NATURE-BASED SOLUTIONS FOR NUTRIENT MANAGEMENT

BACWA Annual Meeting // August 18, 2020

BACWA BAY AREA CLEAN WATER AGENCIES

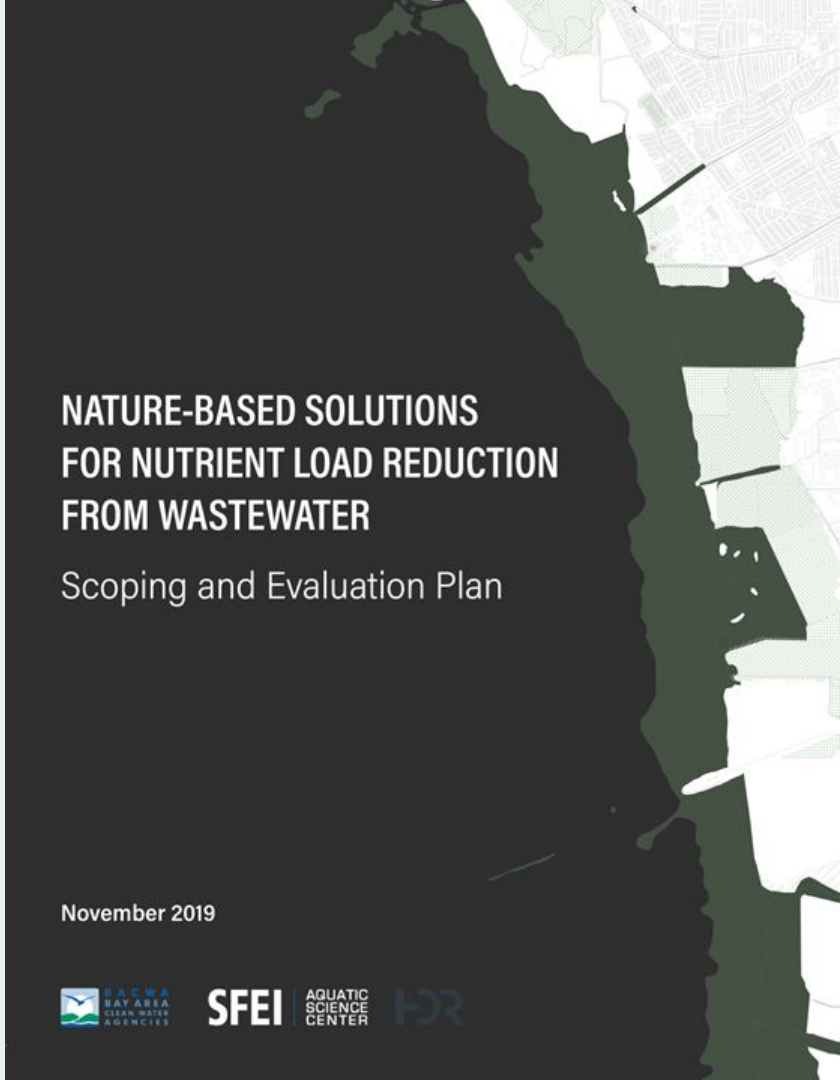
SFEI AQUATIC SCIENCE CENTER

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

Project Elements

1. Data Collection & Screening (In progress)
2. Site Specific Evaluation (2021-2022)
3. Barriers & Coordination (on-going)



Current Status

1. Scoping & Evaluation Plan complete
2. Preparing for submission of 2nd main deliverable in Dec 2020 to quantify areas of potential suitability for each POTW
    a. Survey
    b. Desktop Analysis
    c. Facility-Specific Factsheets & Report

What are Nature-based Solutions?

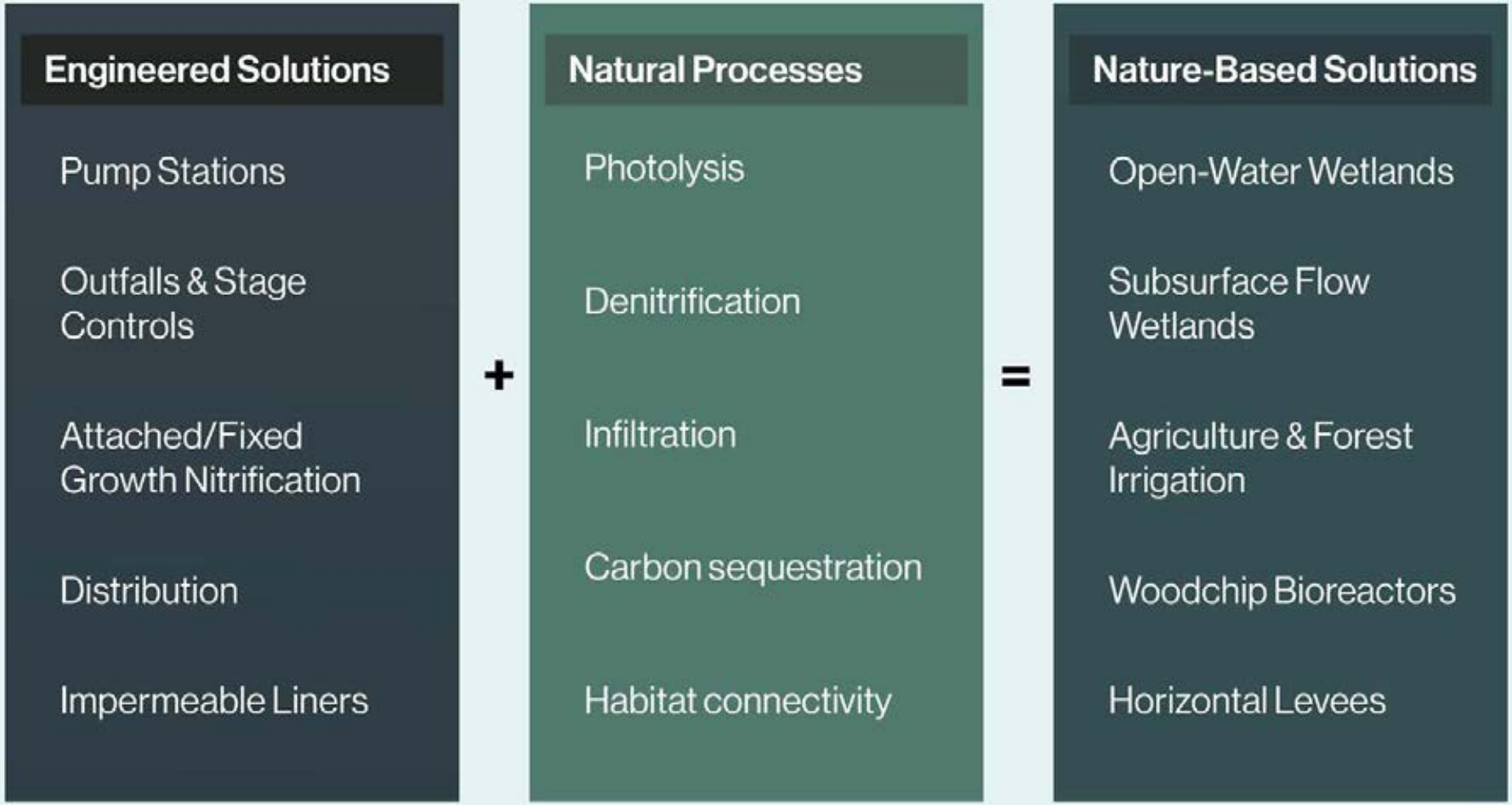
“actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."

IUCN, 2016

What are Nature-based Solutions?

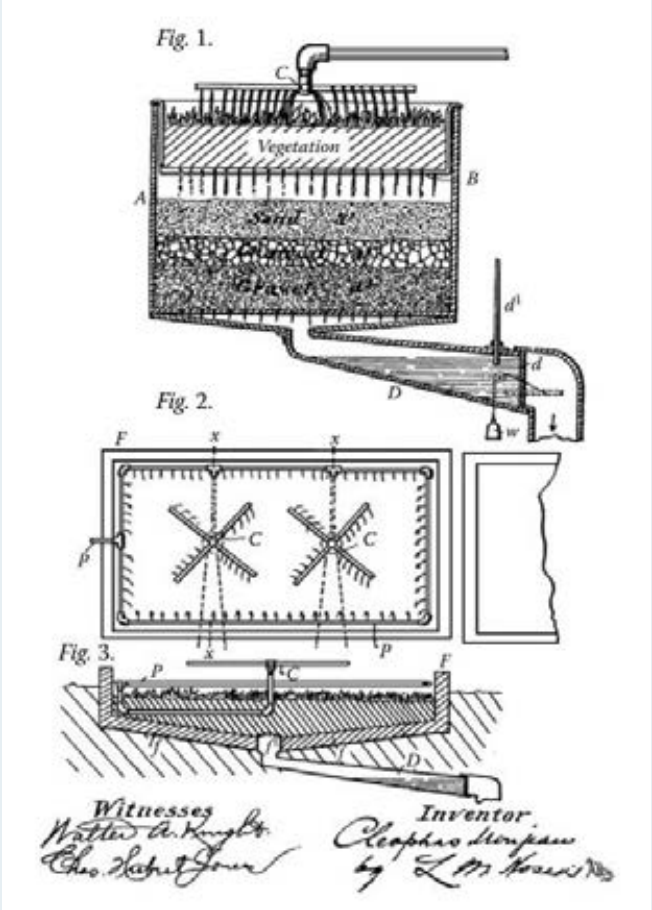
“Nature-based solutions beneficially exploit natural processes providing stand-alone solutions or hybrid approaches integrated with technology-based or engineered solutions to foster urban resilience and sustainability."

Frantzeskaki et. al., 2019


Engineered Solutions
Pump Stations
Outfalls & Stage Controls
Attached/Fixed Growth Nitrification
Distribution
Impermeable Liners
+
Natural Processes
Photolysis
Denitrification
Infiltration
Carbon sequestration
Habitat connectivity
=
Nature-Based Solutions
Open-Water Wetlands
Subsurface Flow Wetlands
Agriculture & Forest Irrigation
Woodchip Bioreactors
Horizontal Levees

Back to the Future

Wastewater treatment evolved from natural systems and is constantly iterating



1901 U.S. patent for a treatment wetland system. (From U.S. Patent 681,884.) Courtesy Kadlec and Wallace 2009.

Unit-Cell Open Water Wetlands

Photo: David Sedlak

Horizontal levees

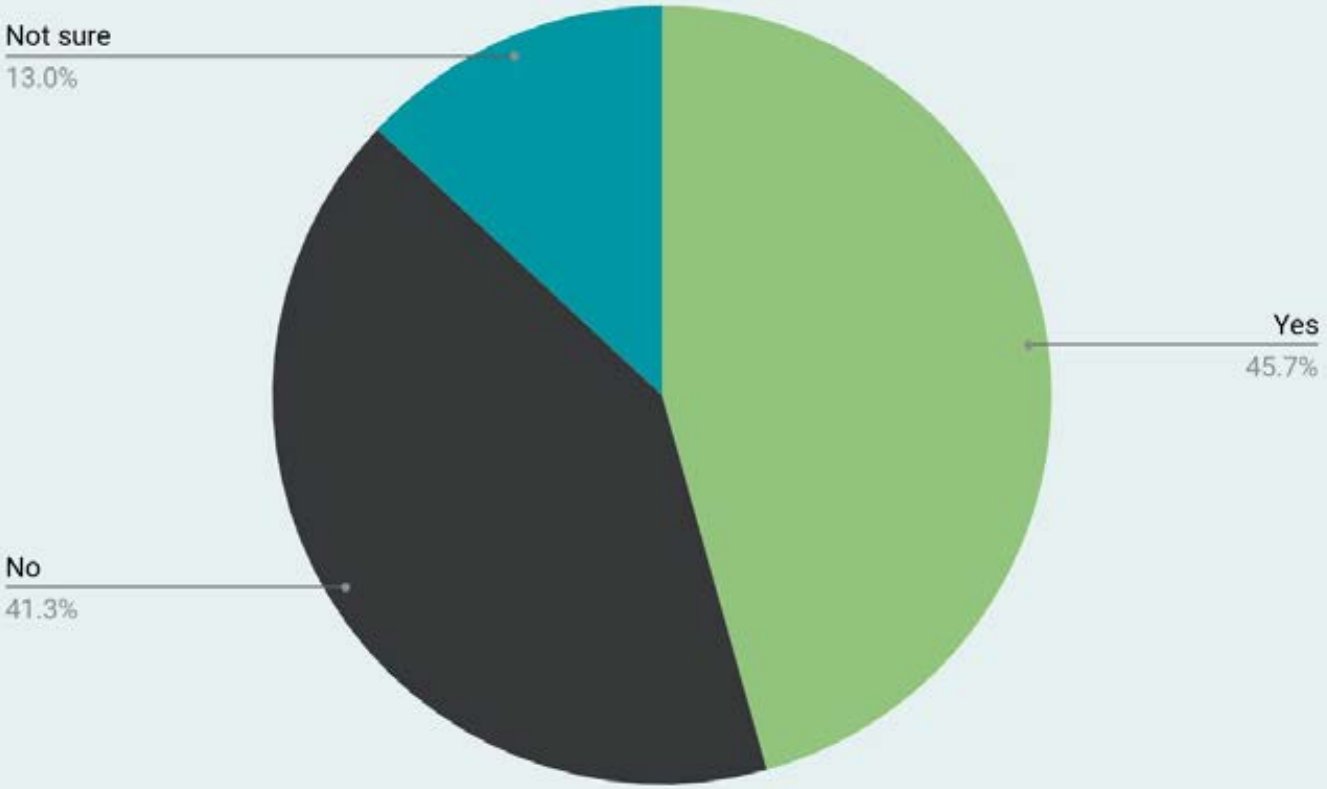
Oro Loma horizontal levee. Photo: SFEP

Nutrient Watershed Permittee Survey

- Joint request for information from HDR (recycled water) and SFEI (NbS)
- Complete responses to the web-based NbS survey from 35 of 37 permittees
- Results will inform selection of facilities for site-specific investigation

