May 19, 2022

ANCHOR QEA

CMANC 2022 Spring Meeting

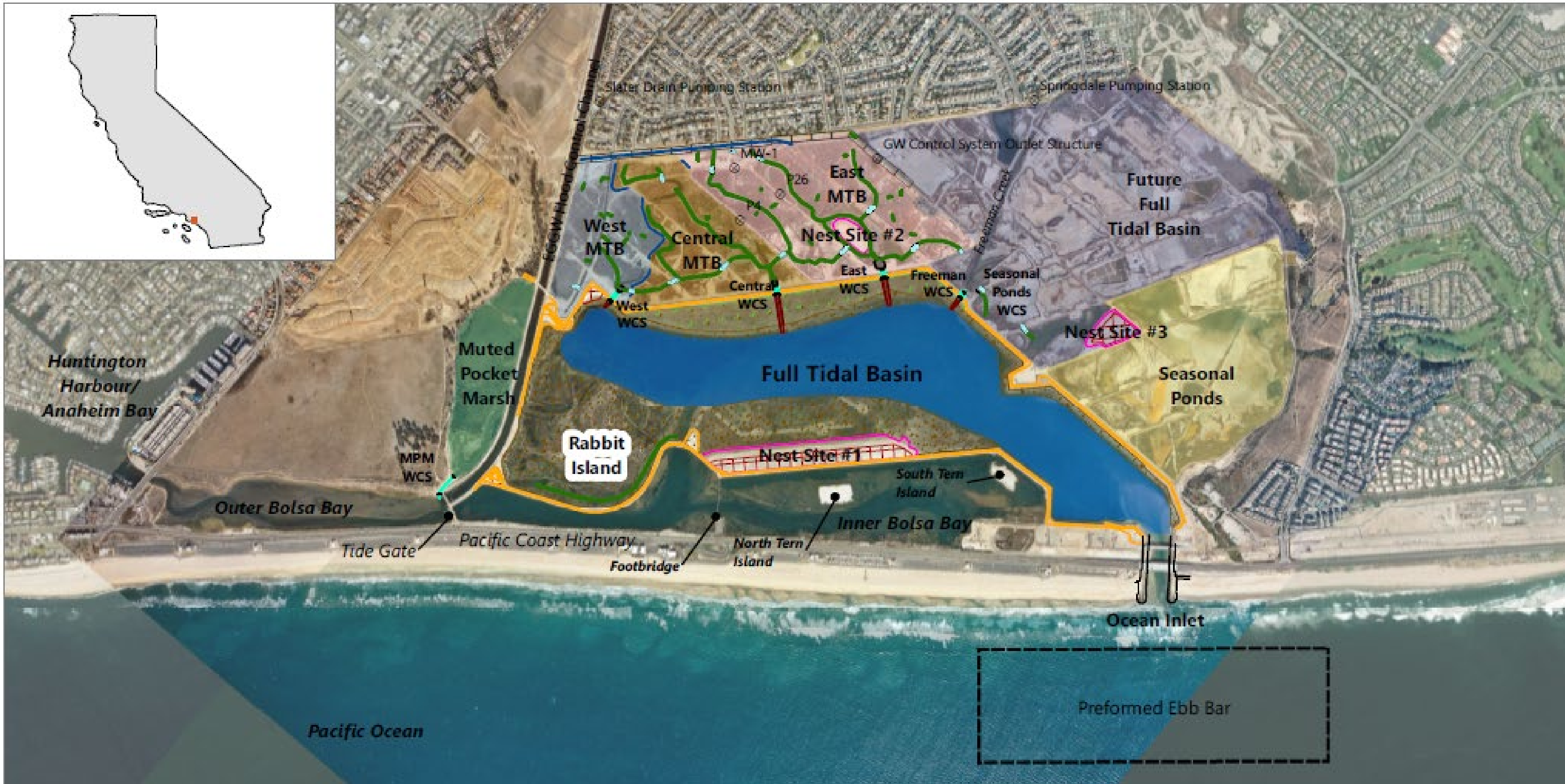
Bolsa Chica Wetlands: Mitigation, Restoration, Beneficial Use, & Sea Level Rise

Presented By: David Cannon, MCE, PE, Principal Engineer

Presentation Overview

- The Project
- Performance & Problems
- Solutions (Remediation Measures)
- Evaluation
- Recommendations

Bolsa Chica Lowlands Restoration Project - BCLRP



LEGEND:

- Nest Sites
- Cordgrass
- Intertidal
- Subtidal
- Ocean Jetty
- Graded Channels
- Culverts
- MTB Dikes
- Levee
- WCS Channels
- WCS Structures
- WCS Culverts
- Groundwater Barrier
- Groundwater Well
- Sequestered Soil Contamination

NOTES:

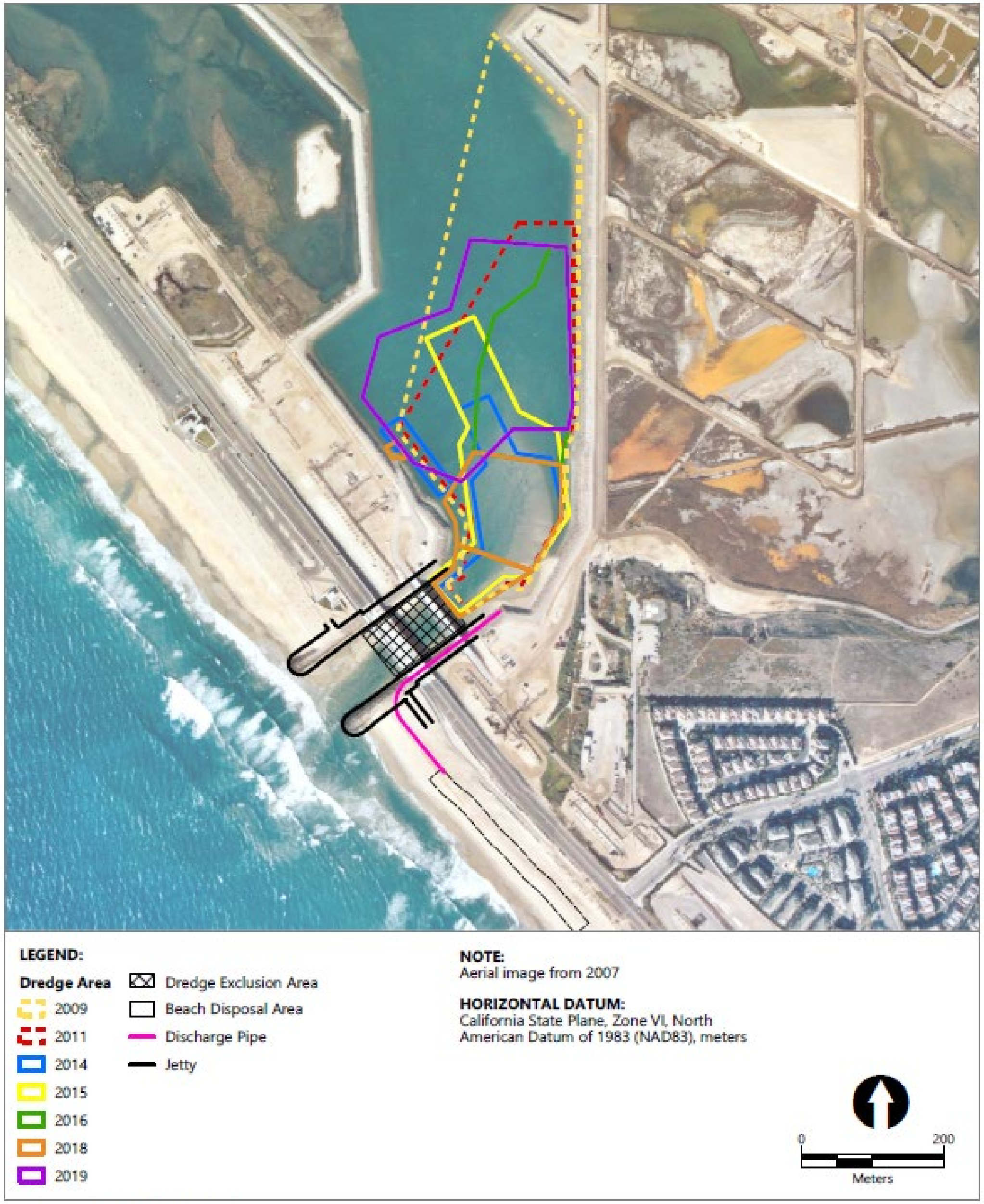
1. Aerial image from 2007 and Esri basemaps
2. MPM: Muted Pocket Marsh
3. MTB: Muted Tidal Basin
4. WCS: Water Control Structure

