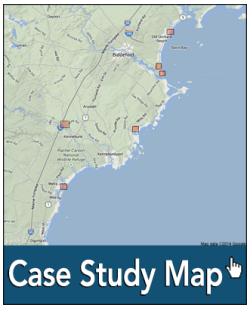
2011

Building a Resilient Coast: Maine Property Owner's Guide to Managing Flooding, Erosion and Other Coastal Hazards

Peter Slovinsky
Maine Geological Survey

Catherine Schmitt
University of Maine, catherine.schmitt@maine.edu

Maine Property Owner's Guide to Managing Flooding, Erosion & Other Coastal Hazards

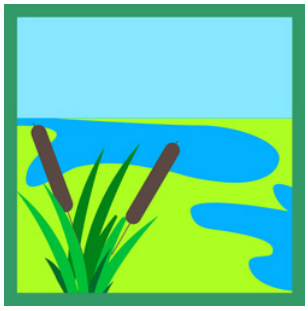


Storms, flooding, and erosion can damage coastal property and affect valued beaches, dunes, and habitat. This guide will help you evaluate these threats and **what you can do** to protect your property (More...).

Choose your solution by first identifying your shoreline type. Do you live on a beach, steep bluff or rocky shore, or near a coastal wetland?

Beaches & Dunes

Bluffs & Rocky Shores



Coastal Wetlands

Not sure? Learn more about the Maine Coast

Beaches & Dunes

Beaches occupy only about two percent, or 75 miles, of Maine's 5,300 miles of coastline. Hazards of living on a beach or in a sand dune system include hurricanes and nor'easters, erosion, storm surge, and flooding. **Learn more about Maine's beaches and dunes** and determine if your beach property is eroding.

NOTE: Maine classifies all areas below the highest annual tide elevation, including rocky shores, sand beaches, mud flats, and salt marshes, as "Coastal Wetlands." In order to facilitate problem solving on this website, Coastal Wetland types have been grouped into three categories: Beaches & Dunes; Bluffs & Rocky Shores; and Coastal Wetlands.

Checklist to ID coastal hazards on your property

A checklist has been developed to help you identify and rank beach and dune hazards, using the maps and other resources in this guide and by conducting a field inventory of your property.

Download Beach, Dune, and Coastal Flooding checklist

Beach Hazard Response Actions At-A-Glance				
Action	Pros	Cons	Effort	Cost
Do nothing	Low cost; easy to implement	Unexpected results; uncertain future	Low	$
Move back	Reduces hazard to structures	Site constraints; may not address erosion	Low - High	$$ - $$$
Move up	Reduces hazard to structures	Site constraints; may not address erosion	Low - Mod	$ - $$
Design appropriately	Reduces hazard	Site constraints	Low - High	$$ - $$$
Protect, construct, plant dunes	Protects uplands, adds sand	Site constraints	Low - Mod	$ - $$
Erect fencing	Cobble-trapping fences may protect property; temporary, open fences allow sand and water to move freely	No closed fences allowed in frontal dunes.	Low	$
Build paths and walkovers	Protects beach; allows natural processes	Site constraints	Low - Mod	$ -$$
Nourish or scrape the beach	Reuses or adds sediment; creates habitat	Site constraints	Mod - High	$$$
Rebuild an existing seawall	Generally easy to permit	Emergency; temporary	Low - Mod	$$ - $$$
Rebuild after severe damage	Allows reconstruction in less hazardous areas	Potential extensive engineering; site constraints; does not address future erosion	High	$$$

My beach is eroding. What can I do?

Speak early and often to town officials and state agency staff.

Weigh the risks, with help from a certified geologist, licensed engineer, or other professional.

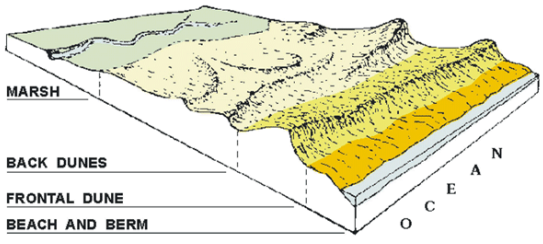
Finally, consider your options for taking action:

Learn more about beaches & dunes

Beaches occupy only about two percent or 75 miles of Maine's coastline. Sand beaches, which account for less than 40 of the 75 miles, are most common along the southern coast between Kittery and Cape Elizabeth, although several stretches of sandy beach occur in midcoast Maine near the mouth of the Kennebec River, and elsewhere as small pocket beaches bound by bedrock headlands. Many pocket beaches do not have an extensive back-barrier marsh system. Other beaches are made up of gravel, cobble, or boulders.

Beaches provide a natural buffer from storm events, and serve as critical habitat for wildlife and plants. Beach-related tourism and recreation contribute significantly to the state's economy.

barrier beach system



Beaches and dunes are extremely dynamic features, changing in response to waves, wind, and tides. Beaches and dunes in Maine experience different kinds of erosion, from seasonal changes and short-term, storm-induced sand loss to long-term erosion and inlet migration.

pocket beach

Erosion of Maine's beaches and dunes

Coastal erosion and associated flooding from storm events can damage property and infrastructure. Erosion also compromises the ability of beaches protect neighboring property, provide habitat for plants and wildlife, and accomodate recreation and attract tourism.

Erosion problems in Maine are generally caused by a persistent rise in sea level, storms, changes in sand availability, and the construction of jetties and seawalls.

10% of Maine's beaches are *highly erosional*, disappearing at a rate of more than two feet per year. Some of these beaches have seawalls along the frontal dune, while few have no seawalls. Most are in need of beach replenishment to replace eroded sand. Many of these shorelines have no beach for about half of the tidal cycle.

50% of Maine's beaches are *moderately erosional*, with erosion rates of one to two feet per year. Along some of these beaches where seawalls are present, the seawalls are regularly overtopped during winter coastal storms, and a limited number of seawalls have been undermined during severe coastal storms. In some areas, local overtopping occurs once or twice a year in winter, but is usually restricted to limited areas of beachfront properties. Natural beaches in this category have chronic dune scarps (steep drop-offs) and frontal dune erosion. Some beaches have exposed gravel berms and limited recreational opportunities at high tide.

About 40% of southern Maine beaches are only *slightly erosional*.

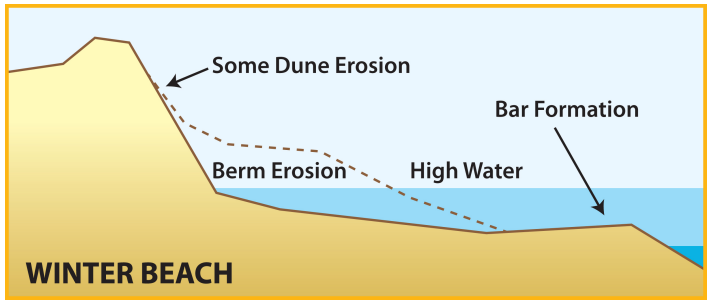
Maine Geological Survey prepared a table that generalizes the status of many of southern Maine's beaches. This information is taken directly from Appendix B of the Protecting Maine's Beaches for the Future (2006) report. This table is meant to provide more information about the general characteristics of some of Maine's beaches, including development status, beach replenishment history, shoreline armoring status, shoreline change status, and public ownership.

Seasonal changes

Typically, beaches and dunes undergo a seasonal transformation from a "summer" beach to a "winter" beach. A summer beach has a wide, well-developed berm often with a vegetated dune where American beach grass grows seaward onto the berm. A winter beach is lower, may not have a berm, and often shows signs of loss of beach grass.

Winter Beach: As storms and wave heights (along with a general change in wave and wind direction) increase during the fall and winter months, beach berms and sometimes the dunes erode in response, lowering the beach as sand is pulled offshore from the upper portions of the beach and deposited in protective offshore sandbars. The result is typically a flatter, more concave beach shape. The sandbars that form offshore in winter help protect the beach by causing waves to break farther offshore.

Summer Beach: In the late spring and early summer months, smaller, calmer waves dominate, and sand slowly returns to the beach and berm, and the beach and dunes typically recover, as long as sediment is not lost offshore. The key to this equilibrium is the berm, which is the part of the beach that changes most during the seasonal cycle.



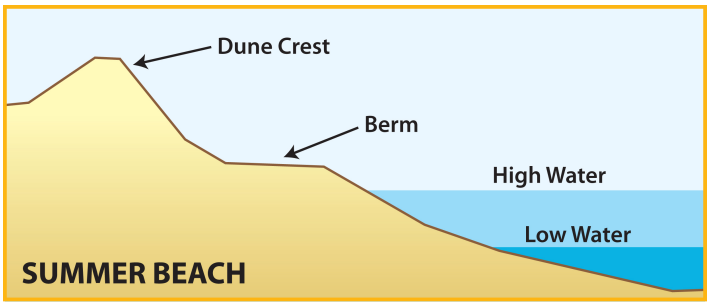


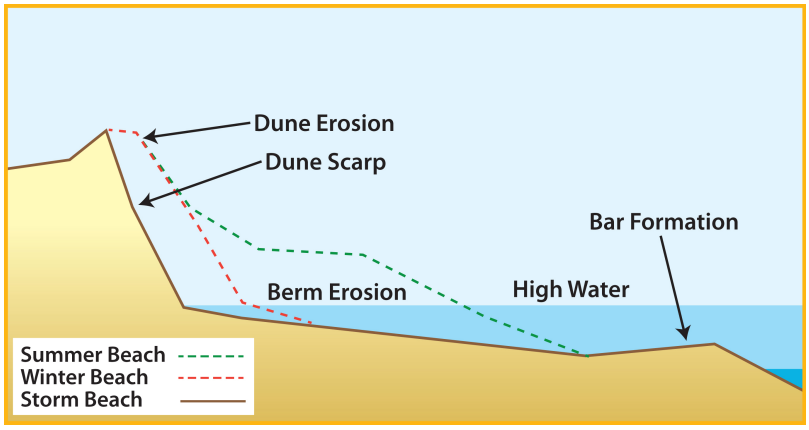
Figure 3 a) Winter profile shape, Kinney Shores, Saco. B) Summer profile shape, Kinney Shores, Saco. Images from the Maine Beach Profiling Program volunteers.

(Above: Seasonal changes in the beach at Kinney Shores in Saco.)

Short-term (storm-induced) erosion

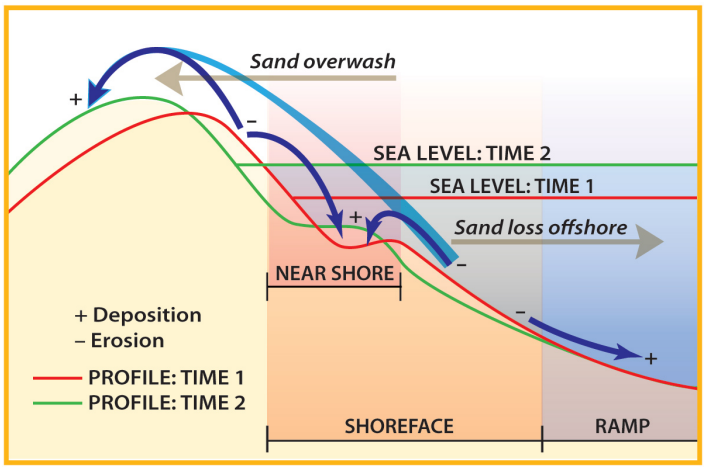
One large storm or a series of storms can cause significant beach and dune erosion. Storm erosion follows a similar but more rapid pattern than seasonal erosion. Damaging storms usually occur in the fall, winter, or early spring months when the "seasonal" beach profile is already relatively lean in shape. Changes seen at the beach are similar to the seasonal changes, with lowering of the beach and extensive loss of the berm. In addition, storm damage usually causes extensive dune erosion, scarping, or complete loss of the frontal dune.

Storm recovery follows a similar process of the seasonal beach, with offshore sandbars providing protection, and slow, gradual build up of the berm in response to smaller waves. This can occur in the course of one season, but may take a year or more. Dune recovery is a much slower process which involves dune vegetation re-establishing, wind transport of sand, and other processes. It can take several seasons to several years or more for a dune to recover naturally from a large storm event.



Long-term erosion

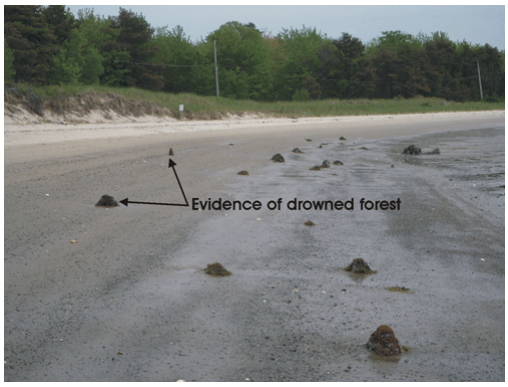
Almost all of Maine's beaches are "transgressing," or moving landward in response to coastal storms and gradual sea-level rise at a rate of about an inch per decade. This landward migration of the beach and dune system is like the motion of a tank tread; the beach basically migrates over itself in response to storms and sea-level rise.



Long-term erosion is considered permanent erosion that occurs over decades due to numerous factors:

- Structures like jetties prevent sand from being transported to the beach.
- Upstream dams on rivers prevent sand from reaching the beach;
- Tidal river dynamics force sand into deltas that serve as sediment sinks or traps.
- Sea-level rise or storm-related erosion occurs faster than the rate of sand deposited on the beach.

The photo to the left shows Scarborough Beach after the Patriots' Day Storm in 2007, when the beach "washed over" into the dunes.

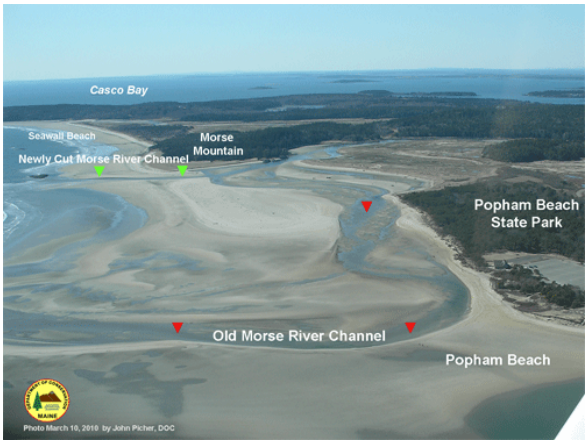


A sure sign of beach and dune transgression is the continual presence of stumps or peat (marsh) deposits in the surf zone; these materials are from historic backbarrier marsh and forested uplands that became covered by sand and then exposed, as in this photo of Ferry Beach in Scarborough.

Inlet erosion

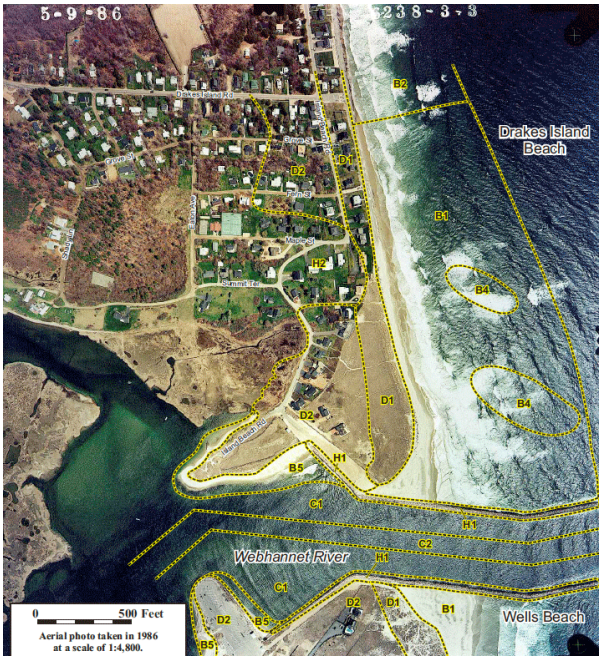
Some of the fastest changing shorelines are found adjacent to tidal inlets, which meander and change shape. Inlets can move unexpectedly one way or another in response to storms, or can migrate in a single direction continuously.

Some inlets migrate in a single direction for a certain amount of time until they reach a point where they jump back to their original starting places.



A great example of this phenomenon is the Morse River at Popham Beach State Park in Phippsburg. The channel of the Morse River migrated dramatically to the northeast over the past few decades, eroding large stretches of Popham Beach. A dramatic course change in 2010 opened a new channel to the west, adjacent to bedrock headlands.

At some inlets that have been stablized by jetties, nearby beach erosion can still occur due to sediment movement associated with ebb-or flood-tidal delta formation. For example, Western Beach in Scarborough, adjacent to the Scarborough River, has undergone extensive erosion due to tidal river dynamics. The beach received nourishment in 2005, but has continued to erode at very high rates along the majority of its stretch, evidenced by the net shoreline movement of the high water line, measured by Maine Geological Survey from 2005-2009.



How do I know if my property is within a beach or sand dune system?

Maine Geological Survey has mapped about 2,000 acres of sand dunes along 30 miles of the Maine coastline. The Coastal Sand Dune Geology Maps, which identify the frontal dune and back dune areas along the majority of southern Maine beach systems, are also available through the local Maine DEP office, and at your town office. All coastal sand dunes and wetlands in Maine are mapped this way. Just because a property is paved or covered with lawn doesn't mean it is not in a sand dune system; dune zones are based on what the landscape would look like in a natural state, because from a construction/design perspective, hazards like storm surge are going to affect your property as if it were a dune.

See the Maps and Data section for links to other beach-related maps, including FEMA Flood Insurance Rate Maps, Coastal Marine Geologic Environment Maps, and Coastal Barrier Resources System Maps.

In addition, the 2011 State of Maine's Beaches report documents general beach profile changes that have been monitored as part of the Maine Volunteer Beach Profile Monitoring Program. The release of these reports coincided with the Maine Beaches Conference, which occurs every two years.

If you are located in Saco Bay, you may want to refer to the Maine Geological Survey Report, Variation of Beach Morphology along the Saco Bay Littoral Cell: An Analysis of Recent Trends and Management Alternatives, which summarizes some of the shoreline trends along the bay.

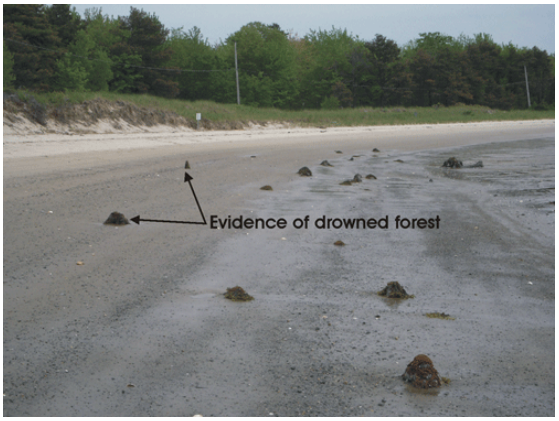
How do I know if the beach is eroding (and posing a hazard to my property?)

A checklist has been developed to help you identify and rank beach and dune hazards, using the maps and other resources in this guide and by conducting a field inventory of your property.

