Evaluating Management Actions to Promote Salt Marsh Resilience

Rachel W. Jakuba, PhD, Buzzards Bay Coalition

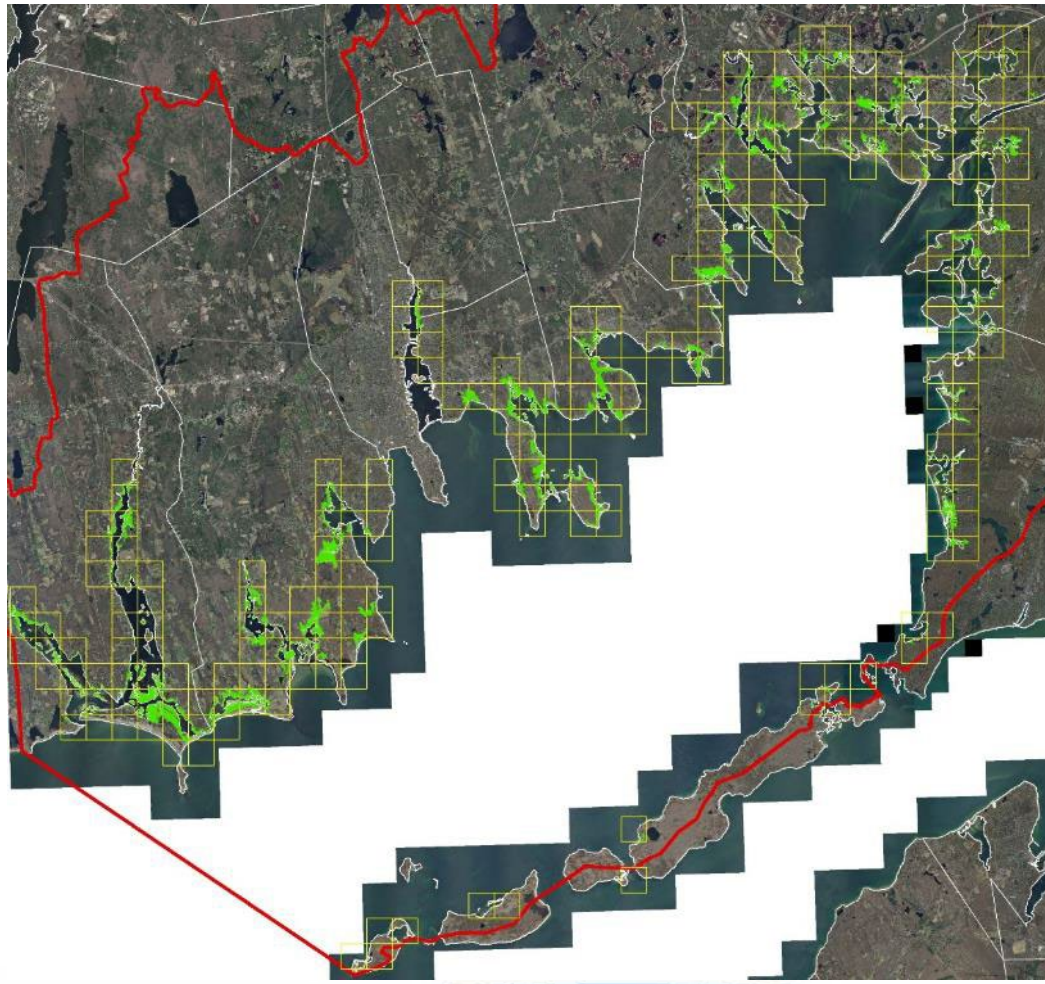
SNEP Symposium, May 18, 2022

Project Team

Alice Besterman	Wenley Ferguson
Joe Costa	Diana Brennan
Linda Deegan	Neil Ganju

Salt Marshes in the Landscape

- Very productive areas of estuaries (store carbon)
- Act like ‘filters’ converting dissolved nutrients into vegetation
- Provide physical barrier to buffer storm impacts, flooding, and coastal erosion
- Valuable habitat for variety of organisms including mussels, crabs, shrimp, striped bass, osprey, etc.



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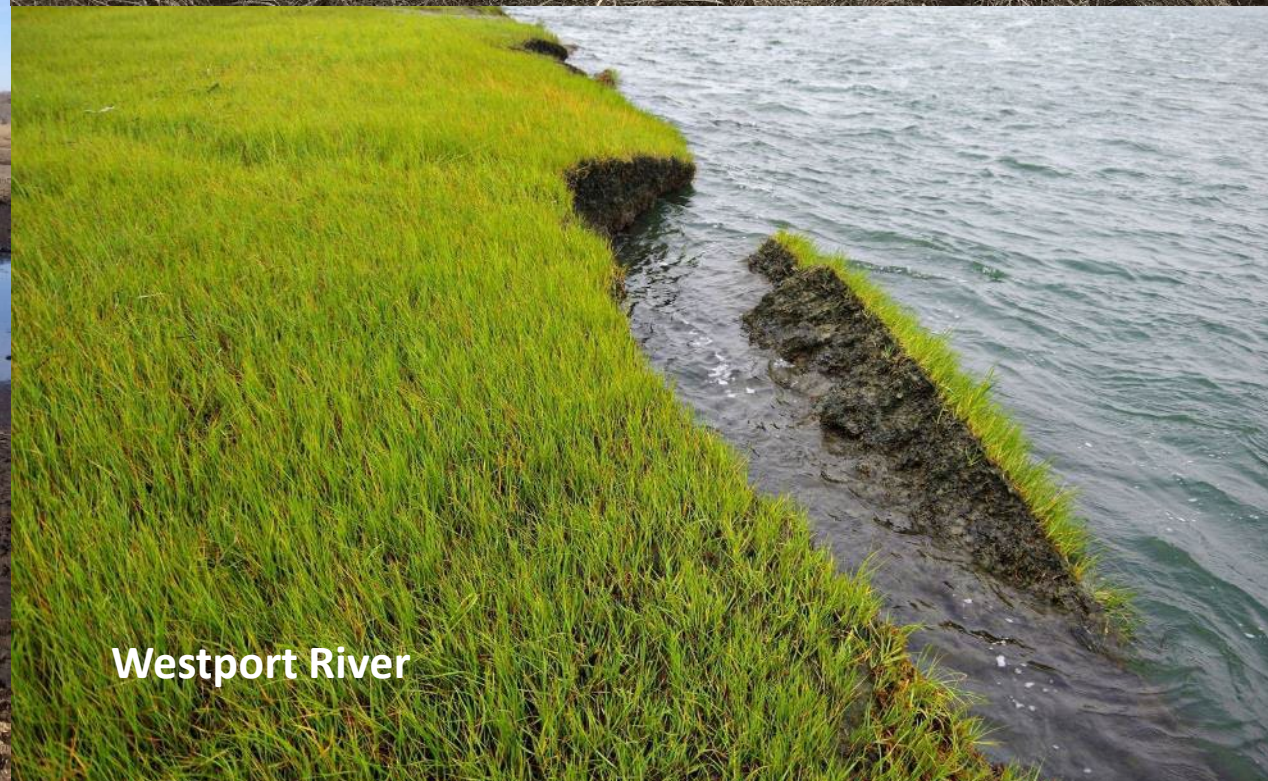
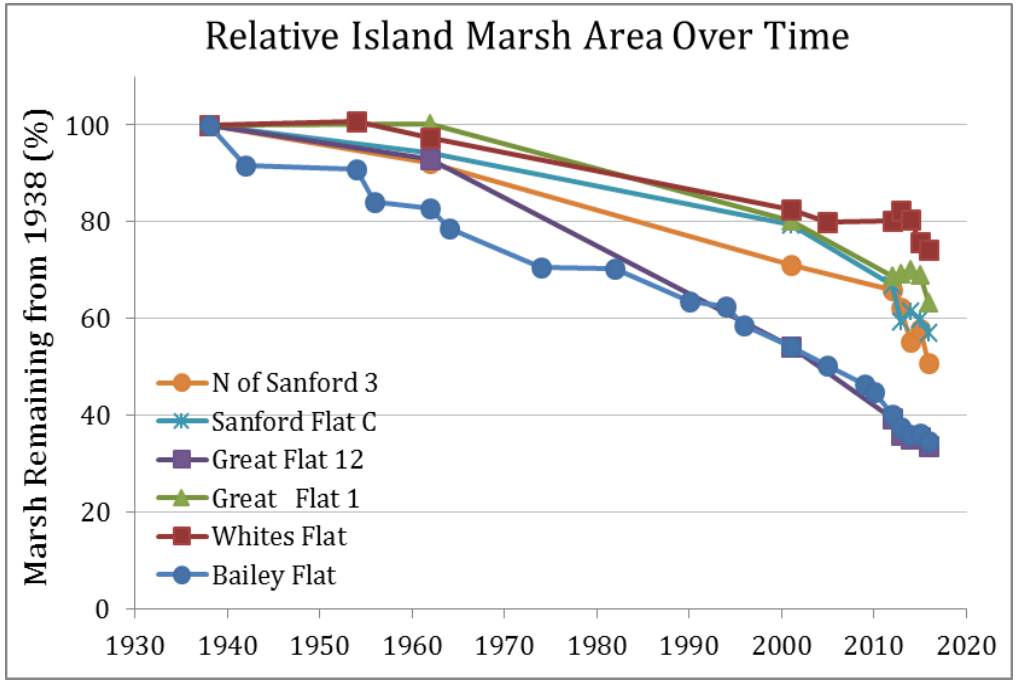
Marsh Loss around Buzzards Bay



Understanding Buzzards Bay marsh loss

- 26 - 66% of salt marsh area lost between 1938 and 2016
- Rate of loss increasing
- On each island, much of the marsh areas lost were the lowest elevation parts of that island
- Relatively low root density at all sites suggests vulnerability to loss due to nitrogen pollution



buzzards BAY COALITION

Buzzards Bay National Estuary Program

Woodwell Climate Research Center

Marine Biological Laboratory Woods Hole

Westport Fishermen's Association
Established 1983 Westport Masssachusetts

Community Concern for Marshes

From an email to the Buzzards Bay Coalition:

“The marsh grass is dying off in patches, leaving just mud that the water now flows into and is creating new smaller canals/rivulets when the tides are high.

The grass die-off is [a] …recent phenomenon, within the last year from what I've seen.

The shoreline itself, which my property abuts, has not changed or been affected yet, though once the marsh goes I would imagine that would soon follow.

This area has brought us so much peace and joy; we are willing to do quite a lot to save it.”

Marsh Loss around Buzzards Bay

If the water stays on the marsh for too long, it drowns the plants. Shallow water areas have the potential to expand outward rapidly, killing vegetation and converting interior marsh platform into open water.

Runnels: Adaptation strategy catching speed

- Runnels are small channels to create tidal connection between shallow water on the marsh surface and a creek or ditch, following topographical low areas or existing flow paths, and draining root zone
- Wenley Ferguson, Save the Bay, RI began piloting runnels for salt marsh adaptation around 2010

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Project Goals

- Synthesize and communicate existing knowledge on runnels
- Test pilot runnels in Buzzards Bay
- Identify where and when runnels are most effective in the context of marsh loss patterns and environmental conditions in Buzzards Bay

Runnel Workshop

- More than 70 scientists, practitioners, resource managers, regulators and other stakeholders
- Opportunity to develop common understanding of potential use for runnels in our region
- Break out sessions to examine and rank potential runnel sites

Journal article

- Overview of the history and use of runnels
- Case study from Winnapaug Marsh in Rhode Island
- Highlights research questions that still need addressing

Estuaries and Coasts
https://doi.org/10.1007/s12237-021-01028-8

PERSPECTIVES

Check for updates

Buying Time with Runnels: a Climate Adaptation Tool for Salt Marshes

Alice F. Besterman[1,2] · Rachel W. Jakuba[1] · Wenley Ferguson[3] · Diana Brennan[4] · Joseph E. Costa[5] · Linda A. Deegan[2]

Received: 13 July 2021 / Revised: 29 October 2021 / Accepted: 8 November 2021

Abstract
A prominent form of salt marsh loss is interior conversion to open water, driven by sea level rise in interaction with human activity and other stressors. Persistent inundation drowns vegetation and contributes to open water conversion in salt marsh interiors. Runnels are shallow channels originally developed in Australia to control mosquitoes by draining standing water, but recently used to restore marsh vegetation in the USA. Documentation on runnel efficacy is not widely available; yet over the past 10 years dozens of coastal adaptation projects in the northeastern USA have incorporated runnels. To better understand the efficacy of runnels used for restoration, we organized a workshop of 70 experts and stakeholders in coastal resource management. Through the workshop we developed a collective understanding of how runnels might be used to slow or reverse open water conversion, and identified unresolved questions. In this paper we present a synthesis of workshop discussions and results from a promising case study in which vegetation was restored at a degraded marsh within a few years of runnel construction. Despite case study outcomes, key questions remain on long-term runnel efficacy in marshes differing in elevation, tidal range, and management history. Runnel construction is unlikely to improve long-term marsh resilience alone, as it cannot address underlying causes of open water conversion. As a part of holistic climate planning that includes other management interventions, runnels may "buy time" for salt marshes to respond to management action, or adapt to sea level rise.

