Living Shoreline Design Training

What is Success?

Presented by
Scott Hardaway

Organized By

C. Scott Hardaway, Jr.
Donna Milligan

Shoreline Studies Program

Karen Duhring

Center for Coastal Resources Management

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Virginia Coastal Zone
MANAGEMENT PROGRAM

March
2021

Shoreline Studies Program
VIMS

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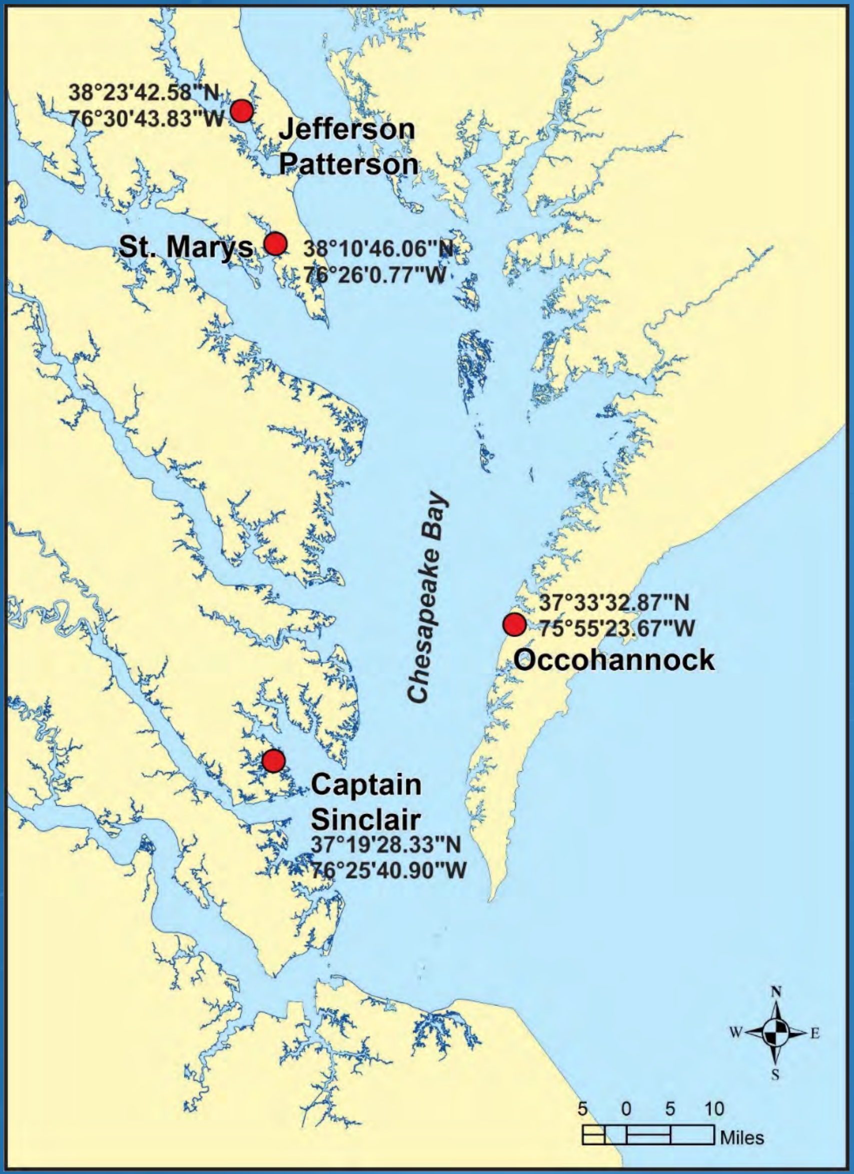

Location of the four sites within the Chesapeake Bay estuarine system

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Sea Level Rise

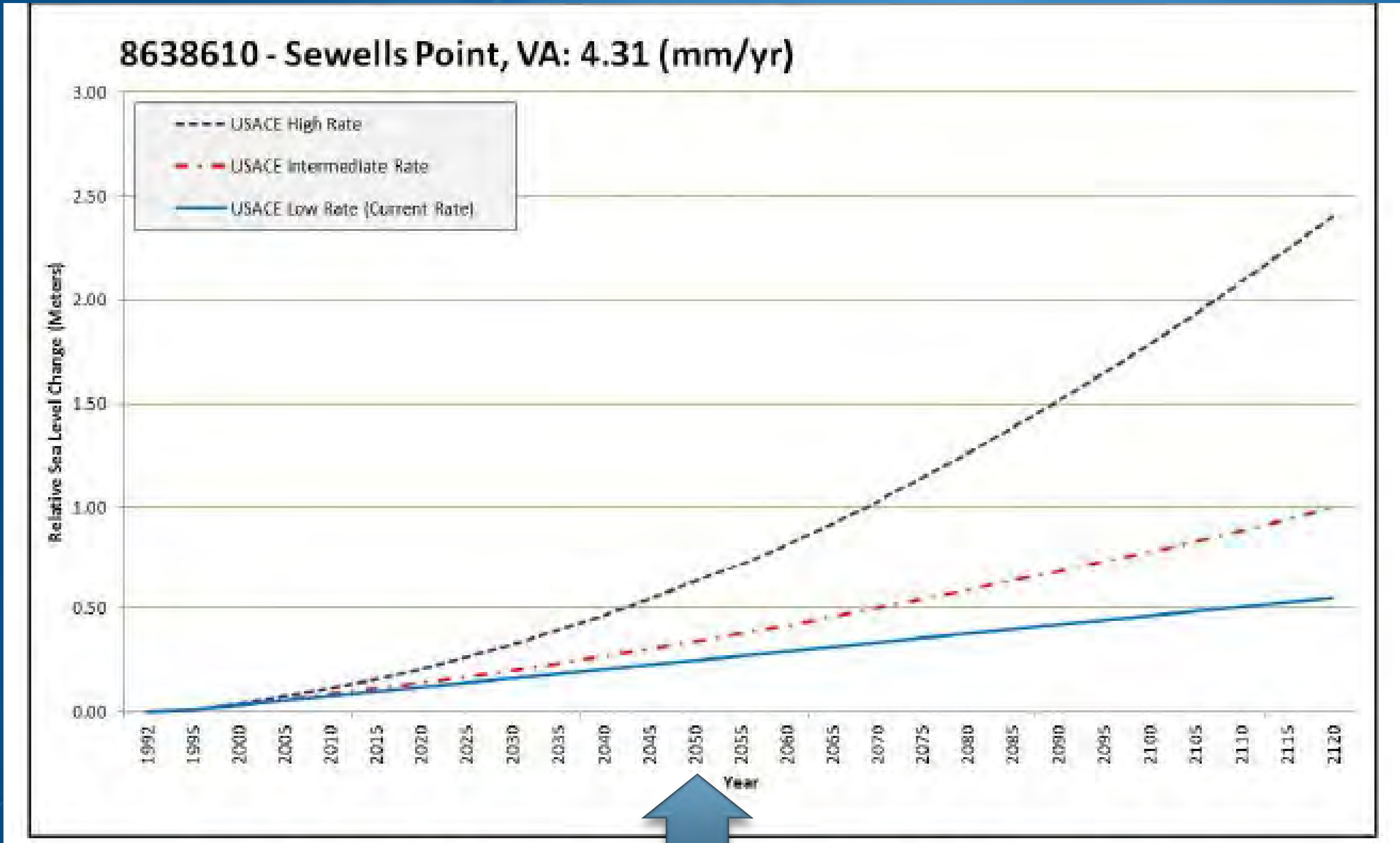

Figure 10: Projected Sea Level Ris… …ewell's Point Station (1992 – 2120)

Sea-level rise predictions from the U.S. Army Corps of Engineers (2014). **2050 : SLR scenarios +1 and +2 feet**

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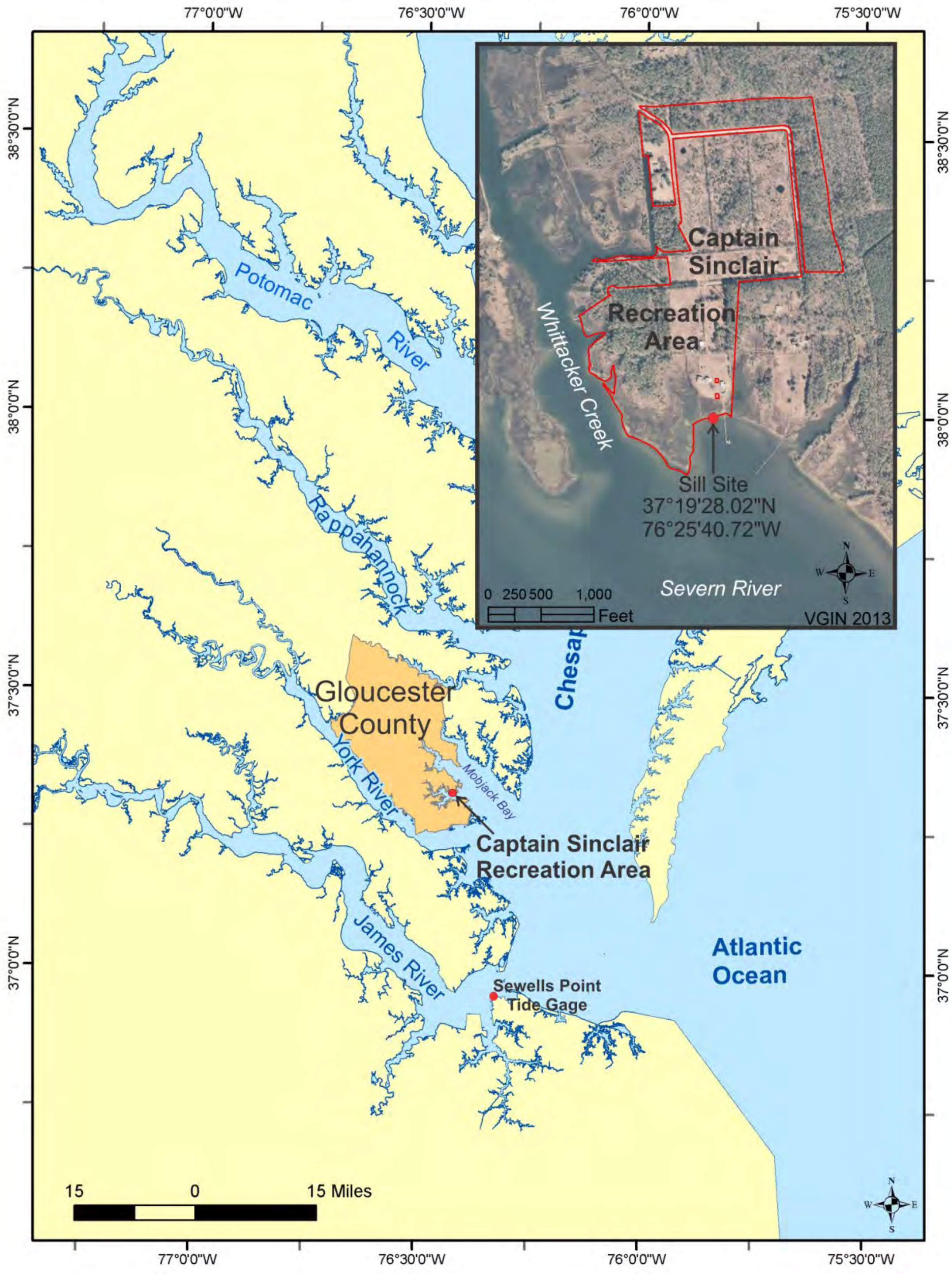
Capt Sinclair Location



