# Coastal Building Successes and Failures

FEMA



**Purpose:** To discuss how coastal construction requirements are different from those for inland construction. To discuss the characteristics that make for a successful coastal building.

## Is Coastal Construction That Different From Inland Construction?

The short answer is ***yes,*** building in a coastal environment is different from building in an inland area:

- ***Flood levels, velocities,*** and ***wave*** action in coastal areas tend to make coastal flooding more damaging than inland flooding.
- Coastal ***erosion*** can undermine buildings and destroy land, roads, utilities, and infrastructure.
- ***Wind speeds*** are typically higher in coastal areas and require stronger engineered building connections and more closely spaced nailing of building sheathing, siding, and roof shingles.
- ***Wind-driven rain, corrosion,*** and ***decay*** are frequent concerns in coastal areas.

In general, homes in coastal areas must be designed and built to withstand ***higher loads*** and ***more extreme conditions***. Homes in coastal areas will require ***more maintenance*** and upkeep. Because of their exposure to higher loads and extreme conditions, homes in coastal areas will cost more to design, construct, maintain, repair, and insure.

*Figure 1. Well-built but poorly sited building.*

## Building Success

In order for a coastal building to be considered a "success," four things must occur:

- The building must be designed to withstand coastal forces and conditions.
- The building must be constructed as designed.
- The building must be sited so that erosion does not undermine the building or render it uninhabitable.
- The building must be maintained/repaired.

A well-built but poorly sited building can be undermined and will not be a success (see Figure 1). Even if a building is set back or situated farther from the coastline, it will not perform well (i.e., will not be a success) if it is incapable of resisting high winds and other hazards that occur at the site (see Figure 2).

*Figure 2. Well-sited building that still sustained damage.*

## What Should Owners and Home Builders Expect From a "Successful" Coastal Building?

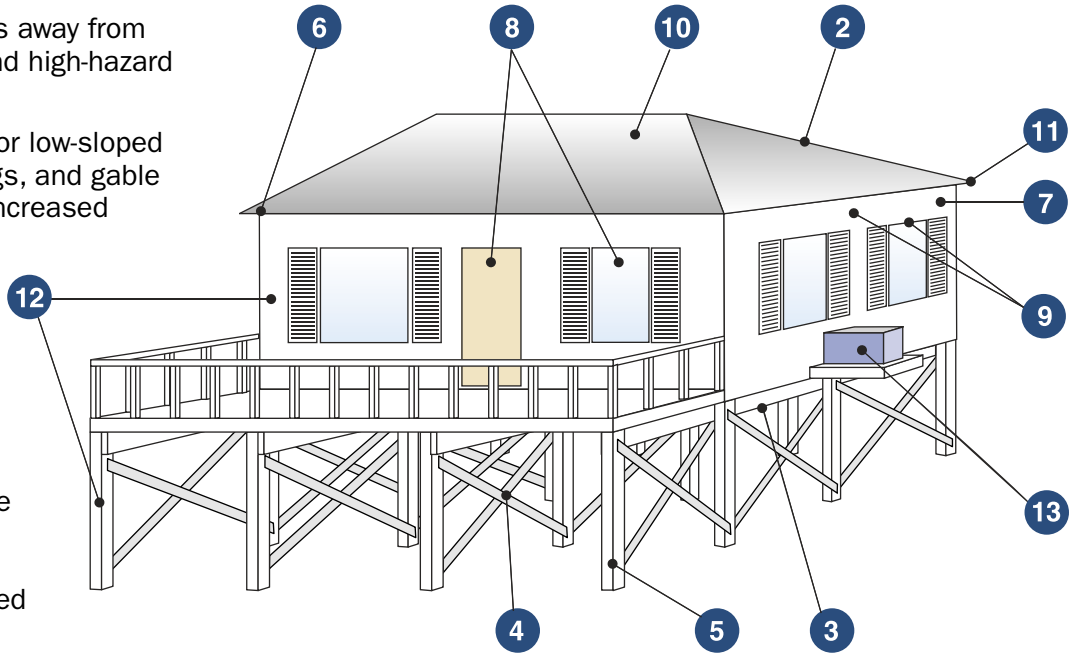
**In coastal areas, a building can be considered a success only if it is capable of resisting damage from coastal hazards and coastal processes over a period of decades.** This statement does not imply that a coastal residential building will remain undamaged over its intended lifetime. It means that the impacts of a design-level flood, storm, wind, or erosion event (or series of lesser events with combined impacts equivalent to a design event) will be limited to the following:

- The building **foundation** must remain intact and functional.
- The **envelope** (walls, openings, roof, and lowest floor) must remain structurally sound and capable of minimizing penetration by wind, rain, and debris.
- The **lowest floor** elevation must be sufficient to prevent floodwaters from entering the elevated building envelope during the design event.
- The **utility connections** (e.g., electricity, water, sewer, natural gas) must remain intact or be restored easily.
- The building must be **accessible** and **usable** following a design-level event.
- Any damage to **enclosures** below the Design Flood Elevation (DFE)* must not result in damage to the foundation, the utility connections, or the elevated portion of the building.

## Recommended Practice

1 **Siting –** Site buildings away from eroding shorelines and high-hazard areas.

2 **Building Form –** Flat or low-sloped porch roofs, overhangs, and gable ends are subject to increased uplift in high winds. Buildings that are both tall and narrow are subject to overturning. Each of these problems can be overcome through the design process, but each must receive special attention. In the design process, chose moderate-sloped hip roofs (4/12 to 6/12) if possible.




3 **Lowest Floor Elevation –** Elevate above the DFE the bottom of the lowest horizontal structural member supporting the lowest floor. Add "freeboard" to reduce damage and lower flood insurance premiums.

4 **Free of Obstructions –** Use an open foundation. Do not obstruct the area below the elevated portion of the building. Avoid or minimize the use of breakaway walls. Do not install utilities or finish enclosed areas below the DFE (owners tend to convert these areas to habitable uses, which is prohibited under the National Flood Insurance Program and will lead to additional flood damage and economic loss).

5 **Foundation –** Make sure the foundation is deep enough to resist the effects of scour and erosion; strong enough to resist wave, current, flood, and debris forces; and capable of transferring wind and seismic forces on upper stories to the ground.

*The DFE is the locally mandated flood elevation, which will be equal to or higher than the Base Flood Elevation (BFE). The BFE is the expected elevation of flood waters and wave effects during the 100-year flood (also known as the Base Flood).

6. **Connections –** Key connections include roof sheathing, roof-to-wall, wall-to-wall, and walls-to-foundation. Be sure these connections are constructed according to the design. Bolts, screws, and ring-shanked nails are common requirements. Standard connection details and nailing should be identified on the plans.

7. **Exterior Walls –** Use structural sheathing in high-wind areas for increased wall strength. Use tighter nailing schedules for attaching sheathing. Care should be taken not to over-drive pneumatically driven nails. This can result in loss of shear capacity in shearwalls.

8. **Windows and Glass Doors –** In high-wind areas, use windows and doors capable of withstanding increased wind pressures. In windborne debris areas, use impact-resistant glazing or shutters.

9. **Flashing and Weather Barriers –** Use stronger connections and improved flashing for roofs, walls, doors, and windows and other openings. Properly installed secondary moisture barriers, such as housewrap or building paper, can reduce water intrusion from wind-driven rain.

10. **Roof –** In high-wind areas, select appropriate roof coverings and pay close attention to detailing. Avoid roof tiles in hurricane-prone areas.

11. **Porch Roofs and Roof Overhangs –** Design and tie down porch roofs and roof overhangs to resist uplift forces.

12. **Building Materials –** Use flood-resistant materials below the DFE. All exposed materials should be moisture- and decay-resistant. Metals should have enhanced corrosion protection.

13. **Mechanical and Utilities –** Electrical boxes, HVAC equipment, and other equipment should be elevated to avoid flood damage and strategically located to avoid wind damage. Utility lines and runs should be installed to minimize potential flood damage.

14. **Quality Control –** Construction inspections and quality control are essential for building success. Even "minor" construction errors and defects can lead to major damage during high-wind or flood events. Keep this in mind when inspecting construction or assessing yearly maintenance needs.

Recommended practice and guidance concerning the topics listed above can be found in the documents referenced in these fact sheets and in many trade publications (e.g., the *Journal of Light Construction,* http://www.jlconline.com).

## Will the Likelihood of Success (Building Performance) Be Improved by Exceeding Minimum Requirements?

States and communities enforce regulatory requirements that determine where and how buildings may be sited, designed, and constructed. There are often economic benefits to exceeding the enforced requirements (see box). Designers and home builders can help owners evaluate their options and make informed decisions about whether to exceed these requirements.

**Benefits of Exceeding Minimum Requirements**

- Reduced building damage during coastal storm events
- Reduced building maintenance
- Longer building lifetime
- Reduced insurance premiums*
- Increased reputation of builder

*Note: Flood insurance premiums can be reduced up to 60 percent by exceeding minimum siting, design, and construction practices. See the V-Zone Risk Factor Rating Form in FEMA's *Flood Insurance Manual* (http://www.fema.gov/nfip/manual.shtm).

# Summary of Coastal Construction Requirements and Recommendations

FEMA



**Purpose:** To summarize National Flood Insurance Program (NFIP) regulatory requirements concerning coastal construction and provide recommendations for exceeding those requirements in some instances.

## Key Issues

- ***New construction**** in coastal flood hazard areas (V zones and A zones) must meet minimum NFIP and community requirements. ***Repairs, remodeling, and additions*** must meet community requirements and may also be subject to NFIP requirements.
- NFIP design and construction requirements are more ***stringent in V zones than in A zones***, in keeping with the increased flood, wave, floodborne debris and erosion hazards in V zones.
- Some coastal areas mapped as A zones may be subject to damaging waves and erosion (these areas are often referred to as Coastal A Zones). Buildings in these areas constructed to minimum NFIP A-zone requirements may sustain major damage or be destroyed during the Base Flood. ***It is strongly recommended that buildings in A zones subject to breaking waves and erosion be designed and constructed to V-zone standards.***
- Buildings constructed to minimum NFIP A-zone standards and subject solely to shallow flooding without the threat from breaking waves and erosion will generally sustain only minor damage during the Base Flood.
- Following the recommendations in the table below will result in lower damage to the building and reduced flood insurance premiums (see the V-Zone Risk Factor Rating Form in FEMA's *Flood Insurance Manual* (http://www.fema.gov/nfip/manual.shtm).

* For floodplain management purposes, new construction means structures for which the start of construction began on or after the effective date of a floodplain management regulation adopted by a community. Substantial improvements, repairs of substantial damage, and some enclosures must meet most of the same requirements as new construction.

The following tables summarize NFIP regulatory requirements and recommendations for exceeding those requirements for both (1) new construction and (2) repairs, remodeling, and additions.

