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Two Years of Post-Project Monitoring of a Navigation Solution in a Dynamic Coastal Environment, Smith Island, Maryland

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June 2022



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Final report

Approved for public release; distribution is unlimited.

Prepared for US Army Corps of Engineers
Regional Sediment Management Program
Vicksburg MS 39180

US Army Corps of Engineers, Baltimore District
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Under Funding Account Code 1K8078/BF6512; AMSCO Code 008303

Abstract

In 2018, jetties and a sill were constructed by the US Army Corps of Engineers adjacent to the Sheep Pen Gut Federal Channel at Rhodes Point, Smith Island, Maryland. These navigation improvements were constructed under Section 107 of the Continuing Authorities Program. Material dredged for construction of the structures and realignment of the channel were used to restore degraded marsh. Following construction and dredging, 2 years of monitoring were performed to evaluate the performance of navigation improvements with respect to the prevention of shoaling within the channel, shoreline changes, and impacts to submerged aquatic vegetation (SAV). Technical Report ERDC/CHL TR-20-14 describes the first year of post-project monitoring and the methodologies employed. This report describes conclusions derived from 2 years of monitoring.

While the navigation improvements are largely preventing the channel from infilling, shoaling within is occurring at rates higher than expected. The placement site appears stable and accreting landward; however, there continues to be erosion along the shoreline and through the gaps in the breakwaters. SAV monitoring indicates that SAV is not present in the project footprint, even though turbidity is comparable to the reference area. Physical disturbance of the bottom sediment during construction may explain SAV absence.

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Preface

This study was conducted for the US Army Corps of Engineers (USACE), Regional Sediment Management (RSM) Program, and the USACE Baltimore District (NAB), under Funding Account Code 1K8078/BF6512, AMSCO Code 008303. The USACE National RSM program manager at the time of publication of this report was Dr. Katherine E. Brutsché.

The work was performed by the Planning, Engineering, and Operations Divisions of the USACE NAB and the US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL), and Environmental Laboratory (ERDC-EL), Wetlands and Coastal Ecology Branch. The Wetlands and Coastal Ecology branch chief was Ms. Patricia M. Tolley, and the Ecosystem Evaluation and Engineering division chief was Mr. Mark Farr. At the time of publication of this report, COL John T. Litz was the NAB Engineer; Dr. Brandon J. Lafferty was the deputy director of EL; and Dr. Edmund J. Russo, Jr., was the director.

The commander of ERDC was COL Teresa A. Schlosser, and the director was Dr. David W. Pittman.

1 Introduction

1.1 Background

Smith Island is a historically significant group of small islands in the Chesapeake Bay, primarily in Maryland. Located in Somerset County, Maryland, Smith Island is home to three small villages: Rhodes Point, Tylerton, and Ewell (Figure 1). Many of the residents of the island rely on the use of the Sheep Pen Gut federal channel for their livelihoods related to fishing or tourism, due to easy access to the Bay. Sheep Pen Gut is a natural waterway, modified by decades of dredging. Prior to construction of the navigation improvements at the channel near Rhodes Point, the channel in-filled at rates of up to 3 ft/yr¹ due to the energy of the open Bay and substantial littoral drift along the shoreline of the island. The authorized depth of Sheep Pen Gut is 6 ft. In addition to channel sedimentation, given exposure to the Bay, erosion of the shoreline was occurring at a high rate. US Fish and Wildlife Service (USFWS) reports that some Smith Island shorelines are eroding at rates of up to 14 ft/yr (USFWS 2016).

In 2017, Somerset County constructed segmented breakwaters along the Bay shoreline north and south of the channel to reduce shoreline erosion. In June 2018, the construction of navigation improvements was completed (Figure 2). These improvements included the construction of jetties north and south of the Sheep Pen Gut channel mouth and a segmented stone breakwater/sill constructed along the shoreline south of the jetties. Dredging of the Sheep Pen Gut channel occurred in November 2018. The sill was constructed to protect the shoreline and provide containment for sediment excavated during construction of the structures and dredged from the Sheep Pen Gut channel.

Approximately 34,000 CY of dredged and excavated material was placed to beneficially restore previously existing wetlands behind the newly constructed stone sill. Project structures were placed to avoid impacts to

¹ For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248-52, <https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf>.

existing submerged aquatic vegetation (SAV), as SAV is a vital living resource in the Chesapeake Bay. Marsh vegetation (*Spartina patens* and *Spartina alterniflora*) was planted at the placement site in June 2019, and the higher elevation hummock area was planted (grasses and woody vegetation) in September 2019. Following dredging of the channel in November 2018, post-project monitoring began to determine the degree to which the navigation project meets its objectives. The first year of monitoring is documented in technical report ERDC/CHL TR-20-14 (Seiple et al. 2020).

Figure 1. Location of the Rhodes Point Navigation Project (pre-construction channel is shown) and Sheep Pen Gut federal channel, which connects to the Rhodes Point to Tylerton federal channel.

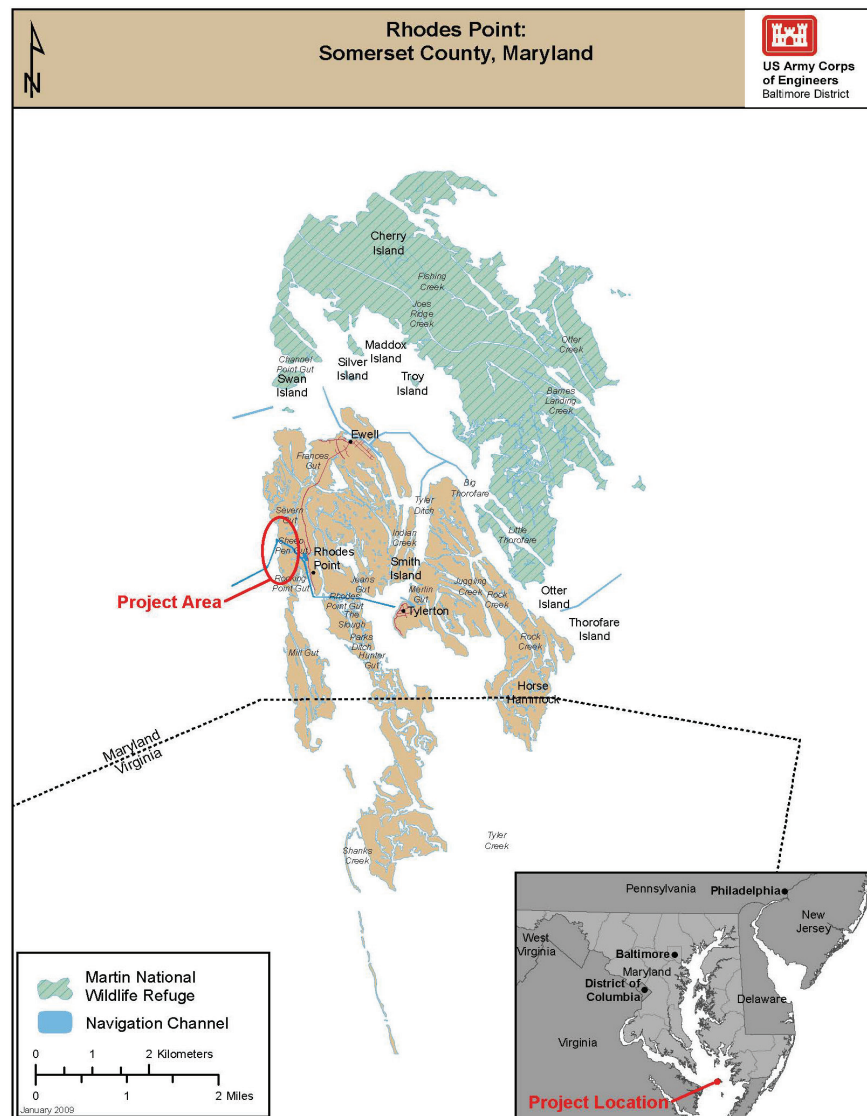


Figure 2. Aerial view of the completed jetties and sill at the Rhodes Point Navigation Project, prior to dredging and material placement in 2018 (photo credit: Coastal Design & Construction, Inc).



1.2 Objectives

Following construction of the navigation improvements and dredging of the Sheep Pen Gut channel in 2018, post-project monitoring was implemented with the primary purpose of evaluating the performance of the navigation improvements with respect to the prevention of shoaling within the channel, shoreline changes, and impacts to SAV. Shoreline response to coastal structures, including scour and deposition, was evaluated to improve design criteria and methodology for future placement of navigation structures in dynamic coastal environments. Findings from the monitoring will also inform future plan formulation by illuminating potential considerations for avoiding indirect impacts of projects on SAV. This report presents and discusses the results of 2 yr of post-construction monitoring.

1.3 Approach

Post-project monitoring began under the Regional Sediment Management Program in Fiscal Year (FY) 2019. In FY19, monitoring included collection of bathymetric and topographic surveys of the channel, project footprint, and placement site; collection of sediment samples for grain size analysis;

structural surveys to evaluate the stability of navigation structures; and SAV monitoring in a reference area and the project vicinity. The methodology and results for the first year's monitoring is detailed in ERDC/CHL TR-20-14 (Seiple et al. 2020). Similar monitoring was conducted in FY20 as described in Section 2.

