

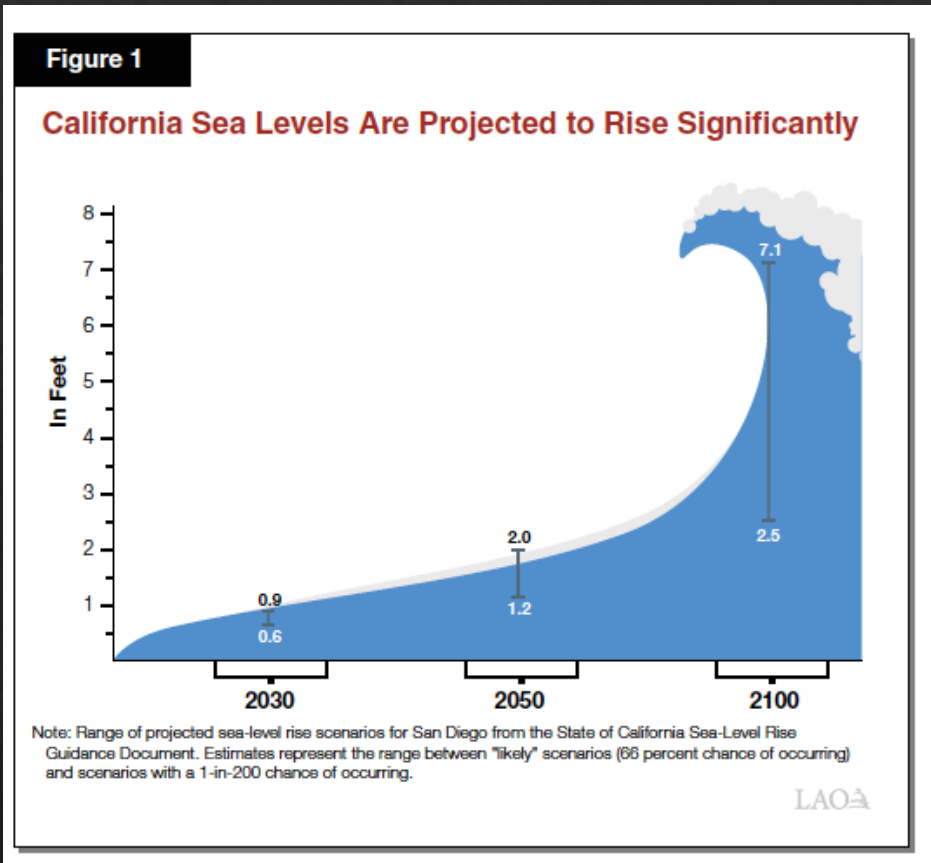


# **Scaling up the Horizontal Levee Concept: Lessons Learned from the Oro Loma and the First Mile Project**

Anthony DeSalvo and Jonathan Uhler, UC Berkeley  
Jackie Zipkin, East Bay Dischargers Authority

State of the Estuary Conference 2024  
May 29, 2024

# Sea Level is Rising

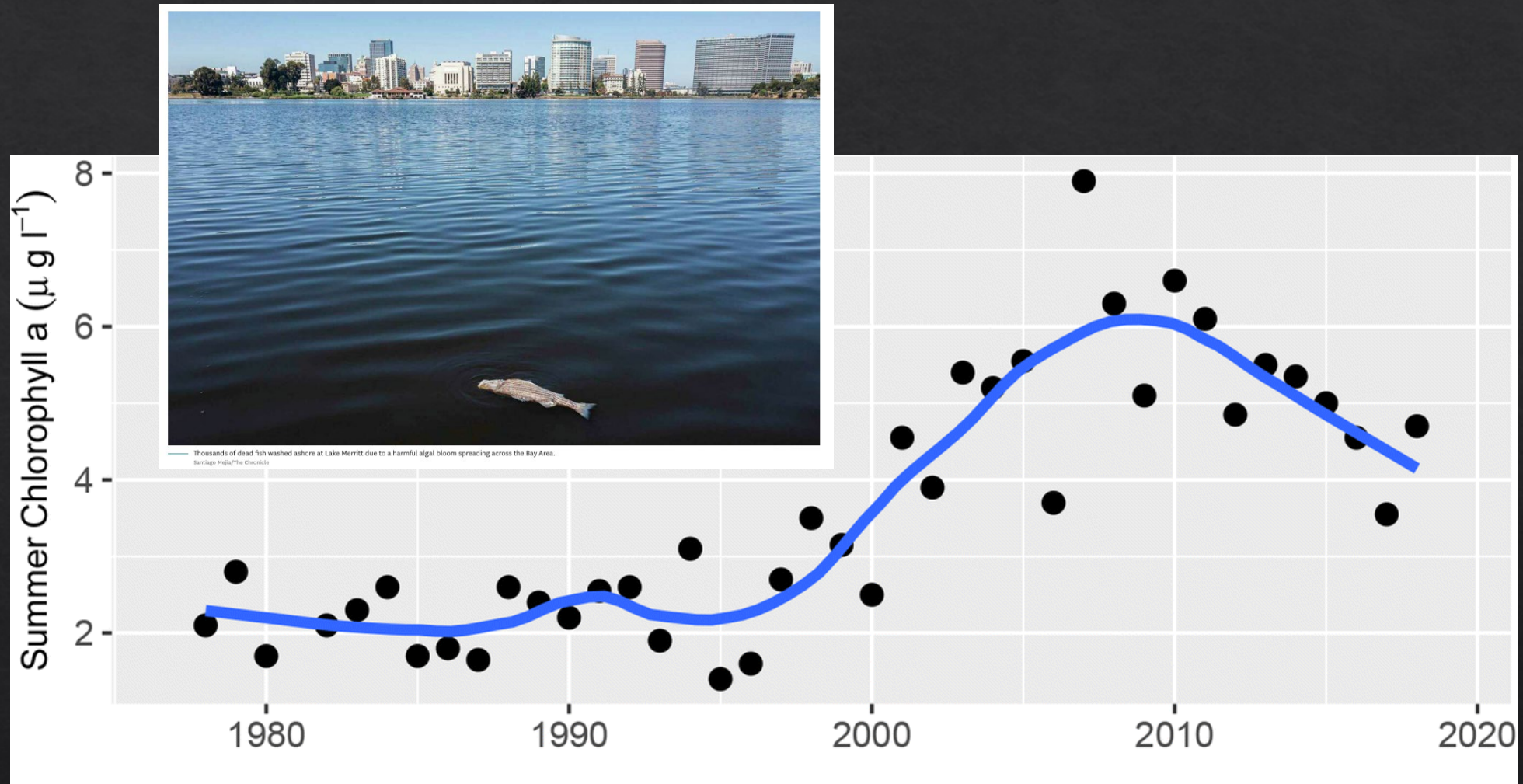


The crumbling sea wall in San Francisco is the subject of Proposition A, a \$425 million plan to rebuild the 100-year-old structure that runs the Embarcadero from Fisherman's Wharf to the San Francisco Giants ballpark. (Karl Mondon/Bay Area News Group)

**San Francisco Seawall Upgrades**  
\$2 Billion for seismic stability  
\$3 Billion to raise height

<https://www.sfportresilience.com/seawall-program>

# Excessive Algal Growth Impacts SF Bay Ecosystems



Cloern et al. (2020)

# We are Struggling to Repurpose Wastewater

## San Jose, Santa Clara mayors drink recycled sewage to push expanding reclaimed water

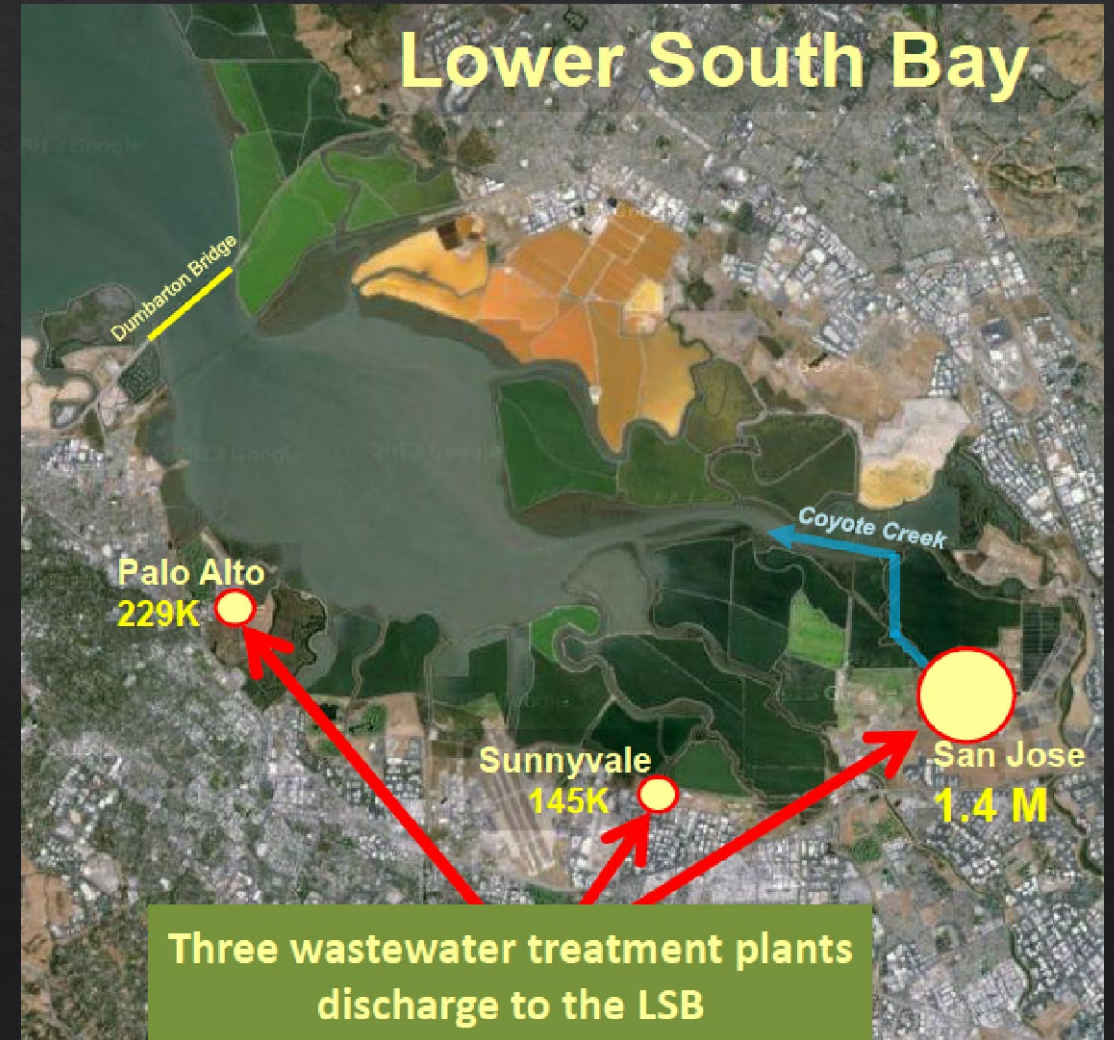
By Paul Rogers | [progers@mercurynews.com](mailto:progers@mercurynews.com)

