Living Shoreline Professionals Advanced Training

August 24 & 31, 2017

Hosted by

Virginia Institute of Marine Science

College of William & Mary

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LIVING SHORELINE PROFESSIONALS
ADVANCED TRAINING
AUGUST 2017

Part 3

DESIGN GUIDELINES FOR MARSH SILLS & OFFSHORE BREAKWATERS

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This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA16NOS4190171 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

Poplar Grove Sill

Description

- Constructed in 2003
- 1,500 ft project
- Combination revetment, sill and spurs
- Longest fetch south 16 miles, unidirectional
- Low upland bank (+4 to +6 MLW) required little to no bank grading
- MEDIUM-High Energy

Lessons Learned

- Site has withstood several significant storms
- Storm waves rolled over the project area and were effectively attenuated
- No signs of bank scarping

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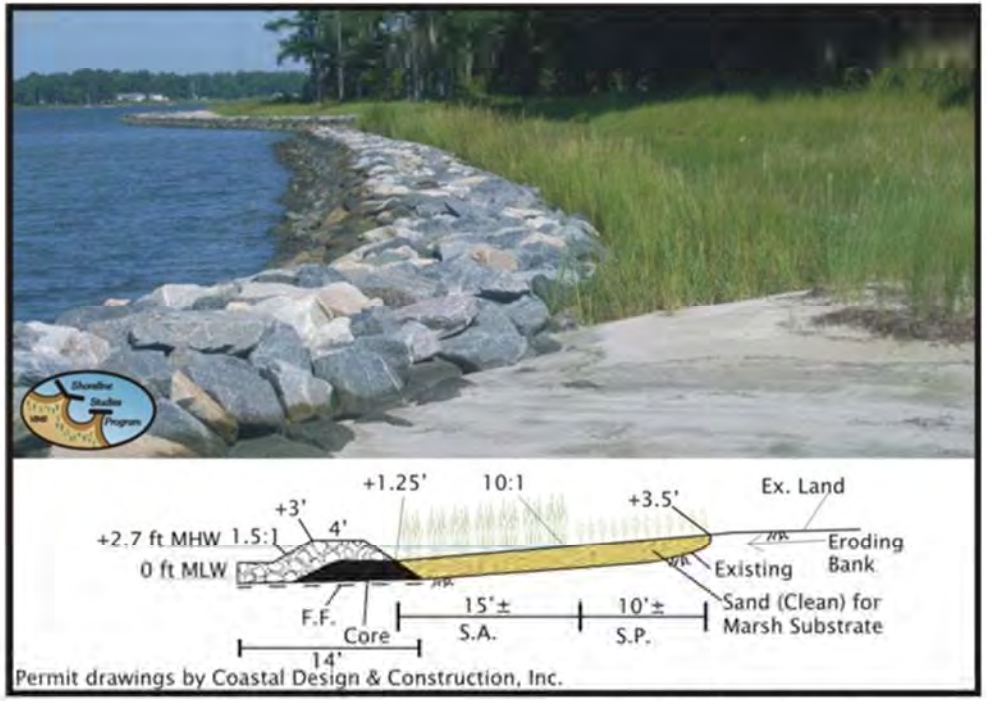
Structural Design Considerations



Sand fill with stone sills and marsh plantings at Poplar Grove, Mathews County, Virginia after six years and the cross-section used for construction

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Location of Cross-Sections at Poplar Grove

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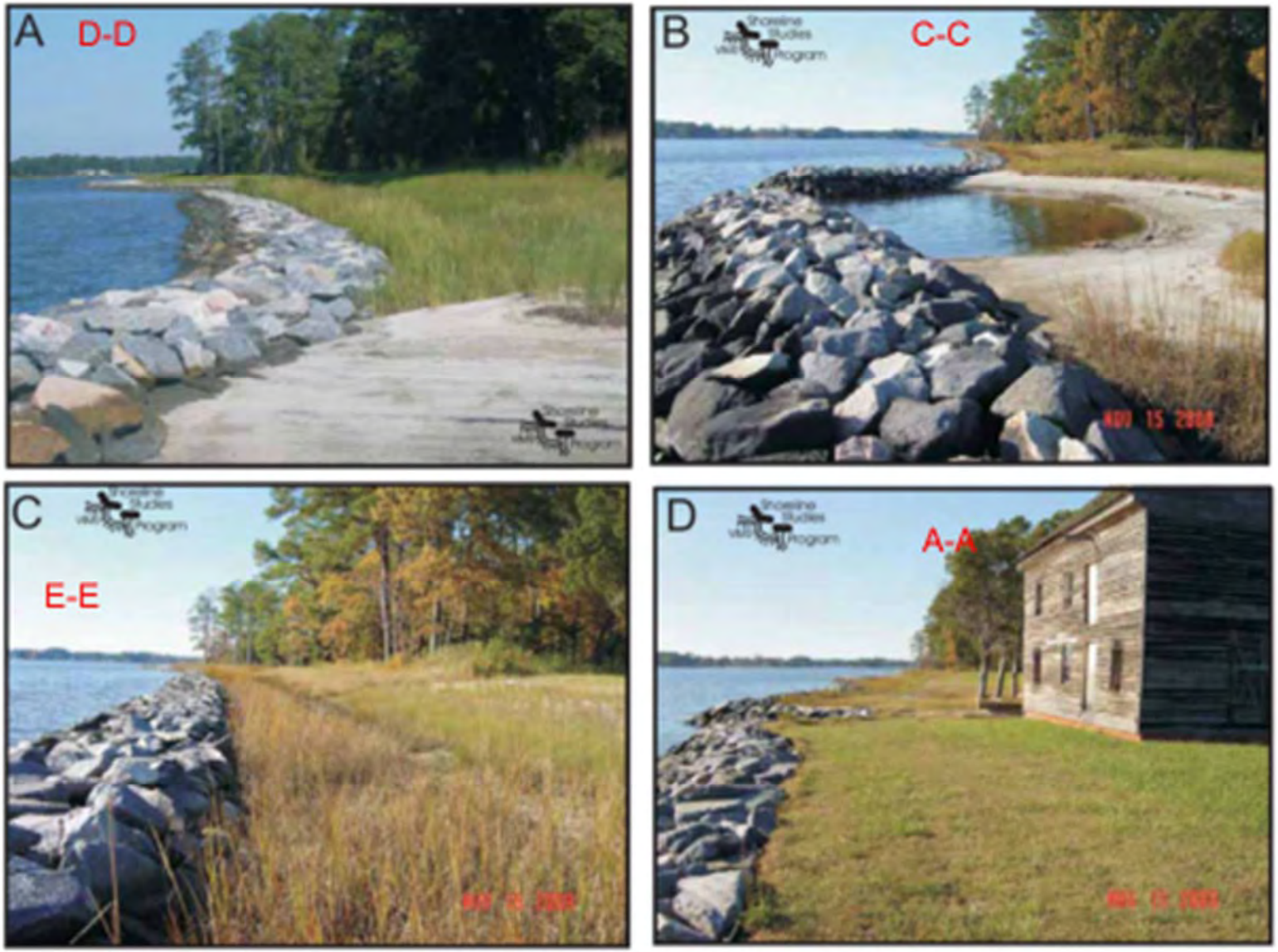
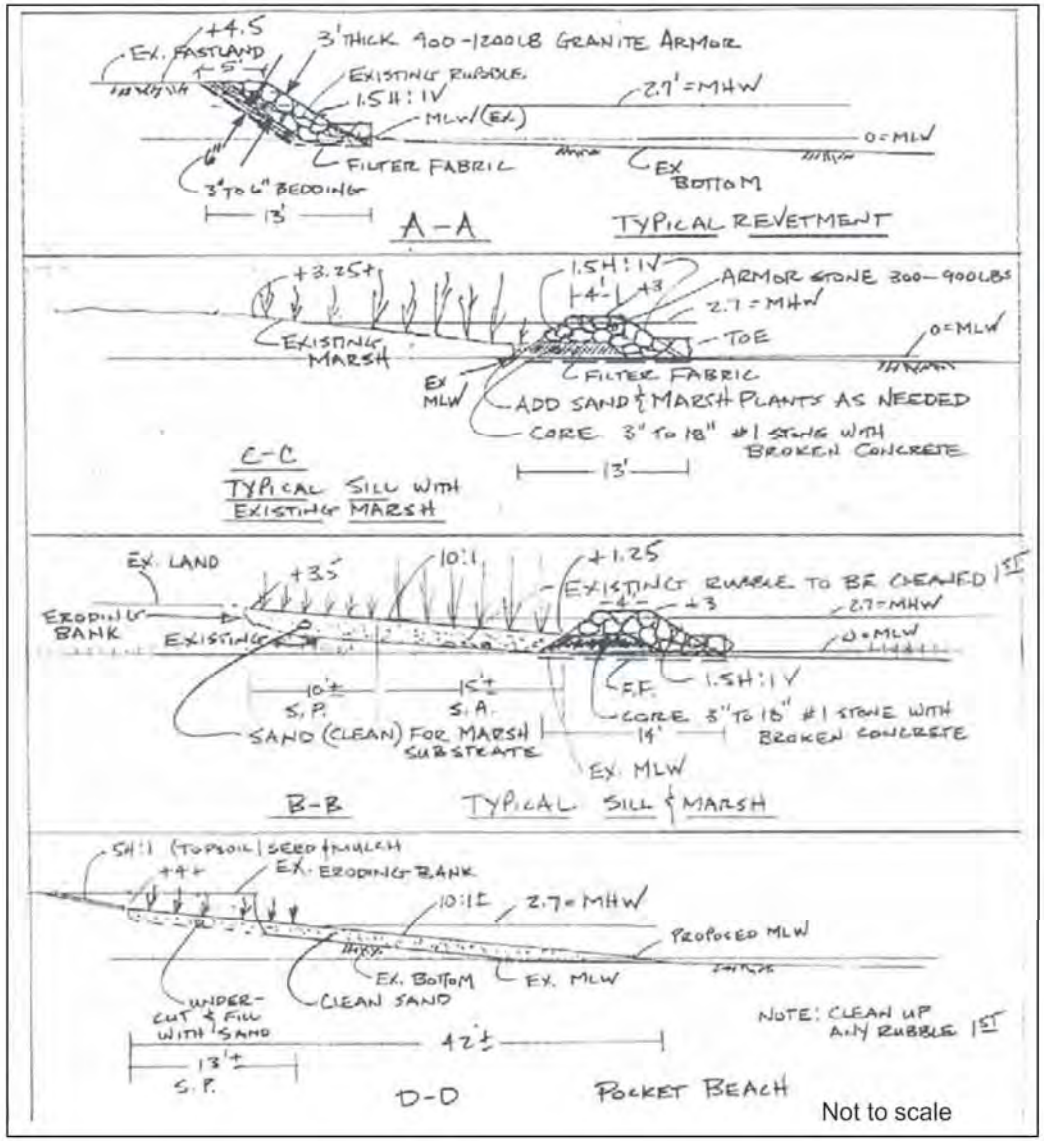
Hardaway, Jr. C.S., D.A. Milligan and K. Duhring, 2010. **Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments**. Special Report in Applied Marine Science and Ocean Engineering #421. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/559/



