Water Resources Division

Sand Dune Stabilization

Description

Sand dune areas, and steeply sloped and sparsely vegetated inland sandy areas often present challenges to site stabilization and the prevention of erosion. Coastal sand dunes are dynamic systems where sand movement is a natural process. However, construction can accelerate erosion.

Landowners and land managers can use the best management practices (BMPs) described here to minimize impacts to dunes and other sandy areas, and to restabilize those areas that have been impacted or eroded.

Applicable Locations

The BMPs can be used in Great Lake shoreline dune areas and sandy inland locations, including steep slopes or hillsides, stream banks, and inland lake shorelines. A permit might be required from the Michigan Department of Environmental Quality (MDEQ) district office, and the local or county soil erosion and sediment control agent.

Pollution Control Goals

The BMPs are designed to prevent and minimize sediment erosion in dunes and other sandy areas, and subsequently prevent deposition (sedimentation) of sand into water bodies and wetlands; and onto structures, roads, and associated infrastructure.

Companion and Alternate Practices

Construction Barrier
Modular Pavement
Porous Asphalt Pavement
Rolled Erosion Control Products
Sediment Basin
Silt Fence
Spoil Piles
Staging and Scheduling
Tree Protection
Trees, Shrubs and Ground Covers

Site Planning and Minimizing Impacts

During site planning, include an evaluation of the existing disturbed areas, slopes, and soils. A detailed description of the site will provide options to minimize erosion and site destabilization during and after construction. More information can be found in the *StormSmart Coasts—StormSmart Properties* series of fact sheets (Massachusetts, 2016).

Minimizing Disturbed Areas

- Use areas previously cleared or graded. By using areas already disturbed the impacts of construction on the site and the areas needing stabilization are minimized.
- Limit the percentage of the site that is disturbed. The less area of the site that is disturbed the less costly it will be to stabilize after construction.
- Avoid areas with slopes greater than 25 percent (1V:4H). Steep slopes can be difficult to stabilize after construction and often require continued maintenance.
- Identify the limits of clearing, grading, and vegetation removal; and establish a minimum construction buffer from the dune, wetland, stream, or lakeshore. Clearly identifying the work area discourages materials and equipment from being stored, used, or driven outside the impact area.
- Leave all stumps and roots in place to stabilize soils and slopes.

Minimizing Soil Movement

- Limit impacts that facilitate slope failure and erosion, including control of storm water and impacts to slopes offsite. Use erosion control measures at both the bottom of the slope (to protect uphill from construction) and at the top of the slope (to protect areas downhill from construction occurring along the crest of a slope).
- Limit the difference between cut and fill volumes, by balancing volumes on site. Minimize bringing new fill on the site, as it can potentially bring invasive, exotic (non-native) seeds or damaging fungus. Removing soils removes seeds of native plants and any topsoil and organic material from the site.
- Refer to the Staging and Scheduling BMP for additional information on staging construction and minimizing disturbed areas throughout the construction project.
- Refer to the Spoil Piles BMP for information regarding proper storage and stabilization of spoil piles during the construction phase.

Slope Stabilization

Slope protection and soil stabilization techniques are used to minimize soil movement at the source and limit sedimentation issues. Appropriate design and installation techniques can minimize soil erosion, reduce sediment pollution, minimize future impacts to slopes, and reduce overall costs. The local conservation district (Michigan Association of Conservation Districts [MACD], 2010) often has information regarding the most effective site stabilization techniques for the area. For inland dune shorelines, refer to the Michigan Natural Shoreline Partnership (MNSP) web page (MNSP, undated). More information can also be found in the *StormSmart Coasts—StormSmart Properties* series of fact sheets (Massachusetts, 2016).

Temporary Slope Protection

- Physical Barriers to Construction Impact:
    - Refer to the Tree Protection BMP for information on preventing damage to trees on steeply sloped and other sensitive areas.
    - Refer to the Construction Barrier BMP for preventing travel of personnel and vehicles into steeply sloped and other sensitive areas.
    - Refer to the Silt Fence BMP for information on installing perimeter controls to keep sediment on-site.
- Temporary Runoff Control:
    - When and where possible, maintain minimal angles of repose on exposed slopes within the construction site. Less than 1V:4H is desirable.
    - Refer to the Silt Fence BMP for information on proper location and installation of silt fencing to minimize erosion/offsite sedimentation.
    - Refer to the Sediment Basin BMP for designing, locating, and constructing this practice to trap sediment in runoff and protect receiving waters.

