Sand Dunes and Beaches in Virginia: Science and Management

Recommendations for Guidance

FINAL REPORT TO
VIRGINIA COASTAL PROGRAM
DEPARTMENT OF ENVIRONMENTAL QUALITY

SUBMITTED BY

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Introduction

Sandy beaches and dunes provide a natural buffer to coastal hazards, habitat for many estuarine species and water quality services. While there are places in Virginia where sand is seemingly abundant, natural forces and human decisions act to limit available sand. Shoreline hardening, bank grading and dredging are among those actions that can result in loss or reduction in sand supply. Less sand means fewer and smaller beaches and sand flats. And as downdrift beaches and sand flats diminish, there is a loss of erosion protection for real property and infrastructure and adverse impacts on ecosystem services including recreation.

The importance of sandy shores was recognized with the passage of the Coastal Primary Sand Dune Protection Act in 1980. Eight localities were included in the Act: the counties of Accomack, Northampton, Mathews, Lancaster, and Northumberland; and the cities of Virginia Beach, Norfolk, and Hampton. The Act also defined a beach and coastal primary sand dune and included a list of those plants which grow upon the dunes.

Along the way, the name of the Act was changed to The Coastal Primary Sand Dune and Beach Act. The purview of the Act was notably modified during the 2008 Session of the General Assembly. The list of local governments authorized to administer the Act was changed from the eight originally specified to include all of Tidewater Virginia as defined in § 28.2-100 of the Virginia Code.

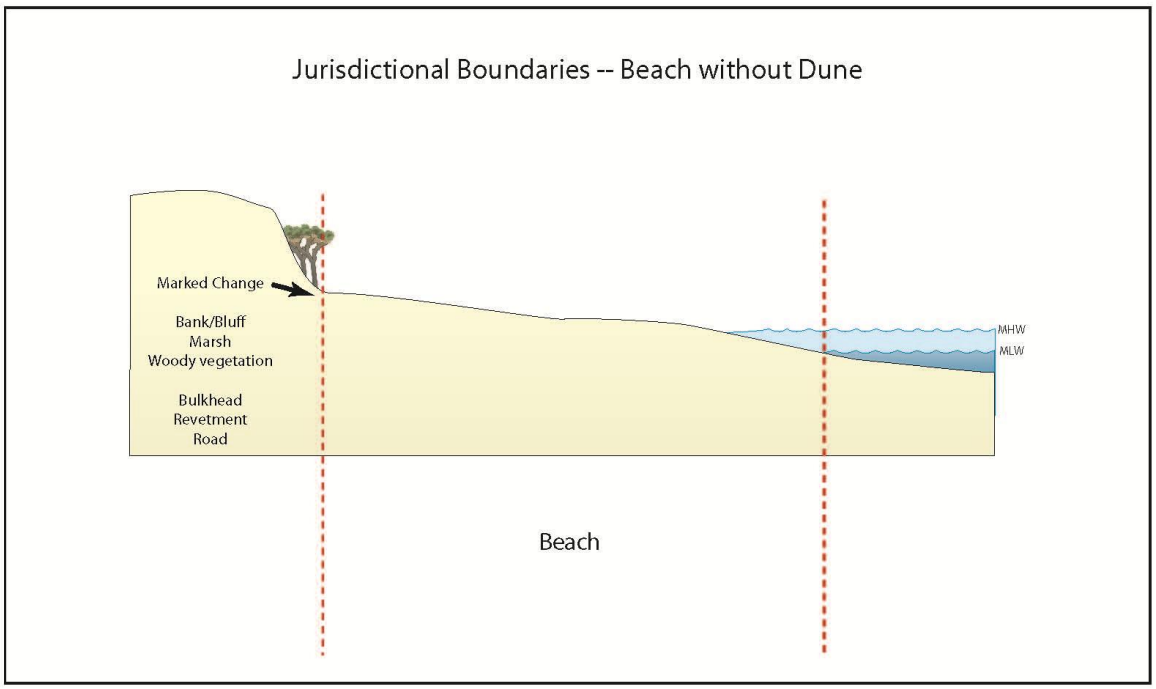
The 2008 changes also added three plant species to the list of dune plants named in the Coastal Primary Sand Dune and Beach Act that are necessary for jurisdictional determinations. The three plants added to the list are the nonnative Japanese sedge (*Carex kobomugi*), the native Virginia pine (*Pinus virginiana*), and the native broom sedge (*Andropogon virginicus*).

