The Town of Nags Head

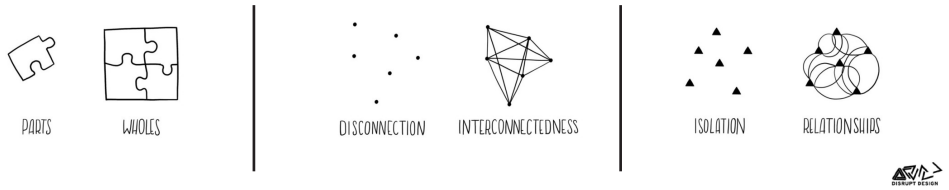
Estuarine Shoreline Management Plan

Biohabitats May 2022

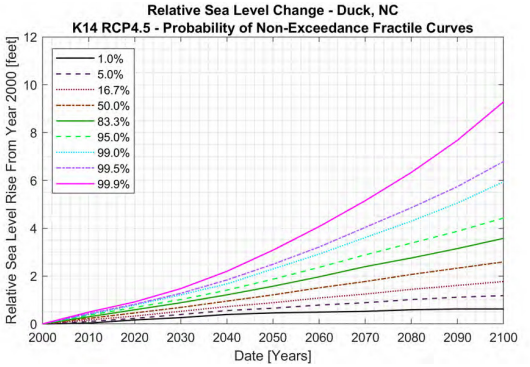
Design Team Insights

INTERNAL REVIEW MEETING - 04/15/22

SYSTEMS THINKING



Threats



Opportunities

EXISTING TYPOLOGY PARAMETERS

Virginia Institute of Marine Science

LIVING SHORELINE DESIGN GUIDELINES - DESIGN CONDITIONS

https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=1833&context=reports

Shoreline Orientation	Related predominant wind direction and multiplier when combined with fetch.
Fetch	**Distance of open water for waves to travel. Highly influential for shoreline erosion and wave intensity.**
Shore Morphology	**Level of protection from wave action provided by the surrounding morphology.**
Depth Offshore	Deeper water can affect wave dissipation and type of boat traffic. Could also determine amount of fill required.
Nearshore Morphology	Evaluates nearshore features (sand bars, tidal flats, etc) in design considerations.
Nearshore SAV & Shellfish	**Can attenuate wave energy and provide habitat benefits. May constrain types of site impacts.**
Tide Range & Sea Level Rise (SLR)	**Slope above Spring High Tide elevation. Important for designing resiliency and marsh migration.**
Storm Surge	Increase in predicted water elevation due to storm event impacts
Erosion Rate	**Comparison of shoreline location over time. Can be a chronic or ephemeral occurance based on catalyst.**
Design Wave	**Size and rate of anticipated waves impacting erosional characterisitcs.**
Site Boundaries	**Parcel information**
Site Characteristics	**Physical upland and shoreline characteristics**
Stormwater Runoff	**Erosional impacts from stormwater runoff are possible. May offer opportunity to incorporate treatment.**
Bank Condition	Impacts of erosion, signs of undercutting of existing banks, and vegetative cover.
Bank Height	High banks erode slower compared to lower banks.
Bank Composition	Bank composition material can impact type and speed of erosion.
Riparian Buffer Vegetation	**Density and typ of bank vegetation can determine the rate of erosion and ease of access/construction.**
Intertidal Zone Width	**Dominated by either marsh or beach. The wider the feature the more wave attenuation is possible.**
Backshore Zone Width	**Zone behind low marsh and dominated by high marsh, sandy backshore terrace or dune environments.**
Boat Wakes	**Watercraft generated waves. Can be difficult to understand the existing frequency/intensity.**
Site & Defense Structures	**Existing hard structures that impacts site hydrodynamics (Piers, boathouses, docks, bulkheads, etc)**
Nearshore Stability	**Type of substrate can determine settling rate of structural elements.**

Stevens Institute of Technology

LIVING SHORELINE ENGINEERING GUIDELINES - DESIGN CONDITIONS

https://www.nj.gov/dep/cmp/docs/living-shorelines-engineering-guidelines-final.pdf

Erosion history	**Erosion can be a consistent, chronic problem or ephemeral and related to changes in surrounding environment.**
Sea Level Rise (SLR)	**Projections vary but adopting federal guidance can help define ultimate design elevations.**
Tidal Range	Depending on site, tidal range can be extreme or no-existent. Understanding is critical to defining planting extents.
Wind Waves	**Generated from meterological conditions and local wind patterns. Usually a dominant factor in living shoreline design.**
Wakes	**Watercraft generated waves. Can be difficult to understand the existing frequency/intensity.**
Currents	**Currents can displace vegetation, erode banks, import debris, and can be super-charged during storm events.**
Ice	Dependent on local climate. Ice can uplift and displace structural elements and act as wrack material to scour banks.
Storm Surge	Less important for living shoreline designs because it is designed to flood, unlike traditional engineered solutions.
Upland Slope	**Slope above Spring High Tide elevation. Importance of understanding for designing potential for marsh migration.**
Shoreline Slope	**Slope between Mean Low Low Water and Spring High Tide elevation. Will determine needed stabilization practices.**
Width	**Horizontal area between existing development and water's edge. Will largely determine the range of options.**
Nearshore Slope	Nearshore slopes will affect wave size, wave break location, amount of incoming sediment transport to the site.
Offshore Depth	Deeper water can affect wave dissipation and type of boat traffic. Could also determine amount of fill required.
Soil Bearing Capacity	**Type of substrate can determine settling rate of structural elements. Important to understand prior to design.**
Water Quality	Ability to establish habitat can be significantly affected by water quality.
Soil Type	Factors into the success of the planting establishment. Root growth, heartiness, and penetration capacity is affected.
Sunlight Exposure	Full sun conditions are optimal for living shoreline planting establishment. Dense canopy needs to be considered in design.

