Nature-based Solutions for **Nutrient Management**

SFEP Implementation Committee | 8/16/23

BACWA BAY AREA CLEAN WATER AGENCIES

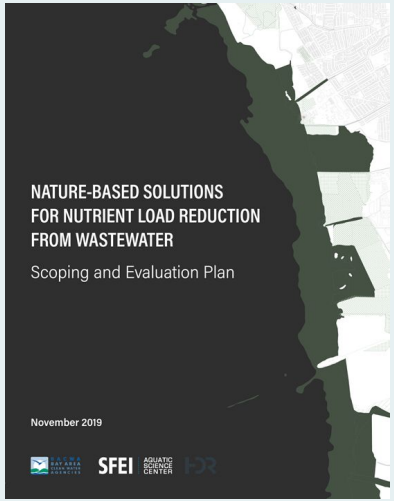
SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

The Project

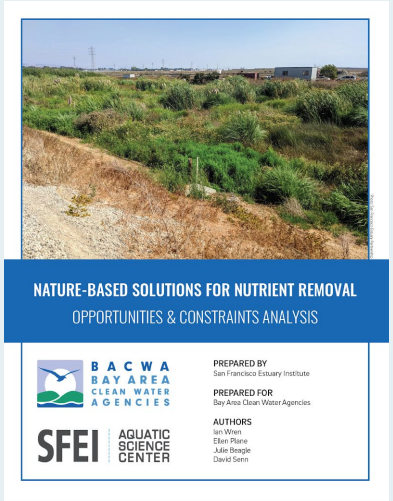
- Requirement of Provision VI.C of the 2019 Nutrient Watershed Permit
- Estimate nutrient reduction potential, on a regional scale, via treatment wetlands (open water & horizontal levees)
- Secondary objective to address barriers to implementation and encourage multi-agency coordination
- Increase resilience to sea level rise and provide co-benefits, such as wildlife habitat, recreation, and educational opportunities

Phases of analysis

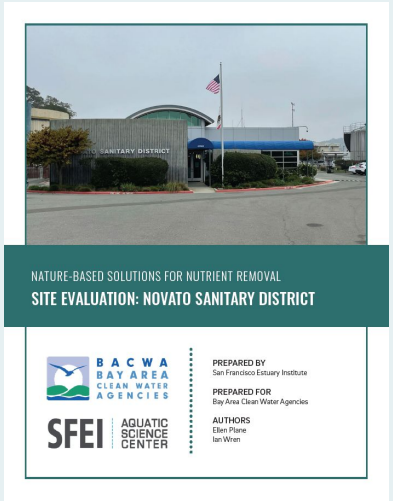
Scoping & Evaluation



Desktop screening (factsheets for 37 facilities)



Site evaluations for 8 high opportunity facilities



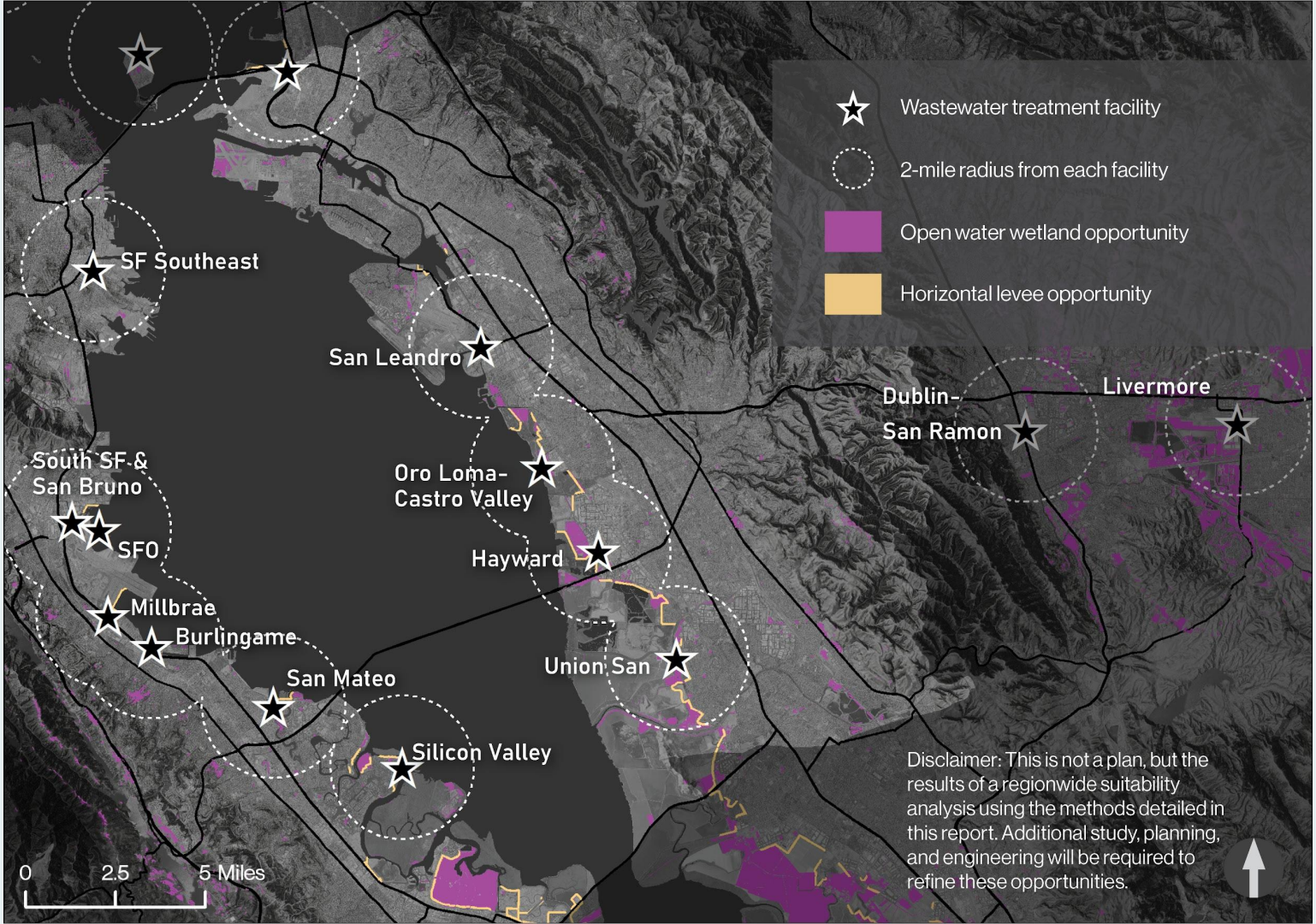
Cost estimates and concept designs for 3 facilities