POSTED: 04/27/2015 04:42:19 PM PDT | UPDATED: 3 MONTHS AGO

45 COMMENTS

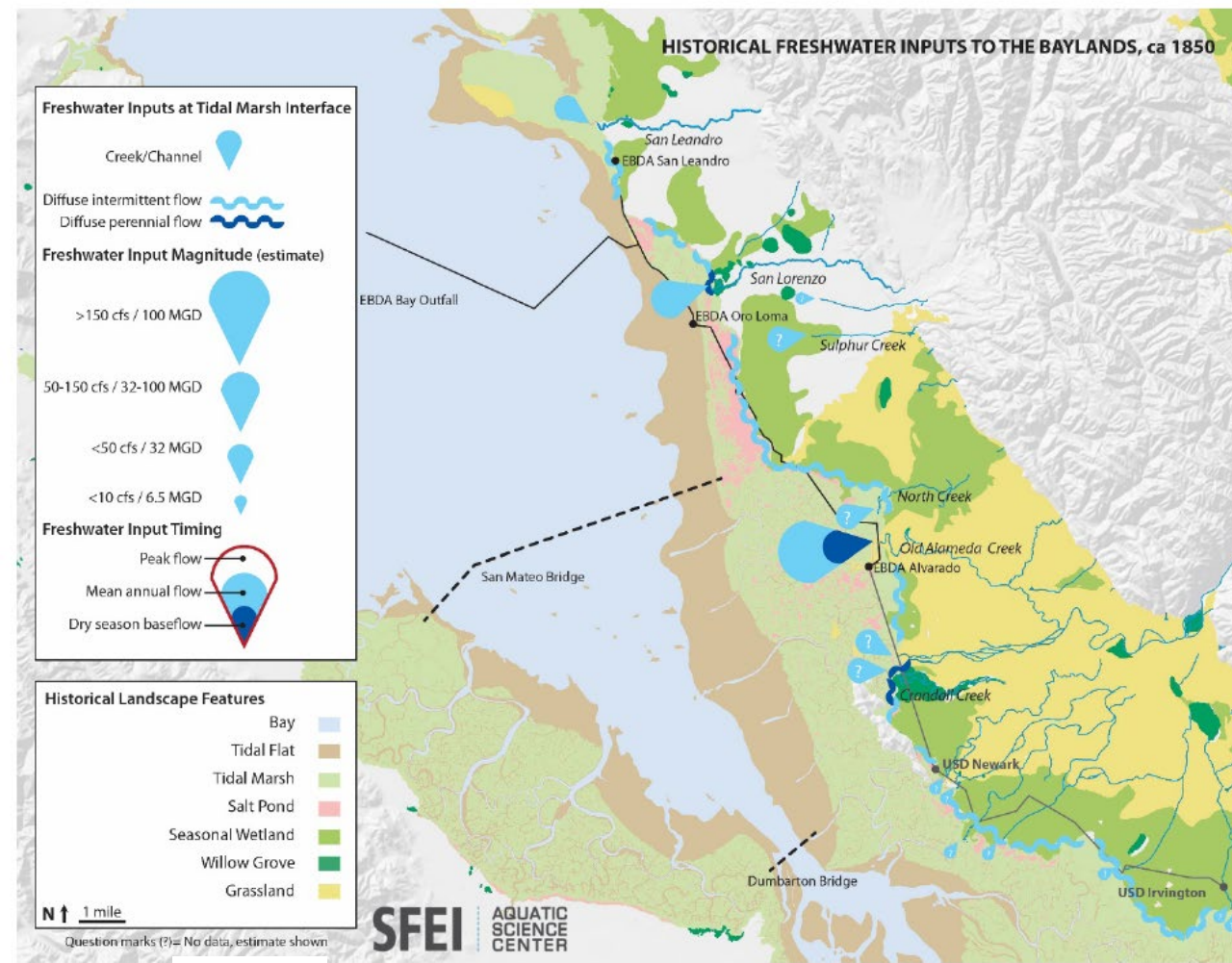
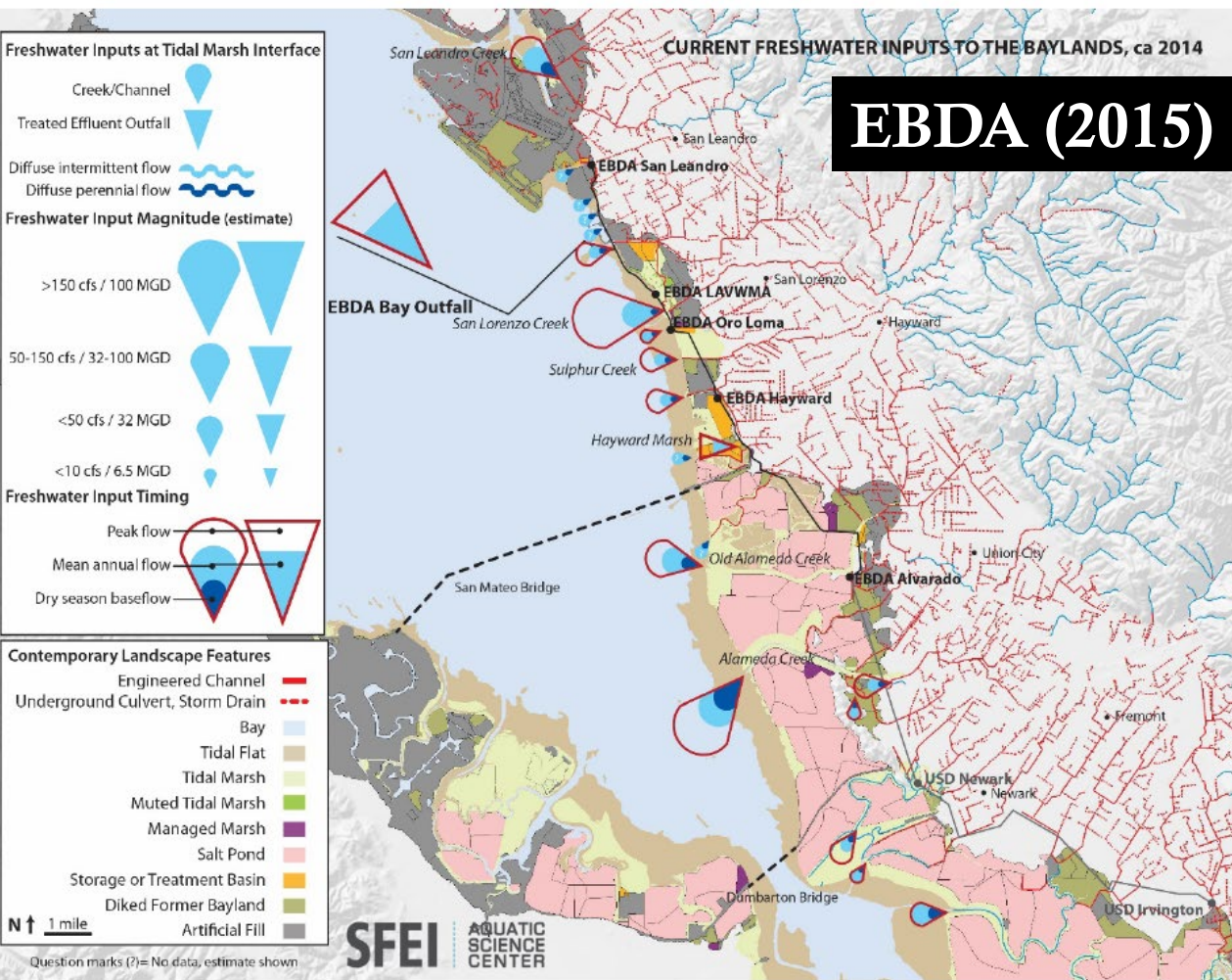


Santa Clara Valley Water District Board chair Gary Kremen, San Jose Mayor Sam Liccardo and Santa Clara Jamie Mathews, drink purified wastewater at a press event at the Silicon Valley Advanced Water Purification Center Monday, April 27, 2015, in Alviso, Calif. (Karl Mondon/Bay Area News Group)

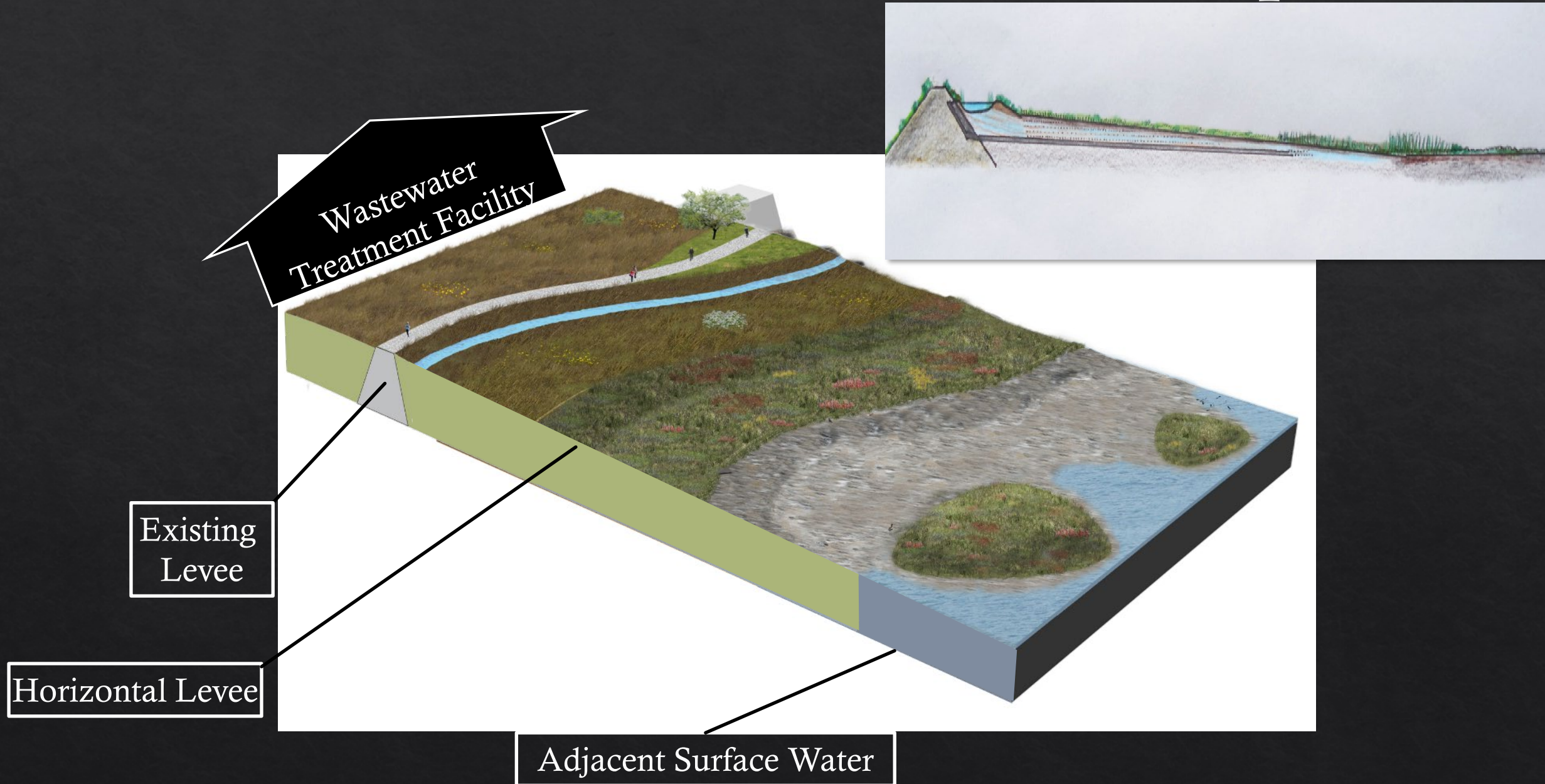


Source: City of San Jose

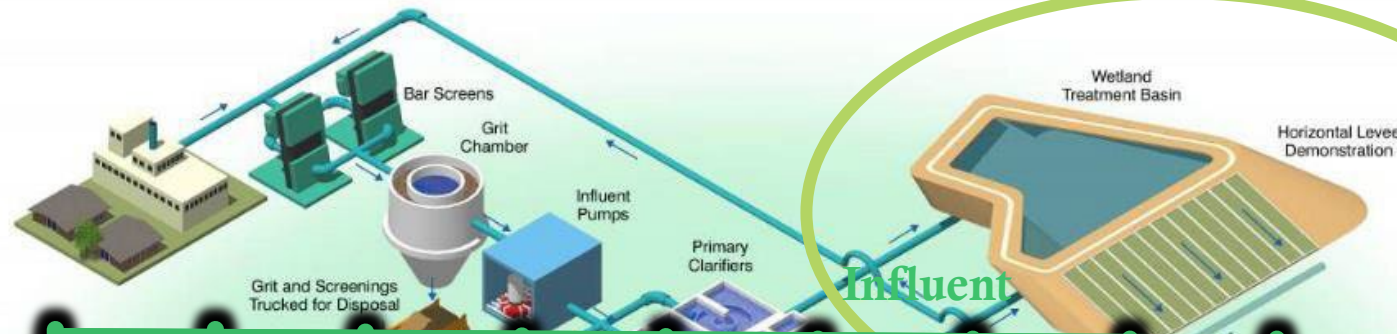
# Restoring Natural Flows to San Francisco Bay