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SYNTHESIS OF LIVING SHORELINE DESIGN GUIDELINES

Erosion history	Erosion can be a consistent, chronic problem or ephemeral and related to changes in surrounding environment.
Sea Level Rise (SLR)	Projections vary but adopting federal guidance can help define ultimate design elevations.
Fetch	Distance of open water for waves to travel. Highly influential for shoreline erosion and wave intensity.
Wind Waves	Generated from meterological conditions and local wind patterns. Usually a dominant factor in living shoreline design.
Wakes	Watercraft generated waves. Can be difficult to understand the existing frequency/intensity.
Currents	Currents can displace vegetation, erode banks, import debris, and can be super-charged during storm events.
Shoreline Morphology	Level of protection from wave action provided by the surrounding morphology
Nearshore SAV	Can attenuate wave energy and provide habitat benefits. May constrain types of site impacts.
Riparian Buffer Vegetaion	Density and type of bank vegetation can determine the rate of erosion and ease of access/construction.
Upland Slope	Slope above Spring High Tide elevation. Importance of understanding for designing potential for marsh migration.
Shoreline Slope	Slope between Mean Low Low Water and Spring High Tide elevation. Will determine needed stabilization practices.
Intertidal Zone Width	Dominated by either marsh or beach. The wide the feature the more wave attenuation is possible
Backshore Zone Width	Zone behind low marsh and dominated by high marsh, sandy backshore terrace or dune environments.
Soil Bearing Capacity	Type of substrate can determine settling rate of structural elements. Important to understand prior to design.
Site Boundaries	Parcel information and boundary lines
Site Characteristics	Physical upland and shoreline characteristics
Stormwater Runoff	Erosional impacts from stormwater runoff are possible. May offer opportunity to incorporate treatment.
Site & Defense Structures	Existing hard structures that impacts site hydrodynamics (Piers, boathouses, docks, bulkheads, etc)

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DESIGN PARAMETERS THAT INFORM EXISTING TYPOLOGIES

PRIMARY DESIGN PARAMETERS

Site Ownership & Boundaries

Shoreline Condition

Wind Waves (WEMO)

Low Marsh Zone Width

Bank Slope

Distance to Infrastructure

INFORMATIVE PARAMETERS

Erosion history

Buffer Vegetation

Stormwater Runoff

Sea Level Rise (SLR)/**Marsh Migration**

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CHARACTERISTICS THAT WILL DEFINE EXISTING TYPOLOGIES

PRIMARY PARAMETERS & CRITERIA SEPARATIONS

Site Ownership & Boundaries

- Private residence
- Public land
- Vacant land (Private & Public)

Shoreline Condition

- Marsh
- Miscellaneous
- Modified (bulkhead, riprap, etc)
- Sediment bank
- Swamp forest

Wind Waves (WEMO)

- maximum Hs >.5ft during normal conditions
- maximum Hs >.5ft during storm events only

Low Marsh Zone Width (horizontal width of low marsh elevation range)

- absent low marsh zone
- less than 6ft
- greater than 6ft

Bank Slope (measured from bottom of low marsh to top of bank)

- steeper than 33%
- between 33-20%
- shallower than 20%

Distance to Infrastructure (structures, roads, utilities, etc)

- less than 15ft
- between 15-30ft
- greater than 30ft

Sea Level Rise (SLR) **Vulnerability/Marsh Migration**

- 2 ft rise
- 3 ft rise
- 4 ft rise

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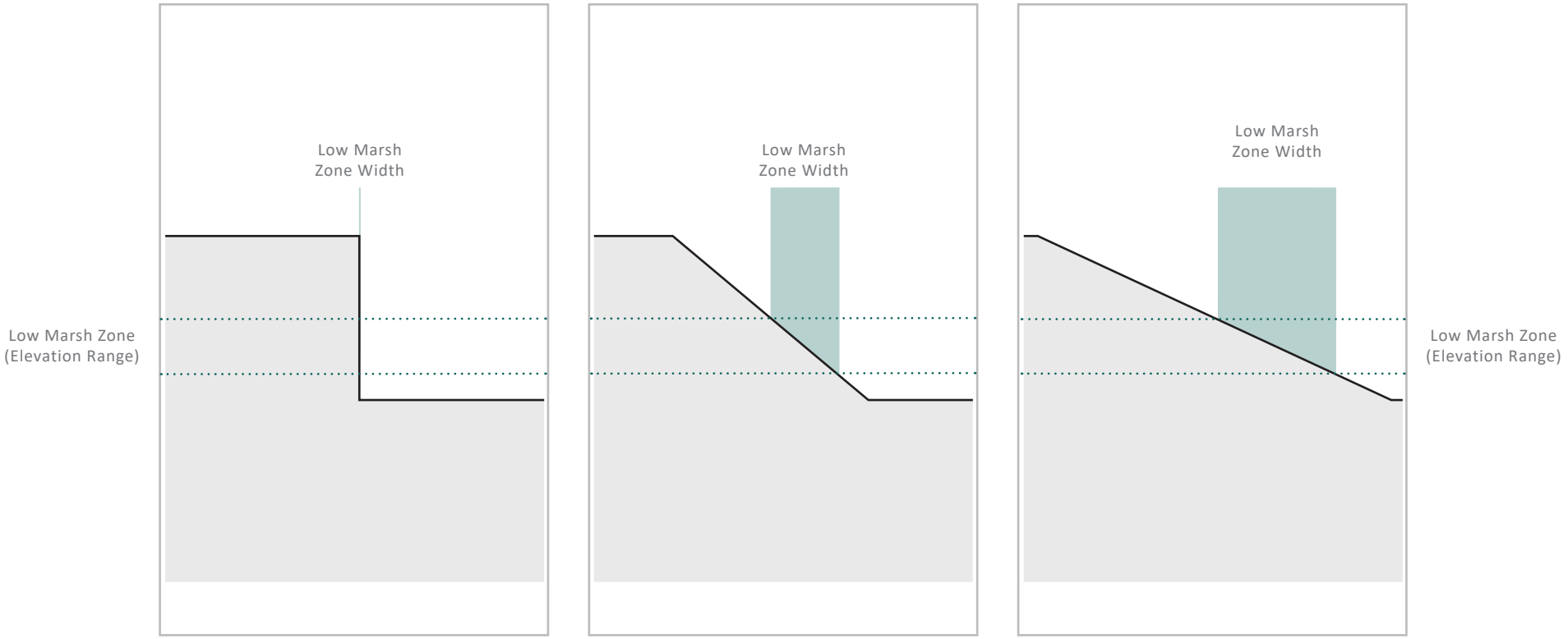
ATTRIBUTES OF EXISTING CONDITIONS TYPOLOGIES

Low Marsh Zone Width



Absent low marsh zone | Less than 6ft wide | Greater than 6ft

Attribute Description:
The focus on low marsh zone is indicative of the existing habitat value along the shoreline. It either highlights areas that could benefit from habitat enhancement or areas that require protection to maintain.

