Interpreting Federal Emergency Management Agency Flood Maps and Studies in the Coastal Zone

Publication Date: October 2015

Table of Contents

FEMA Flood Insurance Rate Maps and Flood Insurance Studies……..…2

Flood Zone Designations on FIRMs……..……..3

How Flood Zones Are Mapped……..7

FIRM Updates……9

Limitations of FIRMs……10

Delineating (or Reviewing a Delineation of) Flood Zones on Site Plans……..11

State Standards……..16

Beyond the FIRMs: When to Consider Additional Information……17

Delineating Velocity Zones (V Zones) in Primary Frontal Dunes……...18

Requesting a Change to FIRMs……..21

FEMA Flood Map and Study Products……..22

Regulations Cited……...24

Technical Guidance and Memorandums……24

Glossary……26

Agency and Organization Websites……..31

Interpreting Federal Emergency Management Agency Flood Maps and Studies in the Coastal Zone

Coastal storms with waves and storm surges can quickly erode beaches, dunes, and banks and threaten homes and properties. When designing, siting, and reviewing projects on the coast, it is therefore important to take into account the potential for dangerous storm-generated wave action and flooding. The Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs) produced by the Federal Emergency Management Agency (FEMA) are the primary tools used to determine the spatial extent and magnitude of predicted flooding in a major coastal storm. This document provides guidance on how to use these tools to better understand the potential effects of flooding on buildings, properties, and the underlying natural resource areas so that homeowners and consultants can design the safest possible coastal projects and public officials can successfully evaluate these projects to ensure they are designed to minimize storm damage, protect public safety, and reduce the financial burden on individuals and municipalities from losses due to coastal storms.

This guidance document includes three general sections. The first gives background information and provides an overview of FIRMs and FISs, and includes the following headings:

- FEMA Flood Insurance Rate Maps and Flood Insurance Studies - Describes the two primary sources of information that are used to determine the spatial extent and magnitude of flood hazards.
- Flood Zone Designations on FIRMs - Provides definitions of the flood zones and their various types of hazards.
- How Flood Zones Are Mapped - Describes the analyses that are performed to determine the extent of flood zones along specific shore-perpendicular lines, called transects.
- FIRM Updates - Explains the different types of map updates and changes that can be made.
- Limitations of FIRMs - Describes how to determine whether new detailed analysis has been performed for maps that have been updated, describes the factors that are not taken into account on FIRMs (e.g., sea level rise), and notes other issues with the FIRMs.

The second section covers guidance on using and interpreting FIRMs and FISs, under these headings:

- Delineating (or Reviewing a Delineation of) Flood Zones on Site Plans - Explains how to delineate the different types of flood zone boundaries on a site plan, including the importance of using a consistent datum.
- State Standards - Describes the primary Massachusetts state laws and regulations relevant to FIRMs and when local officials should use additional information.
- Beyond the FIRMs: When to Consider Additional Information - Provides further

guidance on where and how local officials can reference additional information to find the extent of flooding.

- Delineating Velocity Zones (V Zones) in Primary Frontal Dunes - Provides specific instructions on addressing the issue of the dunes closest to the beach in assessing flood zones.
- Requesting a Change to FIRMs - Explains the process for requesting an official change to a FIRM.

The third section provides the following additional information and references:

- FEMA Flood Map and Study Products
- Regulations Cited
- Technical Guidance and Memorandums
- Glossary
- Agency and Organization Websites

Although this guidance provides practical advice on how to read the FIRMs and delineate the flood zone boundaries, it may not be suitable for purposes of delineating flood zones for insurance or mortgage purposes or to obtain a related Letter of Map Change (which are described on page 21). Evaluation of additional information by FEMA may be necessary to meet those particular requirements.

Check for Updates: While all information in this document was current as of the publication date of October 2015, please check for any updates to state and federal agency policies, procedures, and regulations (see "Agency and Organization Websites" section on page 31 for links to this information).

FEMA Flood Insurance Rate Maps and Flood Insurance Studies

When reviewing, siting, or designing a proposed project in or near the floodplain, it is necessary to know the spatial extent of the flood zones, the location of the project components relative to these zones, and the potential magnitude of flood hazard for these areas. Information published by the FEMA National Flood Insurance Program (NFIP) can be used to determine the flood hazard areas and risks for communities. The two primary sources of information are:

1. Flood Insurance Rate Maps - FIRMs are official maps that depict the predicted extent of the 1%-annual-chance flood (also called the 100-year flood), which is the area that would be flooded in a storm having a 1% chance of occurring in a given year. The current effective FIRMs are the maps that have been finalized by FEMA. The preliminary FIRMs represent draft revised maps that include changes proposed by FEMA for public comment (including an appeals process) and adoption by the community.

2. Flood Insurance Studies - FISs are reports for each county that contain a narrative of the flood history of each community, the engineering methods used to develop the FIRMs, stillwater elevations (i.e., the level of the water without the waves), transect locations where detailed analyses were conducted, and details regarding all updates and revisions that have been made to the FIRMs.

FIRMs and FISs can be viewed or downloaded from FEMA's Flood Map Service Center (https://msc.fema.gov/portal). The FIRMs are available as digital versions that can be viewed or downloaded as an image, as well as the National Flood Hazard Layer (NFHL), a digital layer that can be viewed in FEMA's Geoplatform (an online map viewer). In addition, the NFHL database for the county or state, which includes all data layers for effective FIRMs, can be downloaded and used in a Geographic Information System (GIS). Where available, preliminary FIRM data layers can also be downloaded from FEMA's FIRM Database. Finally, Letters of Map Change (LOMC), which document official clarifications or changes to the effective FIRMs since they were adopted by the community, are also available from the Flood Map Service Center.

A Note of Caution about the Q3 Data Layer: The Q3 data layer available through MassGIS is a digital representation of the paper FIRMs. It was originally designed by FEMA to support some planning and floodplain management activities, but is not appropriate for reviewing or designing a site-specific project. MassGIS has added a new digital floodplain layer called the NFHL, which is more current. Depending on when it was last updated, the NFHL in MassGIS may not be the most current source of data depicting flood zones. Therefore, the use of digital FIRMs available from the FEMA Flood Map Service Center is strongly advised.

Flood Zone Designations on FIRMs

The flood zones depicted on the FIRMs indicate the predicted magnitude and severity of flood hazards in Special Flood Hazard Areas (SFHAs). SFHAs are defined by FEMA as being areas subject to inundation in a 1%-annual-chance flood, or a flood that has a 1% chance of occurring in a given year.[1] For each flood zone, FIRMs typically indicate the elevation the water is expected to reach in a 1%-annual-chance flood, referred to as the Base Flood Elevation (BFE).

This section describes the flood zones that are found on the FIRMs and the types of hazards that define them (see Figure 1 on page 6 for an example of a FIRM depicting the various zones and their descriptions).

Velocity Zones (V Zones, VE Zones)

V Zones (formerly V1-30 on older FIRMs) are also referred to as coastal high hazard areas. The "E" in VE indicates that a predicted elevation of water (e.g., the top of the waves in a

[1]SFHA is also similarly defined in the Massachusetts Wetlands Protection Act Regulations, 310 CMR 10.04.

1%-annual-chance flood) has been determined and is designated on the FIRM. The following criteria are used to identify V Zones:

1. Areas with a projected wave height of 3 foot or greater (wave height is the vertical distance as measured between the top of wave and the adjacent wave trough).
2. Areas with a projected wave runup depth of 3 foot or greater (wave runup depth is the vertical distance between the calculated wave runup profile elevation and the ground contour elevation at that location; see Figure 3 on page 8).
3. Areas within the splash zone (the area extending 30 feet landward of the seaward face of a seawall or other coastal engineering structure that is overtopped by waves).[2]
4. The entire extent of the primary frontal dunes (dunes closest to the beach).[3, 4]

Where multiple V Zone criteria apply, the V Zone extends to the landward-most of the four criteria.

A Zones (AE Zones)

A Zones (formerly A1-30) are areas subject to inundation by a 1%-annual-chance flood that do not meet any of the criteria listed above for being designated as a V Zone. The "E" in AE indicates that a predicted elevation of water has been determined and is designated on the FIRM.[5] Some A Zones in coastal areas are likely to be subject to moving water, overwash, breaking waves (with heights less than 3 feet), storm surge, and wave runup (with depths less than 3 feet)—all of which may cause erosion and scour.

The FEMA *Coastal Construction Manual* (CCM) recognizes that the 1.5- to 3.0-foot waves that may occur in A Zones in coastal areas are capable of damaging or destroying buildings. Consequently, the A Zone in coastal areas is further divided on newer FIRMs (FIRMs based on new studies begun after 2009) to reflect these different levels of hazards. The higher-hazard portion of the A Zone, which is called the Moderate Wave Action (MoWA) area (also known as the "Coastal A Zone"), is subject to wave heights between 1.5 and 3 feet during the 1%-annual-chance flood. The lower-hazard portion of the A Zone, which is landward of

[2]Whether a splash zone is mapped behind a coastal engineering structure is determined by the amount of projected overtopping, as specified in FEMA's *Guidelines and Standards for Flood Risk Analysis and Mapping*.
[3]The Massachusetts Wetlands Protection Act Regulations, 310 CMR 10.04, also determine that the Velocity Zone boundary extends, at a minimum, to the inland limit of the primary frontal dune.
[4]Note that V Zone conditions could extend beyond the landward toe of the primary frontal dune if the dune is overtopped, eroded, or removed in a storm event.
[5]A Zones indicated on FIRMs without the "E" represent areas subject to inundation by a 1%-annual-chance flood where no elevations of water have been predicted or determined by a flood study. These A Zones, referred to as "Unnumbered A Zones," are primarily only found in inland areas. *(For purposes of this document, the generic term "A Zone" refers to all A Zones, not just those that are "unnumbered.")*

the MoWA area, is the Minimal Wave Action (MiWA) area and is subject to wave heights less than 1.5 feet during the 1%-annual-chance flood. The boundary between these two zones is the Limit of Moderate Wave Action (LiMWA) (see Figure 4 on page 13). Because the forces in the MoWA area are capable of damaging or destroying buildings, the CCM recommends building to V Zone standards in the MoWA.[6]

Massachusetts Coastal A Zone Maps, which Depict the LiMWA: FEMA began delineating LiMWA lines on FIRMs from detailed coastal studies initiated after 2009. FIRMs for Massachusetts coastal counties that went into effect in 2009-2012 were based on studies initiated in 2005 and, therefore, do not include the LiMWA lines. FEMA changed their guidance for delineating the LiMWA in 2013, so LiMWA lines that are available on FIRMs are not consistent statewide. To address these discrepancies, the Massachusetts Office of Coastal Zone Management (CZM), in cooperation with the Department of Conservation and Recreation's (DCR) Flood Hazard Management Program, developed the Massachusetts Coastal A Zone Maps in 2015. These maps delineate the LiMWA for coastal communities based on 2013 FEMA guidance (Operating Guidance 13-13) and should be used by property owners, those siting or designing projects, and community officials when applying requirements of the State Building Code and other regulations (e.g., Wetlands Protection Act). These maps will be updated as needed based on LOMCs and new flood zone mapping by FEMA. The Massachusetts Coastal A Zone Maps, information about how they were developed, and the status of their updates is available at: www.mass.gov/czm/coastal-a-zone-maps.

