

Werowocomoco Shoreline Management Plan



Shoreline Studies Program
Virginia Institute of Marine Science
William & Mary
Gloucester Point, Virginia

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Werowocomoco Shoreline Management Plan

Prepared for
National Fish and Wildlife Foundation
And the
National Park Service

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1 Introduction

Werowocomoco is located on the York River in Gloucester County, Virginia (Figure 1). Historical documents identified Werowocomoco as the headquarters of Powhatan, the Algonquian political and spiritual leader when the English founded Jamestown in 1607. For many years, the exact location of the site was unknown; however, in 2003, archeological digs at the site on the York River between Leigh and Bland Creeks confirmed the location. The site has been occupied by Native Americans since 8,000 before the common era (BCE) and is one of the most important Native American sites in the nation.

In 2016, subsequent to the completion of the most recent shoreline stabilization project, the 264 acre Werowocomoco site came

under the protection of the National Park Service (Figure 1). Presently, the site is part of the Captain John Smith Chesapeake National Historic Trail. Goals for the property include making it available for appropriate public use while preserving its historical integrity. The property has almost two miles of open water tidal shoreline along Leigh Creek, the York River, and Bland Creek. Shoreline erosion, historically, is greater along the more open reaches of the York River, but the marshes on either end of the site are also eroding quickly. Several sections of the York River shoreline are protected with living shoreline systems and a revetment along the York River in front of the main house.

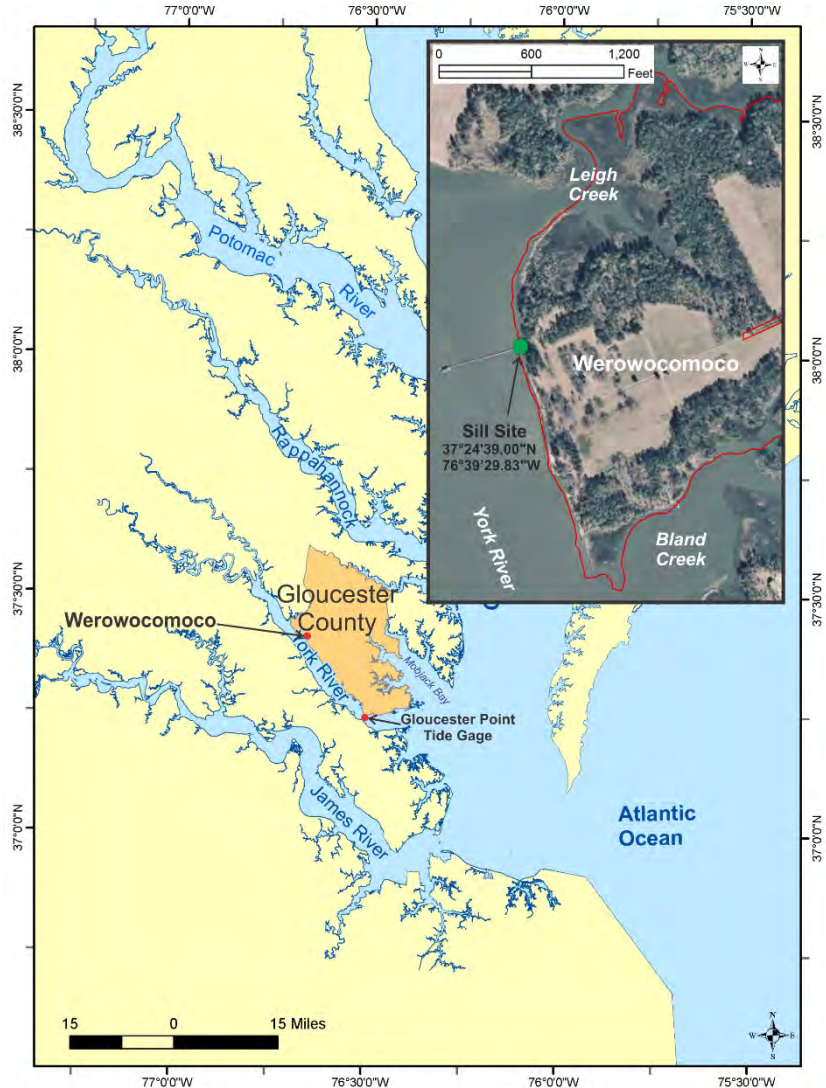


Figure 1. Location of Werowocomoco within the Chesapeake Bay estuarine system.

2 Existing Conditions

2.1 Physical Setting and Shore Change

Werowocomoco has shoreline on the York River as well as Leigh and Bland Creeks. It sits within the natural embayment of Purtan Bay (Figure 2). The upland in the vicinity of the shoreline is relatively high and ranges from 10-25 feet North American Vertical Datum 1988 (NAVD88) (12-27 feet mean low water (MLW)). At Werowocomoco, NAVD88 sits 1.8 feet above MLW. The marshes on either side of the upland at the entrances to the creeks are much lower, between 0 and 5 feet NAVD88 (2 to 7 feet MLW).