Natural sand features, beaches and dunes, are part of a shoreline system that can extend from uplands and eroding banks out to sand bars in nearshore shallow waters. Interactions between these features are critical to the sustainability of the system. An improved scientific understanding of sandy shorelines in Virginia includes better information on the presence of these types of shorelines throughout Virginia and recognition of the need to manage these valuable resources wherever they occur. Effective management will require an understanding of physical processes and ecology and the effects that shoreline activities have upon those processes.

Definitions

Beach means the shoreline zone comprised of unconsolidated sandy material upon which there is a mutual interaction of the forces of erosion, sediment transport and deposition that extends from the low water line landward to where there is a marked change in either material composition or physiographic form such as a dune, bluff, or marsh, or where no such change can be identified, to the line of woody vegetation (usually the effective limit of stormwaves), or the nearest impermeable man-made structure, such as a bulkhead, revetment, or paved road.

Coastal primary sand dune or **dune** means a mound of unconsolidated sandy soil which is contiguous to mean high water, whose landward and lateral limits are marked by a change in grade from ten percent or greater to less than ten percent, and upon which is growing any of the following species: American beach grass (*Ammophila breviligulata*); beach heather (*Hudsonia tomentosa*); dune bean (*Strophostyles spp*.); dusty miller (*Artemisia stelleriana*); saltmeadow hay (*Spartina patens*); seabeach sandwort (*Honckenya peploides*); sea oats (*Uniola paniculata*); sea rocket (*Cakile edentula*); seaside goldenrod (*Solidago sempervirens*); Japanese sedge or Asiatic sand sedge (*Carex kobomugi*); Virginia pine (*Pinus virginiana*); broom sedge (*Andropogon virginicus*); and short dune grass (*Panicum amarum*). For purposes of these guidelines, "coastal primary sand dune" or "dune" shall not include any mound of sand, sandy soil, or dredge spoil deposited by any person for the purpose of temporary storage, beach replenishment or beach nourishment, nor shall the slopes of any such mound be used to determine the landward or lateral limits of a coastal primary sand dune. § 28.2-1400 Code of Virginia.