AH Zones

AH Zones are areas subject to shallow flooding in a 1%-annual-chance flood, usually in the form of ponding with an average depth ranging from 1 to 3 feet. The flood elevation for the zone is designated on the FIRM.

AO Zones

AO Zones are areas subject to inundation in a 1%-annual-chance flood where flooding is characterized by shallow depths (averaging 1 to 3 feet) and/or unpredictable flow paths (usually sheet flow on sloping terrain). The flood depth is designated on the FIRM.

X Zones

X Zones are outside the areas inundated by the 1%-annual-chance flood. Shaded X Zones (formerly B on older FIRMs) designate areas subject to inundation by the 0.2%-annual-chance flood (also known as the 500-year flood). Unshaded X Zones (formerly C on older FIRMs) designate areas where the annual probability of flooding is less than 0.2 percent.

[6]Although FEMA recommends building to V Zone standards in the MoWA, there are no regulatory requirements associated with the MoWA in the 8th Edition of the Massachusetts State Building Code. As of the printing of this publication, there are requirements for Coastal A Zones proposed in the 9th Edition of the State Building Code.

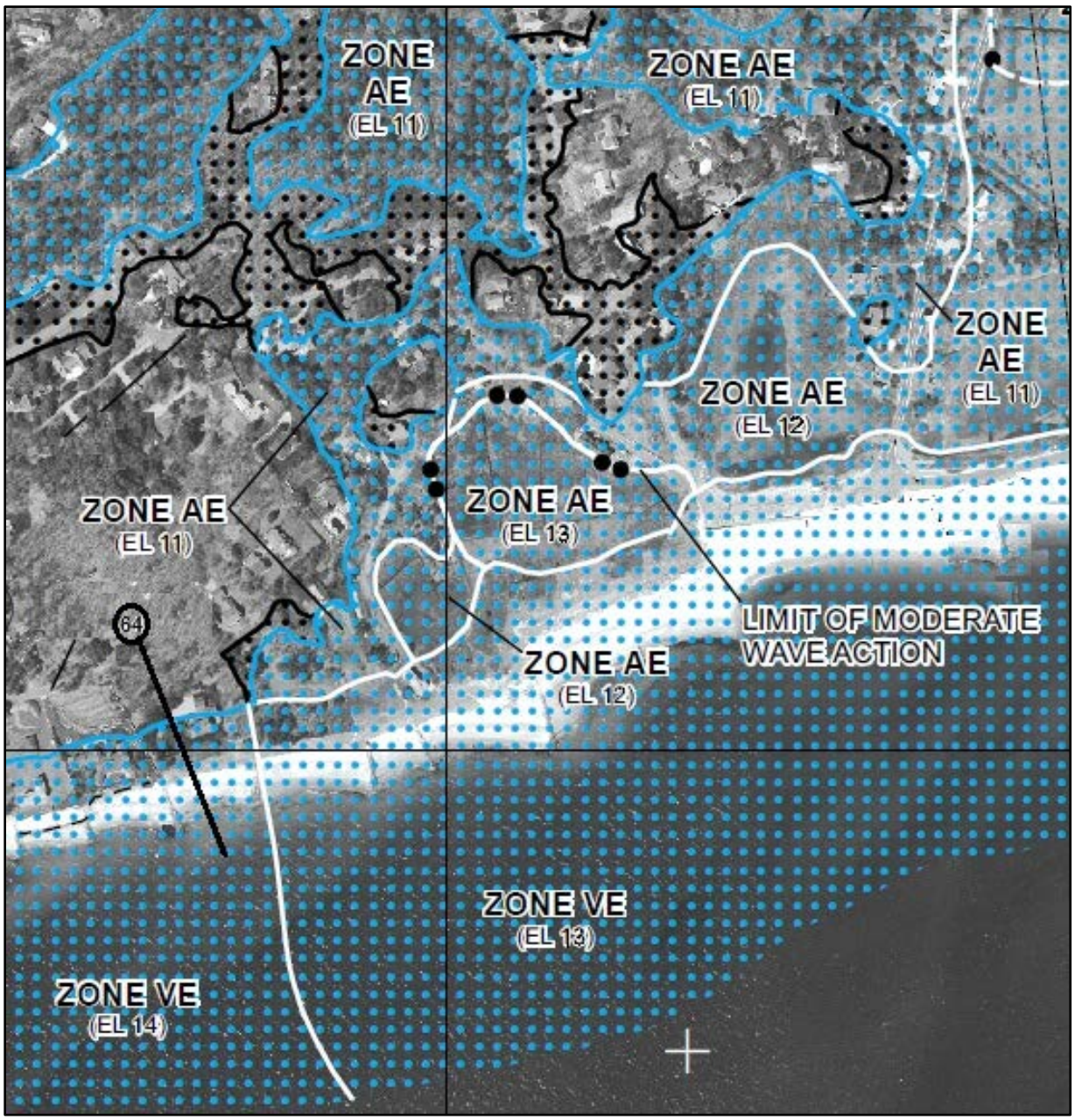


Figure 1. Example of a section of a FIRM showing various flood zones and their Base Flood Elevations (BFEs) overlaid on an aerial photograph. The blue stipple pattern shows the Special Flood Hazard Area (SFHA) subject to inundation by the 1%-annual-chance flood and the blue line designates the extent of the SFHA. The white lines are the boundaries between flood zones, such as between a V Zone and an A Zone. The Limit of Moderate Wave Action (LiMWA) is shown as a white line with intervals of two black dots and designates the boundary between the Moderate Wave Action area (with wave heights between 1.5 and 3.0 feet) and the Minimal Wave Action area (wave heights less than 1.5 feet). In 2015, CZM and DCR developed the Massachusetts Coastal A Zone Maps that updated the LiMWA line for Massachusetts communities, which are available at: www.mass.gov/czm/coastal-a-zone-maps. The black stipple pattern shows the area of the 0.2% or 500-year floodplain and the solid black line indicates its extent. The BFE is the elevation of the top of the water and waves relative to the NAVD 88 datum. The black line with an endpoint circle and numeral indicates a transect line that corresponds with data provided in the Flood Insurance Study.

How Flood Zones Are Mapped

To develop FIRMs, FEMA's mapping consultants conduct a series of analyses to predict what areas will be covered with water in a 1%-annual-chance flood, the extent and type of flood zones, and flood elevations. The detailed analyses are only conducted at specific locations, called transects, which are shore-perpendicular cross-sections extending from offshore to the inland limit of the floodplain. Engineering judgment is used to connect the delineations between these transects.

At each transect, the analyses start with the identification of the predicted height of the stillwater during a 1%-annual-chance flood (also known as the storm surge or coastal storm surge stillwater elevation) and the predicted height of the waves (see Figures 2 and 3). Computer models are used to determine how the waves will break and taper down in elevation as they move onto the shore and across the floodplain in what is called a wave crest profile. The computer models are also used to determine the magnitude and extent of wave runup and wave setup.[7] The extent of the V and A Zones are then identified along the transect by finding the most landward point of each zone based on its definition. See Figure 3 for a depiction of the stillwater elevation, wave crest and runup profiles, and the extent of the V and A Zones under both runup and non-runup scenarios.

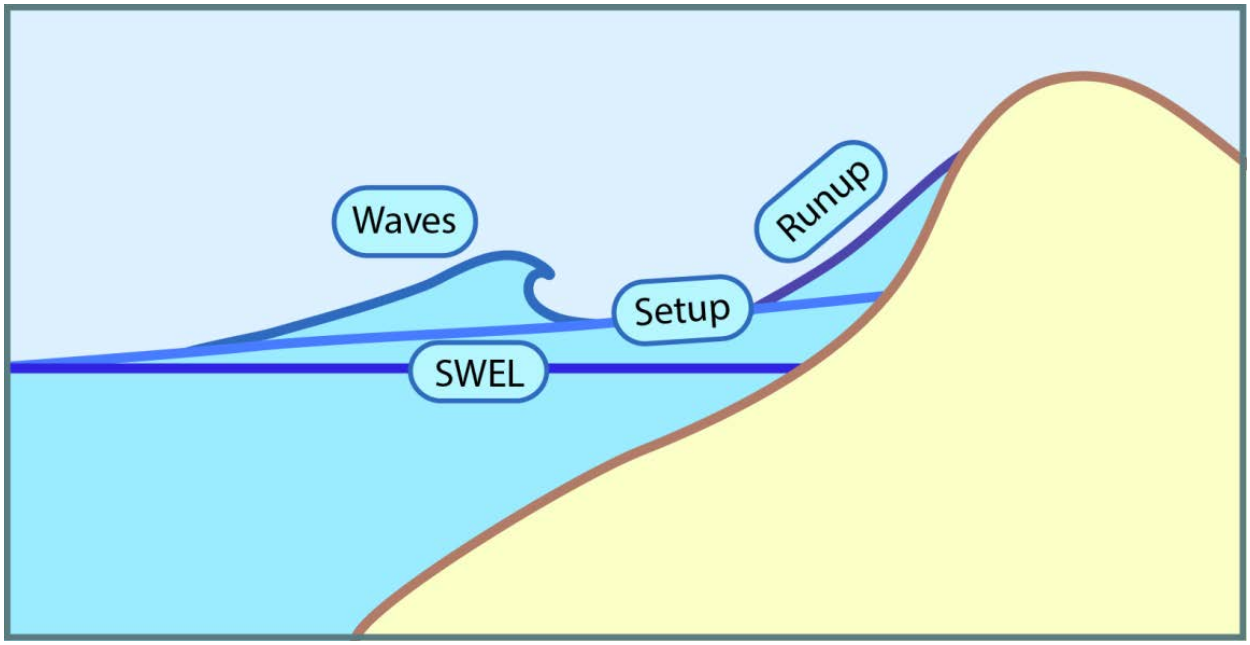


Figure 2. The coastal storm surge stillwater elevation (i.e., the line labeled SWEL on the figure) and the added effects of wave setup and wave runup. Figure modified from FEMA Region II Coastal Analysis and Mapping website (www.region2coastal.com/coastal-mapping-basics).

[7]Wave setup (i.e., the elevated water level associated with waves coming ashore but not fully receding) is another factor that FEMA is now incorporating into their analyses of flood elevations, but is not addressed in detail here due to its complexity. See FEMA *Guidelines and Standards for Flood Risk Analysis Mapping* for more information (for the link, see "Technical Guidance and Memorandums" on page 24).

