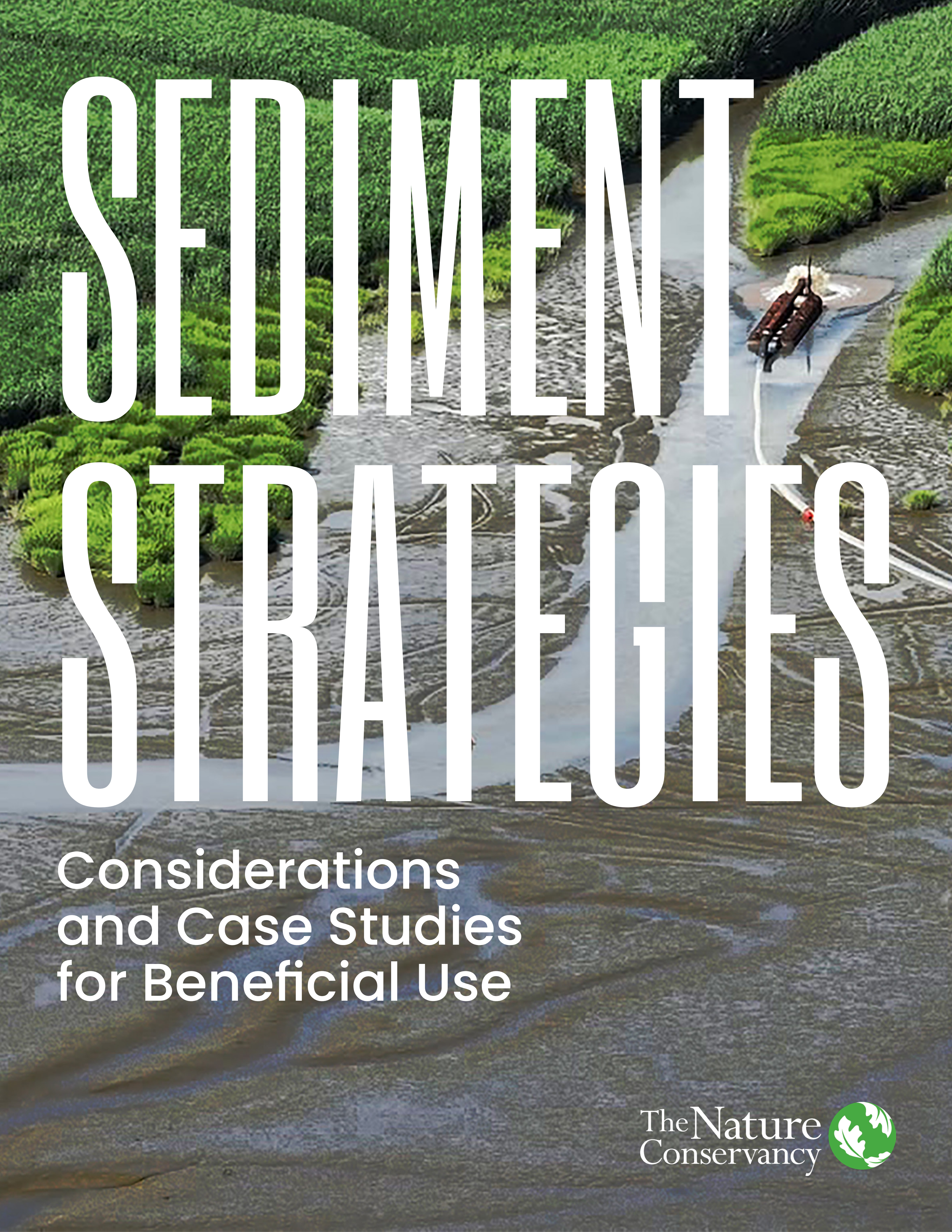

SEDIMENT STRATEGIES

Considerations and Case Studies for Beneficial Use

The Nature Conservancy

ACKNOWLEDGMENTS

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Image Credit: Little Assawoman Canal, DE, S. Messur, Anchor QEA
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Back Image Credit: Maurice River, Sean Burkholder, Proof Projects

LETTER FROM THE NATURE CONSERVANCY

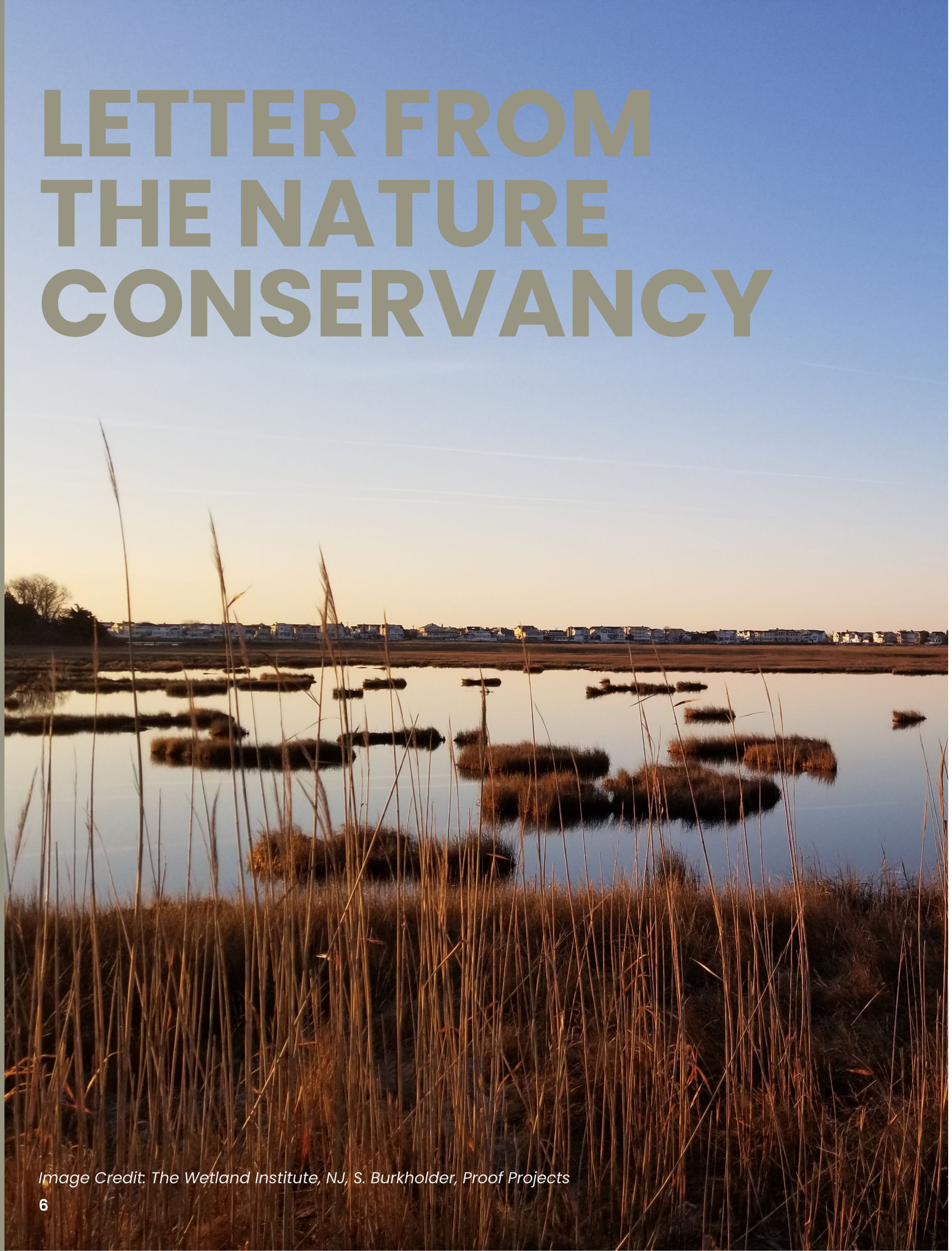


Image Credit: The Wetland Institute, NJ, S. Burkholder, Proof Projects

Dear Reader,

Our team jokes that we make mud pies for a living—only bigger than the ones we used to make as kids. Behind the humor, however, is something real: a sense of wonder about the landscapes we live in and an understanding of our role in shaping them. Sediment Strategies and the journey we went on bringing it to life is a testament to the wonder we feel in wet and watery landscapes, and an appreciation for the complex ways we shape these ecosystems.

Up and down the Atlantic Coast, marshes play an essential role in the functioning of daily life. They buffer storms, filter water, support fisheries, and store carbon. They are the backbone of aquatic recreation, commerce, and community. Yet by 2050, we're projected to lose nearly half of them. At the same time, we move hundreds of millions of cubic yards of sediment annually through dredging—a critical management action that keeps ports open, tributaries navigable, and commerce flowing. The link between these systems is sediment. Yet even though one is a sediment source and the other a sediment sink, they're not often managed together.

That's the beauty of beneficial use. Recycling sediment to enhance aquatic ecosystems and lower the cost of dredging. It's a simple idea, but making it happen is anything but simple. It requires a shared vision, intentional coordination, and technical understanding.

That's why we created Sediment Strategies. To provide common language and an accessible technical reference for practitioners, agencies, and communities who want to make beneficial use the norm—not the exception. It's an invitation: to wonder, to think differently, and to work together.

As you read this guide, picture the marshes you know and love. Imagine safe and navigable waterways. See your role in the story. Shape the future you want to see.

Let's make mud pies together. Because Together, We Find a Way!

Sincerely,

Isaac Hametz & Austin Bamford
The Nature Conservancy

EXECUTIVE SUMMARY

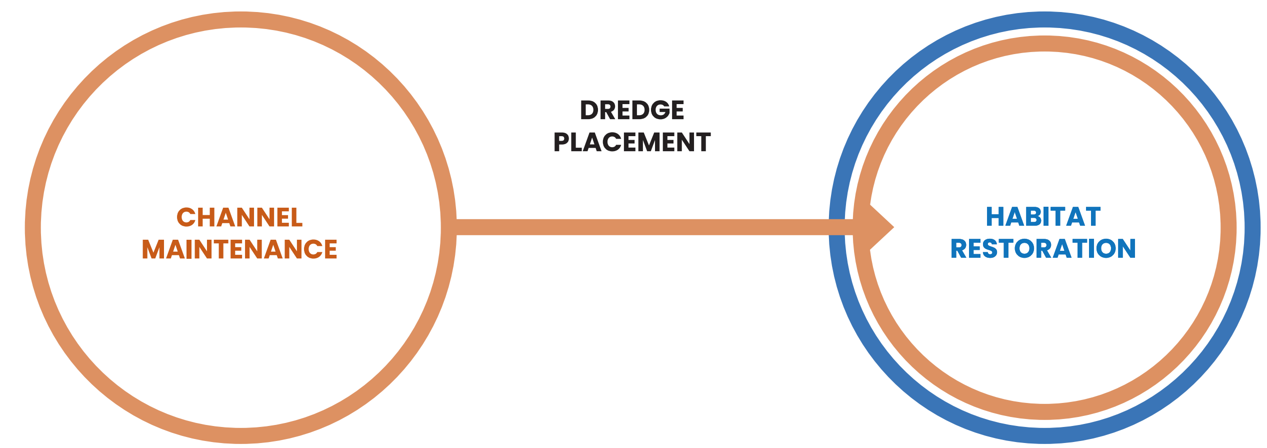
The document highlights BUDM best practices in an accessible and engaging format in order to facilitate communication and collaboration on BUDM as a high-value action that benefits commerce and conservation.

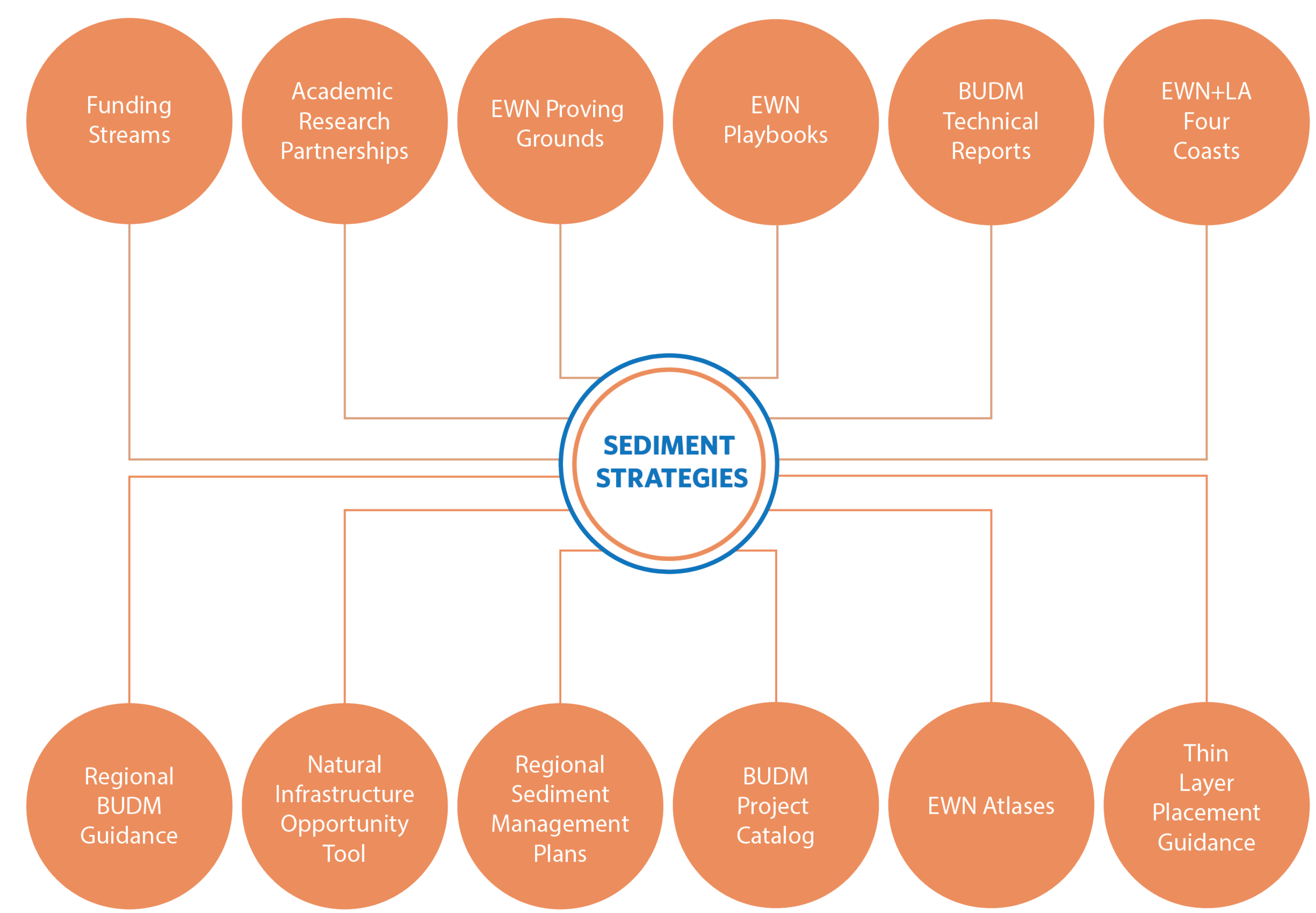
Marshes and tidal habitats on the Atlantic Coast, Gulf Coast, and the Chesapeake Bay are rapidly disappearing. In Maryland alone, it's estimated that these critical wetland coverage has by 30% to 50% since 1850 (Clearwater et al, 2018), presenting a dire threat to coastal biodiversity, livelihoods, and security. A key driver of this loss is marsh subsidence coupled with accelerating sea-level rise, which reduces marsh elevations and impairs ecological functions. Beneficial use, the strategic placement of sediment dredged from commercial and recreational navigation channels onto coastal habitats, explicitly addresses this challenge by enhancing marsh elevations. By restoring and maintaining wetlands, beneficial use offers a cost-effective, scalable approach that connects commerce, conservation, and coastal infrastructure protection, systematically benefiting both waterways and natural resources.

Sediment Strategies highlights key considerations and informative case studies to expand the beneficial use of dredged material. The document synthesizes applied knowledge from industry leaders, regulators, and stakeholders from across the United States with an emphasis on implementation in Maryland. The information presented here is intended to give local governments, non-profits, private property owners, and state and federal agencies a shared knowledge base to communicate, collaborate, and confidently advance sediment management projects. Sediment Strategies compliments existing best practice guidance, initiatives, and partnerships – presenting complex information in an accessible and engaging format.

In alignment with our mission to conserve the lands and waters on which all life depends, the Nature Conservancy has taken a strong interest in Investing in a circular sediment management system that benefits people, the planet, and the economy. Sediment Strategies is a step forward in that mission and was developed by the Maryland/DC Chapter of TNC with contributions from staff in the Northeast, New York, and Southern Divisions.

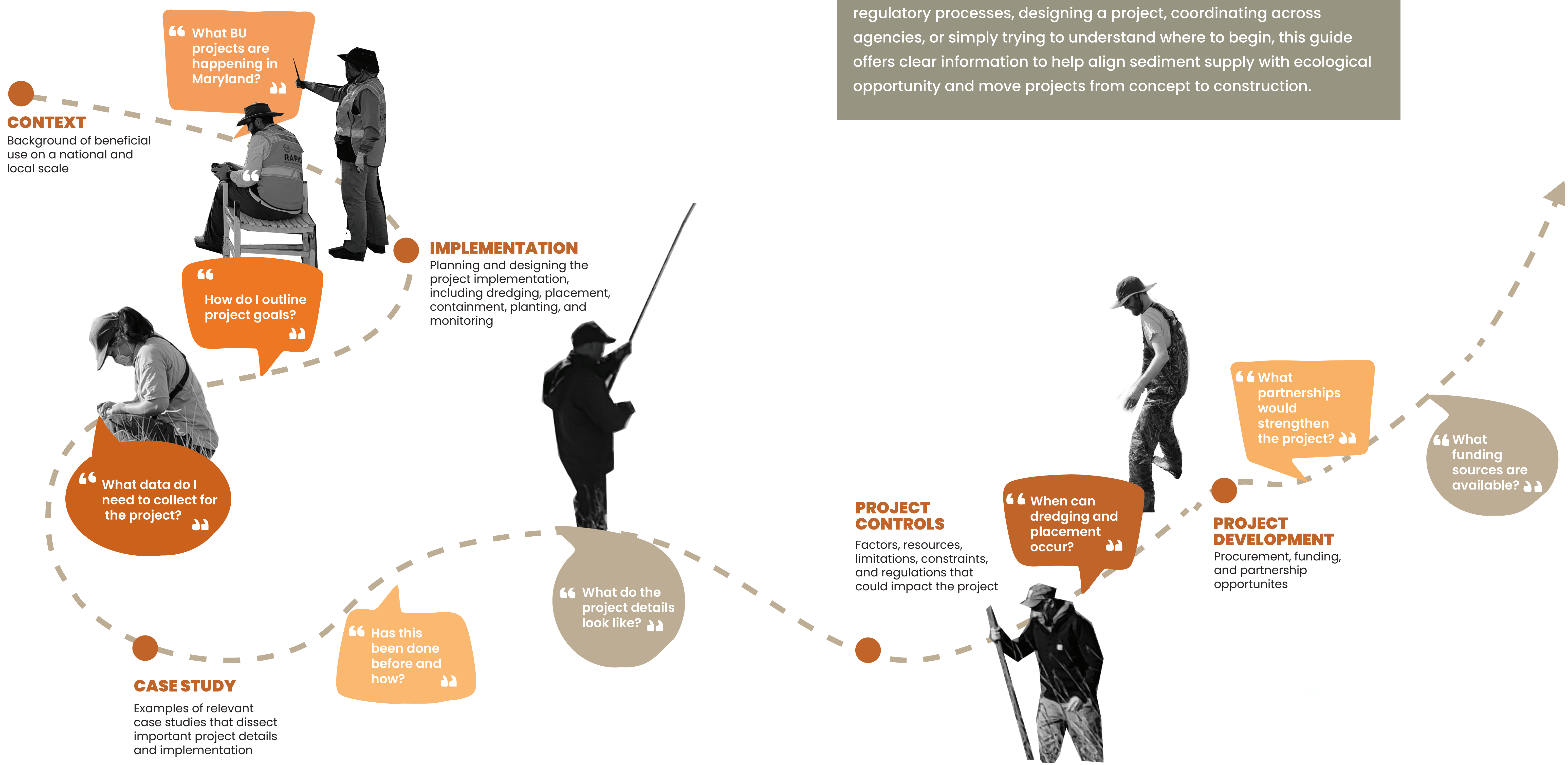
Sediment Strategies is meant to be an implementation resource for sediment management and wetland restoration practitioners with an emphasis on Maryland and the Chesapeake Bay.



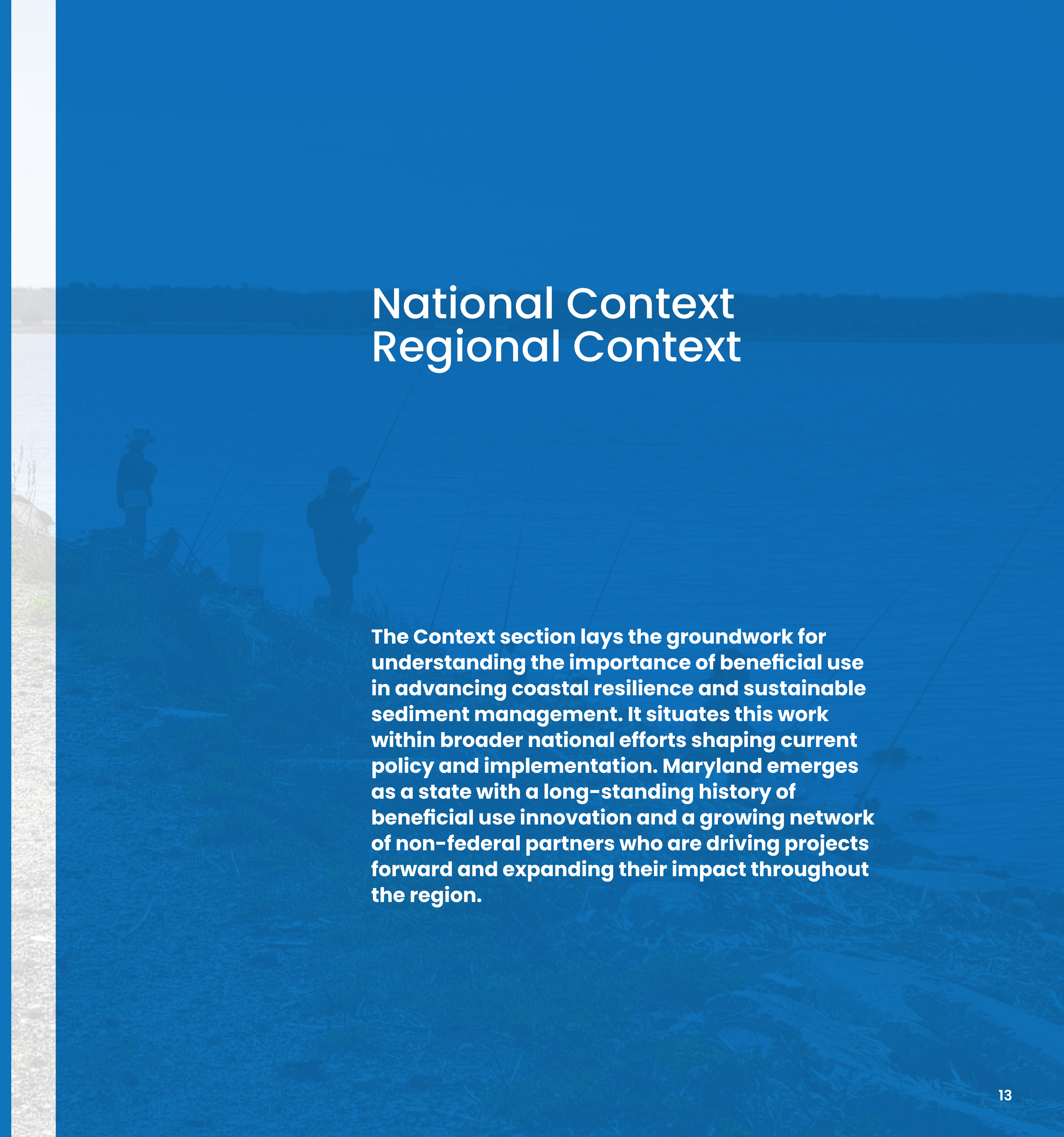


HOW TO USE THIS DOCUMENT

This guide is designed to answer common questions from practitioners, boots-on-the-ground project teams, stakeholder groups, and non-federal agency partners engaged in sediment management and coastal restoration. Organized by topic, it provides practical, accessible information to support future beneficial use of dredged material (BUDM) collaborations. Whether you're navigating regulatory processes, designing a project, coordinating across agencies, or simply trying to understand where to begin, this guide offers clear information to help align sediment supply with ecological opportunity and move projects from concept to construction.



1. CONTEXT



National Context
Regional Context

The Context section lays the groundwork for understanding the importance of beneficial use in advancing coastal resilience and sustainable sediment management. It situates this work within broader national efforts shaping current policy and implementation. Maryland emerges as a state with a long-standing history of beneficial use innovation and a growing network of non-federal partners who are driving projects forward and expanding their impact throughout the region.

Context

BENEFICIAL USE

Maryland's regulatory framework is distinct from the U.S. Army Corps of Engineers (USACE)policy or practices in other states. Its long-standing ban on most forms of open water placement, coupled with more prescriptive beneficial use requirements, shapes both project design and permitting in ways not seen in many other jurisdictions.

USACE, Departments of Transportation, Departments of Natural Resources, maritime industries, and private property owners dredge hundreds of millions of cubic yards of sediment annually, and all of it must be properly managed. Historically, this dredged material was placed in upland disposal facilities or in open water. However, the cost of upland placement is rising, containment facilities are reaching capacity (Williams et al., 2020), and increasingly, states are considering or implementing bans on open water placement. Additionally, moving sediment from the coast to upland sites can disrupt the dynamic equilibrium of coastal systems and exacerbate coastal erosion (NOAA NCCOS, 2025).

At the same time, the U.S. has experienced a net loss of hundreds of thousands of acres of wetlands between 2009-2019 (USFWS, 2024). These habitats provide essential services to the environment, the economy, and human health and well-being. Beneficial use of dredged material (BUDM) represents an opportunity to simultaneously and systematically address sediment management and wetland restoration needs. However, planning, design, implementation, and management of BUDM projects continues face with complex regulatory, technical, and management challenges.

MARYLAND

In Maryland, the statuary definition of beneficial use "means any of the following uses of dredged material from the Chesapeake Bay and its tributary waters placed into waters or onto bottomland of the Chesapeake Bay or its tidal tributaries, including Baltimore Harbor:

+ Restoration of underwater grasses;
+ Restoration of islands
+ Stabilization of eroding shorelines
+ Creation or restoration of wetlands;
+ Creation, restoration, or enhancement of fish or shellfish habitats."

(MDE, MDOT, & MPA, 2019)

Image Credit: Maurice River, NJ, S. Burkholder, Proof Projects

Context

NATIONAL BUDM

USACE aims to beneficially use 70% of the nation's dredged material by 2030. Coordination between USACE districts, federal agencies, and state and local partners is crucial to achieving this goal.

USACE comprises 11 divisions and 41 districts and is a key federal agency involved in dredging and BUDM. USACE districts typically undertake the dredging of federal navigational waterways directly or through contracts. USACE is extensively involved in finding ways to implement BUDM because of the significant amounts of dredged material it manages.

USACE has set a goal of achieving at least 70% beneficial use across all dredging projects by the year 2030 (USACE, 2023). Engineering With Nature, a USACE initiative that aims to align natural and engineering processes within USACE projects, plays a major role in developing and disseminating guidance on beneficial reuse. Engineering With Nature and the 70/30 goal particularly support the advancement BUDM for restoration activities such as marsh creation and enhancement. Beneficial use encompasses a wide range of applications beyond habitat restoration.

However, USACE prioritizes beneficial use strategies that align with their core objectives of ecological restoration and coastal risk management.

Much of the dredging and dredged material management activities undertaken by USACE are governed by the Water Resources Development Act (WRDA), a legislative package that seeks to balance conservation and development of water and related resources in the United States. WRDA authorizes USACE to carry out research and construct projects to improve the country's navigable rivers and harbors. WRDA 2024 codifies USACE's 70/30 goal.

Dredging and dredged material management, either through disposal or beneficial use, cause environmental impacts. Numerous federal agencies regulate environmental impacts and can act as partners on BUDM projects. Similarly, some federal agencies, state agencies, and counties and localities manage land that may be candidate sites for beneficial use. Some of the key agencies are the United States Environmental Protection Agency (USEPA), the United States Fish and Wildlife Service (USFWS), and the National Park Service (NPS).

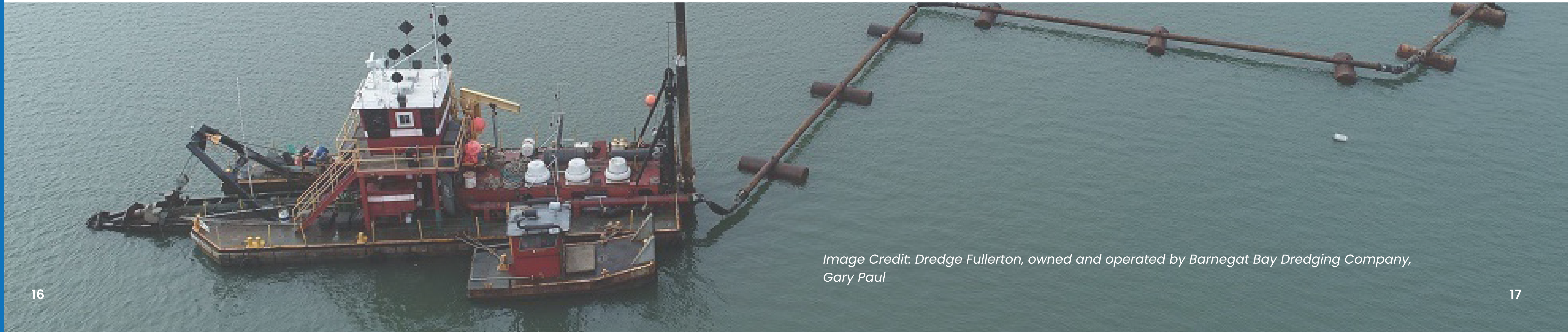


Image Credit: Dredge Fullerton, owned and operated by Barnegat Bay Dredging Company, Gary Paul

Context

MARYLAND SEDIMENT MANAGEMENT

Each year, millions of cubic yards of material are dredged from the Chesapeake Bay and its tributaries. This material is a valuable resource for developing coastal resilience through BUDM.

RESOURCES

MPA + MDE
Innovative Reuse and Beneficial Use of Dredged Material Guidance Document
Provides practical direction for the reuse of all contaminated soils—regardless of origin—by categorizing them based on physical and chemical analysis and identifying appropriate end uses for each category.

In the Chesapeake region, relative sea level rise—the combined forces of erosion, subsidence, and global sea level rise—exceeds the national average (Boesch et al., 2023). Relative sea level rise can lead to marsh degradation and areal loss through drowning, edge erosion, and ponding. At the same time, frequent dredging of major shipping channels to the ports of Baltimore, Salisbury, and Norfolk, nationally significant military installations, and local dredging for recreational and commercial purposes annually produce millions of cubic yards of dredged material throughout the Chesapeake Bay, all of which must be innovative or beneficially reused or moved to a dredged material containment facility (DMCF).

Maryland's Regulatory Context

Dredged material placement in Maryland is subject to the state's Coastal Zone Management Program Enforceable Policies, which prohibit unconfined placement of dredged material unless for restoration purposes. Additionally, these policies mandate that material dredged in Baltimore Harbor (delineated by the North Point – Rock Point line) must be placed in Baltimore Harbor and its associated DMCFs and cannot be exported to the broader Chesapeake Bay for placement.

The primary guiding legislation for dredged material placement in Maryland is the Dredged Material Management Act (DMMA), passed in 2001.

State Agencies and Organizations Involved

State agencies and organizations involved in BUDM in Maryland include the Maryland Department of Natural Resources (MDDNR), MDE, and MPA. Other agencies may be involved depending on project specifics. Ensuring early collaboration with regulatory and funding agencies, during the design phase of the project or sooner, can help streamline a project.

The Paul S. Sarbanes Ecosystem Restoration Project (Poplar Island) is a nationally recognized project using dredged material to rebuild eroded island habitat in the Chesapeake Bay. Led by USACE and the Maryland Port Administration, the restored island will include over 776 acres of tidal wetlands and 829 acres of upland habitat. It provides long-term capacity for approximately 68 million cubic yards of dredged material from federal channels.

Image Credit: Poplar Island, Chesapeake Bay Program, 2017

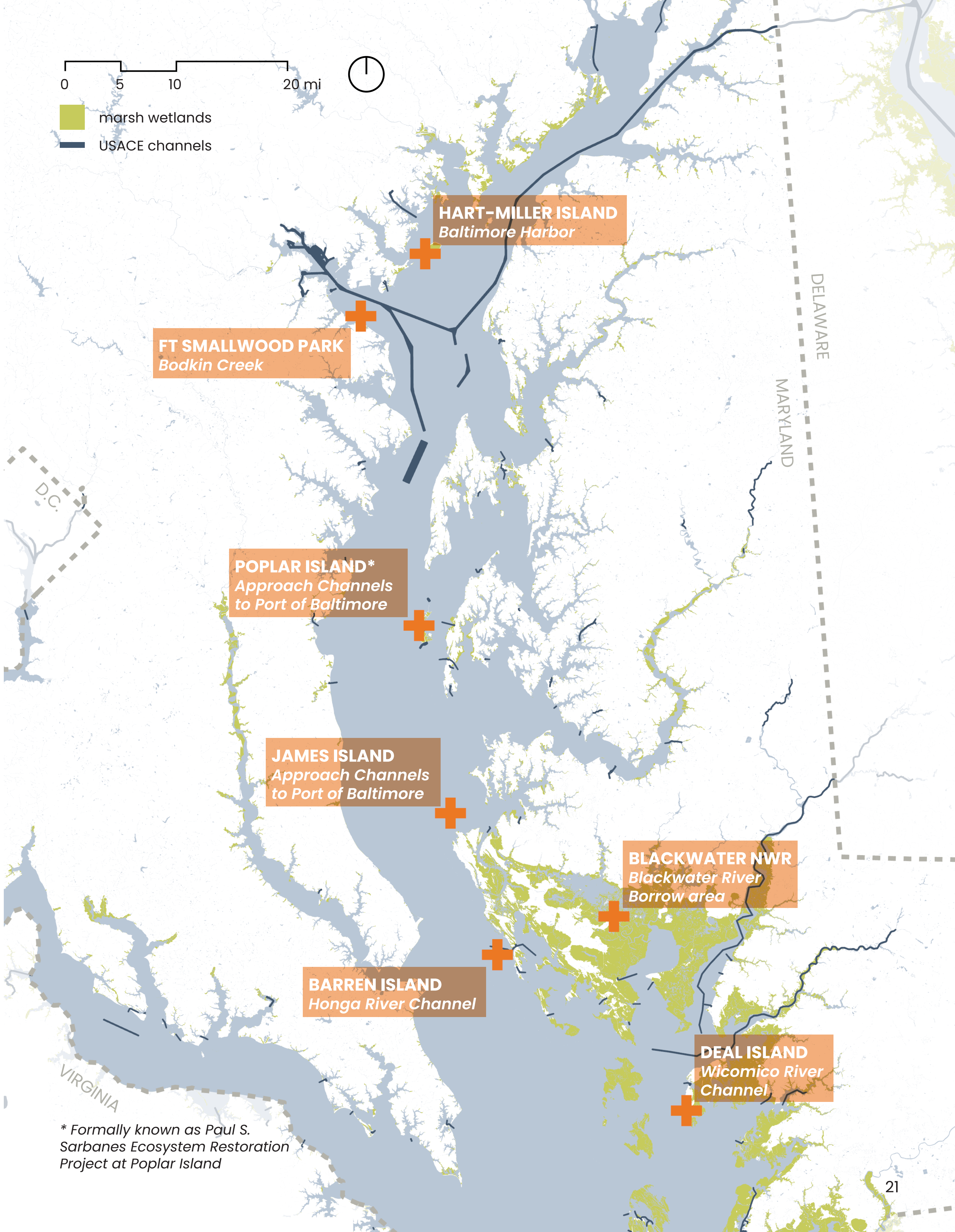
REGIONAL CONTEXT

Maryland's regulatory constraints on unconfined disposal of dredged material made the state a regional leader in BUDM. Several prominent, large-scale beneficial use projects have been carried out in Maryland.

Development of Hart-Miller Island (HMI) in 1981 was the start of use of marsh elevation enhancement projects in Maryland. The HMI Dredged Material Placement Site used dredged material from Baltimore Harbor to rebuild and connect two eroding islands, Hart and Miller, into one large island. HMI was the first beneficial use project in Maryland, and a portion of the 1,100-acre island is now a state park with camping, trails, beaches, and marsh and upland habitats for local wildlife.

HMI has been used as an example to guide and promote new, large-scale beneficial use projects in the state. The Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island (Poplar Island) rebuilt a heavily eroded island in the Chesapeake to its former extent using material dredged from Baltimore Harbor approach channels. The island, which was developed with the goal of creating 1,715 acres of diverse and remote habitat for wildlife, has become an important site for migratory birds. Lessons learned in the rebuilding of Poplar Island have guided the recent Mid-Chesapeake Bay Island Ecosystem Restoration Project, which include placement of dredged material to restore eroding islands such as Barren Island and James Island.

Maryland has continued to innovate in recent years. Blackwater National Wildlife Refuge is the site of the first successful marsh elevation enhancement project in the Chesapeake region. This project used sediment borrowed from the nearby Blackwater River to raise the elevation of the marsh platform as part of a dredging for restoration project in 2016.



* Formally known as Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island

2. IMPLE-MENTATION

Project Objectives
Dredging + Transportation
Placement + Distribution
Containment + Protection
Post-Construction

Implementing a beneficial use project requires careful planning, coordination, and execution. This section outlines the full project lifecycle, beginning with the development of a clear project roadmap. Establishing a strong foundation starts with defining objectives, selecting a suitable site, setting appropriate elevation targets, and identifying the data needed to inform design decisions. Each of these steps plays a critical role in ensuring that project goals align with ecological function and engineering feasibility.

Image Credit: Brick Wetland Restoration, NJ, S. Messur, Anchor QEA

Project Objectives

PROJECT ROADMAP

Understanding project road map, project definition, including target elevation, project assessment, project design.

A successful project roadmap begins with evaluating whether intervention through BUDM is appropriate, based on site conditions, existing trajectories, and restoration needs. Once a need is established, the process moves to defining the site, goals (e.g., wetland restoration or flood protection), and measurable success criteria such as target elevations and vegetation cover. The assessment phase gathers key site data and evaluates logistics, regulatory constraints, and sediment compatibility. Design then focuses on aligning dredging, transport, and placement strategies with site conditions while minimizing complexity. Containment, planting, and protection measures are incorporated as needed. Adaptive management supports resilient outcomes through real-time adjustments informed by monitoring. Flexibility is maintained through performance-based specifications, allowing for the balance of cost, risk, and ecological objectives across planning, implementation, and long-term management.

MARYLAND

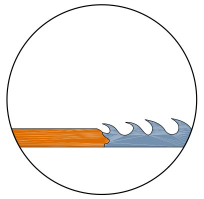
Target elevations for low tidal marsh should be within 1.5 x the local tidal range above mean low water (MLW); with low marsh located between MTL and MHWL and high marsh located between MHWL and 1.5 x the local tidal range above mean low water. (MDE Guidelines).

Projects may consider sea level rise when determining target elevations; as of 2025, projects targeting sea level projections up to 2050 may be accepted (MDE, see UMCES 2023 for 2050 projections).

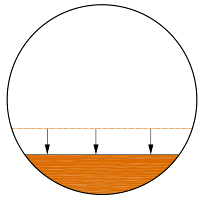
PROJECT CHARACTERIZATIONS

These symbols are used throughout the document to represent key project characteristics. In the Case Studies section, they help describe and categorize each example based on these attributes.

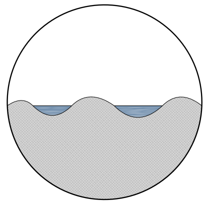
PROJECT OBJECTIVES (MARSH DEGRADATION)



Edge Erosion



Overall Platform Loss



Ponding

ROADMAP OVERVIEW

MARYLAND

For more detailed information on the beneficial use of dredge material planning process in Maryland, see Appendix, page 156-159.

The following pages outline general steps for defining project objectives, conducting site assessments, and developing concept designs. These steps are not exhaustive and typically require multiple iterations and revisions.

PROJECT OBJECTIVES

UNDERSTAND DESIRED OUTCOMES

The Project Definition phase establishes the why of the project. It sets forth the foundational vision, purpose, and intended outcomes such as wetland restoration and sediment reuse. It also sets success criteria and defines risk tolerance and key constraints. Clear definitions at this phase aligns stakeholders and informs all future work.

- **Site Selection** p. 28-29
- **Define Project Goals** p. 30-31
- **Connect Source with Need** p. 144-145
- **Identify Project Partners** p. 152-153

→

PROJECT ASSESSMENT

UNDERSTAND CURRENT CONDITIONS

Determining whether a project can realistically be achieved involves evaluating current site conditions, collecting critical data, identifying logistical and environmental constraints, and conducting feasibility analyses. This phase helps refine the vision into an actionable plan ready for design and permitting.

- **Target Elevations** p. 32-33
- **Site Analysis** p. 34-35
- **Performance Specifications** p. 48 - 49
- **Sediment Characteristics** p. 140-141
- **Funding** p. 148-149
- **Cost Analysis** p. 150-151

→

PROJECT DESIGN

CURRENT CONDITIONS TO DESIRED OUTCOMES

Design shows how to bring the vision to life by translating goals and constraints into technical plans that use the simplest, most-efficient approach. In this phase, sediment delivery methods, site grading, containment, planting, and adaptive strategies are tailored to site conditions.

- **Dredging + Transportation** p. 38-45
- **Placement + Distribution** p. 46-55
- **Containment + Protection** p. 56-65
- **Post-Construction** p. 66-73
- **Monitor** p. 70-73
- **Planting** p. 68-69

Project Objectives

SITE SELECTION

Site selection is a critical early step in any BUDM project because it influences not only the project's design but also its ultimate objectives.

Ideally, BUDM sites are identified based on ecological or biological need—areas where intervention can support habitat restoration, shoreline stabilization, or other environmental benefits. Proximity to active navigation channels is a secondary consideration, as closer sites can reduce transportation costs and limit the need for extensive pipeline networks, booster pumps, and staging infrastructure. Balancing ecological priorities with logistical feasibility is key to effective site selection.

To address these logistical and regulatory constraints early, mapping tools like ArcGIS can be used to align upcoming dredging supply with ecological or coastal protection needs (Piercy et al., 2023). Such tools can also help identify suitable placement sites on public lands, including Wildlife Management Areas, state-owned land, and federal properties, which can streamline real estate coordination and align with local management plans.

The Deal Island project faced unique challenges because the placement site was approximately 9 miles from the Wicomico River dredging area (USACE, 2022). This unusually long transport route required extra coordination and infrastructure. Notably, the site was initially selected based on a field visit and informal assessment by a small group of individuals, underscoring the need for a more inclusive, transparent, and evidence-based site selection process in future projects. In contrast, the Blackwater National Wildlife Refuge restoration site had no navigation channel nearby, so material came from a local borrow area just downstream (Whitbeck et al., 2019). However, this approach, dredging solely for restoration purposes rather than maintenance, can be a regulatory hurdle because permitting agencies often discourage non-navigational dredging and instead prioritize projects that beneficially reuse sediment from routine navigation dredging.

Image Credit: Deal Island, Chris Snow, MDDNR

PROJECT GOALS

Defining project objectives is a fundamental step that directly influences the design, implementation, and ultimate impact of a BUDM effort.

Clear, well-articulated objectives help align stakeholders, guide technical decisions, and establish criteria for success (Myszewski, 2017). Objectives typically emerge from site-specific challenges and opportunities and are best organized into categories such as ecological restoration, navigational needs, and coastal risk management.

Ecological objectives often include restoring wetland functions and habitats. To define these objectives, project teams can assess ponding, edge erosion, general subsidence, habitat loss, habitat conversion, and other environmental factors. If species of concern are present, objectives may include targeting specific habitat types or conditions required for their recovery. Broader ecosystem goals—such as addressing sediment deficits or supporting marsh adaptation to sea level rise—can also direct the project's purpose.

While most microtidal marshes in the Mid-Atlantic are ebb-dominated and unlikely to naturally keep pace with sea level rise, project teams can assess site vulnerability—based on elevation capital, sediment availability, and hydrological conditions—to inform whether sediment intervention is warranted. These ecological drivers help ensure the project supports biodiversity, builds resilience, and promotes long term environmental health.

Navigational objectives are determined by the need to manage material from maintenance dredging. Setting these objectives involves identifying where dredging is already occurring, what sediment is available, and how far it must be transported. Defining a suitable placement site within a manageable distance can significantly reduce costs and determine the feasibility of BUDM. These practical considerations influence project scale, schedule, and partnership opportunities.

Coastal risk management objectives aim to reduce erosion and mitigate coastal flooding impacts. Defining them requires understanding local vulnerabilities, such as infrastructure at risk from flooding or storm surge, and identifying how the project can provide a protective buffer. Coastal risk objectives often intersect with ecological objectives, especially when natural systems like wetlands or sediment platforms are used to serve dual roles in habitat enhancement and hazard mitigation.

Perhaps more than in typical restoration projects, an understanding of risk tolerance, flexibility, and adaptive management is critical to the success of BUDM projects. Despite extensive data collection and planning, BUDM projects often face on-the-ground uncertainties, such as variations in the volume or composition of dredged material, that require rapid adjustment. As a result, defining project objectives goes together with anticipating variability.

Projects with greater risk tolerance, clear contingency planning, and built-in flexibility tend to result in better outcomes. These outcomes may include keeping sediment in the system, enhancing habitat, or creating protective features even if the final implementation diverges from the initial designs. Embracing an adaptive mindset from the outset enables project teams to course-correct without compromising overarching goals.

