MARIN WATER

Strategic Water Supply Assessment

BOARD WORKING SESSION #6

July 12, 2022

Workshop Agenda: Strategic Water Supply Assessment Desalination and Reuse Options

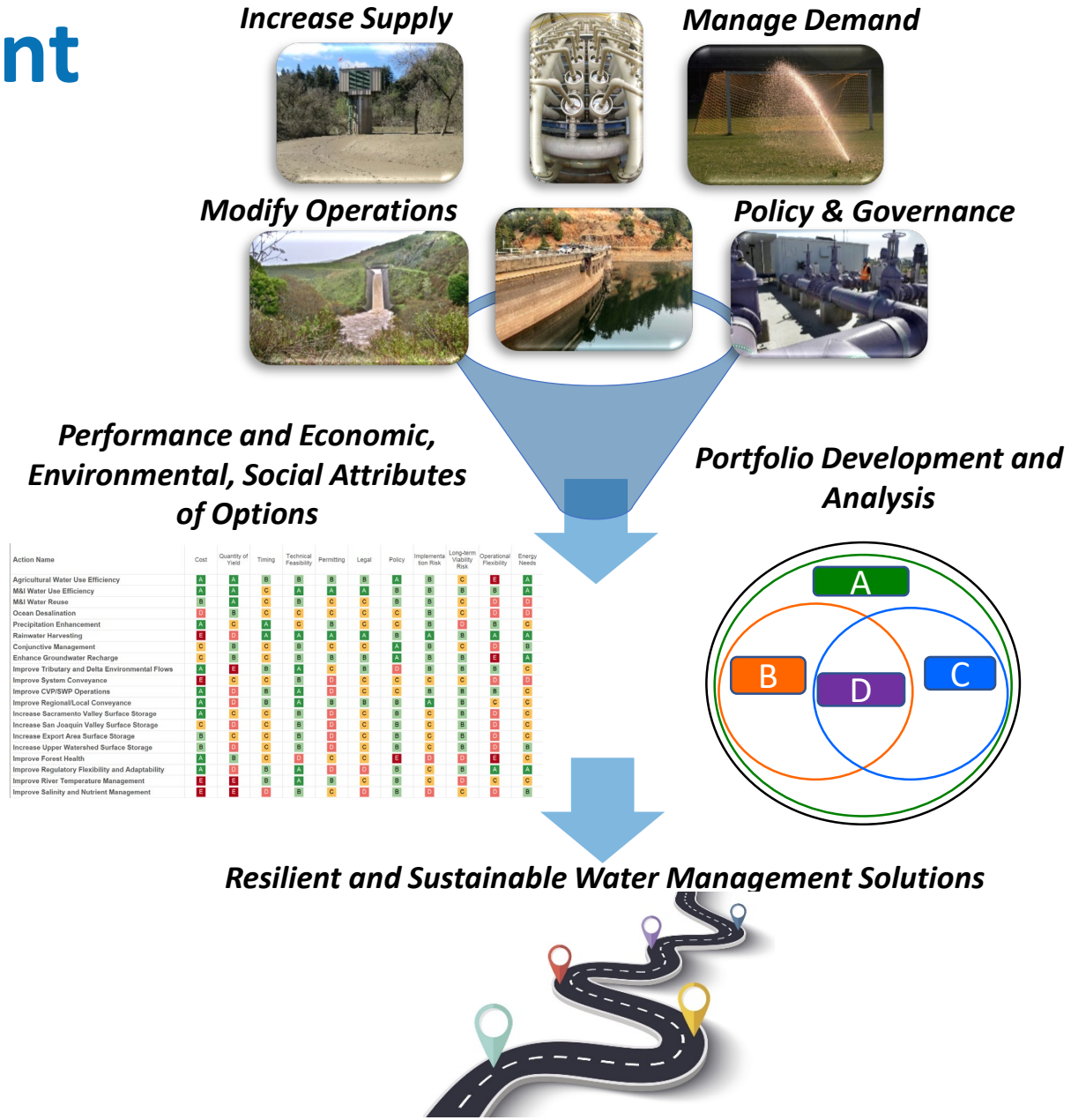
- Project Overview
- Water Supply Alternatives – Reuse and Desalination
- Schedule and Next Steps
- Q&A

Project Overview

Key Project Scope Elements

Water Supply Assessment Process

- Consider a broad range of water management alternatives
- Identify most promising alternatives
- Evaluate alternatives for performance and other economic, environmental, and social criteria
- Explore strategic combinations of alternatives
- Develop roadmap with specific project, pathways, and triggers to achieve resilient and sustainable solutions



Water Supply Alternatives

Water Supply Alternatives

- Baseline – Existing water supply system with planned improvements
- **Desalination**
- **Recycled Water**
- Local Surface Storage
- Sonoma-Marin Partnerships
- Water Purchases with Conveyance through Bay Interties

Assumptions & Estimates

- **Cost Assumptions:**
  - **Class 5 Cost Estimates.**
    - *Typical expected accuracy range for Class 5 estimate is -20 to -50 percent on the low side and +30 to +100 percent on the high side.*
    - *Support the relative cost comparison of alternatives*
  - Capital Costs and Annual O&M Costs
  - 30-year Project Planning Period
  - 3% Interest rate
- 3 Types of Cost Estimating Approaches:
  - Independent evaluation using Jacobs' cost estimating tools
  - Updated estimates from previous studies escalated to reflect 2022 conditions
  - Costs from comparable related projects
- COSTS SHOULD BE CONSIDERED DRAFT AND WILL BE UPDATED

Water Reuse

Water Reuse

1. Recycled Water – expansion of non-potable reuse system (LGVSD-Peacock Gap; CMSA-San Quentin)
2. Indirect Potable Reuse (IPR) – Advanced treatment, discharge to Kent Lake
3. Environmental releases – Advanced treatment, discharge to Kent Lake stream release (IPR)
4. Direct Potable reuse (DPR) – Advanced treatment for DPR, CMSA to distribution system, or discharge to Bon Tempe Lake for Bon Tempe WTP intake

Overview

Wastewater Treatment Facilities

- Central Marin Sanitation Authority (CMSA)
- Sewerage Agency of South Marin (SASM)
- Las Gallinas Valley Sanitary District (LGFVSD)