## Requirements and Recommendations for New Construction[a]

| See page 8 for notes. | V Zone | A Zones in Coastal Areas | |
|---|---|---|---|
| | | Coastal A — Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A — Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
| **General Requirements** | | | |
| **Design** (Also see Certification) | **Requirement:** building and its foundation must be designed, constructed, and anchored to prevent flotation, collapse, and lateral movement due to **simultaneous wind and water loads** [see Fact Sheet No. 5] | **Requirement:** building must be designed, constructed, and anchored to prevent flotation, collapse, and lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy<br>**Recommendation:** follow V-zone requirement | **Requirement:** building must be designed, constructed, and anchored to prevent flotation, collapse, and lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy |

See page 8 for notes.

| | V Zone | A Zones in Coastal Areas | |
|---|---|---|---|
| | | Coastal A — Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A — Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
| **General Requirements (cont.)** | | | |
| **Free of Obstructions** | **Requirement:** the space below the lowest floor must be free of obstructions (e.g., free of any building element, equipment, or other fixed objects that can transfer flood loads to the foundation, or that can cause floodwaters or waves to be deflected into the building), or must be constructed with non-supporting breakaway walls, open lattice, or insect screening. [see Fact Sheet Nos. 5, 27] | **Requirement:** none<br>**Recommendation:** follow V-zone requirement | **Requirement:** none |
| **Materials** [see Fact Sheet Nos. 1, 8] | **Requirement:** structural and nonstructural building materials at or below Base Flood Elevation (BFE) must be flood-resistant | **Requirement:** structural and nonstructural building materials at or below BFE must be flood-resistant | **Requirement:** structural and nonstructural building materials at or below BFE must be flood-resistant |
| **Construction** [see Fact Sheet No. 1] **(Also see Certification)** | **Requirement:** building must be constructed with methods and practices that minimize flood damage | **Requirement:** building must be constructed with methods and practices that minimize flood damage | **Requirement:** building must be constructed with methods and practices that minimize flood damage |
| **Siting** [see Fact Sheet Nos. 6, 7] | **Requirement:** all new construction shall be landward of mean high tide; alteration of sand dunes and mangrove stands that increases potential flood damage is prohibited<br>**Recommendation:** site new construction landward of long-term erosion setback and landward of area subject to erosion during 100-year coastal flood event | **Requirement:** encroachments into floodways designated along rivers and streams are prohibited unless they will cause no increase in flood stage; where floodways have not been designated, encroachments into the Special Flood Hazard Area cannot increase the BFE by more than 1 foot<br>**Recommendation:** follow V-zone requirement | **Requirement:** encroachments into floodways designated along rivers and streams are prohibited unless they will cause no increase in flood stage; where floodways have not been designated, encroachments into the Special Flood Hazard Area cannot increase the BFE by more than 1 foot |
| **Foundation** | | | |
| **Structural Fill** | **Prohibited** [see Fact Sheet No. 11] | Allowed, but **not recommended;** compaction required where used; protect against scour and erosion[d] [see Fact Sheet No. 11] | **Allowed;** compaction required where used; protect against scour and erosion[d] |
| **Solid Foundation** [see Fact Sheet Nos. 11, 15] | **Prohibited** | Allowed, but **not recommended**[d] | **Allowed**[d] |
| **Open Foundation** [see Fact Sheet No. 11] | **Required** | **Recommended**[d] | **Allowed**[d] |
| **Lowest Floor Elevation** [see Fact Sheet No. 4] **(Also see Certification)** | See **Bottom of Lowest Horizontal Structural Member** (below) [see Fact Sheet No. 5] | **Requirement:** top of floor must be at or above BFE[e]<br>**Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE[e] | **Requirement:** top of floor must be at or above BFE[e]<br>**Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE[e] |

See page 8 for notes.

| | V Zone | A Zones in Coastal Areas | |
|---|---|---|---|
| | | Coastal A — Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A — Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
| **Foundation (cont.)** | | | |
| **Bottom of Lowest Horizontal Structural Member** [see Fact Sheet No. 4] | must be at or above BFE[e] [see Fact Sheet No. 5] | Allowed below BFE[e], but **not recommnded**[d]<br>**Recommendation:** follow V-zone requirement | Allowed below BFE[e], but **not recommended**[d]<br>**Recommendation:** follow V-zone requirement |
| **Orientation of Lowest Horizontal Structural Member** | **Requirement:** none<br>**Recommendation:** orient perpendicular to wave crest | **Requirement:** none<br>**Recommendation:** follow V-zone requirement | **Requirement:** none |
| **Freeboard** [see Fact Sheet Nos. 1, 4] | Not required[e], but **recommended** | Not required[e], but **recommended** | Not required[e], but **recommended** |
| **Enclosures Below BFE** | | | |
| **(Also see Certification)** [see Fact Sheet No. 27] | **Prohibited,** except for breakaway walls, open lattice, and screening[f]<br>**Recommendation:** if constructed, use open lattice or screening instead of breakaway walls | Allowed, but **not recommended**<br>**Requirement:** if area is fully enclosed, enclosure walls must be equipped with openings to equalize hydrostatic pressure; size, location, and covering of openings governed by regulatory requirements<br>**Recommendation:** elevate on open foundation; if enclosure is constructed, use breakaway walls (with flood openings), open lattice, or screening, as required in V zone[f,g] | **Allowed**<br>**Requirement:** if area is fully enclosed, enclosure walls must be equipped with openings to equalize hydrostatic pressure; size, location, and covering of openings governed by regulatory requirements[f,g] |
| **Nonstructural Fill** | | | |
| | **Allowed** for minor landscaping and site drainage as long as fill does not interfere with free passage of flood waters and debris beneath building, or cause changes in flow direction during coastal storms that could result in damage to buildings | **Allowed**[h]<br>**Recommendation:** follow V-zone requirement | **Allowed**<br>**Recommendation:** follow V-zone requirement |
| **Use of Space Below BFE**[i] **(see Fact Sheet No. 27)** | | | |
| | **Allowed only** for parking, building access, and storage | **Allowed only** for parking, building access, and storage | **Allowed only** for parking, building access, and storage |
| **Utilities**[i] | | | |
| | **Requirement:** utilities, including ductwork and equipment, must be designed, located, and elevated to prevent flood waters from entering and accumulating in components during flooding; utility lines must not be installed or stubbed out in enclosures below BFE | **Requirement:** utilities, including ductwork and equipment, must be designed, located, and elevated to prevent flood waters from entering and accumulating in components during flooding; utility lines must not be installed or stubbed out in enclosures below BFE | **Requirement:** utilities, including ductwork and equipment, must be designed, located, and elevated to prevent flood waters from entering and accumulating in components during flooding; utility lines must not be installed or stubbed out in enclosures below BFE |

| See page 8 for notes. | V Zone | A Zones in Coastal Areas: Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A Zones in Coastal Areas: Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
|---|---|---|---|
| **Certification** | | | |
| **Elevation** | **Requirement:**<br>bottom of lowest horizontal structural member must be at or above BFE[e]; electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) must be designed and/or located so as to prevent water from entering or accumulating within the components during flooding<br>[see Fact Sheet Nos. 4, 5, 29] | **Requirement:**<br>top of lowest floor must be at or above BFE[e]; electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) must be designed and/or located so as to prevent water from entering or accumulating within the components during flooding<br>[see Fact Sheet Nos. 4, 29]<br>**Recommendation:**<br>follow V zone requirement | **Requirement:**<br>top of lowest floor must be at or above BFE[e]; electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) must be designed and/or located so as to prevent water from entering or accumulating within the components during flooding<br>[see Fact Sheet Nos. 4, 29]<br>**Recommendation:**<br>follow V zone requirement |
| **Structure** | **Requirement:**<br>registered engineer or architect must certify that design and methods of construction are in accordance with accepted standards of practice for meeting design requirements described under **General Requirements**<br>[see Fact Sheet No. 5] | **Requirement:**<br>none<br>**Recommendation:**<br>follow V zone requirement | **Requirement:**<br>none<br>**Recommendation:**<br>follow V zone requirement |
| **Breakaway Walls**<br>[see Fact Sheet Nos. 5, 27]<br>**(Also see Enclosures Below BFE)** | **Requirement:**<br>walls must be designed to break free under larger of (1) design wind load, (2) design seismic load, or (3) 10 psf, acting perpendicular to the plane of the wall; if loading at which breakaway wall is intended to collapse exceeds 20 psf, breakaway wall design shall be certified; when certification is required, registered engineer or architect must certify that walls will collapse under a water load associated with the Base Flood and that elevated portion of building and its foundation will not be subject to collapse, displacement, or lateral movement under simultaneous wind and water loads[f] | Not required, but **recommended**[f,g] with open foundation in lieu of solid walls; if breakaway walls are used and enclose an area, flood openings are required.<br>[see Fact Sheet Nos. 11, 15] | **Requirement:**<br>none[f,g] |
| **Openings in Below-BFE Walls**<br>[see Fact Sheet Nos. 11, 15]<br>**(Also see Enclosures Below BFE)** | Not Applicable[j] | **Requirement:**<br>unless number and size of openings meet regulatory requirements, registered engineer or architect must certify that openings are designed to automatically equalize hydrostatic forces on walls by allowing automatic entry and exit of flood waters | **Requirement:**<br>unless number and size of openings meet regulatory requirements, registered engineer or architect must certify that openings are designed to automatically equalize hydrostatic forces on walls by allowing automatic entry and exit of flood waters |

# Requirements and Recommendations for Repairs, Remodeling, and Additions

See page 8 for notes.

| Repairs, Remodeling, and Additions (see Fact Sheet No. 30 and consult AHJ[k] for building code requirements) | V Zone | A Zones in Coastal Areas: Coastal A — Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A Zones in Coastal Areas: A — Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
|---|---|---|---|
| **Substantial Improvements and Repairs of Substantial Damage** | **Requirement:** must meet current NFIP requirements concerning new construction in V zones[k,l] except for siting landward of mean high tide **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** | **Requirement:** must meet current NFIP requirements concerning new construction in A zones[k,m] **[see Fact Sheet Nos. 4, 11, 15, 27, 29]** **Recommendation:** follow V-zone requirement | **Requirement:** must meet current NFIP requirements concerning new construction in A zones[k,m] **[see Fact Sheet Nos. 4, 11, 15, 27, 29]** **Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE |
| **Lateral Additions That Constitute Substantial Improvement** | **Requirement:** both addition and existing building must meet current NFIP requirements concerning new construction in V zones[k,l,n] **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** | **Requirement:** only addition must meet current NFIP requirements concerning new construction in A zones[k,m,o] (**See Fact Sheet Nos. 4, 7, 11, 15, 27, 29**), *provided* existing building is not subject to any work other than cutting entrance in common wall and connecting existing building to addition; if any other work is done to existing building, it too must meet current NFIP requirements for new construction in A zones **Recommendation:** follow V-zone requirement | **Requirement:** only addition must meet current NFIP requirements concerning new construction in A zones[k,m,o] (**See Fact Sheet Nos. 4, 7, 11, 15, 27, 29**), *provided* the existing building is not subject to any work other than cutting an entrance in a common wall and connecting the existing building to the addition; if any other work is done to existing building, it too must meet current NFIP requirements for new construction in A zones **Recommendation:** elevate bottom of lowest horizontal structural member of addition to or above BFE (same for existing building if it is elevated) |
| **Lateral Additions That Do *Not* Constitute Substantial Improvement** | **Requirement:** *post-Flood Insurance Rate Map (FIRM)* existing building – addition must meet NFIP requirements in effect at time building was originally constructed [k,l,n] pre-FIRM existing building – NFIP requirements concerning new construction not triggered [k] **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** **Recommendation:** make addition compliant with current NFIP requirements for V-zone construction | **Requirement:** *post-FIRM* existing building – addition must meet NFIP requirements in effect at time building was originally constructed [k,m,o] **[see Fact Sheet Nos. 4, 7, 11, 15, 27, 29]** *pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **Recommendation:** follow V-zone requirement | **Requirement:** *post-FIRM* existing building – addition must meet NFIP requirements in effect at time building was originally constructed [k,m,o] **[see Fact Sheet Nos. 4, 7, 11, 15, 27, 29]** *pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **Recommendation:** elevate bottom of lowest horizontal structural member of addition to or above BFE (same for existing building if it is elevated) **[see Fact Sheet No. 4]** |

See page 8 for notes.