Download Beach, Dune & Coastal Flooding checklist - 43KB

You may have a moderately to severely eroding beach and frequent or recurring problem if:

- **Your beach has eroded more than 1 foot per year.**
- **Your beach or dunes are continually eroding.** Look for signs of continued dune lowering and loss with no recovery after storm season, continued beach lowering in front of seawalls, and direct evidence of beach movement.
- **You have a narrow, dry beach** (less than 25 feet) **with small dunes or a seawall.** Typically, seawalls were placed in areas that underwent ongoing erosion before regulations restricted their construction.
- **You see direct evidence of beach movement ("transgression").** Exposed tree roots or peat deposits on the beach are signs that surf zone has moved landward to the backside of the beach. Note that presence of these features may only occur after large storms; if they are present from year-to-year, this may indicate a recurring problem.
- **You experience frequent overwash and flooding** on a frequent basis (i.e., several times a winter) in response to small storm events.
- **You experience chronic structure (seawall, bulkhead) damage.** Chronic damage to a shore protection structure indicates that the beach is attempting to move in a landward direction.
- **You are located in certain FEMA flood zones,** where breaking waves and coastal flooding occur across the extent of the beach.
- **You are located next to an inlet that migrates on a regular basis.** Proximity to a tidal inlet that migrates can increase the erosion hazard of the beach and dune.



You may have a generally stable beach or slightly erosional beach and minor isolated erosion and flooding problem if:

- **Your beach or dune is stable or growing seaward.**
- **Your beach or dune is eroding slightly, less than 1 foot per year.**
- **You have a wide, dry beach (greater than 50 feet) and large dunes.**
- **Your beach or dune erodes during large storms but is able to recover within a year or two.**
- **You experience isolated overwash and flooding,** only after large storms.
- **You are not located in a mapped at-risk flood zone.** If you are not located in one of these zones, you likely don't have flood insurance because your overall risk of coastal flooding is low, although isolated flooding problems may still occur.

Watch for updates to flood zones. Flood risk changes over time, and as a result FEMA is updating flood hazard maps across the country. See the maps page for more information.

Pine Point Beach in Scarborough is an example of a stable beach and coastal sand dune with minimal coastal flood hazards from the ocean side.

Do nothing

The erosion of sand dunes and beaches along the shoreline is, to a large degree, a natural process of shaping and reshaping the coastal environment that has been occurring consistently over time. For this reason, doing nothing to address erosion is an option that should be considered. If the erosion is natural and not causing an immediate hazard to property or infrastructure, doing nothing is almost always the least costly and often the environmentally preferable option.

In evaluating the “do-nothing” alternative, assess the level of risk you are willing to accept in conjunction with the existing and expected uses of the property.The “do nothing” alternative makes the most sense if there aren’t any structures on your property, in areas of critical habitat, or on beaches where erosion is minimal and a structure is located far away from the eroding shoreline, and a defined erosion rate has been determined (in consultation with local experts).

The steps below will help you decide if the “do-nothing” alternative makes sense for your property.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology and biology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

Move back to avoid the hazard

Avoiding existing or potential hazards as much as possible is usually a property owner's most efficient and cost-effective response. This is especially true when siting **new development**, as structures can be built as far away (landward) from the hazard as possible.

To ensure safety of an **existing structure** that is being threatened by erosion or flooding, a property owner can move up or **move back**:

One of the most effective ways to ensure safety of an existing structure that is being threatened by erosion or landslides is to relocate the structure out of the hazardous area, typically in a landward direction. Although moving back can be very effective in minimizing the hazard, it can be expensive. Costs vary from several thousand dollars to tens of thousands of dollars, and are based on the existing foundation of the structure, size of the structure, topography and geology, and distance the structure may need to be moved. Relocation of a structure can also be constrained by the size of a property and any applicable setbacks, such as from other existing structures or roadways.

As much as is practical, consider moving back to avoid some hazards and relocate structures outside of a mapped flood zone. Building standards are extremely restrictive in the "V-Zone" and will be less restrictive if a structure is moved back to the "A-Zone."

Consideration should also be given to significant habitat resources or environmentally sensitive areas, which are usually identified by municipal or state regulations.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Begin by working with your local code enforcement office to determine if your property is in a mapped flood zone and if so, what building requirements apply. Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If moving back involves work below or within 75 feet of Highest Annual Tide (HAT), develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or if moving a structure may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed when moving structures. Local shoreland zoning requirements will determine the acceptable location(s) for structures.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Move up by elevating structures

Case Studies:
Move Up and Move Back
Elevate Homes on a Beach

Existing structures that are threatened with coastal flooding or erosion often can be moved up or elevated. If you are located in a flood zone, your town may require that the lowest structural part of your house be a minimum of one foot above the base flood elevation (this is typically the minimum standard), but check with your local code enforcement officer for local ordinances.

If your structure is older and has been flooded and does not meet current standards, or any time you are doing substantial improvements to your structure, consider the cost of elevating the structure using a flow-through foundation or a pile foundation, especially if structure improvements meet or exceed 50% of the value of the structure. In accordance with Floodplain Management regulations, a "substantial improvement" will require the building to be brought up to code, including elevating the building and its utilities.

Flow-through foundations are typically block or poured cement foundations with adequate spacing (or hydraulic openings) for floodwaters to flow through the foundation without damaging the supports. These structures are acceptable in the A-zone areas of back dune environments that are not considered to be Erosion Hazard Areas.

Pile foundations are typically used in more active flooding areas along open ocean coastlines, and provide much more open space for floodwaters to travel through. Piles are required in the frontal dune and in areas of the back dune classified as Erosion Hazard Areas.

The concept behind both foundation types is that water, sediment, and debris travel *through* the foundation, instead of applying pressure and lateral force to the foundation which can cause structural failure. Both foundation types can significantly reduce potential flood damage to a structure.

In some areas, fill can be added below a foundation to increase the elevation of the structure to meet floodplain standards. **This technique is not recommended, and may not be allowed in some areas, as it can result in potential increased flood hazard impacts to adjacent properties.** Check with local code enforcement for specific standards applicable to your lot.

Many of the state requirements regarding elevation of structures, including a review of techniques, are outlined in Chapter 5 of the Maine Floodplain Management Handbook. Your town may have additional requirements that meet or exceed minimum state standards. Contact your local Code Enforcement Officer for more information about building standards and requirements for each flood zone.

You may also want to review the FEMA Coastal Construction Manual and the FEMA Home Builder's Guide to Coastal Construction Technical Fact Sheets. The Coastal Construction Manual is available as a CD or in print copy by calling FEMA Publications Distribution Facility at 1-800-480-2520, or through the Maine Floodplain Management Program, and should also be available for review at your local town office or public library.

If you consider elevating your structure, think about making other improvements to make your home more storm and flood resilient, such as elevating utilities. Also, consider elevating your structure over and above the elevation required by your floodplain ordinance, in order to take into account expected rates of sea-level rise and higher future floodplain elevations. This higher "freeboard" (or measure of safety above the base flood elevation) may also reduce flood insurance premiums. The State of Maine has adopted an expected rise in sea level of two feet over the next 100 years.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Begin by working with your local code enforcement office to determine if your property is in a FEMA-mapped flood zone and if so, what building requirements apply.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If elevating a structure involves work below or within 75 feet of Highest Annual Tide (HAT), develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or if moving a structure may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This

consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed when moving structures. Local shoreland zoning requirements will determine the acceptable location(s) for structures.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit. Refer to Chapter 305 (Permit by Rule), Chapter 310 (Wetlands) and Chapter 355 (Coastal Sand Dune Rules) for additional requirements relating to impacts to coastal sand dunes associated with elevating structures.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Design, build, and modify new structures appropriately

Case Study:
Multi-hazard Mitigation

Construction techniques that are appropriate to coastal areas involve not only siting of the structure and support structures, including septic, utilities, etc., but also design and building techniques that can withstand hazards and potential land, wind, and water forces associated with the dynamic coastal zone.

Things to consider:

- The construction footprint, given applicable setbacks for sensitive areas;
- The extent of grading needed to achieve a stable building footprint;
- The level of engineering required address erosion or flooding; and
- Potential physical forces such as water and wind.
- *Be neighborly.* Think about potential impacts on your neighbor's property that may result from an activity on your property. At the same time, it may make sense to work with adjacent property owners if a common goal is found or regional approach is being adopted to deal with certain hazards.

Some of the best and most comprehensive resources available regarding proper coastal construction techniques are the FEMA Coastal Construction Manual and the FEMA Home Builder's Guide to Coastal Construction Technical Fact Sheets. In 2015, FEMA issued new guidance about retrofitting structures that can't be elevated. The Coastal Construction Manual is available as a CD or in print copy by calling FEMA Publications Distribution Facility at 1-800-480-2520, or through the Maine Floodplain Management Program, and should also be available for review at your local town office or public library.

Case Study: Multi-hazard Mitigation

Protect, enhance, or construct dunes

Case Study:
Dune Restoration

Dunes contain a reservoir of sand that is released to the beach during storms, providing a natural buffer from storm damage. Preserving or enhancing dune systems can help protect coastal property, especially in areas with low or moderate erosion. Sand dunes are *dynamic features* and will erode or move landward over time. Any dune preservation, enhancement, or reconstruction activities need to keep in mind that the landform is mobile.

Protecting Dunes: For areas with existing dunes and low erosion rates, simply preserving dunes might be all that is needed to help maintain protection from storms. Other options include planting dune grass, erecting fencing, building dune paths and walkovers.

Constructing Dunes: Property owners can work together to increase or create dunes as a protective measure. Teaming with your neighbors can help defray construction costs, and create a more storm-resistant dune. Dune construction requires, at a minimum, a Permit by Rule from the Maine DEP,

though larger projects may require an individual permit. Dune activities are limited by specific timing windows, mostly related to seasonality of plants and threatened or endangered species such as least terns or piping plovers. Most activities are restricted to the periods from March 1 to April 1, or from October 1 to November 15. Refer to the Natural Resources Protection Act for more information specific to certain types of activities that could impact threatened or endangered species such as piping plovers. If these species are present, it's likely you have been made aware of this. In these cases, consultation with state and federal wildlife agencies will be needed before action can be taken.

Further guidance regarding dune construction, fencing, and management is provided by the Maine DEP in a technical guide on dune management and construction. Additional resources are provided in the references section.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials** for advice on applicable regulations before proceeding with a dune restoration project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology and ecology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If dune enhancement involves work below or within 75 feet of Highest Annual Tide (HAT) or within a mapped sand dune system, develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or a new dune or vegetation may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed to complete the work. Local shoreland zoning requirements may apply.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Plant native dune vegetation

Native dune vegetation traps and stabilizes sand on the dune, creating a robust dune environment which is taller and wider, thereby providing increased protection against storms and related erosion.

Most native dune plants have extensive root systems which, when mature, act as a binder to hold the dune system together against the forces of erosion. Native dune plants are extremely salt-tolerant and can withstand periodic flooding by tidal water.

CONSIDERATIONS:

Avoid non-native vegetation
The establishment of non-native dune vegetation, such as lawn grass and typical landscape trees and shrubs, should be minimized within the dune because these plants do not have the vibrant root systems and salt tolerance necessary to create a healthy dune environment with maximum benefit.

Consider site conditions when using Christmas trees
Care should also be taken when considering using discarded Christmas trees as an approach to erosion control in dunes. With this approach, location is a key consideration as there are places where Christmas trees will likely be beneficial, and others where they may detrimental. Favorable conditions would include locations

- with enough available sand to trap;
- with open space between the vegetated dune edge and highest tides;
- with plenty of space between the Christmas trees so as to not "carpet" the dune and prohibit growth of American beach grass.
- in some dune scarps where the beach grass would have trouble growing until enough sand builds up to fill in the scarp.

Manage for endangered species
In some cases on beaches and dunes, actions you might take could impact threatened or endangered species such as piping plovers. You are likely aware if these species are present, and consultation with state and federal wildlife agencies will be needed before action can be taken.

Plant native dune species

Dune planting typically uses species of vegetation that are native to the coastal sand dune system. In Maine, this includes American beach grass (*Ammophila breviligulata*), which is the dominant dune species. Other common species include:

Coastal panicgrass (*Panicum amarum*)
Seaside goldenrod (*Solidago sempervirens*)
Beach pea (*Lathyrus japonicus*)
Northern bayberry (*Morella pensylvanica*)

Special considerations for rugosa or beach rose
Rugosa rose (*Rosa rugosa*), also known as beach or Japanese rose, is native to Asia and was introduced to the United States as a garden and landscape ornamental around 1845. It soon escaped from cultivation and naturalized to the New England coast, where it is now a characteristic feature of seaside Maine. Its ability to spread rapidly and shade out native plants has earned *Rosa rugosa* an invasive designation in some states, and it is not recommended as a species to introduce to a dune system. For dunes where Rosa rugosa is already present, steps should be taken to prevent it from spreading, such as pulling up, weed whacking, mowing, and cutting back new growth.

Planting American beach grass
American beach grass is normally planted in late winter while the plants are still dormant. The grass can be planted using the broom stick method: insert a broomstick 8 inches deep into the sand, and place 2 sprigs of grass in each hole. American beach grass is typically planted in staggered rows at 12-18 inch spacings, depending on the application. The plants can be fertilized easily with dried seaweed from the nearby beach.

American beach grass can be ordered from one of the following locations:

- Pierson Nurseries, Biddeford, ME
- Cape Coastal Nursery, MA
- Great Meadows Nursery, MA
- Quansett Nurseries, Inc., MA
- Church's Beachgrass & Nursery, Cape May, NJ
- Octoraro Native Plant Nursery, PA
- Cape Farms, Inc., DE

Phragmites australis, also known as common reed, is considered an invasive plant by the State of Maine and should not be planted or allowed to spread.

A good resource regarding plants is the USDA Natural Resources Conservation Service Cape May Plant Materials Center which maintain numerous resources for information on Coastal and Shoreline Restoration and Protection.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials** for advice on applicable regulations before proceeding with a dune planting project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal landscapes. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If a planting plan involves work below or within 75 feet of Highest Annual Tide (HAT) or within a mapped sand dune system, develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or vegetation may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed to complete the work. Local shoreland zoning requirements may apply.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Erect fencing

Open fencing (posts with string) can help limit foot traffic within dunes and other sensitive areas, but does little to help trap sand within the dune. Installing open fencing usually does not require a permit. Less open fencing may be permitted if it has specified spacings to allow water and sand movement. No closed fencing is allowed in frontal dunes or erosion hazard areas.

Sand/snow fencing (wooden slats/pickets with wire) can help trap sediment adjacent to the dune system. If the opening between pickets/slats is at least 4 inches wide, or at least double the width of the picket, whichever is greater, a permit is not needed; all other fencing will require a permit from Maine DEP.

Cobble trapping fences may be installed where cobble regularly washes over a seawall and threatens private structures. These fences are permitted only in specific areas adjacent to cobble or gravel beaches, where there are developed areas between the building and the beach (such as lawn), and must be secured with permanent posts. Specific standards relating to these fences are included in Natural Resources Protection Act Chapter 305, 16C.

In some cases on beaches and dunes, actions you might take could impact threatened or endangered species such as piping plovers. If these species are present, it's likely you have been made aware of this. In these cases, consultation with state and federal wildlife agencies will be needed before action can be taken.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials** for advice on applicable regulations before proceeding with a fencing project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology and ecology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If fencing is being considered within 75 feet of Highest Annual Tide (HAT) or within a mapped sand dune system, develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any

permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed to complete the work. Local shoreland zoning requirements may apply.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. No closed fencing is permitted in frontal dunes or erosion hazard areas.

Fencing for trapping cobble on cobble beaches may be approved as a permit-by-rule if the fence is secured with permanent posts; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

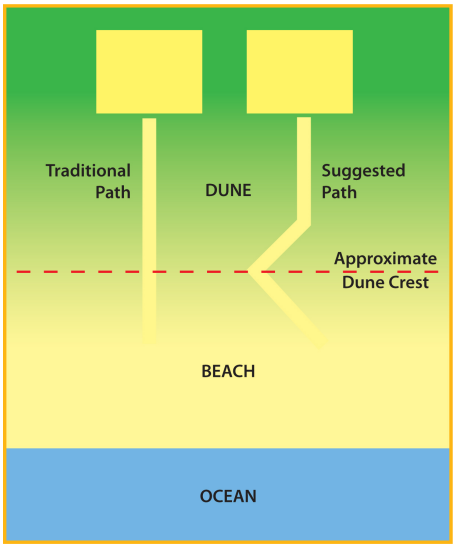
8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Build paths and walkovers

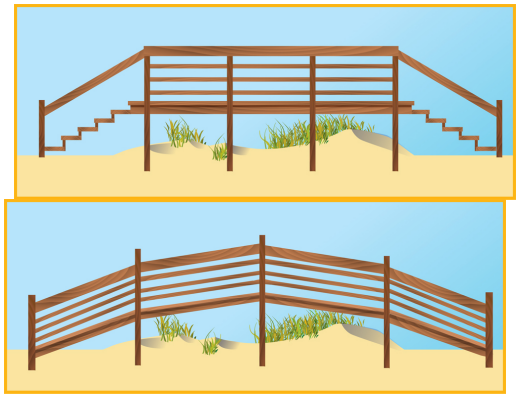
Paths: Dunes can lose their protective cover of vegetation along foot paths where people access the beach. Over time, these paths can act as conduits for floodwaters, wave runup, and overwash.

A path that curves or zig-zags near the seaward edge of the dune can slow erosion and flooding in the back dune. The main turn of the path should occur near the crest of the dune. Path rerouting will likely require a permit-by-rule from the Maine DEP since it impacts dune vegetation.



Dune walkovers: To protect dunes from foot-traffic that can contribute to erosion, elevated walkways or bridges can be constructed perpendicular to the natural sand dune. Temporary structures may be in place for up to 7 months of the year.

Both temporary and permanent walkovers would likely require full permitting from the Maine DEP under the Coastal Sand Dune Rules.



In Maine, no specific guidance is provided by the DEP for construction of walkovers in terms of elevation, slat spacing, or design; dune walkovers are reviewed on a case-by-case basis. Maine DEP suggests contacting their southern Maine regional office to set up a pre-application conference if such a structure is proposed. Usually, walkovers are elevated off the surface of the dune about three feet, with sufficient spacing between individual slats so that dune grass can receive needed sunlight. Most are constructed with handrails and steps, or if used for public access, ADA-compatible ramps. Typically, they must be less than 10 feet wide for public use, and less than 4 feet wide for private use.

Several guides for construction guidance are available from other states, including Florida and Texas, and the FEMA Coastal Construction Manual Volume III, Appendix I.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Begin by working with your local code enforcement office to determine if your property is in a FEMA-mapped flood zone and if so, what building requirements apply.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If paths or walkovers are considered within 75 feet of Highest Annual Tide (HAT) or within a mapped sand dune system, develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed when moving structures. Local shoreland zoning requirements will determine the acceptable location(s) for structures.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Nourish or "scrape" the beach

Beach scraping uses mechanical equipment to scrape sand from the lower part of the beach up to or just below the sand dune. Beach scraping is only a temporary measure to try to protect upland property during a storm. A Maine DEP permit is required for beach scraping, and additional restrictions may be imposed in terms of timing (typically between April 1 and September 1) by the Maine Department of Inland Fisheries and Wildlife.

Beach nourishment is defined as the artificial addition of sand, gravel or other similar natural material to a beach or subtidal area adjacent to a beach and is governed by the Coastal Sand Dune Rules.