Keywords Runnel · Salt marsh · Sea level rise · Shallow water · Climate adaptation · Coastal restoration

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Site Visits to Runnels

- Staff from all 3 regional mosquito control agencies to look at completed runnels and review the process used for site selection, runnel digging, and permitting.
- Stakeholders from Allens Pond and non-profit staff actively engaged in restoration techniques around the watershed.

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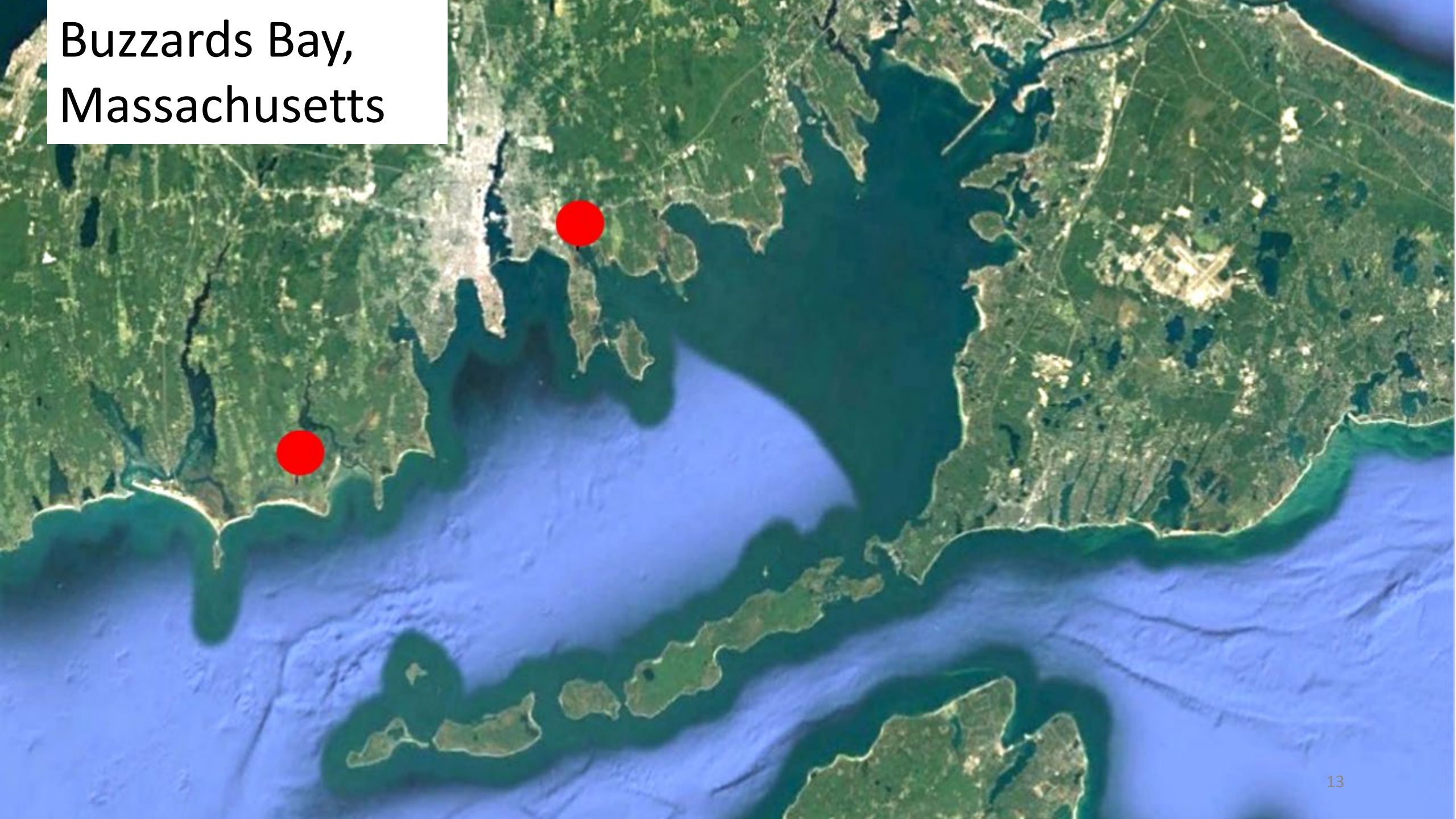
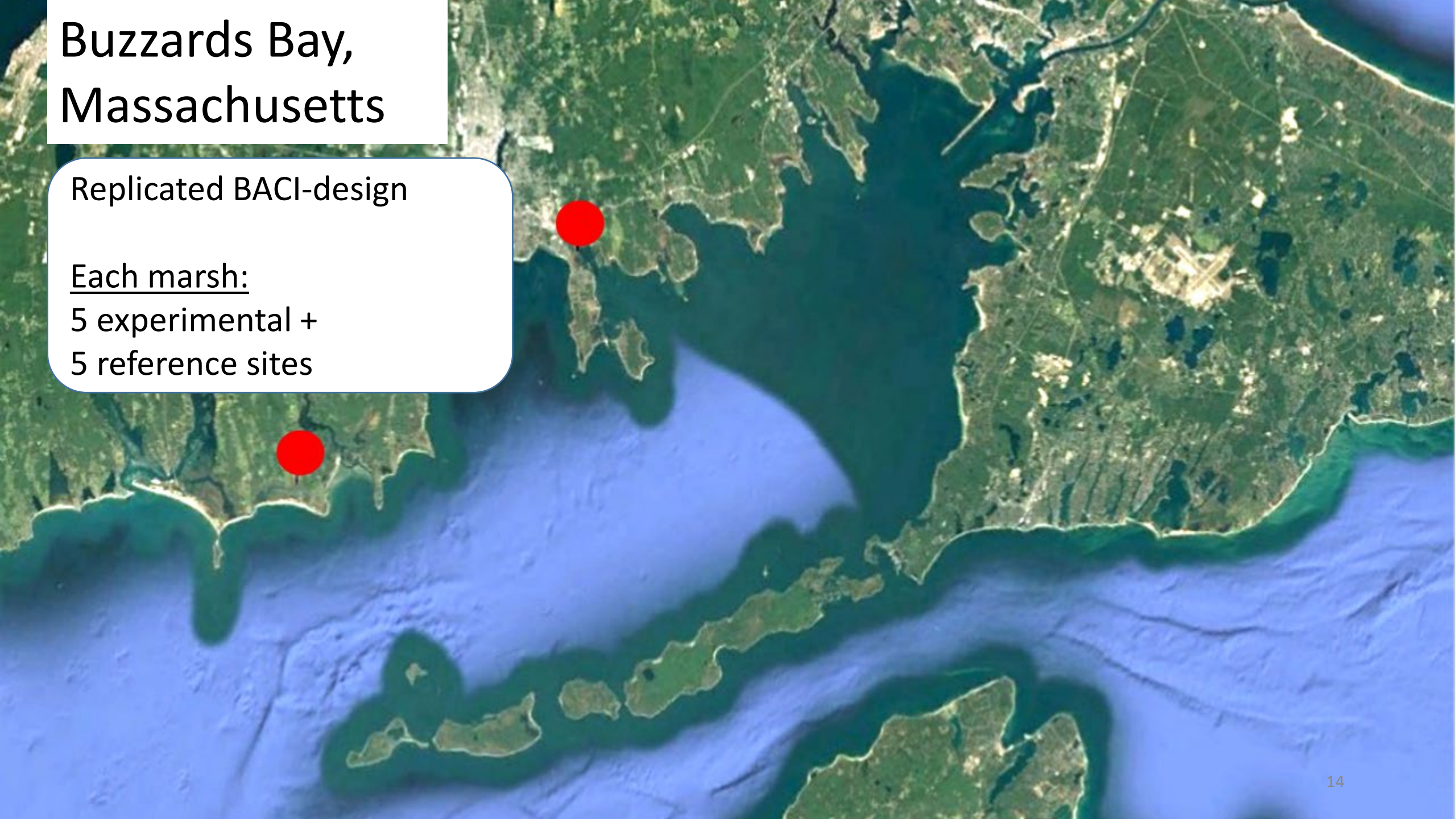

Buzzards Bay,
Massachusetts

Buzzards Bay, Massachusetts

Replicated BACI-design

<u>Each marsh:</u>
5 experimental +
5 reference sites



Buzzards Bay, Massachusetts

Replicated BACI-design

<u>Each marsh:</u>
5 experimental +
5 reference sites

<u>All sites (20)</u>
- Vegetation metrics
- Photo stations

Buzzards Bay, Massachusetts

Replicated BACI-design

<u>Each marsh:</u>
5 experimental +
5 reference sites

<u>All sites (20)</u>
- Vegetation metrics
- Photo stations

<u>Intensive Sites (12)</u>
- Elevation
- Soil characteristics
- Water level
- Shear strength
- Water quality + TSS
- Decomposition
- Other environmental variables

- Pre-monitoring 2020
- Runnels created Oct 2020 - Feb 2021
- Monitor through 2023 at least

