UNIT II: COASTAL ENVIRONMENT

COASTAL ENVIRONMENT

INTRODUCTION

Planning, siting, design, and construction of coastal residential buildings require an understanding of the coastal environment—including a basic understanding of coastal geology, coastal processes, regional variations in coastline characteristics, and coastal sediment budgets. This unit will briefly discuss each of these topics.

UNIT OBJECTIVES

After completing this unit, you should be able to:

2.1 Explain the concept of coastal sediment budget.
2.2 Identify characteristics of major divisions of the U.S. coastlines.
2.3 Interpret basic NFIP map information.
2.4 Define key terms related to Base Flood Elevation (BFE).

COASTAL REGION TERMINOLOGY

COASTAL GEOLOGY

Coastal geology refers to the origin, structure, and characteristics of the sediments that make up the coastal region, from the uplands to the nearshore region (see Fig. 2-1). The sediments can vary from small particles of silt or sand (a few thousandths or hundredths of an inch across), to larger particles of gravel and cobble (up to several inches across), to formations of consolidated sediments and rock.

The sediments can be easily erodible and transportable by water and wind, as in the case of silts and sands, or can be highly resistant to erosion. The sediments and geology that compose a particular coastline will be the product of physical and chemical processes that take place over thousands of years.

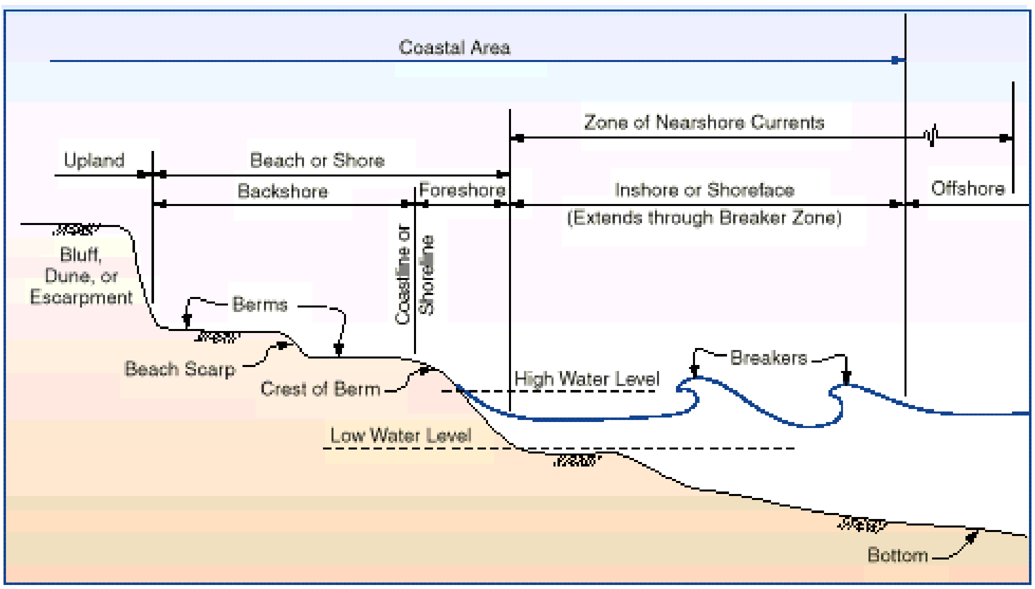


Figure 2-1. Coastal region terminology

COASTAL PROCESSES

Coastal processes refers to those physical processes that act upon and shape the coastline. These processes, which influence the configuration, orientation, and movement of the coast, include:

- Tides and fluctuating water levels.
- Waves.
- Currents (usually generated by tides or waves).
- Winds.

Coastal processes interact with the local coastal geology and sediment supply to form and modify the physical features that will be referred to frequently in this course: beaches, dunes, bluffs, and upland areas. Water levels, waves, currents, and winds will vary with time at a given location (sometimes according to short-term, seasonal, or longer-term patterns) and will vary geographically at any point in time.

A good analogy is weather: weather conditions at a given location undergo significant variability over time but tend to follow seasonal and other patterns. Further, weather conditions can differ substantially from one location to another at the same point in time.

REGIONAL VARIATIONS IN COASTLINES

Regional variations in coastlines will be the product of variations in coastal processes and coastal geology. These variations can be quite substantial, as you will see later in this unit. Thus, shoreline siting and design practices appropriate to one area of the coastline may not be suitable for another.

COASTAL SEDIMENT BUDGETS

Coastal sediment budget refers to the identification of sediment sources and sinks, and the quantification of the amounts and rates of sediment transport, erosion, and deposition within a defined region.

Sediment budgets are used by coastal engineers and geologists to analyze and explain shoreline changes and to project future shoreline behavior.

NOTE

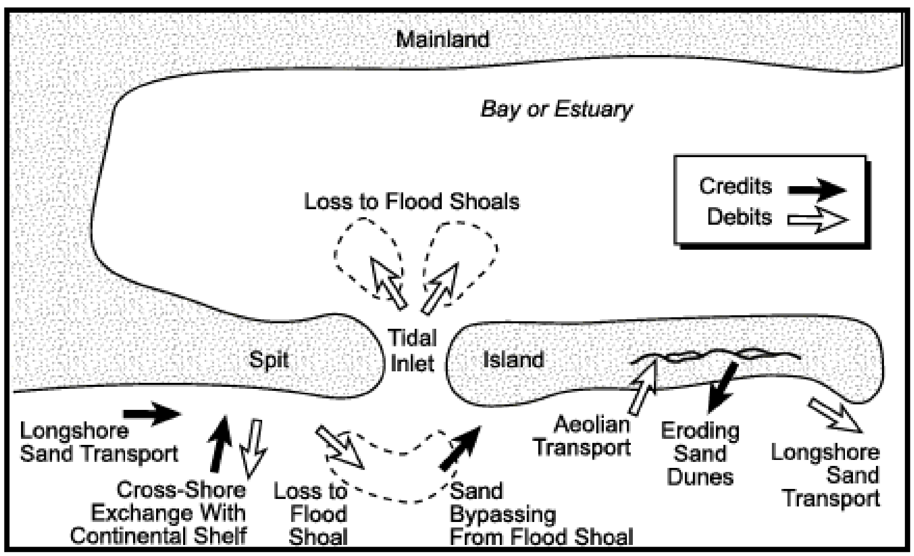
The premise behind a *coastal sediment budget* is simple: if more sediment is transported by coastal processes or human actions into a given area than is transported out, **shoreline accretion** results. If more sediment is transported out of an area than is transported in, **shoreline erosion** results.