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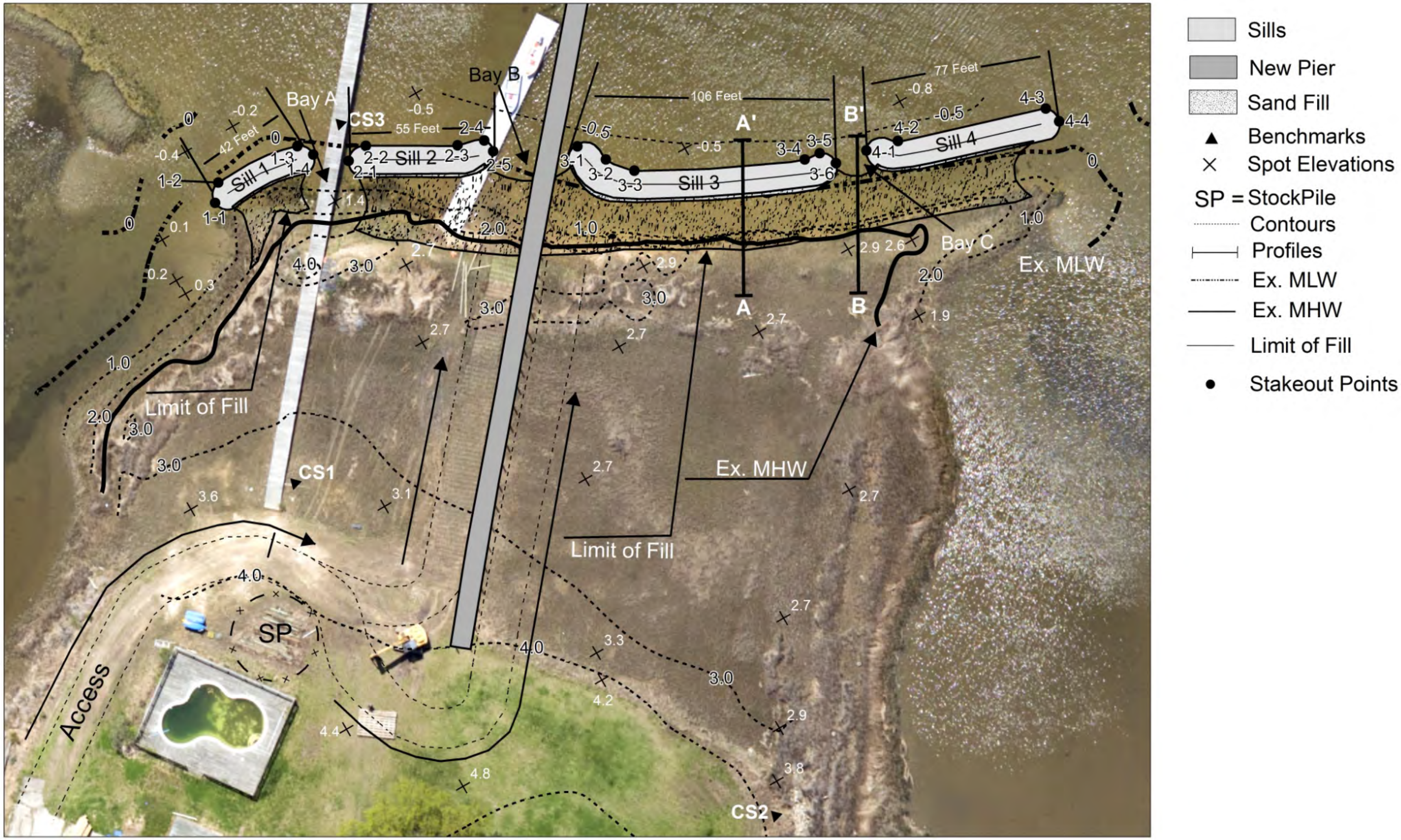
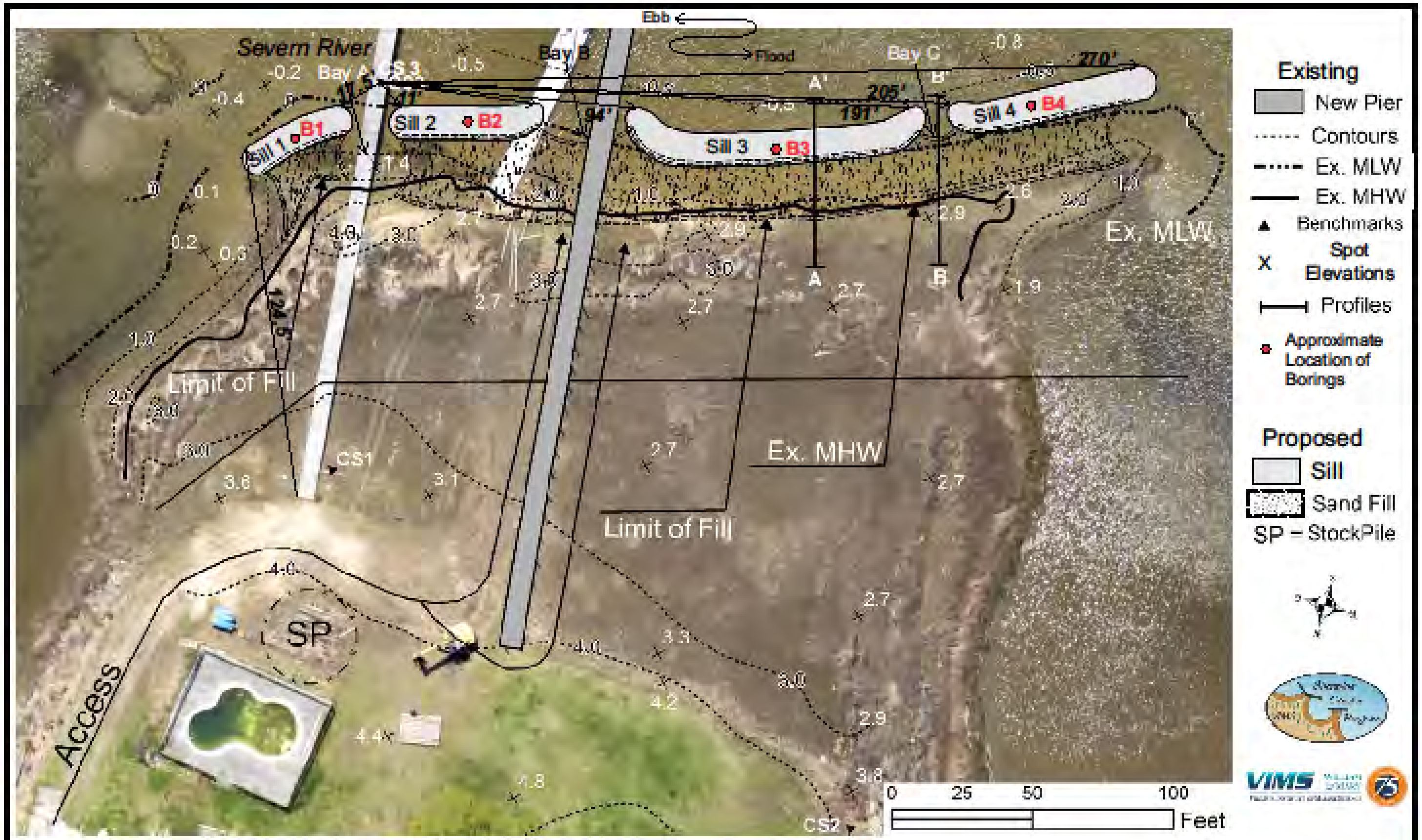
Conditions at Captain Sinclair before the project. Photo: Shoreline Studies Pr ril 2015.



Survey Date: 1 April 2015
Photo Date: April 2015

0 20 40 60 Feet



ADJACENT PROPERTY OWNERS:	Captain Sinclair Living Shoreline Project		APPLICATION BY:
	AT:	PURPOSE:	DATE:
DATUM:	IN:		SHEET

CLIENT:			DATE: October 2015
SUBJECT: Captain Sinclair			
BORING #: B1	Total Depth 2 ft	Elev:	Location:
Type of Boring: auger	Started:	Completed:	Driller: Hardaway

Elevation	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Gray medium dense silty fine sand (SM) trace silt				
	-2		Dark gray loose clayey fine sand (SC) little clay				
			End				

CLIENT:			DATE: October 2015
SUBJECT: Captain Sinclair			
BORING #: B2	Total Depth	Elev:	Location:
Type of Boring: Boring	Started:	Completed:	Driller: Hardaway

Elevation	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Gray loose silty fine sand (SM) trace silt				
	-2		Gray to tan medium dense clayey fine sand (SC) little clay				
			End				

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CLIENT: DATE: October 2015

SUBJECT: Captain Sinclair

BORING #: B3 | Total Depth 2 ft | Elev: | Location:

Type of Boring: auger | Started: | Completed: | Driller: Hardaway

Elevation	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Gray to tan soft sandy clay (CL) little fine sand				
	-2		Blue gray to tan stiff sandy clay (CL) trace fine sand				
			End				

CLIENT: DATE: October 2015

SUBJECT: Captain Sinclair

BORING #: B4 | Total Depth | Elev: | Location:

Type of Boring: Boring | Started: | Completed: | Driller: Hardaway

Elevation	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Dark gray very loose clayey fine sand (SC) trace to little clay				
	-2		Gray to tan medium stiff sandy clay (CL) little fine sand				
			End				

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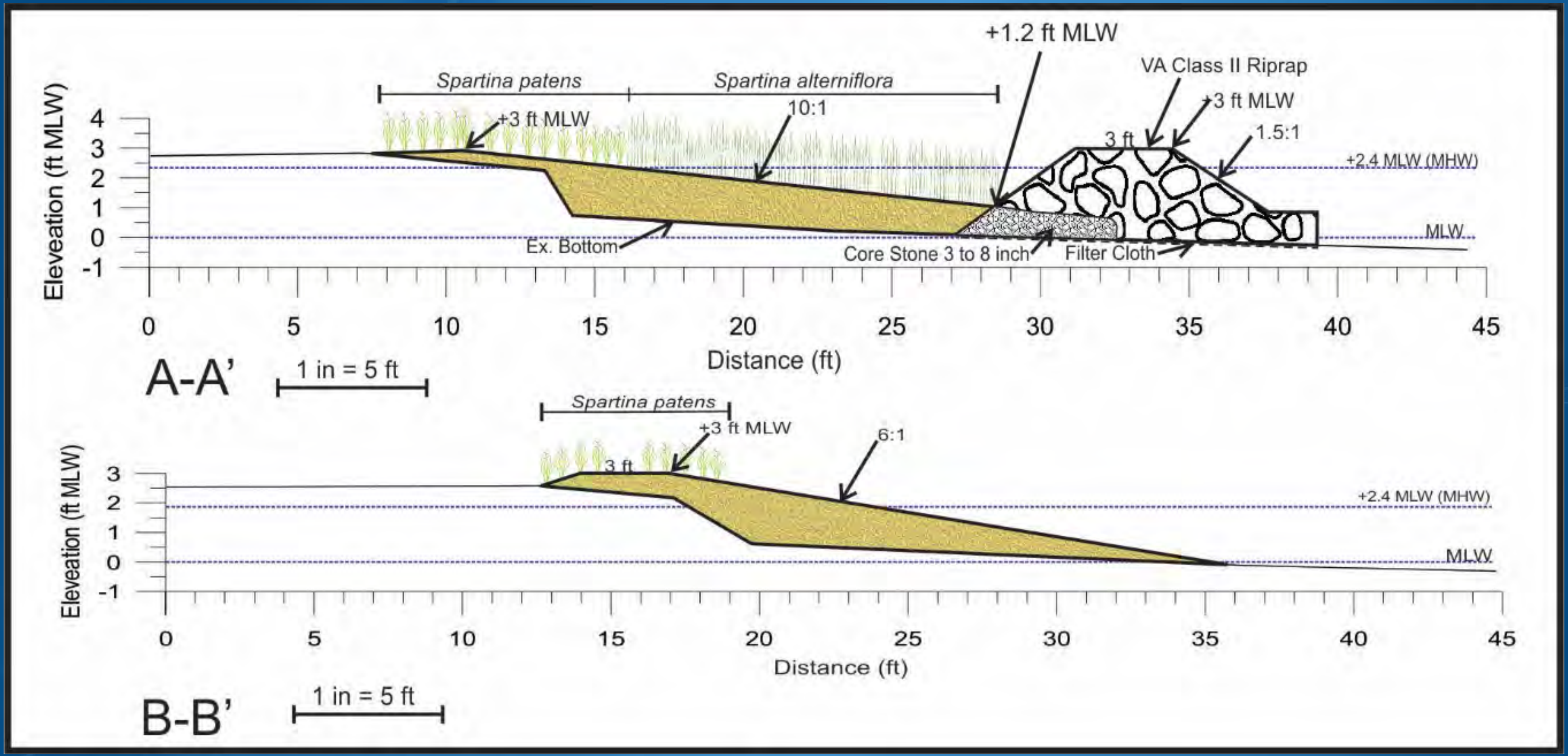
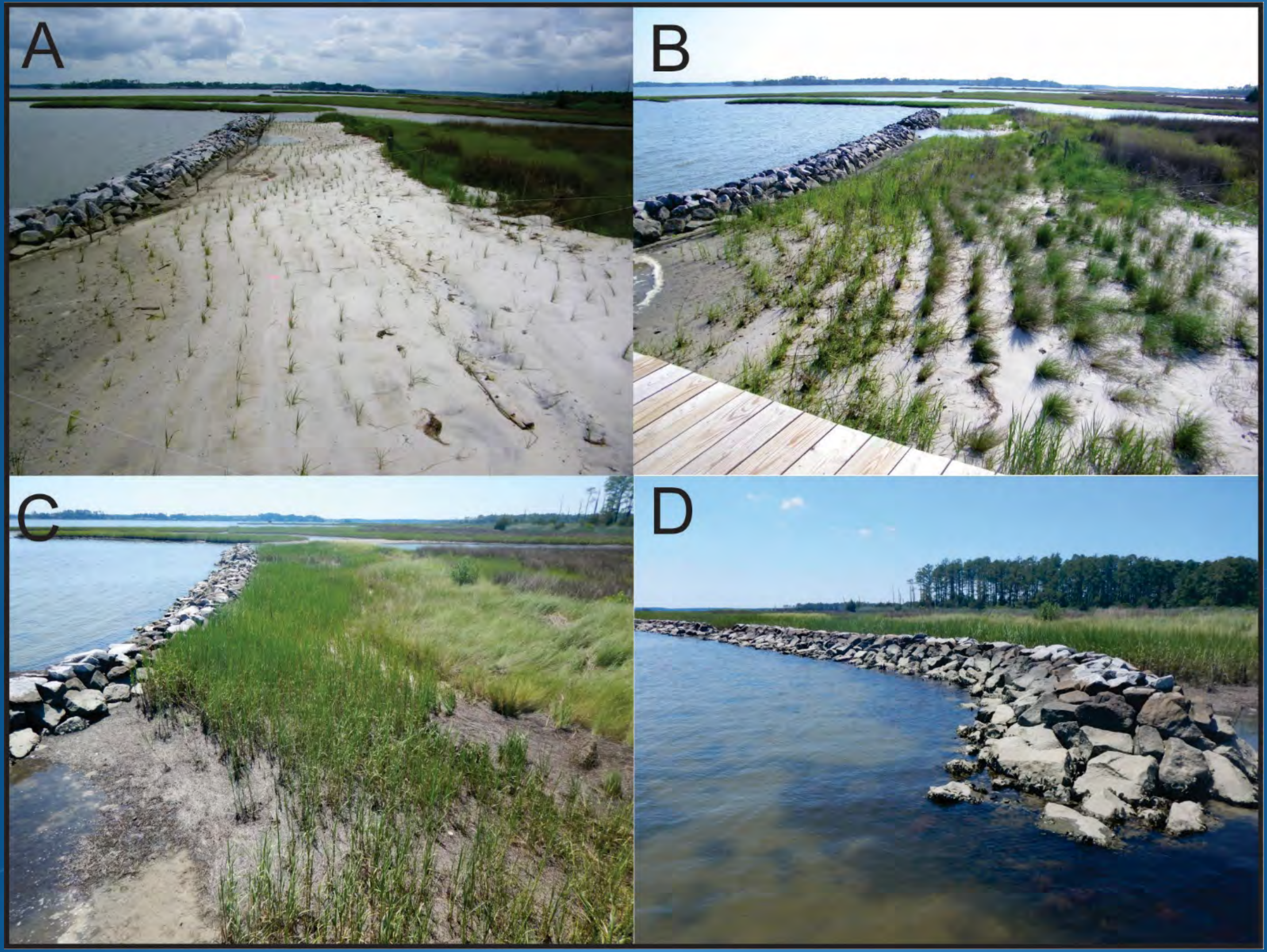


