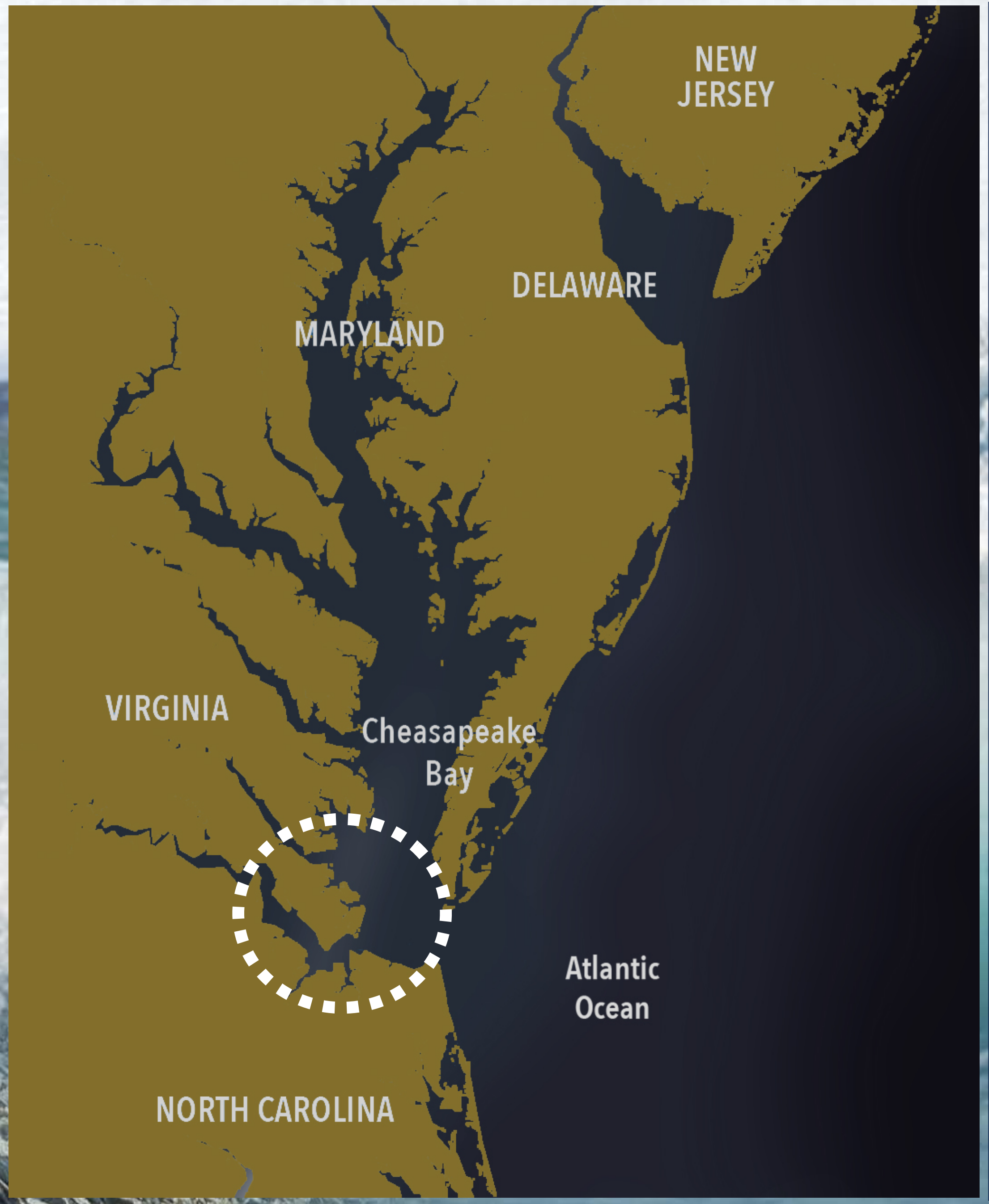
UNIVERSITY OF DELAWARE **COASTAL RESILIENCE DESIGN STUDIO** PRESENTS

Carbon in the TIDEWATER



This is a place of firsts.
The first English settlers chose this place for its comfortable waters and protective cape.
It was here that the first villages of the Kecoughtan were displaced in 1610.
It was here that the first African slave ships arrived in 1619 and
It was here that the first Union Army Camp would free enslaved African Americans in 1861.
From the ramparts of Fort Monroe to the diverse streets of Phoebus,
this place has withstood war, fires, hurricanes, and floods.

Here, pivotal change in America's story has occurred before,
and it is here that the story of our relationship with nature must evolve.

OUR TEAM

DJ Bromley
Landscape Architecture
Marine Science

Christopher Fettke von Koeckritz
Landscape Architecture, Art

Kevin Ganjon
Environmental Studies
Political Science, Data Science

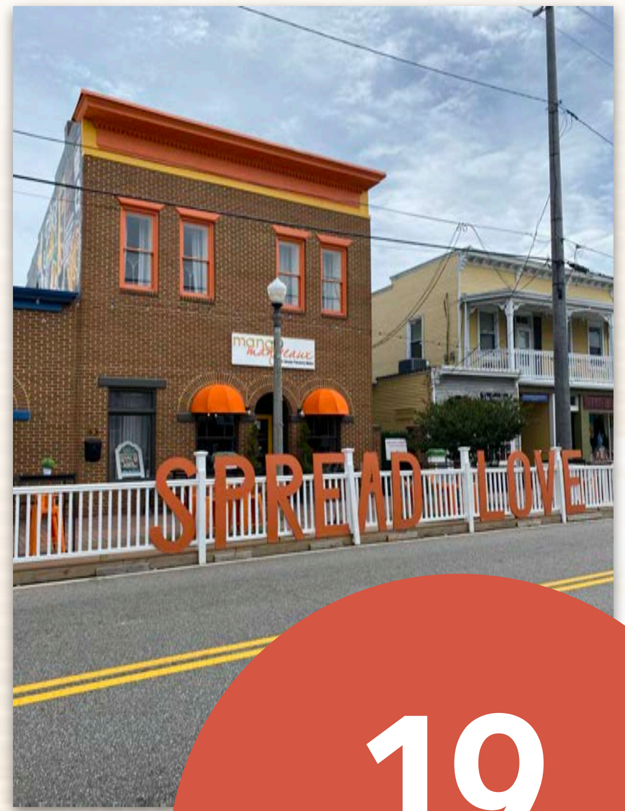
Ryan McCune
Civil & Environmental Engineering

Leigh Muldrow
Landscape Architecture
International Relations, Economics

Delaney Pilotte
Landscape Architecture

CRDS COASTAL RESILIENCE DESIGN STUDIO

Sea Grant Delaware



TEAM VISIT INPUT & INTERVIEWS

19 hours of expert interviews

57 scientific articles reviewed

1721 hours student research & design work

Over the course of the design phase, the team spoke with several experts in the fields of coastal resilience and natural sciences. We would like to thank these individuals for their help and encouragement.

Doug Janeic, Sovereign Consulting & former Army Corps project manager

Emma Ruggiero, University of Delaware-Living Shoreline Design

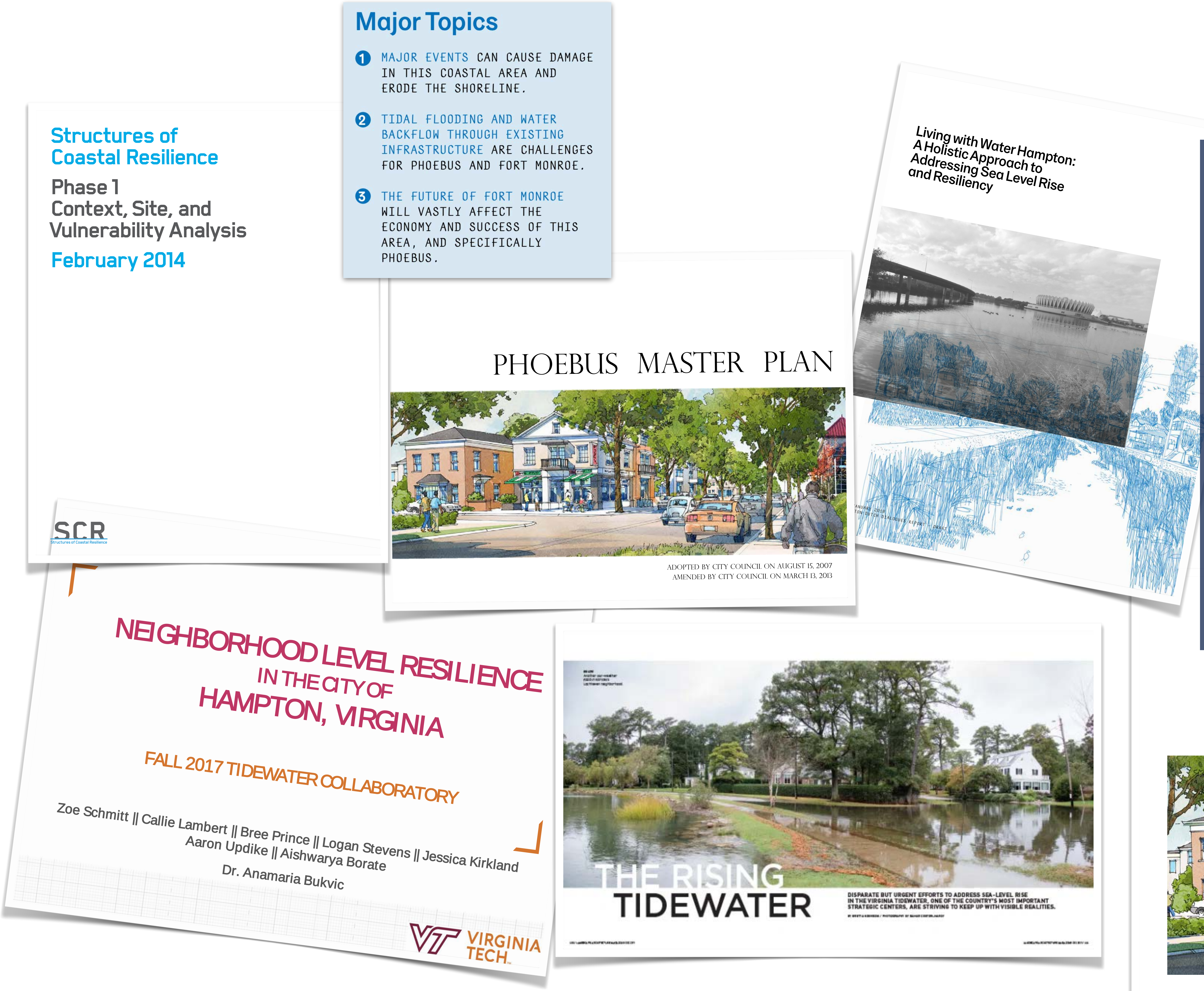
Stefanie Simpson, The Nature Conservancy- Resilient Funding Markets

Rodrigo Vargas, University of Delaware- Carbon Sequestration

Jocelyn Wardrup, University of Delaware -Soil Carbon Stocks

Neils Lindquist, University of North Carolina- Oyster Substrate

PAST PLAN REVIEW



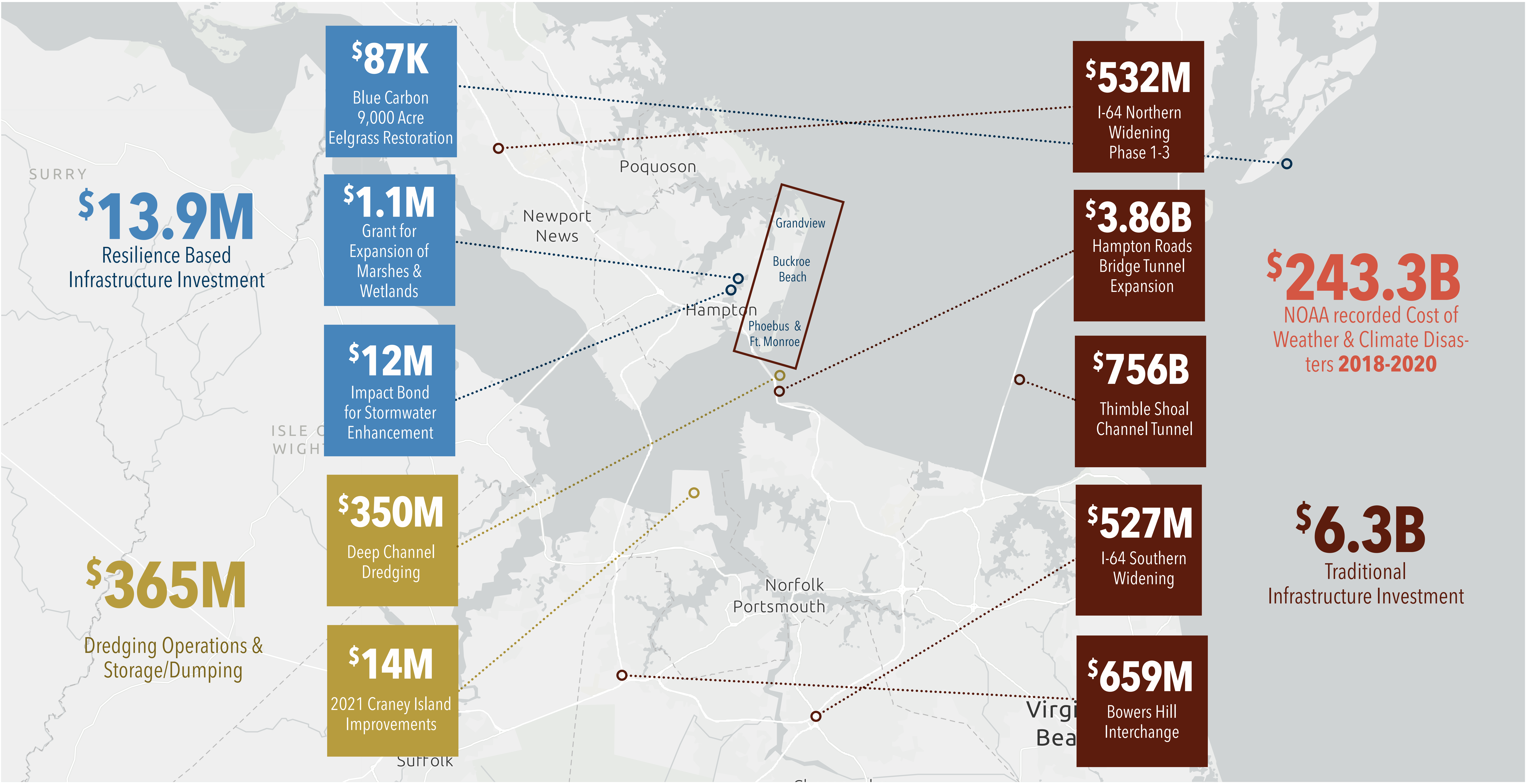
The coastal threat has been named a priority but most of the resilient based plans are focused on **inland stormwater issues.**

The team came to the conclusion that Phoebus & Ft. Monroe could not be protected unless we consider the **coastline holistically.**

TEAM PIVOT

The University of Delaware Coastal Resilience Design Studio team imagines a future with ecologically based infrastructure and development that continually contributes to drawing down carbon from the atmosphere as the ***economic standard*** to tackle the heart of the problem that threatens all life on the planet we call home.

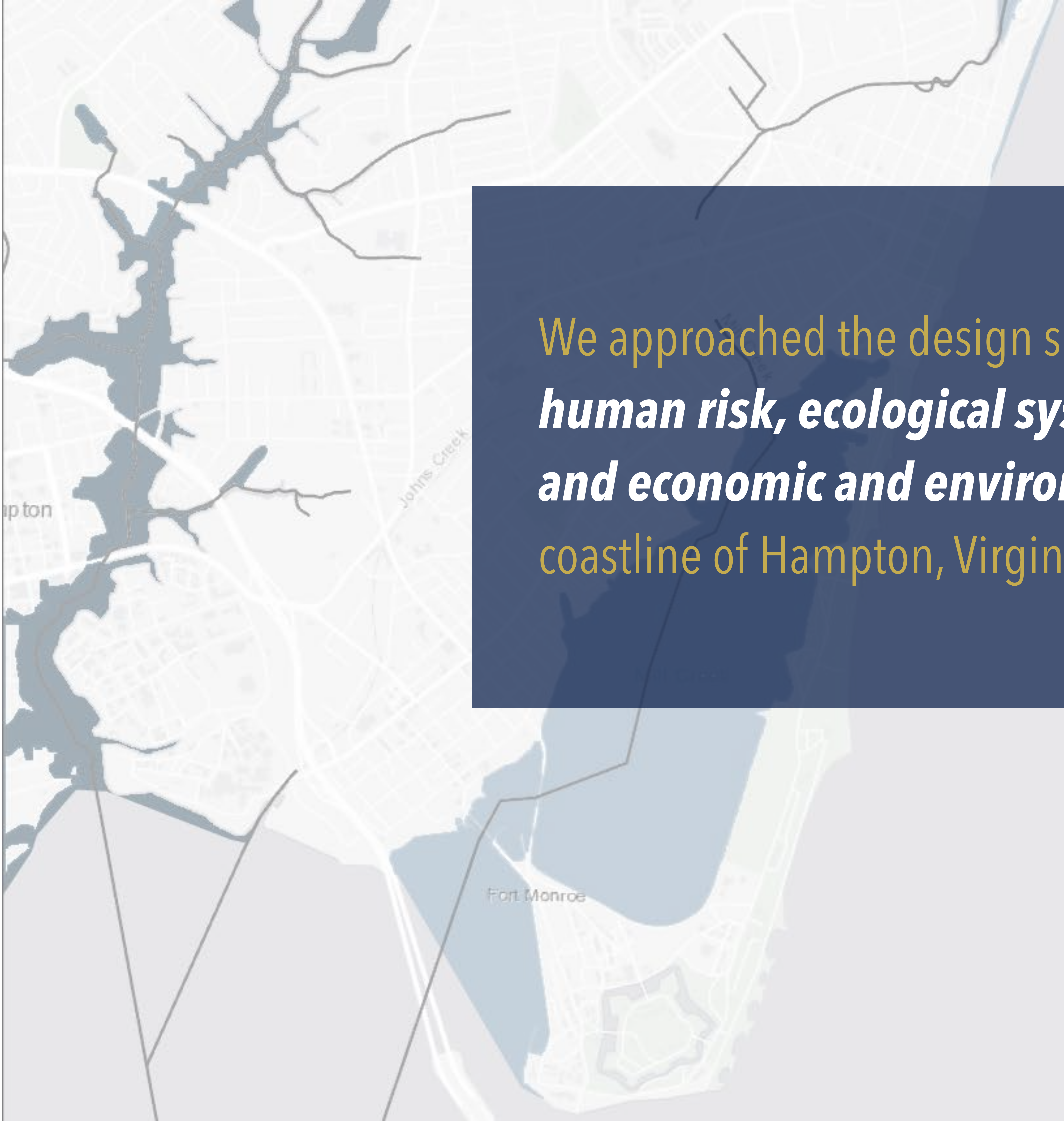
REGIONAL INVESTMENT



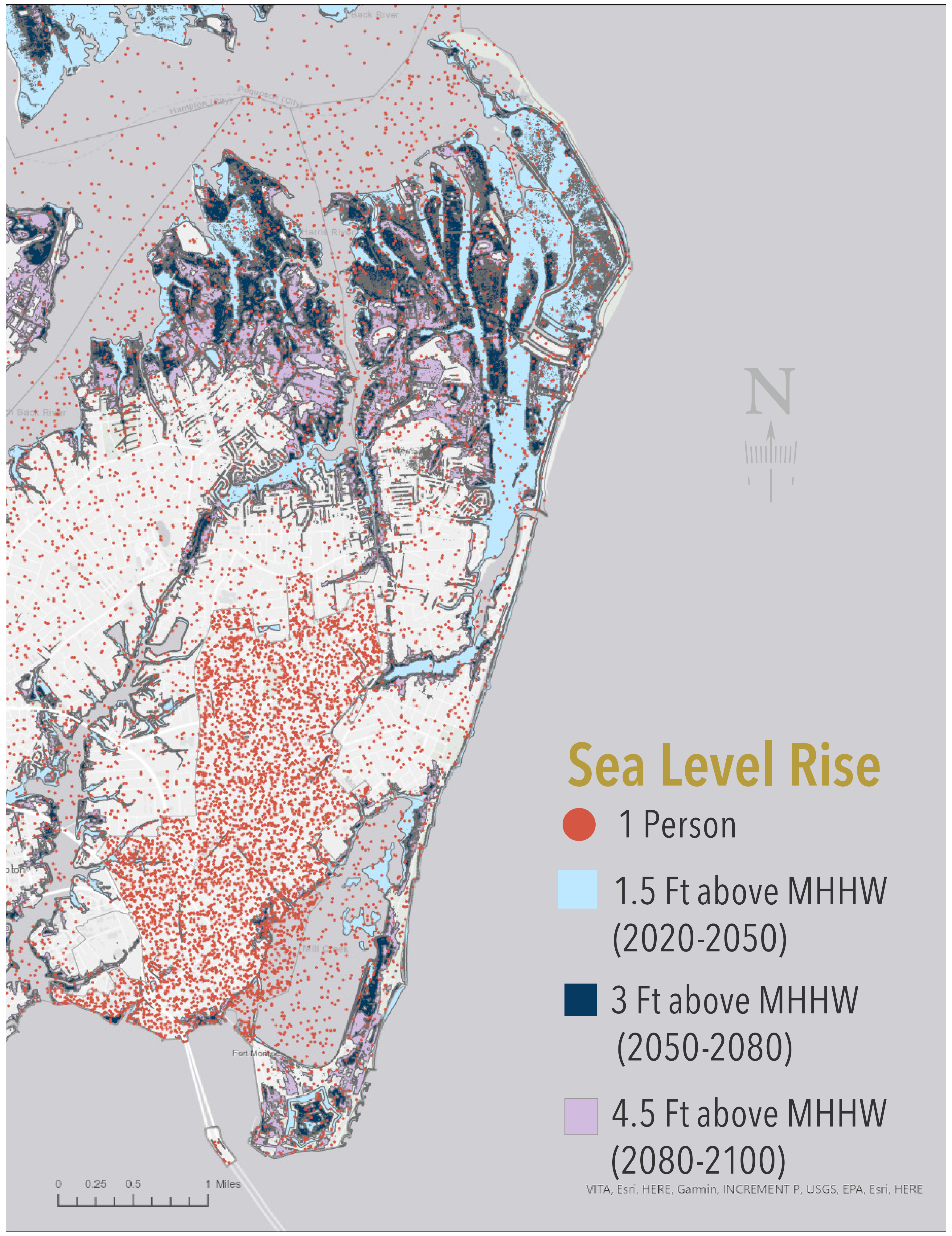
https://www.hrtac.org/page/hrtac-projects/ https://www.dredgingtoday.com/2021/04/23/dredgit-nabs-craney-island-contract/
https://www.portofvirginia.com/who-we-are/newsroom/dredging-to-make-virginia-the-east-coasts-deepest-port-is-underway/ http://www.cbbt.com/project-description/