[In progress]

Desktop screening

GIS suitability analysis, including factors like:

- Land cover
- Elevation
- Slope
- Ownership
- Adjacency (e.g. to tidal marshes and development)


Wastewater treatment facility
2-mile radius from each facility
Open water wetland opportunity
Horizontal levee opportunity
SF Southeast
San Leandro
Dublin-
San Ramon
Livermore
South SF &
San Bruno
Oro Loma-
Castro Valley
SFO
Hayward
Millbrae
Burlingame
San Mateo
Union San
Silicon Valley
0
2.5
5 Miles
Disclaimer: This is not a plan, but the results of a regionwide suitability analysis using the methods detailed in this report. Additional study, planning, and engineering will be required to refine these opportunities.

DELTA DIABLO

NATURE-BASED TREATMENT SOLUTIONS

The Delta Diablo Wastewater Treatment Plant discharges primarily non-nitrified effluent to New York Slough, which feeds into Suisun Bay at the confluence with the San Joaquin River. The facility serves ~57,000 connections in Antioch, Pittsburg, and Bay Point, with a dry weather permitted capacity of 19.5 mgd. In 2014, a conceptual assessment of NbS opportunities was performed identifying potential sites and options for partial treatment and nutrient removal.

Preliminary Findings

Several opportunities for both treatment types were identified, including some in close proximity to the Delta Diablo facility. Together, the three highlighted open water wetland opportunities could reduce the nitrified TIN load by over 90%. The nearest horizontal levee opportunity could reduce TIN loads by 12%.

Opportunities & Constraints

Candidate NbS sites include upland areas adjacent to existing wetlands and a ~20-ac undeveloped property owned by Delta Diablo. Delta Diablo has pilot tested emerging nutrient removal processes and is evaluating water recycling challenges and opportunities as part of a current long-term master planning effort.

Photo courtesy of Google Earth

Refer to pages 14-15 for a key to interpreting the metrics in the following tables:

Overall suitability for nature-based treatment solutions	
Measure	**Suitability**
Open water wetlands	High
Horizontal levees	Moderate

Open water wetland opportunities	*open water wetlands on map*
Within 2 miles of facility	
Total Potentially Suitable Area	488 acres
Nearby sites over 5 acres (outlined in blue on map)	
Potentially Suitable Area	25 - 92 acres
Total Potential Flow Capacity	2.2 - 8.1 mgd
Total TIN Reduction Potential	420 - 1,560 kg/day
Facility-Specific TIN Reduction	29% - over 90%