| | V Zone | A Zones in Coastal Areas: Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A Zones in Coastal Areas: Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
|---|---|---|---|
| **Repairs, Remodeling, and Additions (cont.)** | **(see Fact Sheet No. 30 and consult AHJ[k] for building code requirements)** | | |
| **Vertical Additions That Constitute Substantial Improvement** | **Requirement:** entire building must meet current NFIP requirements concerning new construction in V zones[k,l,n] **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** | **Requirement:** entire building must meet current NFIP requirements concerning new construction in A zones[k,m,o] **[see Fact Sheet Nos. 4, 7, 11, 15, 27, 29]** **Recommendation:** follow V-zone requirement | **Requirement:** entire building must meet current NFIP requirements concerning new construction in A zones[k,m,o] **[see Fact Sheet Nos. 4, 7, 11, 15, 27, 29]** **Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE **[see Fact Sheet No. 4]** |
| **Vertical Additions That Do *Not* Constitute Substantial Improvement** | **Requirement:** *post-FIRM* existing building – addition must meet NFIP requirements in effect at time building was originally constructed [k,l,n] *pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** **Recommendation:** make addition compliant with current NFIP requirements for V-zone construction | **Requirement:** *post-FIRM* existing building – addition must meet NFIP requirements in effect at time building was originally constructed[k,m,o] *pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** **Recommendation:** follow V-zone requirement | **Requirement:** *post-FIRM* existing building – addition must meet NFIP requirements in effect at time building was originally constructed[k,m,o] ***pre-FIRM*** existing building – NFIP requirements concerning new construction not triggered[k] **[see Fact Sheet Nos. 4, 5, 7, 11, 15, 27, 29]** **Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE **[see Fact Sheet No. 4]** |
| **Elevating on New Foundation** | **Requirement:** new foundation must meet current NFIP requirements concerning new construction in V zones[k,l]; building must be properly connected and anchored to new foundation | **Requirement:** new foundation must meet current NFIP requirements concerning new construction in A zones[k,m]; building must be properly connected and anchored to new foundation **Recommendation:** follow V-zone requirement | **Requirement:** new foundation must meet current NFIP requirements concerning new construction in A zones[k,m]; building must be properly connected and anchored to new foundation **Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE **[see Fact Sheet No. 4]** |
| **Enclosures Below Buildings –** When enclosure constitutes a **substantial improvement** | **Requirement:** both enclosure and existing building must meet current NFIP requirements for new construction in V zones[k,l,n] **[see Fact Sheet Nos. 4, 5, 7, 11, 27, 29]** | **Requirement:** both enclosure and existing building must meet current NFIP requirements for new construction in A zones[k,m,o] **[see Fact Sheet Nos. 4, 7, 11, 15, 27, 29]** **Recommendation:** follow V-zone requirement | **Requirement:** both enclosure and existing building must meet current NFIP requirements for new construction in A zones[k,m,o] **[see Fact Sheet Nos. 4, 7, 11, 15, 27, 29]** **Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE **[see Fact Sheet No. 4]** |

See page 8 for notes.

| | V Zone | A Zones in Coastal Areas | |
|---|---|---|---|
| | | Coastal A — Areas With Potential for Breaking Waves and Erosion During Base Flood[b] | A — Areas With Shallow Flooding Only, Where Potential for Breaking Waves and Erosion Is Low[c] |
| **Repairs, Remodeling, and Additions (cont.)** | **(see Fact Sheet No. 30 and consult AHJ[k] for building code requirements)** | | |
| **Enclosures Below Buildings –** When enclosure does ***not*** constitute a substantial improvement | **Requirement:** *post-FIRM* existing building – enclosure must meet NFIP requirements in effect at time building was originally constructed[k,l,n]<br><br>*pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **[see Fact Sheet No. 27]**<br><br>**Recommendation:** make enclosure compliant with current NFIP requirements for new V-zone construction | **Requirement:** *post-FIRM* existing building – enclosure must meet NFIP requirements in effect at time building was originally constructed[k,m,o]<br><br>*pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **[see Fact Sheet Nos. 15, 27]**<br><br>**Recommendation:** construct only breakaway enclosures; install flood openings in enclosure; do not convert enclosed space to habitable use | **Requirement:** *post-FIRM* existing building – enclosure must meet NFIP requirements in effect at time building was originally constructed[k,m,o]<br><br>*pre-FIRM* existing building – NFIP requirements concerning new construction not triggered[k] **[see Fact Sheet Nos. 15, 27]**<br><br>**Recommendation:** install flood openings in enclosure; do not convert enclosed space to habitable use |
| **Reconstruction of Destroyed or Razed Building** | **Requirement:** where entire building is destroyed, damaged, or purposefully demolished or razed, replacement building must meet current NFIP requirements concerning new construction in V zones[k,l], even if built on foundation from original building **[see Fact Sheet Nos. 4, 5, 30]** | **Requirement:** where entire building is destroyed, damaged, or purposefully demolished or razed, replacement building must meet current NFIP requirements concerning new construction in A zones[k,m], even if built on foundation from original building **[see Fact Sheet Nos. 4, 30]**<br><br>**Recommendation:** follow V-zone requirement | **Requirement:** where entire building is destroyed, damaged, or purposefully demolished or razed, replacement building must meet current NFIP requirements concerning new construction in A zones[k,m], even if built on foundation from original building **[see Fact Sheet Nos. 4, 30]** |
| **Moving Existing Building** | **Requirement:** where existing building is moved to new location or site, relocated building must meet current NFIP requirements concerning new construction in V zones[k,l] **[see Fact Sheet Nos. 4, 5, 30]** | **Requirement:** where existing building is moved to new location or site, relocated building must meet current NFIP requirements concerning new construction in A zones[k,m] **[see Fact Sheet Nos. 4, 30]**<br><br>**Recommendation:** follow V-zone requirement | **Requirement:** where existing building is moved to new location or site, relocated building must meet current NFIP requirements concerning new construction in A zones[k,m] **[see Fact Sheet Nos. 4, 30]**<br><br>**Recommendation:** elevate bottom of lowest horizontal structural member to or above BFE **[see Fact Sheet No. 4]** |

## Notes

a "***Prohibited***" and "***Allowed***" refer to the minimum NFIP regulatory requirements; individual states and communities may enforce more stringent requirements that supersede those summarized here. ***Exceeding minimum NFIP requirements will provide increased flood protection and may result in lower flood insurance premiums.***

b In these areas, buildings are subject to flooding conditions similar to, but less severe than, those in V zones. These areas can be subject to breaking waves ≥ 1.5 feet high (which can destroy conventional wood-frame and unreinforced masonry wall construction) and erosion (which can undermine shallow foundations).

c In these areas, buildings are subject to flooding conditions similar to those in riverine A zones.

d Some coastal communities require ***open foundations in A zones.***

e State or community may require ***freeboard*** or regulate to a higher elevation (e.g., Design Flood Elevation (DFE)).

f Some coastal communities ***prohibit breakaway walls*** and allow only open lattice or screening.

g If an area below the BFE in an A-zone building is fully enclosed by breakaway walls, the walls must meet the requirement for ***openings*** that allow equalization of hydrostatic pressure.

h Placement of ***nonstructural fill*** adjacent to buildings in coastal AO zones is not recommended.

i There are some ***differences between*** what is permitted under ***floodplain management regulations*** and what is covered by ***NFIP flood insurance.*** Building designers should be guided by floodplain management requirements, not by flood insurance policy provisions. For more information, see Section 9.3.1.1 in Chapter 9 of FEMA's Coastal Construction Manual (FEMA 55).

j ***Walls below BFE*** must be designed and constructed as breakaway walls that meet the minimum requirements of the NFIP regulations. For more information, see Section 6.4.3.3 in Chapter 6 of FEMA's Coastal Construction Manual (FEMA 55).

k Consult with authority having jurisdiction (AHJ) regarding ***more restrictive requirements for repairs, remodeling, and additions.***

l ***NFIP requirements for new construction in V zones*** include those pertaining to Design and Construction, Flood-Resistant Materials, Siting, Foundations, Lowest Floor Elevation, Enclosures Below the BFE, Free of Obstructions, Utilities, and Certifications.

m ***NFIP requirements for new construction in A zones*** include those pertaining to Design and Construction, Flood-Resistant Materials, Siting, Foundations, Foundation Openings, Lowest Floor Elevation, Enclosures Below the BFE, Utilities, and Certifications.

n An addition in the form of an ***attached garage*** would not have to be elevated to or above the BFE, because its use (parking) would be allowed below the BFE; however, it would have to meet other NFIP requirements for new construction in V zones.

o An addition in the form of an ***attached garage*** would not have to be elevated to or above the BFE, because its use (parking) would be allowed below the BFE; however, it would have to meet other NFIP requirements for new construction in A zones.

# Using a Flood Insurance Rate Map (FIRM)

FEMA



**Purpose:** To explain the purpose of FIRMs, highlight features that are important to coastal builders, and explain how to obtain FIRMs.

## What Is a FIRM?

- Flood hazards have been mapped by FEMA for approximately 20,000 communities in the United States, most commonly on ***FIRMs.*** A FIRM is a product of the Flood Insurance Study (FIS) for a community and is available in paper form and digital form.
- FIRMs delineate Special Flood Hazard Areas (SFHAs) — land areas subject to inundation by a flood that has a 1-percent probability of being equaled or exceeded in any given year (hence, the terms "1-percent annual chance flood" and "100-year flood"). SFHAs are shaded on the FIRM and are divided into different flood hazard zones, depending on the nature and severity of the flood hazard.

## Why Are FIRMs Important?

- FIRMs show the limits of mapped flood hazard areas in a community.
- The insurance zone designations shown on FIRMs are used in the determination of flood insurance rates and premiums.
- The 100-year flood elevations and flood depths shown on FIRMs are the minimum regulatory elevations on which community floodplain management ordinances are based.
- The information shown on FIRMs can affect the design and construction of new buildings, the improvement and repair of existing buildings, and additions to existing buildings (see Fact Sheet Nos. 2 and 29).

## What Are Flood Hazard Zones and Base Flood Elevations, and How Do They Affect Coastal Buildings?

- ***Base Flood Elevations (BFEs)*** are typically shown on FIRMs for flood hazard zones A and V. ***The BFE is the expected elevation of flood waters and wave effects during the 100-year flood (also known as the "Base Flood")***. The BFE is referenced to the vertical datum shown on the FIRM.