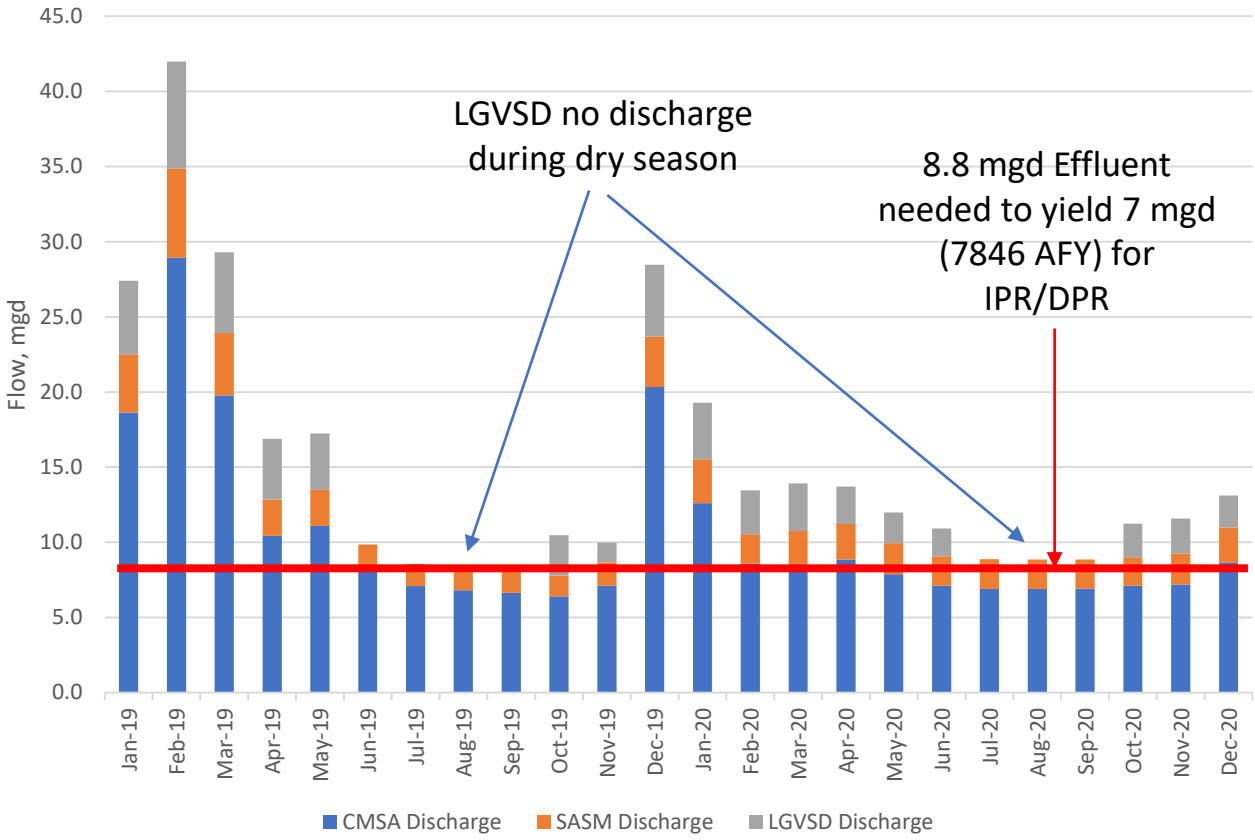
General Considerations:

- Increasing water conservation limits available supply
- Increasing “purple pipe” reuse will limit available supply for regional IPR/DPR concept
- Increased water conservation will change water quality characteristics

CMSA

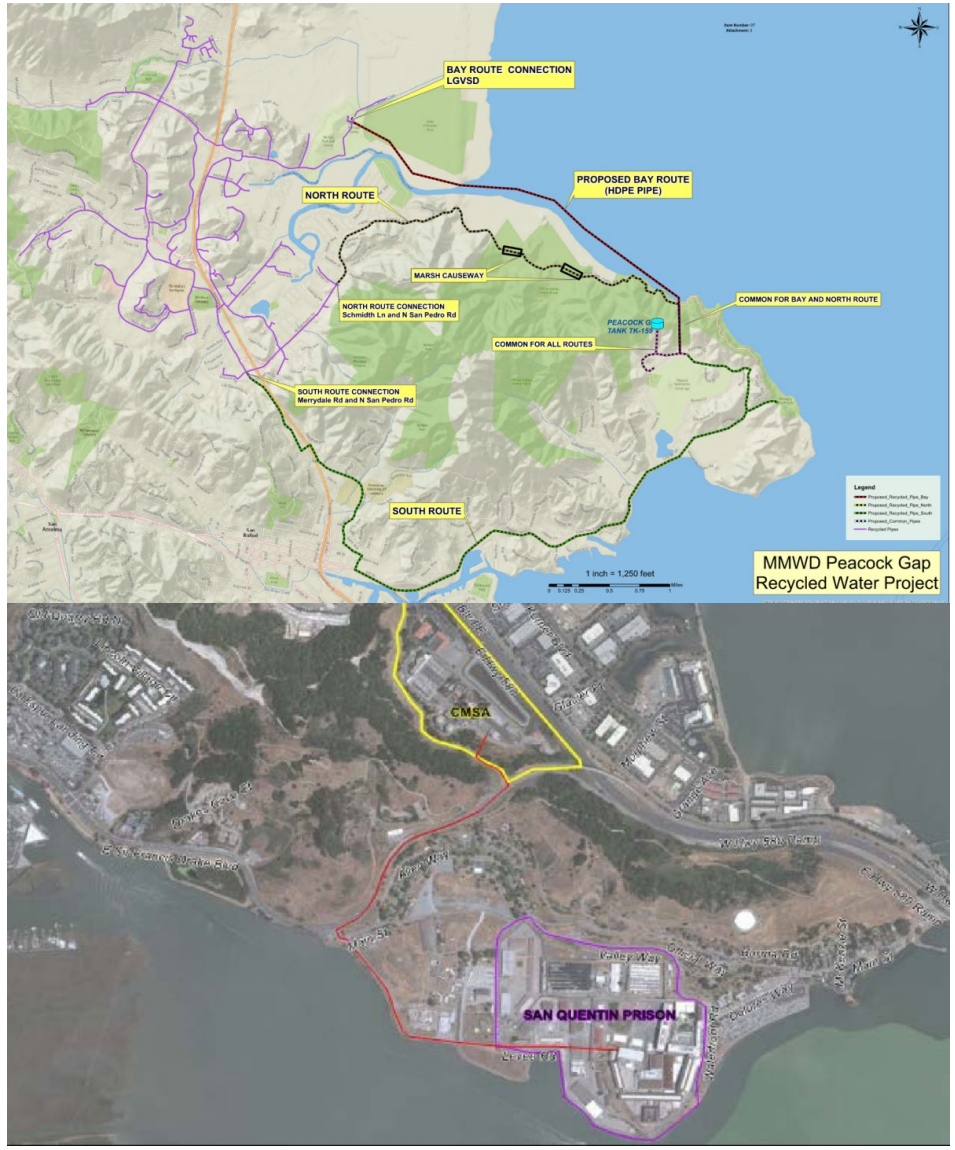
SASM

LGVSD



Option 1: Non-Potable Reuse Expansion

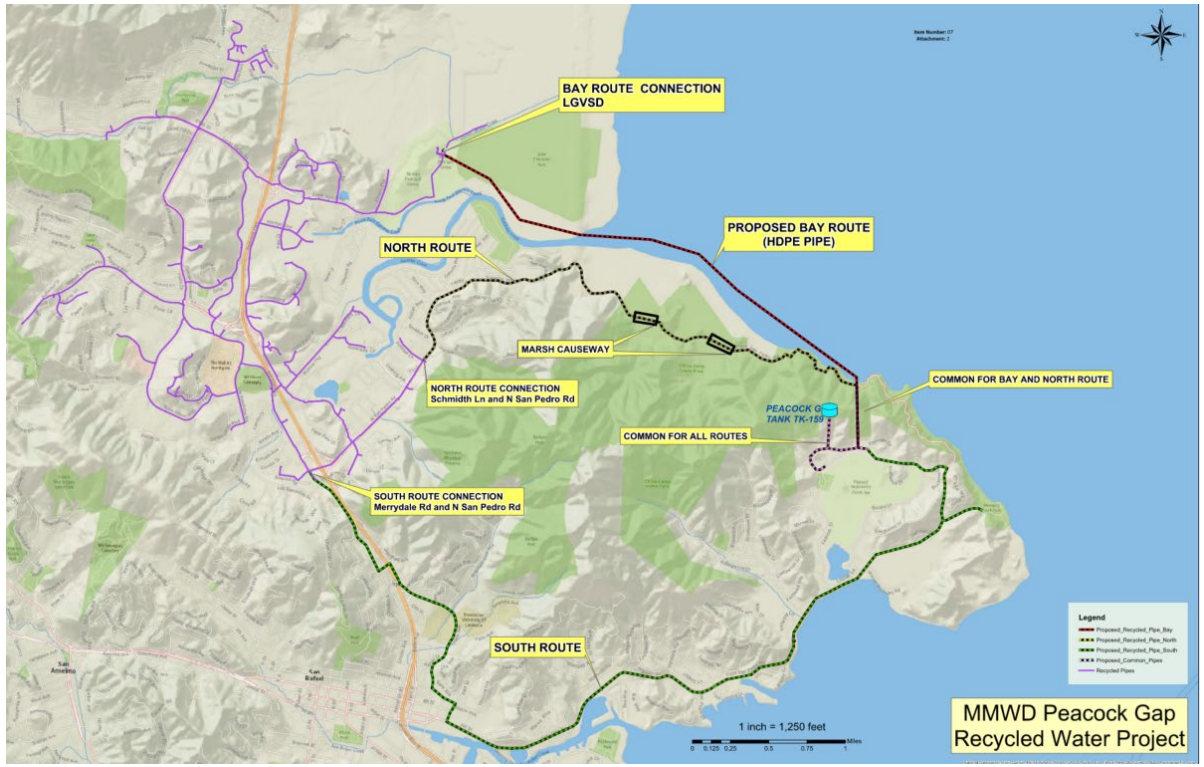
- Two Non-Potable Reuse Projects Considered:
  - Expansion of LGVSD RW distribution system to provide disinfected tertiary RW to Peacock Gap Golf Course (166 AFY)
  - Installation of membrane (MF) at CMSA, provide disinfected tertiary RW to San Quentin Prison (154 AFY)



