Shoreline management & living shoreline design implications

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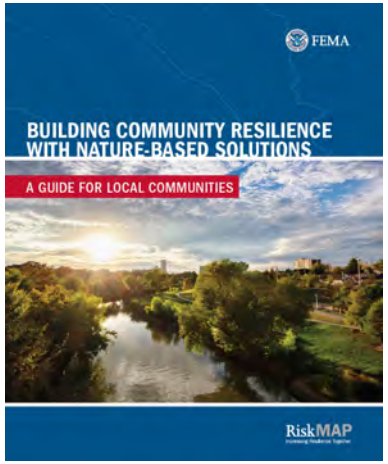
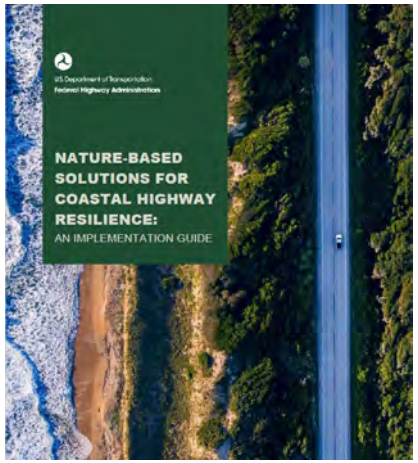
Tidal Marsh Ecology Webinar

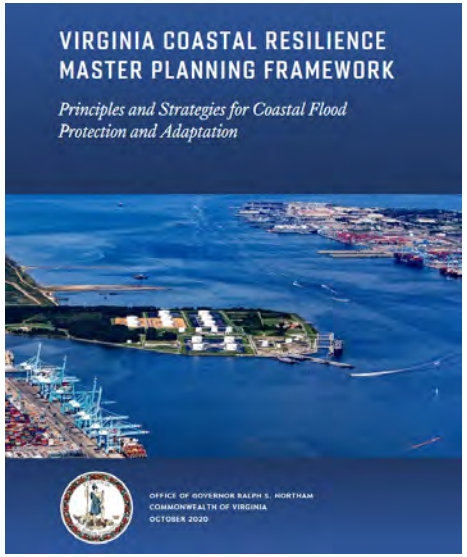
VIMS | William & Mary
Virginia Institute of Marine Science

Center for Coastal Resources Management
Virginia Institute of Marine Science

Nature-Based Solutions for coastal communities








Drone view of the Ohio Creek Watershed Project, Chesterfield Heights, Norfolk,VA in October 2020. Credit: MEB General Contractors / City of Norfolk

"Communities that invest in nature-based approaches to reducing disaster risk can save money, lives, and property in the long-term AND improve quality of life in the short term." FEMA

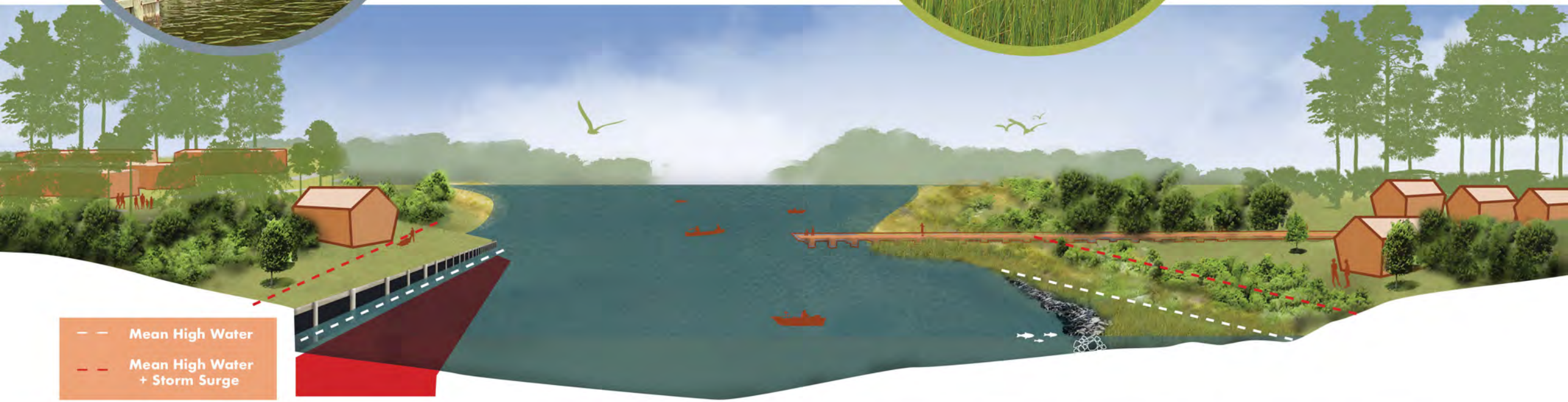
LIVING SHORELINES ARE PART OF THE SOLUTION