TEAM APPROACH

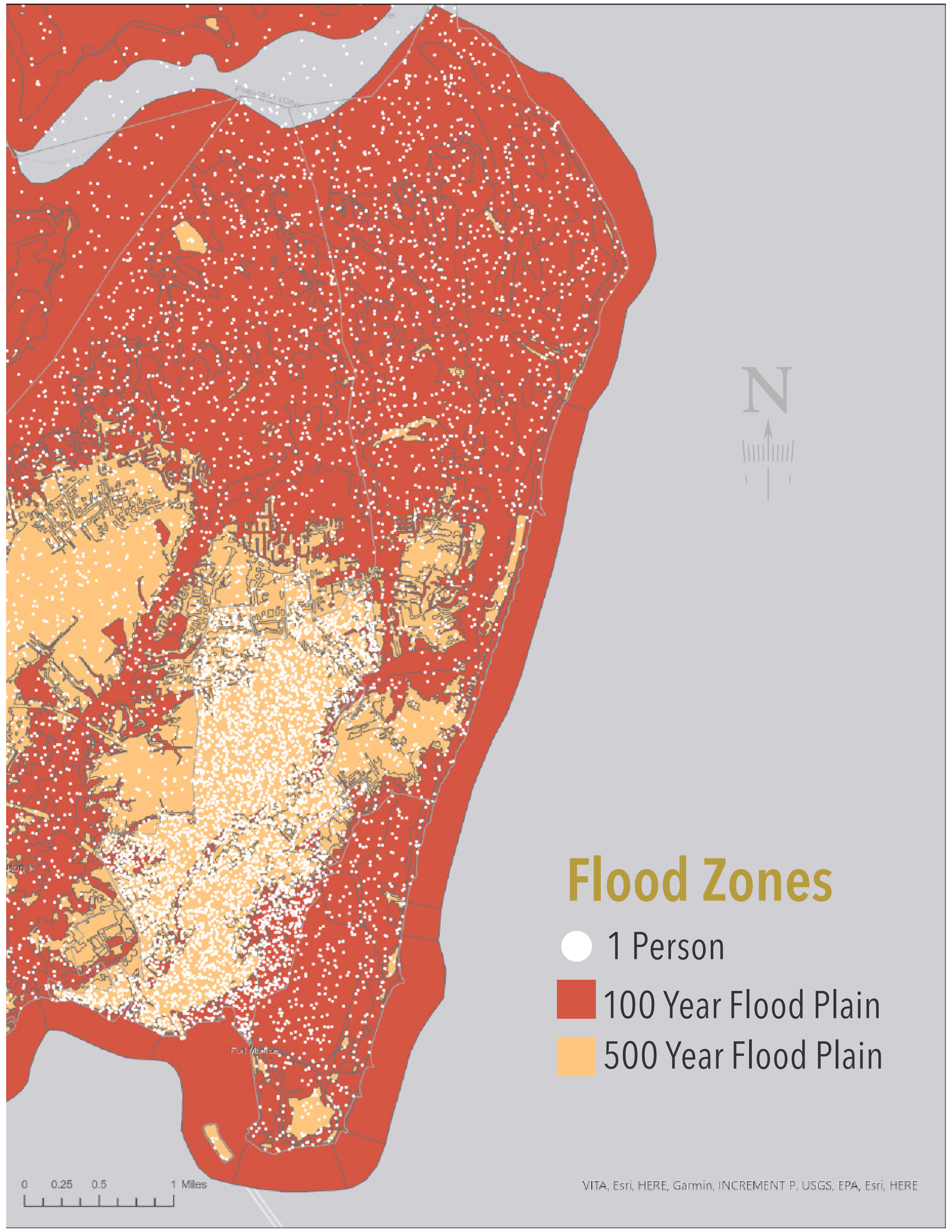
We approached the design solution by examining ***human risk, ecological systems and associated risks, and economic and environmental policies*** affecting the coastline of Hampton, Virginia.



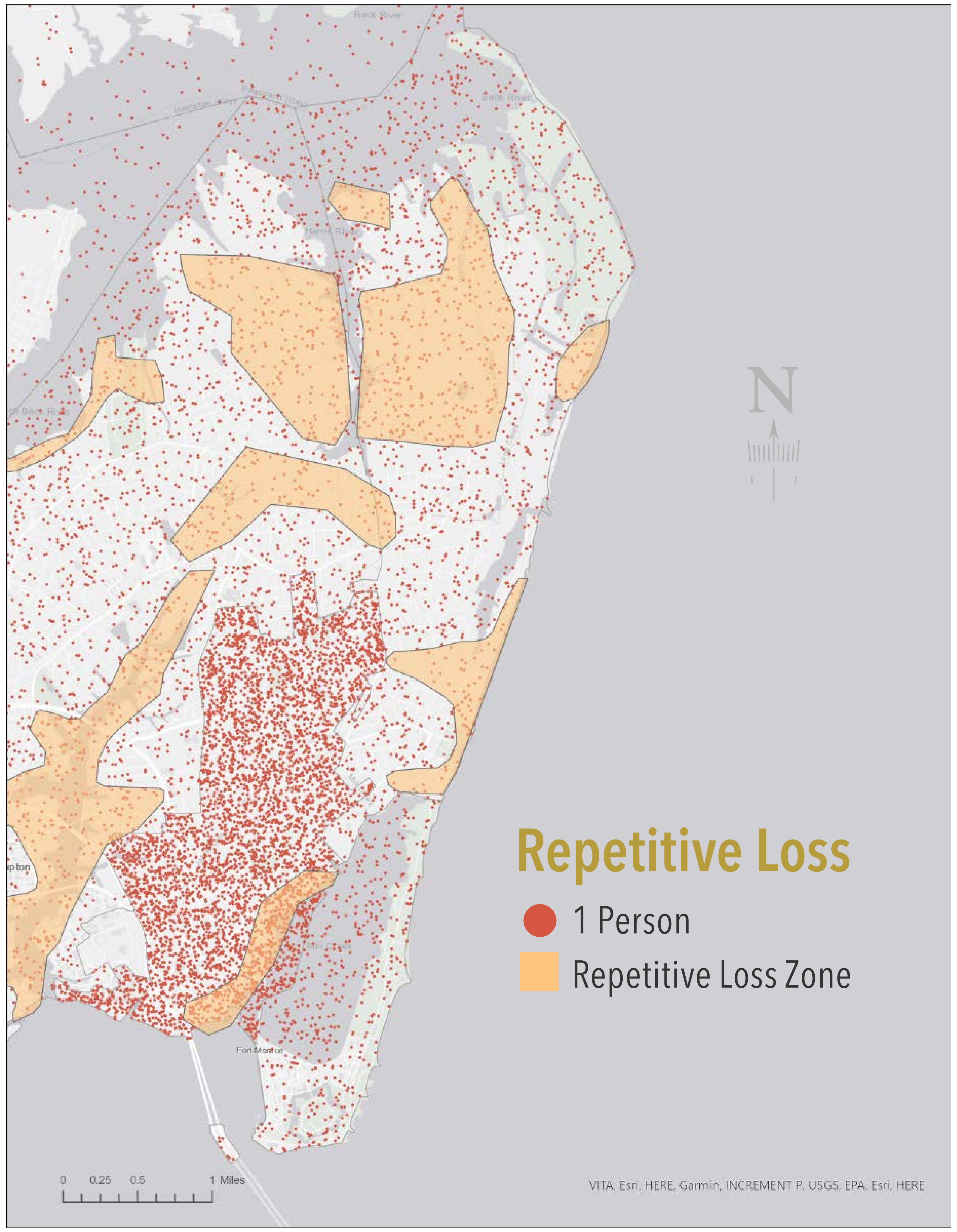
HUMAN RISK



Population Density data from the 2019 Community Survey living in the City of Hampton SLR zones indicate the largest area affected will occur at the 1.5′ level

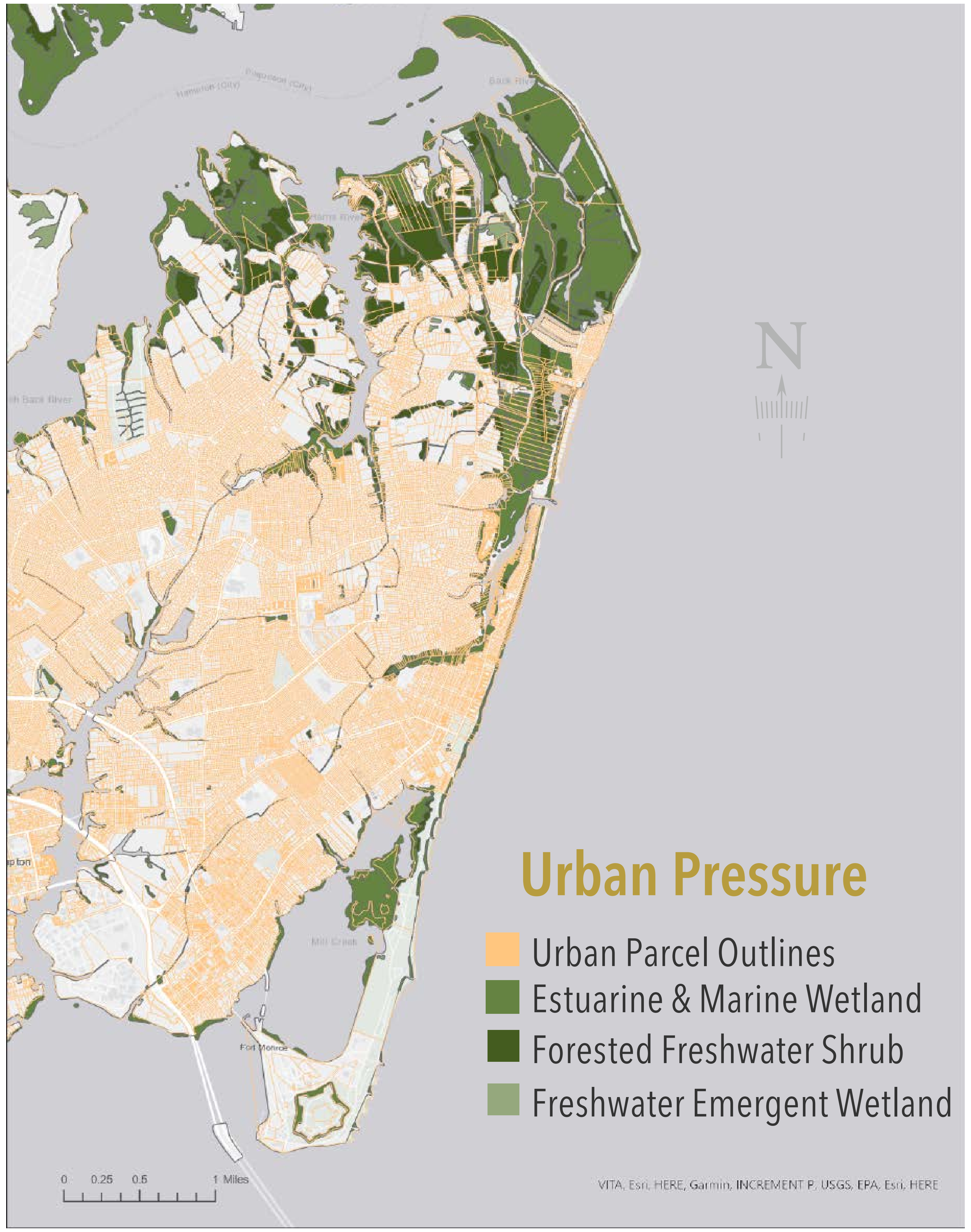


Population Density living in the FEMA designated 100 and 500 Year Floodplain show high density in the lower risk zone, however, this limits increased capacity in that area

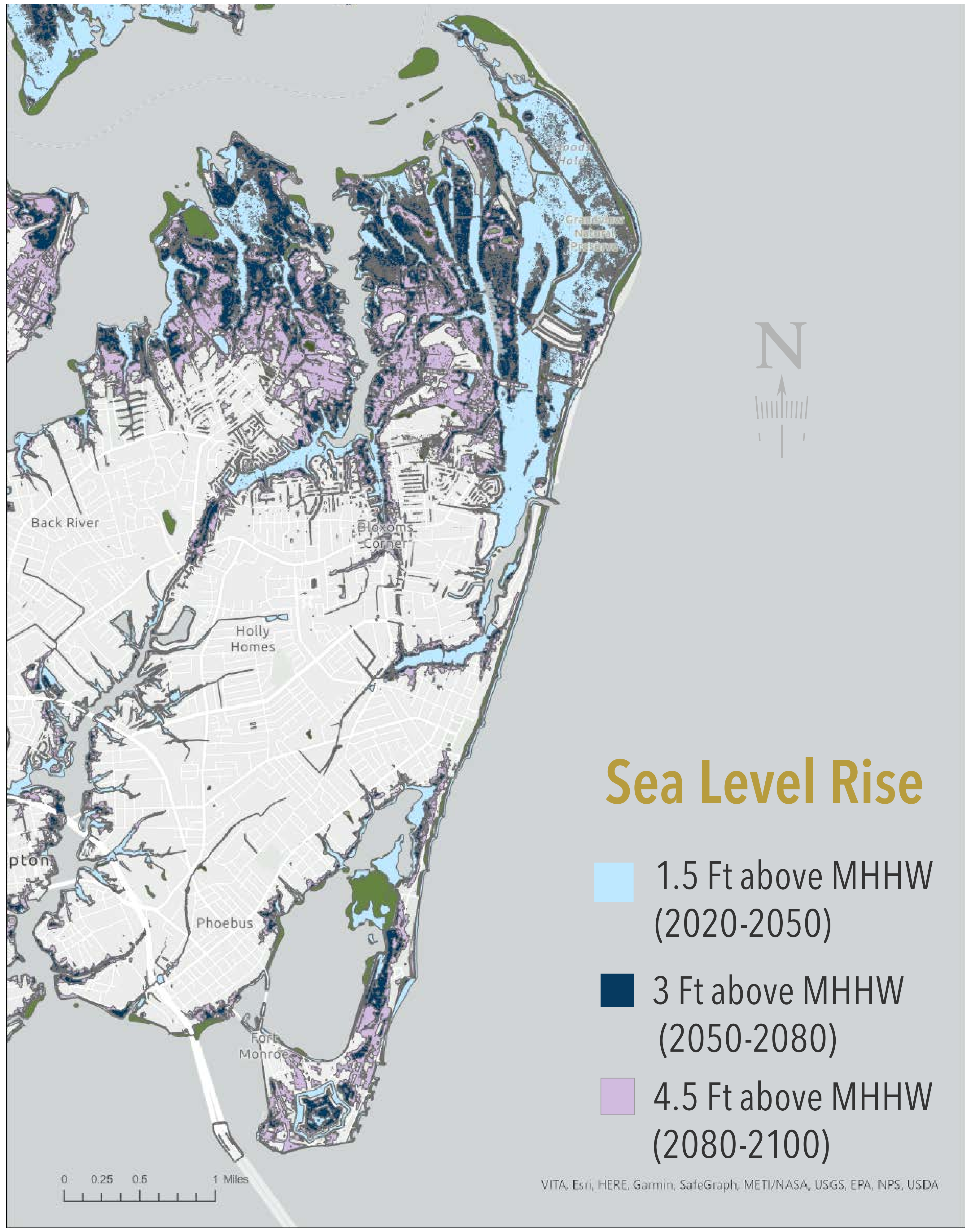


Clusters of Repetitive Loss & Insurance Claims indicate that population density does not directly correlate with recurrent property loss and recovery payouts

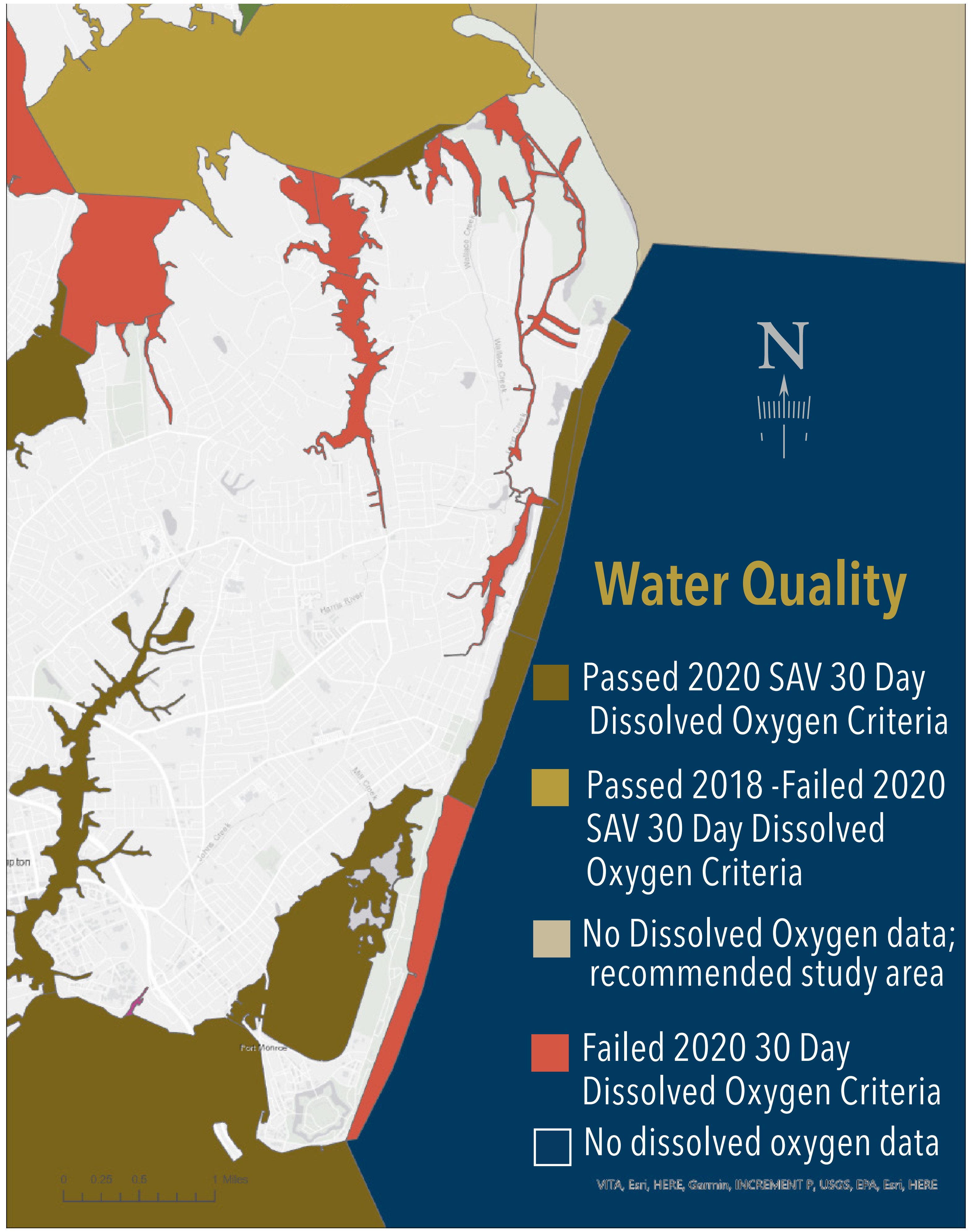
ECOLOGICAL RISK



Analysis of urban pressure on existing wetlands shows the existing parcel lines encroaching on wetlands from the west leaving no space for migration due to sea level rise.