Sill system at Poplar Grove on the East River in Mathews County, Virginia six years after completion. A) The sill and marsh fringe provide a wide buffer between the water and the upland. B) The wide gap in the sill provides a pocket beach access area along the shoreline. C) The project zones are clearly visible: stone sill, S. alterniflora, S. patens, and upland/wooded. D) The old mill sits close to the shoreline. In this area, a revetment was chosen to protect the shoreline. Hardaway, Jr. C.S., D.A. Milligan and K. Duhring, 2010. **Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments**. Special Report in Applied Marine Science and Ocean Engineering #421. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/559/



Typical cross-sections of the Poplar Grove shore protection system including the revetment, sill and marsh and pocket beach. Permit drawings by Coastal Design & Construction, Inc.

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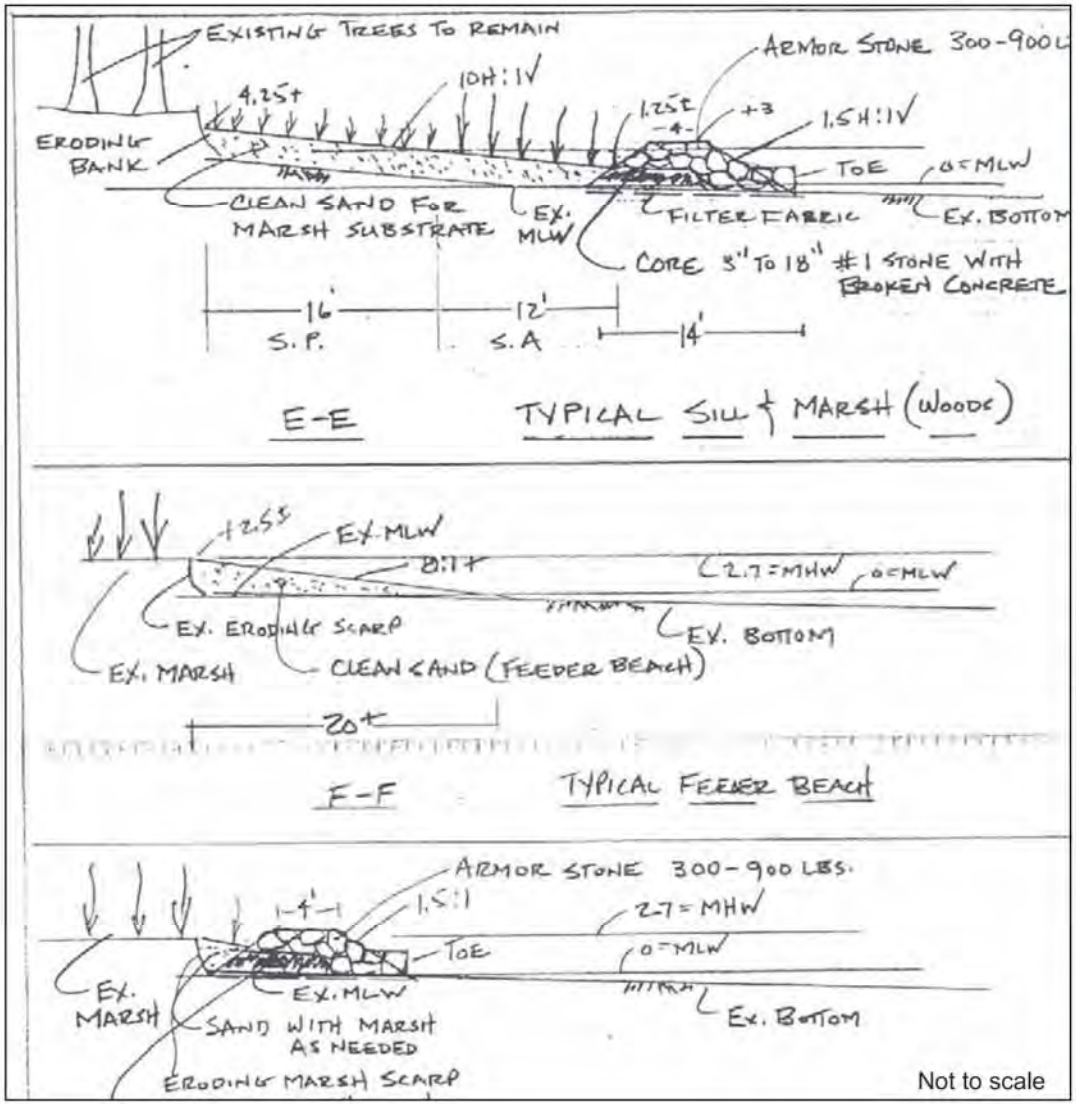
Hardaway, Jr. C.S., D.A. Milligan and K. Duhring, 2010. **Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments**. Special Report in Applied Marine Science and Ocean Engineering #421. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/559/



Typical cross-sections of the Poplar Grove shore protection system including the sill and marsh, feeder beach, and breakwater. Permit drawings by Coastal Design & Construction, Inc.

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Hardaway, Jr. C.S., D.A. Milligan and K. Duhring, 2010. **Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments**. Special Report in Applied Marine Science and Ocean Engineering #421. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/559/

Wave Energy in Chesapeake Bay relative to average fetch:

	Rock size: 2:1 slope
Low energy : > 1.0 mile	Class I – 50 to 150 lbs
Medium energy : 1.0 to 5.0 mile	Class II -150 to 500 lbs
High energy: 5.0 to 10.0 miles	Class III- 500 to 1500 lbs
Very High energy: > 10.0 miles	Type I – 1500 to 4000 lbs

Stone size can be modified up or down depending on site conditions. Increase in front slope grade 1.5:1 may require increase in rock size.

Rock sizes from VDOT (Virginia Department of Transportation) – manual 1982

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Rock: Durable igneous or metamorphic rock with minimum weight of 165 lbs/cubic foot.

Sand: Typically grain size D50 0.6mm (=/-0.25mm) with less than 10% passing the 100 sieve.

Plants: Typically Spartina alterniflora (smooth cordgrass) planted from Mid-tide Level to MHW
Spartina patens (saltmeadow hay) planted above MHW

Graded Banks: Minimum usually 2:1 but 4:1 provides additional buffer

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St. Mary's City Sill

August 2001

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St. Mary's City: Sill with Window: Innovation #3

November 2006

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This sill at St. Mary's City during low tide depicts two of the access pathways including the sill windows and macro-pores in the sill.

