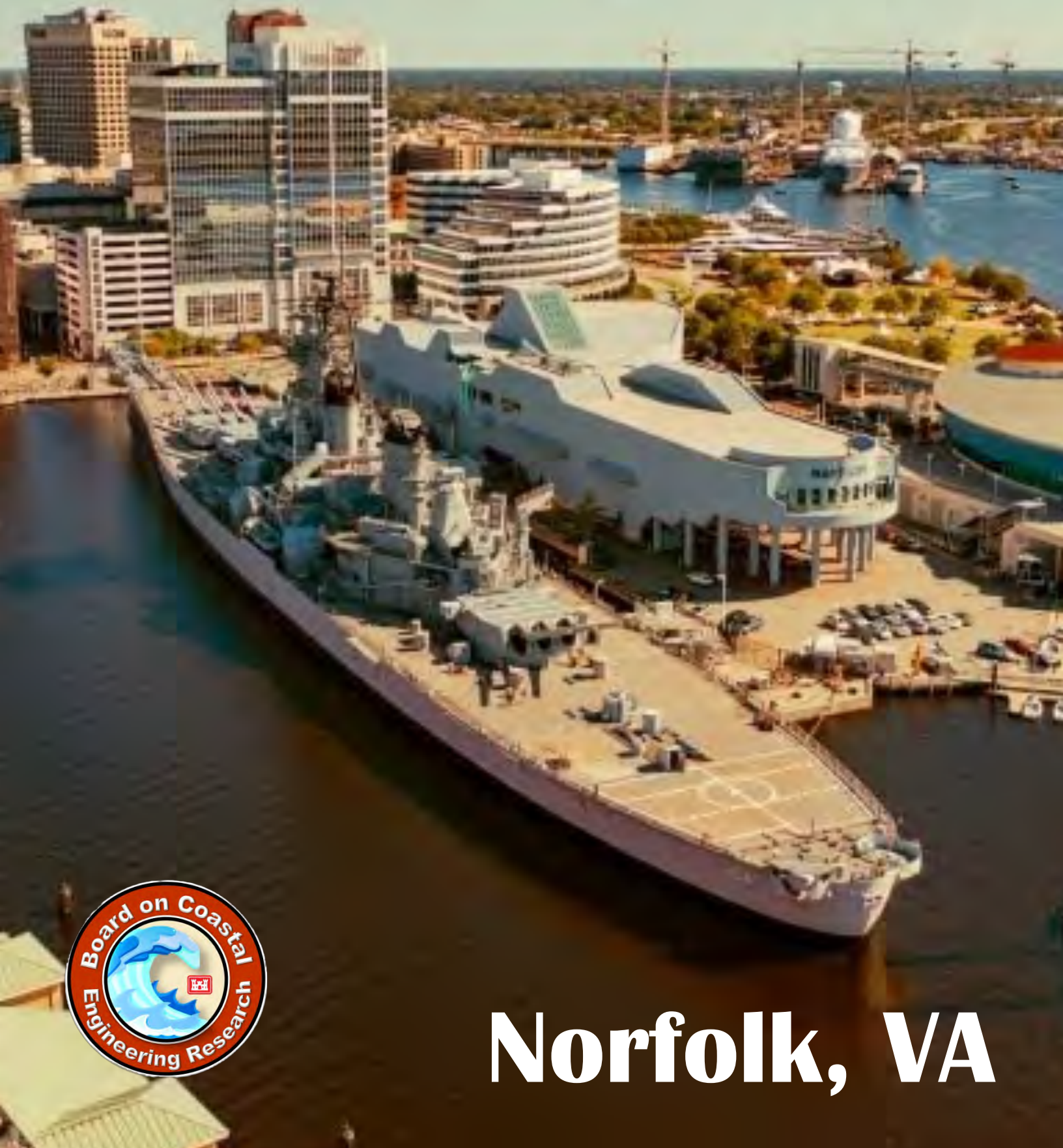


BCER EXECUTIVE SESSION

March 19-20, 2024



Norfolk, VA

Board on Coastal Engineering Research Executive Session

Norfolk, Va

1 MEMBERSHIP/BIOGRAPHICAL

2 CHARTER

3 AGENDA

4 SITE VISIT

5 PRESENTATIONS

*Working Theme: Coastal Storm Risk Management R&D Challenges
and Solutions in Urban Coastal Settings*

MEMBERSHIP
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Executive Secretary

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MG William (Butch) H. Graham

MG Graham assumed responsibility as the Deputy Commanding General for Civil and Emergency Operations, U.S. Army Corps of Engineers on July 20, 2020.

He received his commission from the Reserve Officer Training Corps in 1989 from the University of Pittsburgh. He is an Engineer Officer who has commanded Soldiers at all levels up to division. His commands include: A Company, 1st Engineer Battalion, 1st Brigade, 1st Infantry Division (Mechanized), Fort Riley, Kansas; 40th Engineer Battalion, 2d Brigade, 1st Armored Division, United States Army Europe and Seventh Army, Germany, and OPERATION IRAQI FREEDOM, Iraq; United States Army Corps of Engineers Pittsburgh District, Pittsburgh, Pennsylvania; and North Atlantic Division, United States Army Corps of Engineers, Brooklyn, New York.

Previous assignments also include: Platoon Leader, B Company and later Executive Officer, A Company, 23d Engineer Battalion, 1st Brigade, 3d Armored Division, United States Army Europe and Seventh Army, Germany, and in support of OPERATION DESERT SHIELD/DESERT STORM, Saudi Arabia; Assistant Operations Officer and later Assistant Division Engineer, Engineer Brigade, 1st Infantry Division (Mechanized), Fort Riley, Kansas; Battalion Operations Officer, 1st Engineer Battalion, 1st Brigade, 1st Infantry Division (Mechanized), Fort Riley, Kansas; Operations Officer and later Deputy Commander, United States Army Corps of Engineers Pittsburgh District, Pittsburgh, Pennsylvania; Plans and Operations Officer, Division Engineer Section, G-3, 4th Infantry Division, Fort Hood, Texas; Executive Officer, 588th Engineer Battalion, 4th Infantry Division (Mechanized), Fort Hood, Texas, and in support of OPERATION IRAQI FREEDOM, Iraq; Executive Officer, Engineer Brigade, 1st Armored Division, United States Army Europe and Seventh Army, Germany; Division Engineer, 1st Armored Division, United States Army Europe and Seventh Army, Germany, and in support of OPERATION IRAQI FREEDOM, Iraq; Director, Coalition-Joint Engineering Directorate, Combined Security Transition Command-Afghanistan, and in support of OPERATION ENDURING FREEDOM, Afghanistan; Chief of Staff, United States Army Corps of Engineers, Washington, DC; and Director, Task Force Enhanced Security Zone, OPERATION RESOLUTE SUPPORT, Afghanistan.

Graham is a graduate of the Senior Service College Fellowship at Massachusetts Institute of Technology, the Joint and Combined Warfighting School, and United States Army Command and General Staff College. He holds a Bachelor of Science in Mechanical Engineering from the University of Pittsburgh and a Master of Science in Environmental

Engineering from the University of Kansas. His awards and decorations include the Distinguished Service Medal, Legion of Merit (with one bronze oak leaf cluster), Bronze Star Medal (with four bronze oak leaf clusters), Meritorious Service Medal (with three bronze oak leaf clusters), Army Commendation Medal (with one bronze oak leaf cluster), Army Achievement Medal (with one bronze oak leaf cluster), and the Combat Action Badge.

BG Daniel H. Hibner

Brigadier General Daniel H. Hibner commissioned in 1993 from Kemper Military College. During his 29 years as a commissioned officer, he served in numerous command and staff positions in the United States and the Middle East and currently serves as the commander of the U.S. Army Corps of Engineers, South Atlantic Division. Brigadier General Hibner joined the South Atlantic Division from Fort Leonard Wood, where he served as the Commandant of the U.S. Army Engineer School. Prior to his assignment as Commandant, Brigadier General Hibner commanded the U.S. Army Corps of Engineers Savannah District from 2018 to 2021. He has held various leadership positions from platoon to brigade; and has deployed once in support of Operation Joint Guardian in Kosovo, four combat tours to Iraq during Operation Iraqi Freedom, and one deployment to Afghanistan in support of Operation Enduring Freedom.

Other previous assignments include Levant Branch Chief for the Plans and Policy Directorate, U.S. Central Command; participation in the Joint Advanced Warfighting School (JAWS) Senior Service College, Norfolk, Virginia; Chief of Plans for the 4th Infantry Division; Commander of the 4th Engineer Battalion during Operation Enduring Freedom; Deputy Chief of Staff for the 4th Infantry Division; Operations Officer for the 3rd Brigade Combat Team, 4th Infantry Division; Operations Officer for 1-8 Infantry Combined Arms Battalion, 3rd Brigade Combat Team; Plans Officer for the 4th Infantry Division in Iraq; completion of Command and General Staff College and the Advanced Military Studies Program (SAMS), Emergency Operations Center Chief, District Executive Officer, Project Engineer, Construction Manager, and the Fallujah Resident Office Officer in Charge of Reconstruction for the New Orleans District; Assistant Brigade Engineer and Battalion Adjutant during Operation Joint Guardian in Kosovo; Company Commander of Alpha Company, in 11th Engineer Battalion, 3rd Infantry Division which included a deployment to Iraq for the invasion in January 2003; and Platoon Leader and Battalion Maintenance Officer in the 65th Engineer Battalion.

Brigadier General Hibner served in the U.S. Army Reserves as an infantry officer for three years before transitioning to active duty as an engineer officer. He holds a Bachelor of Science in Construction Management from Purdue University, a Master of Science in Engineering Management from the Missouri University of Science and Technology, a Master of Military Arts and Science from the School of Advanced Military Studies, a Master of Science in Campaign Planning and Strategy from the National Defense University and is a Project Management Professional. His awards and decorations include the Silver Star, Defense Superior Service Medal, Legion of Merit, Bronze Star Medal (with three oak leaf clusters),

Purple Heart, Meritorious Service Medal (with three oak leaf clusters), Joint Service Commendation Medal, Army Commendation Medal (with three oak leaf clusters), Army Achievement Medal, Combat Action Badge, Ranger Tab, Expert Infantryman Badge, Basic Parachutist Badge, Air Assault Badge, and is also the recipient of the Army Engineer Association's Bronze and Silver Order of the de Fleury Medal.

COL James J. Handura

Colonel James J. Handura assumed duties as the Commander and Division Engineer of South Pacific Division (SPD), U.S. Army Corps of Engineers on Nov. 28, 2023. Established in 1888 and headquartered in San Francisco, SPD is one of nine USACE regional commands. The region encompasses all or part of ten states with four operating districts headquartered in Albuquerque, Los Angeles, Sacramento, and San Francisco. As the SPD Commander and Division Engineer, he is responsible for leading a workforce of more than 2,500 military and civilians, overseeing hundreds of water resource development, military, and interagency design and construction projects valued at more than \$6 billion in support of our communities, our Nation, and our warfighters. A native of Clearwater, Florida, Handura graduated in 1996 from Austin Peay State University in Clarksville, Tennessee as a Distinguished Military Graduate with a Bachelor of Science in Geology, and a commission in the Engineer Regiment. He holds a Master of Science in Geology and Geophysics from the University of Missouri-Rolla, a Master's degree in Military Art and Science – Theater Operations from the U.S. Army School of Advanced Military Studies, and a Master's degree in Strategic Studies from the U.S. Army War College. He is also certified Project Management Professional.

Prior to South Pacific Division, Handura served as the Chief of Staff for the U.S. Army Corps of Engineers Headquarters in Washington, DC. Handura began his military service with the United States Navy Seabee Reserves, serving as a Utilitiesman from 1987 to 1989, at Bayboro Harbor, St. Petersburg, Florida. From 1989 to 1993, he served in the U.S. Army as an enlisted Combat Engineer, with the 82nd Engineer Battalion (Federal Republic of Germany) and the 20th Engineer Battalion (Ft. Campbell, Kentucky and later Ft. Hood, Texas). Col. Handura's command assignments include Commander Sacramento District, USACE; Commander 19th Engineer Battalion, 20th Engineer Brigade, XVIII Airborne Corps at Fort Knox, Kentucky; and Deputy District Commander New Orleans District, USACE. Handura's key staff assignments include Joint Staff J7 Deployable Training Division Lead Observer Trainer, and Engineer Observer Trainer; Executive Officer and S3, 7th Engineer Battalion, 20th Engineer Brigade, XVIII Airborne Corps at Fort Drum, New York; Commander's Initiatives Group Strategic Planner, Multi-National Force-Iraq; J3 Future Operations Planner, Multi-National-Force-Iraq; Deputy Resident Engineer, and Project Engineer, Florida Area Office, Mobile District, USACE; and Assistant Task Force Engineer Task Force Falcon KFOR 3B.

Handura's operational deployments include Operation Desert Shield/Desert Storm; Operation Joint Guardian; Operation Enduring Freedom; and Operation Iraqi Freedom. His

military awards and decorations include the Legion of Merit, Bronze Star Medal, Defense Meritorious Service Medal, and the Meritorious Service Medal. He is a recipient of the Ranger Tab, Sapper Tab, Parachutist Badge, Air Assault Badge, Joint Staff Identification Badge, French Commando School Badge, and the Army Engineer Association's Silver de Fleury Medal.

BG John P. Lloyd

BG John P. Lloyd joined the North Atlantic Division as its Commander and Division Engineer June 24, 2022. Previously he was assigned to Headquarters, U.S. Army Corps of Engineers, where he served as the Chief of Staff since July 20, 2020. As USACE Chief of Staff, Lloyd managed the headquarters staff of a three-star direct reporting unit comprised of more than 36,000 Soldiers and civilians with an annual portfolio of nearly \$84 billion. He led the organization through many events decisive to command success, most notably, synchronizing the USACE response to COVID-19 efforts across the enterprise including resource management, personnel resources, logistical support, and subject matter expertise resulting in a coordinated USACE plan and timely response to the needs of state and local governments. He guided the staff through the development, publication, and modification of budgetary guidance to address challenges in a fiscally constrained environment and coordinated Army reporting requirements with the Office of the Chief of Engineers. Lloyd led the development of the Authorization Realignment Policy to effect strategic planning for the future workforce, served as a member of the U.S. Army's People First Task Force, and as a Cohesion Assessment Team Leader.

Prior to his assignment as USACE Chief of Staff, he served as Command Engineer, U.S. Forces Korea, and United Nations Command. As Command Engineer, he oversaw a multi-billion-dollar host nation construction program and managed the environmental program for the USFK commander. He also coordinated and synchronized mine clearing operations within the Demilitarized Zone. From July 2016 to July 2018, Lloyd served as the Commander of the USACE Pittsburgh District, and during this time, acted as Task Force Commander in the U.S. Virgin Islands and Puerto Rico. In this role, he was responsible for overseeing the USACE response to hurricanes Irma and Maria and a subsequent power grid restoration involving more than 200 enterprise employees and 5,000 utility workers. Lloyd has served in a variety of military assignments spanning his career of more than 27 years. Some of his additional assignments include Strategic Planner, 18th Airborne Corps, Fort Bragg, N.C., an assignment that included a deployment to Iraq; Combat Engineer Trainer, Fort Irwin, Calif.; Aide-de-Camp to the Deputy Commanding General, 18th Airborne Corps; Battalion Commander, 19th Engineer Battalion, Fort Knox, Ky.; and Army Fellow assigned to the Asia Pacific Center for Security Studies in Honolulu, Hawaii.

A native of Lockport, N.Y., Lloyd earned his commission May 1995 through the Reserve Officer Training Corps at Cameron University, Lawton, Okla. Along with his bachelor's degree, he has earned a master's degree in Joint Campaign and Strategic Planning from the National Defense University and graduated from the Canadian Forces College where he studied National Security Policy. Lloyd holds a certification in Construction Project Management from Columbia University in New York, a certificate in Advanced Security Cooperation from the Asia Pacific Center, and is a graduate of the Joint Advanced Warfighting School, Norfolk, Va. Lloyd's military awards and decorations include the Legion of Merit, Bronze Star Medal, Defense Meritorious Service Medal, Army Meritorious Service Medal, Army Commendation Medal, the Joint Service Achievement Medal, the Army Achievement Medal, the National Defense Service Medal, and the Bronze Order of the de Fleury Medal. Lloyd is a graduate of the U.S. Army Sapper School, Air Assault School, Pathfinder School, and is a senior rated jumpmaster.

H. Tuba Ozkan-Haller, Ph.D.

Dr. Tuba Özkan-Haller is the Interim Dean of Oregon State University 's College of Earth, Ocean, and Atmospheric Sciences. and Professor in the Colleges of Earth, Ocean, and Atmospheric Sciences and Engineering. CEOAS is the center of Earth sciences research and academic programs at Oregon State. Its oceanography program is ranked no. 3 in the world. Özkan-Haller previously served as Associate Vice President for Research Administration and Development in Oregon State University's Research Office. She previously also served as Associate Dean for Research and Faculty Advancement in the College of Earth, Ocean, and Atmospheric Sciences. As a faculty member, she focuses on the use of numerical, field, laboratory, and analytical approaches to arrive at a predictive understanding of waves, circulation, and beach change in the nearshore ocean, including the continental shelf, the surf zone, inlets, and estuaries. The results of this work are being applied to navigational planning, for the development and design of wave energy conversion devices, and for forecasting of beach-goer hazards.

She has also extensively engaged in work to increase diversity and inclusivity in academia and was a co-Principal Investigator for OSU's ADVANCE grant from the National Science Foundation aimed at increasing the participation of women and other under-represented groups within faculty in STEM disciplines. She has given various invited talks on this subject, including a plenary talk at the 2018 Goldschmidt Conference of the Geochemical Society and the European Association of Geochemistry. Özkan-Haller is passionate about communicating science to the public and has appeared in numerous documentaries produced by the History Channel, the National Geographic Channel, and Oregon Public Broadcasting, and was quoted in various news segments and newspaper articles, most recently about sneaker wave fatalities along the Pacific Northwest Coastline of the US. She has also authored various opinion pieces. Özkan-Haller is the recipient of the Office of Naval Research Young Investigator Award, the Outstanding Faculty Member Award at the University of Michigan as well as the Pattullo Award for Excellence in Teaching Award and Woman of Excellence Award at OSU. She holds a B.S. in Civil Engineering from Boğaziçi University in Istanbul, Turkey, and a M.C.E. and Ph.D. in Civil Engineering from the University of Delaware.

Lewis Ed Link, Ph.D.

Dr. Lewis E Link is currently a Senior Research Engineer, Department of Civil and Environmental Engineering, University of Maryland. His emphasis in teaching and research has been on natural hazard risk and resilience assessment and mitigation. He currently serves as an advisor to the Governor of Maryland as a member of the Maryland Coast Smart Council and to the Chief of Engineers, U S Army Corps of Engineers through the Corps Coastal Engineering Research Board. He led the post-Katrina analysis of New Orleans and Vicinity as Director of the Interagency Performance Evaluation Task Force and participated as a member of the International Advisory Commission, Netherlands, to develop a long-term strategy for adaptation to sea level rise and climate change.

Dr. Link is a contributing Editor for The Military Engineer and has assisted in the development of an enterprise-wide strategy for accelerating innovation and a new strategy for Civil Works Research and Development for the Corps of Engineers. He previously served as a Senior Executive in the Department of Army as Director of Research and Development and Chief Scientific Advisor, U. S. Army Corps of Engineers. He is a member of the National Academy of Construction and has received the Army Engineer Associations Silver and Gold DeFleury Medals as well as the Engineering News Records Award of Excellence.

Julie Dean Rosati, Ph.D., PE

Dr. Rosati is the Lead Technical Director for Civil Works R&D at the U.S. Army Corps of Engineers, Engineer Research Development Center in the Coastal & Hydraulics Laboratory. In this role, she oversees basic and applied research involving coastal, watershed, navigation, and environmental assessments over short-term storm hazards and long-term evolution. She also serves as Technical Director for the Flood & Coastal Risk Management R&D mission area.

Dr. Rosati has published more than 20 peer-reviewed journal articles, two book chapters, and mentored junior researchers in their professional growth by guiding development of their publications. Her recent research applications have focused on interagency collaborations for coastal system resilience, marine transportation resilience, and integrated engineering, environmental, and community resilience. Additional research interests include long-term coastal morphologic change and regional sediment management. Dr. Rosati is a Professional Engineer in Mississippi and serves as an Associate Editor of ASCE's "Waterways" journal and represents the Corps as a founding agency of the multi-organizational US Coastal Research Program. She has been recognized nationally with the the Orville T. Magoon Sustainable Coasts Award from the American Society of Civil Engineers in 2021, and the Morrrough P. O'Brien Award from the American Shore and Beach Preservation Association in 2023.

Charter
Board on Coastal Engineering Research

1. Committee's Official Designation: The committee shall be known as the Board on Coastal Engineering Research (BCER).
2. Authority: The Secretary of Defense, pursuant to 33 U.S.C. § 426-2 and in accordance with the Federal Advisory Committee Act (FACA) (5 U.S.C., Appendix) and 41 C.F.R. § 102-3.50(a), established this non-discretionary advisory committee.
3. Objectives and Scope of Activities: Pursuant to 33 U.S.C. § 426-2, the BCER shall provide independent advice and recommendations on the functions of the Coastal Engineering Research Center, as set out in paragraph four below.
4. Description of Duties: The BCER provides independent advice and recommendations on the work of the Coastal and Hydraulics Laboratory, which includes the Coastal Engineering Research Center, on coastal engineering research priorities and additional functions as assigned by the Commanding General, U.S. Army Corps of Engineers ("the Chief of Engineers").
5. Agency or Official to Whom the Committee Reports: The BCER reports to the Secretary of Defense or the Deputy Secretary of Defense ("the DoD Appointing Authority"), through the Secretary of the Army and the Chief of Engineers, who may act upon the BCER's advice and recommendations in accordance with Department of Defense (DoD) policy and procedures.
6. Support: The DoD, through the Office of the Secretary of the Army, provides support for the BCER's functions and ensures compliance with the requirements of the FACA, the Government in the Sunshine Act (5 U.S.C. § 552b), governing Federal statutes and regulations, and DoD policy and procedures.
7. Estimated Annual Operating Costs and Staff Years: The estimated annual operating cost, to include travel, meeting, and contract support, is approximately \$327,000. The estimated annual personnel cost to the DoD is 2.0 full-time equivalents.
8. Designated Federal Officer: The BCER's Designated Federal Officer (DFO) shall be a full-time or permanent part-time DoD civilian officer or employee, or active duty member of the Armed Forces, designated in accordance with DoD policy and procedures.

The BCER's DFO is required to attend all BCER meetings for the entire duration of each and every meeting. However, in the absence of the BCER's DFO, a properly approved Alternate DFO, duly designated to the BCER in accordance with DoD policy and procedures, shall attend the entire duration of all BCER meetings. The DFO, or the Alternate DFO, approves and calls all BCER meetings; prepares and approves all meeting agendas; and adjourns any meeting when the DFO, or the Alternate DFO, determines adjournment to be in the public interest or required by governing regulations or DoD policy and procedures.
9. Estimated Number and Frequency of Meetings: The BCER shall meet at the call of the BCER's DFO, in consultation with the BCER's Chair. The estimated number of BCER meetings is two per year.
10. Duration: The need for this advisory committee is on a continuing basis; however, the charter is subject to renewal every two years.

Charter
Board on Coastal Engineering Research

11. Termination: The BCER will terminate upon rescission of 33 U.S.C. § 426-2.
12. Membership and Designation: The BCER, pursuant to 33 U.S.C. §§ 426 and 426-2, shall be composed of seven members. Four members shall be officers of the U.S. Army Corps of Engineers, appointed as follows –
 - a. one of whom shall be the Deputy Commanding General for Civil and Emergency Operations, U.S. Army Corps of Engineers (“the Deputy Commanding General”), who shall serve as the Chair of the BCER for no fixed term of service; and
 - b. the other three shall be chosen from among the eight coastal division commanders, based on tenure as a division commander and expertise in the matters before the BCER.

The remaining three BCER members shall be civilian engineers selected with regard to their special fitness, such as expertise and advanced education in the fields of beach erosion, shore protection, nearshore coastal processes and infrastructure, and related fields. Comprehensive expertise of the three civilian members will be able to advise on coastal processes and nearshore beach, dune and bluff response for the Atlantic, Gulf of Mexico, Pacific, and Great Lakes coastal regions of the Nation.

The appointment of the civilian BCER members and the three coastal division commanders shall be approved by the DoD Appointing Authority, for a term of service of one-to-four years in accordance with DoD policy and procedures. Pursuant to 5 U.S.C. § 3109 and DoD policy and procedures, appointments for civilian members of the BCER are subject to annual renewals. No member, unless approved by the DoD Appointing Authority, may serve more than two consecutive terms of service on the BCER or serve on more than two DoD Federal advisory committees at one time.

BCER members who are not full-time or permanent part-time Federal officers or employees, or active duty members of the Uniformed Services, shall be appointed as experts or consultants, pursuant to 5 U.S.C. § 3109, to serve as special government employee (SGE) members. BCER members who are full-time or permanent part-time Federal officers or employees, or active duty members of the Uniformed Services, shall be appointed pursuant to 41 C.F.R. § 102-3.130(a) to serve as ex officio RGE members.

All BCER members are appointed to exercise their own best judgment on behalf of the DoD, without representing any particular point of view, and to discuss and deliberate in a manner that is free from conflict of interest.

Pursuant to section 105 of the Flood Control Act of 1970 (Public Law 91-611), SGE members may be paid at a rate not to exceed the daily equivalent of the rate for a GS-15, step 10, for each day of attendance at BCER meetings, not to exceed 30 days per year, in addition to travel and other necessary expenses connected with their official duties on the BCER, in accordance with the provisions of 5 U.S.C. §§ 5703(b), (d), and 5707. RGE members shall be reimbursed for official BCER-related travel and per diem.

13. Subcommittees: The DoD has determined that subcommittees will not be authorized for this advisory committee.

Charter
Board on Coastal Engineering Research

14. Recordkeeping: The records of the BCER shall be managed in accordance with General Records Schedule 6.2, Federal Advisory Committee Records, or other approved agency records disposition schedule, and the appropriate DoD policy and procedures. These records shall be available for public inspection and copy, subject to the Freedom of Information Act (5 U.S.C. § 552).
15. Filing Date: April 21, 2022

**Executive Session
Board on Coastal Engineering
Research**

19-20 March 2024
Renaissance Portsmouth-Norfolk
Waterfront Hotel, Norfolk, VA

WebEx:
<https://usace1.webex.com/meet/christopher.r.northfield>

Meeting number: 2761 612 4938

Audio connection:
US Toll Free +1-844-800-2712
US Toll +1-669-234-1177

AGENDA

Working Theme: *Coastal Storm Risk Management R&D Challenges and Solutions in Urban Coastal Settings*

Meeting Room: Renaissance Hotel Grand IV Ballroom

Monday March 18, 2024

1800 2000 Registration – Renaissance Hotel Grand IV Ballroom
1830 2100 Board Pre-Brief Dinner – Froggy Bar and Grill-Located inside Hotel

Tuesday March 19, 2024

Meeting Attire: Military- Cammies/OCP; Civilian-Business Casual Meeting

0700	0800	Registration	Renaissance Hotel Grand IV Conference Room
0730	0800	Breakfast	
0800		Call to Order	Dr. Julie Rosati, ERDC/CHL
0800	0830	Welcome and Introductions	MG William H. “Butch” Graham, Jr. Deputy Commanding General for Civil and Emergency Operations, Headquarters (HQ), U.S. Army Corps of Engineers (USACE)
		Welcome to NAO	COL Brian Hallberg Commander Norfolk District, NAO

Panel Session #1: Norfolk District Coastal Processes & Challenges

Moderator: Mr. Brandon Harris

Chief, Design Branch, Engineering and Construction Division, NAO

0830	0900	NAO Coastal Setting, Processes, Projects and R&D Needs	Michelle Hamor, Chief, Planning and Policy Branch, NAO
0900	0930	Challenges to NBS Implementation and Finding Leverage in MDBB Pilot Program	Zach Martin, Chief, Planning Resources Section, NAO Justine Woodward MDBB CSRM Environmental Team Lead, NAO
0930	0945	Break	
0945	1015	NAO Virginia Beach Study	Kristin Mazur, Project Manager, NAO
1015	1045	NAO City of Norfolk CSRM Project and R&D Needs	Kyle Spencer Chief Resilience Officer, City of Norfolk
1045	1115	From the Sea to the Stars, Resilience in Hampton	Scott Smith, Senior Civil Engineer, City of Hampton, Virginia
1115	1145	Sea Level Rise and Climate Resiliency at JBLE-Langley	Cecilia Boyd, Natural Resources Program Manager, USAF Langley

Norfolk Site Visit

1145	1215	Overview of Site Visit	Brandon Harris, NAO
1215	1245	Break; Board Busses	
1245	1700	Box Lunch; Site Visit	
1700	1730	Return to Hotel	
1830	2100	Dinner Social	Roger Brown's Restaurant 316 High Street, Portsmouth, VA

Wednesday, March 20, 2024

Meeting Attire: Military- Cammies/OCP; Civilian-Business Casual

0730	0800	Breakfast	
0800	0830	Welcome Board Comments on Day 1	BCER

Panel Session #2: Coastal Sediment Transport Research Needs and Plans

Moderator: Dr. Jack Puleo

Concept: 15 min per panel speaker interspersed with 45 min Q/A session

0830	0845	Introduction to Panel Session and Panelists	Dr. Jack Puleo, University of Delaware
0845	0900	Non-Cohesive Sediment Transport R&D Needs and Plans	Dr. Kate Brodie, ERDC/CHL
0915	0930	ERDC Cohesive Sediment Transport Capabilities	Dr. Jarrell Smith, ERDC/CHL
0945	1000	Break	
1000	1015	AI applications to sediment transport	Dr. Tom Hsu, University of Delaware
1030	1045	National USACE Sediment Transport Needs in Coastal Planning, Engineering, and O&M	John Winkelman, USACE CWG
1100	1115	A Strategy for Prioritizing CW R&D Investment in Sediment Transport	Dr. Rob Holman, Oregon State University, BCER Emeritus
1130	1200	Discussion: Coastal Sediment R&D – Summary of Priorities	BCER
1200	1300	Working Lunch	

Planning for Next 100 BCER Meetings

1300	1330	WRDA 2022 Section 8106: Assessment of Integrated Compound Storm Impacts	Dr. Gaurav Savant, CHL
1330	1400	BCER Moon-Shots	Dr. Ed Link, BCER
1400	1430	100th BCER Meeting, San Francisco, CA (Action Item 2023-Full-4)	Ms. Heather Schlosser, USACE SPD and BCER Discussion

1430 1445 Break

1445 1515 Synthesis of R&D Priorities Dr. Jane Smith,
Emeritus Senior Research
Scientist, CHL

Closing and Next Steps

1515 1545 Public Comment Written comments must be
submitted to Dr. Julie Rosati,
Julie.D.Rosati@usace.army.mil

1545 1615 BCER Member Discussion BCER

1615 1645 Review Ongoing & New Action Items Dr. Julie Rosati ERDC/CHL

1645 1700 Closing Comments BCER

1700 Adjourn MG Graham

Presentations

Day 1

A Coastal Setting, Processes, Projects and R&D Needs

Ms. Michelle Hamor, Chief, Planning and Policy Branch, NAO
(Briefing to be provided as handout)

Challenges to NBS Implementation and Finding Leverage in MDBB Pilot Program

*Zach Martin
Norfolk District
Norfolk, VA*

*Justine Woodard
Norfolk District
Norfolk, VA*

Introduction

We are witnessing a surge in global coastal storm risk management (CSRМ) projects, with numerous localities rushing to develop coastal resilience plans in response to costly climate change impacts. Amidst this frenzy, stakeholders have called for inclusion nature-based solutions (NBS) as measures in these plans to manage coastal storm risk. However, integrating NBS in CSRМ has been hindered by a range of roadblocks regarding efficacy knowledge gaps, opportunity at scale, design innovation, regulatory constraints, and funding. Many of these plans are being developed in partnership with U.S. Army Corps of Engineers (USACE) to alleviate some of these issues, though this can also leave teams hamstrung by project authority and USACE Civil Works planning policy and process. Moreover, human dimensions among teams and stakeholders like (mis)communication, skepticism, and reluctance tie all of these factors together to make NBS implementation in CSRМ remarkably challenging. USACE Norfolk District's recent experiences have highlighted how these factors have limited NBS inclusion in resilience plans in the past, and how teams can overcome these challenges.

Our study team has firsthand experience encountering these challenges—with notable examples on the issues of efficacy knowledge gaps leading to team skepticism and early screening, inadequate quantitative methods hindering benefits analyses, limited opportunities at scale in urban areas, and mismatches between absolute efficacy and planned risk management levels. Historically, incorporating NBS as a solution for managing coastal storm risk has been a challenge for feasibility studies because of the difficulty in quantifying the economic benefits associated with these measures and minimal agency guidance. During the Norfolk CSRМ feasibility study, the study team initially proposed up to 8.7 cumulative miles of living shoreline or oyster reef NBS. The Recommended Plan included only 0.4 miles of oyster projects justified by their economic benefits in reducing operations and maintenance (O&M) costs associated with several proposed surge barriers. The O&M cost reduction was quantified using a simple provisional approach of applying an adjustment to costs on a percent basis following the findings

from a peer reviewed study on the CSRSM benefits of a variety of NBS measures; the CSRSM benefits of the NBS features were not modeled directly in future with project simulations as is done for other proposed measures.

Regardless, this result speaks to how difficult it can be to find significant lengths and widths of shoreline real estate in coastal urban landscapes that align with dimensions and elevations required by functional NBS projects in areas collocated with CSRSM need. Moreover, the small scale NBS measures that do get proposed struggle to compete in benefit evaluations with gray CSRSM measures serving the same location. With this likely outcome in mind, teams often end up screening out NBS measures early during scoping discussions. Current planning models lack familiar and broadly applicable modules to simulate the effect of NBS features on storm surge and waves alongside any proposed structural and nonstructural measures. This can leave the most important NBS benefits going uncharacterized, hindering both sound comparative analysis and public understanding of NBS effectiveness.

Despite the challenges, the Norfolk CSRSM study team did secure a USACE policy exception approved by vertical leadership to justify an additional 3.9 miles of living shoreline and oyster NBS projects based on a qualitative assessment of co-benefits suggesting an increase in recreational opportunities. This is noteworthy given it was before a 2021 USACE policy directive broadened the scope of benefits of a civil works planning studies to a comprehensive consideration of project benefits including economics, environmental, and social categories. Still, a significant portion of NBS projects remained screened out to the disappointment of the public. The USACE Norfolk District encountered similar challenges on the Miami-Dade Back Bay (MDBB) CSRSM feasibility study, where overwhelming public opposition to proposed gray solutions and demand for NBS in a multiple lines of defense strategy have shaped this study's story. As this study approaches a 2024 final report, the Recommended Plan seeks authorization of a \$150 million NBS Pilot Program. This program will aim to develop a suite of demonstration projects to inform the calculation of CSRSM benefits provided by different NBS types and to enhance understanding of how NBS reduce coastal storm damage to property and infrastructure in the study area. Pilot projects are crucial to addressing specific information gaps associated with the quantitative evaluation of CSRSM benefits and to examine the effectiveness of CSRSM solutions while leveraging environmental and social co-benefits. The proposal for a NBS Pilot Program builds upon extensive stakeholder feedback received from 2019 to present via a variety of settings, proving invaluable to overcoming NBS challenges. Requesting the authorization of a NBS Pilot Program itself is also bound to overcome some of the systemic human dimensions challenges described previously.

Overcoming the challenges to NBS implementation for CSRM is going to take significant commitment to change and research. USACE Norfolk District recommends broad investment in the following knowledge gaps for focused research and development, some of which we plan to address in the MDBB NBS Pilot Program if authorized:

- User-friendly, geospatial tools that facilitate real-time exploration of nature-based services of local existing + FWOP conditions in scoping workshop setting
- Interdisciplinary field studies simultaneously tracking multiple benefits classes (physical, ecological, economic, and social) of NBS with robust (Before-After-Control-Impact) study designs
- Monitoring programs that account for critical temporal data gaps (e.g., storm-time performance; [long-term] lag time to benefits)
- Innovative coupled model frameworks for integrated systems (e.g., hydrodynamics + economics + ecological + social)
- Building off coral and mangrove NBS science: test performance varied by basic design specs of oyster reef in lab + field (e.g., reef crest width; reef porosity / permeability; single strip vs. multi-strip reef)

NATURE-BASED SOLUTIONS: CHALLENGES TO IMPLEMENTATION & FINDING LEVERAGE IN THE MIAMI-DADE BACK BAY PILOT PROGRAM

BOARD OF COASTAL ENGINEERING RESEARCH

March 19, 2024

Zach Martin

Chief, Environmental Analysis Section

Norfolk District, U.S. Army Corps of Engineers

Justine Woodward

Senior Biologist, Environmental Analysis Section

Norfolk District, U.S. Army Corps of Engineers



U.S. ARMY



**US Army Corps
of Engineers**

“The views, opinions and findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation.”



THE STRUGGLE TOWARD GREENER SOLUTIONS

- Coastal storm risk management (CSRM) project 'bubble'
- CSRM project mania → outcry for green solutions
- Project teams hamstrung to implement nature-based solutions (NBS) by diverse array of factors

Opportunity
at scale

Regulatory
compliance

Funding

Design
innovation

Corps
Planning
Policy +
Process

Efficacy

Authority

Quantitative
Ways & Means





HUMAN DIMENSIONS IN NBS IMPLEMENTATION

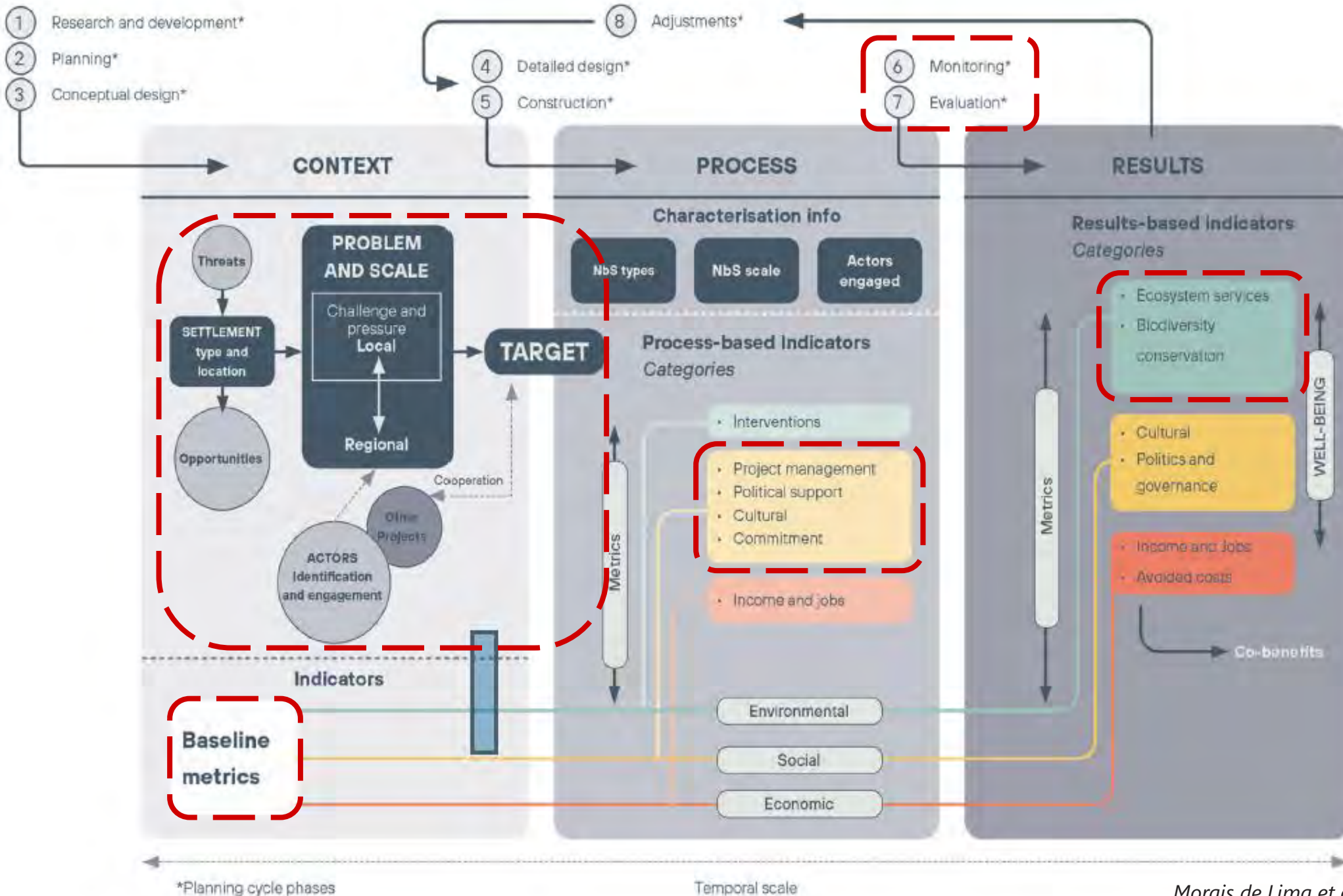
- Communication challenges
- Team skepticism and reluctance
- Local preference
- Lessons from Norfolk District



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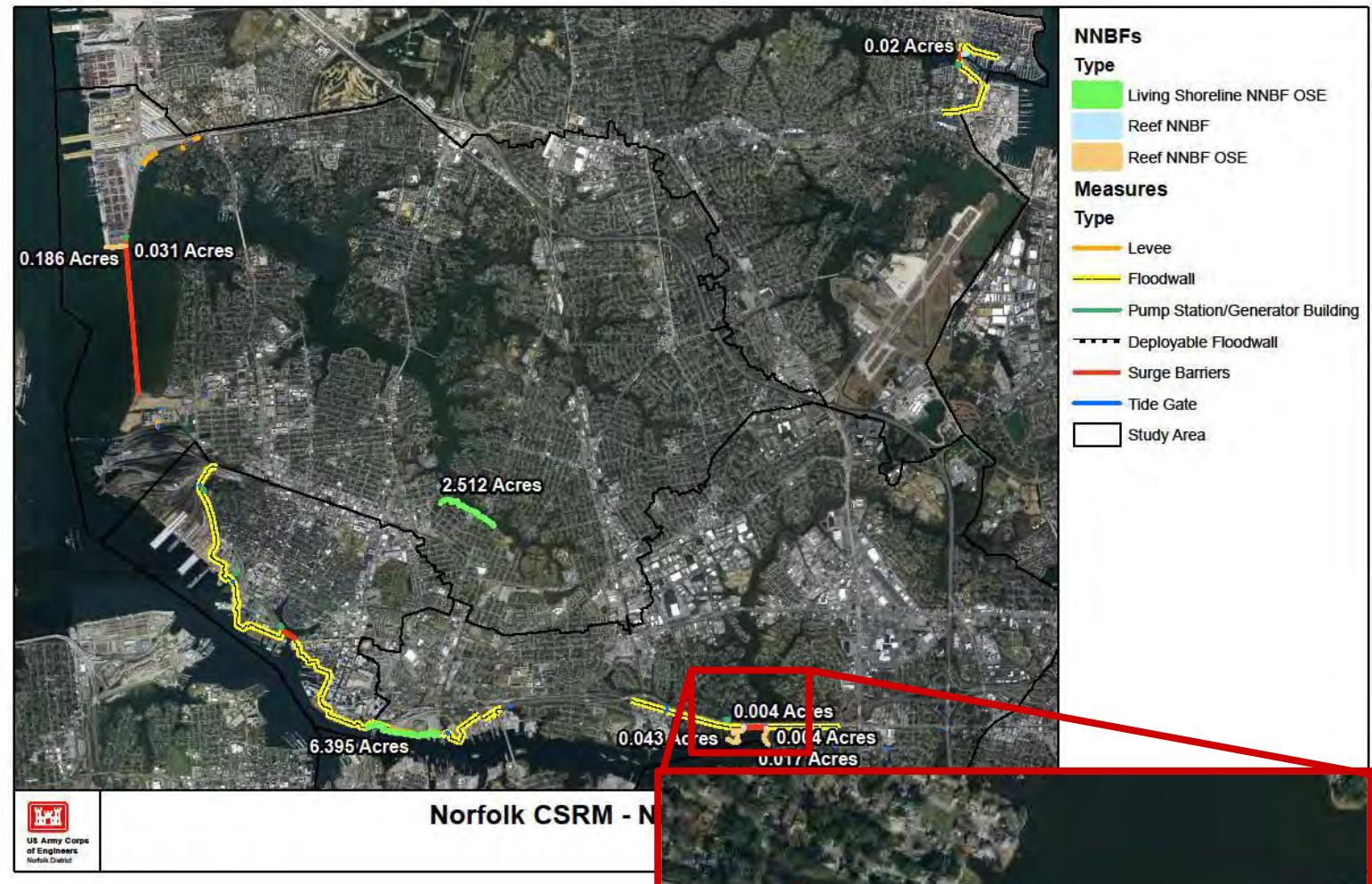


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CASE STUDY: NORFOLK CSRSM

- Stakeholders eager to see NBS projects in plans
- 0.4 mi of oyster reef NBS for \$157k reduction in O&M costs
- 3.9 mi of oyster reef + living shoreline for OSE
- 4.3mi of NBS screened out



TOP CHALLENGES

- Urban setting → limited opportunities at scale
- Limited tools and methodology w/in planning models
- Mismatched efficacy and need
- Policy constraints



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MIAMI-DADE BACK BAY 2024 REPORT: NATURE-BASED SOLUTION PILOT PROGRAM

Public opposed gray solutions proposed in 2020 draft EIS + demanded NBS

Extensively scoping of potential NBS projects with local stakeholders 2022 – 2023

A wide range of **multiple lines of defense** projects on the table



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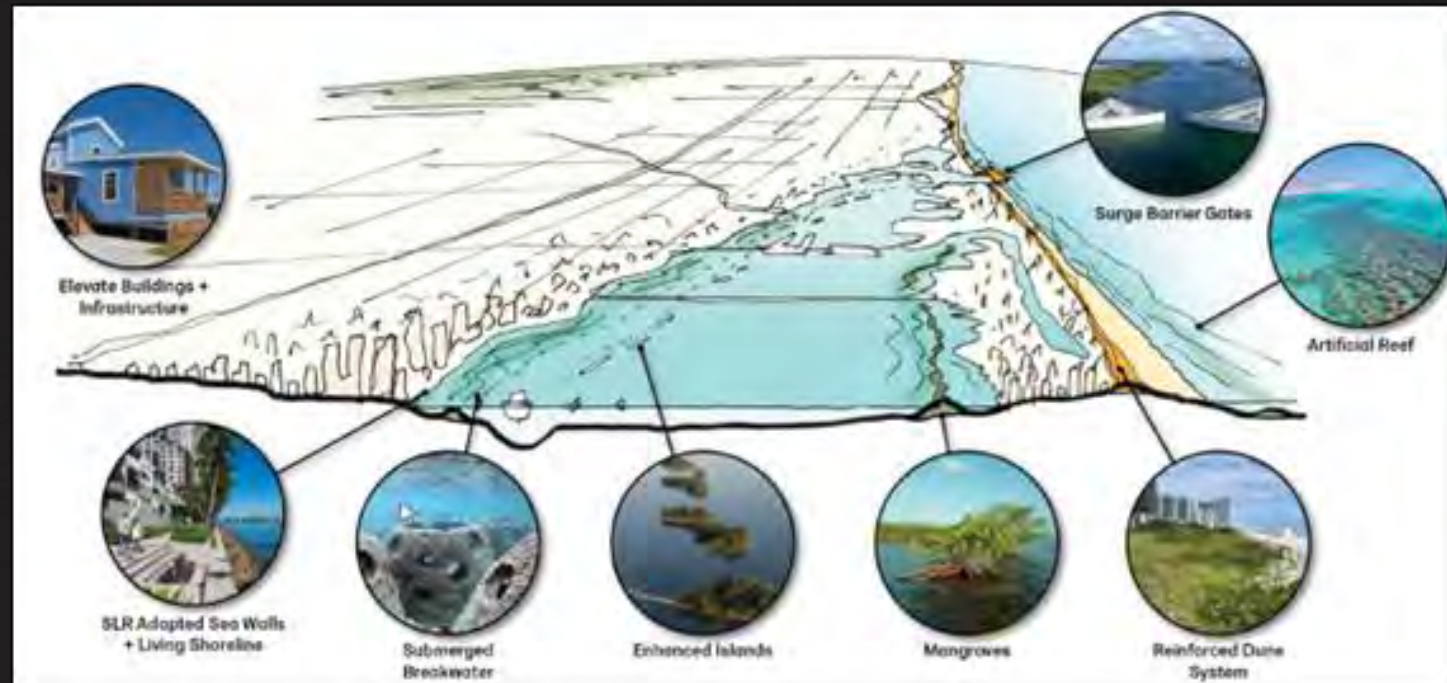
MIAMI-DADE BACK BAY 2024 REPORT: NATURE-BASED SOLUTION PILOT PROGRAM

The 2024 Report will include a request for Programmatic Authorization of a Nature-Based Solution (NBS) Pilot Program.

Purpose: to fund a suite of pilot demonstration projects that will individually inform the calculation of Coastal Storm Risk Management (CSRM) benefits provided by different types of NBS, and collectively contribute to a greater understanding of how nature-based solutions reduce coastal storm damage to property and infrastructure in the Miami-Dade study area.

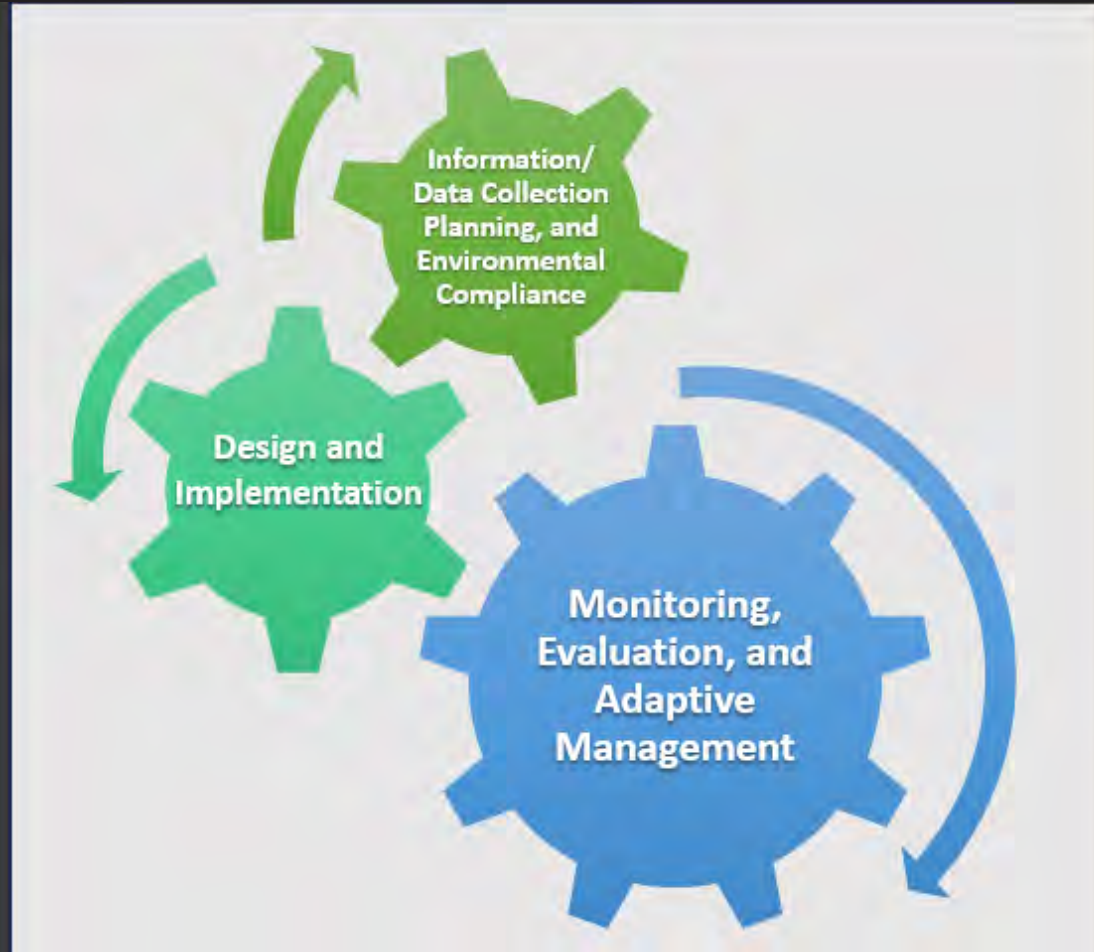
The future pilot projects to be selected in line with County's objectives towards a multiple lines of defense strategy to managing coastal storm risk.

Program Phase	Estimated Cost Ranges
Phase 1: Information / Data Collection, Planning, and Environmental Compliance	\$3,000,000
Phase 2: Design and Implementation	\$4,000,000 - \$19,000,000
Phase 3: Monitoring, Evaluation, and Adaptive Management	\$3,000,000
Individual Demonstration Project Cost (Maximum)	\$25,000,000
Recommended Programmatic Cost Limit	\$150,000,000



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MIAMI-DADE BACK BAY: PROPOSED NBS PILOT PROGRAM



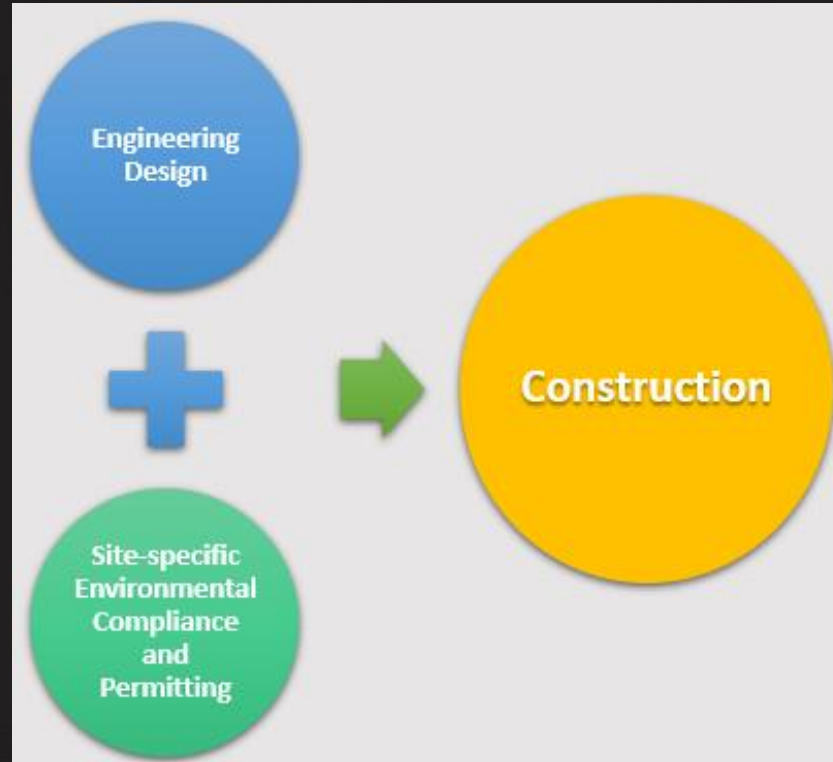
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MIAMI-DADE BACK BAY: PROPOSED NBS PILOT PROGRAM

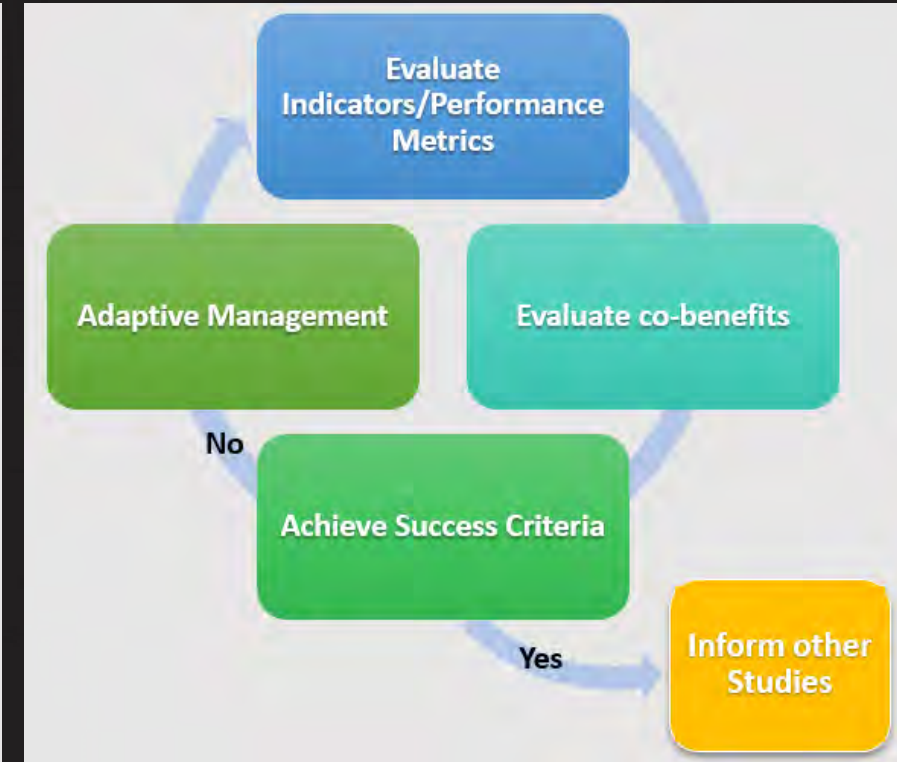
Information/Data Collection,
Planning, and Environmental
Compliance



Design and
Implementation



Monitoring, Evaluation, and
Adaptive Management



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R&D GAPS & RECOMMENDATIONS

- User-friendly, geospatial tools that facilitate real-time exploration of nature-based services of local existing + FWOP conditions in scoping workshop setting
- Interdisciplinary studies simultaneously tracking multiple benefits classes (physical, ecological, economic, and social) of NBS with robust (Before-After-Control-Impact) study designs
- Monitoring that accounts for temporal data gaps (e.g., storm-time performance; [long-term] lag time to benefits)
- Innovative coupled model frameworks for integrated systems (e.g., hydrodynamics + economics + ecology + social)
- Building off coral and mangrove science → test performance of varied by basic design specs of oyster reef in lab + field (e.g., reef crest width; reef porosity / permeability; single strip vs. multi-strip reef)
- Acknowledging the human dimensions aspect of integrating evaluation into planning process

QUESTIONS?



CITY OF VIRGINIA BEACH COASTAL STORM RISK MANAGEMENT

INTEGRATED FEASIBILITY STUDY WITH ENVIRONMENTAL IMPACT STATEMENT

Board on Coastal
Engineering Research

Kristin Mazur
Project Manager

Michelle Hamor
Chief, Planning and Policy Branch



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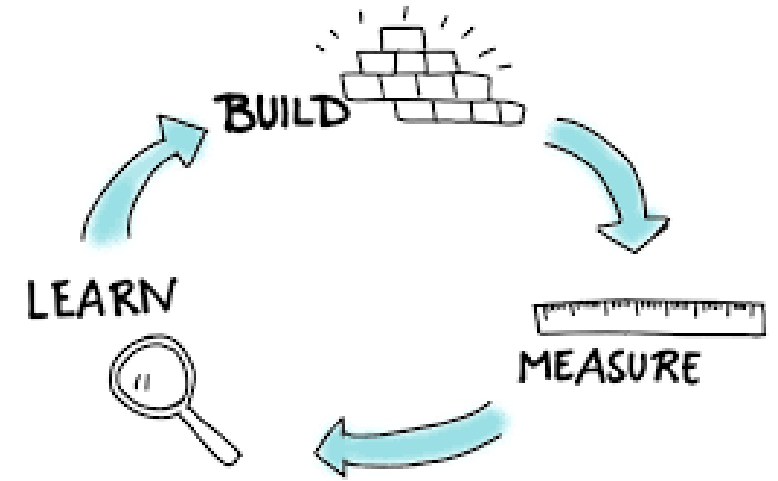
Photos from Virginia Beach Sea Level Wise Adaption Strategy Report



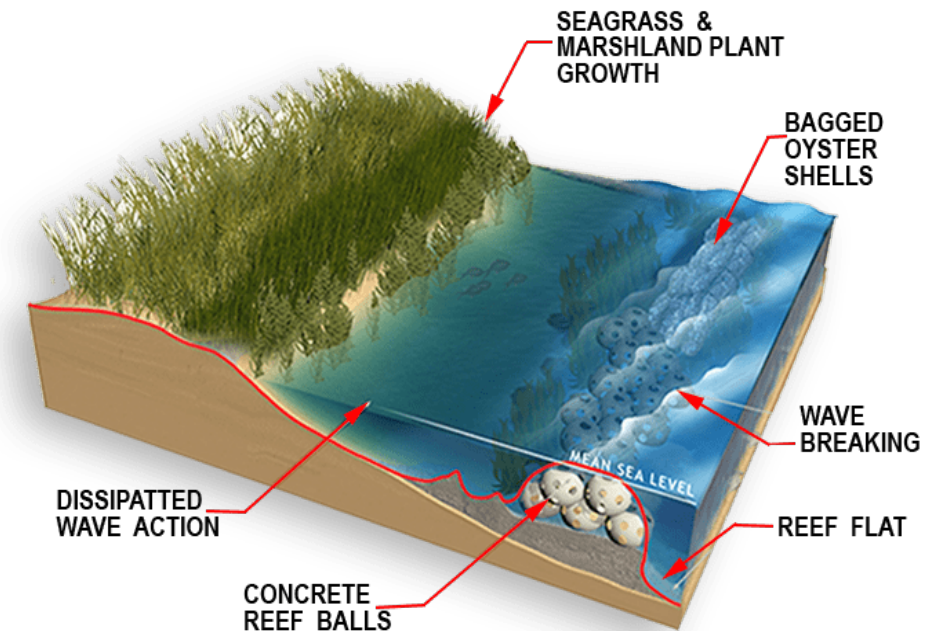
RESEARCH AND DEVELOPMENT NEEDS



- Buy Down Risk and Uncertainty
- Revisit Benefit Cost Ratio calculation
- Invest in Critical Infrastructure Depth Damage Functions
- Available data has not been our friend
- Build, Learn, Measure, Inform future efforts
- Nature-Based Solutions
- Nonstructural Measures



CUI



CUI



RISK AND UNCERTAINTY

- Availability of Sand
- Environmental Compliance
- Construction Timeline

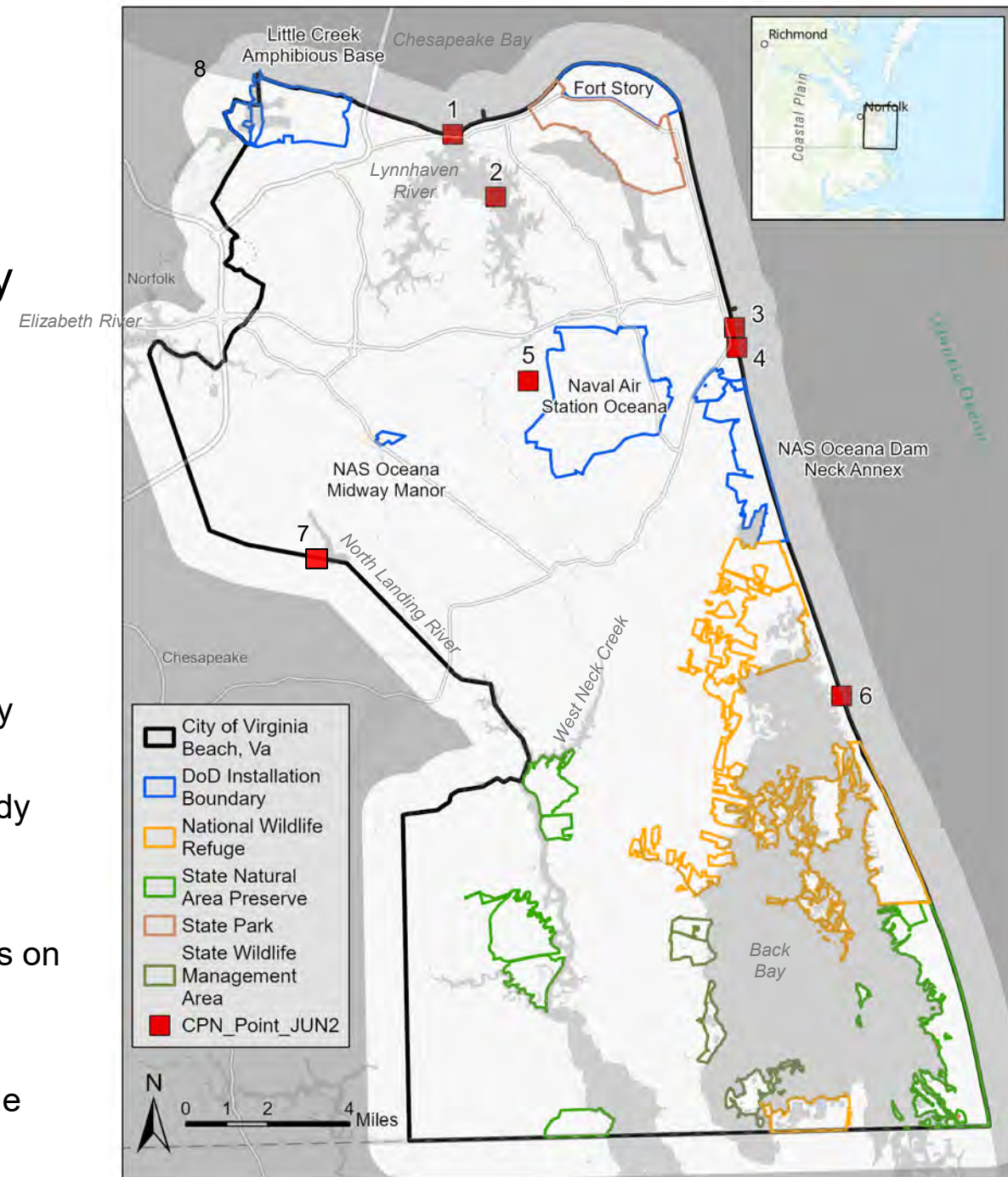




STUDY AREA MAP

- Study area is the City of Virginia Beach
- Multiple existing federal projects within the study area
 1. Lynnhaven Inlet Federal Navigation Channel
 2. Lynnhaven River Basin Ecosystem Restoration Project
 3. Virginia Beach Hurricane Protection Project
 4. Rudee Inlet Federal Navigation Channel
 5. Canal No. 2 Flood Risk Management Project
 6. Sandbridge Hurricane Protection Project
 7. Atlantic Intracoastal Waterway (AIWW) Albemarle and Chesapeake Canal
 8. Norfolk Coastal Storm Risk Management Project (immediately adjacent)
- The study is a single purpose coastal storm risk management study within a large, complex study area.
- Alternatives will be formulated and evaluated to meet the study objectives with the goal of managing the impacts of coastal storms on the population and development within the City of Virginia Beach
- The study will include the reevaluation of the two existing federal beach projects in the city and the Recommended Plan may include modifications to those authorized projects

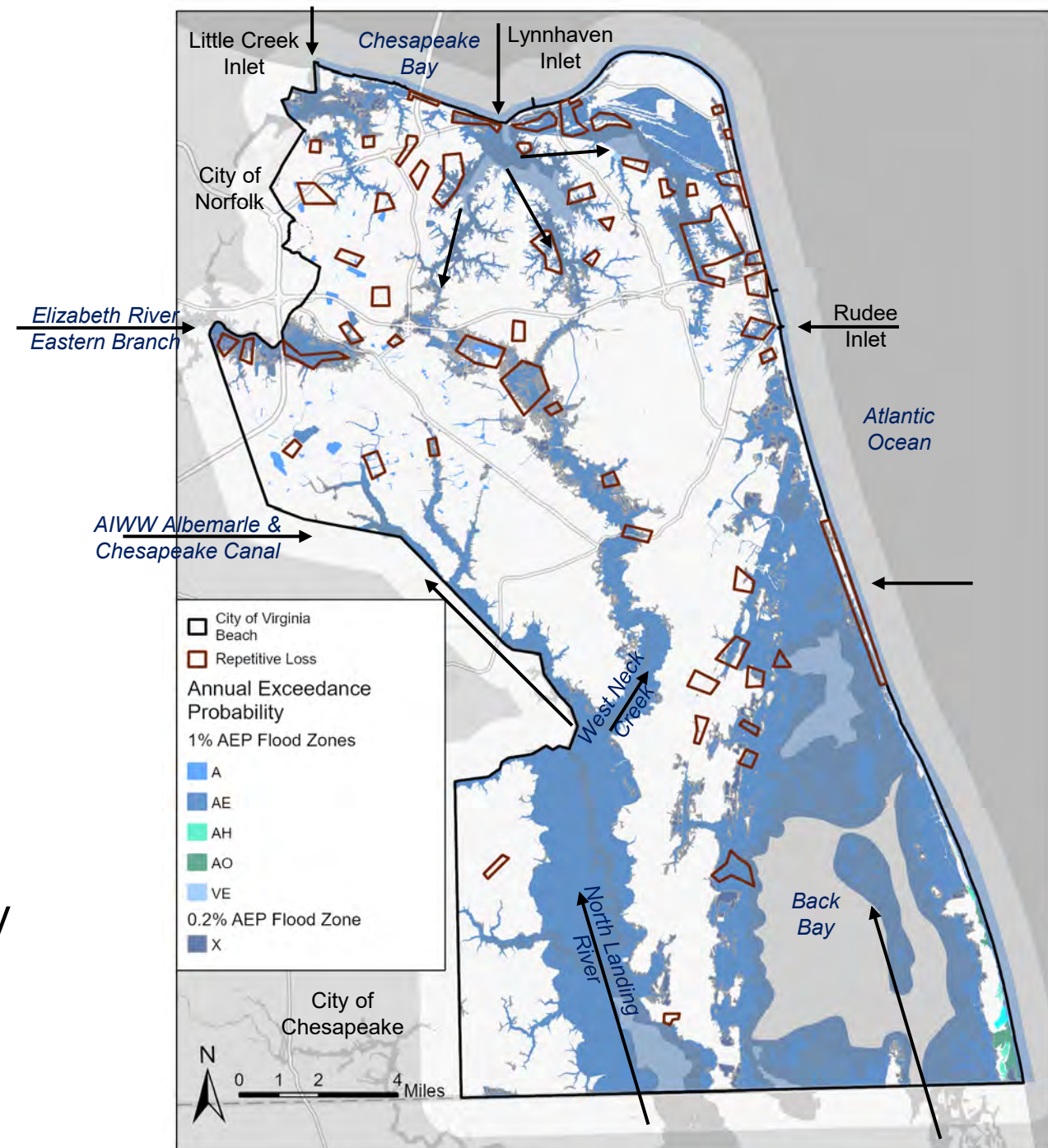
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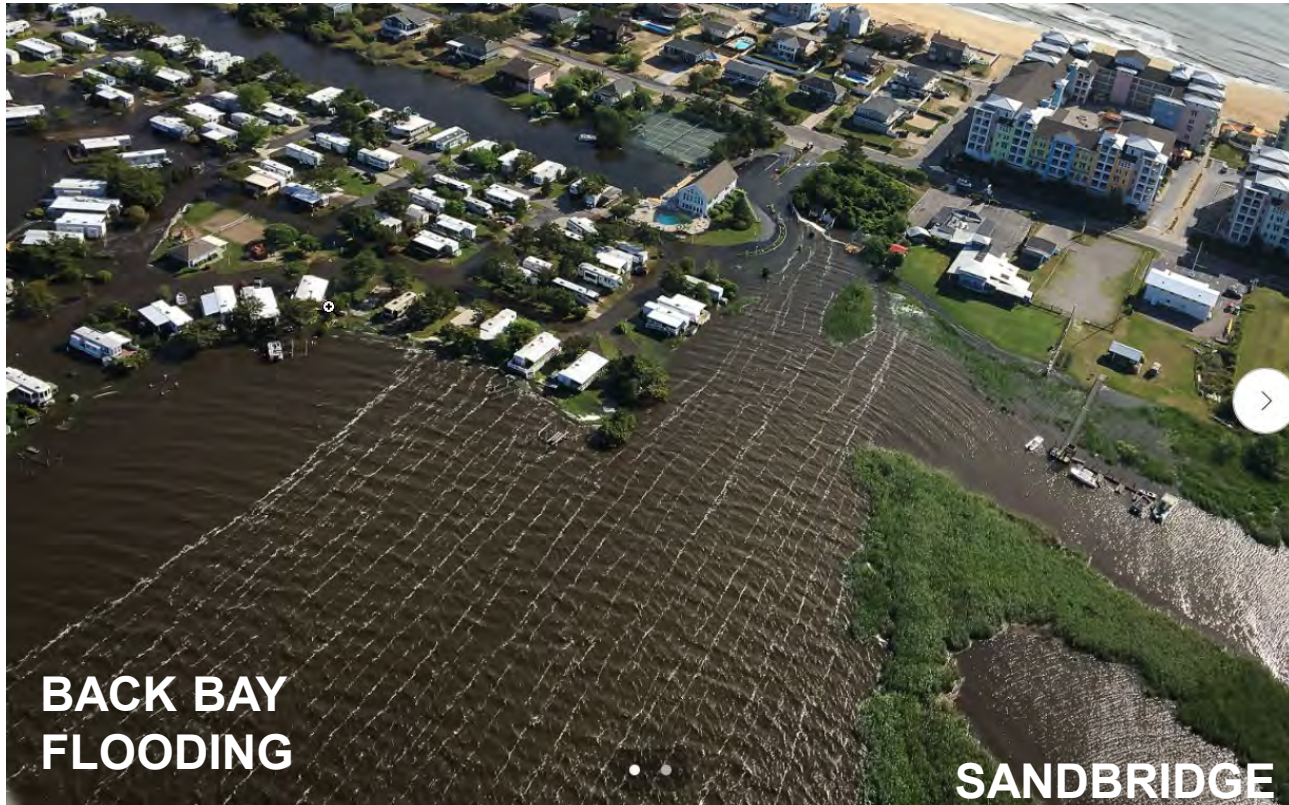
EXISTING CONDITIONS FEMA FLOODPLAINS

- Virginia Beach has the third highest repetitive loss (\$45m) following the Cities of Hampton (\$51m) and Norfolk (\$49m)
- Multiple pathways for flooding
- Sea Level Wise Adaptation Strategy
- City of Virginia Beach participates in the National Flood Insurance Program
- Community Rating System (CRS) Community Rating of 7





FLOODING CHALLENGES





RISK DRIVERS TO COST AND TIME



- **Extensive Modeling Efforts are required due to the Study Area Size, Complexity and Scope:**

- Two economic models are needed to evaluate the Future Without project condition and the alternatives—one model for the beachfront areas and one model for the tidally influenced estuarine areas in the interior of the city.
- The city covers 310 square miles and two watersheds (Chesapeake Bay and Albemarle-Pamlico). The study team estimates approximately 20 miles of beachfront will be modeled with Beach-fx during the study.
- The scope of this study also accounts for the comprehensive documentation of benefits across all four accounts (National Economic Development (NED), Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ) and the consideration of environmental justice communities within the study area.
- The study area includes an inventory of over 150,000 structures.