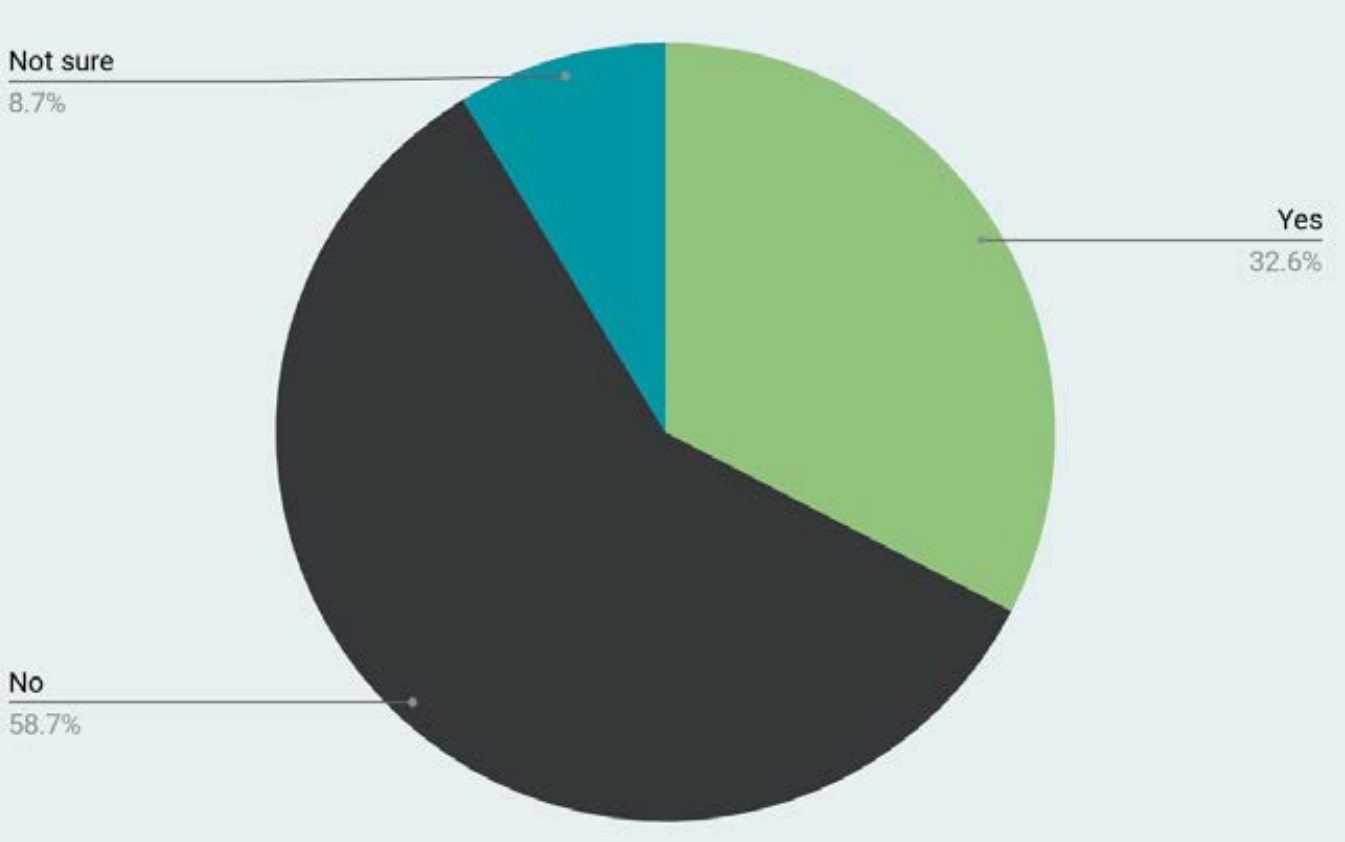
Survey

Has your agency considered nature-based solutions for wastewater treatment/ disposal?



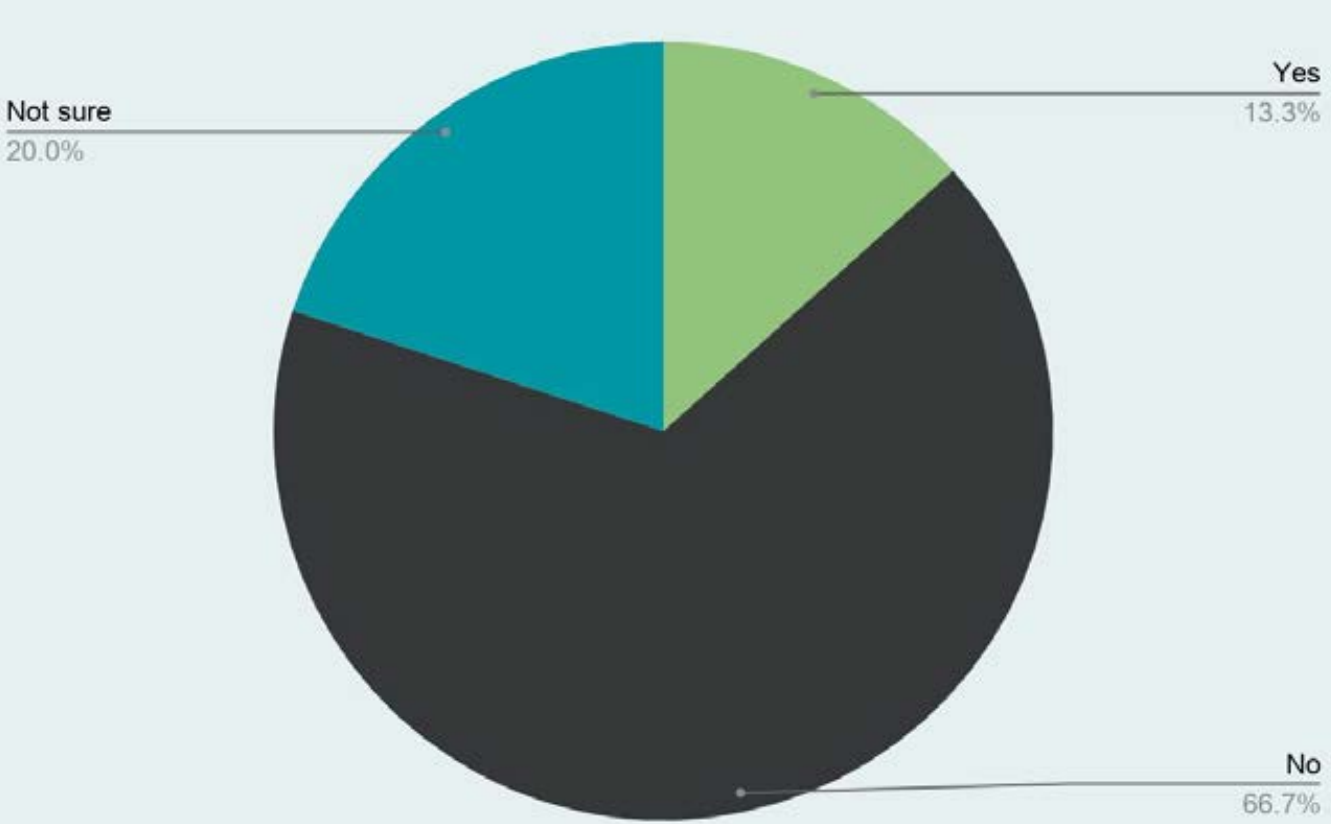
Survey

Has your agency prepared any reports related to the planning or evaluation of NbS for wastewater treatment?



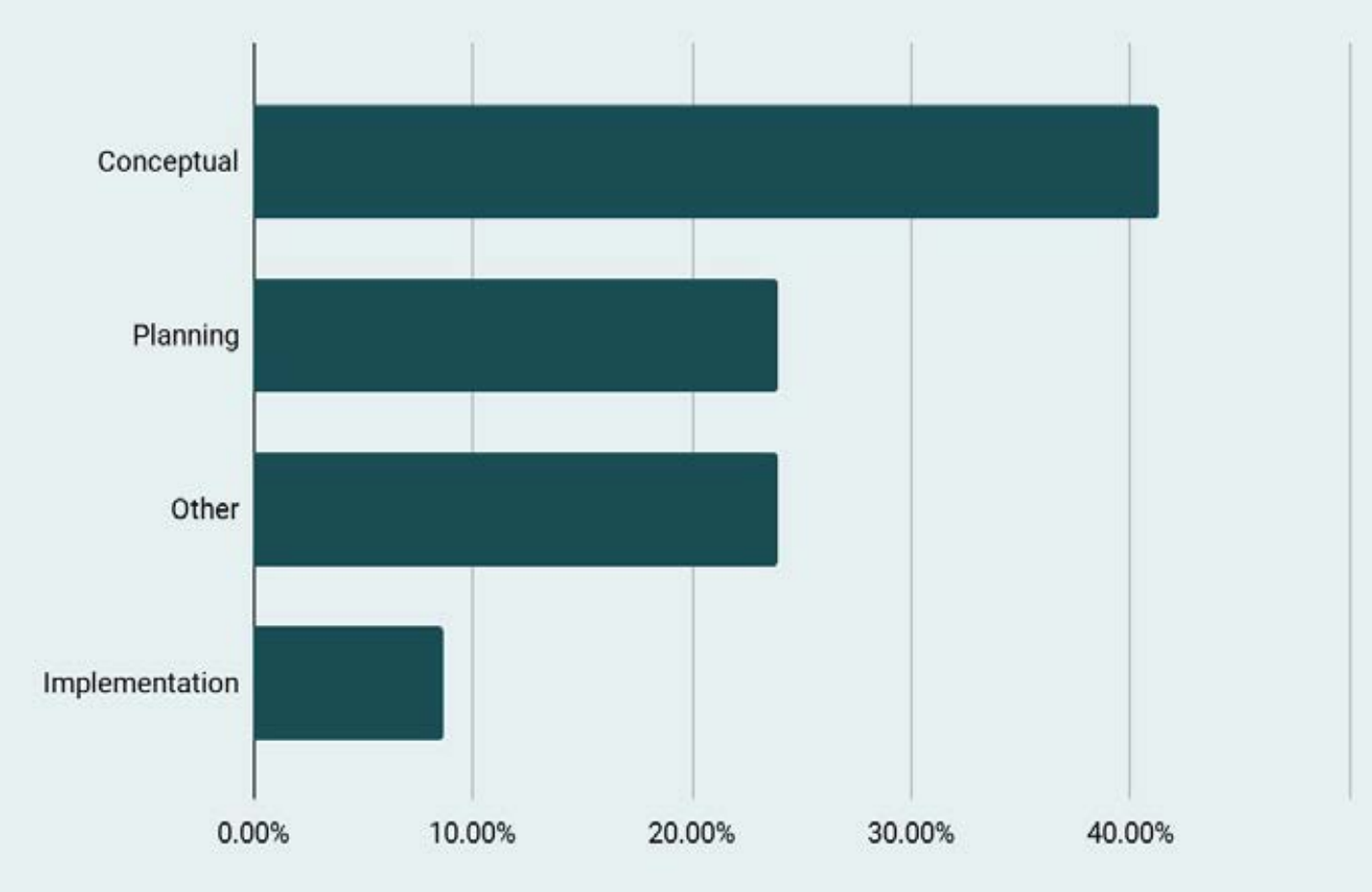
Survey

Do your capital improvement plans consider or plan for implementation of NbS for wastewater treatment or other purposes?



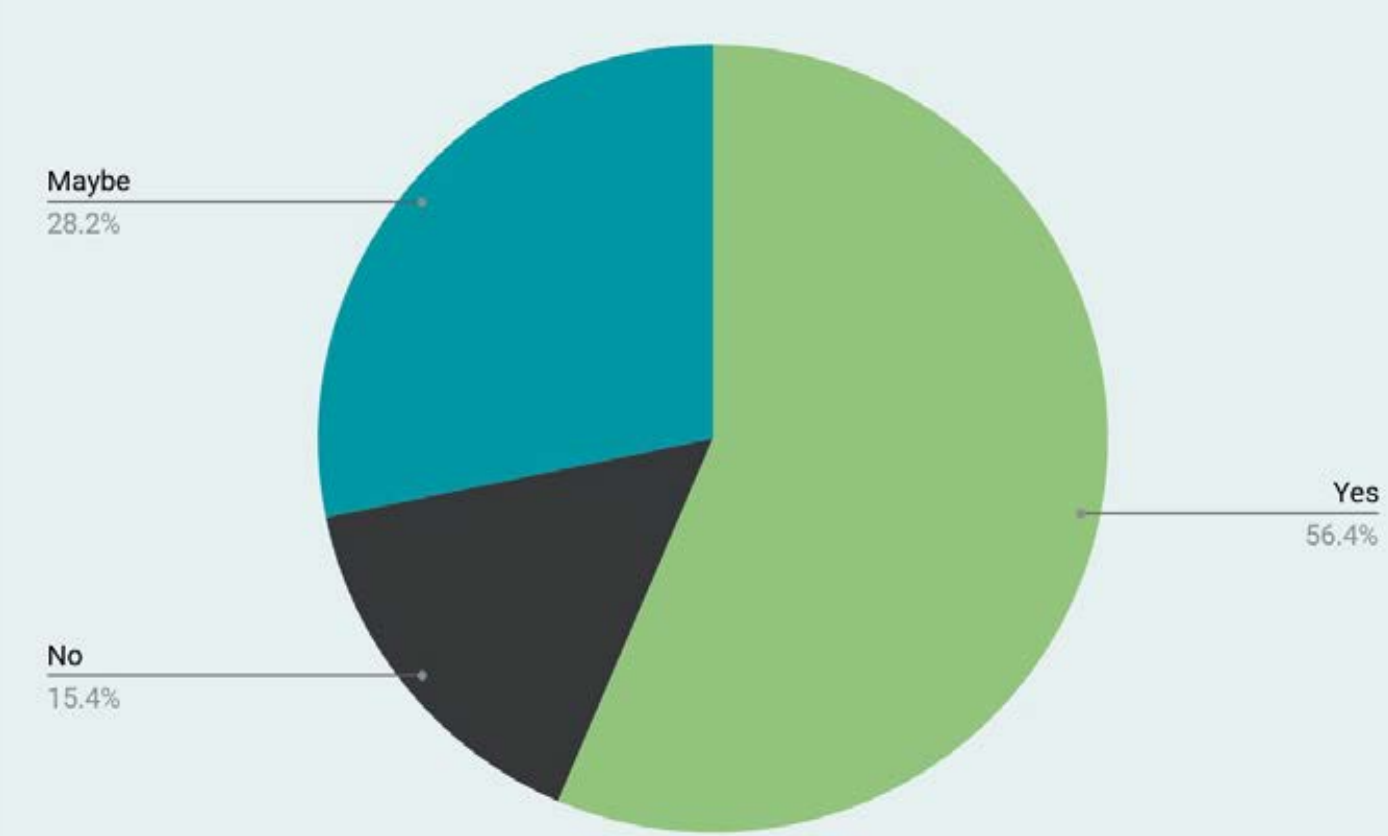
Survey

Describe the level of planning/ implementation performed to date.



