substitute Project Cost Opinion

When a Title XVI project provides water supplies for municipal and industrial use, the benefits of the Title XVI project can be measured in terms of the cost of the alternative most likely to be implemented in the absence of the project. This is assuming that the two alternatives would provide comparable levels of service.

The completion of this feasibility study is good timing for the SFPUC's Alternative Water Supply Program, which is evaluating new projects, including the PREP Project, which will help meet future water supply needs in the SFPUC service area. The SFPUC Commission passed a resolution to initiate CEQA by July 2023 for projects in the SFPUC's Alternative Water Supply Program. In order to be "CEQA Ready," a conceptual-level design and completion of an abbreviated CEQA checklist document must be completed for each of the projects, essentially allowing the project to move forward with CEQA and to be compared with other projects.

As described in Section 4.3, the projects under consideration to meet future supply needs are in various stages of development, and as illustrated in Figure 4-4 there is a wide range in the relative cost and volume of potential new water supplies. At this time there is not a preferred alternative to be implemented in the absence of the PREP Project, and it is likely that multiple projects will be pursued by SFPUC and regional partners to increase drought-year reliability and supplement RWS supplies.

The next step for the PREP Parties will be to develop the PREP Project, or the Proposed Title XVI Project identified by this study, to be "CEQA Ready" to compare to the longer list of Alternative Water Supply Projects being considered.

5.4 Qualitative Benefits and Considerations

Some Title XVI project benefits may be difficult to quantify; for example, a drought tolerant water supply, reduced water importation, and other social or environmental benefits. These benefits shall be documented and described qualitatively as completely as possible. These qualitative benefits can be considered as part of the justification for a Title XVI project in conjunction with the comparison of project costs described above.

Implementation of the PREP Project would benefit the San Francisco Bay Area through:

1. Enhancing local water supply reliability and resiliency for water and wastewater providers on the San Francisco Peninsula to prepare for the unpredictability of climate change.
2. Reducing discharge to the San Francisco Bay – helping communities use locally treated water more efficiently and prevent water from becoming a lost resource.

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Section 6: Selection of the Proposed Title XVI Project

Provide a justification of why the Proposed Title XVI Project is the selected alternative in terms of meeting objectives, demands, needs, cost effectiveness, and other criteria important to the decision.

- *Reduction, postponement, or elimination of development of new or expanded water supplies*
- *Reduction or elimination of the use of existing diversions from natural watercourses, or withdrawals from aquifers*
- *Reduction of demand on existing Federal water supply facilities*
- *Reduction, postponement, or elimination of new or expanded wastewater facilities*

This section describes the alternatives screening approach, which applied decision criteria and a qualitative screening approach to allow the PREP parties to compare alternative concepts for potable reuse. A summary of outcomes, from a water supplier and drinking water supply/distributor perspective, is presented, which led to identifying alternatives removed from further consideration.

Based on the outcomes of the screening approach and input from the PREP Parties, the resulting Proposed Title XVI Project is presented as a combination of the Reservoir Water Augmentation (ResWA) and Treated Water Augmentation (TWA) potable reuse concepts and alternatives described in Section 4. This section describes two hybrid projects, phased to deliver purified water for ResWA then TWA, and provides costs and a summary of benefits and risks.

This section provides a description of the following:

1. Screening Approach
2. Screening Outcomes
3. Proposed Title XVI Project

Additional supporting information for this section is included in:

- Appendix A: Climate Change Considerations for Water Suppliers
- Appendix C: Treatment Supporting Information
- Appendix F: Engineers Opinion of Probable Costs

6.1 Screening Approach

The PREP parties were interested in developing a screening approach to compare alternatives in a qualitative manner to identify alternatives to move forward for further consideration. Due the broad set of alternatives and different parties that would be involved in implementation of a potable reuse project on the Mid-Peninsula, the preferred approach was to use qualitative descriptions and color coding to allow agencies to perform the screening independently, to see where their preferences may lay.

The screening approach also integrated input from the assessment of institutional considerations developed as part of PREP Phase 2. In 2018, each PREP Party was surveyed via an institutional questionnaire, followed by individual agency discussions. The responses provided an initial view of agency perspectives, resources, and drivers to implement potable reuse. Through questionnaires and conversations, a list of relevant issues, challenges and risks were identified by the water and wastewater agencies, as presented in Table 6-1. Input received from the questionnaires and individual agency discussions was compiled and the outcomes were summarized in the *PREP Phase 2 Institutional Considerations* report.

Table 6-1: Outcomes of PREP Phase 2 Institutional Survey

Issue	Challenge/Risk
Source Water Related Issues	Ownership of wastewater
	Decreasing quantity and quality of supply due to conservation
	Competing demands for recycled water
	Source water control
Water Supply Related Issues	Need for new local supply
	Timing of new supply and demands
	Operational Complexity of Regional Water System (RWS) and CSR
	Drought resistant supply
	Direct recipients of purified water
Inter-Agency Related Issues	Existing interagency agreements
	New interagency agreements
	Crossing jurisdictional boundaries
Design/Construction Challenges	Advanced Water Purification Facility (AWPF)
	Conveyance (e.g., pump stations and pipelines)
Financial Capacity	Available funding sources
	Potential grants/loans
Public Acceptance	Proactive and sustained regional approach
Owner/Operator Distinctions	Distinguishing responsibilities
	Creating contracting mechanisms

Due to the wide range of alternatives with varying agency participation, it was not deemed practical to rank alternatives. Instead, the screening approach was set up to allow source water suppliers (wastewater agencies) and drinking water suppliers/distributors (water agencies) to present their own perspective on criteria and alternatives that were applicable to their particular agency. For example, San Mateo may not have a preference on alternatives where only SVCW source water is used, and Cal Water may not have a preference on ResWA alternatives that deliver flow to CSR.

The following sections detail the decision criteria, agency perspectives and a summary of responses.

6.1.1 Decision Criteria

For this study, a range of criteria were compiled to frame the full range of benefits and challenges to compare the alternatives explored as part of this Phase 3 effort. The general criteria categories are presented and defined in Table 6-2, with color coding used to illustrate how each criteria could be applied to compare alternatives that are better able to or unable to meet a criteria. Some of the responses were guided by quantitative information, for example the relative cost per unit of purified water delivered and the financial feasibility are based on the outcomes of the economic analysis, presented in Section xx. Similarly, the available source water quantity and suitable source water quality is based on the analysis in Sections xx and xx. The drought resiliency, normal year and wet year supply benefits are in part informed by the HHLSM modeling efforts. Engineering and operational considerations are based on each agency's intimate knowledge of their existing facilities and operations with an emphasis on how the alternative would alter or impact. The environmental, institutional, and social categories are inherently difficult to quantify with many unknowns, hence the alignment by the Parties to perform the screening analysis in a qualitative manner. Overall, the Parties agreed that this qualitative approach captures the complexity of the framework, range of alternatives being considered and allows for each agency to incorporate their values and perspectives.

Table 6-2: Decision Criteria

GENERAL CRITERIA CATEGORY	Description	Qualitative Comparison		
		better (comparatively)	**neutral (similar impact)**	**worse (comparatively)**
ECONOMIC	Cost Per Unit Delivered	lower unit cost	mid-range unit cost	highest unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	lower capital cost	mid-range capital cost	higher capital cost
SOURCE WATER SUPPLY	Available Source Water Quantity	meets source supply needs	available with demand mgmt	unable to meet source supply needs
	Suitable Source Water Quality	few WQ issues anticipated	suitable WQ with treatment	significant WQ challenges are anticipated
	Source Water Control Requirements	existing strategy meets requirements	new policies needed	significant challenges are anticipated
	Maximize Beneficial Reuse	more reuse w/ continuous ops	diversions displace some reuse	less reuse w/ step-down ops
POTABLE WATER SUPPLY	Drought Resiliency	project capacity has significant benefit to region	project capacity has some benefit to region	project capacity has minimum benefit to region
	Normal and Wet Year Supply Benefit	utilizes project capacity	less than project capacity	much less than project capacity
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	less complex	complex	more complex
	Operational Complexity	minimal changes to existing operations	some adjustments and additional requirements	significant modifications and complex requirements
	Upgrades to Existing Assets	few upgrades anticipated	similar impacts	significant upgrades anticipated
	Potential for Future Expansion	few constraints	some constraints	many constraints
	Regulatory Complexity	straightforward	somewhat complex	challenging
ENVIRONMENTAL	Relative Environmental impacts (construction and operation)	few above/below ground impacts	some above/ below ground impacts	many above/ below ground impacts
	Potential for Environmental Enhancement	many benefits	some benefits	minimal benefits
INSTITUTIONAL	Institutional Complexity	straightforward	somewhat complex	challenging
	Local/Regional Benefits	regional benefits	local benefit	few benefits
SOCIAL	Public Perception	broad public support and high level of comfort	some public support and some level of comfort	unknown public support and uncertain public comfort

Most of the categories are applicable to the source water supplier (wastewater agency) perspective and the drinking water supplier/distributor (water agency) perspective. However, the "source water supply" and "potable water supply" categories are unique to the source water supply and potable water supply perspectives, respectively.

6.1.2 Source Water Supplier (WW Agency) Perspective

The source water supplier criteria are applicable to represent the wastewater agency perspective, and how the alternatives would impact their assets, operations, and mission. Wastewater agencies provided their perspectives to compare potable reuse concepts based on project capacity (Table 6-3) and place of use (Table 6-4). SVCW, San Mateo and Foster City generally aligned on the qualitative comparison for these project concepts. Specific comments from each wastewater agency are provided in the summary section.

Table 6-3: Source Water Supplier Perspective: Comparing Potable Reuse Concepts based on Project Capacity

General Criteria Category	Project Capacity	6 mgd Potable Reuse Project *(ResWA, RWA or DPR)*	12 mgd Potable Reuse Project *(ResWA or DPR)*
	Alts:	***1, 3, 4***	***2, 5***
ECONOMIC	Cost Per Unit Delivered	higher unit cost	lower unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	lower capital cost	higher capital cost
SOURCE WATER SUPPLY	Available Source Water Quantity	available with demand mgmt	available with demand mgmt
	Suitable Source Water Quality	suitable with treatment	suitable with treatment
	Source Water Control Requirements	new policies needed	new policies needed
	Maximize Beneficial Reuse	less reuse	more reuse
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	smaller footprint (less complex)	larger footprint (more complex)
	Operational Complexity	similar impacts	similar impacts
	Upgrades to Existing Assets	similar impacts	similar impacts
	Potential for Future Expansion	some flexibility	some constraints
	Regulatory Complexity	independent of project capacity	independent of project capacity
ENVIRONMENTAL	Relative Environmental impacts	smaller AWTP footprint (few impacts)	larger AWTP footprint (some impacts)
	Potential for Environmental Enhancement	independent of project capacity	independent of project capacity
INSTITUTIONAL	Institutional Complexity	challenging	more challenging
	Local/Regional Benefits	some regional benefits	greater regional benefits
SOCIAL	Public Perception	independent of project capacity	independent of project capacity

Table 6-4: Source Water Supplier Perspective: Comparing Potable Reuse Concepts based on Place of Use

GENERAL CRITERIA CATEGORY	Project Capacity	Reservoir Water Augmentation *(CSR ResWA @ 6 mgd)*	Raw Water Augmentation *(BG RWA @ 6 mgd)*	Treated Water Augmentation *(TWA @ 6 mgd)*
	Alts:	***1***	***3***	***4***
ECONOMIC	Cost Per Unit Delivered	mid-range unit cost	higher unit cost	lower unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	mid-range capital cost	higher capital cost	lower capital cost
SOURCE WATER SUPPLY	Available Source Water Quantity	available with demand mgmt	available with demand mgmt	available with demand mgmt
	Suitable Source Water Quality	suitable with treatment	suitable with treatment	suitable with treatment
	Source Water Control Requirements	new policies needed	new policies needed	new policies needed
	Maximize Beneficial Reuse	less reuse w/ step-down ops	diversions displace some reuse	more reuse w/ continuous ops
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	complex	more complex	less complex
	Operational Complexity	Env barrier provides more ops buffer	Env barrier provides some ops buffer	No env barrier to provides ops buffer
	Upgrades to Existing Assets	similar impacts	similar impacts	similar impacts
	Potential for Future Expansion	some flexibility	more constrained	some flexibility
	Regulatory Complexity	complex	more complex	most complex
ENVIRONMENTAL	Relative Environmental impacts	some above/ below ground impacts	many above/ below ground impacts	few above/below ground impacts
	Potential for Environmental Enhancement	potential surface water benefits	potential surface water benefits	minimal environmental benefits
INSTITUTIONAL	Institutional Complexity	somewhat complex	somewhat complex	somewhat complex
	Local/Regional Benefits	regional benefits	local benefit	local benefit
SOCIAL	Public Perception	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort

6.1.3 Drinking Water Supplier/Distributor Perspective

The drinking water supplier/distributor criteria area applicable to represent the water agency perspective, and how the alternatives would impact their assets, operations, and mission. Water agencies provided their perspectives to compare potable reuse concepts based on project capacity (Table 6-5), type of use (Table 6-6), ResWA concepts (Table 6-7), and DPR concepts (Table 6-8). SFPUC, BAWSCA, Cal Water, Redwood City and Foster City generally aligned on the qualitative comparisons for these project concepts. Specific comments from each water agency are provided in the summary section.

Table 6-5: Drinking Water Supplier/Distributor Perspective: Comparing Potable Reuse Concepts based on Project Capacity

GENERAL CRITERIA CATEGORY	Project Capacity	6 mgd Potable Reuse Project *(ResWA, RWA or DPR)*	12 mgd Potable Reuse Project *(ResWA or DPR)*
	Alts:	***1, 3, 4***	***2, 5***
ECONOMIC	Cost Per Unit Delivered	higher unit cost	lower unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	lower capital cost	higher capital cost
POTABLE WATER SUPPLY	Drought Resiliency	project capacity benefits region	project capacity benefits region more
	Normal and Wet Year Supply Benefit	less than project capacity	much less than project capacity
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	smaller footprint	larger footprint
	Operational Complexity	independent of project capacity	independent of project capacity
	Upgrades to Existing Assets	independent of project capacity	independent of project capacity
	Potential for Future Expansion	some flexibility	more constrained
	Regulatory Complexity	independent of project capacity	independent of project capacity
ENVIRONMENTAL	Environmental Impacts of Construction and Operation	some above/ below ground impacts	many above/ below ground impacts
	Potential for Environmental Enhancement	independent of project capacity	independent of project capacity
INSTITUTIONAL	Institutional Complexity	challenging	more challenging
	Local/Regional Benefits	depends on use	depends on use
SOCIAL	Public Perception	independent of project capacity	independent of project capacity

Table 6-6: Drinking Water Supplier/Distributor Perspective: Comparing Potable Reuse Concepts based on Type of Use

GENERAL CRITERIA CATEGORY	Project Capacity	Reservoir Water Augmentation *(CSR ResWA @ 6 mgd)*	Raw Water Augmentation *(BG RWA @ 6 mgd)*	Treated Water Augmentation *(TWA @ 6 mgd)*
	Alts:	***1***	***3***	***4***
ECONOMIC	Cost Per Unit Delivered	mid-range unit cost	higher unit cost	lower unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	mid-range capital cost	higher capital cost	lower capital cost
POTABLE WATER SUPPLY	Drought Resiliency	project capacity benefits region	project capacity benefits region	project capacity benefits region
	Normal and Wet Year Supply Benefit	less than project capacity	less than project capacity	less than project capacity
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	complex	more complex	less complex
	Operational Complexity	complex	complex	most complex
	Upgrades to Existing Assets	minimal change	significant change	minimal change
	Potential for Future Expansion	some flexibility	more constrained	some flexibility
	Regulatory Complexity	complex	more complex	most complex
ENVIRONMENTAL	Environmental Impacts of Construction and Operation	some above/ below ground impacts	many above/ below ground impacts	Some above and below ground impacts
	Potential for Environmental Enhancement	potential surface water benefits	potential surface water benefits	minimal environmental benefits
INSTITUTIONAL	Institutional Complexity	challenging	challenging	challenging
	Local/Regional Benefits	regional benefits	local benefit	local benefit
SOCIAL	Public Perception	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort

Table 6-7: Drinking Water Supplier/Distributor Perspective: Comparing ResWA Operational Concepts

GENERAL CRITERIA CATEGORY	Project Capacity	6 mgd ResWA Project *(CSR)*	12 mgd ResWA Project *(CSR)*
	Alts:	***1***	***2***
ECONOMIC	Cost Per Unit Delivered	higher unit cost	lower unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	lower capital cost	higher capital cost
POTABLE WATER SUPPLY	Drought Resiliency	project capacity benefits region	project capacity benefits region more
	Normal and Wet Year Supply Benefit	less than project capacity	much less than project capacity
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	complex	more complex
	Operational Complexity	complex	more complex
	Upgrades to Existing Assets	independent of project capacity	independent of project capacity
	Potential for Future Expansion	some flexibility	more constrained
	Regulatory Complexity	independent of project capacity	independent of project capacity
ENVIRONMENTAL	Environmental Impacts of Construction and Operation	some above/ below ground impacts	many above/ below ground impacts
	Potential for Environmental Enhancement	independent of project capacity	independent of project capacity
INSTITUTIONAL	Institutional Complexity	challenging	more challenging
	Local/Regional Benefits	similar benefits	similar benefits
SOCIAL	Public Perception	independent of project capacity	independent of project capacity

Table 6-8: Drinking Water Supplier/Distributor Perspective: Comparing DPR Concepts based on Place of Use

GENERAL CRITERIA CATEGORY	Project Capacity	RWA Cal Water (BG) *(@ 6 mgd)*	TWA - RWC and Cal Water (SC) *(@ 6 mgd)*	TWA - FC and Cal Water (SM) *(@ 6 mgd)*	TWA - RWC and Cal Water (SC and SM) *(@ 12 mgd)*
	Alts:	***3***	***4a/b***	***4c***	***5***
ECONOMIC	Cost Per Unit Delivered	highest unit cost	low unit cost	low unit cost	lower unit cost
	Financing feasibility (based Capital and O&M Costs to Agency)	higher capital cost	low capital cost	low capital cost	higher capital cost
POTABLE WATER SUPPLY	Drought Resiliency	project capacity benefits region	project capacity benefits region	project capacity benefits region	project capacity benefits region more
	Normal and Wet Year Supply Benefit	less than project capacity	less than project capacity	less than project capacity	much less than project capacity
ENGINEERING & OPERATIONAL CONSIDERATIONS	Engineering Complexity	more complex	less complex	less complex	complex
	Operational Complexity	complex	more complex	more complex	more complex
	Upgrades to Existing Assets	significant change	some change	minimal change	some change
	Potential for Future Expansion	more constrained	some flexibility	some flexibility	more constrained
	Regulatory Complexity	complex	more complex	more complex	more complex
ENVIRONMENTAL	Environmental Impacts of Construction and Operation	many above/ below ground impacts	few above/below ground impacts	few above/below ground impacts	some above/ below ground impacts
	Potential for Environmental Enhancement	potential surface water benefits	minimal environmental benefits	minimal environmental benefits	minimal environmental benefits
INSTITUTIONAL	Institutional Complexity	challenging	more challenging	more challenging	more challenging
	Local/Regional Benefits	some local benefit	some local benefit	some local benefit	most local benefit
SOCIAL	Public Perception	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort	unknown public support and uncertain public comfort

6.1.4 Agency Responses to Screening Questions

Following the screening exercise, each agency answered a series of questions to summarize their perspectives, identify alternatives to eliminate from further consideration and provide input on the next steps for the PREP parties. The wastewater agency perspective is summarized in Table 6-9, listing the response by SVCW, San Mateo and Foster City to each question. The water agency perspective is summarized in Table 6-10.

In general, the wastewater agencies show a preference towards a 12-mgd capacity project by WW agencies due to cost effectiveness, regional benefits, and benefits of reducing discharge to the SF Bay. Wastewater agencies did not express a preference for the type of potable reuse that should be pursued (e.g., ResWA, RWA or TWA). There was an openness, by some, to a phased approach to implementing a potable reuse project, though others felt that this could increase cost and complexity. The wastewater agencies did not identify a specific alternative to take off the table, but one noted that there would be a greater interest in alternatives that serve their member agencies. The next steps for wastewater agency involvement would include contractual agreements and presentations of concepts to their respective City Councils and Commissions for initial approvals. Overall, the wastewater agencies are committed to beneficial reuse but need to provide more information to City Councils, Commissions, and the public to get buy-in and feedback. If PREP does not come to fruition these agencies may focus on smaller scale projects to increase reuse.

The perspectives from the water agencies were broader, due in part to the range of agency size and role in water production, distribution, and authority. The larger water agencies tend to prefer a larger project, whereas the smaller local agencies expressed more interest in a small project based on lower initial capital costs, decreased institutional complexity and flexibly for the future (indicating a phased approach may be preferred). Drought resiliency is the primary driver and there is a wide range of perspectives for a preferred type of potable reuse. Water agencies generally recognize the benefit of an environmental buffer and drinking water treatment prior distribution into the drinking water systems, for public acceptance. Though, some water agencies appreciate the benefit of direct potable reuse for local control, however, there are some reservations about purified water dominating the potable water supply for a specific service area. Larger water agencies do not have a preference for the location of TWA at this point, conversely, the smaller water agencies have a broader range of opinions as to the desire for and willingness to implement a TWA project that directly feeds or dominates their community’s water supply. There is alignment in water agency interest in moving forward with a phased approach, or at least further exploring how a phased approach would work. There is also alignment to take alternatives with the highest cost and lowest regional benefit off the table (e.g., Alternatives 3a/3b). The water agencies provided an extensive list of next steps and studies that would need to be conducted to move forward. Much of the uncertainty in the next steps for PREP stems from the need for an identified champion to make decisions and lead negotiations with all the partners.

Table 6-9: Source Water Supplier Perspective: Summary of Responses

Questions	SVCW Response	City of San Mateo Response	City of Foster City Response
1. Based on your ww agency's perspective, which project capacity would you prefer/support (6 mgd, 12 mgd, no preference) and why?	*SVCW's preference would be 12 mgd with SVCW contributing 6 mgd. Maximizing the freshwater and avoiding discharging into the SF Bay would be driver.*	*Due to the planning effort involved in any one option, preference is for a 12 mgd project. This provides a better cost-benefit ratio with greater regional and local benefits.*	*As a 25% owner of the SMWWTP, agree with response from SM: "Due to the planning effort involved in any one option, preference is for a 12 mgd project. This provides a better cost-benefit ratio with greater regional and local benefits."*
2. Based on your ww agency's perspective, which type of potable reuse project would you prefer/support (ResWA, RWA, TWA, no preference) and why?	*No preference. All these options serve our member agencies and offset potable water otherwise used.*	*There are too many varying degrees of complexity. For some options, the organizational/ constructability challenges are significant (sending water to CS), while for others (TWA), the regulatory aspect is most challenging. There is no preference at this point.*	*There is no preference at this point.*
3. Would your agency be interested in moving forward with a phased approach? and if so, what type of project phasing would you envision?	*NO. Phased approach may increase the cost as well as complexity of the project.*	*We understand that while implementing a smaller / phased project does not present the best cost-benefit ratio, it may be more feasible in the short-term although may not be the best approach in the long-term. We would ultimately support a phased approach to increase water supply reliability, however, the benefits to all parties would have to be identified.*	*Yes, open to hearing available options.*
4. Is there an alternative your agency would prefer to have taken off the table? and if so, why?	*No specific alternative. However, any option that does not serve our member agencies would not be our preference.*	*None*	*no*
5. If one or more of your preferences moves forward, what do you think your Agency's next steps would be to move forward with the project?	*SVCW would be willing to get the discussions started on contractual agreements with involved parties and have prepare ourselves for that particular option including our commission approval.*	*As a wastewater agency, the next steps need to be led by the water purveyors.*	*We want to know who is interested in purchasing/treating/conveying our effluent.*
6. Please list any other thoughts or comments you would like to have memorialized as part of this screening process	*SVCW is interested in pursuing recycled water and if PREP does not materialize, we would like to move forward on smaller scale to produce more recycled water. An early commitment would help SVCW in making decision which way to pursue.*	*We are committed to continuing to support water reuse efforts, although the City is not a water purveyor. We believe that a larger scale project would provide the most benefits to the region as a whole.*	*We would like KJ to prepare a presentation to be considered by Executive Level Staff in organization, then the same or similar presentation to the City Council. And a comprehensive outreach effort to obtain public buy-in/feedback on options.*

Table 6-10: Drinking Water Supplier/Distributor Perspective: Summary of Responses

Questions	SFPUC Response	BAWSCA Response	Cal Water Response	City of Redwood City Response	Foster City Response
1. Based on your water agency's perspective, which project capacity would you prefer/support (6 mgd, 12 mgd, no preference) and why? *(note it is assumed that preference for continuous, ramp down and/or shut down operations would be addressed after alternative selection)*	*12 mgd*	*12 mgd due to its importance for drought resiliency. In years of drought the larger project capacity is highly beneficial.*	*Cal Water would support further analysis of the 12 mgd PRP to CSR and the 6 mgd TWA projects.*	*Redwood City would prefer a 6 mgd project based on initial capital costs, decreased institutional complexity and potential to increase capacity in the future.*	*As a water agency, we have reservations regarding APR Water dominating our water supply. Therefore, option 4c is least desirable. The other 6mgd options are less problematic. With respect to the 12mgd options, City has some reservations about the various alignments running through the City. The beach Park alignment seems to have the least disruption to the City.*
2. Based on your water agency's perspective, which type of potable reuse project would you prefer/support (ResWA, RWA, TWA, no preference) and why?	*A combination of ResWA and DPR (either RWA or TWA or both)*	*ResWA or TWA (no preference between the two). BAWSCA is reluctant to move forward with RWA alternative. The costs are too high, and the benefits are limited compared to other alternatives.*	*No preference at this point.*	*Redwood City would support both an ResWA and TWA. TWA provides more direct benefit to Redwood City with lower cost and based on the operational challenges for continuous operation for ResWA at CSR it seems TWA may be more feasible for continued operation. Depending on institutional arrangements TWA could provide a regional benefit by reducing demand on the SFRWS and potentially free up supply for others not directly receiving TWA water. TWA would also provide recipients with drought resistant drinking water supplies and potential to limit the extent for rationing to lower levels. However, an ResWA project may be more acceptable from the public perception due to the natural environmental barriers. Acceptance from the community particularly in regard to cost for funding would likely be contingent on final outcome of Bay Delta Plan. Depending on institutional arrangements TWA may require renegotiation of BAWSCA Tier 2 allocation plan for shortages.*	*Of the options presented, Option 3a/b is preferred. As well, reservoir water augmentation is preferred over TWA (DPR), as the public acceptance may be greater for water that has been treated, diluted in a reservoir, and treated again. Foster City is not interested in being a demonstration agency for TWA (DPR).*
3. Based on your water agency's perspective, which location for a direct potable reuse project would you prefer/support (RWA at Bear Gulch, TWA (RWC/Cal Water SC), TWA (Foster City/Cal Water SM), TWA (RWC/Cal Water SC and SM), no preference)? and why?	*No preference--it is up to the agencies on the Peninsula to decide*	*BAWSCA is in favor of any TWA option but does not have any preference on its location. It would be up to the agencies where the water goes.*	*No preference at this point.*	*Redwood City's preference for location would be for any project that provides a drought tolerant supply for our community. A project in Redwood Shores would provide this opportunity and has the potential to reach all PREP water agency partners plus the Mid-Peninsula Water District. Additional water agencies may also be able to participate in a project by wheeling water through existing inter-agency water connections or short pipeline extensions.*	*We would be least likely to support TWA/DPR for the Foster City/Cal Water SM scenario. We are more interested in a project in which "we are all in this together" versus San Mateo and FC residents solely receiving the water. Otherwise, no other preferences.*
4. Would your agency be interested in moving forward with a phased approach? and if so, what type of project phasing would you envision?	*Yes.*	*Yes, BAWSCA would be interested in a phased approach. Either phasing from 6 mgd to 12 mgd or from IPR to DPR.*	*Cal Water would support further analysis and is open to participating in discussions of how to phase the program moving forward.*	*Yes, Redwood City would be interested in any approach that includes both ResWA and/or TWA. Due to public perception a TWA project may need to be added on as a later phase of a larger ResWA project. However, should the public be receptive to TWA that may allow for a TWA project to move forward as an initial phase. If this is the case a smaller 1 to 2 mgd TWA project could serve as an initial phase with an option to expand in the future.*	*Yes, open to hearing available options.*

Questions	SFPUC Response	BAWSCA Response	Cal Water Response	City of Redwood City Response	Foster City Response
5. Is there an alternative your agency would prefer to have taken off the table? and if so, why?	*TBD based on discussions with others*	*Bear Gulch RWA - High cost and not as feasible as other alternatives*	*The ResWA project at BG Reservoir does not appear to be feasible at this point given the additional investments necessary at BG and the small number of customers who would be receiving the supply.*	*Redwood City believes the RWA project for Bear Gulch provides minimal regional benefit. Other alternatives provide greater regional benefit and, as such, should take priority.*	*We have the most reservations with option 4C, but recognize that absent public perception, this is most beneficial. (Foster City's 24-inch Transmission main alignment runs along East Third Avenue, just adjacent to the SMWWTP.) There would be minimal construction to connect to the City's water source.*
6. If one or more of your preferences moves forward, what do you think your Agency's next steps would be to move forward with the project?	*If ResWA moves forward, SFPUC would need further analysis of WQ impacts at CSR, potential nutrient removal, and then proceed with additional design. Some kind of agreement with our partners would be needed as well*	*The next step is to understand in more detail the environmental and engineering requirements of each alternative. Eventually, a pilot project is needed to understand the public perception aspect of the project.*	*Continue to support further analysis and compare PREP options against other water supply projects/programs as part of our Bay Area Water Supply Reliability Study.*	*For a TWA project the first step would be for the State to adopt the draft regulations for its use. For all types of projects, the next steps would be to Come to terms with project partners, identify funding sources, and build project support within the community. A demonstration project will likely be needed to build community acceptance.*	*We would need KJ to prepare a presentation to be considered by Executive Level Staff in organization, then the same or similar presentation to the City Council. And a comprehensive outreach effort to obtain public buy-in/feedback on options.*
7. Please list any other thoughts or comments you would like to have memorialized as part of this screening process	*SFPUC is interested in maximizing drought supply via PREP through a combination of IPR and DPR implementation*	*Many of the alternatives would be dependent on cities' and SFPUC preferences. BAWSCA is unable to rank the alternatives based on the criteria set because the weight of the criteria is not evident.*	*No additional comments provided*	*No additional comments provided*	*This has not been introduced to the City's elected officials, nor has it been introduced through BAWSCA and its Board Members.*

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6.2 Screening Outcomes

6.2.1 Alternatives to Eliminate from Further Consideration

Based on the screening outcomes and follow up discussions with the PREP Parties, the following alternatives are eliminated from further consideration:

- **ALTERNATIVE 2 - ResWA | 12 mgd to Crystal Springs Reservoir (Alternatives 2a, 2b, 2c, 2d).** Utilizing the full 12 mgd to augment CSR is not a viable option for SFPUC, as purified water delivered through Harry Tracy WTP is not ideally located in the service area to maximize distribution of purified water. Since the majority of the water would go to San Francisco, this would create an unequitable distribution of purified water what would only serve a subset of SFPUC's retail customers. These customers could potentially also receive purified water from other in-City projects. SFPUC requested to take this alternative off the table.

- **ALTERNATIVE 3 - RWA | 6 mgd to Bear Gulch Reservoir (Alternatives 3a and 3b).** Delivering 6 mgd of purified water to Bear Gulch is the most expensive alternative because it would require significant updates to the Bear Gulch filter plant and reservoir, in addition to the treatment and conveyance costs for purified water. The addition of 6 mgd purified water would dominate the supply for the Cal Water Bear Gulch service area (11.4 mgd on average), which only serves approximately 60,000 customers. Cal Water requested to take this alternative off the table.

- **ALTERNATIVE 4c - TWA | 6 mgd with San Mateo Supply and Local Use (Foster City/Cal Water San Mateo).** Delivering 2 mgd of purified water to Foster City's potable water tanks would dominate the supply (4.3 mgd on average) distributed to approximately 38,000 customers in the Estero Municipal Improvement District's service area. This alternative would have challenges with siting a new AWPF in the vicinity of the San Mateo WWTP due to lack of open land and available space. In addition, this alternative would have limited opportunities for expansion and could not be combined with a ResWA at CSR. There was also no clear project sponsor for moving this alternative forward. Though there was some interest by San Mateo in keeping this option on the table to utilize San Mateo's effluent as a source supply, it was not deemed viable to move this alternative forward as a stand-alone project.

- **ALTERNATIVE 5 - TWA | with SVCW and San Mateo Supply and Local Use (Redwood City/Cal Water San Mateo and San Carlos)**. Delivering 12 mgd of purified water to Redwood City and Cal Water's Bayshore District Mid-Peninsula (San Carlos and San Mateo) service areas would dominate the supplies (9.5 mgd and 12.9 mgd on average, respectively) distributed to approximately 90,000 customers in Redwood City and 137,000 customers in Cal Water's Bayshore District Mid-Peninsula service area. Advances straight to direct potable reuse may also be more challenging to gaining public acceptance than taking a phased approach that introduces purified water to the community via an indirect potable reuse project that utilizes an environmental buffer. There was also no clear project sponsor for moving this alternative forward.

6.2.2 Alternatives to Move Forward for Further Consideration

The outcomes of screening exercise identified a short-list of projects to move forward for further analysis, which included:

- ALTERNATIVE 1 - ResWA | 6 mgd to Crystal Springs Reservoir (Alternatives 1a, 1b, 1c, 1d)
- ALTERNATIVE 4a/b - TWA | 6 mgd with SVCW Supply and Local Use (Redwood City and Cal Water San Carlos Service Area)

The PREP Parties aligned on developing a hybrid project that would deliver purified water for ResWA and TWA in a phased approach, summarized as follows:

- Phase 1 –IPR via ResWA at Crystal Springs Reservoir (CSR)
- Phase 2 – DPR via TWA for local use by the City of Redwood City, Cal Water and/or potentially the Mid-Peninsula Water District.
- Construction of a new AWPF that meets regulatory requirements for IPR in Phase 1 and DPR for the Phase 2 expansion.
- Conveyance infrastructure to deliver tertiary effluent to the new AWPF, purified water to the place of use and brine for discharge via the SVCW outfall.
- Upgrades at SFPUC's Pulgas Facility to treat and discharge purified water into CSR.
- Source water derived from up to 8 mgd of tertiary effluent from SVCW and 8 mgd of tertiary effluent from the San Mateo WWP
- An operational strategy where the new AWPF would produce up to 12 mgd of purified water for potable reuse, with 6 mgd or more delivered to CSR.

The next section describes two hybrid phased projects that incorporate the above concepts and serve as the Proposed Title XVI Project for this feasibility study.

6.3 Proposed Title XVI Project

Description of the Proposed Title XVI Project. Include detailed project cost estimate; annual operation, maintenance, and replacement cost estimate; and life cycle costs shall be provided with sufficient detail to permit a more in-depth evaluation of the project, including non-construction costs. In this regard, the cost estimates shall clearly identify expenditures for major structures and facilities, as well as other types of construction and non-construction expenses, and shall be based on calculated quantities and unit prices. The estimated costs shall also be presented in terms of dollars per MG, and/or dollars per acre-foot of capacity, so as to facilitate comparison of the alternatives. References, design data, and assumptions must be identified. The level of detail shall be as required for feasibility studies in RM D&S, Cost Estimating (FAC 09-01).

The Proposed Title XVI Project is presented as part of this feasibility study as Hybrid A and Hybrid B, each representing a combination of the Reservoir Water Augmentation (ResWA) and Treated Water Augmentation (TWA) potable reuse concepts and alternatives described in Section 4. The treatment location and alignments vary, but the supply, production and use of recycled water is similar for Hybrid A and B, thus, these project options are collectively referred to in the remainder of this study as the Proposed Title XVI Project.

Hybrid A and Hybrid B will both be divided into two phases. In Phase 1, 6 mgd of source water from SVCW will be treated at the AWPF and will be used for raw water augmentation at the Crystal Springs Reservoir. However, the AWPF will be located at the site near SVCW for Hybrid A and the AWPF will be located at the site near Highway 101 for Hybrid B. In Phase 2, 6 mgd from the San Mateo WWTP either be blended with the water from SVCW (Hybrid A) or will be routed directly in a separate pipeline to the AWPF (Hybrid B). The treatment train at the AWPF will be expanded to meet the strictest level of treated drinking water standards for both hybrid projects, and the TWA alignments to existing drinking water connection points at two Redwood Shores potable water tanks and the 12" Cal Water Service connection at Shoreway Rd & Skyway Rd will be constructed. The Proposed Title XVI Project is summarized in Table 6-11 and described in the following sections.

Table 6-11: Overview of Proposed Title XVI Project – Hybrid A and B

Alt	Description	Source Water[1]	AWPF Location	Drinking Water System Served[2]	Ave Annual Water Deliveries	
					(mgd)	(AFY)
HYBRID A						
Phase 1	Continuous operation ResWA	SVCW	near SVCW (6-mgd TWA train)	SFPUC (CSR)	6	6,720
Phase 2	TWA for Local Use	Blended SVCW + San Mateo	near SVCW (Expand TWA train to 12 mgd)	Redwood City + Cal Water (SC)	6	6,720
				TOTAL	**12**	**13,440**
HYBRID B						
Phase 1	Continuous operation ResWA	SVCW	Hwy 101 Site (6-mgd ResWA train)	SFPUC (CSR)	6	6,720
Phase 2	TWA for Local Use	San Mateo	Hwy 101 Site (6-mgd TWA train)	Redwood City + Cal Water (SC)	6	6,720
				TOTAL	**12**	**13,440**

[1] SM = effluent from San Mateo WWTP
[2] CSR = SFPUC customers served via Harry Tracy WTP, BG = Bear Gulch Division customers, SC = San Carlos Division customers, SM = San Mateo Division customers

6.3.1 Hybrid A Project

Hybrid A Phase 1 will produce an average of 6 mgd of purified water supply treated to TWDA standards at an AWPF located near SVCW. Tertiary water at the SVCW will serve as influent to the AWPF. A new purified water pipeline would be constructed to convey water produced at the AWPF to the Crystal Springs Reservoir along the Woodside Road – SFPUC ROW alignment. A short open trench pipeline would be constructed along the SF Bay to the SVCW outfall to convey reject water from the AWPF to the SVCW ocean outfall. As part of Phase 2, 6 mgd of tertiary treated water would be conveyed from San Mateo WWTP and blended with the 6 mgd tertiary treated water from SVCW fed to the AWPF influent. The MF/RO/UF/AOP treatment train at the AWPF will be expanded by 6 mgd to meet the strictest level of treated drinking water standards, and the TWA alignments to existing drinking water connection points two Redwood Shores potable water tanks and the 12" Cal Water Service connection at Shoreway Rd & Skyway Rd will be constructed. Hybrid A project components include the following:

- **Treatment Facilities:**
  - **Phase 1:** 6.0-mgd capacity APWF located near SVCW treated to TWA standards, including O3/BAC/MF/RO/UV/AOP/Cl2 unit processes. Associated chemical feed systems, wet wells, inter-process pumps and other appurtenances. Building facilities and O3/BAC process units will be sized for future 12 mgd treatment capacity.
  - **Phase 2:** Expand MF/RO/UV/AOP unit processes and appurtenances from 6 mgd to 12mgd treatment capacity. Potable water system tie-ins at the (2) Redwood Shores potable water tanks and (1) 12" Cal Water Service connection at Shoreway Rd & Skyway Rd.
- **Pipelines:**
  - **Phase 1:** 0.6 miles of 28"-dia tertiary influent pipeline, 15.9 miles of 24"-dia purified water pipeline, and 0.5 miles of 14"-dia brine pipeline.
  - **Phase 2:** 5.5 miles of 20"-dia tertiary influent pipeline. Pipelines to potable water tie-ins are relative short runs and are not estimated.
- **Storage:**
  - **Phase 1**: Convert RWC tank at SVCW for use as equalization prior to AWPF, a new 2-MG steel storage tank(s) for product water tank prior to conveyance to CSR and a new 2-MG equalization tank at the Puglas Dechloramination Facility.
  - **Phase 2:** No additional storage.
- **Pump Stations:**
  - **Phase 1:** One 50-HP pump station to convey brine from AWPF near SVCW to SVCW Outfall, One 80-HP pump station to convey tertiary treated water from SVCW to AWPF near SVCW, and one 3,300-HP pump station to convey purified water from AWPF near SVCW to CSR.
  - **Phase 2**: One 300-HP pump station to convey tertiary treated water from San Mateo WWTP to SVCW RWC RW Tanks
- **Reservoir Discharge Facility:**

- **Phase 1:** Connect to Pulgas Facilities and use the existing Pulgas Discharge Channel (no expansion or modification assumed).
- **Phase 2:** No additional modifications.

- **Project Yield:** 6 mgd of purified water produced on average after Phase 1 and 12 mgd of purified water after Phase 2.
- **Total Project Capital Cost:** $500 million for Phase 1 and $218 million for infrastructure expansion for Phase 2.
- **Annual O&M Cost:** $15 million for 6 mgd of TWA in Phase 1 and $17 million for 6 mgd of TWA in Phase 2, based on energy, chemical usage, and additional labor to operate and maintain the project facilities.
- **Annualized Project Unit Cost for Purified Water Produced/Delivered:** $3,100/AF for ResWA in Phase 1 and $1,400 to expand for TWA in Phase 2.

Figure 6-1 and Figure 6-2 illustrate the location of major project components for Hybrid A Phase 1 and 2, respectively. Detailed feasibility-level estimates of cost tables are provided in **Appendix C**. Life-cycle costs and additional economic analyses are presented in Section 5.

Figure 6-1: Proposed Title XVI Project – Hybrid A – Phase 1

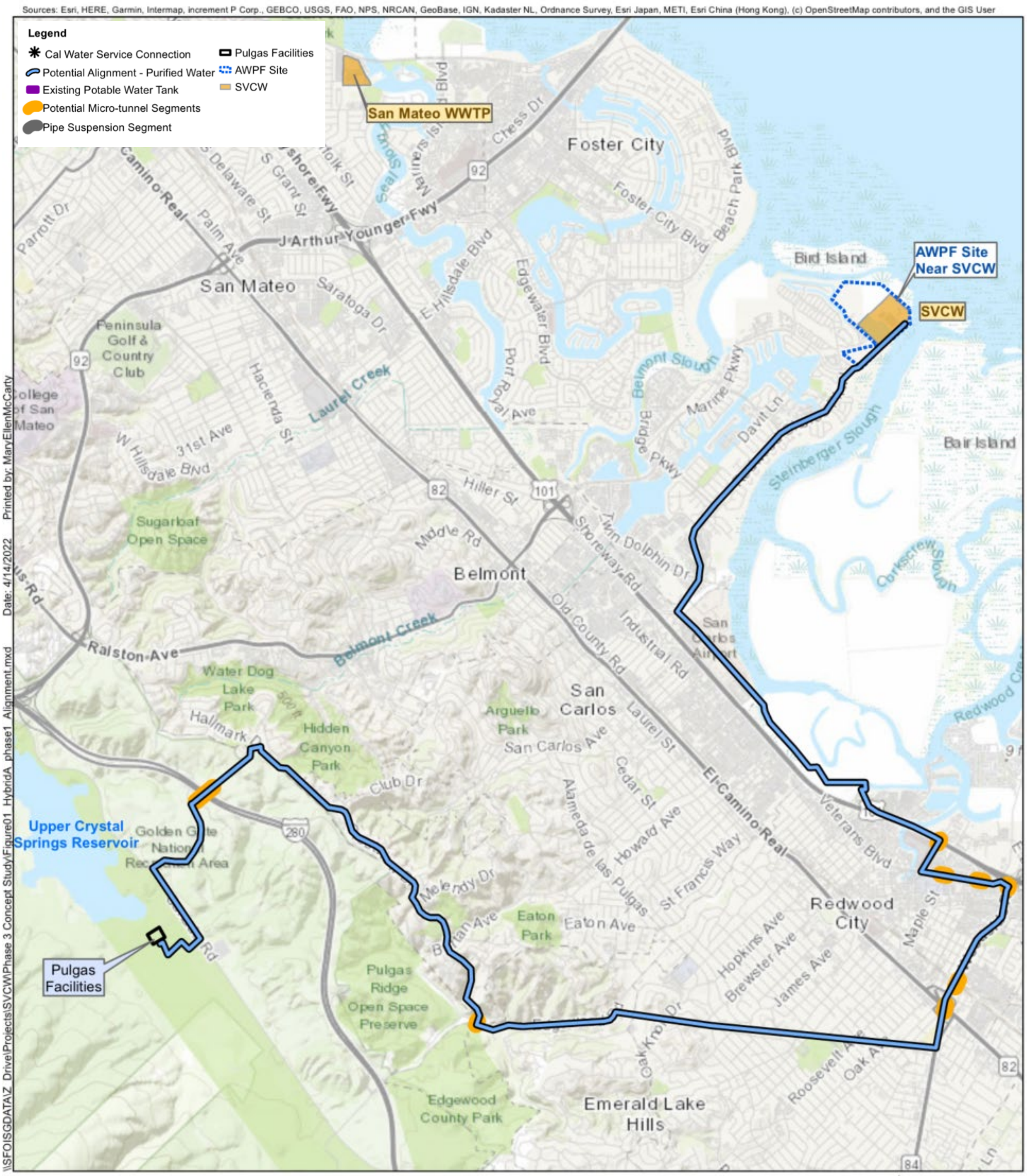
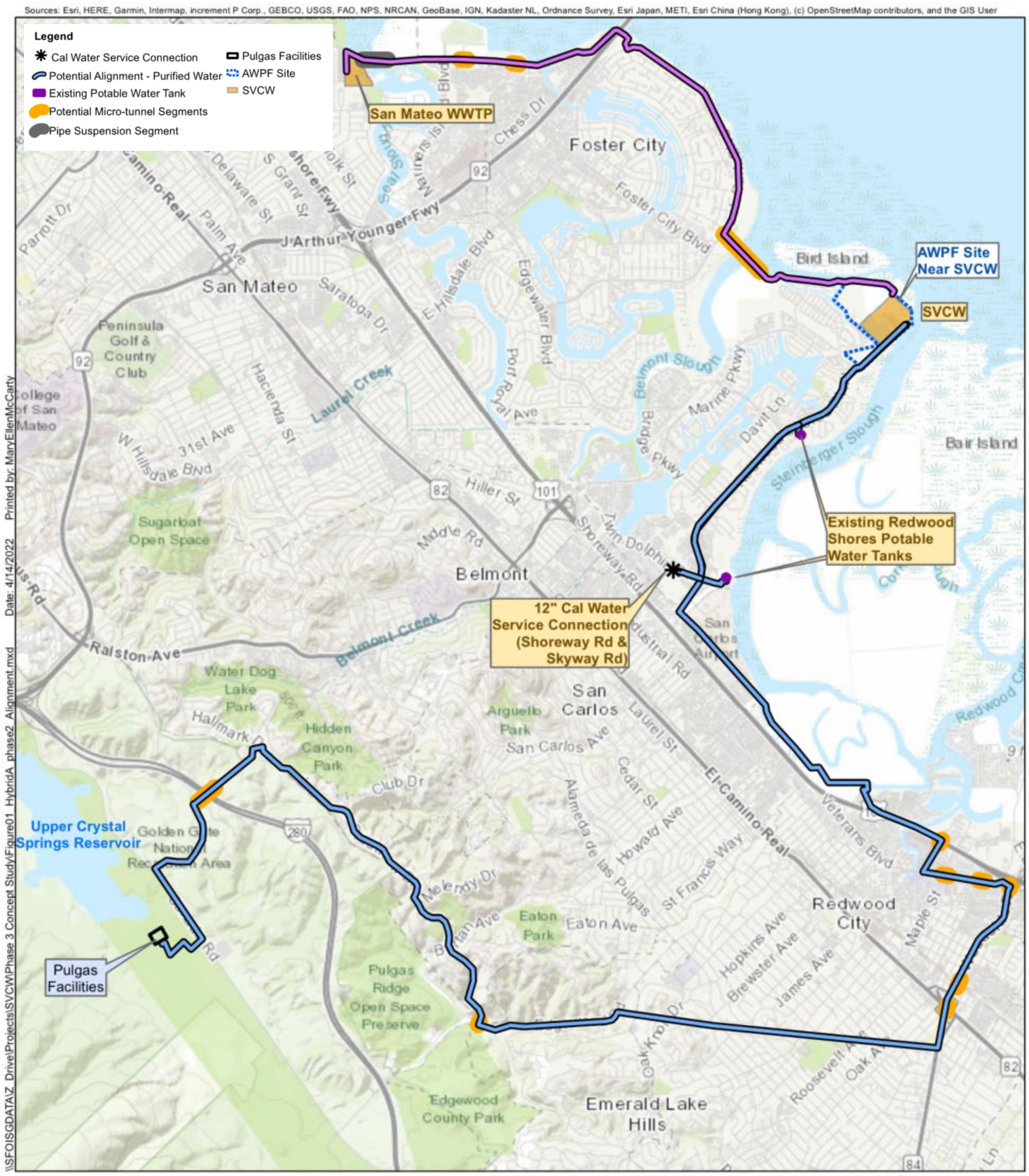


Figure 6-2: Proposed Title XVI Project – Hybrid A – Phase 2



6.3.2 Hybrid B Project

Hybrid B Phase 1 will produce an average of 6 mgd of purified water supply treated to ResWA standards at an AWPF located near Highway 101. Tertiary water from SVCW will serve as influent to the AWPF. A new purified water pipeline would be constructed to convey water produced at the AWPF to the Crystal Springs Reservoir along the Woodside Road – SFPUC ROW alignment. A pipeline from Hwy 101 AWPF Site to the SVCW outfall would be slip-lined in the existing 54”-dia SVCW force main along Redwood Shores Pkwy to convey reject water from the AWPF to the SVCW ocean outfall. As part of Phase 2, 6 mgd of tertiary treated water would be conveyed from San Mateo WWTP in a separate pipeline directly to the AWPF. A new TWDA treatment train (O3/BAC/MF/RO/UV/AOP/Cl2) will be built at the AWPF to meet the strictest level of treated drinking water standards. A new TWA pipeline would be constructed to convey purified water from the AWPF near Highway 101 to existing drinking water connection points two Redwood Shore potable water tanks and the 12” Cal Water Service connection at Shoreway Rd & Skyway Rd will be constructed. Hybrid B project components include the following:

- **Treatment Facilities:**
  - **Phase 1:** 6.0-mgd capacity APWF located near Highway 101 treated to ResWA standards, including MF/RO/UV/AOP/Cl2 treatment unit processes. Associated chemical feed systems, wet wells, inter-process pumps and other appurtenances. An average level of architectural treatment is assumed.
  - **Phase 2:** 6.0-mgd capacity APWF located near Highway 101 treated to TWA standards, including O3/BAC/MF/RO/UV/AOP/Cl2 unit processes which will be independent from the facilities constructed in Phase 1. Associated chemical feed systems, wet wells, inter-process pumps and other appurtenances. Potable water system tie-ins at the (2) Redwood Shores potable water tanks and (1) 12” Cal Water Service connection at Shoreway Rd & Skyway Rd.
- **Pipelines:**
  - **Phase 1:** 2.9 miles of 20”-dia tertiary influent pipeline, 12.7 miles of 24”-dia purified water pipeline, and 2.9 miles of 14”-dia brine pipeline.
  - **Phase 2:** 5.8 miles of 20”-dia tertiary influent pipeline, 1.9 miles of 18”-dia purified water pipeline
- **Storage:**
  - **Phase 1**: Convert RWC tank at SVCW for use as equalization prior to AWPF, new 2MG steel storage tank(s) for product water tank prior to conveyance to CSR and a new 2-MG equalization tank at the Puglas Dechloramination Facility.
  - **Phase 2:** No additional storage.
- **Pump Stations:**

  - **Phase 1:** One 200-HP pump station to convey brine from AWPF near Highway 101 to SVCW Outfall, One 200-HP pump station to convey tertiary treated water from SVCW to AWPF near Highway 101, and one 3,100-HP pump station to convey purified water from AWPF near SVCW to CSR.
  - **Phase 2**: One 300-HP pump station to convey tertiary treated water from San Mateo WWTP to SVCW RWC RW Tanks
- **Reservoir Discharge Facility:**
  - **Phase 1:** Connect to Pulgas Facilities and use the existing Pulgas Discharge Channel (no expansion or modification assumed).
  - **Phase 2:** No additional modifications
- **Project Yield:** 6 mgd of purified water produced on average after Phase 1 and 12 mgd of purified water after Phase 2.
- **Total Project Capital Cost:** $370 million for Phase 1 and $380 million for infrastructure expansion for Phase 2.
- **Annual O&M Cost:** $12 million for 6 mgd of ResWA in Phase 1 and $25 million for 6 mgd of TWA in Phase 2, based on energy, chemical usage, and additional labor to operate and maintain the project facilities.
- **Annualized Project Unit Cost for Purified Water Produced/Delivered:** $4,000/AF for ResWA in Phase 1 and $5,800 to expand for TWA in Phase 2.

Figure 6-3 and Figure 6-4 illustrate the location of major project components for Hybrid B Phase 1 and 2, respectively. Detailed feasibility-level estimates of cost tables are provided in **Appendix C**. Life-cycle costs and additional economic analyses are presented in Section 5.

Figure 6-3: Proposed Title XVI Project – Hybrid B – Phase 1

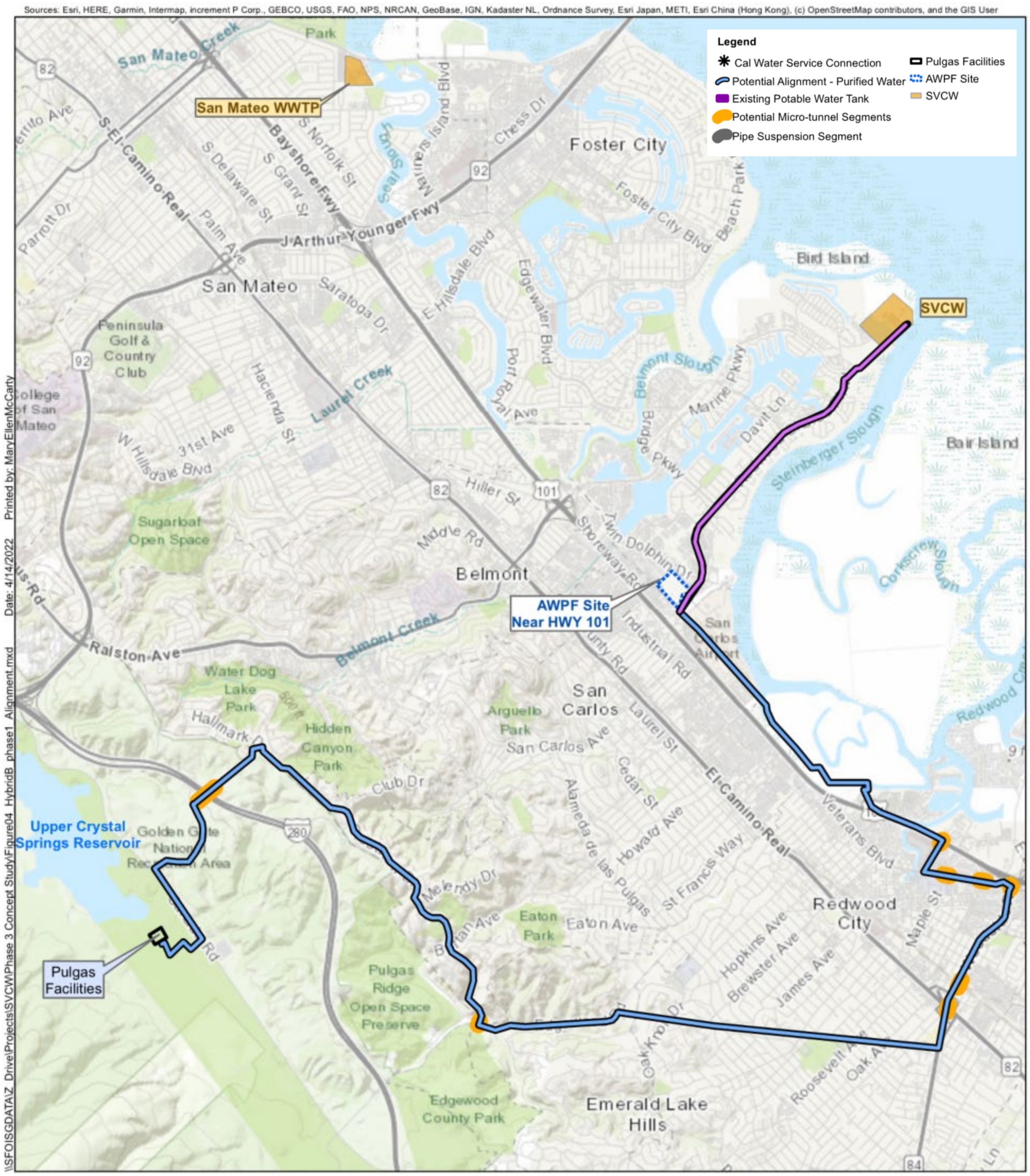
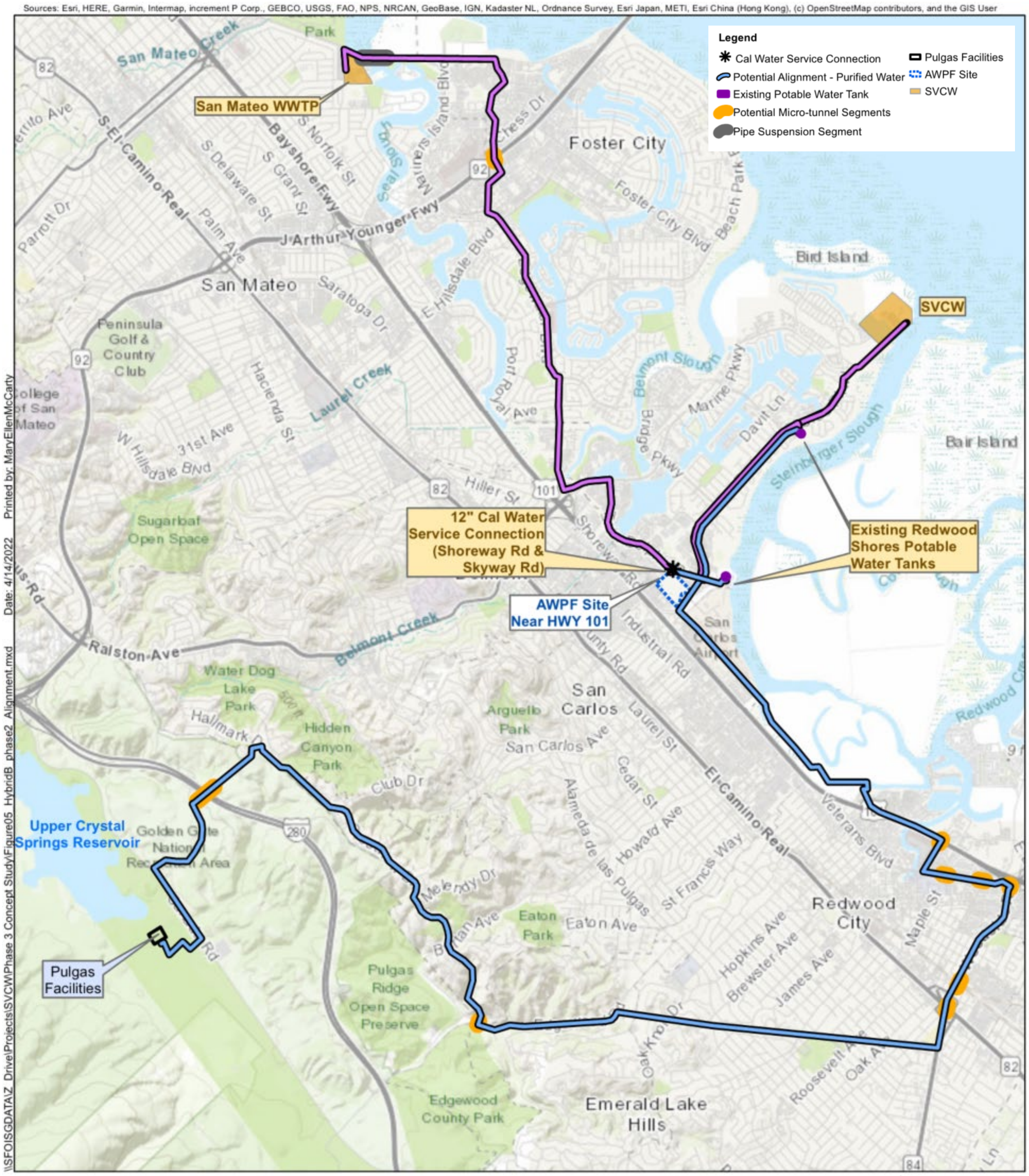


Figure 6-4: Proposed Title XVI Project – Hybrid B – Phase 2



6.3.3 Summary of Costs

The economic analysis presented in Section 5 is applied to the Hybrid A and B projects to estimate capital, annual O&M, and life cycled costs, presented in Table 6-12. The costs are presented based on the phasing of the hybrid projects, as described in the previous sections. Detailed project cost sheets and other supporting information is provided in **Appendix F**.