# The Horizontal Levee: Restoration/Adaptation



# Horizontal Levee Pilot-Scale System at Oro Loma

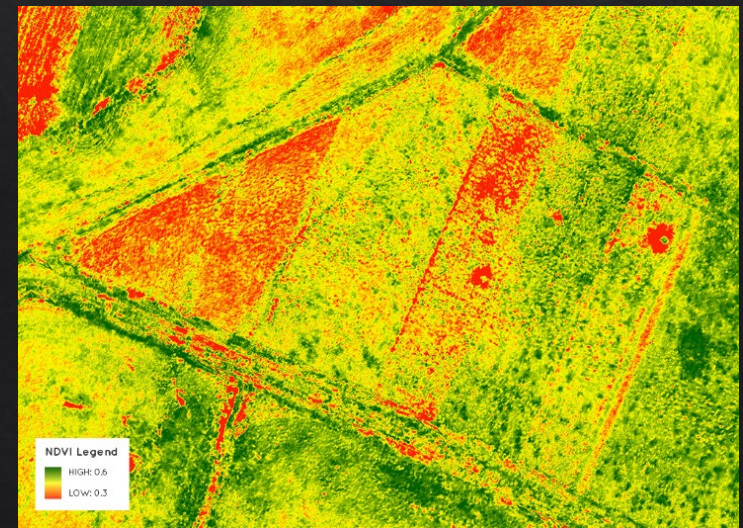
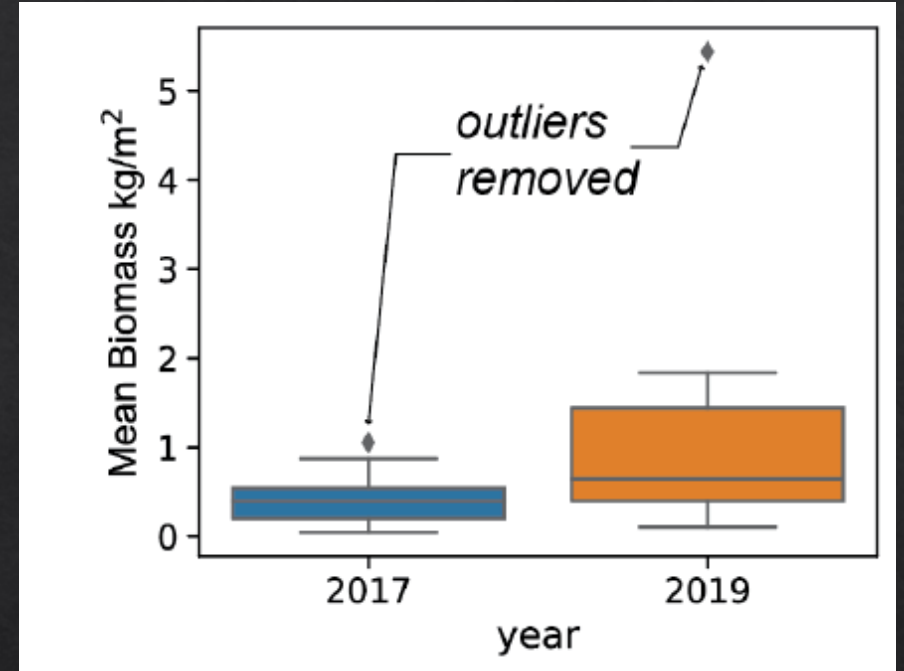


Google Maps

# Establishing the Plant Community

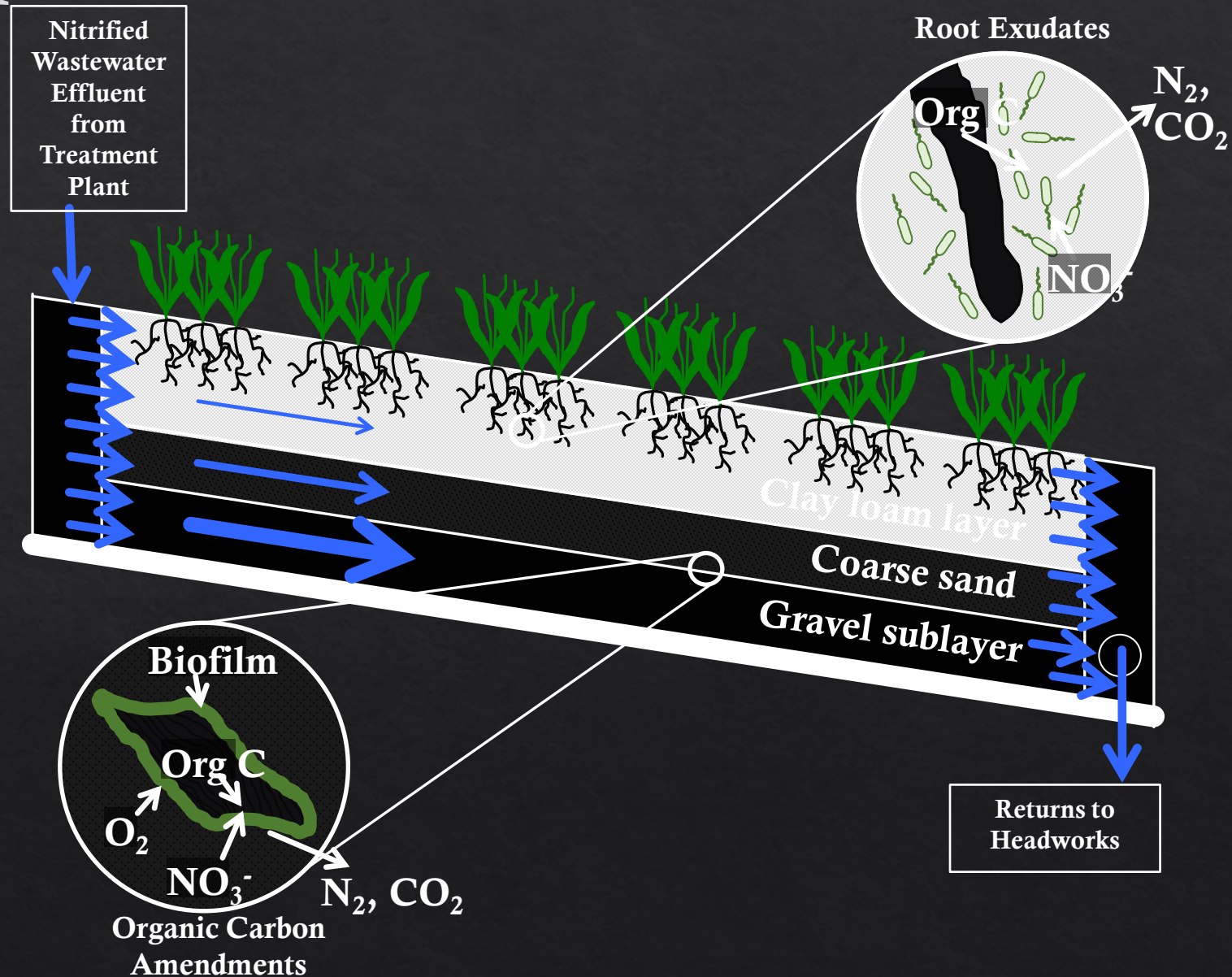


Bay Area  
Integrated  
Regional  
Water  
Management  
Program

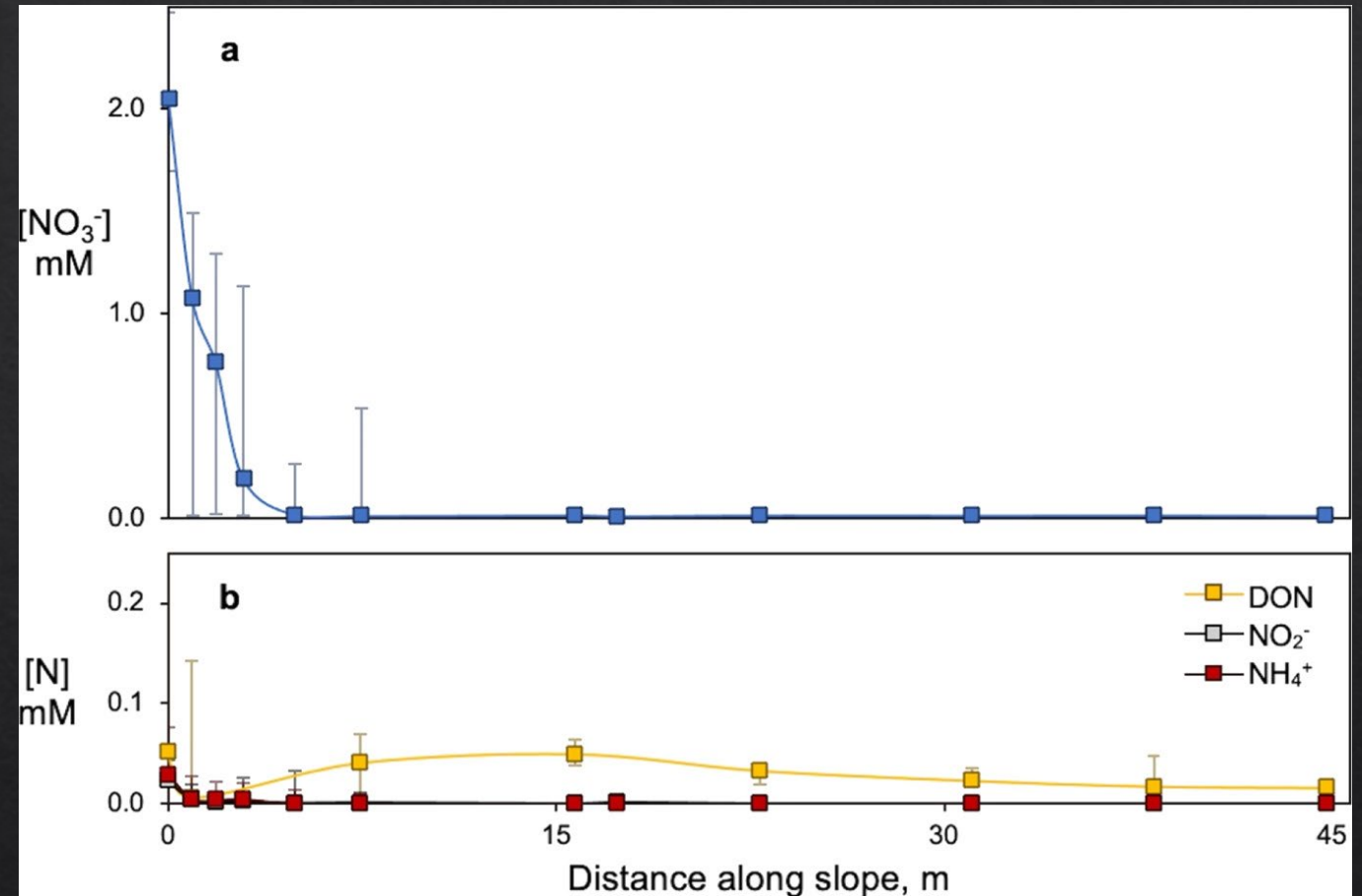
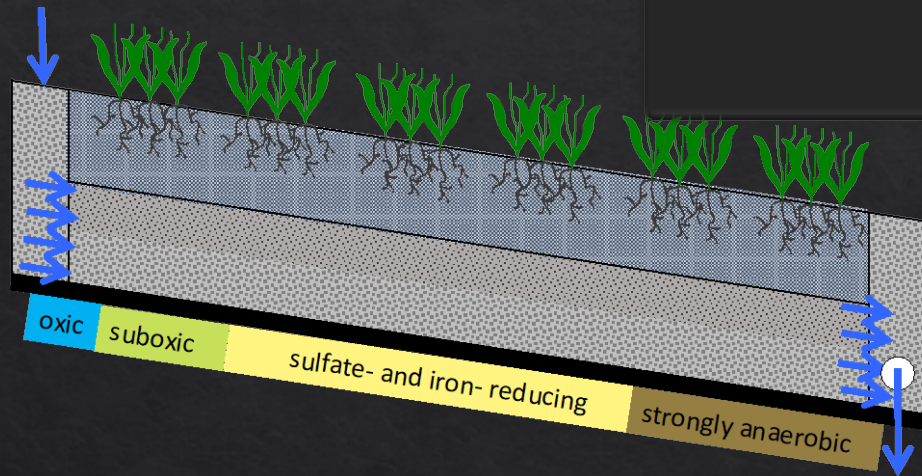