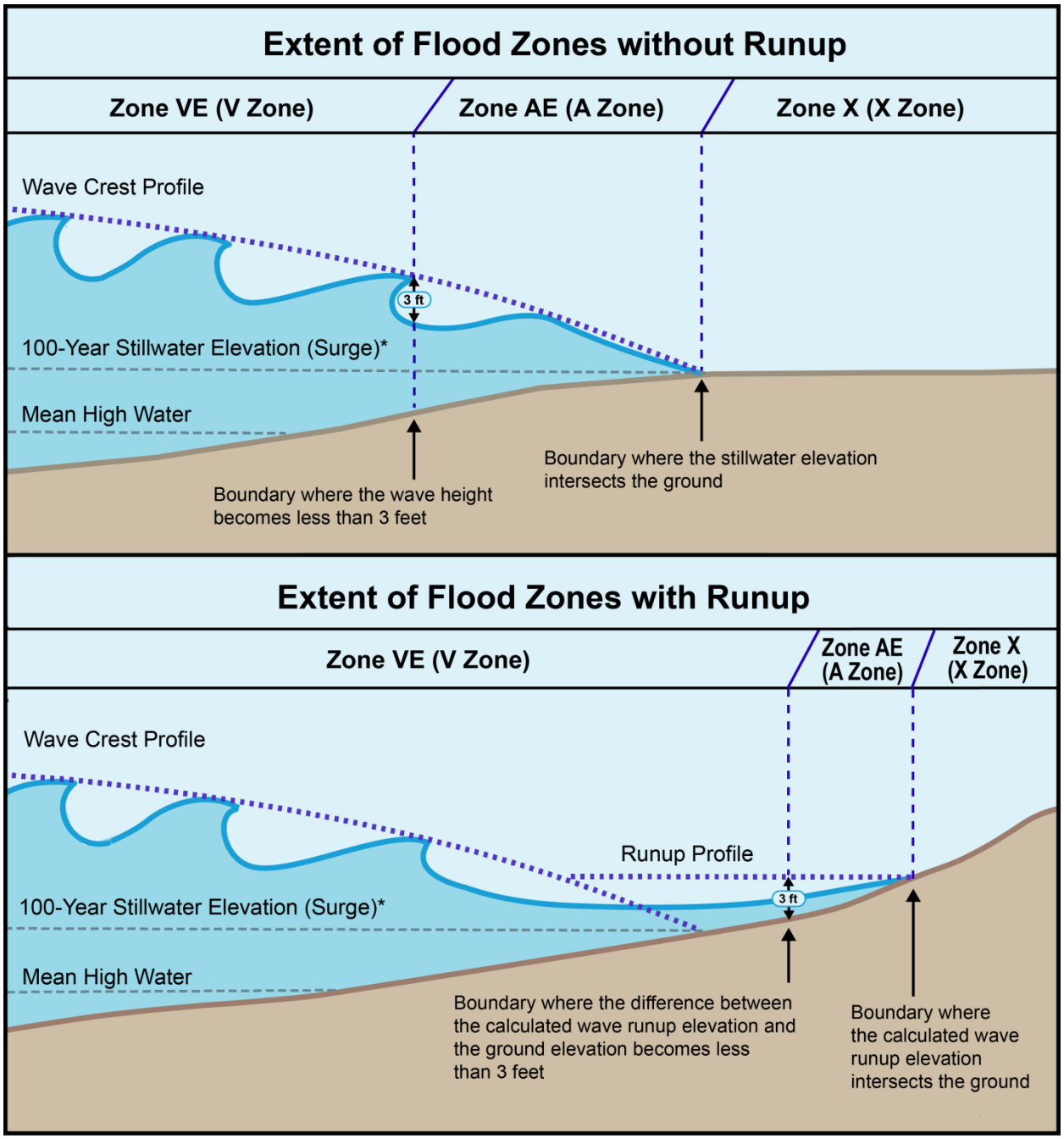


Figure 3. Cross-sectional diagrams of the shoreline showing the wave crest profiles, stillwater elevations, and extent of flood zones in two scenarios: one without and one with wave runup. The wave crest profile indicates the predicted heights of the water during a 1%-annual-chance flood. The wave runup profile indicates the calculated runup elevation. Computer models are used to determine how the waves will taper down in elevation as they reach land and how runup washes up onshore during a 1%-annual-chance flood. Runup occurs primarily in areas with steeply sloping shorelines or where there are sloping coastal engineering structures along the shoreline. The definitions of each flood zone are used to determine where the boundary occurs between zones. *If wave setup effects are present, modeling is based on the Total Water Level (stillwater elevation plus wave setup).

Once the zones are defined and identified along the transect, V and A Zones are then subdivided into *elevation zones*; the zone areas are assigned elevation values based on their Base Flood Elevation, or BFE, which is the predicted height of the water, including surge and waves, in a 1%-annual-chance flood. In coastal areas, the BFE represents the wave crest profile elevation and/or wave runup elevation (zones must have a minimum width of 0.2 inch on the FIRM to be assigned a distinct zone elevation—see more about minimum zone width in "Delineating the V Zone/X Zone Boundary" on page 15). For example, a V Zone area with an average wave crest profile elevation of 16 feet would be designated as VE EL 16 (see Figure 4 on page 13 and Figure 5 on page 15 showing assigned BFEs along a transect). These flood zone designations, their elevations, and their extents are then transferred from the transects to the FIRMs and the boundaries are connected between the transects using topographic information and engineering judgment.

The BFE shown on the FIRM for each V Zone, therefore, is either: 1) the top of the waves (wave crest elevation for that zone), or 2) the calculated maximum wave runup elevation (if wave runup exists). The elevation shown on the FIRM for each A Zone refers to either: 1) the stillwater elevation (the elevation of the surge), including wave setup if appropriate, 2) the top of the waves, or 3) the calculated runup elevation (if runup exists).

Elevations on all revised FIRMs and FISs issued in Massachusetts after 2006 are relative to the North American Vertical Datum of 1988 (NAVD 88). The datum is the geodetic reference point (starting point) from which the elevations are measured. See additional information in the text box on page 11, "Datum Conversions."

For more information on all of the current techniques for mapping flood zones, see FEMA's *Guidelines and Standards for Flood Risk Analysis and Mapping* available on their website (for the link, see "Technical Guidance and Memorandums" on page 24).

FIRM Updates

FEMA has an ongoing process for updating the FIRMs based on priorities (including priorities identified by states) and available funding. There are several types of updates, some of which do not include any new analysis of the flood zones. A typical example includes adding an orthophotograph as the basemap and changing the paneling scheme to be consistent with the U.S. Geological Survey quadrangle maps. Other examples include updating the datum from the National Geodetic Vertical Datum of 1929 (NGVD 29) to the North American Vertical Datum of 1988 (NAVD 88) or redelineating the flood zone boundaries based on newer and more detailed topographic data (e.g., two-foot topographic data instead of ten-foot data). Updates that *do* include new analysis typically involve using new topography at transects and using improved mapping

techniques to assess the storm surge height and wave crest profile to predict the extent of flood hazards. The FISs include the details of all updates and revisions that have been made to the FIRMs.[8]

Limitations of FIRMs

The flood zones depicted on FIRMs are based on engineering predictions of the nature and magnitude of the flood hazard in an area, given the uncertainties and variables in coastal processes during an extreme flood event. Though the flood zone designations on the FIRMs are a useful starting point, they should be used with caution due to the following limitations:

- FIRMs are graphic representations of engineering data. They are predictions of where the extent of the various levels of hazards will occur based on models of the conditions at the time of the study.
- Landforms often change after mapping occurs due to human modification (e.g., construction of seawalls) or natural processes (e.g., erosion).
- FEMA does not take future erosion or sea level rise into account on FIRMs.
- The detailed analyses are only conducted at specific transects and engineering judgment is used to connect the delineations between these transects.

Some additional important points to consider when interpreting flood zones on updated FIRMs:

- Typically, FEMA only conducts new analyses of flood zones for limited sections of communities due to funding limitations. These sections are prioritized based on known, observed differences between the predicted and actual extent of flooding in a storm and the need to update FIRMs based on newer methods that better predict the extent of the hazards (e.g., delineating primary frontal dunes and taking into account wave setup).
- FIRM updates are not always based on new engineering analyses or studies and do not always take into account the best available techniques for predicting the extent of the floodplain. Some updates may just convert the Base Flood Elevations from one datum to a newer one, or redelineate the flood zone boundaries from older modeling onto new topographic data. Such updates may result in a change to flood elevations on the FIRM, even though new analyses or studies have not been performed. Because the effective dates on the FIRMs may not reflect the date mapping analysis was done, the FIS should be consulted to determine when the original flood study was performed and whether any new

[8]The Massachusetts Department of Conservation and Recreation Flood Hazard Management Program (www.mass.gov/eea/agencies/dcr/water-res-protection/hazard-mitigation) can assist local officials with questions about the updates that have been made to the maps.

engineering studies and new data analyses have been conducted to predict the extent of flood hazards.[9]

Although the FIRMs have limitations, they are the best available statewide data source for predicting the extent of the 1%-annual-chance flood.[10] In addition, some regulations require the use of the FIRMs to determine the extent of the floodplain (see "State Standards" on page 16 for details).

Datum Conversions: It is extremely important to ensure that the topographic data on the site plan is relative to the same datum as that of the FIRM (older FIRM elevations are typically referenced to NGVD 29 and the newer FIRM elevations are referenced to NAVD 88). *One* datum must be used to maintain consistency between floodplain elevations and site topography, allowing for a correct delineation of flood zones on the site plan and correct interpretation of whether or not project components are within flood zones. The conversion factor FEMA used in updating maps from NGVD 29 to NAVD 88 is included in the FIS. If datum conversions are necessary, the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Survey website (www.nauticalcharts.noaa.gov) provides tools for computing conversions, such as VDatum, a tool that enables a user to transform elevation data between any two vertical datums among a choice of 28 orthometric, tidal, and ellipsoid vertical datums. The NOAA National Geodetic Survey website (www.ngs.noaa.gov) provides a tool (VERTCON) that computes the difference in height between NGVD 29 and NAVD 88.

Delineating (or Reviewing a Delineation of) Flood Zones on Site Plans

To accurately interpret the information provided by the FIRM(s) and the FIS for a specific site, it is important to understand the different methodologies for delineating flood zones on site plans. Delineating the inland extent of the floodplain (typically the landward boundary of the A Zone) requires a different method than delineating the boundaries between V and A Zones. The following methods describe how to delineate the boundaries between each flood zone and how to determine the landward extent of the 1%-annual-chance floodplain, as described in the A Zone/X Zone boundary and the V Zone/X Zone boundary sections below. In addition, options for considering additional information beyond the FIRM(s) and FIS are also provided.

Delineating the V Zone/A Zone Boundary

As previously stated, the boundary between the V Zone and the A Zone occurs: where the wave height becomes less than 3 feet, where the wave runup depth becomes less

[9]The Massachusetts Department of Conservation and Recreation Flood Hazard Management Program can also assist local officials with questions about flood zone determinations and relevant updates that may affect their community.