HORIZONTAL DATUM:
California State Plane, Zone VI, North American Datum of 1983 (NAD83), meters

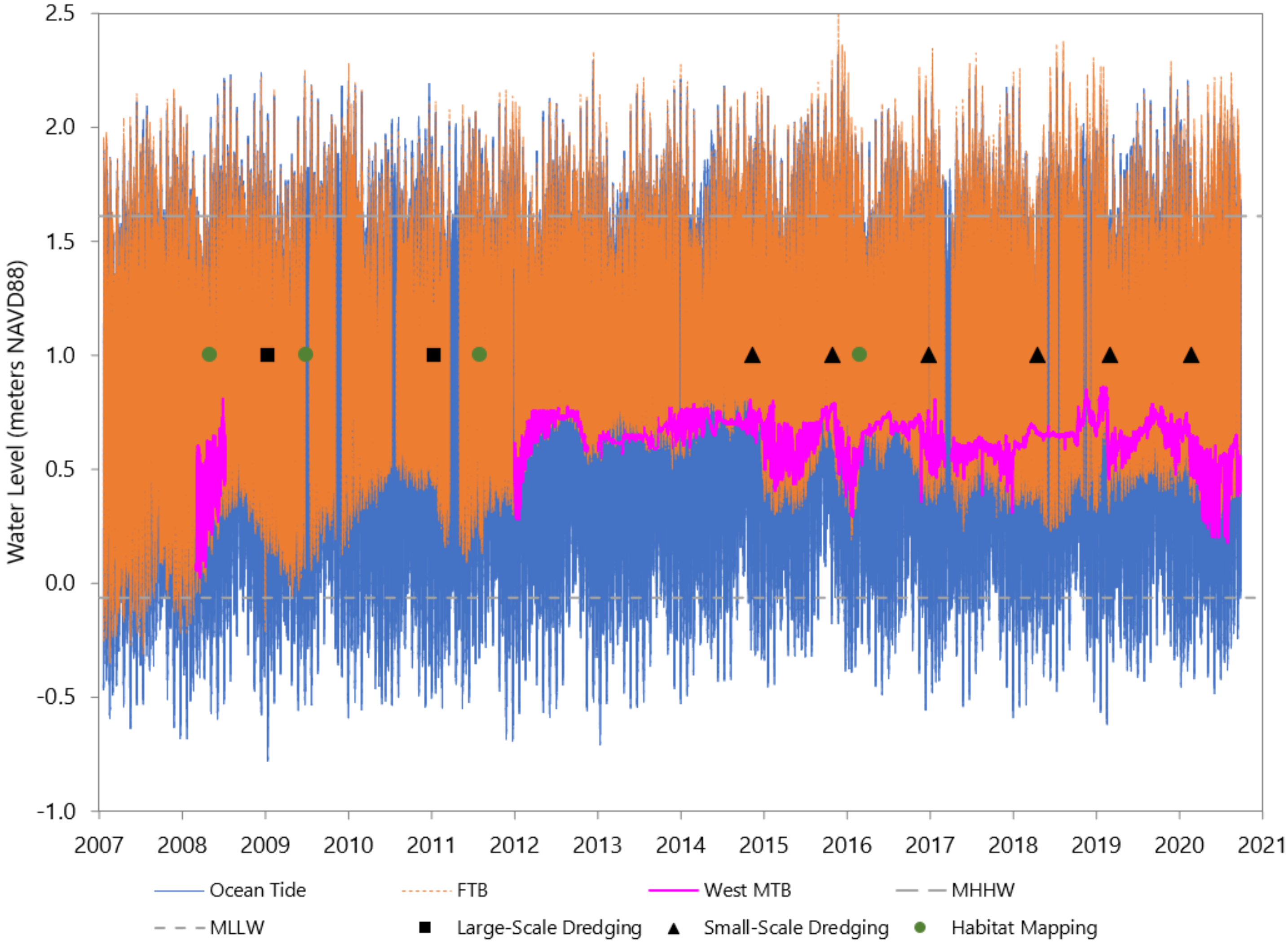
0 400
Meters

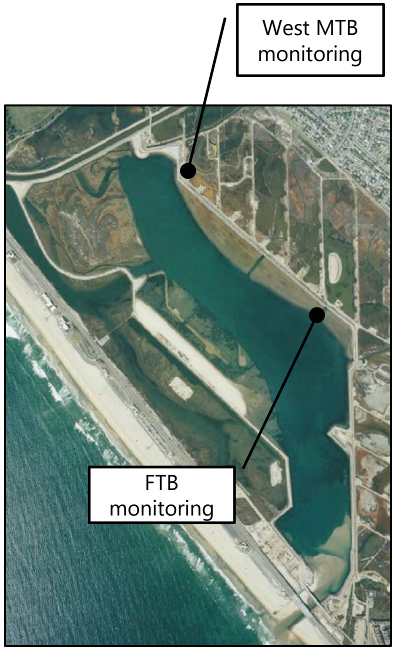
Historical Flood Bar Shoaling

Maintenance Dredging Evolution



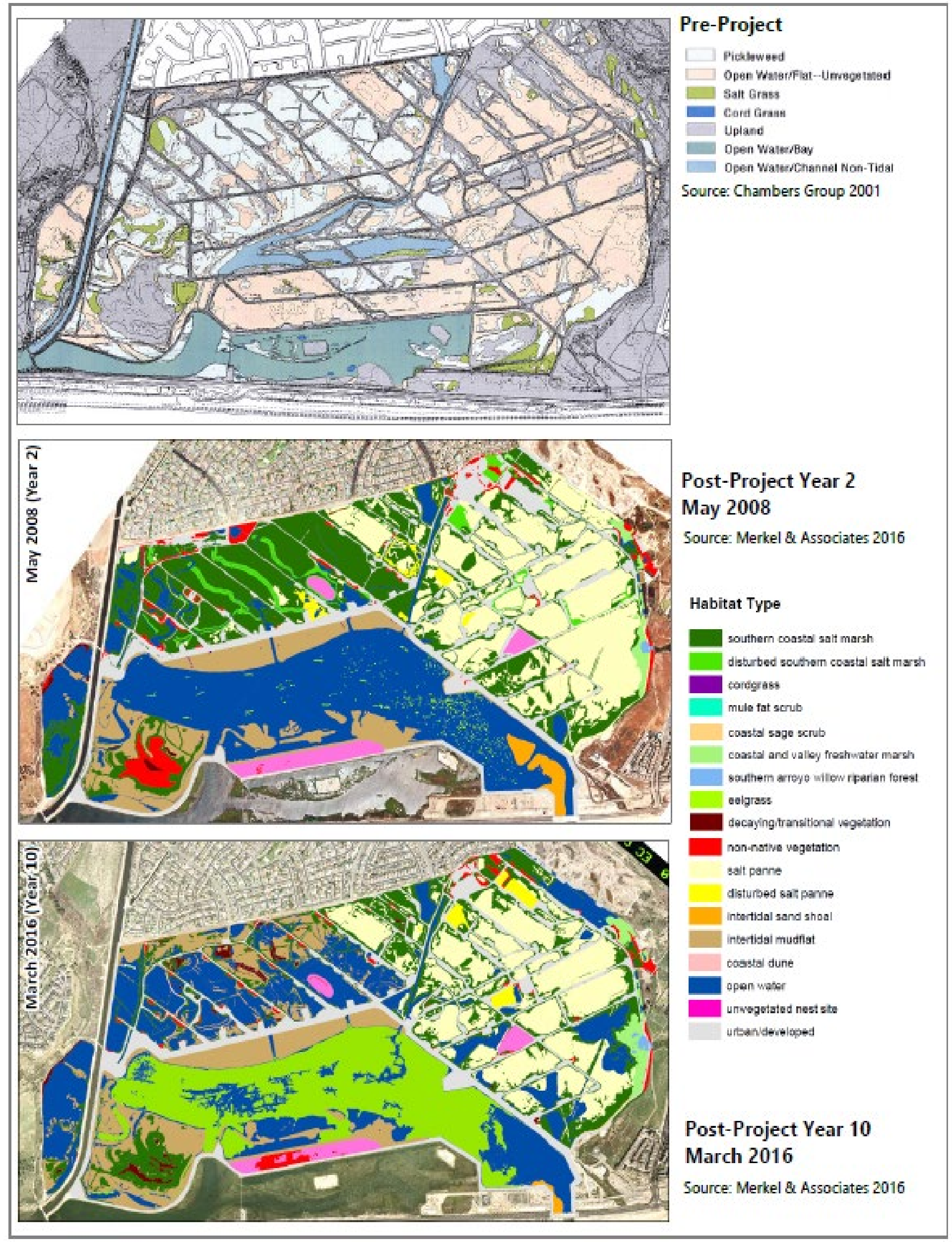
Water Levels: Ocean, FTB, & MTB



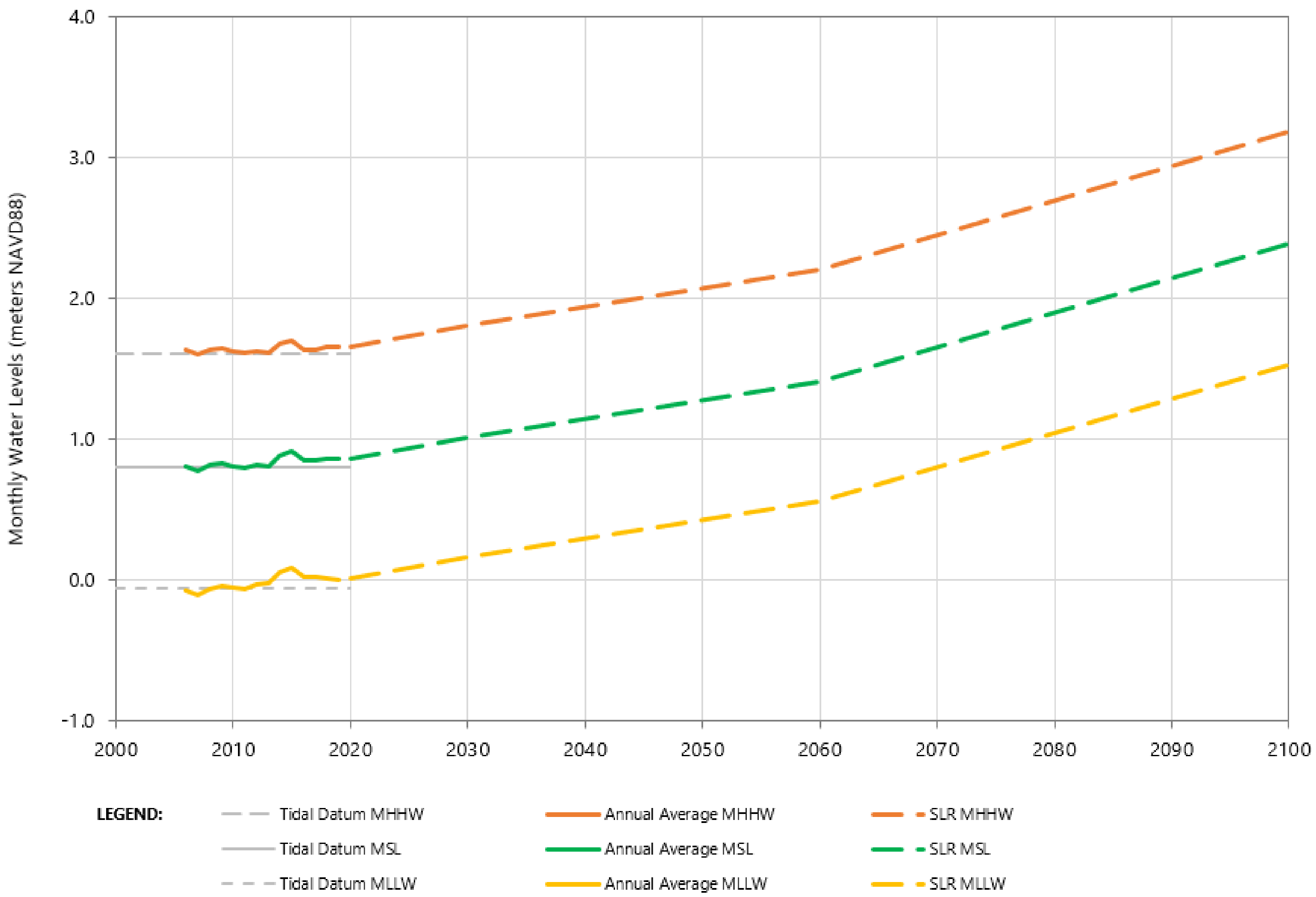


Habitat Morphology

Photo showing mudflats on cordgrass bench (Jan 2021)

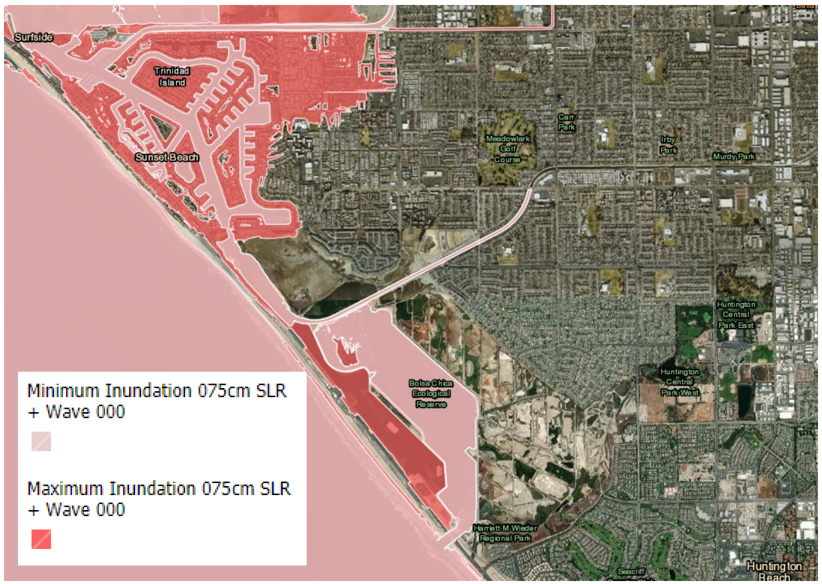


Sea Level Rise: Year 2000-2100



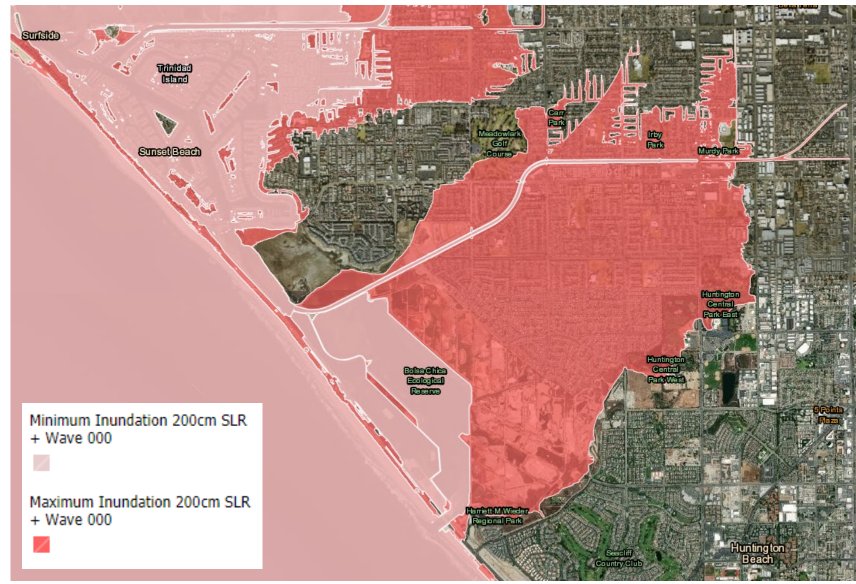
Baseline Not Sustainable with SLR

Mid-Term



Potential flooding with 2.5 feet of SLR
Recommended by CSLC for Year 2060

Long-Term



Potential flooding with 6.7 feet of SLR
Recommended by CSLC for Year 2100

Project Performance & Problem Summary

- Continued shoaling requires maintenance dredging
- Maintenance dredging has been ineffective at restoring/maintaining design tide ranges in FTB
- FTB low tide muting limits MTB draining
- Limited MTB draining inundates MTB vegetation
- Inadequate funding for maintenance dredging
- Designed wetland habitats not achieved or achievable
- Marine habitats doing very well - desire to maintain*
- Sea Level Rise (SLR) poses major concern

- *Project purpose to mitigate impacts due to port landfill

Study Objective: Achieve Desired Goal

- Maintain marine habitats, restore MTB wetlands vegetation, expand FTB wetlands habitats, reduce maintenance costs, and provide stable funding source.

