Beach Nourishment

MassDEP's Guide to Best Management Practices for Projects in Massachusetts

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ACKNOWLEDGEMENTS

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Glossary

Accretion - the gradual addition of land by deposition of water-borne sediment.

Beach Fill – also called "artificial nourishment", "beach nourishment", "replenishment", and "restoration," comprises the placement of sediment within the nearshore sediment transport system (*see littoral zone*). (paraphrased from Dean, 2002)

Beach Profile – the cross-sectional shape of a beach plotted perpendicular to the shoreline.

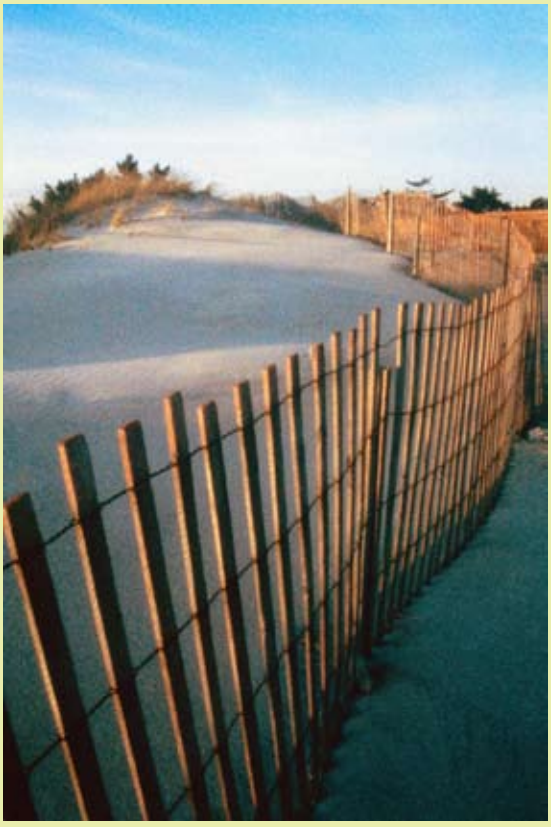
Cross-Shore Response – changes to the beach profile caused by the onshore and offshore movement of sediment after nourishment has taken place. It is the process by which a beach's natural equilibrium profile is reached.

Depth of Closure – the seaward limit of sediment transport due to seasonal beach profile changes such as those caused by erosion and accretion. (Dean 2002)

Downdrift – the alongshore direction coincident with the dominant sediment transport direction. (Adapted from Dean and Dalrymple 2002)

Equilibrium Beach Profile – for the purpose of beach nourishment, equilibration of the on-offshore beach profile from the arbitrary shape created by placing sand on the beach to the natural equilibrium shape created by the environment. This process typically includes transfer of sand from the dry beach and the shallow constructed portions of the profile to the offshore. Wave/water level conditions and sediment size are the controlling factors that determine a beach's equilibrium profile. (Adapted from Dean and Dalrymple 2002)

Fall Velocity – the maximum speed attained by a falling particle under the action of gravity in water (in other words, the terminal velocity). In general, large particles will have a higher fall velocity than small particles; therefore, large particles will be less likely to be suspended in the water column compared to finer particles.



Foreshore Beach – the intertidal portion of the beach. The foreshore, also called the *intertidal* or *littoral zone*, is that part of a beach that is exposed at low tides and submerged at high tides

Hot Spot or Erosional Hot Spot – area along a shoreline where coastal erosion is significantly greater than adjacent areas. Erosional hot spots can occur as a result of nonuniform wave conditions along the shoreline (e.g., offshore shoals redirecting wave energy), nonuniform sediment sizes along the shoreline, and sediment transport into a nearshore excavated area. (Adapted from Dean 2002)

Isolines - term for any graph or map on which some variable feature is contoured.

Lag Deposit – deposit consisting of coarser sediment (generally pebbles, cobbles, and boulders) that remains on a beach after finer particles are transported downdrift by waves, winds and currents. Lag deposits are usually more resistant to erosion than sand beaches.