Armoring

- Erosion or scour can happen in front or on either side of the walls
- Causes marsh loss
- Not adaptable to sea level rise
- More susceptible to damage from storms

Living Shoreline

- Natural buffer to reduce erosion
- Allows marsh migration
- Adaptable to sea level rise
- Wildlife access to water
- Provides critical fish and wildlife habitat
- Improves water quality



Developed by the Virginia Institute of Marine Science (VIMS) at William and Mary for the National Science Foundation (NSF) Coastal Science, Engineering, and Education for Sustainability (SEES) Initiative.Image designed by Kelsey Broich, Network for Engineering with Nature, University of Georgia. (2021). Bulkhead (left) and living shoreline (right) images by VIMS Center for Coastal Resource Management.

2021 Virginia Tidal Wetlands Guidelines

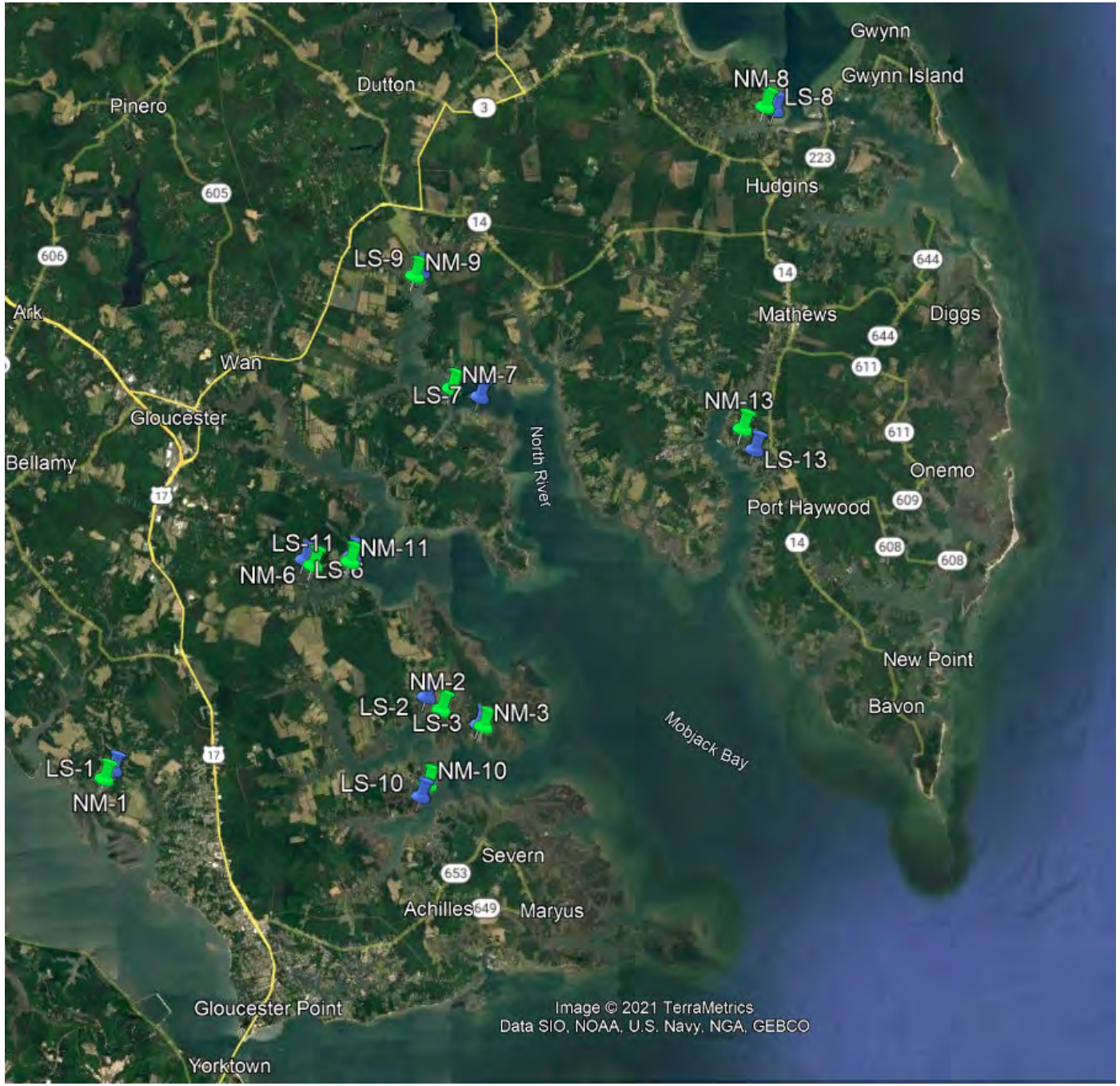
Virginia Marine Resources Commission

"….ensure protection of shorelines and sensitive coastal habitats from sea level rise and coastal hazards…"

"….only living shoreline approaches…are allowed *unless best available science shows that a living shoreline approach is not suitable*."

"**Properly designed and constructed living shorelines are vital** to address coastal resiliency, shoreline stabilization, and tidal wetlands sustainability in response to sea level rise."