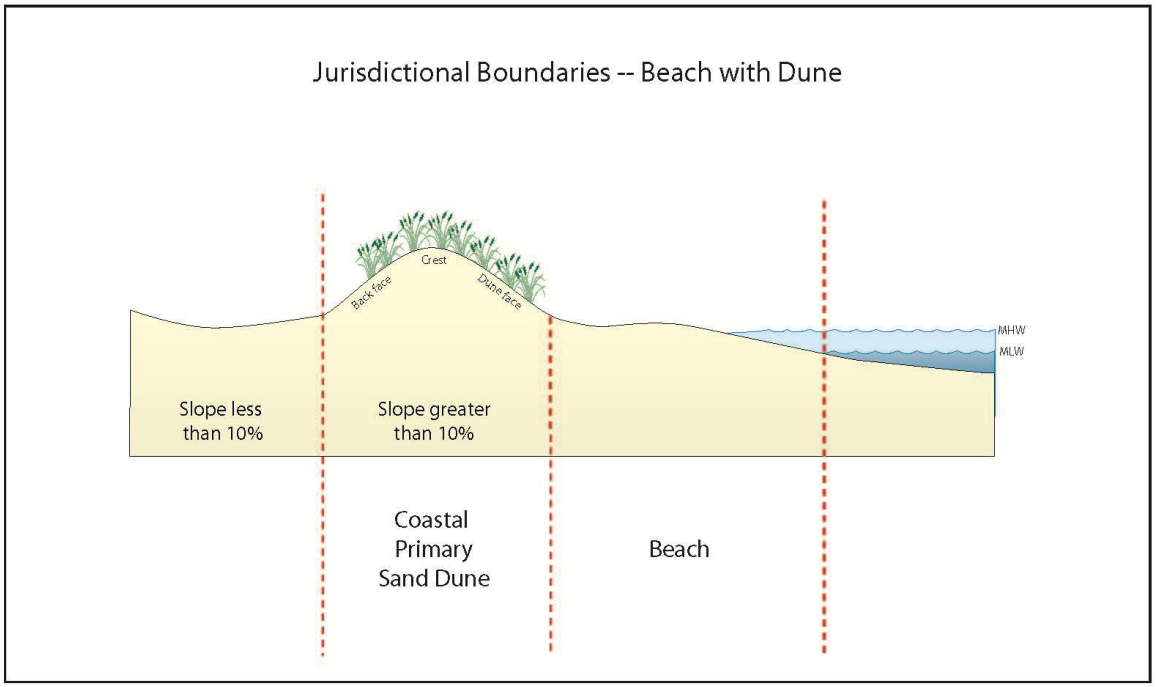


Figure 1. Beach and Beach/Dune jurisdictions.

Coastal Primary Sand Dunes and Beaches in the Ecosystem

Coastal Primary Sand Dunes and beaches perform a host of ecological services that benefit adjacent ecosystems as well as the human inhabitants of these areas. As impacts to these areas represent both an ecological and an economic impact, any proposed activities should be examined carefully to weigh the consequences for both public and private interests in these areas.

On sandy shorelines, sand moves both across and along the shoreline. Sand moves between dunes, beaches, nearshore flats, and off shore sand bars. There is a seasonal element to the sand distribution with steeper beach slopes in winter and gentler slopes in summer. The sand on the shoreline may come from various sources including far upstream, nearby eroding bluffs, off shore and even downstream sand carried by tides.

The primary physical factors that influence the shape and composition of beach and beach-dune shorelines are waves and wind. The transport of sand by wind is called aeolian transport. Waves and wind also create conditions that have the potential to cause loss or damage to real property and infrastructure. And these factors influence the ecosystem processes and services provided by beach and beach-dune systems.

Ecosystem services can be grouped into 3 categories as follows:

Coastal Hazard Protection (Erosion protection)
Habitat, and
Water Quality.

Coastal Hazard Protection

Coastal primary sand dunes and beaches serve as protective barriers to flooding waters and wind and wave generated erosion. The presence of beaches or beaches and dunes serves as a first line of defense against wave and wind energy.

Beaches provide a buffer to wave energy. As waves approach the shallows, the wave slows on the bottom due to friction and the top "spills" over (or breaks). The breaking wave transfers energy to the beach before coming in contact with the upland. The beach sand allows water to "perk" into the beach and return to the waterway below the surface. This process reduces the energy at the surface that could erode sand from the beach.

The physical presence of the dune provides a wind break reducing wind energy and its potential adverse effects on nearby property. The vegetation on the dune provides additional friction to slow the wind and also traps sand being carried by the wind. Trapped sand acts to build new dunes and maintain existing dunes. Notably, dunes also behave as levees in the face of storm water.

Features on sandy shorelines, including primary and secondary dunes, berms, beaches, nearby sandy banks and nearshore sand bars serve as reservoirs of sand. Sand movement

occurs between these features. Sand movement occurs along and across (on-and off-shore) the shoreline. Sources of sand for riverine beaches also include eroding banks and bluffs that contain sandy material. Maintenance of beaches and/or dunes wetlands is dependent upon available sand supply and the capacity for sand to move among these shoreline features.