TARGET ELEVATION

Establishing target elevations is critical because elevation directly influences habitat outcomes, vegetation recovery, hydrology, and long-term project performance.

Consolidation and Post-Placement Behavior
Immediately after placement, sediment undergoes rapid consolidation and dewatering, particularly when fine-grained material is placed at thicknesses of approximately 6 to 12 inches (Piercy et al., 2023, Graham et al, 2013). Elevation loss during the first 10 to 40 days after placement can be significant, with the steepest decline often occurring in the first 10 days. To account for this behavior, construction plans may include an overfill buffer, placing material slightly above the biological target to offset expected subsidence (Carr, n.d.)

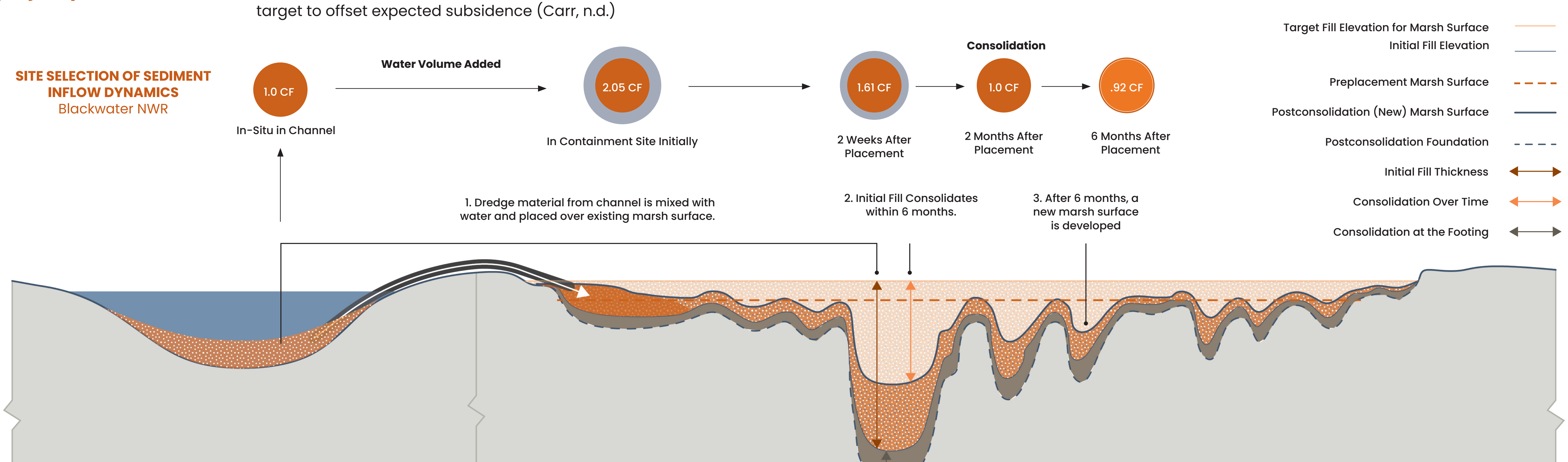
Construction Target-Elevation Range
This is the elevation immediately after placement and often includes a defined maximum or "not-to-exceed" threshold. It represents the upper limit of acceptable fill height to avoid unintended habitat conversion, for example by pushing an intertidal marsh into tidal range (Piercy et al., 2023).

Biological Target-Elevation Range
This is the desired elevation at which biological recovery is expected to begin, typically 1 to 2 years after placement. This elevation range aligns with ecological performance goals, such as supporting marsh vegetation, benthic invertebrate colonization, or shallow water habitat conditions (Piercy et al., 2023).

MARYLAND

The upper limit of tidal marsh is 1.5 x tidal range over MLW, placement of dredge material in tidal water to a target elevation that is above 1.5 x tidal range is considered conversion, but placement of dredge material on wetlands that are already above MHWL is not considered conversion because these are already considered nontidal wetlands.

SITE SELECTION OF SEDIMENT INFLOW DYNAMICS
Blackwater NWR



Source: Adapted from Bailey, Tyler, and Welp (2017)

DATA COLLECTION

Gathering accurate site data is essential to align design objectives with real-world conditions. Topography, sediment properties, hydrodynamics, and access logistics directly inform elevation targets, placement strategies, material needs, and equipment feasibility for effective project design.

For more info, see p. 166-167

SEDIMENT

Focuses on the physical, chemical, and biological properties of soil and sediment that influence compaction, erosion, consolidation, vegetation success, and construction feasibility.

Image Credits: USACE

GEOMORPHOLOGY

Considers the physical structure, elevation, and configuration of the restoration site—including drainage patterns, sediment characteristics, historical landscape features, and site topography. A well-understood geomorphic context informs placement strategy, predicts sediment behavior, and helps maintain natural hydrology.

S. Burkholder

HYDROLOGY

Focuses on water movement and interaction at the site, including tides, waves, groundwater, and precipitation. These dynamics govern sediment deposition, inundation regimes, drainage capacity, and plant suitability. Projects must align placement elevations with expected water levels and assess future conditions such as sea level rise to ensure long-term resilience success, and construction feasibility.

Chesapeake Bay Program

DREDGING

Encompasses sediment availability, quality, compatibility, and logistics. Key considerations include grain size, contamination, slurry properties, dredge type, and transport method. The match between sediment source and placement site influences both performance and regulatory viability. Source testing and volume estimates support feasible, cost-effective project implementation.

Chesapeake Bay Program

ECOLOGY (FAUNA)

Considers existing and target fauna communities, including benthic invertebrates, fish, birds, and other wildlife. Ecological planning incorporates habitat sensitivity mapping, species-specific life cycle and timing restrictions (e.g., nesting or spawning windows), and strategies to support critical habitat functions.

Chesapeake Bay Program

Considers existing and target plant communities, including emergent vegetation, submerged aquatic vegetation (SAV), and upland transition species. Ecological planning includes mapping of plant community zones, timing of planting relative to site conditions (e.g., sediment consolidation, inundation), and species selection to match elevation, salinity, and hydrology.

Chesapeake Bay Program

PROJECT DESIGN

Simple designs can help projects meet goals by minimizing structures and discharge points. Complexity should be added only when site conditions or resource constraints make it necessary. Print the checklist on the right and use it to ask questions about the project design.

Designs that prioritize simplicity to improve constructibility also minimize costs and uncertainty. The number of placement areas, containment features, and discharge points should be limited whenever possible. A straightforward design is easier to implement and monitor, but greater complexity may be necessary due to site-specific challenges such as access limitations, sensitive habitats, or equipment constraints. In those cases, complexity can be used to resolve conflicts, meet regulatory requirements, or optimize resource use while still aligning with project objectives.

Project Objectives

- ○ Evaluate site suitability and appropriateness of BUDM strategy

  Understand present site resources and potential challenges.

  Understand the pre-work to defend functions and prepare site for work

  Set target elevations for vegetation and stability; factor in consolidation and settling
- ○ Establish project goals and performance metrics
- ○ Define risk tolerances and incorporate design flexibility
- ○ Identify success criteria and performance evaluation methodology

Site Plan

- ○ Map site footprint and delineate sediment placement areas
- ○ Incorporate buffers around sensitive and critical habitat
- ○ Develop tidal creek strategy emphasizing ecological function and connectivity
- ○ Plan access routes and equipment staging areas

Dredge and Transportation

- ○ Schedule around environmental work windows
- ○ Ensure full compliance with permits and approvals
- ○ Design slurry transport approach (e.g., pipeline, barge)
- ○ Plan BMPs (e.g., turbidity curtains) to minimize impacts to submerged aquatic vegetation (SAV) and aquatic fauna

Sediment Distribution

- ○ Identify optimal pipeline discharge locations
- ○ Develop inflow sequencing strategy
- ○ Determine appropriate discharge rate and select necessary equipment attachments
- ○ Plan for additional equipment needed to manage sediment or adjust pipeline positioning

Containment

- ○ Choose containment strategy
- ○ Choose appropriate containment material
- ○ Plan containment placement and removal methodologies
- ○ Clarify and design specifically for tidal creek interactions and containment considerations
- ○ Determine and design for wave attenuation measures or additional protective features

Vegetative Strategy

- ○ Develop and implement an adaptive monitoring and management strategy, integrating vegetation establishment and containment effectiveness as key components
- ○ Define monitoring methods for elevation, sediment consolidation, and plant re-establishment
- ○ Specify planting methods and vegetation establishment strategies, responsive to site conditions and monitoring outcomes

Monitoring

- ○ Set reference and control site benchmarks
- ○ Define metrics for long-term success and project

Image Credit: Brick Wetland Restoration, NJ, S. Messur, Anchor QEA

DREDGING + MATERIAL TRANSPORT

In projects connected to navigational dredging, the sediment source is usually predetermined. When a project is combined with navigation dredging, it is important to identify multiple potential placement sites to ensure flexibility. Having alternative placement options allows all sediment to be cleared efficiently from navigation channels, helping to meet both scheduling and budget objectives.

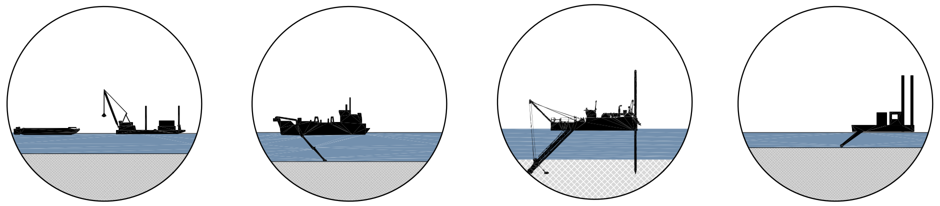
Navigation dredging projects generally fall into two primary categories: new work dredging and maintenance dredging. New work dredging involves excavating areas that have not been previously dredged, typically requiring the removal of more consolidated or denser sediments. In contrast, maintenance dredging focuses on the routine removal of accumulated sediments to preserve the design dimensions of existing navigation channels or harbors.

MARYLAND

Larger navigation maintenance projects often involve material that is mechanically removed and hydraulically unloaded in to DMCFs. Shallow channel maintenance projects often use a hydraulic dredge.

PROJECT CHARACTERIZATIONS

DREDGING EQUIPMENT



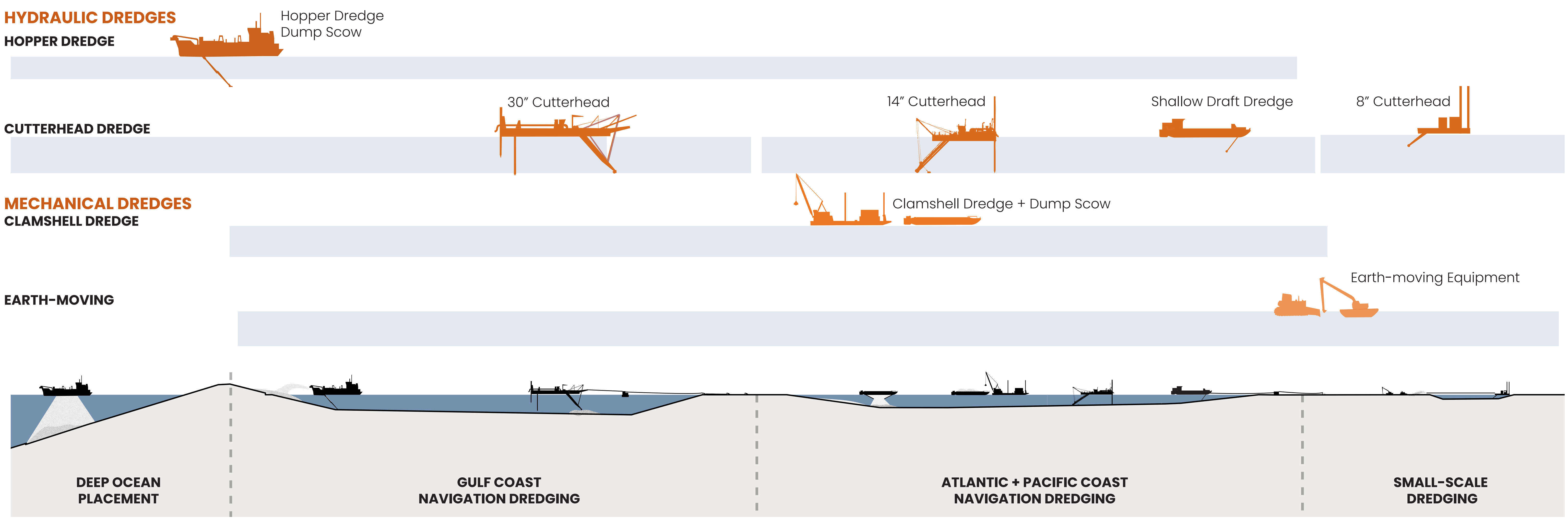
Clamshell + Scow | Hopper Split Hull | 14" Cutterhead | 8" -12" Cutterhead

DREDGING EQUIPMENT

Matching the dredge type to site conditions and operational logistics ensures efficient sediment placement, habitat compatibility, and a cost-effective project.

Hydraulic dredges, particularly cutterhead and hopper types, are commonly used for beneficial use of dredged material (BUDM) projects because they can be scaled to project needs and efficiently transport sediment as slurry over long distances. Smaller cutterhead dredges, with discharge pipe diameters ranging from 8 to 14 inches, are well-suited for wetland restoration projects that require precision and lower volumes. Larger systems, with pipe diameters up to 30 inches, are typically used for high-volume marsh creation, especially along the Gulf Coast. However, their use is expanding in the Northeast for beach nourishment and deep-draft harbor projects. For example, an 18-inch cutterhead dredge was used in the Supawna Meadows NWR restoration project (Monica Chasten, pers. comm.).

In addition to standard equipment, special-purpose dredges such as the shallow-draft Dredge Murden, based out of Wilmington, NC, have been used in federal BUDM projects throughout the Northeast. These vessels are designed to access shallow areas and support sediment placement in sensitive or spatially constrained environments.

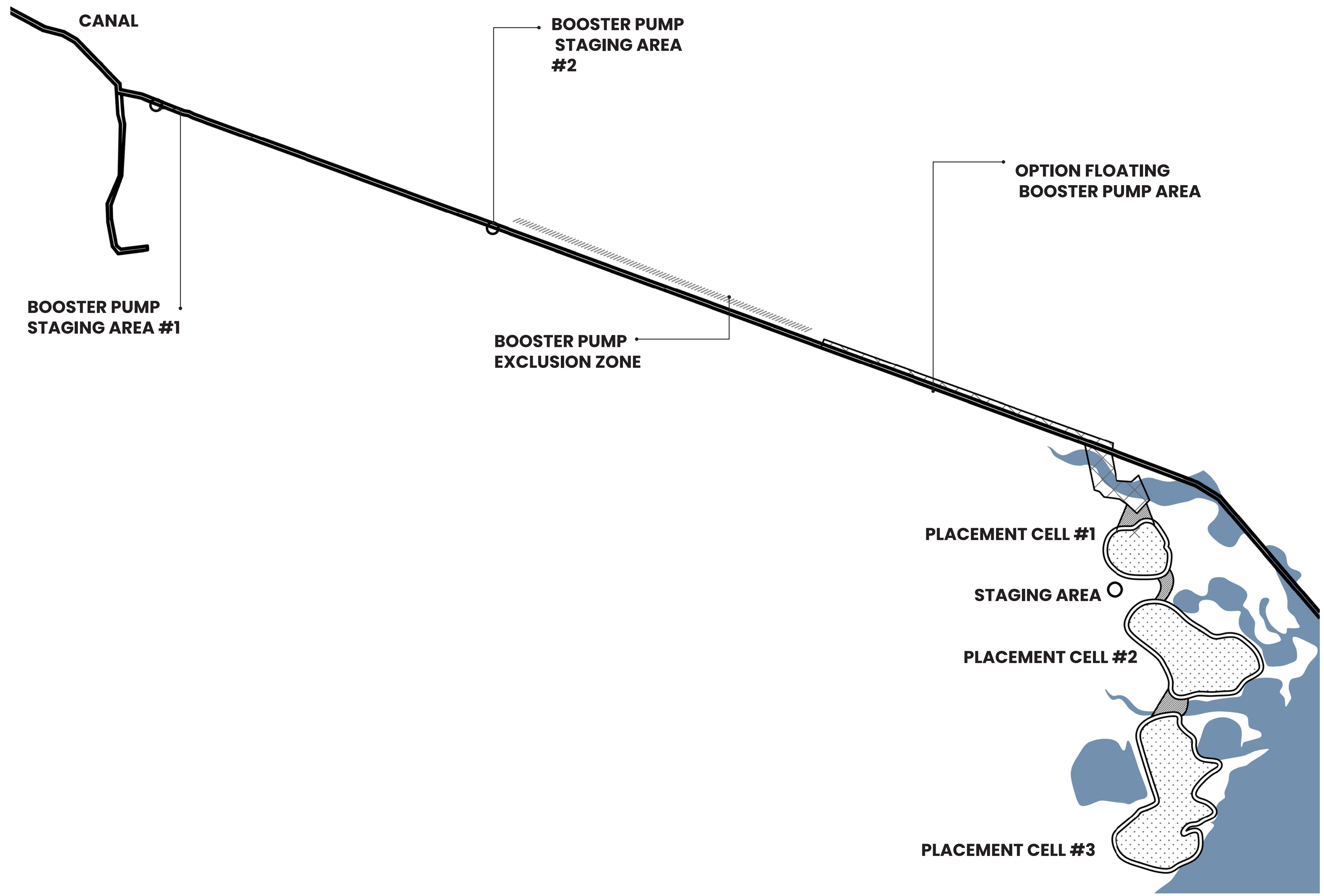


PIPELINE CORRIDOR

The distance from the dredge site to the placement area plays a major role in the project design, cost, and equipment requirements.

Longer transport distances require detailed analysis of pipeline routing, tidal currents, and corridor access to ensure efficient slurry delivery and minimal disruptions. Hydraulic friction increases with pipeline length, especially when high-pressure discharge features like nozzles are used, often necessitating the use of booster pumps to maintain slurry velocity and avoid clogging. Although boosters extend pumping capacity, they also introduce significant cost and logistical complexity. Pipeline corridors are typically 60 to 100 feet wide on land and 100 to 300 feet offshore and are aligned with placement areas to allow progressive restoration of impacted zones.

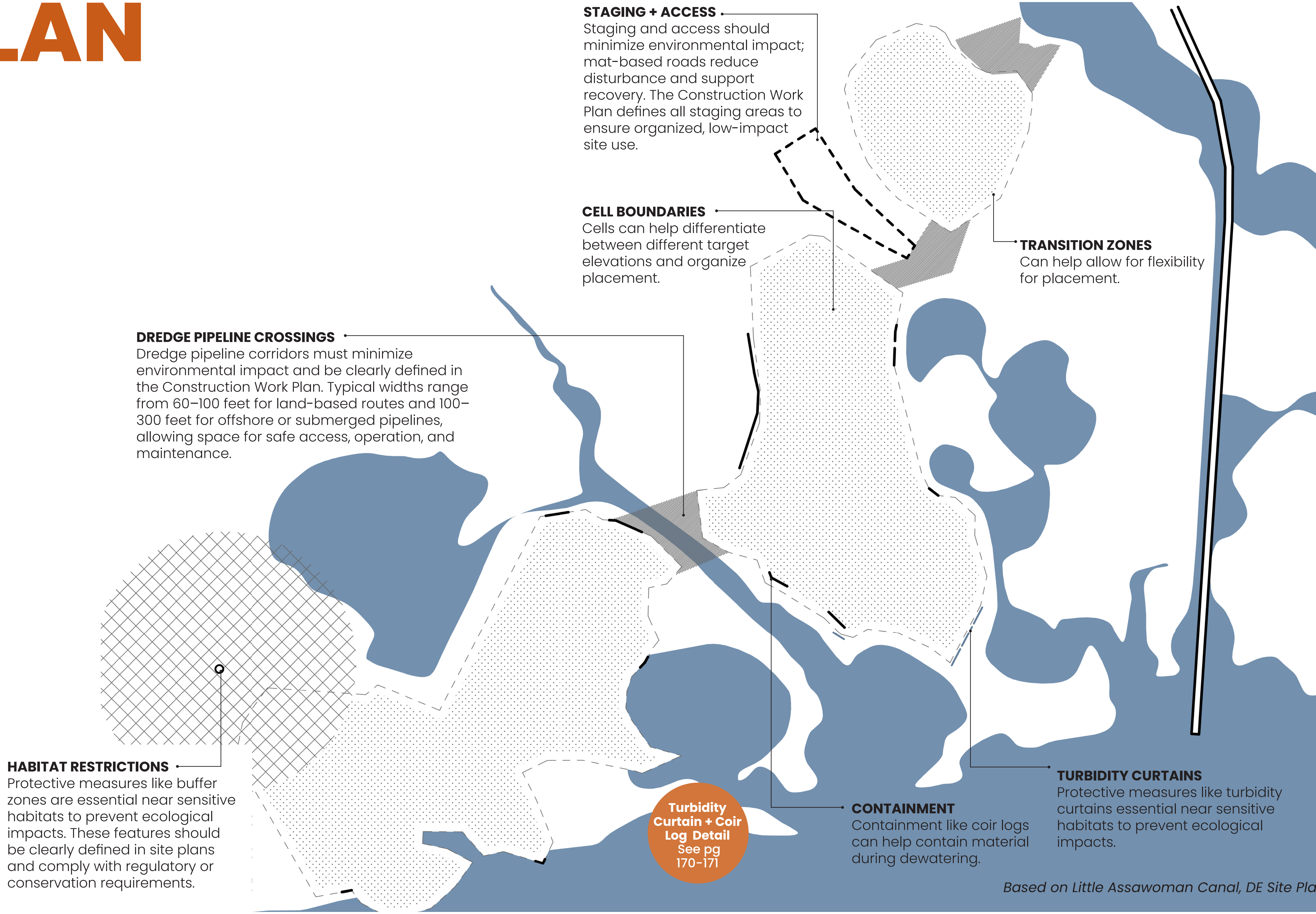
Thoughtful alignment of corridors and pipeline routes is essential to balancing operational feasibility with environmental and cost considerations.



Based on Little Assawoman Canal, DE Site Plan

SITE PLAN

A site plan provides a comprehensive visual layout of a project area, showing key features such as access routes, staging zones, habitat buffers, and infrastructure to guide construction and minimize impacts.



Based on Little Assawoman Canal, DE Site Plan

Image Credit: Brick Township, NJ, S. Messur, Anchor QEA

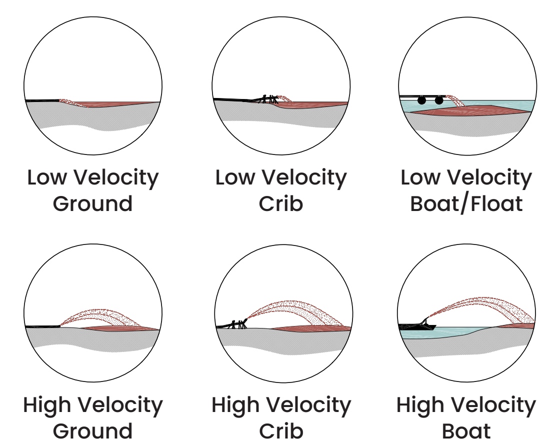
PLACEMENT + DISTRIBUTION

Layer thickness, placement precision, risk tolerance, budget constraints, and other factors all influence the choice of placement option. Thinner layers and more-precise placement are generally more labor intensive and more expensive. Whether pipelines discharge into a single large cell or multiple smaller cells in one lift or multiple sequential lifts has major implications for cost and construction time. Smaller cells can slow construction by necessitating frequent repositioning of the discharge pipe. Multiple thin lifts increase project complexity and expense but may be necessary to meet elevation or habitat targets.

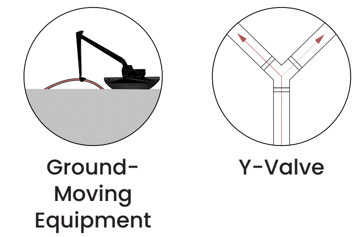
Sediment placement approaches must align with project objectives, which can include habitat restoration, elevation gain, or cost efficiency. Placement varies based on flow velocity, pipe placement, and manual versus natural distribution, as well as sequencing.

PROJECT CHARACTERIZATIONS

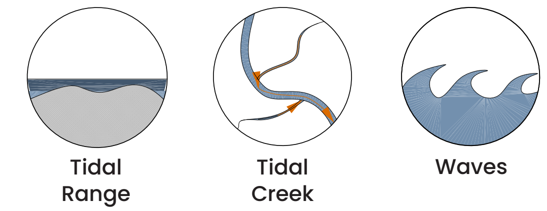
FLOW VELOCITY + HEIGHT



MANUAL DISTRIBUTION



NATURAL DISTRIBUTION FORCES



MARYLAND

In Maryland, BUDM placement should be contained to control spread. Placement method and discharge velocity play key roles in managing distribution and maintaining effective containment.

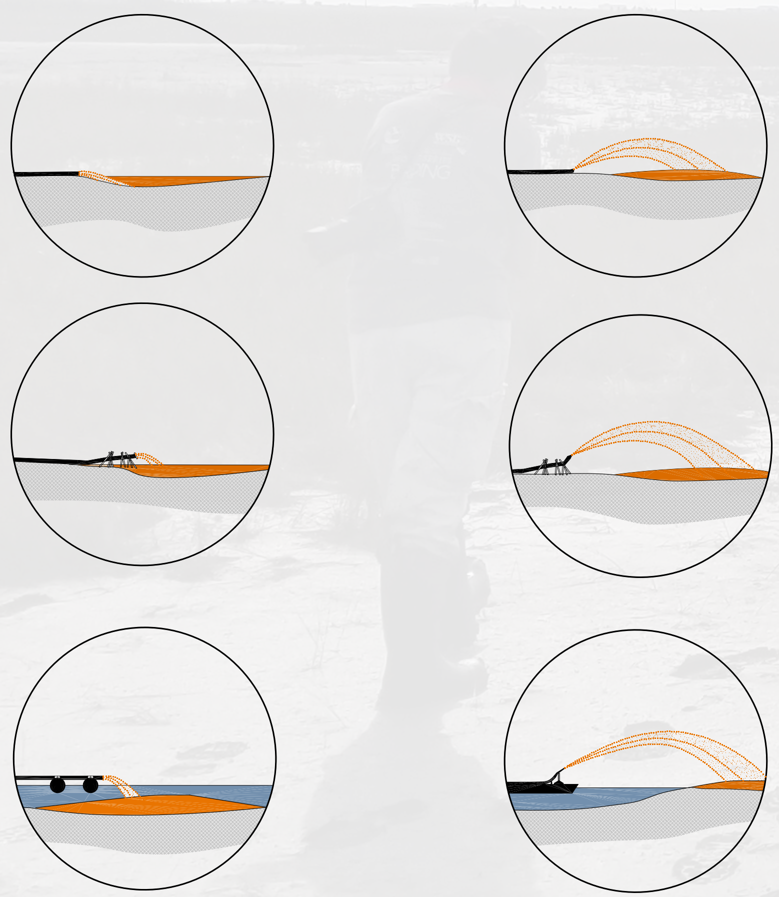
DISCHARGE ATTACHMENTS

Pipeline attachments can be used to control how slurry is deposited at the placement site, generally falling into two categories: low-pressure and high-pressure discharges. In addition to the attachment type, the height and configuration of the discharge setup also influence how easily the pipeline can be repositioned and how broadly the slurry is distributed.

GROUND
Low-profile setup is easier to move, causes less impact, but may lead to sand buildup around the pipe.

CRIB
Low-profile setup is easier to move, causes less impact, but may lead to sand buildup around the pipe.

BOAT + PONTOON
Easier to move with less impact to wetlands; limited to fringe and tidal access but enables open water and subtidal placement.



LOW-PRESSURE DISCHARGE | **HIGH-PRESSURE DISCHARGE**

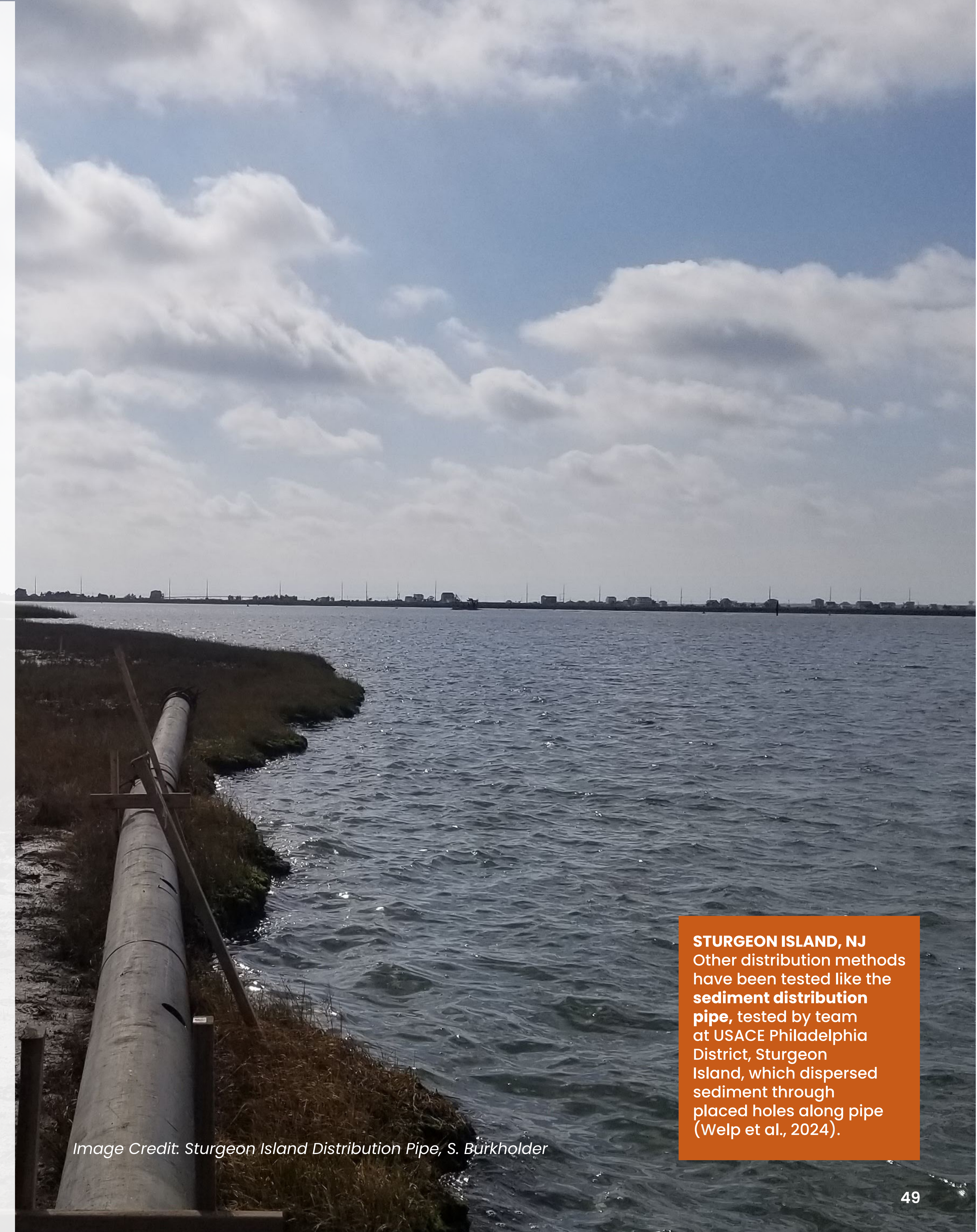


Image Credit: Sturgeon Island Distribution Pipe, S. Burkholder

STURGEON ISLAND, NJ
Other distribution methods have been tested like the **sediment distribution pipe,** tested by team at USACE Philadelphia District, Sturgeon Island, which dispersed sediment through placed holes along pipe (Welp et al., 2024).

PLACEMENT SEQUENCE

Pipeline discharge configuration and inflow choreography directly influence project efficiency, cost, and sediment distribution.

Effective placement requires smart inflow choreography. Smart sequencing, Y-valves and other fittings, and attention to site geometry help optimize placement, especially for multi-cell or multi-lift designs. The orientation and location of the discharge pipe may consider site geometry and the direction of slurry drainage to optimize distribution and avoid oversaturation near cell boundaries. Placement can be sequenced to deposit coarser sediments in deeper or lower areas, such as pools or pannes, where thicker material is beneficial (Piercy et al. 2023). Intermediate fittings such as Y-valves enable the sequential filling of multiple cells, improving operational efficiency and extending de-watering times between lifts. Incorporating dredging contractor expertise in determining placement sequence and methods is critical to any project.

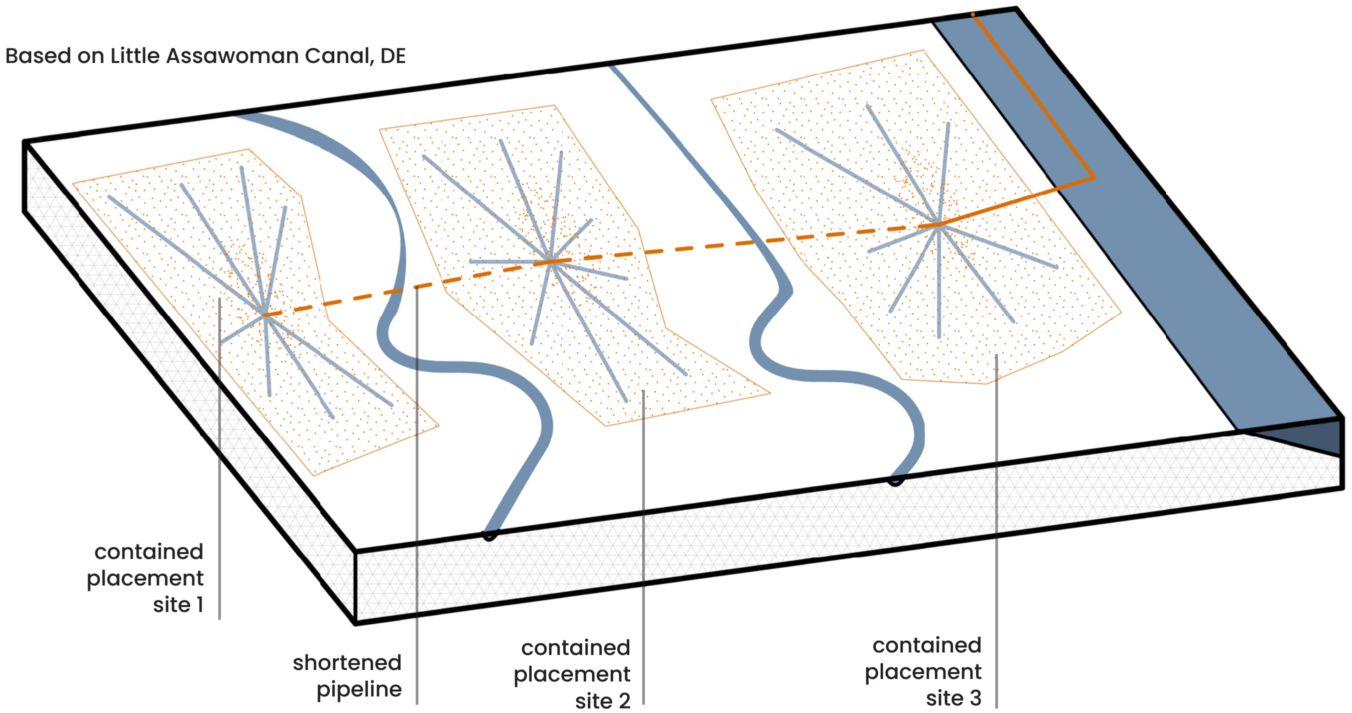
STURGEON ISLAND, NJ
At Sturgeon Island, operators used partially open gate y-valves to split the slurry discharge between two downstream lines. This reduced discharge velocity at the pipe outlets, which in turn minimized scour and channelization on the marsh surface, allowing for more uniform sediment deposition across the site (Chasten et. al, 2022).

Image Credit: Sturgeon Island Phase 3, M. Chasten, USACE Philadelphia District

SEQUENTIAL SEQUENCING

Choreographing the placement of material throughout marsh.

Based on Little Assawoman Canal, DE



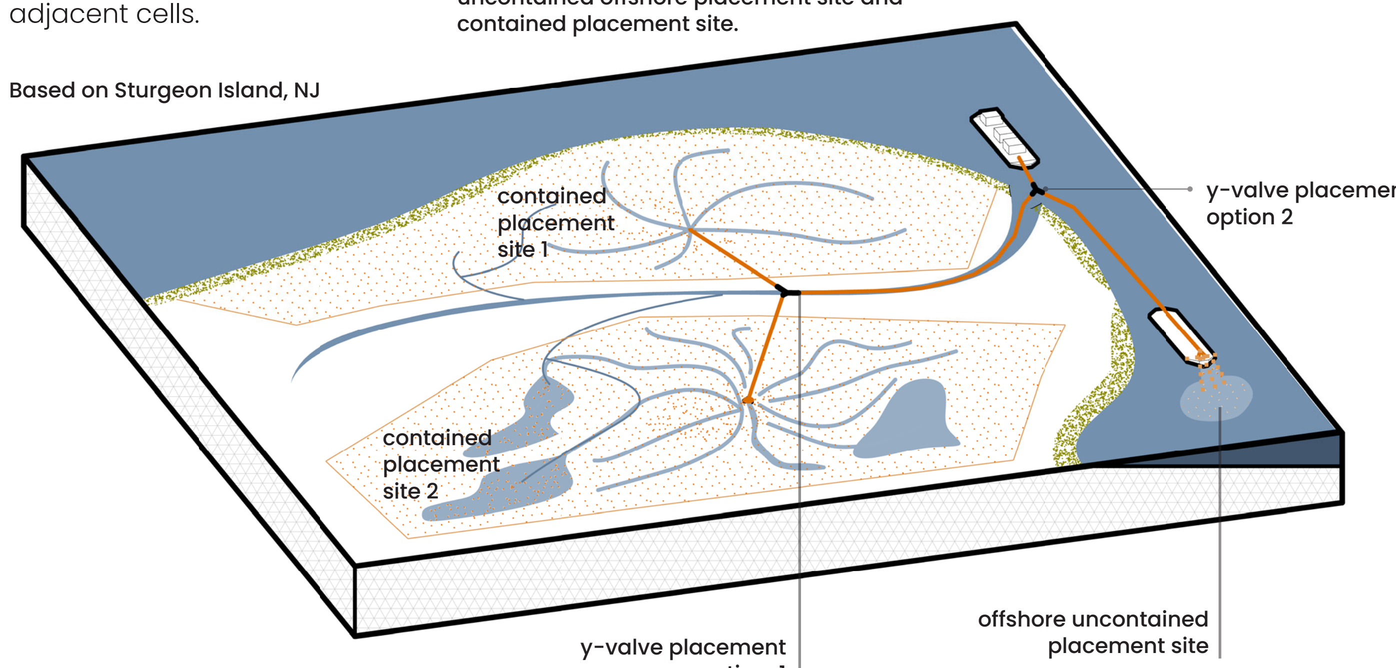
Y-VALVES

Enhance efficiency by allowing alternation between active placement and de-watering in adjacent cells.

In **y-valve option 1**, switch between two contained placement sites for dewatering.

In **y-valve option 2**, switch between uncontained offshore placement site and contained placement site.

Based on Sturgeon Island, NJ



PIPELINE MOVEMENT

Natural distribution relies on tides, wind, and gravity to spread dredged material using fixed infrastructure, while manual distribution requires active equipment adjustments for precise, controlled placement but with higher costs.

Sediment placement can involve a range of distribution approaches, from passive to highly managed. Natural distribution leverages tides, wind, gravity, and existing topography to guide material flow, often using fixed pipes and minimal equipment intervention. This method suits projects where variability in sediment spread is acceptable. Manual distribution introduces more control by actively managing discharge locations and adjusting equipment to target specific areas. Many projects use a combination of both, starting with passive distribution and transitioning to active methods as site conditions evolve. The balance between efficiency, precision, and site impact shapes the overall approach to sediment placement.

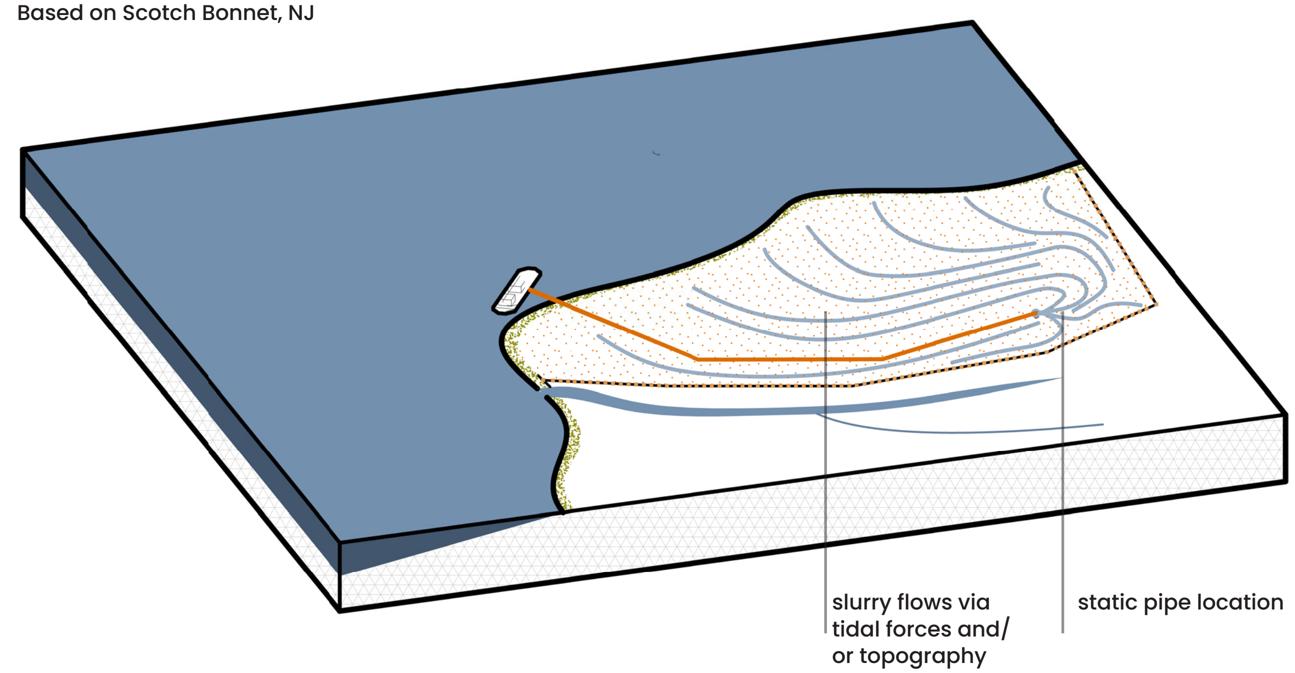
MAURICE RIVER, NJ
A **static** cribbed pipe is located in the tidal creek of a low marsh, as material is redistributed out into the mudflat.

BRICK, NJ
A **non-static** ground pipe is moved around the site via an amphibious excavator.

Image Credit: Maurice River, NJ, S. Burkholder (top); Brick Township, NJ, S. Messur, Anchor QEA (Bottom)

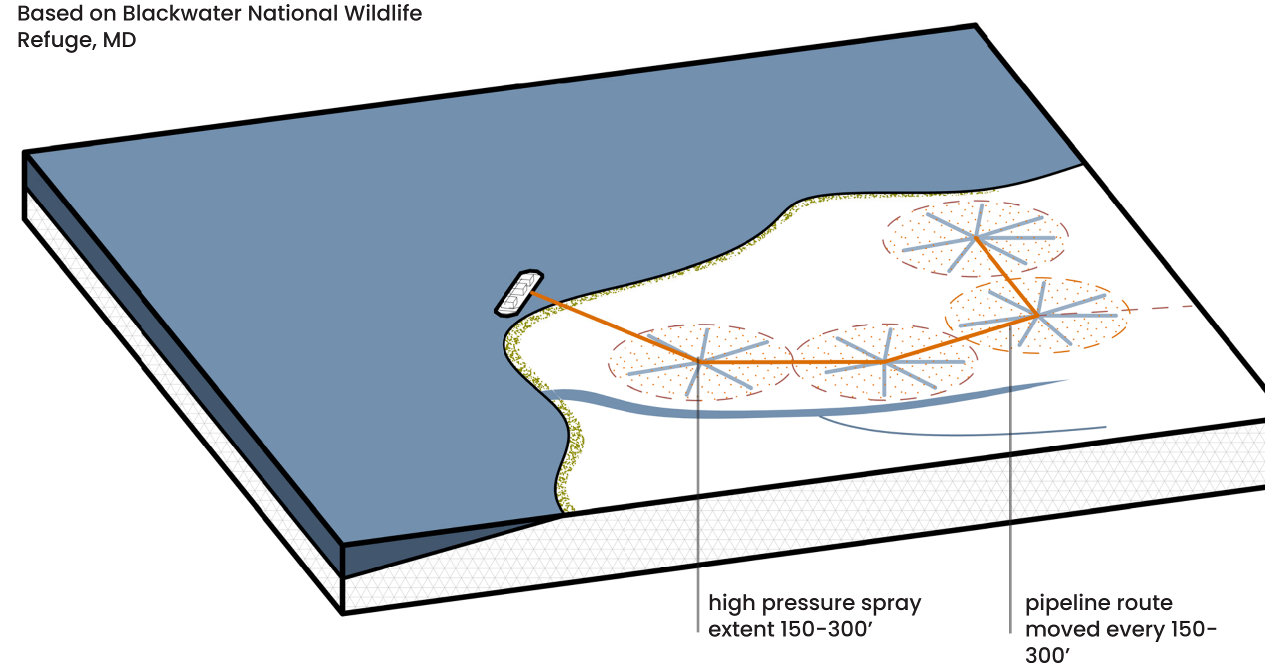
STATIC PIPELINE
Natural forces are utilized to maximize distribution through site.

Based on Scotch Bonnet, NJ



NON-STATIC PIPELINE
Emphasizes active management of sediment placement.