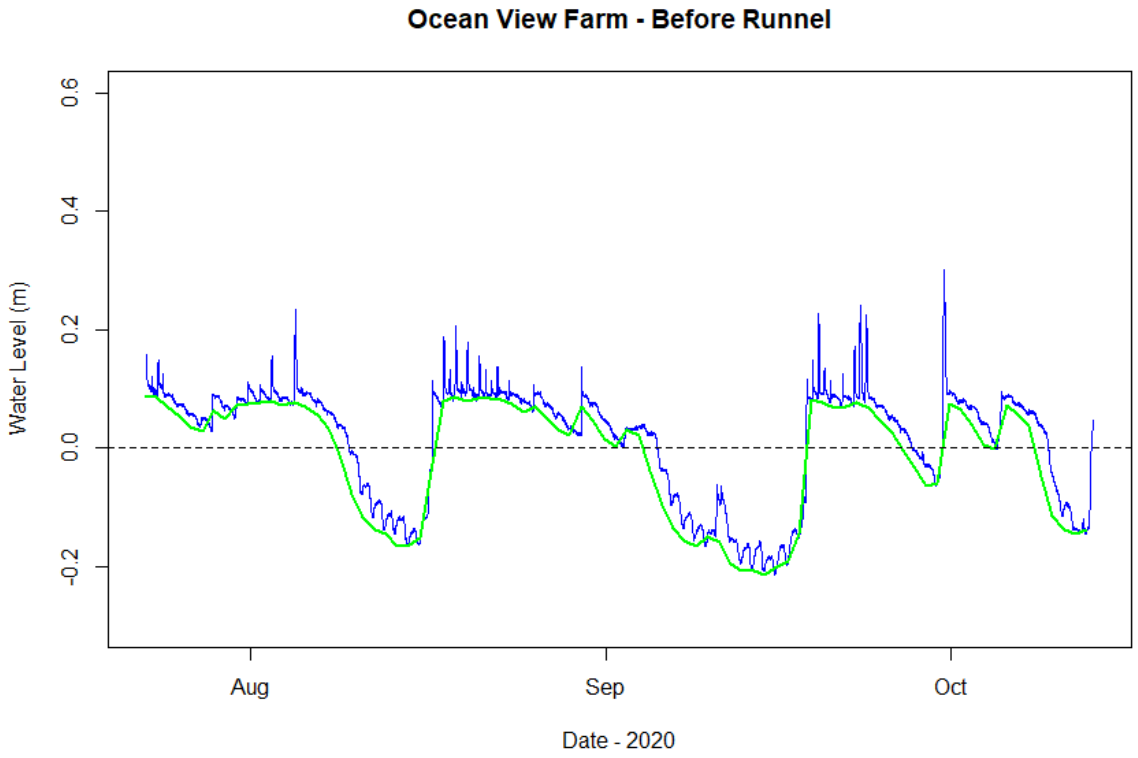
Experimental-runnel site

Reference site

Intensive site

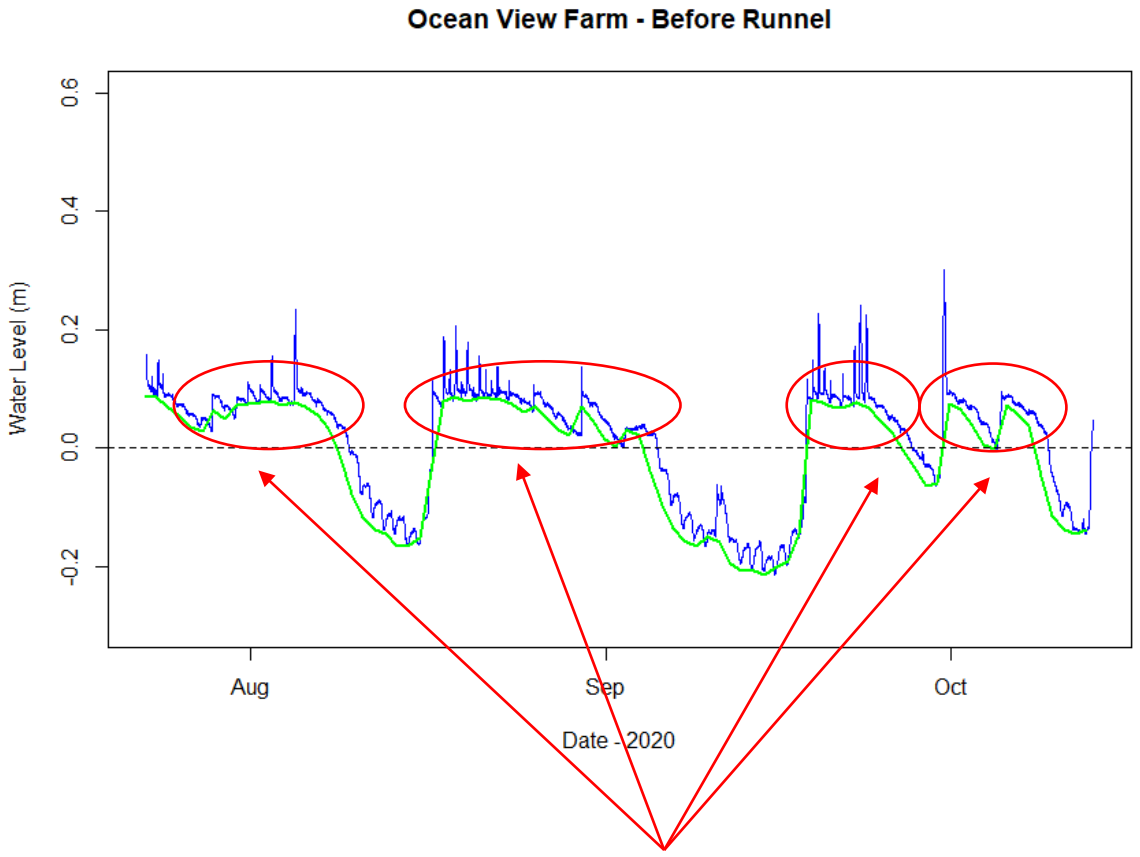
Installation

Initial runnel results



Marsh surface

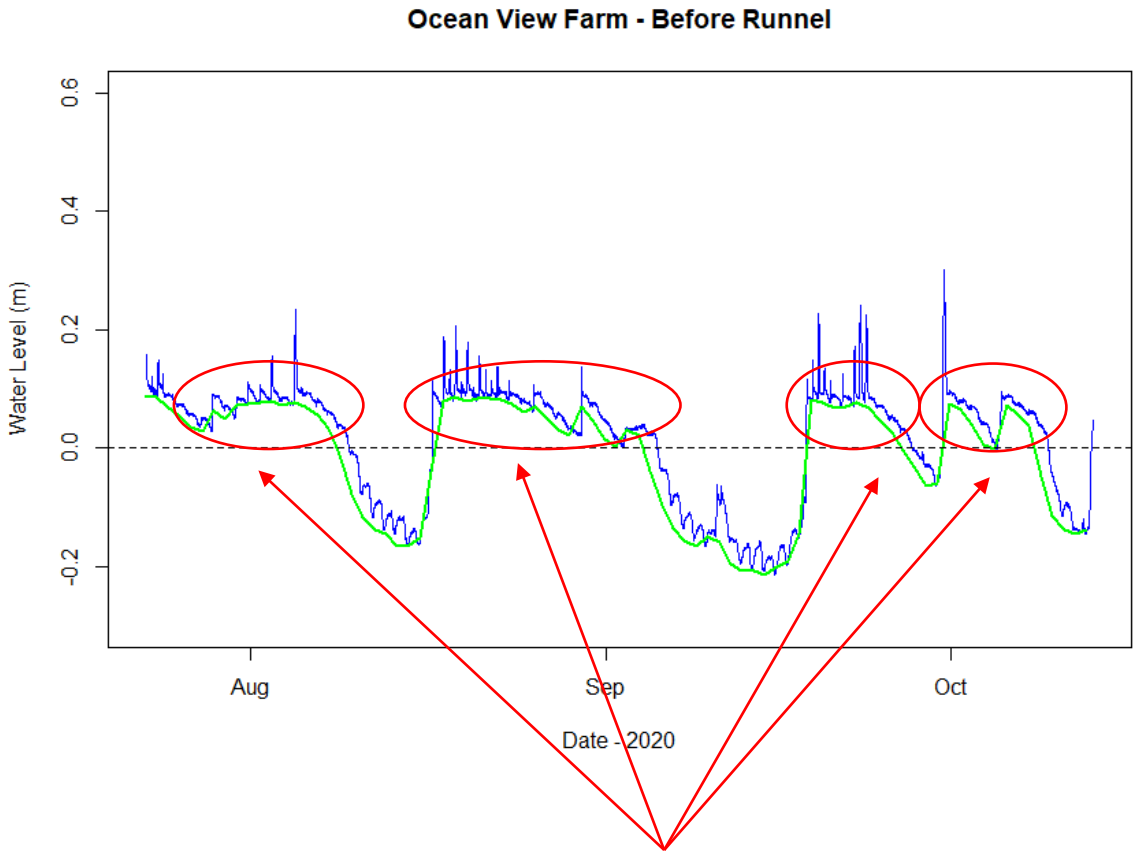
Initial runnel results



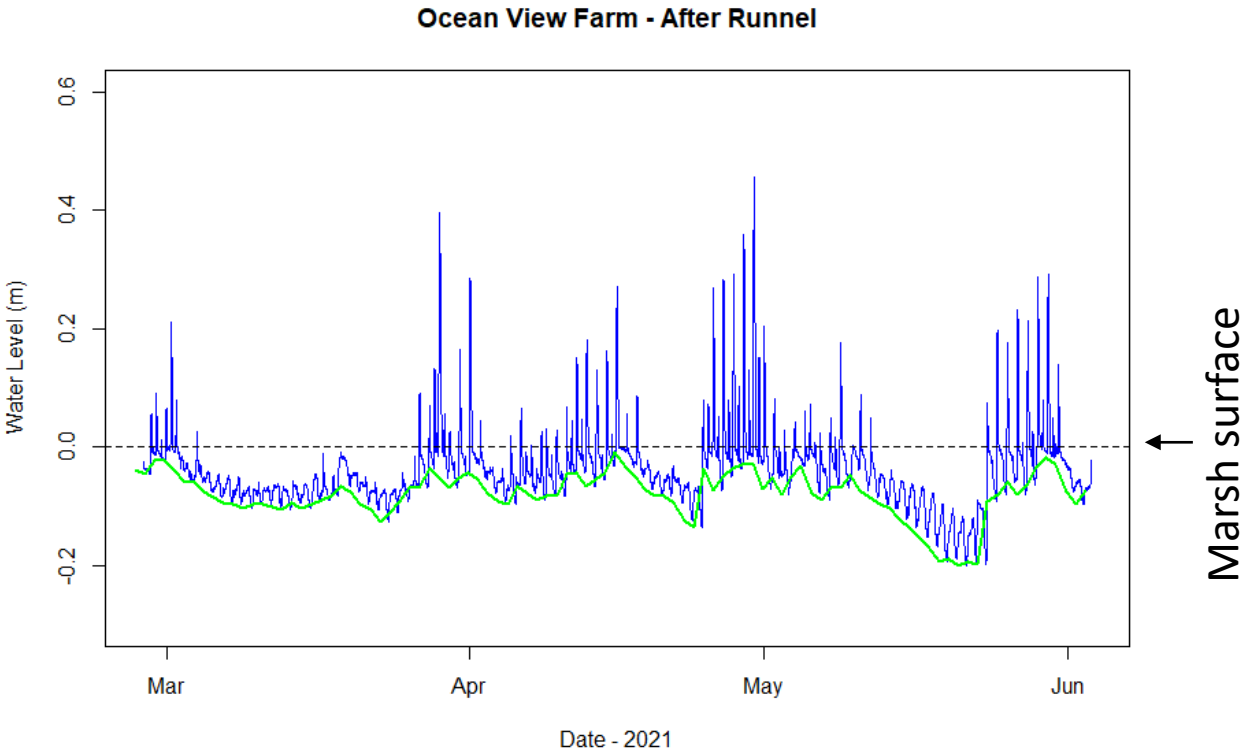
Marsh surface

Before the runnel – extended periods of standing water

Initial runnel results

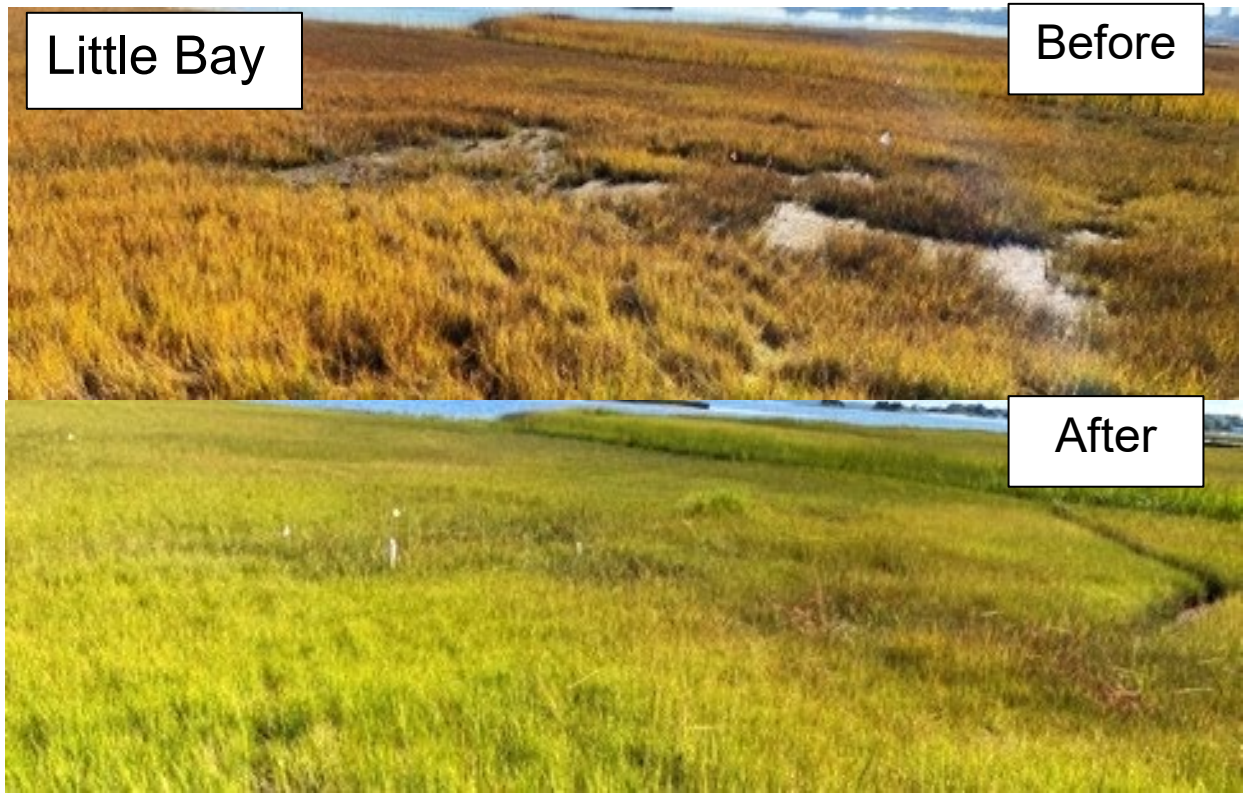


Before the runnel – extended periods of standing water



After the runnel – tidal flooding but no standing water

Initial runnel results



Project Goals

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Lessons Learned

- Small scale features that target specific areas of die-back.
- Runnels are a valuable tool in an overall marsh management scheme.
- Project design is still highly context-specific, so we recommend future runnel projects include individuals with training and experience using the technique, or similar hydrologic management tools.
- Multiple partners provided key support.
- Continued monitoring will be useful for characterizing potential sites.