Remediation Measures

Intended Objective	Remediation Measures
Optimize sediment management efficiency to reduce maintenance dredging costs	1A: Large-Scale Dredging – Conduct maintenance dredging every 2 years by removing all sediment accumulation in the wetlands to reverse tidal muting in the FTB. This was conducted previously in 2009 and 2011 and was deemed unsuccessful at maintaining water levels in the FTB.
	1B: Different Dredging Method – Ongoing adaptative dredging management using different dredging equipment to improve dredging efficiency.
	1C: Install Permanent Infrastructure – Installation of permanent infrastructure to reduce dredging costs.
	1D: Optimize Dredging Operations – Adaptative management to optimize dredging operations through contracting, bidding process, or dredging work sequencing.
	1E: Eliminate Maintenance Dredging – Stop maintenance dredging and allow sedimentation to progress naturally, thereby reducing maintenance dredging costs, burying eelgrass habitat, and increasing the risk of inlet closure. This was previously done from 2011-2014 and it resulted in a reported imminent inlet closure.
Reduce the amount of sediment deposition within the wetlands	2A: Enhanced Ebb Flush – Innovative method to remove sedimentation from the wetlands as an alternative to mechanical dredging. Conceptually, fluidizers (pipes that expel water) would be used to resuspend sediment during ebb tides allowing the ebb tidal currents to flush the sand to the ocean.
	2B: Bedload Barrier – Innovative method to block sediment from depositing inside the FTB during flood tides. Conceptually, pipes would be lowered during flood tides to keep sediment between the inlet jetties and then the pipes would be raised during ebb tides to allow flushing of sediment out of the inlet.
	2C: Increase Tidal Prism – Increase the ebb tidal prism by creating a hydraulic connection between Huntington Harbor and the FTB via Inner Bolsa Bay and Outer Bolsa Bay. A larger ebb tidal prism could potentially increase the flushing of sediment from the wetlands.
	2D: Extend Jetties – Lengthen the existing jetties farther out into the ocean to increase littoral transport blockage near the inlet, thereby potentially reducing the volume of sand that enters the wetlands.
	2E: Narrow Inlet – Narrow the inlet channel by installing a sheet pile wall to deepen the inlet channel to relocate the flood and ebb sand bars to potentially reduce the volume of sand that enters the wetlands.
	2F: Offshore Breakwater – Construct an offshore breakwater parallel to shore to reduce wave-induced suspension of sand at the inlet entrance to potentially reduce the volume of sand that enters the wetlands.
Restore MTB wetland vegetation	3A: MTB Single-Site Pumping – Enhance the gravity drainage through the MTB towards the Freeman Creek Pump Station for discharge into the FTB.
	3B: MTB Multi-Site Pumping – Add pumping stations at the three MTB water control structures to drain water from the MTB into the FTB and provide greater flexibility in managing the MTB water levels.
	3C: Seepage Terrace – Close the MTB tidal connection to restore non-tidal vegetation and regrade the MTB to create a seepage channel that would utilize groundwater to support a variety of non-tidal wetland habitats.
Provide long-term sustainability	4A: Tidal Inlet Abandonment – Provide the primary FTB tidal exchange through Inner Bolsa Bay and regulate or eliminate tidal exchange through the tidal inlet. Modify existing hydraulic connections through Huntington Harbour, Outer Bolsa Bay, and Inner Bolsa Bay to provide tidal exchange to the FTB.
	4B: Ecotone Levee – Place fill in the MTB to create a "horizontal" levee focused on establishing transitional wetland habitat and create new tidal connections between the FTB and MTB.

Short-Term Remediation Measures

Year 2020 to 2030

- 1A: Large-Scale Dredging
- 1B: Different Dredging Method
- 1C: Install Permanent Infrastructure
- 1D: Optimize Dredging Operations
- 1E: Eliminate Maintenance Dredging
- 3A: MTB Single Site Pumping
- 3B: MTB Multiple Site Pumping
- 3C: MTB Seepage Terrace

*Remediation measure currently implemented

Mid-Term Remediation Measures

Year 2030 to 2060

- 2A: Construct Enhanced Ebb Flush
- 2B: Build Bedload Barrier
- 2C: Increase Tidal Prism
- 2D: Extend Jetties
- 2E: Narrow Inlet

*Remediation measure currently implemented

Long-Term Remediation Measures

Year 2060 to 2100

- 4A: Tidal Inlet Abandonment
- 4B: Ecotone Levee

*Remediation measure currently implemented

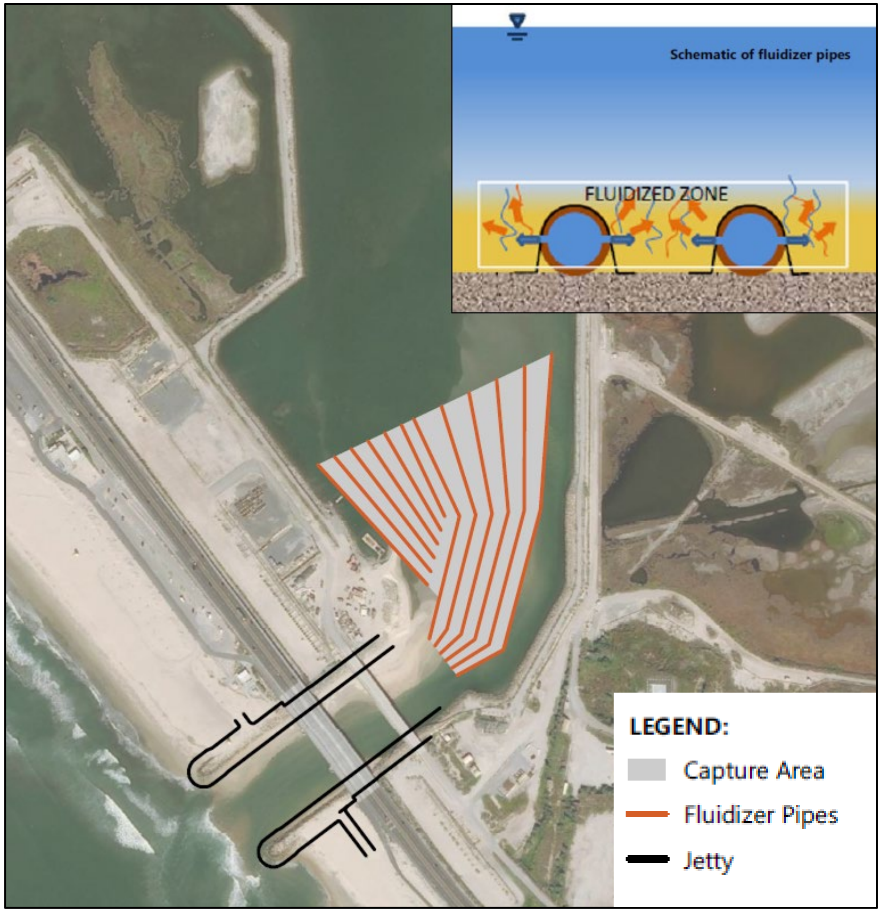
Evaluation Framework

Objective	Potential To Achieve Objective	Degree of Certainty	Evaluation Summary
Maintain/Improve FTB Habitat Stability	High, Moderate, Low	High, Moderate, Low	Textual description of evaluation summary.
Maintain/Improve MTB Habitat Stability			
Minimize Implementation Cost			
Reduce O&M Cost			
Obtain Funding			
Minimize Environmental Impacts			
Obtain Permits			
Garner Stakeholder Support			
Improve SLR Resiliency			
Overall			

Notes:
High: High possibility to improve baseline conditions or high degree of confidence in achieving improvement
Moderate: Minimum or no improvement from baseline conditions or moderate degree of confidence in achieving improvement
Low: No improvement or reduction from baseline conditions or low degree of confidence in achieving improvement

Example: RM 2A -Enhanced Ebb Flush

- Use fluidizer pipes to resuspend sand and transport during ebb tide
- Pros
  - Could achieve the Goal
  - Low maintenance costs
- Cons
  - Partially unproven tech.
  - Expensive "proof of concept" pilot study
  - Expensive design
  - High construction cost



Example Evaluation for RM 2A

Objective	Potential To Achieve Objective	Degree of Certainty	Evaluation Summary
Maintain/Improve FTB Habitat Stability	High	Low	Success tied completely to degree of performance so if it works well the FTB water levels and habitats would be substantially improved.
Maintain/Improve MTB Habitat Stability	Moderate	Low	Successful performance would improve MTB water levels and habitats but not by much.
Minimize Implementation Cost	Moderate	Low	Good experience with pile, pump, and pipeline installation in southern California; however, given the uncertainty in design requirements, the degree of certainty for the implementation cost is low.
Reduce O&M Cost	High	Low	Could substantially reduce O&M costs via replacement of maintenance dredging; however, given experimental nature of this method the degree of certainty is low.
Obtain Funding	Low	High	Likely difficult to attract implementation funding without performance proof and difficult to get performance proof without pilot implementation funding.
Minimize Environmental Impacts	High	High	The system would be installed in the highly dynamic flood bar so environmental impacts would likely be low. Pile and pipelines would have minimal impact on biota and there is good experience with piles and pipelines within marine/estuarine areas.
Obtain Permits	Moderate	Moderate	The components of the system (piles, pipes, & pumps) should be straightforward to get permitted; however, agencies may have concerns regarding the ability to achieve performance, which may be reflected in extensive special conditions (e.g., requirement to remove if performance not realized).
Garner Stakeholder Support	High	Moderate	With the promise to improve FTB water levels and habitats without visual impacts this measure should be supported by all stakeholders; however, some may have concerns over ability achieve performance, although this could be addressed via pilot studies.
Improve SLR Resiliency	Moderate	High	The impacts of SLR on water levels and habitats would not be addressed via implementation of this measure.
Overall	**High**	**Low**	**High potential for improvement but a very high level of uncertainty**