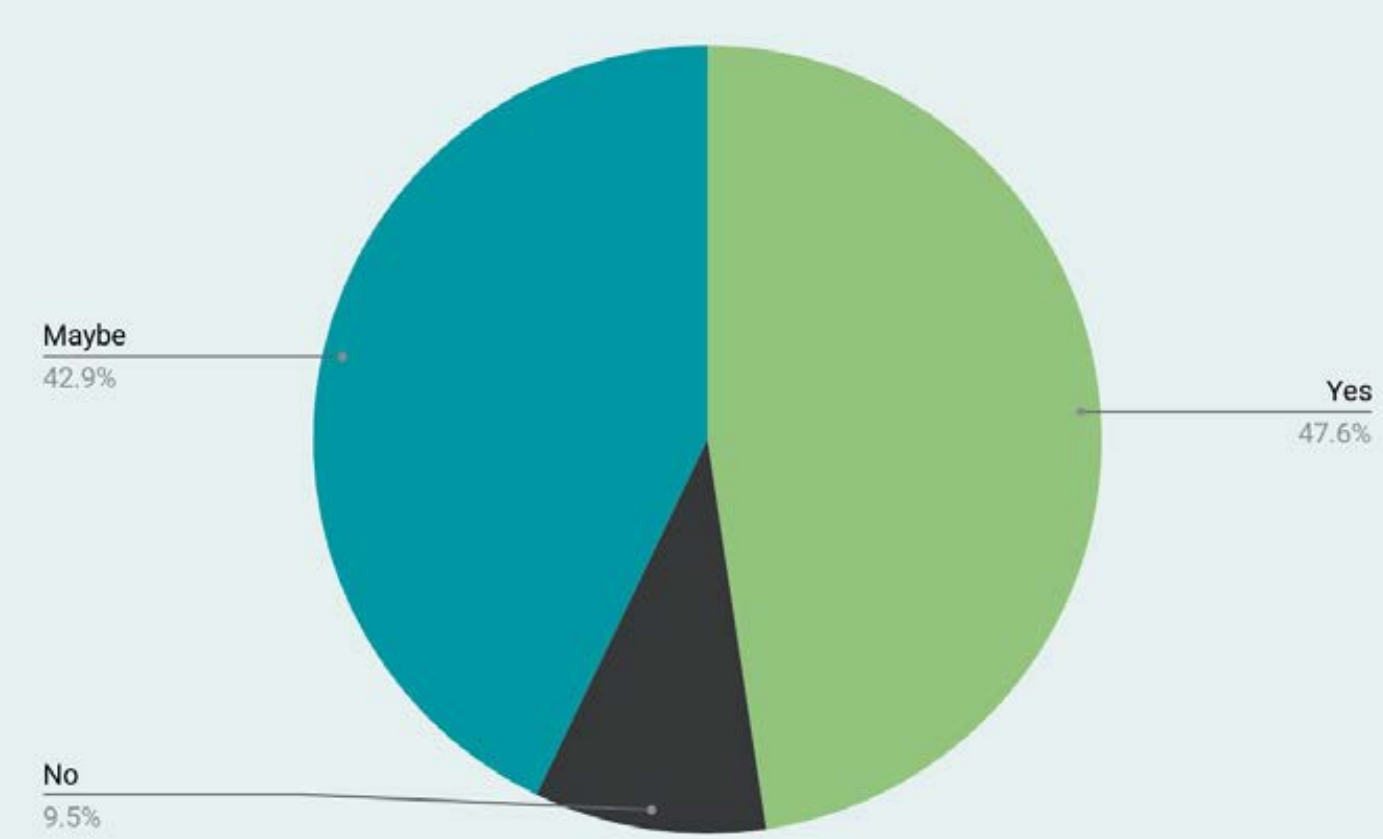
Survey

Is your agency interested in potentially participating in the alternatives development process?



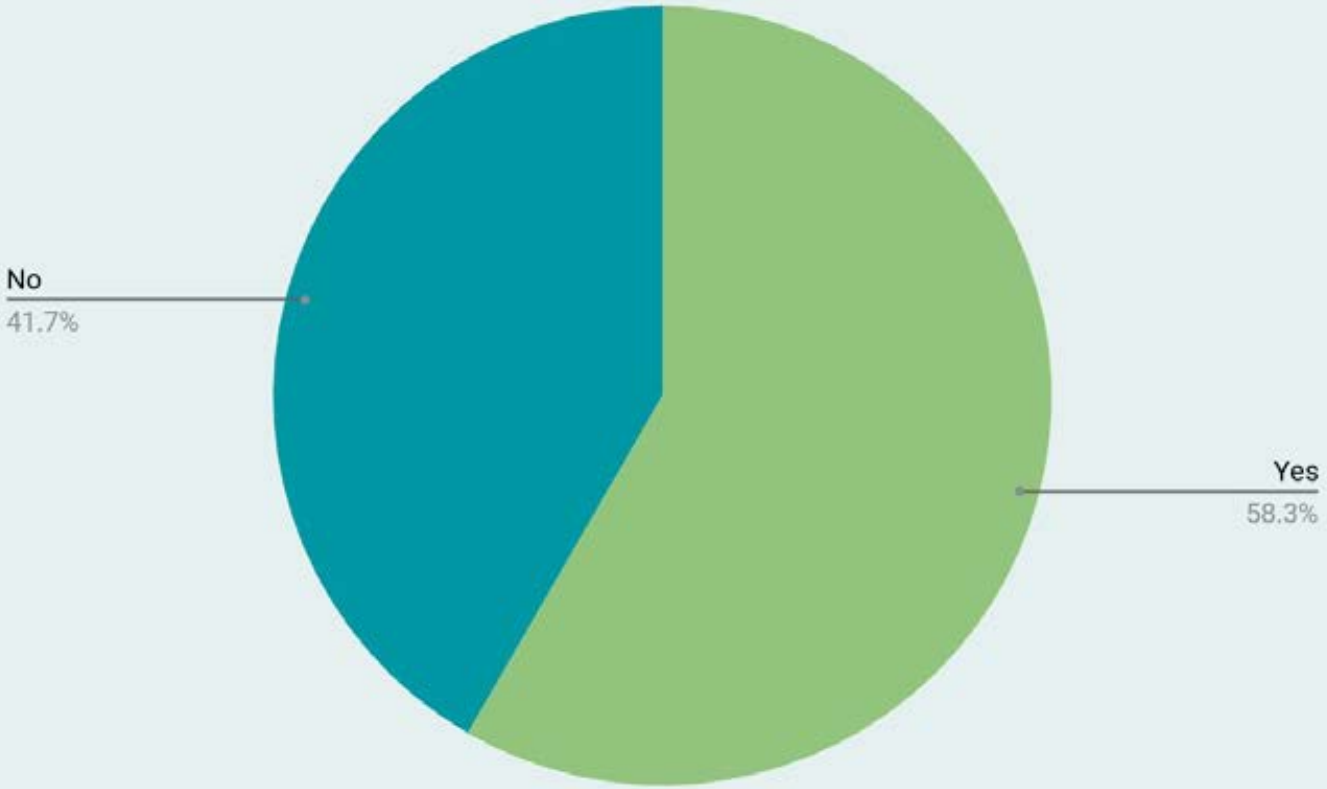
Survey

Is your agency interested in exploring partnerships with other agencies and landowners?



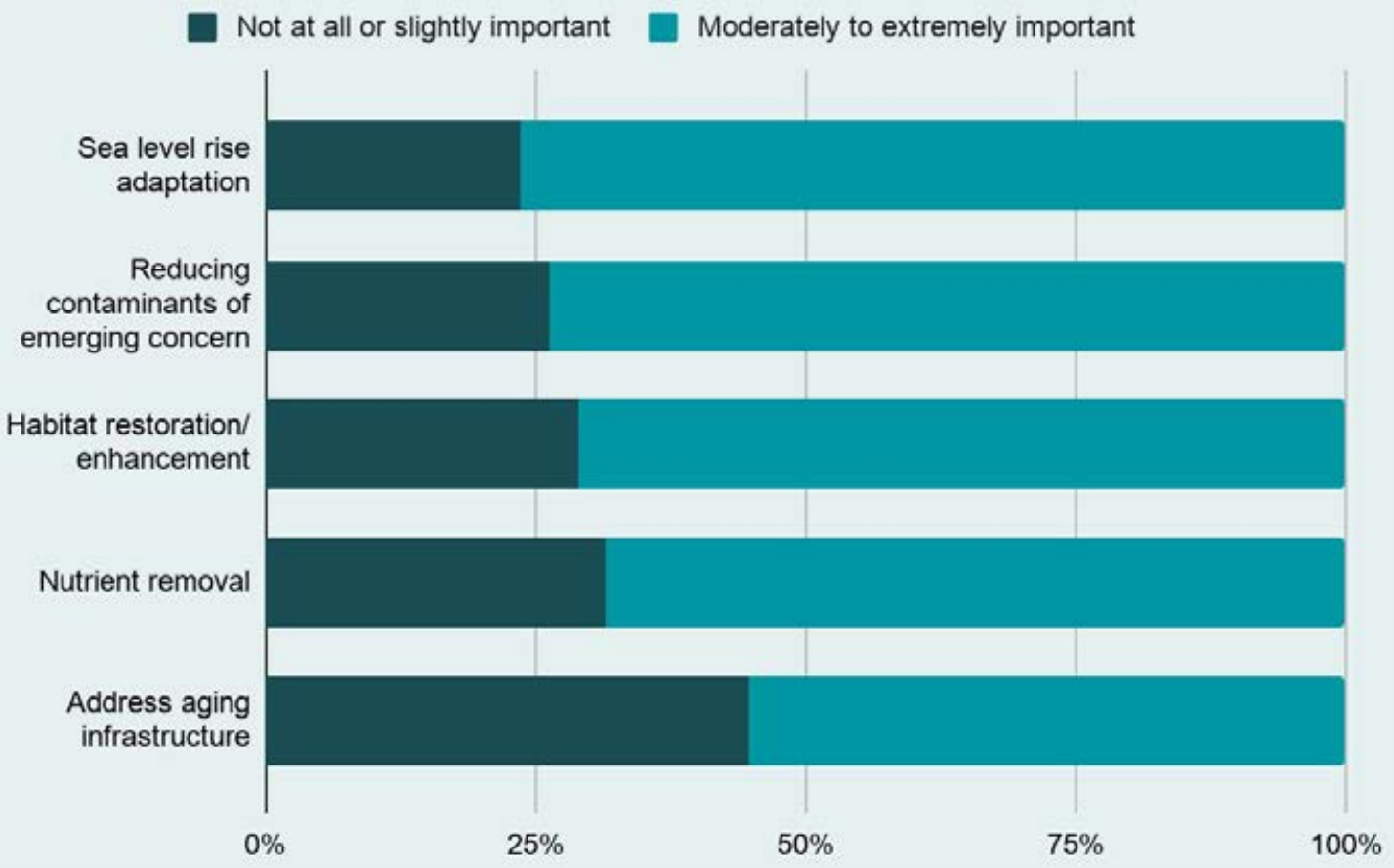
Survey

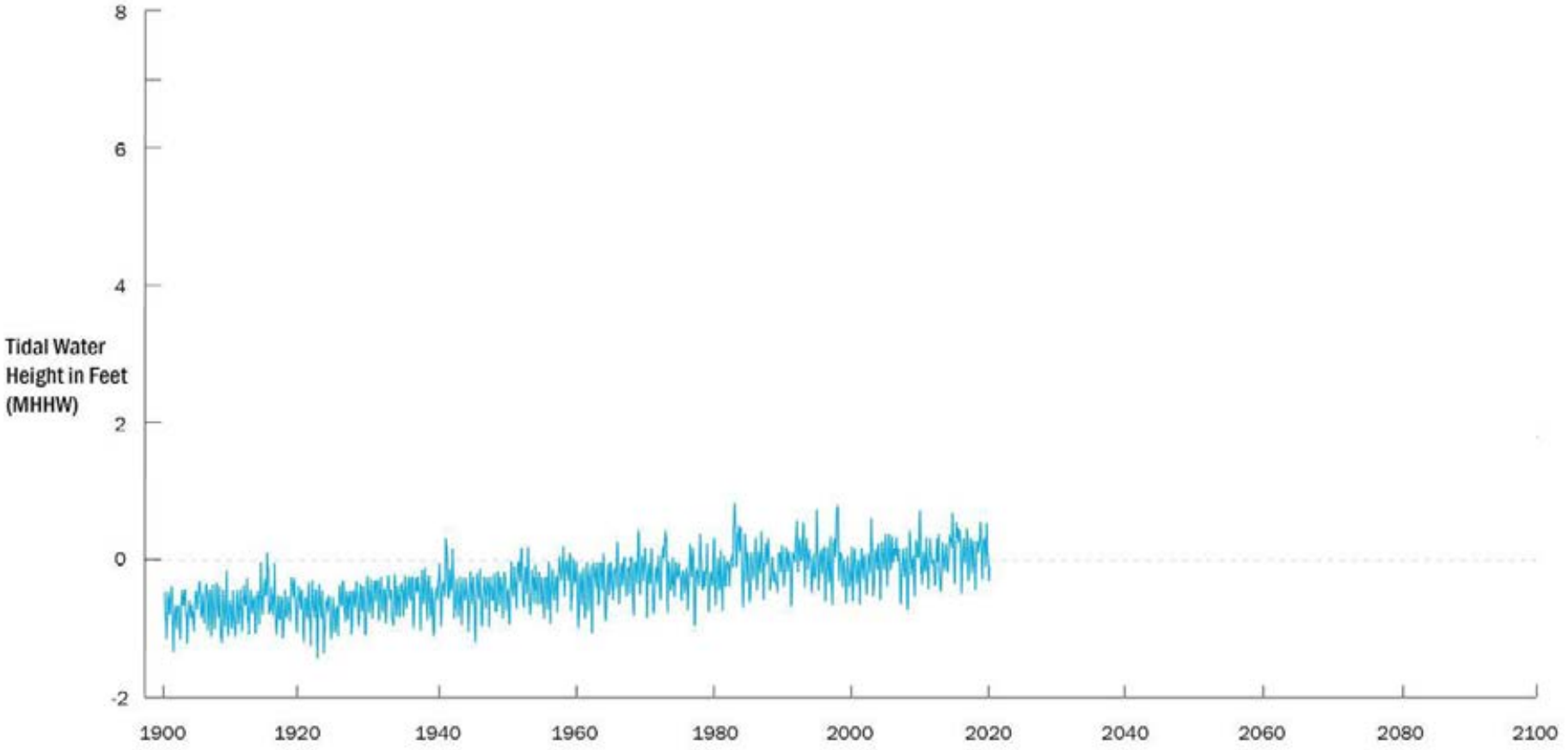
Are you able to identify potentially suitable sites for NbS within your service area or nearby areas?