Typical cross-sections for the Captain Sinclair living shoreline project by Shoreline Studies Program, VIMS.

5.5.16

Gloucester High School Crew team planting Capt. Sinclair under the supervision
Of Walter Priest and Cool Daddy



Photos of Captain Sinclair A) Just planted, 2 June 2016; B) One year post planting, 10 May 2017; C) Two years post-planting, 10 July 2018; D) Oysters line the rock sill shown at low water 10 July 2018. Photo credit: Shoreline Studies Program.

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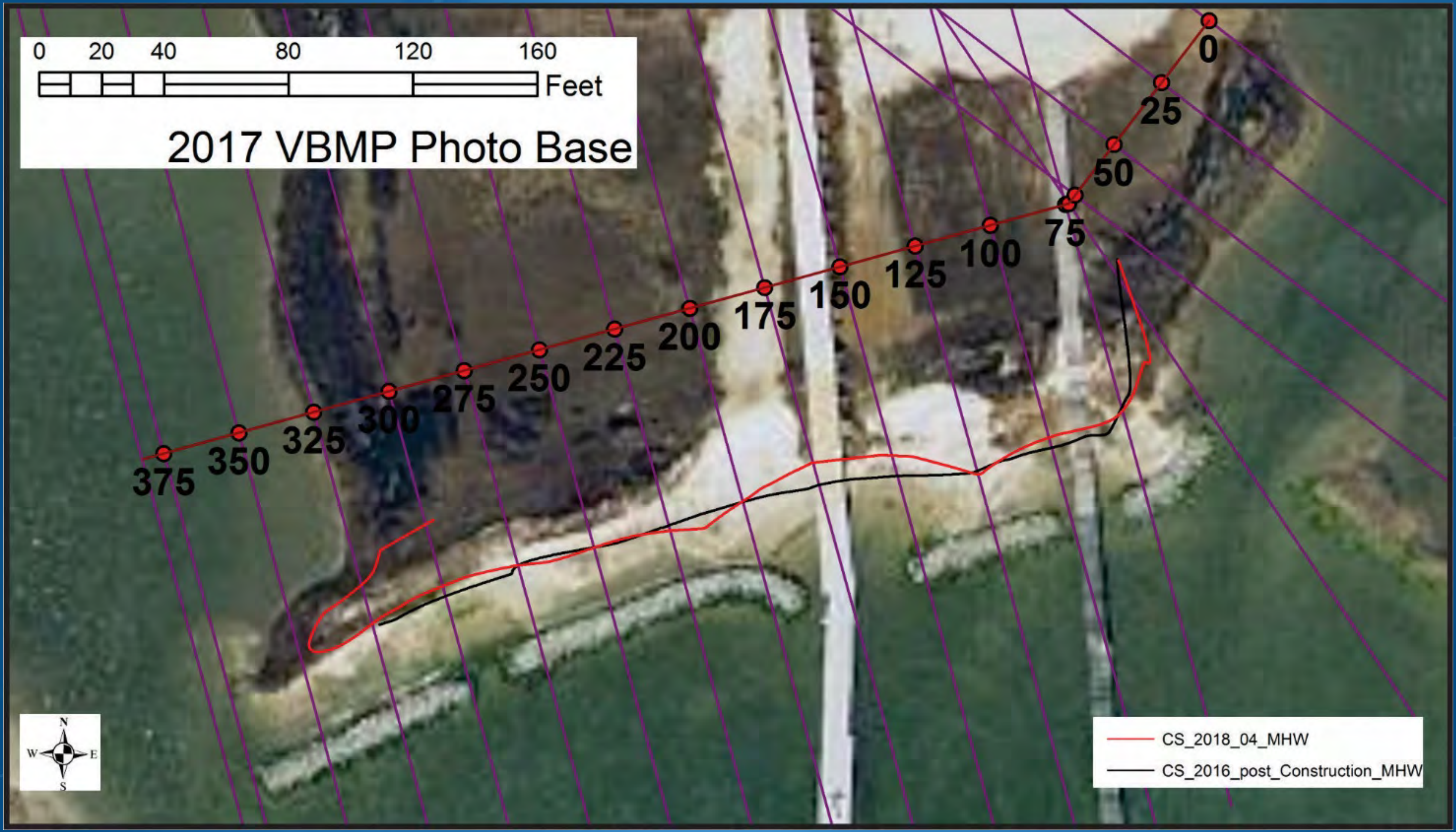

Basemap for Captain Sinclair showing the profile baseline and the position of mean high water in 2016 and in 2018.

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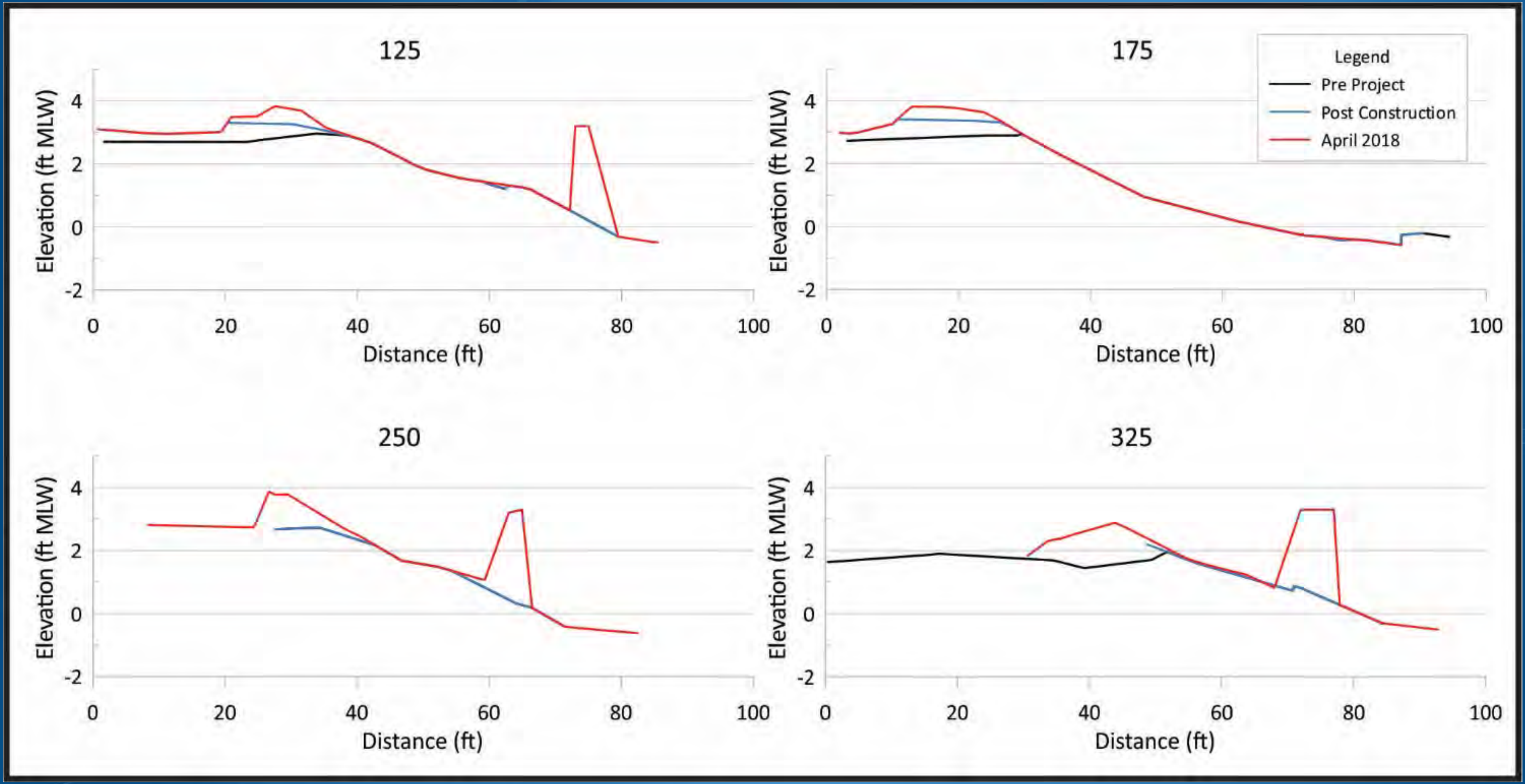
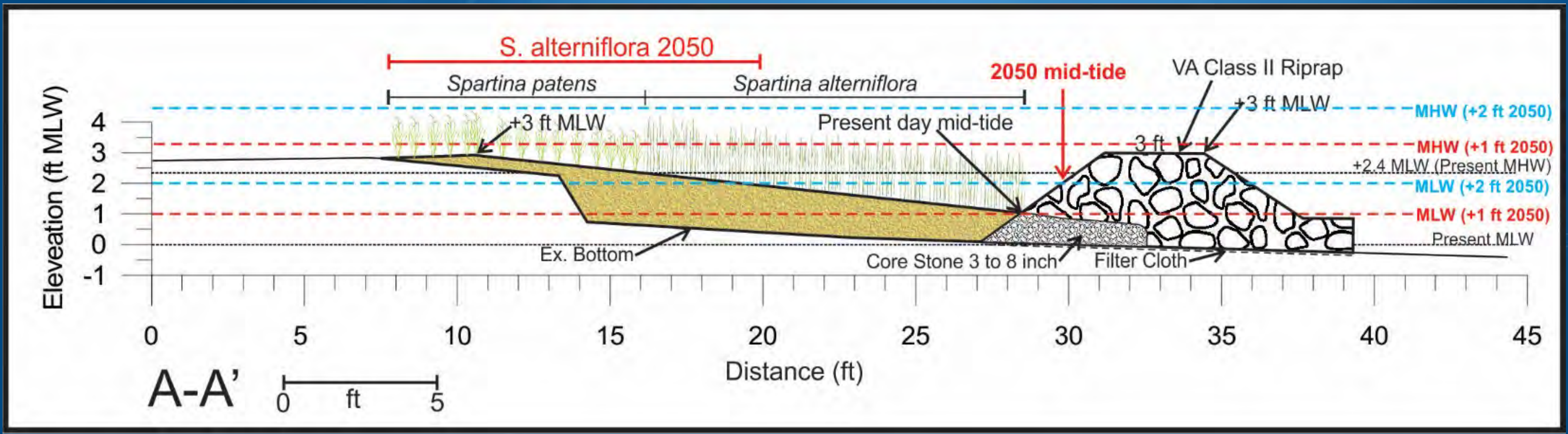


Cross-sections of survey data for Captain Sinclair.