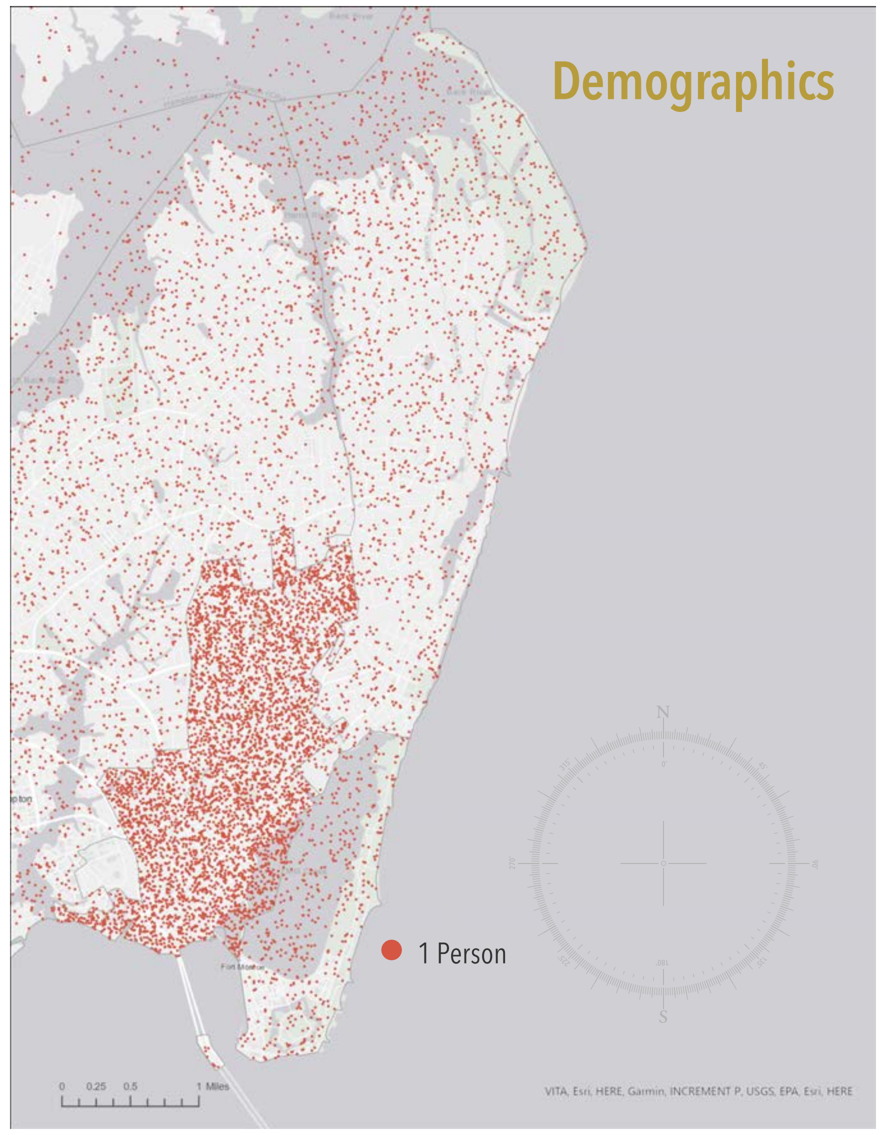


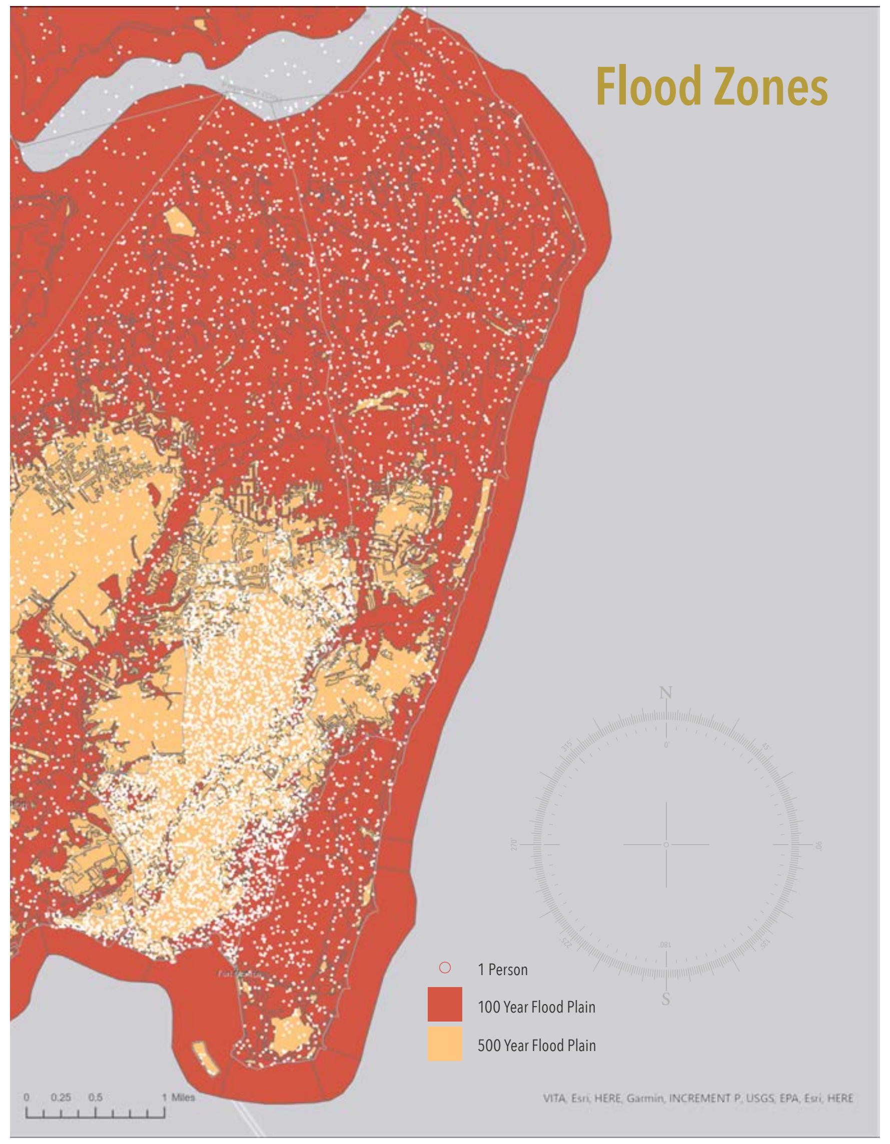
Sea level rise impacts on existing wetlands indicate the greatest area of loss to vital wetland ecosystems will occur at the lowest level of predicted sea level rise

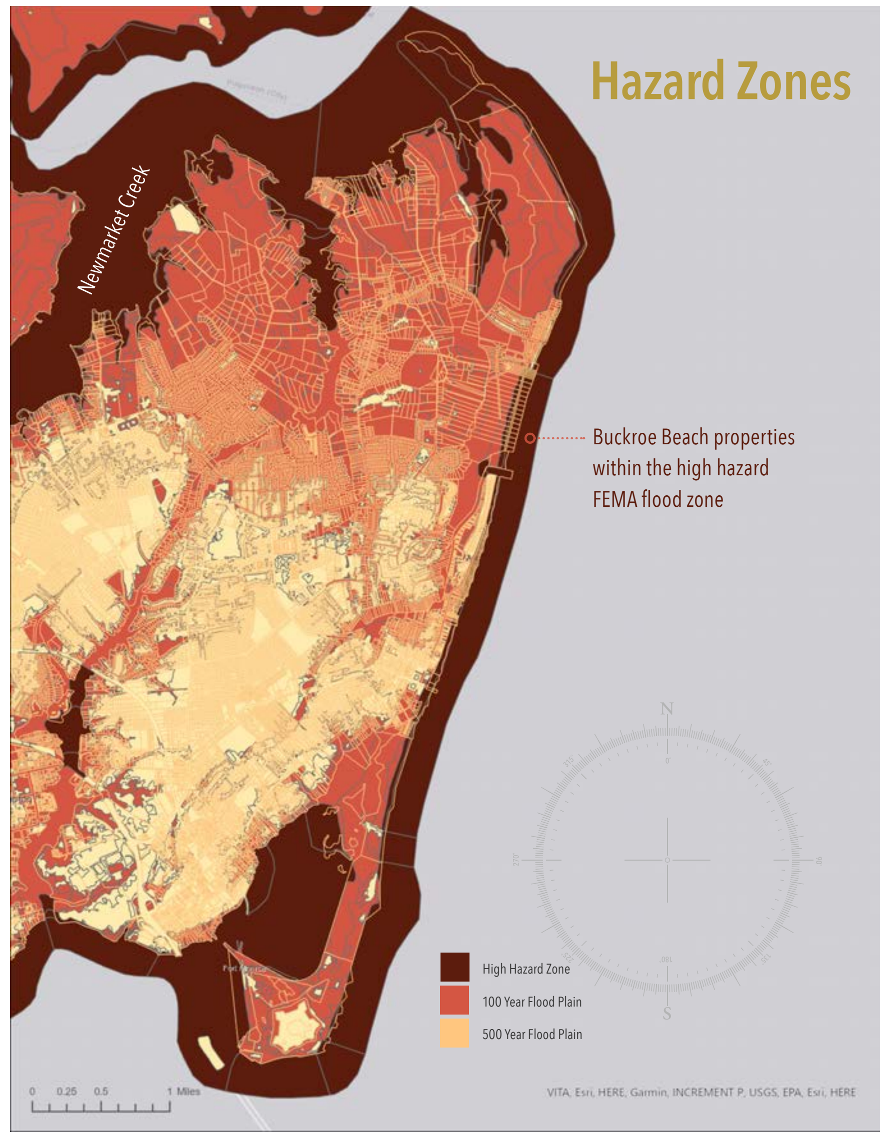


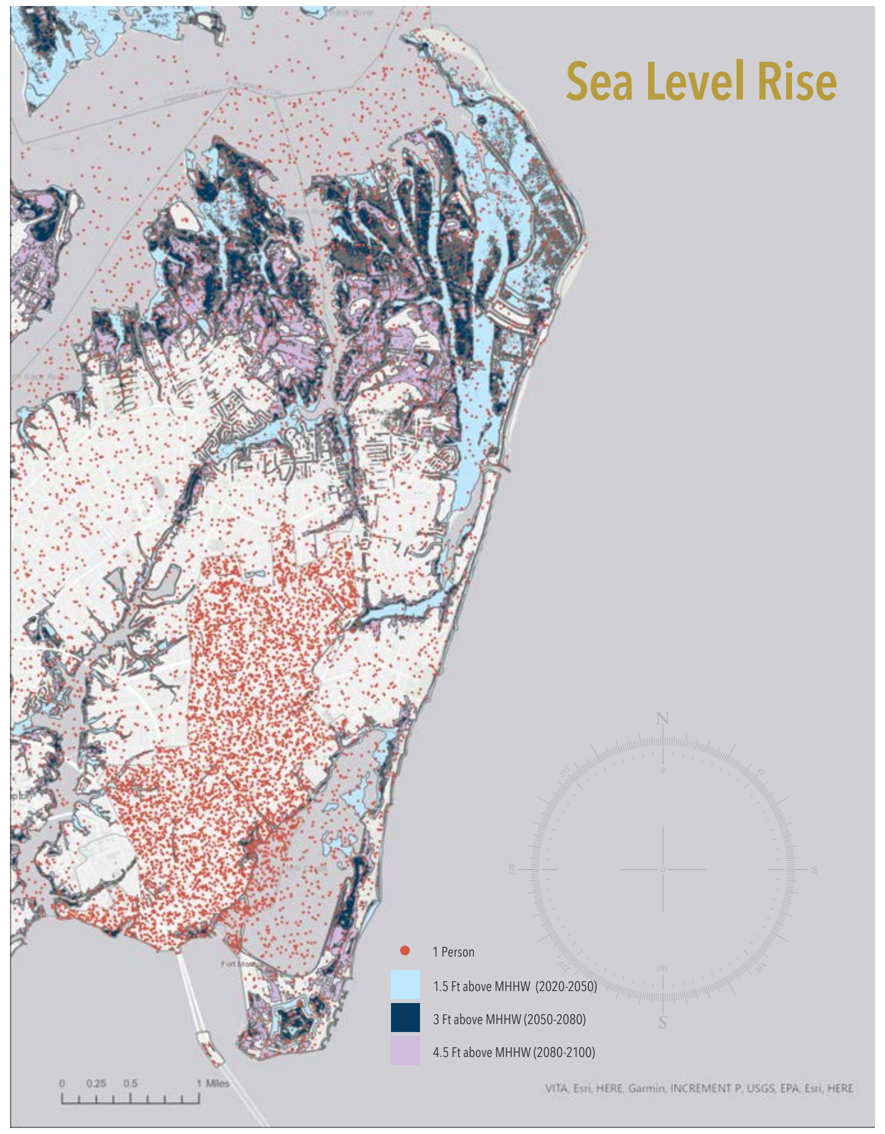
Data from the Virginia DEQ 2020 facilitated a water quality analysis to evaluate areas of potential for future SAV resto-ration and creation