Based on Blackwater National Wildlife Refuge, MD

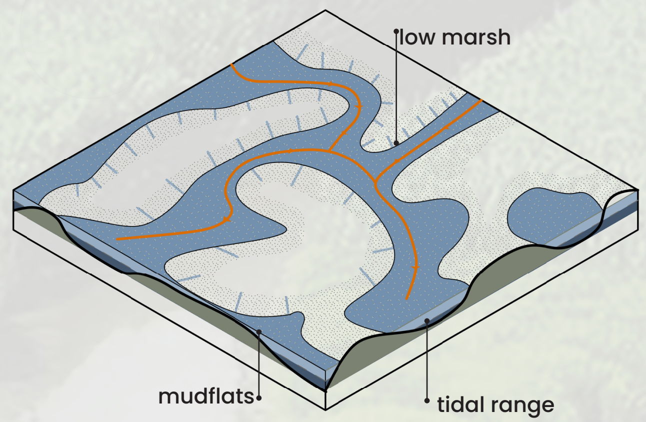


Placement + Distribution

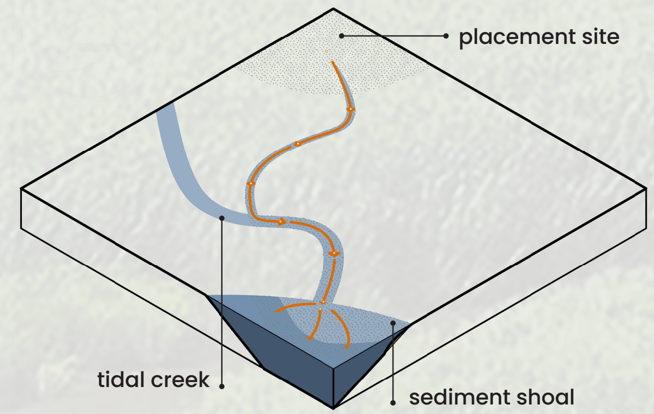
NATURAL FORCES

Natural forces like tides, tidal creeks, waves, currents, and natural drainage can help redistribute sediment throughout placement sites.

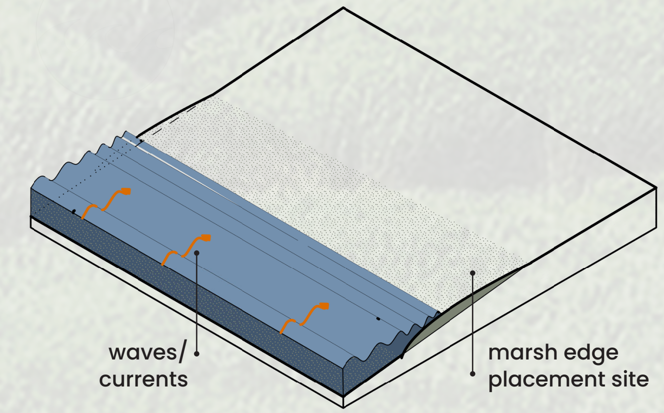
TIDAL RANGE
Tidal range can help distribute sediment across the marsh platform.



TIDAL CREEKS
Existing tidal creeks and low points can be leveraged to help spread sediment across the site.



WAVES + CURRENTS
Can be used to move placed sediment into the nearshore and/ or along the edge.



For more info see pages 94-97

SUPAWNA MEADOWS, NJ
Material is pumped into a **tidal creek**, which then helps distribute the material throughout the mudflats.

 Image Credit: Supawna Meadows NWR, NJ Cottrell Contracting Corporation

Image Credit: Tim Welp, USACE

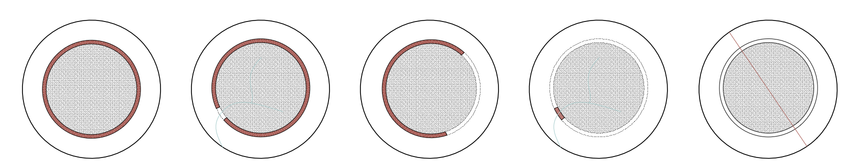
CONTAINMENT + PROTECTION

Containment considerations include amount of containment (or containment strategy), incorporation of natural features, regulatory requirements, and materials used in containment.

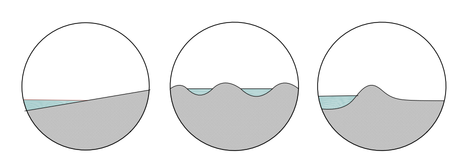
Containment designs aim to control sediment movement during settling and consolidation. However, designs should be minimized whenever feasible to reduce costs, avoid heavy-equipment impacts on marsh surfaces, and mitigate unintended consequences associated with poorly designed structures. Minimal containment supports natural sediment exchange and maintains ecological functions, provided project goals—such as achieving target elevations and sediment stabilization—are met. Effective containment planning must balance practical considerations (e.g., cost, labor), environmental factors (e.g., slurry pressure, tides, waves), proximity to tidal waters (sites distant from major channels may better support containment measures), and specific site conditions. Decisions about whether and how to implement containment are important aspects of the project design phase.

PROJECT CHARACTERIZATIONS

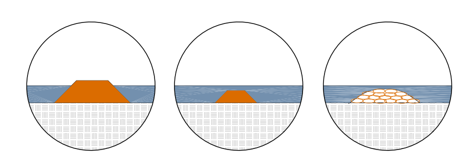
CONTAINMENT STRATEGY



TOPOGRAPHICAL CONTAINMENT



PROTECTION

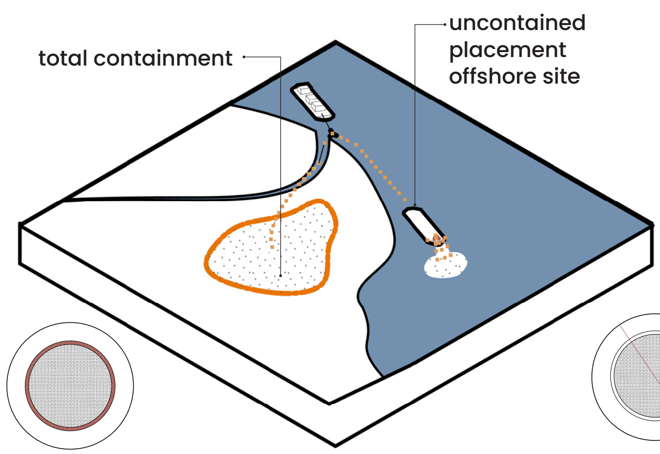


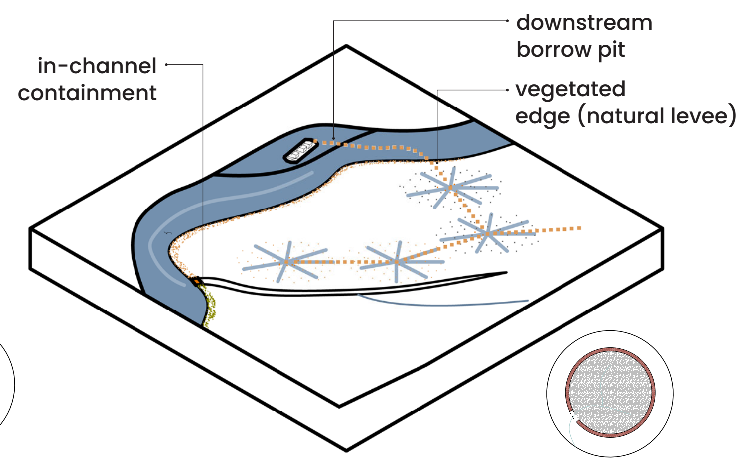
MARYLAND

In Maryland, dredged material should be confined during traditional placement, but exceptions can be made for beneficial use, with BMPs for managing turbidity in place. See Deal Island, Blackwater NWR, and Barren Island examples for different types of containment successfully used in Maryland.

CONTAINMENT STRATEGIES

Wherever possible, simple and straightforward containment strategies may minimize risk.

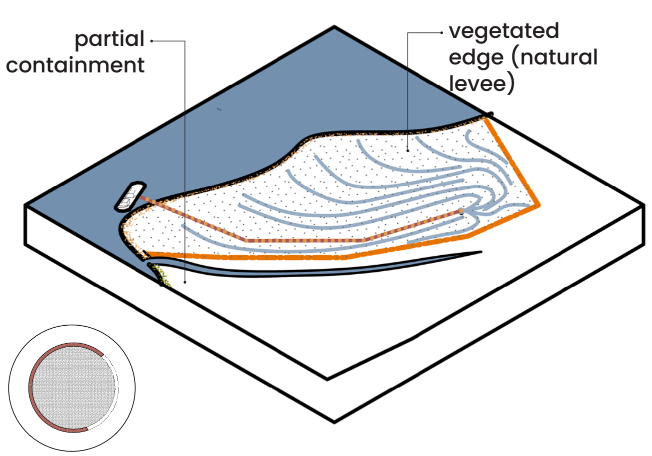


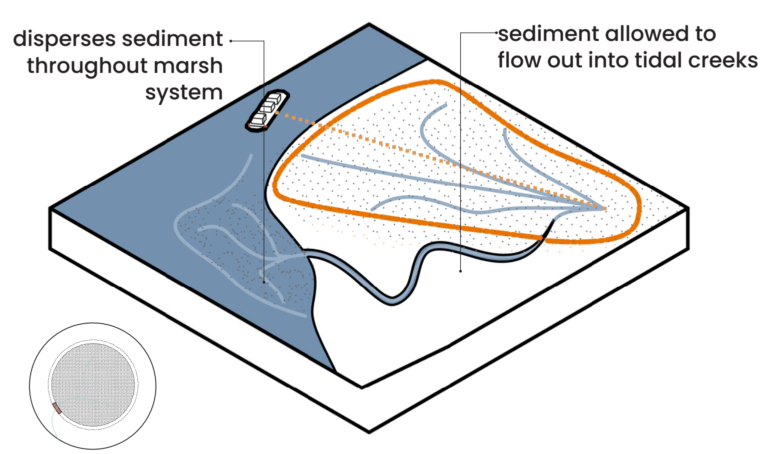


TOTAL CONTAINMENT
Fully encircles the placement area. Useful for precise control but costly and may inhibit hydrological exchange.

UNCONTAINED
No additional containment is used.

TIDAL CREEK CONTAINMENT
Only tidal creeks are contained.





PARTIAL CONTAINMENT
Incorporates natural features of the landscape to help contain the water, including pools, natural levees, and slopes.

TIDAL CREEK OPENING
Containment where all but the tidal creeks are contained. Encourages dewatering while still allowing natural distribution of sediments elsewhere.

GULL ISLAND, NJ
Material was placed in a tidal marsh and allowed to disperse throughout the rest of the site to nourish the nearshore shoal.

Image Credit: Gull Island, NJ, Sean Burkholder

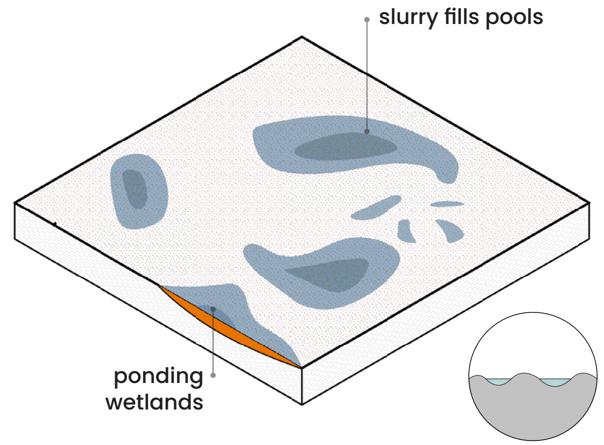
DEAL ISLAND, MD
Hay bales perimeter tied into existing berm to fully contain the site.

Image Credit: Deal Island, MD, Chris Snow, MDDNR

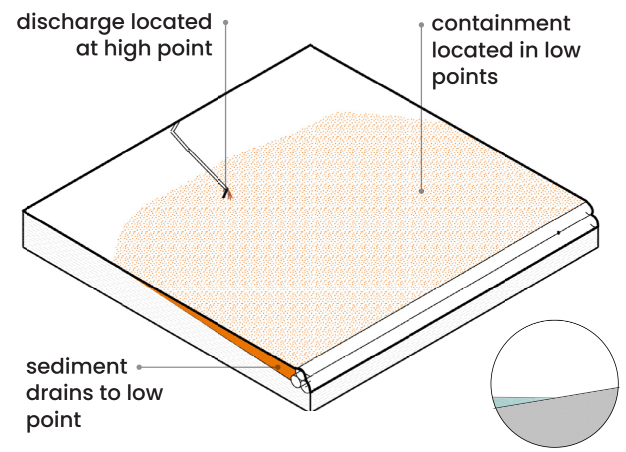
NATURAL FEATURES

High and low points, levees, slopes, and existing drainage paths can help contain and direct sediment flows without the need for extensive engineered structures.

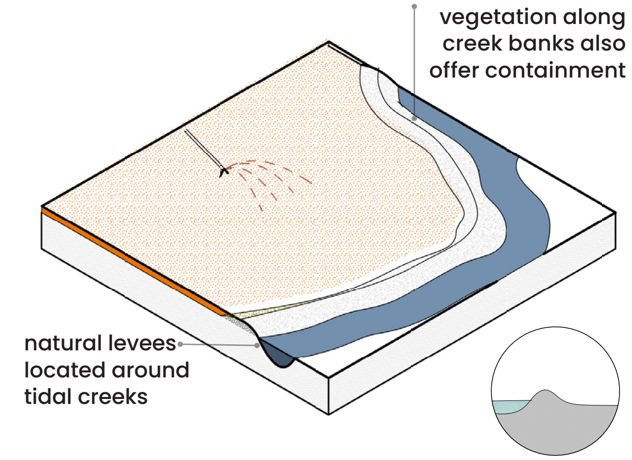
POOLS
Depressions and “bathtubs” (e.g., panne-pool complexes) tend to retain slurry until full, at which point overflow may follow the path of least resistance.



SLOPES
Slopes and surface gradients strongly influence slurry movement and deposition. In particular, flatter slopes help retain sediment in place and are preferred for controlled, even distribution.



NATURAL LEVEES
Natural levees, often form on the banks of tidal creeks, and can prevent sediment from escaping.



Slope and surface gradient also significantly affect how slurry moves and settles across a site. Flatter terrain helps slow the flow and supports even, stable deposition. Steeper slopes can cause slurry to accelerate, increasing the risk that containment will be breached and leading to uneven or unintended placement. Understanding and leveraging such natural features supports efficient design and reduces the need for artificial containment.

Not all tidal ponds are appropriate for filling with sediment; suitability should be assessed based on pond age and ecological value. Recently formed pools (within the last decade) might be suitable candidates, while older pools (e.g., over 50 years) often provide established ecological functions and should generally be preserved.

LITTLE ASSAWOMAN CANAL, DE
In Little Assawoman Canal restoration in Delaware, natural levees helped contain the sediment. Turbidity curtains and coir logs were also used.

Image Credit: Little Assawoman Canal, DE, S. Messur, Anchor QEA

CONTAINMENT MATERIAL

Containment selection may be guided by multiple factors, including ease of sourcing, transport, sediment type, placement volume and depth, on-site installation, and on the effort and feasibility of post-project removal or natural degradation.

For more overall info, see pages 176-177

The range of containment approaches includes the use of on-site soils, naturally occurring features like berms or vegetated ridges, biodegradable materials such as coir logs or hay bales, and temporary or removable structures (Myszewski, 2017; TNC, 2021). Ecological co-benefits such as habitat value, compatibility with native vegetation, and support for marsh edge stabilization may also be considered. Functional performance characteristics are critical and include a material's permeability (to allow controlled drainage or consolidation) and structural integrity under anticipated loads and hydrodynamic conditions. Particular attention can be paid to the risk of containment failures such as blow-outs or overtopping, which can compromise sediment placement.

Image Credit (left to right, top to bottom)
Clam/oyster bags, John H. Chafee, RI, TNC
Haybales, Deal Island, MD, Chris Snow
Breakwater, Barren Island, MD, USACE Baltimore District
Natural levees, Brick Township, NJ, Anchor QEA
Pipeline, Sturgeon Island, NJ, S. Burkholder
Filter Socks, Brick Township, NJ, Anchor QEA
Coir Logs, Jekyll Island, GA, Georgia Department of Natural Resources' Coastal Resources Division
Turbidity Curtain, Maurice River, NJ, S. Burkholder

MARYLAND

*Habitat benefits associated with clam or oyster bags can vary significantly based on local ecological conditions. In regions like Maryland, where intertidal oyster populations are uncommon, their habitat value may be limited and should be carefully assessed prior to implementation.


For breakwater detail, see p. 172-173

Breakwater
+ Wave attenuation
- Costly

Natural Levees
+ Natural topography

Pipeline
+ On site
- Inconsistent


For filter sock detail, see p. 169

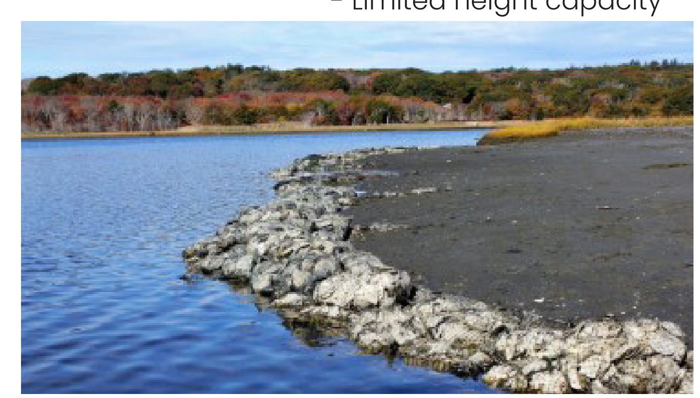
Filter Socks
+ Easy to install
- Hard to remove


For coir log detail, see p. 171

Coir Logs
+ Flexible + biodegradable
- Limited height capacity


For turbidity curtain detail, see p. 170

Turbidity Curtain
+ On site
- Inconsistent



Clam/Oyster Bags
+ Potential habitat benefits*
- Limited containment


For haybale detail, see p. 168

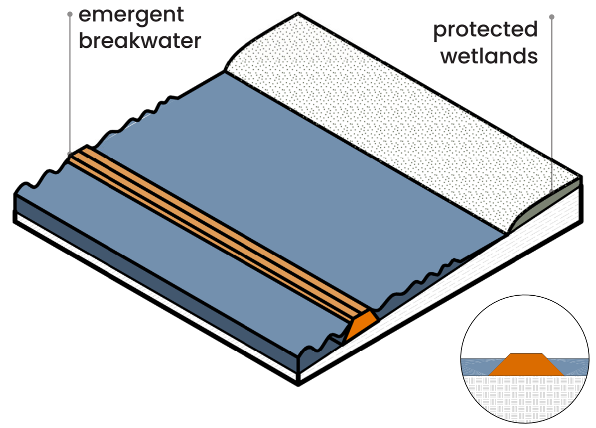
Haybales*
+ Easy to source
- Short lifespan

Containment + Protection

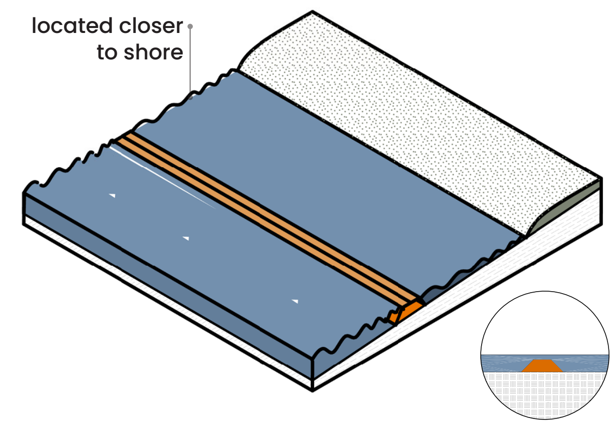
WAVE BREAK

Sills and breakwaters are commonly used to reduce wave energy and protect newly placed sediment, especially in open water where waves can easily erode and re-suspend unconsolidated material.

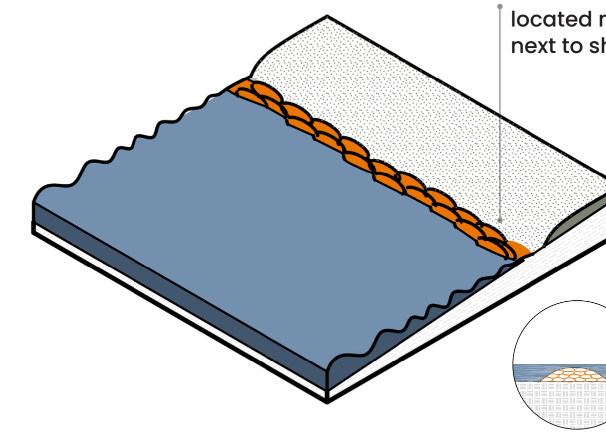
BREAKWATER
Emergent breakwaters can help attenuate waves.



SILL
Submerged or low-crested sill located in the nearshore can help attenuate waves.



LIVING SHORELINES
Nature-based alternatives like oyster reefs, vegetated berms, or other living shoreline approaches can attenuate wave action and offer both erosion-control and ecological benefits.



The design of wave-attenuation features is typically guided by a site's wave climate, dominant fetch, target elevation, and erosion risk during and after placement. Successful designs must strike a balance between retaining sediment and maintaining ecological connectivity to avoid disrupting habitat function or site hydrodynamics.

Sills and breakwaters are commonly constructed within a range of approximately one foot below to three feet above mean high water, with exact elevations determined by site-specific factors such as fetch length and wave energy. Designs that fall outside this typical range generally require additional justification.

For more Barren Island, see pages 80-85

BARREN ISLAND, MD
Modifications to existing sills, new sills, and new breakwaters were built to restore Barren Island.

Image Credit: Barren Island, MD, USACE Baltimore District

Image Credit: Poplar Island MD, Chesapeake Bay Program

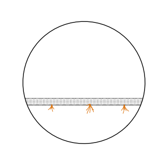
POST-CONSTRUCTION

Post-construction considerations include the re-establishment of native vegetation and the implementation of a long-term monitoring plan. Vegetation recovery may occur through natural colonization or active planting, depending on site conditions, sediment characteristics, and project goals. Strategic replanting with appropriate native species—such as *Spartina alterniflora* or *Spartina patens*—may be necessary in areas where natural regeneration is limited or where rapid stabilization is required to prevent erosion or invasive species encroachment. Monitoring efforts should track parameters such as vegetation cover, species composition, sediment elevation, hydrology, and wildlife use over time. These data help evaluate project performance against ecological targets and can inform adaptive management actions if the site is not progressing toward desired outcomes.

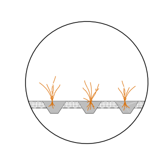
Considerations after construction should include plant re-establishment and continued monitoring.

PROJECT CHARACTERIZATIONS

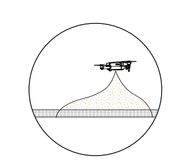
PLANTING STRATEGY



Natural Recolonization



Planting Plugs



Aerial Seeding

MARYLAND

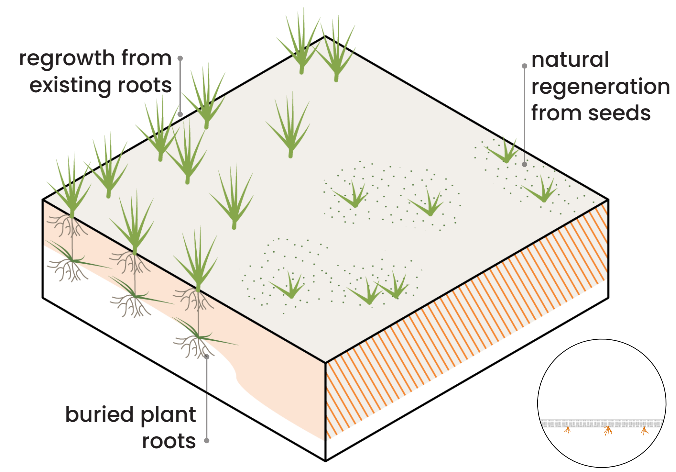
Marsh restoration projects should aim to achieve 85% vegetation cover of new and restored marshland by planting, maintaining, and monitoring the recovery of native marsh species.

Post-Construction

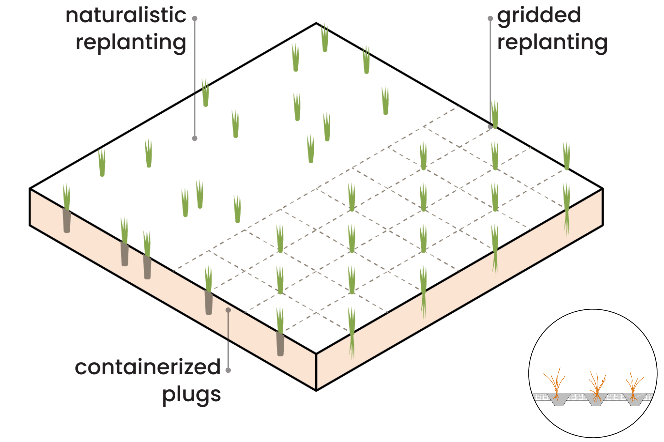
PLANT GROWTH

Vegetation recovery strategies may depend on local regulations and respond to site conditions following placement.

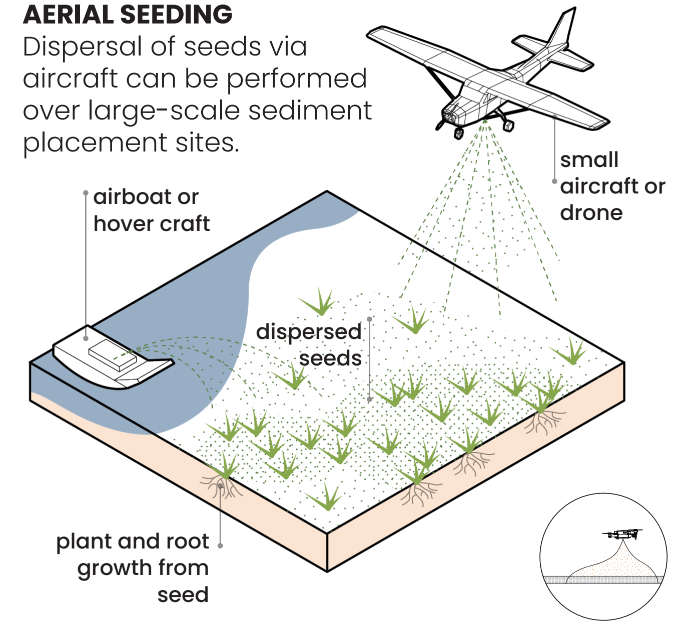
NATURAL RE-VEGETATION
Natural regrowth can occur from existing roots and/or natural seed dispersal. Regrowth from roots is most successful when placed sediment less than 30 cm.



PLANTING PLUGS
Replanting may be necessary to achieve restoration objectives or accelerate plant establishment in degraded settings or where thicker layers of sediment are placed.



AERIAL SEEDING
Dispersal of seeds via aircraft can be performed over large-scale sediment placement sites.



ADAPTIVE STRATEGIES
Planting can be timed to follow critical milestones such as sediment consolidation, often defined as greater than 90%, and the attainment of target elevations (Piercy et al., 2023). Because some sites may take years to stabilize fully, planting strategies are typically adaptive and designed to support long-term recovery.

MARYLAND

Maryland Department of the Environment generally requires plants to be placed 18" on center within 1 year following sediment placement. However, in some atypical circumstances, seed dispersal and/or natural re-vegetation may be permitted.

MONITORING METRICS

Monitoring typically depends on project-specific goals and objectives. Data collection may target parameters that directly affect project performance, ecological function, and adaptive management decisions.

Monitoring schedules depend on the processes being tracked. Rapid changes like sediment consolidation and dewatering may require monitoring within days or weeks of placement. Slower processes like vegetation recovery or wildlife use may unfold over longer periods, with seasonal or annual assessments starting in post-placement years 2 or 3 and extending up to year 5 or beyond. Event-driven monitoring such as post-storm assessments may also be necessary to evaluate sediment redistribution and project resilience.

Construction-phase monitoring focuses on verifying design implementation. Among the key tasks are using grade stakes or hydrographic surveys to confirm placement depths and elevations, using flow meters and density gauges to measure slurry volume, and monitoring turbidity (especially near sensitive areas). Common monitoring parameters include turbidity levels, elevation changes, dewatering and consolidation progress, and initial plant regeneration. Monitoring also supports adaptive management by tracking site-specific metrics such as topographic changes, hydrodynamic conditions like tidal flow or inundation, and ecological indicators like vegetation health and faunal usage. Monitoring plans are often flexible and designed to answer actionable questions.

MARYLAND

Marsh monitoring is a standard requirement for projects that include a planting component. In contrast, projects focused on enhancing non-vegetated habitats—such as mudflats or shallow water areas—typically do not require marsh monitoring but may be subject to additional permitting steps and agency coordination.

Marsh enhancement is an emerging restoration strategy, and robust monitoring can help close key knowledge gaps. By tracking sediment behavior and ecological responses, monitoring not only improves project outcomes but also supports broader learning across the field. Lessons from individual projects can inform future efforts, refine best practices, and strengthen regional guidance for sediment-based restoration. BUDM projects can be understood not only in terms of their immediate physical outcomes, but also as part of a broader learning process (Chasten et al., 2022). Every project contributes to our understanding of sediment behavior, habitat response, regulatory coordination, and implementation logistics.

Spatial Changes

Geographic Information Systems (GIS), Remotely-sensed imagery, Historic aerials

Elevation

RTK ground- penetrating radar (GPR) field survey

Ground-based or aerial Light Detection and Ranging (LiDAR)

Surface Elevation Table (SET)

Single beam or multibeam bathymetric surveys

Flow Velocities

Flow meters

Acoustic Doppler Current Profilers (ADCPs)

Wave Condition

Wave gauges

Water Levels

Water-level loggers

Turbidity

Turbidity sensors

Salinity

Conductivity probes

Soil Characteristics
(grain size, bulk density, pH, etc.)

Grab samples

Soil cores

pH/EC probe of soil and sediment slurry

Bearing capacity (lower the bearing capacity the more the area is improving (has a denser root mass)

Submerged Aquatic Vegetation

Percent cover, Density, Aboveground/belowground biomass, Species

Wetland Vegetation

Percent cover, Density, Aboveground/ belowground biomass, Species, Bearing capacity (see note above)

Invasive Species

Vegetation surveys

Wildlife
(Benthic infauna, fish, nekton, birds, etc.)

Abundance, Diversity, Biomass, Species richness. Species composition shifts, Population density Habitat utilization patterns, Reproductive success rates Behavioral responses (e.g., feeding, nesting, breeding behaviors), Food web interactions and trophic linkages

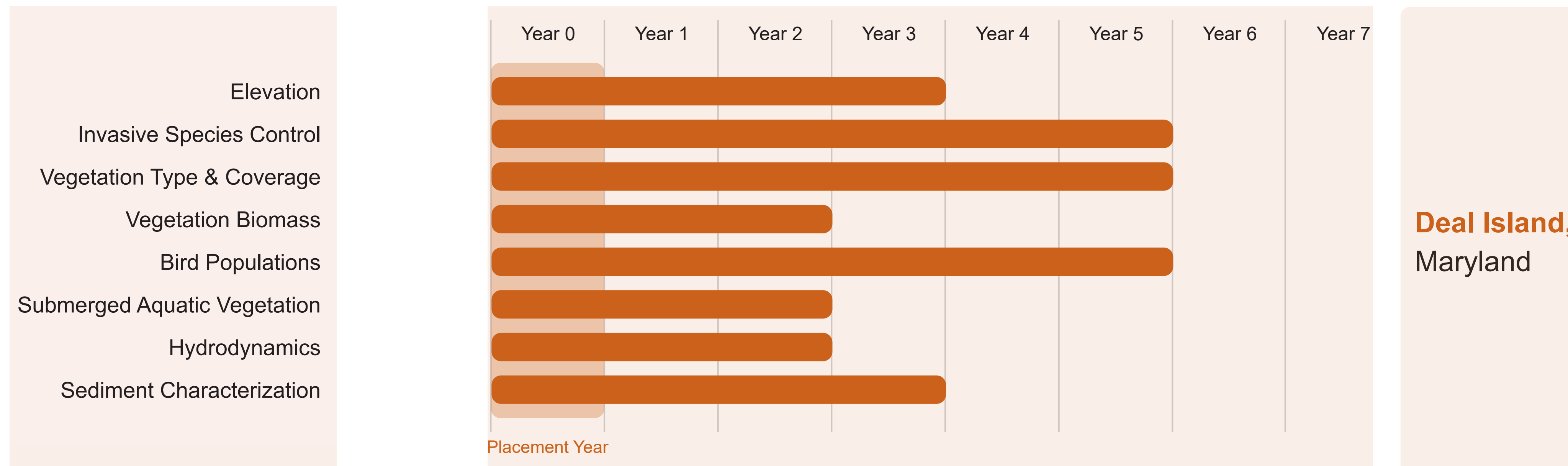
MONITORING TIMELINE

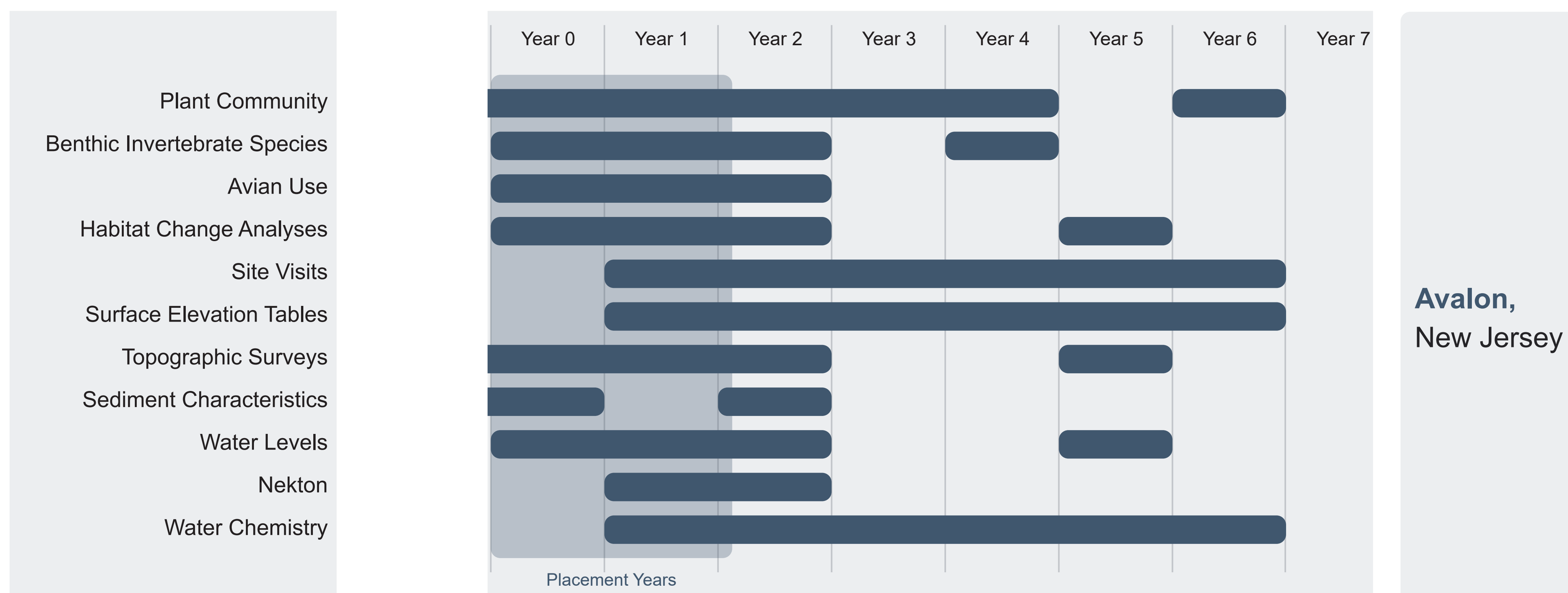
The most effective monitoring plans are developed early in the project planning process, ideally alongside goal setting and design development. Establishing a clear monitoring framework from the outset allows for better integration with adaptive management strategies and ensures that meaningful data are collected to evaluate project performance. Baseline data collection prior to sediment placement is critical for understanding the natural state of the marsh system and for measuring ecological changes over time.

Because monitoring timelines often extend beyond the construction phase, it may be necessary to secure funding through sources separate from those used for implementation. Collaborations with universities or academic institutions can provide cost-effective opportunities to align monitoring with ongoing research, benefiting both scientific inquiry and project evaluation. Ultimately, monitoring is essential not only for compliance, but also for informing adaptive management and improving future restoration efforts.

MARYLAND

Maryland Department of the Environment typically requires five years of marsh vegetation monitoring, with reporting required in years 2, 3, and 5. Monitoring requirements may be extended at MDE's discretion based on site performance or permitting conditions.





3. CASE STUDIES

Islands
Shallow Water
Mudflats
Fringe Wetlands
Marsh Platform

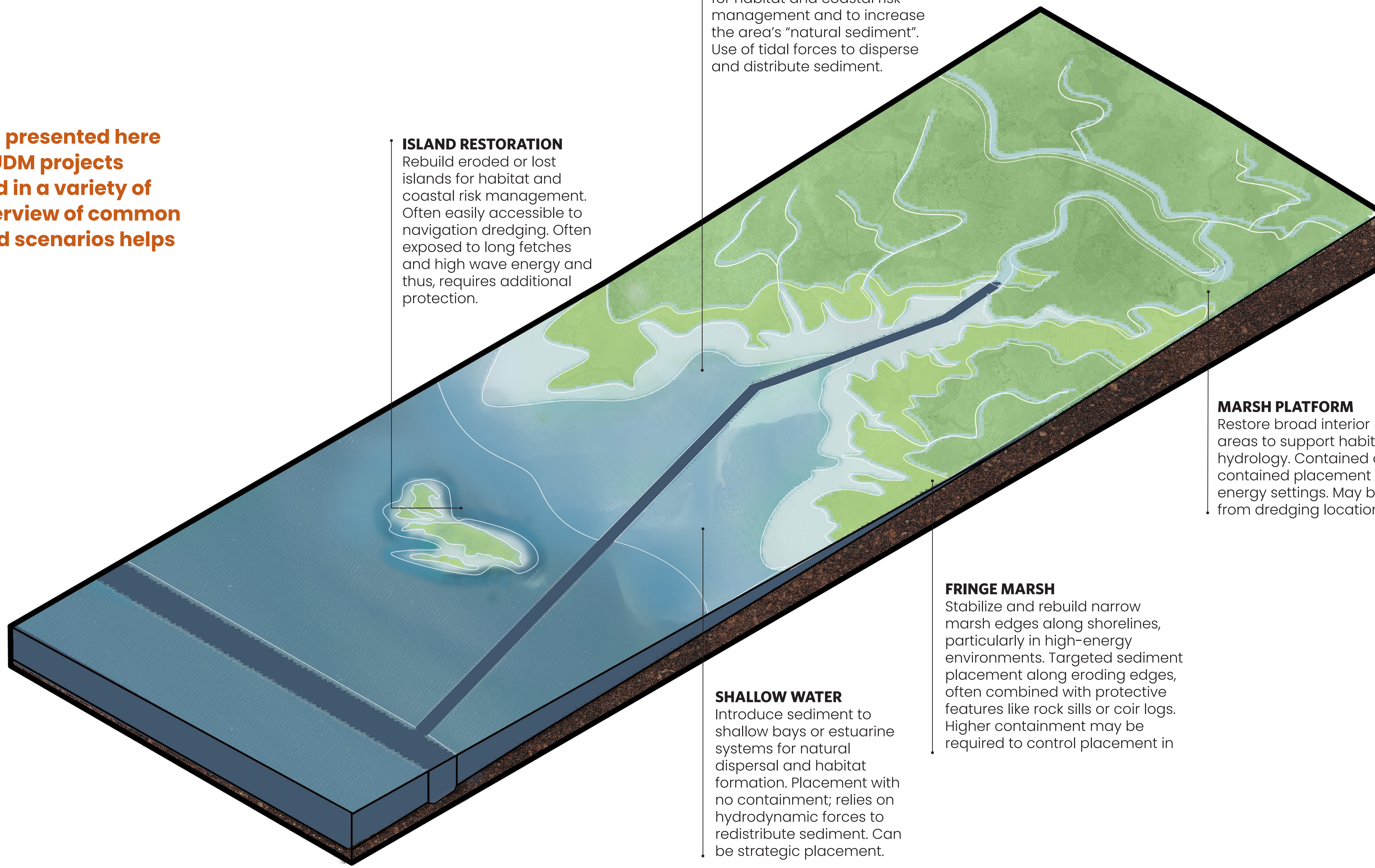
The Case Studies section highlights how beneficial use projects are implemented across a variety of settings. It begins with an overview of common project types and scenarios to help practitioners understand the range of possibilities. The remainder of the section is organized by restoration type, each with its own design considerations and challenges. For each type, an example case study is included to illustrate how the approach has been applied in practice.

PROJECT TYPES

The case studies presented here highlight how BUDM projects are implemented in a variety of settings. The overview of common project types and scenarios helps show the range of possibilities.

MUDFLATS
Nourish the intertidal zone for habitat and coastal risk management and to increase the area's "natural sediment". Use of tidal forces to disperse and distribute sediment.

ISLAND RESTORATION
Rebuild eroded or lost islands for habitat and coastal risk management. Often easily accessible to navigation dredging. Often exposed to long fetches and high wave energy and thus, requires additional protection.



MARSH PLATFORM
Restore broad interior marsh areas to support habitat and hydrology. Contained or semi-contained placement in low-energy settings. May be farther from dredging locations.

FRINGE MARSH
Stabilize and rebuild narrow marsh edges along shorelines, particularly in high-energy environments. Targeted sediment placement along eroding edges, often combined with protective features like rock sills or coir logs. Higher containment may be required to control placement in

SHALLOW WATER
Introduce sediment to shallow bays or estuarine systems for natural dispersal and habitat formation. Placement with no containment; relies on hydrodynamic forces to redistribute sediment. Can be strategic placement.

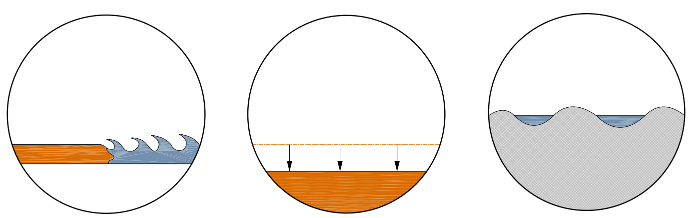
Case Studies

PROJECT CHARACTERISTICS

These symbols are used throughout the document to represent key project characteristics. They help describe and categorize each case study based on common attributes.