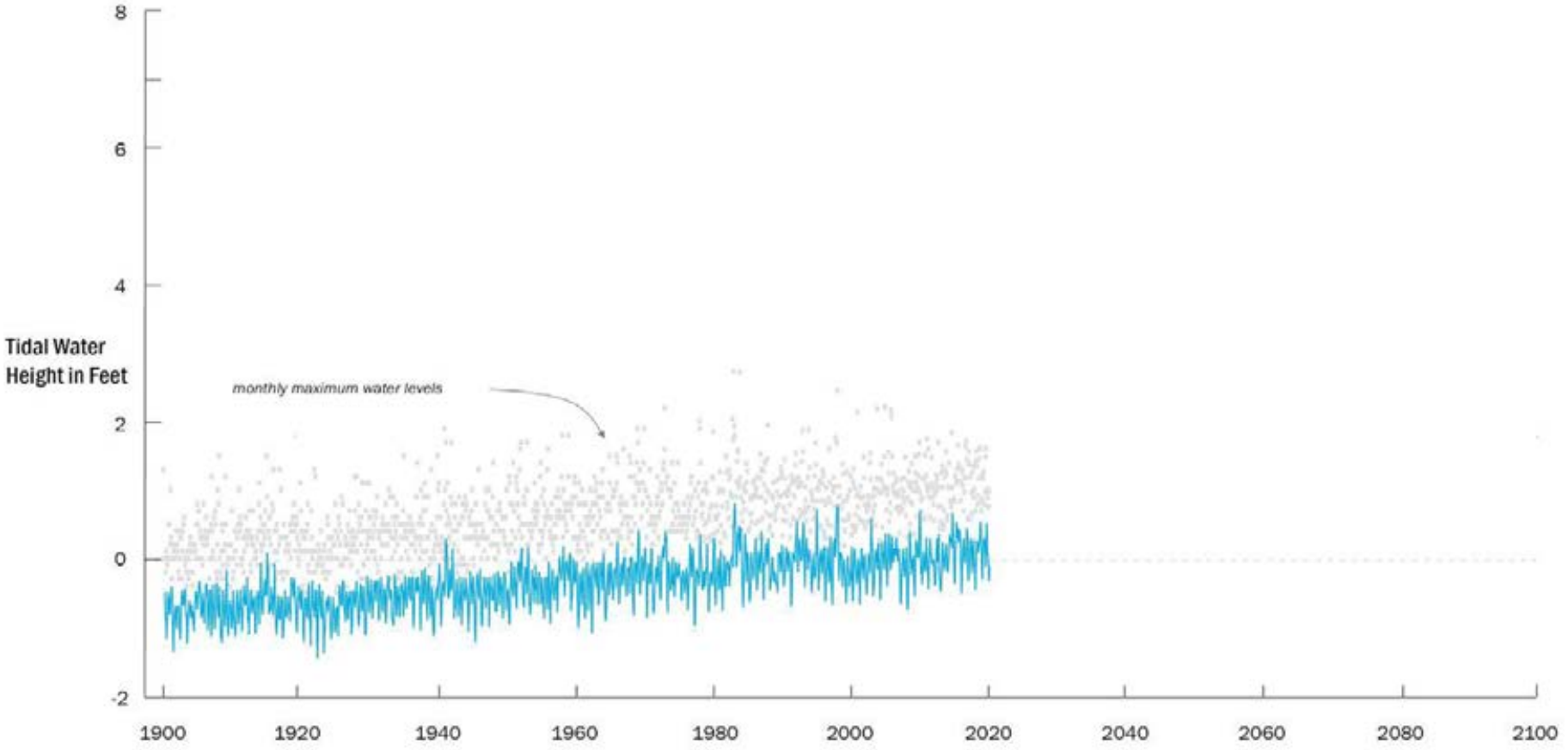
Survey

Rate your agency's interest in pursuing NbS according to the following objectives:





Source: NOAA, BCDC 2020 & OPC 2018



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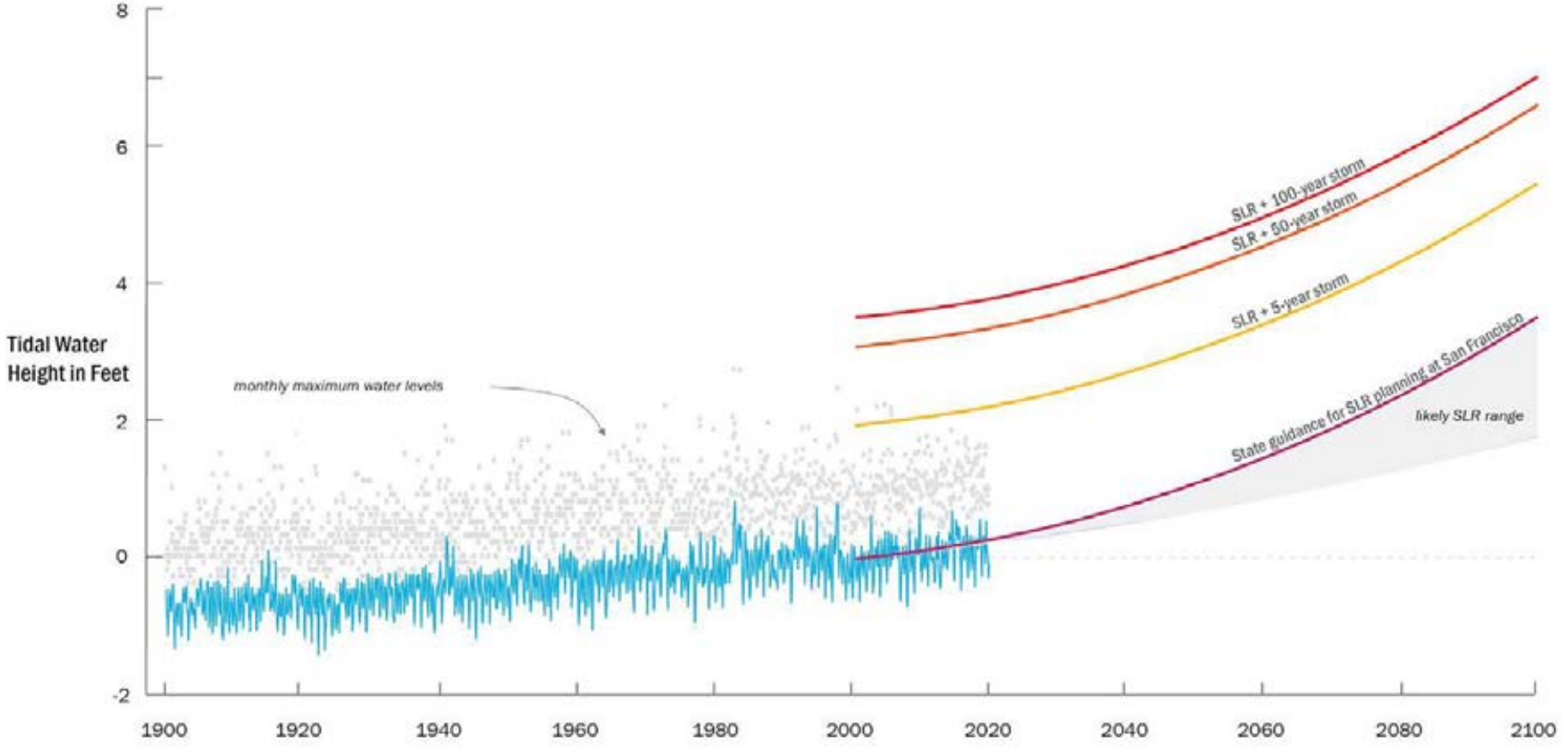
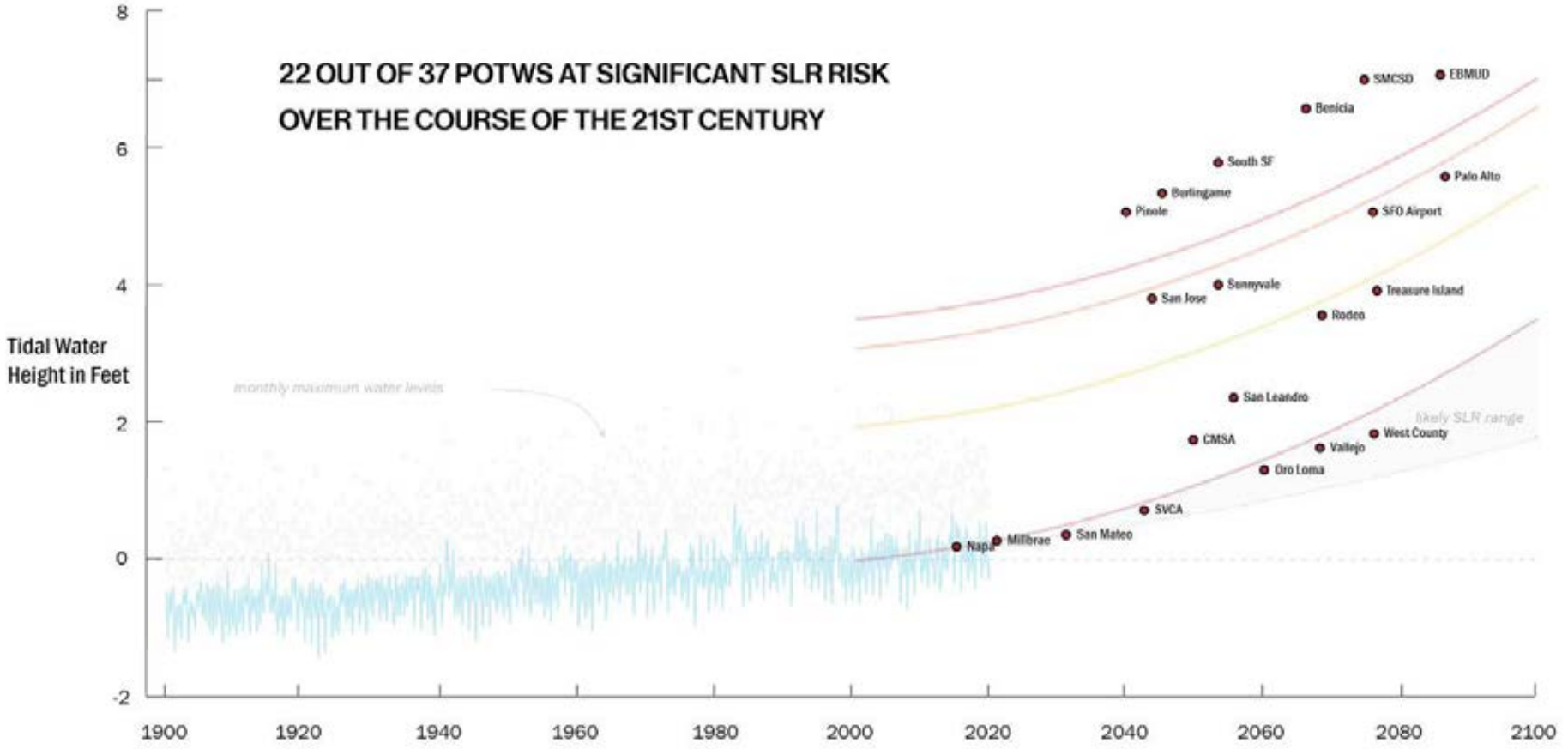


