v

November 2023

Middle Peninsula Planning District Commission

NEXT GENERATION HIGH ENERGY SHORELINE PLAN DEVELOPMENT FINAL REPORT

This project, Task # 73 was funded by the Virginia Coastal Zone Management Program led by the Virginia Department of Environmental Quality through Grant # NA21NOS4190152 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.

Executive Summary

Coastal regions must evolve shoreline planning and designs based on ever changing public need driven by Federal, state, and local governmental priorities, socio-economic need, and environmental protection. Regarding Federal priorities, the Middle Peninsula (specifically the York-Piankatank-Mobjack Bay system) has been identified by the U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA) as an area of special interest for the restoration of coastal resources that support resilient shorelines. USACE and the Commonwealth of Virginia have stated in the Chesapeake Bay Watershed Comprehensive Plan that the York-Piankatank-Mobjack Bay system is a "priority sub-watershed" for coastal habitat restoration. In addition, NOAA has designated this location as a Habitat Focus Area with an emphasis on supporting climate resilient nearshore habitat demonstration projects and oyster restoration. From a state level, recent changes to the Code of Virginia to establish living shorelines as the default rather than the preferred alternative for shoreline protection (see Sidebar to right) has also shifted the policy focus toward promoting resiliency through nature-based solutions. Accordingly, Virginia shoreline planning must evolve to find a new balance between water quality, habitat enhancement, and resiliency protection.

Over time, living shorelines have become the preferred shoreline management strategy for scientists and management professionals and are now the required best management strategy for shore protection in Virginia. Recent changes in the Code of Virginia. (28.2-104.1, 28.2-1301, 28.2-1302, and 28.2-1308) directs that the Virginia Marine Resources Commission shall permit only living shoreline approaches to shoreline management in areas where the best available science shows that such approaches are suitable. If the best available science shows that a living shoreline approach is not suitable, the Commission shall require the applicant to incorporate, to the maximum extent possible, elements of living shoreline approaches into permitted projects. The Virginia Waterway Maintenance Fund administered by the Virginia Port Authority (VPA) under 62.1-132.3:3 requires that resiliency be incorporated into the use and expenditure of VPA funding. VPA funded projects must incorporate design and accommodation for the potential beneficial use of dredged materials for the purpose of mitigation of coastal erosion, flooding, or other purposes for the common good. Lastly, Article 1.3. Virginia Community Flood Preparedness Fund (Department of Conservation and Recreation) 10.1-603.24 through 10.1-603.27 requires that the fund focus on Nature-based solutions which means an approach that reduces the impacts of flood and storm events through the use of environmental processes and natural systems. Under the fund, nature-based solution may provide additional benefits beyond flood control, including recreational opportunities and improved water quality.

Together, these state statutory programs when aligned with Federal Emergency Management Agency (FEMA)'s Building Resilient Infrastructure and Communities (BRIC) program create a tapestry of programs impacting the shoreline. FEMA BRIC is intended to reduce the risks faced from disasters and natural hazards and incorporates nature-based solutions for projects that include sustainable planning, design, environmental management, and engineering practices. All of these new Federal and State programs weave natural features or processes into the built environment without the benefit coordination and planning at the shoreline scale and thus the need for the next generation shoreline plans.

The first element of this project was a literature review which was intended to determine best practices for their design and installation. Many technological advances in the field of shoreline management are presently occurring in many areas including remote sensing and modeling, as well as the development of innovative technologies. Living shorelines are being designed to maximize in equal parts both their shoreline protection capabilities and their enhancement of the local ecosystem. It is anticipated that in Year 2 of the project, a second site in a medium or moderate-energy setting will be assessed and a plan developed. The whitepaper will be updated accordingly and completed in Year 2 of the project.

The second element of the project was to develop a next generation shoreline management planning framework/process and develop a pilot shoreline management plan for a high energy setting which is intended to serve as a template for other shorelines with similar wave energy regimes. In part, the plan focused on how to balance cost-effective shore protection and habitat goals that recognized the priorities and preferences of the property owner. Simultaneously, MPPDC staff contracted with Consociate Media to develop a presentation and video summarizing the story and lessons learned during this effort.

Introduction

With funding through NOAA and the Virginia Coastal Zone Management Program (Virginia CZM), a next generation shoreline management planning process was developed and piloted for one public project. This effort consisted of a research and literature review whitepaper, the development of a framework for the next generation shoreline management planning process, the development of a shoreline management plan design for a publicly owned property with a high wave energy setting, and development of draft project documentation and educational materials summarizing the effort.

Product #1: Next Generation High Energy Shoreline Plan Whitepaper

MPPDC staff contracted with the VIMS Shoreline Studies Program to compile a whitepaper consisted of a literature review of historic and recent research for shorelines in the Chesapeake Bay. The purpose of the literature review was to survey the use of technology, modeling, alternative materials, novel and proprietary products, and innovative nature-based mitigation in the planning process for engineered shoreline protection with ecological benefits on high and medium energy shorelines. It examined the ideas, tools, and materials that are being used successfully in developing resilient shoreline management planning with a specific focus on 1) physical performance of shoreline protection, stabilization, and erosion control, 2) innovation, ease/efficiency of construction and implementation, and cost 3) innovative and/or improved monitoring methods using both emerging technology and traditional approaches, and 4) the future of living shorelines and the shift to putting them in the forefront of coastal resiliency.

The goal was to determine the best practices for proven shore protection that balances habitat restoration, shoreline protection, cost, and coastal resiliency in Chesapeake Bay and to map the future of living shorelines and their use as the emerging preferred strategy for coastal resiliency. In addition to traditional and current practices, innovative nature-based mitigation measures were also examined in the literature. The thrust of this project was hybrid structural living shorelines, so low energy/non-structural shore protection methods generally were not examined except on a case-by-case basis. Peer-reviewed scientific articles and grey literature, with an emphasis on research from the last five years, was reviewed and summarized for this comprehensive report.

This is the summary of literature reviewed in the first year of this two-year project. For this first year, strict boundaries were created for determining what papers would be reviewed. This eased into the initial search for information due to the overwhelming amount of literature in the field. Additional literature types and topics will build upon this information in the second year of the project. The whitepaper is included in **Appendix A**.

Product #2: Pilot Model for Next Generation Shoreline Plan

MPPDC contracted with the Virginia Institute of Marine Science (VIMS) Shoreline Studies Program (SSP) to develop a framework for the Next Generation Shoreline Management planning process, which is included in **Appendix B**. The framework is intended to serve as template for properties in high energy settings and was used as template for a pilot next generation shoreline design of a high energy setting.

MPPDC staff selected and Virginia CZM and NOAA staff approved use of the New Point Comfort Natural Area Preserve in Mathews County as the pilot for the next generation high energy shoreline design site. The property is owned by The Nature Conservancy (TNC) with a conservation and public access easement managed by the Virginia Department of Conservation and Recreation (DCR). The planning process consisted of two distinct approaches. The first focused on strategies for the shoreline area spanning from mean low water to the upland area just above the shoreface. The second approach focused solely beyond mean low water on state-owned bottomland. Each approach factored in immediate and longer-term management solutions which considered human management needs for infrastructure maintenance (boardwalk, observation pier, roads/access, etc.) and natural resource management needs for habitat preservation. VIMS-SSP staff completed a remote site assessment of the property including compiling of existing data, studies, etc. and conducted field work including aerial photography and LiDAR elevation surveys. All remote and field assessments were compiled, and a series of shoreline and habitat management alternatives were presented to TNC staff for consideration. TNC staff selected a design for shoreline protection and habitat restoration that would utilize structures designed and constructed by Natrx. The design for the pilot site also took into consideration design recommendations for the rehabilitation of a public observation deck on the property to be funded through a separate NOAA/Virginia CZM award. VIMS-SSP worked with Natrx to develop a draft plate design for the plan which is intended to serve as the template for future high-energy next generation shoreline plans. A draft Joint Permit Application (JPA) for the preferred alternative was developed and MPPDC submitted the project for consideration for funding under the United States Environmental Protection Agency (EPA) Chesapeake Bay Technical Assistance program. Consociate Media conducted interviews of MPPDC and VIMS-SSP staff to document the pilot process and developed a draft outline/script for a presentation summarizing the process and outcomes. Consociate Media in partnership with MPPDC staff, completed a presentation summarizing the Next Generation Shoreline Management Planning process with expansion of the presentation planned for the second year of the project involving low-moderate energy shoreline conditions. The shoreline management plan is included in **Appendix C** and the draft presentation is included in **Appendix D**.

Appendix A: Living Shorelines and Shoreline Management in Chesapeake Bay Research Literature Review: 2018-Present - Year 1 Summary

Shoreline Management Research Literature Review: 2018-Present

Year 1 Summary

Cameron W. Green

Donna A. Milligan

Shoreline Studies Program
Virginia Institute of Marine Science
William & Mary

This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant # NA21NOS4190152 Task 73 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.

January 2023

Introduction and Summary

The purpose of this literature review is to examine the successful and proven use of technology, modeling, alternative materials, proprietary products in the planning process for engineered shoreline protection with ecological benefits on high and medium energy shorelines in Chesapeake Bay. This literature review summary will examine the ideas, tools, and materials that are being used successfully in developing resilient shoreline management planning. The goal is to determine the best practices for proven shore protection that balances habitat restoration and resiliency in Chesapeake Bay. In addition to as well as practices that are being researched now, innovative nature-based mitigation measures will be examined in the literature. However, this project is mainly concerned with hybrid living shoreline management of medium and high energy sites so low energy/non-structural shore protection methods generally will not be examined outside the biologic research appropriate to all living shorelines.

Over time, living shorelines become the preferred shoreline management strategy for scientists and management professionals and are now the required best management strategy for shore protection in Virginia. This literature review is intended to determine best practices for their design and installation. Many technological advances in the field of shoreline management are presently occurring in many areas including remote sensing and modeling as well as the development of innovative technologies. Living shorelines are being designed to maximize in equal parts both their shoreline protection capabilities and their enhancement of the local ecosystem.

This is the summary of literature reviewed in the first year of this two-year project. For this first year, strict boundaries were created for determining what papers would be reviewed. This eased into the initial search for information due to the overwhelming amount of literature in the field. Additional literature types and topics will build upon this information in the second year of the project.

Methods

Peer-reviewed scientific articles and grey literature, almost entirely from 2018 to present, were reviewed and summarized for information regarding emerging and proven strategies, technology, designs, and general knowledge regarding nature-based shoreline management. The performance of these strategies as compared to traditional methods was investigated as well as their benefits to both humans and the ecosystem, and their successes and problems, both documented and theorized. The literature was grouped based upon general categories and analyzed for keywords and study location. In total, 84 pieces of literature were analyzed. Of the categories examined, the three most prolific were Marsh Habitats (22.5%), Designing Living Shorelines (11.3%), and Shoreline Planning (11.3%) (Table 1). Each paper was assigned only one category. The keywords used are shown in Figure 1. Papers could be assigned more than one keyword. The most common keywords among the literature were “erosion” (31.2%), “vegetation” (22.1%), and “management” (20.8%). In terms of location, the Virginia Chesapeake

Bay was most common (32.5%), followed by Unknown or Unspecified (17.5%) and US Southeast Atlantic (16.2%).

This literature analysis began by creating an outline of topics, keywords, and general categories to research. This outline was used to create an online Google Form which served as a database to store and categorize the literature researched. Research was conducted largely on primary, peer-reviewed journal articles (90%) along with some grey literature (10%) sources. These sources were found by searching specific topics and keywords across several online literature databases, and sources were largely limited to a date range of 2018 to present. Once a potential source was found, the abstract was read to determine if it was useful for this analysis. If the source was deemed of interest, it was read in its entirety, after which it was formatted as a reference into a Microsoft Word document along with a one to two paragraph summary of its contents. Afterwards, an entry in the Google Form was completed wherein the source's reference and summary were entered, along with standardized categorical data such as its general topic and study location.

Table 1. List of categories researched for this literature review and the percent of the total papers that the category represents. Papers only placed in only one category.

Paper Category	**Percent of Total Papers (%)**
Marsh Habitats	22.5
Designing Living Shorelines	11.3
Shoreline Planning	11.3
Remote Sensing	8.8
Coastal Bioengineering	7.5
Ecosystem Service Science	6.3
Coastal Hazards	5
Site Assessment	3.8
Modeling	3.7
Shoreline Change	3.7
Monitoring	2.5
Plant Diversity	2.5
Policy	2.5
Shoreline Management	2.5
Adaptive Management	1.3
Failing Structures	1.3
Non-Marsh Natural Habitats	1.3
Management of Infrastructure	1.2
TMDL	1.2
Coastal Profile	0
Predetermined Targets & Performance Indicators	0
Technology	0

Once the gathering of sources was completed, the Google Form database was analyzed for the statistics mentioned above, and the Word document was entered into an analysis software called dedoose (dedoose.com), a collaborative, inexpensive web-based application for qualitative researchers. This software allows researchers to code keywords and topics so that sources could be easily recalled to aid in creating this report. The sources were grouped into general topics that serve as the section headings below, where they were reviewed for patterns and consensuses in order to create the summary of next generation living shoreline research that is this report.

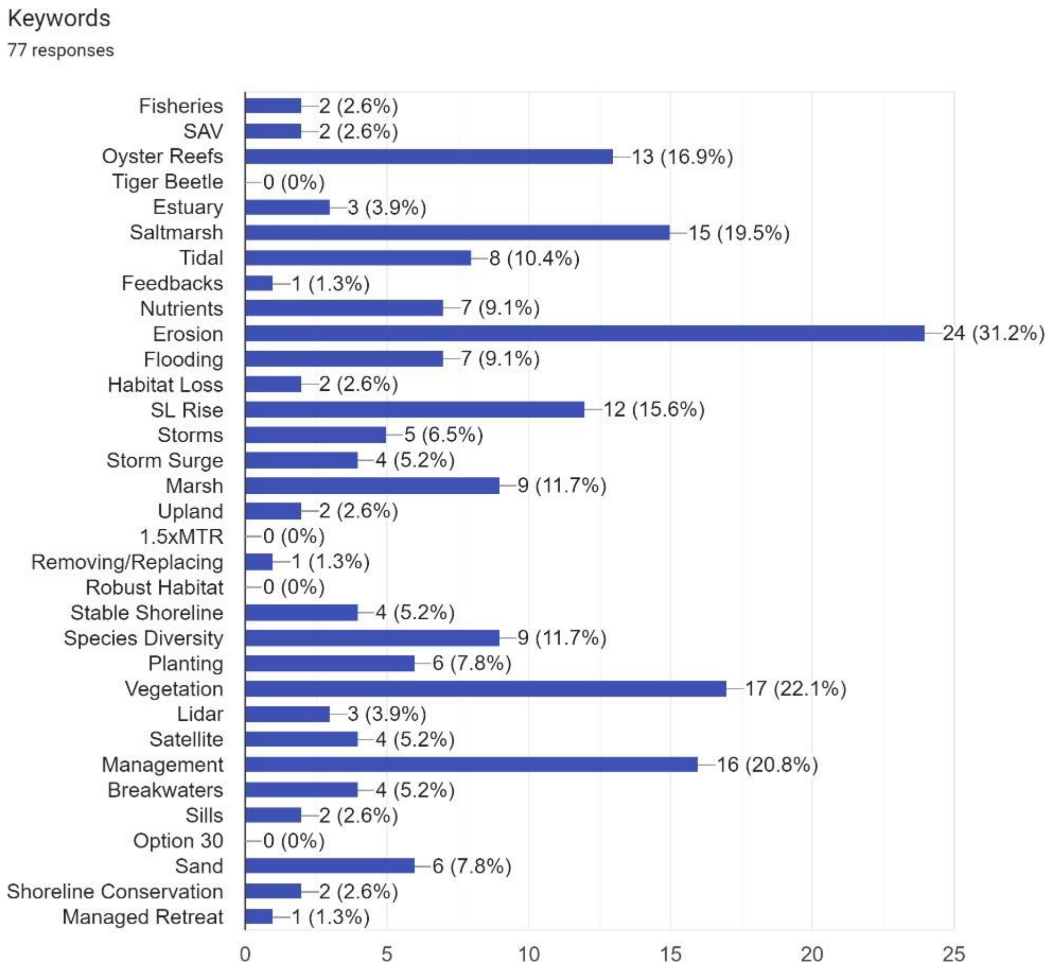


Figure 1. Keywords given to the literature reviewed.

Results

Coastal Resiliency

Sea level rise remains the biggest threat to shorelines and coastal communities and infrastructure. It is becoming increasingly clear that sea level rise trends are likely to exceed previous predictions, though the extent of by how much still remains unclear. It is predicted in the coming decades that sea level rise and climate change will cause more frequent and extreme coastal flooding, as well as more frequent and extreme storm surges, which, combined with greater coastal tidal inundation, pose a serious threat to coastal resilience that existing infrastructure is not equipped to handle (Kyzar et al., 2021; Shen et al., 2022).

Based on multiple studies of current shoreline protective structures, especially in the Chesapeake Bay, the majority of existing structures are “hard” structures like bulkheads, riprap, etc. Landowners who are proponents of these methods do so due to their lower cost and familiarity, as multiple studies showed that private landowners are most likely to choose the same type of structures as their neighbors or community (Stafford & Guthrie, 2020). However, the choice of using living shorelines has become more popular in recent years (Smith et al., 2020), and the same tendency for neighbors to choose similar structures applies to them as well (Stafford & Guthrie, 2020). Similar studies on public lands show that tax payers tend to choose the most "natural" and "physically appealing" strategies as their preferred method of shoreline stabilization and management, with one studying finding that a 3/4ths majority said they would be willing to pay additional taxes for the use of these stabilization methods on public beaches (Charbonneau et al., 2019). That being said, shoreline hardening structures are still the most commonly chosen form of coastal protection, especially by private landowners in the Chesapeake Bay region (Stafford & Guthrie, 2020).

Many studies discuss their findings that living shoreline systems perform better at shoreline stabilization than hardening structures as well as provide benefits to the surrounding ecosystem. Hardening structures, especially bulkheads, often cause more erosion to the nearshore in front of the structure through wave reflection. This not only disrupts the benthic ecosystem (Prosser et al., 2017), but also causes the eventual failure of the structure due to instability of the sediment beneath it, as well as water infiltration behind it (Takahashi et al., 2022). Oppositely, living shoreline systems provide shoreline stability (Polk et al., 2018; Safak et al., 2020), as well as increase the health of the ecosystem; primarily by providing invertebrate and marsh habitat to be the base of a coastal food chain (Davenport et al., 2018), and allowing for more unrestricted access to the marsh surface for marine fauna (Guthrie et al., 2022).

Habitats

While living shoreline systems have been used in a variety of habitats such as cobble beaches (Komar & Allan, 2010) (Winters et al., 2020; Bayle et al., 2021) and mangroves (Spiering et al., 2021), the vast majority are constructed as saltmarshes. As such, much research has been done on the ability of living shorelines to function as a natural marsh system. In terms of ecosystem functions and effects on local fauna, the consensus among the literature is that living shorelines function similarly to natural marshes once they have become established, which can take anywhere from 1 to 10 years (Spiering et al., 2021). For example, established living shoreline system soils contain similar nutrient contents and carbon storage to those of natural marshes (Chambers et al., 2021); however, and most likely due to the sand used to create them (Bilkovic et al., 2021), living shoreline marshes tend to have lower soil organic content (Chambers et al., 2021) (Isdell et al., 2021), which some research suggests can have an effect on benthic organisms (Bilkovic et al., 2021). Established living shoreline vegetation also functions similarly to that of natural shorelines in terms of wave attenuation (Cohn et al., 2021) and can even function better if it is fronted by a structure such as a sill or oyster reef (Hogan & Reidenbach, 2022). Established living shoreline marshes also have statistically similar amounts of biodiversity and species density to natural marshes in terms of marine and coastal fauna (Guthrie et al., 2022; Smith et al., 2021). Finally, established living shoreline marshes function similarly to natural marshes in terms of sediment retention and erosion control (Polk et al., 2018) and may even perform better if they are fronted by a structure (Safak et al., 2020).

One threat to living shoreline marshes, especially before they become established, is the erosion of sediment from the marsh surface before the planted vegetation establishes an extensive root mat (Spiering et al., 2021). Another is herbivory of the vegetation by fauna, especially crabs, which are not deterred by the goose fencing normally used to protect newly-planted vegetation. Multiple studies showed that crab herbivory of marsh grasses can cause huge die-offs of vegetation, which in turn leads to significant amounts of erosion, even among established and natural marsh habitats (Beheshti et al., 2021; Holdredge et al., 2009). Further research into the control of herbivory is needed.

The literature is largely in agreement on the ecological benefits of living shorelines. They perform significantly better in terms of providing habitat and increasing ecosystem health than traditional hardening structures, and, given enough time, perform just as well as natural marshes (Guthrie et al., 2022). There is also the question of how living shoreline marshes will perform into the future as sea-level rises. Though many consider living shorelines as a relatively new management strategy with researcher looking back no more than 10-15 years (Chambers et al., 2021), older sites do exist in Chesapeake Bay and have show the efficacy of these systems over longer time frames (Hardaway et al., 2018; Hardaway et al., 2019; Milligan et al., 2021).

Site Assessment and Monitoring/Emerging Technology

On-site monitoring and surveying are still common, but substantial research is being done regarding the use of remote sensing and modeling for site assessment and monitoring. Several computer programs have been developed and are currently being tested to use aerial and satellite imagery to automatically detect, map, and track shorelines and shoreline change. These programs have not yet been used extensively, but they are showing promising results such as being able to determine waterlines faster and more accurately than conventional aerial photo analyzations (Awad & El-Sayed, 2021), calculating pixel-based tide heights of imagery (Bishop-Taylor et al. 2021), identifying existing structures (Nunez et al., 2022), and automatic, large-scale shoreline mapping and EPR rate calculations (Almeida et al., 2021). Some of these programs can even be used with free software such as Google Earth Engine. There are even programs in development that automatically calculate marsh vegetation coverage from photos (Welch et al., 2021).

Research is also being done into modeling, primarily risk assessment and predicting future coastal hazards. For risk assessment, the models take a variety of factors into consideration, such as socio-economic factors, land use, historical and current flooding, and existing shoreline infrastructure to determine which areas are of highest importance in regards to shoreline protection strategies (Rangel-Buitrago et al., 2020). The coastal hazards models use previous flooding and storm surge trends (Smith & Scyphers, 2019) in combination with different sea level rise predictions (Mitchell et al., 2021) to determine the areas and severity of future flooding, as well as potential conditions of and future impacts to marshes and beaches (Andrews, 2020).

The emerging remote sensing and modeling technology is promising and has produced significant results in testing. However, little if any of it has been used in real-world applications for designing real management plans and protective infrastructure yet, as most projects are still in testing phases. That being said, there have been significant recent developments in technology for shoreline assessment, monitoring, and hazard predictions. Most of these developments allow for fast and automated results via computer programs, and they have been extremely accurate in testing. They may provide the tools for faster, more accurate, and more efficient shoreline management and protection plans, as well as help to prepare for future hazards.

Design

There are many different designs for living shoreline protection systems that have been tested in the literature for a variety of habitats. On the west coast, where cobble beaches are common, some researchers have designed and implemented living shorelines consisting of constructed cobble berms fronted by sand dunes and filled in behind by vegetated sand dunes to mixed results (Bayle et al., 2021; Komar & Allan, 2010; Winters et al., 2020). In some marsh areas of the US and Europe, designs utilizing walls or fences made of stacked wood debris and branches have been used, resulting in some success at wave attenuation, but poor results in longevity of the structures before needing to be rebuilt (Safak et al., 2020).

The most common and researched living shoreline designs, especially in the Chesapeake Bay and the western Atlantic as a whole, consist of a sand-fill marsh surface planted with native vegetation and fronted with either oyster reef structures or some type of stone or otherwise hardened material sill or breakwater. In terms of wave attenuation, sediment retention, and erosion control, living shoreline systems that utilize sill or breakwater structures tend to perform well in a variety of wave energies and tide ranges, and can function just as well as, if not better than, traditional hardening structures (Smith et al., 2018), though research directly comparing the performance of living shorelines to traditional structures is lacking (Smith et al., 2020). Additionally, some preliminary studies show that living shorelines provide better shoreline stabilization in the face of extreme storm events than natural marshes and traditional hardened shorelines (Hardaway et al., 2005; Smith et al., 2018).

Oyster reef living shorelines are a much more complex issue, however. This is largely due to the fact that there is no standard construction of oyster reefs in living shoreline systems or in general, and as such, there are many different designs, substrates, and strategies that have a wide range of success and effectiveness (Morris et al., 2021). Many studies have been done in order to determine which designs are the most effective at both establishing oyster reefs and shoreline protection. Studies show that a variety of substrates are capable at growing significantly-sized reefs, such as concrete (Goelz et al., 2020; Lipcius & Burke, 2018), limestone (Goelz et al., 2020), and recycled crab traps (Johnson et al., 2019). In terms of shore protection, large and sturdy structures like concrete and rock provide better immediate results but are often placed outside of suitable oyster habitat, and become less effective over time due to structural degradation and lack of natural reef. Conversely, reefs that are designed for optimal oyster settlement and development do not initially provide satisfactory shore protection but over time may provide steadily increasing protection as the reef develops (Morris et al., 2019). However, it does not eliminate erosion, only mitigate it. Therefore, it is less practical to develop a “standard” design for oyster reefs. However, standardizing the design process for reef systems to best fit the specific environment they will be placed in to maximize oyster settlement and growth will create the best long-term solution (Chowdhury et al., 2021; Morris et al., 2019).

Many living shoreline designs that have been researched produced mixed results as to their effectiveness at shoreline protection and resilience. Hybrid designs consisting of planted marsh and beach vegetation fronted by structures provide the best and most predictable shoreline protection, but some systems may be lacking in their initial ecological benefits, though studies have shown they tend to mimic natural systems as they mature. Living shorelines utilizing oyster reefs can also provide ecological benefits, but their designs vary widely and their effectiveness even more so making it difficult to quantify. Many researchers agree that some standard designs are needed, but they are not in agreement as to what those designs should be. Additionally, research shows that the most effective long-term solution for shore protection is not a standard design, but instead site-specific designs optimized for oyster settlement and growth. This also applies to the shore protection design process overall.

Policy

As new Virginia law requires the use of living shorelines whenever possible, much of the literature with regards to policymaking to champion living shorelines over other shoreline protection methods is not pertinent to the Virginia portion of Chesapeake Bay. However, some research and suggestions into living shoreline policy are still beneficial for Virginia's consideration. For example, one article mentions the utilization of a policy where requiring existing armored shoreline areas to be flanked by living shorelines provided the ecological benefits of living shorelines to the area while reinforcing the existing structure and surrounding shoreline (Jones & Pippin, 2022). As mentioned before, even though living shorelines are becoming more popular and are now required in Virginia, the majority of protective structures are hard structures. When structures fail, generally, they can be replaced with a similar system. Jones & Pippin (2022) suggest that it would be beneficial to require these armored shorelines to be replaced with living shorelines when they begin to fail, instead of being repaired.

Some issues with current shoreline management policy in the United States brought up in the literature is that much of it uses current or historical flooding, storm surge, and water level data to design management plans and structures, rather than taking future predictions into consideration, which means that these management plans will likely have to be modified or replaced in the future. One article in particular uses the fact that American political cycles occur on a 2 to 4-year basis, and that most of our policies tend to be reactive in nature as opposed to preventative, to state that implementing long-term management and predictive protection policies are unattractive to government officials (Andrews, 2020). Because of this, public education, outreach, and discussion regarding shoreline management and threats to coastal communities is vital to establishing more effective policies, and has been shown to be both well-received by the public and beneficial to the process of choosing more natural solutions to shore protection (Charbonneau et al., 2019).

The property rights framework is an issue that will have to be addressed by coastal managers. Virginia's public/private property line at MLW is constantly shifting, and lands that once belonged to private owners are now technically under the state's control. This can be seen through the 2015 case of *Marble Techs., Inc. v. Mallon* in which a deed from 1936 regarding an easement in Hampton established the property line "along present mean high water." That original line was obviously underwater by 2015, and the question of where the property line should be located was asked. The Virginia Supreme Court decided that, per the literal language of the original deed, the property line should remain at its original location, despite that location now being inaccessible (Messer, 2018). This shows that all current private property lines at MLW are now in jeopardy and that property owners are likely to lose rights to land that they currently own in the future unless changes are made. With regards to shoreline management systems, this could affect current systems constructed on private land, as well as affect future decisions of property owners to implement living shorelines on their land.

While there is peer-reviewed scientific literature on policies regarding living shorelines, it is lacking compared to the previous categories in this review. Virginia is ahead of most of the country in terms of utilizing and requiring living shorelines for shoreline management and protection, but like most coastal areas, may need to address property ownership issues.

Conclusions

The goals of this project were to examine the ideas, tools, and materials that are being used successfully in developing resilient shoreline management planning and to determine the best practices for proven shore protection that provide for resiliency and habitat restoration in Chesapeake Bay as well as practices that are being researched now. There is a great deal of new research being done regarding living shorelines and shoreline science as a whole. While most of the emerging new technology pertains to remote sensing and using computer programs and satellites to map, track, and analyze shorelines, innovative ideas for living shoreline designs are being developed. New research into how coastal habitats are dealing with climate change and sea level rise and how coastal areas will be affected by rising sea level and increased precipitation and storm surges are being researched. Scientists and managers are trying to determine what should be prioritized in terms of shoreline protection decision making, and, most importantly, how this research can be used to improve shoreline management and coastal resiliency.

The overall takeaway from this research is: 1) that natural and developed coastal areas face elevated threats from climate change and sea level rise, 2) particularly in areas where conflicts arise between users and manager, 3) that emerging technology is making it easier and more accurate to analyze shorelines to determine where problems lie and what needs to be done about them, 4) that scientists and managers can use this knowledge and technology, along with continuing research, to enhance and optimize living shoreline designs, 5) that Virginia has already made great strides in their living shoreline policy but can continue to improve it through public involvement and additional legislation, and 6) that the current laws determining coastal/riparian property ownership using MLW open up potential conflicts in the maintenance and construction of living shorelines, especially in the face of rising sea levels.

Limitations and Future Work

Research into shoreline management and particularly, living shorelines, has grown significantly in the last few years. Living shorelines have been installed in Chesapeake Bay since the 1980s. With the Burke et al. (2005) assessment of hybrid shore erosion control projects in Maryland's Chesapeake Bay and the Living Shoreline Summit in 2006, living shoreline research has continued to grow nearly exponentially. Even with the limitations placed on the review (generally limited to Chesapeake Bay research published in peer-review journals since 2018), it was impossible to review all the pertinent literature that is being produced. In addition, the peer-review articles tended to skew toward the biologic components of living shorelines rather than the engineering side. As this review is aimed at shore protection along medium and high energy shorelines, the engineering design considerations are significant but not highly published.

In the second year of this project, the literature will try to focus more on the physical components of shoreline protection system design including its hydrodynamics and coastal hazards components such as future sea-level rise and climate change. In addition, total maximum daily load (TMDL) information is important for management of Chesapeake Bay. This physical component will be specified in future literature reviews. Additional possible literature reviews in year 2 may include more long-term data, socio-economic research, further consensus on the terminology used to describe different types of projects, detached nearshore structures, and research on the types of living shorelines that are most effective in different environmental contexts. Where possible, costs for traditional and innovative structures will be reviewed in the literature.

To better get a some of these topics, older literature and more grey literature will be examined. For a specific subset of the documents, the literature cited section will be analyzed to find documents outside the search parameters that may be important to the knowledge base.

In addition, scientists are increasingly diversifying the way in which their studies are communicated to the wider public and policy-makers. More online resources are becoming available as the web of knowledge becomes more complex and diverse than it was in the earliest research (Teodoro & Nairn, 2020). Though this may present a challenge to identify legitimate and useful sources of science-based information, some online information may be included where appropriate.

References

Almeida, L.P., Efraim de Oliveira, I., Lyra, R., Scaranto Dazzi, R.L., Martins, V.G., Henrique da Fontoura Klein, A. (2021). Coastal Analyst System from Space Imagery Engine (CASSIE): Shoreline management module. *Environmental Modelling and Software, 140,* 105033. doi: 10.1016/j.envsoft.2021.105033

Andrews, E.A. (2020). Legal and policy challenges for future marsh preservation in the Chesapeake Bay region. *Wetlands, 40,* 1777-1788. doi: https://doi.org/10.1007/s13157-020-01389-z.

Awad, M. and El-Sayed, H.M. (2021). The analysis of shoreline change dynamics and future predictions using automated spatial techniques: Case of El-Omayed on the Mediterranean coast of Egypt. *Ocean and Coastal Management, 205,* 105568.

Bayle, P.M., Kaminsky, G.M., Blenkinsopp, C.E., Weiner, H.M., Cottrell, D. (2021). Behaviour and performance of a dynamic cobble berm revetment during a spring tidal cycle in North Cove, Washington State, USA. *Coastal Engineering, 167,* 103898. doi: https://doi.org/10.1016/j.coastaleng.2021.103898

Beheshti, K.M., Wasson, K., Angelini, C., Silliman, B.R., Hughes, B.B. (2021). Long-term study reveals top-down effect of crabs on a California salt marsh. *Ecosphere, 12*(8), e03703. doi: https://doi.org/10.1002/ecs2.3703

Bilkovic, D.M., Isdell, R.E., Guthrie, A.G., Mitchell, M.M., Chambers, R.M. (2021). Ribbed mussel Geukensia demissa population response to living shoreline design and ecosystem development. *Ecosphere, 12*(3), e03402. doi: https://doi.org/10.1002/ecs2.3402

Bishop-Taylor, R., Nanson, R., Sagar, S., Lymburner, L. (2021). Mapping Australia's dynamic coastline at mean sea level using three decades of Landsat imagery. *Remote Sensing of Environment, 267*(15), 112734. doi: 10.1016/j.rse.2021.112734

Burke, D.G., Koch, E.W., & Stevenson, J.C. (2005). Assessment of Hybrid Type Shore Erosion Control Projects in Maryland's Chesapeake Bay, Phases I & II. Retrieved from floridalivingshorelines.com/wp-content/uploads/2015/05/Burke.2005.LSL-effectiveness-study.pdf

Chambers, R., Gorsky, A.L., Isdell, R., Mitchell, M., Bilkovic, D.M. (2021). Comparison of nutrient accrual in constructed living shoreline and natural fringing marshes. *Ocean and Coastal Management, 199,* 105401. doi: ttps://doi.org/10.1016/j.ocecoaman.2020.105401.