[10]More detailed flood studies may have been conducted for small areas along the coast. See "State Standards" on page 16 regarding use of information other than FIRMs and FISs.

than 3 feet, at the landward extent of the splash zone at a coastal engineering structure, or at the landward toe of the primary frontal dune—whichever is farthest landward. Since the BFE for the V Zone is the elevation of the top of the water with waves (or runup), locating the V Zone/A Zone boundary is not as simple as locating the topographic contour line corresponding to the BFE (see Figure 4 on page 13 where the V Zone BFE is elevation 16 feet NAVD 88 but the V Zone does not extend as far as the 16-foot ground contour line). As waves break and wave heights diminish in the landward direction, the V Zone ends (and becomes an A Zone) where wave heights become less than 3 feet. In runup situations, the V Zone ends and becomes an A Zone where the wave runup depth becomes less than 3 feet. To properly locate the V Zone/A Zone boundary on a site plan, use one of the following two options:

- The digital FIRMs *can be overlaid* onto the site plan with the same scale and same projection using GIS software to determine the V Zone/A Zone boundary. It is very important that the projection and scale of both plans (the FIRM and the site plan) are consistent to ensure the accuracy of the boundary location on the site plan. When overlaying data, do not use the Q3 data layer available from MassGIS, since it does not represent the most current flood data and it is not intended for site-specific delineation purposes because it is not fully geo-referenced. Because FIRMs are now available as GIS layers, paper maps should not be digitized and geo-referenced to determine flood zone boundaries.
- The FIRM's V Zone boundary *can be scaled* from a known, fixed point, such as a benchmark or road intersection, to the site plan for the project site. If scaling from a road on a FIRM, the center of the road should be used, since the lines may not represent road edges. Distances should be measured parallel and/or perpendicular to recognizable features and at least two reference points should be used. A shoreline location should not be used as a reference point, since its position changes over time.

Delineating the Limit of Moderate Wave Action

Since the Limit of Moderate Wave Action within the A Zone (represented by the LiMWA line, which is available on the Massachusetts Coastal A Zone Maps) is based on wave heights and not ground elevations (see Figure 4 on page 13), the LiMWA can be delineated by overlaying or scaling this boundary from the Massachusetts Coastal A Zone Maps onto the site plan as described above for the V Zone/A Zone boundary.

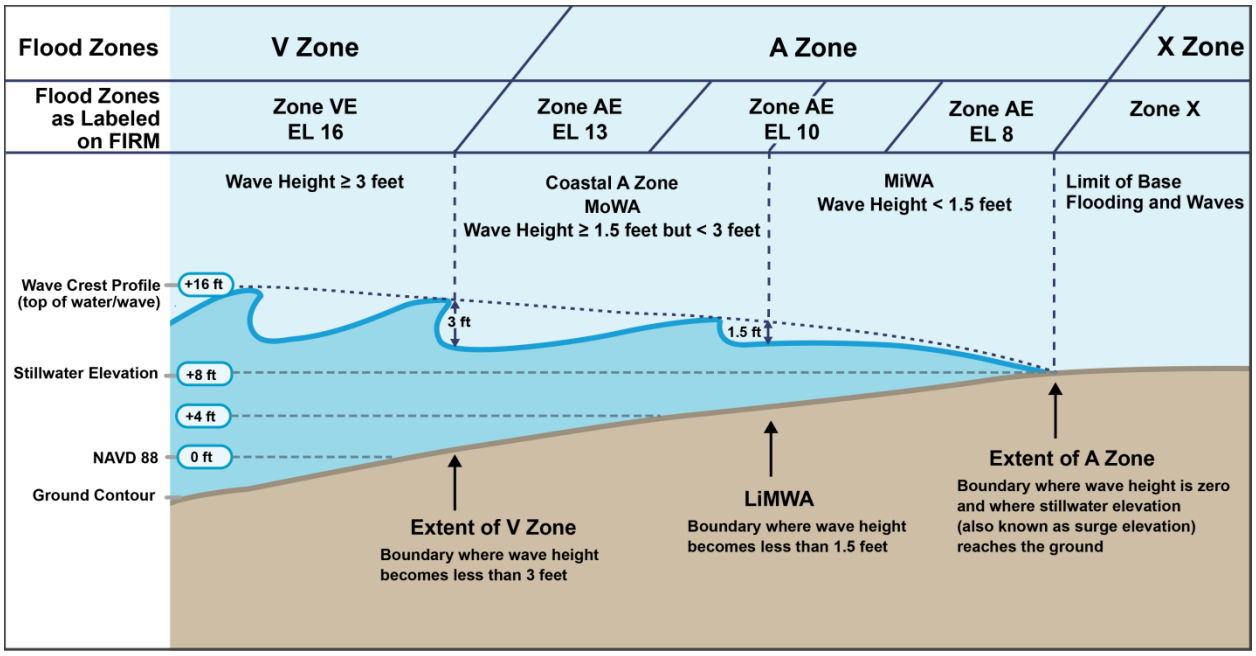


Figure 4. Cross-sectional diagram of flood zones on a gently sloping ground profile with no runup. Profile elevations and Base Flood Elevations are shown in feet above the NAVD 88 datum (as indicated with 0 ft, +4 ft, +8 ft, +16 ft). Although the BFE for the seaward portion of this V Zone is 16 feet NAVD 88 (as indicated by the Zone VE EL 16 on the FIRM), the V Zone does not reach as far landward as the 16-foot ground elevation. Instead, as waves break and wave heights diminish in the landward direction, the V Zone ends where wave heights become less than 3 feet, and the flood designation becomes an A Zone (with decreasing A Zone elevations—13, 10, then 8 feet NAVD 88) that extends landward to the 8-foot ground elevation. The LiMWA marks the landward limit of the Moderate Wave Action (MoWA) area, where wave heights are between 1.5 and 3.0 feet. Landward of the MoWA and the LiMWA boundary is the Minimal Wave Action (MiWA) area, where wave heights are less than 1.5 feet.

Delineating the A Zone/X Zone Boundary

The boundary between the A Zone and the X Zone occurs at the predicted landward extent of the floodwaters (extent of waves, runup, and/or surge) in a 1%-annual-chance flood. This boundary is located at the ground elevation that corresponds to the Base Flood Elevation of the most landward A Zone. This BFE typically corresponds to either the stillwater elevation or, at locations were wave setup exists, the Total Water Level (which is stillwater elevation including wave setup). (In certain circumstances—typically where there is a steep or rising ground profile and wave runup—there is no A Zone shown on the FIRM adjacent to the X Zone. See "Delineating the V Zone/X Zone Boundary" on page 15 for instructions on addressing this issue.)

The BFE on the FIRM is rounded to the whole foot, but the stillwater elevation or Total Water Level is provided to the nearest tenth of a foot in the FIS. Although the elevation in the FIS should be consulted, there are circumstances where the BFE on the FIRMs should be used instead. To determine which elevation to use, follow these guidelines:

- First identify the BFE of the most landward A Zone on the FIRM. Next, look at the number given for the Total Water Level in the FIS. *[Please note: Total Water Level is not*

available for all coastal communities. For the communities where it is available in the FIS, it is referred to as "Total Water Level" or "stillwater elevation including setup." Table 1 below indicates which counties and communities have this information as of the printing of this document, along with whether it is referred to as "Total Water Level" or "stillwater elevation including setup."] If this number can be rounded to the whole number used for the BFE on the FIRM, then the higher value (either the Total Water Level provided in the FIS or the BFE on the FIRM) should be used as the ground elevation for determining the A Zone/X Zone boundary.

- If the Total Water Level cannot be rounded to the whole number provided on the FIRM (or if Total Water Level is not available), then compare the whole number for the BFE with the stillwater elevation (without setup) given in the FIS. If the stillwater elevation can be rounded to the BFE, then the higher value (either the stillwater elevation or the BFE on the FIRM) should be used as the ground elevation for determining the A Zone/X Zone boundary. *(Note: Use the 1%-annual-chance stillwater elevation, which is typically found in the same table as the Total Water Level in the FIS, or in another table immediately before or after it.)*
- If neither the Total Water Level nor stillwater elevation rounds to the BFE provided on the FIRM, then the BFE value should be used as the ground elevation for determining the A Zone/X Zone boundary.

To delineate the A Zone/X Zone boundary on the site plan, locate the ground contour line corresponding to the selected elevation on a surveyed topographic plan (the plan that was generated for the proposed project or the most recent detailed topographic data available). If a contour line does not exist for the selected elevation, one should be created. Using this detailed topographic data, as opposed to observing the boundary relative to the FIRM's aerial photograph basemap (which is often based on less detailed topographic data), allows for a more accurate delineation/location of the boundary.

County	Communities with Total Water Level information	Table Number in FIS	Terminology used to indicate Total Water Level	Notes
Barnstable	All	Table #10	Total Water Level	
Bristol	Berkley, Dighton, Fall River, Freetown, Rehoboth, Seekonk, Somerset, and Swansea	Table #15	Total Water Level	
Dukes	All	Table #10	Stillwater elevation (including setup)	In Revised Preliminary FIS issued April 2015
Essex	All except Newburyport and Salisbury	Table #10	Stillwater elevation (including setup)	
Nantucket	All	Table #6	Total Water Level	
Norfolk	Quincy	Table #19	Total Water Level	
Plymouth	Cohasset, Duxbury, Kingston, Marshfield, Plymouth, and Scituate	Table #14	Total Water Level	In Preliminary FIS issued May 2013
Suffolk	All	Table #12	Total Water Level	In Preliminary FIS issued July 2015

Table 1. Reference table for determining which communities have Total Water Level information in their FIS (as of September 2015).

Requesting Official Changes to FIRMs: Where the A Zone/X Zone boundary shown on the FIRM differs significantly from the topographic contour line corresponding to the A Zone BFE, a Letter of Map Amendment or Letter of Map Revision from FEMA may be necessary to correct the inconsistency. See "Requesting a Change to FIRMs" on page 21 for further information.

Delineating the V Zone/X Zone Boundary

In certain circumstances—typically where there is a steep or rising ground profile and wave runup—there is no A Zone shown on the FIRM. When no A Zone is shown landward of the V Zone, the V Zone/X Zone boundary is delineated at the ground contour elevation that corresponds to the most landward V Zone BFE shown on the FIRM, using the same method described above for delineating the A Zone/X Zone boundary. An A Zone will technically still exist, but is too narrow to be mapped (the minimum zone width is 0.2 inch on the FIRM). Figure 5 below depicts a situation where the A Zone is too narrow to be mapped on the FIRM.