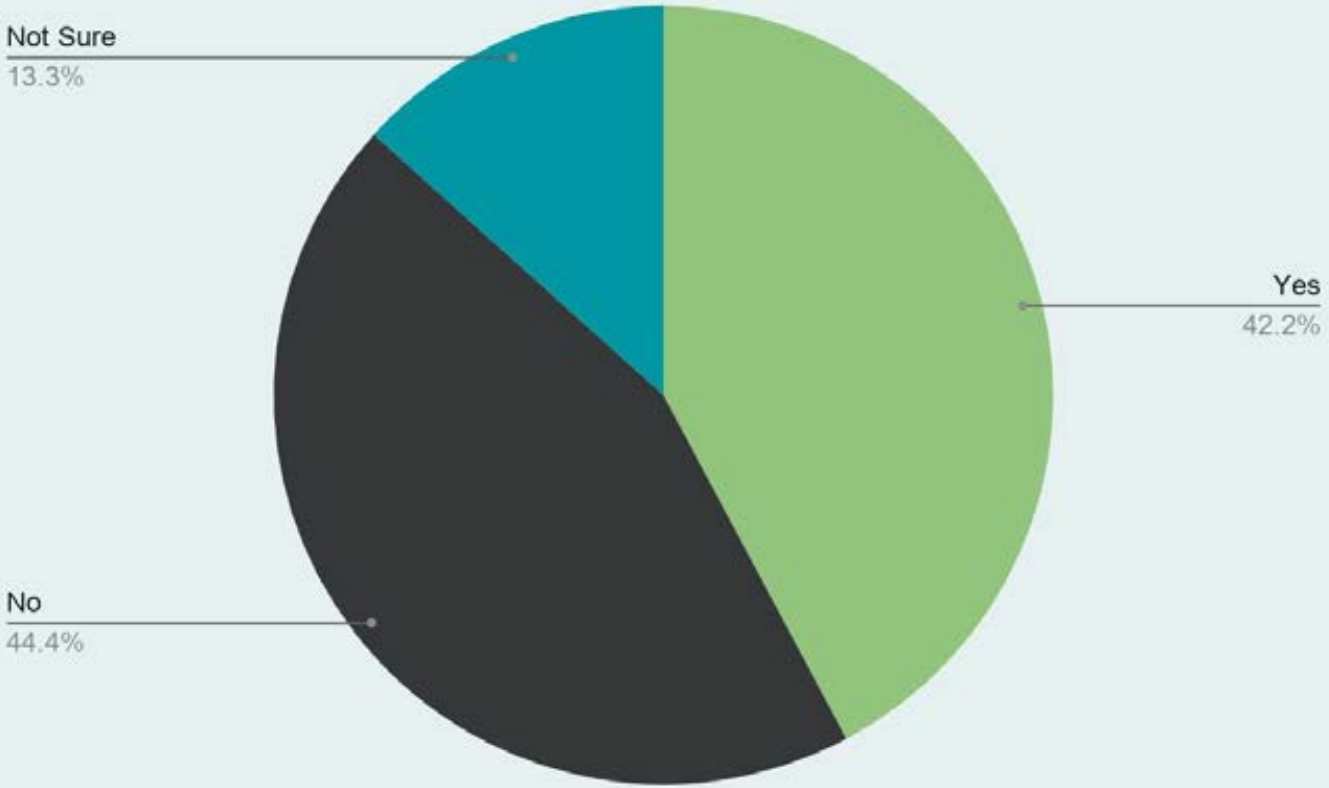
Source: NOAA, BCDC 2020 & OPC 2018



Source: NOAA, BCDC 2020 & OPC 2018

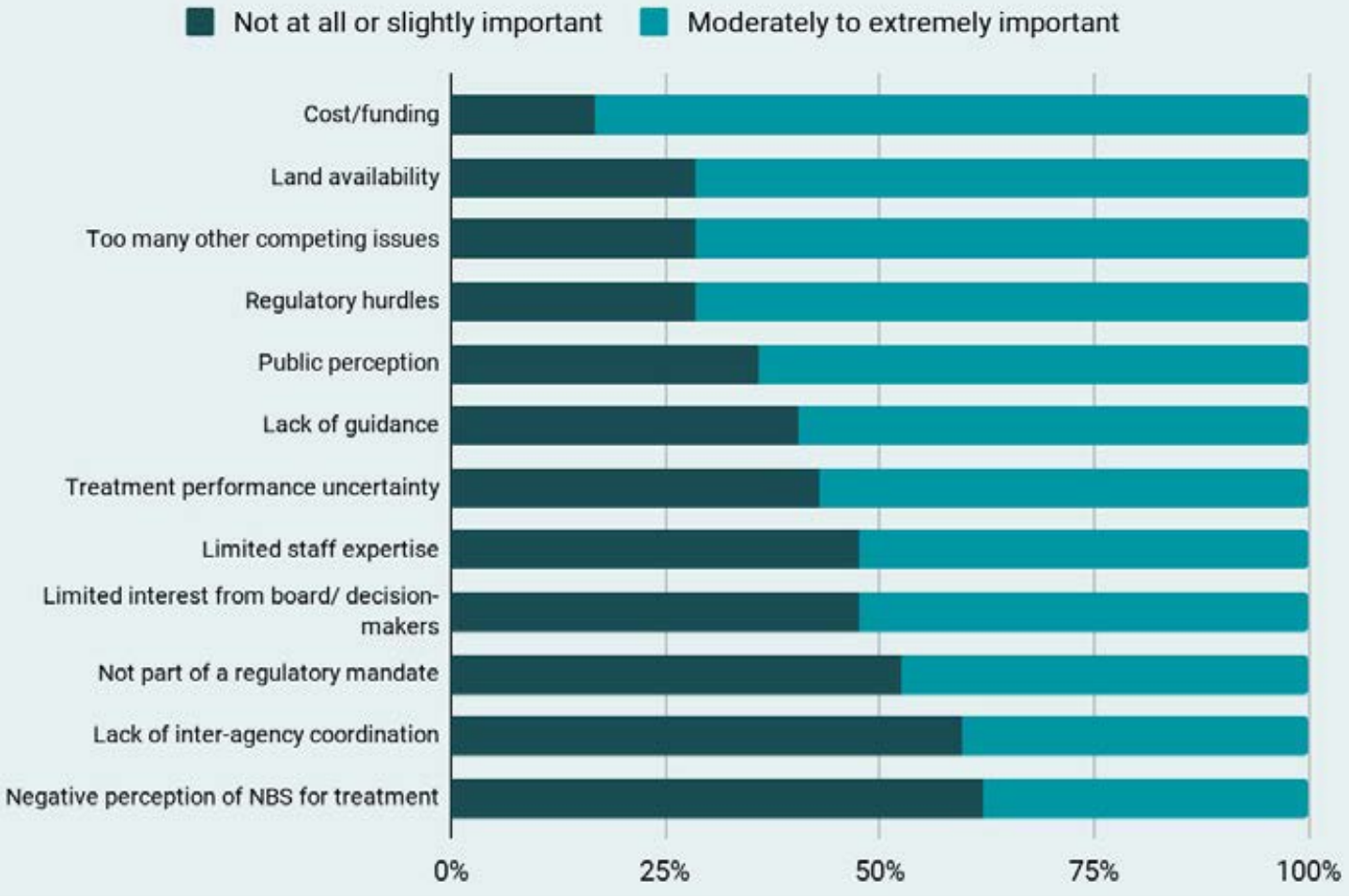
Survey

Has your agency prepared any reports related to sea-level rise assessment or adaptation?



Survey

Rate the following factors, in terms of preventing or constraining your agency's adoption of NbS for wastewater treatment:



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Research article

A mixed-methods approach to strategic planning for multi-benefit regional water infrastructure

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[b] Eawag: Swiss Federal Institute of Aquatic Science and Technology, Switzerland
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Nutrient management
Wastewater treatment
Stakeholder analysis

ABSTRACT

Finding regional solutions for water infrastructure and other environmental management challenges requires coordination, communication, and a shared understanding among different stakeholders. To develop a more versatile and collaborative decision-making process for nutrient management in the San Francisco Bay Area, we used a mixed-methods approach consisting of stakeholder analysis with cluster analysis, multi-criteria decision analysis (MCDA), and scenario planning. These methods allowed us to identify agreements and disagreements in stakeholder objectives and preferences, clarify ways in which different options could meet the goals of diverse stakeholders, and elucidate how scientific uncertainty about technical performance and future conditions could affect management strategies. Results of the analysis indicate that several non-conventional nutrient management options like constructed wetlands and increased water recycling for irrigation met the goals of many stakeholders under a variety of future scenarios. A comparison of MCDA results with a more traditional 'cost-efficiency' measure (i.e., optimizing for the lowest cost per mass of nutrients removed) revealed little correlation

water

MDPI

Article

Towards a New Paradigm of Urban Water Infrastructure: Identifying Goals and Strategies to Support Multi-Benefit Municipal Wastewater Treatment

Sasha Harris-Lovett [1,2,*], Judit Lienert [3] and David L. Sedlak [2,4]

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2 Engineering Research Center for Reinventing the Nation's Urban Water Infrastructure (ReNUWIt), Berkeley, CA 94720, USA; sedlak@berkeley.edu
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Abstract: Over the past decade, water professionals have begun to focus on a new paradigm for urban water systems, which entails the recovery of resources from wastewater, the integration of engineered and natural systems, and coordination among agencies managing different facets of

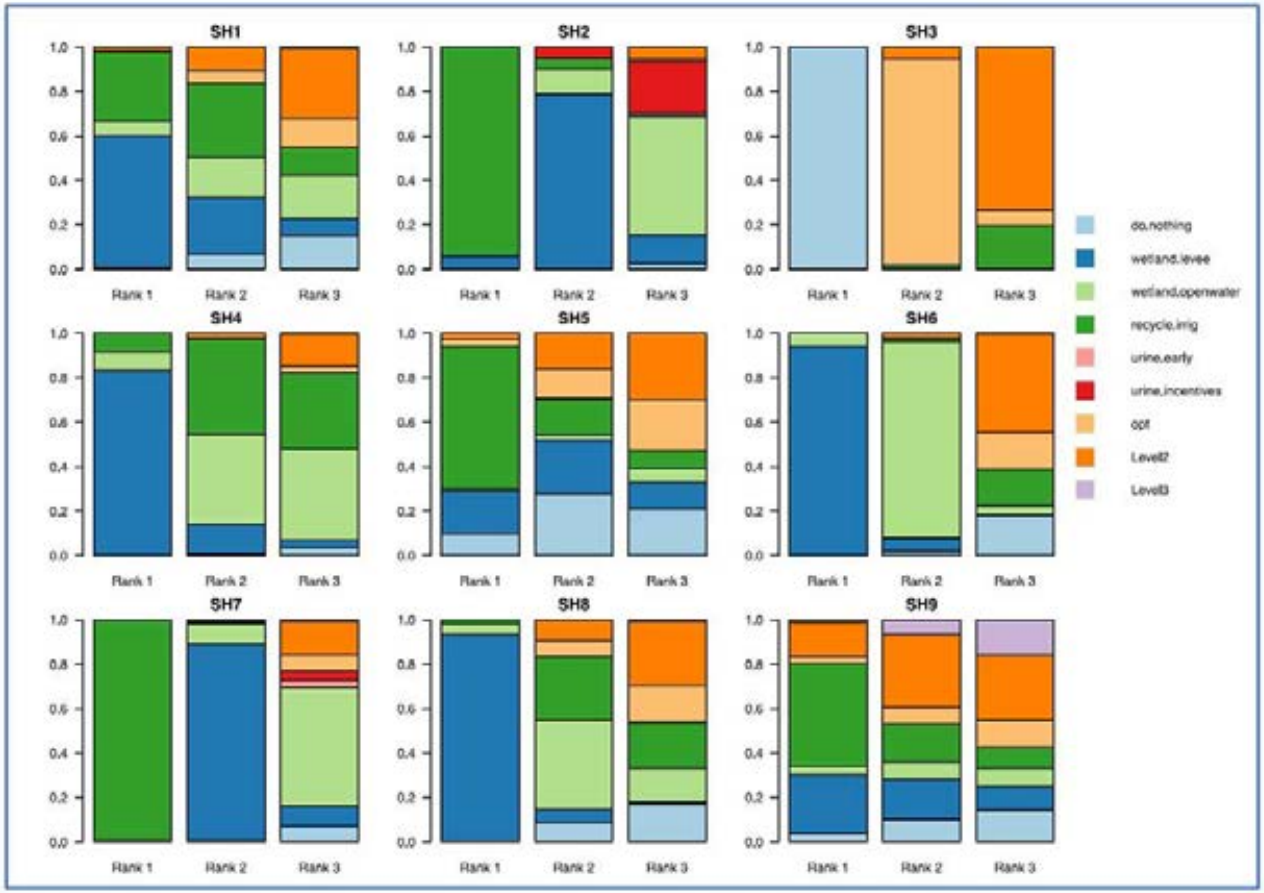


Fig. 3. The probability of the top three ranked options for each of nine stakeholders (SH) given uncertainty in attribute predictions, Status quo scenario. Color coding options see legend and Table 1. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

INSTITUTIONAL

lack of leadership

interagency collaboration

regulatory constraints

risk tolerance

SOCIAL

public opinion

public compliance

TECHNICAL

effects on existing treatment train

Desktop Study of Opportunities & Constraints

- Leverage SFEI's Adaptation Atlas and GreenPlanIT tools to identify opportunities for open water treatment wetlands and horizontal levees
- Refine the model outputs in consultation with BACWA representatives and local experts
- Generate factsheets to communicate opportunities and constraints
- Inform site-specific analyses at WWRFs with high NbS potential

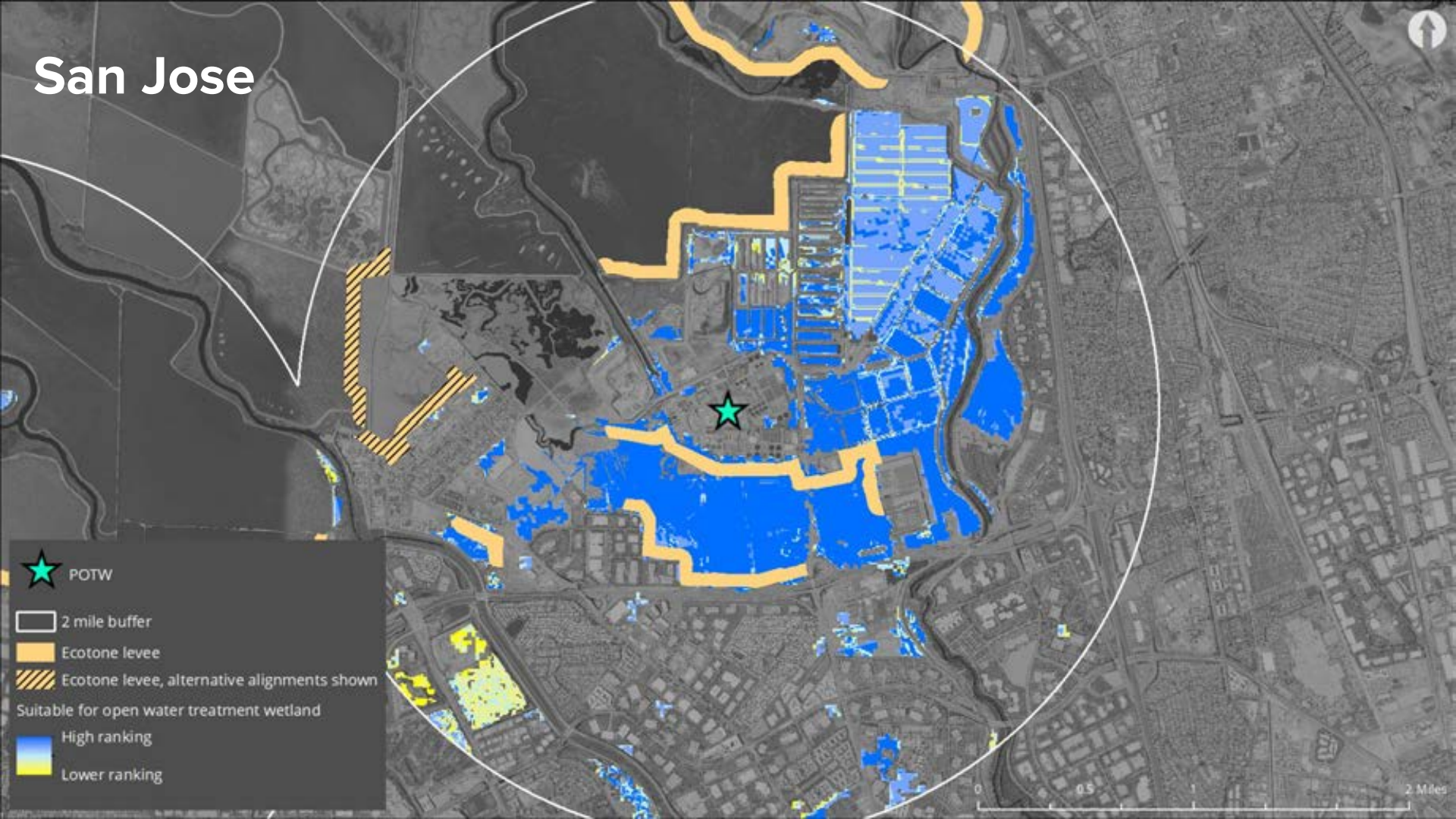
Hayward


POTW
2 mile buffer
Ecotone levee
Ecotone levee, alternative alignments shown
Suitable for open water treatment wetland
High ranking
Lower ranking
0
0.5
1
2 Miles

Union San


POTW
2 mile buffer
Ecotone levee
Ecotone levee, alternative alignments shown
Suitable for open water treatment wetland
High ranking
Lower ranking
0
0.5
1
2 Miles