While the calculation of sediment budgets is beyond the scope of typical planning and design studies for coastal residential structures, it is useful to consider the basic concept and to review the principal components that make up a sediment budget. Moreover, sediment budgets may have been calculated by others for the shoreline segment containing a proposed building site.

Figures 2-2 and 2-3 illustrate the principal components of sediment budgets for the majority of U.S. coastline types.

Note that there may be other locally important sediment sources and sinks that are not shown in the figures. For example, the addition of sand to a beach through **beach nourishment** could be considered a significant source in some communities. The loss of sediment through storm-generated **overwash** could represent an important loss in some areas.

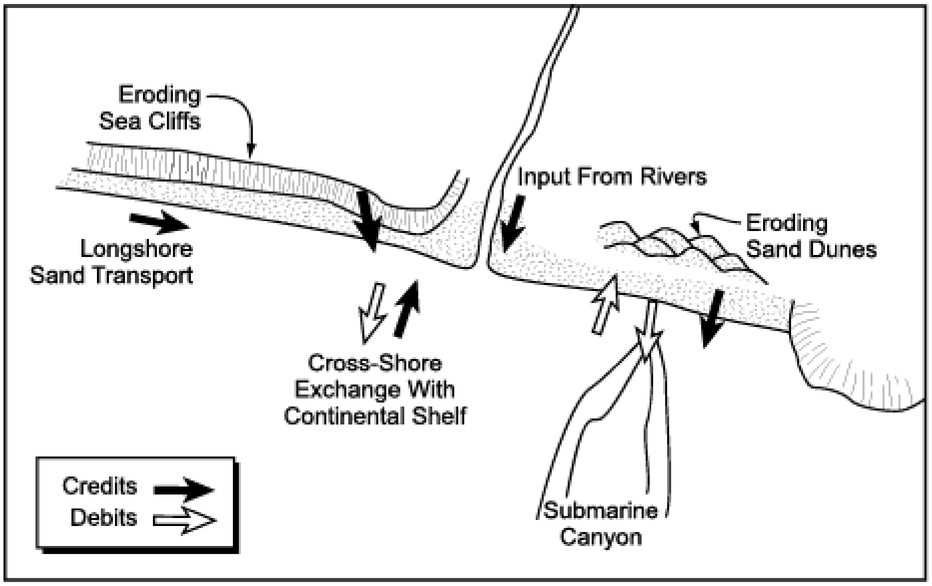
Figure 2-2.
Principal components of a typical sediment budget for a barrier island and barrier spit shoreline.



Flood shoals are sediment deposits formed just inside a tidal inlet by flood tidal currents (also called flood tidal delta).

Ebb shoals are sediment deposits formed by ebb tidal currents just offshore of a tidal inlet (also called ebb tidal delta).

Figure 2-3.
Principal components of a typical sediment budget for a mainland shoreline backed by bluffs and dunes.



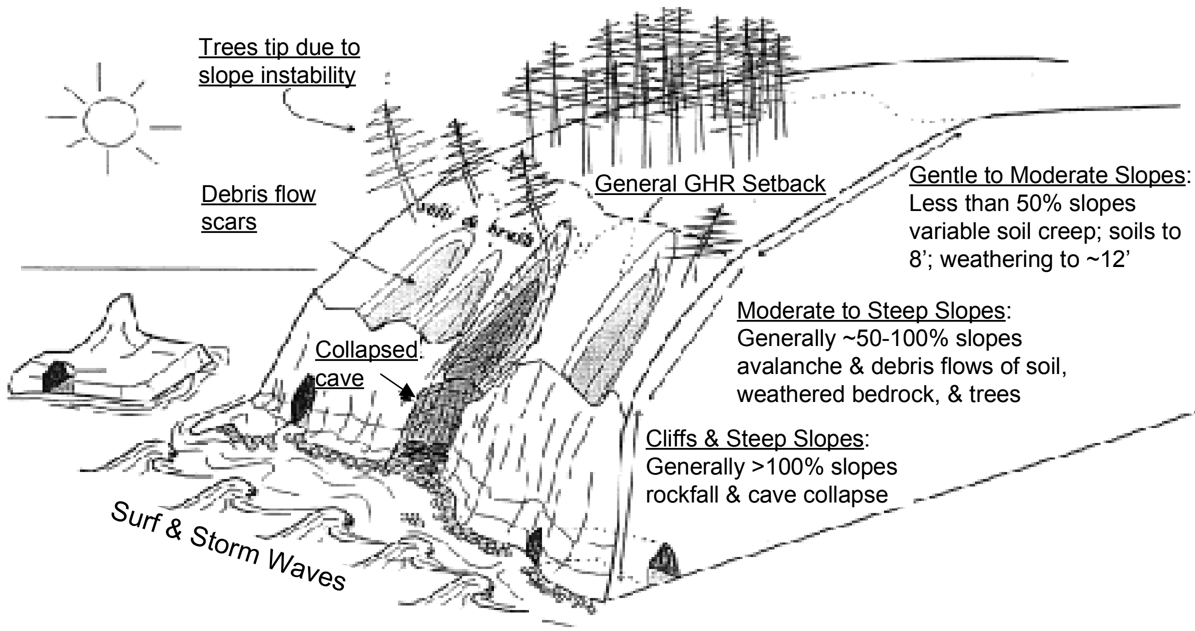
Longshore sand transport is wave- and/or tide-generated movement of shallow-water coastal sediments parallel to the shoreline.

Cross-shore sand transport is wave- and/or tide-generated movement of shallow-water coastal sediments toward or away from the shoreline.

Note that Figures 2-2 and 2-3 do not characterize all coastlines, particularly those rocky coastlines that are generally resistant to erosion and whose existence does not depend upon littoral sediments transport by coastal processes.

Rocky coastlines typical of many Pacific, Great Lakes, New England, and Caribbean areas are better represented by Figure 2-4, which illustrates the slow process by which rocky coasts erode in response to elevated water levels, waves, and storms.

Figure 2-4. Generalized depiction of erosion process along a rocky coastline.



Breakers erode base of cliff, forming caves in cones of weakness; caves eventually form arches, then stacks; some caves collapse. Weathering causes rockfall on cliff face. Debris flows and avalanches on steeper slopes are triggered by seismicity, heavy soil saturation, and loss of tree root strength.