Beach nourishment can be an effective, temporary response to coastal erosion, though it tends to be costly, and its effectiveness is generally short-lived (5 years or less), especially in areas with high erosion rates. Generally, there are two sources of material in Maine that have been used for beach nourishment:

1. "beneficial reuse" of dredged material, usually in conjunction with a federal (US Army Corps of Engineers) dredging project of navigable waterways; and
2. upland sourcing of material, typically from a gravel pit, where trucks are used to transport material from an upland source to the beach.

Generally, if the US Army Corps dredges a project and the material is considered to be clean, beach-compatible sand, the beneficial reuse of dredged materials as beach nourishment is encouraged. If beach nourishment is considered to be a least cost alternative for disposal of the dredged material, the costs of dredging and material placement are borne by the federal government. If not, some cost-matching by a local sponsor (typically the receiving community) is required for the Corps to proceed with a project.

Private beach nourishment projects using dredged material – either from an adjacent river channel or other offshore source – have not been undertaken in Maine. One of the reasons for this is cost: finding, dredging, and transporting material can run between $10-20 per cubic yard of sand, depending on source and its proximity to the nourishment site.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Begin by working with your local code enforcement office to determine if your property is in a FEMA-mapped flood zone and if so, what building requirements apply.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If beach scraping or nourishment is planned within 75 feet of Highest Annual Tide (HAT) or within a mapped sand dune system, develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed when moving structures. Local shoreland zoning requirements will determine the acceptable location(s) for structures.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Rebuild or enhance an existing seawall

No new seawalls may be constructed along Maine's beaches or sand dune system. The Maine Geological Survey estimates that about half of Maine's sandy beaches are armored with "hard" engineering structures like seawalls that limit the natural ability of beach and dune systems to move in response to storm events and maintain themselves by exchanging sediment.

In an emergency, a property owner can make temporary fixes to an existing seawall to protect private infrastructure from storm damage. The specific activities are outlined in the Natural Resources Protection Act (Title 38 Section 480-W). If you have questions about an emergency, temporary fix to protect your property, **contact local, state and/or federal regulatory officials** for advice on applicable regulations before proceeding.

Normal maintenance of existing seawalls does not generally require a permit. Maintenance includes activities that do not alter the overall size or location of the seawall, and that involve work on less than 50% of an entire seawall structure. Alterations to more than 50% of a seawall structure are considered to be a replacement of the seawall, which will require a permit. Any modifications to the design of

an existing seawall that will alter the size and location of the structure will require a permit. Again, **contact local, state and/or federal regulatory officials** for advice on applicable regulations before proceeding with seawall maintenance or repair.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Begin by working with your local code enforcement office to determine if your property is in a FEMA-mapped flood zone and if so, what building requirements apply.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion, as well as flood insurance through the National Flood Insurance Program.

4) If seawall replacement is planned within 75 feet of Highest Annual Tide (HAT) or within a mapped sand dune system, develop **a site stabilization plan**. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed when moving structures. Local shoreland zoning requirements will determine the acceptable location(s) for structures.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act such as a sand dune, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Rebuild after severe storm damage

If a seawall protecting property is damaged, a coastal property owner may replace or repair the seawall in-kind and in-place (i.e., same materials, same dimensions as the previously existing structure) with a Permit by Rule. Seawall repair or reconstruction requires a survey plan prepared by a licensed engineer, surveyor, or geologist.

If a property owner proposes to change their seawall in some way, a full permit through the Coastal Sand Dune Rules (Chapter 355) would be required. A seawall located farther landward, sloped, or both, is potentially less damaging to the beach and dunes.

Case Study:
Move Up and Move Back

Bluffs & Rocky Shores

The majority (58%) of the Maine coast is hard rock. The rocky coast is relatively stable over time, but soil can erode along the shoreline. Another 40% or 1,400 miles of Maine's shoreline has soft bluffs: tall (over three feet), with steep slopes of loose rock, gravel, clay, or sand that easily erode. One of the biggest hazards associated with soft bluffs is the threat of landslides, especially in high coastal bluffs made of muddy sediment.

NOTE: Maine classifies all areas below the highest annual tide elevation, including rocky shores, sand beaches, mud flats, and salt marshes, as "Coastal Wetlands." In order to facilitate problem solving on this website, Coastal Wetland types have been grouped into three categories: Beaches & Dunes; Bluffs & Rocky Shores; and Coastal Wetlands.

Learn more about Maine's rocky shores and soft bluffs.

Checklist to ID coastal hazards on your property

A checklist has been developed to help you identify and rank bluff hazards, using the maps and other resources in this guide and by conducting a field inventory of your property.

Download Bluff and Landslide checklist - 123KB

Hard Bluff

Soft Bluff

Bluff Hazard Response Actions At-A-Glance				
Action	Pros	Cons	Effort	Cost
Do nothing	Easy to implement	Uncertain results; unknown future	Low	$
Move back	Reduces hazard	May not address erosion	Low - High	$$ - $$$
Design appropriately	Reduces hazard	Site constraints	Low - High	$$ - $$$
Plant vegetation	Stabilizes slope; low impact; blends with natural environment	Takes time to establish; may not be effective when used alone	Low	$ - $$
Improve drainage	Reduces drainage stress	Site constraints	Low - Mod	$ - $$
Change the slope	Reduces stress on the shoreline	Site constraints	Mod - High	$$ - $$$
Install rip-rap	Reduces erosion; can be targeted	May not be effective when use alone; requires engineering	Mod - High	$$ - $$$
Build a seawall	Reduces erosion at base of bluff	Unintended consequences; impacts visual character; requires engineering	Mod - High	$$ - $$$

My bluff is eroding. What can I do?

Speak early and often to town officials and state agency staff.

Weigh the risks, with help from a certified geologist, licensed engineer, or other professional.

Finally, consider your options for taking action:

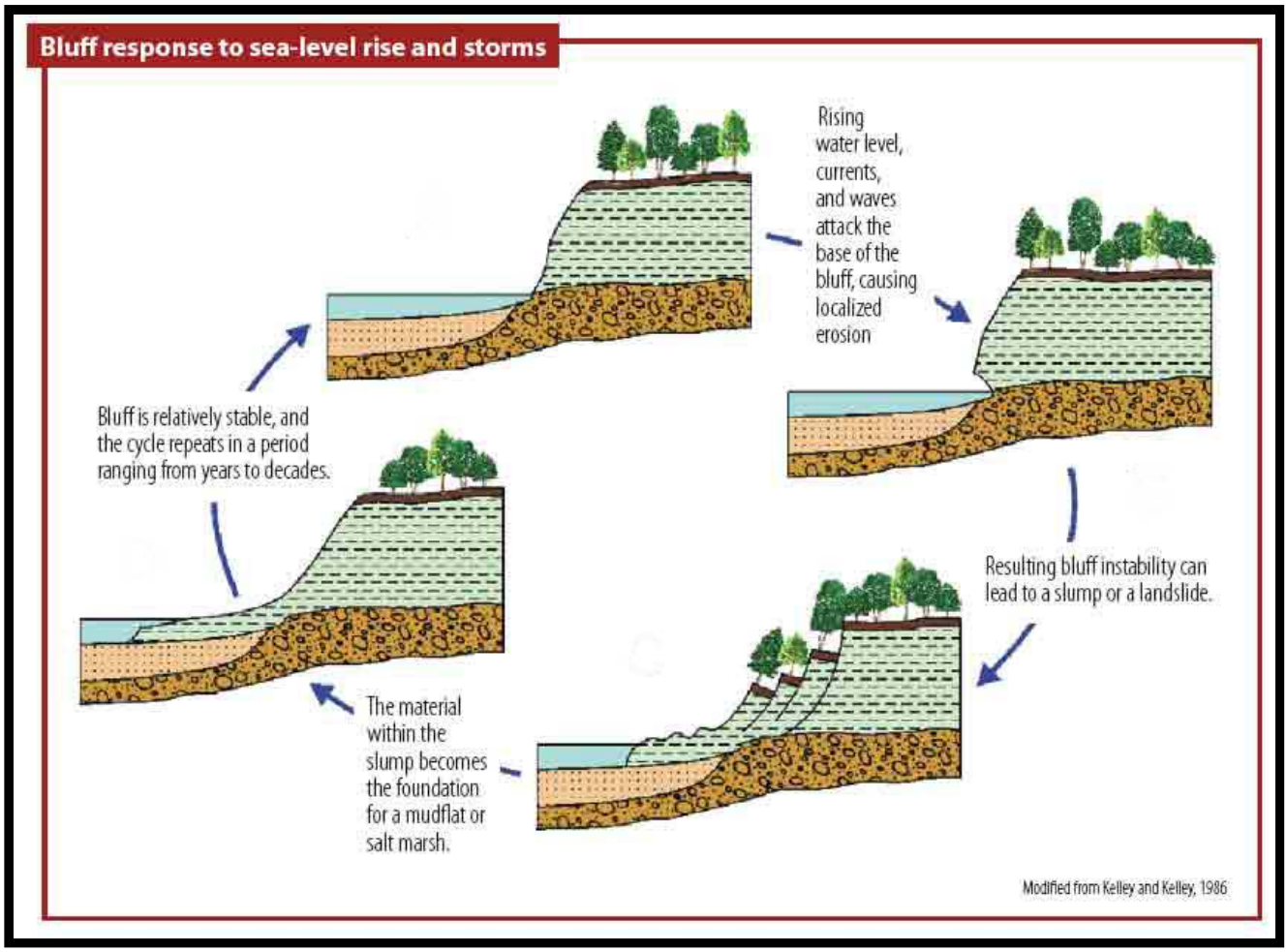
Learn more about bluffs & rocky shores

Most of the Maine coastline is rocky, and erosion isn't a major problem. But 40% or 1,400 miles of coast have loose or "unconsolidated" rock, clay, sand, or gravel bluffs that slope steeply down to just above the high tide line and are easily eroded.

Bluffs form where the rising sea has encountered piles of sediment left behind by the glaciers during or soon after the last Ice Age. Storms, coastal floods, waves, and tides all work to remove bluff sediments and redistribute them in the coastal zone. Bluff stability varies based on the frequency of waves and storms and whether or not the base of the bluff is protected by a wetland or marsh. Bluffs will continue to erode and move landward due to rising sea levels.

Bluff erosion and stability

As a bluff erodes, the top edge moves landward. This is a natural process that becomes a hazard when it threatens buildings or other developed property. Bluff erosion rates will vary from year to year, much like the weather. Even a steep bluff may remain unchanged for many years, or slump a large amount of sediment once every few years. Fine silt and clay eroded from bluffs may end up on mud flats or salt marshes at the base of the bluff, helping to reduce wave energy and slow the overall rate of bluff erosion. Eroded sand and gravel become part of the beach at the base of the bluff, helping to stabilize the shoreline.



A Highly Unstable Bluff is near vertical or very steep with little vegetation and lots of exposed, loose sediment. Fallen trees and displaced chunks of sediment are common on the bluff face and at the base of the bluff.

An Unstable Bluff is steep to gently sloping and mostly covered by shrubs with a few bare spots. Bent and tilting trees may be present.




A Stable Bluff has a gentle slope with continuous cover of grass, shrubs or mature trees, and a wide zone of ledge or sediment at its base. Over time, stable bluffs can become unstable due to natural changes or human activities.

Factors influencing coastal bluff stability

There are numerous, interconnected factors that influence the overall stability of a bluff, bluff erosion, and the formation of landslides. Landslides are one of the biggest hazards associated with coastal bluffs, especially high coastal bluffs made of muddy sediment. Landslides have occurred frequently enough in Maine that geologists have learned from them and identified ways to reduce risk and improve response in an emergency.

The information provided below has been developed from text used for the Maine Geological Survey's Landslide Hazard Maps, and information from the State of Washington Department of Ecology.

Height. The taller/thicker the sediment deposit, the more likely its weight will cause movement or slippage. >>top

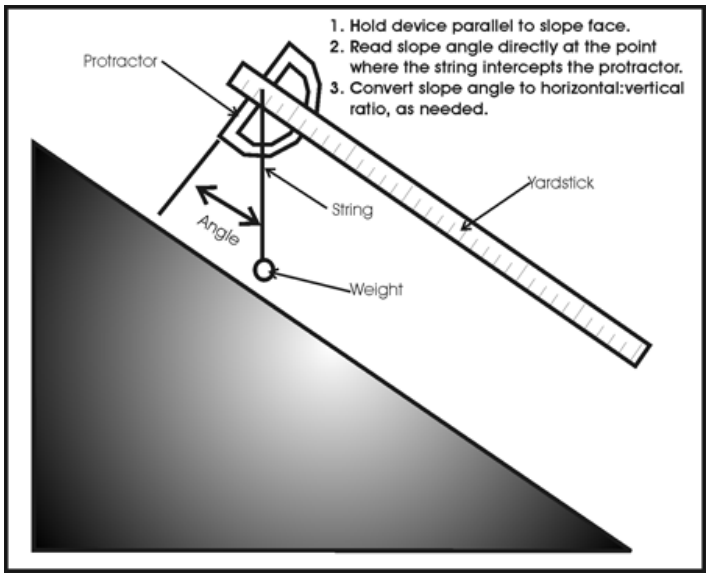
Sediment type. The finer the sediment, the greater the risk. Muddy clay and silt are the most unstable materials. Mud is structurally weak and prone to slow-motion creep, moderate slumping, or sometimes large landslides. Beneath many Maine bluffs lies a bluish-gray glaciomarine clay known as the Presumpscot Formation. Landslides are most common in this Presumpscot Formation both along the coast and inland; landslides in sand and gravel bluffs are less frequent. Rock or ledge is much more stable and not likely to erode or slide. The elevation of bedrock at the shore and inland beneath a bluff is important in determining landslide risk. >>back to top

Slope. The steeper the slope, the easier it is for gravity to initiate a landslide. The angle of a bluff face varies due to sediment type, rate of erosion at the base of the bluff, and the history of slumps and landslides at the site. Some slopes are uniformly straight while others are terraced or uneven due to prior earth movements.

A concave surface that concentrates water flow and increases pressure on the surrounding sediment is more susceptible to failure than a straight slope or convex slope.

The most accurate way to determine the slope is to use an inclinometer or clinometer. You can make your own using a protractor, string, and a yardstick. When the yardstick is held up and aligned with what appears to be the average slope of the land, the slope angle can be read directly from the protractor. This slope angle can then be converted to the appropriate horizontal/vertical ratio, if needed.

Slope height or the elevation of the land above the shoreline, can be estimated from topographic maps or GPS. The quickest but least accurate way to estimate slope height is to visually estimate the height of some nearby vertical structure on the slope (like a tree or bluff face) and then estimate how



many tree heights would equal the overall slope height. Determine slope angle by dividing the measured horizontal distance from the top to the toe of the bluff by the elevation or slope height. >>back to top

Slope aspect. South-facing slopes undergo more extensive freeze/thaw cycles in winter months than slopes that face other directions. Repeated freeze-thaw cycles increase the likelihood of shallow soil slumps. >>back to top

Topography. Swales, gullies, or ditches can direct surface water toward or away from the bluff face and slope. They also affect the recharge of sub-surface water and groundwater. Steep-sided channels concentrate and accelerate runoff, increasing surface erosion. These features often indicate past erosion or landslides. >>back to top

Vegetation. The type, age, health, and abundance of vegetation growing on a bluff can offer valuable clues to determine slope stability. Even the presence of stumps and fallen trees can tell a story to a knowledgeable observer. Vegetative indicators are best interpreted in combination with soil and geological data.

- Tree trunks that are tilted or twisted in the same direction may indicate soil shift due to previous landslides or gradual surface creep.
- Curved tree trunks near the roots often indicate land movement down the face of a bluff.
- Jackstrawed trees that are jumbled in groups on sediment that slid down a slope usually indicates that a groundwater problem or slope instability caused the mass of soil and vegetation to move downslope as a single unit or block.
- Distinct lines of trees growing across a slope may indicate one of two different conditions. If the trees are young, fast-growing species such as alder or willow, they may have colonized an exposed area created by a previous landslide. The age of trees growing in this manner can be a clue to when the slide occurred. A distinct line of trees of a similar, water-loving species may indicate an area where water or groundwater seepage is perched above a layer of impervious material underlying a deposit of sandy soil. >>back to top

Microclimate and Aspect. The weather along Maine's diversely shaped coastline varies from cove to cove and beach to beach. Microclimates depend on local topography, aspect, and exposure to sunlight. >>back to top

Waves, tides, and sea level. A gradual, but ongoing rise in sea level at a rate of about an inch per decade is causing chronic erosion along the base of many bluffs. As sea level rises, wave action and coastal flooding can reach higher and farther inland and scour more sediment from a bluff. In winter, sea ice erodes tidal flats and the base of bluffs. Tides wash away eroded bluff sediment, which helps wave action move inland. Storm-driven wind, waves, and flooding can cause more extreme erosion at the base of a bluff, increase the bluff slope, and make a landslide more likely. >>back to top

Drainage. Water can be the most common factor that causes bluff instability, either from groundwater seepage within a bluff, or surface runoff on the bluff itself. Look for drainage issues during or directly after heavy rain, and in spring when water tables tend to be highest as the ground thaws (Ground Water Handbook for the State of Maine). >>back to top

Surface water. Wetlands, ponds, and streams above the bluff can supply water to the bluff face and also to the ground water. The elevation or topography of the land surface determines which way surface water will flow. Water that runs over the face of a bluff can wash sediment to sea, increase the bluff face slope, and weaken the remaining sediment holding up the bluff. Removal of sediment from the bluff face can increase the risk of erosion or a landslide. Direct rainfall to a bluff is sometimes the deciding factor influencing bluff stability. However, wind and frost wedging do act upon some exposed slopes. Many of the other features listed in this section (vegetation, soil type, etc.) are usually related with drainage. >>back to top

Ground water. Ground water comes from surface sources, such as rain or a stream, uphill in the local watershed. Ground water tends to flow horizontally beneath the surface and may seep out the face of a bluff. Seeps and springs on the bluff face contribute to surface water flow and destabilize the bluff face. In addition, a high water table can saturate and weaken muddy sediment and make the ground more prone to slope failure. >>back to top

Weathering. Weathering in clay and silt can change the strength of bluff sediment and stability of the bluff face. Drying of clay can increase resistance to sliding. The seasonal cycle of freezing and thawing of the bluff face can lead to slumping after a thaw. >>back to top

Earthquakes. Landslides can be triggered by earthquakes. Ground vibration loosens sediment enough to reduce the strength of material supporting a bluff and a landslide results. Most landslides triggered by earthquakes in sediment like that found in Maine have been of Richter magnitude 5 or more. These are relatively rare events, but a few have occurred in Maritime Canada. >>back to top

Land use. Human actions can enhance or reduce the risk of a landslide. Actions that increase surface water flow to a bluff face, such as watering lawns or grading slopes, add to natural processes destabilizing the bluff face. Surface water, collected by roofs, driveways, paths, and lawns flows toward and down the bluff face. Walkways down the face of a bluff can lead to greater erosion from foot traffic or the concentration of surface water flow. Elevated stairs can shade the slope and prevent vegetation from stabilizing the slope. Both surface and ground water above a bluff can be supplied by pipes, culverts, surface drains, and septic systems. Increased water below ground can weaken a bluff and lead to a landslide. Greater seepage of water out of the bluff face can also increase the risk.