# Development of Subsurface Redox Zones



# Nitrate Removal Mainly Through Denitrification

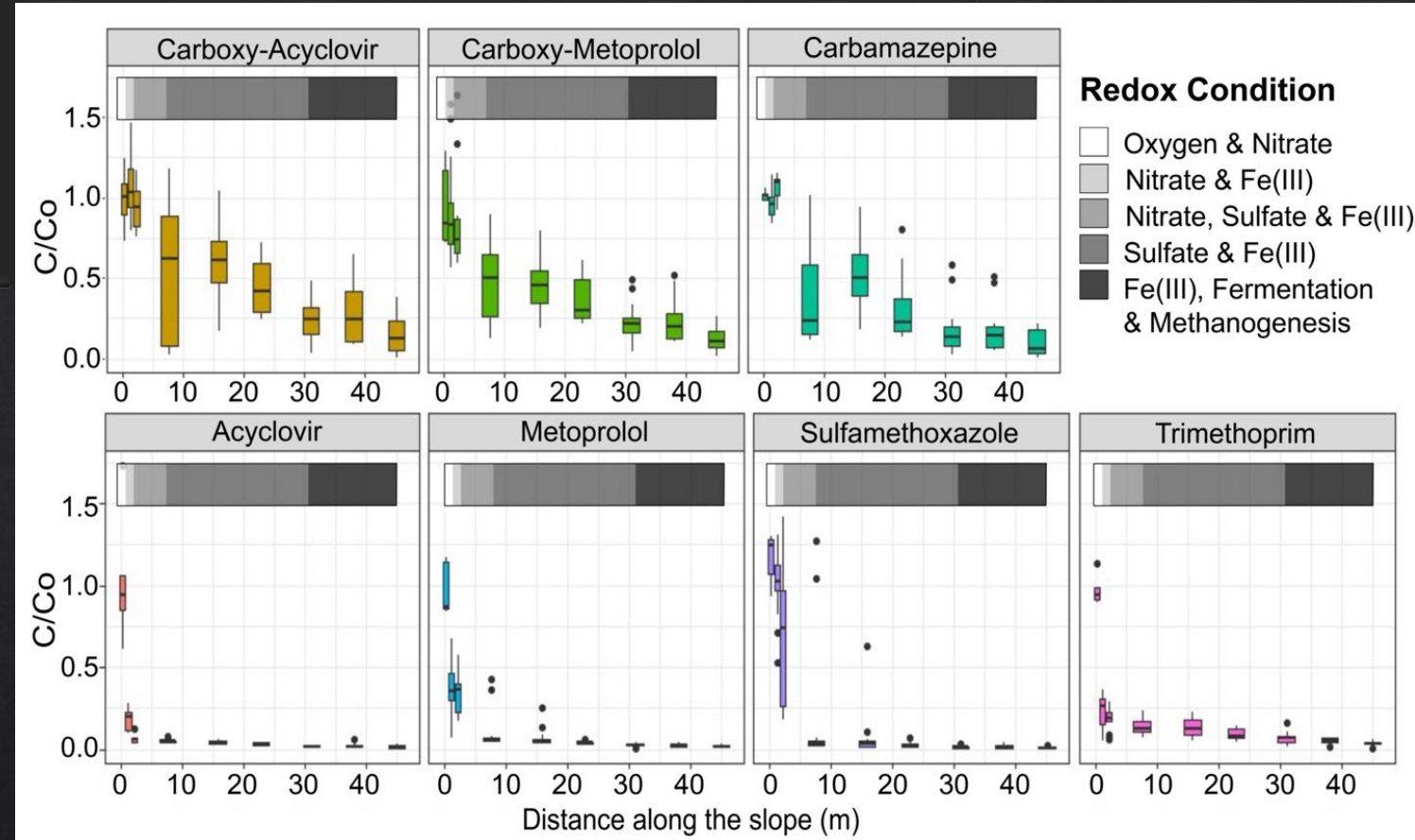
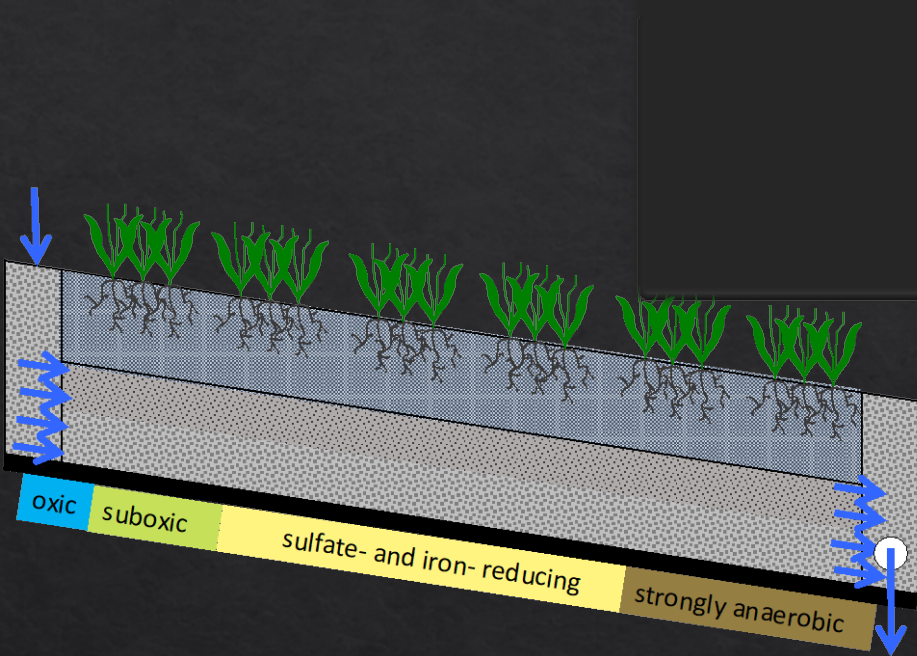


Cecchetti et al. (2022) Fate of dissolved nitrogen in a horizontal levee: seasonal fluctuations in nitrate removal processes. *Environ. Sci. Technol.* 56: 2770-2782.

Cecchetti et al. (2020) Use of stable nitrogen isotopes to track plant uptake of nitrogen in a nature-based treatment system. *Water Research X*, 9, 100070.

Cecchetti et al. (2020) The horizontal levee: a multi-benefit nature-based treatment system that improves water quality and protects coastal levees from the effects of sea level rise. *Water Research X*, 7, 100052.

# Trace Organics and the Redox Gauntlet

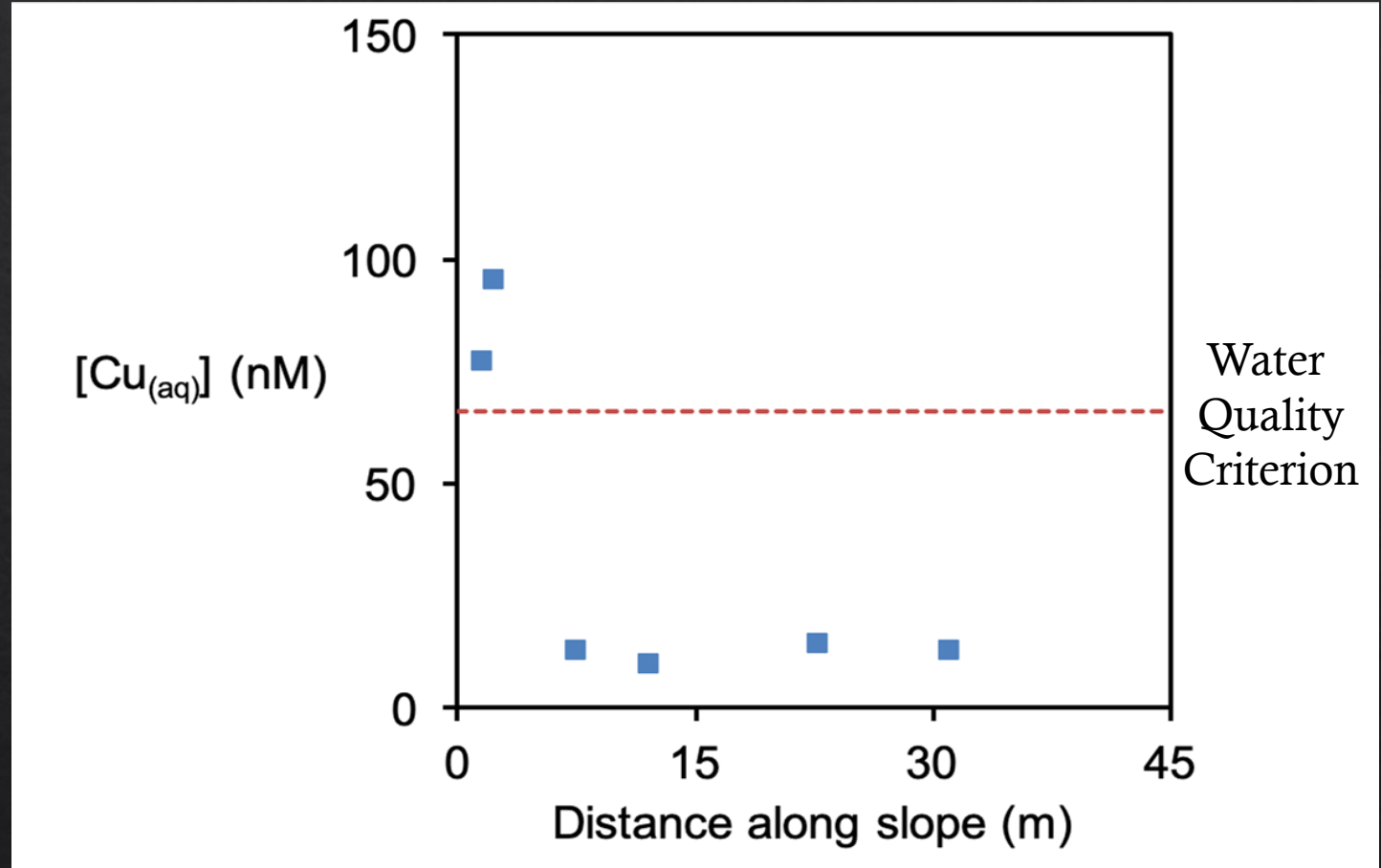
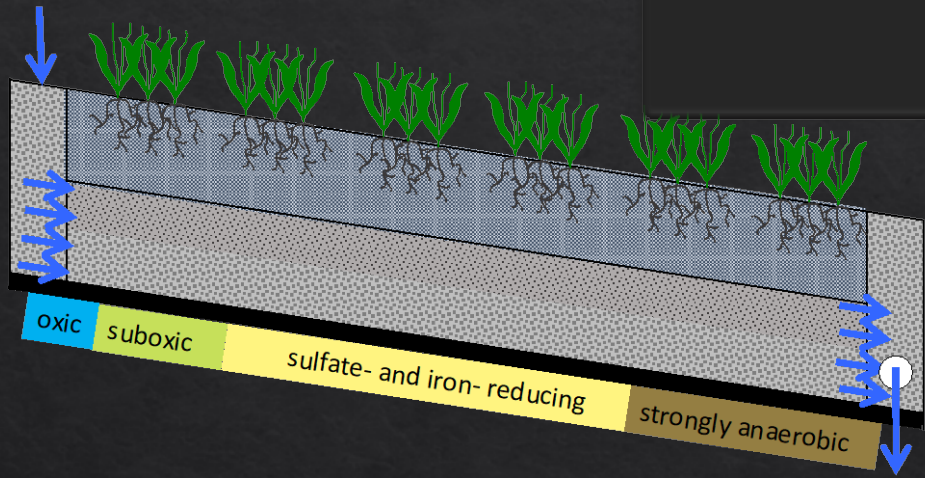


Stiegler et al. (2023) Persistent Trace Organic Contaminants are Transformed Rapidly Under Sulfate- and Fe(III)-Reducing Conditions in a Nature-Based Subsurface Water Treatment System. *In Review*

