Bothin Marsh at High Tide

Coyote Creek to Bothin Marsh Dredge Sediment Beneficial Reuse Feasibility Study

Funded by NBWA

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Roger Leventhal, PE, Senior Engineer, Marin County

Peter Baye, PhD, Coastal Ecologist

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Study Goals

Evaluate the feasibility (opportunities/constraints and costs) for two SLR adaptation techniques that beneficially reuse dredged sediment from Coyote Creek at Bothin Marsh:

1. Thin-lift placement of dredge sediment from Coyote Creek flood control dredge
2. Coase-grained “beach” edge treatment at eroding edge of Bothin Marsh

➢ Received $25,000 NBWA grant – thanks!

Talk Outline

- Bothin Marsh flooding and loss of habitat
- Past marsh restoration approaches (deep fill)
- Thin-lift dredge placement approach
- Natural analogues to thin-lift
- Coarse-grained beach edge
- Feasibly study results
- Applicability elsewhere in the Bay
- Next Steps

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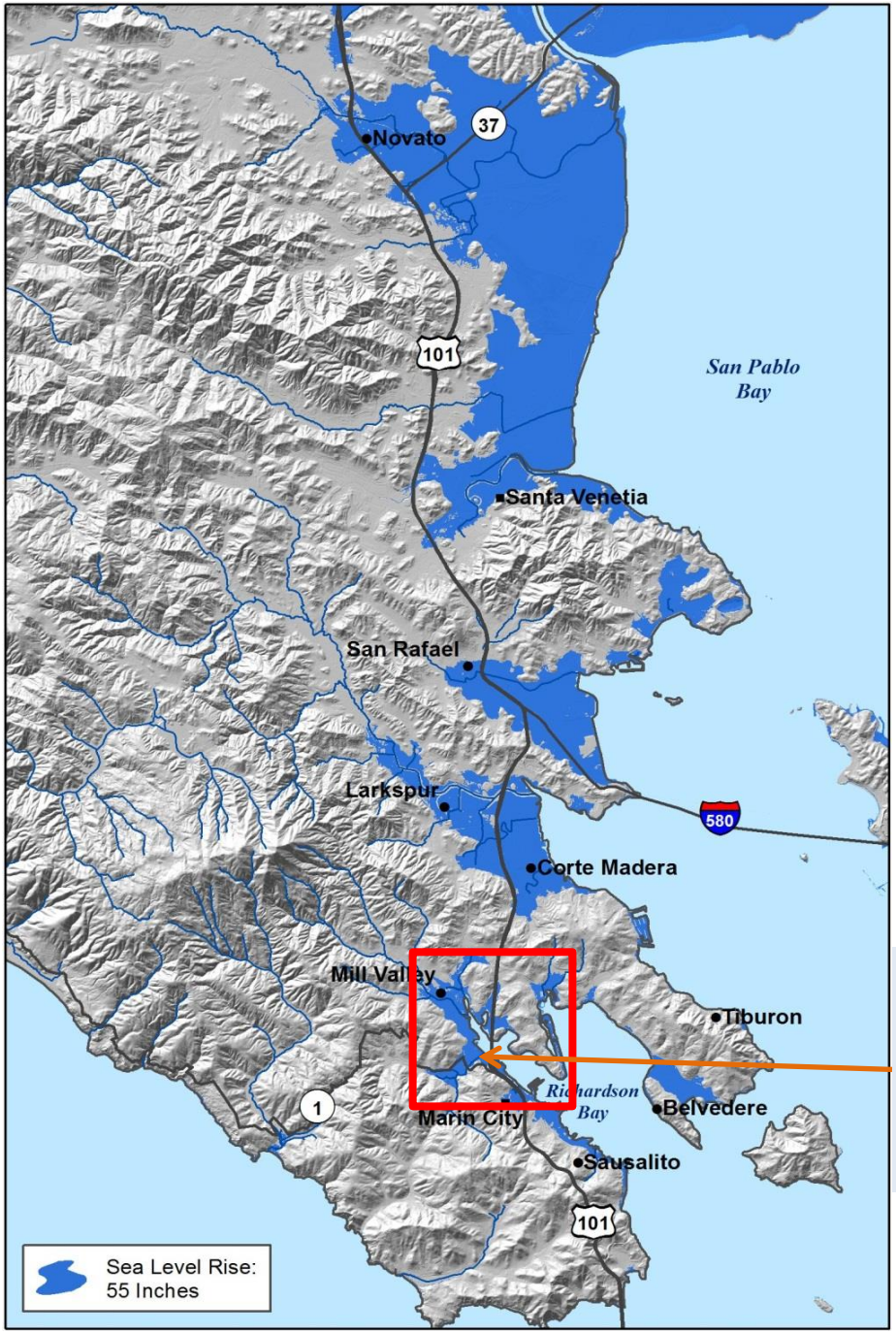
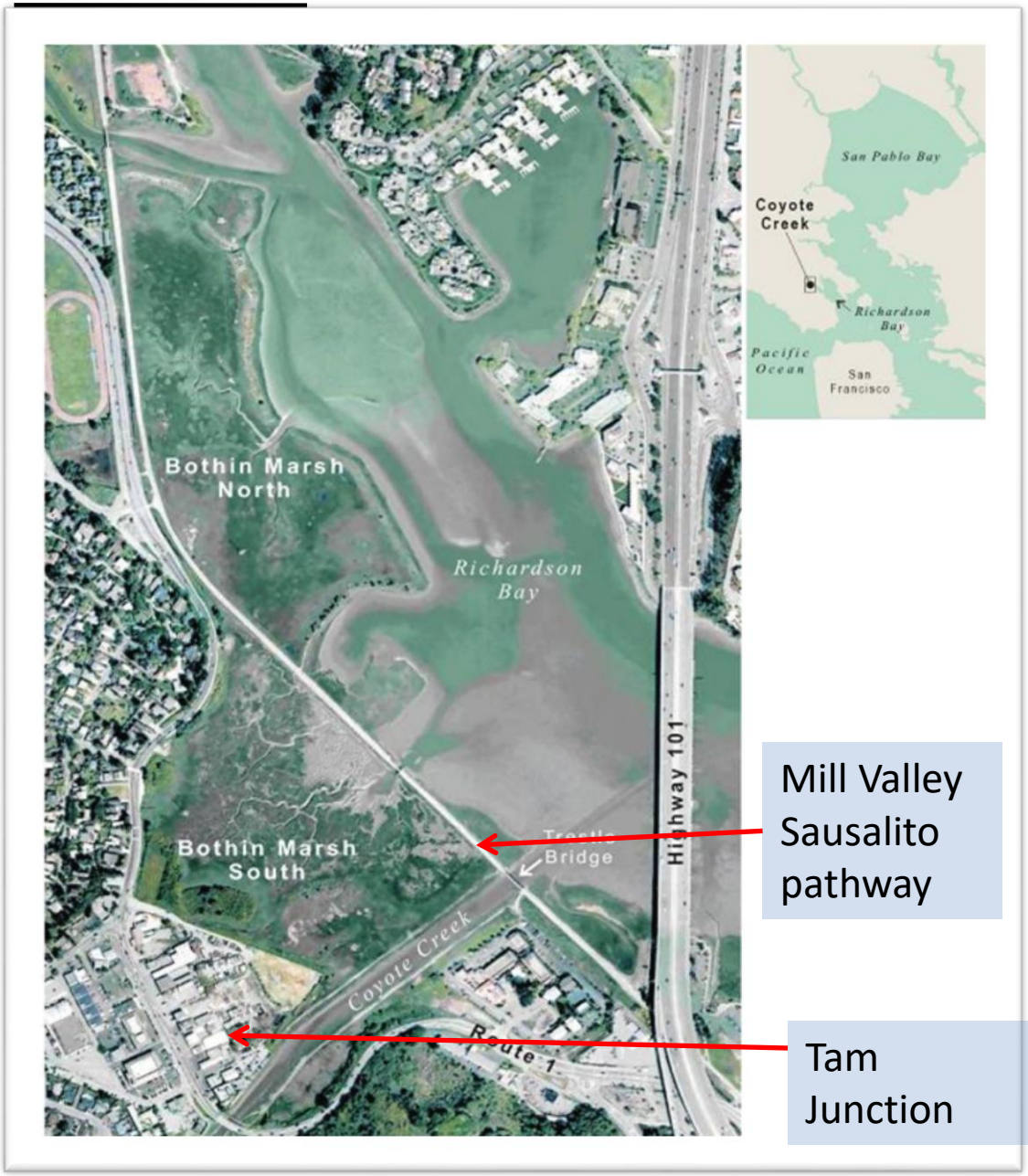


Richardson Bay and the Bothin Marsh Complex



Bothin Marsh fronts highly urbanized edge of Mill Valley

Regularly flooded on high tides

Much used trail

Adjacent to flood control channel periodically dredged

Flooding and Loss of Marsh Habitat

Bothin Marsh Overtopping on High Tides

Overflow flooding onto roadways

Preview of SLR around the Bay

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Flooding of Roads and Trails