Clearing of vegetation from the bluff face can lead to greater bluff erosion and a steeper bluff that is more prone to landslide. Vegetation tends to remove ground water, strengthen soil with roots, and lessen the impact of heavy rain on the bluff face. Removal of vegetation within a shoreland zone to enhance a view may require a permit from the Maine DEP and/or your city or town.

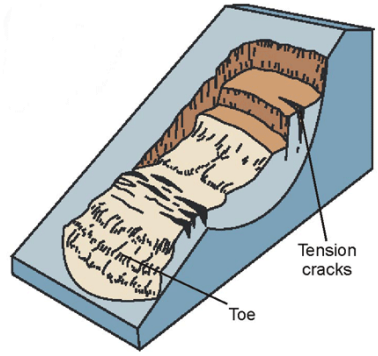
Adding weight to the top of a bluff can increase the risk of a landslide. Saturating the ground with water also adds weight. Even ground vibration, such as well drilling or deep excavation, may locally increase the risk of a landslide.

Shoreline engineering in the form of seawalls, rip-rap, or other solid structures is sometimes used to reduce wave erosion at the toe of a bluff. In some settings, engineering can increase the rate of beach or tidal flat erosion and lower the shore profile over time. This intertidal erosion can undermine engineering and result in less physical support of the base of the bluff by natural sediment. When coastal engineering ends along a shoreline, "end effect" erosion can cause worse erosion on adjacent properties. Engineering alone cannot prevent some large landslides. In general, human activities that increase the amount or rate of natural processes may, in various ways, contribute to landslide risk. >>back to top

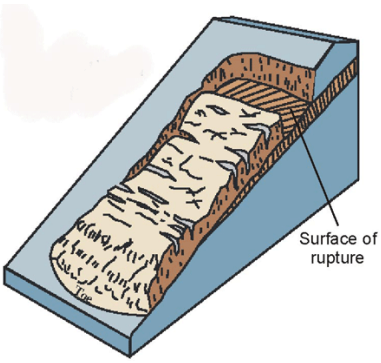
Common types of landslides in Maine

The different types of landslides featured here are from US Geological Survey.

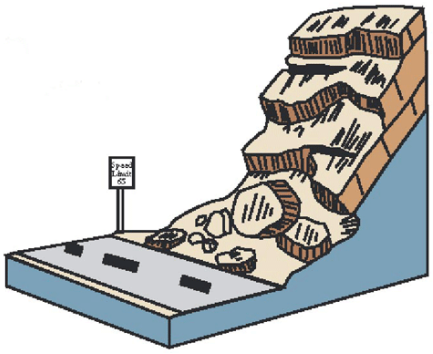
Rotational slide results in a concave surface.



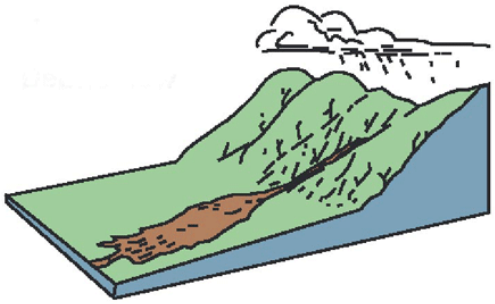
Translational slide moves along a roughly planar surface with little rotation or backward tilting.



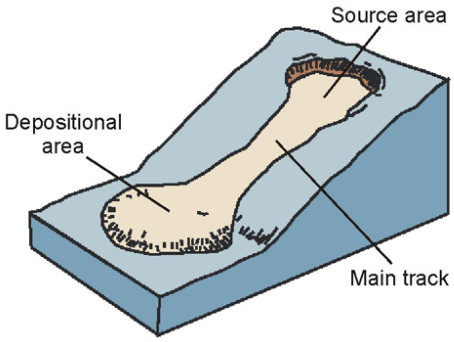
Rockfalls happen when masses of rocks or boulders become detached from steep slopes or cliffs and move abruptly downhill.



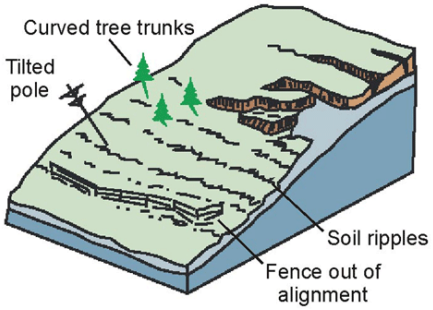
Debris flow is a rapid mass movement of loose soil, rock, organic matter, and water as a slurry that flows downslope.



Earthflow is a viscous flow of fine-grained materials that have been saturated with water.



Creep is the imperceptibly slow, steady, downward movement of slope-forming soil or rock. The bluff changes shape but doesn't fall apart.



How do I know if my property is on or near a soft bluff?

It's pretty easy to tell if your property is on the rocky coast. In contrast, soft bluffs may be "hidden" by plants and trees, or may seem like a high, stable point of land. However, in some locations, erosion and landslides are hazards to properties on or near a soft bluff.

Shorefront property that overlooks the ocean and is not on solid rock or above a bedrock cliff, may be on or landward of a soft bluff. Bluffs are mapped by the Maine Geological Survey. Landslide Hazard Maps describe the internal stability of sediment bluffs. The companion Coastal Bluff Maps describe the processes and stability of the face of a bluff. These maps provide additional information about the slope, shape, and amount of vegetation covering a coastal bluff and the adjacent shoreline. These factors are directly related to how susceptible a bluff is to ongoing erosion or landslides.

An additional series of maps are available from the Maine Geological Survey. Other maps show topography, sediment composition, groundwater characteristics, bedrock geology, and other factors which influence the stability of a bluff or potential for landslides to occur. Some specific map titles are available online, others are available in print format. State geologists are available to explain these maps.

See the maps and data section for more information.

How do I know if the bluff I live on is eroding?

A checklist has been developed to help you identify and rank bluff hazards, using the maps and other resources in this guide and by conducting a field inventory of your property.
Download Bluff & Landslide checklist - 43KB

Numerous features—including sediment type, slope, shape, and amount of vegetation—can indicate whether or not a bluff is stable. These are described in more detail in the bluff erosion and stability section.

Do nothing

The erosion of soft coastal bluffs along the shoreline is, to a large degree, a natural process that has been occurring consistently over time, shaping and reshaping the coastal environment. For this reason, doing nothing to address erosion is an option that should be considered. If the erosion is not causing an immediate hazard to property or infrastructure, doing nothing is usually the least costly and environmentally preferable option.

In evaluating the "do-nothing" alternative, assess the level of risk you are willing to accept in conjunction with the existing and expected uses of the property. The "do nothing" alternative often makes the most sense if there aren't any structures on the property, or if existing structures are located far away from the eroding bluff, and the bluff has an identified and steady erosion rate.

Prior to deciding if the "do-nothing" alternative is right for a given situation coastal property owners should:

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project. And sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

Move back to avoid the hazard

Avoiding existing or potential hazards as much as possible is usually the most efficient and cost-effective response, especially when siting **new development**.

One of the most effective ways to ensure safety of an **existing structure** that is being threatened by erosion or landslides is to relocate the structure out of the hazardous area, typically in a landward direction. Although moving back can be very effective in minimizing the hazard, it can be expensive. Costs vary from several thousand dollars to tens of thousands of dollars, and are based on the existing foundation of the structure, size of the structure, topography and geology, and distance the structure may need to be moved. Consultation with a local contractor is suggested, and local and state permits may be needed. Relocation of a structure can also be constrained by the size of a property and any applicable setbacks, such as from other existing structures or roadways.

As much as is practical with your building considerations, consider **moving back to avoid the hazard.** Consideration should also be given to significant habitat resources or environmentally sensitive areas, which are usually identified by municipal or state regulations.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer, landscape architect, or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project. And sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

4) If moving back involves work below or within 75 feet of Highest Annual Tide (HAT), develop a site stabilization plan. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) Be neighborly. If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to drainage on their property. This consultation is a courtesy at this stage, and not a regulatory mandate, however obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that lead to costly permitting and/or construction delays.

6) Share plans with local code enforcement to determine what, if any, local ordinances apply. Local Shoreland Zoning requirements will determine the acceptable location for structures such as drainage features, catch basins, roads/driveways, paths, etc.

7) If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act (NRPA), or within a development permitted by the Site Location of Development Act (Site Law), a permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit or a site law permit may be required.

8) If the plan involves work below the HAT, and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities to determine which permits may be necessary.

9) It is good general practice to hire contractors who are experienced with coastal stabilization projects and the implementation of Best Management Practices.

Design, build, or modify new and existing structures appropriately

Construction techniques that are appropriate to coastal areas involve not only siting of the structure and support structures, including septic, utilities, etc., but also design and building techniques that can withstand hazards and potential land, wind, and water forces associated with the dynamic coastal zone.

Things to consider:

- The construction footprint, given applicable setbacks for sensitive areas;
- The extent of grading needed to achieve a stable building footprint;
- The level of engineering required address erosion or landslides; and
- Potential physical forces such as water and wind.
- *Be neighborly.* Think about potential impacts on your neighbor's property that may result from an activity on your property. At the same time, it may make sense to work with adjacent property owners if a common goal is found or regional approach is being adopted to deal with certain hazards.

Some of the best and most comprehensive resources available regarding proper coastal construction techniques are the FEMA Coastal Construction Manual, the FEMA Home Builder's Guide to Coastal Construction Technical Fact Sheets and the Maine Erosion and Sediment Control BMP Manual. These resource materials provide detailed descriptions of the techniques recommended to mitigate erosion and build smart within the coastal environment. The Coastal Construction Manual is available as a CD or in print copy by calling FEMA Publications Distribution Facility at 1-800-480-2520, and should also be available for review at your local town office or public library.

Stabilize the bluff by planting vegetation

Planting vegetation can help stabilize slightly or moderately eroding bluffs. Vegetation tends to remove ground water, strengthen soil with roots, and lessen the impact of heavy rain on the bluff face.

The Washington Department of Ecology's guide on vegetative planting techniques contains many techniques applicable to Maine, though plant species will be different. The Maine Natural Areas Program's *Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystems* provides guidance on existing dominant vegetative species in different landscapes in Maine. A database of plant communities located at coastal headlands can be used as general guidance. The University of Maine Cooperative Extension has compiled a listing of native plant species in Maine. For additional information on bluff-appropriate vegetation species and techniques in Maine, consult with local garden centers and landscape architects.

Clearing vegetation from the bluff face may lead to increased erosion in the short term while new vegetation is established. Be careful when considering removing one type of vegetation in order to establish another. Removal of vegetation within a shoreland zone may require a permit from the municipality.

In most cases, establishing vegetation along the shoreline is a good Best Management Practice (BMP), and often is most effective when combined with other measures such as drainage improvements, changes to the bluff slope and/or the installation of rip-rap. The Maine Erosion and Sediment Control BMP Manual provides a detailed description of all the structural and non-structural methods to mitigate erosion.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer, landscape architect, or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project. And sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

4) If implementation of one or more Best Management Practices (BMPs) is recommended, develop an erosion mitigation plan. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) Be neighborly. If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to drainage on their property. This consultation is a courtesy at this stage, and not a regulatory mandate, however obtaining “buy in” from abutter(s) can potentially avoid neighbor disputes that lead to costly permitting and/or construction delays.

6) Share plans with local code enforcement to determine what, if any, local ordinances apply. Local Shoreland Zoning requirements will determine the acceptable location for structures such as drainage features, catch basins, roads/driveways, paths, etc.

7) If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act (NRPA), or within a development permitted by the Site Location of Development Act (Site Law), a permit will likely be required. Typically work within 25 feet of the highest annual tide line is not allowed under permit-by-rule, however, there is some exception for disturbances associated with establishing vegetation. An individual permit will be required for any plan that does not qualify for permit-by-rule, and alterations to a development or a lot within a development permitted under the Site Law may require a permit revision.

8) If the plan involves work below the HAT, and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities to determine which permits may be necessary.

9) It is good general practice to hire contractors that are experienced with coastal stabilization projects and the implementation of Best Management Practices.

Improve drainage on bluffs

Runoff from upland areas (both on and below the land surface) can cause coastal erosion. Changes to the landscape due to changes in land use over time can change runoff patterns and/or increase the amount of water that is moving through the area, again contributing to added stress on the shoreline. Drainage, consequently, is a key factor in bluff stability. Actions that increase surface and subsurface water flow to a coastal bluff, such as ditching, construction of new impervious area (roofs, roads/driveways, paths, etc.), changes to natural grading, and removal of or changes to vegetation, can contribute to destabilization of the coastal bluff and cause soil erosion. Saturated soils add weight to coastal bluffs and can weaken stability, contributing to increased risk of slumping or landslides.

When surface water collected by roofs, driveways, paths, and lawns flows toward and down the bluff face, erosion can accelerate over time or in some cases the bluff can collapse. Walkways down the face of a bluff can also concentrate surface water flow and contribute to bluff instability. Drainage may be a contributing factor to coastal erosion even when signs of surface erosion are not evident due to the presence of subsurface water within the soil profile. Seepage of water out of the bluff face, in addition to surface erosion due to runoff and wave action, can often be a large contributor to coastal bluff erosion.

Addressing drainage issues requires a detailed understanding of the root causes of the water issues, as well as the soil conditions on the site. In most cases, Best Management Practices (BMPs) can be applied to mitigate or improve drainage. The Maine Erosion and Sediment Control BMP Manual provides a detailed description of the recommended structural and non-structural methods to mitigate erosion. The best solution for a given drainage issue may involve the construction of one or a combination of BMPs, such as curtain drains, catch basins, open and closed ditches, french drains, dry wells, etc.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order, although some steps may be conducted concurrently.

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer, landscape architect, or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

4) If implementation of one or more Best Management Practices (BMPs) is recommended, develop an erosion mitigation plan.

5) Be neighborly. If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to drainage on their property. This consultation is a courtesy at this stage, and not a regulatory mandate, however obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that lead to costly permitting and/or construction delays.

6) Share plans with local code enforcement to determine what, if any, local ordinances apply. Local Shoreland Zoning requirements will determine the acceptable location for structures such as drainage features, catch basins, roads/driveways, paths, etc.

7) If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act (NRPA), or within a development permitted by the Site Location of Development Act (Site Law), a permit will likely be required.

8) If the plan involves work below the HAT, and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities to determine which permits may be necessary.

9) It is good general practice to hire contractors that are experienced with coastal stabilization projects and the implementation of Best Management Practices.

Stabilize the bluff by changing the slope

Case Study:
Move Back and Change the Bluff Slope

Changing the coastal bluff slope should be considered only in extreme cases when other actions are impractical due to cost or site constraints. Changing the slope will alter the surface and subsurface drainage patterns on the site so it is important to consult with a qualified environmental professional prior to implementing grading to ensure that the project will not have unintended consequences for abutting properties, nearby sections of shoreline, or the coastal resources in proximity to the project. Reducing the bluff slope could potentially relieve stress caused by the weight of soil on the bluff. A project that involves changing the bluff slope would be done in conjunction with other actions, such as installing drainage features and establishing new vegetation, and would likely require review by Maine Geological Survey. Any plans to alter the slope of a coastal bluff should be prepared and/or evaluated by a qualified soil scientist or engineer to ensure that the design does not diminish slope stability.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order, although some steps may be conducted concurrently.

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer, landscape architect, or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

4) Develop an erosion mitigation plan. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) Be neighborly. If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to drainage on their property. This consultation is a courtesy at this stage, and not a regulatory mandate, however obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that lead to costly permitting and/or construction delays.

6) Share plans with local code enforcement to determine what, if any, local ordinances apply. Local Shoreland Zoning requirements will determine the acceptable location for structures such as drainage features, catch basins, roads/driveways, paths, etc.

7) If the plan involves alterations below or within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act (NRPA), or within a development permitted by the Site Location of Development Act (Site Law), a permit will likely be required. If changing the slope involves work within 25 feet of the highest annual tide, the project will not qualify for a permit-by-rule and an individual permit will be required. Alterations to a development or a lot within a development permitted under the Site Law may require a permit revision.

8) If the plan involves work below the HAT, and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities to determine which permits may be necessary.

9) It is good general practice to hire contractors that are experienced with coastal stabilization projects and the implementation of Best Management Practices.

Stabilize the bluff with a seawall

Shoreline engineering in the form of a seawall is sometimes used to reduce wave erosion at the toe of a bluff. **Seawalls are an extreme form of stabilization that should be considered only when all other means of stabilization have been ruled out.** Typical seawalls are vertical structures of stone, wood, concrete, steel, or some combination of these materials. When properly constructed, seawalls form a physical barrier to forces of erosion such as tides and storm waves. Seawalls achieve their protection by deflecting the energy of the water away from the area being protected by the seawall. The deflected energy travels horizontally along the seawall until it finds a weak point in the seawall, "scouring" or undermining and weakening the integrity the seawall itself. Deflected energy can also cause "end effect erosion" on adjacent properties that are not also protected by a seawall. Extreme care should be exercised when considering the construction of a seawall in order to determine if other BMPs would be effective as an alternative or in combination to ensure that the seawall addresses the erosion issue without unnecessary consequences for the abutting shoreline. Engineering alone cannot prevent some large landslides. In general, human activities that increase the amount or rate of natural processes may, in various ways, contribute to landslide risk.

Eroding bluffs sometimes can be stabilized solely at the base or along the entire bluff surface using a single technique or combination of tree rafts, wattles, geotextile fabrics, rip-rap, or gabion structures. The costs associated with bluff stabilization can be quite high, depending on the size and project design specifications, and a licensed engineer should be contracted for such a design. Permitting may be required for not only the actual activity, but also for staging or seasonal use of equipment, especially if it occurs from the seaward side of the project and is within the "coastal wetland" or below highest annual tide. Maine Department of Environmental Protection rarely approves seawalls as a general practice because an alternative intervention that is less environmentally damaging is generally available. The guide to Maine Erosion and Sediment Control Best Management Practices, contains stabilization techniques applicable to coastal bluff and landslide sites which should be considered as alternatives to seawalls, including:

- land grading and slope protection
- use of geotextile fabric
- stabilizing slopes with rip-rap
- stabilizing slopes with gabions (rock-filled wire baskets)
- stabilizing streambanks
- Additional resources regarding slope stabilization are provided by the US Army Corps of Engineers Coastal and Hydraulics Laboratory

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer, landscape architect, or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

4) If the project involves work within 75 feet of Highest Annual Tide (HAT), develop a site stabilization plan.

5) Be neighborly. If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to drainage on their property. This consultation is a courtesy at this stage, and not a regulatory mandate, however obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that lead to costly permitting and/or construction delays.

6) Share plans with local code enforcement to determine what, if any, local ordinances apply. Local Shoreland Zoning requirements will determine the acceptable location for structures such as drainage features, catch basins, roads/driveways, paths, etc.

7) If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act (NRPA), or within a development permitted by the Site Location of Development Act (Site Law), a permit will likely be required. The construction of new seawalls does not qualify for a Permit-by-Rule; however, the replacement of existing seawalls can qualify for Permit-by-Rule. An individual permit will be required for any plan that does not qualify for a Permit-by-Rule. **This step is critical** for all situations that involve bluffs that are exhibiting signs of groundwater discharge through the bluff face. In some cases properly installed seawalls can restrict the natural movement of groundwater which may cause super saturation of the soil and lead to catastrophic slope failure or a landslide.