SELF-CHECK REVIEW: COASTAL REGION TERMINOLOGY

Instructions: Answer the following questions. Then turn the page to check your answers. If you answered any questions incorrectly, you should review the related material before continuing.

1. ___________________ refers to the origin, structure, and characteristics of the sediments that make up the coastal region.

   a. Coastal sediment budget
   b. Coastal geology
   c. Longshore sand transport
   d. Cross-shore sand transport

2. ___________________ refers to the identification of sediment sources and sinks, and the quantification of the amounts and rates of sediment transport, erosion, and deposition within a defined region.

   a. Coastal sediment budget
   b. Coastal geology
   c. Longshore sand transport
   d. Cross-shore sand transport

3. ___________________ refers to wave- and/or tide-generated movement of shallow-water coastal sediments toward or away from the shoreline.

   a. Coastal sediment budget
   b. Coastal geology
   c. Longshore sand transport
   d. Cross-shore sand transport

4. ___________________ refers to wave- and/or tide-generated movement of shallow-water coastal sediments parallel to the shoreline.

   a. Coastal sediment budget
   b. Coastal geology
   c. Longshore sand transport
   d. Cross-shore sand transport

5. If more sediment is transported by coastal processes or human actions into a given area than is transported out, shoreline erosion results.

   True False

ANSWER KEY

1. ____________________ refers to the origin, structure, and characteristics of the sediments that make up the coastal region.

   b. Coastal geology

2. ____________________ refers to the identification of sediment sources and sinks, and the quantification of the amounts and rates of sediment transport, erosion, and deposition within a defined region.

   a. Coastal sediment budget

3. ____________________ refers to wave- and/or tide-generated movement of shallow-water coastal sediments toward or away from the shoreline.

   d. Cross-shore sand transport

4. ____________________ refers to wave- and/or tide-generated movement of shallow-water coastal sediments parallel to the shoreline.

   c. Longshore sand transport

5. If more sediment is transported by coastal processes or human actions into a given area than is transported out, shoreline erosion results.

   False.
   In this situation, shoreline accretion results.

UNITED STATES COASTLINE CHARACTERISTICS

The coastline of the United States can be divided into seven major segments and smaller segments, as shown in Figure 2-5. Each of the subsegments generally describes coastlines of similar origin, characteristics, and hazards.

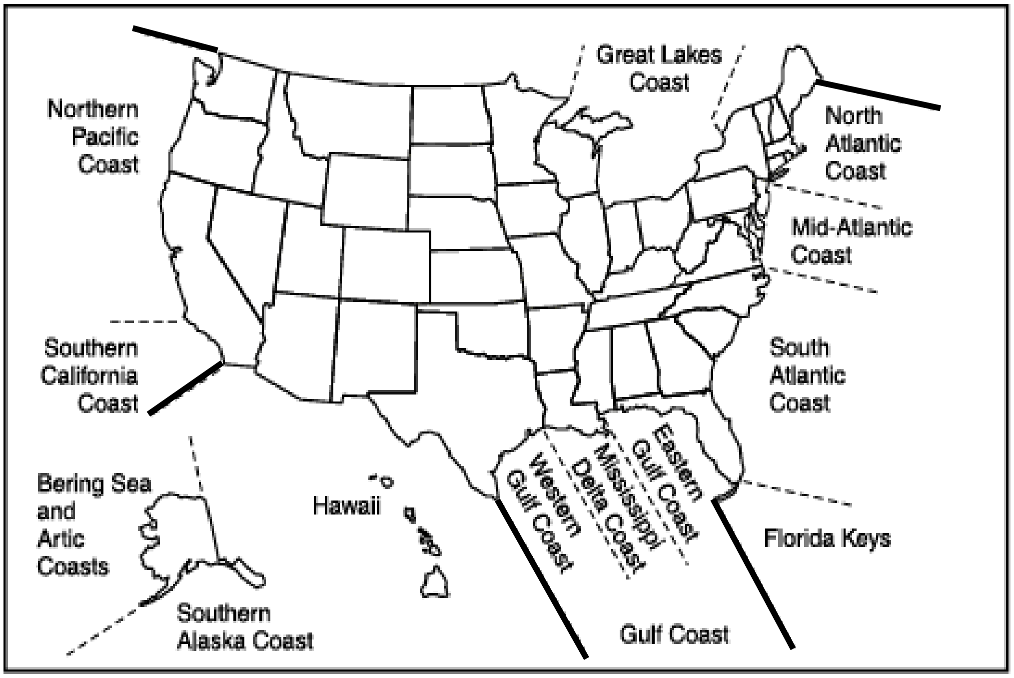


Figure 2-5.
The United States coastline

SECTIONS AND SUBSECTIONS

1) **Atlantic coast.** The Atlantic coast is divided into:

- **North Atlantic** coast—from Maine to Long Island, New York.
- **Mid-Atlantic** coast—from New Jersey to Virginia.
- **South Atlantic** coast—from North Carolina to South Florida.
- **Florida Keys**.

2) **Gulf of Mexico coast.** The Gulf coast is divided into:

- **Eastern Gulf** coast—from southwest Florida to Mississippi.
- **Mississippi Delta** coast of southeast Louisiana.
- **Western Gulf** coast of Louisiana and Texas.

3) **Pacific coast.** The Pacific coast is divided into:

- **Southern California** coast—from San Diego County to Point Conception (Santa Barbara County), California.
- **North Pacific** coast—from Point Conception, California, to Washington.

4) **Great Lakes coast**, which extends from Minnesota to New York.

5) **Coast of Alaska**.

6) **Coast of Hawaii** and **Pacific Territories**.

7) **Coast of Puerto Rico** and the **U.S. Virgin Islands**.

The U.S. Army Corps of Engineers in 1971 estimated the total shoreline length of the continental United States, Alaska, and Hawaii at 84,240 miles, including 34,520 miles of exposed shoreline and 49,720 miles of sheltered shoreline. The shoreline length of the continental United States alone was put at 36,010 miles (13,370 miles exposed, 22,640 miles sheltered).

ATLANTIC COAST

The **North Atlantic** coast is glacial in origin. It is highly irregular, with erosion-resistant rocky headlands and pocket beaches in northern New England, and erodible bluffs and sandy barrier islands in southern New England and along Long Island, New York.

The **Mid-Atlantic** coast extends from New Jersey to Virginia and includes two of the largest estuaries in the United States—Delaware Bay and Chesapeake Bay. The open coast shoreline is generally composed of long barrier islands separated by tidal inlets and bay entrances.