Habitat

Dunes and beaches provide habitat for a variety of plants and animals. Plants adapted for life on coastal primary sand dunes survive in the face of very limited amounts of fresh water, constant salt spray, and marked variations in temperature. Endemic plants and animals, those that live only on beaches and dunes, are adapted to these physical stresses.

Species of worms, bivalves, isopods and crustaceans live in the spaces between the sand grains on the beach, the interstitial spaces. These animals, called infauna, rely on the organic material delivered by waves that filter through the beach. Animals that occupy the beach are highly adapted to extreme conditions of physical disturbance. Because grain size affects the water chemistry, oxygen content and organic matter content of the beach, it also determines the species of animals and numbers of individuals. The greatest numbers of species and individuals are found on intertidal areas with sand of various sizes along with some finer sediment - silts and clays.

The infauna are an important food source for foraging fish and crustaceans that are on the beach at high tide, and wading shorebirds.

Many species use the beach and/or dune for nesting, feeding, corridors, nursery or refuge. Some animals on the beach and dunes, or the adjacent waterways, may be rare, threatened or endangered. Limitations in scope, scale or time may be placed on activities or projects that could have an adverse effect on these species. Time of year restrictions may be required to avoid adverse effects during particularly vulnerable life stages of certain animals.

Gloucester County Beach

Water Quality

Beaches and dunes provide water quality services through water filtration, nutrient cycling, nutrient uptake and water storage.

Waves wash over intertidal beaches and large volumes of water sink into the sand. This process filters particulate and dissolved organic material from the water. The organic matter is delivered to the interstitial animals (those living in the spaces between the sand grains). Beaches with sand particles of varying sizes, including small fractions, retain the greatest amount of organic matter. As such beaches with varying sized sands are most effective at removing organic matter from ambient waters.

While ambient waters may be a source of organic matter, beaches have little primary production and are generally nutrient poor. Nutrients deposited on the beach are quickly processed. Nitrogen is cycled through the beach by the following processes:

It is returned to the waterway from tidal and groundwater flushing,
It is trapped in the beach and used by microbes or in-fauna
It is transferred to the groundwater, or
It is removed from the system by bacteria that convert organic nitrogen to N2 gas. This process is called denitrification.

On the vegetated portions of the sandy shoreline, plants remove nutrients through the production of plant material. Some of this plant material is directly consumed by insects which are eaten by other animals forming part of the coastal food-web. Primary production not directly consumed provides detritus to the waterway and organic matter for the interstitial fauna on the beach.

The low areas between dunes, know as swales, are often areas of ground water discharge. Sufficient amounts of water in the swales can support the presence of a wetland community that can act to remove nutrient and other pollutants from the groundwater. The groundwater may discharge on the beach or in the nearshore.

Essex County Beach

General Criteria for Beach/ Dune Projects

Preference for sustainable actions

Coastal shorelines and nearshore shallow waters tend to be dynamic and interconnected with the surrounding landscape and vegetative and animal life. Any action on one part of the system not only results in direct impacts to that habitat, but has the potential to impact adjacent habitats. Therefore, activities that impact shoreline should be avoided whenever possible.

To reduce the cumulative and secondary impacts of activities within the multiple jurisdictions and management programs affecting the littoral and riparian zones, better coordination and integration of policies and practices is necessary. When making decisions regarding beaches and dunes, it is important to optimize water quality, habitat functions and coastal hazard mitigation/erosion protection across the entire cross-shore environment. Special emphasis should be placed on the preservation or enhancement of attributes (such as dunes, sandy beaches, riparian vegetation and wetlands) that contribute to ecosystem services.