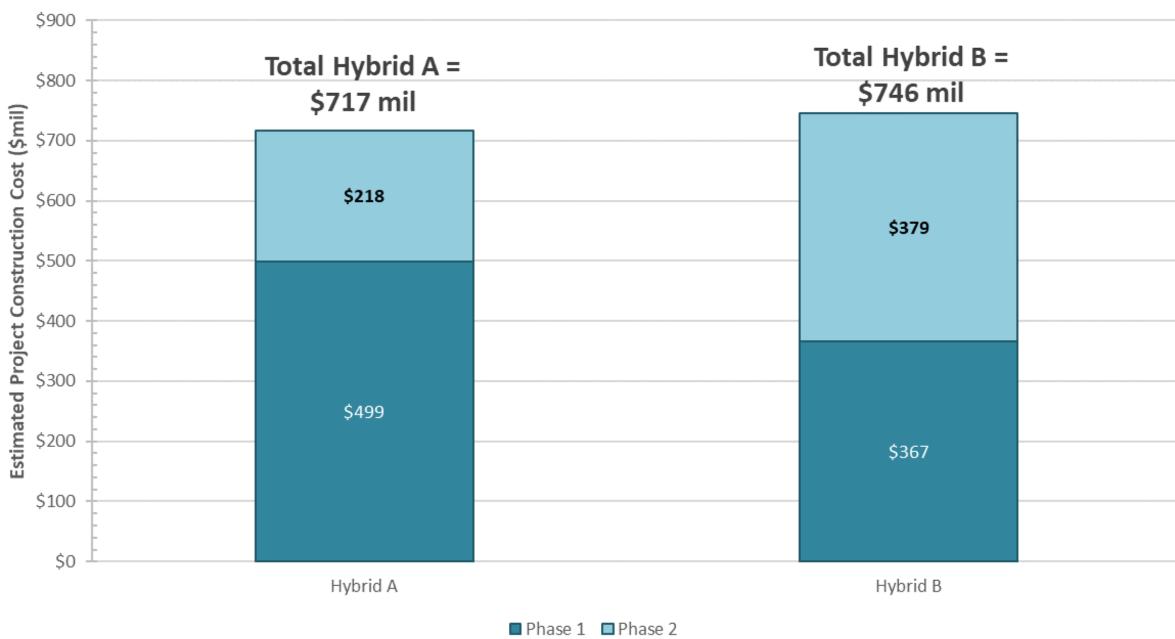
Table 6-12: Proposed Title XVI Project – Hybrid A and B Cost Summary

Sub-Alternative	Hybrid A - Phase 1	Hybrid A - Phase 2	Hybrid B - Phase 1	Hybrid B - Phase 2
AWPF Location	AWPF near SVCW	AWPF near SVCW	AWPF Near HW 101	AWPF Near HW 101
Operations	Continuous Operation	Continuous Operation	Continuous Operation	Continuous Operation
Receiving Water System	6 mgd CSR (SFPUC)	6 mgd DPR (RWC / CalWater SC)	6 mgd CSR (SFPUC)	6 mgd DPR (RWC / CalWater SC)
Source Water	SVCW (~8 mg)	San Mateo (~8 mgd) blended with SVCW	SVCW (~8 mgd)	San Mateo (~8 mgd)
Average Purified Water Deliveries (Assumed Wet and Dry Years)				
Purified Water Produced (mgd)	**6.0**	**6.0**	**6.0**	**6.0**
Purified Water Produced (AFY)	**6,720**	**6,720**	**6,720**	**6,720**
Ave Annual Displaced Water or "Spill"	**2,430**	**2,430**	**2,430**	**2,430**
Purified Water Benefit (AFY)	**4,290**	**4,290**	**4,290**	**4,290**
Dry Year Average Spill (AFY)	**378**	**378**	**378**	**378**
Wet Year Average Spill (AFY)	**4,485**	**4,485**	**4,485**	**4,485**
Purified Water Benefit (mgd)	**3.8**	**3.8**	**3.8**	**3.8**
Facility Component				
Treatment	$329,000,000	$140,000,000	$208,000,000	$290,000,000
Pipelines	$112,000,000	$73,000,000	$101,000,000	$79,000,000
Pump Station	$40,000,000	$5,000,000	$44,000,000	$5,000,000
Storage	$7,000,000	$0	$4,200,000	$4,600,000
Reservoir Facility Improvements	$10,500,000	$0	$9,600,000	$0
Total Est. Capital Cost ($)	**$498,500,000**	**$218,000,000**	**$366,800,000**	**$378,600,000**
Estimated Capital Cost ($mil)	**$499**	**$218**	**$367**	**$379**
Annualized Capital Cost ($mil/yr)	$20.7	$9.2	$15.0	$13.7
Annualized Unit Capital Cost for Produced Water ($/AF)	**$3,080**	**$1,370**	**$2,240**	**$2,040**
Annual O&M Cost ($/yr)	$15,028,000	$17,109,000	$12,100,000	$24,920,000
Annual Unit O&M Cost for Purified Water Produced/Delivered ($/AF)	**$2,240**	**$2,550**	**$1,800**	**$3,710**
Annulaized Project Unit Cost for Purified Water Produced/Delivered ($/AF)	**$5,320**	**$3,920**	**$4,040**	**$5,750**
Unit Cost ($/CCF)	$19.1	$14.1	$14.5	$20.6
Unit Cost ($/gal)	$0.026	$0.019	$0.019	$0.028
Average Annual Cost of Purified Water Produced/Delivered ($mil)	**$35.8**	**$26.3**	**$27.1**	**$38.6**
Average Annual Cost of "Spill" ($mil)	**$12.9**	**$9.5**	**$9.8**	**$14.0**
Dry Year Average Annual Cost of "Spill" ($mil)	**$2.0**	**$1.5**	**$1.5**	**$2.2**
Wet Year Average Annual Cost of "Spill" ($mil)	**$23.9**	**$17.6**	**$18.1**	**$25.8**

Figure 6-5 illustrates the total capital cost for Hybrid A and B, differentiating costs incurred by phase. The following bullets explain some of the nuances that contributed to the phased costs and total costs:

- Hybrid A incurs greater facility costs in Phase 1, because the AWPF building, some treatment processes and storage are sized to meet TWA requirements for the full 12 mgd capacity.
- Hybrid B has a more balanced phased costs and also a higher overall costs because this option assumes two independent AWPFs, one to treat SVCW effluent to meet ResWA requirements and an independent facility to treat San Mateo WWTP effluent to meet TWA requirements, losing some of the economy of scale.
- Escalation to midpoint of construction – Phase 1 ResWA is assumed to begin construction in 2030 and end in 2033 (43% escalation applied). Phase 2 TWA is assumed to begin construction in 2034 and end in 2036 (56% escalation applied).
- Both Hybrid A and B assume that the pipeline to convey San Mateo WWTP effluent to the AWPF would be constructed during Phase 2.

Figure 6-5: Proposed Title XVI Project – Summary of Capital Costs



6.3.4 Summary of Benefits and Risks

Implementation of the Proposed Title XVI Project, irrespective of which hybrid option is chosen, could benefit the San Francisco Bay Area through:

- ✓ Development of a new locally-controlled, reliable supply of high-quality water that is drought-resilient
- ✓ Reduce dependence on imported water and potential to result in reduced diversions from the Tuolumne River
- ✓ Reduction in discharges to the SF Bay
- ✓ Treatment of local wastewater more efficiently and prevention of water from becoming a lost resource.
- ✓ Addressing the unpredictability of climate change.
- ✓ Combined resources and regional institution collaboration to maximize water reuse

There are of course inherent risks and uncertainties that accompany project implementation, such as

- Operational and water quality challenges in Crystal Springs Reservoir
- Ability to reliably meet Bay discharge requirements
- Construction challenges in constructing alignments along the Bay and through Silicon Valley
- Water supply during non-drought years would impact operations and storage availability in the Regional Water System
- Decreasing quantity and quality of source supplies due to conservation
- Uncertainty related to DPR regulatory requirements
- Institutional agreements to share costs and risks
- Equity in distribution of purified water and costs
- Community support and acceptance

These, and other challenges, will be addressed as the project progresses.

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Section 7: Environmental Consideration and Potential Effects

The review of a Title XVI feasibility study report does not require National Environmental Policy Act (NEPA) compliance. The Department of the Interior categorical exclusion 1.11 "Activities which are educational, informational, advisory, or consultative to other agencies, public and private entities, visitors, individuals or the general public" applies to Reclamation's consultative review, and preparation of the Title XVI feasibility study reports. As stated in Paragraph 1. Scope, Reclamation is not making a recommendation to go forward with the Proposed Title XVI Project, nor is Reclamation using the Title XVI feasibility study report to propose an action to the Congress

The purpose of this preliminary environmental evaluation is to identify expected environmental impacts from construction and operation of the Proposed Title XVI Project. This evaluation also describes the level of environmental documentation that will be needed to comply with the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). Findings from previously prepared environmental documents relevant to the proposed Title XVI Project are discussed and referenced in this section.

As noted earlier in Section 5.3, the PREP Parties are committed to developing a conceptual-level design and completion of an initial CEQA checklist in 2023 to allow the project to move forward with CEQA and to be compared with other projects being explored by SFPUC's Alternative Water Supply Program]. NEPA analysis and requirements will be followed to comply with federal funding requirements for Title XVI.

This section focuses on NEPA and Federal Law Compliance for Proposed Title XVI Project and provides the preliminary environmental evaluation of the proposed AWPF facility and proposed pipeline alignments which are the primary facilities associated with the Proposed Title XVI Project. The need for pump station locations outside of the AWPF location have not been confirmed at this time, and would likely require a small footprint, thus it is assumed that environmental considerations would be revisited during future siting studies.

Supporting environmental documentation is included in **Appendix G**.

7.1 NEPA and Federal Law Compliance

7.1.1 Potentially Significant Environmental and Cultural Impacts

Discussion whether, and to what extent, the Proposed Title XVI Project will have potentially significant impacts on endangered or threatened species, public health or safety, natural resources, regulated waters of the United States, or cultural resources.

A high-level environmental screening was completed for potential pipeline alignments (discussed in Section 4.7) and potential AWPF site locations (discussed in Section 0) using the United States Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IpaC) system and Geographic Information System (GIS). Shapefiles for the five potential pipeline alignments and two AWPF locations were uploaded to the IpaC system database to evaluate potential environmental considerations in each area, including endangered species, critical habitats, migratory birds, and wetlands (USFWS, 2019). Natural hazard and land use information was summarized from the Redwood City GIS portal, including land use, and zoning information (Redwood City, 2019). IpaC natural resource lists and detailed maps are included in **Appendix C**.

Construction activities associated with the Proposed Title XVI Project would include grading, excavation, installation of pipelines, pump stations, and installation of AWPF building and equipment (e.g., associated chemical feed systems, wet wells, pumps, mixing aerators) and diffusers in the reservoir. Pipeline installation would primarily occur along existing roadways, or existing rights of way by means of open cut trenching, except in sensitive areas such as stream crossings or roadway boundary crossings, where directional drilling or similar methods would be used. Operation and maintenance activities would include mechanical and chemical treatment of wastewater, to meet ResWA regulatory requirements, and energy and material use associated with facility operations. Ancillary impacts may be associated with augmentation of potable water supplies, as well as reduction in potable water use from groundwater and surface water.

The Proposed Title XVI Project construction activities are anticipated to have short-term impacts to endangered or threatened species, water quality, hydrology, natural resources, waters of the United States, and cultural resources. Short-term construction impacts can be mitigated by methods such as utilizing trenchless technologies for sensitive areas, performing biological and cultural surveys, and implementing best management practices.

This section addresses environmental considerations associated with the following:

- Endangered or Threatened Species
- Public Health or Safety
- Natural Resources
- Waters of the United States
- Cultural Resources

A summary of the environmental screening findings for the pipeline alignments and potential AWPF locations can be found in Table 7-1 and Table 7-2, respectively.

Table 7-1: Environmental Screening Summary of Potential Pipeline Alignments

Pipeline Alignment	Endangered Species Count	Critical Habitats Count	Migratory Birds Count	Wetlands Present	Approximate Area Disturbed (acres)	Potential Environmental Considerations
Tertiary Water Alignment (San Mateo to AWPF)						
Option A – Beach Park *(to SVCW Site)*	21	0	39	YES	180	• Coastal waterway crossings • Coastal Zone Consistency
Option B – Edgewood Blvd *(to Hwy 101 Site)*	18	0	22	YES	190	• Coastal waterway crossings • Coastal Zone Consistency
Purified Water Alignment (AWPF to CSR)						
SFPUC ROW	24	1	24	YES	450	• San Francisco Bay National Wildlife Refuge crossing • Several coastal water crossings • Fish hatcheries • Coastal Zone Consistency

Source: (USFWS 2019; Redwood City 2019)

Table 7-2: Environmental Screening Summary of Potential AWPF Locations

Potential AWPF Location	Endangered Species Count	Critical Habitats Count	Migratory Birds Count	Wetlands Present	Approximate Area Disturbed (acres)	Potential Environmental Considerations
AWPF Site Near SVCW	13	0	21	YES	4- 6 acres	• Wetland planning, permitting, and mitigation • Sea level rise inundation • Coastal Zone consistency • Flood zones AE, X • Land use: tidal plain, preservation
Highway 101 AWPF Site	18	0	21	YES	4- 6 acres	• Located near airport • Wetland planning, permitting, and mitigation • Flood zone X • Land use: community park/ preservation

Source: (USFWS 2019; Redwood City 2019)

Endangered or Threatened Species

Based on review of available literature, and the USFWS IpaC database, species listed as endangered, threatened, proposed endangered, and proposed threatened are expected to be found along each of the five (5) potential pipeline alignments and at two (2) potential AWPF locations evaluated. Supporting information regarding endangered or threatened species can be found in the IpaC Resource Lists in **Appendix G**. Consultations should be made with local, state, and federal agencies to evaluate potential impacts to endangered species. Actions that are conducted, permitted, funded, or licensed by federal agencies are subject to Section 7 of the Endangered Species Act (USFWS 2019).

Critical Habitats for listed endangered species are expected to overlap with three (3) of five (5) proposed pipeline alignments (USFWS 2019). Consultations should be made with local and Federal agencies to evaluate potential impacts to critical habitats that may occur within the proposed AWPF locations or alignments. Biological surveys may be required in concert with future NEPA and CEQA documentation to determine the presence/absence of sensitive species.

Migratory birds are protected under the Migratory Bird Treaty Act. Migratory birds are expected along each of the five (5) potential pipeline alignments and two (2) potential AWPF locations evaluated (USFWS 2019). Consultations should be made with local and Federal agencies to evaluate potential impacts to endangered species. Biological surveys may be required to determine the likelihood of presence of endangered species and migratory birds. The proposed Hwy 101 AWPF Site may require wildlife mitigation planning for migratory birds due to its proximity to San Carlos Airport (Redwood City 2019).

Public Health or Safety

Short-term construction activities associated with implementation of the Project may cause short-term air emissions, increased noise levels, increased traffic, and similar impacts. These impacts are expected to be mitigated by implementation of best management practices to comply with local and state standards and would be similar for all potential pipeline alignments and AWPF sites.

Purified water produced by the AWPF would meet all ResWA regulatory requirements (as defined in SBDDW-16-02) and would be protective of the environment and public health. A Title 22 Engineering Report would be developed for the Project, which would describe the PREP Parties' plan for compliance with the California Code of Regulations (CCR) Title 22 Water Recycling Criteria, including ResWA regulations and to request approval from DDW for the project. A water quality monitoring plan would also be developed to identify constituents that would be monitored in the AWPF produced water, Crystal Springs Reservoir, and SVCW/San Mateo WWTP effluent and to define the frequency for monitoring and analysis for each location.

Waters of the United States

Wetland areas are expected to overlap with the potential pipeline alignments and AWPF locations (USFWS 2019). Planning efforts should include consultations with the U.S. Army Corps of Engineers for potential wetland determination, delineation, and permitting requirements and with the Regional Water Quality Control Board and California Department of Fish and Wildlife Environmental Services Division and the Wildlife Management Division. Directional drilling should be considered for wetlands and sensitive crossings.

The AWPF Site Near SVCW overlaps a freshwater emergent wetland, estuarine and marine wetland, and freshwater pond.

The AWPF Site at Hwy 101 overlaps a freshwater emergent wetland.

For both the AWPF sites, future CEQA and permitting compliance studies should include a wetland jurisdictional determination, as well as consultations with USACE, CDFW, and RWQCB. AWPF site layouts would avoid jurisdictional features.

Depending on the methods used, pipeline crossings of streams and wetlands may be subject to the Clean Water Act (CWA), including the acquisition of appropriate USACE and RWQCB permits and USFWS consultation, as appropriate. Permits will be required by CDFW for all stream crossings, regardless of crossing method.

Cultural Resources

Because construction of pipeline alignments would generally be conducted within existing disturbed rights-of-way, it is unlikely that pipeline construction would impact cultural resources. It is assumed that alignment specific impacts would be identified as part of future studies.

Potential cultural resources at the proposed AWPF sites have not been evaluated at the time of this study. However, a prior study has conducted a cultural resources inventory for the proposed Silicon Valley Clean Water joint powers authority upgrade which has an overlapping project location. The SCCW RESCU Integrated Final EIR (RESCU EIR) (September 2017) conducted exploratory coring's in accessible areas of elevated sensitivity and a surface inventory of areas of potential effects (APEs). These areas encompass both potential AWPF sites (near SVCW and near Hwy 101). Historical maps show the project area lies under twentieth-century artificial fill that overlies bay and marsh deposits, indicating there is no possibility for intact prehistoric Native American archaeological sites to be present on the surface of the APE. Historical maps also show a low potential for historical archaeological sites to be present within the APE.

AWPF Site (near SVCW): This area is in the vicinity of the existing SVCW WWTP site, entirely in the historical extent of the San Francisco Bay and estuary. According to the RESCUE EIR, this aquatic setting is not sensitive for surface or near-surface prehistoric sites. In addition, no submerged archaeological sites were found in the deep cores in the vicinity of the SVCW and potential future AWPF site.

AWPF Site (near Hwy 101): This area lies along the bay's edge in the southern San Francisco Peninsula east of the historic-era bay shoreline, and nearly all structures and developments there are built on artificial fill. The RESCU (September 2017) noted there are no potentially eligible historic resources within or near the Project area that could be affected by the proposed Project.

The California Historical Resources Information System will be contacted as part of the CEQA/NEPA evaluations to identify potential cultural and historical resources near planned facilities.

7.1.2 Additional and Unique Environmental Risks

Discussion whether, and to what extent, the project will have potentially significant environmental effects, or will involve unique or undefined environmental risks.

Soil Disturbance

Total soil disturbance from excavation, grubbing, and grading for each of the proposed pipeline alignments and the AWPF locations is expected to range from 200-500 acres, assuming a 10-foot trench for the pipeline alignment and a 4 to 6-acre site. Planning should include erosion control measures and stormwater Best Management Practices (BMP).

Land Use

Land use and zoning restrictions are expected to affect the proposed pipeline alignments and AWPF locations. Land use and zoning requirements should be reviewed with local planning agencies during future project phases.

Flood Zones and Coastal Hazards

Some of the proposed conveyance pipeline alignments and both AWPF locations are expected to be located within flood zones, flood fringe zones, or coastal zones. Consultations should be made to review requirements such as setbacks, waterproofing, and elevation. For proposed pipeline and AWPF locations in the coastal zone, a federal Coastal Zone Consistency determination may be required. Nuisance flooding and sea level rise are expected to affect both proposed AWPF locations. The proposed Hwy 101 AWPF Site is located near an airport, which may impose additional land use restrictions and planning requirements.

7.1.3 Environmental and Cultural Compliance Measures

Description of the status of required Federal, state, tribal, and/or local environmental compliance measures for the Proposed Title XVI Project, including copies of any documents that have been prepared, or results of any relevant studies.

Table 7-3 provides an overview of environmental requirements identified in previous studies and during this environmental review that are expected to be required for the Proposed Title XIV Project.

Table 7-3: Overview of Regulatory Permitting Requirements

Agency	Regulation	Trigger	Permit
USACE	Section 404 of the CWA	Impacts to Waters of the U.S.	404 Authorization (Nationwide or Individual) Permit)
USFWS/ NOAA	Section 7 of the FESA	Impacts to federally listed species and/or critical habitat where a federal agency has discretionary action	Biological Opinion; jeopardy decision; incidental take permit
CDFG	Section 1602 of the Fish and Game Code	Impacts to Waters of the State	Streambed Alteration Agreement (1602 Permit)
CDFG	Section 2080.1 of the CESA	Impacts to State-listed species that are included in a FESA permit	Consistency Determination
CDFG	Section 2081 of the CESA	Impacts to State-listed species	Incidental Take Permit
RWQCB	Section 401 of the CWA	Impacts to Waters of the U.S.	401 Water Quality Certification
RWQCB	Section 402 of the CWA	Construction; dewatering	NPDES Permit (General Construction Permit)
RWQCB	Porter-Cologne Act	Impacts to Waters of the State	Waste Discharge Requirement
SBDDW	Title 22, CCR Division 4, Chapter 3 – Articles 1, 5, 7 Chapter 17 – Article 9	A project involving the planned placement of recycled municipal wastewater into a surface water reservoir that is used as a source of domestic drinking water supply, for the purpose of supplementing the source of domestic drinking water supply.	ResWA Project permit (for the water recycling agency) and a ResWA public water system (PWS) domestic water supply permit TWA requirements have yet to be established but will similarly require permits to be secured by the direct potable reuse responsible agency (DiPRRA)
SHPO	Section 106 of the NHPA	Section 404 Permit	106 Compliance

7.1.4 NEPA Compliance Measures

Any information available that would assist with assessing the measures that may be necessary to comply with NEPA, and other applicable Federal, state or local environmental laws such as the Endangered Species Act or the Clean Water Act.

Due to the potential for federal funding for construction of the Proposed Title XVI Project, The NEPA compliance would be required. The project sponsor would serve as the lead agency for NEPA as well as CEQA compliance.

To meet NEPA and CEQA compliance requirements, a joint Environmental Assessment (EA) or an Environmental Impact Statement (EIS) would be prepared, depending on the level of significant impacts findings. The EA/EIS would evaluate biological resources, cultural resources, water quality, hydrology, land use, seismic, traffic, and other issues of environmental concern to assess potential impacts of the Proposed Title XVI Project.

7.1.5 Regional Water Supply and Quality Effects

Discussion of how the Proposed Title XVI Project will affect water supply and water quality from the perspective of a regional, watershed, aquifer, or river basin condition.

The Proposed Title XVI Project would augment the supply of water to be stored at the existing CSR and existing drinking water systems. This diversion of wastewater effluent for recycled water production would eliminate discharges of recycled water to the San Francisco Bay, helping SCVW/San Mateo WWTP to meet their NPDES discharge requirements. Based on hydrodynamic modeling of Crystal Springs Reservoir, the 10:1 minimum dilution and 100:1 preferred dilution criteria required by the ResWA Regulations can be consistently met. However, modifications to RWS operations may be needed to maintain a retention time of greater than 2 months at all times. The water quality discharged into CSR would be treated to match or be compatible with the background levels in CSR to meet the SF Bay Basin Plan.

Future studies would include the development of a hydrodynamic model and conducting a tracer study to calibrate the hydrodynamic model. Within the first six months of ResWA operations, another tracer study would be conducted to meet permitting requirements.

7.1.6 Public Outreach and Involvement

Discussion of the extent to which the public was involved in the feasibility study, and a summary of comments received, if any.

Public outreach and involvement were not conducted as part of this Feasibility Study but will be completed as the Project moves forward. A Public Outreach Strategy will be developed as part of the next step in the project, which will focus on supporting the PREP Parties in identifying education and outreach approaches to inform their decision makers, board/commission/council members, and/or elected officials about the Proposed Title XVI Project. NEPA and CEQA activities will include outreach to stakeholders, adhering to meet federal and state requirements.

7.1.7 Historical Impacts and Mitigation

Description of the potential effects the project may have on historic properties. Discussion must include potential mitigation measures, the potential for adaptive reuse of facilities, an analysis of historic preservation costs, and the potential for heritage education, if necessary.

No potential effects on historic properties were identified as part of this effort.

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Section 8: Legal and Institutional Requirements

The Title XVI feasibility study shall identify any legal or institutional requirements, or barriers to implementing the Proposed Title XVI Project.

This section provides a brief description of the following:

1. Potential Water Rights Issues
2. Legal and Institutional Requirements
3. Multi-Jurisdictional or Interagency Agreements
4. Permitting Procedures
5. Unresolved Issues
6. Current and Projected Wastewater Discharge Requirements
7. Wastewater Discharge Rights

Additional supporting information for this section is included in **Appendix B**: Permitting and Regulatory Requirements.

8.1 Potential Water Rights Issues (Compliance with State Water Law)

Analysis of any water rights issues potentially resulting from implementation of the proposed water reclamation and reuse project. All Proposed Title XVI Projects must comply with state water law.

A determination of rights to treated wastewater is required prior to long-term project expenditures. Ownership of the rights to wastewater is addressed in three separate state laws or codes, summarized below, that cover property and water rights as well as changes to instream flows if discharge of treated wastewater occurs.

- **Clean Water and Water Bond Law of 1978** established that treated wastewater is the property of the treatment facility that produced it and that this property could be sold or transferred for beneficial use regardless of detriment to downstream users.
- **California Department of Fish and Game Code, Section 1600** covers changes to surface waters and could be relevant to protect fish or wildlife resources in the event that a project changes the flow regime in a water body.
- **Water Code (WC), Sections 1210, 1211 and 1702** address various aspects of wastewater ownership as follows
    - ✓ WC Section 1210 describes the ownership of treated wastewater from within and outside of the watershed of discharge and that discharged water that supports instream or riparian habitat may accrue environmental water rights that supersede those of the treatment plant owner.

- ✓ WC Section 1211 addresses changes in point of discharge, place of use or purpose of use of treated wastewater to surface water bodies similar to changes required of appropriative water rights.
- ✓ Since the Legislature did not intend either WC Section 1210 or 1211 to affect the rights of downstream water users to the treated wastewater under common law (i.e., statutory "no-injury" rule), WC section 1702 codifies the common law no injury rule and therefore should be interpreted consistently with case law that interprets and applies the common law rule.

Under Water Code Section 1210 "The owner of a wastewater treatment plant…shall hold the exclusive right to the treated wastewater as against anyone who has supplied the water discharged into the wastewater collection and treatment system...". The SVCW JPA and San Mateo/EMID are the owners of the sourced wastewater for the Proposed Title XVI Project and at this time have made no arrangements nor agreements to transfer jurisdiction of rights to the wastewater. Thus, there are no anticipated issues related to water or wastewater rights resulting from the Implementation of the Proposed Title XVI Project.

Under Water Code Section 1211 "Prior to making any change in the point of discharge, place of use, or purpose of use of treated wastewater, the owner of any wastewater treatment plant shall obtain approval of the board for that change." Potential considerations related to discharge requirements to the San Francisco Bay are discussed in Sections 8.6 and 8.7.

Water Codes Section 1702 would not apply since there are no downstream legal users from SVCW and the San Mateo WWTP.

In all cases, the advice of legal counsel for individual determinations and the development of the most equitable and least detrimental projects for all affected parties are recommended.

8.2 Legal and Institutional Requirements

E.g., contractual water supply obligations, Indian trust responsibilities, water rights settlements, regional water quality control board requirements), state, and/or local requirements with the potential to affect implementation of the project. Title XVI projects using Reclamation project water must address contractual requirements as described in RM Policy, Reuse of Project Water (WTR P09).

Contractual recycled water supply obligations between SVCW and Redwood City have been accounted for in the supply analysis. There are currently no contractual recycled water supply obligations for San Mateo's effluent, though potential non-potable recycled water uses in Foster City have been considered as part of the PREP Phase 2 Study and could be served in the future if desired. There are no known Indian trust responsibilities or water rights settlements related to the project.

The Proposed Title XVI Project will need to meet State Board and San Francisco Bay RWQCB requirements for potable reuse and any local requirements for construction (e.g., permitting, traffic, noise, etc.). **Appendix B** details applicable permitting and regulatory requirements.

8.3 Multi-Jurisdictional or Interagency Agreements

Discussion of the need for multi-jurisdictional or interagency agreements, any coordination undertaken, and any planned coordination activities.

The PREP Parties comprise a regional partnership of water and wastewater agencies to study potable reuse opportunities in the San Francisco Mid-Peninsula region as described in Section 1.1 and Section 1.2. There are a number of existing and relevant agreements in place between the PREP Parties, as listed in Table 8-1.

Table 8-1 Summary of Existing Relevant Agreements

Agreement	Agencies	Overview
Joint Exercise of Powers Agreement	SVCW	JPA between Cities of Belmont, Redwood City, and San Carlos and West Bay Sanitary District.
Agreement for Production and Delivery of RW	SVCW / Redwood City	Covers production and delivery or recycled water between SVCW and Redwood City.
Lease Agreement for Recycled Water Treatment/Storage/ Pumping	SVCW / Redwood City	Separate lease agreement covers RW treatment, storage, and pumping facility on SVCW land from 2006 through 2056.
RWC Tributary Sewer District Agreements	Redwood City/ Edgewood, Emerald Lake Heights, Fair Oaks	Covers operations, maintenance, treatment, and disposal of sewage that is part of Redwood City and/or SVCW sewerage facilities.
Joint Powers Agreement and Amendments	San Mateo / Estero Municipal Improvement District	Related to the construction and operation of the water quality control plant. Most recent amendment reflects the “Clean Water Program” and associated improvements.
Existing Agreements	San Mateo	Adherence to various agreements with Foster City/EMID, and Town of Hillsborough/Crystal Springs County Sanitation District/San Mateo County would be required.

Agreement	Agencies	Overview
Water Supply Agreement (WSA) and Amendments	San Francisco and the Wholesale Customers	Covers delivery of water and supply assurances between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County and Santa Clara County. BAWSCA enforces the agreement on behalf of the BAWSCA agencies but is not a party to the WSA. Projects that have been contemplated in the past assume that water in SFPUC facilities becomes a part of the SFPUC RWS. The WSA could then govern the distribution of that water, including how it would be divided during times of drought. An amendment to the WSA would likely be required if ResWA is implemented.
BAWSCA-SFPUC Pilot Water Transfer Agreement	BAWSCA-SFPUC	The draft agreement between SFPUC and BAWSCA defines how the water would be exchanged and how it would be tracked in the RWS both under mandatory drought rationing conditions and during a non-mandatory drought condition.
Purchased Water Supply Contract	Cal Water / SFPUC	Cal Water's purchased water supply from the SFPUC is subject to the 2009 Water Supply Agreement (WSA).
Raker Act	United States Congress	Permitted building of O'Shaughnessy Dam and flooding of Hetch Hetchy Valley, which specified that because the source of the water and power was on public land, no private profit could be derived from the development.

In addition to meeting the stipulations of existing interagency agreements, implementation of the Proposed Title XVI Project will need to meet form new interagency agreements and coordinate with entities across jurisdictional boundaries. A summary of inter-agency related issues is presented in Table 8-2.

Table 8-2: Summary of Inter-Agency Related Issues

Inter-Agency Related Issues	Considerations/Approaches to Address
Existing interagency agreements	Project will need to consider existing JPAs, water supply and other agreements related to water, wastewater and brine disposal. See Table 8-1 for a summary of relevant agreements.
New interagency agreements	The project sponsor would need assurance and commitment (e.g., to secure financing, take-or-pay contracts with step-up provisions, etc.) from other agencies contributing the source water, receiving the purified water (directly or indirectly), and disposing of the reject water (RO concentrate). New agreements would also be needed for repurposed or dual-purpose existing infrastructure.
Crossing jurisdictional boundaries	An encroachment permit would be needed for pipeline and facility construction across jurisdictional boundaries. Access to ROWs and lease and/or purchase of land may also be required.

The pursuit of a potable reuse project in this region would solicit the interest of numerous stakeholders on the Mid-Peninsula and the surrounding area. An initial list of potential stakeholders that may be interested in future developments of the Proposed Title XVI Project is provided in Table 8-3. This list will evolve over time and should be revisited in the future. Public outreach to potential stakeholders is critical and will need to be proactively initiated and sustained through the project to maintain transparent and open communications with stakeholders and customers on the regional benefits of a local and regional water supply. An agency specific and regional approach to public outreach would likely be most beneficial for this type of project once a project and its structure are defined.

Table 8-3: List of Potential Stakeholders

Category	Potential Stakeholders
PREP Parties	SFPUC, BAWSCA, Cal Water, SVCW, City of Redwood City and City of San Mateo
Hetch Hetchy Regional Water System Members	City and County of San Francisco BAWSCA 26 Member Agencies
Direct Connections to CSR	Coastside County Water District City of Daly City, South San Francisco, City and County of San Francisco, City of San Bruno, Westborough, North Coast County Water District,
Other Direct Connections to CSR or Harry Tracy WTP	Agencies/cities that may receive flows from the Sunset Branch pipeline during emergencies/outages
Cities or other entities **in ROW or Party to Existing JPAs/Agreements**	Redwood City, Belmont, Foster City, San Carlos, City of San Mateo, San Mateo County, West Bay Sanitary District, Estero Municipal Improvement District
Environmental groups	Natural Resources Defense Council, Sierra Club, California Coastkeepers Alliance, Surfrider Foundation, Pacific Institute, San Francisco Baykeeper, Save the Bay, Tuolumne River Trust Open the SF Watershed, Bay Institute, Wholly H2O,
Universities/Schools (if interested)	San Francisco Universities: UC San Francisco, San Francisco State University, University of San Francisco, Golden Gate University Silicon Valley Universities: Stanford University, San Jose State University, Santa Clara University, others. Local schools
Community Groups	Sustainable Silicon Valley, Sustainable San Mateo County, Silicon Valley Leadership Group, Silicon Valley Joint Venture, Redwood Shores, Concerned Citizens, Green County San Mateo
Other Groups	**Medical Groups** – Santa Clara County, San Mateo County, and other Medical Associations **Industry/Business Groups** – Bay Area Council, Bay Area Council Economic Institute, Association of Bay Area Governments (ABAG), Silicon Valley Leadership Group **Water-Related Associations/Organizations** – WateReuse, AWWA, CWEA, ACWA, BACWA, San Francisco Estuary Institute, ReNUWit
Governmental/Regulatory	SWRCB/DDW, San Francisco Bay RWQCB County Health Departments, California Public Utilities Commission, California EPA and US EPA, US Bureau of Reclamation (Title XVI)

8.4 Permitting Procedures

Discussion of permitting procedures required for the implementation of water reclamation projects in the study area, and any measures that the non-Federal project sponsor can implement that could speed the permitting process.

Implementation of the Title XVI Project will require coordination with various State and Local Agencies to achieve regulatory approvals and obtain the appropriate construction permits, as summarized in Table 8-4.

Table 8-4 Summary of Relevant Regulations and Permits

Regulations/ Permits	Agencies	Overview
Reservoir Water Augmentation (ResWA)	RWQCB/ DDW	The State Board DDW and the RWQCBs regulate potable reuse and will serve as the lead agencies in approving ResWA with purified water.
NPDES (CSR)	RWQCB, SFPUC	Subject to EPA concurrence, the RWQCB has approval over the NPDES discharge permit, which will regulate the discharge to the reservoir. The NPDES permit will implement applicable state and federal water quality standards and will incorporate applicable ResWA regulations recommended by DDW.
NPDES (ORDER No. R2-2018-0005 NPDES No. CA0038369)	RWQCB, SVCW	Covers SVCW's discharge of advanced secondary treated municipal wastewater into lower San Francisco Bay just south of the San Mateo Bridge. The NPDES permit establishes monitoring and reporting requirements. Brine disposal via the existing outfall would need to meet permit requirements.
NPDES (ORDER No. R2-2015-004 NPDES No. CA0038365)	RWQCB, SFPUC	Covers water discharge requirements (WDRs) of dechlorinated or dechlorinated potable water at the SFPUC's Pulgas Dechloramination Facility prior to release into CSR. The NPDES permit establishes monitoring and reporting requirements.
Water Supply Permits	RWQCB/ DDW, SFPUC	DDW will regulate the project through modification of the water supply permits which regulate water supply operations of agencies that derive water supply from the reservoir. Modification by DDW of the existing CSR water supply permits would be required as part of the overall reservoir augmentation program to reflect the new source.
Fountain Thistle Compensation Plan	USFWS / CDFW/ SPFUC	Requirements outlined in Lower Crystal Springs Dam Improvement Project Biological Opinion related to storage capacity in the Lower CSR must be met.
Encroachment Permits	Cities, County, Dept of Transportatio n (CalTrans)	An encroachment permit would be needed to construct pipelines in public streets, including traffic control plans. An encroachment permit would be needed from CalTrans to cross Highways 101 and I-280. Other special crossings include Caltrain and complex intersections.

Regulations/ Permits	Agencies	Overview
Local Building Codes	Multiple	Local building codes and planning ordinances would be adhered to for new above and below ground infrastructure.
Admin. Policy	Redwood City	Policy to not use recycled water where children play due to public.
Administrative Codes	San Mateo	City Municipal Code Section 23.72.160 RECYCLED WATER, or any codes or conditions of approval which require installation of recycled water piping in new or re-developments.
CPUC Approval and Oversight	Cal Water	Oversight by the CPUC ensures that necessary improvements are made to the water system, that the system is operated efficiently, and that the company only earns a modest return on the funds it invests in water system infrastructure. The CPUC's job is to protect customers and make sure that rates are fair and reasonable.

8.5 Unresolved Issues

Discussion of any unresolved issues associated with implementing the proposed water reclamation and reuse project, how and when such issues will be resolved, and how the project would be affected if such issues are not resolved.

There are a number of unresolved issues that arise as part of the development of complex inter-agency projects, particularly one involving potable reuse. A summary of potential source water, water supply, regulatory and implementation issues, and considerations/approaches to address them is provided in Tables 8-5 to 8-8.

Table 8-5: Summary of Source Water Related Issues

Issues	Considerations/Approaches to Address
Source Water Related Issues	
Ownership of wastewater	A determination of rights to treated wastewater is required prior to long-term project expenditures. Ownership of the rights to wastewater is addressed in three separate state laws or codes: Clean Water and Water Bond Law of 1978, California Department of Fish and Game Code, Section 1600, Water Code, Sections 1210, 1211 and 1702. These cover property and water rights, as well as changes to instream flows for discharges of treated wastewater. The advice of legal counsel for individual determinations is recommended.
Decreasing quantity and quality of supply due to conservation	Exploration/identification of policies, regulations, and/or ordinances which may be needed to ensure sufficient wastewater availability to meet source water demands and quality and address discharge water quality to SF Bay .
Competing demands for recycled water	May include SVCW (Redwood City NPR expansion, West Bay Sanitary), San Mateo (Foster City NPR potential), and decentralized onsite recycling plants. It may be beneficial to seek agreements and/or ordinances to preserve recycled water supply in the future.
Source water control	Review existing industrial pretreatment and source control programs, public outreach, and policy development efforts to identify and enhance proactive approaches for source investigation and monitoring program that address evolving potable reuse requirements.

Table 8-6: Summary of Water Supply Related Issues

Challenge/Risk	Considerations/Approaches to Address
Water Supply Related Issues	
Need for new local supply	For the foreseeable future, the Regional Water System (RWS) is able to meet most customer demands, including demand from San Jose and Santa Clara, except during the 2nd year of drought onward. Explore operational flexibility to store water during non-drought periods to deliver during dry years, including impact on RWS operations. Each agency would need to assess reliability benefits and their perceived value of a drought-resistant, local water supply. Results from SFPUC's Long-Term Vulnerability Assessment and Adaptation Plan (currently underway to look at future risks to water supply) will further define needs for additional water supply in the region.
Timing of new supply and demands	The most cost-effective operation of the AWPF would be continuous, which may not always align with annual and seasonal demands. RWS and reservoir modeling should be performed to understand seasonal and annual variability in demands and the impacts/benefits of the continuous augmentation of purified water into CSR.
Operational Complexity of RWS and CSR	CSR is used as an in-town reservoir to help balance water supplies. In drought years, there is not enough water in Upcountry system to keep all the RWS reservoirs full; but in most years, water is released to the Tuolumne River when there is no storage capacity available. To be able to use/store purified water, under current operations, SFPUC anticipates releasing additional Hetch Hetchy water to Tuolumne River in all years but dry years to be able to use the purified water. Management of water levels in Lower CSR creates further limitations on available storage because of regulatory water surface elevations defined for the Fountain Thistle Compensation Plan. The ability to store, bank, or exchange water for future use is uncertain at this time. RWS and reservoir modeling would need to be performed to assess impacts/benefits of the continuous augmentation of purified water into CSR.
Drought-resistant supply	Consider who benefits from this new drought resistant supply and to what degree. Beneficiaries may include: the entire SF RWS, SFPUC, all wholesale customers, a subgroup of customers, San Jose/Santa Clara. Partner agency alignment on benefits will inform and support negotiations on who pays for the project and how.
Direct recipients of purified water from CSR	Coastside County Water District receives flows from Upper CSR via the Cahill Pump Station, which is treated at the Nunes WTP. Harry Tracy WTP sends the majority of CSR water to sunset reservoir on the west side of the City. Daly City, South SF, NCCWD and San Bruno are served along the way. The Sunset Branch pipeline (from HTWTP) can send treated potable water down to the lower Peninsula during annual shutdowns or emergencies. However, modification would be needed to efficiently send water down to the lower Peninsula. Releases from CSR are also made to San Mateo Creek to meet environmental instream flow requirements. Environmental and regulatory criteria would need to be met in all cases and in some cases additional agreements may be required.
Equitable distribution of DPR water	Identify preferred points of connection to introduce purified water into the existing drinking water distribution systems owned and operated by water agencies and determine potential operational and hydraulic constraints, minimum blending criteria and infrastructure requirements.

Table 8-7: Summary of Regulatory Related Issues

Challenge/Risk	Considerations/Approaches to Address
Regulatory Related Issues	
Ability to reliably meet Bay discharge requirements	The construction of a RO concentrate line will require an agreement with SVCW for disposal of RO concentrate via the SVCW existing outfall. The addition of RO concentrate must ensure the ability of SVCW to meet NPDES water quality discharge requirements. Coordination with the RWQCB would be required.
Ability to reliably meet CSR discharge requirements	The augmentation of purified water to CSR will require an agreement with SFPUC for discharge at or near the Pulgas Dechloramination Facility into CSR. Augmented water must be able to meet NPDES water quality discharge requirements.
Ability to reliably meet ResWA criteria and requirements	The State Board DDW and the RWQCBregulate potable reuse and will serve as the lead agencies in approving ResWA with purified water. The project must meet all ResWA criteria and requirements.
Ability to reliably meet TWA criteria and requirements	The State Board DDW and the RWQCBregulate potable reuse and will serve as the lead agencies in approving TWA with purified water. Once DPR regulations are finalized, the project must meet all TWA criteria and requirements.

Table 8-8: Summary of Other Implementation Issues

Challenge/Risk	Considerations/Approaches to Address
Design/Construction/Operational Challenges	
AWPF	Siting challenges related to cost of land, proximity to sensitive receptors, traffic, and other local impacts related to construction and operation. A siting study, including completion of the environmental documentation process (CEQA/EIR) would be required to select the most appropriate location and solicit community input. Additional investigation of the treatment processes and equipment, including a potential demonstration project is advised.
Conveyance	Pipeline alignment challenges related to ROWs, cost of land, utilities, geotechnical, difficult crossings, trenchless technologies, proximity to sensitive receptors, traffic, and other local impacts related to construction. A conveyance alignment study to and from the AWPF would be conducted to explore options and to select the preferred alternative.
Storage	Storage capacity in CSR is only available in drought years, which could have design, operational and/or cost challenges related to the ability to accept purified water.
Financial Capacity	
Available funding sources	Potential funding partners may be identified, as appropriate, depending on the potential for a public private partnership (P3) or regional consortium to make the Project more cost-effective and/or to reduce risk. The project sponsor would take the lead on pursuit and selection of the appropriate funding sources.
Potential grants/loans	Construction costs are expected to be funded through a combination of grants, loans, and municipal bonds. The project sponsor would take the lead on pursuit and selection of the appropriate grant/loans or partner to be eligible to compete.
Public Acceptance	
Public Outreach	Public outreach is critical and would need to be proactively initiated and sustained through the project to maintain transparent and open communications with stakeholders and customers on the regional benefits of a local and regional water supply. An agency specific and regional approach to public outreach would likely be most beneficial for this type of project once a project and its structure are defined.
Environmental Justice	The project must address potential inequities in access to safe, affordable water. Environmental justice considerations can be integrated into the development and implementation of the project by promoting meaningful public participation and ensuring effective cross-media coordination and accountability.
Owner Operator Distinctions	
Owner Operator Distinctions	In the case of a non-SFPUC sponsor structure, distinguishing between owner and operator responsibilities may be complex and would require additional investigation to identify the appropriate agreements/contracting mechanisms.

8.6 Current and Projected Wastewater Discharge Requirements

Identification of current and projected wastewater discharge requirements resulting from the Proposed Title XVI Project (e.g., brine disposal).

Current and projected wastewater discharge requirements are summarized in Section 4.8 and detailed in **Appendix B.5**. As the owner and permit holder for the outfall to be used for brine disposal, the SVCW JPA, will work collaboratively with the RWQCB to discuss modifications to the NPDES and WDR permits that are in place to regulate the Bay discharge requirements:

- SVCW WDR: Order No. R2-2018-0005, NPDES No. CA0038369
- WDR for Mercury and PCBs: ORDER No. R2-2017-0041, NPDES No. CA0038849
- WDR for Nutrients: ORDER No. R2-2014-0014, NPDES No. CA0038873

8.7 Wastewater Discharge Rights

Description of rights to wastewater discharges resulting from implementation of the Proposed Title XVI Project.

Since the Proposed Title XVI Project involves use of wastewater effluent that is currently directly discharged into the San Francisco Bay, there are no downstream rights to wastewater discharges to compete with the project. The SVCW JPA and San Mateo/EMID, as owners of the sourced wastewater for the Proposed Title XVI Project would seek legal counsel for individual determinations of the use of their supply.

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Section 9: Financial Capability of Sponsor

At the Title XVI feasibility study stage, Reclamation must request enough information to determine that the non-Federal project sponsor is likely to demonstrate financial capability if the project moves to construction. Reclamation will request more detailed information to make a determination that the non-Federal project sponsor is financially capable of funding the non-Federal share of the project's costs before a funding agreement covering construction can be executed. Accordingly, the following information is required to be included in the Title XVI feasibility study report.

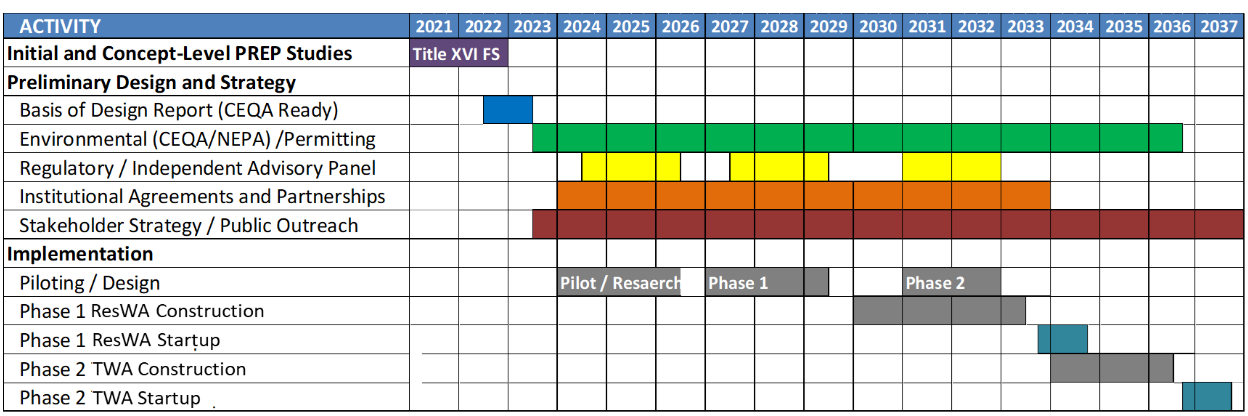
This section provides a brief description of the following:

1. Proposed Project Schedule
2. Non-Federal Project Sponsor Preparedness
3. Funding Plan
4. Federal and Non-Federal Funding and Restrictions

9.1 Proposed Title XVI Project Schedule

A high-level potential timeline for implementation of the Proposed Title XVI Project is shown in Figure 9-1. The intent of this timeline is to provide a general and conservative estimate of when major activities would occur over a 15-year period. The schedule could be reduced by overlapping activities and reducing time between activities, depending on project drivers. This preliminary schedule is based loosely on the duration and schedule for other ResWA projects in progress by East County Advanced Water Purification Program and Pure Water Project Las Virgenes-Triunfo.

Figure 9-1: Potential Timeline for Major Activities to Implement Proposed Title XVI Project



Activities and studies included for the line items in Figure 9-1 may include, but are be limited to:

Basis of Design Report (BODR): The PREP Parties are committed to initiating a BODR in 2022 to meet the requirements of SFPUC's definition of CEQA Ready by July 1, 2023. This effort will include:

- Development of a conceptual-level design at or near the 10-percent level, for the Proposed Title XVI Project
- Completion of an abbreviated CEQA checklist document, which would allow the project to move forward with CEQA and to be compared with other projects.
- NEPA considerations will be incorporated as appropriate.

Environmental (CEQA/NEPA) /Permitting: Includes development and implementation of strategies for environmental documentation (e.g., NPDES requirement for discharge to CSR and the SF Bay, CEQA/NEPA checklist, potential mitigation requirements, other documentation) and permitting. Includes:

- Development environmental documentation to complete CEQA, EIR or MND, and NEPA for a pilot project (if developed), Phase 1 ResWA and Phase 2 TWA.
- Securing land, right-of-water and construction permits and other approvals necessary to finalize design and move to construction for a pilot project (if developed), Phase 1 ResWA and Phase 2 TWA.

Regulatory / Independent Advisory Panel (IAP): Includes development and implementation of strategies for regulatory compliance to meet ResWA and TWA requirements. Includes:

- Engagement of the SBDDW/SWRCB early in the process related to strategies to demonstrate the ability to meet, or validation needed, to meet regulatory requirements for ResWA and TWA.
- Creation of anIAP, consisting of external experts to support initial coordination with regulatory agencies.
    - The IAP could guide the development of demonstration testing and reservoir tracer study concepts, as part of the piloting process
    - Presentation of project updates to IAP external experts on demonstration testing, reservoir tracer study, and Title 22 Report outcomes to secure preliminary approvals from SBDDW and the RWQCB.
    - The IAP would coordinate with regulatory agencies, in effect providing third party review and validation of project findings.
    - The IAP could ramp up as-needed to support the distinct phases of the project.
- Activities to meet regulatory requirements, such as completing a Title 22 report (for ResWA and TWA) and any updated studies required for SBDDW drinking water permits and complete RWQCB NPDES and Bay discharge permits, including applicable state and federal water quality standards, policies, provisions, and prohibitions.

Institutional Agreements and Partnerships: Includes development and implementation of strategies for institutional agreements and partnerships, including financial and funding options. Specific activities may include:

- Defining institutional operations and ownership models and roles for partners.
- Development of institutional agreements and terms, which would include a partnership framework to guide contracts, cost sharing, commitments between parties, and other contracts as-defined by the framework.
- Finalizing contracts, purchase agreements, and other binding documents, as needed through piloting, Phase 1 and 2 design and construction.
- Identification of state and federal funding programs that are available to assist agencies with planning, piloting, design, and construction of regional reuse projects.
- Consideration of alternate delivery and financing approaches (e.g., design-build, design-bid-build, design-build-operate, etc.).
- Applying apply for design and construction dollars and administer grant/loan if successful.
- Securing financing and/or alternative delivery approach.

Stakeholder Strategy / Public Outreach: Includes development and implementation of strategies for stakeholder and public outreach, continue stakeholder and public engagement activities, which would continue through the different phases to gain support for the project, and address concerns regarding construction and operational activities.

Piloting: Includes reservoir modeling and development of a treatment demonstration project, including data gathering, water quality sampling and validation of outcomes to demonstrate that regulatory requirements would be met. Activities may include:

- Water quality sampling to support:
  - treatment process evaluation, and ongoing sampling if needed. May include monitoring for specific constituents and surrogates, identifying type and frequency of monitoring, and determining analytical methodology to be used.
  - calibration of reservoir model or to support baseline surface water quality monitoring efforts.
- Development of a reservoir mixing model to support
  - hydrologic, hydraulic, limnological and evaluations,
  - modeling of the reservoir to confirm assumptions regarding reservoir operations, retention, dilution, and mixing.
  - Work may include an assessment of existing system capacities and infrastructure requirements to use the SFPUC Pulgas Facilities
  - Conducing a tracer study and validation modeling to test and validate detention projections and mixing in the reservoir.

- Pilot project
    - To support ResWA and TWA treatment concepts through piloting treatment process technologies to demonstrate strategies for compliance and verify treatment process performance. This may be done in phases to support ResWA and TWA.
    - Includes identification of an appropriate location for the facility, design, and construction activities
    - Utilization of the pilot to identify preferred equipment vendors through evaluation of performance, refine treatment design, and validate performance for log reduction credits.
    - Use a demonstration facility as a tool to support public outreach and provide training for treatment plant operators.
    - Continue to implement testing concepts to support implementation, such as continued water sampling, water monitoring, and outreach for the source water control program.

Phase 1 Design: Includes activities to initiate design of the Phase 1 ResWA facilities, based on input from BODR, piloting and other strategies (e.g., regulatory, permitting, institutional, outreach), may include but not be limited to:

- Source water control evaluations to identify existing chemical constituent source control and industrial/commercial pretreatment programs and identify potential modifications, improvements and/or additional programs.
- Development of initial operations and maintenance (O&M) plans for major facilities, including integration with existing operations (e.g., Redwood City's recycled water system, SFPUC Pulgas Facilities), treatment facility operation, reservoir operations, management plans, and operator requirements.
- Design of major facilities for treatment, conveyance, discharge, and other infrastructure. Includes evaluation of power availability and needs.
- Development of finalized specifications and preparation of bid documents.
- Development of detailed O&M Plans/Manuals to guide activities for ResWA operational scenarios.
    - Create a contingency plan to respond to potential water quality excursions and to ensure inadequately treated recycled water will not be used for potable purposes.
    - Conduct a Critical Control Points (CCP) study to identify locations to detect treatment lapses (should they occur) and time to implement contingency plans.
    - Demonstrate the ability to provide adequate failure response time (FRT).
    - Develop a Monitoring and Reporting Plan to meet regulatory/permitting requirements (e.g., the frequency and duration of monitoring and reporting will be outlined in the permitting requirements for the project).
- Pre-procurement of treatment equipment, if-preferred.

Phase 1 Construction/Startup: Includes preparation of information and materials for bid and award, executing construction and startup activities, development of Standard Operating Procedures (SOPs) and conducting training for ResWA.

Phase 2 Design: Includes activities to initiate design of the Phase 2 TWA facilities, based on input from BODR, piloting and other strategies (e.g., regulatory, permitting, institutional, outreach), may include but not be limited to:

- Phase 1 treatment evaluations to validate/confirm ability to meet TWDA requirements, including identification of potential modifications, improvements and/or additional programs.
- Development of refined operations and maintenance (O&M) plans to deliver water to drinking water systems, including updates to management plans, and operator requirements.
- Design of major facilities for treatment, conveyance, discharge, and other infrastructure. Includes evaluation of power availability and needs.
- Development of finalized specifications and preparation of bid documents.
- Development or refinement of detailed O&M Plans/Manuals to guide activities for TWA operational scenarios.
- Pre-procurement of treatment equipment, if-preferred.

Phase 2 Construction/Startup: Includes preparation of information and materials for bid and award, executing construction and startup activities, development of Standard Operating Procedures (SOPs) and conducting training for TWA.

9.2 Non-Federal Project Sponsor Preparedness

Discussion of the willingness of the non-federal project sponsor to pay for its share of capital costs and the full operation, maintenance, and replacement costs.

The PREP Parties are committed to continuing to work together to define an institutional arrangement and cost-sharing structure to lead a mutually beneficial regional project that is consistent with their legal authorities and the expected value of the benefits they receive. As discussed in Section 1.3, the project sponsor has not been defined at this time. Once the project sponsor is identified, a cost allocation framework will be developed, and the appropriate combination of cash contributions identified.

Construction costs are expected to be funded through a combination of grants, loans, and municipal bonds. Potential funding partners may be identified, as-appropriate, depending on the potential for a Regional Consortium to make the Project more cost-effective and/or to reduce risk. The project sponsor will likely pursue funding through available grants, low-interest loan programs and partnerships for the project construction at the appropriate time.

It is anticipated that the project sponsor would fund full operation, maintenance, and ongoing replacement costs through ongoing rates and charges. At this point, a method for allocating costs among the applicable service types: potable water, recycled water, and sanitation has not been developed. As the Project moves forward, this allocation method will be developed in order to properly determine cost impacts on each respective customer class.

9.3 Funding Plan

A plan for funding the proposed water reclamation and reuse project's construction, operation, maintenance, and replacement costs, including an analysis of how the non-federal project sponsor will pay construction and annual operation, maintenance, and replacement costs.

As part of the next steps for the project, the BODR will identify potential approaches to fund the project as it moves into construction, irrespective of institutional agreements, cost sharing and ownership framework. The financial plan developed as part of that effort will utilize the updated cost analysis from the BODR effort, identify typical funding sources (financing approaches, bonds, grants/loans) and discuss common pricing policies to identify key considerations for financial planning. Since the project sponsor will not be identified as part of the BODR effort, the financing plan will be at a conceptual level, documenting established vehicles used by the PREP Parties to fund capital projects and recovery annual costs. The intent will be to identify the connectivity between design, environmental/permitting and construction activities on funding (e.g., eligibility for grants/loans to payback considerations).

The outcomes of this assessment will be developed to support the comparison of the Proposed Title XVI project to other projects being considered by SFPUC as part of the Alternative Water Supply Program. It is likely that a more comprehensive financial plan will be developed as part of the broader effort to identify the overall range of increases the RWS customers may expect to see to create a more resilient system through multiple projects.

9.4 Federal and Non-Federal Funding and Restrictions

Description of all federal and non-federal sources of funding and any restrictions on such sources. For example, minimum or maximum cost-share limitations. Generally, for Title XVI authorized projects, the federal cost share is limited to 25 percent, or $30,000,000, whichever is less.

Sponsors of water recycling projects authorized under the Water Infrastructure Improvements for the Nation (WIIN) Act and/or that have submitted a Title XVI Feasibility study for Reclamation review by the date of a Notice of Funding Opportunity (NOFO) is posted and found to meet all requirements of WTR 11-01 no later than the defined NOFO date would be eligible for WaterSMART: Title XVI WIIN Water Reclamation and Reuse Program funding. If Title XVI funding is available and authorized; the Project could seek up to $30 million in federal funding, or possibly more depending on the scale of the project and available funding in a given year. The remaining non-federal match would be derived from a combination of local contributions, state and local grants, state, or federal loans, and/or municipal bonds.

Non-federal government entities often work with the private sector, in quasi Private-Public-Partnerships, to assess, plan, and develop water reuse infrastructure needed to meet local water supply needs. There are current efforts being conducted to support the White House Public/Private Partnership Initiative to modernize U.S. infrastructure by removing impediments to infrastructure development and facilitating private sector efforts to construct infrastructure projects serving American needs. In this case, the potential inclusion of CalWater, a private entity, as part of the project sponsor team may add complexities to identifying funding restrictions, which would require future definition before any contract is defined. A future detailed analysis would be conducted to delineate costs to and benefits received by each public and private partner, such that the funding contract would be executed in accordance with Title XVI and other applicable laws.

The project sponsor would evaluate available funding options at the appropriate time when project costs and agreements are further refined, and the Title XVI Project is closer to construction. It is possible that construction funding may be influenced by project phasing, where separate application could be submitted for Phase 1 and 2 construction activities.

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SECTION 10: Research Needs

At a minimum, the report must include a statement on whether the proposed water reclamation and reuse project includes basic research needs, and the extent that the Proposed Title XVI Project will use proven technologies and conventional system components. The following information is required only if further research is necessary to implement the Proposed Title XVI Project.

The Proposed Title XVI Project will use a combination of proven technologies and conventional system components along with the potential to explore innovative areas of research. The AWPF will rely on proven advanced treatment processes to meet regulatory requirements for ResWA and TWA (once finalized). Conveyance of flows to and from the AWPF will consist of conventional conveyance components (e.g., pipelines and pump stations) implemented via industry standard design and construction practices.

As discussed in Section 9.1, there are a number of additional studies that would be warranted to take the next steps to demonstrating the ability to meet ResWA/TWA regulations, evaluate pipeline alignments and facility siting, explore treatment options for purification and nutrient removal, and initiate outreach to the community to gain social acceptance for potable reuse.