The **South Atlantic** coast consists of three regions:

- The North Carolina and northern South Carolina shoreline—composed of long barrier and mainland beaches (including the Outer Banks and the South Carolina Grand Strand region).

- The region extending from Charleston, South Carolina, to the St. Johns River entrance at Jacksonville, Florida—a tide-dominated coast composed of numerous short barrier islands, separated by large tidal inlets and backed by wide expanses of tidal marsh.

- The east coast of Florida—composed of barrier and mainland beaches backed by narrow bays and rivers.

The **Florida Keys** are a series of low-relief islands formed by limestone and reef rock, with narrow, intermittent carbonate beaches.

Vulnerability: The entire Atlantic coast is subject to high storm surges from hurricanes and/or northeasters. Wave runup on steeply sloping beaches and shorelines in New England is also a common source of coastal flooding.

GULF OF MEXICO COAST

Cheniers are Mississippi Delta sediments transported westward to form sandy ridges atop mud plains.

The Gulf of Mexico coast can be divided into three regions:

- The eastern Gulf coast from southwest Florida to Mississippi—composed of low-lying sandy barrier islands south of Tarpon Springs, Florida, and west of St. Marks, Florida, with a marsh-dominated coast in between in the Big Bend area of Florida.
- The Mississippi Delta region—characterized by wide, marshy areas and a low-lying coastal plain.
- The western Gulf of Mexico coast, including the **cheniers** of southwest Louisiana, and the long, sandy barrier islands of Texas.

Vulnerability: The entire Gulf coast is vulnerable to high storm surges from hurricanes. Some areas (e.g., the Big Bend area of Florida) are especially vulnerable because of a wide, shallow continental shelf and low-lying upland areas.

PACIFIC COAST

The Pacific coast can be divided into two regions:

- The southern California reach—dominated by long, sandy beaches and coastal bluffs.
- The northern Pacific reach—characterized by rocky cliffs, pocket beaches, and occasional long sandy barriers near river mouths.

Vulnerability: Open coast storm surges along the Pacific shoreline are generally small (less than 2 feet) because of the narrow continental shelf and deep water close to shore. However, storm wave conditions along the Pacific shoreline are very severe, and the resulting wave runup can be very destructive. In some areas of the Pacific coast, tsunami flood elevations can be much higher than flood elevations associated with coastal storms.

GREAT LAKES COAST

The shorelines of the Great Lakes are highly variable and include wetlands, low and high cohesive bluffs, low sandy banks, and lofty sand dunes perched on bluffs (200 feet or more above lake level).

Vulnerability: Storm surges along the Great Lakes are generally less than 2 feet except in embayments (2–4 feet) and on Lake Erie (up to 8 feet). Periods of active erosion are triggered by heavy precipitation events, storm waves, rising lake levels, and changes in groundwater outflow along the coast.

COAST OF ALASKA

The coast of Alaska can be divided into two areas:

- The southern coast, dominated by steep mountainous islands indented by deep fjords.
- The Bering Sea and arctic coasts, backed by a coastal plain dotted with lakes and drained by numerous streams and rivers.

Vulnerability: The climate of Alaska and the action of ice along the shorelines set it apart from most other coastal areas of the United States.

COAST OF HAWAII AND PACIFIC TERRITORIES

The islands that make up Hawaii are submerged volcanoes; thus, the coast of Hawaii is formed by rocky cliffs and intermittent sandy beaches. Coastlines along the Pacific Territories are generally similar to those of Hawaii.

Vulnerability: Coastal flooding can result from two sources: storm surges from hurricanes or cyclones, and wave runup from tsunamis.

COAST OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Like the Hawaiian Islands and Pacific Territories, the islands of Puerto Rico and the Virgin Islands are the products of ancient volcanic activity. The coastal lowlands of Puerto Rico, which occupy nearly one-third of the island's area, contain sediment eroded and transported from the steep, inland mountains by rivers and streams. Ocean currents and wave activity rework the sediments on pocket beaches around each island.

Vulnerability: Coastal flooding is usually caused by hurricanes, although tsunami events are not unknown to the Caribbean.

SELF-CHECK REVIEW: U.S. COASTLINE CHARACTERISTICS

Instructions: Answer the following questions. Then turn the page to check your answers. If you answered any items incorrectly, you should review the related material before continuing.

For each item on the left, find the phrase on the right that best applies to it. Write the letter of the phrase in the blank.

1.	___ North Atlantic coast	a.	Rocky cliffs
2.	___ Gulf of Mexico coast	b.	Two of the largest estuaries in the U.S.
3.	___ Southern Pacific coast	c.	Erodible bluffs and sandy barrier islands
4.	___ Coast of Alaska	d.	Long, sandy beaches and coastal bluffs
5.	___ Mid-Atlantic coast	e.	Action of ice along the shoreline
6.	___ South Atlantic coast	f.	Marshy coast, low-lying coastal plain, cheniers
7.	___ Northern Pacific coast	g.	Barrier islands, mainland beaches, large tidal inlets

Circle True or False.

8. The entire Atlantic coast is subject to high storm surges from hurricanes and/or northeasters.

   True False

9. The entire Gulf coast is vulnerable to storm surges from hurricanes or cyclones, and wave runup from tsunamis.

   True False

10. In some areas of the Pacific coast, tsunami flood elevations can be much higher than flood elevations associated with coastal storms.

    True False

ANSWER KEY

1. <u>**c**</u> North Atlantic coast	a. Rocky cliffs
2. <u>**f**</u> Gulf of Mexico coast	b. Two of the largest estuaries in the U.S.
3. <u>**d**</u> Southern Pacific coast	c. Erodible bluffs and sandy barrier islands
4. <u>**e**</u> Coast of Alaska	d. Long, sandy beaches and coastal bluffs
5. <u>**b**</u> Mid-Atlantic coast	e. Action of ice along the shoreline
6. <u>**g**</u> South Atlantic coast	f. Marshy coast, low-lying coastal plain, cheniers
7. <u>**a**</u> Northern Pacific coast	g. Barrier islands, mainland beaches, large tidal inlets

8. The entire Atlantic coast is subject to high storm surges from hurricanes and/or northeasters.

   True

9. The entire Gulf coast is vulnerable to storm surges from hurricanes or cyclones, and wave runup from tsunamis.

   False.
   The Gulf coast is vulnerable to high storm surges from hurricanes, but there is no particular risk of tsunamis in this region.