Capt. Sinclair: May 20, 2020



Sea-level rise scenarios modeled at Captain Sinclair and depicted on a typical cross-section.

Location of St. Mary's sills.

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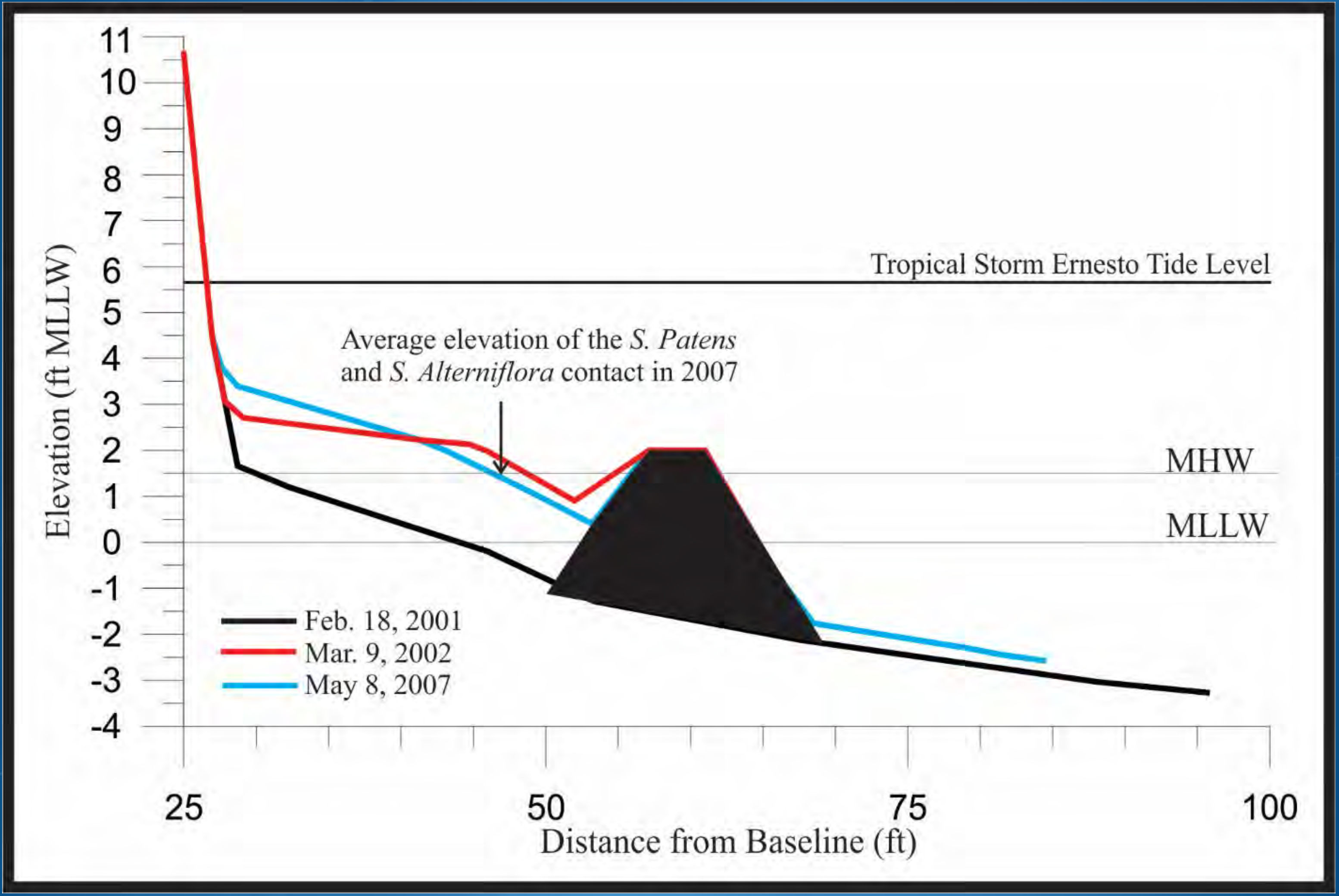
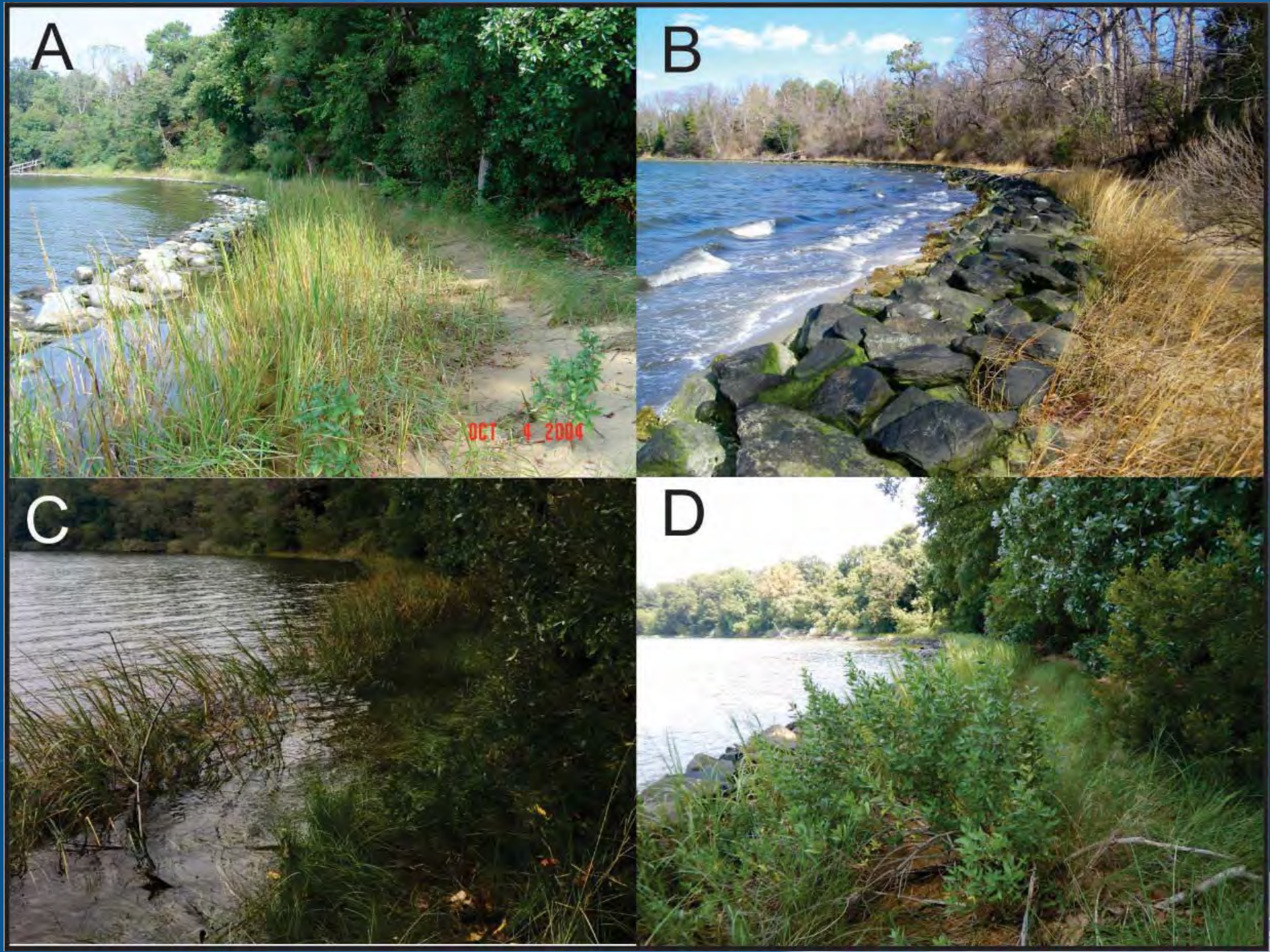
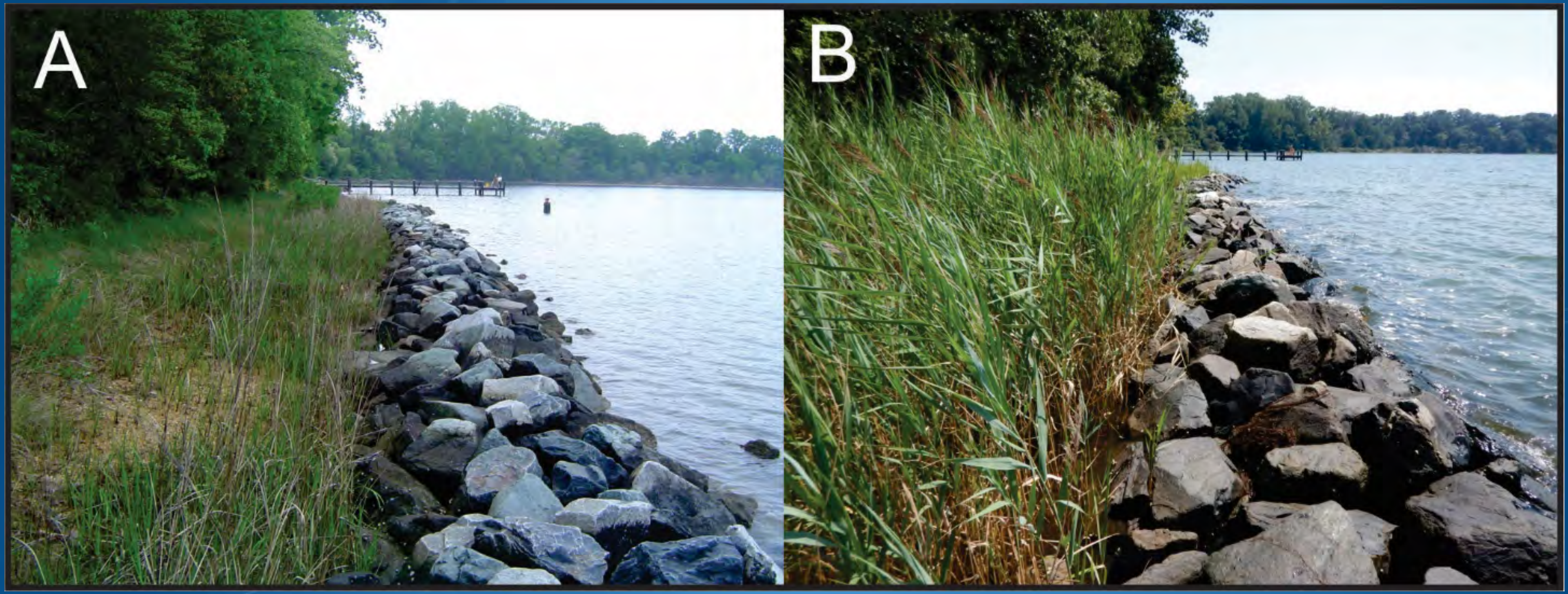


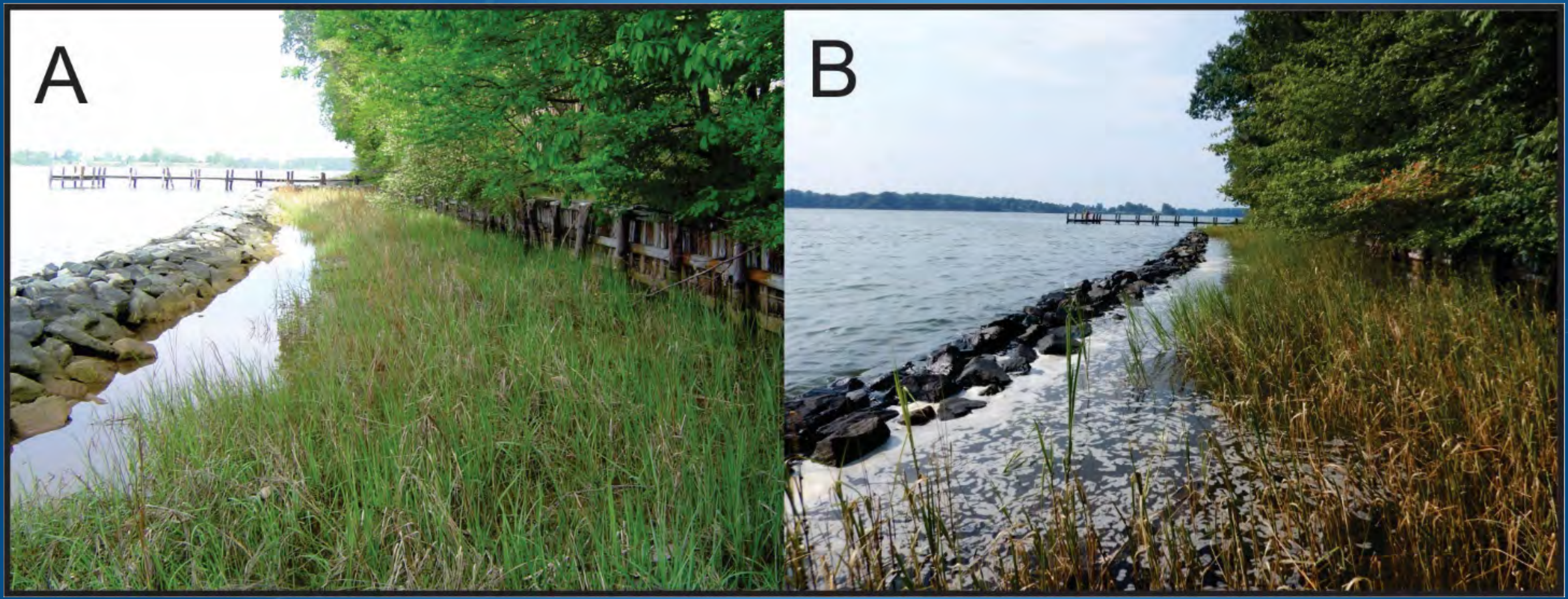
Typical St. Mary's City sill profile from survey data.