Charbonneau, B.R., Cochran, C., Avenarius, C. (2019). What we know and what we think we know: Revealing misconceptions about coastal management for sandy beaches along the U.S. Atlantic Seaboard. *Journal of Environmental Management, 245,* 131-142. doi: 10.1016/j.jenvman.2019.04.008

Chowdhury, M.S.N., La Peyre, M., Coen, L.D., Morris, R.L., Luckenbach, M.W., Ysebart, T., Walles, B., Smaal, A.C. (2021). Ecological engineering with oysters enhances coastal resilience efforts. *Ecological Engineering, 169,* 106320. doi: https://doi.org/10.1016/j.ecoleng.2021.106320

Cohn, J.L., Franz, S.C., Mandel, R.H., Nack, C.C., Brainard, A.S., Eallonardo, A., & Magar, V. (2021). Strategies to work towards long-term sustainability and resiliency of nature-based solutions in coastal environments: A review and case studies. *Integrated Environmental Assessment and Management, 18*(1), 123-134. doi: https://doi.org/10.1002/ieam.4484.

Davenport, T.M., Seitz, R.D., Knick, K.E., & Jackson, N. (2018). Living shorelines support nearshore benthic communities in upper and lower Chesapeake Bay. *Estuaries and Coasts, 41,* 197-206. doi: https://doi.org/10.1007/s12237-017-0361-8.

Erdle, S.Y, Davis, J.L.D., & Sellner, K.G. (Eds.) (2006). Management, Policy, Science, and Engineering of Nonstructural Erosion Control in the Chesapeake Bay, proceedings of the 2006 Living Shoreline Summit. Retrieved from www.vims.edu/GreyLit/VIMS/LivingShoreline2006.pdf

Goelz, T., Vogt, B., & Hartley, T. (2020). Alternative substrates used for oyster reef restoration: a review. *Journal of Shellfish Research, 39*(1), 1-12. doi: https://doi.org/10.2983/035.039.0101.

Guthrie, A.G., Bilkovic, D.M., Mitchell, M., Chambers, R., Thompson, J.S., & Isdell, R.E. (2022). Ecological equivalency of living shorelines and natural marshes for fish and crustacean communities. *Ecological Engineering, 176,* 106511. doi: https://doi.org/10.1016/j.ecoleng.2021.106511

Hardaway, C., Milligan, D. A., & Wilcox, C. A. (2018) Living Shoreline Sea-Level Resiliency: Performance and Adaptive Management of Existing Sites. Virginia Institute of Marine Science, William & Mary.

Hardaway, C., Milligan, D. A., Wilcox, C. A., & Milligan, A. C. (2019) Living Shoreline Sea Level Resiliency: Performance and Adaptive Management of Existing Breakwater Sites, Year 2 Summary Report. Virginia Institute of Marine Science, William & Mary.

Hardaway, Jr., C.S., Milligan, D.A., Wilcox, C.A., Meneghini, L.M., Thomas, G. R., Comer, T. R., 2005. The Chesapeake Bay Breakwater Database Project: Hurricane Isabel Impacts to Four Breakwater Systems. Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, Virginia.

Holdredge, C., Bertness, M.D., Altieri, A.H. (2009). Role of crab herbivory in die-off of New England salt marshes. *Conservation Biology, 23*(3), 672-679. doi: https://doi.org/10.1111/j.1523-1739.2008.01137.x

Hogan, S. and Reidenbach, M.A. (2022). Quantifying tradeoffs in ecosystem services under various oyster reef restoration designs. *Estuaries and Coasts, 45,* 677-690. doi: https://doi.org/10.1007/s12237-021-01010-4

Isdell, R.E., Bilkovic, D.M., Guthrie, A.G., Mitchell, M.M., Chambers, R.M., Leu, M., Hershner, C. (2021). Living shorelines achieve functional equivalence to natural fringe marshes across multiple ecological metrics. *PeerJ, 9,* 11815. doi: https://doi.org/10.7717/peerj.11815.

Johnson, E.E., Medina, M.D., Bersoza Hernandez, A.C., Kusel, G.A., Batzer, A.N., Angelini, C. (2019). Success of concrete and crab traps in facilitating eastern oyster recruitment and reef development. *PeerJ, 7*, e6488. doi: 10.7717/peerj.6488

Jones, S.C. and Pippin, J.S. (2022). Towards principles and policy levers for advancing living shorelines. *Journal of Environmental Management, 311*, 114695. doi: 10.1016/j.jenvman.2022.114695

Komar, P.D. and Allan, J.C. (2010). "Design with Nature" strategies for shore protection- The construction of a cobble berm and artificial dune in an Oregon State Park. *Puget Sound Shorelines and the Impacts of Armoring- Proceedings of a State of the Science Workshop, May 2009: U.S. Geological Survey Scientific Investigations Report 2010*(5254), 117-126.

Kyzar, T., Safak, I., Cebrian, J., Clark, M., Dix, N., Dietz, K., Gittman, R., Jaeger, J., Radabaugh, K., Roddenberry, A., Smith, C., Sparks, E. (2021). Challenges and opportunities for sustaining coastal wetlands and oyster reefs in the southeastern United States. *Journal of Environmental Management, 296,* 113178. doi: 10.1016/j.jenvman.2021.113178

Lipcius, R.N. and Burke, R.P. (2018). Successful recruitment, survival and long-term persistence of eastern oyster and hoked mussel on a subtidal, artificial restoration reef system in Chesapeake Bay. *PLoS ONE, 13*(10), e0204329. doi: https://doi.org/10.1371/journal.pone.0204329

Messer, E. (2018). Waterfront property rights: The potential impact of government projects. *Virginia Coastal Policy Center, William & Mary Law School,* Williamsburg, Virginia.

Milligan, D.A., Hardaway, Jr., C.S., Wilcox, C.A., & DiNapoli, N.J., (2021). Living Shoreline Sea Level Resiliency: Performance and Adaptive Management of Existing Breakwater Sites, Year 2 Summary Report. Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA.

Mitchell, M., Isdell, R.E., Herman, J., Tombleson, C. (2021). Impact assessment and management challenges of key rural human health infrastructure under sea level rise. *Frontiers in Marine Science, 8*, 631757. doi: 10.3389/fmars.2021.631757

Morris, R.L., Bilkovic, D.M., Boswell, M.K., Bushek, D., Cebrian, J., Goff, J., Kibler, K.M., La Peyre, M.K., McClenachan, G., Moody, J., Sacks, P., Shinn, J.P., Sparks, E.L., Temple, N.A., Walters, L.J., Webb, B.M., Swearer, S.E. (2019). The application of oyster reefs in shoreline protection: Are we over-engineering for an ecosystem engineer? *Journal of Applied Ecology, 56*(7), 1703-1711. doi: https://doi.org/10.1111/1365-2664.13390.

Morris, R.L., La Peyre, M.K., Webb, B.M., Marshall, D.A., Bilkovic, D.M., Cebrian, J., McClenachan, G., Kibler, K.M., Walters, L.J., Bushek, D., Sparks, E.L., Temple, N.A., Moody, J., Angstadt, K., Goff, J., Boswell, M., Sacks, P., Swearer, S.E. (2021). Large-scale variation in wave attenuation of oyster reef living shorelines and the influence of inundation duration. *Ecological Application, 31*(6), e02382. doi: https://doi.org/10.1002/eap.2382.

Nunez, K., Rudnicky, T., Mason, P., Tombleson, C., Berman, M. (2022). A geospatial modeling approach to assess site suitability of living shorelines and emphasize best shoreline management practices. *Ecological Engineering, 179,* 106617. doi: https://doi.org/10.1016/j.ecoleng.2022.106617.

Polk, M.A., Eulie, D.O. (2018). Effectiveness of living shorelines as an erosion control method in North Carolina. *Estuaries and Coasts*, *41*, 2212-2222. doi: https://doi.org/10.1007/s12237-018-0439-y

Prosser, D.J., Jordan, T.E., Nagel, J.L., Seitz, R.D., Weller, D.E., Whigham, D.F. (2017). Impacts of coastal land use and shoreline armoring on estuarine ecosystems: an introduction to a special issue. *Estuaries and Coasts, 41,* 2-18. doi: https://doi.org/10.1007/s12237-017-0331-1.

Rangel-Buitrago, N., Neal, W.J., de Jonge, V.N. (2020). Risk assessment as a tool for coastal erosion management. *Ocean and Coastal Management, 186,* 105099. doi: 10.1016/j.ocecoaman.2020.105099

Safak, I., Norby, P.L., Dix, N., Grizzle, R.E., Southwell, M., Veenstra, J.J., Acevedo, A., Copper-Kolb, T., Massey, L., Sheremet, A., Angelini, C. (2020). Coupling breakwalls with oyster restoration structures enhances living shoreline performance along energetic coasts. *Ecological Engineering, 158,* 106071. doi: https://doi.org/10.1016/j.ecoleng.2020.106071.

Spiering, D.W., Kibler, K.M., Kitsikoudis, V., Donnelly, M.J., Walters, L.J. (2021). Detecting hydrodynamic changes after living shoreline restoration and through an extreme event using a Before-After-Control-Impact experiment. *Ecological Engineering, 169,* 106306. doi: https://doi.org/10.1016/j.ecoleng.2021.106306.

Shen, Y., Tahvildari, N., Morsy, M.M., Huxley, C., Chen, T.D., Goodall, J.L. (2022). Dynamic modeling of inland flooding and storm surge on coastal cities under climate change scenarios: transportation infrastructure impacts in Norfolk, Virginia USA as a case study. *Geosciences, 12*(6), 224. doi: https://doi.org/10.3390/geosciences12060224

Smith, C.S., Puckett, B., Gittman, R.K., Peterson, C.H. (2018). Living shorelines enhanced the resilience of saltmarshes to Hurricane Matthew (2016). *Ecological Applications*, *28*(4), 871-877. doi: https://doi.org/10.1002/eap.1722.

Smith, C.S., Scyphers, S. (2019). Past hurricane damage and flood zone outweigh shoreline hardening for predicting residential-scale impacts of Hurricane Matthew. *Environmental Science and Policy, 101*, 46-53. doi: https://doi.org/10.1016/j.envsci.2019.07.009.

Smith, C.S., Rudd, M.E., Gittman, R.K. Melvin, E.C., Patterson, V.S., Renzi, J.J., Wellman, E.H., Silliman, B.R. (2020). Review of novel restoration strategies for shoreline protection. *Frontiers in Marine Science,* 7(434). doi: https://doi.org/10.3389/fmars.2020.00434

Smith, C.S., Paxton, A.B., Donaher, S.E., Kochan, D.P., Neylan, I.P., Pfeifer, T., van Hoeck, R.V., Taylor, J.C. (2021). Acoustic camera and net surveys reveal that nursery enhancement at living shorelines may be restricted to the marsh platform. *Ecological Engineering, 166,* 106232. doi: https://doi.org/10.1016/j.ecoleng.2021.106232.

Stafford, S. and Guthrie, A.G. (2020). What drives property owners to modify their shorelines? A case study of Gloucester County, Virginia. *Wetlands, 40,* 1739-1750. doi: https://doi.org/10.1007/s13157-020-01358-6

Takahashi, H., Zdravkovic, L., Tsiampousi, A., Mori, N. (2022). Destabilization of seawall ground by ocean waves. *Geotechnique*, (ahead of print). doi: https://doi.org/10.1680/jgeot.21.00420

Teodoro, J.D. and Nairn, B. (2020). Understanding the knowledge and data landscape of climate change impacts and adaptation in the Chesapeake Bay region: A systematic review. *Climate*. 8(4), 58. https://doi.org/10.3390/cli8040058

Welch, L., Liu, X., Kahanda, I., Reddivari, S., Umapathy, K. (2021). Vegetation coverage in marsh grass photography using convolutional neural networks. *The International Florida Artificial Intelligence Research Society Conference Proceedings, 34.* doi: https://doi.org/10.32473/flairs.v34i1.128498.

Winters, M.A., Leslie, B., Sloane, E.B., Gallien, T.W. (2020). Observations and preliminary vulnerability assessment of a hybrid dune-based living shoreline. *Journal of Marine Science and Engineering*, *8*(11), 920. doi: https://doi.org/10.3390/jmse8110920

Appendix B: Framework for Determining Elements of a Next Generation Shoreline Management Plan

Framework for Determining Elements of a Next Generation Shoreline Management Plan

Donna A. Milligan

C. Scott Hardaway, Jr.

Shoreline Studies Program
Virginia Institute of Marine Science
William & Mary

This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant # NA21NOS4190152 Task 73 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.

January 2023

Table of Contents

1 Introduction

Coastal regions should develop shoreline planning and designs based on everchanging public need driven by Federal, state, and local governmental priorities, socio-economic need, and environmental protection. From a state level, the recent changes to the Code of Virginia to establish living shorelines as the default alternative for shoreline protection have also shifted the policy focus toward promoting resiliency through nature-based solutions. Accordingly, Virginia shoreline planning must evolve to find a new balance between water quality, habitat enhancement, and resiliency protection.

Research has shown that living shoreline protections systems, if designed correctly, can mitigate erosion and protect upland structures. The physics of the problem remains the same; however, concerns have been raised about the anthropogenic impacts due to conversion of coastal habitats. Typically, living shorelines may include breakwater and sill systems (created beaches and marshes) that must extend channelward from an eroding property often extending beyond MLW. This, in the view of permitting agencies, particularly the Corps of Engineers and their advisory agencies, is encroachment onto shallow water habitat. Project minimization is recommended. Therefore, the living shoreline design must be for the optimum project to address both shore protection and habitat creation.

A next generation of choices are needed as we try to shift from property by property designs to create more community-based projects. This has been the philosophy for shoreline management in Virginia since the 1970s, assessing shorelines on a reach basis (Byrne & Anderson, 1978; Byrne et al., 1979). The challenge is engaging multiple property owners to share the plan and support the costs.

Virginia is unique in that structures can be placed on state bottom below mean low water (MLW) subject to approval by Virginia Marine Resources Commission (VMRC). However, the federal government is responsible for the water above it. The area between MLW and 1.5 x the tide range falls under the jurisdiction of the local wetlands board. If a tidal locality does not have a Wetlands Board, VMRC will administer any impacts to those vegetated and non-vegetative wetlands. This has led to a collision of private property rights and the commonwealth goal of increasing living shorelines in Chesapeake Bay. Permitting wants to protect public trust; science wants to do reach because best for habitats; and homeowners want what best for them.

This is the landscape that next generation planning will have to navigate. Today, shore protection is still generally on a parcel by parcel level. However, larger projects can be more effective and provide more habitat creation. The issue with this is funding the projects. The idea of “next generation” is to reframe conversation to get funding for bigger projects. How does the money flow through the system so that you can get bigger, better designed projects?

The coastal hazard threats against the property are only going to increase. If the property goes away, they lose value. Creating plans that are easy to use and account for how decisions are made in this space is key. This is the first year of the project. This framework for the next generation shoreline management plans may be refined over the next year. The framework is not intended to is not to describe shoreline management and living shoreline design; guides presently exist for both those topics (Hardaway & Byrne, 1999, Hardaway et al., 2017; National Research Council, 2007). Rather, the goal is to describe the components that make up a next generation shoreline management plan and ask the questions that can help move long-term management, shore protection funding, and permitting into a space where they work together.

This framework summary was developed in Year 1 of a two-year project. It is not intended to take the place of existing information on living shoreline design which is readily available from a variety of sources. It is intended to address ways to enhance coastal resiliency through cohesive, reach-based site assessment, data analysis and management practices both along the shoreline and in the adjacent upland. During year 2, conversations will continue with stakeholders on how to refine this framework so that it is applicable to any shoreline and so that it provides guidance to those managers, designers, and contractors who are active in Chesapeake Bay.

2 Define the problem

2.1 Existing Conditions

2.1.1 Coastal Geology and Morphology

Using the site assessment techniques in Hardaway et al., (2017) and Hardaway and Byrne (1999), the site should be assessed for physical characteristics, including:

Physical description of the site
Landforms that may exist at the site
Geology of the area
Nearshore bathymetric depths
Existing shore protection structures and location of infrastructure at the site
Archaeological sites
Land use
Shore zone habitats (beach/dune, marsh fringe or wide marsh, forested upland, SAV)
High bank/low bank
Bank composition
Resource protection area (RPA)

2.1.2 Shore Change and Energy Classification

Energy classification
Long-term and recent shore change
Base of bank and bank face classification
What are the critical areas? - rate of erosion only or rate of erosion with infrastructure

2.1.3 Hydrodynamic Setting

Tide range, storm surge, sea-level rise (SLR)
Direction of face and storm impacts
Fetch can be used as a simple measure of relative wave energy acting on shorelines (Hardaway & Byrne, 1999).
Design wave

2.1.4 Marine Resources

Submerged aquatic vegetation (SAV)
Private oyster leases, Baylor grounds, and public clamming grounds
Oysters along the shoreline and nearby reefs
Virginia Department of Health advisories, Salinity
Endangered species

2.2 Extents

For each project, the extent should be determined at several scales: parcel, community, reach (morphology, littoral cell, larger system. Typically, every project should be assessed at the Reach level. A “reach” is defined as a segment of shoreline where the erosion processes and responses mutually interact. For example, very little sand is transported by wave action beyond a major headland, creek mouth, tidal inlet or major change in shoreline orientation. This will define the end of a reach.

Several properties may be contained within a reach. Though detailed site assessment would not occur on all properties in the reach, understanding the six basic elements that go into an evaluation is helpful.

1. Determine the reach limits in which the site is located.
2. Determine the historical rates and patterns of erosion and accretion for the reach. Identify shore types (upland banks, marsh etc.) and impacts to shoreline processes and evolution.
3. Determine within the reach which sites supply sand and the volume of that supply for incremental erosion distances. Often, within a reach, there are subreaches that interact with each other. These subreaches either supply sediment to other subreaches (erosion), transport sediment from one subreach to the next, or are subreaches where sediments accumulate (accretion). A reach may feature all three types of subreaches.
4. Determine wave climate and the direction of net littoral sand drift.
5. Identify the factors causing erosion (other than waves). These may include groundwater, surface runoff, or other processes.
6. Estimate potential and active sources of nutrient loading (*i.e.,* farmland, commercial, or residential land), and the means by which this occurs, such as surface runoff, eroding sediments, and/or groundwater discharge. Nutrients do not impact erosion, but they do impact water quality. Adding shoreline erosion treatments, inevitably change water discharge patterns and thus the overall coastal water quality. In order to minimize water quality problems, shoreline erosion strategies can and should be designed so that nutrients do not adversely impact water quality or are actually treated by the strategy.

Understanding the size of the reach and those factors which influence it gives property owners a sense of the spatial parameters within which to address shoreline erosion—it puts the problem into context and moves it beyond just their parcel.

2.3 Coastal Resiliency Considerations

Upland land use/runoff
Bank height: for high banks, marshes are in a coastal squeeze. There is no where for them to migrate upslope.
Existing vegetation; what are the marsh grass types, is *Phragmites australis* an issue?
Grading considerations – is the infrastructure too close to the top of bank to grade the bank; are there archeological considerations that impact grading.

3 System Assessment

3.1 Parcel Level

Parcel level considerations are based primarily on property boundaries which are often not conveniently concurrent with the coastal geomorphology. These are the items needed to obtain:
Site Length
Bank Height and Composition
Orientation
Habitat width and elevation
Nearshore stability
Boat wakes
Existing structures
Potential downdrift impacts
Marine resources (oysters, SAV) present or not

3.2 Community Level

What defines a community project? Typically, a community project will primarily focus on the waterfront properties which may have one or many parcels. An example of one property owner can vary from public lands like parks and beaches to Home Owners Associations (HOAs) with numerous entities. This can be the most efficient and cost-effective way to manage a reach and associated subreaches. HOAs can be challenging because everyone has different financial capabilities to put toward the project as well as opinions on how the project should go. That is why recent trends around the Bay to seek out funding opportunities, like grants and low interest loans for nature-based projects and living shorelines, is important to getting these projects built. Having a solid plan, design and permitted, in other words, shovel ready, is a plus in the funding “industry”.

3.3 Larger System/Reach

The boundaries of the larger system will vary depending on the site. Determining the effect sediment movement within the littoral cells will have on parcels is important at the reach level. This analysis should include all the factors that could impact the long-term protection of the shoreline and adjacent habitats.

4 Create Alternatives that Meet Goals

4.1 State Goals

It is important to work with the property owner to determine their goals. These goals should include both shoreline and upland. Some specific goals may include: Prevention of loss of land and protection of upland improvement; protection, maintenance, enhancement and/or creation of wetland habitat both vegetated and non-vegetated; viewshed considerations; and management of upland runoff and groundwater flow which may exacerbate bank erosion. A variety of shoreline management strategies may be recommended for each shore reach. The strategies should be based on their effectiveness in the site's hydrodynamic environment and may include any of the following:

1. Do nothing and/or move infrastructure

2. Offensive approach with living shorelines (stone sills with wetlands plantings, attached stone breakwaters and beach fill with wetlands planting are placed in the nearshore)

3. Headland control with living shorelines (stone breakwaters/sills strategically placed) to allow the shoreline to erode between the structures. Sand and wetlands planting are used with the structures to attach to the shoreline and provide the living component. This method is often used on long stretches of shoreline such as farm land when it would be cost-prohibitive to do more closely spaced structures.

4. Intertidal oyster reefs or other habitat-based designs

5. Detached structures

One or a combination of the above strategies may be appropriate for a given reach depending on the availability of funds and project goals. Phasing shoreline management strategies through time should be addressed for larger projects because it is usually the more prudent and cost-effective approach. For a proposed shoreline strategy, addressing potential secondary impacts within the reach which may include impacts to downdrift shores through a reduction in the sand supply or the encroachment of structures onto subaqueous land and wetlands.

These goals must be assessed in the context of a shoreline reach. While all objectives should be considered, each one will not carry equal weight. In fact, satisfaction of all objectives for any given reach is not likely as some may be mutually exclusive. These areas of concern could then be addressed specifically in the shore change and hydrodynamic analysis.

Living shorelines are a best management practice that addresses 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. Living shoreline strategies provide the suitable gradient to address sea-level rise and enhance the coastal resiliency of a site.

4.2 Determine Alternatives

4.2.1 What will be Effective?

The purpose of assessment is to determine the "immediate" need for any specific shoreline management strategy and how the strategies fit into the long-term plan. After both the site and reach have been assessed, recommendations can be made based on the results.

Small fetch – can do property ownership level
Larger fetch- having multiple participants would have a more effective project. If not, the reach ends up with fragmented management without community buy-in.
Living shorelines are more effective both from a habitat and shore protection standpoint over longer shore lengths.
For oyster reefs to be effective, they require salinity above 8 parts per thousand (ppt) (CBF, 2022)
In some areas, the bank may be undercut due to trees shading out the marsh. Just trimming trees and planting marsh can be effective.
Existing projects within the system that can inform design by showing elements that were successful and those that were not.

Alternatives analysis - incorporate what happens for each alternative. If do nothing, what will happen over time - erosion & sea level rise. This will include levels of protection by making sure it is understood that if the design is only for a 10-year event, parts of the system will be affected by storms that are larger. The size of the structure is directly related to the threat.

This leads into what is presently permittable.

4.2.2 What is Permittable?

Recent changes in the Code of Virginia (28.2-104.1, 28.2-1301, 28.2-1302, and 28.2-1308 directs that the Virginia Marine Resource Commission shall permit only living shoreline approaches to shoreline management in areas where the best available science shows that such approaches are suitable. Permitting agencies want to protect public trust while science wants to do what's best for habitats, and homeowners want what is best for them. Merging these three ideas into a permittable plan can be a challenge.

The design should minimize/optimize encroachment onto shallow water habitat and consider: SAV, private oyster leases, grading, and endangered species. Generally, living shorelines that utilize rock, sand, and plants have been used in Chesapeake Bay for the last 40 years and a well-designed system should be permittable. One area of concern has been the proliferation of intertidal oyster reefs and other nature-based non-structural living shorelines for shore protection. So many different types of units have been created, and materials are being used. Making sure that a particular unit is permittable could be a challenge.

Other considerations for what is permittable would be detached breakwaters and subtidal oyster reefs. Detached breakwaters, such as occur along the Norfolk shoreline, are placed in the nearshore and address the incoming wave climate. They typically are successful in areas where large amounts of sand occur in the littoral system. Would they be permittable as a living shoreline even though they do not have sand and plant components? What about large subtidal reefs? How can they be designed to provide shore protection? Would they be permittable because they would convert large swaths of sandy shallow water habitat to oyster reefs?

4.2.3 How do Property Rights Impact the Project?

The land ownership framework is an important consideration in long-term shoreline management planning. Every property owner has a right to do a different thing on their shoreline and some have more means than others. Recognizing that some owners may not be financially able to contribute to community projects allows us to address the issue. By providing recommendations outside the boundaries of individual properties, we can illuminate what they could do if you work with others (reach basis) to solve a problem.

We want to think more holistically to address the problems created by proximity infrastructure is to an actively eroding shoreline. The property rights framework is an issue that will have to be addressed by coastal managers. Virginia's public/private property line at MLW is constantly shifting, and lands that once belonged to private owners are now technically under the state's control. This can be seen through the 2015 case of Marble Techs., Inc. v. Mallon in which a deed from 1936 regarding an easement in Hampton established the property line "along present mean high water." That original line was obviously underwater by 2015, and the question of where the property line was asked. The Virginia Supreme Court decided that, per the literal language of the original deed, the property line should remain at its original location, despite that location now being inaccessible (Messer, 2018). This shows that all current private property lines at MLW are now in jeopardy and that property owners are likely to lose rights to land that they currently own in the future unless changes are made. With regards to shoreline management systems, this could affect current systems constructed on private land, as well as affect future decisions of property owners to implement living shorelines on their land. Erosion is reconfiguring acreage and parcel boundaries daily. It will only continue in the future.

4.2.4 What is the Cost and the Funding Source?

By developing different levels of conceptual plans, alternatives of what works for a property owner within their budget can be created as well as what the shore protection could look like if it was done on a reach-basis. It can be difficult to determine costs for some recommendations particularly for some of the reach components. They may require additional on-the-ground site assessment and analysis to be able to develop a cost. In addition, when proprietary or innovative structures are part of the recommendations, costs can be difficult to develop. Due to site-specific considerations, costs can vary significantly for similar treatments. Having a database of living shoreline projects where site conditions and treatments can be determined would help tease out costs.

Whoever is paying for the project will define the scope of the project. Homeowners cannot be compelled to build the proposed concepts; however, reach-based systems could be incentivized to implement the goals of the project through grants, loans, tax breaks. The state can also facilitate design/build projects to help the landowners ensure that the project will be done correctly.

This would require grants and loans for private property.

In the end, the kind of structure that will be built will be based on the physics of the system and what can they can afford. In general, traditional rock, sand, plant systems are larger, provide more shore protection, and have a higher initial cost and require maintenance. Smaller, ecohabitat-based projects will cost less for materials and possibly installation, but the level of protection may not be as high.

4.3 Final Shore Protection Plan

After developing the system assessment and conceptual plans at the parcel, community, and reach level, discussing options with the property owner will provide guidance in how to proceed. Elements of coastal resiliency and construction considerations also need to be considered.

Designing shore protection structures for specific return storm surge frequencies provides a metric by which the proposed system can expect to perform during that event. Costs, what's being protected, and durability are factors to consider. The shore protection system is designed for a particular storm condition. However, a system does not necessarily fail at higher water levels and wave energies. During larger storms, bank erosion may occur when the system is overtopped, but the sediment from the bank will slump onto the fronting protective marsh, perhaps covering some. This process can actually create a more stable bank condition as it evolves to a more equilibrium slope. Typical eroding banks are at a 1:1 slope, but as they move toward a 1.3:1 slope, they become more stable.

Creating an understanding of both the short-term and long-term performance is important to a next-generation plan. Funding options also should be included in the final plan.

5 Monitoring, Maintenance, & Resiliency

5.1 Monitoring

Natural resource managers and homeowners generally want to establish the effectiveness of their living shoreline for shoreline stabilization but are not necessarily sure how to go about it. Creating a monitoring plan for the site is necessary for a next generation plan. Using metrics that document sand retention, movement and elevation variability, tidal inundation allow you to evaluate the success of the plantings and, where necessary, provide information for remedial actions. The data from these metrics are the information needed to answer the critical questions about the success of a living shoreline designed primarily for shoreline stabilization i.e. Are the measured parameters improving? staying the same? or deteriorating? Monitoring plans can vary depending on the level of expertise of the property owner.

In living shoreline marshes, monitoring to determine if bare spots occur in the marsh. It is required to determine why the bare spots are there because it will provide the action needed to remedy the situation. If the bare spot is due to shading, trees can be trimmed. If it is due to the low elevation of the marsh substrate which causes flooding, additional sand may be needed to raise the elevation. Overland or spring freshwater flows may be affecting marsh growth and may need to be redirected. Debris could be on the marsh, smothering it. This will need to be removed.

Regardless of the level of monitoring at the site, the metrics obtained can be used to inform and address any maintenance issues.

5.2 Maintenance of Living Shorelines

Maintenance is critical for the success of a living shoreline project. Keeping the shore protection system at its most effective is the best way to negate impacts from short-term hazardous events (Milligan et al., 2021). Regularly maintaining the site will provide needed information to determine when the system's effectiveness needs to be addressed. The erosion resistant marsh and dune grasses are an important component of the living shoreline. Maintaining these are crucial to the success of the overall system. Routinely replanting vegetation as needed, trimming tree branches to reduce shade on the marsh (depending on the native vegetation's sunlight requirements), removing debris that can smother grasses, and removing any invasive species, such as *Phragmites australis* are all items that need to be addressed.

The effectiveness of a shore protection system may decrease over time due to an increase in sea level, a lack of maintenance, and changes in vegetation. The project's decline in performance may happen slowly over time so that it is not easily recognized, or it may happen quickly during a storm. Understanding the short-term and long-term effects of hazardous events on the living shoreline is crucial to determining when action is needed. Short-term events can result in a reactive approach to resiliency because there is usually little time before the event to address potential impacts (Milligan et al., 2021). Longer-term effects due to an increase in sea level may be easier to consider because if the system is being maintained and monitored, adjustments do not have to be reactive.

5.3 Future Adaptation for Resiliency

To determine how best to address coastal resiliency at a site, these questions could be asked (from Milligan et al., 2021):

Is the system designed to provide wave protection at increased water levels?

Are structures designed for the increased water levels that bring a consequent increase in wave energy to the shoreline?

Will structures need to adapt to SLR by adding rock, sand and plants?

Will addition of rock and/or sand change the design parameters of the system thereby reducing the system's effectiveness?

What is the elevation of the upland immediately adjacent to the system? Is it a coastal squeeze or will the marsh be able to migrate upslope?

How wide is the upper marsh? Wider upper marshes provide room for the low marsh to migrate.

What is the coverage of plants in the marsh?

Are nutrients affecting the marsh? Nutrients, possibly from agricultural fields and septic tanks can reduce marsh grass coverage because the nutrients affect root growth. However, Phragmites thrives in these conditions and will colonize the system.

Are sediments readily available?

Have upland issues been included in the adaptation scheme?

These are just some of the questions that can be reviewed for a coastal resiliency analysis of a site. Understanding how the storm surge and recurrent flooding will impact a site is important to the long-term stability of the management plan.

6 Additional Questions

As the project moves into the second year, beginning to address some of these questions will help tackle issues in the larger arena of shore management design and permitting. Would further defining the type of living shoreline in the VMRC database assist in long-term planning by developing information on how effective certain types of projects are?

If Virginia is providing funding for shore protection projects through grants and loans, how do we define a community project? Is it by number of property owners, length, littoral cell?

How will the solution be delivered across the coastal zone? What localities or governmental groups will be proactive and able to assist property owners with this effort? How can contractor training fit in to this?

What will the permitting space look like for next generation plans? Will there be plans in place when it is necessary to respond to emergency permits due to storms? With the frequency of storms increasing, how will they respond to allow homeowners to protect their property.

This framework may be refined as answers to questions are found in year 2 and new questions are uncovered. The overall goal is to create a way for property owners to consider all of their options for shore protection and address it in a that provides the best results for all involved. At the end of Year 2, this framework will be honed to create a separate document that defines next generation shoreline management planning in Virginia's Chesapeake Bay.

7 References

Byrne, R.J. and G.L. Anderson, (1978). Shoreline Erosion in Tidewater Virginia. Special Report in Applied Science and Ocean Engineering No. 111. Virginia Institute of Marine Science, Gloucester Point, VA, 102 p.

Byrne, R.J., C.H. Hobbs III, N.B. Theberge, W.R. Kerns, M. Langeland, J. Scheid, N.J. Barber and R.J. Olthof, (1979). Shore Erosion in the Commonwealth of Virginia: Problems Practices and Possibilities. Special Report in Applied Marine Science and Ocean Engineering No. 220, Virginia Institute of Marine Science, Gloucester Point, VA. 205 p.

CBF, 2022. Are oysters an option for your living shoreline? Chesapeake Bay Foundation. Retrieved from https://www.cbf.org/about-cbf/locations/virginia/issues/living-shorelines/are-oysters-an-option-for-your-living-shoreline.html

Hardaway C.S. and R.J. Byrne, (1999). Shoreline Management in Chesapeake Bay. Special Report in Applied Marine Science and Ocean Engineering No. 356. Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, VA.

Hardaway, Jr. C.S., Milligan, D.A., Duhring, K. & Wilcox, C. (2017). Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments. Special Report in Applied Marine Science and Ocean Engineering #463. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

Messer, E. (2018). Waterfront property rights: The potential impact of government projects. *Virginia Coastal Policy Center, William & Mary Law School,* Williamsburg, Virginia.

Milligan, D. A., Hardaway, C., Wilcox, C. A., & DiNapoli, N. J. (2021) Living Shoreline Sea-Level Resiliency: Performance and Adaptive Management of Existing Sites Year 3 Summary Report. Virginia Institute of Marine Science, William & Mary. https://doi.org/10.25773/sfsv-bc33NOAA. 2022. Sea Level Rise and Coastal Flooding Impacts Data. Retrieved from coast.noaa.gov/slr/.

National Research Council (2007). Mitigating Shore Erosion Along Sheltered Coasts. Washington, DC: The National Academies Press. https://doi.org/10.17226/11764.

Appendix C: New Point Comfort Natural Area Preserve Shoreline Management Plan – High Wave Energy Pilot

New Point Comfort Natural Area Preserve Shoreline Management Plan

January 2023

Shoreline Management Plan
New Point Comfort Natural Area Preserve

Donna A. Milligan
C. Scott Hardaway, Jr.
Cameron W. Green
Christine A. Wilcox

Shoreline Studies Program
Virginia Institute of Marine Science
William & Mary

This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant # NA21NOS4190152 Task 73 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.

January 2023

Executive Summary

The New Point Comfort Natural Area Preserve is located in Mathews County, Virginia on the New Point Comfort peninsula between Mobjack Bay and Chesapeake Bay. The 105-acre site is owned and managed by The Nature Conservancy and provides food and habitat for local and migratory birds, as well as vital protection for the federally-threatened northeastern beach tiger beetle (*Cicindela dorsalis*). The area is primarily marsh shoreline along Mobjack Bay, of which 1,900 feet was the focus for site-specific shoreline management. However, the Chesapeake Bay shoreline and coast adjacent to the observation walkway were also included in management planning.