2 Data Collection and Monitoring

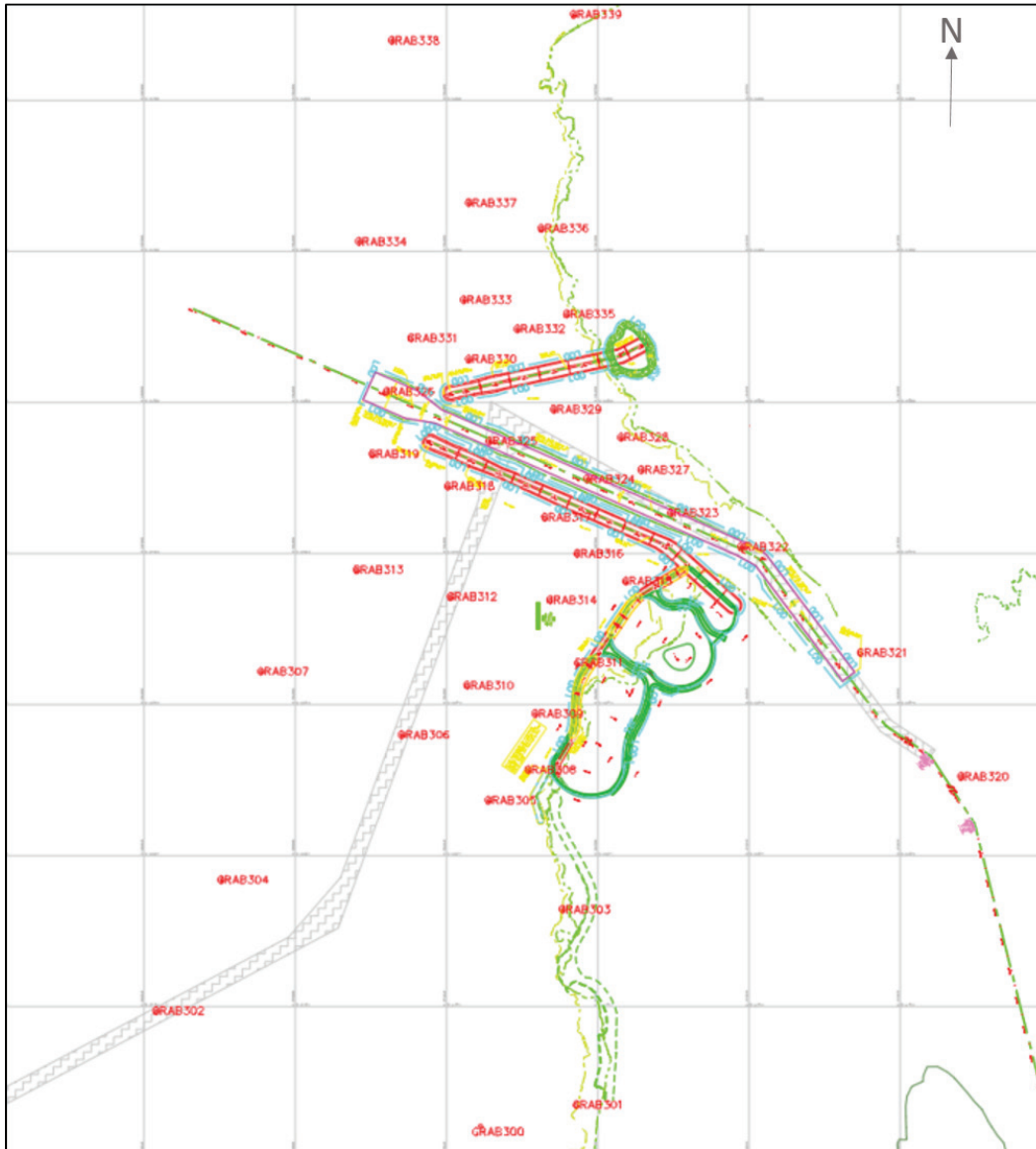
2.1 Bathymetric and topographic data

Although two bathymetric survey events were planned for FY20, the March 2020 survey was canceled due to travel restrictions imposed by COVID-19. In July 2020, a bathymetric survey of the channel and project footprint outside the channel was completed by a survey vessel (see Section 3.1). In addition, nearshore bathymetry was collected by wading. Topographic data were collected for the sediment placement site, and the location of the shoreline was surveyed. Similar to 2019 from these data, maps were generated in geographic information systems to evaluate changes over time.

2.2 Sediment sampling

Sediment samples were collected prior to project construction in 2008 and 2015 for the design of the Rhodes Point Section 107 Navigation Project. Sediment samples for grain size analysis were also collected in FY19. Technical report ERDC/CHL TR-20-14 (Seiple et al. 2020) describes samples collected in previous years. In July 2020, 40 sediment grab samples were collected at locations similar to those collected in the previous year. Forty samples were visually evaluated, and 20 samples were analyzed using mechanical sieve tests by a certified civil engineering technician. Material was classified according to the American Society of Testing and Materials D2487. Figure 3 shows the July 2020 sample locations with respect to project features, shoreline, and the previous navigation channel. Section 3.3 describes the sediment data.

Figure 3. July 2020 grab sample locations.



2.3 Structural surveys

In June 2019, points for cross-sectional transects were established at stations every 200 ft along the centerline of the north and south jetty and along a portion of the sill. Points were not established on sill segments that were unreachable due to the tide and submersion. Cross-section transects were established near the waterline, at approximately mid slope, at the top of slope, on the left and right sides, and on the jetty centerline (Figure 4).

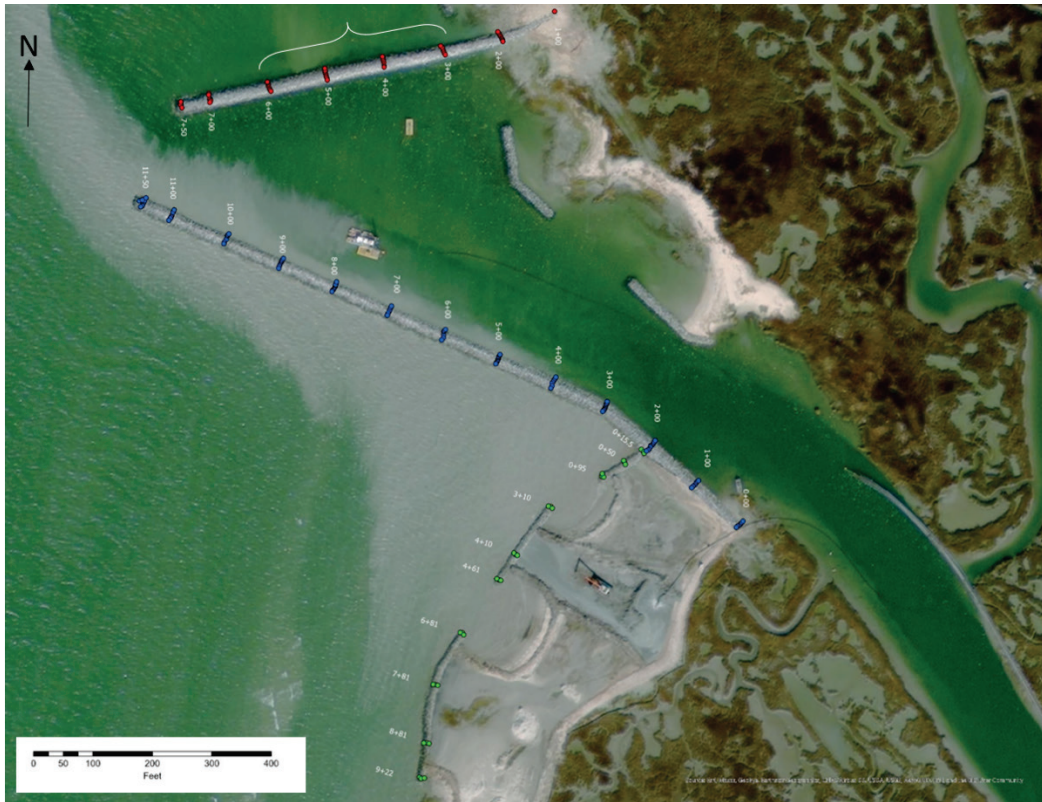
In FY 2020, the transect resolution was increased over that of FY 2019 when transects were surveyed every 60 m. In September 2020, to establish

additional points for future years and to determine if movement had occurred at points surveyed in 2019, transect points were established at 100 ft stations for the north and south jetties and along a greater portion of the sill. Points were not collected on a small portion of the sill because some of those points were submerged. After collecting elevations on the first segment of the sill (up to Station 0+95) that was not submerged, the team estimated the length of the submerged portions and projected stations on the remaining segments. Markings for approximately 60% of the previously established points had been erased and were relocated as accurately as possible, relabeled (with spray paint since they were too hard to chisel), and resurveyed. Figure 5 shows the locations of points surveyed.

Figure 4. Crew setting up transects for analysis of structural stability.



Figure 5. Locations of points and transects surveyed and projected for the structural stability analysis. White bracket at north jetty illustrates area of displacement discussed in Section 3.4.



2.4 Submerged aquatic vegetation (SAV) monitoring

As performed in FY19, SAV sampling for *Ruppia maritima* and *Zostera marina* beds was conducted during the SAV growing season. The objectives of the 2020 field monitoring effort were to conduct SAV surveys to determine bed location and collect turbidity data in the project area and reference location during a portion of the SAV growing season. Two SAV surveys were conducted in 2020. One survey was conducted on June 21 and another on August 21.