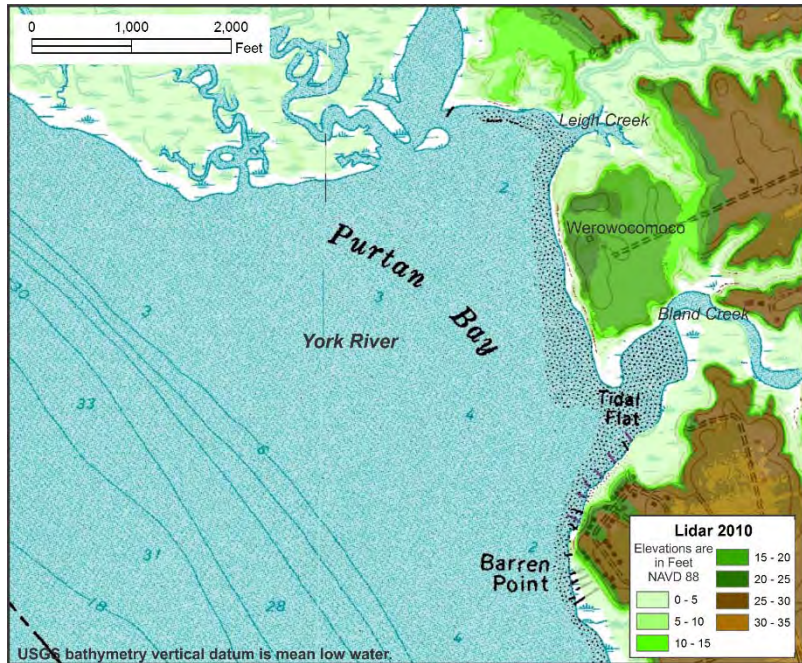


Figure 2. LIDAR data depicting upland elevation overlain on a topographic and bathymetric map. NAVD88 is 1.8 feet above MLW.

The nearshore is very shallow with the six foot MLW contour about 3,500 feet offshore and extensive tidal flats exist along the shoreline and into the creeks.

Three reaches of shoreline exist along Werowocomoco: The shoreline along Leigh Creek, Bland Creek, and along the York River (Figure 3). The Leigh Creek reach consists entirely of marsh shoreline. The creek itself has a narrow channel, and while some channel widening has occurred since 1937, there has been relatively little change along the Leigh Creek shoreline (Figure 4).

The York River coast consists of wide marshes on either end with a high eroding bank along most of the reach much of which has been protected. Figure 4 shows that most of the change is occurring on the ends of the reach. The calculated rates of change between 1937 and 2013 (Figure 5) show that the middle section of the property along the York River had very low rates of change while the ends are eroding at low and medium rates of change. The shoreline has fetches of 2.4 miles to the west, 3.5 miles to the west-northwest, and 2.8 miles to the southwest which results in a medium energy wave climate. Over time, structures have been constructed along the shoreline to mitigate the erosion and for recreational purposes. A 575 foot pier extends from the shoreline to provide boating access. The long length is necessary since the nearshore is so shallow. An existing revetment, approximately 285 feet long, and a 700 foot long, continuous sill were built by the previous owner to protect the

eroding bank. Most recently, a gapped sill system comprised of two stone sills were built in March-May 2016 along 330 feet of shoreline near the pier to address the eroding bank and to protect vital archaeology which was eroding from the bank (Appendix A). The construction of the structures will reduce the shore change rates in the future.

Approximately 1,200 feet of shoreline is unprotected and eroding along the York River. The shoreline north of the gapped sill system is mostly eroding marsh toward Leigh Creek. The shoreline south of the revetment also is eroding marsh. The shoreline between the continuous sill and revetment is upland.

Bland Creek has changed significantly since 1937 (Figure 4). The loss of large amounts of marsh on both sides of the creek has created a much wider channel. This wider channel allows more and larger waves to impact the shoreline along this reach. Much of the shoreline consisted of marsh in 1937 and its loss has allowed the exposed upland bank to begin to erode. This section of the property has about 550 feet of marsh near the mouth and about 600 feet of eroding upland.

2.2 Tide Range and Sea Level Rise

The mean tide range is 2.8 feet at Werowocomoco. Storm surge frequencies for the 10, 50, and 100 year events are 3.9, 5.4, and 6.2 feet NAVD 88, respectively. These stillwater elevations adjusted to MLW for the 10, 50, and 100 year return levels are 5.7, 7.2 and 8.0 feet (FEMA, 2010).

Sea-Level rise was calculated to be 3.81 mm/year (NOAA Tides and Currents, 2016). At this rate, by 2050, 0.4 ft of sea level rise will occur. NOAA's Sea Level Rise and Coastal Flooding Impacts (NOAA, 2016) interactive mapping tool showed the extent of 1 foot of sea-level rise and 6 feet sea-level rise on Werowocomoco (Figure 6). Generally, the low marshes are the areas that will be impacted most by sea-level rise at Werowocomoco. The low marsh will be lost due to flooding over time



Figure 3. Rectified aerial mosaic showing the shoreline reaches at Werowocomoco.

because the uplands are too high for the marsh to be able to migrate landward with sea level. The high upland areas will not be flooded under normal conditions; however the additional water level will increase wave action acting directly on the bank.