Bothin Marsh Overtopping on High Tides

Overflow flooding onto roadways

Preview of SLR around the Bay

January 16, 2017 King Tides

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January 16, 2017 King Tides

January 16, 2017 King Tides


Days Past

Pathway Trail

Lack of High Tide Cover

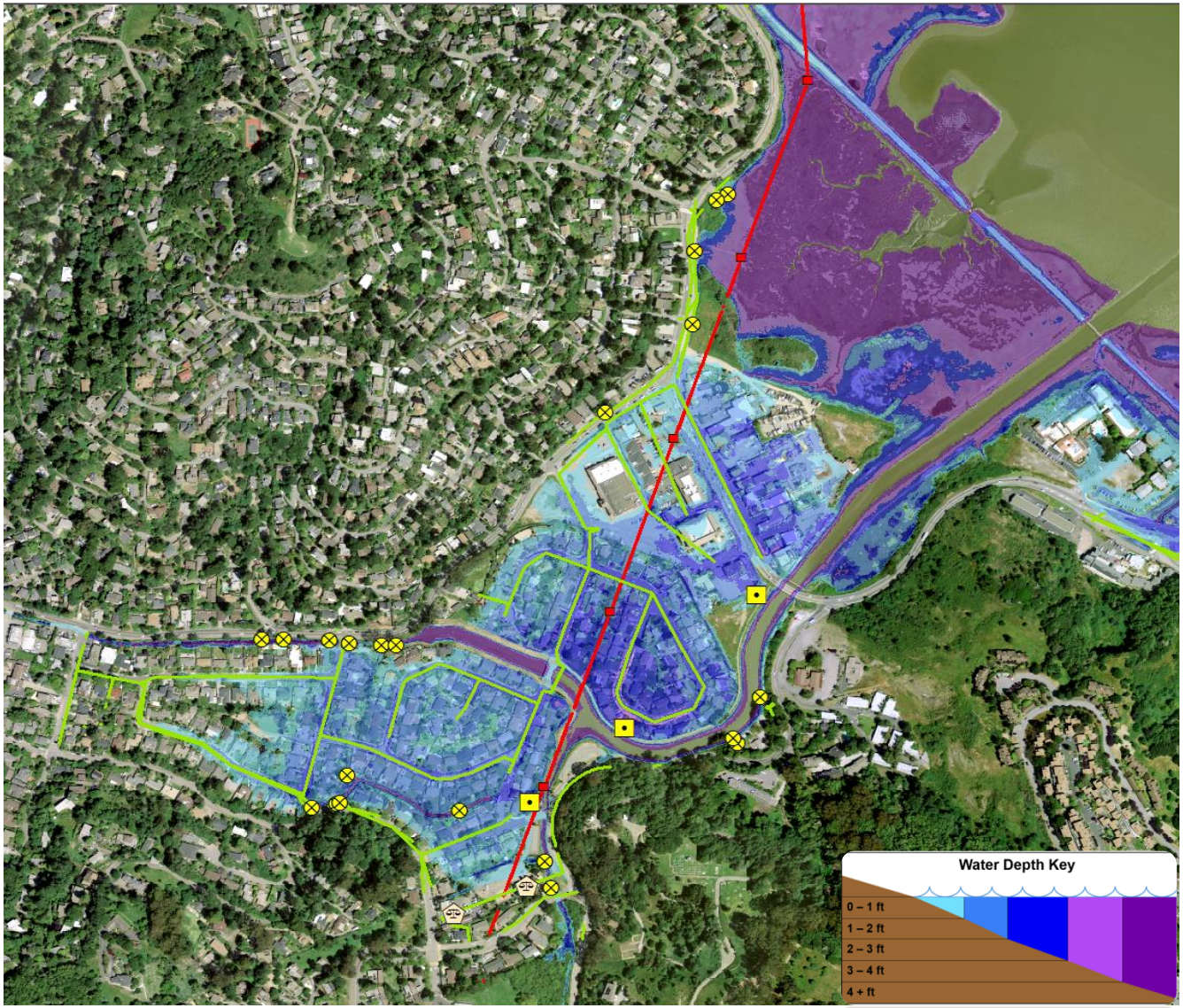
Flooding of Mammals

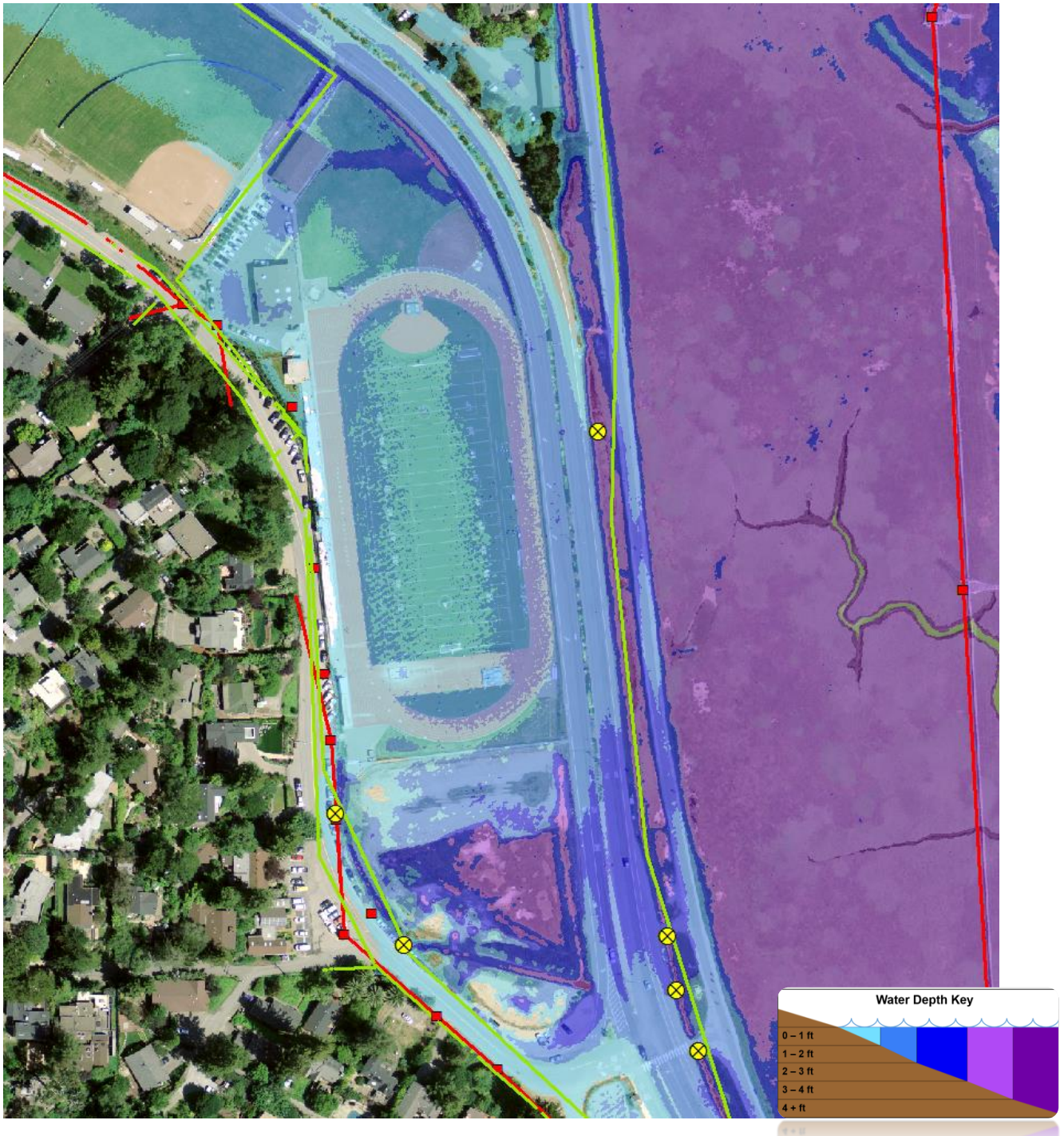
Concrete Rubble Piles

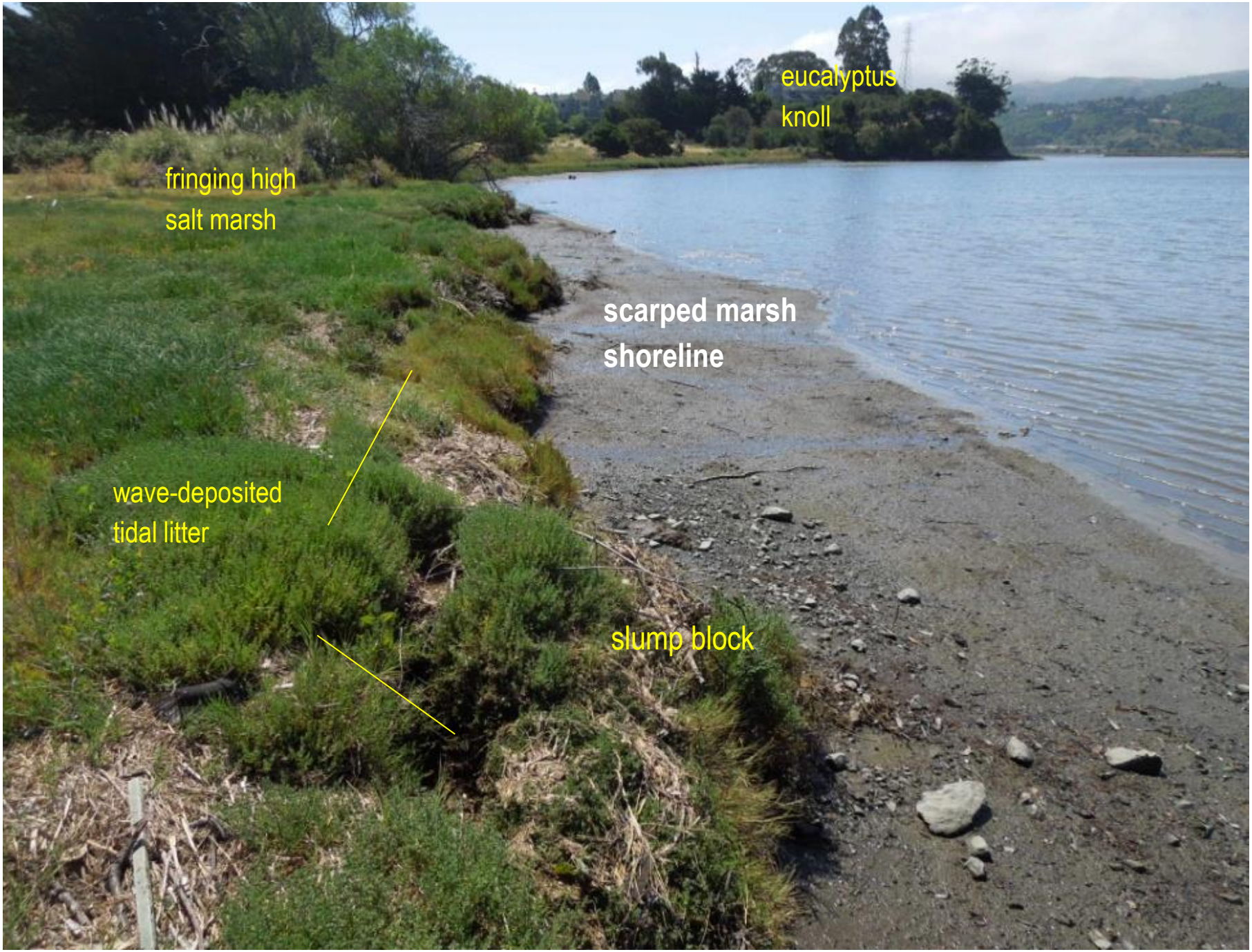
Rubble Piles at King Tide

Invasive Sea Lavender

Bothin and SLR




Water Depth Key
0 – 1 ft
1 – 2 ft
2 – 3 ft
3 – 4 ft
4 + ft


eucalyptus
knoll
fringing high
salt marsh
scarped marsh
shoreline
wave-deposited
tidal litter
slump block

Bay Side Park

Wave-eroded scarps and slumps below high salt marsh north of the pedestrian-bike trail (North Bothin Marsh and Richardson Bay). Coarse sediment addition, and embedded coarse woody debris to impede drifting of coarse sediment, would buffer erosion as it has done at Aramburu Island, Richardson Bay.