- **Environmental Documentation and Compliance includes survey and modeling**

- The study area is the largest city in Virginia and includes both beachfront area and tidally influenced estuarine areas that are affected by coastal storm events.
- Funds and time scoped include contracted habitat surveys, plus hydrodynamic, water quality, and sediment transport modeling required for environmental compliance.



MODELING EFFORT: SBEACH, BEACH-FX AND G2CRM

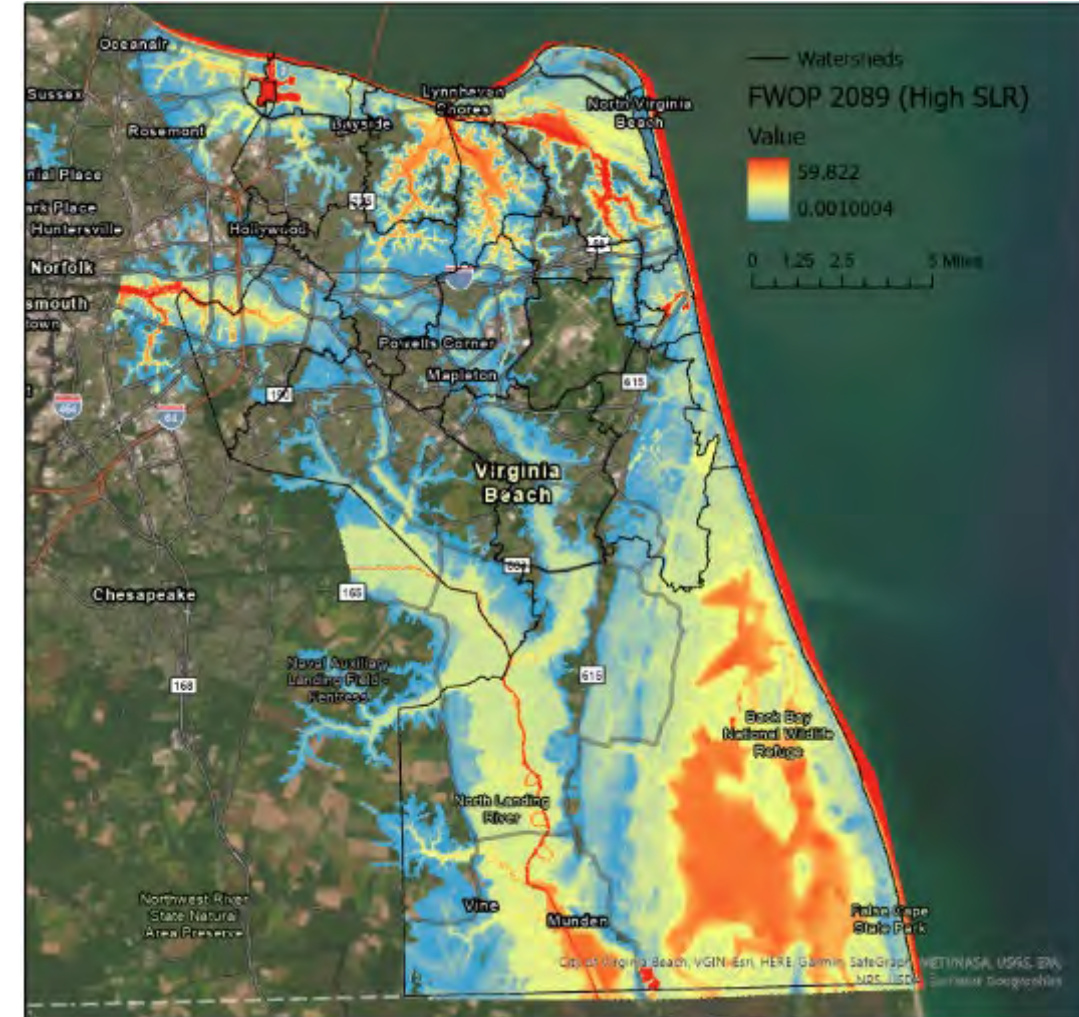


Modeling Efforts

- Beach-fx will be used to evaluate structure damage caused by coastal storm inundation, waves, and erosion/land loss in beachfront areas
- G2CRM will be used to evaluate structure damage caused by coastal storm surge flooding in tidally influenced areas that are not beachfront

Risks to the Study

- Analyzing approximately 20 miles of non-federal beachfront
- Alignment with Norfolk CSRM and Naval Facilities throughout the study area
- Cannot be completed within the 3x3x3 SMART study schedule or budget requirements
 - Extensive time for model setup
 - Extensive time for model runs and analysis

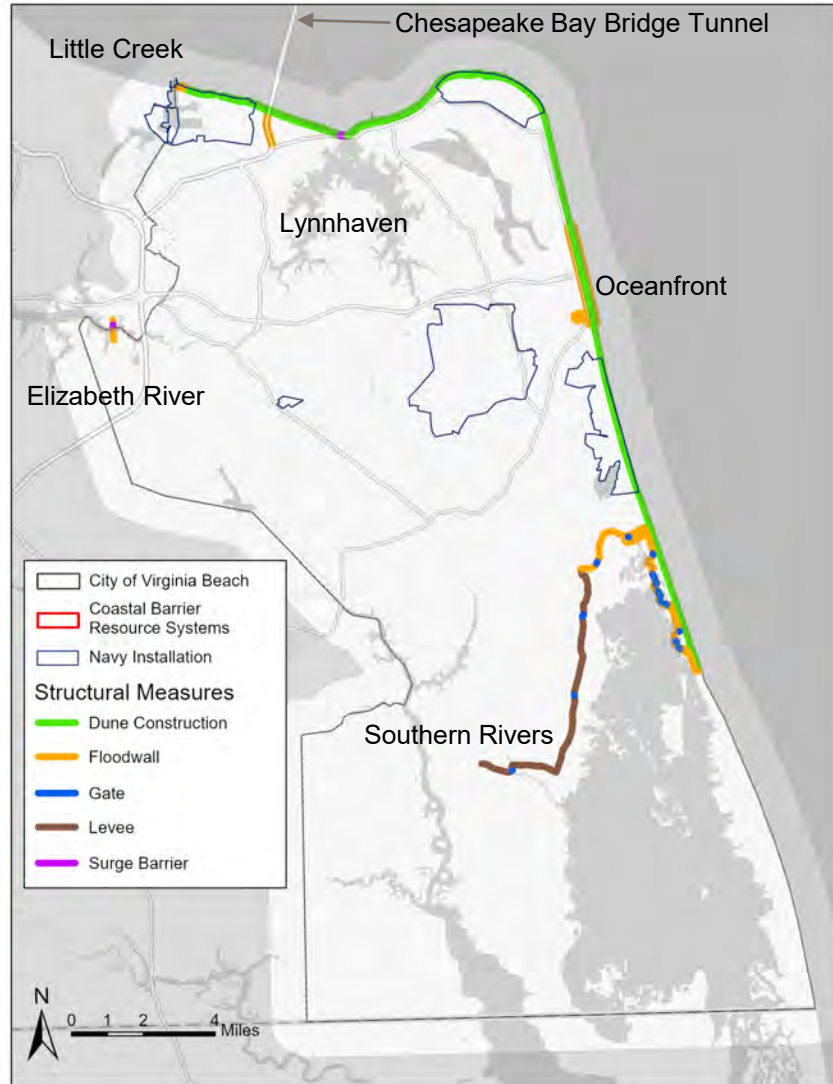




POTENTIAL STRUCTURAL MEASURES

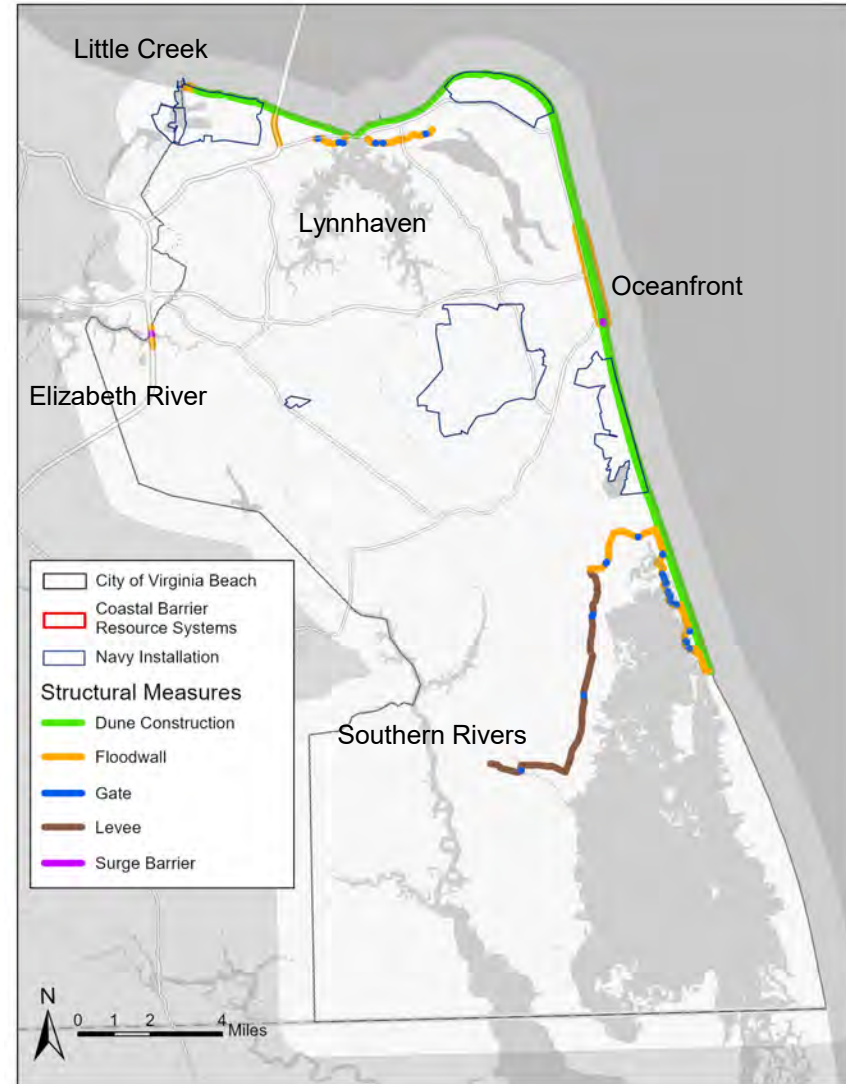


Measures – Option A



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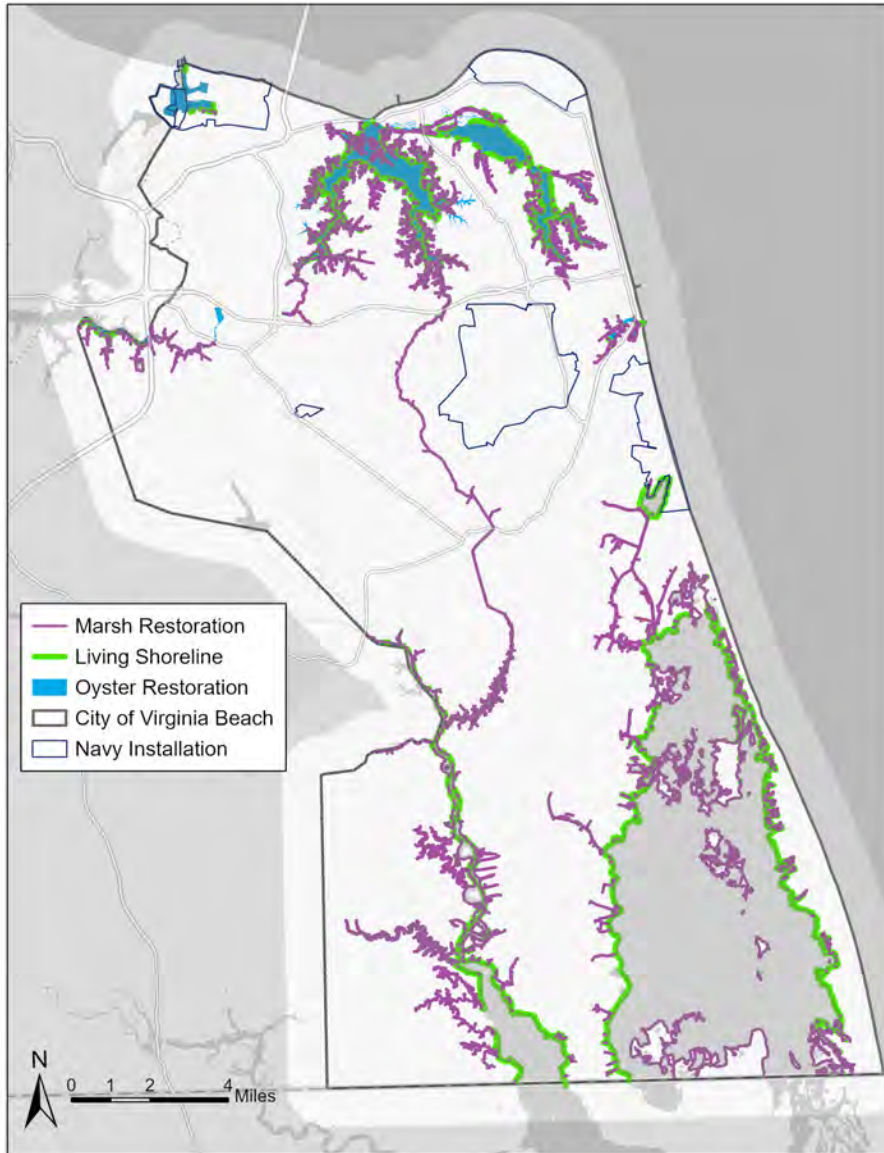
Measures – Option B



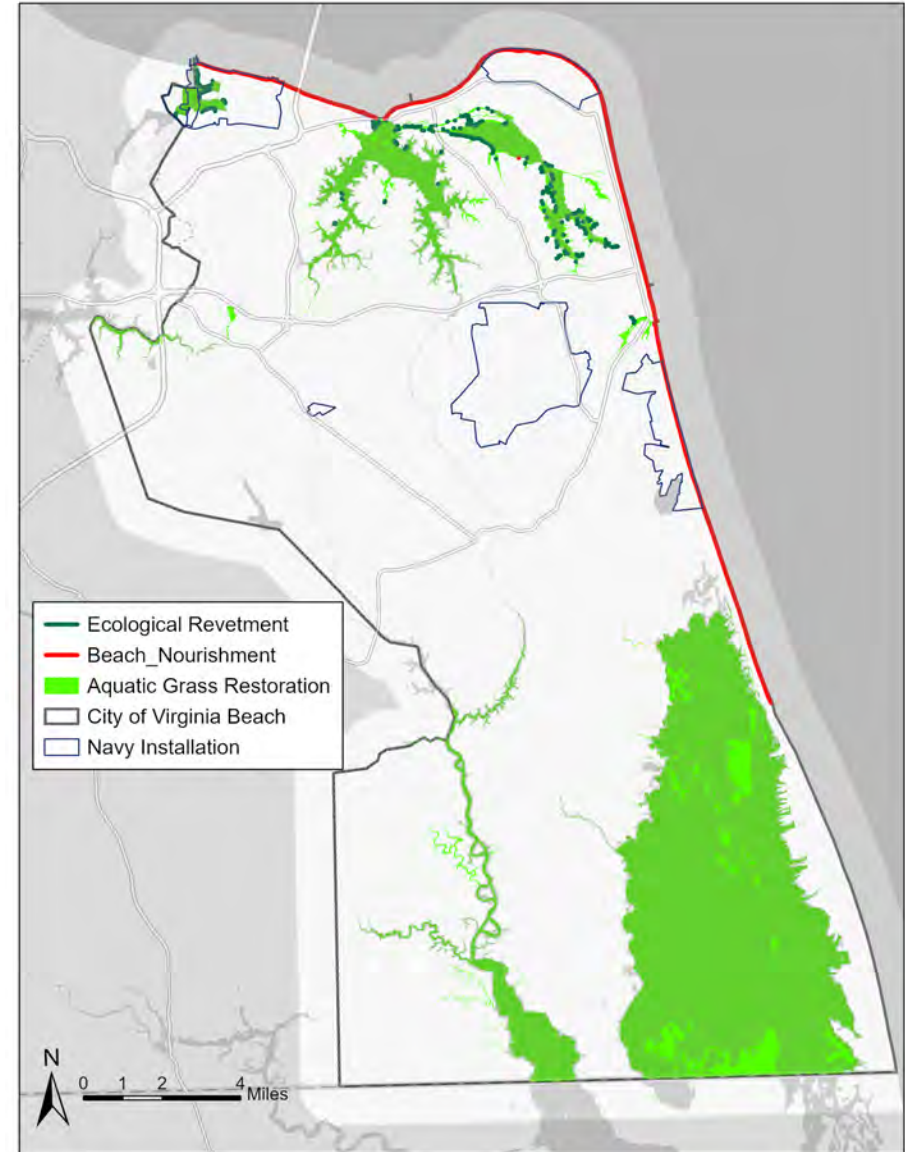
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NATURAL AND NATURE-BASED FEATURES CONSIDERATIONS



CUI



CUI



PROPOSED STUDY SCHEDULE



Milestone	VTAM Date	Proposed Date
Signing of Feasibility Cost Share Agreement (CW130)	21-Jul-2022 (A)	21-Jul-2022 (A)
Alternatives Milestone (CW261)	9-Nov-2022(A)	9-Nov-2022(A)
Tentatively Selected Plan Milestone (CW262)	13-Dec-2024 (S)	
Draft Report Submittal to HQ (CW150)	13-Mar-2025 (S)	
Public Release of Draft (CW250)	14-Mar-2025 (S)	
Agency Decision Milestone (CW263)	25-Apr-2027 (S)	
Submit Final Report Package to Vertical Team (CW160)	11-Nov-2027 (S)	
Signed Chief's Report (CW270)	13-Jun-2028 (S)	



PATH TO TENTATIVELY SELECTED PLAN



Completed - FY23

- SBEACH and Beach-fx
- G2CRM Refinement
- Begin Environmental Surveys to establish Existing and FWOP condition
- Begin Cultural Resources Assessment
- Geological/Geotechnical literature review to establish Existing and FWOP condition
- Establish Existing and FWOP Projects to be included into the modeling

FY24

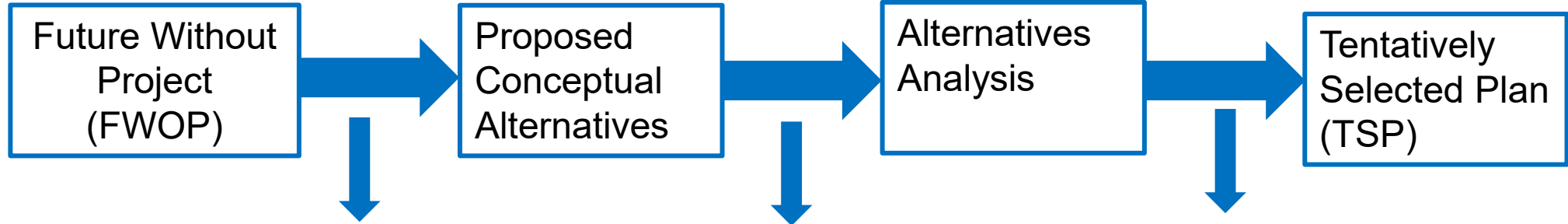
- SBEACH and Beach-fx (Continue)
- G2CRM Refinement (Continue)
- Total Benefit Plan Formulation Strategy Workshop (Vertical and Horizontal Team)
- Coordination with Navy on path forward for included installations
- Existing Condition Community Outreach
- Model the Existing and FWOP Condition (Coastal and Economics)
- Environmental Surveys to establish Existing and FWOP condition (Continue)
- Cultural Resources Assessment (Continue)
- Geological/Geotechnical literature review to establish Existing and FWOP condition (Continue)

FY25

- FWOP IPR with the Vertical Team- November 2024
- FWOP Community Outreach
- FWP Formulation



PROPOSED IPRS TO GET TO TSP



- IPR to Review FWOP:
- Bias Corrected
 - Geotechnical Data Analysis Complete
 - *Environmental Surveys Complete*

- IPR to Review Conceptual Alternatives:
- Coordination with Navy on Alternatives
 - Bring Conceptual Alternatives to the Public

- IPR to Review Alternatives:
- Incorporation of LPP if necessary
 - Incorporation of Public Comments from Conceptual Alternatives
 - Comprehensive benefits



QUESTIONS AND DISCUSSION



BACKUP



ENVIRONMENTAL DOCUMENTATION AND COMPLIANCE



- An Environmental Impact Statement (EIS) and Record of Decision (ROD) are anticipated based on significant environmental impacts associated with structural measures and the presence of sensitive environmental resources in the study area.
- Additional time and funding for habitat surveys and modeling efforts (*i.e.*, water quality, hydrodynamic, marsh degradation, and sediment transport) will inform the impact analysis and evaluation, including the potential system-level impacts associated with structural measures. (\$600K)
- This information would reduce uncertainty associated with potential impacts and is necessary to complete consultation requirements pursuant to the Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act.



STUDY AUTHORIZATIONS



- Section 1201 of the America's Water Infrastructure Act of 2018, dated January 3, 2018.

“The Secretary is authorized to conduct a feasibility study for the following projects for water resources development and conservation and other purposes, as identified in the reports titled “Report to Congress on Future Water Resources Development” submitted to Congress on March 17, 2017, and February 5, 2018, respectively, pursuant to section 7001 of the Water Resources Reform and Development Act of 2014 (33 U.S.C. 2282d) or otherwise reviewed by Congress: (9) COASTAL VIRGINIA, VIRGINIA.—Project for flood risk management, ecosystem restoration, and navigation, Coastal Virginia.”

- Public Law 84-71, dated June 15, 1955

“An Act to authorize an examination and survey of the coastal and tidal areas of the eastern and southern United States, with particular reference to areas where severe damages have occurred from hurricane winds and tides.”



CONSTRUCTION AUTHORIZATIONS— FEDERAL BEACH PROJECTS AND CANAL NO. 2



- Virginia Beach Hurricane Protection Project
 - Public Law 99-662, dated November 17, 1986
 - Public Law 102-580, dated October 31, 1992
 - Public Law 104-303, dated October 12, 1996

- Sandbridge Beach Erosion Control and Hurricane Protection Project
 - Public Law 102-580, dated October 31, 1992
 - Public Law 106-541, Sec. 338, dated December 11, 2000

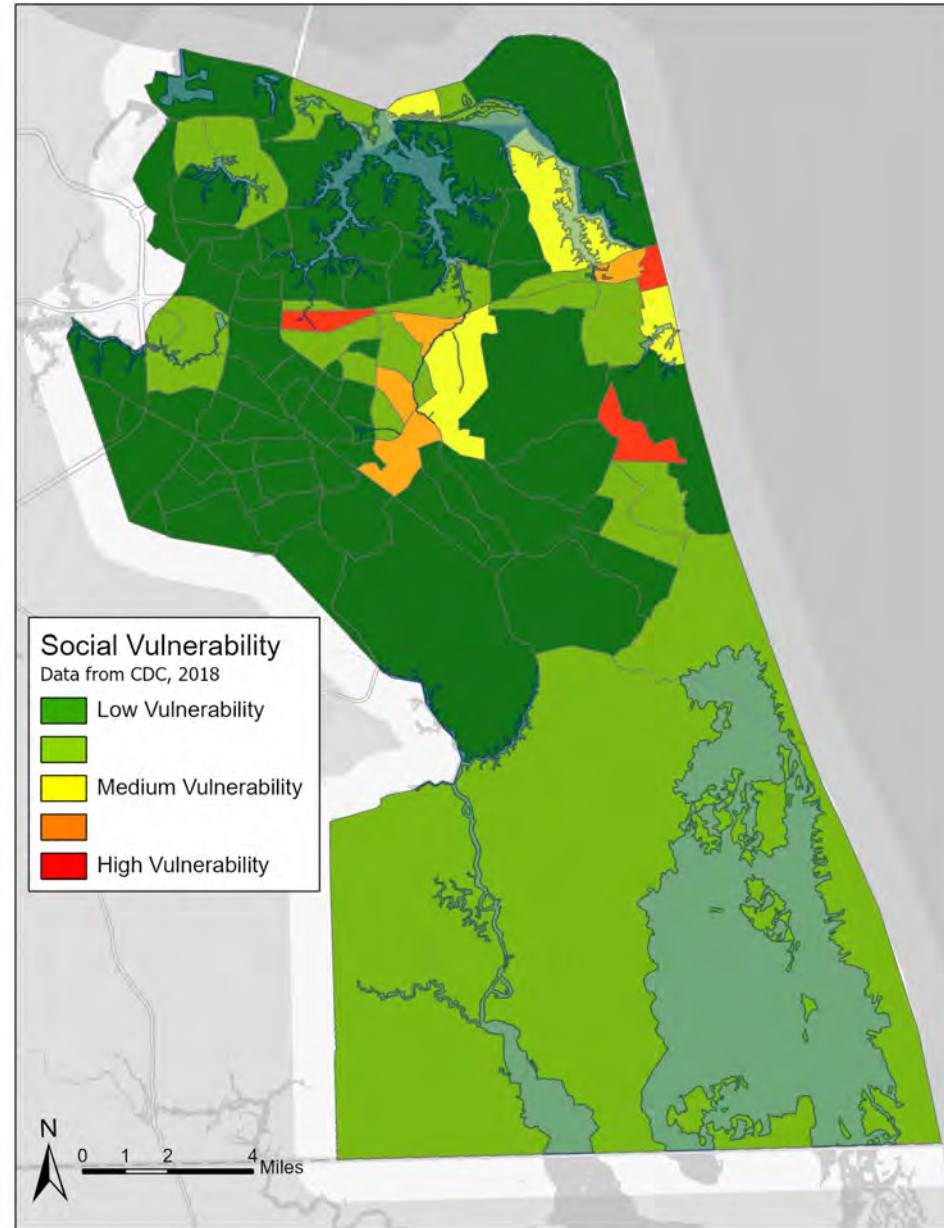
- Virginia Beach Streams, Canal No. 2
 - Public Works Committee Resolutions (identical) dated 1 October 1976 and 23 September 1976



SOCIAL VULNERABILITY IN VIRGINIA BEACH



Overall Vulnerability	Socioeconomic Status	Below Poverty
		Unemployed
		Income
		No High School Diploma
	Household Composition & Disability	Aged 65 or Older
		Aged 17 or Younger
		Civilian with a Disability
		Single-Parent Households
	Minority Status & Language	Minority
		Speaks English "Less than Well"
	Housing Type & Transportation	Multi-Unit Structures
		Mobile Homes
		Crowding
		No Vehicle
		Group Quarters



The CDC's Social Vulnerability Index score (2020) for the City of Virginia Beach is 0.32 which is classified as a low to medium level of vulnerability considering a scale of 0 (lowest vulnerability) to 1 (highest vulnerability)

Additional coordination with city's staff will ensure Environmental Justice communities are notified and provided the opportunity to meaningfully participate in the study process. The PDT will plan to host additional scoping and plan formulation activities to engage disadvantaged communities. These activities will also serve to ground truth the data made available via the EPA's EJScreen Tool.

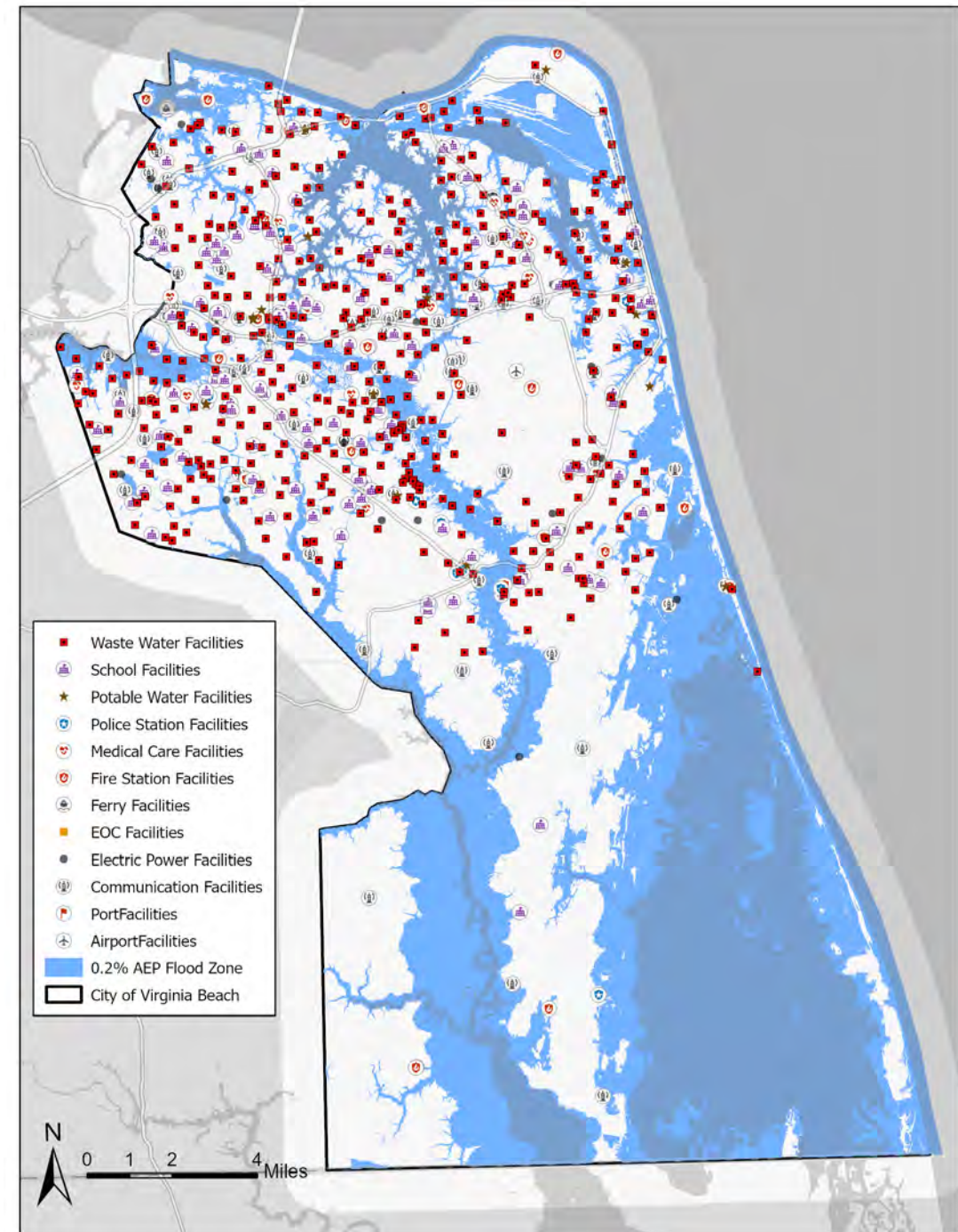


CRITICAL INFRASTRUCTURE

Critical Infrastructure Located in the Study Area

Type	Facility	Count
Essential Facility	Emergency, Hospitals, Medical Care, Fire, Police Stations	56
Essential Facility	Schools	111
Utility	Communications, Oil, Potable Water, Electric, Wastewater	605
Transportation	Bridges, Port, Ferry, Airport Facilities	129
High Potential Loss Facilities	Hazardous Materials Facilities	9

Sources: Hazus Stock Essential Facilities, Dewberry Building Master, Homeland Infrastructure Foundation-Level Data (HIFLD), GIS Parcels/Tax Roll, and GIS Points of Interest





EXISTING CONDITIONS-STRUCTURES AT RISK



	Occupancy Type	Count of Structures	Total Hazus Reported Replacement Value (Building and Content)	Total Hazus Annualized losses (0' SLC)	Total Hazus Annualized losses (3' SLC)
Within All of Virginia Beach	AGR	52	\$ 60,769,426	\$ 5,647	\$ 279,552
	COM	5,098	\$ 29,803,188,938	\$ 909,374	\$ 64,976,420
	EDU	90	\$ 2,406,280,757	\$ 1,475	\$ 3,367,894
	GOV	162	\$ 526,802,204	\$ 52,858	\$ 866,927
	IND	268	\$ 1,570,886,518	\$ 55,034	\$ 1,584,895
	REL	14,851	\$ 304,880,864,826	\$ 131,217	\$ 2,450,677
	RES	155,132	\$ 155,287,050,934	\$ 27,252,785	\$ 494,258,563
	Grand Total	175,653	\$ 494,535,843,603	\$ 28,408,390	\$ 567,784,928
	Within FEMA 500 Year	AGR	4	\$ 5,459,994	\$ 2,396
COM		401	\$ 1,067,770,282	\$ 862,146	\$ 14,979,153
EDU		2	\$ 35,228,704	\$ 1,475	\$ 452,137
GOV		20	\$ 52,485,212	\$ 52,858	\$ 817,655
IND		10	\$ 61,650,906	\$ 38,061	\$ 1,057,220
REL		3,281	\$ 68,152,659,922	\$ 128,817	\$ 1,995,623
RES		16,458	\$ 15,319,284,140	\$ 26,745,020	\$ 212,322,489
Grand Total		20,176	\$ 84,694,539,160	\$ 27,830,773	\$ 231,680,538

Source: Dewberry Coastal Flooding and Economics Loss Analysis using refined Hazus data estimates for Virginia Beach

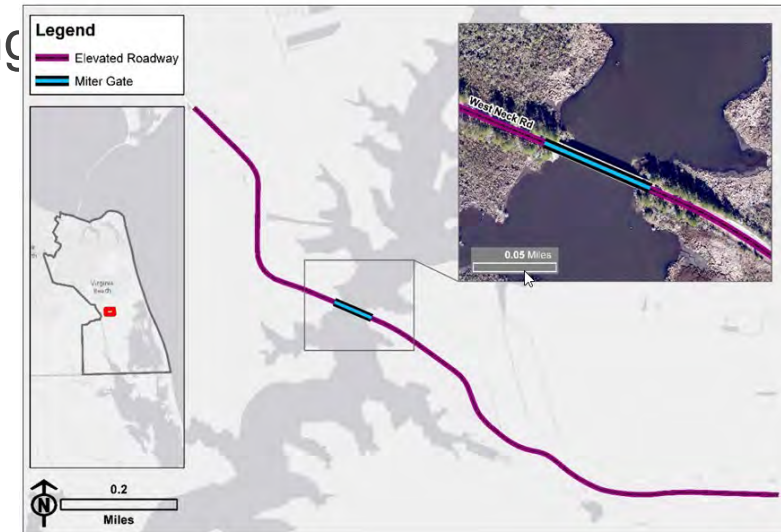
Price Level: DHS/FEMA 2006 Cost/square foot adjusted using 2016 CPI



FUTURE WITHOUT PROJECT CONDITION



- Study area is expected to continue experiencing impacts from coastal storms in the future
- The population of Virginia Beach is expected to increase from 459,000 (2020 Census) to 497,500 by 2040 (Hampton Roads Hazard Mitigation Plan, 2017)
- Sandbridge Hurricane Protection Project was initially constructed in 1998, 50-year renourishment period will end in 2048
- Virginia Beach Hurricane Protection Project was initially constructed in 2001, 50-year renourishment period will end in 2051
- There are two CBRS units in Virginia Beach which overlap the study area VA-61P and VA-62P. However, these are Otherwise Protected Area (OPAs). The only prohibition within OPAs is on federal flood insurance. CBRA consultation is not required for projects within OPAs.
- The City of Virginia Beach has confirmed they will be implementing their own within the next 10 years:
 - Marsh Restoration in Back Bay
 - Elizabeth River Wetland and Floodplain Restoration
 - West Neck Creek Bridge



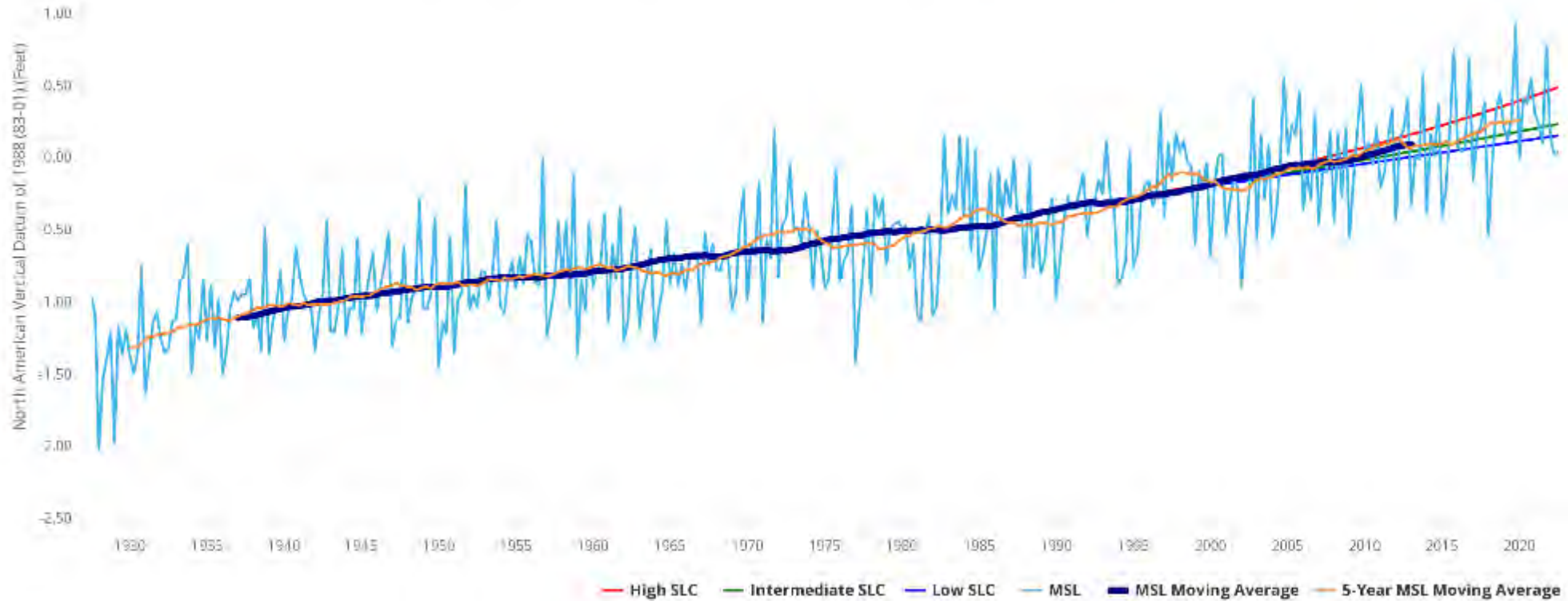


SEA LEVEL CHANGE PROJECTIONS



Sea Level Rise with USACE SLC Scenarios for Sewells Point, VA (8638610)

Active and compliant tide gauge



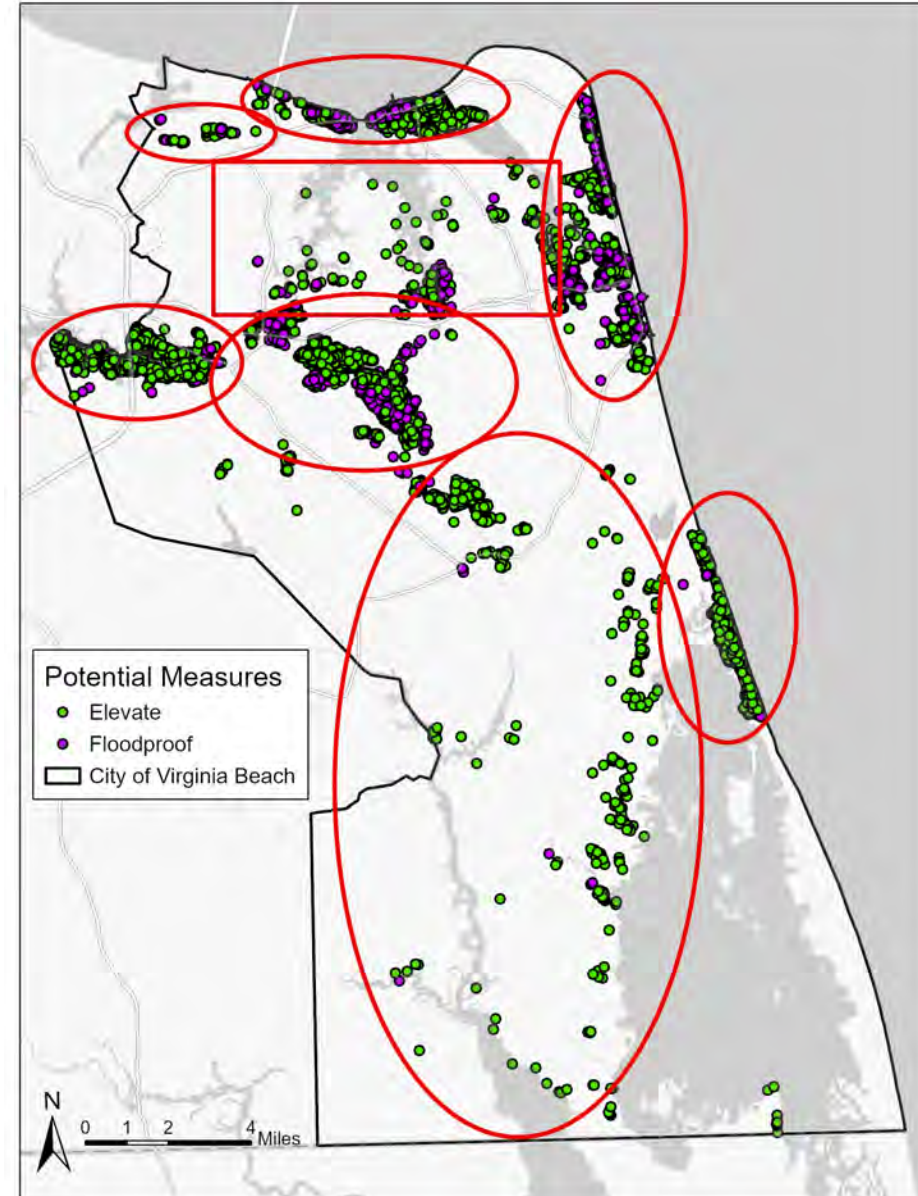
USACE Sea Level Change Predictions for Sewells Point, VA (NOAA Tidal Gauge #8638610) for user selected datum: NAVD88.
 Timeframe: Aug, 1927 - Aug, 2022 (95 years, 1 months)
 Timeframe contains 4 missing points; the longest gap is 0 years, 2 months.
 Rate of Sea Level Change: 0.0155 ft/yr (2020)



NONSTRUCTURAL MEASURES CONSIDERED



- Structures within the 500yr floodplain where Hazus results showed damage
- Aggregated initially based on location and flood source/type and considering structural measure areas

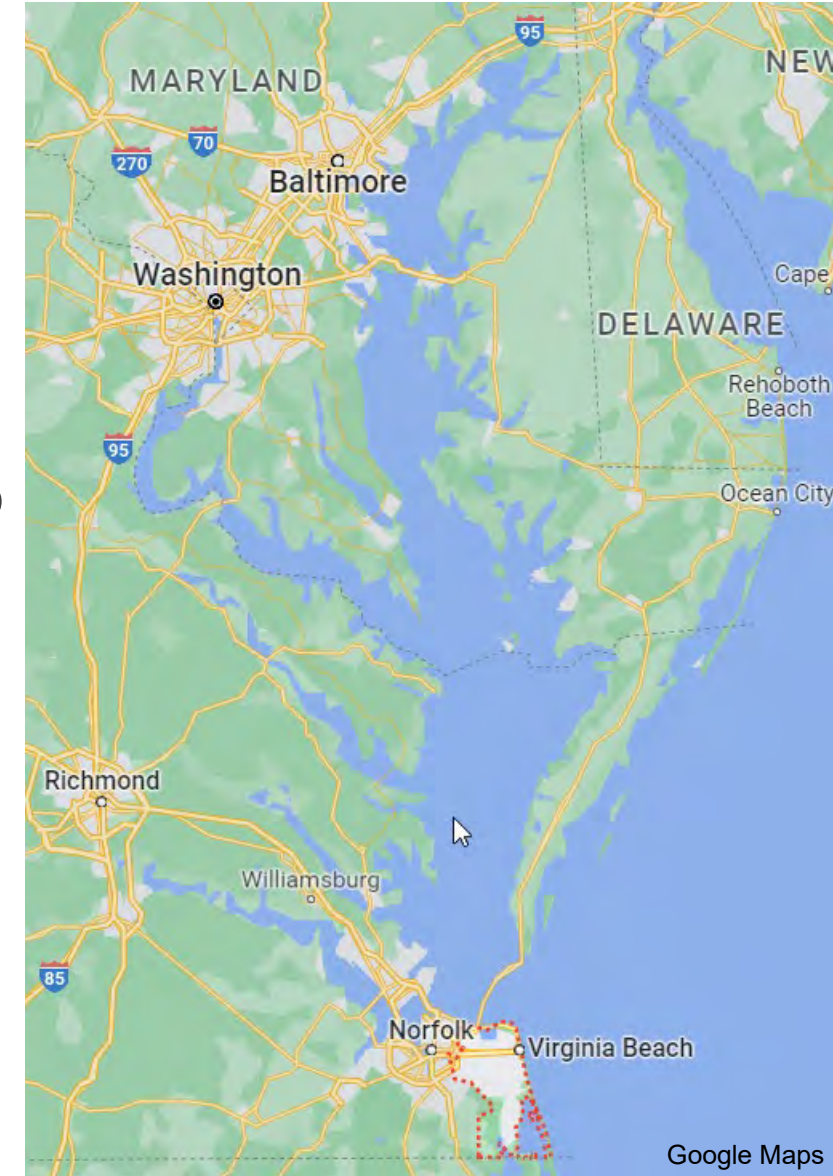




BACKGROUND AND FEDERAL INTEREST

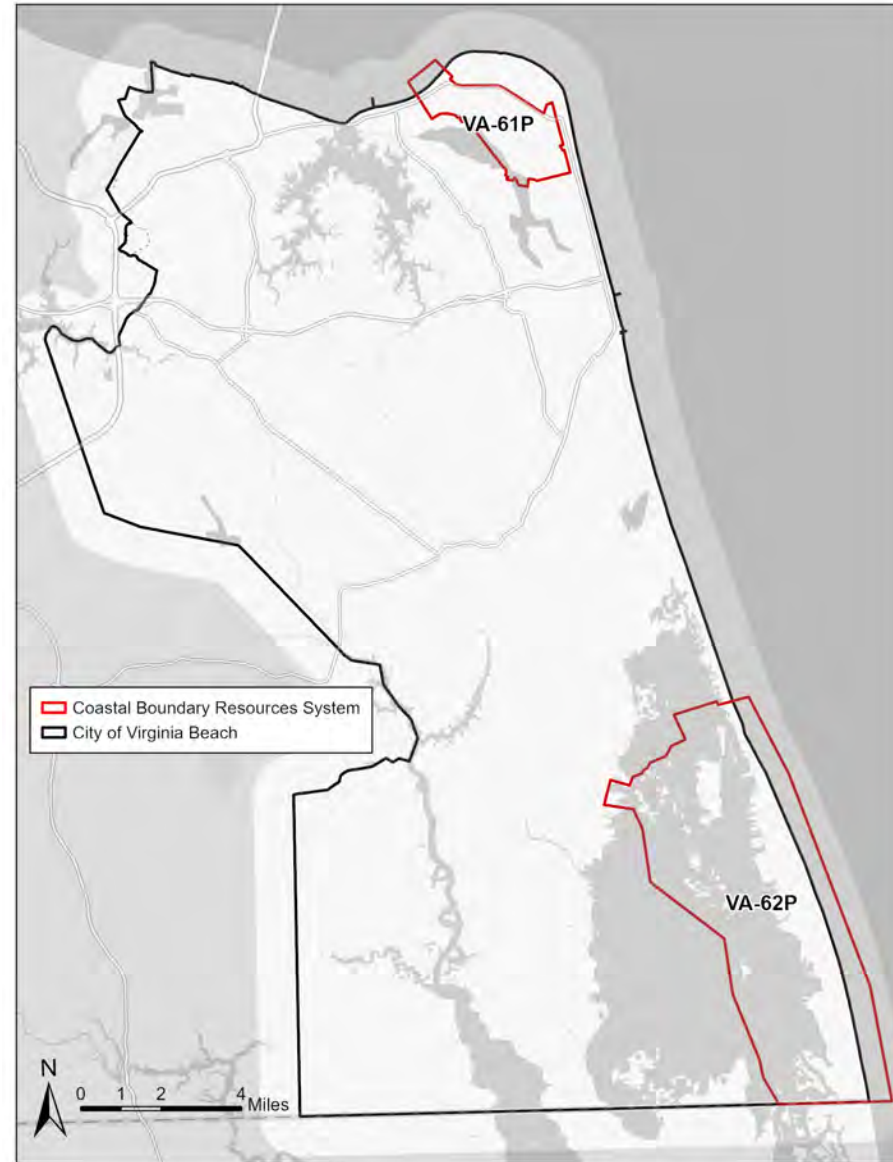


- Non-Federal Sponsor is the City of Virginia Beach
- The FCSA was executed on 21 July 2022
- Virginia Beach is located at the mouth of the Chesapeake Bay. Multiple rivers and tributaries flow through the city contributing to the risk of impacts due to flooding, waves, and erosion due to coastal storms
- Virginia Beach is the most populous city in the Commonwealth of Virginia with a population of 459,000 (2020 Census)
- The City of Virginia Beach completed Sea Level Wise in 2020 which recommended an adaptation strategy that includes structural, nonstructural, and NNBF measures to address impacts from coastal storms and sea level change





COASTAL BARRIER RESOURCE SYSTEMS



NAO City of Norfolk CSRM Project and R&D Needs

*Kyle Spencer.
City of Norfolk
Norfolk, Virginia*

The City of Norfolk is increasingly at risk from flooding and damage from coastal storms due to having one of the highest rates of relative sea level rise in the country. The Resilient Norfolk Coastal Storm Risk Management (CSRM) Project will help protect the city from major coastal storm events like hurricanes or nor'easters, through the construction of features that will reduce coastal flood risk and impacts. Our goal is to design the coastal community of the future.

The Resilient Norfolk CSRM Project, a partnership with the City of Norfolk and U.S. Army Corps of Engineers (USACE), is the first of its kind funded prior to a major storm. It's a new philosophy for the nation and we hope this starts a new way of coastal storm risk management.

The project features storm surge barriers, nearly nine miles of floodwalls and levees, 11 tide gates, and ten pump stations. It also includes nature-based features and a series of property-specific, nonstructural projects that include home elevations, basement fills, and commercial floodproofing. The features will be constructed during five phases across the city. These five phases work together to make Norfolk more resilient against coastal storms and flooding.

The USACE Norfolk District is design phase 1a in-house and will be reaching the 100% design milestone in late spring. Currently, the city is conducting exploratory work to collect data that the USACE will use to identify and confirm the alignment for the structural features of the project. These data will be used for preliminary designs that will support to recertifying the cost estimates by the fall of 2025.

While the Resilient Norfolk CSRM Project was approved by Norfolk City Council in 2023, a request was submitted to USACE to re-evaluate the results from the 2019 CSRM Feasibility Study for the Southside neighborhoods and Willoughby Spit area. The cost/benefit analysis conducted at that time did not find that the Southside qualified for structural measures, and the north side of Willoughby was not included in the nonstructural program because of an overlapping beach nourishment project underway at the time of the CSRM Study.

Since the 2019 study, Justice 40 and comprehensive benefits have been introduced as information to include in a cost/benefit analysis. The city is requesting that the USACE approve their re-evaluation request and conduct a new study to determine if structural features can be included for the Southside and include the north side of Willoughby in the nonstructural program.

The goal is to have the new recommended plan in time for WRDA 2028 if funding is approved in time.

For more information about the Resilient Norfolk CSRM Project, please visit www.resilientnorfolk.com



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RESILIENT NORFOLK

COASTAL STORM RISK MANAGEMENT

Norfolk CSR Update
BCER Meeting

March 19, 2024





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Overview

The city of Norfolk is increasingly at risk of flooding and damage from coastal storms. Norfolk has one of the highest rates of relative sea level rise (RSLR) among Atlantic coastal communities. The Coastal Storm Risk Management (CSRM) Project will reduce the city's risk from coastal flooding and damage from nor'easters, hurricanes, and other significant storm events.



3rd Bay and Pretty Lake Avenues



15th View Street



48th Street Dead End



The Hague

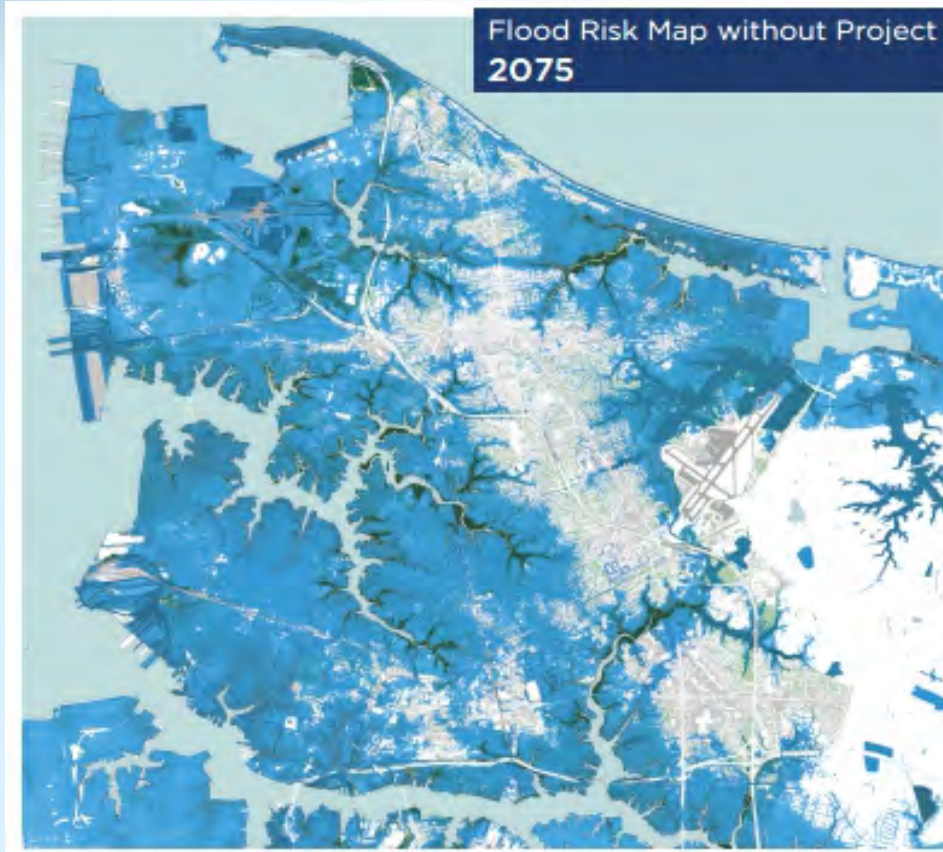




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Building Resilience

Reduce risk from coastal flooding and significant storm events





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Partnership



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Communications Strategy

August 2023 to Present

1 Program Progress Meeting with environmental groups	2 Conference abstracts accepted	Stakeholder mapping exercise
2 Citywide workshops	5 Media interviews conducted	Media training for key program leaders
3 Neighborhoods contacted out data collection	1 Case study placement in international publication	Strategic communications workshop
5 Civic league/task force meetings	3 Community special events	Joint Communications Plan expansion
		Key message refinement
		Website augmentation





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Communications Strategy



Design Workshops



Industry Day



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of Engineers®

Communications Strategy

Looking Ahead

4 Resilient Norfolk Flood Strategy Open Houses beginning March 14	5 more civic league/task force meetings planned (so far!)	Follow-up meeting with environmental interest groups
Virtual Open House Space	Community handout series	Continued data collection outreach
Proactive media strategy implementation including Op-Ed placement, media roundtable	Nonstructural program rollout	Continued updates to Resilient Norfolk Website
Public meetings to finalize/rollout alignment	Continued presence at community and Citywide events	Ongoing updates to City Council



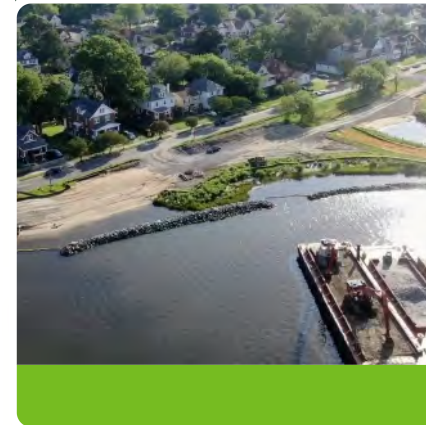


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Project at a glance

\$2.6 Billion Project

- Storm-surge barriers
- Nearly 9 miles of floodwalls and levees
- 11 tide gates
- 10 pump stations
- Home elevations
- Basement fills
- Commercial floodproofing





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Project Features

Structural

Constructed measures that counteract coastal flooding

Property-Specific, Nonstructural

Home elevations, basement fills, floodproofing commercial structures

Natural and Nature-based Features

Oyster reefs, living shorelines, and wetlands mitigation



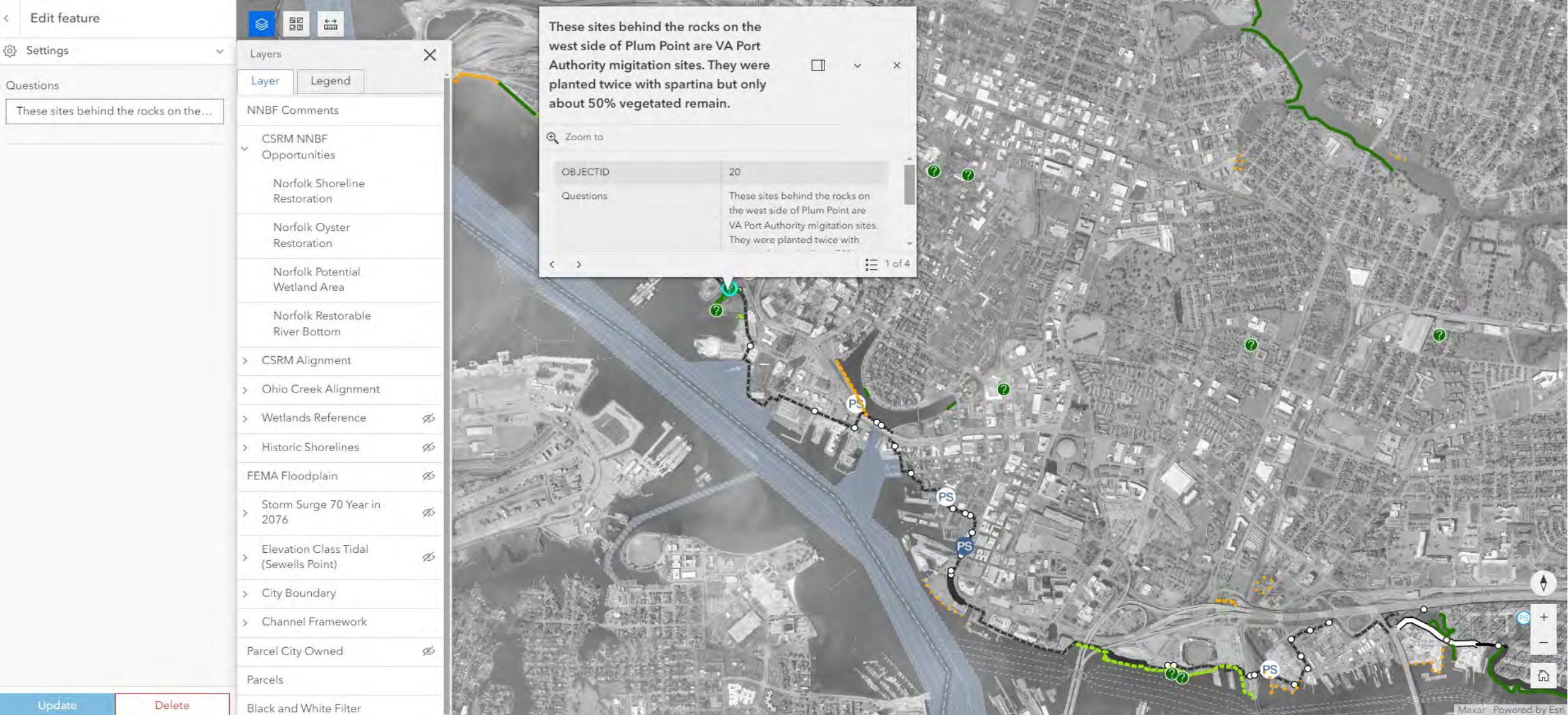
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Natural and Nature Based Features



Natural / Nature-based features – Are incorporated in all phases of the project and are environmentally friendly solutions to flood mitigation techniques. They can enhance the resilience of coastal areas challenged by sea level rise and coastal storms.







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Risk Reduction Features

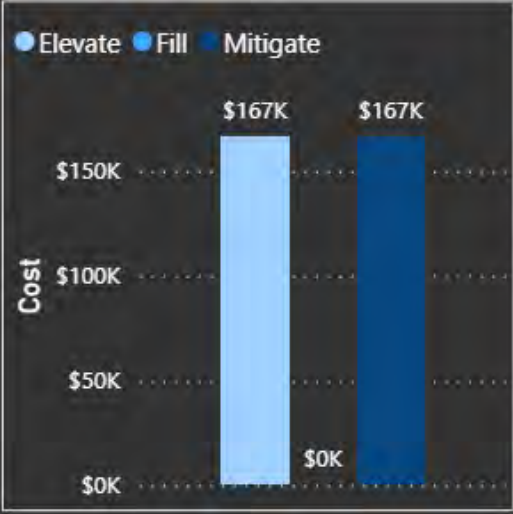
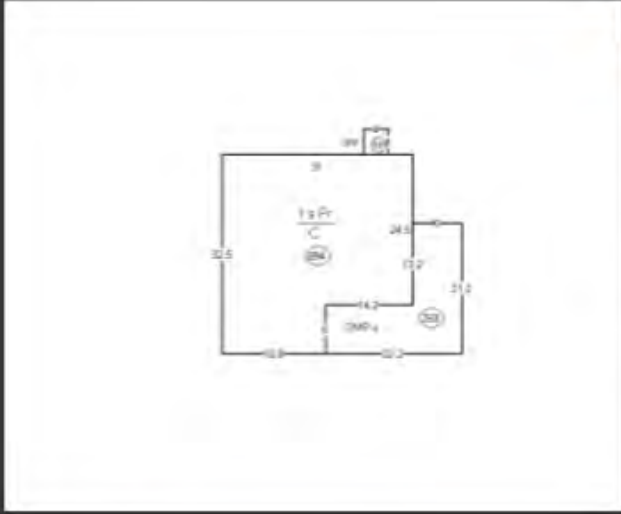


Property-specific, nonstructural -
These focus on reducing the damages caused by flooding to homes, businesses and critical infrastructure.



Critical infrastructure - Flood mitigation solutions that will protect the assets, systems and networks that are essential to the City's function.





9629 14th View St

Street Address

Search

- Select all
- 100 Kimberly La, Norfolk, VA, 23502
- 1000 Campos Pl, Norfolk, VA, 23523
- 1000 Fauquier St, Norfolk, VA, 23523
- 1000 Oakwood St, Norfolk, VA, 23523
- 1000 Waltham St, Norfolk, VA, 23523
- 1001 W Ocean View Av, Norfolk, VA, 23503
- 1001 Waltham St, Norfolk, VA, 23523
- 1002 Campos Pl, Norfolk, VA, 23523
- 1003 Fauquier St, Norfolk, VA, 23523
- 1004 Campos Pl, Norfolk, VA, 23523
- 1005 Grayson St, Norfolk, VA, 23523
- 1006 Campos Pl, Norfolk, VA, 23523
- 1006 Fauquier St, Norfolk, VA, 23523

Single Family - Det...	1932	894	894	1	OWN	1
Type	Year Built	Sq. Ft.	Footprint sqft	Stories	Rent/Own	CSRM Area
2	Willoughby	Crawl	Wood frame	Raise	3.30	6.30
Risk Tier	Neighborhood	Foundation	Framing	Mitigation Me...	Ground El.	FFE
11	4.70	0.00	0.00	\$166,672	Boone, Lisa Sellers ...	No
CSRM DFE	Elevate Ht.	Basement Fill Ht	Fill Cu. Ft.	Est. Cost of Mi...	Owner	Historic
AE	NO	No	YES	1	6	
FloodZone	Wave Action	CBPA	InRepLoss	Ward	Super Ward	

Phase

- Select all
- 1
- 2
- 3
- 4
- CBPA**
- No
- Yes

Foundation Type

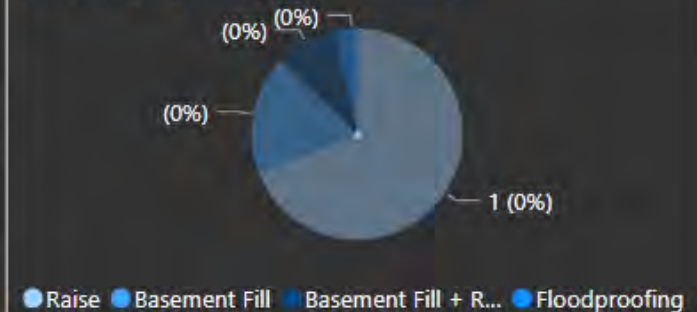
- Basement
- Crawl
- Slab
- Mitigation Measure**
- Select all
- Basement Fill
- Basement Fill + Raise
- Floodproofing
- Raise

Neighborhood

- All
- Rent/Own**
- All
- ADA**
- All
- Ward**
- All
- Super Ward**
- All

Raise

Property by Mitigation Measure



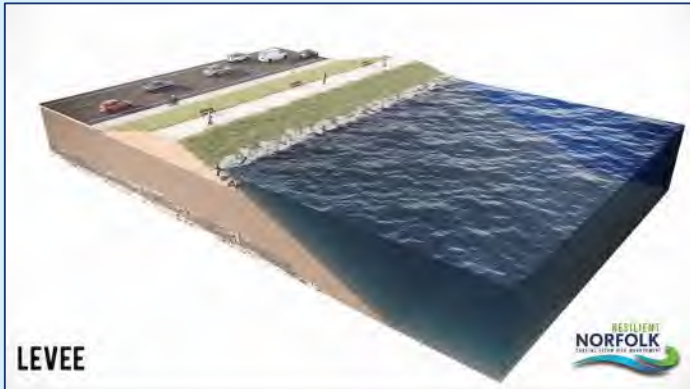


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Risk Reduction Features



Levee - Man-made structures, such as an earthen embankment, designed and constructed practices to contain, control, or divert the flow of water.



T-wall - A sturdy concrete wall, shaped like an upside-down T. It consists of a concrete base with tall floodwall panels extending upward.



Bin-wall - A gravity retaining wall system made from adjoining closed-faced bins, then backfilled with soil.

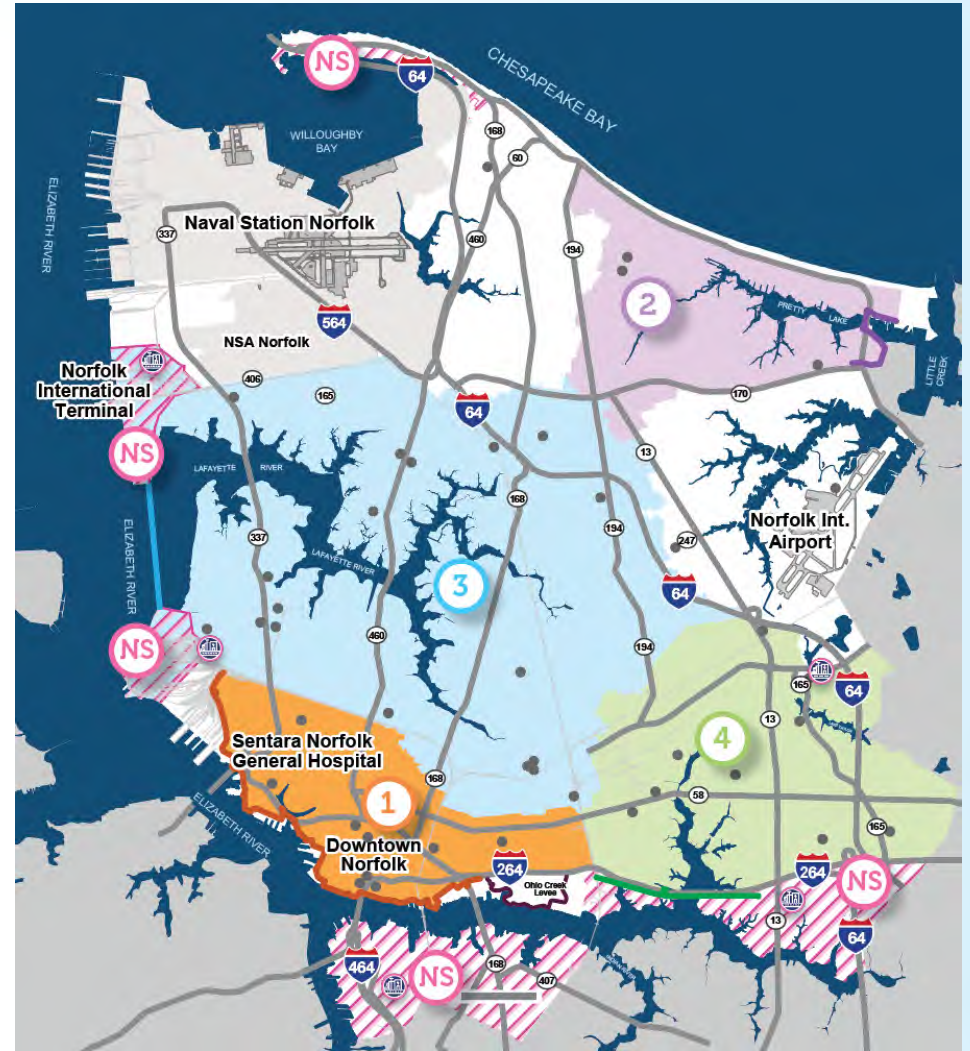




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5 IMPLEMENTATION PHASES

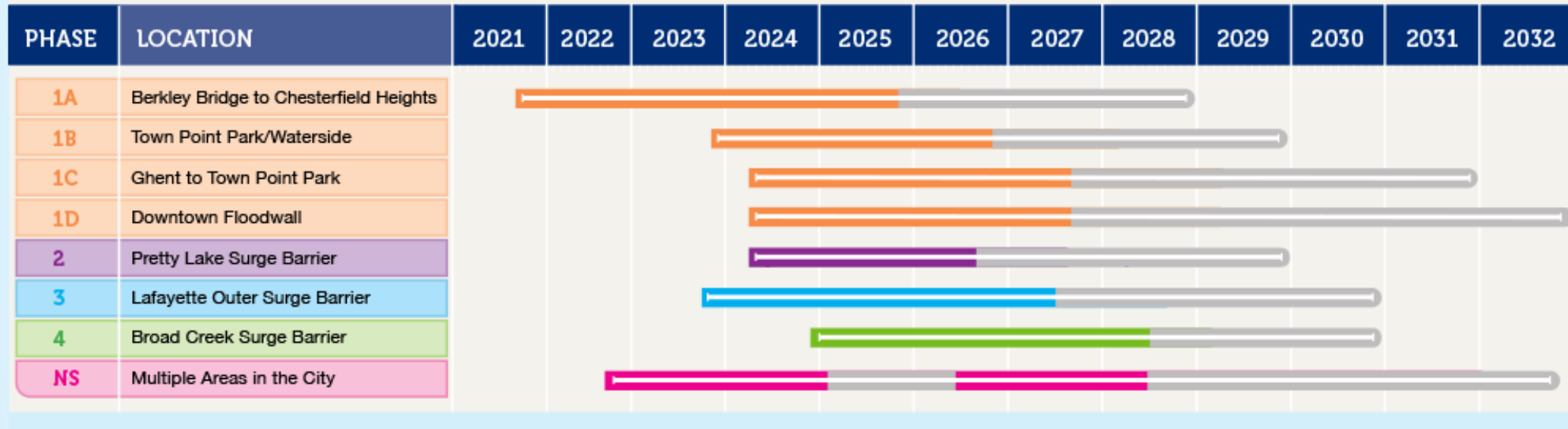
- 1 Downtown
- 2 Pretty Lake
- 3 Lafayette
- 4 Broad Creek
- NS Nonstructural





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Project Timeline



*Timelines are approximate and subject to change.