10. In some areas of the Pacific coast, tsunami flood elevations can be much higher than flood elevations associated with coastal storms.

    True

COASTAL FLOOD HAZARDS

Coastal flood hazards at a site will depend upon several factors:

- The elevation and topography of the site.
- The erodibility of the site.
- The nature and intensity of coastal flood events affecting the site.

FEMA has developed procedures for estimating and mapping coastal flood hazards that take the above factors into account. This section describes some of the underlying concepts and mapping issues.

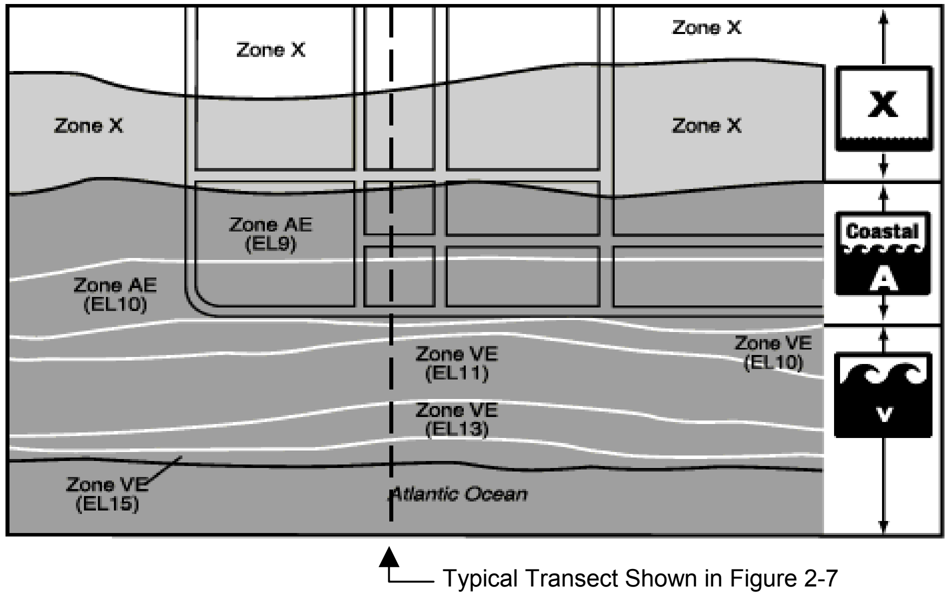
Figure 2-6 shows a portion of a typical Flood Insurance Rate Map (FIRM) that a designer is likely to encounter for a coastal area. Three flood hazard zones have been mapped: V zones, A zones, and X zones. The V zone is the most hazardous of the three areas because structures there will be exposed to the most severe flood and wind forces, including wave action, high-velocity flow, and erosion. **The A zone shown on the map should be thought of as a coastal A zone.**

NOTE

As noted earlier, the *Coastal Construction Manual* introduces the concept of the **coastal A zone** to differentiate A zones in coastal areas from those in inland areas. Coastal A zones are not currently mapped or regulated by FEMA any differently than inland A zones; however, post-disaster damage inspections consistently show the need for such a distinction. Flood hazards in coastal A zones, like those in V zones, can include the effects of waves, velocity flow, and erosion (although the magnitude of these effects will be less in coastal A zones than in V zones).

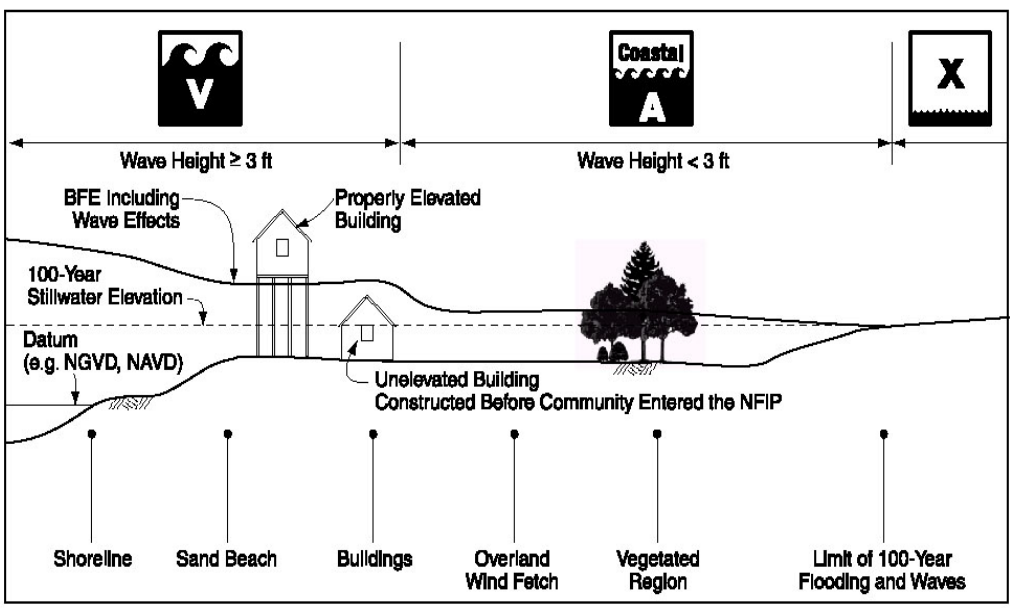
FEMA's flood mapping procedures show the area designated as Zone X on the map has less than a one percent probability of flooding in any year.

Figure 2-6. Portion of a FIRM



- Dark gray = coastal Special Flood Hazard Area (SFHA)
- Light gray = 500-year flood hazard area.
- Numbers in parentheses = Coastal BFEs.
- Flood insurance rate zones: AE and VE = SFHA; VE = Coastal High Hazard Area; X = areas outside the SFHA

Figure 2-7. Typical shoreline-perpendicular transect used in the analysis of stillwater and wave crest elevations



STILLWATER ELEVATION

A FIRM is the product of a **Flood Insurance Study** (FIS) conducted for a community under FEMA's National Flood Insurance Program. A coastal FIS is completed with specified techniques and procedures to determine stillwater and wave elevations along transects drawn perpendicular to the shoreline (see Figures 2-6 and 2-7).

The determination of the 100-year stillwater elevation (and stillwater elevations associated with other return periods) is usually accomplished through the statistical analysis of historical tide and water level data, or by the use of a numerical storm surge model.

Wave heights and elevations are computed from stillwater and topographic data with established procedures and models that account for wave dissipation by obstructions (e.g., sand dunes, buildings, vegetation) and wave regeneration across overland fetches.