The Shoreline Studies Program at the Virginia Institute of Marine Science was tasked with two goals: 1) to determine how erosion can be managed at the site using The Nature Conservancy's goals, and 2) to create a "next generation" management plan that incorporates previous knowledge of Chesapeake Bay shore protection, site assessment, and design. The objective of this project is to create a plan utilizes a holistic approach to incentivize reach-based shore protection while simultaneously enhancing habitat and future coastal resiliency along a singular reach.

What was found during the site assessment process was that the shoreline is a high energy site, primarily eroding (-1.0 ft/yr) saltmarsh habitat that transitions into an accreting and migrating low sand overwash and dune system to the south. Additionally, the access road at the site sits at a relatively low elevation, which floods during moderate storm events. In response, the Shoreline Studies Program has created several suggested management options including a hands-off managed retreat approach, a variety of sill system designs, utilizing artificial intertidal oyster reef systems, a headland control rock sill living shoreline system, and thin-layer sediment placement. After providing these suggestions to The Nature Conservancy, they decided that 3D-printed Natrx intertidal oyster reef modules were the management strategy that best suited their goals. Six structures ranging from 81 to 196 ft long are proposed to be placed at mean low water along the marsh shoreline. It is the hope of both the Shoreline Studies Program and The Nature Conservancy that this strategy will provide shoreline protection to conserve this vital protected habitat as well as create new oyster habitat.

This project is year 1 of a two-year project. The overall goal was to develop a framework that can be used for next generation management planning and applying it to a site, NCPNAP. The framework is included as an appendix to this report. It is in-progress as the framework may be refined during Year 2 when it is applied to another site.

Table of Contents

1 Introduction

1.1 Site Location and Project Information

The Nature Conservancy (TNC) property (New Point Comfort Natural Area Preserve, NPCNAP) is located in Mathews County, Virginia (Figure 1-1) on the New Point Comfort peninsula complex which is set between Mobjack Bay and Chesapeake Bay (Figure 1-2). The property is a 105-acre site that provides food as well as nesting and breeding habitat for birds. New Point Comfort's sandy beaches also provide protection for the federally threatened northeastern beach tiger beetle.

The TNC property has mainly marsh shoreline along Mobjack Bay and a beach fronting the marsh on Chesapeake Bay. Only the 1,900 feet of shoreline along the west coast and Mobjack Bay was considered for site-specific shoreline management. The NPCNAP Chesapeake Bay shoreline, as well as its marsh and wooded habitats, were included in the reach analysis. The west coast adjacent to the NPCNAP observation walkway was included in the shoreline management planning.

The goal of this project was twofold: 1) to determine how erosion can be managed NPCNAP in coordination with TNC's goals, and 2) to create a "next generation" management framework that incorporates previous knowledge of site assessment and design of shore protection in Chesapeake Bay (Hardaway & Byrne, 1999, Hardaway et al., 2017; National Research Council, 2007) while including additional considerations such as property ownership, littoral cell and reach concerns, funding options, and property rights. The objective is to create a plan that provides the reasoning and knowledge to incentivize reach-based shore protection while also providing habitat enhancement and future coastal resiliency. The goal is to look at shore erosion and coastal resiliency holistically along a reach and find ways for problems to be solved on a reach basis. This report provides a summary of the site assessment, shore survey, data analysis, and management planning undertaken for the site.

1.2 Define Problem

Several issues were identified as the project began. The shoreline along the TNC property is mostly eroding marsh shoreline along with associated habitats, mostly high (*Spartina patens*) and low (*Spartina alterniflora*) marsh with some invasive Phragmites (Figure 1-3A&C). The southern end of the property transitions to a low sand overwash and dune system (Figure 1-3B). While the sandy shoreline has been accreting and migrating north, the marsh coast is eroding at about -1.0 ft /yr.

A second issue is the elevation of road to approach the site. The access road to the TNC property (Lighthouse Road/Rt. 600) is relatively low and floods during moderate storm events (Figure 1-3B). This access road also serves the bayside communities of Bavon Beach and Chesapeake Shores, where tidal flooding for access by emergency vehicles is critical.

Lastly, although the access road to the observation deck on the TNC property has been there since the 1930s to service work boats on a pier that no longer exists, the observation deck was installed around 2000. Over time, the wood frame deck has become weather-worn and needs replacement (Figure 1-3C). These 3 issues have led to the development of a Shoreline Management Plan for the NPCNAP.

2 Methods

2.1. Existing GIS Data

For the site assessment, existing geographic information system (GIS) data were used from various sources (Table 2-1). This included imagery data from both VGIN and the VIMS Shoreline Studies Program databases. The lidar data was used to assess habitat and road elevations. For the road analysis, the center of Lighthouse Road was digitized as a line and then points were created from the line at 3-ft intervals. The Spatial Analyst tool 'Extract Value to Points' was used to bring over the elevation data of the 2019 Lidar DEM onto the points. This data was then summarized, and the average elevation calculated on a segment basis.

The site boundary shapefile was provided from TNC. It varies from the site boundary in the Mathews County online GIS data (https://mathewsgis.timmons.com/#/mwl). Public oyster grounds, public clamming grounds, and private leases were obtained from the Virginia Marine Resources Commission online data. Shorelines digitized from the vertical, rectified imagery were obtained from the Shoreline Studies Program database. However, the 2021 shoreline needed to be digitized for this project. The submerged aquatic vegetation (SAV) composite footprint between 2016 and 2021 was obtained from the VIMS SAV program.

Table 2-1. Listing of existing GIS data used for the site assessment.

Name	Type	Information
Imagery	Vertical, rectified imagery	SSP Mosaics (1937, 1978) VGIN Mosaics (2002, 2007, 2009, 2017 and 2021) https://vims-wm.maps.arcgis.com/apps/webappviewer/index.html?id=cd5cf9b788d0407fb9ba5ffb494e9bae
Lidar	2019 NGS data	https://coast.noaa.gov/dataviewer/#/lidar/search/
Site boundary	Shapefile	Provided by TNC
Oysters	GIS Server file	Baylor Grounds and private leases. https://webapps.mrc.virginia.gov/public/maps/chesapeakebay_map.php
Shorelines	Shapefiles	SSP Shorelines: 1937, 1978, 2002, 2007, 2009, 2017, 2021
Submerged Aquatic Vegetation (SAV)	GIS Server file (2016-2021)	VIMS SAV program https://www.vims.edu/research/units/programs/sav/access/maps/index.php

2.2 Shore Change

The extension Digital Shoreline Analysis System (DSAS) from the US Geological Survey (USGS) was used to calculate the End Point Rates and Linear Regression Rates (EPR and LRR). The EPR was calculated between 1937 and 2021. The process involved creating baselines in ArcMap parallel and offshore from the 1937, 1978, 2002, 2007, 2009, 2007, 2017, and 2021 digitized shorelines. Perpendicular transects were generated every 33 feet along the baselines. This transect shapefile ultimately contained the End Point Rates and Linear Regression Rates data and the corresponding categories created by SSP. Rates were categorized as shown in Table 2-2.

Table 2-2. Rate of change categories for shore change analysis.

Rate	Category
>+10 ft/yr	Very high accretion
+10 to +5 ft/yr	High accretion
+5 to +2 ft/yr	Medium accretion
+2 to +1 ft/yr	Low accretion
+1 to 0 ft/yr	Very low accretion
0 to -1 ft/yr	Very low erosion
-1 to -2 ft/yr	Low erosion
-2 to -5 ft/yr	Medium erosion
-5 to -10 ft/yr	High erosion
>-10 ft/yr	Very high erosion

2.3 Marsh Change

The marsh, sand, water, and forested (tree) areas were digitized on the 1978, 2002, and 2021 mosaics. The polygons were attributed according to the features they represented. The water polygons, such as ponds, were deleted from the final product. To visually view the changes, especially within the marsh areas, a union between 1978 and 2002, 1978 and 2021 and 2002 and 2021 was performed. This union allowed for the changes to be visually shown by various symbology and for the statistical changes to be calculated. In general, if after a union with 1978 and 2021, 1978 showed marsh but none was seen in 2021, it was then considered a loss. If there was no marsh in 1978 but some showing in 2021, then that was considered a gain in marsh area. If both years showed marsh, there was no change in those areas. Any other features, except marsh, that either changed or stayed the same, were labeled as ‘not marsh’, since the only feature of real concern are the marshes and forested areas.

2.4 Site Survey

The site was surveyed on 22 June 2022 on foot using a Trimble R8 real-time kinematic global positioning system (rtk-gps). Transects were surveyed by walking from the back marsh to the nearshore, taking points at specific geographic features such as changes in vegetation, top of scarp, and toe of the beach as well as changes in elevation. This was done from the end of the road on the north, south to the sandy beach where the property line occurs. Horizontal datum was Universe Transverse Mercator (UTM), North America Datum (NAD)83, in meters. The vertical datum was North American Vertical Datum (NAVD)88, meters.

The data were processed in Trimble Business Center to convert from meters to feet. The data were converted from NAVD88 to mean low water (MLW) using Shoreline Studies Program's Google Earth datum converter (https://www.vims.edu/research/departments/physical/programs/ssp/shoreline_management/living_shorelines/class_info/tideranges_and_conversions/index.php). At NPCNAP, the conversion from NAVD88 to MLW is 1.5 ft.

Ground photos were taken at the site to provide a basis for monitoring the site through time. The photos were rectified and input to GIS so that their location could be mapped.

A geotechnical analysis of the sediment in the nearshore occurred during the survey. Augers were taken by hand alongshore (Figure 2-1). Sediment samples were taken at 1 ft and 2 ft deep. The samples were field classified for color and texture using the Unified Soils Classification System (USCS). In addition, sediment samples were processed for percent gravel, sand, silt, and clay by the VIMS Analytical Service Center. The auger logs and sediment analysis results are shown in Appendix A.

3 System Assessment

3.1 Physical Setting

3.1.1 Shore Setting

A system assessment includes both remote sensing data and a site visit to determine site-specific conditions (Hardaway et al., 2017). New Point Comfort is a prominent point of land on the southeast end of Mathews County, Virginia. It consists of recent Coastal Plain Holocene marsh and intertidal mud headland deposits. The New Point Comfort Lighthouse was commissioned by Thomas Jefferson in 1801. The sand spit and lighthouse can be seen on 1853 boat sheets and on 1916 topographic maps (Figure 3-1). Over time, New Point Comfort has gotten progressively smaller and is threatening the lighthouse itself. By 1937, the sandy island complex had become more fragmented (Figure 3-2), and an access road to the north end of the project site can be seen with workboats anchored in the near shore of Harbor Creek.

The lighthouse, in 1953, was still attached to the spit complex which had further fragmented, and a pier can be seen on the north end of the project in the approximate location of today's observation walkway. By 1960, the lighthouse had become detached from the spit, which had further fragmented to an island feature. By 1978, the island feature had developed into a roughly triangular shape and separated from the lighthouse by about 1,200 feet. Deep Creek no longer existed, as a 650-ft wide tidal channel had formed separating the island from the mainland. With the end of the New Point peninsula further fragmented, providing less wave sheltering from Bay's wind wave climate, the west side coast began to actively erode. The pier off the north end of the project shore was gone except at the very end, a square distal end remained. In 1994, the island had moved north closing the tidal channel to about 300 feet wide. The west coast erosion continued and extended up to and past the project shoreline. There was no sign of the old pier.

The island, in 2002, had become elongated and was only about 150 feet from the mainland moving north-northwest. West coast erosion continues at a slow rate. SAV, which has been abundant in the nearshore off the west coast of the New Point peninsula, is clearly shown. The present-day observation deck can be seen at the end of the access road to the project site. By 2007, the island had attached to the mainland point and was no longer an island, but a northward migrating beach feature (Figure 3-5). A semi-tidal pond has developed at the end of the New Point peninsula with a small inlet to Mobjack Bay. In 2013, the west coast beach feature continues moving northward along the west coast, forcing the tidal pond channel northward. (Figure 3-6). Since there is no longer an island off New Point Peninsula, partially controlling sediment transport, sand can now enter Mobjack Bay and add volume to the shore attached beach feature.

In 2021, the big beach has moved onto TNC property and the project shoreline, further forcing the tidal pond inlet feature north (Figure 3-7). The sandy beach material will most likely continue northward along TNC property as long as the Bay's wind/wave climate is a factor and until a state of "equilibrium" is reached. Of note is the east coast of the New Point peninsula where the residents of Bavon Beach put in a headland breakwater system in 2016.

Today the project shoreline, as it has been through recent time, is an eroding marsh with exposed peat scarps.

3.1.2 Shore Change Analysis

The west side of the New Point peninsula has had little erosion since 1937, but the east coast had undergone significant shore recession (Figure 3-8). The inlet to the tidal pond is seen along with the position of the 1937 shoreline for reference. The erosion rate of the marsh shoreline from the tidal inlet to the end of the access road between 1937 and 2021 is very low and low erosion averaging about -0.6 ft/yr. The east side of the peninsula on the Chesapeake Bay side has medium (-2 to -5 ft/yr) and high (-5 to -10 ft/yr) erosion. The area where the sand is moving north along the shoreline is accreting. The net change along the peninsula is shown in Figure 3-9.

As shown in Figures 3-3 to 3-7, the sand spit attached to the shoreline and is migrating rapidly north. While the back side of the peninsula is accreting, the front side is eroding. This significant shore change is very noticeable along this shore reach between 2006 and 2009 (Figure 3-10). Sand has moved onto the shoreline creating a wider beach at the peninsula's southern end and along the backside, while erosion has occurred along the front side. The two ponds pointed to in each image are closer to the shoreline in 2009. Also noticeable is the formation of many ghost trees in the upland area.

The recent site assessment survey revealed that the sand is continuing to move north. The survey, which occurred on 22 Jun 2022, shows that MLW and MHW are farther seaward than shown on the 2021 VGIN image which is typically flown in the spring of that year (Figure 3-11). So, after about 1 year, MLW is approximately 100 ft seaward of the 2021 image. The position of MHW was more variable because of the tidal inlet channel that exits onto the shoreline, but it moved out approximately 75 ft. Overall, the sand has moved about 100 ft north between 2021 and 2022 and should continue to move northward.

3.1.3 Habitat Change Analysis

Habitats were mapped using aerial imagery in 1978, 2002, and 2021 (Figure 3-12A, B, & C). Marsh, forested, and sand areas were outlined and their total area calculated. The maps show that the forested areas have decreased significantly since 1978 (Table 3-1), and water area inside the marsh has increased. Sand habitat has increased significantly from 9 acres, predominantly on the Chesapeake Bay side of the peninsula in 1978, to 25 acres on the southern end of the peninsula and along Mobjack Bay shoreline as the sand shoal attached to the shoreline and migrated north.

Overall, net habitat loss was only 10 acres. The erosion on the Chesapeake Bay side was offset by accretion on the backside. Forest acreage dropped from 63 acres in 1978 to 36 acres in 2002. However, the rate of loss slowed with only 5 acres being lost between 2002 and 2021. Figure 3-12D shows the net change between 1978 and 2021. Marsh loss (depicted as red) occurred along the Chesapeake Bay side due to erosion. On the Mobjack Bay side, it was covered by sand as it migrated north. In addition, open water expansion within the marsh also resulted in net marsh habitat loss. Marsh gain (depicted as green) is mostly the result of marsh migration into the forested areas.

Table 3-1. Marsh, sand, and forested habitats mapped in 1978, 2002, and 2021.

Year	Marsh (acre)	Sand (acre)	Forested (acre)	Total Acres
1978	71	9	63	143
2002	92	10	36	138
2021	77	25	31	133

An invasive grass known as Phragmites, which is found intermittently around Chesapeake Bay, was present on the TNC property. *Phragmites australis* is a tall coarse grass with a feathery seed head. Commonly known as Reed Grass, it is a familiar invader of disturbed low or marsh areas. The broad, acutely tapering leaves, the characteristic seed head, and very long rhizomes are trademarks of this giant grass which can grow 12 feet high.

It is a very aggressive plant, as the long, creeping rhizomes enable this grass to propagate quickly. Reed Grass often competes successfully with other, more valuable marsh plants such as cordgrass, in some brackish marshes. This competition is of potential concern to wetlands managers (Silberhorn, 1976). At New Point Comfort, some Phragmites occurs around the observation walkway and in some of the back dunes on the southern end of the site.

3.1.4 Elevations

The maximum land elevations in the area are about +5.5 ft MLW (+4 ft NAVD88; 3.2 ft mean higher high water (MHHW)) in the forested areas as well as along the southern section of the reach where the sand is migrating and dunes are being built (Figure 3-13A). The top of the peat scarp ranges between +2.3 and +2.8 ft MLW (0 ft MHHW to 0.5 ft MHHW). The digital elevation model shows the tidal creek that has migrated north from the pond as the sand migrated. The nearshore bathymetry is very shallow and has a gentle slope off of the TNC property (Figure 3-13B). Along the northern end, depths are about -2.5 to -3 ft MLW about 1,000 ft from the shoreline. Along the southern end, sand waves are clearly visible in the bathymetry data. The observation walkway has a maximum elevation at the end of the structure of +7.5 ft MLW (+5.3 ft MHHW).

Using the 2019 Lidar data, the elevation of the access road was determined in three sections (Figure 3-14). The minimum, maximum, and average elevations were determined relative to MHHW and MLW (Table 3-2). Section 1 is closest to the NPCNAP. Section 2 extends from section 1 to where the roads to Bavon Beach and Chesapeake Shores occur. Section 3 extends through the marsh between Harper Creek and Dyer Creek. There is little difference in the average elevation between each section of road.

Table 3-2. Elevations of the access road in the 3 sections shown on Figure 3-14).

Road Section	Min (ft MHHW)	Max (ft MHHW)	Avg (ft MHHW)	Avg (ft MLW)
1	0.86	1.77	1.25	3.55
2	0.93	1.73	1.25	3.55
3	1.06	1.68	1.40	3.70

3.2 Hydrodynamic Setting

3.2.1 Tide Range and Water Levels

The tide range at New Point Comfort is 2.1 ft. The storm surge frequencies for the 10, 50, 100, and 500-year events are 5.6 ft, 6.4 ft, 6.8 ft and 7.7 ft MLW, respectively (FEMA, 2014, Transect 38). The entire preserve is either in Flood Zone VE or AE which means they are subject to inundation by the 1% annual chance (100 year) event. Along the shoreline, the VE zone has additional hazards associated with storm-induced waves. Using the survey data, the present position of MHW and MLW could be mapped (Figure 2-1).

3.2.2 Sea-level rise

Using the VIMS quadratic sea-level rise (SLR) estimate, water levels will rise between 1.7 and 2.2 ft above MSL by 2050 (Figure 3-15). The quadratic estimate incorporates acceleration of SLR that the linear rate does not. Using the NOAA SLR intermediate scenario has similar predictions of water level as the VIMS data. SLR would continue to force changes to habitat such as inundation of marshes and loss of forest. NOAA's sea-level rise viewer shows that when sea level rises 1 ft above MHHW by 2040 much of the marsh at New Point Comfort will be flooded. Using NOAA's intermediate SLR prediction, by 2040 (+1.08 ft MHHW), the lowest parts of the road (0.86 ft to 1.06 ft MHHW) will continually be flooded. The higher parts of the road will be flooded near high tide (Figure 3-16A). With 2 ft of SLR, most of New Point Comfort will be under water (Figure 3-17B).

The observation walkway has a maximum elevation at the end of the structure of +7.5 ft MLW (+5.3 ft MHHW). Most areas of the site will flood during large storms. The observation deck will be impacted by the largest storms with waves directly breaking on the decking.

3.2.3 Wave Climate

The wind driven wave climate operating throughout Chesapeake Bay is determined by fetch exposure and wind speeds. In the case of NPCNAP, the average fetch is about 10 miles with a longest fetch of about 15 miles. A 40-mph wind provides a significant wave of 3.7 feet in 4.7 feet of water at the shoreline.

The nearshore bathymetry is an important element along both shore reaches. Along the Mobjack Bay shoreline, the nearshore is relatively shallow which may significantly attenuate waves impacting the shore. The nearshore becomes quite narrow just north of New Point on the Chesapeake Bay side before it widens again northward across Bavon Beach and Chesapeake Shores (Figure 3-13). The narrow nearshore embayment would allow a higher wind/wave climate to impact the coast. This affects the littoral transport of sand along shorelines.

3.3 Marine Resources

Marine resources adjacent to the project site are assessed in order to determine if the proposed shoreline project will impact them. These resources include private oyster leases, Baylor grounds, public clamming grounds, and SAV. Oyster leases near the project shoreline are shown in Figure 3-17 where no leases or Baylor grounds will be impacted. The 2016-2020 footprint shows that the SAV can reside very close to the shoreline so any shoreline project needs to be landward of that boundary. Public clamming grounds occur on the Chesapeake Bay side of the peninsula.

Five oyster reefs occur in Mobjack Bay (VOSARA, 2023). The stock assessment from oyster reefs in Mobjack Bay is necessary to determine if shore protection based on oyster reefs will recruit spat. Recruitment was good in these reefs in 2019, and Brown's Bay 1, the largest reef in Mobjack Bay, had the highest density of market oysters in 2021. Oysters occur in the substrate along the site indicated that the site is a good candidate for intertidal oyster reef installation.

4 Alternatives and Final Design

4.1 Site Design Options

The shoreline analyzed for shore protection is located along the west side of the New Point Comfort peninsula. It is mostly a low eroding marsh coast. The TNC shoreline property extends from the access road southward about 1,900 ft, with the north 1,300 ft being eroding marsh and the south 600 feet being the northward-migrating beach. This living shoreline design project shoreline occurs along the marsh shoreline.

After the analysis, several options for shoreline management were created along the project coast. They include:

1. Do Nothing: This would allow the shoreline to continue eroding at a rate that is currently less than -1 ft/yr and costs nothing.
2. Sill System @+4 ft MLW: Sills 1-6, Meant to address Coastal Resiliency with sand fill at +4 MLW
3. Sill System @+3 ft MLW: Sills 1-6. Basic shore protection
4. Headland Control @+4 ft MLW: Sills 1, 3, and 5
5. Intertidal Oyster Reefs

In the case of NPCNAP coast, most of the marsh coast is 2 ft under water during the 10-year event. The key to securing the eroding marsh shoreline is to install a system that will survive constant fluctuating water levels and the wind/wave climate while remaining intact over time. Options 2-5 will achieve this goal at varying level of protection during storms. They also have varying viewshed considerations, which is important to TNC.

4.1.1 Rock Sill Living Shoreline

To protect the marsh shoreline, a living shoreline using rock, sand, and plants could be constructed. The sill system would be close to the shoreline so that SAV in the nearshore would not be impacted. It consists of 6 rock sills (Figure 4-1) that are Sill #1 = 210 ft; Sill #2 = 150 ft; Sill #3 = 160 ft; Sill #4 = 90 ft; Sill #5 = 180 ft; Sill #6 = 120 ft; Total = 910 ft. The sill crest elevation is at +4 ft MLW to provide marsh edge protection during storms. The cost of this system is about $600-$700/linear foot (lf), for a total of $526,000 - $637,000 (910 ft). This recommendation addresses coastal resiliency along the project shoreline because the added sand fill will create a dune feature upon which the low marsh can migrate upslope from both the marsh side and Bay side.

Another option would be to construct a slightly smaller system that has a +3 ft MLW sill crest elevation and sand/marsh interface. The cost of this system would about $500-$600/lf, for a total of $455,000 - $526,000 (910 ft).

Lastly, headland control is an option for this shoreline. Rock sills would be built at +4 ft MLW, but only sills 1, 3, and 5 would be constructed. Because the rate of erosion is low, the marsh could be left to erode between the sills, thereby eventually creating a stable embayment between structures. The cost for this would be $600-$700/lf, for a total of $330,000 - $385,000 (550 ft).

4.1.2 Intertidal Oyster Reefs

Intertidal oyster reefs are being used as shore erosion mitigation in many areas of the Bay. In recent times, many proprietary and non-proprietary structures have been developed. The goal of these structures is to recruit oysters and develop a reef along the shoreline that will reduce the waves impacting the shoreline. Oyster reefs are typically best suited for eroding marsh shorelines where the goal is to reduce the low-water impinging wind-driven waves that undercut the marsh peat causing chronic erosion. The use of this type of products will allow and encourage oyster growth, which, in turn, will help stabilize the marsh edge. These types of intertidal oyster reef, have erosion control capability and contribute to habitat enhancement as oyster reefs and the associated attraction of a variety of fish species. Unlike engineered rock structures, a level of protection cannot be provided for these structures. The intertidal reefs are limited in elevation because oysters won't grow above MHW. Several of the options are described here.

- Oyster bags are mesh bags filled with oyster shells (Figure 4-2A). They are stacked in a triangular configuration that can be sized to the shoreline situation. A recent oyster sill installation showed that the bags are successful at oyster recruitment as well as being used by other organisms. The bags slowed down erosion and allowed some sediment to accumulate landward of the sill. However, marsh erosion still occurred. As the oyster reefs age, it is anticipated that the coastal profile will become gradual enough to allow marsh to grow. These cost about $3 per bag and can be placed by volunteers. These may not be appropriate for high energy areas because the bags can roll before the oysters cement them together.
- Oyster castles® are pre-formed concrete structures that are stacked together (Figure 4-2B). Oysters grow on the many sides of the structure essentially gluing the blocks together. These too can be placed by volunteers. Oyster shells are sometimes placed on the castles after installation to enhance recruitment. (https://blogs.ubc.ca/royaloysters/2014/11/25/oysters-thriving-on-man-made-castles-installed-on-south-carolinas-shores/; https://www.delmarvanow.com/story/news/local/virginia/2017/08/28/concrete-castles-oysters-erosion/587651001/)
- Diamond and X-Reefs are two shapes of pre-cast concrete that have shells embedded in the structure (Figure 4-2C). These are proprietary structures. Oyster spat may prefer to attach to oyster shells so these forms have the ease of pre-cast concrete but could allow for better spat settlement. These structures are larger than the previous two and require construction equipment for installation. (https://www.dailypress.com/news/dp-nws-evg-biogenic-water-reefs-20170630-story.html).

- Natrx (https://natrx.io/) is a company that provides adaptive infrastructure for shore protection (Figure 4-3). Their proprietary modules are designed by engineers to a specific site, 3D printed, and transported to the site. Though used in other areas, only a few Natrx installations have occurred in Chesapeake Bay. As such, the authors consider this an innovative technique which will need to monitored. The structures can be 3D printed into various shapes with varying degrees of "pore space" where oyster spat can settle and colonize, and modules can be created to be stacked in higher energy areas. Cost is a consideration. Because the modules need to be placed with construction equipment, they cost more than the structures that can be placed by volunteers; however, they may be more appropriate for higher energy shorelines. The fact that these structures have copyright restrictions leading to sole source designation could be problematic from a practical marine construction application.

The rock sills and intertidal oyster reefs have been permitted and installed in Chesapeake Bay. The rock sills have been extremely effective shore protection for 40years and will provide a higher level of protection and more coastal resiliency than the intertidal oyster reefs, but the tradeoff is a higher cost. In addition, the larger rock structures will impact the viewshed as they will be visible along the shoreline. The oyster reefs will generally provide shore erosion mitigation at the site for a lower cost. Oyster bags and oyster castles are units that can be installed by volunteers ensuring that the cost is minimal. Diamond and X reefs and Natrx units must be stockpiled and installed using heavy construction equipment. Therefore, their cost will vary per site due to site-specific conditions including access and construction considerations.

4.1.3 Thin-Layer Placement

Thin layer placement (TLP), or thin-layer sediment addition, is a process in which sediment removed from navigation channels during dredging is transported to a marsh restoration site, where it is applied to the surface of the marsh by spraying a slurry of water, sand, and silt (VIMS, 2014). The main goal of TLP is to restore and maintain coastal wetlands by emulating the natural processes of gradual sediment deposition, slightly increasing their elevation to allow the marshes to continue to exist and thrive in the face of erosion and sea-level rise without limiting vegetation growth (Raposa et al., 2020). The amount of sediment deposited through thin-layering depends on its usage. The restoration and maintenance of an existing wetland requires approximately six inches of sediment deposition, while the creation of a new wetland requires at least a foot of sediment deposition (Welp et al., 2014). Adding too little sediment may not allow the marsh to withstand erosion and flooding, which can damage vegetation. However, adding too much sediment may limit natural plant growth and leave the marsh vulnerable to invasive species like *Phragmites australis*. Due to the Chesapeake Bay's conditions of rising water levels and land subsidence, in conjunction with its many channels and inlets in need of dredging, thin-layering techniques may prove to be extremely beneficial in creating, restoring, and maintaining coastal wetlands in the region (VIMS, 2014). Though done in other areas of the country, thin-layer placement (TLP) is only recently started being used in Virginia. Many areas of the NPCNAP (Figure 4-4) could be enhanced with TLP.

4.2 Reach Design Considerations

Using a reach approach for shoreline management was recommended by Hardaway & Byrne (1999). However, for many property owners, shore protection has the narrow focus of their own property. The next generation management planning needs to consider options outside of the property that will enhance the reach overall. By combining options, larger, more resilient options can be obtained than on a parcel by parcel level. Parcel boundary lines do not often coincide with a coastal reach, and projects constructed may not be as effective. However, the planning framework has not been in place to assist property owners to work on a multi-parcel or reach basis.

At NPCNAP, several recommendations can be considered that will enhance the preserve's property while also creating resiliency on adjacent properties. Thin-layer placement (Figure 4-4) is one management strategy that would be enhanced with a reach approach. It would be more cost-effective to place dredge material on all of marsh on the New Point Comfort peninsula rather than just on the preserve's property. Material could be placed along the southern end of the Peninsula and on the adjacent property to the north in order to provide some protection for the road.

Along the Chesapeake Bay coast, a pond could potentially breach which would fragment the point. The pond is not on TNS's property, but by protecting the pond, the reserve would be more stable. The marsh and beach coast south of Bavon Beach would benefit from a southward extension of the Bavon Beach breakwater system. A headland control system might be more appropriate and cheaper. Long headland breakwaters can be strategically placed along shore with one placed in front of the pond to prevent breaching.

The movement of the sand island to the north-northwest has been well-documented. Placement of a feeder beach in the nearshore at the southern end of the peninsula would ensure that sand would continue to feed into the alongshore sediment movement along the Mobjack Bay shoreline. Identifying a source for the material could be an issue. If sandy dredge material is available locally, it is required to be placed along the shoreline. Permitting might be an issue for overboard dredge disposal to create a feeder beach. These issues would have to be worked out. Another option is to buy sand to place in the nearshore, however, it would be better served to place along the shoreline on the south end and let it move north.

Lastly, dune fencing could be placed along the sand on the southern end of the peninsula to help the formation of dunes along the shoreline. The dunes will provide coastal resiliency by protection the landward marsh that is lower in elevation.

4.3 Final Design

The NPCNAP property is owned and managed by TNC. In consultation with them, they decided that the Natrx modules would meet their goals for the property. The Natrx modules will reduce erosion along the edge of the marsh, create additional habitat with intertidal oyster reefs, and will not impact the site's viewshed as intertidal oysters are common in many areas of Chesapeake Bay. Six structures were designed to be placed generally at low water along the shore (Figure 4-5). The structures are 165 ft, 165 ft, 81 ft, 155 ft, 148 ft, and 196 ft long. The modules themselves are 36 inches wide, 32 inches high, and 36 inches long (Figure 4-6). Each block will weigh about 2,000 lbs. Building 910 ft of intertidal oyster reef will require about 300 Natrx modules. When placed, the modules will extend to just above MHW. The project will have no downdrift impacts. The draft Joint Permit Application (JPA) for the project is located in Appendix B. The JPA only includes the project description, site impacts, and drawings. Other construction considerations (described below) need to be decided on by the contractor, in conjunction with TNC, and included in the JPA.

One construction issue might be a stockpile location for the modules. With the entire area marsh, the only place to stockpile the Natrx modules would be the road. This would block access to the observation walkway during construction. The modules may have to be placed onto the shoreline from a barge; otherwise heavy construction equipment would have to access the shoreline through the marsh as there is no sand in the project to build a platform from which construction equipment could work.

Because this is a public property, the intertidal reef installation could potentially receive grants or loans. The intertidal oyster reef will provide ecosystem services while reducing marsh erosion at the site. The reach-based recommendations would be more difficult to fund because they are partially on private property. If material could be found in a local dredge project, it possible that the costs for TLP could be rolled into the dredge project. This would involve working with adjacent property owners to allow placement on their marshes. Being able to dispose of a large amount of material is necessary because if all of the dredge material cannot be used, it would not be cost-efficient for the dredge project. Permitting could also be an issue as not many TLP have been created in Virginia. Because the reach approach would assist in raising the marsh levels adjacent to Lighthouse Road, potentially reducing nuisance flooding of the road, the property owners in Bavon Beach and Chesapeake Shores, as well as the Virginia Department of Transportation could be brought into the conversation.

5 Maintenance, Monitoring, & Resiliency

5.1 Maintenance

Project maintenance is minimal for the intertidal oyster reef installation. The goal of the project is for a thriving reef to develop in the nearshore. This would not require any maintenance.

5.2 Monitoring

Monitoring should occur at the site because the Natrx modules are considered an innovative technology in Chesapeake Bay. At the minimum, ground photography of the units along the shoreline, over time should be taken to see how they are developing into a reef. This can take several years.

Surveying for elevation at certain cross-sections would also show how the structure is affecting the shoreline. The goal is to have the scarp erode into a gentler coastal profile that grasses can grow on. Surveying at least once a year is recommended. Because it can be difficult to measure small changes in elevation, setting up high resolution benchmarks is suggested.

As the profile gentles landward of the reef, the marsh may expand landward. Documenting growth of grasses in the intertidal zone is recommended.

5.3 Coastal Resiliency

The goal of an intertidal reef is to protect the edge of the marsh from erosion and help break storm waves before they impact the site. The marsh will still flood during storms and SLR will continue to impact the site. However, the reef itself can adjust to SLR by continuing to grow in elevation.

6 Summary

This undertaking was the first year of a two-year project that is looking at next generation shoreline management planning. The goals were two-fold. First, to develop a framework to describe to property owners what they should consider on their property and on a reach basis to provide more effective shore protection and coastal resiliency. This framework is in Appendix C. The second objective was to apply the framework to NPCNAP and develop a next generation shoreline management plan for New Point Comfort Natural Area Preserve. The framework is a work in progress as it may be modified in year 2 of the project.

Using remotely-sensed data and a site visit, an understanding of the NCPNAP shoreline was developed. Using this data, several levels of conceptual recommendations were created for the site as well as for the entire reach. After consulting with the property owner, TNC, a detailed site plan and JPA was developed for Natrx intertidal oyster reefs at the site. The intertidal reefs would reduce erosion at the site, create oyster habitat, and not impact the viewshed of the site.

In addition to site-specific recommendations, additional reach-based recommendations were made to enhance the peninsula as a whole. Thin-layer placement of dredge material would require TNC to work with the adjacent property owners to allow the deposition of material which would increase the surface elevation of the marsh. This would increase coastal resiliency of the site by helping the marsh to migrate vertically.