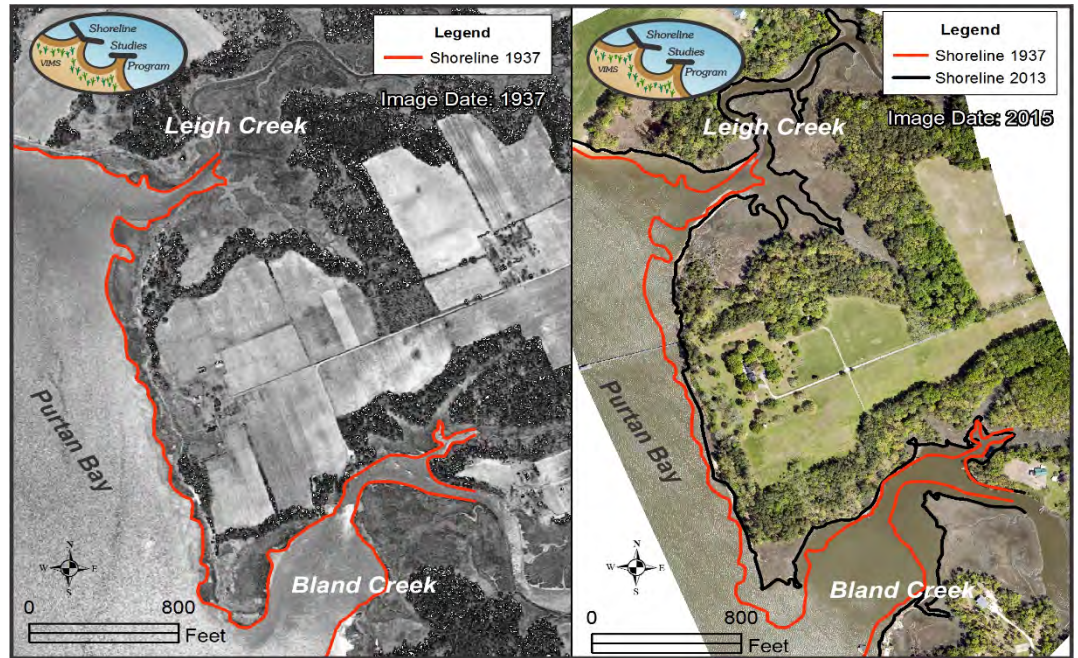


Figure 4. Present shore conditions as depicted by Shoreline Studies Program's April 2015 rectified aerial photo mosaic overlaid on a Virginia Base Mapping Program 2013 image.

2.3 Marine Resources

The Submerged Aquatic Vegetation (SAV) Program at the Virginia Institute of Marine Science (VIMS) has not documented any SAV in Puritan Bay since they began monitoring SAV extent in Chesapeake Bay in 1987.

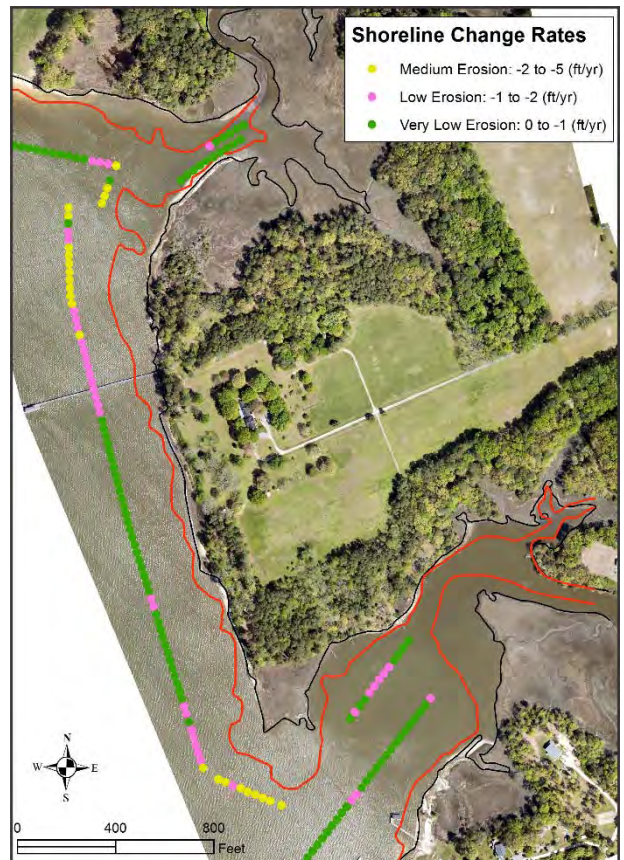


Figure 5. Rate of shoreline change calculated from digitized shorelines in 1937 and 2013.