The June survey started with rapid SAV assessments in which transects were sampled using a quick visual scan. The start and end points of the transects from the June 2019 survey (Seiple et al. 2020), along with two additional reference transects, were marked with floats. Each transect was walked, and it was noted if SAV was found. If no SAV was found, the transect was considered completed. The subset of transects with observed SAV were sampled in more detail following typical SAV survey methodology. SAV abundance was measured using a 0.5 m quadrat divided

into 25, 10 × 10 cm squares. A grid cell was considered covered when at least one SAV shoot was located within the grid cell. Species-specific (abundance of each SAV species in a quadrat) as well as total SAV coverage was determined by the number of cells each species occupied within the quadrat. Quadrat samples were taken at odd intervals of quadrat flips from the starting point. A Global Positioning System unit recorded coordinates for each quadrat sample. Additional transects were conducted to find a location for deployment of the water quality sonde in the reference area.

In August, the rapid SAV assessment was conducted again. Detailed quadrat sampling to determine SAV coverage was not conducted as none were encountered outside of the reference areas, and a rapid assessment was adequate to verify that SAV was still growing in close proximity to the reference water quality sonde. Sampling in both June and August captures peak growth of *Ruppia*, the dominant species in the area. June sampling captures the peak growth of *Zostera*. During mid-late summer, *Zostera* begins to slow its rate of growth and has been observed to experience summer dieback in some years. A total of 13 transects (numbered 1–10 in the project footprint; 11–13 in the reference area) was surveyed in June and August (Figure 6).

A major factor for SAV growth is light penetration to a depth that enables plants to photosynthesize. Generally, water that has greater turbidity (reduced water clarity) tends to have less light penetration and therefore less SAV growth. To determine whether turbidity differed in the project and reference sites, water quality sondes were deployed on June 21, 2020, in the project area and in the reference area. Location of the sondes is shown in Figure 6. Both sondes utilized the YSI EXO model platform equipped with a center wiper and turbidity probe. Sondes were attached to rebar embedded in 30–40 kg concrete blocks (Figure 7). Sonde placement in the project area was based on 2015–2017 SAV presence from aerial SAV surveys conducted by the Virginia Institute of Marine Science (VIMS). The water quality sonde in the reference area was placed within 10 m of several SAV beds found during the survey on June 21. Turbidity measurements were recorded every 15 min. The single 15 min sample was generated using an average of 40 samples taken in 1 sec intervals just prior to the 15 min timestamp. The 15 min sample points were then averaged for each day.

Figure 6. Map showing locations of project area (1-10) and reference area (11-13) SAV transects. No SAV was found along transects 1-10 during 2020 surveys. The two black flags are locations of the water quality sondes. (Note: The aerial image predates planting of placement site, so turbidity is not representative of 2020 survey conditions)

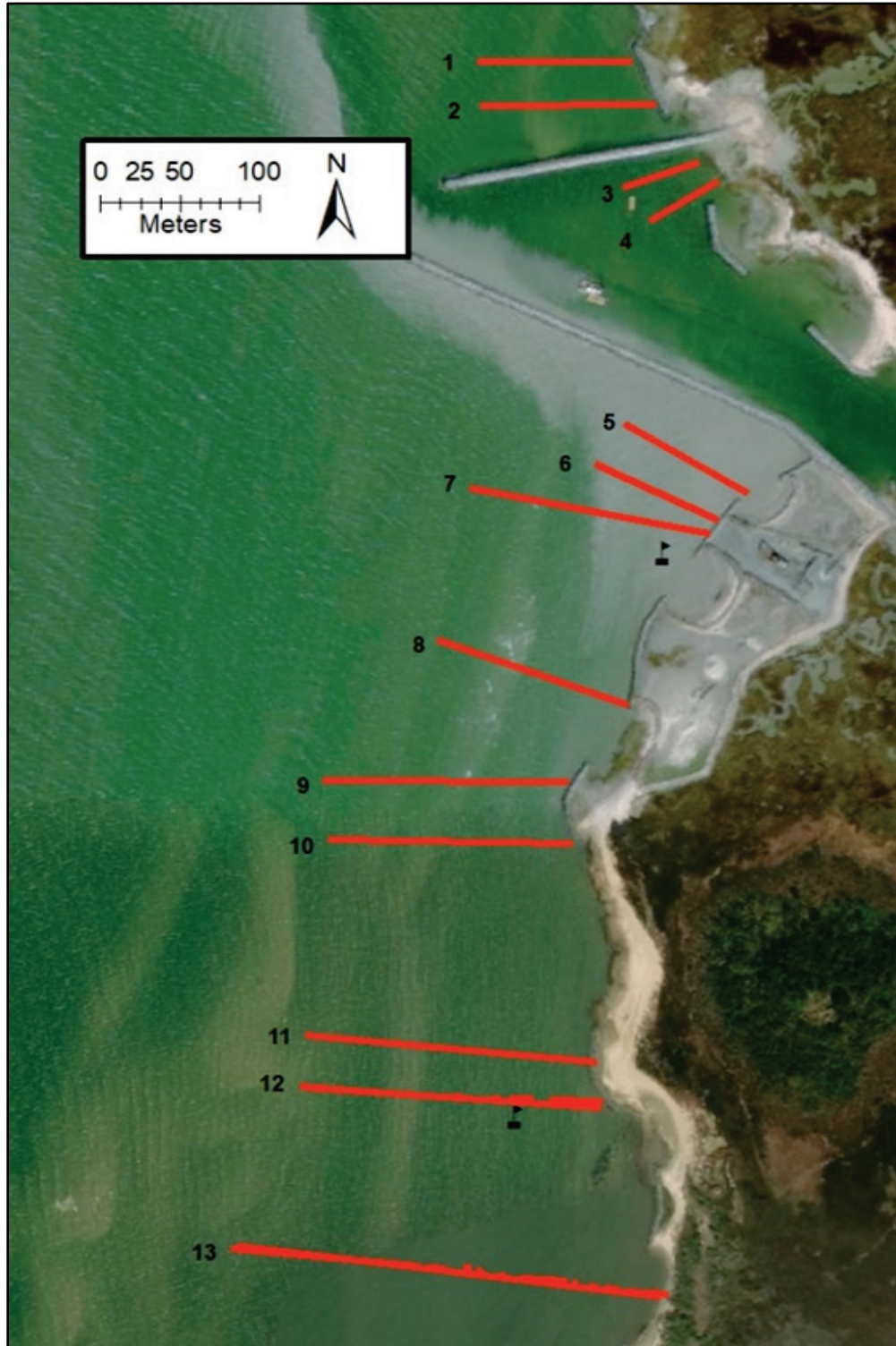


Figure 7. The two water quality sondes attached to concrete stands.



3 Observations

To evaluate change in conditions of the study area, the data must be put into the context of pre- and post-construction of the navigation improvements. The following timeline is provided:

- Records indicate maintenance dredging of the Rhodes Point to Tylerton portion of the channel occurred most recently in 2002 and 2009. Because dredging is so infrequent, it could not be conclusively determined when dredging last occurred at the mouth of Sheep Pen Gut.
- Shore-parallel breakwaters were constructed north and south of Sheep Pen Gut by Somerset County in 2017.
- Construction of the jetties and sill and placement of excavated material behind the sill occurred from January to June 2018.
- Dredging of the Sheep Pen Gut Navigation Channel (to 6 ft depth) and placement of material behind the sill occurred in November 2018.
- Placement site was unplanted from November 2018 to June 2019.
- Planting of the placement site low and high marsh elevations occurred in June 2019.
- Planting of the placement site hammock (higher) elevations occurred in September 2019.

3.1 Channel stability

The primary purpose for the Rhodes Point Navigation Project was to prevent shoaling within the Sheep Pen Gut channel. To assess post-construction sedimentation in the channel and outside the channel within the project footprint, the following comparisons were completed using bathymetric survey data. Post-dredge bathymetric surveys were conducted for this project in February 2019, July 2019, and July 2020. The hydrographic survey data are accurate to ± 0.2 ft.

Figures 8 and 9 show comparisons of the channel for the time period from February 2019 to July 2020. Sedimentation (shoaling causing decreased depth) is evident between the two jetties, although some of the channel appears to have increased in depth. Conversely, up to 6 ft of new scour is evident at the very end (west side) of the jetties whereas sedimentation is occurring in the Bay outside of the structures. For the depth categories shown in Figure 8, as a percentage of total channel area, approximately 54% of the channel has accreted (decreased in depth) over the time period

from February 2019 to July 2020 whereas 46% of the channel area has scoured (increased in depth). Most of the increased sedimentation (41% of the channel area) is on the order of 0 ft to 1 ft of depth change (shallowing). An artifact of data collection and/or processing related to the February 2019 survey is evident in Figures 8 and 9, shown by the sharp demarcation between the northern quarter of the Bay in the image and the area south. This is not believed to have a major impact on the analyses described in this report.

Table 1 shows an evaluation of sediment volume within the channel (above 6 ft mean lower low water [MLLW] in depth) from channel cross sections. The spatial domain of the area considered for this volume estimate is shown by the red polygon in Figure 10. Sedimentation occurred in the channel in the years leading up to construction of the project (1998–2017). Dredging was performed in November 2018, as indicated by the immediately-before-dredging (IBD) and after-dredge (AD) surveys. There was very little change between the AD survey in February 2019 and a survey performed in July 2019. Between July 2019 and July 2020, the volume in the channel above a depth of 6 ft MLLW increased by 1,216 CY.

Figure 8. Comparison of bathymetric surveys for February 2019 and July 2020 showing elevation difference between surveys (negative denotes increased depth or erosion/scour).



Figure 9. Comparison of bathymetric surveys for February 2019 and July 2020 showing areas above (shallower) and below (deeper) than previously surveyed elevation.