Acknowledgements

- Alice Besterman
- Joe Costa
- Wenley Ferguson
- Linda Deegan
- Diana Brennan
- Neil Ganju

Landowners, Collaborators, Students/Interns

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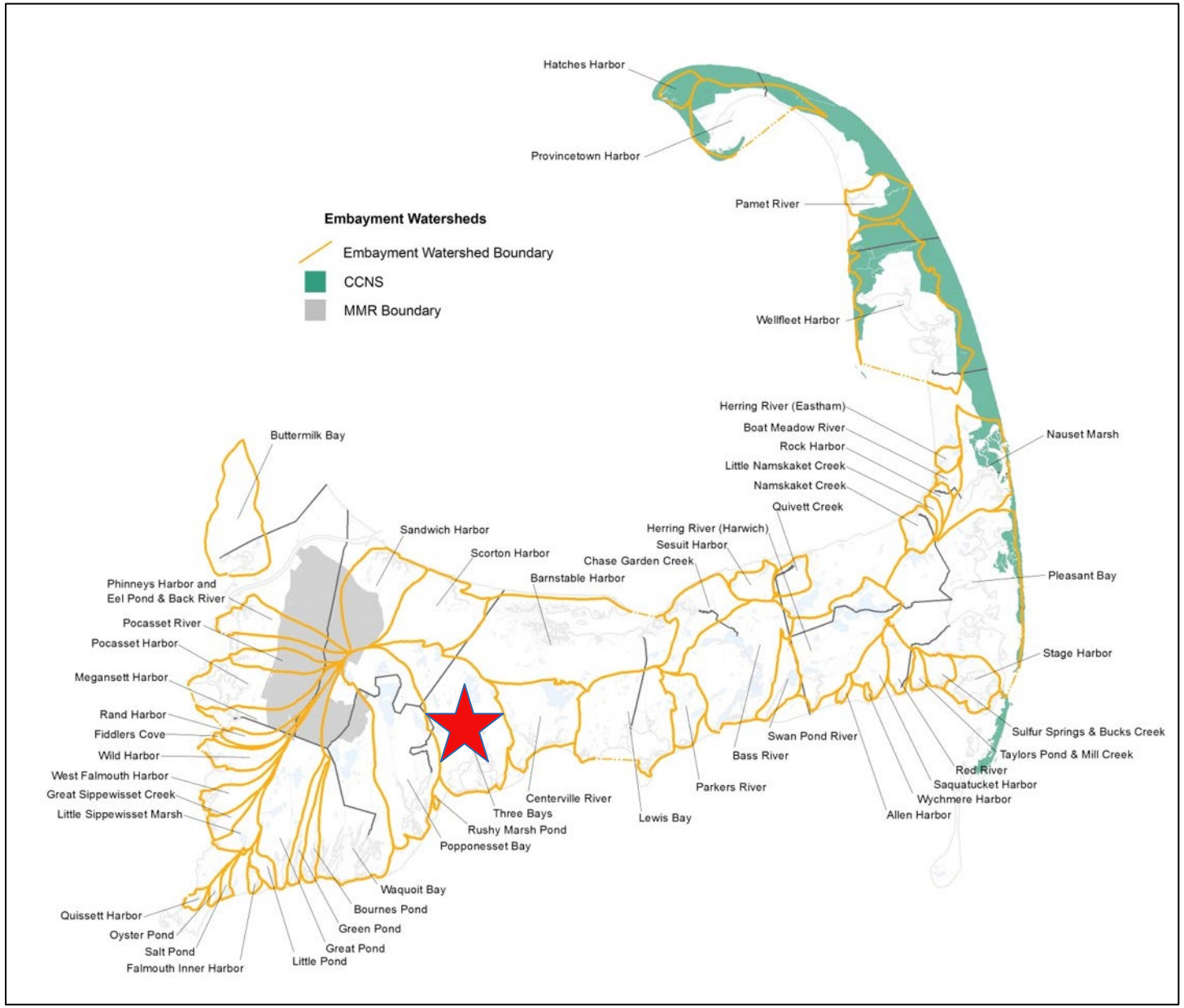
Whitney McClees (Town of Fairhaven)

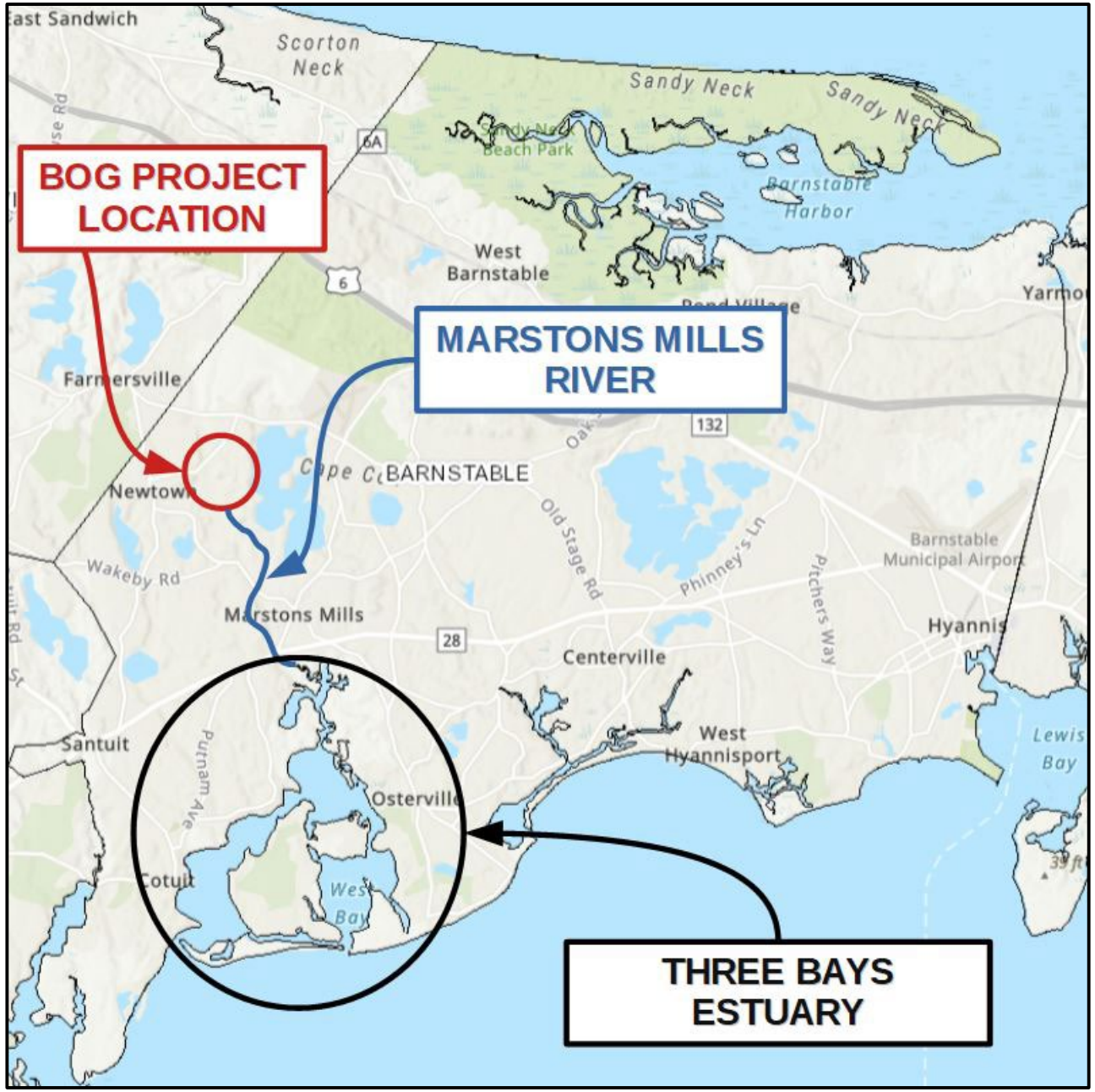
Hillary Sullivan, Kara Falvey, Dawson Little, Melissa Herring, Nico Gentile, Jennifer Sepanara, Gizella Spencer, Lillie Hoffart, Julia Holtzer, Shea Stobaugh

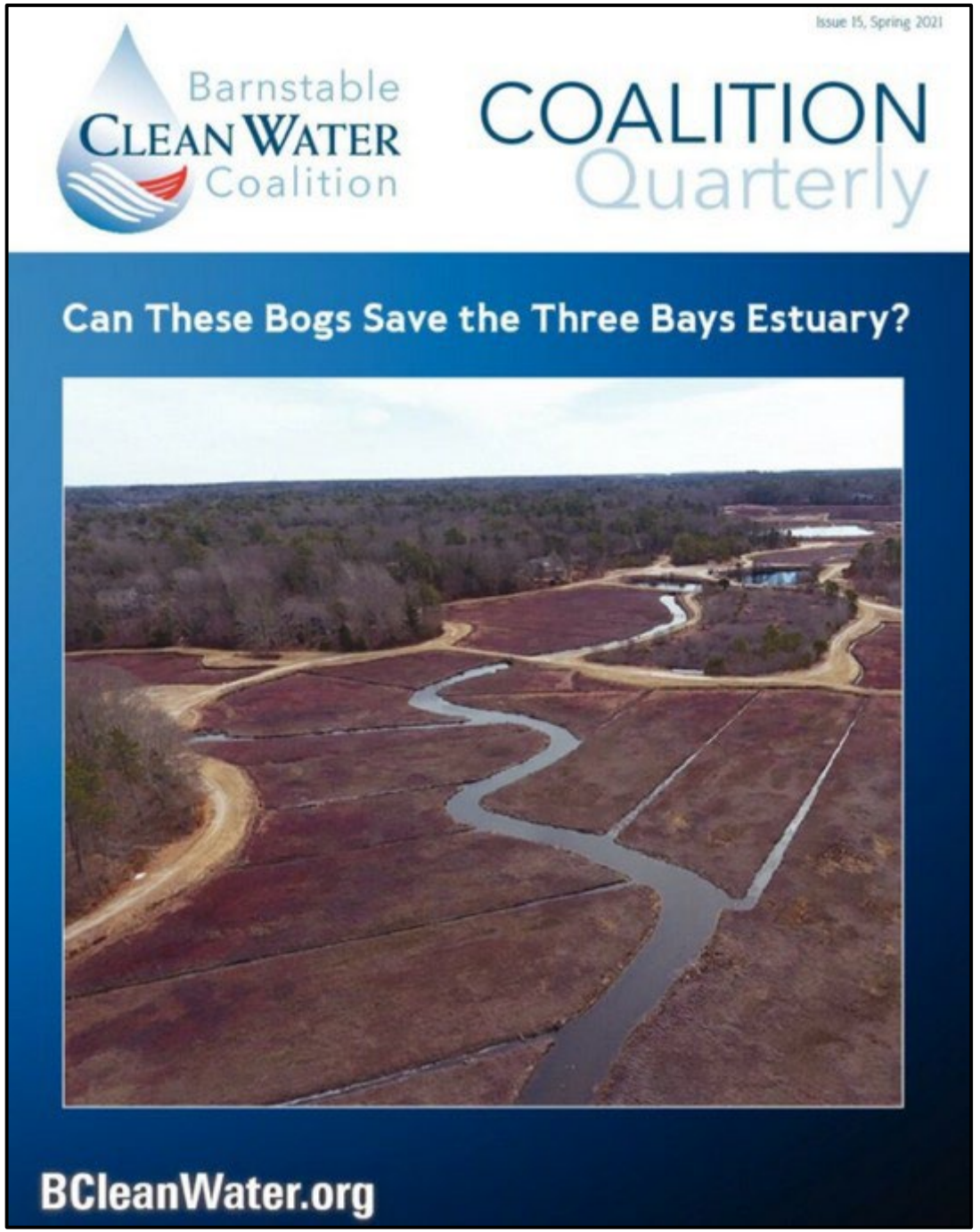
Marstons Mills River Headwaters Cranberry Bog Restoration Project

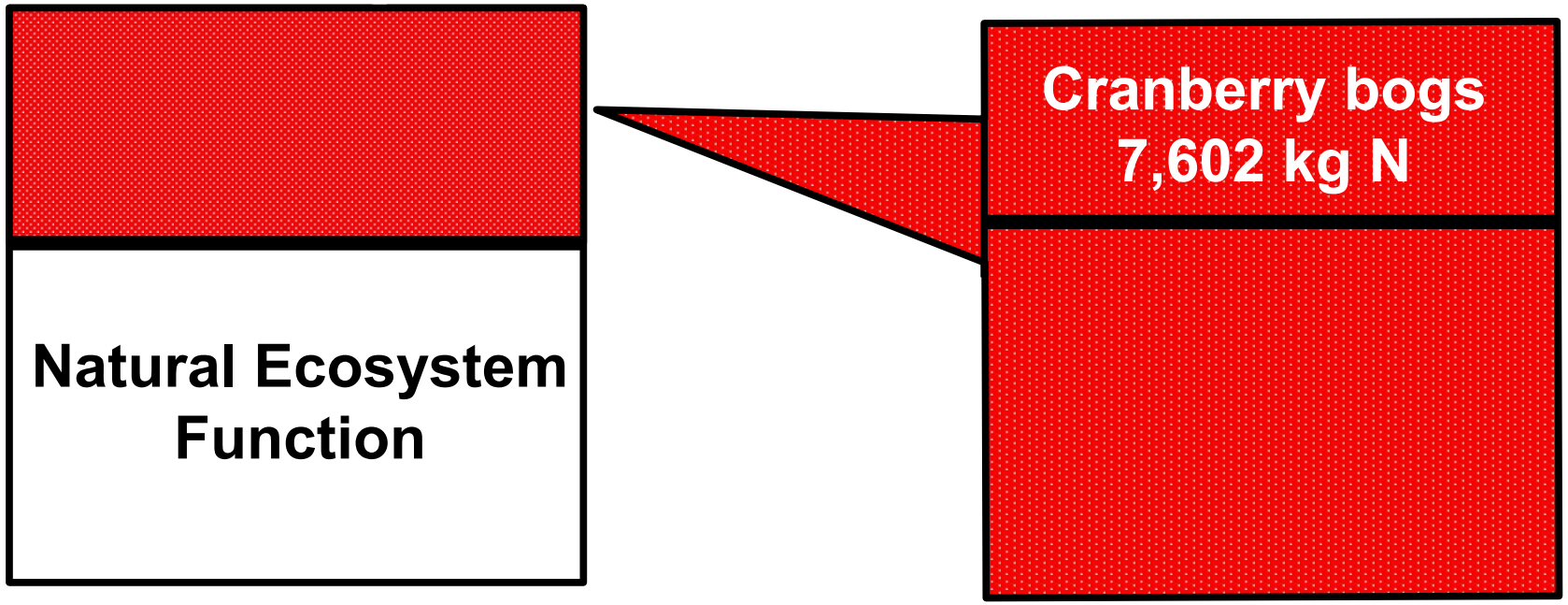
At **Barnstable Clean Water Coalition (BCWC)** our mission is to restore and preserve clean water throughout Barnstable.