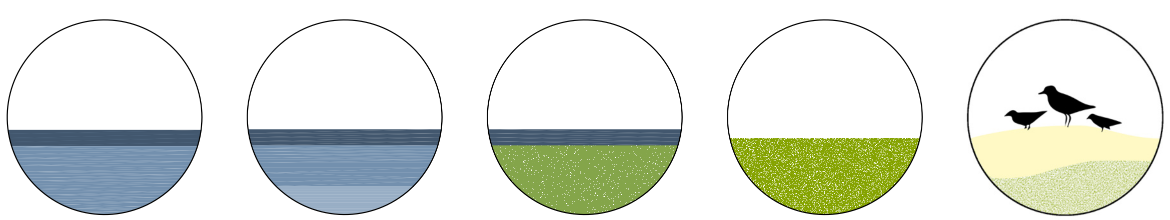
RESTORATION

RESTORATION OBJECTIVES



Edge Erosion | Overall Platform Loss | Ponding

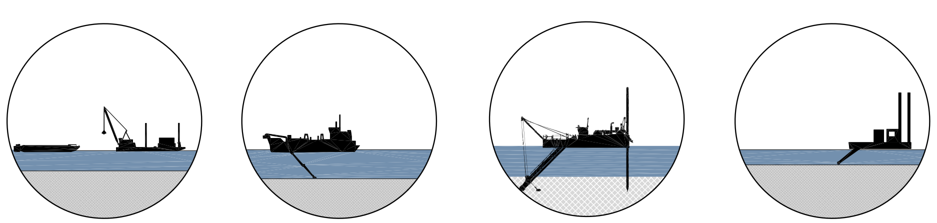
HABITAT



Open Water | Mudflat | Low Marsh | High Marsh | Bird Habitat

DREDGING + TRANSPORTATION

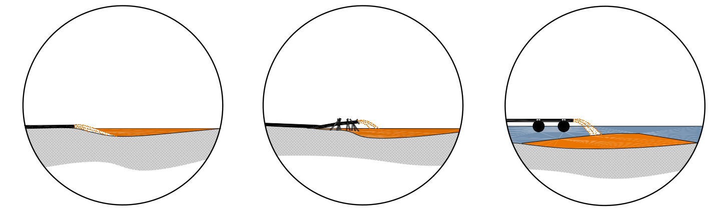
DREDGING EQUIPMENT



Clamshell + Scow | Hopper Split Hull | 14" Cutterhead | 8-12" Cutterhead

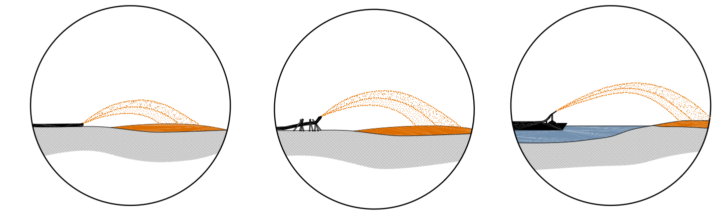
PLACEMENT + DISTRIBUTION

LOW- PRESSURE DISCHARGE



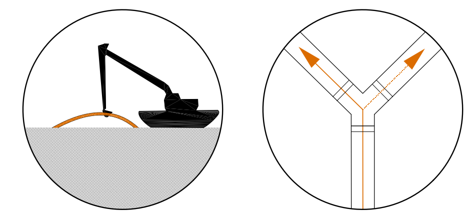
Low Discharge Ground | Low Discharge Crib | Low Discharge Boat

HIGH- PRESSURE DISCHARGE



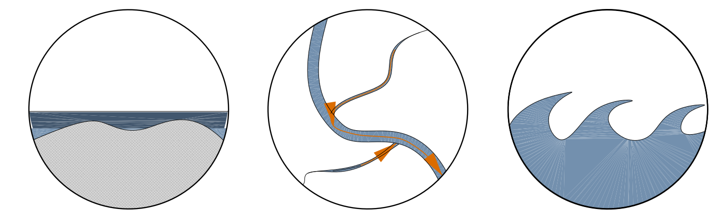
High Discharge Ground | High Discharge Crib | High Discharge Boat

DISTRIBUTION EQUIPMENT



On-the-ground Equipment | Y-Valve

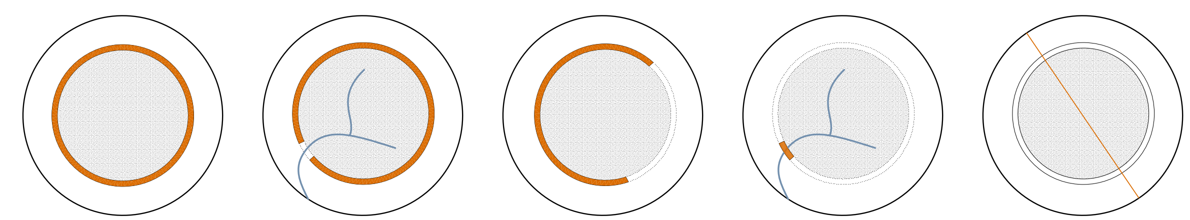
NATURAL DISTRIBUTION



Tidal Range | Tidal Creek | Waves

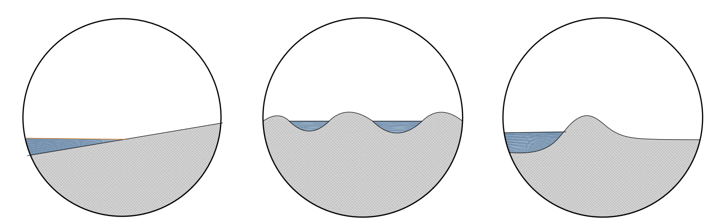
CONTAINMENT + PROTECTION

CONTAINMENT STRATEGY



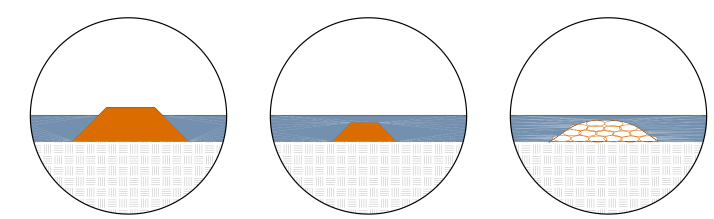
Full Containment | Full with tidal creeks | Partial | Tidal Creeks | No Containment

NATURAL CONTAINMENT



Slope | Pooling | Natural Levee

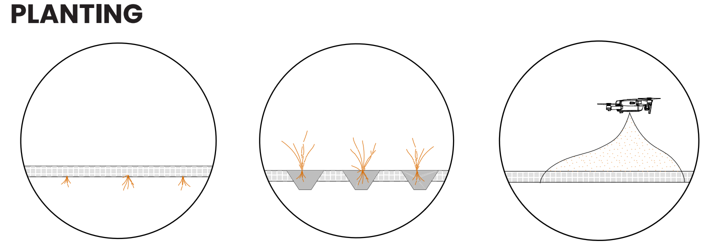
PROTECTION



Emergent Breakwater | Sill | Living Shoreline

POST CONSTRUCTION

PLANTING



Natural Recolonization | Planting Plugs | Aerial Seeding

Image Credit: Barren Island, MD, USACE Baltimore District

ISLAND RESTORATION

More than 400 islands have vanished since the 19th century in the Chesapeake Bay, and the remaining islands are highly vulnerable to erosion and sea level rise. Major dredged material management projects have often been carried out on islands in the Chesapeake region such as Poplar and Hart-Miller islands. Their proximity to major navigation channels makes them well-suited for BUDM. At the same time, their exposure to long fetches leaves them susceptible to high wave energy and associated erosion, and the scope and scale of these projects come at a considerable cost. Island loss is also a problem outside of the Chesapeake, in coastal bays along the Atlantic and Gulf coasts.

Islands in the Chesapeake Bay and in Atlantic coastal bays have historically provided important ecological functions, habitat for oysters, SAV, and fish and wildlife, and contributed to coastal risk reduction.

MARYLAND

In Maryland, islands can be restored but not created. Historic shorelines can be used to justify the restoration of an island. Case studies in Maryland include Barren and James Island, Poplar Island, and Hart-Miller island.

BARREN ISLAND, MD

The Barren Island Restoration Project is a significant ecological initiative of the Mid-Chesapeake Bay Island Ecosystem Restoration Project led by USACE.

Situated in Dorchester County, Maryland, Barren Island has experienced substantial erosion over the past century, resulting in the loss of critical wetland and island habitats. The project uses material dredged from local shallow draft Federal navigation channels, including the Honga River channel, to rebuild and stabilize Barren Island's shoreline and interior wetlands. To contain and protect the dredged material, 13,000 linear feet of stone sills and over 4,600 linear feet of segmented breakwaters were installed to shield the restored areas from wave action and prevent further erosion. The project includes a plan for diverse habitats, including low and high marshes, ponds, channels, and hummocks (MPA, 2024).

PARTNERS

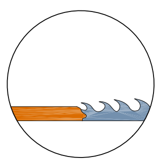
+ USACE, Baltimore District, MPA, USFWS, National Aquarium, Friends of Blackwater, SeaCoast Marine Construction Inc.

COSTS*

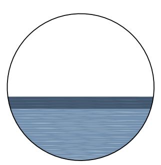
+ $43.1 million contract with Coastal Design & Construction (2022)
+ $39.9 million contract with Seacoast Marine Construction Inc. (2024)

**Future contract amounts are unknown*

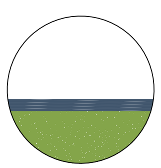
RESTORATION



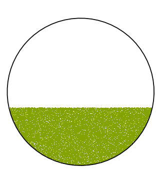
EDGE EROSION
Significant island and wetland area has been lost to erosion and submergence.



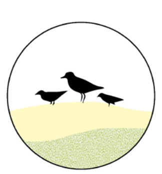
OPEN WATER HABITAT
Island restoration and breakwaters will protect SAV habitat. Rock reefs will provide additional habitat for fish.



LOW + HIGH MARSH
Sediment placement will restore elevations necessary to support low marsh habitat as part of 83 acres of wetland restoration.

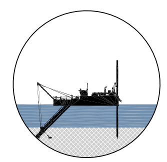


HIGH MARSH
Sediment placement will restore elevations necessary to support high marsh habitat as part of 83 acres of wetland restoration.



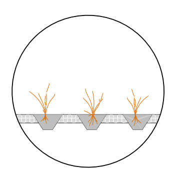
BIRD HABITAT
Sediment placement will restore elevations necessary to support high marsh habitat as part of 83 acres of wetland restoration.

DREDGING



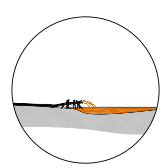
DREDGE
Approximately 4-500,000 cubic yards of material will be dredged from local channels for use in this project.

PLANTING



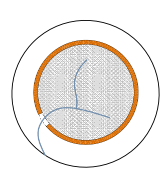
PLANTING PLUGS
Installed native grasses and shrubs to stabilize newly placed sediment and created tidal creeks to stimulate natural re-vegetation.

PLACEMENT

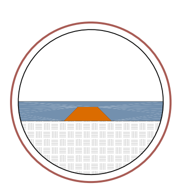


SEDIMENT DISCHARGE
Sediment will be discharged within the contained wetland cells.

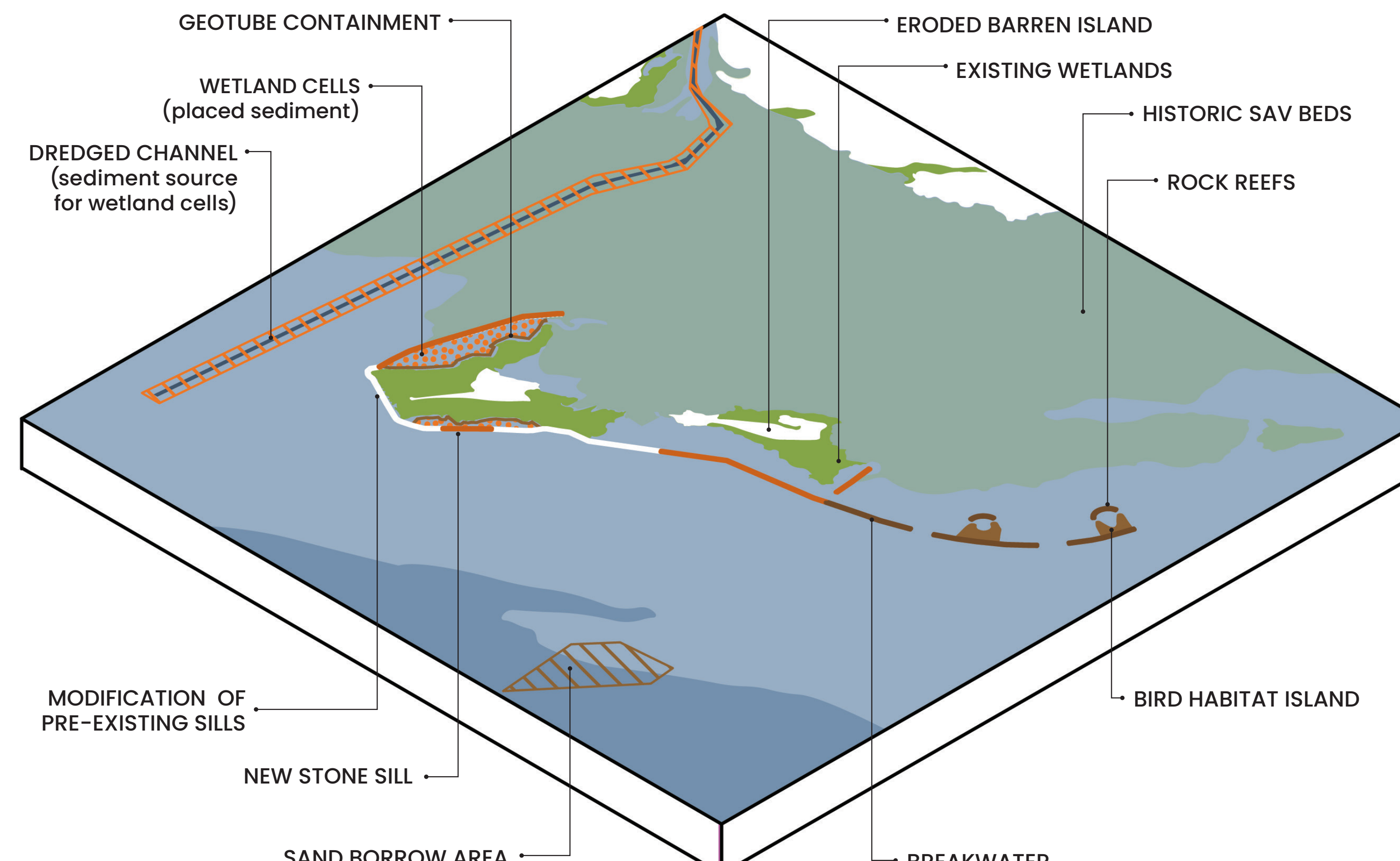
CONTAINMENT



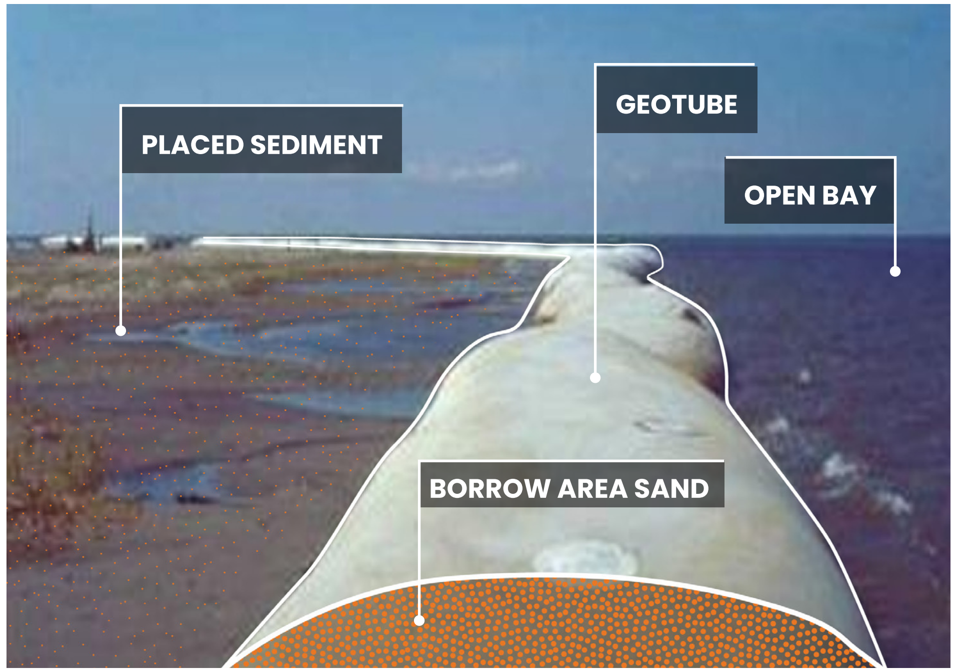
FULL WITH TIDAL CREEKS
Geotubes and sills will confine placed sediments, and constructed spillways will be utilized to control outflow of water.



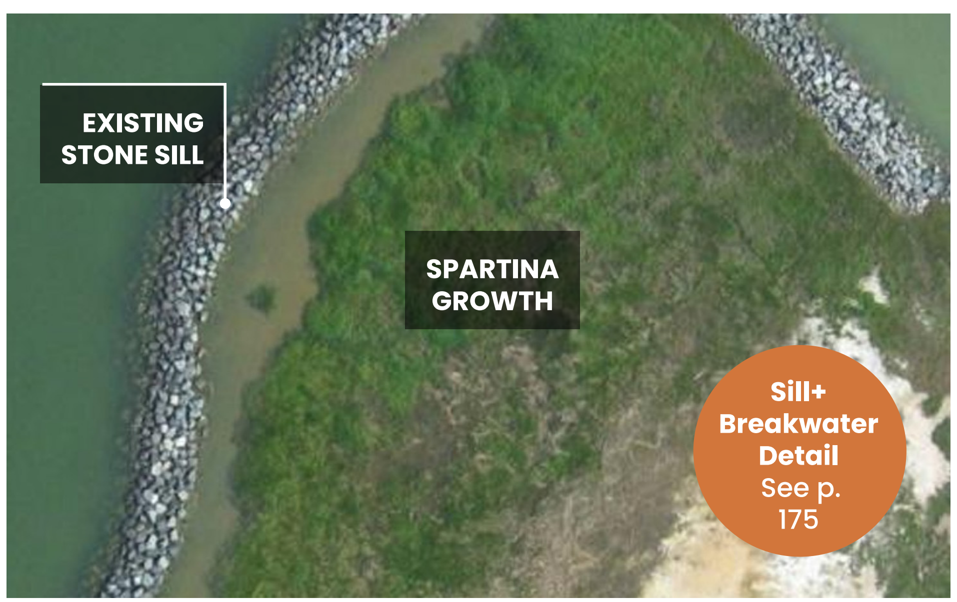
SILL
The existing and newly constructed stone sills contribute to the containment of placed sediments.



A variety of construction, dredging, sediment distribution, and sediment containment techniques will be used to create diverse island habitats on the island that counteract erosion and protect adjacent submerged aquatic vegetation habitat.



Geotubes filled with sand from a nearby borrow area will help contain placed BUDM within wetland cells. Photo shows a geotube alignment from a previous project at Barren Island (2002). In the current project, geotubes will be placed along the island's shore and will not interface with the open bay. See pg 162-163 for advantages and disadvantages of geotube containment.



The breakwaters and sediment placement will support the development of marsh habitat adjacent to Barren Island (photo from 2008, three years after dredged material placement).

HABITAT TRADE OFFS

The project at Barren Island includes the construction of bird islands using sand borrowed from productive crabbing habitat. Agencies like NOAA and the Fish and Wildlife Service raised concern about the impacts of this dredging, and the project team worked mitigate impacts to fish by altering their plan to include rock reefs and improved fish connectivity.

Image Credit (All): Barren Island, MD USACE Baltimore District

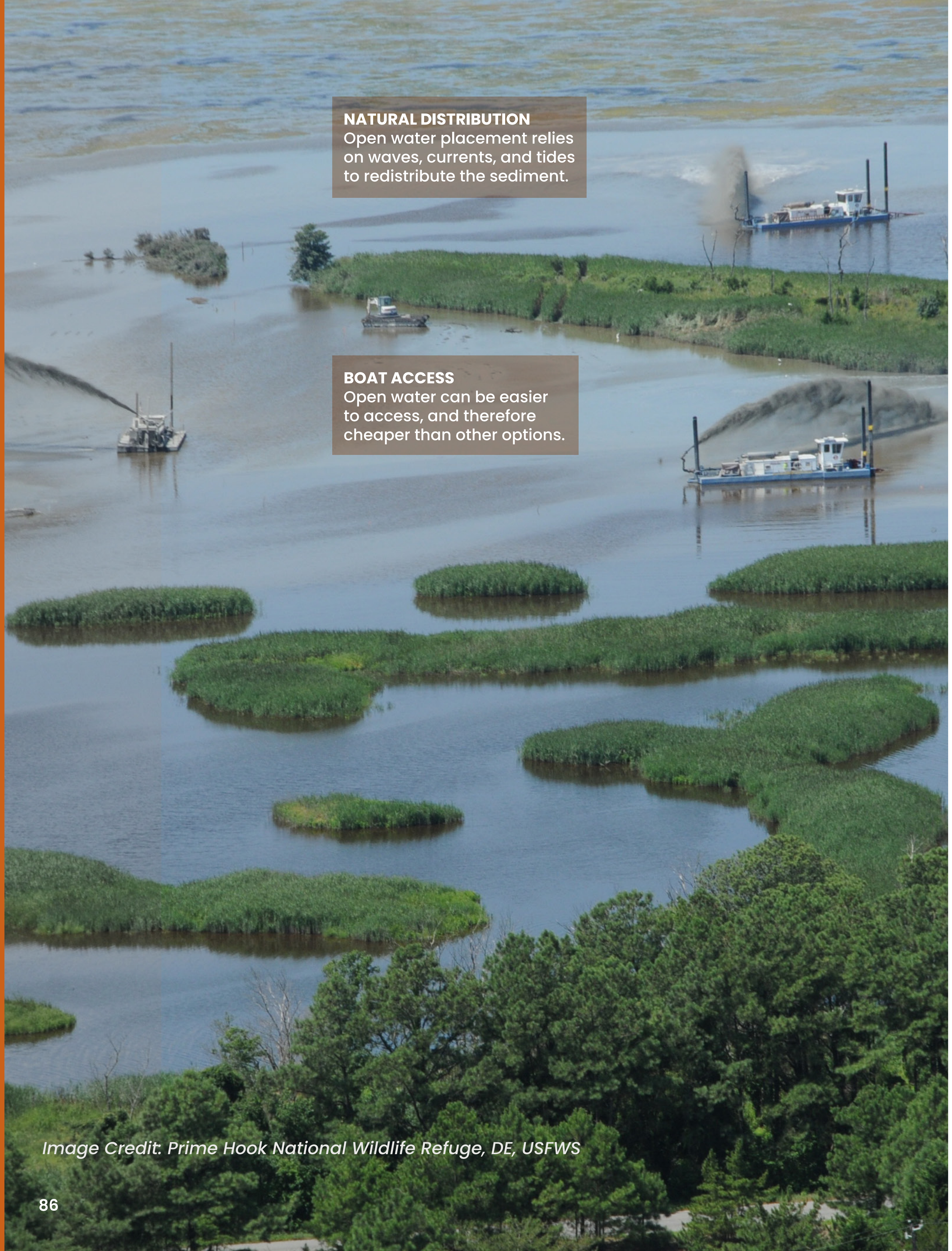


Image Credit: Prime Hook National Wildlife Refuge, DE, USFWS

SHALLOW WATER

For shallow water projects, the objective may be to disperse sediment into shallow bays or tidal systems in a way that allows it to disperse naturally and remain active within the system. This approach, often called strategic placement, relies on hydrodynamic forces such as tides and wind waves to redistribute sediment across the landscape. In some cases, sediment layers as thin as 1 cm are delivered to the target area, emphasizing subtle nourishment rather than elevation change. The strategy is based on maintaining sediment within the active system rather than isolating it. Common equipment includes hydraulic dredges with open pipeline discharge, spray nozzles, or shallow scows, depending on site depth and sediment type. Operations are typically timed with tidal cycles to maximize sediment transport and deposition. Eden Landing in California is a key example of strategically placing sediment in shallow open water to support tidal marsh restoration and ecological enhancement.

Shallow water placement supports the littoral sediment budget in coastal and estuarine environments and helps sustain natural sediment transport.

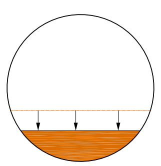
MARYLAND

For unconfined projects in shallow water, the burden will have to be made that this activity does create, enhance, or restore fish and shellfish habitat in order to accept that this is BUDM instead of unconfined dredge placement. There may be additional permitting steps and coordination to prove this justification.

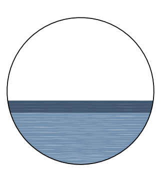
EDEN LANDING, CA

The innovative Eden Landing Strategic Placement Project in the San Francisco Bay Area aims to enhance wetland resilience through the strategic placement of dredged sediment.

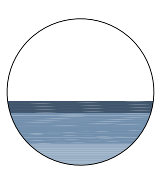
RESTORATION



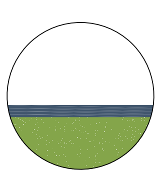
PLATFORM LOSS + MARSH EROSION
Marsh has subsided and edge has eroded due to loss of sediment in the system and sea level rise.



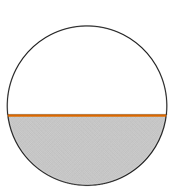
OPEN WATER
Sediment was placed in open water, increasing sediment in the system.



MUDFLAT HABITAT
Sediment placement will nourish intertidal habitats.

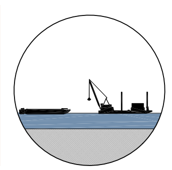


LOW + HIGH MARSH
Sediment will help nourish low marsh habitat.



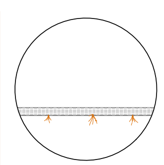
STRATEGIC SEDIMENT PLACEMENT
Placed sediment will nourish target marsh and pond complex by 1 to 3 mm

DREDGING



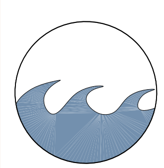
MECHANICAL DREDGE
A mechanical clamshell dredged material and a shallow scow (1,600 + 300 CY) transported into water 9 to 12 feet deep.

PLANTING



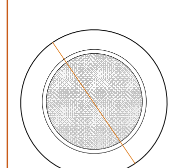
NATURAL VEGETATION
The placement was conducted out of range of eelgrass (SAV) habitat, and was in suspension as it moved toward the mudflat and existing marsh.

PLACEMENT



NATURAL FORCES
Waves and currents resuspend material, while daily tides carry it through channels. During extreme water levels, the material is transported across the marsh, where it becomes trapped by vegetation and is ultimately deposited, distributing it across the target marsh and mudflat areas.

CONTAINMENT



NO CONTAINMENT
Bay is naturally turbid and the individual scow placements created a spike in turbidity which lasted 1 to 2 hours, and never exceeded natural conditions.

Approximately 90,000 cubic yards of sediment dredged from the Port of Redwood City were deposited by shallow dump scow in 9 to 12 feet of water offshore of Eden Landing and Whale's Tail Marsh. This approach leverages natural tidal and wave action to move sediment from shallow offshore deposits to adjacent mudflats and marshes, promoting habitat restoration and adaptation to sea level rise. The Eden Landing site was selected based on hydrodynamic and sediment transport modeling to optimize natural sediment movement toward the shoreline (USACE, 2023A).

PARTNERS

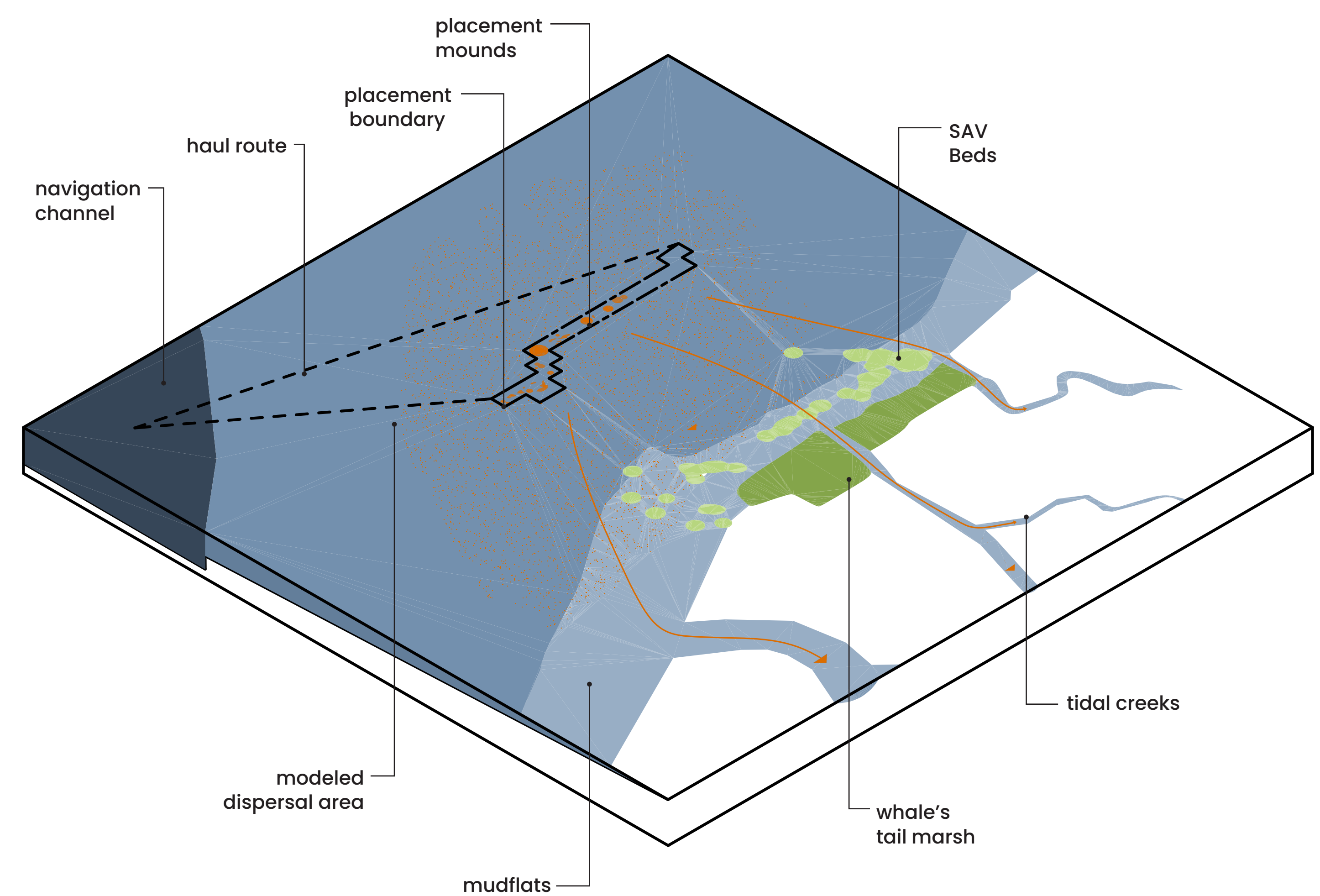
+ U.S. Army Corps of Engineers, San Francisco District, USACE Engineering with Nature, USGS, Port of Redmond City, California State Coastal Conservancy, HME Construction

SEDIMENT VOLUME

+ 90,000 CY

COST

+ $34/CY (approximately $3 million)



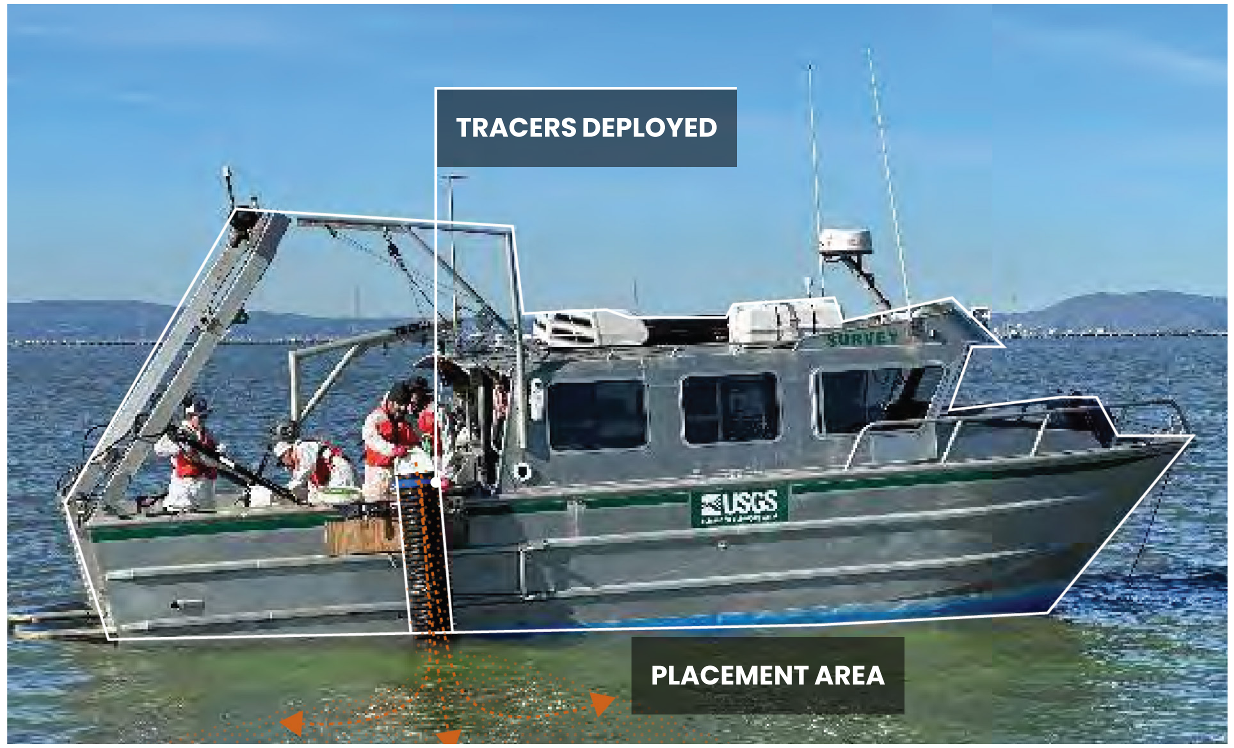
Initial monitoring of turbidity, eelgrass, and sediment deposition indicates promising outcomes.

Post construction surveys show an 80% increase in eelgrass coverage and a 27% overall rise in density. While turbidity levels temporarily increased during sediment placement, they remained within the range of natural variability.

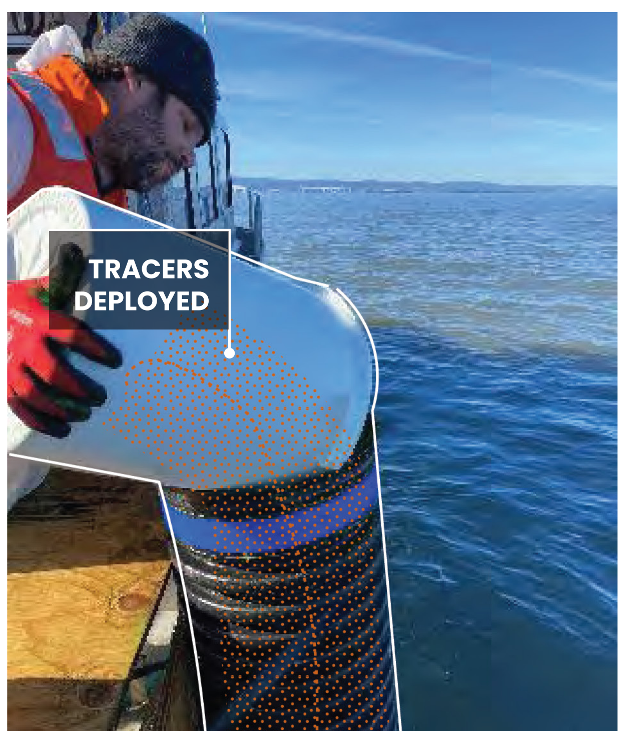
Initial bathymetric surveys revealed that the tallest sediment mounds dispersed more rapidly and effectively.

Initial results from tracer study show presence of tracers in the back of the Eden Landing Complex and on Whales Tail marsh.

The type of sediment material used can significantly influence project outcomes, affecting sediment stability, transport dynamics, vegetation establishment success, and impacts to local flora and fauna.



One thousand kg of fluorescent, magnetically coated silt particles were released at a single location in the placement area.



Nineteen magnet stations were installed one day after tracer deployment. Additional magnets were placed in tidal creeks to capture the trace.

Image Credit (all): Eden Landing Placment, J. Beagle, USACE San Francisco District

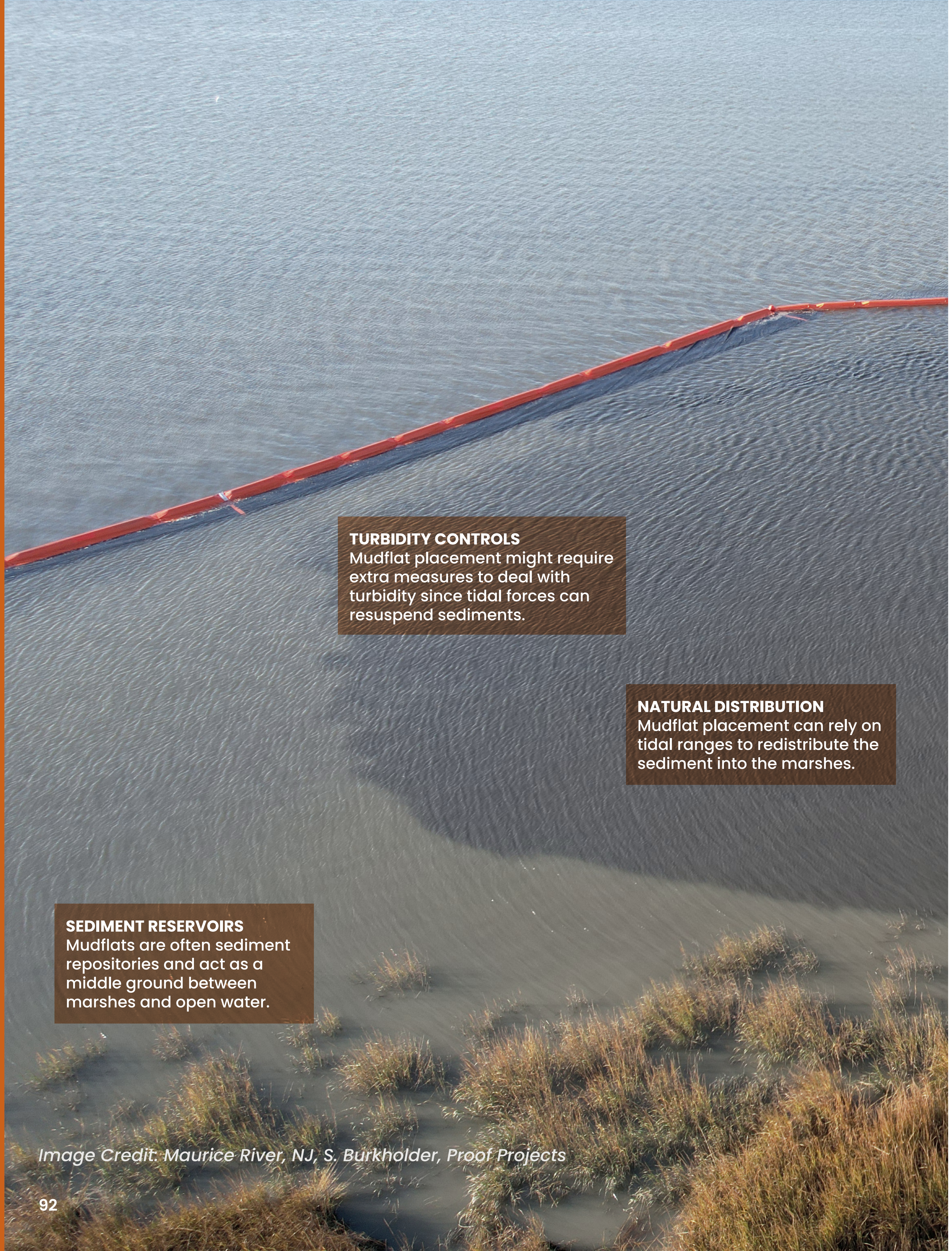


Image Credit: Maurice River, NJ, S. Burkholder, Proof Projects

MUDFLAT HABITAT

Exposed at low tide and submerged at high tide, mudflats support diverse and productive biological communities. Their flat, open surfaces and proximity to degraded marshes make mudflats ideal for BUDM. Sediment can be pumped directly onto or near mudflats where tides, waves, and currents will naturally disperse it across the landscape. In this way, mudflats act as temporary sediment reservoirs, enabling passive sediment distribution that can mimic natural accretion processes and deliver sediment to nearby wetlands where it is most needed for restoration.

Mudflats are intertidal zones composed primarily of fine-grained sediments such as silts and clays and typically found in sheltered coastal environments like estuaries, bays, and tidal rivers.

MARYLAND

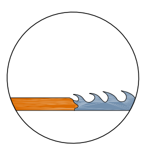
For unconfined projects in mudflats, the burden will have to be made that this activity does create, enhance, or restore fish and shellfish habitat in order to accept that this is BUDM instead of unconfined dredge placement. There may be additional permitting steps and coordination to prove this justification.

Mudflat

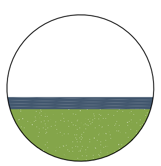
SUPAWNA MEADOWS, NJ

The Salem River federal navigation channel was hydraulically dredged with strategic sediment placement to maximize running time and utilize flows from a tidal creek to distribute the material within the Goose Pond area of Supawna Meadows.

RESTORATION

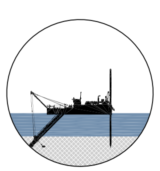


EDGE EROSION
Deteriorated wetland edge has eroded.



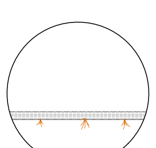
INTERTIDAL HABITAT
Sediment is placed in intertidal habitat to restore low and high marsh.

DREDGING



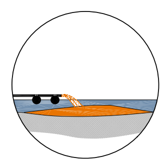
HYDRAULIC DREDGE
18" cutter-suction dredge dredged Salem River and material was piped two miles to Supawna Meadows.

PLANTING

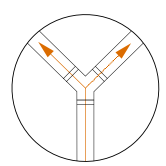


NATURAL VEGETATION
Vegetation allowed to re-establish naturally.

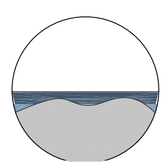
PLACEMENT



LOW DISCHARGE PONTOON
Sediment was distributed through a pipeline attached to a pontoon. A plate was fitted at the end.

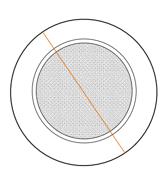


Y-VALVES
A Y-valve was included in the design but not used. In coordination with the dredging contractor, a pontoon was selected instead for certain sediment types.

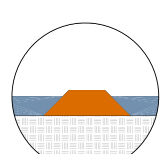


TIDAL CYCLES
Tidal cycles and tidal creeks helped disperse the sediment into the nearby mudflats and low marsh.

CONTAINMENT



NO TEMPORARY CONTAINMENT
Containment relies on existing conditions.



EXISTING BREAKWATER
The stone breakwater provides semi-containment of sediments on landward side. Higher marsh elevation wetlands will also provide containment.

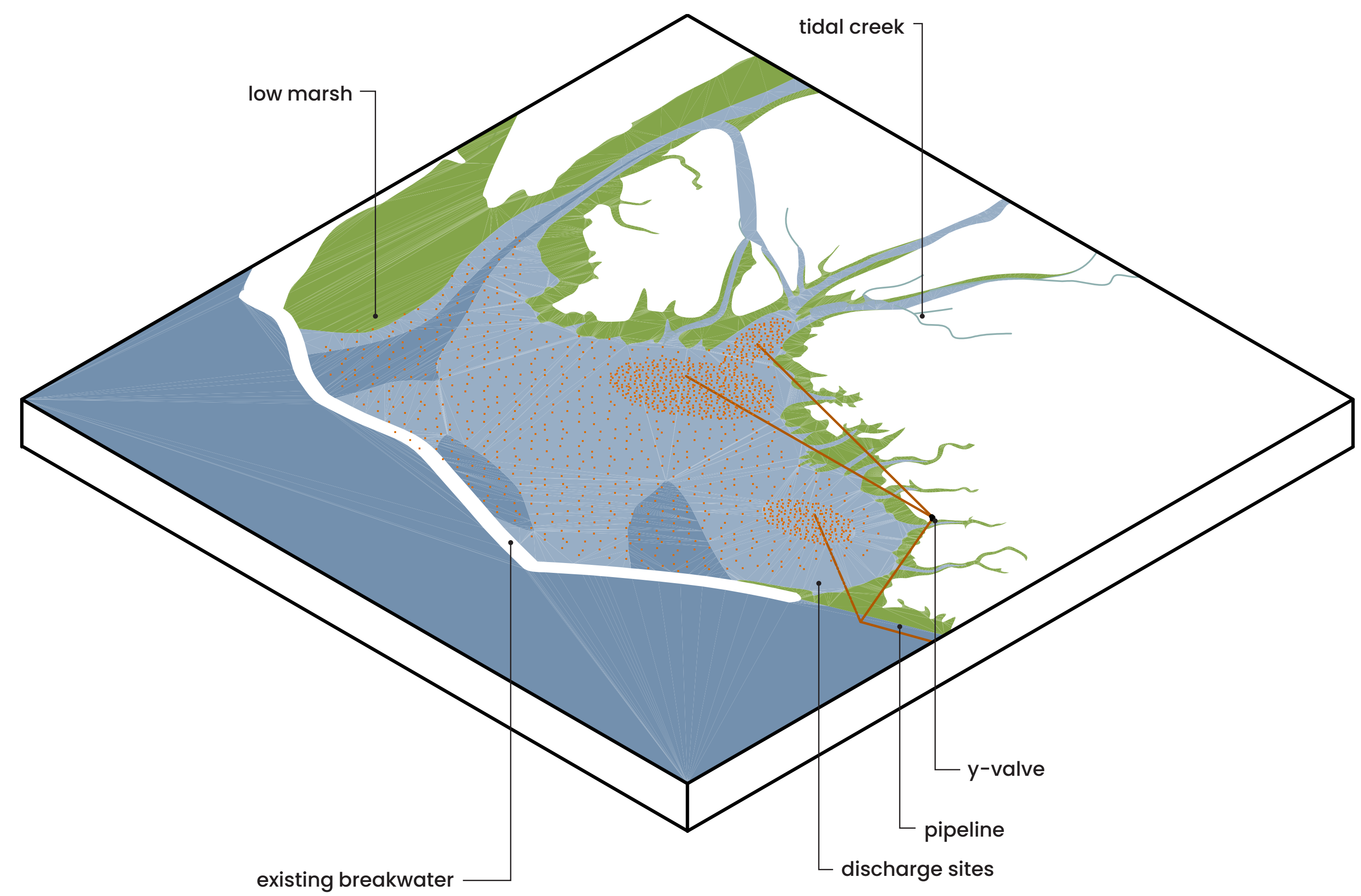
The initial BUDM phase was conducted in designated areas of a degraded marsh platform where concurrent habitat enhancements were carried out. Over several months, 200,000 cubic yards of sediment from the Salem River navigation channel—primarily silts/clays with some fines sands—were hydraulically dredged and pumped through a network of valves for widespread distribution. The sediments' movement and settling were influenced by tidal flows and the surrounding landscape. Containment was provided by existing breakwaters and marsh vegetation, which helped to minimize sediment loss and promote deposition (USACE NAP, 2024).

PARTNERS

+ U.S. Army Corps of Engineers, Philadelphia District, USFWS, Ducks Unlimited, Cottrell Contracting Corporation

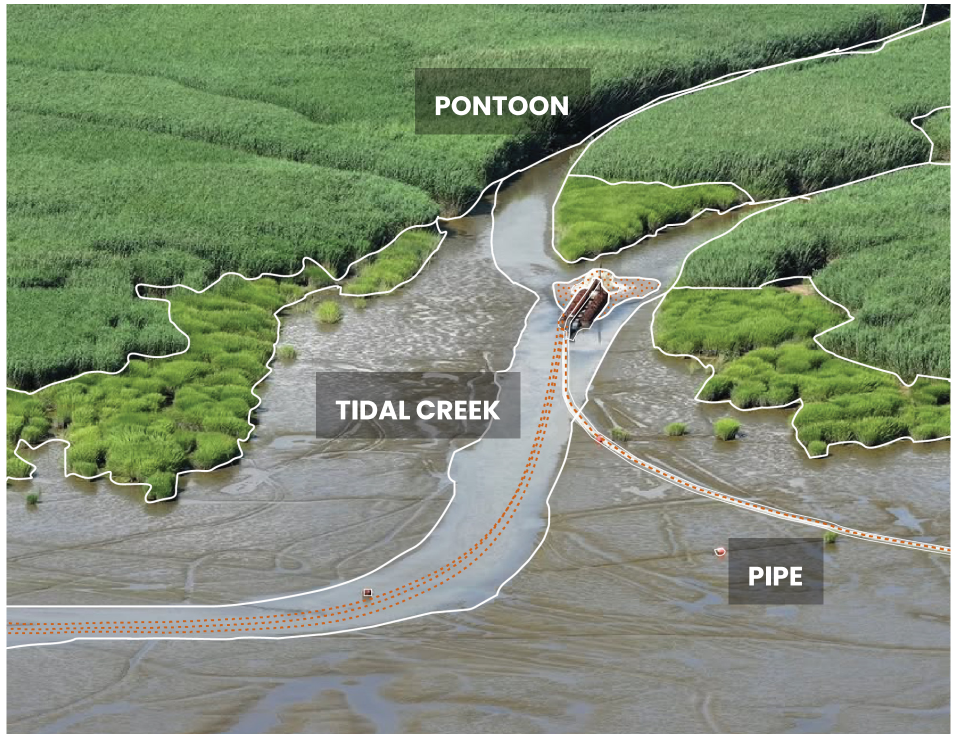
SEDIMENT VOLUME

+ 200,000 CY (first placement)



Mudflat

Special equipment like a pontoon-mounted pipe enabled the distribution of a low-discharge sediment slurry around the tidal creeks. Sediment accumulation was visible soon after placement began.