North of Coyote Creek mouth, south of South Bothin Marsh bridge/culvert: barren bank at low tide, June 20 2016. Frequent trampling of “bypass” trail (at edge of paved path), stony fill (boulders and rocky fill inhibits root penetration) and summer desiccation (hypersalinity) inhibit establishment of vegetation and facilitates wave erosion of the steep, wave-reflective bank

Wave-eroded rocky bank fill facing Richardson Bay near South Bothin Marsh bridge and culvert

Loss of Natural Sediment Connectivity

Roads and flood control channels impact as follows:

- cut off natural sediment connection from watershed (terrestrial derived sediments)
- and from the bay (estuarine) derived sediments)

➢ These sediments maintain marshes

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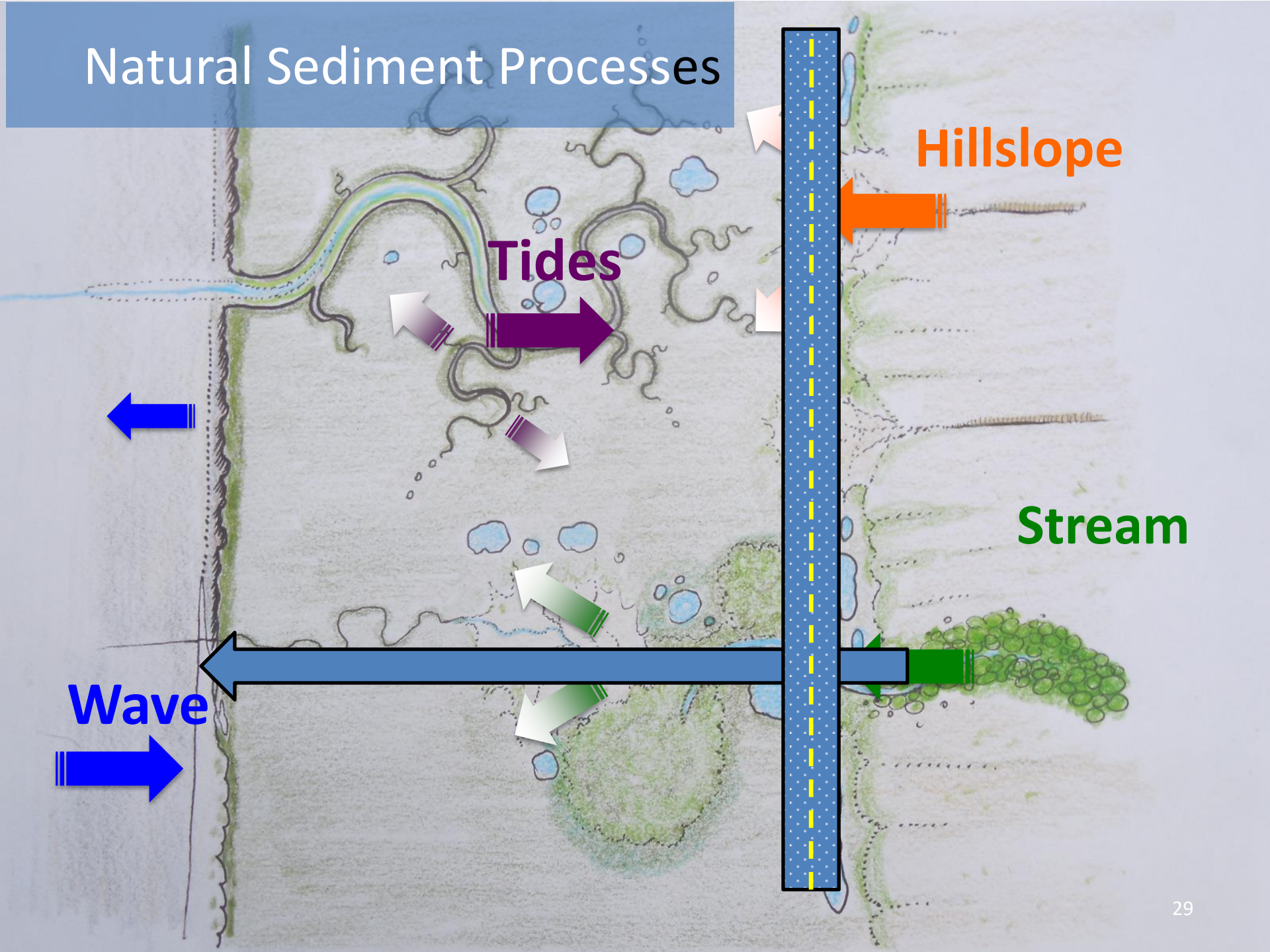
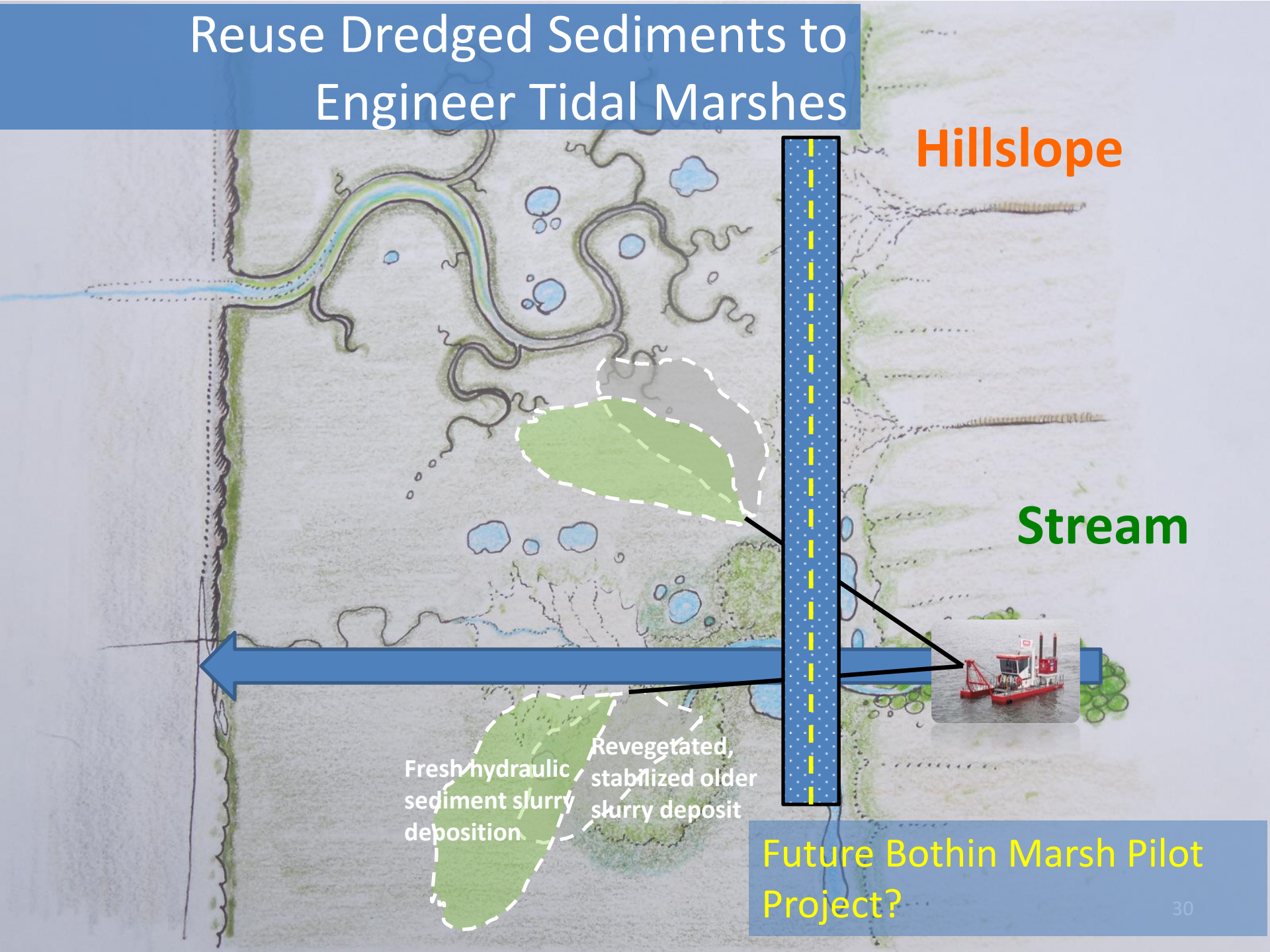
Natural Sediment Processes