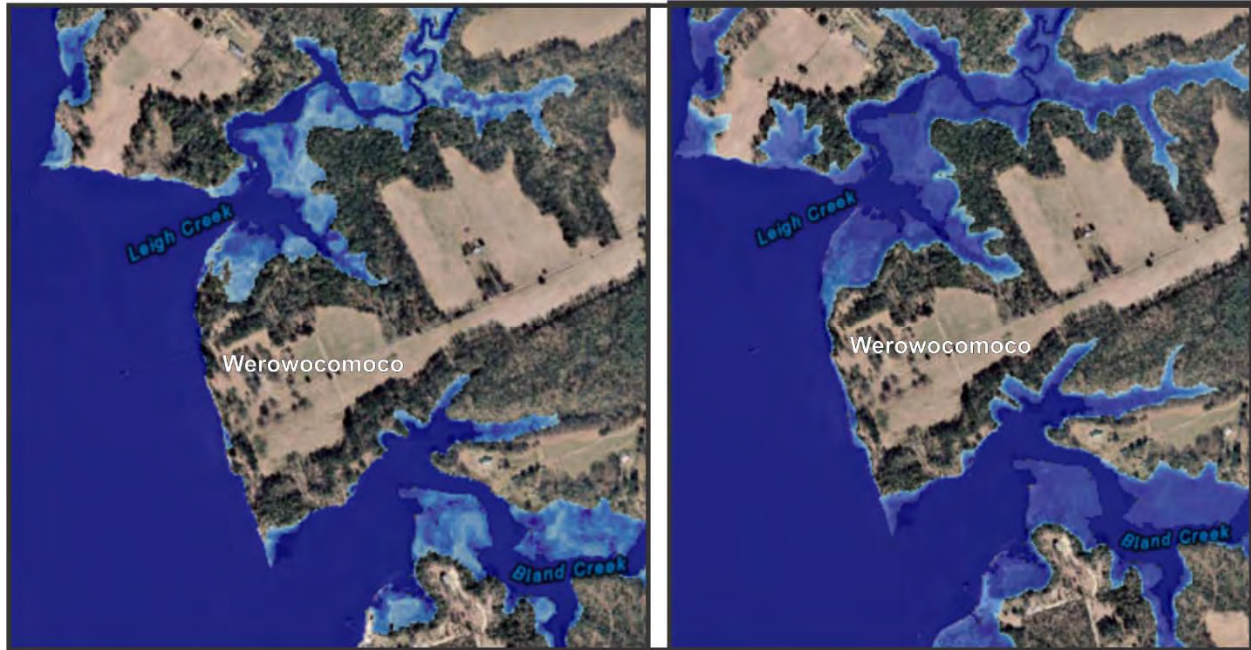


Figure 6. Predicted sea level rise at Werowocomoco with (left) 1 foot sea-level rise, and (right) 6 feet sea-level rise. Very little spatial variation is noted in the two rates due to the elevation of the upland. Additional water will impact farther up the creeks.

3 Shoreline Management

Living Shorelines are a preferred management practice that address erosion and enhance ecosystem services by providing long-term protection, restoration, or enhancement of vegetated shoreline habitats through strategic placement of plants, stone, sand fill and other structural or organic materials (Hardaway *et al.*, 2010). Living Shorelines is the overarching guide for the recommended management strategies along Werowocomoco because they are effective shore protection and will protect archaeology while establishing a marsh edge at the site and recreating habitat that existed when Powhatan occupied the site.

In low energy environments such as those along Bland Creek, recommended shoreline management options often do not require the use of large structures. In medium energy settings such as those along the York River, structural living shoreline management strategies are required.

Much of the York River shoreline is protected by a continuous stone sill and a stone revetment (Figure 7). The high sill protects the bank and has an established marsh habitat. The sill has reduced impacts to the upland bank which is now stable. However, the section of bank near the pier was actively eroding due to the complete loss of marsh at the site (Figure 8).



Figure 7. Top: Existing revetment along Werowocomoco. Bottom: Existing continuous high sill along the site.

Great concern for the loss of high value archaeology associated with Powhatan and the Native American occupation of the site due to continued erosion of the bank in unprotected areas resulted in the construction of a stone gapped sill living shoreline system (Appendix A). In 2014, VIMS received a grant from the National Fish and Wildlife Foundation to design, permit, and build the structures (#45177) and develop this overall shoreline management plan for the entire tidal shoreline. Additional funding from the Virginia Department of Conservation and Recreation’s Water Quality Improvement Fund (WQIF-2016-03) was received to support the construction project.

The Werowocomoco Living Shoreline project created/restored estuarine intertidal and riparian habitat, provided sustainable coastal hazards protection to a vulnerable historic resource, and provided the structure to mitigate the effects of sea level rise. The desired restoration goal was a diverse coastal habitat supporting aquatic, terrestrial, and avian fauna which affords shore and archaeological resource protection from storms and sea-level rise as well as sediment reduction to Chesapeake



Figure 8. Marsh loss at the site. Top: In 2012, several areas of marsh still existed in front of the bank, however, it was eroding quickly. Middle: By 2015, the marsh in front of the bank was completely gone and several of the trees on the shoreline had fallen due to erosion. Bottom: Concern for archaeology in the actively eroding bank led to the placement of a gapped sill living shoreline system.

Bay. Construction began in March 2016 and was completed in May 2016 by Coastline Design and Construction, Inc. Two stone, gapped sills were constructed along 330 feet of shoreline (Appendix A). Planting of approximately 15,000 square feet with *Spartina alterniflora* and *Spartina patens* in May/June 2016 created marsh habitat (Appendix A). The project resulted in the reduction of 3060 lbs/ft/year of sediment, 0.7 lbs/ft/year of total phosphorus (TP), and 0.9 lbs/ft/year of total nitrogen (TN) entering the Bay through upland and marsh erosion. These numbers were calculated using site-specific information. The shore change between 1937 and 2013, as shown by the Shoreline Studies Program Shore Change Database as well as the existing bank height were used in the calculations. The TN and TP were estimated using ratios of results in Ibison *et al.* (1992). Additional site protections were enacted to protect potential archeology in the upland from potential effects of heavy truck traffic. Logging mats were placed along 1,100 feet of the property along the access route so that the weight of the trucks bringing in the rock and sand would not impact any unidentified archeology (Figure 9).

In order to determine existing conditions along the rest of the shoreline, the site was visited on foot and surveyed for elevations. Three areas were determined as eroding necessitating the implementation of a management strategy. It should be noted that construction at the site must occur from land because of the shallowness of the nearshore. Additional site costs above and beyond mobilization and demobilization costs are necessary for the protection of potential archeology.