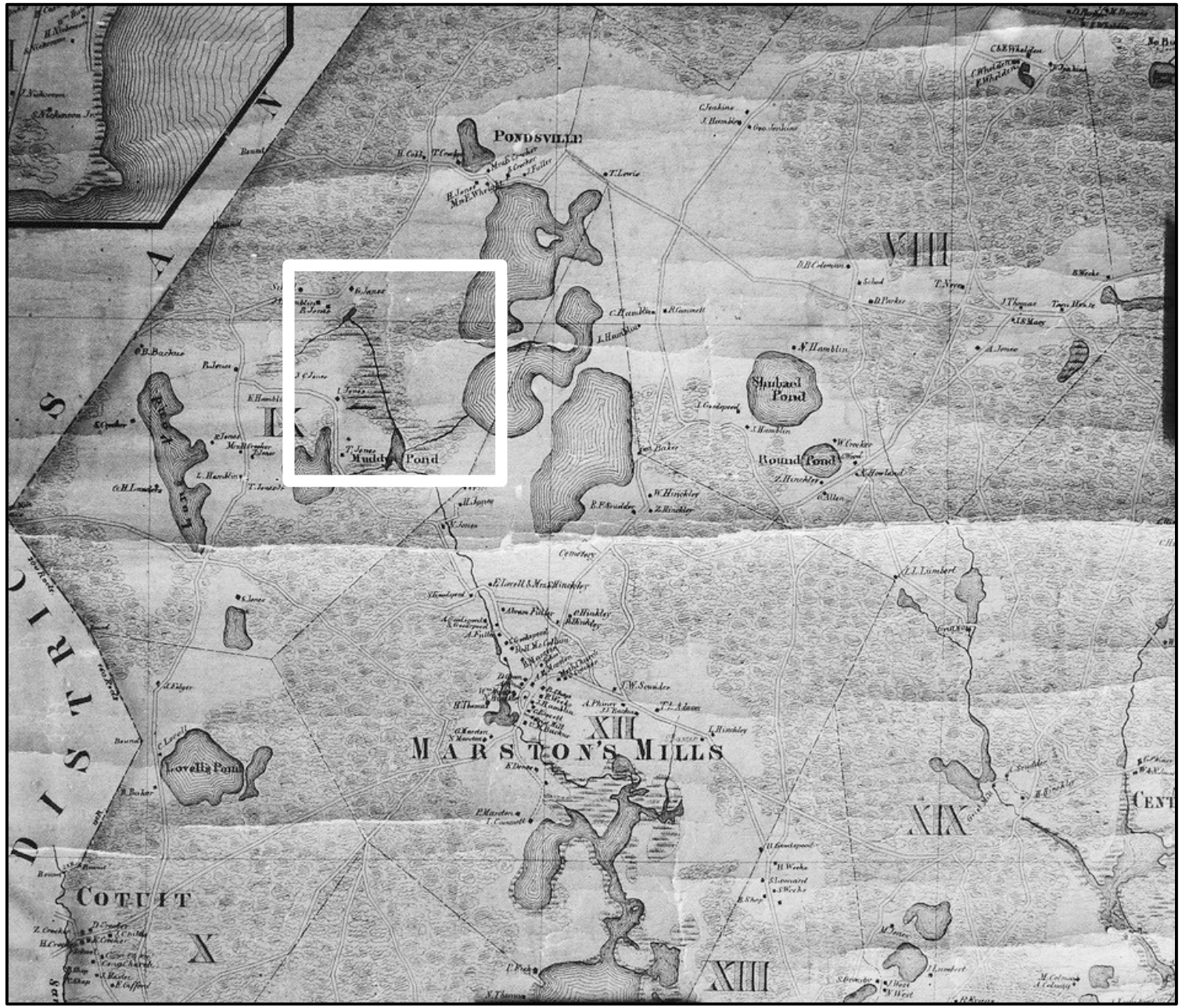
With science as our foundation, BCWC utilizes four core components to accomplish our mission: ***educate***, ***monitor***, ***mitigate*** and ***advocate***.

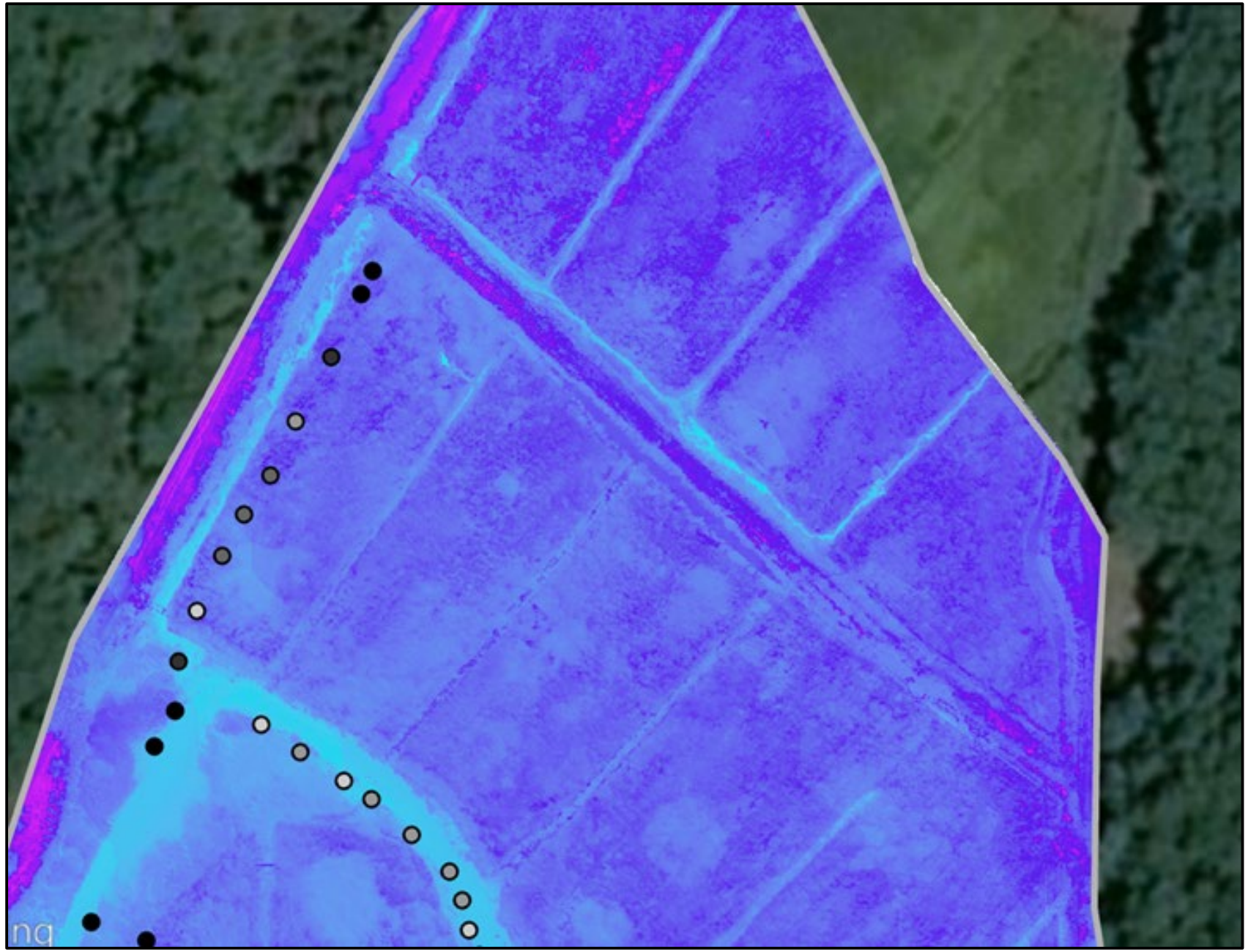

Embayment Watersheds
Embayment Watershed Boundary
CCNS
MMR Boundary
Hatches Harbor
Provincetown Harbor
Pamet River
Wellfleet Harbor
Herring River (Eastham)
Boat Meadow River
Rock Harbor
Little Namskaket Creek
Namskaket Creek
Quivett Creek
Nauset Marsh
Buttermilk Bay
Sandwich Harbor
Scorton Harbor
Barnstable Harbor
Herring River (Harwich)
Sesuit Harbor
Chase Garden Creek
Pleasant Bay
Phinneys Harbor and
Eel Pond & Back River
Pocasset River
Pocasset Harbor
Megansett Harbor
Rand Harbor
Fiddlers Cove
Wild Harbor
West Falmouth Harbor
Great Sippewisset Creek
Little Sippewisset Marsh
Stage Harbor
Sulfur Springs & Bucks Creek
Taylors Pond & Mill Creek
Red River
Saquatucket Harbor
Wychmere Harbor
Allen Harbor
Swan Pond River
Bass River
Parkers River
Lewis Bay
Centerville River
Three Bays
Rushy Marsh Pond
Popponesset Bay
Waquoit Bay
Bournes Pond
Green Pond
Great Pond
Little Pond
Quissett Harbor
Oyster Pond
Salt Pond
Falmouth Inner Harbor

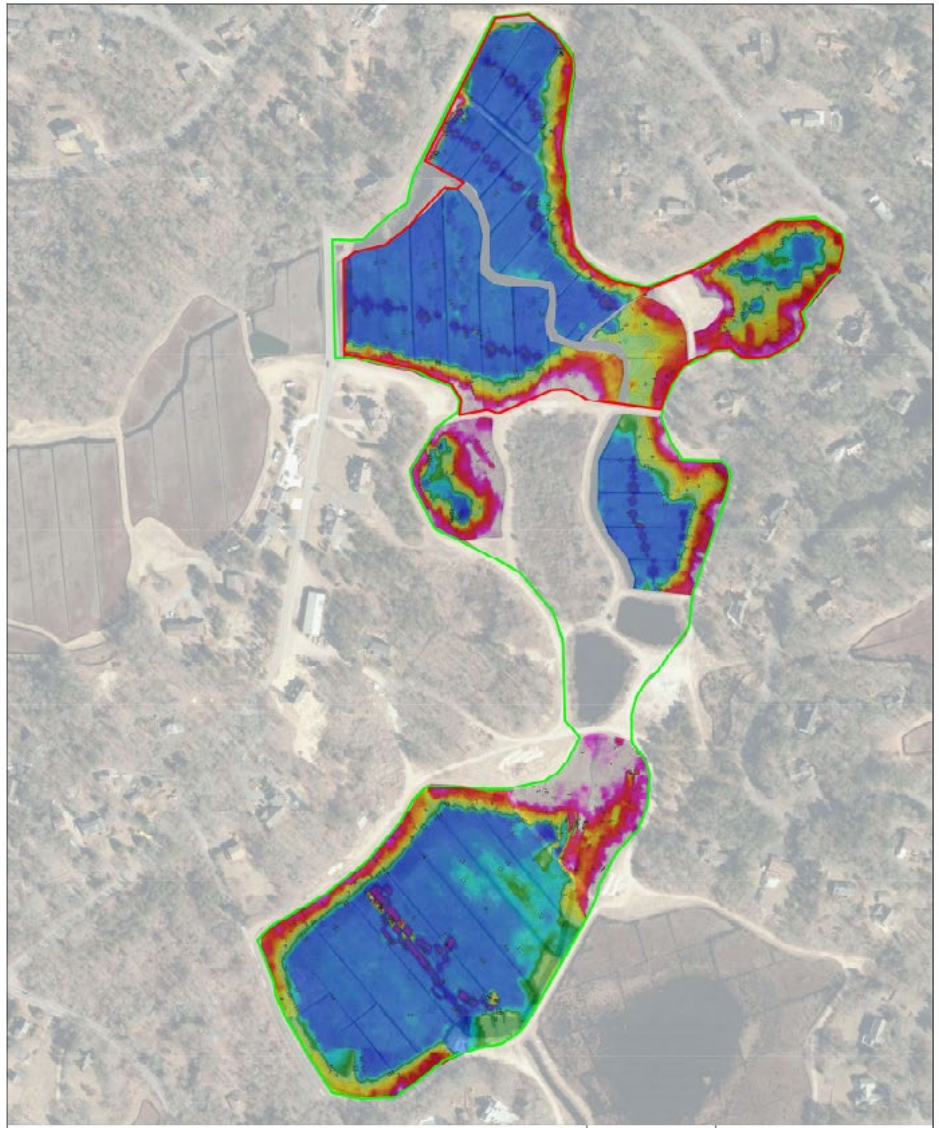

BOG PROJECT LOCATION
MARSTONS MILLS RIVER
THREE BAYS ESTUARY
East Sandwich
Scorton Neck
Sandy Neck
Sandy Neck Beach Park
Barnstable Harbor
West Barnstable
Yarmouth
Farmersville
Newtown
Cape Cod
BARNSTABLE
Wakeby Rd
Marstons Mills
Old Stage Rd
Phinney's Ln
Pitchers Way
Barnstable Municipal Airport
Hyannis
Centerville
West Hyannisport
Lewis Bay
Santuit
Putnam Ave
Osterville
Cotuit
West Bay
6A
6
132
28


Issue 15, Spring 2021
Barnstable Clean Water Coalition
COALITION Quarterly
Can These Bogs Save the Three Bays Estuary?
BCleanWater.org


Natural Ecosystem Function
Cranberry bogs
7,602 kg N


PONDSVILLE
Stubael Pond
Round Pond
Mudd Pond
Lovells Pond
MARSTON'S MILLS
COTUIT
DISTRICT
VIII
XII
XIII
XIX
X