Option 1a: Non-Potable Reuse Expansion LGVSD RW to Peacock Gap

- Description:
  - Expansion of LGVSD RW distribution system to provide disinfected tertiary RW to Peacock Gap Golf Course
  - **Annual Demand 166 AFY**
  - Ongoing project, using existing 5 MGD LGVSD recycled water treatment plant for disinfected tertiary
  - South Route (expansion of existing distribution system through southern route to Peacock Gap Golf Course area) being investigated

- Considerations
  - **Small volume of water relative to cost**
  - Demand is seasonal
  - Extension of distribution system
  - It will limit effluent availability for IPR/DPR program if implemented



Option 1b: Non-Potable Reuse Expansion CMSA RW to San Quentin

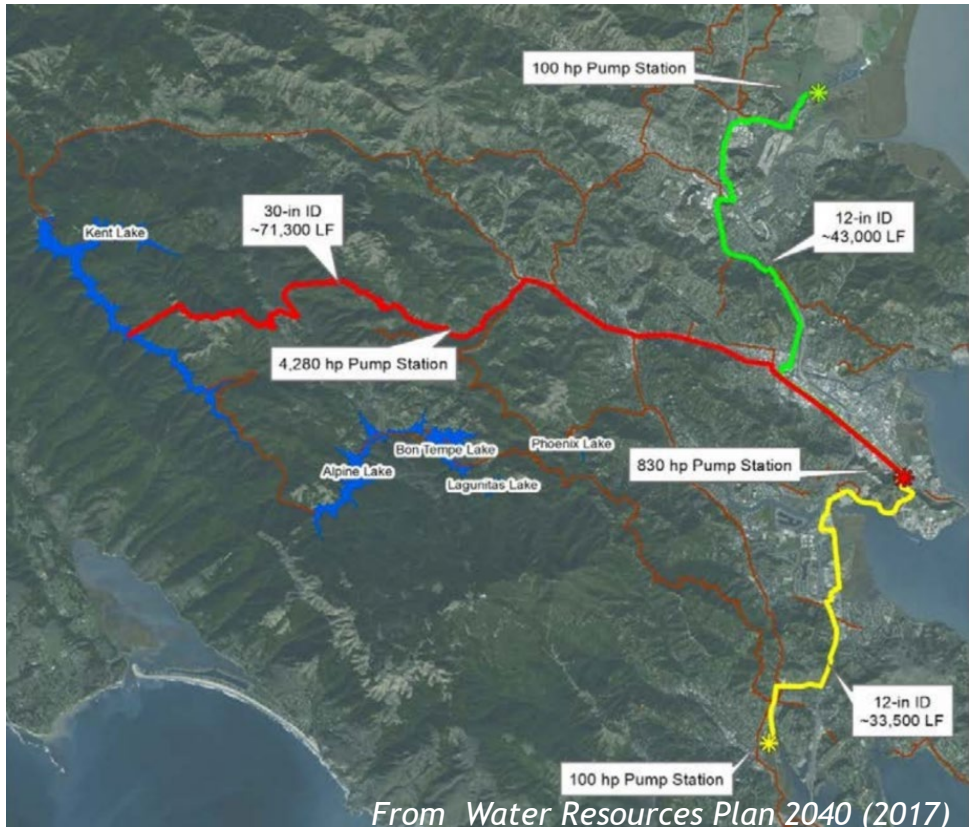
- Description:
  - Installation of membrane (MF) at CMSA, provide disinfected tertiary RW to San Quentin Prison
  - **Annual Demand 154 AFY**
  - Microfiltration disinfected tertiary treatment plant
  - Delivery of recycled water to San Quentin Prison for toilet flushing, landscape irrigation, boiler makeup
  - 6-inch, 3,800 LF distribution pipeline
  - 50 HP 290 gpm pump station

From Water Resources Plan 2040 (2017)

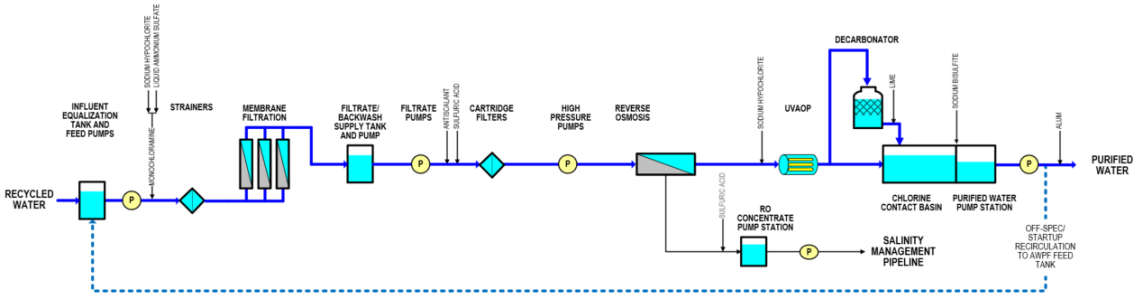
- Considerations
  - **Small volume of water relative to cost**
  - Available space at CMSA for plant and potential addition of full advanced treatment process for IPR/DPR
  - Secondary effluent is not nitrified (not suitable for typical evaporative cooling, if considered)

Option 2: Indirect Potable Reuse (IPR)

- Description
  - Expected annual yield 7,840 AFY (7 mgd)
  - Collect secondary effluent from LGVSD and SASM to CMSA
  - Provide Advanced Water Purification Facility to meet Surface Water Augmentation IPR: Ultrafiltration, Reverse Osmosis, UV-AOP, conditioning
  - Discharge RO reject to CMSA effluent outfall
  - Convey purified water to Kent Lake
- Considerations
  - Permitting for blending purified recycled water into Kent Lake water
  - Public outreach and public acceptance
  - Water balance (secondary effluent availability)
  - Discharge permit for RO concentrate
    - Nutrient watershed permit
    - Salinity
    - Trace contaminants
  - Strict reliability requirements, contingency plans and monitoring requirements for IPR
  - CMSA footprint to accommodate the AWPF
  - **No operating surface water augmentation IPR in California**