7 References

FEMA (2014). Mathews County Flood Insurance Study. Retrieved from https://msc.fema.gov/portal/advanceSearch

Hardaway C.S. & Byrne, R.J. (1999). Shoreline Management in Chesapeake Bay. Special Report in Applied Marine Science and Ocean Engineering No. 356. Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, VA.

Hardaway, Jr. C.S., Milligan, D.A., Duhring, K. & Wilcox, C. (2017). Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments. Special Report in Applied Marine Science and Ocean Engineering #463. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

National Research Council (2007). Mitigating Shore Erosion Along Sheltered Coasts. Washington, DC: The National Academies Press. https://doi.orG/10.17226/11764.

Raposa, K., Wasson, K., Nelson, J., Fountain, M., West, J., Endris, C., & Woolfolk, A. (2020). Guide for thin-layer sediment placement as a strategy to enhance tidal marsh resilience to sea-level rise. Retrieved from https://www.nerra.org/wp-content/uploads/2020/02/TLP-Guidance-for-Thin-Layer-Placement-20200217-HRes.pdf

Silberhorn, G.M. (1976). Tidal Wetlands Plants of Virginia. Educational Series Number 19 of the Virginia Institute of Marine Science, Gloucester Point, VA.

VIMS (2014). Thin-layer sediment addition of dredge material for enhancing marsh resilience. Retrieved from https://www.vims.edu/GreyLit/VIMS/2014DredgeBrief.pdf.

VOSARA (2023). Virginia Oyster Stock Assessment and Replenishment Archive. Retrieved from https://cmap22.vims.edu/VOSARA/

Welp, T., Maglio, Coraggio, Estes, T., Acevedo-Acevedo, D. (2014, 30 July). DOTS Webinar Thin Layer Placement. Retrieved from https://tlp.el.erdc.dren.mil/wp-content/uploads/2015/07/Webinar-DOTS-Thin-Layer-Placement-20140730_final.pdf

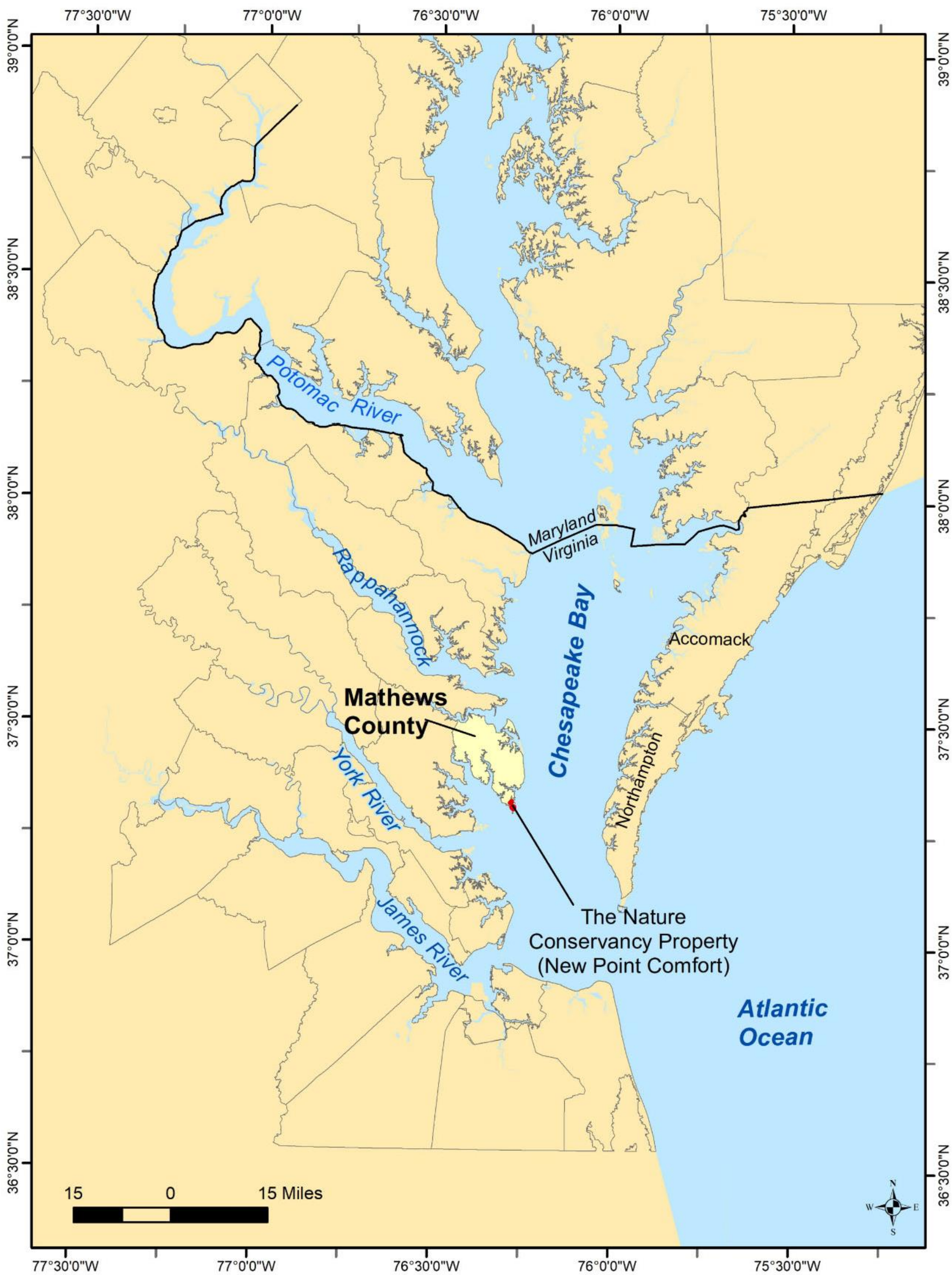


Figure 1-1. Location of New Point Comfort Natural Area Preserve within the Chesapeake Bay estuarine system.

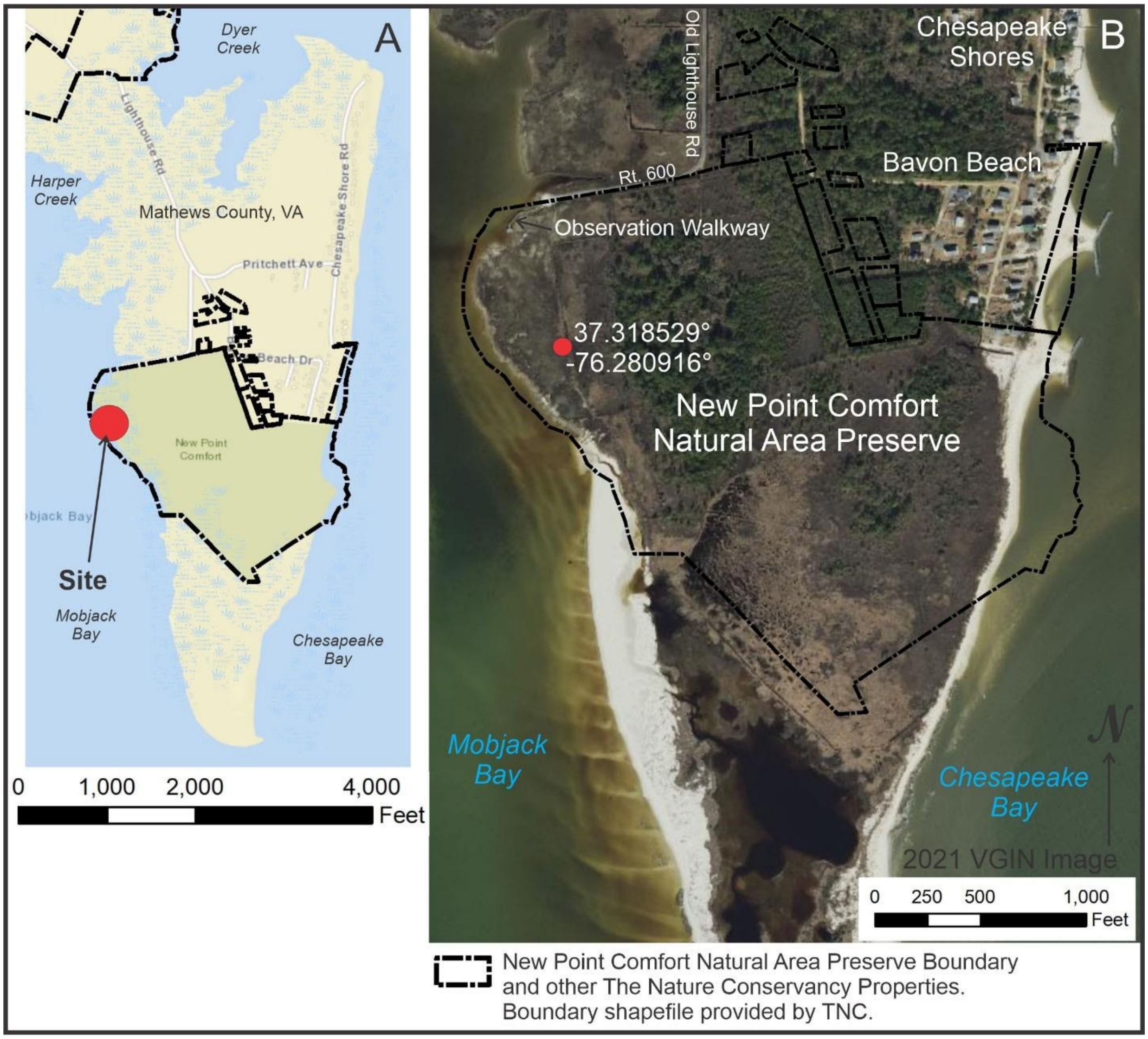


Figure 1-2. A) Location of the natural area preserve along a peninsula between Mobjack Bay and Chesapeake Bay, and B) 2021 Virginia Geographic Information Network (VGIN) image showing habitats and the general region of the project area.

Figure 1-3. Photos taken of the A) marsh scarp on the northern end of the site; B) of the sandy beach area on the south end of the site; and C) the observation walkway and the eroding marsh with *Phragmites australis*. Photos taken by SSP, 22 June 2022.

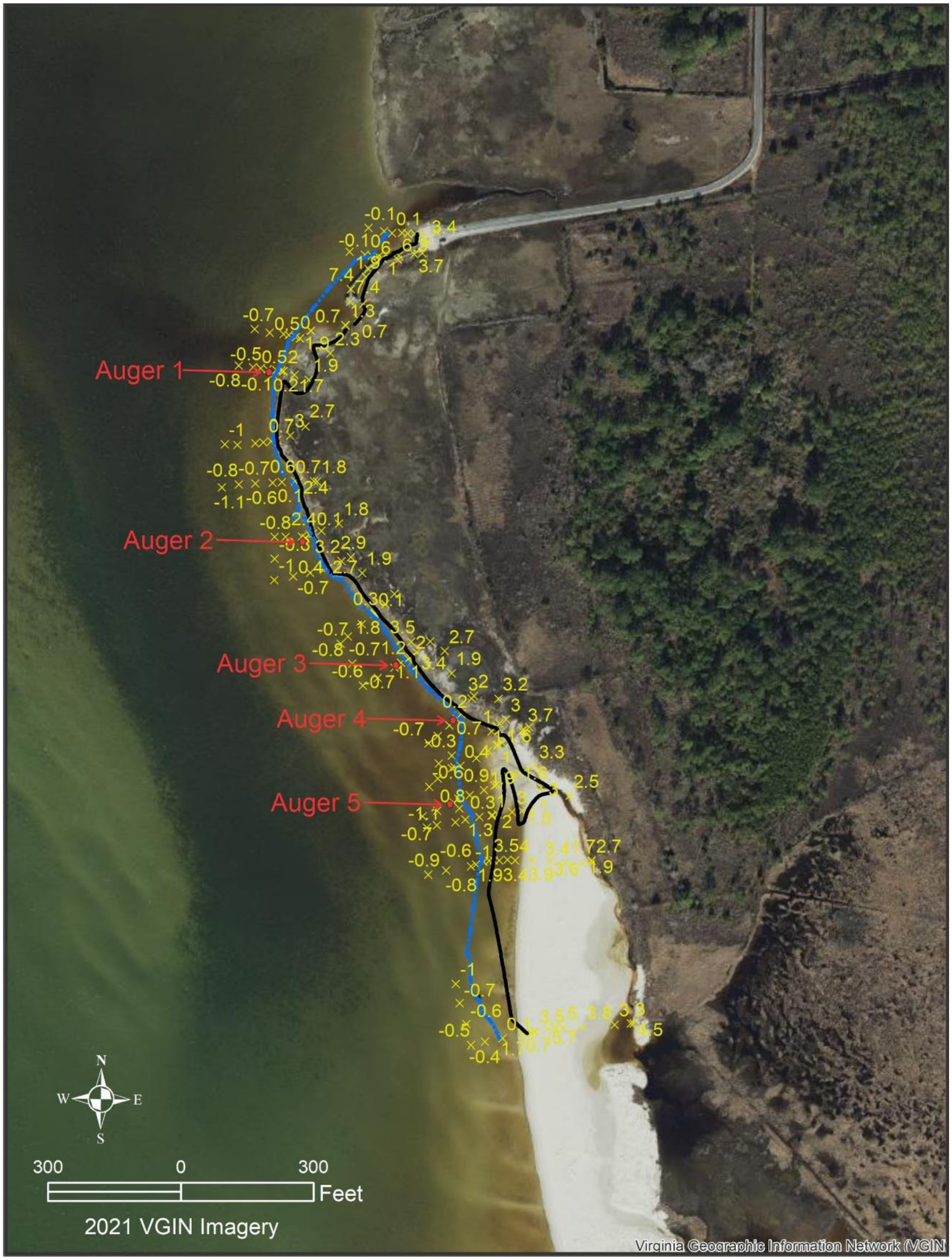


Figure 2-1. Survey points and auger locations taken 22 June 2022. Also shown is the calculated MHW (black) and MLW (blue).

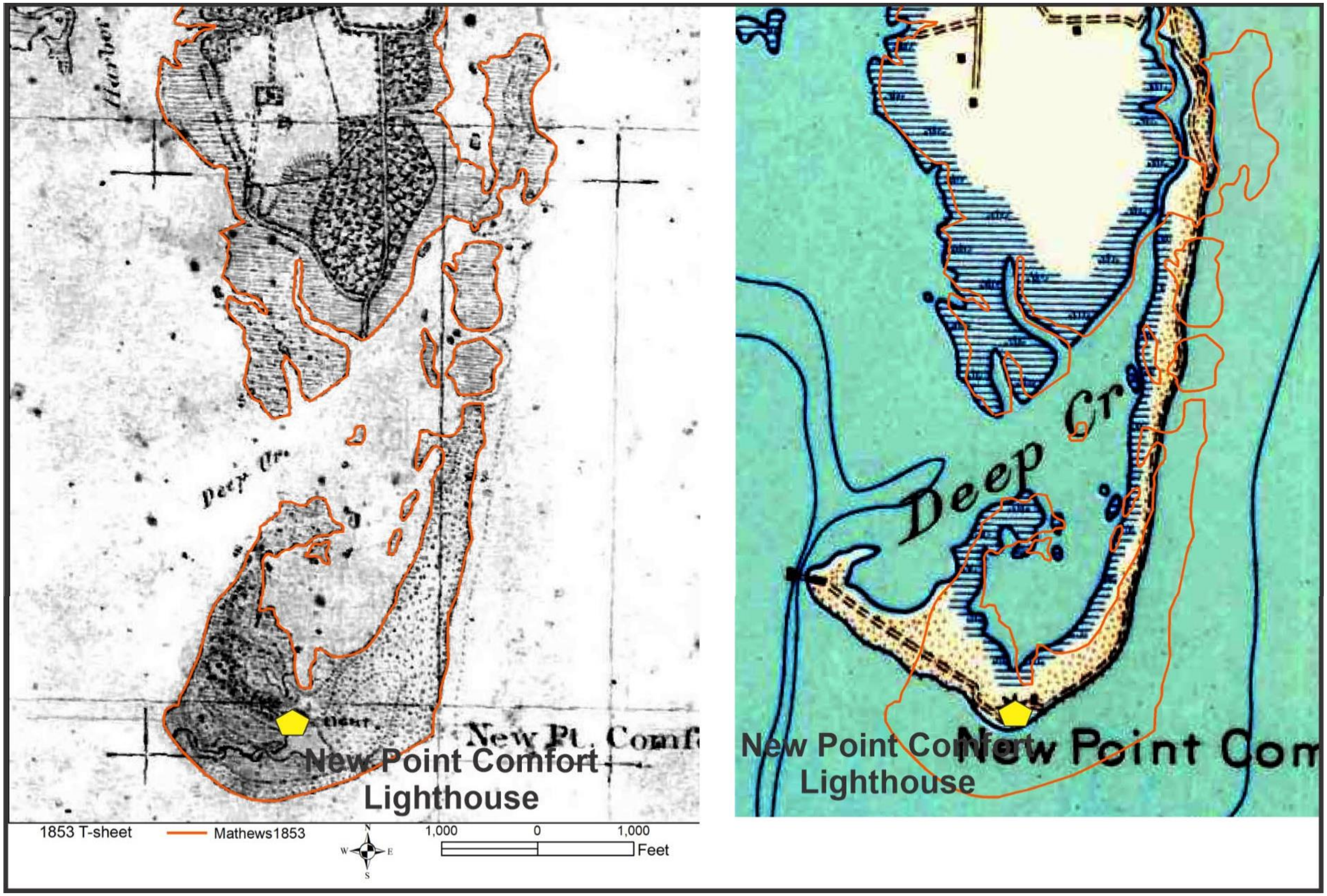


Figure 3-1. An 1853 T-sheet and digitized shoreline (left) and 1916 topographic map (right) showing the change in the spit surrounding the New Point Comfort Lighthouse.

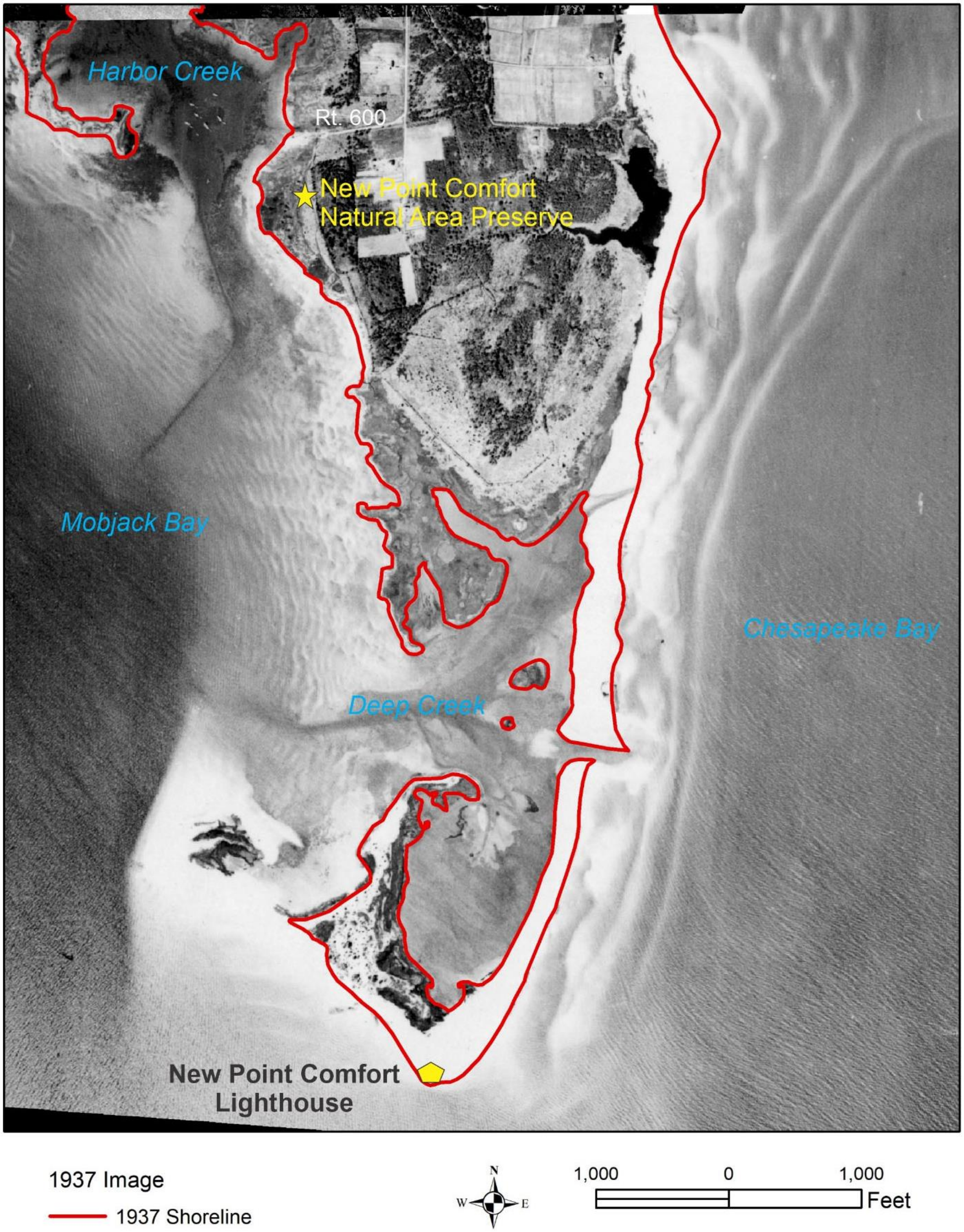


Figure 3-2. A 1937 photo with digitized shoreline.

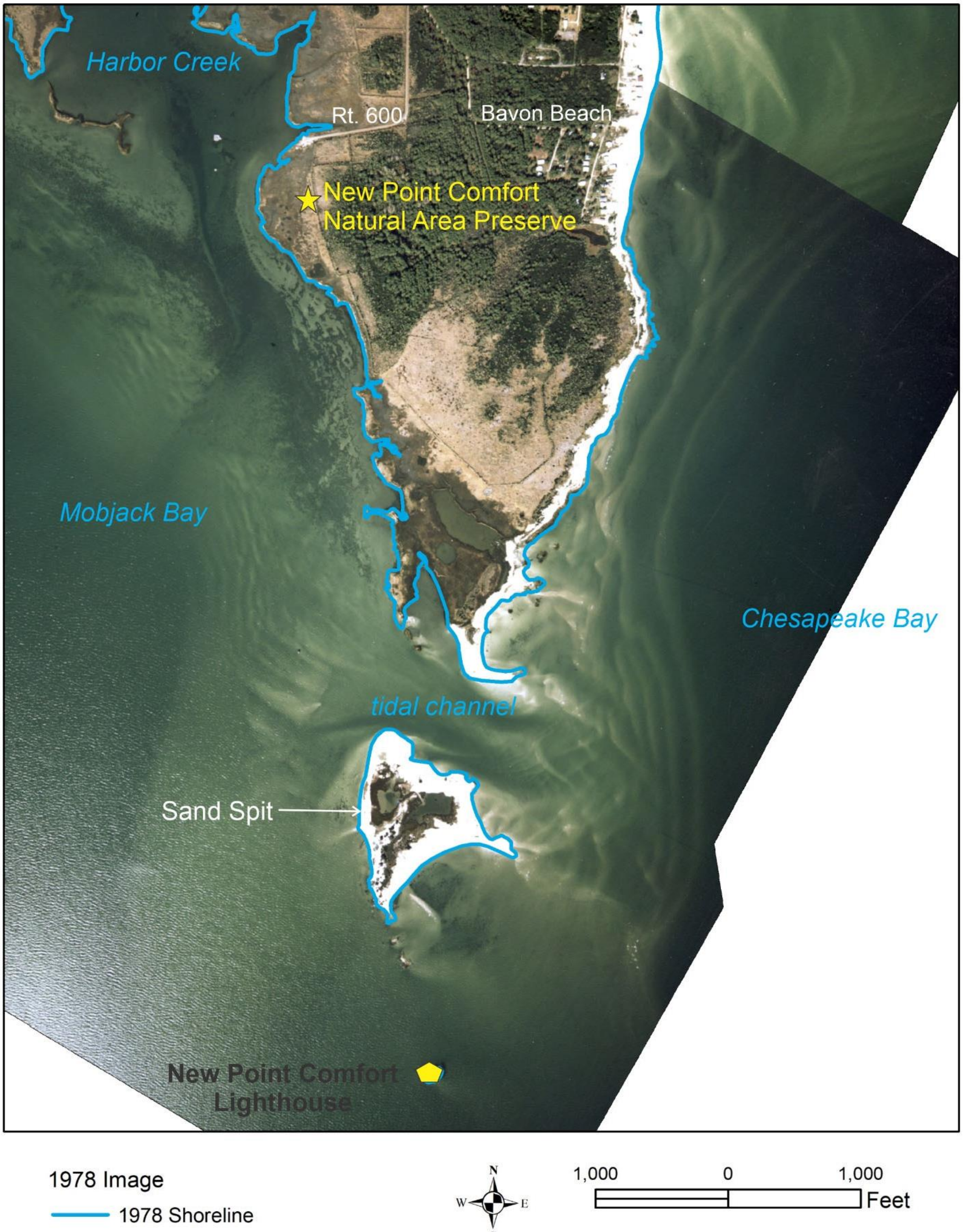


Figure 3-3. A 1978 photo with digitized shoreline.

Figure 3-4. A 2002 photo with digitized shoreline.

Figure 3-5. A 2007 photo with digitized shoreline.

Figure 3-6. A 2013 photo with digitized shoreline.

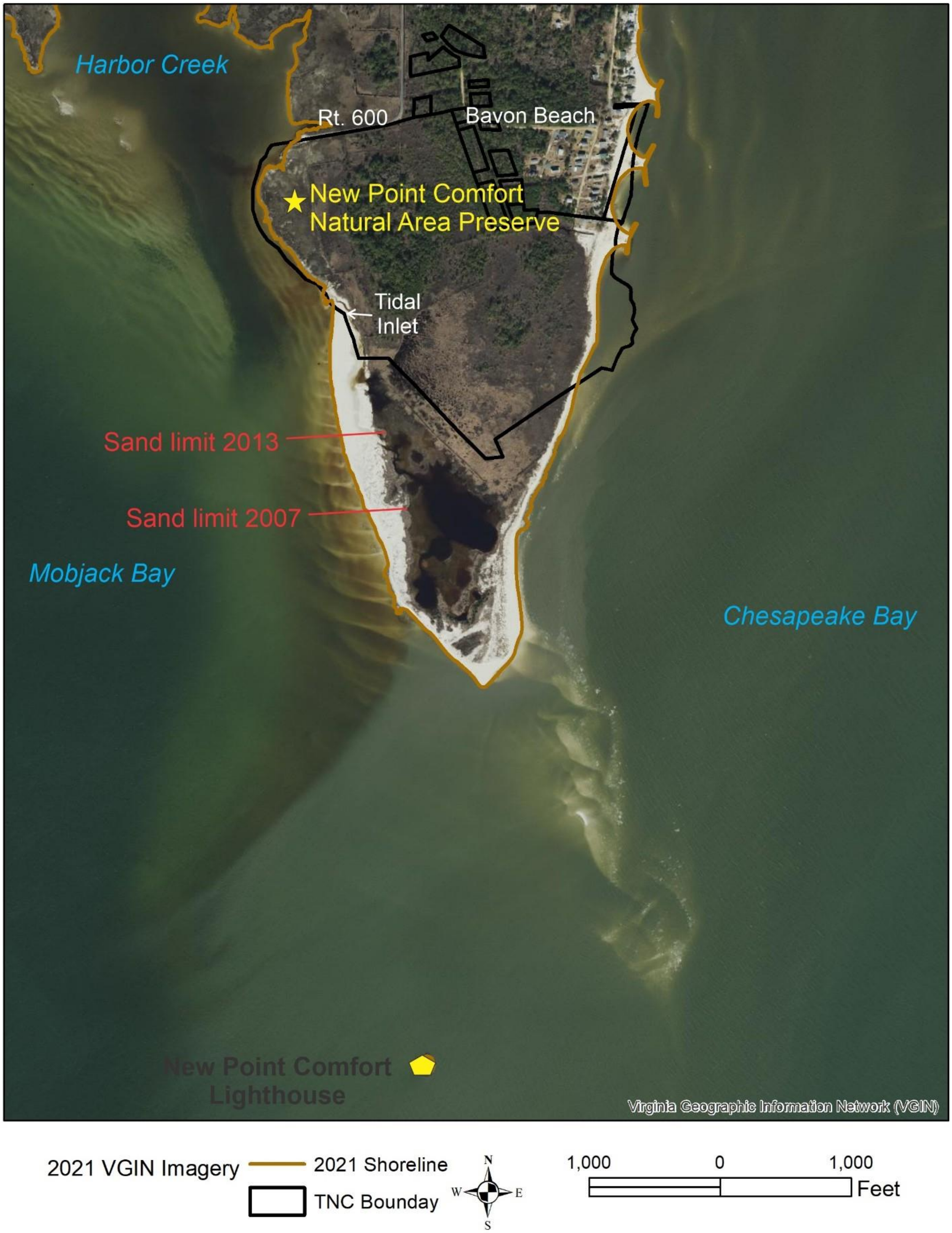


Figure 3-7. A 2021 photo with digitized shoreline.

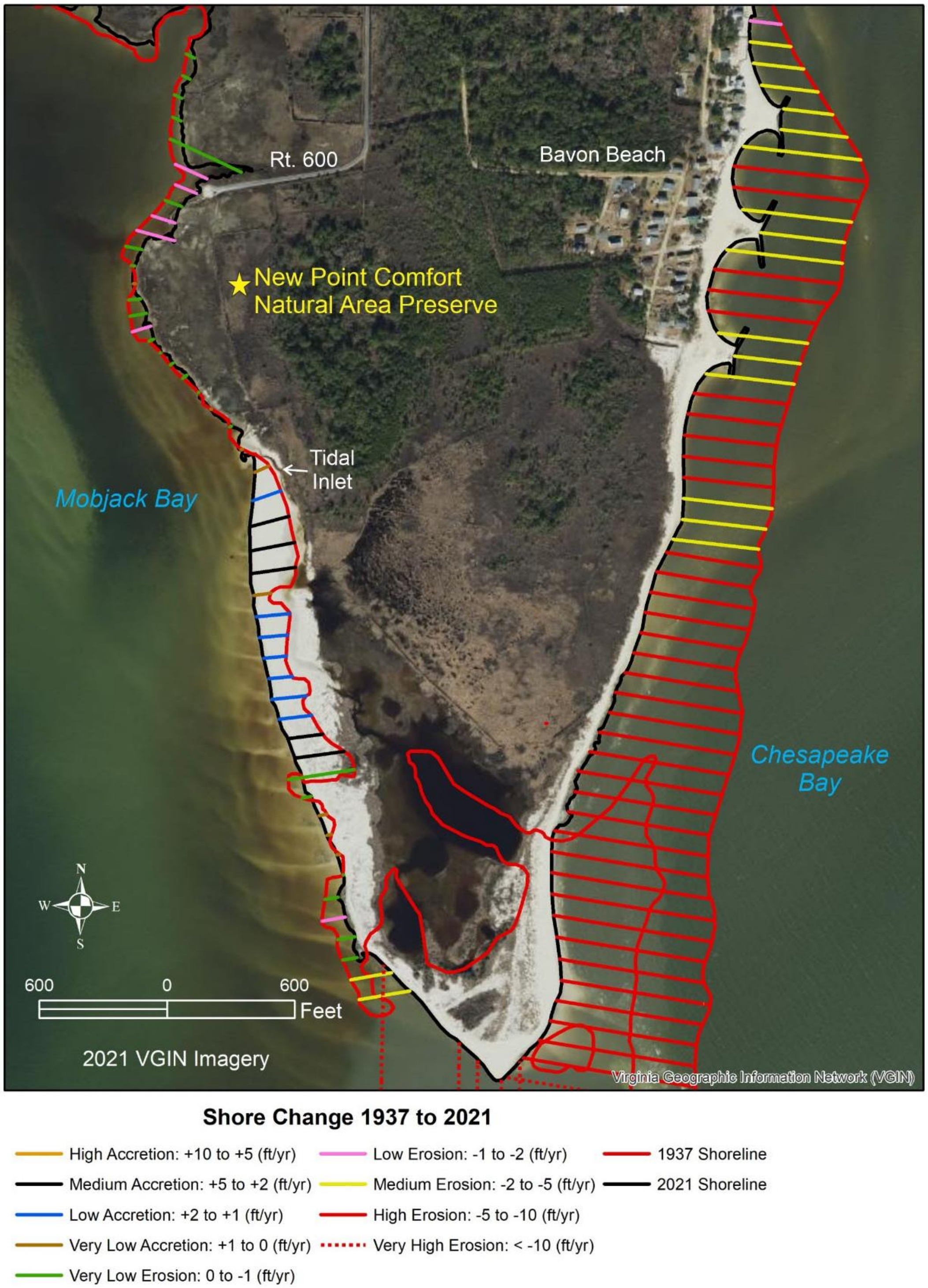


Figure 3-8. Shore change transects between 1937 and 2021.