Littoral Zone – the area of beach that lies between the high water line and the depth of closure. The littoral zone is where a majority of sediment transport processes occur along the shoreline. Also known as the foreshore beach and intertidal zone.

Longshore Transport – the amount of sediment moved along the coast through the combined effect of waves and currents. (Adapted from Dean and Dalrymple 2002)

Nomograph - a chart representing numerical relationships.

Subaerial Beach – the entire upper portion of a beach that is not under water at low tide.

SUMMARY

Basic steps for Beach Nourishment Projects

Proponents of beach nourishment projects in Massachusetts are required to determine beach conditions and stability, characterize the physical and chemical properties of the material to be dredged, as well as the physical properties of the material on the receiving beach. Keep in mind that the most important factors for beach nourishment projects is the grain size distribution of the source material as compared to the native beach material, and the location of the project in relation to sensitive coastal receptors.

STEP 1. Determine if the project is near endangered species habitat and in or adjacent to: Shellfish Beds, Vegetated Shallows, Spawning Ares, or Rocky Sub-tidal Habitat. Detail the impacts of the proposed project on these areas.

If a beach or dune nourishment project is near endangered species habitat, proponents should consult with the Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program (www.mass.gov/dfwele/dfw/nhesp/nhesp.htm) concerning potential impacts to the habitat. Proposed beach and dune nourishment slopes can often be modified to avoid impacts to rare, threatened, or endangered species.

Species and plant density should be surveyed and extent of habitat mapped, particularly in shellfish beds, vegetated shallows, spawning areas, or rocky sub-tidal habitat. Time of Year (TOY) restrictions, along with other restrictions, may be necessary to minimize impacts to marine fisheries or other biological organisms, particularly during spawning season.

STEP 2. Determine Wetlands and Waterways Permits required from MassDEP or other agency approvals for the project and note application timelines.

The following Wetlands & Waterways permits may be required for beach nourishment and beneficial reuse projects.

The **Public Waterfront Act** (MGL Chapter 91) requires a Chapter 91 waterways license or permit for any activity located in, under, or over flowed tidelands, filled tidelands, Great Ponds and certain non-tidal rivers and streams located throughout the Commonwealth. In general, beach nourishment and the beneficial reuse of dredged sediment as beach fill qualify as Water-Dependent projects. Such projects fall in the category of MassDEP application # BRP WW 01.

The **Massachusetts Wetlands Protection Act** (MGL Chapter 131, § 40) prohibits the removal, dredging, filling, or altering of wetlands without a permit. To obtain a permit (called an Order of Conditions), a project proponent must submit a Notice of Intent to the municipal Conservation Commission and MassDEP.

A **401 Water Quality Certification** from MassDEP is required under the federal Clean Water Act for any activity that results in a discharge of dredged material, dredging, or dredged material disposal greater than 100 cubic yards to waters subject to regulation by any federal agency. If no federal permit is needed for an activity, then no 401 Certification is required from MassDEP.

For a copy of these permit applications and for more information regarding the application process and timelines, refer to MassDEP's permitting web page: www.mass.gov/dep/service/online/gettings.htm.

STEP 3. Determine the profile of the receiving beach.

The placement of dredged sediment should take into account the profile of the existing beach and the location of the dredging area. If the proposed nourishment profile varies significantly from the existing profile, then the material will adjust quickly as the beach system tries to re-establish a slope, resulting in less material on the beach, as material is shifted into the near-shore region of the beach. The adjustment of the beach profile could possibly harm adjacent coastal resources. Dredging material should be placed downdrift of the dredge site to minimize sediment returning to the area it was dredged, and to facilitate the movement of sediment alongshore. (*See Attachment A for more details.*)

STEP 4. Determine the grain size of receiving beach.