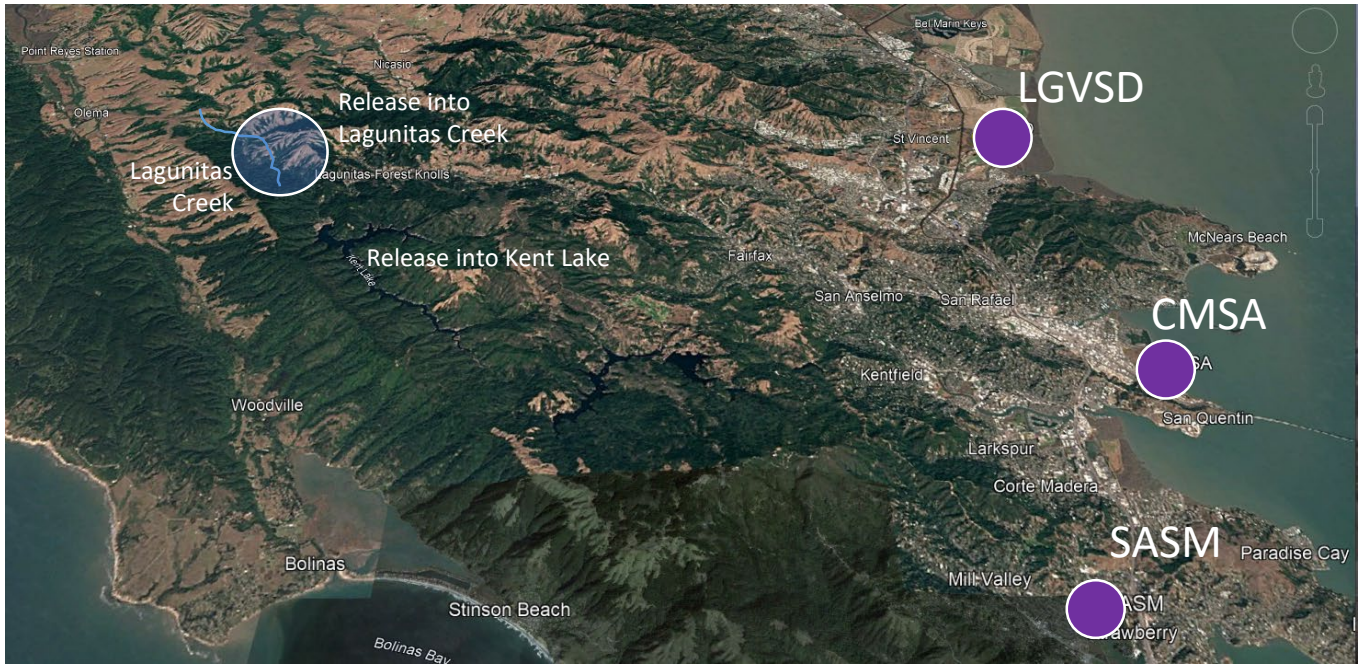


From Water Resources Plan 2040 (2017)



Option 3: In-lieu for Streamflow Release

- Description
  - Provide advanced treatment, cool to adjust temperature, release to Lagunitas Creek, or
  - Provide IPR as described in Option 2, discharge purified water to Kent Lake to provide both IPR and streamflow augmentation
- Considerations for Direct Discharge to Lagunitas Creek
  - Effluent needs temperature adjustment
  - Tertiary effluent will not meet quality requirements – will require full advanced treatment (drinking water intake in Lagunitas Creek)
  - **Fold into the Regional IPR concept – dual benefit between IPR and Streamflow, maximizes use of available effluent flow**



Option 4: Direct Potable Reuse (DPR)

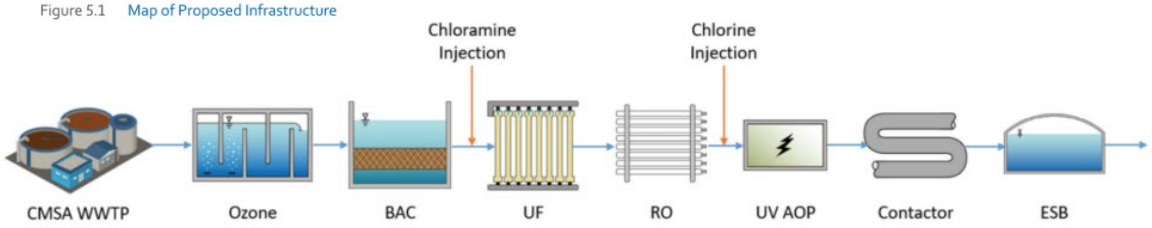
- Two DPR Projects Considered:
  - **Treated Water Augmentation DPR**: Treat CMSA effluent, connection to exiting distribution at up to 4 mgd (per ongoing CMSA DPR study)
  - **Raw Water Augmentation DPR:** Convey secondary effluent from LGVSD and SASM, produce up to 7 mgd purified water and convey to Bon Tempe Lake (Modification of Regional IPR concept)

From DPR TM (2022)

Option 4a: Treated Water Augmentation Direct Potable Reuse (DPR)

- Description
  - Advanced Water Purification Facility at CMSA, only treat CMSA effluent, connection to exiting distribution (treated water augmentation) at up to 4 mgd
  - Advanced Water Purification Facility targeted to meet DRAFT DPR treatment requirements
  - Treatment Trains include:
    - Ozone/BAC
    - Ultrafiltration
    - Reverse Osmosis
    - UV-Advanced Oxidation
    - Chlorine contact
    - Dechlorination (for Bon Tempe discharge only)
    - Purified water transfer pump station
    - Engineered Storage/Bon Tempe Lake discharge
    - RO reject disposal to CMSA outfall
- Considerations
  - Public acceptance –**No implementation of treated water augmentation in the world** (first of this kind if implemented)
  - Strict reliability requirements, contingency plans and monitoring requirements for DPR
  - DPR regulations to be in place by December 2023 (could be a delay; could be changes in requirements from current draft)
  - Discharge permit for RO concentrate
    - Ammonia was identified for exceedance with existing permit
    - Trace contaminants

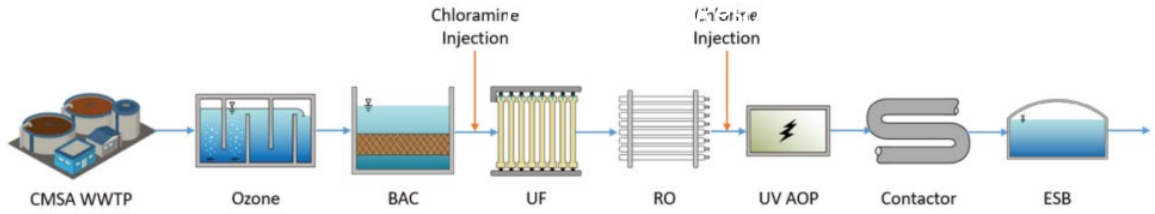
Figure 5.1 Map of Proposed Infrastructure



From DPR TM (2022)

Option 4b: Raw Water Augmentation Direct Potable Reuse (DPR)

- Description
  - Advanced Water Purification Facility at CMSA, convey secondary effluent from LGVSD and SASM, treat up to 8.8 mgd to produce up to 7 mgd purified water and convey to Bon Tempe Lake (raw water augmentation)
  - Advanced Water Purification Facility targeted to meet DRAFT DPR treatment requirements
  - Treatment Trains include (Additional unit process from IPR):
    - Ozone/BAC
    - Ultrafiltration
    - Reverse Osmosis
    - UV-Advanced Oxidation
    - Chlorine contact
    - Dechlorination (for Bon Tempe discharge only)
    - Purified water transfer pump station
    - Engineered Storage/Bon Tempe Lake discharge
    - RO reject disposal to CMSA outfall
- Considerations
  - Public acceptance – **No project in operation for raw water augmentation DPR yet**
  - Discharging to a lake – California Toxics Rule applies
  - Strict reliability requirements, contingency plans and monitoring requirements for DPR
  - DPR regulations to be in place by December 2023 (could be a delay; could be changes in requirements from current draft)
  - Water balance (secondary effluent availability for DPR)
  - Discharge permit for RO concentrate
    - Nutrient watershed permit, ammonia limit
    - Salinity, trace contaminants
  - CMSA footprint to accommodate the AWPF