(from Hardaway et al., 2007)

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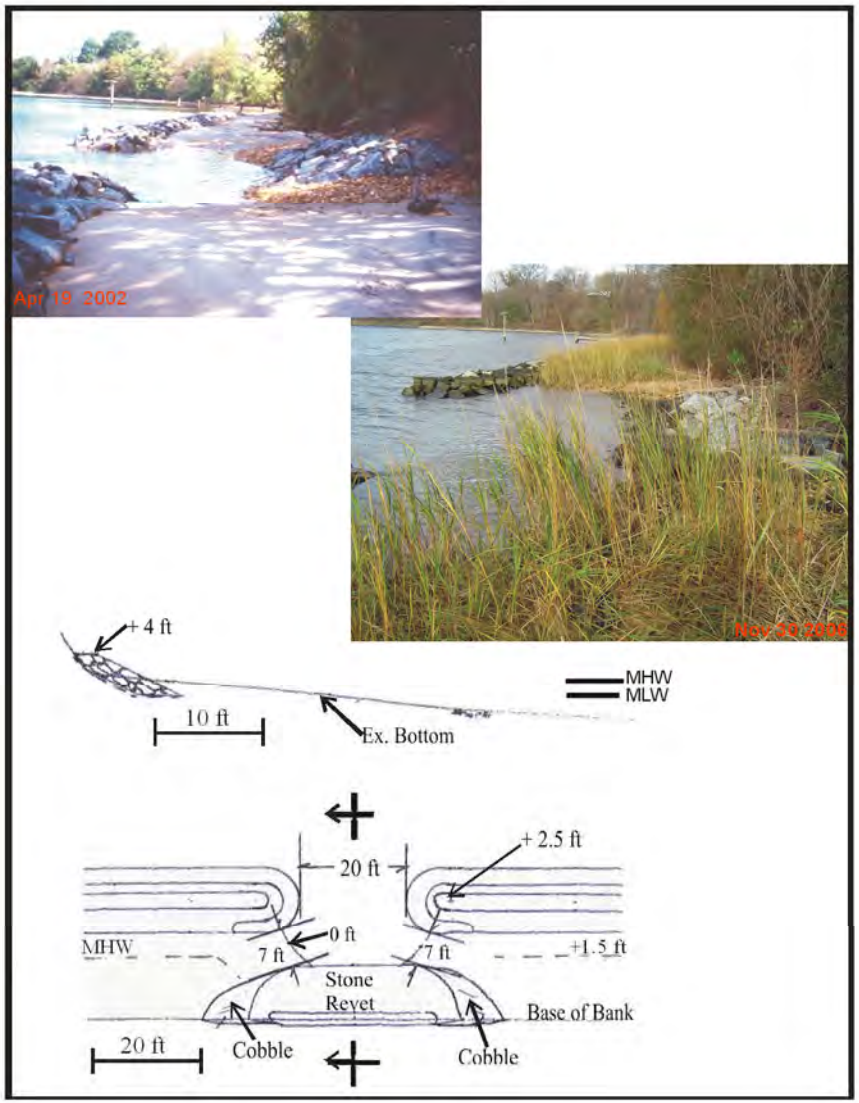
Hardaway, Jr., C.S. W.G. Reay, J. Shen, S. Lerberg, D.A. Milligan, C.A. Wilcox, K.P. Obrien, 2007. **Performance of Sills: St. Mary's City, St. Mary's River, Maryland.** Contract report for the Virginia Department of Environmental Quality's Coastal Resource Program. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/560/



Photos showing a window in the Historic St. Mary's City sill post construction in 2002 and in 2006. The window 9 has a stone revetment along the backshore shown in the planform and cross-sectional design.

(From Hardaway et al., 2007)

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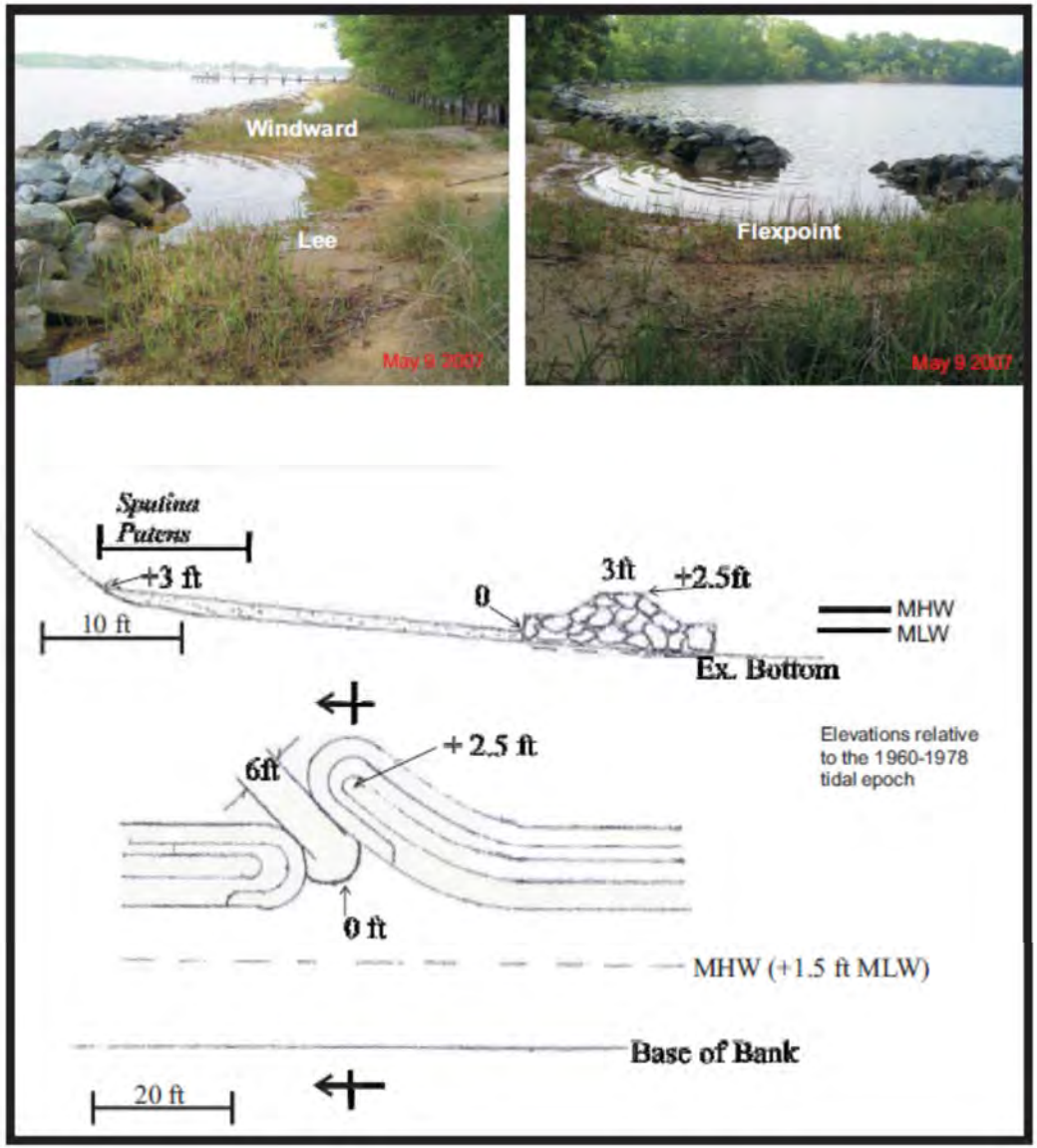
Hardaway, Jr., C.S. W.G. Reay, J. Shen, S. Lerberg, D.A. Milligan, C.A. Wilcox, K.P. Obrien, 2007. **Performance of Sills: St. Mary's City, St. Mary's River, Maryland.** Contract report for the Virginia Department of Environmental Quality's Coastal Resource Program. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/560/