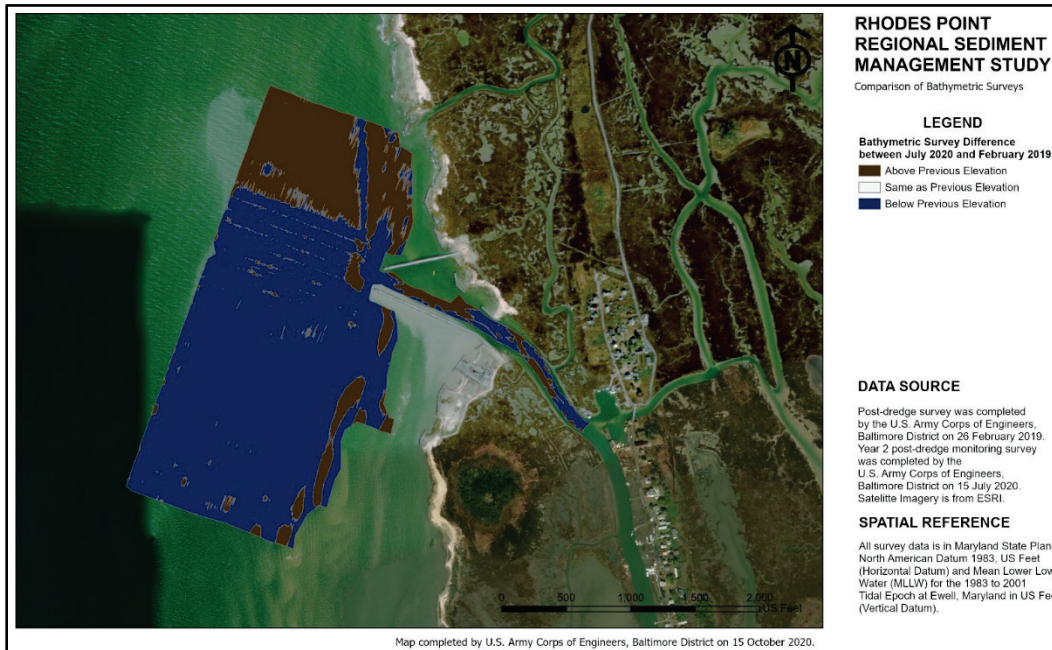


Table 1. Sediment volume in the Sheep Pen Gut channel above depth of 6 ft.

Agency (Survey Type)	Month	Year	Volume (CY)
USACE	JULY	1998	5236.70
USACE	MARCH	2008	7829.20
USCAE	JUNE	2015	7564.50
USACE (IBD)	NOVEMBER	2017	8793.50
MD DNR	JUNE	2018	4016.40
WATERWAYS (IBD)	SEPTEMBER	2018	5780.80
WATERWAYS (AD)	NOVEMBER	2018	1926.00
USACE (AD)	FEBRUARY	2019	573.00
USACE	JULY	2019	579.90
USACE	JULY	2020	1796.20

IBD - Immediately before dredging; AD - After dredge

Figure 10. Bathymetric survey from July 2020, with federal channel and areas of deposition and scour described in the text.

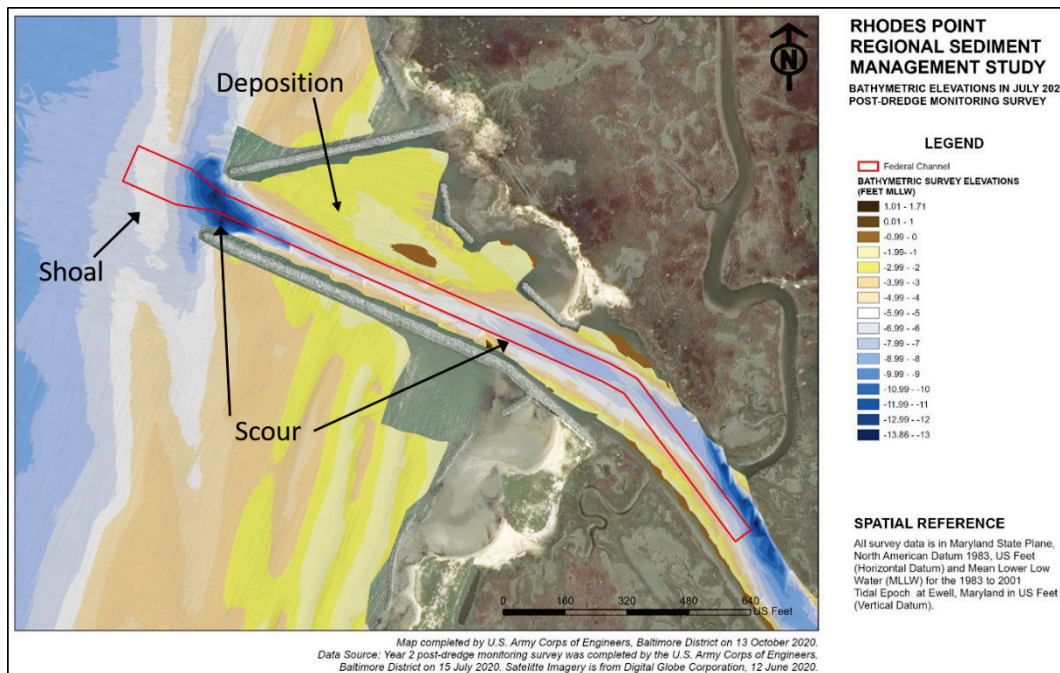
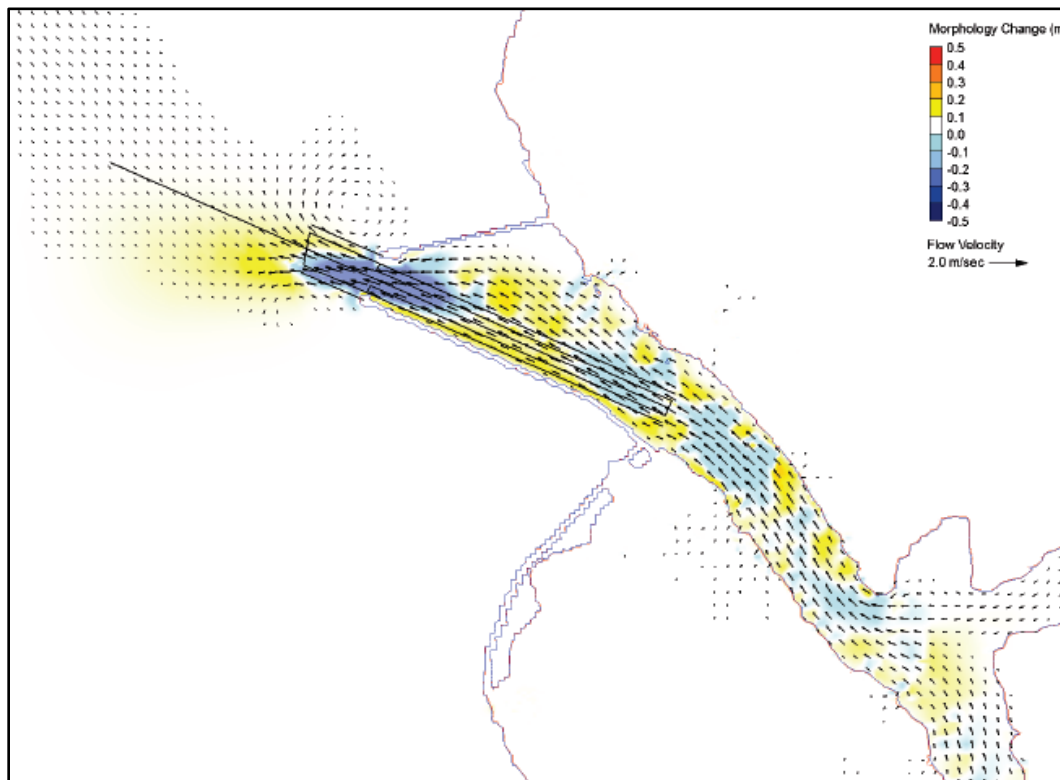


Figure 10 shows the most recent survey and the outline of the federal channel. Dredging occurred within the outline of the federal channel in November 2018. Despite the increased volume indicated by the volume calculations and shown by Figure 8, calculations from the bathymetric map from the July 2020 survey show that most (58%) of the channel area is still deeper than the authorized depth of 6 ft. Figures 8 through 10 show the deeper areas to be located at the narrowest points of the channel, including the entrance to the jetties and where the channel is constrained by the easternmost breakwater within the channel. Sedimentation is occurring where there is the greatest distance between the angled jetties, presumably where currents are reduced. It is also evident that although dredged in 2018, the first shoal outside of the channel is reforming, potentially impeding scour and sediment transport outside of the jetties.

Modeling completed (Demirbilek et al. 2016) to support the Rhodes Point Navigation Improvement Project predicted short-term changes in in-channel morphology with the construction of the jetties. Figure 11 shows flow for the ebb current and morphology change for 1 month of erosion and deposition for the constructed jetty configuration. When compared to bathymetry changes in Figures 8 and 9, the same pattern of sedimentation is evident, with scour at the entrance to the jetties, sedimentation within the widest section of the channel, and scour at the interior (eastern)

portion of the channel. The magnitude of the change shown by the model is less than shown in Figure 8, but the modeling report states, “The short-term estimates of morphology change based on a 1-month-long simulation with waves, currents, and sediment transport cannot be extrapolated to predict long-term channel shoaling rates,” but rather helps to determine sedimentation patterns in the channel.