Phase 1B

Phase 1A



RISK REDUCTION FEATURES

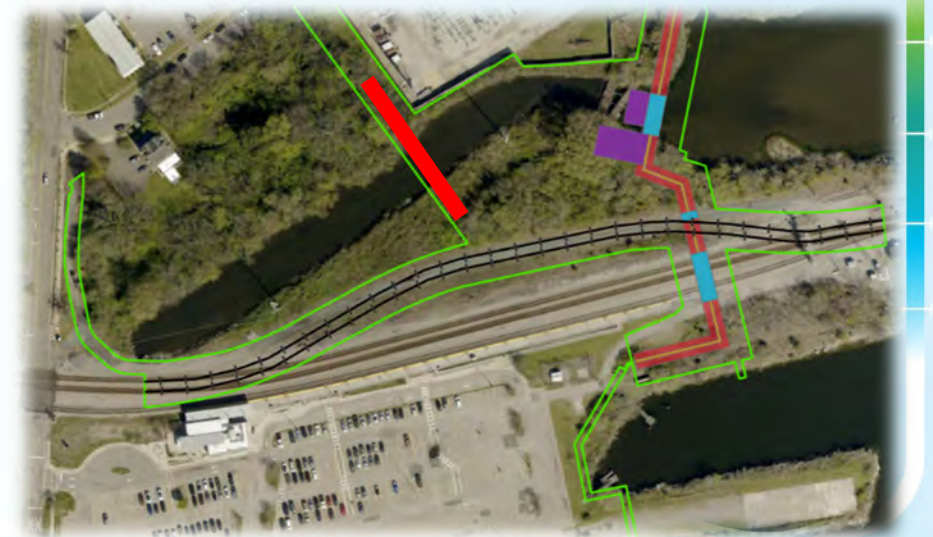
- T-wall** - A sturdy concrete wall, shaped like an upside-down T. It consists of a concrete base with tall floodwall panels extending upward.
- T-wall / Levee** - This combination is the T-wall, with compacted, heightened material on one side to provide additional support.
- Bin-wall** - A gravity retaining wall system made from adjoining closed-faced bins, then backfilled with soil.
- Levee** - Man-made structures, such as an earthen embankment, designed and constructed practices to contain, control, or divert the flow of water.
- Property-specific, nonstructural** - These focus on reducing the damages caused by flooding to homes and businesses.
- Natural / Nature-based features** - These are flood mitigation solutions that mimic natural processes and include varied practices that can be applied at many different scales.
- Gate** - Adjustable gates used to control water flow in flood barriers, reservoirs, rivers, streams, or levee systems.
- Pump station** - These help protect areas by pumping away large volumes of water, preventing the occurrence of flooding.



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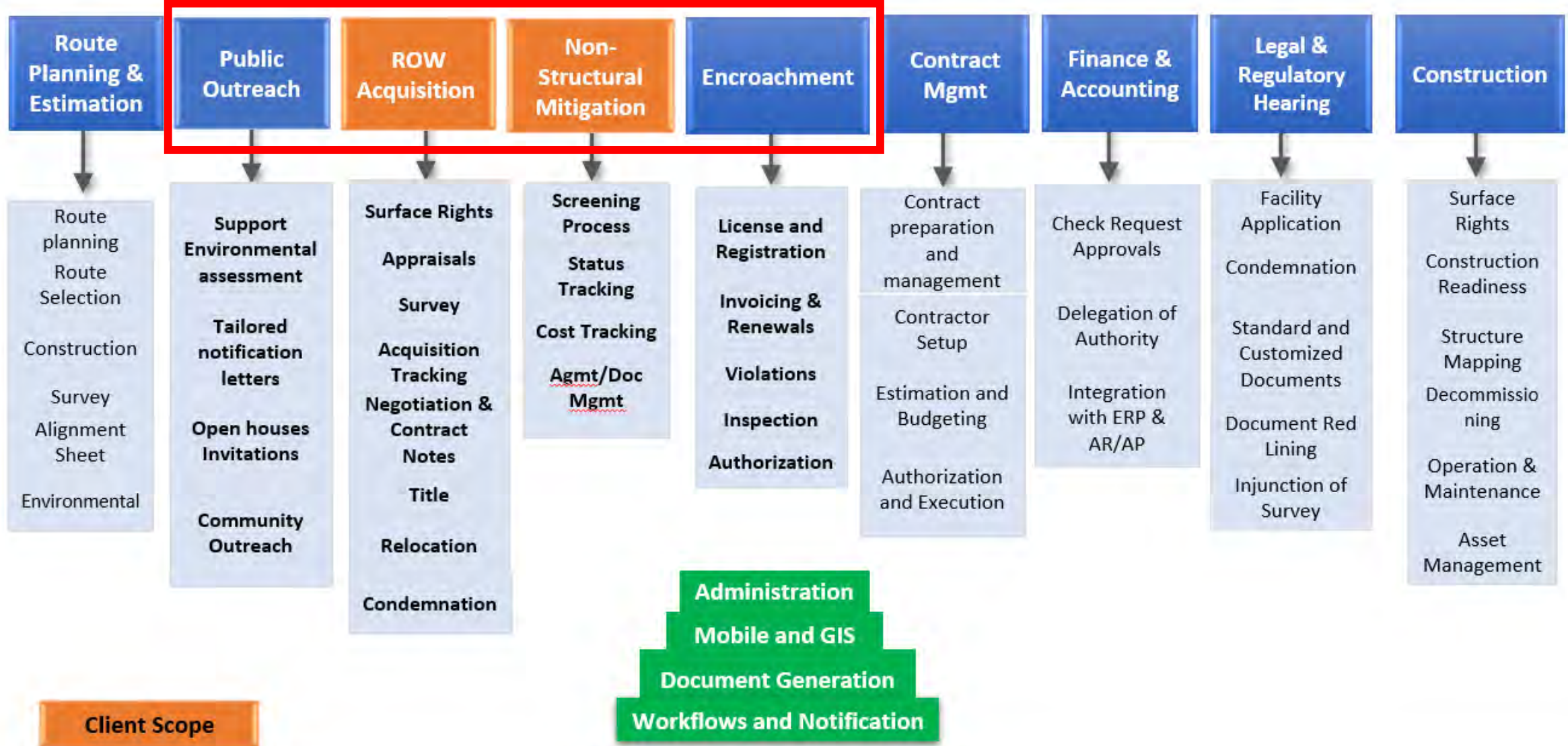
NORFOLK CSRM - PHASE 1A Summary

- Project 1 – Design-Build
 - Pump Station at Newtown’s Creek
 - Tide Gate at Newtown’s Creek
 - Pump Station at Harbor Park
 - 15% Design, utilizing existing AE MATOC within USACE
 - 15% Design RFP Package underway
 - DB Construction award est December 2024
- Project 2 – Design Bid Build
 - Levee/Wall from Berkley Bridge to Campostella, Living Shoreline
 - 100% Design by the Norfolk District
 - DBB Construction award est December 2024
 - Construction NTP est March 2025
- Concurrent Phase 1A Construction Projects:
 - Shoo-Fly for Railroad Track Diversion (City design underway)
 - Access Bridge for Newton Creek Pump Station (City design underway)
 - Integration of Casino Portion



Cradle to grave Project Management Support

Process Integration across the Enterprise





902 PACR Design & Exploratory Work Update





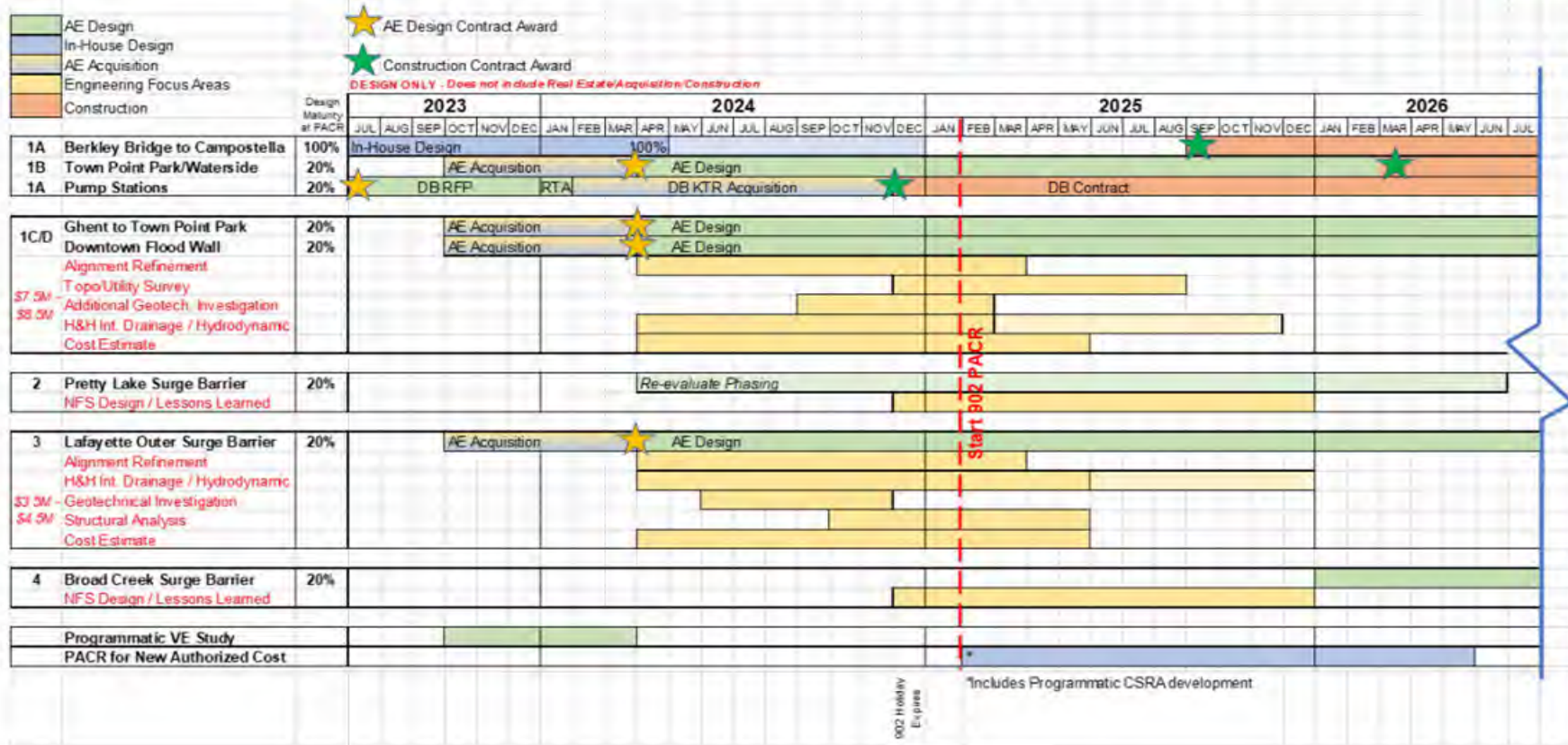
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SCHEDULE AND STRATEGY FOR 902 COST PACR

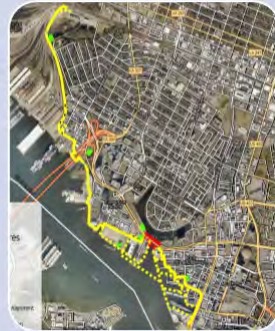


13





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Phase 1A

Berkley Bridge to
Campostella
In-House Design
**Design Maturity at
PACR = 100%**
➤ Award DBB
Construction
Contract: SEP 2025

Phase 1A Pump Stations

➤ Award DB
Construction
Contract: DEC
2024

Phase 1B

Town Point
Park/Waterside
AE Design
In-House Design
advanced during PED

**Design Maturity
at PACR = 20%**

➤ Award DBB
Construction
Contract: MAR
2026

Phase 1C/D

Ghent to Town
Point
Park/Downtown
AE Design
Refine Alignment
Topo/Utility Survey
Geotech Investigation
H&H Modeling

**Design Maturity
at PACR = 20%**

Phase 2

Pretty Lake Surge
Barrier
NFS Design /
lessons learned
from previous
phases.

**Design Maturity
at PACR = 20%**

Phase 3

Lafayette Outer
Surge Barrier
AE Design
Refine Alignment
Topo/Utility Survey
Geotech Investigation
H&H Modeling
Structural Analysis
**Design Maturity
at PACR = 20%**

Phase 4

Broad Creek
Surge Barrier
NFS Design /
lessons learned
from previous
phases.
**Design Maturity
at PACR = 20%**



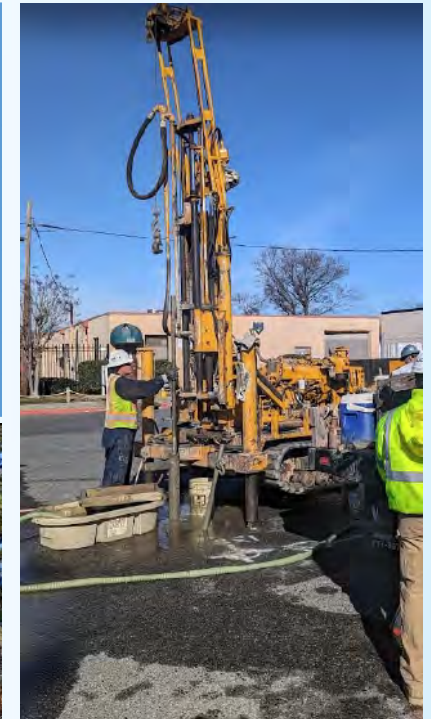
Field Data Collection

- Land topography
- Utility locating
- Geotechnical Exploration
- Open-water bathymetry
- Environmental Phase I (ESA)

Phase	# Geotechnical Explorations Planned	Notes
Phase 1A	18	Filling existing data gaps
Phase 1B	0	existing data is adequate
Phase 1C	44	
Phase 1D	0	existing data is adequate
Phase 2	21	
Phase 3	29	
Phase 4	26	



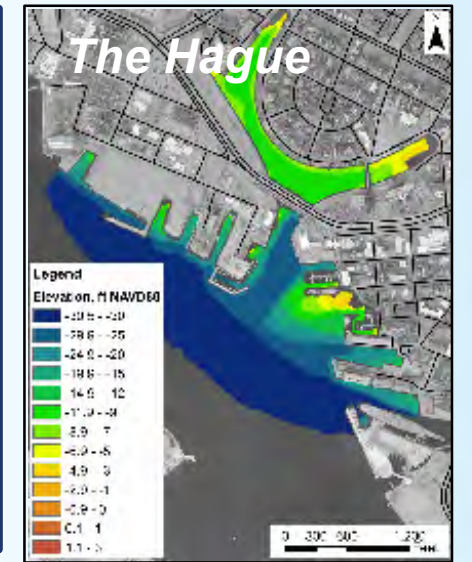
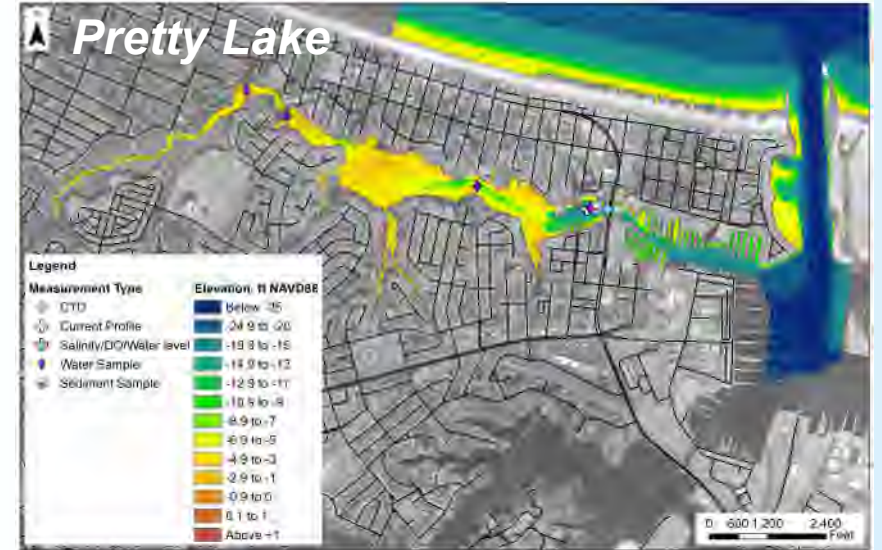
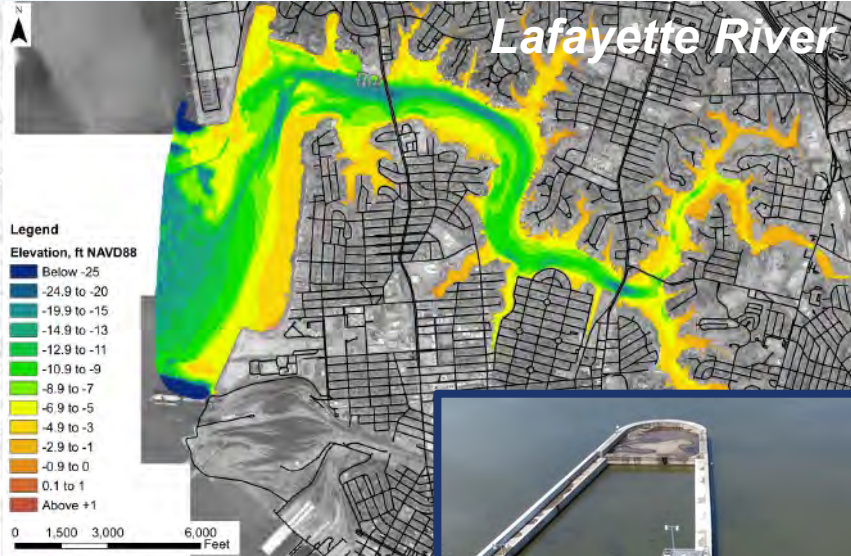
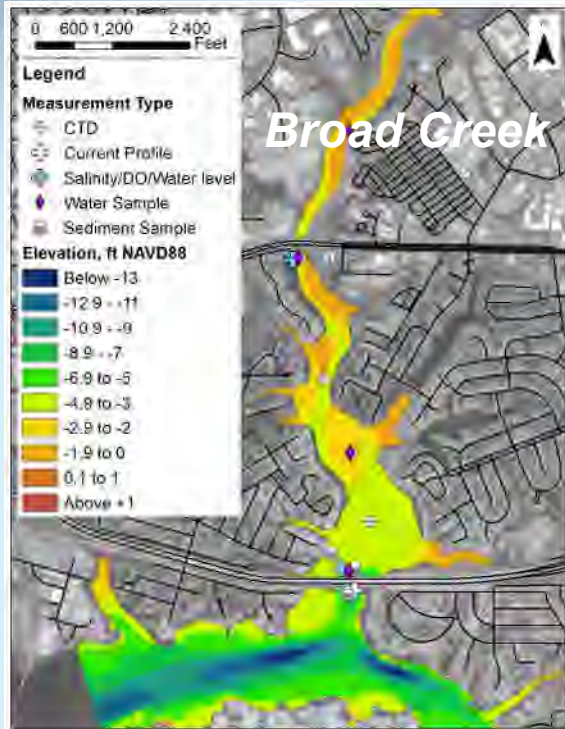
Cone Penetrometer Rig



Soil Boring Rig



Open-Water Bathymetry





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Non-Structural PACR Update





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Three areas of focus for the PACR



- Re-evaluation of structural measures in the Berkley and Campostella Neighborhoods (Southside).
- Reformulation of nonstructural measures, with a focus on the economic analysis of acquisitions.
- Evaluation of structures in the Willoughby community subject to flooding from Willoughby Bay.





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Additional background

- On June 12, 2023, Norfolk District briefed Michael Connor, Assistant Secretary of the Army for Civil Works, prior to the NCSRM Project Partnership Agreement signing.
- At the PPA signing ceremony, Senator Mark Warner spoke in support of re-evaluating the “Southside” [Berkley and Campostella Neighborhoods].
- City council voted to request a re-evaluation of the Southside and Willoughby features by the USACE and the request has been submitted to the Norfolk District.



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What's included in the new feasibility study for the Southside

- Justice 40 considerations
- Comprehensive benefits to improve the Benefit-Cost Ratio



Campostella



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Justice 40

- Environmental Justice addresses negative human health and environmental effects on minority populations and disadvantaged communities.
- Justice 40 was established in 2021 to identify negative consequences of underinvestment in disadvantaged communities.
- Provides greater opportunity to consider community impacts and benefits to improve the Benefit-Cost Ratio to bolster the chances for federal approval.



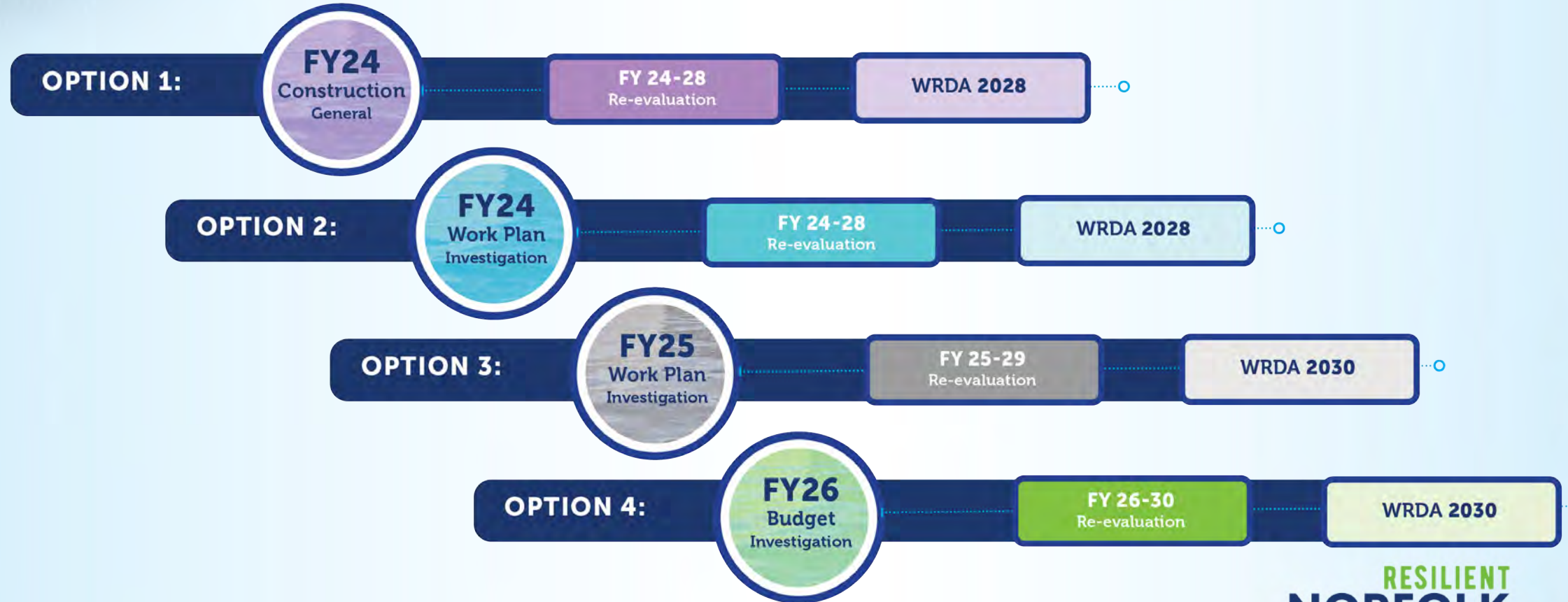
*Climate Justice and Economic Screening Tool (CJEST)
results for Norfolk; blue indicates disadvantaged area*



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What happens next:

Funding, Re-Evaluation & Water Resources Development Act (WRDA) Authorization





R&D Recommendations





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R&D Gaps

- A threshold/sensitivity analysis is needed to determine the point at which surge gate closures, combined with rainfall, will cause significant damage to natural resources. The results will drive barrier design and operation, both at present and into the future as adaptation is needed to address climate changes.
- New standards for increased precipitation is needed to right size the pump stations in lieu of NOAA ATLAS 15 being released. Virginia Beach led modeling efforts the region is adopting for stormwater design projects with percentage increases over today's ATLAS 14 levels and increases for future rainfall amounts.
- Potential wave attenuation capacity of nature-based solutions, including manufactured modular systems that mimic nature, needs to be better understood in confined urban settings. Where applicable, use of nature-based solutions may allow for lower elevation walls and levees, while adding numerous other co-benefits.



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R&D Gaps

- Additional research and guidelines for calculating BCRs using comprehensive benefits with additional depth damage functions for a broader range of structures is needed. Critical infrastructure and buy-out recommendations were limited by these issues.
- Development of visuals and data analysis is needed to explain the impacts of structural measures on adjacent communities/structures that did not have structural measures recommended (i.e. Norfolk Southern, Southside, Portsmouth). These analysis should include induced flooding, wave action, and erosion concerns.





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R&D Gaps

- Development of new approved for use deployable walls for waterfront promenade and critical infrastructure – 2024 Challenge with RISE



RISE
Resilience Innovations





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Thank You!



Kyle Spencer, Chief Resilience Officer
Kyle.Spencer@norfolk.gov

ResilientNorfolk.com





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Questions?

ResilientNorfolk.com



From the Sea to the Stars, Resilience in Hampton

*Scott Smith
City of Hampton
Hampton, VA*

This presentation will cover the approach Hampton is taking to adapting to and mitigating the impacts of Climate Change. Several projects are proposed to address the impacts. The challenges to implementing mitigation projects besides funding are as follows;

- How do we demonstrate to residents that are either outside a line of protection or opposite that protection, that the protection measure will not negatively impact their property? In riverine conditions we protect flood plain and we promote wetlands as flood storage. In the coastal environment a line of protection may cut off that storage area, how do we demonstrate that the ocean is an infinite reservoir and cutting off 100 acres of storage will not raise water levels outside the level of protection?
- Modeling of wave action of flood protection systems to demonstrate the rebounding wave energy will not create erosion or damage on the opposite shore.
- Better understanding of the impacts of sea level rise on inland flooding. Especially with increased precipitation.

HAMPTON VA

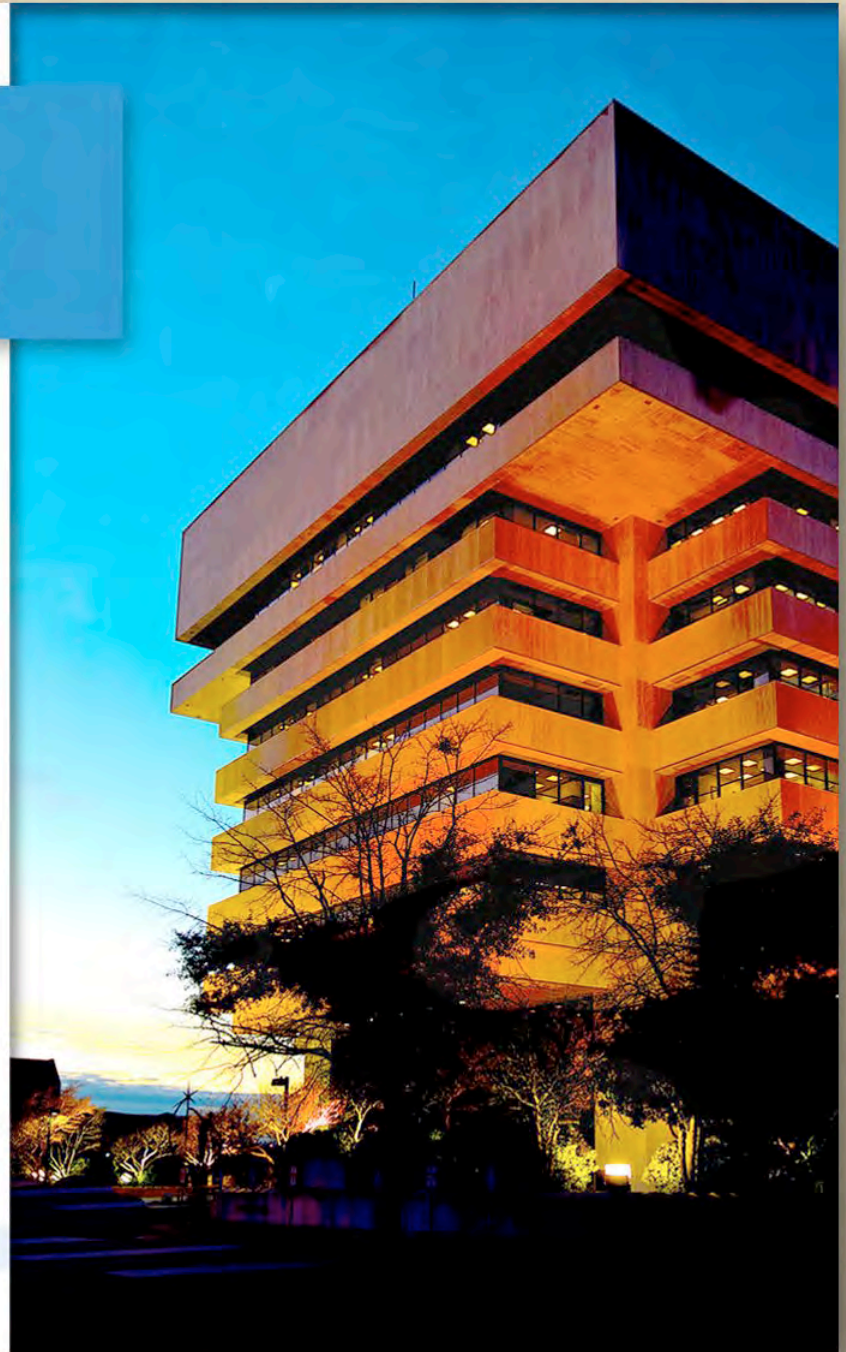
From the Sea to the Stars, Resilience in Hampton



RESILIENT HAMPTON

Board on Coastal Engineering Research

March 20, 2024



Living with Water Strategic Priority



Addressing coastal resiliency, reoccurring flooding, waterways, and environmental sustainability while enhancing our tax base and quality of life.

Address the challenge of flooding

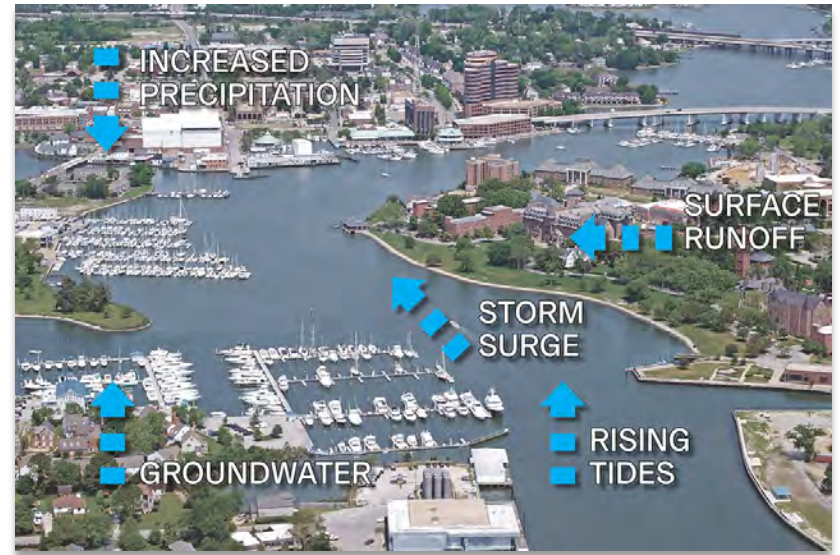


Recognize & treat water resources as assets



Resilient Hampton

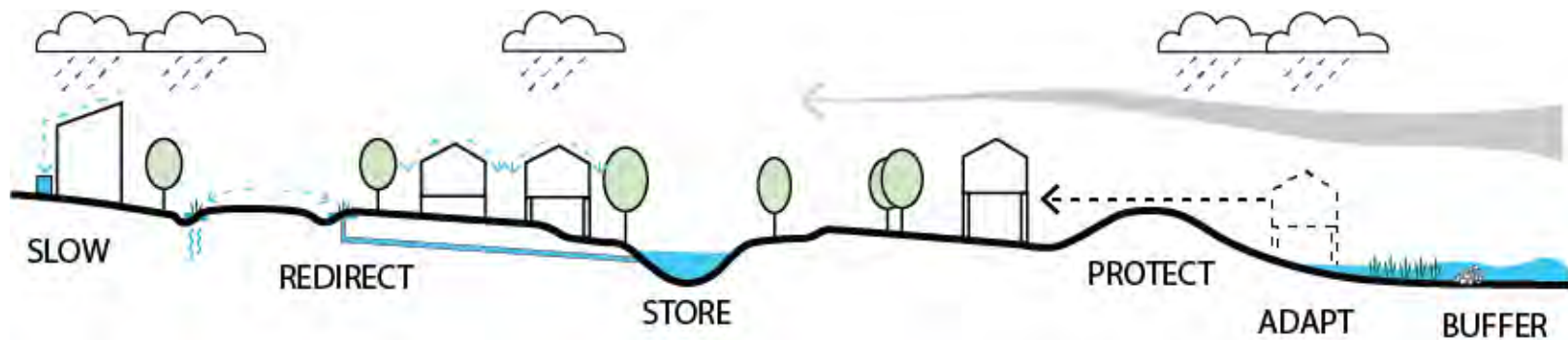
Resilience is the bolstering of a community's **inherent strengths** in order to alleviate **chronic stresses** and enable recovery from **extreme events and shocks** in ways that make the community even **stronger than before**.





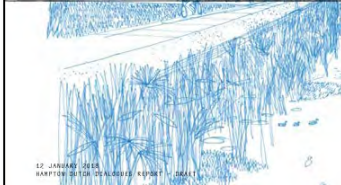
Our Mission: Living with Water

To envision, create, and empower Hampton to **live and thrive with water and the impacts of climate change** through approaches driven by data and values.



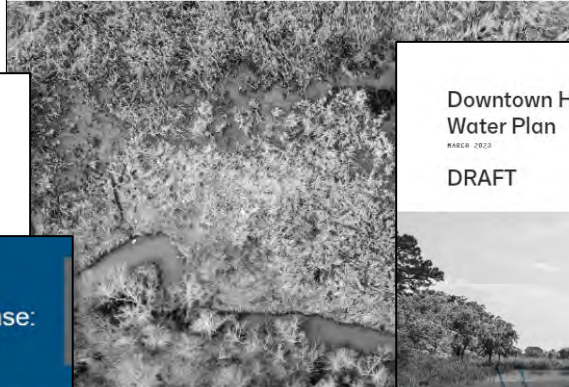


**Living with Water Hampton:
A Holistic Approach to
Addressing Sea Level Rise
and Resiliency**



12 JANUARY 2020
HAMPTON WATER DEVELOPMENT REPORT | DRAFT

**Resilient Hampton
Newmarket Creek Pilot Project Area
Water Plan**



MARCH 2021


**Hampton-Langley Air Force Base
Joint Land Use Study Addendum:
Resiliency and Adaptation**



21 AUGUST 2024

CUI

**JBLE-Langley Air Force Base:
LaSalle Avenue Corridor Resiliency Plan
FINAL Report**



HAMPTON VA

December 2021

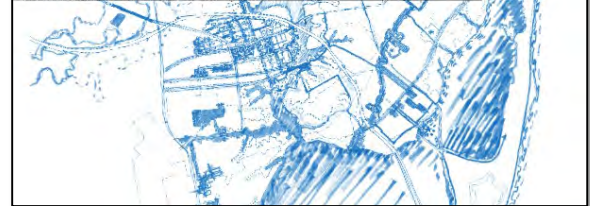



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Controlled by: 633 CESE / CEHP
CUI Category: CRIT
Distribution Statement: B
POC: Ms. Jere L. Gimms, DAFC (757) 225-4323

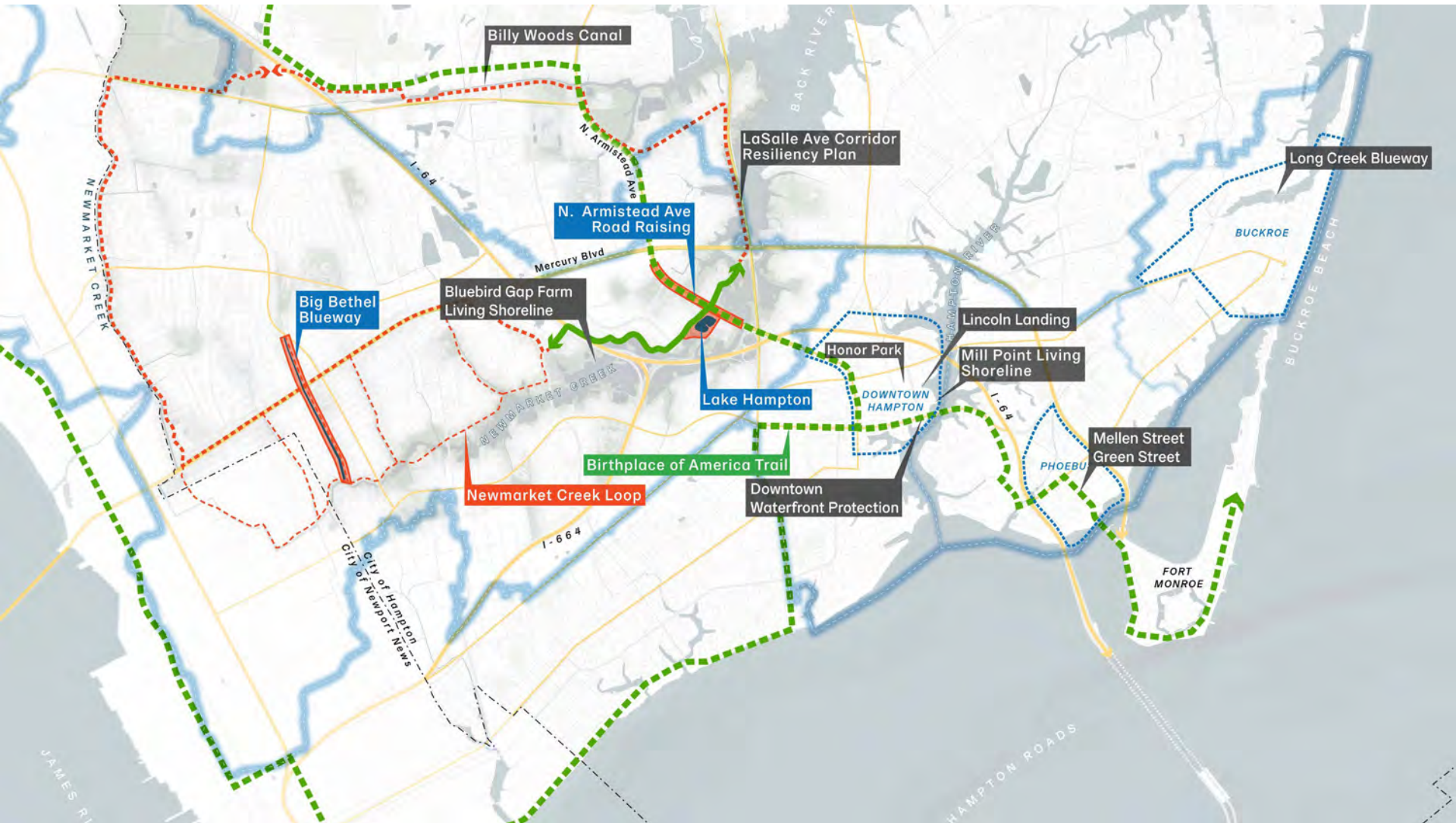
**Downtown Hampton, Phoebus, & Buckroe
Water Plan**

MARCH 2023

DRAFT



Planning and Creating Project Pipelines



Lake Hampton & North Armistead Avenue





Big Bethel Blueway

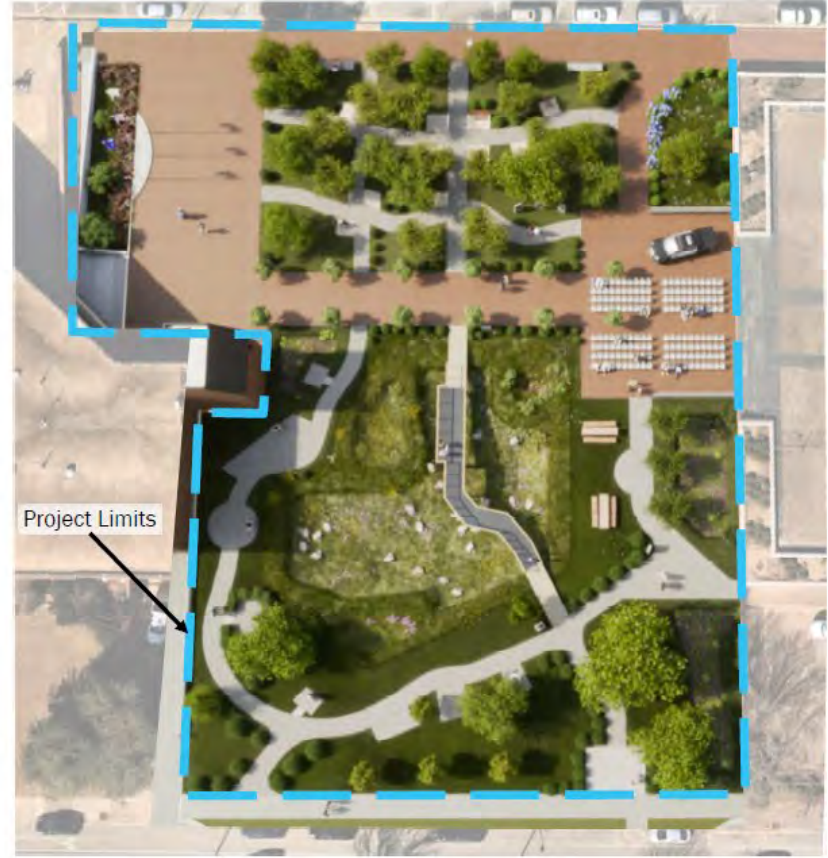


Honor Park Resilience Park

EXISTING CONDITIONS



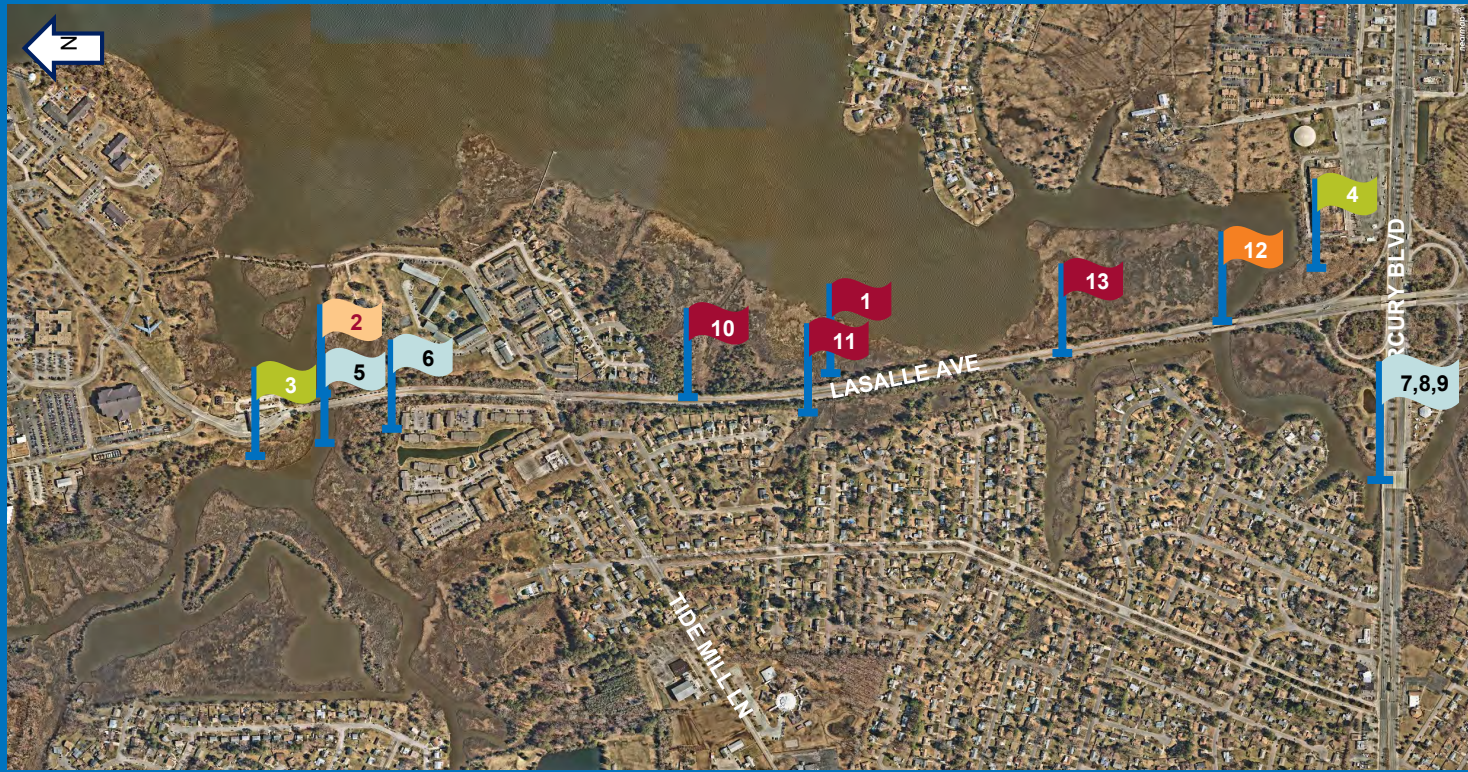
PROPOSED CONCEPT



Lincoln Landing Stormwater Park



LaSalle Avenue Corridor Resiliency Plan

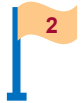


LASALLE AVENUE CORRIDOR BIKE/PED PATH

PROPOSED MITIGATION MEASURES



RAISING LASALLE AVENUE



**REPLACE LASALLE BRIDGE
(NORTH)**



LASALLE NORTH FLOOD WALL



LASALLE SOUTH FLOOD WALL



BACKRIVER FLOOD GATE



BACKRIVER PUMP STATION



MERCURY BLVD FLOOD GATE



REPLACING MERCURY BLVD BRIDGE



MERCURY BLVD PUMP STATION



**BOX CULVERT AND SLUICE GATE
(NORTH)**



BOX CULVERT AND SLUICE GATE (SOUTH)

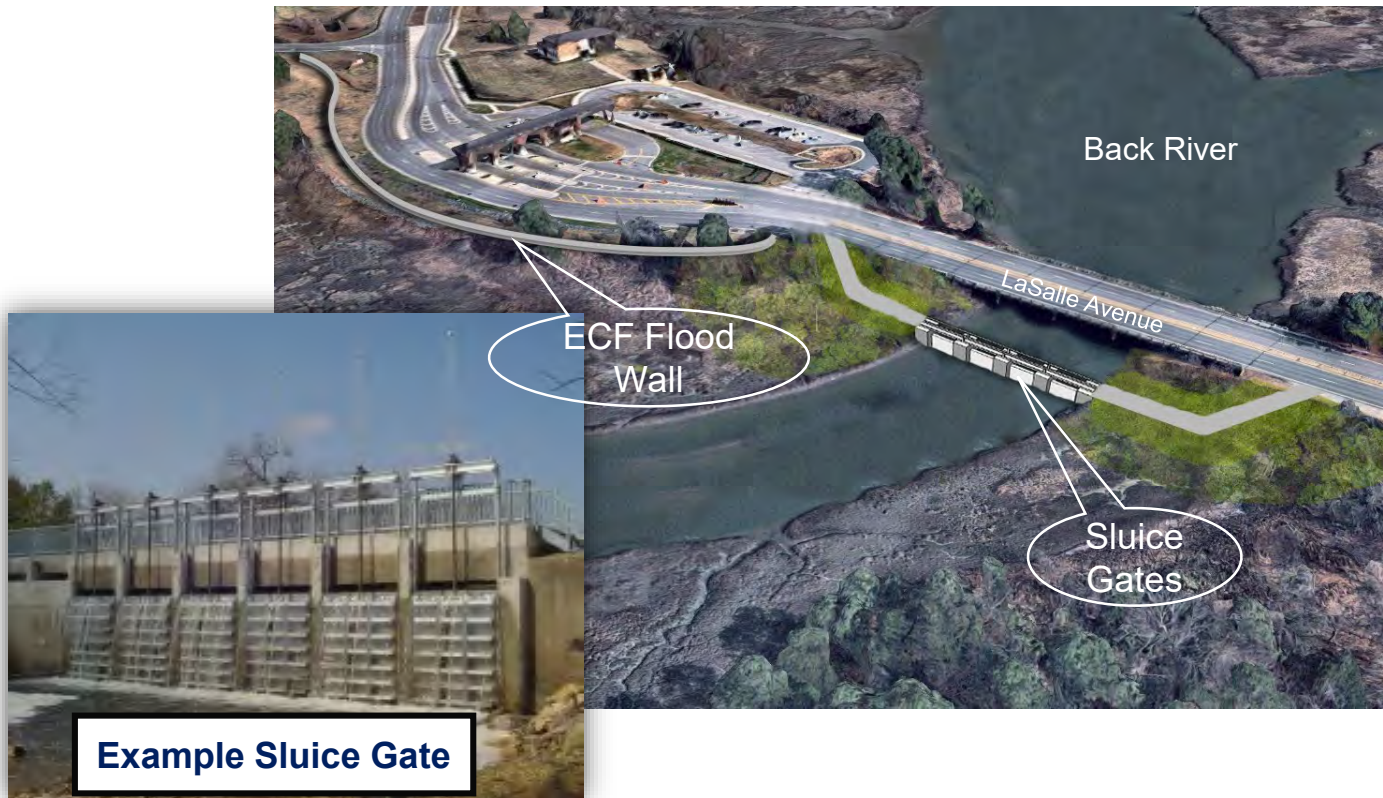


NEWMARKET FLOOD GATE



NEWMARKET CREEK TRAIL

BACK RIVER FLOOD GATE

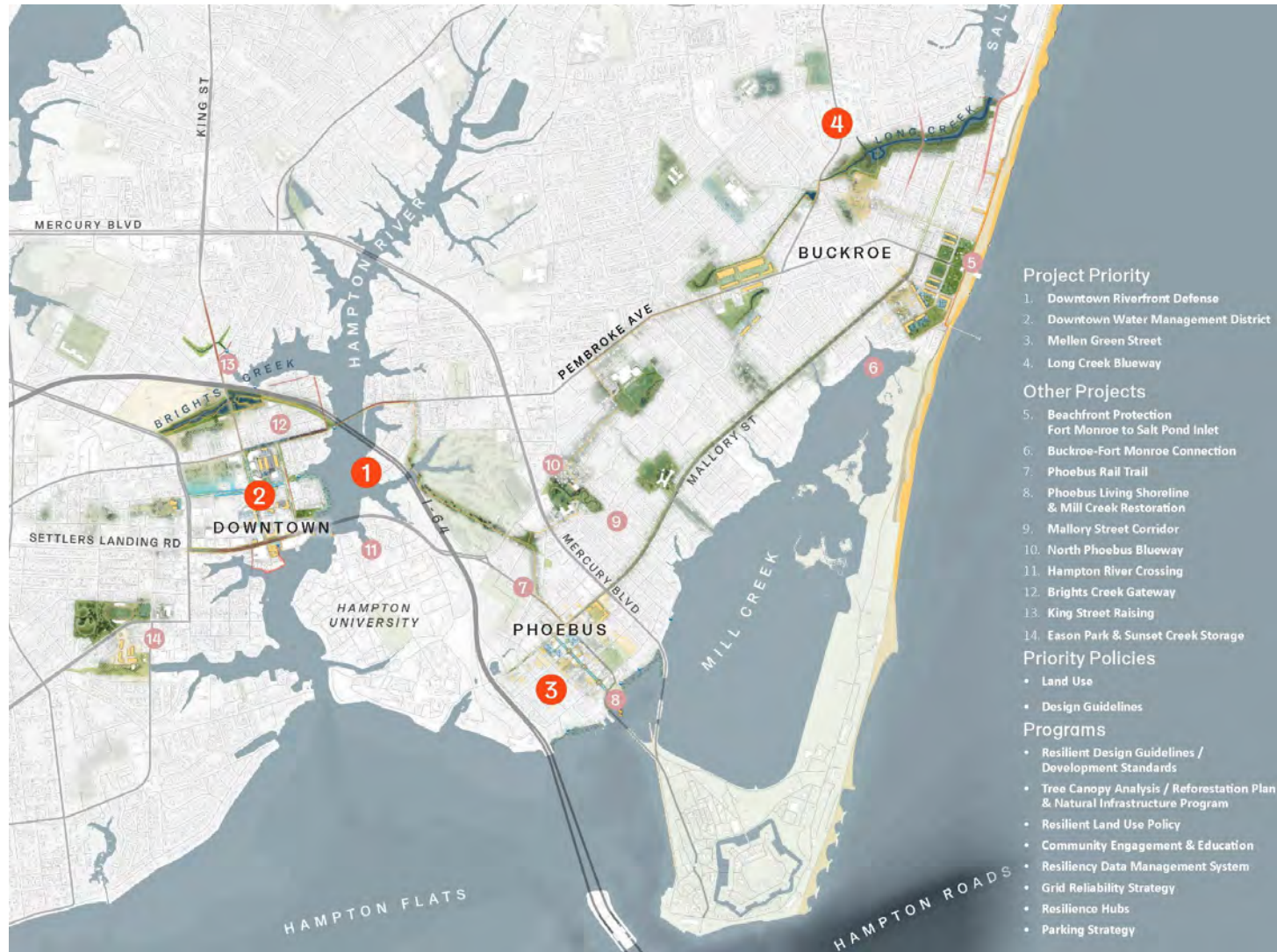


NEWMARKET CREEK FLOOD GATE



Example Crest Gate

Projects & Programs



Downtown Waterfront Defense

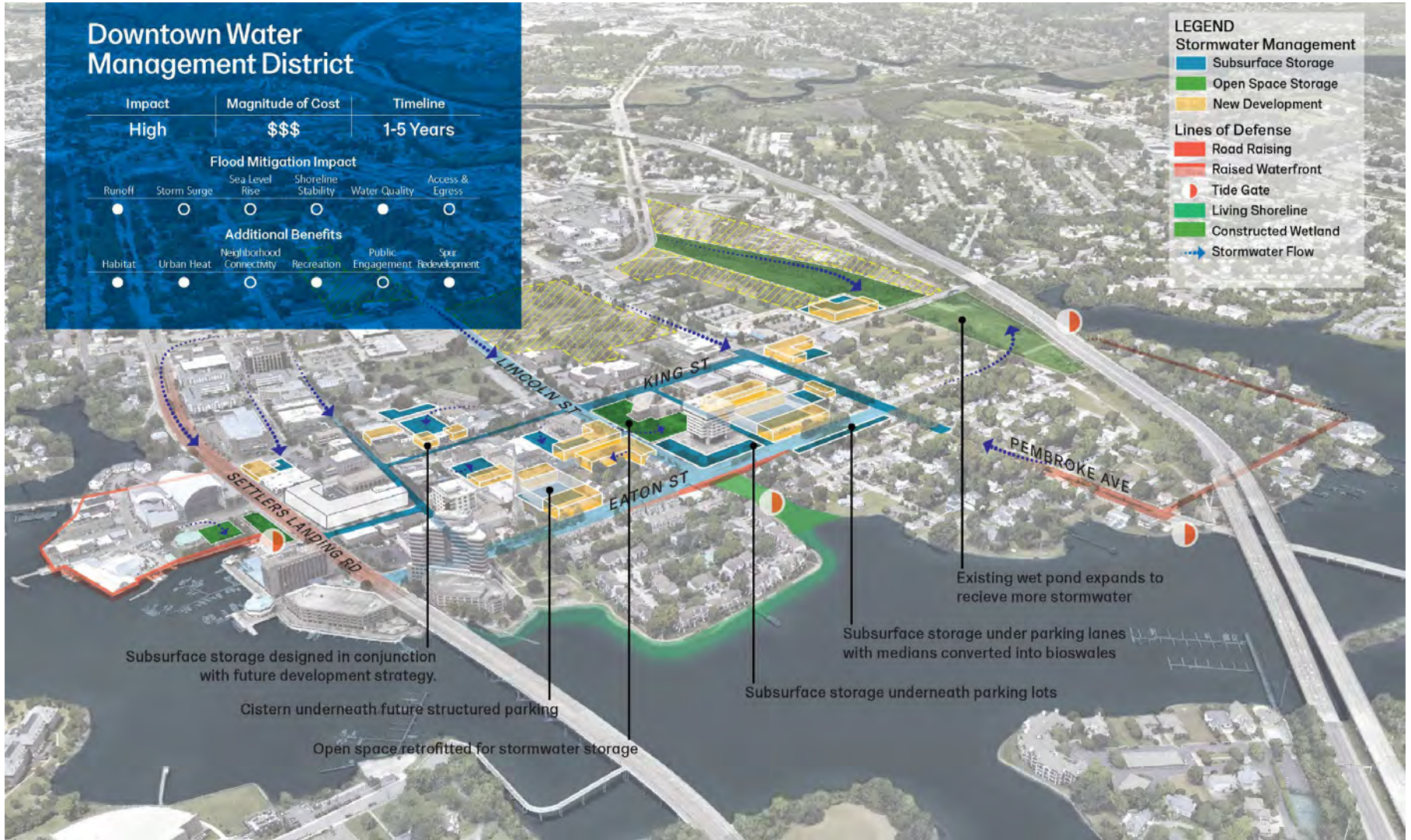
Impact		Magnitude of Cost		Timeline	
High		\$\$\$\$		10+ Years	
Flood Mitigation Impact					
Runoff	Storm Surge	Sea Level Rise	Shoreline Stability	Water Quality	Access & Egress
○	●	●	●	●	●
Additional Benefits					
Habitat	Urban Heat	Neighborhood Connectivity	Recreation	Public Engagement	Spur Redevelopment
●	○	○	○	●	○



Downtown Water Management District

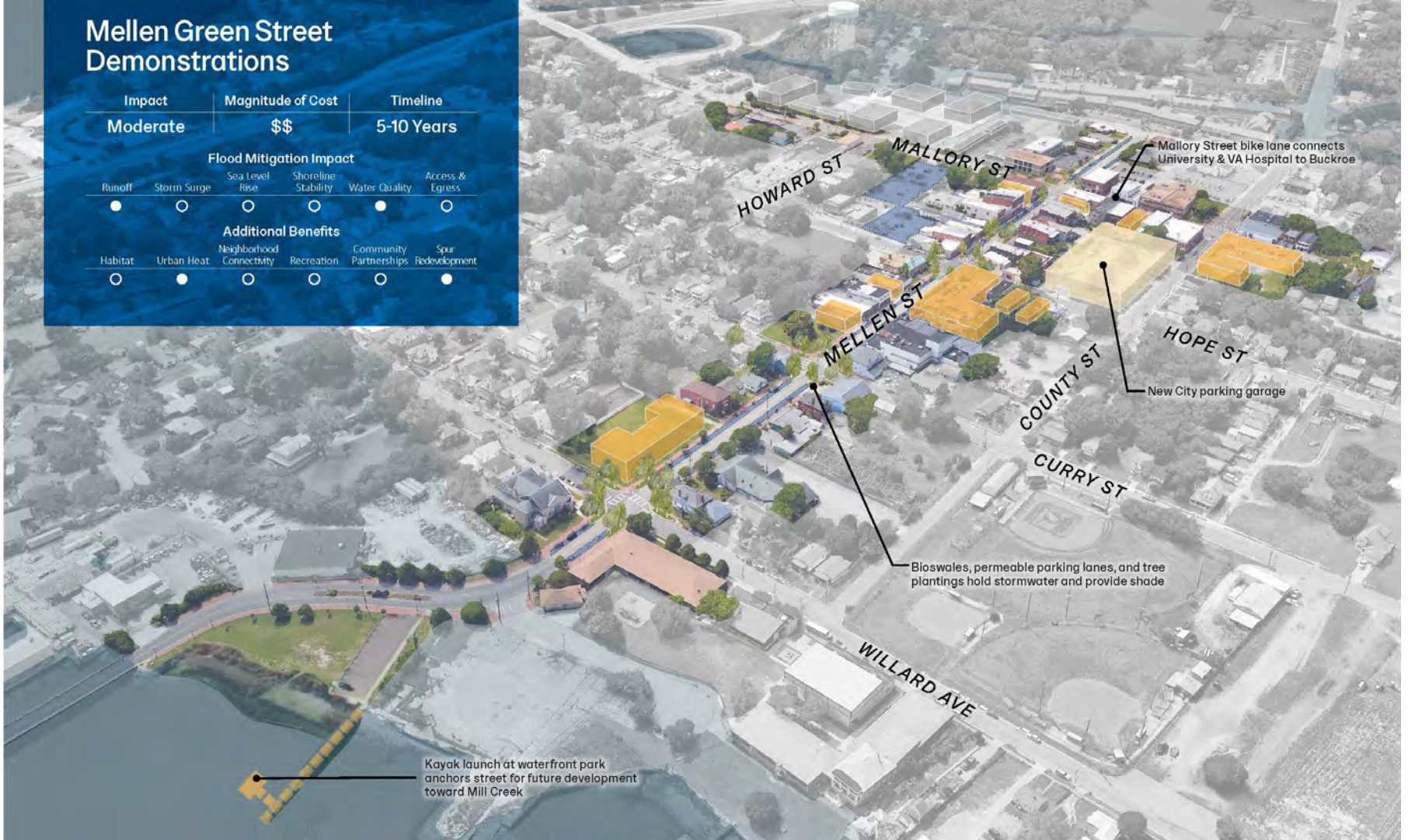
Impact		Magnitude of Cost	Timeline		
High		\$\$\$	1-5 Years		
Flood Mitigation Impact					
Runoff	Storm Surge	Sea Level Rise	Shoreline Stability	Water Quality	Access & Egress
●	○	○	○	●	○
Additional Benefits					
Habitat	Urban Heat	Neighborhood Connectivity	Recreation	Public Engagement	Spur Redevelopment
●	●	○	○	○	○

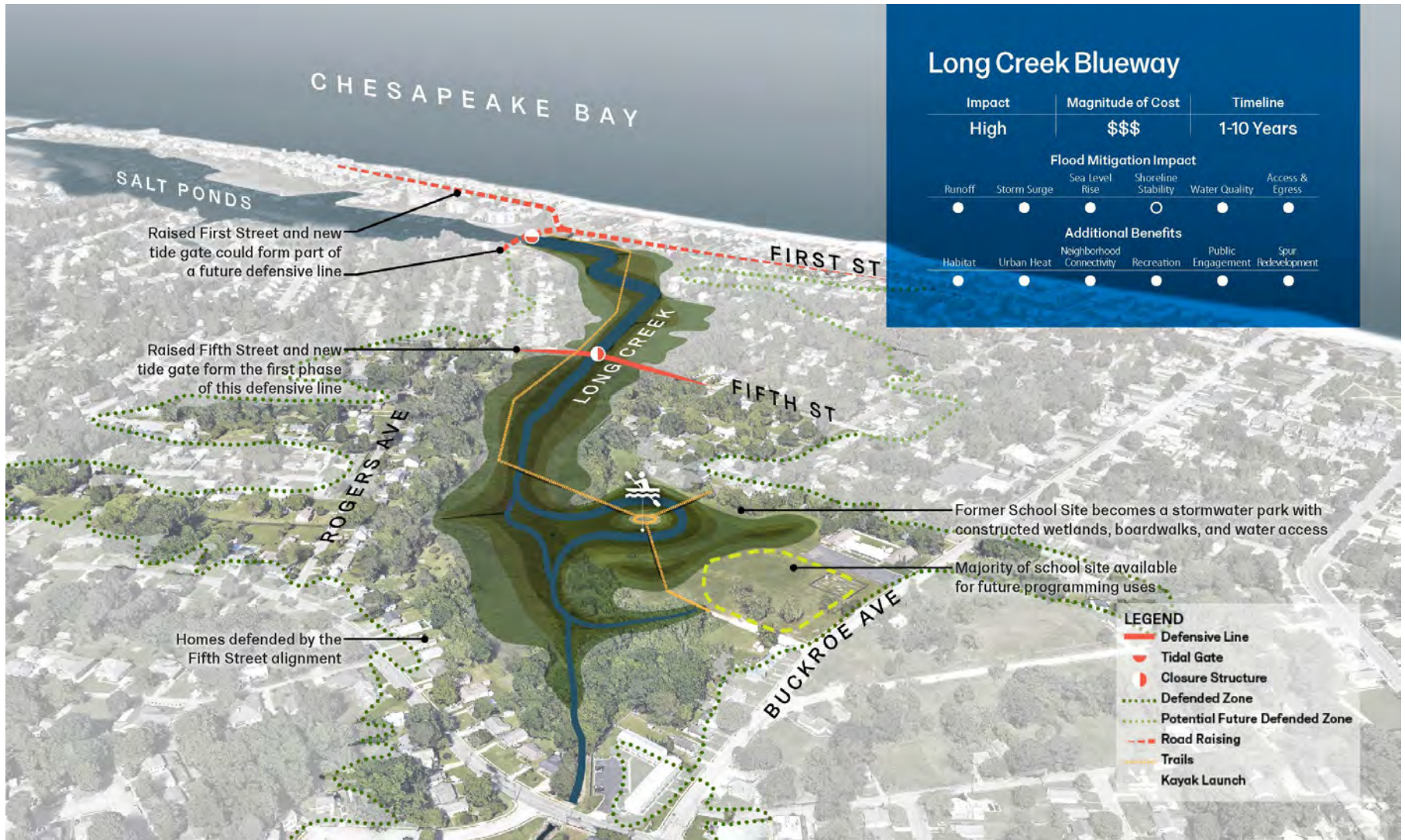
- LEGEND**
- Stormwater Management**
- Subsurface Storage
 - Open Space Storage
 - New Development
- Lines of Defense**
- Road Raising
 - Raised Waterfront
 - Tide Gate
 - Living Shoreline
 - Constructed Wetland
 - Stormwater Flow



Mellen Green Street Demonstrations

Impact		Magnitude of Cost	Timeline
Moderate		\$\$	5-10 Years
Flood Mitigation Impact			
Runoff	Storm Surge	Sea Level Rise	Shoreline Stability
●	○	○	○
Water Quality	Access & Egress		
●	○		
Additional Benefits			
Habitat	Urban Heat	Neighborhood Connectivity	Recreation
○	●	○	○
Community Partnerships	Spur Redevelopment		
○	●		





Long Creek Blueway

Impact		Magnitude of Cost	Timeline		
High		\$\$\$	1-10 Years		
Flood Mitigation Impact					
Runoff	Storm Surge	Sea Level Rise	Shoreline Stability	Water Quality	Access & Egress
●	●	●	○	●	●
Additional Benefits					
Habitat	Urban Heat	Neighborhood Connectivity	Recreation	Public Engagement	Spur Redevelopment
●	●	●	●	●	●

Estimated Project Costs

Project	Estimated Cost
Lake Hampton	\$4M*
North Armistead Road Raising	\$24M*
Big Bethel Blueway	\$7M*
Honor Park	\$7M
Lincoln Landing	\$2M
Downtown Waterfront Defense	\$\$
Downtown Water Management District	\$\$
Long Creek Blueway	\$\$
La Salle Avenue Resilience Corridor	\$400M
*Funded Projects	

City-Wide Natural Infrastructure Study



Tree Planning and Planting CAMPAIGNS
 A Guide for Reforesting Cities and Towns

TREE MAPPING

CANOPY GOALS

SOCIAL TREE EQUITY

TREE BENEFITS

The Green Infrastructure Center Inc.
 June 2022

UAS Forest Service
 Funded by the Southern Region of the USDA Forest Service.

Thank You!

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(757) 727-6244

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SCAN TO SIGN UP FOR OUR
NEWSLETTER

www.hampton.gov/resilient

Research Topics

The challenges to implementing mitigation projects besides funding are as follows;

- How do we demonstrate to residents that are either outside a line of protection or opposite that protection, that the protection measure will not negatively impact their property? In riverine conditions we protect flood plain and we promote wetlands as flood storage. In the coastal environment a line of protection may cut off that storage area, how do we demonstrate that the ocean is an infinite reservoir and cutting off 100 acres of storage will not raise water levels outside the level of protection?
- Modeling of wave action of flood protection systems to demonstrate the rebounding wave energy will not create erosion or damage on the opposite shore.
- Better understanding of the impacts of sea level rise on inland flooding. Especially with increased precipitation.

Sea Level Rise and Climate Resiliency at JBLE-Langley

*Cecilia Boyd
Langley Air Force Base
Hampton, Virginia*

The location of Joint Base Langley-Eustis (JBLE) Langley is uniquely vulnerable to climate impacts on mission operations. Most of the installation is below the 100-year flood level. This coastal Virginia region, Hampton Roads, is experiencing the second highest relative sea level rise rate in the United States. Because of this, the installation has been proactive in resiliency planning inside and outside the fence line. Current actions can only mitigate some harm from climate change and improve recovery time, but the danger of extreme weather events is increasing and will continue to be a planning priority.

In 1933, an unnamed storm hit Langley Fields resulting in 8.9ft of flooding. In 2003, Hurricane Isabel caused \$146M in damage from 7.9ft of flooding. In 2009, a strong nor'easter wind caused 7.6ft of flooding. Routine annual flooding from strong easterly wind and during king tides already impact transportation routes outside of storm events. Extreme high tides and storms cause flooding on airfield, and drainage is hampered by old, inefficient stormwater conveyance.

Due to our high vulnerability, JBLE-Langley is at the forefront for the Air Force of planning and regional partnership to address climate change. Work to begin to address climate resiliency began with vigor after Hurricane Isabel in 2003. Resiliency was further vitalized by our partnership with the City of Hampton in the 2018 addendum to our Joint Land Use Study. As part of the addendum, both parties agreed to improve future individual planning efforts to increase resiliency. In 2022, JBLE-Langley was chosen as a pilot Air Force installation for the rollout of Installation Climate Resiliency Plans which forecasts and rates climate hazards unique to the installation. Severe Weather and Climate Hazards considered high risk for the installation are hurricanes, rising sea levels, extreme heat, non-storm surge flooding, storm surge flooding, tornados, and subsidence. Execution of resiliency planning has been supported and/or required by executive orders directed at federal climate resiliency since 2009.

Infrastructure resiliency that has already been implemented includes the 2004 flightline stormwater pump station, installation of door dams at vulnerable facilities, and building requirements that infrastructure must be 10.5ft above mean sea level and outside of the 100-year flood level. JBLE-Langley developed a study completed in 2020 to identify facilities vulnerable to sea level rise and place seawalls and stormwater backflow prevention along critical areas to

prevent nuisance routine tidal flooding predicted within the next 10 years. This \$8 - \$10 million project is funded and will be implemented in the next few years.

Natural resiliency has focused on natural shorelines. From 2006-2021, JBLE-Langley installed living shorelines along over 1/3 the installation's developed shoreline. Of the remaining area, over 1/2 is rip rap or marsh. In 2022, JBLE-Langley began collaboration with the Army Corps of Engineers' Engineering with Nature (EWN) initiative to large scale design nature-based solutions for resiliency. Two workshops were held with EWN and regional regulators and stakeholders to prioritize locations and methods for nature-based designs. The EWN research concluded in 2024 with 10% designs for four natural infrastructure projects to improve coastal resilience at the installation and surrounding communities. These designs focus on thin layer placement, living oyster sill breakwaters and shorelines, and ephemeral sand islands along the Back River. Grant funding is being sought to implement these nature-based designs beginning with thin layer placement of dredge materials.



Sea Level Rise and Climate Resiliency at JBLE-Langley

Cecilia Boyd

Natural Resources Program Manager

JBLE-Langley, VA 23665

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Cecilia.Boyd@us.af.mil

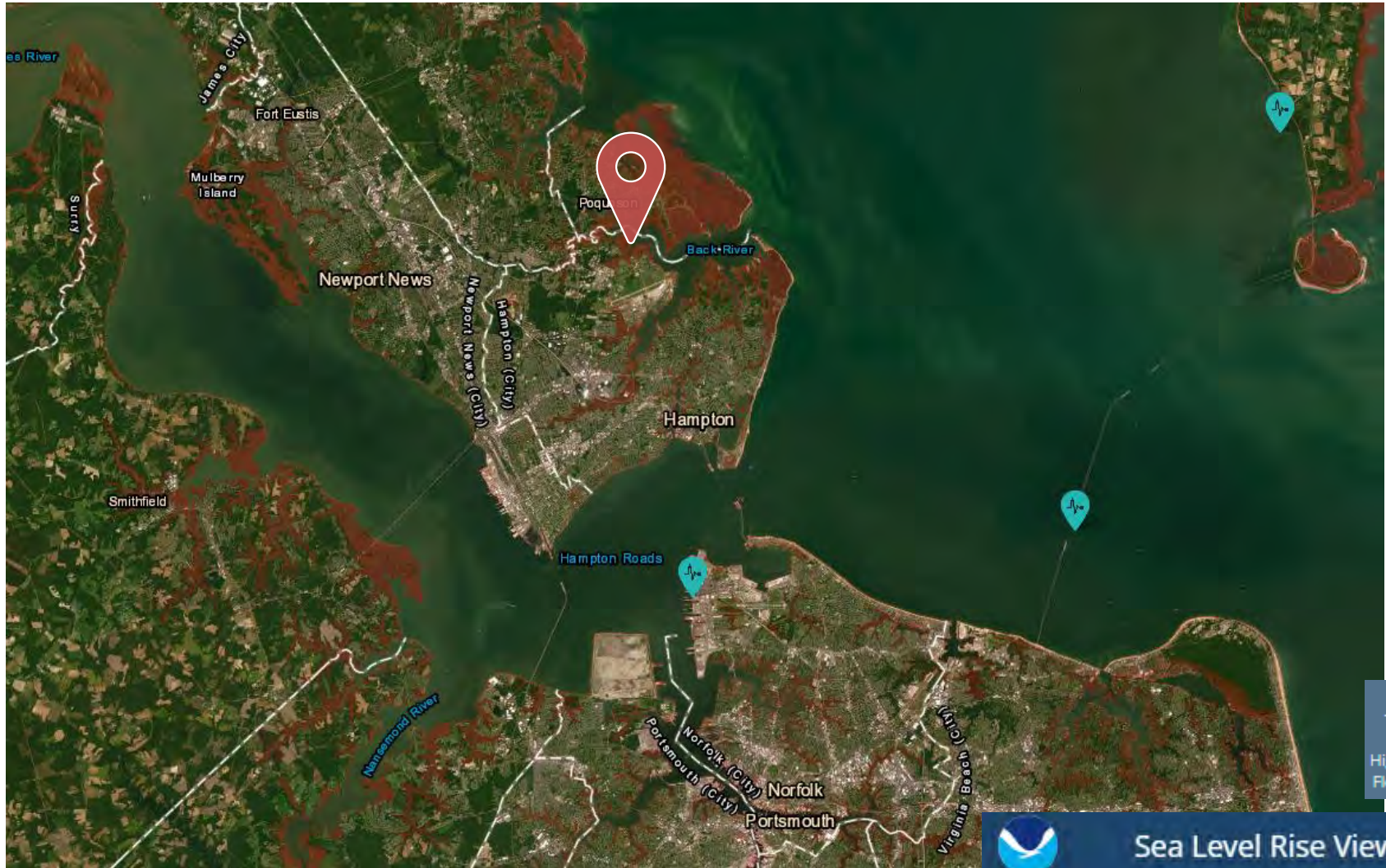


1. Overview
2. JBLE-Langley Background
3. Flood Resiliency and History
4. Current Resiliency Measures
5. Planned Resiliency Efforts
6. R&D Gaps and Recommendations





JBLE-Langley Overview



High Tide
Flooding



Sea Level Rise Viewer

1. Overview



JBLE-Langley Overview



High Tide
Flooding



Sea Level Rise Viewer

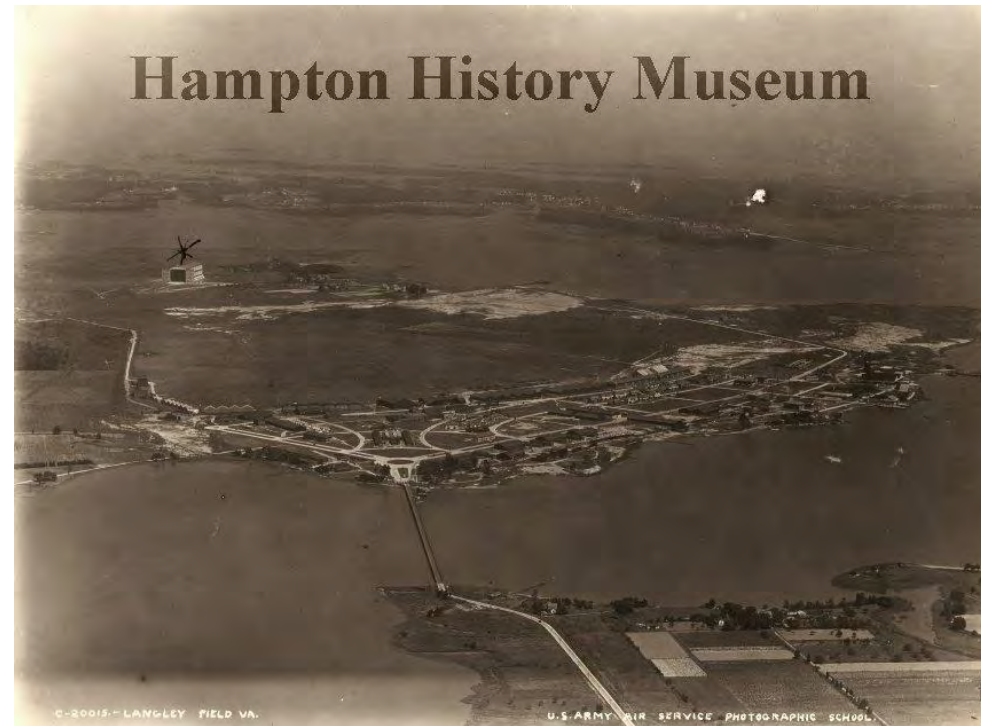


JBLE-Langley Background



• Langley Fields

- Majority of Main Base within the 100-year floodplain
- Langley Fields founded in 1916. Area was mostly farmland
- Most of the natural vegetation in and around the Main Base and Bethel Reservoir has been lost or modified since urbanization and installation establishment.