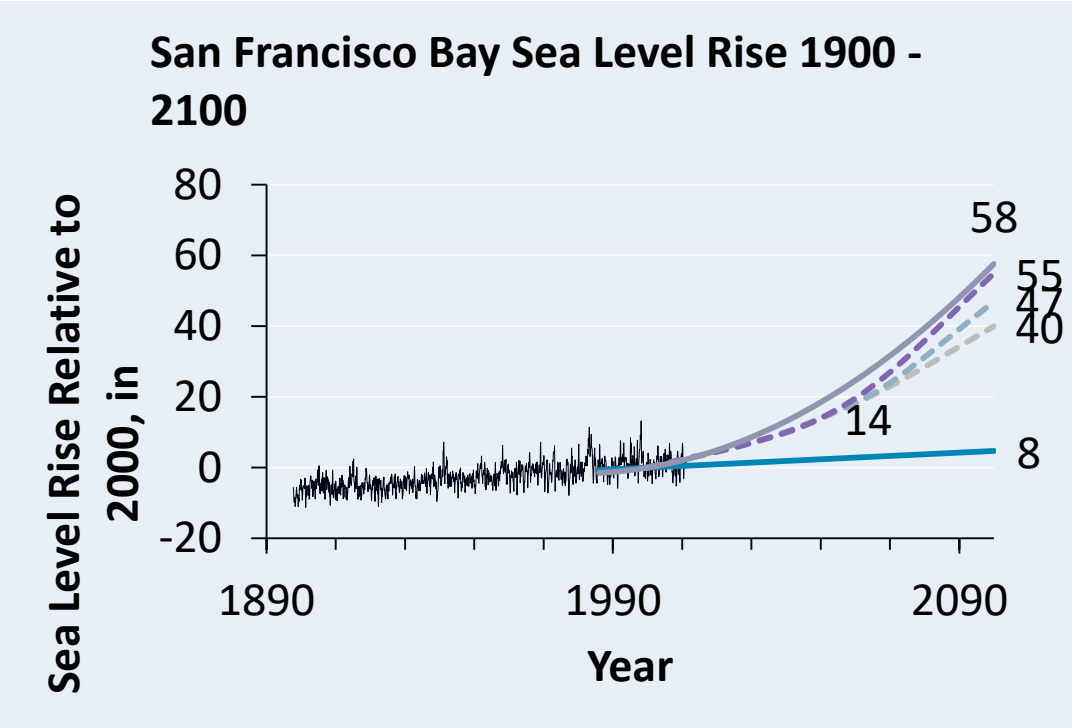
Reuse Dredged Sediments to Engineer Tidal Marshes



Future Bothin Marsh Pilot Project?

What Happens to Tidal Marshes as Sea Level Rises

- Can tidal marshes maintain elevation under SLR conditions?
- Estimates are millions of sediment required to maintain marshes and build H Levees

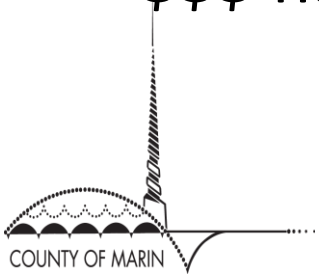


Importance of Sediment Reuse for SLR

- Maintaining habitat and providing flood protection will require development of cost-effective approaches to sediment reuse
- Need more pilot demonstration projects
  - Develop cost-effectiveness and evaluate impacts of thin-lift and beach edge restoration for agencies and design and construction community

Typical Restoration Approaches

- Most tidal marsh in Bay focused on restoration of diked subsided baylands by thick fill from marina/port dredging
- Expensive to transport and pump large volumes of sediment
  - funded by navigation dredging funds
  - $$$ harder to find these days



Dredged material placement at the Hamilton Wetlands Restoration Project

Cullinan Ranch 2017

Thin-Lift Dredge Placement

- Hydraulically dredge and place sediment in 6 to 10 inch lifts
- Allows for plant regrowth
- Pioneered By USACE in Louisiana and used on the East Coast

Typically done in Louisiana with spray dredge – **NOT** how pilot project proposes to place sediment

Thin-Lift Dredge Placement

Seal Beach Pilot Project, So Cal 2016
Proposed pilot is for a smaller 8 to 10-inch dredge with end diffuser

Natural Analogues for Thin-Lift

Sonoma Baylands 2006

Sonoma Baylands 2012

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China Camp Analogue

Natural alluvial fan sedimentation over mature salt marsh, China Camp State Park, San Rafael, Marin

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Hydraulic Dredge splay, Montezuma Wetlands

Thin-Lift Pilot Monitoring

Need to pilot both engineering and habitat techniques and impacts

- Thickness for plant regrowth
- Impacts of sediment chemistry
- Control of placement
- Production rate and costs

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Coarse-Grained “Beach” Edge

Coarse-grained “beach” edge as a SLR adaptation technique to inhibit marsh edge scarping

Engineered bay beach pioneered in Marin by Baye/Siegel/Leventhal design team for R Bay Audubon at Aramburu Island 2011/2012

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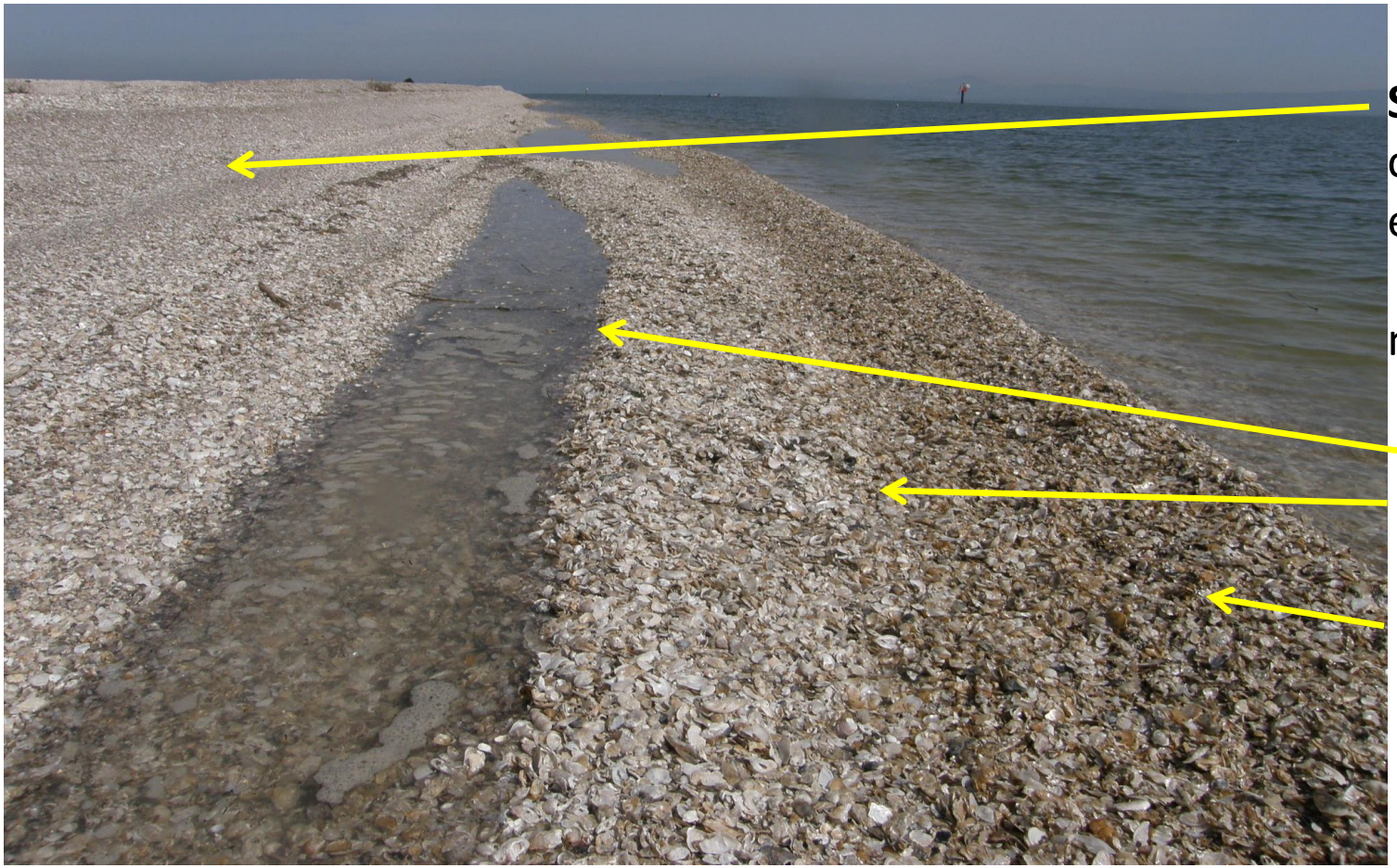
Dynamic beach v. static armor shorelines:

beaches move with waves and SLR



Storm berm crest elevation ≈ 1 m > salt marsh plain

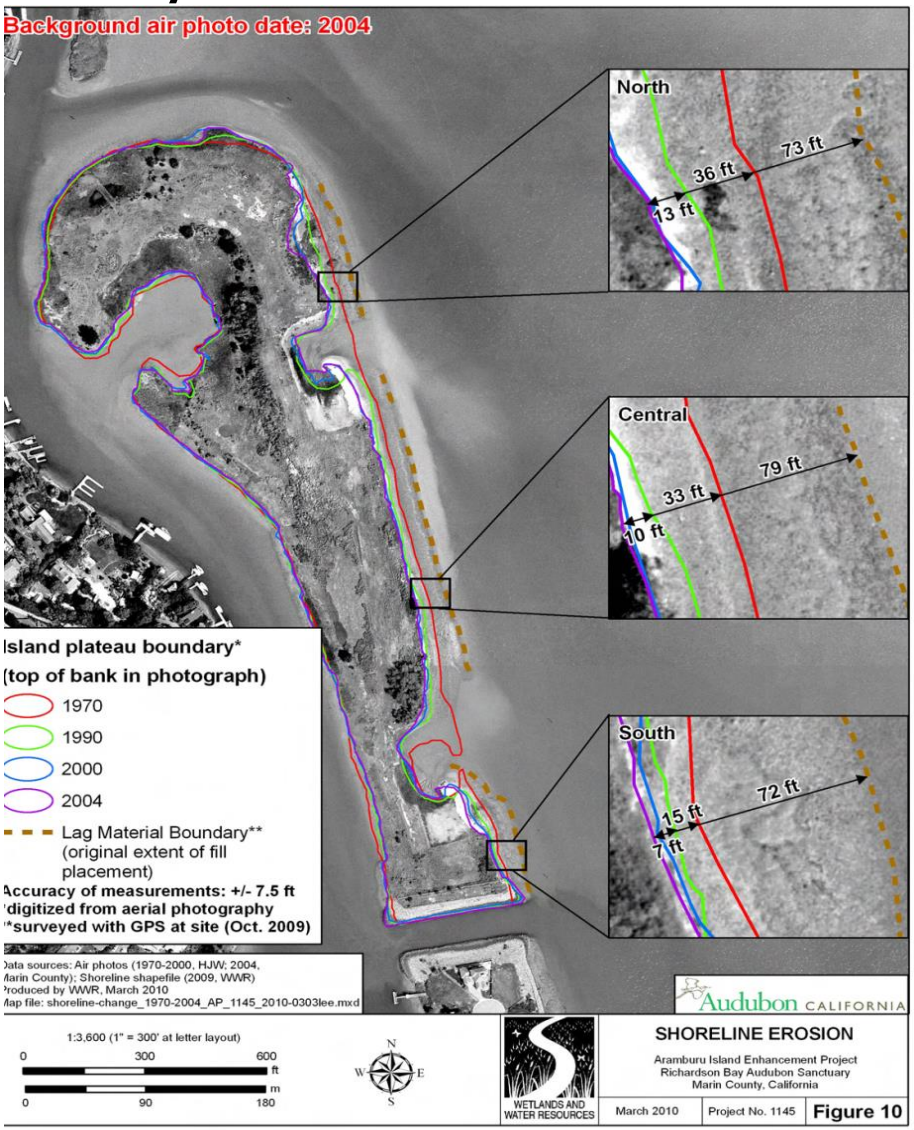
Relict neap berms

Freshly deposited swash bar (boat wakes)

Bair Island, Redwood City

Aramburu Island, Richardson Bay

45+ yr shoreline retreat > 130 ft; boulder-cobble lag



Central cell pre-construction profile: scarp above cobble-boulder lag

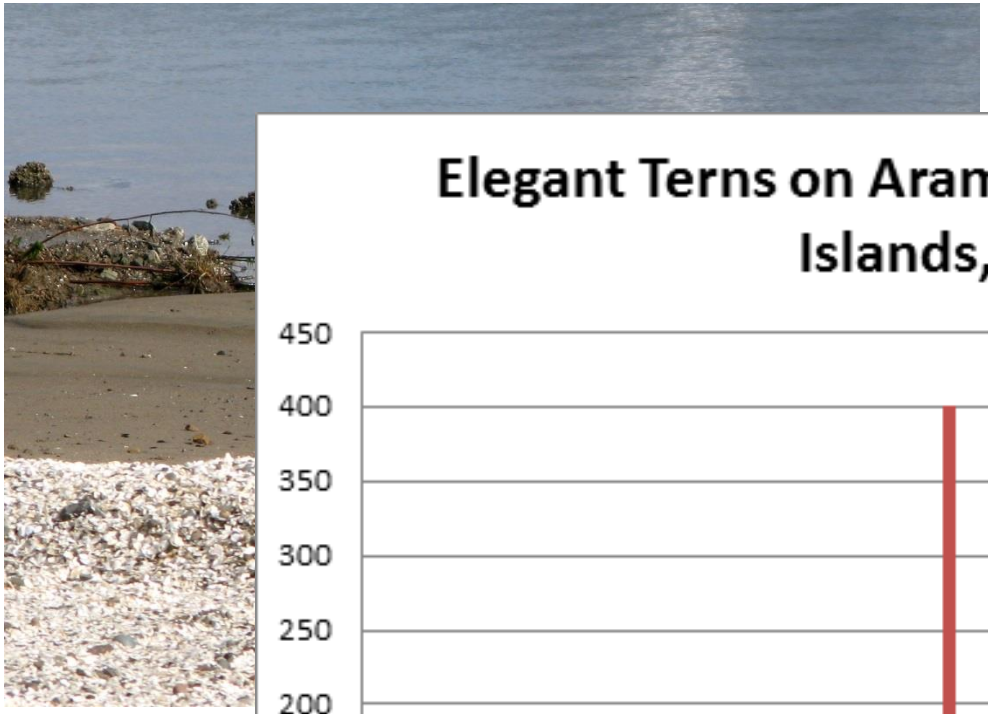
Initial coarse sand beach profile and initial placement of oyster shell hash