This section focuses on considerations for the next steps to further explore opportunities to enhance the Proposed Title XVI Project through research and provides a brief description of the following:

1. Research Needs and Objectives
2. Reclamation's Participation
3. Researchers
4. Research Timeframe

10.1 Research Needs and Objectives

Description of research needs associated with the proposed water reclamation and reuse project, including the objectives to be accomplished through research.

Basic research needs include but are not limited to the following topic areas:

- **Reservoir Research Studies at CSR** to assess potential water quality impacts, or benefits, from the addition of purified water. Activities could include water quality sampling and development or use of a reservoir mixing model to answer questions related to reservoir water surface elevations and quality, impacts on vegetation and fisheries and approaches to reservoir operations to minimize risks.

- **Bench Scale Testing to Evaluate Breakpoint Chlorination** at Pulgas Facilities to assess the ability to remove ammonia in the purified water stream, reducing potential to stimulate algae growth and adversely impact water quality in CSR. Activities could include bench and potentially pilot-scale testing is needed at SFPUC's Westside Recycled Water Treatment Facility (RWTF), where start-up of an AWPF is currently underway using similar treatment and wastewater ammonia concentrations. A scope of work for this effort has been submitted to SFPUC.
- **Pilot and/or Demonstration Facility** to support ResWA and TWA treatment concepts through piloting treatment process technologies to demonstrate strategies for compliance and verify treatment process performance. This may be done in phases to support ResWA and TWA and would also be a tool to support public outreach and provide training for treatment plant operators.

The scope of these areas of research will be further defined as part of discussions with regulators and recommendations by the IAP. Research areas related to TWA may not be initiated until Phase 1 activities are underway.

10.2 Reclamation's Participation

Description of the basis for reclamation participation in the identified research.

Reservoir research studies through sampling and modeling could offer innovative approaches to addressing technical issues that Reclamation water and power managers, customers, and stakeholders experience across the country. Research studies at CSR could potentially be eligible for funding through Reclamation's Science and Technology (S&T) Program Research Project areas for developing water supplies, environmental issues in deliver and management and water operations.

Bench scale testing to evaluate breakpoint chlorination could support Reclamation's Desalination and Water Purification (DWPR) Program, which seeks to explore purification technologies to develop water supplies from otherwise unusable sources. Demonstrating the ability of breakpoint chlorination on purified water to sufficiently reduce nutrient concentrations would be instrumental in providing potable reuse projects alternatives to costly and space intensive nitrification/denitrification facilities to meet regulatory requirement. Reclamation's WaterSMART Title XVI Water Reclamation and Reuse Program Research Studies could be another potential funding source for this effort.

Pilot and/or Demonstration Facility planning, design, construction and operation provides an opportunity to test equipment, train operators and support public outreach for purified water projects. A pilot facility could be funded under Reclamation's WaterSMART Title XVI Water Reclamation and Reuse Program Research Studies, as this activity would clearly offer opportunities to streamline the implementation of clean water technology at new facilities. The available funding potential currently varies by funding group (I, II or III) and a cost share of 75% is currently required. The availability and max potential funding would be confirmed as the pilot facility strategy develops.

The PREP Parties will coordinate with Reclamation as these, and other research opportunities, materialize to identify opportunities for funding and collaboration through Reclamation participation.

10.3 Researchers

Identification of the parties who will administer and conduct necessary research.

It is assumed that the project sponsor and/or facility owner would administer and lead the research studies teaming with recognized local and national academic and consulting experts in the field of potable reuse. The project sponsor would likely engage local regulatory agencies to share findings and facilitate permitting.

10.4 Research Timeframe

Identification of the timeframe necessary for completion of necessary research.

The research studies would be conducted prior to design and construction of the Proposed Title XVI Project and research efforts could be independently developed to support Phase 1 ResWA and Phase 2 TWDA. As illustrated in Figure 9-1, it is assumed that piloting and research would take place between 2024 and 2026, prior to the initiation of Phase 1 ResWA design activities. Reservoir modeling and water quality studies could take place as part of the environmental, permitting, regulatory and IAP activities and input, starting as early as 2023, once the BODR is complete. Additional research areas may be identified to support the Phase 2 TWA activities based on the finalized DPR regulations and the implementation of Phase 1.

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Prepared for:

July 2022

Potable Reuse Exploratory Plan (PREP) Title XVI Feasibility Study

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APPENDIX A: Climate Change Considerations

Intensified effects of climate change are becoming evident through California as the State has been experiencing consecutive years of drought and consistent higher-than-average temperatures. These dramatic climate shifts are stressing water reservoirs and changing demands for residential, agricultural, and commercial water use. The lowest water storage levels have been recorded through the State, and reduced river and stream flows is harming water quality and threatening aquatic life. These factors are now being considered in urban water management planning for water districts in Northern California. As a component of this, several efforts are in the works to identify and assess the risks of climate change and water shortages, and to plan out solutions to avoid considerable damage to water systems, human life, and the economy.

Climate change and other changing conditions may jeopardize the future ability of the Regional Water Service (RWS) to meet the SFPUC's desired level of service. The most significant water supply vulnerability right now is due to new flow requirements on the Tuolumne River through the State Water Resources Control Board (State Board) adopted amendments to the Bay Delta Water Quality Control Plan.

A.1 California Governor's 2021 Proclamation

The western United States is potentially facing its third consecutive year of drought, with California experiencing its worst drought since the late 1800s, measured by both lack of precipitation and high temperatures. Serving as the end of the 2021 water year, the second driest water year on record, the month of August was the driest and hottest on record. These extremes have increased water loss from reservoirs and streams due to increased demands by communities and agriculture. In response to these drought conditions and the record low water storage in California, Governor Gavin Newsom issued a proclamation on October 19, 2021, to extend the drought emergency statewide and urge Californians to step up water conservation efforts. The proclamation enables the State Water Resources Control Board to ban wasteful water practices, including the use of potable water for washing sidewalks and driveways. The Governor had previously proclaimed a state of emergency in several counties due to severe drought conditions, but this proclamation extended the state of emergency to eight additional counties. As part of the proclamation, all local water suppliers are required to implement water shortage contingency plans in response to local conditions and prepare for a potential third dry year. Newson also reinforced the importance of Californians voluntarily reducing their water use by 15 percent from their 2020 levels by implementing water-saving measures from his July 2021 Executive Order.

A.1.1 Recent Drought Actions

Urban Water Management Plans (UWMPs) are prepared by urban water suppliers every five years to support the suppliers' long-term resource planning to ensure that adequate water supplies are available to meet existing and future water needs. Under the California Water Code Section 10632, every urban water supplier was required to prepare and adopt a Water Shortage Contingency Plans (WSCP) to ensure that water suppliers have the resources and management responses prepared to protect health and human safety, minimize economic disruptions, and preserve environmental and community assets during times of water supply shortages. The WSCPs outline responses and actions to take at distinct levels of water shortage, which include actions to take at distinct stages of a drought.

The SFPUC provides a water supply condition update every two weeks to assess the RWS, which is ultimately used to declare if there is water shortage on an annual basis. Depending on the level of the shortage, SFPUC may adopt a resolution declaring a water shortage emergency under the California Water Code, or lesser actions such as voluntary conservation efforts. To determine how to allocate RWS supplies in the event of a water shortage condition, SFPUC utilizes the Water Shortage Allocation Plan (WSAP) to define how RWS supplies will be split between the SFPUC's retail customers and the Wholesale Customers collectively, and the Retail Water Shortage Allocation Plan (RWSAP) to define how a retail water shortage will be allocated amongst retail customers.

BAWSCA does not prepare its own UWMP nor WSCP, but the agency does provide additional resources, rebates, and programs to target water conservation and drought preparedness in the area. Each BAWSCA member has their own WSCP to be engaged in the case of a water shortage event, defining specific policies and actions to be implemented at different shortage level tiers. The WSCPs also identify mitigation measures to implement at different levels of water shortage, and outlines procedures to assess the likelihood of a water shortage occur in the coming year. Many of the water supply management efforts focus on the reduction of non-essential water uses such as landscape irrigation to prioritize health, safety, welfare, and the economy of its customers.

A.1.2 Climate Change Studies

Climate change has increasingly become a crucial factor in water resource planning throughout the State and is a major consideration in urban water management planning. Rising global temperatures have created changes in climate patterns and California's climate change projections indicate a further intensification of wet and dry extremes and shifting temperatures across the state which will impact water supplies, storage and demands. Extreme and higher average temperatures, and intensified drought conditions may lead to:

- Increase in water demand for agriculture and residential uses;
- Reductions in the average Sierra Nevada annual snowpack, and a shift in snowmelt runoff to earlier in the year which would change stream flows and reservoir operations;
- Less available surface water may exacerbate ongoing stress in groundwater basins;
- Long-term changes in watershed vegetation and increased incidence of wildfires;
- Sea level rise and an increase in saltwater intrusion; and
- Increased water temperatures with accompanying adverse effects on fishers and water quality.

All these potential changes pose a threat to water security, and because of this, recycled water has recently been given a major push. Recycled water is a local, drought resistant supply and a renewable resource, unlike traditional water sources. Recycled water is used and produced in a closed loop, so it is not significantly impacted by precipitation or hydrologic year type, and its widespread use will help to build climate change resiliency throughout water districts.

SFPUC Long Term Vulnerability Assessment

SFPUC evaluates the effects of climate change on an ongoing basis, updating its assessments to reflect improvements in climate science, atmospheric/ocean modeling, and human response to the threat of greenhouse gas emissions. A current project being undertaken by the SFPUC is a Long Term Vulnerability Assessment, which is a comprehensive study of the potential effects of climate change on water supply. The effort will provide the information needed for future urban water management planning by conducting a comprehensive vulnerability assessment of climate and other drivers for change and will produce an adaptation planning process. The project aims to identify vulnerabilities through an evaluation of uncertainty ranges of future conditions, and then assess the associated risks by integrating the best available climate information (e.g., a range of different probable increases in temperature and changes in precipitation between 2020 to 2070). Future phases of the project will develop and evaluate an adaption plan with a range of solutions that are flexible to changing available data and projections.

Cal Water Climate Change Study

Cal Water is also committed to incorporating climate change into its ongoing water supply planning and is currently in the process of developing a multi-phase climate change study. Phase 1 included a literature and tools review of previous studies, Phase 2 (in progress) includes District-level vulnerability assessments of its facilities and operations to evaluate climate impacts to Cal Water and Phase 3 (final phase) will focus on a review of climate-driven impacts to water supply resources and demand. Cal Water is actively working to further quantify and consider future climate change impacts as part of its Cal Water’s ongoing supply and operations planning.

Bay Area Integrated Regional Water Management Plan

Both the SFPUC and BAWSCA participated in the 2020 update of the Bay Area Integrated Regional Water Management Plan, which identifies several potential climate change vulnerabilities of the region's water resources, asses their risk, and describes climate change adaptation strategies.

A.1.3 Bay-Delta Plan Amendment

As climate changes, the need to balance municipal, agricultural and ecosystem demands in river and surface water systems will be more critical than ever. The State Water Resource Control Board (Water Board) is responsible for adopting and updating the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). Phase 4 of the Comprehensive Plan establishes water quality control measures and develops flow objectives for the major tributaries of the Sacramento-San Joaquin River Delta. These objectives will have regulatory effect and will be developed with the intention of protecting the beneficial uses of the resource in the watershed including agriculture, municipal, and hydropower applications. The objectives are also a part of the Water Board's urgent efforts to address the decline of native aquatic species and protect their ecosystem within the Bay-Delta. Ongoing drought and water pumping has led to declining water levels throughout the tributaries and a change in water quality.

Each major tributary of the River Delta will have its own unique set of flow objectives, tailored to the unique hydraulic and geomorphic characteristics of the tributary, and uses of the water. The development of flow objectives will be informed by flow criteria that consider the needs of each watershed's organisms, emphasizing the protection of threatened and endangered species. The flow objectives will be paired with an implementation plan that includes an adaptive management component to establish a flexible framework to accommodate data from new studies, changes to the watershed, a shift in stakeholder agreements, and climate change. The Water Board intends to develop the flow criteria, flow objectives, and associated implementation plans for a minimum of five priority tributaries by 2025, and for the remaining tributaries thereafter.

SFPUC is in discussions with the Water Board on potential instream flow requirements for the Tuolumne River as part of the Bay Delta Plan Amendment. SFPUC's 2020 UWMP indicates that they are modeling the anticipated new flow standard, which would require a release of release is 40 percent of unimpaired flow (also referred to as the Bay Delta 40 instream flow requirements). If the Bay-Delta Plan Amendment is implemented, the SFPUC would be able to meet the projected water demands presented in this UWMP in normal years but would experience supply shortages in single dry years or multiple dry years. Implementation of the Bay-Delta Plan Amendment would require rationing in all single dry years and multiple dry years. Implementation of the Bay-Delta Plan Amendment is, however, uncertain due to pending litigation, water rights and institutional obstacles. SFPUC's 2020 UWMP therefore looked at two future supply scenarios, both with and without implementation of the Bay-Delta Plan Amendment (SFPUC 2021).

Of relevance for PREP Phase 3 Study is that implementation of a potable reuse project would help to supplement supplies needed in single or multiple dry years.

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APPENDIX B: Permitting and Regulatory Requirements

This section discusses regulations and treatment requirements for recycled water use to protect public health and the environment, providing an overview of the different types of reuse, detailing current and anticipated requirements regulations for ResWA, RWA and TWA and providing an overview of SF Bay Basin Plan and discharge requirements.

B.1 Reservoir Water Augmentation (ResWA) Regulations

In the state of California, a reservoir water augmentation project is defined as a project that plans to use purified recycled water from a municipal wastewater facility for augmenting a reservoir that is designated as a source of domestic water supply, commonly known as DPR. The (California) State Board was charge with proposing DPR regulations, discussed above, and in partnership with an expert panel, set forth the following proposed requirements:

1) An initial minimum theoretical retention time of no less than 180 days (calculated as total monthly volume divided by total monthly outflow); however, an alternative minimum theoretical retention time of no less than 60 days may be considered for approval.
2) A dilution requirement in the reservoir of 100:1 (one percent by volume), or 10:1 (ten percent by volume) with an additional 1-log microbial pathogen treatment, to demonstrate the percent of recycled water withdrawn from the reservoir, by volume, during any 24-hour period.
3) The expert panel charged with ensuring the State Board's proposed DPR regulations are protective of public health, have mandated that for all DPR treatment technologies, Ozone BAC go before reverse osmosis.

Unique to the State of California an "alternatives clause," similar to the groundwater augmentation regulations. The intent of an "alternatives clause" is to provide adaptability to offer alternative permitting pathways for innovative projects that build off the expanding knowledge base (Trussell 2016). Alternative approaches could apply to the treatment train, monitoring plan, or approaches used to demonstrate meeting minimum retention time (as noted in item 1 above). The Final ResWA Regulations include language that allows for alternative approaches if it can be demonstrated to the State Board that the proposed alternative provides equivalent or better performance. Written approval from the State Board would be requested prior to implementation, and in some cases a public hearing may be required.

In addition, the Final ResWA Regulations establish requirements for:

- Recycled water source control
- Treatment and pathogen removal
- Demonstration testing
- Operations and maintenance
- Effluent and process monitoring and reporting
- Reliability and redundancy
- Identification and responses to failure events
- Reservoir dilution, retention, tracer studies, and monitoring
- Public comment and notification

A ResWA project would likely be implemented within two key permits:

- State Board Division of Drinking Water (SBDDW) drinking water supply permit
- NPDES permit issued by the RWQCBon behalf of the U.S. Environmental Protection Agency (EPA)

Current SBDDW drinking water supply permits specify applicable state and federal drinking water requirements and establish conditions under which a water supplier acquires, stores, treats, monitors, and distributes to a drinking water supply to the public. Modification of the drinking water supply permit would be required as part of implementing a ResWA project.

The RWQCB regulates discharges of recycled water to surface waters on behalf of the EPA through the issuance of NPDES permits. NPDES permits implement applicable state and federal water quality standards, policies, provisions, and prohibitions. NPDES permits would also incorporate applicable SBDDW recycled water and ResWA requirements.

B.2 ResWA Treatment Requirements

The treatment requirements for ResWA require recycled water to be treated by full advanced treatment (e.g., reverse osmosis [RO] and an advanced oxidation process [AOP]) prior to delivery to a reservoir. The treatment train must achieve a minimum of 8/7/8 microbial log-removal for virus, *Giardia*, and *Cryptosporidium* (V/G/C), with at least two separate treatment processes credited with no less than 1.0-log removal, and no separate treatment process credited with more than 6-log removal. The ResWA Regulations require that any 24-hour input of recycled water into a reservoir must be mixed such that water withdrawn for use as drinking water never contains more than 1 percent recycled water.

For those projects where recycled water delivered to a reservoir during any 24-hour period makes up 10 percent of water withdrawn for use as drinking water, the recycled water treatment train must achieve an additional 1-log removal (i.e., 9/8/9) with at least three separate treatment processes credited with no less than 1.0-log removal. In addition, although alternative minimum reservoir retention times as low as 60 days may be considered, ResWA projects with minimum retention times of less than 120 days must provide an additional 1-log treatment. The ResWA criteria and treatment requirements are summarized in Table B-1.

Table B-1: ResWA Criteria and Treatment Requirements

Retention Time (days)[1]	Dilution (Volume:Inflow$_{day}$)[2]	Log Removal at AWPF (V/G/C)[3]	# of Treatment Processes
$\geq$ 120	100:1	8/7/8	2
	10:1	9/8/9	3
$\geq$ 60	100:1	$\geq$ 9/8/9	2

[1] Retention time is calculated as total volume divided by total outflow

[2] Dilution of 100:1 = one percent, by volume, of purified water delivered to the surface water reservoir during any 24-hour period. Dilution of 10:1 = ten percent, by volume, of purified water delivered to the surface water reservoir during any 24-hour period

[3] Log reduction credits at a drinking water treatment plant (4/3/2 V/G/C) were previously included in the total log removal values (LRV) requirement in prior versions of the Draft ResWA Regulations but are not included in the Final ResWA Regulations.

Anticipated pathogen removal credits for treatment train processes are discussed in Appendix C. The ultimate inactivation credit achieved may be based on site-specific performance and/or a negotiated validation approach with SBDDW on a case-by-case basis. For example, the tertiary treatment process prior to the Advanced Water Purification Facility (AWPF) may receive additional inactivation credits for V/G/C and multiple disinfection processes, such as ozone and free chlorine in addition to UV-AOP, could provide for an additional 4 to 6 virus inactivation credits, respectively. Critical control points identified between individual treatment processes can provide both process control and be used to establish log reduction credits (WateReuse 2016). A proposed treatment train for ResWA is also presented in Appendix C.

B.3 Raw Water and Treated Water Augmentation Regulations

The draft Direct Potable Reuse (DPR) regulations currently impose the same requirements for both RWA and TWA projects. According to DDW, this is primarily because RWA is defined as "the planned placement of recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant." Under this definition, RWA could potentially refer to the introduction of recycled water into a system that does not have a Surface Water Treatment Plant (SWTP) and does not confer the benefits of a SWTP. For example, a drinking water system that only has chlorination or disinfection, does not have to go through a conventional SWTP process which provides additional public health protection. In addition, not all water treatment systems have sources of raw water that that are available for blending to the dilute the potential wastewater contaminants from recycled water. Hence, DDW has currently chosen to regulate both raw water augmentation and TWA under one comprehensive DPR regulation.

The draft DPR regulations require the designation of one direct potable reuse responsible agency (DiPRRA) that will be responsible for complying with the DPR regulations. The DiPRRA is required to be a public water system that is responsible for using the DPR water. Responsibilities for the DiPRRA include:

- Demonstrating that all treatment processes are designed, installed, and operated in compliance with the DPR regulations and an approved Operations Plan,
- Compliance with the California Waterworks Standards, Title 22, Division 4, Chapter 16,
- Subjecting its facilities and operations to an annual inspect to evaluate its
    - Source(s) and treatment
    - Cross-connection control program
    - Enhanced source control program
    - Technical, managerial, and financial capacity and that of its partner agencies
    - Operations Plan, Monitoring Plan and Water Safety Plans

The draft DPR criteria are currently being reviewing by the DPR expert panel and the final recommendations are expected to be released in December 2023.

B.4 Treatment Requirements for RWA and TWA

The draft DPR criteria currently include a minimum microbial log removal value (LRV) requirement of 20/14/15 for virus, *Giardia*, and *Cryptosporidium* (V/G/C), which must be achieved using multiple treatment processes, providing multi-barrier protection. Other criteria and considerations include:

- Need for at least four (4) separate treatment processes credited with no less than 1.0-log removal for each pathogen. Treatment processes with less than 1.0-log removal will be allowed; but no separate treatment process credited with more than 6-log removal would be allowed to promote multiple barriers of treatment.
- Treatment train is required to have at least three (3) diverse treatment mechanisms that have been demonstrated to be effective for IPR including UV disinfection, physical separation, and chemical disinfection.
- Inclusion of an ozone / biological activated carbon (BAC) process, a reverse osmosis process and an advanced oxidation process, in that specific treatment sequence. However, if there is sufficient blending of wastewater with other water (e.g., potable water or raw water) to dilute wastewater contaminants, ozone/BAC may not be required.
- Similar to the final Reservoir Water Augmentation and Groundwater Augmentation regulations, the draft DPR criteria includes an alternative clause that allows for an alternative to these stipulated treatment requirements.
- A SWTP log reduction credit and blending ratio credit may be allowed to capture the benefits provided by systems that have these additional protections.

The draft DPR pathogen control treatment requirements are summarized in Table B-2.

Table B-2: Summary of Draft DPR Pathogen Control Treatment Requirements

Sum of LRVs for DPR Treatment Train at AWPF (V/G/C)	Minimum # of Treatment Processes with >1 log-removal	Minimum # of Diverse Treatment Processes[1]	Minimum Typical Treatment Train Requirements
20/14/15	4	3	• Ozone/BAC • RO • UV-AOP

[1] Includes: UV disinfection, physical separation, chemical disinfection

As previously discussed for ResWA, the ultimate inactivation credit achieved for each treatment process may be based on site-specific performance and/or a negotiated validation approach with DDW on a case-by-case basis.

In addition to the treatment requirements for DPR regulations, drinking water distribution system requirements will also need to be met. Currently, there are no federal regulations directly addressing potable water reuse, which is why the State Board has mandated all generally applicable Safe Drinking Water Act (SDWA), Clean Water Act (CWA) and other state regulations specific to water reuse are met. Some of the SDWA aspects that are applicable to the PREP Parties projects that may apply include, but are not limited to:

- **Lead and Copper Rule** – to demonstrate optimized corrosion control, appropriate water quality parameter monitoring and adherence to action levels
- **Total Coliform Rule** – to control bacterial growth through monitoring, investigation, and notifications
- **Surface Water Treatment Rules** – to maintain disinfectant residuals through monitoring, investigation, and notifications
- **Disinfectants/Disinfection Byproduct (DBP) Rules** – to control DBP formation, identify potential hot spots, implement monitoring plans and treatment techniques for disinfection byproduct precursors control (e.g., TOC reduction requirements)
- **Other regulations governing distribution systems** – including California Waterworks Standards for materials, installation, separation requirements, meters, flushing, isolation/release valves and other requirements and Water System Operations and Maintenance Plan requirements, if directed by DDW.

The DiPRRA is required to work collaboratively with the public water system receiving purified water to jointly address potential impacts resulting from the introduction of advanced treated water into a water treatment plant and/or introduction of finished water into a drinking water distribution system and submit necessary plans and reports.

B.5 Bay Discharge Requirements

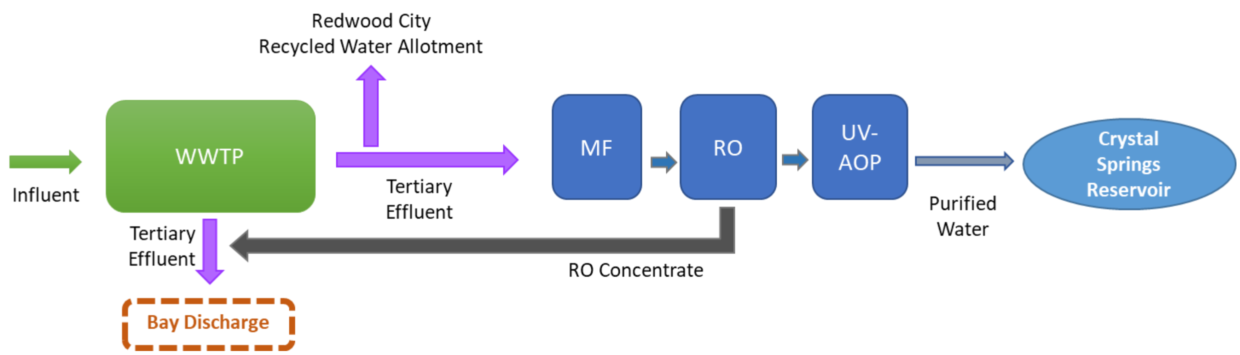
Discharge of treated wastewater from SVCW's outfall is regulated under three (3) Waste Discharge Requirements (WDRs) / National Pollutant Discharge Elimination System (NPDES) permits, as summarized in Table B-3, and illustrated in Figure B-1.

These permits establish requirements for the overall water quality-based effluent limitations, mercury and polychlorinated biphenyls limitations, and nutrients monitoring requirements, respectively. With an AWPF, the combined effluent discharged from SVCW's outfall will consist of the RO concentrate from the AWPF blended with the remaining effluent. This combined effluent will need to meet the requirements described in the WDR/NPDES permits.

Table B-3: Summary of Existing and Future Regulations at SVCW Outfall to SF Bay

Permit	Permit Type	Key Relevant Items
SVCW WDR **ORDER No. R2-2018-0005** **NPDES No. CA0038369**	**Individual**	**Dry Season (May 1 to Sept 30) Effluent Limits**
WDR for Mercury and PCBs **ORDER No. R2-2017-0041** **NPDES No. CA0038849**	**SF Bay Watershed**	**Year-Round Effluent Limits** Average annual – by mass Monthly and weekly – by concentration
WDR for Nutrients **ORDER No. R2-2014-0014** **NPDES No. CA0038873**	**SF Bay Watershed**	**Focus on Nutrients** 2014 – 2018: Concentration and load monitoring 2019 – 2024: Load targets 2025 onwards: Potential load caps

Figure B-1: Flow Diagram Highlighting Bay Discharge Contributions



B.5.1 Existing SVCW NPDES Permit

This individual NPDES permit is specific to SVCW and includes effluent limitations, discharge specifications, and monitoring requirements. Effluent limitations include monthly, weekly, daily, and instantaneous limits on CBOD, total suspended solids (TSS), turbidity, total chlorine residual, ammonia, and whole effluent acute toxicity, as shown in Table B-4. In general, the dry season limits are more stringent than the wet season limits. Receiving water limitations include limits on floating material, temperature changes, and suspended material or coloration that cause a nuisance. These limits are generally developed based on the Water Quality Control Plan for the San Francisco Bay Basin (SF Bay Basin Plan). Monitoring of constituents at one influent location, three effluent locations, and one biosolids location is also described in this NPDES permit.

Table B-4: Summary of SVCW Dry Season Effluent Limitations

Parameter	Units	Average Monthly	Average Weekly	Max Daily	Inst. Min	Inst. Max
$CBOD_5$	mg/L	8	12	-	-	-
TSS	mg/L	8	12	-	-	-
Oil and Grease	mg/L	10	-	20	-	-
pH	s.u.[1]	-	-	-	6	9
Turbidity	NTU	10	-	20	-	-
Chlorine, Total Residual	mg/L	-	-	-	-	0
Ammonia, Total	mg/L as N	170	-	250	-	-
Copper, Total Recoverable	µg/L	52	-	84	-	-
Cyanide, Total	µg/L	21	-	36	-	-

Notes:
1. s.u. = standard units.

B.5.2 Existing San Mateo NPDES Permit

The City of San Mateo Wastewater Treatment Plant also has an individual WDR permit (Order No. R2-2018-0016, NPDES No. CA0037541), which defines effluent limitations, monitoring requirements as well as additional qualitative limitations on receiving water (San Francisco Bay). Effluent limitations include monthly and weekly limits on CBOD and TSS for wet and dry seasons, and year-round limits on oil and grease, pH, total chlorine residual, total ammonia, copper, cyanide, nickel, and dioxins, as shown in Table B-5. Receiving water limitations include limits on floating material, turbidity, temperature changes, suspended materials, and coloration. These limits are also generally developed based on the Water Quality Control Plan for the SF Bay Basin Plan. The permit also outlines monitoring requirements for one influent location, two effluent locations and one biosolids location.

For this study, the ability to meet the more stringent dry season effluent limitations is evaluated. Compliance with other limitations and discharge specification will be assessed during future phases.

Table B-5: Summary of San Mateo Dry Season Effluent Limitations

Parameter	Units	Average Monthly	Average Weekly	Max Daily	Inst. Min	Inst. Max
$CBOD_5$	mg/L	15	25	-	-	-
TSS	mg/L	20	30	-	-	-
Oil and Grease[2]	mg/L	10	-	20	-	-
pH[2]	s.u.[1]	-	-	-	6	9
Chlorine, Total Residual[2]	mg/L	-	-	-	-	0
Ammonia, Total[2]	mg/L as N	66	-	120	-	-
Copper, Total[2]	µg/L	51	-	72	-	-
Cyanide, Total[2]	µg/L	20	-	38	-	-
Dioxin-TEQ[2]	µg/L	1.4×10^{-8}	-	2.8×10^{-8}	-	-
Nickel, Total[2]	µg/L	30	-	71	-	-

Notes:

1 s.u. = standard units.

2 Effluent limitations are applicable year-round.

B.5.3 Existing Mercury and PCBs NPDES Permit

This order specifies the waste load allocations and implementation requirements of the SF Bay mercury and PCBs Total Maximum Daily Load (TMDL) adopted in 2006 and 2008, respectively. This watershed permit applies to both municipal wastewater and industrial wastewater discharges to SF Bay. It requires them to monitor discharges for mercury and PCBs and comply with concentration and mass loading limits. Compliance with this NPDES permit would need to be assessed during future phases.

B.5.4 Existing and Future Nutrients NPDES Permit

The nutrient permit is another region-wide SF Bay watershed permit applicable to discharges to SF Bay. This permit addresses municipal wastewater discharges of nutrients, such as nitrogen and phosphorus, into the SF Bay. Similar to the Mercury and PCBs watershed NPDES permit, the nutrient watershed permit complements SVCW's individual NPDES permit and stipulates additional requirements that relate to nutrients. The first nutrient watershed permit, the 2014 nutrient permit, did not include water quality-based limits for nutrients since the Water Board determined that there was insufficient evidence to conclude that nutrients contribute to bio-stimulation in the SF Bay. Effluent limitations for ammonia continue to be specified in individual WWTP NPDES permits.

The new 2019 nutrient watershed permit, effective on May 8, 2019, and effective on July 1, 2019, similarly does not specify effluent limitations for nutrients. This 2019 permit includes effluent monitoring requirements for ammonia, nitrate-nitrite, total inorganic nitrogen, and total phosphorus.

While the 2019 nutrient watershed permit does not include effluent limitations, it includes 2024 load targets for inorganic nitrogen for each discharger. Since the growth-limiting nutrient for phytoplankton in the SF bay is nitrogen, only inorganic nitrogen load targets are included; there are no phosphorus load targets. The 2024 load targets are based on the historical 2014 – 2017 maximum dry season average loads, escalated to include a 15 percent population growth buffer. It is anticipated that these load targets will turn into load caps during the 2024 permit cycle. It is also anticipated that the load caps will be implemented on a sub-embayment basis, with the potential for nutrient credit trading to meet compliance. In the meantime, municipal wastewater discharges described in the permit have and will continue to fund scientific studies to determine what nutrient load reductions are necessary to protect the SF Bay. A summary of SVCW's nutrient loads are shown in Table B-6.

Table B-6: Summary of SVCW Nutrient Load Targets

Parameter	Inorganic Nitrogen
2014 – 2017 Max Dry Season Average Load	2,500 kg/day
2024 Dry Season Average Load Target	2,900 kg/day

*Dry Season = May 1 – Sept 30
Source: Table F-5 of San Francisco Bay Nutrient Watershed Permit, R2-2019-0017

It should be noted that these load targets and load caps are mass-based and not concentration-based. Thus, the RO concentrate from an AWPF would not negatively impact compliance with a potential new effluent nutrient limit that is load based. On the other hand, unlike a tertiary effluent recycled water project that removes nutrients from the discharge to SF Bay by allowing beneficial reuse, a potable reuse project that uses RO conveys the nutrients in the form of the RO concentrate back to the outfall and will not reduce the overall nutrient loading to the SF Bay. However, toxicity in RO concentrate is a key parameter that would warrant additional evaluation in future studies, particularly during summer months when the RO concentrate dominates the outfall discharge flow.

B.6 CSR Augmentation Regulatory Considerations

Any augmentation of CSR would not only need to comply with ResWA requirements but would also need to meet local SF Bay Basin Plan requirements. In addition, the background water quality concentrations of the receiving water should also be considered. Regulations and water quality considerations related to augmenting CSR with purified water are summarized in Table B-7 and illustrated in Figure B-2. Ammonia limits are controlled by the SF Bay Basin Plan regulations, which have more stringent water quality limits as compared to the background concentrations in CSR. Phosphorus limits are controlled by background CSR concentrations since there are no Basin Plan limits, but anti-degradation provisions apply.

The following sections discuss these requirements and considerations in more detail.

Table B-7: Summary of Regulations and Water Quality Considerations for Augmentation of CSR

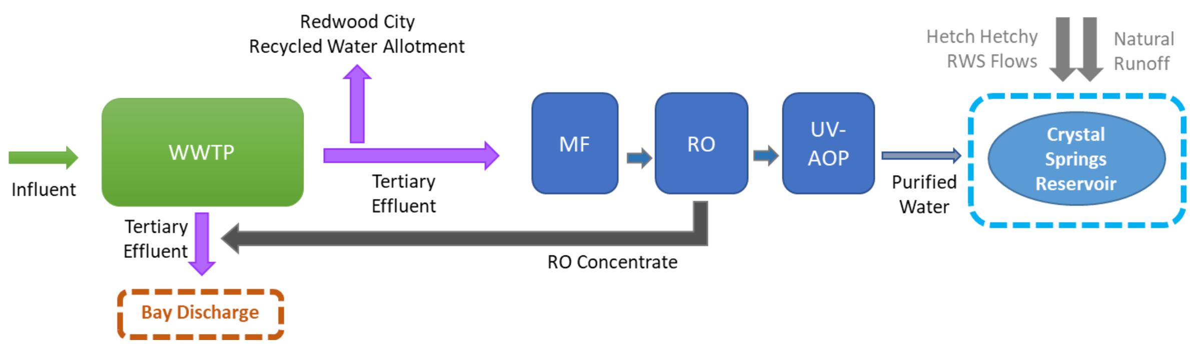
Regulation / Permit	Key Relevant Items
ResWA Requirements	*Discussed in Section 4.2*

SF Bay Basin Plan	**Specific quantitative limits**
	▪ Un-ionized Ammonia
	    ▪ Annual median= 0.025 mg/L as N
	    ▪ Maximum = 0.4 mg/L as N
	    ▪ Dissolved Oxygen – 7.0 mg/L for cold water habitats
	▪ **General qualitative limits**
	    ▪ E.g., bioaccumulation, biostimulatory substances, population, and community ecology etc.
	▪ *There are currently no limits for phosphorus*

CSR Background Water Quality Considerations[1]	**Existing Conditions** ▪ Ammonia = 0.0 – 0.3 mg/L as N (0.01 – 0.28 in Upper CSR and 0.0 – 0.3 in Lower CSR) ▪ Total Phosphorus = 0.03 – 0.4 mg/L (0.03 – 0.3 mg/L in Upper CSR and 0.1 to 0.4 mg/L in Lower CSR)

[1] Sources: SFPUC 2020 Watershed Sanitary Survey Update for the Peninsula Watershed (Stantec 2021) for Lower CSR data. Upper CSR data from Phase 2.

Figure B-2: Flow Diagram Highlighting CSR Augmentation Contributions



B.6.1 SF Bay Basin Plan Requirements

The SF Bay Basin Plan includes specific quantitative and general qualitative limits related to the discharge of water into CSR; these limits will be implemented through the permit process. CSR is part of the South Bay Basin. Relevant quantitative limits include limits on un-ionized ammonia and dissolved oxygen; there are no quantitative limits for phosphorus. Qualitative limits include limits on bioaccumulation, biostimulatory substances, population, and community ecology, etc. Purified water that is added to CSR will have to meet these regulatory limits.

B.6.2 CSR Background Water Quality Considerations

Phosphorus limits are controlled by background CSR concentrations since there are no SF Bay Basin Plan limits, but antidegradation provisions apply. Some of the background water quality parameters that could be potentially impact CSR include ammonia and phosphorus. Increasing nitrogen loads in CSR could potentially increase risk of algal blooms, which in turn raises the risk of cyanotoxins, and/or taste and odor compounds, occurring in the reservoir during the summer months. Since there are no phosphorus limits in the SF Bay Basin Plan, background phosphorus levels in CSR would form the basis for purified water quality evaluation for reservoir water augmentation at CSR. At this level of planning, it would be conservative to assume that the water quality of augmented water would need to match or be compatible with the background levels.

B.7 Bear Gulch Raw Water Augmentation Regulatory Considerations

B.7.1 SF Bay Basin Plan Requirements

Similar to Crystal Springs Reservoir, the SF Bay Basin Plan includes specific quantitative and general qualitative limits related to the discharge of water into Bear Gulch Reservoir as well; these limits will be implemented through the permit process. Bear Gulch reservoir is part of the Santa Clara Basin. Similar to CSR, relevant requirements include quantitative limits on un-ionized ammonia and dissolved oxygen; there are no quantitative limits for phosphorus. Qualitative limits include limits on bioaccumulation, biostimulatory substances, population, and community ecology, etc. Purified water that is added to Bear Gulch Reservoir will have to meet these regulatory limits. If the Bear Gulch RWA project were to move forward, additional analysis would be performed to confirm regulatory and operational water quality objectives. At this level of planning, it would be conservative to assume that the water quality of augmented water would need to match or be compatible with the background levels in Bear Gulch and furthermore it is assumed that the purified water quality from the AWTP would meet the same criteria as were estimated for CSR.

B.7.2 Bear Gulch Reservoir Background Water Quality Considerations

No data on existing nutrient levels in Bear Gulch Reservoir were available at the time of this study. Historically, the reservoir has had challenges with blue green algae, which were resolved by the addition of bottom aeration in 2015. This indicates that the water body may be sensitive to nutrient loads. Without reservoir water quality data, it is not possible to determine whether purified water from SVCW and/or San Mateo WWTP would impact existing water quality. If the Bear Gulch RWA project were to move forward, additional nutrient monitoring would be performed to background water quality.

APPENDIX C: Treatment Supporting Information

The two potential sources water for the project include tertiary effluent from the SVCW facility and/or the San Mateo WWTP. These tertiary flows would serve as influent flow to a new Advanced Water Purification Facility (AWPF).

This section provides supporting information for the AWPF treatment concepts, including the AWPF treatment processes, RO concentrate disposal, nutrient removal, dechlorination/dechloramination and other water quality considerations, for the five project alternatives:

- **Alternative 1:** 6-mgd ResWA in Crystal Springs Reservoir
- **Alternative 2:** 12-mgd ResWA in Crystal Springs Reservoir
- **Alternative 3:** 6-mgd RWA in Bear Gulch Reservoir
- **Alternative 4:** 6-mgd TWA on the San Francisco Mid-Peninsula
- **Alternative 5:** 12-mgd TWA on the San Francisco Mid-Peninsula

C.1 Overview of Treatment Processes for Potable Reuse

The two potential sources of water for the project include tertiary effluent from the SVCW facility and/or the San Mateo WWTP. These tertiary flows would serve as influent flow to a new AWPF. Table C-1 summarizes treatment processes considered for potable reuse. The AWPF treatment processes assumed for implementation of each type of potable reuse to meet the regulatory requirements is detailed in the following sections.

Table C-1: Summary of Treatment Technologies

Treatment Process	Description
Tertiary Filtration	A wastewater post-treatment process that provides filtration to remove the majority of the remaining suspended solids and other pollutants using sand or media filtration.
Microfiltration (MF) or Ultrafiltration (UF)	A membrane-based, low-pressure-driven separation process that provides a barrier to the passage of solids and microorganisms. MF and/or UF does not remove salts (i.e., Total Dissolved Solids [TDS]) or other dissolved constituents like ammonia. For potable reuse applications, the primary goal of MF/UF is to provide pre-treatment for the reverse osmosis (RO) membranes, and to remove suspended particulate matter and larger microorganisms.
Membrane Bioreactors (MBR)	A MBR combines a bioreactor and microfiltration into one-unit process. The microfiltration membrane (cassette) is submerged in the bioreactor and water flows through the membrane either by vacuum or by gravity.
Reverse Osmosis (RO)	A membrane-based, high-pressure-driven separation process that provides a barrier to the passage of particles, colloids, organics, bacteria and pathogens, and the vast majority of dissolved salts. RO produces a very low-TDS product stream and a high-TDS concentrate stream. Initially, RO was considered to be completely effective at removing all pathogens and chemicals; however, with improving analytical methods, select trace organic compounds have been detected in the RO permeate. This gave rise to the required advanced oxidation process following RO (discussed below).
Chlorine-based Disinfection	The most common disinfection technology in wastewater treatment and reuse. Chlorine inactivates a diverse group of pathogens, including viruses, and residual chlorine prevents pathogen re-growth during storage and distribution. Free chlorine disinfection can be implemented to achieve virus and *Giardia* credits at multiple places in a potable reuse treatment train. Currently, California water recycling regulations do not differentiate between free and combined chlorine disinfection.
Ultraviolet (UV) Disinfection	Treatment by applying a broad spectrum of radiation with intense peaks at certain wavelengths. UV light penetrates an organism's cell walls and disrupts the cell's genetic material, making reproduction impossible. With the proper dosage, UV irradiation has proven to be an effective disinfectant for bacteria, protozoa, and virus in water, while not contributing to the formation of disinfection byproducts (DBPs).

Treatment Process	Description
UV-based Advanced Oxidation Process (AOP)	Treatment by applying light in the presence of an auxiliary oxidant that has been added to the wastewater, such as hydrogen peroxide, ozone, or chlorine. Photo-excited oxidants quickly degrade to form highly-reactive free radicals, which are strong oxidants capable of degrading most natural and synthetic organic compounds present in wastewater. The design of a UV-AOP typically requires UV doses in great excess of those needed for disinfection alone.
Ozone	To generate ozone (O_3), energy is added to oxygen (O_2), splitting the molecules into individual atoms which then collide with oxygen forming ozone. Ozone is then bubbled into water where it oxidizes compounds directly or forms hydrogen peroxyl (HO_2) and hydroxyl (OH) radicals, which oxidize certain contaminants.
Biological activated carbon (BAC)	A biologically enhanced granular activated carbon (GAC) process that removes dissolved organics through adsorption by the activated carbon and biodegradation by bacteria attached on the activated carbon. Biologically activated carbon (BAC) has not been used in a full-scale potable reuse project in California to date but is currently being pursued for the City of San Diego's ResWA project. BAC filtration is often used after ozonation.
Breakpoint Point Chlorination	Breakpoint chlorination is method to remove ammonia by adding high concentrations of chlorine to oxidize ammonia to nitrogen gas. Ratios of chlorine to ammonia to achieve breakpoint chlorination are assumed to be ~10:1.

C.2 Advanced Water Purification Facility (AWPF)

As discussed in Section 5, for potable reuse, additional treatment processes are added beyond secondary or tertiary treatment to remove dissolved solids and other contaminants. An AWPF provides the additional steps to purify recycled water. The specific combination of treatment processes needed for a given project will depend on the quality of the treated wastewater and the intended use. The following sections discuss the treatment capacity, additional treatment processes, AWPF locations, and the RO concentrate disposal considerations assumed for the PREP Phase 2 Concept Study.

C.2.1 Treatment Capacity

The available wastewater supply and seasonality of wastewater flows can limit the capacity of a recycled water project. The monthly wastewater flows at the SVCW facility generally increase during the winter wet-weather season, from December to March, and are at their lowest during summer months. Although an AWPF could be sized to treat peak winter flow, this would require an exceptionally large treatment facility with shutdown procedures for unused treatment facilities for periods when source water flows are low. Sizing to treat winter flows results in larger capital investment and a higher unit life cycle cost. Operating the AWPF at a relatively constant flow year-round is preferable to keep treatment facility costs down, simplify operations, and to maximize returns on economies of scale.

It is assumed that a potable reuse project could receive up to 8 mgd of tertiary effluent from the SVCW facility and up to 8 mgd from the City of San Mateo's future BNR/MBR facility, or a total of 16 mgd (approximately 18,000 AFY). Assuming a recovery rate of 75 percent, this would yield 12 mgd (approximately 13,500 AFY) of purified water.

C.2.2 Advanced Treatment Process for ResWA, RWA and TWA

For the alternatives evaluation, the AWPF train is assumed to consist of a low-pressure membrane (MF or UF) as pretreatment prior to the RO system. The next step would employ an advanced oxidation process (AOP), which typically combines UV treatment with the addition of an oxidant (e.g., hydrogen peroxide [H_2O_2] or ozone) to oxidize most remaining natural and synthetic organic compounds that are not removed by RO. The addition of ozone and biologically activated carbon (BAC) could be advantageous for ResWA and is anticipated to be required for a RWA or TWA project. Anticipated pathogen removal credits for treatment train processes are shown in Table C-2.

Table C-2: Summary of Potential LRCs for Unit Treatment Processes

	Virus	*Giardia*	*Cryptosporidium*
Wastewater Treatment			
Tertiary Filtration [a]	0–2	0–2.5	0–2
MBR [b]	Unknown	Unknown	Unknown
nBAF [c]	Unknown	Unknown	Unknown
Membrane Filtration [d]	0–4	4	4
Reverse Osmosis [e]	1.5-- 3.5	1.5-- 3.5	1.5-- 3.5
UV and AOP			
UV low dose	0.5-- 4	4	4
UV high dose with AOP	6	6	6
Ozone [f]	1-6	1-6	1-3
BAC [g]	Unknown	Unknown	Unknown
Free Chlorine	4-6	0-3	0
Surface Water Treatment Plant	4	3	2

Adapted from: Phase 1 RWFPS – Appendix A TM #1a Evaluation of Treatment Requirements
The ultimate inactivation credit achieved for a given process may be based on site-specific performance and/or a negotiated validation approach with DDW on a case-by-case basis (WateReuse 2016).
[a] Through sand filtration Olivieri et al. (2016)
[b] MBRs have not been credited for pathogen removal performance in potable reuse in California (TM #1a Section 4.3) but could receive up to 2/2/2.
[c] nBAF is not currently listed as an approved T22 tertiary treatment process
[d] Protozoa removal based on EPA (2005).
[e] Most potable reuse facilities receive between 1 and 2 LRCs, though options for higher credits are being pursued.
[f] None of the permitted potable reuse projects utilize ozone disinfection, though projects under development will pursue ozone credit.
[g] While removal credits for BAC may be attainable, none of the existing or planned projects in California are seeking LRCs for this process.

The ultimate inactivation credit achieved may be based on site-specific performance and/or a negotiated validation approach with the State Board Division of Drinking Water (DDW) on a case-by-case basis. For example, the tertiary treatment process prior to the AWPF may receive additional inactivation credits for V/G/C and multiple disinfection processes, such as ozone and free chlorine in addition to UV-AOP, could provide for additional inactivation credits. Critical control points identified between individual treatment processes can provide both process control and be used to establish log reduction credits (WateReuse 2016). Table C-2 can be used as a guide for planning purposes; however, it should be recognized that DDW allocates treatment credits on a case-by-case basis for each project based on monitoring provided and the performance of the unit process.

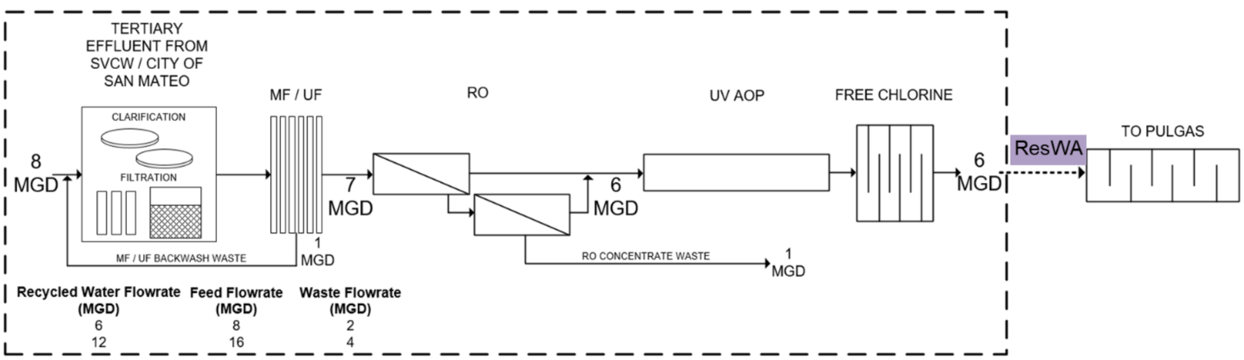
AWPF Train for ResWA

The RO/UV-AOP combination of treatment processes, also referred to as Full Advanced Treatment (FAT), is assumed to be sufficient for ResWA. As discussed in Section 5, additional treatment steps may be required, or preferred, including but not limited to:

- ✓ Free chlorine or ozone addition at the AWPF to provide additional log reduction credits for virus or giardia if the dilution credits are insufficient.
- ✓ Biological activated carbon (BAC) addition to the AWPF to provide an additional barrier and remove dissolved organics through adsorption by the activated carbon and biodegradation by bacteria attached on the activated carbon.
- ✓ Breakpoint Chlorination at Pulgas Facilities to reduce ammonia.
- ✓ Dechlorination or Dechloramination prior to discharge into the reservoir to meet surface water requirements.
- ✓ Nutrient removal before or after the AWPF process to reduce nutrients prior to discharge into the reservoir to meet surface water requirements.

The AWPF process assumed for implementation of ResWA is illustrated in Figure C-1.

Figure C-1: Potential AWPF Treatment Processes for ResWA

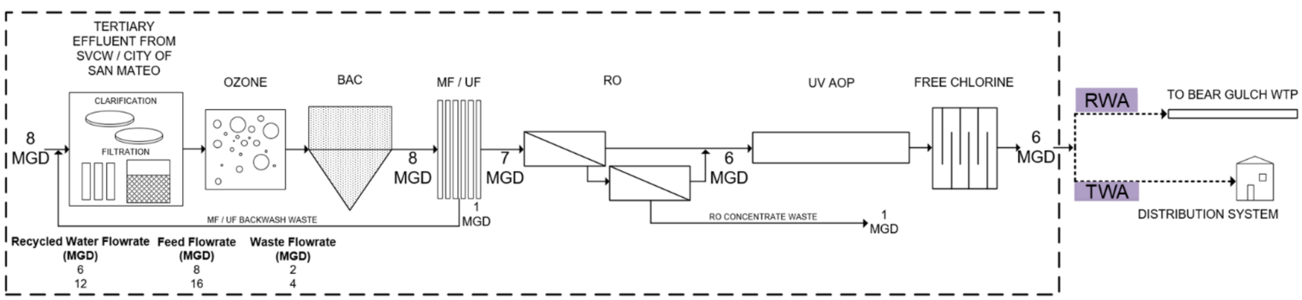


Further evaluation of additional treatment requirements and processes would be performed in future phases of a potable reuse program to assure the appropriate level of treatment and to optimize treatment process design.

AWPF Train for RWA and TWA

The requirements for an AWPF for DPR (via RWA or TWA) are significant and can be separated into two overlapping sets of mandatory treatment steps. For pathogen control, the AWPF would need to have a minimum of four treatment processes that show at least 1 log-removal for target pathogens including physical separation, chemical disinfection, and UV disinfection. For chemical control, the treatment train must comprise of a minimum of three diverse treatment processes including ozone followed by biologically active carbon filtration (Ozone-BAC), reverse osmosis membrane process, an advanced oxidation process. The characteristics of some of these treatment process make them applicable for both pathogen and chemical control, for example, reverse osmosis membrane filtration meets both criteria for pathogen control physical separation and chemical control reverse osmosis membrane process. Overall, the combined treatment train will need to meet indicator pathogen log removal values and chemical indicator removal requirements to meet current DPR regulations. The AWPF process assumed for implementation of RWA or TWA is illustrated in Figure C-2.

Figure C-2: Potential AWPF Treatment Processes for RWA or TWA



Further evaluation of additional treatment requirements and processes would be performed in future phases of a potable reuse program to assure the appropriate level of treatment and to optimize treatment process design.

C.2.3 AWPF Ramp Down and Shut Down Considerations

During wet months of wet years, the available storage in the RWS would result in an upcountry "spill" of water to make room for purified water in the RWS. For this reason, the ResWA alternatives included a ramp-down and a shutdown operational scenario. RO membranes must remain wet and generally cannot be removed from operation for greater than 24 hours without membrane preservation practices. Thus, ramp-down and shutdown operations would require additional operational actions to maintain membrane integrity. Membrane preservation is typically performed using 500-1,000 mg/L of sodium bisulfite to prevent biological growth and performing the preservation can be time consuming and chemical intensive. However, membrane preservation may be avoided, or reduced, in ramp-down scenarios by rotating operational RO skids daily to ensure all membranes remain wet and are not out of service for longer than 24 hours. Rotating operational RO skids is commonly performed in membrane plants and is not expected to be highly labor intensive. If the treatment plant is shut down for an extended period, RO membrane preservation with sodium bisulfite solution is necessary and the solution is conservatively assumed to be replaced every two weeks.

C.2.4 Treatment Location

For the purpose of the PREP Phase 3 Feasibility Study, it is assumed that the AWPF would be located near the SVCW facility (herein referred to as the AWPF Site near SVCW), or at a site near the San Carlos Airport (herein referred to as the Hwy 101 AWPF Site), or at a site near the San Mateo WWTP as shown in Figure C-3. The facility footprint would range from 4 acres to 6 acres, for a 6 mgd and 12 mgd AWPF, respectively. A preferred configuration or location of the AWPF was not identified as part of this work. Based on initial discussions with SVCW, it is assumed that the AWPF would be an independent facility from SVCW. This could prove to be beneficial in terms of the potential positive public perception due to separation of wastewater and purified water systems.

Consistency Helps Efficiency
Operating an AWPF at a relatively constant flow year-round is preferable to keep treatment facility costs down, simplify operations, and maximize returns on economies of scale.

The AWPF Site Near SVCW would require less pumping and shorter pipelines to convey tertiary effluent to the AWPF and the RO concentrate from the AWPF, as compared to the Hwy 101 AWPF Site. There may also be holistic water cycle benefits for a location adjacent to SVCW. For example, increasing awareness of what is eliminated through the wastewater treatment system. A siting study would be conducted to compare the benefits and limitations of these and other nearby sites prior to identification of a preferred AWPF site. Future discussions and agreements between the PREP Parties would determine preferences for ownership, operation, and maintenance of the AWPF. The cost to purchase or lease land for the AWPF has not been explored as part of this work but would be evaluated as part of a future siting study.

Figure C-3: Potential AWPF Treatment Locations

Note: The areas within the orange dashed line are intended to represent a possible area that may be suitable for an AWPF. A future siting study would investigate the availability of areas within these boundaries, conflicts with other land use plans, environmental sensitivities, and other benefits and limitations of these and other nearby sites prior to identification of a preferred AWPF site.

C.3 RO Concentrate Disposal

The advanced treatment of wastewater for potable reuse using RO membranes would produce reject water (herein referred to as the RO concentrate) for disposal. It is assumed that the RO concentrate would be blended with remaining tertiary effluent and discharged via SVCW's existing ocean outfall pipeline to the SF Bay. The relevant permits that regulate SVCW's discharge to the SF Bay are previously described in Section 4.8.

For this study, the average monthly estimated combined the RO concentrate and tertiary effluent discharge (herein referred to as combined effluent) is evaluated against the monthly limits shown in the NPDES discharge permits for SVCW and San Mateo. A more detailed evaluation of average weekly, maximum daily, instantaneous minimum, and instantaneous maximum limits should be evaluated in future phases. It is assumed that at least 2.7 mgd and 1.6 mgd of tertiary effluent would be available to be blended with the RO concentrate at SVCW and San Mateo, respectively. To be conservative, 75 percent recovery of product water at the AWPF and 100 percent rejection of most constituents at the RO are assumed, with the exception of ammonia, which is assumed to be 95 percent rejected. A summary of the estimated combined effluent concentrations for a 6 mgd scenario at SVCW or San Mateo and 12 mgd scenario at SVCW blended with San Mateo tertiary effluent compared to the average monthly effluent limits for ten parameters of interest is shown in Table C-3 for SVCW and Table C-4 for San Mateo. The City of San Mateo Wastewater Treatment Plant is currently undergoing treatment improvements and reported concentrations are based on estimated water quality following treatment improvements.

Table C-3: Summary of SVCW's Dry Season Effluent Limitations and Estimated Combined Effluent Concentrations

Parameter	Units	Average Dry Season Monthly Effluent Limit	2013 – 2021 Dry Months (May – Oct) Averages	6-mgd AWPF[1]		12-mgd AWPF[2]	
				Estimated RO Conc	Estimated Combined Effluent[3]	Estimated RO Conc	Estimated Combined Effluent[3]
$CBOD_5$	mg/L	8	3.4	14.3	7.8	17.8	11.7
TSS	mg/L	8	Removed by MF/UF treatment				
Oil and Grease	mg/L	10	Removed by MF/UF treatment				
pH	s.u.[4]	-	Can be adjusted as part of treatment process to meet discharge requirements				
Turbidity	NTU	10	Removed by MF/UF treatment				
Chlorine, Total Residual	mg/L	-	ND[5]	ND	ND	ND	ND
Ammonia, Total	mg/L as N	170	48.0	194.2	108.0	104.3	80.8
Copper, Total Recoverable	µg/L	52	5.8	24.7	13.6	24.7	16.8
Cyanide, Total	µg/L	21	3.0	12.9	7.1	6.5	5.0
Dioxin – TEQ	µg/L	$1.4x10^{-8}$	unk[6]	unk	unk	unk	unk

[1] 6-mgd AWPF assumes source water from SVCW only.
[2] 12-mgd AWPF assumed source water from SVCW and San Mateo.
[3] Combined effluent refers to the RO concentrate blended with 2.7 mgd of SVCW tertiary effluent. Based on available allotments and demands, the available effluent for dilution from SVCW may range from 1.7 mgd to 3. 7 mgd. The availability of source water will be further evaluated during design phases.
[4] s.u. = Standard units
[5] ND = non detect
[6] unk= unknown

Table C-4: Summary of San Mateo's Dry Season and Year Round Effluent Limitations and Estimated Combined Effluent Concentrations

Parameter	Units	Average Dry Season Monthly Effluent Limit	2015-2020 Average from 2020 NPDES Self-Monitoring Report; CBOD and Ammonia Based on 2017 Projected Water Quality	6-mgd AWPF[1]	
				Estimated RO Conc	Estimated[2] Combined Effluent
$CBOD_5$	mg/L	15	5.0	21.3	11.5
TSS	mg/L	20	OK-- Removed by MF/UF treatment		
Oil and Grease	mg/L	10	OK-- Removed by MF/UF treatment		
pH	s.u.[3]	-	OK-- Can be adjusted as part of treatment process to meet discharge requirements		
Turbidity	NTU	-	OK-- Removed by MF/UF treatment		
Chlorine, Total Residual	mg/L	-	unk[4]	unk	unk
Ammonia, Total	mg/L as N	66	1.0	0.0	0.0
Copper, Total Recoverable	ug/L	51	5.8	24.7	13.3
Cyanide, Total	ug/L	20	DNQ[5]	DNQ	DNQ
Dioxin-TEQ	ug/L	1.4×10^{-8}	unk[4]	unk	unk

[1] 6-mgd AWPF assumes source water from San Mateo only.
[2] Combined effluent refers to the RO concentrate blended with 1.6 mgd of San Mateo tertiary effluent
[3] s.u. = Standard units
[4] unk= unknown
[5] DNQ = Detected, not quantified

Given the level of analysis performed for this study, the following assumptions and considerations are noted:

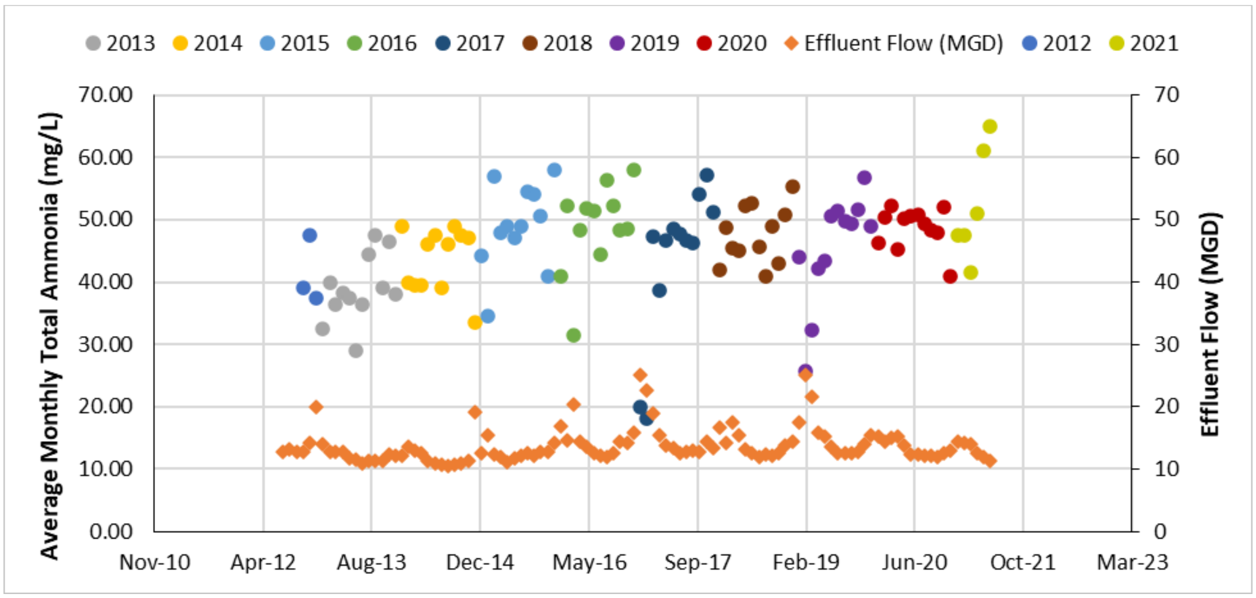
- A preliminary estimate of the RO concentrate total dissolved solids (TDS) concentration is on the order of 6,000 mg/L, which is about 20 percent to 25 percent of the TDS in the South SF Bay. TDS is also not currently a regulated parameter in SVCW's NPDES permit.
- Toxicity is a key parameter that warrants additional evaluation in future studies, particularly during summer months when the RO concentrate dominates the outfall discharge flow. SVCW and San Mateo's NPDES permit includes toxic pollutant effluent limitations. This may be a concern for both the 6-mgd and 12-mgd scenarios and will need to be looked into further during future studies.