From DPR TM (2022)

Water Reuse Risk Factors

No operating facility for IPR surface water augmentation or DPR

Supply reliability

- Water demand down = reuse supply source (Wastewater effluent) availability down
- Competing demand between existing/expanding non-potable reuse and potable reuse
- For potable reuse options, lower Wastewater flow means more concentrated wastewater, potential challenges in RO recovery (current assumption is 80-85%)

Constituents of concern, challenges with source control

- Trace contaminants
  - Pharmaceuticals, personal care products, PFAS, other trace organics
  - Some chemicals are detectable after full advanced treatment
- Concentrate management – for IPR/DPR options, these chemicals will end up in RO concentrate, to be discharged to the Bay
  - Dissolved solids, Nutrients
  - Trace contaminants

Public acceptance

- Implementing a potable reuse program not yet in operation in California
- Public concerns on low but detectable trace constituents going into water system or lakes
- How RO concentrate is managed

Water Reuse Options Cost Estimate Summary

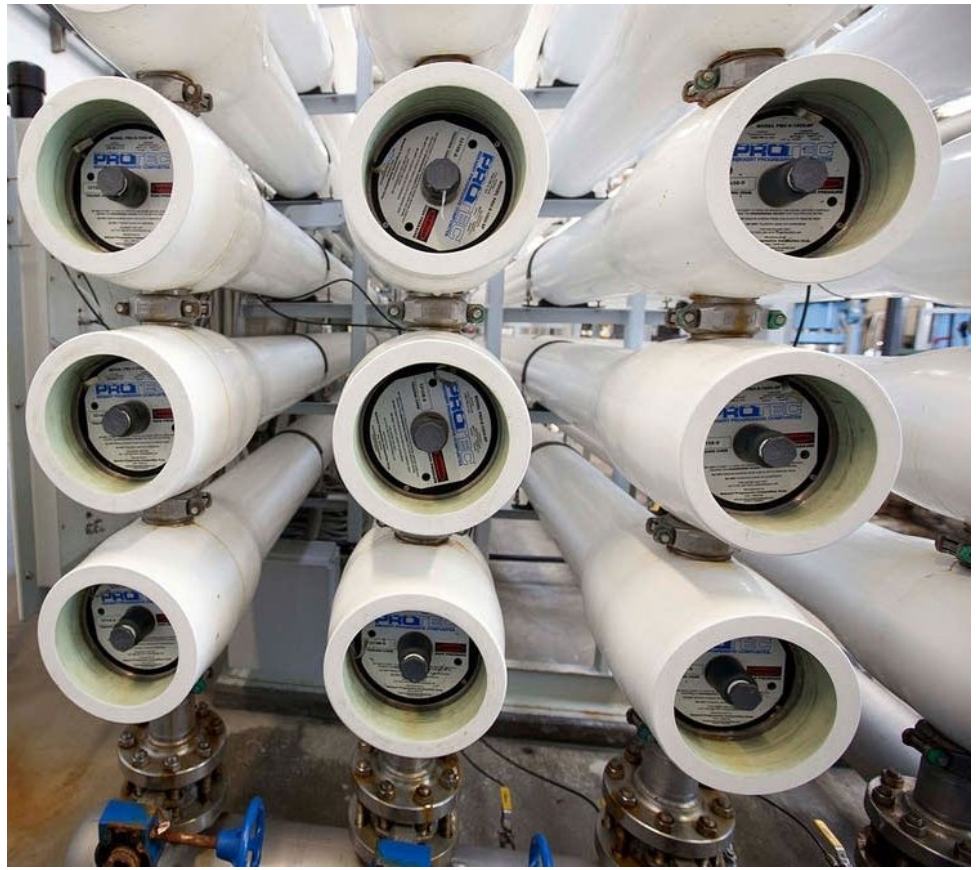
Alternative	Option 1A: Non-Potable CMSA – 0.14 mgd	Option 1B: Non-Potable Peacock Gap 0.15 mgd	Option 2: Regional IPR (In lieu Streamflow 7 mgd)	Option 4A: CMSA DPR (Treated Water Augmentation 4 mgd)	Option 4B: Regional DPR (Raw Water Augmentation 7 mgd)
Capital Cost	$ 10,026,000	$ 14,000,000	$ 451,965,000	$ 124,395,000	$ 433,864,000
Annual O&M Cost	$ 136,000	$ 166,000	$ 9,964,000	$ 8,981,000	$ 16,009,000
Total Annualized Cost	$ 648,000	$ 880,000	$ 33,023,000	$ 15,328,000	$ 38,144,000
Yield, AFY	154	166	7840	4480	7840
Cost per AF	**$ 4,200**	**$ 5,300**	**$ 4,200**	**$ 3,400**	**$ 4,900**

** Cost estimates should be considered DRAFT. Updates are likely as evaluation continues to progress. Typical expected accuracy range for this class estimate (Class 5) is –20 to –50 percent on the low side and +30 to +100 percent on the high side. (Updated)

Desalination

Desalination

1. Marin Regional Desalination Facility
2. Containerized/Leased Desalination Facility
3. Bay Area Regional Desalination Facility
4. Petaluma Brackish Regional Desalination (details in progress)

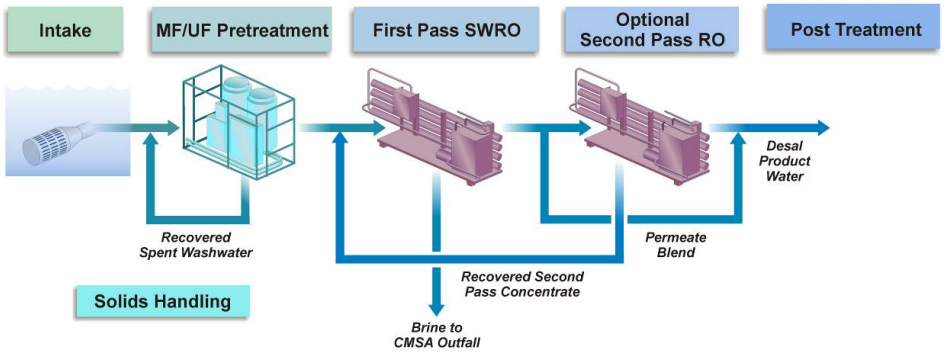


Presentation Topics

- Options summary
- Refinement of capital and operating costs
- Updated cost summary
- Cost comparison with other CA desal facilities

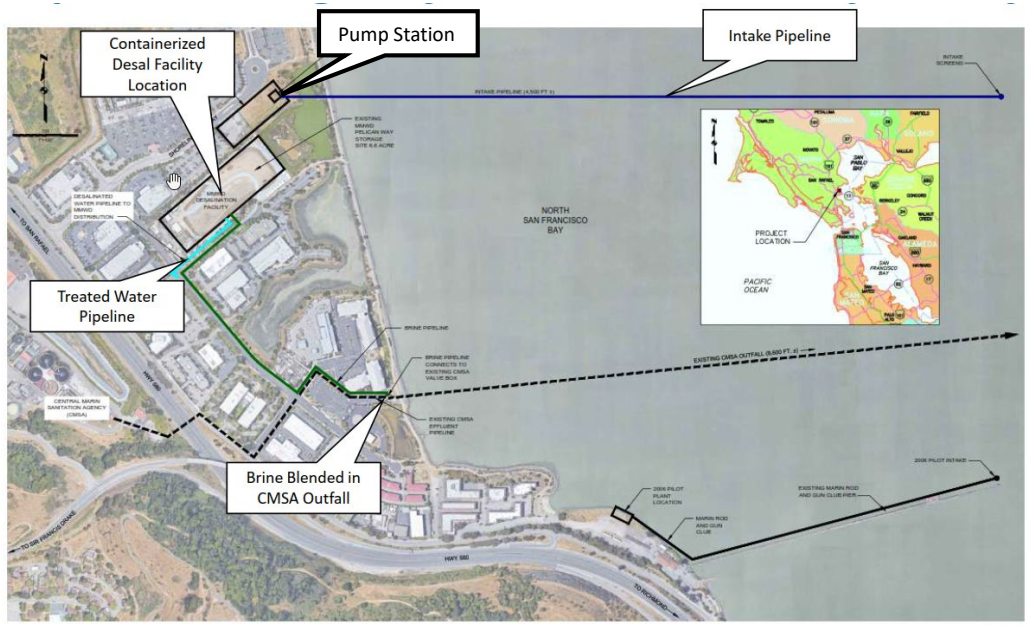
Option 1: Marin Regional Desalination Facility (MRDF)