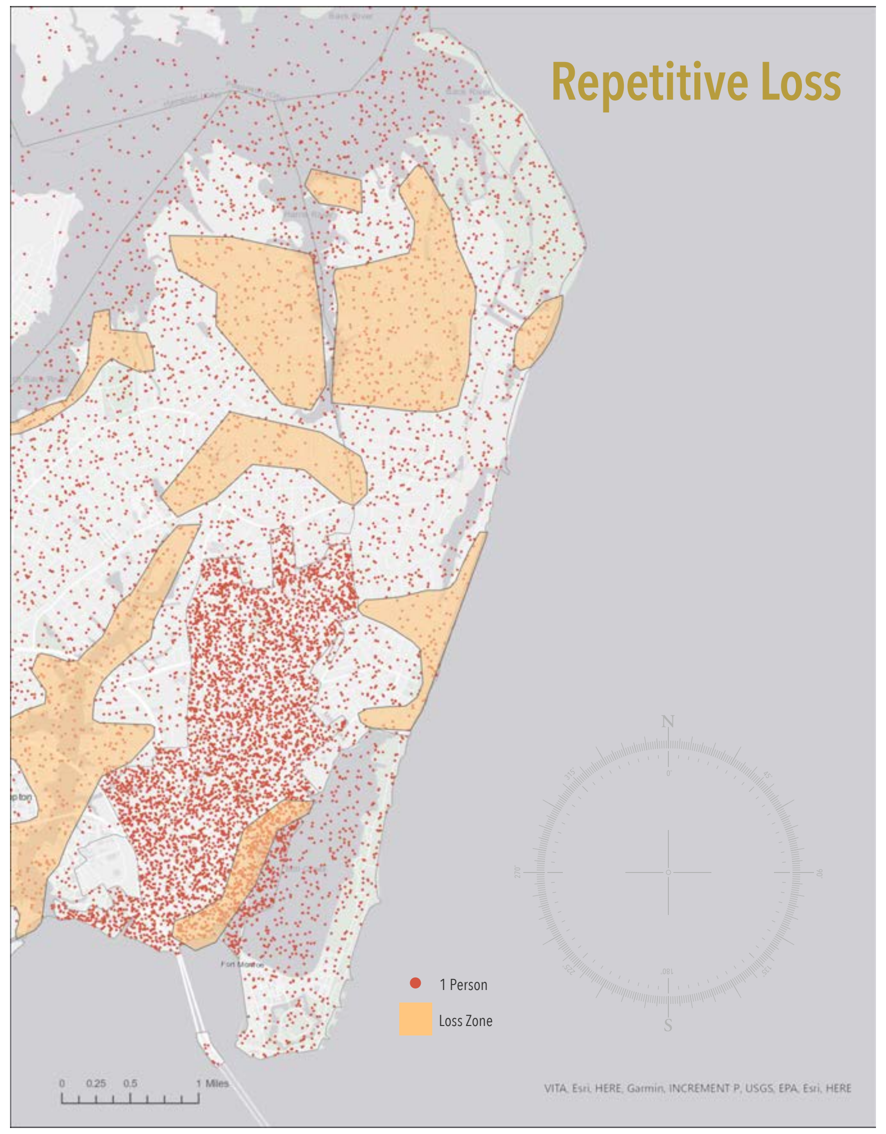
COASTAL ANALYSIS

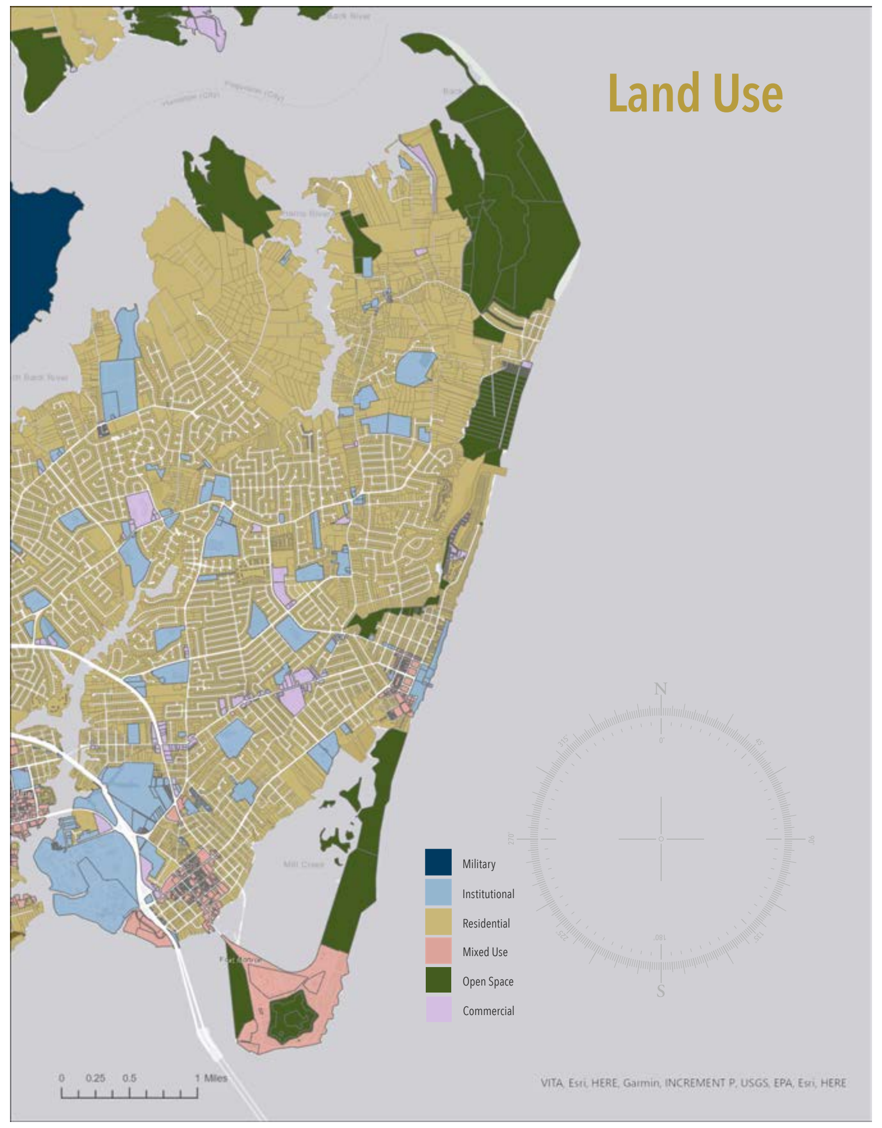


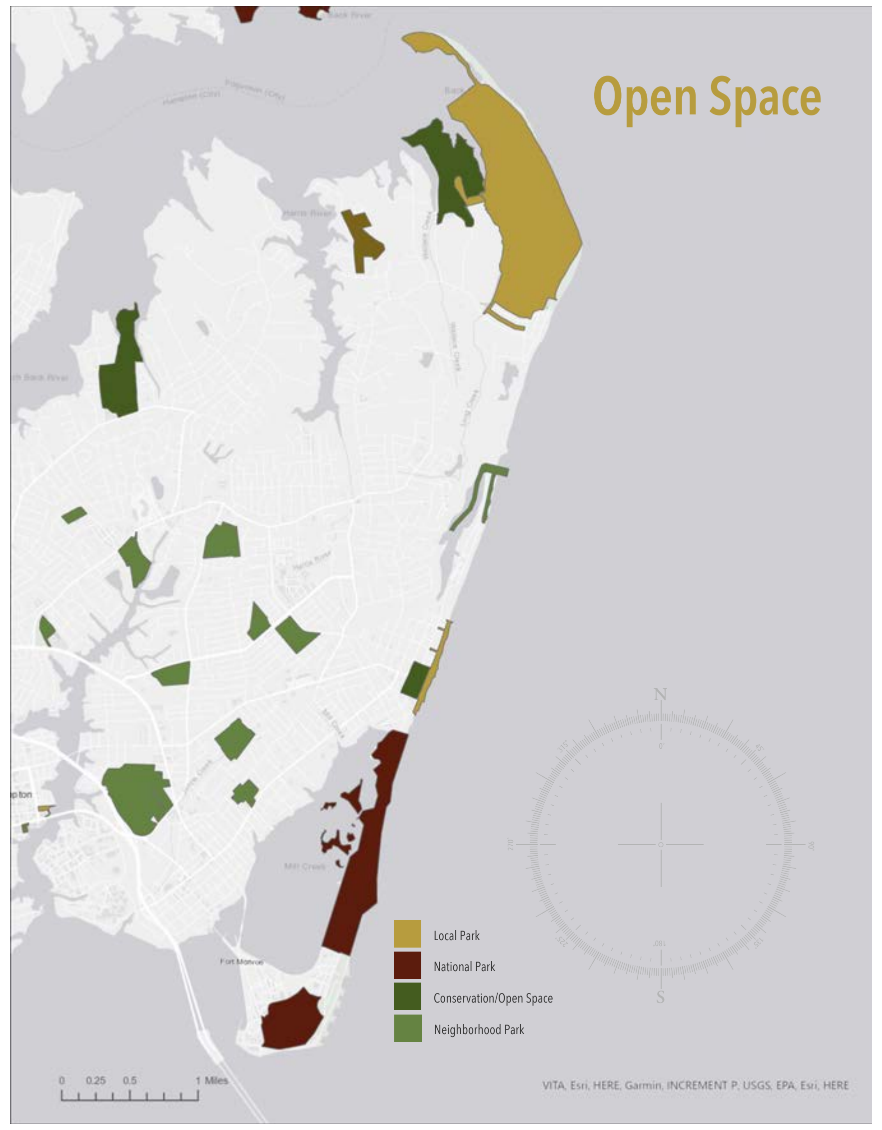


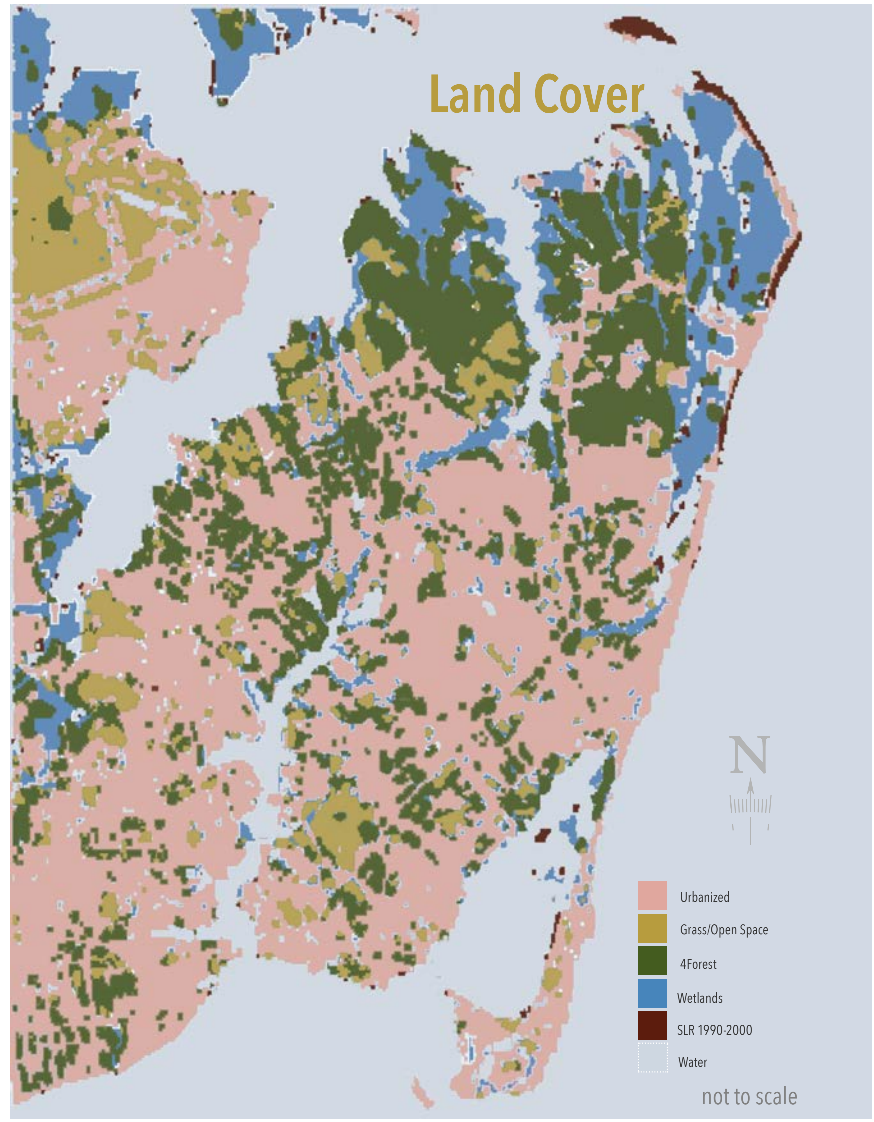


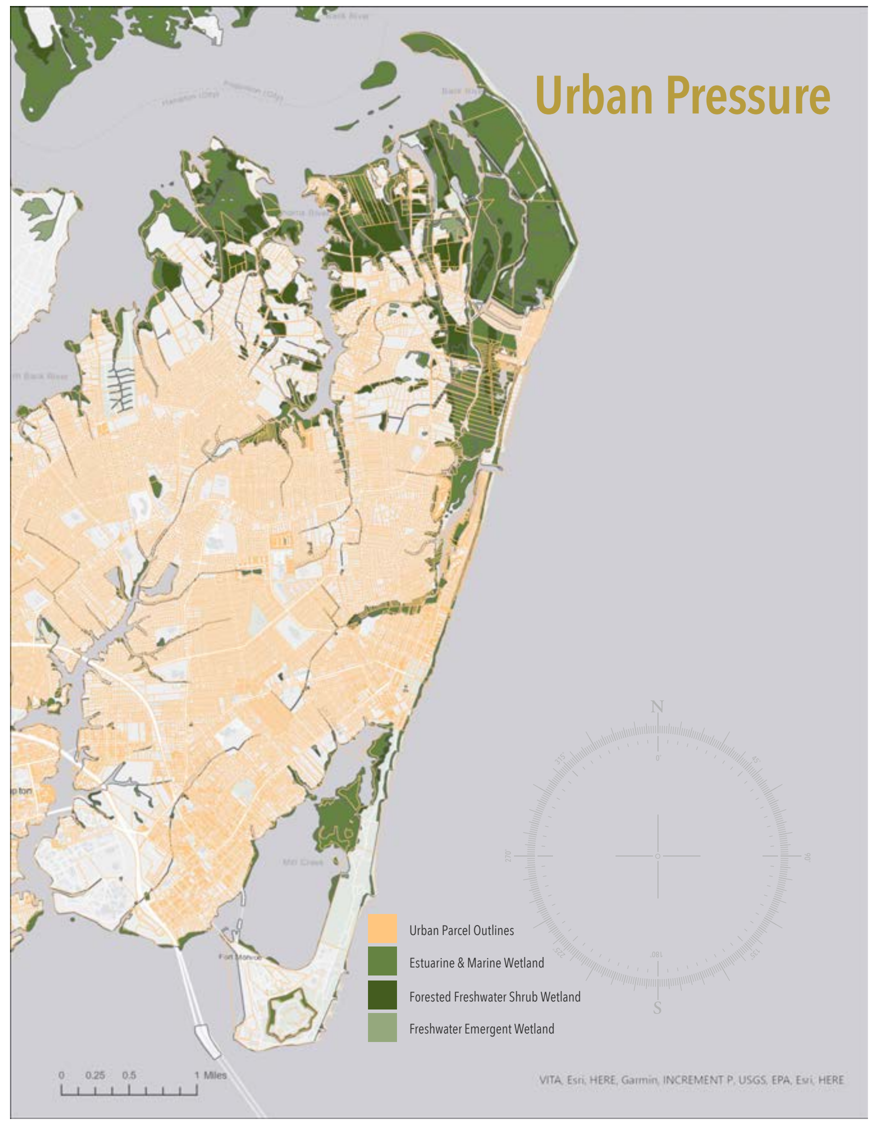


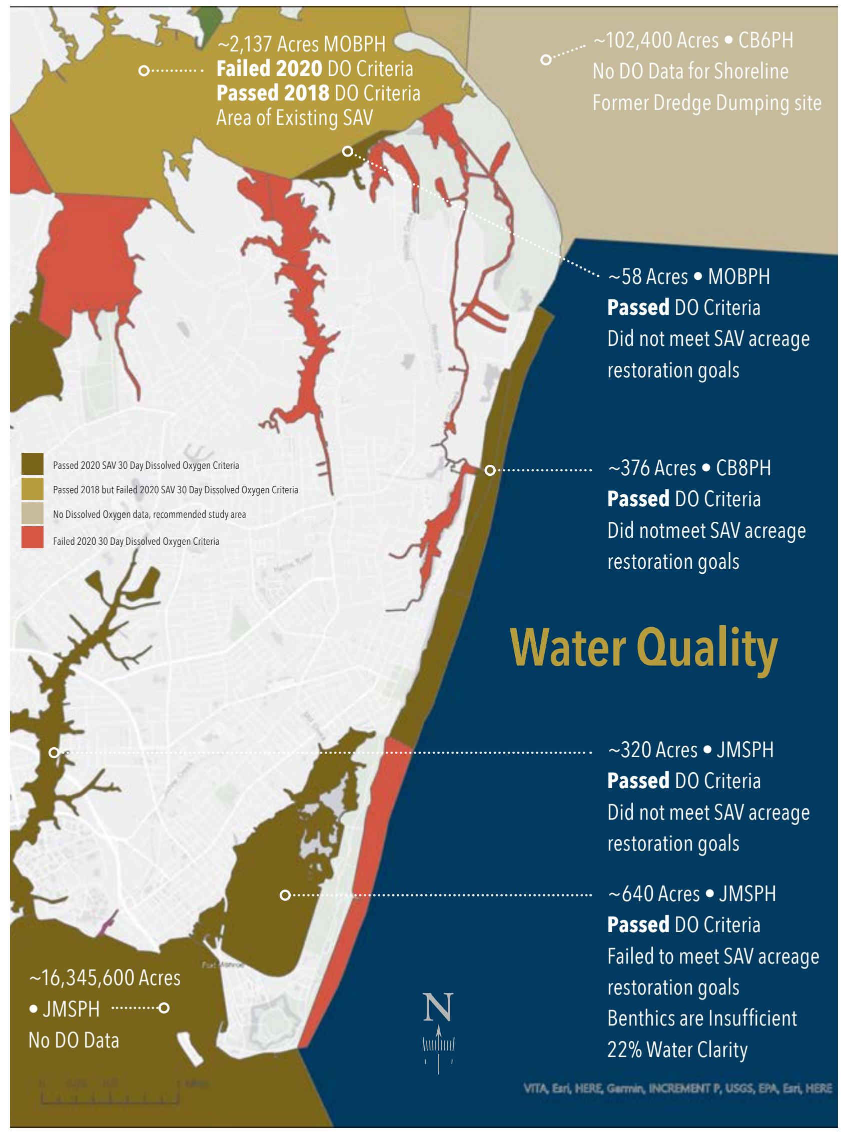




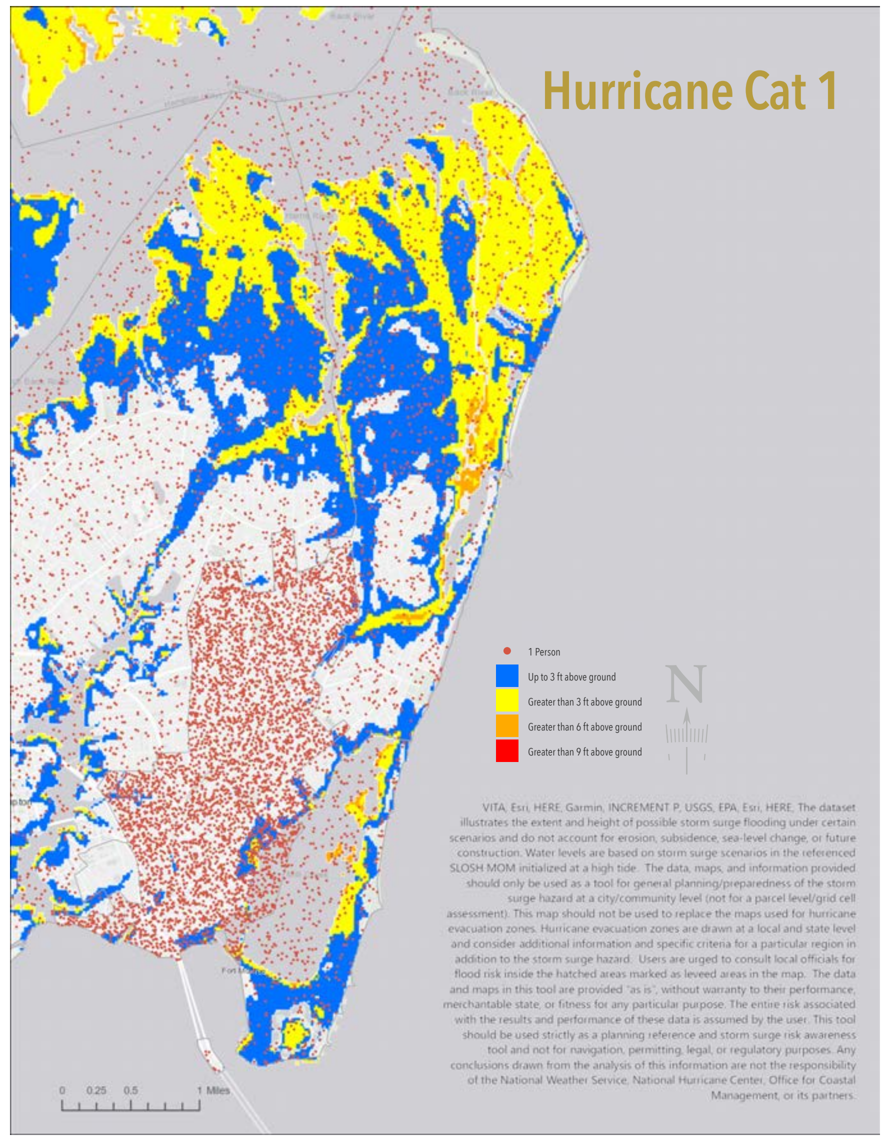


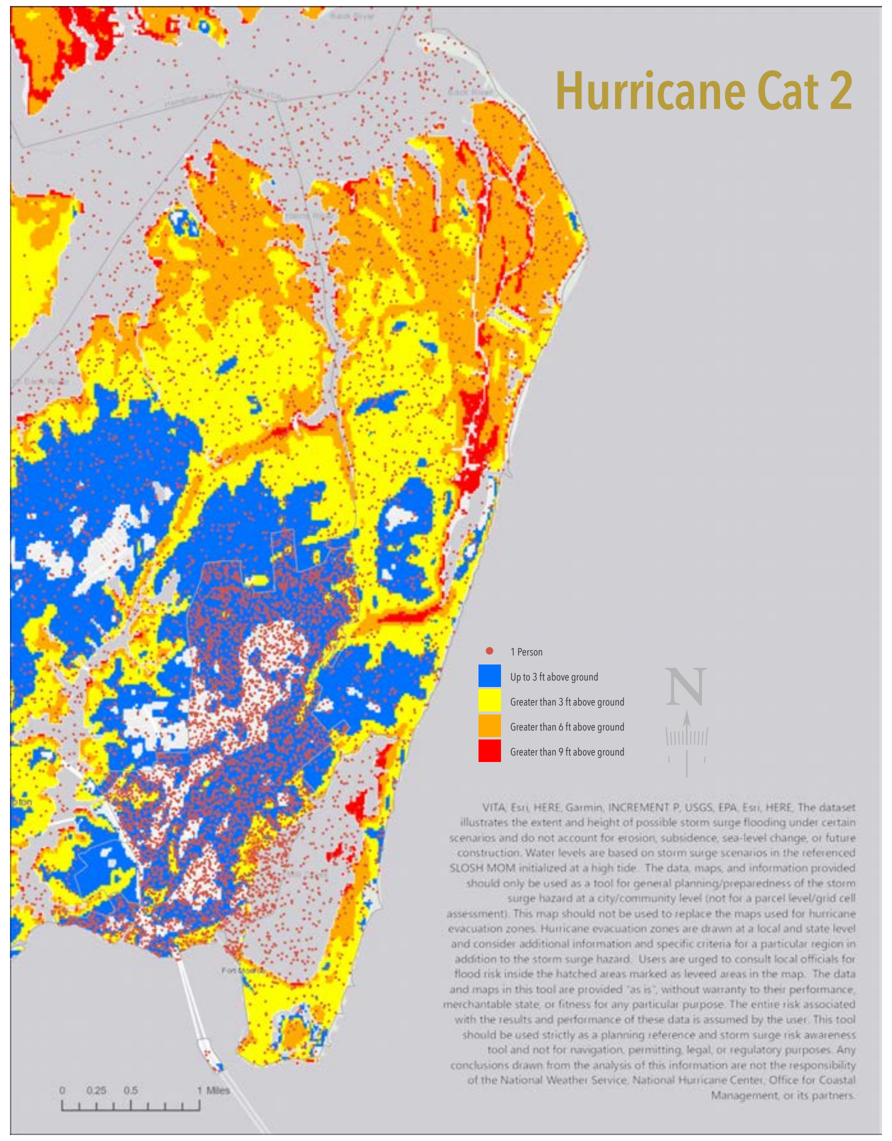


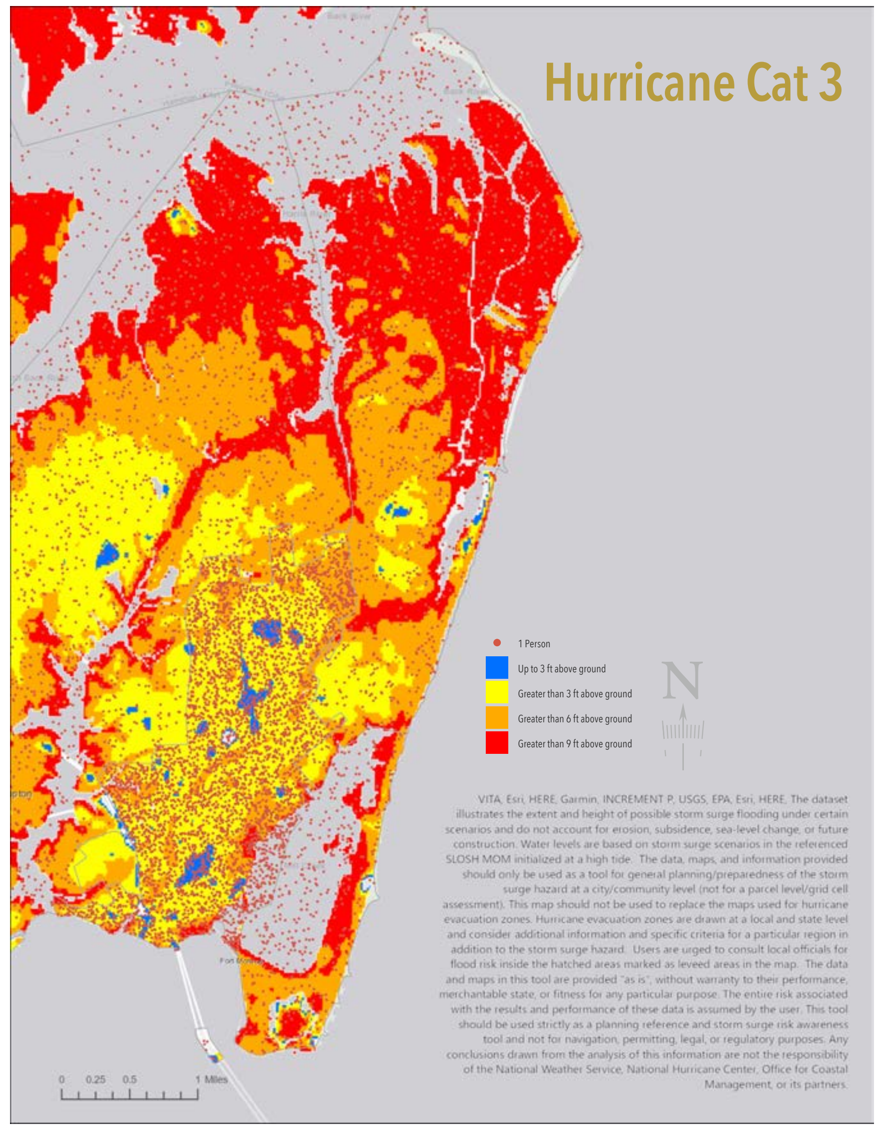


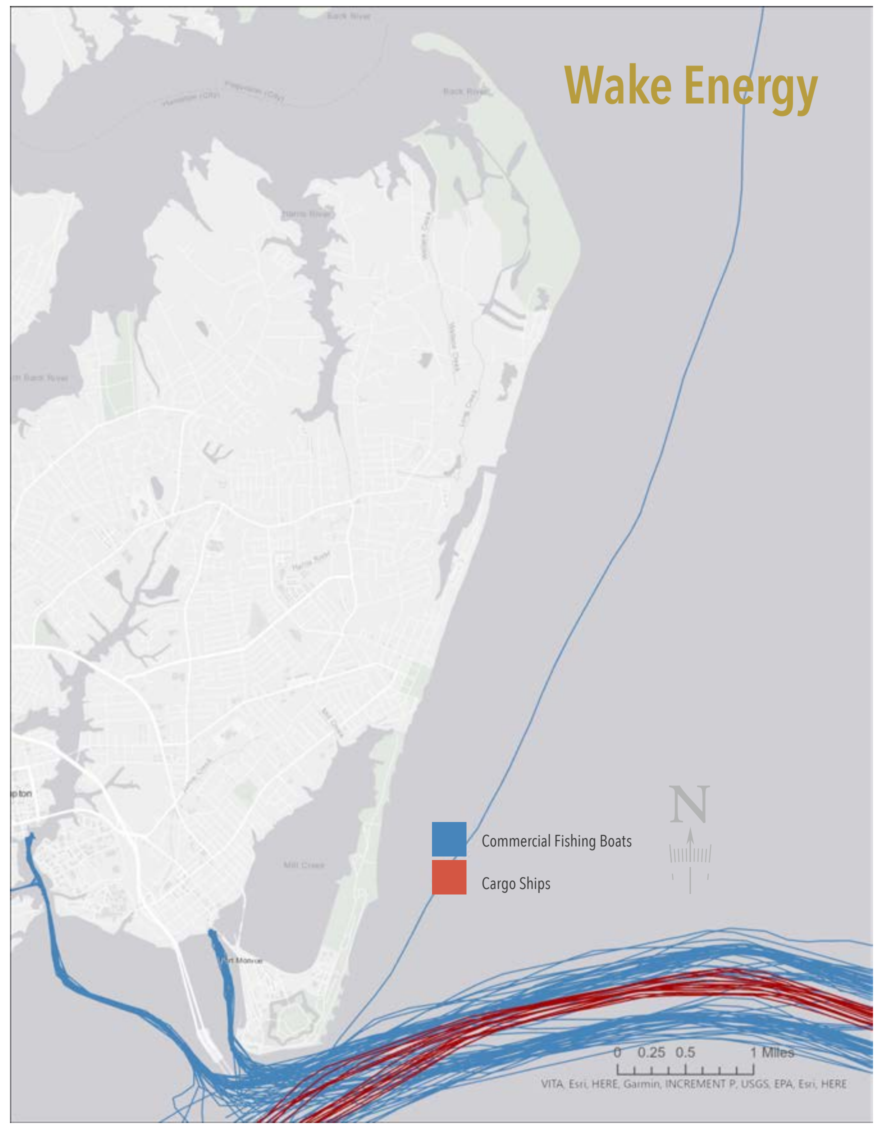


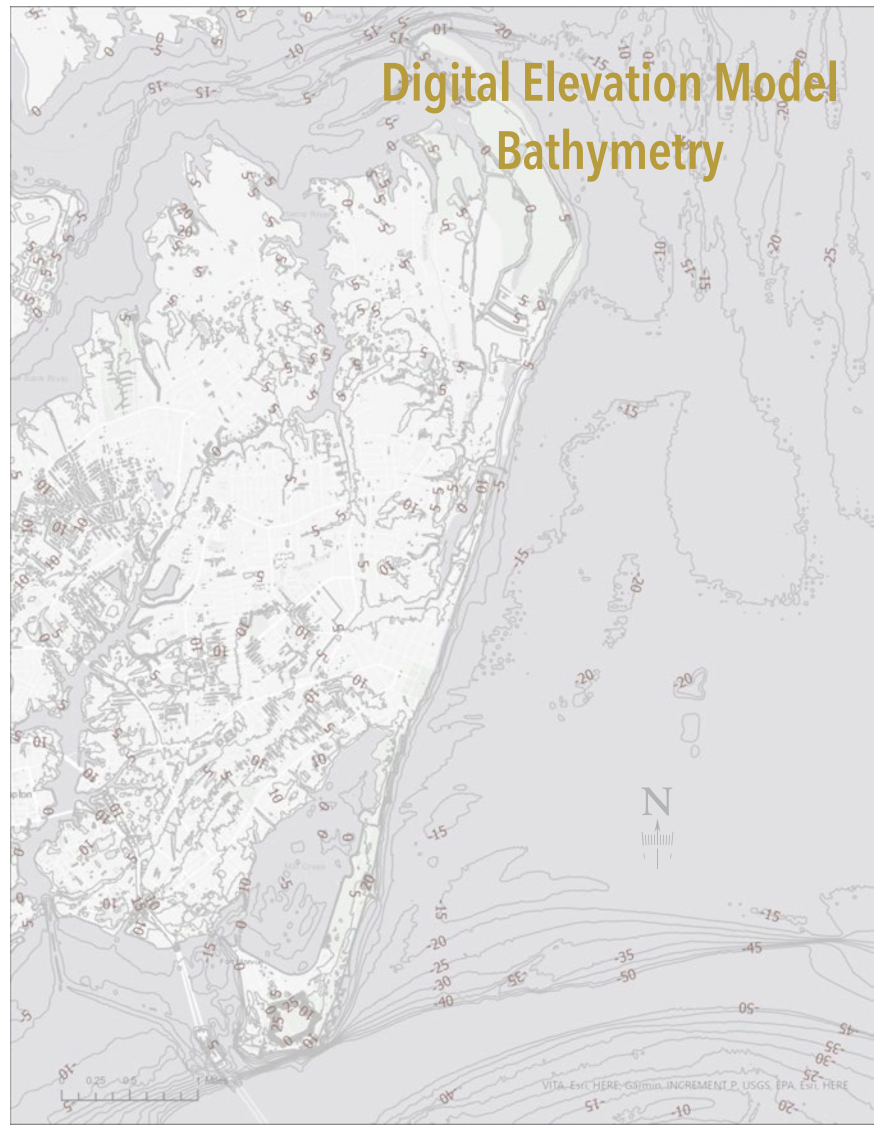
COASTAL ANALYSIS

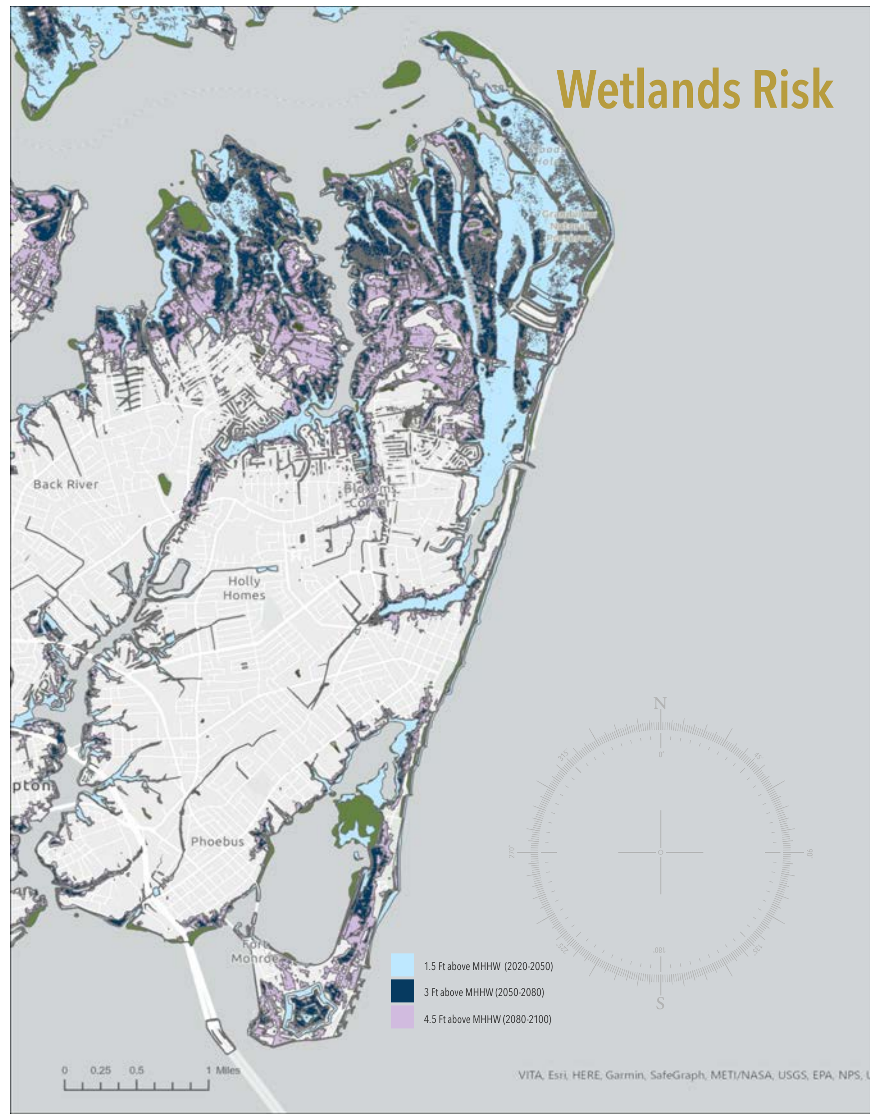