1917

1

2



Hampton History Museum

1

2

3

1920s

2. JBLE-Langley Background

2020s



1

2

3



1

2

3

2. JBLE-Langlely Background



Flood Resiliency



Coastal Flood Hazard Composite

- 1 Hazard Zone
- 2 Hazard Zones
- 3 Hazard Zones
- 4 Hazard Zones
- 5 Hazard Zones
- 6 Hazard Zones
- 7 Hazard Zones
- 8 Hazard Zones
- 9 Hazard Zones
- 10 Hazard Zones
- 11 Hazard Zones

	1933	1999	2003	2009	2011	2012	2015	2016	2016
	Unk.	Floyd	Isabel	Nor'easter	Irene	Sandy	Joaquin	Hermine	Matthe w
Water Level Above Mean Sea Level (Ft)	8.9	6.3	7.9	7.6	7.5	6.9	6.5	6.12	5.78
Storm Wind (MPH)	82	55	62	75	85	90	46	65	61
Damage (\$)	No Data	No Data	\$146M	\$44M	\$1.5 M	\$40K	\$6.5M	\$9K	\$168K
Base Closure	No Data	No Data	7 days	48 hrs	24 hrs	24 hrs	72 hrs	-	-



2003 Hurricane Isabel 7.9ft flood



Current Resiliency Measures



Shoreline Stabilization



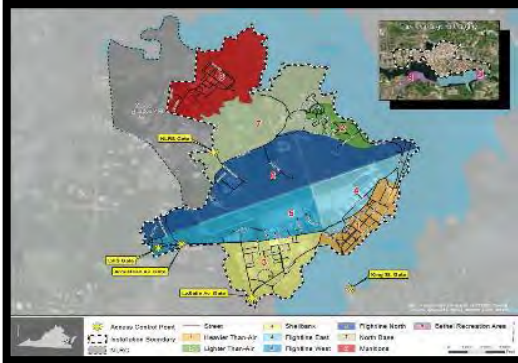
Raised Infrastructure



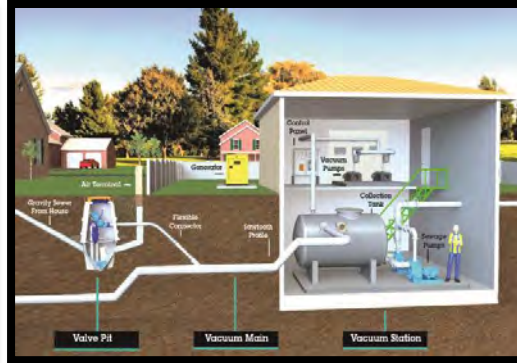
Flood Barrier Program



Master Planning



Vacuum Sanitary Sewer System



Protection of Infrastructure



4. Current Resiliency



Current Resiliency Measures



- 2004 Stormwater Pump Station
- 2006 Shoreline Restoration
- 2018 Hampton Joint Land Use Study
- 2020 Langley Climate Impact Study
- 2022 Army Corps of Engineers: Engineering with Nature Plan
- 2022 Installation Climate Resilience Plan





Stormwater Pump Station



- Completed 2004
- 4 high efficiency pumps
- 31K gallons/minute
- 7.4 million gallons per hour





Stormwater Pumping Station



Flood recovery not prevention





Stormwater Pumping Station



Flood recovery not prevention
Flooding must be below 3ft to function

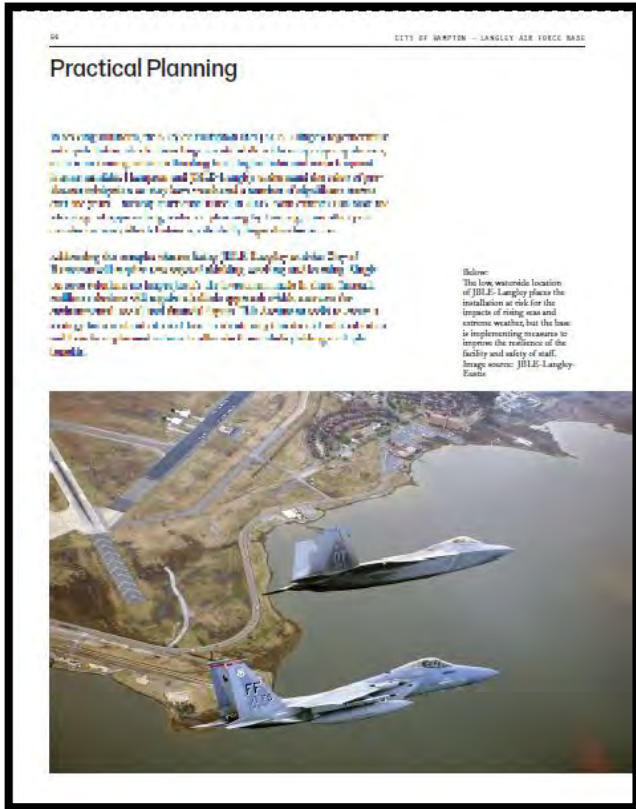




Hampton Joint Land Use Study



- Partnership commitment between JBLE-Langley and City of Hampton
 - Climate Resiliency addendum to 2010 Plan added in 2018
- Protect transportation routes to Langley
 - LaSalle Corridor
- Improve regional design standards
 - Sea level rise
 - Langley must build above 100 yr flood plain
- Work together to research management of flooding and sea level rise





Installation Climate Resilience Plan



- Completed 2022
- New Requirement for DoD / Air Force Installations
 - Driven by Executive Order
 - Langley Pilot Installation for Plan
- Risk Assessment of Severe Weather /Climate Hazards
 - Ex: Hurricanes
 - Sea Level Change
 - Extreme Cold
- Climate Impacts on Assets

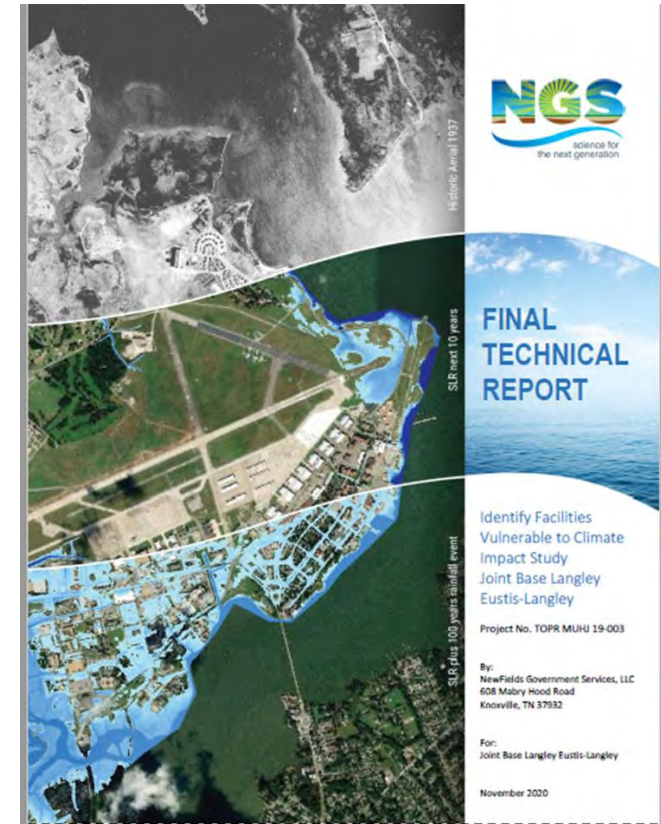
RISK ASSESSMENT MATRIX		PROBABILITY					
		FREQUENCY OF OCCURRENCE OVER TIME					
		FREQUENT Continuously experienced	LIKELY Will occur frequently	OCCASIONAL Will occur several times	SELDOM Unlikely; can be expected	UNLIKELY Improbable, but possible	
SEVERITY	EFFECT OF HAZARD	CATASTROPHIC Death, Loss of Asset, Mission Capability, or Unit Readiness	EH	EH	H	H	M
	CRITICAL Severe Injury/Damage, Significantly Degraded Mission Capability or Unit Readiness	EH	H	H	M	L	
	MODERATE Minor Injury/Damage, Degraded Mission Capability or Unit Readiness	H	M	M	L	L	
	NEGLIGIBLE Minimal Injury/Damage, Little/No Impact to Mission Capability or Unit Readiness	M	L	L	L	L	
			Risk Assessment Levels:				
		EH – Extremely High	H – High	M – Medium	L – Low		



Langley Climate Impact Study



- Result of 2018 Hampton JLUS
- Contracted by Langley and finished in 2020
- Study Focuses:
 - Hydrologic Modeling
 - Flood Vulnerability
 - Proposed Seawalls/Sea Gates
- Contractor now working on:
 - Strategic Stormwater Credit Planting Plan
 - Wetland offset planning
 - Improving Hydro modeling
 - Stormwater Infrastructure Surveying





Langley Climate Impact Study



HMU4 Flood Prone Areas



HMU4 Proposed BMPs





Planned Resiliency Efforts



- Installation Construction Projects
 - Repair Airfield Drainage (Phase II)
 - Flood Walls and Backflow Prevention Climate Impact Study
 - Repair Base-wide Outfall Drainage System
- Other Initiatives
 - Strategic Planting and Wetland Study (Construction Impact Offsetting)
 - Bethel Dam and Reservoir Study
 - Engineering With Nature Large Scale Nature-Based Infrastructure





USACE Engineering With Nature



Background

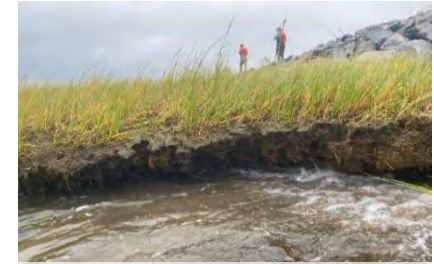
- FY 22: JBLE-Langley began a partnership with the USACE Engineering With Nature (EWN) program.
- EWN is now directly supporting JBLE-Langley's climate resiliency and is fully funded to complete 10% design work.
- Their team of scientific experts made a climate/coastal resiliency roadmap using environmental designs for Tyndall AFB following Hurricane Michael in FY 18.

Workshop

In Nov 23, EWN, Langley, and regional regulators and stakeholders had a 2-day workshop to define priorities and identify large, regional, nature-based resiliency projects. This produced 3 major projects areas and design solutions.

Next Steps

- Data collection with water sensors/buoys for baseline resiliency work
- Seek grant funding for design implementation
- Coordinate with Sentinel Landscapes program
- Continued outreach and discussion with Stakeholders



Shoreline Erosion at End of Flightline



Stakeholders in Bayview for Nov 23 Workshop





USACE Engineering With Nature



Planned Water Sensor Placement

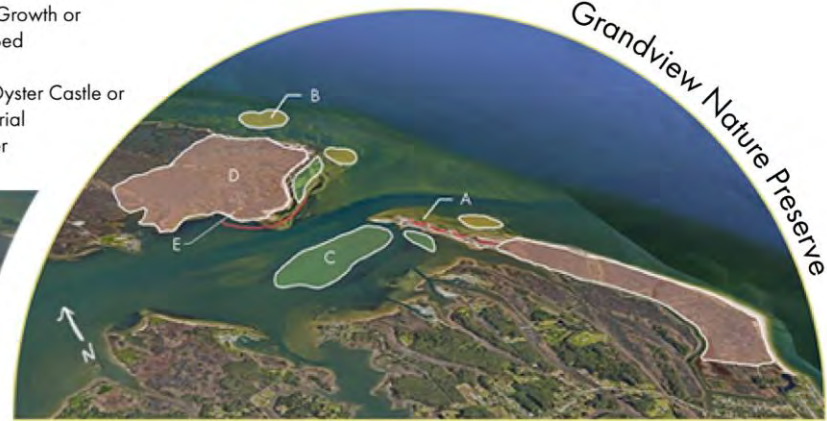
Overview of Concepts



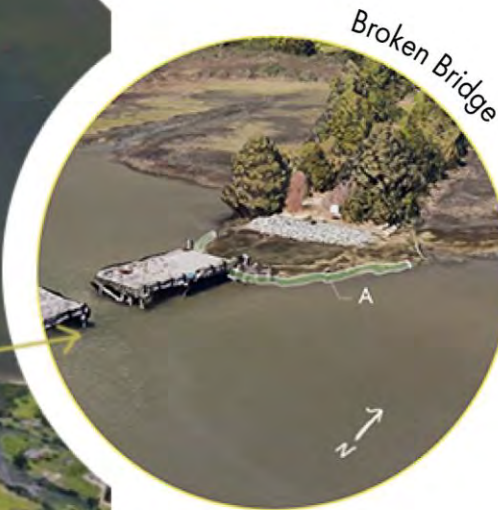
- A: Horizontal Levee Re-graded
- B: Fill to Widen Existing Marsh
- C: Reduce Mowing Native Plant Area
- D: Thin Layer Placement
- E: Living Shoreline Reef Structure



- A: Proposed Floodplain Area
- B: Submerge Aquatic Vegetation Bio-bed
- C: Perched Beach for Wetland Growth or Shellfish Bed
- D: Living Sill
- E: Gabion, Oyster Castle or Reef Material Breakwater

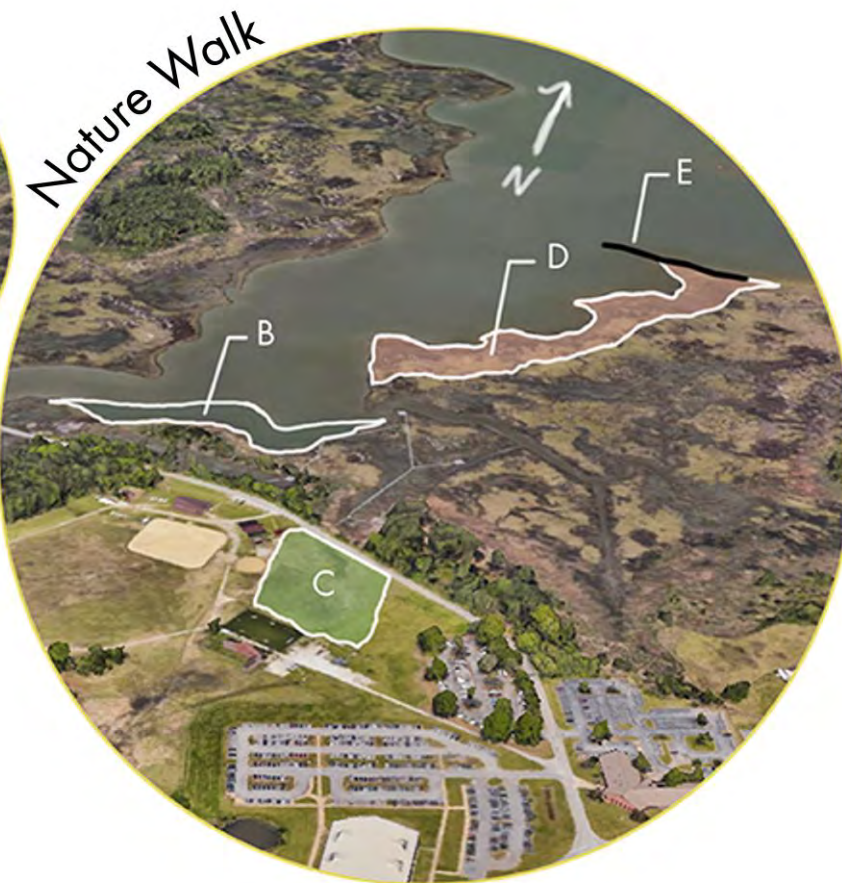


- A: Living Oyster Breakwater
- B: Ephemeral Island/Sand Motors
- C: Submerged Aquatic Vegetation Bed
- D: Wetland and Habitat Enhancement Thin Layer Placement
- E: Four 8 by 3 Meter Plots Planting Testing

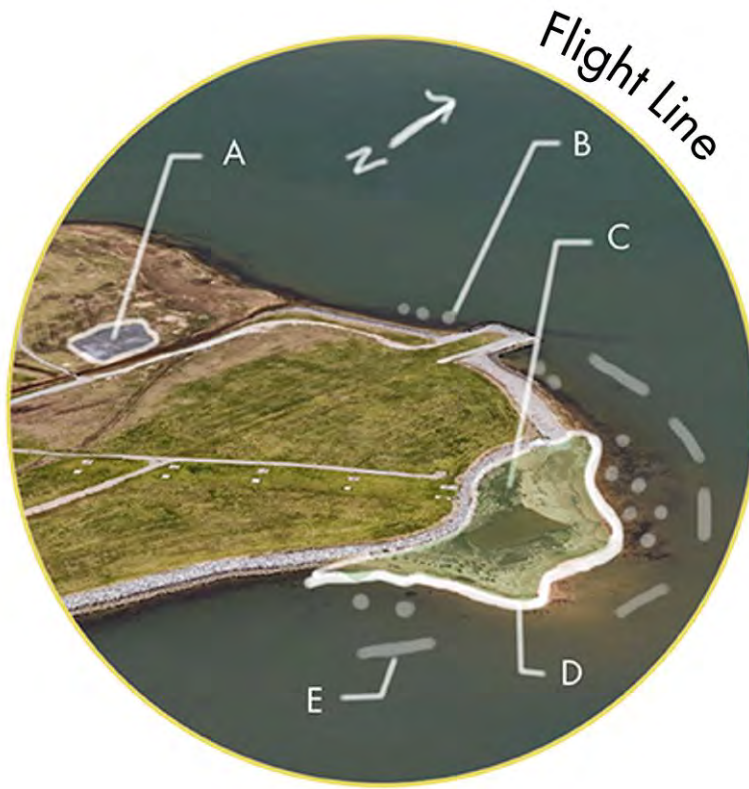


- A: Oyster Reef Structure

5. Planned Resiliency



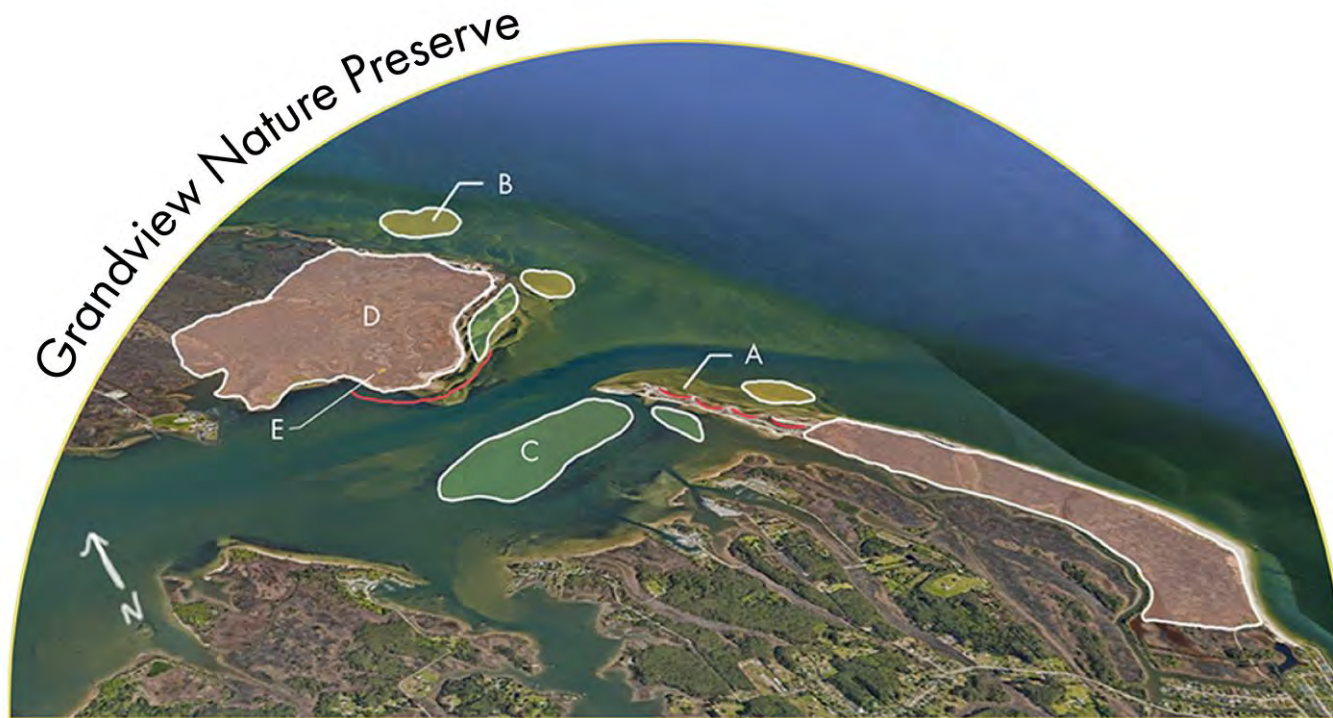
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A: Oyster Reef Structure



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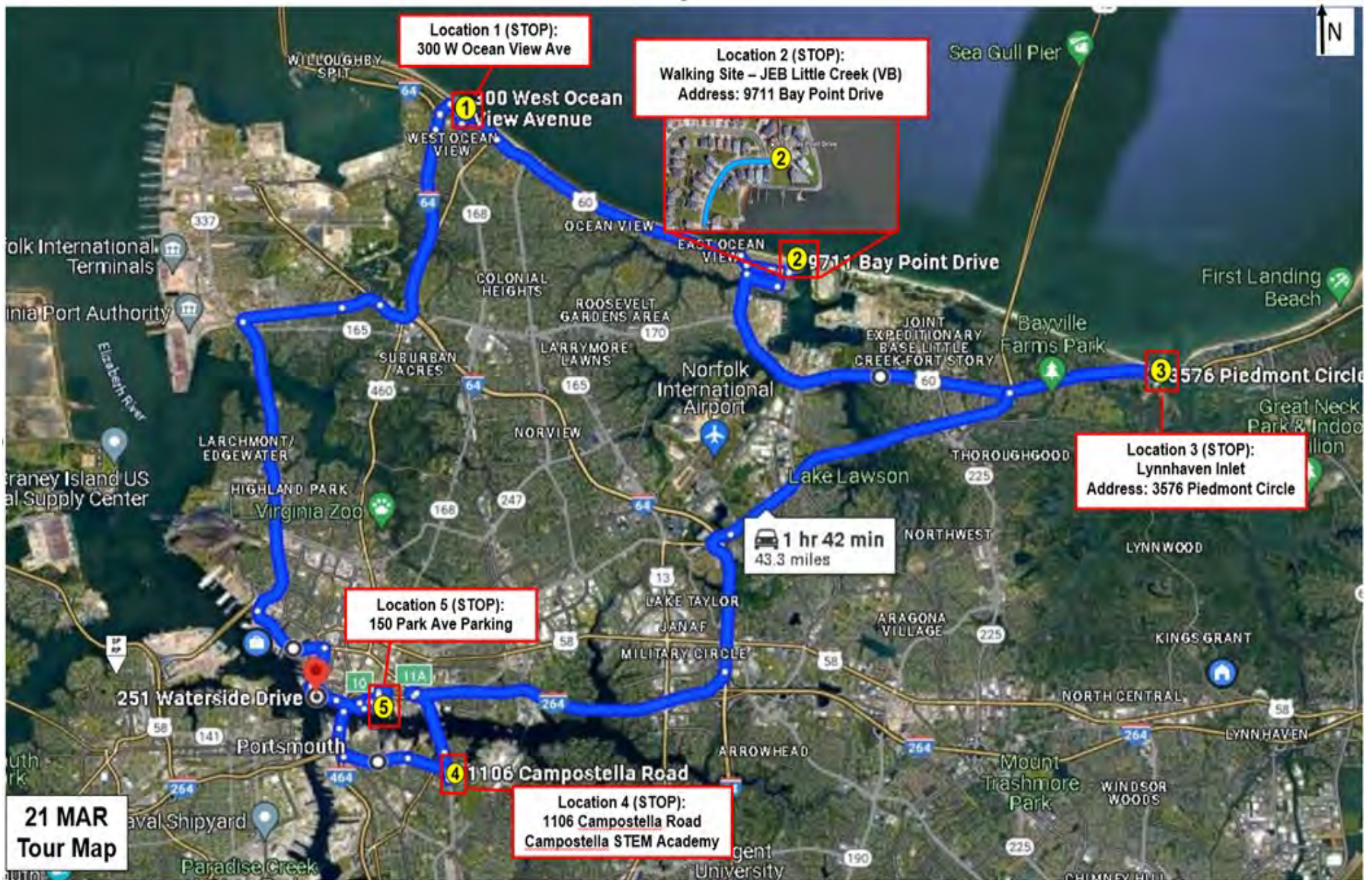
R&D Gaps/ Recommendations

- Understanding local Hydrodynamics and Sediment
 - Will our sand islands and TLP work?
- Establishing Thin Layer Placement Workflow
- Understanding Regional Subsidence
 - How fast are we going down and why?
- Dedicated Installation Climate Resiliency Specialist/
Advocate

A serene sunset over a body of water. The sky is filled with soft, warm colors of orange, yellow, and pink, transitioning into a darker blue at the top. The water in the foreground is calm, reflecting the light from the sky. In the middle ground, there are silhouettes of reeds and a dense line of trees. The overall mood is peaceful and contemplative.

Thank You!

Site Visit



Site Visit Tour Map

Bus leaves in front of hotel at 1245pm.

Presentations

Day 2

Non-Cohesive Coastal Sediment Transport Research at ERDC

*Katherine Brodie Ph.D.
U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
Field Research Facility
Duck, NC*

Introduction

Within the U.S. Army Corps of Engineers, there is a need to better design and manage Coastal Storm Risk Management (CSRM) and Navigation projects. Deficiencies in our understanding of sediment transport processes hinder USACE efforts in shore protection, coastal flooding, entrance channel in-filling, coastal structure impact, and wetlands/habitat protection. To account for non-cohesive sediment movement and resultant coastal morphology evolution in federal planning, design, operations, and management decision making processes, USACE typically uses numerical models of varying fidelity (e.g. empirical tools to wave-resolving process-based models), all of which simplify and parameterize hydrodynamic and sediment processes to some degree. While these models are used to inform billion-dollar decisions on the management of sand along our coasts, these simplifications result in unreliable morphology evolution predictions at time scales relevant for engineering decisions (storms to decades).

Applied Engineering Gaps

1. CSRM Project Design & Planning: USACE 3x3x3 requirements require fast answers from engineering models, yet errors can have costly impacts. For example, lifecycle planning models for CSRM projects require estimates of natural beach recovery between erosive storm events. Without an available process-based approach, the present methodology uses simple rule-based recovery, where 90% of the eroded volume is arbitrarily returned to the beach within a set time window following a storm regardless of physical processes.
2. CSRM Project Maintenance & Operations: From a maintenance perspective, USACE's operational program to nationally monitor the morphology of our coasts only provides observations once every five years (and in response to extreme storms as requested). This schedule lacks the temporal resolution to assess project performance, make adaptive management decisions, assess storm impacts, and validate/improve predictive numerical tools across different geographic domains.
3. Beneficial Use of Dredged Material (BUDM): USACE's goal is to increase from ~30-35% to 70% BUDM by 2030. Recent USACE directives have specifically encouraged nearshore berm and foredune construction with BUDM to benefit CSRM. However, the lack of reliable

predictive capabilities have largely prevented the optimization of these features to achieve required project performance.

4. Dredging: Transport of non-cohesive sandy sediments is responsible for infilling navigation channels in many coastal inlets nationwide which causes USACE to spend significant resources on dredging. Improved sediment transport and morphology evolution estimates along our Nation's coast would better inform the mobilization and frequency of dredge mobilization.

Fundamental Science Gaps

1. Fundamental understanding of sediment transport processes is still lacking at the basic physics level. One reason for this shortfall lies in the difficulty of observing and directly measuring suspended and bed-load sediment transport, which limits a complete theoretical understanding of these processes.
2. Our ability to accurately model phase- and time-averaged surf-zone hydrodynamics is relatively good. However, while phase-resolved models can simulate many of the detailed processes likely important for sediment transport (e.g., wave shape, infragravity motions, vorticity), phase-resolved models lack skill in coastal morphology and sediment transport for engineering scales. In fact, all of our low and high-fidelity, process-based modeling approaches struggle to account for the multi-scale details of sediment transport. For instance, wide heterogeneity in bed sediment types, highly turbulent flows, and some element of randomness in natural environments complicate direct translation of controlled, lab-derived parameterizations of sediment transport rates to field settings.

Status

Our 2019 paper from ERDC researchers to the CERB on this topic provided the following suggestions: (1) long-term investment in sediment transport, with a focus on integrated lab, field, and numerical modeling studies including rigorous assessment of model skill through test-beds and development of new measurement techniques; (2) exploration of multi-fidelity numerical modeling approaches, in which higher fidelity models inform lower-fidelity models, including the exploration of surrogate modeling using AI/ML; and (3) development of approaches to include uncertainty quantification and probabilistic modeling of coastal morphology evolution. The current R&D framework within USACE continues to present challenges to executing visions for focused, strategic research on a topic. Since 2019, while a few small efforts have been funded that make progress towards these goals, these efforts have largely been projects of opportunity spread throughout the USACE R&D portfolio without a coherent unifying strategy. With the exception of USCRP-funded efforts and Congressional-directed academic partnerships, these few projects are

typically hidden within tactical research efforts addressing RARG and SON driven research requirements as opposed to strategic basic and applied research developing a broader capability. Current or recent projects including sediment transport R&D within ERDC, and their funding source/collaborators are described below:

Micro-scale Processes:

- **Measurements:** surf-zone olivine sediment tracer experiments (EWN), subaqueous suspended sediment sensor development and testing (USCRP academic-funded efforts - lab, field; CFDC - field), subaqueous bedload sediment transport measurements (USCRP academic-funded efforts - lab, field; DOER), and aeolian sediment transport sensor development and testing (CFDC, 6.1 GRE).
- **Processes:** vegetative effects on dune erodibility (EWN), vegetation and wrack effects on wind-blown transport and dune accretion (EWN, OSU partnership), infragravity wave fundamentals (SIO partnership), cobble dynamics (SIO partnership), swash processes (CODS, SIO partnership), non-linear wave induced turbulence and sea-swell/IG wave coupling (USCRP - academic partners; SIO partnership), and wave shape (SIO partnership; 6.1 ME; LUCI).

Meso-scale Processes:

- **Measurements:** new operational observation capabilities for morphology (CODS - CorpsCam) and sediment composition measurement technology (CIRP, RSM, DOER – SandSnap) are improving accessibility to observations of our coasts supplementing existing efforts within the NCMP. In addition, there are ongoing lower TRL efforts focused on using satellite remote sensing and autonomous survey technology for morphology monitoring (CODS), and continued investment in long-term datasets on the east (CFDC – FRF) and west (CODS/SIO) coasts.
- **Processes:** An operational model test-bed at the FRF has been setup, where models are run in real-time and compared against FRF data (CODS). The test bed was utilized to make improvements in CMS, CSHORE, STWAVE and WAVEWATCH 3, and assessment of XBeach and CSHORE is a focus in FY24. Additional work has focused on sandbar evolution (CODS), storm-induced morphology change (CODS), beach-tundra erosion in the Arctic (EWN, military), nearshore berm placement (CIRP, DOER), equilibrium and analytical tools for shoreline dynamics (CODS, CIRP - GENCADE) and erosional and accretional dune evolution (CIRP, EWN - Dune Response Tool).

Model Development:

- Little active model development on sub-aqueous sediment transport has been funded through USACE Civil Works, though there has been some progress on linking codebases and models (CMS, CShore - CIRP; ADCIRC-EWN, UGA partnership) and on validating USACE tools (e.g. SMT-CIRP, DOER). For sub-aerial sediment transport, some model development has been funded on improving sediment transport and bed shear approaches (OSU partnership), and on multi-process model coupling with OpenFOAM-AeoLiS (military) and GenVEG-AeoLiS (OSU partnership).

Uncertainty Quantification (UQ):

- Efforts to develop UQ morphology modeling capabilities have occurred, but have been limited. Initial work has focused on the ability for CSHORE to simulate sandbar dynamics on dissipative beaches, including model parameter sensitivity and inter-site model transferability (CODS, OSU partnership). Probabilistic morphological modeling approaches, including consideration of non-stationary climate forcings, for shoreline contour modeling (CODS – GENCADE), tundra retreat (EWN), and dune evolution (military, OSU partnership) are being explored.

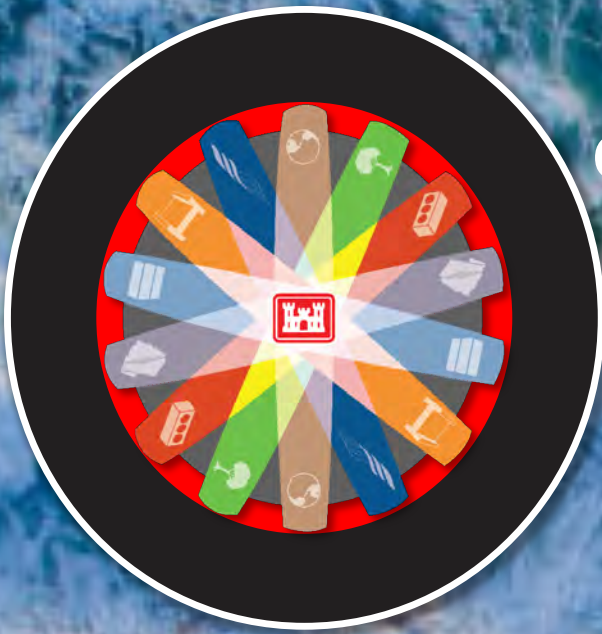
Recommendations

The original goals of the 2019 white paper generally still stand, as there has not been any direct or prioritized effort in response. However, USACE requires better tools to actively manage our sandy coasts now. We recommend a two-pronged approach to meet these needs. The first is a focus on improved operational, national-scale coastal morphology monitoring coupled to probabilistic modeling capabilities with uncertainty estimation. This would be akin to the weather community's approach to operational hurricane modeling, which uses probabilistic ensemble modeling of hurricane tracks that are continually refined through significant observations. The second approach should focus on improving our fundamental ability to measure and model non-cohesive sediment transport. This would include concerted model development on multi-fidelity and process modeling, including basic research on sediment transport measurement and understanding through coordinated lab, field, and numerical investigations driven by a cohesive strategy.

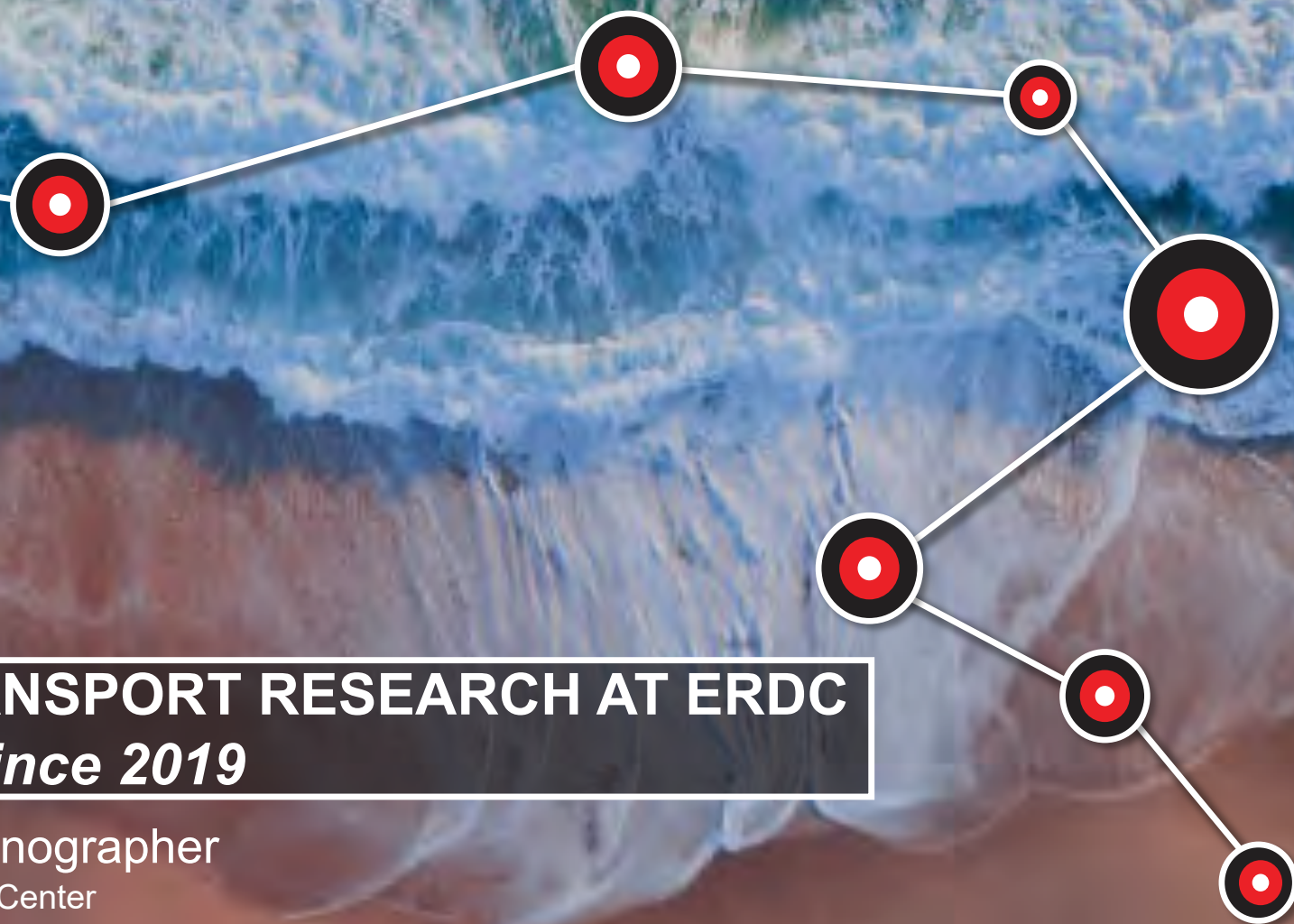
The complexity of the coastal sediment transport problem limits the ability of a single equation, tool, or model framework to be suitable for addressing all USACE-related transport problems. Indeed, predicting coastal sediment transport is a formidable challenge, but significant advances are possible, and improvements will derive from rational model development and deliberate comparison of predictions and data for all model components. A coastal transport model based on physical principles alone is unlikely to ever exist, and predictive technologies will

therefore remain dependent on empirical relations. The next generation of process-based models will require improvements in these parameterizations based on better laboratory and field measurements over a wider range of hydrodynamic forcing. Only comprehensive datasets that cover a wide range of environmental and morphological conditions and which include wave, hydrodynamic, sediment, and transport measurements will suffice to properly identify model weakness and permit further development of more reliable predictive capabilities of coastal sediment transport and morphology change.

Finally, CHL should develop a non-cohesive sediment transport strategy and road-map which integrates these efforts, identifies potential partners, and assesses required skills for future human capital investment. Without organizational prioritization and complimentary dedicated resources allocated to advancing sediment transport knowledge and capabilities across the basic to applied research continuum, it is unlikely that considerable progress will be made on solving these pressing and costly sediment management challenges.



**CONNECTING
THE DOTS TO
INNOVATION**



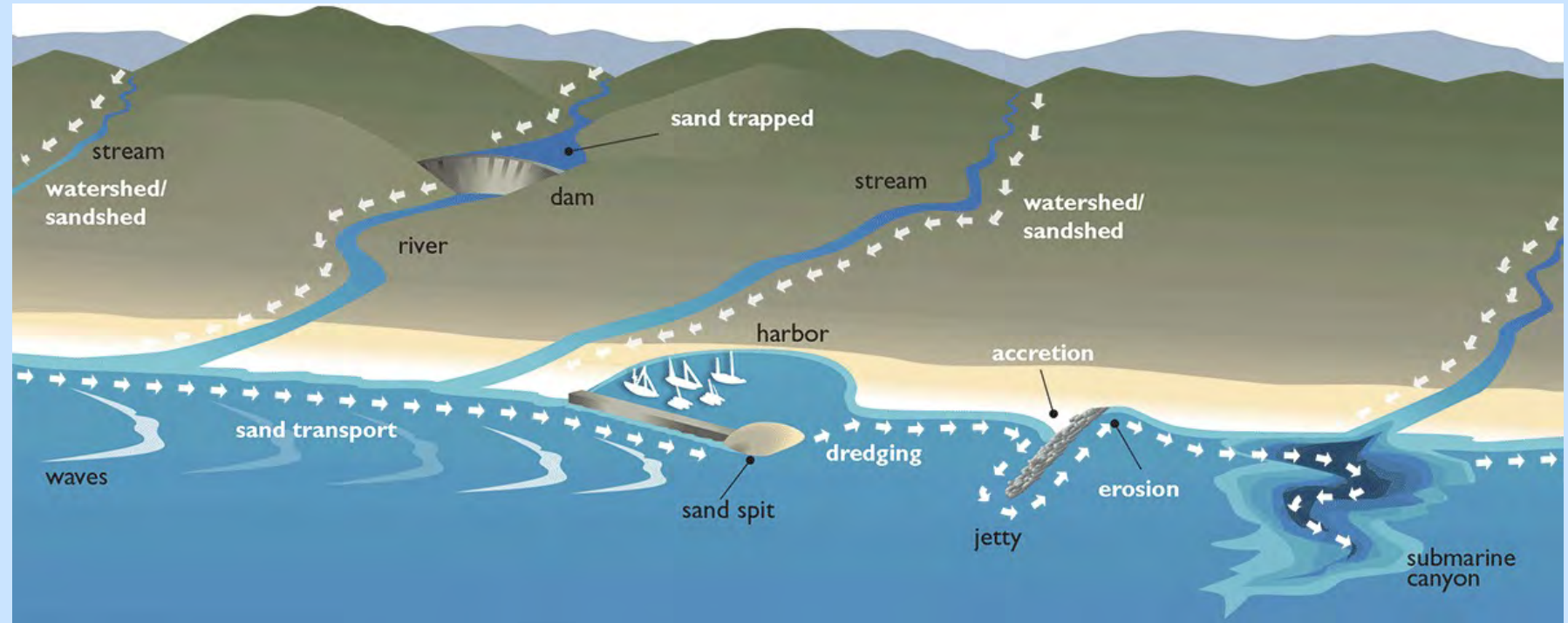
NON-COHESIVE SEDIMENT TRANSPORT RESEARCH AT ERDC
Updates since 2019

Dr. Kate Brodie, Senior Research Oceanographer
US Army Engineer Research and Development Center
Katherine.L.Brodie@erdc.dren.mil

OUTLINE

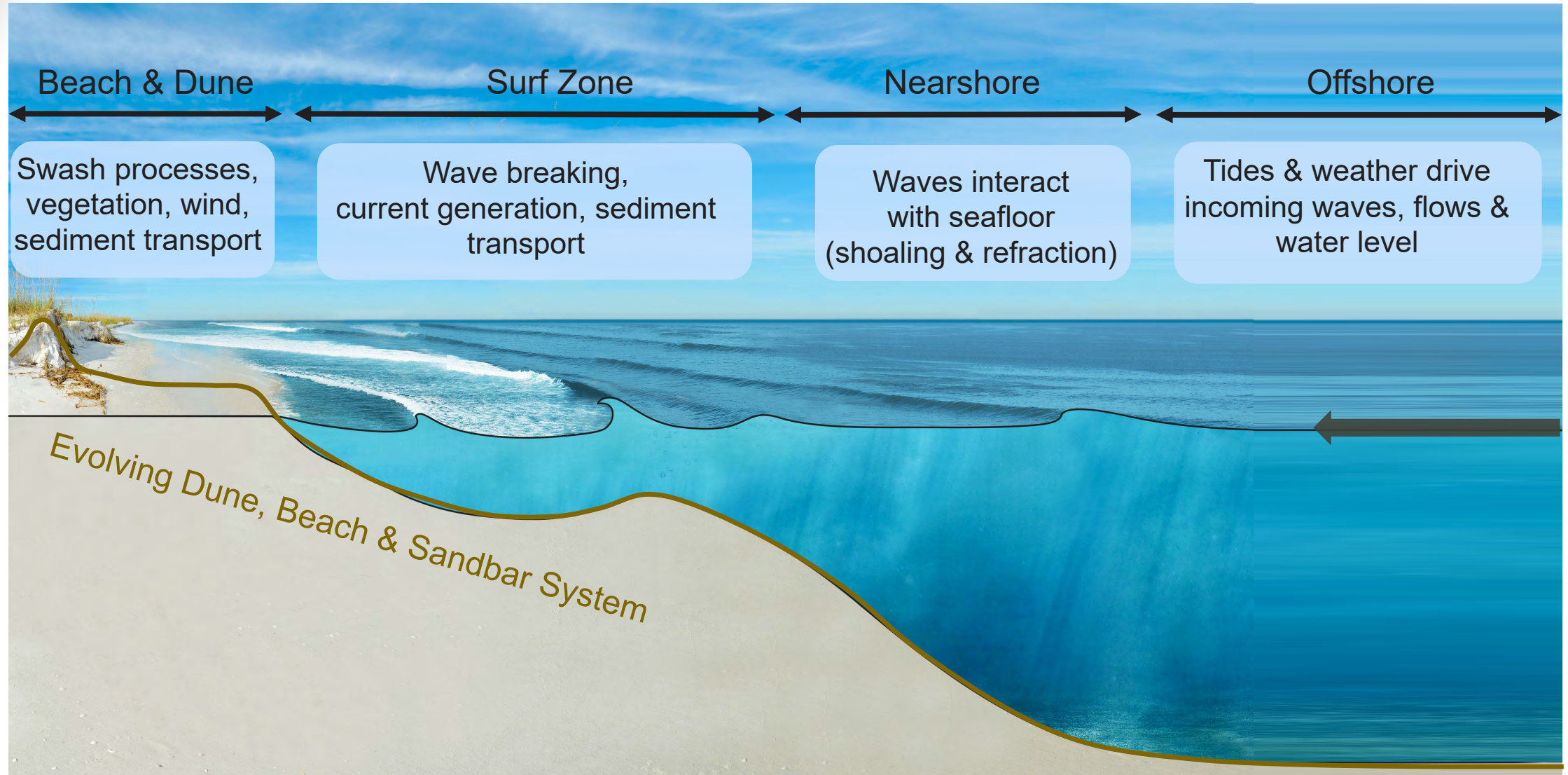
UNCLASSIFIED

1. Introduction to Coastal Processes & Sediment Transport
2. Context of USACE Operational & Research Needs
3. 2019 Review
4. 2019 – 2024 ERDC & Partner Research Highlights
5. Path Forward



UNCLASSIFIED

COASTAL PROCESSES





US Army Corps of Engineers®

UNCLASSIFIED

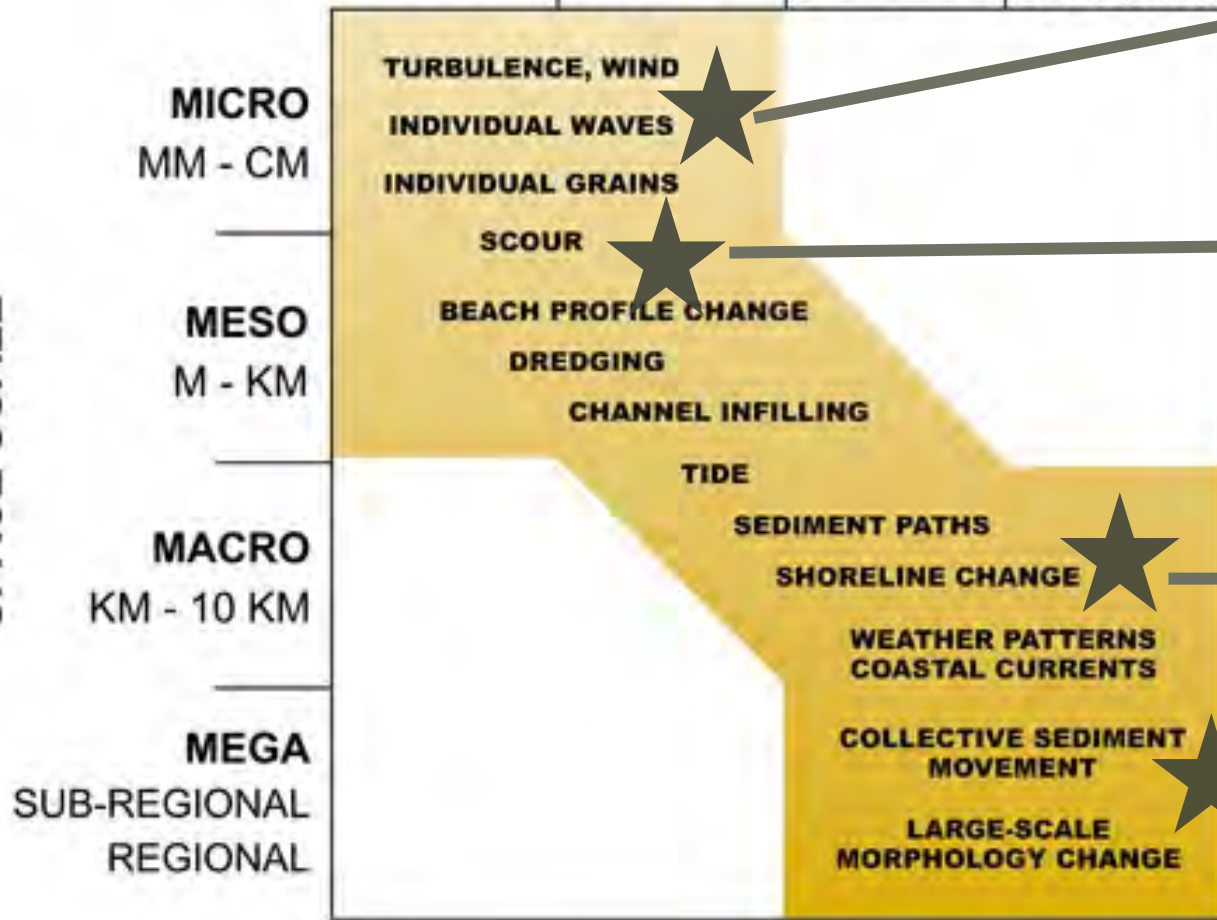
COASTAL PROCESSES



TIME SCALE

MICRO SEC-MIN	MESO HR - DAY	MACRO MON - YR	MEGA DECADE - CENTURY
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SPACE SCALE



Fundamental Processes

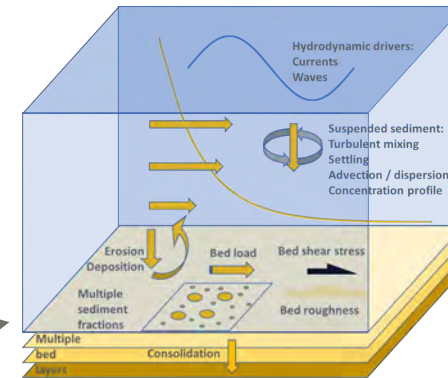
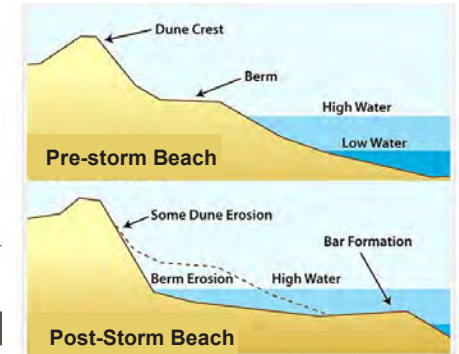
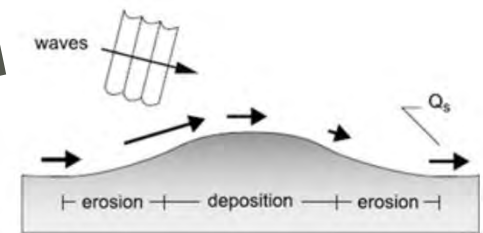


Image from Australian Water School

Storm Processes



Shoreline Change & Renourishment Cycles



Ashton & Murray 2000



Image from Washington Department of Ecology

Regional Sediment Management

UNCLASSIFIED

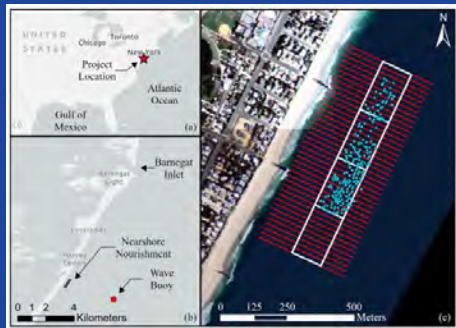
CSRМ Project Design & Planning Example



→ To estimate recovery, lifecycle planning models for CSRМ use simple rule-based recovery estimates where X% of the eroded volume is arbitrarily returned to the beach within a set time window following a storm regardless of physical

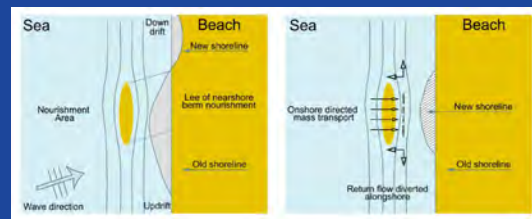
CSRМ Project Maintenance & Operations Example

Beneficial Use of Dredged Material Example



McGill, S.P., et al., 2022., *Journal of Marine Science and Engineering*, 10(11), p.1622.

→ Lack of reliable predictive capabilities has largely prevented the optimization of features like nearshore berms to achieve required project performance



Onnink, C.J., 2020. Dynamic shoreline response to a shallow concentrated nearshore berm nourishment.

Dredging Example

→ While USACE simple modeling tools can provide insight into how to optimize beach placement and dredging activities, the tools require significant calibration and at times, inclusion of background observed shoreline change rates to provide meaningful answers.



Beck, T.M. and Wang, P., 2019. *Ocean & Coastal Management*, 177, pp.31-51.

SCIENCE GAPS

Fundamental understanding of sediment transport processes is still lacking at the basic physics level.

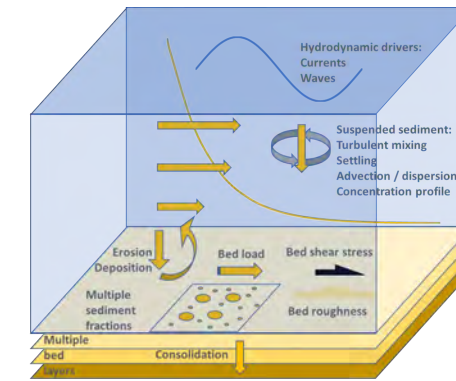
→ all of our numerical modeling tools (e.g. empirical tools to wave-resolving process-based models):

- simplify and parameterize hydrodynamic and sediment processes to some degree
- struggle to account for the multi-scale details of sediment transport
 - heterogeneity in bed sediment types
 - highly turbulent flows & randomness

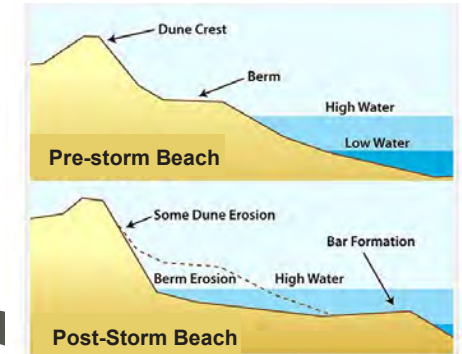
→ Getting morphology change right, requires integrating over these gradients in sediment transport over multi-scale time-space scales

- we are lucky if we get the direction of sediment transport correct (i.e. along the coast or on/offshore movement of bar or shoreline; regardless of the magnitude); rarely the volume change; and even less likely the exact distribution in space

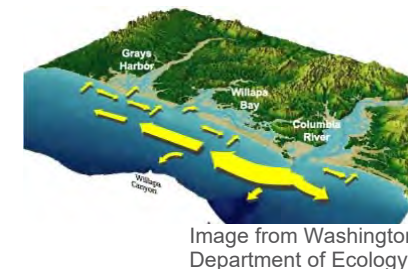
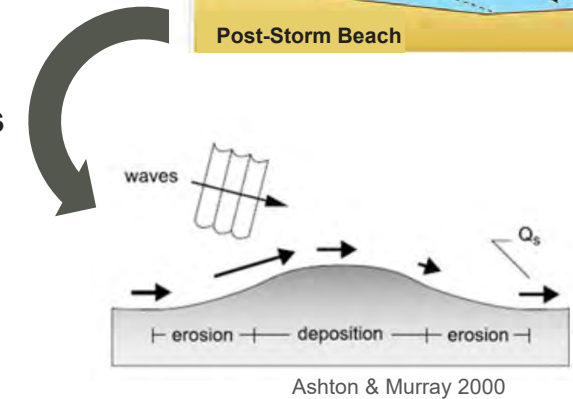
Fundamental Processes



Storm Processes



Shoreline Change & Renourishment Cycles



Regional Sediment Management



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PROGRESS SINCE 2019



2019 Recommendations

- 1) long-term investment in sediment transport, with a focus on integrated lab, field, and numerical modeling studies including rigorous assessment of model skill through test-beds and development of new measurement techniques;
- 2) exploration of multi-fidelity numerical modeling approaches, in which higher fidelity models inform lower-fidelity models, including the exploration of surrogate modeling using AI/ML; and
- 3) development of approaches to include uncertainty quantification and probabilistic modeling of coastal morphology evolution.



2019-2024 Actuals

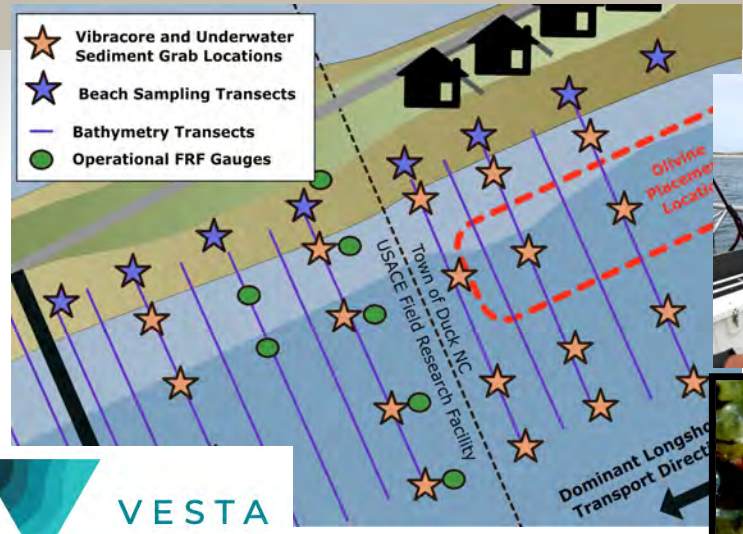
- 1) small investment in disparate lab, field, modeling studies; some work in new measurements (micro → meso scale); some collaborative work with universities; test-beds mostly focused on hydrodynamics
- 2) minimal model development investment; mostly focused on sub-aerial morphology modeling
- 3) some work in UQ with CShore for simulating sandbar dynamics on dissipative beaches and probabilistic modeling, including response to non-stationary climate forcings for shoreline contour modeling, dune modeling, and arctic tundra retreat.

WHY? USACE R&D System has not been conducive to largescale, coordinated, strategic initiatives. Instead, this type of research has had to be spread throughout the R&D portfolio and included as ancillary efforts to tactical SoN-driven projects.

MICRO-SCALE PROCESSES: MEASUREMENTS

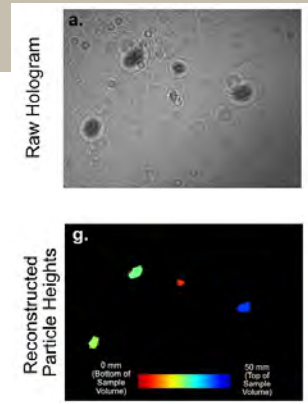
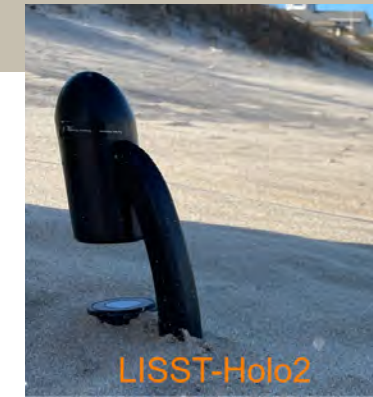
Surf Zone Sediment Tracer Studies Using Olivine

EWN



New Observations of Aeolian Sediment Transport

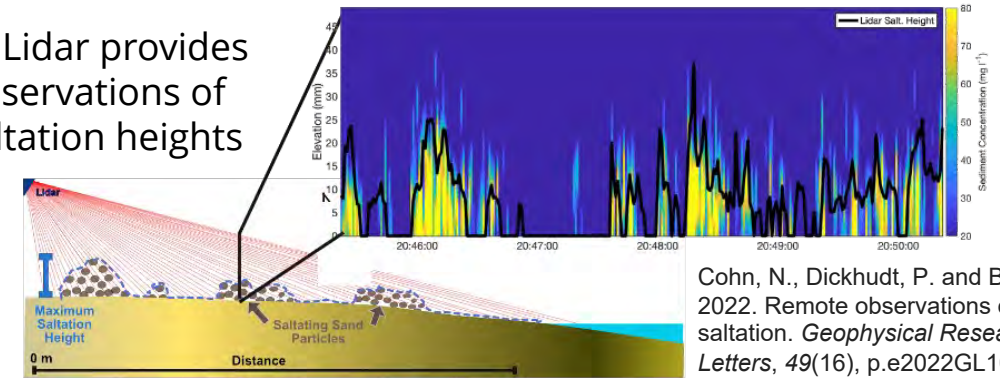
6.1 GRE



→ in-line holographic technology provides quasi-3D images of saltating particles near the bed during an aeolian transport event

Cohn, N., Dickhudt, P. and Marshall, J., 2022. In-situ measurement of grain size characteristics within the aeolian saltation layer on a coastal beach. *Earth Surface Processes and Landforms*, 47(9), pp.2230-2244.

→ Lidar provides observations of saltation heights

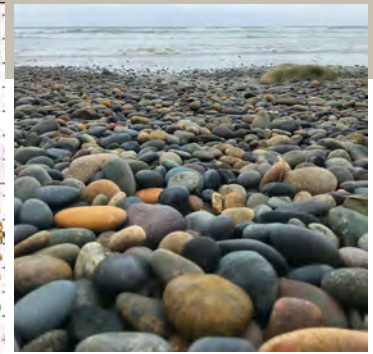
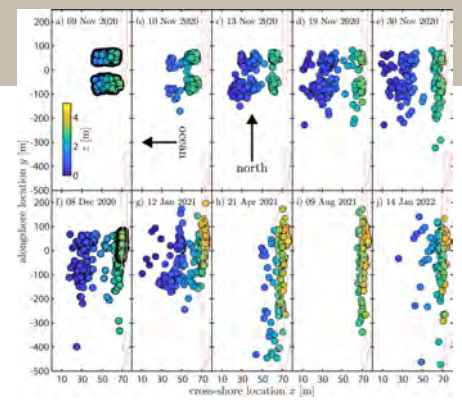


Cohn, N., Dickhudt, P. and Brodie, K., 2022. Remote observations of aeolian saltation. *Geophysical Research Letters*, 49(16), p.e2022GL100066.

Cobble Transport on West Coast Beaches

CODS: SIO Partnership

→ Three hundred forty four radio-frequency identification tagged cobbles were tracked for 26 months at a southern California beach

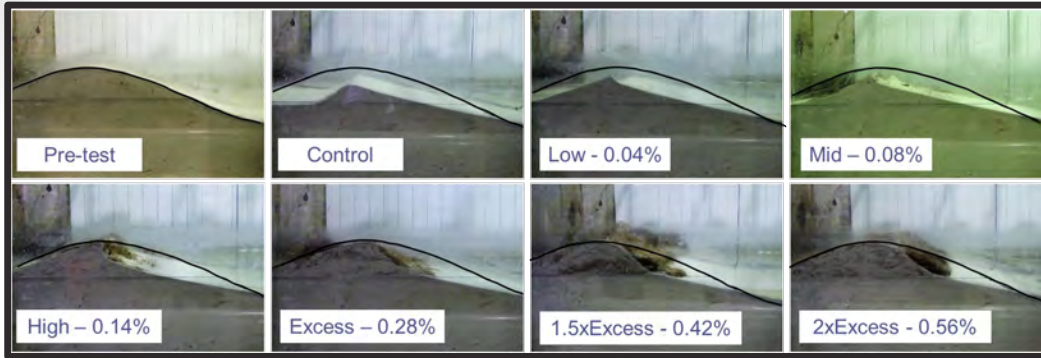


IMPACT:
New measurement approaches enable fundamental observations that drive model development

MICRO-SCALE PROCESSES

Eco-morphodynamics

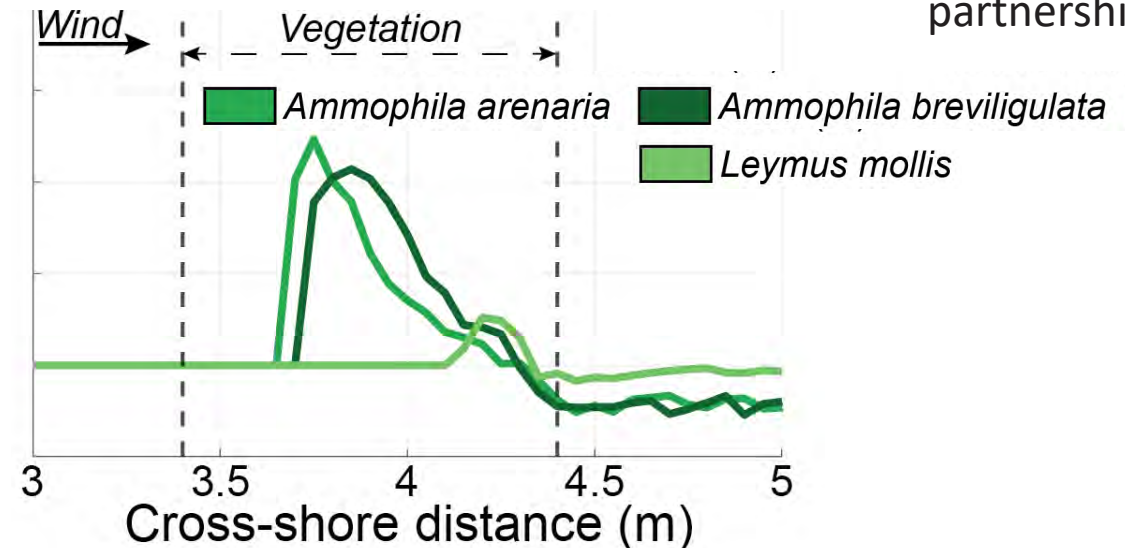
Internal Biomass Effects on Dune Erodiability



EWN

Species-Specific Effects On Sediment Trapping

EWN, OSU
partnership



Wrack Effects on Dune Dynamics

EWN, OSU partnership



IMPACT:
This research informs design of Dunes (Natural and Nature-Based coastal protection features) which utilize vegetation to increase coastal resilience



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MICROSCALE PROCESSES: USCRP



\$4.5M USCRP Funded Effort to Study Sediment Transport in ERDC Laboratory Facilities

- ***Understanding fundamental processes of sediment transport***
 - Understanding fluid-sediment dynamics in nearshore environments
- ***Improving numerical modeling of sediment transport***
 - Furthering the development of existing numerical models by incorporating novel or better physics formulations derived from laboratory test
 - Identifying and prioritizing parameters that cause uncertainty in numerical modeling of sediment transport processes
- ***Improving instrumentation and advances in experimental techniques***
 - Applying previously tested and validated sensors and instrumentation
 - Piloting novel approaches for sediment-transport and related phenomena
 - Advances in experimental techniques related to sediment transport, including scaling laws



University of
New Hampshire



STANFORD





MESO-SCALE PROCESSES: MEASUREMENTS



Operational Measurements of Coastal Morphology & Grain Size

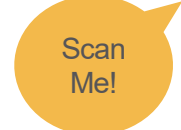
CorpsCam
Real-Time Monitoring of Coastal Projects via Quantitative Video Imagery

<https://coastalimaging.erdcdren.mil/CorpsCam>

- ERDC-CHL Field Research Facility**
Location: Duck, NC
- Northern Duck**
Location: Duck, NC
- Lynnhaven Inlet**
Location: Virginia Beach, VA
- Avalon Pier**
Location: Kill Devil Hills, NC
- New Smyrna Beach**
Location: New Smyrna Beach, FL
- Sunset Beach: Cliffside**
Location: North Shore, Hawaii
- Folly Beach**
Location: Folly Beach, SC

IMPACT:
Real-time data on project condition and performance to inform adaptive management strategies

CODS Base Program



sandsnap
sandsnap-erdcdchl.hub.arcgis.com

SandSnap

A collaborative project engaging citizen scientists in creating a sand grain database and educating the next generation about coastal processes.

Very Coarse	2 mm (0.08 in.)
Coarse	1 mm (0.04 in.)
Medium	0.5 mm (0.02 in.)
Fine	0.25 mm (0.01 in.)
Very Fine	0.125 mm
Very Coarse	0.062 mm
Coarse	0.031 mm
Medium	0.016 mm
Very Fine	0.008 mm
Very Coarse	0.004 mm

SandSnap Now!
Your efforts will help researchers and resource managers make better decision and provide students with the opportunity to use authentic data in the classroom

Learn More
To understand how and why coastlines change, we must know the grain size of the sand on the beach.