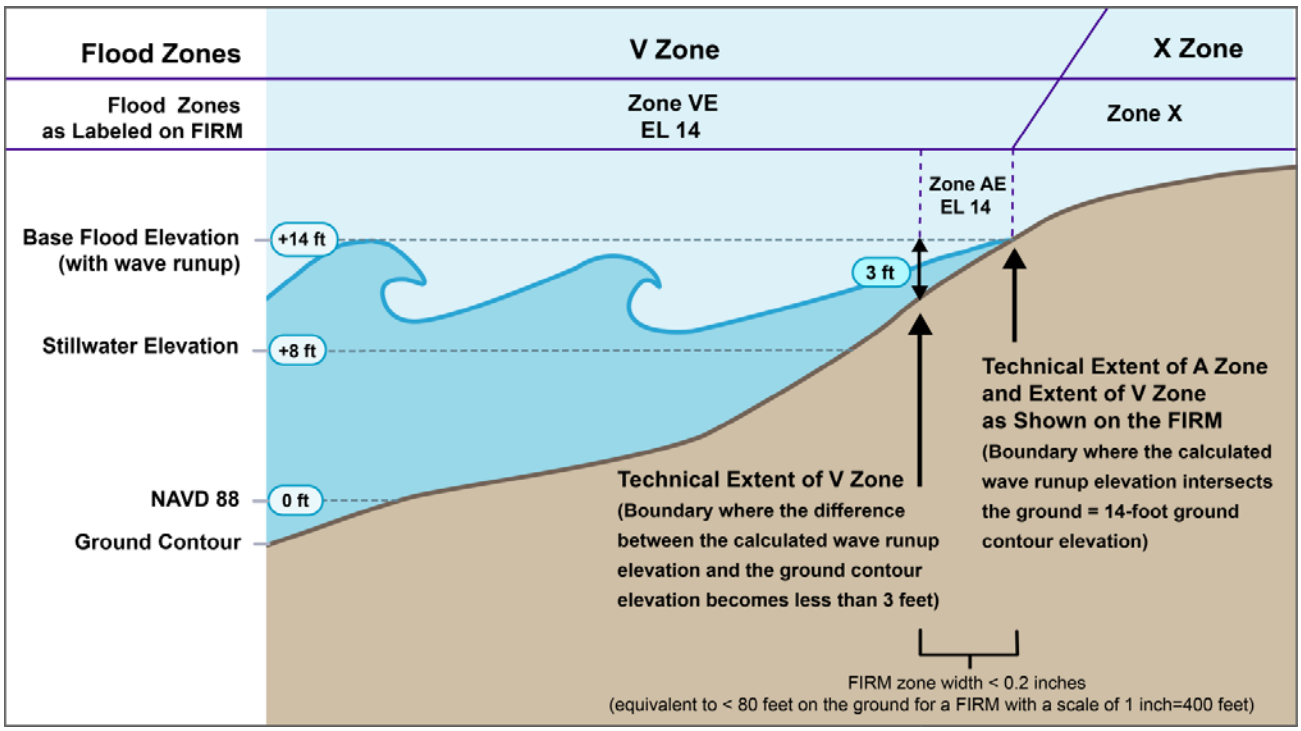


Figure 5. Cross-sectional diagram of flood zones on a steep embankment with runup. Here, an A Zone is shown in the profile, but would not be mapped on the FIRM because the zone is less than 0.2 inches in width on the FIRM—thereby not meeting the minimum zone width for mapping at the scale used for FIRMs. Where A Zones such as these are not mapped, the V Zone will extend to the designated ground elevation that corresponds to the V Zone BFE on the FIRM.

Delineating Unnumbered A Zones

If an A Zone is unnumbered (no flood elevations are provided), no hydrologic/hydraulic analyses have been conducted, or no flood profiles and transects are available, use the

overlay or scaling method. Alternately, BFEs can be estimated based on the guidance and methodology in the Wetlands Protection Act Regulations at 310 CMR Section 10.57(2)(a)3 or FEMA Publication #265, *The Zone A Manual: Managing Floodplain Development in Approximate Zone A Areas*. A Letter of Map Change will likely be needed to show that FEMA agrees with the analysis (see "Requesting a Change to FIRMs" on page 21).

State Standards

State and local regulations differ in their requirements for using the FIRMs as the official source regarding the extent of the floodplain. The requirements of the primary Massachusetts state laws and regulations relevant to FIRM use (as of the time of publication of this guidance document) are listed below:

- Massachusetts Basic Building Code (8th Edition) - The *effective* FIRMs and FISs must be used to determine the extent of V and A Zones and associated BFEs,[11] as well as relevant requirements under the State Building Code. However, building officials should provide project applicants with any new data that are available to help inform designs that can reduce potential coastal storm damage, including the Massachusetts Coastal A Zone Maps.[12]
- Title 5 (Septic Systems) - For V Zones, the effective or preliminary FIRMs must be used to determine the extent of the V Zone in accordance with 310 CMR 15.002, definition of Velocity Zone, except in primary frontal dune areas. In primary frontal dunes, the inland limit of the primary frontal dune should be used to determine the landward extent of the V Zone if it is farther landward than the V Zone delineated on the FIRM (see "Beyond the FIRMs: When to Consider Additional Information" on page 17 for more detail). For determining the extent of regulatory floodways shown on the FIRMs, Title 5 also allows the use of the "most recently available flood profile data" from the FIS to determine the extent of the floodway.
- Wetlands Protection Act (WPA) and Regulations - When determining the extent of the coastal floodplain, which is referred to as Land Subject to Coastal Storm Flowage or Special Flood hazard Area under the WPA, applicants and Conservation Commissions should review the best available information, which should first include the current effective and preliminary FIRM(s),[13] FISs, and Massachusetts Coastal A Zone Maps, in conjunction with an assessment of the current landform and its condition. A Commission should ensure that flood zone delineations are in basic agreement with credible historical flood data and current shoreline

[11]The effective FIRM includes any Letters of Map Revision issued by FEMA that supersede the FIRM. These are available on the FEMA Map Service Center website; they are indicated by a LOMC symbol in a column next to the panel number in the list of effective maps available for the community when you "Search All Products" and can be viewed by clicking on the LOMC symbol. LOMCs are periodically incorporated into the NFHL.

[12]As of the printing of this publication, requirements for Coastal A Zones are proposed in the 9th Edition of the State Building Code.

[13]Preliminary FIRMs are considered best available information regarding the extent of flood zones, except any portion of the map that has been appealed and the appeal has not been resolved (310 CMR 10.04, definition of Special Flood Hazard Area and Velocity Zone). Preliminary FIRMs can be found on the Preliminary FEMA Map Products web page at http://hazards.fema.gov/femaportal/prelimdownload/ or by searching all products from the FEMA Flood Map Service Center at https://msc.fema.gov/portal.

conditions (see "Beyond the FIRMs: When to Consider Additional Information" below). Applicants and Conservation Commissions should use new information rather than the FIRM when the new information demonstrates that Base Flood Elevations are higher or flood zones are extending landward. To err on the side of caution, however, when BFEs are shown to be lower than indicated on the FIRM, Commissions should use the FIRM information until a revised FIRM or LOMC becomes effective. In dune areas, Conservation Commissions should use the delineation of the inland limit of a primary frontal dune to find the landward extent of the V Zone (see "Delineating Velocity Zones in Primary Frontal Dunes" on page 18).

Local officials implementing other regulatory programs, such as Planning Boards and Zoning Boards of Appeals, should review the appropriate regulatory language to determine what they can/should use.

Beyond the FIRMs: When to Consider Additional Information

When questions arise over whether the FIRM accurately depicts the predicted flood hazards at a site, Conservation Commissions and some other local officials are not required to rely exclusively on the FIRM-designated flood zones and their delineations. For example, under the Wetlands Protection Act Regulations, the Land Subject to Coastal Storm Flowage definition includes "land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record or storm of record, whichever is greater" (i.e., a Commission *can use evidence of higher flood elevations than shown on the FIRMs*). To use evidence of higher flood elevations, a competent source must provide *credible evidence* relating to storm surge elevations, inundation extent, flood levels, and waves. Commissions will need to use their best professional judgment on a case-by-case basis to determine whether the submitted information and evidence is credible. For instance, photographs that show flooding without any reference to a known point or landmark are not a reliable source of information, while field measurements and engineering data presented on topographic data, with cross sections and reference points, are considered credible.

Local officials and those siting and designing projects may also need to consider various scenarios and future conditions that are beyond the scope of the FIRMs. The following sources of information may be helpful for determining the extent of flooding under various scenarios, such as sea level rise, shoreline change, and hurricane inundation. (Be sure to reference the "State Standards" section on page 16 regarding who has authority to require the use of additional information and who can only recommend its use. For information requirements for a delineation of a V Zone in a primary frontal dune, see the next section.)

- The Massachusetts Shoreline Change Project (www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/shoreline-change) links to an interactive shoreline change browser showing the relative positions of historic shorelines, along with information on erosion since

the mid-1800s. The site provides short-term (30 years) and long-term (100 years) rates of erosion and accretion.

- The National Oceanic and Atmospheric Administration (NOAA) Sea Level Trends website (http://tidesandcurrents.noaa.gov/sltrends/sltrends.html) provides sea level rise data for various tide stations along the Massachusetts coastline.
- The National Weather Service's Sea Lake and Overland Surges from Hurricanes (SLOSH) maps (www.nhc.noaa.gov/surge/slosh.php) predict the extent of flooding from hurricanes of various magnitudes and storm surges. SLOSH Category 5 Hurricane mapping typically predicts inundation farther inland than the FIRMs.
- The StormSmart Coasts Assessing Vulnerability of Coastal Areas and Properties webpage (www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/vulnerability) includes information regarding erosion rates, storm surge, sea level rise rates, and sea level rise inundation scenarios.
- As discussed on page 5, the Massachusetts Coastal A Zone Maps (which are available at www.mass.gov/czm/coastal-a-zone-maps) were developed in 2015 by CZM and DCR and delineate the LiMWA for coastal communities based on 2013 FEMA guidance (Operating Guidance 13-13). At the time of publication of this document, they represent the most updated information on the extent of Coastal A Zones and should be used when applying the requirements of the State Building Code and other regulations.

The shoreline change data, hurricane inundation zones from the SLOSH maps, and sea level rise inundation scenarios are available on the Massachusetts Ocean Resource Information System (MORIS) (www.mass.gov/czm/moris), a web-based mapping tool for interactively viewing coastal data layers.

Delineating Velocity Zones (V Zones) in Primary Frontal Dunes

FEMA determined in a 1988 revision to their regulations that the *V Zone includes all primary frontal dunes* (dunes closest to the beach, also known as primary dunes). Therefore, *the inland limit of the V Zone is, at a minimum, the landward toe of the primary dune.*[14] Despite this 1988 revision, some effective FIRMs *have not* been updated to reflect this standard. (As funding allows for new analysis, these updates are being made by FEMA, along with other relevant updates using new mapping methodologies.) Building Inspectors must use the information found on the effective FIRM—whether the primary frontal dune has been mapped or not. Boards of Health should consider primary frontal dunes as V Zones because Title 5 defines the V Zone as not only the area shown as the V Zone on the FIRM, but also the *area extending onshore to the inland limit of the primary frontal dune*, where this inland limit is *landward* of the V Zone boundary shown on the FIRM. Conservation

[14]Please note that the V Zone extends, at a minimum, to the landward toe of the primary dune even if the primary dune "passes" the 540 square-foot criteria, which is the FEMA standard for evaluating whether a dune is likely to withstand a 1%-annual-chance flood. (See discussion and Figure 6 on page 20.)