Absent low marsh zone: A project area without a low marsh zone is characteristic of a reinforced shoreline and has minimal existing habitat value.

Between 0 & 6ft: 6ft was chosen because it is the horizontal width, within the low marsh zone, of a 3:1 sloped bank. This angle is a typical slope of a riprap embankment and may not be indicative of a vegetated marsh zone. These areas will need to be compared against the shoreline type to better understand the conditions.

Greater than 6ft: A project area with 6+ft of low marsh width will probably have a vegetative condition/higher habitat value and will be a candidate for enhancement of the habitat or breakwater protection.

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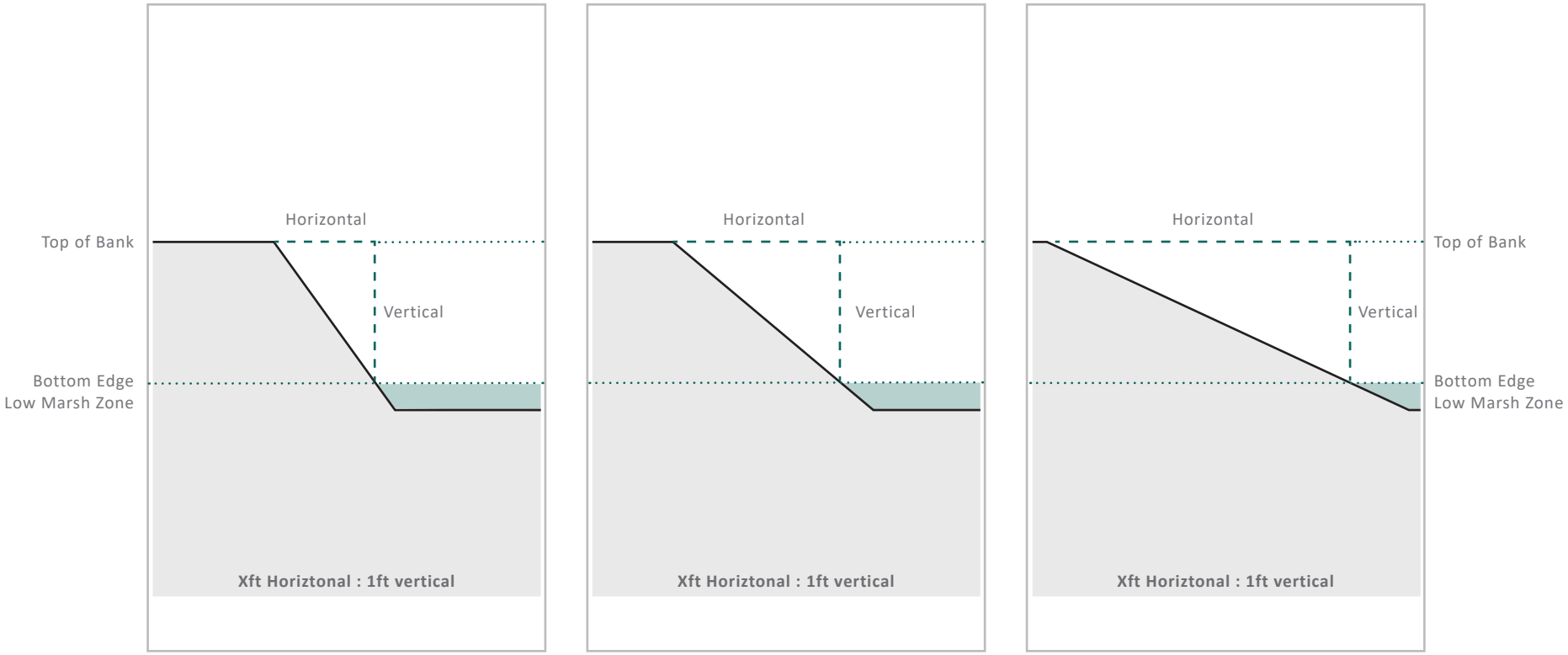
ATTRIBUTES OF EXISTING CONDITIONS TYPOLOGIES

Bank Slope



Steeper than 33% slope | Between 33-20% slope | Shallower than 20% slope

Attribute Description:
Bank slope is indicative of the erosional or depositional forces that are impacting the site. Bank slope will also incorporate the low marsh zone to understand the interaction of the bank and the water interface. Slope analysis also informs the range of proposed conditions by identifying the vertical/horizontal characterics and distances from which to design.

Steeper than 33% slope: A bank slope steeper than 33% slope is probably a hardened shoreline element with limited solutions.

Between 33-20% slope: A slope between 33-20% is within the hardened shoreline range but is also within the vegetated range. A comparison with shoreline characteristics will need to confirm condition.

Shallower than a 20% slope: A slope shallower than 20% offers a range of options and will be the ideal category for habitat value enhancement.

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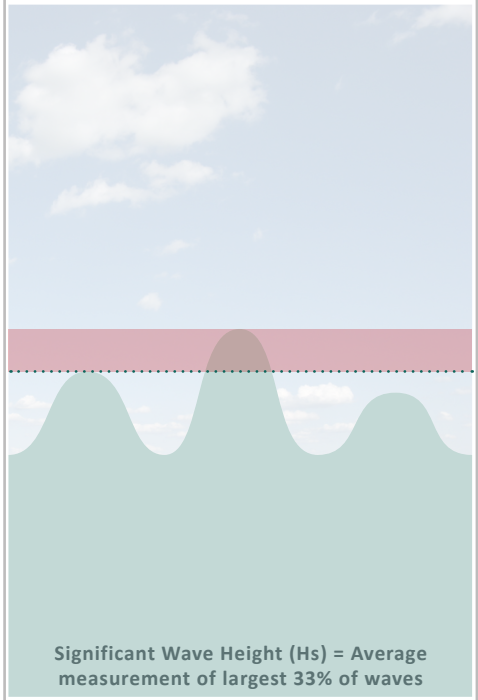
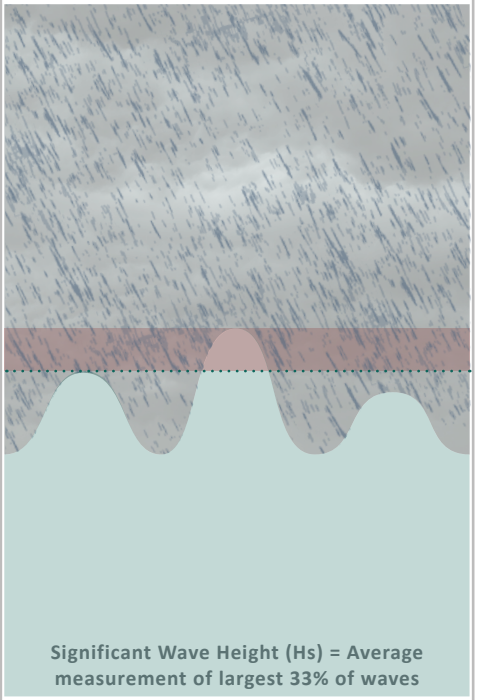
ATTRIBUTES OF EXISTING CONDITIONS TYPOLOGIES