IMPACT:
National database of grain size provides input to USACE planning & design tools

CIRP, RSM, DOER



MESO-SCALE PROCESSES: MEASUREMENTS

Future Operational Measurements of Coastal Morphology

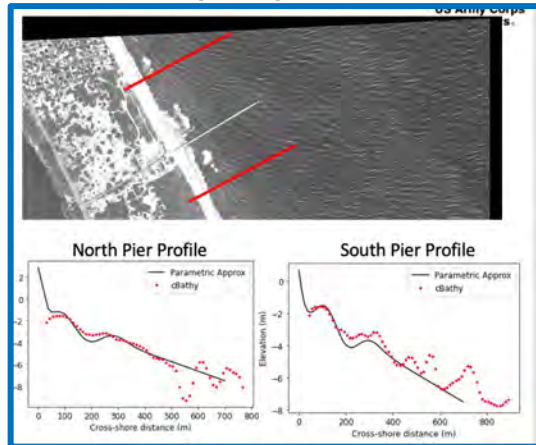
Satellite-Based Observations of Shoreline Position, Topography, and Bathymetry

CODS Base Program; → Water Modeling SFA

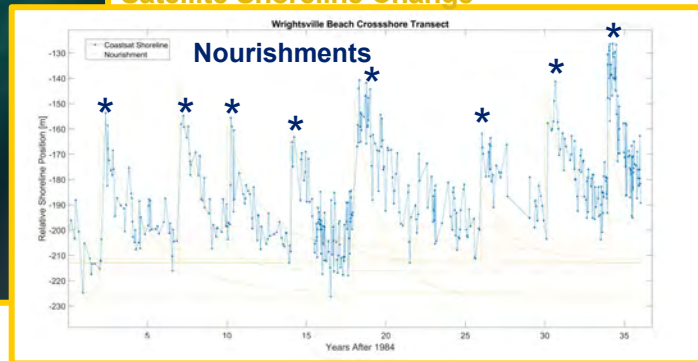


Satellite Topography

Satellite Bathymetry

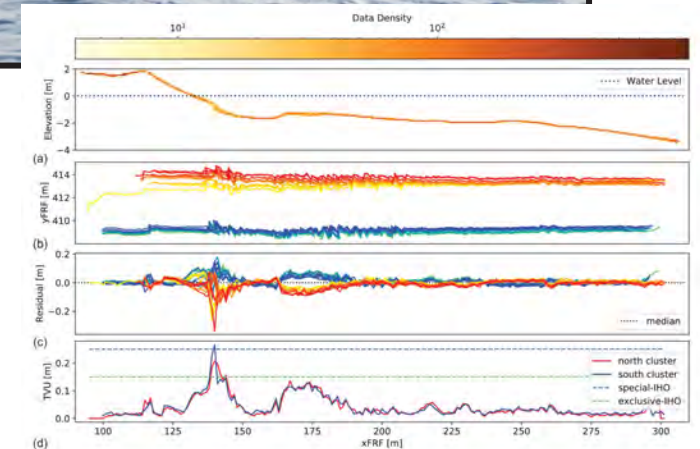


Satellite Shoreline Change



Autonomous Systems for Coastal Project Surveys

CODS Base Program; → Water Modeling SFA



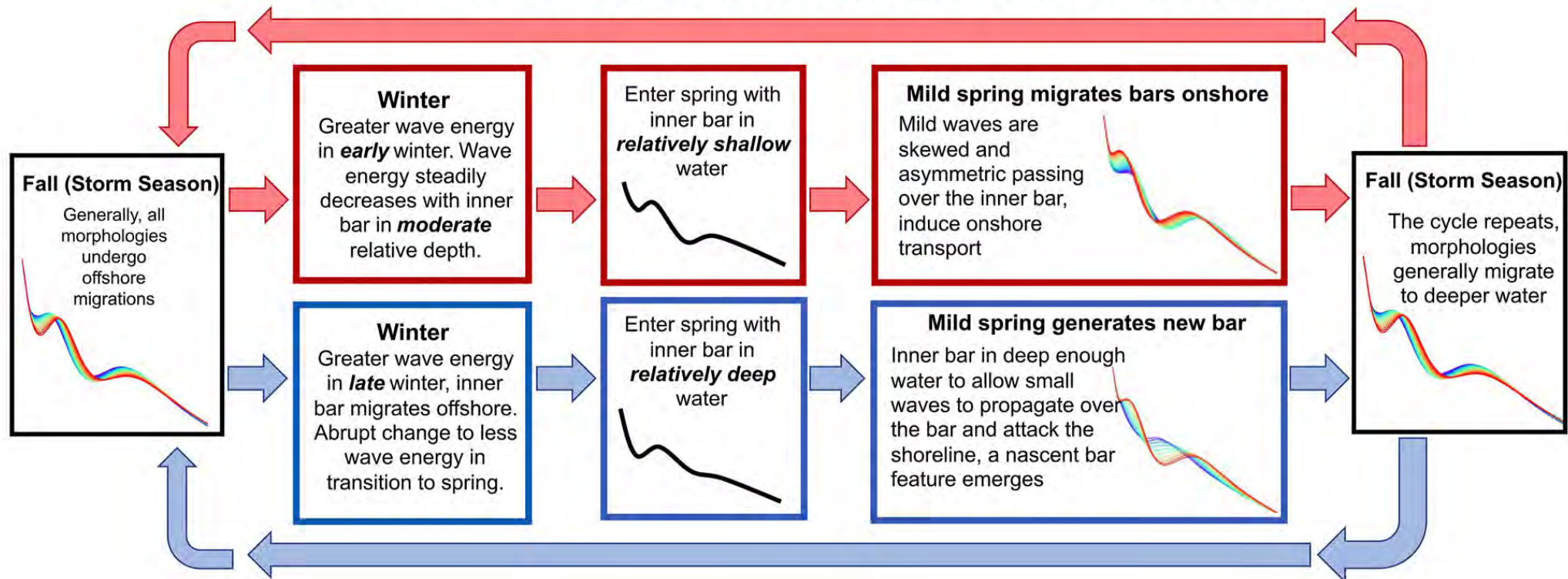
Bak, A.S., Durkin, P., Bruder, B., Saenz, M.J., Forte, M.F. and Brodie, K.L., 2023. Amphibious Uncrewed Ground Vehicle for Coastal Surfzone Survey. *Journal of Surveying Engineering*, 149(4), p.04023011.

MESO-SCALE PROCESSES: PROCESSES

Research Highlight: New Insights on Sandbar Dynamics from Duck's 41-year bathymetry record

IMPACT: Quantifies the importance of appropriately accounting for storm sequencing variability in tools designed to simulate multi-year beach profile evolution for CSRM Projects on Intermediate Beaches.

Conceptual Flow Map for Interannual Sandbar Evolutions



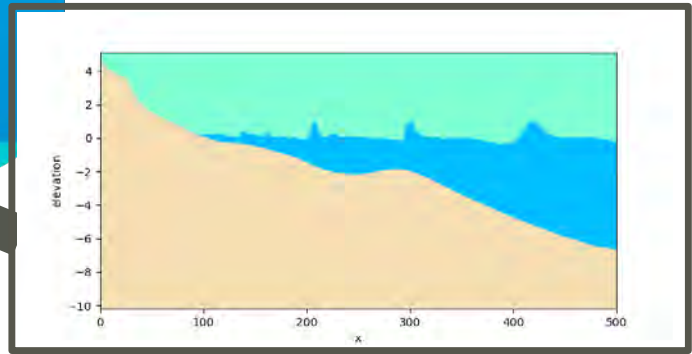
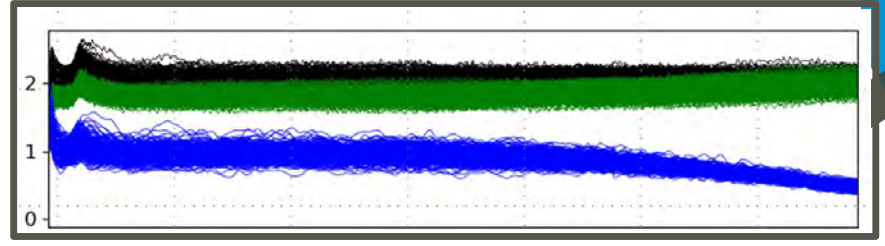
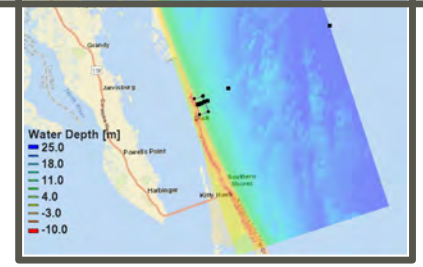
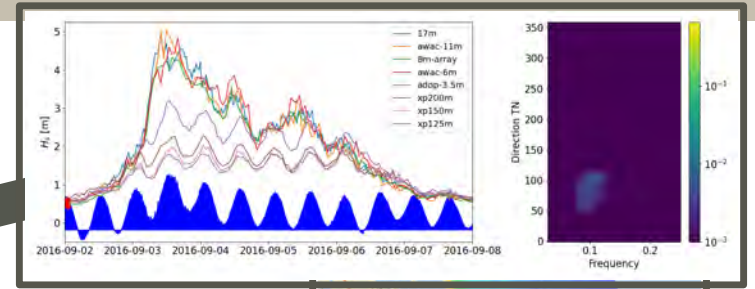
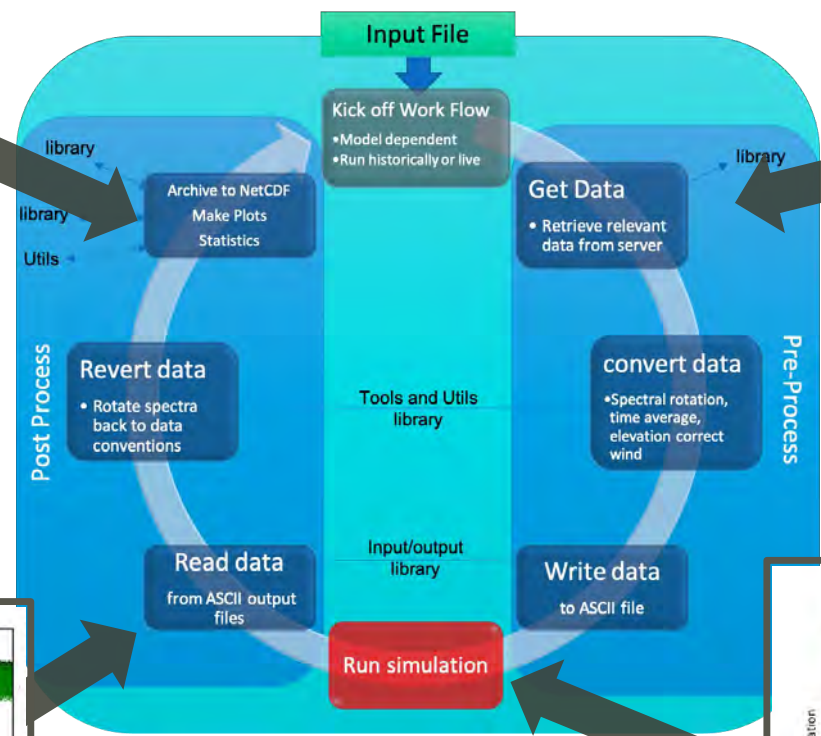
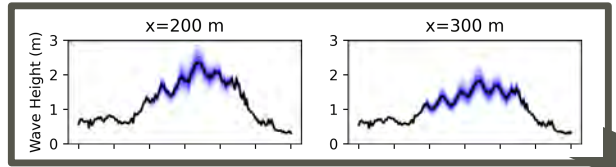
Anderson, D., Bak, A.S., Cohn, N., Brodie, K.L., Johnson, B. and Dickhudt, P., 2023. The Impact of Inherited Morphology on Sandbar Migration During Mild Wave Seasons. *Geophysical Research Letters*, 50(3), p.e2022GL101219.

MESO-SCALE PROCESSES: PROCESSES

Coastal Model Test Bed in Duck, NC: Continuous operational modeling with near real-time validation

IMPACT: transferable analysis framework that provides model agnostic evaluation in a range of conditions and enables development of future methods to incorporate uncertainty estimation and probabilistic approaches

Approach: The Coastal Model Testbed (CMTB) builds a bridge between high quality in-situ and remote measurements of the coastal environment with numerical models to allow for rapid deployment and evaluation. The CMTB allows for streamlined validation tools to visualize accuracy and uncertainty in a variety of forcing conditions





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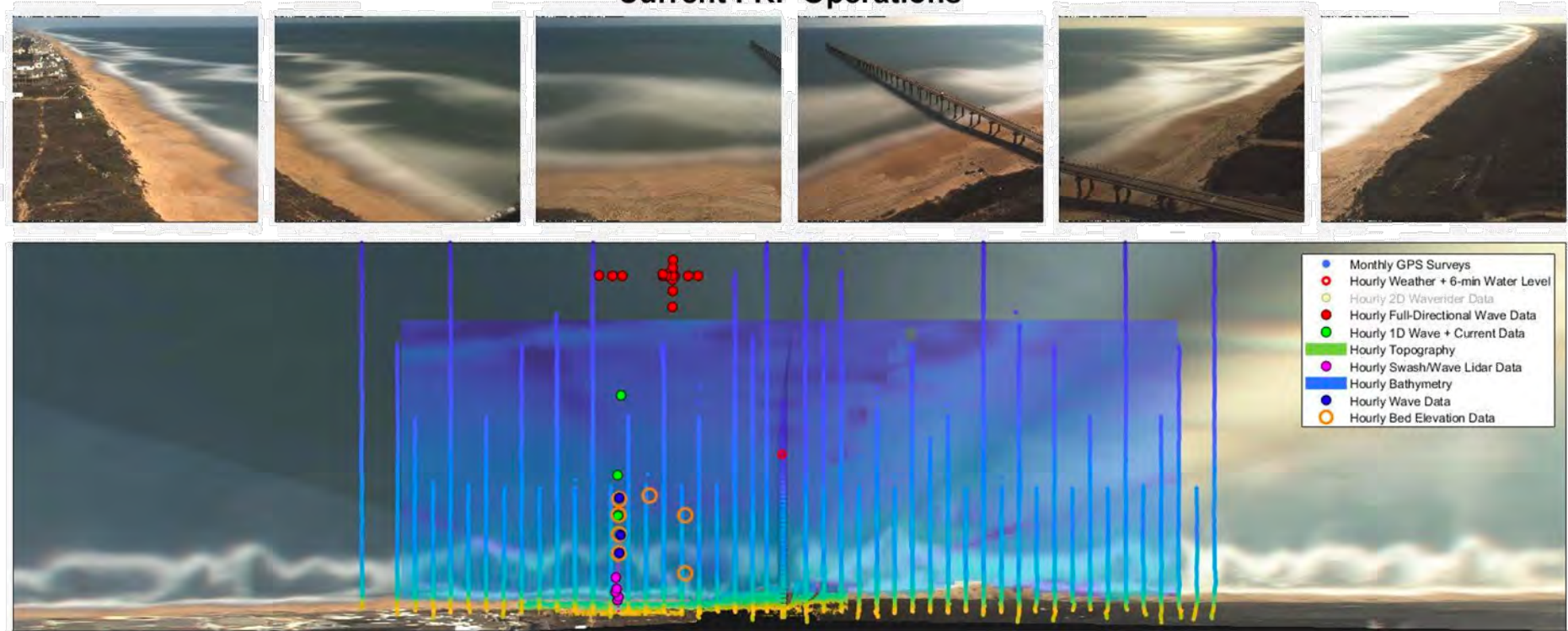
MESO-SCALE PROCESSES: PROCESSES



Coastal Model Test Bed in Duck, NC: Continuous operational modeling with near real-time validation

IMPACT: transferable analysis framework that provides model agnostic evaluation in a range of conditions and enables development of future methods to incorporate uncertainty estimation and probabilistic approaches

Current FRF Operations



The extensive continuous remotely sensed and in-situ observations provided by the CFDC Program at the FRF are critical to the functionality of the **CMTB**

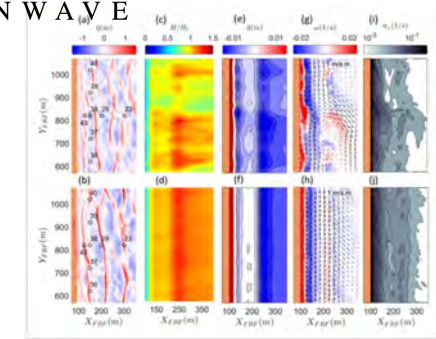
MESO-SCALE PROCESSES: PROCESSES

Coastal Model Test Bed in Duck, NC: Continuous operational modeling with near real-time validation

IMPACT: transferable analysis framework that provides model agnostic evaluation in a range of conditions and enables development of future methods to incorporate uncertainty estimation and probabilistic approaches

.Initial Results: Hydrodynamic Models

Operational modeling and comparisons to data identified problems in 3 of USACE's hydrodynamic modeling technology (FUNWAVE, CMS-Wave, WAVEWATCH III)



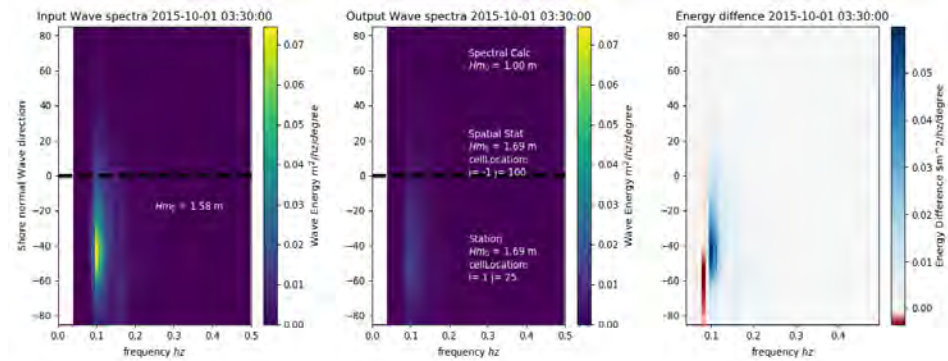
- FUNWAVE-TVD alongshore coherent waves affecting cross-shore/alongshore spatial wave height variability
 - Increasing offshore frequency discretization minimizes but does not solve problem

Salatin, Reza, et al. "Effects of Wave Coherence on Longshore Variability of Nearshore Wave Processes." *Journal of Geophysical Research: Oceans*: e2021JC017641

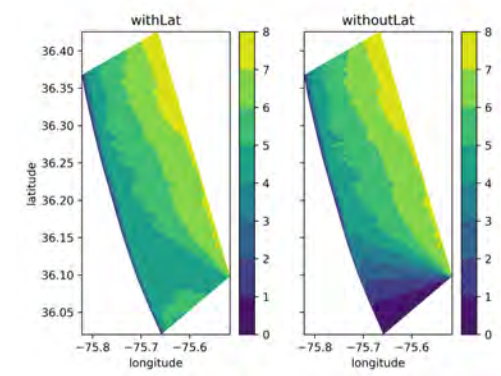
CMS-Wave

Conservation of energy issue on the boundary

- Testing in CMTB identified the bug and helped developer test solutions



WAVEWATCH III



- Unstructured WAVEWATCH III problem with shadowing from the lateral boundary
 - Neumann conditions reduce boundary shadowing for oblique boundary conditions

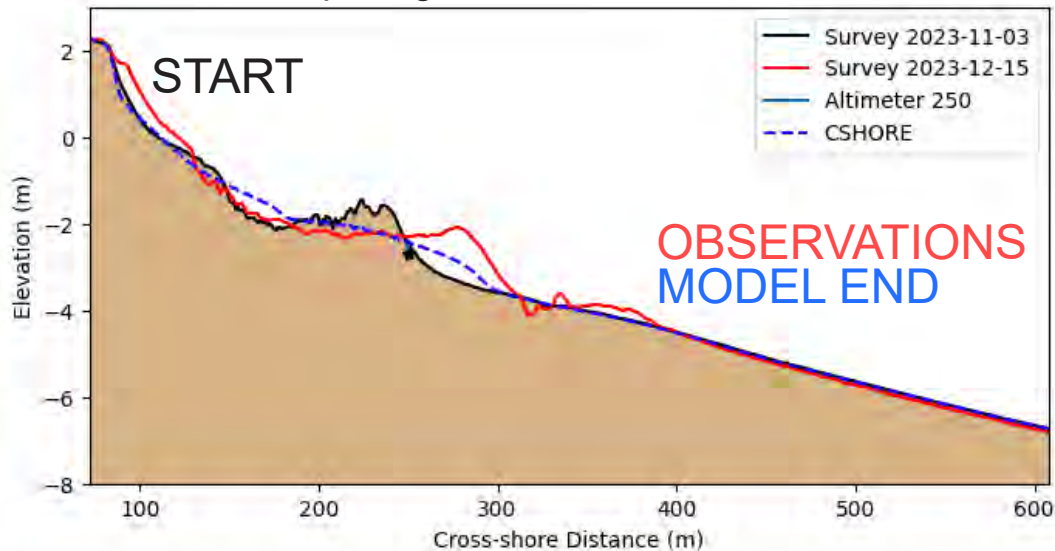
MESO-SCALE PROCESSES: PROCESSES

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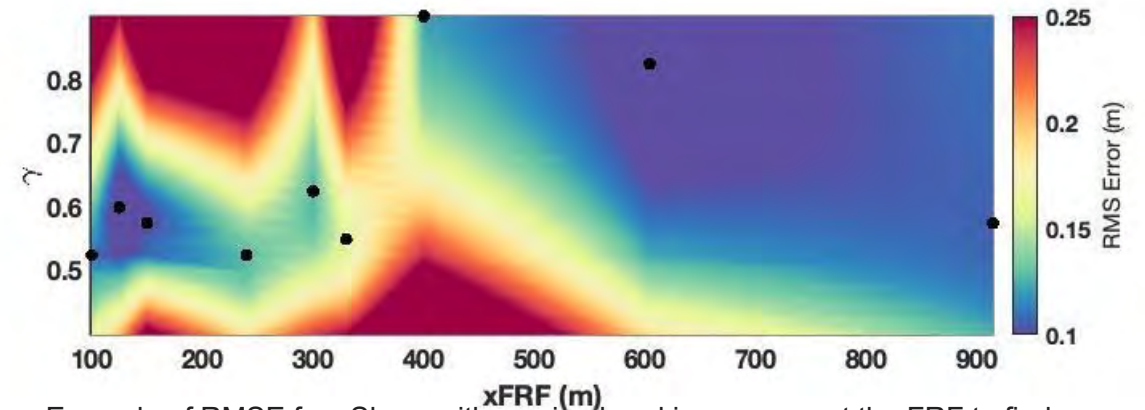
FY24 GOALS: Operational Morphology Modeling; Framework development for Uncertainty; Web-portal

In FY24, CMTB is focused on the evaluation and improvement of coastal morphological models CSHORE and xBEACH.



CSHORE morphology results from CMTB between the last two FRF Surveys. The model uses boundary forcing from the 6m Signature Sensor and results are compared to the LARC survey line at 940 in the FRF alongshore.

The CMTB is implementing the the **MIT Uncertainty Quantification Library (MUQ)** to explore influence of parameters on model results (forward uncertainty) and rapid optimization of best-fit model parameters (inverse uncertainty) using FRF observations.



Example of RMSE for cShore with varying breaking gamma at the FRF to find optimal gamma value for best hydrodynamic estimates

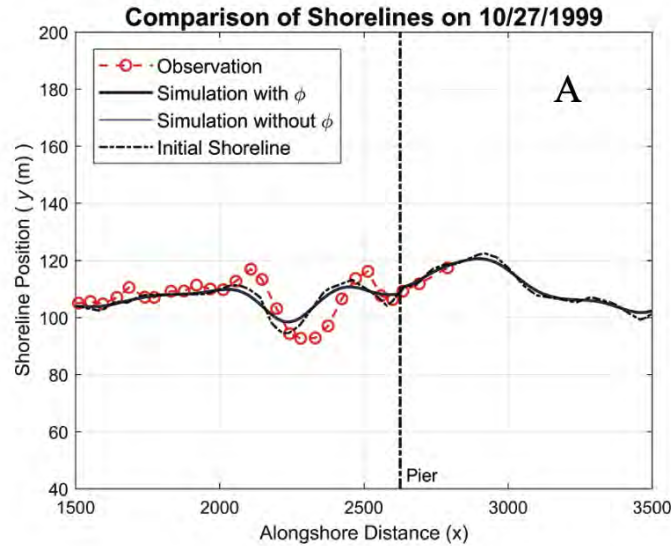
The CMTB software framework and **CMTB-MUQ** bridge allows for easy switching of multiple models and rapid validation through data comparisons.

FY25 GOALS: West-Coast deployment of Test Bed to Southern California

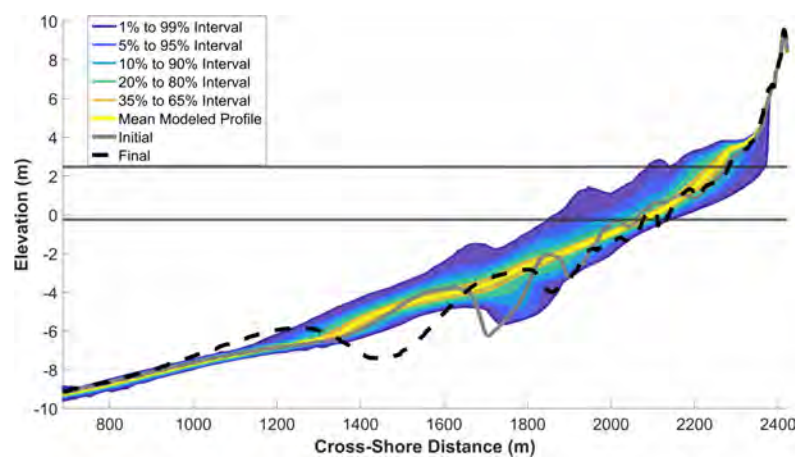
UQ & PROBABILISTIC MODELING

Shoreline Contour Modeling

Modeling

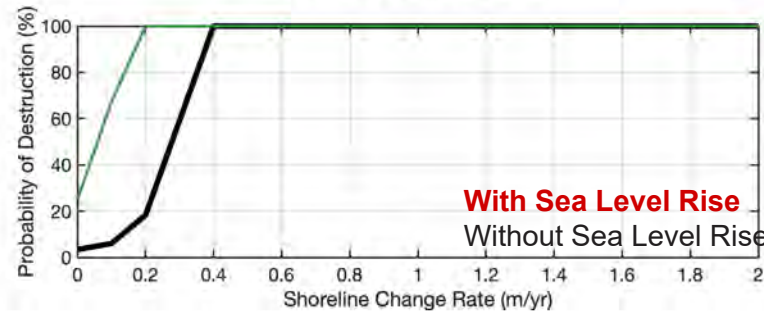
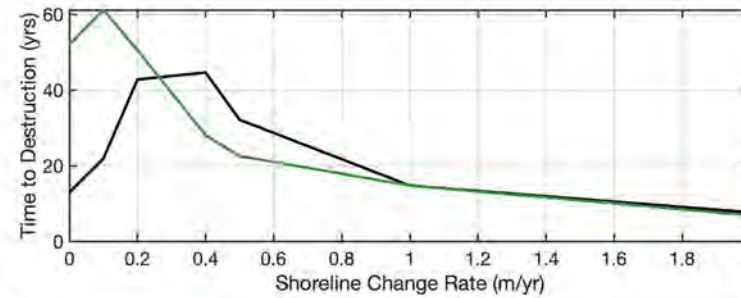
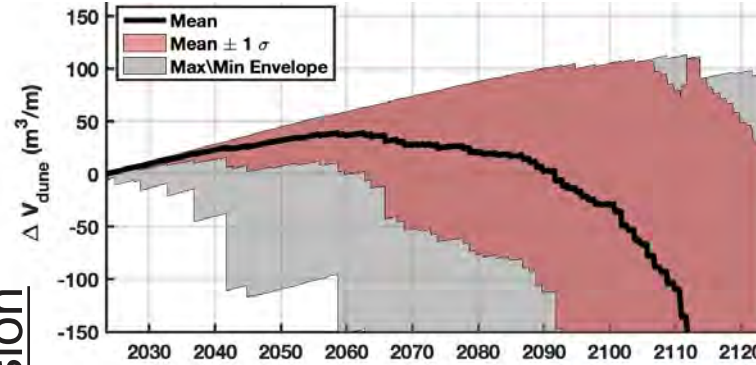


Sandbar Dynamics

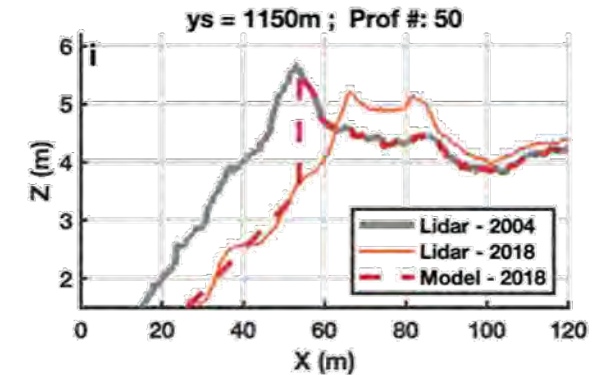
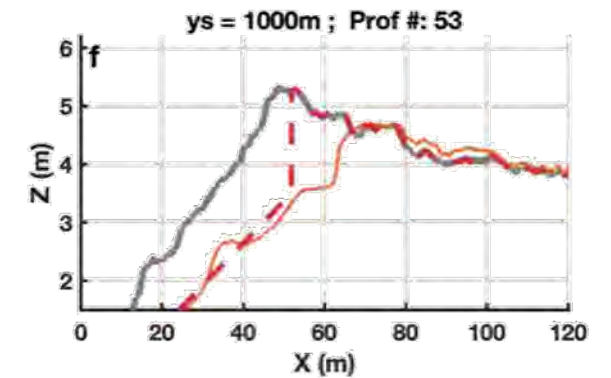
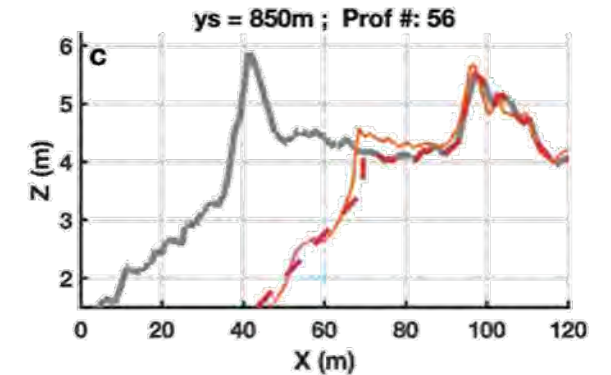


Probabilistic Dune Growth/Erosion

Growth/Erosion



Arctic Coastal Tundra Retreat



PATH FORWARD



Organizational Investment & Research Structure

→ Develop & commit funds to coherent sediment transport R&D plan



National-scale Operational Morphology Monitoring Technology

→ Helps provide answers now & inform engineering actions.



Probabilistic Morphology Modeling

→ Better communicates risk & uncertainty in our predictions.



Coordinated Lab, Field, & Numerical Investigations

→ Builds new understanding to improve future answers.

R&D Focus Areas





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PATH FORWARD



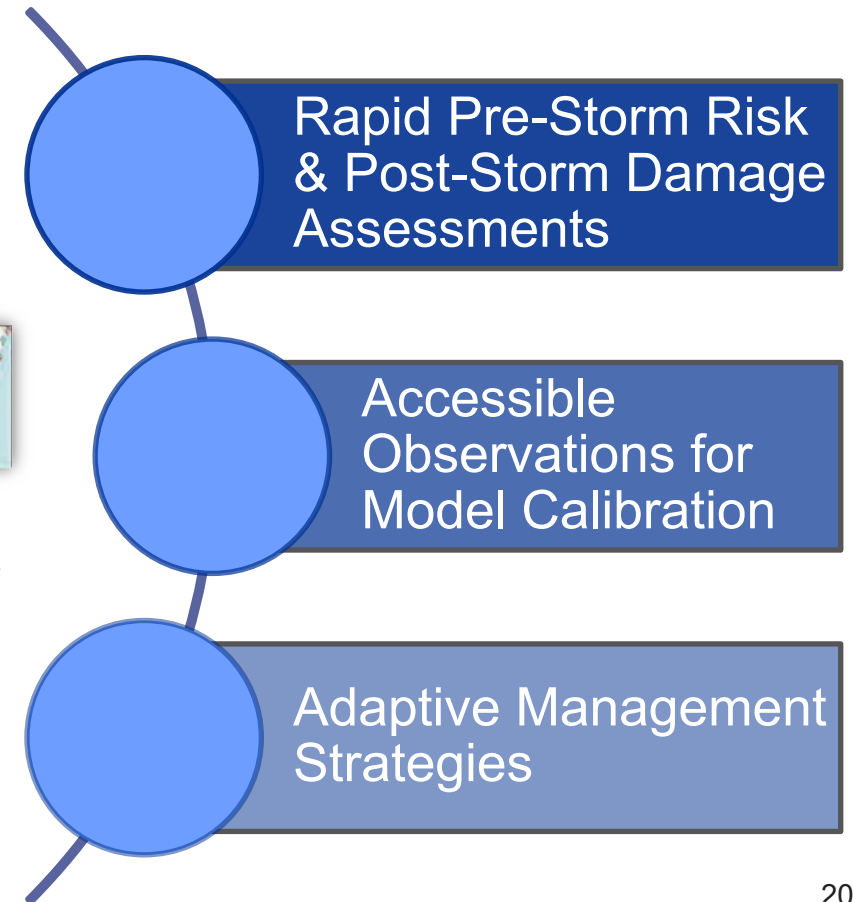
National-scale Operational Morphology Monitoring Technology

→ Helps provide answers now & inform engineering actions.

Water Modeling SFA – Open Coast Physical Process Work Package

INTEGRATED COASTAL OBSERVATIONS

Goal: layered technology to monitor USACE coastal project sites continuously ensuring timely information on coastal state is available, which enables:





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PATH FORWARD



Probabilistic Morphology Modeling

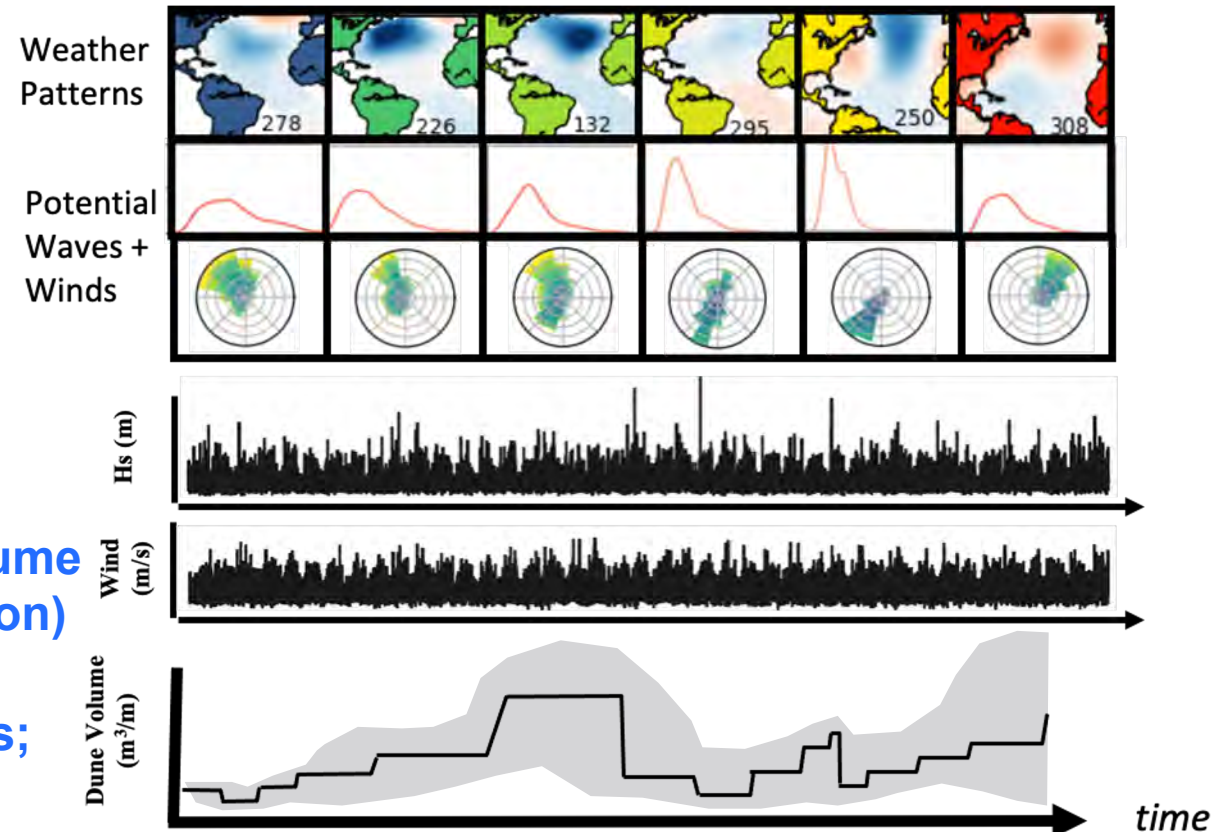
→ Better communicates risk & uncertainty in our predictions.

Water Modeling SFA – Open Coast Physical Process Work Package

- Stochastic environmental forcing enables consideration of effects of a non-stationary climate and variations in storm climatology/sequencing on the evolution of open-coast NNBF (beach nourishments; dunes)
- Incorporation of uncertainty propagation as a result of model parameter unknowns

Low Fidelity Tools for Planning (Constructed Dune volume needs; Life-cycle analyses → Eventual CHART Transition)

High Fidelity Tools for Design (Alternative assessments; placement optimization)





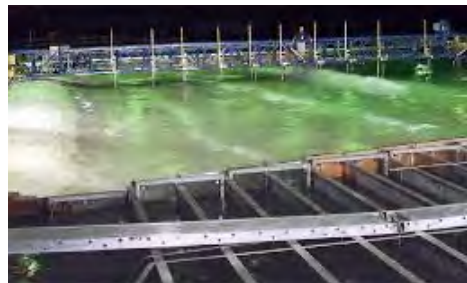
Coordinated Lab, Field, & Numerical investigations

→ Builds new understanding to improve future answers.

Partial Support within Water Modeling SFA – Open Coast Physical Process Work Package

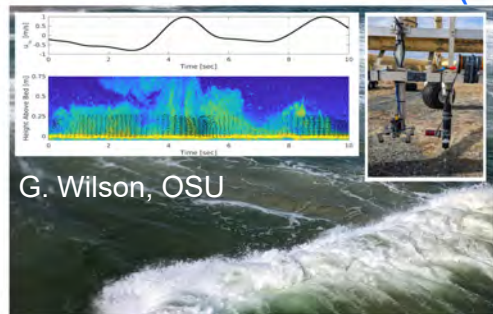
Fundamental Understanding

Detailed Lab Measurements



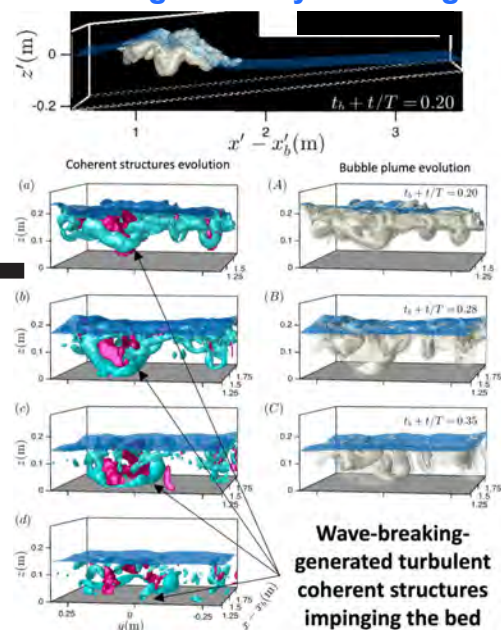
ERDC LSTF Laboratory Facility

Detailed Field Measurements (FRF)



G. Wilson, OSU

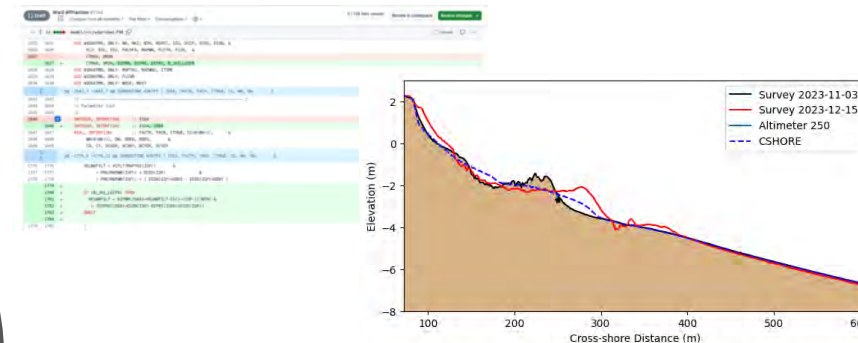
High-Fidelity Modeling



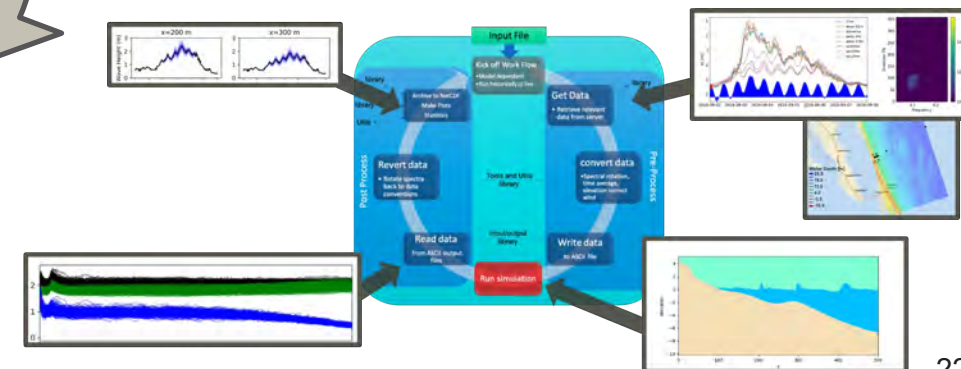
M. Derahkti, UW

Wave-breaking-generated turbulent coherent structures impinging the bed

Numerical Model Development



Deployable Test Beds



ERDC Cohesive Sediment Transport Capabilities

*Jarrell Smith Ph.D.
U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
Vicksburg, Mississippi*

Introduction

Presently, many challenges remain in understanding and predicting cohesive sediment transport for coastal zone sediment management. The USACE Navigation and Storm Damage Reduction missions are inseparably linked to cohesive sediment management issues. Most dredging in the coastal zone is classified as cohesive or mixed (sand plus cohesive) sediment. Coastal wetlands, built on a platform of cohesive sediment, provide storm protection to coastal infrastructure and a medium for diverse and rich ecosystems. Two decades ago, the USACE initiated Regional Sediment Management (RSM) practices to treat sediment as a resource to be retained within the coastal zone. Such innovative practices as strategic placement, wetland restoration, and thin-layer placement were developed to keep sediment in natural systems to realize the potential benefits that sediment fosters within these systems. To assess project alternatives utilizing these innovative sediment management practices demands a higher level of understanding in cohesive sediment transport processes than the traditional practices of dredging and placement in confined facilities or offshore disposal. The RSM practices require understanding of additional cohesive sediment transport processes such as: transport in vegetated environments, transport processes in intertidal zones, and the biogeochemical compatibility of the sediment to the receiving ecosystem. This document assesses present capabilities in cohesive sediment transport related to USACE missions and identifies gaps in understanding that are presently hindering the full implementation of RSM practices in the coastal zone.

Present Capabilities and Gaps

Technological developments over the past 20 years have led to significant advances in the field of cohesive sediment transport. The development and improvement of acoustic and optical instrumentation, increased computing power, and improved understanding of hydrodynamic and sediment transport phenomena have increased general predictive capabilities for management of cohesive sediment in the coastal zone. Advances in computing technology and numerical models now permit simulation of regional-scale hydrodynamic and sediment transport in the coastal zone. USACE-developed modeling systems such as Advanced Hydrodynamics (ADH), Global-Scale Multi-block (GSMB), and the Coastal Modeling System

(CMS) are equipped to leverage multi-core desktop computing systems and High Performance Computing (HPC) centers. These general transport frameworks access specific cohesive sediment transport modules such as SEDZLJ or SEDLIB. Presently, hydrodynamic and sediment transport models are specifically coupled, yielding model combinations such as ADH-SEDLIB or GSMB-SEDZLJ. This specific model-model coupling has been an expedient means to exploit the increased computing technology but imposes limitations on modeling of complex RSM applications. Efforts have begun to prepare the sediment transport methods as standardized computational libraries (CORESED) that can be easily called from virtually any hydrodynamic transport model. Additional investment in development of the CORESED libraries will pay meaningful dividends with the ability to pair hydrodynamic and sediment transport models that bring the greatest advantage to the study site. Additional investments in increased computational capacity (hardware and efficiency) are also warranted. While regional-scale domains with project-level resolution are presently feasible, doing so for multi-year simulations is not.

While advances in computing and modeling technologies have permitted regional-scale applications with project-level resolution, significant gaps remain in hydrodynamic and cohesive sediment transport processes. Acoustic velocimeters introduced in the 1990's revolutionized the study of turbulence and baroclinic hydrodynamics. Consequently, improved mixing and turbulence closure methods were introduced to USACE hydrodynamic models. Field observations from acoustic velocimeters and video settling columns have likewise led to the development of improved cohesive sediment flocculation and breakup algorithms. These algorithms account for the complex interactions between hydrodynamics, floc growth, and floc breakup. However, most of these new methods are not yet implemented in USACE sediment transport models. Field observations have also been instrumental in identifying shortcomings in process understanding. In the 2000s, field observations suggested that suspended dredged material settles much faster than previously assumed. Subsequent research identified a class of dense bed aggregates suspended by dredging operations that had been neglected. Including this class of aggregates in modeled dredge plumes significantly improved the agreement between model and observation. Additional research in the 2010s found that these dense bed aggregates are also produced by bed erosion. Presently USACE models have limited-capability in representing the transport of eroded bed aggregates. A more advanced, multi-class population balance framework is required to support modeling of this poorly represented cohesive sediment process.

Innovative RSM practices for placement in shallow estuaries and near or within coastal wetlands requires knowledge of cohesive sediment interactions with vegetation and intertidal areas. USACE cohesive sediment transport models were initially developed to represent

sediment transport in deeper, open water, where vegetation and intertidal processes are negligible. Present USACE cohesive sediment transport models have limited capability for vegetated or inter-tidal applications. To increase predictive capability in these environments requires empirical or process-based descriptions of the interaction between hydrodynamics, vegetation, and cohesive sediment. Furthermore, the process understanding for these interactions is poorly understood and likely to be dependent upon vegetation density and structure. Significant research and development is required to address flow and sediment interactions with biological structures such as marsh grasses, mangrove roots, submerged aquatic vegetation, shellfish reefs, and coral for natural and dredging-related sediment suspensions.

A key RSM tenant is to keep sediment in the regional system. Presently, an obstacle to this practice is ensuring ecosystem compatibility of the dredged material with targeted receiving areas. A particular challenge in this regard is factoring changes in sediment characteristics such as composition, chemistry, or biological compatibility associated with the dredging and placement processes. Additionally, the USACE must assess the evolution of the dredged material deposit and ecosystem response over time to project recovery time from the initial project disturbance. New methods are required to predict changes in dredged material composition between the dredging site and placement site. Furthermore, resource agency partners require a forecast of the likely evolution of the placement site over timescales of days to decades. This research and development effort should be paired with region-specific pilot studies to evaluate and demonstrate improved methods to apply dredged material to benefit coastal ecosystems.

Summary

USACE cohesive sediment modeling technology was largely developed to address historical, USACE practices of estimating navigation channel infilling and open-water placement of dredged material. RSM promotes sustainable management of dredged material in the coastal zone. Innovative practices such as in-bay placement, thin-layer placement, strategic placement near or within tidal flats or coastal wetlands challenge or exceed present modeling technology and understanding of sediment transport and dredging processes. Significant gains in understanding and prediction of cohesive sediment are possible in these new application areas through investment in targeted research and development for predictive models, the underlying process understanding, and the measurement technologies that enable new discoveries.



U.S. ARMY

ADVANCING COHESIVE SEDIMENT MANAGEMENT

Jarrell Smith Ph.D, PE

20 March 2024

DISTRIBUTION UNLIMITED



US Army Corps
of Engineers



DISCOVER | DEVELOP | DELIVER

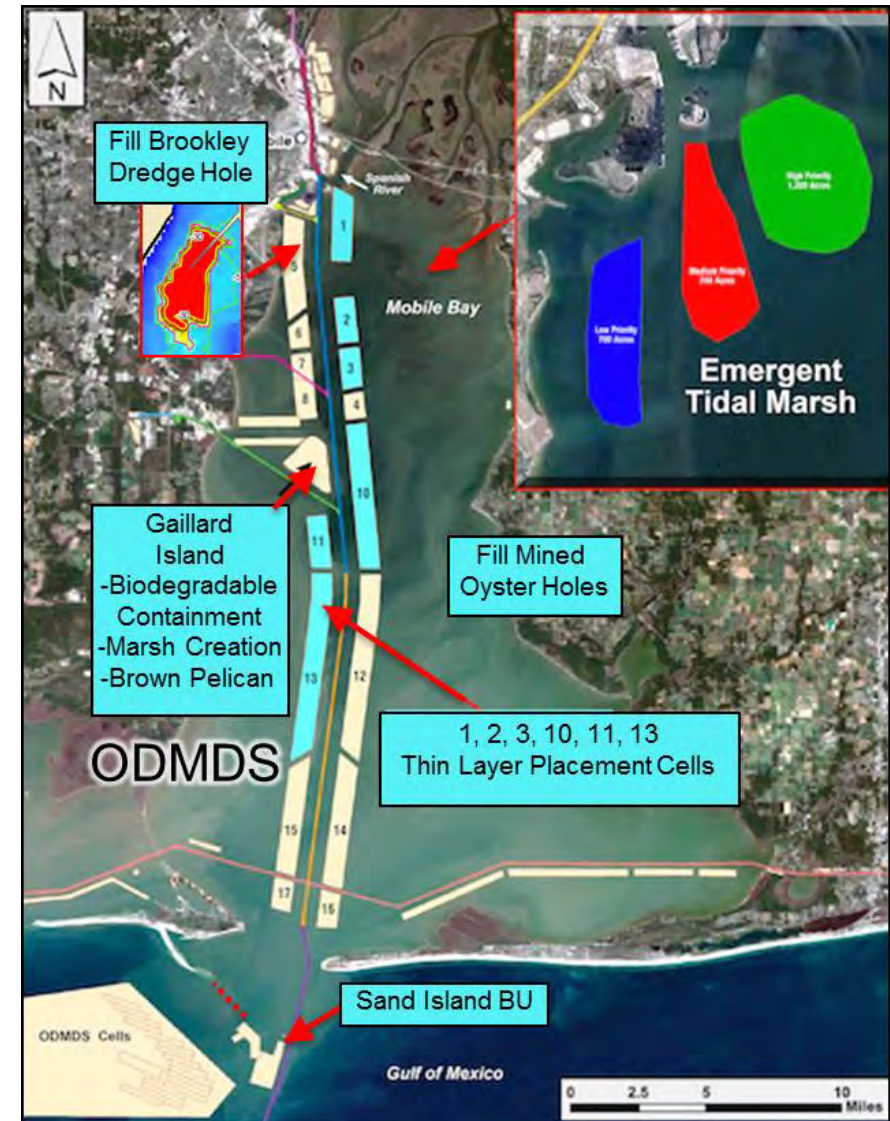
Cohesive Sediment Management Challenges

Changing USACE Operating Environment

- Historical
 - Offshore and Confined
- Emerging
 - In-bay placement
 - BU
 - NNBF

Significant Benefits

- Mobile District savings ~\$6M/y
 - ERDC modeling
 - RSM interagency workshop
- Ecosystem benefits



Predictive Tool Limitations

Process Understanding

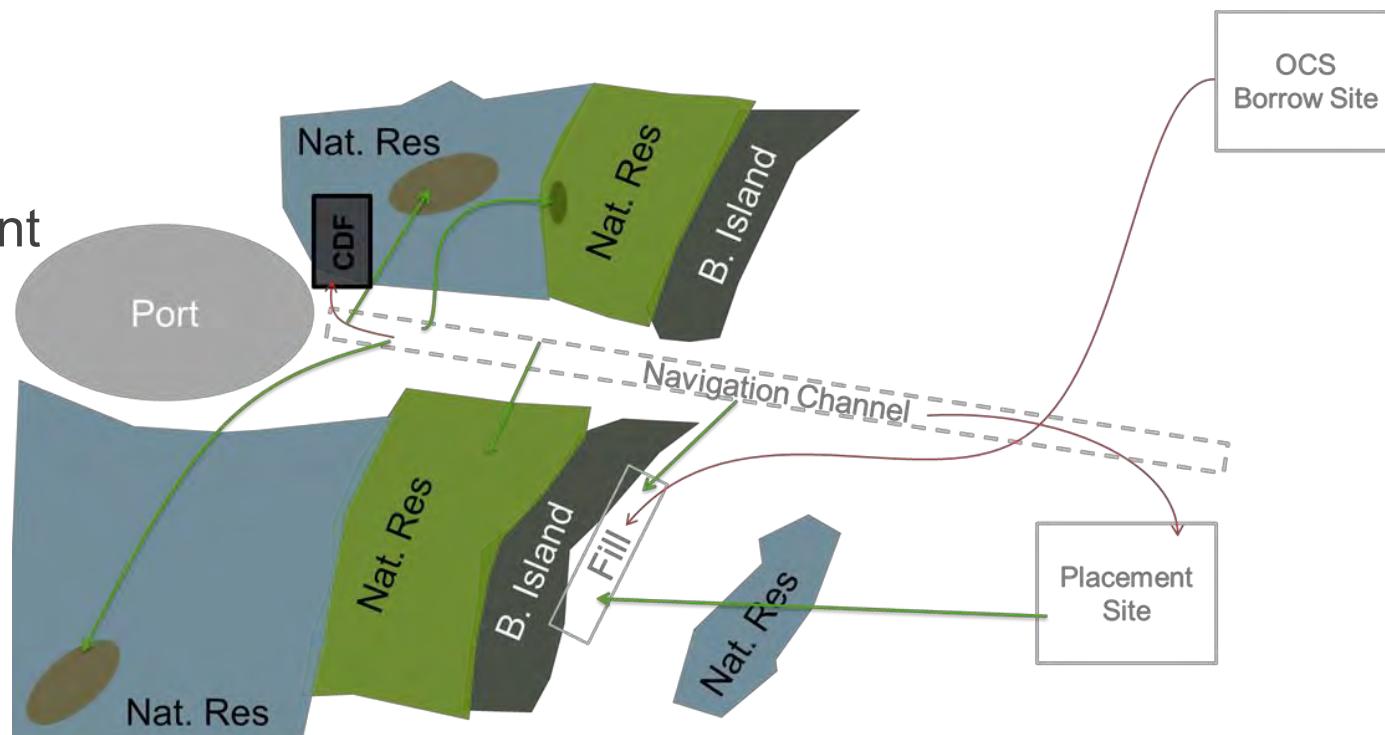
- Intertidal (shallow) and vegetated environments
- Dredging process influence on sediment properties

Model Framework

- process implementation
- model framework unsuitable

Funding

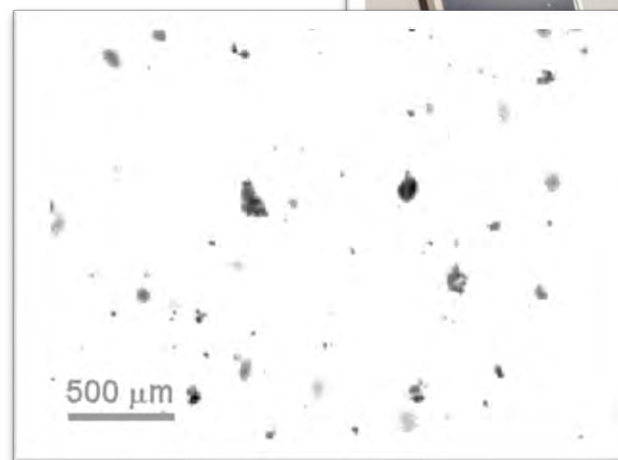
- CW funding for sediment transport prediction at ~1% of CW R&D budget.



Recent Progress

Erosion of sand-mud mixtures

- Transitions between sand and mud erosion thresholds and rates



Mud Aggregate Transport

- Transport processes for dredge-mobilized or eroded clasts



Sediment-Vegetation Interaction

- What are the underlying processes that control mud sedimentation in vegetation?

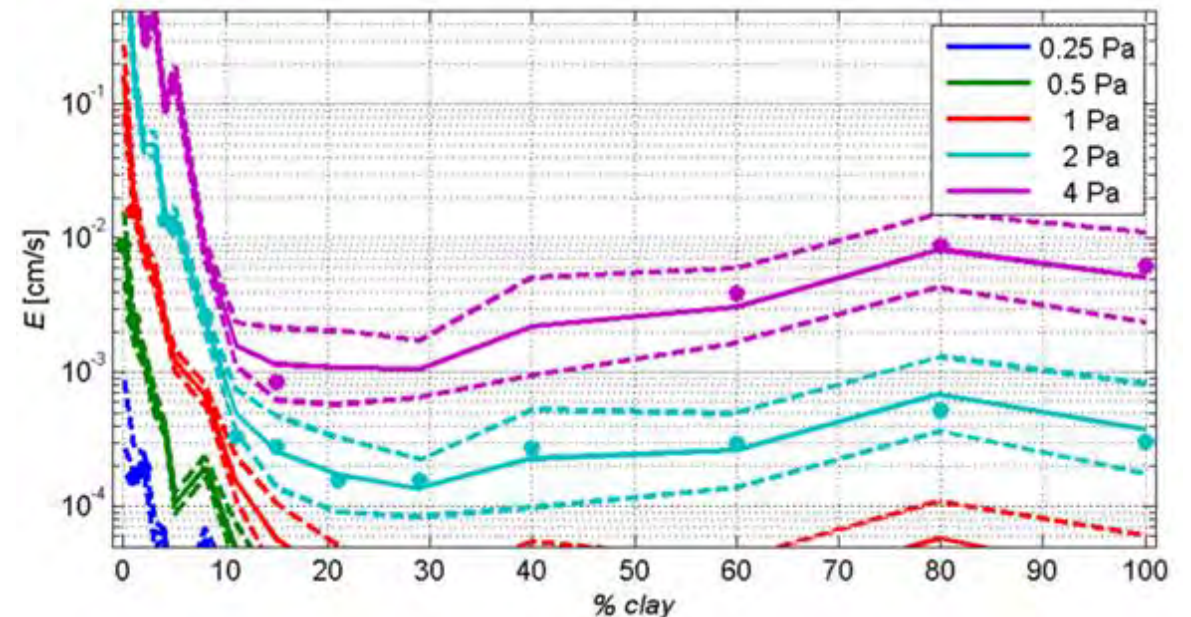


Erosion of Sand/Mud Mixtures

- Defined transition in erosion from pure sand to pure mud.
 - 100-1000x slower with as little as 5% mud!
 - 30%+ mud erodes similarly to 100% mud.

- Mud strongly influences erosion
 - 100-1000x slower with as little as 5% mud!
 - 30%+ mud erodes similarly to 100% mud.

- Relationship developed for numerical models
 - Still requires laboratory testing of clay material.



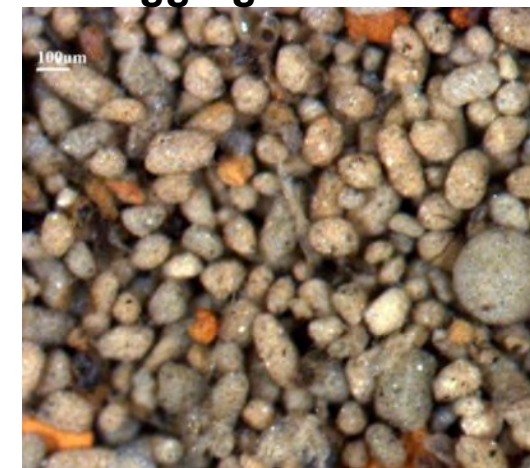
Dense Aggregate Transport

- Dredging and bed erosion produces dense mud aggregates.
- Laboratory and field testing of 13 sediments from coastal environments.
 - Initial aggregate size
 - Breakup rate
- Processes previously absent from numerical models.
- **Modeling framework developed and tested.**

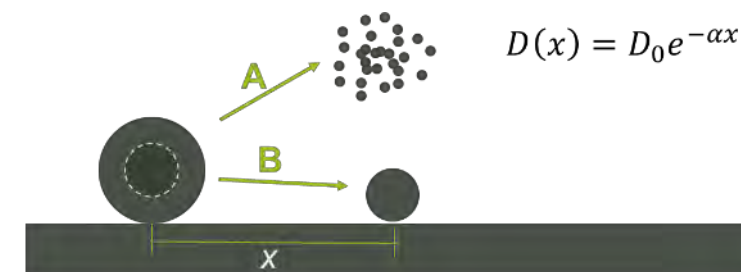


Mikkelsen and Pejrup (2001)

bed aggregates

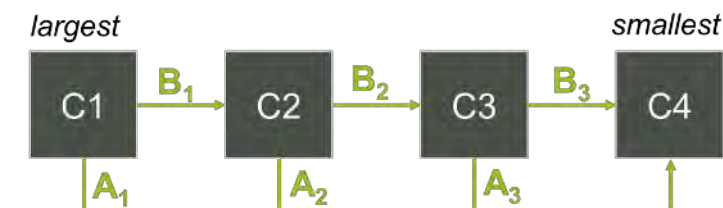


Perkey et al. (2019)



$$D(x) = D_0 e^{-\alpha x}$$

Aggregate Class Model

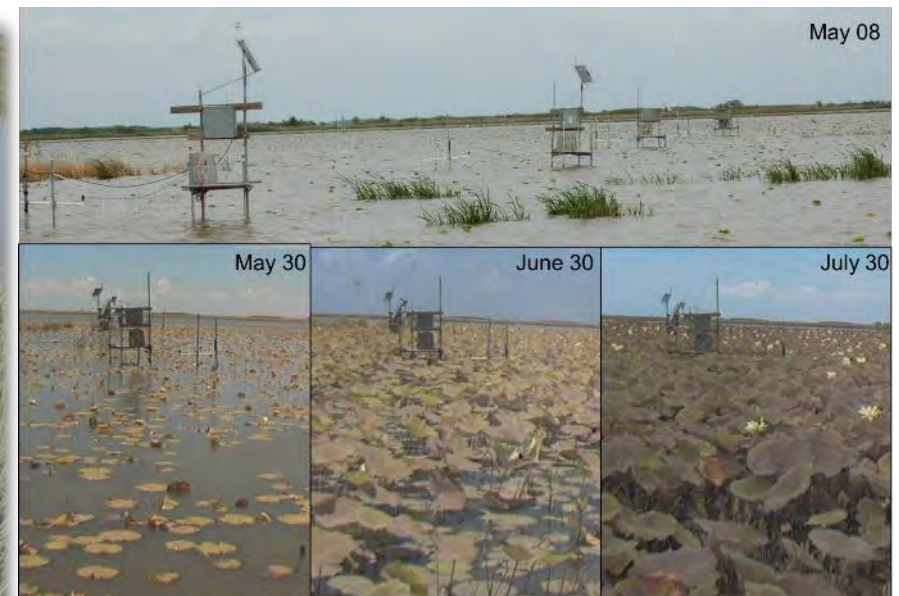


Sediment-Vegetation Interactions

- **Hydrodynamic-Sediment-Biological Interactions**
 - Deposition near coral, oysters, seagrass, marsh.
 - Feedbacks between flow, biology, sediment.
- **In-Progress**
 - Complex topic, with many unknowns.
 - Model approximations will be essential.



Photo courtesy The Nature Conservancy



Sediment Transport Advisory Board

- Board to advance sediment transport prediction across regimes

- Key Messages
 - CW R&D programs with strong tactical bent
 - Development teams 1-2p deep
 - Need strategic plan and research

- Present Activities
 - Strategic Plan for sediment transport
 - CW FY26 Work Package
“Modernizing Sediment Transport Prediction”



Recommendations

Continue tactical research

- Bed characterization methods
- Dredging processes
- Innovative material placement methods

Strategic R&D

- Commitment and sustained funding
- Model frameworks for the future
- Sediment-structure interactions
- Develop new observational methods, remote sensing, machine learning, ...

Test Beds

- Establish in USACE's most challenging (expensive) settings
- Cohesive Testbeds
 - Salt Wedge (Mississippi River Delta)
 - Partially Mixed (Chesapeake, San Francisco Bays)
 - Well Mixed (Cook Inlet or other)
 - Beneficial Use
 - ▶ Mangrove
 - ▶ Coastal marsh
 - ▶ Tidal mudflat
 - ▶ River delta
 - Reservoirs....

AI Applications to Sediment Transport

*Tom Hsu, Ph.D.
University of Delaware
Newark, Delaware*

Sea-level rise and abnormal weather patterns have posed new challenges to the coastal communities, critical infrastructures, and military assets through flooding, land loss, scour, sand overwash, and altered biogeochemical balance in coastal ecosystems, to name a few. Conventional modeling tools tackling these regional-scale issues rely on highly empirical parameterizations to model the un-resolved processes and they need to be greatly enhanced for dealing with these new challenges. Conversely, many high-fidelity numerical models that are designed to resolve these fine-scale processes are too computationally expensive to be coupled with regional-scale models. With the recent advances of Artificial Intelligence and Machine Learning (AI/ML), new opportunities arise to revolutionize our capability to solve multi-scale coastal processes and facilitate decision making. This presentation will introduce several research directions where AI/ML can be useful in advancing scientific discoveries, dissemination of research products, and inform decision making. These directions include,

1. ML is a powerful tool to create parameterizations and sub-grid closure models of un-resolve processes due to temporal and spatial averaging.
2. The use of AI/ML to develop efficient and reliable surrogate models to replace computationally intensive high-fidelity models. The surrogate models facilitate comprehensive scenario studies and decision-making.
3. AI/ML allows effective integration of in-situ sensor data, remote sensing data, and physical laws to create surrogate model of a given coastal system via the use of physics-informed neural networks.
4. AI may greatly facilitate effective dissemination of complex science results.

Several recent examples carried out by pioneering researchers in the area of coastal processes to facilitate prediction, scientific understanding, and decision-making will be discussed. The presentation will be concluded with recommendations for future research on AI/ML-enabled parameterizations, surrogate model developments, and the idea of creating a “digital-twin” for a given coastal system of interest.

Executive Session, Board on Coastal Engineering Research, March 19~20, 2024

Panel Session #2: Coastal Sediment Transport Research Needs and Plans

AI applications to multi-scale coastal processes

Tian-Jian Hsu (Tom)
Professor, Civil and Environmental Engineering,
Director, Center for Applied Coastal Research
University of Delaware

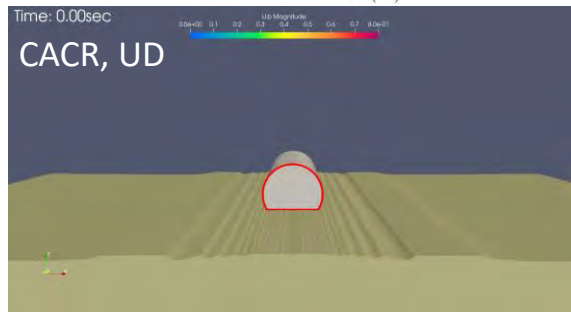
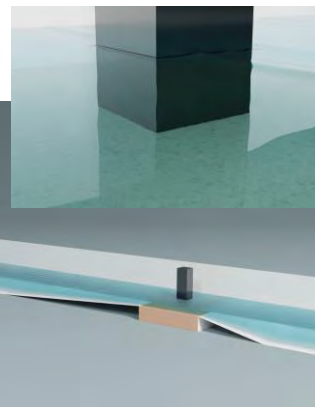
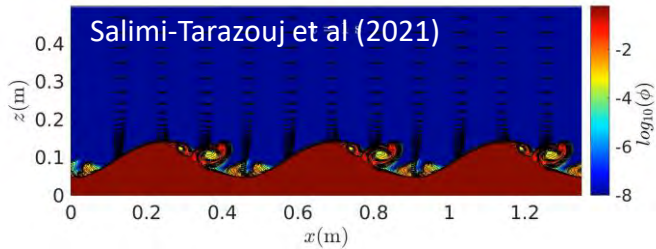
Contributors/collaborators:

Roger Wang, Jack Puleo, Ryan Schanta, Jiaye
Zhang, Pinar Kullu, Fengyan Shi

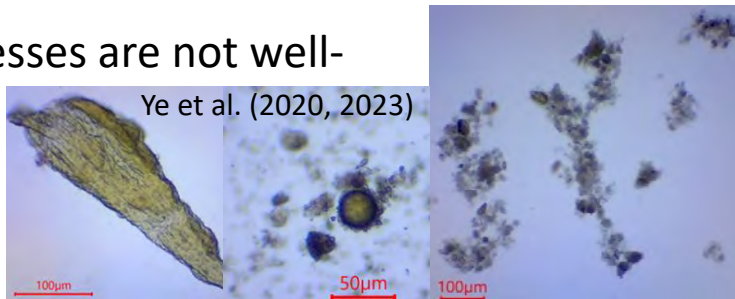


Artificial Intelligence and Machine Learning (AI/ML) may revolutionize our capability to solve multi-scale coastal process challenges and facilitate decision-making

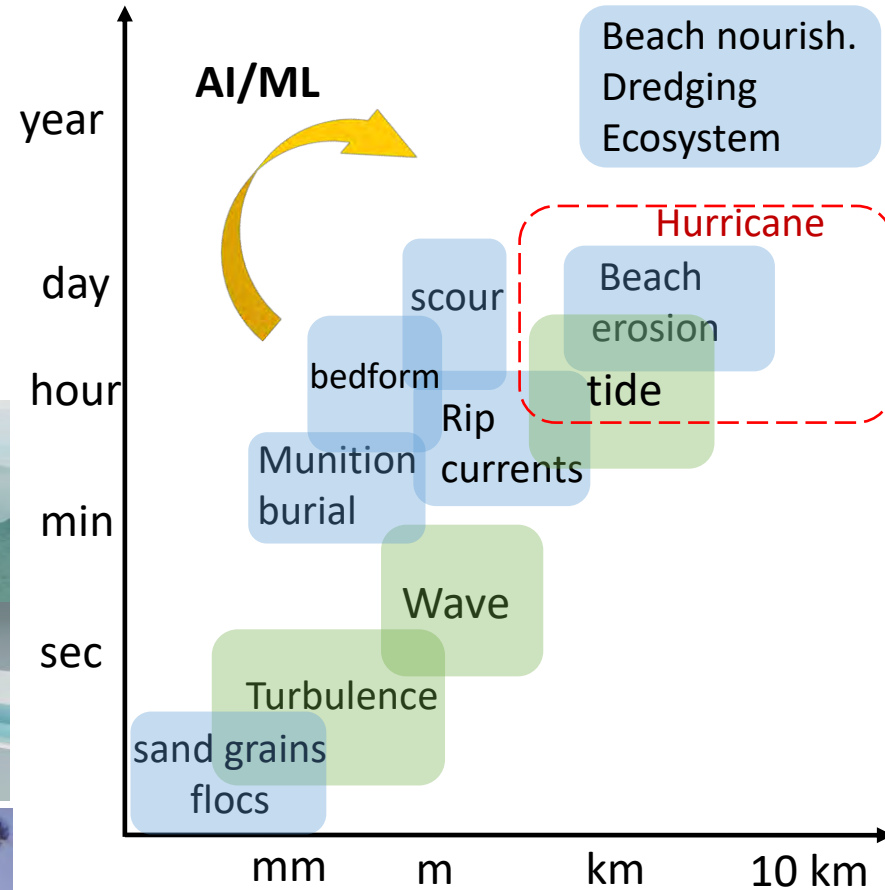
- High-fidelity simulations require high computational cost



- Some processes are not well-understood



- Coastal management issues are of much larger temporal and spatial scale.



- Empirical closure models are used to parameterize these un-resolved physics with mixed success. AI/ML can help!

- Machine learning: Models that automatically learn from data and past experiences to identify patterns and make predictions.
- AI/ML must be coupled with algorithms that can identify pattern, carry out dimensional reduction, optimization, and probabilistic analysis.
- Coastal researchers are familiar with these algorithms; Here, we name a few pioneering work:

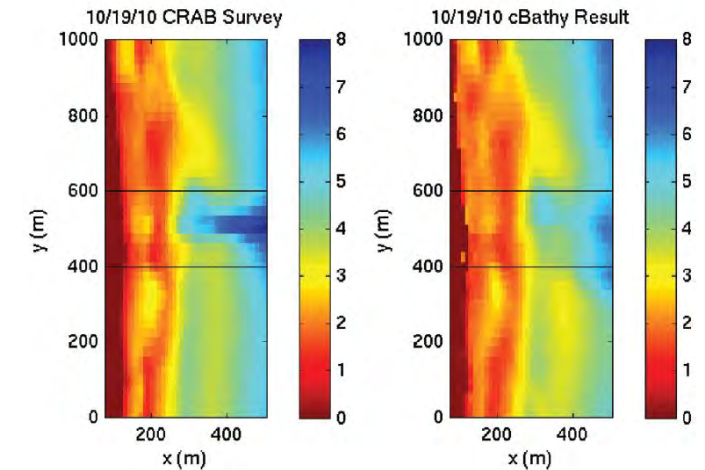
- Prediction:

- Predicting bathymetry from surface waves cBathy (*Holman et al. 2013, JGR Oceans; EOF applied to spatial features*).
- Underwater Munitions Expert System (UnMES) using Bayesian Network (*Rennie 2017, SERDP project report, MR-2227*)

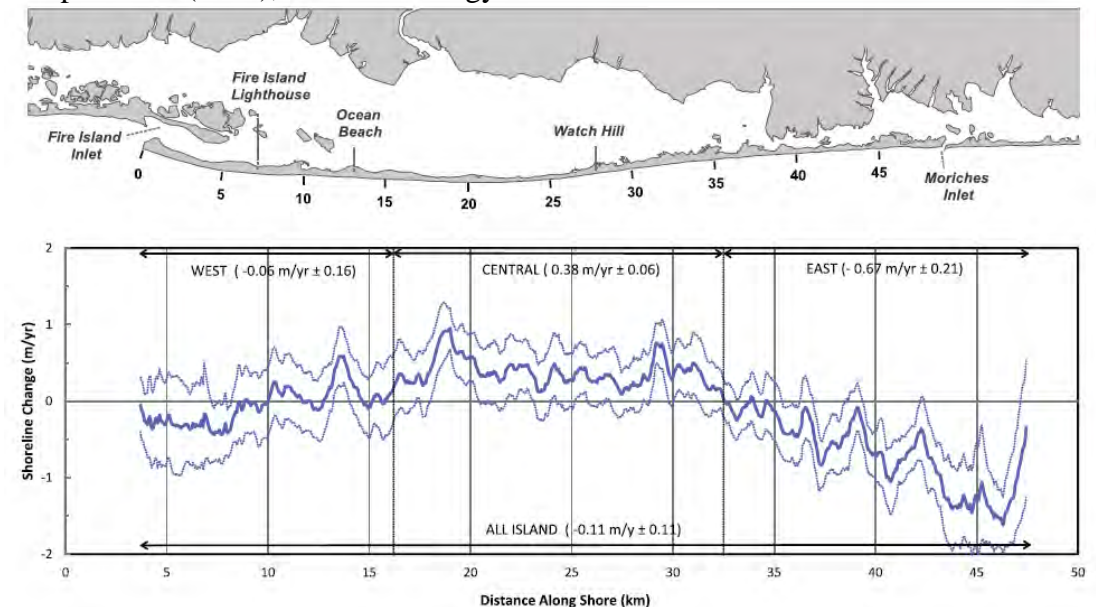
- Identifying mechanisms

- Shoreline response to Hydrodynamic forcing vs. Geologic features (EOF applied to time series; *Hapke et al. 2016, Marine Geology*)
- The role of dune height in predicting shore change (Bayesian network, *Plant et al. 2016, Earth's Future*).