Window 4 Type 1

From Hardaway et al., 2007

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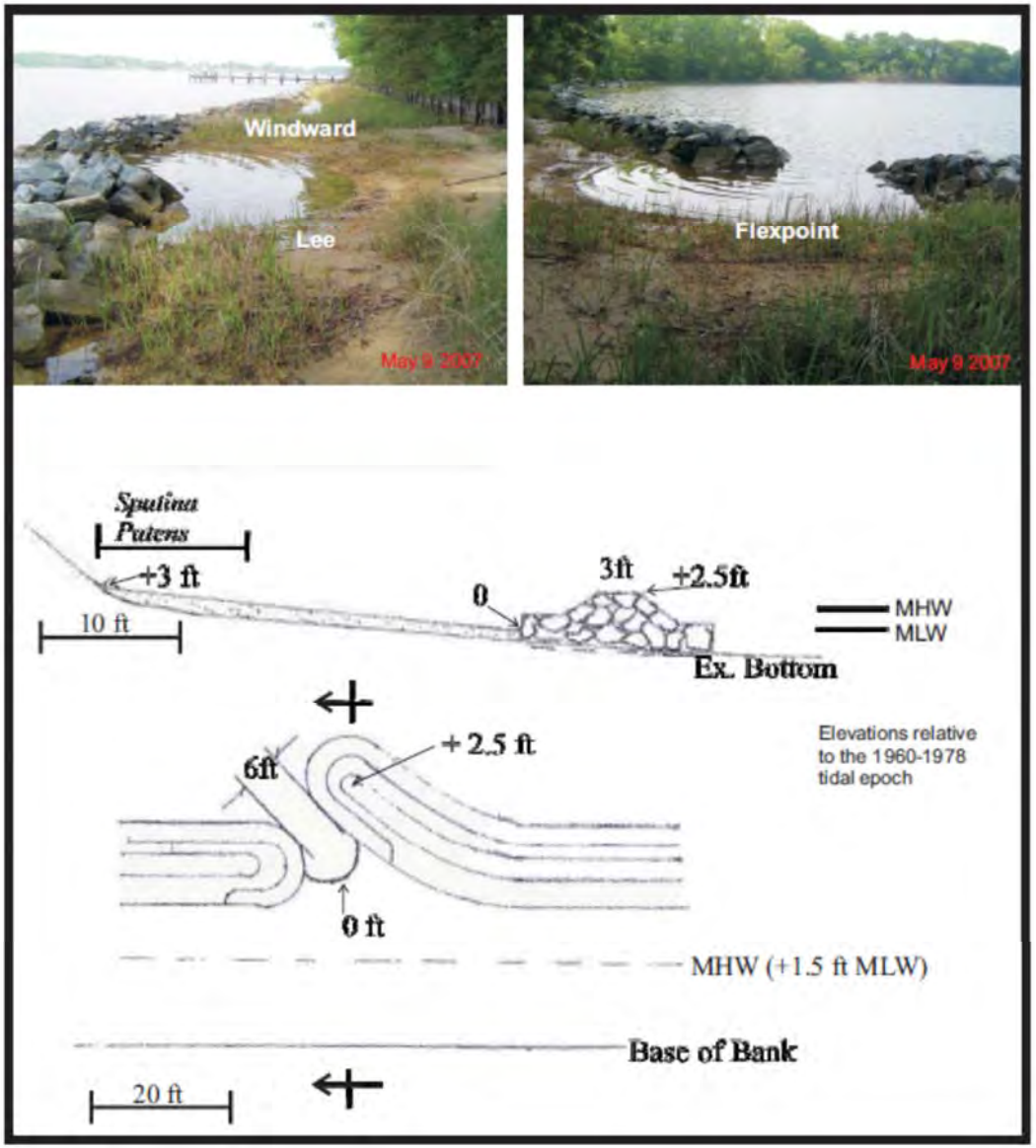
Hardaway, Jr., C.S. W.G. Reay, J. Shen, S. Lerberg, D.A. Milligan, C.A. Wilcox, K.P. Obrien, 2007. **Performance of Sills: St. Mary's City, St. Mary's River, Maryland.** Contract report for the Virginia Department of Environmental Quality's Coastal Resource Program. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/560/



Window 4 Type 1

From Hardaway et al., 2007

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Hardaway, Jr., C.S. W.G. Reay, J. Shen, S. Lerberg, D.A. Milligan, C.A. Wilcox, K.P. Obrien, 2007. **Performance of Sills: St. Mary's City, St. Mary's River, Maryland.** Contract report for the Virginia Department of Environmental Quality's Coastal Resource Program. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Va. https://publish.wm.edu/reports/560/

Summary: Marshes

- As fetch exposure increases so does the marsh width and elevation needed to attenuate wave action.
- At some point (> 0.5 nm fetch) a sill may be needed for long term marsh fringe stabilization.
- Marshes can provide long term protection if properly maintained.
- A large data base of marsh sites exists around the Bay along with various brochures and reports to support the Living Shoreline concept.
- This historical site data allows us to proclaim that shore erosion control can be achieved by creating ***Living Shorelines (i.e. marsh fringes).***

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Offshore Breakwaters

Most appropriate for high energy sand beach sites

Create stable pocket beaches between fixed headlands

At least 2 units

Proper design requires advanced knowledge of coastal processes at site

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Drummond Field; James River
June 2005

First Chesapeake Bay Breakwater Project Innovation BW #1

Installed 1985
By Coastal Design and Construction, Inc.

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Drummond Field 1985: Beginning the Dream

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Drummond Field: Virginia's First Tombolo

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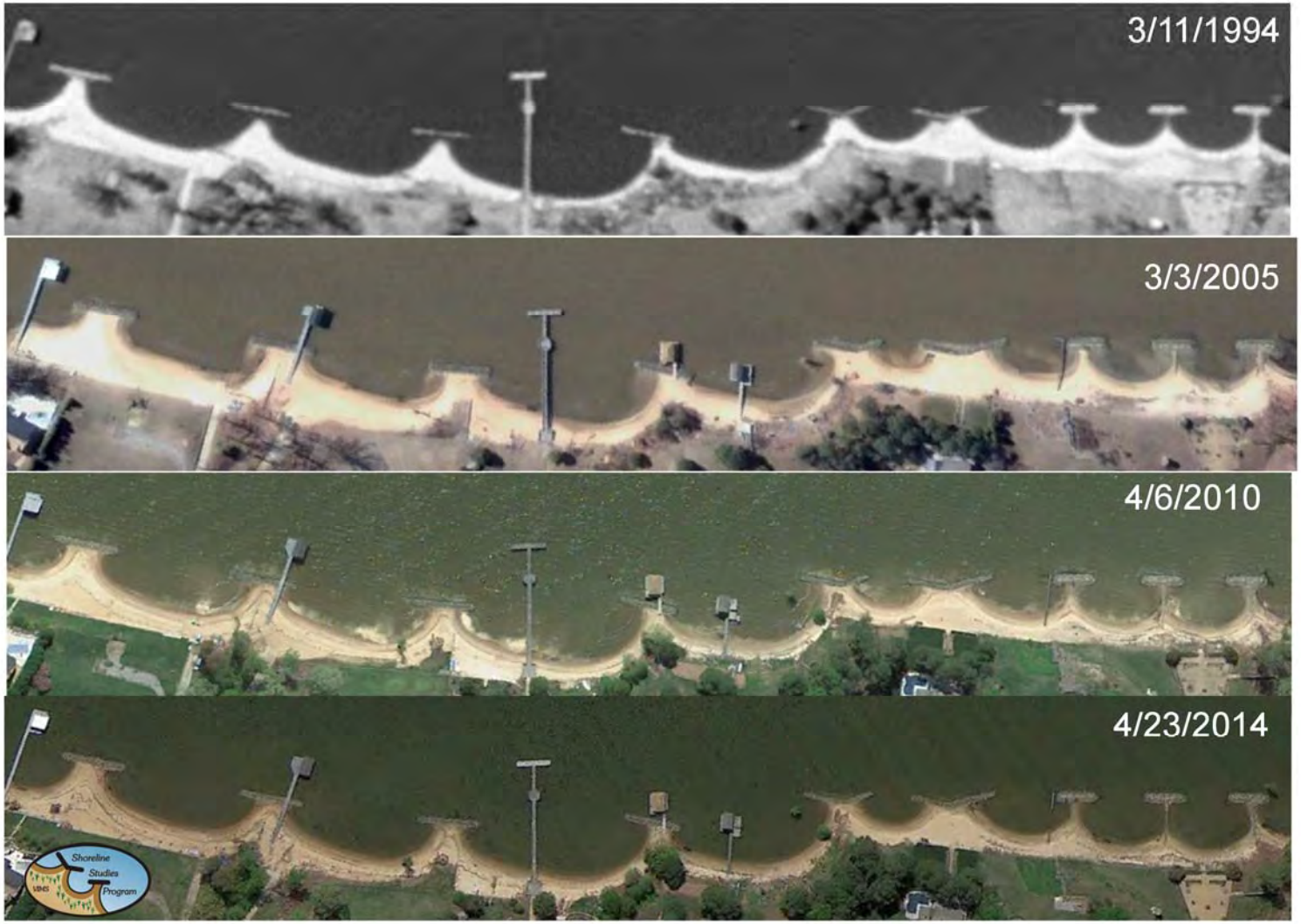
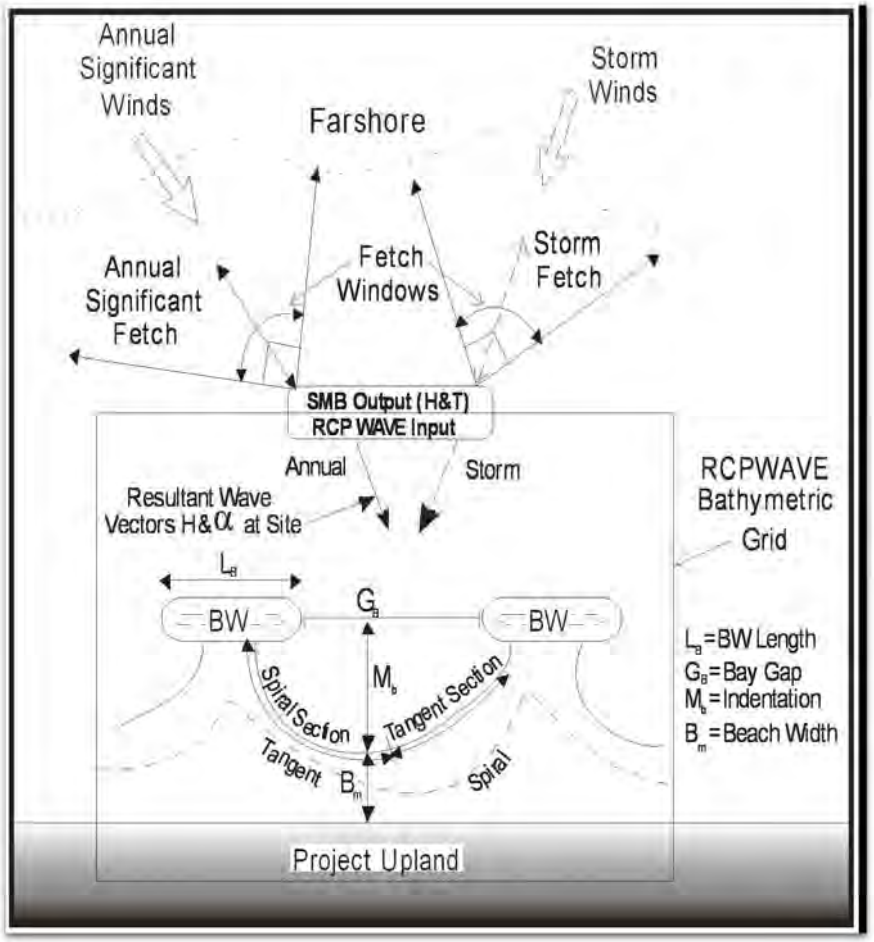
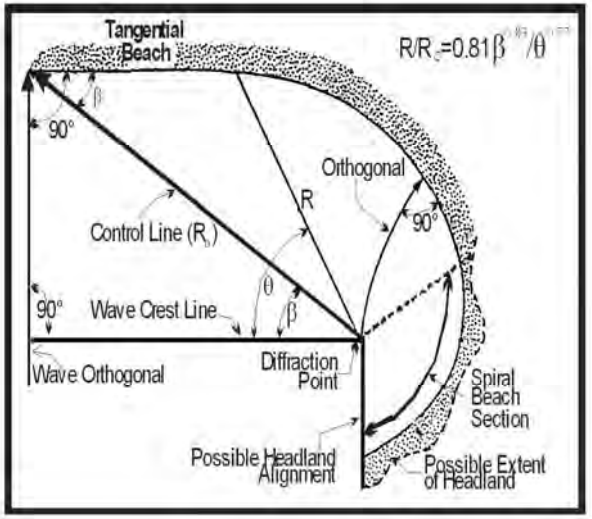
Drummond Field performance