- The WDR for nutrients in the SF Bay Watershed includes 2019-2024 load targets, which are anticipated to turn into load caps as part of the next permit for 2025 onwards. Since these are load targets, and not concentration-based targets, the combined RO concentrate, and tertiary effluent discharge would not be impacted by the nutrient permit.
- $CBOD_5$ is the only constituent that does not meet monthly effluent limits for the 12-mgd scenario at SVCW and is close to the monthly effluent limits for the 6-mgd scenario at SVCW. To meet monthly effluent discharge limits for the 12-mgd scenario, a reduction in recovery during periods of high CBOD flow may be implemented to meet NPDES discharge limits or to increase the tertiary effluent contribution from San Mateo thereby increasing the available tertiary effluent from SVCW for dilution and discharge. For the 6-mgd scenario, a similar reduction in recovery during periods of high CBOD concentration may be implemented should $CBOD_5$ concentrations exceed monthly discharge limits. Because $CBOD_5$ cannot be monitored instantaneously, surrogate monitoring parameters such as total organic carbon (TOC) or chemical oxygen demand (COD) may be used to develop a relationship between $CBOD_5$ and TOC/COD concentrations.
- Tables C-3 and C-4 show that the estimated combined effluent under both the 6-mgd and 12-mgd scenarios would likely meet the ammonia discharge limit. However, ammonia should be continuously monitored to ensure effluent limits are not exceeded at SVCW because SVCW does not currently treat for ammonia. The planned treatment improvements to the San Mateo wastewater treatment plant are expected to significantly decrease ammonia concentrations to with a goal of <1 mg/L. High concentrations of ammonia have been reported during winter months (November/December) at SVCW. The rate of increase in ammonia concentration is higher than the rate of increase of effluent flows, consistent with Phase 2 findings. This is a common trend seen at WWTPs in California over the past few years and is likely due to growth in the wastewater service area coupled with water conservation. Figure C-4 shows the trend for SVCW average monthly total ammonia (mg/L as N) and effluent flows (in mgd) from 2013 to 2021. Although a similar trend is not observed for San Mateo, the planned treatment improvements at San Mateo would likely negate any potential ammonia fluctuations and impacts on discharge limits.
- TSS, Oil and Grease, and Turbidity would mostly be removed by the MF or UF treatment process. MF or UF reject would be sent back to the plant headworks and the RO concentrate is not anticipated to contain elevated levels of TSS, oil and grease, or turbidity.
- The AWPF would be able to meet pH effluent limits with the addition of chemicals to adjust the pH to be within the acceptable range. Typical chemicals used include sulfuric acid to decrease pH and sodium hydroxide to increase pH.
- Total residual chlorine levels have been below non-detect (ND) at SVCW and San Mateo outfall over the past few years and are not anticipated to be an issue. Chlorine would likely be added to form chloramines as part of the AWPF process to reduce biofouling in membranes (MF/UF/RO). Sodium bisulfite (SBS) is typically added to the RO concentrate stream prior to discharge to ensure there is no remaining chlorine residual.

- Copper and Cyanide concentrations are anticipated to increase since these constituents are not removed by the MF or UF membranes. However, both the estimated RO concentrate, and combined effluent concentrations are estimated to be below the average monthly limits for both SVCW and San Mateo.

Given the high-level analysis performed as part of this study, a more detailed analysis of water quality is warranted in future phases.

Figure C-4: SVCW Average Monthly Total Ammonia (mg/L as N) and Effluent Flow (mgd)



C.4 Nutrient Management

C.4.1 Nutrient Removal to Meet CSR Discharge Requirements

As shown in Table C-3, ammonia levels in the purified water would need to be reduced by roughly 3 log from 48 mg/L of ammonia as N to meet the annual median (0.025 mg/L as N) and maximum (0.4 mg/L as N) limits stipulated in the SF Bay Basin Plan, or possibly lower to meet background conditions in Upper CSR. To be conservative, ammonia concentrations from SVCW are evaluated for ammonia removal due to the higher ammonia concentrations from SVCW compared to San Mateo and the planned wastewater treatment improvements at San Mateo to reduce discharge ammonia concentrations. The SF Bay Basin Plan provides ammonia limits as un-ionized ammonia. Ammonia may exist as ionized or un-ionized depending on pH; however, it is conservative to reduce total ammonia concentrations to below the SF Bay Basin Plan limits.

Ammonia can be removed before entering the AWPF at the WWTP or in the purified water stream likely following RO treatment (i.e., RO permeate). Phosphorous is effectively rejected by RO membranes (>99 percent) and is not a major concern for the final recycled water. Nutrient removal in the RO concentrate is not needed because the discharges to SF Bay nutrient permit are based on a load target/cap and not a concentration limit. Still, RO concentrate considerations have also been included, should regulations change, and the load target/caps may also be breached if there is no further treatment in the long term. Nutrient removal strategies in the RO feed, permeate, and concentrate are summarized in Table C-5.

Table C-5: Nutrient Removal Strategies

Treatment Location	Nitrogen Removal	Phosphorus Removal (Not needed)
RO Feed	• The RO permeate and concentrate nitrogen level reduced using one system • Alkalinity and micronutrient in feed water can be used to buffer pH and support microbial growth • Biosolids can be disposed at existing sludge handling facilities • Highly buffered water may require significant chemical usage for pH adjustment • Difficult to achieve low ammonia concentrations required by SF Bay Basin Plan Limits by one treatment technology	• The RO permeate and concentrate phosphorus level reduced using one system • Chemical phosphorus removal system would need to be larger to support full AWPF flow
RO Permeate	• Carbon, phosphorus, and micronutrient addition needed for biological denitrification could negatively impact water quality • Lower ammonia concentrations to remove due to 95 percent rejection of ammonia by RO	• Phosphorus removal not required due to high rejection by RO
RO Concentrate (not anticipated to be needed)	• High concentration and lower flow could allow for novel treatment processes (e.g., Anammox) to be used • A second system would be required for permeate nitrogen removal	• Chemical phosphorus removal kinetics and system size may be more optimal due to high concentrations and lower flows

Ammonia can be removed at the WWTP prior to the AWPF using biological techniques (i.e., nitrification, denitrification) with several benefits including having one treatment system that can handle both (1) nitrogen removal for the AWPF feed and (2) nitrogen reduction in the RO concentrate (if needed in the future). Nitrogen removal at the AWPF also has the benefit of allowing the biosolids to be disposed at existing sludge handling facilities at SVCW. Physical ammonia removal methods such as ammonia stripping may also be implemented at the WWTP following biological treatment. However, ammonia stripping requires elevated pH's for effective stripping (e.g., pH 11) indicating significant chemical usage to raise and lower the pH before and after treatment, respectively.

Several treatment approaches that remove nitrogen at the RO feed were evaluated at a conceptual level: nitrification and denitrification (NDN) filters, moving bed bioreactor (MBBR) systems, and ammonia stripping. Advantages and disadvantages for these technologies are summarized in Table C-6.

NDN filters are filters that support bacterial growth and are used to accomplish nitrification and denitrification to remove ammonia. MBBR systems are systems that combine conventional activated sludge processes and biofilm media for nitrification and denitrification to remove ammonia. NDN filters are commonly used for tertiary nitrogen removal and have a smaller spatial footprint compared to MBBR systems. Both systems produce effluent that is low in nitrogen, with the NDN filter producing effluent that is slightly lower in nitrogen than the MBBR. MBBR systems have lower O&M costs, mainly due to lower energy requirements while NDN has a high energy demand for aeration.

Ammonia stripping is an air stripping process that strips gaseous ammonia from the water. Ammonia stripping is a relatively straightforward process that can be accomplished using traditional stripping towers and does not require nitrification and denitrification. However, significant chemicals are often required to increase the pH (and subsequently decrease the pH) of the feedwater to basic conditions (pH 10-11) to ensure optimal ammonia removal. Mineral scaling may also form on the packing material and ammonia stripping is less effective in cold weather conditions.

These proposed technologies may not be able to achieve the low effluent ammonia concentrations required by the SF Bay Basin Plan Limits at 0.025 mg/L as N alone indicating additional polishing treatment technologies may be required at the WWTP or after the AWPF and incur additional costs.

Table C-6: Nutrient Removal Strategies: RO Feed Treatment

Process	Advantages	Disadvantages
Nitrification and Denitrification (NDN) Filters	• Commonly used for tertiary nitrogen removal • Carbon not consumed in aerobic zone • Small footprint compared to MBBR • Very low solids production • Very low effluent N • Low effluent TSS	• Submerged filters have high energy demand for aeration • Carbon addition required • Backwash tank and solids handling required • Nitrifying trickling filters susceptible to predation • Higher pumping energy
Moving Bed Bioreactor (MBBR)	• Small footprint compared to activated sludge (AS) systems • Higher treatment rates compared to AS • No sludge recycling • No backwashing required • Low solids production • Low effluent N	• Secondary settling tank required • Solids wasting and handling required • Carbon may be consumed in aerobic zone • Biofilm carrier media is patented and may only be provided by a single supplier
Ammonia Stripping	• Simple operation • Not significantly impacted by fluctuations in water quality	• Requires significant addition of chemicals to increase and decrease pH for treatment • Carbonate scale formation • pH and temperature dependent

Ammonia removal systems may also be following RO treatment as summarized in Table C-7. RO membranes are conservatively assumed to achieve ~95 percent rejection of ammonia. Assuming no ammonia removal occurs prior the AWPF, the resulting ammonia concentration in the RO permeate is conservatively expected to be 2.4 mg/L (Table C-3). Treatment technologies should therefore aim to reduce ammonia from 2.4 mg/L to below 0.025 mg/L.

While biological processes (nitrification/dentification, nitrification only) can be implemented for ammonia removal in the RO permeate and the system size may be smaller than if implemented at the WWTP, these systems would require carbon, phosphorous, and micronutrient addition to support biological growth. The addition of these constituents can adversely impact water quality and should not be implemented after filtration. Ammonia stripping in the RO permeate may require less chemical addition for pH adjustment due to lower alkalinity in the RO permeate than in the WWTP but is less effective for a dilute ammonia stream. Similar to the challenges associated with implementing ammonia removal technologies prior at the WWTP and prior to the AWPF, these technologies may not be able to achieve the low ammonia concentrations (0.025 mg/L) required to meet the Basin Plan limits (Table C-3) in the final recycled water when implemented alone.

Breakpoint chlorination of the RO permeate may be a promising and more cost-effective ammonia removal method that can achieve ammonia concentrations below 0.025 mg/L without the need for additional ammonia removal technologies other than RO in the AWPF. Breakpoint chlorination utilizes high concentrations of chlorine to oxidize ammonia to nitrogen gas. While implementing breakpoint chlorination as a treatment technology can be expensive due to the high contact times and footprints needed, these costs may be mitigated by leveraging existing breakpoint chlorination operations at Pulgas Facilities, discussed later in Section C.5. Thus, breakpoint chlorination will be the assumed treatment technology for ammonia removal in this study. The specific treatment technology should be evaluated in future studies.

Table C-7: Nutrient Removal Strategies: Permeate Water Treatment

Process	Advantages	Disadvantages
Nitrification and Denitrification (NDN) Filters	• Commonly used for tertiary nitrogen removal • Carbon not consumed in aerobic zone • Small footprint compared to MBBR • Very low solids production • Very low effluent N • Low effluent TSS	• Requires addition of carbon and micronutrients that can impact downstream water quality • Submerged filters have high energy demand for aeration • Carbon addition required • Backwash tank and solids handling required • Nitrifying trickling filters susceptible to predation • Higher pumping energy
Nitrification Only	• Does not require denitrification	• Introduces undesirable high nitrate concentrations to water • Can still induce algal growth
Breakpoint Chlorination	• Leverages existing breakpoint chlorination facilities at Pulgas	• Requires high chlorine doses (10:1 ratio of chlorine to ammonia) • May induce formation of DBPs
Ammonia Stripping	• Simple operation • Not significantly impacted by fluctuations in water quality	• Not as effective in low ammonia concentration waters (i.e., first order kinetics) • Requires significant addition of chemicals to increase and decrease pH for treatment • Carbonate scale formation • pH and temperature dependent

As previously discussed, phosphorus removal would not be needed to meet SF Bay Basin Plan requirements; however, there may be interest in managing phosphorus levels. Phosphorus removal strategies in the RO concentrate are listed in Table C-8.

Table C-8: Phosphorus Removal Strategies: RO Concentrate

Process	Advantages	Disadvantages
Chemical Addition + Moving Bed Filter (Continuous Backwash)	• Relatively constant head loss across filter due to continuous backwash • Small footprint • Readily available and uses common sand media • Long-lasting media requiring infrequent replacement and replenishment • Continuous filtration reduced operational	• Higher pumping energy • Airlift pump to wash filter media required and continuously operated • High backwash rate, up to 5% of treated water volume
Chemical Addition + Cloth Disk Filter	• Consistent effluent water quality • Lower backwash rate, typically 5% of treated water flow • Lower pumping energy • Small footprint • Continuous filtration	• Specifically, designed cloths • Cloths must be periodically replaced • Increased level of automation

C.4.2 Nutrient Removal to Meet Bear Gulch Discharge

Consistent with nutrient removal techniques to meet CSR discharge requirements, breakpoint chlorination may be a promising method used to remove ammonia in the final recycled water to meet Bear Gulch discharge requirements. While breakpoint chlorination contact basins can be installed and implemented at Bear Gulch, a cost-effective alternative may be to perform breakpoint chlorination in the conveyance pipeline from the AWPF to Bear Gulch.

C.4.3 Nutrient Removal to Meet Drinking Water Requirements

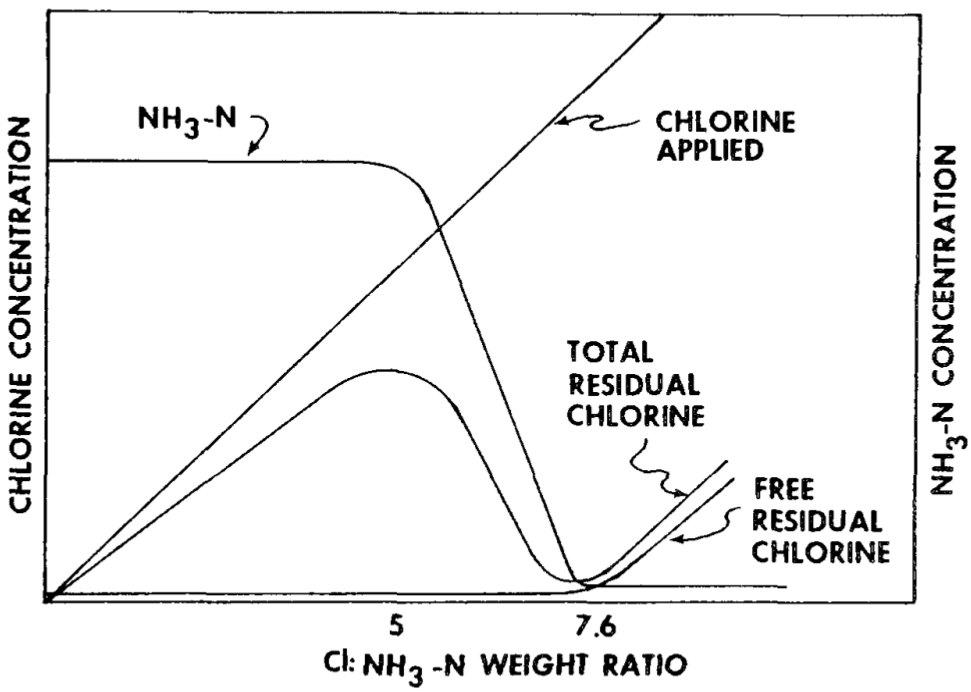
Additional ammonia removal may not be required for TWA because the recycled water is not discharged to a surface water body. A potential use for the ammonia may be to generate chloramine disinfectants, which are currently used in SFPUC drinking water supplies. However, thorough testing should be performed to validate the exact conditions (e.g., ratio, pH, temperature) required to generate chloramines. Testing should also be performed to validate the compatibility of mixing the treated recycled water and the drinking water to ensure compatible water quality and chloramine residual is maintained.

C.5 Breakpoint Chlorination and Dechloramination

C.5.1 Breakpoint Chlorination

Breakpoint chlorination is commonly performed in water treatment and utilizes chlorine to oxidize ammonia to nitrogen gas. Figure C-5 shows a typical breakpoint chlorination curve at near neutral pH conditions. At a weight ratio below 5:1 chlorine to ammonia, monochloramines are primarily formed. As more chlorine as added, the free chlorine residual and ammonia concentration decreases to a minimum defined as the breakpoint. Stoichiometrically, this is when the ratio of chlorine to ammonia is 7.6:1 at neutral pH. Past the breakpoint, the concentration of free chlorine matches that of the added chlorine. In practice, greater ratios of chlorine to ammonia may be required to achieve breakpoint chlorination (e.g., 10:1).

Figure C-5. Breakpoint Chlorination Curve



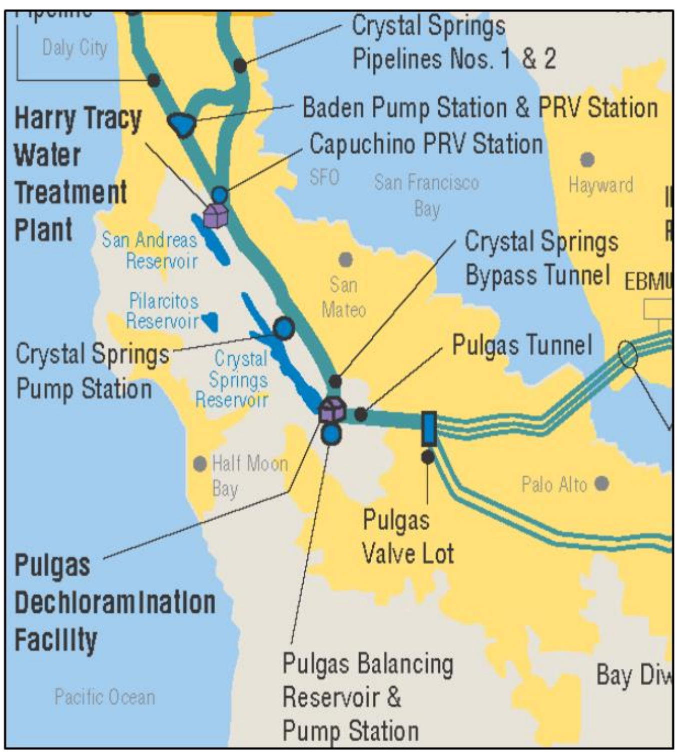
Source: (adapted from Westrick et al. 1978 EPA-600/2-78-165)

The formation of DBPs such as haloacetic acids (HAAs), trihalomethanes (THMs), and n-nitrosamines (e.g., N-Nitrosodimethylamine (NDMA)) can form upon chlorination or breakpoint chlorination and should be evaluated. Performing breakpoint chlorination following reverse osmosis treatment can limit DBP formation due to the significantly lower concentration of DBP precursors in the RO permeate. Still, future testing is necessary to determine the formation of DBPs and to determine if additional treatment is needed to reduce the concentration of these DBPs following breakpoint chlorination.

C.5.2 SFPUC Pulgas Facilities for ResWA at CSR

Purified water from the AWPF (chloraminated during conveyance) would be blended with water from the RWS at the Pulgas Facilities before entering Upper CSR. The Pulgas Facilities include the Pulgas Tunnel, Pulgas Pump Station, Pulgas Balancing Reservoir, and Pulgas Dechloramination Facility, as shown in Figure C-6. All water supplied from the RWS, and the Sunol Valley Water Treatment Plant is transmitted from the mid-Peninsula to the northern portion of the Peninsula and San Francisco via the Pulgas Tunnel. The Pulgas Tunnel conveys water from the Pulgas Valve Lot in Redwood City to either the Crystal Springs Bypass System or to the Pulgas Pump Station. The Crystal Springs Bypass System diverts water directly to the low-pressure zone transmission pipelines on the northern portion of the Peninsula thereby bypassing the Peninsula Reservoirs and Harry Tracy WTP. When the Pulgas Tunnel flowrate exceeds the demand downstream of the Crystal Springs Bypass System, the excess water fills the Pulgas Balancing Reservoir, and eventually is discharged to CSR. The 60-MG Pulgas Balancing Reservoir supplements the system during peak demand periods and is located across from the Pulgas Dechloramination Facility. The Pulgas Dechloramination Facility removes chlorine and ammonia and balances pH prior to releases to Upper CSR. Among other upgrades to the Pulgas Facilities implemented by SFPUC over the years, the Pulgas Discharge Channel discharge capacity will be restored to accommodate flows up to 250 mgd in the coming years.

Figure C-6: RWS Pulgas Facilities



Above: Flows from the Pulgas Dechloramination Facility enter the Pulgas Discharge Chanel for release to Upper CSR.

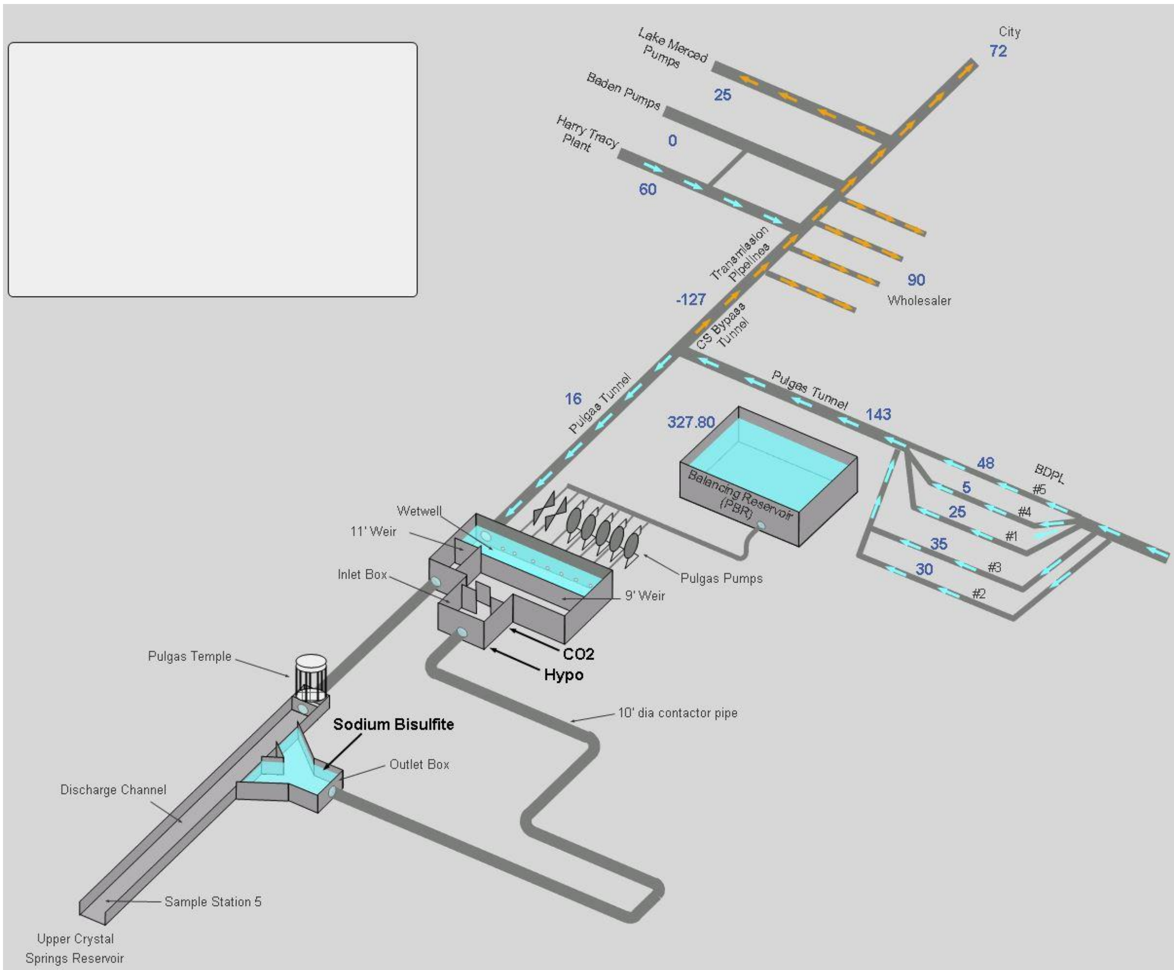
Source: SFPUC Regional Water System Training Presentation http://baywork.org/wp-content/uploads/2017/08/RegWtrSysOvrw_7-2017-sm.pdf

The Pulgas Facilities are designed for unmanned, automated process control using feedback from sampling stations implemented throughout the facility. CO_2 and sodium hypochlorite are added at the inlet box upstream of the 10' diameter contact pipes as shown in Figure C-7. CO_2 is added for pH control (targeting ~pH 7.5) and sodium hypochlorite is added for breakpoint chlorination. Assuming a flow of 100 mgd, the current chlorine contactor after sodium hypochlorite addition achieves a contact time of 15 minutes for breakpoint chlorination. Sodium bisulfite is then dosed at the outlet box to remove any chlorine residual before discharge to CSR.

For the purpose of the PREP Phase 3 Concept Study, it is assumed that a connection from the new purified pipeline to the existing Pulgas Facilities would be constructed. Upon preliminary discussions with SFPUC, a potential tie-in location to the existing facilities would be prior to the 9' or 11' weir to maintain separation between the existing potable and proposed treated recycled water supply. At this level of study, it would be conservative to assume that the water quality of augmented water would need to match or be compatible with the background levels of water entering the Pulgas Facilities to aid in the treatment at the Pulgas Dechloramination Facility. Additional points of monitoring for flow and water quality, as well as flow control, would be warranted upstream of where the purified water enters the Pulgas Facilities to provide SFPUC with operational flexibility.

Given the planned increase in capacity of the Pulgas Discharge Channel and current capacity of the Pulgas Dechloramination Facility, no major capital infrastructure modifications are assumed. However, SFPUC mentioned there are operational challenges associated with flows lower than 20 mgd at Pulgas. Because all current projected reuse scenarios are less than 20 mgd and there are periods of no flow at Pulgas, additional tanks (e.g., 2 MG) for increased detention time may be required to effectively perform breakpoint chlorination. Annual O&M costs for dechloramination are based on current chemical costs and concentrations used at the Pulgas Facilities for carbon dioxide, sodium hypochlorite, and sodium bisulfite (quantities provided by SFPUC). O&M costs for the purified water flows through the discharge channel are not included.

Figure C-7: Pulgas facilities schematic



C.5.3 New Facilities for RWA at Bear Gulch

Breakpoint chlorination and dechloramination at Bear Gulch can be accomplished by installing new chlorine contact pipes and facilities at Bear Gulch; however, costs may be saved by utilizing the conveyance pipeline from the AWPF to Bear Gulch as the contactor for breakpoint chlorination.

C.5.4 Consideration for TWA

Additional ammonia removal may not be required for TWA due to the purified water not being discharged to a surface water body. Alternatively, chlorine can be added to generate chloramines; however, thorough testing should also be performed to validate the compatibility of mixing the treated recycled water and the drinking water to ensure compatible water quality and chloramine residual is maintained.

C.6 Water Quality Improvement for Redwood City

There is an opportunity to use Redwood City's existing infrastructure, storage, and pipelines to reduce capital infrastructure costs for the project. Another opportunity for regional benefits would be to blend some of the high-quality purified water with tertiary recycled water to improve water quality for Redwood City's existing non-potable recycled water system.

Redwood City's recycled water is high in both chlorides and ammonia, making the recycled water corrosive to pipelines. Redwood City's recycled water currently (2019) has a chloride concentration of about 250 mg/L. At these levels, corrosion to Type 304 stainless steel could occur and the more expensive Type 316 stainless steel would be needed. In addition, carbon steel and other pipeline materials that are even less resistant to corrosion are currently used in Redwood City's service area for indoor commercial use. Reducing the chlorides to below 200 mg/L would minimize the potential and impact for corrosion on recycled water pipelines. Ammonia concentrations will not be significantly reduced by blending with the RO permeate and biological nitrogen removal would be required.

Redwood City continues to explore options to improve water quality, particularly related to controlling corrosion. An evaluation of piping alternatives for new commercial construction and code improvements for existing copper-plumbed buildings is being performed in 2019. Blending high-quality purified water with tertiary recycled water offers an opportunity to meet water quality objectives through treatment. Considering water quality aspects such as pH, alkalinity, and chloride concentrations, as well as the aesthetic characteristics, a 50:50 blend could be beneficial, but potential blends would need to be further investigated with initial testing.

Water quantity, water quality, and infrastructure considerations would need to be further explored to assess the viability and benefits of blending purified water with Redwood City's existing recycled water supply.

- **Water quantity:** Availability of tertiary recycled water, the seasonal demand of Redwood City's existing non-potable users, and the additional 0.9 mgd allocation for future non-potable users would all need to be considered. For example, if the influent to the AWPF is increased from 8 mgd to 8.9 mgd to use the remaining allocation, then AWPF capacity would need to be increased by just over 10 percent and the RO concentrate flow would also need to be higher (~2.2 mgd instead of 2 mgd). This would result in a ratio of 1:3 for the purified water that would be blended with the existing 2 mgd of Redwood City's demand. Another option would be to pass more of Redwood City's existing tertiary flow through the AWPF to increase the percent of purified water available for blending in for non-potable use to 50:50. This would involve sending 1.66 mgd of Redwood City's overall 2.9 mgd allocation to the AWPF, which would in turn further require an increase in the AWPF capacity to 9.66 mgd. A follow-up study would be warranted to explore the benefits, limitations, and costs of these options.

- **Water quality:** Closer examination of the entire water chemistry would be needed to decide on blending ratios in the long-term that would achieve effluent limits, reduce corrosion impacts, and keep the water aesthetics unchanged compared to the current quality.
- **Infrastructure:** Additional infrastructure would be required to blend purified water back into Redwood City's non-potable storage tank or directly into the distribution system. As noted, the AWPF facility may also need to be upsized to treat a portion of Redwood City's allocated supply without diminishing the amount of purified water produced for ResWA.

One approach to exploring options to improve the water quality of Redwood City's non-potable supply would be to conduct a demonstration project to blend purified water with tertiary effluent from SVCW in their recycled water tank. A demonstration project could serve multiple benefits by providing a vehicle to test the most current treatment technologies directly on source water from SVCW and produce a purified product water that could be beneficially used to improve water quality for Redwood City in the near-term. A demonstration project could potentially transition into a permanent system to continue to treat a side stream of recycled water to serve Redwood City.

C.7 Summary of Treatment Processes Assumed for Alternatives

All reuse alternatives including ResWA at CSR, RWA at BG, and TWA will require Full Advanced Treatment (FAT), which include MF, RO, and UV-AOP. However, reuse alternatives RWA at BG and TWA are considered direct potable reuse and additional log reduction credits are likely needed. These credits can be attained through the addition of ozone and BAF to FAT. Because reuse alternative ResWA at CSR is considered indirect potable reuse, ozone and BAF are not expected to be required, but may be added in the future if additional log reduction credits are needed.

To meet SF Bay Basin Plan Limits, nutrient removal, specifically ammonia removal, is required for reuse alternatives ResWA at CSR and RWA at Bear Gulch. Breakpoint chlorination is a promising treatment method that can remove ammonia at low cost and leverage existing infrastructure at Pulgas to concentrations < 0.025 mg/L ammonia as N, as required by the SF Bay Basin Plan. TWA may not require similar nutrient removal; instead, chloramine disinfectants may be generated from the ammonia in the recycled water. Treatment alternatives and methods are summarized in Table C-10.

Table C-10: Summary of Treatment Process for Alternatives

Use	Nutrient Removal Strategy[1]	AWPF	Disinfection Residual	Disinfection Removal
Alt 1 & 2 ResWA @ CSR	Breakpoint Chlorination	MF/RO/UV/AOP	Match RWS inflow to Pulgas	Pulgas Dechloramination
Alt 3 RWA @ BG	Breakpoint Chlorination	MF/RO/UV/AOP + O3 + BAC	N/A	New Dechlorination station

1 Nutrient removal drivers include meeting SF Bay Basin Plan requirements or match background concentrations for CSR and Bear Gulch Reservoir and meeting potable water distribution requirements for TWA.

APPENDIX D: Conveyance Considerations and Potential Pipeline Alignments

Conveyance is a critical component of any recycled water system and often accounts for a significant percentage of capital costs for a project. All potable reuse alternatives would involve conveyance of:

1. Tertiary recycled water from SVCW and/or San Mateo at a new AWPF
2. Purified water from the new AWPF to place of use for augmentation.
3. RO concentrate from the new AWPF to an existing outfall to the SF Bay
4. Repurposing existing infrastructure, such as abandoned pipelines, if available.

This appendix describes considerations for repurposing infrastructure at and hear the AWPF locations, potential alignments and pumping requirements and includes pipeline separation references.

D.1 Conveyance Considerations to Repurpose Infrastructure

Repurposing existing infrastructure offers a unique opportunity to reduce costs and impacts associated with constructing new facilities. This section discusses the potential to reuse pipelines owned by SVCW, use existing recycled water facilities owned by the City of Redwood City, and leverage existing SFPUC facilities and the right-of-way for their Bay Division pipelines to save money and reduce environmental and community impacts.

D.1.1 Repurpose SVCW Abandoned Pipelines

SVCW has embarked on the SVCW Gravity Pipeline Project to replace a failing sewer force main with 17,600 feet of gravity sewer pipeline in a 16-foot diameter tunnel deep under Redwood Shores. Upon completion of the project in 2023, some of the existing 54" and 48" pipelines will be abandoned. This creates an opportunity to repurpose these valuable assets, highlighted in Figure D-1, by installing and/or suspending a new pipeline within the abandoned pipe, as described below:

- **SVCW Influent Line** is a 54-inch pipeline that will be abandoned in 2022. This segment is approximately three miles in length and traverses through the Redwood Shores area, a community that is particularly sensitive to new construction. One, or possibly two, pipelines could be slip-lined into the abandoned pipeline and supported inside to convey: 1) purified water to the place of use; 2) tertiary effluent to the AWPF at the Hwy 101 site; and/or 3) the RO concentrate or reject water back to the SVCW outfall.

- **SVCW Abandoned Sewer Line** includes 48-inch to 54-inch pipeline segments that are also planned to be abandoned in 2022 after the SVCW Gravity Pipeline Project is complete. This segment is approximately 2.4 miles in length and passes through an environmentally sensitive area on Inner Bair Island (part of the Don Edwards San Francisco Bay National Wildlife Refuge managed by the US Fish and Wildlife Service), which would be a challenging and expensive stretch to lay new pipeline. A segment of the pipeline on Bair Island, now decommissioned and out of service, is subject to ground movement in poor soils and has had joint leaks while in service and operating under pressure.

Figure D-1: Reuse of Abandoned SVCW Pipelines

The PREP Phase 1 Initial Study provided a high-level assessment of the cost implications of repurposing these pipelines by installing a purified water, tertiary effluent, and/or the RO concentrate pipeline(s) within an abandoned segment to avoid new trenching or costly microtunneling. It was estimated that repurposing abandoned SVCW pipelines could realize a 10 percent overall project savings from those that assumed construction of all new pipelines.

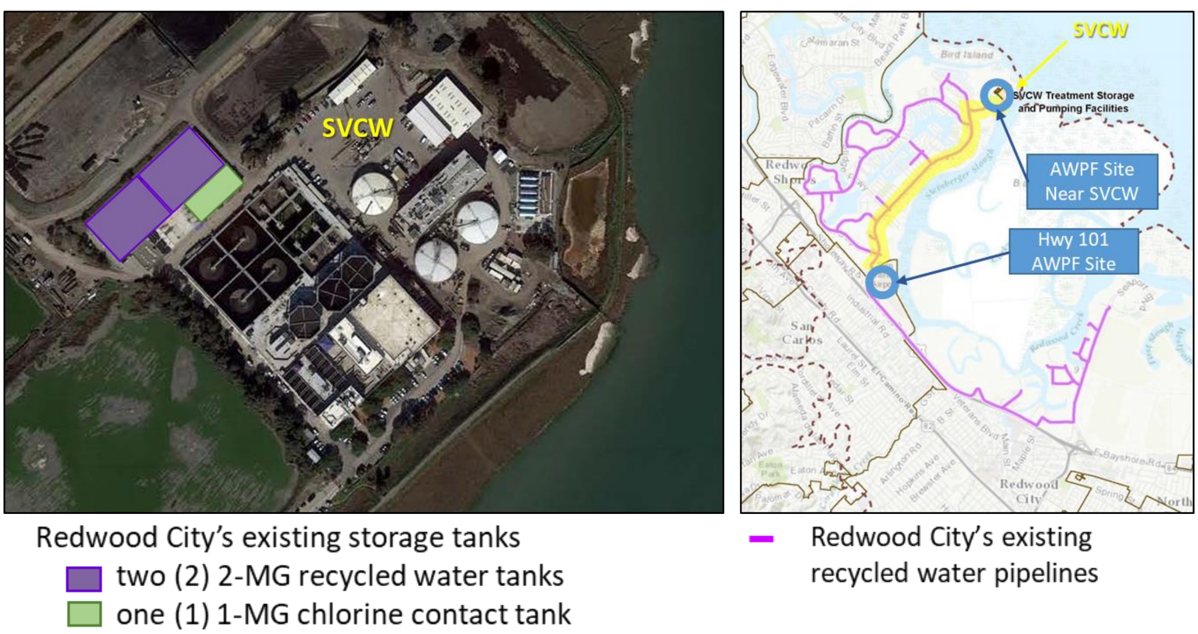
The PREP Phase 2 Concept Study and Phase 3 Feasibility Study similarly assumed that SVCW's abandoned pipelines would be repurposed where possible, in most cases by slip-lining a new pipeline inside the abandoned segment. Section 4.7 discusses assumptions related to the number of assumed access and receiving pits that would be required to slip-line a new pipeline segments within an existing pipeline. A future study would be needed to confirm points of entry into the abandoned pipeline, location of insertion and receiving pits to pull the pipeline through, anchoring techniques, and other risks and cost implications.

D.1.2 Use Redwood City Existing Infrastructure

Redwood City's Recycled Water Program was first introduced to the community in 2000, with a small trial in Redwood Shores. The program later expanded along the eastern edge of Hwy 101 from Redwood Shores to the Greater Bayfront Area, as shown in Figure D-2. Redwood City owns and operates two 2-MG storage tanks, a 1-MG chlorine contact tank and a distribution pump station at the SVCW facility, and 17 miles of distribution pipelines to serve non-potable reuse customers.

Based on discussions with Redwood City, there is a potential opportunity to use their existing recycled water tanks for source water equalization prior to the AWPF (if-needed). This would be a mutually beneficial opportunity to improve current recycled water quality in the tanks due to issues with stagnant water and underused capacity, while reducing costs associated with the need for a new equalization storage for AWPF-produced purified water.

Figure D-2: Redwood City Recycled Water Infrastructure



Repurposing the tanks to provide purified water equalization would likely require a revision of the recycled water Distribution Pump Station control strategy, which has taken RWC several years to tune to its current operations, as well as modification of the current contract arrangement between SVCW and Redwood City. Structural modifications to the tank(s) would also be needed to install a new outlet to convey flow to a new pump station that would send the stored water to the AWPF site, which could be near SVCW or at the Hwy 101 site. Further discussions with Redwood City would be warranted to explore opportunities for shared use of their infrastructure.

The PREP Phase 1 Initial Study assumed reuse of Redwood City facilities, including the use of Redwood City's existing recycled water pipelines to convey tertiary flow from SVCW to an AWPF at the Hwy 101 Site and minor modifications to the existing Redwood City storage tank for use as source water equalization. The use of these facilities was assumed for all alternatives.

For the PREP Phase 2 Concept Study and this Phase 3 Feasibility Study, it is similarly assumed that these facilities would be repurposed where possible. Further discussions with Redwood City for use of their infrastructure would be needed to confirm risks and cost implications. There may also be an opportunity to blend high-quality purified water from the project with tertiary recycled water to improve water quality in Redwood City's Title 22 system.

D.1.3 Repurposing Infrastructure based on AWPF Location

AWPF at Site near SVCW

Should an AWPF Site Near SVCW be selected, the RO concentrate would be sent a short distance to the SVCW facility for treatment and blending prior to discharge. Purified water could be sent towards CSR via a slip-lined pipeline in the soon to be abandoned 54"-dia force main located in Redwood Shores Parkway. Similar to the prior section, repurposing this asset would minimize open trench construction, reduce community disruption, and require future studies to confirm pit locations, costs, and risks.

Highway 101 Site

Should the Highway 101 AWPF Site be selected, available capacity in the Redwood City recycled water system could be used to send available Title 22 flow from SVCW to an AWPF at the Hwy 101 Site via the existing recycled water main in Redwood Shores, shown by the highlighted segment in Figure D-2 This would eliminate the need for 3 miles of new pipeline, reducing project costs and reducing impacts to the Redwood Shores community. The Redwood Shores recycled water pipeline would only be used for an alternative project that sends Title 22 flow from SVCW to Hwy 101 AWPF Site. As previously noted, further discussions with Redwood City would be warranted to explore opportunities and limitations for shared use of their infrastructure.

An RO concentrate pipeline would still be needed to send the Ro reject water from the AWPF back to the SVCW outfall, which could use the soon to be abandoned 54"-dia force main located in Redwood Shores Parkway, shown in Figure D-1. This would also eliminate the need for 3 miles of new open trenched pipeline, reducing costs and impacts to the Redwood Shores community. It is assumed that 11 access or "insertion pits" and 11 receiving or "pulling pits" would be required at consistent intervals or key locations where the pipe makes a bend (both horizontal and vertical) to slip-line pipeline segments. Future alignment studies would be needed to refine exact pit locations and confirm cost implications and risks.

AWPF at Site near San Mateo WWTP

Tertiary effluent from the San Mateo WWTP could be treated at either the Hwy 101 AWPF Site or the AWPF Site near SVCW. There are no abandoned pipelines or existing assets identified to repurpose for conveying flows from the San Mateo WWTP to the AWPF. New pipelines would be constructed through the City of Foster City with the potential to serve non-potable recycled water customers along the way. AWPF facility sizing and associated costs to treat additional flows from the San Mateo WWTP, convey the associated purified water to the place of use and dispose of the RO concentrate are included in this effort.

The AWPF could also be located at the San Mateo WWTP. The AWPF would be supplied with the tertiary effluent from the San Mateo WWTP, and the purified water would tie-in to the potable drinking water system. Pipelines would be constructed to connect the AWPF with existing Foster City potable water tanks off of East 3rd Avenue. Purified water could also be sent directly to the CalWater distribution system at two points in the vicinity: a 12" connection at Norfolk Street and Newbridge Avenue and a 24" connection at Delaware Street and Newbridge Avenue.

D.2 SFPUC Pipeline Alignment and Infrastructure Considerations

As the owner and operator of the Hetch Hetchy Regional Water System, including CSR, SFPUC could leverage opportunities within their rights-of-way (ROWs) and existing infrastructure at CSR to reduce costs for a ResWA project. This section includes a list of considerations, provided by SFPUC, for estimating preliminary pipeline routing and costs to convey purified water to CSR. In general, it is recognized that it would be possible to co-locate a potable reuse transmission pipeline in the SFPUC's ROW from the Redwood City area to CSR. Major exclusions noted by SFPUC include the need to steer clear of the portion of the Bay Division Pipeline (BDPL) located in the East Bay (BDPL No. 5) and find an alternative path under Hwy 280 to avoid the Pulgas Tunnel.

D.2.1 SFPUC Considerations for Estimating Preliminary Pipeline routing and Costs

The following notes were provided by SFPUC on 28 April 2017 regarding the use of the Crystal Springs ROW, ***from the Redwood City area to Crystal Springs Reservoir,*** for a purified water pipeline.

Bay Division Pipelines in ROW

- There are three pipelines (Bay Division 1, 2, and 5) in the ROW on Edgewood Road. In the vicinity of Edgewood Road and Cordilleras Road, the three pipelines converge with two more (Bay Division 3 and 4).
- Five Bay Division pipelines jog NW to Hassler Road where they enter into the Pulgas Tunnel at the horseshoe of Hassler Road.
- Pulgas Tunnel is approximately two miles in length.

Co-locating a potable reuse transmission pipeline in the ROW

- Allow for uncertainty in the project's consideration of alternatives.
- There is a limit to confirming the feasibility of locating a pipeline in the ROW.
- Assuming an 18" transmission pipeline.
- The terrain looks to be difficult for heavy equipment access in the ROW.
- Would not be able to put the potable reuse transmission pipeline in the tunnel. Would have to open cut around the tunnel area.
- Would need to tunnel under 280.
- Need to steer clear of Bay Division 5
- 15' clear between lines and 5 feet clear between pipeline and boundary.
    - The SFPUC will allow situations where these requirements are not met for short distances, like where the lines cross or where obstacles are skirted, but at those locations, as everywhere, the State's requirements for separation of drinking water pipelines and non-potable water pipelines must be complied with, or State approved variances.
    - Consider allowing that the location of the drinking water pipelines is only approximately known – this means that separation requirements are not to be violated if the drinking water pipelines are found to occupy a space closer than expected to the proposed pipeline's alignment. In such cases the proposed pipeline must be realigned and/or State-approved measures for separation of potable and non-potable water pipelines must be provided.
- Pulgas Tunnel daylights at Pulgas Water Temple. Pulgas Water Pipeline runs from Water Temple to the Pulgas Dechloramination Facility, then into reservoir.
- SPFUC would own and operate the section of pipeline in the SFPUC's ROW.

There are other special considerations of locating a non-potable water pipeline within the SFPUC's drinking water pipeline ROW:

- Design life and duty – the line should be designed to serve trouble-free for at least 75 years and to withstand heavy pipeline construction loading.
- Construction materials – no element of the proposed facility should ever require painting within its lifespan.
- ROW – any pipeline project is to conform and protect the earth cover of existing drinking water pipelines and provide for their structural protection from construction loading, as well as provide finish grading to assure positive drainage of the entire width of the ROW and provide for proper conveyance of ROW drainage to local storm water systems.

- Depth of burial – finished grading is to allow for a minimum of 4’ of soil cover to top of proposed pipe, except where shallower installation is specifically confirmed by maintenance engineering analysis.
- Appurtenances – all air-release, vacuum relief, blow-off and any fill or sample extraction appurtenances are to be provided with water-tight containment and water-tight drainage to sanitary sewer systems.
- Zone valving stations are to allow isolation and drainage of reaches of 2 miles or less.
- Monitoring and automation – instrumentation and SCADA is to be provided to monitor pressures in each reach of the proposed pipeline and automatic shutdown in the event of sudden pressure loss.
- Corrosion protection – cathodic protection is to be provided to assure design life, and the proposed water pipeline can in no way contribute to the corrosion of drinking water pipelines in the ROW – galvanic corrosion from contact with dissimilar metals is prohibited.
- Earthquake design criteria – seismic hardness and performance criteria of the proposed pipeline are to meet or exceed the standards established for pipelines under SFPUC’s Water System Improvement Program.
- Pressure design criteria – transient pressure performance criteria of the proposed pipeline are to meet or exceed the standards established for pipelines under WSIP.
- It is likely that there will not be a contiguous ROW for this pipeline, however, it should be obtained.

Operations

- Water quality of the purified water would need to meet the requirements in the NPDES permit for Crystal Springs. Requirements are unique and have to do with wildlife and plants. Need to look at the parameters in the permit, and what the quality would be from the Advanced Water Purification Facility.
- Water quality would need to be monitored.
- Could potentially run water through Pulgas Dechloramination Facility if necessary.

D.2.2 Phase 3 Assumptions regarding use of SFPUC Right of Way

The SFPUC prefers 15-feet of clear separation between pipelines and 5-feet between the pipeline and boundary but will allow situations where these requirements are not met for short distances, like where the lines cross, or where obstacles are skirted, but at those locations as everywhere, the Title 22 of the California Code of Regulations (CCR) requirements for separation of drinking water pipelines and non-potable water pipelines must be complied with, or State approved variances. Pipeline separation considerations are further discussed in the following section.

The use of the ROW and identification of potential fatal flaw issues have not been vetted by SFPUC’s Water Supply and Treatment Division as part of this study. SFPUC has encountered issues on other projects related to putting purple pipe into a drinking water ROW, even in cases where regulatory requirements were met. Consideration of the use of the SFPUC ROW requires further investigation, but for the purpose of this study an alignment in the SFPUC ROW will move forward as one of the options.

For the purpose of the PREP Phase 3 Feasibility Study, it is assumed that an alignment could be identified within the SFPUC ROW that would provide sufficient separation from BDPL No. 5 and would not use the Pulgas Tunnel. Contingencies are included to address other considerations and preferences noted by SFPUC, recognizing that future studies would be needed to confirm alignments, construction methods, and costs. Use of the SFPUC ROW is considered as one of three options to convey purified water to CSR.

D.2.3 Phase 3 Assumptions regarding use of Puglas Facilities

SFPUC owns and operates the Pulgas Dechloramination Facility and a discharge facility that delivers Hetch Hetchy flows to CSR. Purified water could potentially run through these facilities to save costs and avoid the need to build a new dechlorination system and a new discharge facility.

D.3 Pipeline Separation Considerations

Current regulations clearly define separation requirements between potable water pipelines and other pipelines, such as sanitary sewers, raw water, tertiary recycled water, and other non-potable fluids. Specifically, the CCR(CCR Title 22, Division 4, Chapter 16, Section 64572) establish criteria for the separation of new water mains and new supply lines from non-potable pipelines (excerpt included in Section D.3.1). This section also includes criteria for separation between purified water pipelines and potable water mains.

Separations between recycled water or purified water pipelines and other non-potable pipelines are not specified in regulations and are looked at by SBDDW on a case-by-case basis. Due to the lack of specific regulations or design requirements, the industry design standard for this scenario generally adheres to the separation requirements between potable water mainlines and non-potable water mains.

A 2017 SBDDW memo (included in Section D.3.2) addresses requests for alternatives to the waterworks standards. Specifically, it states that "The SBDDW recognizes that certain conditions may call for the installation of pipelines with less separation distance than what is required by the regulations. In these situations, the water system may propose an alternative pursuant to CCR, Title 22, Section 64551; 100." The request for a waiver must demonstrate the proposed alternative would provide at least the same level of protection to public health, and a written approval from the SBDDW is required prior to implementation.

Other Considerations

Pipeline separation between a purified water pipeline and Bay Division pipelines carrying untreated RWS flows within SFPUC's ROW would need to be evaluated from a regulatory, risk, and operational perspective. Similarly, all tertiary, the RO concentrate, and purified water pipeline alignment traversing through the San Francisco Mid-Peninsula region would require an in-depth study of existing water, wastewater, and other utilities to ensure separation requirements and/or preferences are met.

Slip-lining one or more pipelines into one of the abandoned SVCW pipelines would also warrant an assessment of separation criteria from regulatory, risk, and operational perspectives. For example, placing a tertiary recycled water and a purified water pipeline together in the abandoned 54"-dia SVCW influent line along Redwood Shores may not have specific regulatory separation requirements, however there may be some operational criteria related to O&M and access that may influence the design and viability. Permitting approval for slip-lining a purified water pipeline into an abandoned sewer line may require specific installation, suspension, or lining techniques to address areas of poor soils or segments that have had prior joint leaks.

To protect from cross-contamination risks, fused high density polyethylene (HDPE) pipeline could be used for conveyance of purified water and the RO concentrate. HDPE pipelines do not have joints and therefore are not prone to cracking or joint failure that could lead to losses, which could create cross-contamination scenarios. Slip-lined pipes in the abandoned SVCW RCP force main pipe would likely be surrounded by low-strength flowable grout that would support the pipes and contain any leaks at joints, if any. The use of grout and jointless pipes would reduce the risk of cross contamination between potable and non-potable slip-lined pipelines, making the regulatory requirements the largest hurdle to overcome.

For the purpose of this study, the placement of a 20"-dia tertiary pipeline and a 24"-dia purified water pipeline together in the 54"-dia SVCW influent line, in the case of a 12-mgd ResWA project with the AWPF located near SVCW, was considered but deemed not viable due to separation considerations as stated above. It was assumed that a new open trench pipeline would be required in Redwood Shores in addition to slip-lining, in this case.

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D.3.1 California Code of Regulations (CCR), Title 22, Division 4, Chapter 16, Section 64572 Water Main Separation

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§ 64572. Water Main Separation.
22 CA ADC § 64572
BARCLAYS OFFICIAL CALIFORNIA CODE OF REGULATIONS

Barclays Official California Code of Regulations Currentness
Title 22. Social Security
Division 4. Environmental Health
Chapter 16. California Waterworks Standards
Article 4. Materials and Installation of Water Mains and Appurtenances

22 CCR § 64572

§ 64572. Water Main Separation.

(a) New water mains and new supply lines shall not be installed in the same trench as, and shall be at least 10 feet horizontally from and one foot vertically above, any parallel pipeline conveying:

(1) Untreated sewage,

(2) Primary or secondary treated sewage,

(3) Disinfected secondary-2.2 recycled water (defined in section 60301.220),

(4) Disinfected secondary-23 recycled water (defined in section 60301.225), and

(5) Hazardous fluids such as fuels, industrial wastes, and wastewater sludge.

(b) New water mains and new supply lines shall be installed at least 4 feet horizontally from, and one foot vertically above, any parallel pipeline conveying:

(1) Disinfected tertiary recycled water (defined in section 60301.230), and

(2) Storm drainage.

(c) New supply lines conveying raw water to be treated for drinking purposes shall be installed at least 4 feet horizontally from, and one foot vertically below, any water main.

(d) If crossing a pipeline conveying a fluid listed in subsection (a) or (b), a new water main shall be constructed no less than 45-degrees to and at least one foot above that pipeline. No connection joints shall be made in the water main within eight horizontal feet of the fluid pipeline.

(e) The vertical separation specified in subsections (a), (b), and (c) is required only when the horizontal distance between a water main and pipeline is less than ten feet.

(f) New water mains shall not be installed within 100 horizontal feet of the nearest edge of any sanitary landfill, wastewater disposal pond, or hazardous waste disposal site, or within 25 horizontal feet of the nearest edge of any cesspool, septic tank, sewage leach field, seepage pit, underground hazardous material storage tank, or groundwater recharge project site.

(g) The minimum separation distances set forth in this section shall be measured from the nearest outside edge of each pipe barrel.

(h) With State Board approval, newly installed water mains may be exempt from the separation distances in this section, except subsection (f), if the newly installed main is:

(1) less than 1320 linear feet,

(2) replacing an existing main, installed in the same location, and has a diameter no greater than six inches more than the diameter of the main it is replacing, and

(3) installed in a manner that minimizes the potential for contamination, including, but not limited to:

(A) sleeving the newly installed main, or

(B) utilizing upgraded piping material

Note: Authority cited: Sections 116271, 116350 and 116375, Health and Safety Code. Reference: Sections 116275 and 116375, Health and Safety Code.

HISTORY

1. New section filed 2-8-2008; operative 3-9-2008 (Register 2008, No. 6).

2. Change without regulatory effect amending subsection (h) and Note filed 6-2-2015 pursuant to section 100, title 1, California Code of Regulations (Register 2015, No. 23).

This database is current through 5/3/19 Register 2019, No. 18

22 CCR § 64572, 22 CA ADC § 64572

END OF DOCUMENT

D.3.2 State Water Resources Control Board – Division of Drinking Water (SBDDW) 2017 - Separation of Water Mains and Non-Potable Pipelines – Requests for Alternatives to the Waterworks Standards

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CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board
Division of Drinking Water

December 14, 2017

Separation of Water Mains and Non-Potable Pipelines – Requests for Alternatives to the Waterworks Standards

Dear Public Water System Owners and Operators:

This letter supersedes prior guidance regarding the separation of water mains and non-potable pipelines, including Guidance Memo 2003-02, dated October 16, 2003. Guidance Memo 2003-02 and previous versions should be discarded.

The California Waterworks Standards (California Code of Regulations (CCR), Title 22, Division 4, Chapter 16, Section 64572) establish criteria for the separation of new water mains from non-potable pipelines. Public water systems should ensure that these distances are met, whenever feasible, for all new construction. The Division of Drinking Water (Division) recognizes that certain conditions may call for the installation of pipelines with less separation distance than what is required by the regulations. In these situations, the water system may propose an alternative pursuant to CCR, Title 22, Section 64551.100:

§64551.100. Waivers and Alternatives.

(a) A water system that proposes to use an alternative to a requirement in this chapter shall:

(1) Demonstrate to the State Board that the proposed alternative would provide at least the same level of protection to public health; and

(2) Obtain written approval from the State Board prior to implementation of the alternative.

In proposing an alternative to the Waterworks Standards, water systems should observe the following:

- The water system must accept responsibility for the adequacy of the proposed alternative. The Division may require a written statement, signed by the water system's management, certifying that the proposed alternative adequately protects public health.
- In most circumstances, the Division cannot offer technical assistance with pipeline or infrastructure design. The water system proposing an alternative must demonstrate adequate expertise on the part of its own personnel or its hired consultants.
- The water system should describe how the proposed alternative provides at least the same level of protection to public health as the minimum separation distances prescribed in the regulation.
- While exorbitant cost may present a hardship in meeting the regulatory separation requirements and can be considered, public health must be prioritized above construction costs in determining an acceptable alternative.

The Division has prepared an application checklist that may be used by water systems in proposing an alternative to the Waterworks Standards (Enclosure). The purpose of the checklist is to ensure that the Division has sufficient information to evaluate the proposal. **The water system may submit the information in a different format from the checklist, provided that the submittal provides adequate information.** The checklist may also be used to provide written certification that the proposed alternative adequately protects public health.

If you have any questions, please contact the Division office that oversees your water system.

Sincerely,

Darrin Polhemus, P.E.
Deputy Director
Division of Drinking Water

Enclosure: Waterworks Standards Main Separation Alternative Request Example Checklist

APPENDIX E: Water Supply Modeling

This appendix describes the existing water supply models used to simulate operations of the Regional Water System (RWS) and reservoir operations for Crystal Spring Reservoir (CSR) and Bear Gulch Reservoir, the two surface water reservoirs being considered for potable reuse as part of the PREP Phase 3 Study.

E.1 Hetch Hetchy Local Simulation Model (HHLSM)

The SFPUC has developed and maintained a monthly timestep water balance model called the Hetch Hetchy Local Simulation Model (HHLSM), which simulates RWS operations using historical hydrology from 1920 to 2017. HHLSM can be used to simulate the way that different combinations of RWS infrastructure and operational requirements would perform through the historical hydrology. For the PREP Phase 3 Study, the HHLSM model was primarily used to understand the amount of available storage space for purified water in the RWS in dry years, the associated water supply benefits for the RWS, and conversely to evaluate the amount of water that would “spill” from the RWS to make room for purified water when the reservoir system is full (e.g., primarily in wet years).