Monitoring Photos 2012-2013

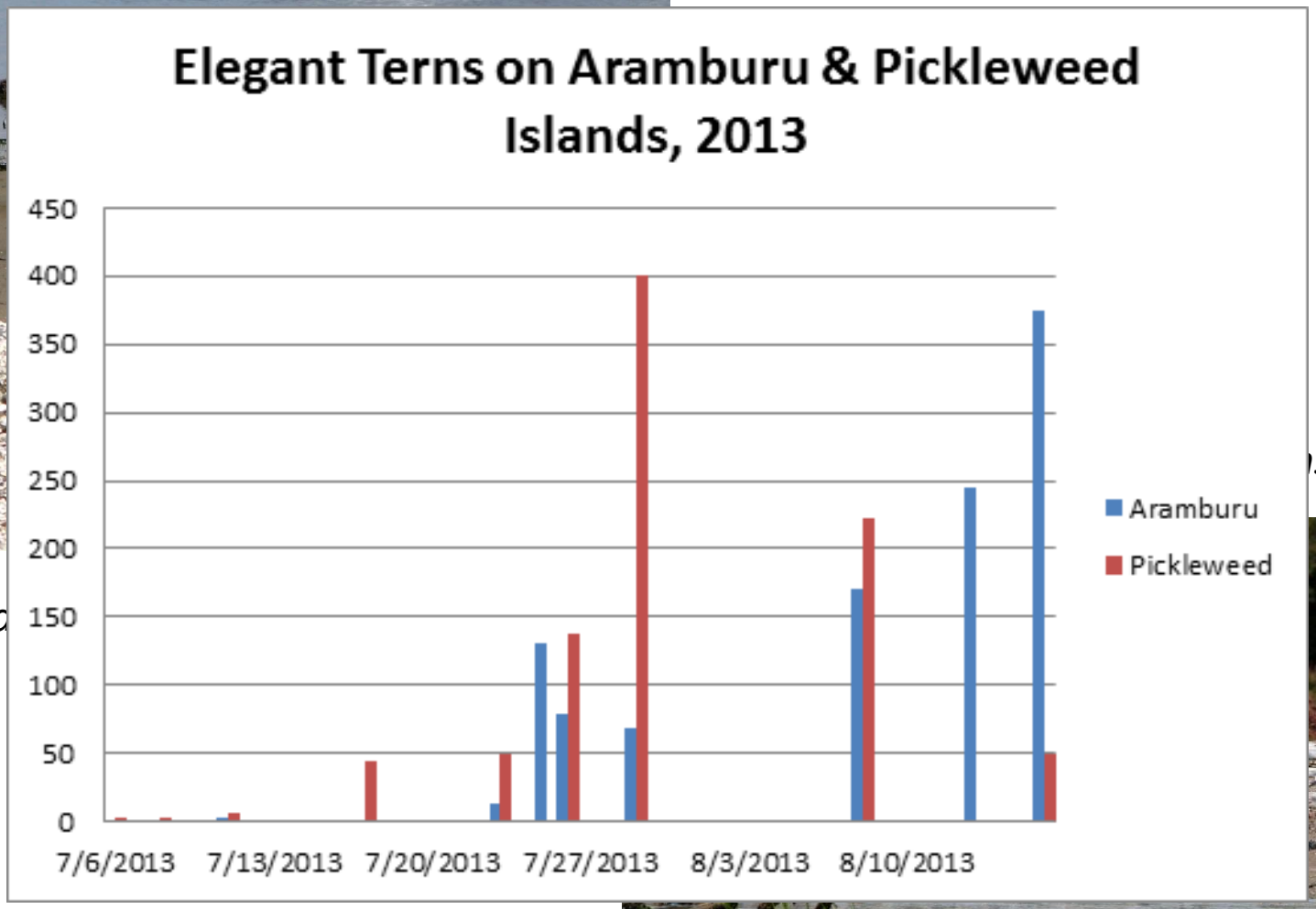
Dec 5, 2012 post-construction

April 16, 2013 post significant southern storms

Sept 19, 2013 post storms



Aramburu Island Birds 2013



Oyster co

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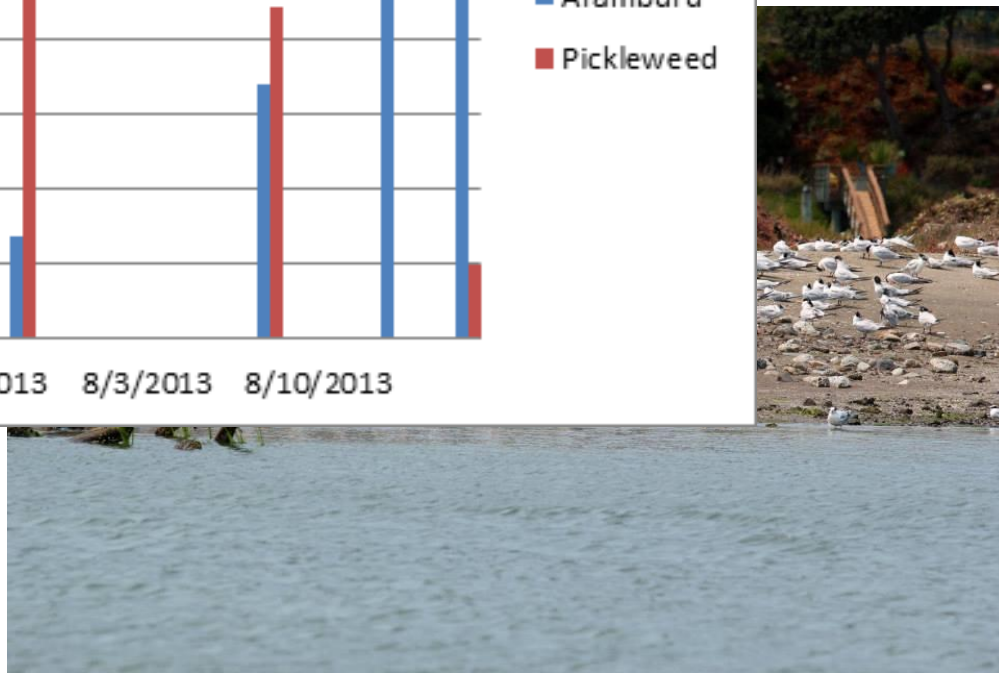

Beach Edge Pilot Monitoring

Focus on engineering techniques

- Placement methods and costs
- Design of sediment retention structure (LWD, microgroins)
- Sustainability and nourishment requirements
- Effectiveness for erosion reduction
- Limits of effectiveness – wind/wave climate limitations

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Feasibly Study Results

Study submitted 1/30/17

To be posted soon

Coyote Creek to Bothin Marsh
Dredge Sediment Beneficial Reuse
Feasibility Study

January 30, 2017

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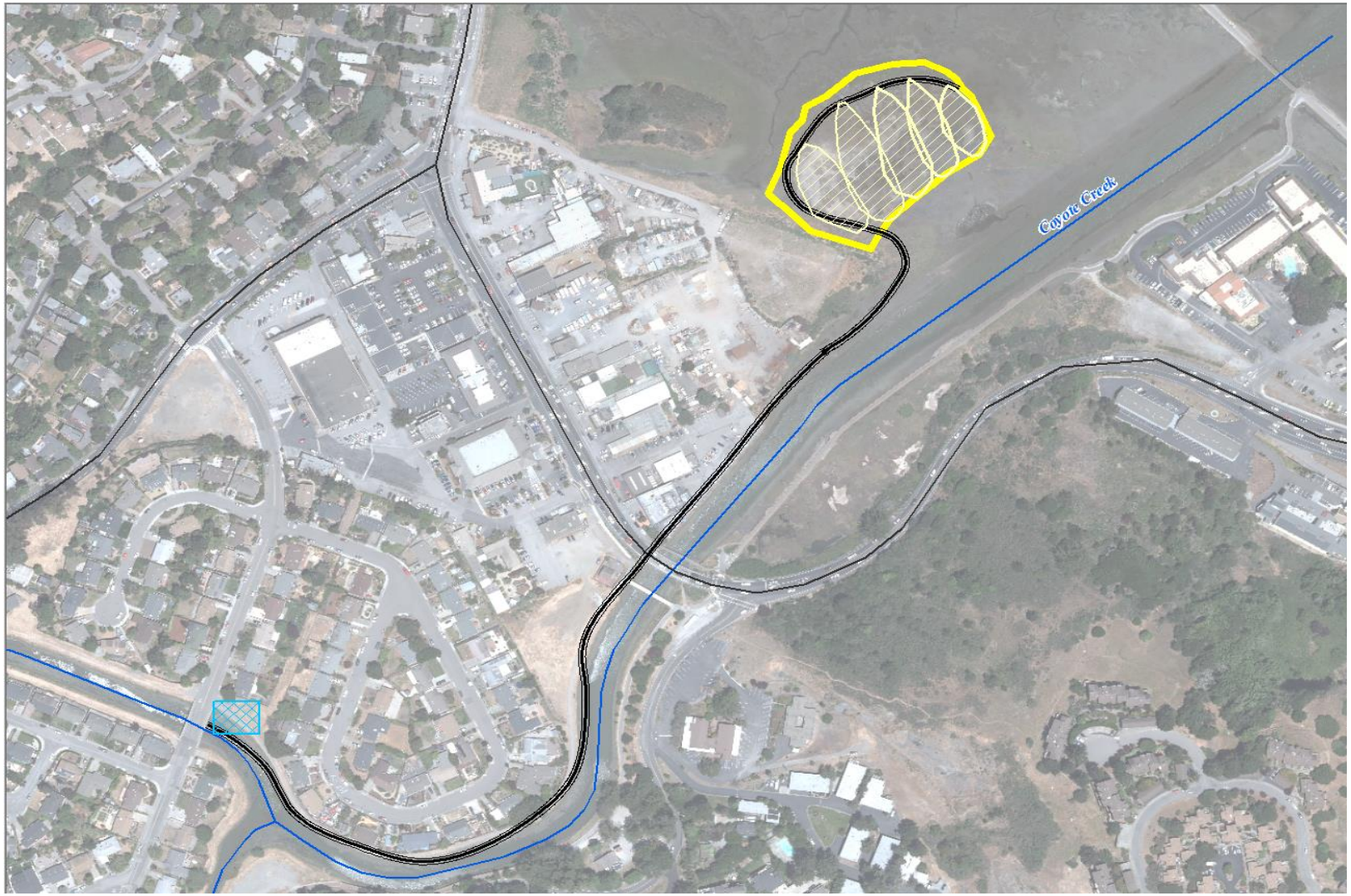
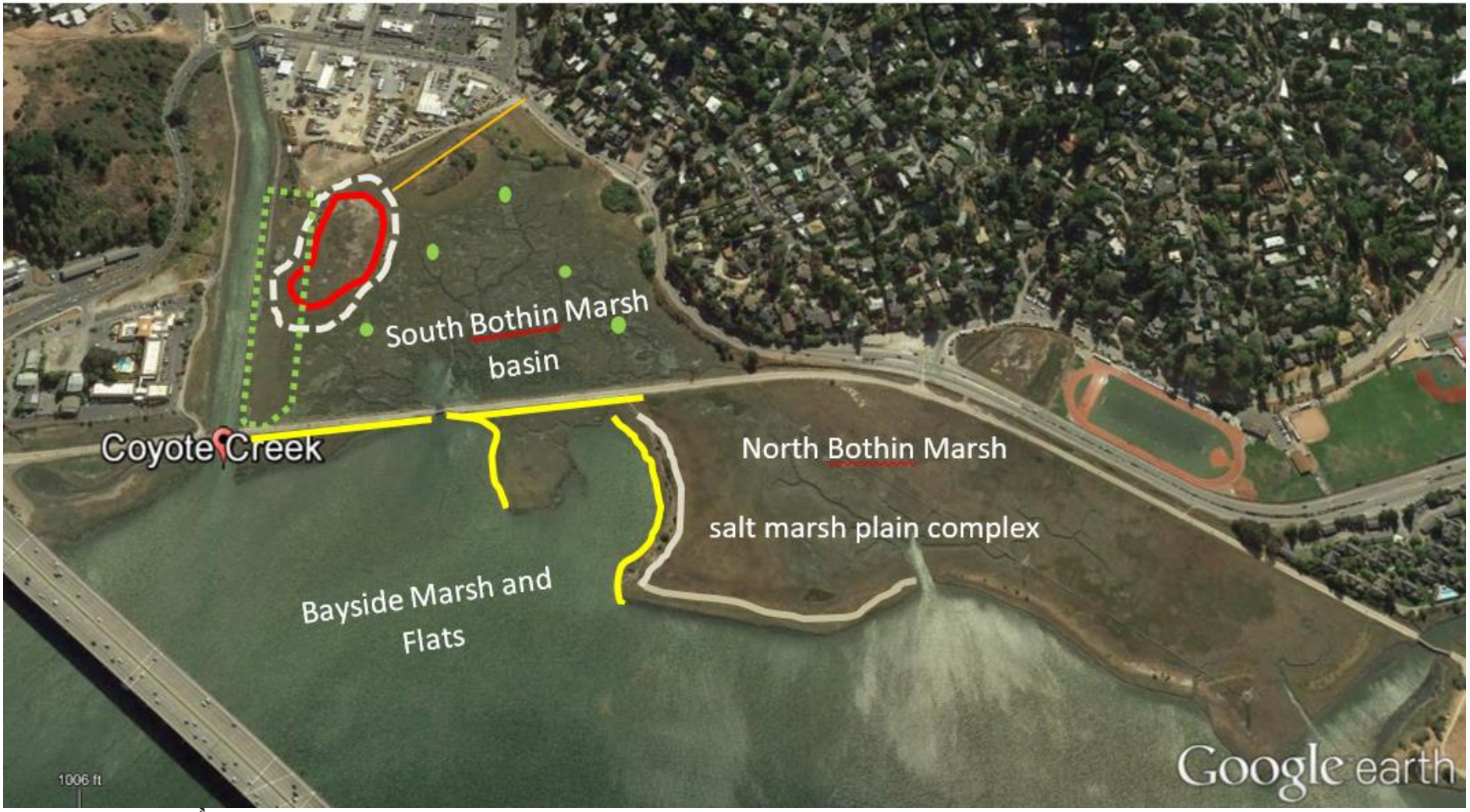
Dredge Pipeline and Placement