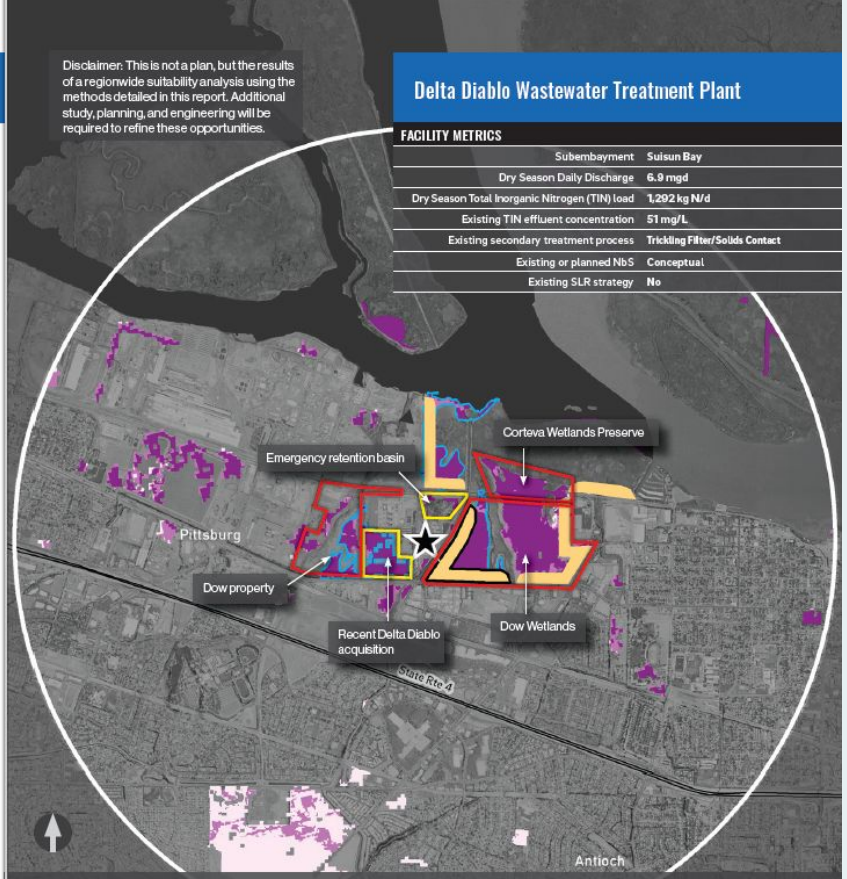
Horizontal levee opportunities	*horizontal levees on map*
Potentially Suitable Length	1.2 - 4.1 km
Total Potential Flow Capacity	2.1 - 6.9 mgd
Total TIN Reduction Potential	160 - 530 kg/day
Facility-Specific TIN Reduction	12% - 41%

Site opportunities and constraints	
Consideration	**Relative Magnitude**
Excess Treatment Capacity	Low
Land Use/Regulatory Conflicts	Moderate

Disclaimer: This is not a plan, but the results of a regionwide suitability analysis using the methods detailed in this report. Additional study, planning, and engineering will be required to refine these opportunities.

Delta Diablo Wastewater Treatment Plant

FACILITY METRICS	
Subembayment	Suisun Bay
Dry Season Daily Discharge	6.9 mgd
Dry Season Total Inorganic Nitrogen (TIN) load	1,292 kg N/d
Existing TIN effluent concentration	51 mg/L
Existing secondary treatment process	Trickling Filter/Solids Contact
Existing or planned NbS	Conceptual
Existing SLR strategy	No