Wind Waves

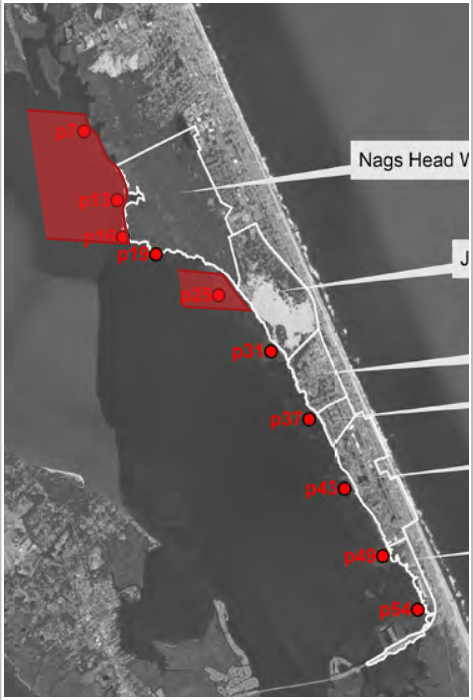
Increased Erosive Energy
Above 6" Wave Crest



Hs greater than 6in during normal conditions



Hs greater than 6in during storm events



Engineering Report - Analysis point locations

Attribute Description:
The wind wave category seeks to differentiate locations that maintain a highly erosive energy during normal conditions from those that are highly erosive during infrequent storm events. A Significant Wave Height (Hs) is the average wave height of the largest 33% of incoming waves. A max Hs greater than 6in is a threshold above which has been shown to be erosional to marsh communities.

Significant Hs greater than 6in during normal conditions: Consistently erosive conditions will require heavier breakwater protection to maintain marsh edge.

Significant Hs greater than 6in during storm events: Infrequently erosive conditions would benefit from moderate/light breakwater protection.

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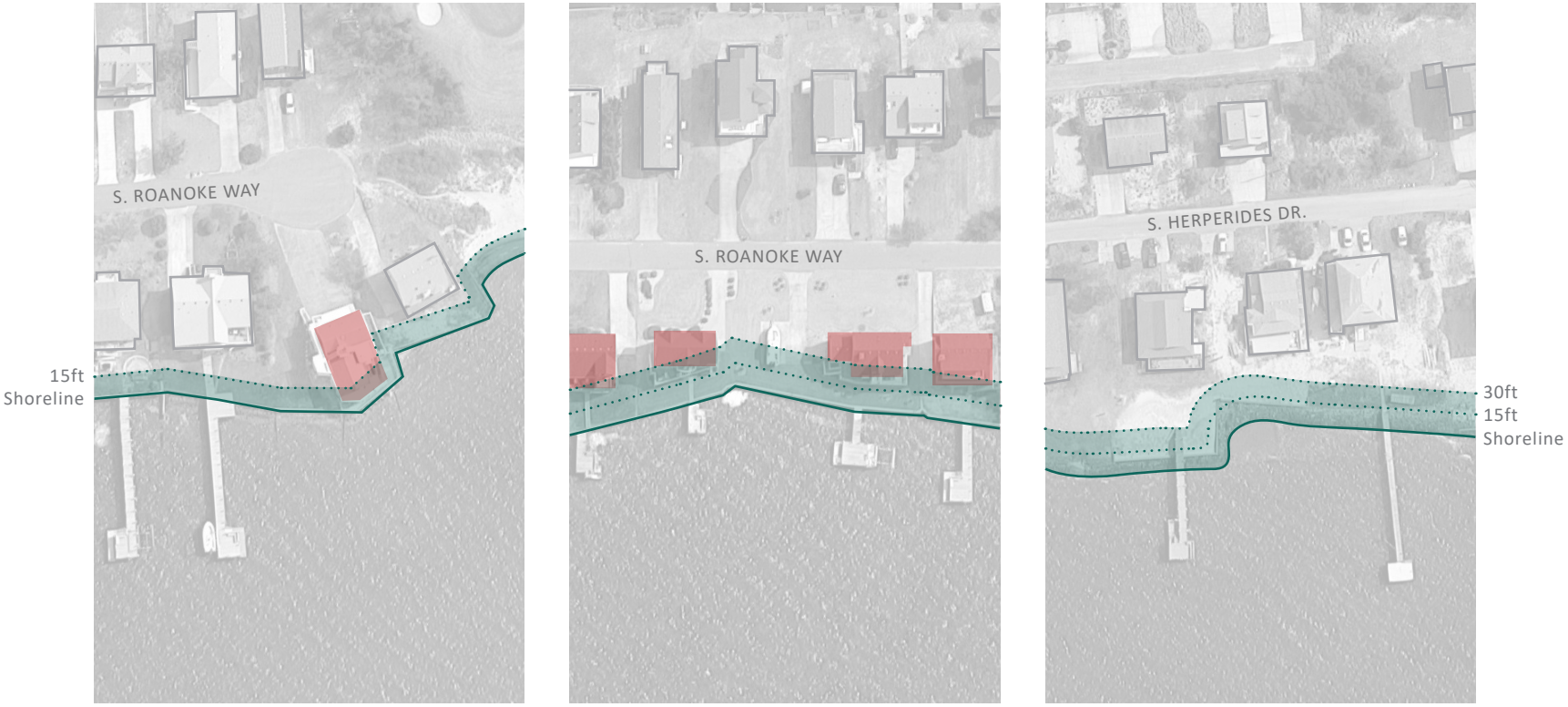
ATTRIBUTES OF EXISTING CONDITIONS TYPOLOGIES

Distance of Infrastructure from Shoreline



Less than 15ft | Between 15ft - 30ft | Greater than 30ft

Attribute Description:
The focus on 15ft was chosen because it is a typical distance allowed for the passage of large construction equipment.