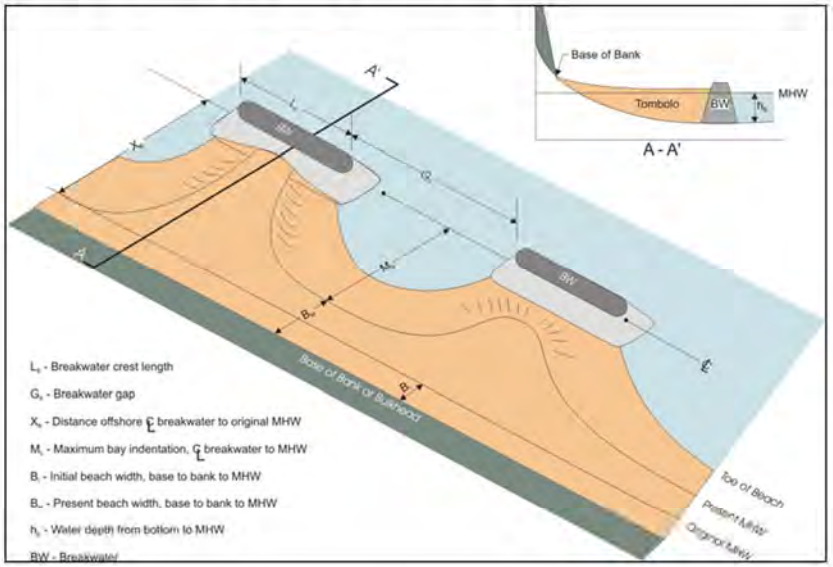


Innovation Bw#2 : Apply Model to BW design

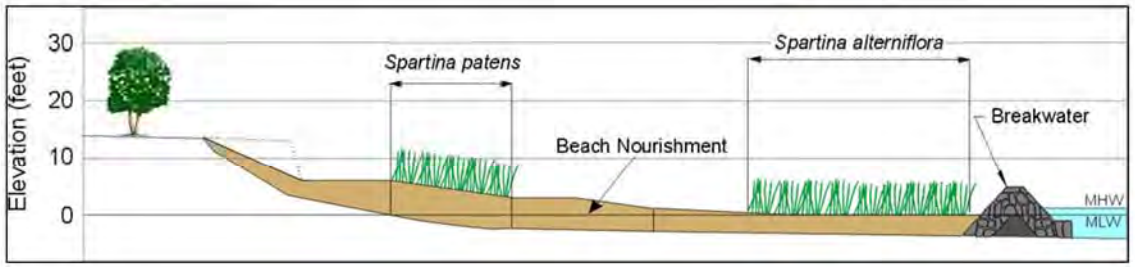
Left drawing: Hardaway, C.S., AF.ASCE, and Gunn, J.R., 1999. Chesapeake Bay: Design and Early Performance of Three Headland Breakwater Systems. Proceedings of the 1999 Conference on Coastal Sediments.
Right drawing: Hsu, J.R.C., Silvester, R, and Xia, Y.M., 1989. Applications of Headland Control. Journal of Waterway, Port, Coastal, and Ocean Engineering, 115(3): 299-310.

Breakwater Design Guidelines
Innovation Bw #3

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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Top: Breakwater design parameters.
Bottom: Typical tombolo with breakwater and bay beach cross sections.
Hardaway, Jr., C.S. & Byrne, R.J. (1999). Shoreline Management in Chesapeake Bay. Special Report in Applied Marine Science and Ocean Engineering Number 356. Gloucester Point, VA: Virginia Institute of Marine Science. http://web.vims.edu/physical/research/shoreline/docs/ShorelineErosionInCBay.pdf

Breakwaters with nourishment now are in wide use in estuaries and provide simple predictive algorithms proven to ensure sustainability under most erosive shoreline situations. The simple tombolo ratios of approximately 1.65:1 provide confidence to natural resource managers and shoreline engineers.

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Yorktown
Post Storm November 1985

Milligan et al., 1996

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Milligan, D.A., C.S. Hardaway, Jr. and G.R.Thomas, 1996. Public Beach Assessment Report, Yorktown Public Beach, Yorktown, Virginia. Technical Report. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 47pp. + app. https://publish.wm.edu/reports/554/

Yorktown
Pre-project 1994

Milligan et al., 1996

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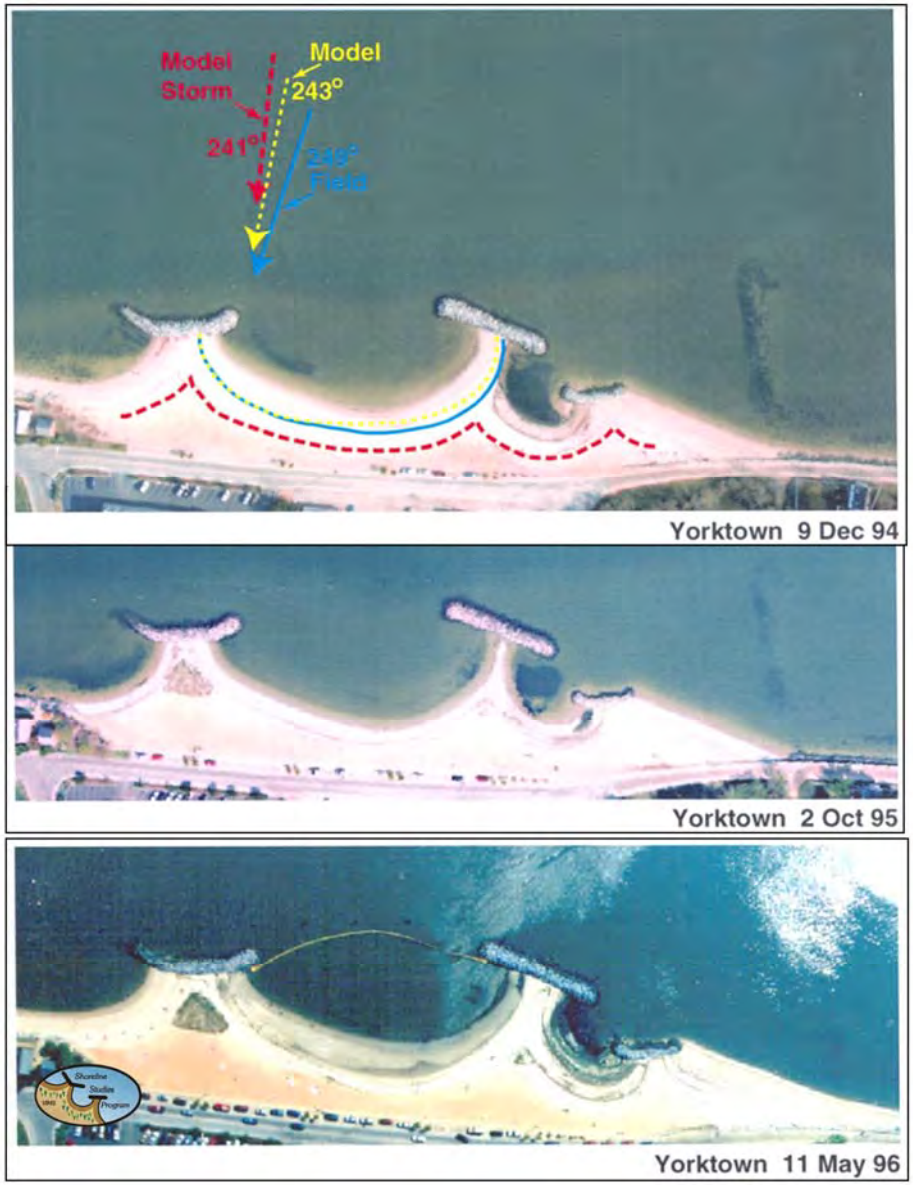
Milligan, D.A., C.S. Hardaway, Jr. and G.R.Thomas, 1996. Public Beach Assessment Report, Yorktown Public Beach, Yorktown, Virginia. Technical Report. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 47pp. + app. https://publish.wm.edu/reports/554/