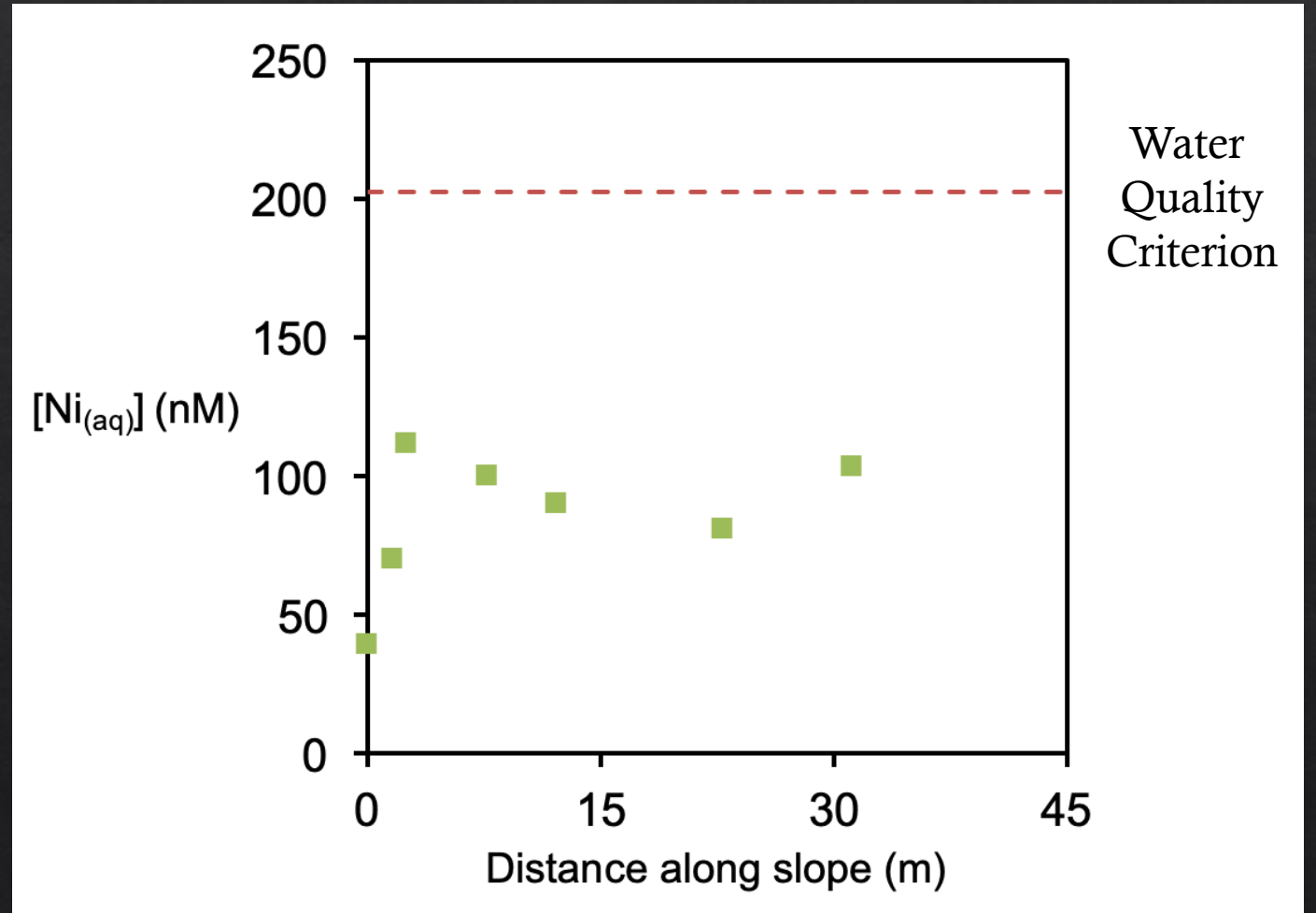
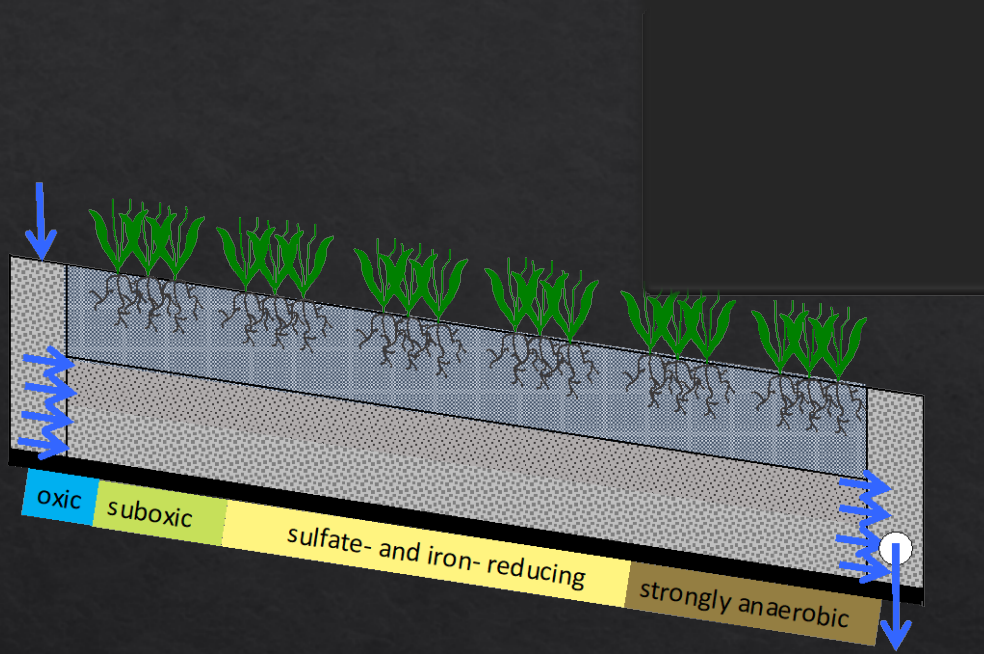
Stiegler et al. (2023) Plant Uptake of Trace Organic Contaminants in Effluent-Dominated Streams: An Overlooked Terrestrial Exposure Pathway. *Environ. Sci. Technol. Letters* 9: 929-936.

Cecchetti et al. (2020) The horizontal levee: a multi-benefit nature-based treatment system that improves water quality and protects coastal levees from the effects of sea level rise. *Water Research X*, 7, 100052.

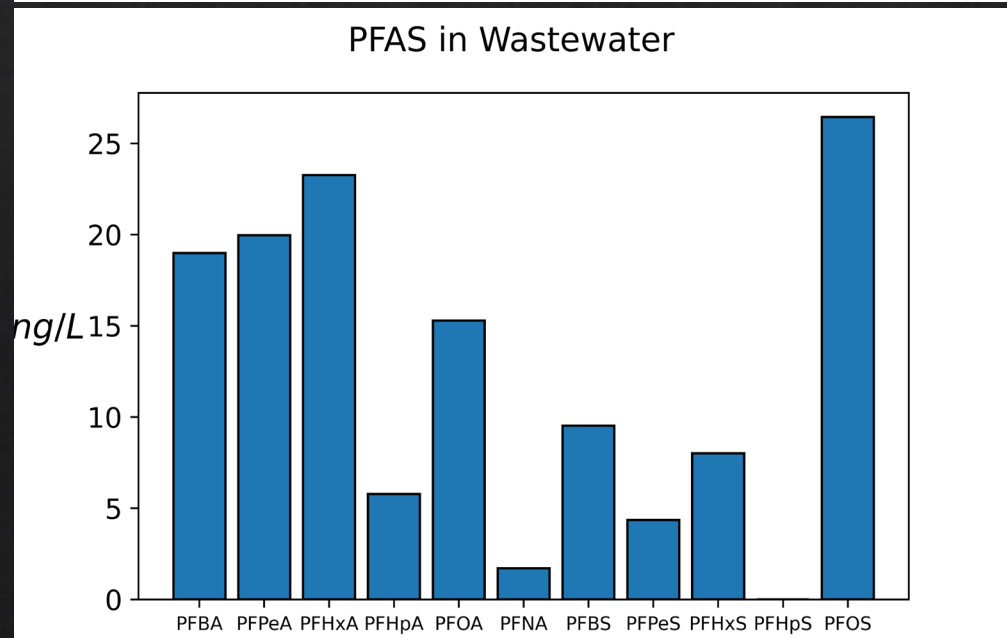
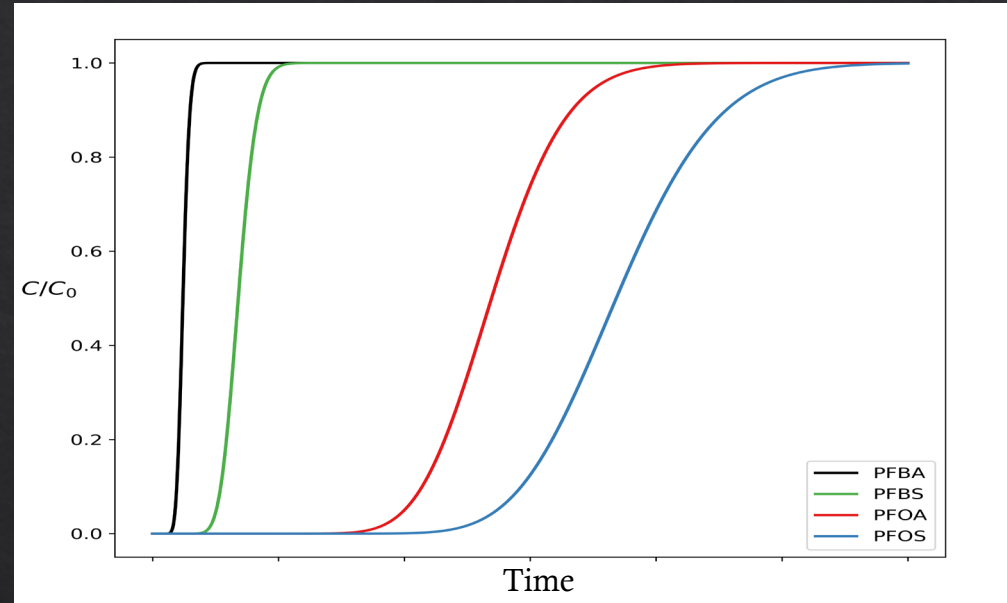
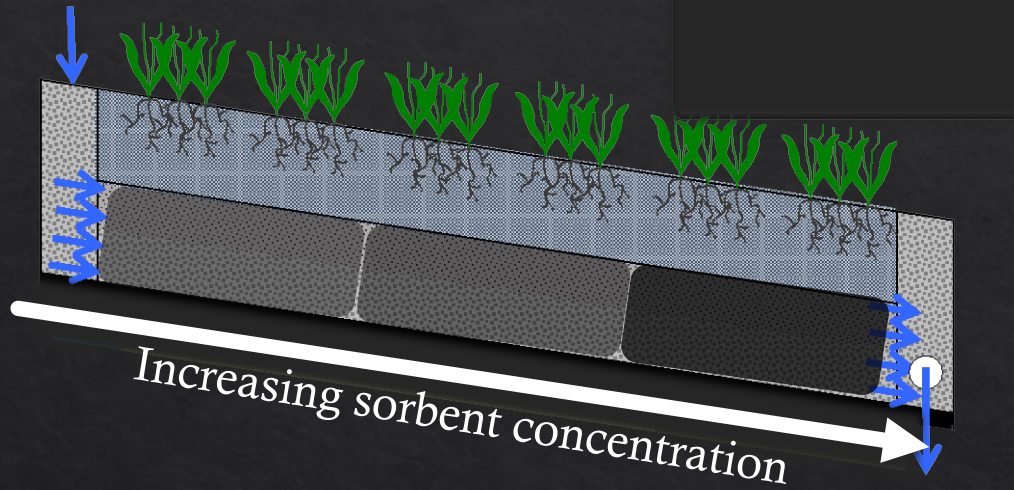
# Copper Removal and Sulfate Reduction