Holman et al. (2013), JGR



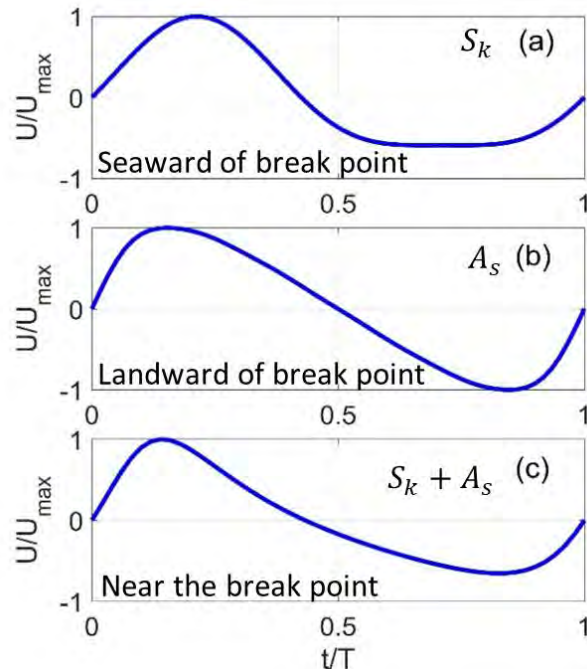
Hapke et al. (2016), Marine Geology



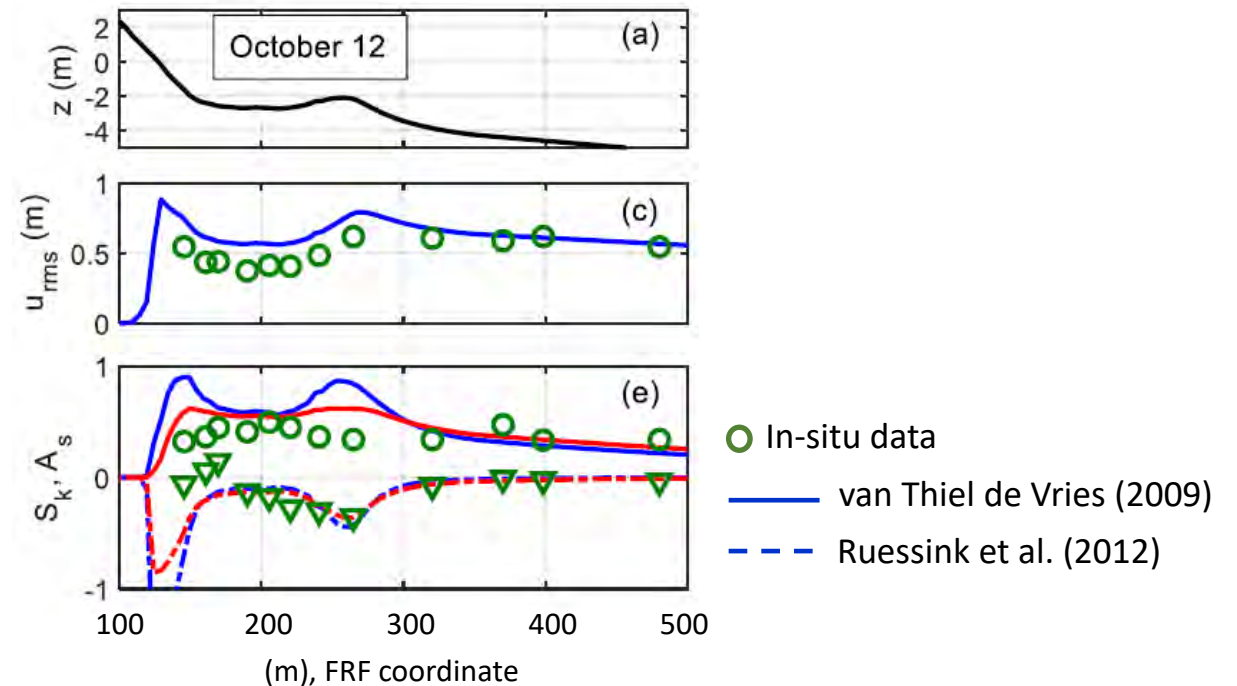
➤ AI/ML need a lot of data. Here is a simple machine learning example:

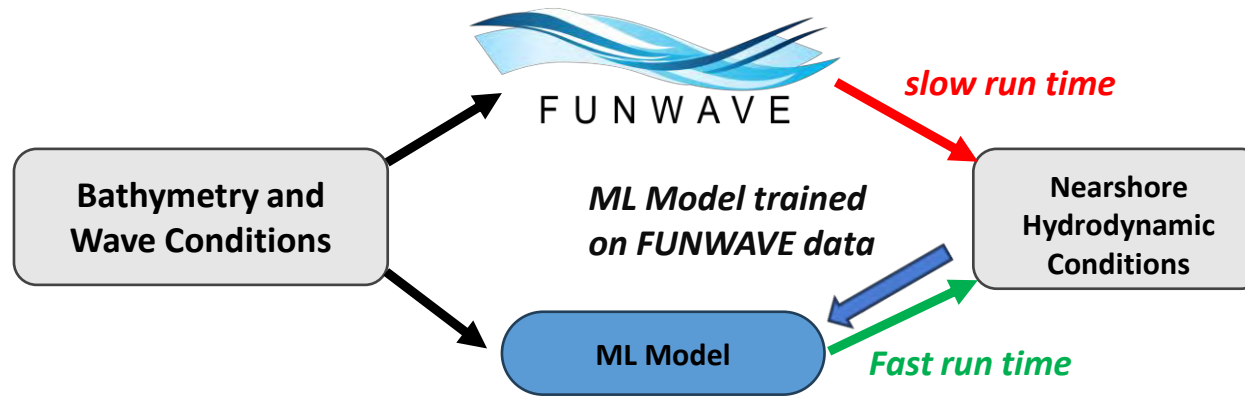
Predicting wave velocity skewness and asymmetry in the sur zone – Schanta et al.

- Wave orbital velocity skewness S_k and asymmetry A_s are key parameters to drive onshore sediment transport and cause beach accretion and recovery.
- Nearshore morphodynamic models are developed based upon wave-averaged formulations and cannot resolve S_k and A_s .
- Evidences show that existing empirical parameterizations do not perform well.
- A wave-resolving model can directly predict S_k and A_s , but too time consuming to predict morphodynamics.

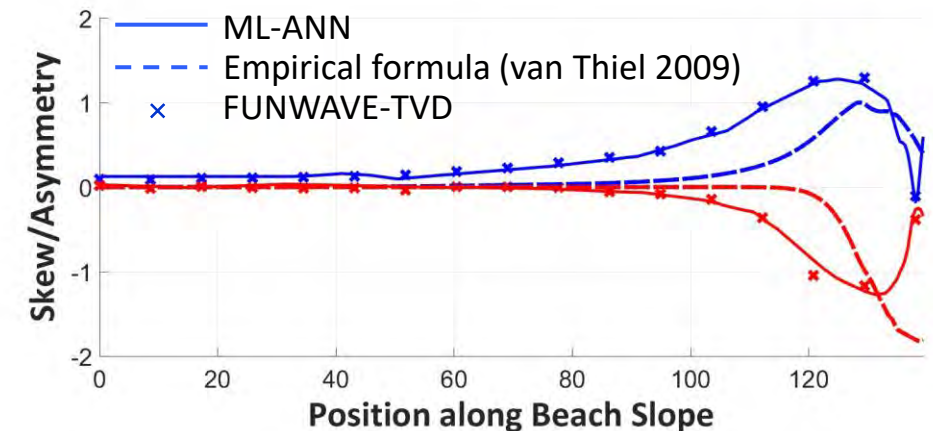
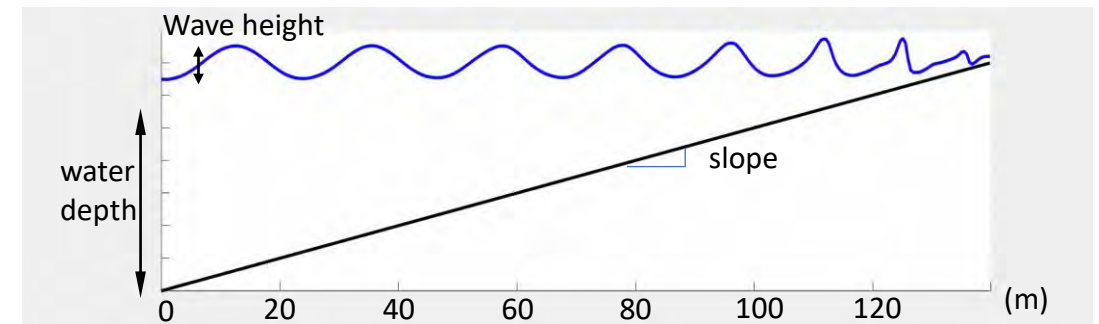


S_k and A_s at FRF, Duck94. Rafati et al. (2021), Coast. Eng.





- FUNWAVE-TVD (Shi et al. 2012, Ocean Modelling) is a wave-resolving Boussinesq wave model.
- Use FUNWAVE-TVD to run 1000 simulations of different wave conditions and slopes.
- Use publicly available feedforward artificial neural network from KERAS; 80% (20%) FUNWAVE-TVD data is used for training (testing).



FUNWAVE Variable Parameters

Parameter	Range	Unit
Beach Slope	0.05-0.1	
Wave Amplitude	0.5-1.5	m
Wave Period	3-12	s
Water Depth	10	m

1. ML is a powerful tool to create parameterizations and sub-grid closure models of un-resolve processes due to temporal and spatial averaging.
 - ⇒ Learn from data and generalize to unseen data. It is a subfield of statistics that focus on “prediction” (Bernard 2021) and usually does better than conventional statistical methods.
 - ⇒ The problem with ML is that it cannot explain “why”? However, we can combine ML with probabilistic analysis and physics (governing equations, high-fidelity simulation data).
 - ⇒ AI/ML should be one of our tools to discover science.

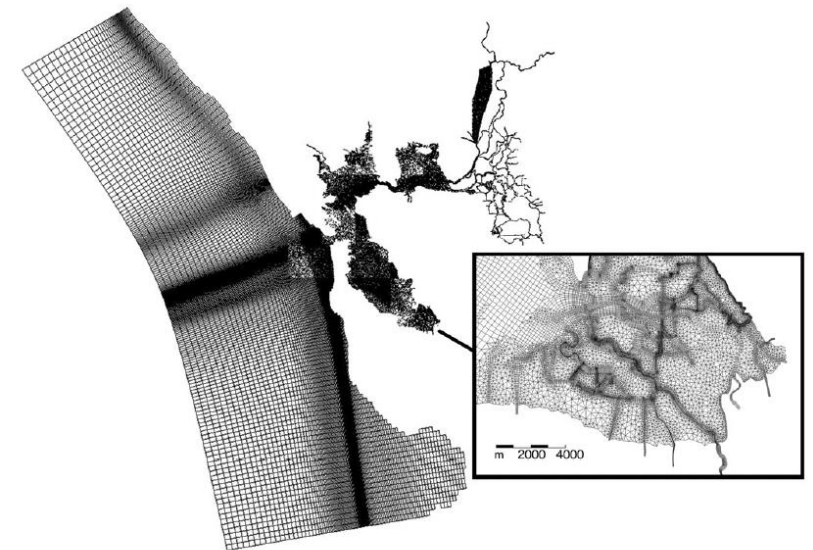
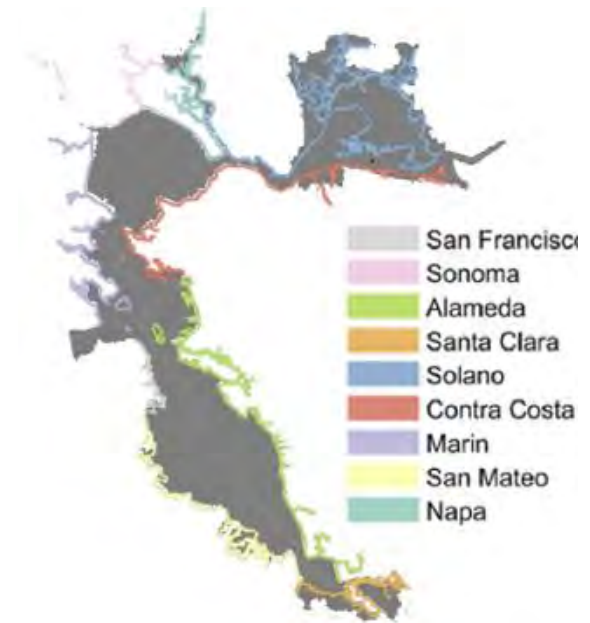
2. Use AI/ML to develop efficient and reliable surrogate models to replace computationally intensive high-fidelity models. The surrogate models facilitate comprehensive scenario studies and decision-making.

➤ Surrogate model example:

Impact of shoreline alternation on peak water level (PWL) in San Francisco Bay in response to future sea-level rise (SLR)

— by Jia, Wang and Stacey (2019, *Advances in Water Resources*, 126, 165-175)

- Each of the 8 counties may decide to construct a sea-wall as a counter-measure to SLR. Total number of scenarios due to the counties' decision is $2^8 = 256$.
- Using Delft3D-FM with a resolution of 50m in the bay, the number of grid point is about 100,000 (forward modeling, *Wang et al. 2019, Earth's Future*).
 - ⇒ Each Delft3D-FM simulation is time consuming; hope to use the smallest number of training datasets.
 - ⇒ It is difficult to deal with high-dimensional input data (100,000) in ML because it requires large matrix manipulation (bottleneck).

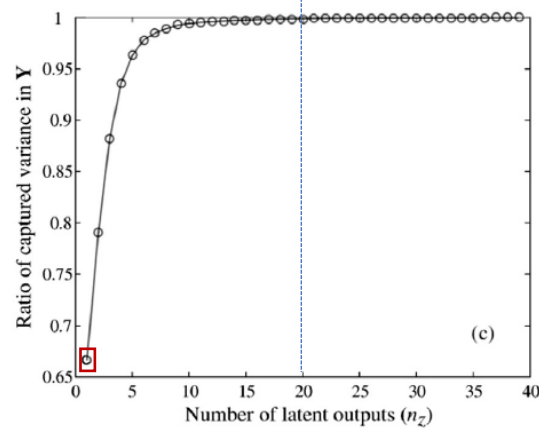


Jia et al. (2019)

- The goal is to simply predict PWL, do we really need to know the info at each grid point ? (backward modeling)

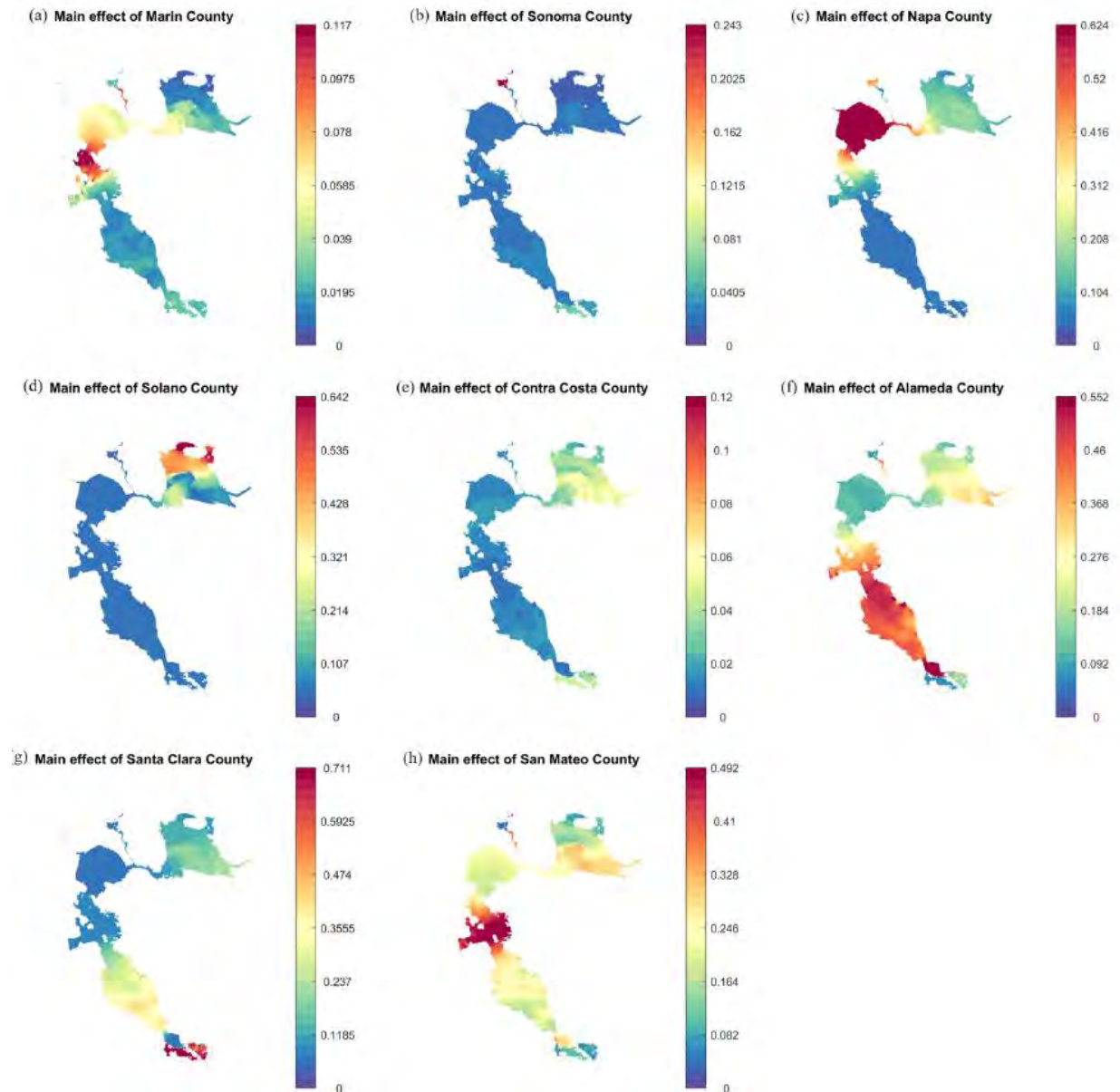
⇒ Principal component analysis (PCA): reduce the dimensions of a given problem based on the feature of interest.

For predicting PWL, we only need the first 20 modes (modes associated with the 20 largest eigen values).



⇒ Based on analyzing the reduced dimension (latent) output error, turns out only 40 simulations are need for training data.

$$\frac{\text{high fidelity model}}{\text{dimension reduce surrogate model}} = \frac{256 * 100000}{40 * 20} = 32000$$



First-order effect on PWL variation (Jia et al. 2019)

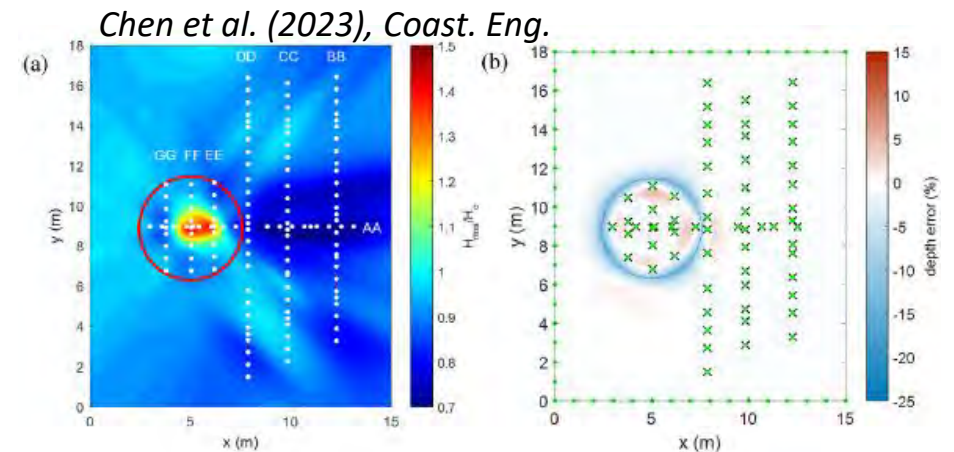
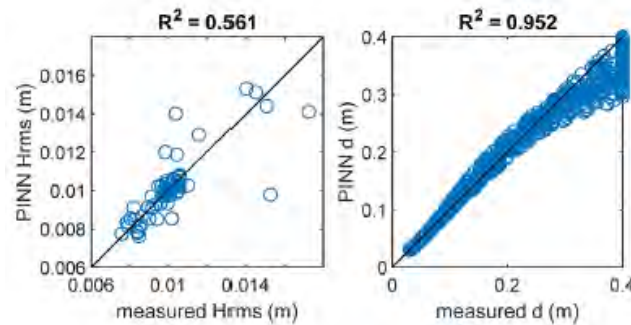
- AI/ML allows effective integration of in-situ sensor data, remote sensing data, and physical laws to create surrogate model of a given coastal system via the use of physics-informed neural networks (PINNs)

PINN: Incorporate model equations as part of the neural network; use ML to solve partial differential equations!

Example: Simultaneous mapping of nearshore bathymetry and waves based on physics-informed deep learning

— by Qin Chen et al. (2023, Coastal Engineering, 183, 104337)

- Sensor data is limited; only 63 locations are used for training of waves over a circular shoal.
- Traditional ANN prediction is unsatisfactory.

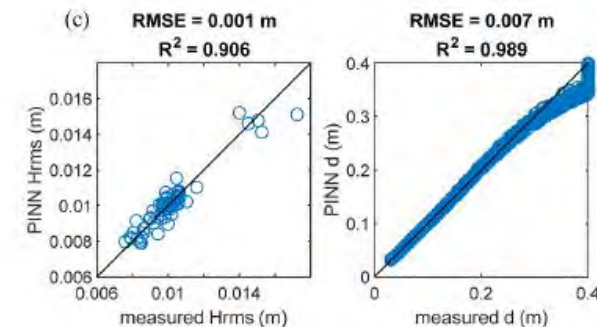


- PINN includes wave energy balance and dispersion relationship.

⇒ minimizing their residual f_1 and f_2 . The prediction is much improved.

$$f_1(x, y, \theta) := \frac{\partial ec_{gx}}{\partial x} + \frac{\partial ec_{gy}}{\partial y} + \frac{\partial ec_{g\theta}}{\partial \theta} + d_w$$

$$f_2(x, y) := \omega^2 - gk \tanh(kh)$$



4. AI allows us to effectively disseminate complex science results:

- Computer vision and Expert system
- Straightforward Q&As user manual via generative AI

 You

What is the US Army Corps of Engineers' strategy to protect the US shoreline?

 ChatGPT

The U.S. Army Corps of Engineers (USACE) employs various strategies to protect the U.S. shoreline from erosion, storm damage, and other coastal hazards. These strategies typically involve a combination of structural and non-structural measures aimed at reducing risk and enhancing resilience. Some key elements of the USACE's shoreline protection strategy include:

1. **Coastal Structures:** The USACE constructs and maintains a variety of coastal structures to mitigate erosion and protect infrastructure. These structures include seawalls, revetments, breakwaters, jetties, and groins, which are designed to dissipate wave energy, stabilize shorelines, and prevent erosion.
2. **Beach Nourishment:** Beach nourishment involves adding sand or sediment to eroded beaches to restore their width and volume. The USACE conducts beach nourishment projects to replenish beaches, enhance recreational opportunities, and provide natural storm protection by absorbing wave energy.
3. **Dune Restoration:** Coastal dunes play a critical role in protecting shorelines from erosion and storm surge. The USACE undertakes dune restoration projects to enhance dune systems through vegetation planting, sand fencing, and other measures aimed at stabilizing dunes and preserving natural coastal processes.
4. **Storm Damage Reduction Projects:** In areas prone to hurricanes, tropical storms, and other extreme weather events, the USACE implements storm damage reduction projects to mitigate the impacts of storm surge, flooding, and erosion. These projects may include levees, floodwalls, and storm surge barriers to protect coastal communities and critical infrastructure.
5. **Coastal Engineering Studies:** The USACE conducts comprehensive coastal engineering studies to assess shoreline vulnerabilities, analyze coastal processes, and develop risk reduction strategies. These studies help inform decision-making, prioritize investments, and guide the development of coastal protection projects.
6. **Ecosystem Restoration:** In addition to protecting shorelines from erosion and storm damage, the USACE promotes ecosystem restoration efforts to enhance coastal habitats, restore natural ecosystems, and improve the resilience of coastal ecosystems to climate change impacts.

Overall, the USACE's shoreline protection strategy involves a multi-faceted approach that integrates engineering solutions with natural and nature-based features to enhance coastal resilience, protect communities, and preserve coastal ecosystems.



Recommendations

AI/ML can facilitate scientific discovery, prediction, forecast and decision-making

1. Powerful tool to create parameterizations and sub-grid closure models of un-resolve processes.
2. Efficient surrogate models of temporally- and spatially-dependent processes governed by partial differential equations (high-fidelity models) of a given coastal system. Ideas:
 - Create an AI/ML-enabled parameterization for predicting settling velocity of cohesive sediment due to flocculation, which can be used in regional-scale coastal models.
 - Create surrogate models for a give coastal system integrating in-situ sensors, remote sensing data and numerical model data – need a testbed with big data, FRF? New testbed cohesive sediment?

Challenge: Utilize generative AI and surrogate modeling to create a “digital twin” for a given coastal system of interest.

? There are unlimited possibilities in this new area; Maybe community input is the first step.

National USACE Sediment Transport Needs in Coastal Planning Engineering and O&M

*John Winkelman
U.S. Army Corps of Engineers Headquarters
Concord, Massachusetts*

Sediment management is fundamental to each of the USACE mission areas (Navigation, FRM/CSRM, and Aquatic Ecosystem Restoration). In support of Navigation, USACE dredges over 200 million yds³ per year. Understanding where and why that material is moving in our navigation systems is vitally important, especially in consideration of our focus on Regional Sediment Management (RSM) and our stated goal of 70% beneficial use (BU) of dredged material by the year 2030. A realistic path to meeting the BU goal is integrating our dredged sediment into Ecosystem Restoration and Natural Based Solutions (NBS) for Coastal Storm Risk Management (CSRM). Implementation and success are dependent upon our understanding of how sediment will move in both the short term and longer-term time scales. The original USACE NBS, beach fill has been implemented on 350 miles of beach since 1956. Understanding and being able to predict how sediment will move on the beach, in the nearshore profile, and at the borrow site during/after dredging are all essential to properly designing, maintaining, and evaluating impacts of our projects. No other agency is so impacted by sediment, and as such, predicting and understanding sediment transport must continue to be a priority.

The importance of this topic to USACE is highlighted by the significant research and development (R&D) investments over the years. The resulting knowledge and tools are used by our districts in the execution of our Civil Works Missions. However, the blunt reality is that for all the past work and efforts, our understanding and ability to predict sediment movement is at a trend level at best in many cases with volumetric results having errors in excess of 100%. In a world that is increasingly focused on more accurate and precise answers, that level of “accuracy” is largely unacceptable. Increasingly that level of uncertainty is hampering our ability to advance our approaches to meeting our missions i.e. NBS, BU, climate change adaption, resiliency reporting, etc. In general, our predictive skill increases when looking at long duration timelines, along long distances where historical data, averaging, and calibration can be used. One could argue that is associated more with tuning a tool vs. understanding and modeling sediment transport. For shorter durations and more localized analysis we have poor predictive skill.

The impacts related to the lack of predictive accuracy have long been reported by our districts through direct communications and through the many submitted Statements of Need

(SoN) each year via the Research Area Review Groups (RARGs). The Coastal Working Group has reported these needs during the annual presentations to the Coastal Engineering Research Board. The bottom line is we need much better predictive capability for sediment transport across the temporal spectrum, the grain size spectrum, and in all coastal environments. An incomplete list of needs is provided below that provides some context.

1. Navigation channels - we need significant improvements for accurately predicting accretion and erosion in our navigation channels. Currently the districts report significant discrepancies between historic survey records and model predictions/skill. Accurately predicting/modeling sediment movement in our channels is important for our maintenance activities but it is perhaps more vital for determining impacts related to deepening projects. We have had cases where the post deepening shoaling rates have been significantly different (much higher) than predicted during the study/design phase. This need covers clay, silt, sand, and gravel type sediments.
2. Dredge material placement is a critical need for our navigation activities. Regardless of location (shallow water back bay to deep water disposal) and regardless of purpose (ecosystem restoration to the lowest cost disposal option) understanding, with accuracy, how sediment will move at all time scales, and covering all grain sizes is needed.
3. Nearshore structures (CSRM and Navigation) - we need to have models that can accurately predict sediment movement, accretion, and erosion around our coastal structures. This must cover acute areas that impact structural stability to the broader areas which impact nearby bottom habitats, navigation channels, other infrastructure, etc. This must be predictive in the short term (days to weeks) through the longer term (years at least). Once again this must cover the range of grain sizes we typically work with (clay to gravel/cobble).
4. Beach nourishment and understanding beach behavior are critically important to USACE due to the large number of beach fill CSRM projects we currently have constructed and will likely construct in the future. Understanding and predicting sediment movement (including mixed grain to cobble/gravel) from the depth of closure to past the dune are needed. Once again accuracy must be a focus.
5. Storm/hazard modeling morphology inclusion is needed for more realistic and accurate understanding of our coastal hazards and also how alternative mitigation

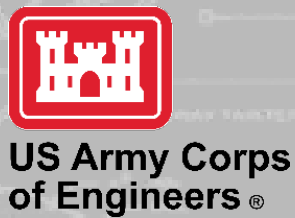
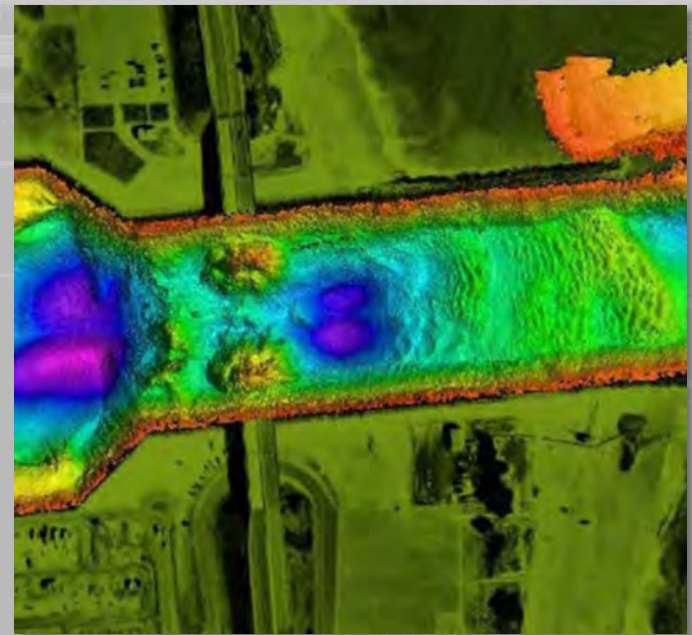
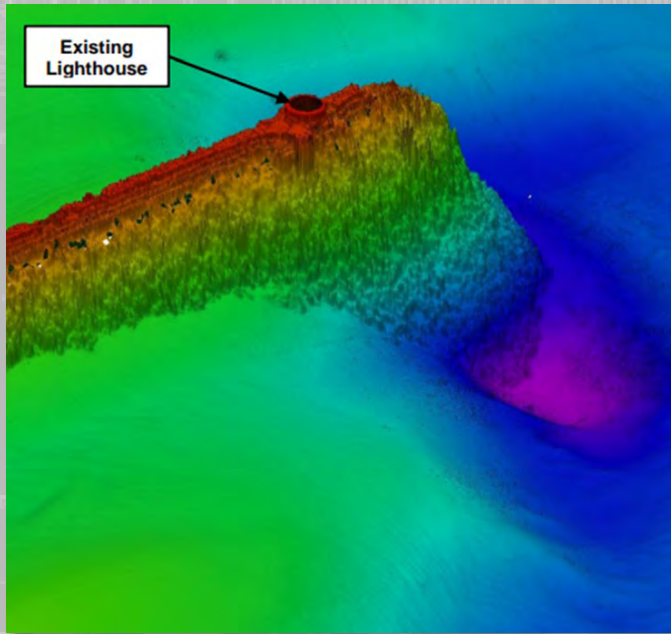
measures will behave. Static bathymetry/topography is a recognized limitation and source of inaccuracy/uncertainty.

6. Back bay sediment transport specific issues are at the forefront due to our increased CSRSM focus in these areas, the drive towards NBS, the goal of 70% BU, etc. The reality of the different physical oceanography of this area brings new challenges i.e. channelized currents, shorter period/smaller waves, more acute wind generated currents, vessel waves, salinity gradients/flocculation, etc.

It is understood by all involved that this is a difficult, highly complex problem which faces challenges from an understanding of fundamental physics to the sheer complexity/capability of modeling those physics. Due to computational limits most of our sediment modeling has been done in the phased average 2-D modeling world and/or 1-D modeling. Just now we are seemingly within reach of integrated 2-D models in the nearshore, through the surf zone, onto the beach and into the dunes. However, in recent work/presentations by ERDC, the accuracy limitations inherently imposed by those modeling approaches is sobering and the paraphrased statement of 'Our skill in making predictions of sediment transport in the time frame of days-weeks for nearshore morphology change is nil' is alarming. I say frightening because we as a society, and as an agency tend to look at answers, regardless of source, and the answer is rarely considered or appreciated in regard to the associated inaccuracies and uncertainties. While often reported and explained in technical reports, decision makers and the public in general do not acknowledge or understand the implications of that information. As such we must continue to strive for improved accuracy across the full spectrum of coastal sediment transport knowledge and modeling so as to provide answers and solutions with significantly increased predictive skill. Given the increased availability and access to high performance computers and cloud based resources it may be time for a rethink and a new overall strategy for our sediment transport modeling capabilities.

NATIONAL USACE SEDIMENT TRANSPORT NEEDS IN COASTAL PLANNING, ENGINEERING, AND O&M

John Winkelman
Coastal Working Group Lead
Headquarters
Date: 20 March 2024





PRESENTATION OVERVIEW



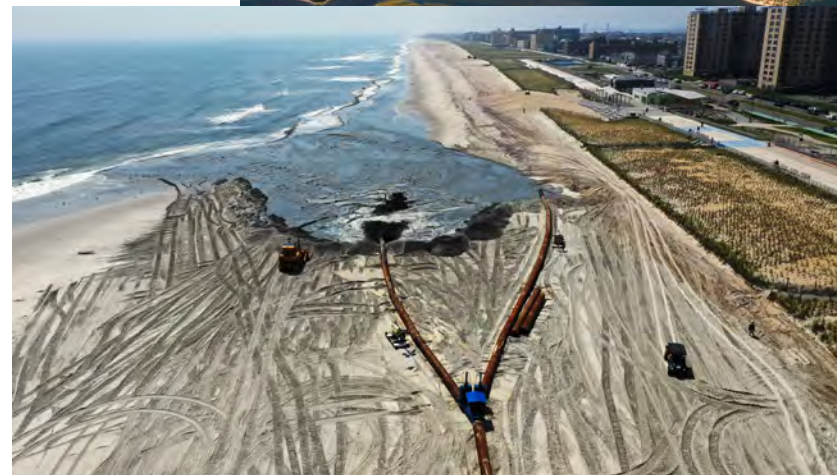
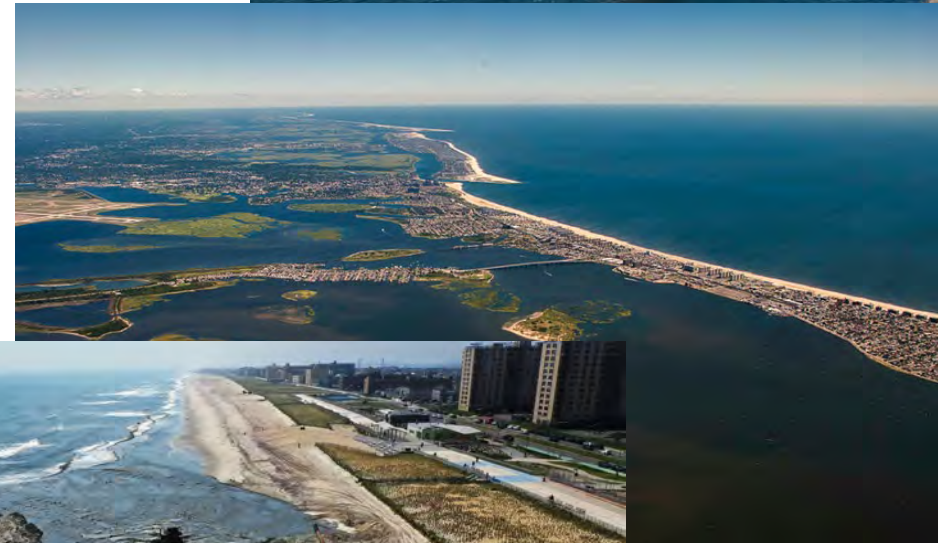
- 1. Motivation – why is sediment transport important to USACE**
- 2. Mission discussion**
- 3. Connectivity and complexity**
- 4. Importance to the field**
- 5. R&D Ideas**



WHY IS SEDIMENT TRANSPORT IMPORTANT?



- **Fundamental to each USACE Mission Areas**
 - No other agency is so impacted/involved with sediment
- **Navigation**
 - 200+ million yds³/yr dredged
 - \$1.5 billion/yr
 - 13,000 miles of deep draft coastal channels
 - 400 ports, harbors and turning basins
 - Deepening studies/projects
 - Beneficial Use – 70%
- **Coastal Storm Risk Management**
 - 350 miles of beach fill projects
 - Back Bay Studies
 - Natural based solutions
- **Aquatic Environmental Restoration**
 - 111,000 acres restored
 - \$224 million budget

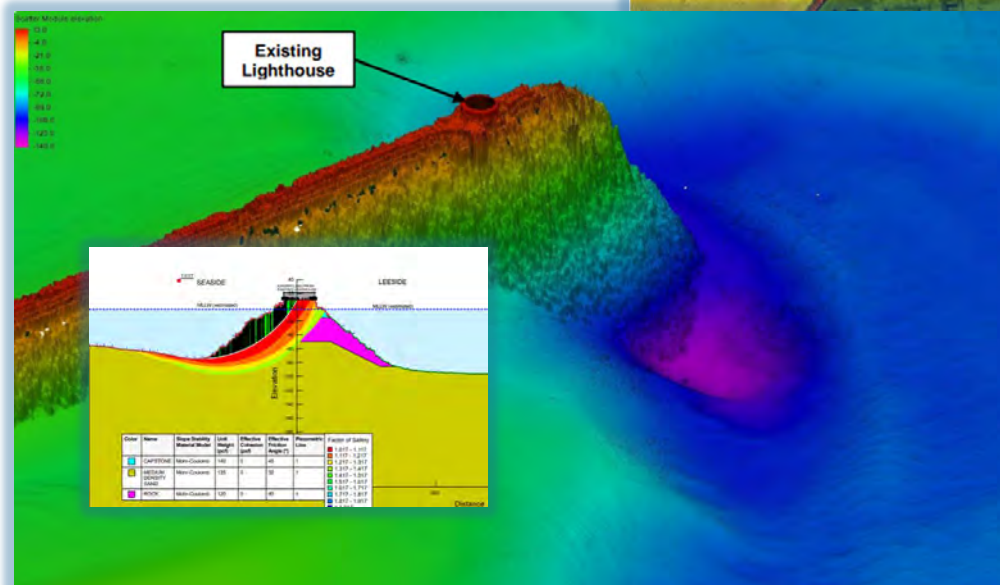
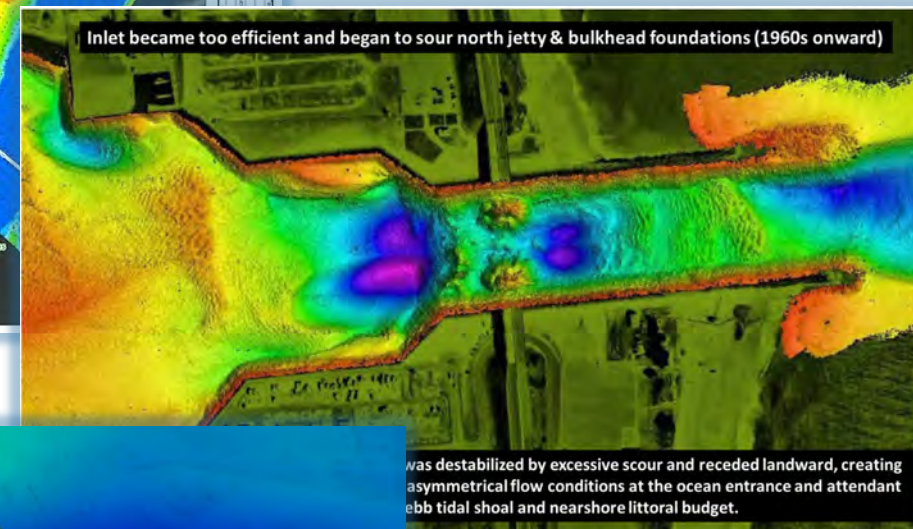
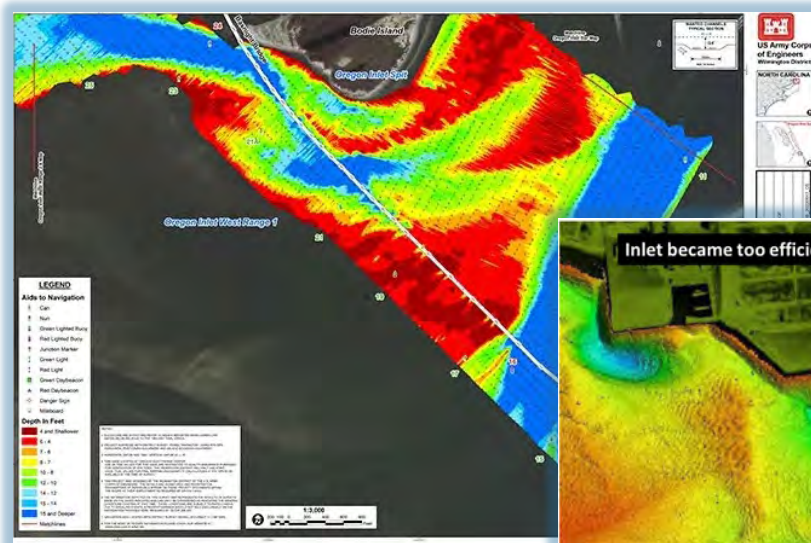




COASTAL NAVIGATION – CHANNELS AND STRUCTURES



- Channel Shoaling/Erosion
- Deepening studies/projects
- Localized scour/accretion
- Dredge material placement
- Coastal impacts/stability

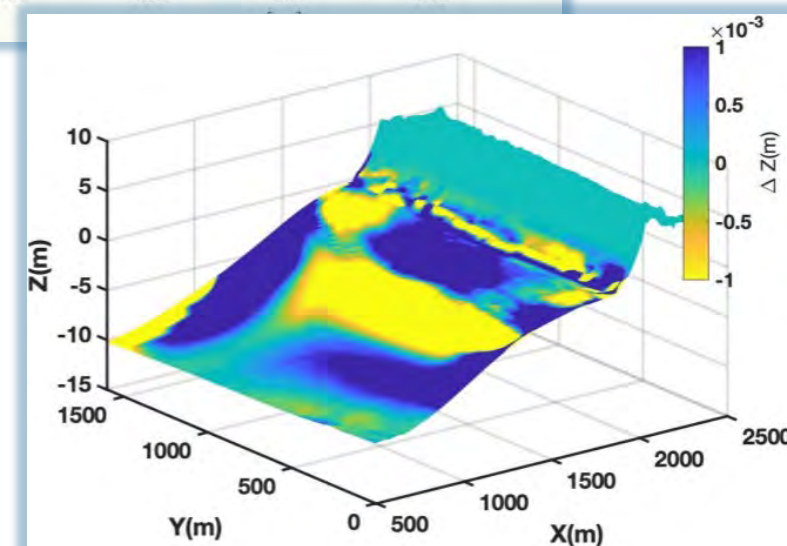
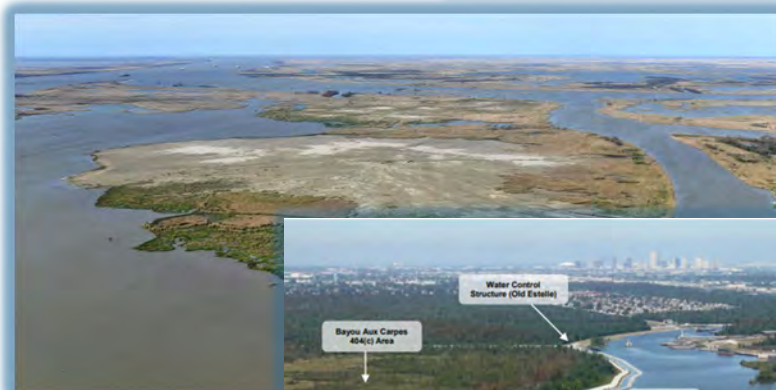
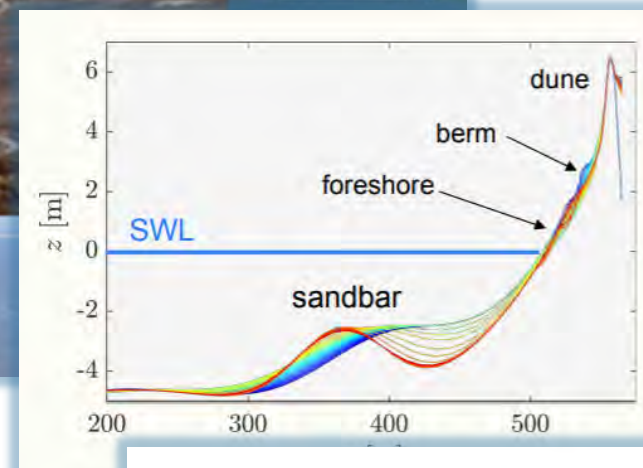
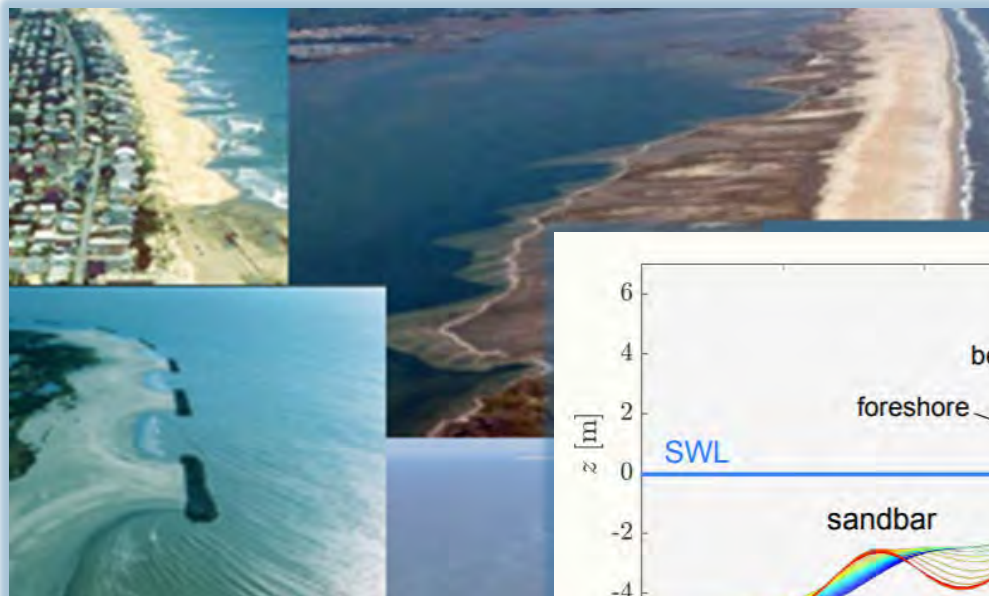




COASTAL STORM RISK MANAGEMENT



- Shoreline Erosion
- Beach fill studies/projects
- Storm change morphology
- CSRМ structures
- Natural Based Solutions

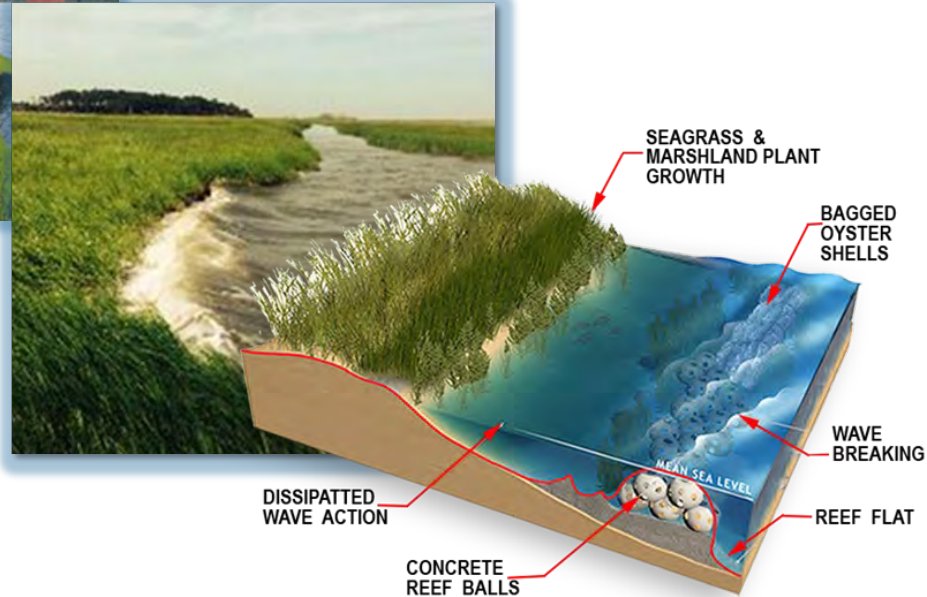




AQUATIC ECOSYSTEM RESTORATION AND NATURAL BASED SOLUTIONS



- Wider array of sediment grain sizes
- A complex set of forcing
- Estuarine specific oceanography
- Placement challenges





ENGINEERING WITH NATURE/NATURAL AND NATURE BASED FEATURES



Dunes and Beaches

Benefits/Processes
 Breaking of offshore waves
 Attenuation of wave energy
 Slow inland water transfer

Performance Factors
 Berm height and width
 Beach slope
 Sediment grain size and supply
 Dune height, crest, and width
 Presence of vegetation

Vegetated Features

Benefits/Processes
 Breaking of offshore waves
 Attenuation of wave energy
 Slow inland water transfer
 Increased infiltration

Performance Factors
 Marsh, wetland, or SAV elevation and continuity
 Vegetation type and density

Oyster and Coral Reefs

Benefits/Processes
 Breaking of offshore waves
 Attenuation of wave energy
 Slow inland water transfer

Performance Factors
 Reef width, elevation, and roughness

Barrier Islands

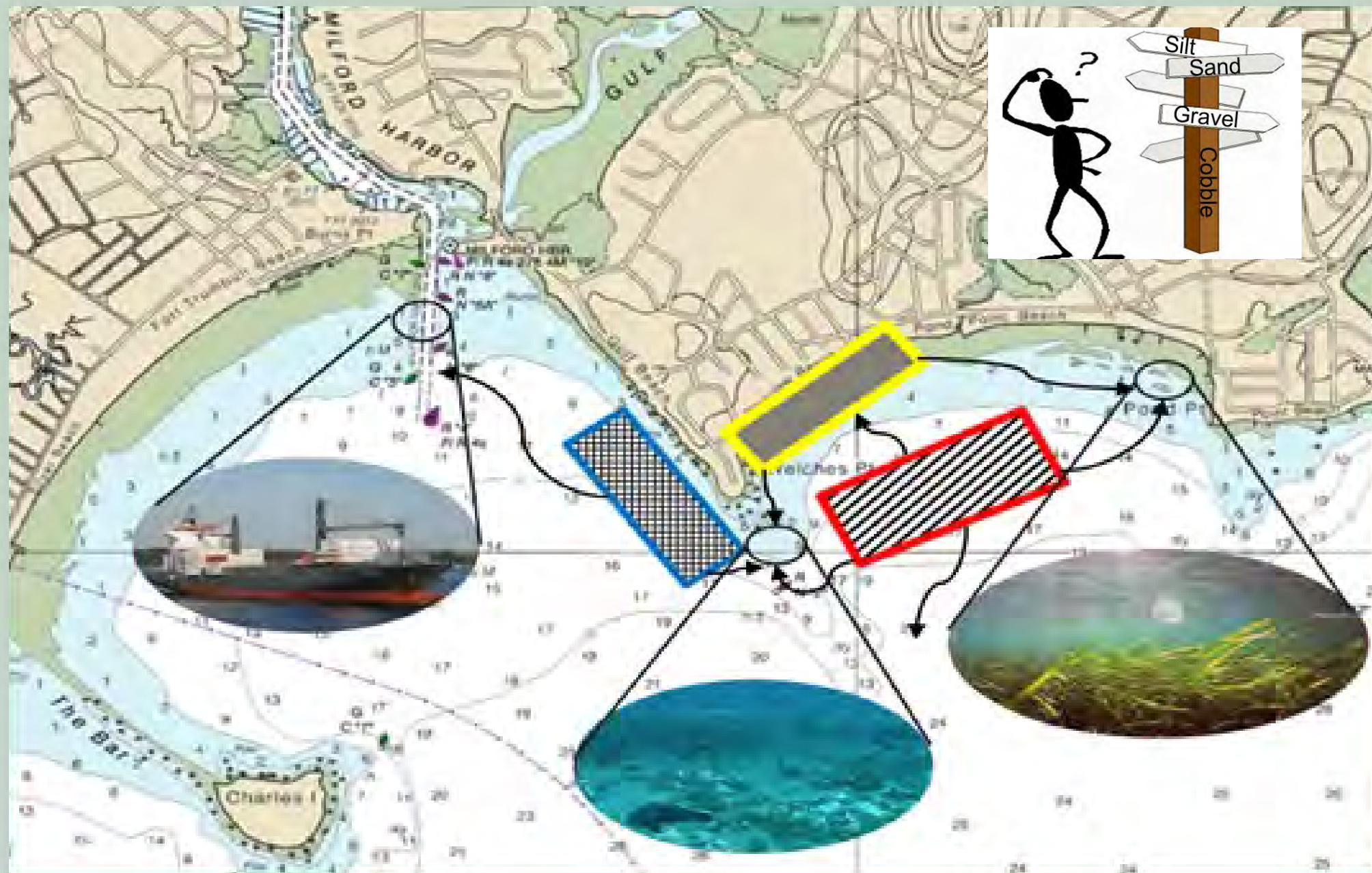
Benefits/Processes
 Wave attenuation and/or dissipation
 Sediment stabilization

Performance Factors
 Island elevation, length, and width
 Land cover
 Breach susceptibility
 Proximity to mainland shore

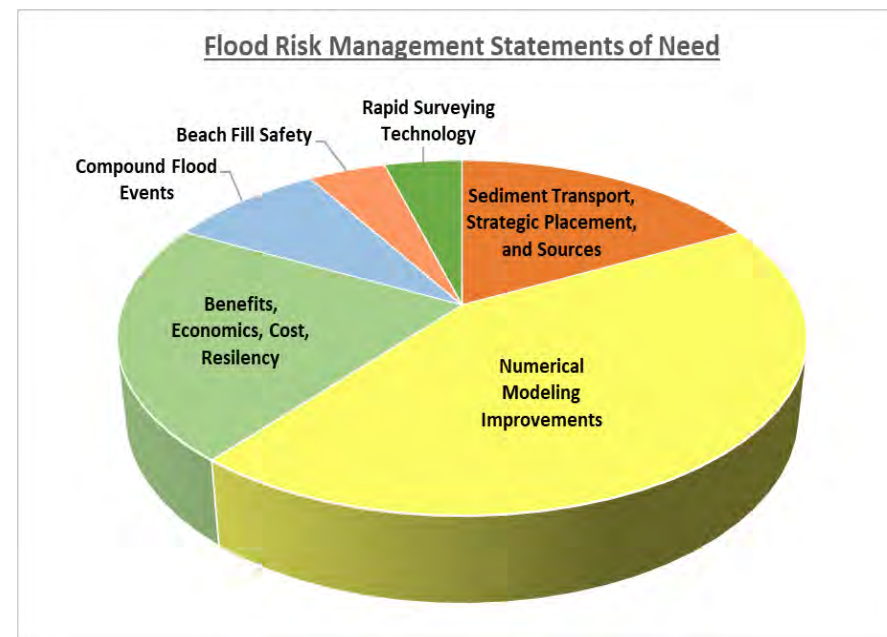
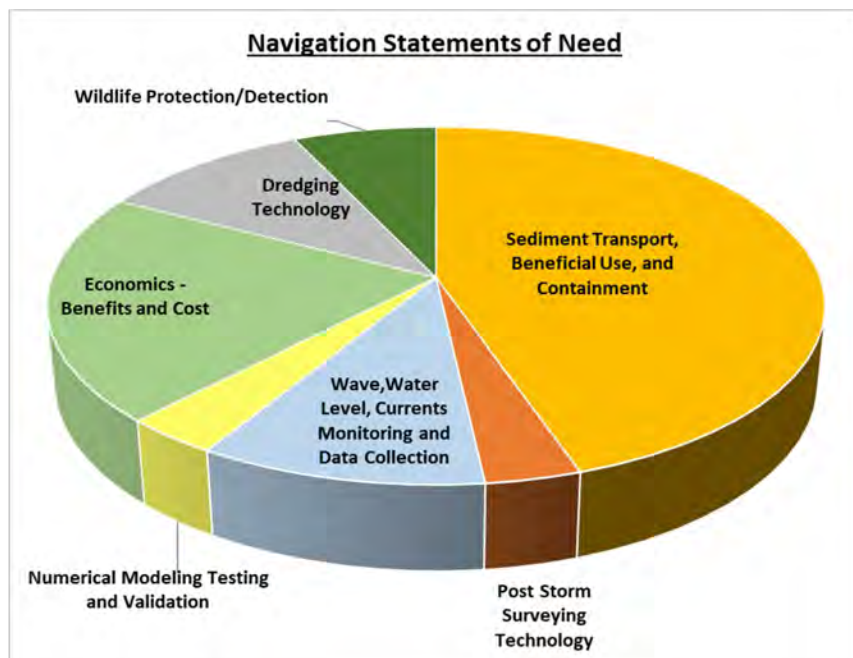
Maritime Forests/Shrub Communities

Benefits/Processes
 Wave attenuation and/or dissipation
 Shoreline erosion stabilization
 Soil retention

Performance Factors
 Vegetation height and density
 Forest dimension
 Sediment composition
 Platform elevation



IMPORTANCE TO THE FIELD – R&D REQUESTS



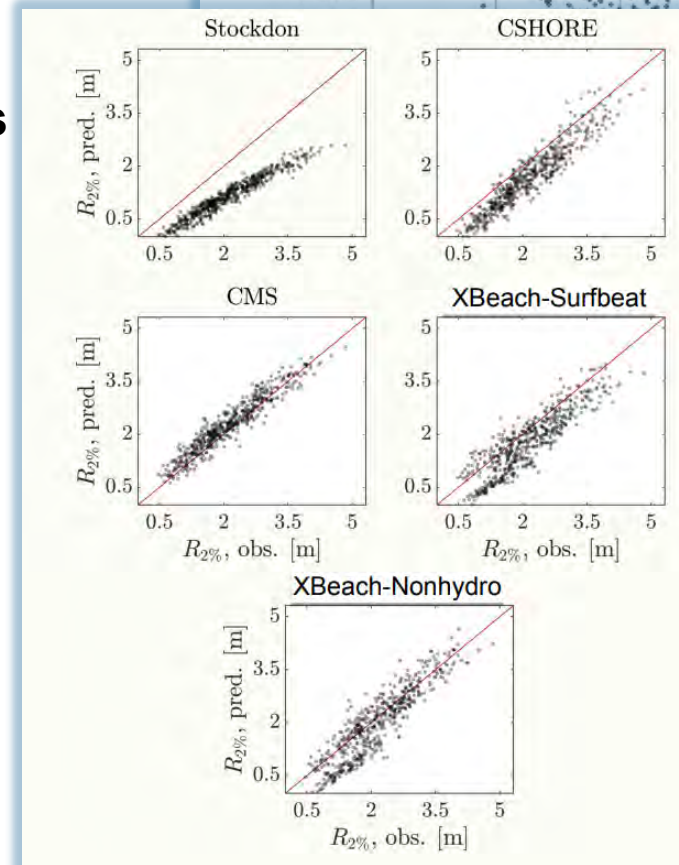
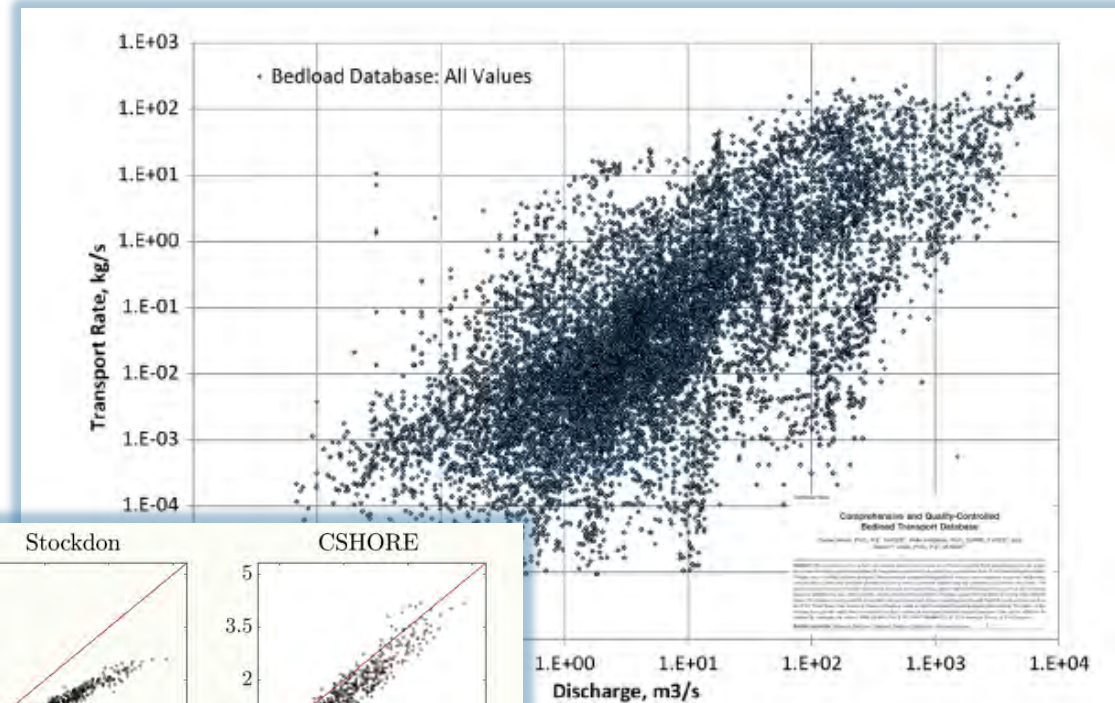
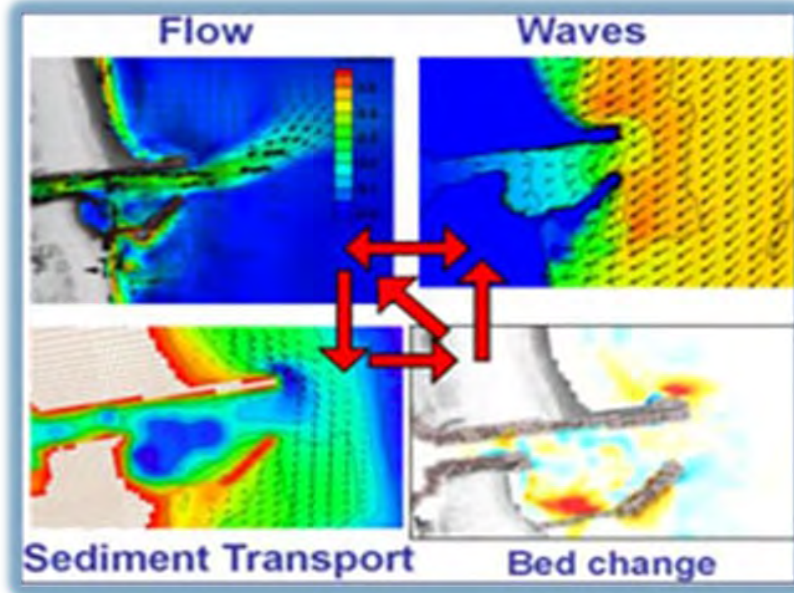
“Predicting sediment transport and morphology change in the nearshore region is fundamental to the USACE coastal mission. Nearshore flooding and sediment transport and morphology change remain poorly understood and predictive technologies are often in gross error”

However, the blunt reality is that for all the past work and efforts, our understanding and ability to predict sediment movement is at a trend level at best in many cases with volumetric results having errors in excess of 100%. In a world that is increasingly focused on more accurate and precise answers, that level of “accuracy” is largely unacceptable.



WHY SO INACCURATE?

- Phase averaged models
- Depth averaged models
- Long time steps
- Limited data
- Far from complete understanding of physics
- Immense number of variables



tips for 15,000 measurements included in database
Hydraulic Engrg, Hinton et al 2017



NEEDS OF THE FIELD



- “A comprehensive numerical model that allows for the accurate prediction of nearshore flooding potential and morphology change is required, wherein the system of shelf, surf, swash, beach, and dune is properly treated as an interconnected whole.”
- A model(s) that fully incorporates the full range of sediment grain sizes
- Navigation Channels
 - Accurate prediction of accretion and erosion (acute/local to full channel and beyond)
 - Dredge material placement – how, when and where is sediment going to move
- Nearshore structures (CSRM and Navigation) - accurate prediction of transport, accretion, and erosion (acute and wide scale).
- Beaches and beach nourishment – depth of closure past the dunes.
- Storm/hazard modeling morphology - understanding of our coastal hazards
- Back bay/estuarine sediment transport



R&D NEEDS - SUMMARY



- **Data Collection – Numerical Model Test Beds**
- **More research into fundamental physics and Incorporation of physics – details matter**
- **High-Performance Computer/Cloud Computing**
- **Physics based 3D models with refined grids**
- **Machine Learning and Artificial Intelligence**
- **Additional sediment transport expertise - researchers**
- **Sediment Library – shareable “right” codes for models**



Thank you Discussion and Questions



A Strategy for Prioritizing CW R&D Investment in Sediment Transport

*Robert Holman Ph.D.
Oregon State University
Corvallis, Oregon*

The Problem:

USACE CW holds a national responsibility for understanding and managing how sediment volumes affect national needs and security. CW is responsible when there is too much sediment (dredging) or too little sediment (flooding, nourishment or trapping). These volumes are the result of sediment transport and motivate R&D investment, but understanding all details of sediment transport is not a primary goal, only those that drive important changes in volumes at management scales.

Limitations in our understanding vary widely among the many CW mission areas. CSRSM usually deals with non-cohesive sediments driven by combined waves, currents and wind, with important responses at hazard and long-term time scales. Navigation and dredging typically deals with the long-term accumulation of cohesive sediments and their proper disposal. Within each business line, the nature of the threats varies across the nation, with East Coast beach dynamics different from those on the West Coast and estuary shoaling problems depending on the varying balances of tide, river and wave influences. It is clear that there can be no single best investment strategy for sediment transport R&D.

What then should be the basis for USACE R&D investment in sediment transport? What are the primary drivers for sediment volume change across the many USACE areas for responsibility and what don't we understand?

Numerical Model Test Beds:

The issue of R&D prioritization has faced many research communities, including the nearshore academic community in the early 2000's after several decades of focused programs wound down. To address that problem, a small but influential group met at Duck in 2002 with the purpose of assessing knowledge gaps that limit US agencies with coastal missions, and developing an R&D prioritization based on the highest impact gaps. After three days of discussion, a vote showed that each attendee identified different priorities. Thus, the surprising conclusion of the meeting was that "models have not been sufficiently exercised with data to know what elements of the physics are most critically in need of improvement", and that "we should seek out and formalize the unceasing comparison of models with all possible sources of data". This was also in agreement with growing interests in observing systems in many science

specialties at that time and the late-2010's USACE investment in a Numerical Model Test Bed (NMTB) based at the FRF and with a primary focus on nearshore hydrodynamics.

The essence of a test bed is the organized collection and archiving of relevant data streams at a representative field site and their unceasing comparison against model predictions. An organized and predictable data structure ensures that any engineer anywhere can test any model continually and that strengths and weakness of each model can be objectively quantified.

The arguments for operational test beds are compelling:

- Data collection investment can benefit a large number of researchers with no extra costs.
- The test bed is available to researchers throughout the world, thus serving as a magnet to the world's research talent,
- Objective measures of performance and performance improvement are easily made under a wide range of conditions,
- Knowledge weaknesses can be identified objectively.

Test Beds and Sediment Transport Research

The heart of a test bed is the organized and accessible data collection of system behavior and inputs at application scales. For a beach, this would be measurements of bathymetry/topography at time scales of engineering interest (say monthly with possible extra focus on storms) as well as bulk measurements of wave forcing at more frequent intervals. The Duck Test Bed has been largely focused on hydrodynamics but is also ideal for sediment transport purposes. Completion of the FRF test bed set up and entrainment of international interest would have high payoff for USACE.

The FRF is a unique and expensive facility that would be difficult to duplicate. But one could imagine other model test beds that would only require predictable collection of engineering level data. These could be chosen as representative sites for the main USACE applications, for example dredging, nourishment and coastal flooding. USACE CW spends \$2B per year on dredging and dredge disposal. Why couldn't a site be chosen that can serve as an NMTB for dredging and disposal, comparing engineering model predictions with regular measurements that likely must be made anyway, as well as with historical dredging records. Dredging is a global problem, and a good test bed could attract the best modelers from around the world. There could also be topical (versus geographic) test beds, for example a collection of many disposal site experiments.

There are several important principles. We wish to maximize the use of collected data and the testing of our numerical model tools. We wish to engage and encourage collaboration

with the world's best engineers. We wish to develop an objective basis for identifying weaknesses in our capabilities as a guide to R&D investment. Numerical model test beds accomplish all of these purposes.

How to Proceed?

The essential elements of test beds would need discussion, but limited budgets would dictate that data collection should be affordable but must still encompass the main engineering problem. In many cases, for example for dredging or beneficial use, the basic data could be annual surveys which are presumably collected anyway, and bulk measures of forcing. For ocean beaches, because bathymetry surveys are expensive, remote sensing methods such as satellites, Argus, radar and Lidar would be preferable and can likely provide sufficient engineering level data on both forcing and response when supplemented by limited in situ instrumentation.

The most obvious first step is to operationalize the FRF NMTB for both hydro and sediment transport purposes. FRF data are now well organized and available (thank you), but I am unaware of any program of regular testing of models within USACE or even any international awareness of the potential of or hopes for this resource to serve as an international test bed. Further progress awaits a commitment to a final push and then entrainment of the global community through advertising and personal connections. It is hard to imagine this not leading to an enthusiastic response, but it will require engaged leadership.

The next step is identification of other test bed sites. It has long been acknowledged that the dynamics of West Coast beaches are different from the east, especially under storms. A West Coast NMTB should be identified that represents the unknown physics and societal/research interests and for which adequate sampling can be achieved using a mix of in situ and remote sensing. One or more estuarine and navigation-driven sites should be identified based on Corps needs, length of historical record and representativeness of the physics. Presumably there are dredge disposal sites that could serve an NMTB purpose too.

One would hope and expect that in the future decisions on R&D investment in sediment transport could be motivated by demonstrated failure of predictive capability from test beds rather than just speculation on worthy research topics. We need to overcome our hesitancy to test our existing knowledge and models against all possible data and to step away from relying solely on the small community of USACE scientists, instead embracing the global exposure of USACE problems and data to the world's best scientists.