LEGEND

- Survey Boundaries
- Soil Probing Flags
- GPR Track
- Contour Showing Total Peat Thickness (Feet); Interval = 0.5 Feet

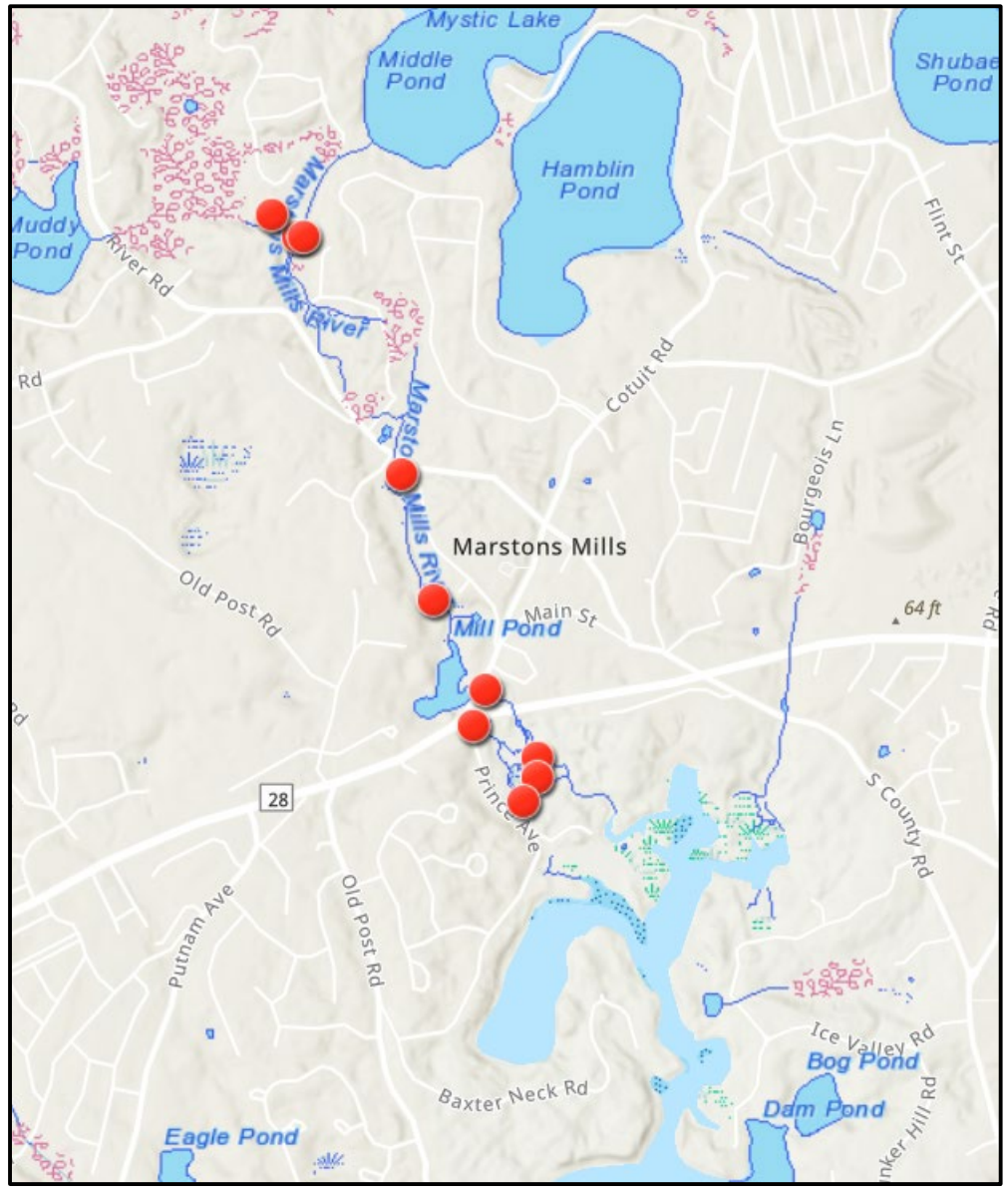
Approximate Thickness of Peat

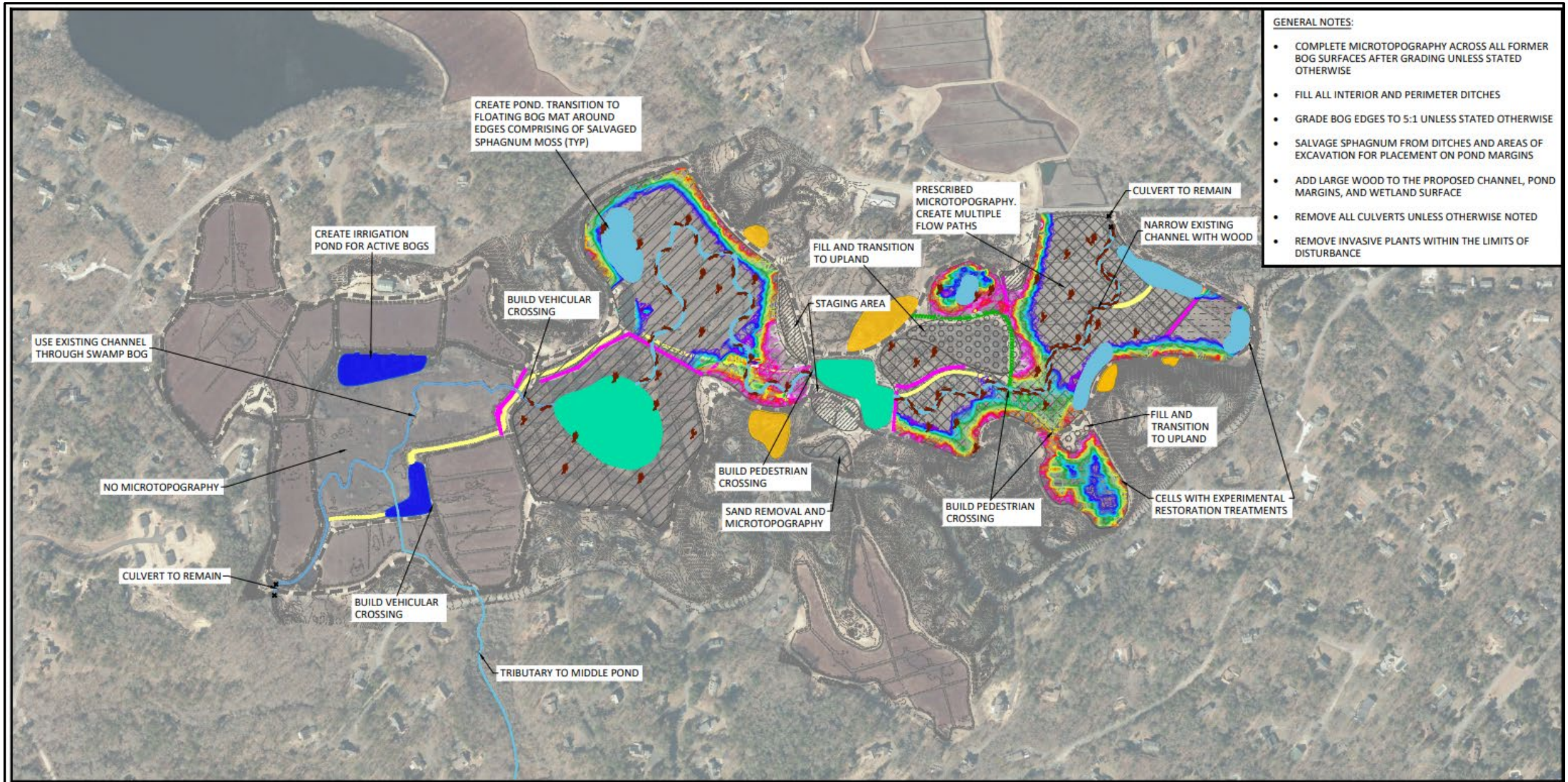
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0

COORDINATE SYSTEM
MASSACHUSETTS
STATE PLANE NAD(83)
US SURVEY FEET

FIGURE 4
APPROXIMATE PEAT THICKNESS
SOIL CLASSIFCATION
USING GPR
HAMBLIN BOGS
299-71 BOG ROAD
MARSTONS MILLS, MASSACHUSETTS
Prepared for
Inter-Fluve, Inc.
JUNE 2021

RSI Geophysics for People and the Environment
Radar Solutions International, Inc.

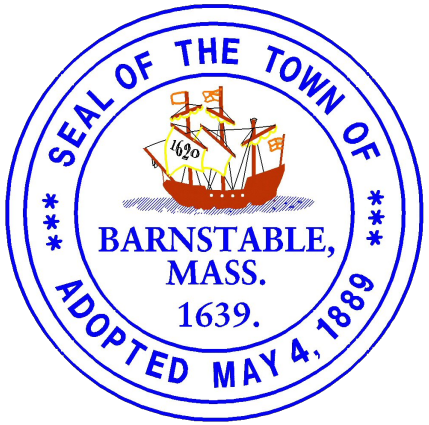

Mystic Lake
Middle Pond
Hamblin Pond
Shubae Pond
Muddy Pond
River Rd
Flint St
Cotuit Rd
Bourgeois Ln
Marstons Mills
Old Post Rd
Main St
Mill Pond
64 ft
28
Prince Ave
S County Rd
Putnam Ave
Old Post Rd
Ice Valley Rd
Bog Pond
Dam Pond
Baxter Neck Rd
Eagle Pond


CREATE POND. TRANSITION TO FLOATING BOG MAT AROUND EDGES COMPRISING OF SALVAGED SPHAGNUM MOSS (TYP)
CREATE IRRIGATION POND FOR ACTIVE BOGS
BUILD VEHICULAR CROSSING
USE EXISTING CHANNEL THROUGH SWAMP BOG
NO MICROTOPOGRAPHY
CULVERT TO REMAIN
BUILD VEHICULAR CROSSING
TRIBUTARY TO MIDDLE POND
PRESCRIBED MICROTOPOGRAPHY. CREATE MULTIPLE FLOW PATHS
FILL AND TRANSITION TO UPLAND
STAGING AREA
BUILD PEDESTRIAN CROSSING
SAND REMOVAL AND MICROTOPOGRAPHY
CULVERT TO REMAIN
NARROW EXISTING CHANNEL WITH WOOD
FILL AND TRANSITION TO UPLAND
BUILD PEDESTRIAN CROSSING
CELLS WITH EXPERIMENTAL RESTORATION TREATMENTS
GENERAL NOTES:
COMPLETE MICROTOPOGRAPHY ACROSS ALL FORMER BOG SURFACES AFTER GRADING UNLESS STATED OTHERWISE
FILL ALL INTERIOR AND PERIMETER DITCHES
GRADE BOG EDGES TO 5:1 UNLESS STATED OTHERWISE
SALVAGE SPHAGNUM FROM DITCHES AND AREAS OF EXCAVATION FOR PLACEMENT ON POND MARGINS
ADD LARGE WOOD TO THE PROPOSED CHANNEL, POND MARGINS, AND WETLAND SURFACE
REMOVE ALL CULVERTS UNLESS OTHERWISE NOTED
REMOVE INVASIVE PLANTS WITHIN THE LIMITS OF DISTURBANCE
PLAN LEGEND
EXISTING 1FT CONTOURS
CHANNEL FILLING
EXISTING CULVERT TO REMAIN
PROPOSED CHANNEL ALIGNMENT
STAGING AREA
MICROTOPOGRAPHY
PRESCRIBED MICROTOPOGRAPHY
TOTAL PEAT DEPTH
0
200
400
SCALE IN FEET

2021	2022	2023	2024	2025
QAPP Approval				
Feasibility Study				
Conceptual Design				
	Design and permitting			
			Construction	
Monitoring				


The Nature Conservancy


USGS
science for a changing world


SEAL OF THE TOWN OF
BARNSTABLE,
MASS.
1639.
ADOPTED MAY 4, 1889
1620


SNEP
Southeast New England Program


NATIVE LAND CONSERVANCY


Massachusetts Department of Fish and Game
Division of Ecological Restoration
Invested in Nature and Community


UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

Marstons Mills River Headwaters Cranberry Bog Restoration Project

Teaneck Creek Park Habitat Restoration:
Regenerative Stormwater Conveyance & Sand Seepage Wetlands

Southeast New England Program 2022 Symposium

Virtual

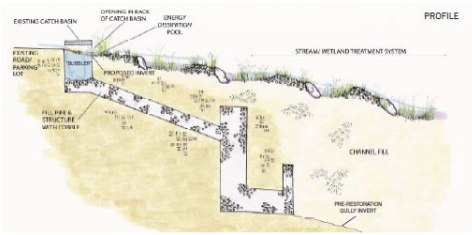
May 18, 2022

KEVIN DAHMS, PE

WATER RESOURCES ENGINEER

BIOHABITATS, INC.