Figure 11. Morphology change shown by the 2016 model (ebb current, 1 month of erosion and deposition (Demirbilek et al. 2016).



3.2 Shoreline, topographic change, and vegetation

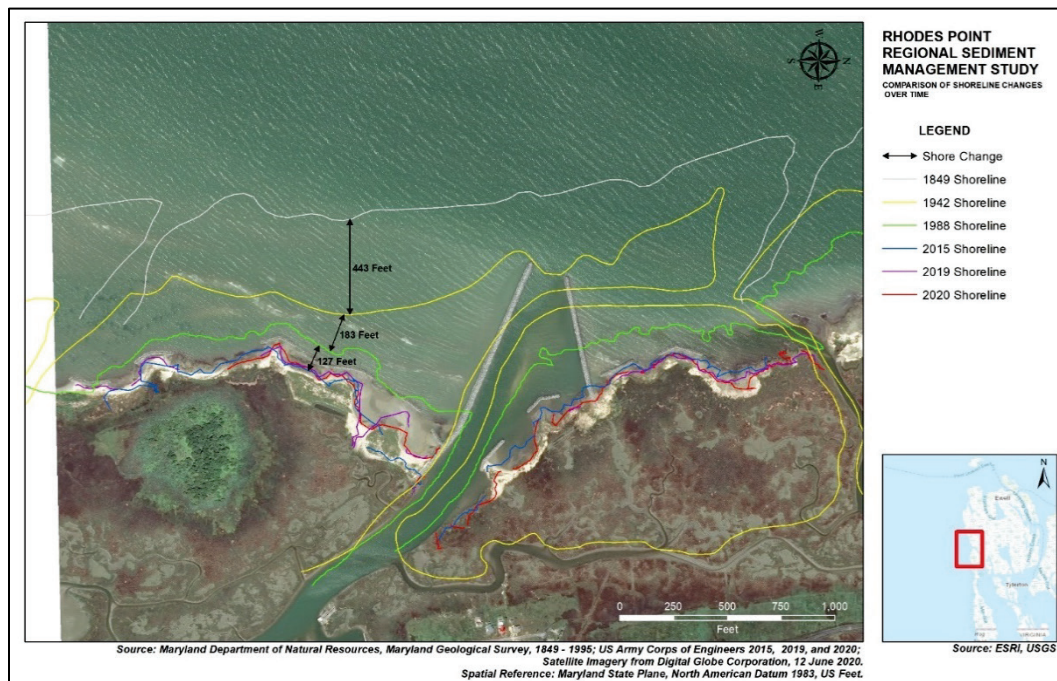
Existing and historical shoreline data were used to map shoreline change over time. Technical report ERDC/CHL TR-20-14 (Seiple et al. 2020) presents the methods used for processing these data, with shoreline or waterline extracted from topographic surveys. Note that tidal variation in this area may have an influence on the waterline at the time of survey, so observed variations likely reflect changes in geomorphology plus differing water levels.

Figure 12 shows the significant shoreline change in the study area from 1849 to the present. Over time, the length of the Sheep Pen Gut channel shortened due to shoreline erosion, and its location shifted to the

southeast. The shoreline has eroded hundreds of feet since 1849, with an estimated erosion rate from this figure of approximately 3.9 to 4.9 ft/yr.

Following dredging in November 2018, dredged material was placed behind the sill (south of the south jetty) and contoured for marsh restoration. However, the placement site was not planted until June 2019 and September 2019. Consequently, the site was bare for several months over the winter of early 2019. With the construction of the sill and breakwaters, the shoreline should erode at a much slower rate, which remains to be seen over time.

Figure 12. Shoreline changes from 1849 to 2020.



The placed dredged material included elevation zones designed and graded to support planted vegetation assemblages, including low marsh, high marsh, and hummock. Post-construction site visits noted that elevation zones were higher than nearby natural elevations for those plant assemblages and especially for the high marsh, which could lead to the establishment of invasive *Phragmites*. Site visits in October 2019 and June 2020 (Figures 13, 14, and 15) found that plants in place were generally healthy and establishing well. There was some loss of plants along the waterline in the intertidal zone, and an erosive scarp formed along a section of the placement area, behind the breakwaters.

The current site topography is shown in Figure 16 and still largely reflects the as-built elevation ranges for the fill that was placed behind the sill south of the south jetty and on landward side of the north jetty. Post-placement changes in site elevation between July 2019 and July 2020 are shown in Figure 17. The placement area, especially landward, appears to be gaining elevation, mostly in the 0 to 1 ft range, but up to 3 ft in some locations. Overwash deposits were observed during site visits and presumably provided material to increase elevation in lower areas. It is possible that wind action could have acted to deposit sand at higher elevations, analogous to natural sand dunes. However, the gaps in the breakwater continue to allow for erosion of the south placement site through the gaps and behind the breakwaters (Figure 18). The scarped area also continues to erode and is labeled in Figure 18.

Figure 13. Looking south from the south jetty just after the site was completely planted, October 2019.



Figure 14. Left: At south jetty looking south across placement site toward sill (June 2020). Right: South placement site looking north toward jetties (June 2020).



Figure 15. Left: Plantings along the shoreline behind the sill (June 2020). Right, top: Plantings at the north placement site. Right, bottom: Formation of scarp behind gap in segmented sill.



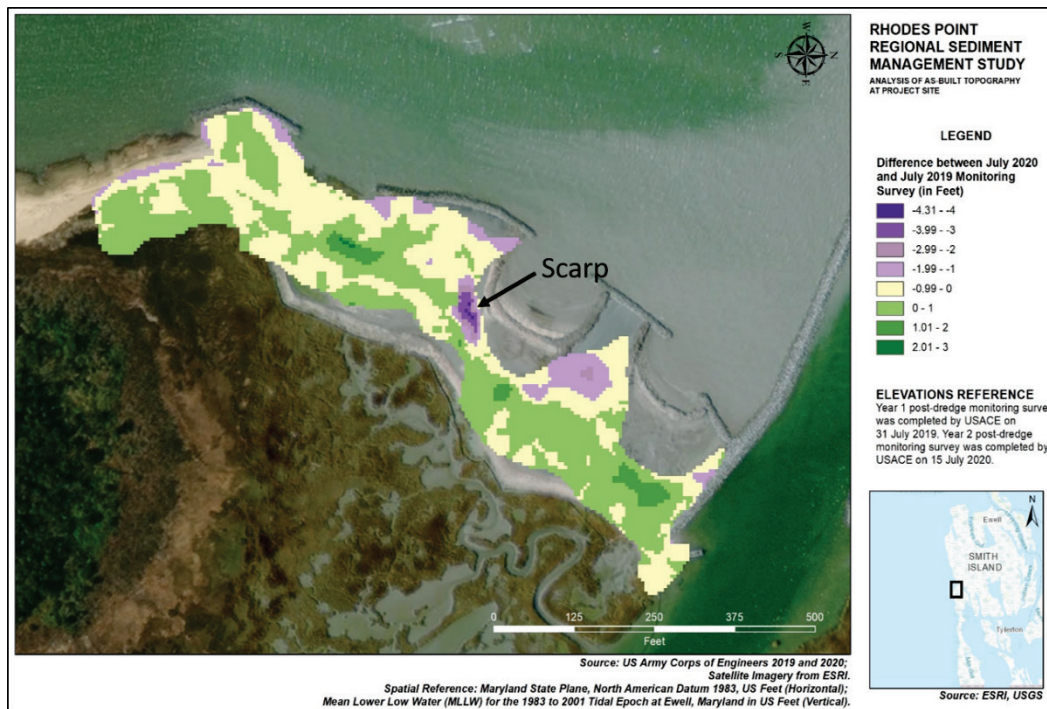
Figure 16. Topographic survey elevations from July 2020. Note the sediment plume coming off the placement site as the base image was taken prior to planting of the placement site in June 2019.



Figure 17. Differences in topographic survey between July 2019 and July 2020. Note the sediment plume coming off the placement site as the base image was taken prior to planting of the placement site in June 2019.



Figure 18. Elevation change at south placement site between July 2019 and July 2020 (arrow denotes location of the scarp).



3.3 Sediment transport

Sediment grab samples were collected at the same locations in FY 2019 and 2020 to monitor changes in grain size at these locations. These 25 locations represent a range of conditions, including the in-navigation channel and open bay. Figure 3 shows all sample locations, including for the 25 sample locations that were the same in FY 2019 and FY 2020. Graphs were generated to assist in the comparison of these samples and also with comparison to samples collected pre-project construction (Figures 19 and 20). The following observations were gained from the evaluation of the characteristics of the surface sediment samples pre- and post-construction:

- Relatively high percentages of fine material composed the pre-construction samples that were taken in 2015. The percentages of fine material (Unified Soil Classification System, grain size less than 0.075 mm) decreased significantly in the FY 2019 samples (first set of post-construction samples) as shown from example graphs in Figure 19. This is likely a result from the dredging that occurred in 2018. Fine sediments are more likely to be agitated and removed/disturbed during dredging versus sediments that are more compact or larger grained.

- From February 2019 to July 2020, fine contents remained stable, or where there is a trend have generally increased (Figure 20). Increased deposition of fine material generally represents locations of reduced wave energy.
- For samples x20 (e.g., 120, 220, 320) and x21, shown as Area X (Figure 21) inside the southeast extent of the channel, grain size shifted from silt (grain size less than 0.075 mm) to coarse sand (grain size less than 4.75 mm; 2% fine content) immediately following dredging and has since become siltier (53% and 70% fine content, respectively), possibly representing re-sedimentation within the channel and/or reduced wave energy.