Notes:
High: High possibility to improve baseline conditions or high degree of confidence in achieving improvement
Moderate: Minimum or no improvement from baseline conditions or moderate degree of confidence in achieving improvement
Low: No improvement or reduction from baseline conditions or low degree of confidence in achieving improvement

Overall Evaluation

Remediation Measure	Overall Potential To Achieve Objectives	Overall Degree of Certainty	Overall Summary
Short-Term (2020 to 2030)			
1A: Large-Scale Dredging	Low	High	Not sustainable for costs
1B: Different Dredging Method	Moderate	High	Minimal improvement from Baseline
1C: Install Permanent Infrastructure	Moderate	High	Minimal improvement from Baseline
1D: Optimize Dredging Operations	Moderate	High	Minimal improvement from Baseline
1E: Reduce Maintenance Dredging	Low	High	Not sustainable for hydrology and habitats
2E: Narrow Inlet	Moderate	High	Minimal improvement from Baseline
3A: MTB Single-Site Pumping	Moderate	High	Minimal improvement only for MTB
3B: MTB Multi-Site Pumping	High	High	Improvement only for MTB
3C: MTB Seepage Terrace	High	High	Improvement only for MTB
Mid-Term (2030 to 2060)			
2A: Enhanced Ebb Flush	High	Low	Potentially sustainable for hydrology and habitats, but low degree of certainty
2D: Extend Jetties	Low	High	Not sustainable for costs
2F: Offshore Breakwater	Low	High	Not sustainable for costs
3C: MTB Seepage Terrace	High	High	Improvement only for MTB
4B: Ecotone Levee	High	High	Improvement only for MTB
Long-Term (2060 to 2100)			
3C: MTB Seepage Terrace	High	High	Improvement only for MTB
4A: Tidal Inlet Abandonment	High	Moderate	Improvement only for FTB
4B: Ecotone Levee	High	Moderate	Improvement only for MTB

Notes:
High: High possibility to improve baseline conditions or high degree of confidence in achieving improvement
Moderate: Minimum or no improvement from baseline conditions or moderate degree of confidence in achieving improvement
Low: No improvement or reduction from baseline conditions or low degree of confidence in achieving improvement

Recommendations

- Short-Term:
  - Continue maintenance dredging
  - Identify & develop mid-term pilot projects
  - Pursue funding for maintenance & SLR adaptation planning
  - Monitor SLR and associated impacts
- Mid-Term:
  - Implement mid-term pilot projects
  - Identify & develop long-term projects
  - Pursue funding for maintenance & SLR adaptation implementation
  - Monitor SLR and associated impacts
- Long-Term:
  - Implement long-term projects
  - Maintain funding for maintenance
  - Monitor SLR and associated impacts

Questions/Discussion

1A: Large-Scale Dredging

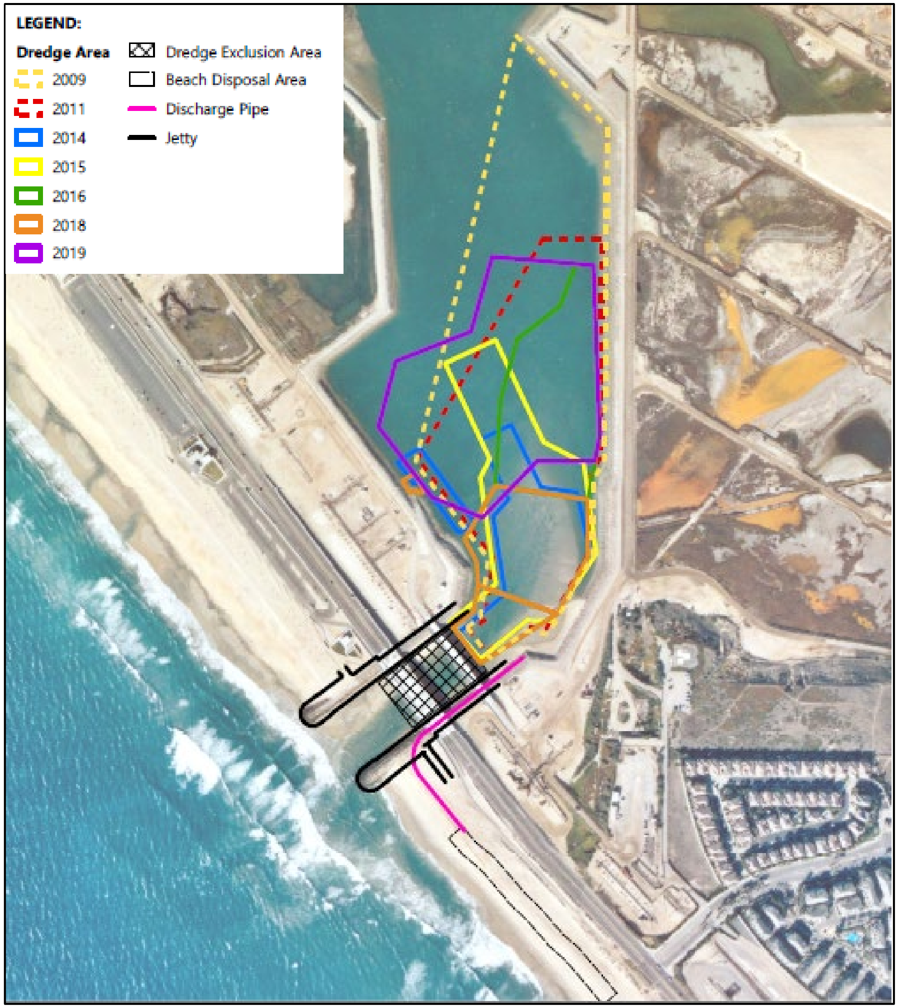
- Dredge 300,000m^3 every 2 years
- Conducted in 2009 and 2011
- Previously unsuccessful
  - Designed tide range not achieved
  - Temporary improvements in FTB tide range (6 to 7 months)
  - Cordgrass was not able to establish on shelf

1B: Different Dredging Method

- Small-scale dredging with hydraulic suction dredge
- Excavator with cutterhead and pump
- In bidding process, provide contractors with information on prior dredge methods

1C: Install Permanent Infrastructure

- Install permanent infrastructure such as discharge pipe or fixed pump
- Reasons for removal
  - Logistics difficult due to different contractors and equipment
  - Unknown responsibility and liability for maintaining infrastructure

