Thank you for joining our seventh Crisfield/EPA ORD Technical Working Group (TWG) providing technical feedback on proposed nature-based solutions (NBS) and co-benefits for Crisfield’s coastal resilience!

AGENDA for July 30:

* Report back from the Crisfield community workshop on July 10
* Presentation and discussion about climate smart design and adaptive management of Crisfield NBS projects: <https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=366771>

Attendees:

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| **Organization** | **Expertise** |
| City of Crisfield, climate resilience projects | Local knowledge, funding |
| US Army Corps of Engineers, Engineering with Nature program | Coastal hydraulics, modeling of nature-based solutions |
| Center for Watershed Protection | Watershed planning, providing engineering support for Crisfield |
| Eastern Shore Regional GIS Cooperative | Local mapping, spatial data |
| University of Maryland, Environmental Finance Center | Finance and green infrastructure, coastal resilience |
| Maryland Sea Grant Extension Program | Coastal climate assessment |
| Maryland Department of Natural Resources | Erosion prevention, living shorelines |
| Lower Shore Land Trust | Local marsh knowledge |
| Tetra Tech | Environmental science, project management |
| EPA Office of Research and Development | Project Navigator |
| EPA Office of Research and Development | Ecosystem co-benefits |
| EPA Office of Research and Development | Coastal ecology, climate impacts |
| EPA Office of Research and Development | Evaluation, community capacity |

Two new members with Maryland-specific coastal protection and nature-based strategy knowledge joined the Technical Working Group from the Maryland Sea Grant Extension Program and the Maryland Department of Natural Resources. Both attended the in-person Crisfield July 10 public meeting, are up to speed on the project, and provided helpful local and subject-matter specific feedback on the currently considered NBS projects. The ORD Community Engagement lead was reassigned to EPA Office of Land and Emergency Management but will try to continue to participate as much as possible in this project, as her new role allows. About half of the rest of the ORD project staff have been reassigned, as well. ORD will continue working on and sharing information about this project as long as we are able. All public results are going to continue to be posted on this webpage: <https://www.epa.gov/water-research/coastal-community-resilience-research-project-updates>

Most recently available results include the external report identifying NBS strategies for Crisfield based on literature review of successful, already implemented strategies in locations that share environmental characteristics with Crisfield: <https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryID=366018>

Presentation slides from Crisfield July 10 Public Input Session: <https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=366609>

Summary of content and community feedback from July 10 public meeting:

* Presented Crisfield resilience summary, including hard infrastructure and how NBS fits into larger, comprehensive plans, and present latest co-benefit results for implementing each of the four main NBS types in potential locations in Crisfield: marsh restoration, dune restoration or artificial reefs off Janes and Cedar Island, and living breakwaters in Lower Annemessex
* Plots showing average percent attenuation of wave heights during 30 worst hours of the storm
* Realistic NBS performance during same 1-in-50-year storm used for hard infrastructure design
* Greatest wave percent reductions observed where open water was restored back to marsh
* Results for each NBS type in Crisfield based on Batch 1 modeling:
  + Oyster reefs: Current design (long, linear formations along edges of marshes) does not reduce wave heights much in changing wind field. Shorter, thicker patch reefs may be more effective, especially in identified erosion hotspots like south of Island Point or southwest side of Cedar Island. Useful to consider because protect marsh edges, oyster co-benefits and little maintenance. Cheapest per unit cost ($300/foot), $23M total to implement full modelled footprint of 70,000 feet (but not all necessary).
  + Living breakwaters: Some localized wave attenuation in waves approaching and receding from Crisfield, but maximum benefit not visible in changing wind field (should be able to attenuation 20-80% of wave heights based on literature). Need to evaluate if redirecting water or sediment in ways that cause erosion (analysis will be part of pre-permitting). Creates new, calm water habitat behind them for seagrass, juvenile fish and crabs. Second cheapest option at $850/foot, $9M to implement all three breakwaters of 10,000 feet total.
  + Dune restoration: Clearly show wave energy reduction at edges of marshes which protects marsh from erosion. Protections look like they extend to Daugherty Creek by likely preventing surge from coming through open water areas of Janes Island, creating effective natural flood barriers. Possible challenge may be potential presence of endangered beetles. Need to determine which part of dune system is most effective since they are second most expensive option at $3500/foot, with total modeled 36,000 feet costing $158M.
  + Marsh restoration: Looks like biggest effect on wave attenuation but also the biggest suggested project set. Shows protections in Daugherty Creek likely because eroded channel in middle of Janes Island was converted from open water to marsh. Restoring Cedar Island Marsh Sanctuary does not necessarily provide additional protections since water can move through Jenkins Creek and towards land through that pathway. Most expensive option at $38,000/acre, with totally modeled 10,000 acres costing $380M.
* Existing natural infrastructure clearly decreases wave heights in marshes and Daugherty Creek. By 2050 with no intervention they will only be able to reduce wave heights half as much or less, since marshes will be further underwater due to sea level rise, and not as able to obstruct waves at the surface as they are now. This makes sense to incorporate into bigger picture resilience strategies over the next 25 years.
* Changes in co-benefits with different NBS options were calculated as resulting from changes in land cover (e.g., open water becoming marsh or mud flats becoming marsh or, in the case of sand dunes, sometimes marsh becoming a dune). ORD prepared bar charts showing relative community-identified benefits (e.g., marsh quality, crab, waterfowl, kayak trails) for each NBS type.
* Community pointed out that marsh restoration had the greatest increase in benefits, with the exception of decreasing waterfowl (because preferred open water areas were filled in with marsh). Oyster reefs benefited fish habitat the most. Breakwaters did not have many benefits other than wave reduction. Dune restoration helped Island Point erosion prevention most. Discussion that these are the kind of tradeoffs that need to be evaluated among options.
* Participants were asked to rank each type of benefit on scale of 1 to 10 with following results:

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| **Benefit type** | **Average** |
| Maximizing storm protection and wave height reduction nearest Crisfield | 6.6 |
| Maintaining or improving blue crab | 6.3 |
| Maintaining or improving water quality | 6.1 |
| Minimizing the effort and grant funding needed for project implementation | 5.6 |
| Maintaining or improving marsh quality | 5.4 |
| Maintaining or improving waterfowl | 5.4 |
| Reducing wave-related erosion at culturally or ecologically important locations | 5.3 |
| Maintaining any of these benefits through at least 2050 | 5.1 |
| Maintaining or improving striped bass | 5.0 |
| Reducing wave heights in kayaking or other boating areas | 4.1 |

* Small group discussions comparing just two options shared the following pros and cons:

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| *GROUP 1 CHART* | |
| **Dune Restoration** | |
| *Pros:* | *Cons:* |
| * Preserve Janes Island Park back-country campsites * Is there a small-scale project that would benefit Crisfield? | * Sand dunes need replenishment * Limited footprint * Not enough co-benefits |
| **Oyster Reefs** | |
| *Pros:* | *Cons:* |
| * More options for locations * New technology ↓ costs * Oysters very important to MD * Water quality filtration ↑ * Is there a small-scale project to benefit Crisfield? * Modular—could test what works * Budgetary benefit—stretch resources | * Boating safety * Less wave protection |
| **What to do with $10 Million** | |
| Marsh restoration w/ dredge material   * Somerset County ditch excavation * Best location to benefit Crisfield (wave attenuation) * Provides all co-benefits | |

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| *GROUP 2 CHART* | |
| **Marsh Restoration** | |
| *Pros:* | *Cons:* |
| * Help collect water * Beneficial use of dredging material * Could be good for bird habitat | * Not helpful to the areas with a lot of flooding * Financial cost * Requires monitoring |
| **Living Breakwaters** | |
| *Pros:* | *Cons:* |
| * Could help businesses * Doesn’t interrupt open water | * Doesn’t help the living organisms * Hard sell permit-wise |
| **What to do with $10 Million** | |
| 75% breakwater and like 25% marsh | |

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| *GROUP 3 CHART* | |
| **Marsh Restoration** | |
| *Pros:* | *Cons:* |
| * Natural silt fence/prevent dirt into town * Lot of environmental co-benefits * Best for wave attenuation | * High cost * Why would we be likely to be selected? (Others apply for funding too) * Hard to permit converting water to marsh |
| **No NBS** | |
| *Pros:* | *Cons:* |
| * Cheaper * Might be better to move away from coast * Flooding not that big of a deal (media makes it sound worse than it is) * When lose marsh, gain elsewhere (marsh migration) | * Want to spend a little for a lot of benefit (jetties cheaper) * Don’t want to see marshes go |
| **What to do with $10 Million** | |
| Marsh restoration seems to have the most benefits. | |