Sediment transport research at USACE: *How to motivate and focus a program*

Rob Holman
Oregon State University

- Sediment transport R&D – the business case
- Goal of a plan
- Plan Elements

The Business Case for Sediment Transport R&D Investment

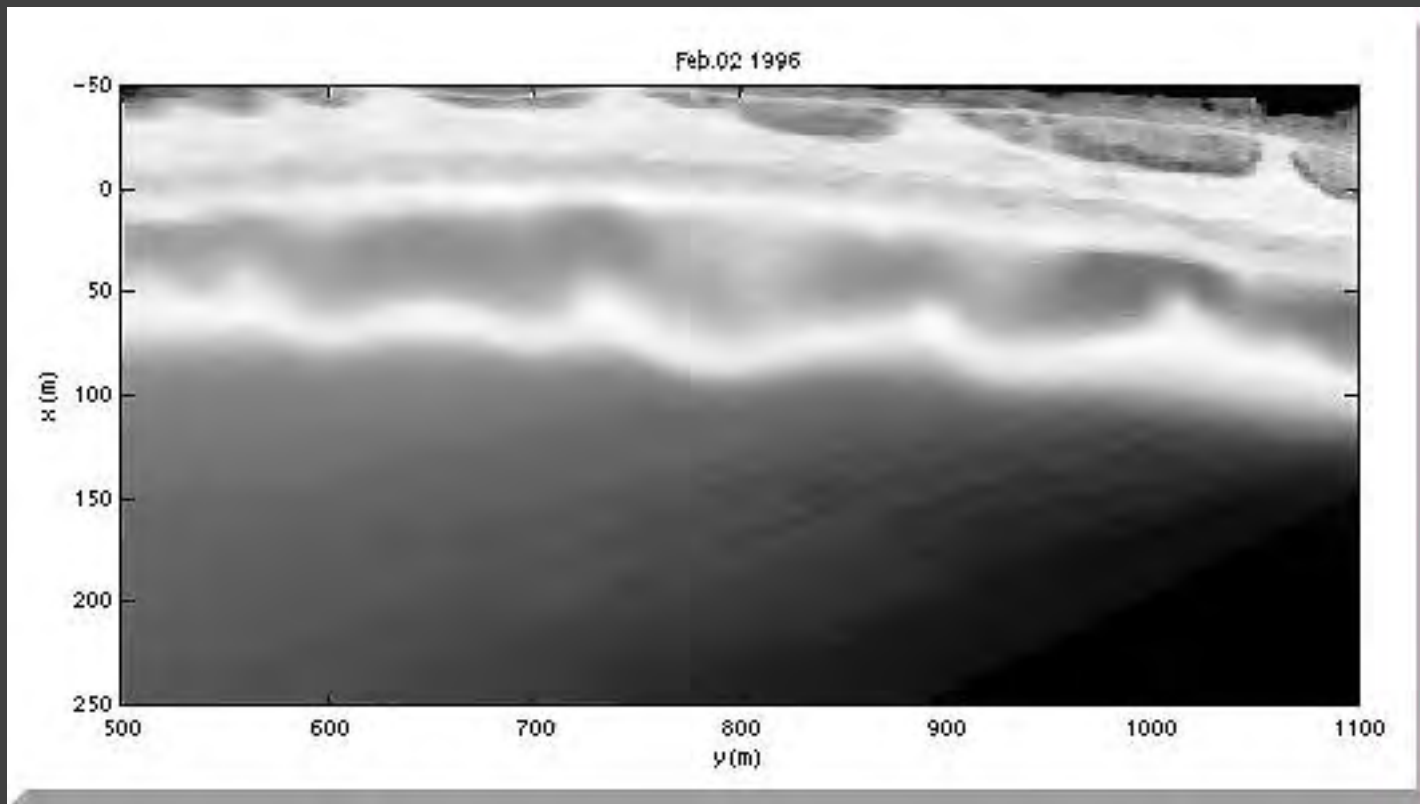
- Typical annual budget of \$11B including supplementals
- Roughly \$2B per year on dredging
- Probably at least that amount for nourishment and CFRM
- Perhaps half or more goes to sediment-driven problems
- USACE should “own” sediment transport (Jose Sanchez, 2017, and many others)

The Business Case for Sediment Transport R&D Investment

- Sediment transport should be a “core competency” in USACE
- Limitations in our understanding have large financial and capability consequences
- We have poor knowledge of the mapping between our scientific ignorance and these limitations and costs
- Therefore we can't invert to find optimum research plan
- (cool science problems are often low impact)

Example Scientific Problem: *Sand bar morphodynamics on ocean beach*

Time exposure movie, Palm Beach, Australia, 1996



Example Scientific Problem:

Sand bar morphodynamics on ocean beach

- Encompasses tons of cool physics at all scales including strong aspects of nonlinear dynamical systems
- Mostly not a primary USACE concern
- USACE cares about shorelines and runup
- We should test what the Corps cares about

Our Goal

- Develop an objective basis for prioritizing R&D investment for maximum **long-term** impact
- Entrain the world's best engineers and scientists to help

Our Method

Numerical Model Test Beds (NMTBs)

- Numerical Models – embodiment of our knowledge-based prediction tools (models, TDAs, whatever)
- Test Beds – relevant ground truth measurements of things we care about.
- NMTB – seamless and relentless testing of NM against TB data to highlight key weaknesses.

Observatories and NMTB (Why is FRF so successful?)

- Provides field capability academics can't otherwise afford
- Open data policies and 40+ years of historical records
- Serves as magnet to world's best
- Win-win for USACE



FRF ~1982

FRF Limitations

Operational limitations

- Hydrodynamics NMTB still underachieving
- Limited sediment transport

Geographic limitations

- East Coast dynamics
- Non-cohesive
- Open-ocean conditions only



Five NMTBs??

Candidate site types

- FRF
- West Coast site
- Gulf coast
- Cohesive estuary site
- Dredge spoil site?



Beverly Beach, OR, 2001

International collaborative sites? (ICON)

- Netherlands
- Australia
- ...

Can We Afford Five FRFs?



- Likely not
- Need cheaper sampling strategies
- Remote sensing
- Use sites where we are taking data anyway
- Focus on “engineering” data with detailed processed data added as needed

Summary

Research Gaps:

- yes

Recommendations

- Operationalize FRF hydro NMTB
- Build FRF sed trans NMTB
- Select, design and create a suite of NMTBs at representative USACE locations
- Maximize use of existing data collections and low-cost methods
- Continue development of robust data collection and archiving methods
- Advertise to the world.
- Management to include good scientists and international representation

Questions?



Corvallis Oregon,
2017 total eclipse

Coastal and Inland Compound Flooding – WRDA 2022 Section 8106

*Gaurav Savant Ph.D.
U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
Washington D.C.*

Compound flooding refers to flood events caused by more than one source, such as storm surge from a hurricane combined with high river flows from a previous heavy rain event. Coastal flooding from storm surge and so called “king” tides are being exacerbated in many areas due to sea level rise. For example, last year in Key Largo, FL, one neighborhood was “flood for over 75 days due to high sea levels, an event that used to only happen during king tides and would last for only a week or so,” (Allen, 2019). Climate research is also indicating a likelihood that severe thunderstorms will become more intense and produce more precipitation. With individual flood sources potentially increasing in frequency, a natural question is what about combined events, will there be more of them and will the compounded flooding be worse? In many cases, the sources of the compound flooding are from different events, e.g. high river flows in the Mississippi River occurring at the same time as Hurricane Barry in 2019. At other times, a single event may cause back-to-back flooding, such as Hurricane Harvey, 2016 and Hurricane Florence, 2017 where each produced a storm surge and then produced severe inland flooding from rainfall.

The current state of the practice for numerical modeling for compound flooding events is to model the processes separately and then to combine the results. This includes single event modeling for operational needs as well as large scale flood risk management studies such as the North Atlantic Coastal Comprehensive Study (NACCS), Coastal Texas Comprehensive Study (CTXCS), and the South Atlantic Coast Study (SACS), as well as large regional flood protection studies, such as the New York/New Jersey Harbors and Tributaries study, Coastal Texas barrier study and the Sabine to Galveston pre-construction engineering and design (PED) project. Current numerical modeling capabilities are very mature and the modeling and analysis from each source of flooding is performed within a complex statistical context. For example, the coastal storm risk modeling makes use of the joint probability method of optimum sampling (JPM-OS) and riverine flooding analysis makes use of methods and data from the Atlas 14 historical rainfall study by the National Weather Service. Recently, progress is being made on estimating compound flood event potentials (Arns et al. 2020), but more work is needed on this topic. Others have begun to investigate coupling models and the challenges these present.

Examples of how some of these models have been coupled and new capabilities developed were presented in earlier BCER meetings. This presentation focusses on the WRDA 2022 Section 8106 requirements for coastal and inland flooding and compound flooding studies

WRDA 2022 Section 8106 has required that the USACE consider several drivers of flooding whether acting alone or in a compounded fashion at the request of the local partner.

Below are the salient contents from the accompanying presentation.

Slides 2-3: Present an outline of the issue and creates a common foundation for how we define “Compound Flooding”.

Slide 4: Presents a graphical overview of flooding and other water hazards that the nation has faced in the recent past.

Slide 5: Presents where the USACE is in terms of state-of-the-art application of analysis for FRM and CSR design.

Slides 6-9: Present an overview of the WRDA 2022 Section 8106 requirements, how the USACE can meet the requirements and some potential drawbacks in present technology.

Slide 10: Presents a forward leaning approach to the R&D required to meet USACE obligations as a result of WRDA 2022 Section 8106. This R&D approach is supported by the **Water Modeling Strategic Focus Area’s** Coastal and Inland Compound Flooding (CICF) FY24 (Appropriations pending) Work Package.

Slide 11: Presents the “What might have been” arrow of progress if Tactical Statement of Need (SoN) 12112019 had been successful, and the “Future” arrow of progress for CICF R&D along with transition milestones and partners.

Slide 12: Tabulates the total R&D investment required to efficiently and accurately meet WRDA 2022 Section 8106 requirements.

Slide 13: Summarizes the presentation.

Slides 14-Onwards: Present backup slides about recent military engineering or external agency funded ERDC R&D.

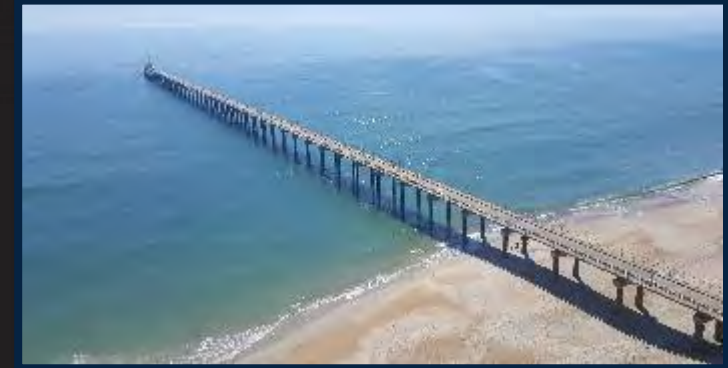
Reference:

Allen, G., (2019). This Florida Keys neighborhood has been flooded for nearly 3 months. Online news article, “<https://wusfnews.wusf.usf.edu/post/florida-keys-neighborhood-has-been-flooded-nearly-3-months>”.

Arns, A., **Wahl, T.**, Wolff, C., Vafeidis, A., Haigh, I., Woodworth, P., & Jensen, J. (2020). Tide-surge interaction modulates global extreme sea levels, coastal flood exposure, and impacts, **Nature Communications**, 11, 1918, doi: 10.1038/s41467-020-15752-5.

WRDA 2022. SEC 8106 - COASTAL AND INLAND COMPOUND FLOODING (CICF)

Coastal and Hydraulics Laboratory
US Army Engineer Research and Development
Center



U.S. ARMY



US Army Corps
of Engineers®



PRESENTATION OUTLINE

- Background
 - Definition
 - Why we care
 - What has been done
- WRDA 2022. SEC 8106 (a)
- The vision and advocacy gap
- The path forward



COASTAL AND INLAND COMPOUND FLOODING

Definition

“Compound Flooding occurs when multiple flood processes interact to amplify flood hazards above that of their individual components” (Zscheischler et al., 2018)

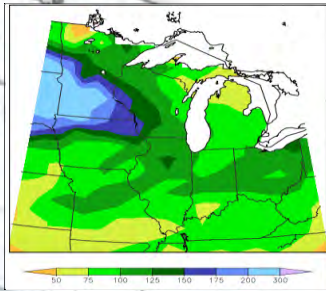
Types of Compound Flooding

Compound Flooding can be described by four broad categories

- 1. An event aggravates an existing condition*
- 2. Multivariate – where weakly related events lead to an impact*
- 3. Temporally compounding – a succession of events leads to an (several) impacts*
- 4. Spatially compounding – events in connected regions lead to an impact*



COASTAL AND INLAND COMPOUND FLOODING



Burlington: 10' of rainfall

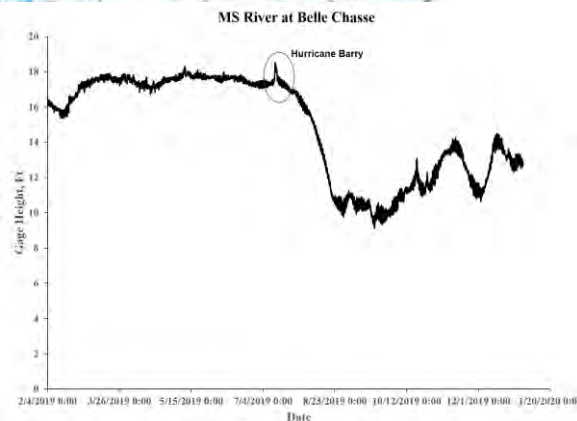


Alton: Levees at risk



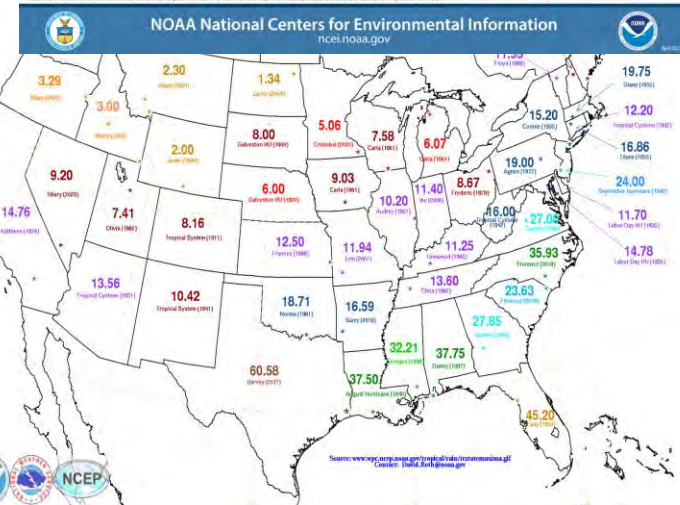
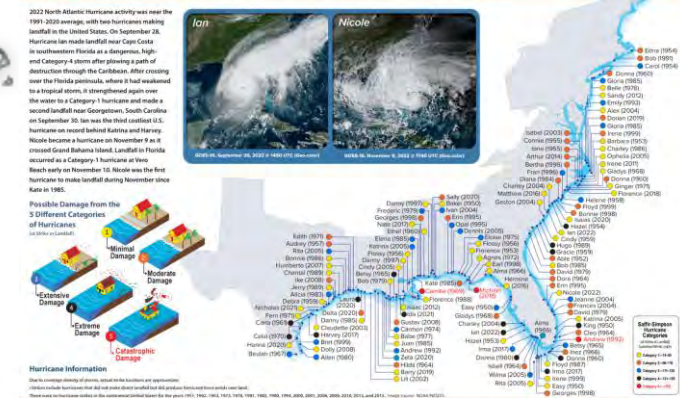
Spencer Dam: Combination of hydrologic loads and ice-jam

Vicksburg. Agricultural year lost

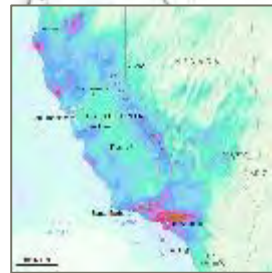


Continental United States Hurricane Strikes 1950-2022*

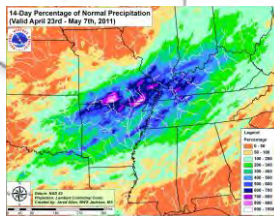
The GOES-16 enhanced imagery shows 2022 Hurricanes Nicole and Ian in detail.



150 to 300% of Normal Snow Water Equivalents over the Watershed North of Dubuque, IA from Dec 1, 2010 to Feb 28, 2011



Record rainfall and mudslides in California, Feb 5-7, 2024
Washington Post, 2/6/2024



Percent of Normal Precipitation Over Portions of the Lower Mississippi and Ohio Watersheds From April 23 to May 7, 2011

NY times, 9/12/2019

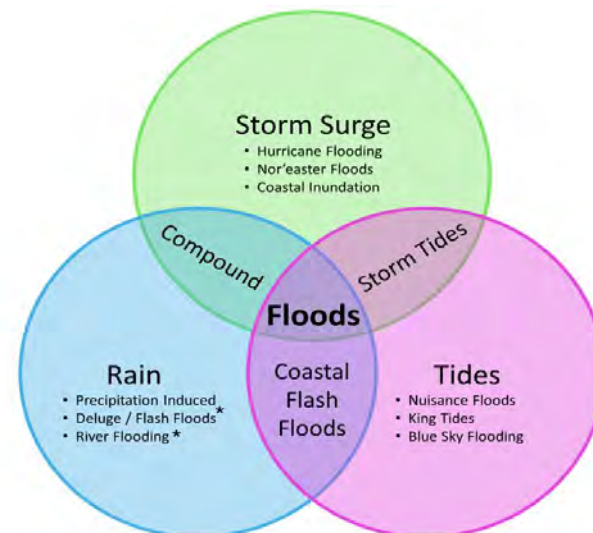




COASTAL AND INLAND COMPOUND FLOODING

What Has Been Done – Response to Drivers We Know

- Hurricane Katrina revolutionized how USACE tackled coastal drivers of coastal hazards
 - Probabilistic approach to storms and waves
 - The Katrina Interagency Performance Evaluation Team (IPET) did not consider
 - Non-hurricane rainfall
 - Groundwater emergence
 - Tidal flooding
 - Urban Drainage Networks: It considered pumps and other structures
- Hurricane Harvey spotlighted the limitations of “one driver causes all hazards” approach
 - Academia led the charge on inland drivers of coastal hazards
 - Multivariate relationships between storm surge and storm induced rainfall->runoff



* Limited to flows because of storm rainfall/runoff



COASTAL AND INLAND COMPOUND FLOODING

WRDA 2022. SEC 8106 (a)

- For **FRM** or **hurricane and storm damage** risk reduction
- At the request of the non-Federal interest
- Formulate alternatives for benefits from the reduction of comprehensive flood risk
- From isolated and compound effects of-
 - 1) River flow
 - 2) Inundation, wave attack, and erosion from hurricanes and coastal storms,
 - 3) Tidal flooding in rivers, bays, and estuaries connected to the coast,
 - 4) Rainfall of any frequency or magnitude,
 - 5) Tidal flooding
 - 6) Seasonal water level variation,
 - 7) Groundwater emergence,
 - 8) SLR,
 - 9) Subsidence, or
 - 10) Any other driver of flood risk



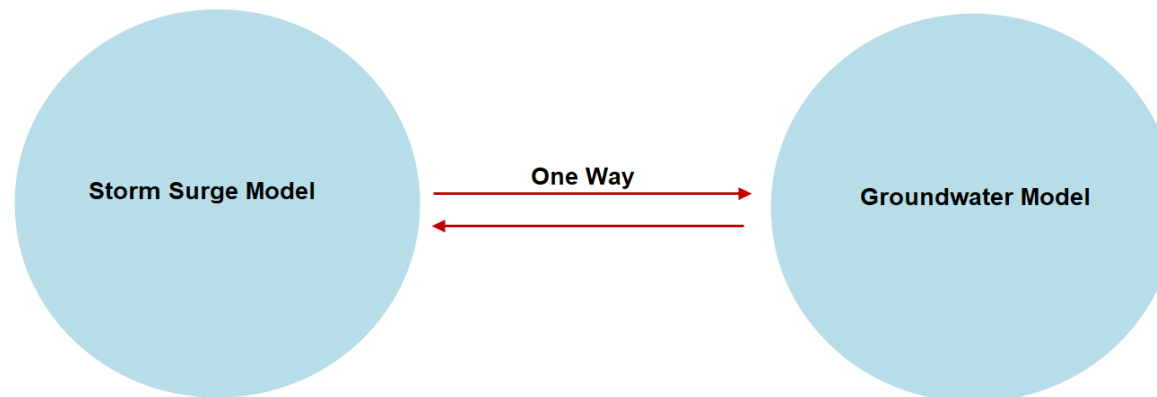
COASTAL AND INLAND COMPOUND FLOODING

WRDA 2022. SEC 8106

What can we do now?

All of it, but in an ad-hoc manner without streamlined modeling or guidance.
Complexity in application severely limits adherence to SMART planning timelines.

Example: Groundwater emergence with storm surge (Tropical Storm Melissa, Super Storm Sandy)



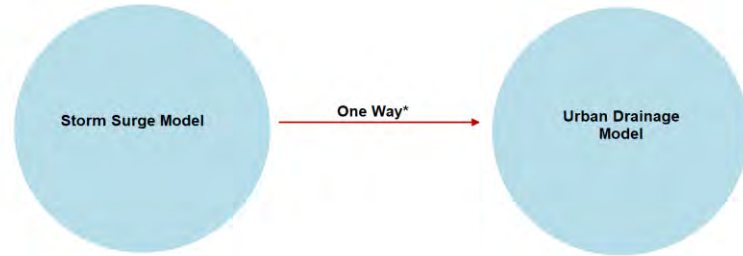
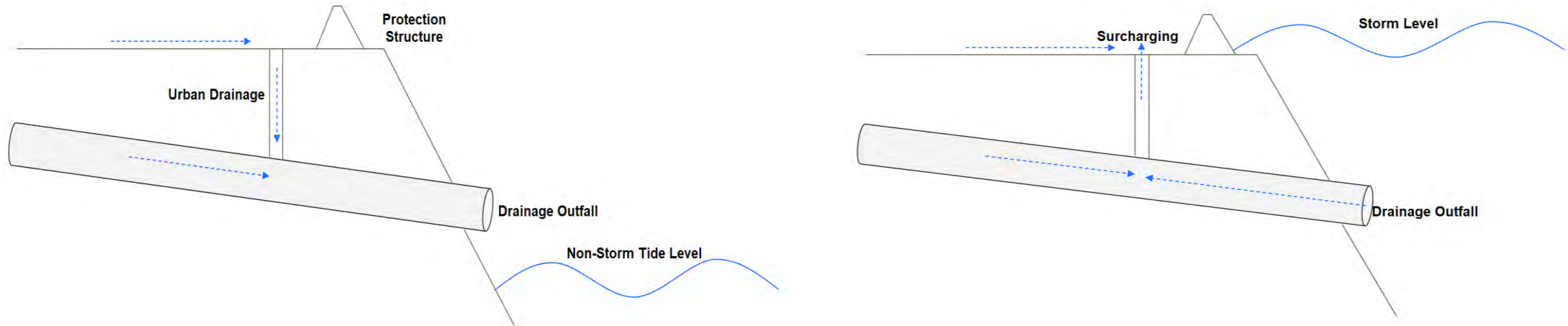


COASTAL AND INLAND COMPOUND FLOODING

WRDA 2022. SEC 8106 (a)

Any other driver of flood risk

Example: Urban drainage and/or sewer surcharge with storm surge (Super Storm Sandy, Hurricane Harvey)



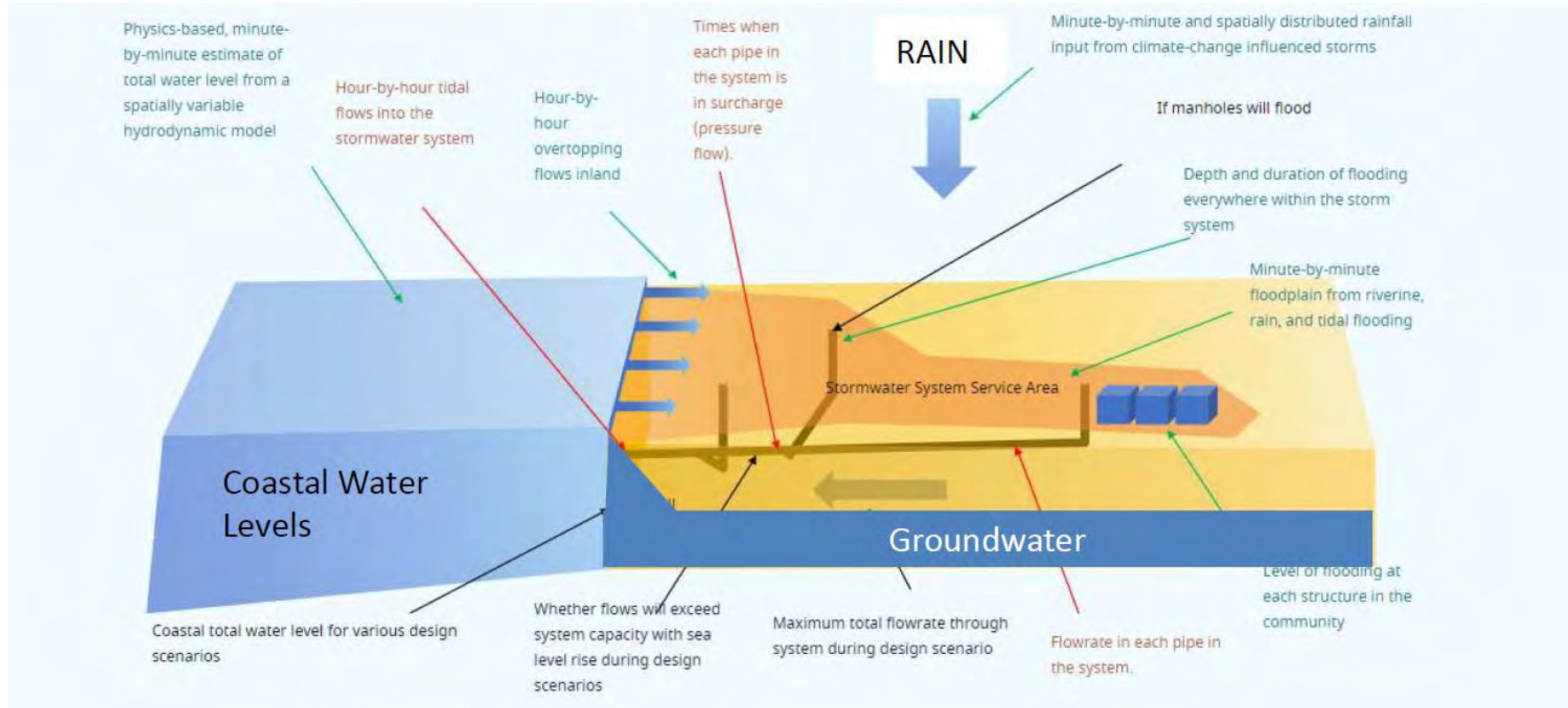
* One way is adequate



COASTAL AND INLAND COMPOUND FLOODING

WRDA 2022. SEC 8106 (a)

The Problem



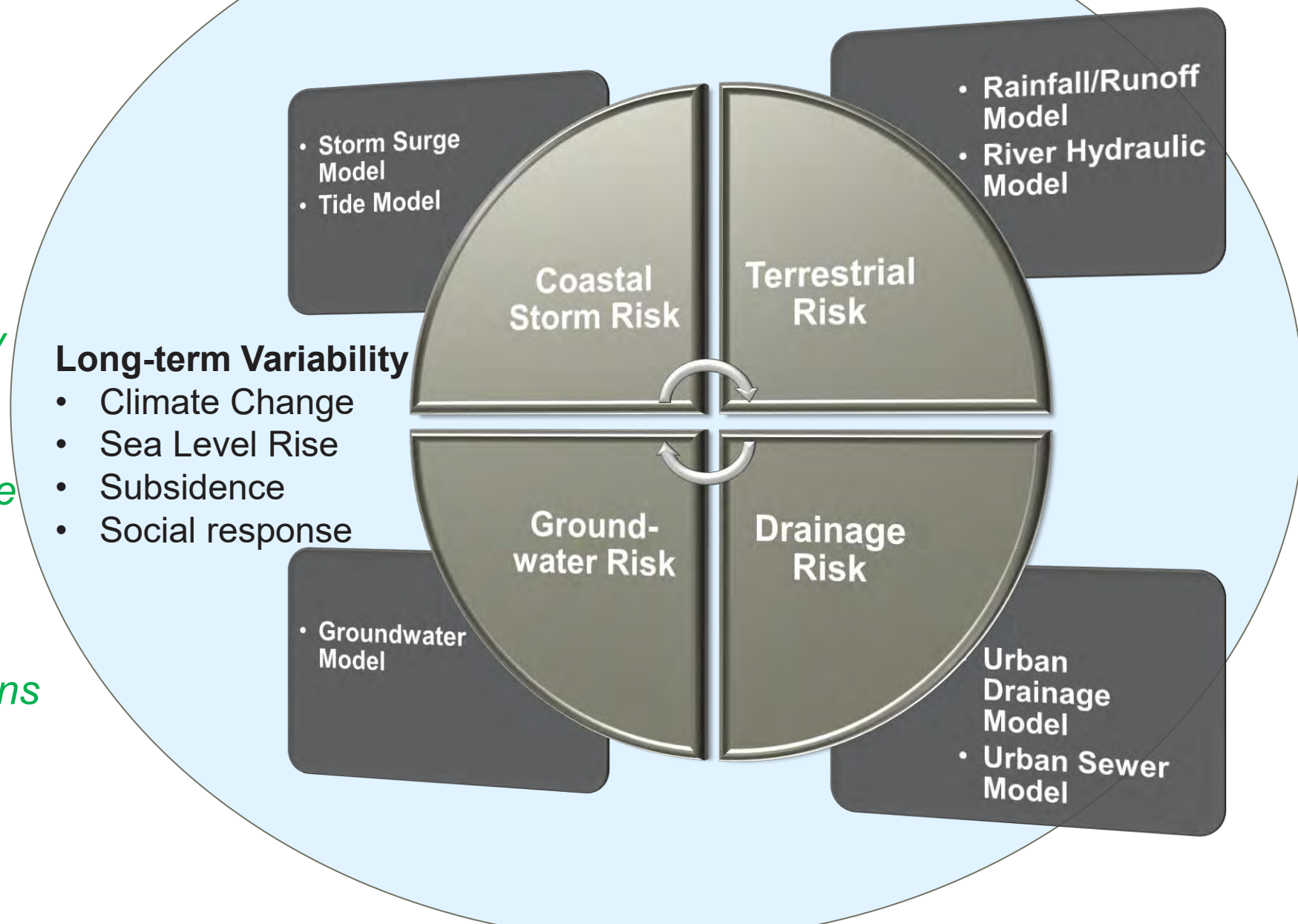


COASTAL AND INLAND COMPOUND FLOODING

WRDA 2022. SEC 8106 (a)

The Vision

- *Compound Flood Vulnerability*
- *What is the vulnerability combination?*
- *Flood Hazard Models*
- *Model the hazard for the vulnerability*
- *Scenarios*
- *Evaluate range of potential future conditions*

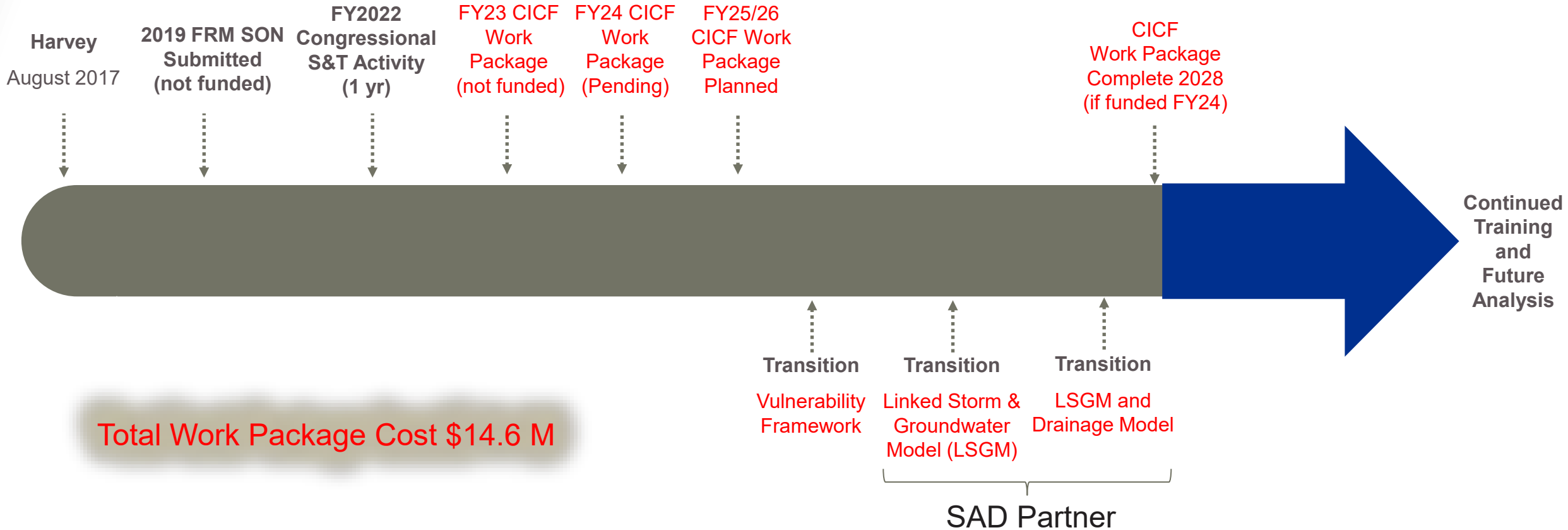




COASTAL AND INLAND COMPOUND FLOODING (CICF)¹¹ TIMELINE

Advocacy Gap

Water Modeling SFA





COASTAL AND INLAND COMPOUND FLOODING

The Vision Cost

Proponent	HH&C CoP																																			
Category	FY22				FY23				FY24				FY25				FY26				FY27				FY28				FY29				FY30			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Effort									Discover				Coastal and Inland Compound Flooding												Deliver											
Task 1									Hydrodynamic Model Linkage																											
Task 2									Basin Scale Hydrology																											
Task 3									Coastal and Inland Hazard System (CHS and IHS)																											
Regional Sediment Management	\$2.5M	\$0M			\$0M				\$0M				\$0M				\$0M				\$0M				\$0M											
Coastal Ocean Data System	\$0M	\$0M			\$1.2M				\$2M				\$1M				\$0.5M				\$0M				\$0M											
Coastal Ocean Data System	\$0M	\$0M			\$2.4M				\$2.5M				\$2.5M				\$1M				\$1.5M				\$0M											
Total (\$M)	\$2.5M	\$0M			\$3.6M				\$4.5M				\$3.5M				\$1.5M				\$1.5M				\$0M											
CUI	Total Funding (FY24-FY28)= \$14.6M																																			



ANTICIPATING FUTURE R&D REQUIREMENTS

*WRDA 2022 Section 8106 highlights need to develop R&D products to be ready to address emerging challenges....**before they are critical***

CICF is Long-Known Area of Need

- Need for rapid compound flooding tools was well-known even before Katrina (2005)
- Need has only become more dire with time

Existing CW R&D Process Insufficient

- Planned & programmed to meet need
- Dedicated funding for CICF has not yet occurred

R&D Account is required

- Anticipate future needs
- Develop products in pipeline ready for field testing and implementation
- Future needs include WRDA 2022 Section 8106 (b) and others
 - 8106(b) calls for ability to formulate alternatives to maximize combined net benefits for “Water Supply, Water Conservation, and Drought Risk Reduction” if they will reduce potential adverse impacts of extreme weather events

Coastal Hazards System (CHS)

What is the CHS?

A national-scale, multi-agency initiative for accurate, efficient, and consistent quantification of coastal storm hazards along U.S. coastlines and other strategic locations critical to our national security.

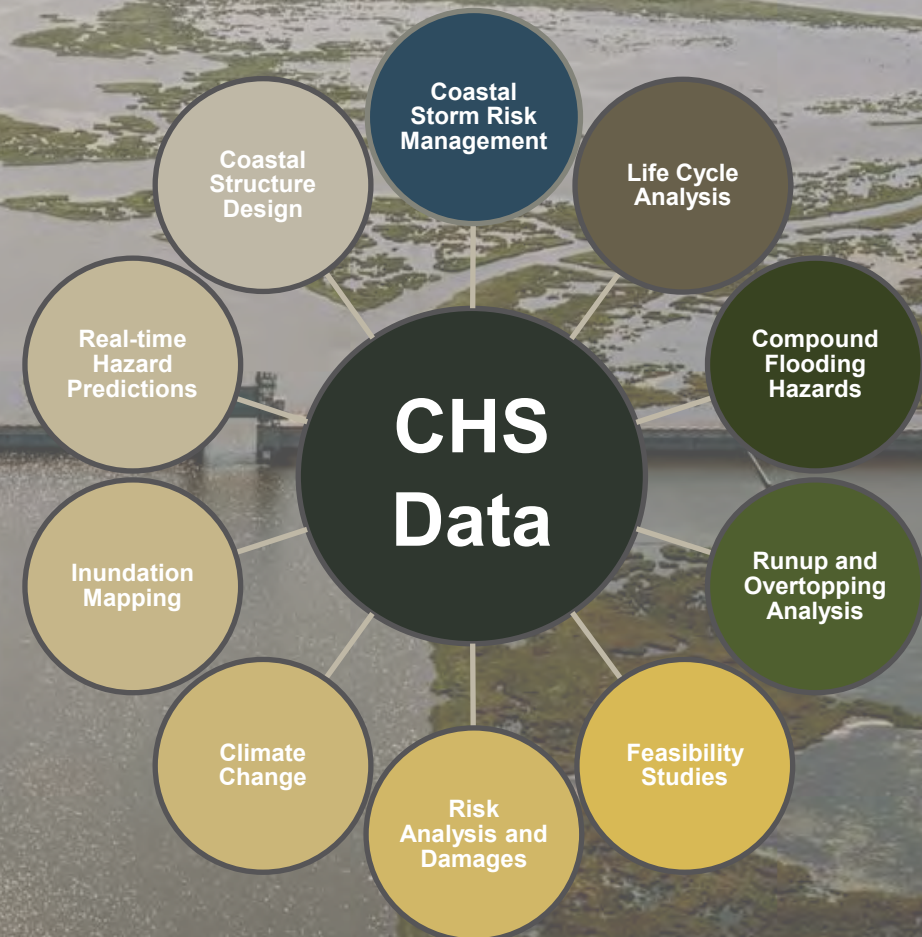
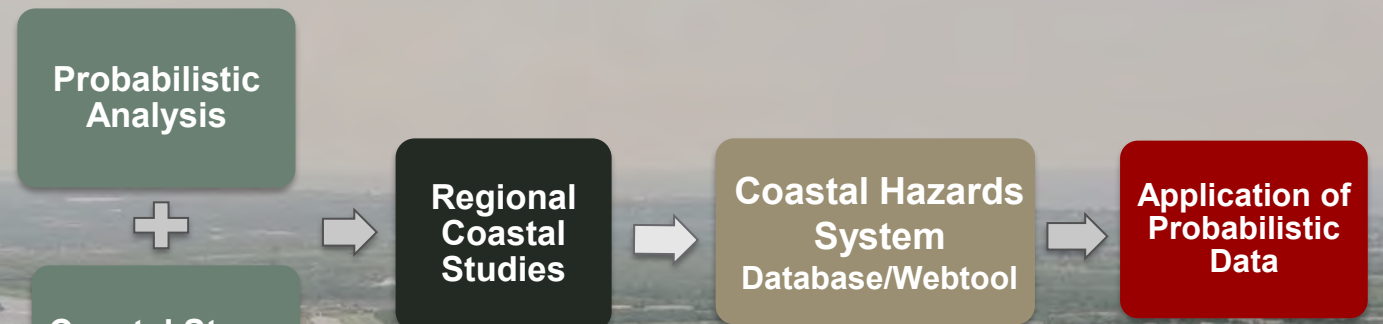
Goal:

Provide high-fidelity, high-resolution state-of-the-art hydrodynamic and probabilistic modeling and companion tools in a multivariate statistical context for coastal planning, engineering, and operations and maintenance.

Impact to the Nation:

Methods, data, and tools within the CHS serve as the basis for coastal engineering by providing high-fidelity, probabilistic coastal hazards on a national scale.

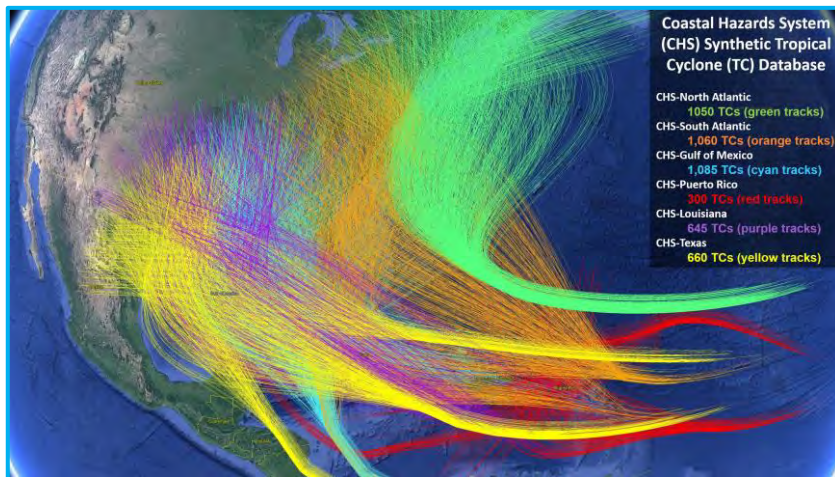
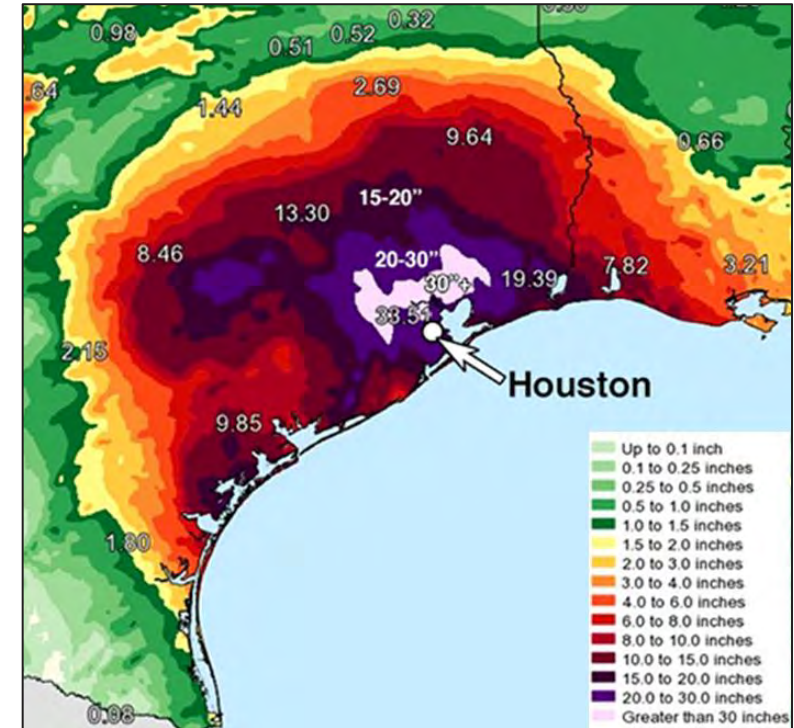
<https://chs.erdcdren.mil>



CHS-CF: COMPOUND FRAMEWORK

- Until recently, coastal flood hazard studies focused on surge and wave.
- Hurricane Harvey and tropical cyclones (TCs) have shown the risks of compound surge-rainfall flood hazards.

NEED: A *compound hazards framework* that is *statistically consistent* to assess tropical cyclone hazards due to compound **STORM SURGE AND RAINFALL/RIVERINE FLOODING**



APPROACH:

Expand the established **Coastal Hazards System (CHS) Probabilistic Framework** to compound flooding for a **CHS-Compound Framework**.

- Develop TC Rainfall (TCR) fields for more than 4,500 synthetic TCs.
- Integrate machine learning (ML) and Joint Probability Method (JPM).
- Create hazard and model results for synthetic TCs in the Atlantic and Gulf.

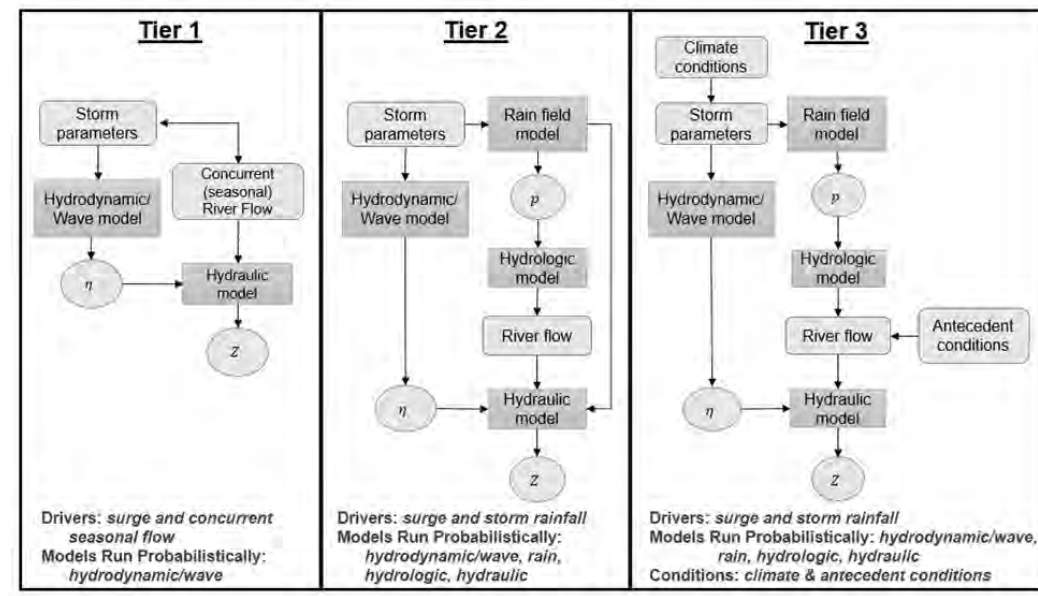
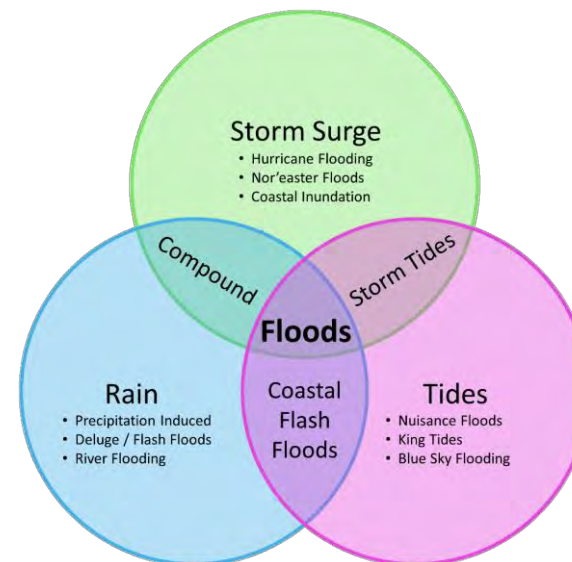


CHS-CF TIERED FRAMEWORK

CHS-CF is implemented as a tiered framework

Increasingly complex tiers provide for meeting project needs such as timeline, detail needed, and data availability.

- **Tier 1:** Link hazards by correlation, such as seasonality of river flow with hurricane intensity
- **Tier 2:** Incorporate H&H models probabilistically, such as TC rainfall, hydrologic, and hydraulic models.
- **Tier 3:** Integrate additional watershed-specific conditions/scenarios (e.g., climate and antecedent conditions, flows, etc.).



Tiered Framework
Increasing Complexity



CHS-CF TC RAINFALL (TCR)

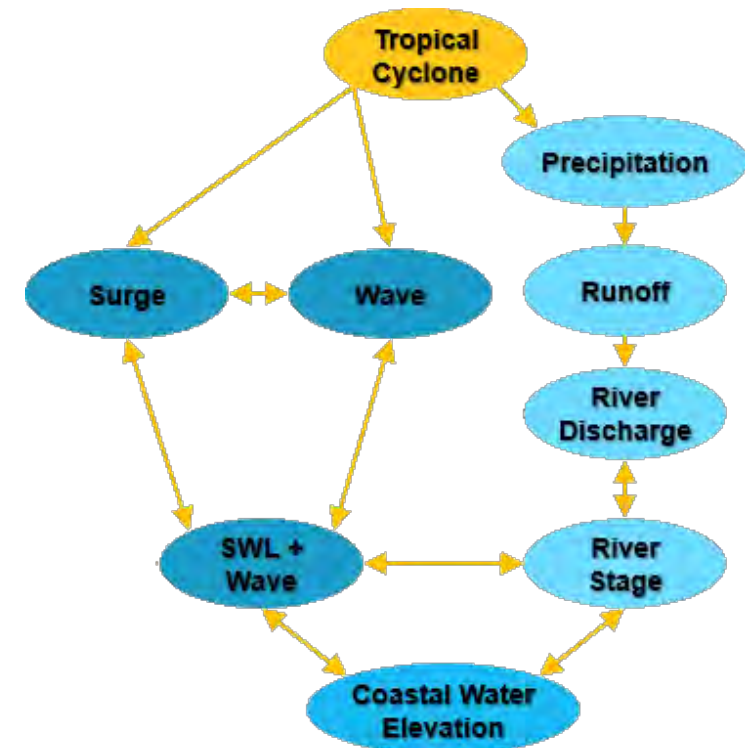
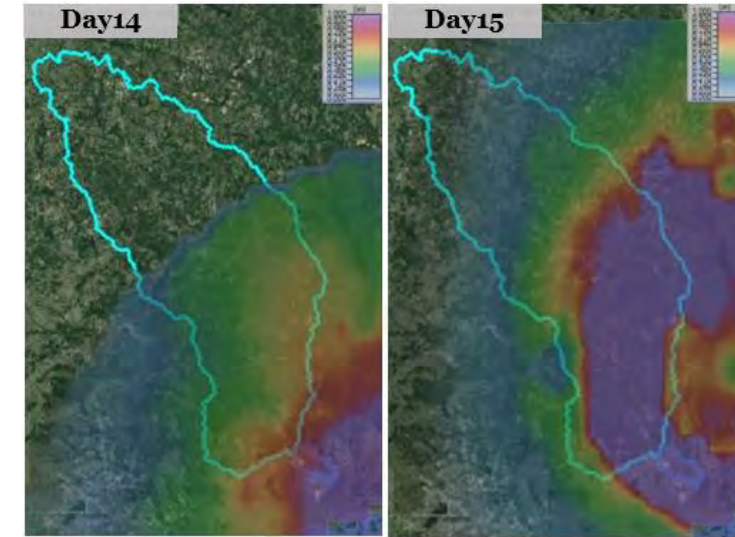
CHS-CF Approach Using TC Rainfall

A computationally efficient tropical cyclone rainfall (TCR) model is used to drive inland flooding (TCR, [Lu et al. 2018](#)).

- TCR model is driven by *the same atmospheric forcing parameters* that drive the surge hazard (i.e., synthetic TCs)

ESTABLISHES A CONCURRENT COMPOUND HAZARD CHARACTERIZATION IN A SINGLE WORKFLOW

- Input synthetic TC's time-varying parameters (W_{max} , R_{max} , track position)
- Outputs gridded, time-varying rainfall across basin





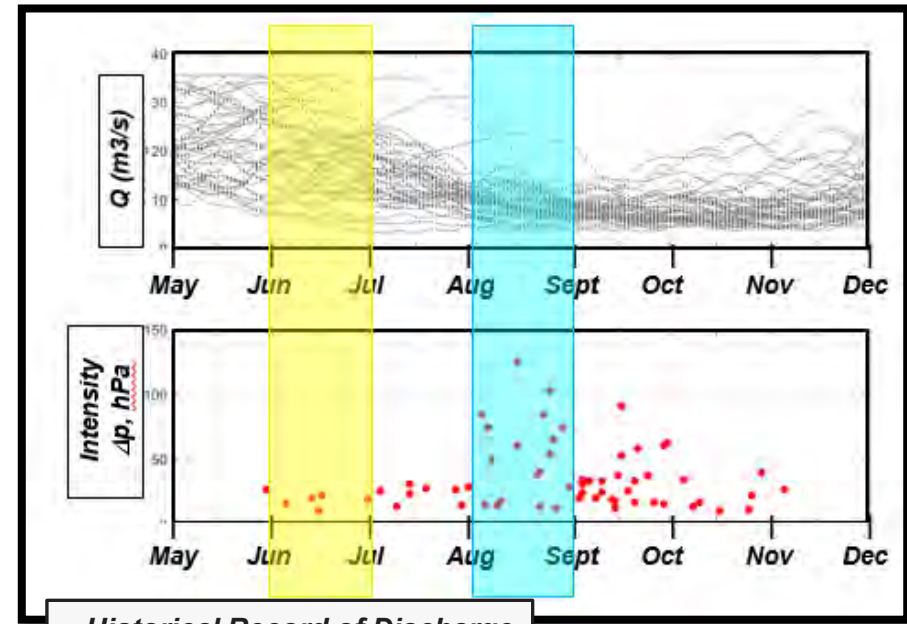
CHS-CF TIER 1

HYBRID JPM-MONTE CARLO

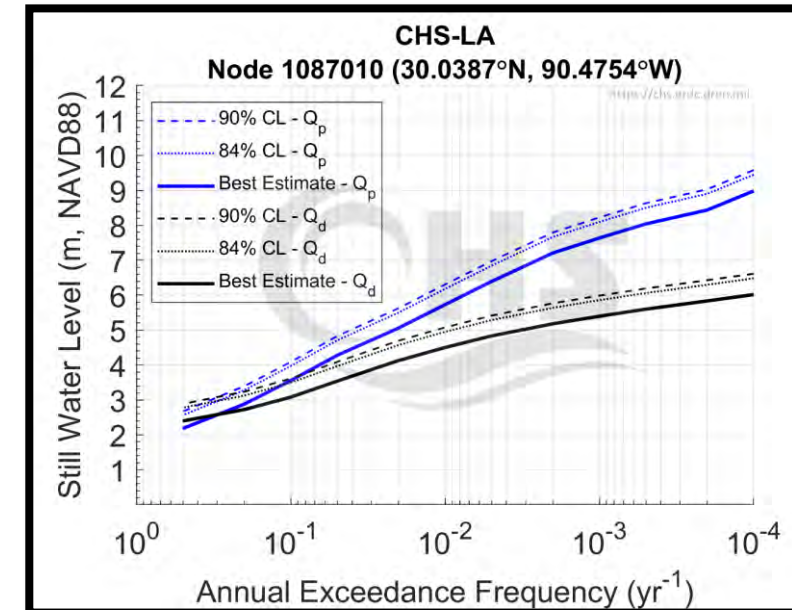
CHS-LA: Coastal and Riverine Hazard Analysis

Incorporated the effect of river discharge on storm surge

- Seasonal correlation between observed Mississippi River Flow (Q) and TC intensity determined.
- Coastal hazards modeled hydrodynamically at several discharges. Results were used to train the Gaussian Process Metamodel (GPM).
- Developed an augmented (larger) set of 748,000 synthetic TCs from Gaussian Copula and Q correlation.
- Predicted water level and Q using GPM across a range of TCs and Qs.
- Calculated Compound Water Level (CWL) hazard across LA.



*Historical Record of Discharge and TC Intensity at Gage
 June (yellow): High Q, Low Δp;
 August (cyan): Low Q, High Δp*





CHS-CF TIER 2 & 3 PILOTS

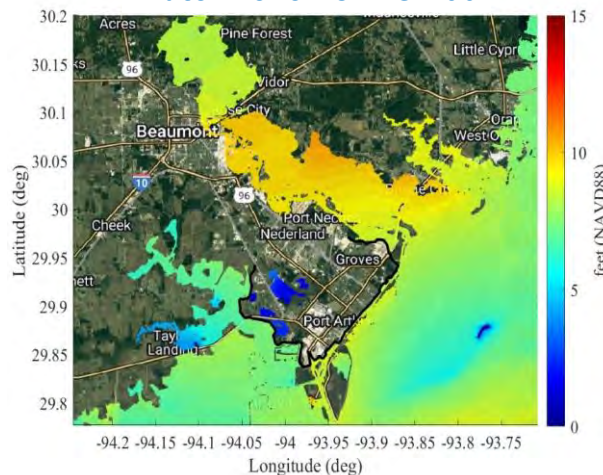


Tier 2 - Neches River, TX

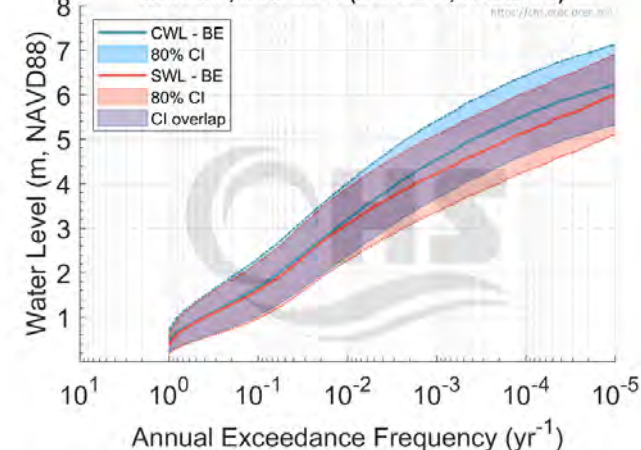
(Nuclear Regulatory Commission Pilot)

CHS-TX synthetic storms drove TCR, hydrologic (HEC-HMS), and modified ADCIRC models, ML/metamodel, integrated to compound water level (CWL) hazard.

Example Compound
Water Level for TC 466



CWL/JPM-AMP and SWL/JPM-AMP, CH-TC, SLC0
CG FP271; NVG 17442 (30.0722°N, 94.0551°W)

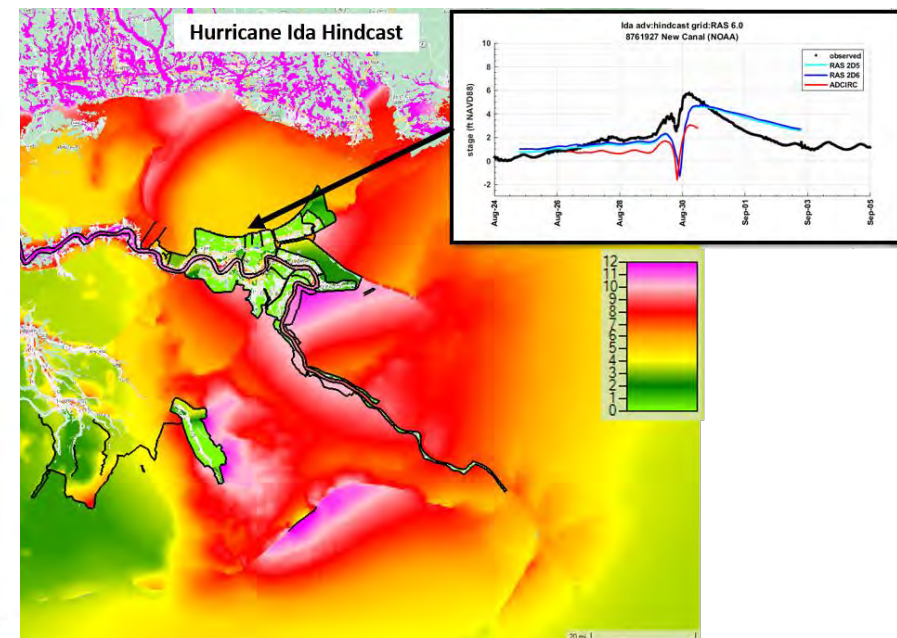
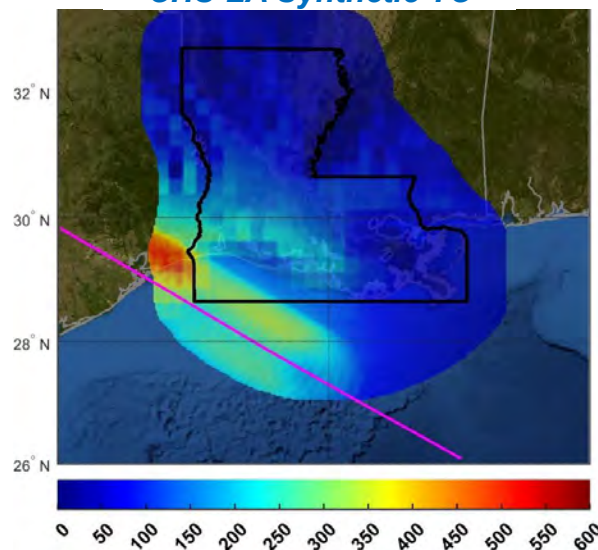


Tier 3 – Southeast LA

(FEMA/USACE Pilot - in progress)

Incorporating natural variability and bias correction in TC rainfall impacting urban and rural areas with levees and flood mitigation structures. Using 2D HH&C modeling workflow and assessing model skill and coupling (via boundary conditions).

Example TC Rainfall
CHS-LA Synthetic TC



BCER Moonshots

*Lewis ((Ed) Link, Ph.D.
University of Maryland
College Park, Maryland*

*Jack Puleo, Ph.D.
University of Delaware
Newark, Delaware*

In January 2021, prior to the Department of Defense's Zero-Based Review of all Federal Advisory Committees, the Board on Coastal Engineering Research (BCER) had initiated a list of "Big Ideas" or Moon Shots to guide future Coastal R&D investments. Moon Shots are defined herein as concepts that are of long-term strategic value to the coastal engineering community but may incorporate significant risk, may take years to decades to complete, and are challenging to support within the resources and time frame of the existing Civil Works R&D program. Moon Shot ideas were briefly revisited and expanded upon during the August 2023 BCER meeting. The compilation of ideas has provided some general input to the formulation of the Civil Works Strategic R&D that is now being implemented but not specifically examined with respect to the future challenges of the Corps and the coastal community in general.

A list of Moon Shots has value for planning R&D priorities, especially for the strategic component of the R&D program. It offers a means to identify strategic topics that may be currently un-resourced but should be considered with respect to the changing challenges of the future. Endorsement of Moon Shots by the BCER will provide weight to addressing grand, inspirational goals and potentially enhance resourcing. As such, the current civilian and some former members of the BCER were asked to examine and prioritize the topics on the existing list. The effort resulted in additional informal discussion on what the Moon Shot list should represent and how would it best be exploited by the Board and the Corps. To address these questions a sub-group was formed to provide a briefing to the full BCER at the Norfolk meeting. In addition, Coastal District commanders were also requested to provide their most significant "decadal coastal challenges".

The objective of this brief is to stimulate a re-evaluation of the purpose and content of the Moon Shot list, with intent to synthesize and provide a final recommendation and action items to the BCER in the 100th meeting scheduled for August 2024. To facilitate that discussion, the briefing will define a Moon Shot for our purposes, provide a synopsis of the Coastal District Commanders' decadal challenges, and offer examples of Moon Shot topics based on the

assessment of the existing list but modified to represent big picture/strategic issues faced by the Corps in the future. The objective is to reach consensus on the form and function of the Moon Shot concept to be most actionable and useful and provide input to the Board with respect to Moon Shot recommendations planned for the 100th BCER meeting.

Moonshots

Guiding strategic R&D initiatives into the future

Moonshot

1. Urban Dictionary: awesome, fantastic, almost impossible to achieve, the best, the reason for success, reaching the highest point, right on target.
2. Elle, Netflix Movie Kissing Booth 2: “It’s like something amazing that you want really badly, but its not super likely to happen.”
3. BCER: A strategic long-term goal representing a major advancement in knowledge and capability with broad significance to Corps and the coastal communities it serves.

*A moonshot should be bold and carry risk with the potential for a high reward

Successful Moonshot Example: USACE FRF

Problem: Deficit in knowledge of coastal hydrodynamics and sediment transport processes of relevance to Corps needs

Solution: Develop the Field Research Facility (1977).

Output: Most extensive data set on waves, hydrodynamics, and morphodynamics for process understanding, model development, and tool development for coastal design and construction.



Moonshot Examples Derived from Original List/Discussions

Plan, resource, construct, and manage water projects for long-term performance under significant uncertainty in the physical, environmental, and social domains

LEAD a national network of integrated observation and coupled modeling efforts (physics to human behavior)

Invest heavily in new methodologies for quantifying sediment transport and developing predictive capability. ✓
A) Massive-scale sediment transport studies B) develop model test beds for all to use

Unified national strategy for long-term coastal management with supporting risk maps

Adaptive Policy Frameworks that have a forward-looking component and the mechanisms for anticipating and achieving updates prior to critical needs

District Feedback on Decadal Challenges

All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)

Assessment of Value/Impact of N and NBF, Design/Standards for NNBF that consider non-stationarity

Incorporating Adaptive Strategies in Project Planning (methods and policy)

Pacific Coast measurements/observations (FRF-West?); Pacific Certified CHS

More Holistic Assessment of Study Areas and Surround (Watershed/Region)

Compound Hazard/Flood Modeling and Assessment Capabilities

Methods to Assess/Quantify Other Social Effects and Environment

Partnering with Non-Federal Sponsors (increased authority)

Strategies for addressing decreasing sustainability of coastal infrastructure (considering non-stationarity)

Moonshot Strategic Examples

Plan, resource, construct and manage water projects for long term under increasing uncertainty

Lead National network of integrated observations and coupled modeling

New Methodologies for modeling and forecasting sediment transport via large scale studies and model testbeds

Unified national strategy for long term coastal management and risk mitigation

Adaptive policy frameworks to enable rapid transition to new methods and priorities

District Decadal Challenges

- Incorporate adaptive planning in project formulation
- NNBF standards/designs that consider non-stationarity
- More holistic analysis of regions and associated projects

- Pacific Observations and measurement capability
- Methods to assess compound flooding

- All Things Sediment

- Strategy to address decreasing sustainability of coastal infrastructure

- Methods to evaluate/quantify OSE and Env Effects
- Partnering with non-federal partners

“NORMAL NO LONGER EXISTS”



+



=



SOURCE: DELTARES, MAR 2024

PLANNING FOR THE 100TH BCER MEETING AUGUST 13-14, 2024 SAN FRANCISCO, CA

Heather Schlosser
SPD Navigation and Coastal Program Manager
20 March 2024



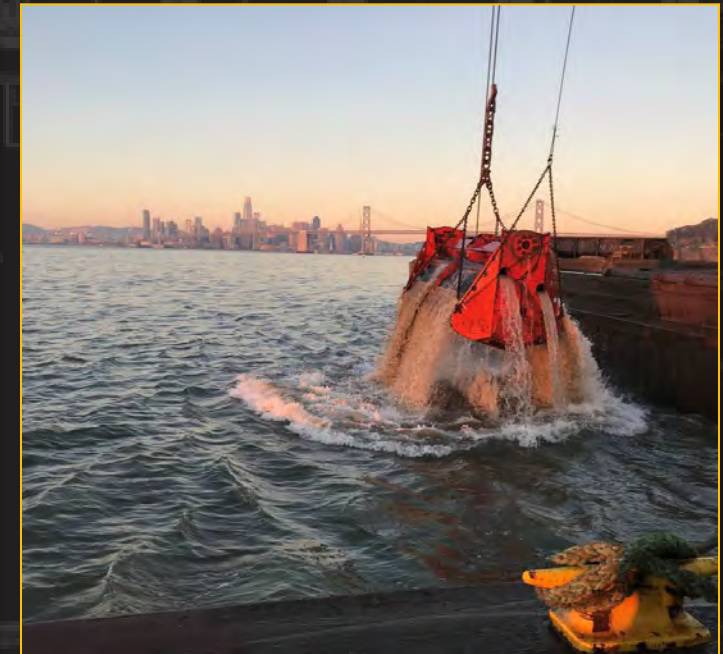
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to Serve and Strengthen
All Communities”*



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LONG-TERM CHALLENGES IN NWD, POD AND SPD

2



- ❑ Establishing a framework of nested models and observation systems to best support Pacific basin understanding as well as utilization for targeted analysis/design.
- ❑ Understanding the larger processes that have the potential to influence data, tools, analysis, design, and resilience (ice melt in Alaska, permafrost, threshold-exceedance of fringing reefs and onshore thresholds, increased precipitation and atmospheric rivers, duration and direction of storm systems, decadal basin cycles)
- ❑ Impacts of Future Sea Level Change and Sustainable Solutions
 - Understanding of ocean to inland processes as well as how inland processes may affect shoreline resilience, threshold-exceedance, and adaptation
- ❑ Lack of Available Dredging Infrastructure and the lack of Science regarding Beneficial Use of Dredged Material





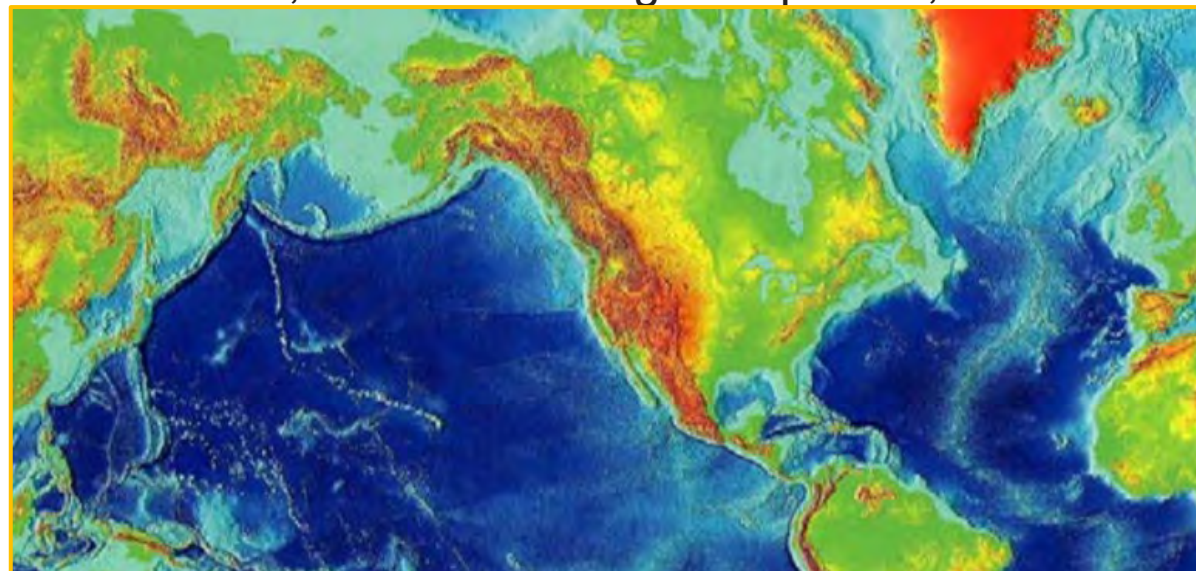
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SPECIAL CONSIDERATIONS IN NWD, POD AND SPD



3

- ❑ Wide range of district project exposure, vulnerability, construction, and project execution
- ❑ Project Missions are focused on Flood Risk Management, Ecosystem Restoration and Navigation rather than Coastal Storm Risk Management
- ❑ Storm and Hydrodynamic Systems
 - Extra-tropical systems (frequent, long-duration, high powered events) dominate much of the Pacific region
 - El Nino, King Tides, Atmospheric Rivers, larger ocean current, long wave periods, infragravity, etc
- ❑ Topography/Bathymetry/Geology
 - Narrow continental shelf, fringing reefs, submarine canyons, high cliffs/bluffs, rocky shorelines, cobble beaches, areas of permafrost, areas experiencing wave/storm exposure due to reduction in ice cover, contributions of atmospheric rivers/increased precipitation/wild fires, island sheltering or exposure, earthquake and tsunami vulnerability
- ❑ Suitable Nature Based Solutions





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CHALLENGES/TOOLS IN NWD, POD AND SPD

4



Monitoring and Modeling Needs

- Coastal Hazards System - range of concerns/issues per district may vary widely and inclusion of all districts input is essential
- Need for full range of data collection and monitoring tools from drones to satellites - with software/methods to fully track and utilize the results over varying timescales.
- Coastal bluff failure modeling needed
- Start with the Problems and where the Pacific Ocean differs before starting model/data/monitoring plan development

Use of WRDA Provisions

- WRDA 2020 Section 125 (Beneficial Use of Dredged Material)
- WRDA 2022 Section 8106 (Compound Flooding): Analyze compound flooding, but unclear if USACE has the authority to expend federal funds on a project
- WRDA 2022 Section 8101 (Resilient Structures)
- WRDA 2020 Section 203a (Tidal Flooding)

Beneficial Use of Dredged Material

- Funding
 - Islands – Small volume, large cost
 - Areas in need may not have local funding available
- Habitat Trade-Offs





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Issues

- Beneficial Use of Dredged Material
- Urban Environment
- Climate Change
- Atmospheric Rivers
- Regulatory Environment

Comprehensive Benefits

- Oakland Turning Basin
- San Francisco Shoreline
- San Francisco Regional Dredged Material Management Plan
- San Francisco Waterfront



50 Million Tons
Commerce (2021)



2.2 Million Cubic Yards
Dredged (2023)

Potential Tour Ideas

- Bel Marin Keys and Hamilton Wetlands
- San Francisco Shoreline
- San Francisco Waterfront

Synthesis of R&D Priorities: Coastal Storm Risk Management, Sediment Transport, and Decadal Challenges

Jane McKee Smith, Ph.D.
U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
Vicksburg, Mississippi

Julie Dean Rosati, Ph.D.
U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
Washington, D.C.

The Hampton Roads region of Virginia has unique challenges related to coastal storm risk management. The area is urban with a large military presence, and the economy, ecology, and lifestyle require connectivity with and access to the water. Hurricanes and extratropical storms and a high rate of relative sea level rise (RSLR) leads to a range of flooding from nuisance to severe (Hurricane Isabel in 2003 produced over \$3B in damages in Virginia). The relatively flat topography and connectivity to the Atlantic, Chesapeake Bay, and various rivers make the region susceptible to compound flooding events. Stakeholders favor coastal storm risk reduction measures based on nature-based solutions (NBS) that enhance the environment and preserve the community connectivity to the water. Projects in Norfolk, Virginia Beach, Hampton, and Joint Base Langley-Eustis provide examples of the storm risk challenges. The following Coastal Storm Risk Management research requirements were highlighted:

- Nature-based solution tools: scoping, robust models (long/short term, coupling to econ/eco/social models, testbeds)
- Monitoring and adaption methods/guidance
- Nonstationary incorporated into tools/policy (RSLR, climate, subsidence)
- Robust compound flooding models: urban infrastructure, project constraints, and guidance

Sediment transport research supports USACE missions in Navigation, Coastal Storm Risk Management, and Aquatic Environmental Restoration. Application of nature-based solutions is reliant on understanding sediment processes. Limitations in our understanding and ability to measure and model sediment transport processes impacts USACE effectiveness and efficiency. Challenges include the complexity of the processes, the broad range of relevant time and space scales, the randomness and nonlinearity of the hydrodynamics, and the inhomogeneity of the sediments. Measurements are lacking in diverse environments. New research applying artificial

intelligence and machine learning holds promise to parameterize processes, create efficient surrogate models, and integrate models and measurements. Accelerating progress in sediment transport will require the best and brightest researchers. The following research requirements for improved understanding/modeling of sediment transport were highlighted:

- Implement diverse testbeds
- Improve data collection methods and archives
- Improve accuracy/applicability of models and frameworks
- Incorporate AI to improve efficiency and accuracy of models
- Grow workforce, partnerships, STEM internships, and training

MG Graham and the Board on Coastal Engineering Research requested input from Commanders of coastal Districts and Divisions on Decadal Challenges related to their coastal engineering missions. These challenges are summarized in Table 1 (first column) with the number of Districts within each Division (Lakes and Rivers Division (LRD), Mississippi Valley Division (MVD), North Atlantic Division (NAD), Pacific Ocean Division (POD), South Pacific Division (SPD), South Atlantic Division (SAD), and Southwestern Division (SWD)) highlighting the issue tabulated in each labeled column. These challenges align with many of the topics discussed during this meeting (nature-based solution guidance, sediment transport, compound flooding, watershed approach, workforce development, partnering) and recent meetings (adaptive strategies and expanded benefit quantification). Quantifying nature-based solution value and impact and improving quantification of sediment transport were the top two challenges identified.