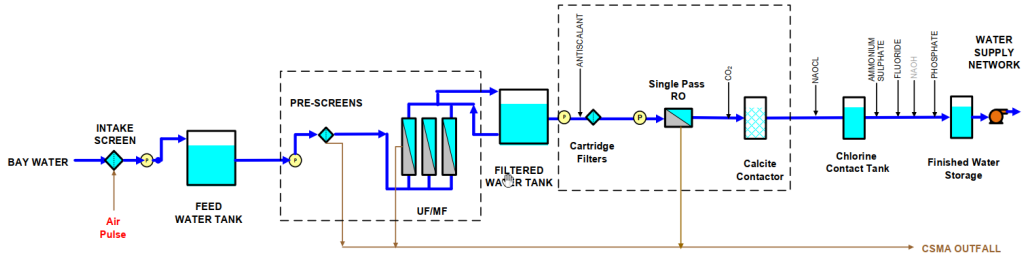
- Description
  - Permanent facility at Pelican Way storage site
  - Intake pump station on un-developed property north of PW site
  - 5-mgd capacity, expandable to 10 or 15 mgd
  - Treated water connections to existing distribution system in Forbes and Ross pressure zones
- Treatment Process
  - Open (screened) intake and pump station
  - Strainer (fine screen)
  - Micro- or ultra-filtration with coagulant feed
  - 1st pass reverse osmosis (RO)
  - 2nd pass RO (optional)
  - Post treatment (remineralization, disinfection, corrosion control and fluoridation)
  - Residuals treatment and offsite solids disposal
- Brine discharge to CMSA outfall
- Considerations
  - Update of EIR and CEQA
  - Considerable timeline to obtain all required permits
  - O&M strategy if used for drought mitigation only



Option 2: Containerized Desalination Facility

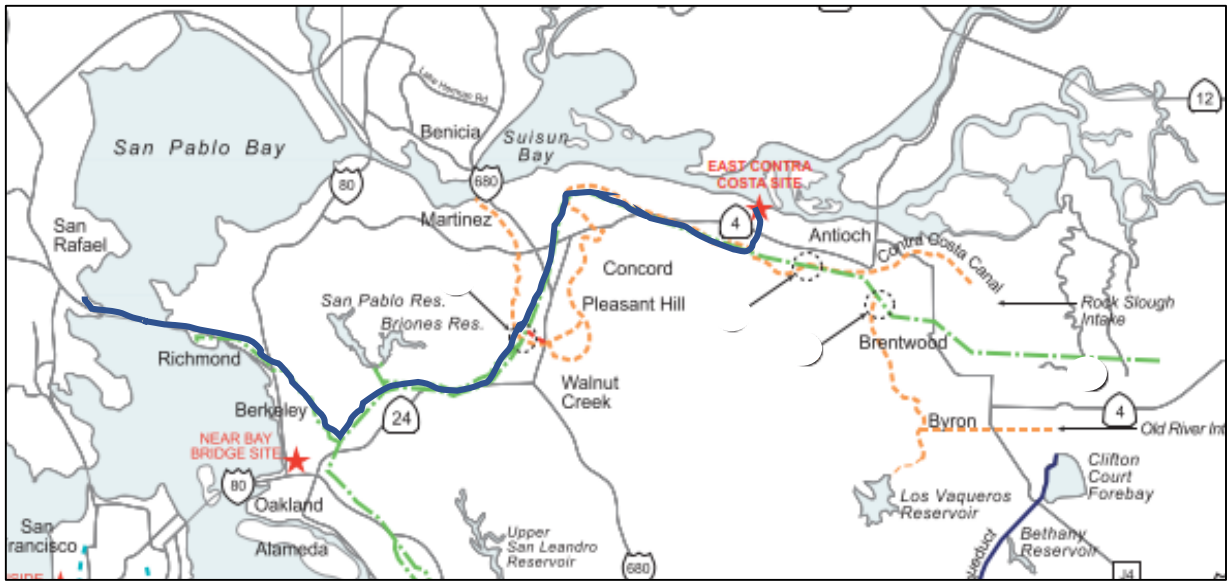
- Description:
  - 5.4-mgd capacity (three 1.8-mgd systems)
  - Integrated, containerized system for process equipment
  - Could be leased or purchased
  - Default provider: Osmoflo (Australia); other providers (Suez, Seven Seas)
- Treatment Process:
  - Open (screened) intake and pump station
  - Strainer (fine screen)
  - Micro- or ultra-filtration
  - 1st pass reverse osmosis (RO)
  - Post treatment (remineralization, disinfection, corrosion control and fluoridation)
  - Treated water stored and pumped into DS at Francisco Way
- Brine (and backwash waste) discharge to CMSA outfall
- Considerations:
  - Update of EIR and CEQA
  - Considerable timeline to obtain all required permits
  - O&M strategy if used for drought mitigation only
  - Equipment availability and reliability

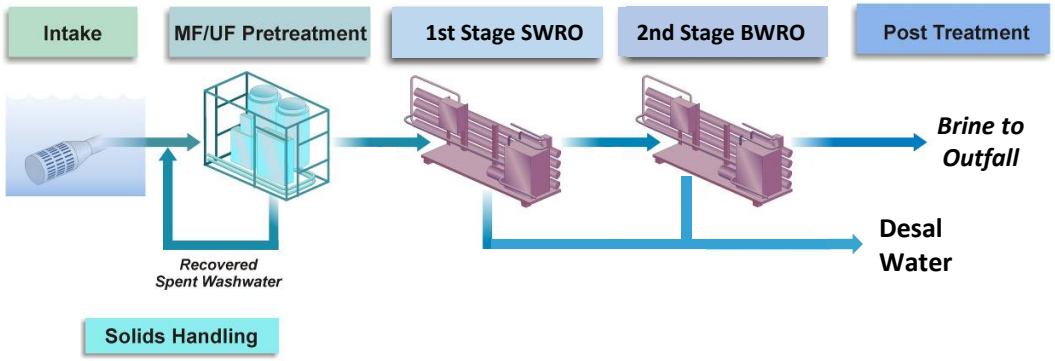




Option 3: Bay Area Regional Desalination Facility (BARDF)

- Partners
  - CCWD, EBMUD, SFPUC, Valley Water, Zone 7 Water Agency
- Description
  - Intake (existing) and desal facility at CCWD Mallard Slough site
  - 20-mgd capacity; 5 mgd dedicated to MMWD
  - Treated water wheeled to Pelican Way site
  - Store and pump from Pelican Way into distribution system (similar to Option 1)
- Treatment Process
  - Similar to Desal options 1 and 2 except:
    - 2-stage seawater/brackish RO system
    - Higher recovery (82 versus 45%)
- Brine discharge to CCCSD or DDSD outfall
- Considerations
  - Availability of water given other partner's needs
  - Minimal MMWD permit requirements
  - Fewer project permits and shorter permitting