Sediment placement in tidal creeks utilizes natural tidal flow for marsh-flat distribution; prior habitat assessments of mudflats should inform decisions to avoid unintended ecological impacts.

A pontoon-mounted pipe with a baffle plate directs low-discharge sediment slurry around a creek mouth, using controlled flow to minimize erosion and support natural sediment distribution.

Image Credit (all): Cottrell Consulting Corporation, Supawna Meadows NWR, NJ

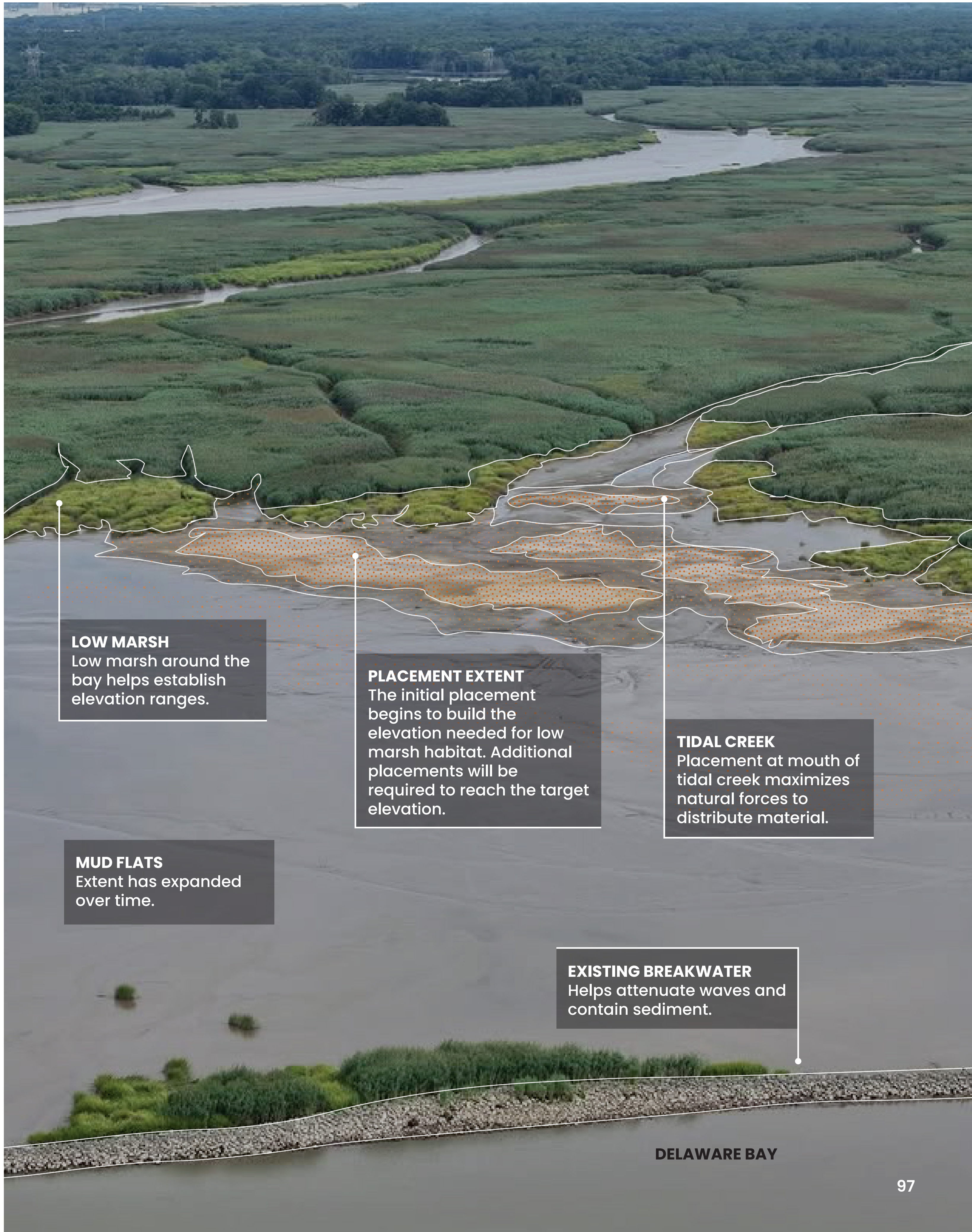


Image Credit: Chesapeake Bay Program

FRINGE WETLAND

Fringe wetlands play a vital role in coastal resilience and critical habitat protection . They are highly vulnerable to erosion and submergence, especially where they are situated between rising seas and hard shorelines. Bulkheads and revetments interrupt sediment supply and tidal flow, further narrowing fringe wetlands. These wetlands are more exposed to wave action and thus may require extra protection when sediment is placed.

Fringe wetlands are narrow bands of wetlands typically found along the edges of estuarine systems, rivers, and tidal bays, particularly in low-energy environments.

MARYLAND

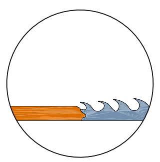
In Maryland, fringe wetland projects, such as Fort Smallwood, are often implemented in socially valuable areas like public parks or along critical infrastructure. These projects tend to be more expensive and require greater protection measures due to their exposure and ecological sensitivity.

Fringe Wetland

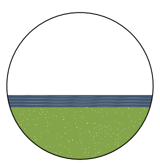
LIGHTNING POINT, AL

Spearheaded by The Nature Conservancy in collaboration with local, state, and federal partners, this project aims to enhance coastal resilience, restore vital habitats, and support the vibrant seafood and shipbuilding industries along with growing tourism.

RESTORATION

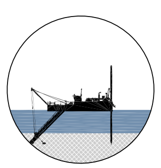


EDGE EROSION
Breakwaters constructed to protect erosion of new tidal marsh habitats and existing marsh habitats.

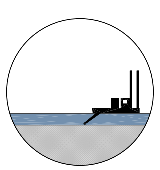


TIDAL MARSH HABITAT
Sediment used to restore lost tidal marsh habitat.

DREDGING

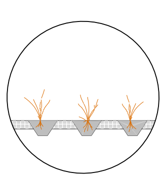


HYDRAULIC DREDGE
Off-shore borrow area dredged by 18-in cutterhead suction dredge.



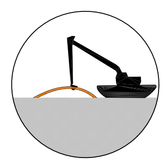
HYDRAULIC DREDGE
Borrow area "Alpha" dredged by 12-in swinging ladder cutterhead suction dredge.

PLANTING

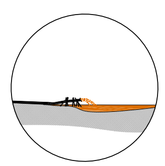


PLANTING PLUGS
Installed native grasses and shrubs to stabilize newly placed sediment and created tidal creeks to stimulate natural re-vegetation.

PLACEMENT

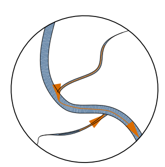


MECHANICAL EQUIPMENT
Amphibious excavators used in marsh creation areas to control sediment discharge and grading.

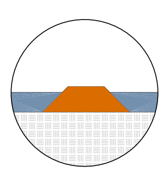


HYDRAULIC DISCHARGE
Sediment was strategically discharged across the footprint of the marsh creation areas. Turbidity was controlled with dikes, super sandbags, and weirs.

CONTAINMENT



TIDAL CREEKS
Creeks were re-established connect to the Mississippi Sound and mimic natural conditions.



BREAKWATERS
Breakwaters protect the restored habitat from wave energy.

The Lightning Point Shoreline Restoration Project is a comprehensive coastal restoration initiative in Bayou La Batre, Alabama, that repurposed more than 300,000 cubic yards of dredged material. The project constructed 1.5 miles of overlapping, segmented breakwaters and jetties to buffer wave action and created more than 40 acres of diverse habitats, including tidal marshes, scrub-shrub uplands, and tidal creeks (Moffatt & Nichol, 2019).

PARTNERS

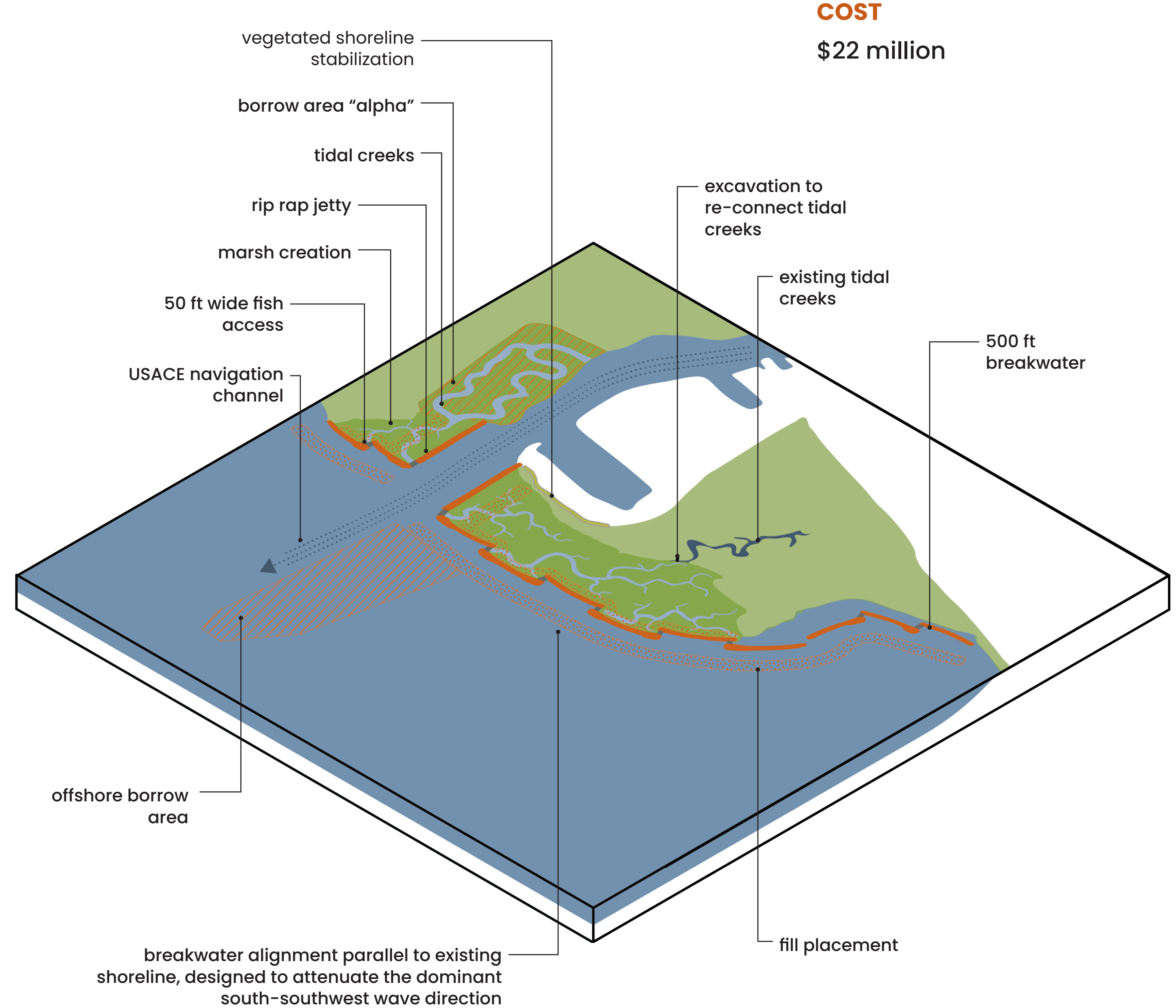
+ TNC, Moffatt & Nichol, National Fish and Wildlife Foundation, Alabama Department of Conservation and Natural Resources, USACE Mobile District, Dauphin Island Sea Lab, Mobile County, City of Bayou La Batre

SEDIMENT VOLUME

300,000 CY

COST

$22 million



On-site and off-site borrow areas supplied sediment for new marsh and tidal creek creation. New marsh creation areas were constructed simultaneously with protective breakwaters.

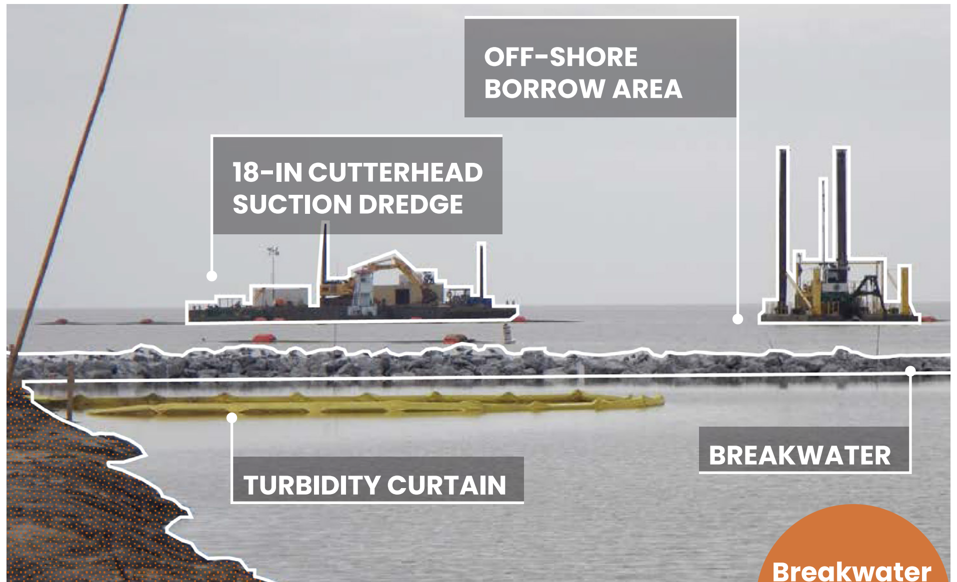


Image Credit: Moffatt & Nichol

Breakwater Detail See p. 174

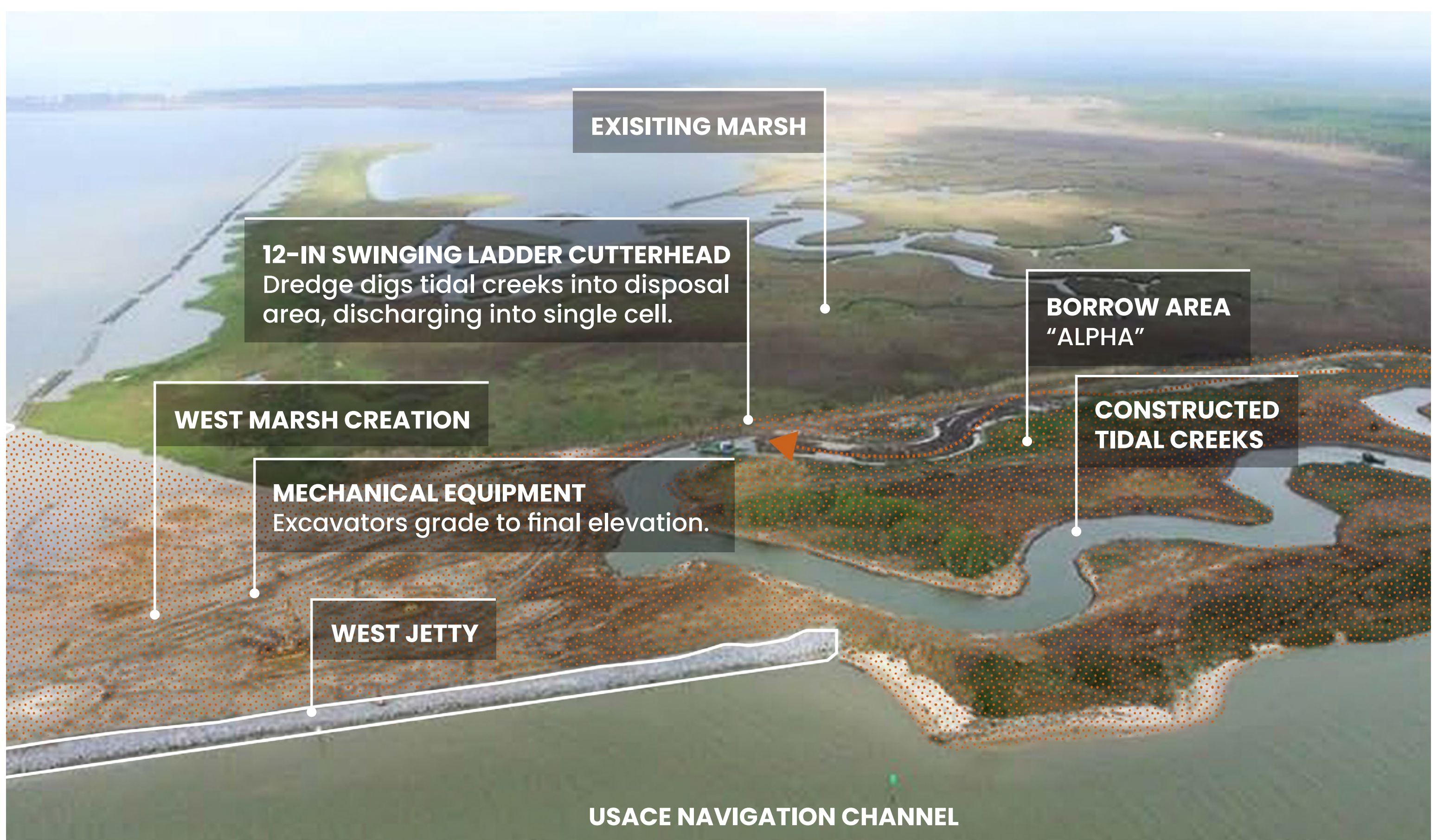


Image Credit: Lightning Point, AL, Moffatt & Nichol

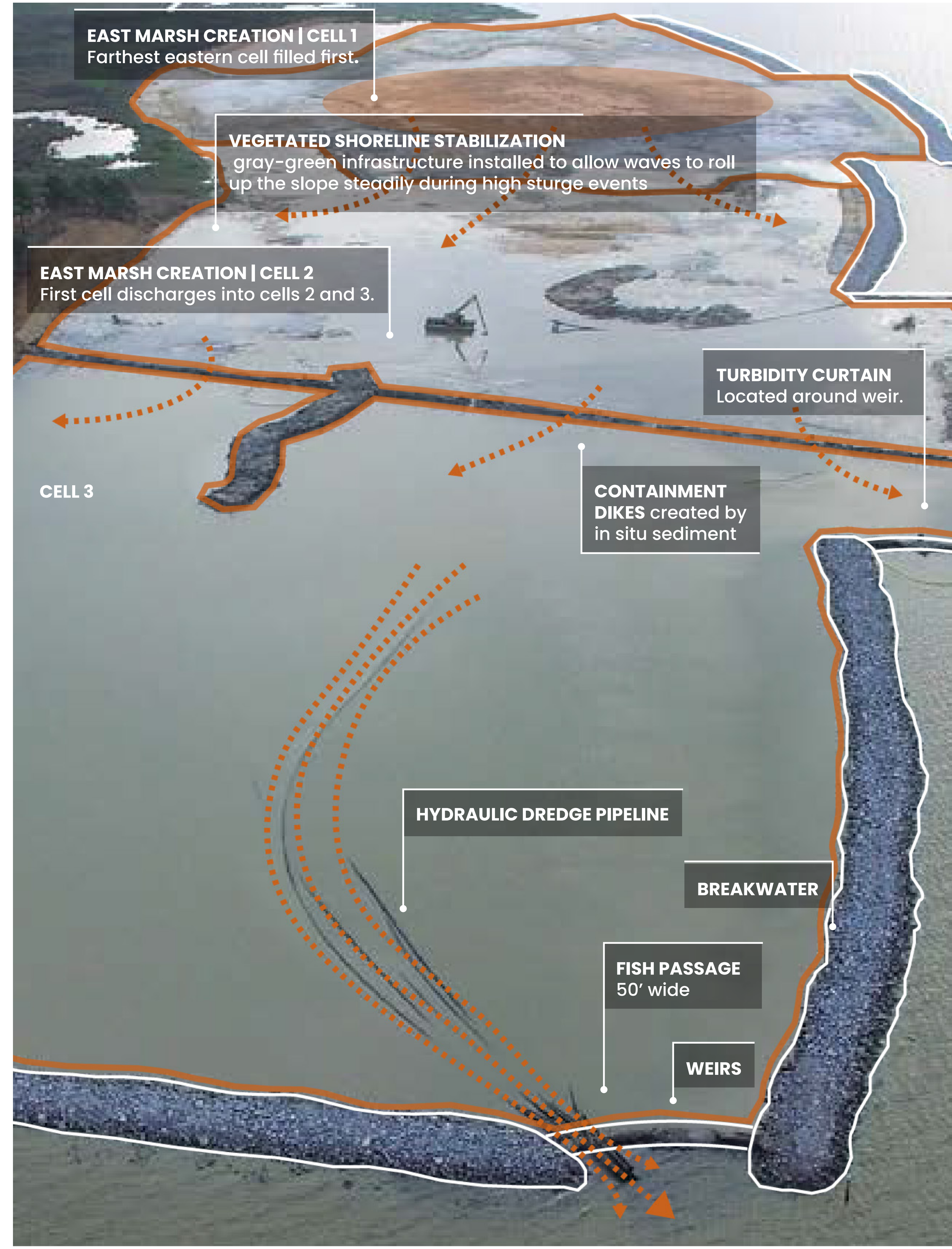


Image Credit: Lightning Point, Moffatt & Nichol

MARSH PLATFORM

An interior marsh platform is the broad, relatively flat area landward of a marsh's edge. These platforms are the core of many tidal wetland systems. Their saturated, anoxic soils rich in organic matter that often forms deep deposits of peat. Located away from open water and protected from direct wave energy and storm surges, marsh platforms typically lie within the intertidal zone and regularly flood at high tide and slowly drain at low tide.

They are often a focal point of restoration efforts because of their vulnerability to both subsidence due to pooling and to sea-level rise. In these efforts, sediment is placed carefully to restore lost elevation, enhance plant vigor, and prolong wetland function. But damage to the marsh caused by equipment used to place the sediment from dredging sites is a consideration for project planners.

Marsh platforms, the flat area landward of a marsh's edge, are the core of many tidal wetland systems.

MARYLAND

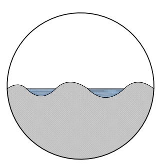
It should be noted that State tidal wetlands jurisdiction only extends to the MHWL. All vegetated wetlands (even if they appear to be tidal and are considered estuarine wetlands) landward of MHWL are considered nontidal wetlands. A marsh platform placement of dredge material may involve a nontidal permit.

Image Credit: Blackwater NWR, Chesapeake Bay Program

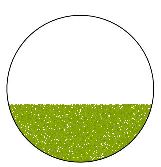
BLACKWATER NWR, MD

Sediment was used to restore a ponding marsh at Blackwater National Wildlife Refuge. The material used in the restoration was dredged downstream of the site, so any material that left the site filled in the borrow area.

RESTORATION

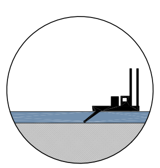


PONDING MARSH
The deteriorated wetland exhibited areas of ponding, some of which are historic, while others have formed more



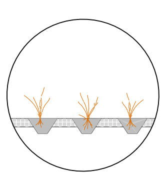
HIGH MARSH WETLAND
Sediment restored high marsh wetland.

DREDGING



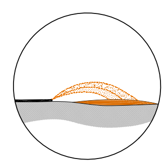
HYDRAULIC DREDGE
Borrow area dredged by 12-in cutterhead dredge.

POST CONSTRUCTION

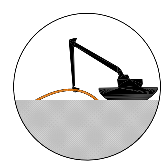


PLANTING PLUGS
Site planted to supplement natural re-vegetation.

PLACEMENT

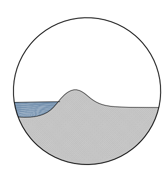


DISCHARGE POINTS
Sediment dispersed radially 150' from each discharge point using a surface-mounted swivel spray nozzle.

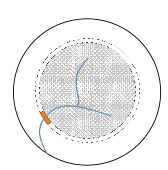


EQUIPMENT MOVEMENT
Mini-pontoon excavator repositioned the pipeline every 300'

CONTAINMENT



NATURAL LEVEE
Natural levees located around the creek banks acted as containment

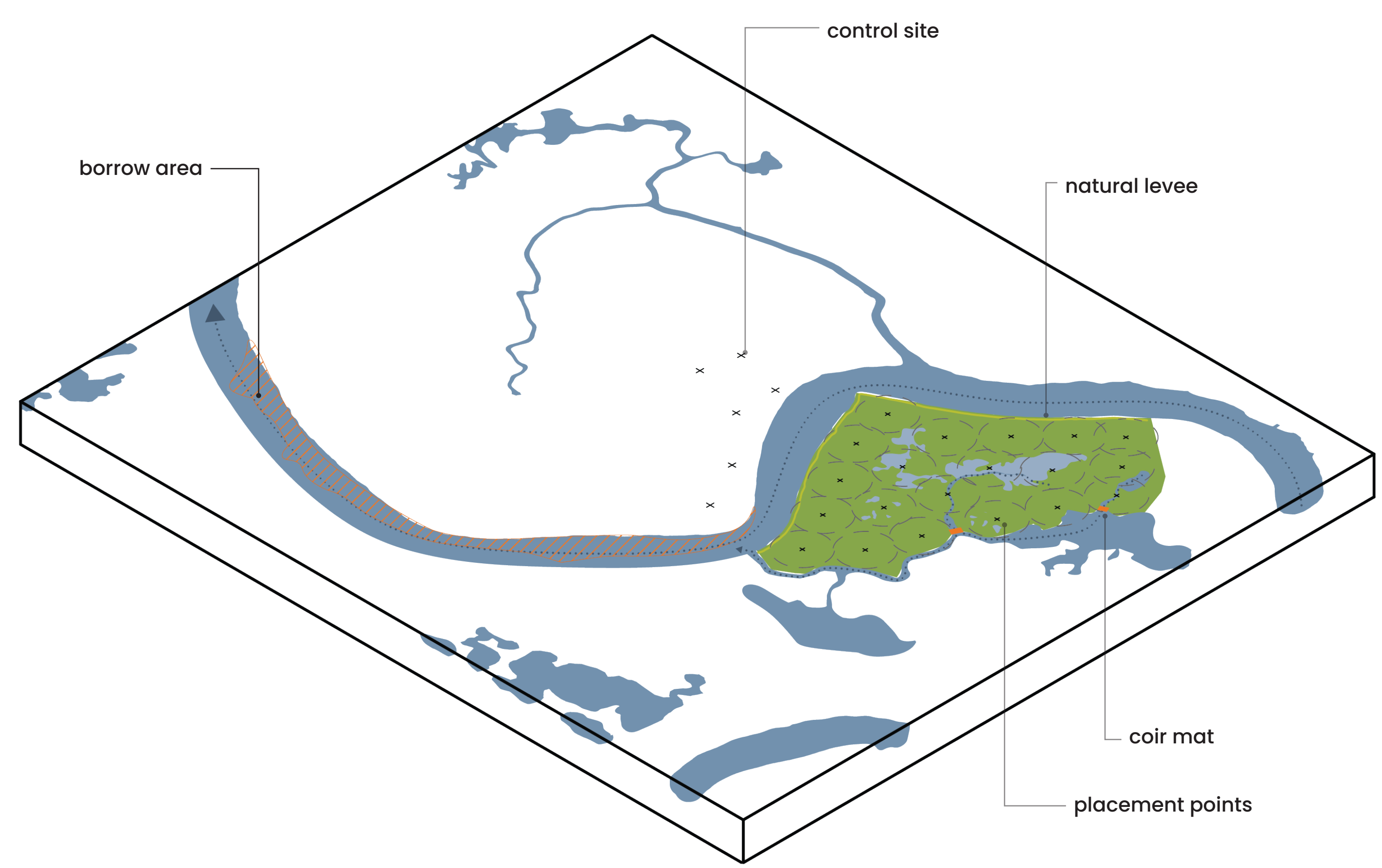


IN-CHANNEL CONTAINMENT
Temporary coir mat in two tidal creek locations. Any sediment lost flowed down to borrow pit.

A 12-inch cutterhead hydraulic dredge was used to deliver slurry to the site through a surface-mounted, 6-inch swivel spray nozzle. Observations during placement indicated that sediment dispersed radially up to 150 feet from each discharge point. Once grade stakes confirmed the target elevations had been achieved, a mini-pontoon excavator moved the nozzle approximately 300 feet and pumping resumed to achieve uniform coverage across the site. This process created concentric placement patterns, with coarser sands settling near the point of discharge and finer materials extending outward (Whitbeck et al., 2019).

PARTNERS

+ The Conservation Fund, Audubon Maryland-DC, Sustainable Sciences LLC, USFWS, USGS, USACE Baltimore District, Dredge America, Ecological Restoration and Management, Geo-Technology Associates, Inc.



“Witness boards” were used not only to measure the grade attained but also to predict consolidation of dredged material. Coir mats were used to minimize sediment flow into undesired locations.

Image Credit: Middleton Evans

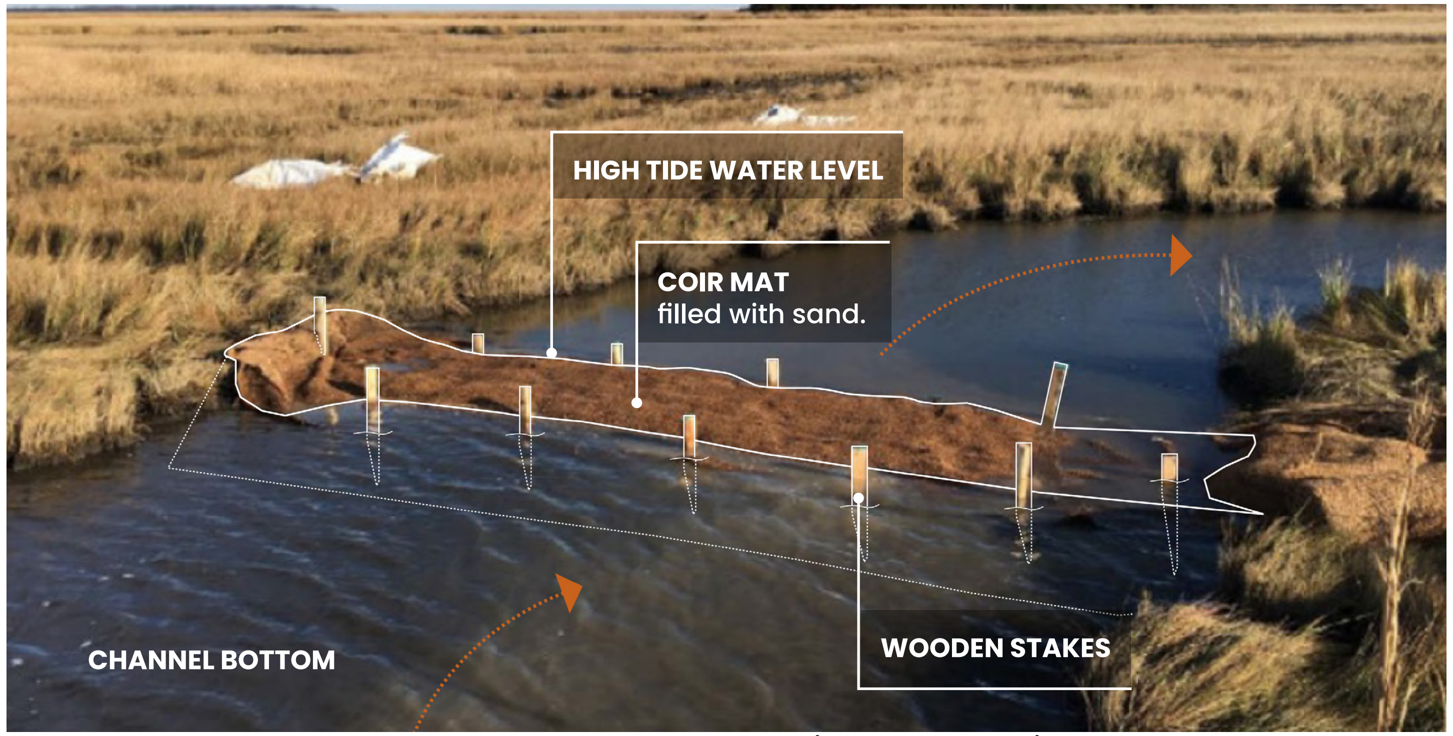
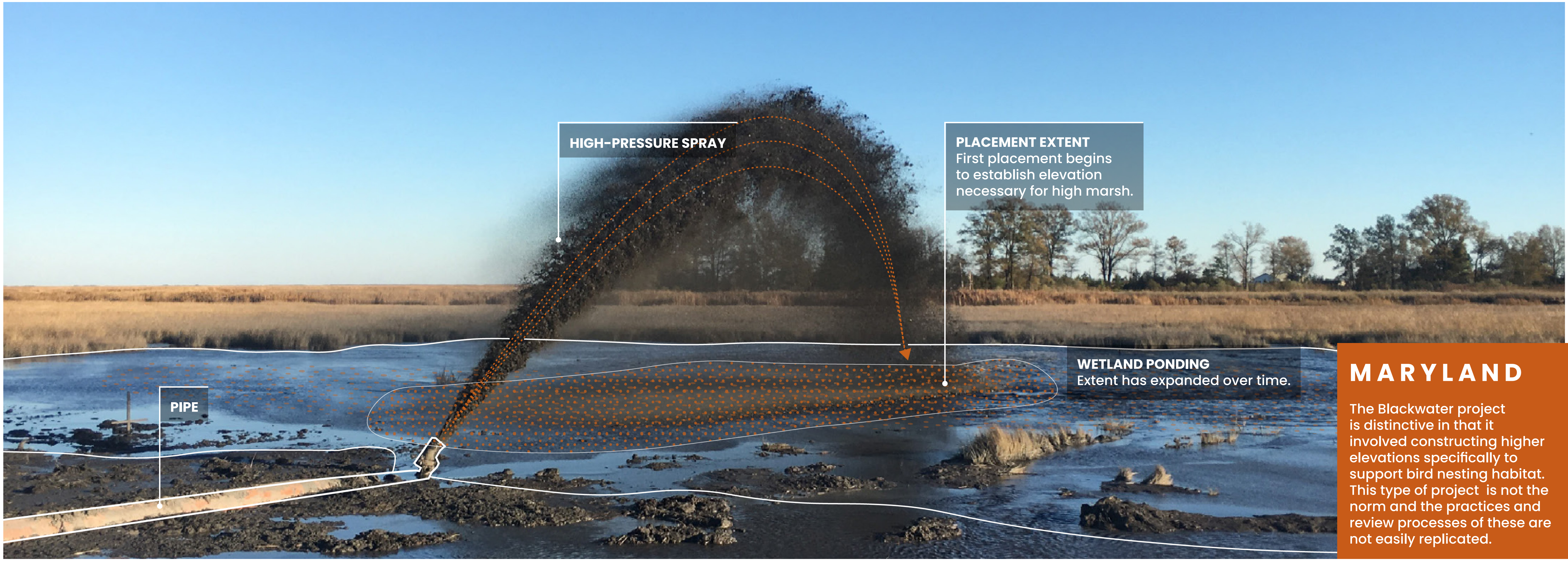


Image Credit: Albert McCullough, Sustainable Sciences, LLC (Top Left, Bottom)



MARYLAND

The Blackwater project is distinctive in that it involved constructing higher elevations specifically to support bird nesting habitat. This type of project is not the norm and the practices and review processes of these are not easily replicated.

QUESTIONS

These questions were used to guide the information-gathering process for the case studies. They can also serve as a framework for further research by individuals or agencies seeking insights from other projects.

BUDM Project List (Non-Exhaustive)
See p. 178-183

OVERVIEW

Where is the project located?

What were the project goals?

How long did the project take to plan, design, fund, implement, and monitor?

PROJECT GOALS

What habitat existed at the site prior to degradation?

What was the condition of the habitat immediately prior to restoration?

What was the target elevation range and how was it determined?

Was sea level rise (SLR) considered or monitored?

Are there sensitive habitats present (e.g., submerged aquatic vegetation, oyster reefs)?

What planting techniques and species were used?

COST + FUNDS

What was the total cost of the project and project cost breakdown (dredging, placement, containment)?

What were the funding sources (e.g., federal, state, local, private)?

REGULATORY

What permits were required for the project?

Which agencies or jurisdictions were involved in regulatory oversight?

Were there any special circumstances (e.g., endangered species, cultural resources, unique site conditions)?

DREDGING

What was the total volume of dredged material?

What was the distance between the dredging source and the placement site?

What was the grain size composition of the dredged material, and how did it influence placement design?

How was material transported to the placement site?

PLACEMENT

How was placement sequenced (e.g., use of Y-valves, equipment movement, multiple lifts, dewatering)?

How were target elevations established and achieved?

CONTAINMENT

What type of containment was used, if any?

What site-specific considerations shaped the containment approach?

How was containment deployed, managed, and eventually removed?

MONITORING

What aspects of the project were adaptively managed during construction and placement?

How did adaptive management influence outcomes?

How was vegetation, elevation, wildlife, hydrology, invasive species, and turbidity monitored, and what were the results?

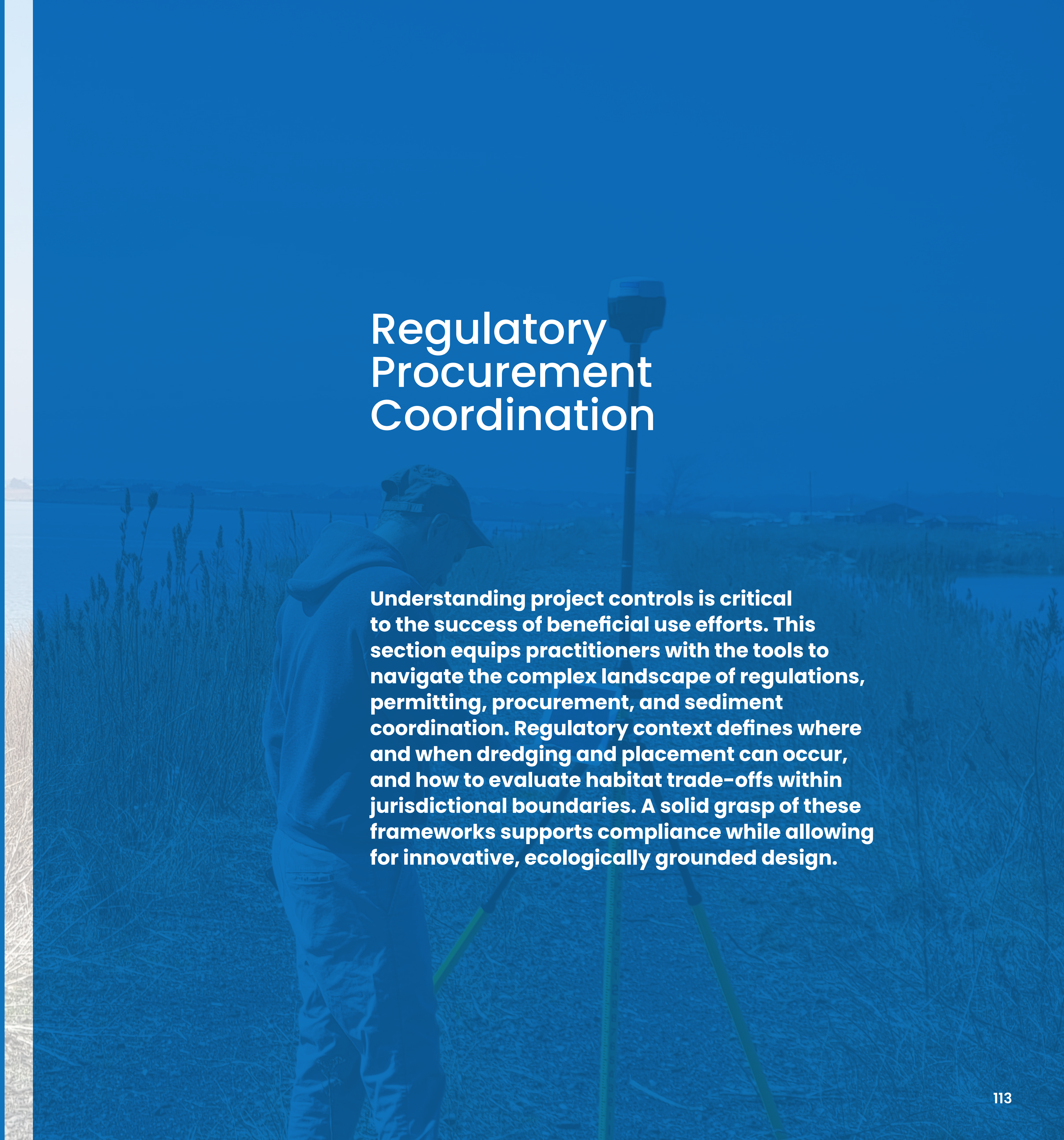
LESSONS

What innovative practices, designs, or methods were introduced in this project?

What lessons were learned that could inform future projects?

What additional context or information is important to capture about this project?

4. PROJECT CONTROLS



Regulatory Procurement Coordination

Understanding project controls is critical to the success of beneficial use efforts. This section equips practitioners with the tools to navigate the complex landscape of regulations, permitting, procurement, and sediment coordination. Regulatory context defines where and when dredging and placement can occur, and how to evaluate habitat trade-offs within jurisdictional boundaries. A solid grasp of these frameworks supports compliance while allowing for innovative, ecologically grounded design.

Regulatory

SEA LEVEL RISE

Targeted interventions are critical to enable marshes to maintain functionality as sea levels rise.

RESOURCES

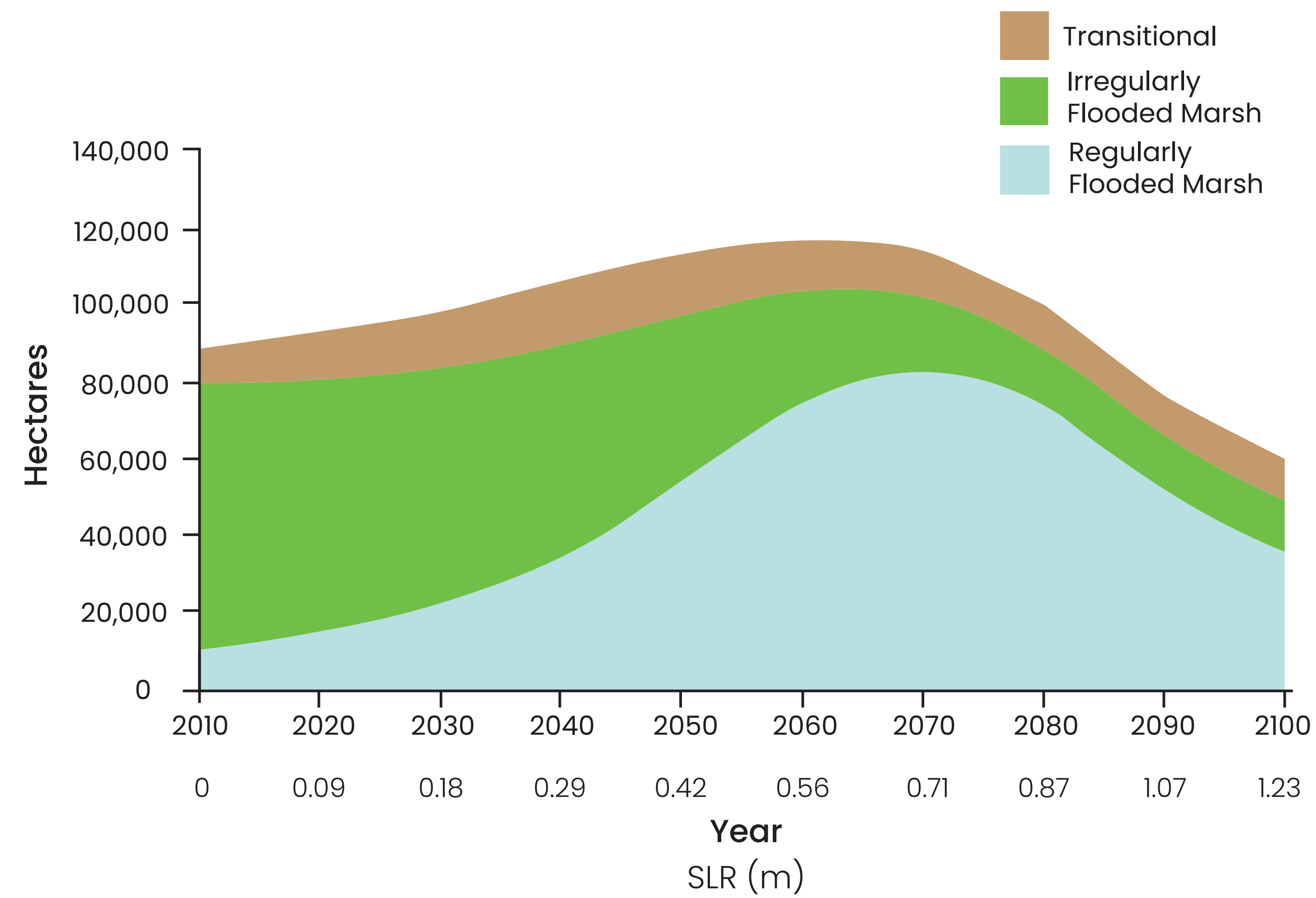
NOAA + USFWS
[Coastal Marsh Restoration: An Ecosystem Approach for the Mid-Atlantic]

Addresses many of the challenges with habitat trade-offs in marsh enhancement and recommends an ecosystem-based approach to coastal restoration, where habitat conservation is planned on an estuary-wide, or watershed-wide context, rather than restoration approaches that focus on a single species or habitat type (Correll et al., 2024).