San Jose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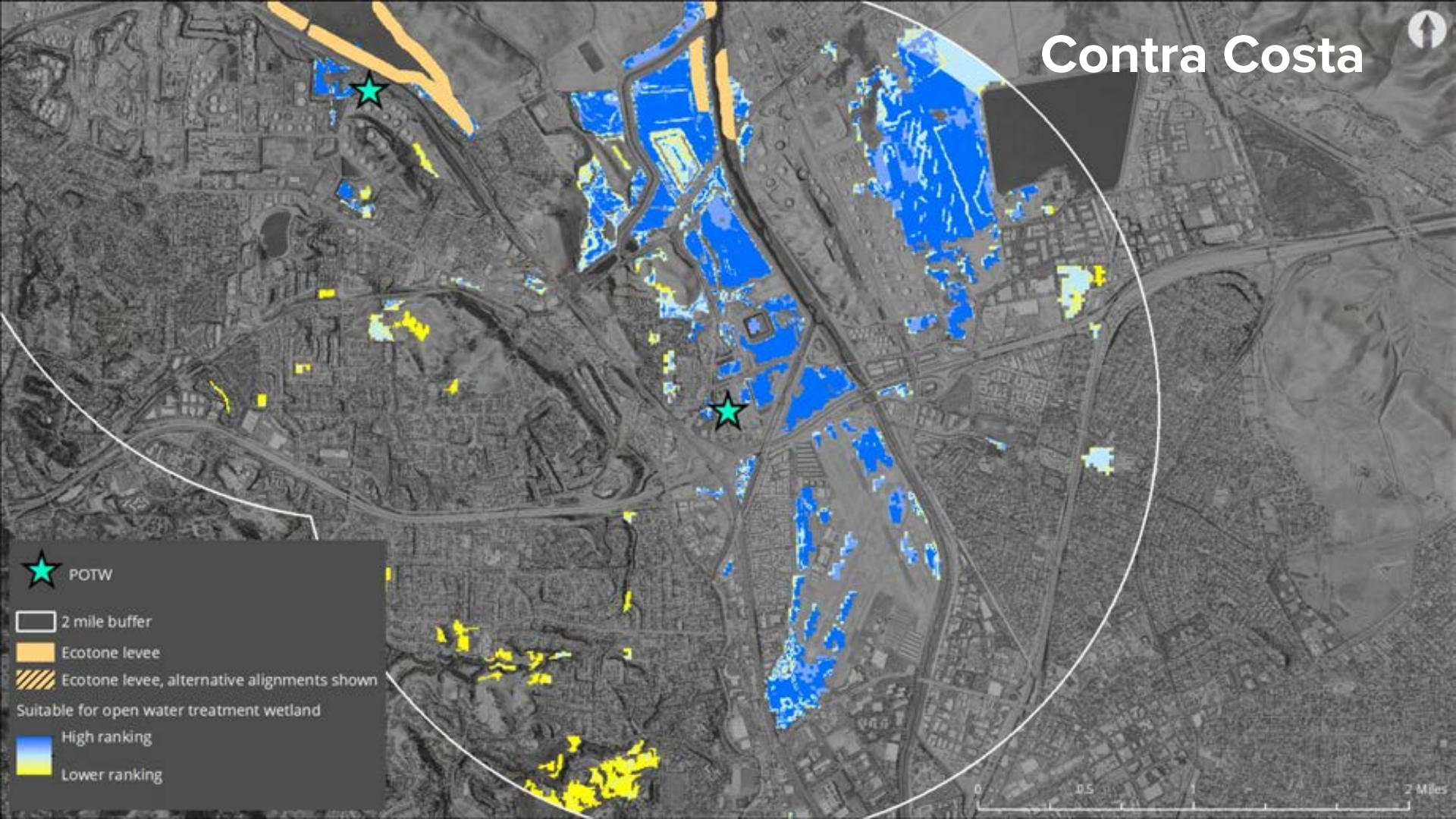
Contra Costa
POTW
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Suitable for open water treatment wetland
High ranking
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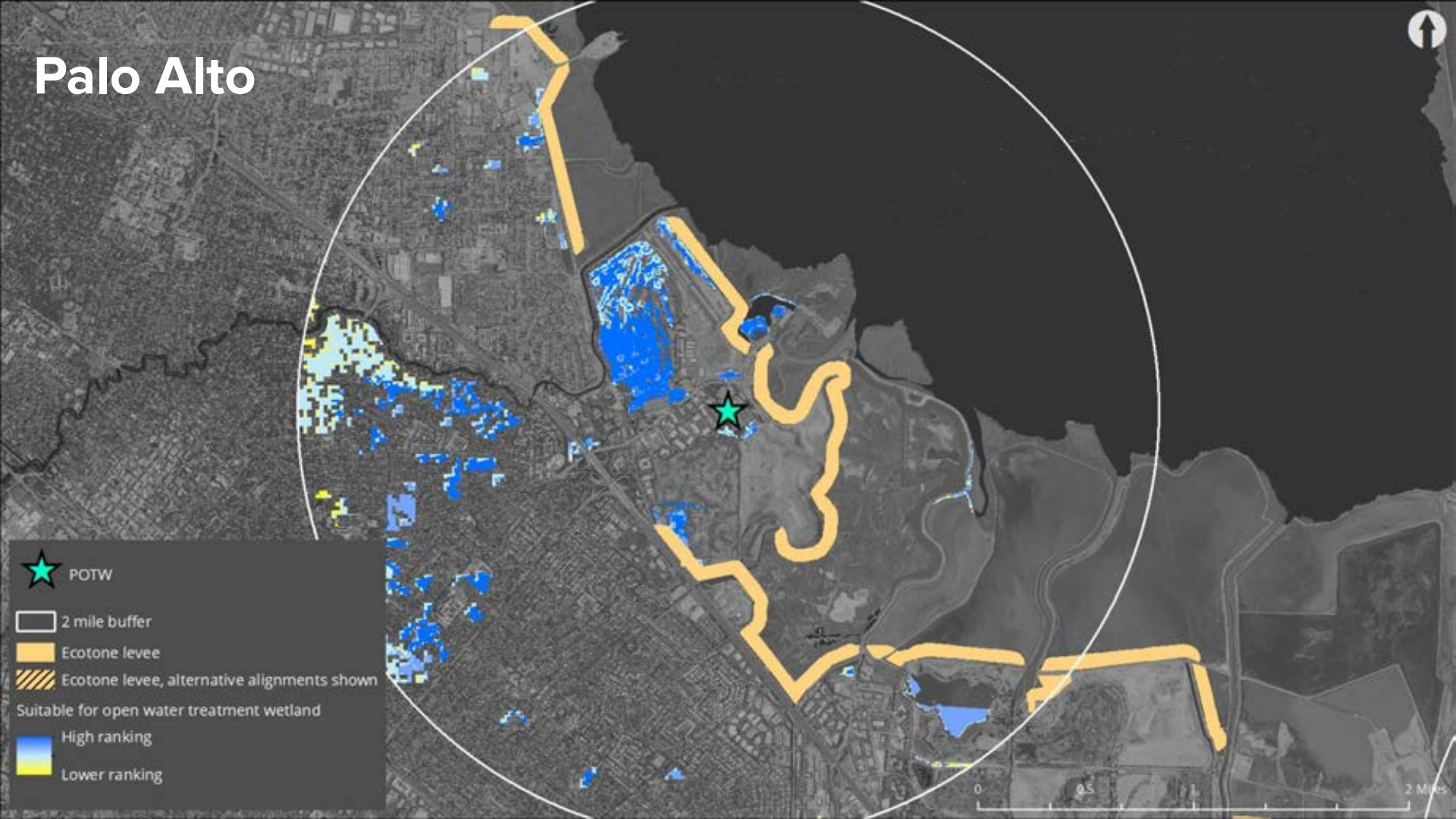
Palo Alto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Suitable for open water treatment wetland
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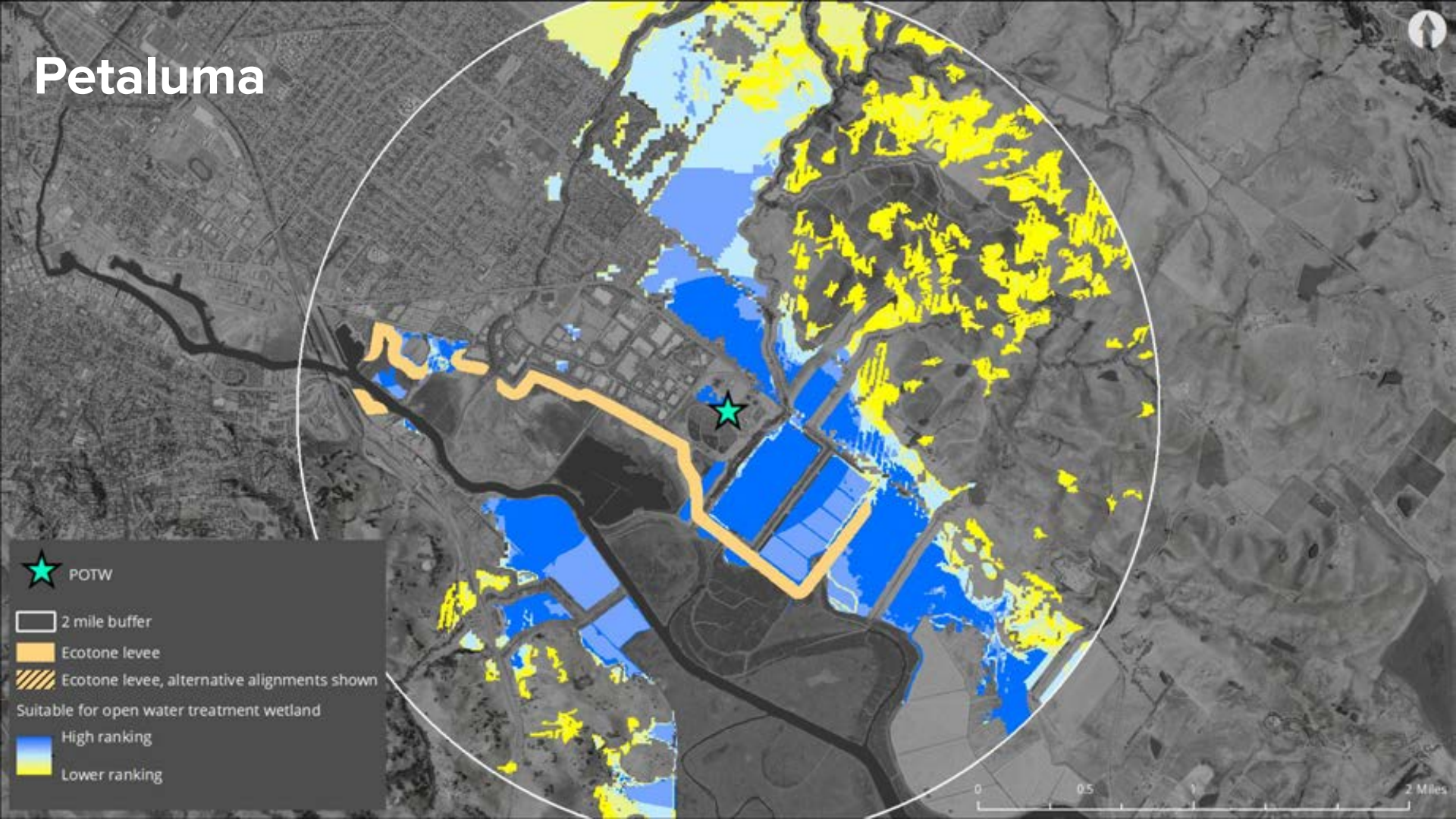
Petaluma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Ecotone levee, alternative alignments shown
Suitable for open water treatment wetland
High ranking
Lower ranking
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EBMUD
POTW
2 mile buffer
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Ecotone levee, alternative alignments shown
Suitable for open water treatment wetland
High ranking
Lower ranking
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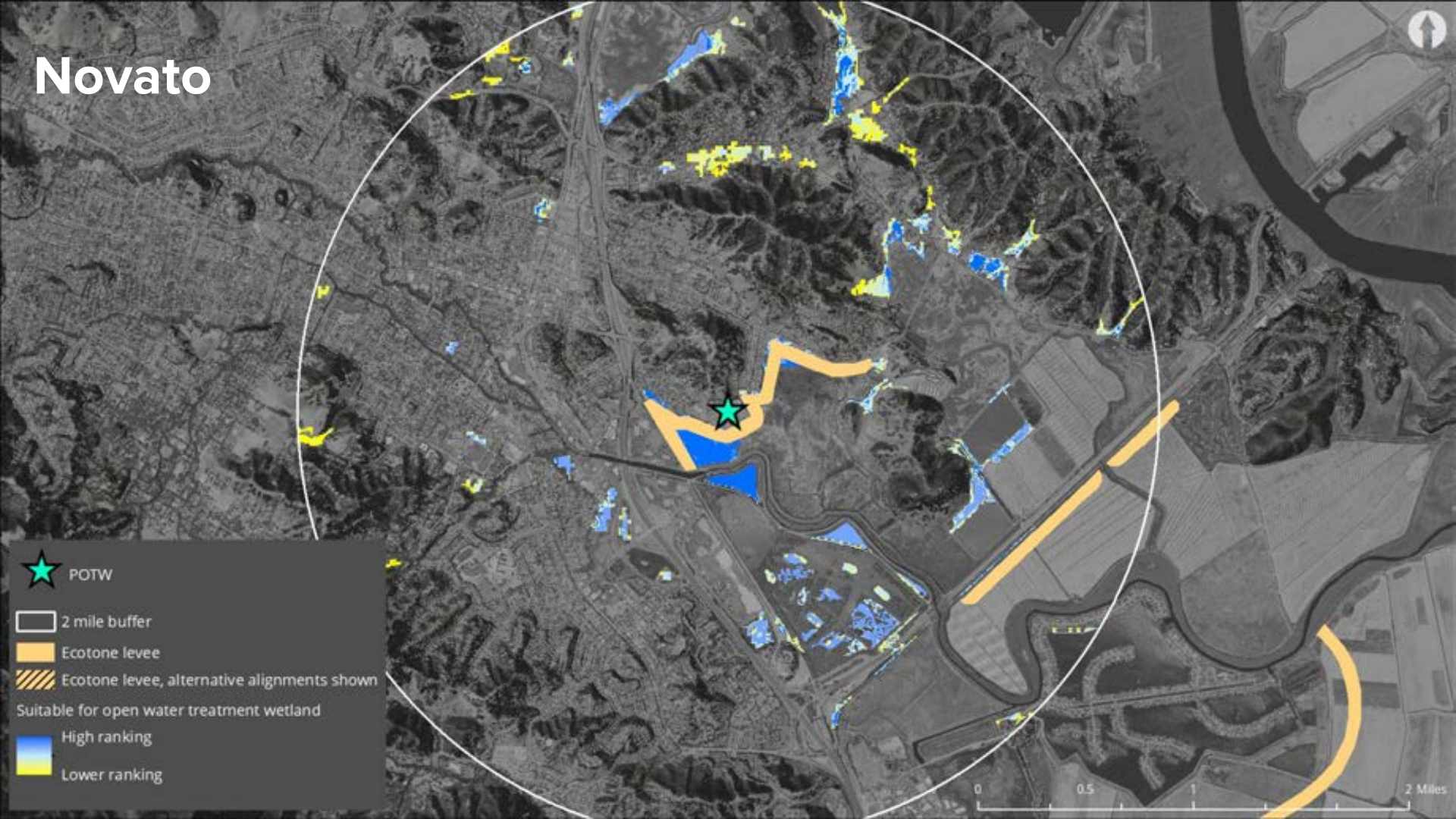
1
2 Miles