Photos of St. Mary's, South end: **A**) two years after construction (4 Oct 2004), **B)** 11 years after construction (1 Feb 2013), **C**) 15 years after construction (13 Oct 2017**), D**) 16 years after construction (15 Aug 2018).



Sill at St. Mary's City A) five years after construction (9 May 2007), B) 16 years after construction (15 Aug 2018). Phragmites has colonized behind the structures.



Sill backed by bulkhead at St. Mary's A) five years after construction (9 May 2007), B) 16 years after construction (15 Aug 2018). No change in the plants occurred

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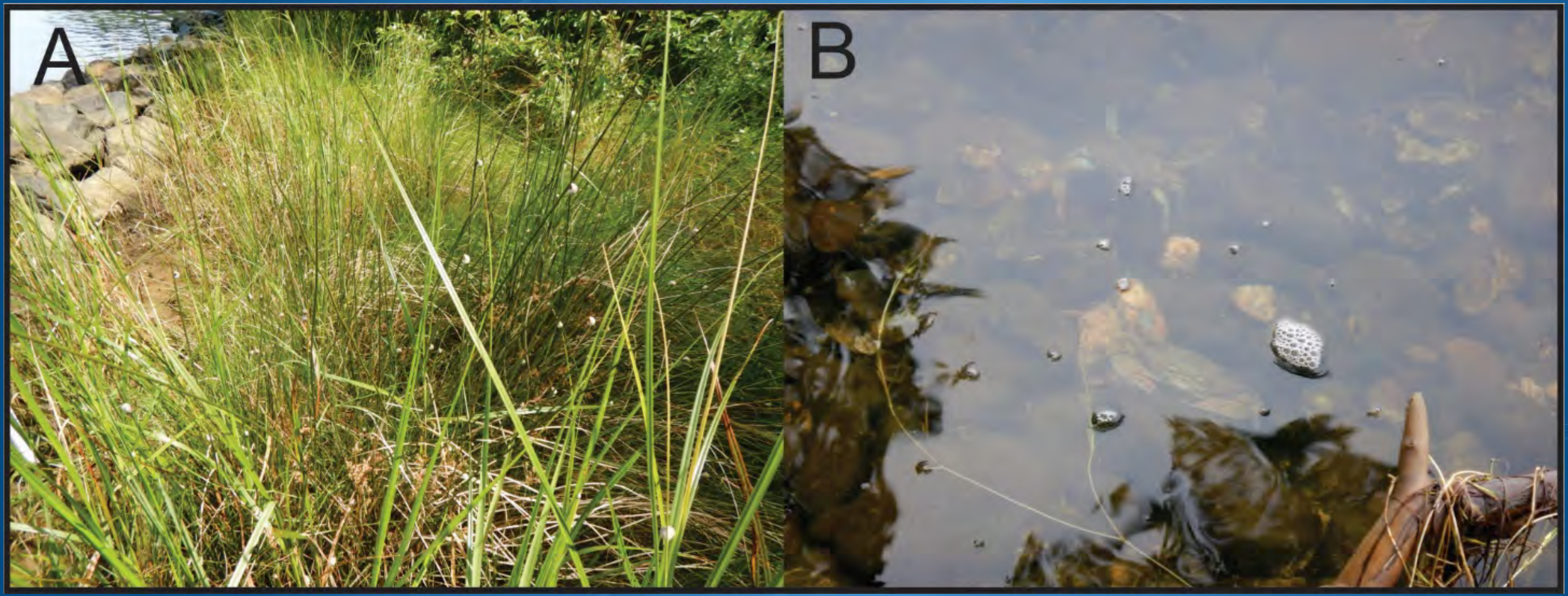
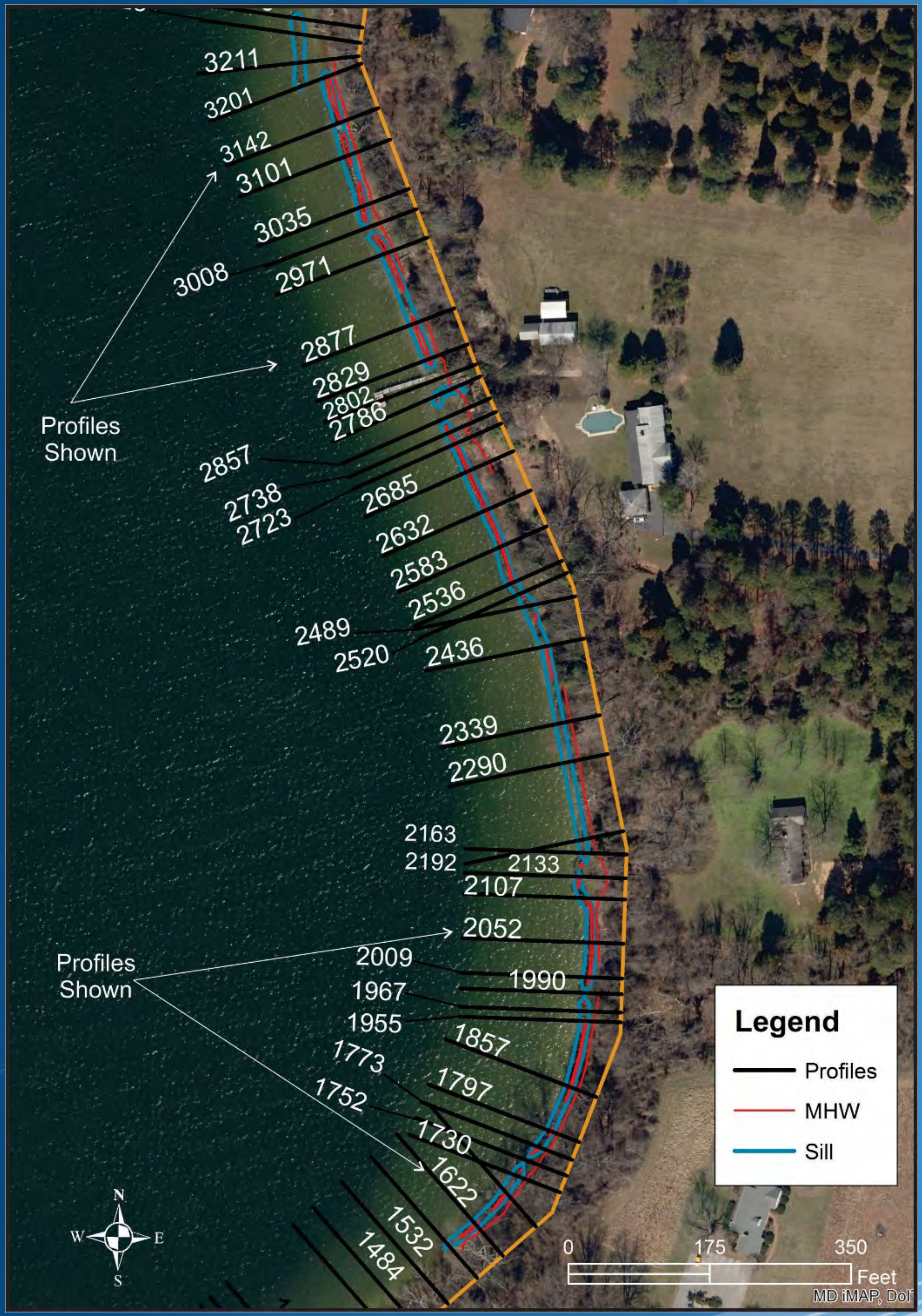


Sill at St. Mary's (15 Aug 2018) A) Needlerush has colonized some sections, B) blue crabs are prevalent along the shore.



Cross-sectional profile baseline.
Also shown are the outline of the sill structures (blue) and the 2018 mapped mean high water line.