The HHLSM quantifies the amount of available storage in the RWS, including in the SFPUC Water Bank Account (Water Bank) in New Don Pedro Reservoir (Don Pedro). The Water Bank is typically the last RWS storage to be filled, and it is typically the first RWS storage to be emptied during droughts.

Figure E-1 illustrates the amount of available storage in the Water Bank during the 6-year drought and 6-year normal/wet period hydrologic flow regime. When water stored in the Water Bank is less than the maximum allowable account storage, there is room for new supplies to be added to the system, as indicated by the blue area. When the water bank is at the maximum account storage, then there is no room to capture or store additional water, and any additional inflow “spills” from the RWS system.

Figure E-2 illustrates the amount of upcountry “spill” (green line) that would occur during normal and wet years during current operations when there is insufficient room in the NDP Water Bank to store water. Over the 12-year sequence, approximately 6,350,000 AF (2 trillion gal) would “spill” during normal operations and approximately 1,057,000 AFY (340 billion gal per year) would “spill” on average during 6-year wet period.

During these “spill” periods, any new supplemental supplies, for example from a purified water project, would result additional releases from the system. However, under the proposed instream flow requirements in the Bay-Delta Water Quality Control Plan update, there would be more room for supplemental supplies as increases to required releases to the Tuolumne River would “free-up” space in the Water Bank more frequently than under current conditions.

Figure E-1: Available Water Storage in the Water Bank during Dry and Wet Periods

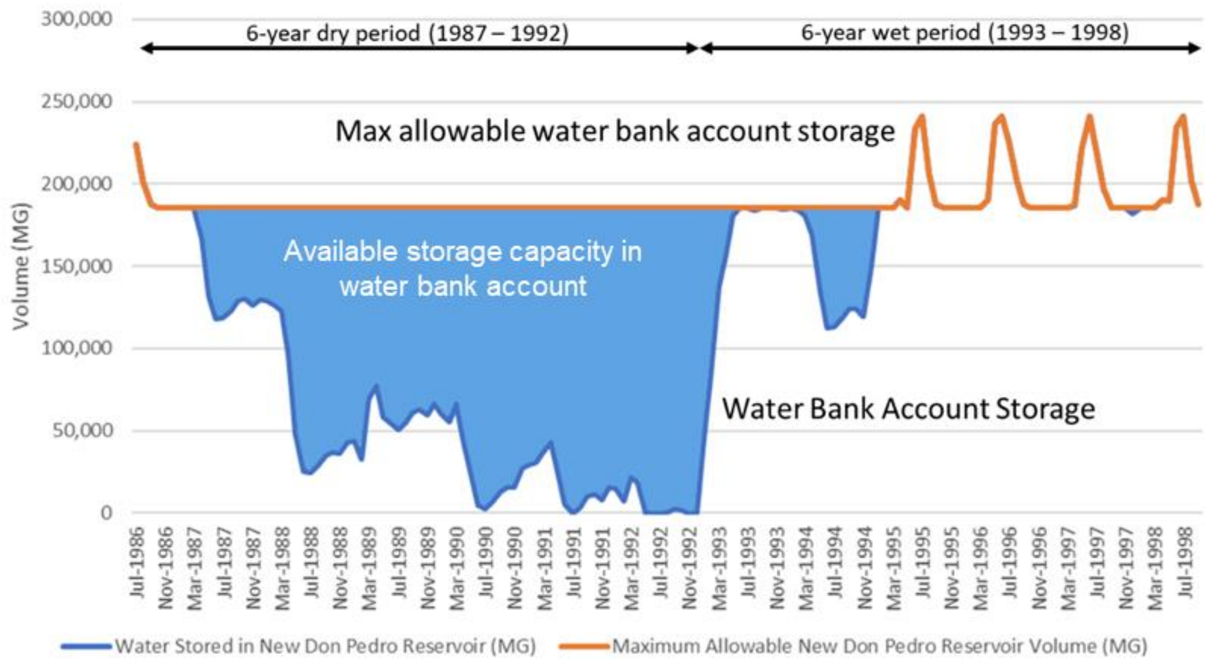
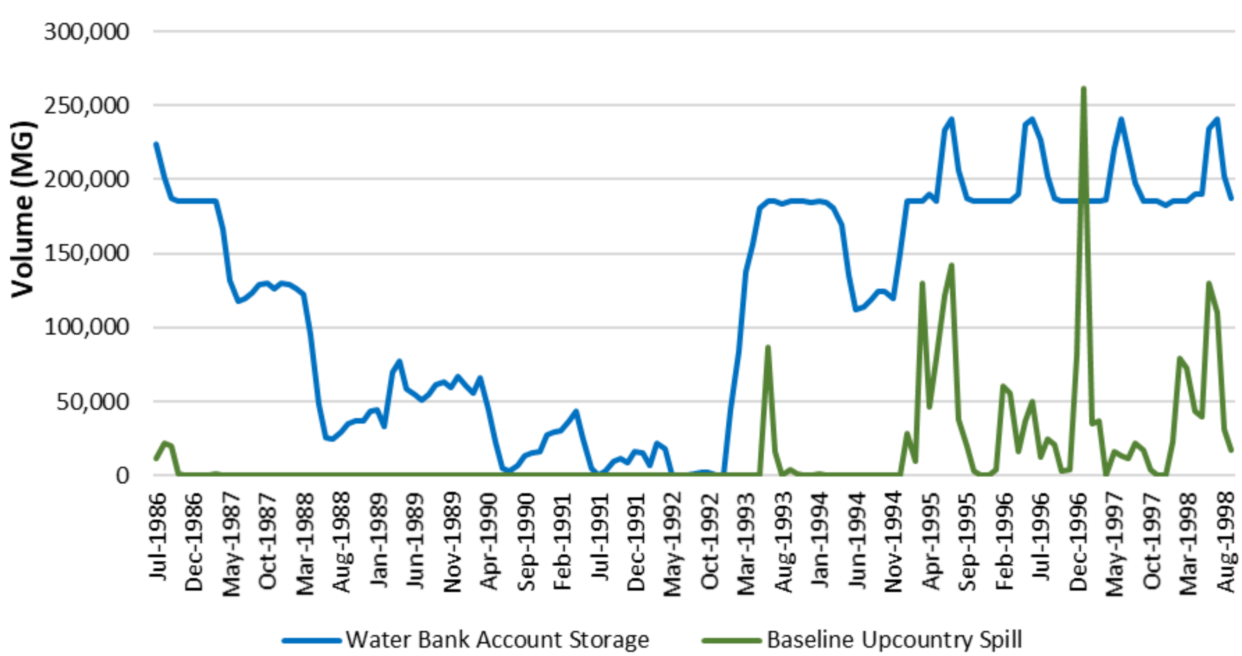


Figure E-2: Water Bank Account Storage and Spills Under Current Operational Scenarios



E.2 BAWSCA Regional Water Reliability Model

The Bay Area Water Supply BAWSCA has developed a Regional Water Reliability Model to develop BAWSCA's long-term reliable water supply strategy and support decision making. This model receives inputs from but is independent from the SFPUC's HHLSM model. BAWSCA's Regional Water Reliability Model also receives input through regional cooperation with Valley Water's Water Evaluation and Planning (WEAP) Model, Alameda County Water District's Integrated Resources Planning Model (IRPM) and other local supply information (e.g., Cal Water's Bear Gulch System). The study area includes the RWS downstream of San Antonio Reservoir through the City of San Francisco. The model provides member agency perspective on frequency, magnitude and timing of shortages based on each agencies demand and regional supplies. Hazen and Sawyer provided the PREP Parties output of modeled shortages from July 1986-2011 to simulate shortages by the PREP Parties during the defined hydrologic flow regimes.

Annual shortages were simulated by BAWSCA's Regional Water Reliability Model during the historical 6-year drought period that was used to evaluate the PREP project alternatives. These shortages are presented in Table E-1. The Cal Water Bear Gulch shortage ranged from 2.4 mgd in the winter to 4.5 mgd in the summer, while the combined Cal Water San Mateo/San Carlos shortage ranged from 3.7 mgd in the winter to 5.0 mgd in the summer. Foster City's shortage ranged from 0.4 mgd in the winter to 0.7 mgd in the summer and Redwood City's shortage ranged from 2.3 mgd in the winter to 3.1 mgd in the summer. A potable reuse project could serve to reduce or even eliminate these shortages in dry periods.

Table E-1: Summary of BAWSCA Regional Water Reliability Model – Shortages Output for PREP Water Suppliers

Fiscal Year	DPR RELEVANCE							
	Bear Gulch		SM/SC		Foster City		Redwood City	
	CWS Bear Gulch Diversion Shortage		CWS Bayshore Mid-Peninsula Diversion Shortage		EMID (Foster City) Shortage		Redwood City Diversion Shortage	
(FY)	(AF)	(mgd)	(AF)	(mgd)	(AF)	(mgd)	(AF)	(mgd)
1988	2,576	2.3	3,173	2.8	334	0.3	1,539	1.4
1989	3,013	2.7	3,586	3.2	383	0.3	1,748	1.6
1990	4,624	4.1	5,453	4.9	764	0.7	2,966	2.6
1991	3,587	3.2	4,405	3.9	551	0.5	2,292	2.0
1992	4,207	3.8	5,095	4.5	699	0.6	2,738	2.4
1993	1,348	1.2	2,766	2.5	392	0.4	1,524	1.4

E.3 Crystal Springs/San Andres Integrated Reservoir System Operations

E.3.1 Overview of the Integrated Reservoir System

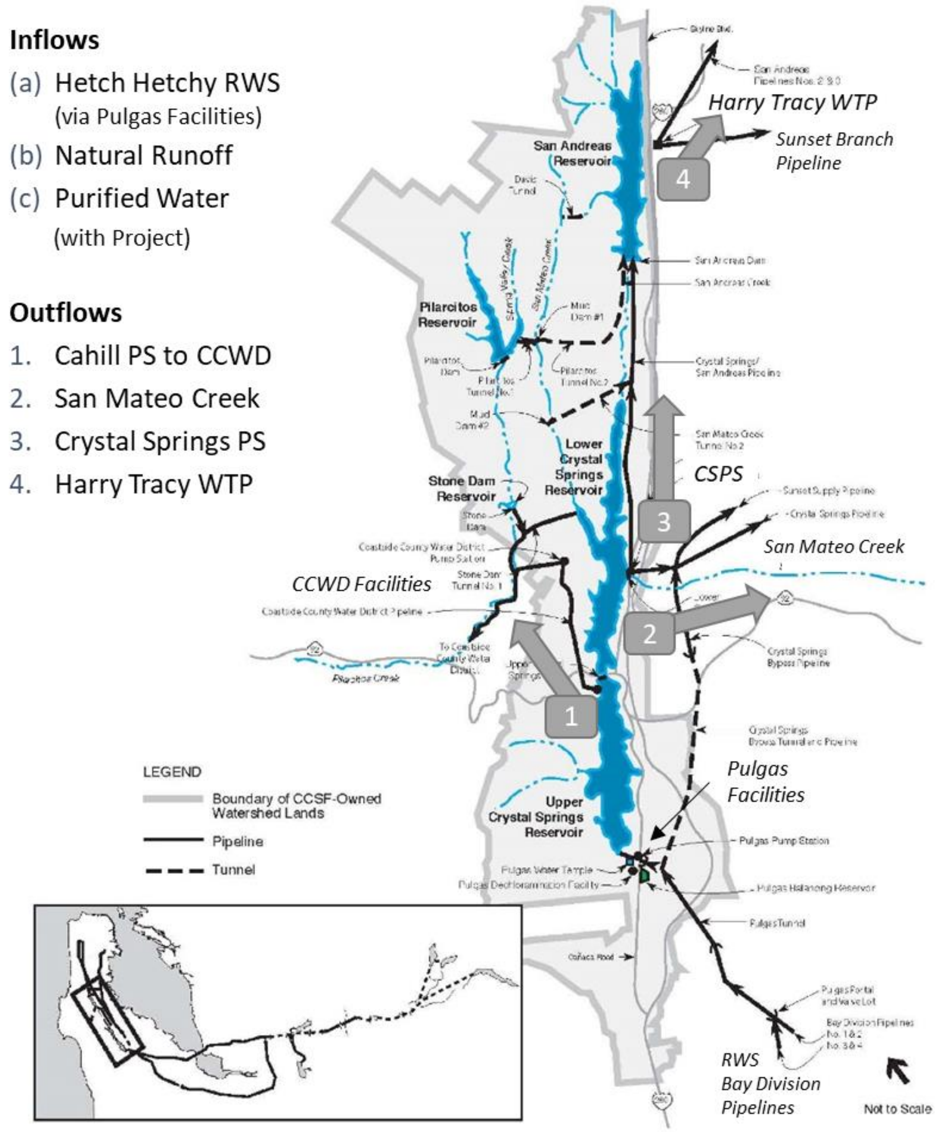
The Crystal Springs/San Andres Integrated Reservoir System consists of Upper Crystal Springs Reservoir (CSR), Lower CSR, and San Andreas Reservoir. Upper and Lower CSR are hydraulically connected via two culverts and are operated as a single reservoir. Lower CSR is connected to San Andreas Reservoir in the north via the Crystal Springs Pump Station (CSPS) and Crystal Springs-San Andreas pipeline. The two-reservoir system (CSR and San Andreas Reservoir) is owned and operated as part of the RWS.

When CSR is refilled with water from the Tuolumne River or the RWS East Bay watersheds, treated drinking water in the RWS transmission system is dechloraminated and discharged into Upper CSR at the Pulgas Facilities. Upper and Lower CSRs also capture water from local runoff their respective local watersheds. Water from the Pilarcitos Creek watershed is also periodically transferred to Lower CSR.

As illustrated in Figure E-3, there are three main outflows from the three-reservoir system.

1. Water is pumped out of Upper CSR through the Cahill Ridge Pump Station to **Coastside County Water District (CCWD)** facilities to supplement the other three sources of supply for use in Half Moon Bay. All CCWD water supplies are treated at the Nunes Water Treatment Plant (Nunes WTP), which has a capacity of 4.5 mgd.
2. Stream releases to **San Mateo Creek** occur at the release structures in Lower CSR Reservoir. Water is released from Lower Crystal Springs Dam to San Mateo Creek based on a release schedule defined as part of the Lower Crystal Springs Dam Improvement Project (SFPUC 2010). The minimum release depends on both the type of water year (normal/wet or dry) and time of year. In winter and spring of wetter years, additional releases from CSR to San Mateo Creek are commonly made to keep the reservoir storage at the operational target.
3. Water is pumped through the Crystal Springs Pump Station to San Andreas Reservoir, then to the **Harry Tracy Water Treatment Plant** east of the reservoir, where it is treated before being supplied to RWS drinking water customers. San Andreas Reservoir storage is generally maintained at seasonal target storage, so the CSPS rate tends to generally match Harry Tracy WTP production rate. Under typical operation, most of the water treated at Harry Tracy WTP flows to San Francisco, but there are a few wholesale turnouts along the way that include Daily City, City of South San Francisco, City of San Bruno, Westborough, North Coast County Water District, and the Crystal Springs Golf Course. When running at peak capacity, Harry Tracy WTP could be used to feed San Francisco and other RWS wholesalers on the peninsula, but that is not typical operation.

Figure E-3: Crystal Springs/San Andres Integrated Reservoir System - Inflows and Outflows



SOURCE: PEIR ON SFPUC WATER SYSTEM IMPROVEMENT PROGRAM / 203287

Other hydraulic features include open culverts that connect Upper and Lower CSR, which is not considered an outflow but instead a static condition, and the Crystal Springs Pump Station (CSPS), which conveys flows from Lower CSR to San Andres Reservoir. The Sunset Branch pipeline can convey untreated water from Lower CSR to RWS wholesalers on the peninsula, but as noted above this is not typical operation and would only be used in an extreme emergency when raw water flows are needed to fight a large fire for example.

CSR's large surface area (approximately 1,300 acres) and significant capacity (approximately 18 billion gallons), along with its existing infrastructure, make this reservoir a suitable reservoir for ResWA. The elongated shape with natural separations between each holding area is beneficial for meeting an extended retention time. The reservoir's overall large capacity provides for generous dilution even at high augmentation rates.

SFPUC's existing water treatment plant (Harry Tracy WTP) and the Pulgas Facilities at the southern end of CSR, including a dechloramination system and discharge facility, have sufficient capacity to accept purified water from a ResWA project. The Pulgas Facilities are further discussed in Appendix C. The following sections provide a high-level evaluation of estimated retention times, dilution, and source water quality to assess the viability of a ResWA project at CSR to meet existing regulations.

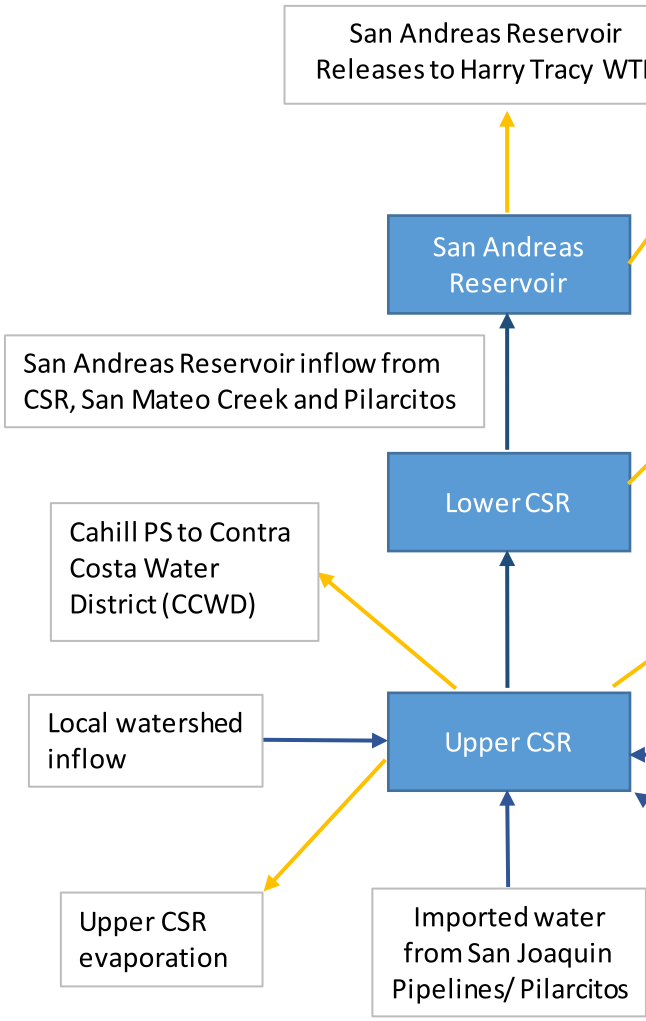
E.3.2 CSR Reservoir Operation Model

As part of the PREP Phase 3 effort, a CSR Reservoir Operations Model (CSR ROM) for Reservoir Water Augmentation was developed using a monthly time-step based on outputs from SFPUC's HHLSM model (described in Section E-1). The purpose of the CSR ROM is to:

1) Estimate the available storage in the RWS and the amount of Hetch Hetchy water that would "spill" in the upcountry system as a result of purified water addition to CSR, and
2) Simulate how a potable reuse project that introduces purified water into CSR would meet ResWA regulatory requirements for retention and dilution.

The ROM uses HHLSM data from 1987 to 1998 to represent the 12-year flow regime selected for the evaluation to represent both an extended 6-year dry period (1987 – 1992) and extended 6-year wet period (1993 – 1998). Model parameters include inflows, storage volumes, and outflows to Upper CSR, Lower CSR and San Andres reservoir, available storage in the RWS and releases to Harry Tracy WTP. A flow diagram for the CSR ROM is illustrated in Figure E-4.

Figure E-4: CSR ROM Flow Diagram



E.4 Bear Gulch Reservoir Operations

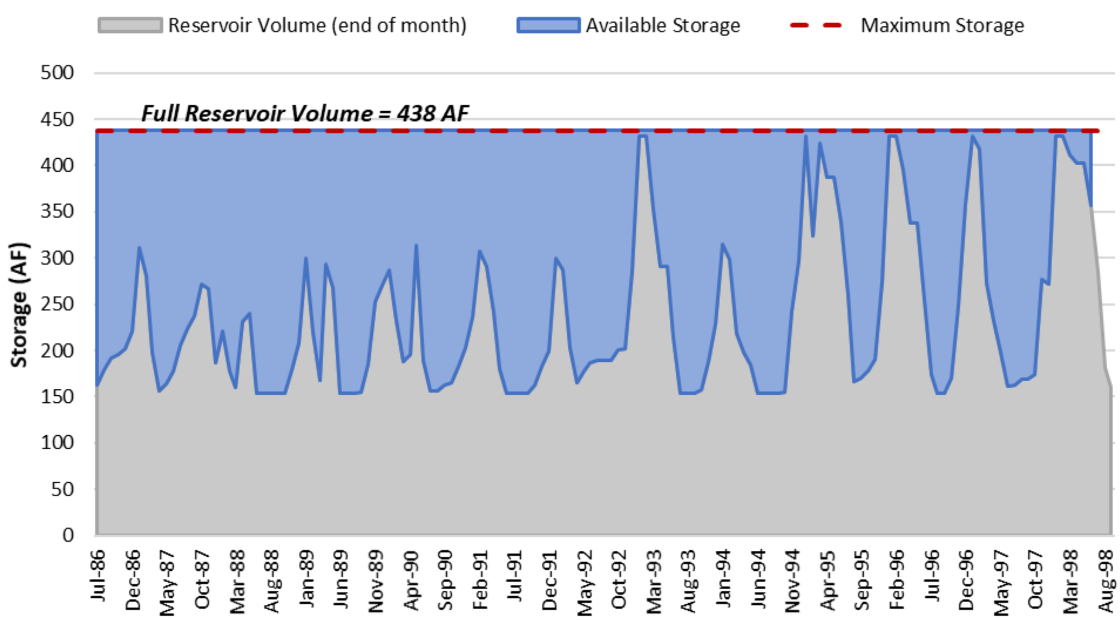
E.4.1 Overview of the Bear Gulch Reservoir System

Bear Gulch is a small reservoir located in a residential area in Atherton, owned and operated by the California Water Service Company (Cal Water). The reservoir provides 20 percent of water supply for the cities of Menlo Park, Atherton, Portola Valley, and Woodside. Bear Gulch is filled via runoff from the Santa Cruz Mountains that is captured by Woodside Diversion Dam, as well as water diverted from the upper and lower portions of Bear Gulch Creek near Manzanita Rd. in Woodside. Stored water is conveyed from the reservoir outlet to the Station 2 Filter Plant (shown in Figure E-5), which is also owned by Cal Water. The outflow is through the Filter Plant or drain is used for wet-weather emergencies only. Treated water is then distributed via a potable water transmission pipeline to 18,000 customer connections in the Bear Gulch System (Tenera Environmental, 2011).

Figure E-5: Bear Gulch Reservoir

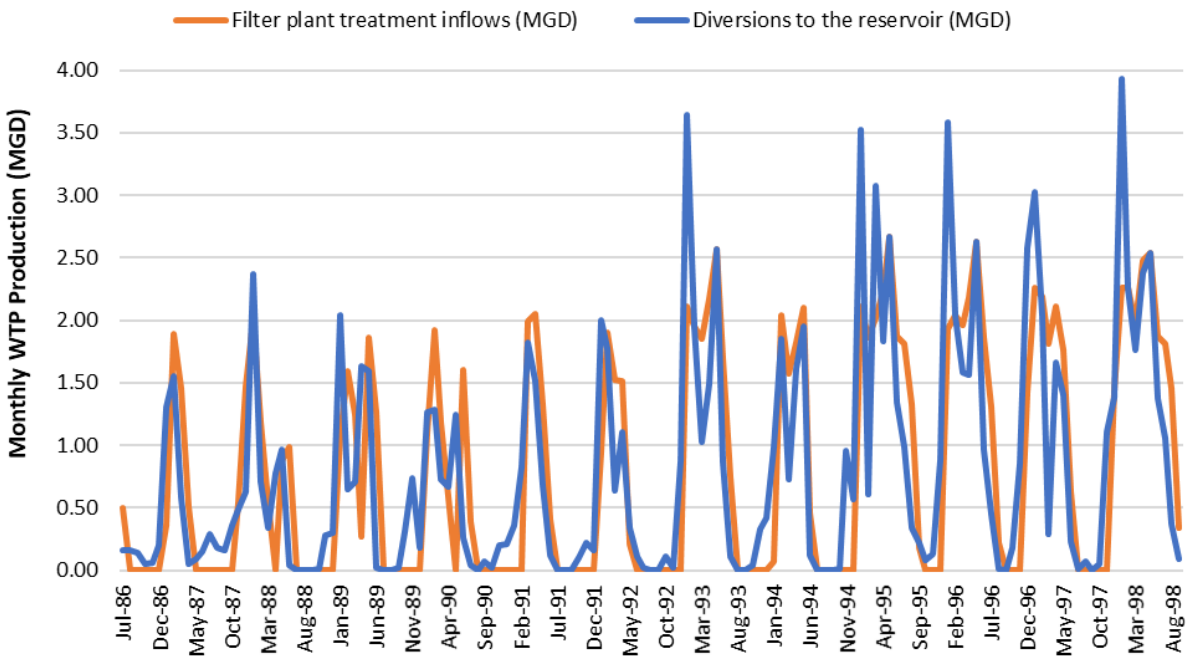
The current capacity of Bear Gulch Reservoir is 166 million gallons (MG), with a maximum operating elevation capacity of 143 MG (438 AF), and an emergency low, or base level capacity of 50 MG, at which point the filtration plant is shut down. The reservoir must be operated such that the water surface elevation does not drop more than 0.3 feet per day, including evaporation. In the summer months, the typical outflow is 0.7 mgd when the reservoir contains more than 50 MG. Winter outflows can range from 0.1 to 2.7 mgd. Storage data for the reservoir, provided by Cal Water for the 12-year flow period, is illustrated in Figure E-6, which shows the monthly historical storage levels in Bear Gulch Reservoir at the end of each month after accounting for diversions to the reservoir as well as outflows to the filter plant. There is a seasonal fluctuation in the reservoir levels due to inflow to the reservoir from natural runoff in the winter period and subsequently the filter plant does not operate year-round. The amount of storage available in the reservoir to add purified water would be limited in winter months and wet years unless operations were to be modified.

Figure E-6: Bear Gulch Reservoir Historical Storage Levels



The average daily inflows to the Filter Plant inflows and the total diversions to the reservoir is shown in Figure E-7, illustrating that the Filter Plant operation is timed to coincide with the wet winter months, when there are diversions to the reservoir. The total filter plant capacity is 6 mgd, however historically the average filter plant production was far less, ranging from 0.7 mgd to 1.2 mgd during the 6-year dry period and the 6-year wet period, respectively.

Figure E-7: Bear Gulch Reservoir Baseline Operations

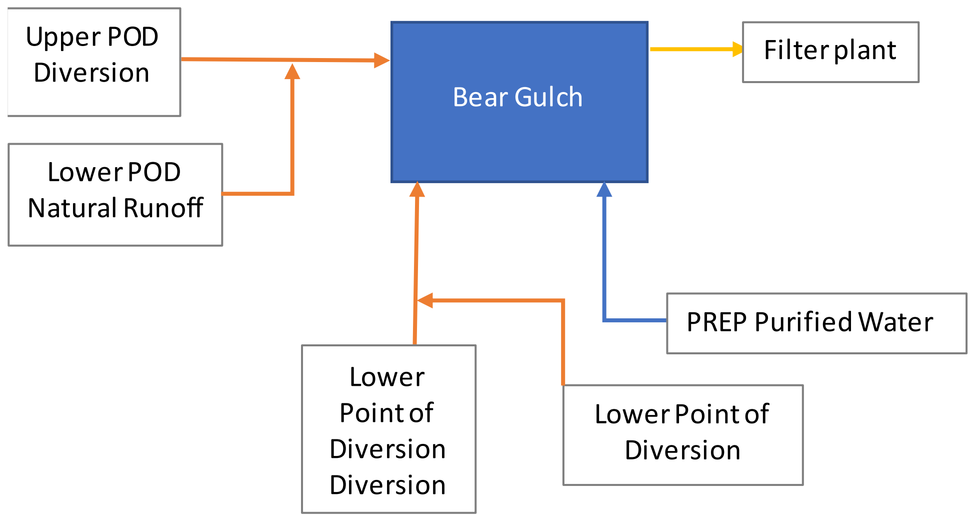


E.4.2 Bear Gulch Reservoir Operations Model

A Bear Gulch Reservoir Operations Model (BG ROM) was developed as a monthly time-step model, with similar operational considerations that were taken into account for the CSR ROM. Monthly data from 1987 to 1998, provided by Cal Water, was used to evaluate a RWA project at Bear Gulch Reservoir. Model parameters include inflows, storage volume, and outflows to the filter plant. A flow diagram for the BG ROM is illustrated in Figure E-8.

As previously discussed, historically, the filter plant at Bear Gulch has been operated at partial capacity during wet periods, when local diversions are used to fill the reservoir. For any RWA, the filter plant would be continuously operated at the full capacity (6 mgd) to utilize the augmented purified water. This change in operational practices would require significant upgrades to the treatment plant and reservoir, which is discussed in the following section.

Figure E-8: CSR ROM Flow Diagram



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APPENDIX F: Engineers Opinion of Probable Costs

This appendix includes a summary of the cost approach and detailed cost sheets for each sub-alternative.

F.1 Capital Cost Assumptions

The following assumptions are applied to estimate facility costs:

- **Distribution Pipelines:** unit costs used for pipeline costs are listed in Table F-1. Cost numbers are based on recently bid projects and professional experience.

Table F-1: Distribution Pipeline Unit Cost Assumptions

Construction Type	Unit	$/Unit	Location
Open Trench			
Regular	per inch-dia LF	$ 12-18	Unpaved roads, SFPUC ROW
Busy Areas	per inch-dia LF	$ 18-19	Heavy traffic and commercial areas
Environmental-Sensitive Areas	per inch-dia LF	$ 25	Along the bay
Microtunneling (<1000 ft Segment, 36 ft deep pit)			
Microtunneling	per inch-dia LF	$ 30	Under major intersections, highways, railroads
Jacking Pit (35 ft deep)	EA	$ 150,000	
Receiving Pit (35 ft deep)	EA	$ 100,000	
Modified Microtunneling (>1000 ft Segment, 60 ft deep pit)			
Microtunneling	per LF	$ 700-800	Belmont slough crossing at the end of Foster City Blvd.
Jacking Pit (60 ft deep)	EA	$ 2,000,000	
Receiving Pit (60 ft deep)	EA	$ 2,000,000	
Modified Microtunneling (>1000 ft Segment, 100 ft deep pit)			
Microtunneling	per LF	$ 700-800	Belmont slough crossing at the end of Baffin St.
Jacking Pit (100 ft deep)	EA	$ 2,000,000	
Receiving Pit (100 ft deep)	EA	$ 2,000,000	
Slip-lining			
Slip-lining	per inch-dia LF	$ 10	Inside existing SVCW pipelines to Shoreway Rd and to Woodside Rd.
Access Pits	EA	$ 150,000	
Receiving Pits	EA	$ 60,000	
Pipe Suspension			
Slip-lining	per LF	$ 300	East 3rd St. Bridge

Note: EA = Each (per unit)

- **Pump Stations:** Pumping costs were estimated based on brake Hp requirements, assuming different redundancy factors for different alternatives; pumps and motor control centers located outside; and variable speed pumps. A unit cost of $5,000 per Hp required is applied and multiplied by redundancy factors for standby pumps, enclosure, drive factor, wet-well and empirical coefficients based on pump station design experience. Land acquisition costs for pump stations are not included in the cost estimate.
- **Operational Storage:** The unit cost for new storage tanks (concrete and steel) is based on cost curves from RS Means, recently constructed projects in California, and from professional experience (range is from $0.60 to $1.00 per gallon).
- **AWPF:** Cost estimates for tertiary, MF, RO, UV-AOP, and chlorination facilities are provided based on recent projects, planning studies, and professional experience. Additional unit costs include post treatment and chemical handling, enclosed buildings, and off-site additional costs (e.g., new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc.). Loaded estimates of AWPF costs are within the range of similar facilities being designed or recently constructed by other California water agencies (between $8/gal to $16/gal depending on capacity and other factors).
- **Nutrient Removal:** There are a variety of established technologies and new innovative strategies that could be implemented to reduce nutrients prior to reuse, with a wide range of costs. Additional studies would be needed to identify a preferred treatment alternative that would meet the potable reuse requirements. These would need to be further explored with the RWQCB /SBDDW and with SVCW to provide a nexus with their long-term nutrient management objectives.
    - Nutrient Removal for ResWA: assuming breakpoint chlorination is the selected treatment technology, and unit cost of $0.0002/gallon was used. This cost only includes chemical dosing costs which includes sodium hypochlorite dosing for breakpoint chlorination followed by sodium bisulfite dosing for dechlorination. It was assumed that the existing breakpoint chlorination contact infrastructure at Pulgas would be sufficient. Additional capital costs were included for 2, 1 MG storage tanks for equalization during low flow periods and for additional chemical dosing pumps and storage tanks. These costs are not represented in the unit cost of $0.0002/gallon.
    - Nutrient Removal for RWA: similar to nutrient removal for ResWA, breakpoint chlorination was assumed to be the selected treatment technology at the same unit cost of $0.0002/gallon. These again include chemical costs for sodium hypochlorite and sodium bisulfite. Although no breakpoint chlorination infrastructure exists at bear gulch, it is assumed that breakpoint chlorination may be performed in the conveyance pipeline to bear gulch. Additional capital costs for chemical dosing and storage were also included, but not represented in the unit cost of $0.0002/gallon.

- Nutrient Removal for TWA: unlike nutrient removal for ResWA and RWA, ammonia may not need to be removed and be used to generate chloramine disinfectants as SFPUC currently uses chloramines in the drinking water. Still, significant testing is needed to validate this treatment approach. The unit costs for chloramination are assumed to be $0.000085/gallon and include the dosing chemical costs for chlorine and ammonia. Capital costs for chemical dosing and storage are also included, but not represented in the $0.000085/gallon unit costs.

- **Other cost benefits**: from an integrated water management approach could be realized; resulting in cost and energy savings to the community that are worth investigating.

The following allowances, contingencies, and non-contract cost percentages are applied to the **Subtotal Facility Costs:**

- **Additional Facility Capital Costs:** The following percentages are applied to subtotal of treatment, pump station, storage, discharge facility, and well costs: site development costs at 5 percent; yard piping at 5 percent; and Electrical, Instrumentation and Controls (I&C), and Remote (low-tech) Control at 15 percent.
- **Taxes:** 8.75 percent is applied to materials (estimated at 40 percent of the total facility cost).

The following allowances, contingencies, and non-contract cost percentages are applied to the **Facility Direct Costs**:

- **Allowance for Unlisted Items:** A markup of 5 percent for mobilization, bonds, and permits; 10 percent for engineering and design; 15 percent for construction management; 15 percent for owner's administration; 5 percent for environmental/permitting; and 15 percent for Contractor Overhead and Profit are applied to the facility direct costs.
- **Estimated Contingency:** A markup of 40 percent of the facility direct costs was added to pay contractors for overruns on quantities, changed site conditions, change orders, etc. Contingencies are considered as funds to be used after construction starts and not for design changes or changes in project planning.

The resulting **Subtotal with Contractor Markups and Contingency** is increased by 3 percent per year to reflect escalation to midpoint of construction, based on project implementation timeline assumptions (start and end date of 2026 and 2029 respectively).

The **Project Capital Cost** includes all facility costs, allowances, markups, contingencies, and the escalation to the midpoint of construction. Costs are provided in January 2019 dollars using the Engineering News-Record Construction Cost Index (ENRCCI) for San Francisco.

F.2 O&M Cost Assumptions

Operations and maintenance (O&M) costs are estimated to include the following items:

- **Energy Cost:** The cost for power varies diurnally and seasonally, thus energy costs are estimated to be $0.20/kWh for continuous treatment and pumping. A factor of 10 percent is applied to all energy costs.
- **Labor Costs:** Treatment-related labor is based on a full-time salary with benefits of $175,000 per year. Labor for other work such as work related to pipelines, pump stations, and customer service is based on a full-time salary with benefits of $125,000 per year.
- **Chemical Costs:** for advanced treatment processes is estimated at approximately $100 per acre foot of purified water produced for pre-treatment to minimize fouling and post-treatment to stabilize the RO permeate and meet regulatory requirements. Chemicals may include, but are not limited to sodium hypochlorite, sodium bisulfite, citric acid, caustic soda, sulfuric acid, scale inhibitors, lime, carbon dioxide, chlorine, etc. Dechloramination chemical costs are based on current unit costs and doses at the Pulgas Dechloramination Facility provided by SFPUC (September 2021), which are estimated to be approximately $61/MG. Breakpoint chlorination chemical costs are also based on current unit costs and doses at the Pulgas Dechloramination Facility provided by SFPUC (September 2021), which are estimated to be approximately $200/MG. Chloramination costs were based on current unit costs provided by SFPUC (September 2021) for sodium hypochlorite and anhydrous ammonia costs were based on the average anhydrous ammonia costs from 2009 to 2020 taken from the Agricultural Marketing Services and reported on the website FarmDocDaily from the University of Illinois at Urbana Champaign. The estimated cost is approximately $85/MG.
- **Maintenance Costs:** A unit cost of $170/AF is included to account for replacement and repair of AWPF facility membranes, UV lights, and other AWPF process equipment. General maintenance costs for other items are estimated at 1.5 percent of capital costs (not including the AWPF)**.**
- **Contingency**: A contingency of 10 percent of the subtotal of O&M costs is also included.

F.3 Ramping Down and Shutting Down AWPF

Ramp down or shutdown scenarios occur during a wet year where the demand for recycled water is low, and the treatment plant is required to reduce treatment capacity. The primary treatment process that requires special consideration during reduced treatment demand are RO membranes. RO membranes generally cannot be out of service for more than 24 hours and if removed from service for more than 24 hours, the membranes should be preserved by a solution of 500-1000 mg/L sodium bisulfite. During a ramp-down scenario, a common practice is to rotate operational RO skids daily to ensure membranes remain wet and in operation and is not expected to be labor intensive. Therefore, no additional O&M costs were assumed in a ramp-down scenario. For a shut-down scenario, membrane preservation is required and assumed to cost ~$8,333/MG per year ($50,000/year for 6 mgd plant shutdown, $100,000/year for 12 mgd plant shutdown). These costs include chemical costs for sodium bisulfite (1000 mg/L preservation solution) and operator time for preservation assumed to occur every two weeks. A summary of ramp down and shutdown cost assumptions is provided in Table F.2.

Table F-2: Ramp Down and Shutdown Cost Assumptions

		6-mgd Capacity			12-mgd Capacity		
		CONTINUOUS	WET YEAR RAMP DOWN	WET YEAR SHUT DOWN	CONTINUOUS	WET YEAR RAMP DOWN	WET YEAR SHUT DOWN
Wet Year	(mgd)	6	4.5	3	12	9	6
Dry Year	(mgd)	6	6	6	12	12	12

Purified Water Delivered and Use:	**6-mgd Capacity ResWA**				**12-mgd Capacity ResWA**				**6-mgd Capacity RWA**		**6-mgd Capacity TWA**			**12-mgd Capacity TWA**
Flow Scenarios:	**Continuous**		**Wet Year Ramp Down**	**Wet Year Shut Down**	**Continuous**		**Wet Year Ramp Down**	**Wet Year Shut Down**	**Continuous**	**Wet Year Ramp Down**	**Continuous**			**Continuous**
Alts:	**1a**	**1b**	**1c**	**1d**	**2a**	**2b**	**2c**	**2d**	**3a**	**3b**	**4a**	**4b**	**4c**	**5**
TOTAL Annual O&M Costs ($mil/year)	**$8.6**	**$9.4**	**$7.9**	**$7.4**	**$16.3**	**$15.5**	**$15.1**	**$14.1**	**$6.3**	**$6.1**	**$3.9**	**$4.2**	**$3.2**	**$17.3**
Δ Annual O&M Costs (%)	n/a	n/a	-7%	-14%	n/a	n/a	-7%	-13%	n/a	-4%	n/a	n/a	n/a	n/a
Annual Unit O&M Costs ($/AF)	**1,275**	**1,396**	**1,349**	**1,459**	**1,209**	**1,157**	**1,286**	**1,399**	**945**	**1,032**	**582**	**631**	**470**	**1,286**
Δ Annual Unit O&M Costs (%)	n/a	n/a	6%	14%	n/a	n/a	6%	16%	n/a	9%	n/a	n/a	n/a	n/a

F.4 Engineers Opinion of Probable Costs

This appendix includes an overall cost summary by facility components and supporting detailed treatment and conveyance cost sheets.

Overall Cost Summary: by facility component for Alternatives 1 to 5 and Hybrid A and B projects

Treatment Cost Sheets:

ALTERNATIVES

- Reservoir Water Augmentation at CSR – Treatment + Storage + Discharge Facility – 6 mgd IPR
- Reservoir Water Augmentation at CSR – Treatment + Storage + Discharge Facility – 12 mgd IPR
- Raw Water Augmentation at Bear Gulch – Treatment + Storage + Discharge Facility – 6 mgd DPR
- Treated Water Augmentation – Treatment + Storage + Discharge Facility – 6 mgd DPR
- Treated Water Augmentation – Treatment + Storage + Discharge Facility – 12 mgd DPR

PROPOSED TITLE XVI PROJECT

- HYBRID A - Phase 1 | Treated Water Augmentation - Treatment + Storage - 6 MGD DPR sized for future 12MGD capacity
- HYBRID A - Phase 2 | Treated Water Augmentation - Treatment + Storage - Expansion to 12 MGD DPR Capacity
- HYBRID B - Phase 1 | Reservoir Water Augmentation at CSR - Treatment + Storage + Discharge Facility - 6 MGD IPR
- HYBRID B - Phase 2 | Treated Water Augmentation - Treatment + Storage - 6 MGD DPR

Conveyance Cost Sheets:

ALTERNATIVES

- 1a – Reservoir Water Augmentation at CSR – Pipelines + Pump Stations – AWPF near SVCW Site – 6 mgd IPR
- 1b – Reservoir Water Augmentation at CSR – Pipelines + Pump Stations – AWPF at HWY 101 Site – 6 mgd IPR
- 2a – Reservoir Water Augmentation at CSR – Pipelines + Pump Stations – AWPF near SVCW Site – 12 mgd IPR
- 2b – Reservoir Water Augmentation at CSR – Pipelines + Pump Stations – AWPF at HWY 101 Site – 12 mgd IPR
- 3a-b – Raw Water Augmentation at Bear Gulch – Pipelines + Pump Stations – 6 mgd DPR
- 4a – Treated Water Augmentation – Pipelines + Pump Stations + POC to Redwood City/CalWater – 6 mgd DPR
- 4b – Treated Water Augmentation – Pipelines + Pump Stations + POC to Redwood City/CalWater – 6 mgd DPR
- 4c – Treated Water Augmentation – Pipelines + Pump Stations + POC to Foster City/CalWater – 6 mgd DPR
- 5 – Treated Water Augmentation – Pipelines + Pump Stations + POC to Redwood City/CalWater – 12 mgd DPR

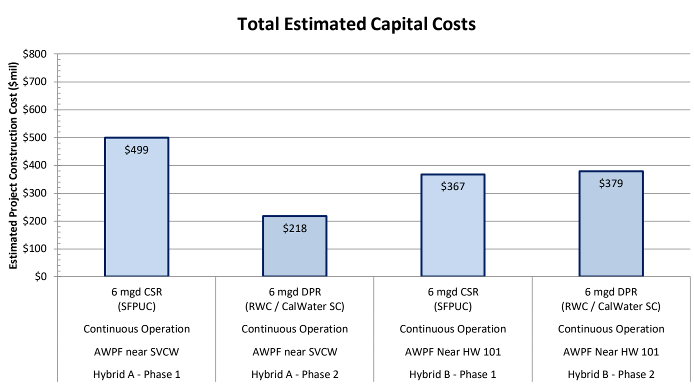
PROPOSED TITLE XVI PROJECT

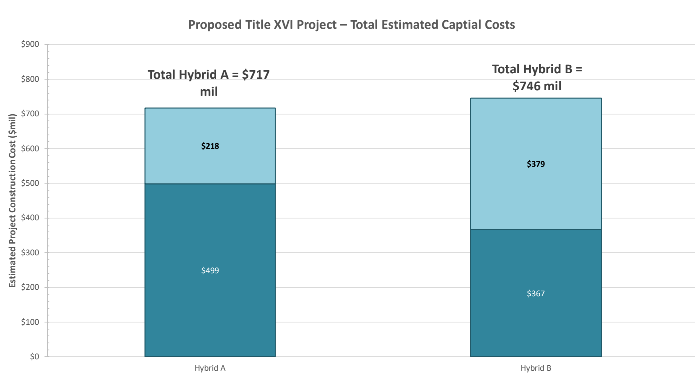
- HYBRID A - Phase 1 | ResWA at CSR - Pipelines + Pump Stations - AWPF near SVCW Site - 12 MGD Capacity
- HYBRID A - Phase 2 | Pipelines + Pump Stations from San Mateo to AWPF near SVCW Site + POC to Redwood City/CalWater – 6 mgd DPR
- HYBRID B - Phase 1 | ResWA at CSR - Pipelines + Pump Stations - AWPF at HWY 101 Site - 12 MGD Capacity
- HYBRID B - Phase 2 | Pipelines + Pump Stations from San Mateo to AWPF at HWY 101 Site + POC to Redwood City/CalWater – 6 mgd DPR

PREP Phase 3 | COST SUMMARY TABLE

Sub-Alternative	Hybrid A - Phase 1	Hybrid A - Phase 2	Hybrid B - Phase 1	Hybrid B - Phase 2
AWPF Location	AWPF near SVCW	AWPF near SVCW	AWPF Near HW 101	AWPF Near HW 101
Operations	Continuous Operation	Continuous Operation	Continuous Operation	Continuous Operation
Receiving Water System	6 mgd CSR (SFPUC)	6 mgd DPR (RWC / CalWater SC)	6 mgd CSR (SFPUC)	6 mgd DPR (RWC / CalWater SC)
Source Water	SVCW (~8 mg)	San Mateo (~8 mgd) blended with SVCW	SVCW (~8 mgd)	San Mateo (~8 mgd)
Average Purified Water Deliveries (Assumed Wet and Dry Years)				
Purified Water Produced (mgd)	**6.0**	**6.0**	**6.0**	**6.0**
Purified Water Produced (AFY)	**6,720**	**6,720**	**6,720**	**6,720**
Ave Annual Displaced Water or "Spill"	**2,430**	**2,430**	**2,430**	**2,430**
Purified Water Benefit (AFY)	**4,290**	**4,290**	**4,290**	**4,290**
Dry Year Average Spill (AFY)	**378**	**378**	**378**	**378**
Wet Year Average Spill (AFY)	**4,485**	**4,485**	**4,485**	**4,485**
Purified Water Benefit (mgd)	**3.8**	**3.8**	**3.8**	**3.8**
Facility Component				
Treatment	$329,000,000	$140,000,000	$208,000,000	$290,000,000
Pipelines	$112,000,000	$73,000,000	$101,000,000	$79,000,000
Pump Station	$40,000,000	$5,000,000	$44,000,000	$5,000,000
Storage	$7,000,000	$0	$4,200,000	$4,600,000
Reservoir Facility Improvements	$10,500,000	$0	$9,600,000	$0
Total Est. Capital Cost ($)	**$498,500,000**	**$218,000,000**	**$366,800,000**	**$378,600,000**
Estimated Capital Cost ($mil)	**$499**	**$218**	**$367**	**$379**
Annualized Capital Cost ($mil/yr)	$20.7	$9.2	$15.0	$13.7
Annualized Unit Capital Cost for Produced Water ($/AF)	**$3,080**	**$1,370**	**$2,240**	**$2,040**
Annual O&M Cost ($/yr)	$15,028,000	$17,109,000	$12,100,000	$24,920,000
Annual Unit O&M Cost for Purified Water Produced/Delivered ($/AF)	**$2,240**	**$2,550**	**$1,800**	**$3,710**
Annulaized Project Unit Cost for Purified Water Produced/Delivered ($/AF)	**$5,320**	**$3,920**	**$4,040**	**$5,750**
Unit Cost ($/CCF)	$0.0	$0.0	$14.5	$20.6
Unit Cost ($/gal)	$0.000	$0.000	$0.019	$0.028
Average Annual Cost of Purified Water Produced/Delivered ($mil)	**$35.8**	**$26.3**	**$27.1**	**$38.6**
Average Annual Cost of "Spill" ($mil)	**$12.9**	**$9.5**	**$9.8**	**$14.0**
Dry Year Average Annual Cost of "Spill" ($mil)	**$2.0**	**$1.5**	**$1.5**	**$2.2**
Wet Year Average Annual Cost of "Spill" ($mil)	**$23.9**	**$17.6**	**$18.1**	**$25.8**

PREP Phase 3 | COST SUMMARY BAR CHARTS



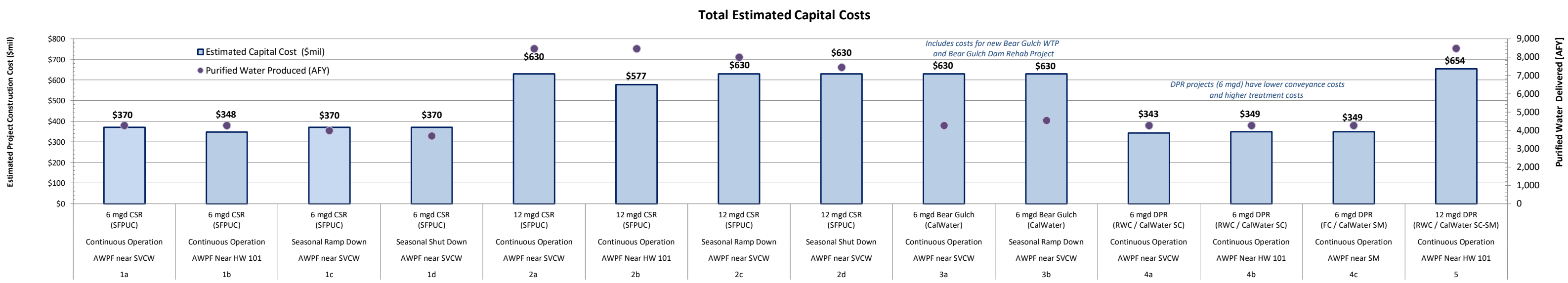


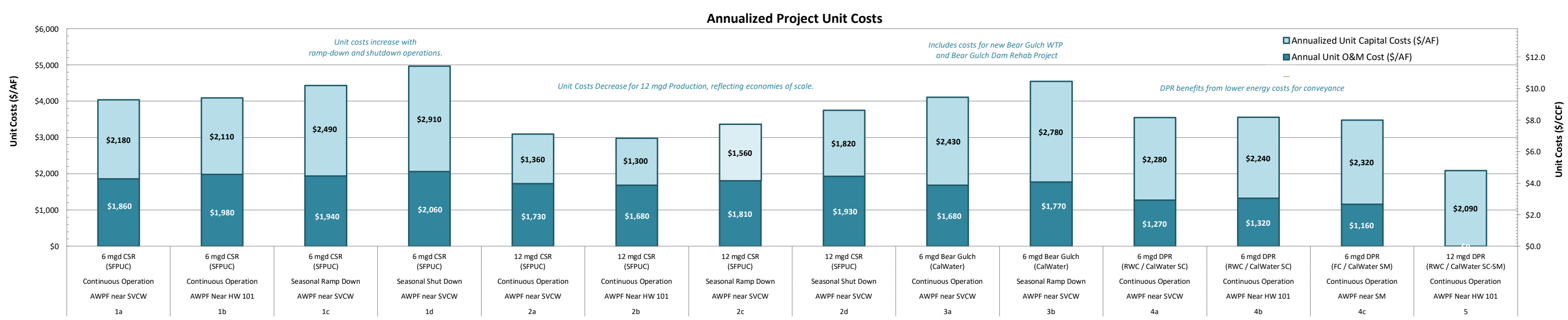
PREP Phase 3 | COST SUMMARY TABLE

102%   21%

Sub-Alternative	1a	1b	1c	1d	2a	2b	2c	2d	3a	3b	4a	4b	4c	5
AWPF Location	AWPF near SVCW	AWPF Near HW 101	AWPF near SVCW	AWPF near SVCW	AWPF near SVCW	AWPF Near HW 101	AWPF near SVCW	AWPF near SVCW	AWPF near SVCW	AWPF near SVCW	AWPF near SVCW	AWPF Near HW 101	AWPF near SM	AWPF Near HW 101
Operations	Continuous Operation	Continuous Operation	Seasonal Ramp Down	Seasonal Shut Down	Continuous Operation	Continuous Operation	Seasonal Ramp Down	Seasonal Shut Down	Continuous Operation	Seasonal Ramp Down	Continuous Operation	Continuous Operation	Continuous Operation	Continuous Operation
Receiving Water System	6 mgd CSR (SFPUC)	6 mgd CSR (SFPUC)	6 mgd CSR (SFPUC)	6 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	12 mgd CSR (SFPUC)	6 mgd Bear Gulch (CalWater)	6 mgd Bear Gulch (CalWater)	6 mgd DPR (RWC / CalWater SC)	6 mgd DPR (RWC / CalWater SC)	6 mgd DPR (FC / CalWater SM)	12 mgd DPR (RWC / CalWater SC-SM)
Source Water	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)		SVCW (~8 mg) + San Mateo (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mgd)	SVCW (~8 mg) + San Mateo (~8 mgd)
Average Purified Water Deliveries (Assumed Wet and Dry Years)														
Purified Water Produced (mgd)	6.0	6.0	5.3	4.5	12.0	12.0	10.5	9.0	6.0	5.3	6.0	6.0	6.0	12.0
Purified Water Produced (AFY)	6,720	6,720	5,880	5,040	13,440	13,440	11,760	10,080	6,720	5,880	6,720	6,720	6,720	13,440
Ave Annual Displaced Water or "Spill"	2,430	2,430	1,880	1,320	4,960	4,960	3,750	2,630	2,431	1,324	2,431	2,431	2,431	4,958
Purified Water Benefit (AFY)	4,290	4,290	4,000	3,720	8,480	8,480	8,010	7,450	4,289	4,556	4,289	4,289	4,289	8,482
Dry Year Average Spill (AFY)	378	378	236	95	880	880	473	190						
Wet Year Average Spill (AFY)	4,485	4,485	3,512	2,539	9,037	9,037	7,024	5,078						
Purified Water Benefit (mgd)	3.8	3.8	3.6	3.3	7.6	7.6	7.2	6.7	3.8	4.1	3.8	3.8	3.8	7.6
Facility Component														
Treatment	$227,000,000	$208,000,000	$227,000,000	$227,000,000	$385,000,000	$346,000,000	$385,000,000	$385,000,000	$459,000,000	$459,000,000	$301,000,000	$290,000,000	$306,000,000	$466,000,000
Pipelines	$105,000,000	$99,000,000	$105,000,000	$105,000,000	$184,000,000	$166,000,000	$184,000,000	$184,000,000	$66,000,000	$66,000,000	$31,000,000	$47,000,000	$29,000,000	$147,000,000
Pump Station	$24,000,000	$27,000,000	$24,000,000	$24,000,000	$45,000,000	$49,000,000	$45,000,000	$45,000,000	$20,000,000	$20,000,000	$7,000,000	$8,000,000	$10,000,000	$34,000,000
Storage	$4,200,000	$4,200,000	$4,200,000	$4,200,000	$6,400,000	$6,400,000	$6,400,000	$6,400,000	$4,600,000	$4,600,000	$4,200,000	$4,200,000	$4,200,000	$7,000,000
Reservoir Facility Improvements	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$9,600,000	$80,700,000	$80,700,000	n/a	n/a	n/a	n/a
Total Est. Capital Cost ($)	**$369,800,000**	**$347,800,000**	**$369,800,000**	**$369,800,000**	**$630,000,000**	**$577,000,000**	**$630,000,000**	**$630,000,000**	**$630,300,000**	**$630,300,000**	**$343,200,000**	**$349,200,000**	**$349,200,000**	**$654,000,000**
Estimated Capital Cost ($mil)	**$370**	**$348**	**$370**	**$370**	**$630**	**$577**	**$630**	**$630**	**$630**	**$630**	**$343**	**$349**	**$349**	**$654**
Annualized Capital Cost ($mil/yr)	$14.7	$14.2	$14.7	$14.7	$18.3	$17.4	$18.3	$18.3	$16.3	$16.3	$15.3	$15.0	$15.6	$28.1
Annualized Unit Capital Cost for Produced Water ($/AF)	**$2,180**	**$2,110**	**$2,490**	**$2,910**	**$1,360**	**$1,300**	**$1,560**	**$1,820**	**$2,430**	**$2,780**	**$2,280**	**$2,240**	**$2,320**	**$2,090**
Annual O&M Cost ($/yr)	$12,500,000	$13,300,000	$11,400,000	$10,400,000	$23,300,000	$22,600,000	$21,300,000	$19,500,000	$11,300,000	$10,400,000	$8,518,000	$8,850,000	$7,826,000	#VALUE!
Annual Unit O&M Cost for Purified Water Produced/Delivered ($/AF)	**$1,860**	**$1,980**	**$1,940**	**$2,060**	**$1,730**	**$1,680**	**$1,810**	**$1,930**	**$1,680**	**$1,770**	**$1,270**	**$1,320**	**$1,160**	**#VALUE!**
Annulaized Project Unit Cost for Purified Water Produced/Delivered ($/AF)	**$4,040**	**$4,090**	**$4,430**	**$4,970**	**$3,090**	**$2,980**	**$3,370**	**$3,750**	**$4,110**	**$4,550**	**$3,550**	**$3,560**	**$3,480**	**#VALUE!**
Unit Cost ($/CCF)	$14.5	$14.7	$15.0	$15.5	$11.3	$10.8	$11.4	$11.7	$14.8	$13.5	$12.8	$12.8	$12.5	#VALUE!
Unit Cost ($/gal)	$0.019	$0.020	$0.020	$0.021	$0.015	$0.015	$0.015	$0.016	$0.020	$0.018	$0.017	$0.017	$0.017	#VALUE!
Average Annual Cost of Purified Water Produced/Delivered ($mil)	**$27.1**	**$27.5**	**$26.0**	**$25.0**	**$41.5**	**$40.1**	**$39.6**	**$37.8**	**$27.6**	**$26.8**	**$23.9**	**$23.9**	**$23.4**	**#VALUE!**
Average Annual Cost of "Spill" ($mil)	**$9.8**	**$9.9**	**$8.3**	**$6.6**	**$15.3**	**$14.8**	**$12.6**	**$9.9**	**$10.0**	**$6.0**	**$8.6**	**$8.7**	**$8.5**	**#VALUE!**
Dry Year Average Annual Cost of "Spill" ($mil)	**$1.5**	**$1.5**	**$1.0**	**$0.5**	**$2.7**	**$2.6**	**$1.6**	**$0.7**						
Wet Year Average Annual Cost of "Spill" ($mil)	**$18.1**	**$18.3**	**$15.6**	**$12.6**	**$27.9**	**$26.9**	**$23.7**	**$19.0**						

PREP Phase 3 | COST SUMMARY BAR CHARTS





Engineers Opinion of Probable Cost
Reservoir Water Augmentation at CSR - Treatment + Storage + Discharge Facility - 6 MGD IPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	**Average Annual Influent Flow:**	7.84 mgd
Project:	ResWA at Crystal Springs Reservoir	**Date Prepared:**	Sep-2021	**Average Annual Product Flow:**	6.00 mgd
				RW Produced:	6720 Average Annual Production (AFY)
				Spill:	2431 Average Annual Spill (AFY)
				RW Benefit:	4290 Average Annual Benefit (AFY)
AWPF Location:	AWPF at HW 101 Site or near SVCW	**K/J Proj. No.**	1668011.03	**Design Capacity:**	4,167 Max Day Demand (gpm)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*		
Estimate:	Conceptual Level Cost-Analysis				