Sea level rise intensifies flooding, erosion, and elevation loss in marshes, resulting in rapid habitat degradation. To maintain ecological function and keep pace with rising waters, marshes must actively accumulate sediment and increase elevation. Therefore, targeted restoration techniques such as sediment placement and hydrological interventions (e.g., ditch remediation and runneling) are crucial tools for sustaining marsh resilience.

As sea level rise progresses, the distribution of marsh habitats will shift, starting with a decline in irregularly flooded marshes, followed eventually by losses in regularly flooded marshes. Given these anticipated changes, strategic decisions might need to be made proactively to convert marsh habitats, preserving ecological integrity ahead of time. However, raising elevations above state-defined reference lines carries regulatory risks, potentially disqualifying areas from tidal wetland classification, thereby affecting grant eligibility and the feasibility of future restoration efforts. Additionally, elevating marshes too much can lead to the colonization of invasive species like *Phragmites australis* and the development of acidic soil conditions.

Projections from the Sea Level Affecting Marshes Model (SLAMM), specifically under Maryland's "Upper Limit of Likely Range" scenario, illustrate these trends, highlighting the expected decline in marsh extent as regularly flooded marshes transition to tidal flats and open water.



Source: Adapted from *Marshes for Tomorrow*, Curson et al, 2025 based on TNC's Application of the *Sea-Level Affecting Marshes Model to Coastal Maryland* (2021)

LONG-TERM PLANNING

Successful marsh restoration or creation requires thoughtful planning to navigate habitat trade-offs while maximizing environmental and resilience benefits.

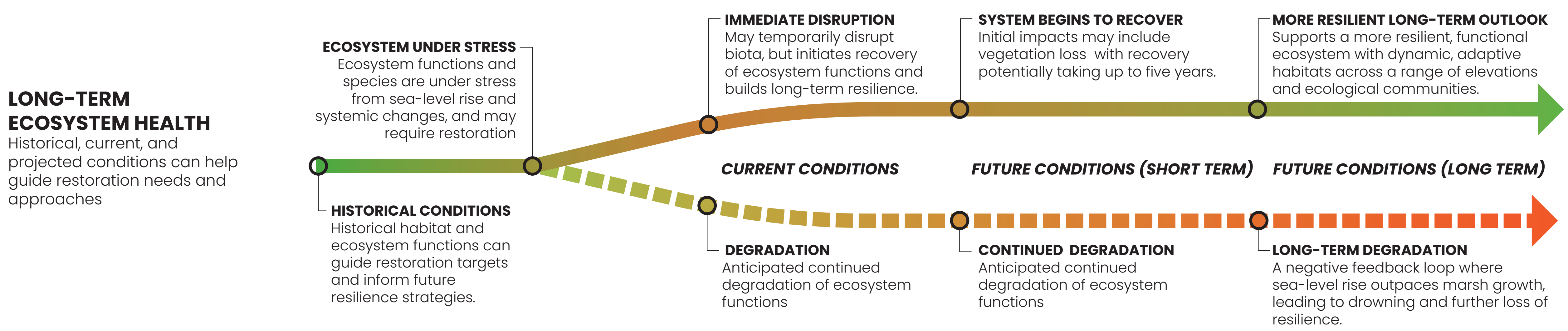
Marsh restoration planning should account for both the immediate and long-term ecological effects of habitat conversion, aiming to support a diverse range of system functions and services for terrestrial, avian, and aquatic species. Project plans and documentation should address not only the short-term impacts but also the projected long-term outcomes, including how site conditions may shift over time.

A system-wide perspective helps integrate diverse objectives and guide more holistic decision-making. Restoration designs and permitting documents should prioritize habitat resilience across elevation gradients and planning for long-term ecological shifts, rather than fixed outcomes.

Successful marsh restoration or creation requires thoughtful planning to navigate habitat trade-offs while maximizing environmental and resilience benefits. The creation of new islands, restoration of historical island footprints (e.g., Poplar, Barren, and James islands in Maryland), or extension of marshes into open water may result in the loss of **benthic habitat**, including **submerged aquatic vegetation (SAV)** and **essential fish habitat (EFH)**. NOAA, USFWS, and EPA are responsible for the management and regulation of SAV and EFH.
Early coordination with state and local resource agencies is critical to identify tradeoffs, guide habitat surveys, inform potential mitigation measures, and minimize adverse impacts. Baseline ecological conditions can be determined through pre-construction surveys to allow meaningful comparisons with the results of post-construction monitoring.

MARYLAND

MDE is the permitting agency for any projects involving dredging or dredged material in Maryland. While MDDNR sometimes requires documentation for projects that impact SAV in Maryland, for any project involving dredging, all documentation goes through MDE, and MDDNR is a commenting

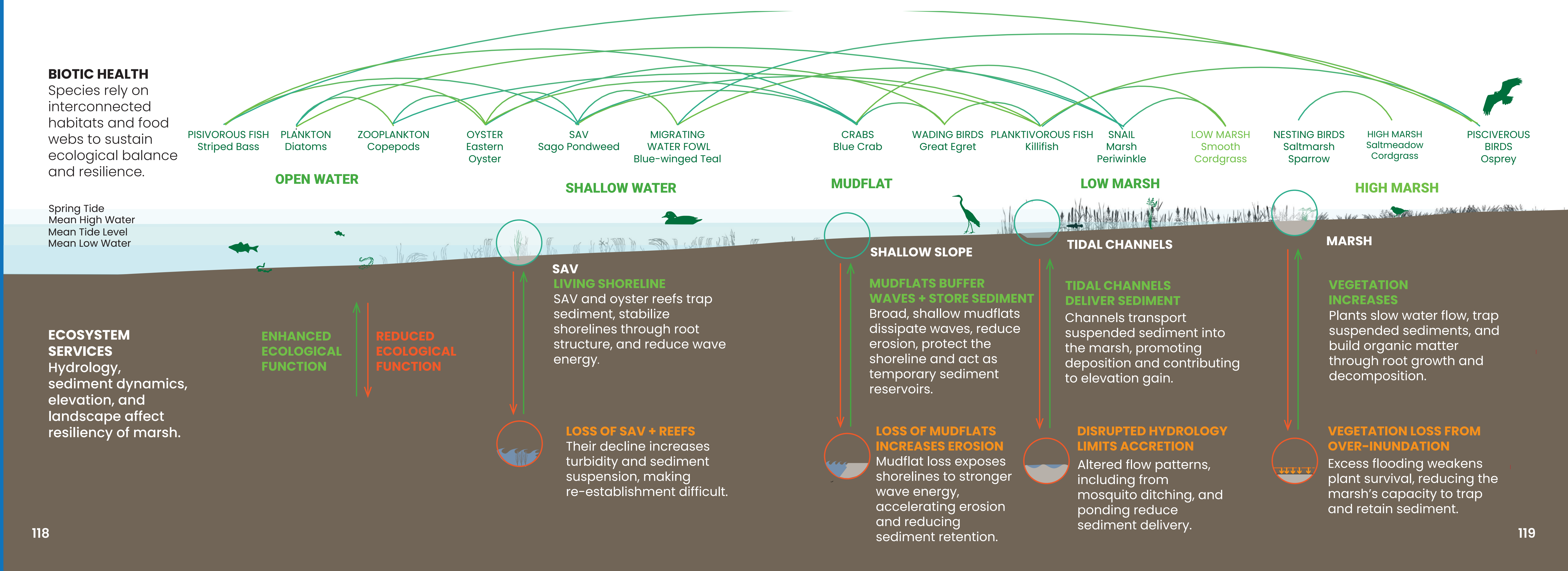


HABITAT CONVERSION

Effective application of beneficial use requires a thorough understanding of the habitats present on site and the potential changes to a habitat mosaic that sediment placement may create.

Changes in vegetation communities highlight the need for balance between the different agency priorities. Resilient coastal systems are composed of a mosaic of habitats that support a wide range of species, and effective restoration often requires addressing the underlying physical processes that shape the landscape.

Restoring long-term ecosystem function in coastal environments requires a holistic design approach. This includes modifying key features such as tidal flow patterns, elevation gradients, channel networks, and vegetation structure to reestablish natural dynamics and improve system resilience over time.



THE FEDERAL STANDARD

The Federal Standard, which is the least-cost, environmentally acceptable method of discharging dredged material consistent with sound engineering practices, is sometimes referred to as the "base plan."

RESOURCES

USEPA + USACE

The Role of the Federal Standard in the Beneficial Use of Dredged Material from U.S. Army Corps of Engineers New and Maintenance Navigation Projects: Beneficial Uses of Dredged Materials

Details the implementation of the Federal Standard and federal cost sharing.

The Federal Standard

The Federal Standard, which is the least-cost, environmentally acceptable method of discharging dredged material consistent with sound engineering practices, is sometimes referred to as the "base plan" (USEPA and USACE, 2007b). The costs associated with the Federal Standard option for initial channel construction are assigned to the navigational purpose of a dredging project and shared between USACE and the non-federal sponsor according to set percentages based on channel depth. However, for Operations & Maintenance (O&M) dredging performed after the initial channel construction, the costs associated with the Federal Standard are fully (100%) federally funded.. Often, in states other than Maryland, the Federal Standard is open water disposal of the dredged material. But because of local needs, opportunities, and sponsor interest, the Federal Standard is not always the option selected for the placement of dredged material.When the selected option exceeds the Federal Standard—which can occur with beneficial use if the full range of benefits is not fully considered—the additional costs are shared by USACE and the non-federal sponsor, depending on the type of beneficial use. For projects that protect, restore, or create aquatic habitat, USACE may fund a portion of these additional costs under Section 204 of the Water Resources Development Act (WRDA) of 1992. However, beneficial use alternatives are not inherently more expensive and may be cost-effective when all associated benefits and avoided costs are fully evaluated.

Non-Federal Sponsors

The role of the non-federal sponsor may vary by project but usually includes contributing to the project's feasibility costs, engineering and design costs, construction costs, and formal assurance of local cooperation at the project level (USACE NAB n.d.-b). A non-federal sponsor can be a state, tribe, political subdivision of a state or group of states, a quasi-public organization chartered under state laws (e.g., a port authority, flood control district, or conservation district), an interstate agency, or a non-profit organization that has entered into a formal project partnership agreement (PPA) with the U.S. government. Non federal sponsors in general are subject to all applicable federal, state, and local permitting requirements.

A federal cost share with USACE provided most of the funding for the Deal Island Wildlife Management Area in Maryland's Wicomico County. The remainder was paid by the non-federal sponsor, Wicomico County, with additional funds paid by the DNR.

MARYLAND

A federal cost share with USACE provided most of the funding for the BUDM project at Deal Island Wildlife Management Area in Maryland's Wicomico County. The remainder was paid by the non-federal sponsor, Wicomico County, with additional funds paid by MDDNR.

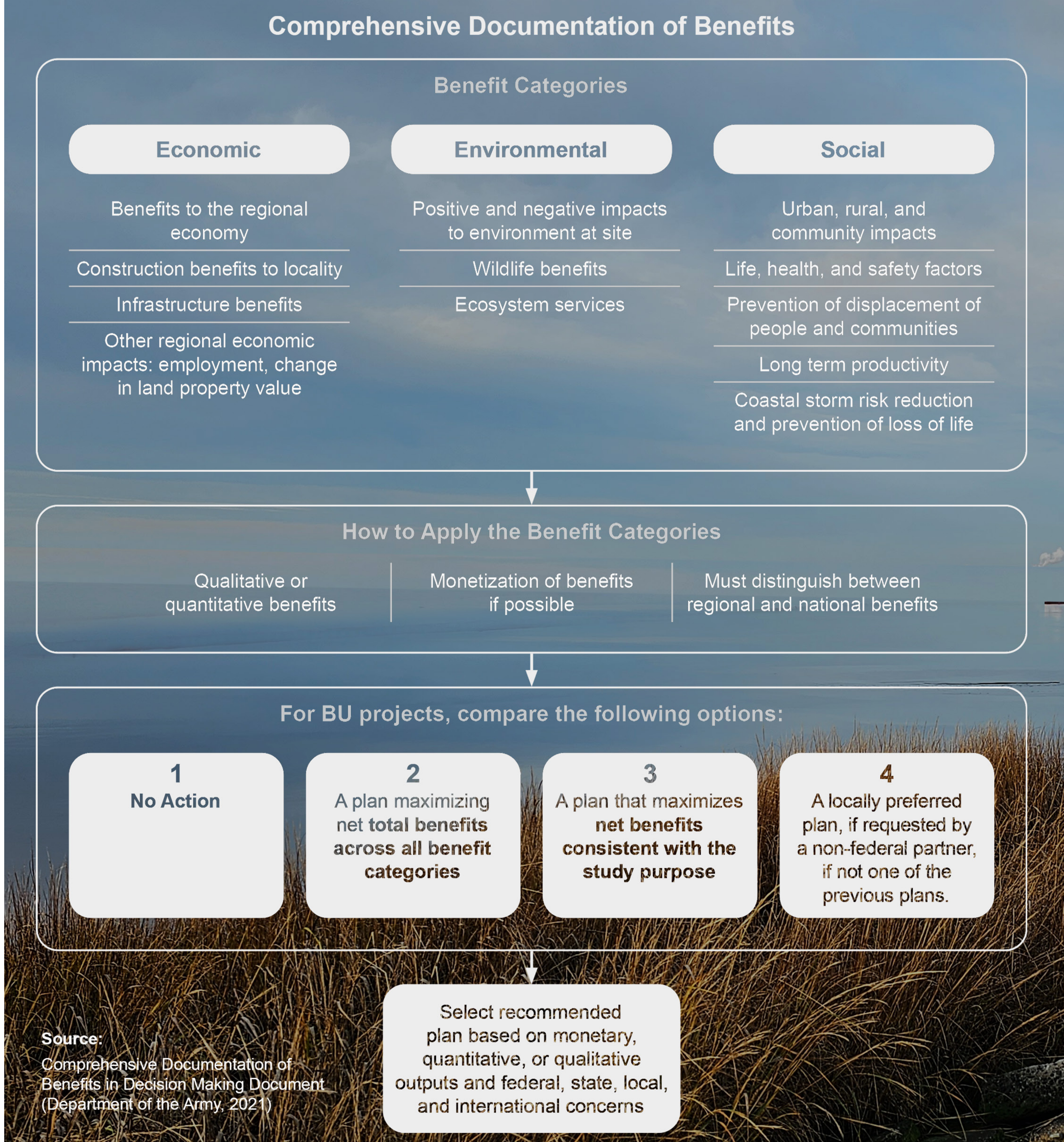
Regulatory

DOCUMENTATION OF BENEFITS

Recent guidance expands dredged material decision, making to include environmental and social benefits, beyond cost alone, supporting broader justification for BUDM projects.

The Federal Standard was initially focused on identifying the least-cost, environmentally acceptable dredged material placement option consistent with sound engineering practices. Historically, this prioritization of economic efficiency has constrained the implementation of beneficial use alternatives which, although costlier and requiring monitoring and maintenance, can provide additional environmental and social benefits. Recent guidance like the Comprehensive Documentation of Benefits in Decision-Making Document goes beyond economic factors to include consideration of environmental and social benefits and requires the evaluation and consideration of a proposed project's benefits across all three categories (SACW, 2021).

Environmental benefit assessments are increasingly expected to consider both the loss of existing habitat functions and their duration, as well as the provisioning of new or augmented habitat functions and how long those benefits will persist. These evaluations can explore a range of ecosystem services, including improvements to shallow water habitat (e.g., nursery functions, water quality enhancement), emergent marsh (e.g., carbon sequestration, wave attenuation, biodiversity support), and adjacent upland habitat (e.g., habitat connectivity, pollinator resources, edge stability).



Regulatory

ADAPTIVE MANAGEMENT

Uses structured decision-making, monitoring, and flexibility to adjust project management based on changing circumstances or new knowledge about which approaches may be most effective.

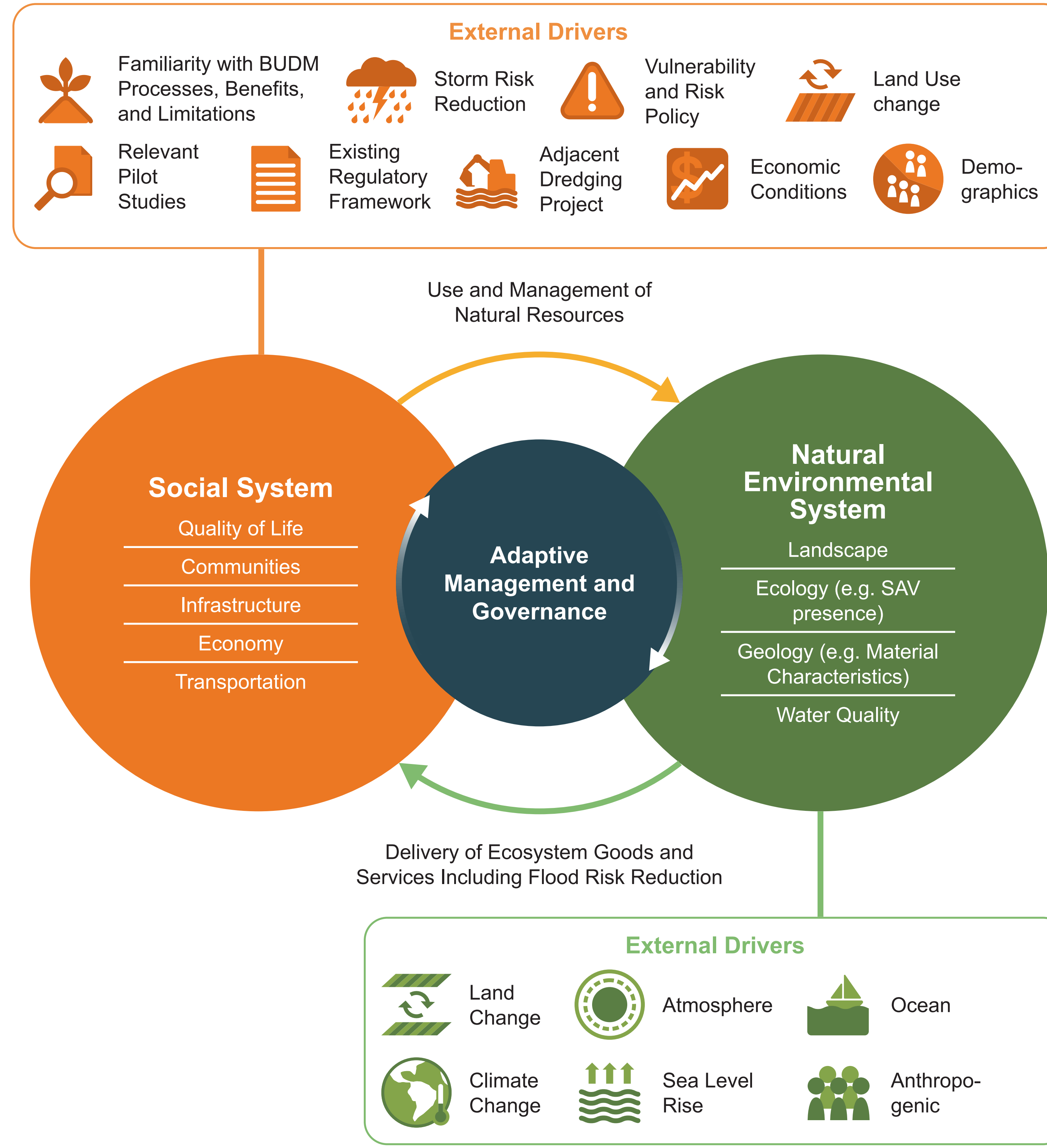
RESOURCES

DWH NRD Trustees
Monitoring and Adaptive Management Manual
Provides a framework for successful adaptive management of coastal restoration and resilience projects, including guidance, information and examples. (Deepwater Horizon (DHW) Natural Resource Damage Assessment Trustees)

NOAA + USFWS
Coastal Marsh Restoration: An Ecosystem Approach for the Mid-Atlantic
Has detailed information on holistic monitoring for adaptive management purposes in mid-Atlantic marshes, taking an ecosystems-based approach where all aspects of habitat at a site are considered.

Adaptive management uses structured decision-making, monitoring, and flexibility to adjust project management based on changing circumstances or new knowledge about which approaches may be most effective (Piercy et al., 2023). Adaptive management is especially vital in projects like marsh restoration and creation using dredged material because ecosystem-level impacts such as vegetation growth, wildlife usage, erosion, and hydrology can be complex, interconnected, and hard to predict. Because of this unpredictability, flexible targets and project goals are important aspects of beneficial use projects.

Effective adaptive management plans can be developed early, during the project design phase, to ensure projects receive the benefits of the adaptive management approach. Adaptive management by nature involves monitoring and specific goals to determine whether a project is operating as intended. Examples of adaptive management include replanting when monitoring of natural vegetation reveals limited recovery following sediment placement and additional sediment placement if elevation monitoring shows target elevations were not achieved because of erosion or consolidation.



MARYLAND

Prior to implementation of the project at Poplar Island, a detailed adaptive management plan was developed for two components of the project: cell development and habitat restoration. Monitoring as part of the plan included extensive monitoring on the island and in the surrounding benthic environment.

The plan outlines corrective actions to be taken if progress was not met, and was reviewed and updated annually during the project period (USACE NAB, 2005). Poplar Island's extensive adaptive management needs are unique due to the large scope of the project. The adaptive management plan is a living document and is regularly discussed and updated based on meetings of the habitat workgroup.

TIME OF YEAR RESTRICTIONS

Time of year restrictions (TOYRs) for dredging are implemented to minimize impacts by limiting construction activities, such as dredging or construction, during periods when aquatic species are most vulnerable.

Dredging TOYRs may be set in response to the seasonal presence of species, particularly species that are federally or state managed or listed as threatened or endangered. If federally or state managed species are present, consultation with NOAA Fisheries and USFWS is required because additional permitting may be necessary if moderate or significant impacts are anticipated.

TOYRs vary by region and may be influenced by local conditions such as tidal cycles and sediment dynamics. Therefore, early coordination with resource agencies and a thorough understanding of the project area are critical to identify applicable restrictions and develop effective mitigation strategies.

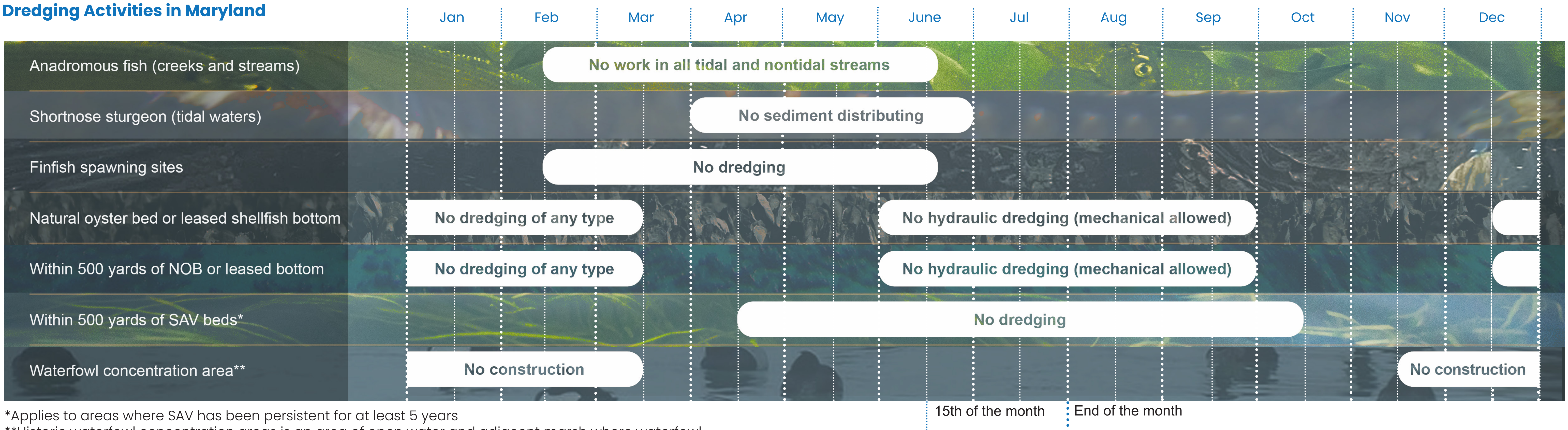
RESOURCES

USFWS

[Information for Planning and Consultation (IPAC)]
Online tool that can support the early identification of species that may be affected by activities near a project

[Maryland Coastal Atlas]
Provides spatial data on where TOYRs may apply

Common TOYRs for Dredging Activities in Maryland



*Applies to areas where SAV has been persistent for at least 5 years
**Historic waterfowl concentration areas is an area of open water and adjacent marsh where waterfowl gather during migration and throughout the winter season
Note: Other Time of Year Restrictions (TOYRs) may exist depending on project specifics

Source: *MDDNR Environmental Review Common Time of Year Restrictions*

JURISDICTIONAL ZONES

Jurisdiction over coastal areas in Maryland depends in part on the critical area, which serves as a buffer around the Chesapeake and other tidal waters to protect sensitive aquatic habitat.

USACE Jurisdiction

The USACE Baltimore District defines wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USACE NAB, 2025). USACE uses three characteristics to determine whether an area is a wetland: vegetation, soil, and hydrology.

A jurisdictional determination (JD) is a written USACE determination that a wetland or waterbody is subject to regulation under Section 404 of the CWA or Sections 9 or 10 of the Rivers and Harbors Act of 1899. JDs are requested on line through the federal Regulatory Request System (RRS). The regulation applies to any dredging or disposal of dredged materials, excavation, filling, re-channelization, or any other modification of a navigable water of the U.S. that may alter its course, condition, or capacity.

Maryland Jurisdiction

Critical Area (MDDNR)

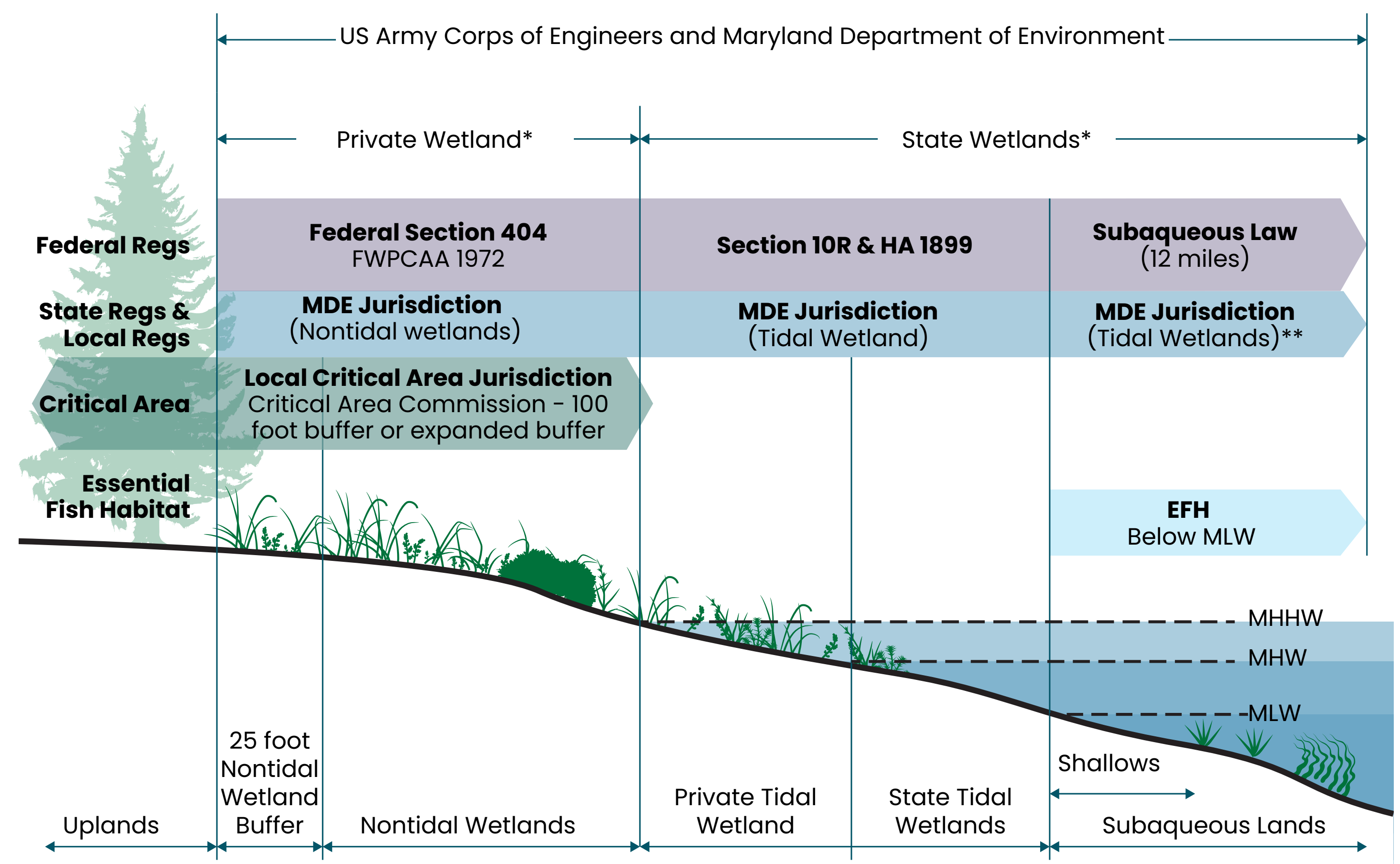
In Maryland, MDDNR defines Critical Area as "all land within 1,000 feet of Maryland's tidal waters and wetlands... the waters of the Chesapeake Bay, the Atlantic Coastal Bays, their tidal tributaries, and the lands underneath those tidal areas" (MDDNR, n.d.). The purpose of Critical Area Protection is to control future land use development in the Chesapeake watershed to protecting the watershed from negative impacts of intense development.

State and Private Wetlands

Section 16-101 of the Annotated Code of Maryland Wetlands and Riparian rights defines wetlands as either state or private wetlands:

State Wetlands are any land under the navigable waters of the state below the mean high tide, affected by the regular rise and fall of the tide.

Private Wetlands are any land not considered "state wetlands" bordering on or lying beneath tidal waters, which are subject to regular or periodic tidal action and support aquatic growth.



Regs = Regulations, CA = Critical Area, MWRRA = Maryland Wetlands and Riparian Rights Act
*Some exceptions may apply **3 miles from low water mark on the Atlantic Coast

Regulatory

PERMITTING PROCESS

In Maryland, federal and state permitting for the alteration of wetlands and waterways is streamlined through the Joint Federal/State Permit Application (JPA). Generally, State wetland licenses may take approximately 12 months to be issued, but is case-by-case basis.

RESOURCES

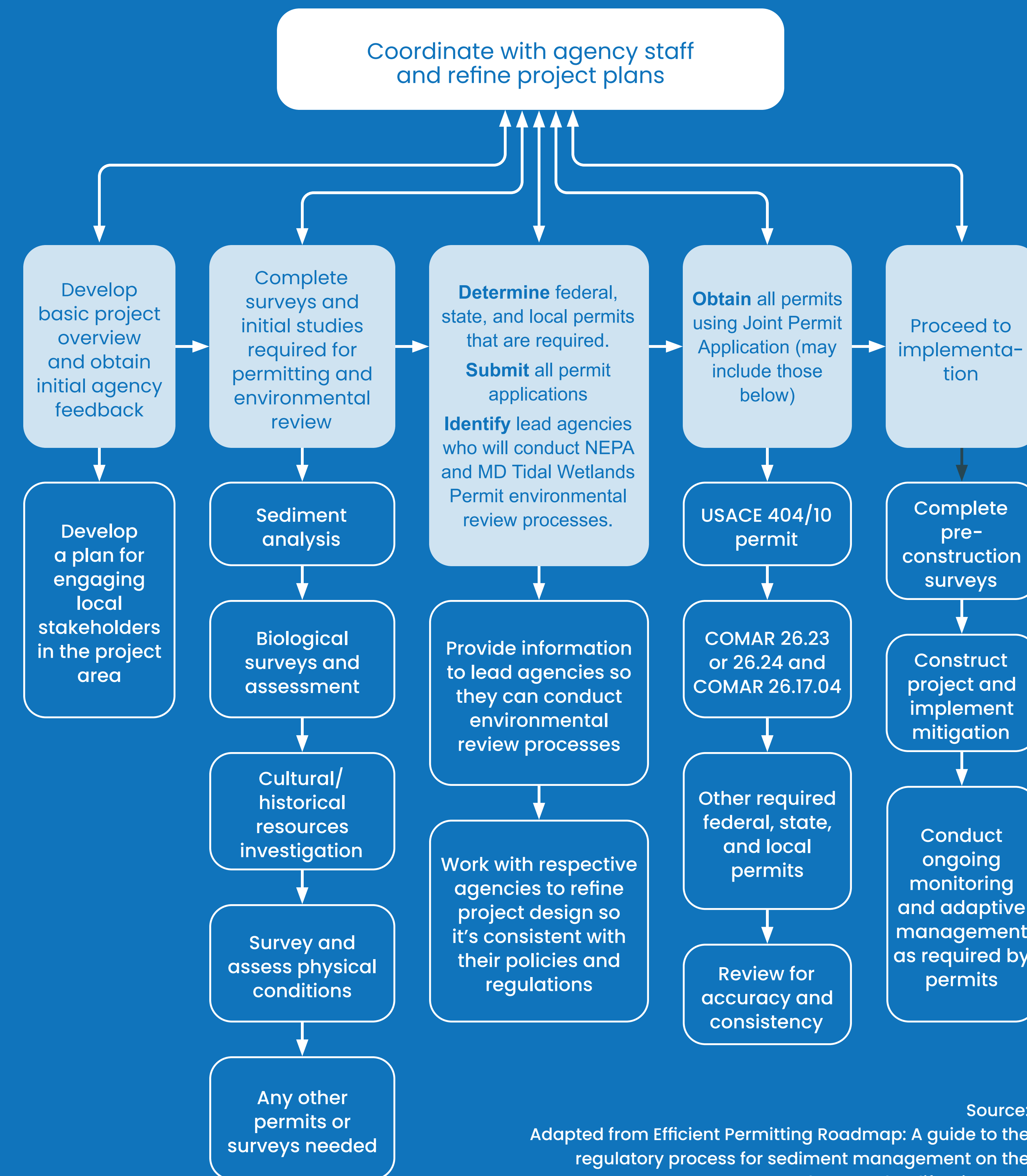
MDE + USACE
Joint Federal/State Permit Application
Hosts permits submitted through MDE and reviewed by MDE, USACE, and other relevant authorities

MDE
MDE Permitting Website
Has information on the permit, including checklists and pre-application details

In Maryland, federal and state permitting for the alteration of wetlands and waterways is streamlined through the Joint Federal/State Permit Application (JPA), submitted to the Maryland Department of the Environment (MDE) and jointly reviewed by MDE, the U.S. Army Corps of Engineers (USACE), and other relevant authorities such as local planning boards and county agencies. Regulatory agencies also consult with resource agencies to ensure environmental, ecological, and public interest considerations are addressed.

The process should begin with sound site selection based on ecological need, physical suitability, and long-term viability. Poor site justification can delay or derail approval. Early reconnaissance, including biological surveys, helps differentiate viable locations. After site selection, project teams should define clear goals and develop monitoring and adaptive management plans, which are increasingly expected in permit applications.

The JPA—which has tidal and non-tidal versions—requires plan views showing water depths, parcel boundaries, structure and channel dimensions, and a dredged material management plan. Applicants may also need to notify and obtain signatures from adjoining riparian property owners.Coordination with agency staff helps refine plans and avoid delays. Pre-application meetings clarify requirements and surface concerns early. A well-prepared application with strong site justification, clear goals, and adaptive strategies is more likely to gain approval.



Source:
Adapted from Efficient Permitting Roadmap: A guide to the regulatory process for sediment management on the north-central California coast

REGULATORY PATHWAYS

The speed and ease of permitting depend on how well the project aligns with Maryland's standards, including vegetation cover goals, target elevations, and sea level rise projections.

RESOURCES

MDDNR
Shore Erosion Control
Describes existing project types within the erosion control program.

MDE
Ecological Restoration Permitting Study Report
Outlines potential updates to enhance and streamline the existing permitting structure for ecological restoration in Maryland.

Factors that drive the timelines and ease of permitting include whether the project adheres to existing paradigms within the shoreline erosion control program (project types include living shorelines, revetments, and replacement of existing bulkheads).

Some MDE guidelines include:

+ Projects should aim to achieve 85% vegetation cover of new and restored marshland by planting native species.

+ Target elevations for the marsh should be within 1.5x the local tidal range above mean low water (MLW).

+ Projects may consider sea level rise when determining target elevations; as of 2025, projects targeting sea level projections up to 2050 may be accepted.

A recent study by the MDE recommends updating the regulatory landscape surrounding ecological restoration and permitting in Maryland. The study recommended updates across eight focus areas:

1. Define ecological restoration in Maryland
2. Refine the permit application and decision process
3. Establish a regular evaluation of regulations
4. Identified continued education needs
5. Ensure permits are issued in a timely manner
6. Develop a holistic review of permits
7. Recommend changes to statutes and regulations
8. Identify any resource needs

The full list of recommendations and details can be found in the 2024 Ecological Restoration Study Report, located on the **MDE website.**

PROCUREMENT OPTIONS

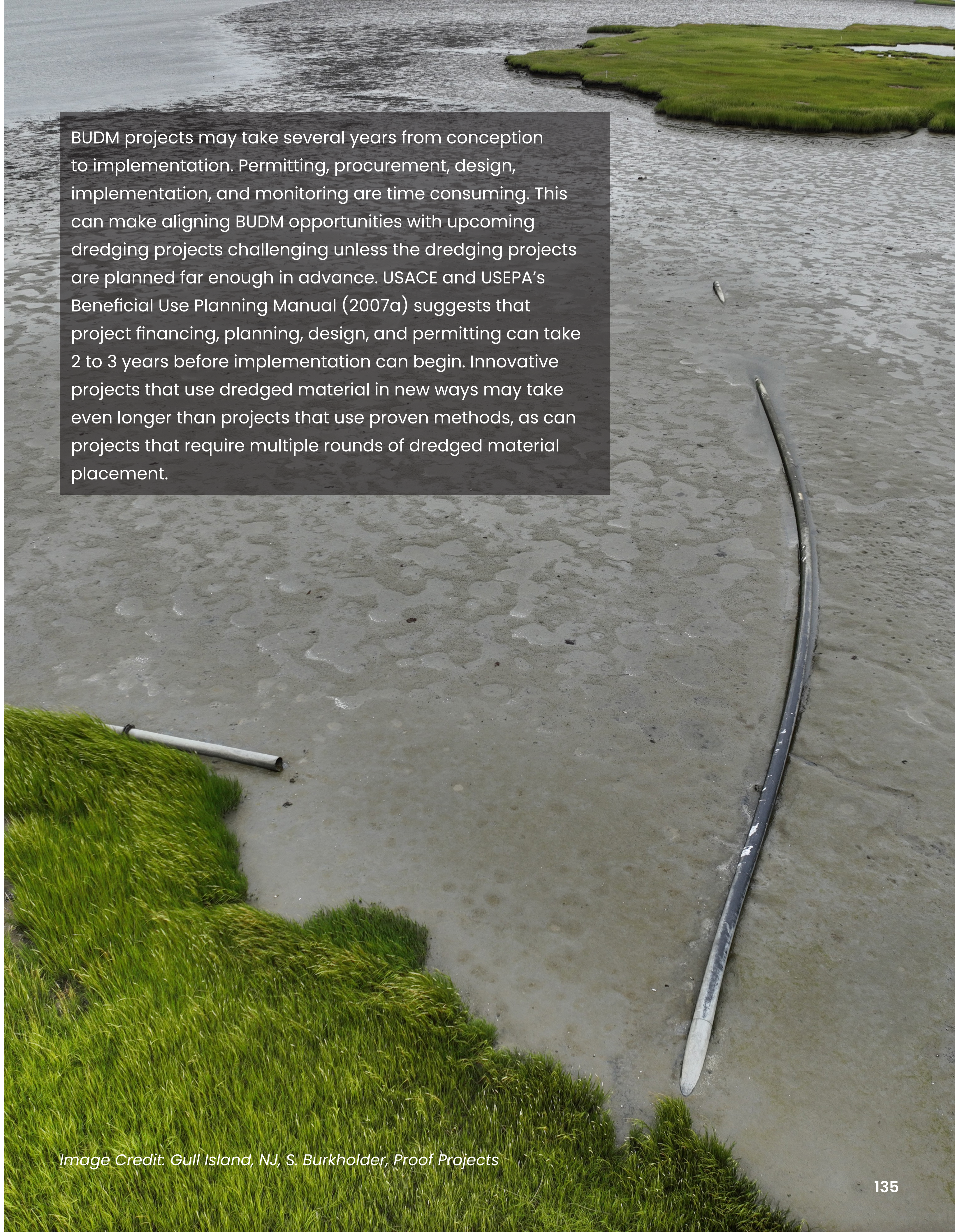
Beneficial use projects take several years from conception to implementation, though exact timelines vary.

Procuring contractors to implement engineering design and construction is an important step in the BUDM process. If a project in Maryland uses state funds, contractor procurement is subject to the regulations in the State of Maryland Procurement Manual. If funding sources are not subject to these regulations, contractors may be selected through various acquisition strategies. For example, a low-bid approach—known by the U.S. Army Corps of Engineers (USACE) as an Invitation for Bid (IFB)—selects the contractor offering the lowest price among responsive and responsible bidders. A best value approach—such as USACE's Request for Proposal-Best Value Trade-Off—considers both price and non-price factors (e.g., technical approach, past performance, and relevant experience) to identify the proposal that offers the optimal overall value to the project.

State and local agencies may use similar or different terminology and evaluation processes when applying these strategies. If a project in Maryland uses state funds, contractor procurement is subject to the regulations in the State of Maryland Procurement Manual. Dredging and material placement services can be procured separately or combined. Each approach has its pros and cons; procuring separately requires extensive and effective communication and collaboration between partners but can allow project managers to select contractors with specialized experience in dredging or restoration.

RESOURCES

State of Maryland
Procurement Manual
Regulations if a project in Maryland uses state funds.



BUDM projects may take several years from conception to implementation. Permitting, procurement, design, implementation, and monitoring are time consuming. This can make aligning BUDM opportunities with upcoming dredging projects challenging unless the dredging projects are planned far enough in advance. USACE and USEPA's Beneficial Use Planning Manual (2007a) suggests that project financing, planning, design, and permitting can take 2 to 3 years before implementation can begin. Innovative projects that use dredged material in new ways may take even longer than projects that use proven methods, as can projects that require multiple rounds of dredged material placement.

Image Credit: Gull Island, NJ, S. Burkholder, Proof Projects

TIMELINE

FORT SMALLWOOD PARK,
ANNE ARUNDEL COUNTY, MD

Fort Smallwood Park, in Anne Arundel County, Maryland, Fort Smallwood Park is a living shoreline project that included a small amount of dredged material.

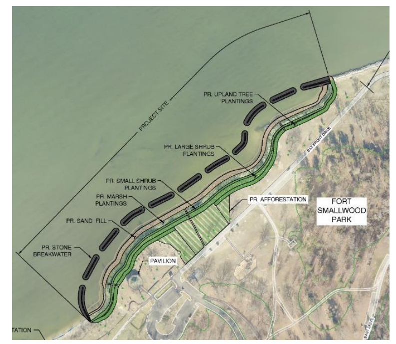
PROJECT TEAM:
Anne Arundel County Department of Public Works (DPW), Anne Arundel County Parks and Rec, Shoreline Design LLC, Bayland Consulting

Phase 0

DESIGN, PERMITTING, FINANCING

began in 2007, with a shoreline evaluation report by Anne Arundel County recommending design approaches, permitting in 2017, went to bid in 2018): 2007-2018

Phase 1

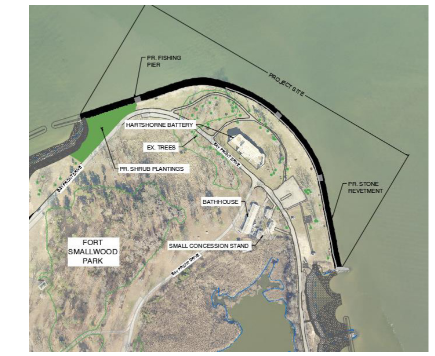


Shoreline armoring with stone breakwaters, sandy dredged material fill, and vegetation planting on northwestern shore of park in 2019

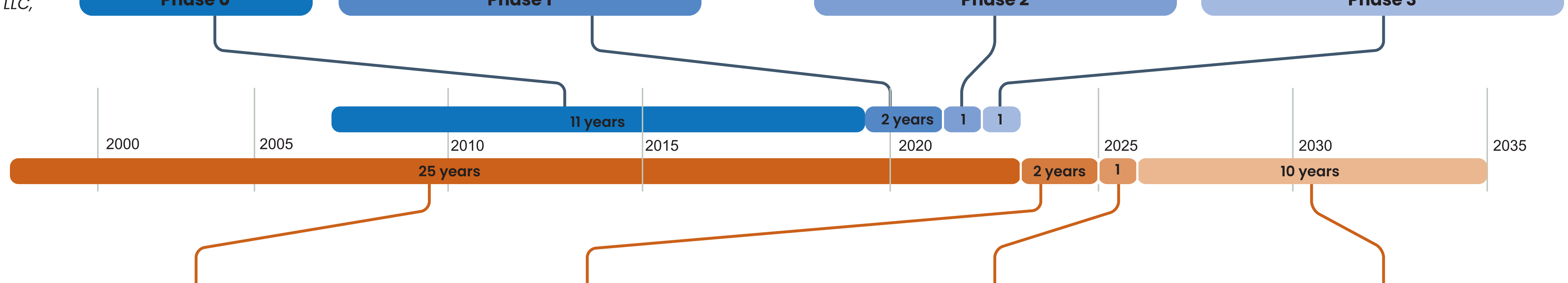
Phase 2

Headland breakwaters, beach nourishment, and vegetation planting on eastern shore of park in 2021

Phase 3



Stone revetment shoreline armoring on northern shore of park in 2021-2022



BARREN ISLAND
DORCHESTER COUNTY, MD

Barren Island, a much larger project that will receive multiple rounds of dredged material placement, is expected to take up to 40 years to complete.