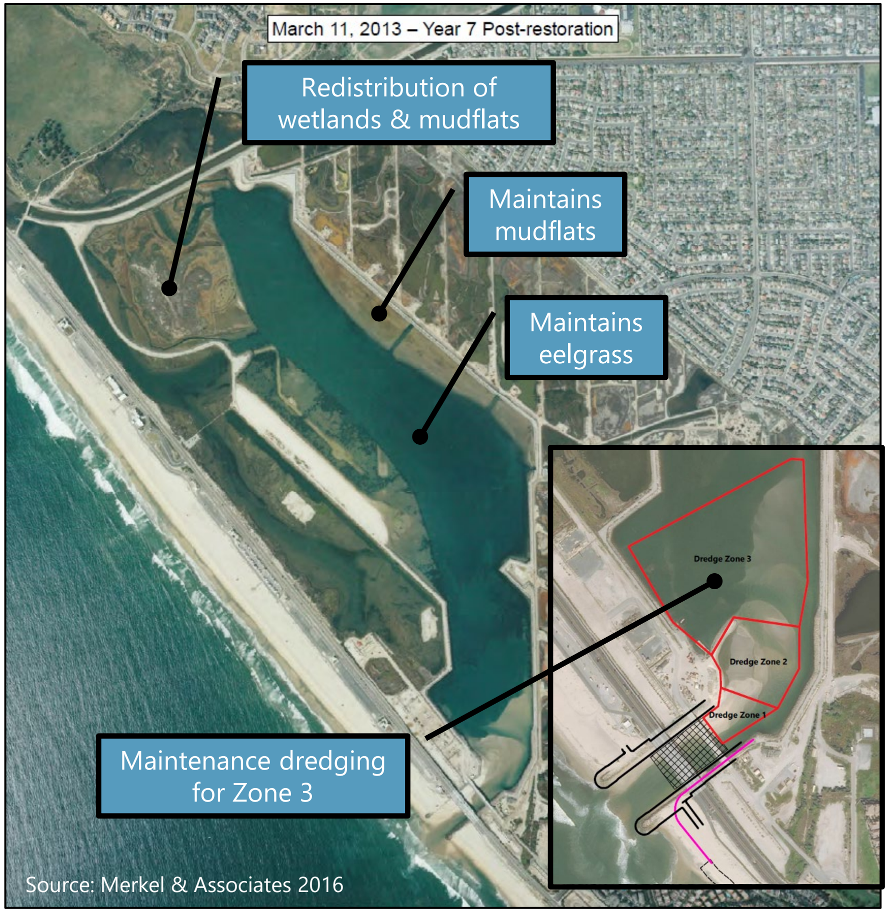


1D: Optimize Dredging Operations

- Continue optimizations
  - Multi-year contract
  - Varied contract rate
- New optimizations
  - Dredging of Zone 3 only
  - Adjust dredging sequence (Zones 1 and 2, Zone 3, Zones 1 and 2)
- Potential cost savings

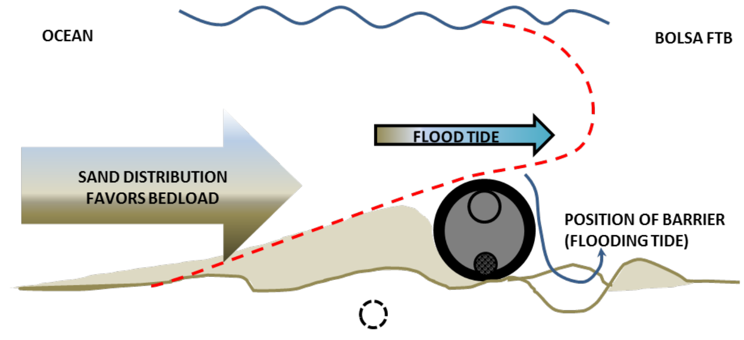
1E: Reduce Maintenance Dredging

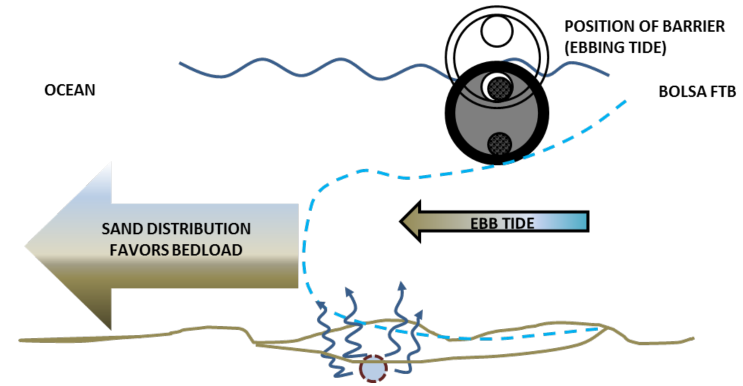
- Maintain reduced tide range like 2013
- Increases risk of inlet closure
- Prevents drainage of MTB
- Focus dredging in Zone 3 to remove accumulation of 25,000 m^3/year
- Reduce maintenance dredging costs to $667,000/year

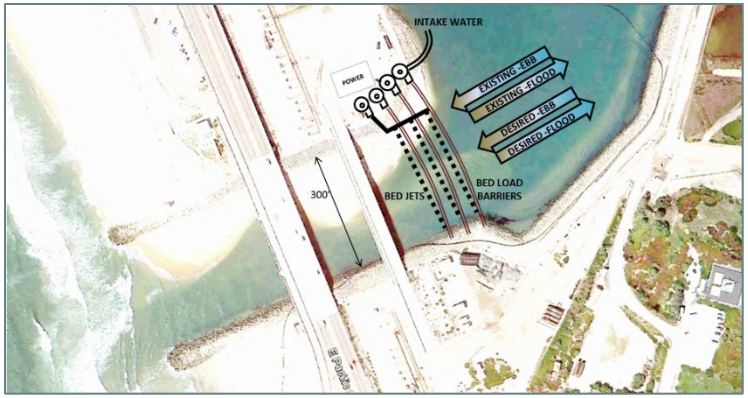


2B: Bedload Barrier

- Block bedload transport within inlet during flood tide
- Reasons for removal
  - Unproven technology
  - Expensive “proof of concept” pilot study
  - Expensive design effort
  - High construction cost ($5M)
  - Requires maintenance dredging

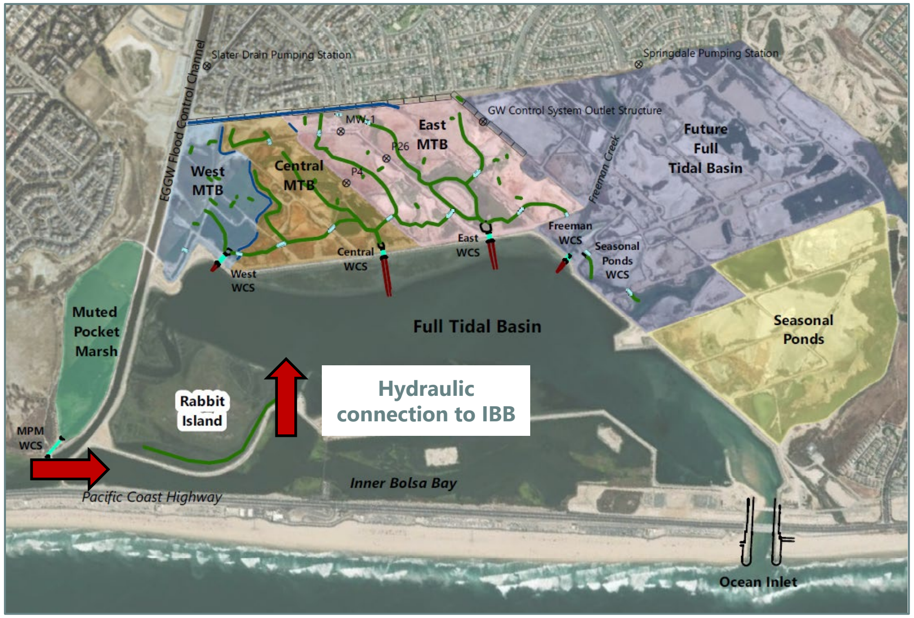






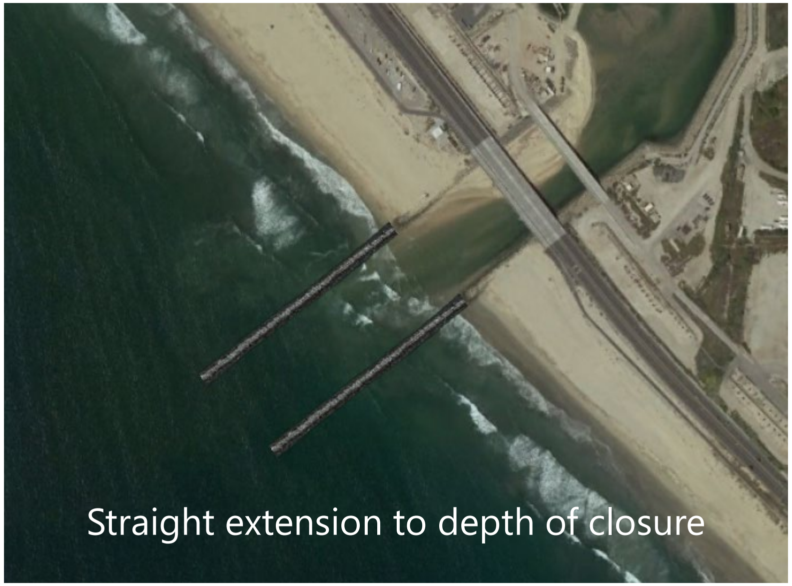
2C: Increase Tidal Prism

- Increase tidal prism from Inner Bolsa Bay (IBB)
- Install culvert with flap gate between IBB and FTB
- Reasons for removal
  - IBB mean water level lower than FTB, cannot gravity drain
  - IBB ebb tidal prism 6% of FTB ebb prism so too small to significantly reduce flood bar shoaling