8) If the plan involves work below the HAT, and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities to determine which permits may be necessary.

9) It is good general practice to hire contractors that are experienced with coastal stabilization projects and the implementation of Best Management Practices.

Stabilize bluffs and rocky shores with rip-rap

The natural movement of the tides and severe to moderate storms with wave surge at high tide can cause the erosion of upland soils at the edge of the coastal bluff. Placing rip-rap (angular stone in various sizes usually larger than two feet diameter) can stabilize the base of an eroding bluff and slow erosion in some cases. The rip-rap must be placed on a bed of crushed stone or geotextile fabric to fully protect the soils underneath, and be installed at the angle of the existing bluff or no steeper than a 2:1 slope. The slope of the installation is critical, as it will allow the rip-rap to blend with the natural shoreline and absorb wave energy. Pack stones densely to prevent wave action from pulling erodible soils out of the bluff through the stones. The height of the rip-rap should be limited to no greater than twice the maximum wave height for the affected area. Rip-rap is most effective when placed in areas that are likely to be under heavy wave stress. Areas on the bluff that are above wave action can, in most cases, be stabilized with a combination of other techniques. Often, vegetation is used in conjunction with rip-rap to improve its overall effectiveness.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) Contact local, state and/or federal officials to obtain regulatory advice. Individuals experienced with coastal regulations may not need to seek regulatory advice in all cases; however, if in doubt seek advice before proceeding with a project.

2) Obtain an assessment from a certified engineer, landscape architect, or other qualified environmental professional. In most cases, local, state, and/or federal regulators can help identify the best professional discipline to assist with a specific project. This step is critical for bluffs that are exhibiting signs of groundwater discharge through the bluff face. In some cases, even properly installed rip-rap can restrict the natural movement of groundwater, potentially causing super saturation of the soil and catastrophic slope failure or a landslide.

3) Owners of coastal property along eroding bluffs or near landslide-prone areas should check their insurance coverage to make sure they have adequate liability coverage related to loss due to landslides or shoreline erosion, as well as flood insurance.

4) If implementation of one or more Best Management Practices (BMPs) is recommended, develop an erosion mitigation plan. The plan does not need to be prepared by a professional in all cases; however, a good, clear plan can improve the efficiency and timeliness of any permitting that may be required. Good plans also will be beneficial to the construction contractor and can help avoid costly mistakes during the construction process.

5) Be neighborly. If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to drainage on their property. This consultation is a courtesy at this stage, and not a regulatory mandate, however obtaining “buy in” from abutter(s) can potentially avoid neighbor disputes that lead to costly permitting and/or construction delays.

6) Share plans with local code enforcement to determine what, if any, local ordinances apply. Local Shoreland Zoning requirements will determine the acceptable location for structures such as drainage features, catch basins, roads/driveways, paths, etc.

7) If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act (NRPA), or within a development permitted by the Site Location of Development Act (Site Law), a permit will likely be required. Replacing existing rip-rap usually qualifies for permit-by-rule; however, installing new rip-rap does not, and an individual permit may be required.

8) If the plan involves work below the HAT, and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities to determine which permits may be necessary.

9) It is good general practice to hire contractors that are experienced with coastal stabilization projects and the implementation of Best Management Practices.

Rebuilding after a landslide or severe storm damage

There is no standard process property owners can follow in the case of a catastrophic event that damages a coastal bluff. Property owners are encouraged to contact state and local officials immediately to arrange consultation.

Coastal Wetlands

Salt marshes, freshwater tidal marshes, tidal flats, inlets, and coastal streams, rivers, and ponds are vulnerable to flooding and erosion. Just like on the open coast, the boundary between coastal wetlands and adjacent uplands is not static, and changes in response to daily and annual high tides, storm events, and sea-level rise. Wetlands and river banks buffer upland environments from storm damage and flooding. Wetlands protect water supplies and provide habitat for fish and wildlife, including commercially important fish species. **Learn more about Maine's coastal wetlands or find out if your property contains or is near wetlands.**

NOTE: Maine classifies all areas below the highest annual tide elevation, including rocky shores, sand beaches, mud flats, and salt marshes, as "Coastal Wetlands." In order to facilitate problem solving on this website, Coastal Wetland types have been grouped into three categories: Beaches & Dunes; Bluffs & Rocky Shores; and Coastal Wetlands.

Checklist to ID coastal hazards on your property

A checklist has been developed to help you identify and rank beach and dune hazards, using the maps and other resources in this guide and by conducting a field inventory of your property.

Download the Coastal Wetlands Checklist - 131KB

Coastal Wetlands Hazard Response Actions At-A-Glance				
Action	Pros	Cons	Effort	Cost
Do nothing	Low cost, easy to implement	Uncertain results; unknown future	Low	$
Move back	Reduces hazard	May not address erosion	Low - High	$$ - $$$
Move up	Reduces hazard	May not address erosion	Low - Mod	$ - $$
Design appropriately	Reduces hazard	Site constraints	Low - High	$$ - $$$
Create/maintain buffer	Stabilizes property, enhances habitat	Takes time to establish; may not be effective when used alone	Low	$
Create/restore wetlands	Stabilizes property, enhances habitat	Takes time to establish; may not be effective when used alone	Low - Mod	$
Add rip-rap	Reduces hazard, can be targeted	May not be effective when used alone; engineering; potential wetland damage	Mod - High	$$
Build a seawall	Reduces upland erosion	Unintended consequences; impacts visual character; requires engineering	Mod - High	$$ - $$$
Rebuild after damage	Can increase resilience	Requires engineering	High	$$$

My property floods often and the wetland boundaries are changing. What can I do?

Speak early and often to town officials and state agency staff.

Weigh the risks, with help from a certified geologist, licensed engineer, or other professional.

Finally, consider your options for taking action:

Learn more about coastal wetlands

The Maine coast contains approximately 19,500 acres of wetland, more than any other New England state, New York, or Canadian province in the Gulf of Maine. Marsh types vary along the coast due to different geology and tidal ranges, from extensive back-barrier marshes in southern Maine to river-fringing tidal marshes and pocket wetlands in central and eastern Maine.

Much of the information in this section is from the extremely comprehensive guide, Maine Citizen's Guide to Evaluating, Restoring, and Managing Tidal Marshes. Other sources for information on Maine's salt marshes include Maine Salt Marshes: Their Function, Values, and Restoration and Salt Marshes in the Gulf of Maine, Human Impacts, Habitat Restoration and Long-Term Change Analysis.

How coastal wetlands work & the benefits they provide

Wetlands are part of what makes the Maine coast beautiful and attractive to residents and tourists alike. And they provide a variety of valuable and related ecological and societal benefits:

Shoreline anchoring: Coastal wetlands "anchor" barrier beaches and sand dunesto the mainland. As new sediment washes into the marsh with each tide, the marsh surface maintains elevation as sea level rises.

Storm surge protection: Coastal wetlands slow wind-driven waves, and help to protect uplands from erosion during storm-related coastal flooding.

Pollutant buffering: By trapping sediments and filtering water, marshes prevent pollution from reaching surface and ground water.

Vital habitat: Many species of birds, fish, and other wildlife use salt marshes for food and shelter. Marshes provide nursery and breeding habitat for commercially valuable fish and shellfish.

Recreational uses: Coastal wetlands support activities such as hunting, fishing, birdwatching, clamming, etc.

Marsh System Types

Marsh systems in Maine can generally be classified into three different types based on their overall geomorphology and shape.

Back-Barrier Marshes

Coastal Back Barrier Marsh System
(e.g., Webhannet River marsh, Wells, ME)

Located adjacent to barrier beaches, with direct access to the ocean through tidal inlets. Usually dominated by high marsh.

Finger Marshes

Finger Marsh System
(e.g., Cousins River marsh, Yarmouth, ME)

Long marshes along tidal channels. The area of high marsh is large compared to size of the channel.

Fringe Marshes

Fringing Marsh System
(e.g., Presumpscot River marsh, Portland, ME)

Marshes on the edges of protected shorelines in estuarine coves and rivers, or at the toe of eroding bluffs. With less area of high marsh and bordered by mud flats, fringe marshes are strongly influenced by erosion from ice and waves.

Vegetation Zones

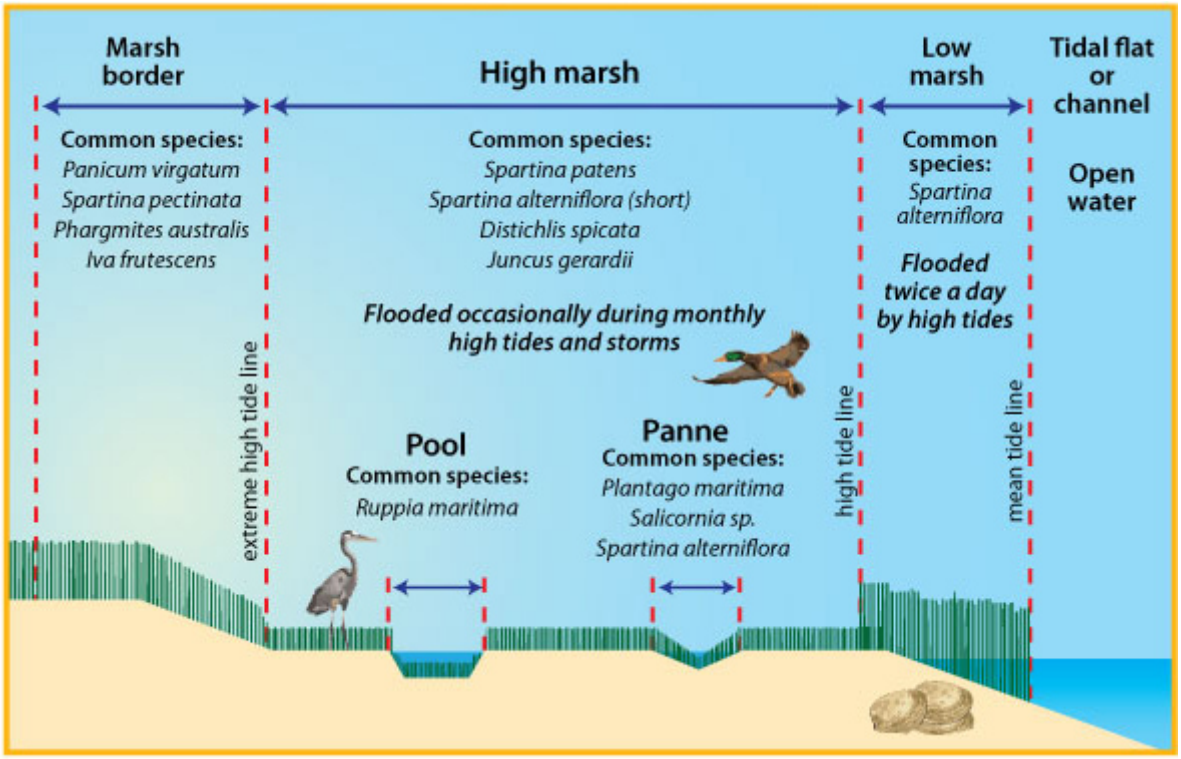
A typical coastal wetland in Maine has several different zones of vegetation based on the tides.

Low marsh, between mean low tide and mean high tide, is flooded twice daily by tidal action.

High marsh is flooded by above-average tides twice a month and irregularly by storm tides.

Pannes are shallow "ponds" in the high marsh that are flooded periodically by high tides. Deeper pannes that remain filled with water (pools) may contain widgeon grass (*Ruppia maritima*), sheepshead minnow, and mummichogs, providing a source of food for waterfowl.

Tidal channels, open water, and tidal flats are all important components of the marsh ecosystem. Tidal flats may support economically significant marine worm and clam populations.



Flooding and erosion of Maine's coastal wetlands

Property on and adjacent to coastal wetlands usually floods during the annual high tide, during heavy rains or spring snowmelt, or during periods of storm surge. These areas, from a regulatory standpoint, are part of a coastal wetland since they are at or below the reach of the tides. Coastal property flooding problems may be chronic, with regular inundation by high tides or minimal storm surges. Flooding may be less frequent and occur only in larger storm events and high storm surges.

Erosion of marsh surfaces can be caused by:

Sea-level rise. Coastal wetlands persist when sediment is delivered to the marsh surface at the same pace as sea-level rise, which has been fairly steady over the last century. However, if sea-level rise accelerates and sedimentation rates cannot keep up, marsh loss could occur.

Tidal currents. At high speeds, ebbing and flooding tidal currents can erode marsh surfaces, especially along the edges and outer banks where a tidal channel bends.

Wind-driven waves. Waves, especially those associated with storms, can erode marsh surfaces at high tide. At lower tides, waves can erode marsh banks along tidal channels. This relates to the aspect (or direction) that a marsh faces and the fetch (distance) that the wind can blow over the water. A longer fetch will allow larger waves to form. Typically in Maine, marsh surfaces or channels that face northeast are most susceptible to erosion.

Boat wakes. Motorboat wakes can cause abnormally large waves to erode the edges of the marsh.

Foot traffic. In some areas, traditional public access has cut across marsh surfaces to access fishing or recreational locations. Heavy foot-traffic on marsh surfaces, even for a short amount of time, can damage marsh vegetation and erode the surface of the marsh.

Ice floes. Winter high tides can lift frozen blocks of ice, mud, and plants off the marsh and expose the underlying surface to additional erosion. In other instances, ice floes actually transport sediment from one area of the marsh to another.

How do I know if coastal wetlands are a part of my property or neighborhood?

Section 4 of the Maine Citizens Tidal Marsh Guide provides an outline of characteristics that can help you identify coastal wetlands as well as the different values and services that a wetland may provide.

The National Wetland Inventory Maps created by the US Fish and Wildlife Service identify large areas of coastal wetlands, although they were created using 1980s aerial photographs, so existing marsh conditions may be different than those mapped.

Expect boundaries to change. The nature and location of coastal wetlands may change in the future with changing elevation of the highest annual tide due to sea-level rise. (See the Maine Geological Survey mapping efforts for sea-level rise in southern Maine.)

The Maine Geological Survey has simulated the potential impacts of sea-level rise on the coastal wetland boundary for the Drakes Island and Wells Beach, Wells area. Additional online reports and maps for coastal communities in southern Maine will be available in the future. Wetland information is also available from resources on the Maps & Data page.

How do I know if wetlands are vulnerable to flooding and erosion?

Once you have identified the presence, absence, type, and extent of coastal wetlands on or adjacent to your property, use the Coastal Wetland and Coastal Flooding Checklist to evaluate the hazards posed to and by the wetlands. Think about how existing wetlands, and their associated hazards like erosion and flooding, may respond to sea-level rise or increased storm events.

Download Coastal Wetland & Coastal Flooding checklist - 43KB

Classify the level of risk associated with each hazard. That is, if tidal marsh or bank erosion is occurring, at what rate in the short term? The long term? How close is your structure to the highest annual tide?

Consider having a professional geologist, licensed geotechnical engineer, or coastal floodplain expert investigate your property to help you further classify the risk associated with identified hazards, including erosion and coastal flooding.

Do nothing

The erosion of coastal wetlands along the shoreline is, to a large degree, a natural process that has been occurring over a long period of time, shaping and reshaping the coastal environment. For this reason, doing nothing to address erosion is an option that should be considered. If the erosion is natural and not causing an immediate hazard to property, structures, or infrastructure, doing nothing is usually the least costly and environmentally preferable option.

In evaluating the "do-nothing" alternative, assess the level of risk you are willing to accept in conjunction with the existing and expected uses of the property. The "do nothing" alternative makes the most sense if:

- there aren't any structures on your property,
- the property is in areas of critical habitat,
- or in areas where erosion is minimal and a structure is located far away from the wetland.

Expect wetland boundaries to change. The nature and location of coastal wetlands may change in the future with increasing elevation of the highest annual tide due to sea-level rise. (See the Maine Geological Survey mapping efforts for sea-level rise in southern Maine.)

The steps below will help you decide if the "do-nothing" alternative makes sense for your property.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology and biology. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion or flooding, as well as flood insurance through the National Flood Insurance Program.

Move back to avoid the hazard

Avoiding wetlands and their associated hazards as much as possible is usually the most efficient and cost effective response, especially when siting new development.

One of the most effective ways to ensure safety of an **existing structure** that is being threatened by erosion or flooding is to relocate the structure out of the hazardous area. Although moving back can be very effective in minimizing the hazard, it can be expensive. Costs vary from several thousand dollars to tens of thousands of dollars, and are based on the existing foundation of the structure, size of the structure, topography and geology, and distance the structure may need to be moved. Relocation of a structure can also be constrained by the size of a property and any applicable setbacks, such as from other existing structures, lot boundaries, or roadways.

When planning new development, review the Flood Insurance Rate Map for your proximity to a flood zone. It is easier to site new development away from the flood zone than to mitigate or rebuild later. If you are moving a structure, consider also elevating the structure at the same time. The National Flood Insurance Program insurance rates increase for a structure in a flood zone, but decrease if the structure is elevated. Contact the Maine Floodplain Management Program for guidance.

As much as is practical with your building considerations, consider moving back to avoid some hazards. Consideration should also be given to significant habitat resources or environmentally sensitive areas, which are usually identified by municipal or state regulations.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology and flood hazards. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion or flooding, as well as flood insurance through the National Flood Insurance Program.

4) **Develop a mitigation plan** if professional and regulatory consultations result in a recommendation that you move structures to address coastal erosion or flooding concerns.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or if moving a structure may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed when moving structure, such as shoreland zoning.

7) **Need a state permit?** If the plan involves alterations below or within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Move up by elevating structures

Existing structures that are threatened with coastal flooding or erosion often can be elevated to raise the living space above flood level. If your property is located in a flood zone, you may be required by your town's floodplain management ordinance to have the lowest structural part of your house be elevated above the base flood level. This elevation factor for safety, called freeboard, is one foot for most Maine communities, with a few communities adopting a higher standard. Consult town officials for your local standards.

If you have an older structure that has been flooded and does not meet current standards, or any time you are doing substantial improvements to your structure, consider the cost of elevating the structure using flood vents, a flow-through foundation, or a pile foundation, especially if structural improvements are substantial, meaning the cost of the improvements meets or exceed 50% of the value of the structure. A substantial improvement to a structure requires bringing the structure up to code, including to floodplain management standards. Increasing the elevation may lower insurance costs.


Example of Flow Through Foundation, Wells, ME. Image by P.A. Slovinsky, 08/2008

Flow-through foundations are typically block or poured cement foundations with adequate spacing for floodwaters to flow through the foundation without damaging the supports.

Pile foundations are typically used in more active flooding areas along open ocean coastlines, and provide much more open space for floodwaters to travel through.

The concept behind both these foundation types is that water, sediment, and debris can *travel through* the foundation, thus not applying significant pressure and lateral force to the foundation which can cause structural failure. Both applications can significantly reduce potential flood damage to a structure.

Many of the state requirements regarding elevation of structures, including a review of techniques, are outlined in Chapter 5 of the Maine Floodplain Management Handbook. Your town may have additional requirements that meet or exceed minimum state standards. Contact your local Code Enforcement Officer for more information. You may also want to review the FEMA Coastal Construction Manual and the FEMA Home Builder's Guide to Coastal Construction Technical Fact Sheets. The Coastal Construction Manual is available as a CD or in print copy by calling FEMA Publications Distribution Facility at 1-800-480-2520, and should also be available for review at your local town office or public library.