Permanent Slope Protection

- Runoff Control/Infiltration Areas - Implementing runoff control in site design and landscaping is the first step in eventual stabilization of sandy areas and sandy shoreline bluffs. This is done so that runoff control measures slow, capture, and infiltrate runoff, to prevent it from concentrating and causing soil erosion. For example, direct rooftop downspouts to vegetated areas to slowly infiltrate water and avoid channelization and erosion.
    - Permeable Surfaces - To encourage runoff infiltration, reduce impervious surfaces by converting concrete or asphalt driveways to grass, gravel, or permeable pavement (either porous asphalt pavement, permeable concrete, or modular pavement.)

- Turfgrass versus Native Vegetation - Minimize the use of turfgrass, because it can worsen runoff issues when water readily runs off mowed grass, and the soil underneath tends to become compacted over time, losing infiltration capacity. Instead, plant or maintain native vegetation (Michigan, 2014). Combinations of native grass, forb, shrub, and tree species are recommended.

- Vegetated Buffer Strips - Plant vegetated buffer strips 5 to 10 feet wide, landward of the top of slope or dune to be protected. Native vegetation with deep roots including grasses, forbs, and shrubs are recommended, to help slow and absorb erosive runoff, as well as to hold in place any loose soil. Avoid using typical lawn grass species, which tend to have shallow root systems.

- Ground Surface/Slope Stabilization – Combine runoff control measures with other soil stabilization measures to permanently prevent erosion and off-site sedimentation.

  - Revegetation – Plant trees, shrubs, and ground covers to stabilize sandy soils and serve as integral parts of the site's erosion control plan. Review Michigan's plant list to ensure that invasive species (Michigan, 2017) are not included in the revegetation plan. Runoff is directed to the vegetated areas while directing flow away from structures and building foundations. Areas stabilized with vegetation slow and infiltrate runoff, filter pollutants, moderate temperature changes, and add shade. Information on plant species and planting methods appropriate for sandy areas is provided in the "Revegetation/Planting Guide" below.

  - Bioengineering with Fiber Blankets - Installation of fiber blankets on shoreline banks, bluffs, and other steep slopes helps stabilize loose soils (sand) in place while planted vegetation takes root, as depicted in Figure 1. The planted vegetation then actively holds the bluff or slope in place as it develops root structure while the fiber blanket biodegrades. Some design considerations include:

    - Selecting a fiber blanket of materials that will decompose after vegetation is established.

    - Fiber blankets are most effective in areas with higher beach elevations where the toe of the bank is not constantly subject to erosion from waves.

    - Blankets are typically installed over the entire surface of a non-vegetated bank or bluff, but they can also be placed in specific areas where a bank or bluff is devoid of vegetation.

    - Blankets will not prevent erosion on unstable slopes or in areas subject to erosion from a seiche or storm waves.