Basis of Design for Option 1 Cost Estimates

- Option 1: Permanent Facility
  - 5-, 10- and 15-mgd facilities with inherent **expandability** from 5 to 15 mgd
    - Masonry building size sized for 15-mgd of process equipment
    - Intake, raw water, brine and finished water piping sized for 15 mgd
    - Yard piping sized for 15 mgd
    - Raw water, brine and finished water pump station
    - Other facilities sized based on plant capacity
      - Pump stations
      - Process equipment
  - This approach results in higher construction and production costs for 5-mgd facility compared with fixed-capacity facility

Adjustments to Capital Cost Estimate Factors

- Percentage-based cost factors used to estimate capital costs were adjusted in 2022 to account for current market conditions and other factors
- This results in a significant increase in capital costs for all desal options
- For July 2022 refined draft cost estimates, permitting has been decreased from 3 to 2.5%; other percentages remain the same

Non-Direct Facility Costs	2021	2022	Increase
Additional Project Costs			
Sitework	6.0%	6.0%	
Yard Electrical	10.0%	10.0%	
Yard Piping	7.0%	7.0%	
Plant Instrumentation and Controls	5.0%	3.0%	
Sales Tax on Material	0.0%	8.3%	
General Conditions	0.0%	7.0%	13.3%
Contractor Markups			
Overhead	6.0%	12.0%	
Profit	10.0%	6.0%	
Mob/Bonds/Insurance	3.0%	8.2%	7.2%
Contingency	30.0%	30.0%	0.0%
Permitting	1.0%	3.0%	
Engineering	8.0%	11.5%	
Services during Construction	8.0%	13.5%	11.0%

Option 1: Marin Regional Desalination Facility (MRDF)

- Cost refinements have resulted in lower capital, operating and production costs for 2022 estimates

	Draft 2022 Cost Estimate				Refined Draft 2022 Cost Estimate		
Plant Size (MGD)	5	10	15		5	10	15
AFY	5,605	11,210	16,815		5,605	11,210	16,815
SWRO Facility Costs	$120,506,400	$153,161,100	$178,058,800		$95,206,304	$125,360,930	$147,758,712
Reduced cost for MF/UF system					($5,000,000)	($7,500,000)	($10,000,000)
Removal of treated water conveyance cost					($20,300,128)	($20,300,128)	($20,300,128)
Additional Project Costs	$49,708,700	$63,178,900	$73,449,300		$39,272,475	$51,711,413	$60,950,588
Contractor Markups	$44,545,300	$56,616,200	$65,819,600		$35,192,893	$46,339,742	$54,619,407
Contingency @ 30% on Subtotal Incl Additional Project Costs	$64,428,000	$81,886,800	$95,198,400		$50,901,300	$67,023,600	$78,998,700
Non-Construction Costs	$78,173,000	$99,356,000	$115,507,000		$80,957,128	$100,170,128	$114,440,128
Addition of treated water conveyance cost					$20,300,128	$20,300,128	$20,300,128
Total Desalination Facility Cost including Non-Construction Costs	**$357,361,423**	**$454,199,000**	**$528,033,000**		**$302,133,128**	**$375,161,128**	**$456,767,534**
Annualized Plant Costs	$18,079,800	$22,979,100	$26,714,500		$15,415,000	$19,140,000	$22,290,000
O&M Costs	$14,998,700	$25,265,300	$35,076,200		$12,930,100	$21,567,770	$29,868,600
Reduction in SWRO and other' category O&M costs					($2,068,000)	($3,697,500)	($5,207,600)
Total Annualized Costs	**$33,078,500**	**$48,244,400**	**$61,790,700**		**$28,378,100**	**$40,707,800**	**$52,158,600**
Water Production Costs, $/AF	**$5,900**	**$4,300**	**$3,700**		**$5,100**	**$3,600**	**$3,100**

Basis of Design for Option 3 Cost Estimate

- Two major infrastructure components
  - 20-mgd highly brackish desalination facility
    - Based on results of ‘08-’09 pilot study at Mallard Slough and subsequent desalination plant design
    - Updated cost estimate using design information published in 2010
    - Permanent facility similar in design approach for Option 1
  - Raw water and treated water conveyance costs based on 2021 MMWD intertie for emergency pipeline
- Includes $/AF costs for:
    - Use of Mallard Slough pump station and CCWD water fees
    - Wheeling of water through aqueduct and intertie

Options 2 & 3 Cost Refinements

- Option 2- Containerized Desalination Facility
  - Re-allocation of treated water conveyance costs (as shown for Option 1)
  - Reduces capital/total annualized costs and cost per acre foot
- Option 3- Bay Area Regional Desalination Facility (BARDF)
  - Re-allocation of treated water conveyance costs (as shown for Option 1)
  - Reduction in ‘other’ category O&M costs (as shown for Option 1)
  - Reduces capital/O&M/total annualized costs and cost per acre foot

Desalination Options – Refined Draft Cost Estimate Summary

Alternative	Option 1A: Marin Regional Desal Facility-5 mgd	Option 1B: Marin Regional Desal Facility-10 mgd	Option 1C: Marin Regional Desal Facility-15 mgd	Option 2: Containerized Desal Facility-5.4 mgd	Option 3: Bay Area Desal Facility-5 mgd	Option 4: Petaluma Brackish Desal
Capital Cost	$302,133,000	$375,161,000	$436,903,000	$ 113,444,000	$262,297,000	In Progress
Annual O&M Cost	$12,963,000	$21,568,000	$29,869,000	$ 9,369,000	$ 5,887,000	
Total Annualized Cost	$ 28,378,000	$ 40,708,000	$ 52,159,000	$ 34,140,000	$ 19,269,000	
Yield, AFY	5,600	11,200	16,800	6,000	5,600	
Cost per AFY	**$ 5,100**	**$ 3,600**	**$ 3,100**	**$ 5,700**	**$ 3,900**	
Total annualized cost based on 30 years for Options 1 and 3, and 5-years for Option 2						

Cost estimates should be considered DRAFT. Updates are likely as evaluation continues to progress.
Typical expected accuracy range for this class estimate (Class 5) is –20 to –50 percent on the low side and +30 to +100 percent on the high side.

Comparison with Other CA Desal Facilities

- Antioch
- Santa Barbara
- Doheny

Antioch Brackish Desalination Plant

- In construction
- Advertised Capital Cost is $110M for 6 mgd production (no details on costs); construction cost let in 2020 (start of COVID); doesn't reflect market cost volatility
- Plant treats variable salinity water (between fresh and ~10,000 mg/L; average ~7,200 mg/L)
- This compared to 30,000 mg/L for Bay water (Option 1)
- Higher TDS increases cost of treatment. RO recovery is 82% for Antioch versus 50% for MMWD.
- For 5-mgd MMWD (Option 1) facility:
  - Intake/pump station and brine pump station/pipeline are 4x larger
  - Pretreatment system is 40% larger; ***Antioch plant doesn't include pretreatment- uses existing WTP***
  - RO system requires 50% more membrane elements and larger skids; uses more expensive, highly corrosion-resistant materials operating at higher pressure
  - Process building is significantly larger
  - Energy consumption of MF/UF and RO system are significantly higher
- **Capital, O&M and cost of water between Antioch and Marin Regional Desalination facilities are not comparable**

Santa Barbara Desalination Plant

- Operational
- $72M capital cost for 2.8 mgd
- Plant treats seawater with slightly higher TDS than Bay water (34 vs 30 g/L); minimal impact on cost of wetted infrastructure
- Plant leverages existing site, intake (with new screen), outfall and distribution system connection from original desalination plant (which cost $34M)
- Plant infrastructure is less reliable and very different than that proposed for Marin Regional Desalination Plant
  - Equipment fabricated offsite (at lower cost) and shipped to site; minimal site work
  - No process building; all equipment outdoors; trailer used for Ops building
  - Much cheaper pretreatment system (pressure media filters versus micro-/ultra-filtration)
  - MMWD pretreatment system ensures plant can handle algal bloom in Bay
- **Water cost for Santa Barbara and Marin Regional Desalination facilities is not comparable**