Proposed Pilot Projects – Plan View



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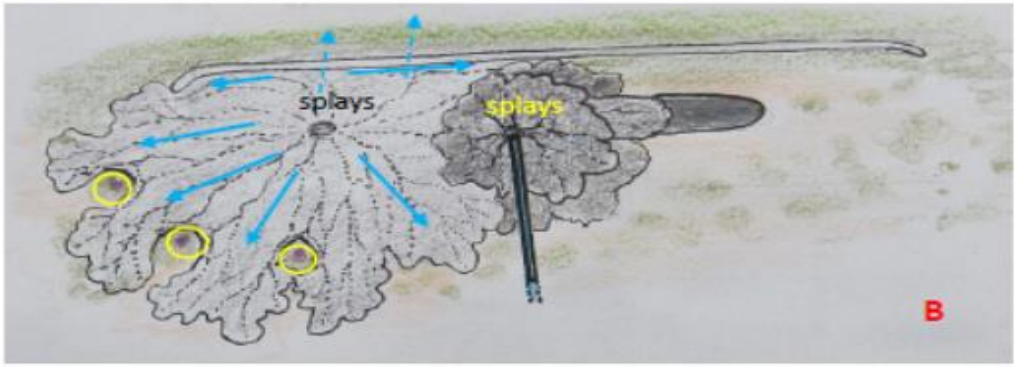
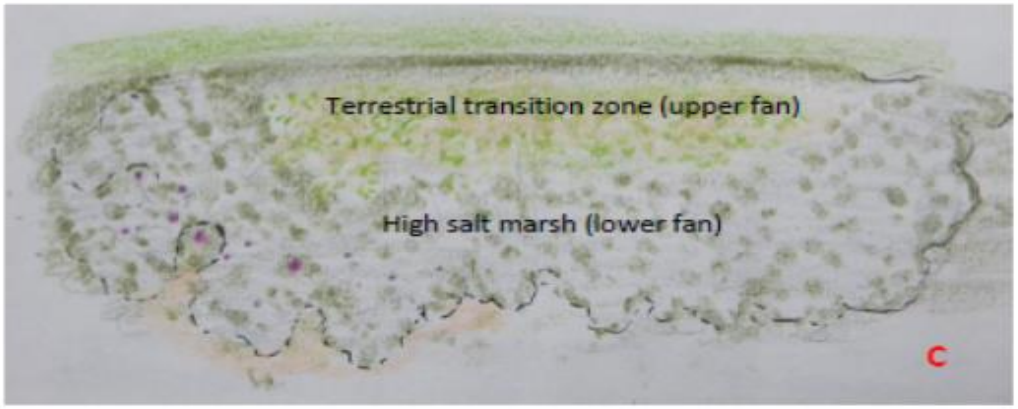
Red outline: rubble pile. Dashed white line: sediment slurry deposition zone. Green dots: high salt marsh mound pairs at heads of tidal channels (mitigation) Yellow lines: coarse sediment placement zones. Tan lines: old perimeter levees (breached, subsided). Green dotted line: Coyote Creek high marsh plain. Orange line: likely pathway for ground-based equipment over upland fill, with wood mat crossings over ditches.

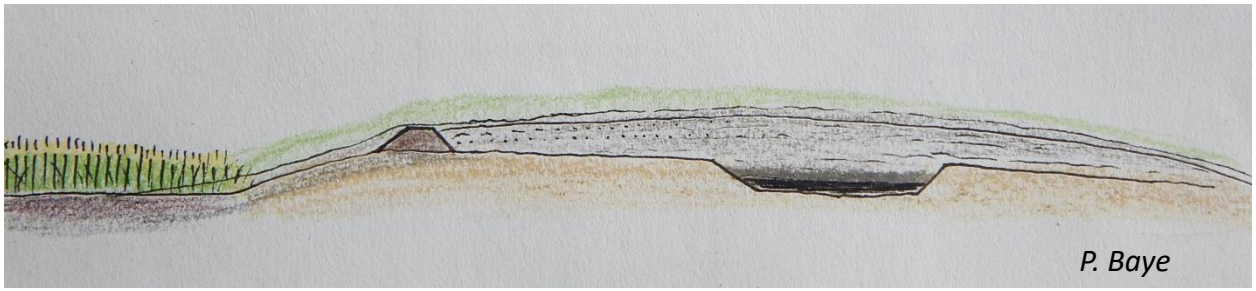
Thin-Lift Dredge Sediment Placement Illustrative Figures