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment, Storage and Discharge								
Facility Capital Costs - Part 1								
1.0	**Treatment**				52,430,196			**Unloaded Unit Treatment Costs**
1.1	Microfiltration	7.8	MGD	$ 1,600,000	12,549,020	**30**	**640,242**	AWTF = $8.7 /gal before contingencies
1.2	Reverse Osmosis	7.1	MGD	$ 2,400,000	16,941,176	**30**	**864,326**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 500,000	3,000,000	**30**	**153,058**	Total Treatment = $8.7 /gal before contingencies
1.4	Free Chlorine	6.0	MGD	$ 100,000	600,000	**30**	**30,612**	**Increased building cost for more complicated sites**
1.5	Post Treatment and Chem Handling	6.0	MGD	$ 800,000	4,800,000	**50**	**186,554**	SVCW Site = $10.2 million b/c of need for piles in bay mud
1.6	Building (standard)	30,000	SF	$ 250	7,500,000	**75**	**252,510**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
1.7	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.2	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.10	Breakpoint Chlorination Dosing - Chemical/Storage	1	LS	$ 200,000.00	200,000	**50**	**7,773**	Additional chemical dosing and storage at Pulgas OR new facilities at the AWPF
1.11	Breakpoint Chlorination - Contact Pipe for Retention			not incl				Assume retention for breakpoint chlorination at Pulgas or in conveyance pipeline from AWPF
1.12	Off-Site Additional Costs			15%	6,840,000	**50**	**265,840**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tanks**				1,060,000	**50**	**41,197**	Assume equalization needed for influent and product water
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			Placeholder cost provided for new connection from RWC tank to AWPF
2.2	Steel Storage Tanks for Product Water Tank	1	MG	$ 860,000	860,000			
3.0	**Upgrades at Pulgas Facilities**				2,420,000	**50**	**94,054**	
3.1	Connection to Pulgas Facilities	1	LS	$ 1,000,000	1,000,000			Assume connection to d/s of wet well - exact location to be determined in future study
3.2	Pulgas Dechlorimation - New Equalization Tank	2	MG	$ 710,000	1,420,000			Additional tanks to accomodate continuous low flow (change to current operations)
3.3	Discharge Facility Upgrades			not incl				Assume current discharge channel capacity of 250 mgd is sufficient
								– no capital upgrades needed to support additional flow
		Subtotal Facility Capital Costs - Part 1			**$55,910,196**	**Annualized**	**$2,536,166**	
Facility Capital Costs - Part 2								
4.0	Site Development Costs	@	5%		2,795,510		126,808	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		2,795,510		126,808	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		8,386,529		380,425	% of Subtotal facility costs (not inluding pipelines)
		Subtotal Facility Capital Costs - Part 2			**$13,977,549**	**Annualized**	**$634,042**	
		Facility Direct Costs			**$69,887,745**	**Annualized**	**$3,170,208**	
Markups and Contingency								
	Taxes	@	8.75%		1,956,857		88,766	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		3,494,387		158,510	% of Facility Direct Costs
	Engineering and Design	@	10%		6,988,775		317,021	% of Facility Direct Costs
	Planning and Acquisition	@	15%		10,483,162		475,531	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		10,483,162		475,531	% of Facility Direct Costs
	Owner's Administration	@	15%		10,483,162		475,531	% of Facility Direct Costs
	Environmental/Permitting	@	5%		3,494,387		158,510	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		10,483,162		475,531	% of Facility Direct Costs
	Estimate Contingency	@	40%		27,955,098		1,268,083	% of Facility Direct Costs
		Subtotal with Markups and Contingency			**$155,709,896**	**Annualized**	**$7,063,223**	
	Escalation to Midpoint of Construction	@	43%		66,295,183		3,007,244	assume = 3.0% over years = 12
								construction start = 2030 end = 2033
		Project Capital Cost Total			**$222,005,080**	**Annualized**	**$10,070,468**	
				Annualualized Capital Costs ($/AF)			**$2,347**	project life = 50 interest rate = 3%
				Annualualized Capital Costs ($/gal)			**$0.007**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total		Notes
1.0	**Energy Costs**						
1.1	Energy - Treatment	6,033,655	KWh	$ 0.20	1,210,000		Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	121,000		8760 hours operated per year
							2755 KWH/MG
2.0	**Chemicals**						
2.1	**AWPF**	6,720	AF	$ 100.50	680,000		
	Breakpoint Chlorination						
2.2	Sodium Hypochlorite	2,190	MG	$ 191	418,000		Additional chemical dosing at Pulgas OR new facilities at the AWPF
2.3	Sodium Bisulfite	2,190	MG	$ 9	20,000		Additional chemical dosing at Pulgas OR new facilities at the AWPF
	Pulgas Dechloramination O&M (chemicals only)						Assume chemical costs similar to current use (unit costs and loads provided by SFPUC 9.29.2021)
2.4	Carbon dioxide	2,190	MG	$ 9	19,700		Carbon dioxide - $0.30/LB dosed at 30 lbs/MG
2.5	Sodium Hypochlorite	2,190	MG	$ 27	59,000		Sodium Hypochlorite - $0.96/LB dosed at 3.4 mg/L
2.6	Sodium Bisulfite	2,190	MG	$ 25	55,000		Sodium Bisulfite – $731.19/dry ton dosed at 8.13 mg/L
3.0	**Labor Costs**						
3.1	Labor - AWPF	8.0	staff	$ 175,000	1,400,000		full time staff at $175,000 average salary + benefits per year
3.2	Labor - Pulgas		not incl.				Assume existing staff could accommodate changes in operation
4.0	**Discharge Facility O&M**			not incl			Assume no additional discharge facility O&M costs
5.0	**Maintenance:**						
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 170	1,140,000		Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other Equipment (Replacement/Repair)	@	1.5%		260,000		% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		540,000		% of above O&M costs
				Annual O&M Costs ($/year)	**$5,922,700**		
				Annual Unit O&M Costs ($/AF)		**$1,400**	

Engineers Opinion of Probable Cost
Reservoir Water Augmentation at CSR - Treatment + Storage + Discharge Facility - 12 MGD IPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	**Average Annual Influent Flow:**	15.69 mgd
Project:	ResWA at Crystal Springs Reservoir	**Date Prepared:**	Sep-2021	**Average Annual Product Flow:**	12.00 mgd
				RW Delivered:	13440 Average Annual Production (AFY)
				Spill:	4958 Average Annual Spill (AFY)
				RW Benefit:	8490 Average Annual Benefit (AFY)
AWPF Location:	AWPF at HW 101 Site or near SVCW	**K/J Proj. No.**	1668011.03	**Design Capacity:**	8,333 Max Day Demand (gpm)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*		
Estimate:	Conceptual Level Cost-Analysis				

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment, Storage and Discharge								
Facility Capital Costs - Part 1								
1.0	**Treatment**				87,185,686			**Unloaded Unit Treatment Costs**
1.1	Microfiltration	15.7	MGD	$ 1,300,000	20,392,157	**30**	**1,040,393**	AWTF = $7.3 /gal before contingencies
1.2	Reverse Osmosis	14.1	MGD	$ 1,900,000	26,823,529	**30**	**1,368,517**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Advanced Oxidation Process (includes UV)	12.0	MGD	$ 400,000	4,800,000	**30**	**244,892**	Total Treatment = $7.3 /gal before contingencies
1.4	Free Chlorine	12.0	MGD	$ 100,000	1,200,000	**50**	**46,639**	**Increased building cost for more complicated sites**
1.5	Post Treatment and Chem Handling	12.0	MGD	$ 600,000	7,200,000	**50**	**279,832**	SVCW Site = $20.3 million b/c of need for piles in bay mud
1.6	Building (standard)	60,000	SF	$ 250	15,000,000	**75**	**505,019**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
1.7	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.2	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.10	Breakpoint Chlorination Dosing - Chemical/Storage	2	LS	$ 200,000.00	400,000	**50**	**15,546**	Additional chemical dosing and storage at Pulgas OR new facilities at the AWPF
1.11	Breakpoint Chlorination - Contact Pipe for Retention			not incl				Assume retention for breakpoint chlorination at Pulgas or in conveyance pipeline from AWPF
1.12	Off-Site Additional Costs			15%	11,370,000	**50**	**441,901**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tank**				**1,620,000**	**50**	62,962	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			Placeholder cost provided for new connection from RWC tank to AWPF
2.2	Steel Storage Tanks for Product Water Tank	2	MG	$ 710,000	1,420,000			
3.0	**Upgrades at Pulgas Facilities**				**2,420,000**	**50**	94,054	
3.1	Connection to Pulgas Facilities	1	LS	$ 1,000,000	1,000,000			Assume connection to d/s of wet well - exact location to be determined in future study
3.2	Pulgas Dechlorimation - New Equalization Tank	2	MG	$ 710,000	1,420,000			Additional tanks to accomodate continuous low flow (change to current operations)
3.3	Discharge Facility Upgrades			not incl				Assume current discharge channel capacity of 250 mgd is sufficient
								– no capital upgrades needed to support additional flow
	Subtotal Facility Capital Costs - Part 1				**$91,225,686**	**Annualized**	**$4,099,755**	
Facility Capital Costs - Part 2								
4.0	Site Development Costs	@	5%		4,561,284		204,988	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		4,561,284		204,988	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		13,683,853		614,963	% of Subtotal facility costs (not inluding pipelines)
	Subtotal Facility Capital Costs - Part 2				**$22,806,422**	**Annualized**	**$1,024,939**	
	Facility Direct Costs				**$114,032,108**	**Annualized**	**$5,124,694**	
Markups and Contingency								
	Taxes	@	8.75%		3,192,899		143,491	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		5,701,605		256,235	% of Facility Direct Costs
	Engineering and Design	@	10%		11,403,211		512,469	% of Facility Direct Costs
	Special Studies	@	15%		17,104,816		768,704	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		17,104,816		768,704	% of Facility Direct Costs
	Owner's Administration	@	15%		17,104,816		768,704	% of Facility Direct Costs
	Environmental/Permitting	@	5%		5,701,605		256,235	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		17,104,816		768,704	% of Facility Direct Costs
	Estimate Contingency	@	40%		45,612,843		2,049,877	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$254,063,536**	**Annualized**	**$11,417,817**	
	Escalation to Midpoint of Construction	@	43%		108,170,317		4,861,260	assume = 3.0% over years = 12
								construction start = 2030 end = 2033
	Project Capital Cost Total				**$362,233,853**	**Annualized**	**$16,279,077**	
					Annualualized Capital Costs ($/AF)		**$1,917**	project life = 50 interest rate = 3%
					Annualualized Capital Costs ($/gal)		**$0.006**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total		Notes
1.0	**Energy Costs**						
1.1	Energy - Treatment	12,067,310	KWh	$ 0.20	2,410,000		Treatment Operation = 24 hours per day
1.2	Energy - Other		KWh	10%	241,000		8760 hours operated per year
							2755 KWH/MG
2.0	**Chemicals**						
2.1	**AWPF**	13,440	AF	$ 101	1,350,000		
	Breakpoint Chlorination						
2.2	Sodium Hypochlorite	4,380	MG	$ 191	837,000		Additional chemical dosing at Pulgas OR new facilities at the AWPF
2.3	Sodium Bisulfite	4,380	MG	$ 9	39,000		Additional chemical dosing at Pulgas OR new facilities at the AWPF
	Pulgas Dechloramination O&M (chemicals only)						Assume chemical costs similar to current use (unit costs and loads provided by SFPUC 9.29.2021)
2.4	Carbon dioxide	4,380	MG	$ 9	39,400		Carbon dioxide - $0.30/LB dosed at 30 lbs/MG
2.5	Sodium Hypochlorite	4,380	MG	$ 27	118,000		Sodium Hypochlorite - $0.96/LB dosed at 3.4 mg/L
2.6	Sodium Bisulfite	4,380	MG	$ 25	110,000		Sodium Bisulfite – $731.19/dry ton dosed at 8.13 mg/L
3.0	**Labor Costs**						
3.1	Labor - AWPF	11.0	staff	$ 175,000	1,930,000		full time staff at $175,000 average salary + benefits per year
4.0	**Discharge Facility O&M**			not incl			Assume no additional discharge facility O&M costs
5.0	**Maintenance:**						
5.1	AWPF Equipment (Replacement/Repair)	13,440	AF	$ 160	2,150,000		Estimated for MF/RO/UV-AOP equipment and pumps
7.2	Other (Replacement/Repair)	@	1.5%		400,000		% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		960,000		% of above O&M costs
	Annual O&M Costs ($/year)				**$10,584,400**		
					Annual Unit O&M Costs ($/AF)	**$1,200**	

Engineers Opinion of Probable Cost

Raw Water Augmentation at Bear Gulch - Treatment + Storage + Discharge Facility - 6 MGD DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	**Average Annual Influent Flow:**	7.84	mgd
Project:	Direct Potable Reuse (RaWA or TWA)	**Date Prepared:**	Sep-2021	**Average Annual Product Flow:**	6.00	mgd
AWPF Location:	AWPF at HW 101 Site or near SVCW	**K/J Proj. No.**	1668011.03	**RW Delivered:**	6720	Average Annual Reuse (AFY)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*	**Spill:**	2431	Average Annual Spill (AFY)
Estimate:	Conceptual Level Cost-Analysis			**RW Benefit:**	4290	Average Annual Benefit (AFY)
				Design Capacity:	4,167	Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment, Storage and Discharge								
Facility Capital Costs - Part 1								
1.0	**Treatment**				**105,787,000**			**Unloaded Unit Treatment Costs**
1.1	Ozone	7.8	MGD	$ 700,000	5,490,000	**30**	**280,096**	DPR AWTF = $11.8 /gal before contingencies
1.2	BAC	7.8	MGD	$ 1,100,000	8,627,000	**30**	**440,143**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Microfiltration	7.8	MGD	$ 1,600,000	12,549,000	**30**	**640,241**	Bear Gulch new WTP = $5.8 /gal before contingencies
1.4	Reverse Osmosis	7.1	MGD	$ 2,400,000	16,941,000	**30**	**864,317**	Total Treatment = $17.6 /gal before contingencies
1.5	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 410,000	2,460,000	**30**	**125,507**	
1.6	Free Chlorine	6.0	MGD	$ 100,000	600,000	**30**	**30,612**	
1.7	Post Treatment and Chem Handling	6.0	MGD	$ 720,000	4,320,000	**50**	**167,899**	
1.8	Building (standard)	30,000	SF	$ 250	7,500,000	**75**	**252,510**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
	Install piles in Bay Mud	30,000	SF	$ 89	2,670,000	**75**	**89,893**	Recent Experience at SVCW site
1.10	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.11	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.12	Breakpoint Chlorination Dosing - Chemical/Storage	1	LS	$ 200,000	200,000	**50**	**7,773**	Additional chemical dosing and storage at the AWPF
1.13	Breakpoint Chlorination - Contact Pipe for Retention			not incl				Assume suffficient retention for breakpoint chlorination in conveyance pipeline to Bear Gulch
1.14	New Dechlorination Facility at/near Bear Gulch	1	LS	$ 200,000	200,000	**50**	**7,773**	To remove residual chlorine after breakpoint chlorination in conveyance pipeline
1.15	Off-Site Additional Costs			15%	9,230,000	**50**	**358,729**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
1.16	New Water Treatment Plant at Bear Gulch	1	LS	$ 35,000,000	35,000,000	**50**	**1,360,292**	Per Woodard&Curran estimate in 2021 dollars; assumes 6 MGD capacity, unloaded (per M. Hurley)
								The majority of the unit process and major mechanical equipment is approaching, at, or past its expected useful life at the current filtration plant, this reflects cost for full plant replacement
2.0	**Storage Tank**				**1,060,000**	**50**	**41,197**	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				*Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization*
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			*Placeholder cost provided for new connection from RWC tank to AWPF*
2.2	Steel Storage Tanks for Product Water Tank	1	MG	$ 860,000	860,000			
3.0	**Connection to Bear Gulch Facilities**				**18,600,000**			
3.1	Discharge Facility (new) (Alt 3a/3b)	1	LS	$ 1,100,000	1,100,000	**50**	**42,752**	Assume new diffuser into Bear Gulch Reservoir
3.2	BG Dam Rehab project	1	LS	$ 17,500,000	17,500,000	**75**	**589,189**	Dam/Intake restoration to utilize full storage volume (per M. Hurley based on est. from Woodard&Curran)
	Subtotal Facility Capital Costs - Part 1				**$125,447,000**	**Annualized**	**$5,298,924**	
Facility Capital Costs - Part 2								
4.0	Site Development Costs	@	5%		6,272,350		264,946	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		6,272,350		264,946	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		18,817,050		794,839	% of Subtotal facility costs (not inluding pipelines)
	Subtotal Facility Capital Costs - Part 2				**$31,361,750**	**Annualized**	**$1,324,731**	
	Facility Direct Costs				**$156,808,750**		**$6,623,655**	
Markups and Contingency								
	Taxes	@	8.75%		4,390,645		185,462	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		7,840,438		331,183	% of Facility Direct Costs
	Engineering and Design	@	10%		15,680,875		662,365	% of Facility Direct Costs
	Special Studies	@	15%		23,521,313		993,548	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		23,521,313		993,548	% of Facility Direct Costs
	Owner's Administration	@	15%		23,521,313		993,548	% of Facility Direct Costs
	Environmental/Permitting	@	5%		7,840,438		331,183	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		23,521,313		993,548	% of Facility Direct Costs
	Estimate Contingency	@	40%		62,723,500		2,649,462	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$349,369,895**	**Annualized**	**$14,757,503**	
	Escalation to Midpoint of Construction	@	56%		194,937,018		8,234,206	assume = 3.0% over years = 15
								construction start = 2034 end = 2036
	Project Capital Cost Total				**$544,306,913**	**Annualized**	**$22,991,708**	
	Annualualized Capital Costs ($/AF)						**$3,421**	project life = 50 interest rate = 3%
	Annualualized Capital Costs ($/gal)						**$0.010**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			Notes/Source
1.0	**Energy Costs**							
1.1	Energy - Treatment	10,211,970	KWh	$ 0.20	2,040,000			Treatment Operation = 24 hours per day
1.2	Energy - Other		KWh	10%	204,000			8760 hours operated per year
								4663 KWH/MG
2.0	**Chemicals**							
2.1	**AWPF**	6,720	AF	$ 116	780,000			
	Breakpoint Chlorination							
2.2	Sodium Hypochlorite	2,190	MG	$ 191	418,000			Additional chemical dosing at the AWPF
2.3	Sodium Bisulfite	2,190	MG	$ 9	20,000			Additional chemical dosing at the AWPF
	Bear Gulch Dechlorination O&M (chemicals only)							
2.4	Carbon dioxide	2,190	MG	$ 9	19,700			Carbon dioxide - $0.30/LB dosed at 30 lbs/MG
2.5	Sodium Hypochlorite	2,190	MG	$ 27	59,000			Sodium Hypochlorite - $0.96/LB dosed at 3.4 mg/L
2.6	Sodium Bisulfite	2,190	MG	$ 25	55,000			Sodium Bisulfite – $731.19/dry ton dosed at 8.13 mg/L
	New WTP at Bear Gulch O&M							Not included as this is assumed to be similar to treatment cost for displaced water
3.0								
3.1	**Labor Costs**							
	Labor - AWPF	8.0	staff	$ 175,000	1,400,000			full time staff at $175,000 average salary + benefits per year
	Labor - New WTP at Bear Gulch							Not included as this is assumed to be similar to treatment cost for displaced water
4.0								
	Discharge Facility and BG Dam O&M	@	2.0%		372,000			Assume percent of discharge facility capital costs for discharge facility and Dam rehab
5.0	**Maintenance:**							
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 170	1,140,000			Estimated for MF/RO/UV-AOP equipment and pumps
	New WTP Bear Gulch (Replacement/Repair)	@	1.5%		525,000			
5.2	Other Equipment (Replacement/Repair)	@	1.5%		770,000			% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		700,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$8,502,700**			
	Annual Unit O&M Costs ($/AF)						**$1,300**	

Engineers Opinion of Probable Cost
Treated Water Augmentation - Treatment + Storage - 6 MGD DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	**Average Annual Influent Flow:**	7.84 mgd
Project:	Direct Potable Reuse (RaWA or TWA)	**Date Prepared:**	Sep-2021	**Average Annual Product Flow:**	6.00 mgd
				RW Delivered:	6720 Average Annual Production (AFY)
				Spill:	2431 Average Annual Spill (AFY)
				RW Benefit:	4290 Average Annual Benefit (AFY)
AWPF Location:	AWPF at HW 101 Site or near SVCW	**K/J Proj. No.**	1668011.03	**Design Capacity:**	4,167 Max Day Demand (gpm)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*		
Estimate:	Conceptual Level Cost-Analysis				

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment and Storage								
Facility Capital Costs - Part 1								
1.0	**Treatment**				66,797,000			**Unloaded Unit Treatment Costs**
1.1	Ozone	7.8	MGD	$ 700,000	5,490,000	**30**	**280,096**	DPR AWTF = $11.1 /gal before contingencies
1.2	BAC	7.8	MGD	$ 1,100,000	8,627,000	**30**	**440,143**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Microfiltration	7.8	MGD	$ 1,600,000	12,549,000	**30**	**640,241**	Total Treatment = $11.1 /gal before contingencies
1.4	Reverse Osmosis	7.1	MGD	$ 2,400,000	16,941,000	**30**	**864,317**	
1.5	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 410,000	2,460,000	**30**	**125,507**	**Increased building cost for more complicated sites**
1.6	Free Chlorine			not incl				SVCW Site = $10.2 million b/c of need for piles in bay mud
1.7	Post Treatment and Chem Handling	6.0	MGD	$ 720,000	4,320,000	**50**	**167,899**	San Mateo Site = $11.3 million for two-story bld due to space
1.8	Building (standard)	30,000	SF	$ 250	7,500,000	**75**	**252,510**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
1.9	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.10	Nutirent Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.11	Chloramination - Chemical Storage and Dosing	1.00	LS	$ 200,000	200,000	**50**	**7,773**	Chemical Storage and dosing - Chloramination
1.12	Off-Site Additional Costs			15%	8,710,000	**50**	**338,518**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tank**				1,060,000	**50**	**41,197**	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			Placeholder cost provided for new connection from RWC tank to AWPF
2.2	Steel Storage Tanks for Product Water Tank	1	MG	$ 860,000	860,000			
3.0	**Connections to Potable Water System**							**POCs to Potable Distribution System may include:**
3.1	Included in Conveyance cost sheets							2 Connect to Redwood City Tanks
								2 Connect to CalWater distribution pipelines
								3 Connect to Foster City Tanks
	Subtotal Facility Capital Costs - Part 1				**$67,857,000**	**Annualized**	**$3,158,202**	
Facility Capital Costs - Part 2								
4.0	Site Development Costs	@	5%		3,392,850		157,910	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		3,392,850		157,910	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		10,178,550		473,730	% of Subtotal facility costs (not inluding pipelines)
	Subtotal Facility Capital Costs - Part 2				**$16,964,250**	**Annualized**	**$789,550**	
	Facility Direct Costs				**$84,821,250**		**$3,947,752**	
Markups and Contingency								
	Taxes	@	8.75%		2,374,995		110,537	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		4,241,063		197,388	% of Facility Direct Costs
	Engineering and Design	@	10%		8,482,125		394,775	% of Facility Direct Costs
	Special Studies	@	15%		12,723,188		592,163	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		12,723,188		592,163	% of Facility Direct Costs
	Owner's Administration	@	15%		12,723,188		592,163	% of Facility Direct Costs
	Environmental/Permitting	@	5%		4,241,063		197,388	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		12,723,188		592,163	% of Facility Direct Costs
	Estimate Contingency	@	40%		33,928,500		1,579,101	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$188,981,745**	**Annualized**	**$8,795,592**	
	Escalation to Midpoint of Construction	@	56%		105,445,656		4,907,654	assume = 3.0% over years = 15
								construction start = 2034 end = 2036
	Project Capital Cost Total				**$294,427,401**	**Annualized**	**$13,703,246**	
	Annualualized Capital Costs ($/AF)						**$3,194**	project life = 50 interest rate = 3%
	Annualualized Capital Costs ($/gal)						**$0.010**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	Notes
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					
1.1	Energy - Treatment	10,211,970	KWh	$ 0.20	2,040,000	Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	204,000	8760 hours operated per year
						4663 KWH/MG
2.0	**Chemicals**	6,720	AF	$116	780,000	
	Chloramination O&M (chemicals only)					
2.1	Ammonia - Chloramination	2,190.0	MG	$ 5	11,000	Ammonia - $659/dry ton dosed at 2 mg/L
2.2	Sodium Hypochlorite - Chloramination	2,190.0	MG	$ 80	175,000	Sodium Hypochlorite - $0.96/LB dosed at 10 mg/L
	Dechlorination			not incl		Assume no additional dechlorination costs prior to entering drinking water system
3.0	**Labor Costs**					
3.1	Labor - AWPF	8.0	staff	$ 175,000	1,400,000	full time staff at $175,000 average salary + benefits per year
4.0	**Discharge Facility O&M**			not incl		No Discharge facility required
5.0	**Maintenance:**					
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 170	1,140,000	Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other Equipment (Replacement/Repair)	@	1.5%		270,000	% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		600,000	% of above O&M costs
.						
	Annual O&M Costs ($/year)				**$6,620,000**	
	Annual Unit O&M Costs ($/AF)				**$1,500**	

Engineers Opinion of Probable Cost
Treated Water Augmentation - Treatment + Storage - 12 MGD DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	**Average Annual Influent Flow:**	15.69 mgd
Project:	Direct Potable Reuse (TWA)	**Date Prepared:**	Sep-2021	**Average Annual Product Flow:**	12.00 mgd
				RW Delivered:	c Average Annual Reuse (AFY)
				Spill:	4958 Average Annual Spill (AFY)
				RW Benefit:	#VALUE! Average Annual Benefit (AFY)
AWPF Location:	AWPF at HW 101 Site/near SVCW	**K/J Proj. No.**	1668011.03	**Design Capacity:**	8,333 Max Day Demand (gpm)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*		
Estimate:	Conceptual Level Cost-Analysis				

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment and Storage								
Facility Capital Costs - Part 1								
1.0	**Treatment**				107,459,000			**Unloaded Unit Treatment Costs**
1.1	Ozone	15.7	MGD	$ 500,000	7,843,000	**30**	**400,144**	DPR AWTF = $9.0 /gal before contingencies
1.2	BAC	15.7	MGD	$ 700,000	10,980,000	**30**	**560,191**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Microfiltration	15.7	MGD	$ 1,300,000	20,392,000	**30**	**1,040,385**	Total Treatment = $9.0 /gal before contingencies
1.4	Reverse Osmosis	14.1	MGD	$ 1,900,000	26,824,000	**30**	**1,368,541**	
1.5	Advanced Oxidation Process (includes UV)	12.0	MGD	$ 400,000	4,800,000	**30**	**244,892**	**Increased building cost for more complicated sites**
1.6	Free Chlorine			not incl				SVCW Site = $20.3 million b/c of need for piles in bay mud
1.7	Post Treatment and Chem Handling	12.0	MGD	$ 600,000	7,200,000	**50**	**279,832**	
1.8	Building (standard)	60,000	SF	$ 250	15,000,000	**75**	**505,019**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
1.9	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.10	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.11	Chloramination - Chemical Storage and Dosing	1.0	LS	$ 400,000.00	400,000	**50**	**15,546**	Chemical Storage and dosing - Chloramination
1.12	Off-Site Additional Costs			15%	14,020,000	**50**	**544,894**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tank**				1,620,000	**50**	**62,962**	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				*Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization*
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			*Placeholder cost provided for new connection from RWC tank to AWPF*
2.2	Steel Storage Tanks for Product Water Tank	2	MG	$ 710,000	1,420,000			
3.0	**Connections to Potable Water System**							**POCs to Potable Distribution System include:**
3.1	Included in Conveyance cost sheets							2 Connect to Redwood City Tanks
								4 Connect to CalWater distribution pipelines
			Subtotal Facility Capital Costs - Part 1		**$109,079,000**	**Annualized**	**$5,022,407**	
Additional Facility Capital Costs								
4.0	Site Development Costs	@	5%		5,453,950		251,120	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		5,453,950		251,120	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		16,361,850		753,361	% of Subtotal facility costs (not inluding pipelines)
			Subtotal Facility Capital Costs - Part 2		**$27,269,750**	**Annualized**	**$1,255,602**	
				Facility Direct Costs	**$136,348,750**		**$6,278,009**	
Markups and Contingency								
	Taxes	@	8.75%		3,817,765		175,784	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		6,817,438		313,900	% of Facility Direct Costs
	Engineering and Design	@	10%		13,634,875		627,801	% of Facility Direct Costs
	Special Studies	@	15%		20,452,313		941,701	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		20,452,313		941,701	% of Facility Direct Costs
	Owner's Administration	@	15%		20,452,313		941,701	% of Facility Direct Costs
	Environmental/Permitting	@	5%		6,817,438		313,900	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		20,452,313		941,701	% of Facility Direct Costs
	Estimate Contingency	@	40%		54,539,500		2,511,203	% of Facility Direct Costs
			Subtotal with Markups and Contingency		**$303,785,015**	**Annualized**	**$13,987,403**	
	Escalation to Midpoint of Construction	@	56%		169,502,140		7,804,515	assume = 3.0% over years = 15
								construction start = 2034 end = 2036
				Project Capital Cost Total	**$473,287,155**	**Annualized**	**$21,791,918**	
					Annualualized Capital Costs ($/AF)		**#VALUE!**	project life = 50 interest rate = 3%
					Annualualized Capital Costs ($/gal)		**#VALUE!**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total		Notes/Source
Annual Operations and Maintenance Costs							
1.0	**Energy Costs**						
1.1	Energy - Treatment	19,547,940	KWh	$ 0.20	3,910,000		Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	391,000		8760 hours operated per year
							4463 KWH/MG
2.0	**Chemicals**	c	AF	$ 116	#VALUE!		
	Chloramination O&M (chemicals only)						
2.1	Ammonia - Chloramination	4,380	MG	$ 5	22,000		Ammonia - $659/dry ton dosed at 2 mg/L
2.2	Sodium Hypochlorite - Chloramination	4,380	MG	$ 80	350,000		Sodium Hypochlorite - $0.96/LB dosed at 10 mg/L
	Dechlorination						Assume no additional dechlorination costs prior to entering drinking water system
3.0	**Labor Costs**						
3.1	Labor - AWPF	11.0	staff	$ 175,000	1,930,000		full time staff at $175,000 average salary + benefits per year
4.0	**Discharge Facility O&M**			not incl			No Discharge facility required
5.0	**Maintenance:**						
5.1	AWPF Equipment (Replacement/Repair)	c	AF	$ 160	#VALUE!		Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other (Replacement/Repair)	@	1.5%		430,000		% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		#VALUE!		% of above O&M costs
		Annual O&M Costs ($/year)			**#VALUE!**		
					Annual Unit O&M Costs ($/AF)	**#VALUE!**	

Engineers Opinion of Probable Cost
HYBRID A - Phase 1 | Treated Drinking Water Augmentation - Treatment + Storage - 6 MGD DPR sized for future 12MGD capacity

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	KAT, DT
Project:	Hybrid A - RWA and Direct Potable Reuse (TDWA)	**Date Prepared:**	May-2022
	Phase 1 AWPF 6.0-mgd capacity APWF treated to TDWA standards. Building facilities and O3/BAC process units will be sized for future 12 mgd treatment capacity.		
AWPF Location:	AWPF near SVCW	**K/J Proj. No.**	1668011.03
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Average Annual Influent Flow:	7.84	mgd
Average Annual Product Flow:	6.00	mgd
RW Delivered:	6720	Average Annual Reuse (AFY)
Spill:	2431	Average Annual Spill (AFY)
RW Benefit:	4290	Average Annual Benefit (AFY)
Design Capacity:	4,167	Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment and Storage								
Facility Capital Costs - Part 1								
1.0	**Treatment**				75,814,880			* assume 130% of unit cost for Phase 1 to allow for expansion in Phase 2
1.1	Ozone	7.8	MGD	$ 600,000	4,704,000	30	239,995	**Unloaded Unit Treatment Costs**
1.2	BAC	7.8	MGD	$ 900,000	7,056,000	30	359,992	DPR APWF = $11.1 /gal before contingencies
1.3	Microfiltration	7.8	MGD	$ 1,700,000	13,328,000	30	679,985	Nutrient Removal = $0.0 /gal before contingencies
1.4	Reverse Osmosis	7.1	MGD	$ 2,500,000	17,640,000	30	899,980	Total Treatment = $11.1 /gal before contingencies
1.5	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 500,000	2,998,800	30	152,997	**Increased building cost for more complicated sites**
1.6	Free Chlorine			not incl				SVCW Site = $20.3 million b/c of need for piles in bay mud
1.7	Post Treatment and Chem Handling	6.0	MGD	$ 800,000	4,798,080	50	186,480	
1.8	Building (standard)	60,000	SF	$ 250	15,000,000	75	505,019	Standard building @ Hwy 101 Site. Sized for 12MGD capacity. 5,000 sf/mgd
1.9	Land Cost			not incl				Cost of land NOT included in this analysis
1.10	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.11	Chloramination - Chemical Storage and Dosing	1.0	LS	$ 400,000.00	400,000	50	15,546	Chemical Storage and dosing - Chloramination
1.12	Off-Site Additional Costs			15%	9,890,000	50	384,380	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tank**				1,620,000	50	62,962	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)			not incl				*Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization*
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			*Placeholder cost provided for new connection from RWC tank to AWPF*
2.2	Steel Storage Tanks for Product Water Tank	2	MG	$ 710,000	1,420,000			
3.0	**Connections to Potable Water System**							**POCs to Potable Distribution System include:**
3.1	Included in Conveyance cost sheets							2 Connect to Redwood City Tanks
								1 Connect to CalWater distribution pipelines
4.0	**Upgrades at Pulgas Facilities**				2,420,000	50	94,054	
4.1	Connection to Pulgas Facilities	1	LS	$ 1,000,000	1,000,000			Assume connection to d/s of wet well - exact location to be determined in future study
4.2	Pulgas Dechlorimation - New Equalization Tank	2	MG	$ 710,000	1,420,000			Additional tanks to accomodate continuous low flow (change to current operations)
4.3	Discharge Facility Upgrades			not incl				Assume current discharge channel capacity of 250 mgd is sufficient
								– no capital upgrades needed to support additional flow
				Subtotal Facility Capital Costs - Part 1	**$79,854,880**	**Annualized**	**$3,581,389**	
Additional Facility Capital Costs								
4.0	Site Development Costs	@	5%		3,992,744		179,069	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		3,992,744		179,069	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		11,978,232		537,208	% of Subtotal facility costs (not inluding pipelines)
				Subtotal Facility Capital Costs - Part 2	**$19,963,720**	**Annualized**	**$895,347**	
				Facility Direct Costs	**$99,818,600**		**$4,476,737**	
Markups and Contingency								
	Taxes	@	8.75%		2,794,921		125,349	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		4,990,930		223,837	% of Facility Direct Costs
	Engineering and Design	@	10%		9,981,860		447,674	% of Facility Direct Costs
	Special Studies	@	15%		14,972,790		671,510	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		14,972,790		671,510	% of Facility Direct Costs
	Owner's Administration	@	15%		14,972,790		671,510	% of Facility Direct Costs
	Environmental/Permitting	@	5%		4,990,930		223,837	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		14,972,790		671,510	% of Facility Direct Costs
	Estimate Contingency	@	40%		39,927,440		1,790,695	% of Facility Direct Costs
			Subtotal with Markups and Contingency		**$222,395,841**	**Annualized**	**$9,974,169**	
	Escalation to Midpoint of Construction	@	56%		124,089,633		5,565,261	assume = 3.0% over years = 15
								construction start = 2034 end = 2036
				Project Capital Cost Total	**$346,485,474**	**Annualized**	**$15,539,430**	
					Annualualized Capital Costs ($/AF)		**$3,622**	project life = 50 interest rate = 3%
					Annualualized Capital Costs ($/gal)		**$0.011**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total		Notes
Annual Operations and Maintenance Costs							
1.0	**Energy Costs**						
1.1	Energy - Treatment	10,211,970	KWh	$ 0.20	2,040,000		Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	204,000		8760 hours operated per year
							4663 KWH/MG
2.0	**Chemicals**	6,720	AF	$ 116	780,000		
	Chloramination O&M (chemicals only)						
2.1	Ammonia - Chloramination	2,190	MG	$ 5	11,000		Ammonia - $659/dry ton dosed at 2 mg/L
2.2	Sodium Hypochlorite - Chloramination	2,190	MG	$ 80	175,000		Sodium Hypochlorite - $0.96/LB dosed at 10 mg/L
	Dechlorination						Assume no additional dechlorination costs prior to entering drinking water system
3.0	**Labor Costs**						
3.1	Labor - AWPF	11.0	staff	$ 175,000	1,930,000		full time staff at $175,000 average salary + benefits per year
4.0	**Discharge Facility O&M**			not incl			No Discharge facility required
5.0	**Maintenance:**						
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 160	1,080,000		Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other (Replacement/Repair)	@	1.5%		360,000		% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		660,000		% of above O&M costs
		Annual O&M Costs ($/year)			**$7,240,000**		
					Annual Unit O&M Costs ($/AF)	**$1,700**	

Engineers Opinion of Probable Cost

HYBRID A - Phase 2 | Treated Drinking Water Augmentation - Treatment + Storage - Expansion to 12 MGD DPR Capacity

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	KAT, DT	**Average Annual Influent Flow:**	7.84 mgd
Project:	Hybrid A - RWA and Direct Potable Reuse (TDWA)	**Date Prepared:**	May-2022	**Average Annual Product Flow:**	6.00 mgd
	Phase 2 - Expand AWPF to 12.0-mgd TDWA capacity			**RW Delivered:**	6720 Average Annual Reuse (AFY)
				Spill:	4958 Average Annual Spill (AFY)
AWPF Location:	AWPF near SVCW	**K/J Proj. No.**	1668011.03	**RW Benefit:**	1770 Average Annual Benefit (AFY)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*	**Design Capacity:**	4,167 Max Day Demand (gpm)
Estimate:	Conceptual Level Cost-Analysis				

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment and Storage								
Facility Capital Costs - Part 1								
1.0	**Treatment**				32,204,080			* assume 70% of unit cost for expansion in Phase 2
1.1	Ozone	7.8	MGD	$ 300,000	2,352,000	**30**	**119,997**	**Unloaded Unit Treatment Costs**
1.2	BAC	7.8	MGD	$ 500,000	3,920,000	**30**	**199,995**	DPR APWF = $11.1 /gal before contingencies
1.3	Microfiltration	7.8	MGD	$ 900,000	7,056,000	**30**	**359,992**	Nutrient Removal = $0.0 /gal before contingencies
1.4	Reverse Osmosis	7.1	MGD	$ 1,400,000	9,878,000	**30**	**503,968**	Total Treatment = $11.1 /gal before contingencies
1.5	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 300,000	1,799,280	**30**	**91,798**	**Increased building cost for more complicated sites**
1.6	Free Chlorine			not incl				SVCW Site = $0.0 million b/c of need for piles in bay mud
1.7	Post Treatment and Chem Handling	6.0	MGD	$ 500,000	2,998,800	**50**	**116,550**	
1.8	Building (standard)			not incl				included in Hybrid A - Phase 1
1.9	Land Cost			not incl				Cost of land NOT included in this analysis
1.10	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.11	Chloramination - Chemical Storage and Dosing			not incl				included in Hybrid A - Phase 1
1.12	Off-Site Additional Costs			15%	4,200,000	**50**	**163,235**	included in Hybrid A - Phase 1
2.0	**Storage Tank**				0	**50**	**0**	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)			not incl				Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization
	Alternately convert RWC for use as EQ tank			not incl				included in Hybrid A - Phase 1
2.2	Steel Storage Tanks for Product Water Tank			not incl				included in Hybrid A - Phase 1
3.0	**Connections to Potable Water System**							**POCs to Potable Distribution System include:**
3.1	Included in Conveyance cost sheets							2 Connect to Redwood City Tanks
								1 Connect to CalWater distribution pipelines
4.0	**Upgrades at Pulgas Facilities**				0	**50**	**0**	
4.1	Connection to Pulgas Facilities			not incl				included in Hybrid A - Phase 1
4.2	Pulgas Dechlorimation - New Equalization Tank			not incl				included in Hybrid A - Phase 1
4.3	Discharge Facility Upgrades			not incl				Assume current discharge channel capacity of 250 mgd is sufficient
								– no capital upgrades needed to support additional flow
		Subtotal Facility Capital Costs - Part 1			**$32,204,080**	**Annualized**	**$1,555,536**	
Additional Facility Capital Costs								
4.0	Site Development Costs	@	5%		1,610,204		77,777	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		1,610,204		77,777	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		4,830,612		233,330	% of Subtotal facility costs (not inluding pipelines)
		Subtotal Facility Capital Costs - Part 2			**$8,051,020**	**Annualized**	**$388,884**	
				Facility Direct Costs	**$40,255,100**		**$1,944,420**	
Markups and Contingency								
	Taxes	@	8.75%		1,127,143		54,444	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		2,012,755		97,221	% of Facility Direct Costs
	Engineering and Design	@	10%		4,025,510		194,442	% of Facility Direct Costs
	Special Studies	@	15%		6,038,265		291,663	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		6,038,265		291,663	% of Facility Direct Costs
	Owner's Administration	@	15%		6,038,265		291,663	% of Facility Direct Costs
	Environmental/Permitting	@	5%		2,012,755		97,221	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		6,038,265		291,663	% of Facility Direct Costs
	Estimate Contingency	@	40%		16,102,040		777,768	% of Facility Direct Costs
		Subtotal with Markups and Contingency			**$89,688,363**	**Annualized**	**$4,332,167**	
	Escalation to Midpoint of Construction	@	56%		50,043,184		2,417,208	assume = 3.0% over years = 15
								construction start = 2034 end = 2036
				Project Capital Cost Total	**$139,731,547**	**Annualized**	**$6,749,375**	
					Annualualized Capital Costs ($/AF)		**$3,813**	project life = 50 interest rate = 3%
					Annualualized Capital Costs ($/gal)		**$0.012**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total		
1.0	**Energy Costs**						
1.1	Energy - Treatment	9,773,970	KWh	$ 0.20	1,950,000		Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	195,000		8760 hours operated per year
							4463 KWH/MG
2.0	**Chemicals**	6,720	AF	$ 116	780,000		
	Chloramination O&M (chemicals only)						
2.1	Ammonia - Chloramination	2,190	MG	$ 5	11,000		Ammonia - $659/dry ton dosed at 2 mg/L
2.2	Sodium Hypochlorite - Chloramination	2,190	MG	$ 80	175,000		Sodium Hypochlorite - $0.96/LB dosed at 10 mg/L
	Dechlorination						Assume no additional dechlorination costs prior to entering drinking water system
3.0	**Labor Costs**						
3.1	Labor - AWPF	11.0	staff	$ 175,000	1,930,000		full time staff at $175,000 average salary + benefits per year
4.0	**Discharge Facility O&M**			not incl			No Discharge facility required
5.0	**Maintenance:**						
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 160	1,080,000		Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other (Replacement/Repair)	@	1.5%		120,000		% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		620,000		% of above O&M costs
		Annual O&M Costs ($/year)			**$6,861,000**		
					Annual Unit O&M Costs ($/AF)	**$3,900**	

Engineers Opinion of Probable Cost

HYBRID B - Phase 1 | Reservoir Water Augmentation at CSR - Treatment + Storage + Discharge Facility - 6 MGD IPR

Kennedy Jenks

				Average Annual Influent Flow:	7.84 mgd
Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	KAT, DT	**Average Annual Product Flow:**	6.00 mgd
Project:	Hybrid B - RWA at Crystal Springs Reservoir (CSR)	**Date Prepared:**	May-2022	**RW Produced:**	6720 Average Annual Production (AFY)
	Phase 1 - 6.0-mgd capacity AWPF located near Highway 101				
	treated to RWA standards for discharge into CSR			**Spill:**	2431 Average Annual Spill (AFY)
				RW Benefit:	4290 Average Annual Benefit (AFY)
AWPF Location:	AWPF at HW 101 Site	**K/J Proj. No.**	1668011.03	**Design Capacity:**	4,167 Max Day Demand (gpm)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*		
Estimate:	Conceptual Level Cost-Analysis				

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment, Storage and Discharge								
Facility Capital Costs - Part 1								
1.0	**Treatment**				**52,430,196**			**Unloaded Unit Treatment Costs**
1.1	Microfiltration	7.8	MGD	$ 1,600,000	12,549,020	**30**	**640,242**	APWF = $8.7 /gal before contingencies
1.2	Reverse Osmosis	7.1	MGD	$ 2,400,000	16,941,176	**30**	**864,326**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 500,000	3,000,000	**30**	**153,058**	Total Treatment = $8.7 /gal before contingencies
1.4	Free Chlorine	6.0	MGD	$ 100,000	600,000	**30**	**30,612**	**Increased building cost for more complicated sites**
1.5	Post Treatment and Chem Handling	6.0	MGD	$ 800,000	4,800,000	**50**	**186,554**	SVCW Site = $10.2 million b/c of need for piles in bay mud
1.6	Building (standard)	30,000	SF	$ 250	7,500,000	**75**	**252,510**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
1.7	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.8	Nutrient Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.9	Breakpoint Chlorination Dosing - Chemical/Storage	1	LS	$ 200,000.00	200,000	**50**	**7,773**	Additional chemical dosing and storage at Pulgas OR new facilities at the AWPF
1.10	Breakpoint Chlorination - Contact Pipe for Retention			not incl				Assume retention for breakpoint chlorination at Pulgas or in conveyance pipeline from AWPF
1.11	Off-Site Additional Costs			15%	6,840,000	**50**	**265,840**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tanks**				**1,060,000**	**50**	**41,197**	Assume equalization needed for influent and product water
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			Placeholder cost provided for new connection from RWC tank to AWPF
2.2	Steel Storage Tanks for Product Water Tank	1	MG	$ 860,000	860,000			
3.0	**Upgrades at Pulgas Facilities**				**2,420,000**	**50**	**94,054**	
3.1	Connection to Pulgas Facilities	1	LS	$ 1,000,000	1,000,000			Assume connection to d/s of wet well - exact location to be determined in future study
3.2	Pulgas Dechlorimation - New Equalization Tank	2	MG	$ 710,000	1,420,000			Additional tanks to accomodate continuous low flow (change to current operations)
3.3	Discharge Facility Upgrades			not incl				Assume current discharge channel capacity of 250 mgd is sufficient
								– no capital upgrades needed to support additional flow
		Subtotal Facility Capital Costs - Part 1			**$55,910,196**	**Annualized**	**$2,536,166**	
Facility Capital Costs - Part 2								
4.0	Site Development Costs	@	5%		2,795,510		126,808	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		2,795,510		126,808	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		8,386,529		380,425	% of Subtotal facility costs (not inluding pipelines)
		Subtotal Facility Capital Costs - Part 2			**$13,977,549**	**Annualized**	**$634,042**	
				Facility Direct Costs	**$69,887,745**	**Annualized**	**$3,170,208**	
Markups and Contingency								
	Taxes	@	8.75%		1,956,857		88,766	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		3,494,387		158,510	% of Facility Direct Costs
	Engineering and Design	@	10%		6,988,775		317,021	% of Facility Direct Costs
	Planning and Acquisition	@	15%		10,483,162		475,531	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		10,483,162		475,531	% of Facility Direct Costs
	Owner's Administration	@	15%		10,483,162		475,531	% of Facility Direct Costs
	Environmental/Permitting	@	5%		3,494,387		158,510	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		10,483,162		475,531	% of Facility Direct Costs
	Estimate Contingency	@	40%		27,955,098		1,268,083	% of Facility Direct Costs
		Subtotal with Markups and Contingency			**$155,709,896**	**Annualized**	**$7,063,223**	
	Escalation to Midpoint of Construction	@	43%		66,295,183		3,007,244	assume = 3.0% over years = 12
								construction start = 2030 end = 2033
				Project Capital Cost Total	**$222,005,080**	**Annualized**	**$10,070,468**	
					Annualualized Capital Costs ($/AF)		**$2,347**	project life = 50 interest rate = 3%
					Annualualized Capital Costs ($/gal)		**$0.007**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total		Notes
Annual Operations and Maintenance Costs							
1.0	**Energy Costs**						
1.1	Energy - Treatment	6,033,655	KWh	$ 0.20	1,210,000		Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	121,000		8760 hours operated per year
							2755 KWH/MG
2.0	**Chemicals**						
2.1	**AWPF**	6,720	AF	$101	680,000		
	Breakpoint Chlorination						
2.2	Sodium Hypochlorite	2,190	MG	$ 191	418,000		Additional chemical dosing at Pulgas OR new facilities at the AWPF
2.3	Sodium Bisulfite	2,190	MG	$ 9	20,000		Additional chemical dosing at Pulgas OR new facilities at the AWPF
	Pulgas Dechloramination O&M (chemicals only)						Assume chemical costs similar to current use (unit costs and loads provided by SFPUC 9.29.2021)
2.4	Carbon dioxide	2,190	MG	$ 9	19,700		Carbon dioxide - $0.30/LB dosed at 30 lbs/MG
2.5	Sodium Hypochlorite	2,190	MG	$ 27	59,000		Sodium Hypochlorite - $0.96/LB dosed at 3.4 mg/L
2.6	Sodium Bisulfite	2,190	MG	$ 25	55,000		Sodium Bisulfite – $731.19/dry ton dosed at 8.13 mg/L
3.0	**Labor Costs**						
3.1	Labor - AWPF	8.0	staff	$ 175,000	1,400,000		full time staff at $175,000 average salary + benefits per year
3.2	Labor - Pulgas		not incl.				Assume existing staff could accommodate changes in operation
4.0	**Discharge Facility O&M**			not incl			Assume no additional discharge facility O&M costs
5.0	**Maintenance:**						
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 170	1,140,000		Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other Equipment (Replacement/Repair)	@	1.5%		260,000		% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		540,000		% of above O&M costs
				Annual O&M Costs ($/year)	**$5,922,700**		
					Annual Unit O&M Costs ($/AF)	**$1,400**	

Engineers Opinion of Probable Cost

HYBRID B - Phase 2 | Treated Drinking Water Augmentation - Treatment + Storage - 6 MGD DPR

Kennedy Jenks

				Average Annual Influent Flow:	7.84	mgd
Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	KAT, DT	**Average Annual Product Flow:**	6.00	mgd
Project:	Hybrid B - Direct Potable Reuse (TDWA)	**Date Prepared:**	May-2022	**RW Delivered:**	6720	Average Annual Production (AFY)
	Phase 2 - 6.0-mgd capacity AWPF located near Highway 101 treated to TDWA standards			**Spill:**	2431	Average Annual Spill (AFY)
				RW Benefit:	4290	Average Annual Benefit (AFY)
AWPF Location:	AWPF at HW 101 Site	**K/J Proj. No.**	1668011.03	**Design Capacity:**	4,167	Max Day Demand (gpm)
Repurpose:	RWC Tanks	**ENR**	13,098 *(Jan 2021 SF)*			
Estimate:	Conceptual Level Cost-Analysis					

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Treatment and Storage								
Facility Capital Costs - Part 1								
1.0	**Treatment**				**66,797,000**			**Unloaded Unit Treatment Costs**
1.1	Ozone	7.8	MGD	$ 700,000	5,490,000	**30**	**280,096**	DPR APWF = $11.1 /gal before contingencies
1.2	BAC	7.8	MGD	$ 1,100,000	8,627,000	**30**	**440,143**	Nutrient Removal = $0.0 /gal before contingencies
1.3	Microfiltration	7.8	MGD	$ 1,600,000	12,549,000	**30**	**640,241**	Total Treatment = $11.1 /gal before contingencies
1.4	Reverse Osmosis	7.1	MGD	$ 2,400,000	16,941,000	**30**	**864,317**	
1.5	Advanced Oxidation Process (includes UV)	6.0	MGD	$ 410,000	2,460,000	**30**	**125,507**	**Increased building cost for more complicated sites**
1.6	Free Chlorine			not incl				SVCW Site = $10.2 million b/c of need for piles in bay mud
1.7	Post Treatment and Chem Handling	6.0	MGD	$ 720,000	4,320,000	**50**	**167,899**	San Mateo Site = $11.3 million for two-story bld due to space
1.8	Building (standard)	30,000	SF	$ 250	7,500,000	**75**	**252,510**	Standard building @ Hwy 101 Site. 5,000 sf/mgd
1.9	Land Cost		SF	not incl				Cost of land NOT included in this analysis
1.10	Nutirent Removal			not incl				Assume RO is the primary method of nutrient removal and residual ammonia will be removed by breakpoint chlorination. Costs for breakpoint chlorination included in O&M
1.11	Chloramination - Chemical Storage and Dosing	1.00	LS	$ 200,000	200,000	**50**	**7,773**	Chemical Storage and dosing - Chloramination
1.12	Off-Site Additional Costs			15%	8,710,000	**50**	**338,518**	Account for new access roads, security, lighting, admin building, ancillary facilities, landscaping, etc (apply to above treatment facility costs)
2.0	**Storage Tank**				**1,060,000**	**50**	**41,197**	**Assume equalization needed for influent and product water**
2.1	Steel Storage Tanks for EQ Tank (prior to AWPF)		MG	not incl				Per Justin E. - additional storage in RWC tanks at SVCW could be repupropsed for equalization
	Alternately convert RWC for use as EQ tank	1	LS	$ 200,000	200,000			Placeholder cost provided for new connection from RWC tank to AWPF
2.2	Steel Storage Tanks for Product Water Tank	1	MG	$ 860,000	860,000			
3.0	**Connections to Potable Water System**							**POCs to Potable Distribution System may include:**
3.1	Included in Conveyance cost sheets							2 Connect to Redwood City Tanks
								2 Connect to CalWater distribution pipelines
								3 Connect to Foster City Tanks
				Subtotal Facility Capital Costs - Part 1	**$67,857,000**	**Annualized**	**$3,158,202**	
Facility Capital Costs - Part 2								
4.0	Site Development Costs	@	5%		3,392,850		157,910	% of Subtotal facility costs (Includes grading, erosion control, cut/fill, etc.)
5.0	Yard Piping	@	5%		3,392,850		157,910	% of Subtotal facility costs (not inluding pipelines)
6.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		10,178,550		473,730	% of Subtotal facility costs (not inluding pipelines)
				Subtotal Facility Capital Costs - Part 2	**$16,964,250**	**Annualized**	**$789,550**	
				Facility Direct Costs	**$84,821,250**		**$3,947,752**	
Markups and Contingency								
	Taxes	@	8.75%		2,374,995		110,537	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		4,241,063		197,388	% of Facility Direct Costs
	Engineering and Design	@	10%		8,482,125		394,775	% of Facility Direct Costs
	Special Studies	@	15%		12,723,188		592,163	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		12,723,188		592,163	% of Facility Direct Costs
	Owner's Administration	@	15%		12,723,188		592,163	% of Facility Direct Costs
	Environmental/Permitting	@	5%		4,241,063		197,388	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		12,723,188		592,163	% of Facility Direct Costs
	Estimate Contingency	@	40%		33,928,500		1,579,101	% of Facility Direct Costs
				Subtotal with Markups and Contingency	**$188,981,745**	**Annualized**	**$8,795,592**	
	Escalation to Midpoint of Construction	@	56%		105,445,656		4,907,654	assume = 3.0% over years = 15
								construction start = 2034 end = 2036
				Project Capital Cost Total	**$294,427,401**	**Annualized**	**$13,703,246**	
					Annualualized Capital Costs ($/AF)		**$3,194**	project life = 50 interest rate = 3%
					Annualualized Capital Costs ($/gal)		**$0.010**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			Notes
Annual Operations and Maintenance Costs								
1.0	**Energy Costs**							
1.1	Energy - Treatment	10,211,970	KWh	$ 0.20	2,040,000			Treatment Operation = 24 hours per day
1.2	Energy - Other			10%	204,000			8760 hours operated per year
								4663 KWH/MG
2.0	**Chemicals**	6,720	AF	$116	780,000			
	Chloramination O&M (chemicals only)							
2.1	Ammonia - Chloramination	2,190.0	MG	$ 5	11,000			Ammonia - $659/dry ton dosed at 2 mg/L
2.2	Sodium Hypochlorite - Chloramination	2,190.0	MG	$ 80	175,000			Sodium Hypochlorite - $0.96/LB dosed at 10 mg/L
	Dechlorination			not incl				Assume no additional dechlorination costs prior to entering drinking water system
3.0	**Labor Costs**							
3.1	Labor - AWPF	8.0	staff	$ 175,000	1,400,000			full time staff at $175,000 average salary + benefits per year
4.0	**Discharge Facility O&M**			not incl				No Discharge facility required
5.0	**Maintenance:**							
5.1	AWPF Equipment (Replacement/Repair)	6,720	AF	$ 170	1,140,000			Estimated for MF/RO/UV-AOP equipment and pumps
5.2	Other Equipment (Replacement/Repair)	@	1.5%		270,000			% of facility direct costs not including Treatment
6.0	**Contingency**	@	10.0%		600,000			% of above O&M costs
.								
			Annual O&M Costs ($/year)		**$6,620,000**			
					Annual Unit O&M Costs ($/AF)		**$1,500**	

Engineers Opinion of Probable Cost

Reservoir Water Augmentation at CSR - Pipelines + Pump Stations - AWPF near SVCW Site - 6 MGD IPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021
AWPF Location:	AWPF near SVCW	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Average Annual Influent Flow:	7.84	mgd
Average Annual Product Flow:	6.00	mgd
Brine Flow:	1.84	mgd
Conveyance Design Capacity:	4,167	Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs: $/Unit	Total Costs: Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				$ 31,319,000	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near SVCW to SVCW Outfall (Brine - open trench)**							
	Open Cut Pipeline	2,800	LF	$ 150	$ 420,000	**100**	**$ 13,292**	10 in-diameter $150 /LF
1.2	**SVCW RWC RQ Tank to AWPF near SVCW (Tertiary - open trench)**							
	Open Cut Pipeline	3,200	LF	$ 300	$ 960,000	**100**	**$ 30,381**	20 in-diameter $300 /LF
1.3	**AWPF near SVCW to Hwy101(Purified - repurpose - slip lining)**							
	Slip Lining	15,400	LF	$ 180	$ 2,772,000	**100**	**$ 87,725**	18 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.4	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 180	$ 2,268,000	**100**	**$ 71,775**	18 in-diameter $10 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.5	**Hwy101/Whipple to CSR (Purified - open trench)**							
	Open Cut Pipeline - SFPUC ROW	17,000	LF	$ 270	$ 4,590,000	**100**	**$ 145,258**	18 in-diameter $270 /LF
	Open Cut pipeline - along bay	12,200	LF	$ 450	$ 5,490,000	**100**	**$ 173,740**	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	23,300	LF	$ 330	$ 7,689,000	**100**	**$ 243,331**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost in remaining
								sections (busy areas) higher unit cost for special shoring along the bay
1.6	**AWPF near SVCW to CSR (Purified - trenchless - Hwy)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 540	$ 1,080,000	**100**	**$ 34,178**	18 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 100,000	$ 200,000			$100,000 /EA
1.7	**AWPF near SVCW to CSR (Purified - trenchless - Major Intersection)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,500	LF	$ 540	$ 810,000	**100**	**$ 25,634**	18 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	3	EA	$ 150,000	$ 450,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	3	EA	$ 100,000	$ 300,000			$100,000 /EA
2.0	**Pump Station**				$ 6,150,000	**50**	**$ 239,023**	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	$ 320,000	$ 320,000			1,280 total flow (gpm) 49 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary)	1	LS	$ 360,000	$ 360,000			5,447 total flow (gpm) 28 ft (TDH)
2.3	AWPF near SVCW to CSR (Purified)	1	LS	$ 5,470,000	$ 5,470,000			4,167 total flow (gpm) 1258 ft (TDH)
				Subtotal Facility Capital Costs - Part 1	**$ 37,469,000**	**Annualized**	**$ 1,064,336**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 1,873,450		$ 53,217	% of Subtotal facility costs - Part 1
4.0	Yard Piping	@	5%		$ 307,500		$ 53,217	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 922,500		$ 159,650	% of Subtotal facility costs (not inluding pipelines) - Part 1
				Subtotal Facility Capital Costs - Part 2	**$3,103,450**	**Annualized**	**$266,084**	
				Facility Direct Costs	**$40,572,450**	**Annualized**	**$1,330,420**	
Markups and Contingency								
	Taxes	@	8.75%		$ 1,311,415		$ 37,252	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 2,028,623		$ 66,521	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 4,057,245		$ 133,042	% of Facility Direct Costs
	Special Studies	@	15%		$ 6,085,868		$ 199,563	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 6,085,868		$ 199,563	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 6,085,868		$ 199,563	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 2,028,623		$ 66,521	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 6,085,868		$ 199,563	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 16,228,980		$ 532,168	% of Facility Direct Costs
				Subtotal with Markups and Contingency	**$90,570,805**	**Annualized**	**$2,964,176**	
	Escalation to Midpoint of Construction	@	43%		$ 38,561,506		$ 1,262,030.33	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
				Project Capital Cost Total	**$129,132,311**	**Annualized**	**$ 4,226,206.62**	
						Annualized Capital Costs ($/AFY)	**#DIV/0!**	Total Annualized Captial Cost divided by AFY
						Annualualized Capital Costs ($/gal)	**$0.002**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs: $/Unit	Total Annual Costs: Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	350,400	KWh	$ 0.20	$ 70,000			Pump Station Hp = 40 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary)	438,000	KWh	$ 0.20	$ 88,000			Pump Station Hp = 50 Total Motor HP Required
1.3	Energy - AWPF near SVCW to CSR (Purified)	16,644,000	KWh	$ 0.20	$ 3,330,000			Pump Station Hp = 1,900 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 350,000			% of above energy cost
2.0	**Labor Costs**							
3.1	Other Labor (pipeline, PS, wells)	2.0	staff	$ 125,000	$ 250,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 1,940,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 600,000			% of above O&M costs
				Annual O&M Costs ($/year)	**$6,628,000**			
						Annual Unit O&M Costs ($/AF)	**#DIV/0!**	
						Annual Unit O&M Costs ($/gal)	**$0.003**	