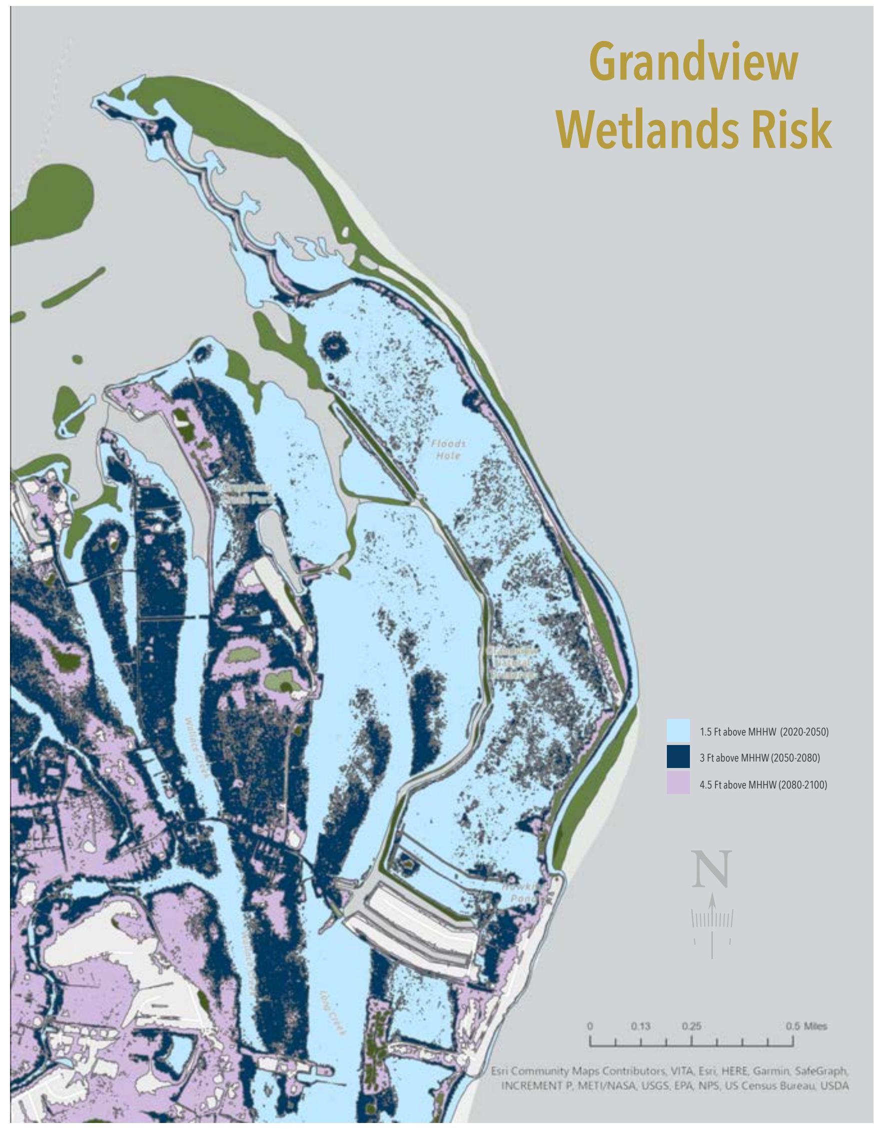


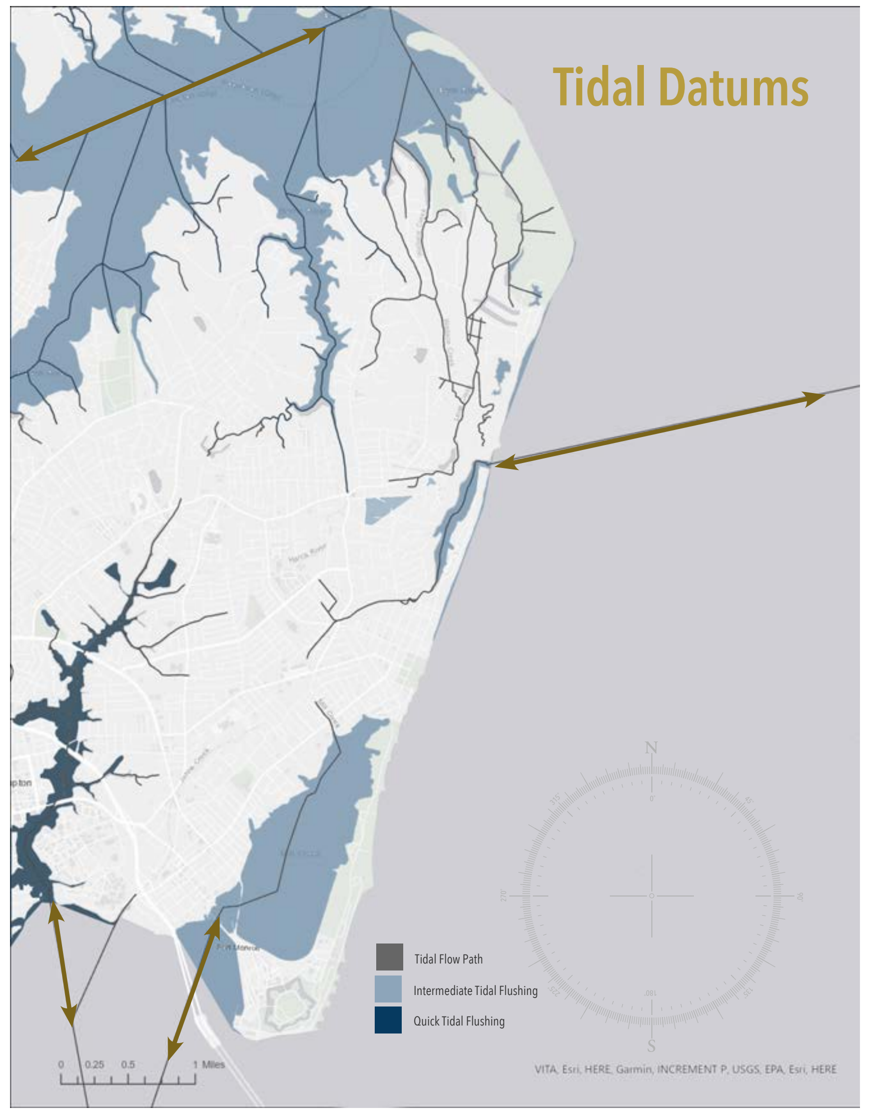


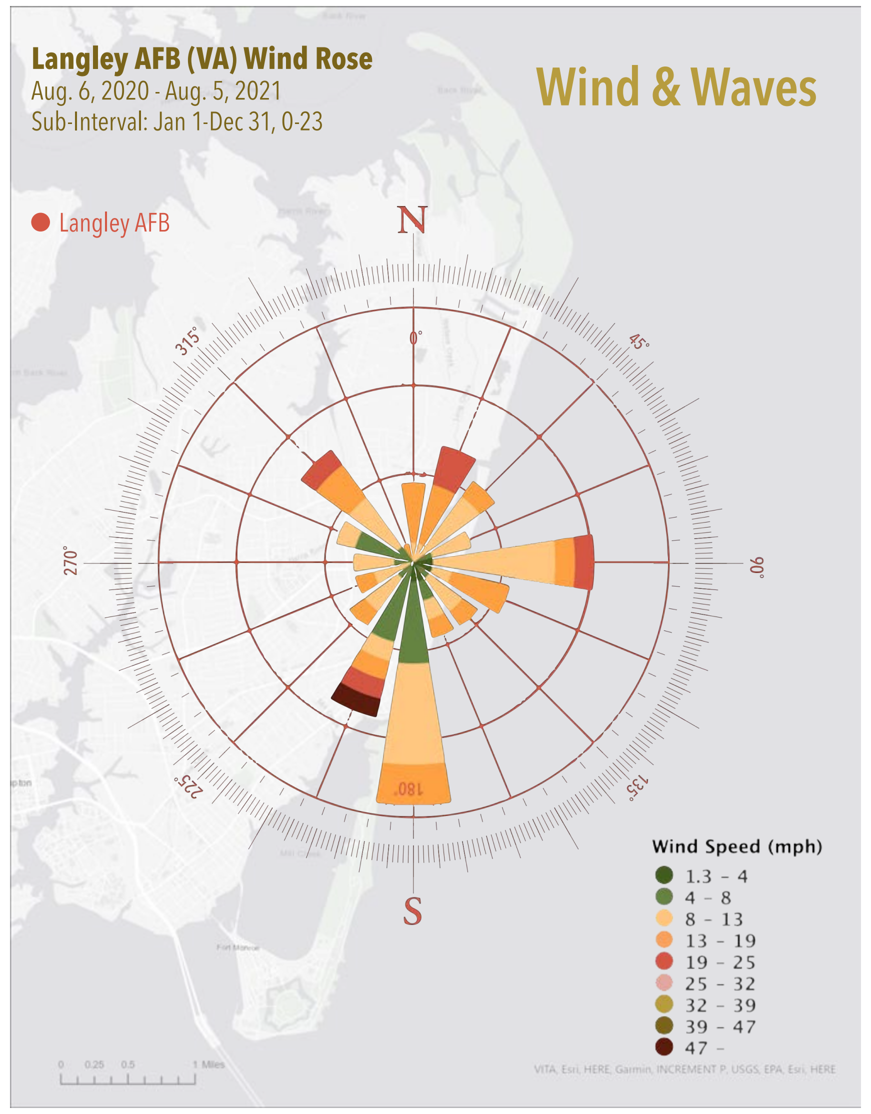












THE IDEA

The team synthesized scientific research, emerging engineering technologies, resilience based case studies, policy, and interviewed experts in the fields of resilience, soils, engineering, and carbon capture.

The result is a ***four layer approach*** that addresses the need for coastline protection that is regenerative and adaptive, harnessing the ***global carbon market*** as a finance tool.