mrc.virginia.gov/Regulations/Final-Wetlands-Guidelines-Update_05-26-2021.pdf



Natural Marsh Living Shoreline Pairs

5-yr study

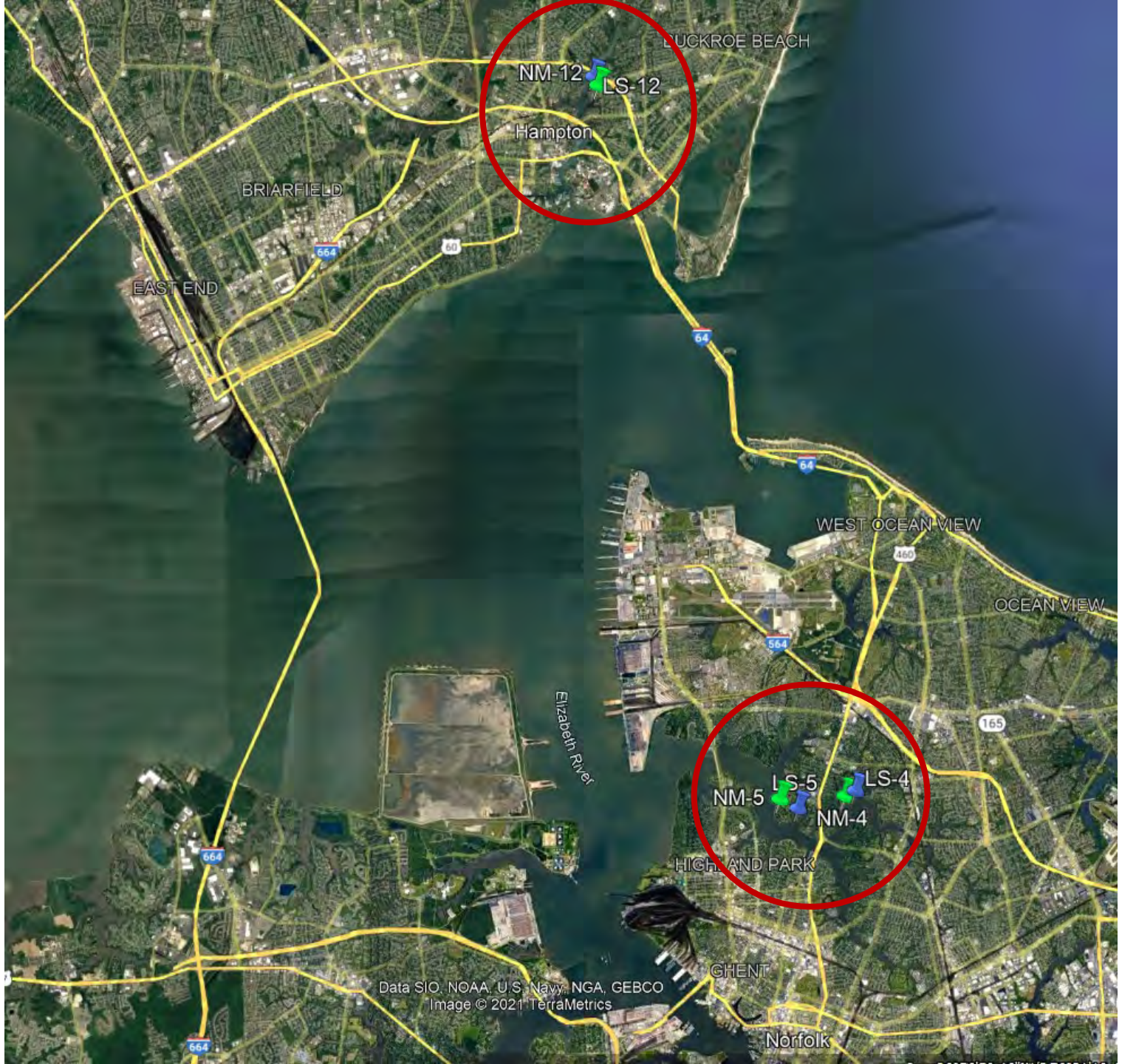
10 sites

Middle Peninsula region

Gloucester & Mathews County

Rural residential (8)

Public lands (2)



Natural Marsh Living Shoreline Pairs

5-yr study

3 sites

City of Hampton & Norfolk

Urban residential

ShoreScape Settings

10 rural sites

Large public & residential parcels
with natural surroundings

3 urban sites

Not intensely developed
Lafayette River location has many natural features

Erosion Problems Solved

Upland Bank erosion

Marsh erosion

Failing bulkhead

Living Shoreline Project Length

LS13

LS5

LS4

Total Project Length

175 – 1,020 linear feet

Average 335 linear feet

Smaller study areas within project

Natural + Planted Tidal Salt Marshes

LS4

LS3

LS2

All sites had natural marshes in vicinity

Some had natural marsh in project area with eroding edge

Coarse sand fill required for water quality protection & navigation concerns

Spartina alterniflora & *Spartina patens*
Nursery-grown stock planted in rows

Regularly flooded marsh (Low)
Irregularly flooded marsh (High)

Invasive *Phragmites australis* at one site controlled by property owner

Living Shoreline Tidal Marsh Width

Distance for wave attenuation

High marsh irregularly flooded
+
Low marsh flooded daily

LS2

LS11

Total Marsh Width

Range 11 - 47 ft Average 23 ft

Plant Stem Density & Height

Stem density & height affects:

Wave attenuation

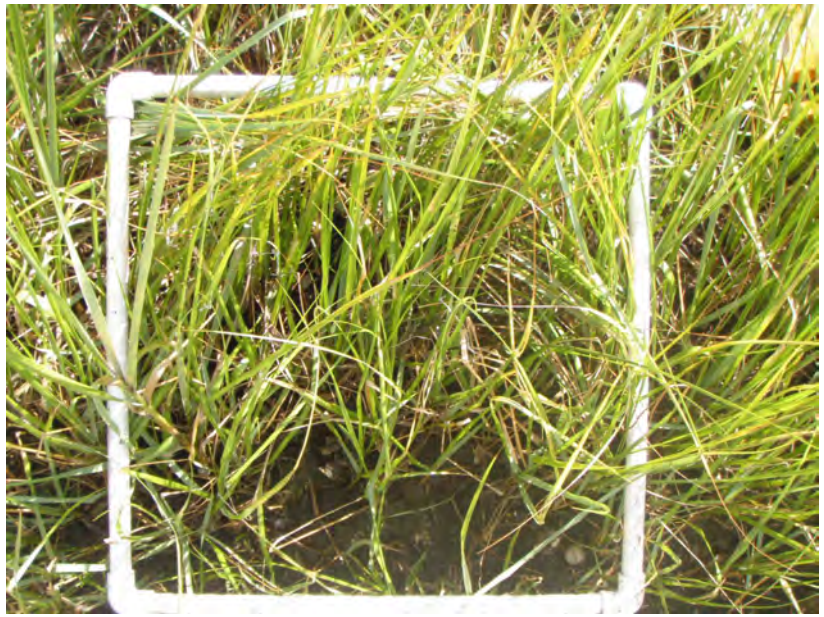
Sediment capture

Belowground biomass for stability

Nitrogen removal

Carbon storage

Ribbed mussel survival



Fairly high plant density
at all 13
living shoreline marshes

Sills & Waves

Primary purposes: reduce wave energy & contain sand fill

Sills must be able to withstand expected waves & extreme storms

Stone sizes are determined by fetch & wave climate

Sill height is determined by tidal range

Sill width is determined by level of protection needed

Sill Height

LS03

LS13

Tide range ~2.5 feet at all sites except 1 (1.25 ft)