Engineers Opinion of Probable Cost

Reservoir Water Augmentation at CSR - Pipelines + Pump Stations - AWPF at HWY 101 Site - 6 MGD IPR

Kennedy Jenks

Average Annual Influent Flow:	7.84	mgd	
Average Annual Product Flow:	6.00	mgd	
Brine Flow:	1.84	mgd	
Conveyance Design Capacity:	4,167	Max Day Demand (gpm)	

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021
AWPF Location:	AWPF near HW 101	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
	Pipeline				**$ 29,507,000**	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near Hwy 101 to SVCW Outfall (Brine - sliplining)**							
	Slip Lining	15,400	LF	$ 100	$ 1,540,000	**100**	**$ 48,736**	10 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.2	**SVCW RWC RQ Tank to AWPF near HWY 101 (Tertiary - SVCW - repurpose - RWC Purple Line)**							
	repurpose RWC purple pipe	15,400	LF		not incl			20 in-diameter
								Assume no addition constructuion cost
	Turnout and conncet RWC purple pipe to AWPF	1	LS	$ 1,000,000	$ 1,000,000	**100**	**$ 31,647**	Conservative estimate due to heavy traffic and wetlands on the NE side of the potential AWPF location
1.3	**Hwy101/Whipple to CSR (Purified - open trench)**							
	Open Cut Pipeline - SFPUC ROW	17,000	LF	$ 270	$ 4,590,000	**100**	**$ 145,258**	18 in-diameter $270 /LF
	Open Cut pipeline - along bay	12,200	LF	$ 450	$ 5,490,000	**100**	**$ 173,740**	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	23,300	LF	$ 330	$ 7,689,000	**100**	**$ 243,331**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for
								special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.4	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 180	$ 2,268,000	**100**	**$ 71,775**	18 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.5	**AWPF near SVCW to CSR (Purified - trenchless - Hwy)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 540	$ 1,080,000	**100**	**$ 34,178**	18 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 60,000	$ 120,000			$60,000 /EA
1.6	**AWPF near SVCW to CSR (Purified - trenchless - Major Intersection)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,500	LF	$ 540	$ 810,000	**100**	**$ 25,634**	18 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	3	EA	$ 150,000	$ 450,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	3	EA	$ 60,000	$ 180,000			$60,000 /EA
2.0	**Pump Station**				**$ 6,860,000**	**50**	**$ 266,617**	
2.1	AWPF near hwy 101 to SVCW (Brine)	1	LS	$ 480,000	$ 480,000			1,280 total flow (gpm) 194 ft (TDH)
2.2	SVCW to AWPF near Hwy101 (Tertiary)	1	LS	$ 910,000	$ 910,000			5,447 total flow (gpm) 101 ft (TDH)
2.3	AWPF near hwy101 to CSR (Purified)	1	LS	$ 5,470,000	$ 5,470,000			4,167 total flow (gpm) 1258 ft (TDH)
				Subtotal Facility Capital Costs - Part 1	**$ 36,367,000**	**Annualized**	**$ 1,040,916**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 1,818,350		$ 52,046	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 343,000		$ 52,046	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 1,029,000		$ 156,137	% of Subtotal facility costs (not inluding pipelines) - Part 1
				Subtotal Facility Capital Costs - Part 2	**$3,190,350**	**Annualized**	**$260,229**	
				Facility Direct Costs	**$ 39,557,350**	**Annualized**	**$ 1,301,145**	
Markups and Contingency								
	Taxes	@	8.75%		$ 1,272,845		$ 36,432	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 1,977,868		$ 65,057	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 3,955,735		$ 130,115	% of Facility Direct Costs
	Special Studies	@	15%		$ 5,933,603		$ 195,172	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 5,933,603		$ 195,172	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 5,933,603		$ 195,172	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 1,977,868		$ 65,057	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 5,933,603		$ 195,172	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 15,822,940		$ 520,458	% of Facility Direct Costs
				Subtotal with Markups and Contingency	**$ 88,299,015**	**Annualized**	**$ 2,898,952**	
	Escalation to Midpoint of Construction	@	43%		$ 37,594,267		$ 1,234,260	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
				Project Capital Cost Total	**$125,893,282**	**Annualized**	**$4,133,212**	
						Annualized Capital Costs ($/AFY)	**#DIV/0!**	Total Annualized Captial Cost divided by AFY
						Annualualized Capital Costs ($/gal)	**$0.002**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary)	2,628,000	KWh	$ 0.20	$ 526,000			Pump Station Hp = 300 Total Motor HP Required
1.3	Energy - AWPF near SVCW to CSR (Purified)	16,644,000	KWh	$ 0.20	$ 3,330,000			Pump Station Hp = 1,900 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 420,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	2.0	staff	$ 125,000	$ 250,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 1,890,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 680,000			% of above O&M costs
				Annual O&M Costs ($/year)	**$7,446,000**			
						Annual Unit O&M Costs ($/AF)	**#DIV/0!**	
						Annual Unit O&M Costs ($/gal)	**$0.003**	

Engineers Opinion of Probable Cost

Reservoir Water Augmentation at CSR - Pipelines + Pump Stations - AWPF near SVCW Site - 12 MGD IPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021
AWPF Location:	AWPF near SVCW	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Average Annual Influent Flow:	15.69	mgd
Average Annual Product Flow:	12.00	mgd
Brine Flow:	3.69	mgd
Conveyance Design Capacity:	8,333	Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				**$ 54,957,600**	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near SVCW to SVCW Outfall (Brine - open trench)**							
	Open Cut Pipeline	2,800	LF	$ 210	$ 588,000	**100**	**$ 18,608**	14 in-diameter $210 /LF
1.2	**SVCW RWC RQ Tank to AWPF near SVCW (Tertiary - open trench)**							
	Open Cut Pipeline	3,200	LF	$ 448	$ 1,433,600	**100**	**$ 45,369**	28 in-diameter $448 /LF
1.3	**AWPF near SVCW to Hwy101(Purified - Repurpose - sliplining)**							
	Slip Lining	15,400	LF	$ 240	$ 3,696,000	**100**	**$ 116,966**	24 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.4	**San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo - open trench)**							
	Open Cut Pipeline	25,600	LF	$ 370	$ 9,472,000	**100**	**$ 299,757**	20 in-diameter $370 /LF
1.5	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary San Mateo - trenchless - Belmont Slough)**							
	Microtunneling (Trenchless) - 100ft Pit	2,500	LF	$ 800	$ 2,000,000	**100**	**$ 63,293**	20 in-diameter 40 per inch-dia-LF
	Microtunnelling Jacking Pit (100 ft deep)	1	EA	$ 2,000,000	$ 2,000,000			$2,000,000 /EA
	Microtunnelling Receiving Pit (100 ft deep)	1	EA	$ 2,000,000	$ 2,000,000			$2,000,000 /EA
1.6	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary San Mateo - pipe suspension - E 3rd Ave Bridge)**							
	Pipe Suspension	1,000	LF	$ 6,000	$ 6,000,000	**100**	**$ 189,880**	20 in-diameter $300 /LF
1.5	**Hwy 101 to CSR(Purified - open trench)**							
	Open Cut Pipeline - SFPUC ROW	17,000	LF	$ 270	$ 4,590,000	**100**	**$ 145,258**	24 in-diameter $270 /LF
	Open Cut pipeline - along bay	12,200	LF	$ 600	$ 7,320,000	**100**	**$ 231,654**	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	23,300	LF	$ 330	$ 7,689,000	**100**	**$ 243,331**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for
								special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.8	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 240	$ 3,024,000	**100**	**$ 95,700**	24 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.9	**AWPF near SVCW to CSR (Purified - trenchless - Hwy)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 30	$ 60,000	**100**	**$ 1,899**	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 60,000	$ 120,000			$60,000 /EA
1.10	**AWPF near SVCW to CSR (Purified - trenchless - Major Intersection)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,500	LF	$ 30	$ 45,000	**100**	**$ 1,424**	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	3	EA	$ 150,000	$ 450,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	3	EA	$ 60,000	$ 180,000			$60,000 /EA
2.0	**Pump Station**				**$ 11,390,000**	**50**	**$ 442,678**	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	360,000	$ 360,000			2,560 total flow (gpm) 37 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary - Combined)	1	LS	480,000	$ 480,000			10,894 total flow (gpm) 22 ft (TDH)
2.3	San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo)	1	LS	1,260,000	$ 1,260,000			5,447 total flow (gpm) 158 ft (TDH)
2.4	AWPF near SVCW to CSR (Purified)	1	LS	9,290,000	$ 9,290,000			8,334 total flow (gpm) 1158 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 66,347,600**	**Annualized**	**$ 1,895,817**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 3,317,380		$ 94,791	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
		145,200	SQFT		$ 12,269,400			SVCW is built on bay mud and would require piles
								From XL, recent SVCW project had a pile cost of $89/sqft of building (2021 dollars) = $84.50/sqft in 2019 dollars
4.0	Yard Piping	@	5%		$ 569,500		$ 94,791	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 1,708,500		$ 284,373	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 17,864,780**	**Annualized**	**$ 473,954**	
	Facility Direct Costs				**$ 84,212,380**	**Annualized**	**$ 2,369,771**	
Markups and Contingency								
	Taxes	@	8.75%		$ 2,322,166		$ 66,354	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 4,210,619		$ 118,489	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 8,421,238		$ 236,977	% of Facility Direct Costs
	Special Studies	@	15%		$ 12,631,857		$ 355,466	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 12,631,857		$ 355,466	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 12,631,857		$ 355,466	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 4,210,619		$ 118,489	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 12,631,857		$ 355,466	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 33,684,952		$ 947,908	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 187,589,402**	**Annualized**	**$ 5,279,850**	
	Escalation to Midpoint of Construction	@	43%		$ 79,868,230		$ 2,247,954	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$267,457,632**	**Annualized**	**$7,527,804**	
	Annualized Capital Costs ($/AFY)						**#DIV/0!**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.002**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	438,000	KWh	$ 0.20	$ 88,000			Pump Station Hp = 50 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary - Combined)	700,800	KWh	$ 0.20	$ 140,000			Pump Station Hp = 80 Total Motor HP Required
1.3	Energy - San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - SM)	2,628,000	KWh	$ 0.20	$ 530,000			Pump Station Hp = 300 Total Motor HP Required
1.4	Energy - AWPF near SVCW to CSR (Purified)	28,908,000	KWh	$ 0.20	$ 5,780,000			Pump Station Hp = 3,300 Total Motor HP Required
1.5	Energy - Other		KWh	10%	$ 650,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 4,010,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 1,160,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$12,738,000**			
	Annual Unit O&M Costs ($/AF)						**#DIV/0!**	
	Annual Unit O&M Costs ($/gal)						**$0.003**	

Engineers Opinion of Probable Cost

Kennedy Jenks

Reservoir Water Augmentation at CSR - Pipelines + Pump Stations - AWPF at HWY 101 Site - 12 MGD IPR

Average Annual Influent Flow:	15.69	mgd	
Average Annual Product Flow:	12.00	mgd	
Brine Flow:	3.69	mgd	
Conveyance Design Capacity:	8,333	Max Day Demand (gpm)	

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021
AWPF Location:	AWPF near HW 101	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				$ 49,686,000	100		only apply est facility life to pipelines (not pits)
1.1	**AWPF near Hwy 101 to SVCW Outfall (Brine - Slip lining)**							
	Slip Lining	15,400	LF	$ 140	$ 2,156,000	100	$ 68,230	14 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.2	**AWPF near SVCW to Hwy101(Purified - Repurpose - sliplining)**							
	repurpose RWC purple pipe	15,400	LF		not incl			20 in-diameter
								Assume no addition constructuion cost
	Turnout and conncet RWC purple pipe to AWPF	1	LS	$ 1,000,000	$ 1,000,000	100	$ 31,647	Conservative estimate due to heavy traffic and wetlands on the NE side of the potential AWPF location.
1.3	**San Mateo WWTP to Hwy 101 (Tertiary - San Mateo - open trench)**							
	Open Cut Pipeline	27,600	LF	$ 370	$ 10,212,000	100	$ 323,176	20 in-diameter $370 /LF
1.4	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - trenchless - Slough)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 600	$ 600,000	100	$ 18,988	20 in-diameter 30 per inch-dia-LF
	Microtunnelling Jacking Pit (35 ft deep)	1	EA	$ 600,000	$ 600,000			$600,000 /EA
	Microtunnelling Receiving Pit (35 ft deep)	1	EA	$ 500,000	$ 500,000			$500,000 /EA
1.5	**San Mateo WWTP to SVCW RWC RW Tanks(Tertirary - San Mateo - trenchless - hwy92)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 600	$ 600,000	100	$ 18,988	20 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	1	EA	$ 150,000	$ 150,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	1	EA	$ 100,000	$ 100,000			$100,000 /EA
1.6	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - pipe suspension - E 3rd Ave Bridge)**							
	Pipe Suspension	1,000	LF	$ 6,000	$ 6,000,000	100	$ 189,880	20 in-diameter $300 /LF
1.7	**Hwy 101 to CSR(Purified - open trench)**							
	Open Cut Pipeline - SFPUC ROW	17,000	LF	$ 270	$ 4,590,000	100	$ 145,258	24 in-diameter $270 /LF
	Open Cut pipeline - along bay	12,200	LF	$ 600	$ 7,320,000	100	$ 231,654	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	23,300	LF	$ 330	$ 7,689,000	100	$ 243,331	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.8	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 240	$ 3,024,000	100	$ 95,700	24 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.9	**AWPF near SVCW to CSR (Purified - trenchless - Hwy)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 30	$ 60,000	100	$ 1,899	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 60,000	$ 120,000			$60,000 /EA
1.10	**AWPF near SVCW to CSR (Purified - trenchless - Major Intersection)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,500	LF	$ 30	$ 45,000	100	$ 1,424	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	3	EA	$ 150,000	$ 450,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	3	EA	$ 60,000	$ 180,000			$60,000 /EA
2.0	**Pump Station**				$ 12,370,000	50	$ 480,766	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	$ 910,000	$ 910,000			2,560 total flow (gpm) 128 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary - SVCW only)	1	LS	$ 910,000	$ 910,000			5,447 total flow (gpm) 101 ft (TDH)
2.3	San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo)	1	LS	$ 1,260,000	$ 1,260,000			5,447 total flow (gpm) 172 ft (TDH)
2.4	AWPF near SVCW to CSR (Purified)	1	LS	$ 9,290,000	$ 9,290,000			8,334 total flow (gpm) 1158 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				$ 62,056,000	Annualized	$ 1,850,940	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 3,102,800		$ 92,547	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 618,500		$ 92,547	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 1,855,500		$ 277,641	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				$ 5,576,800	Annualized	$ 462,735	
	Facility Direct Costs				$ 67,632,800	Annualized	$ 2,313,675	
Markups and Contingency								
	Taxes	@	8.75%		$ 2,171,960		$ 64,783	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 3,381,640		$ 115,684	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 6,763,280		$ 231,368	% of Facility Direct Costs
	Special Studies	@	15%		$ 10,144,920		$ 347,051	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 10,144,920		$ 347,051	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 10,144,920		$ 347,051	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 3,381,640		$ 115,684	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 10,144,920		$ 347,051	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 27,053,120		$ 925,470	% of Facility Direct Costs
	Subtotal with Markups and Contingency				$ 150,964,120	Annualized	$ 5,154,868	
	Escalation to Midpoint of Construction	@	43%		$ 64,274,618		$ 2,194,741	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
	Project Capital Cost Total				$215,238,738	Annualized	$7,349,610	
	Annualized Capital Costs ($/AFY)						#DIV/0!	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						$0.002	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary - SVCW only)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.3	Energy - San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - SM)	2,628,000	KWh	$ 0.20	$ 530,000			Pump Station Hp = 300 Total Motor HP Required
1.4	Energy - AWPF near SVCW to CSR (Purified)	27,156,000	KWh	$ 0.20	$ 5,430,000			Pump Station Hp = 3,100 Total Motor HP Required
1.5	Energy - Other		KWh	10%	$ 670,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 3,230,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 1,090,000			% of above O&M costs
	Annual O&M Costs ($/year)				$12,030,000			
	Annual Unit O&M Costs ($/AF)						#DIV/0!	
	Annual Unit O&M Costs ($/gal)						$0.003	

Engineers Opinion of Probable Cost

Raw Water Augmentation at Bear Gulch - Pipelines + Pump Stations - 6 MGD DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021	
AWPF Location:	AWPF near SVCW	**K/J Proj. No.**	1668011.03	
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098	*(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis			

Average Annual Influent Flow:	7.84	mgd
Average Annual Product Flow:	6.00	mgd
Brine Flow:	1.84	mgd
Conveyance Design Capacity:	4,167	Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				$ 19,708,000	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near SVCW to SVCW Outfall (Brine - open trench)**							
	Open Cut Pipeline	2,800	LF	$ 150	$ 420,000	**100**	**$ 13,292**	10 in-diameter $150 /LF
1.2	**SVCW RWC RQ Tank to AWPF near SVCW (Tertiary - open trench)**							
	Open Cut Pipeline	3,200	LF	$ 300	$ 960,000	**100**	**$ 30,381**	20 in-diameter $300 /LF
1.3	**AWPF near SVCW to Hwy101(Purified - repurpose - slip lining)**							
	Slip Lining	15,400	LF	$ 180	$ 2,772,000	**100**	**$ 87,725**	18 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.4	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 180	$ 2,268,000	**100**	**$ 71,775**	18 in-diameter $10 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.5	**Hwy 101 to Bear Gulch Res**							
	Open Cut Pipeline - SFPUC ROW	0	LF	$ 270	$ -	**100**	**$ -**	18 in-diameter $270 /LF
	Open Cut pipeline - along bay	1,400	LF	$ 450	$ 630,000	**100**	**$ 19,937**	23,000 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	21,600	LF	$ 330	$ 7,128,000	**100**	**$ 225,577**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost in remaining
								sections (busy areas) higher unit cost for special shoring along the bay
1.6	**Hwy 101 to Bear Gulch Res**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 540	$ 540,000	**100**	**$ 17,089**	18 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	4	EA	$ 150,000	$ 600,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	4	EA	$ 100,000	$ 400,000			$100,000 /EA
								Assume for highway crossing
2.0	**Pump Station**				$ 5,070,000	**50**	**$ 197,048**	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	$ 320,000	$ 320,000			1,280 total flow (gpm) 49 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary)	1	LS	$ 360,000	$ 360,000			5,447 total flow (gpm) 28 ft (TDH)
2.3	AWPF near SVCW to Bear Gulch (Purified)	1	LS	$ 4,390,000	$ 4,390,000			4,167 total flow (gpm) 541 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 24,778,000**	**Annualized**	**$ 662,824**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 1,238,900		$ 33,141	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 253,500		$ 33,141	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 760,500		$ 99,424	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 2,252,900**	**Annualized**	**$ 165,706**	
	Facility Direct Costs				**$ 27,030,900**	**Annualized**	**$ 828,530**	
Markups and Contingency								
	Taxes	@	8.75%		$ 867,230		$ 23,199	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 1,351,545		$ 41,426	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 2,703,090		$ 82,853	% of Facility Direct Costs
	Special Studies	@	15%		$ 4,054,635		$ 124,279	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 4,054,635		$ 124,279	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 4,054,635		$ 124,279	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 1,351,545		$ 41,426	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 4,054,635		$ 124,279	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 10,812,360		$ 331,412	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 60,335,210**	**Annualized**	**$ 1,845,964**	
	Escalation to Midpoint of Construction	@	43%		$ 25,688,373		$ 785,939.25	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$86,023,583**	**Annualized**	**$2,631,903**	
	Annualized Capital Costs ($/AFY)						**#DIV/0!**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	350,400	KWh	$ 0.20	$ 70,000			Pump Station Hp = 40 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary)	438,000	KWh	$ 0.20	$ 88,000			Pump Station Hp = 50 Total Motor HP Required
1.3	Energy - AWPF near SVCW to Bear Gulch (Purified)	7,095,600	KWh	$ 0.20	$ 1,420,000			Pump Station Hp = 810 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 160,000			% of above energy cost
2.0	**Labor Costs**							
3.1	Other Labor (pipeline, PS, wells)	2.0	staff	$ 125,000	$ 250,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 1,290,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 330,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$3,608,000**			
	Annual Unit O&M Costs ($/AF)						**#DIV/0!**	
	Annual Unit O&M Costs ($/gal)						**$0.002**	

Engineers Opinion of Probable Cost

Treated Water Augmentation - Pipelines + Pump Stations + POC to Redwood City / CalWater - 6 MGD DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost
AWPF Location:	AWPF near SVCW
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd
Estimate:	Conceptual Level Cost-Analysis

Prepared By:	RX, DT
Date Prepared:	Sep-2021
K/J Proj. No.	1668011.03
ENR	13,098 *(Jan 2021 SF)*

Average Annual Influent Flow:	7.84	mgd
Average Annual Product Flow:	6.00	mgd
Brine Flow:	1.84	mgd
Conveyance Design Capacity:	4,167	Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs: $/Unit	Total Costs: Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				$ 8,530,000	100		only apply est facility life to pipelines (not pits)
1.1	**AWPF near SVCW to SVCW Outfall (Brine - open trench)**							
	Open Cut Pipeline	2,800	LF	$ 150	$ 420,000	100	$ 13,292	10 in-diameter $150 /LF
1.2	**SVCW RWC RQ Tank to AWPF near SVCW (Tertiary - open trench)**							
	Open Cut Pipeline	3,200	LF	$ 300	$ 960,000	100	$ 30,381	20 in-diameter $300 /LF
1.5	**From AWPF near SVCW to Hwy 101 with connections to Rdwd Shore tanks and Calwater**							
	Open Cut Pipeline - SFPUC ROW	0	LF	$ 270	$ -	100	$ -	18 in-diameter $270 /LF
	Open Cut pipeline - along bay	15,000	LF	$ 450	$ 6,750,000	100	$ 213,615	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	0	LF	$ 330	$ -	100	$ -	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost in remaining
								sections (busy areas) higher unit cost for special shoring along the bay
1.6	**Potable Water Tie Ins**							
	Connect to Redwood City Tanks	2	LS	$ 150,000	$ 300,000	100	$ 9,494	Tank connection, with air gap
	Connect to CalWater distribution pipelines	2	LS	$ 50,000	$ 100,000	100	$ 3,165	12 in-diameter potable water lines
2.0	**Pump Station**				$ 1,590,000	50	$ 61,796	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	$ 320,000	$ 320,000			1,280 total flow (gpm) 49 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary)	1	LS	$ 360,000	$ 360,000			5,447 total flow (gpm) 28 ft (TDH)
2.3	AWPF to tanks(Purified)	1	LS	$ 910,000	$ 910,000			4,167 total flow (gpm) 1258 ft (TDH)
				Subtotal Facility Capital Costs - Part 1	**$ 10,120,000**	**Annualized**	**$ 331,742**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 506,000		$ 16,587	% of Subtotal facility costs - Part 1
		79,600	SQFT		$ 6,726,200			(Includes grading, erosion control, cut/fill, etc.)
								SVCW is built on bay mud and would require piles
								From XL, recent SVCW project had a pile cost of $89/sqft of building (2021 dollars) = $84.50/sqft in 2019 dollars
4.0	Yard Piping	@	5%		$ 79,500		$ 16,587	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 238,500		$ 49,761	% of Subtotal facility costs (not inluding pipelines) - Part 1
				Subtotal Facility Capital Costs - Part 2	**$ 7,550,200**	**Annualized**	**$ 82,936**	
				Facility Direct Costs	**$ 17,670,200**	**Annualized**	**$ 414,678**	
Markups and Contingency								
	Taxes	@	8.75%		$ 354,200		$ 11,611	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 883,510		$ 20,734	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 1,767,020		$ 41,468	% of Facility Direct Costs
	Special Studies	@	15%		$ 2,650,530		$ 62,202	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 2,650,530		$ 62,202	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 2,650,530		$ 62,202	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 883,510		$ 20,734	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 2,650,530		$ 62,202	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 7,068,080		$ 165,871	% of Facility Direct Costs
				Subtotal with Markups and Contingency	**$ 39,228,640**	**Annualized**	**$ 923,902**	
	Escalation to Midpoint of Construction	@	56%		$ 21,888,303		$ 515,507.22	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 15
								construction start = 2034 end = 2036
								project life = 50 interest rate = 3%
				Project Capital Cost Total	**$61,116,943**	**Annualized**	**$1,439,409**	
						Annualized Capital Costs ($/AFY)	**$345**	Total Annualized Captial Cost divided by AFY
						Annualualized Capital Costs ($/gal)	**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs: $/Unit	Total Annual Costs: Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Egnergy - AWPF near SVCW to SVCW (Brine)	350,400	KWh	$ 0.20	$ 70,000			Pump Station Hp = 40 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary)	438,000	KWh	$ 0.20	$ 88,000			Pump Station Hp = 50 Total Motor HP Required
1.3	Energy - AWPF near Cal Water Tanks and Redwood Shores (Purified)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 50,000			% of above energy cost
2.0	**Labor Costs**							
3.1	Other Labor (pipeline, PS, wells)	2.0	staff	$ 125,000	$ 250,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 920,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 170,000			% of above O&M costs
				Annual O&M Costs ($/year)	**$1,898,000**			
						Annual Unit O&M Costs ($/AF)	**$400**	
						Annual Unit O&M Costs ($/gal)	**$0.001**	

Engineers Opinion of Probable Cost

Kennedy Jenks

Treated Water Augmentation - Pipelines + Pump Stations + POC to Redwood City / CalWater - 6 MGD DPR

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT		**Average Annual Influent Flow:**	7.84 mgd
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021		**Average Annual Product Flow:**	6.00 mgd
AWPF Location:	AWPF near HW 101	**K/J Proj. No.**	1668011.03		**Brine Flow:**	1.84 mgd
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098	*(Jan 2021 SF)*	**Conveyance Design Capacity:**	4,167 Max Day Demand (gpm)
Estimate:	Conceptual Level Cost-Analysis					

Item No.	Description	Qty	Units	Total Costs: $/Unit	Total Costs: Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
	Pipeline				**$ 12,830,000**	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near Hwy 101 to SVCW Outfall (Brine - sliplining)**							
	Slip Lining	15,400	LF	$ 100	$ 1,540,000	**100**	**$ 48,736**	10 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.2	**SVCW RWC RQ Tank to AWPF near SVCW (Tertiary - open trench)**							
	repurpose RWC purple pipe	15,400	LF	$ 200	$ 3,080,000			20 in-diameter 10.00 $/in-dia/LF
								Assume no addition constructuion cost $200 $/LF
	Turnout and conncet RWC purple pipe to AWPF	1	LS	$ 1,000,000	$ 1,000,000	**100**	**$ 31,647**	Conservative estimate due to heavy traffic and wetlands on the NE side of the potential AWPF location
1.3	**From Hwy 101 AWPF to Rdwd Shores Tanks**							
	Open Cut Pipeline - SFPUC ROW	0	LF	$ 270	$ -	**100**	**$ -**	18 in-diameter $270 /LF
	Open Cut pipeline - along bay	10,000	LF	$ 450	$ 4,500,000	**100**	**$ 142,410**	18 in-diameter $25 per inch-dia-LF
	Open Cut pipeline - Remaning	0	LF	$ 330	$ -	**100**	**$ -**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for
								special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.4	**Potable Water Tie Ins**							
	Connect to Redwood City Tanks	2	LS	$ 150,000	$ 300,000	**100**	**$ 9,494**	Tank connection, with air gap
	Connect to CalWater distribution pipelines	2	LS	$ 50,000	$ 100,000	**100**	**$ 3,165**	12 in-diameter potable water lines
2.0	**Pump Station**				**$ 1,910,000**	**50**	**$ 74,233**	
2.1	AWPF near hwy 101 to SVCW (Brine)	1	LS	$ 480,000	$ 480,000			1,280 total flow (gpm) 194 ft (TDH)
2.2	SVCW to AWPF near Hwy101 (Tertiary)	1	LS	$ 910,000	$ 910,000			5,447 total flow (gpm) 101 ft (TDH)
2.3	AWPF near hwy101 to Redwood Shores Tanks (Purified)	1	LS	$ 520,000	$ 520,000			4,167 total flow (gpm) 1258 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 14,740,000**	**Annualized**	**$ 309,684**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 737,000		$ 15,484	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 95,500		$ 15,484	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 286,500		$ 46,453	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 1,119,000**	**Annualized**	**$ 77,421**	
	Facility Direct Costs				**$ 15,859,000**	**Annualized**	**$ 387,105**	
Markups and Contingency								
	Taxes	@	8.75%		$ 515,900		$ 10,839	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 792,950		$ 19,355	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 1,585,900		$ 38,711	% of Facility Direct Costs
	Special Studies	@	15%		$ 2,378,850		$ 58,066	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 2,378,850		$ 58,066	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 2,378,850		$ 58,066	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 792,950		$ 19,355	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 2,378,850		$ 58,066	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 6,343,600		$ 154,842	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 35,405,700**	**Annualized**	**$ 862,471**	
	Escalation to Midpoint of Construction	@	56%		$ 19,755,227		$ 481,231	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 15
								construction start = 2034 end = 2036
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$55,160,927**	**Annualized**	**$1,343,701**	
	Annualized Capital Costs ($/AFY)						**$322**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs: $/Unit	Total Annual Costs: Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near HWY 101 to SVCW (Brine)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.3	Energy - AWPF to Cal Water and Redwood Shores Tanks	788,400	KWh	$ 0.20	$ 160,000			Pump Station Hp = 90 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 90,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	2.0	staff	$ 125,000	$ 250,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 830,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 200,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$2,230,000**			
	Annual Unit O&M Costs ($/AF)						**$500**	
	Annual Unit O&M Costs ($/gal)						**$0.001**	

Engineers Opinion of Probable Cost

Treated Water Augmentation - Pipelines + Pump Stations + POC to Foster City / CalWater - 6 MGD DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT	**Average Annual Influent Flow:**	7.84	mgd
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021	**Average Annual Product Flow:**	6.00	mgd
AWPF Location:	AWPF near SM	**K/J Proj. No.**	1668011.03	**Brine Flow:**	1.84	mgd
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*	**Conveyance Design Capacity:**	4,167	Max Day Demand (gpm)
Estimate:	Conceptual Level Cost-Analysis					

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
	Pipeline				$ 7,842,000	100		only apply est facility life to pipelines (not pits)
1.1	**San Mateo AWTF to Outfall (Brine)**							
	Open Cut Pipeline (Tertiary)	3,200	LF	$ 200	$ 640,000	**100**	**$ 20,254**	20 in-diameter 10.00 per inch-dia-LF
	Open Cut Pipeline (Brine)	2,800	LF	$ 100	$ 280,000	**100**	**$ 8,861**	10 in-diameter 10.00 per inch-dia-LF
								18 in-diameter $270 /LF
1.2	**From SM AWPF to Foster City tanks**							52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut Pipeline - along bay	6,500	LF	$ 450	$ 2,925,000	50	**$ 113,682**	$450 /LF
								Assume no addition constructuion cost $/LF
1.3	**From SM AWPF to Distribution lines at newbridge/Norfolk and Newbridge/Delaware**							
	Open Cut Pipeline - SFPUC ROW	0	LF	$ 270	$ -	**100**	**$ -**	
	Open Cut pipeline - along bay	7,300	LF	$ 450	$ 3,285,000	**50**	**$ 127,673**	
	Open Cut pipeline - Remaning	0	LF	$ 450	$ -	**100**	**$ -**	
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for
1.4	**From SM AWPF to Distribution lines at newbridge/Norfolk and Newbridge/Delaware (Highway Crossing - trenchless)**							18 in diameter
	Open Cut Pipelines	300	LF	$ 540	$ 162,000			$ 30.00 $/in/LF
								$ 540.00 $/LF
								special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.4	**Potable Water Tie Ins**							
	Connect to Foster City Tanks	3	LS	$ 150,000	$ 450,000	**100**	**$ 14,241**	Tank connection, with air gap
	Connect to CalWater distribution pipelines	2	LS	$ 50,000	$ 100,000	**100**	**$ 3,165**	12 in-diameter potable water lines
2.0	**Pump Station**				$ 2,270,000	**50**	**$ 88,225**	
2.1	SM AWTF to SM Outfall (Brine)	1	LS	$ 480,000	$ 480,000			1,280 total flow (gpm) 194 ft (TDH)
2.2	San Mateo to SM AWTF (Tertiary)	1	LS	$ 910,000	$ 910,000			5,447 total flow (gpm) 101 ft (TDH)
2.3	SM AWTF to Foster City Tanks/Distribution Lines (Purified)	1	LS	$ 880,000	$ 880,000			4,167 total flow (gpm) 1258 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 10,112,000**	**Annualized**	**$ 376,100**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 505,600		$ 18,805	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 113,500		$ 18,805	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 340,500		$ 56,415	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 959,600**	**Annualized**	**$ 94,025**	
	Facility Direct Costs				**$ 11,071,600**	**Annualized**	**$ 470,125**	
Markups and Contingency								
	Taxes	@	8.75%		$ 353,920		$ 13,163	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 553,580		$ 23,506	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 1,107,160		$ 47,012	% of Facility Direct Costs
	Special Studies	@	15%		$ 1,660,740		$ 70,519	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 1,660,740		$ 70,519	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 1,660,740		$ 70,519	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 553,580		$ 23,506	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 1,660,740		$ 70,519	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 4,428,640		$ 188,050	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 24,711,440**	**Annualized**	**$ 1,047,438**	
	Escalation to Midpoint of Construction	@	56%		$ 13,788,178		$ 584,437	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 15
								construction start = 2034 end = 2036
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$38,499,618**	**Annualized**	**$1,631,875**	
	Annualized Capital Costs ($/AFY)						**$392**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWTF near San Mateo to Foster City	613,200	KWh	$ 0.20	$ 123,000			Pump Station Hp = 70 Total Motor HP Required
1.2	Energy - AWTF near San Mateo to CWS Connections	613,200	KWh	$ 0.20	$ 123,000			Pump Station Hp = 70 Total Motor HP Required
1.3	Energy - Other		KWh	10%	$ 20,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	2.0	staff	$ 125,000	$ 250,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 580,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 110,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$1,206,000**			
	Annual Unit O&M Costs ($/AF)						**$200**	
	Annual Unit O&M Costs ($/gal)						**$0.001**	

Engineers Opinion of Probable Cost

Kennedy Jenks

Treated Water Augmentation - Pipelines + Pump Stations + POC to Redwood City / CalWater - 12 MGD DPR

Average Annual Influent Flow:	15.69 mgd
Average Annual Product Flow:	12.00 mgd
Brine Flow:	3.69 mgd
Conveyance Design Capacity:	8,333 Max Day Demand (gpm)

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	RX, DT
Project:	SWA at Crystal Springs Reservoir - Pipeline & Pump Station Cost	**Date Prepared:**	Sep-2021
AWPF Location:	AWPF near HW 101	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				**$ 40,214,000**	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near Hwy 101 to SVCW Outfall (Brine - Slip lining)**							
	Slip Lining	15,400	LF	$ 140	$ 2,156,000	**100**	**$ 68,230**	14 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.2	**AWPF near SVCW to Hwy101(Purified - Repurpose - sliplining)**							
	repurpose RWC purple pipe	15,400	LF		not incl			20 in-diameter
								Assume no addition constructuion cost
	Turnout and conncet RWC purple pipe to AWPF	1	LS	$ 1,000,000	$ 1,000,000	**100**	**$ 31,647**	Conservative estimate due to heavy traffic and wetlands on the NE side of the potential AWPF location.
1.3	**San Mateo WWTP to Hwy 101 (Tertiary - San Mateo - open trench)**							
	Open Cut Pipeline	27,600	LF	$ 370	$ 10,212,000	**100**	**$ 323,176**	20 in-diameter $370 /LF
1.4	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - trenchless - Slough)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 600	$ 600,000	**100**	**$ 18,988**	20 in-diameter 30 per inch-dia-LF
	Microtunnelling Jacking Pit (35 ft deep)	1	EA	$ 600,000	$ 600,000			$600,000 /EA
	Microtunnelling Receiving Pit (35 ft deep)	1	EA	$ 500,000	$ 500,000			$500,000 /EA
1.5	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - trenchless - hwy92)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 600	$ 600,000	**100**	**$ 18,988**	20 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	1	EA	$ 150,000	$ 150,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	1	EA	$ 100,000	$ 100,000			$100,000 /EA
1.6	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - pipe suspension - E 3rd Ave Bridge)**							
	Pipe Suspension	1,000	LF	$ 6,000	$ 6,000,000	**100**	**$ 189,880**	20 in-diameter $300 /LF
1.7	**AWPF at HWY 101 to and Alameda De Las Pulgas**							
	Open Cut Pipeline - SFPUC ROW	0	LF	$ 270	$ -	**100**	**$ -**	24 in-diameter $270 /LF
	Open Cut pipeline - along bay	15,000	LF	$ 600	$ 9,000,000	**100**	**$ 284,820**	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	18,200	LF	$ 330	$ 6,006,000	**100**	**$ 190,070**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.8	**AWPF near HWY 101 to Alameda (Trenchless)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 30	$ 60,000	**100**	**$ 1,899**	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 60,000	$ 120,000			$60,000 /EA
1.9	**Potable Water Tie Ins**							
	Connect to Redwood City Tanks	2	LS	$ 150,000	$ 300,000	**100**	**$ 9,494**	Tank connection, with air gap
	Connect to CalWater distribution pipelines	4	LS	$ 50,000	$ 200,000	**100**	**$ 6,329**	12 in-diameter potable water lines
2.0	**Pump Station**				**$ 7,730,000**	**50**	**$ 300,430**	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	$ 910,000	$ 910,000			2,560 total flow (gpm) 128 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary - SVCW only)	1	LS	$ 910,000	$ 910,000			5,447 total flow (gpm) 101 ft (TDH)
2.3	San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo)	1	LS	$ 1,260,000	$ 1,260,000			5,447 total flow (gpm) 172 ft (TDH)
2.4	AWPF near HWY 101 to Alameda and Redwood Shores Tanks	1	LS	$ 4,650,000	$ 4,650,000			8,334 total flow (gpm) 1158 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 47,944,000**	**Annualized**	**$ 1,443,951**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 2,397,200		$ 72,198	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 386,500		$ 72,198	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 1,159,500		$ 216,593	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 3,943,200**	**Annualized**	**$ 360,988**	
	Facility Direct Costs				**$ 51,887,200**	**Annualized**	**$ 1,804,939**	
Markups and Contingency								
	Taxes	@	8.75%		$ 1,678,040		$ 50,538	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 2,594,360		$ 90,247	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 5,188,720		$ 180,494	% of Facility Direct Costs
	Special Studies	@	15%		$ 7,783,080		$ 270,741	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 7,783,080		$ 270,741	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 7,783,080		$ 270,741	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 2,594,360		$ 90,247	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 7,783,080		$ 270,741	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 20,754,880		$ 721,975	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 115,829,880**	**Annualized**	**$ 4,021,403**	
	Escalation to Midpoint of Construction	@	56%		$ 64,629,299		$ 2,243,812	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 15
								construction start = 2034 end = 2036
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$180,459,179**	**Annualized**	**$6,265,215**	
	Annualized Capital Costs ($/AFY)						**$752**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near HWY 101 to SVCW (Brine)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.2	Energy - SVCW to AWPF near HWY 101 (Tertiary - SVCW only)	350,400	KWh	$ 0.20	$ 70,000			Pump Station Hp = 40 Total Motor HP Required
1.3	Energy - San Mateo WWTP to AWTF at 101 (Tertiary - San Mateo)	2,628,000	KWh	$ 0.20	$ 530,000			Pump Station Hp = 300 Total Motor HP Required
1.4	Energy - AWPF near SVCW to CSR (Purified)	27,156,000	KWh	$ 0.20	$ 5,430,000			Pump Station Hp = 3,100 Total Motor HP Required
1.5	Energy - AWPF at 101 to Redwood Shores Tanks	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.6	Energy - AWPF at 101 to Cal Water Connections	9,636,000	KWh	$ 0.20	$ 1,930,000			Pump Station Hp = 1,100 Total Motor HP Required
1.7	Energy - Other		KWh	10%	$ 640,000			% of above energy cost
2.0	Labor Costs							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 2,710,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 1,240,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$13,630,000**			
	Annual Unit O&M Costs ($/AF)						**$1,600**	
	Annual Unit O&M Costs ($/gal)						**$0.003**	

Engineers Opinion of Probable Cost

HYBRID A - Phase 1 | RWA at CSR - Pipelines + Pump Stations - AWPF near SVCW Site - 12 MGD Capacity

Kennedy Jenks

Study: Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3
Project: Hybrid A Phase 1 - 12 MGD Capacity RWA Conveyance to CSR - Pipeline & Pump Station Cost
AWPF Location: AWPF near SVCW
Repurpose: SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd
Estimate: Conceptual Level Cost-Analysis

Prepared By: KAT, DT
Date Prepared: May-2022
K/J Proj. No. 1668011.03
ENR 13,098 *(Jan 2021 SF)*

Average Annual Influent Flow: 15.69 mgd
Average Annual Product Flow: 12.00 mgd
Brine Flow: 3.69 mgd
Conveyance Design Capacity: 8,333 Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				**$ 33,485,600**	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near SVCW to SVCW Outfall (Brine - open trench)**							
	Open Cut Pipeline	2,800	LF	$ 210	$ 588,000	**100**	**$ 18,608**	14 in-diameter $210 /LF
								Sized for 12 MGD treated flow
1.2	**SVCW RWC RQ Tank to AWPF near SVCW (Tertiary - open trench)**							
	Open Cut Pipeline	3,200	LF	$ 448	$ 1,433,600	**100**	**$ 45,369**	28 in-diameter $448 /LF
								Sized for 12 MGD treated flow
1.3	**AWPF near SVCW to Hwy101(Purified - Repurpose - sliplining)**							
	Slip Lining	15,400	LF	$ 240	$ 3,696,000	**100**	**$ 116,966**	24 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			$150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.4	**Hwy 101 to CSR(Purified - open trench)**							
	Open Cut Pipeline - SFPUC ROW	17,000	LF	$ 270	$ 4,590,000	**100**	**$ 145,258**	24 in-diameter $270 /LF
	Open Cut pipeline - along bay	12,200	LF	$ 600	$ 7,320,000	**100**	**$ 231,654**	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	23,300	LF	$ 330	$ 7,689,000	**100**	**$ 243,331**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.5	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 240	$ 3,024,000	**100**	**$ 95,700**	24 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.6	**AWPF near SVCW to CSR (Purified - trenchless - Hwy)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 30	$ 60,000	**100**	**$ 1,899**	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 60,000	$ 120,000			$60,000 /EA
1.7	**AWPF near SVCW to CSR (Purified - trenchless - Major Intersection)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,500	LF	$ 30	$ 45,000	**100**	**$ 1,424**	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	3	EA	$ 150,000	$ 450,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	3	EA	$ 60,000	$ 180,000			$60,000 /EA
2.0	**Pump Station**				**$ 10,130,000**	**50**	**$ 393,707**	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	360,000	$ 360,000			2,560 total flow (gpm) 37 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary - Combined)	1	LS	480,000	$ 480,000			10,894 total flow (gpm) 22 ft (TDH)
2.3	AWPF near SVCW to CSR (Purified)	1	LS	9,290,000	$ 9,290,000			8,334 total flow (gpm) 1158 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 43,615,600**	**Annualized**	**$ 1,293,916**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 2,180,780		$ 64,696	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
		145,200	SQFT		$ 12,269,400			SVCW is built on bay mud and would require piles
								From XL, recent SVCW project had a pile cost of $89/sqft of building (2021 dollars) = $84.50/sqft in 2019 dollars
4.0	Yard Piping	@	5%		$ 506,500		$ 64,696	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 1,519,500		$ 194,087	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 16,476,180**	**Annualized**	**$ 323,479**	
	Facility Direct Costs				**$ 60,091,780**	**Annualized**	**$ 1,617,395**	
Markups and Contingency								
	Taxes	@	8.75%		$ 1,526,546		$ 45,287	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 3,004,589		$ 80,870	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 6,009,178		$ 161,739	% of Facility Direct Costs
	Special Studies	@	15%		$ 9,013,767		$ 242,609	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 9,013,767		$ 242,609	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 9,013,767		$ 242,609	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 3,004,589		$ 80,870	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 9,013,767		$ 242,609	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 24,036,712		$ 646,958	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 133,728,462**	**Annualized**	**$ 3,603,556**	
	Escalation to Midpoint of Construction	@	43%		$ 56,936,349		$ 1,534,253	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$190,664,811**	**Annualized**	**$5,137,809**	
	Annualized Capital Costs ($/AFY)						**#DIV/0!**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	350,400	KWh	$ 0.20	$ 70,000			Pump Station Hp = 40 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary - Combined)	438,000	KWh	$ 0.20	$ 88,000			Pump Station Hp = 50 Total Motor HP Required
1.3	Energy - AWPF near SVCW to CSR (Purified)	16,644,000	KWh	$ 0.20	$ 3,330,000			Pump Station Hp = 1,900 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 350,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 2,860,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 710,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$7,788,000**			
	Annual Unit O&M Costs ($/AF)						**#DIV/0!**	
	Annual Unit O&M Costs ($/gal)						**$0.002**	

Engineers Opinion of Probable Cost

HYBRID A - Phase 2 | Pipelines + Pump Stations from San Mateo to AWPF near SVCW Site + POC to Redwood City/CalWater – 6 mgd DPR

Kennedy Jenks

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	KAT, DT
Project:	Hybrid A Phase 2 - 6 MGD Capacity RWA Conveyance from San Mateo WWTP to AWPF and DPR pipeline to potable water system tie-ins - Pipeline & Pump Station Cost	**Date Prepared:**	May-2022
AWPF Location:	AWPF near SVCW	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Average Annual Influent Flow:	15.69	mgd	
Average Annual Product Flow:	12.00	mgd	
Brine Flow:	3.69	mgd	
Conveyance Design Capacity:	8,333	Max Day Demand (gpm)	

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				**$ 21,822,000**	**100**		only apply est facility life to pipelines (not pits)
1.1	**San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo - open trench)**							
	Open Cut Pipeline	25,600	LF	$ 370	$ 9,472,000	**100**	**$ 299,757**	20 in-diameter $370 /LF
1.2	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary San Mateo - trenchless - Belmont Slough)**							
	Microtunneling (Trenchless) - 100ft Pit	2,500	LF	$ 800	$ 2,000,000	**100**	**$ 63,293**	20 in-diameter 40 per inch-dia-LF
	Microtunnelling Jacking Pit (100 ft deep)	1	EA	$ 2,000,000	$ 2,000,000			$2,000,000 /EA
	Microtunnelling Receiving Pit (100 ft deep)	1	EA	$ 2,000,000	$ 2,000,000			$2,000,000 /EA
1.3	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary San Mateo - pipe suspension - E 3rd Ave Bridge)**							
	Pipe Suspension	1,000	LF	$ 6,000	$ 6,000,000	**100**	**$ 189,880**	20 in-diameter $300 /LF
1.4	**Potable Water Tie Ins**							
	Connect to Redwood City Tanks	2	LS	$ 150,000	$ 300,000	**100**	**$ 9,494**	Tank connection, with air gap
	Connect to CalWater distribution pipelines	1	LS	$ 50,000	$ 50,000	**100**	**$ 1,582**	12 in-diameter potable water lines
2.0	**Pump Station**				**$ 1,260,000**	**50**	**$ 48,971**	
2.1	San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo)	1	LS	1,260,000	$ 1,260,000			5,447 total flow (gpm) 158 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 23,082,000**	**Annualized**	**$ 612,977**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 1,154,100		$ 30,649	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
		145,200	SQFT		$ 12,269,400			SVCW is built on bay mud and would require piles
								From XL, recent SVCW project had a pile cost of $89/sqft of building (2021 dollars) = $84.50/sqft in 2019 dollars
4.0	Yard Piping	@	5%		$ 63,000		$ 30,649	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 189,000		$ 91,947	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 13,675,500**	**Annualized**	**$ 153,244**	
	Facility Direct Costs				**$ 36,757,500**	**Annualized**	**$ 766,222**	
Markups and Contingency								
	Taxes	@	8.75%		$ 807,870		$ 21,454	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 1,837,875		$ 38,311	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 3,675,750		$ 76,622	% of Facility Direct Costs
	Special Studies	@	15%		$ 5,513,625		$ 114,933	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 5,513,625		$ 114,933	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 5,513,625		$ 114,933	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 1,837,875		$ 38,311	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 5,513,625		$ 114,933	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 14,703,000		$ 306,489	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 81,674,370**	**Annualized**	**$ 1,707,142**	
	Escalation to Midpoint of Construction	@	43%		$ 34,773,752		$ 726,834	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$116,448,122**	**Annualized**	**$2,433,976**	
	Annualized Capital Costs ($/AFY)						**#DIV/0!**	Total Annualized Captial Cost divided by AFY
	Annualualized Capital Costs ($/gal)						**$0.001**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			Notes/Source
Annual Operations and Maintenance Costs								
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	438,000	KWh	$ 0.20	$ 88,000			Pump Station Hp = 50 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary - Combined)	700,800	KWh	$ 0.20	$ 140,000			Pump Station Hp = 80 Total Motor HP Required
1.3	Energy - San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - SM)	2,628,000	KWh	$ 0.20	$ 530,000			Pump Station Hp = 300 Total Motor HP Required
1.4	Energy - AWPF near SVCW to CSR (Purified)	28,908,000	KWh	$ 0.20	$ 5,780,000			Pump Station Hp = 3,300 Total Motor HP Required
1.5	Energy - Other		KWh	10%	$ 650,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 1,750,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 930,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$10,248,000**			
	Annual Unit O&M Costs ($/AF)						**#DIV/0!**	
	Annual Unit O&M Costs ($/gal)						**$0.002**	

Engineers Opinion of Probable Cost

Kennedy Jenks

HYBRID B - Phase 1 | RWA at CSR - Pipelines + Pump Stations - AWPF at HWY 101 Site - 12 MGD Capacity

Average Annual Influent Flow:	15.69 mgd
Average Annual Product Flow:	12.00 mgd
Brine Flow:	3.69 mgd
Conveyance Design Capacity:	8,333 Max Day Demand (gpm)

Study:	Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3	**Prepared By:**	KAT, DT
Project:	Hybrid B Phase 1 - 12 MGD Capacity RWA Conveyance to CSR - Pipeline & Pump Station Cost	**Date Prepared:**	May-2022
AWPF Location:	AWPF near HWY 101	**K/J Proj. No.**	1668011.03
Repurpose:	SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd	**ENR**	13,098 *(Jan 2021 SF)*
Estimate:	Conceptual Level Cost-Analysis		

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				**$ 30,249,000**	**100**		only apply est facility life to pipelines (not pits)
1.1	**AWPF near Hwy 101 to SVCW Outfall (Brine - Slip lining)**							
	Slip Lining	15,400	LF	$ 140	$ 2,156,000	**100**	**$ 68,230**	14 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	11	EA	$ 150,000	$ 1,650,000			Sized for 12 MGD treated flow $150,000 /EA
	Slip Lining Receiving Pit	11	EA	$ 60,000	$ 660,000			$60,000 /EA
1.2	**AWPF near SVCW to Hwy101(Purified - Repurpose - sliplining)**							Sized for 6 MGD treated flow
	repurpose RWC purple pipe	15,400	LF		not incl			20 in-diameter
								Assume no addition constructuion cost
	Turnout and conncet RWC purple pipe to AWPF	1	LS	$ 1,000,000	$ 1,000,000	**100**	**$ 31,647**	Conservative estimate due to heavy traffic and wetlands on the NE side of the
								potential AWPF location.
1.3	**Hwy 101 to CSR(Purified - open trench)**							
	Open Cut Pipeline - SFPUC ROW	17,000	LF	$ 270	$ 4,590,000	**100**	**$ 145,258**	24 in-diameter $270 /LF
	Open Cut pipeline - along bay	12,200	LF	$ 600	$ 7,320,000	**100**	**$ 231,654**	52,500 LF of pipeline $25 per inch-dia-LF
	Open Cut pipeline - Remaning	23,300	LF	$ 330	$ 7,689,000	**100**	**$ 243,331**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for
								special shoring along the bay, and higher unit cost in remaining sections (busy areas)
1.4	**Repurpose Alignment No.3 to Whipple Road(Purified - repurpose - slip lining)**							
	Slip Lining	12,600	LF	$ 240	$ 3,024,000	**100**	**$ 95,700**	24 in-diameter 10.00 per inch-dia-LF
	Slip Lining Access Pit	8	EA	$ 150,000	$ 1,200,000			$150,000 /EA
	Slip Lining Receiving Pit	8	EA	$ 60,000	$ 480,000			$60,000 /EA
1.5	**AWPF near SVCW to CSR (Purified - trenchless - Hwy)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	2,000	LF	$ 30	$ 60,000	**100**	**$ 1,899**	24 in-diameter $30 /LF
	Microtunnelling Jacking Pit (15 ft deep)	2	EA	$ 150,000	$ 300,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	2	EA	$ 60,000	$ 120,000			$60,000 /EA
2.0	**Pump Station**				**$ 11,110,000**	**50**	**$ 431,796**	
2.1	AWPF near SVCW to SVCW (Brine)	1	LS	$ 910,000	$ 910,000			2,560 total flow (gpm) 128 ft (TDH)
2.2	SVCW to AWPF near SVCW (Tertiary - SVCW only)	1	LS	$ 910,000	$ 910,000			5,447 total flow (gpm) 101 ft (TDH)
2.3	AWPF near SVCW to CSR (Purified)	1	LS	$ 9,290,000	$ 9,290,000			8,334 total flow (gpm) 1158 ft (TDH)
				Subtotal Facility Capital Costs - Part 1	**$ 41,359,000**	**Annualized**	**$ 1,249,514**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 2,067,950		$ 62,476	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 555,500		$ 62,476	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 1,666,500		$ 187,427	% of Subtotal facility costs (not inluding pipelines) - Part 1
				Subtotal Facility Capital Costs - Part 2	**$ 4,289,950**	**Annualized**	**$ 312,378**	
				Facility Direct Costs	**$ 45,648,950**	**Annualized**	**$ 1,561,892**	
Markups and Contingency								
	Taxes	@	8.75%		$ 1,447,565		$ 43,733	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 2,282,448		$ 78,095	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 4,564,895		$ 156,189	% of Facility Direct Costs
	Special Studies	@	15%		$ 6,847,343		$ 234,284	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 6,847,343		$ 234,284	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 6,847,343		$ 234,284	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 2,282,448		$ 78,095	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 6,847,343		$ 234,284	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 18,259,580		$ 624,757	% of Facility Direct Costs
				Subtotal with Markups and Contingency	**$ 101,875,255**	**Annualized**	**$ 3,479,896**	
	Escalation to Midpoint of Construction	@	43%		$ 43,374,499		$ 1,481,604	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
				Project Capital Cost Total	**$145,249,754**	**Annualized**	**$4,961,500**	
						Annualized Capital Costs ($/AFY)	**#DIV/0!**	Total Annualized Captial Cost divided by AFY
						Annualualized Capital Costs ($/gal)	**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total			
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary - SVCW only)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.3	Energy - AWPF near SVCW to CSR (Purified)	10,512,000	KWh	$ 0.20	$ 2,100,000			Pump Station Hp = 1,200 Total Motor HP Required
1.4	Energy - Other		KWh	10%	$ 280,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 2,180,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 560,000			% of above O&M costs
				Annual O&M Costs ($/year)	**$6,200,000**			
						Annual Unit O&M Costs ($/AF)	**#DIV/0!**	
						Annual Unit O&M Costs ($/gal)	**$0.001**	

Engineers Opinion of Probable Cost

Kennedy Jenks

HYBRID B - Phase 2 | Pipelines + Pump Stations from San Mateo to AWPF near HWY 101 + POC to Redwood City/CalWater – 6 mgd DPR

Study: Potable Reuse Exploratory Plan (PREP) Decision Tool Phase 3
Hybrid B Phase 2 - 6 MGD Capacity RWA Conveyance from San Mateo WWTP to AWPF and DPR pipeline to potable water system tie-ins - Pipeline & Pump
Project: Station Cost
AWPF Location: AWPF near HW 101
Repurpose: SVCW Pipeline along Redwood Shores Pkwy & along Shoreway Rd
Estimate: Conceptual Level Cost-Analysis

Prepared By: KAT, DT
Date Prepared: May-2022
K/J Proj. No. 1668011.03
ENR 13,098 *(Jan 2021 SF)*

Average Annual Influent Flow: 15.69 mgd
Average Annual Product Flow: 12.00 mgd
Brine Flow: 3.69 mgd
Conveyance Design Capacity: 8,333 Max Day Demand (gpm)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Est Facility Life	Annualized Capital Cost	Notes/Source
Pipelines and Pump Stations								
Facility Capital Costs - Part 1								
1.0	**Pipeline**				**$ 23,612,000**	**100**		only apply est facility life to pipelines (not pits)
1.1	**San Mateo WWTP to Hwy 101 (Tertiary - San Mateo - open trench)**							
	Open Cut Pipeline	27,600	LF	$ 370	$ 10,212,000	**100**	**$ 323,176**	20 in-diameter $370 /LF
1.2	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - trenchless - Slough)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 600	$ 600,000	**100**	**$ 18,988**	20 in-diameter 30 per inch-dia-LF
	Microtunnelling Jacking Pit (35 ft deep)	1	EA	$ 600,000	$ 600,000			$600,000 /EA
	Microtunnelling Receiving Pit (35 ft deep)	1	EA	$ 500,000	$ 500,000			$500,000 /EA
1.3	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - trenchless - hwy92)**							
	Microtunneling (Trenchless) - 15ft & 35ft Pit	1,000	LF	$ 600	$ 600,000	**100**	**$ 18,988**	20 in-diameter $30 per inch-dia-LF
	Microtunnelling Jacking Pit (15 ft deep)	1	EA	$ 150,000	$ 150,000			$150,000 /EA
	Microtunnelling Receiving Pit (15 ft deep)	1	EA	$ 100,000	$ 100,000			$100,000 /EA
1.4	**San Mateo WWTP to SVCW RWC RW Tanks(Tertiary - San Mateo - pipe suspension - E 3rd Ave Bridge)**							
	Pipe Suspension	1,000	LF	$ 6,000	$ 6,000,000	**100**	**$ 189,880**	20 in-diameter $300 /LF
1.50	**From Hwy 101 AWPF to Rdwd Shores Tanks**							
	Open Cut Pipeline - SFPUC ROW	0	LF	$ 270	$ -	**100**	**$ -**	18 in-diameter $270 /LF
	Open Cut pipeline - along bay	10,000	LF	$ 450	$ 4,500,000	**100**	**$ 142,410**	18 in-diameter $25 per inch-dia-LF
	Open Cut pipeline - Remaning	0	LF	$ 330	$ -	**100**	**$ -**	$330 /LF
								Assume regular unit cost for trenching along SFPUC ROW, higher unit cost for
1.60	**Potable Water Tie Ins**							
	Connect to Redwood City Tanks	2	LS	$ 150,000	$ 300,000	**100**	**$ 9,494**	Tank connection, with air gap
	Connect to CalWater distribution pipelines	1	LS	$ 50,000	$ 50,000	**100**	**$ 1,582**	12 in-diameter potable water lines
2.0	**Pump Station**				**$ 1,260,000**	**50**	**$ 48,971**	
2.1	San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - San Mateo)	1	LS	$ 1,260,000	$ 1,260,000			5,447 total flow (gpm) 172 ft (TDH)
	Subtotal Facility Capital Costs - Part 1				**$ 24,872,000**	**Annualized**	**$ 753,489**	
Facility Capital Costs - Part 2								
3.0	Site Development Costs	@	5%		$ 1,243,600		$ 37,674	% of Subtotal facility costs - Part 1
								(Includes grading, erosion control, cut/fill, etc.)
4.0	Yard Piping	@	5%		$ 63,000		$ 37,674	% of Subtotal facility costs (not inluding pipelines) - Part 1
5.0	Electrical, I&C, and Remote (high-tech) Control	@	15%		$ 189,000		$ 113,023	% of Subtotal facility costs (not inluding pipelines) - Part 1
	Subtotal Facility Capital Costs - Part 2				**$ 1,495,600**	**Annualized**	**$ 188,372**	
	Facility Direct Costs				**$ 26,367,600**	**Annualized**	**$ 941,861**	
Markups and Contingency								
	Taxes	@	8.75%		$ 870,520		$ 26,372	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		$ 1,318,380		$ 47,093	% of Facility Direct Costs
	Engineering and Design	@	10%		$ 2,636,760		$ 94,186	% of Facility Direct Costs
	Special Studies	@	15%		$ 3,955,140		$ 141,279	Not included (note that this may be a significant future cost for the program)
	Construction Management	@	15%		$ 3,955,140		$ 141,279	% of Facility Direct Costs
	Owner's Administration	@	15%		$ 3,955,140		$ 141,279	% of Facility Direct Costs
	Environmental/Permitting	@	5%		$ 1,318,380		$ 47,093	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		$ 3,955,140		$ 141,279	% of Facility Direct Costs
	Estimate Contingency	@	40%		$ 10,547,040		$ 376,744	% of Facility Direct Costs
	Subtotal with Markups and Contingency				**$ 58,879,240**	**Annualized**	**$ 2,098,466**	
	Escalation to Midpoint of Construction	@	43%		$ 25,068,477		$ 893,445	% of Subtotal with Markups and Contingency
								assume = 3.0% over years = 12
								construction start = 2030 end = 2033
								project life = 50 interest rate = 3%
	Project Capital Cost Total				**$83,947,717**	**Annualized**	**$2,991,910**	
					Annualized Capital Costs ($/AFY)		**#DIV/0!**	Total Annualized Captial Cost divided by AFY
					Annualized Capital Costs ($/gal)		**$0.001**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			Notes/Source
1.0	**Energy Costs**							Pump Operation = 24 hours per day
								(applies to all pumping) 8760 hours operated per year
1.1	Energy - AWPF near SVCW to SVCW (Brine)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.2	Energy - SVCW to AWPF near SVCW (Tertiary - SVCW only)	1,752,000	KWh	$ 0.20	$ 350,000			Pump Station Hp = 200 Total Motor HP Required
1.3	Energy - San Mateo WWTP to SVCW RWC RW Tanks (Tertiary - SM)	2,628,000	KWh	$ 0.20	$ 530,000			Pump Station Hp = 300 Total Motor HP Required
1.4	Energy - AWPF near SVCW to CSR (Purified)	10,512,000	KWh	$ 0.20	$ 2,100,000			Pump Station Hp = 1,200 Total Motor HP Required
1.5	Energy - Other		KWh	10%	$ 330,000			% of above energy cost
2.0	**Labor Costs**							
2.1	Other Labor (pipeline, PS, wells)	3.0	staff	$ 125,000	$ 380,000			full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance - General**	@	1.5%		$ 1,260,000			% of Project capital cost total
4.0	**Contingency**	@	10.0%		$ 530,000			% of above O&M costs
	Annual O&M Costs ($/year)				**$5,830,000**			
					Annual Unit O&M Costs ($/AF)		**#DIV/0!**	
					Annual Unit O&M Costs ($/gal)		**$0.001**	