Characterization of the receiving beach material is vital for a successful beach nourishment project. The first step is to develop and implement a sediment sampling and analysis plan. Elements of the plan should include:

- sampling locations,
- sampling method,
- number of samples to be collected,
- what method will be used to composite representative samples, and
- how grain-size distribution will be determined.

Typically, sediment samples are collected along survey profile-lines that run perpendicular to the shoreline, and should include all the features found in the project area (e.g. dune, dune base, mid-backshore, berm crest, mean high water, mid-tide, mean low water, trough, and bar crest.). In general, beach/dune systems having a narrow range of grain-sizes will require fewer samples to characterize them than will systems with a wide range of grain-sizes.

After all the locations along the profile-line are sampled, the individual samples should be combined. To create a combined sample, the samples collected at key locations along the profile-line must be dried before an equal-weight portion of each is measured out. Then the equal portions are combined together to create a single sample for grain-size distribution analysis. This process should be repeated for each profile-line established. Ultimately, there will be one combined sample for each profile-line. Then evaluate the grain size distribution for each sample. For detailed information on this process, refer to Attachment B.

STEP 5. Characterize source materials and determine best dredging source.

For each possible source material location, sediment samples will need to be collected and compared to the receiving beach sediment for compatibility. Obtain samples by taking cores from the entire depth of the dredging area. Generally, collect one core for each 5,000 cubic yards to be dredged. However, this can vary based on the homogeneity of the material – the less homogeneous, the more samples that need to be taken. Up to 3 cores may be combined to create a single sample for analysis, using the procedure outlined above in step 4. Then, evaluate the grain size distribution for each sample. (*See Attachment B.*) Additional chemical testing for contamination of the sediment may also be required. (*See Attachment C.*)

The physical properties of sediment that are the most important for determining its suitability as nourishment material are composition, grain size, mechanical strength, and resistance to abrasion. In most areas of New England, sediment is predominantly composed of quartz particles, so that borrow material will likely have adequate strength and high resistance to abrasion.

Ideally, the grain size of the source material should be the same size or larger than the native beach sand to minimize erosion. Material that has a smaller diameter than the native sand can remain in equilibrium only at slopes flatter than the existing beach. If smaller diameter sand is used, the volume of material required will be much greater and consequently, more costly.

STEP 6. Develop a beach monitoring/maintenance plan.

The primary objectives of monitoring a beach nourishment project are:

- to document and evaluate whether the project is performing as designed,
- to identify maintenance and re-nourishment requirements, and
- to evaluate project impacts.

Ideally, monitoring plans should include beach profile surveys to determine material stability. Generally, a number of surveys should be performed during the first year following construction preferably seasonally. After the first year, the beach nourishment transects can be monitored annually. Collection of post-storm profile information is also helpful in evaluating the cross-shore response of the project to storm waves and tides. Beach profile monitoring provides information on the following:

- the percent nourishment remaining within the project area compared to baseline conditions,
- the occurrence of downdrift accretion on beaches,
- affected terrestrial and marine species,
- the presence of areas highly susceptible to erosion (i.e., "hot spots") as indicated by variable longshore beach widths, and
- the future nourishment volumes needed to maintain the sediment supply.

For all projects, monitor the material placed on the beach to determine shoreline changes and whether the beach fill is shifting. Monitoring requires measuring elevations along a series of shore perpendicular control transects along the length of the project area. The number of transects required to evaluate the nourishment depends on the size of the nourishment project, as well as the presence of shoreline features that may control sediment transport. Typically, transects should be spaced every 100 to 400 feet. Surveys are generally conducted landward of any expected long-term changes in beach/dune shape, to a water depth where changes between the equilibrated nourishment profile and the pre-construction profile are anticipated to be minimal.

Monitoring reports are typically prepared after the first year of complete data evaluation, and bi-annually thereafter. These reports should include general information regarding the wave climate and storm activity, changes in sand volume over time, and measured shoreline changes. The information is used to evaluate performance, assess any adverse environmental impacts, and estimate future re-nourishment requirements.