Wastewater treatment facility

3.2 km (2 mi) buffer

Horizontal levee opportunity

Possible horizontal levee location

Nearest horizontal levee to facility

Open water wetland opportunity

Highly suitable

Moderately suitable

Less suitable

Nearest 3 sites over 5 acres

Facility interview annotations

Likely infeasible

Worth exploring

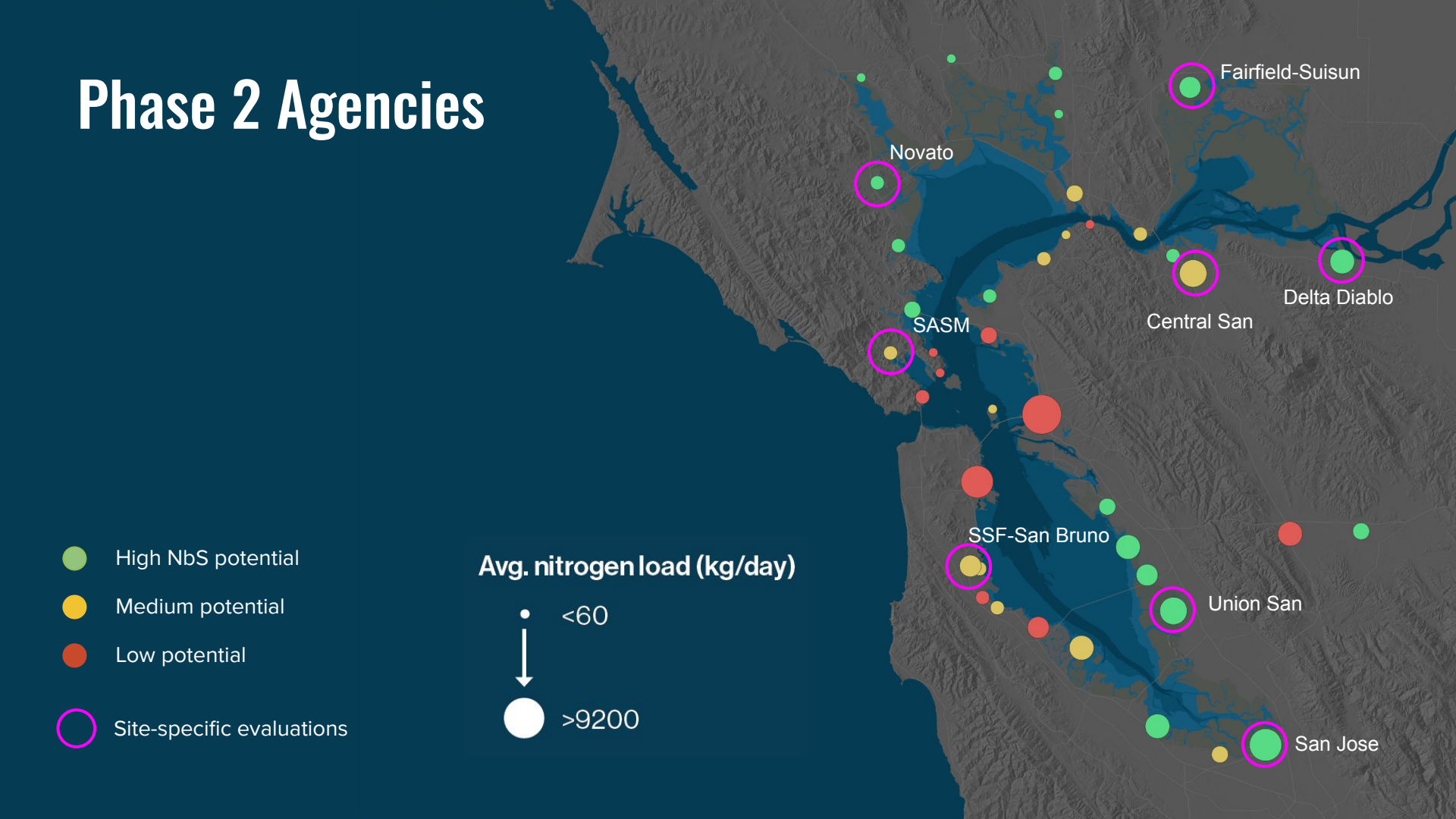
0 0.5 1 mi

0.5 1 km

Phase 2 Site-Specific Evaluations

- Develop site-specific memos for 8 facilities
- Better inform opportunities & constraints
- Identify limitations and agency interest
- Develop conceptual alternatives & graphics for feedback from agencies & key stakeholders
- Use this information to develop planning-level designs & cost estimates for 3 facilities (Phase 3)

Phase 2 Agencies



Phase 2 Opportunities & Constraints

Facilities
Central Contra Costa Sanitary District
Delta Diablo
Fairfield-Suisun Sewer District
Novato Sanitary District
San Jose-Santa Clara
Sewerage Agency of Southern Marin
Union Sanitary District
South San Francisco and San Bruno