Several factors can contribute to the 100-year stillwater elevation in a coastal area. The most important factors include:

- Offshore bathymetry.
- Astronomical tide.
- Wind setup (rise in water surface as strong winds blow water toward the shore).
- Pressure setup (rise in water surface from low atmospheric pressure).
- Wave setup (rise in water surface inside the surf zone from the presence of breaking waves).
- Seiches and long-term changes in lake levels (in the case of the Great Lakes).

NOTE

Base Flood Elevations (BFEs) in coastal areas will be controlled by the higher of the wave crest elevation or the wave runup elevation.

WAVE HEIGHTS AND WAVE CREST ELEVATIONS

FEMA's primary means of establishing Base Flood Elevations (BFEs) and distinguishing between V zones, (coastal) A zones, and X zones is the **wave height**. The wave height is simply the vertical distance between the crest and trough of a wave propagating over the water surface. BFEs in coastal areas are usually set at the crest of the wave as it propagates inland.

The maximum **wave crest elevation** (used to establish the BFE) is determined by the maximum wave height, which depends largely on the 100-year stillwater depth (d_{100}). This depth is the difference between the 100-year stillwater elevation (E_{100}) and the ground elevation (GS).

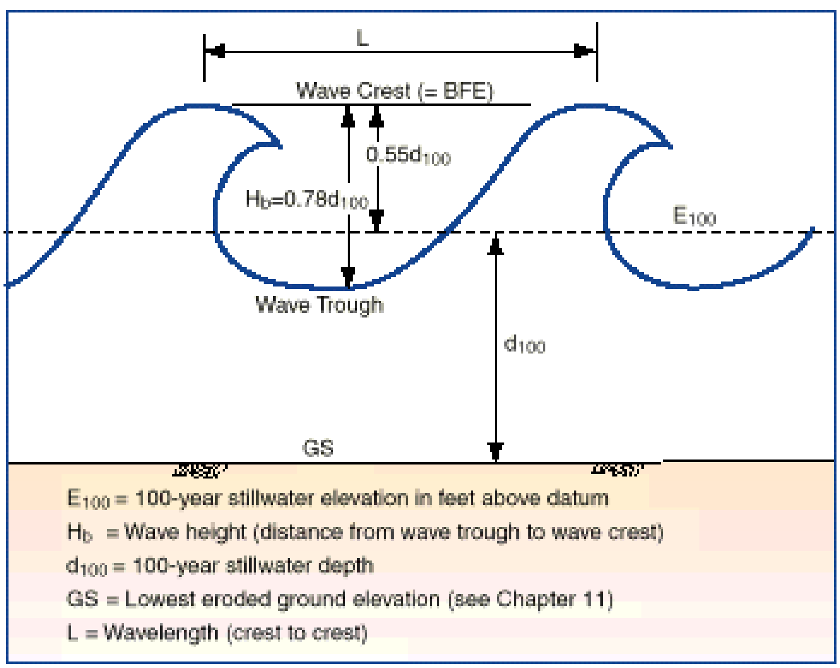
(Note that GS is ***not*** the existing ground elevation; it is the ground elevation that will result from the amount of erosion expected to occur during the 100-year flood.)

def-a-

Wave height is the vertical distance between the wave crest and wave trough (see Fig. 2-8).

Wave crest elevation is the elevation of the crest of a wave, referenced to the NGVD or other datum.

Figure 2-8. Determination of BFE in coastal flood hazard areas where wave crest elevations exceed wave runup elevations (zones A and V). Note that BFE = E_{100} + $0.55d_{100}$.



Wave setup is an increase in the stillwater surface near the shoreline, because of the presence of breaking waves. Wave setup typically adds 1.5 to 2.5 feet to the 100-year stillwater flood elevation.

In relatively shallow waters, such as those in coastal areas of the United States, the maximum height of a breaking wave (H_b) is determined by the equation $\mathbf{H_b = 0.78d_{sw}}$, where d_{sw} is the stillwater depth.

The maximum height of a breaking wave above the stillwater elevation is equal to $0.55d_{100}$ (see Fig. 2-8). Note that for wind-driven waves, water depth is only one of three parameters that determine actual wave height at a particular site (wind speed and fetch length are the other two). In some instances, actual wave heights may be below the computed maximum height.

For a coastal flood hazard area where the ground is gently sloping, the BFE shown on the FIRM is equal to the ground elevation (referenced to the NGVD or other datum) plus the 100-year stillwater depth (d_{100}) plus $0.55d_{100}$.

> Example: Where the ground elevation is 4 feet NGVD and d_{100} is 6 feet, the BFE is equal to 4 feet plus 6 feet plus 3.3 feet, or 13.3 feet NGVD.

WAVE RUNUP

On steeply sloped shorelines, the rush of water up the surface of the natural beach, including dunes and bluffs, or the surface of a manmade structure, such as a revetment or vertical wall, can result in flood elevations higher than those of the crests of wind-driven waves.

For a coastal flood hazard area where this situation occurs, the BFE shown on the FIRM is equal to the highest elevation reached by the water (see Fig. 2-9). The methodology adopted by FEMA for the computation of wave runup elevations includes the determination of wave heights. Where the wave runup elevations are lower than the wave height elevations, the BFE equals the wave height elevation.

Wave runup is the rush of water up a slope or structure.

Wave runup elevation is the elevation reached by wave runup, referenced to the NGVD or other datum.

Wave runup depth at any point is equal to the maximum wave runup elevation minus the lowest eroded ground elevation at that point.

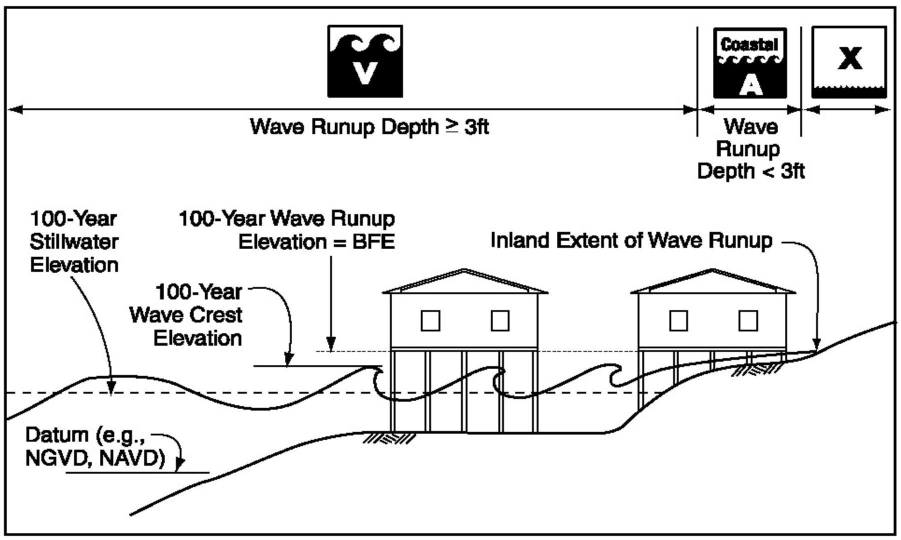


Figure 2-9.
Where wave runup elevations exceed wave crest elevations, the BFE is equal to the runup elevation.