Less than 15ft: A project area with clearance space to infrastructure less than 15ft would preclude the use of such equipment (depending on the type of infrastructure) and limit the potential projects available along the shoreline.

Between 15 & 30ft: A project with greater than 15ft but less than 30ft expands the project potential with the use of construction equipment, while limiting landward excavation options.

Greater than 30ft: A project area with 30+ft of clearance allows for intensive excavation activities to provide varied habitat and resiliency opportunities.

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ATTRIBUTES OF EXISTING CONDITIONS TYPOLOGIES

Sea Level Rise (SLR) Vulnerability & Marsh Migration

2ft rise

3ft rise

4ft rise

Attribute Description:
Sea Level Rise Vulnerability assesses different SLR scenarios and relative impacts to the shoreline. Marsh migration refers to an existing marshes ability to adapt to SLR by moving to higher elevations. Though not physically relocating, migration sees new growth establishing at a higher elevation to achieve the desired vegetative saturation regime as the waters rise. SLR information informs cost/benefit calculations and potential longevity of proposed interventions. Projections are highly inaccurate and based on our collective response in addressing climate change. Timeframes described below assumes an intermediate emissions pathway.

2ft SLR: A rise of 2ft and presumed location of mean sea level (MSL). Estimated timeframe is 30 years (2052 a.d.)

3ft SLR: A rise of 3ft and presumed location of mean sea level (MSL). Estimated timeframe is 50 years (2072 a.d.)

4ft SLR: A rise of 4ft and presumed location of mean sea level (MSL). Estimated timeframe is 70 years (2092 a.d.)

TYPOLOGY DETERMINATION

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EXISTING CONDITIONS TYPOLOGIES

TIER 1 - PROTECTION LEVEL

Exposed Sheltered

TIER 2 - SHORELINE CHARACTERIZATION

Bulkhead Riprap Beach Low Bank Marsh Scrub-Shrub

TIER 3 - SHORELINE FEATURES

Bank Slope Low Marsh Zone Width

TIER 4 - ADDITIONAL SITE-SCALE DESIGN PARAMETERS

Wind Wave Property Ownership Distance to Infrastructure Sea-Level Rise

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EXISTING CONDITIONS TYPOLOGIES

SHELTERED, SOLID BULKHEAD STRUCTURES

- Slopes >33%
- Absent LMZ
- Private ownership
- Sheltered from wind waves
- Distance to infrastucture mixed

SHELTERED RIPRAP

- Slopes >33%
- Absent LMZ
- Public, Vacant Private
- Sheltered from wind waves
- Distance to infrastucture >30ft

SHELTERED, VEGETATED LOW BANKS

- Slopes 20-33%
- Absent LMZ
- Private, Vacant Private
- Sheltered from wind waves
- Distance to infrastucture >30ft

SHELTERED, SCRUB-SHRUB/WETLANDS

- Slopes 20-33%
- Absent LMZ
- Private, Vacant Private
- Sheltered from wind waves
- Distance to infrastucture >30ft

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EXISTING CONDITIONS TYPOLOGIES

EXPOSED, SOLID BULKHEAD STRUCTURES

- Slopes >33%
- **Absent LMZ**
- Private, Vacant Private
- Wind Waves - Hs storm
- Distance to infrastucture >30ft

EXPOSED RIPRAP

- Slopes >33%
- Absent LMZ
- Public, Private
- Wind Waves - Hs storm
- Distance to infrastucture mixed

EXPOSED, SOLID BULKHEAD STRUCTURES WITH LOW MARSH ZONE

- Slopes >33%
- **LMZ > 6ft**
- Private ownership
- Wind Waves - Hs normal and storm
- Distance to infrastucture mixed

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EXISTING CONDITIONS TYPOLOGIES

EXPOSED, FAILING, VEGETATIVE BANKS

- Slopes >33%
- LMZ > 6ft
- Public & Private ownership
- Wind Waves - Hs normal
- Distance to infrastucture >30ft

EXPOSED, LOW BANK & BEACHES

- Slopes <20%
- LMZ > 6ft
- Public & Private ownership
- Wind Waves - Hs normal & storm
- Distance to infrastucture >30ft

EXPOSED SALT AND BRACKISH-WATER MARSHES

- Slopes <20%
- LMZ > 6ft
- Public, Private
- Wind Waves - Hs normal & storm
- Distance to infrastucture >30ft

PRELIMINARY PROPOSED TYPOLOGIES

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ANTICIPATED PROPOSED TYPOLOGIES

POTENTIAL SCENARIOS

- Upland buffer enhancements
- Existing bulkhead enhanced with habitat features (green bulkheads)
- Vegetated riprap revetment
- Replacing bulkhead with vegetated bank and living shoreline
- Replacing portion of riprap embankment with high marsh/scrub shrub
- Resiliency terraces (multiple habitat terraces that provide path for marsh migration)
- Living shoreline creation/protection
- Submerged breakwaters for existing marsh protection
- Woody aggredation structures