## FIRMs Are Used By:

- ***Communities***, to regulate new construction* (e.g., foundation type, lowest floor elevation, use of enclosed areas below the lowest floor)
- ***Designers and builders***, to ascertain flood hazards and plan new construction*
- ***Lenders***, to determine whether flood insurance is required
- ***Insurance agents***, to establish flood insurance premiums
- **Land surveyors and engineers,** to complete National Flood Insurance Program (NFIP) elevation certificates (see Fact Sheet No. 4)

## Flood Hazard Zones In Coastal Areas

(see the sample FIRM on the next page)

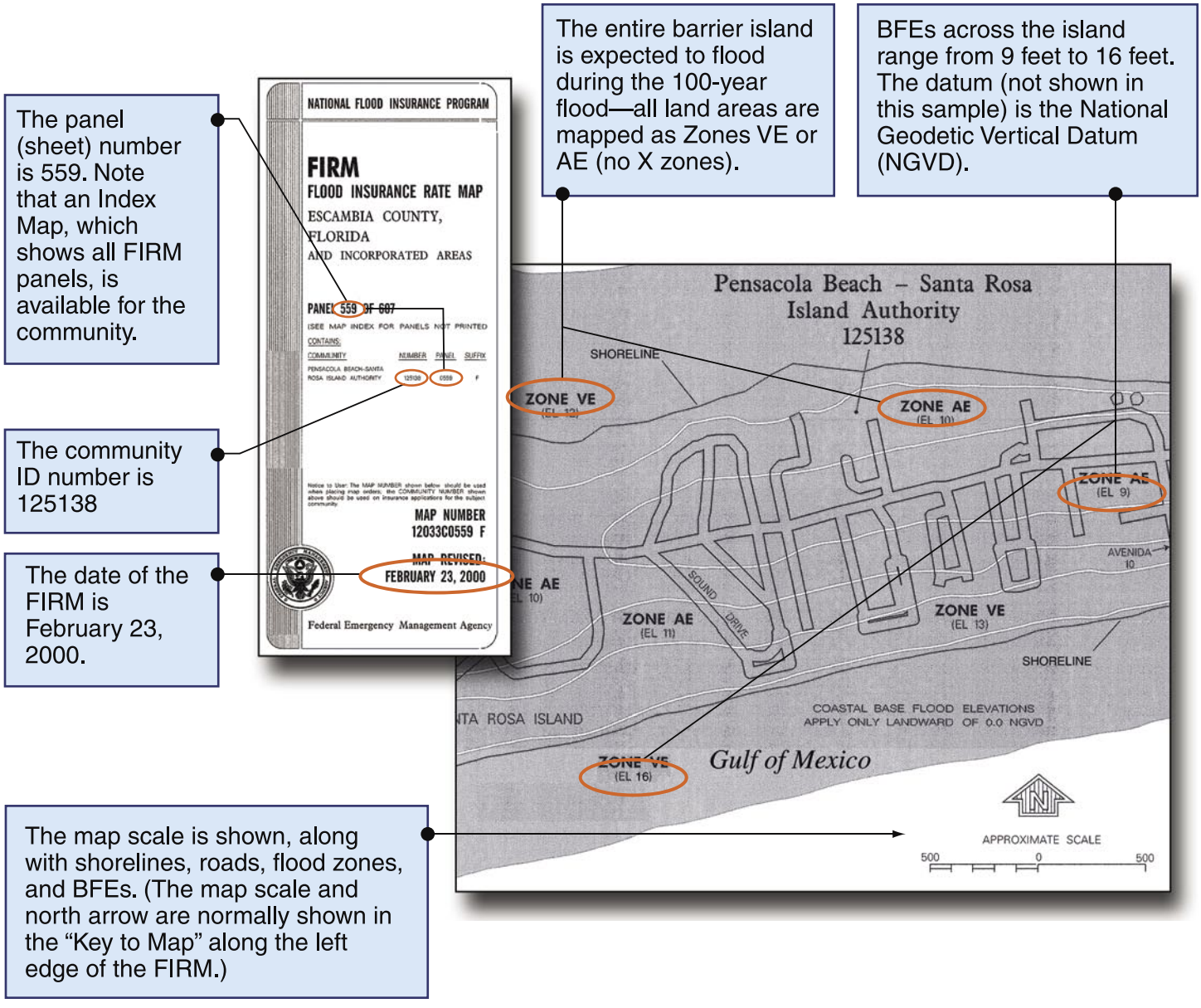
- V zones are those areas closest to the shoreline and subject to wave action, high-velocity flow, and erosion during the 100-year flood.
- A zones are areas subject to flooding during the 100-year flood, but where flood conditions are less severe than those in V zones.
- AO zones are areas subject to shallow flooding or sheet flow during the 100-year flood. If they appear on a coastal FIRM, they will most likely occur on the landward slopes of coastal dunes. Flood depths, rather than BFEs, are shown for AO zones.
- X zones are areas that are not expected to flood during the 100-year flood.
- Newer FIRMs label zones as "VE" (V zone with BFE determined) and "AE" (A zone with BFE determined).
- Older FIRMs label zones with a letter and number (e.g., A1, A10, V10). Ignore the number and look at the letter.
- Older FIRMs label X zones as zone "B" or zone "C." Treat the old and new zone designations the same.

- The ***BFE and flood hazard zone*** will affect the ***lowest floor elevation and foundation type*** for new construction* ***(see Fact Sheet Nos. 4 and 11)***.
- ***Some communities have adopted higher standards for coastal construction*** (e.g., lowest floor elevations above the BFE, restrictions on foundation types and enclosures in A zones). ***Builders should consult their local jurisdiction for details.***
- Most ***communities have adopted the latest FIRM and FIS*** (and, therefore, the flood hazard zone and BFE designations) as part of their efforts to regulate new construction* in coastal floodplains. These communities will have adopted a ***floodplain management ordinance***, which spells out the detailed requirements.

* Note that "new construction" will include some additions, improvements, repairs, and reconstruction — consult the community about "substantial improvement" and "substantial damage" requirements.

## Sample FIRM

This map is a portion of the FIRM for the barrier island community, Pensacola Beach, Florida. As shown below, several things are apparent from the map.



## Where Can I Get FIRMs and Other Information?

***The FIRM for a community, and the local floodplain management regulations,*** should be on file and available for viewing at the office of the ***community floodplain administrator***.

***FEMA's Map Service Center*** can be accessed at http://msc.fema.gov/MSC/. ***Index sheets and individual FIRM panels*** can be ***viewed on line*** through the MSC web site, and *"**FIRMettes**"* (user-selected portions of flood maps such as the sample above) can be created, saved, and printed.

## Is There Anything Else I Should Know About Coastal Flood Hazard Zones and Flood Elevations?

- Many FIRMs are ***more than a few years old*** and ***may no longer accurately represent coastal flood hazards***. Sections 7.8 and 7.9 of FEMA's revised *Coastal Construction Manual* (FEMA-55, 2000) describe how coastal flood hazards are mapped and ***how to determine whether coastal FIRMs reflect present day flood hazards***.
- ***FIRMs do not incorporate*** the effects of ***long-term shoreline erosion***. This information should be obtained from other sources (see Fact Sheet No. 7).
- Recent ***post-storm investigations*** and studies have shown flood forces and damage in ***coastal A zones*** can be very similar to those in V zones. Although FIRMs (and minimum NFIP building standards) don't differentiate between A zones in coastal areas and riverine A zones, ***builders should consider adopting V-zone foundation and elevation standards for new construction in many coastal A zones***.
- Many communities and states require lowest floor elevations to be above the BFE. One term used to describe this higher elevation standard is ***Design Flood Elevation (DFE)***.
- Many property owners have ***voluntarily*** constructed their buildings with the lowest floor several feet above the BFE in recognition that the flood elevation in some storms will exceed the BFE.

Copies of FIRMs, FISs, and related products can also be obtained from FEMA for a nominal fee. Contact FEMA's Map Service Center at:

**FEMA**
Map Service Center (MSC)
PO Box 1038
Jessup, MD 20794-1038

(800) 358-9616

# Lowest Floor Elevation

FEMA



**Purpose:** To discuss benefits of exceeding the National Flood Insurance Program (NFIP) minimum elevation requirements, to point out common construction practices that are violations of NFIP regulations and result in significantly higher flood insurance premiums, and to discuss the NFIP Elevation Certificate.

## Why Is the Lowest Floor Elevation Important?

In inland areas, experience has shown that floods damage areas of buildings not elevated above the flood level and destroy contents of those areas. In coastal areas, wave action causes even more damage, often ***destroying enclosed building areas below the flood level (and any building areas above the flood level that depend on the lower area for structural support). Once waves rise above the lowest structural member in a V zone or coastal A zone, the elevated portion of the building is likely to be severely damaged or destroyed.***

## Recommended Lowest Floor Elevations*

Because of the additional hazard associated with wave action in V zones and in A zones in coastal areas, it is recommended that the minimum elevation requirements of the NFIP be exceeded in these areas:

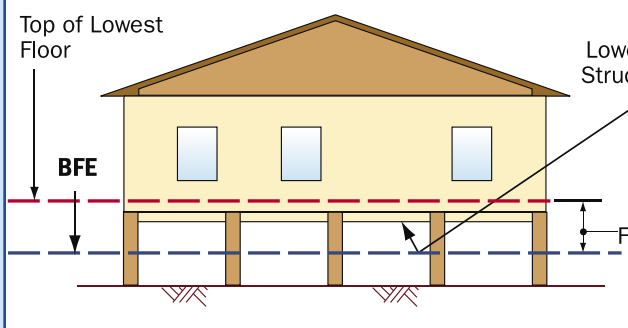
- It is recommended that ***the bottom of the lowest horizontal structural member of V-zone buildings be elevated 1 foot or more above the Base Flood Elevation (BFE),*** i.e., add freeboard.
- It is recommended that ***the lowest horizontal structural member of A-zone buildings in coastal areas be elevated 1 foot or more above the BFE*** (i.e., add freeboard).

*NFIP minimum elevation requirements: A zone – elevate top of lowest floor to or above BFE; V zone – elevate bottom of lowest horizontal structural member to or above BFE. **In both V and A zones, many people have decided to elevate a full story for below-building parking, far exceeding the elevation requirement.** See Fact Sheet No. 2 for more information about NFIP minimum requirements in A and V zones.

**Recommended Practice:**

Coastal A

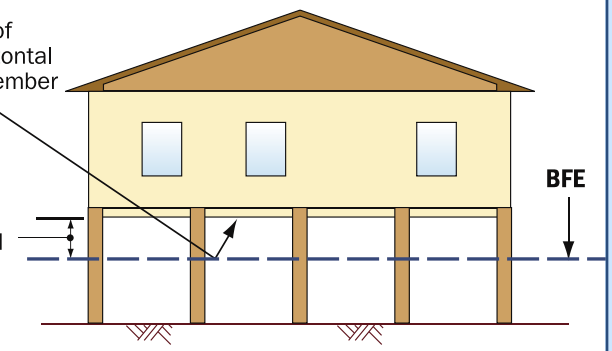
**A Zones in Coastal Areas:**
**Subject to Breaking Waves and Erosion During the Base Flood**
**Lowest Horizontal Structural Member Above BFE (Freeboard)**




A-Zone Building (Open Foundation)

V

**V Zones:**
**Bottom of Lowest Horizontal Structural Member Above BFE (Freeboard)**




V-Zone Building (Open Foundation)

## What Does FEMA Consider the Lowest Floor?

- The "lowest floor" means **the lowest floor of the lowest enclosed area, except for unfinished or flood-resistant enclosures used solely for parking of vehicles, building access, or storage**.
- If the lowest enclosed area is used for anything other than ***parking of vehicles, building access, or storage***, the floor of that area is considered the lowest floor. This will violate NFIP requirements and drastically increase flood insurance premiums.
- Note that ***any below-BFE finished areas***, including foyers, will violate NFIP requirements, sustain unreimbursable flood damage, and increase flood insurance premiums.
- The floor of a basement (where "basement" means the floor is below grade on all sides) will ***always*** be the lowest floor, regardless of how the space is used.
- Walls of enclosed areas below the BFE must meet special requirements in coastal areas (see Fact Sheet No. 27).

## Construction Practices and the Lowest Floor

Setting the lowest floor at the correct elevation is critical. Failure to do so can result in a building being constructed below the BFE. As a result, work can be stopped, certificates of occupancy can be withheld, and correcting the problem can be expensive and time-consuming.

- After piles have been installed, the intended elevation of the lowest floor should be checked before the piles are cut off.
- Alternatively, after piers or columns have been constructed, the intended elevation of the lowest floor should be checked before the lowest horizontal structural supporting members are installed.
- After the lowest horizontal structural supporting members have been installed, the elevation should be checked again, before any further vertical construction is carried out.

Do not modify building plans to create habitable space below the intended lowest floor. Doing so will put the building in violation of flood regulations and building codes.

## FEMA Elevation Certificate

The NFIP requires participating communities to adopt a floodplain management ordinance that specifies minimum requirements for reducing flood losses. One such requirement is that communities ***obtain, and maintain a record of, the lowest floor elevations for all new and substantially improved buildings***.
The Elevation Certificate (see following pages) provides a way for a community to comply with this requirement and for insurers to determine flood insurance premiums.