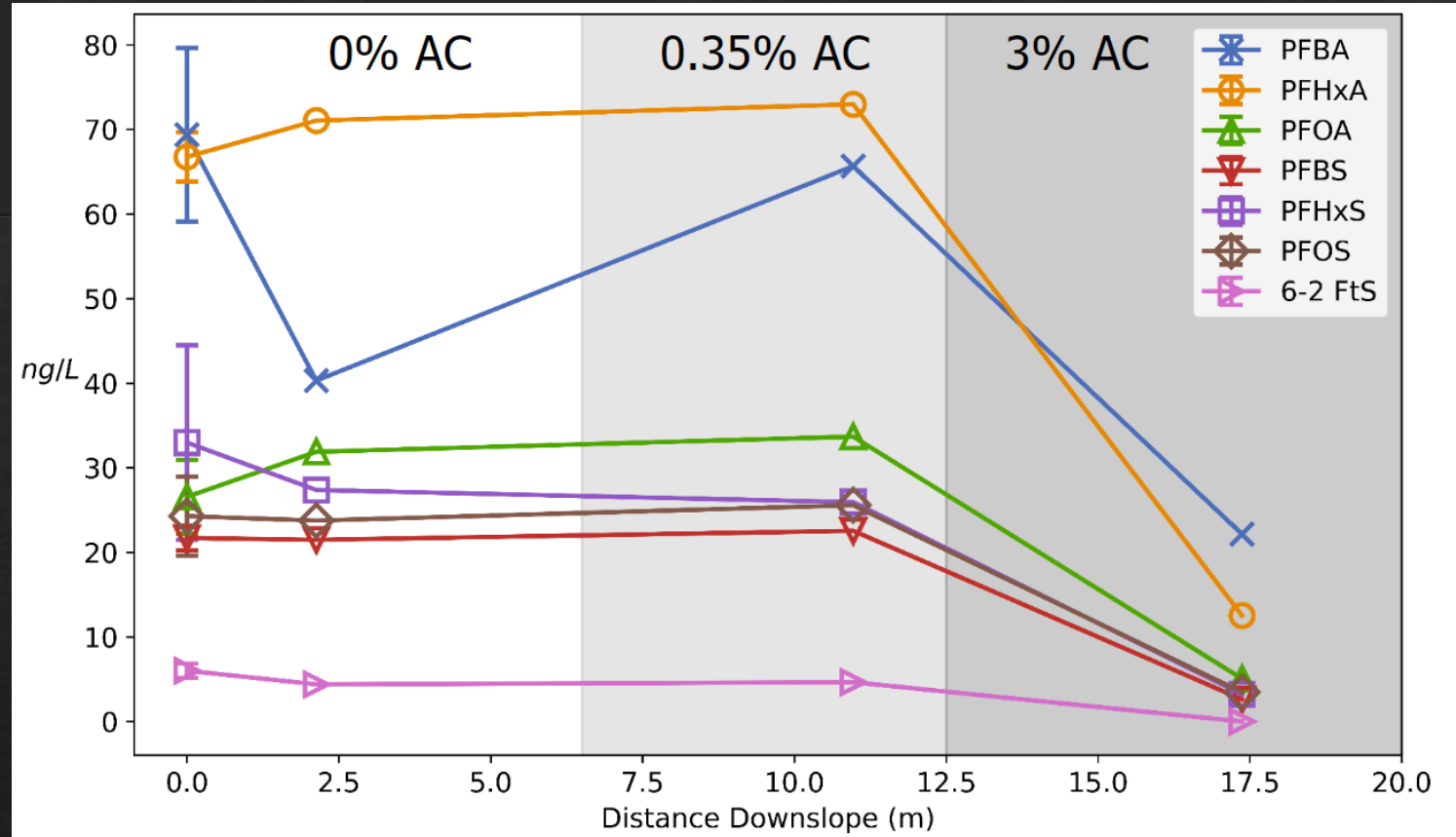
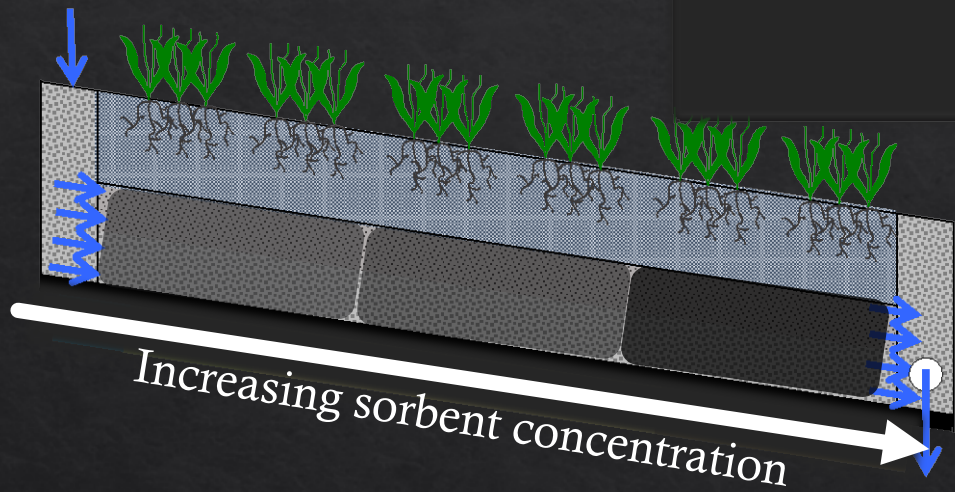
# Nickel Leaching



# PFAS Removal

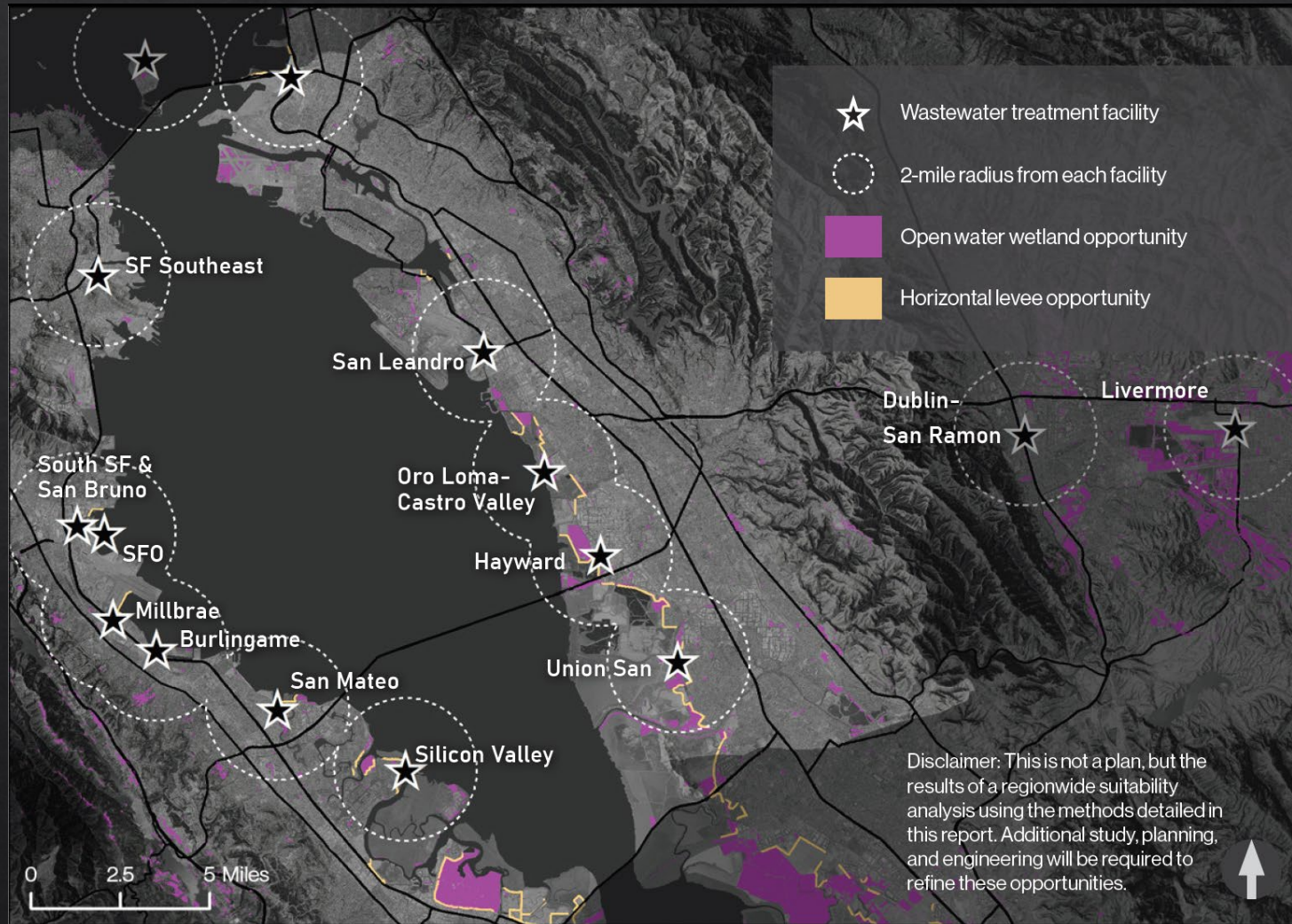


# PFAS Removal



Cell 1A receiving reuse concentrate, data collected approximately 180 days after startup

# Applying these Lessons at Scale

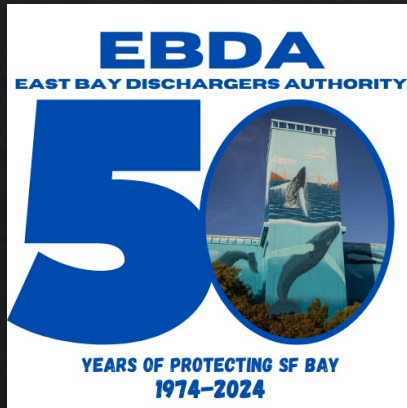




# First Mile Horizontal Levee Project



San Francisco  
**ESTUARY PARTNERSHIP**



Imagery: Nate Kaufman

# Alternate Visions of the Future



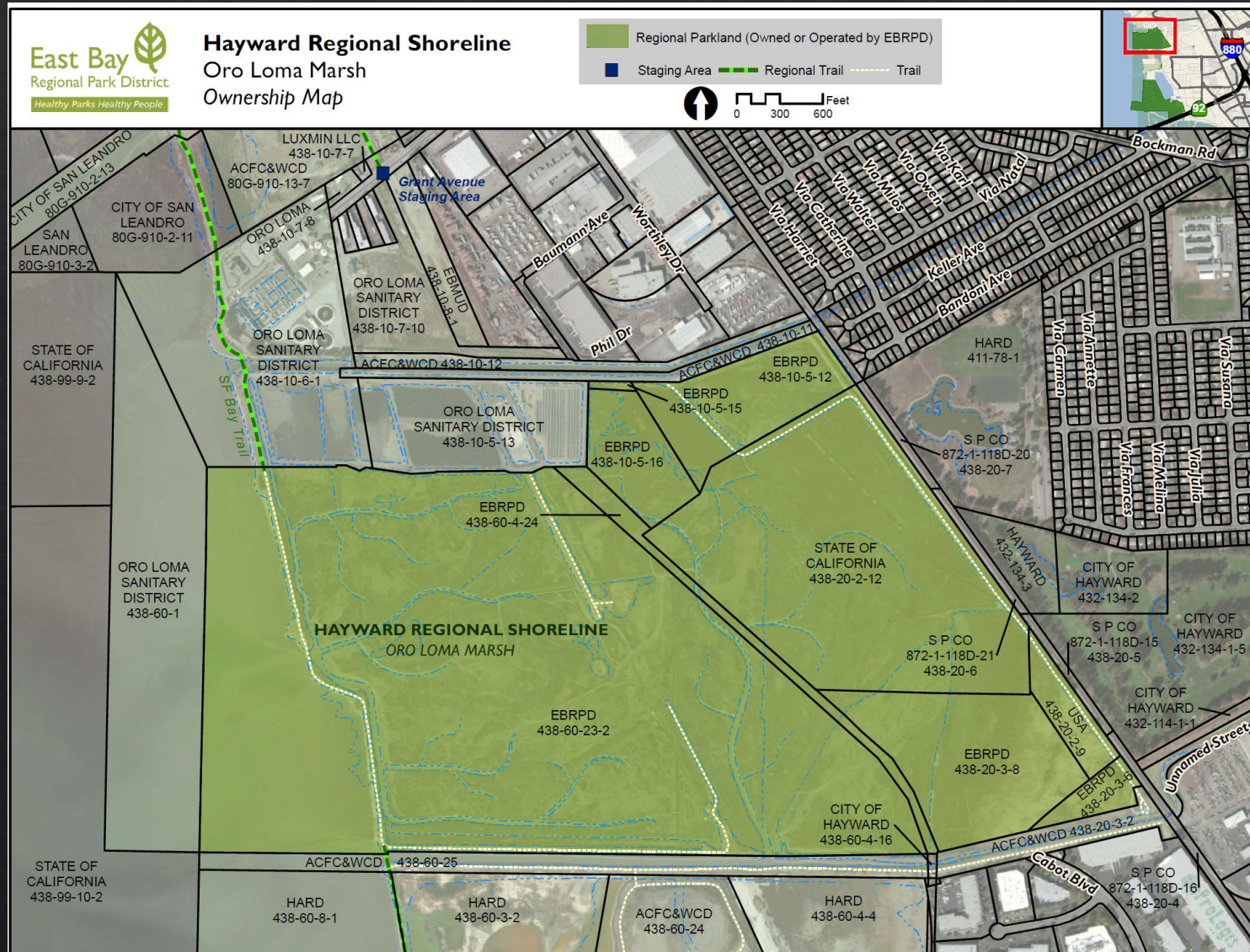
Imagery: Nate Kauffman

# The preliminary goals of the First Mile Project are to:

- ◇ implement a full-scale demonstration of the horizontal levee concept,
- ◇ contribute to reducing current and future flood risk for the HASPA planning area,
- ◇ enhance habitat for special status and native wetland-dependent species,
- ◇ make existing habitats more resilient to sea level rise,
- ◇ provide public access to the Hayward Regional Shoreline that is resilient to sea level rise,
- ◇ support recreational and social benefits to nearby communities, and
- ◇ improve water quality in San Francisco Bay.