Novato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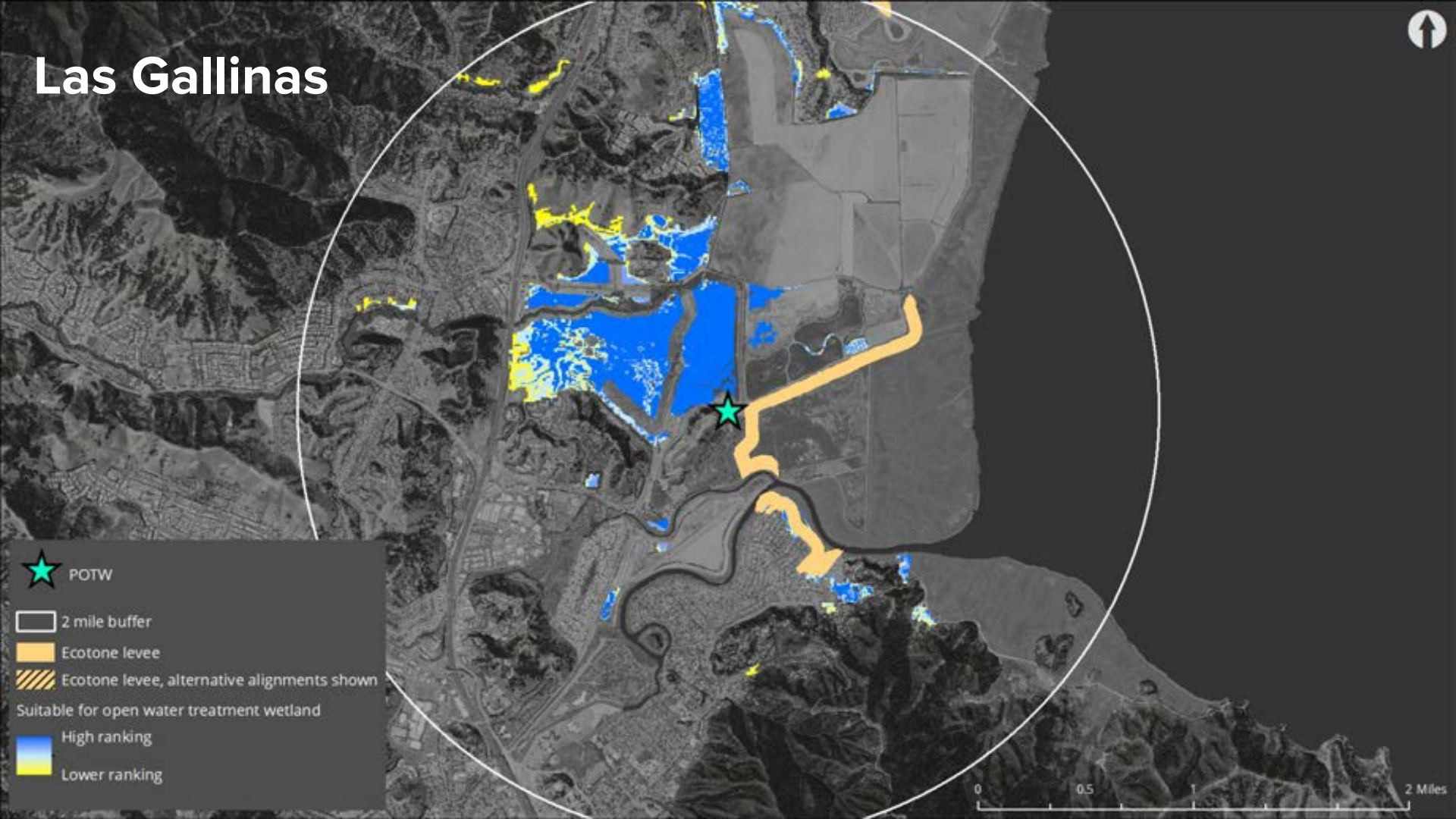
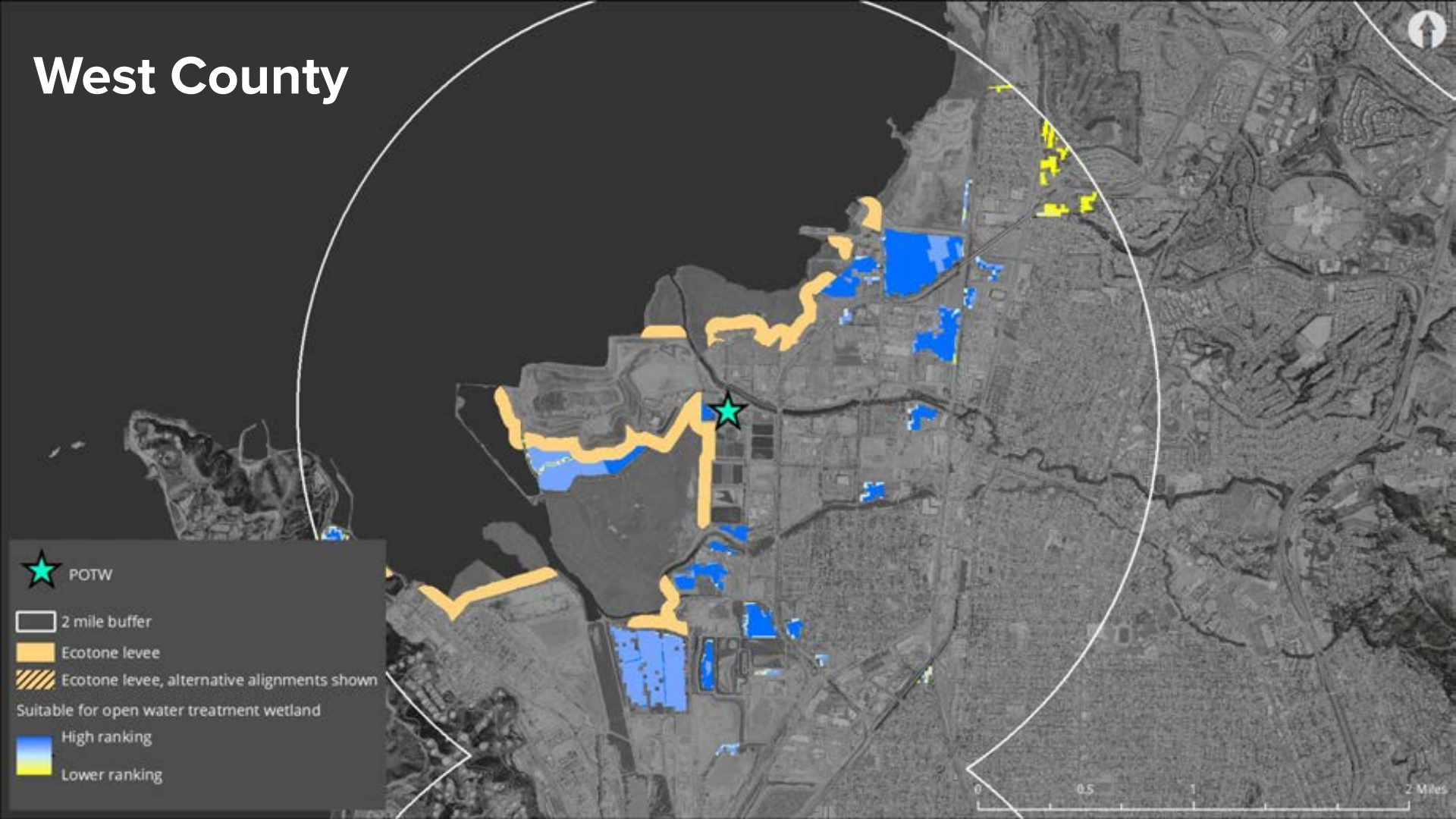
2 Miles

Las Gallinas



West County


POTW
2 mile buffer
Ecotone levee
Ecotone levee, alternative alignments shown
Suitable for open water treatment wetland
High ranking
Lower ranking
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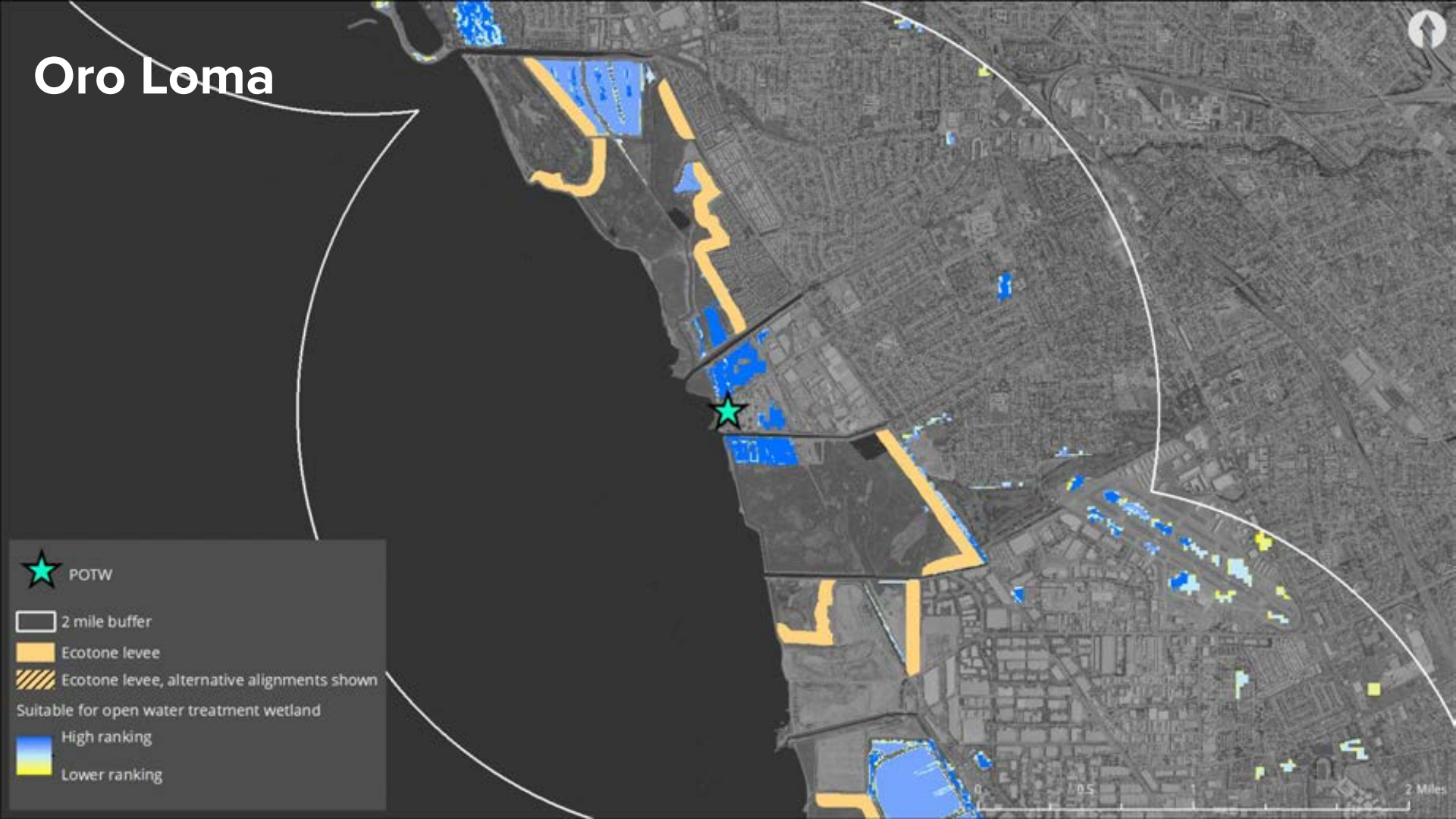
0.5
1
2 Miles

Oro Loma


POTW
2 mile buffer
Ecotone levee
Ecotone levee, alternative alignments shown
Suitable for open water treatment wetland
High ranking
Lower ranking
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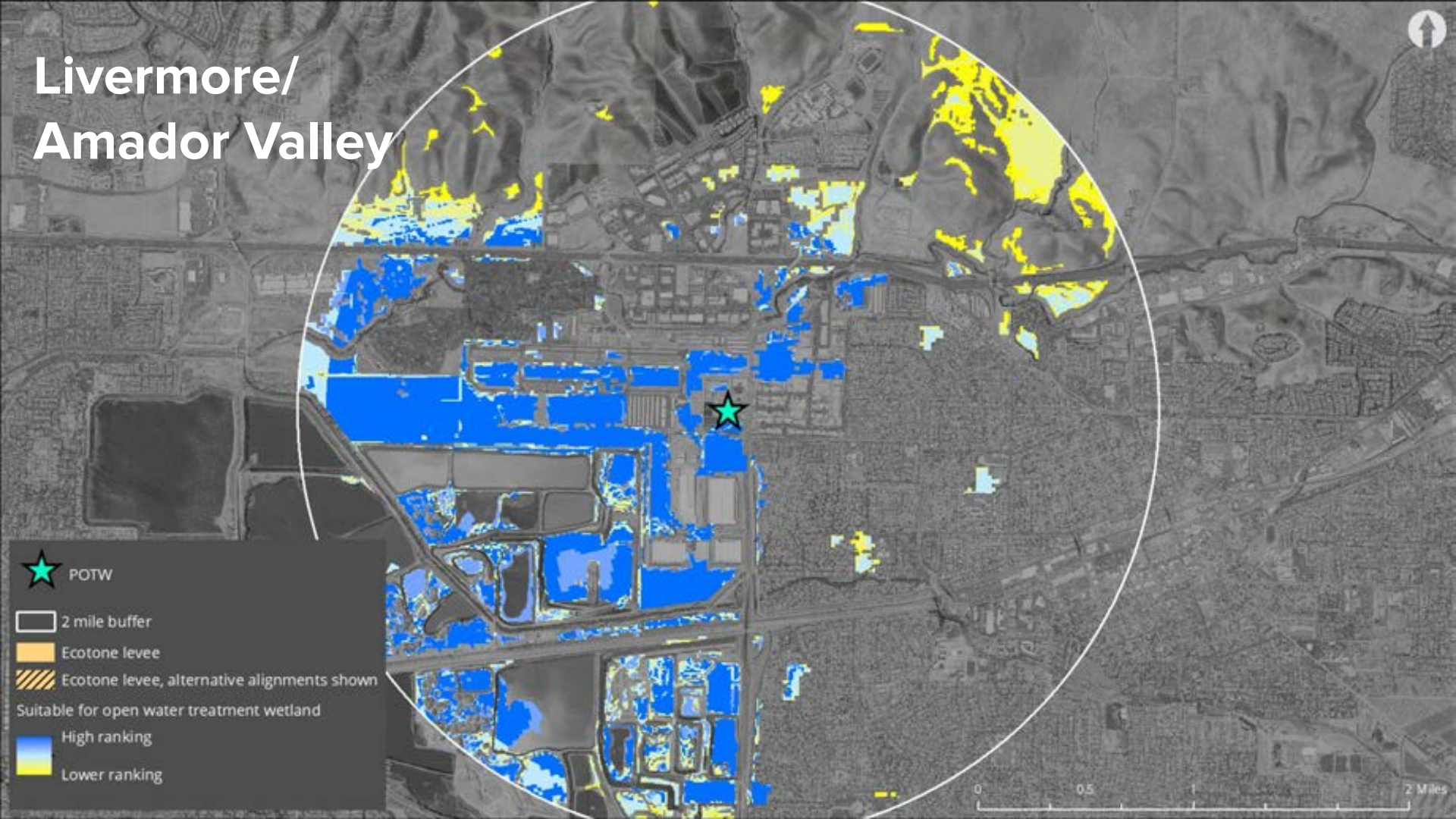
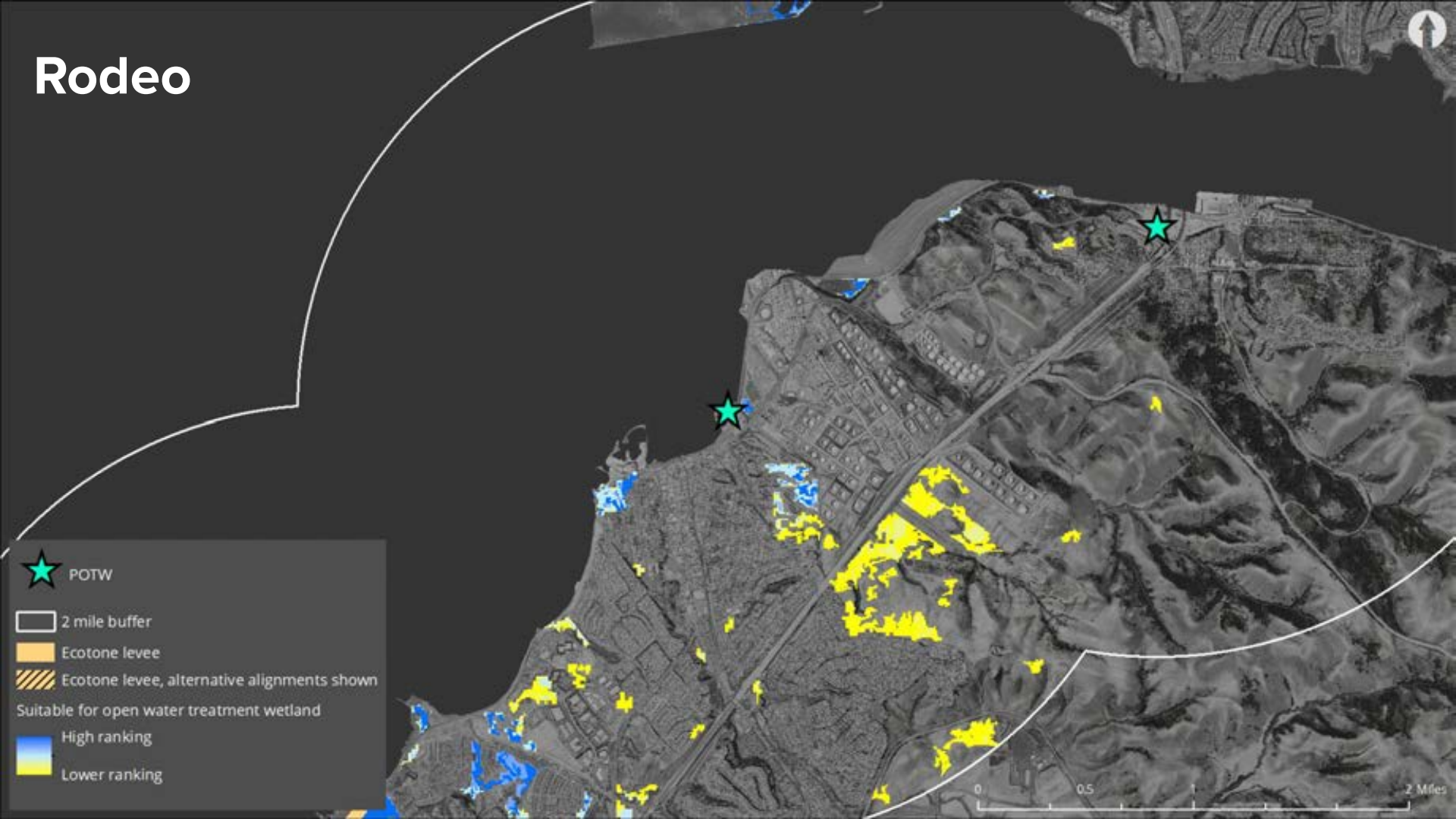
2 Miles