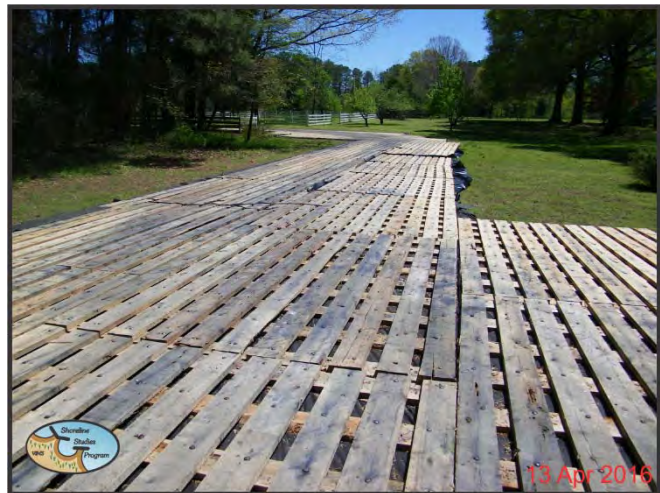


Figure 9. Logging mats and filter cloth were placed on the upland to protect potential archeology from the weight of trucks carrying materials during the project.

Between the high continuous existing sill and the revetment, the shoreline consists of a sandy beach with an eroding backshore and sloped bank (Figure 10). This area of the shoreline offers excellent access to the River. In order to protect the upland bank and provide access, two spurs off the existing structures are recommended (Figure 11). These structures are 80 and 90 feet long, 15 and 18 feet wide, 4 feet high and extend at an angle from the existing structures. Sand will be placed between the structures to maximize accessibility to the water.

On the southern end of the reach, the existing marsh is eroding and wide tidal flats occur (Figure 12). Two gapped sills, 75 feet and 125 feet, 12 feet wide, and 3 feet high are recommended (Figure 11). Sand will be placed behind the structures which will be planted with *Spartina alterniflora* and *Spartina patens*. Access to this site should not be an issue since the bank is sloped in this area.



Figure 10. The sandy beach between the high continuous sill and rock revetment has a sloped bank making the area accessible.

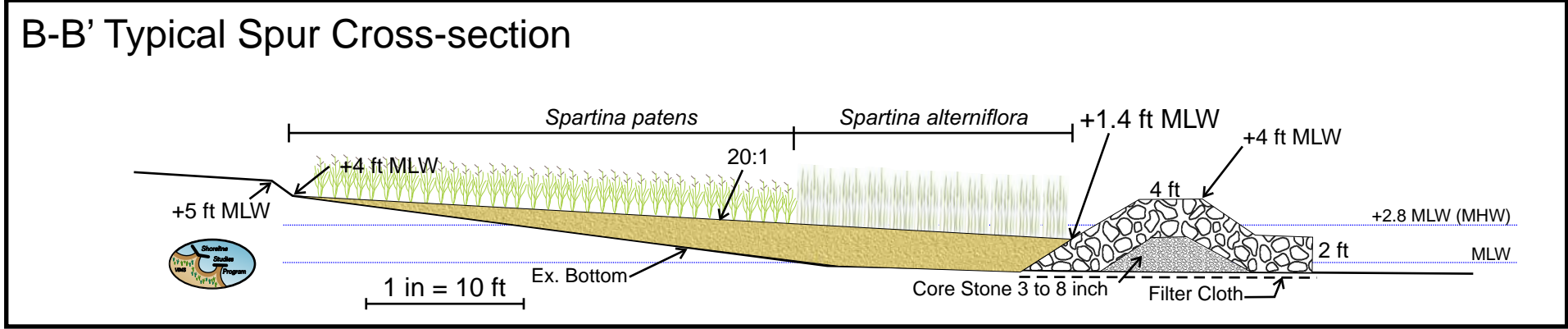
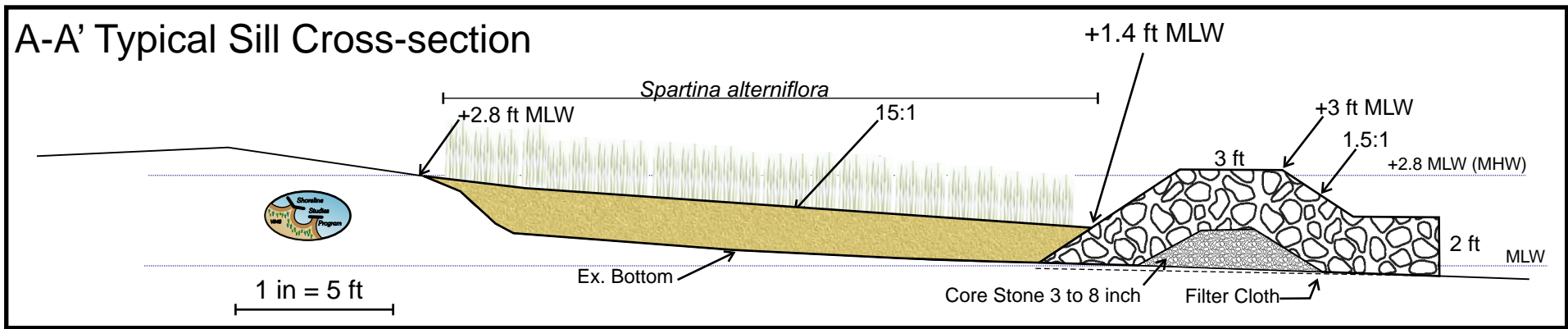
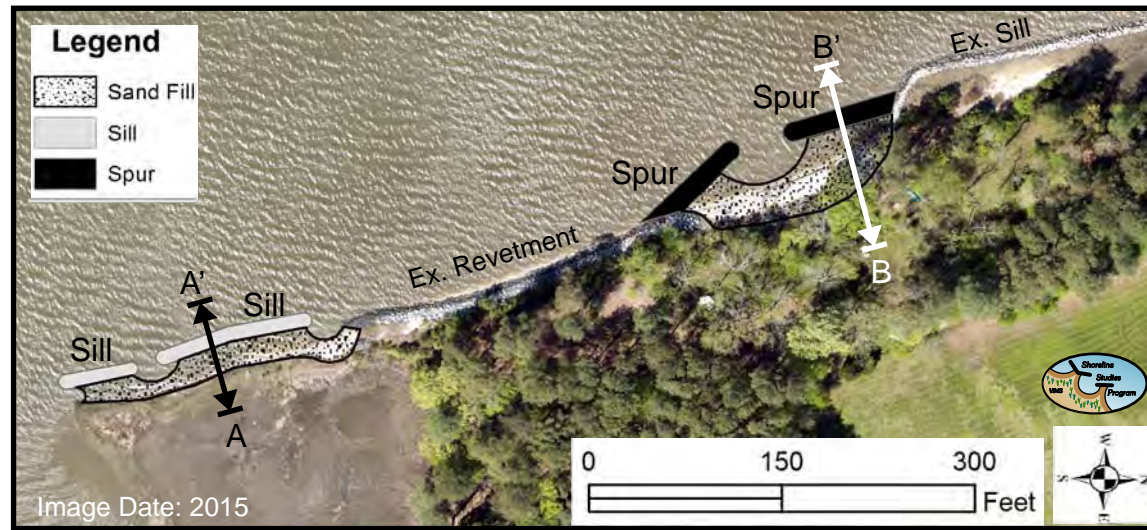