Overview | Purpose, Beach Nourishment, BMPs, Permit Requirements

Purpose

The intent of establishing these best management practices is to:

1) provide guidance to those proposing beach nourishment projects on how to minimize erosion and maximize the time sand remains on the beach;
2) provide guidance to those designing the project on how to minimize potential adverse impacts to any natural resource areas;
3) promote the beneficial reuse of clean, compatible, dredge material and keep it in the longshore sediment transport system; and
4) expedite regulatory review.

By following this guidance, proponents can expedite the permitting process.

Beach Nourishment

The term beach nourishment generally refers to the process of adding sediment, also known as "beach fill," to a beach and/or dune system. Massachusetts has defined two types of beach nourishment projects. The most common is the beneficial re-use of clean, compatible sediment from a nearby dredging project to augment the volume of a beach or dune. This is done by directly placing sand either on the beach/dune, or in the nearshore where it can act as a source of sediment for the beach/dune system. Beach nourishment can also refer to a designed, engineered project where a specified volume of sand is added to a beach/dune system to provide a desired level of storm damage protection and flood control. The expectations and results associated with each type of nourishment are different; beneficial re-use projects are designed to keep the dredged sediment in the littoral system, but not necessarily to provide any specific level of protection, while engineered projects are designed to provide a specific level of storm damage protection.

Local, state, and federal regulatory agencies strongly encourage the use of non-structural measures such as beach nourishment to prevent storm damage and control flooding, because beach nourishment closely resembles natural processes and is the least disruptive to the littoral transport processes. Structural measures include seawalls and revetments which often have adverse effects on adjacent and nearby beaches by increasing erosion through wave reflection and by eliminating important sediment sources. However, site-specific conditions (e.g., erosion rate, grain size distribution, wave climate) and proximity of coastal resources (e.g., salt marsh, eelgrass, shellfish, rocky sub-tidal habitat) must be considered to minimize potential impacts to these sensitive resource areas as well as maximize protection of coastal development and infrastructure.

The most important factor for beach nourishment projects is the grain size distribution of the source material as compared to the native beach material, also referred to as sediment compatibility. For dredging projects, state policy requires that clean, compatible sediment be placed on adjacent beaches to keep the material in the littoral system. Note that location is important. If sediment is placed where it would not be stable due to its incompatibility, then unintended adverse impacts on eelgrass, shellfish beds, salt marshes, or the dredge channel could result.

For the purposes of this document it is assumed that the sand source is either a dredging project related to maintaining navigational channels, access to docks, piers, and boat ramps, or from a terrestrial location. The document does not address sand mining, where dredging is undertaken exclusively for obtaining sand for a nourishment project.

Local, state and federal permitting processes require biological and physical characterization of dredging sites and the proposed beach nourishment site. Applicants must compile information about shellfish resources, submerged aquatic vegetation, fisheries, coastal shorebird habitat, and other natural coastal resources. Local, state, or federal government may impose conditions as part of the permit or certification process to protect those coastal resources. The extent of the physical characterization of the sediment depends on the size of the project, with larger projects requiring more characterization.

Beach nourishment in rare coastal shorebird habitat for such species as Piping Plovers and Roseate and Least Terns requires careful consideration, planning, design, and coordination with the Natural Heritage and Endangered Species Program.

These species require specific feeding and nesting habitat requirements. Nourishment projects can enlarge and enhance these habitat features and are generally considered a benefit in the project review phase. Nourishment design should include specific plant species that provide the needed nesting and escape cover. Because these species nest and fledge during times of peak outdoor recreational season, fencing and resource management must address the competing use.