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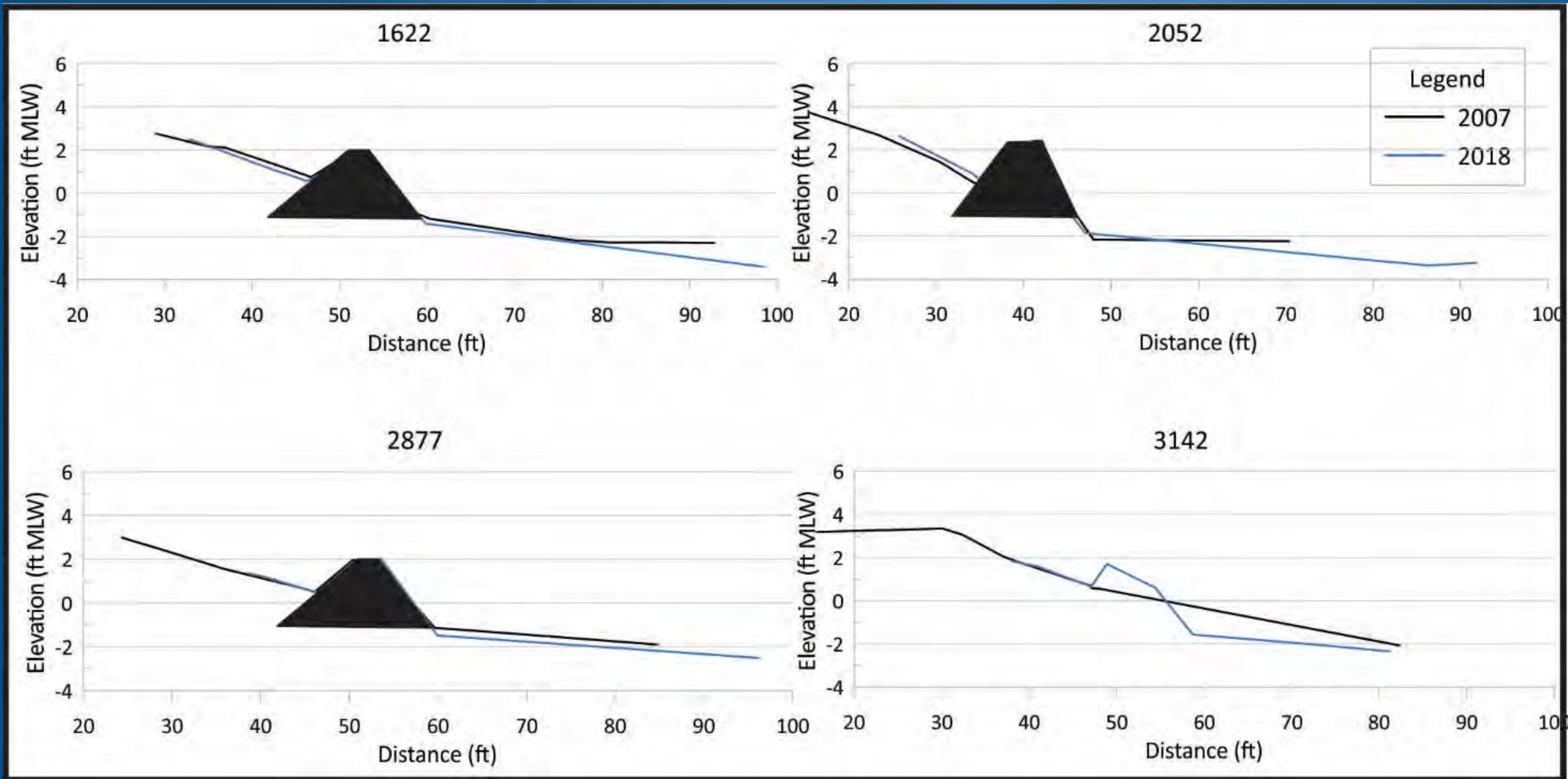
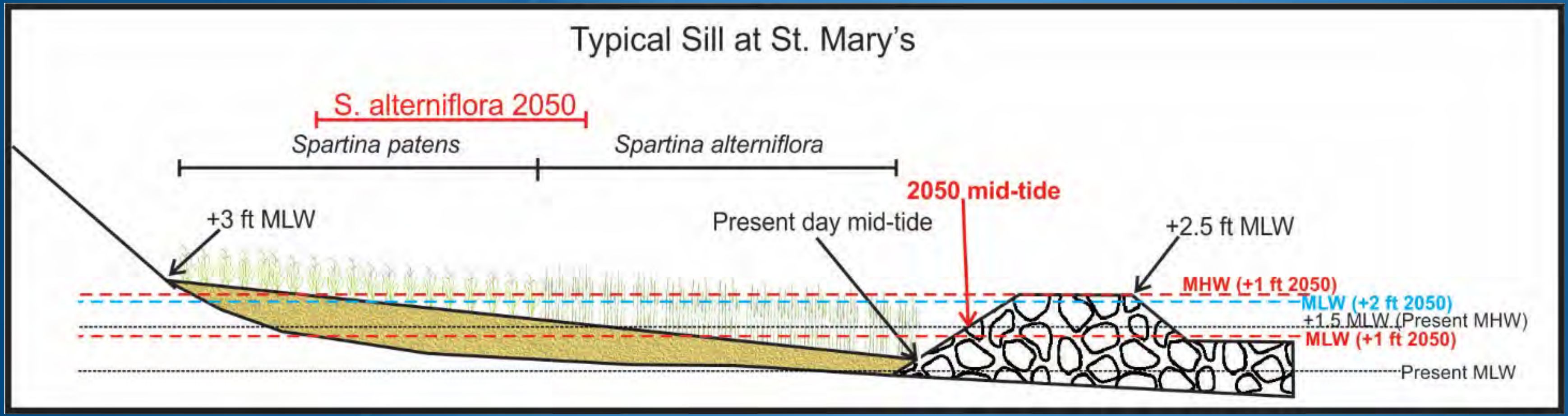
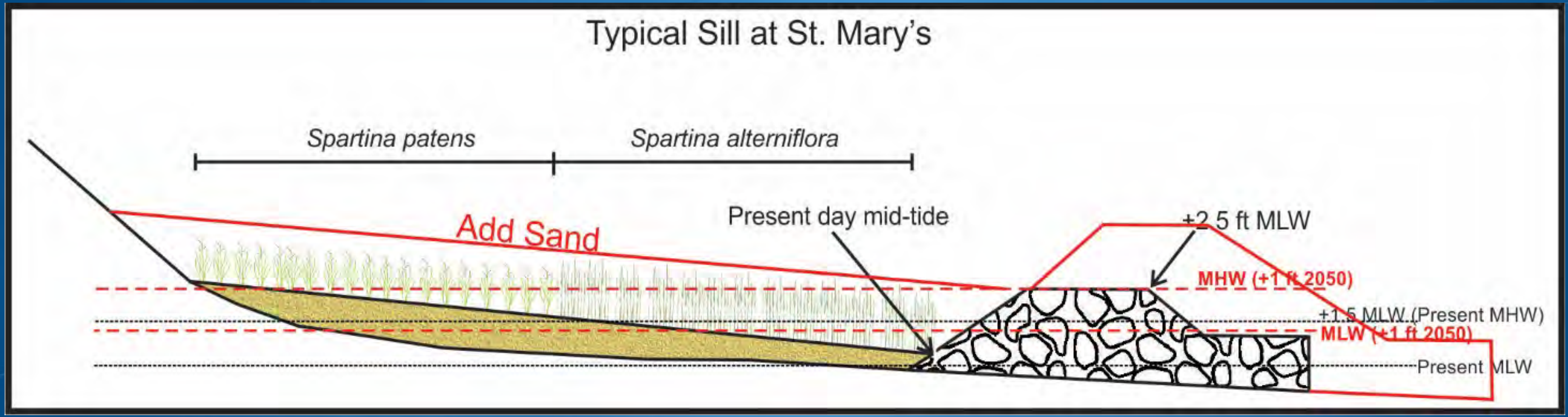


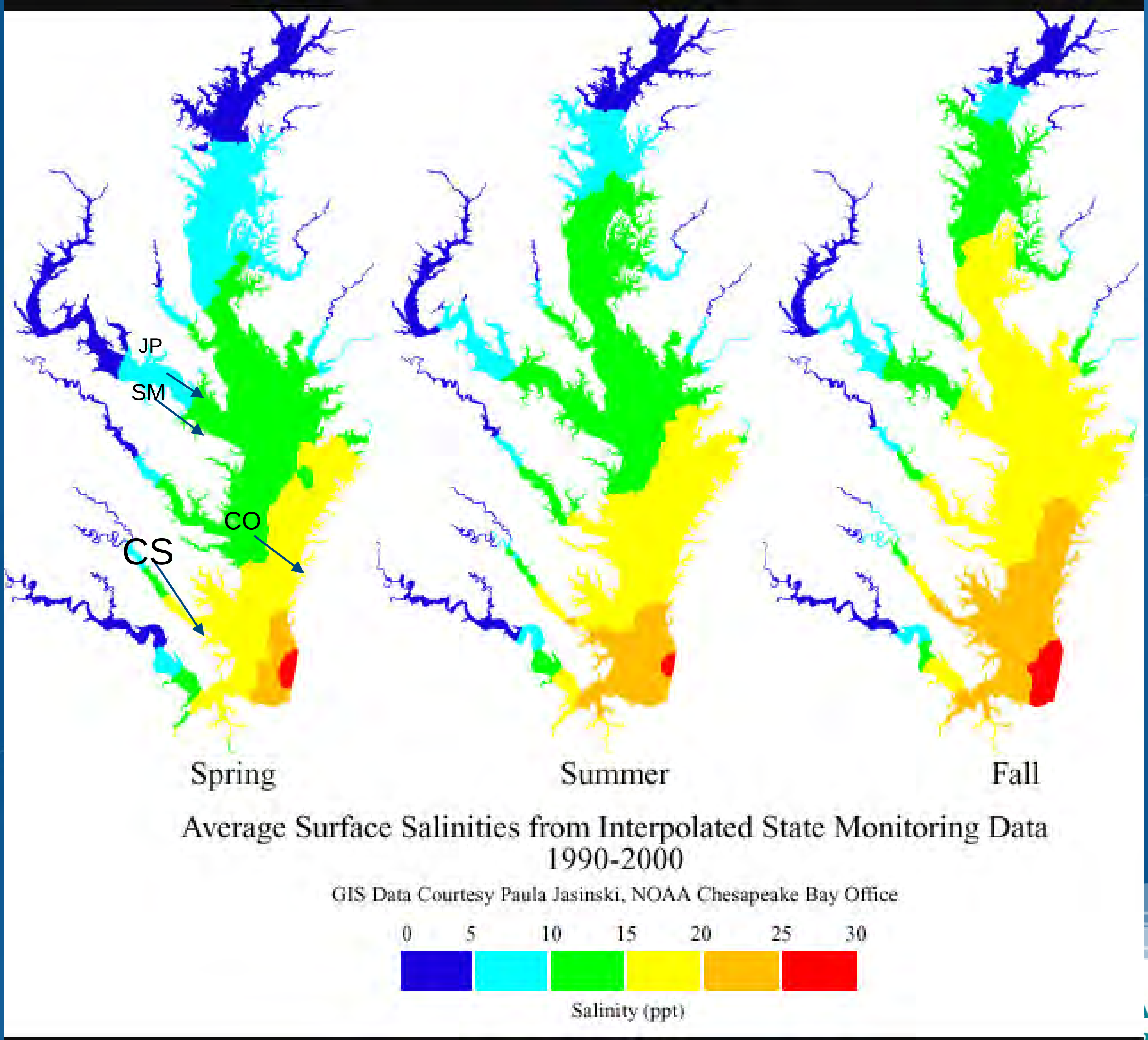
Selected cross-sectional profiles showing the shoreline in 2007, 5 years after construc
and in 2018, 16 years after construction.



Sea-level rise scenarios modeled at St. Mary's and depicted on a typical cross-section.



Sea-level rise scenarios modeled at Occohannock. Also shown is the adaptive management strategy coastal resiliency of the living shoreline. Rock and sand could be added to the system to "reset" it thereby protecting the base of the bank.


JP
SM
CO
CS
Spring
Summer
Fall
Average Surface Salinities from Interpolated State Monitoring Data
1990-2000
GIS Data Courtesy Paula Jasinski, NOAA Chesapeake Bay Office
0
5
10
15
20
25
30
Salinity (ppt)

Living Shoreline Sea Level Resiliency: Performance and Adaptive Management of Existing Breakwater Sites

November 2019

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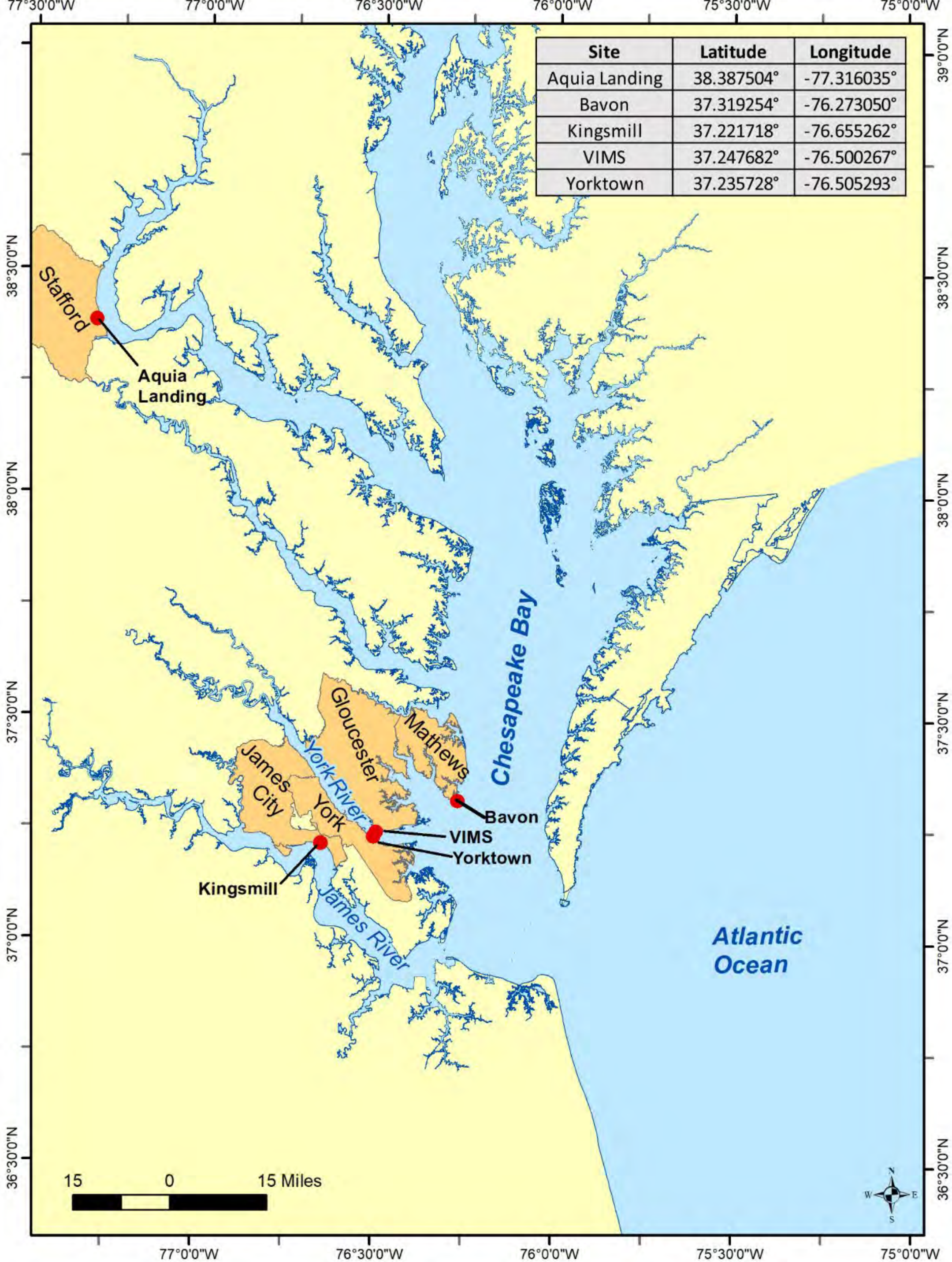