Figure 11. Top: Planform showing the recommended shore protection strategies for the southern end of Werowocomoco's York River shoreline. Bottom: Typical cross-sections for the recommended structures.



Figure 12. Existing conditions (left) along the northern section of the reach at Leigh Creek and (right) along the southern section of the reach at Bland Creek.

The marsh along the northern section of the York River property is extensive but has an eroding scarp (Figure 12). A series of five gapped sills are recommended along this shore reach. The structures vary between 130 feet and 200 feet long. They are 12 feet wide and 3 feet high (Figure 13). Sand will be placed behind the structures which will be planted with *Spartina alterniflora* and *Spartina patens*. Access to this section of shoreline might be difficult because there is a possibility that the Native American burial ground may occur on the adjacent upland.

The shoreline along Bland Creek would also benefit from a living shoreline. A 230 foot sill along the eroding upland would protect the bank (Figure 14). Depending on the NPS planning process, the adjacent area could potentially be used for a kayak launch site.

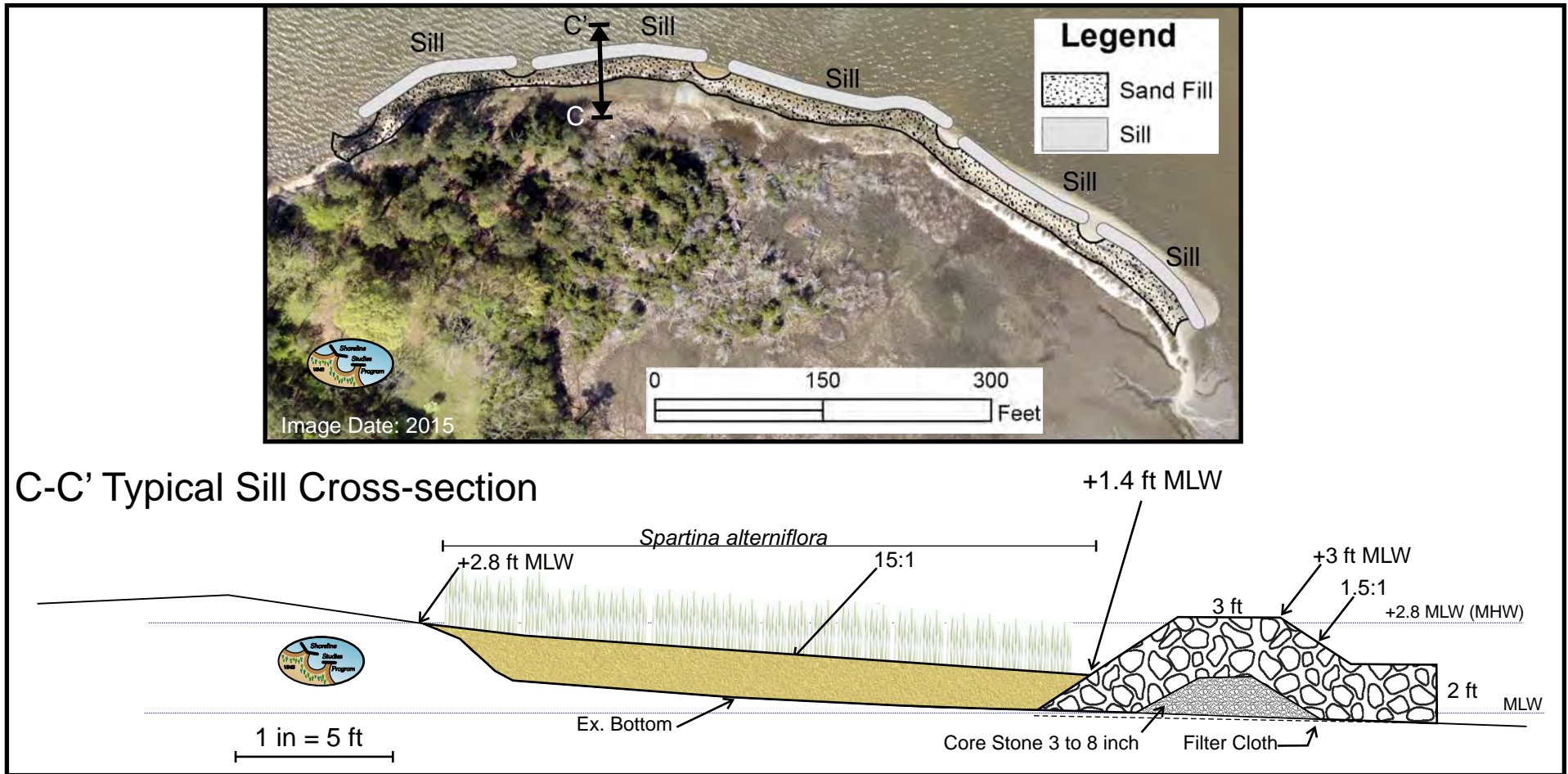


Figure 13. Top: Planform showing the recommended shore protection strategies for the northern end of Werowocomoco's York River shoreline. Bottom: Typical cross-sections for the recommended structures.

4 Summary

Werowocomoco is a very important archaeological site in Gloucester County, Virginia which has about two miles of marsh and upland shoreline. Much of the shoreline has a low erosion rate with the exception of the low marsh at the confluence of Bland and Leigh Creeks with the York River. Between 1937 and 2013, these marshes point were eroding at up to 4feet/year.