1. **The following should be avoided:**
    - Placement of non water-dependent structures on dunes or beaches
    - Excavation of dunes or beaches

2. **Adverse impacts of projects should be minimized by appropriately designing and constructing for the physical setting.**

3. **Time of year restrictions should be applied, as necessary, based upon project location and extent.**

King George County Beach

Specific Criteria for Beach/ Dune Projects

Stabilization Methods

The natural position of a dune at any given time is the result of a balance of wind, waves and storms. Dynamic processes along a sandy shoreline include continuous sand movement between offshore sand bars, the beach and the dune. This sand movement is critical to dune creation and maintenance processes. Structures to stabilize a dune or beach in a particular location inhibit this natural fluctuation and buffering capability. Reflected wave energy can increase beach erosion and loss and adversely impact habitat for beach-dependent species. Generally structures are not advised on the dune face, dune crest or beach backshore.

Stabilization methods that maintain or enhance the natural dynamics of the beach-dune ecosystem are preferred. Management approaches can be grouped in order of preference as follows:

1) No action, maintain or enhance natural dune/ beach features
2) Non-structural techniques, including sand fencing
3) Combined non-structural and structural techniques, and
4) Structural techniques.

No action, maintain or enhance natural dune/ beach features.

Erosion control efforts should be avoided unless there is a risk of significant loss of property and upland improvement. Activities to restore or enhance the ecology of the shoreline by planting dune vegetation may be possible.

Non-structural techniques, including sand fencing

a. Sand fencing

Sand fences help build dunes by trapping wind-blown sand. If installed improperly, they can impede public access to the beach and wildlife movement.

Sand fences in the Sandbridge area of Virginia Beach should comply with guidelines adopted by the City of Virginia Beach, the US Army Corps of Engineers and the Sandbridge Civic League.

b. Beach Nourishment

Although the placement of sand on the beach can enhance erosion protection, it can also impact habitat of protected species (e.g. sea turtles, Northeastern beach tiger beetle). Existing dune vegetation may be buried. Manipulation of beach fill may also result in artificial dune lines that are not reliable indicators of suitable building and access locations. Temporary water quality impacts are also likely and may be widespread in both area and time if the fill contains a large amount of fine-grained material and it is exposed to wind or wave erosion. Additionally, adverse impacts associated with the use

of fine-grained material include flattening of the foreshore slope, increased aeolian transport upland, greater changes in the beach profile and changes in the species and number of animals living within the beach.

When the proposed project is for shoreline protection, beach nourishment is the preferred approach for sandy shorelines as it enhances the natural capacity of the beach to provide the desired erosion protection. The maintenance of the beach may require the use of a rock structure, such as a nearshore sill or offshore breakwater(s), and maintenance nourishment efforts.

Only clean sand fill that contains at least 90% coarse-grained sand should be used. Time of year restrictions may be required for protected species. The nourishment area should be stabilized with appropriate vegetation.

Combined non-structural and structural techniques

a. Breakwater

Breakwaters are comprised of two elements: one or more free standing structures placed in the nearshore waters, and sandy material used as beach nourishment. Beach nourishment is a preferred approach for sandy shorelines as it enhances the natural capacity of the beach to provide the desired erosion protection.

Breakwaters cause the conversion of nearshore shallow waters to rock, or other non-native material, and sandy shoreline. The construction of the breakwater will cause temporary water quality impacts and may interrupt sediment transport. Breakwaters are most effective on high energy sandy shorelines and when designed for longer sections of shoreline.

b. Groins

Groin(s) will, by design, interrupt sediment transport along the shore. This will likely result in a loss of sediment on the down drift side of the groin, increase the erosion risk, and increase the loss of shoreline habitats.

The creation of new groin fields should be avoided. However, the placement of a groin or groins may be a preferred alternative within an existing effective groin field with an adequate sand supply. Beach nourishment with clean, properly sized sand is recommended for proposed groin projects.