Doheny Desalination Plant

- In Planning
- $119M capital cost for 5 mgd
- Plant treats seawater with slightly higher TDS than Bay water (34 vs 30 g/L); minimal impact on cost of wetted infrastructure
- Design differences produce different costs
  - Slant well has higher costs than open intake
  - Pressure media filtration has lower CAPEX and OPEX cost compared to membrane filtration
  - Calcite filters have lower post-treatment costs compared to dry lime
- Doheny cost estimate developed in 2019
- Cost estimate doesn’t account for:
  - Project development costs (e.g., permitting, WQ testing, etc)
  - Impact of COVID, escalation, market volatility

Status and Next Steps

Work in Progress

- Water management alternatives, costs, and other evaluation criteria being further progressed
- Integration of water management alternatives into decision support model is **necessary** to evaluate yield of supplies when integrated into system
- Structure for forecast-based decision-making on integrating and optimizing supplies
- Detailed evaluation criteria

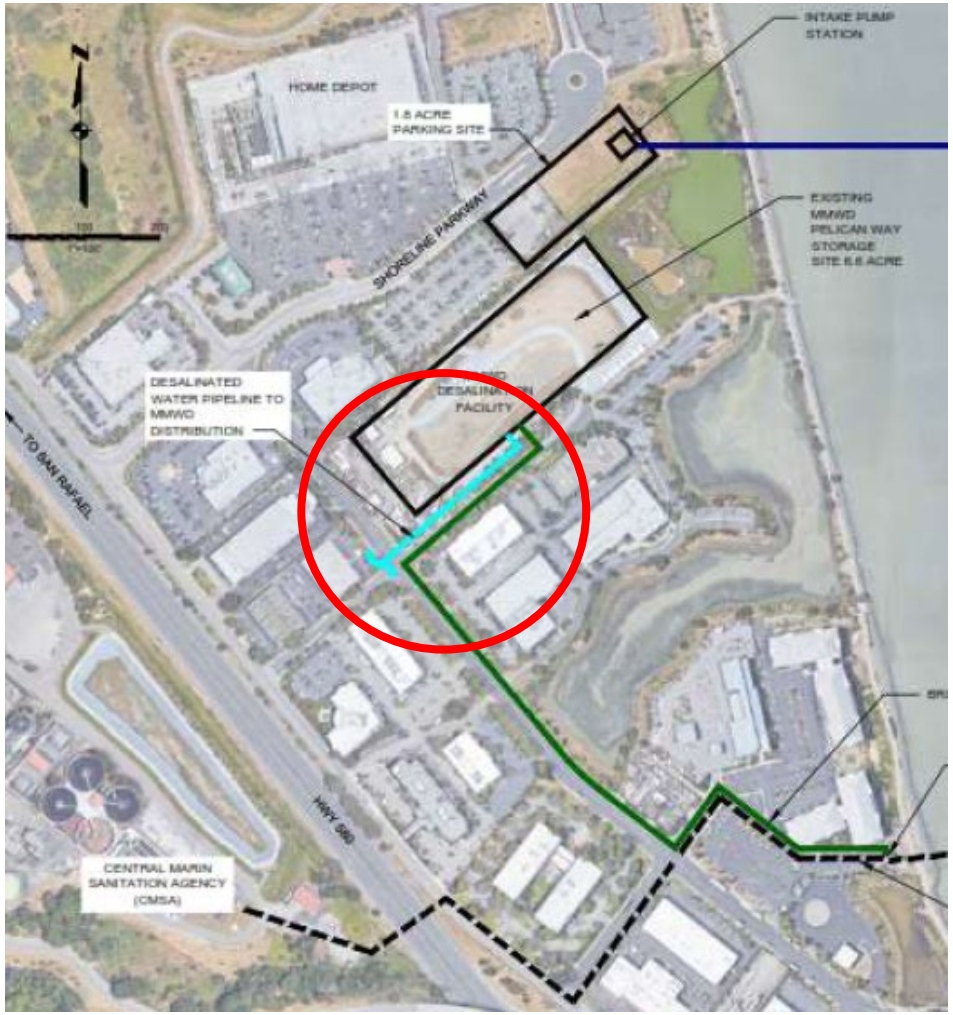
Strategic Water Supply Assessment: Schedule

- July 12 (5pm-7pm) – Review Desalination and Recycled Water
- **July 19 (7:30pm – 9:30pm) – Local Supply Enhancement, Sonoma options and Review Interties**
- July 28 (5pm-7pm) – Public Workshop #3
- August 9 (5pm-7pm) – Evaluation of Water Management Alternatives
- August 23 (5pm-7pm) – Evaluation of Water management alternatives
- August TBD – Public Workshop

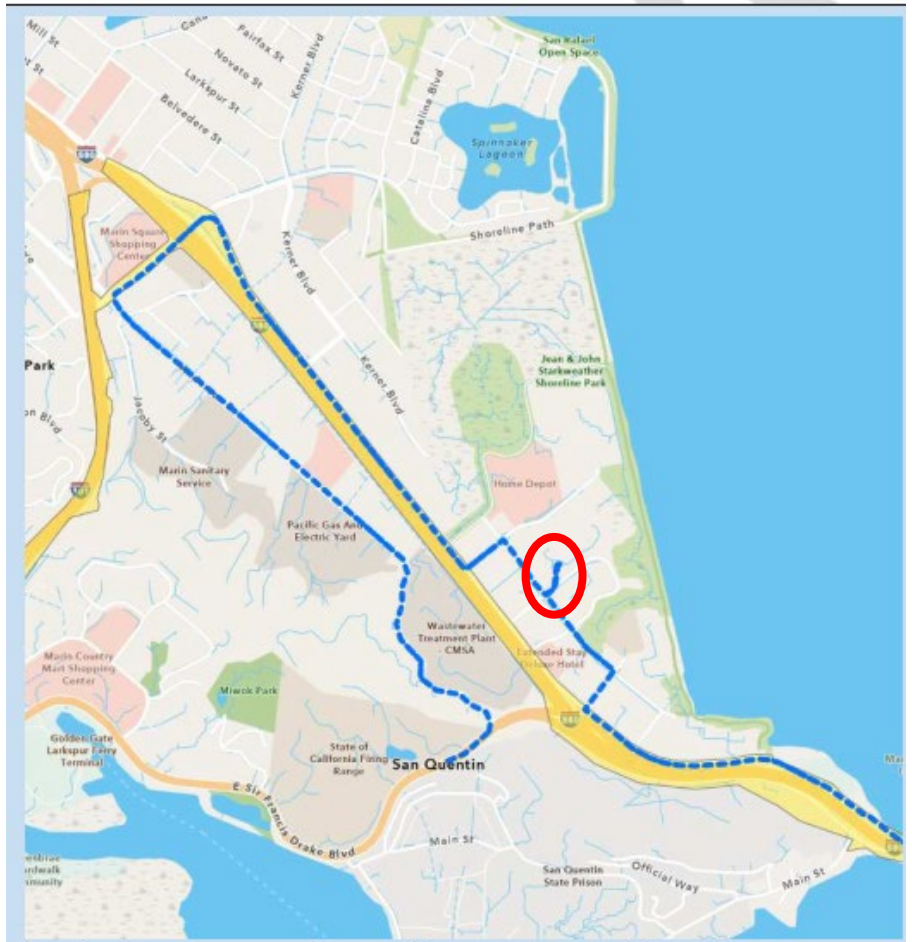
Q & A

Option 1 Conveyance Routing Change

2021 routing



2022 routing



The discharge piping from Pelican runs to Bellam, thence to Andersen, connecting at two points in the Forbes zone, before a final tie-in to the Ross zone in Sir Francis Drake.