EROSION CONSIDERATIONS AND FLOOD HAZARD MAPPING

Current FIS procedures account for the potential loss of protective dunes during the 100-year flood. However, this factor was not considered in the preparations of many older coastal FIRMs, which delineated V zones without any consideration for storm-induced erosion. V-zone boundaries were often drawn at the crest of the dune solely on the basis of the elevation of the ground and without regard for the erosion that would occur during a storm.

Designers, property owners, and floodplain managers should be careful not to assume that flood hazard zones shown on FIRMs accurately reflect current flood hazards. For example, flood hazard restudies completed after Hurricanes Opal (1995—Florida Panhandle) and Fran (1966—Topsail Island, North Carolina) have produced FIRMs that are dramatically different from the FIRMs in effect prior to the storms.

Figure 2-10 compares pre- and post-storm FIRMs for Surf City, North Carolina. The map changes are attributable to two factors:

- Pre-storm FIRMs did not show the effects of erosion that had occurred since the FIRMs were published and did not meet technical standards currently in place.

- Hurricane Fran caused significant changes to the topography of the barrier island.

Not all coastal FIRMs would be expected to undergo such drastic revisions after a flood restudy; however, many FIRMs may be in need of updating, and designers should be aware that FIRMs may not reflect present flood hazards at a site.

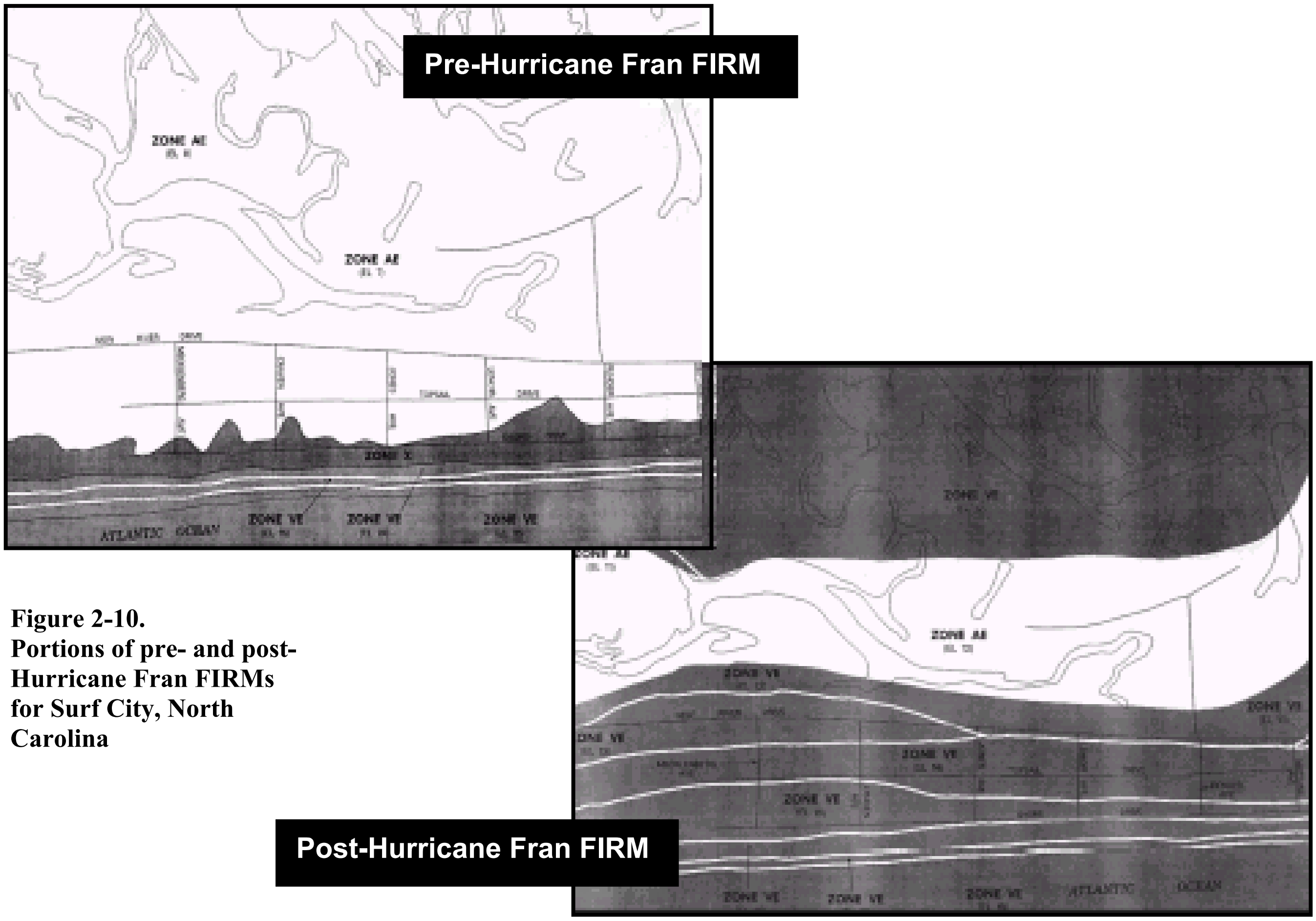


Figure 2-10.
Portions of pre- and post-Hurricane Fran FIRMs for Surf City, North Carolina

SELF-CHECK REVIEW: COASTAL FLOOD HAZARDS

Instructions: Answer the following questions. Then turn the page to check your answers. If you answered any items incorrectly, you should review the related material before continuing.