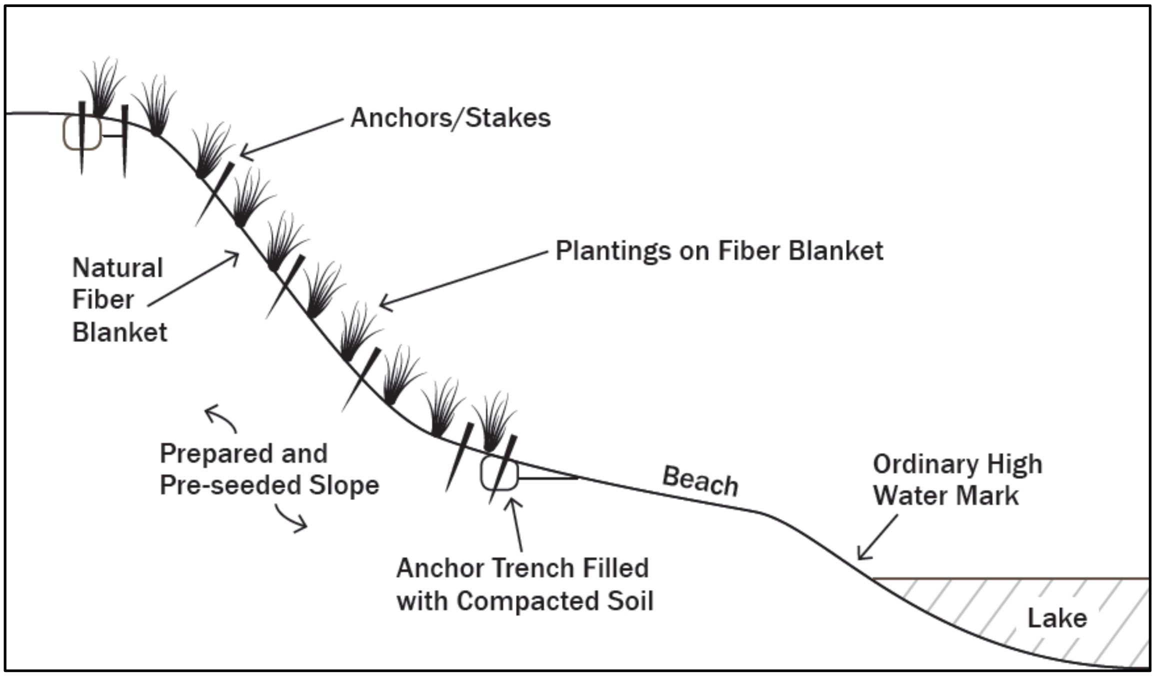

Figure 1. Natural Fiber Blanket Installation Using Anchor Trenches and Planted with Native Grasses. (Adapted from Massachusetts, 2016.)

- On banks/bluffs where the toe is subject to erosion from storm waves, it might be appropriate to combine natural fiber blankets and vegetation with other shoreline stabilization options. Coir rolls can be installed at the toe to help prevent erosion there, and any subsequent sloughing or slope failure.

- Refer to the Rolled Erosion Control Products BMP for further information on selecting and installing/planting different fiber blanket types.

- Bioengineering with Coir Rolls - If the toe of a bank is eroding, the upper bank might collapse even if it is well vegetated. Coir rolls can be used to protect and stabilize the toe of a bank or bluff by providing a physical barrier that buffers waves and reduces erosion of exposed sediment, as depicted in Figure 2. Coir rolls provide stability and protection to the site while the vegetation planted in and above the rolls becomes established. As the coir rolls disintegrate, typically over 5 to seven 7 years, the plants take over the job of site stabilization. Considerations in the design and use of coir rolls include:

    - For sites exposed to very high wave energy, consider an alternate form of bank stabilization. If coir rolls are used, it might be necessary to replace and maintain the coir rolls at the toe of the bank to provide longer-term stability.

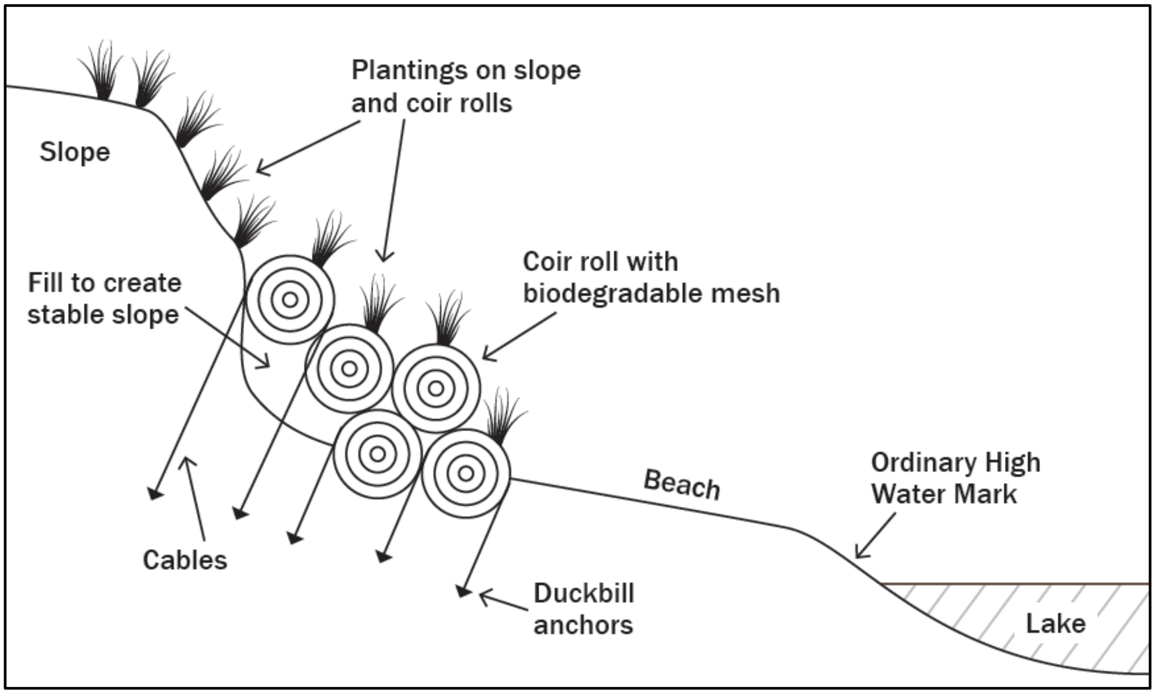

Figure 2. Cross-Section of Bluff/Bank Bioengineering Using Coir Rolls. (Adapted from Massachusetts, 2016.)