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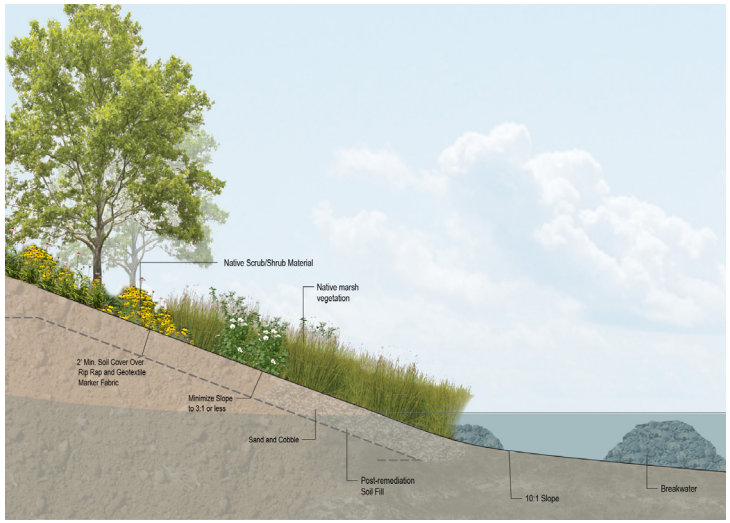
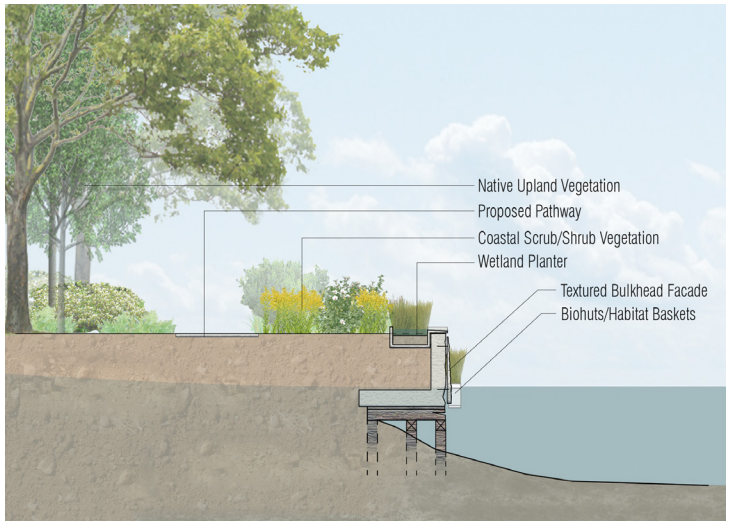
ANTICIPATED PROPOSED TYPOLOGIES

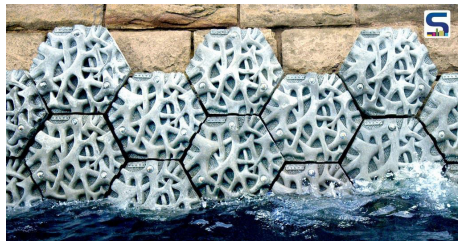


Living Shoreline

Projects shown are examples only; CAMA fill concerns to be addressed.



Green Bulkhead Enhancements



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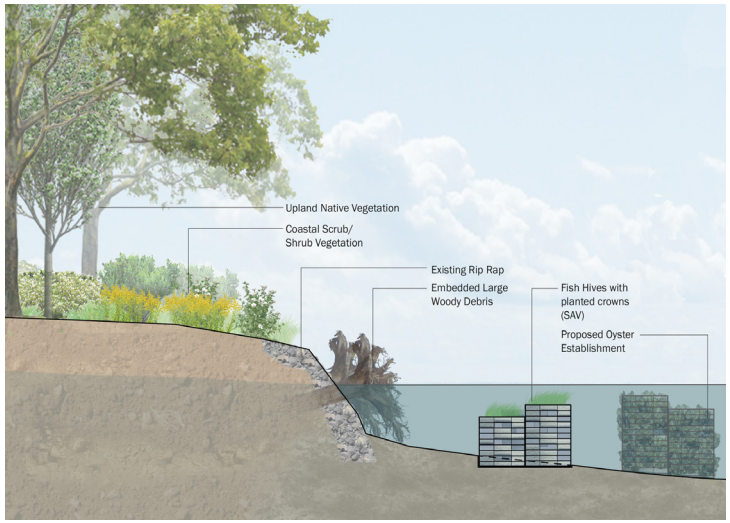
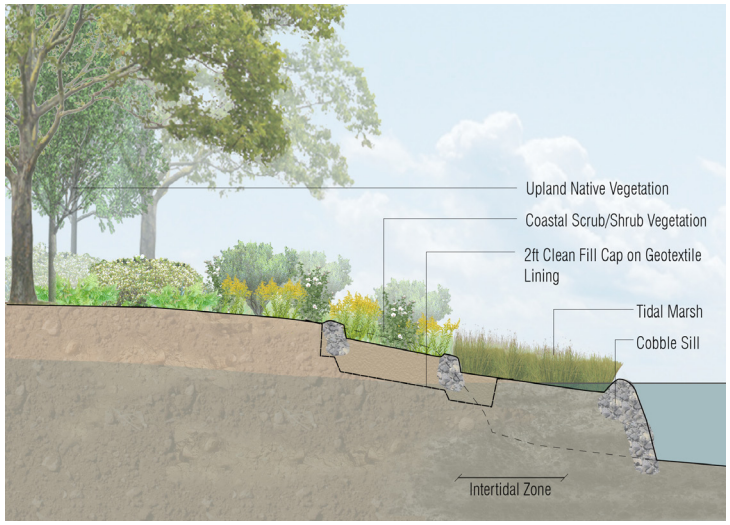
ANTICIPATED PROPOSED TYPOLOGIES



Embedded LWD Habitat and Breakwaters



Resiliency Terraces

Projects shown are examples only; CAMA fill concerns to be addressed.