Site-specific outreach

Fairfield

Delta Diablo

Figure 5. Infrastructure, recreation, & disadvantaged communities

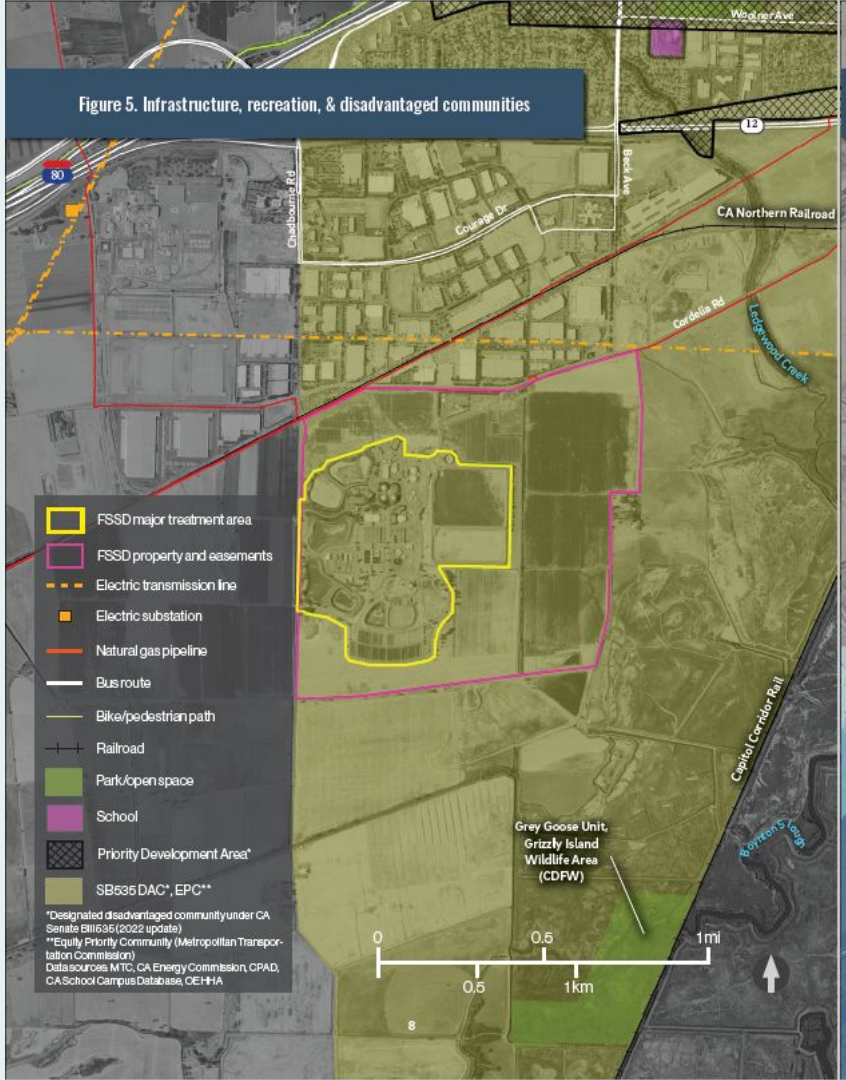
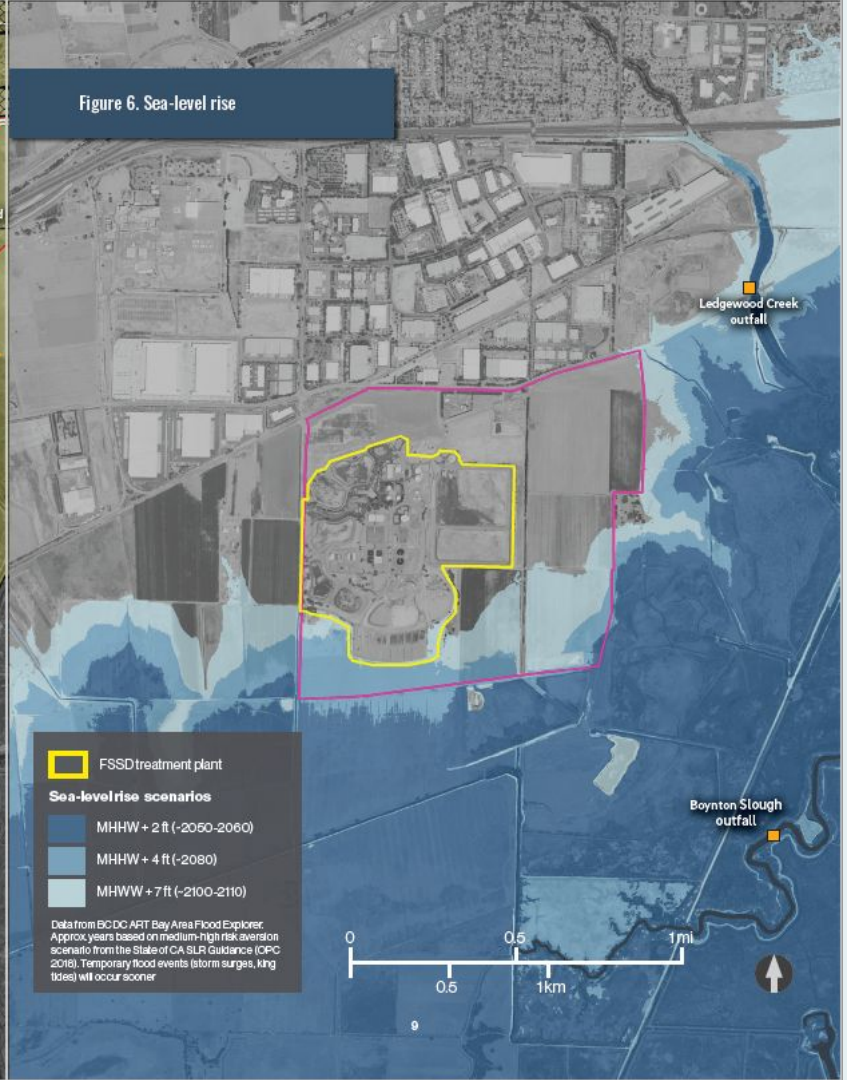