Yorktown Post Project

Milligan et al., 1996

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Milligan, D.A., C.S. Hardaway, Jr. and G.R.Thomas, 1996. Public Beach Assessment Report, Yorktown Public Beach, Yorktown, Virginia. Technical Report. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 47pp. + app. https://publish.wm.edu/reports/554/

Yorktown 2010

Yorktown 2006

Yorktown

Shoreline Studies Program: Chesapeake Bay Breakwater Database

29 Oct 2010

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VIMS, Gloucester Point, Virginia

The Virginia Institute of Marine Science's main campus is located at Gloucester Point, Virginia on the York River. It consists of the main campus on the east shore of the point and the boat basin and facilities located on the west shore of the point. Gloucester County has a locally-owned beach south of VIMS along the point. The Coleman Bridge (Rt. 17) crosses the York River at this point.

VIMS

Tropical Storm Ernesto,
September 1, 2006

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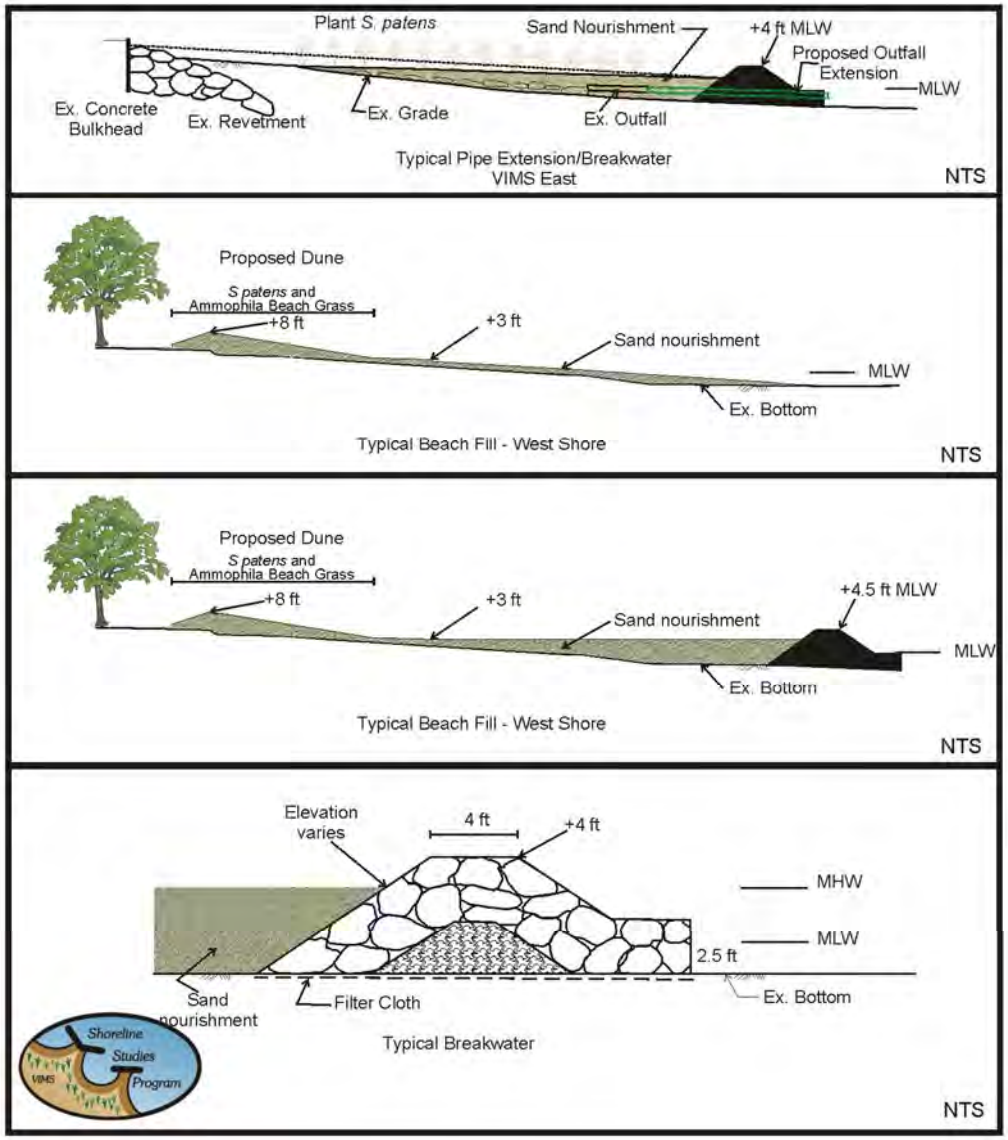
VIMS Shoreline Plan: Need a Plan

Conceptual plan by Shoreline Studies Program at VIMS 2003



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Construction Plan by Vanasse Hangen Brustlin (VHB); Coastal Design and Construction, Inc.

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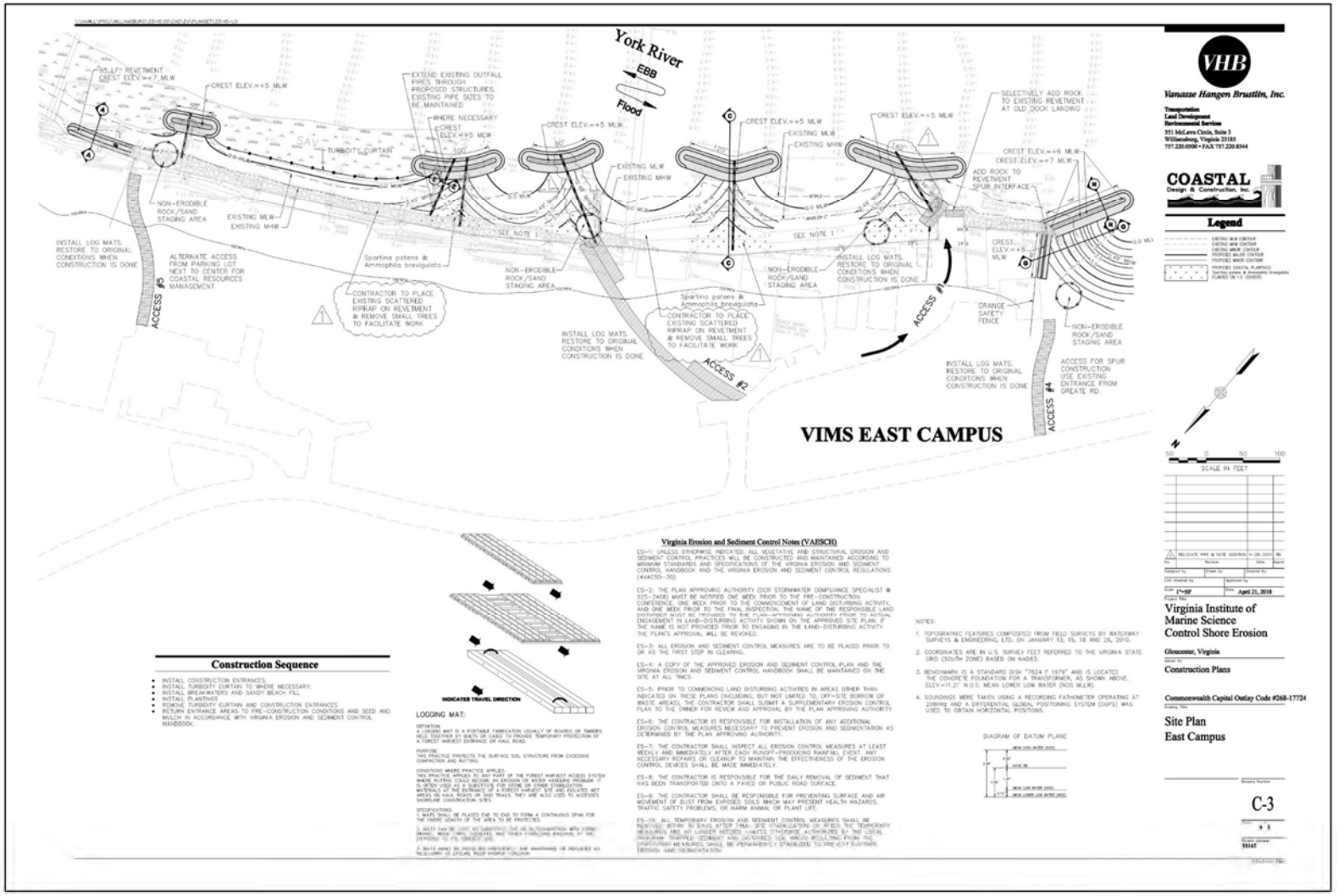

Construction Plan by Vanasse Hangen Brustlin (VHB); Coastal Design and Construction, Inc.