Figure 19. Graphs showing grain size changes over time for grab samples taken in 2015 (Grab 15, 10, and 11) and samples taken in May 2019 (Samples 104, 120, and 123), July 2019 (Samples 120, 220, and 320), and July 2020 (Samples 123, 223, and 323) at the same location.

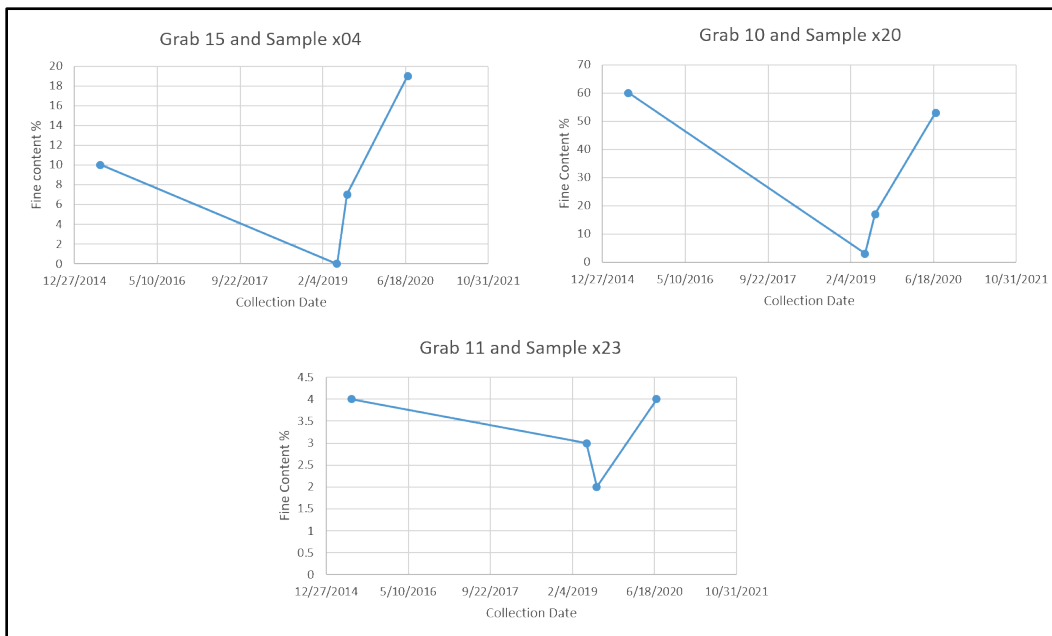


Figure 20. Comparison of grain size (fine content) for samples collected in May 2019, July 2019, July 2020 (Note: where bar cannot be seen, fine content percentage is zero).

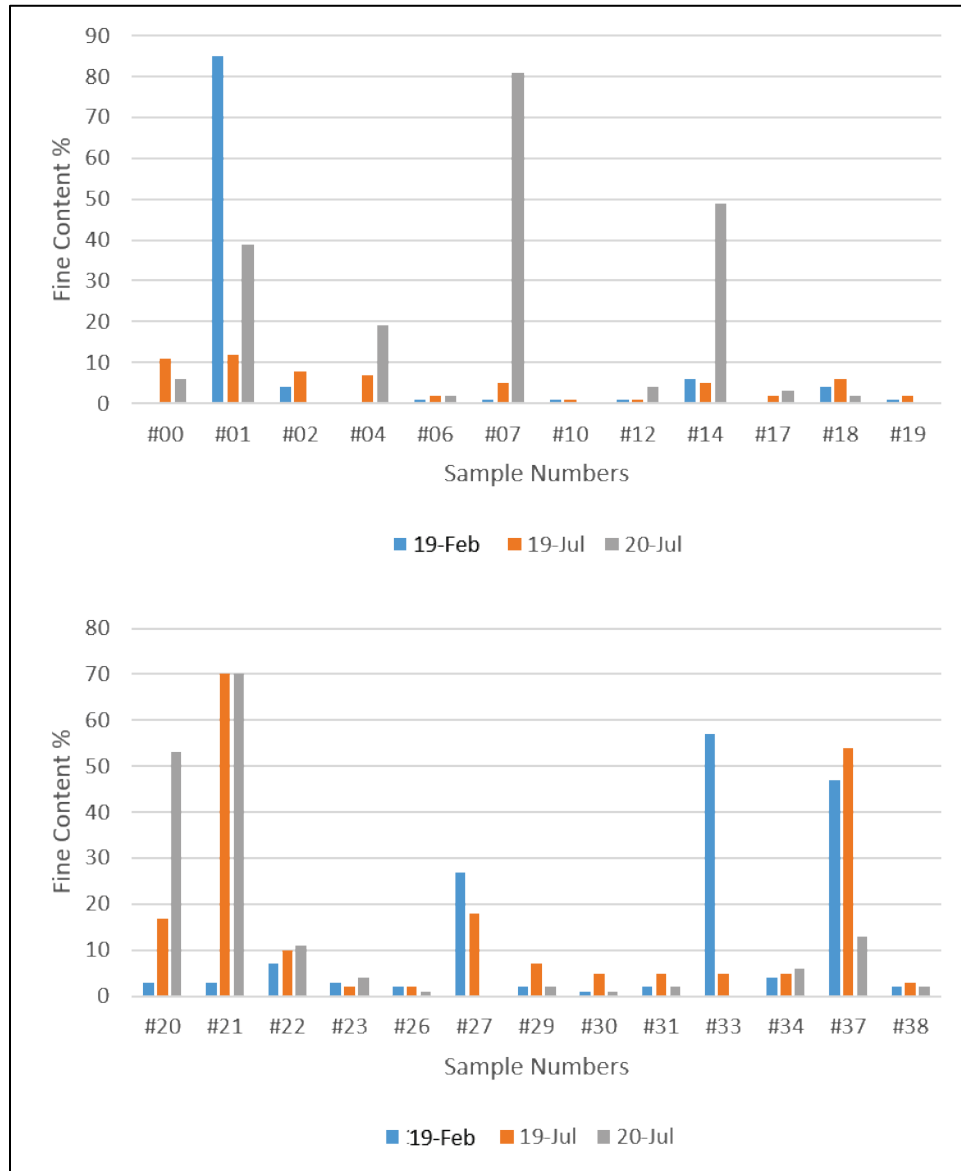
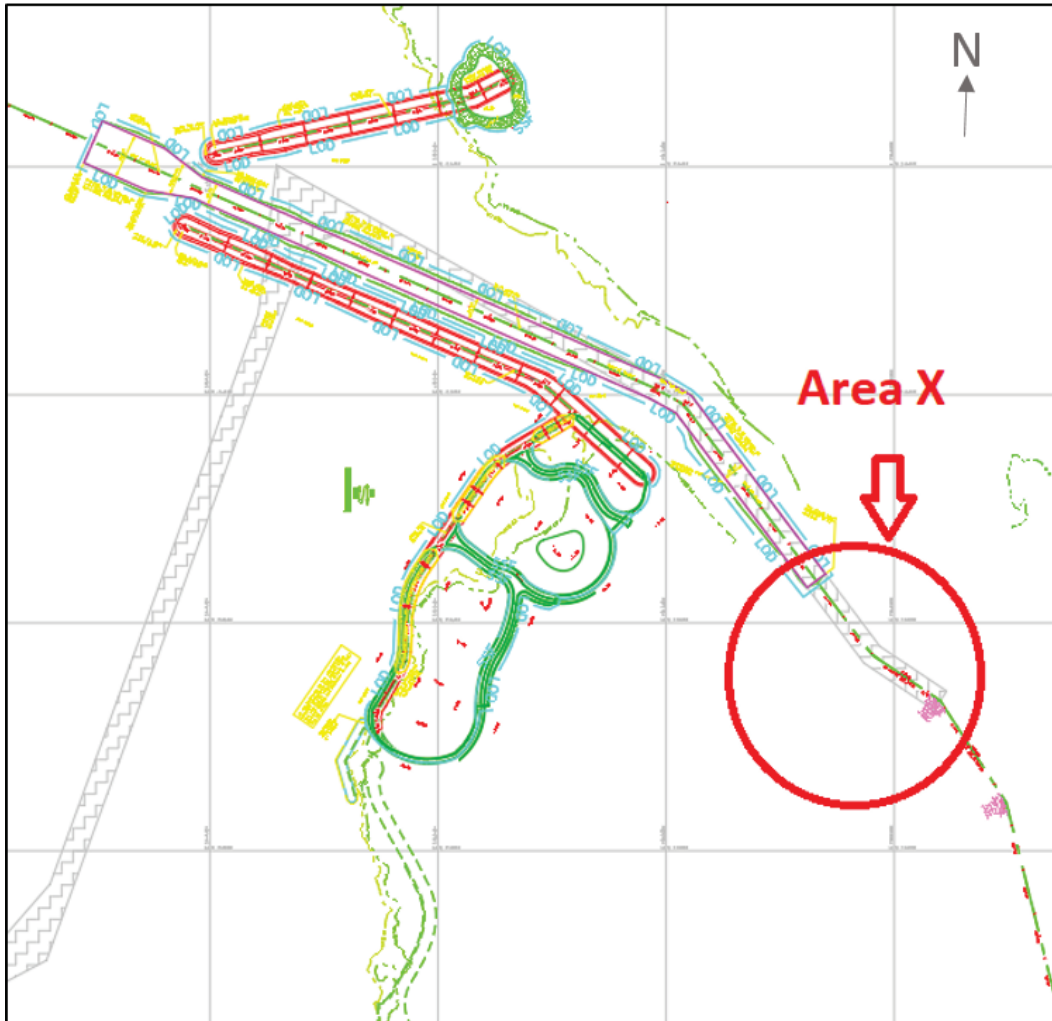


Figure 21. Location of Area X described in the text.