1. In the portion of a FIRM shown below,

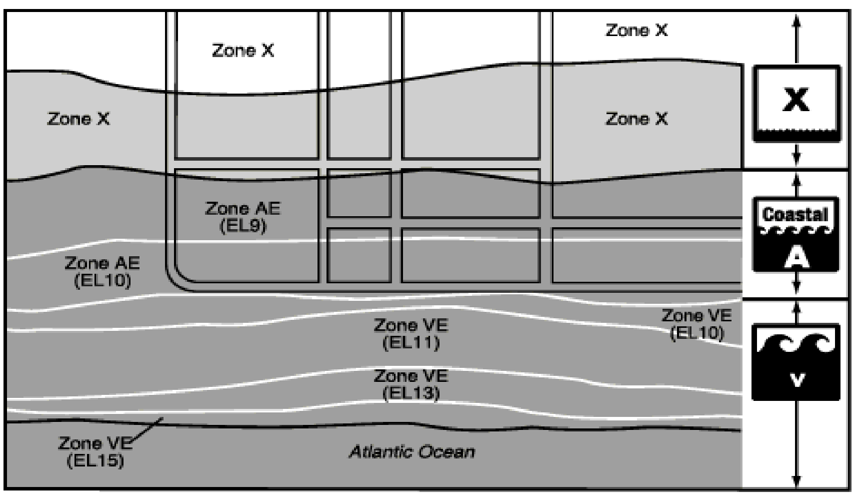
   a. The SFHA is shown as dark/light gray. (Circle one)

   b. The 500-year flood hazard area is shown as dark/light gray. (Circle one)

   c. The numbers in parentheses are ____.

   d. What is the zone of highest flood hazard? ________________________________.

   e. What is the zone of lowest flood hazard? ________________________________.



2. ____________________ is the vertical distance between the wave crest and wave trough.

3. ____________________ is the rush of water up a slope or structure.

4. ____________________ is an increase in the stillwater surface near the shoreline, because of the presence of breaking waves.

5. Why is it unwise to assume that flood hazard zones shown on FIRMs accurately reflect current flood hazards?

ANSWER KEY

1. a. The SFHA is shown as **dark** gray.

   b. The 500-year flood hazard area is shown as **light** gray.

   c. The numbers in parentheses are **Base Flood Elevations (BFEs).**

   d. What is the zone of highest flood hazard? **the V zone.**

   e. What is the zone of lowest flood hazard? **the X zone.**

2. **<u>Wave height</u>** is the vertical distance between the wave crest and wave trough.

3. **<u>Wave runup</u>** is the rush of water up a slope or structure.

4. **<u>Wave setup</u>** is an increase in the stillwater surface near the shoreline, because of the presence of breaking waves.

5. Why is it unwise to assume that flood hazard zones shown on FIRMs accurately reflect current flood hazards?

   Older FIS procedures did not account for the potential loss of protective dunes during the 100-year flood. V zones were delineated without consideration for storm-induced erosion.

UNIT II EXERCISE

Instructions: Use this Unit Exercise to test how well you learned the material presented in Unit II. When you complete the exercise, check your answers against those in the Answer Key that follows. If you answered any questions incorrectly, be sure to review the corresponding section of the unit before proceeding to Unit III.

1. Briefly explain the concept of coastal sediment budget.

2. ___________________________ results when more sediment is transported into a given area than is transported out.

3. The Atlantic coast includes erosion-resistant rocky headlands, barrier islands, mainland beaches, low-relief islands—all of which are subject to high storm surges from hurricanes and/or northeasters.

   True   False

4. Open coast storm surges along the Pacific shoreline are generally quite high (over 8 feet) because of shallow waters near the shore.

   True   False

For each term on the left, select the best definition from the list on the right. Write the letter of the definition in the space provided.

5. ___ Wave height	a. An increase in the stillwater surface near the shoreline because of the presence of breaking waves.
6. ___ Wave crest elevation	b. The rush of water up a slope or structure.
7. ___ Wave setup	c. The vertical distance between the wave crest and wave trough.
8. ___ Wave runup	d. The elevation of the crest of a wave, referenced to the NGVD or other datum.

9. The maximum wave crest elevation is determined by the maximum wave height, which depends largely on the

    ____.

10. On a FIRM, a V zone is:

    a. Unshaded
    b. Shaded light gray
    c. Shaded dark gray
    d. Indicated by parentheses

11. Base Flood Elevations (BFEs) in coastal areas will be controlled by the highest of:

    a. Stillwater elevation or wave crest.
    b. Wave height or wave setup.
    c. Wave trough or wave runup elevation.
    d. Wave crest elevation or wave runup elevation.

12. Wave setup typically adds ____________________ to the 100-year stillwater flood elevation.

The Answer Key for the preceding Unit Exercise is located on the next page.

UNIT II EXERCISE — ANSWER KEY

NOTE: Some of your answers may be slightly different, but they should include the same main points.

1. Briefly explain the concept of coastal sediment budget.

   Coastal sediment budget refers to the identification of sediment sources and sinks, and the quantification of the amounts and rates of sediment transport, erosion, and deposition within a defined region.

   If more sediment is transported by coastal processes or human actions into a given area than is transported out, shoreline accretion results. If more sediment is transported out of an area than is transported in, shoreline erosion results.

2. **Shoreline accretion** results when more sediment is transported into a given area than is transported out.

3. The Atlantic coast includes erosion-resistant rocky headlands, barrier islands, mainland beaches, low-relief islands—all of which are subject to high storm surges from hurricanes and/or northeasters.

   True

4. Open coast storm surges along the Pacific shoreline are generally quite high (over 8 feet) because of shallow waters near the shore.

   False. Open coast storm surges along the Pacific shoreline are generally small (less than 2 feet) because of the narrow continental shelf and deep water close to shore.

5. **c** Wave height
6. **d** Wave crest elevation
7. **a** Wave setup
8. **b** Wave runup

a. An increase in the stillwater surface near the shoreline because of the presence of breaking waves.

b. The rush of water up a slope or structure.

c. The vertical distance between the wave crest and wave trough.

d. The elevation of the crest of a wave, referenced to the NGVD or other datum.

9. The maximum wave crest elevation is determined by the maximum wave height, which depends largely on the **100-year stillwater depth.**

10. On a FIRM, a V zone is:

    c. Shaded dark gray

11. Base Flood Elevations (BFEs) in coastal areas will be controlled by the highest of:

    d. Wave crest elevation or wave runup elevation.

12. Wave setup typically adds **1.5 to 2.5 feet** to the 100-year stillwater flood elevation.