2D: Extend Jetties

- Create total or partial littoral barrier to trap sand before it enters wetlands
- Reasons for removal
  - High construction cost
  - Would require sand bypassing with associated O&M cost
  - Would be difficult to obtain permits (CDP)

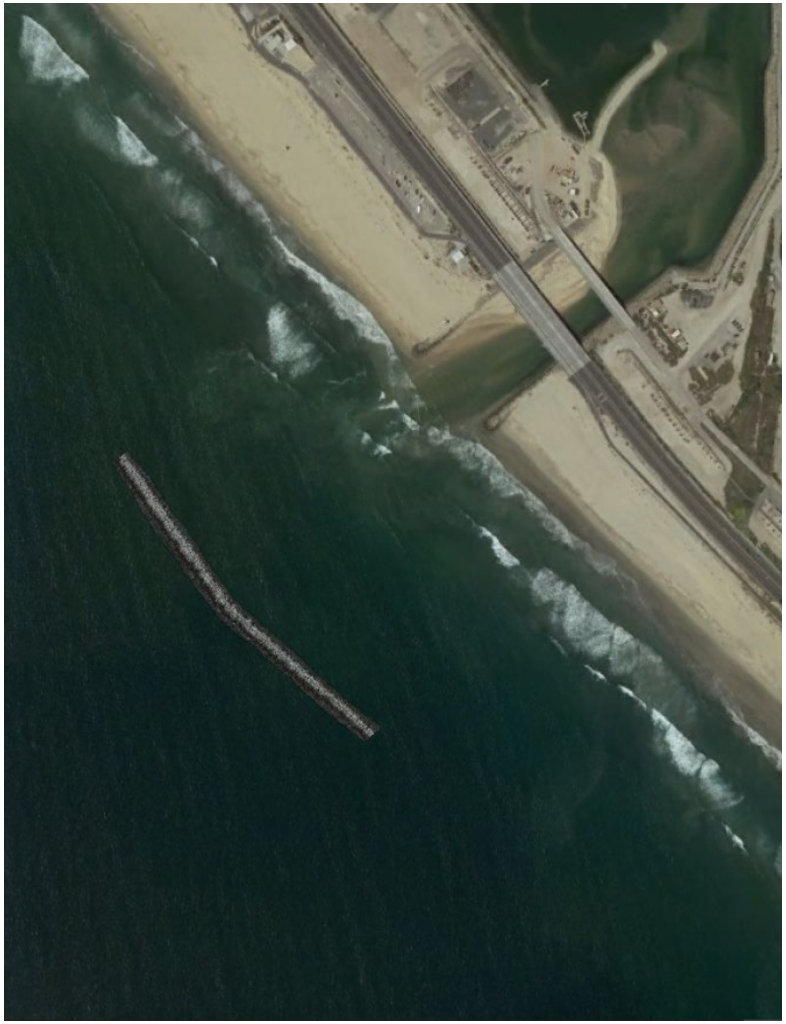


2E: Narrow Existing Inlet

- Narrow inlet to increase tidal velocity and deepen channel
- Reasons for removal
  - Would allow sand farther into FTB further impacting marine habitat
  - Would require continued maintenance dredging at distances farther from beach
  - Improved tide range likely to be short-lived following dredging

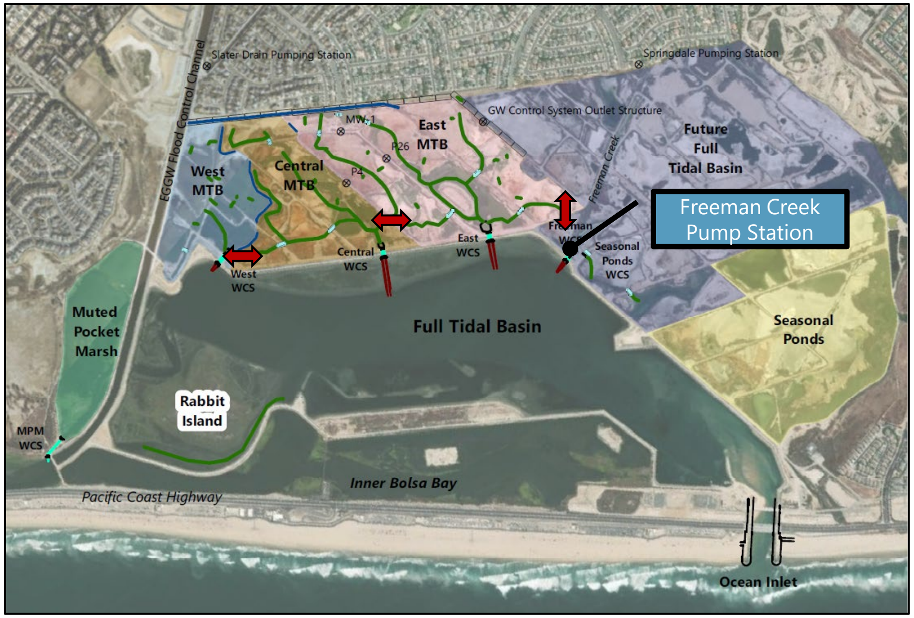
2F: Offshore Breakwater

- Shield inlet from wave action to reduce flood bar shoaling
- Reasons for removal
  - High construction cost
  - Would require sand bypassing with associated O&M cost
  - Would be difficult to obtain permits (CDP)
  - Unproven technology given that shoaling continues at similar sites (e.g., Marina Del Rey, Channel Islands Harbor)



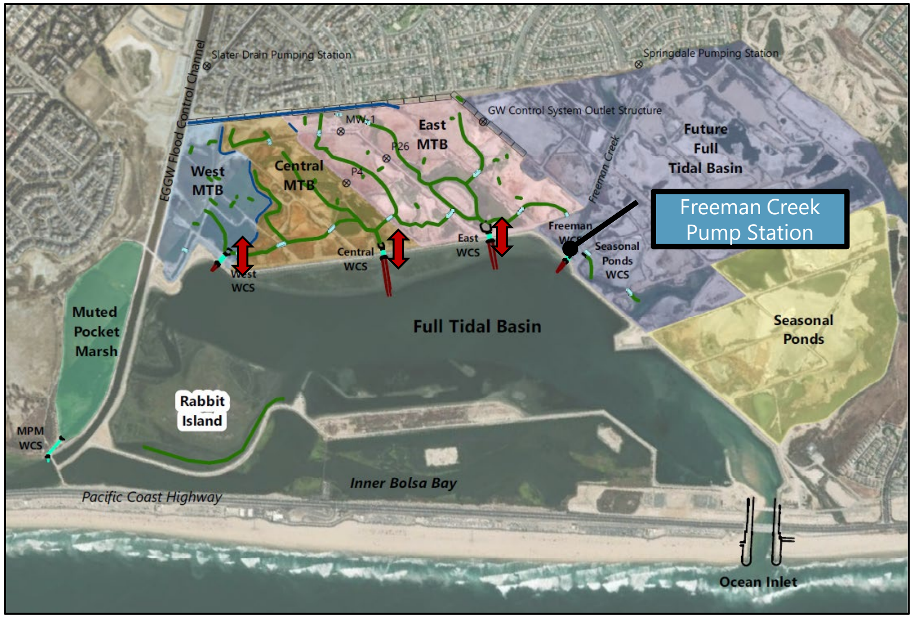
3A: MTB Single-Site Pumping

- Continue flood water management with Freeman Creek Pump Station
- 2010 installed Freeman Creek Pump Station
- 2012 installed culverts between West, Central, and East MTB
- 2016 installed 2nd pump at Freeman Creek