Most communities require permit applicants to retain a surveyor, engineer, or architect to complete and submit the elevation certificate. Note that ***multiple elevation certificates may need to be submitted for the same building***: a certificate *may* be required when the ***lowest floor level is set*** (and before additional vertical construction is carried out); a certificate *will* be required ***upon completion of all construction***.

The Elevation Certificate requires that the following information be ***certified and signed by the surveyor/engineer/architect*** and ***signed by the building owner***:

- elevations of certain floors in the building
- lowest elevation of utility equipment/machinery
- floor slab elevation for attached garage
- adjacent grade elevations
- flood opening information (A zones)

The Elevation Certificate is available on FEMA's web site: http://www.fema.gov/nfip/elvinst.shtm

FEDERAL EMERGENCY MANAGEMENT AGENCY
NATIONAL FLOOD INSURANCE PROGRAM

O.M.B. No. 3067-0077
Expires December 31, 2005

# ELEVATION CERTIFICATE

**Important: Read the instructions on pages 1 - 7.**

## SECTION A - PROPERTY OWNER INFORMATION

| | |
|---|---|
| BUILDING OWNER'S NAME | For Insurance Company Use: |
| | Policy Number |
| BUILDING STREET ADDRESS (Including Apt., Unit, Suite, and/or Bldg. No.) OR P.O. ROUTE AND BOX NO. | Company NAIC Number |
| CITY STATE ZIP CODE | |

PROPERTY DESCRIPTION (Lot and Block Numbers, Tax Parcel Number, Legal Description, etc.)

BUILDING USE (e.g., Residential, Non-residential, Addition, Accessory, etc. Use a Comments area, if necessary.)

LATITUDE/LONGITUDE (OPTIONAL) ( ##° - ##' - ##.##" or ##.#####°) HORIZONTAL DATUM: |__| NAD 1927 |__| NAD 1983 SOURCE: |__| GPS (Type): _____ |__| USGS Quad Map |__| Other _____

## SECTION B - FLOOD INSURANCE RATE MAP (FIRM) INFORMATION

| B1. NFIP COMMUNITY NAME & COMMUNITY NUMBER | B2. COUNTY NAME | B3. STATE |
|---|---|---|
| | | |

| B4. MAP AND PANEL NUMBER | B5. SUFFIX | B6. FIRM INDEX DATE | B7. FIRM PANEL EFFECTIVE/REVISED DATE | B8. FLOOD ZONE(S) | B9. BASE FLOOD ELEVATION(S) (Zone AO, use depth of flooding) |
|---|---|---|---|---|---|
| | | | | | |

B10. Indicate the source of the Base Flood Elevation (BFE) data or base flood depth entered in B9.
|__| FIS Profile |__| FIRM |__| Community Determined |__| Other (Describe): _____

B11. Indicate the elevation datum used for the BFE in B9: |__| NGVD 1929 |__| NAVD 1988 |__| Other (Describe): _____

B12. Is the building located in a Coastal Barrier Resources System (CBRS) area or Otherwise Protected Area (OPA)? |__| Yes |__| No
Designation Date:_____

## SECTION C - BUILDING ELEVATION INFORMATION (SURVEY REQUIRED)

C1. Building elevations are based on: |__|Construction Drawings* |__|Building Under Construction* |__|Finished Construction
*A new Elevation Certificate will be required when construction of the building is complete.

C2. Building Diagram Number _____ (Select the building diagram most similar to the building for which this certificate is being completed - see pages 6 and 7. If no diagram accurately represents the building, provide a sketch or photograph.)

C3. Elevations – Zones A1-A30, AE, AH, A (with BFE), VE, V1-V30, V (with BFE), AR, AR/A, AR/AE, AR/A1-A30, AR/AH, AR/AO
Complete Items C3.a-i below according to the building diagram specified in Item C2. State the datum used. If the datum is different from the datum used for the BFE in Section B, convert the datum to that used for the BFE. Show field measurements and datum conversion calculation. Use the space provided or the Comments area of Section D or Section G, as appropriate, to document the datum conversion.
Datum _____ Conversion/Comments _____
Elevation reference mark used_____ Does the elevation reference mark used appear on the FIRM? |__| Yes |__| No

- ❑ a) Top of bottom floor (including basement or enclosure) _____ . ___ ft.(m)
- ❑ b) Top of next higher floor _____ . ___ ft.(m)
- ❑ c) Bottom of lowest horizontal structural member (V zones only) _____ . ___ ft.(m)
- ❑ d) Attached garage (top of slab) _____ . ___ ft.(m)
- ❑ e) Lowest elevation of machinery and/or equipment servicing the building (Describe in a Comments area.) _____ . ___ ft.(m)
- ❑ f) Lowest adjacent (finished) grade (LAG) _____ . ___ ft.(m)
- ❑ g) Highest adjacent (finished) grade (HAG) _____ . ___ ft.(m)
- ❑ h) No. of permanent openings (flood vents) within 1 ft. above adjacent grade _____
- ❑ i) Total area of all permanent openings (flood vents) in C3.h _____ sq. in. (sq. cm)

License Number, Embossed Seal, Signature, and Date

## SECTION D - SURVEYOR, ENGINEER, OR ARCHITECT CERTIFICATION

This certification is to be signed and sealed by a land surveyor, engineer, or architect authorized by law to certify elevation information.
*I certify that the information in Sections A, B, and C on this certificate represents my best efforts to interpret the data available.*
*I understand that any false statement may be punishable by fine or imprisonment under 18 U.S. Code, Section 1001.*

CERTIFIER'S NAME LICENSE NUMBER

TITLE COMPANY NAME

ADDRESS CITY STATE ZIP CODE

SIGNATURE DATE TELEPHONE

| IMPORTANT: In these spaces, copy the corresponding information from Section A. | For Insurance Company Use: |
|---|---|
| BUILDING STREET ADDRESS (Including Apt., Unit, Suite, and/or Bldg. No.) OR P.O. ROUTE AND BOX NO. | Policy Number |
| CITY STATE ZIP CODE | Company NAIC Number |

## SECTION D - SURVEYOR, ENGINEER, OR ARCHITECT CERTIFICATION (CONTINUED)

Copy both sides of this Elevation Certificate for (1) community official, (2) insurance agent/company, and (3) building owner.

COMMENTS

|__| Check here if attachments

## SECTION E - BUILDING ELEVATION INFORMATION (SURVEY NOT REQUIRED) FOR ZONE AO AND ZONE A (WITHOUT BFE)

For Zone AO and Zone A (without BFE), complete Items E1. through E5. If the Elevation Certificate is intended for use as supporting information for a LOMA or LOMR-F, Section C must be completed.

E1. Building Diagram Number _____ (Select the building diagram most similar to the building for which this certificate is being completed – see pages 6 and 7. If no diagram accurately represents the building, provide a sketch or photograph.)

E2. The top of the bottom floor (including basement or enclosure) of the building is |__|__| ft. (m) |__|__| in. (cm) |__| above or |__| below (check one) the highest adjacent grade. (Use natural grade, if available.)

E3. For Building Diagrams 6-8 with openings (see page 7), the next higher floor or elevated floor (elevation b) of the building is |__|__| ft. (m) |__|__|in. (cm) above the highest adjacent grade. Complete Items C3.h and C3.i on front of form.

E4. The top of the platform of machinery and/or equipment servicing the building is |__|__| ft. (m) |__|__| in. (cm) |__| above or |__| below (check one) the highest adjacent grade. (Use natural grade, if available.)

E5. For Zone AO only: If no flood depth number is available, is the top of the bottom floor elevated in accordance with the community's floodplain management ordinance? |__| Yes |__| No |__| Unknown. The local official must certify this information in Section G.

## SECTION F - PROPERTY OWNER (OR OWNER'S REPRESENTATIVE) CERTIFICATION

The property owner or owner's authorized representative who completes Sections A, B, C (Items C3.h and C3.i only), and E for Zone A (without a FEMA-issued or community-issued BFE) or Zone AO must sign here. *The statements in Sections A, B, C, and E are correct to the best of my knowledge.*

PROPERTY OWNER'S OR OWNER'S AUTHORIZED REPRESENTATIVE'S NAME

ADDRESS CITY STATE ZIP CODE

SIGNATURE DATE TELEPHONE

COMMENTS

|__| Check here if attachments

## SECTION G - COMMUNITY INFORMATION (OPTIONAL)

The local official who is authorized by law or ordinance to administer the community's floodplain management ordinance can complete Sections A, B, C (or E), and G of this Elevation Certificate. Complete the applicable item(s) and sign below.

G1. |__| The information in Section C was taken from other documentation that has been signed and embossed by a licensed surveyor, engineer, or architect who is authorized by state or local law to certify elevation information. (Indicate the source and date of the elevation data in the Comments area below.)

G2. |__| A community official completed Section E for a building located in Zone A (without a FEMA-issued or community-issued BFE) or Zone AO.

G3. |__| The following information (Items G4-G9) is provided for community floodplain management purposes.

| G4. PERMIT NUMBER | G5. DATE PERMIT ISSUED | G6. DATE CERTIFICATE OF COMPLIANCE/OCCUPANCY ISSUED |
|---|---|---|
| | | |

G7. This permit has been issued for: |__| New Construction |__| Substantial Improvement

G8. Elevation of as-built lowest floor (including basement) of the building is: _____ . ___ ft. (m) Datum:_____

G9. BFE or (in Zone AO) depth of flooding at the building site is: _____ . ___ ft. (m) Datum:_____

LOCAL OFFICIAL'S NAME TITLE

COMMUNITY NAME TELEPHONE

SIGNATURE DATE

COMMENTS

|__| Check here if attachments

# V-Zone Design and Construction Certification

FEMA



**Purpose:** To explain the certification requirements for structural design and construction in V zones.

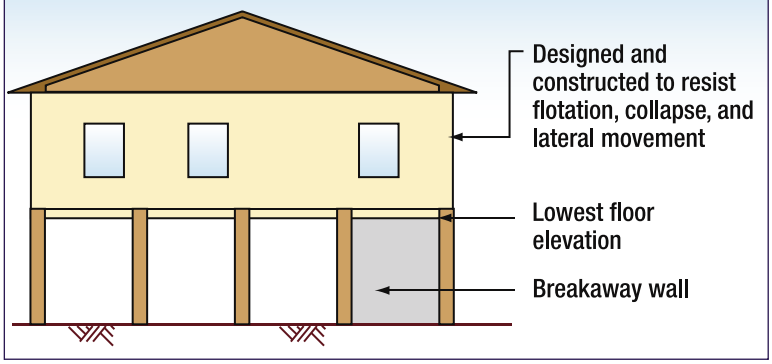
## Structural Design and Methods of Construction Certification

As part of the agreement for making flood insurance available in a community, the National Flood Insurance Program (NFIP) requires the community to adopt a floodplain management ordinance that specifies minimum design and construction requirements. Those requirements include a ***certification of the structural design and the methods of construction.***

Specifically, NFIP regulations and local floodplain management ordinances require that:

1. a ***registered professional engineer or architect*** shall ***develop or review*** the ***structural design, specifications, and plans*** for the construction, and
2. a ***registered professional engineer or architect*** shall ***certify that the design and methods of construction*** to be used are in accordance with accepted standards of practice for meeting the following criteria:
   - the ***bottom of the lowest horizontal structural member of the lowest floor*** (excluding the pilings or columns) is elevated to or above the Base Flood Elevation (BFE); and
   - the pile or column foundation and structure attached thereto is ***anchored to resist flotation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously*** on all building components. Water loading values used shall be those associated with the Base Flood. Wind loading values used shall be those required by applicable state or local building standards.

**Required Certifications in V Zones**




The community, through its inspection procedures, will verify that the building is built in accordance with the certified design.