Summary of climate-smart adaptation design strategies for Crisfield:

* Goal is to use vulnerability and resilience information to evaluate strategic NBS design to ensure they remain robust in the face of climate change and other interacting stressors over time.
* Focus case study on Janes Island marsh restoration, oyster reef construction, and dune restoration, thinking about which climate stressors can affect these potential projects how, and what design changes can be implemented to account for and be resilient to those effects
* Vulnerability evaluation identified potential climate threats and impacts such as sea level rise and wave energy increase resulting in more marsh inundation with potential consequent marsh breakup and collapse. (The full technical summary, available here: <https://cfpub.epa.gov/si/si_public_record_report.cfm?LAB=CPHEA&dirEntryID=367037>, includes comprehensive tables documenting evidence evaluating whether and how each climate stressor of concern (sea level rise, air temperature, water temperature, extreme weather events, precipitation, salinity, streamflow changes, pH/acidity changes, hypoxia, and Chesapeake Bay stratification, i.e., separating into vertical water layers based on differences in water density) could potentially change over time and affect each of the three evaluated NBS at Janes Island (marsh restoration, oyster reef construction, and dune restoration) over time—summary table of stressors versus NBS types is shown on slide 9 of meeting slide deck linked above and here: <https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=366771>
* Each combination of stressor and NBS is then evaluated for adaptive capacity to each type of impact (e.g., marshes can migrate inland in response to sea level rise, if not blocked by human infrastructure; oyster reefs do not have the capacity to move in response to adverse conditions)
* Based on expected impacts and adaptive capacities (or not), different types of adjustments can be incorporated into NBS design to maximize robustness and resilience over time
* Types of adjustments (summarized for each NBS on slide 14 of linked meeting slide deck) include:
  + Biological design (e.g., use species of vegetation and shelled mollusks (oysters or replace with mussels) that are robust to anticipated temperature and salinity changes)
  + Engineering design (e.g., use heavier oyster reef balls for increasing wave energy environments, increase frequency of dune sand replenishment for conditions of more extreme weather events and resulting erosion, more frequent marsh sediment placement with more frequent storms)
  + Location selection (e.g., locate oyster reefs where currents are predicted to maximize larval supplies for colonization, account for predicted changes in storm pathways when selecting angle and distance from shorelines of restored dunes)
  + Timing selection (e.g., seasonally time marsh sediment placement to avoid greatest storm occurrences, seasonally time oyster reef installation to potentially changing environmental conditions that maximize larval supply availability and settlement, establishment, and survival of spat)
* Ideally, adaptive management is then employed to monitor stressor exposures and system responses, and continuously adjust and improve actions in response to new information
* Would be good to understand who is already monitoring parameters vital to NBS robustness (e.g., oyster larval supply, disease, dune erosion rates or vegetation growth, marsh species composition changes – more suggestions on slide 18) to create efficiencies or see if there is a way to get the community involved in monitoring programs of some parameters

Feedback from TWG:

* July 10 meeting was great – everyone seemed engaged and people left feeling very informed. How is it that storm wave attenuation seems to be the central issue? ORD responded that the EPA portion focused on natural infrastructure is part of Crisfield’s larger resilience efforts with a lot of different interacting components. The community identified flooding as a major concern.
* It would be useful to explore combinations of NBS to target the most impactful spots for maximum cost-benefit. ORD explained that combinations were modeled in Batch 1, and there were no clear synergistic effects easily discernable initially, just additive effects, so it made sense to look at them one by one at this point. The next steps will be to model the top five implementable projects (defined as no more than $10M, which can be applied for in a single grant), with results presented at the next TWG meeting in late August. ORD is also working on reports with all the detail to make the analyses and modeling iterations public.
* This environmental vulnerability analysis and identification and justification of climate-smart design considerations is immensely helpful to grant writing and project management.
* Likely Chesapeake Bay Foundation, Chesapeake Bay Trust, or MDNR monitor needed parameters

Questions?

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**[END MEETING]**