If you consider elevating your structure, think about making other improvements to make your home more storm and flood resilient, such as elevating utilities or tying down heating fuel tanks. Also, consider elevating your structure over and above the elevation required by your floodplain ordinance, in order to take into account expected rates of sea-level rise and higher future floodplain elevations, while lowering your flood insurance premiums.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer or other qualified professional** with expertise in coastal geology and flood hazards. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion or flooding, as well as flood insurance through the National Flood Insurance Program.

4) **Develop a mitigation plan** if professional and regulatory consultations result in a recommendation that you elevate structures to address coastal erosion or flooding concerns.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or if elevating a structure may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances (such as shoreland zoning) may need to be followed when elevating a structure.

7) **Need a state permit?** If the plan involves alterations below or within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process; otherwise an individual permit may be required. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with the best practices associated with construction in or adjacent to natural resources.

Design structures appropriately

Construction techniques that are appropriate to coastal areas involve not only siting of the structure and infrastructure, including septic, utilities, etc., but also design and building techniques that can withstand land, wind, and water forces associated with the dynamic coastal zone.

Things to consider:

- The construction footprint, given applicable setbacks for sensitive areas.
- The extent of grading needed to achieve a stable building footprint.
- The level of engineering required to address erosion or flooding.
- Potential physical forces such as water and wind.

Consult the FEMA Coastal Construction Manual and the FEMA Home Builder's Guide to Coastal Construction Technical Fact Sheets, which provide detailed descriptions of recommended techniques to mitigate erosion and build smart within the coastal environment. The Construction Manual is available as a CD or in print copy by calling FEMA Publications Distribution Facility at 1-800-480-2520, and should also be available for review at your local town office or public library.

Create or maintain a buffer next to the wetland

Keeping a healthy, diverse, vegetated upland buffer adjacent to a coastal wetland can lessen erosion and protect property. Without a buffer, development disturbs the fringing marsh boundary and may also compromise the wetland's ability to store floodwaters. Fertilizer usage can degrade marsh vegetation and allow colonization by invasive species. If you live on or near a coastal wetland, try to maintain, to the maximum width practicable, a naturally vegetated, woody upland buffer between the "developed" (planted lawn or infrastructure) portion of your property, and adjacent coastal wetlands. Other things you can do include:

- Enhance the width of existing buffers with native vegetation.
- Minimize disturbances adjacent to coastal wetlands.
- Limit planting and maintenance of lawns and subsequent use of nitrogen-rich fertilizers.
- Remove invasive species within the buffer, especially common reed (*Phragmites australis*), preferably without the use of pesticides.
- Limit the amount of unnatural freshwater runoff (or stormwater) directed into coastal wetlands from the adjacent uplands.
- To avoid impacts to surrounding development, do not block the flow of floodwaters that naturally drain into the wetland.

A great general resource for buffer management is from the Save the Bay Narragansett Bay Backyards on the Bay Yard Care Guide for the Coastal Homeowner.

Case Study: Marsh Buffer

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer, landscape architect, or other qualified professional**. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion or flooding, as well as flood insurance through the National Flood Insurance Program.

4) **Develop a mitigation plan** if implementation of one or more "best management practices" is recommended. The plan does not need to be prepared by a professional in all cases; however, the quality and clarity of the plan will generally improve the efficiency and timeliness of any subsequent permitting that may be required. Good plans will also benefit the construction contractor and can help prevent costly mistakes.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or planting vegetation that may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed. Local shoreland zoning ordinances may contain requirements for vegetation removal and re-planting.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process. Typically work within 25 feet of the highest annual tide line is not allowed under permit-by-rule, however there is some exception for disturbances associated with establishing vegetation. An individual permit will be required for any plan that does not qualify for permit-by-rule. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with coastal stabilization projects and the implementation of "best management practices."

Create or restore wetlands

Planted marshes are generally considered to be one of the most cost-effective and environmentally desirable erosion-control approaches. In contrast to wide "meadow" marshes, fringing marshes are narrow areas of marsh plants lining the shoreline of rivers and bays. Like meadow marshes, fringing marshes protect adjacent uplands by gradually dissipating wave energy, absorbing the force of breaking waves, and stabilizing the soft, underlying soil. Marshes can be created or restored by increasing tidal flow. Additionally, planting marsh grass can be a particularly effective restoration strategy where previous marshes were destroyed by dredging and filling. Planting is also cost-effective, as you may be able to do it yourself.

Marsh planting is most effective in areas that are sheltered from the wind and where waves and boat wakes are not a major problem. A fringing marsh at least 10 feet wide is necessary for erosion control, but 20 feet or more is preferred. If the marsh is not established continuously along the shoreline, erosion can continue on the unprotected areas. In some cases, two or more planting attempts may be required for the marsh to take hold. From a regulatory standpoint, marsh creation or restoration will likely require permitting from state and federal regulatory agencies.

North Carolina's Shoreline Erosion Control Using Marsh Vegetation and Low-Cost Structures provides a good outline for how to plant and create a new coastal wetland. Similarly, the North Carolina Coastal Federation Erosion Control: Non-Structural Alternatives, A Shorefront Property Owner's

Guide provides some good guidance for marsh plantings. The techniques and species discussed in these guides are applicable to Maine's marsh systems. Tidal bank protection using vegetative plantings is also outlined by the Maine DEP under their Maine Erosion and Sediment Control Best Management Practices.

Commonly used grasses include species native to Maine salt marshes, such as saltmeadow hay (*Spartina patens*) and smooth cordgrass (*Spartina alterniflora*). Planting elevations can vary but can be determined by observing the elevations of healthy native marshes nearby. Marsh grasses may be purchased from specialized commercial nurseries (such as Pierson Nurseries in Biddeford), or possibly can be transplanted from existing marshes with a permit.

Be aware of the threat posed by invasive species. *Phragmites australis*, also known as common reed, is considered an invasive plant by the State of Maine and should not be planted or allowed to spread.

Increasing tidal flow into marsh areas by removing or replacing inadequately functioning road culverts can help facilitate the natural proliferation of marsh plants. Adequate tidal flushing is required for marsh growth, and also helps eliminate invasive species that are not salt-tolerant. Increasing tidal flow also helps dissipate floodwaters by allowing water to drain naturally to the ocean, while restricting the flow will often increase flooding. Note that permits are likely required from Maine DEP and the US Army Corps of Engineers for work associated with road culverts.

The above marsh restoration information was adapted from Managing Erosion on Estuarine Shorelines, which was prepared for estuarine shorelines in North Carolina. However, much of the information and techniques outlined transfer to Maine's marshes. Additional online resources regarding techniques that provide good guidance for marsh restoration and creation include Maine Salt Marshes: Their Function, Values, and Restoration and Salt Marshes in the Gulf of Maine, Human Impacts, Habitat Restoration and Long-Term Change Analysis.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer, landscape architect, or other qualified professional**. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion or flooding, as well as flood insurance through the National Flood Insurance Program.

4) **Develop a mitigation plan** if implementation of one or more "best management practices" is recommended. The plan does not need to be prepared by a professional in all cases; however, the quality and clarity of the plan will generally improve the efficiency and timeliness of any subsequent permitting that may be required. Good plans will also benefit the construction contractor and can help prevent costly mistakes.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, or activity that may affect an abutter's "viewshed," consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances may need to be followed. Local shoreland zoning ordinances generally contain requirements for vegetation removal and re-planting.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. When possible, plan to meet standards of a permit-by-rule to simplify the state regulatory review process. Typically work within 25 feet of the highest annual tide line is not allowed under permit-by-rule, however there is some exception for disturbances associated with establishing vegetation. An individual permit will be required for any plan that does not qualify for permit-by-rule. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with coastal stabilization projects and the implementation of "best management practices."

Add rip-rap to wetlands

Rip-rap (angular stone in various sizes usually larger than two feet in diameter) is generally not recommended because it limits the ability of coastal wetlands to move (or migrate) inland, and also limits the transfer of sediment from uplands that are critical to the long term sustainability of coastal wetlands. It may be possible to use rip-rap to protect property in situations where no other viable alternative is readily available. An individual permit will be required from Maine DEP in order to pursue rip-rap placement adjacent to or within a coastal wetland.

Rip-rap best management practices for placement and construction techniques are available from Maine DEP. Other good resources include the North Carolina Coastal Federation Erosion Control: Non-Structural Alternatives, A Shorefront Property Owner's Guide, Shoreline Erosion Control Using Marsh Vegetation and Low-Cost Structures, and Maine DEP's guide for the use of gabions.

Follow the steps below to gain the environmental and regulatory information needed for decision making. The steps are listed in general order although some steps may be conducted concurrently.

1) **Contact local, state and/or federal regulatory officials.** Individuals experienced with coastal regulations may not need to consult officials in all cases; however, if in doubt seek regulatory advice before proceeding with a project.

2) **Obtain an environmental assessment from a certified engineer, coastal geologist, or other qualified professional**. In most cases local, state, and/or federal regulators can help direct you to the best professional discipline to assist with your specific project. Sometimes it is helpful to have the consultant completing the environmental assessment and the construction contractor present at regulatory consultation meetings.

3) **Evaluate your risk.** Check your insurance coverage to make sure you have adequate liability coverage related to loss due to shoreline erosion or flooding, as well as flood insurance through the National Flood Insurance Program.

4) **Develop a mitigation plan** if implementation of one or more "best management practices" is recommended. The plan does not need to be prepared by a professional in all cases; however, the quality and clarity of the plan will generally improve the efficiency and timeliness of any subsequent permitting that may be required. Good plans will also benefit the construction contractor and can help prevent costly mistakes.

5) **Be Neighborly.** If the plan involves work at or near a property boundary, consider sharing the plan with the abutter(s) to make sure they fully understand the work to be performed and the potential impact to their property. This consultation is a courtesy at this stage, and not a regulatory mandate; however, obtaining "buy in" from abutter(s) can potentially avoid neighbor disputes that may lead to costly permitting and/or construction delays.

6) **Need a local permit?** Share plans with local code enforcement in order to determine what, if any, town ordinances (such as shoreland zoning) may need to be followed.

7) **Need a state permit?** If the plan involves alterations within 75 feet of highest annual tide (HAT), within or adjacent to another protected natural resource as defined by the Maine Natural Resources Protection Act, or within a development permitted by the Site Location of Development Act, a state permit will likely be required. An individual permit will be needed, since coastal rip-rap projects do qualify for permit-by-rule, and the permit application will have to provide a compelling argument that existing structures on the property are in danger. Alterations to a development or a lot within a development permitted under the Site Location of Development Act may require the revision or amendment of the development's permit.

8) **Need a federal permit?** If the plan involves work below the highest annual tide (HAT) and/or in a freshwater wetland or habitat for endangered or threatened species, a federal permit(s) under the Federal Clean Water Act and Rivers and Harbors Act may be required. Share the plan with all applicable federal authorities in order to determine what permits may be necessary.

9) **Hire qualified contractors** who are experienced with coastal stabilization projects and the implementation of "best management practices."

Build a seawall

Seawalls are not generally recommended because they limit the migration and the transfer of sediment that is critical to the long-term sustainability of coastal marshes. Seawalls may accelerate erosion at the ends of the structure.

But in situations where no other viable alternative is readily available, it may be possible to construct a seawall in or adjacent to a coastal marsh to protect property in proximity to an eroding bank. An individual permit will be required from Maine DEP in order to pursue construction of a seawall that impacts a coastal marsh, but generally Maine DEP will not approve the use of a seawall in most coastal wetland areas.

Additionally, new seawalls are not allowed in coastal sand dune systems.

Both of the photos below are from the same cove. The photo on left shows property where a wall was constructed many years ago. The photo on the right shows property without walls where an extensive wetland persists and buffers the residence from the waves.

Rebuilding after severe storm damage

There is no standard process property owners can follow in the case of a catastrophic event that damages the shoreline of a coastal wetland. Property owners are encouraged to contact state and local officials immediately. Permits for stabilization and/or restoration of the shoreline will be required, so seek guidance before beginning any work.

The Maine Coast

Maine's coastline is made up of diverse geologic landscapes that were created by glaciers during and after the last Ice Age. Maine's coastal landscape is also influenced by the tide, which ranges from about eight feet in southern Maine to over 18 feet along the Downeast coast.

The majority of the shoreline (58% or about 2,000 miles) is Maine's characteristic cliffed rocky coast (what geologists call "consolidated bluffs"). However, about 40% or 1,400 miles are soft, loose ("unconsolidated") bluffs that are vulnerable to erosion. Sand beaches make up only about 2% or 70 miles of the Maine coast, mostly in the southern part of the state.

Learn more about these coastal shoreline types and their associated hazards:

- BEACHES
- ROCKY SHORES AND BLUFFS
- MARSHES AND COASTAL WETLANDS

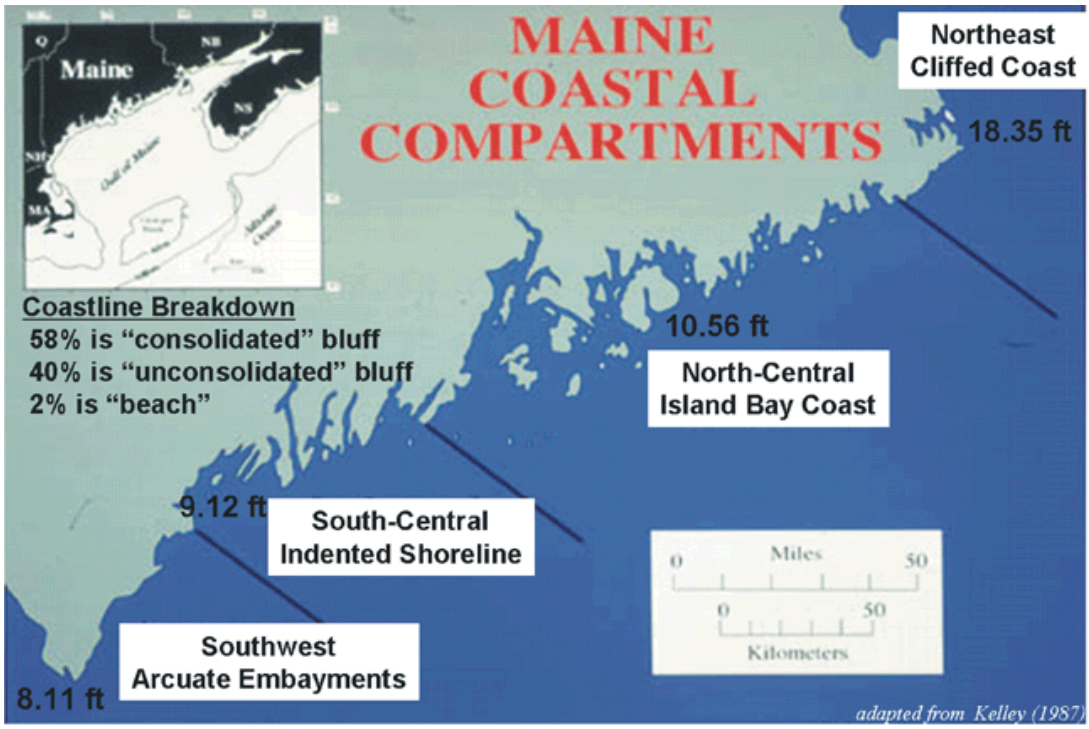
Geologists have classified the Maine coast into four major compartments. Each of these different shoreline types have different characteristics, and each their own inherent hazards.

Southwest Arcuate Embayments
Sandy beaches and salt marshes are most common from the New Hampshire border to Cape Elizabeth, where a sandy bays are separated by a series of rocky headlands.

South-Central Indented Shoreline
In Midcoast Maine from Casco Bay to Port Clyde, long, rocky peninsulas alternate with relatively deep but narrow estuaries that drain bedrock valleys.

North Central Island-Bay Coast
From Penobscot Bay to Cutler, numerous granite islands shelter broad embayments with mud and mixed mud-gravel flats in the intertidal zone.

Northeast Cliffed Coast
From Cutler to Cobscook Bay, a steep, straight bedrock coast is scoured by 20-foot tides and floored with extensive tidal flats.



Maps & Data

Maine Property Owner's Guide to Managing Erosion, Flooding & Other Coastal Hazards

The maps and other data resources described here link to various agencies and organizations. In some cases, maps are not readily available online and may need to be viewed in your town office or with expert assistance.

Coastal Sand Dune Geology Maps *Maine Geological Survey*

These color maps provide detailed information about Maine's largest beaches and dune systems. The maps show frontal dunes, back dunes, and other geologic environments conforming to the Department of Environmental Protection's 2006 Coastal Sand Dune Rules for the following towns: Biddeford, Bristol, Cape Elizabeth, Georgetown, Kennebunk, Kennebunkport, Kittery, Ogunquit, Old Orchard Beach, Phippsburg, Saco, Scarborough, South Portland, Wells, and York.

These maps can be viewed online at the Maine Geological Survey website and are also available through the local Maine DEP office, and may also be available at your city or town office. Additional dune and beach environments are shown on the Coastal Marine Geologic Environments map.

>>Return to top of page

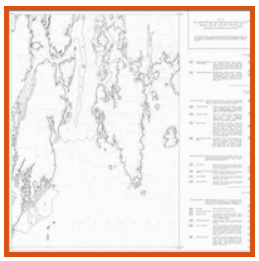
Coastal Barrier Resources Systems, *US Fish and Wildlife Service*

The Coastal Barrier Resources Act of 1982 and its later amendments designated the following undeveloped coastal barrier beaches, sand bars, and islands--a total of 6,781 acres and 38 shoreline miles in Maine--for inclusion in the John H. Chafee Coastal Barrier Resources System. Infrastructure and erosion protection activites in these locations cannot use public funding, and flood insurance is not available through FEMA.

Cape Elizabeth, Crescent Beach (ME-19, ME-19P, A06)
Cranberry Isles, Thrumcap (ME-12)
Cumberland, Great Chebeague Island (A05C)
Cutler, Cross Island, Grassy Point and Seal Cove (ME-03P, ME-04)
Deer Isle, Pond Island (ME-11)
Georgetown, Little River (Reid State Park) (ME-15P)
Harpswell, Stover Point (ME-18)
Harrington, Carrying Place Cove (ME-01)
Islesboro, Seven Hundred Acre Island (A05A)
Jonesport, Popplestone Beach and Roque Island (A03C)
Jonesport, Flake Point Bar (ME-08)
Kennebunk, Crescent Surf Beach, Parsons Beach (A08)
Kittery, Seapoint (A09)
Lubec, Sand Bar (A01)
Lubec, Bailey's Mistake (A01A)
Machiasport, Howard Cove (A03)
Machiasport, Starboard Cove (A03B)
Milbridge, Bois Bubert and Petit Manan Island (ME-09P)
Mussel Ridge Islands, Andrews Island, Nash Point (ME-14)
Ogunquit, Ogunquit Beach (ME-20P)
Perry, Birch Point (ME-02)
Phippsburg, Head Beach, Hunnewell Beach, Small Point Beach (A05B, ME-16, ME-16P, ME-17)
Portland, Cliff Island (A05C)
Roque Bluffs, Bare Cove (ME-06)
Roque Bluffs, Schoppee Point (Roque Bluffs State Park) (ME-07P)
Scarborough, Scarborough Beach (A07)
Steuben, Over Cove, Chair Pond, and Wood Pond Point (Petit Manan Point) (ME-10, ME-10P)
Wells, Laudholm Beach, Moody (A08, ME-20P)
York, Phillips Cove (ME-23)

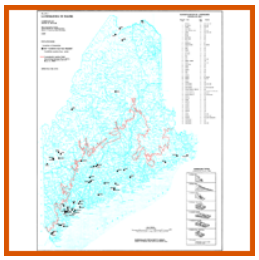
For more information on the Coastal Barrier Resources System and associated Maine units, visit the Maine Geological Survey and the US Fish and Wildlife Service.