OUR PLAN

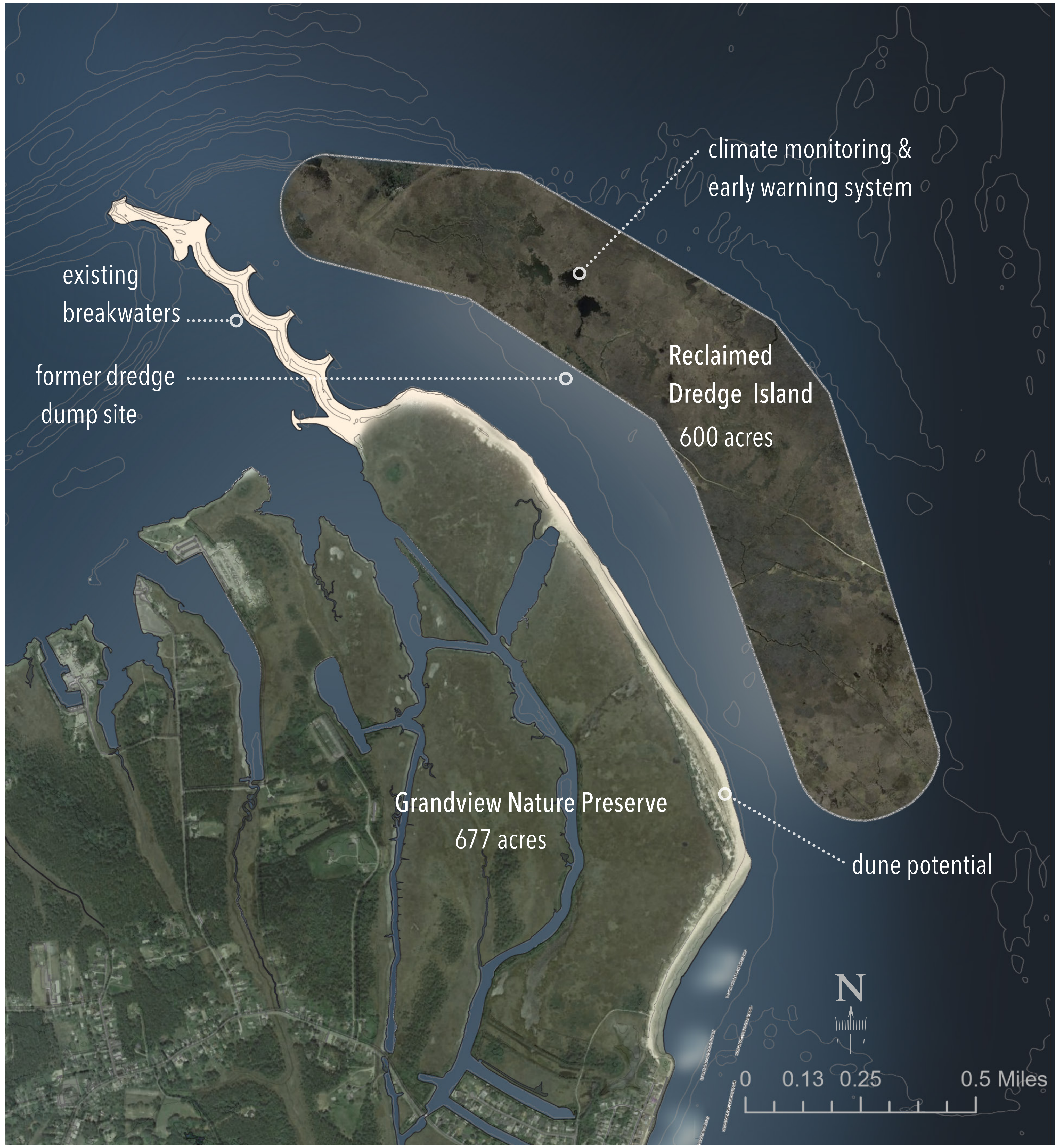
RESILIENT SELF-GENERATIVE INFRASTRUCTURE

We propose four treatments along a 5.2 mile portion of Hampton's coastline. These resilient self-generative infrastructure treatments rely on ecological processes to protect the urban environment, sequester carbon, clean water, and generate carbon credits for the benefit of Hampton through the year 2100.

- *600 Acre Protective Barrier Island*
- *37 Living Oyster Reef Breakwaters and Seagrass Beds*
- *Restored and Constructed Wetland*
- *Citizen Driven Carbon Sequestration Program*

GRANDVIEW BARRIER ISLAND

GRANDVIEW BARRIER ISLAND



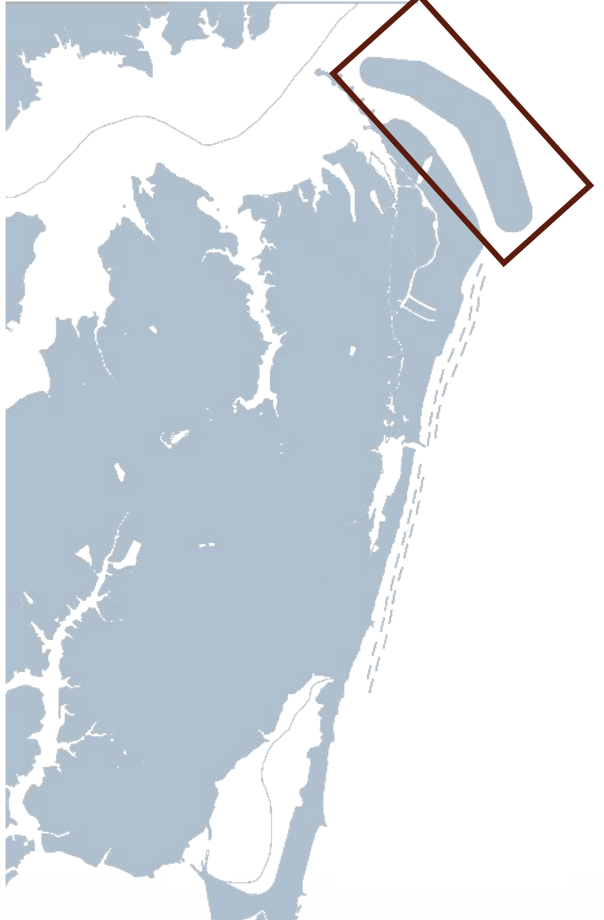
Inspired by The Disappearing Islands of the Chesapeake (Cronin, 2005) and sited on the location of a former dredge dump site (USGS), this newly created 600 acre reclaimed dredge barrier island provides habitat, carbon sequestration potential, addresses water quality issues, and provides

strong protection to the critical, existing wetland system at Grandview Nature Preserve.

The existing wetland provides critical flood protection and management, and is a valuable blue carbon stock and storage resource that will be lost to early levels of SLR.

Remote weather and climate monitoring systems are placed on the island, creating a new warning system and a way for residents to interact with the protected offshore habitat.

GRANDVIEW BARRIER ISLAND



GRANDVIEW BARRIER ISLAND

2021

GRANDVIEW NATURE PRESERVE
CURRENT CONDITION

GRANDVIEW BARRIER ISLAND

2050

1.5 FT SEA LEVEL RISE
NO INTERVENTION SCENARIO

GRANDVIEW BARRIER ISLAND

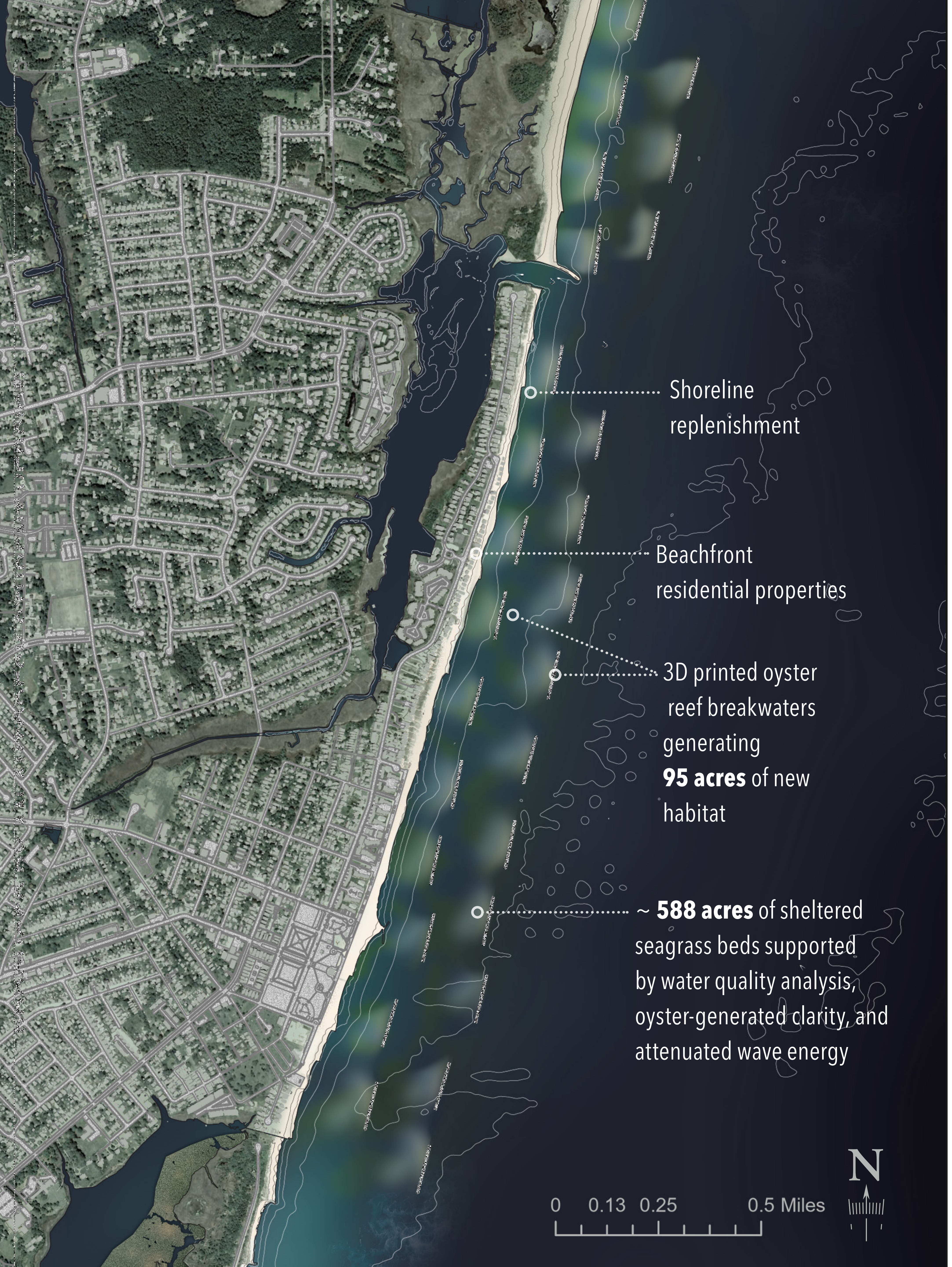
2050

1.5 FT SEA LEVEL RISE INTERVENTION SCENARIO

GRANDVIEW BARRIER ISLAND

BUCKROE BREAKWATER

BUCKROE BREAKWATER



Inspired by historic Virginia oyster middens, this resilient Oyster Reef Breakwater is designed to serve as an adaptive protected edge for Hampton's vulnerable coastline, sized to last through 2100 and beyond.

Hosting 95 acres of oyster habitat, capable of filtering 2.3 billion gallons of water per day, this reef also provides a clean, sheltered zone for 588 acres of eelgrass meadow.

This coastal engineering design innovation synthesizes scientific research on oyster habitat supporting structures, SAV supporting conditions, related carbon sequestration rates, and emerging construction technologies.

BUCKROE BREAKWATER

The breakwaters are assembled with 3D printed formless concrete plates that lock together, supported by a recycled concrete and reclaimed dredge material core. The additive manufacturing of concrete is a relatively new technology entering the world of construction. By utilizing a computer-aided design, 3D printers are able to extrude concrete to create free-form structures. This beneficial process is scalable and fully customizable to handle anything from single unit blocks to entire bridges.

RSGI

3D Printed Biomimicry Living Breakwater Plate

INFRASTRUCTURE THAT GROWS.

RESILIENT
SELF GENERATIVE
INFRASTRUCTURE

BUCKROE BREAKWATER
2100
Significant Wave
Height 9.5ft
2100
Depth at MSL 14.5ft
2020
Depth at MSL 9.75ft
Elev: -10'-0"
Recycled
Concrete
Structural
Core
Recycled
Concrete
Aggregate
Productive
Reuse
Dredge
3D Printed
Biomicicry
Form

BUCKROE BREAKWATER

SAV Habitat potential
588 acres

Eelgrass planting zones along the coast are defined by qualifying dissolved oxygen content from the 2020 Virginia DEQ water quality report and expanded based on ecological mutualism between eelgrass and oysters.

968,657
cubic yards
Dredge Spoils Reuse

Oyster Habitat potential
95.3 acres

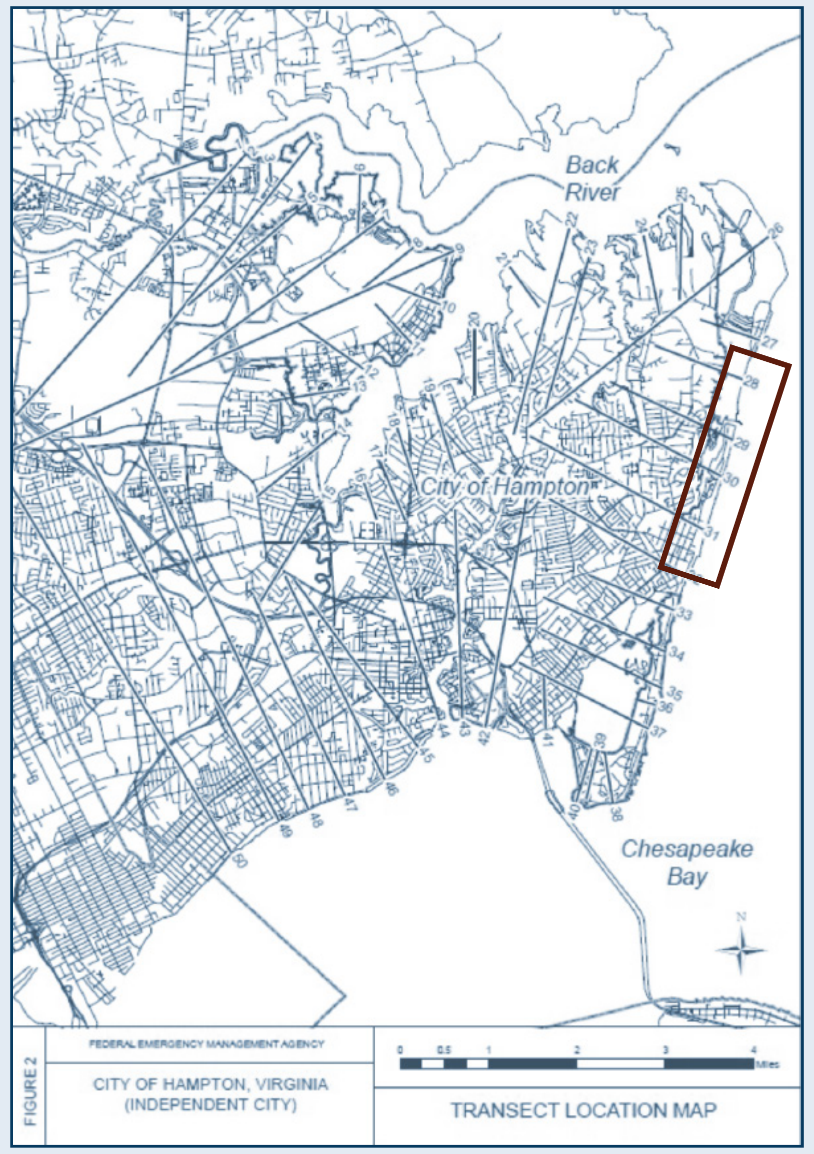
Oysters living on the breakwater below MHHW cover approximately 25 ft of each sloped side

Oyster Reef filters **2.3 Billion** gallons water per day

28.6 tonnes C
SAV Sequestration

50.5 tonnes C
Oyster Sequestration

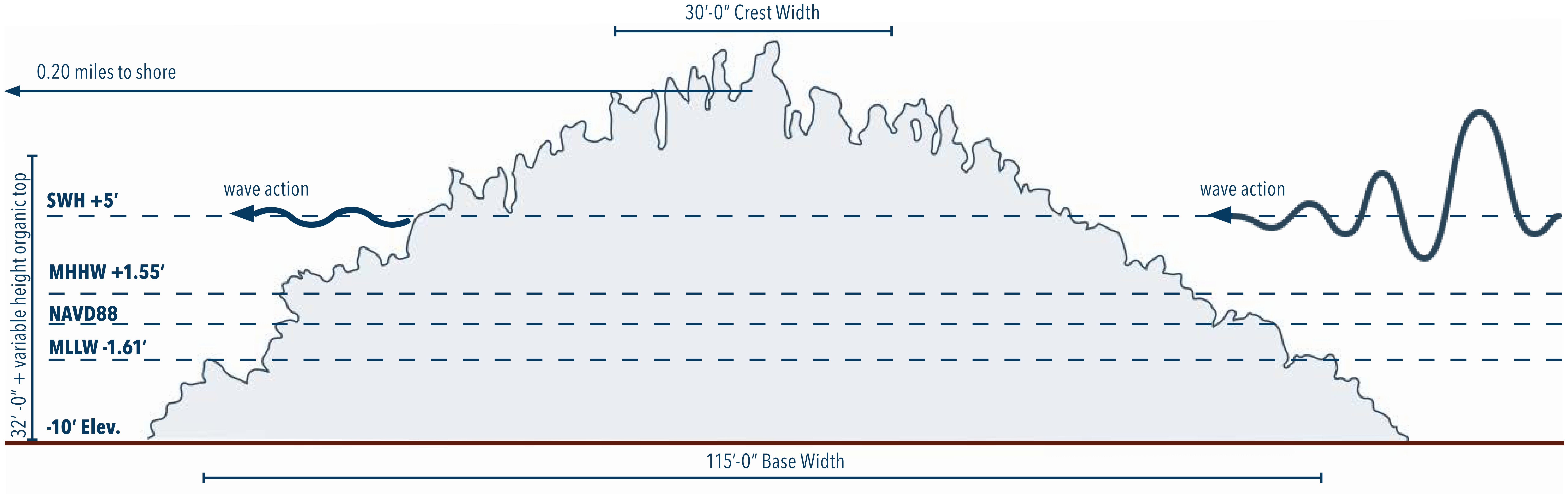
BUCKROE BREAKWATER



FEMA Flood Insurance Transect Map

The breakwater design is intended to protect the shoreline of Hampton from significant damage during future storm events and allow the existing shoreline to accrete additional landmass. Based on data from a 2016 areawide flood insurance study (FEMA, 2016), the breakwater was designed to serve as a non-over topping rubble-mound style structure that accounts for a 100 year storm event for up to 80 years of current sea level rise estimates. The specifications will potentially protect this coastline at higher sea level rise estimates further into the future as an over-topping breakwater. Oyster populations serve as a major component of the structure allowing the reef to grow and adapt over time to maintain pace with future sea level rise.