# It's Complicated



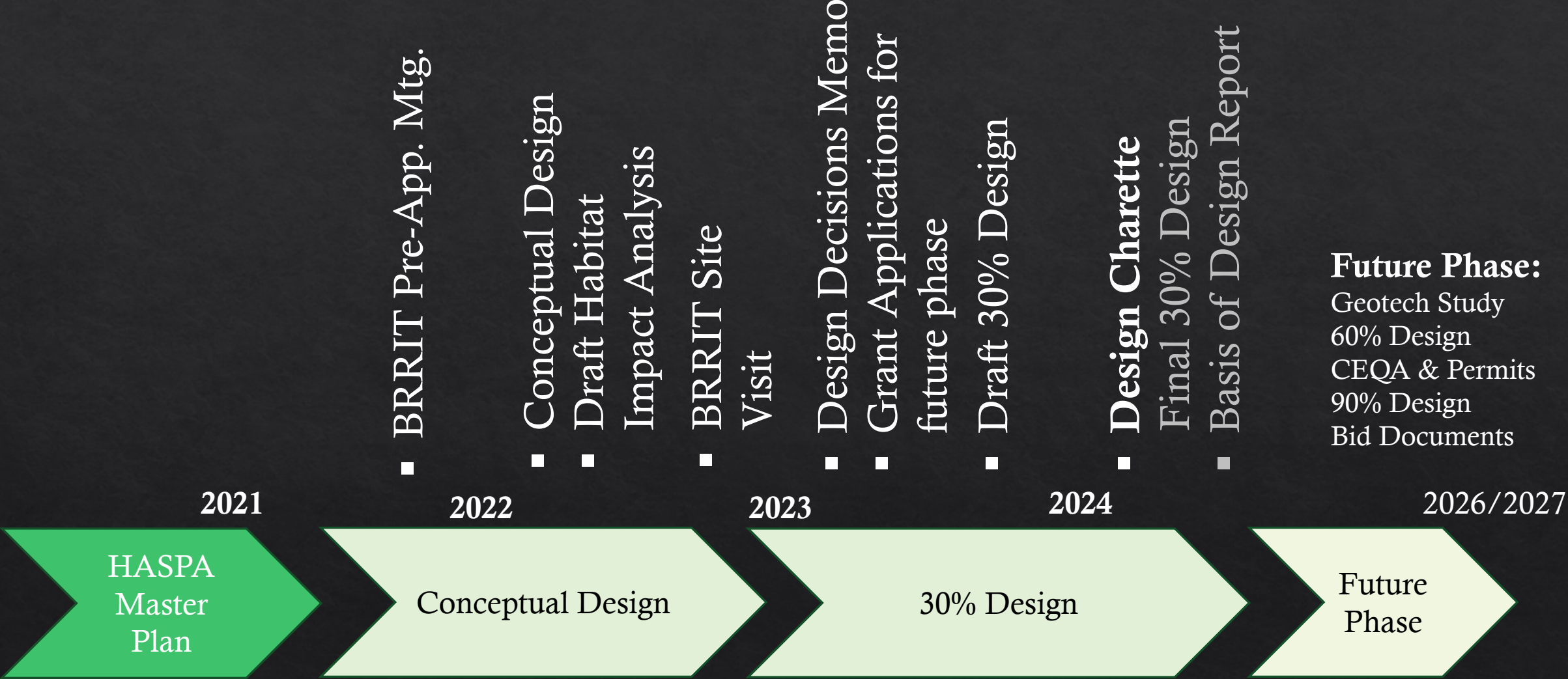
- ◆ Land ownership
- ◆ Historical uses
- ◆ Permitting
- ◆ Mitigation requirements
- ◆ Public engagement
- ◆ Stormwater management
- ◆ Responsibility for O&M

# Integrated Planning Processes Help

HASPA Master Plan:  
*haywardshorelinemasterplan.com*



# First Mile Planning and Design Timeline

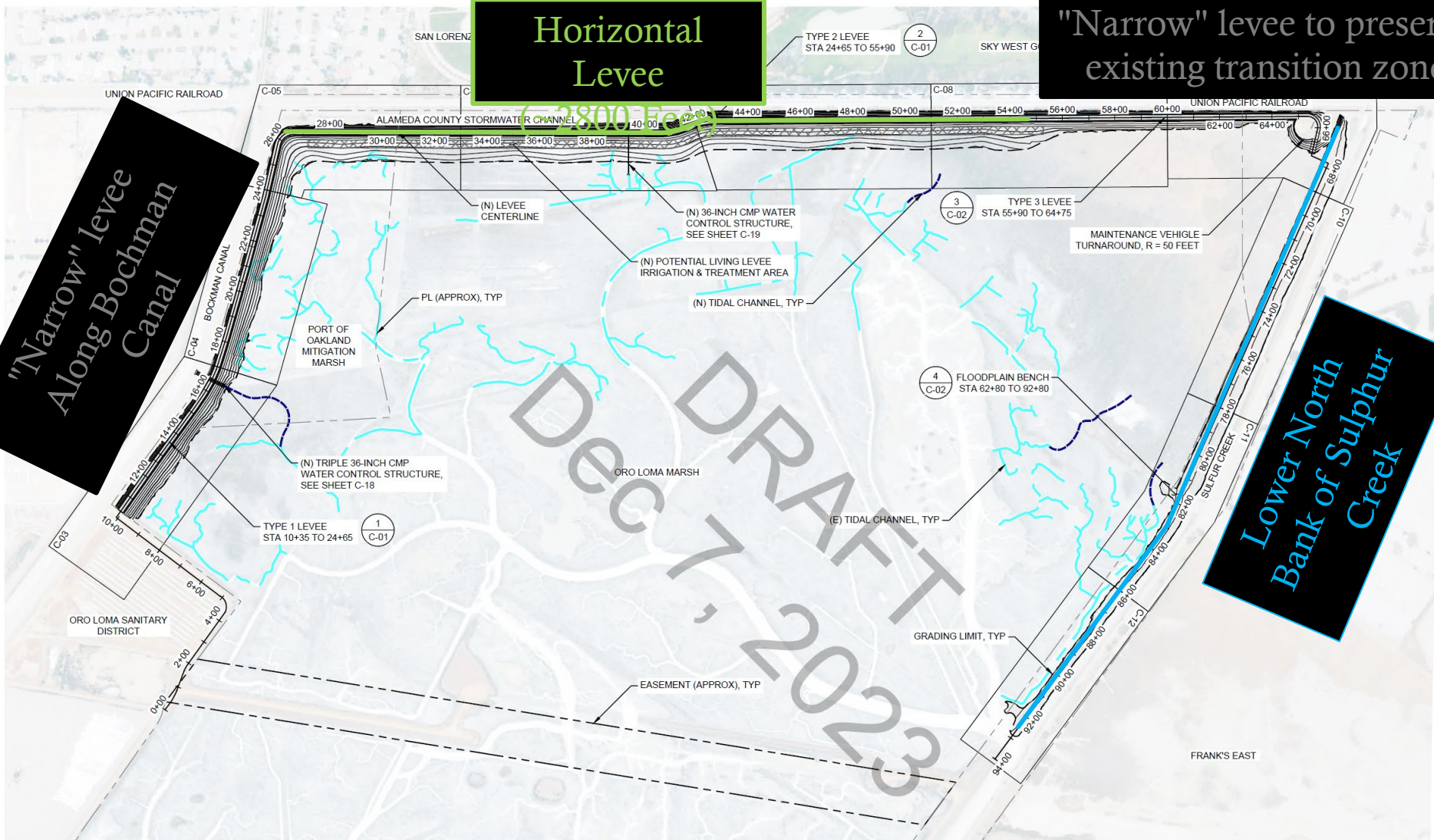


Horizontal  
Levee

"Narrow" levee to preserve  
existing transition zone

"Narrow" levee  
Along Bochman  
Canal

Lower North  
Bank of Sulphur  
Creek



**Draft 30% Design**

PROJECT OVERVIEW  
PLAN

SCALE: 1" = 200'



**ESA**  
550 KEARNY STREET,  
SUITE 800  
SAN FRANCISCO, CA 94108  
OFFICE - 415.886.5900  
WWW.ESASSOC.COM

STAMP  
PRELIMINARY  
NOT FOR  
CONSTRUCTION

CONSULTANT  
**EBDA**  
EAST BAY DISCHARGERS AUTHORITY

PROJECT NAME  
**FIRST MILE  
HORIZONTAL LEVEE  
PROJECT**  
2655 GRANT AVENUE  
SAN LORENZO, CA 94550

REVISIONS

#	DATE	DESCRIPTION

DESIGNED	E. DIVITA
DRAWN	SM/DH/LT
CHECKED	E. DIVITA
IN CHARGE	E. DIVITA
	C81281

PROJECT NUMBER 201800437.01  
ISSUE DATE 12/07/2023  
SCALE IS AS SHOWN WHEN  
PLOTTED TO FULL SIZE (22"x34")  
1" = 200'