Biohabitats



PROJECT BACKGROUND | PROJECT DRIVERS | PROJECT APPROACH | LESSONS LEARNED

PROJECT PARTNERS

PROJECT LEAD

DESIGN

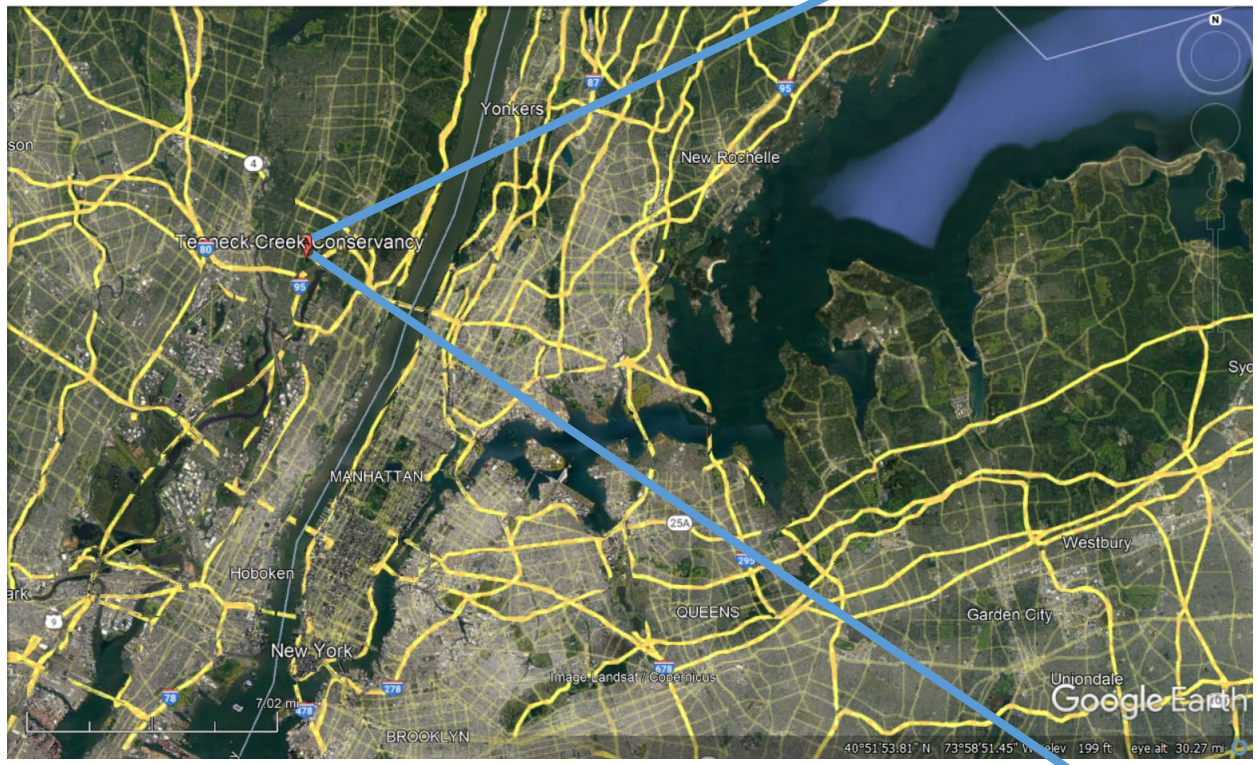
CONSTRUCTION MANAGEMENT

CONTRACTOR

PARTNERS & FUNDING

PROJECT LOCATION

Teaneck Creek Park, Teaneck, NJ



PROJECT/SITE HISTORY

PRE-RESTORATION CONDITIONS

PRE-RESTORATION CONDITIONS

Clay liner

Trail system

Art and educational programming

Biohabitats

PROJECT DRIVERS

- Public experience: noise from adjacent roads, degraded paths, debris piles
- Impaired water quality (Dragonfly Pond, Teaneck Creek)
- Erosion from stormwater
- Infestation of invasive species

PROJECT DRIVERS

Eroding brook

Eroding stormwater gullies

PROJECT DRIVERS

Poor WQ in Dragonfly Pond and Teaneck Creek

PROJECT DRIVERS

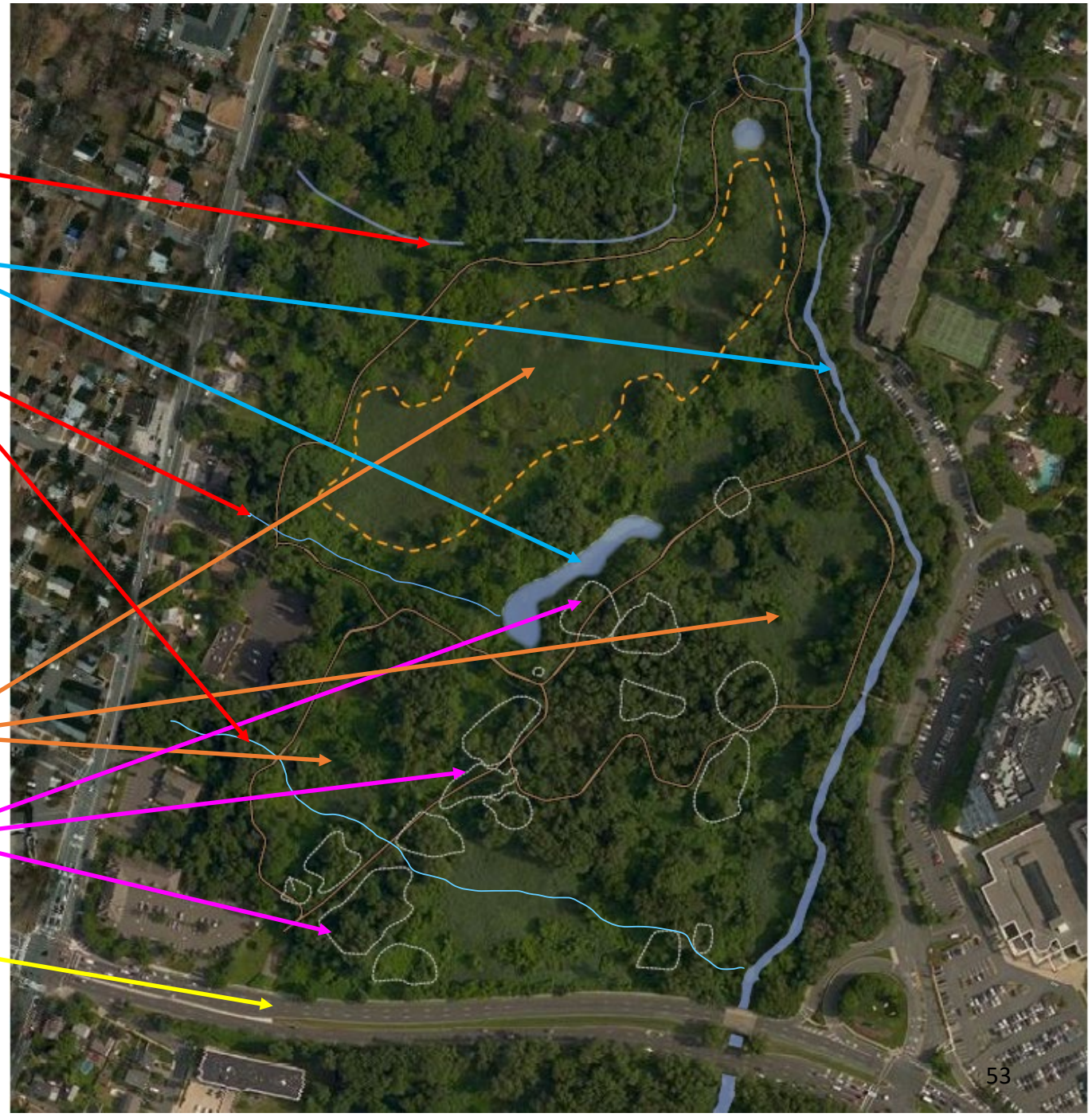
Invasive species (throughout)

PROJECT DRIVERS

Debris piles (throughout)

PROJECT DRIVERS

PROJECT DRIVERS

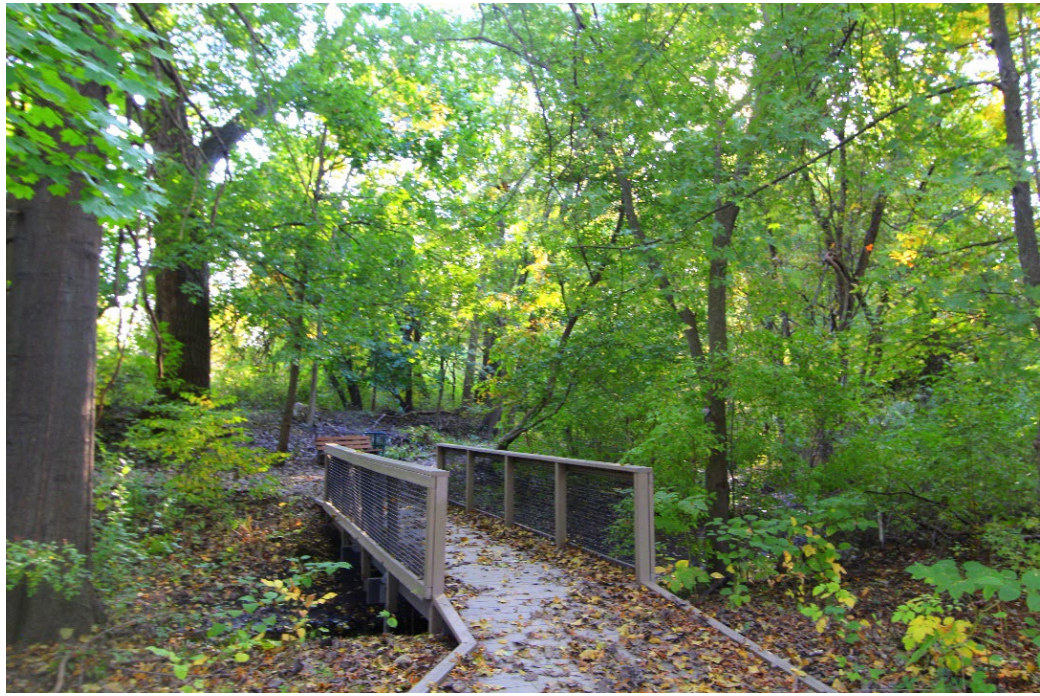


PROJECT GOALS

- Enhance the site's natural resources
- Increase biodiversity
- Mitigate erosive forces of stormwater throughout the site
- Improve public access and visitor experience
- Improve community health and well-being
- Educate the public about the park's habitat and ecology

PROJECT METRICS

- Over 20 acres of habitat restoration
- 430 linear feet of stormwater channel restoration
- 300 linear feet of trail realignment
- 16 debris piles removed or capped



PROJECT PLANS

- Regenerative stormwater conveyance
- Sand seepage wetlands
- Invasive species management (mechanical/chemical)
- Native plantings
- Trail rehabilitation
- Debris pile removal
- Lookout berm creation

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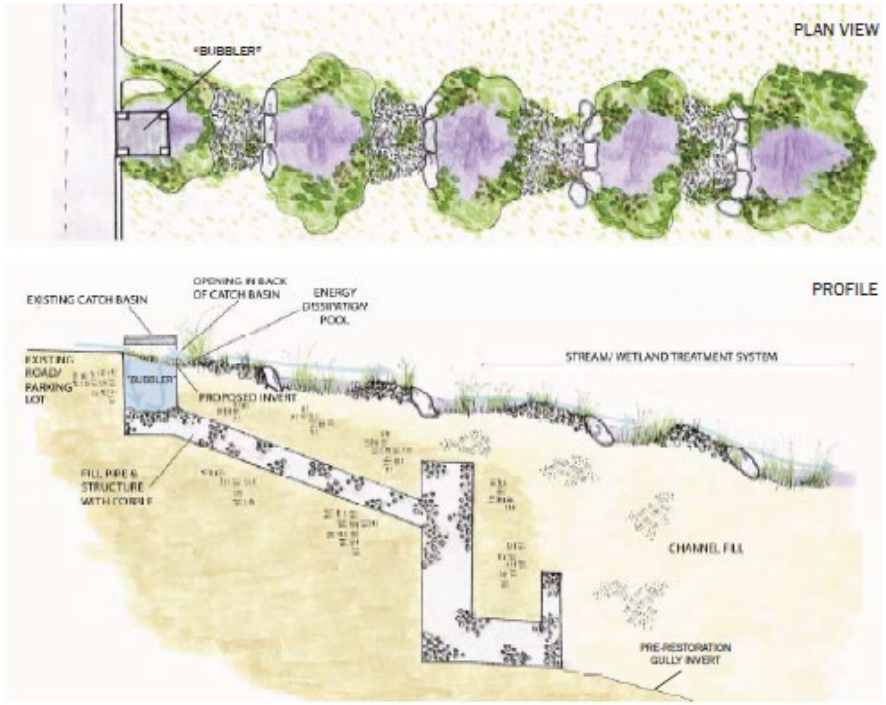
PROJECT DETAILS – REGENERATIVE STORMWATER CONVEYANCE