Commissions should also consider the landward toe of the primary frontal dune to be the minimum extent of the V Zone under the Wetlands Protection Act Regulations.[15]

Where a FIRM *has* been updated and revised to include the entire primary frontal dune at the project site—and where these FIRM zone designations are consistent with flooding history, storms/surges of record, wave activity, and landform changes at the site—*local officials should use the flood zone designations as depicted on the FIRM*, unless the shoreline and landform have changed significantly (such as from storm events, ongoing erosion, and landward beach and dune migration) since the FIRM was updated. Where a FIRM *has not* been updated and/or revised to reflect FEMA's regulation change—or where the landform has changed significantly since detailed analysis was conducted or where flood zone designations are not consistent with flood history and storms of record—both Conservation Commissions and Boards of Health (and other local officials where appropriate) may require a delineation of the landward extent of the primary frontal dune to find the *minimum* extent of the V Zone.[16] If the landward extent of the primary frontal dune is found to be seaward of the mapped V Zone, however, then the Conservation Commission should continue to use the more landward mapped boundary.[17]

Conservation Commissions, other local officials, and those planning or designing projects in or near the floodplain should also consider that the delineation of the landward toe of the primary frontal dune may not give a complete picture of the real extent of the V Zone. Depending on the project (such as a project proposed immediately landward of the primary frontal dune), it may be important to determine whether V Zone conditions are predicted to extend farther landward through additional engineering analysis. FEMA developed criteria to determine whether a primary frontal dune will be completely eroded in a 1%-annual-chance flood. The criteria states that primary frontal dunes will not be considered effective barriers to storm surges and associated wave action from a 1%-annual-chance flood where the cross-sectional area of the frontal dune reservoir is equal to, or less than, 540 square feet. Figure 6 on page 20 demonstrates how the primary frontal dune reservoir is measured on both a ridge-type primary dune and a mound-type primary dune.

Velocity conditions are likely to extend *farther* landward than the landward toe of the primary frontal dune if the frontal dune reservoir does not meet this 540-square-foot threshold. FEMA's *Coastal Construction Manual* states that post-storm assessments and analysis have since determined that a 1,100 square-foot threshold (rather than 540 square feet) more accurately accounts for long-term erosion rates, cumulative effects of multiple storms that may occur within short periods of time, and dune removal during a 1%-annual-chance flood. FEMA recommends that 1,100 square feet be used for planning purposes, but their Guidelines and Standards used to map flood zones on the FIRMs currently require the use of the 540-square-foot threshold.

[15]Pursuant to 310 CMR 10.04, definition of Velocity Zone.
[16]Technical guidance for delineating and reviewing delineations of primary dunes is being developed by the Massachusetts Department of Environmental Protection and the Massachusetts Office of Coastal Zone Management.
[17]By definition, the landward extent of the V Zone is located at the landward-most point of the four criteria (see criteria on page 4).

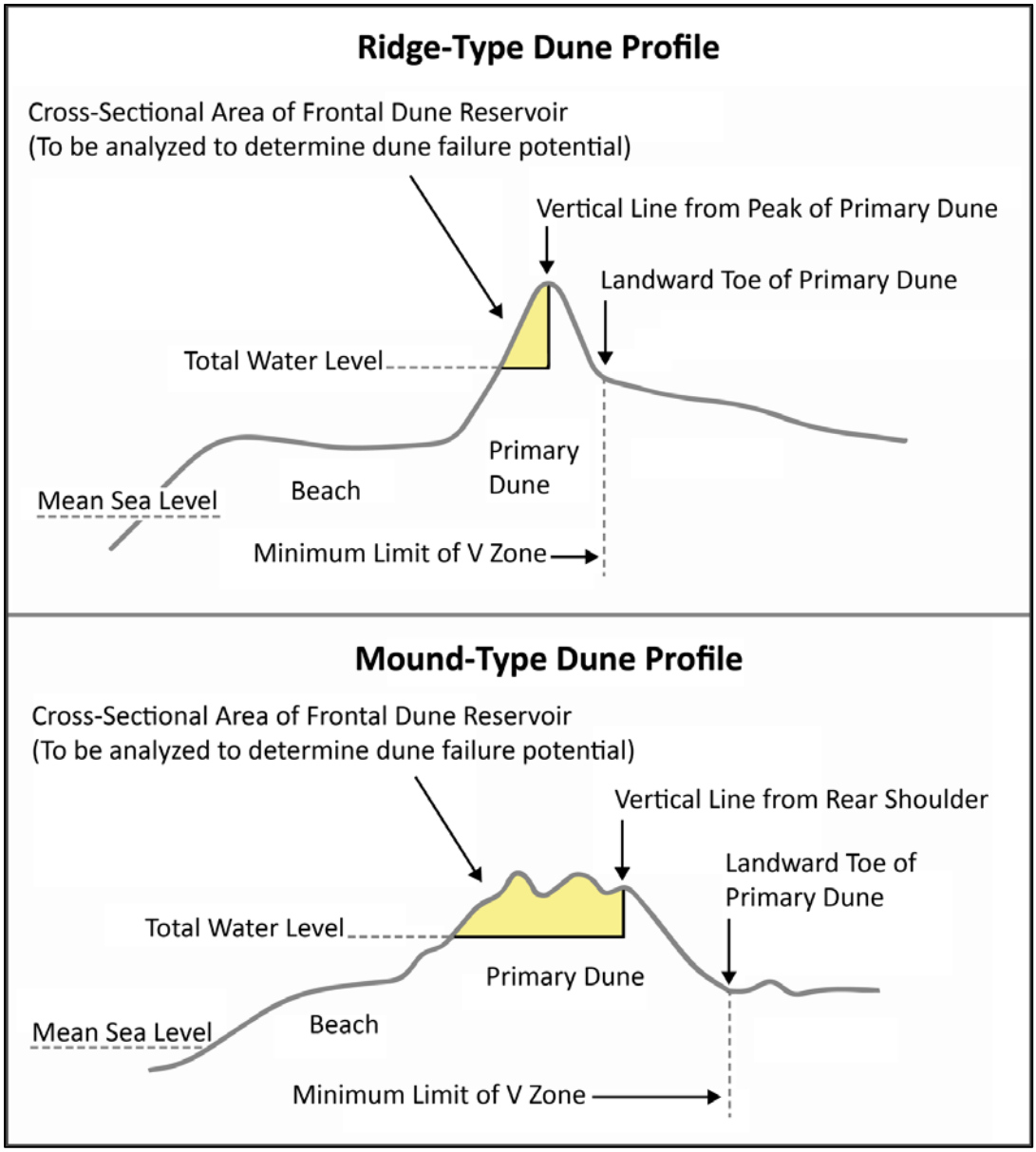


Figure 6. Cross-sectional diagram of the primary frontal dune reservoir of a ridge-type and mound-type primary dune. The shaded area is the primary frontal dune reservoir and is measured perpendicular to the shoreline, above the Total Water Level (the 100-stillwater elevation + wave setup; available in the FIS),[18] and either seaward of the peak of a ridge-type primary dune or seaward of the rear shoulder peak on a mound-type primary dune. If the area is less than 1,100 square feet, the assumption is that the primary frontal dune will be removed by erosion in a 1%-annual-chance flood and velocity conditions may extend farther landward than the landward toe of the primary frontal dune. (Figure modified from the FEMA *Coastal Construction Manual*.)

[18]The baseline for calculating the 540 rule was changed to the Total Water Level by Operating Guidance 15-13, a technical memorandum issued by FEMA on October, 30, 2013 (www.fema.gov/media-library-data/1386337351905-03d00f8c6260a1a3589c7a8fc076b5f2/Operating%20Guidance%2015-13-Revised%20Guidance%20for%20Dune%20Erosion%20Analysis%20for%20the%20Atlantic%20Ocean%20and%20Gulf%20of%20Mexico%20Coasts%20%28Oct%202013%29.pdf). Some FISs (e.g., Essex County) list stillwater elevations with a footnote that they include wave setup, which is equivalent to Total Water Level (see Table 1 on page 14 for a list of communities with FISs that use this terminology).

The entire primary frontal dune is considered V Zone in part to take into account the effects that are likely to occur from multiple storms, ongoing erosion, wave runup, and overtopping. Due to the extreme conditions that occur in V Zones—significant wave action, hazardous flooding, high energy conditions, and erosion—primary frontal dunes (including those with a frontal dune reservoir greater than 1,100 square feet), and any structures on these dunes, are vulnerable to future storm events.

Requesting a Change to FIRMs

Local communities and property owners can request an official map change from FEMA when there is evidence that the FIRM flood zone designations do not reflect the actual flood hazards at a given site. For example, a property owner may have more detailed topographic data for their property that shows they are outside the area inundated by the 1%-annual-chance flood. In these cases, a Letter of Map Amendment (LOMA) or Letter of Map Revision (LOMR), which are both Letters of Map Change, can be applied for through FEMA.

A LOMA is an interpretation from FEMA of what the current FIRM depicts for a specific site—it does *not* reflect any change or update to the FIRM based on new data and detailed engineering analysis (such as extending the V Zone to the inland limit of the primary frontal dunes). Site-specific ground elevations are typically submitted as part of a LOMA request to demonstrate that the site is located outside the floodplain. Where there is a dispute with a LOMA, local officials may want to seek technical assistance from the Massachusetts Department of Conservation and Recreation Flood Hazard Management Program (DCR FHMP) (www.mass.gov/eea/agencies/dcr/water-res-protection/hazard-mitigation).

A LOMR is a request to FEMA (typically a property owner or community) to change the FIRM based on new, site-specific data and detailed engineering analysis. FEMA evaluates the information submitted and, if warranted, issues a LOMR to the applicant and the community. The LOMR officially revises the FIRM and sometimes the FIS. *Local officials should not use a flood elevation or line less restrictive than the FIRM unless FEMA has issued a LOMR for that FIRM that reduces the extent or elevation of the flood zone.* If the LOMR appears inconsistent with local knowledge, officials may want to seek technical assistance from the DCR FHMP.

All LOMAs and LOMRs become part of the official FIRMs. Information regarding LOMAs and LOMRs is available online through FEMA's Map Service Center. Under the list of map panels available for a community when you "Search All Products," there is a LOMC symbol indicating where Letters of Map Change have been issued for that panel. The individual letters issued by FEMA are available for download. LOMRs are also periodically incorporated into both the NFHL and the Massachusetts Coastal A Zone Maps.