Figure 6. Sea-level rise



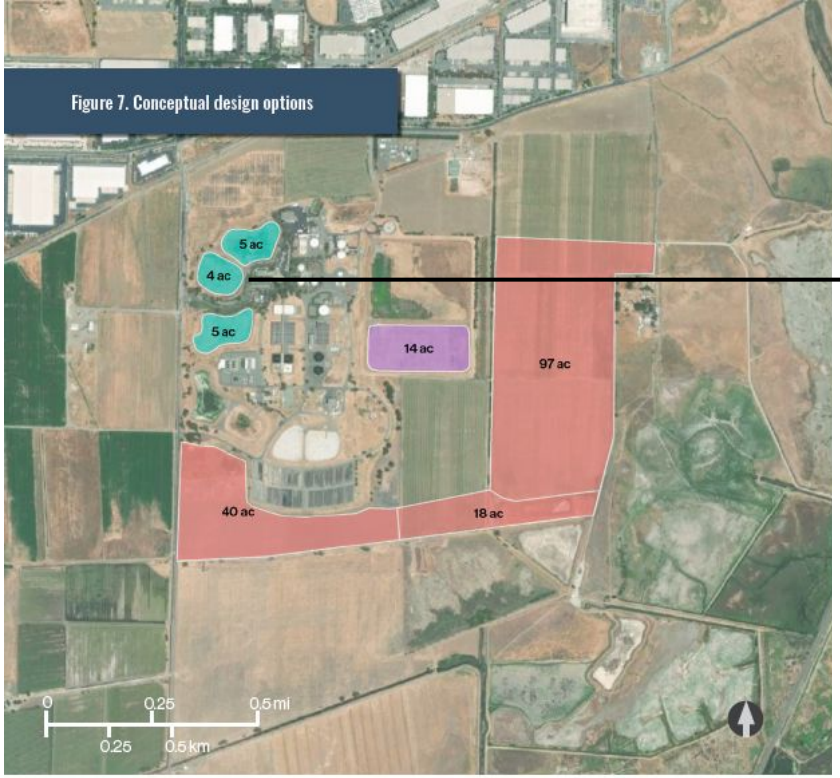
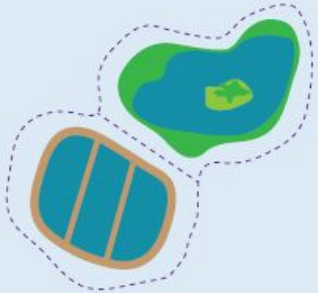


Figure 7. Conceptual design options

- Option 1: Convert former final effluent ponds into train of open water wetlands optimized for various purposes
- Option 2: Dual-purpose wet-weather equalization / open water treatment cell with seepage slope sides
- Option 3: Construct perimeter horizontal levee in phases. Eventually reconnect to restored tidal marsh (Option 4)
- Option 4: Convert the 97-acre parcel to a multi-benefit wastewater polishing wetland. Future phases may include construction of polishing wetlands in the parcels the south of the plant and partnerships with duck clubs to construct temporary freshwater wetlands to build peat (elevation) and prepare for future tidal restoration.

OPTION 1

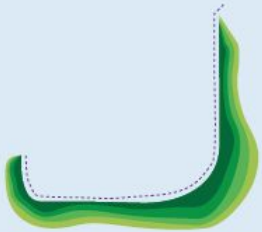
Convert one or more of the effluent holding ponds in the northwest area of the plant to a train of ponds or segmented sections optimized separately for ecological enhancement and nutrient removal. These holding ponds are currently underutilized and could be repurposed to achieve multiple benefits. The train of ponds could provide a valuable recreational opportunity in an underserved area with minimal access to parks. This could include wildlife viewing opportunities as well as educational components including signage describing the design and purpose of each pond. The series could include 1-2 unvegetated ponds optimized for nutrient and contaminants of emerging concern (CEC) removal and 1-2 vegetated ponds optimized for waterbird habitat.



Example concept sketch demonstrating Option 1.
The open water treatment cell on the left is optimized for denitrification - with woodchip seepage slopes and baffles to minimize hydraulic short-circuiting. The pond on the right is a vegetated open water wetland with a habitat island. A trail with educational signage (purple dotted line) surrounds the two ponds.

OPTION 3

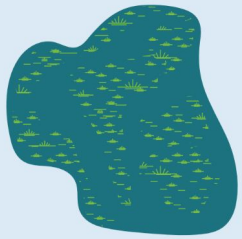
Build a horizontal levee around the treatment plant on the farmed parcels to the south and east. The levee could be developed in phases, with the first phase on the parcels to the east or south of the plant, and later phases completing the ring with a levee on the edge of the southeast parcel. Initially, the purpose of the horizontal levee would be nutrient removal, with additional co-benefits if tidal marsh is restored bayward of the levee. The horizontal levee could be designed to include trails for public access, recreation, and education. Figure 7 shows the parcels where the horizontal levee could be constructed. The actual construction footprint would be smaller than these parcels and can be determined in later design stages. The design would need to be integrated with the design of future flood risk management infrastructure needed to protect the plant.