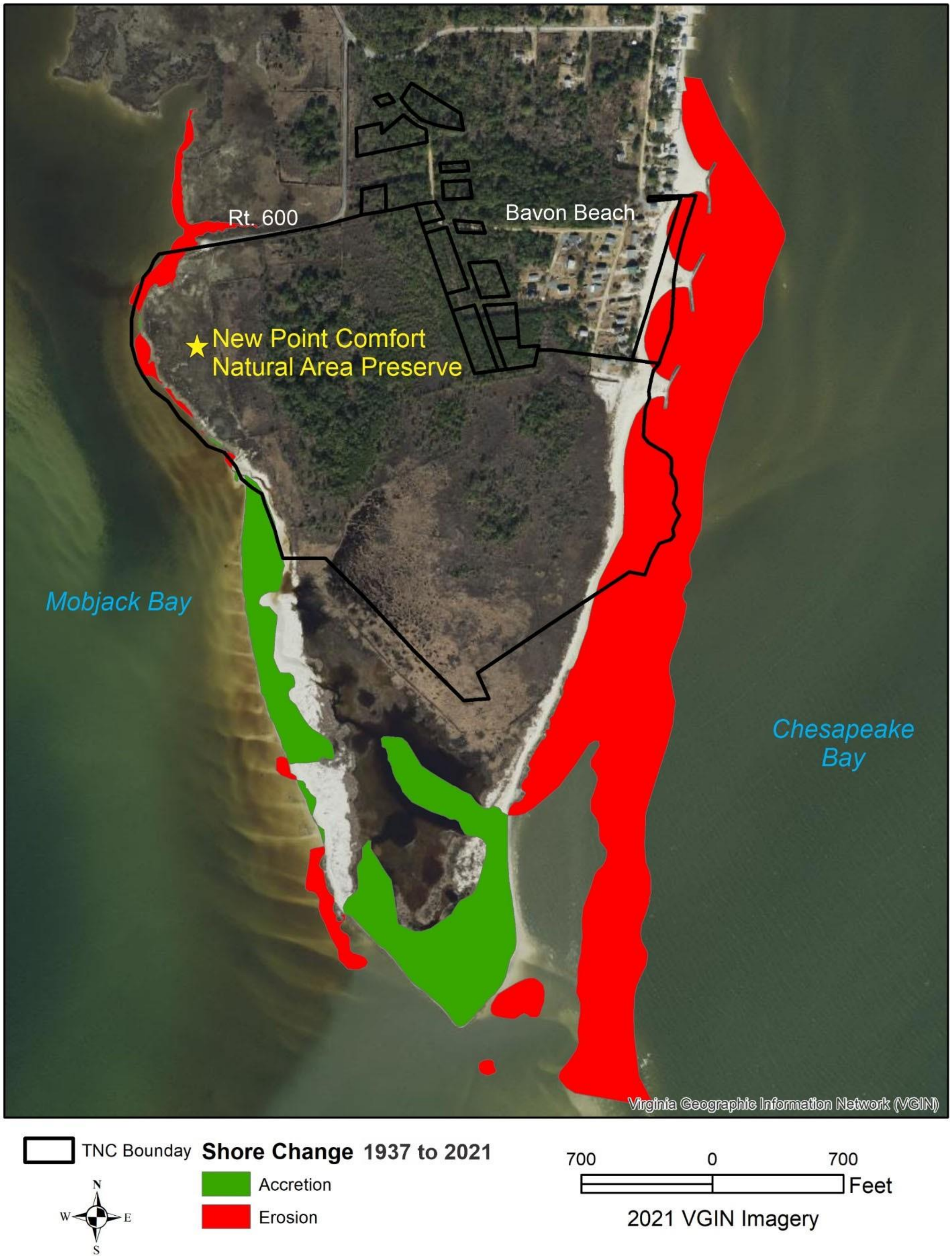


Figure 3-9. Net shore change between 1937 and 2021.

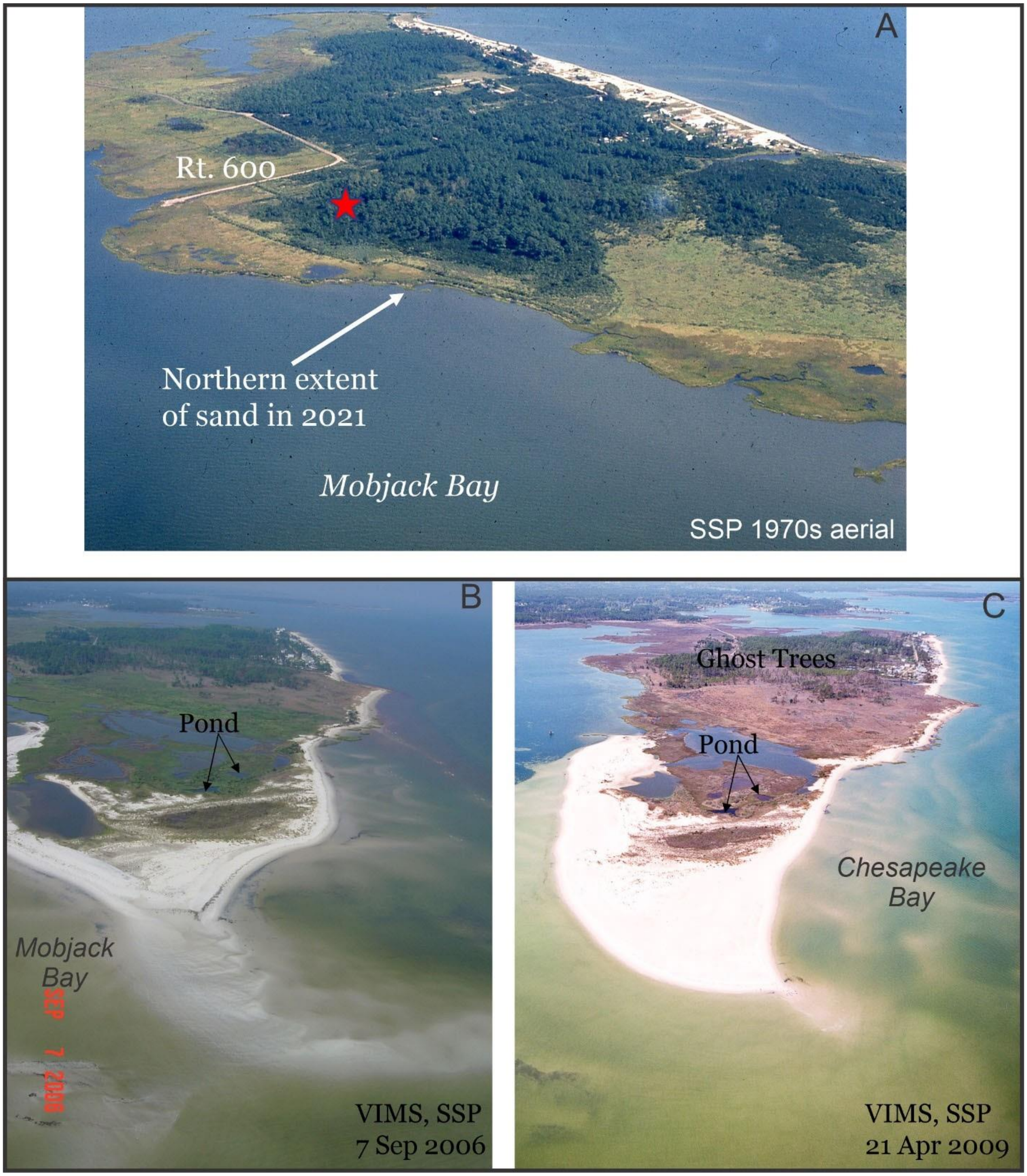


Figure 3-10. Photos of New Point Comfort peninsula A) in the 1970s showing the northern extent of sand in 2021; B) 2006; and C) 2009.

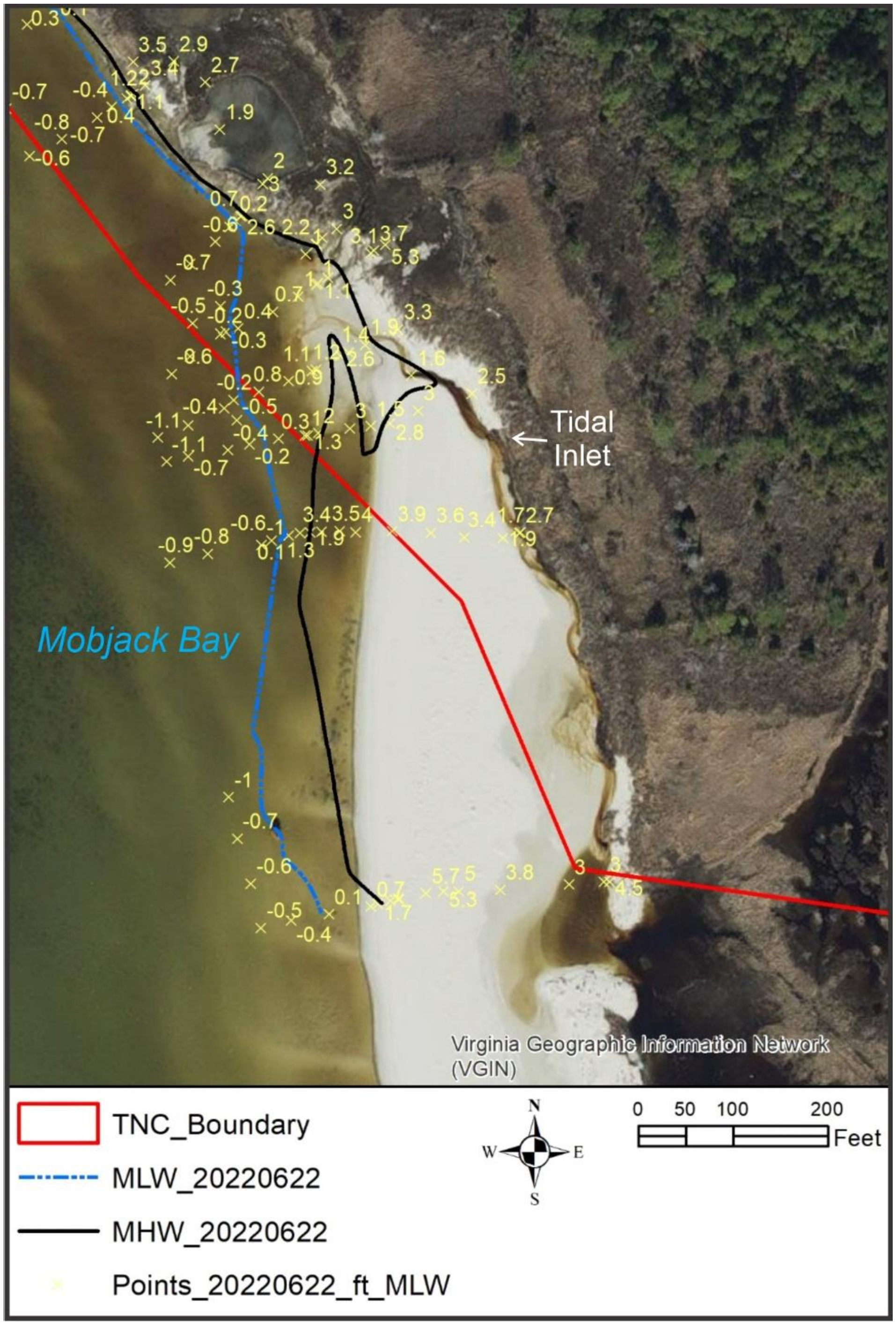


Figure 3-11. Close up of the southern extent of the site showing how much change has occurred between the 2021 photos and the 2022 survey.

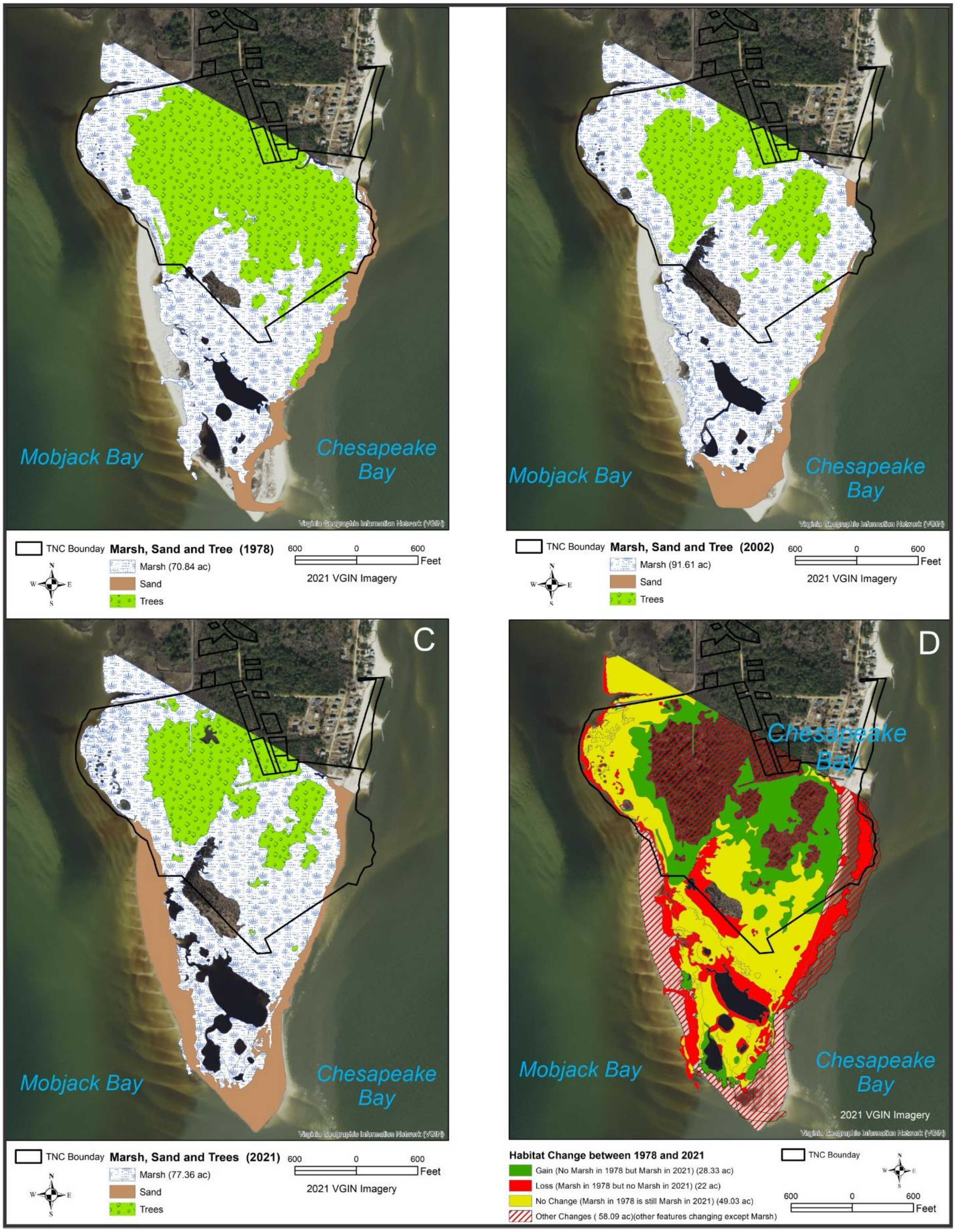


Figure 3-12. Habitat mapping in A) 1978; B) 2002; C) 2021; and D) habitat change between 1978 and 2021.

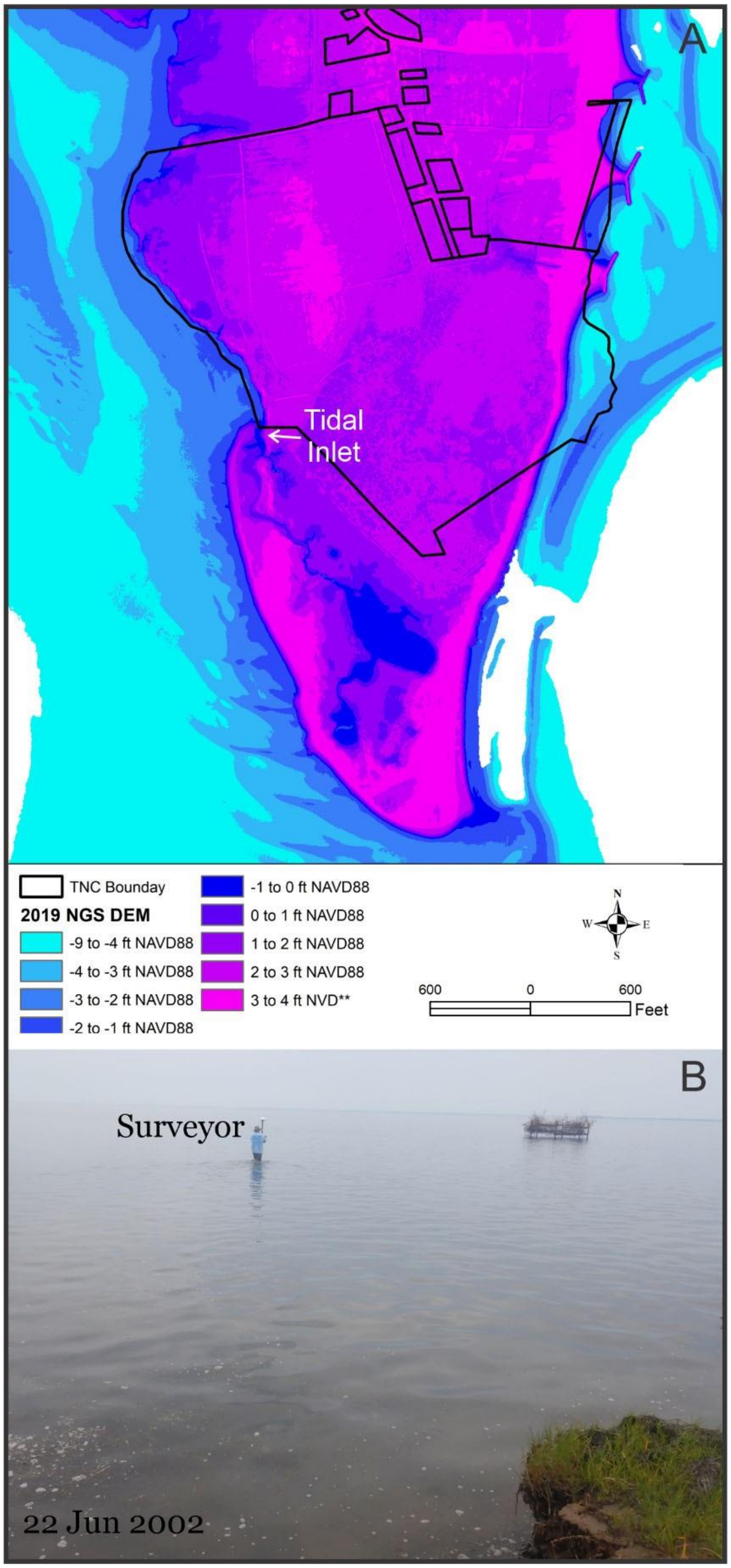


Figure 3-13. A) 2019 Lidar digital elevation model (DEM) showing the upland and nearshore elevations; and B) photo showing the surveyor in the nearshore.

Figure 3-14. The section of roads that were analyzed for elevation from Lidar data.

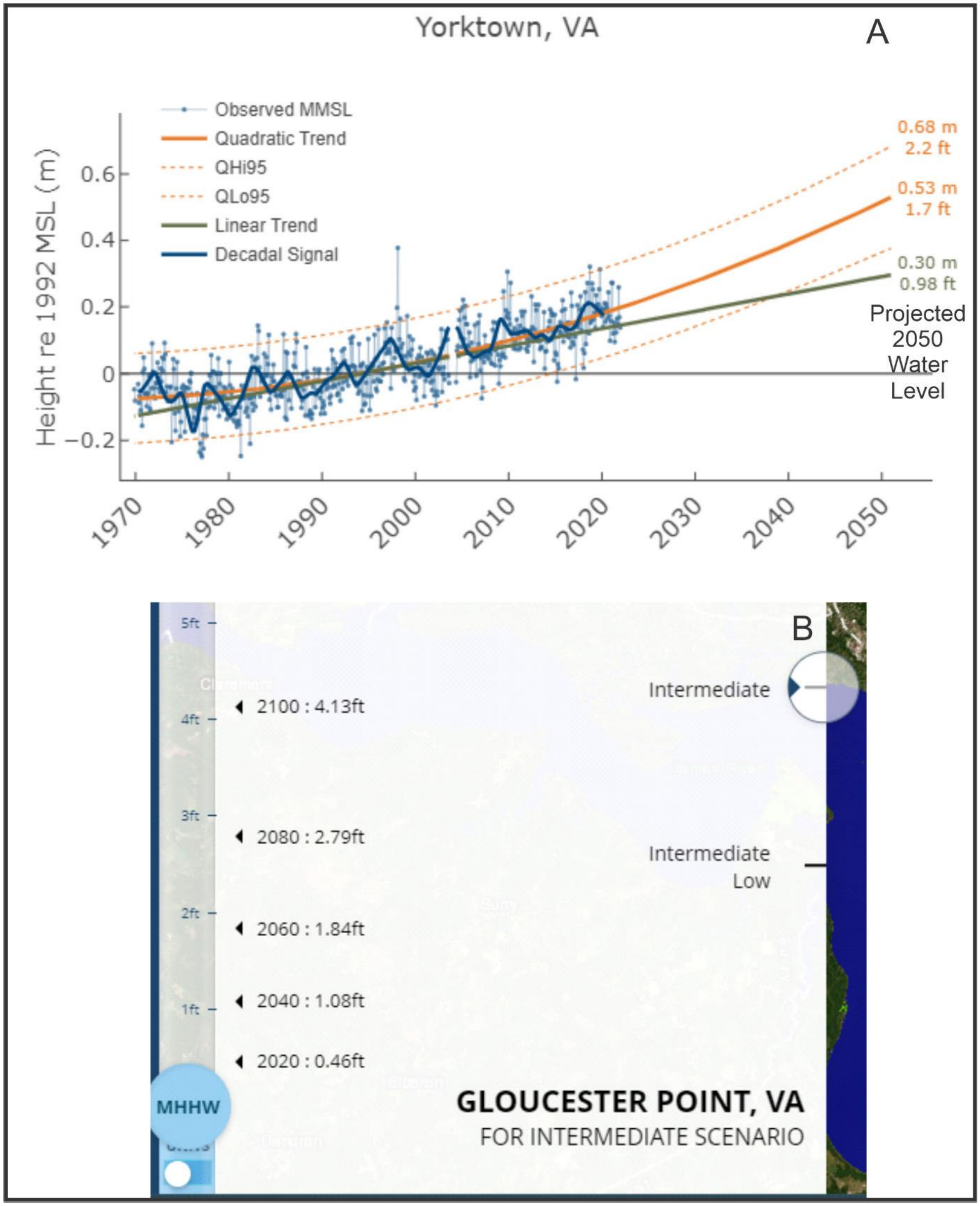


Figure 3-15. A) Quadratic rate of sea-level rise until 2050. The quadratic trend includes acceleration; and B) NOAA's intermediate rate of sea-level rise predictions.

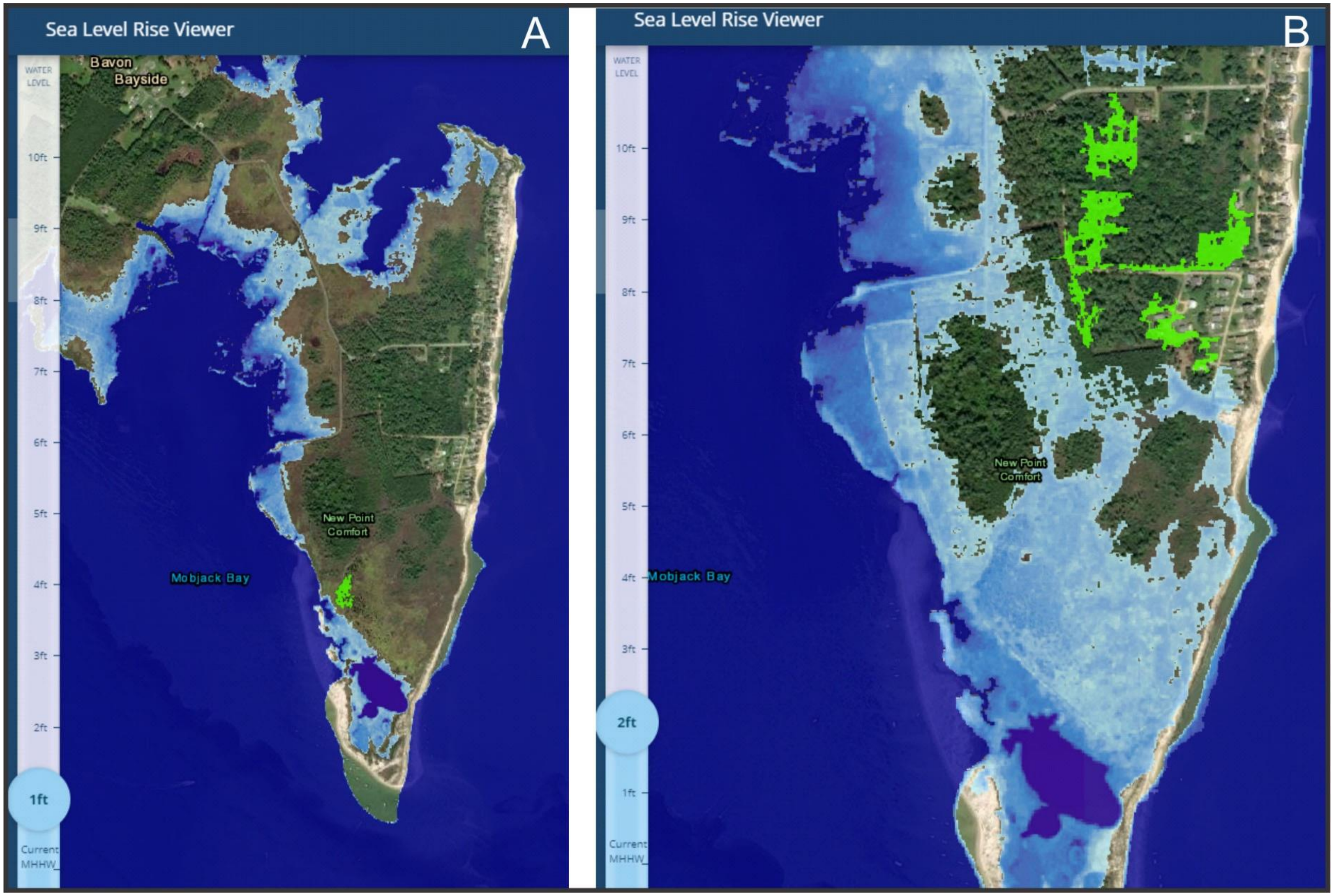


Figure 3-16. NOAA sea-level rise viewer showing how New Point Comfort will be affected by A) 1 ft and B) 2 ft of sea-level rise.

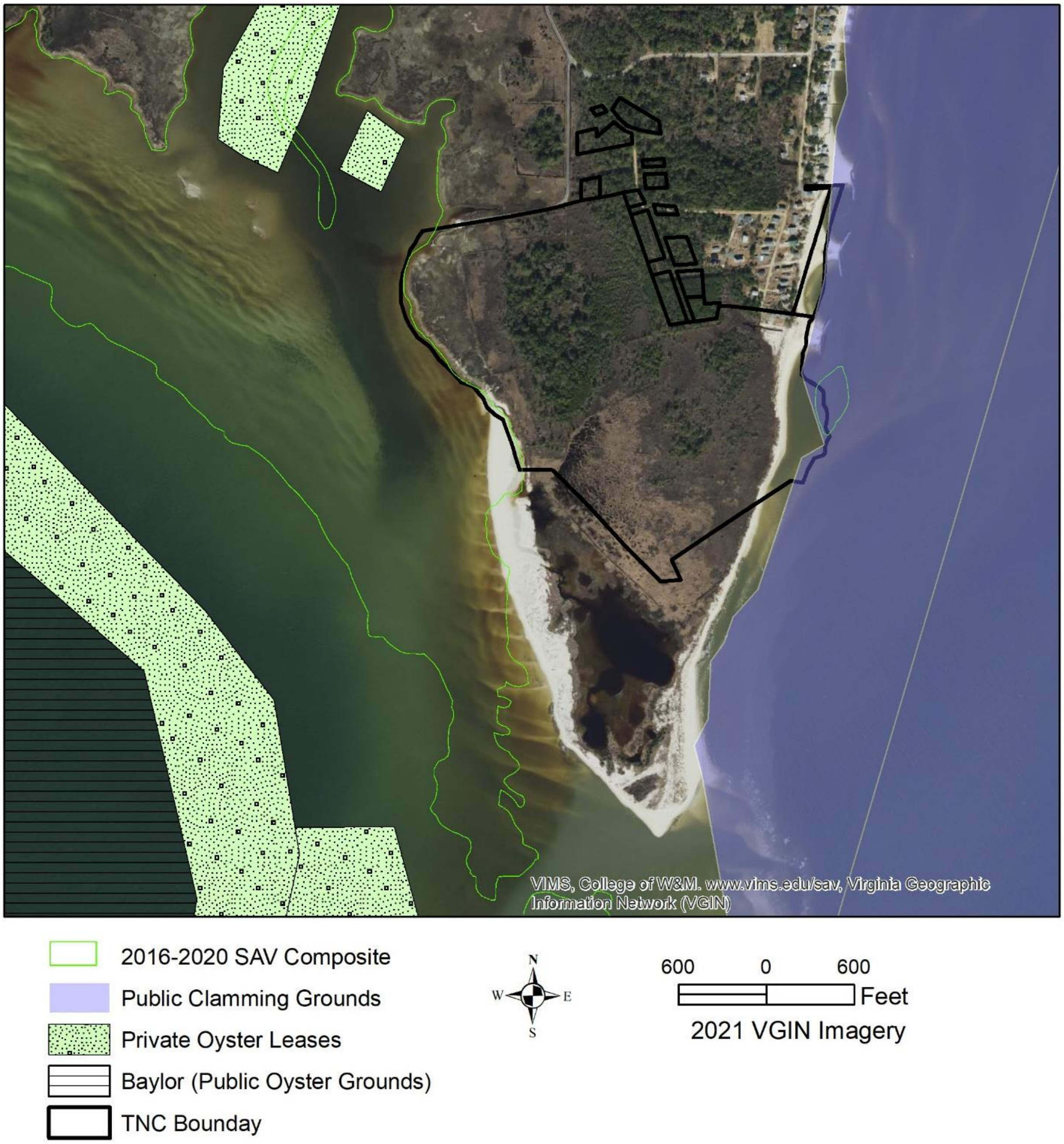


Figure 3-17. Marine resources mapped in the vicinity of New Point Comfort.

Figure 4-1. Rock sill living shoreline conceptual design for the site.

Figure 4-2. Intertidal oyster reef options A) oyster bag sill at installation and 5 years later; B) Oyster castles just after installation and with oyster growth; and C) Diamond reefs and x-reefs.

Figure 4-3. Natrx installation at another site in Mathews.

Figure 4-4. Reach-based recommendations for New Point Comfort peninsula.

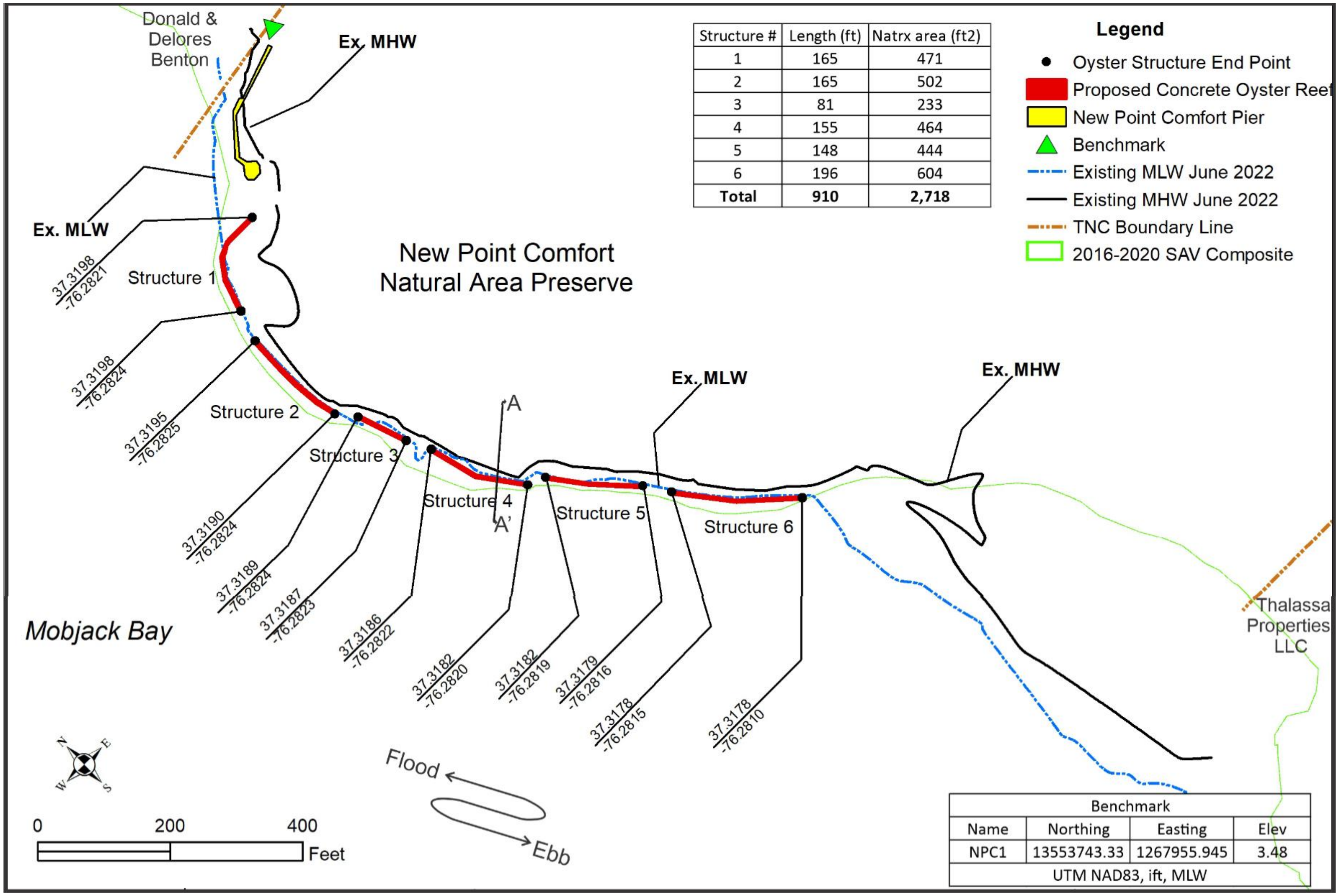


Figure 4-5. Map showing the placement of the Natrx structures.

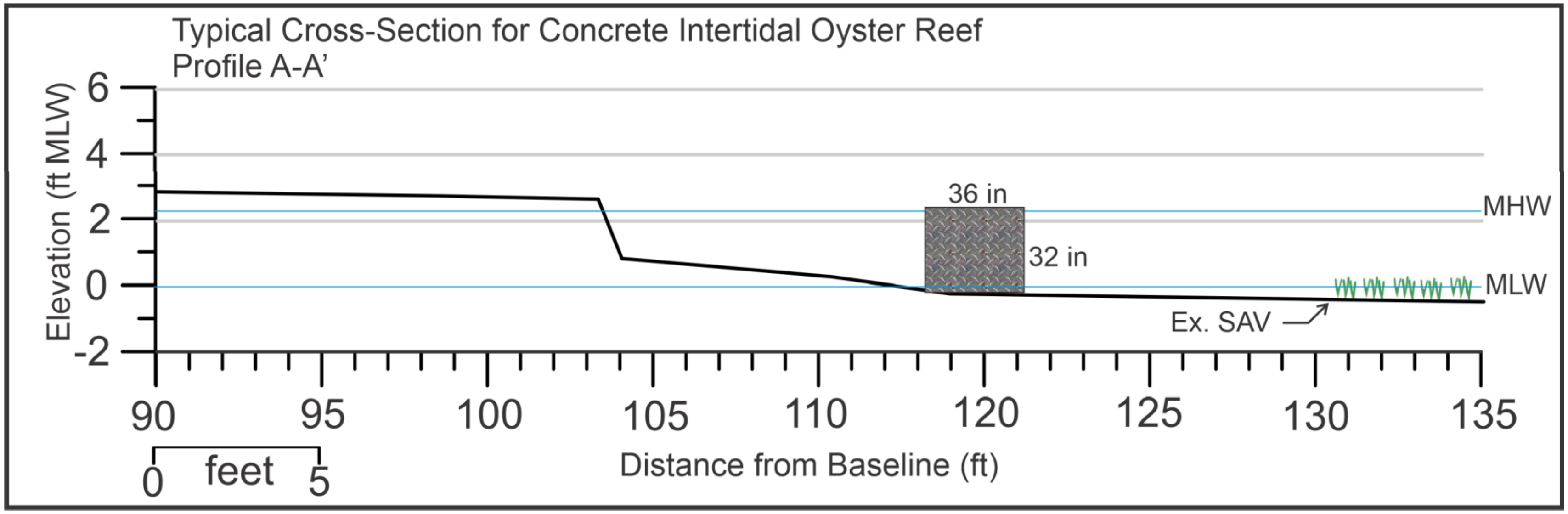


Figure 4-6. Typical cross-section of a Natrx structure.