APPENDIX G: Supporting Information for Environmental Review

G.1 Purified Water Pipeline Alignment to CSR: IPaC Resources Report and Map

G.2 Tertiary Effluent Pipeline Alignment - Option A: IPaC Resources Report and Map

G.3 Tertiary Effluent Pipeline Alignment Option B - Edgewood Blvd: IPaC Resources Report and Map

G.4 Potential AWPF Location - Highway 101: IPaC Resources Report and Map

G.5 Potential AWPF Location – near SVCW: IPaC Resources Report and Map

APPENDIX G.1

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

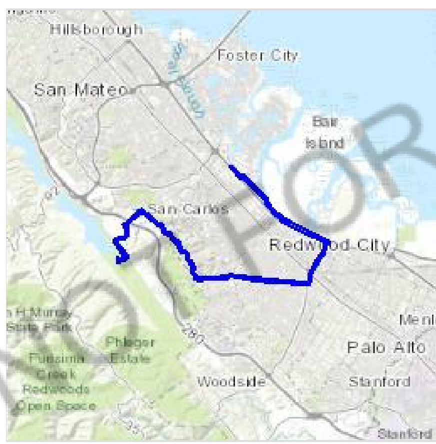
IPaC resource list Purified Water Pipeline Alignment to CSR

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

San Mateo County, California



Local offices

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

San Francisco Bay-Delta Fish And Wildlife

(916) 930-5603
(916) 930-5654

650 Capitol Mall
Suite 8-300
Sacramento, CA 95814

http://kim_squires@fws.gov

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse Reithrodontomys raviventris No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/613	Endangered

Birds

NAME	STATUS
California Clapper Rail Rallus longirostris obsoletus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern Sterna antillarum browni No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8104	Endangered
Marbled Murrelet Brachyramphus marmoratus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/4467	Threatened
Western Snowy Plover Charadrius nivosus nivosus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/8035	Threatened
Yellow-billed Cuckoo Coccyzus americanus There is **proposed** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Alameda Whipsnake (=striped Racer) Masticophis lateralis euryxanthus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/5524	Threatened
Green Sea Turtle Chelonia mydas No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6199	Threatened

San Francisco Garter Snake Thamnophis sirtalis tetrataenia No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5956	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander Ambystoma californiense There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened
Tidewater Goby Eucyclogobius newberryi There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/57	Endangered

Insects

NAME	STATUS
Bay Checkerspot Butterfly Euphydryas editha bayensis There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2320	Threatened
Mission Blue Butterfly Icaricia icarioides missionensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/6928	Endangered
Myrtle's Silverspot Butterfly Speyeria zerene myrtleae No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6929	Endangered

San Bruno Elfin Butterfly Callophrys mossii bayensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/3394	Endangered

Crustaceans

NAME	STATUS
Vernal Pool Fairy Shrimp Branchinecta lynchi There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/498	Threatened

Flowering Plants

NAME	STATUS
Fountain Thistle Cirsium fontinale var. fontinale No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7939	Endangered
Marin Dwarf-flax Hesperolinon congestum No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5363	Threatened
San Mateo Thornmint Acanthomintha obovata ssp. duttonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2038	Endangered
San Mateo Woolly Sunflower Eriophyllum latilobum No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7791	Endangered
Showy Indian Clover Trifolium amoenum No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6459	Endangered
White-rayed Pentachaeta Pentachaeta bellidiflora No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7782	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
California Red-legged Frog Rana draytonii https://ecos.fws.gov/ecp/species/2891#crithab	Final

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act

[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY

BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)

Allen's Hummingbird Selasphorus sasin — Breeds Feb 1 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9637

Bald Eagle Haliaeetus leucocephalus — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1626

Black Oystercatcher Haematopus bachmani — Breeds Apr 15 to Oct 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9591

Black Skimmer Rynchops niger — Breeds May 20 to Sep 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5234

Black Turnstone Arenaria melanocephala — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Burrowing Owl Athene cunicularia — Breeds Mar 15 to Aug 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9737

California Thrasher Toxostoma redivivum — Breeds Jan 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Clark's Grebe Aechmophorus clarkii — Breeds Jan 1 to Dec 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Common Yellowthroat Geothlypis trichas sinuosa — Breeds May 20 to Jul 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/2084

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Gull-billed Tern Gelochelidon nilotica — Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Lawrence's Goldfinch Carduelis lawrencei — Breeds Mar 20 to Sep 20

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9464

Long-billed Curlew Numenius americanus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Marbled Godwit Limosa fedoa — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9410

Oak Titmouse Baeolophus inornatus — Breeds Mar 15 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9656

Rufous Hummingbird selasphorus rufus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8002

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Song Sparrow Melospiza melodia — Breeds Feb 20 to Sep 5
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Spotted Towhee Pipilo maculatus clementae — Breeds Apr 15 to Jul 20
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/4243

Tricolored Blackbird Agelaius tricolor — Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3910

Whimbrel Numenius phaeopus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9483

Willet Tringa semipalmata — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wrentit Chamaea fasciata — Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ “Proper Interpretation and Use of Your Migratory Bird Report” before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

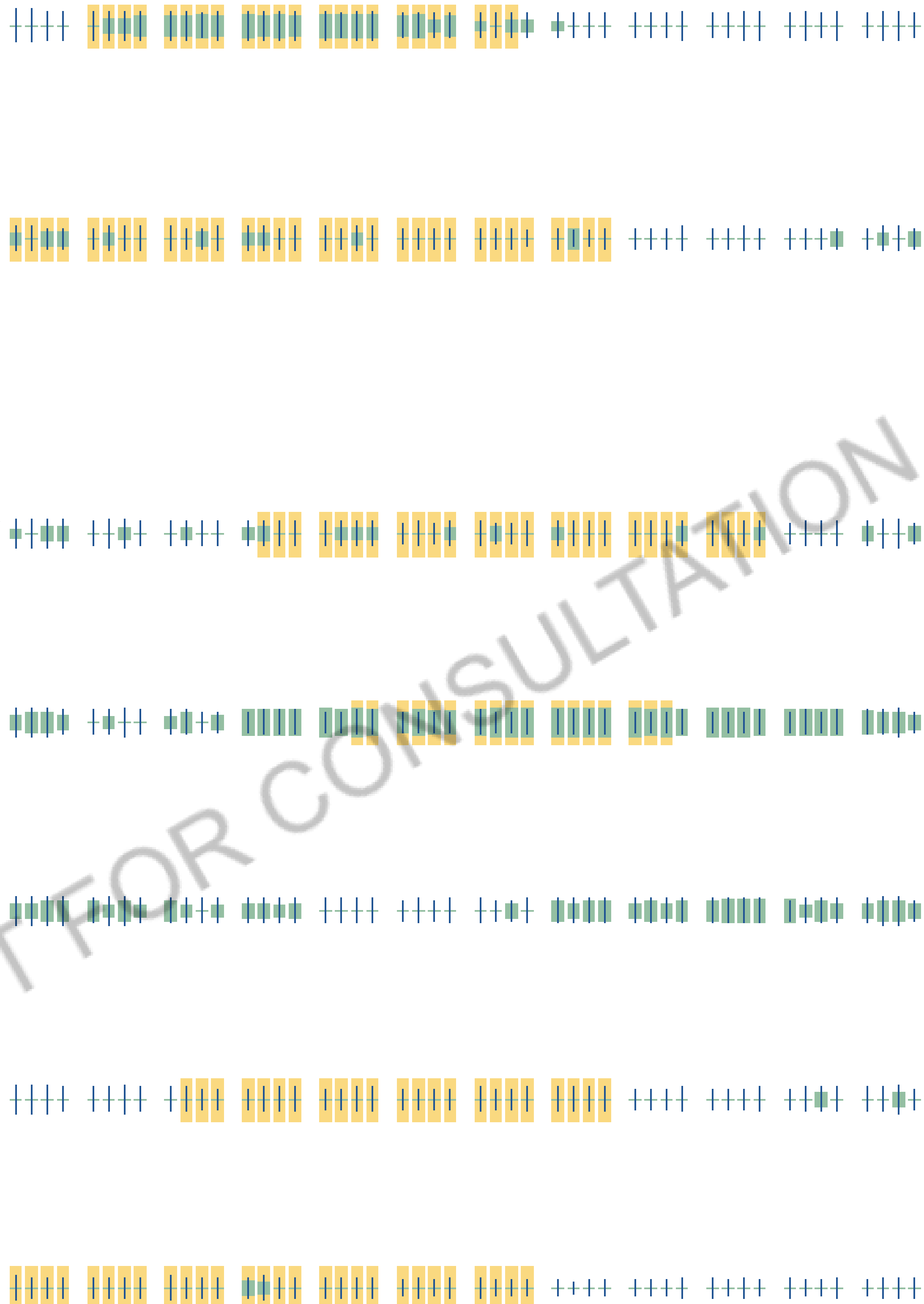
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

■ probability of presence ■ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC



Allen's Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Bald Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Black Oystercatcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

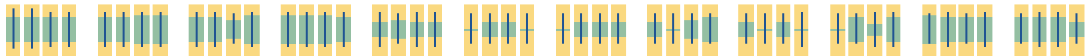
Black Skimmer
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Black Turnstone
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

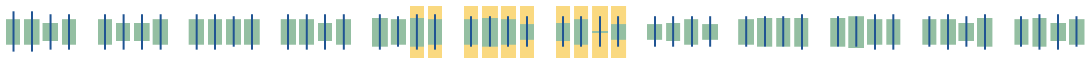
Burrowing Owl
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

California Thrasher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

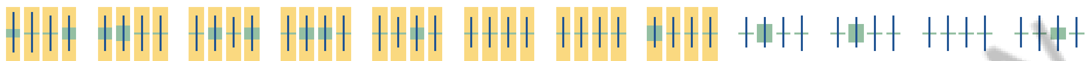
Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



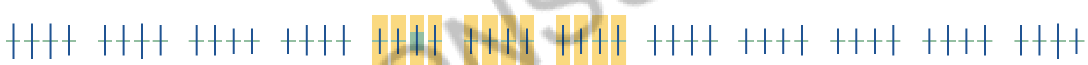
Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



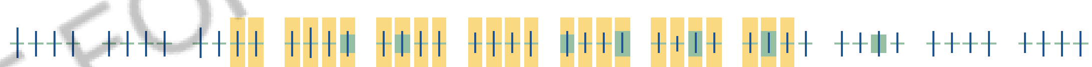
Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Gull-billed Tern
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

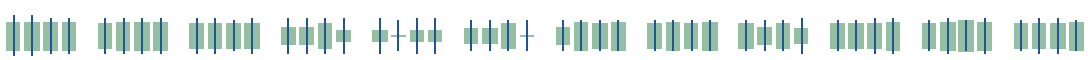


Lawrence's Goldfinch
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

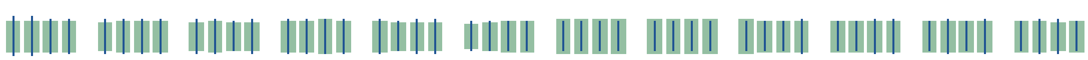


SPECIES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

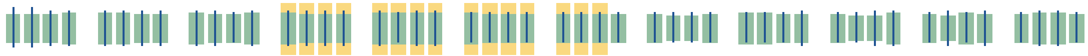
Long-billed Curlew
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



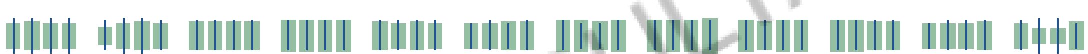
Nuttall's Woodpecker
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



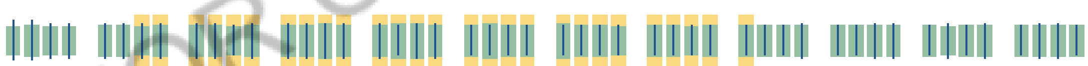
Oak Titmouse
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Rufous Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

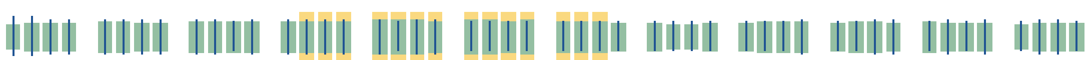
Short-billed Dowitcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



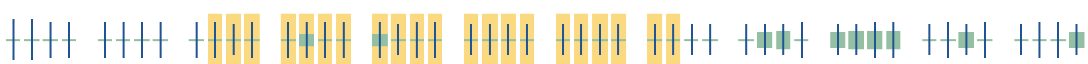
Song Sparrow
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



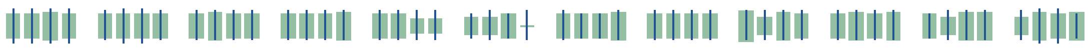
Spotted Towhee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



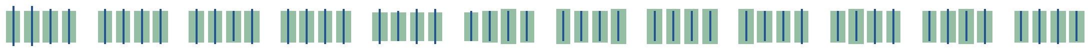
Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



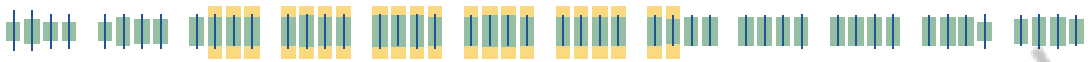
Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Wrentit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ “What does IPaC use to generate the migratory birds potentially occurring in my specified location”. Please be aware this report provides the “probability of presence” of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the “no data” indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ “Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds” at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
Don Edwards San Francisco Bay National Wildlife Refuge	24,718.59 acres

(510) 792-0222
(510) 792-5828

1 Marshlands Road
Fremont, CA 94555

https://www.fws.gov/refuges/profiles/index.cfm?id=81648

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

ESTUARINE AND MARINE DEEPWATER
- E1UBL

ESTUARINE AND MARINE WETLAND
- E2EM1N
- E2SBNx
- E2EM1Nh
- E2USN
- E2SBN

FRESHWATER EMERGENT WETLAND
- PEM1Ch

FRESHWATER FORESTED/SHRUB WETLAND
- PSSC
- PSSAh
- PFOA

FRESHWATER POND
- PUSCh
- PUBFh
- PUBH

LAKE
- L2UBHh3

RIVERINE
- R4SBC
- R4SBCx
- R5UBF
- R4SBAx

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

APPENDIX G.2

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

IPaC resource list

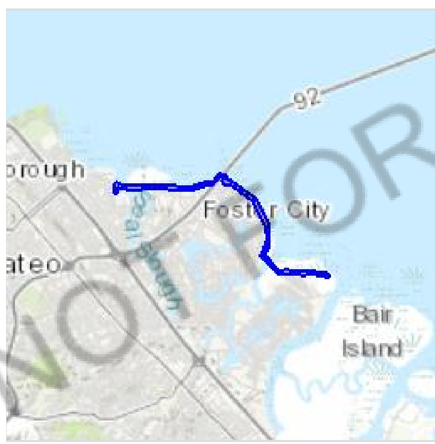
Tertiary Effluent Pipeline Alignment Option A - Beach Park

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

San Mateo County, California



Local offices

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

San Francisco Bay-Delta Fish And Wildlife

(916) 930-5603
(916) 930-5654

650 Capitol Mall
Suite 8-300
Sacramento, CA 95814

http://kim_squires@fws.gov

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse Reithrodontomys raviventris No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/613	Endangered

Birds

NAME	STATUS
California Clapper Rail Rallus longirostris obsoletus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern Sterna antillarum browni No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8104	Endangered
Marbled Murrelet Brachyramphus marmoratus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/4467	Threatened
Western Snowy Plover Charadrius nivosus nivosus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/8035	Threatened

Reptiles

NAME	STATUS
Alameda Whipsnake (=striped Racer) Masticophis lateralis euryxanthus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/5524	Threatened
Green Sea Turtle Chelonia mydas No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6199	Threatened
San Francisco Garter Snake Thamnophis sirtalis tetrataenia No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5956	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander Ambystoma californiense There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Bay Checkerspot Butterfly Euphydryas editha bayensis There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2320	Threatened
Mission Blue Butterfly Icaricia icarioides missionensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/6928	Endangered
Myrtle's Silverspot Butterfly Speyeria zerene myrtleae No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6929	Endangered
San Bruno Elfin Butterfly Callophrys mossii bayensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/3394	Endangered

Crustaceans

NAME	STATUS
Vernal Pool Fairy Shrimp *Branchinecta lynchi* There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/498	Threatened

Flowering Plants

NAME	STATUS
Fountain Thistle *Cirsium fontinale var. fontinale* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7939	Endangered
Marin Dwarf-flax *Hesperolinon congestum* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5363	Threatened
San Mateo Thornmint *Acanthomintha obovata ssp. duttonii* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2038	Endangered
San Mateo Woolly Sunflower *Eriophyllum latilobum* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7791	Endangered
White-rayed Pentachaeta *Pentachaeta bellidiflora* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7782	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act

[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Allen's Hummingbird Selasphorus sasin This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9637	Breeds Feb 1 to Jul 15
Black Oystercatcher Haematopus bachmani This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9591	Breeds Apr 15 to Oct 31
Black Scoter Melanitta nigra This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds elsewhere
Black Skimmer Rynchops niger This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5234	Breeds May 20 to Sep 15
Black Turnstone Arenaria melanocephala This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Bonaparte's Gull Chroicocephalus philadelphia This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds elsewhere

Brown Pelican Pelecanus occidentalis — Breeds Jan 15 to Sep 30

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/6034

Burrowing Owl Athene cunicularia — Breeds Mar 15 to Aug 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9737

Clark's Grebe Aechmophorus clarkii — Breeds Jan 1 to Dec 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Common Loon gavia immer — Breeds Apr 15 to Oct 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/4464

Common Murre Uria aalge — Breeds Apr 15 to Aug 15

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Common Tern Sterna hirundo — Breeds May 10 to Sep 10

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/4963

Common Yellowthroat Geothlypis trichas sinuosa — Breeds May 20 to Jul 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/2084

Double-crested Cormorant phalacrocorax auritus — Breeds Apr 20 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/3478

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Gull-billed Tern Gelochelidon nilotica — Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Herring Gull Larus argentatus — Breeds Apr 20 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Least Tern Sterna antillarum — Breeds Apr 20 to Sep 10

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Long-billed Curlew Numenius americanus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Long-tailed Duck Clangula hyemalis — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/7238

Marbled Godwit Limosa fedoa — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9410

Oak Titmouse Baeolophus inornatus — Breeds Mar 15 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9656

Parasitic Jaeger Stercorarius parasiticus — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Red Phalarope Phalaropus fulicarius — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Red-breasted Merganser Mergus serrator — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Red-necked Phalarope Phalaropus lobatus — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Red-throated Loon Gavia stellata — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Ring-billed Gull Larus delawarensis — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Rufous Hummingbird selasphorus rufus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8002

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Song Sparrow Melospiza melodia This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Feb 20 to Sep 5
Spotted Towhee Pipilo maculatus clementae This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/4243	Breeds Apr 15 to Jul 20
Surf Scoter Melanitta perspicillata This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds elsewhere
Tricolored Blackbird Agelaius tricolor This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3910	Breeds Mar 15 to Aug 10
Whimbrel Numenius phaeopus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9483	Breeds elsewhere
White-winged Scoter Melanitta fusca This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds elsewhere
Willet Tringa semipalmata This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Wrentit Chamaea fasciata This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 15 to Aug 10

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ “Proper Interpretation and Use of Your Migratory Bird Report” before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

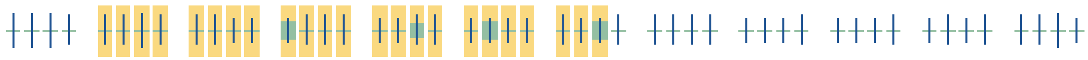
No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

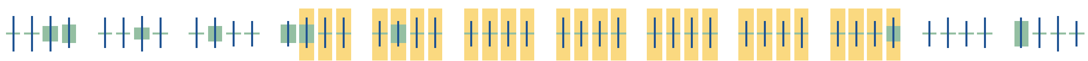
■ probability of presence ■ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Allen's Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

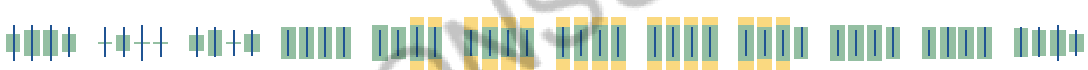


Black Oystercatcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



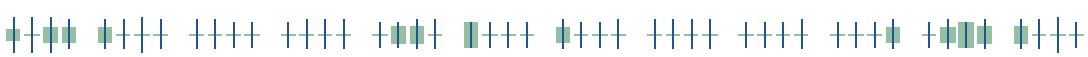
Black Scoter
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Black Skimmer
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

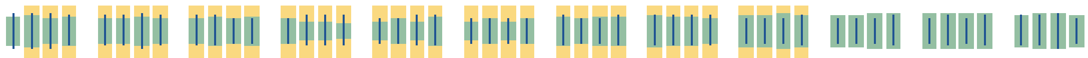


Black Turnstone
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

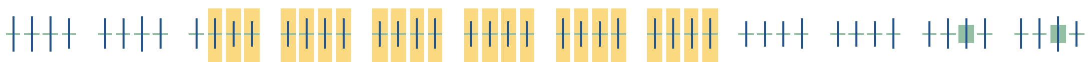
Bonaparte's Gull
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



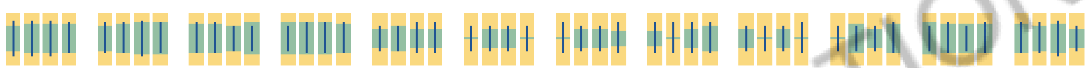
Brown Pelican
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



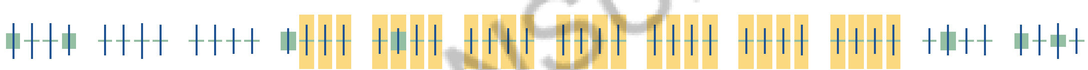
Burrowing Owl
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



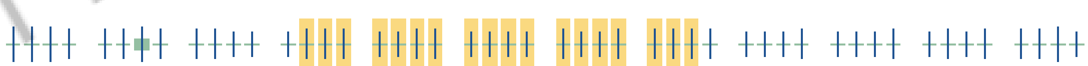
Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



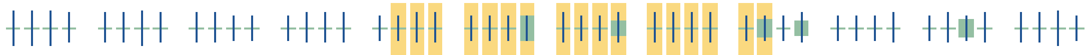
Common Loon
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Common Murre
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

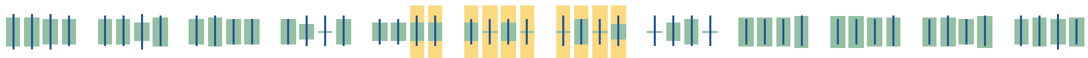


Common Tern
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

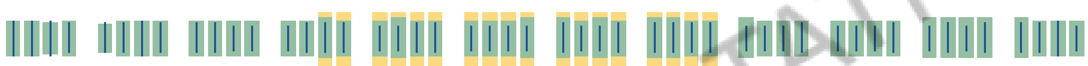


SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

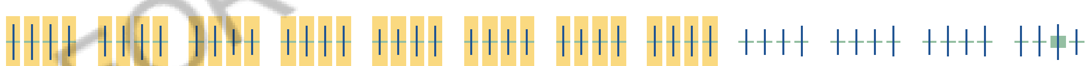
Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



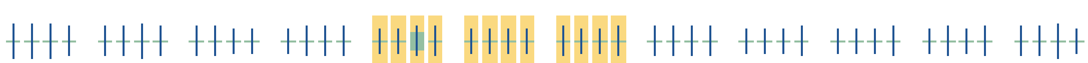
Double-crested Cormorant
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



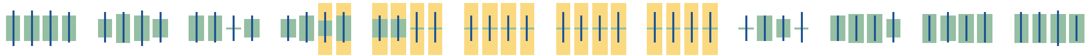
Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



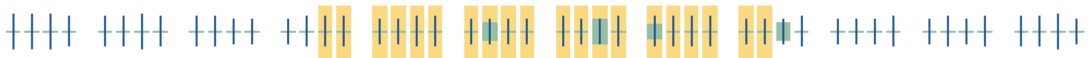
Gull-billed Tern
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



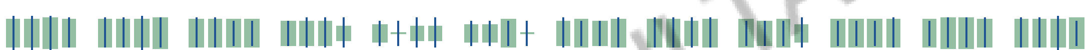
Herring Gull
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Least Tern
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

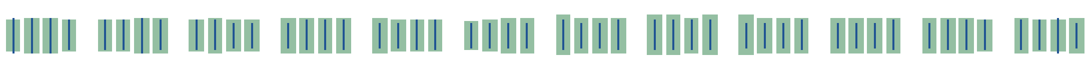


Long-billed Curlew
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

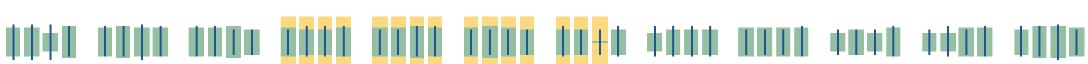


Long-tailed Duck
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

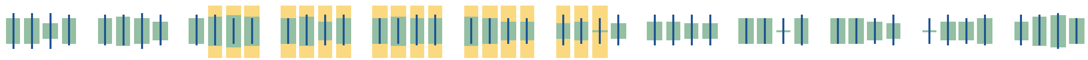
Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Nuttall's Woodpecker
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



Oak Titmouse
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



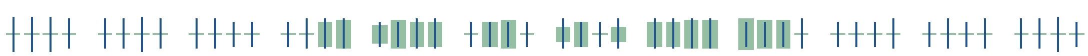
Parasitic Jaeger
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Red Phalarope
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Red-breasted Merganser
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Red-necked Phalarope
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

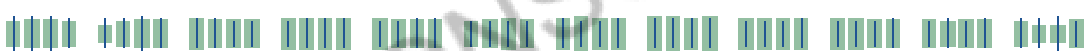


Red-throated Loon
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

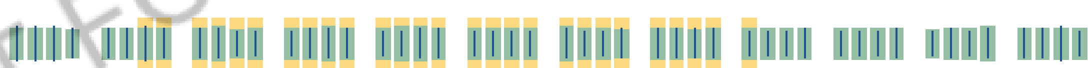
Ring-billed Gull
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Rufous Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

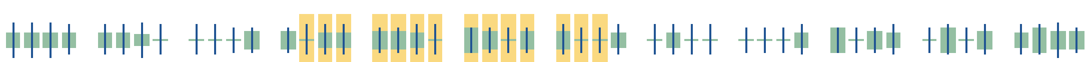
Short-billed Dowitcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



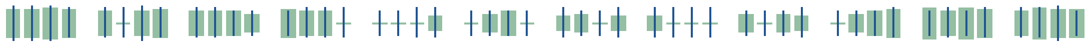
Song Sparrow
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



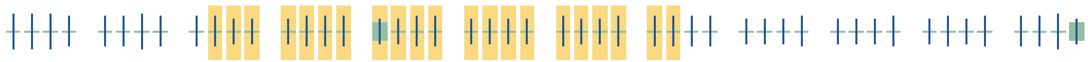
Spotted Towhee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



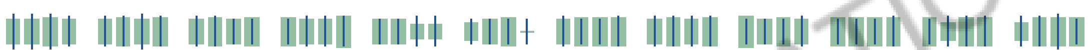
Surf Scoter
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



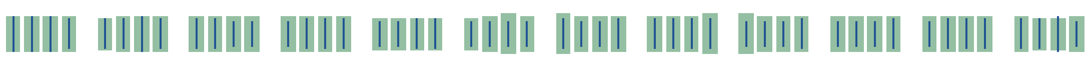
Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



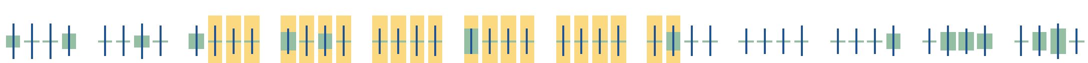
SPECIES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

White-winged Scoter
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Wrentit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
Don Edwards San Francisco Bay National Wildlife Refuge	24,718.59 acres

(510) 792-0222
(510) 792-5828

1 Marshlands Road
Fremont, CA 94555

https://www.fws.gov/refuges/profiles/index.cfm?id=81648

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

ESTUARINE AND MARINE DEEPWATER
- E1UBL

ESTUARINE AND MARINE WETLAND
- E2USN
- E2USMh
- E2EM1N
- E2USM
- E2SBN
- E2EM1P

FRESHWATER EMERGENT WETLAND
- PEM1Ah
- PEM1Ch

FRESHWATER POND
- PUBHh3

[PUSCh](#)
[PUBHh](#)
[PUBKx1](#)

LAKE

[L2UBHh3](#)

RIVERINE

[R3UBHx](#)

A full description for each wetland code can be found at the [National Wetlands Inventory website](#)

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

APPENDIX G.3

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

IPaC resource list

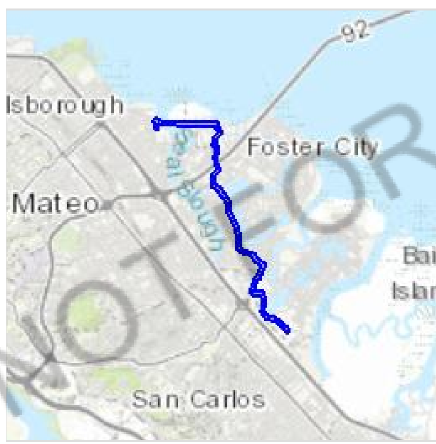
Tertiary Effluent Pipeline Alignment Option B - Edgewood Blvd

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

San Mateo County, California



Local offices

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

San Francisco Bay-Delta Fish And Wildlife

(916) 930-5603
(916) 930-5654

650 Capitol Mall
Suite 8-300
Sacramento, CA 95814

http://kim_squires@fws.gov

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse *Reithrodontomys raviventris* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/613	Endangered

Birds

NAME	STATUS
California Clapper Rail *Rallus longirostris obsoletus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern *Sterna antillarum browni* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8104	Endangered
Marbled Murrelet *Brachyramphus marmoratus* There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/4467	Threatened
Western Snowy Plover *Charadrius nivosus nivosus* There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/8035	Threatened

Reptiles

NAME	STATUS
Green Sea Turtle *Chelonia mydas* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6199	Threatened
San Francisco Garter Snake *Thamnophis sirtalis tetrataenia* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5956	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Bay Checkerspot Butterfly Euphydryas editha bayensis There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2320	Threatened
Mission Blue Butterfly Icaricia icarioides missionensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/6928	Endangered
Myrtle's Silverspot Butterfly Speyeria zerene myrtleae No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6929	Endangered
San Bruno Elfin Butterfly Callophrys mossii bayensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/3394	Endangered

Flowering Plants

NAME	STATUS
Fountain Thistle Cirsium fontinale var. fontinale No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7939	Endangered
Marin Dwarf-flax Hesperolinon congestum No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5363	Threatened
San Mateo Thornmint Acanthomintha obovata ssp. duttonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2038	Endangered

San Mateo Woolly Sunflower *Eriophyllum latilobum* Endangered
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/7791

White-rayed Pentachaeta *Pentachaeta bellidiflora* Endangered
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/7782

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act [1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Allen's Hummingbird *Selasphorus sasin* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9637	Breeds Feb 1 to Jul 15
Black Oystercatcher *Haematopus bachmani* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9591	Breeds Apr 15 to Oct 31
Black Skimmer *Rynchops niger* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5234	Breeds May 20 to Sep 15
Black Turnstone *Arenaria melanocephala* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Burrowing Owl *Athene cunicularia* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9737	Breeds Mar 15 to Aug 31

Clark's Grebe Aechmophorus clarkii — Breeds Jan 1 to Dec 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Common Yellowthroat Geothlypis trichas sinuosa — Breeds May 20 to Jul 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/2084

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Gull-billed Tern Gelochelidon nilotica — Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Long-billed Curlew Numenius americanus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Marbled Godwit Limosa fedoa — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9410

Oak Titmouse Baeolophus inornatus — Breeds Mar 15 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9656

Red-throated Loon Gavia stellata — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Rufous Hummingbird selasphorus rufus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8002

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Song Sparrow Melospiza melodia — Breeds Feb 20 to Sep 5
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Spotted Towhee Pipilo maculatus clementae — Breeds Apr 15 to Jul 20
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/4243

Tricolored Blackbird Agelaius tricolor — Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3910

Whimbrel Numenius phaeopus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9483

Willet Tringa semipalmata — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wrentit Chamaea fasciata — Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ “Proper Interpretation and Use of Your Migratory Bird Report” before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

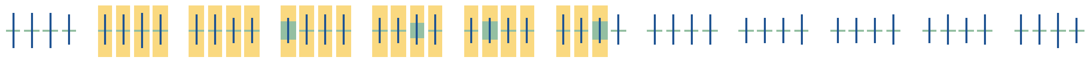
No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

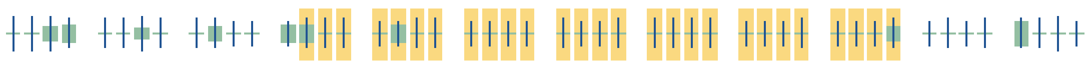
■ probability of presence ■ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

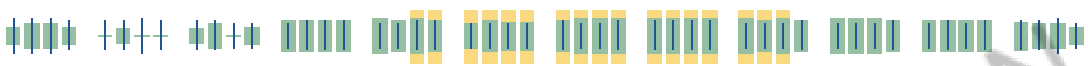
Allen's Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



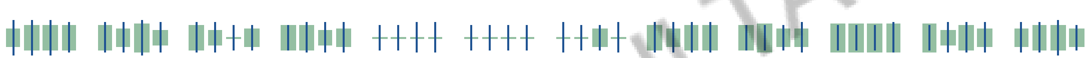
Black Oystercatcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



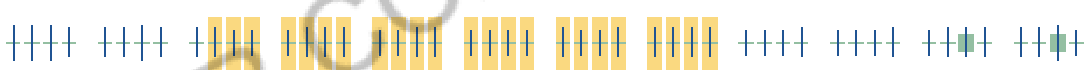
Black Skimmer
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



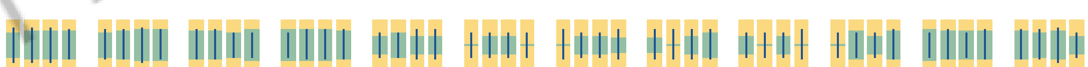
Black Turnstone
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



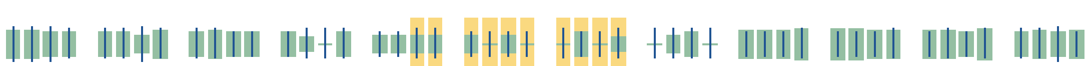
Burrowing Owl
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



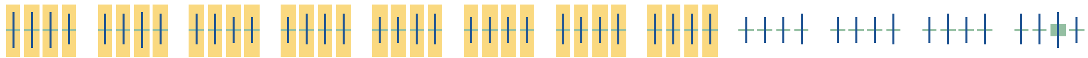
Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



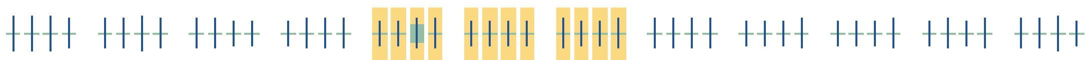
Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



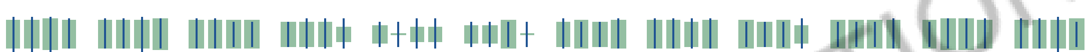
Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Gull-billed Tern
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

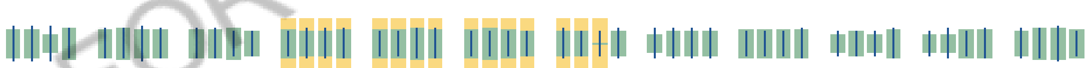


Long-billed Curlew
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



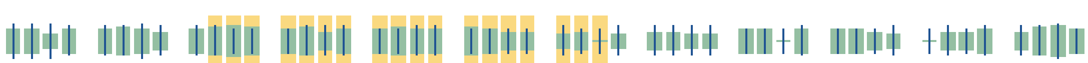
Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Nuttall's Woodpecker
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



SPECIES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Oak Titmouse
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

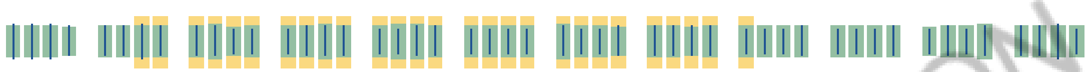


Red-throated Loon
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

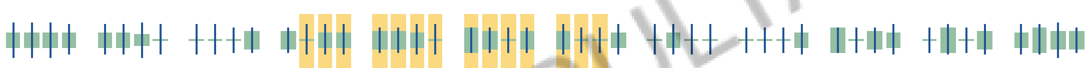
Rufous Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Short-billed Dowitcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

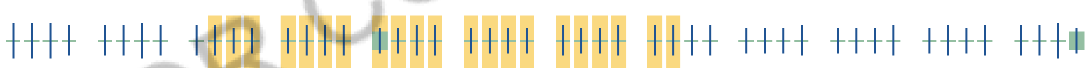
Song Sparrow
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



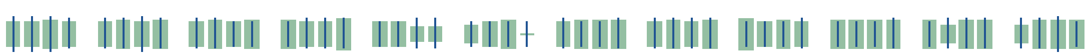
Spotted Towhee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



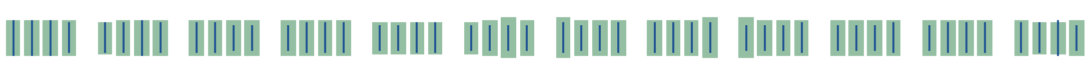
Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



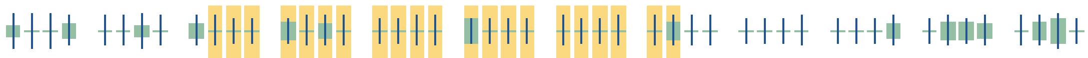
Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Wrentit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

ESTUARINE AND MARINE DEEPWATER
- E1UBL

ESTUARINE AND MARINE WETLAND
- E2USN
- E2USMh
- E2EM1N
- E2SBN
- E2SBNx
- E2USM

FRESHWATER EMERGENT WETLAND
- PEM1Ch

FRESHWATER POND
- PUBHx
- PUBHh

[PUSCh]
[PUSCx]

LAKE

[L2UBHh3]

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

APPENDIX G.4

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

IPaC resource list

Potential AWPF Location - Highway 101

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

San Mateo County, California

Local office

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse Reithrodontomys raviventris No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/613	Endangered

Birds

NAME	STATUS
California Clapper Rail Rallus longirostris obsoletus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern Sterna antillarum browni No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8104	Endangered
Marbled Murrelet Brachyramphus marmoratus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/4467	Threatened
Western Snowy Plover Charadrius nivosus nivosus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/8035	Threatened

Reptiles

NAME	STATUS
Green Sea Turtle Chelonia mydas No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6199	Threatened
San Francisco Garter Snake Thamnophis sirtalis tetrataenia No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5956	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Bay Checkerspot Butterfly Euphydryas editha bayensis There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2320	Threatened
Mission Blue Butterfly Icaricia icarioides missionensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/6928	Endangered
Myrtle's Silverspot Butterfly Speyeria zerene myrtleae No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6929	Endangered
San Bruno Elfin Butterfly Callophrys mossii bayensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/3394	Endangered

Flowering Plants

NAME	STATUS
Fountain Thistle Cirsium fontinale var. fontinale No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7939	Endangered
Marin Dwarf-flax Hesperolinon congestum No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5363	Threatened
San Mateo Thornmint Acanthomintha obovata ssp. duttonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2038	Endangered

San Mateo Woolly Sunflower *Eriophyllum latilobum* Endangered
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/7791

White-rayed Pentachaeta *Pentachaeta bellidiflora* Endangered
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/7782

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act [1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Allen's Hummingbird Selasphorus sasin This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9637	Breeds Feb 1 to Jul 15
Black Oystercatcher Haematopus bachmani This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9591	Breeds Apr 15 to Oct 31
Black Skimmer Rynchops niger This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5234	Breeds May 20 to Sep 15
Black Turnstone Arenaria melanocephala This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Burrowing Owl Athene cunicularia This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9737	Breeds Mar 15 to Aug 31

Clark's Grebe Aechmophorus clarkii — Breeds Jan 1 to Dec 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Common Yellowthroat Geothlypis trichas sinuosa — Breeds May 20 to Jul 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/2084

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Gull-billed Tern Gelochelidon nilotica — Breeds May 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Long-billed Curlew Numenius americanus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Marbled Godwit Limosa fedoa — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9410

Oak Titmouse Baeolophus inornatus — Breeds Mar 15 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9656

Rufous Hummingbird selasphorus rufus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8002

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Song Sparrow Melospiza melodia — Breeds Feb 20 to Sep 5

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Spotted Towhee Pipilo maculatus clementae — Breeds Apr 15 to Jul 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/4243

Tricolored Blackbird Agelaius tricolor — Breeds Mar 15 to Aug 10

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3910

Whimbrel Numenius phaeopus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9483

Willet Tringa semipalmata — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wrentit Chamaea fasciata — Breeds Mar 15 to Aug 10

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ “Proper Interpretation and Use of Your Migratory Bird Report” before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

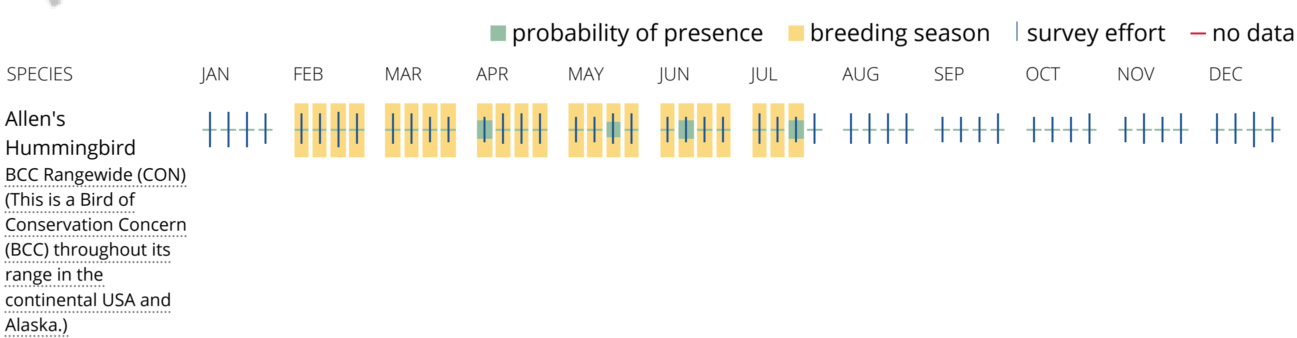
Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

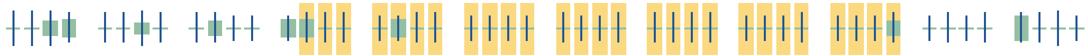
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



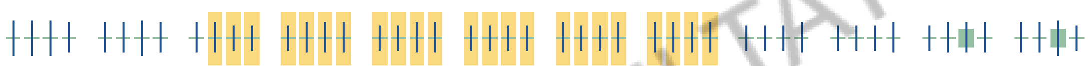
Black Oystercatcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



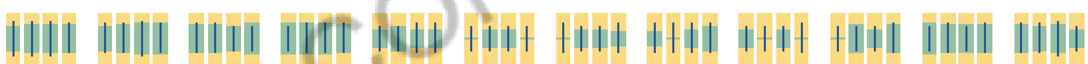
Black Skimmer
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Black Turnstone
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

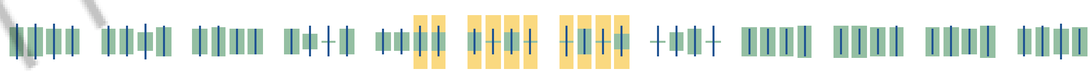
Burrowing Owl
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



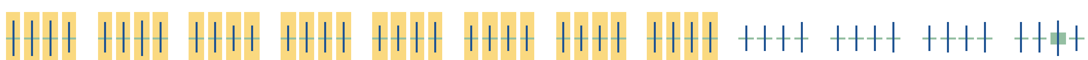
Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

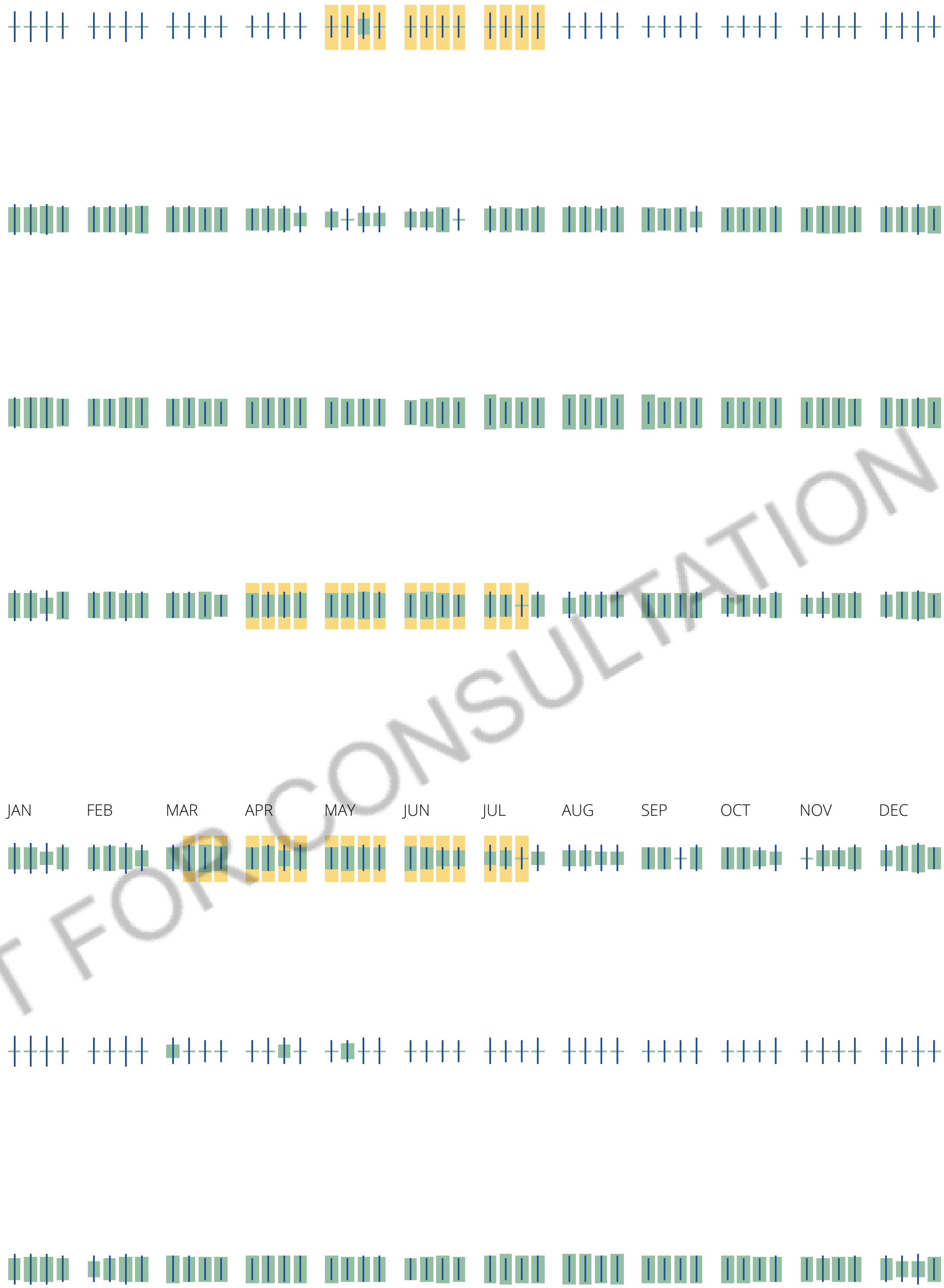


Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)





Gull-billed Tern
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Long-billed Curlew
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Nuttall's Woodpecker
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

SPECIES

Oak Titmouse
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Rufous Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Short-billed Dowitcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Song Sparrow
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Spotted Towhee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Wrentit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review.

Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND
- PEM1Ch

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

APPENDIX G.5

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

Potential AWPF Location – near SVCW

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

San Mateo County, California

Local offices

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

San Francisco Bay-Delta Fish And Wildlife

(916) 930-5603
(916) 930-5654

650 Capitol Mall
Suite 8-300
Sacramento, CA 95814

http://kim_squires@fws.gov

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Salt Marsh Harvest Mouse Reithrodontomys raviventris No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/613	Endangered

Birds

NAME	STATUS
California Clapper Rail Rallus longirostris obsoletus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4240	Endangered
California Least Tern Sterna antillarum browni No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8104	Endangered
Western Snowy Plover Charadrius nivosus nivosus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/8035	Threatened

Reptiles

NAME	STATUS
Alameda Whipsnake (=striped Racer) Masticophis lateralis euryxanthus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/5524	Threatened
Green Sea Turtle Chelonia mydas No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6199	Threatened
San Francisco Garter Snake Thamnophis sirtalis tetrataenia No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5956	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander Ambystoma californiense There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
San Bruno Elfin Butterfly Callophrys mossii bayensis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/3394	Endangered

Crustaceans

NAME	STATUS
Vernal Pool Fairy Shrimp Branchinecta lynchi There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/498	Threatened

Flowering Plants

NAME	STATUS
San Mateo Thornmint Acanthomintha obovata ssp. duttonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2038	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act

[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY

	BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Allen's Hummingbird Selasphorus sasin This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9637	Breeds Feb 1 to Jul 15
Black Oystercatcher Haematopus bachmani This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9591	Breeds Apr 15 to Oct 31
Black Skimmer Rynchops niger This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5234	Breeds May 20 to Sep 15
Black Turnstone Arenaria melanocephala This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Burrowing Owl Athene cunicularia This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9737	Breeds Mar 15 to Aug 31
Clark's Grebe Aechmophorus clarkii This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jan 1 to Dec 31
Common Yellowthroat Geothlypis trichas sinuosa This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/2084	Breeds May 20 to Jul 31

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Gull-billed Tern Gelochelidon nilotica — Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Long-billed Curlew Numenius americanus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Marbled Godwit Limosa fedoa — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9410

Oak Titmouse Baeolophus inornatus — Breeds Mar 15 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9656

Red-throated Loon Gavia stellata — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Rufous Hummingbird selasphorus rufus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8002

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Song Sparrow *Melospiza melodia* Breeds Feb 20 to Sep 5
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Spotted Towhee *Pipilo maculatus clementae* Breeds Apr 15 to Jul 20
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/4243

Tricolored Blackbird *Agelaius tricolor* Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3910

Whimbrel *Numenius phaeopus* Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9483

Willet *Tringa semipalmata* Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wrentit *Chamaea fasciata* Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

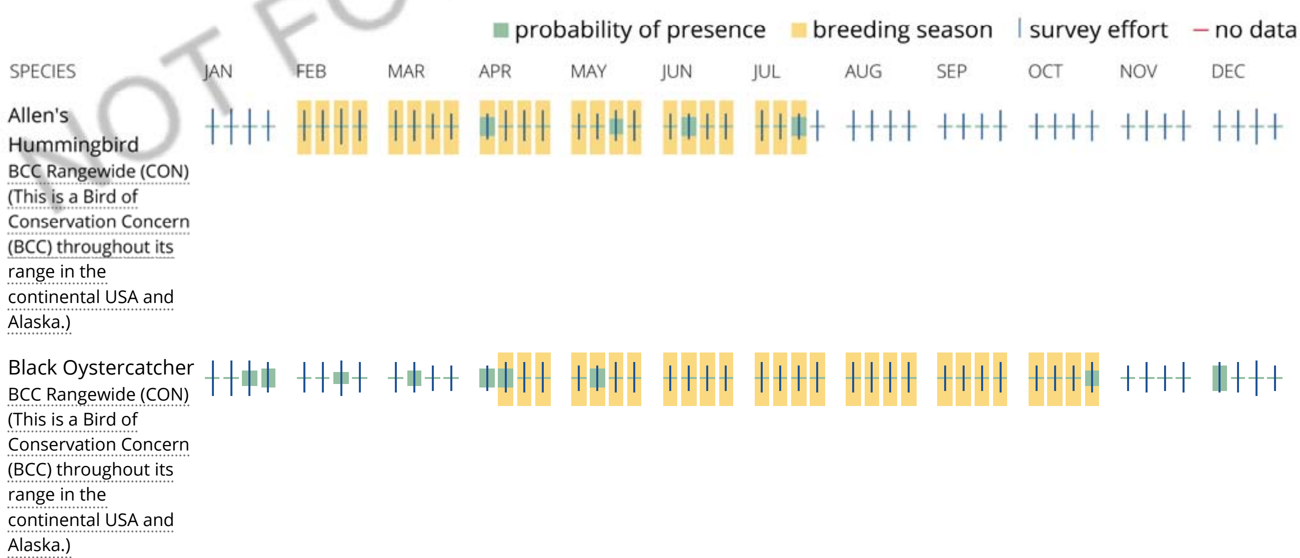
Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

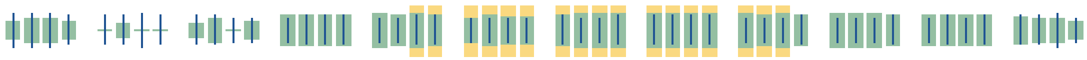
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

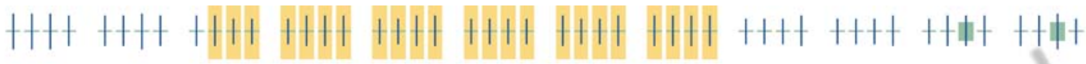


Black Skimmer
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Black Turnstone
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Burrowing Owl
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

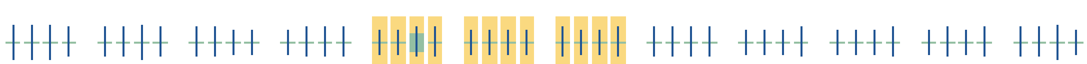


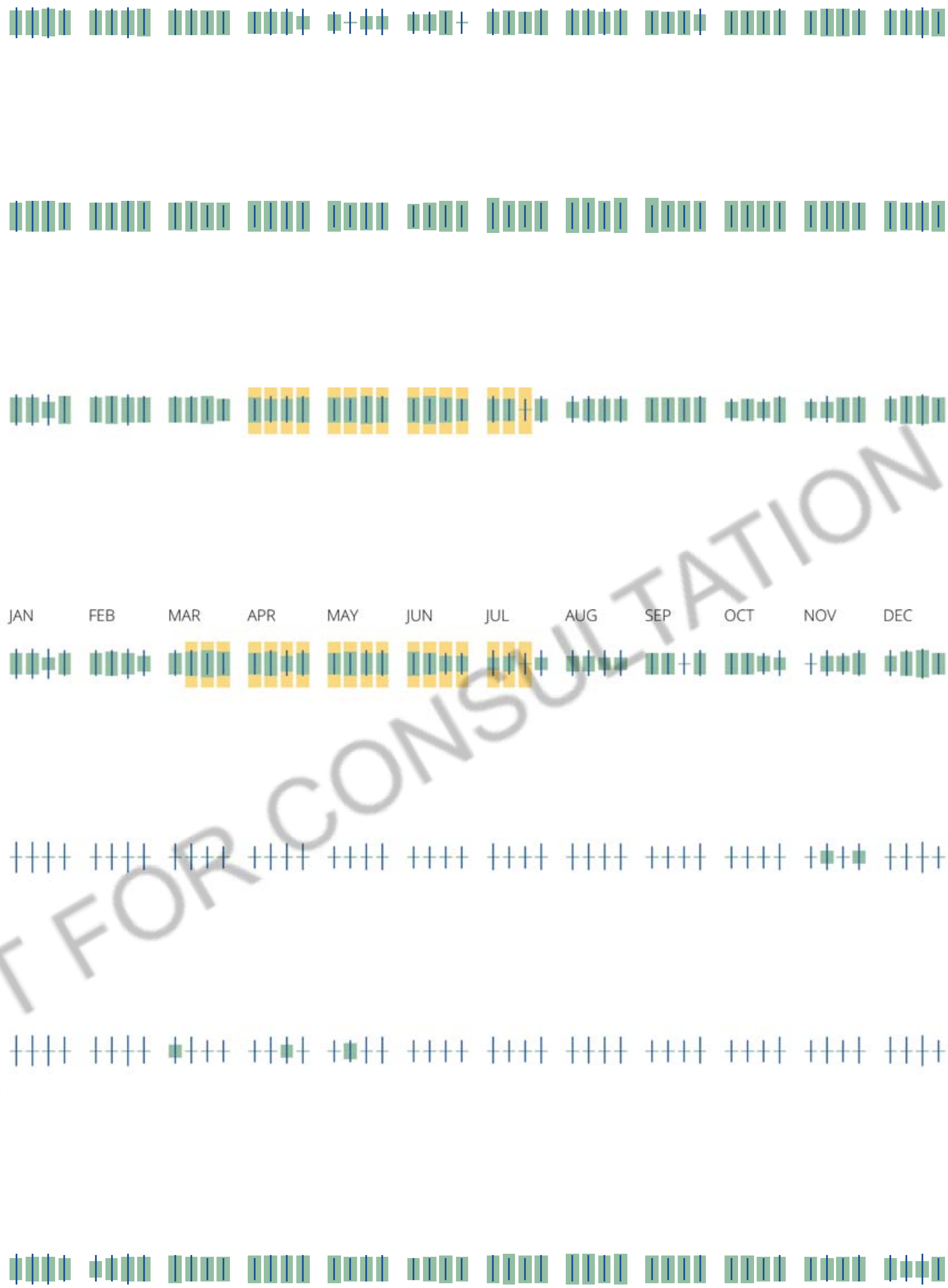
Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Gull-billed Tern
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)





Long-billed Curlew
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Nuttall's Woodpecker
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

SPECIES

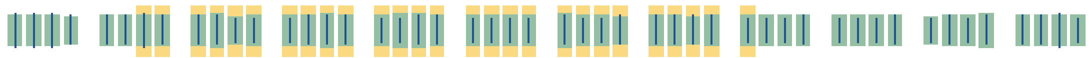
Oak Titmouse
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Red-throated Loon
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

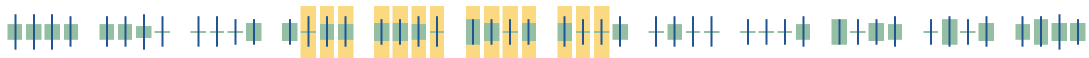
Rufous Hummingbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Short-billed Dowitcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

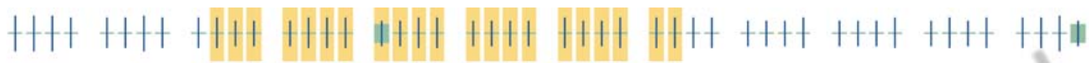
Song Sparrow
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



Spotted Towhee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Wrentit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review.

Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your *Migratory Bird Report*

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

ESTUARINE AND MARINE WETLAND
- E2EM1N
- E2SBNx

FRESHWATER EMERGENT WETLAND
- PEM1Ah

FRESHWATER POND
- PUBKx
- PUBKx1
- PUBK1

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Contact Information

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