Specifications and Best Management Practices for Beach Nourishment Projects

Below are the recommended best management practices for beach nourishment projects. Proponents of beach nourishment projects in Massachusetts are required to determine beach stability, and characterize the physical and chemical properties of the material to be dredged, as well as the physical properties of the material on the receiving beach. Note that the extent to which a project may need to be modified based on these recommendations is a function of several elements: the design life and cost of the project, the potential adverse impacts on local natural resource areas, and the benefits of beach nourishment versus other alternatives, such as relocating coastal infrastructure or implementing structural or bio-engineering solutions.

General

- For publicly funded dredging projects, downdrift public beaches should take priority for placement of the dredge sediments.
- For projects involving beneficial re-use of clean, compatible dredge sediment, dredge material should generally be placed on a beach or dune downdrift of the dredge site to minimize the potential for material returning to the area where it was dredged, and to facilitate the movement of sediment alongshore through the littoral system. Exceptions to this rule are allowed and should be evaluated on a case-by-case basis.

Beach Stability and Characterization

- The proposed placement of dredged sediment should take into account the slope of the existing beach. If the proposed equilibrated nourishment profile varies significantly from the existing beach profile, then the nourishment will adjust relatively quickly as the beach system tries to re-establish an equilibrated slope, resulting in less material on the beach face, as material is shifted into the near-shore region of the beach profile. The adjustment of the beach profile could possibly harm adjacent coastal resources. Attachment A provides a step-by-step methodology for determining general beach nourishment stability. Attachment B provides a methodology for determining the biological and physical characteristics of the receiving beach.
- If a beach or dune nourishment project is near a state or federal endangered species habitat, then proponents should consult with the Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program (www.mass.gov/dfwele/dfw/nhesp/nhesp.htm) concerning potential impacts to the habitat. The NHESP web site also features maps that will identify areas of concern. Proposed beach and dune nourishment slopes can often be modified to avoid impacts to rare, threatened or endangered species. Time of Year (TOY) Restrictions may be necessary to minimize impacts to marine fisheries or other biological organisms.
- The use of vegetation and sand fencing on coastal dune enhancement projects and the landward portions of beach nourishment projects can reinforce the stability of the material placed at the site. Sand fencing and specific dune vegetation in coastal shorebird habitat should be designed to ensure the viability of the bird habitat and to reduce impacts from human disturbance during the nesting and fledgling times. Information on managing shorebird habitat, including rare species habitat, may be found in the "Guidelines for Barrier Beach Management in Massachusetts: A Report of the Massachusetts Barrier Beach Task Force," February 1994. Copies of the report can be ordered from the Massachusetts Office of Coastal Zone Management.

Source Material Characterization

- The grain-size distribution of the dredge or source material should be compared to the grain size distribution at the proposed placement site to determine sediment compatibility. Attachment C presents a methodology for characterizing the source material. In general, source material that is similar to or coarser than the native

sediment at the placement site is likely to be more stable after placement. If the grain size of the source material is finer than the grain size of the receiving beach, it will be more susceptible to erosion. If it is susceptible to an erosion rate greater than the historic rate, then beach fill could drift into adjacent coastal resources. The likelihood of eroded sediment drifting into these resources needs to be quantified as part of the regulatory review process. If there are no sensitive resource areas nearby, then incompatibility may not be as problematic, although it will still result in a shorter project life. Attachment A provides an approach to assess the stability of sediment placed on a beach for nourishment, and Attachment D provides an example on how to determine sediment compatibility for a nourishment project designed for shore protection.