The upland is high, ranging from 10-25 feet NAVD88, and the nearshore is very shallow. Sea level rise will have an effect on the low marshes of the site over the next 50 years because the high upland bank will not allow for migration of the marsh.

Overall, many sections of eroding shoreline at Werowocomoco have been addressed. The high continuous sill and rock revetment along with the new gapped sill protect over 1,300 feet of shoreline. In order to protect potential archaeology and provide shore access for visitors, additional living shoreline structures are needed.

5 References

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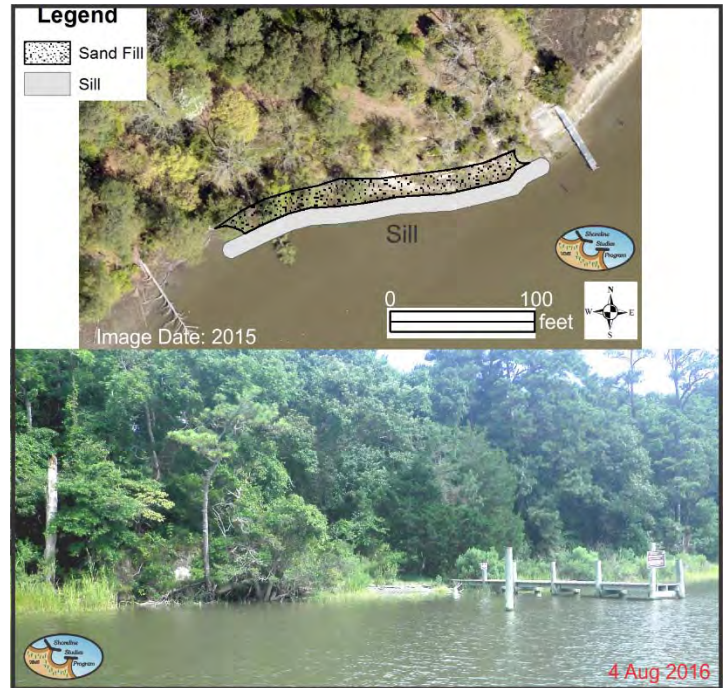


Figure14. Top: Recommended living shoreline protection along Bland Creek. Bottom: Existing conditions of the shoreline. Intermittent fringe marsh exists, but the bank is eroding.

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Appendix A

2016 Living Shoreline Project Data Sheet

Werowocomoco Living Shoreline Project Summary

Location
37°24'39.00"N,
76°39'29.83"W

Werowocomoco is located on Purtan Bay on the York River in Gloucester County, Virginia. The 264 acre property has about two miles of open water, tidal shoreline. The living shoreline project addressed erosion of the upland bank in order to protect valuable archaeology at the site and reduce sediment input to the Chesapeake Bay. It created a diverse coastal habitat capable of supporting aquatic, terrestrial, and avian fauna and affords shore and archaeological resource protection from storms and sea-level rise. This reach of coast has fetches to the west-northwest of 3.5 miles, west of 2.4 miles, and to the southwest of 2.8 miles which is a medium energy exposure.