## Completing the V-Zone Certification

There is no single V-zone certificate used on a nationwide basis. Instead, local communities and/or states have developed their own certification procedures and documents.

Registered engineers and architects involved in V-zone construction projects should ***check with the authority having jurisdiction regarding the exact nature and timing of required certifications***.

Page 2 shows a sample certification form developed by one state. It is intended to show one of many possible ways by which a jurisdiction may require that the certification and supporting information be provided. In this instance, three certifications are included on the form (Lowest Floor Elevation, Design and Methods of Construction, Breakaway Wall Collapse).

**Other Certifications Required in V Zones**

- Lowest Floor Elevation, by a surveyor, engineer, or architect (see Fact Sheet No. 4)
- Breakaway Wall Collapse, by a registered professional engineer or architect (see Fact Sheet No. 27)

**The Design and Methods of Construction certification should take into consideration the NFIP Free-of-Obstruction requirement for V zones:** *the space below the lowest floor must be free of obstructions (e.g., free of any building element, equipment, or other fixed objects that can transfer flood loads to the foundation, or that can cause floodwaters or waves to be deflected into the building), or must be constructed with non-supporting breakaway walls, open lattice, or insect screening.* **(See NFIP Technical Bulletin 5-93 and Fact Sheet No. 27.)**

Note: The V-zone certificate is not a substitute for and cannot be used without the NFIP Elevation Certificate (see Fact Sheet No. 4), which is required for flood insurance rating.

# V-ZONE CERTIFICATE

Name_____ Policy Number *(Insurance Co. Use)* _____
Building Address or
Other Description _____
City _____ State _____ Zip Code _____

## SECTION I: Flood Insurance Rate Map (FIRM) Information

Community Number_____ Panel Number _____ Suffix _____ Date of FIRM Index _____ FIRM Zone_____

## SECTION II: Elevation Information

***NOTE: This Certificate does not substitute for an Elevation Certificate***

1. Elevation of the Bottom of Lowest Horizontal Structural Member……_____ feet (NGVD)
2. Base Flood Elevation (BFE)……_____ feet (NGVD)
3. Elevation of Lowest Adjacent Grade……_____ feet (NGVD)
4. Approximate Depth of Anticipated Scour/Erosion used for Foundation Design……_____ feet (NGVD)
5. Embedment Depth of Pilings or Foundation Below Lowest Adjacent Grade……_____ feet (NGVD)

## SECTION III: V-Zone Certification Statement

***NOTE: This section must be certified by a registered engineer or architect***

I certify that I have developed or reviewed the structural design, plans, and specifications for construction and that the design and methods of construction to be used are in accordance with accepted standards of practice for meeting the following provisions:

- The bottom of the lowest horizontal structural member of the lowest floor (excluding piles and columns) is elevated to or above the BFE; and
- The pile and column foundation and structure attached thereto is anchored to resist flotation, collapse, and lateral movement due to the effects of the wind and water loads acting simultaneously on all building components. Water loading values used are those associated with the base flood. Wind loading values used are those required by the applicable State or local building code. The potential for scour and erosion at the foundation has been anticipated for conditions associated with the base flood, including wave action.

## SECTION IV: Breakaway Wall Certification Statement

***NOTE: This section must be certified by a registered engineer or architect when breakaway walls exceed a design safe loading resistance of 20 pounds per square foot***

I certify that I have developed or reviewed the structural design, plans, and specifications for construction and that the design and methods of construction to be used for the breakaway walls are in accordance with accepted standards of practice for meeting the following provisions:

- Breakaway wall collapse shall result from a water load less than that which would occur during the base flood; and
- **The elevated portion of the building and supporting foundation system shall not be subject to collapse, displacement, or other structural damage due to the effects of wind and water loads acting simultaneously on all building components (wind and water loading values to be used are defined in Section III).**

## SECTION V: Certification

***Signature below certifies: ____ Section III; ____ Section IV***

Certifier's Name _____ Company Name_____
Title _____ License Number _____
Street Address _____
City _____ State _____ Zip Code _____

Signature _____ Date _____ Telephone Number _____

# How Do Siting and Design Decisions Affect the Owner's Costs?

FEMA

HOME BUILDER'S GUIDE TO COASTAL CONSTRUCTION FEMA 499/August 2005 *Technical Fact Sheet No. 6*

**Purpose:** To show the effects of planning, siting, and design decisions on coastal home costs.

## Key Issues

- When building a coastal home, initial, operating, and long-term costs (i.e., life cycle costs) must be considered.
- Coastal (especially oceanfront) homes cost more to design, construct, maintain, repair, and insure than inland homes.
- Determining the risks associated with a particular building site or design is important.
- Siting, designing, and constructing to minimum regulatory requirements do not necessarily result in the lowest cost to the owner over a long period of time. Exceeding minimum design requirements costs slightly more initially, but can save the owner money in the long run.

## Costs

A variety of costs should be considered when planning a coastal home, not just the construction cost. Owners should be aware of each of the following, and consider how siting and design decisions will affect these costs:

**Initial costs** include property evaluation and acquisition costs and the costs of permitting, design, and construction.

**Operating costs** include costs associated with the use of the building, such as the costs of utilities and insurance*.

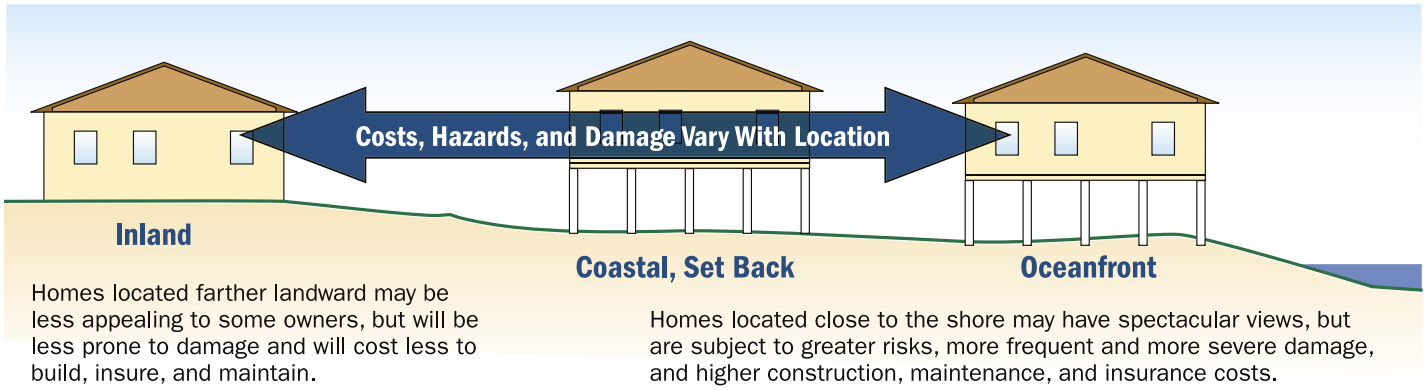
**Long-term costs** include costs for preventive maintenance and for repair and replacement of deteriorated or damaged building components.

*Note: Flood insurance premiums can be reduced up to 60 percent by exceeding minimum siting, design, and construction practices. See the V-Zone Risk Factor Rating Form in FEMA's *Flood Insurance Manual* (http://www.fema.gov/nfip/manual.shtm).

## Risk

One of the most important building costs to be considered is that resulting from storm and/or erosion damage. But how can an owner decide what level of risk is associated with a particular building site or design? One way is to consider the probability of a storm or erosion occurring and the potential building damage that results (see matrix).

| Potential $ Loss \ Probability of Occurrence | Low | Medium | High |
|---|---|---|---|
| Low | Low Risk | Low Risk | Medium Risk |
| Medium | Low Risk | Medium Risk | High Risk |
| High | Medium Risk | High Risk | Extreme Risk |




Homes located farther landward may be less appealing to some owners, but will be less prone to damage and will cost less to build, insure, and maintain.

Homes located close to the shore may have spectacular views, but are subject to greater risks, more frequent and more severe damage, and higher construction, maintenance, and insurance costs.

***Building sites or designs resulting in extreme or high risk should be avoided*** — the likelihood of building loss is great, and the long-term costs to the owner will be very high. Building sites or designs resulting in medium or low risk should be given preference.

## Siting

Note that over a long period, poor siting decisions are rarely overcome by building design.

## Design

- How much more expensive is it to build near the coast as opposed to inland areas? The table below suggests approximately 10 - 30 percent more.
- What about exceeding minimum design requirements in coastal areas? The table suggests that the added construction costs for meeting the practices recommended in the ***Home Builder's Guide to Coastal Construction*** (beyond typical minimum requirements) are nominal.

| **Design Item** (Items in bold are required by National Flood Insurance Program (NFIP) and/or local building code.) | **Cross-Reference to Fact Sheets** | **Added Initial Costs** (when compared to typical ***inland*** construction) **Required by Code or NFIP** | **Added Initial Costs** (to exceed Code/NFIP minimum requirements) **for Home Builder's Guide to Coastal Construction Recommended Practices** | **Effect of Design Item on Cost** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Reduce wind/storm damage** | **Reduce flood damage** | **Longer material life** | **Reduce maintenance** | **Lower insurance** | **Lower utility bills** |
| A zone, pile/column foundation | 1, 4, 11 | High | High | ✓ | ✓ | | | ✓ | |
| **V zone, pile/column foundation** | 1, 4, 5, 11 | High | | | ✓ | | | ✓ | |
| Joists sheathed on underside | | Low | Low | | ✓ | ✓ | | | ✓ |
| **Structurally sheathed walls** | | Medium | | ✓ | | | | | |
| **Corrosion protection** | 1, 8 | Low | | ✓ | ✓ | ✓ | ✓ | | |
| **Decay protection** | 1, 8 | Medium | | ✓ | ✓ | ✓ | ✓ | | |
| Hip roof shape | 1 | Low | Low | ✓ | | | | | |
| **Enhanced roof sheathing connection** | 1, 18 | Low | Low | ✓ | | | | | |
| **Enhanced roof underlayment** | 19 | Low | Low | ✓ | | | | | |
| **Upgraded roofing materials** | 1, 20 | Medium | | ✓ | | ✓ | ✓ | | |
| **Enhanced flashing** | 1, 22, 24 | Low | | ✓ | | ✓ | ✓ | | |
| **Housewrap** | 1, 22, 23 | Low | | ✓ | | | | | ✓ |
| **Superior siding and connection** | 25 | Medium | Medium | ✓ | | | ✓ | | |
| **Protected or impact-resistant glazing** | 1, 26 | High | Medium | ✓ | | | | ✓ | |
| **Connection hardware** | 1, 8, 17 | Low | | ✓ | ✓ | | | | |
| **Flood-resistant materials** | 1, 8 | Low | | | ✓ | ✓ | | ✓ | |
| **Protected utilities and mechanicals** | 1, 29 | Low | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **Estimated Total Additional Cost (% of building cost)** | | **15 - 30** | **±5** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | |
|---|---|
| **Low** | <0.5% of base building cost |
| **Medium** | 0.5% - 2.0% of base building cost |
| **High** | >2.0% of base buildig cost |

Estimates are based on a 3,000-square-foot home with a moderate number of windows and special features. Many of the upgraded design features are ***required*** by local codes, but the level of protection beyond the code minimum can vary, depending on the owner's preference.

# Selecting a Lot and Siting the Building



**Purpose:** To provide guidance on lot selection and siting considerations for coastal residential buildings.

## Key Issues

- Purchase and siting decisions should be long-term decisions, not based on present-day shoreline and conditions.
- Parcel characteristics, infrastructure, regulations, environmental factors, and owner desires constrain siting options.
- Conformance with local/state shoreline setback lines does not mean buildings will be "safe."
- Information about site conditions and history is available from several sources.