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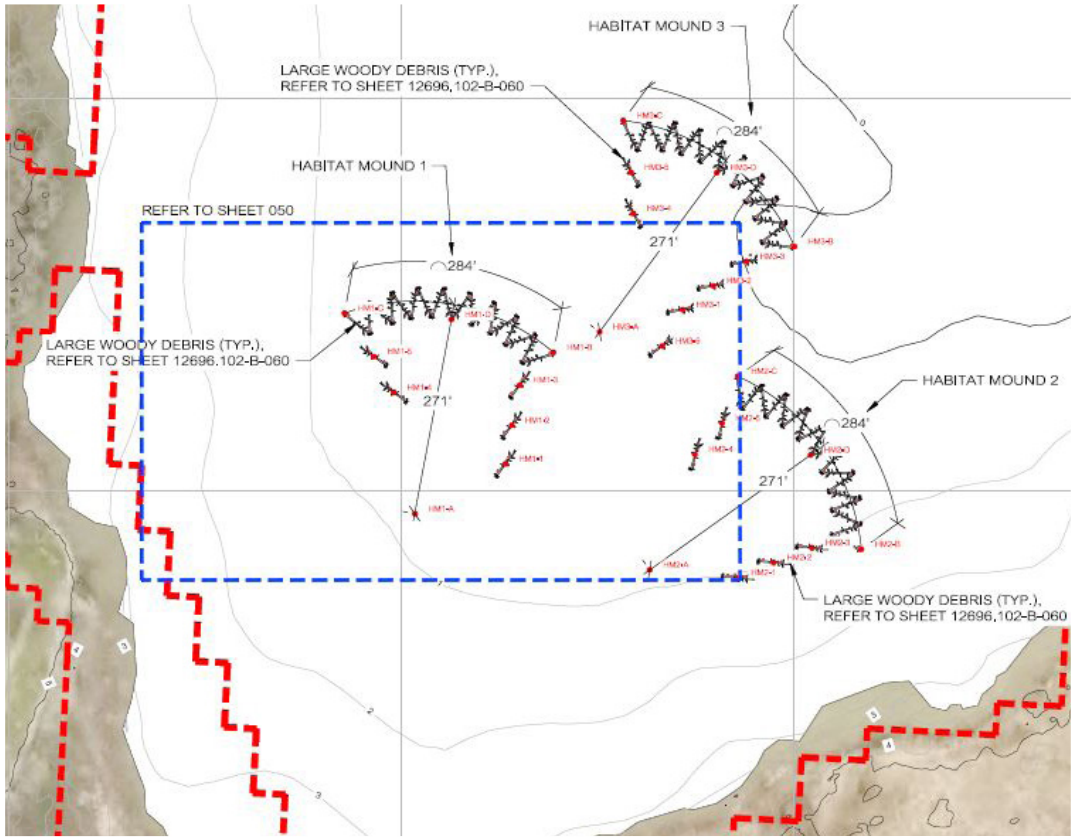
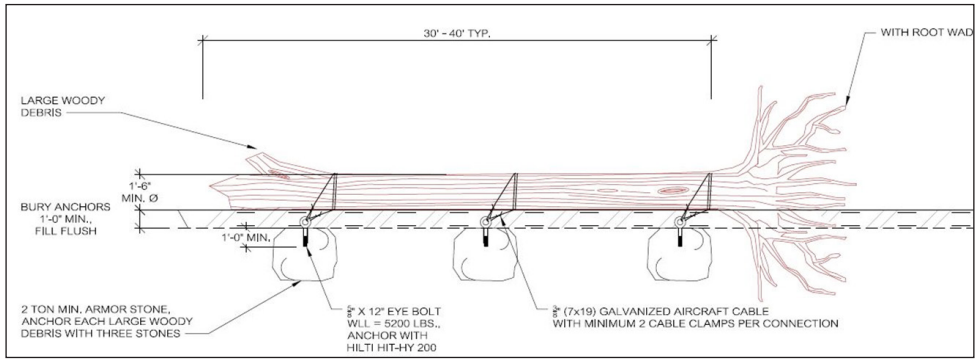
ANTICIPATED PROPOSED TYPOLOGIES





SITE SELECTION

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SITE SELECTION RATIONALE

OWNERSHIP & ACCESS

Range of Ownership Types

Recreation & Visitor Access

Partnership Potential

EROSION HISTORY

Areas of Concern - Repetitive Loss Areas

Areas of Concern - High Erosion Rates

Enhance Areas of Deposition?

INFRASTRUCTURE PROTECTION

Areas of Concern - Threatened Infrastructure

Proactive Protection of Future Threats

SITE SIZE - PROJECT IMPACT

Larger Continous Site,

Larger Project Benefits

Pilot Projects

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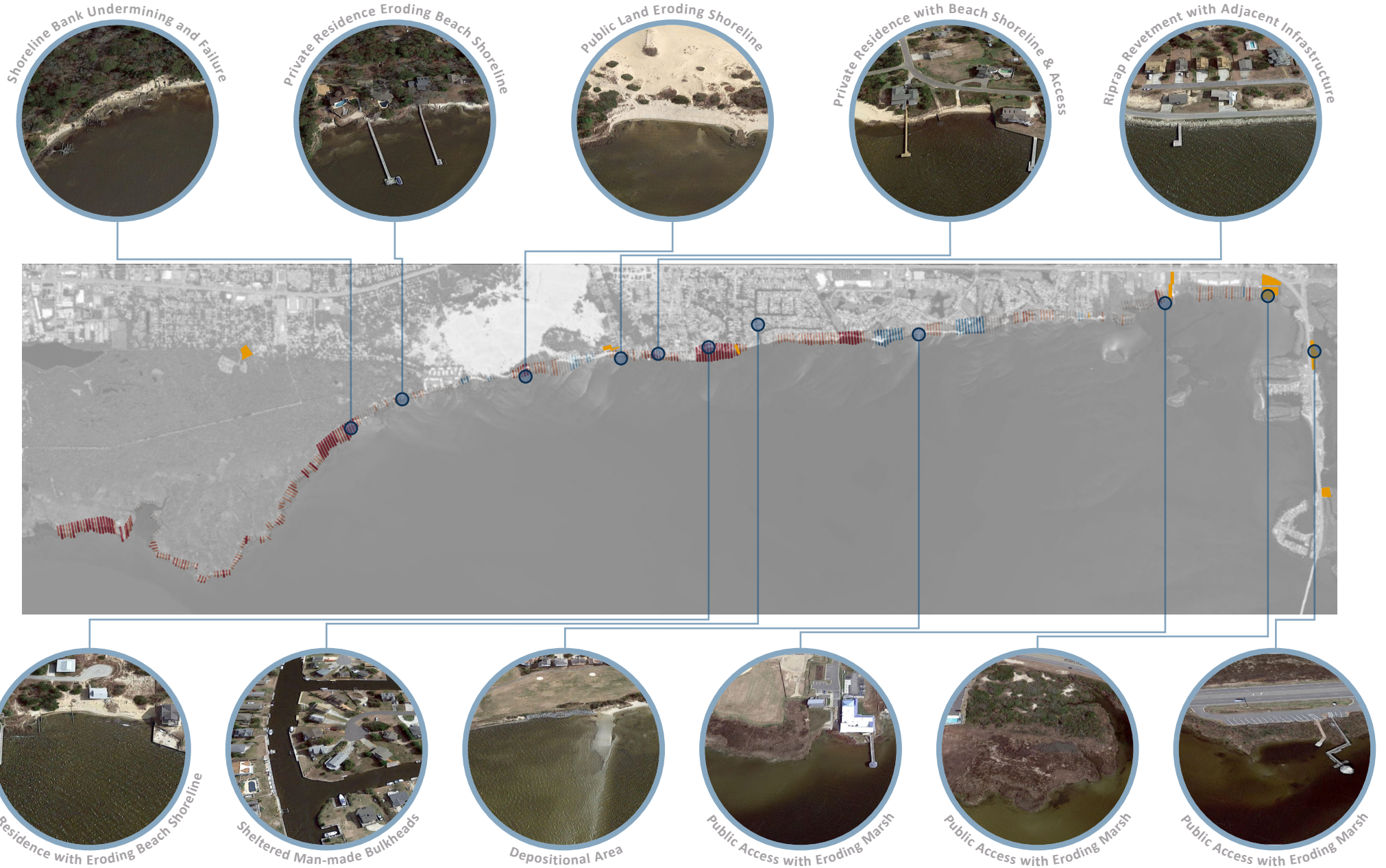
TOP 11 POTENTIAL PROJECT LOCATIONS