Lighter color rocks remain above water level most of the time

Darker rocks are submerged often

Light color rocks < 1ft at top of sills at all 13 sites

6 sites mostly dark rocks

Sills & Tidal Inundation

LS7

Tidal marsh must drain completely during low tide

Rising & falling tides move through rocks

High tides may overtop sills

Sill Openings

LS1

LS9

LS2

Canoe-Kayak Launch

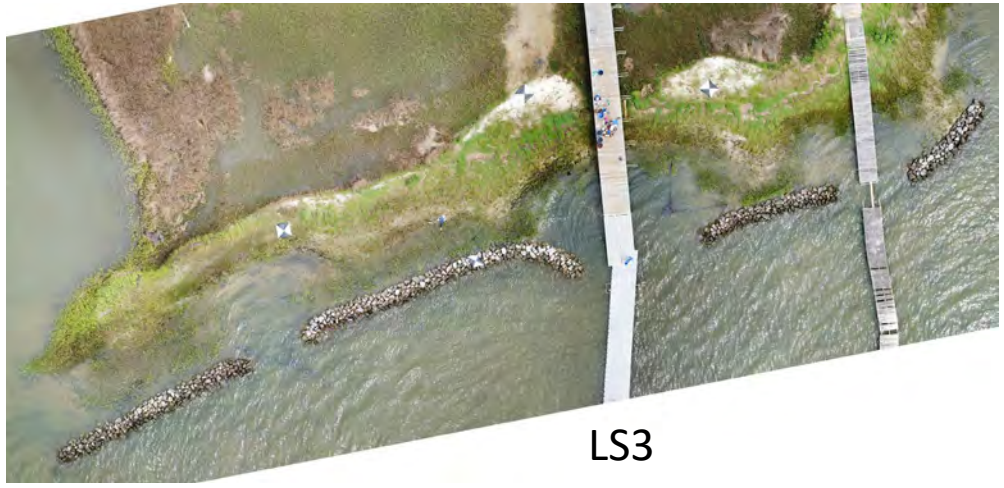
Openings at each end of sills

Between sections

At piers

For recreation access

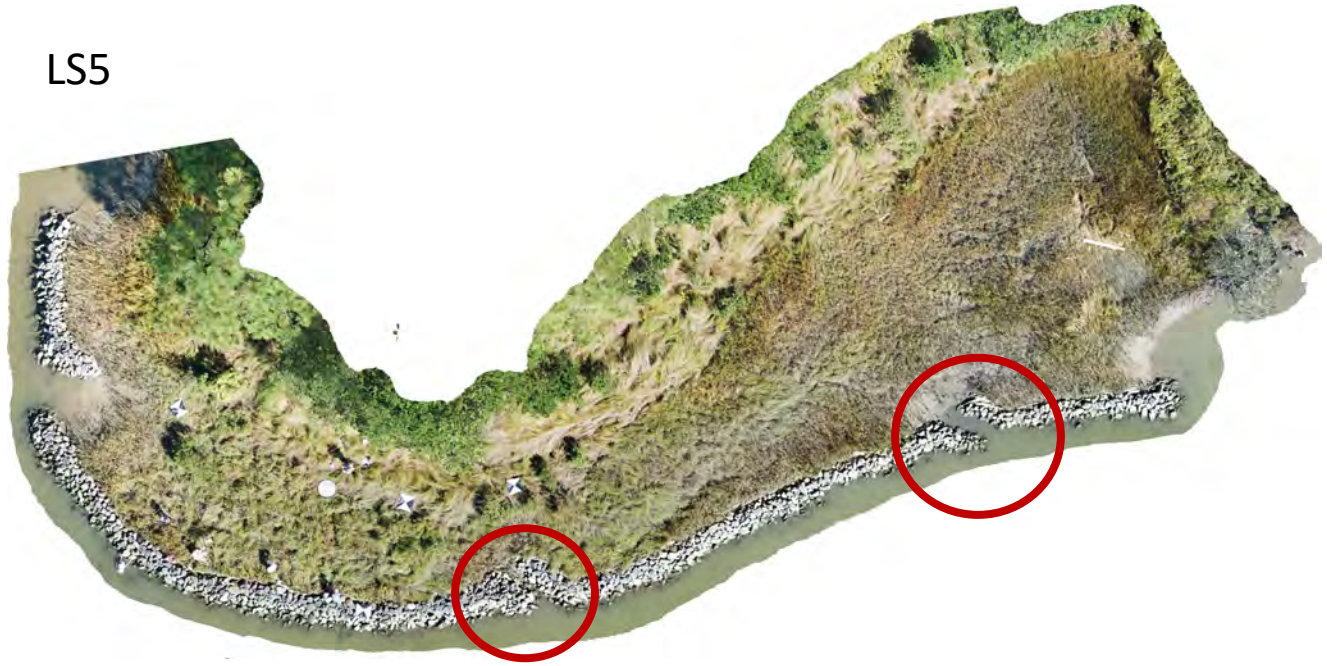
Stormwater outfalls



LS3

Overlapping – Curved – Narrow Sill Openings

Less wave energy within tidal marsh with smaller openings



More study needed on sill openings
and
effects on hydrodynamics & ecology

Sill Attachment & Refuge Habitat

Attachment surfaces for oysters, ribbed mussels, barnacles

Mostly up to mid-tide level

Protected refuge between stones

Functionally Equivalent Living Shorelines with Marsh Sills

within natural marsh – living shoreline pairs

SETTING

Surrounding landscape includes natural features

PLANTS

Wide marshes avg > 20 feet with Low + High Marsh

Dense plant stems & below ground biomass for sediment capture/marsh accretion + wave attenuation

SILLS

Tidal flow through rocks

Sill heights <1 feet above high water levels

Sill openings at ends &/or gaps in the middle

Spaces between rocks below mid-tide for habitat

Dynamic Living Shoreline Design

Minimize Wave Energy

Wide tidal marshes

Wave attenuation structures that allow tidal inundation & sedimentation

Maximize Sediment Accretion

Dense plants in clusters + ribbed mussels

Provide Retreat Pathway

Grade bank for suitable slopes wherever possible

Reserve adjacent upland spaces with compatible land uses

Maintenance Interventions

Reserve access for future thin-layer fill additions & raise sill height

M. Mitchell & D. Bilkovic 2019 Embracing dynamic design for climate-resilient living shorelines. Journal of Applied Ecology

Shoreline Management & Living Shoreline Design Implications

SUMMARY

- Protect all remaining tidal wetlands in present & future locations
- Living shorelines are now the default approach for stabilization in Virginia
- Proven effectiveness in both rural and urban settings
- Effective marsh sill living shorelines have dynamic features working together
- Anticipate landward migration & maintenance interventions for resilient shorelines
- More studies needed to improve understanding of design features
- Community effort to advocate & watch shorelines over time

Questions?

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