PROJECT DETAILS – REGENERATIVE STORMWATER CONVEYANCE

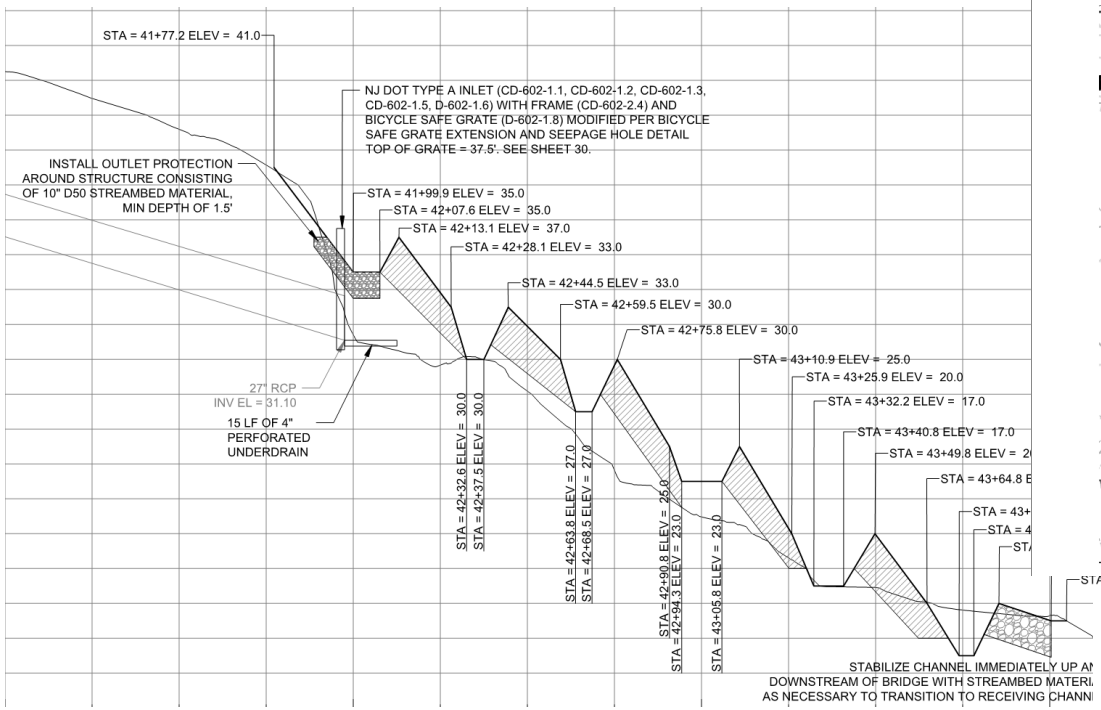
Carriage Hills Channel Restoration

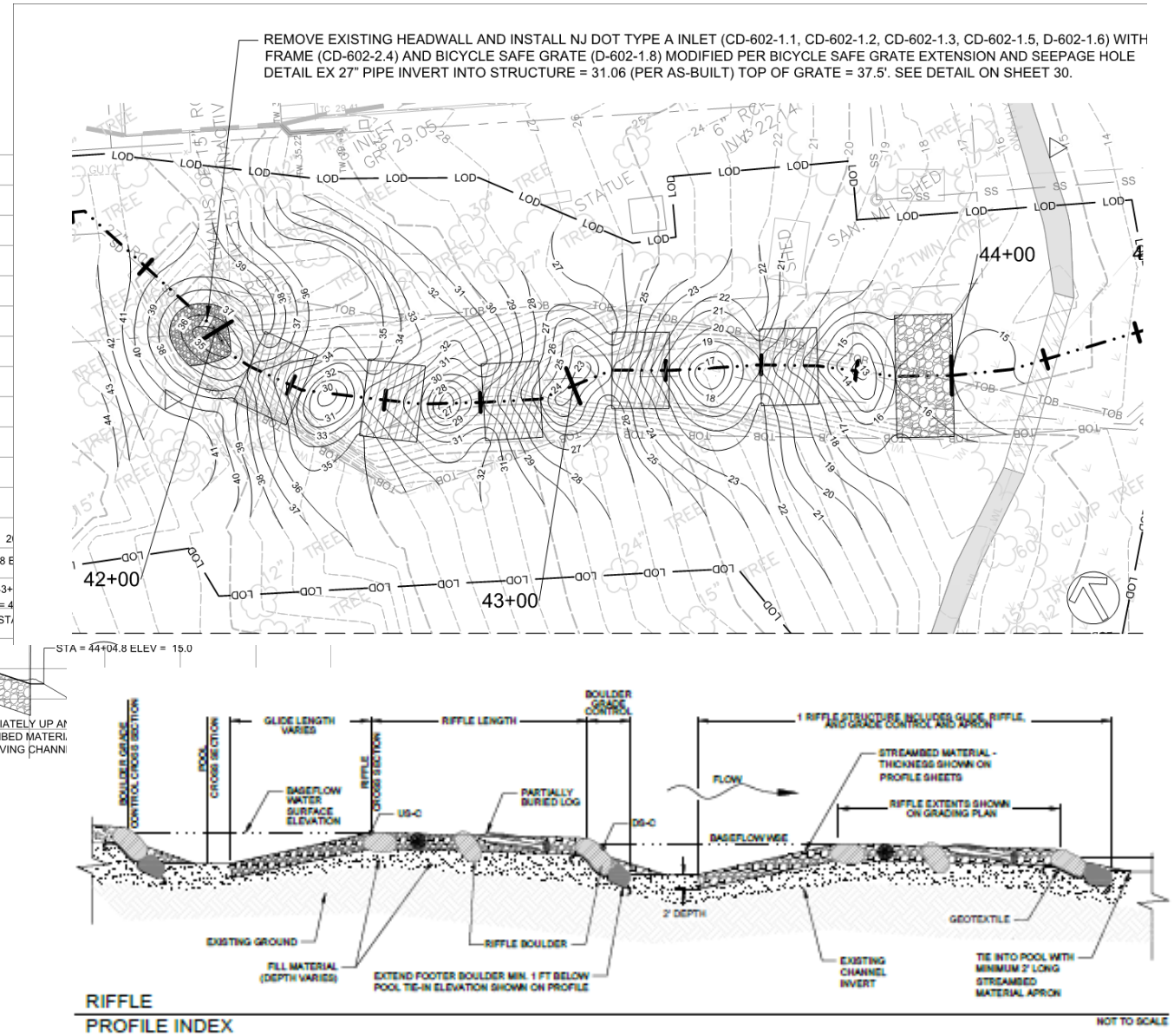
Restoration provides stable surface conveyance with boulder cascades and pools during large events and conversion to groundwater flow during smaller events, attenuating discharge and treating water. Inset shows initial conditions with incised channel approximately 20 feet deep.

Existing storm drain system converted to a "bubbler" outfall leading to natural stream/wetland treatment system



PROJECT DETAILS – REGENERATIVE STORMWATER CONVEYANCE





Hillside RSC - Before

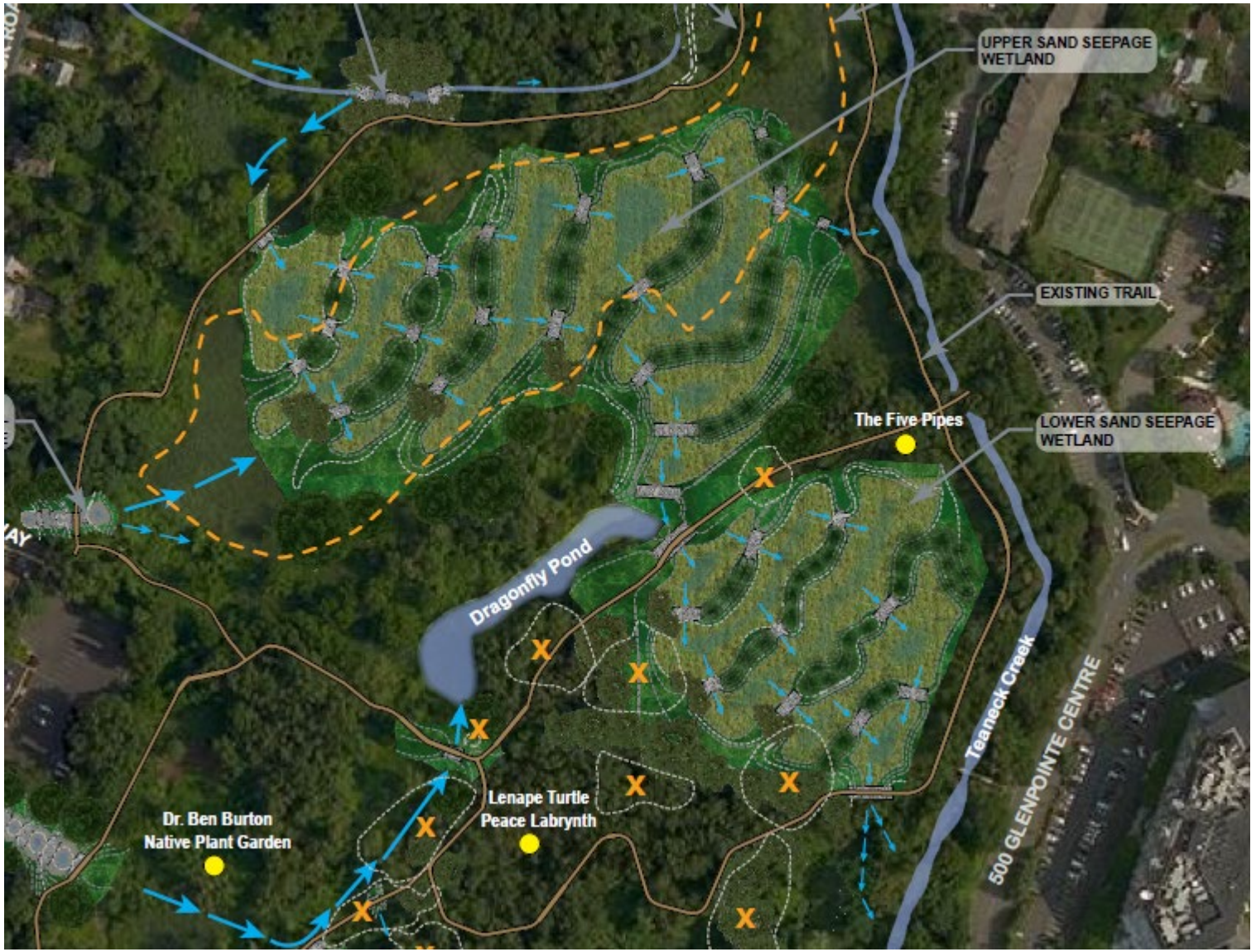
Hillside RSC - After

Hillside RSC - After

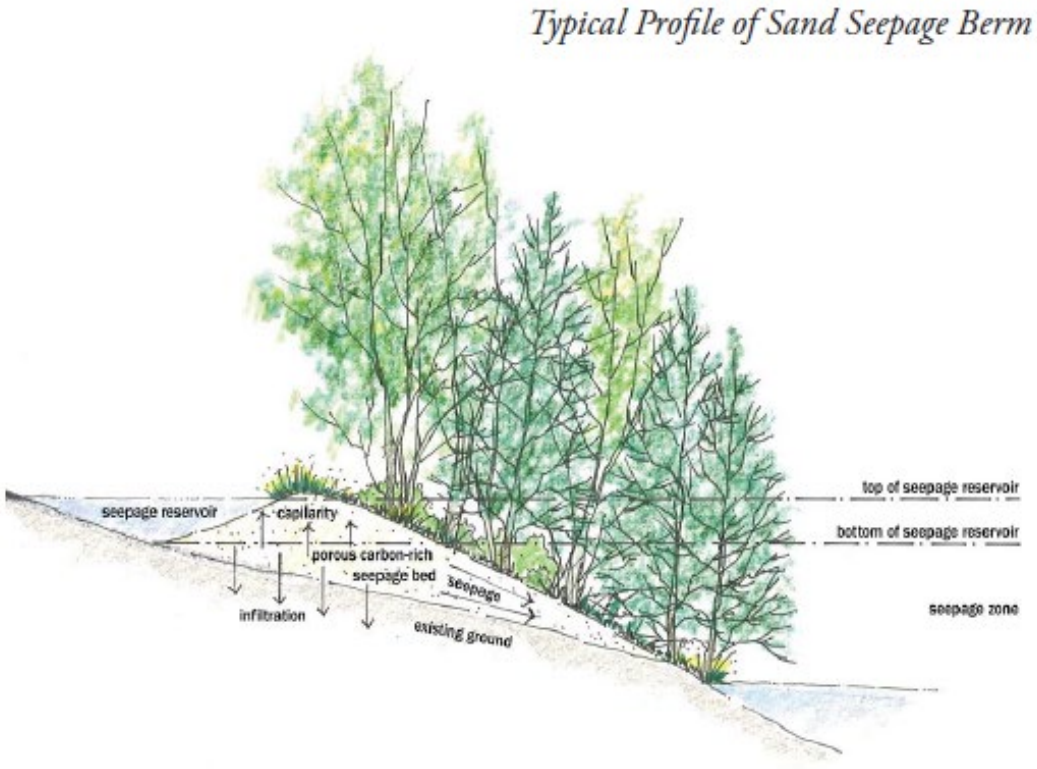
Oakdene RSC - Before

Oakdene RSC - After

PROJECT DETAILS – SAND SEEPAGE WETLANDS



PROJECT DETAILS – SAND SEEPAGE WETLANDS



Upper Sand Seepage - Before

Upper Sand Seepage - After

Photo Credit: SiteWorks

Lower Sand Seepage - After

Precedent Project - Maryland

Post-Earthwork

Post-Planting

10 Years After Construction

LESSONS LEARNED

- Communication to stakeholders
- Understanding timeline and schedule
- Collaboration between project partners
- Phasing of large projects
- Site stabilization and vegetation establishment
- Multi-pronged invasive species control (and long-term stewardship)
- Maintenance of structures


Thank You
Questions?
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