Livermore/ Amador Valley



Rodeo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2 Miles

HAYWARD WATER POLLUTION CONTROL FACILITY

Nature-based treatment solutions

There are multiple opportunities for nature-based treatment at the Hayward Water Pollution Control Facility. One possibility is to convert the existing wet weather storage ponds into open-water treatment wetlands. These could be integrated with a horizontal levee on the outboard side of the ponds, which would provide additional nutrient reduction benefits.

This horizontal levee could also provide multiple co-benefits, including valuable high tide refuge habitat for marsh species, wave attenuation to reduce flood risk, and marsh migration space for adjacent Cogswell Marsh.

SELECTED MEASURES

Horizontal levees	●
Open water constructed wetlands	◐

● Highly Suitable ◐ Moderately Suitability ◔ Limited Suitability ○ Unsuitable

PRELIMINARY FINDINGS

Table 1. Open water wetland suitability

Open water wetlands	Highly suitable	Moderately suitable	Less suitable
Acres	350	85	30
TN reduction (kg)	1,360	600	376
TN reduction (%)	94%	55%	25%

* estimated by weather performance, assuming nitrification prior to discharge to shallow depth (30 cm) unit cell open water wetlands

Table 2. Horizontal levee suitability

Horizontal levee	Total
Length (km)	11.8
TN reduction (kg)*	3,900
TN reduction (%)*	>100%

* assumes optimal nitrate reduction potential along length of levee, including the presence of a 1-meter thick woody biomass fer layer and 40-meter length and nitrate removal based on Addy et al. 2016

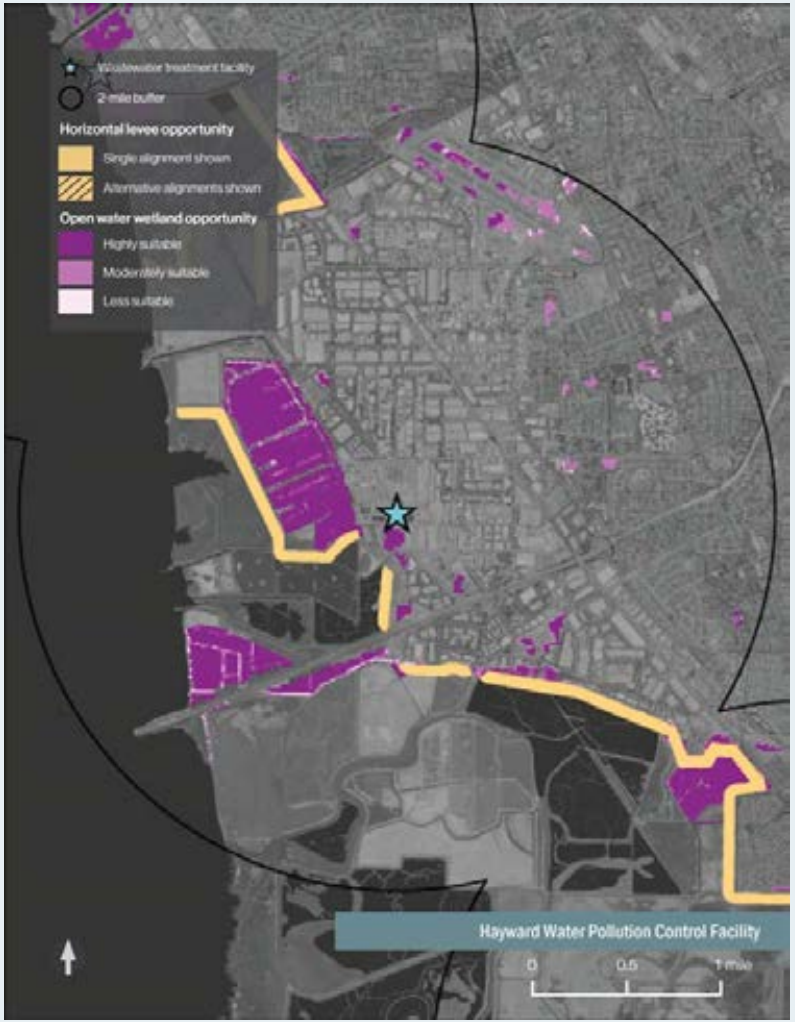
WRRF-SPECIFIC METRICS

Service area	City of Hayward
Permitted ADWF capacity (mgd)	16.5
Daily TIN loading (3-yr average)	1,427 kg N
Daily P loading (3-yr average)	TBD
Existing GIN/TP effluent concentration (3-yr average)	TBD
Existing secondary treatment process	trickling filter/solids contact
Existing or planned N&R	nonenphael
Existing or planned nutrient reduction strategy	no
% of facility flooded by 3m SLR	TBD
% of facility exposed to ground water emergence at 1m SLR	TBD
Existing SLR strategy document	in preparation
Existing or planned nitrification of treated effluent	no

OPPORTUNITIES & CONSTRAINTS

Based on mapping and survey responses received from all regional WWRFs, several key opportunities or barriers to NbS implementation have been defined. Recognizing unique situations apply to each WWTF, a relative weighting of generalized opportunities and constraints will influence evaluations going forward.

Opportunity or Constraint	Relative Magnitude
Relative land availability	high
Regulatory/environmental conflicts	moderate



Near-term Schedule

Oct 19

Draft Factsheets

Compiled Draft Factsheets and supporting documentation to BACWA

Nov 6

Comment Deadline

Stakeholders return comments

Nov 24

Final to BACWA

SFEI submits the Final Report to BACWA

Dec 1

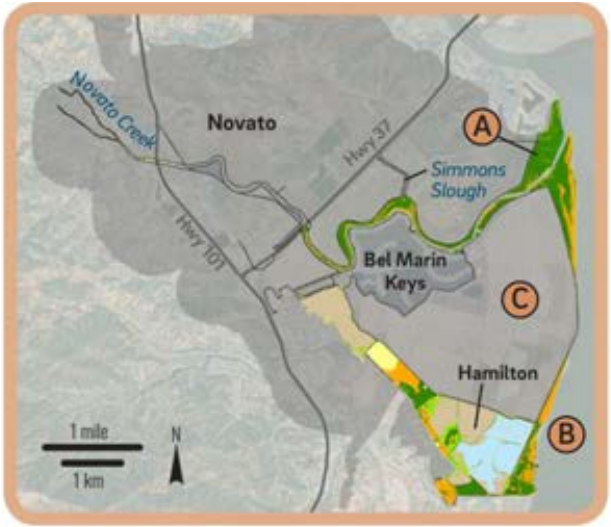
Final Submission

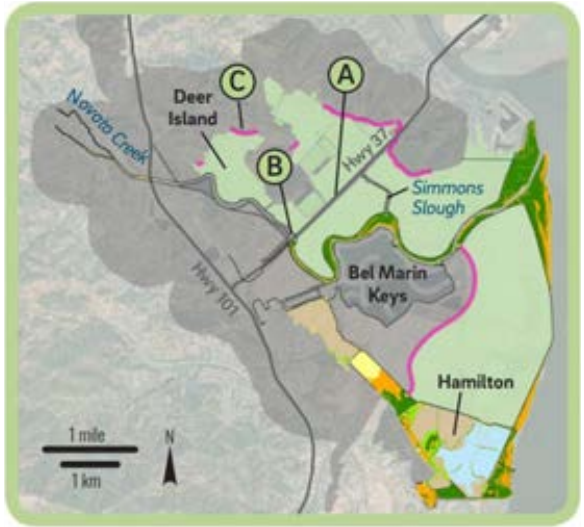
BACWA submits final to the Water Board

Next Steps

1. Identify those WWRFs with the highest NbS potential in consultation with the Project CMG
2. Perform site visits (as permitted) and outreach to 10-15 sites
3. Develop brief memo on each
4. Identify 5-10 sites for deeper dive to develop planning-level designs, cost estimates, SLR adaptation pathways
5. Continually engage partners and aligned projects, to encourage cooperation, address regulatory hurdles, and reduce barriers to implementation

Leveraging the Adaptation Atlas: example alternative adaptation strategies





Novato OLU case study from Marin Adaptation Framework

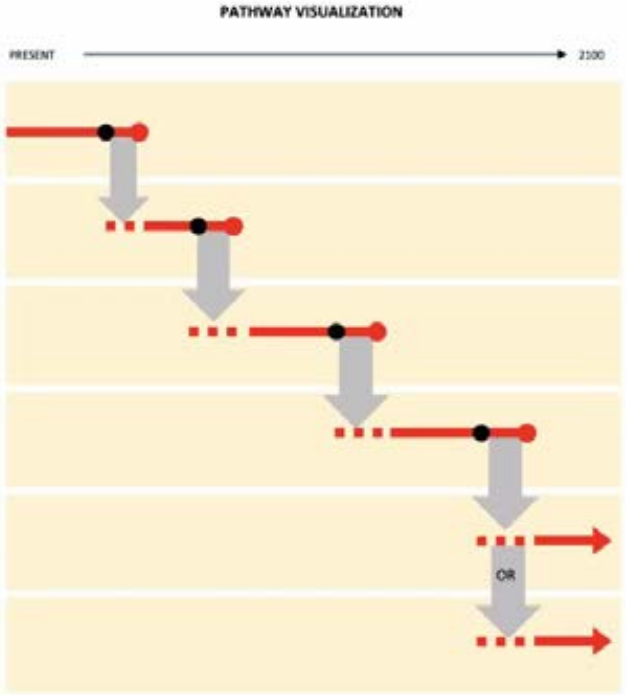
Evaluating tradeoffs

Benefit	Indicator	Units	Strategies: Hold the line	Strategies: Buffer with open space	Strategies: Maximize habitat
Cost considerations					
Low cost construction	Fill volume for ecotone levees[1]	million cubic yards	● 0.00	○ 2.22	○ 2.25
Low cost maintenance	Linear distance of existing shoreline protection that would need to be raised or maintained[2]	miles	○ 21	● 11	● 9
Supporting services					
Biodiversity support (habitat, species)	Projected area of marsh in 2030	acres	○ 980	◒ 1,136	● 1,276
Cultural/social services					
Recreation	Length of new trails[3]	miles	○ 0	◒ 3.2	● 4.2

Adaptation Pathways

Seabright State Beach: *Public Property: Incremental Retreat*

PHASE	ADAPTATION STRATEGY	SECONDARY CONSEQUENCES OF STRATEGY	TRIGGER(S) TO NEXT PHASE
Existing	Dune restoration Wide beach	Improved beach habitat, wide beach	Dune failure, narrowing of beach width, loss of public use and access
1	Dune construction/ Living shoreline with cobble	Improved beach habitat, potential impact on dredging	Dune failure, narrowing of beach width, cliff erosion
2	Managed retreat: 1- way traffic, maintain lateral cliff & beach access	Loss of one lane traffic	Cliff erosion
3	Managed retreat: No vehicle access, maintain rec/ped access	Loss of road and parking (retain sidewalk)	Cliff erosion, loss of public use and access
4a	Managed retreat: Remove vulnerable private infrastructure	Loss of private property- maintenance of bluff top public access	NA
OR 4b	Armor: Construct armor to protect private property	Private property maintained, loss of public access	NA



Source: City of Santa Cruz

Nexus to Other Projects

Nature-based wastewater treatment is an emerging regional priority.

How to integrate a diversity of priorities is the challenge:

- Habitat restoration
- Recreation & education
- Flood risk
- Recycled water concentrate management

Photo: USFWS

Nexus to Other Projects

- Transforming Shorelines (SFEP)
- Bay Adapt (BCDC)
- ReNUWIt / Bay Area One Water
- Valley Water - RO concentrate management
- Plan Bay Area (MTC)
- Regional Board Basin Planning
- BCDC Bay Plan Amendments

THANK YOU AND PLEASE GET IN TOUCH!

Ian Wren, Ellen Plane, Julie Beagle, Dave Senn

BACWA Annual Meeting // August 18, 2020

BACWA BAY AREA CLEAN WATER AGENCIES

SFEI AQUATIC SCIENCE CENTER