Siting, design, and construction should be considered together (see Fact Sheet No. 6), but know that poor lot selection and siting decisions can rarely be overcome by improved design and construction. Building failures (see Fact Sheet No. 1) are often the result of poor siting.

## The Importance of Property Purchase and Siting Decisions

***The single most common and costly siting mistake made by designers, builders, and owners is failing to consider future erosion and slope stability*** when an existing coastal home is purchased or when land is purchased and a new home is built. Purchase decisions—or siting, design, and construction decisions — based on present-day shoreline conditions often lead to future building failures.

Over a long period of time, owners of poorly sited coastal buildings may spend more money on erosion control and erosion-related building repairs than they spent on the building itself.

## What Factors Constrain Siting Decisions?

Many factors affect and limit a home builder's or owner's ability to site coastal residential buildings, but the most influential is probably ***parcel size***, followed by ***topography***, ***location of roads and other infrastructure***, ***regulatory constraints***, and ***environmental constraints***.

Given the cost of coastal property, parcel sizes are often small and owners often build the largest building that will fit within the permissible development footprint. Buyers frequently fail to recognize that siting decisions in these cases have effectively been made at the time the land was platted or subdivided, and that shoreline erosion can render these parcels unsuitable for long-term occupation.

In some instances, however, parcel size may be large enough to allow a hazard-resistant coastal building to be sited and constructed, but an ***owner's desire*** to push the building as close to the shoreline as possible increases the likelihood that the building will be damaged or destroyed in the future.

## Coastal Setback Lines – What Protection Do They Provide?

Many states require new buildings to be sited at or landward of coastal construction setback lines, which are usually based on ***long-term, average annual erosion rates***. For example, a typical minimum 50-year setback line with an erosion rate of 2.5 feet/year would require a setback of 125 feet, typically measured from a reference feature such as the dune crest, vegetation line, or high-water line.

Building at the 125-foot setback (in this case) does ***not*** mean that a building will be "safe" from erosion for 50 years.

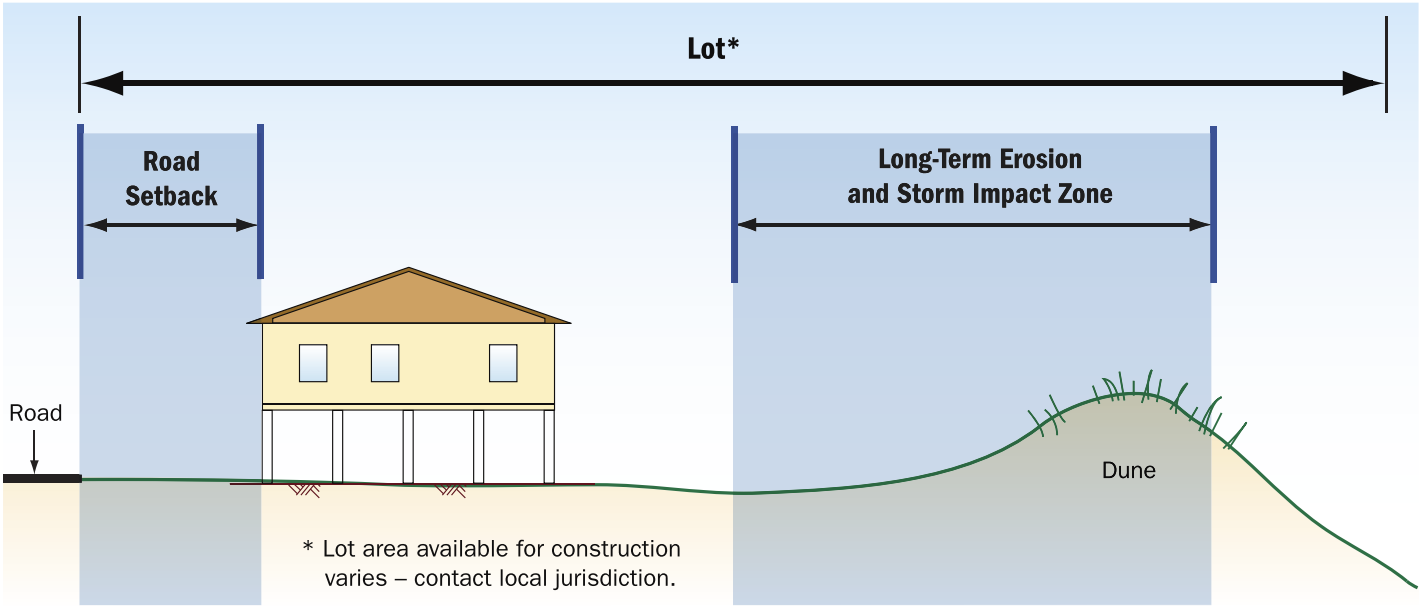
- Storms can cause short-term erosion that far exceeds setbacks based on long-term averages.
- Erosion rates vary over time, and erosion could surpass the setback distance in just a few years' time. The rate variability must also be known to determine the probability of undermining over a given time period.

## What Should Builders, Designers, and Owners Do?

- Consult local and state agencies, universities, and consultants for detailed, site-specific erosion and hazard information.
- Look for historical information on erosion and storm effects. How have older buildings in the area fared over time? Use the experience of others to guide siting decisions.
- Determine the owner's risk tolerance, and reject parcels or building siting decisions that exceed the acceptable level of risk.

## Common Siting Problems

- Building on a ***small lot between a road and an eroding shoreline*** is a recipe for trouble.
- ***Odd-shaped lots*** that force buildings close to the shoreline increase the vulnerability of the buildings.
- Siting a building near the ***edge of a bluff*** increases the likelihood of building loss, because of both bluff erosion and changes in bluff stability resulting from development activities (e.g., clearing vegetation, building construction, landscaping, changes in surface drainage and groundwater flow patterns).
- Siting near a ***tidal inlet*** with a dynamic shoreline can result in the building being exposed to increasing flood and erosion hazards over time.
- Siting a building ***immediately behind an erosion control structure*** may lead to building damage from wave overtopping and may limit the owner's ability to repair or maintain the erosion control structure.
- Siting a new building ***within the footprint*** of a pre-existing building does not guarantee that the location is a good one.




*Recommended building location on a coastal lot.*

Siting should consider both long-term erosion and storm impacts.
Siting should consider site-specific experience, wherever available.

# Coastal Building Materials

FEMA



**Purpose:** To provide guidance on the selection of building materials used for coastal construction.

## Key Issues

- The ***durability*** of a coastal home relies on the types of materials used to construct it. For more details, see the U.S. Department of Housing and Urban Development (HUD) report *Durability by Design, A Guide for Residential Builders and Designers*, available on the HUD User website at http://www.huduser.org/publications/destech/durdesign.html.
- Materials and construction methods should be resistant to ***flood and wind damage, driving rain, corrosion, moisture, and decay***.
- All coastal buildings will require ***maintenance and repairs*** (more so than inland construction) — use proper materials and methods for repairs, additions, and other work following initial construction (see Fact Sheet No. 30).

Section 60.3(a)(ii) of the National Flood Insurance Program (NFIP) regulations requires that all new construction and substantial improvements in floodprone areas be constructed with materials below the Base Flood Elevation (BFE) that are resistant to flood damage. (See Fact Sheet No. 30 for a definition of "substantial improvement.")

## Flood-Resistant Materials

Flooding accounts for a large percentage of the damage caused by a coastal storm. Building materials exposed to flooding must be resilient enough to sustain a certain amount of water exposure in order to avoid the need for complete replacement after the flood.

FEMA defines a flood-resistant material as *any building material capable of withstanding direct and prolonged contact (i.e., at least 72 hours) with floodwaters without sustaining significant damage (i.e., requires more than cosmetic repair).*

The following are examples of flood-resistant materials:

- **Lumber:** pressure-treated or naturally decay-resistant, including redwood, cedar, some oaks, and bald cypress
- **Concrete:** a sound, durable mix, and when exposed to saltwater or salt spray, made with a sulfate-resisting cement, with a 28-day compressive strength of

***Select building materials that can endure periodic flooding.***

5,000 psi minimum and a water-cement ratio not higher than 0.40 – consult ACI 318-02, *Building Code Requirements for Structural Concrete and Commentary*, by the American Concrete Institute International

- **Masonry:** reinforced and fully grouted
- **Structural Steel:** coated to resist corrosion
- **Insulation:** plastics, synthetics, and closed-cell foam, or other types approved by local building officials

This table lists examples of flood-resistant materials used in coastal homes.

| Location of Material Use | Name of Material |
|---|---|
| **Piles and posts** | Round, tapered wood piles preservative-treated for ground contact, at a minimum; square-section piles or wood posts preservative-treated for marine use |
| **Piers** | Reinforced concrete or concrete masonry units (CMU) (see "Flood-Resistant Materials" above and Fact Sheet No. 14) |
| **Foundation walls** | Reinforced concrete or CMU, or wood that is preservative-treated for foundation or marine use (see Fact Sheet No. 15) |
| **Beams** | Solid sawn timbers and glue-laminated products, either naturally decay-resistant or preservative-treated for aboveground exposure; built-up members preservative-treated for ground contact |
| **Decking** | Preservative-treated or naturally decay-resistant wood, or composite wood members (e.g., manufactured of recycled sawdust and plastic) |
| **Framing** | Sawn wood or manufactured lumber (preservative-treated or naturally resistant to decay if in close proximity to the ground) |
| **Exterior sheathing** | High-capacity shearwall sheathing rated "Exterior" |
| **Subflooring** | Plywood or oriented strand board (OSB) rated "Exposure 1," or rated "Exterior" if left permanently exposed (e.g., exposed underside of elevated house on open foundation) |
| **Siding** | Vinyl or naturally decay-resistant wood (see Fact Sheet No. 25) |
| **Flooring** | Latex or bituminous cement formed-in-place, clay, concrete tile, pre-cast concrete, epoxy formed-in-place, mastic flooring, polyurethane formed-in-place, rubber sheets, rubber tiles with chemical-set adhesives, silicone floor formed-in-place, terrazzo, vinyl sheet-goods, vinyl tile with chemical-set adhesives, pressure-treated lumber or naturally decay-resistant lumber |
| **Walls and ceilings** | Cement board, brick, metal, cast stone in waterproof mortar, slate, porcelain, glass, glass block, clay tile, concrete, CMU, pressure-treated wood, naturally decay-resistant wood, marine grade plywood or pressure-treated plywood |
| **Doors** | Hollow metal |
| **Insulation** | Foam or closed-cell |
| **Trim** | Natural or artificial stone, steel, or rubber |

Many coastal jurisdictions make available a list of approved materials that can be used in coastal environments. Check for locally approved flood-resistant materials. Include all proposed construction and materials in approved plans. For guidance on testing specific materials, refer to *NES Evaluation Protocol for Determination of Flood-Resistant Properties of Building Elements* (NES, Inc. – http://www.nateval.org).

## Wind-Resistant Materials

Homes in many coastal areas are often exposed to winds in excess of 90 mph (3-second peak gust). Choose building materials (e.g., roof shingles, siding, windows, doors, fasteners, and framing members) that are designed for use in high-wind areas.

**Examples:**

- shingles rated for high winds (see Fact Sheet No. 20)
- double-hemmed vinyl siding (see Fact Sheet No. 25)
- deformed-shank nails for sheathing attachments (see Fact Sheet No. 18)
- wind-resistant glazing (see Fact Sheet No. 22)
- reinforced garage doors
- tie-down connectors used throughout structure (from roof framing to foundation — see Fact Sheet Nos. 10 and 17)
- wider framing members (2x6 instead of 2x4)

**Remember:** A wind-resistant material is only as good as its connection. Always use recommended fasteners and connection methods.