Flood Source	Transect	Significant Wave Height (ft)	Peak Wave Period (sec)	Starting Stillwater Elevation (feet NAVD 88)				Sea Level Rise			Minimum Breakwater Crest Elevation (Non-overtopping)						Slope Width	Crest Width	Total Width
				10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	30-year	60-year	80-year	Current - 10 yr	Current - 100 yr	30 yrs - 10 yr	30 yrs - 100 yr	80 yrs - 10 yr	80 yrs - 100 yr			
Back River	25	2.7	2.6	5.0	6.4	7.0	8.4	1.5	3.0	4.5	7.7	9.7	9.2	11.2	12.2	14.2	48.4	30.0	126.8
Chesapeake Bay	26	8.9	7.3	4.7	6.0	6.6	7.7	1.5	3.0	4.5	13.6	15.5	15.1	17.0	18.1	20.0	60.0	30.0	150.0
Chesapeake Bay	27	9.1	7.4	4.8	6.2	6.7	7.8	1.5	3.0	4.5	13.9	15.8	15.4	17.3	18.4	20.3	60.6	30.0	151.2
Chesapeake Bay	28	8.1	7.5	5.0	6.3	6.8	8.1	1.5	3.0	4.5	13.1	14.9	14.6	16.4	17.6	19.4	58.8	30.0	147.6
Chesapeake Bay	29	9.4	7.5	5.0	6.3	6.9	8.1	1.5	3.0	4.5	14.4	16.3	15.9	17.8	18.9	20.8	61.6	30.0	153.2
Chesapeake Bay	30	9.8	7.4	5.0	6.4	6.9	8.2	1.5	3.0	4.5	**14.8**	**16.7**	**16.3**	**18.2**	**19.3**	**21.2**	62.4	30.0	154.8
Chesapeake Bay	31	9.8	7.5	5.0	6.4	6.9	8.2	1.5	3.0	4.5	**14.8**	**16.7**	**16.3**	**18.2**	**19.3**	**21.2**	62.4	30.0	154.8
Chesapeake Bay	32	9.7	7.6	5.0	6.5	7.0	8.2	1.5	3.0	4.5	14.7	16.7	16.2	18.2	19.2	21.2	62.4	30.0	154.8
Chesapeake Bay	33	9.6	7.5	5.0	6.5	7.0	8.3	1.5	3.0	4.5	14.6	16.6	16.1	18.1	19.1	21.1	62.2	30.0	154.4
Chesapeake Bay	34	9.2	7.4	5.1	6.5	7.1	8.4	1.5	3.0	4.5	14.3	16.3	15.8	17.8	18.8	20.8	61.6	30.0	153.2
Chesapeake Bay	35	9.0	7.4	5.0	6.5	7.1	8.3	1.5	3.0	4.5	14.0	16.1	15.5	17.6	18.5	20.6	61.2	30.0	152.4
Chesapeake Bay	36	2.1	2.6	5.0	6.5	7.1	8.5	1.5	3.0	4.5	7.1	9.2	8.6	10.7	11.6	13.7	47.4	30.0	124.8
Chesapeake Bay	37	8.8	7.3	5.1	6.6	7.1	8.4	1.5	3.0	4.5	13.9	15.9	15.4	17.4	18.4	20.4	60.8	30.0	151.6
Hampton Roads	38	7.7	6.7	5.1	6.5	7.1	8.3	1.5	3.0	4.5	12.8	14.8	14.3	16.3	17.3	19.3	58.6	30.0	147.2
Hampton Roads	39	2.1	2.7	5.1	6.7	7.4	8.8	1.5	3.0	4.5	7.2	9.5	8.7	11.0	11.7	14.0	48.0	30.0	126.0
Hampton Roads	40	5.2	6.6	5.1	6.5	7.1	8.4	1.5	3.0	4.5	10.3	12.3	11.8	13.8	14.8	16.8	53.6	30.0	137.2
Hampton Roads	41	2.9	2.8	5.1	6.5	7.0	8.3	1.5	3.0	4.5	8.0	9.9	9.5	11.4	12.5	14.4	48.8	30.0	127.6



BUCKROE BREAKWATER

2050

BUCKROE BEACH
NO INTERVENTION SCENARIO
100 YEAR STORM EVENT

BUCKROE BREAKWATER

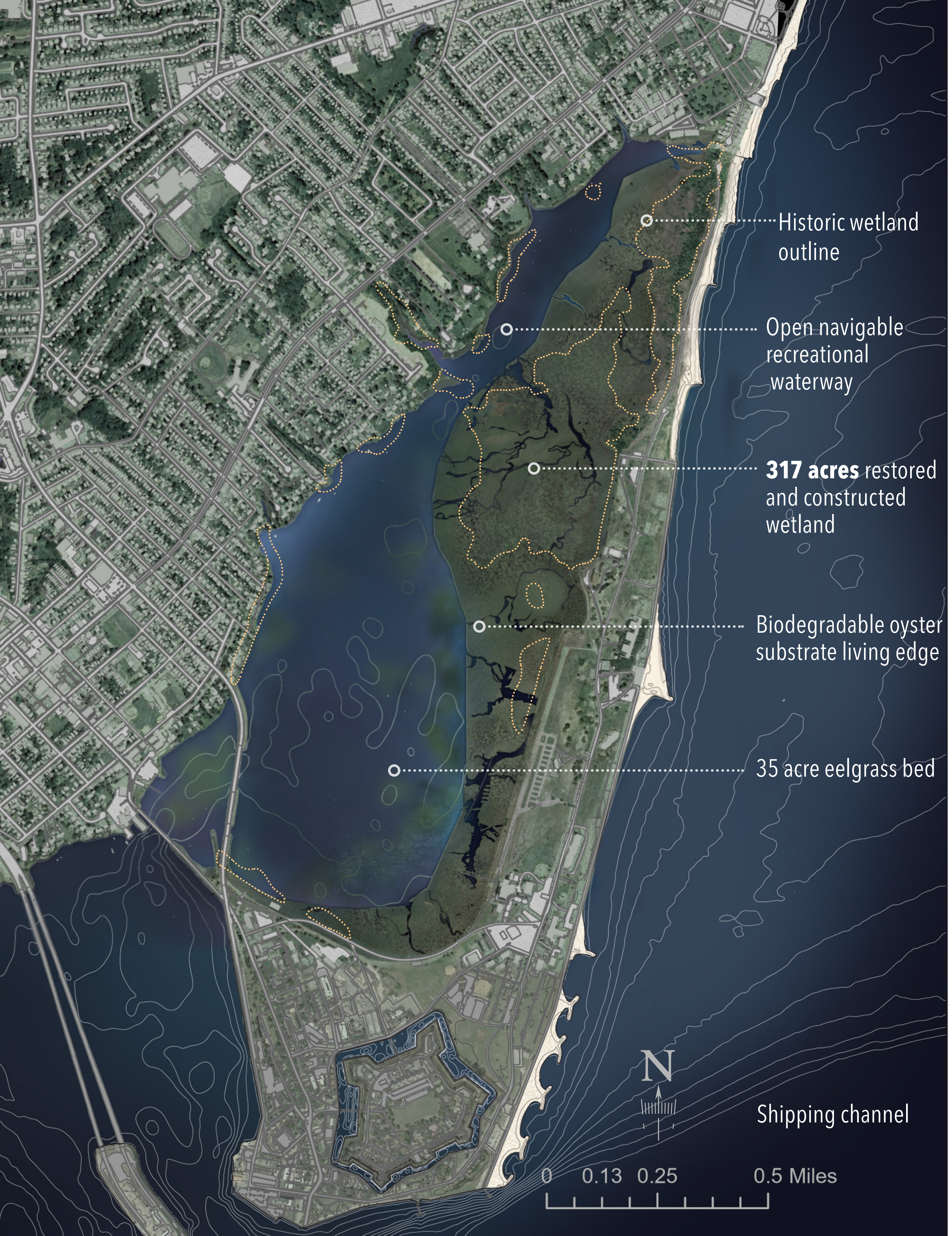
2050

BUCKROE BEACH
INTERVENTION SCENARIO
100 YEAR STORM EVENT

GRANDVIEW BARRIER ISLAND

BUCKROE BREAKWATER

FORT MONROE WETLAND RESTORATION



FT. MONROE WETLAND RESTORATION

The barrier island that has been home to Fort Monroe, protecting Phoebus for over 400 years, is at significant risk.

Northern portions of Fort Monroe will be inundated by sea level rise, allowing wave energy from storms to breach the barrier island and enter Mill Creek.

The naturally protective wetland system in Mill Creek has been slowly going under water and will be the first to be totally inundated at the lowest projected level of sea level rise by 2050.

This area is of significant value to the residents of Phoebus ecologically and structurally. The team evaluated tidal flushing rates, the close proximity of dredge material, water quality, and Virginia environmental policy.

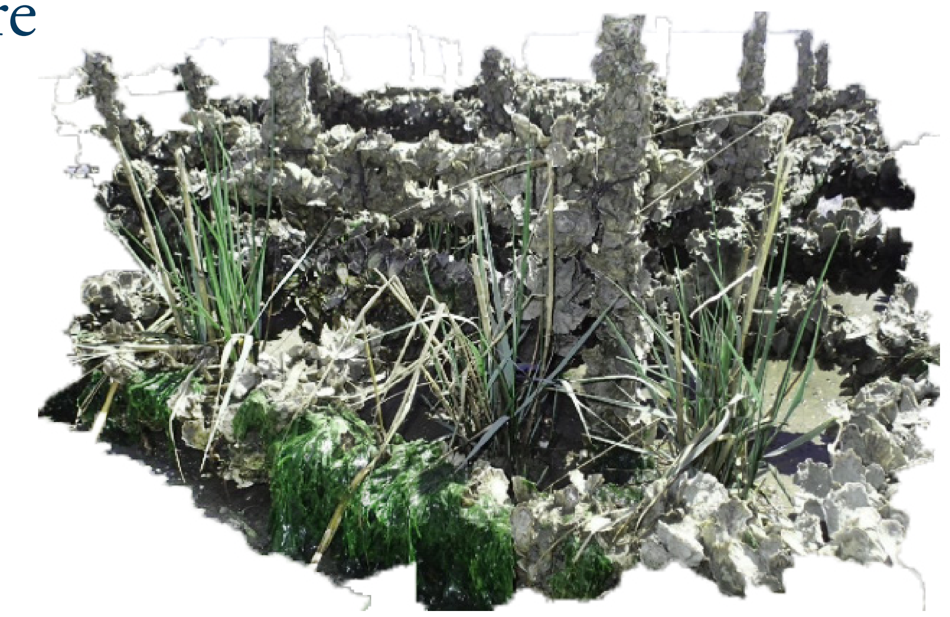
FT. MONROE WETLAND RESTORATION

SAV Habitat potential
18 acres

Eelgrass planting zones inside Mill Creek are defined by qualifying dissolved oxygen content from the 2020 Virginia DEQ water quality report with an assumption of improved benthics and water clarity from the oyster inhabited living shoreline along the wetland edge.

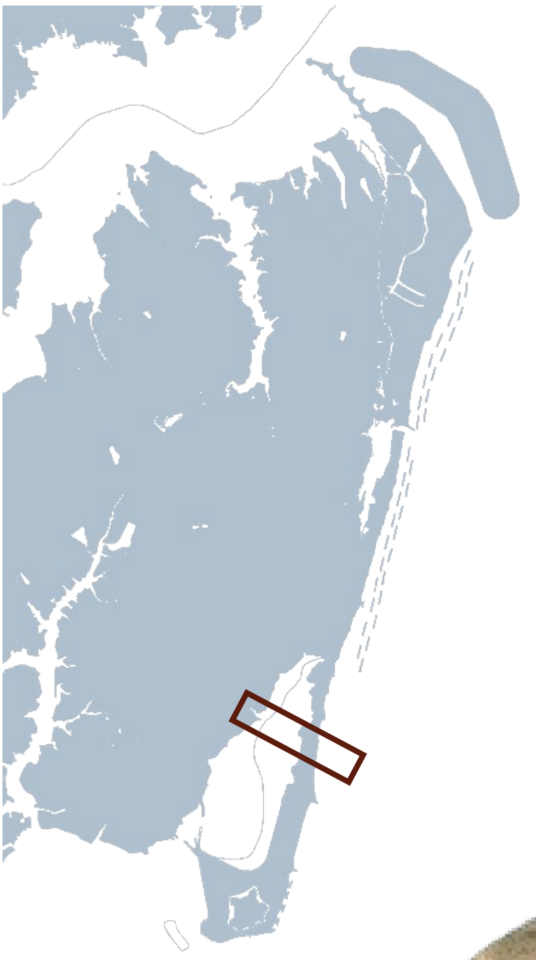
Biodegradable Oyster Substrate
11 acres

These biodegradable, modular units with proven success in North Carolina are suggested in place of a traditional coir log edge surrounding the wetland.



FT. MONROE WETLAND RESTORATION

2021

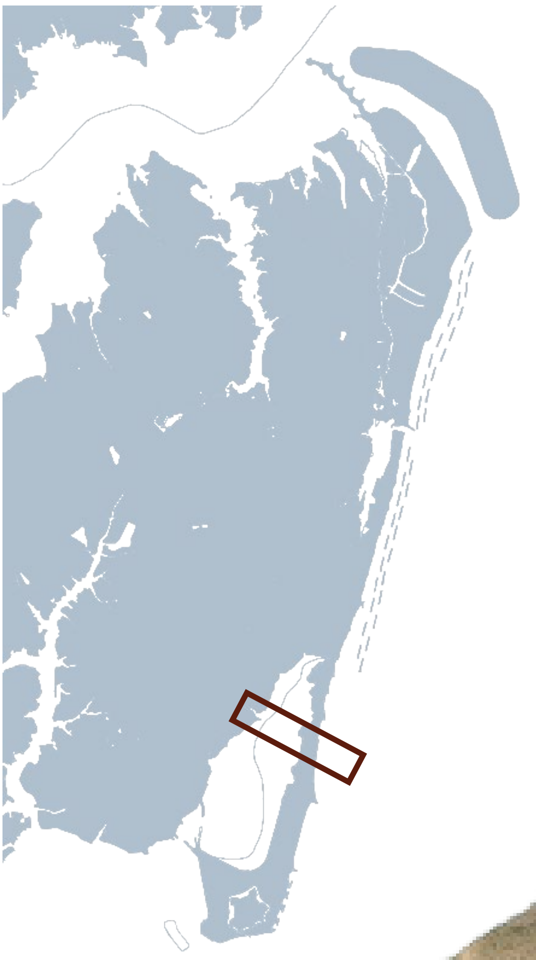


FT. MONROE WETLAND CURRENT CONDITION

REMAINING SEGMENTS OF WETLAND ARE HIGHLY THREATENED BY SEA LEVEL RISE

FT. MONROE WETLAND RESTORATION

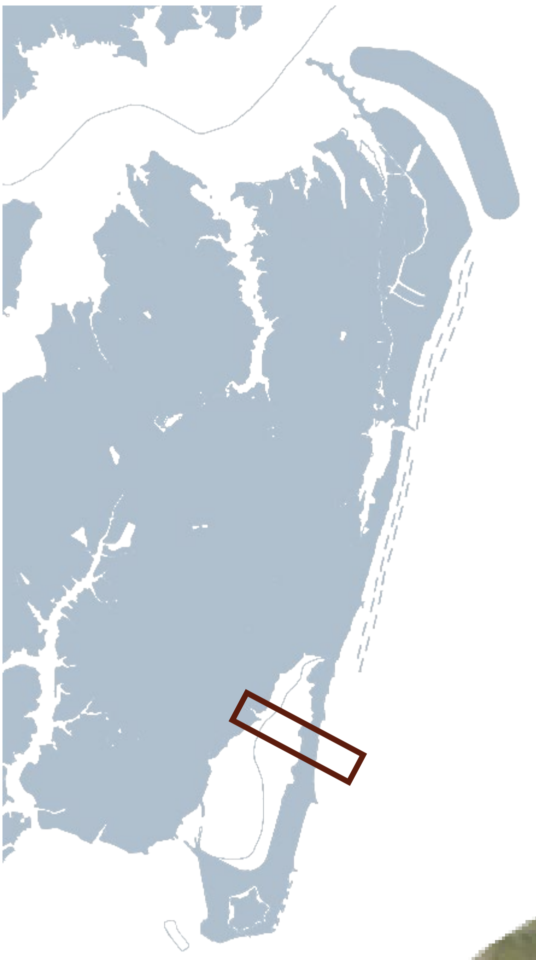
2050



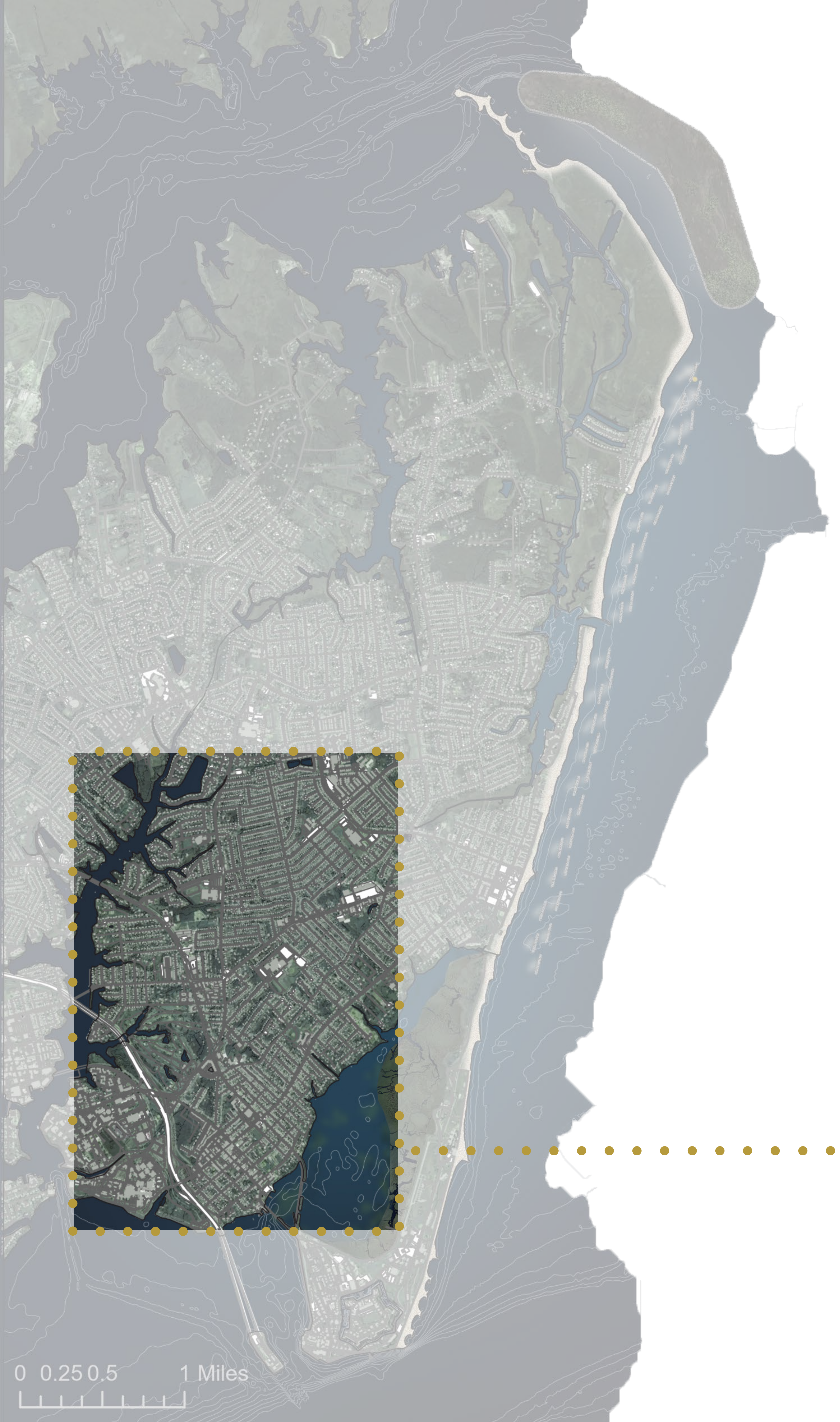
**FT. MONROE WETLAND
NO INTERVENTION**

FT. MONROE WETLAND RESTORATION

2050



FT. MONROE WETLAND INTERVENTION

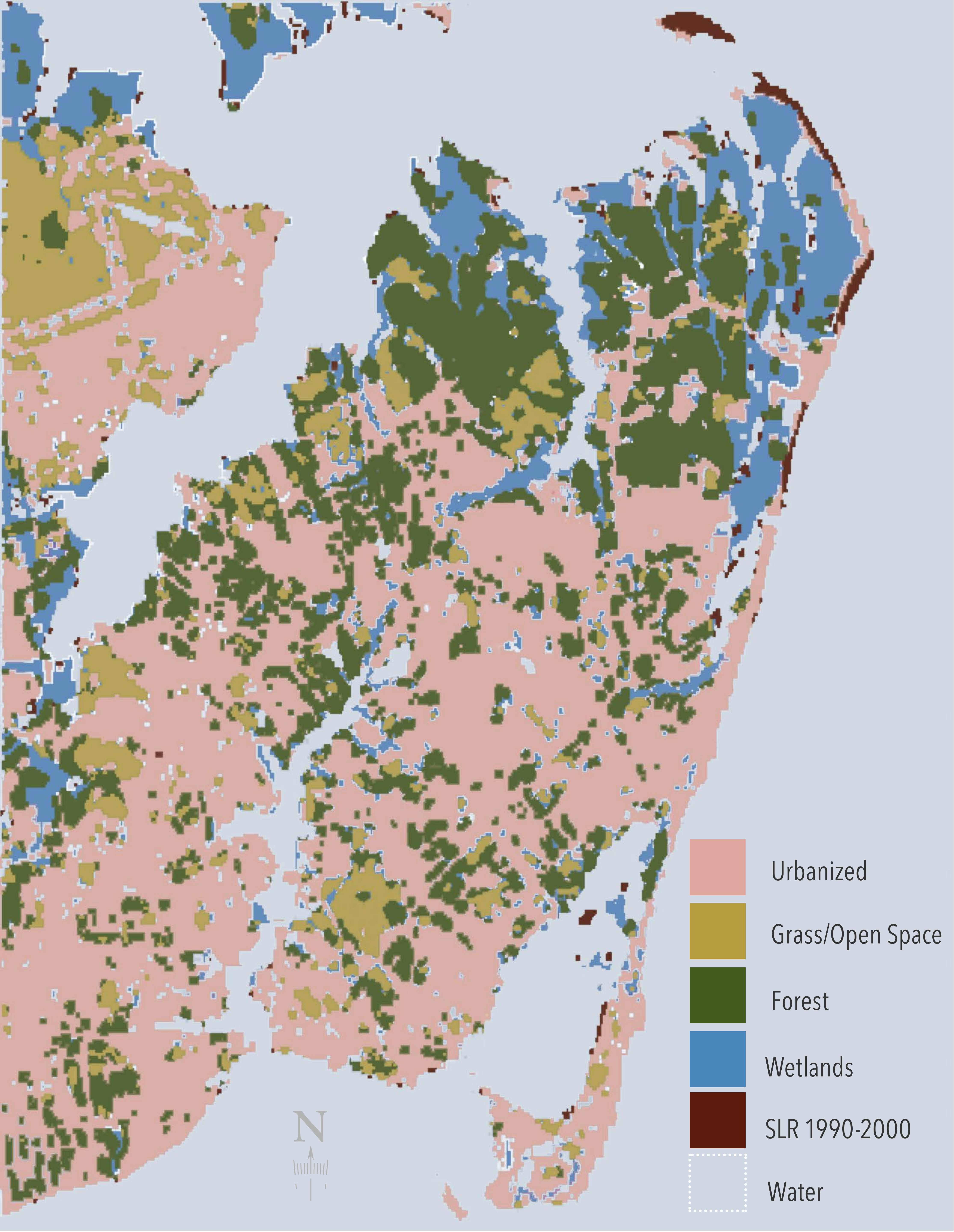


GRANDVIEW ISLAND

BUCKROE BREAKWATER

FORT MONROE WETLAND RESTORATION

CHESAPEAKE CARBON GARDENS



CHESAPEAKE CARBON GARDENS

Private land and community open space represents a valuable component of resilience planning.