Example concept sketch demonstrating option 3.
A horizontal levee/seepage slope is located to the south and east of the plant. An option includes adding recreational access at the top of the flood levee behind the seepage slope for public access and educational/wildlife viewing opportunities.

OPTION 4

Convert the 97-acre agricultural parcel to the east of the treatment plant to a treatment wetland for wastewater polishing, education, and possible recreation. Other areas potentially suitable for conversion to freshwater marsh include the 40- and 18-acre parcels south of the plant and nearby duck clubs. Based on management priorities, the area could serve long-term wastewater treatment purposes or be encouraged to build a peat layer to increase land elevation and sea-level rise resilience. As maintenance of perimeter dikes becomes more challenging with sea-level rise, strategic breaches may connect the area to tidal influence via Suisun Marsh sloughs. Eventually, the marsh could migrate upland toward a horizontal levee, if incorporated with Option 3, and freshwater flowing through the horizontal levee could be discharged in a diffuse manner to the tidal marsh. This option would enhance the connectivity of the landscape to Suisun Marsh and increase the resilience of the wastewater plant and surrounding lands to sea-level rise.



Example concept sketch demonstrating option 4.
Treated wastewater is used to create a temporary freshwater wetland to build up organic matter for increasing elevation and resilience to sea-level rise.

Table 1. Comparison of each option's relative contribution to achieving goals of NbS implementation.

●= Achieves. ◑ = Partially achieves. ○= Does not achieve.

For TIN removal, 'Achieves' is>30% removal, 'Partially achieves' is 5-20% removal, and "Does not achieve is <5% removal.

	Option 1. Convert former final effluent ponds into train of wetlands optimized for various purposes (14-ac total)[1]	**Option 2.** Dual purpose wet weather equalization / open water treatment cell with seepage slope sides (155-ac total)	**Option 3.** 2.4-km horizontal levee along the interior portions of the three potential freshwater wetland cells[2]	**Option 4.** Convert the 97-acre parcel to a multi-benefit wastewater polishing wetland
Goal 1: Reduces nutrient loads to the Bay and improves overall water quality.				
Reduces TIN *Estimated dry-season reduction (kg d-1 / % reduction of daily TIN load)*	● *100 kg d-1 / 10%*	● *1,200 kg d-1 potential / 100%*	◑ *310 kg d-1 / 30%*	● *730 kg d-1 / 70%*
Reduces CECs	●	●	●	●
Goal 2: Reduces flood risk for the plant and/or associated infrastructure.				
Attenuates waves and provides erosion resistance	○	○	●	●
Facilitates marsh accretion	○	○	○	●
Goal 3: Create and/or enhance habitat				
Provides marsh-upland transition zone habitat and marsh migration space	○	○	●	○
Provides high tide refuge habitat for wildlife	○	○	●	○
Increases habitat complexity	●	◑	●	●
Provides freshwater pond/marsh habitat	●	◑	●	●
Goal 4: Enhances recreational opportunities.				
Provides opportunity for public trails and wildlife viewing	●	○	●	●
Goal 5: Provides additional co-benefits.				
Reduces use of potable water for irrigation	○	○	○	○
Supports goals of partner organizations (e.g. facilitates neighboring restoration projects)	N/A	N/A	N/A	N/A