Structural techniques

a. Revetment

Revetments sever the connection between the nearshore bars, the beach and the beach berm or dune. Placement of a revetment within this cross-shore area will have adverse

effects on the movement of sand both across and along the shoreline and is a change from natural sand and vegetation to rock. The result is a loss in the water filtration capacity of the beach/dune, a reduction in sand availability to nearby shorelines, a loss of erosion buffering capacity and a change in the animal habitat.

Revetments should not be placed on the dune face, dune crest or beach backshore. If used as the core of a constructed dune, rock structures should be buried with adequate volumes of sand and planted with dune vegetation. Existing dune features disturbed by construction activity should be restored.

b. Bulkhead

Vertical bulkheads constructed along the beach interfere with natural coastal processes such as the natural movement of sand between the beach and the dune, disturb valuable habitat, are subject to failure from shifting and eroding sand, and may not provide the intended shoreline protection during extreme storm events.

Bulkheads change beach profiles, alter the movement of waves along the shoreline and may cause increased erosion on neighboring properties. Bulkheads may contribute to their own destruction by reflecting waves and eroding the shoreline on the water side of the structure and are subject to overtopping and failure during storm events.

As a matter of public policy, HB2586 validated the use of bulkheads for erosion protection in Sandbridge Beach Subdivision in the City of Virginia Beach. Virginia Code § 28.2-1408.2.

Bulkheads adversely affect beach and dune ecosystem processes. Bulkheads are not resilient and typically fare poorly in the face of the moderate to high energy found in beach environments.

Residential, Commercial & Accessory Structures

Structures interfere with wind and sand deposition patterns adversely effecting sand movement along and across the shore and natural dune building processes. Structures may be subject to burial, resulting in frequent excavation and movement of sand which reduces stability of the dune and the amount of sand available for flood and erosion protection. Structures may also shade or displace dune vegetation.

All structures should be located landward from the beach and/or dune system. If dune encroachment is necessary, then the footprint should be minimized and limited to the dune backface (the back slope of the dune). Since the dune backface is the most active sand deposition area, only elevated open-pile construction should be used; slab foundations and other structures that require excavations should be avoided. If sand must be excavated, it should remain in the local vicinity and be strategically placed and stabilized with vegetation to enhance the existing beach and dune features.

Beach Access Structures

Pedestrian or vehicle traffic access points through the dune will create a breach for wind and waves through the dune line.

Walkways & decks over dune vegetation will have shading impacts. Access structures are subject to failure, particularly during storms, resulting in scattered solid waste debris.

Elevated open-pile structures are preferred to minimize disturbance of vegetation and natural dune building processes. The footprint of the structures should be the minimum necessary to provide the desired access, this mean as direct and narrow as possible. The elevation depends on dune crest and vegetation height. Designated access points are preferred over multiple paths or elevated walkways. Construction mats placed on grade can be used for temporary vehicle access.

Dune Leveling & Relocation

Leveling a dune eliminates the storm and erosion buffering capability and reduces the amount of sand available for the nearby beaches. These losses occur not only at the site, but for adjacent areas as well. If dune vegetation is removed, then the associated sand accretion, stabilization and habitat functions are also reduced.

Dunes should be maintained as a relatively uniform, uninterrupted dune line in order to offer the maximum flood and erosion protection. Relocating part of a dune line creates a breach and hazard for property behind the relocated dune and adjacent properties.

Dune alterations are not advised. If they are considered necessary, then sand should be strategically placed and stabilized with vegetation to enhance natural beach and dune features.

Dredging on Sand Beaches

Dredging to remove sand or change sand transport patterns to maintain navigation channels reduces the sand supply available for storm protection and interferes with natural dune building processes. Dredging on sand beaches should be avoided. Sand bypass systems should be considered.

Dune Restoration

Actions to create more extensive, better-stabilized dunes are generally beneficial. They should be designed to enhance natural dune lines, height and vegetation communities. Clean, coarse-grained sand should be imported from an upland source rather than borrowed from existing beaches and dunes.