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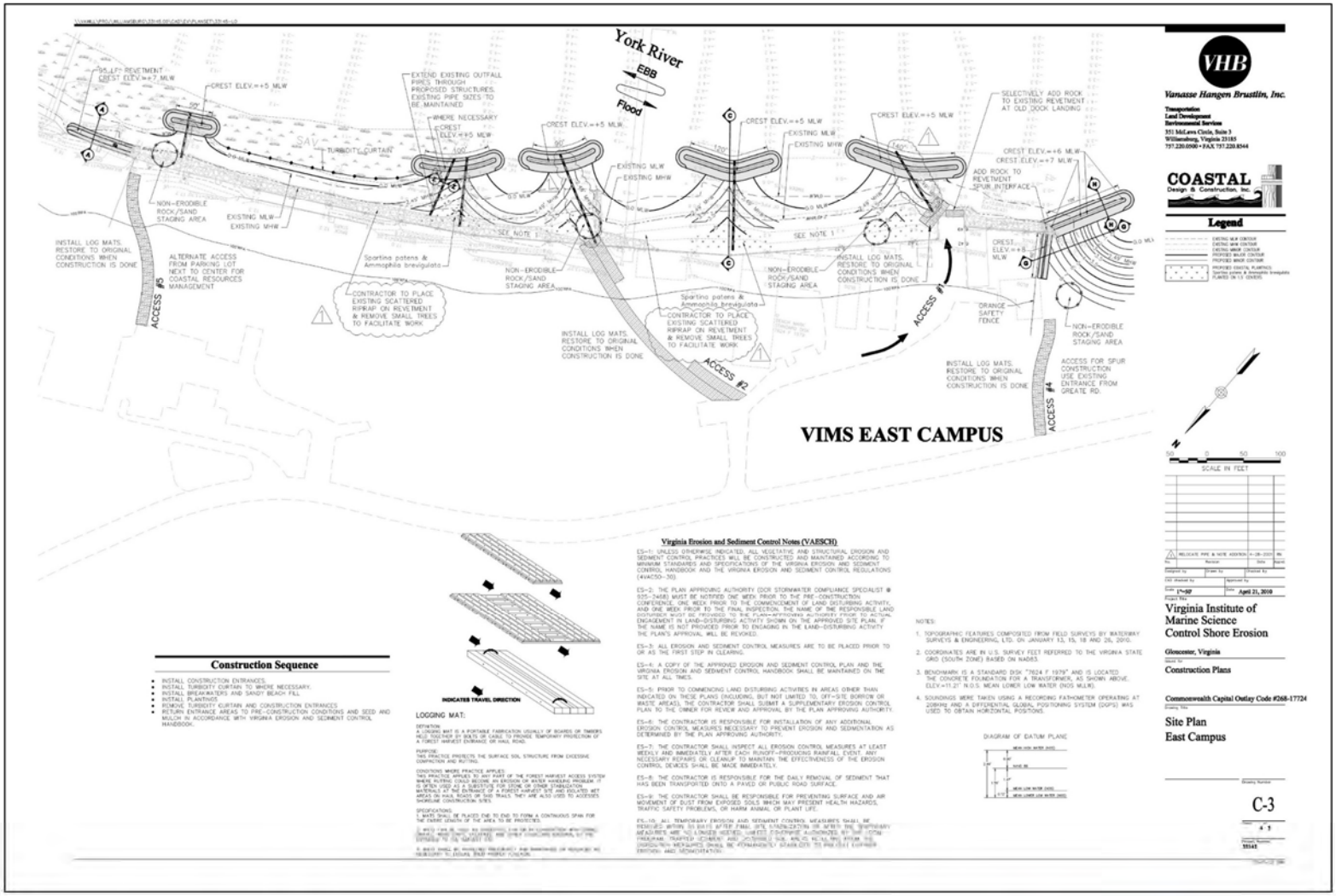

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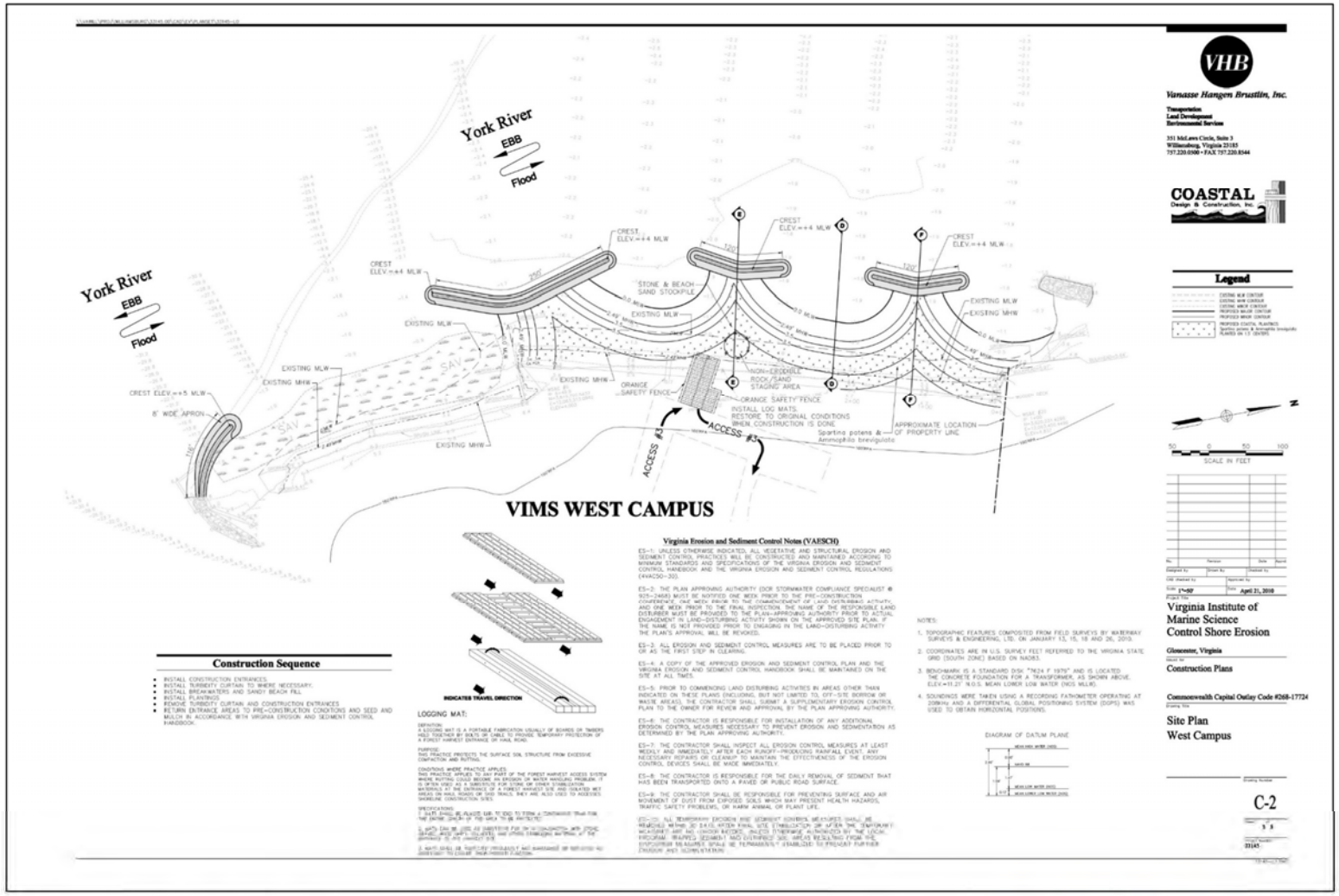