- Coir rolls are most effective in areas where the rolls are not constantly subject to erosion from waves. If the dry beach is narrow, the beach elevation is relatively low, and/or the site is exposed to moderate wave energy, more than one row of coir rolls will likely be needed on the face of the bank, as well as at the base.

- In some cases, coir rolls can also be used to effectively reduce erosion from hard structures such as seawalls. Depending on the wave energy coir rolls can be effectively installed at the base of and next to hard structures to help reduce erosion problems under the structure and on neighboring properties. They are also used on the face of the bank above the structure to stabilize the area.

- On banks and bluffs, a single steady slope is essential for project success. If the bottom of the bank/bluff has eroded and its slope is steeper than the upper portion of the bank/bluff, it is likely about to slump or collapse. In order to remedy this, regrade the bank/bluff by removing soil from the top portion of the bluff (cutting the top back) resulting in one single, steady slope down to the toe or beach.

- To minimize any redirection of waves onto adjacent properties, carefully design the ends of a coir roll project. Tapering the rolls down in number and height so that the project blends in to the adjacent bank helps address this problem.

- To create continuous rolls parallel to the shoreline, place coir rolls end-to-end, and lace them together with jute or coir twine. Anchor the rolls on the waterward side of the rolls with stakes, earth anchor systems, or a combination of these two techniques.

- To minimize the potential for waves getting behind the rolls and eroding the bank, fully cover the coir rolls with sediment, or tie them into the existing bank at both ends of the project.

- The number of rows of coir rolls needed and their diameter depends on: 1) how exposed the site is to waves, 2) how frequently waves reach the base of the bank, and 3) the steepness of the bank face. In more sheltered sites or on relatively shallow bank slopes, one or two rows of 12-inch-diameter coir rolls might be sufficient. In more exposed areas and on steeper banks, multiple rows of 20-inch-diameter rolls might be needed up the face of the bank to provide effective site stabilization. The bottom row of coir rolls is often buried during installation to prevent undermining by beach erosion during storms. In some cases, two side-by-side rows of rolls are installed at the base to provide more stability for the rows of rolls above.

- The density at which the coconut husk fibers are packed into the coir rolls is also an important design element. While more densely packed rolls provide greater initial erosion protection, loosely packed rolls can be more heavily planted (because the vegetation can be easily inserted into the roll). This heavy planting allows the plants to become established more quickly, allowing the plant roots to effectively stabilize the site as the coconut fibers degrade. Both high-density and low-density coir rolls can be used together when heavily planted low-density rolls are installed adjacent to high-density rolls to help ensure the high-density rolls become vegetated over time.

Sand Fencing Installation

Sand fencing, also called snow fencing, is designed to help capture sand to build dunes. It is typically made of thin, wooden slats that are connected with twisted wire to wooden or metal stakes. While other fence materials such as plastic, polyethylene, and metal are sometimes used to trap sand, they are not recommended for shoreline use due to their non-biodegradability, potential for increasing shoreline debris and subsequent hazard to wildlife. Sand fencing provides a low-cost, easy-to-install, and effective way to help build up dunes and protect inland areas from storm damage. Unlike seawalls, rock revetments, or other “hard” shoreline stabilization structures, properly designed sand fencing projects do not reflect or redirect waves onto beaches or neighboring properties. Design considerations include:

- When locating sand fencing, ensure that it will not direct or collect sand onto building structures or sensitive habitats, such as where dune vegetation could become smothered, or in nesting shorebird habitat.

- Install sand fencing where it is not reached by high water and waves from storms. Sand fencing can be installed to build up an existing dune, build a dune at the base of an existing bank, or build a dune in low-lying areas where there is blowing sand. Sand fencing can also be strategically placed to direct pedestrian traffic to a designated access point to minimize dune impacts from foot traffic.

- Install sand fencing as far landward as possible, well landward of the ordinary high water mark (OHWM), to minimize potential impacts to beachgoers and wildlife, and to protect the fencing from storm waves.