Plan View





Profile



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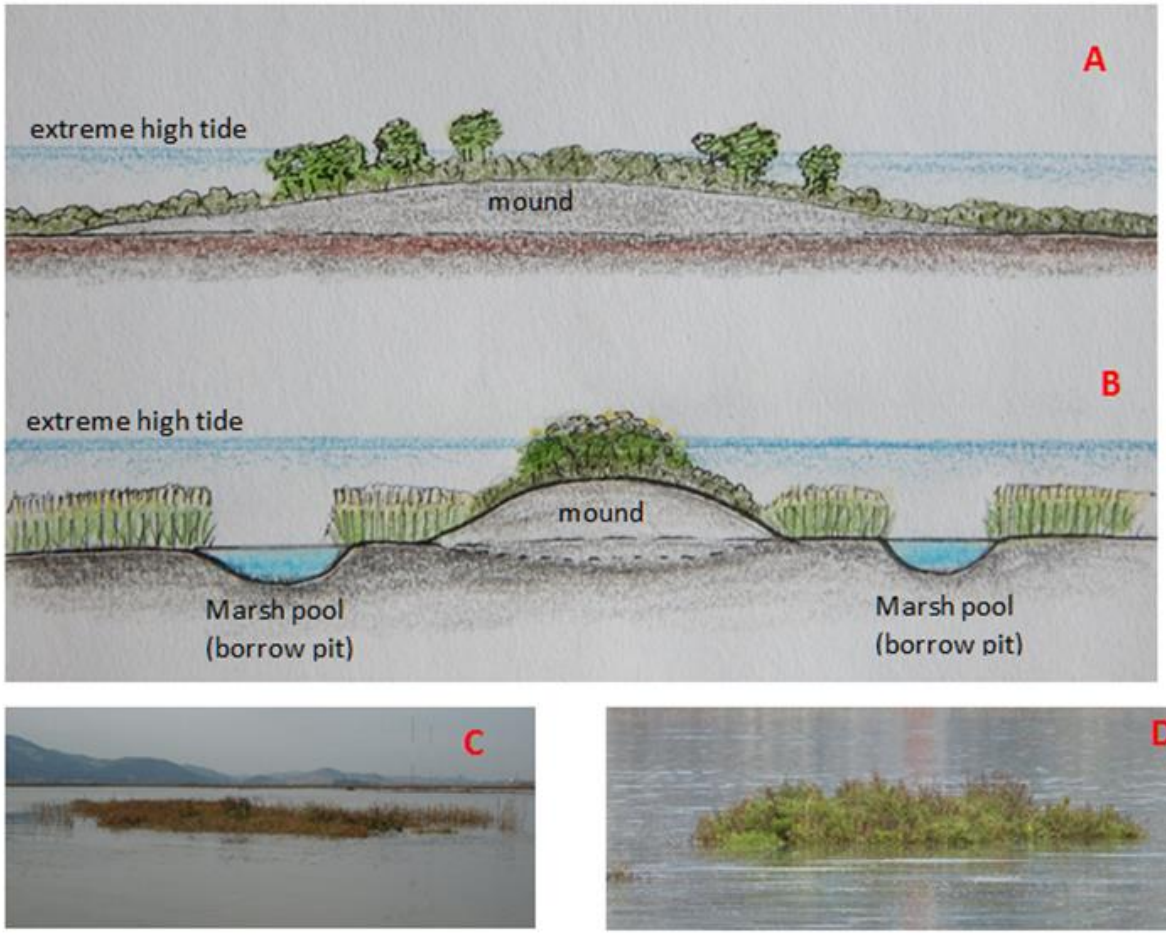
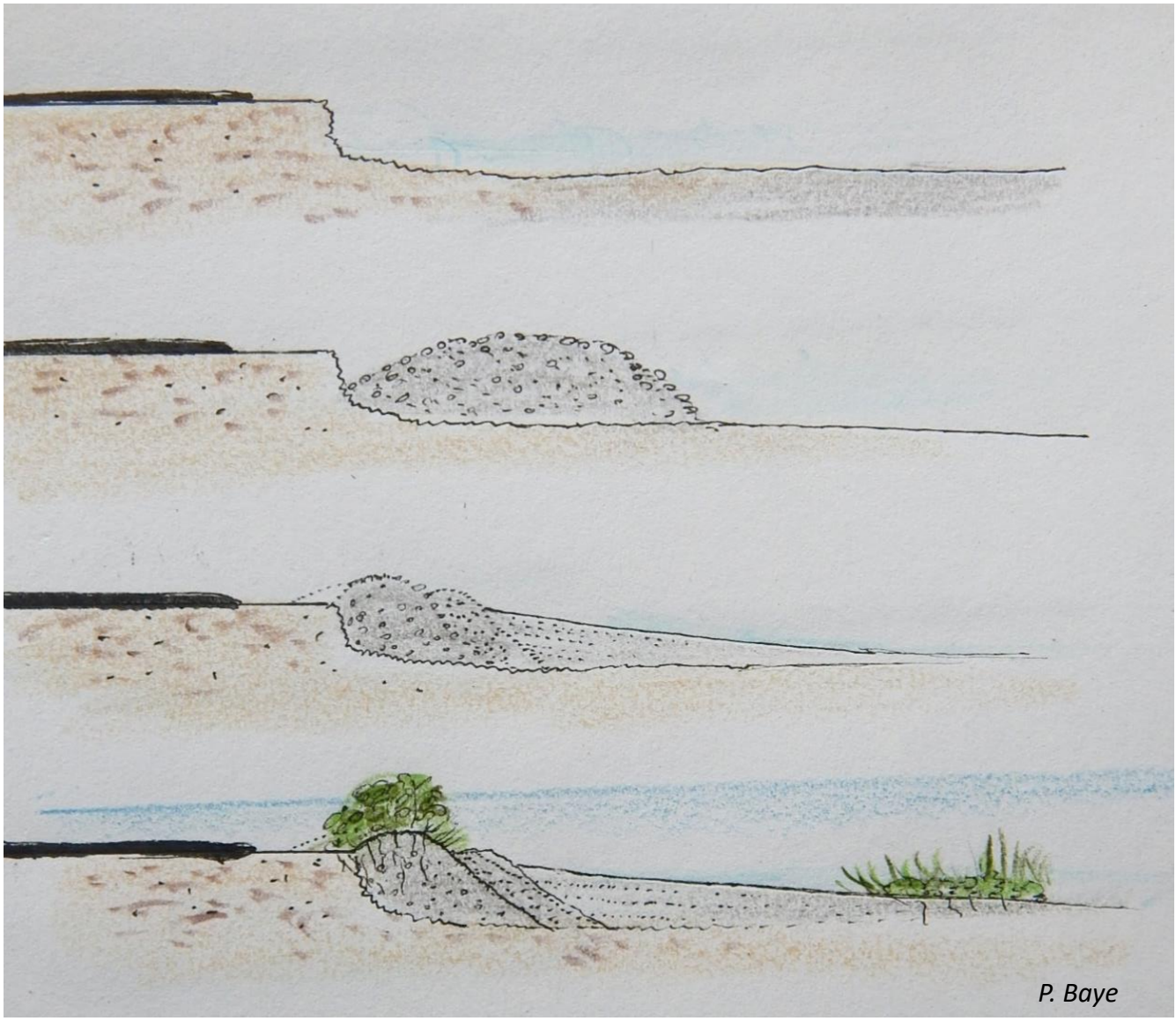
Potential Mitigation Measure



Mitigation measure: high salt marsh refuge habitat mounds constructed in North Bothin Marsh pickleweed marsh (A) and South Bothin Marsh cordgrass marsh (B).

Coarse-grained “beach” edge illustrative figures



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Soil Chemistry Analysis

- Six samples collected and analyzed for sulfides and ammonia as NH3
- Results indicate elevated sulfides
- May require special placement below grade if resampling confirms

Table 2: Summary of Sediment Chemistry Results for Ammonia and Sulfide

Sample number	*Ammonia as NH3 (mg/kg) [RL=2]*	*Sulfide mg/kg [RL=25]*
SA-1	ND	640
SA-2	ND	33
SA-3	4.6	810
SA-4	2.4	540
SA-5	ND	460
SA-6	ND	290

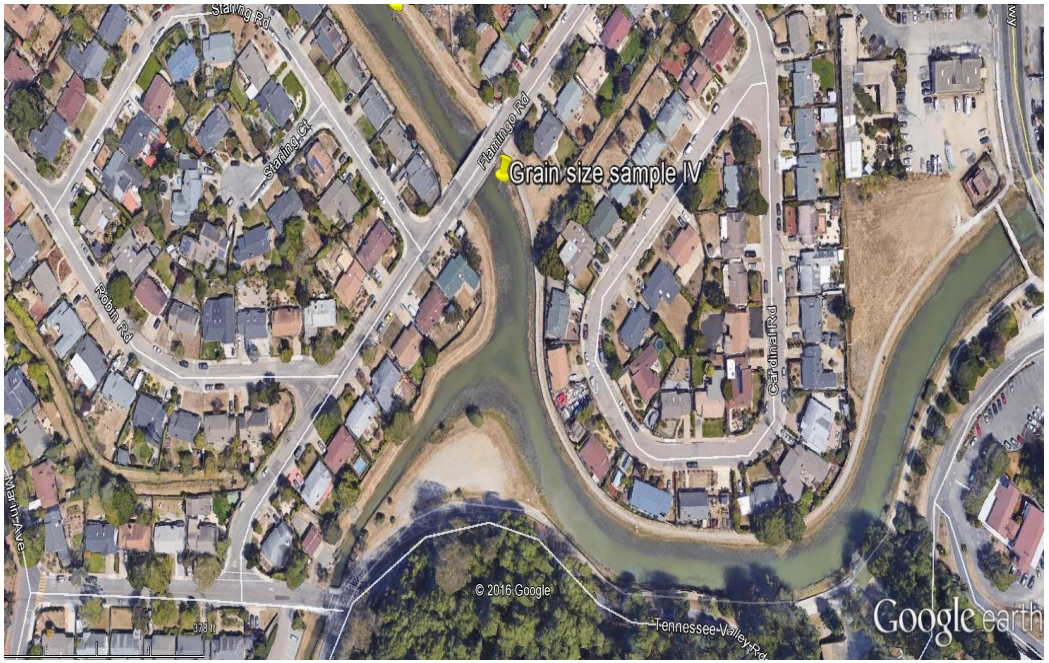
RL= reporting limit, ND= non-detectible at reporting limits

Sediment Grain Size Analysis

- Three samples collected and analyzed for grain size form upper reach
- Results indicate coarse-grained terrestrial sediments
- Useful for beach edge

Table 1: Summary of Grain Size Results

Sample Number	*Classification*
Sample II	Well graded gravel with silt and gravel (SW-SM)
Sample III	Well graded sand with clay and gravel (SW)
Sample IV	Well graded gravel with sand (GW)



Feasibility Level Costs

Table 3: Summary of Feasibility Level Cost Estimates

Cost Item	Costs with 50% Contingency ($)	Costs with no Contingency ($)	Costs for Pilot Project Only w/o contingency ($)
Construction costs	$ 1,727,625	$ 1,151,750	$ 746,600
Engineering design and permitting	$ 489,000	$ 326,000	$ 326,000
5 year monitoring and reporting	$ 142,500	$ 95,000	$ 95,000
TOTALS:	$ 2,359,125	$ 1,572,750	$ 1,167,600

Summary of Feasibility Study

Pros

Excellent location and setting for proposed pilot studies (i.e. flooding condition/degraded area)

Easily accessible with scientific support from Rhomberg Center

Adjacent to FC channel

High visibility

Green community and political support

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Summary of Feasibility Study

Cons

Costs are high for small dredge

High visibility – high community interest and aawareness

Active marsh with T&E species – May be more difficult to permit

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Applicability Elsewhere in the North Bay

Marin County

Applicable for Corte Madera, Gallinas and Novato Creeks

Sonoma County

TBD

Napa County

TBD

Bay Wide – Important as Demonstration

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Next Steps

- Take feasibility level design to the next level – preliminary design (30%) and develop permit applications and assess impacts
- Public outreach and education
- Marin Open Space working with OneTam the lead on the project and Bothin Marsh planning
- Seek $$$ for implementation

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