Table 1. Coastal Commanders' Decadal Challenges.

Coastal Commanders' Decadal Challenges	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total
Assessment of Value /Impact of NNBF	3	1	5	1	1	0	5	0	16
All Things Sediment	2	0	5	1	1	2	3	0	14
More Holistic Assessment of Study Areas and Surround (Watershed /region)	3	0	4	1	2	1	3	0	14
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure	2	1	4	1	1	1	2	1	13
Compound Flooding Modeling and Assessment Capabilities	2	1	1	1	1	1	5	0	12
Incorporating Adaptive Strategies in Project Planning (methods & policy)	0	1	2	2	1	2	1	1	10
Workforce : Supporting a large & talented enough workforce to meet CSRM demand	1	0	2	0	2	2	3	0	10
Partnering with Non-Federal Sponsors (increased authority)	0	0	2	2	1	1	1	1	8
Benefits : Methods to Assess Other Social Effects and Environment	0	0	1	0	1	0	0	0	2
<i>Districts responding per division</i>	3	1	5	2	2	2	5	1	

These identified challenges provide perspective for the Board on Coastal Engineering Research to shape their actions and recommendations. The Board is considering strategic long-term goals that would represent a major advancement in knowledge and capability with broad significance to Corps and the coastal communities it serves. These moon-shot ideas include:

1. Plan, resource, construct, manage, and adapt water projects for long term under increasing uncertainty.
2. Lead National network of integrated observations and coupled modeling.
3. New Methodologies for modeling and forecasting sediment transport via large scale studies, model testbeds, and AI approaches.
4. Unified national strategy for long term coastal management and risk mitigation.
5. Adaptive policy frameworks to enable rapid transition to new methods and priorities.

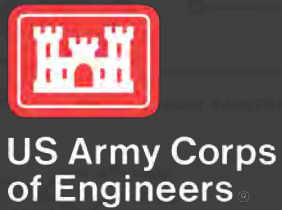
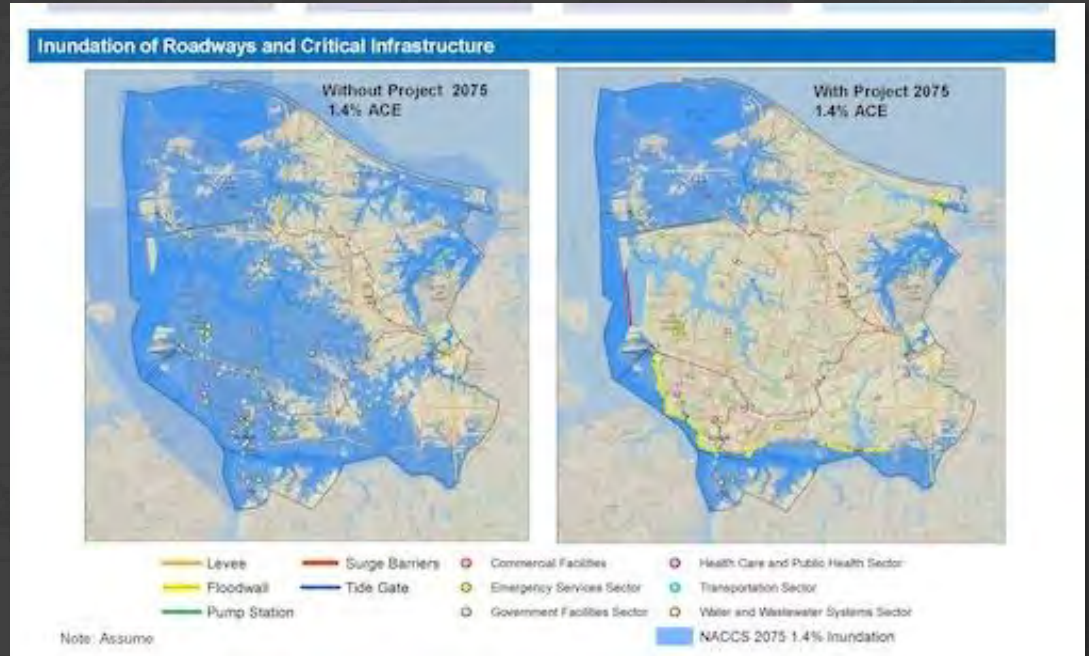
USACE Strategic R&D is critical to focus and resource priority moon-shot goals with transition into open-source, community practice to reduce community risk while optimizing economic, environmental, and social resilience.

Synthesis of R&D Priorities

Coastal Storm Risk Management R&D Challenges and Solutions in Urban Coastal Settings

Jane McKee Smith, PE, PhD
Julie Dean Rosati, PE, PhD
Coastal and Hydraulics Laboratory (CHL)

Board on Coastal Engineering Research
March 20th, 2024



Coastal Commanders' Decadal Challenges

	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total
Assessment of Value /Impact of NNBF	3	1	5	1	1	0	5	0	16
All Things Sediment	2	0	5	1	1	2	3	0	14
More Holistic Assessment of Study Areas and Surround (Watershed /region)	3	0	4	1	2	1	3	0	14
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure	2	1	4	1	1	1	2	1	13
Compound Flooding Modeling and Assessment Capabilities	2	1	1	1	1	1	5	0	12
Incorporating Adaptive Strategies in Project Planning (methods & policy)	0	1	2	2	1	2	1	1	10
Workforce : Supporting a large & talented enough workforce to meet CSRSM demand	1	0	2	0	2	2	3	0	10
Partnering with Non-Federal Sponsors (increased authority)	0	0	2	2	1	1	1	1	8
Benefits : Methods to Assess Other Social Effects and Environment	0	0	1	0	1	0	0	0	2
<i>Districts responding per division</i>	3	1	5	2	2	2	5	1	

Norfolk District

★ Commander Decadal Challenge

Processes & Challenges

- **Communities surrounded by water**

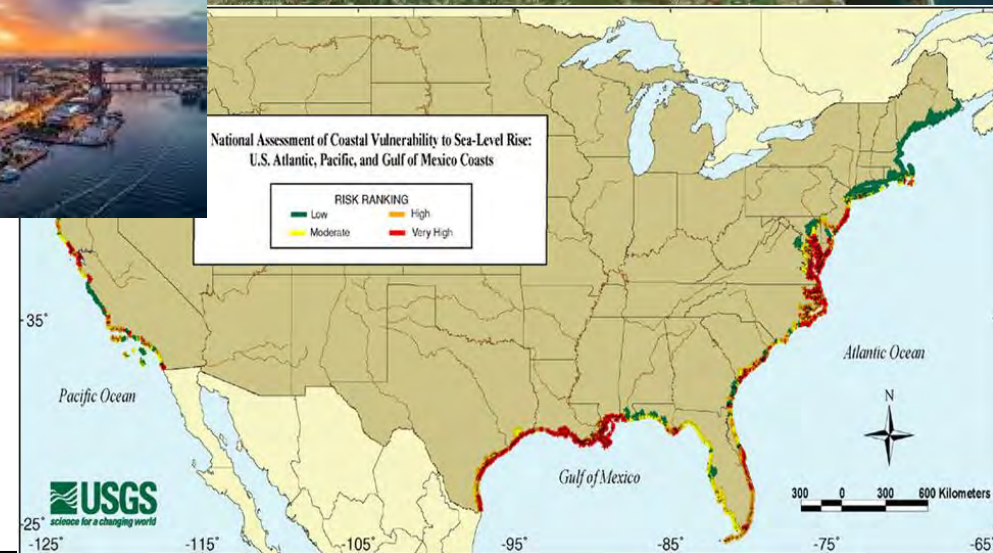
- Urban
- Military
- Water-based industry & recreation
- Environmentally sensitive

- **High RSLR + storms**

- ★ • **Compound flooding**

- **Desired solutions**

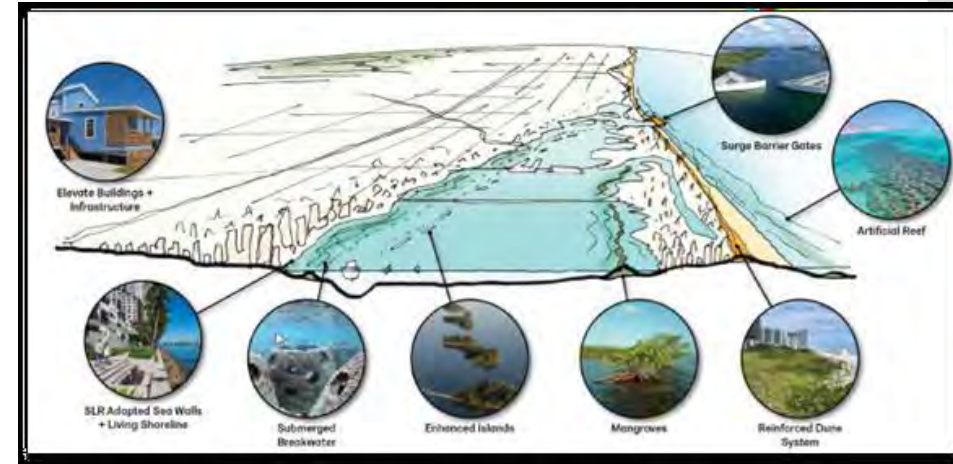
- Nature-based
- ★ ■ Enhance the environment/ecology
- ★ ■ Preserve connection to the water



Nature-Based Solution Challenges: Norfolk

- **Desire for Nature-Based Solutions:**

- Urban setting ~ scale
- Stakeholders “concerned and eager”
- Limited tools & policy constraints
- Leverage Miami-Dade pilot program

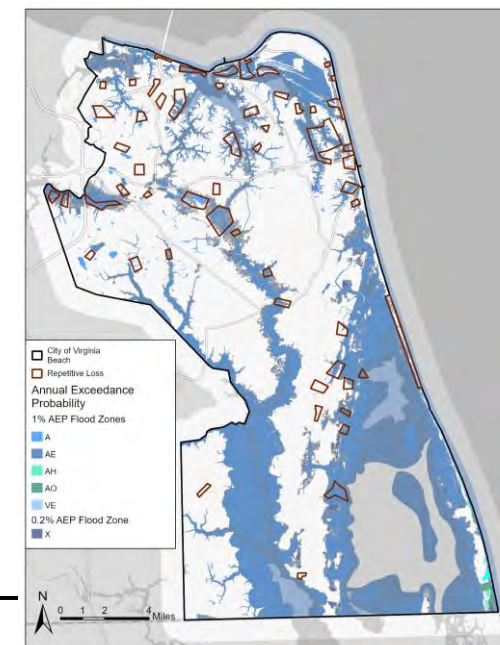


- **Research Needs:**

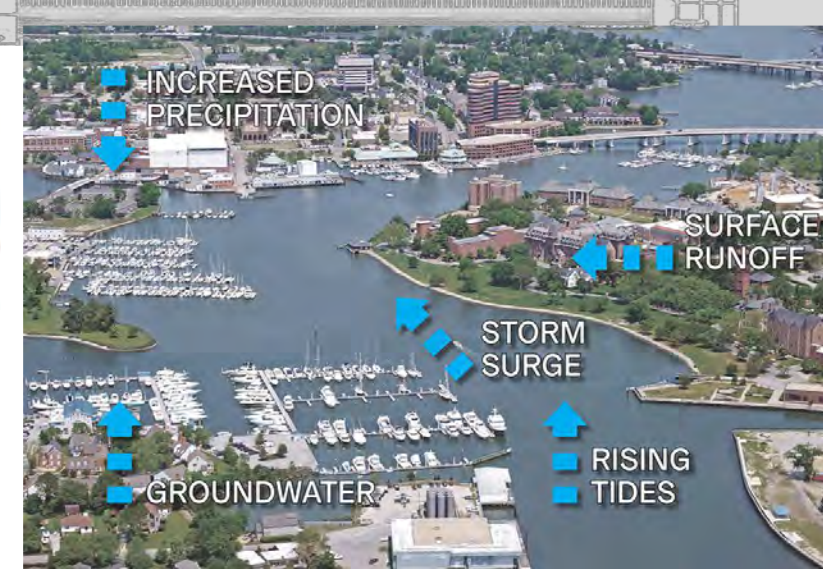
- User-friendly, geospatial NBS scoping tools
- Integrated model frameworks (hydro + econ + eco + social)
 - Quantify diverse NBS interdisciplinary performance & benefits
 - Performance testing (lab & field) for oyster reefs, coral, mangrove
- Methods to monitor short- to long-term performance
- Human dimension integrated into the planning process

Coastal Storm Risk Management: Virginia Beach

- **Large, complex study area:**
 - Eight existing projects within study area
 - Multiple pathways to flooding, repetitive losses
 - Extensive modeling (exceeds 3x3x3)
 - Account for benefits across 4 accounts
 - Risk/uncertainty: sand, compliance, construction timeline
- **Research Needs:**
 - Methods to buy down risk and uncertainty
 - Benefit cost ratio calculation (4 accounts)
 - ★ ■ Improved critical infrastructure depth damage functions
 - Data to expediate planning process
 - ★ ■ Monitoring of projects for adaption & learning
 - ★ ■ Innovative NBS and nonstructural measures



Living with Water: Hampton

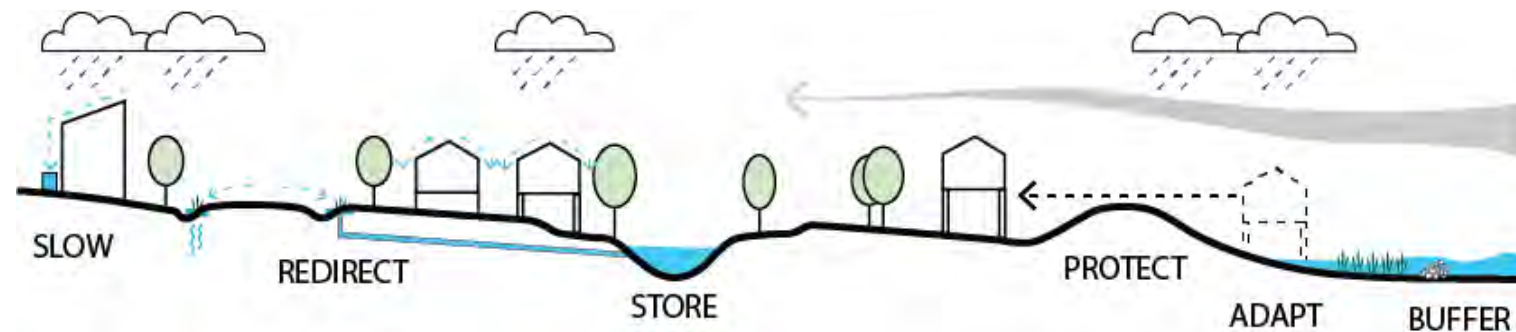


- **Resilient Community:**

- Flooding challenges (climate change)
- Enhance/protect water resource assets

- **Research Needs:**

- Methods to demonstrate impacts (or no impact) of protection system on areas outside of the system (waves & surge)
- ★ ▪ Methods to quantify impacts of sea level rise and increased precipitation on flooding



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- **Sea level rise & climate resiliency:**
 - Flooding challenges (climate change) ~ 7.9 ft flood H. Isabel 2003
 - Measures: master planning, shoreline stabilization, flood barriers, raised infrastructure, pumping stations
 - Cooperation w/ USACE Engineering with Nature Program
- **Research Needs:**
 - Methods to quantify local hydrodynamic and sediment system
 - ★ ■ Thin layer placement workflow (marsh enhancement)
 - Quantification of regional subsidence



Non-Cohesive Sediment Transport

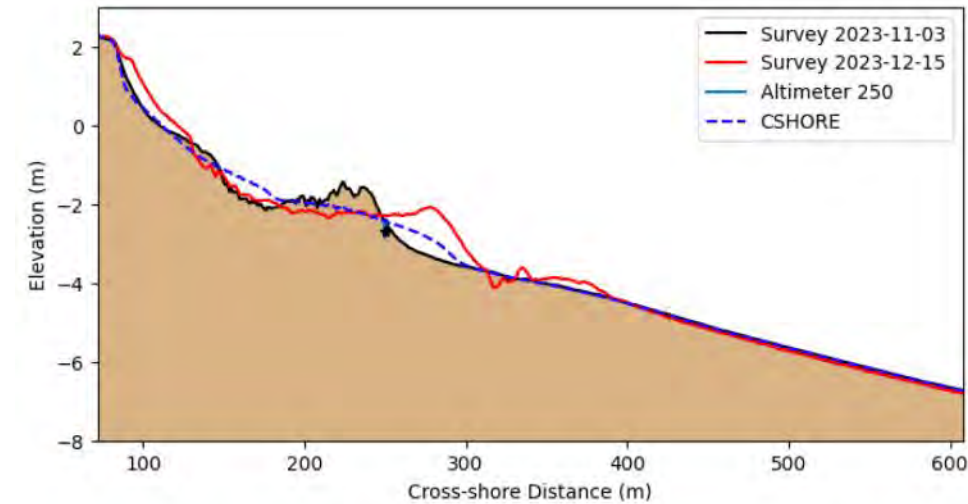
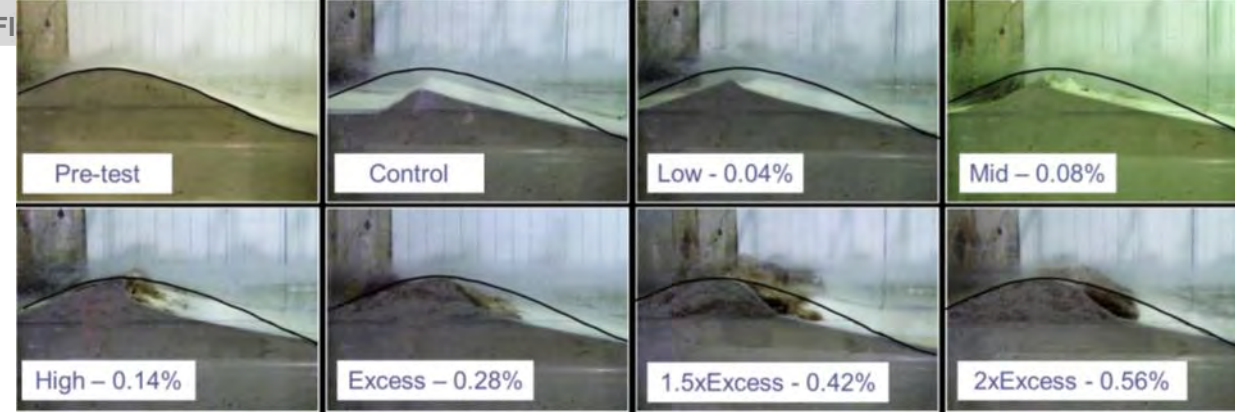


- **Challenges:**

- Multi-scale details of sediment transport
- Heterogeneity in sediment types
- Turbulence and randomness
- Morphology modeling in general
- Observation methods and data

- **Research Needs:**

- National operational morphology monitoring technology
- Probabilistic morphology modeling (communicate risk/uncertainty)
- Coordinated lab, field, and numerical investigations
- Strategic plan and financial commitment



Cohesive Sediment Transport[★]



Photo courtesy The Nature Conservancy

- **Challenges:**

- Beneficial use of dredged material (NNBF, ecosystem enhancement)
- Predictive tool limitations: intertidal & vegetated environment, dredging process impacts
- Model framework limitations
- Limited funding & bench depth

- **Research Needs:**

- Tactical R&D: Bed characterization, dredging processes, innovative placement
- Strategic R&D: Improved model framework, sediment-structure interaction, observation methods (AI)
- Testbeds: Diverse field environments (living labs?)



AI Application to Multi-Scale Coastal Processes ★

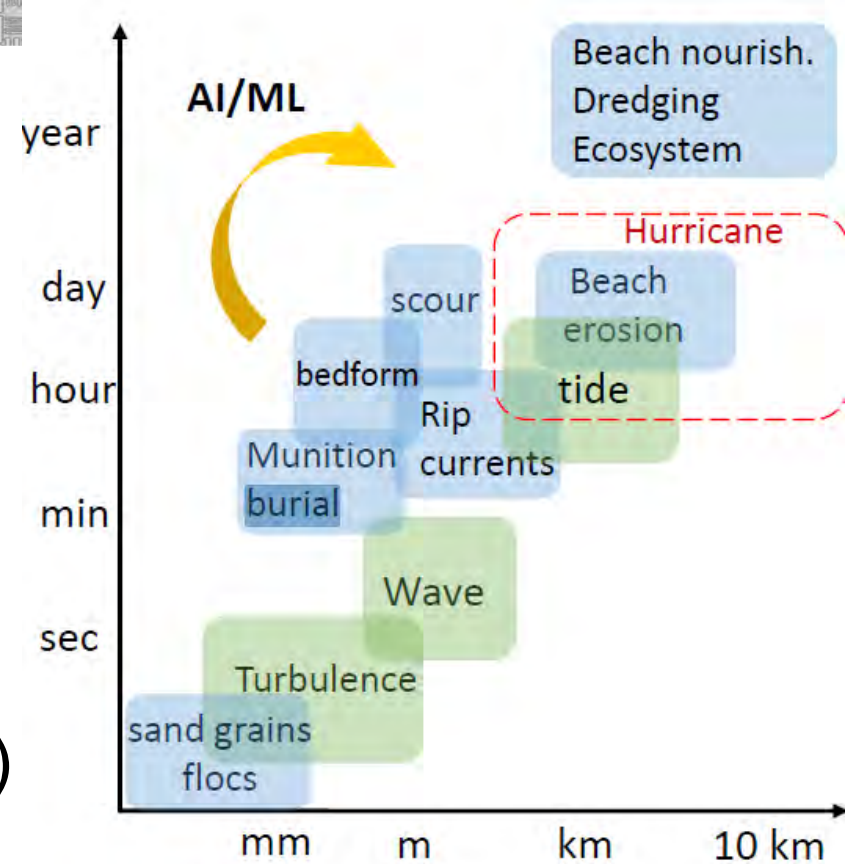
Coastal Processes

• Challenges:

- High-fidelity simulations are too slow
- Sediment process knowledge gaps
- Long temporal/spatial scales (km & yrs) for engineering decisions
- Empirical “closures” are crude (AI/ML can help)

• Research Needs:

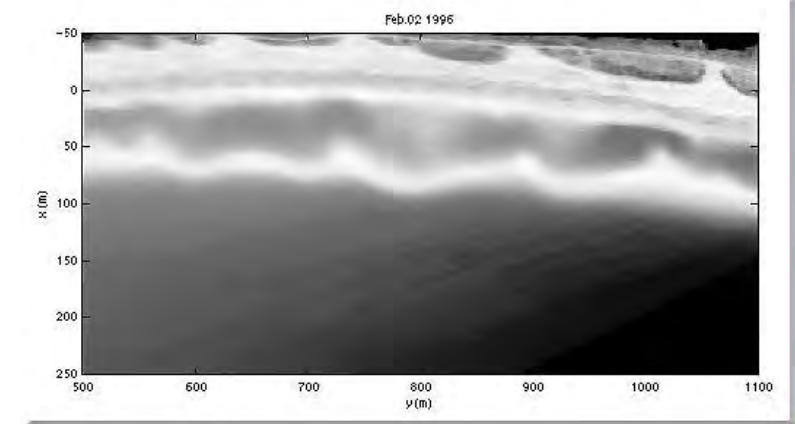
- AI/ML to parameterize & create sub-grid closures of unresolved processes in sediment models
- AI/ML to develop efficient surrogate models of nonlinear processes
- AI/ML to integrate suite of measurements and models (testbed)
- Digital twin of coastal system with AI/surrogate modeling



Sediment Transport Research[★]



- **Challenges:**
 - USACE should own sediment transport research
 - Limits in understanding → \$\$ consequences
- **Goal:** invest for max long-term impact, “entrain” world’s best
- **Recommendations:**
 - Create a suite of numerical model testbeds at representative USACE locations ~ focused on USACE project types
 - Maximize use of existing and low-cost data collection methods
 - Develop robust data collection & archiving methods
 - Advertise to the world: collaborate broadly



Moonshots

**Innovation in Sediment Prediction
(testbeds/modeling/AI)**



**Adaptive frameworks
(policy/engineering)**

**National Testbed Network
(observations/modeling)**

**Integrate uncertainty in projects
(plan, resource, manage, adapt)**

**Strategy for long-term coastal risk
(management and mitigation)**

R&D Challenges/Needs

- **Coastal Storm Risk Management + Urban Setting:**

- Develop nature-based solution tools: scoping, robust models (long/short term, coupling to econ/eco/social models, testbeds)
- Provide monitoring and adaption methods/guidance
- Incorporate nonstationary into tools/policy (RSLR, climate, subsidence)
- Develop robust compound flooding models: urban infrastructure, project constraints, and guidance

- **Sediment Transport:**

- Implement diverse testbeds
- Improve data collection methods and archives
- Improve accuracy/applicability of models and frameworks
- Incorporate AI to improve efficiency and accuracy of models
- Grow partnerships, STEM internships, and training opportunities

Backup

- **Summary of Coastal Commanders' Decadal Challenges (Feb 2024)**
- **BCER Action Item Summary 2023 Exec and Full Meetings**
- **Action Item 2023-Full-1: CHART “multicomponent protection system”**
- **Action Item 2023-Full-2, “Circulate Federal Register for Agency Specific Procedures for implementing the Principles, Requirements & Interagency Guidelines (PR&G)”**
- **Recurring Action Items at Executive BCER Meetings**
 - **2016-Full-2: Summarize FY23 Coastal Products**
 - **2016-Exec-4: Present annually at the BCER executive session a financial breakdown of coastal R&D as a subset of the CW R&D program**

SUMMARY: Coastal Commanders' Decadal Challenges (Mar 2024)

	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total	KEY: # Districts in Division with Challenge
Assessment of Value /Impact of NNBF	3	1	5	1	1	0	5	0	16	
All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)	2	0	5	1	1	2	3	0	14	5
More Holistic Assessment of Study Areas and Surround (Watershed /region)	3	0	4	1	2	1	3	0	14	4
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure	2	1	4	1	1	1	2	1	13	3
Compound Flooding Modeling and Assessment Capabilities	2	1	1	1	1	1	5	0	12	2
Incorporating Adaptive Strategies in Project Planning (methods & policy)	0	1	2	2	1	2	1	1	10	1
Workforce : Supporting a large & talented enough workforce to meet CSRSM demand	1	0	2	0	2	2	3	0	10	0
Partnering with Non-Federal Sponsors (increased authority)	0	0	2	2	1	1	1	1	8	
Benefits : Methods to Assess Other Social Effects and Environment	0	0	1	0	1	0	0	0	2	
<i>Districts responding per division</i>	3	1	5	2	2	2	5	1		

DETAILS: USACE Coastal Commanders Decadal Challenges (Mar 2024)

	LRD-LRB	LRD-LRC	LRD-LRE	MVD-MVN	NAD-NAB
Supporting a large & talented enough workforce to meet CSRSM demand	X				X
All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)					
•Model support for RSM, BUDM, or sediment budgets	X		X		X
•Sediment availability (quantity or quality) or dredge-related concerns	X		X		X
•Funding concerns (RSM & BU)	X				X
•Gaps in transport modeling: mixed grained sediments	X				X
•Research into CSRSM BU of fines					
•Gaps in transport modeling: other than mixed grained sediments					
•Research on BUDM on nearshore environmental resources					
Assessment of Value/Impact of N and NBF					
•Systemic site-specific CSRSM planning in feasibility stage	X				X
•Research & standards of practice for NNBF & hybrid installs			X	X	
•Risk Informed Decision Making tool across multiple USACE business lines		X			
More Holistic Assessment of Study Areas and Surround (Watershed/region)					
•Limited ability of models to accurately simulate gamut of nearshore cond	X	X	X		X
•Gap in computational or survey resources needed			X		
•Need for “West of the Mississippi” or lacustrine based coastal models			X		
Compound Flooding Modeling and Assessment Capabilities					
•Consistent & robust observational nearshore hydrodynamic data to inform	X		X		
•Research in saltwater intrusion or bayside or compound flooding				X	
Methods to Assess Other Social Effects and Environment					
Incorporating Adaptive Strategies in Project Planning (methods & policy)					
•Growing need for adaptation pathways or data-driven solutions for best solution				X	
•Authorizing “adaptation flexibility” in CSRSM					
•Community buy-in on different CSRSM options (traditional vs. newer options)					
Partnering with Non-Federal Sponsors (increased authority)					
•Organizational or interagency cooperation or efficiency					
•Increased permitting issues					
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure					
•Complex quantification of benefits surrounding CSRSM		X		X	
•Research, methods, or guidance of coastal infrastructure adaptation			X	X	X

DETAILS: USACE Coastal Commanders Decadal Challenges (Mar 2024)

	NAD-NAE	NAD-NAN	NAD-NAO	NAD-NAP	NWD-NWP
Supporting a large & talented enough workforce to meet CSRSM demand			X		
All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)					
•Model support for RSM, BUDM, or sediment budgets	X	X	X		
•Sediment availability (quantity or quality) or dredge-related concerns		X		X	X
•Funding concerns (RSM & BU)			X	X	
•Gaps in transport modeling: mixed grained sediments			X		
•Research into CSRSM BU of fines	X			X	
•Gaps in transport modeling: other than mixed grained sediments	X				
•Research on BUDM on nearshore environmental resources					
Assessment of Value/Impact of N and NBF					
•Systemic site-specific CSRSM planning in feasibility stage	X		X	X	
•Research & standards of practice for NNBF & hybrid installs	X	X	X	X	
•Risk Informed Decision Making tool across multiple USACE business lines				X	
More Holistic Assessment of Study Areas and Surround (Watershed/region)					
•Limited ability of models to accurately simulate gamut of nearshore cond	X		X		
•Gap in computational or survey resources needed	X			X	
•Need for “West of the Mississippi” or lacustrine based coastal models					
Compound Flooding Modeling and Assessment Capabilities					
•Consistent & robust observational nearshore hydrodynamic data to inform			X		
•Research in saltwater intrusion or bayside or compound flooding					
Methods to Assess Other Social Effects and Environment	X				
Incorporating Adaptive Strategies in Project Planning (methods & policy)					
•Growing need for adaptation pathways or data-driven solutions for best s	X			X	X
•Authorizing “adaptation flexibility” in CSRSM	X			X	X
•Community buy-in on different CSRSM options (traditional vs. newer optio	X				
Partnering with Non-Federal Sponsors (increased authority)					
•Organizational or interagency cooperation or efficiency	X			X	
•Increased permitting issues	X			X	X
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure					
•Complex quantification of benefits surrounding CSRSM	X	X	X		X
•Research, methods, or guidance of coastal infrastructure adaptation					X

DETAILS: USACE Coastal Commanders Decadal Challenges (Mar 2024)

	NWD-NWS	POD-POA	POD-POH	SPD-SPL	SPD-SPN
Supporting a large & talented enough workforce to meet CSRSM demand		X	X	X	X
All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)					
•Model support for RSM, BUDM, or sediment budgets			X		X
•Sediment availability (quantity or quality) or dredge-related concerns			X	X	X
•Funding concerns (RSM & BU)			X	X	X
•Gaps in transport modeling: mixed grained sediments			X		
•Research into CSRSM BU of fines			X		X
•Gaps in transport modeling: other than mixed grained sediments			X		X
•Research on BUDM on nearshore environmental resources			X		X
Assessment of Value/Impact of N and NBF					
•Systemic site-specific CSRSM planning in feasibility stage	X		X		
•Research & standards of practice for NNBF & hybrid installs	X				
•Risk Informed Decision Making tool across multiple USACE business lines	X				
More Holistic Assessment of Study Areas and Surround (Watershed/region)					
•Limited ability of models to accurately simulate gamut of nearshore cond	X	X	X		X
•Gap in computational or survey resources needed		X			X
•Need for “West of the Mississippi” or lacustrine based coastal models	X	X	X		X
Compound Flooding Modeling and Assessment Capabilities					
•Consistent & robust observational nearshore hydrodynamic data to inform	X	X			
•Research in saltwater intrusion or bayside or compound flooding					X
Methods to Assess Other Social Effects and Environment			X		
Incorporating Adaptive Strategies in Project Planning (methods & policy)					
•Growing need for adaptation pathways or data-driven solutions for best s	X		X		
•Authorizing “adaptation flexibility” in CSRSM				X	X
•Community buy-in on different CSRSM options (traditional vs. newer optio	X				X
Partnering with Non-Federal Sponsors (increased authority)					
•Organizational or interagency cooperation or efficiency	X	X			
•Increased permitting issues				X	
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure					
•Complex quantification of benefits surrounding CSRSM				X	
•Research, methods, or guidance of coastal infrastructure adaptation			X		

DETAILS: USACE Coastal Commanders Decadal Challenges (Mar 2024)

	SAD-SAC	SAD-SAJ	SAD-SAM	SAD-SAS	SAD-SAW
Supporting a large & talented enough workforce to meet CSRSM demand	X		X		X
All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)					
•Model support for RSM, BUDM, or sediment budgets	X		X		X
•Sediment availability (quantity or quality) or dredge-related concerns					X
•Funding concerns (RSM & BU)	X		X		X
•Gaps in transport modeling: mixed grained sediments	X		X		X
•Research into CSRSM BU of fines					
•Gaps in transport modeling: other than mixed grained sediments					
•Research on BUDM on nearshore environmental resources					
Assessment of Value/Impact of N and NBF					
•Systemic site-specific CSRSM planning in feasibility stage	X		X		X
•Research & standards of practice for NNBF & hybrid installs		X		X	
•Risk Informed Decision Making tool across multiple USACE business lines				X	
More Holistic Assessment of Study Areas and Surround (Watershed/region)					
•Limited ability of models to accurately simulate gamut of nearshore cond	X		X		X
•Gap in computational or survey resources needed					
•Need for “West of the Mississippi” or lacustrine based coastal models					
Compound Flooding Modeling and Assessment Capabilities					
•Consistent & robust observational nearshore hydrodynamic data to inform	X		X		X
•Research in saltwater intrusion or bayside or compound flooding		X		X	
Methods to Assess Other Social Effects and Environment					
Incorporating Adaptive Strategies in Project Planning (methods & policy)					
•Growing need for adaptation pathways or data-driven solutions for best s				X	
•Authorizing “adaptation flexibility” in CSRSM				X	
•Community buy-in on different CSRSM options (traditional vs. newer optio					
Partnering with Non-Federal Sponsors (increased authority)					
•Organizational or interagency cooperation or efficiency				X	
•Increased permitting issues					
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure					
•Complex quantification of benefits surrounding CSRSM		X			X
•Research, methods, or guidance of coastal infrastructure adaptation					

DETAILS: USACE Coastal Commanders Decadal Challenges (Mar 2024)

	SWD-SWG	TOTAL
Supporting a large & talented enough workforce to meet CSRSM demand		10
All Things Sediment (influence of CC, Erosion, modeling, transport/tracking)		
•Model support for RSM, BUDM, or sediment budgets		11
•Sediment availability (quantity or quality) or dredge-related concerns		10
•Funding concerns (RSM & BU)		10
•Gaps in transport modeling: mixed grained sediments		7
•Research into CSRSM BU of fines		4
•Gaps in transport modeling: other than mixed grained sediments		3
•Research on BUDM on nearshore environmental resources		2
Assessment of Value/Impact of N and NBF		
•Systemic site-specific CSRSM planning in feasibility stage		10
•Research & standards of practice for NNBF & hybrid installs		9
•Risk Informed Decision Making tool across multiple USACE business lines		4
More Holistic Assessment of Study Areas and Surround (Watershed/region)		
•Limited ability of models to accurately simulate gamut of nearshore cond		13
•Gap in computational or survey resources needed		5
•Need for “West of the Mississippi” or lacustrine based coastal models		5
Compound Flooding Modeling and Assessment Capabilities		0
•Consistent & robust observational nearshore hydrodynamic data to inform		8
•Research in saltwater intrusion or bayside or compound flooding	X	5
Methods to Assess Other Social Effects and Environment		2
Incorporating Adaptive Strategies in Project Planning (methods & policy)		
•Growing need for adaptation pathways or data-driven solutions for best s		7
•Authorizing “adaptation flexibility” in CSRSM		6
•Community buy-in on different CSRSM options (traditional vs. newer optio	X	4
Partnering with Non-Federal Sponsors (increased authority)		
•Organizational or interagency cooperation or efficiency	X	6
•Increased permitting issues		4
Strategies for Addressing Decreasing Sustainability of Coastal Infrastructure		
•Complex quantification of benefits surrounding CSRSM		9
•Research, methods, or guidance of coastal infrastructure adaptation	X	6

Action Items and Recommendations: 2023 Executive BCER				
NUMBER	ACTION ITEM / RECOMMENDATION	Due	POC(s)	Status
ACTION ITEMS Executive BCER Meeting, Chicago, IL				
2023-Exec-1	Briefing on CHART Fundamentals. Brief BCER on Fundamentals of the Coastal Hazard Analysis and Risk Toolkit (CHART); Describe CHART Capability to Evaluate Range of Engineering and Environmental Scenarios	2023 Full BCER	Kevin Hodgens	Completed
2023-Exec-2	Briefing on NAD Environmental Justice and Non-Structural Challenges. Brief BCER on North Atlantic Division's non-structural challenges and potential solutions	2023 Full BCER	Susan Durden	Completed
2023-Exec-3	Incorporating Environmental Justice into Coastal Analyses Summarize Approaches to Incorporate Environmental Justice data into coastal planning, engineering and design	2023 Full BCER	Susan Durden	Completed
2023-Exec-4	BCER Feedback. At their request, provide BCER feedback on their effectiveness in providing impactful and actionable advice and recommendations to the Coastal and Hydraulics Laboratory, the Chief of Engineers, and the Secretary of the Army	2024 Exec-Full BCER Reschedule	Wamsley, Rosati	In process; Reschedule to Full BCER
2023-Exec-5	Proposal for 100th BCER Meeting. BCER requested a briefing with ideas to celebrate the 100th meeting of the board which will occur Summer 2024. Briefing will include proposed theme, location and venue, and suggested VIP attendees	2023 Full BCER	Wamsley, Rosati	In process
2023-Exec-6	"Moonshot" R&D to Address Coastal Engineering Challenges. Brief the BCER on "moonshot" ideas in coastal engineering to address the next-generation challenges	2024 Executive BCER	BCER	In process
RECOMMENDATIONS Executive BCER Meeting, Chicago, IL				
2023-Exec-REC-1	Pursue Development of a National Coastal Risk Map. Integrate with physical processes (Coastal Hazards System), Coastal Storm Risk Management projects, Structural Inventory, and Social Vulnerability/ Environmental Justice; incorporate tools for adaptation pathways.			

<p>2023-Exec-REC-2</p>	<p>Conduct a Forensic Review of Coastal Storm Risk Management Projects exceeding Original Cost Estimates Original projects designs may not be sufficient; review why costs were exceeded, and document lessons learned for use in future project planning and design process. Review how benefits were quantified in each of the four benefit categories, and the criteria used to approve project construction.</p>			
<p>2023-Exec-REC-3</p>	<p>Collaborate with NOAA's Interagency Group Collecting Data on Underserved Communities as part of NOAA's Coastal Resilience Mission</p>			

ACTION ITEMS Full BCER, Miami, FL August 15-17, 2023				
2023-Full-1	Create comprehensive figure for the Coastal Hazard Analysis and Risk Toolkit (CHART) to visualize “multicomponent protection system” and associated terminology.	2024 Exec BCER	Kevin Hodgens	Completed; 2024 Exec BCER RAH
2023-Full-2	Circulate Federal Register for Agency Specific Procedures for implementing the Principles, Requirements & Interagency Guidelines (PR&G) when available	Fall 2023	Maria Wegner/ Julie Rosati	Completed; 2024 Exec BCER RAH
2023-Full-3	Identify basic research gaps and drivers across enterprise and identify who our academic and industry partners are.	2024 Exec BCER	BCER	In process
2023-Full-4	Identify location for next Executive and Full BCER meetings, in preparation for the 100 th BCER meeting in Summer 2024.	Fall 2023	Chair, BCER	Completed
2023-Full-5	At the next BCER meetings, invite key decision makers from the Assistant Secretary of the Army, Civil Works, and USACE HQ Program Integration Division and their staffs to engage with the BCER’s preparations for 100 th Meeting and provide funding and policy perspectives.	2024 Exec and Full BCERs	Chair, BCER	In process

RECOMMENDATIONS Full BCER Meeting, Miami, FL August 15-17, 2023		
2023-Full-Rec-1	Pursue continued research into comprehensive benefit analysis including consistent metrics across Flood Risk Management and Coastal Storm Risk Management projects, including recreational features that can enhance project purposes.	
2023-Full-Rec-2	Pursue opportunities to better communicate and tell USACE projects stories in real time including tools to effectively communicate compounded risk, uncertainty, and comprehensive benefits.	
2023-Full-Rec-3	Consider research opportunities to define and establish thresholds for triggers leading to coastal adaptation.	

COASTAL HAZARDS ANALYSIS AND RISK TOOLKIT (CHART) *BCER ACTION ITEM 2023-FULL-1*

Kevin Hodgens, P.E.

Research Hydraulic Engineer
Coastal Hydraulics Laboratory
Engineer Research & Development Center

06 MAR 2024



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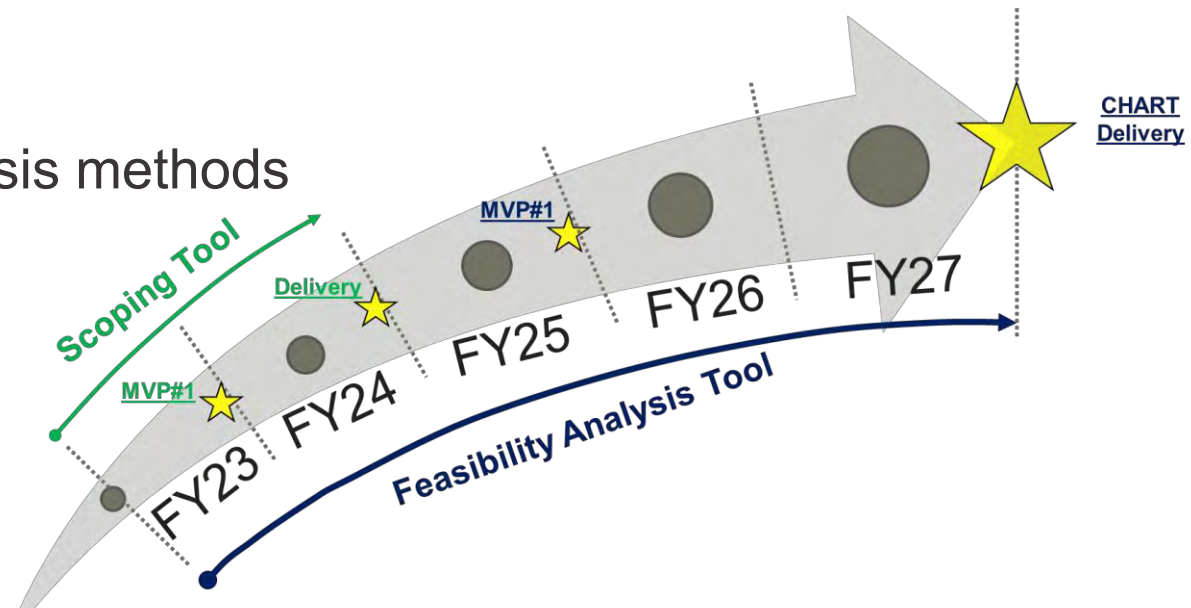


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BOTTOM LINE UP FRONT (BLUF)

- Reference *BCER Action Item 2023-Full-1*, “Create comprehensive figure for the Coastal Hazard Analysis and Risk Toolkit (CHART) to visualize “multicomponent protection system” and associated terminology.”
- CHART is a five year, \$5M agency investment (FY23 to FY27) guided by Research and Development Statement of Need (SoN) and submitted by division and headquarter components.
- Replaces existing Coastal Storm Risk Management (CSRM) feasibility study support tools (Beach-fx and G2CRM)
 - Enhanced user experience and error tracing
 - Enhanced accuracy of risk estimates
 - Utilizes modern high-fidelity datasets and analysis methods





WHAT IS CHART?



Coastal Hazards Analysis and Risk Toolkit

- CHART links detailed information about the non-stationary hazards, system performance, and consequences across Monte Carlo lifecycle simulations to evaluate federal interest in Coastal Storm Risk Management (CSRM) feasibility studies.
- Addresses SoN 1498, “Future Directions for CSRM Modeling for PL Studies”
- SoN 1498 desired outcome includes:
 - Transparent, layered, and simple model-components
 - Accessible code base to facilitate transparency, easy updates, and simplified repairs
 - Seamless integration of various online data sources
 - Numerical and GIS-based outputs that can easily translate into graphics
- CHART briefed to BCER at MAR 2023 (Executive) and AUG 2023 (Full) BCER Meetings



DEFINITIONS

Risk is broadly defined as a situation or event where something of value is at stake and its gain or loss is uncertain

A **Hazard** is what causes harm to something of interest; in this case a coastal storm event.

Physical System Response is how a given area reacts to and modifies incoming hazards (i.e., performance)

Exposure refers to the persons and/or property subjected to harm from the hazard.

Vulnerability is the susceptibility to harm human beings, property, and the environment when exposed to the hazard

Consequence is the harm that results from a single occurrence of the hazard.

A **multicomponent protection system** utilizes multiple management measures to achieve desired risk management outcomes





Risk = f (Hazards, Physical System Response, Exposure, Vulnerability)

Risk / Consequences

- Life Loss
- Economic
- Environmental
- Social & Cultural

Hazards

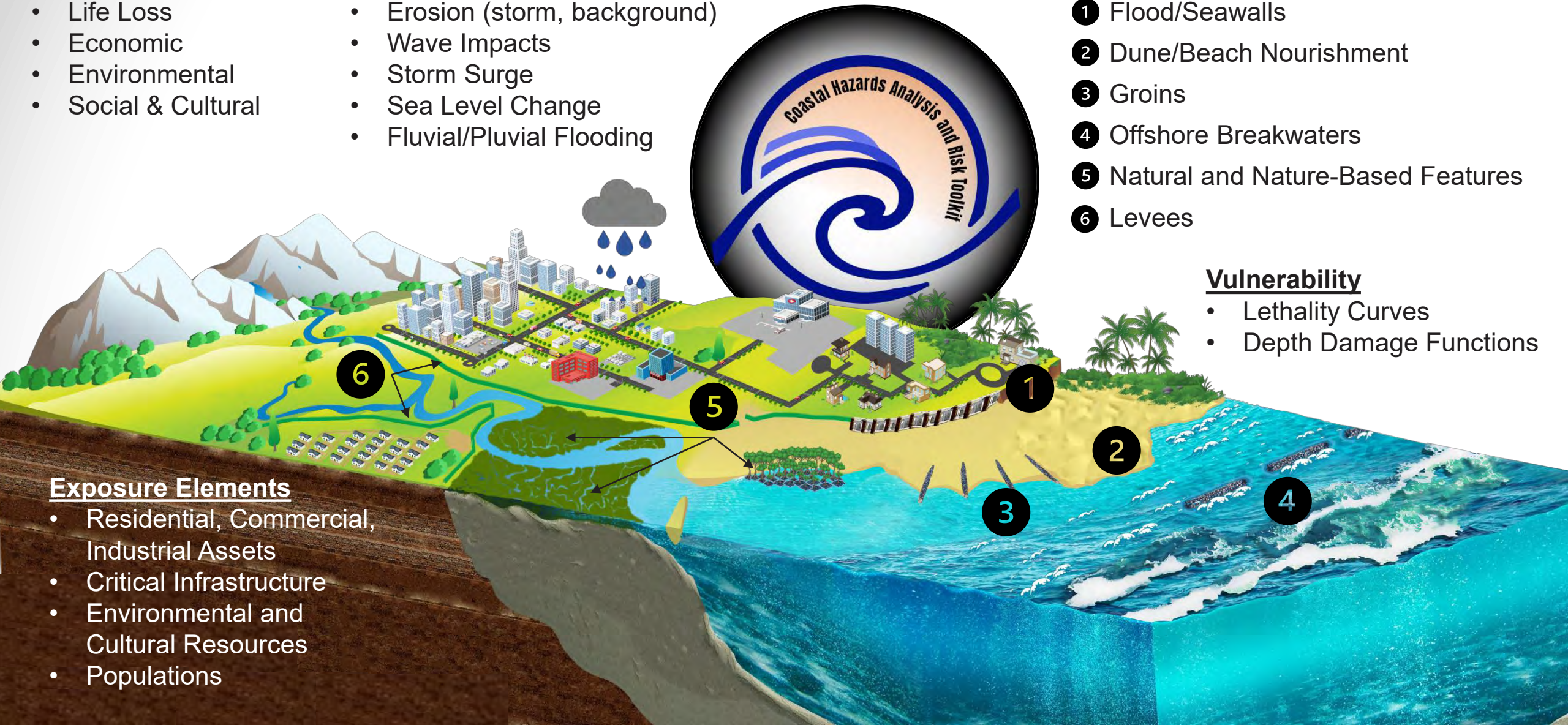
- Erosion (storm, background)
- Wave Impacts
- Storm Surge
- Sea Level Change
- Fluvial/Pluvial Flooding

Physical System Measures

- 1 Flood/Seawalls
- 2 Dune/Beach Nourishment
- 3 Groins
- 4 Offshore Breakwaters
- 5 Natural and Nature-Based Features
- 6 Levees

Vulnerability

- Lethality Curves
- Depth Damage Functions



Exposure Elements

- Residential, Commercial, Industrial Assets
- Critical Infrastructure
- Environmental and Cultural Resources
- Populations



MULTICOMPONENT SYSTEM EXAMPLE

CHART will calculate life-cycle performance as a function of hazards and SLC for a multicomponent protection system, e.g., Breakwater + Beach Nourishment + Seawall.

1

2

3



BCER Action Item 2023-Full-2, “Circulate Federal Register for Agency Specific Procedures for implementing the Principles, Requirements & Interagency Guidelines (PR&G)”

The Federal Register Publication on the Proposed USACE Principles, Requirements and Guidelines for Federal Investments in Water Resources was published on Feb 15, 2024.

The public comment period ends on 15 April 2024.

<https://www.federalregister.gov/documents/2024/02/15/2024-02448/corps-of-engineers-agency-specific-procedures-to-implement-the-principles-requirements-and>

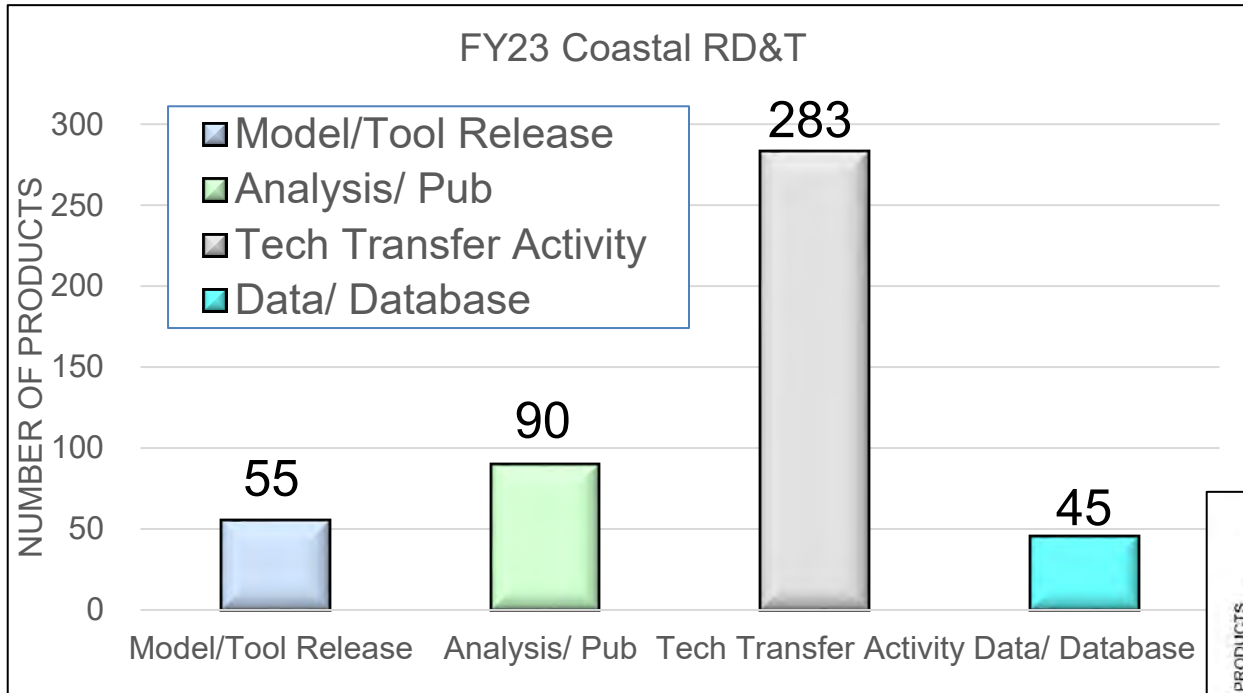
See attached pdf, “**Federal Register** / Vol. 89, No. 32 / Thursday, February 15, 2024 / Proposed Rules”

Summary of Recurring BCER Action Items

2016-Full-2: Summarize FY23 Coastal Products

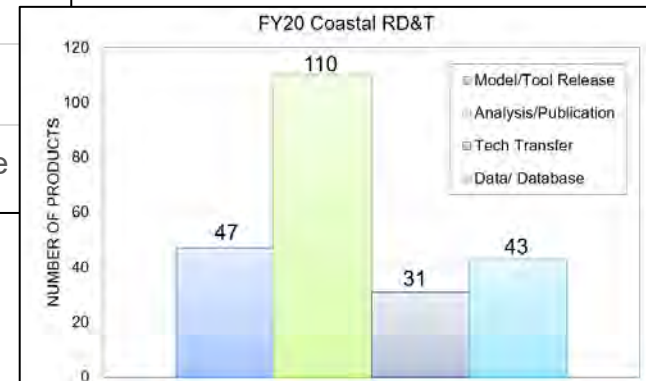
2016-Exec-4: Present annually at the BCER executive session a financial breakdown of coastal R&D as a subset of the CW R&D program.

2016-Full-2: Summarize FY23 Coastal Products



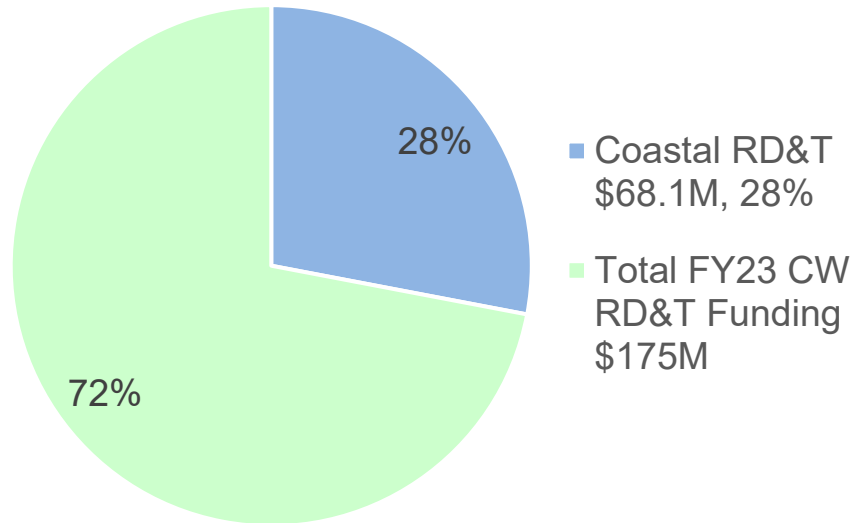
FY20 to FY23

Models/Tools: +17%
 Analysis/Pubs: -18%
 Tech Trans: +800%
 Data/Database: +5%



2016-Exec-4: Coastal R&D as a subset of the CW R&D

FY23 Civil Works RD&T Funding

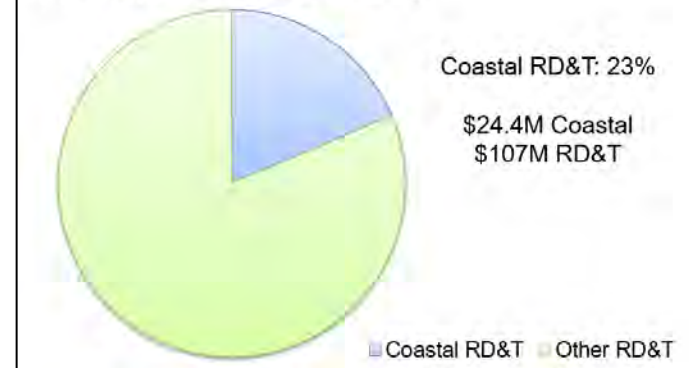


FY20 to FY23

Coastal RD&T increased from 23% to 28% of total

Total CW RD&T increased from \$107M to \$175M

FY20 Civil Works RD&T Funding



BACKUP

Detailed listing of FY23 Coastal Metrics

- Model/ Tool Releases
- Analysis/ Publications
- Technology Transfer Activities
- Data/ Database

FY23 Coastal Model/Tool Releases (1/2)

- CFDC: Deep learning based runup time series extraction method for fixed coastal scanning lidar system
- F&CS: USACE Coastal Engineering Toolkit (formerly ACES); National Structure Inventory (NSI) updates (~7M/ yr savings for planning); USACE GRiD, USACE Natl Levee DB, and USGS 3DEP data integration into H&H models
- EMRRP: Oyster population conceptual Model; Marsh morphological changes during experiment & modeling; Integrated salt marsh model - model and conference presentation
- Coastal NMM: WaterWorks on Demand (alpha) -- Microsoft Azure Cloud (Initial dashboard and execution of SMS, ADCIRC, STWAVE, CSTORM, Beach-fx and G2CRM within cloud
- Coastal NMM: Surfacewater Modeling System (SMS) Version 13.3 community access for ADCIRC, STWAVE, CSTORM, Beach-fx, and G2CRM plus 5 HH&C CoP preferred tools funded for transition to community access.
- CODS: Satellite Shoreline Mapper (SSM) Tool; Sediment Budget Model for Cardiff State Beach; New Tool for UAV Video Stabilization and Rectification; CDIP WAVE Data Portal; Menu of CDIP wave database advanced visualization tools
- CIRP: 1) Satellite Shoreline Mapper (SSM) Tool, released Nov-23; 2) CMS 5.3 - Current Release is CMS2D_v5.3 (update 3) - 7 April 2023; 3) Aeolis (Joint release with TU Delft/LundU) 2023; 4) SandSnap V2.1 update, released Feb. 2024
- USCRP: Sediment transport, Storm tracking, Pollutant transport, Hydrodynamics, Wave processes, Geomorphic change, Compound events

CFDC = Coastal Field Data Collection; F&CS = Flood & Coastal Systems; EMRRP = Ecosystem Management Restoration Research Program; Coastal NMM = Coastal Numerical Model Modernization Congressional; CODS = Coastal Ocean Data Systems; USCRP = U.S. Coastal Research Program; EWN = Engineering with Nature; DIG = Dredging Innovations Group; RSM= Regional Sediment Management; NCMP = National Coastal Mapping Program

FY23 Coastal Model/Tool Releases (2/2)

- EWN Modeling Toolkit for CSTORM; EWN Modeling Toolkit Expansion Pack; EWN Project Mapper (ProMap)
- DIG: NavPortal Dev Site
- RSM: Decision Support Tool; Lakeshore Geomorphic Vulnerability Index
- NCMP: DUNEVEG Toolbox version 3 (<https://erdc-library.erdcdren.mil/jspui/handle/11681/47649>); Dune Feature Extraction toolbox; Representative Beach Profile Generator Code <https://erdc-library.erdcdren.mil/jspui/handle/11681/46916>

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US Army Corps of Engineers • Engineer Research and Development Center

FY23 Coastal Analysis/ Pubs (1/5)

- CFDC: 1) Automated Extraction of a Depth-Defined Wave Runup Time Series From Lidar Data Using Deep Learning. 2) Acoustic remote sensing in the bubbly sand-laden inner surfzone (in review)
- F&CS: 1) OSE Literature Library, 2) Levee backwards erosion pipping model V&V, 3) CHART The Military Engineer (Summer 2023 issue)
- EMRRP: Marsh morphological changes during experiment/modeling – dataset & analysis; Indicator of reduction in soil (IRIS): a review - JA; Fate of iron sulfide compounds following simulated wetland sediment deposition - JA
- Geophysical Computational Modeling: Coastal Levee Resilience JA Oct 2023; Seven Mile Island Innovation Laboratory JA Dec 2023, Feb 2024
- Oyster Reefs: Atlantic Sturgeon movement in and around MS Sound - Thesis
- CODS: Wave influence on altimetry sea level at the coast. The Impact of Inherited Morphology on Sandbar Migration During Mild Wave Seasons. Amphibious Uncrewed Ground Vehicle for Coastal Surfzone Survey. Remotely sensed short-crested breaking waves in a laboratory directional wave basin. Alongshore variable accretional and erosional coastal foredune dynamics at event to interannual timescales. Automated Extraction of a Depth-Defined Wave Runup Time Series From Lidar Data Using Deep Learning. Performance of moored GPS wave buoys. Cross-shore wind-induced changes to field-scale overturning wave shape. Observations of beach change and runup, and the performance of empirical runup parameterizations during large storm events. Performance of ERA5 Wind Speed and Significant Wave Height Within Extratropical Cyclones Using Collocated Satellite Radar Altimeter Measurements.

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FY23 Coastal Analysis/ Pubs (2/5)

- CODS: Global climatology of extratropical cyclones from a new tracking approach and associated wave heights from satellite radar altimeter. An open-source Python package for creating common coastal image products. Morphological Analysis of a Nearshore Nourishment along the Atlantic Coast of New Jersey, USA. Quantifying surfcam imagery to measure the 2022 Hunga Tonga-Hunga Ha'apai tsunami along the California coast. Nearshore wave angles and directional variability during storm events. Analysis of beach cusp formation and evolution using high-frequency 3D lidar scans. Blending Bathymetry: Combination of Parametric Beach Tool and Celerity data sets for real-time bathymetry estimation. Insights into nearshore sandbar dynamics through process-based numerical and logistic regression modeling. 3D Measurements of Water Surface Elevation Using a Flash Lidar Camera. A large-scale community storm processes field experiment: the During Nearshore Event Experiment (DUNEX) overview reference report.
- CODS: Applicability of CoastSnap, a Crowd-Sourced Coastal Monitoring Approach, for USACE District Use. Quantifying Coastal Evolution and Project Performance at Beaches Using Satellite Imagery. Assessing Planet SkySat Video Collects for Coastal Applications. Modifications to An Unoccupied Robotic System (UxS) for Survey Operations. UAV video-based estimates of nearshore bathymetry. Quantitative regional observations of gravel and bedrock influence on beach morphologies. Alongshore variability of a southern California beach, before and after nourishment. Shifting Sands: Using a Sediment Budget Model to Predict Beach Width Changes for Cardiff State Beach (MS thesis). California winter precipitation variability revealed by 100-year ocean salinity record. Cobble tracking observations at Torrey Pines State Beach, CA.

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FY23 Coastal Analysis/ Pubs (3/5)

- CODS: Development of an automated mobile grain size mapping of a mixed sediment beach. Free infragravity waves on the innershelf: Observations and Parameterization at two Southern California beaches. Subaerial Profiles at Two Beaches: Equilibrium and Machine Learning. A Climatic Sand Management Model for Cardiff State Beach, CA. Rising Sea Levels and the Increase of Shoreline Wave Energy at American Samoa. Wind velocities inferred from wave spectra measured by CDIP buoys and experimental observing platforms. Wave-tide interaction for a strongly modulated wavefield.
- CIRP: Apparent Relationship of Navigation Channel Dredging Volumes and Energy Production in Southwest LA. Calcasieu Modeling JA. Vessel Wake Impact Forces on Marsh Scarp.
- CIRP: Morphological Analysis of a Nearshore nourishment along the Atlantic Coast of New Jersey, USA. Dune Response Tool (CHETN). Aeolis-Wrack Incorporation (CHETN). Aeolis (Tech Report)
- EWN: International NNBF Guidelines. Wave Attenuation Of Coastal Mangroves During Extreme Water Levels At Near Prototype Scales.
- DOER: 1) Lit review of all existing biological opinions and other documents of incidental take for species encountered by USACE projects - report; 2) Annual result of By-pass shoaling sediment collector - report; 3) TN: Governing physical processes for marsh-edge strategic placement, 4) TR: Field observations of transport of strategically placed dredge material through a tidal creek; 5) JA: Marsh-edge strategic placement of dredged material as a sediment source to coastal wetlands;

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FY23 Coastal Analysis/ Pubs (4/5)

- DOER: 6) TR: Improving Aquatic Placement Practices for Beneficial Use of Dredged Material in the Great Lakes. 7) TR: Systematic beneficial use of dredged sediments: Nex Gen Water Quality Monitoring During Dredging Operations: Knowns, Unknowns, Path Forward. In review (Submission September 2023) ; 8) TR Bayou Rigaud Turbidity Assessment: EcoMapper Surveys. ERDC White Paper Submitted to USACE MVN. (Complete July 2023)
- DOTS: Forecasting Sediment Accumulation in the Southwest Pass with Machine-Learning Models
- NCMP: During Nearshore Event Vegetation Gradation (DUNEVEG): Geospatial Tools for Automating Remote Vegetation Extraction. Multi-Temporal Trend Analysis of Coastal Vegetation Using Metrics Derived from Hyperspectral and LiDAR Data.
- NCMP: Geomorphic Monitoring of Coastal Marsh Restoration Sites: Insights from Field and Remote Sensing Approaches in Louisiana. Leveraging 25 years of lidar data to quantify the geomorphic resilience of a highly-engineered estuarine beach. Inlet and barrier island sediment pathways: Insights from volume change analysis near Barnegat Inlet, NJ. Temporal Patterns of Geomorphic Resilience in Mississippi's Mainland Beaches and Dunes. Decadal Variability of Beach-Dune Geomorphic Resilience and Cross-Shore Aeolian Fetch in NE Florida – Applications of the USACE Coastal Engineering Resiliency Toolbox. Temporal and Spatial Variability of Cross-shore Fetch and the Potential for Aeolian Dune Recovery at Anastasia Island, FL. Evolution of the USACE National Coastal Mapping Program and Implementation of Small Unmanned Aerial Systems.

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FY23 Coastal Analysis/ Pubs (5/5)

- NCMP: Use of the Geomorphons GIS Tool to Support Feature Extraction at Structures and Inlets. Geologic, Hydrodynamic, and Anthropogenic Controls on Inlet Evolution: Indian River Inlet, Delaware, U.S.A . Application of Coastal Resilience Metrics at Panama City Beach, Florida. Geomorphology Feature Extraction in The Great Lakes to Support Sediment Budgets and Vulnerability Assessments. Demonstrated coastal engineering applications using lidar data. JALBTCX rapid-response aerial survey reconnaissance missions. Representative Beach Profile Generator. Geomorphic feature extraction to support the Great Lakes Restoration Initiative's sediment budget and Geomorphic Vulnerability Index for Lake Michigan.
- NCMP: Calibration and Validation of the Coastal Storm Modeling System (CSTORM-MS) for the Great Lakes Restoration Initiative (GLRI) Study for Lake Superior. Creation of a Near-Seamless Digital Elevation Model of Lake Ontario to Support CSTORM Modeling.
- RSM: ERDC TR: Evaluation of structural and operational alternatives to optimize the distribution of water and sediment in the Passes of the Mississippi River. Journal Paper: Morphological Analysis of a Nearshore Nourishment along the Atlantic Coast of New Jersey, USA. ERDC TN: Testing the Compatibility of the Sediment Budget Analysis System 2020 with Various Data Sources

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FY23 Coastal Tech Transfer Activities (1/4)

- F&CS: 1) NSI NOAA HAZUS Workshop; 2) OSE brief to the new USACE Social Sciences Community of Practice; 3) Coastal Hazards System damage prevention brief to NOAA NHC; 4) 2 CHART briefs to CERB; 6) CHART brief to FEMA FFRD Oversight Team; 7) CHART brief to Districts on overland flow modeling; 8) CHART collaboration RMC on life loss signaling
- EMRRP: Iron sulfide effects in marsh restoration - 2 webinars; Integrated salt marsh model - conference presentation
- Coastal NMM: Developed and taught a graduate level course at JSU on CSRМ engineering tools including the use of WaterWorks on Demand; USACE Hands-on Training for CSRМ workflows (CSTORM, StormSim, G2CRM, SMS) (5 days); USACE Hands-on Training for SMS (1 Day);
- Coastal NMM: Gitlab Basics (USACE Training 2 hours); Presentation at ASBPA on cloud based CSRМ models (WaterWorks on Demand).
- CODS: 1) 31 USACE District Projects using WIS; 2) 5 new District CorpsCam Installations; 3) CIRN Workshop (75 attendees; 20 international attendees; 4 USACE Districts); CWG Training for Satellite Shoreline Mapper; 4) 2 ERDC Pod-Casts; 5) 18 Conference Presentations; 6) Hurricane Idalia Storm Assessment (2 - CorpsCam; CoastSat); 1) 110 Stakeholder Meetings and Conference Presentations 2) CDIP Waves team installed 3 new stations to support specific District data needs;
- CIRP: 1) Coastal Sediments International Conference 2023: Workshop on Aeolis; 6 CPs and presentations; Coastal Working Group Annual Meeting 2024

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FY23 Coastal Tech Transfer Activities (2/4)

- EWN: 3D Printing Natural materials to create nature-inspired infrastructure workshop; N-EWN Knowledge Series : NNBF Islands Deliverables : Measuring What Matters (Papers and Summit) : Environmental Applications of Additive Manufacturing Featuring Nature-Inspired Design using Natural Materials - Engineering With Nature (dren.mil); Assessing Opportunities for Equitable Natural Infrastructure Planning: Accounting for Human Well-Being and Comprehensive Benefits - Engineering With Nature (dren.mil); Linking CE-QUAL-W2 with SWAT - Engineering With Nature (dren.mil); Integrating Water Resources Infrastructure with Upland Management to Advance Nature-Based Solutions for Water Quantity and Quality - Engineering With Nature (dren.mil); N-EWN Policy Summit; N-EWN Knowledge Webinar Series: 3D Printing Natural Materials to Create Nature-Inspired Infrastructure;
- EWN: International Working Group workshop; Thin Layer Placement Guide; EWN Atlas 3
- DOER: 1) Webinar: strategic placement of dredged material as source of sediment to coastal saltmarsh; 2) Development of INFO PAPER and participation in briefing to USACE HQ Chief of Operations and Regulatory, and Chief of Environmental Programs regarding PFAS in Sediment and the USACE Navigation Program (9/29/2023); 3) Presentation to Great Lakes and Ohio River Division Operations Chiefs “PFAS and Dredged Material Management” (8/7/2023); 4) Meetings/webinars with USACE District sediment scientists and dredged material managers regarding PFAS, including drafting of talking points (February 8 and 13, June 22, August 16); 5) Media release: ERDC scientists assist USACE New Orleans District with turbidity assessment at Bayou Rigaud; monthly DOER webinars.

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FY23 Coastal Tech Transfer Activities (3/4)

- DOTS: Technical support (3), CSAT Training Workshop for Savannah District.
- NCMP: JALBTCX Workshop, 150 participants; JALBTCX 25th Anniversary VIP event, 4 agencies; JALBTCX 25th Anniversary public event, 150 participants; Interagency Working Group on Ocean and Coastal Mapping Annual face-to-face retreat; 2022 JALBTCX workshop tool demo: “Geospatial Tools for Automating Remote Vegetation Extraction”; 2023 JALBTCX workshop presentations and demos: “Land Use Assessments and Multi-Temporal Trend Analyses of Coastal Vegetation Using Metrics Derived from Hyperspectral and Lidar Data” (technical presentation); “DUNEVEG toolbox and multi-metric/landcover analysis” (open house technical demo); “DUNEVEG toolbox and multi-metric/landcover analysis” (VIP demo); NCMP to Tech Spotlight to the Chief;
- NCMP: Panel Session at ASBPA Coastal Summit; Flood Risk management Remaining Items and Research Development, and Technology Congressionally Directed Work Annual Meeting; USGS Inland Hydrography Workshop; Florida Coastal Mapping Program Meeting; Alaska Coastal Mapping Summit; Regional Sediment Management In-Progress-Review; NOAA Emergency Response Division Chief; Photogrammetry, 3D, Lidar Community of Practice 2023 Meeting; Interagency Ecological Restoration Quality Committee (IERQC) Technical presentation (Glenn) on 7 DEC 2023 to Great Lakes interagency RE: NCMP Ontario data; Leveraging 25 years of lidar data to quantify the geomorphic resilience of a highly-engineered estuarine beach, Ocean Sciences 2024; Inlet and barrier island sediment pathways: Insights from volume change analysis near Barnegat Inlet, NJ. ASBPA 2023;

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FY23 Coastal Tech Transfer Activities (4/4)

- NCMP: Temporal Patterns of Geomorphic Resilience in Mississippi's Mainland Beaches and Dunes, ASBPA 2023; Decadal Variability of Beach-Dune Geomorphic Resilience and Cross-Shore Aeolian Fetch in NE Florida – Applications of the USACE Coastal Engineering Resiliency Toolbox, National Conference on Beach Preservation Technology; Temporal and Spatial Variability of Cross-shore Fetch and the Potential for Aeolian Dune Recovery at Anastasia Island, FL; Evolution of the USACE National Coastal Mapping Program and Implementation of Small Unmanned Aerial Systems; Use of the Geomorphons GIS Tool to Support Feature Extraction at Structures and Inlets; Geologic, Hydrodynamic, and Anthropogenic Controls on Inlet Evolution: Indian River Inlet, DE;
- NCMP: Geomorphology Feature Extraction in The Great Lakes to Support Sediment Budgets and Vulnerability Assessments; Development of training materials for the JALBTCX suite of tools (continuing in FY24)
- RSM: Bi-monthly seminars; Building coastal resilience kick-off workshop.

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