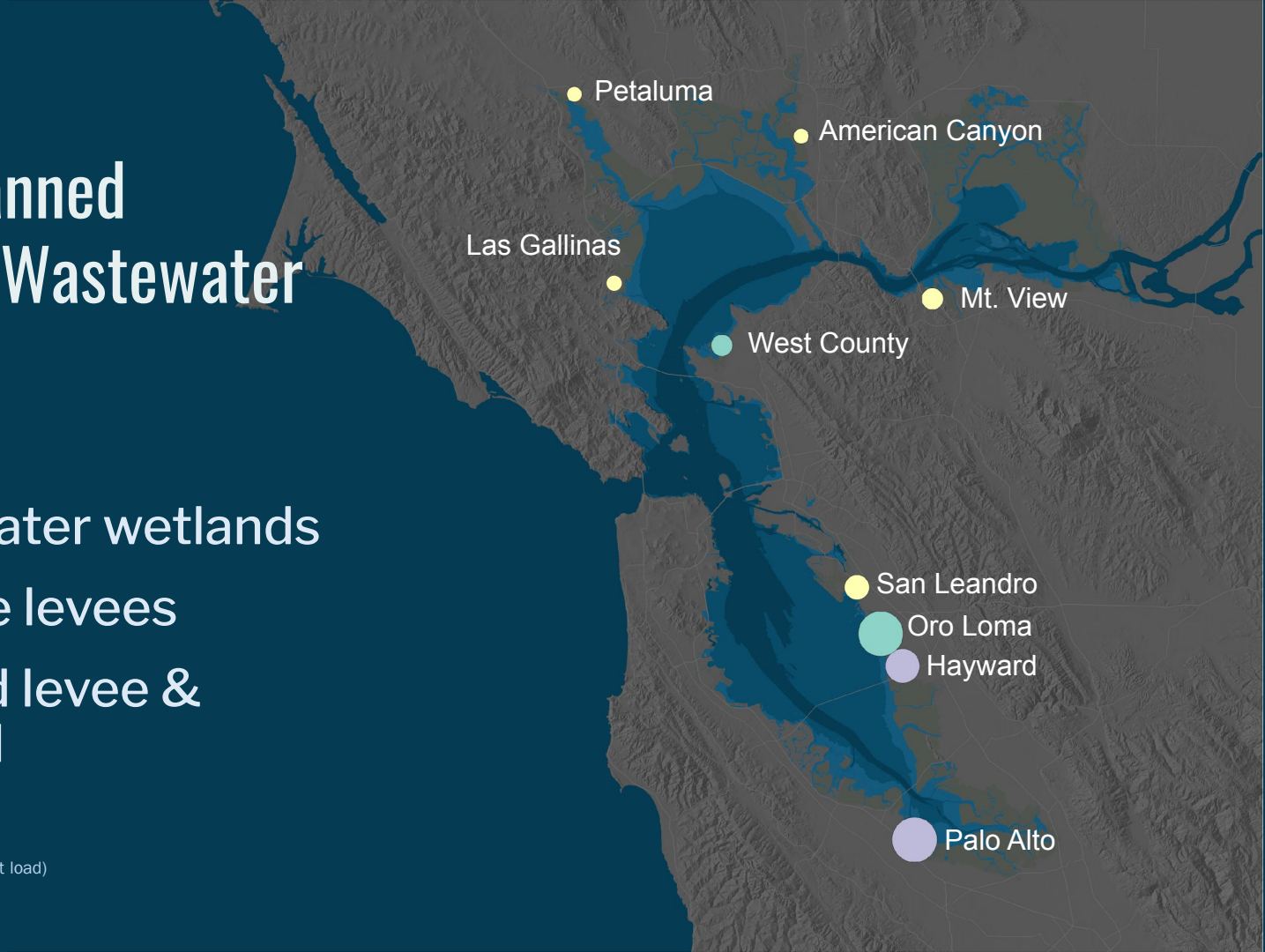
Phase 3 Cost Estimates & Concept Designs

Facility
Delta Diablo
Fairfield-Suisun Sewer District
San Jose-Santa Clara

Existing or Planned Nature-based Wastewater Treatment

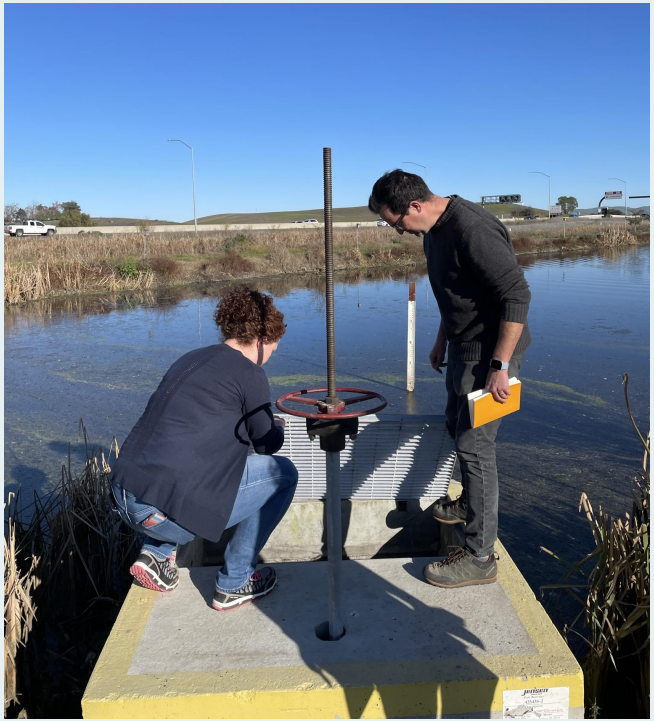
- Open water wetlands
- Ecotone levees
- Planned levee & wetland

(circles scaled to nutrient load)



Status Update: Case Studies of Existing NbS Projects

Facility
Union San (Hayward Marsh)
Petaluma
Las Gallinas
Mt. View (Moorhen Marsh)
Oro Loma (Horizontal levee)



Moorhen Marsh, Mt. View Sanitary District

Next steps

- Continuing engagement with facilities not selected for detailed study in previous project through EPA-funded project
- Pursuing design & implementation funding for FSSD (and hopefully additional facilities)
- Producing additional deliverables, including case studies

THANK YOU

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