>>Return to top of page



Coastal Marine Geologic Environment (CMGE) Maps, *Maine Geological Survey*
These black-and-white paper maps illustrate the size and location of marine geologic environments for the entire Maine coast, including areas not described in the Coastal Sand Dune Geology Maps. The maps illustrate which areas are rocky, muddy, sandy, etc. along the shoreline between the high- and low-tide lines, as well as the location of salt marshes and other tidal wetlands. The maps are available in paper version from the Maine Geological Survey.

>>Return to top of page

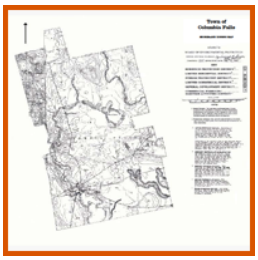


Coastal Bluff Maps and Coastal Landslide Hazard Maps, *Maine Geological Survey*
The Bluff Maps show the shoreline type and relative stability of bluffs along the Maine coast; the Landslide Maps show locations of known landslides and areas of potential landslide hazard on bluffs along the Maine coast. Landslides can occur in high coastal bluffs composed of muddy sediment. The maps can be purchased from the Maine Geological Survey or viewed online.

>>Return to top of page

National Wetlands Inventory, *US Fish and Wildlife Service*
These maps identify and classify large wetlands, including tidal wetlands and salt marshes. The US Fish and Wildlife Service created the National Wetlands Inventory maps using 1980s aerial photographs, so existing marsh conditions may be different than those mapped and small wetland areas may not appear. Paper NWI maps should be available at your town office, can be purchased from the Maine Geological Survey or viewed online via the Wetlands Mapper or Google Earth.

>>Return to top of page



Shoreland Zoning Maps, *Maine Municipalities*

Maine communities adjacent to the ocean, lakes, rivers, and some wetlands are subject to regulation under the Mandatory Shoreland Zoning Act, as interpreted by individual municipal ordinances. Before beginning any project, contact your city or town office to find out if your property is located within the shoreland zone, and if so, what is the "district designation." Local Shoreland Zoning maps may be based on National Wetland Inventory maps, or could include more updated information.

The shoreland zone is all land areas within 250 horizontal feet of the

- normal high-water line of any great pond or river;
- upland edge of a coastal wetland, including all areas affected by tidal action;
- upland edge of a freshwater wetland, as defined in ordinance; and
- all land areas within 75 horizontal feet of the normal high-water line of a stream (as defined in ordinance).

The shoreland zone does *not* represent the setback for structures. Setbacks are based on district designations and adjacent resources. Also note that vegetation removal within the Shoreland Zone is limited and may require a permit. View the Citizen's Guide to Shoreland Zoning for more information on zoning districts and regulations.

>>Return to top of page

Flood Insurance Maps *Federal Emergency Management Agency (FEMA)*

Flood risk changes over time, and as a result the Federal Emergency Management Agency (FEMA) is currently in the process of conducting new coastal studies and updating flood insurance maps (view the update schedule). If you are unable to get a map from your local municipality, access your community FIRM via FEMA's map service center (if using the 'search by street address' option, use a major road, for example Atlantic Avenue for Old Orchard Beach).

Flood Insurance Rate Maps are used to identify flood insurance premiums in areas associated with different flooding events. These events include the 100-year flood elevation (1% chance of being equaled or exceed each year) and 500-year flood elevation (0.2% chance of being equaled or exceeded each year). The maps also can be viewed in paper form at your town office, or by request from the Maine State Planning Office. FLOOD MAPS ARE PERIODICALLY REVISED, so check with your town office or Maine State Planning Office of Floodplain Management for the latest information on local flood zone mapping. In addition, Maine Geological Survey conducted a Coastal Erosion Assessment for Maine FIRMs and Map Modernization Program report which outlined shoreline erosion impacts for the majority of southern Maine. The assessment includes some detailed information on different coastal communities regarding general erosion rates and trends. This information will be used to help the State of Maine prioritize areas for revised mapping.

FEMA has developed information on each specific flood zone and how to read the maps.
The Office of Floodplain Management has also released a Maine Floodplain Management Handbook which can be a great resource to property owners.

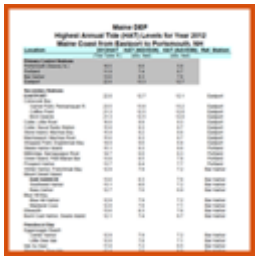
For Property Owners and Communities:
Flood Map Update Schedule Tool
FEMA Letters: Flood Risk and Policy Options provides important information to help National Flood Insurance Program (NFIP) policyholders, insurance agents and others understand letters all NFIP policyholders will be receiving each year, starting in January 2017.

For Real Estate and Insurance Professionals:
FEMA Letters: Flood Risk and Policy Options provides important information to help National Flood Insurance Program (NFIP) policyholders, insurance agents and others understand letters all NFIP policyholders will be receiving each year, starting in January 2017.
Help Protect Your Customer's New Home: What to Know and Say about Flood Risk and Flood Insurance (PDF)
National Flood Insurance Program Grandfathering Rules for Agents (PDF)

FEMA commissioned the **Flood Economics** website to make an economic argument for flood mitigation through case studies as well as broad nationwide data analysis. A recent message from the creators of the website offered the following: "The highlight of Flood Economics is the 11 community case studies, which feature interviews with community leaders that tell the story of how mitigation action ultimately saved money and

benefited each community in a unique way. Other areas of Flood Economics include insights derived from a state-level analysis of projects and benefits data for each state and information on how users can take steps toward action. There are options on certain portions of the website to filter information and search by location and population in order to find the most relevant information."

>>Return to top of page

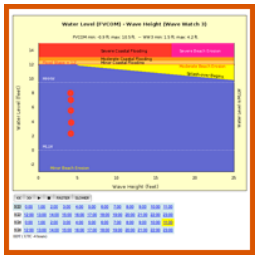


Highest Annual Tide Table, *Maine Department of Environmental Protection*

The highest annual tide line is the jurisdictional limit for all coastal wetlands and is used by local, state, and federal authorities in determining setbacks or impact to the natural resource. The highest annual tide typically occurs several times a year and corresponds to the full moon. Highest annual tide is not the average high tide that occurs twice each day. Each year, Maine Geological Survey provides the Department of Environmental Protection with a list of the highest annual tides for many communities along the Maine coastline, based on tide information from the NOAA National Ocean Service. Maine DEP staff use the data to establish the upper limits of the coastal wetland, based on the regulatory definition, using tidal elevations.

View 2012 Highest Annual Tide Table (PDF) or learn how to calculate Highest Annual Tide.

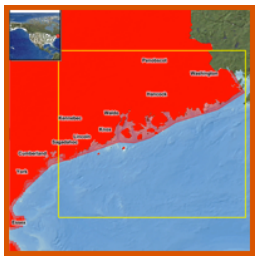
>>Return to top of page



Coastal Flooding and Erosion Forecast, *Gulf of Maine Ocean Observing System*

The National Weather Service, in conjunction with the Gulf of Maine Ocean Observing System (GoMOOS), developed this tool that predicts coastal flooding and beach erosion in real time based on water levels, tides, and wave heights in the Portland area. If a large storm is approaching, property owners and municipal officials can consult the model for anticipated flood levels and timing.

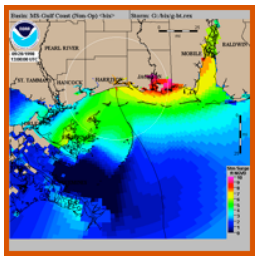
>>Return to top of page



Coastal Elevation Data (LIDAR), *NOAA*

Elevation and topographic data, including that collected recently using Light Detection and Ranging (LIDAR), is available from the NOAA Coastal Services Center and can be searched using the Digital Coast Viewer. If you have GIS capabilities, you can view LIDAR data collected along the Maine coastline and get a sense of coastal elevations on or adjacent to your property.

>>Return to top of page



Hurricane Surge Maps (SLOSH), *National Hurricane Center*

Storm surge heights and winds associated with hurricanes are estimated with a computer model (called SLOSH) and mapped by the US Army Corps of Engineers. Hurricane Surge Maps for the Maine coastline show surge elevations and their inland graphical extent and represent the potential maximum surge for a given location. The maps can be used for preliminary planning purposes to help identify areas that may potentially be inundated during a tropical storm event. GIS data layers are available for download through the Maine Office of GIS.

>>Return to top of page

Determining Highest Annual Tide

The highest annual tide line is the jurisdictional limit for all coastal wetlands and is used by local, state, and federal authorities in determining setbacks or impact to the natural resource. The highest annual tide typically occurs several times a year and corresponds to the full moon. Highest annual tide is not the average high tide that occurs twice each day.

The highest annual tide elevation can be determined by professionals; however, in lieu of hiring a professional there is a simple method for locating highest annual tide that can be performed by property owners with a few simple tools (NOAA Annual Tide Table, grade stake, string, and a line level).

1) Obtain the annual tide table for your area from the NOAA website. The pdf annual tide table format provides a good snapshot of the predicted tidal elevation for a 12-month period.

2) Obtain the time and elevation of today's high tide as well as the highest elevation listed for the 12-month period from the tide table. For example, today's high tide might be at 2:14 pm and be a 9.2-foot tide, while the highest tide listed might be a 12.1-foot tide.

3) At the exact time of today's high tide place the stake at the location of the high tide.

4) Measure up the stake the difference between today's tide elevation and the highest one listed in the tide table and mark the location on the stake.

5) Tie the string to the mark on the stake and with the line level attached, pull the string back toward land (away from the water) until the level string intersects the beach or bluff profile. Mark this location as it represents the highest annual tide elevation. Since tidal elevations are not typically straight lines, repeat this exercise at several locations across the frontage to accurately locate the highest annual tide line.

Permitting & Rules

Local, state, and federal regulations govern activities on coastal properties. Here are some suggestions to make understanding them easier:

1. Identify your property type and the hazards you face.
2. Speak early and often to town officials and state agency staff.
3. Weigh the risks, with help from a certified geologist, licensed engineer, or other expert.
4. Consider your options for taking action.
5. Determine setbacks and other permit requirements.

Shoreland Zoning
Maine Natural Resources Protection Act (NRPA)
- Permit-by-Rule (NRPA)
- Tier Wetland Permit (NRPA)
- Individual Permit (NRPA)
- Coastal Sand Dune Rules (NRPA)
- Wetland Protection Rules (NRPA)
- Assessing and Mitigating Impacts to Existing Scenic and Aesthetic Uses (NRPA)

Site Location of Development Act (Site Law)
Erosion and Sediment Control Law
Federal Clean Water Act and Rivers and Harbors Act
Water Quality Certification

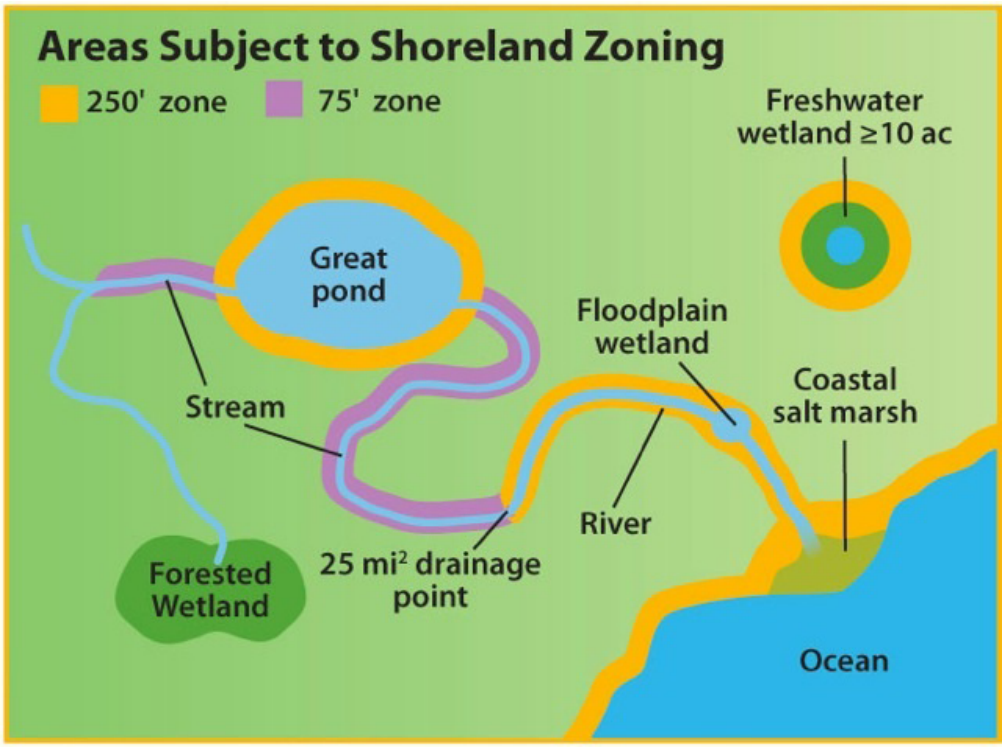
Mandatory Shoreland Zoning Act

By law, all Maine towns and cities adjacent to the ocean, lakes, rivers, and some streams and wetlands, are required to have a local Shoreland Zoning Ordinance. All local ordinances must be compliant with the minimum standards outlined in the Shoreland Zoning Act. If a project is located wholly or in part within a Shoreland Zone, the "district designation" assigned by the municipality will determine if the project is an allowed activity and which standards apply. Allowed activities and building standards may differ between district designations. Copies of the local Shoreland Zoning Ordinance are available from the town office.

The width of the Shoreland Zone varies by community, so check with local code enforcement for specific guidance. Typically, the Shoreland Zone is all land areas within

- 250 feet of the normal high-water line of any great pond or river;
- 250 feet of the upland edge of a coastal wetland, including all areas affected by tidal action;
- 250 feet of the upland edge of a freshwater wetland, as defined in ordinance; and
- 75 horizontal feet of the normal high-water line of a stream (as defined in ordinance).

The Shoreland Zone does *not* represent the setback for structures. Setbacks are based on district designations and adjacent resources. Also note that vegetation removal within the Shoreland Zone is limited and may require a permit. The Maine DEP has released a Citizen's Guide to Shoreland Zoning which helps explain zoning districts and regulations.



>>Return to top of page

Maine Natural Resources Protection Act (NRPA)

The NRPA is a state law (38 M.R.S. § 480 *et. seq.*) which regulates protected natural resources such as rivers, streams, great ponds, freshwater wetlands, significant wildlife habitats, fragile mountain areas, sand dunes, and coastal wetlands. Alterations to lands in or within 75 feet of one of these resources may require a permit from the Maine Department of Environmental Protection (but some activities are exempt, see section 480-Q). If an activity is not exempt, a permit is required prior to beginning construction. Depending on the sale and scope of the activity, a Permit-by-Rule (permitting for *de minimus* or routine activities), a freshwater wetland Tier 1, Tier 2, or Tier 3 Permit, or an Individual NRPA Permit will be required.

>>Return to top of page

Permit-by-Rule (NRPA Chapter 305)

The Natural Resources Protection Act Chapter 305 Permit-by Rule Standards (CMR 06 096 Ch 305) contain an expedited permitting process that typically applies to de minimus or routine activities, provided they are undertaken in a manner that minimizes the impacts on the affected natural resource(s). The permitting process requires the submittal of a Permit-by-Rule Notification Form to Maine DEP, along with a nominal permit fee and a description of the work to be performed. In order to qualify for a Permit-by-Rule, the project design must be able to be constructed in accordance with the prescribed standards outlined by the appropriate section(s) of the Chapter 305 Rules. Standards are categorized by project type and it is possible to design a project that qualifies in more than one section, so be sure to read all the sections. For example, a typical shoreline stabilization project may require filing under Section 2, "Activity adjacent to a protected natural resource," and Section 8, "Shoreline stabilization." Permit-by-Rule notifications are processed by DEP within 14 days of receipt. The DEP does not typically notify the applicant of an approval, so it is recommended that notifications be submitted by certified mail with a return receipt request so that the applicant can track the 14-day review time. If a permit is rejected by the DEP, the applicant will receive written notification with an explanation for why the notification was rejected.

In an emergency situation where action needs to be taken quickly to avoid slope failure or excessive erosion, a Notification can be hand-delivered to the appropriate DEP office and approved immediately. If this is necessary, please contact the office and arrange an appointment with staff to ensure that someone will be available to look at the notification.

>>Return to top of page

Tier 1, Tier 2 & Tier 3 Freshwater Wetland Permit (NRPA)

Activities in freshwater wetlands that do not qualify for the "minor impacts to freshwater wetlands" exemption in the NRPA will require a Tier wetland permit. The tier permit required is based on the size and location of the wetland to be affected. Freshwater wetlands located within the Shoreland Zone are classified as wetlands of special significance and typically require a Tier 3 wetland permit; however, some activities can be waived down to a Tier 1 or Tier 2 permit by state regulators. Tier Permit applications must be processed by DEP within 45 to 120 days of submittal depending upon the proposed activity and application fees vary. The applicant will receive a written permit decision from DEP upon completion of permit review.