Appendix A

Auger Logs and Sediment Sample Analysis

Samples taken 22 June 2022

Sediment samples processed by the VIMS Analytical Services Center for grain size

CLIENT: TNC DATE: 22 June 2022

SUBJECT: New Point Comfort

BORING #: B-1	Total Depth	Elev:	Location:
Type of Boring:	Started:	Completed:	Driller: CSH

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Dark gray medium stiff silty clay (CL)				B1-1
	-2		Olive gray stiff clayey sand (SC), trace organics (SAV)				B1-2
	-3						
	-4						
	-5						

CLIENT: TNC DATE: 22 June 2022

SUBJECT: New Point Comfort

BORING #: B-2	Total Depth	Elev:	Location:
Type of Boring:	Started:	Completed:	Driller: CSH

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Olive gray soft clayey silt (ML), trace organics (SAV)				B2-1
	-2		Olive gray soft clayey silt (ML), trace organics (SAV)				B2-2
	-3						
	-4						
	-5						

CLIENT: TNC							DATE: 22 June 2022
SUBJECT: New Point Comfort							
BORING #: B-3		Total Depth		Elev:		Location:	
Type of Boring:			Started:	Completed:		Driller: CSH	

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Light gray loose medium sand (SP)				B3-1
	-2		Olive gray silty sand (SM), little clay				B3-2
	-3						
	-4						
	-5						

CLIENT: TNC							DATE: 22 June 2022
SUBJECT: New Point Comfort							
BORING #: B-4		Total Depth		Elev:		Location:	
Type of Boring:			Started:	Completed:		Driller: CSH	

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Olive gray silty sand (SM), little clay				B4-1
	-2		Olive gray silty sand (SM), little clay				B4-2
	-3						
	-4						
	-5						

CLIENT: TNC				DATE: 22 June 2022			
SUBJECT: New Point Comfort							
BORING #: B-5		Total Depth	Elev:	Location:			
Type of Boring:		Started:	Completed:	Driller: CSH			

Elevation MLW	Depth		Description of Materials (classification)	Sample Blows	Sample Depth (ft)	Moisture Content (%)	Remarks
	0						
	-1		Greenish gray loose, medium fine sand (SP)				B5-1
	-2		Light gray medium dense fine sand (SP), trace silt and clay				B5-2
	-3						
	-4						
	-5						

Lab#	Collect_Date	SampleID	% Gravel Units: % MDL: 0.1	% Sand Units: % MDL: 0.1	% Silt Units: % MDL: 0.1	% Clay Units: % MDL: 0.1
221118R001	6/22/2022	New Point B1-1	0	45.4	28.9	25.7
221118R002	6/22/2022	New Point B1-2	0	54.1	26.3	19.6
221118R003	6/22/2022	New Point B2-1	0	44.5	31.9	23.6
221118R004	6/22/2022	New Point B2-2	0	46.4	32.3	21.3
221118R005	6/22/2022	New Point B3-1	0	93.3	3.9	2.8
221118R006	6/22/2022	New Point B3-2	0	57.3	25	17.7
221118R007	6/22/2022	New Point B4-1	0	51.4	28.1	20.5
221118R008	6/22/2022	New Point B4-2	0	59	24.4	16.6
221118R009	6/22/2022	New Point B5-1	0	94.2	2.8	3
221118R010	6/22/2022	New Point B5-2	0	84.9	8.6	6.5

Appendix B

Draft Joint Permit Application for NPCNAP Natrx intertidal oyster reef project

Drawings included

Cost and construction considerations need to be added by the contractor before submittal

Regulatory Agency Contact Information

Virginia Marine Resources Commission (VMRC)
Habitat Management Division
380 Fenwick Road, Building 96
Fort Monroe, VA 23651
Phone: (757) 247-2200, Fax: (757) 247-8062
Website: http://www.mrc.virginia.gov/hmac/hmoverview.shtm

United States Army Corps of Engineers (USACE)
Norfolk District
803 Front Street, ATTN: CENAO-WR-R
Norfolk, Virginia 23510-1011
Phone: (757) 201-7652, Fax: (757) 201-7678
Website: http://www.nao.usace.army.mil/Missions/Regulatory.aspx

Virginia Department of Environmental Quality (DEQ)
Virginia Water Protection Permit Program
Post Office Box 1105
Richmond, Virginia 23218
Phone: (804) 698-4000
Website: http://www.deq.virginia.gov/

LOCAL WETLANDS BOARD (LWB) CONTACT INFORMATION:
Links to LWB information on the Web can be found at
http://ccrm.vims.edu/permits_web/guidance/local_wetlands_boards.html
In addition, the phone numbers listed below can be used to contact the LWB. Please be advised that these phone numbers are subject to change at any time.

Accomack County (757) 787-5721, Cape Charles (757) 331-3259, Charles City County (804) 829-9296, Chesapeake (757) 382-6248, Colonial Heights (804) 520-9275, Essex County (804) 443-4951, Fairfax County (703) 324-1364, Fredericksburg (540) 372-1179, Gloucester County (804) 693-2744, Hampton (757) 727-6140, Hopewell (804) 541-2267, Isle of Wight County (757) 365-6211, James City County (757) 253-6673, King and Queen County (804) 769-4978, King George County (540) 775-7111, King William County (804) 769-4927, Lancaster County (804) 462-5220, Mathews County (804) 725-5025, Middlesex County (804) 758-0500, New Kent County (804) 966-9690, Newport News (757) 247-8437, Norfolk (757) 664-4368, Northampton County (757) 678-0442, Northumberland County (804) 580-8910, Poquoson (757) 868-3040, Portsmouth (757) 393-8836, Prince William County (703) 792-6984, Richmond County (804) 333-3415, Stafford County (540) 658-8668, Suffolk (757) 923-3650, Virginia Beach (757) 427-8246, Westmoreland County (804) 493-0120, West Point (804) 843-3330, Williamsburg (757) 220-6130, York County (757) 890-3538

Tidewater Joint Permit Application (JPA)
For Projects Involving Tidal Waters, Tidal Wetlands and/or Dunes and Beaches in Virginia

This application may be used for most commercial and noncommercial projects involving **tidal waters, tidal wetlands and/or dunes and beaches in Virginia** which require review and/or authorization by Local Wetlands Boards (LWB), the Virginia Marine Resources Commission (VMRC), the Department of Environmental Quality (DEQ), and/or the U. S. Army Corps of Engineers (USACE). This application can be used for:

- **Access-related activities**, including piers, boathouses, boat ramps (without associated dredging or excavation*), moorings, marinas.
- **Shoreline stabilization projects** including living shorelines, riprap revetments, marsh toe stabilization, bulkheads, breakwaters, beach nourishment, groins, and jetties. It is the policy of the Commonwealth that living shorelines are the preferred alternative for stabilizing tidal shorelines (Va. Code § 28.2-104.1).
- **Crossings** over or under tidal waters and wetlands including bridges and utility lines (water, sewer, electric).
- **Aquaculture structures**, including cages and floats except "oyster gardening"**

***Note:** for all dredging, excavation, or surface water withdrawal projects you **MUST** use the Standard JPA form; for noncommercial, riparian shellfish aquaculture projects (i.e., "oyster gardening") you must use the abbreviated JPA found at https://mrc.virginia.gov/forms/2019/VGP3_Aquaculture_form_2019.pdf or call VMRC for a form.

The DEQ and the USACE use this form to determine whether projects qualify for certain General, Regional, and/or Nationwide permits. If your project does not qualify for these permits and you need a DEQ Virginia Water Protection permit or an individual USACE permit, you must submit the Standard Joint Permit application form. You can find this application at http://www.nao.usace.army.mil/Missions/Regulatory/JPA.aspx. Please note that some health departments and local agencies, such as local building officials and erosion and sediment control authorities, do not use the Joint Permit Application process or forms and may have different informational requirements. The applicant is responsible for contacting these agencies for information regarding those permitting requirements.

HOW TO APPLY

Submit one (1) completed copy of the Tidewater JPA to VMRC:

1. If by mail or courier, use the VMRC address provided on page 1.
2. If by electronic mail, address the package to: **JPA.permits@mrc.virginia.gov.** The application must be provided in the .pdf format and should not exceed 10 MB. If larger than 10 MB you may provide a file transfer protocol (ftp) site for download purposes.

The Tidewater JPA should include the following:

1. **Part 1** – General Information
2. **Part 2** – Signatures
3. **Part 3** - Appendices (A, B, C, and/or D as applicable to your project)
4. **Part 4** – Project Drawings.
   The drawings shall include the following for **ALL** projects:
   - Vicinity Map (USGS topographic map, road map or similar showing project location)
   - Plan View Drawing (overhead, to scale or with dimensions clearly marked)
   - Section View Drawing (side-view, to scale or with dimensions clearly marked)

Sample drawings are included at the end of Part 4 of this application to show examples of the information needed to consider your application complete and allow for the timely processing.

When completing this form, use the legal name of the applicant, agent, and/or property owner. For DEQ application purposes, *legal name* means the full legal name of an individual, business, or other organization. For an individual, the legal name is the first name, middle initial, last name, and suffix. For an entity authorized to do business in Virginia, the legal name is the exact name set forth in the entity's articles of incorporation, organization or trust, or formation agreement, as applicable. Also provide the name registered with the State Corporation Commission, if required to register. DEQ issues a permit or grants coverage to the so-named individual or business, who becomes the 'permittee'. Correspondence from some agencies, including permits, authorizations, and/or coverage, may be provided via electronic mail. If the applicant and/or agent wishes to receive their permit via electronic mail, please remember to include an e-mail address at the requested place in the application.

In order for projects requiring LWB authorization to be considered complete (Virginia Code § 28.2-1302); "The permit application shall include the following: the name and address of the applicant; a detailed description of the proposed activities; a map, drawn to an appropriate and uniform scale, showing the area of wetlands directly affected, the location of the proposed work thereon, the area of existing and proposed fill and excavation, the location, width, depth and length of any proposed channel and disposal area, and the location of all existing and proposed structures, sewage collection and treatment facilities, utility installations, roadways, and other related appurtenances of facilities, including those on the adjacent uplands; a description of the type of equipment to be used and the means of access to the activity site; the names and addresses of record of adjacent land and known claimants of water rights in or adjacent to the wetland of whom the applicant has notice; an estimate of cost; the primary purpose of the project; and secondary purpose of the proposed project; a complete description of measures to be taken during and after alteration to reduce detrimental offsite effects; the completion date of the proposed work, project, or structure; and such additional materials and documentation as the wetlands board may require."

You may include signed Adjacent Property Owner (APO) Acknowledgement Forms found at the end of this Short Form. You must provide these addresses in Part 1 whether or not you use the APO forms. VMRC will request comments from APOs for projects that require permits for encroachment over state-owned submerged lands. VMRC or your local wetlands board must notify all APO's of public hearings required for all proposals involving tidal wetlands and dunes/beaches that are not authorized by statute. This information will not be used by DEQ to meet the requirements of notifying riparian land owners.

Regional Permit 17 (RP-17), authorizes the installation and/or construction of open-pile piers, mooring structures/devices, fender piles, covered boathouses/boatslips, boatlifts, osprey pilings/platforms, accessory pier structures, and certain devices associated with shellfish gardening, for private use, subject to strict compliance with all conditions and limitations further set out in the RP-17 enclosure located at http://www.nao.usace.army.mil/Missions/Regulatory/RBregional/. In addition to the information required in this JPA, prospective permittees seeking authorization under RP-17 must complete and submit the 'Regional Permit 17 Checklist' with their JPA. A copy of the 'Regional Permit 17 Checklist' is found on pages 13 and 14 of this application package. If the prospective permittee answers "yes" (or "N/A", where applicable) to all of the questions on the 'Regional Permit 17 Checklist', the permittee is in compliance with RP-17 and will not receive any other written authorization from the Corps but may not proceed with construction until they have obtained all necessary state and local permits. ***Note: If the prospective permittee answers "no" to any of the questions on the 'Regional Permit 17 Checklist' then their proposed structure(s) does not meet the terms and conditions of RP-17 and written authorization from the Corps is required before commencement of any work.***

Note: Land disturbance (grading, filling, etc.) or removal of vegetation associated with projects located in Chesapeake Bay Preservation Areas will require approval from local governments. Certain localities utilize this application during their Bay Act review. Part 5 of this application is included to provide assistance for the applicant to comply with Bay Act /or Erosion and Sediment Control requirements concurrent with this application.

WHAT HAPPENS NEXT

Upon receipt of an application, VMRC will assign a permit application number to the JPA and will then distribute a copy of the application and any original plan copies submitted to the other regulatory agencies that are involved in the JPA process. All agencies will conduct separate but concurrent reviews of your project. Please be aware that each agency must issue a separate permit (or a notification that no permit is required). Note that in some cases, DEQ may be taking an action on behalf of the USACE, such as when the State Program General Permit (SPGP) applies. Make sure that you have received all necessary authorizations, or documentation that no permit is required, from each agency prior to beginning the proposed work.

During the JPA review process, site inspections may be necessary to evaluate a proposed project. Failure to allow an authorized representative of a regulatory agency to enter the property, or to take photographs of conditions at the project site, may result in either the withdrawal or denial of your permit application.

For certain federal and state permit applications, a public notice is published in a newspaper having circulation in the project area, is mailed to adjacent and/or riparian property owners, and/or is posted on the agency's web page. The public may comment on the project during a designated comment period, if applicable, which varies depending upon the type of permit being applied for and the issuing agency. In certain circumstances, the project may be heard by a governing board, such as a Local Wetlands Board, the State Water Control Board, or VMRC in cases where a locality does not have a wetlands board and with certain subaqueous cases. You may be responsible for bearing the costs for advertisement of public notices.

Public hearings that are held by VMRC occur at their regularly scheduled monthly commission meetings under the following situations: Protested applications for VMRC permits which cannot be resolved; projects costing over $500,000 involving encroachment over state-owned subaqueous land; and all projects affecting tidal wetlands and dunes/beaches in localities without a LWB. All interested parties will be officially notified regarding the date and time of the hearing and Commission meeting procedures. The Commission will usually make a decision on the project at the meeting unless a decision for continuance is made. If a proposed project is approved, a permit or similar agency correspondence is sent to the applicant. In some cases, notarized signatures, as well as processing fees and royalties, are required before the permit is validated. If the project is denied, the applicant will be notified in writing.

PERMIT APPLICATION OR OTHER FEES

Do not send any fees with the JPA. VMRC is not responsible for accounting for fees required by other agencies. Please consult agency websites or contact agencies directly for current fee information and submittal instructions.

- USACE: Permit application fees are required for USACE Individual (Standard) permits. A USACE project manager will contact you regarding the proper fee and submittal requirements.

- ❖ DEQ: Permit application fees required for Virginia Water Protection permits – while detailed in 9VAC25-20 – are conveyed to the applicant by the applicable DEQ office (http://www.deq.virginia.gov/Locations.aspx). Complete the Permit Application Fee Form and submit it per the instructions to the address listed on the form. Instructions for submitting any other fees will be provided to the applicant by DEQ staff.
- ❖ VMRC: An application fee of $300 may be required for projects impacting tidal wetlands, beaches and/or dunes when VMRC acts as the LWB. VMRC will notify the applicant in writing if the fee is required. Permit fees involving subaqueous lands are $25.00 for projects costing $10,000 or less and $100 for projects costing more than $10,000. Royalties may also be required for some projects. The proper permit fee and any required royalty is paid at the time of permit issuance by VMRC. VMRC staff will send the permittee a letter notifying him/her of the proper permit fees and submittal requirements.
- ❖ LWB: Permit fees vary by locality. Contact the LWB for your project area or their website for fee information and submittal requirements. Contact information for LWBs may be found at http://ccrm.vims.edu/permits_web/guidance/local_wetlands_boards.html.

FOR AGENCY USE ONLY	
	Notes:
	JPA #

APPLICANTS
Part 1 – General Information

PLEASE PRINT OR TYPE ALL ANSWERS: If a question does not apply to your project, please print N/A (not applicable) in the space provided. If additional space is needed, attach 8-1/2 x 11 inch sheets of paper.

Check all that apply		
Pre-Construction Notification (PCN) ☐ NWP # ______________ (*For Nationwide Permits ONLY - No DEQ-VWP permit writer will be assigned*)	Regional Permit 17 (RP-17) ☐	

County or City in which the project is located: Mathews

Waterway at project site: Mobjack Bay

PREVIOUS ACTIONS RELATED TO THE PROPOSED WORK (Include all federal, state, and local pre application coordination, site visits, previous permits, or applications whether issued, withdrawn, or denied)

Historical information for past permit submittals can be found online with VMRC - https://webapps.mrc.virginia.gov/public/habitat/ - or VIMS - http://ccrm.vims.edu/perms/newpermits.html

Agency	Action / Activity	Permit/Project number, including any non-reporting Nationwide permits previously used (e.g., NWP 13)	Date of Action	If denied, give reason for denial

Part 1 - General Information (continued)

1. Applicant's legal name* and complete mailing address: Contact Information:

Home (____)______________
Work (____)______________
Fax (____)______________
Cell (____)______________
e-mail ___________________

State Corporation Commission Name and ID Number (if applicable) ______________

2. Property owner(s) legal name* and complete address, if different from applicant: Contact Information:

The Nature Conservancy
652 PETER JEFFERSON PARKWAY
SUITE 190
CHARLOTTESVILLE, VA 22911

Home (____)______________
Work (____)______________
Fax (____)______________
Cell (____)______________
e-mail ___________________

State Corporation Commission Name and ID Number (if applicable) ______________

3. Authorized agent name* and complete mailing address (if applicable): Contact Information:

Home (____)______________
Work (____)______________
Fax (____)______________
Cell (____)______________
e-mail ___________________

State Corporation Commission Name and ID Number (if applicable) ______________

*** If multiple applicants, property owners, and/or agents, each must be listed and each must sign the applicant signature page.**

4. Provide a detailed description of the project in the space below, including the type of project, its dimensions, materials, and method of construction. Be sure to include how the construction site will be accessed and whether tree clearing and/or grading will be required, including the total acreage. If the project requires pilings, please be sure to include the total number, type (e.g. wood, steel, etc), diameter, and method of installation (e.g. hammer, vibratory, jetted, etc). If additional space is needed, provide a separate sheet of paper with the project description.

The project site occurs on the west side of the New Point Comfort Peninsula. The Mobjack Bay coast of the New Point Comfort Natural Area Preserve is eroding at about -1 ft/yr and has an exposed marsh scarp. Though the erosion rate is low, it is a high energy site with an average fetch of 10 miles and a longest fetch of 15 miles. To protect the marsh and create oyster reef habitat, the project consists of 6 intertidal oyster reefs constructed of Natrx 3D-printed concrete structures. Each structure will be 36 inches wide, 32 inches high, and about 36 inches long. Each structure will be about 2,000 lbs. The modules will be placed in a line along the shore generally at about MLW with small breaks between the units where geomorphology suggests. They will be placed landward of the submerged aquatic vegetation composite footprint (2016-2021) at the site and will not impact any SAV. The project will be built by barge so no tree clearing or grading will occur, and the marsh will not be impacted. No sand fill will be placed for the project.

Part 1 - General Information (continued)

5. Have you obtained a contractor for the project?____Yes* x___ No. *If your answer is "Yes" complete the remainder of this question and submit the Applicant's and Contractor's Acknowledgment Form (enclosed)

Contractor's name* and complete mailing address:

Contact Information:
Home (____)_____________
Work (____)_____________
Fax (____)_____________
Cell (____)_____________
email ___________________

State Corporation Commission Name and ID Number (if applicable) _____________________

<u>* If multiple contractors, each must be listed and each must sign the applicant signature page.</u>

6. List the name, address and telephone number of the newspaper having general circulation in the area of the project. Failure to complete this question may delay local and State processing.

Name and complete mailing address:
Gloucester-Mathews Gazette-Journal
P.O. Box 2060
Gloucester, Va. 23061

Telephone number
(804) 693-3101

7. Give the following project location information:

Street Address (911 address if available)_____________________
Lot/Block/Parcel# Parcel ID: 44-A-19
Subdivision_____________________
City / County Mathews ZIP Code_____________
Latitude and Longitude at Center Point of Project Site (Decimal Degrees):
37.318529 / - 76.280916 (Example: 36.41600/-76.30733)

If the project is located in a rural area, please provide driving directions giving distances from the best and nearest visible landmarks or major intersections. *Note: if the project is in an undeveloped subdivision or property, clearly stake and identify property lines and location of the proposed project. A supplemental map showing how the property is to be subdivided should also be provided.*

Take 17N to Gloucester Courthouse. Follow Hwy 17N and VA-14 about 25 miles to State Rte 611. Turn right onto St. Rte. 611. Go 2.4 miles and turn right onto VA-14E. Go 8 miles and turn left onto Rt. 600. Go 1.2 miles to the end of the road.

8. What are the *primary and secondary purposes of and the need for* the project? For example, the primary purpose <u>may</u> be "to protect property from erosion due to boat wakes" and the secondary purpose <u>may</u> be "to provide safer access to a pier."

Primary purpose is to reduce erosion of the marsh. The secondary purpose is to create oyster reef habitat.

Part 1 - General Information (continued)

9. Proposed use (check one):
   ___ Single user (private, non-commercial, residential)
   _X_ Multi-user (community, commercial, industrial, government)

10. Describe alternatives considered and the measures that will be taken to avoid and minimize impacts, to the maximum extent practicable, to wetlands, surface waters, submerged lands, and buffer areas associated with any disturbance (clearing, grading, excavating) during and after project construction. *Please be advised that unavoidable losses of tidal wetlands and/or aquatic resources may require compensatory mitigation.*

    The structures will be placed at about mean low water so that no marsh nor submerged aquatic vegetation will be impacted. They will extend to just above MHW so that they provide wave attenuation and maximum area for oyster growth.

11. Is this application being submitted for after-the-fact authorization for work which has already begun or been completed? ___Yes _X_No. If yes, be sure to clearly depict the portions of the project which are already complete in the project drawings.

12. Approximate cost of the entire project (materials, labor, etc.): $____________________________
    Approximate cost of that portion of the project that is channelward of mean low water:
    $____________

13. Completion date of the proposed work:_________________________________-_____________

14. Adjacent Property Owner Information: List the name and complete **mailing address**, including zip code, of each adjacent property owner to the project. (NOTE: If you own the adjacent lot, provide the requested information for the first adjacent parcel beyond your property line.) Failure to provide this information may result in a delay in the processing of your application by VMRC.

    BENTON, DONALD L. & DELORES C.
    9132 BRAMPTON DRIVE
    MECHANICSVILLE, VA 23116

    THALASSA PROPERTIES, L.L.C.
    P.O. BOX 213
    GWYNN, VA 23066-0213

    Data from Mathews County GIS online data.

Part 2 - Signatures

1. Applicants and property owners (if different from applicant).
NOTE: REQUIRED FOR ALL PROJECTS

<u>PRIVACY ACT STATEMENT</u>: The Department of the Army permit program is authorized by Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, and Section 103 of the Marine Protection Research and Sanctuaries Act of 1972. These laws require that individuals obtain permits that authorize structures and work in or affecting navigable waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters prior to undertaking the activity. Information provided in the Joint Permit Application will be used in the permit review process and is a matter of public record once the application is filed. Disclosure of the requested information is voluntary, but it may not be possible to evaluate the permit application or to issue a permit if the information requested is not provided.
CERTIFICATION: I am hereby applying for all permits typically issued by the DEQ, VMRC, USACE, and/or Local Wetlands Boards for the activities I have described herein. I agree to allow the duly authorized representatives of any regulatory or advisory agency to enter upon the premises of the project site at reasonable times to inspect and photograph site conditions, both in reviewing a proposal to issue a permit and after permit issuance to determine compliance with the permit. In addition, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

______________________________ ______________________________
Applicant's Legal Name (printed/typed) (Use if more than one applicant)

______________________________ ______________________________
Applicant's Signature (Use if more than one applicant)

____
Date

______________________________ ______________________________
Property Owner's Legal Name (printed/typed) (Use if more than one owner)
(If different from Applicant)

______________________________ ______________________________
Property Owner's Signature (Use if more than one owner)

____
Date

Part 2 – Signatures (continued)

2. Applicants having agents (if applicable)

CERTIFICATION OF AUTHORIZATION

I (we),____________________, hereby certify that I (we) have authorized ___________________________
(Applicant's legal name(s)) (Agent's name(s))
to act on my behalf and take all actions necessary to the processing, issuance and acceptance of this permit and any and all standard and special conditions attached.

We hereby certify that the information submitted in this application is true and accurate to the best of our knowledge.

___________________________________ ________________________________
(Agent's Signature) (Use if more than one agent)

____
(Date)

___________________________________ ________________________________
(Applicant's Signature) (Use if more than one applicant)

____
(Date)

3. Applicant's having contractors (if applicable)

CONTRACTOR ACKNOWLEDGEMENT

I (we),______________________, have contracted____
(Applicant's legal name(s)) (Contractor's name(s))
to perform the work described in this Joint Permit Application, signed and dated________________________.

We will read and abide by all conditions set forth in all Federal, State and Local permits as required for this project. We understand that failure to follow the conditions of the permits may constitute a violation of applicable Federal, state and local statutes and that we will be liable for any civil and/or criminal penalties imposed by these statutes. In addition, we agree to make available a copy of any permit to any regulatory representative visiting the project to ensure permit compliance. If we fail to provide the applicable permit upon request, we understand that the representative will have the option of stopping our operation until it has been determined that we have a properly signed and executed permit and are in full compliance with all terms and conditions.

____
Contractor's name or name of firm

____
Contractor's or firms address

_______________________________ ____________________________________
Contractor's signature and title Contractor's License Number

_______________________________ ____________________________________
Applicant's signature (use if more than one applicant)

____
Date

Part 2 – Signatures (continued)

ADJACENT PROPERTY OWNER'S ACKNOWLEDGEMENT FORM

I (we),______________________________________, own land next to (across the water
(Print adjacent/nearby property owner's name)

from/on the same cove as) the land of_______________________________________.
(Print applicant's name(s))

I have reviewed the applicant's project drawings dated _________________________
(Date)

to be submitted for all necessary federal, state and local permits.

I HAVE NO COMMENT_______ABOUT THE PROJECT.

I DO NOT OBJECT______TO THE PROJECT.

I OBJECT______TO THE PROJECT.

The applicant has agreed to contact me for additional comments if the proposal changes prior to construction of the project.

(Before signing this form be sure you have checked the appropriate option above).

____
Adjacent/nearby property owner's signature(s)

____
Date

Note: If you object to the proposal, the reason(s) you oppose the project must be submitted in writing to VMRC. An objection will not necessarily result in denial of the project; however, valid complaints will be given full consideration during the permit review process.

Part 2 – Signatures (continued)

ADJACENT PROPERTY OWNER'S ACKNOWLEDGEMENT FORM

I (we),______________________________________, own land next to (across the water
(Print adjacent/nearby property owner's name)

from/on the same cove as) the land of____.
(Print applicant's name(s))

I have reviewed the applicant's project drawings dated ___________________________
(Date)

to be submitted for all necessary federal, state and local permits.

I HAVE NO COMMENT_______ABOUT THE PROJECT.

I DO NOT OBJECT______TO THE PROJECT.

I OBJECT______TO THE PROJECT.

The applicant has agreed to contact me for additional comments if the proposal changes prior to construction of the project.

(Before signing this form, be sure you have checked the appropriate option above).

____
Adjacent/nearby property owner's signature(s)

____
Date

Note: If you object to the proposal, the reason(s) you oppose the project must be submitted in writing to VMRC. An objection will not necessarily result in denial of the project; however, valid complaints will be given full consideration during the permit review process.

Part 3 – Appendices (continued)

Appendix B: Projects for Shoreline Stabilization in tidal wetlands, tidal waters and dunes/beaches including riprap revetments and associated backfill, marsh toe stabilization, bulkheads and associated backfill, breakwaters, beach nourishment, groins, jetties, and living shoreline projects. Answer all questions that apply. Please provide any reports provided from the Shoreline Erosion Advisory Service or VIMS**.**

NOTE: It is the policy of the Commonwealth that living shorelines are the preferred alternative for stabilizing tidal shorelines (Va. Code § 28.2-104.1). **Information on non-structural, vegetative alternatives (i.e., Living Shoreline) for shoreline stabilization is available at http://ccrm.vims.edu/coastal_zone/living_shorelines/index.html.**

1. Describe each **revetment, bulkhead, marsh toe, breakwater, groin, jetty, other structure, or living shoreline project** separately in the space below. Include the overall length in linear feet, the amount of impacts in acres, and volume of associated backfill below mean high water and/or ordinary high water in cubic yards, as applicable:

   Six intertidal reefs will be constructed by placing Natrx modules generally just below MLW. Each module is 36 in wide, 32 in high,a nd 36 in long and will placed in a lines along the shore 165 ft, 165 ft, 81 ft, 155 ft, 148 ft, and 196 ft long, totaling 910 linear ft. They will impact 471 ft2, 502 ft2, 233 ft2, 465 ft2, 444 ft2, and 604 ft2 totaling 2,718 ft2 or 0.06 acres. No fill is associated with the project.

2. What is the maximum encroachment channelward of mean high water? 87 feet.
   Channelward of mean low water? 15 feet.
   Channelward of the back edge of the dune or beach? N/A feet.

3. Please calculate the square footage of encroachment over:
   - Vegetated wetlands N/A square feet
   - Non-vegetated wetlands 270 square feet
   - Subaqueous bottom 2,450 square feet
   - Dune and/or beach N/A square feet

4. For bulkheads, is any part of the project maintenance or replacement of a previously authorized, currently serviceable, existing structure?_____Yes_____No.

   If yes, will the construction of the new bulkhead be no further than two (2) feet channelward of the existing bulkhead?______Yes_____No.

   If no, please provide an explanation for the purpose and need for the additional encroachment.

Part 3 – Appendices (continued)

5. Describe the type of construction and **all** materials to be used, including source of backfill material, if applicable (e.g., vinyl sheet-pile bulkhead, timber stringers and butt piles, 100% sand backfill from upland source; broken concrete core material with Class II quarry stone armor over filter cloth).
   NOTE: **Drawings must include construction details, including dimensions, design and all materials, including fittings if used**.

   The construction material is a 3D printed concrete structure 36 in wide and 32 in high. No fill is associated with the project.

6. If using stone, broken concrete, etc. for your structure(s), what is the average weight of the:
   Core (inner layer) material__________pounds per stone Class size ________
   Armor (outer layer) material__________pounds per stone Class size ________

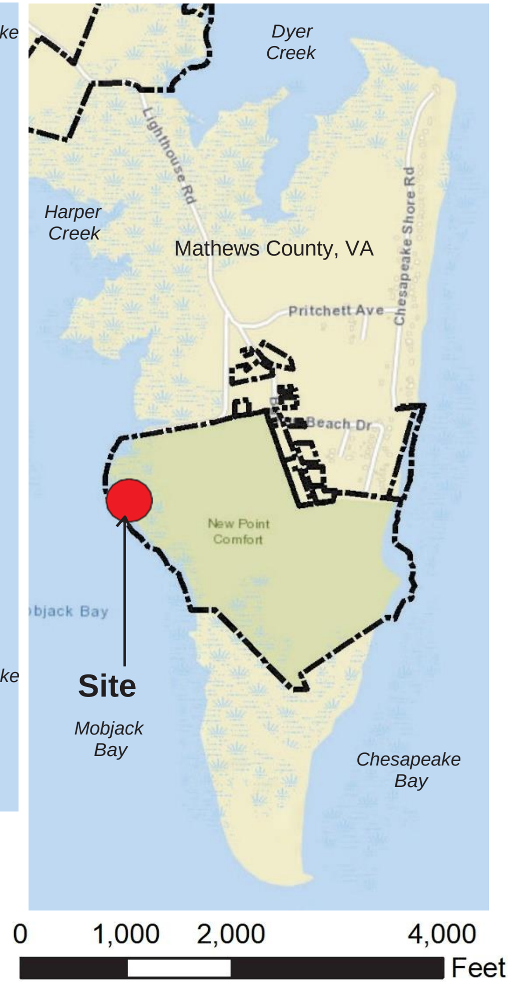
7. For **beach nourishment**, including that associated with breakwaters, groins or other structures, provide the following:

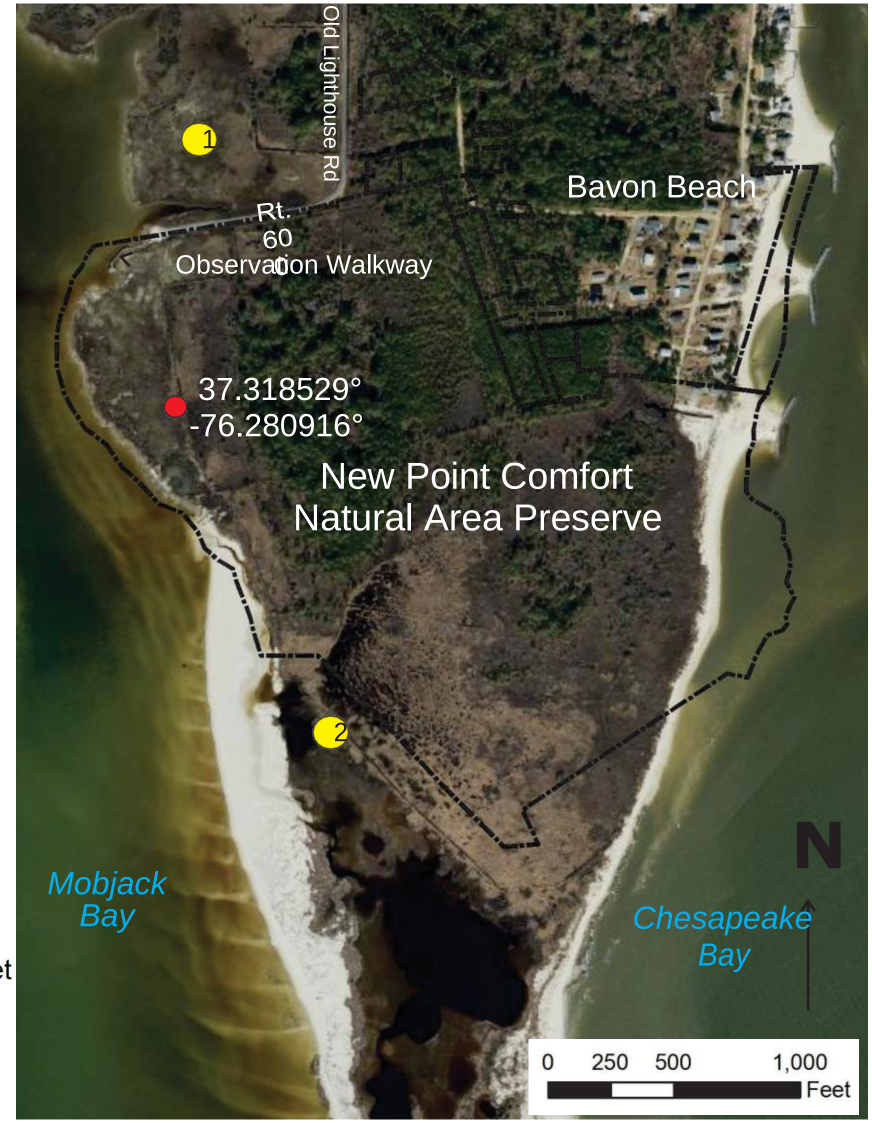
- Volume of material ___________cubic yards channelward of mean low water
  ___________ cubic yards landward of mean low water
  ___________ cubic yards channelward of mean high water
  ___________ cubic yards landward of mean high water

- Area to be covered ___________square feet channelward of mean low water
  ___________ square feet landward of mean low water
  ___________ cubic yards channelward of mean high water
  ___________ cubic yards landward of mean high water

- Source of material, composition (e.g. 90% sand, 10% clay):__________________________
- Method of transportation and placement:
  ____
- Describe any proposed vegetative stabilization measures to be used, including planting schedule, spacing, monitoring, etc. Additional guidance is available at http://www.vims.edu/about/search/index.php?q=planting+guidelines:

  None.