- Sediment containing greater than 10% by weight of the material passing the No. 200 U.S. Standard Series Testing Sieve is generally unsuitable for beach or dune nourishment.
- The appropriateness of using source material coarser than the native sediment should be evaluated on a case-by-case basis. If the placement of the material will not adversely affect the natural function of the beach, dune, or near shore resources, or cause adverse changes in wave reflection or refraction, then there are unlikely to be significant environmental impacts. However, coarser material could affect recreational use and aesthetics.
- Regular monitoring of the beach nourishment project may be needed to evaluate the effectiveness of the project, document any effects on adjacent sensitive resources, or to understand changes in beach dynamics for future planning purposes. A sample beach-monitoring plan is included in Attachment E. Monitoring of rare coastal shorebird habitat may be required by the Natural Heritage and Endangered Species Program if the project is within their priority habitats or may be required to determine its potential use by such species.
- If material from a publicly funded dredge project will be placed on a private beach, it is likely that an easement for public access will be needed for the area where nourishment is placed in order to comply with 310 CMR 9.00, available online at www.mass.gov/dep/water/laws/regulati.htm#wways. Attachment F provides a sample easement that can be used for beach nourishment projects.

Permit Requirements and Timelines

The following Wetlands & Waterways permits may be required for beach nourishment and beneficial reuse projects.

- The Public Waterfront Act MGL Chapter 91 and its regulations require a Chapter 91 waterways license or permit for any activity located in, under, or over flowed tidelands, filled tidelands, Great Ponds and certain non-tidal rivers and streams located throughout the Commonwealth. In general, beach nourishment and the beneficial reuse of dredged sediment as beach fill qualify as Water-Dependent projects. Such projects fall in the category of MassDEP application # BRP WW 01.
- The Massachusetts Wetlands Protection Act (General Law Chapter 131, Section 40) prohibits the removal, dredging, filling, or altering of wetlands without a permit. To obtain a permit (called an Order of Conditions), a project proponent must submit a Notice of Intent to the municipal Conservation Commission and MassDEP. The Conservation Commission issues a decision on the permit requests. Any appeals made to the Conservation Commission's permit are subsequently submitted to MassDEP.
- A 401 Water Quality Certification from MassDEP is required under the federal Clean Water Act for any activity that results in a discharge of dredged material, dredging, or dredged material disposal greater than 100 cubic yards (c.y.) to waters subject to regulation by any federal agency. If no federal permit is needed for an activity, then no 401 Certification is required from MassDEP. Projects subject to 401 regulations may be classified as either major (BRP WW 07) or minor (BRP WW 08). Major projects involve the dredging of 5,000 c.y. or greater, while minor projects involve dredging less than 5,000 c.y.

To apply for any permit, proponents will need to send a transmittal form for permit application, application fee, and appropriate application. If you are applying for multiple permits related to the same project, MassDEP advises you to notify us. General timelines of the application review process for each of these three permits can be found on the next page. These timelines begin once MassDEP receives your payment and complete application. For a copy of these permit applications and for more information regarding the application process, refer to the following website: http://www.mass.gov/dep/service/online/gettings.htm.

Permitting Timelines

Chapter 91, Wetlands Permitting,
401 Water Quality Certification

Chapter 91 License Application

For Water-Dependent Projects (application type BRP WW01)

Time Period	MassDEP Action
	Application received at MassDEP
30 to 60 days	Public Comment Period (includes Public Hearing if needed)
Within 60 days	Administrative Completeness review
Within 90 days	Technical Review and Issue Written Determination
21 days	Appeal Period
------	Issue License
Maximum Application Time = 276 days	

Wetlands Permitting Process

Time Period	MassDEP Action
	Notice of Intent application received at MassDEP
Within 21 days	Public hearing (hearing notice must be published in a public newspaper at least 5 days prior to hearing)
Within 21 days	Order of Conditions permit
10 days	Appeal Period
Within 70 days	Superseding Order of Conditions if local Order is appealed
10 days	Appeal Period
Within one year	Adjudicatory hearing and Final agency hearing
Maximum Application Time = 500 days (if adjudicatory hearing required)	

401 Water Quality Certification

For Major projects (BRP WW07) and Minor projects (BRP WW08)

Time Period		Action
BRP WW07	BRP WW08	
30 days	30 days	Review for Administrative Completeness
120 days	90 days	Technical Review
120 days	90 days	Second Technical Review*

**A second technical review will take place only if necessary.*