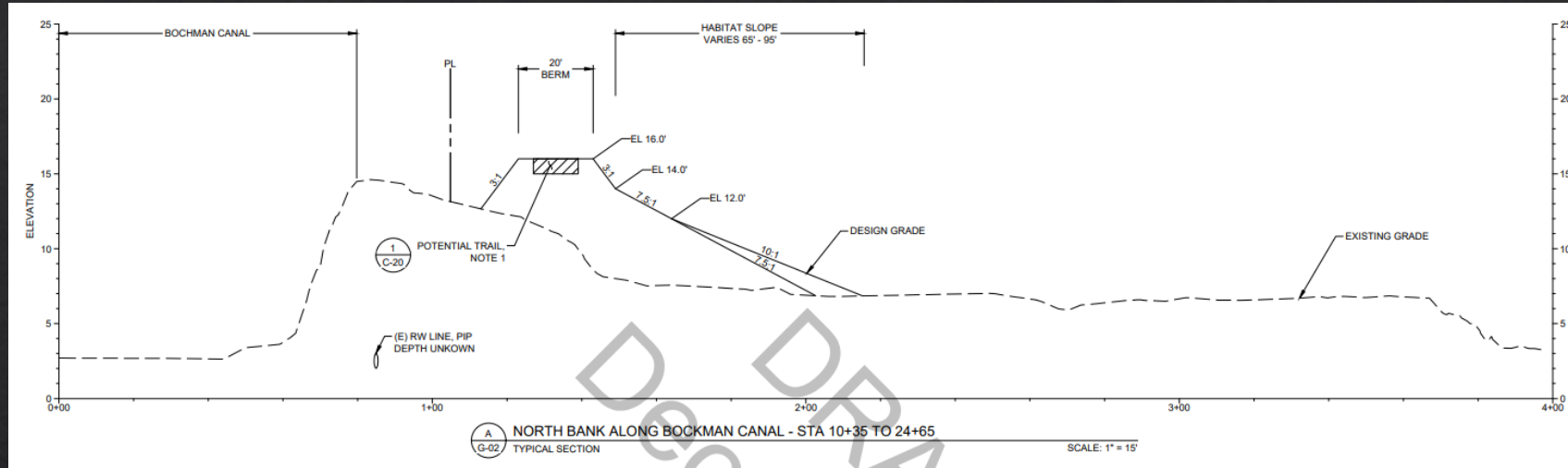
PHASE  
30% DESIGN

SHEET TITLE  
**PROJECT  
OVERVIEW**

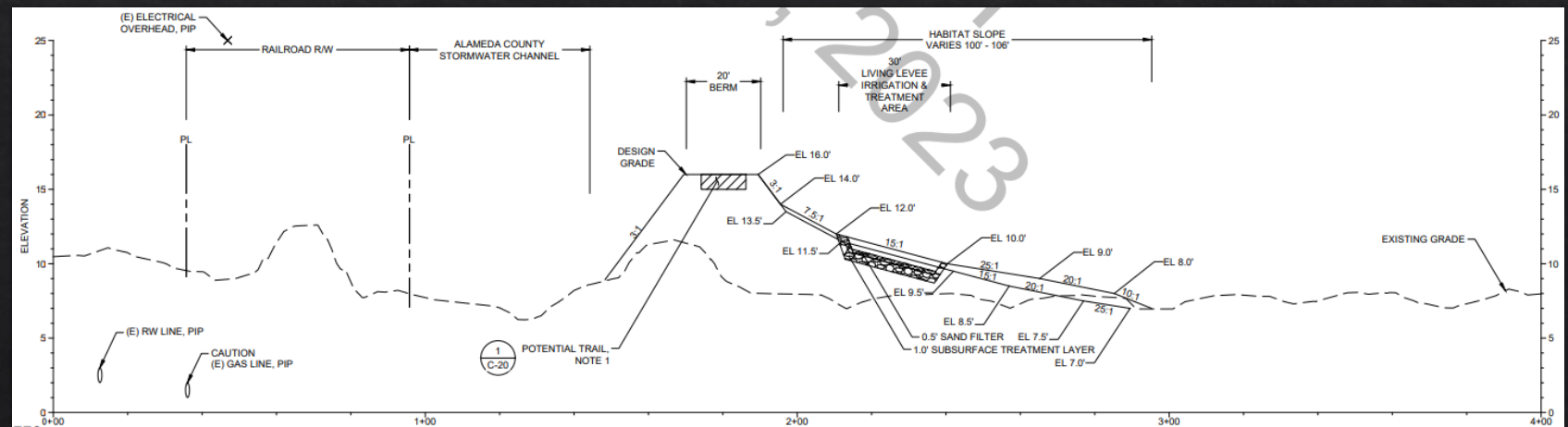
SHEET NUMBER  
**G-02**  
SHEET 2 OF 33

# Typical Levee Cross Sections

**Narrow Levee (No Treatment Zone): ~60ft Wide Ecotone Slope**



**Horizontal Levee (With Treatment Zone): 100ft Ecotone Slope with Treatment Zone**



*Draft levee cross sections will be revised based on geotechnical analysis*



# Treatment Zone and Ecotone Slope Tradeoffs

## Treatment Zone & Ecotone Slope Benefits

- ◆ Advanced nutrient and contaminant removal
- ◆ Supports native upland/transition zone/non-tidal wetland plants, and provides potential benefits to certain wildlife

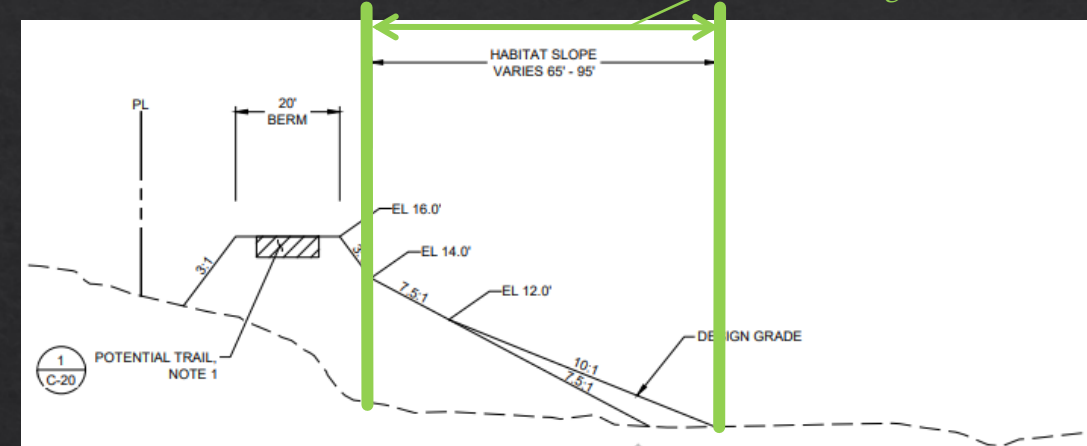
## Habitat Tradeoffs

- ◆ Creates: Managed wet meadow/brackish marsh, native grassland, transition zone habitats
- ◆ Impacts: Tidal marsh (with impacts to SMHM, CABR, RWR)

## Impacts to Jurisdictional Wetlands

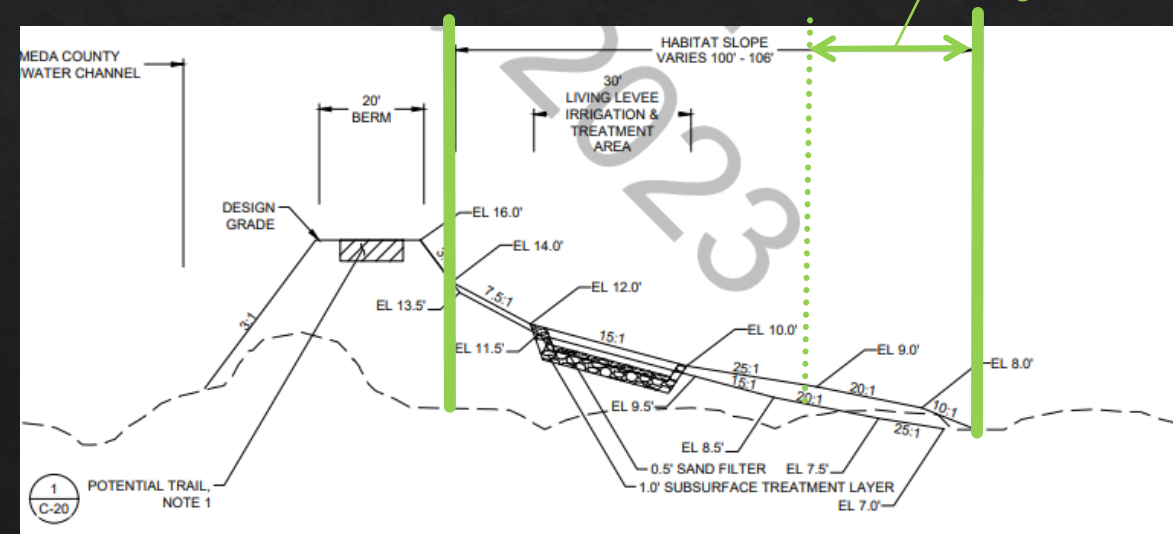
- ◆ Approx. ~4.5 acres impacted
- ◆ Permits will likely require offsets or compensation for these impacts (offset via restoration elsewhere on-site, offsite mitigation, or fee)

Unavoidable  
Impacts to  
Existing Habitats



**Narrow Levee (No Treatment Zone)**

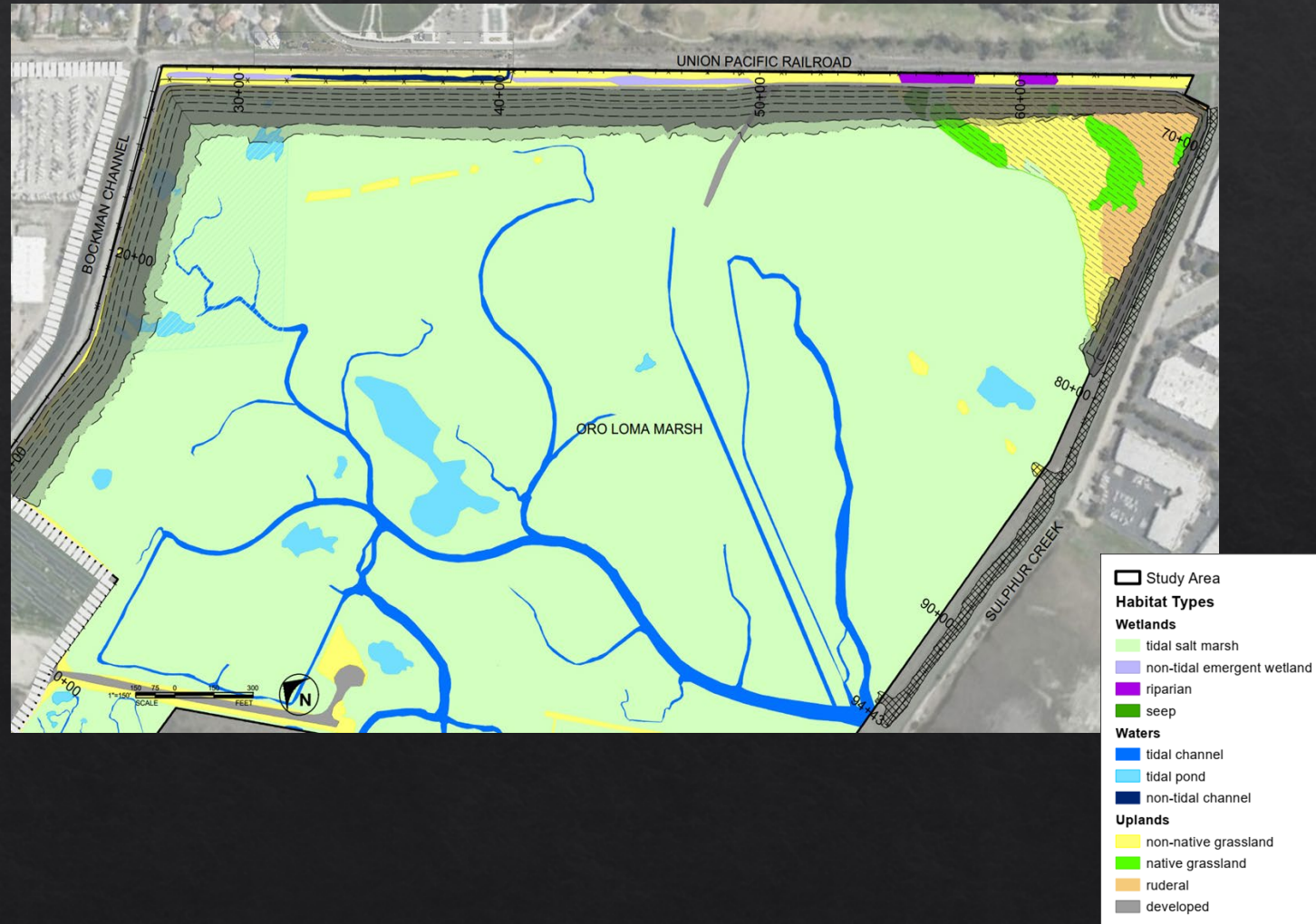
Additional  
Impacts to  
Existing Habitats



**Horizontal Levee (With Treatment Zone)**

# Permitting Considerations

- ◇ Habitat Baseline
  - ◇ Future sea-level rise conditions
  - ◇ Future habitat conversion/loss without project
- ◇ Habitat type conversion
  - ◇ Beneficial fill
  - ◇ Freshwater input to tidal marsh
- ◇ Protected species considerations
  - ◇ Short-term construction impacts
  - ◇ Long-term benefits (mid-high marsh, upland habitats)
- ◇ NPDES permitting
  - ◇ Point of compliance for effluent limits
  - ◇ Nutrient reduction “credit”



# Long-term SLR Adaptation



# Conclusions

- ◆ Huge opportunity to achieve multiple objectives
- ◆ Multiple objectives leads to multiple trade-offs
- ◆ Challenge to balance protecting for the future while minimizing impacts today
- ◆ Community benefits is an area that needs more attention
- ◆ Important to get all key stakeholders (in our case, flood control and railroad) to the table



Imagery: Nate Kauffman

A sunset over a beach with a dark vertical bar on the right side. The sky is filled with orange and yellow clouds, and the sun is low on the horizon. The water is dark blue, and the beach is dark with some wet sand reflecting the light. The text "Questions and Discussion" is written in white serif font in the upper left quadrant of the image.

# Questions and Discussion

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**Anthony DeSalvo**  
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**Jackie Zipkin**  
[jzipkin@ebda.org](mailto:jzipkin@ebda.org)