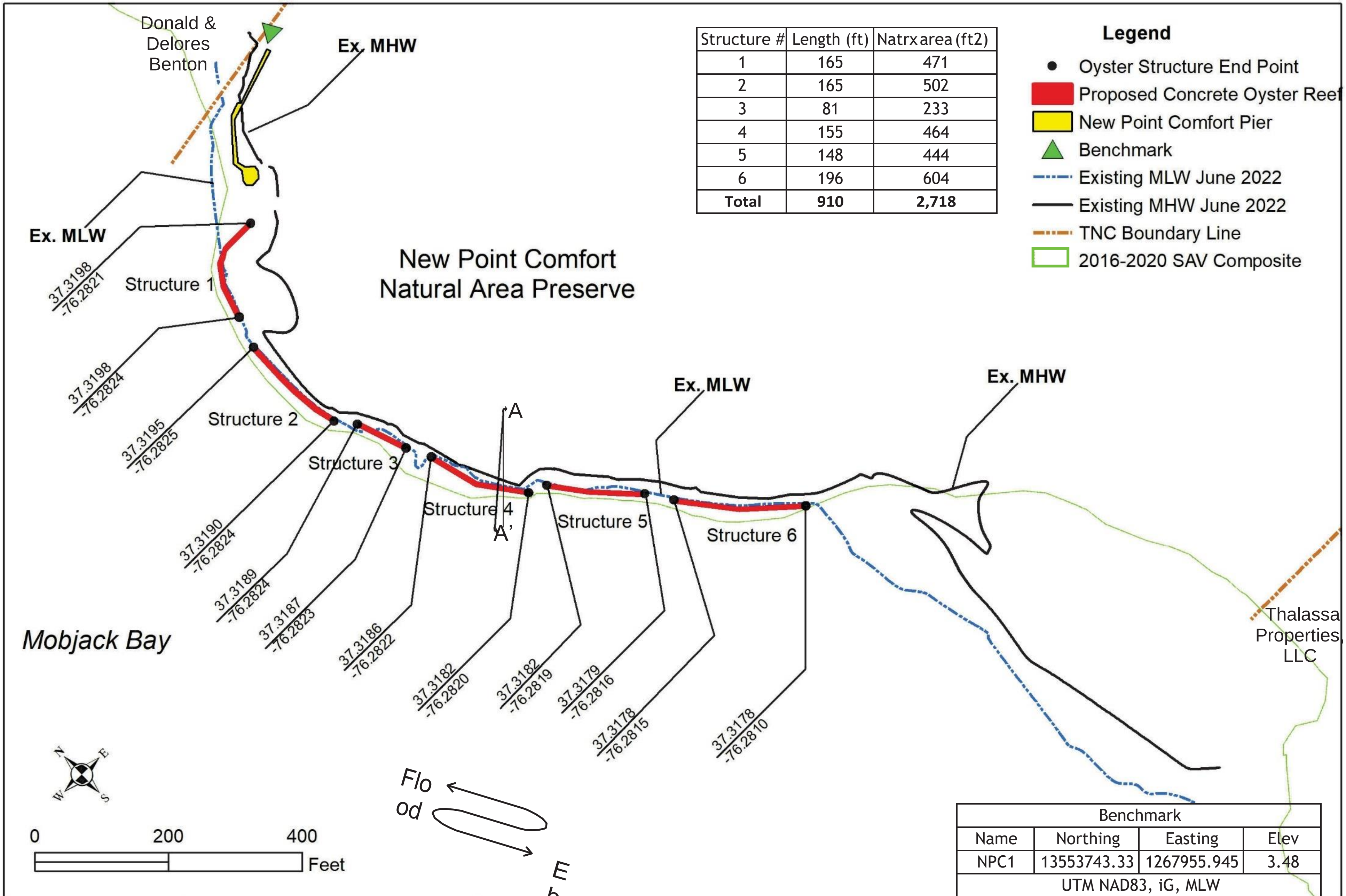




New Point Comfort Natural Area Preserve Boundary and other The Nature Conservancy Properties

Shoreline Studies Program (VIMS)	Adjacent Property Owners 1 Donald & Delores Benton 2 Thalassa Properties, LLC	New Point Comfort Natural Area Preserve Mathews , VA	Application By:
	Datum: MLW	At: In:	Purpose: Shore Erosion Control & Habitat Enhancement
			Date: 1/18/2023 Sheet: 1 of 4

Shoreline Studies Program VIMS	Adjacent Property Owners:	**New Point Comfort Natural Area Preserve** **Mathews, Virginia**	Application By:
			Date: 1/18/2023
	Datum: MLW	At: In:	Purpose:
			Sheet No. 2 of 4



Structure #	Length (ft)	Natrx area (ft2)
1	165	471
2	165	502
3	81	233
4	155	464
5	148	444
6	196	604
Total	**910**	**2,718**

Benchmark			
Name	Northing	Easting	Elev
NPC1	13553743.33	1267955.945	3.48
UTM NAD83, iG, MLW			

Shoreline Studies Program VIMS

Adjacent Property Owners:

New Point Comfort Natural Area Preserve
Mathews, Virginia

Application By:

Date: 1/18/2023

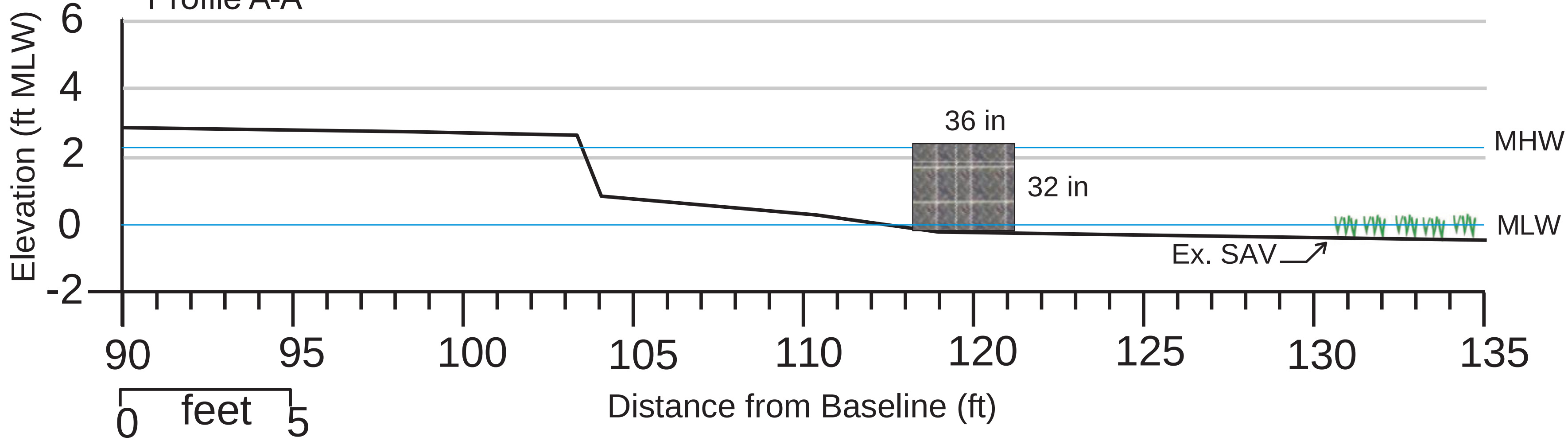
Datum: MLW

At:
In:

Purpose:

Sheet No. 3 of 4

Typical Cross-Section for Concrete Intertidal Oyster Reef
Profile A-A'



Similar Natrx modules recently installed as intertidal oyster reefs at different site in Mathews.
Size is slightly smaller than proposed modules at New Point Comfort.

Shoreline Studies Program, VIMS	Adjacent Property Owners	New Point Comfort Natural Area Preserve Mathews, VA	Application By:
	Datum: MLW	At: In:	Purpose: Shore Erosion Control & Habitat Enhancement
			Date: 1/18/2023 Sheet: 4 of 4

Appendix C

Framework for Determining Elements of a

Next Generation Shoreline Management Plan

This is a summary of work done in Year 1 of a two-year project.

Additional information and considerations will be added to the framework in Year 2.

Framework for Determining Elements of a Next Generation Shoreline Management Plan

Donna A. Milligan

C. Scott Hardaway, Jr.

Shoreline Studies Program
Virginia Institute of Marine Science
William & Mary

This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant # NA21NOS4190152 Task 73 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.

January 2023

Table of Contents

1 Introduction

Coastal regions should develop shoreline planning and designs based on everchanging public need driven by Federal, state, and local governmental priorities, socio-economic need, and environmental protection. From a state level, the recent changes to the Code of Virginia to establish living shorelines as the default alternative for shoreline protection have also shifted the policy focus toward promoting resiliency through nature-based solutions. Accordingly, Virginia shoreline planning must evolve to find a new balance between water quality, habitat enhancement, and resiliency protection.

Research has shown that living shoreline protections systems, if designed correctly, can mitigate erosion and protect upland structures. The physics of the problem remains the same; however, concerns have been raised about the anthropogenic impacts due to conversion of coastal habitats. Typically, living shorelines may include breakwater and sill systems (created beaches and marshes) that must extend channelward from an eroding property often extending beyond MLW. This, in the view of permitting agencies, particularly the Corps of Engineers and their advisory agencies, is encroachment onto shallow water habitat. Project minimization is recommended. Therefore, the living shoreline design must be for the optimum project to address both shore protection and habitat creation.

A next generation of choices are needed as we try to shift from property by property designs to create more community-based projects. This has been the philosophy for shoreline management in Virginia since the 1970s, assessing shorelines on a reach basis (Byrne & Anderson, 1978; Byrne et al., 1979). The challenge is engaging multiple property owners to share the plan and support the costs.

Virginia is unique in that structures can be placed on state bottom below mean low water (MLW) subject to approval by Virginia Marine Resources Commission (VMRC). However, the federal government is responsible for the water above it. The area between MLW and 1.5 x the tide range falls under the jurisdiction of the local wetlands board. If a tidal locality does not have a Wetlands Board, VMRC will administer any impacts to those vegetated and non-vegetative wetlands. This has led to a collision of private property rights and the commonwealth goal of increasing living shorelines in Chesapeake Bay. Permitting wants to protect public trust; science wants to do reach because best for habitats; and homeowners want what best for them.

This is the landscape that next generation planning will have to navigate. Today, shore protection is still generally on a parcel by parcel level. However, larger projects can be more effective and provide more habitat creation. The issue with this is funding the projects. The idea of “next generation” is to reframe conversation to get funding for bigger projects. How does the money flow through the system so that you can get bigger, better designed projects?

The coastal hazard threats against the property are only going to increase. If the property goes away, they lose value. Creating plans that are easy to use and account for how decisions are made in this space is key. This is the first year of the project. This framework for the next generation shoreline management plans may be refined over the next year. The framework is not intended to is not to describe shoreline management and living shoreline design; guides presently exist for both those topics (Hardaway & Byrne, 1999, Hardaway et al., 2017; National Research Council, 2007). Rather, the goal is to describe the components that make up a next generation shoreline management plan and ask the questions that can help move long-term management, shore protection funding, and permitting into a space where they work together.

This framework summary was developed in Year 1 of a two-year project. It is not intended to take the place of existing information on living shoreline design which is readily available from a variety of sources. It is intended to address ways to enhance coastal resiliency through cohesive, reach-based site assessment, data analysis and management practices both along the shoreline and in the adjacent upland. During year 2, conversations will continue with stakeholders on how to refine this framework so that it is applicable to any shoreline and so that it provides guidance to those managers, designers, and contractors who are active in Chesapeake Bay.

2 Define the problem

2.1 Existing Conditions

2.1.1 Coastal Geology and Morphology

Using the site assessment techniques in Hardaway et al., (2017) and Hardaway and Byrne (1999), the site should be assessed for physical characteristics, including:

Physical description of the site
Landforms that may exist at the site
Geology of the area
Nearshore bathymetric depths
Existing shore protection structures and location of infrastructure at the site
Archaeological sites
Land use
Shore zone habitats (beach/dune, marsh fringe or wide marsh, forested upland, SAV)
High bank/low bank
Bank composition
Resource protection area (RPA)

2.1.2 Shore Change and Energy Classification

Energy classification
Long-term and recent shore change
Base of bank and bank face classification
What are the critical areas? - rate of erosion only or rate of erosion with infrastructure

2.1.3 Hydrodynamic Setting

Tide range, storm surge, sea-level rise (SLR)
Direction of face and storm impacts
Fetch can be used as a simple measure of relative wave energy acting on shorelines (Hardaway & Byrne, 1999).
Design wave

2.1.4 Marine Resources

Submerged aquatic vegetation (SAV)
Private oyster leases, Baylor grounds, and public clamming grounds
Oysters along the shoreline and nearby reefs
Virginia Department of Health advisories, Salinity
Endangered species

2.2 Extents

For each project, the extent should be determined at several scales: parcel, community, reach (morphology, littoral cell, larger system. Typically, every project should be assessed at the Reach level. A "reach" is defined as a segment of shoreline where the erosion processes and responses mutually interact. For example, very little sand is transported by wave action beyond a major headland, creek mouth, tidal inlet or major change in shoreline orientation. This will define the end of a reach.

Several properties may be contained within a reach. Though detailed site assessment would not occur on all properties in the reach, understanding the six basic elements that go into an evaluation is helpful.

1. Determine the reach limits in which the site is located.
2. Determine the historical rates and patterns of erosion and accretion for the reach. Identify shore types (upland banks, marsh etc.) and impacts to shoreline processes and evolution.
3. Determine within the reach which sites supply sand and the volume of that supply for incremental erosion distances. Often, within a reach, there are subreaches that interact with each other. These subreaches either supply sediment to other subreaches (erosion), transport sediment from one subreach to the next, or are subreaches where sediments accumulate (accretion). A reach may feature all three types of subreaches.
4. Determine wave climate and the direction of net littoral sand drift.
5. Identify the factors causing erosion (other than waves). These may include groundwater, surface runoff, or other processes.
6. Estimate potential and active sources of nutrient loading (*i.e.,* farmland, commercial, or residential land), and the means by which this occurs, such as surface runoff, eroding sediments, and/or groundwater discharge. Nutrients do not impact erosion, but they do impact water quality. Adding shoreline erosion treatments, inevitably change water discharge patterns and thus the overall coastal water quality. In order to minimize water quality problems, shoreline erosion strategies can and should be designed so that nutrients do not adversely impact water quality or are actually treated by the strategy.

Understanding the size of the reach and those factors which influence it gives property owners a sense of the spatial parameters within which to address shoreline erosion—it puts the problem into context and moves it beyond just their parcel.

2.3 Coastal Resiliency Considerations

Upland land use/runoff
Bank height: for high banks, marshes are in a coastal squeeze. There is no where for them to migrate upslope.
Existing vegetation; what are the marsh grass types, is *Phragmites australis* an issue?
Grading considerations – is the infrastructure too close to the top of bank to grade the bank; are there archeological considerations that impact grading.

3 System Assessment

3.1 Parcel Level

Parcel level considerations are based primarily on property boundaries which are often not conveniently concurrent with the coastal geomorphology. These are the items needed to obtain:
Site Length
Bank Height and Composition
Orientation
Habitat width and elevation
Nearshore stability
Boat wakes
Existing structures
Potential downdrift impacts
Marine resources (oysters, SAV) present or not

3.2 Community Level

What defines a community project? Typically, a community project will primarily focus on the waterfront properties which may have one or many parcels. An example of one property owner can vary from public lands like parks and beaches to Home Owners Associations (HOAs) with numerous entities. This can be the most efficient and cost-effective way to manage a reach and associated subreaches. HOAs can be challenging because everyone has different financial capabilities to put toward the project as well as opinions on how the project should go. That is why recent trends around the Bay to seek out funding opportunities, like grants and low interest loans for nature-based projects and living shorelines, is important to getting these projects built. Having a solid plan, design and permitted, in other words, shovel ready, is a plus in the funding "industry".

3.3 Larger System/Reach

The boundaries of the larger system will vary depending on the site. Determining the effect sediment movement within the littoral cells will have on parcels is important at the reach level. This analysis should include all the factors that could impact the long-term protection of the shoreline and adjacent habitats.

4 Create Alternatives that Meet Goals

4.1 State Goals

It is important to work with the property owner to determine their goals. These goals should include both shoreline and upland. Some specific goals may include: Prevention of loss of land and protection of upland improvement; protection, maintenance, enhancement and/or creation of wetland habitat both vegetated and non-vegetated; viewshed considerations; and management of upland runoff and groundwater flow which may exacerbate bank erosion. A variety of shoreline management strategies may be recommended for each shore reach. The strategies should be based on their effectiveness in the site's hydrodynamic environment and may include any of the following:

1. Do nothing and/or move infrastructure

2. Offensive approach with living shorelines (stone sills with wetlands plantings, attached stone breakwaters and beach fill with wetlands planting are placed in the nearshore)

3. Headland control with living shorelines (stone breakwaters/sills strategically placed) to allow the shoreline to erode between the structures. Sand and wetlands planting are used with the structures to attach to the shoreline and provide the living component. This method is often used on long stretches of shoreline such as farm land when it would be cost-prohibitive to do more closely spaced structures.

4. Intertidal oyster reefs or other habitat-based designs

5. Detached structures

One or a combination of the above strategies may be appropriate for a given reach depending on the availability of funds and project goals. Phasing shoreline management strategies through time should be addressed for larger projects because it is usually the more prudent and cost-effective approach. For a proposed shoreline strategy, addressing potential secondary impacts within the reach which may include impacts to downdrift shores through a reduction in the sand supply or the encroachment of structures onto subaqueous land and wetlands.

These goals must be assessed in the context of a shoreline reach. While all objectives should be considered, each one will not carry equal weight. In fact, satisfaction of all objectives for any given reach is not likely as some may be mutually exclusive. These areas of concern could then be addressed specifically in the shore change and hydrodynamic analysis.

Living shorelines are a best management practice that addresses 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. Living shoreline strategies provide the suitable gradient to address sea-level rise and enhance the coastal resiliency of a site.

4.2 Determine Alternatives

4.2.1 What will be Effective?

The purpose of assessment is to determine the "immediate" need for any specific shoreline management strategy and how the strategies fit into the long-term plan. After both the site and reach have been assessed, recommendations can be made based on the results.

Small fetch – can do property ownership level
Larger fetch- having multiple participants would have a more effective project. If not, the reach ends up with fragmented management without community buy-in.
Living shorelines are more effective both from a habitat and shore protection standpoint over longer shore lengths.
For oyster reefs to be effective, they require salinity above 8 parts per thousand (ppt) (CBF, 2022)
In some areas, the bank may be undercut due to trees shading out the marsh. Just trimming trees and planting marsh can be effective.
Existing projects within the system that can inform design by showing elements that were successful and those that were not.

Alternatives analysis - incorporate what happens for each alternative. If do nothing, what will happen over time - erosion & sea level rise. This will include levels of protection by making sure it is understood that if the design is only for a 10-year event, parts of the system will be affected by storms that are larger. The size of the structure is directly related to the threat.

This leads into what is presently permittable.

4.2.2 What is Permittable?

Recent changes in the Code of Virginia (28.2-104.1, 28.2-1301, 28.2-1302, and 28.2-1308 directs that the Virginia Marine Resource Commission shall permit only living shoreline approaches to shoreline management in areas where the best available science shows that such approaches are suitable. Permitting agencies want to protect public trust while science wants to do what's best for habitats, and homeowners want what is best for them. Merging these three ideas into a permittable plan can be a challenge.

The design should minimize/optimize encroachment onto shallow water habitat and consider: SAV, private oyster leases, grading, and endangered species. Generally, living shorelines that utilize rock, sand, and plants have been used in Chesapeake Bay for the last 40 years and a well-designed system should be permittable. One area of concern has been the proliferation of intertidal oyster reefs and other nature-based non-structural living shorelines for shore protection. So many different types of units have been created, and materials are being used. Making sure that a particular unit is permittable could be a challenge.

Other considerations for what is permittable would be detached breakwaters and subtidal oyster reefs. Detached breakwaters, such as occur along the Norfolk shoreline, are placed in the nearshore and address the incoming wave climate. They typically are successful in areas where large amounts of sand occur in the littoral system. Would they be permittable as a living shoreline even though they do not have sand and plant components? What about large subtidal reefs? How can they be designed to provide shore protection? Would they be permittable because they would convert large swaths of sandy shallow water habitat to oyster reefs?

4.2.3 How do Property Rights Impact the Project?

The land ownership framework is an important consideration in long-term shoreline management planning. Every property owner has a right to do a different thing on their shoreline and some have more means than others. Recognizing that some owners may not be financially able to contribute to community projects allows us to address the issue. By providing recommendations outside the boundaries of individual properties, we can illuminate what they could do if you work with others (reach basis) to solve a problem.

We want to think more holistically to address the problems created by proximity infrastructure is to an actively eroding shoreline. The property rights framework is an issue that will have to be addressed by coastal managers. Virginia's public/private property line at MLW is constantly shifting, and lands that once belonged to private owners are now technically under the state's control. This can be seen through the 2015 case of Marble Techs., Inc. v. Mallon in which a deed from 1936 regarding an easement in Hampton established the property line "along present mean high water." That original line was obviously underwater by 2015, and the question of where the property line was asked. The Virginia Supreme Court decided that, per the literal language of the original deed, the property line should remain at its original location, despite that location now being inaccessible (Messer, 2018). This shows that all current private property lines at MLW are now in jeopardy and that property owners are likely to lose rights to land that they currently own in the future unless changes are made. With regards to shoreline management systems, this could affect current systems constructed on private land, as well as affect future decisions of property owners to implement living shorelines on their land. Erosion is reconfiguring acreage and parcel boundaries daily. It will only continue in the future.

4.2.4 What is the Cost and the Funding Source?

By developing different levels of conceptual plans, alternatives of what works for a property owner within their budget can be created as well as what the shore protection could look like if it was done on a reach-basis. It can be difficult to determine costs for some recommendations particularly for some of the reach components. They may require additional on-the-ground site assessment and analysis to be able to develop a cost. In addition, when proprietary or innovative structures are part of the recommendations, costs can be difficult to develop. Due to site-specific considerations, costs can vary significantly for similar treatments. Having a database of living shoreline projects where site conditions and treatments can be determined would help tease out costs.

Whoever is paying for the project will define the scope of the project. Homeowners cannot be compelled to build the proposed concepts; however, reach-based systems could be incentivized to implement the goals of the project through grants, loans, tax breaks. The state can also facilitate design/build projects to help the landowners ensure that the project will be done correctly.

This would require grants and loans for private property.

In the end, the kind of structure that will be built will be based on the physics of the system and what can they can afford. In general, traditional rock, sand, plant systems are larger, provide more shore protection, and have a higher initial cost and require maintenance. Smaller, ecohabitat-based projects will cost less for materials and possibly installation, but the level of protection may not be as high.

4.3 Final Shore Protection Plan

After developing the system assessment and conceptual plans at the parcel, community, and reach level, discussing options with the property owner will provide guidance in how to proceed. Elements of coastal resiliency and construction considerations also need to be considered.

Designing shore protection structures for specific return storm surge frequencies provides a metric by which the proposed system can expect to perform during that event. Costs, what's being protected, and durability are factors to consider. The shore protection system is designed for a particular storm condition. However, a system does not necessarily fail at higher water levels and wave energies. During larger storms, bank erosion may occur when the system is overtopped, but the sediment from the bank will slump onto the fronting protective marsh, perhaps covering some. This process can actually create a more stable bank condition as it evolves to a more equilibrium slope. Typical eroding banks are at a 1:1 slope, but as they move toward a 1.3:1 slope, they become more stable.

Creating an understanding of both the short-term and long-term performance is important to a next-generation plan. Funding options also should be included in the final plan.

5 Monitoring, Maintenance, & Resiliency

5.1 Monitoring

Natural resource managers and homeowners generally want to establish the effectiveness of their living shoreline for shoreline stabilization but are not necessarily sure how to go about it. Creating a monitoring plan for the site is necessary for a next generation plan. Using metrics that document sand retention, movement and elevation variability, tidal inundation allow you to evaluate the success of the plantings and, where necessary, provide information for remedial actions. The data from these metrics are the information needed to answer the critical questions about the success of a living shoreline designed primarily for shoreline stabilization i.e. Are the measured parameters improving? staying the same? or deteriorating? Monitoring plans can vary depending on the level of expertise of the property owner.

In living shoreline marshes, monitoring to determine if bare spots occur in the marsh. It is required to determine why the bare spots are there because it will provide the action needed to remedy the situation. If the bare spot is due to shading, trees can be trimmed. If it is due to the low elevation of the marsh substrate which causes flooding, additional sand may be needed to raise the elevation. Overland or spring freshwater flows may be affecting marsh growth and may need to be redirected. Debris could be on the marsh, smothering it. This will need to be removed.

Regardless of the level of monitoring at the site, the metrics obtained can be used to inform and address any maintenance issues.

5.2 Maintenance of Living Shorelines

Maintenance is critical for the success of a living shoreline project. Keeping the shore protection system at its most effective is the best way to negate impacts from short-term hazardous events (Milligan et al., 2021). Regularly maintaining the site will provide needed information to determine when the system's effectiveness needs to be addressed. The erosion resistant marsh and dune grasses are an important component of the living shoreline. Maintaining these are crucial to the success of the overall system. Routinely replanting vegetation as needed, trimming tree branches to reduce shade on the marsh (depending on the native vegetation's sunlight requirements), removing debris that can smother grasses, and removing any invasive species, such as *Phragmites australis* are all items that need to be addressed.

The effectiveness of a shore protection system may decrease over time due to an increase in sea level, a lack of maintenance, and changes in vegetation. The project's decline in performance may happen slowly over time so that it is not easily recognized, or it may happen quickly during a storm. Understanding the short-term and long-term effects of hazardous events on the living shoreline is crucial to determining when action is needed. Short-term events can result in a reactive approach to resiliency because there is usually little time before the event to address potential impacts (Milligan et al., 2021). Longer-term effects due to an increase in sea level may be easier to consider because if the system is being maintained and monitored, adjustments do not have to be reactive.

5.3 Future Adaptation for Resiliency

To determine how best to address coastal resiliency at a site, these questions could be asked (from Milligan et al., 2021):

Is the system designed to provide wave protection at increased water levels?

Are structures designed for the increased water levels that bring a consequent increase in wave energy to the shoreline?

Will structures need to adapt to SLR by adding rock, sand and plants?

Will addition of rock and/or sand change the design parameters of the system thereby reducing the system's effectiveness?

What is the elevation of the upland immediately adjacent to the system? Is it a coastal squeeze or will the marsh be able to migrate upslope?

How wide is the upper marsh? Wider upper marshes provide room for the low marsh to migrate.

What is the coverage of plants in the marsh?

Are nutrients affecting the marsh? Nutrients, possibly from agricultural fields and septic tanks can reduce marsh grass coverage because the nutrients affect root growth. However, Phragmites thrives in these conditions and will colonize the system.

Are sediments readily available?

Have upland issues been included in the adaptation scheme?

These are just some of the questions that can be reviewed for a coastal resiliency analysis of a site. Understanding how the storm surge and recurrent flooding will impact a site is important to the long-term stability of the management plan.

6 Additional Questions

As the project moves into the second year, beginning to address some of these questions will help tackle issues in the larger arena of shore management design and permitting. Would further defining the type of living shoreline in the VMRC database assist in long-term planning by developing information on how effective certain types of projects are?

If Virginia is providing funding for shore protection projects through grants and loans, how do we define a community project? Is it by number of property owners, length, littoral cell?

How will the solution be delivered across the coastal zone? What localities or governmental groups will be proactive and able to assist property owners with this effort? How can contractor training fit in to this?

What will the permitting space look like for next generation plans? Will there be plans in place when it is necessary to respond to emergency permits due to storms? With the frequency of storms increasing, how will they respond to allow homeowners to protect their property.

This framework may be refined as answers to questions are found in year 2 and new questions are uncovered. The overall goal is to create a way for property owners to consider all of their options for shore protection and address it in a that provides the best results for all involved. At the end of Year 2, this framework will be honed to create a separate document that defines next generation shoreline management planning in Virginia’s Chesapeake Bay.

7 References

Byrne, R.J. and G.L. Anderson, (1978). Shoreline Erosion in Tidewater Virginia. Special Report in Applied Science and Ocean Engineering No. 111. Virginia Institute of Marine Science, Gloucester Point, VA, 102 p.

Byrne, R.J., C.H. Hobbs III, N.B. Theberge, W.R. Kerns, M. Langeland, J. Scheid, N.J. Barber and R.J. Olthof, (1979). Shore Erosion in the Commonwealth of Virginia: Problems Practices and Possibilities. Special Report in Applied Marine Science and Ocean Engineering No. 220, Virginia Institute of Marine Science, Gloucester Point, VA. 205 p.

CBF, 2022. Are oysters an option for your living shoreline? Chesapeake Bay Foundation. Retrieved from https://www.cbf.org/about-cbf/locations/virginia/issues/living-shorelines/are-oysters-an-option-for-your-living-shoreline.html

Hardaway C.S. and R.J. Byrne, (1999). Shoreline Management in Chesapeake Bay. Special Report in Applied Marine Science and Ocean Engineering No. 356. Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, VA.

Hardaway, Jr. C.S., Milligan, D.A., Duhring, K. & Wilcox, C. (2017). Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments. Special Report in Applied Marine Science and Ocean Engineering #463. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

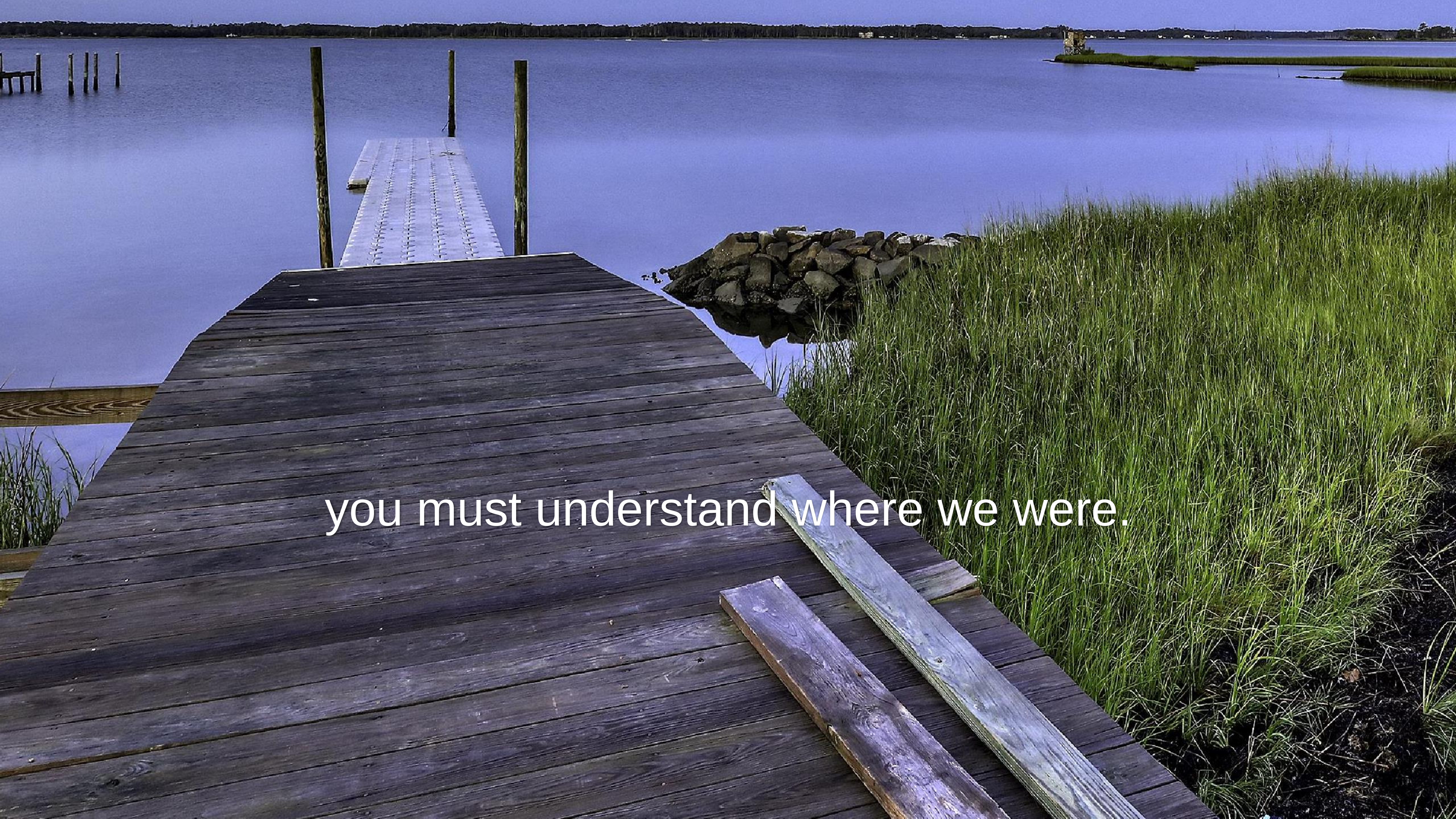
Messer, E. (2018). Waterfront property rights: The potential impact of government projects. *Virginia Coastal Policy Center, William & Mary Law School,* Williamsburg, Virginia.