Site	Latitude	Longitude
Aquia Landing	38.387504°	-77.316035°
Bavon	37.319254°	-76.273050°
Kingsmill	37.221718°	-76.655262°
VIMS	37.247682°	-76.500267°
Yorktown	37.235728°	-76.505293°

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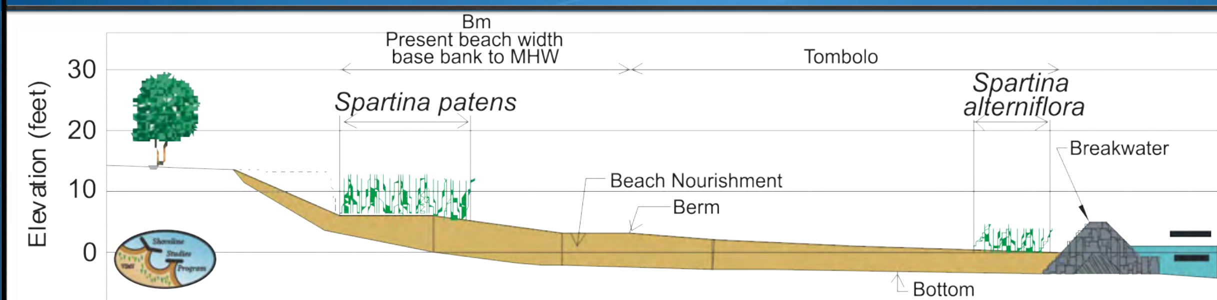

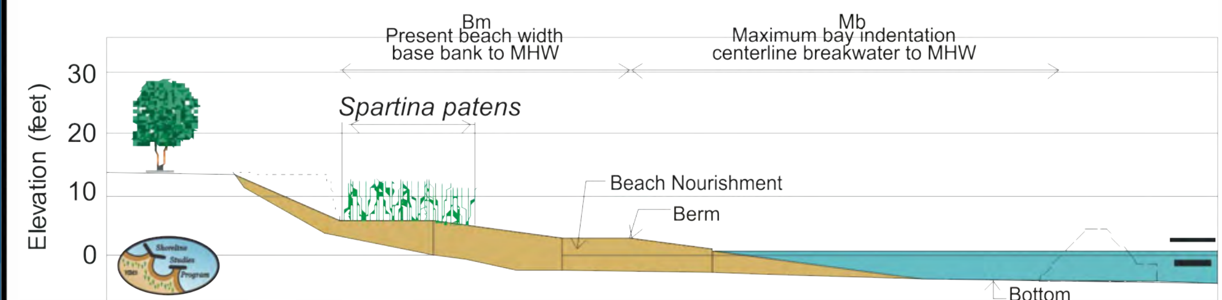

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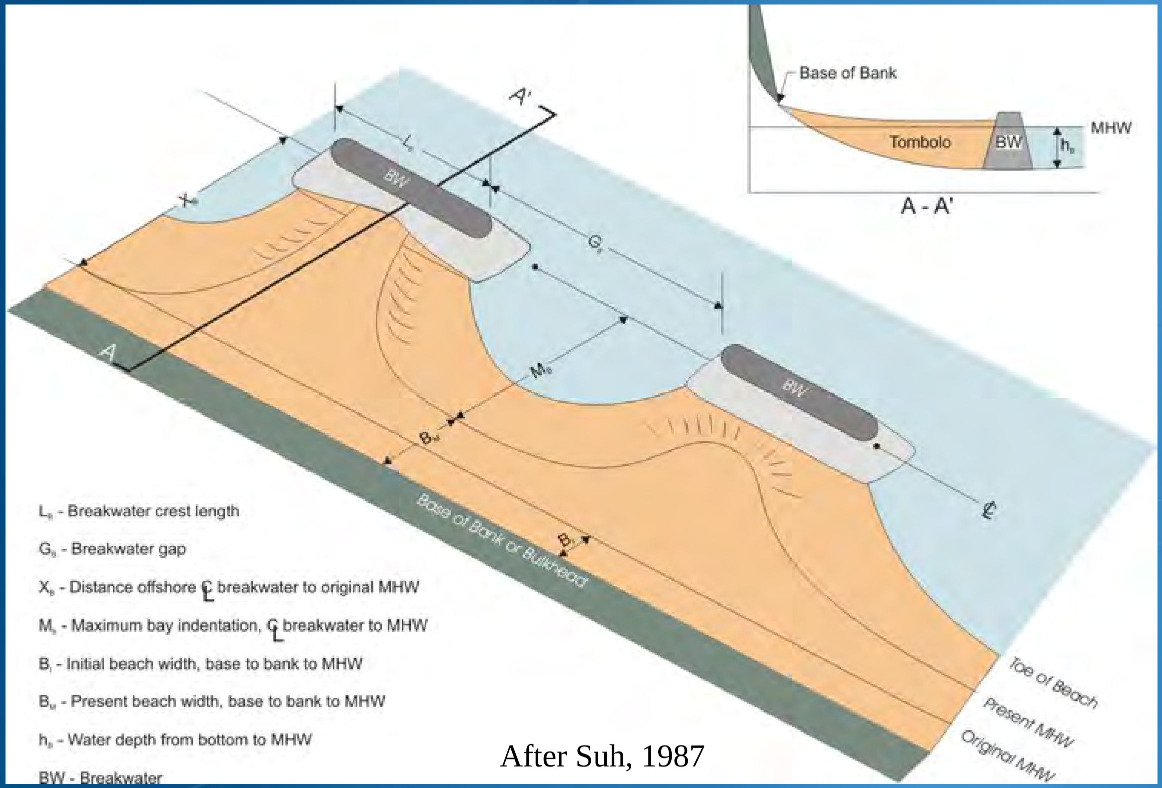
Breakwater Design Guidelines



After Suh, 1987

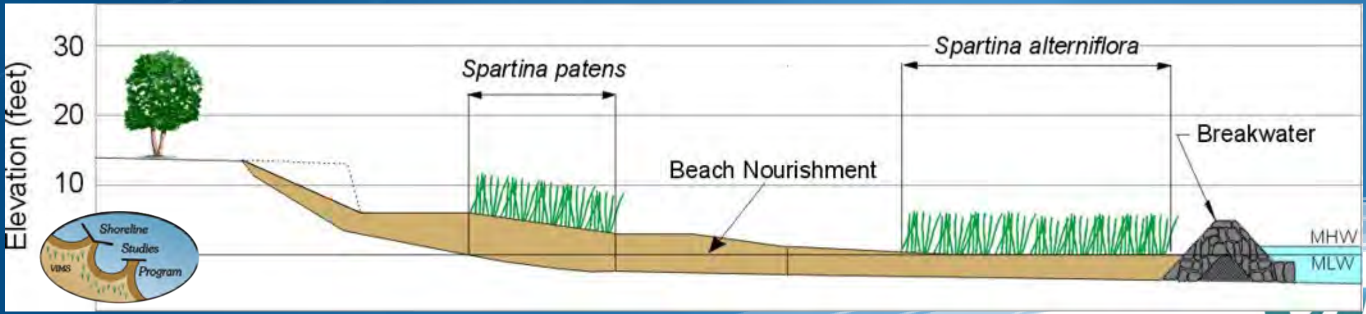
Breakwater Design Parameter

Maximum Bay Indentation: Gap Width

Mb:Gb
1:1.65

Crest Length: Gap Width

Lb:Gb
1:1.4



Hardaway and Byrne (1999)

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Left: Location of Aquia Landing breakwaters, and Right: Aerial image of breakwaters taken on 23 Sep 2019.

Aquia Landing shoreline on 11 March 1982 prior to the breakwater installation.

Timber groins were becoming detached from the shoreline and were no longer effective shore protection.

Aquia Landing shoreline on 30 September 2003 post Hurricane Isabel. Though sand washed over the jersey wall, overall the system is intact

A wide recreational beach exists at Aquia Landing shoreline on 16 Jul 2019.

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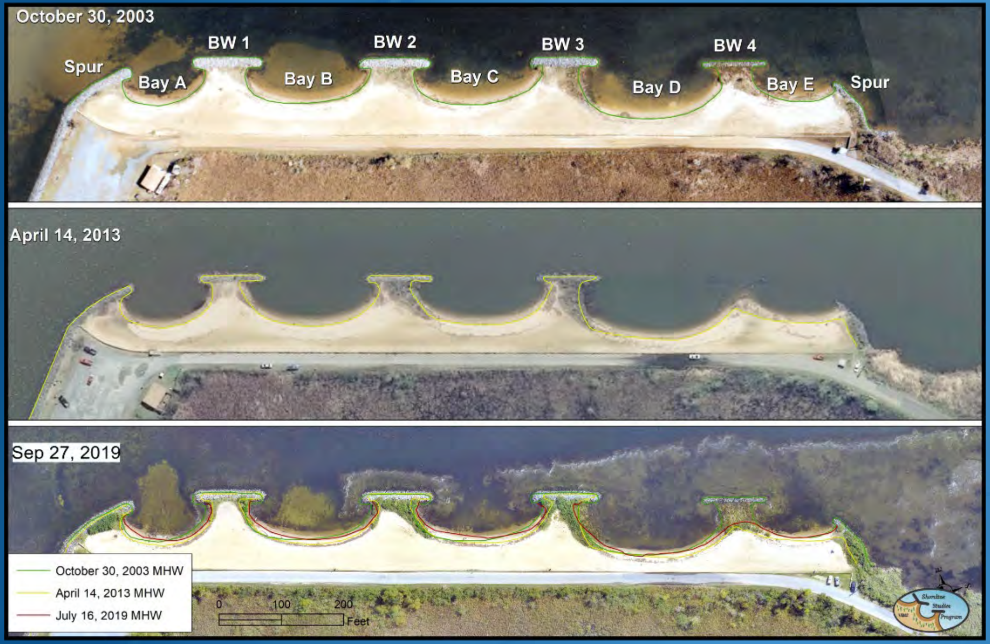
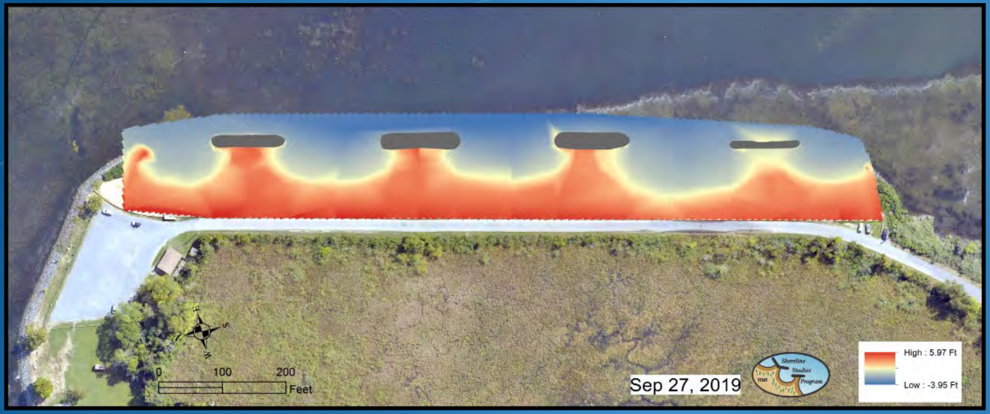


Shoreline change between 2003 and 2019 at the Aquia Landing breakwaters. The 2003 and 2013 shorelines are approximately mean high water based on the digitizer's best guess of the features shown on the aerial photo. The 2019 shoreline is from the survey data.



Digital elevation model of the collected survey points at Aquia Landing.