This plan offers an accessible way for neighborhoods and individuals to impact climate change and stormwater through the addition of Chesapeake Carbon Gardens.

Our project analysis revealed the urban plantable space potential in the project area is 1,131 acres currently planted as turf grass. Our conservative goal was to convert 10%, or 113 acres, to Chesapeake Carbon Gardens.

By educating & empowering Hampton residents with attractive options and predefined planting palettes, citizens can contribute to a better carbon future by converting a portion of their lawn to a carbon garden.

CHESAPEAKE CARBON GARDENS

LAWN DOMINANT LANDSCAPE

Annual Sequestration
Based on 1/2 acre lot with 30% impervious space, and 70% lawn

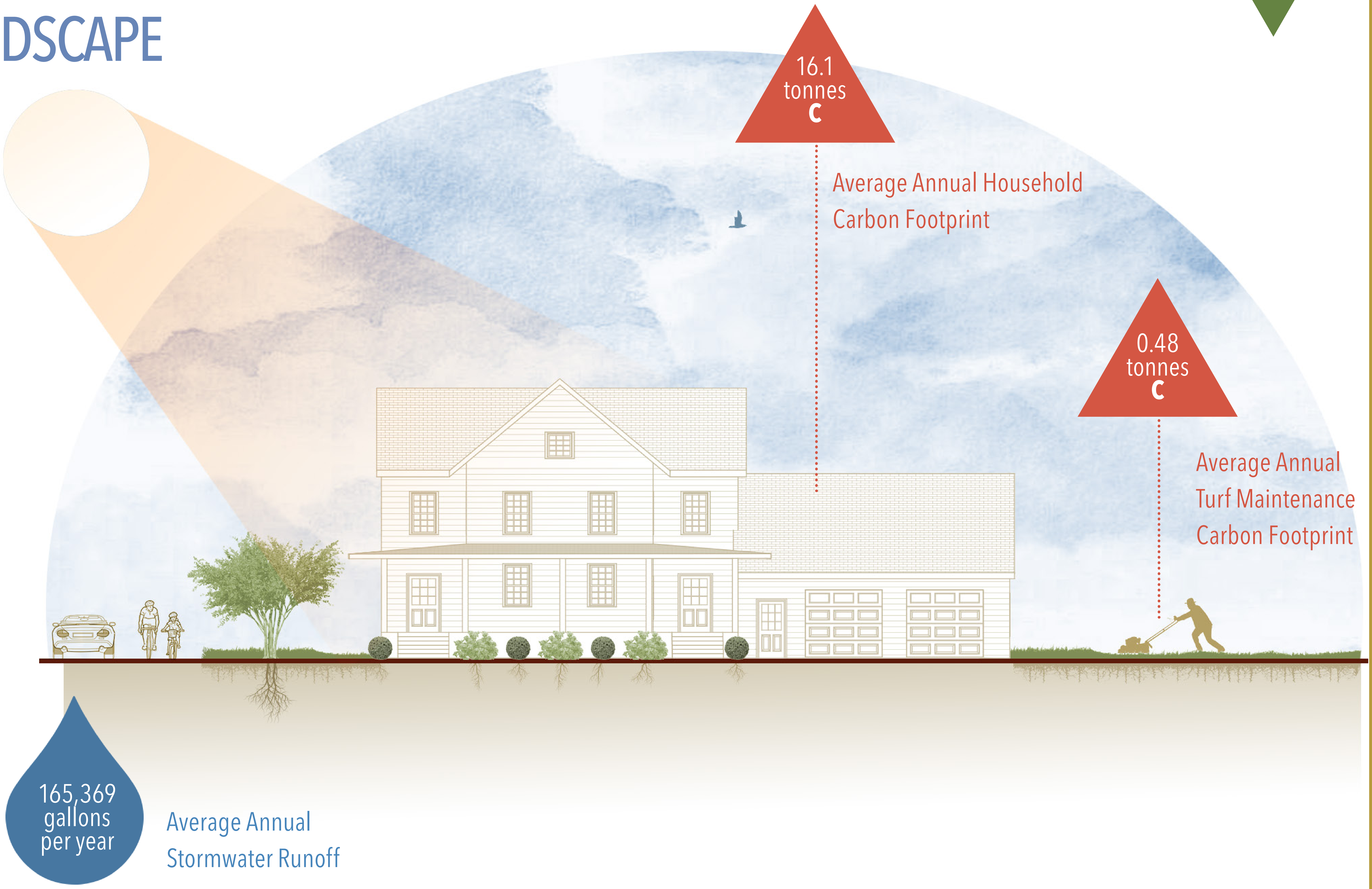
0.04 tonnes C

Ornamental tree

Evergreen shrub

Deciduous shrub

Turf grass

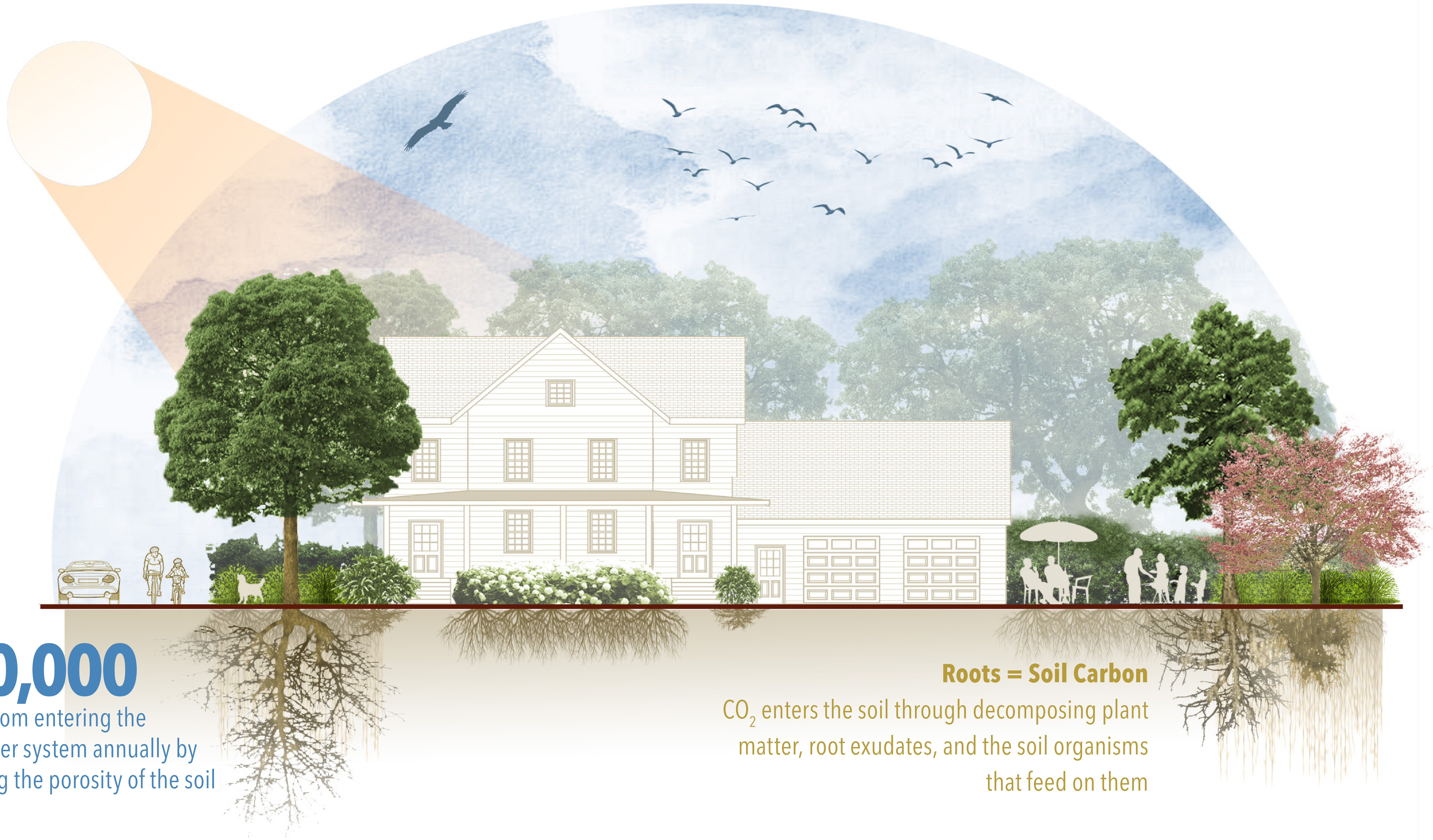


CHESAPEAKE CARBON GARDENS

HISTORIC TIDEWATER INSPIRED DESIGN

Increased Annual Sequestration
Based on 1/2 acre lot with 30% impervious space, 35% lawn, and 35% planted space

0.40 tonnes C



reduced runoff

100,000
gallons from entering the stormwater system annually by increasing the porosity of the soil

Roots = Soil Carbon
CO_2 enters the soil through decomposing plant matter, root exudates, and the soil organisms that feed on them

Sources: Epa.gov, NC State Carbon Footprint Calculator, Climate Positive Design Carbon Calculator

CHESAPEAKE CARBON GARDENS

VERNACULAR TIDAL INSPIRED DESIGN

Increased Annual Sequestration
Based on 1/2 acre lot with 30% impervious space, 35% lawn, and 35% planted space

0.41 tonnes C

Liriodendron tulipifera

Aesculus hippocastanum

Hamamelis virginiana

Ilex verticillata

Andropogon gerardii

Bouteloua gracilis

Eragrostis spectabilis

Muhlenbergia capillaris

Schizachyrium scoparium

Sorghastrum nutans

Sources: Epa.gov, NC State Carbon Foot-print Calculator, Climate Positive Design Carbon Calculator

CARBON SEQUESTRATION

1395 tonnes C

$$.43\ tC \cdot ha^{-1} \cdot yr^{-1} \times (588\ ac / 247) ha = 102.34\ tC \cdot yr^{-1}$$

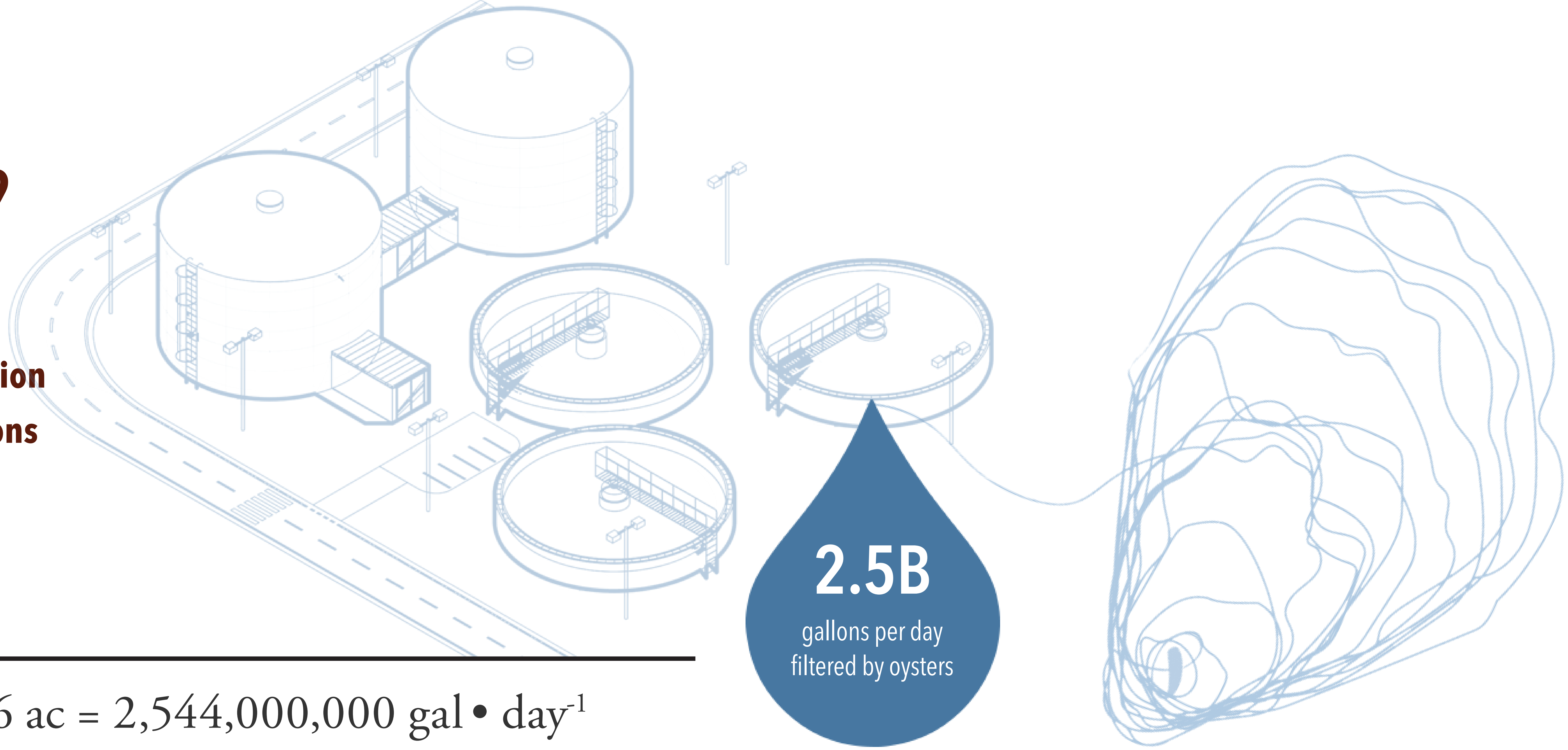
Intervention	Sequestration Rate	Area (acres)	Total Carbon Sequestered
Oysters - Breakwaters	131 $gC\ m^{-2}\ yr^{-1}$	95	50.53 $tC\ yr^{-1}$
Oysters - Ft. Monroe	131 $gC\ m^{-2}\ yr^{-1}$	11	5.78 $tC\ yr^{-1}$
Eelgrass - Coastal	0.12 $gC\ m^{-2}\ yr^{-1}$	588	28.60 $tC\ yr^{-1}$
Eelgrass - Ft. Monroe	0.12 $gC\ m^{-2}\ yr^{-1}$	18	0.87 $tC\ yr^{-1}$
Wetland - Ft. Monroe	161.8 $gC\ m^{-2}\ yr^{-1}$	317	207.64 $tC\ yr^{-1}$
Wetland - Grandview	161.8 $gC\ m^{-2}\ yr^{-1}$	677	443.45 $tC\ yr^{-1}$
C4 Veg - Barrier Island	2.66 $tC\ ha^{-1}\ yr^{-1}$	390	419.82 $tC\ yr^{-1}$
Trees - Barrier Island	1.43 $tC\ ha^{-1}\ yr^{-1}$	210	121.53 $tC\ yr^{-1}$
C4 Veg - C Gardens	2.66 $tC\ ha^{-1}\ yr^{-1}$	73.45	79.07 $tC\ yr^{-1}$
C4 Veg - C Gardens	1.43 $tC\ ha^{-1}\ yr^{-1}$	39.55	22.89 $tC\ yr^{-1}$

WATER FILTRATION

The Hampton Roads Sanitation district has a total capacity of 249 million gallons per day, serving 1.7 million people.

The oyster reef breakwater design, with 4.15 million square feet of oysters, each one filtering 50 gallons per day, has the potential to clean

9.5 times more water.



$$24{,}000{,}000 \text{ gal} \bullet \text{ac}^{-1} \bullet \text{day}^{-1} \times 106 \text{ ac} = 2{,}544{,}000{,}000 \text{ gal} \bullet \text{day}^{-1}$$

Project Zone	Area (acres)	Water Filtration Capacity	Total Water Filtration	
Breakwaters	95.00	24,000,000 gal ac $^{-1}$ day $^{-1}$	2,280,000,000 gal/day	832,200,000,000 gal/year
Ft. Monroe	11.00	24,000,000 gal ac $^{-1}$ day $^{-1}$	264,000,000 gal/day	93,360,000,000 gal/year

As the planet warms and waters rise, we have the opportunity to synthesize science, technology, engineering, and the resilient superpower of nature to capture carbon, clean water, and provide coastal protection.

We have the opportunity to be first.

https://en.wikipedia.org/wiki/Fort_Monroe

Thank You

PROFESSIONAL ADVISORY TEAM

Jules Bruck
Lead faculty, UD Landscape Architecture

Eric Bardenhagen
UD Landscape Architecture

Michael Chajes
UD Civil Engineering

Monique Head
UD Civil Engineering

Andrew Hayes
ForeSite Associates, Inc.,
Sr. Engineer and Landscape Architect

Carbon in the Tidewater
HAMPTON, VIRGINIA | UNIVERSITY OF DELAWARE COASTAL RESILIENCE DESIGN STUDIO
Resilient Self-Generative Infrastructure
NEW JERSEY
DELAWARE
MARYLAND
VIRGINIA
Chesapeake Bay
Atlantic Ocean
NORTH CAROLINA
Grandview Barrier Island
Buckroe Breakwater
Ft. Monroe Wetland Restoration
Chesapeake Carbon Gardens
0 0.25 0.5 1 Miles
Shoreline Restoration
29,044,444 cubic yards Dredge Spoils Reuse
200-300 million cubic yards dredged annually
20-30% is reused for beneficial purposes (NDT, 2003).
$40,081,333 in dredge storage savings (Craney Island Dredged Material Management Area).
Phalacrocorax auritus
Haematopus palliatus
Pelecanus occidentalis
Ardea alba
Ardea herodias
Sand Dune
Littoral Zone
Zostera marina
Coastal Shallows
Oyster Reef Breakwater
Forested Wetland
Grassed Wetland
Open Bay
Centropristis striata
Crassostrea virginica
Cirripedia
Brevoortia tyrannus
Alosa aestivalis
Diadumene leucolena
Pogonias cromis
Micropogonius undulatus
541.35 tonnes C
Average Annual Carbon Sequestration Potential of Barrier Island
2050 Barrier Island & Replenished Shoreline Intervention
2050 No Intervention
1.5 Feet Projected Sea Level Rise
2100 Significant Wave Height 9.5 ft
2100 Depth at MSL 14.5 ft
2020 Depth at MSL 9.75 ft
Elev: -10'-0"
Recycled Concrete Structural Core
Recycled Concrete Aggregate
Productive Reuse Dredge
3D Printed Biomimicry Form
3D Printed Biomimicry Living Breakwater Plate
INFRASTRUCTURE THAT GROWS.
RESILIENT SELF GENERATIVE INFRASTRUCTURE
SAV Habitat potential
588 acres
Eelgrass planting zones along the coast are defined by qualifying dissolved oxygen content from the 2020 Virginia DEQ water quality report and expanded based on ecological mutualism between eelgrass and oysters.
968,657 cubic yards Dredge Spoils Reuse
Oyster Habitat potential
95.3 acres
Oysters living on the breakwater below MHHW cover approximately 25 ft of each sloped side
Oyster Reef filters 2.3 Billion gallons water per day
28.6 tonnes C
SAV Sequestration
50.5 tonnes C
Oyster Sequestration
SAV Habitat potential
18 acres
Eelgrass planting zones inside Mill Creek are defined by qualifying dissolved oxygen content from the 2020 Virginia DEQ water quality report with an assumption of improved benthics and water clarity from the oyster inhabited living shoreline along the wetland edge.
Oyster Reef filters
264 Million
gallons water per day
5.78 tonnes C
Oyster Sequestration
207 tonnes C
Vegetation Sequestration
0.87 tonnes C
SAV Sequestration
Restored Wetland
Upland
Living Shoreline
Eelgrass Beds
Navigable Waterway
Oyster Living Shoreline
Biodegradable Oyster Substrate
11 acres
These biodegradable, modular units with proven success in North Carolina are suggested in place of a traditional coir log edge surrounding the wetland.
Typical Landscape Design
0.04 tonnes C
Annual Sequestration
165,369
gallons of stormwater runoff
Historic Tidewater Inspired Design
0.40 tonnes C
Annual Sequestration
66,226
gallons of stormwater runoff
Vernacular Tidal Inspired Design
0.41 tonnes C
Annual Sequestration
62,878
gallons of stormwater runoff