>>Return to top of page

Individual Permit (NRPA)

An individual permit is required for all projects that require alteration in or within 75 feet of a protected natural resource and which do not otherwise qualify for an exemption or the Permit-by-Rule permitting program. Individual permit applications must be processed by DEP within 120 days of submittal. The typical review takes between 45 and 90 days, depending on the complexity of the application, so plan ahead to allow enough time to

complete the regulatory review before the desired construction time. The application fee will vary depending upon the activity being proposed. The applicant will receive a written permit decision from DEP upon completion of permit review.
>>Return to top of page

Site Location of Development Law

Alterations to a development or a lot within a development permitted under the Site Location of Development Law may require the revision or amendment of the development's permit. The Site Law requires developments of state or regional significance which may substantially affect the environment to obtain a permit from the State of Maine or delegated municipality prior to construction. The law typically applies to developments that encompass greater than 20 acres of land, contain greater than three acres of structure (roads, buildings, parking, etc.), or residential and commercial subdivisions. Once a development has been permitted under the Site Law, alterations to the development typically require a revision or amendment of the permit. For example, if a shoreline stabilization project is proposed on a lot within a Site Law subdivision, a minor revision to the permit will be required. This minor revision will be in addition to any permits required under the NRPA. Minor revision applications must be processed by DEP concurrently with any required NRPA permits in accordance with the longest review time, so plan ahead to allow enough time to complete the regulatory review before the desired construction time. There is a minimal application fee for a Site Law minor revision application.
>>Return to top of page

Coastal Sand Dune Rules (NRPA Chapter 355)

Chapter 355 of the Natural Resources Protection Act provides regulatory guidance for projects proposed within Maine's mapped Coastal Sand Dune System. The boundaries of the Coastal Sand Dune System are portrayed on the Maine Geological Survey Coastal Sand Dune Geology Maps. Note that these maps have been updated in digital format and are available upon request to the Maine DEP, MGS, and most town offices. The maps include the boundaries of the frontal dune and back dune systems, in addition to a defined Erosion Hazard Area, which is the predicted shoreline location in 100 years, combining the impacts of sea-level rise, short-term erosion, and long-term erosion. Refer to the Coastal Sand Dune Rules for specific text supporting the definition.
>>Return to top of page

Maine Wetland and Waterbody Protection Rules (NRPA Chapter 310)

The Natural Resources Protection Act Chapter 310 provides regulatory guidance for projects proposed within and adjacent to Maine's protected water resources, such as rivers, streams, great ponds, freshwater and coastal wetlands. Wetlands and waterbodies may occur within a mapped Coastal Sand Dune System, so both Wetland and Sand Dune Rules may apply in some locations. In situations where both sets of rules apply, a project must be designed in conformance with both. If permits are required under multiple sets of rules, applications must be submitted concurrently to DEP for review.
>>Return to top of page

Assessing and Mitigating Impacts to Existing Scenic and Aesthetic Uses (NRPA Chapter 315)

The Natural Resources Protection Act Chapter 315 Assessing and Mitigating Impacts to Existing Scenic and Aesthetic Uses Rules provide regulatory guidance for projects located within the jurisdiction of the NRPA and which will be visible from a set of designated scenic resources of significance. Coastal Wetlands, for example, are listed as a scenic resource of significance, therefore any project that requires an Individual Permit under the NRPA for impacts to the coastal wetland and which will be visible from the coastal wetland, must be evaluated to ensure that its design conforms to the scenic guidelines and principles outlined in the rule. The methods used to evaluate projects potential scenic impact is outlined in the rule.
>>Return to top of page

Erosion and Sediment Control Law

The Erosion and Sediment Control Law requires that anyone who conducts an activity involving filling, displacing, or exposing earthen materials take measures to prevent unreasonable erosion of soil or sediment beyond the project site or into a protected natural resource. Learn more about creating an erosion or site stabilization plan.
>>Return to top of page

Federal Clean Waters Act and Rivers and Harbors Act

Sections of the federal Clean Water Act and Rivers and Harbors Act govern activities within coastal wetlands (and therefore waters associated with beaches) and tidal creeks and adjacent rivers. Permits are administered by both the US Army Corps of Engineers and the US Environmental Protection Agency. Federal permitting includes comments provided by the US Fish and Wildlife Service and National Marine Fisheries Service. Text supporting both of these Acts can be seen at the Wetlands Regulation Center.

Section 10 of the Rivers and Harbors Act requires an Army Corps permit for any work in navigable (tidal) waters below the mean high water line. Section 404 of the Clean Water Act requires an Army Corps permit for the discharge of dredged or fill material into US waters.

The US EPA maintains good information describing the overall laws and applicable regulations that pertain to federal permitting of activities within waters of the United States.

It is the responsibility of the property owner to determine if federal jurisdiction applies to a proposed project. State regulators may be able to provide some general guidance; however, the final determination of jurisdiction must be obtained from the federal agencies.
>>Return to top of page

Water Quality Certification

An applicant for a federal license or permit to conduct an activity that may result in a discharge to a navigable water of the United States must supply the federal licensing authority with a water quality certification from the State of Maine that any such discharge will comply with state water quality standards. The federal license or permit may not be issued until water quality certification has been issued or waived. The water quality certification is automatically included with any state permit that involves a discharge to a navigable water.
>>Return to top of page

Erosion Mitigation/Site Stabilization Plans

When regulatory and professional consultations lead to a recommendation that one or more erosion Best Management Practices (BMPs) be considered, an erosion mitigation or site stabilization "plan" should be designed. The plan should include a detailed plan sheet(s) depicting the property boundaries and the location of all proposed BMPs, and a description of the work to be performed. The plan does not need to be prepared by a professional in all cases; however, the quality and clarity of the plan will generally improve the efficiency and timeliness of any subsequent permitting that may be required from local, state, and federal authorities. Good plans will benefit the construction contractor and can help avoid costly mistakes during the construction process.

Professional Assistance

Professional expertise in the disciplines of both coastal geology and biology will be needed in all coastal types for an environmental assessment. A landscape professional (architect or engineer) will likely be needed for the creation of mitigation plans.

Environmental Professionals:

The causes and likely consequences of an erosion issue are often difficult to diagnose; therefore, assessment should be completed with the assistance of a professional familiar with coastal erosion and the implementation of Erosion and Sediment Control Best Management Practices (BMP's). Consulting firms may be able to provide site-specific investigations with state-licensed geologists, soil scientists, or engineers. In some cases, staff from the Maine Geological Survey or the Soil Conservation District may be available to provide low- or no-cost consultation and explanation of existing resource information.

Certified Professional in Erosion & Sediment Control:

This organization develops and maintains standards and procedures for certifying persons who are qualified to practice in the fields of erosion and sediment control, and maintains a list of certified professionals for Maine.

The Maine NPS Training Center also maintains a list of contractors and companies that are voluntarily certified in Maine's erosion and sediment control BMPs.

Regulatory Assistance

local | state | federal

Local Officials:

The project may be subject to local ordinance and may possibly require a local permit. Contact the local Code Enforcement Officer early in the process to seek advice regarding project design and permitting. For work in a Special Flood Hazard Area, the municipality (generally the Code Enforcement Officer or Planning Board) is responsible for permitting development. The municipality is responsible for knowing where the flood zones are located, permitting development in a flood zone, and building standards for development in a flood zone.

State Officials:

In many cases, state resource agency or regulatory staff are available to visit project sites at no charge and provide a verbal and/or written field determination or advice. Staff can recommend possible solutions, as well as describe which regulations apply and what permits may be necessary for a chosen action.

Maine Department of Environmental Protection (DEP) regional "on call" staff (based in Portland, Augusta, and Bangor) are available to assist property owners in evaluation of erosion issues and navigating the state permitting process. When contacting Maine DEP regarding a shoreline erosion issue, ask to speak with the "on call" person in the Division of Land Resource Regulation.

DEP also provides assistance through the Nonpoint Source (NPS) Training Center, via workshops, various publications, and a video lending library.

The Maine Floodplain Management Program at the Department of Agriculture, Conservation and Forestry can offer assistance with identifying if property is in a flood zone, if a municipality participates in the National Flood Insurance Program (NFIP), and with interpreting federal regulations and building recommendations, such as the Coastal Construction Manual.

The Maine Emergency Management Agency (MEMA) can offer disaster and mitigation assistance.

Federal Officials:

Staff at the US Army Corps of Engineers are available to help property owners navigate the federal permitting process.

Regional staff from the US Fish and Wildlife Service are available to answer questions about endangered species.

Staff from the US Environmental Protection Agency are available to help answer questions about federal regulations and permits.

The Federal Emergency Management Agency (FEMA) can offer technical assistance, insurance assistance, and guidelines for development concerns in coastal flood zones.

>>back to top

About

This Guide was created by Maine Sea Grant to help coastal property owners and municipal officials identify features and different types of hazards on the Maine coast, and evaluate potential responses and actions. This guide is an outcome of the project, Coastal Community Resilience: Developing and Testing a Model of State-based Outreach.

Project Leaders: Kristen Grant and Esperanza Stancioff, *Maine Sea Grant and UMaine Cooperative Extension*

Written by: Peter Slovinsky, *Maine Geological Survey* Click here for a PDF version of the original document.
Edited and converted for the web by: Catherine Schmitt, *Maine Sea Grant*
Web design and development: Jenny Peters, *Maine Sea Grant*
Graphic artist: Kathlyn Tenga-Gonzalez, *Maine Sea Grant*

Advisory Committee:
Dee Brown, *Maine property owner*
Phil Carey, *Maine State Planning Office*
Stephen Dickson, *Maine Geological Survey*
Andrew Fisk, *Maine Department of Environmental Protection*
Robert Hamblen, *City of Saco Planning Department*
Jonathan T. Lockman, *Southern Maine Regional Planning Commission*

Questions and comments may be submitted to erosionguide@seagrant.umaine.edu.

Disclaimer
Please note that this website should be used for general guidance purposes only to help understand coastal features and their associated hazards. Although this guide covers features and hazards found on a great portion of the Maine coast, it is not meant to identify all existing hazards along the Maine coastline, nor is it intended to be the sole basis upon which specific land-use decisions are made by coastal property owners.

For an evaluation of specific coastline features, hazard risks or historical trends, certified geologists or geotechnical engineers should conduct site-specific studies. NOAA, Maine Sea Grant, the Department of Conservation, the Maine Coastal Program, the University of Maine, and their employees or agents: (1) make no warranty, either expressed or implied for merchantability or fitness for a particular purpose, as to the accuracy or reliability of the information included herein; nor are they (2) liable for any damages, including consequential damages, from using this Guide or the inability to use this Guide.

References

Beaches & Dunes

Beach Stakeholders' Group. 2006. Protecting Maine's Beaches for the Future, A Report to the Joint Standing Committee on Natural Resources 122nd Maine Legislature, 2nd Regular Session. Augusta, ME: Department of Environmental Protection.

Neal, W.J., O.H. Pilkey, and J.T. Kelley. 2007. Atlantic Coast Beaches: A Guide to Ripples, Dunes, and Other Natural Features of the Seashore. Missoula, MT: Mountain Press Publishing Company.

O'Connell, J.F. 2002. Stabilizing Dunes and Coastal Banks Using Vegetation and Coastal Engineering, Technical Report WHOI-2002-11. Woods Hole, MA: Woods Hole Oceanographic Institution.

Rogers, S. and D. Nash. 2003. The Dune Book. Raleigh, NC: North Carolina Sea Grant.

>>Return to top of page

Wetlands

Bryan, R.R., M. Dionne, R.A. Cook, and A. Goodspeed. 1997. Maine Citizens Guide to Evaluating, Restoring, and Managing Tidal Marshes. Maine Audubon Society and Wells National Estuarine Research Reserve.

Dionne, M., E. Bonebakker, and K. Whiting-Grant. 2003. Maine's salt marshes: their functions, values, and restoration. Orono, ME: Maine Sea Grant.

Taylor, P.H. 2008. Salt Marshes in the Gulf of Maine: Human Impacts, Habitat Restoration, and Long-term Change Analysis. Portland, ME: Gulf of Maine Council on the Marine Environment.

>>Return to top of page

Erosion & Sediment Control

Broome, S.W., S.M. Rogers Jr., and E.D. Seneca. 1992. Shoreline Erosion Control Using Marsh Vegetation and Low-Cost Structures, UNC-SG-92-12. Raleigh, NC: North Carolina Sea Grant.

Bureau of Land and Water Quality. 2003. Maine Erosion and Sediment Control BMPs, DEPLW0588. Augusta, ME: Department of Environmental Protection.

Myers, R.D. 1993. Slope Stabilization and Erosion Control Using Vegetation: A Manual of Practice for Coastal Property Owners. Olympia, WA: Shorelands and Coastal Zone Management Program, Washington Department of Ecology.

NCCF. Undated. Erosion Control: Non-Structural Alternatives A Shorefront Property Owner's Guide. Newport, NC: North Carolina Coastal Federation.

Northwest Regional Planning Commission. The Shoreline Stabilization Handbook for Lake Champlain and Other Inland Lakes. Lake Champlain Sea Grant.

O'Neill, C.R. 1986. Structural methods for controlling coastal erosion. Ithaca, NY: Cornell Cooperative Extension.

Rogers, S., and T.E. Skrabal. 2001. Managing Erosion on Estuarine Shorelines, The Soundfront Series. Raleigh, NC: Division of Coastal Management, North Carolina Sea Grant, and North Carolina State University College of Design.

Tidal Wetlands Division. 2006. Shore Erosion Control Guidelines for Waterfront Property Owners. Baltimore, MD: Department of Natural Resources.

>>Return to top of page

Shoreland Zoning

Maine DEP. 2000. A Homeowner's Guide to Environmental Laws Affecting Shorefront Property in Maine's Organized Towns. Augusta, ME: Department of Environmental Protection.

Maine DEP. 2008. Maine Shoreland Zoning A Handbook for Shoreland Owners, DEPLW0674-D08. Augusta, ME: Department of Environmental Protection.

>>Return to top of page

Groundwater

Caswell, W.B. 1987. Ground Water Handbook for the State of Maine, Second Edition. Augusta, ME: Maine Geological Survey.

Maine Geological Survey. 2010. Maine's ground water and wells. Augusta, ME: Department of Conservation.

>>Return to top of page

Building & Construction

FEMA. FEMA Home Builder's Guide to Coastal Construction Technical Fact Sheet Series, FEMA 499. Washington, DC: Federal Emergency Management Agency.

FEMA. 2001. Coastal Construction Manual, FEMA 55. Washington, DC: Federal Emergency Management Agency.

>>Return to top of page

Flooding & Sea-Level Rise

Federal Energy Regulatory Commission. 2015. Reducing flood risk to residential buildings that cannot be elevated, FEMA P-1037.

Dickson, S.M., and W.L. Sidell. 2003. Coastal Erosion Assessment for Maine FIRMs and Map Modernization Plan. Augusta, ME: Maine Geological Survey.

Maine Floodplain Management Program. 2007. Maine Floodplain Management Handbook. Augusta, ME: Maine State Planning Office.

Saco Bay Sea Level Adaptation Working Group, Southern Maine Regional Planning Commission

Schmitt, C. 2010. Maine's Climate Future: Coastal Vulnerability to Sea-Level Rise. Orono, ME: Maine Sea Grant College Program.

Slovinsky, P.A., and S.M. Dickson. 2006. Impacts of Future Sea Level Rise on the Coastal Floodplain, MGS Open-File 06-14. Augusta, ME: Maine Geological Survey.

Wake, C., et al. 2009. Climate Change in the Casco Bay Watershed: Past, Present and Future. Portland, ME: Casco Bay Estuary Partnership.

>>Return to top of page

Other Guides & Resources

Baker, S. 1977. The citizen's guide to North Carolina's shifting inlets. North Carolina Sea Grant.

CICEET. 2007. Living Coasts Program. Durham, NH: Cooperative Institute for Coastal and Estuarine Environmental Technology.

Cromwell, N., W. Ferguson, and A. Lipsky. 1999. Backyards on the Bay: A Yard Care Guide for the Coastal Homeowner. Providence, RI: Save the Bay.

CT DEP. Living on the Shore Shoreline Protection. Hartford, CT: Department of Environmental Protection.

Herrington, T.O. 2003. Manual for Coastal Hazard Mitigation, NJSG-03-0511. Trenton, NJ: Department of Environmental Protection Coastal Management Program.

Hwang, D.J., and D.K. Okimoto. 2007. Homeowner's Handbook to Prepare for Natural Hazards. Honolulu, HI: University of Hawai'i Sea Grant Program.

Kelley, J.T., and A. Kelley. 1988. Living with the Coast of Maine. Durham, NC: Duke University Press.

Maine Coastal Program

Maine Department of Environmental Protection

Maine Emergency Management Agency

Maine Geological Survey

Maine Sea Grant. Coastal Community Resilience project site. Orono, ME: Maine Sea Grant College Program.

MA CZM. StormSmart Coasts Program. Boston, MA: Massachusetts Office of Coastal Zone Management

NSGL. Digital Libraries: Coastal Hazards>Erosion. Narragansett, RI: National Sea Grant Library.

US EPA. 2009. Synthesis of Adaptation Options for Coastal Areas, EPA 430-F-08-024. Washington, DC: Environmental Protection Agency.

US Environmental Protection Agency. Climate Ready Estuaries Program.

>>Return to top of page

Frequently Asked Questions

Note: This page is still under development

Where can I find flood map information?

The Federal Emergency Management Agency (FEMA) is currently in the process of conducting new coastal studies and creating digitized flood insurance rate maps (FIRMs), but the project won't be complete for approximately two years. If you are unable to get a map from your local municipality, you can access your community FIRM at the FEMA website. If using the 'search by street address' option, use a major road (i.e., Atlantic Avenue for Old Orchard Beach).

Where can I find out about local rules? State rules? Federal rules?

You can find more information on local, state and federal rules in the permitting section of this website. Visit your town office or code enforcement officer to find out about local rules. For state rules, contact your regional office of the Department of Environmental Protection.

What about climate change and sea-level rise?

To learn more about this topic, visit the sea-level rise page at Maine Climate News, and/or watch the DVD on Building a Resilient Coast: Maine Confronts Climate Change.

How do I know if I have invasive plants growing on my coastal property? Where can I find out about native plants?

The University of Maine Cooperative Extension is a great resource for identifying invasive plants, and for consultation on low-impact, effective ways to address the issue (How to Get Rid of Invasive Plants). The Maine Natural Areas Program also has information about invasive plants.

Can't find the answer? Submit your question to erosionguide@seagrant.umaine.edu.

Assistance

When considering any activity on a coastal property, you may find you need:

- assistance from town officials or state agency staff;
- assistance from geologists, engineers or other professionals.

Site Map

Beaches & Dunes
Learn what you can do if your beach is eroding
Learn more about beaches and dunes - identifying beach and dune systems, as well as threats due to erosion
Download Beach, Dune & Coastal Flooding checklist - 43KB

Bluffs & Rocky Shores
Learn what you can do if your bluff is eroding, and how to deal with the threat of landslides
Learn more about bluffs and rocky shores - bluff erosion, stability, and the different types of landslides
Download Bluff & Landslide checklist - 43KB

Coastal Wetlands
Learn what you can do if your property floods often, or the wetland boundaries are changing
Learn more about coastal wetlands - the different types, how they work, their benefits and vulnerabilities
Download Coastal Wetland & Coastal Flooding checklist - 43KB

The Maine Coast
Learn about the different shoreline types that make up the coast of Maine, and their inherent hazards

Maps & Data
This section offers resources available from a variety of agencies, including zoning, flood and hurricane surge maps, tide tables, aerial geological photographs and more

Permitting & Rules
This section offers a list of steps to help you decide how to manage your property, as well as links to the laws and ordinances that pertain to the shoreline

About this site
This Guide was created by Maine Sea Grant to help coastal property owners and municipal officials identify features and different types of hazards on the Maine coast, and evaluate potential responses and actions. Visit the About page for more information

References

A list of relevant publications organized by topic area

The Maine Property Owner's Guide to Managing Flooding, Erosion & Other Coastal Hazards

Download the original Owner's Guide as a printer-friendly PDF that provides the basis for this site.

Questions and comments may be submitted to erosionguide@seagrant.umaine.edu.

Disclaimer

Please note that this website should be used for general guidance purposes only to help understand coastal features and their associated hazards. Although this guide covers features and hazards found on a great portion of the Maine coast, it is not meant to identify all existing hazards along the Maine coastline, nor is it intended to be the sole basis upon which specific land-use decisions are made by coastal property owners.

For an evaluation of specific coastline features, hazard risks or historical trends, certified geologists or geotechnical engineers should conduct site-specific studies. NOAA, Maine Sea Grant, the Department of Conservation, the Maine Coastal Program, the University of Maine, and their employees or agents: (1) make no warranty, either expressed or implied for merchantability or fitness for a particular purpose, as to the accuracy or reliability of the information included herein; nor are they (2) liable for any damages, including consequential damages, from using this Guide or the inability to use this Guide.