This Living Shoreline project consists of two sills (152 feet and 170 feet long) with one window (25 feet wide). The southern sill was attached to an existing higher, continuous sill. Sand fill was placed behind the structures and planted with marsh grasses on a two foot grid. The upper elevation of sand fill was set at +5.0 ft MLW to interface with the eroding bank, and extends on a 12:1 slope to about mean tide level at the back of the proposed stone sills. Once established the project will provide an erosion-control marsh fringe and protect the base of bank from erosion.

This living shoreline project was designed, permitted, and bid for construction by the Shoreline Studies Program at the Virginia Institute of Marine Science. It was funded by a grant through the National Fish and Wildlife Foundation (#45177) with additional funding by Virginia's Department of Conservation and Recreation's Water Quality Improvement Fund (WQIF-2016-03). Construction of the project began in March 2016 and was completed in May 2016 by Coastline Design and Construction, Inc. of Gloucester. Grasses were planted by volunteers in May/June 2016. Approximately 15,000 ft² of marsh was created. The construction of the Living Shoreline project resulted in the reduction of 3060 lbs/ft/year of sediment, 0.7 lbs/ft/year of total phosphorus, and 0.9 lbs/ft/year of total nitrogen entering the Bay through upland and marsh erosion. Logging mats and filter cloth were placed along the 1,100 foot access route to mitigate the effect of the weight of the trucks bringing supplies on potential archaeology at the site. Goose fencing was installed to protect the marsh grass plugs from geese.

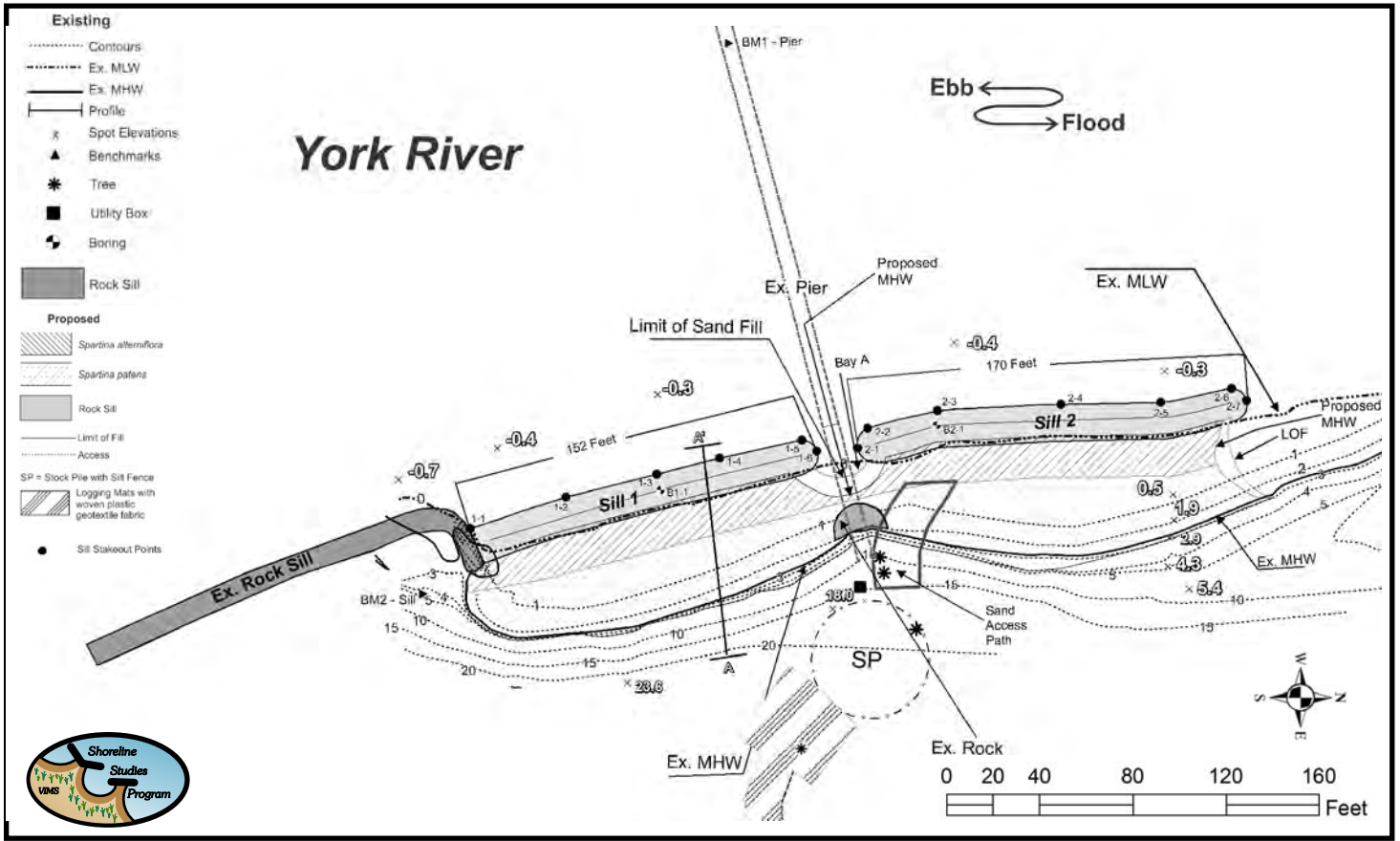
Pre-Construction Shoreline



Post-Construction Shoreline



Design Planview



Design Cross-Section