PROJECT TEAM:
MPA, USACE, USFWS, the National Aquarium, Friends of Blackwater, SeaCoast Marine Construction Inc.

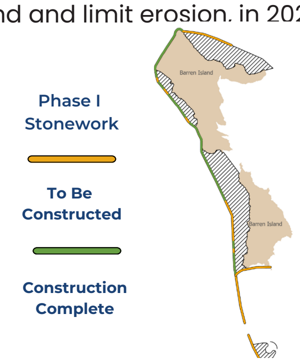
Phase 0

DESIGN, PERMITTING, FINANCING

- 1997-2009: feasibility (study) phase
- 2009-2018: Chief's report and authorization
- 2022: Permitting and environmental assessment reporting
- 2018-2022: design and project partnership

Phase 1

Large rock sills laid out, or improvements made to existing sills, to create footprint of future island and limit erosion, in 2022-2024

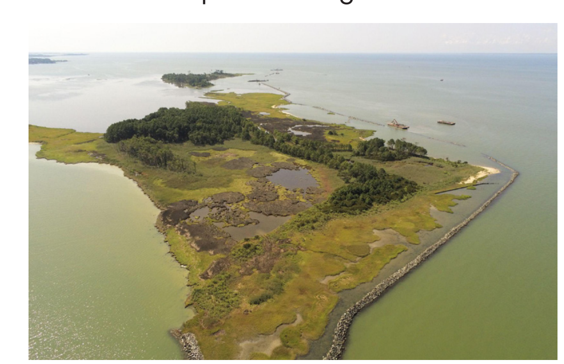


Phase 2

Proposed wetland areas filled-in using dredged material from a shallow-draft channel in the Honga River to the east, additional sill work, began in 2024

Phase 3

Continued site development, monitoring, and adaptive management



PERFORMANCE SPECIFICATIONS

Performance-based specs, along with monitoring and adaptive management, add flexibility and space for corrective action to project designs.

Performance-based specifications, sometimes called performance specs or performance standards, are targets that relate to monitoring and performance of a site over time, often as part of an adaptive management strategy. Performance-based specs are standard in compensatory mitigation projects, where they are often required by law, but they can also be used to guide non-compensatory projects. If performance-based specs are not met during a specified period, corrective action is taken that may involve replanting vegetation, placing additional material, or restructuring hydrology. Performance-based specs are typically time bound with specific, quantifiable goals and often include the corrective action to be taken if the target is not met.

RESOURCES

MDE
Ecological Performance Standards and Monitoring Protocol for Nontidal Wetland Mitigation Sites in Maryland
Provides detailed guidance on ecological performance standards in nontidal wetland mitigation sites in MD that require compensatory mitigation. While this guidance was developed for nontidal systems, it includes examples and context for the types of ecological targets that wetland creation and restoration projects in the Chesapeake could use as performance-based design specs.

PERFORMANCE SPECIFICATIONS FROM WETLAND CREATION AND RESTORATION PROJECTS.

Location/Project	Year	Size	Performance-based specifications
Alabama salt marsh creation	1985	40 acres	75% survival of planted *Juncus roemerianus*, or 4,800 plants per acre, after 3 growing seasons
Maryland forested wetland restoration	1996	850 linear feet of stream bank	85% of site vegetated by the planted species and/or naturally regenerated vegetation approved by regulatory agencies after 5 years
Florida wetland creation (1991)	1991	21.9 acres	Sustain 85% or greater cover by wetland plant species; less than 10% cover by nuisance plant species; and proper hydrological conditions after 5 years. Requires contingency plan if not on track to meet standards at 3 years.
Maryland wetland creation	1990	5.75 acres	85% areal cover by planted herbaceous species and 75% areal cover by planted woody species; no open water ponding; after 2 years
Illinois wetland creation and enhancement	1995	1.47 acres restored; 30.68 acres created	80% survival of planted stock each year; at least 50% native perennials by the end of year 5; along with detailed annual targets for percent cover requirements based on plant community (wet-mesic meadow, shallow marsh, and reference unplanted area)
New Jersey salt marsh creation	1980	28.2 acres	Permanently vegetated stand (*Spartina alterniflora*) over 85% of disturbed area after first growing season (dead plants must be replaced); documentation of saturated soil and tidal hydrology; no *Phragmites*; documentation of "animal use" for portion of site
Alaska wetland restoration	1997	19 acres	No less than 33% of natural stem densities found in adjacent areas after 1 year
Texas wetland creation	1997	54 acres	Must meet the regulatory definition of wetlands, monitored indefinitely until performance standard is met and verified by USACE
Virginia forested wetland restoration and creation	1995	27.4 acres	Hydrology must meet wetland definition (1987 USACE Wetland Manual); at least 50% of woody vegetation must be facultative wetland species at stem count of 400 per acre or canopy cover of 30% or greater; at least 50% of herbaceous vegetation must be facultative wetland species with aerial cover of at least 50% in emergent wetland areas

Note that performance standards may have changed since the execution of the above projects, which represent examples of the types of performance standards used in the past.

Source: *Adapted from Appendix E of Compensating for Wetland Losses Under the Clean Water Act (2001) by National Research Council*

SEDIMENT CHARACTERISTICS

Material dredged from the Chesapeake is fine-grained, but the majority of marsh restoration projects require some proportion of coarse-grained material.

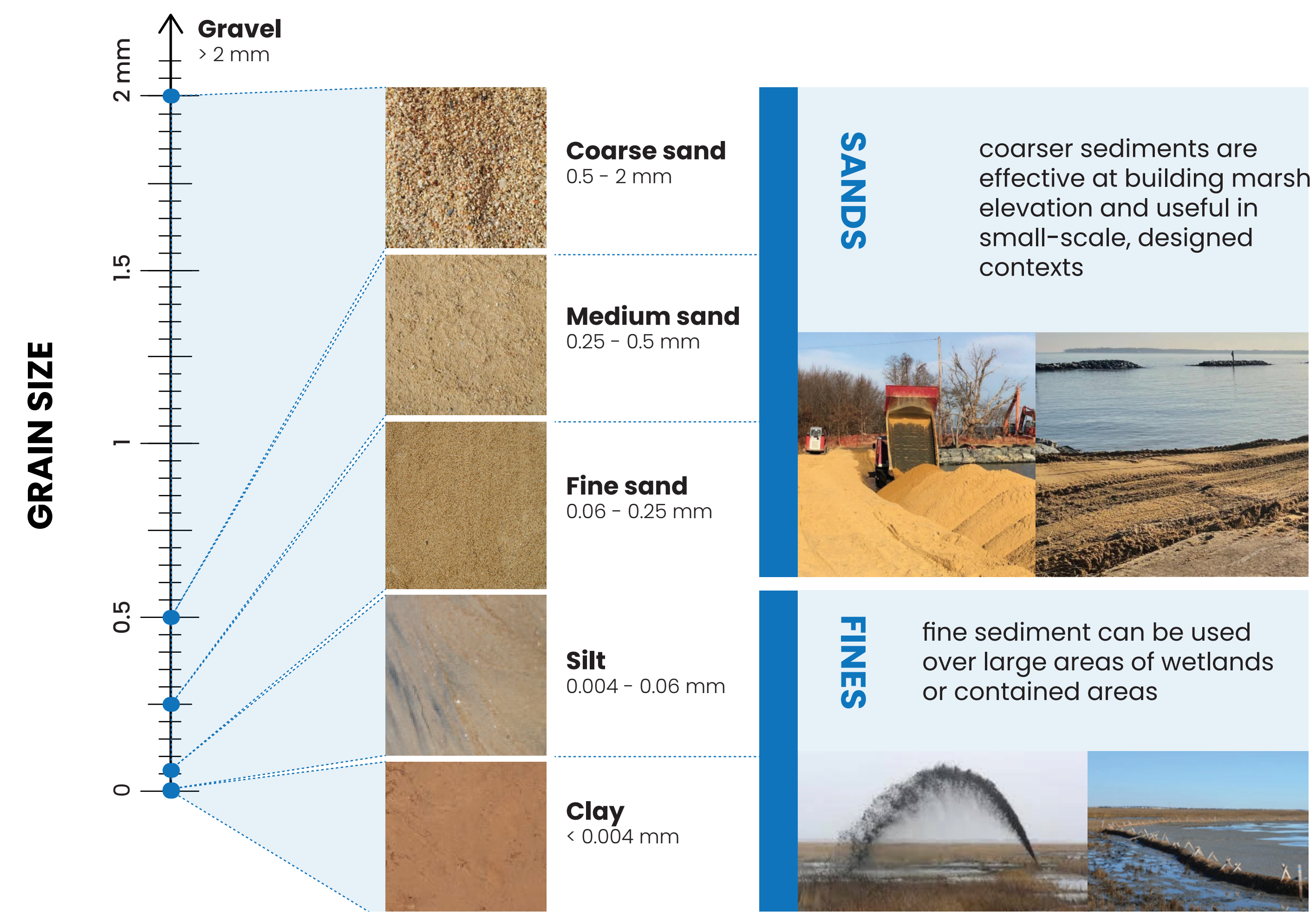
Fine-grained dredged sediments, silts and clays, have historically been viewed as more challenging to use due to perceptions of greater dispersal risk and the difficulty of contouring compared to sand. However, recent USACE field experience, including unconfined thin-layer placements at the Seven Mile Island Innovation Laboratory (SMIIL), has shown that in suitable hydrodynamic settings, fine-grained materials can successfully build and sustain marsh elevation while promoting natural consolidation and vegetation establishment. In many cases, these sediments integrate more seamlessly with existing marsh soils than sand, supporting plant colonization and enhancing habitat quality over time (Chasten et al., 2022).

Sand remains a valuable material for certain objectives, such as rapid elevation gains or high-energy settings where coarser material is needed for stability. However, fine-grained material can offer unique advantages: its ability to spread across a marsh surface can help achieve uniform elevation targets, improve water retention, and support a wider range of plant communities. The decision to use fine-grained or sandy dredged material, or a mix, should be guided by project-specific objectives, site energy regime, and hydrology.

Other sediment properties, like moisture content, bulk density, specific gravity, particle size distribution, Atterberg limits, soil classification, and resistance to penetration, also inform placement methods, expected consolidation rates, and containment needs. The growing body of research and field demonstrations highlights the importance of evaluating fine-grained sediments as a valuable resource for wetland restoration, rather than a liability, and incorporating them into design strategies where they can provide long-term ecological and geomorphic benefits (Raposa et al., 2022; Correll et al., 2024).

MARYLAND

In many states, including Maryland, only material that is less than 10% fines is deemed suitable for construction by permitting agencies.



Coordination

OPERATIONAL CONTROLS

Successful beneficial use projects require early consideration of a wide range of site-level, logistic details such as existing habitat, land ownership, potential hazards at the site, dredged material availability and volume.

RESOURCES

USACE
[Guidelines for how to approach thin layer placement projects]

Includes a page on safety, which mention the following hazards and reduction practices

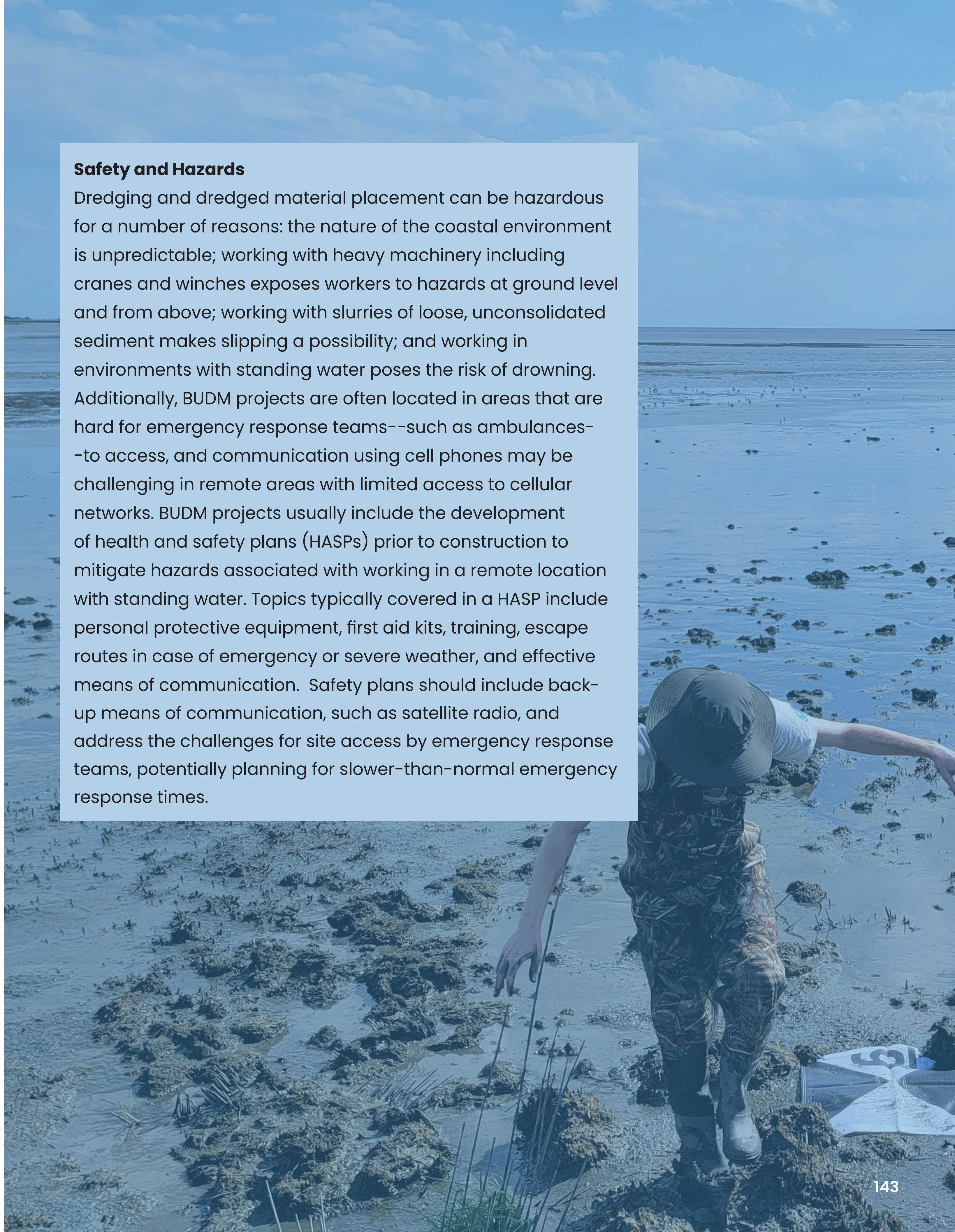
USACE
[Safety and Health Requirements Manual]

More general USACE Safety Guidelines

Logistics

Site-level considerations during the design phase can include the proximity of available dredged material to the site; sensitive habitats in the project vicinity; property ownership and access; on site infrastructure such as roads and transmission lines; shipping channels; military installations; unexploded ordinance and other navigational hazards; cultural and historic resources such as shipwrecks; and stakeholder interest and community buy-in or opposition.

Logistical considerations may also affect decisions about dredging and transporting material. Which transport option is most cost effective will depend on how far from the placement site the material is dredged. Material volume also affects project decision-making. If millions of cubic yards of material will be dredged, the material may be better placed in a large-scale beneficial use of dredged material (BUDM) placement site like as an island than used to increase the elevation of a small area of wetland (USEPA & USACE, 2007). Early consideration of these, and other, logistical details can guide projects toward effective and successful use of dredged material.



Safety and Hazards

Dredging and dredged material placement can be hazardous for a number of reasons: the nature of the coastal environment is unpredictable; working with heavy machinery including cranes and winches exposes workers to hazards at ground level and from above; working with slurries of loose, unconsolidated sediment makes slipping a possibility; and working in environments with standing water poses the risk of drowning. Additionally, BUDM projects are often located in areas that are hard for emergency response teams--such as ambulances--to access, and communication using cell phones may be challenging in remote areas with limited access to cellular networks. BUDM projects usually include the development of health and safety plans (HASPs) prior to construction to mitigate hazards associated with working in a remote location with standing water. Topics typically covered in a HASP include personal protective equipment, first aid kits, training, escape routes in case of emergency or severe weather, and effective means of communication. Safety plans should include back-up means of communication, such as satellite radio, and address the challenges for site access by emergency response teams, potentially planning for slower-than-normal emergency response times.

Image Credit: Maurice River, NJ, S. Burkholder, Proof Projects

CONNECTING SITE + SOURCE

When beneficial use projects are financed, designed, permitted, and "shovel-ready" well ahead of nearby dredging, successful implementation is more likely.

RESOURCES

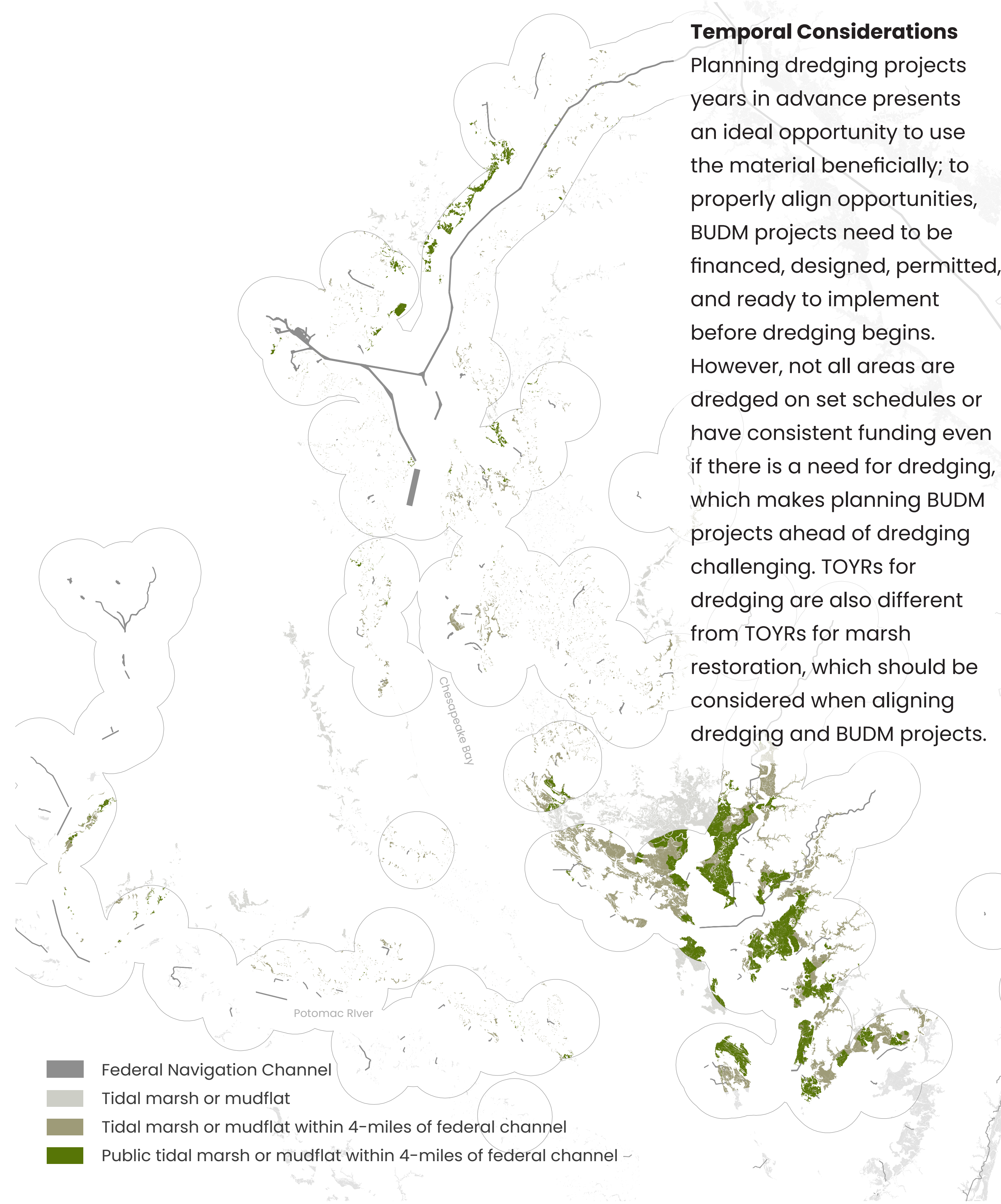
MDDNR
[Maryland BUILD (Beneficial Use: Identifying Locations for Dredge)]

An ArcGIS tool available as a layer in the Maryland Coastal Atlas

Spatial Considerations
As the distance between dredging and beneficial use sites increases, so do costs—often dramatically. While many BUDM projects are located within 5 to 6 miles of a dredging site, longer transport distances can quickly become cost-prohibitive. In some cases, hauling dredged material even a few additional miles can escalate expenses to the point that restoration projects become infeasible, regardless of the ecological value or availability of suitable sediment. This is particularly true when neither the dredging location nor the potential BUDM site is near a confined disposal facility, making sediment transport one of the most significant cost drivers in project planning. Proximity alone, however, does not guarantee feasibility—some sites located near federal channels may not currently require sediment, underscoring the need to align timing, need, and opportunity.

Dredged material quantity and characteristics vary greatly. Quantity can depend on the type of dredging project and the size and maintenance needs (shoal development, dredging frequency) of the location to be dredged. If the material comes from a large, federally managed channel, a large-scale BUDM site, like Barren Island, designed to receive multiple placements over long time frames may be required. Dredging projects in recreational waterways or marinas that generate relatively small quantities of material may be better matched to smaller scale BUDM projects and one-time material applications.

Temporal Considerations
Planning dredging projects years in advance presents an ideal opportunity to use the material beneficially; to properly align opportunities, BUDM projects need to be financed, designed, permitted, and ready to implement before dredging begins. However, not all areas are dredged on set schedules or have consistent funding even if there is a need for dredging, which makes planning BUDM projects ahead of dredging challenging. TOYRs for dredging are also different from TOYRs for marsh restoration, which should be considered when aligning dredging and BUDM projects.



5 PROJECT DEVELOP- MENT

Funding Partnerships

Project development outlines preliminary steps for initiating a successful sediment-based restoration or beneficial use effort. Early decisions around funding and partnerships can significantly influence a project's trajectory, shaping what is possible in both scope and scale.

FUNDING OPPORTUNITIES

Legend:
Dredging
Beneficial Use

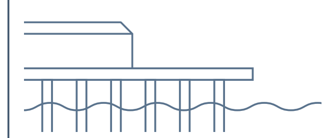
Format:
Opportunity
Project Stage

The speed and ease of permitting depend on how well the project aligns with Maryland's standards, including vegetation cover goals, target elevations, and sea level rise projections.

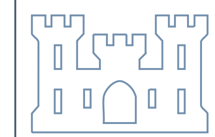
Funding for BUDM projects can come from a variety of sources. In some cases, the dredging and the material placement aspects of a project are funded differently. Many projects involving USACE are funded through federal cost-share, described in the regulatory chapter. Non-federal sponsors and project managers on non-federal dredging projects may obtain funding from grants, loans, special tax districts, local funds, and more. Grants, loans, and other funding sources may be geared toward dredging and navigation improvements, community resilience and restoration, or both. Several successful projects have been funded through special federal programs aimed at disaster relief.

The amount of total funding available within each funding source is variable, depending on legislative decisions, budget considerations, and other economic factors. For example, the Waterway Improvement Fund, available to public jurisdictions with dredging and other boating access needs, is sourced through a statewide excise tax on new boat purchases. The amount of funding available therefore varies considerably from year to year depending on excise tax revenue

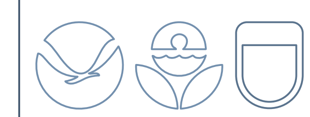
MD Coastal Resilience Program
Dredging Beneficial Use



MD Waterway Improvement Fund
Dredging Beneficial Use



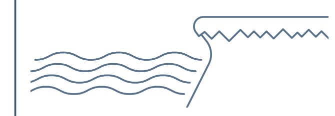
USACE Federal Cost-share
Dredging Beneficial Use



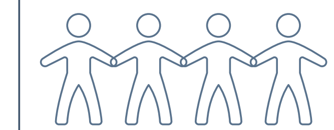
Non-USACE Federal funding: NOAA (CZM), EPA, USFWS
Dredging Beneficial Use

Special tax districts
Dredging (mainly)
Beneficial Use (possibly)

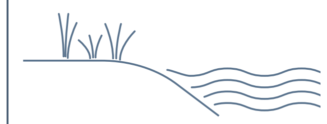
Local funds (community, county, township, etc.)
Dredging Beneficial Use



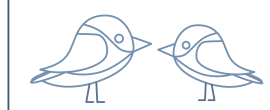
Shoreline Erosion Loan Program
Dredging Beneficial Use



Community Resiliency Grant Program
Beneficial Use (specifically living shorelines)



Resiliency through Restoration Initiative
Beneficial Use



Competitive state wildlife grants
Beneficial Use

Special federal programs for disaster relief (i.e. Hurricane Sandy, Deepwater Horizon)
Beneficial Use

Other
Potentially other unlisted or yet unknown opportunities

RESOURCES

MDDNR
Grants Gateway

Provides detailed information on availability of Maryland state funding programs and their applicability to various projects.

BUDM PROJECT COST

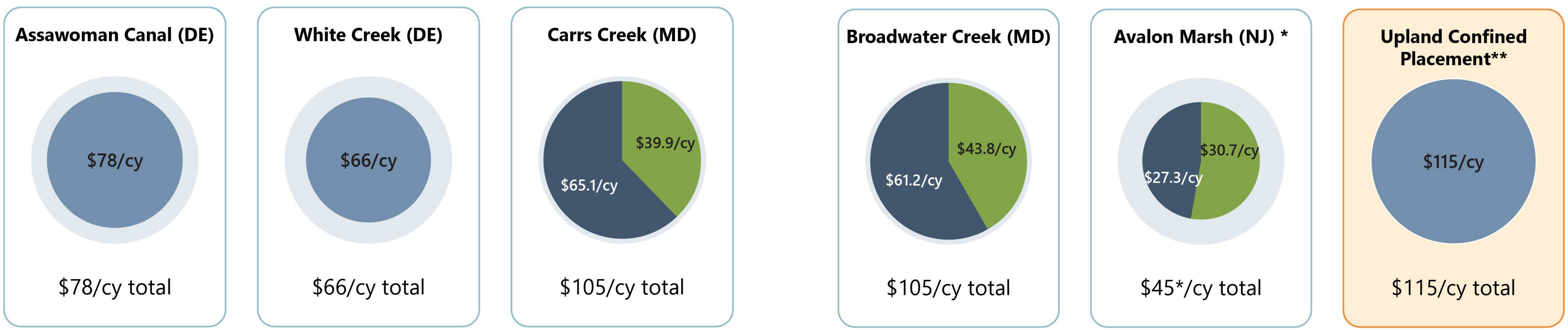
Beneficial use project costs vary widely and depend on volume of material, timelines, and techniques used.

The costs of BUDM projects vary widely and may be higher or lower than traditional placement methods depending on such factors as project location, regulatory context, sediment transport logistics, and placement techniques employed. New, innovative placement techniques that require extensive modeling, development, and monitoring may cost more than proven methods.

Despite their sometimes-higher costs, BUDM projects can become more cost-efficient over time as techniques are refined and replicated. The need for shoreline armoring, compensatory mitigation, and other factors can significantly affect a project's total cost. Although innovative BUDM applications may have higher initial costs, they offer long term ecological and economic benefits such as reduced disposal costs, shoreline stabilization benefits, and ecosystem service enhancements. Additionally, BUDM sites are sustainable, allowing repeated placement of material, unlike upland disposal sites that have a finite capacity. Once an upland site is filled, it necessitates constructing a new facility, a costly process that consumes additional space and resources.

MARYLAND

Cost estimates from projects in the design phase in Anne Arundel County, Maryland, range from 80% to 90% of traditional placement because of a combination of regulatory and technical factors. The Anne Arundel County projects will employ well-understood methods to enhance marsh elevations, and the traditional disposal alternative for Maryland is placement in a confined disposal facility, which is costlier than overboard placement.



Cost breakdown unavailable | Cost for placement | Cost for dredging

* Sourced from TNC, 2021.
** Sourced from Baylands, Inc., 2023.
Costs not adjusted for inflation

POTENTIAL PARTNERS

Potential Project Partners for Maryland Beneficial Use (non-exhaustive)

Agency (Federal, state, county, etc.)

Roles may involve permitting, review, funding, monitoring, design, implementation, etc.

FEDERAL

- USACE Baltimore District
- United States Geological Survey (USGS)
- U.S. Fish and Wildlife Service (USFWS)
- National Oceanic and Atmospheric Administration (NOAA)
- Environmental Protection Agency (EPA)
- National Park Service (NPS)
- U.S. Department of Defense

STATE

- Maryland Department of Natural Resources (MDDNR)
- Maryland Port Administration (MPA)
- Maryland Department of the Environment (MDE)

COUNTIES, COUNTY AGENCIES, TRIBES, AND LOCAL TOWNSHIPS

Non-Profit

Roles may involve funding, monitoring, implementation, design, etc.

ORGANIZATIONS

- The Nature Conservancy (TNC)
- Ducks Unlimited
- Audubon Mid-Atlantic
- American Shore & Beach Preservation Association
- The National Aquarium
- Maryland Coastal Bays Program
- Chesapeake Bay Program
- Chesapeake Bay Trust
- The Conservation Fund
- World Wildlife Fund
- Chesapeake Conservancy
- Alliance for the Bay
- Local nonprofits and conservancies

Academic

Roles may involve monitoring, research, design, ect.

LOCAL AND REGIONAL UNIVERSITIES

- University of Maryland center for Environmental Science (UMCES)
- Virginia Institute of Marine Sciences (VIMS)
- University of Maryland System
- Towson University
- Johns Hopkins University
- Morgan State University
- Howard University
- Salisbury University
- St. Mary's University
- Georgetown University
- Virginia Tech
- George Mason University
- George Washington University
- Other universities

ACADEMIC INSTITUTIONS

- Smithsonian Environmental Research Center
- Other institutions

STRONGER WITH PARTNERS

Large project teams with partners from federal and state agencies, academia, local communities, nonprofit organizations, and private companies collaborated to drive two separate, successful beneficial use projects in southeastern Maryland. Although the team members and their specific roles varied, numerous players took part in design, implementation, monitoring, and more.

Deal Island Marsh Elevation Enhancement

Non-exhaustive list of project partners

FEDERAL AGENCIES
NOAA Fisheries, National Estuarine Research Reserves, USFWS, USACE Baltimore district

STATE + LOCAL AGENCIES
MDDNR, Wicomico County, Somerset County, Deal Island Peninsula Partnership

NON-GOVERNMENT ORGANIZATIONS
Audubon Mid-Atlantic

ACADEMIC INSTITUTIONS
University of Maryland, UMCES, U.S. Naval Academy

CONTRACTORS
Cottrell Contracting Corporation, Sustainable Science LLC, Ecological Restoration and Management

The 70-acre project at Deal Island Wildlife Management Unit involved a very large project team and a detailed monitoring plan that included various roles for different organizations depending on their strengths. Through extensive collaboration, the Deal Island project successfully raised the marsh surface to target elevations and positively engaged the local community.

Project partners played multiple roles leading to one cohesive BUDM effort. USACE carried out dredging and material placement, coordination and outreach with local stakeholders and community groups, and monitoring for ecological and hydrological impacts. The Deal Island Peninsula Partnership, a community engagement group that includes the University of Maryland, the Chesapeake Bay National Estuarine Research Reserve-Maryland, state and county officials, local stakeholders, and community group, carried out sociological research on community attitudes during the project. Audubon coordinated a multi-partner monitoring team to monitor ecological impacts.

Blackwater National Wildlife Refuge Marsh Elevation Enhancement

Non-exhaustive list of project partners

FEDERAL AGENCIES
USFWS, USGS, USACE Baltimore district

NON-GOVERNMENT ORGANIZATIONS
The Conservation Fund, Audubon Maryland-DC, National Fish and Wildlife Foundation, Town Creek Foundation, the National Aquarium, Friends of Blackwater National Wildlife Refuge

CONTRACTORS
Sustainable Science LLC, Dredge America, Ecological Restoration and Management, Geo-Technology Associates Inc.

The 40-acre marsh elevation enhancement project at Blackwater National Wildlife Refuge was the first project of its kind in the Chesapeake region. The goals of the project were to increase the resiliency of the tidal marsh by raising the marsh surface elevation, and to provide high quality habitat for salt marsh birds. Considerable monitoring was carried out by partners including the USGS, USFWS, and Audubon MD-DC. Although the project used sediment dredged for the purpose of restoration rather than material dredged for navigation purposes, it can provide lessons to inform BUDM.

The project was part of Blackwater 2100, an initiative to outline a suite of climate adaptation strategies that would ensure the long term persistence of Southern Dorchester County’s tidal marsh ecosystem.

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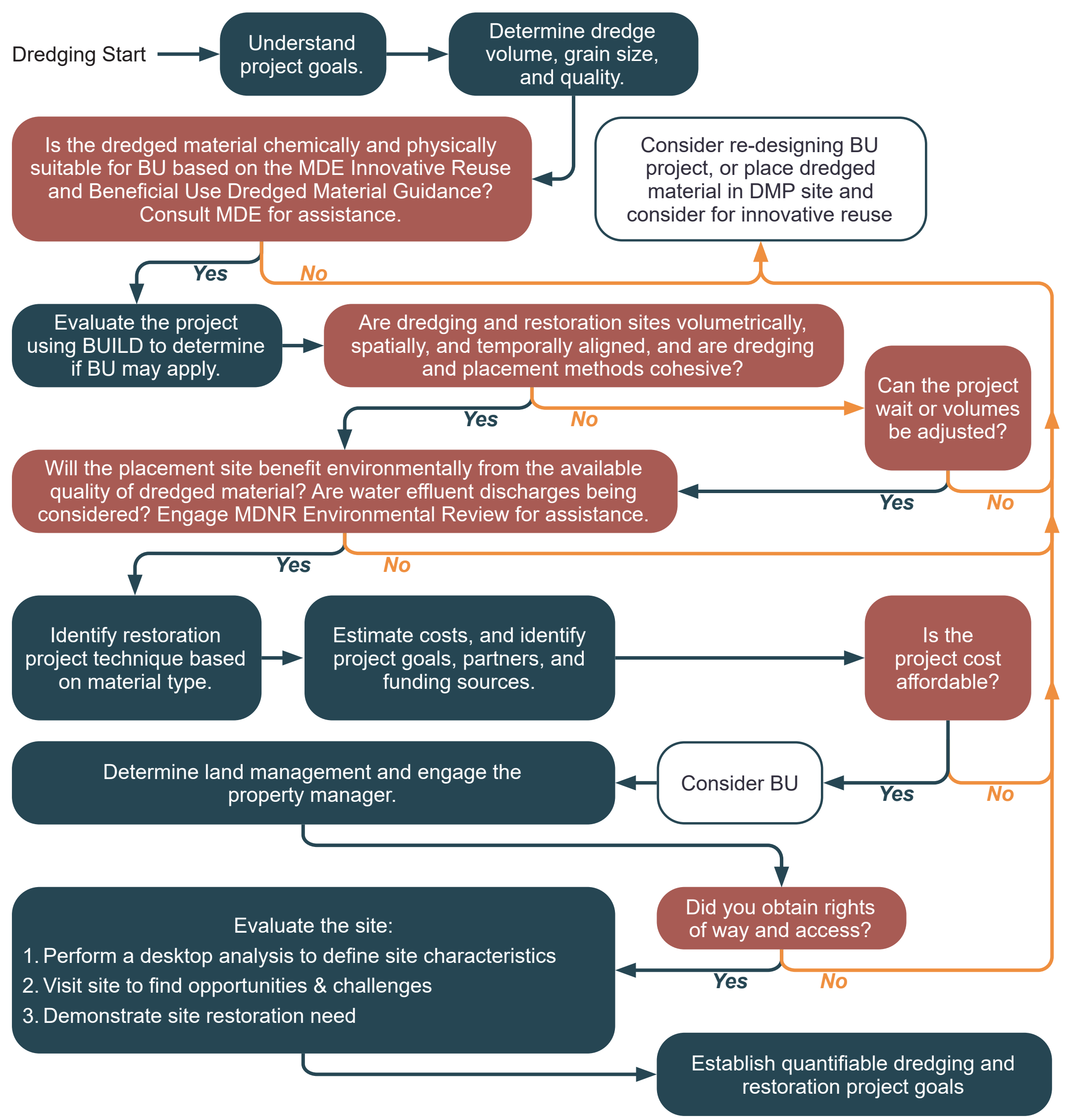
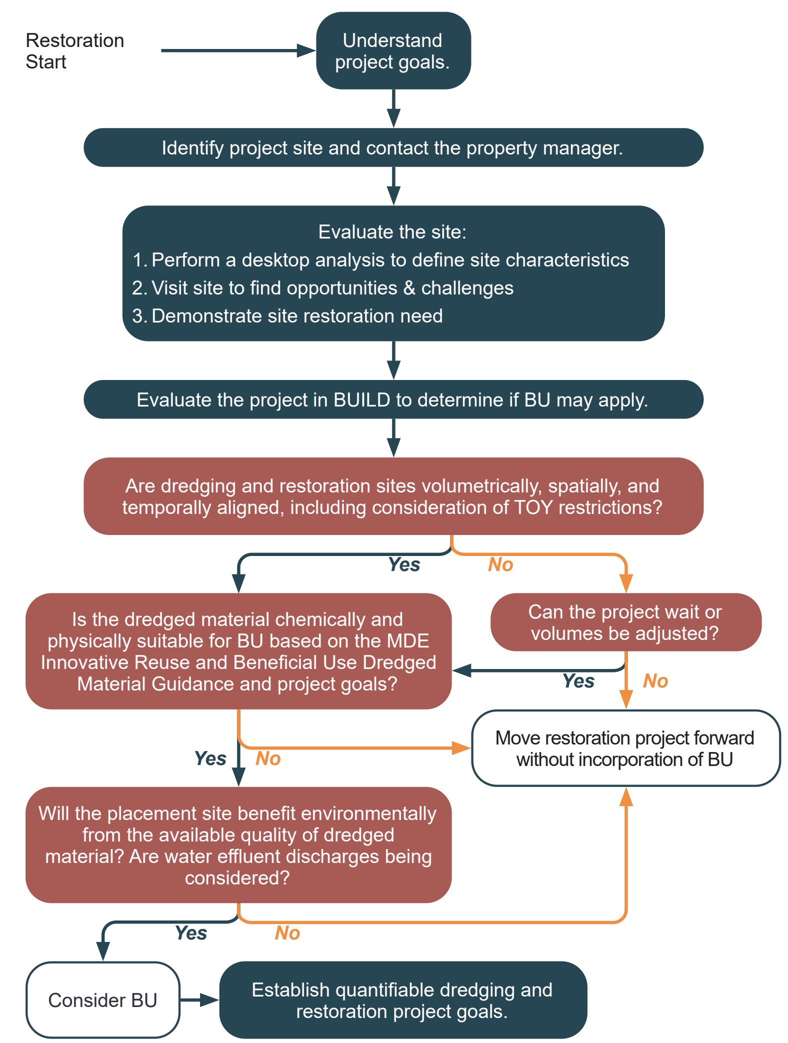
APPENDIX

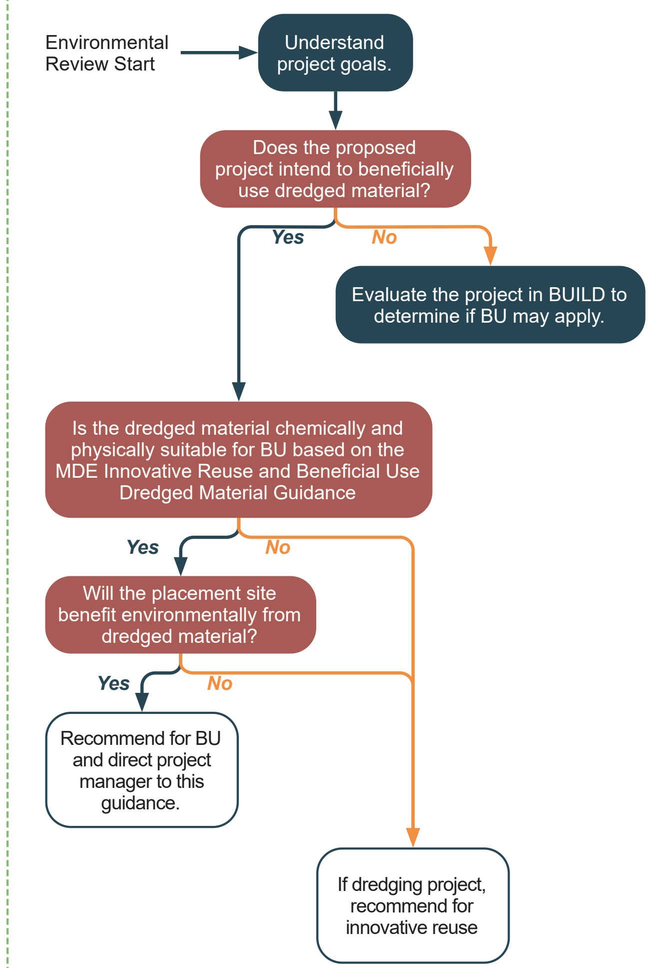
BUDM Planning Process
Data Collection
Containment Details
Containment Materials
Pilot Project Summary

BUDM PLANNING PROCESS

The chart below helps guide whether beneficial use can be considered. This process is intended as a framework for utilizing the beneficial use of dredged material and may not be representative of all projects.





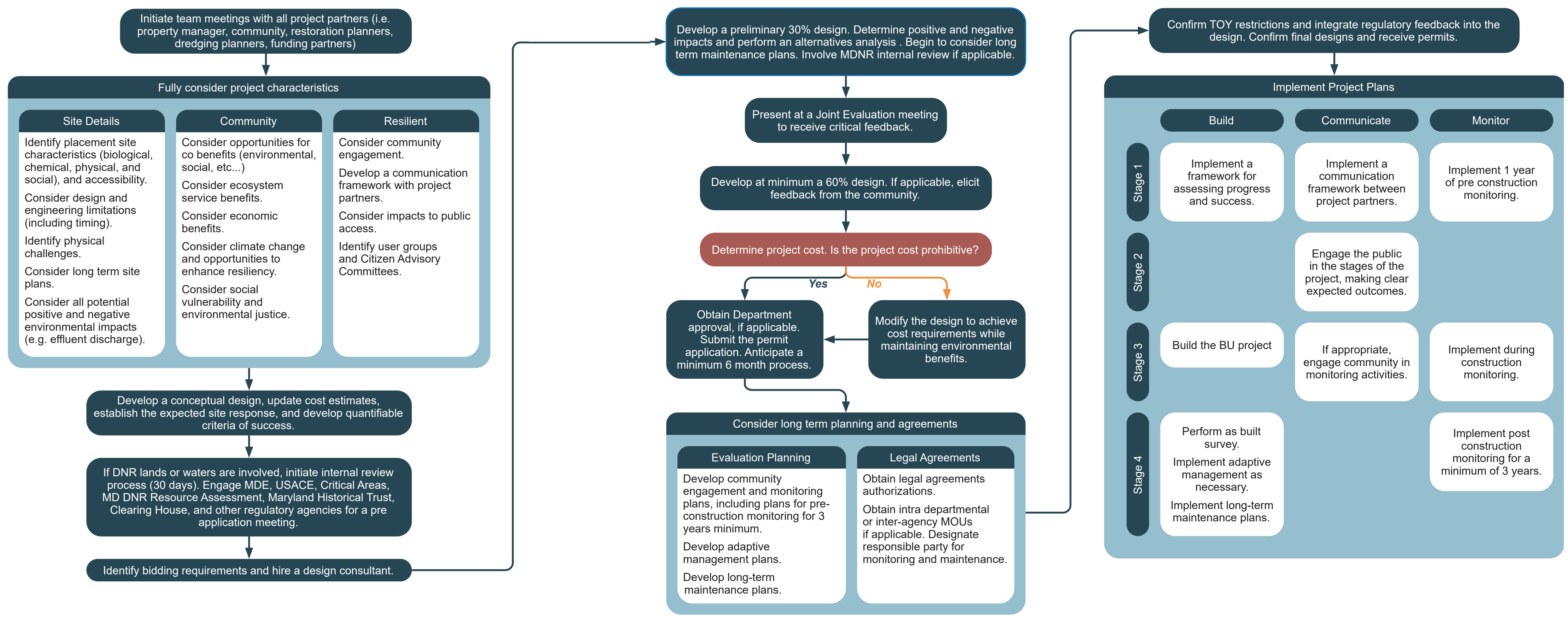


Source: *Adapted from Maryland Department of Natural Resources, 2019, Beneficial Use of Dredged Material Planning Process*

BU - Beneficial Use
BUILD - Beneficial Use: Identifying Locations for Dredge
DMP - Dredged Material Placement
MDE - Maryland Department of the Environment
MD DNR - Maryland Department of Natural Resources
MOU - Memorandum of Understanding

BUDM PLANNING PROCESS

If beneficial use is pursued (see previous page), the next steps are to identify project partners, assess site and material characteristics, develop a conceptual design, estimate project costs, and incorporate regulatory feedback."