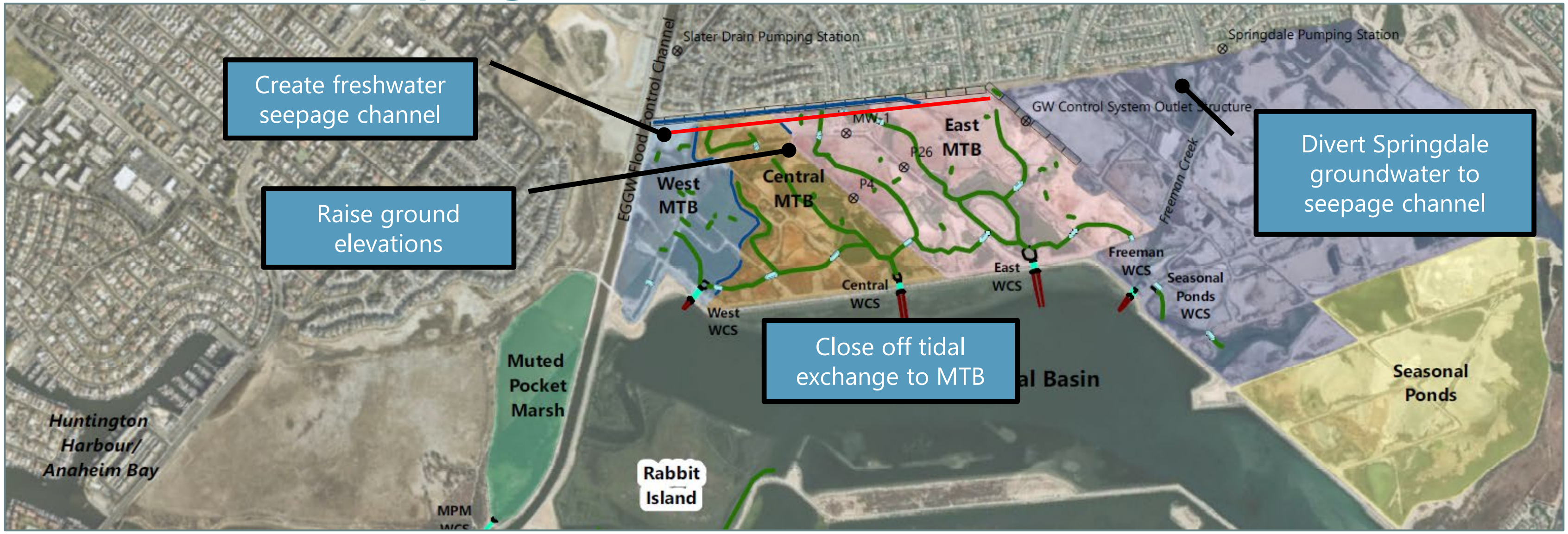


3B: MTB Multi-Site Pumping

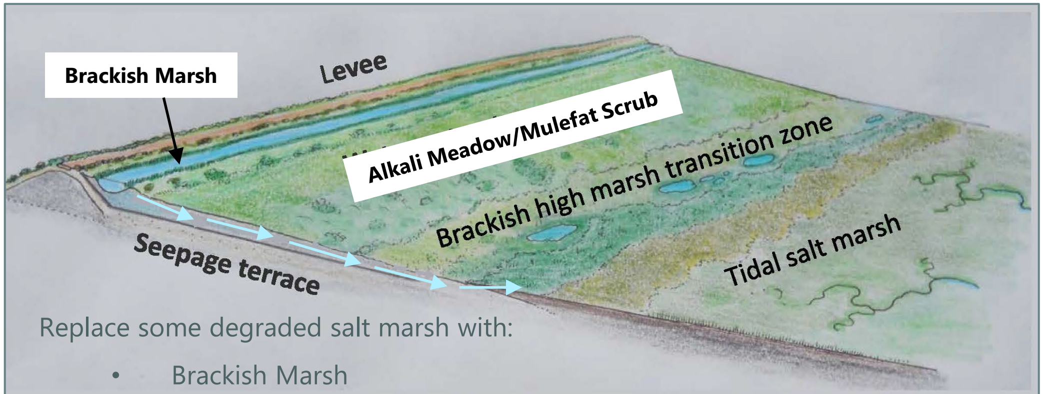
- Add 3 pump stations at WCSs to drain the MTB to provide tidal exchange
- Provides flexibility to manage flood water
- Converts existing open water in the MTB to vegetated wetlands and expands mudflat habitat for shorebirds



3C: MTB Seepage Terrace



- Short-term: Close MTB from tidal exchange
- Mid-term: Construct seepage terrace
- Long-term: Adjustments for SLR

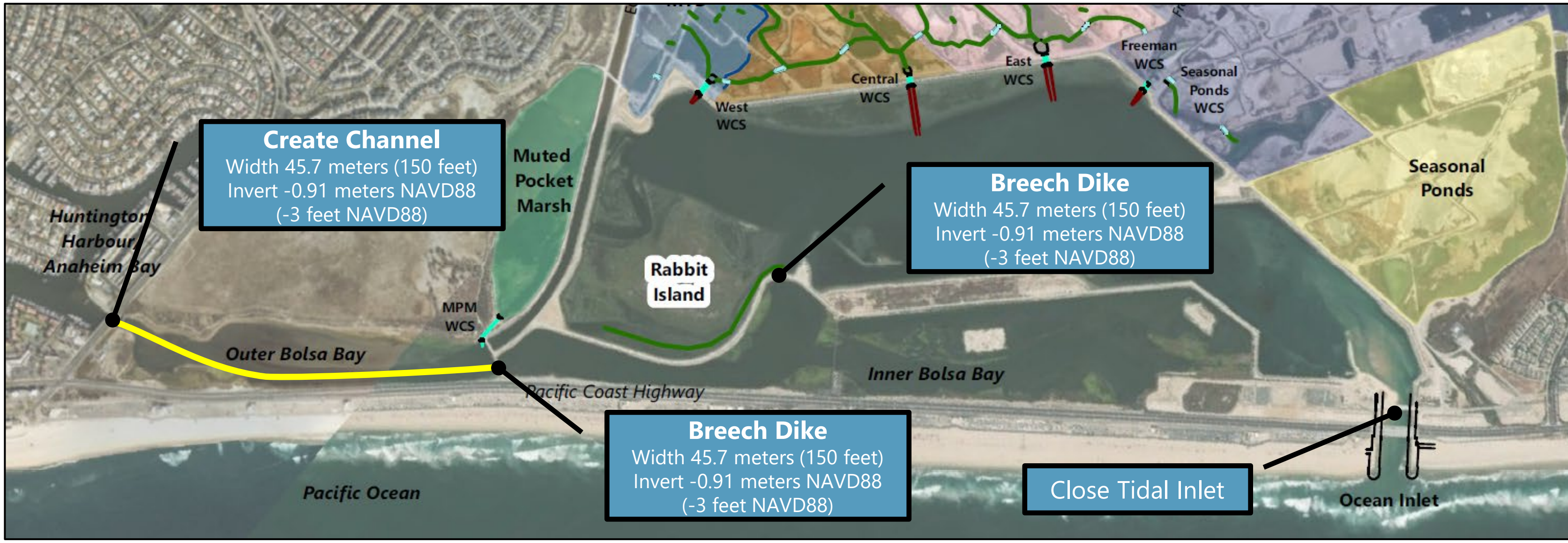


Replace some degraded salt marsh with:

- Brackish Marsh
- Mulefat Scrub
- Alkali Meadow

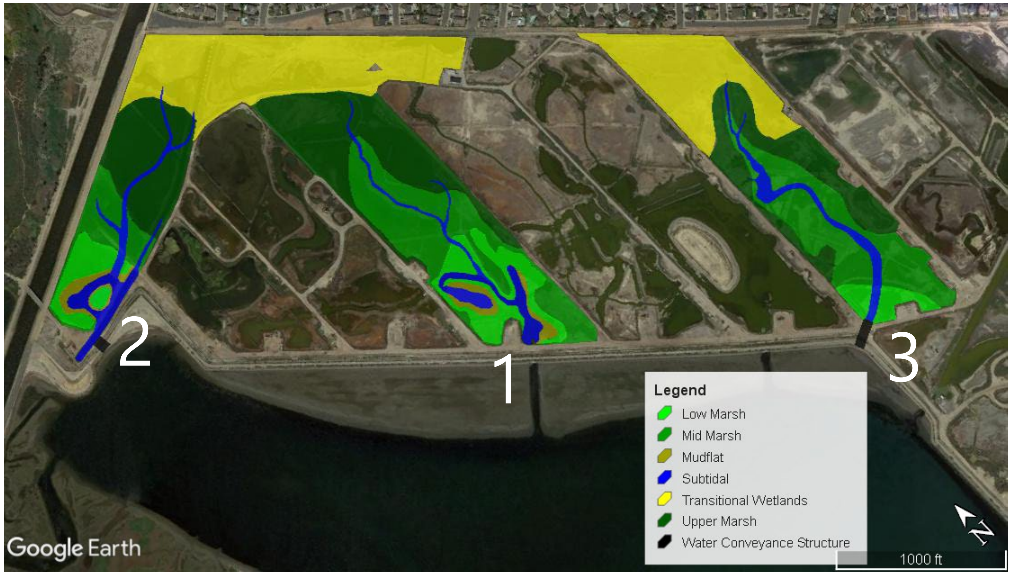
Source: Peter Baye

4A: Tidal Inlet Abandonment



- Close inlet and create new tidal connection between FTB and Huntington Harbour

4B: Ecotone Levee



January 2021 photo of upland-transition & tidal marsh in West MTB

Several options for how water could be controlled between the FTB & MTB.

1. Use existing connection
2. Create new connection for already connected cell
3. Create new connection for currently unconnected cell