FEMA Flood Map and Study Products

Flood Insurance Rate Maps (FIRMs) - FIRMs are available to be viewed and downloaded for free from the FEMA Flood Map Service Center (https://msc.fema.gov/portal) through an "Address Search" or a "Search All Products" function. The Flood Map Service Center provides effective FIRMs, as well as preliminary and historic maps. On this website, you can also create a FIRMette (a section of a FIRM that is considered an official copy of the FIRM), which can be formatted and printed. Paper FIRMs can be viewed at local government offices, such as the Building Inspector, Planning Board, or Conservation Commission. (For an overview of the Flood Map Service Center and its products and services, see www.msc.fema.gov/portal/resources/productsandtools; for additional details on finding a specific FIRM, see https://msc.fema.gov/portal/howto#msc-findmap.)

Flood Insurance Study (FIS) - The FIS is a report for each county that contains a narrative of the flood history of each community, the engineering methods used to develop the FIRMs, stillwater elevations (level of the water without the waves), transect locations where detailed analyses were conducted, and details regarding the dates of the original flood study and all updates and revisions that have been made to the FIRMs. FISs can be viewed or downloaded for free through FEMA's Flood Map Service Center (https://msc.fema.gov/portal) through the "Search All Products" function (search by jurisdiction and then expand the "Effective Products" folder in the search results to find "FIS Reports").

National Flood Hazard Layer (NFHL) - The NFHL is a digital dataset with the current effective flood data, available to be used with GIS applications. The NFHL combines the flood hazard data from the FIRMs with the updates issued through LOMRs to provide a unified view of the flood hazards on Effective FIRMs. The NFHL data can be downloaded from FEMA's Flood Map Service Center (https://msc.fema.gov/portal/advanceSearch) by searching by jurisdiction and then expanding the "Effective Products" folder in the search results and downloading "NFHL Data" by state or by county. A full list of the layers available in the NFHL may be found in the NFHL GIS Services User Guide (www.fema.gov/media-library/assets/documents/33052). *Please note: The versions of the NFHL in MassGIS and MORIS do not include all of the data layers available in the FEMA's NFHL database.*

FIRMette - A FIRMette is a section of a FIRM that is considered an official copy. It can be created, formatted, and printed from FEMA's Flood Map Service Center (https://msc.fema.gov/portal). The box on page 23 illustrates the steps to use to make a FIRMette.

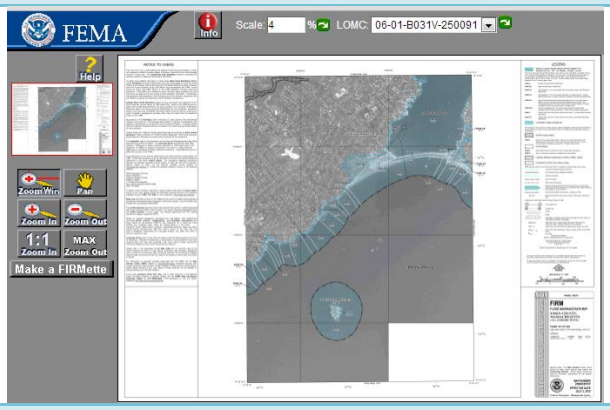
How to Make a “FIRMette”

At **https://msc.fema.gov/portal**, click on “MSC Search” and enter your search criteria in either the “Search by Address” or “Search All Products” function.

If you searched by address, click the “View” icon.

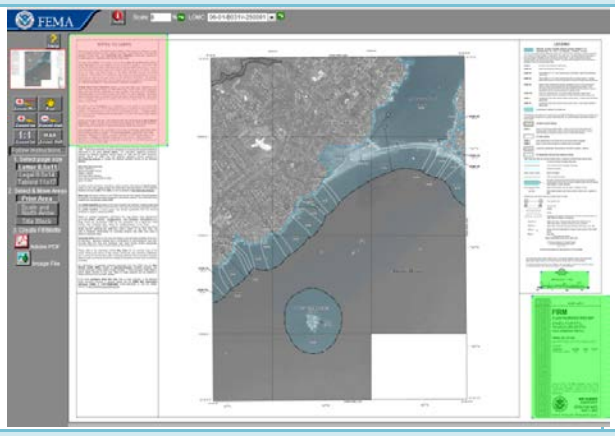
If you searched all products, expand “Effective Products” and expand “FIRM Panels.” Find your map of interest and select the “View” icon.

A new window will open up the full FIRM map panel.



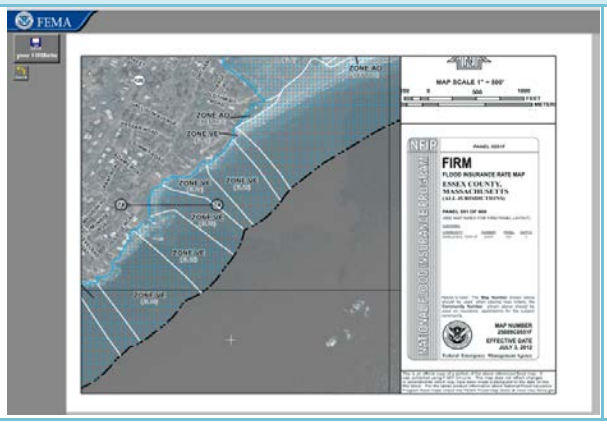
Select “Make a FIRMette.”

Another screen will open with zoom, paper size, and print options.



Select the desired paper size and leave the “Print Area” button as the default setting. Using the pan (hand) tool, drag the pink box to cover your area of interest on the map and then choose either the Adobe PDF or Image File button under the “Create FIRMette” category.

A window will open with your FIRMette, showing front panel information and map scale and legend.



Click “Save your FIRMette.”

Regulations Cited

Massachusetts State Building Code (780 CMR, 8th Edition), comprised of Massachusetts amendments and the International Residential Code 2009, incorporated by reference (www.mass.gov/eopss/consumer-prot-and-bus-lic/license-type/csl/building-codebbrs.html). Effective date February 2, 2011. Boston, MA: Massachusetts Department of Public Safety.

Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) for Administering the Wetlands Protection Act (M.G.L. c. 131, § 40) (www.mass.gov/eea/agencies/massdep/water/regulations/regulations-and-standards.html#12). Effective date October 24, 2014. Boston, MA: Massachusetts Department of Environmental Protection.

State Environmental Code, Title 5: Standard Requirements for the Siting, Construction, Inspection, Upgrade and Expansion of On-Site Sewage Treatment and Disposal Systems and for the Transport and Disposal of Septage (310 CMR 15.000) (www.mass.gov/eea/agencies/massdep/water/regulations/310-cmr-15-00-septic-systems-title-5.html), promulgated pursuant to the authority of M.G.L. c. 21A, § 13. Last amended January 1, 2014. Boston, MA: Massachusetts Department of Environmental Protection.

Title 44, Code of Federal Regulations, Subpart B, Section 65.11: Evaluation of sand dunes in mapping coastal flood hazard areas (53 FR 16279) (www.gpo.gov/fdsys/pkg/CFR-2002-title44-vol1/pdf/CFR-2002-title44-vol1-sec65-11.pdf). Revised October 1, 2002. Federal Emergency Management Agency.

Technical Guidance and Memorandums

Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Construction, and Maintaining Residential Buildings in Coastal Areas, 4th Edition (FEMA P-55) (CCM), 2011, FEMA. www.fema.gov/library/viewRecord.do?id=1671

> The CCM includes recommendations based on lessons learned from various coastal storm events, an overview of coastal processes and coastal flood hazards, definitions of terms related to the floodplain and coastal flood events, guidance regarding hazard identification, definitions and further information for identifying and understanding the LiMWA, MoWA, and MiWA areas, and an overview of building codes and other regulations.

Guidelines and Standards for Flood Risk Analysis and Mapping, FEMA. www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping

> The guidelines and standards define the specific implementation of the statutory and regulatory requirements for NFIP flood risk analysis and flood zone mapping and address the performance of flood risk projects, processing of Letters of Map Change, and related activities. The Policy for Flood Risk Analysis and Mapping (www.fema.gov/media-library/assets/documents/35313) comprises the standards of the Risk MAP program for practitioners (which is separate from the guidance materials).

Information for Property Owners, National Flood Insurance Program, FEMA.
www.fema.gov/information-property-owners

This web page provides links to information about flood preparedness and flood insurance, estimating premiums and filing claims, determining your flood risk, and viewing and obtaining FIRMs.

Operating Guidance No. 13-13, FEMA.
www.fema.gov/media-library-data/1386337213132-fb592f899608839353d98680c3b8c8fe/ce+for+Improving+the+Identification+and+Mapping+of+the+LiMWA+on+Regulatory+and+Non-Regulatory+NFIP+Products+(Oct+2013).pdf

This memorandum provides guidance for improving the mapping and identification of the Limit of Moderate Wave Action on Flood Insurance Rate Maps.

Operating Guidance No. 15-13, FEMA.
www.fema.gov/media-library-data/1386337351905-03d00f8c6260a1a3589c7a8fc076b5f2/Operating+Guidance+15-13-Revised+Guidance+for+Dune+Erosion+Analysis+for+the+Atlantic+Ocean+and+Gulf+of+Mexico+Coasts+(Oct+2013).pdf

This document provides guidance regarding the proper techniques to use in conducting dune erosion analysis for flood zone mapping along the Atlantic and Gulf of Mexico Coasts.

Policy and Procedures for Identifying and Mapping Areas Subject to Wave Heights Greater than 1.5 Feet as an Informational Layer on Flood Insurance Rate Maps, Procedure Memorandum #50, FEMA.
http://www.fema.gov/media-library-data/1388777384290-38232504045198441b721fb93b5fbd0b/Procedure+Memorandum+50-Policy+and+Procedures+for+Identifying+and+Mapping+Areas+Subject+to+Wave+Heights+Greater+than+1.5+feet+as+an+Informational+Layer+on+Flood+Insurance+Rate+Maps+%28FIRMs%29+%28Dec+2008%29.pdf

This memorandum provides the policy and procedures for identifying and mapping areas subject to wave heights greater than one and a half feet (i.e., the LiMWA) as Informational Layers on FIRMs.

Protecting Homes, FEMA.
www.fema.gov/protecting-homes

This FEMA site provides additional information, such as building code resources, guidance on using flood-resistant construction materials, and other resources for protecting homes from floods and other hazards.

The Zone A Manual: Managing Floodplain Development in Approximate Zone A Areas (FEMA 265), 1995, FEMA.
www.fema.gov/national-flood-insurance-program-flood-hazard-mapping/zone-manual-managing-floodplain-development

This manual provides engineering guidelines for determining Base Flood Elevation in Special Flood Hazard Areas that were studied by approximate methods only and are labeled Zone A on the effective FIRM.

Glossary

1%-Annual-Chance Flood (100-Year Flood) - A flood of a certain magnitude having a 100-year recurrence interval, i.e., a flood having a 1 percent chance of happening in any year; also called the base flood.