Source: *Adapted from Maryland Department of Natural Resources, 2019, Beneficial Use of Dredged Material Planning Process*

BU - Beneficial Use
BUILD - Beneficial Use: Identifying Locations for Dredge
DMP - Dredged Material Placement
MDE - Maryland Department of the Environment
MD DNR - Maryland Department of Natural Resources
MOU - Memorandum of Understanding

DATA COLLECTION

Sediment & Soil Factors

Characteristic
Design Implication

Soil and sediment grain size
Coarse sediments resist erosion; fine sediments may erode or consolidate

Organic content
High organics need placement adjustments; affect bulk density

Bulk density
High density hinders consolidation and plant rooting; impacts equipment support

Moisture content
High moisture causes consolidation; must be measured for design

Consolidation and settling
Critical for predicting elevation changes; affects project timelines and costs

Erosion Potential
Study hydrodynamics; coarser sediments may be needed

Iron Sulfide (FeS) and pH
Requires tidal flow to manage pH and sulfide oxidation impacts

Soil Strength and Bearing Capacity
Check for equipment use; prepare soft soils if needed

Site Hetero-geoentiy
Requires detailed sampling and varied placement strategies

Geomorphology

Characteristic
Design Implication

Geo-morphology of site
Consider sediment interaction with features; affects sediment distribution; drainage may need additional control

Elevation
Determine placement areas based on biological elevation ranges

Placement Design for Shallow Water
Sediment loss/re-distribution expected; plan to minimize ecological disturbance

Survey Accuracy requirements
High precision needed for small tidal ranges or sensitive vegetation; RTK GPS commonly used

Impact of soft bottoms
Select survey methods carefully; may need manual or specialized surveys

Shallow water bathymetry
Essential for site capacity assessment; important for pipelines, access, and containment

Tidal influence on vegetation
Match design to target vegetation elevations; greater precision in microtidal areas

Surveying technique for wetlands
Capture wetland and elevation variability; use SETs to track subsidence and accretion

Geotechnical investigations
Critical for understanding compaction and settling; plan for final site elevation adjustments

Hydrology

Characteristic
Design Implication

Tide ranges and velocity regimes
Placement elevation must match inundation regime; impacts vegetation and sediment stability

Inundation and drainage patterns
Assess slurry containment needs; important for dewatering and consolidation planning

Currents (open water sites)
Critical for sediment fate, erosion, and dispersion

Sediment transport dynamics
May require protection structures; affects placement timing and settlement

Sea level rise considerations
Elevation targets should account for future change

Groundwater interactions (freshwater inflows)
Affects salinity, soil chemistry, and consolidation behavior

Precipitation and drought patterns
Must plan for water balance changes in sensitive or drought-prone areas

Proximity to uplands or barrier features
Can increase groundwater influence on sediment behavior

Reference site analysis
Sets realistic targets for elevation, hydrology, and vegetation recovery

Ecology

Characteristic
Design Implication

Vegetation and Macroalgae
Use imagery and field surveys to map species and transitions; identify sensitive zones and monitor recovery

Submerged Aquatic Vegetation (SAV)
Avoid impacting SAV beds; use turbidity controls like turbidity curtains during placement

Vegetation Metrics
Use biomass (above- and belowground) to measure success; monitor belowground biomass for long-term health

Threatened and Endangered Species
Check databases for protected species; follow timing restrictions and adapt design to protect habitats

Faunal Use (Birds, Nekton, Marine Mammals)
Survey species use; implement seasonal work limits and habitat features to support fauna

Benthic Organisms
Assess before and after placement;use of ponar grabs; design for benthic recovery

Habitat Sensitivity Mapping
Avoid sensitive areas; add buffers to reduce impact

Reference and Control Sites
Set benchmarks using baseline sites; compare post-construction data to validate outcomes

Precipitation and Drought Conditions
Consider climate impacts on hydrology and vegetation; monitor drought-prone areas closely

Source Material

Characteristic
Design Implication

Grain Size Distribution
Affects slurry behavior, sediment stability, and vegetation growth

Wet and Dry Density
Informs slurry density, equipment selection, and settling rates

Organic Content
Impacts consolidation rates and nutrient availability

Porewater salinity
Affects plant species compatibility and ecological design

Potential Contamination
Early testing needed; contamination may disqualify a source

Presence of Debris
Complicates dredging and may delay or increase costs

Sediment Volume
Affects project feasibility and requires planning for large volumes

Dredge Size and Discharge rate
Smaller dredges preferred for precise placement; large dredges need special design

Transport Distance and Method
Longer distances raise pumping costs; transport method must be planned

Dredging and Placement Windows
Regulatory restrictions may limit working seasons; plan early

Other

Characteristic
Design Implication

Land Ownership and Easements
Property searches and access negotiations needed early to avoid conflicts

Easements or Sensitive Habitat
Map easements and critical habitats; may limit activities

Pipelines, Cables, and Utilities
Locate with sonar and magnetometers; avoid during construction

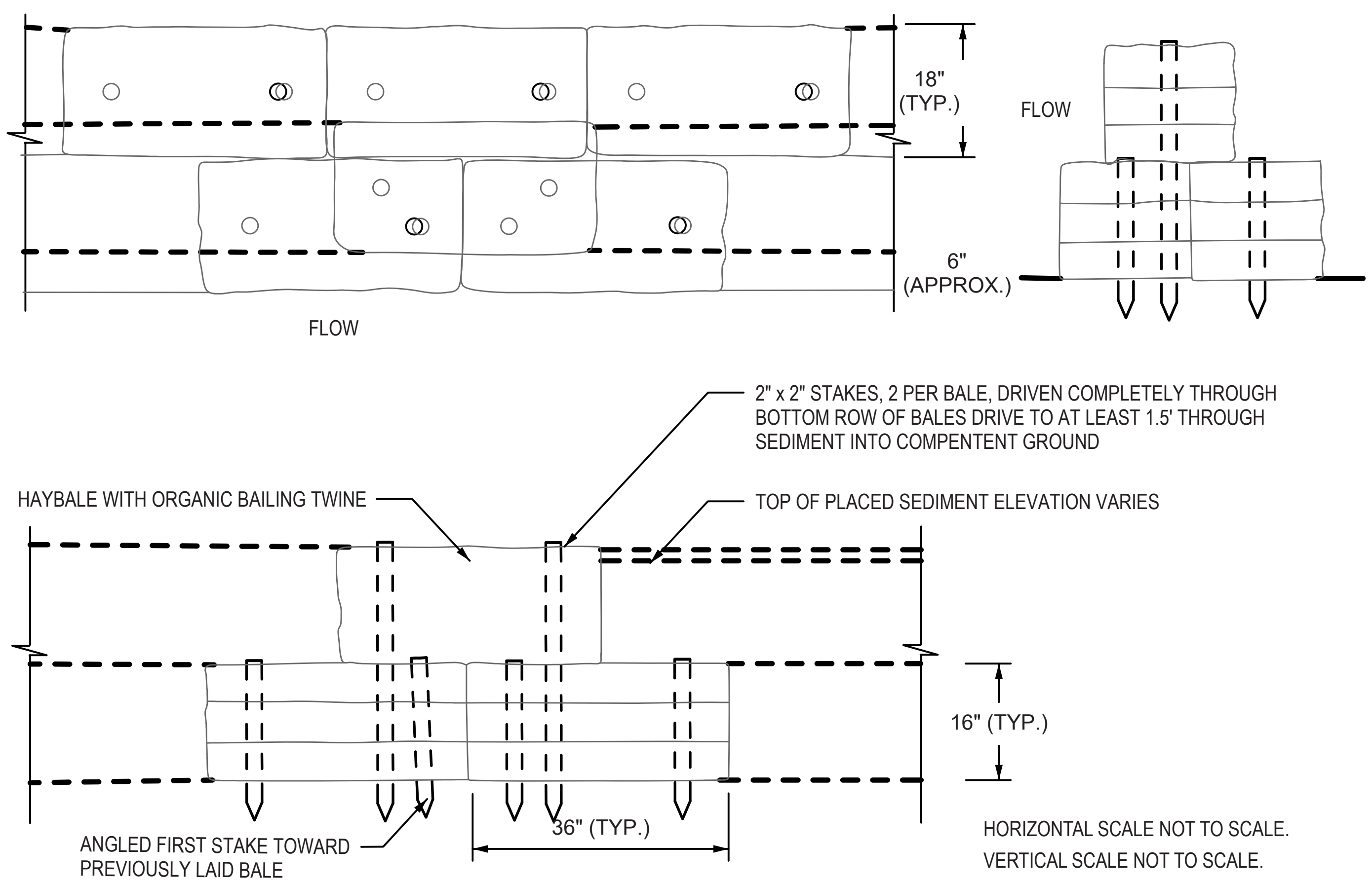
Gas Pipelines
High risk to equipment and personnel; rerouting or protective measures needed

Bathymetry, Magnetometer, and Sonar Surveys
May be required to support CARA and infrastructure mapping before design

Site-Specific Investigations
Needed if suspect features found; adds planning time and cost

HAYBALES

Drainage Channel Block as detailed from Brick Township Restoration project.



1) HAYBALES THAT COMPRISE THE DRAINAGE CHANNEL BLOCK SHALL BE PLACED AS SHOWN ON PLAN VIEW DRAWINGS AND IN A ROW THAT ENDS TIGHTLY ABUTTING THE ADJACENT HAYBALES.

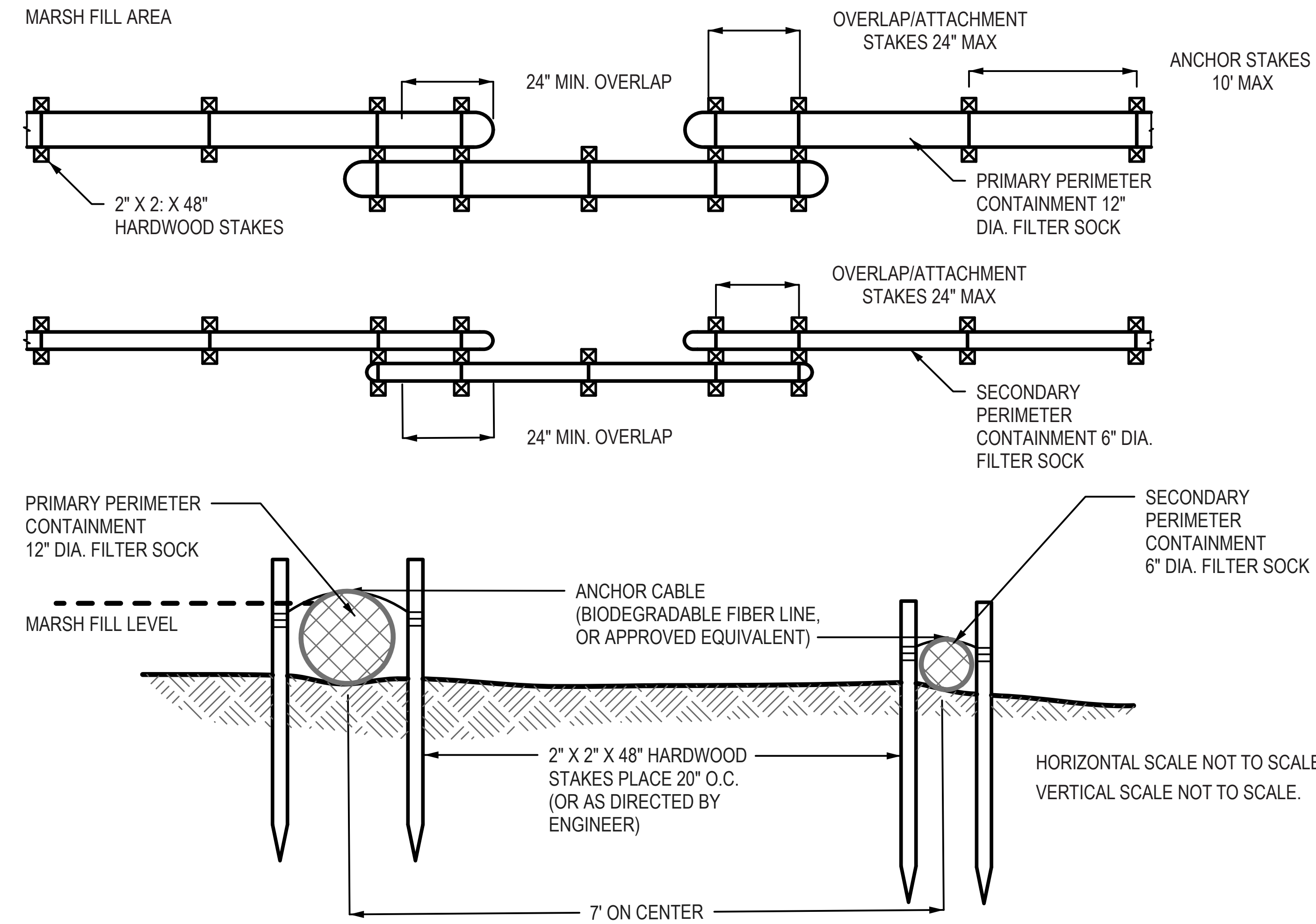
2) EACH HAYBALE SHALL BE PLACED SO THE BINDING ARE HORIZONTAL

3) HAYBALES SHALL BE SECURELY ANCHORED IN PLACED BY TWO STAKES DRIVEN THROUGH THE HAYBALE THE FIRST STAKE IN EACH HAYBALE SHALL BE DRIVEN TOWARD THE PREVIOUSLY LAID HAYBALE AT AN ANGLE TO FORCE THE HAYBALES TOGETHER. STAKES SHALL BE DRIVEN FLUSH WITH THE HAYBALE.

4) DRAINAGE CHANNEL BLOCKS SHALL BE REMOVED AS DIRECTED BY THE RESIDENT PROJECT REPRESENTATIVE FOLLOWING CONSULTATION WITH TH ENGINEER OF RECORD FOR WETLAND RESTORATION.

FILTER SOCKS

Primary & secondary perimeter containment, as detailed in Brick Township Wetland Restoration.

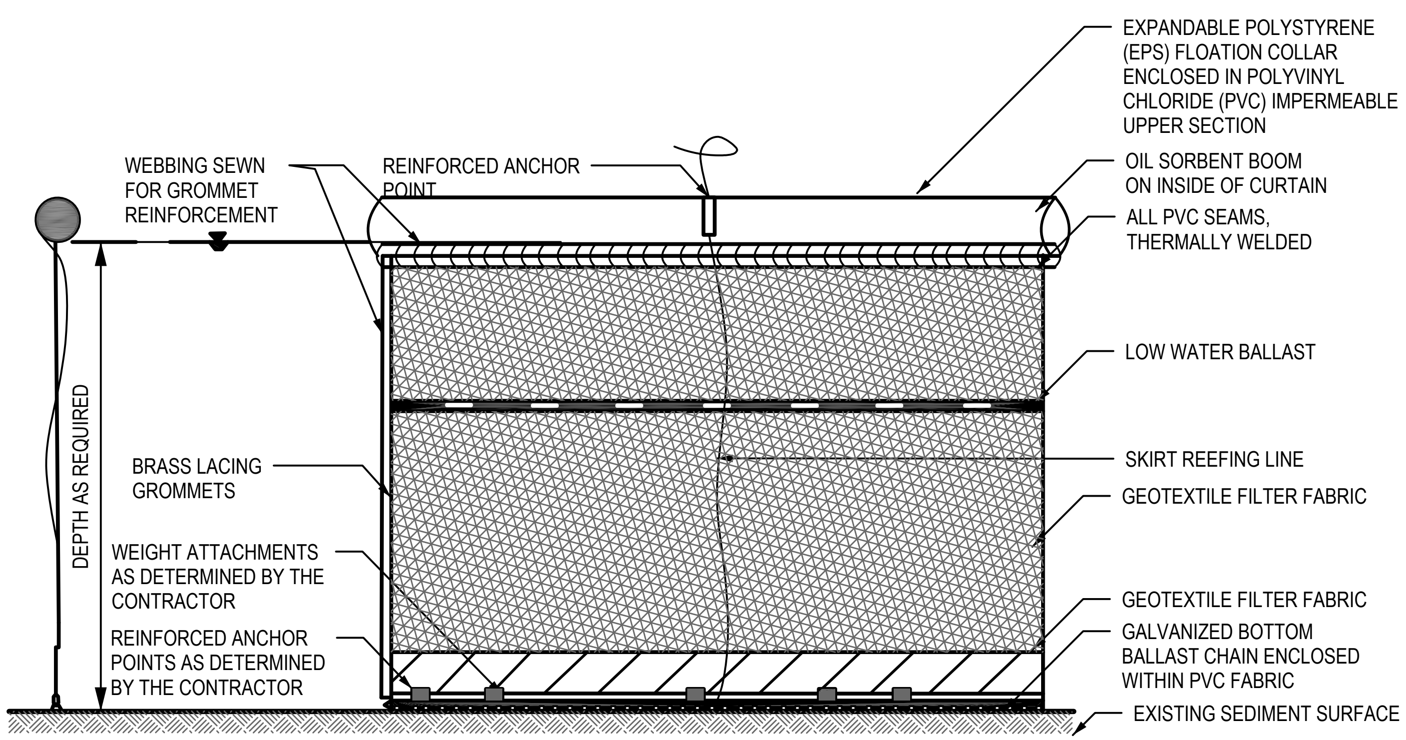


1) PRIMARY AND SECONDARY PERIMETER STAKES SHALL BE HAMMERED IN PLACE OR REMOVED AS DIRECTED BY THE RESIDENT PROJECT REPRESENTATIVE

2) PRIMARY & SECONDARY PERIMETER FILTER SOCKS SHALL BY CUT UP TO EXPOSE INNER CORE AND LEFT IN PLACED AS DIRECTED BY THE RESIDENT PROJECT REPRESENTATIVE FOLLOWING CONSULTATION WITH THE ENGINEER OF RECORD FOR WETLAND RESTORATION.

TURBIDITY CURTAIN

Permeable turbidity curtain detail from Little Assawoman Canal wetland restoration project.



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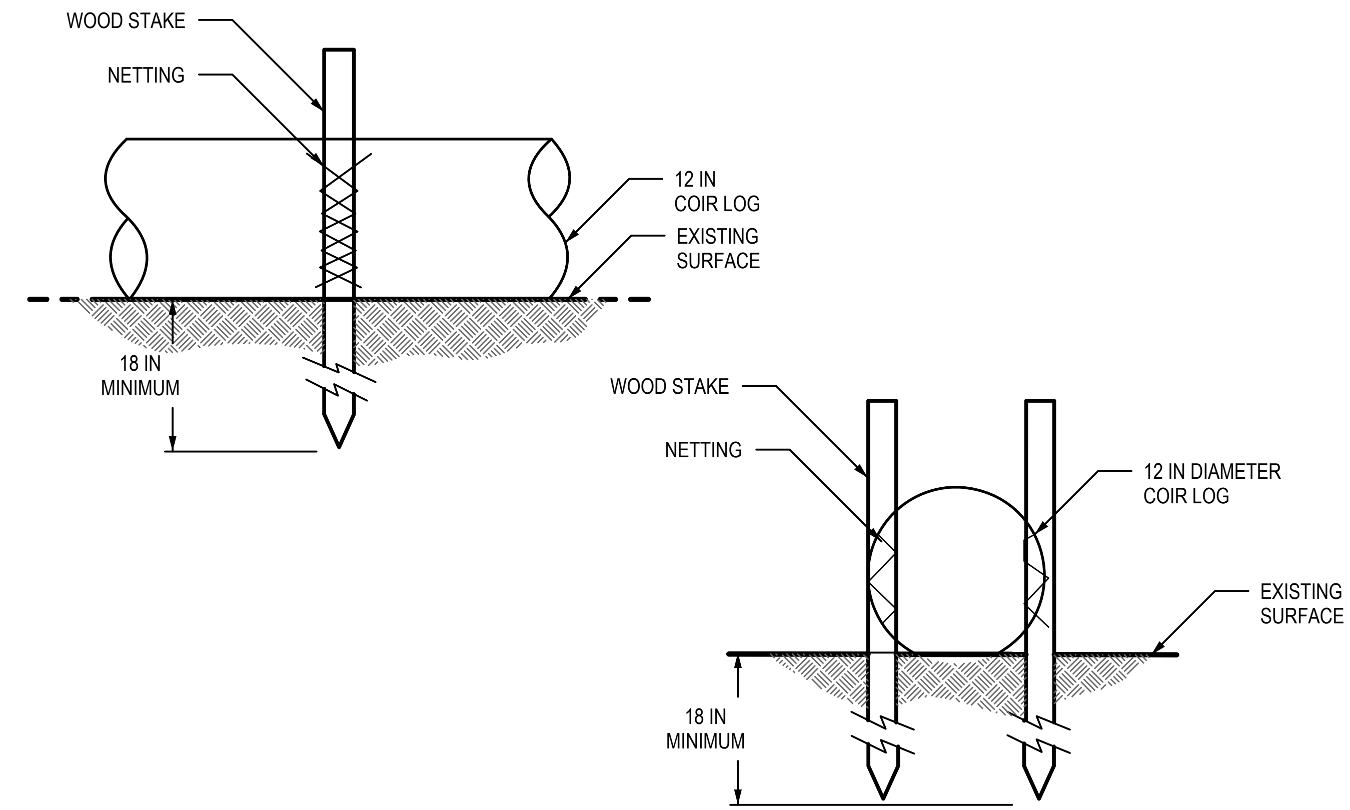
COIR LOGS

Coir log detail from Little Assawoman Canal wetland restoration project.



1) COIR LOG MUST BE PLACED AS SHOWN ON THESE CONTRACT DRAWINGS, AND IN A ROW WITH A MINIMUM 1-FT OVERLAP AT THE ENDS

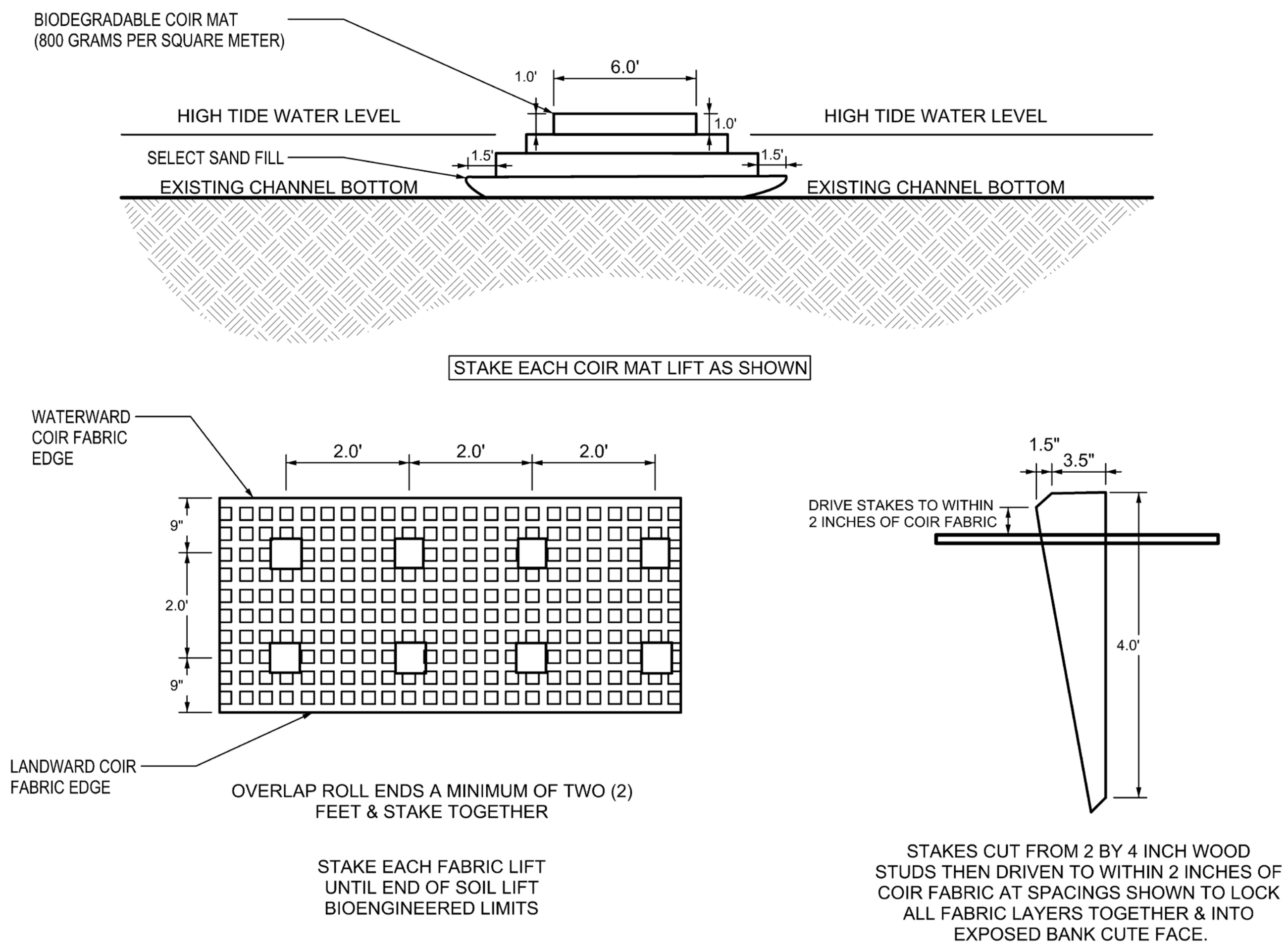
2) COIR LOG MUST BE SECURELY ANCHORED IN PLACED BY TWO STAKES DRIVEN THROUGH THE COIR LOG NETTING AS SHOWN IN THE COIR LOG DETAIL. STAKES MUST BE DRIVEN FLUSH WITH THE COIR LOG.

3) COIR LOG MUST BE REMOVED AS DIRECTED BY THE OWNER'S REPRESENTATIVE.

4) COIR LOG PLACED ON SOIL MUST BE ANCHORED IN PLACE WITH STAKES DRIVEN THROUGH THE LOG EVERY 4 FEET AT A MINIMUM.

TIDAL PLUG

Used in Blackwater NWR Marsh Resiliency Project + Deal Island, this tidal plug was used for containment of tidal channels.



NOTES:

1)SELECT SAND FILL SHALL BE COMPRISED OF CLEAN WASHED SAND WITH NO MORE THAN TEN (10) PERCENT PASSING BY WEIGHT THE NO. 100 SIEVE.

2) SLOPE BEHIND BIOENGINEER PRACTICE TO BE GRADED TO A 1.5H: 1 V INCLINATION.

3) BIODEGRADABLE COIR MAT SHALL BE CONSTRUCTED OF COCONUT FIBER WITH A TIGHT WEAVE AND WEIGHT OF 900 GRAMS PER SQUARE METER.

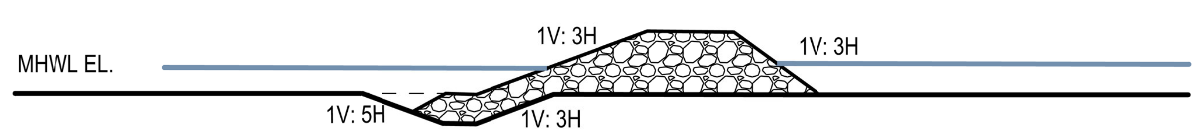
4) COIR MAT BOTTOM SHALL EXTEND A MINIMUM 2 FEET UNDER THE ONE (1) FOOT THICK SELECT SAND FILL. AFTER PLACING & GRADING THE SELECT SAND FILL THE COIR FABRIC SHALL BE PULLED TIGHTLY BACK OVER THE TOP INTO THE GRADED BANK FOR A MINIMUM OF 3.5 FEET

BREAKWATER

Typical sills and breakwaters generally vary between -1 MHWL to +3 MHWL depending on fetch, wave energy, and other site-specific factors. Designs that exceed that requires additional justification.

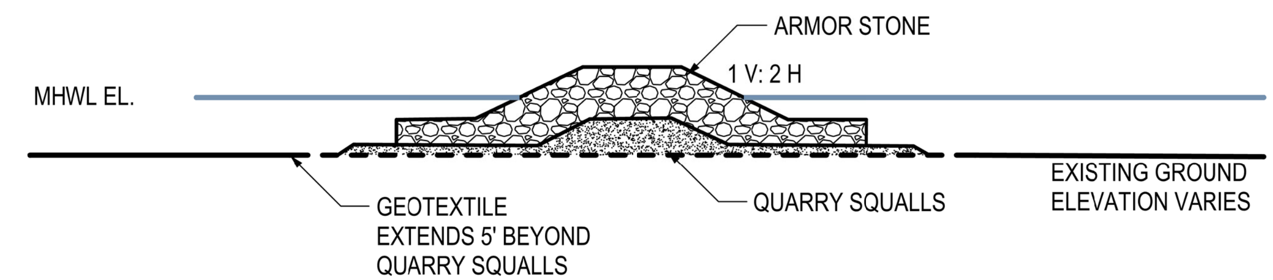
As detailed from **Lightning Point.** Revised typical breakwater cross-section to include toe feature.

BREAKWATER WITH TOE (TYP.)

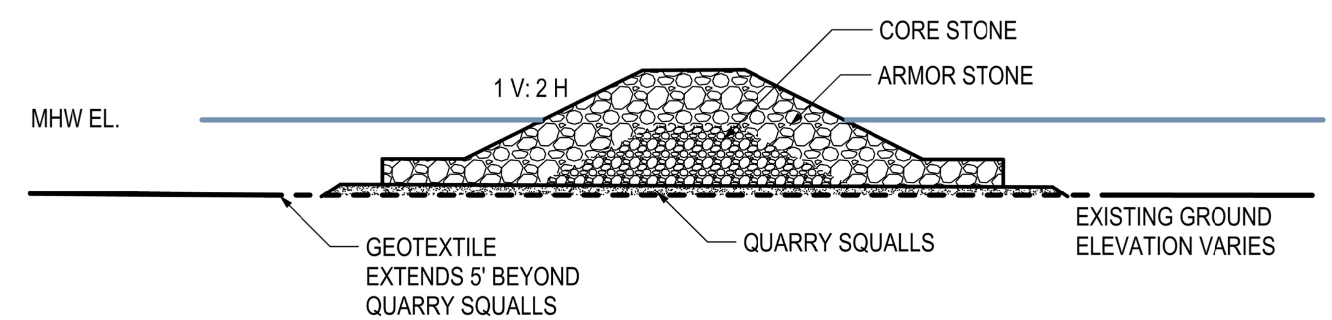


As detailed from **Barren Island.**

SILL (TYP.)



BREAKWATER (TYP.)



CONTAINMENT MATERIALS

Type of Containment	Examples	Advantages and Disadvantages
Geotubes Large, tube-shaped bag made of porous geotextile and filled with a sand slurry	Barren Island, MD - geotubes help contain placed sediment in wetland cells	**Advantage:** low-cost **Disadvantage:** can degrade in sun and fail, not typically recommended
Earthen Berms Constructed perimeter of earth used to fully contain sediment during placement; often breached post-settlement.	East Marsh Island, LA – used in 363-acre marsh creation with final breaching after partial consolidation	**Advantage:** High structural integrity; Easily shaped for targeted containment **Disadvantage:** Labor-intensive construction and removal; Can alter hydrology
Sand Bunds Linear mounds of sand used to shape placement area	Tidal restoration projects in LA and Elevant Marsh Platform in Sturegon Island, NJ	**Advantage:** Readily available in coastal areas; Compatible with natural sediments **Disadvantage:** Can erode during storm events; May require heavy equipment
Pipeline (as structure) Rigid piping used to place dredged sediment; when left in place briefly, can help contain initial discharge.	Sturgeon Island, NH	**Advantage:** Already present in dredging; **Disadvantage: Inconsistent containment**
Turbidity curtains (Burlap for biodegradable qualities) Natural fiber barriers that float in the water column to reduce suspended sediment and slow effluent dispersion.	Used in Mordecai Island to limit fine sediment dispersion. Most recently used in Maurice River project	**Advantage:** Already present in dredging BMPs. Reduces turbidity; Allows limited water flow. **Disadvantage:** Fragile in high-flow conditions; Requires anchoring and tensioning
Coir Logs Biodegradable cylindrical structures placed along wetland edges or creeks to slow and retain sediment.	Avalon, NJ; Scotch Bonnet, NJ	**Advantage:** Biodegradable; Adds habitat structure; Flexible for curved boundaries **Disadvantage:** Can shift or break down in high flows; Limited height capacity
Hay Bales Square or round compressed straw structures used in temporary or low-energy systems for flow and sediment control.	Deal Island, Pepper Creek, DE – minimal containment pilot using only hay bales	**Advantage:** Low-cost; Easy to source; Biodegradable **Disadvantage:** Short lifespan (can fail if set out too early and left to degrade); Can float or dislodge; Degrade quickly in wet environments; Can only be constructed to particular heights (width of haybales); depending on site may need to remove hay bale material.
Filter Socks Permeable fabric tubes filled with compost or sediment to capture fines near outfalls or discharge ends.	Fortescue, NJ	**Advantage:** Pre-filled and easy to install; Targeted containment at pipeline ends **Disadvantage:** Can clog; Limited reuse; Heavy when saturated so difficult to remove
Clam / Oyster Bags Mesh bags filled with shells that serve as low-profile, semi-porous barriers with ecological benefits.	Mobile Bay, AL – living shoreline; habitat and containment dual role; John H. Chafee NWR, RI – 14-acre thin-layer using shell bags	**Advantage:** Natural habitat benefits; Biodegradable; Low-cost reuse of shell. **Disadvantage:** Limited structural containment; Site-specific utility (Habitat benefits associated with clam or oyster bags can vary significantly based on local ecological conditions).
In-channel containment: Coir Mats (Filled) Flat biodegradable mats filled with sand to direct flow within restored channels or contain placement zones.	Blackwater NWR – coir mat plugs used to guide channel filling	**Advantage:** Anchored structure; Provides stability in shallow water **Disadvantage:** Heavy and less flexible than coir logs; More costly
In-channel containment: Hay Bales/Coir Logs Used in small, shallow, slow-moving streams to deflect flow and temporarily contain dredged material.		**Advantage:** Soft containment; Easy to obtain and replace; Biodegradable **Disadvantage:** Fragile under high flow; Can cause blockages
In-channel containment: Clay Plugs Excavated channels lined with clay used to direct or hold water and sediment in wetland reconnection projects.	Agricultural wetland re-hydration in Delta regions	**Advantage:** Utilizes native materials; Long-lasting in-situ structure **Disadvantage:** Requires clay source

PILOT PROJECT SUMMARY

Project	Project Team (Non-Exhaustive)	Location	Landscape Type		Material Source	Brief Project Description
Chesapeake Bay Environmental Center	Maryland Department of Natural Resources (MDDNR), CBEC/Chesapeake Bay Trust, Queen Anne's County	Chesapeake Bay Environmental Center, near Kent Narrows, Queen Anne's County, MD	Fringe Wetland		Prices Creek, Kent Narrows	A living shoreline demonstration project was built using dredged material and recycled concrete rubble, restoring 400 feet of shoreline and creating 2 acres of tidal wetland. An ongoing project is further enhancing 4 acres of tidal marsh using approximately 8,500 cubic yards of dredged material from Prices Creek and Kent Narrows.
Masonville Cove Substrate Enhancement	Maryland Port Authority (MPA), MES, Moffatt & Nichol, Gahagan & Bryant, Findling, Inc., EA	Baltimore, MD	Mudflat		Baltimore Harbor Shipping Channels	Dredged material was used to elevate substrate levels in Masonville Cove, improving habitats for wading birds and small fishes, and capping contaminated sediments.
Blackwater National Wildlife Refuge	USFWS, The Conservation Fund, Audubon Mid-Atlantic, USGS, VIMS, GWU, USGS, Sustainable Science LLC, Dredge America, Ecological Restoration and Management, Geo-Technology Associates Inc.	Blackwater NWR , Dorchester County, MD	Marsh Platform		Blackwater River	In 2016, dredged material was placed over 40 acres, with subsequent planting of marsh species. This project involved material explicitly dredged for marsh restoration and was not a BUDM project.
Swan Island	MDDNR, USFWS, National Oceanic and Atmospheric Administration (NOAA), USACE Engineering and Research Development Center (ERDC)	Swan Island, Martin National Wildlife Refuge, MD	Island		Big Thorofare and Twitch Cove	Approximately 60,000 cubic yards of dredged sediment restored Swan Island, creating about 12 acres of productive intertidal marsh and dune habitat. A coir log failure during construction led to leakage of sediment and burial of subtidal SAV adjacent to the island.
Ellis Bay	USACE	Ellis Bay Wildlife Management Area, Somerset County, MD	Fringe Wetland		Lower Wicomico River	Dredged material was placed in front of tidal wetlands using coir logs, but breaches led to sediment runoff, negatively impacting water quality and benthic organisms.
Deal Island Marsh Elevation Enhancement	USACE, NOAA, NOAA Fisheries, USFWS, Audubon, MDDNR, Wicomico County, Somerset County, Cottrell Contracting Corporation, Sustainable Science LLC, Ecological Restoration and Management	Deal Island Wildlife Management Area, Somerset County, MD	Marsh Platform		Lower Wicomico River near Deal Island	Maintenance dredging of lower Wicomico River produce DM (silt and sand) that was transported via hydraulic pump to eroding marsh at nearby Deal Island Wildlife Management Area from fall 2021-early 2022. Material was placed 1.5 ft above existing grade followed by replanting (plugs and aerial seed deployment)
Hurst Creek	MDDNR, Dorchester County, Delmarva Resource Conservation and Development Council, Coastline Design Inc., ShoreLine Design	Hurst Creek on the Choptank River, Dorchester County, MD	Fringe Wetland		Hurst Creek	In early 2023, 1200 feet of living shoreline was created near the mouth of Hurst Creek, a small tributary of the Choptank River. 12500 cubic yards of sandy dredged material from the creek (Hurst Creek) was used as fill, and marsh grasses were planted.
Selsey Road	MD Coastal Bays Program, Worcester County, MDDNR, University of Maryland Center for Environmental Science (UMCES), West Ocean City Homeowner's Association (since disbanded), Coastline Design Inc.	West Ocean City, Worcester County, MD	Fringe Wetland		Ocean City canals and harbors	Shoreline stabilization involved using a combination of hard infrastructure, marsh planting, and the expansion of existing marsh areas. Approximately 5,381 cubic yards of dredged material from local harbors and Ocean City canals created 1.22 acres of tidal marsh comprising both high and low marsh species.

Fort Smallwood Park	Anne Arundel County Department of Public Works (DPW), Anne Arundel County Parks and Rec, Shoreline Design LLC, Bayland environmental engineering firm	Anne Arundel County near Springdale, MD	Fringe Wetland		Bodkin Creek	The eroding shoreline of Fort Smallwood Park was stabilized using breakwater structures combined with marsh planting, sand fill, and beach nourishment using 4,100 cubic yards of dredged material from Bodkin Creek. Phases 1 and 2 of this three-phase project utilize dredged material. The project received the ASBPA's "Best Restored Shore" award in 2024.
Barren Island	MPA, USACE, USFWS, the National Aquarium, Friends of Blackwater, SeaCoast Marine Construction Inc.	Offshore of Blackwater NWR, Dorchester County, MD	Island		Honga River	Barren Island, an eroded island in the Chesapeake, will receive dredged material beginning in late 2025 or early 2026 to restore its size and support marsh and submerged aquatic vegetation (SAV) habitats. Initial material will originate from the Honga River. This project is part of the larger Mid-Chesapeake Bay Island Ecosystem Restoration Project, which also includes James Island
Ring Island Elevated Nesting Habitat, Marsh Enhancement	USACE, New Jersey Department of Environmental Protection (NJDEP), Local Partners	Cape May County, NJ	Marsh Platform		NJ Intracoastal Waterway	A 1-acre elevated bird habitat was created using dredged sand to provide secure nesting grounds for species such as black skimmers. Thin-layer placement of additional dredged material raised marsh elevation, enhanced vegetation growth, and improved habitat resilience.
Avalon Marsh Enhancement	USACE, NJDEP, The Wetlands Institute (TWI), TNC	Avalon, NJ	Marsh Platform		NJ Intracoastal Waterway	The first project phase restored 7 acres of marshland using fine-grained dredged material to fill degraded pools and elevate marsh surfaces. The second phase further enhanced 45 acres of marshland with over 50,000 cubic yards of dredged material to restore elevation and promote vegetation recovery.
Fortescue Marsh Enhancement Project	USACE, NJDEP, Local Partners, TNC	Cumberland County, NJ	Marsh Platform		NJ Intracoastal Waterway	Marsh elevation was increased by 9 inches using a combination of sandy and fine-grained dredged material to support native vegetation growth and enhance ecological resilience.
Mordecai Island	USACE, NJDEP, Mordecai Land Trust	Barnegat Bay, NJ	Island		NJ Intracoastal Waterway	The island was restored and stabilized using 25,000 cubic yards of dredged sand, reconnecting fragmented segments and enhancing salt marsh habitats.
Sturgeon Island	USACE, NJDEP, TWI	Seven Mile Island, NJ	Island, Marsh Platform, Shallow water, Mudflat		NJ Intracoastal Waterway	Marsh elevations were enhanced using approximately 19,000 cubic yards of mixed fine sand and mud, promoting Spartina recovery and creating intertidal shallows.
Gull Island	USACE, NJDEP, TWI	Seven Mile Island, NJ	Island, Marsh Platform, Mudflat		NJ Intracoastal Waterway	Approximately 40,000 cubic yards of dredged material were placed to elevate marsh platforms, create habitat mosaics, and enhance tidal connectivity.
Maurice River	USACE, NJDEP, University of Pennsylvania EMLab	Cumberland County, NJ	Mudflat		Maurice River	Around 70,000 cubic yards of dredged sediment were placed at the edge of low marsh habitat near Maurice River.
Scotch Bonnet	USACE, NJDEP, TWI, UPenn	Cape May County, NJ	Marsh Platform		NJ Intracoastal Waterway	Around 25,000 cubic yards of dredged material was placed at The Wetland Institute to elevate marsh. The material was contained using coir logs.
Abbotts Meadows	New Jersey Department of Transportation (NJDOT), NJDEP	Salem County, NJ	Marsh Platform		NJ Wind Port Construction Project	Marsh resilience was enhanced by elevating marsh surfaces and improving tidal connectivity, specifically to support bird and fish habitats in the Delaware Bay region.
Brick Township Wetland Restoration	USFWS, Anchor QEA, Brick Township	Brick, NJ	Marsh Platform		Trader Coves Marina	Sediment dredged from marina operations was used to augment marsh areas within the USFWS Forsythe National Wildlife Refuge.
Supawna Meadows National Wildlife Refugre	USACE, USFWS, Ducks Unlimited, Cottrell Contracting Corporation	Salem, NJ	Mudflat		Salem River Federal Navigation Channel Maintenance Dredging Project	Approximately 200,000 cubic yards of dredged material were beneficially used to restore ecological health across 430 acres of tidal marsh at Supawna Meadows National Wildlife Restoration Project.
Assawoman Creek	Woods Hole Group, Delware Department of Natural Resources (DNREC), Anchor QEA	Selbyville, DE	Fringe Wetlands		White Creek/ White Canal	Material dredged from White Creek and White Canal was placed in the nearby to restore the Muddy Neck Marsh Complex.

Sheep Island	USACE	Jonesport, ME	Mudflat		Jonesport, Maine	USACE placed dredged material from construction and dredging operations in Jonesport, Maine, into a shallow circular basin enclosed by larger rocks to stabilize the soft, muddy sediment. An additional mudflat was unintentionally created during sediment disposal activities.
Jekyll Island TLP project	TNC, Georgia Southern University, the University of South Carolina, USACE ERDC	St. Simons Sound, GA	Marsh Platform, Shallow Water		Atlantic Intracoastal Waterway, GA	A naturally deepened area known as the "Deep Hole," located north of Jekyll Creek in St. Simons Sound was selected for sediment placement to ensure navigational safety and promote natural dispersal through tidal action. About 97% of the 220,000 cubic yards of sediment was placed in the Deep Hole, with the remainder utilized for marsh enhancement efforts (MEE).
Salt Aire	Mobile County Commission, USACE	Mobile County, AL	Fringe Wetland		U.S. Army Corps of Engineers' Fowl River Open Water Dredged Material Management Area	Dredged material was hydraulically pumped into the designated restoration areas between the breakwaters and the existing shoreline to create suitable elevations for marsh vegetation.
Lightning Point	TNC, Moffatt & Nichol, National Fish and Wildlife Foundation (NFWF), Alabama Department of Environmental Management (ADEM), ADCNR	Bayou La Batre, AL	Fringe Wetland		Bayou La Batre Navigation Channel, Two Other Local Borrow Site	Dredged material was used to elevate marshland habitat. Breakwaters were engineered to retain sediment, safeguard shorelines, and support marsh habitat restoration using dredged material. The design incorporated tidal creeks to enhance natural water flow, hydrological connectivity, and species recovery from previous oil spill impact.
Mobile Bay 2012 TLP Event	USACE, ADEM, ASPA	Mobile County, AL	Shallow Water		Upper Mobile Bay Navigation Channel	Approximately 9 million cubic yards (mcy) of sediment was placed in thin layers (≤12 inches) in historic open-water placement areas, ensuring environmental compliance and benthic recovery.
Sand Island Beneficial Use Area	USACE, NMFS, ASPA	Mobile County, AL	Shallow Water		Mobile Harbor Deepening and Maintenance Dredging Activities.	Strategically placed dredged material fostered seagrass growth and created aquatic habitats.
Lake Pontchartrain	NFWF, Gulf of Mexico Energy Security Act, NOAA	New Orleans, LA	Fringe Wetland		Lake Pontchartrain	Nine constructed breakwaters protect a 20-acre marsh area, utilizing sediment dredged from various locations within the lake to bolster marsh volume and protect the adjacent levee system.
Horseshoe Island	USACE EWN	St Mary Parish, LA	Island		Horseshoe Bend navigation channel	Sediment dredged from the Horseshoe Bend navigation channel was strategically placed upstream of a naturally forming sandbar. Natural river currents redistributed these sediments, facilitating the spontaneous formation and growth of the island over time.
Hancock County Shoreline Project	NOAA, USACE, Mississippi Department of Environmental Quality (MDEQ), Anchor QEA	Hancock County, MI	Fringe Wetland		Port Bienville, Pearl River, and Bayou Caddy	Locally sourced dredged sediment was strategically positioned behind constructed breakwaters, successfully establishing 46 acres of marshland.