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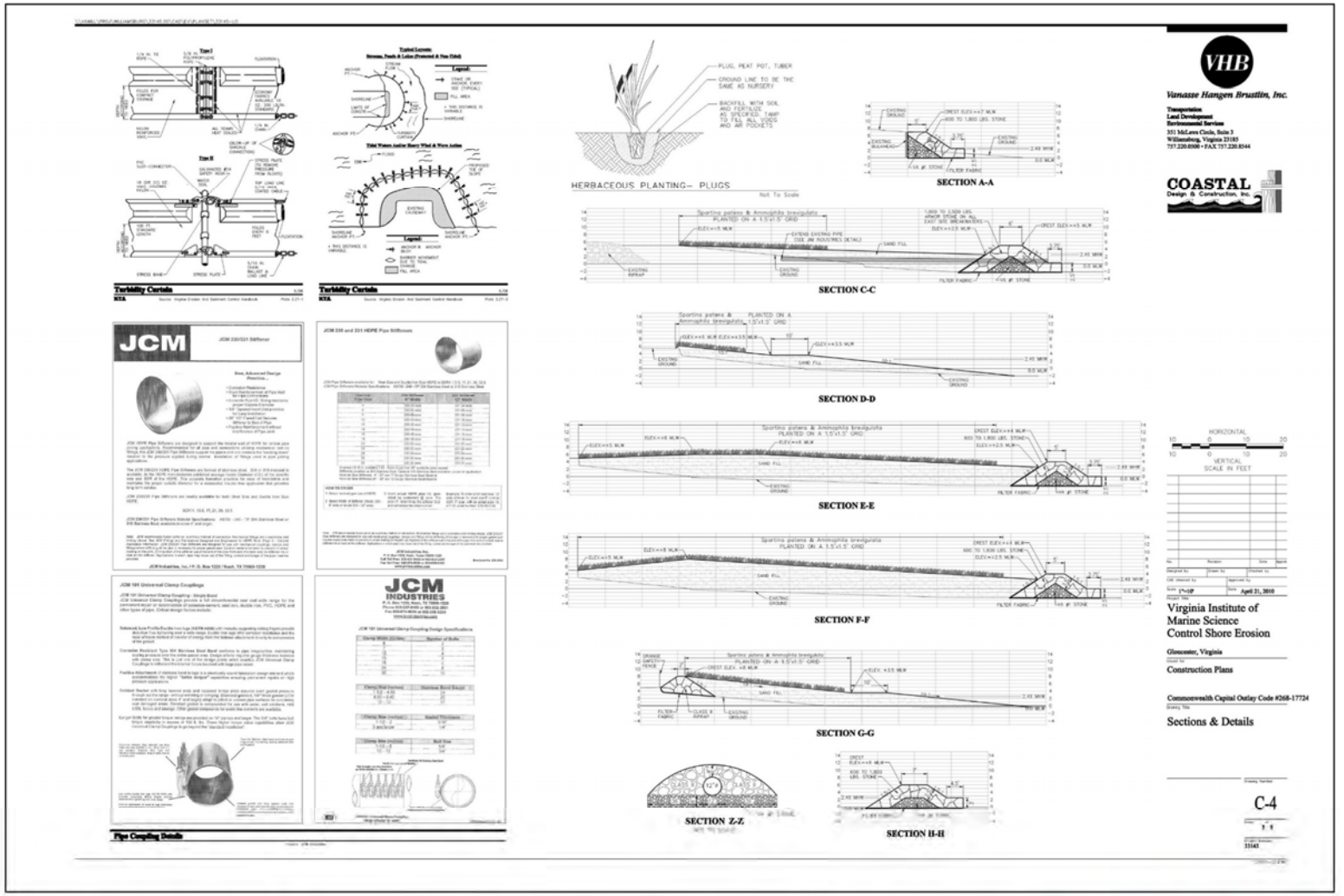

Construction Plan by Vanasse Hangen Brustlin (VHB); Coastal Design and Construction, Inc.

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VIMS East Shore

Sep 2012

Feb 2013

VIMS East Shore

6 October 2015

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VIMS East Shore

25 August 2017

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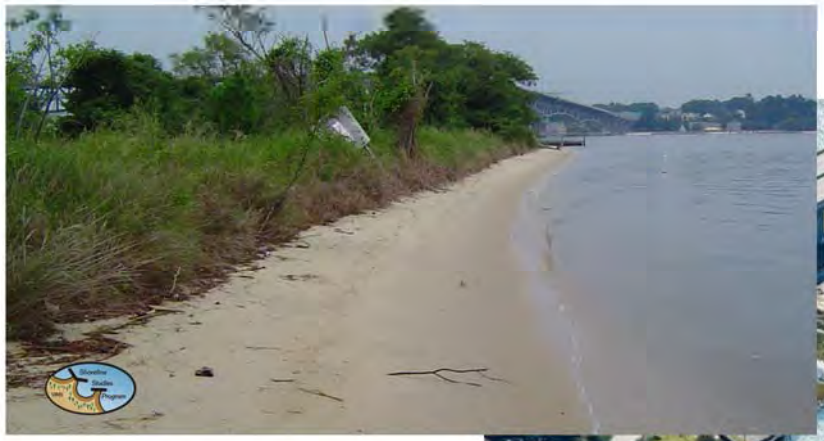
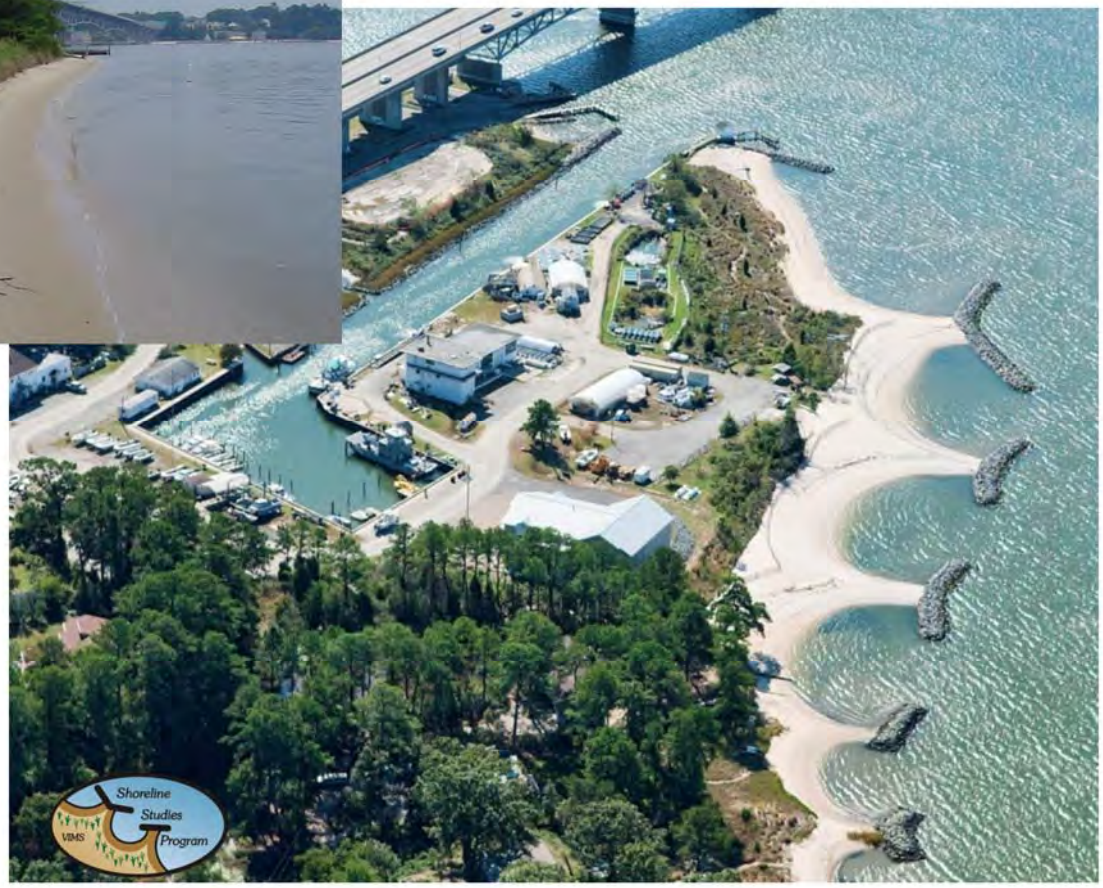
VIMS West Shore

Pre-Construction



After Construction



VIMS West Shore

VIMS West Shore

After Construction

Jan 2012

VIMS West Shore

6 October 2015

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VIMS West Shore

25 August 2017

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Beaches

- Naturally occurring beaches can provide shore protection if wide and high enough.
- Beach nourishment is a method used to maintain a protective beach.
- In Chesapeake Bay, ongoing beach nourishment projects are usually done in conjunction with some type of securing structure such as groins or breakwaters.
- The use of breakwaters on private property began in 1985.

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Estimated Cost

Type of Structure	Estimated Cost per Linear Foot*
Low Sill	$150 -$250
High Sill	$250 - $400
Breakwater	$600 - $1,000

Table 1. *Approximate typical structure cost per linear foot.*

**Based on typical cross-section. Cost includes only rock, sand, plants. It does not include design, permitting, mobilization or demobilization.*

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Hardaway, Jr., C.S., Milligan, D.A., Wilcox, C.A., Berman, M., Rudnicky, T., Nunez, K., & Killeen, S. (2016). Gloucester County Shoreline Management Plan. Gloucester Point, VA: Virginia Institute of Marine Science. https://publish.wm.edu/reports/256/

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THE END

http://web.vims.edu/physical/research/shoreline/

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Links to Additional Resources

VIMS: York County Map Viewer
http://cmap.vims.edu/CCRMP/YorkCCRMP/York_CCRMP.html

VIMS: Living Shoreline Design Guidelines
http://web.vims.edu/physical/research/shoreline/LivingShorelineDesign.html

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
http://www.cbf.org/document.doc?id=60

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

York County Shoreline Management Plan
http://www.vims.edu/research/departments/physical/programs/ssp/_docs/York_MP_final2014-lr.pdf

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