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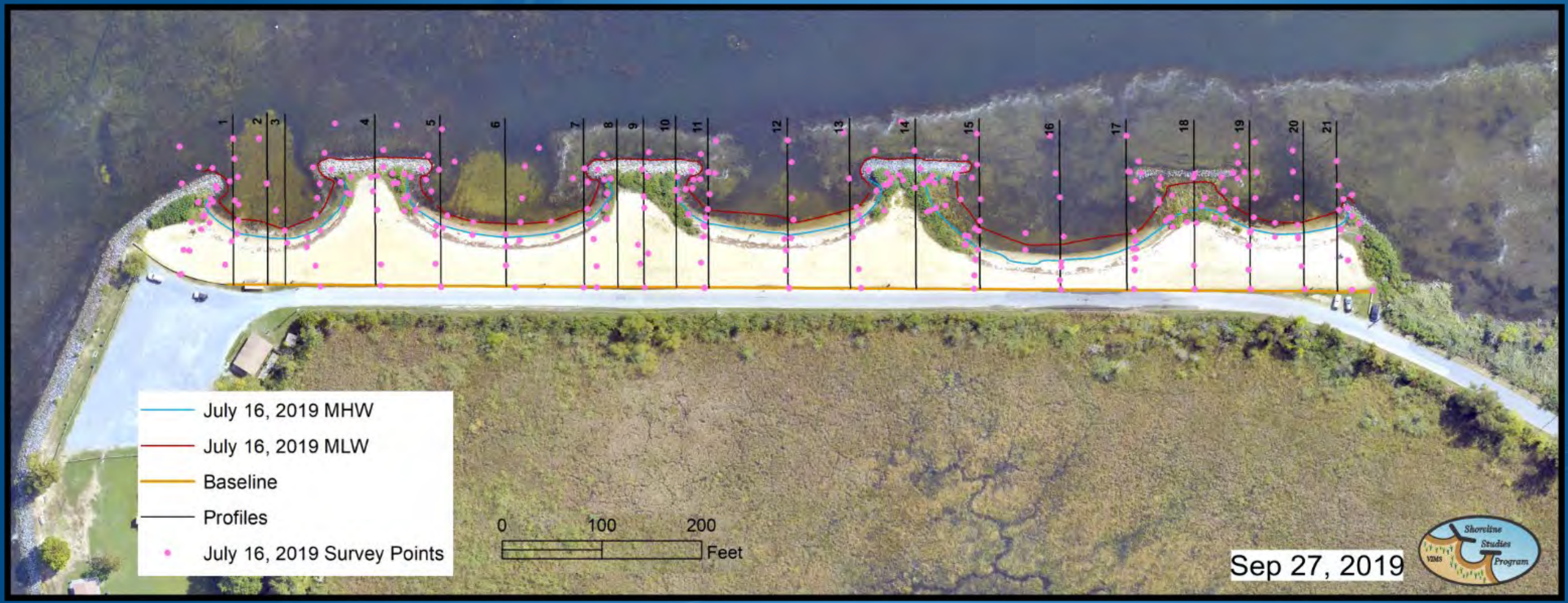
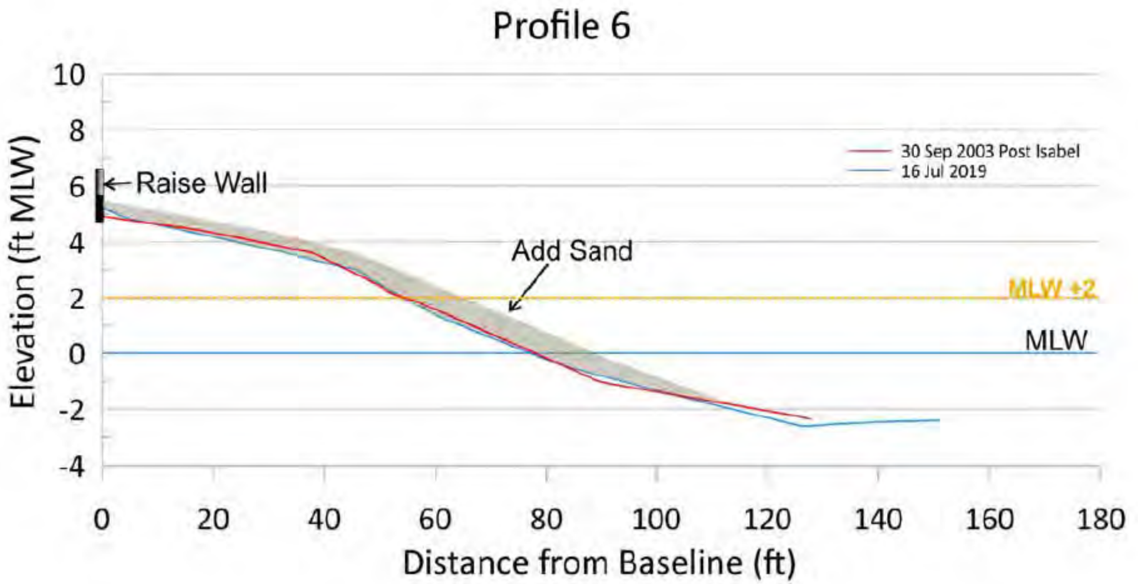
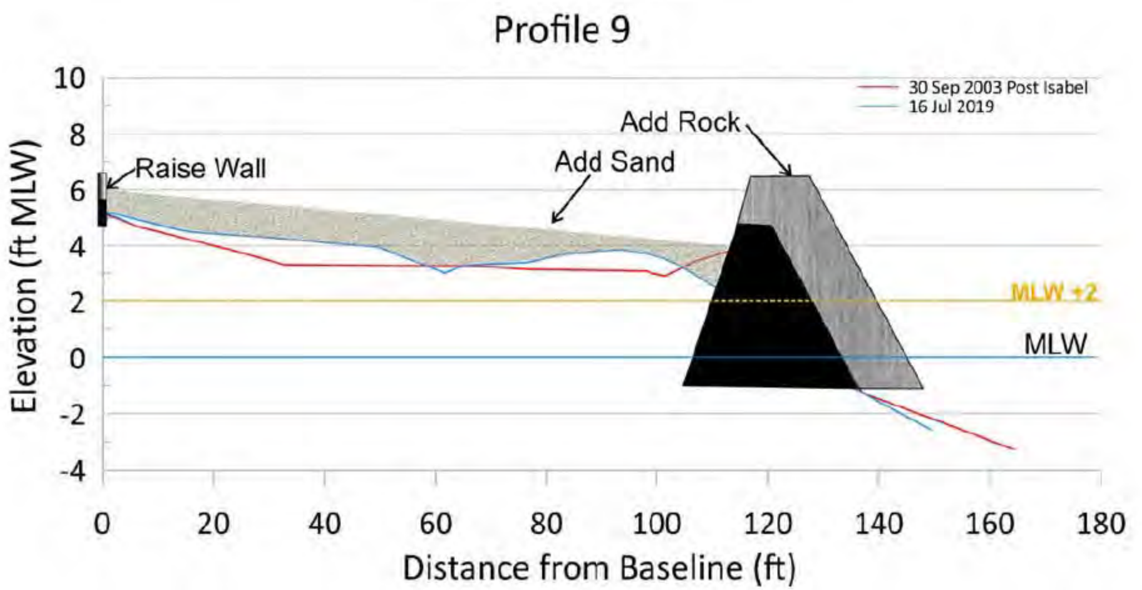


Data points collected to determine elevation changes at the site since installation. Also shown are the measured mean high water and mean low water lines and the cross-sectional profiles exported for the project.





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Summary of Headland Breakwater Systems

from Hardaway and Byrne (1999)

Fetch: 1 to 5 miles: Lb = 60 to 150 ft
Bm = 35-45 ft

Fetch: 5 to 10 miles: Lb = 90 to 200 ft
Bm = 45 to 65 ft

Fetch: >10 Miles: Lb = 150 ft to 300ft
Bm = 50 to 75 ft

Summary Continued
from Hardaway and Byrne (1999)

Unidirectional: Average **Mb:Gb = 1:1.9**
Range: 1:1.6 to 1:2.5;
Average Lb:Gb = 1:1.8, Range: 1:1.5 to 1:2.0

Bimodal: Average **Mb:Gb= 1:1.4**
Range 1:1.0 to 1:1.7
Average Lb:Gb = 1:1.2, range : 1:1.0 to 1:1.5

Overall average Mb:Gb =1:1.65
Lb:Gb = 1:1.4

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Henry's Island
Lancaster County Pre-Isabel 2002

Henry’s Island: 9.25.03 Post Isabel

Henry's Island
Lancaster County Post-Isabel 2005

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Henry's Island
Lancaster County 2015

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Breakwater Design Guidelines: Rules of Thumb

- *Don't place structure further offshore than its length.*
- *The breakwater length should be 2 to 2.5 times the design wave length.*
- *Use coarse sand and overfill the stable planform.*
- *Maintain access for maintenance.*

Coastal Resiliency

Two Concepts for Coastal Resiliency

Resiliency: The capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to the economy and the environment.

Adaptation: An adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.

Coastal Resiliency Design Considerations

Sea-Level Rise (SLR)

Rising water levels affect living shorelines in several ways:

- Plant populations can be displaced due to the increased duration and extent of flooding and increased salinities.
- The marsh may not be able to migrate inland where high banks occur (coastal squeeze).
- Higher water levels particularly during storms overtop systems reducing the effectiveness of the stone structures to lessen the amount of wave energy impacting the site leading to erosion of the backshore or bank.

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Tidal Benchmarks

In Living Shoreline design, using tidal benchmarks to place structures, sand, and grasses is essential. However, the present tidal epoch (1983-2001) has been affected by SLR which means that calculated tidal datums have also been affected.

The new tidal datum epoch (2002-2020) will not be released until 2025. This means that tidal datums will continue to be affected and should be looked at critically in the design process.

When designing systems, field parameters such as biologic benchmarks should be noted.

Spartina alterniflora typically resides between MSL and MHW
Spartina patens typically resides above MHW

* Biological benchmarks are based on empirical data and direct observation of natural plant communities. Generally, a given plant community will establish spatial extents based on the frequency and duration of inundation by water.

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Coastal Resiliency Design Considerations

Unpredictable Water Levels: Storm surge and storm waves

- Coastal areas are experiencing more frequent and more intense storms.
- Modeled significant wave heights may not reflect the energy impacting a site during storms.
- To provide a level of protection for the project, balancing the average fetch vs the longest fetch is needed size rock appropriately to maintain the structure during storms.

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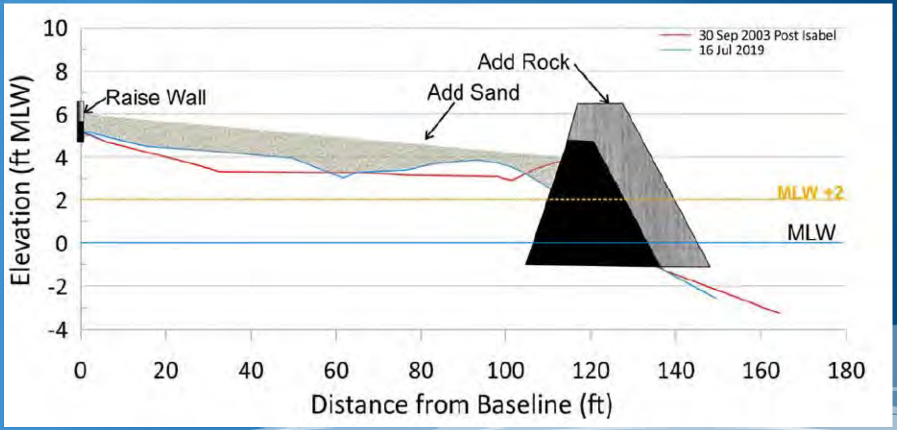
Adaptation

- *For a marsh to survive under SLR, habitats migrate from S. alterniflora to S. patens.*
- *High banks lead to a coastal squeeze for marsh habitats because the upper marsh is trapped.*
- *To adapt, banks must be graded or the whole system has to move up.*

Westmoreland 16Jul2012

- To add rock and sand, armor size has to be sized so you have to raise it to a certain level.
- Should the cost be higher now or wait until it is needed?
- Will there be access to the site when the adaptations need to occur?
- By designing for a higher level of protection (50 yr vs 10 yr), the site can adapt and adjust to SLR better before intervention is needed.



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Marsh Grass Evolution

Phragmites australis – an invasive non-native marsh plant

- As sites mature, it is more likely that Phrag will invade a site grows.
- Its mat root structure does provide significant erosion control benefits.
- Large stands of Phrag have significant ecological alterations in vegetation and in soil because it outcompetes native marsh plants.
- Phrag stands may limit fauna use of the marsh.
- It is more of an issue in lower salinity areas.
- The higher the nutrient load at a site, the more likely Phrag is to take hold.

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Questions?

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Links to Additional Resources

VIMS: Living Shoreline Design Guidelines
https://www.vims.edu/research/departments/physical/programs/ssp/shoreline_management/living_shorelines/class_info/index.php

VIMS: Why a Living Shoreline?
http://ccrm.vims.edu/livingshorelines/index.html

NOAA: Living Shoreline Implementation Techniques
http://www.habitat.noaa.gov/restoration/techniques/livingshorelines.html

Chesapeake Bay Foundation: Living Shoreline for the Chesapeake Bay Watershed
https://www.cbf.org/about-cbf/locations/virginia/issues/living-shorelines/index.html

Virginia Department of Conservation and Recreation
http://www.dcr.virginia.gov/soil-and-water/seas

VIMS: **Shoreline Management In Chesapeake Bay**, Hardaway and Byrne 1999
https://scholarworks.wm.edu/reports/581/