A Zone - The area within the Special Flood Hazard Area (subject to inundation by the 1%-annual-chance flood) that is not within the coastal high hazard area. Zones AE, AO, AH, and A are collectively referred to as A Zones. Some A Zones in coastal areas are subject to wave effects, quick-moving water, erosion, scour, or combinations of these forces. See the Limit of Moderate Wave Action and Moderate Wave Action area for information on identifying the portion of the A Zone affected by wave heights greater than 1.5 feet (also known as the Coastal A Zone). A Zones that are not depicted as AE, AO, or AH Zones on the FIRM are areas subject to inundations by a 1%-annual-chance flood, but the predicted elevation of the water has not been determined by a flood study (also referred to as Unnumbered A Zones; these zones are typically found in inland areas).

AH Zone - An area with a 1%-annual chance of shallow flooding, usually in the form of ponding, with an average depth ranging from 1 to 3 feet.

AO Zone - An overwash area (usually sheet flow on sloping terrain) for which flood depths range from 1 to 3 feet and flow velocities and paths vary.

Base Flood Elevation (BFE) - The elevation associated with the flood event having a 1 percent annual chance of being equaled or exceeded in any given year (also known as the 100-year flood). The BFE is shown on the Flood Insurance Rate Map.

Coastal A Zone - See definition for Moderate Wave Action area.

Coastal High Hazard Area - An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. For the criteria used to map this area, see page 4.

Contour Line - A line on a topographic map that connects all points of the same elevation.

Datum - A reference from which measurements are made. In surveying and geodesy, a vertical datum is used for measuring the elevations of points on the Earth's surface. Vertical datums are either tidal (based on sea levels) or geodetic (based on ellipsoid models of the Earth). The datum points most often referenced are the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Vertical Datum of 1988 (NAVD 88). Occasionally, a reference point can be zeroed to a pre-established datum held on a local benchmark and data will be acquired relative to this position.

Effective FIRM - The National Flood Insurance Program map issued by the Federal Emergency Management Agency that is currently in effect. The date of the effective FIRM is available from the FEMA Map Service Center.

FIRM Database - Compilations of digital GIS data representing the information for preliminary or pending Flood Insurance Rate Maps. When FIRMs and FIRM Databases become effective, that data is incorporated into the National Flood Hazard Layer.

Flood Insurance Rate Map (FIRM) - A map on which the floodplains for a 1%- and 0.2%-annual-chance flood (i.e., 100-year and 500-year flood), Base Flood Elevations, and risk premium zones are delineated to enable insurance agents to issue flood insurance policies to homeowners in communities participating in the National Flood Insurance Program. FIRMs can be viewed online or downloaded and viewed in typical image viewers or through digital mapping and analysis software, such as GIS software. A compilation of digital FIRM data can be found within the National Flood Hazard Layer, which is to be used with GIS applications. When in preliminary or pending status, the FIRMs can be found in the database referred to as the FIRM Database.

Flood Insurance Study (FIS) - A report available from the Federal Emergency Management Agency for each community/county that generally contains a narrative of the flood history of a community, the engineering methods used to develop the Flood Insurance Rate Maps, and the date of their completion.

Floodplain - Any land area susceptible to being inundated by water from any source.

Floodway - The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height (typically one foot), the boundary of which is the area designated as floodway on the most recently available flood profile data prepared for the site.

Frontal Dune Reservoir - The portion of a primary frontal dune analyzed by the Federal Emergency Management Agency to determine whether the dune is likely to withstand a 1%-annual-chance flood or be completely eroded. The frontal dune reservoir is above the Total Water Level and seaward of the peak of the primary frontal dune. For mound-shaped primary frontal dunes, the landward-most peak is used as the crest.

Letter of Map Amendment (LOMA) - An interpretation from the Federal Emergency Management Agency of the flood zone boundaries that currently exist on a Flood Insurance Rate Map; it does not reflect any change to the FIRM based on the evaluation of new data.

Letter of Map Change (LOMC) - A general term used to refer to a clarification or change to a Flood Insurance Rate Map that can be accomplished by letter, including a Letter of Map Amendment (LOMA) and a Letter of Map Revision (LOMR).

Letter of Map Revision (LOMR) - A request to FEMA by an applicant (typically a property owner or community) to change the Flood Insurance Rate Map based on new, site-specific data and detailed engineering analysis. All LOMR determinations become part of the effective FIRM.

Limit of Moderate Wave Action (LiMWA) - The approximate boundary of the 1.5-foot breaking wave identified on the Massachusetts Coastal A Zone Maps (also the boundary between the Moderate Wave Action [MoWA] area and the Minimal Wave Action [MiWA] area).

Massachusetts Coastal A Zone Maps - These maps developed by the Massachusetts Office of Coastal Zone Management and Department of Conservation and Recreation in 2015 delineate the Limit of Moderate Wave Action (LiMWA) based on current Federal Emergency Management Agency guidance (Operating Guidance 13-13).

Mean High Water (MHW) - As defined in the Massachusetts Wetland Protection Act Regulations at 310 CMR 10.23, the line where the arithmetic mean of the high water heights observed over a specific 19-year metonic cycle (the National Tidal Datum Epoch) meets the shore, determined using hydrographic survey data of the National Ocean Survey of the U.S. Department of Commerce.

Minimal Wave Action (MiWA) Area - The portion of the Special Flood Hazard Area in coastal areas where base flood wave heights are less than 1.5 feet.

Moderate Wave Action (MoWA) Area (Also known as the Coastal A Zone) - The portion of the Special Flood Hazard Area in coastal areas where base flood wave heights are between 1.5 and 3.0 feet, and where wave characteristics are deemed sufficient to damage typical A Zone construction. The MoWA is depicted on the Massachusetts Coastal A Zone Maps.

Mound-Type Primary Dune - A primary frontal dune with more than one peak.

National Flood Hazard Layer (NFHL) - A computer database that contains all of the Federal Emergency Management Agency's current effective digital flood hazard data that are available as of the dataset release date. The NFHL can be used in GIS applications to provide users with the ability to determine the flood zone, Base Flood Elevation, and floodway status for a particular geographic location. It also includes information and data on the National Flood Insurance Program community, map panel, cross sections and hydraulic structures, Coastal Barrier Resource Systems, and basemaps, such as road, stream, and public land survey data. Data that are in preliminary or pending status are available in FEMA's FIRM Database.

National Flood Insurance Program (NFIP) - The Federal Emergency Management Agency regulatory program under which flood-prone areas are identified and flood insurance is made available to residents of participating communities.

Preliminary FIRMs - Draft revised Flood Insurance Rate Maps issued to the community for review and public comment.

Primary Frontal Dune (Also referred to as a Primary Dune) - A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms (i.e., the dune closest to the beach). The landward (inland) limit of the primary frontal dune, also known as the toe of the dune, occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope.

Ridge-Type Primary Dune - A primary frontal dune with one distinct peak.

Special Flood Hazard Area (SFHA) - Any area inundated by the 1%-annual-chance flood; these areas are identified on the Flood Insurance Rate Map as Zones A, AE, AH, AO, AR, A1-30, A99, V, VE, and V1-30.

Splash Zone - The portion of the V Zone that extends beyond and farther landward than a seawall or revetment that is overtopped by waves. The splash zone is typically 30 feet from the seaward side of the seawall.

Stillwater Elevation - The projected elevation that flood waters would reach (referenced to the National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or other datum) in the absence of waves resulting from wind or seismic effects. The stillwater elevation includes the storm surge.

Storm Surge - The water, combined with normal tides, which is pushed toward the shore by strong winds during a storm. This rise in water level can cause severe flooding in coastal areas, particularly when the storm coincides with the normal high tides. The height of the storm surge is affected by many variables, including the storm intensity, storm track and speed, presence of waves, offshore depths, and shoreline configuration.

Total Water Level - Stillwater elevation plus wave setup.

Velocity Zone (V Zone, VE Zone) - The V Zone, also referred to as the coastal high hazard area, is the portion of the Special Flood Hazard Area that extends from offshore to the inland limit of a primary frontal dune along an open coast, and any other area subject to high-velocity wave action from storms or seismic sources. For the criteria used to map this area, see page 4.

Wave Crest Profile - The predicted height of flood waters (including wave crests, which are the highest part of the wave) that is plotted along a transect. The wave crest profile tapers down in elevation as it moves onto the shore and across the floodplain.

Wave Height - The vertical distance between the wave crest (the highest part of the wave) and adjacent wave trough (the lowest part of the wave).

Wave Runup - The movement of water that occurs as waves break and flow up beaches, sloping surfaces, and vertical surfaces. Wave runup can drive large volumes of water against or around coastal buildings, inducing fluid impact forces (albeit smaller than breaking wave forces), current drag forces, and localized erosion and scour.

Wave Runup Depth - The depth that equals the vertical distance between the calculated wave runup profile elevation and the ground contour elevation at that location.

Wave Runup Elevation - The elevation reached by wave runup, referenced to the North American Vertical Datum of 1988 (NAVD 88), or other datum.

Wave Setup - Wave setup is the elevated water level associated with waves coming ashore but not fully receding.

X Zone - The area beyond (landward of) the 1%-annual-chance floodplain (i.e., beyond the V, AE, AO, and AH Zones) that may be shown on Flood Insurance Rate Maps. Shaded X Zones designate areas subject to inundation by the 0.2%-annual-chance flood (also known as the 500-year flood). Unshaded X Zones designate areas where the annual probability of flooding is less than 0.2 percent.

Agency and Organization Websites

Association of State Floodplain Managers - www.floods.org

Federal Emergency Management Agency (FEMA), Region One - www.fema.gov/region-i-ct-me-ma-nh-ri-vt

Massachusetts Department of Conservation and Recreation (DCR), Flood Hazard Management Program - www.mass.gov/eea/agencies/dcr/water-res-protection/hazard-mitigation

Massachusetts Department of Environmental Protection (MassDEP) - www.mass.gov/dep

Massachusetts Department of Public Safety - www.mass.gov/eopss/agencies/dps

Massachusetts Office of Coastal Zone Management (CZM) - www.mass.gov/czm

United States Army Corps of Engineers, New England District - www.nae.usace.army.mil

COMMONWEALTH OF MASSACHUSETTS
Charlie Baker, Governor

EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Matthew A. Beaton, Secretary

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT
Bruce K. Carlisle, Director

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT | 251 Causeway Street, Suite 800 | Boston, MA 02114 | (617) 626-1200
CZM INFORMATION LINE: (617) 626-1212 | **CZM WEBSITE:** www.mass.gov/czm

This is a publication of the Massachusetts Office of Coastal Zone Management (CZM) pursuant to the National Oceanic and Atmospheric Administration Award No. NA14NOS4190068. This publication is funded (in part) by a grant/cooperative agreement from the National Oceanic and Atmospheric Administration (NOAA). Printing of this document was funded by Hazard Mitigation Grant Award No. HMGP 1895-08 from the Federal Emergency Management Agency (FEMA). The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its sub-agencies or of FEMA. ***This information is available in alternate formats upon request.***

PUBLICATION DATE: OCTOBER 2015 **PHOTOS:** Massachusetts Office of Coastal Zone Management | **PRINTED ON RECYCLED PAPER**