- Carefully consider post material and size in project design. As for material, only untreated wooden posts are recommended for use on coastal beaches and dunes. Metal posts rust and become a hazard to public safety and aquatic life; fiberglass posts often shatter when they break, and can leave dangerous shards on the beach; and wooden posts treated with preservatives do not break down very quickly, and if lost in a storm can remain a debris hazard for much longer than untreated wood. The larger the posts, the more potential for erosion around the base from wind and water, so smaller posts are recommended to minimize scour, which is the erosion of sediment around a stationary object. The recommended maximum post size is 2 by 4 inches for rectangular posts, and 3 inches in diameter for circular posts.

- To avoid excessive erosion from scour, limit the number of fence posts as much as possible. Space the posts at least 4 feet apart, and to withstand erosion and waves, bury them at least 4 feet into the sand.

- Whenever possible, select native plants with extensive root systems as part of a sand fencing project, generally on the landward side of the fencing. These plants are extremely effective at holding sediment in place and help to stabilize windblown sand accumulated by sand fencing. For more information on plant species and planting methods, refer to the "Revegetation/Planting Guide" below. As shown in Figure 3, when sand builds up and buries the fencing to approximately two-thirds of its original height, an additional row of sand fencing can be installed to continue to help the dune grow (if there is sufficient space available landward of the OHWM).

Revegetation/Planting Guide

Proper revegetation of bare or eroded areas within dunes or other sandy areas is critical to long-term stabilization, and is an important component to the bioengineering methods described here. Selection of proper plant species for the particular setting, as well as use of proper methods and materials will help to ensure successful long-term vegetative stabilization. The use of native plants and trees is encouraged as they thrive well and require less maintenance when matched to the site. Invasive species (Michigan, 2017) should not be planted. For further information, refer to the Trees, Shrubs and Ground Covers BMP, or the Natural Resource Conservation Service (NRCS) document Dune Stabilization with Grass (NRCS, 2007.)

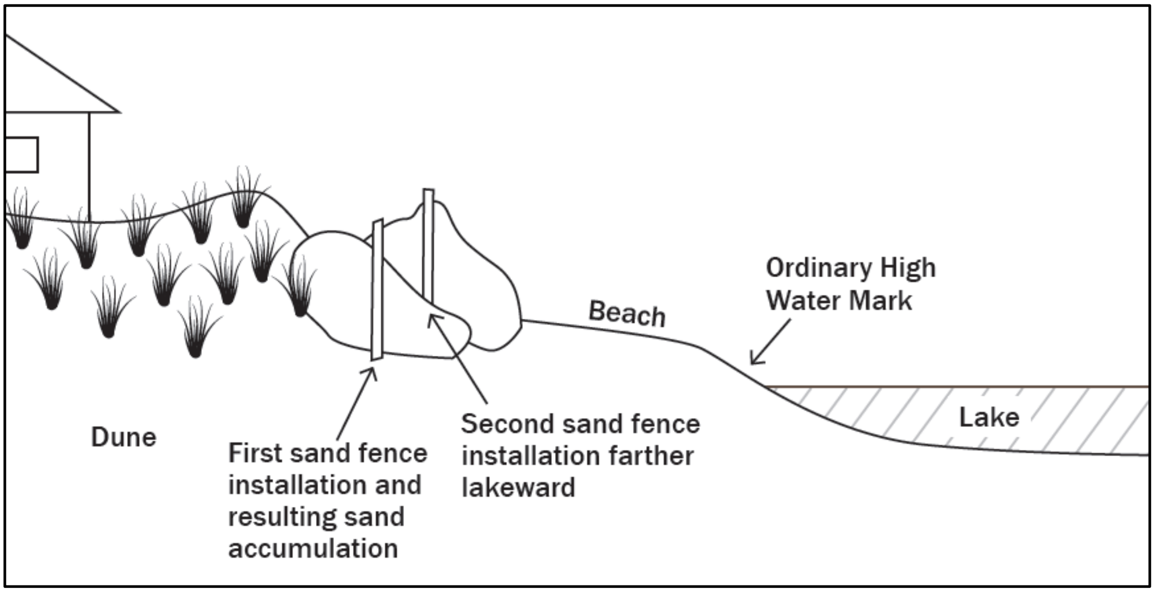

Figure 3. Using Multiple Lines of Sand Fencing to Accumulate Sand Waterward of an Eroded Dune Face. (Adapted from Massachusetts, 2016.)

Site Management and Maintenance

The maintenance of installed erosion control structures will provide a stable site with minimal risk of sedimentation in nearby lakes and streams. Revegetate sandy areas that have become barren due to construction; not doing so can make them vulnerable to runoff and wind erosion. Build elevated stairways, boardwalks or trams to minimize erosion of a slope. Appropriate land management techniques not only protect the dune landscape, but also reduce overall maintenance costs and allow landowners to minimize the need for permits.

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