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SHORELINE STABILIZATION PERMITTING CATEGORIES

GENERAL PERMITS (GP)

- Issued by DCM field staff and are streamlined major permits for routine projects (permit issuance averages 5-14 days)

MAJOR PERMITS

- Reviewed by 10 state & 4 federal agencies and are issued at the Division headquarters (permit issuance averages 75-90 days)

MINOR PERMITS/EXEMPTIONS

- Special circumstances such as maintenance/post- storm repairs, etc.

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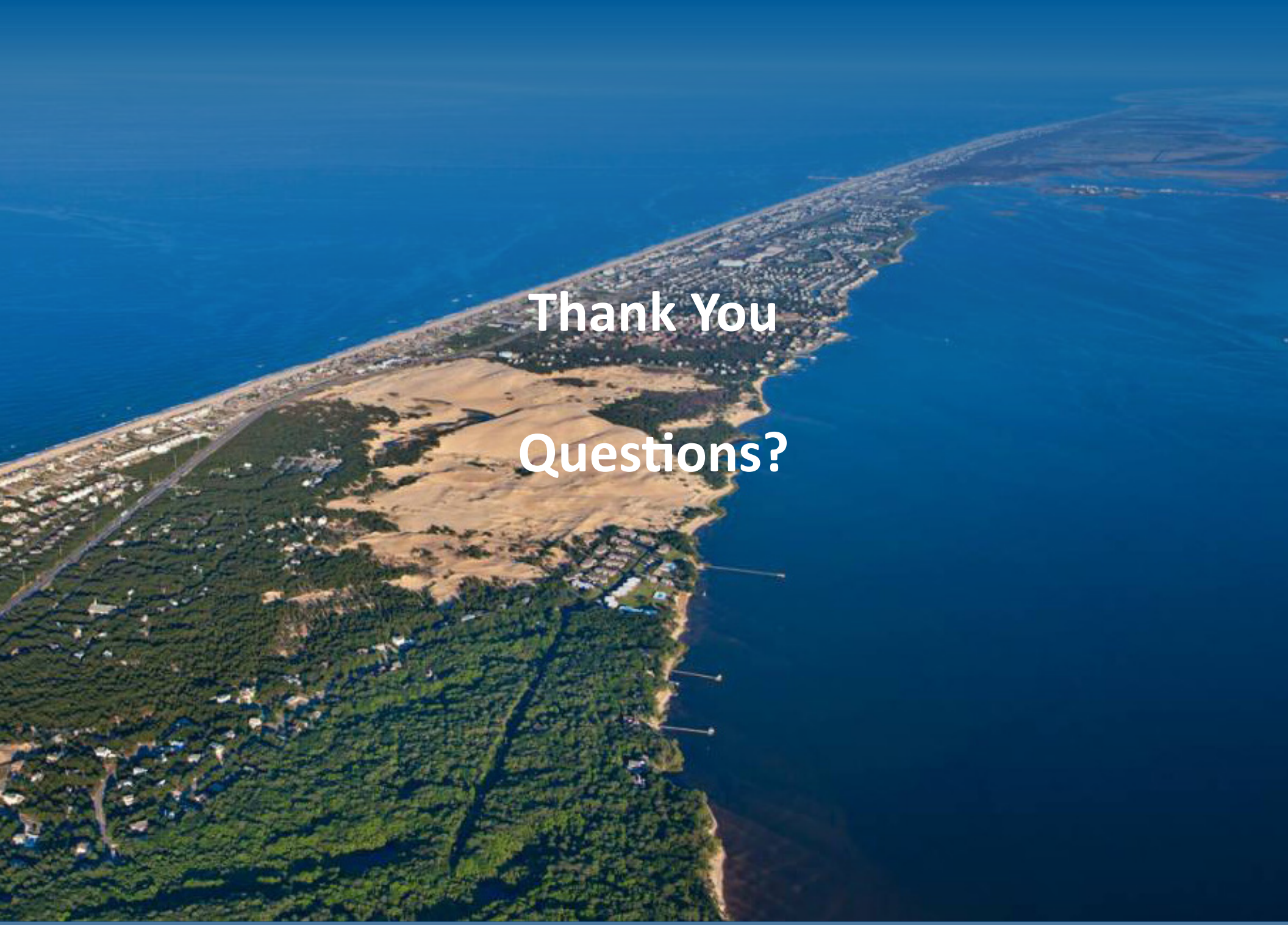
CAMA GENERAL PERMIT FOR LIVING SHORELINES

GENERAL PERMITS (GP)

- Limited to 30’ past normal high water or 5’ past existing wetlands, whichever is greater
- Cannot exceed 1’ above normal high water
- Slope cannot exceed 1.5’ horizontal distance over a 1’ vertical rise
- Max length 500’ with a 5’ openings every 100’, max base width of 12’
- Must be marked for navigational purposes
- Cannot construct over existing SAV or oyster beds
- No associated backfill


Thank You
Questions?