3.4 Structural stability

The team observed that the segment of the jetties that was closer to the landmass was more stable than segments farther into the Bay. Segments farther into the Bay were susceptible to rock displacement (change in position in any direction) and minor settlement. Visually observable displacement had occurred at the north jetty, including rocks that had been displaced such that the originally marked rock was underneath other rocks. Table 2 and Figure 3 show locations on the north jetty have been substantially displaced.

Table 2. Approximate displacement on the north jetty.

North Jetty Station	Displacement (cm)	Notes
3+00	30 cm northwest of original point	Video clip No. DSCN9476.MP4, available upon request.
4+00	48 cm west of original point	Rock marked in 2019 were displaced underneath other rocks.
5+00	20 cm west of original point	
6+00	5 cm north of original point	Rock marked in 2019 was displaced underneath other rocks.

The team did not visually observe displacement on the south jetty. However, especially at the south jetty, survey marks with rock displacement had a negative change in elevation (i.e., no settlement, but an increase in height related to the displacement). The negative height change was most pronounced in the south jetty and at the tip of both jetties in the Bay. Across the site, where settlement occurred, the magnitude of the change generally ranged from approximately 0 ft to 0.3 ft; however, settlement of 0.9 ft and 0.6 ft occurred at the landward end of the south jetty at stations 0+00 and 2+00, respectively. Surveys are accurate to 0.09 ft. In analyses performed prior to construction, settlement up to 0.5 ft was predicted.

3.5 SAV

A total of 13 transects (numbered 1–10 in the project footprint; 11–13 in the reference area) was surveyed in June and August 2020. Figure 22 shows SAV monitoring transects and results. No SAV was found in the project area during the June and August 2020 surveys while both *Ruppia maritima* and *Zostera marina* were found during both surveys in the reference area. For comparison with 2020 monitoring data, Figure 23 shows SAV presence as determined by VIMS (VIMS 2020) for 2015 to 2018, prior to project construction. Both SAV species were documented along the southernmost transects within the project area (transect 9 and 10) during the June 2019 survey but were absent in 2020. Because transects 9 and 10 had SAV during the first growing season following the channel realignment, it is assumed there was not physical disturbance along those transects, and current SAV absence is not due to the realignment project. Absence of SAV in transects 9 and 10 may be representative of ongoing local changes in SAV distribution. The VIMS aerial surveys (VIMS 2020) report SAV coverage receding in a southerly

direction from the channel since 2016/2017, prior to the channel realignment (Figure 23).

Both water quality sondes remained in place from placement on June 21 and recorded turbidity measurements during the entire deployment. Although biofouling was observed on both water quality sondes, the wiper on the reference sonde appeared to keep the turbidity probe clean (Figure 24). Upon retrieval, the water quality sonde in the project area was primarily buried by sediment. Based on the data downloaded from the sondes, it appears the sonde in the project footprint was buried approximately August 3, corresponding to the presence of Hurricane Isaias (Figure 25). It is assumed that the wiper on the project area water quality sonde kept the turbidity probe clean prior to this burial event. Water quality data in the project area following the burial event are highly questionable, so only data prior to the hurricane (August 3) are discussed.

Turbidity values in the reference and project areas were very similar, with mean values of 21 nephelometric turbidity units (NTU) in both sites ($\pm .203$ and $.248$ Standard Deviation, respectively). There was also very little difference in the range of turbidity values observed in the reference site compared to the project area (4-54 NTU, 3-77 NTU, respectively). A two-tail independent t-test assuming unequal variance showed that turbidity within the project area was not significantly different from the reference turbidity values (p-value 0.95). The turbidity values within the project area follow a similar pattern to the reference values with most days being within 5 NTU of each other (Figure 25). During the 42-day sampling period, the reference site had lower values for 21 days, and the project site had lower values the other 21 days. The values during relatively high turbidity events were greater in the reference area compared to the project area (Figure 25).

It was also observed that the benthic substrate along transects 1–4 (around the north jetty) was very jagged with mounds and crevices of hard clay material. This was very different from the benthic profiles in the reference transects 11–13. The benthic substrate along transects 5–10 was flat and sandy and was very similar to reference transects 11–13, which had SAV.

Figure 22. Left: Results from rapid SAV survey in August 2020, with green areas where SAV was found. Right: SAV locations and coverage density measured along the reference transects (11–13) in June 2020 SAV survey. The black flag is the reference water quality sonde location.

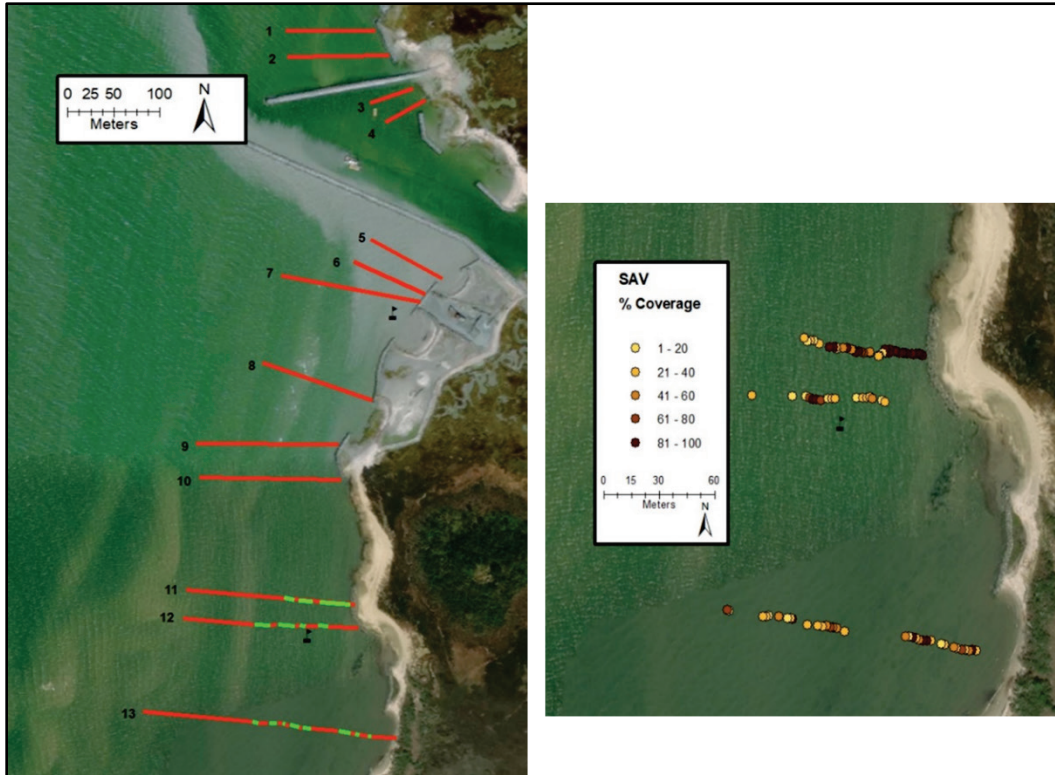


Figure 23. 2015–2018 occurrence of SAV as documented by VIMS (VIMS 2020).