Milligan, D. A., Hardaway, C., Wilcox, C. A., & DiNapoli, N. J. (2021) Living Shoreline Sea-Level Resiliency: Performance and Adaptive Management of Existing Sites Year 3 Summary Report. Virginia Institute of Marine Science, William & Mary. https://doi.orG/10.25773/sfsv-bc33NOAA. 2022. Sea Level Rise and Coastal Flooding Impacts Data. Retrieved from coast.noaa.gov/slr/.

National Research Council (2007). Mitigating Shore Erosion Along Sheltered Coasts. Washington, DC: The National Academies Press. https://doi.orG/10.17226/11764.

Appendix D: Shoreline Management Planning Process Draft Summary Presentation


To best understand where we are

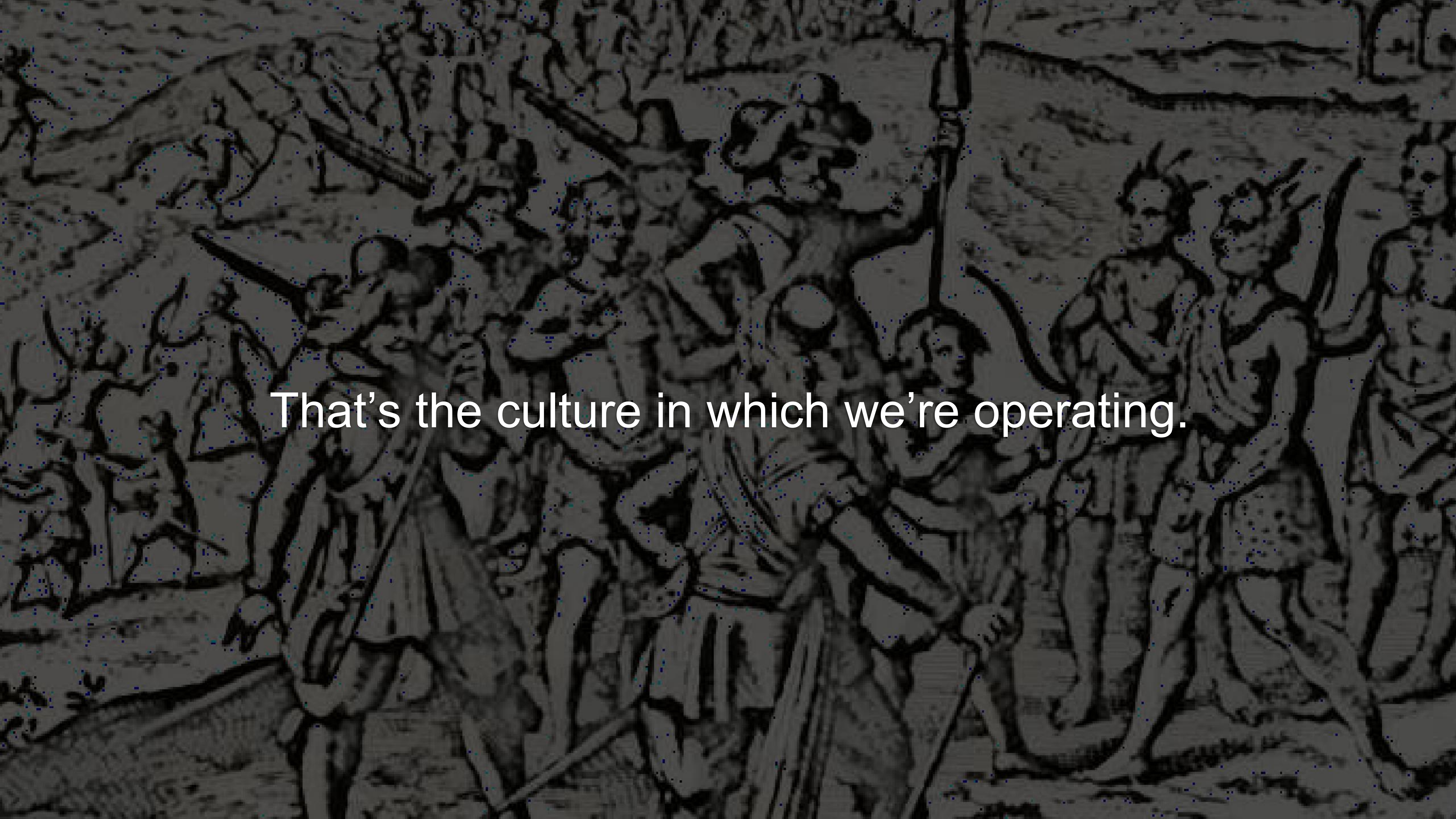

you must understand where we were.

Before the colonization of the Americas, when the population was Native American residents, people lived and moved with nature.

When the water came, they moved.

But then colonists came and English property law came into being. Humans put stakes in the ground for property rights and ownership.

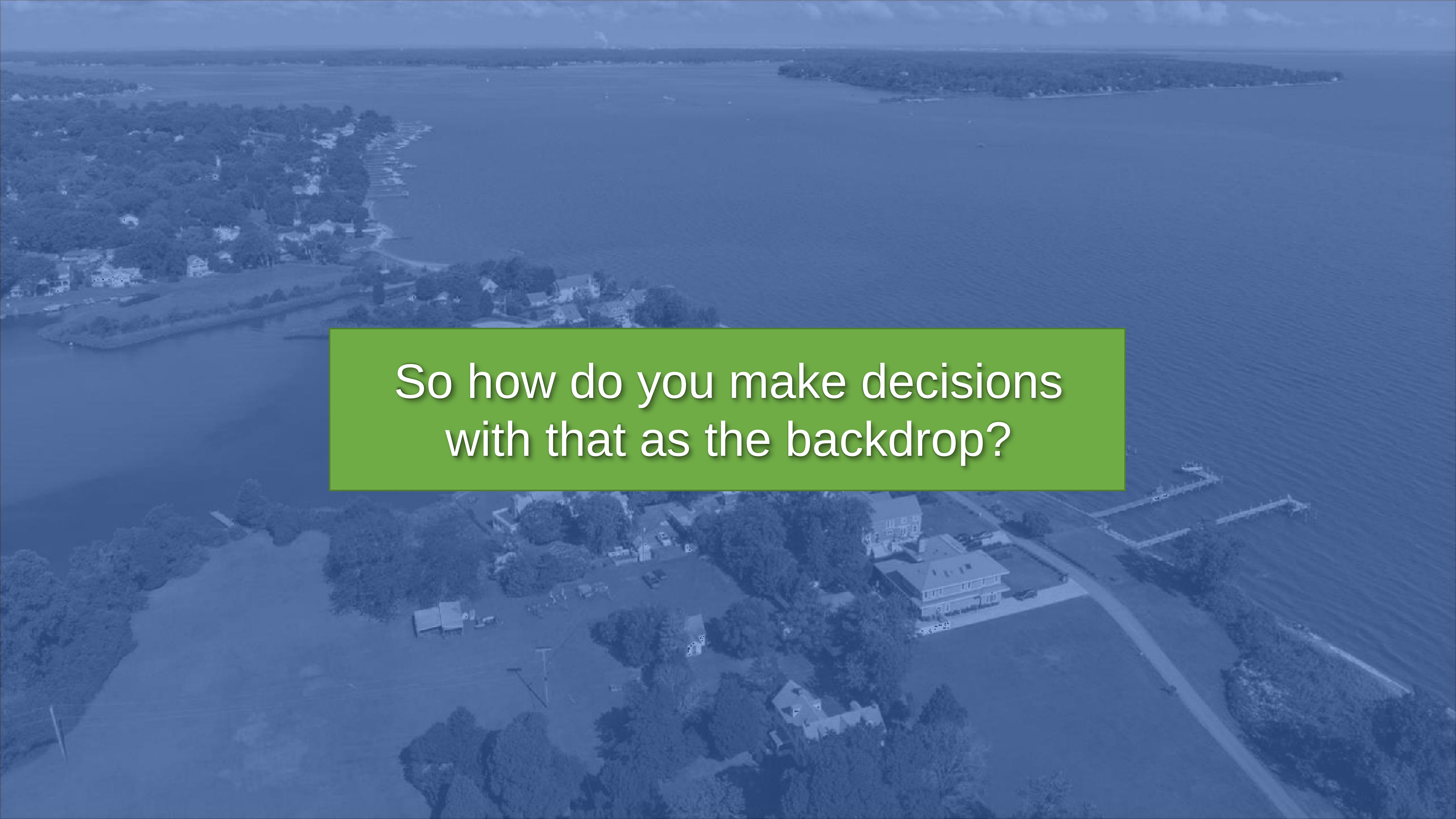
If the water came, it didn't matter. They weren't leaving because they owned the land.



That’s the culture in which we’re operating.


People want to hold in place
What Mother Nature wants to move…


their land.


So how do you make decisions
with that as the backdrop?


v
How do you make decisions with the complexities of all those land ownerships rights


and regulations in place to govern it all.

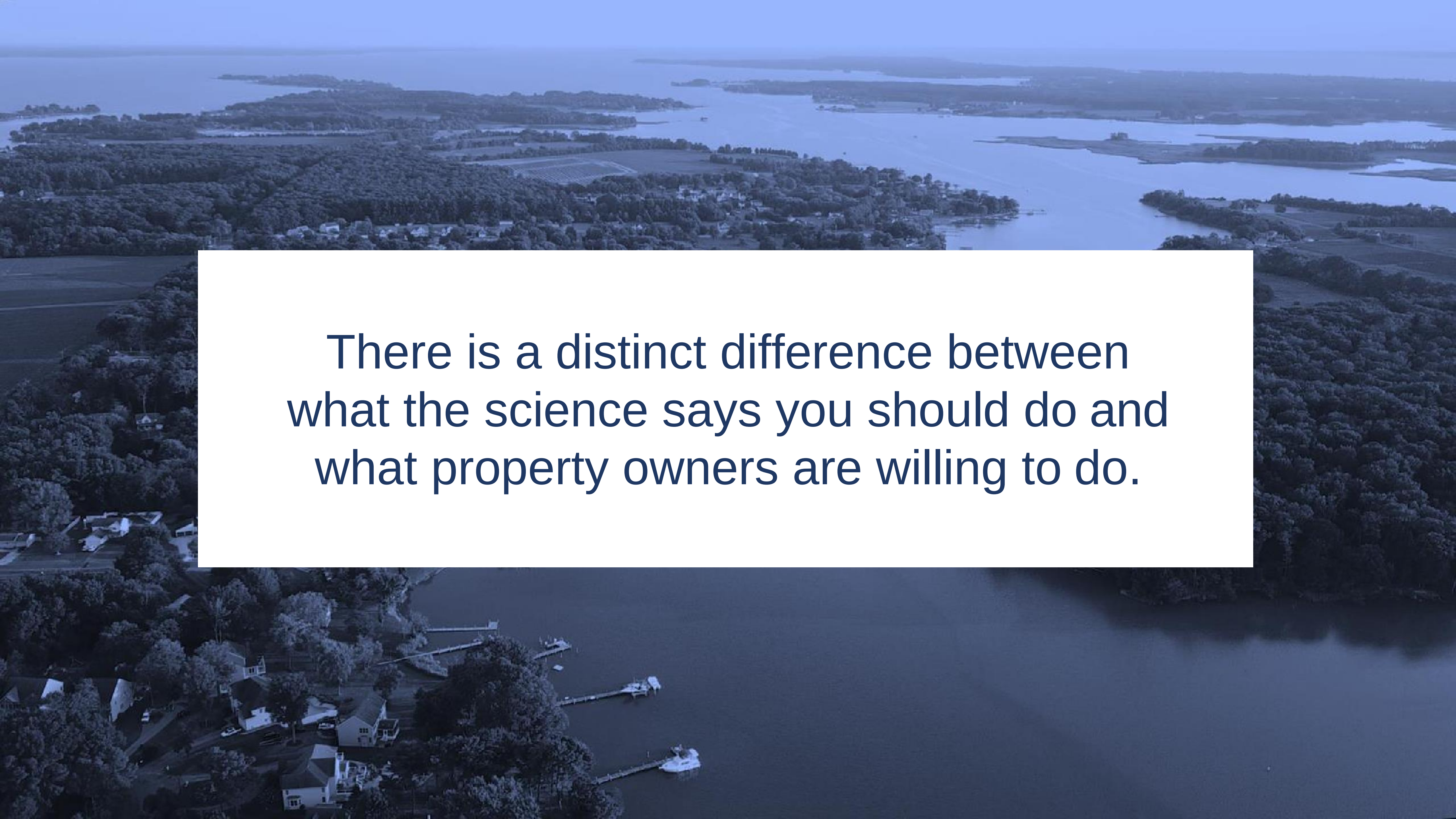
Up until now, all of the solutions to mitigating water encroachment have assumed shorelines with no borders were the reality.

The actual reality is much different.

What makes Next Gen Shoreline project special isn’t its innovative engineering solutions.

It’s the mindset shift.

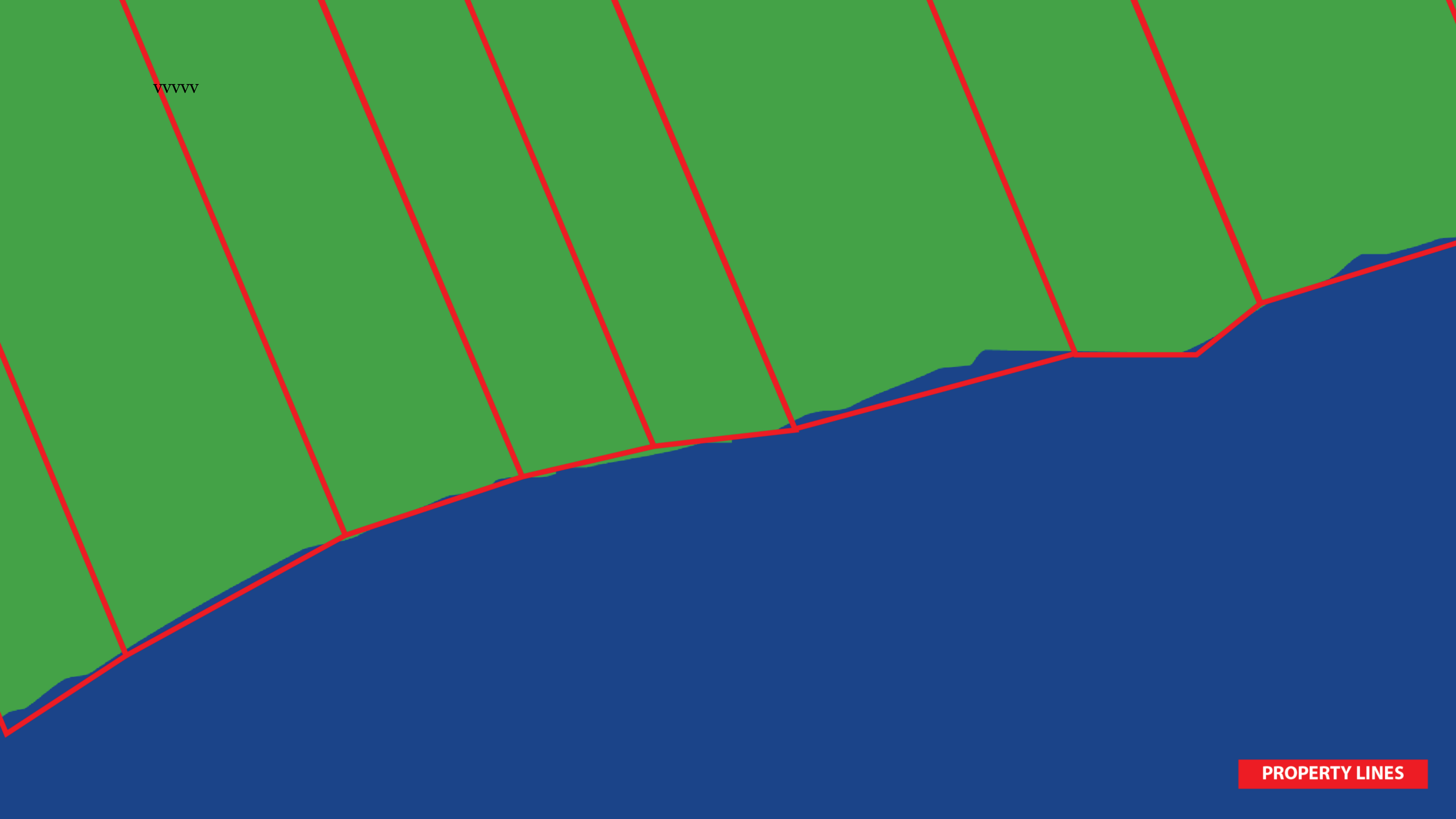
It’s having ALL stakeholders understanding the complexity of both the human and the regulatory dimensions of shoreline preservation.



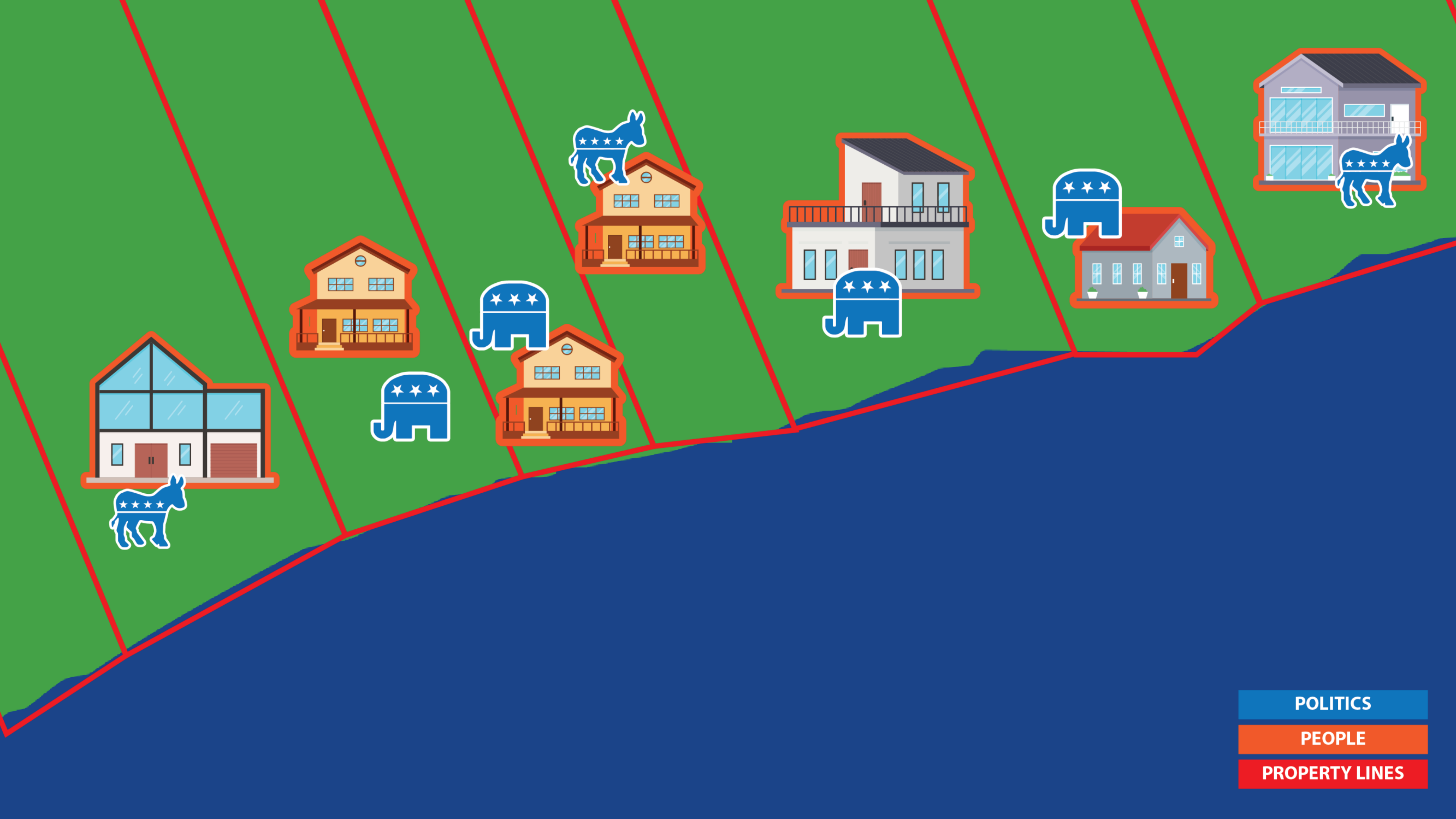
There is a distinct difference between what the science says you should do and what property owners are willing to do.


v

v


vvvvv
PROPERTY LINES


PEOPLE
PROPERTY LINES


POLITICS
PEOPLE
PROPERTY LINES

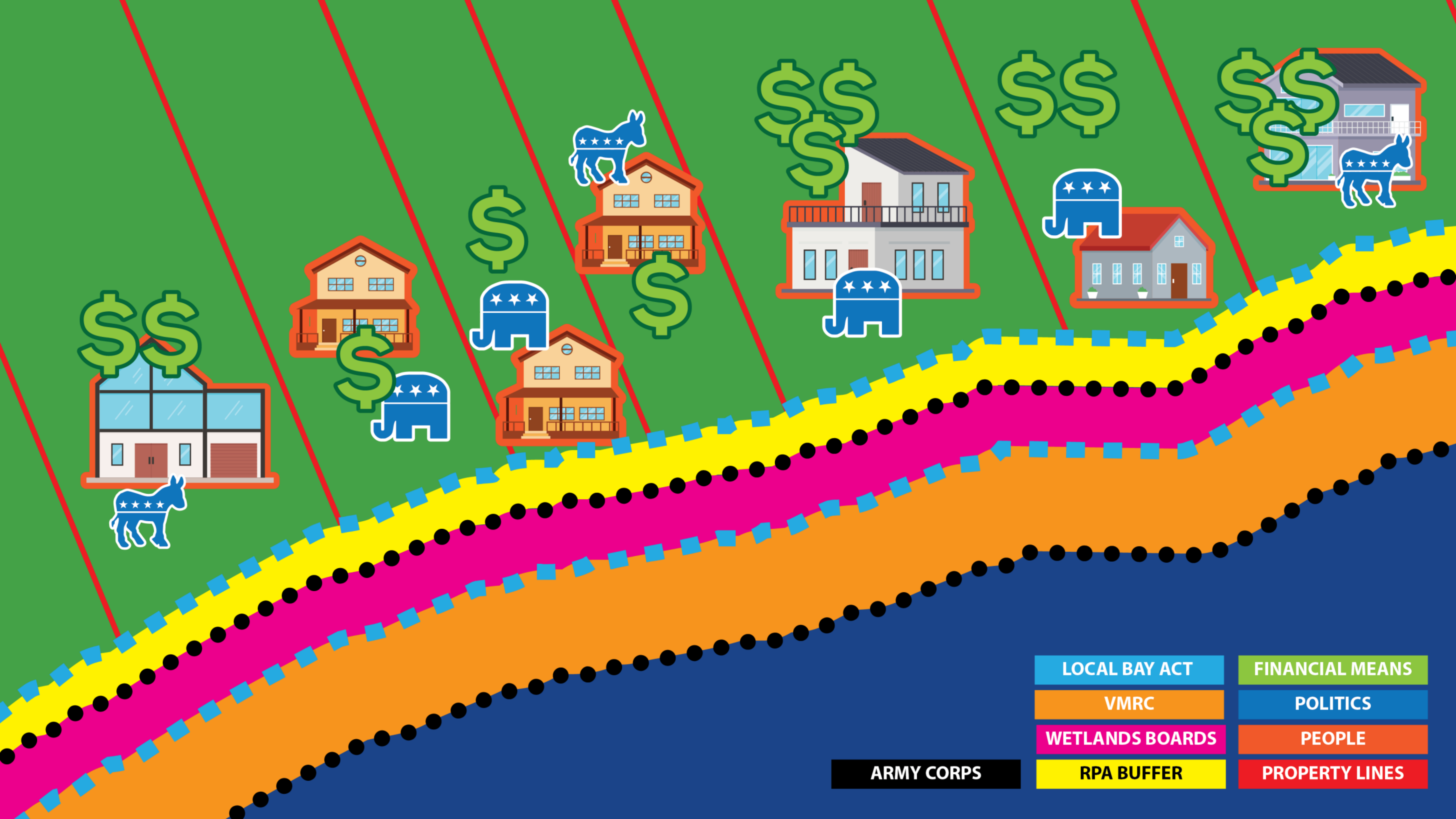

FINANCIAL MEANS
POLITICS
PEOPLE
PROPERTY LINES

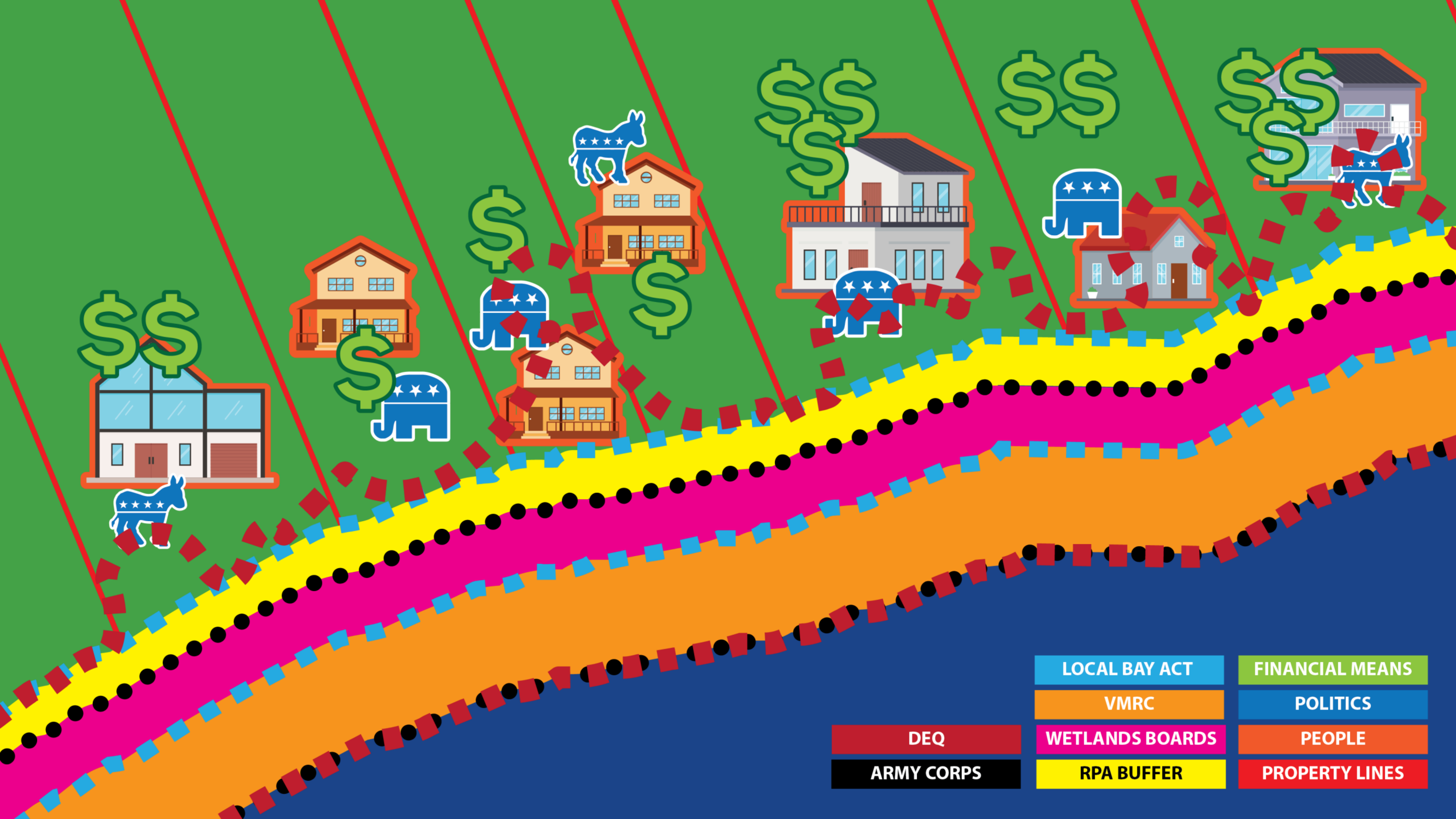

FINANCIAL MEANS
POLITICS
PEOPLE
RPA BUFFER
PROPERTY LINES


FINANCIAL MEANS
POLITICS
WETLANDS BOARDS
PEOPLE
RPA BUFFER
PROPERTY LINES


FINANCIAL MEANS
VMRC
POLITICS
WETLANDS BOARDS
PEOPLE
RPA BUFFER
PROPERTY LINES

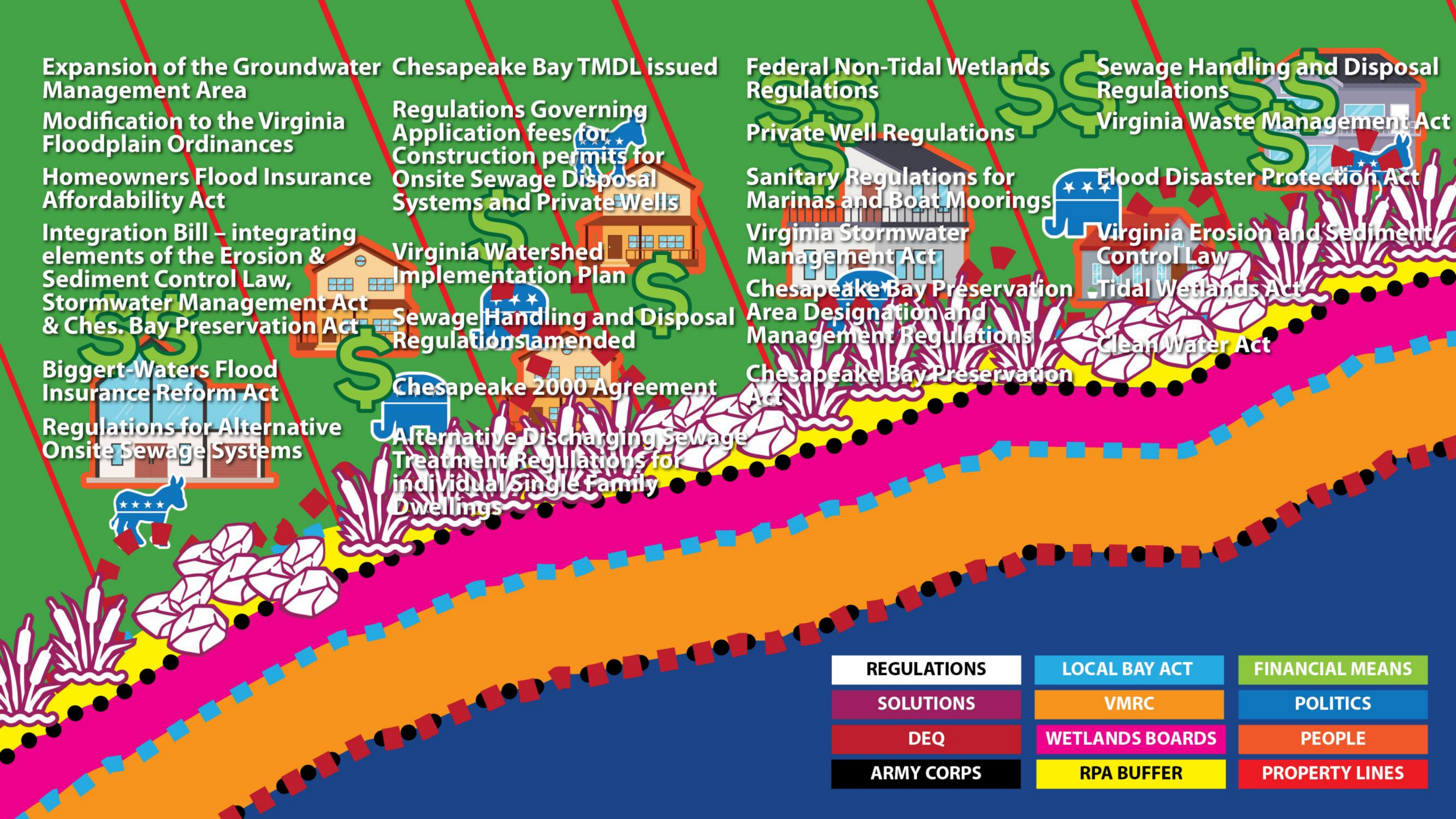

LOCAL BAY ACT
FINANCIAL MEANS
VMRC
POLITICS
WETLANDS BOARDS
PEOPLE
RPA BUFFER
PROPERTY LINES


LOCAL BAY ACT
FINANCIAL MEANS
VMRC
POLITICS
WETLANDS BOARDS
PEOPLE
ARMY CORPS
RPA BUFFER
PROPERTY LINES



LOCAL BAY ACT
FINANCIAL MEANS
VMRC
POLITICS
DEQ
WETLANDS BOARDS
PEOPLE
ARMY CORPS
RPA BUFFER
PROPERTY LINES


LOCAL BAY ACT
FINANCIAL MEANS
SOLUTIONS
VMRC
POLITICS
DEQ
WETLANDS BOARDS
PEOPLE
ARMY CORPS
RPA BUFFER
PROPERTY LINES


Expansion of the Groundwater Management Area
Modification to the Virginia Floodplain Ordinances
Homeowners Flood Insurance Affordability Act
Integration Bill – integrating elements of the Erosion & Sediment Control Law, Stormwater Management Act & Ches. Bay Preservation Act
Biggert-Waters Flood Insurance Reform Act
Regulations for Alternative Onsite Sewage Systems
Chesapeake Bay TMDL issued
Regulations Governing Application fees for Construction permits for Onsite Sewage Disposal Systems and Private Wells
Virginia Watershed Implementation Plan
Sewage Handling and Disposal Regulations amended
Chesapeake 2000 Agreement
Alternative Discharging Sewage Treatment Regulations for individual Single Family Dwellings
Federal Non-Tidal Wetlands Regulations
Private Well Regulations
Sanitary Regulations for Marinas and Boat Moorings
Virginia Stormwater Management Act
Chesapeake Bay Preservation Area Designation and Management Regulations
Chesapeake Bay Preservation Act
Sewage Handling and Disposal Regulations
Virginia Waste Management Act
Flood Disaster Protection Act
Virginia Erosion and Sediment Control Law
Tidal Wetlands Act
Clean Water Act
REGULATIONS
LOCAL BAY ACT
FINANCIAL MEANS
SOLUTIONS
VMRC
POLITICS
DEQ
WETLANDS BOARDS
PEOPLE
ARMY CORPS
RPA BUFFER
PROPERTY LINES