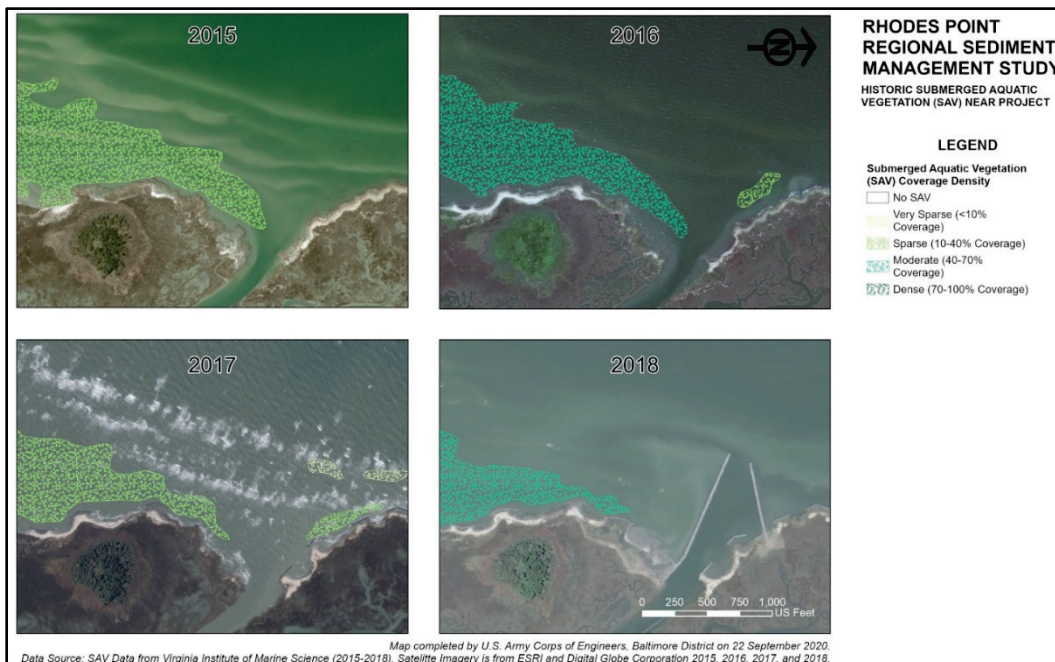
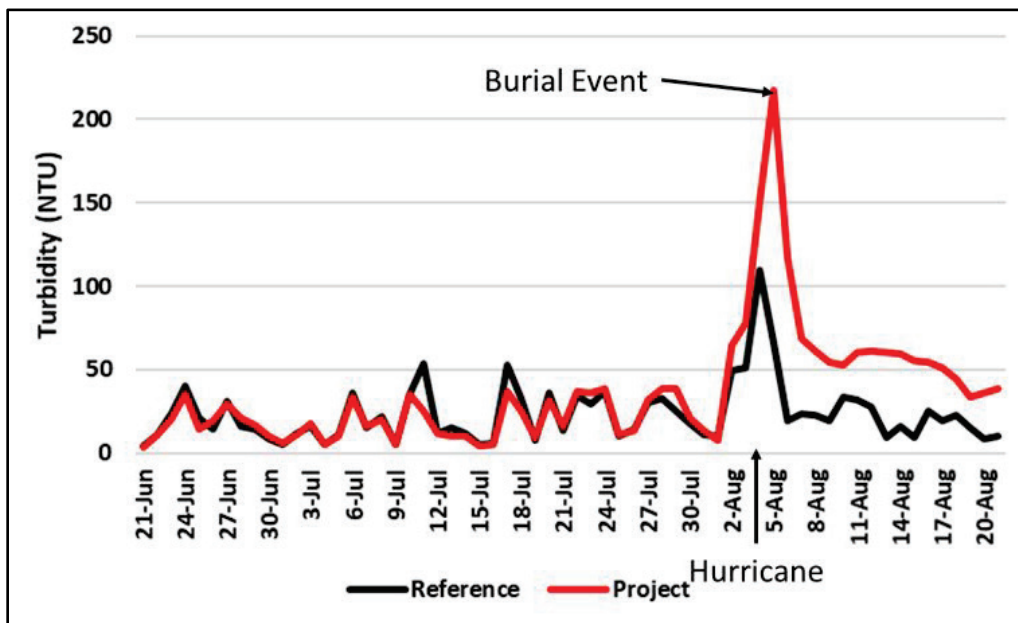


Figure 24. Biofoul on the reference area water quality sonde; however, the wiper kept the turbidity probe (left) clean during the deployment.



Figure 25. Plot showing turbidity measured during sonde deployment. The increase and subsequent high turbidity readings recorded by the project area sonde likely correspond to the sonde being buried by sediment. Measurements after August 3, 2020, were not used for data analyses.



4 Conclusions and Recommendations

4.1 Conclusions

Bathymetric surveys and volume calculations indicate the channel is shoaling more quickly than expected. It was anticipated that post-project dredging would need to occur on 8 yr cycles. For the most recent two times that the channel was dredged prior to project construction, dredging occurred when approximately 8,700 CY and 5,800 CY, respectively, of material was present above the authorized depth. Given the rate of shoaling indicated by this monitoring, 3,823 CY of material will be present approximately 3–4 yr from now, indicating that dredging will be needed around year 5 versus year 8 as predicted. Shoaling rate was based on historical rates at the time that the authorizing report was written in 2003. Modeling in 2016 did evaluate sedimentation but only on a short timescale. It was evident when construction began in early 2018, that sedimentation was significant even since the time that surveys were completed during the generation of design plans in 2016/2017, thereby indicating that conditions contributing to sedimentation are highly dynamic and variable over time. In the future, it is recommended that design surveys be performed as close to construction as possible to avoid contract modifications and that every attempt is made to accurately predict longer-term sediment transport.

The scour at the Bay-side entrance to the jetties is a common feature at the end of matched jetties resulting from ebb tidal currents through the structures. It is possible that some of the material scoured from the end of the jetties by ebb tidal currents is being moved back into the channel on the flood tide. The coast off of Smith Island is highly dynamic (rapid erosion) and is subject to extreme weather events. Since dredging the channel in November 2018, the area has been affected by the remnants of nine hurricanes or tropical storms, which could contribute to more rapid infilling of the channel. Other factors at play related to changes in sediment dynamics could include onshore/offshore bar movement, reduced sediment supply and erosion from shoreline stabilization, continued export of placed material in scarp area, and infilling of the former navigation channel alignment.

The interior of the placement site appears to be stable and accreting; however, there continues to be erosion along the shoreline, particularly

through and behind the gaps in the breakwaters. In retrospect, instead of constructing a segmented breakwater/sill, a staggered breakwater might have been able to reduce the wave energy and better contain the placed material. Alternatively, some of the material could have been placed farther landward on drowning Smith Island tidal wetlands, and this could remain a future option for channel material.

SAV monitoring results in June 2019 and June/August 2020 determined that SAV beds were not present adjacent to the jetties or placement areas where SAV occurred several years ago. Generally, in the Chesapeake Bay, the main reason SAV remains absent from an area of suitable depth and bottom conditions is due to regionally impaired water clarity caused by suspended sediment or eutrophication. Water clarity data (turbidity) from this study showed very similar values between the reference site, which had SAV, and the project area, void of SAV. These results suggest water clarity is not currently impacted by the channel realignment. Instead, physical disturbance (by vessels and equipment) of SAV (leaves and roots) and bottom sediment during construction may explain why SAV is currently absent from the project vicinity. Indirect impacts of excess turbidity following construction from erosion of placed material could have contributed to 2019 SAV absence. SAV beds have evolved to handle episodic physical disturbance and burial, mostly from strong storms. Numerous studies have shown that SAV recovers after being uprooted or buried during storm events (e.g., Gurbisz et al. 2016; James et al. 2008). If physical disturbance during construction is the reason SAV is currently absent, there are plenty of *Ruppia* and *Zostera* seeds to recolonize the area, and the benthic substrate and water depths are similar to reference areas.

4.2 Recommendations

It is expected that the shoaling rates within the channel will slow with time as the local environment comes into dynamic equilibrium with the new jetties and recent dredging. It is recommended that monitoring be conducted periodically (every few years) to determine if longer-term sedimentation and erosion patterns continue to evolve or reach dynamic equilibrium.

There are many variables that could be affecting SAV within the project footprint, and it is too soon after project construction to determine why the SAV beds are not present within the project footprint. Monitoring findings preliminarily indicate that construction sequencing and

positioning of construction equipment and vessels outside SAV habitat to reduce direct physical bottom disturbance could be a means to locally minimize SAV impacts from in-water construction and dredging projects. It is recommended that the site be revisited in several years to determine if SAV beds have regained a foothold in the project vicinity.

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Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
cubic feet	0.02831685	cubic meters
cubic inches	1.6387064 E-05	cubic meters
cubic yards	0.7645549	cubic meters
feet	0.3048	meters
inches	0.0254	meters
miles (US statute)	1,609.347	meters
square feet	0.09290304	square meters
square inches	6.4516 E-04	square meters
square miles	2.589998 E+06	square meters
square yards	0.8361274	square meters
yards	0.9144	meters

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1. REPORT DATE June 2022		2. REPORT TYPE Final Report		3. DATES COVERED (From - To) FY19–FY20	
4. TITLE AND SUBTITLE Two Years of Post-Project Monitoring of a Navigation Solution in a Dynamic Coastal Environment, Smith Island, Maryland				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Jacqueline A. Seiple, Luis E. Santiago, Christopher C. Spaur, Safra Altman, Matthew T. Balazik, Tom Laczko, Daniel O. Mensah, Warunika G. Amarasingha, Andrew W. Payson, and Danielle Szimanski				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Environmental Laboratory US Army Engineer Research and Development Center 3909 Halls Ferry Road Vicksburg, MS 39180-6199		8. PERFORMING ORGANIZATION REPORT NUMBER ERDC/EL TR-22-5			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Army Corps of Engineers Regional Sediment Management Program Vicksburg MS 39180		10. SPONSOR/MONITOR'S ACRONYM(S) USACE		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES Funding Account Code 1K8078/BF6512, AMSCO Code 008303					
14. ABSTRACT In 2018, jetties and a sill were constructed by the US Army Corps of Engineers adjacent to the Sheep Pen Gut Federal Channel at Rhodes Point, Smith Island, Maryland. These navigation improvements were constructed under Section 107 of the Continuing Authorities Program. Material dredged for construction of the structures and realignment of the channel were used to restore degraded marsh. Following construction and dredging, 2 years of monitoring were performed to evaluate the performance of navigation improvements with respect to the prevention of shoaling within the channel, shoreline changes, and impacts to submerged aquatic vegetation (SAV). Technical Report ERDC/CHL TR-20-14 describes the first year of post-project monitoring and the methodologies employed. This report describes conclusions derived from 2 years of monitoring. While the navigation improvements are largely preventing the channel from infilling, shoaling within is occurring at rates higher than expected. The placement site appears stable and accreting landward; however, there continues to be erosion along the shoreline and through the gaps in the breakwaters. SAV monitoring indicates that SAV is not present in the project footprint, even though turbidity is comparable to the reference area. Physical disturbance of the bottom sediment during construction may explain SAV absence.					
15. SUBJECT TERMS Aquatic plants, Channels (Hydraulic engineering), Chesapeake Bay (Md. And Va.), Coastal engineering, Dredging spoil, Jetties, Rhodes Point (Md.), Salt marshes					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON David W. Perkey
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (Include area code) 601-634-2736
Unclassified	Unclassified	Unclassified	SAR	42	