***Select building materials that are suitable for the expected wind forces.***

## Corrosion and Decay Resistance

Coastal environments are conducive to metal corrosion and moisture- and termite-related decay of other building materials. Metal corrosion is most pronounced on coastal homes (within 3,000 feet of the ocean), but moisture- and termite-related decay are prevalent throughout coastal areas.

### Corrosion-Resistant Metals

Most jurisdictions require metal building hardware to be hot-dipped galvanized or stainless steel. Some local codes require protective coatings that are thicker than "off-the-shelf" products typically have. For example, a G90 zinc coating (0.75 mil on each face) may be required, which is thicker than the common G60 (0.5 mil on each face) coating.

### Recommendations

- Use hot-dipped galvanized or stainless steel hardware. Reinforcing steel should be protected from corrosion by sound materials (masonry, mortar, grout, concrete) and good workmanship (see Fact Sheet No. 16). Use

The term "corrosion-resistant" is widely used but, by itself, is of little help to those specifying or evaluating materials for use in a coastal home. Every material resists corrosion to some extent, or conversely, every material corrodes.

The real issue is *how long will a given material serve its intended purpose at a given home?* The answer depends on the following:

- the material
- where it is used in the home
- whether installation techniques (e.g., drilling, cutting, bending) will compromise its resistance
- its degree of exposure to salt air, moisture, and corrosive agents
- whether maintenance required of the homeowner is performed

The bottom line: **do not blindly specify or accept a product just because it is labeled *corrosion-resistant***. Evaluate the nature of the material, its coating type and thickness (if applicable), and its performance in similar environments before determining whether it is suitable for a particular application.

For guidance on the selection of metal hardware for use in coastal environments, consult an engineer with experience in corrosion protection. For more information about corrosion in coastal environments, see FEMA Technical Bulletin 8-96, *Corrosion Protection for Metal Connectors in Coastal Areas for Structures Located in Special Flood Hazard Areas* (see the Additional Resources section of this fact sheet).

galvanized or epoxy-coated reinforcing steel in situations where the potential for corrosion is high (see Fact Sheet No. 14).

- Avoid joining dissimilar metals, especially those with high galvanic potential (e.g., copper and steel).
- Some wood preservatives should not be used in direct contact with galvanized metal. Verify that wood treatment is suitable for use with galvanized metal, or use stainless steel.
- Metal-plate-connected trusses should not be exposed to the elements. Truss joints near vent openings are more susceptible to corrosion and may require increased corrosion protection.

### Moisture Resistance

Materials resistant to moisture can greatly reduce maintenance and extend the life of a coastal home (however, by themselves, such materials cannot prevent all moisture damage. Proper design and installation of moisture barriers (see Fact Sheet No. 9) is also required).

### Recommendations

- Control wood decay by separating wood from moisture, using preservative-treated wood, using naturally decay-resistant wood, and applying protective wood finishes.
- Use proper detailing of wood joints and construction to eliminate standing water and reduce moisture absorption by the wood (e.g., avoid exposure of end grain cuts, which absorb moisture up to 30 times faster than the sides of a wood member).
- Do not use untreated wood in ground contact or high-moisture situations. Do not use untreated wood in direct contact with concrete.
- Field-treat any cuts or drill holes that offer paths for moisture to enter wood members.
- For structural uses, employ concrete that is sound, dense, and durable; control cracks with welded wire fabric and/or reinforcing, as appropriate.
- Use masonry, mortar, and grout that conform with the latest building codes.

### Termite Resistance

Termite damage to wood construction occurs in many coastal areas (attack is most frequent and severe along the southeastern Atlantic and Gulf of Mexico shorelines, in California, and in Hawaii and other tropical areas). Termites can be controlled by soil treatment, termite shields, and the use of termite-resistant materials.

***Metals corrode at a much faster rate near the ocean. Always use well-protected hardware, such as this connector with thick galvanizing. (For information about pile-to-beam connections, see Fact Sheet No. 13).***

***Wood decay at the base of a wood post supported by concrete.***

### Recommendations

- Incorporate termite control methods into design in conformance with requirements of the authority having jurisdiction.
- Where a masonry foundation is used and anchorage to the foundation is required for uplift resistance, the upper block cores must usually be completely filled with grout, which may eliminate the requirement for termite shields (see Fact Sheet No. 14).
- Use preservative-treated wood for foundations, sills, above-foundation elements, and floor framing.

## Additional Resources


FEMA. NFIP Technical Bulletin 2-93, *Flood-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas*. (http://www.fema.gov/fima/techbul.shtm)

FEMA. NFIP Technical Bulletin 8-96, *Corrosion Protection for Metal Connectors in Coastal Areas for Structures Located in Special Flood Hazard Areas*. (http://www.fema.gov/fima/techbul.shtm)

American Concrete Institute International. (http://www.aci-int.org/general/home.asp)

American Wood-Preservers' Association. (http://www.awpa.com)

International Code Council Evaluation Service, Inc. Protocol for Testing the Flood Resistance of Materials. (http://www.icc-es.org/index.shtml)

# Moisture Barrier Systems



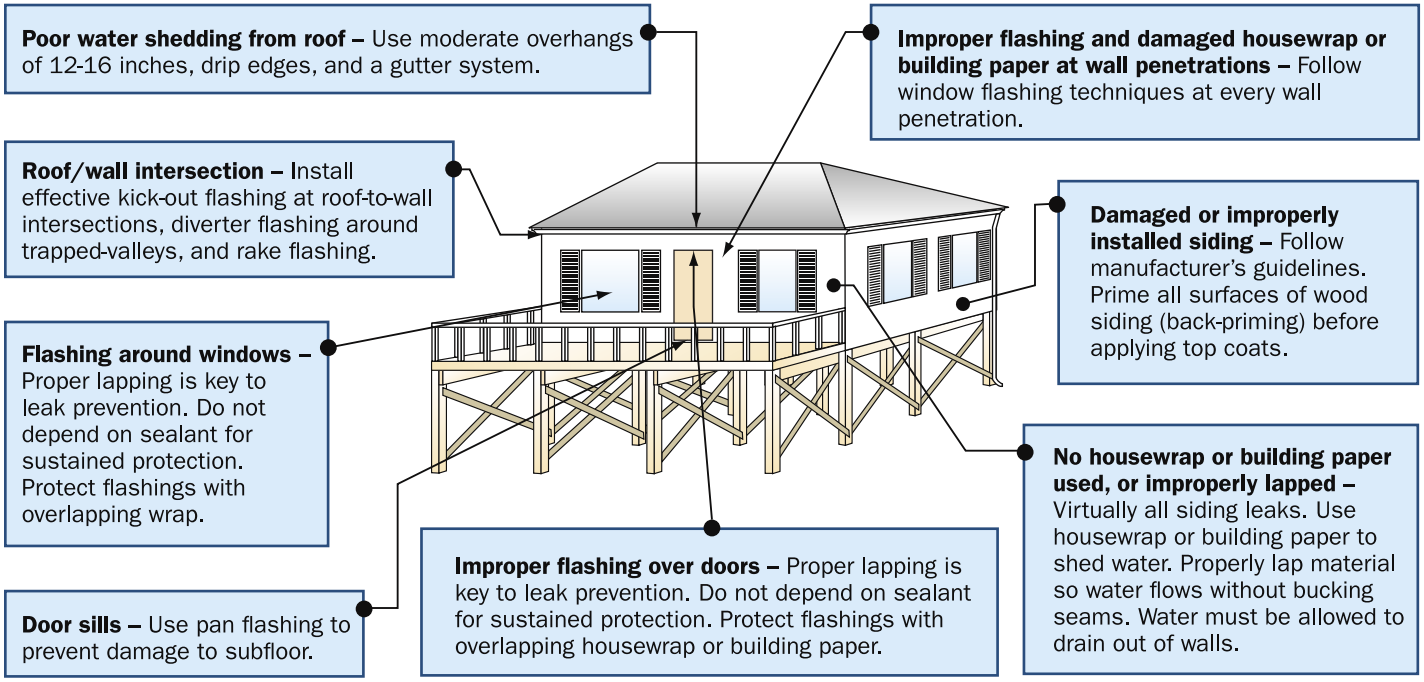
**Purpose:** To describe the moisture barrier system, explain how typical wall moisture barriers work, and identify common problems associated with moisture barrier systems.

## Key Issues

- A successful moisture barrier system will limit water infiltration into unwanted areas and allow drainage and drying of wetted building materials.
- Most moisture barrier systems for walls (e.g., siding and brick veneer) are "redundant" systems, which require at least two drainage planes (see page 2).
- Housewrap or building paper (asphalt-saturated felt) will provide an adequate secondary drainage plane.
- Proper flashing and lapping of housewrap and building paper are critical to a successful moisture barrier system.
- Sealant should never be substituted for proper layering.

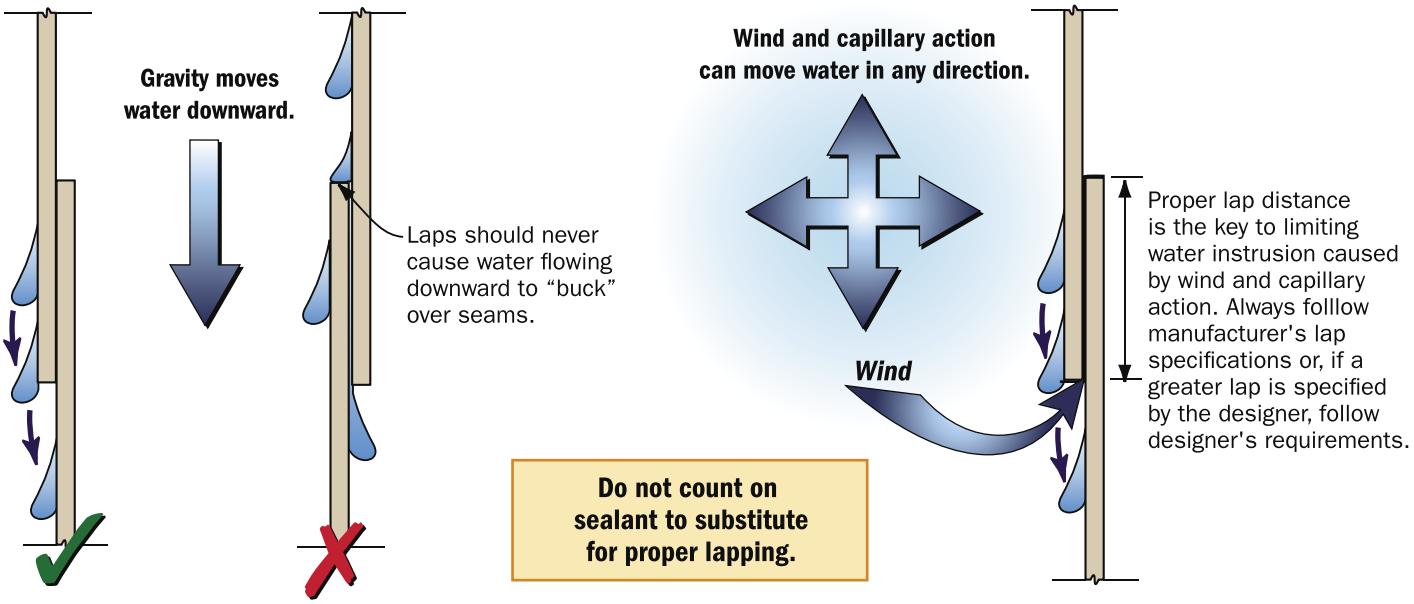

The purpose of the building envelope is to control the movement of water, air, thermal energy, and water vapor. The goal is to prevent water infiltration into the interior, limit long-term wetting of the building components, and control air and vapor movement through the envelope.

## Locations and Causes of Common Water Intrusion Problems



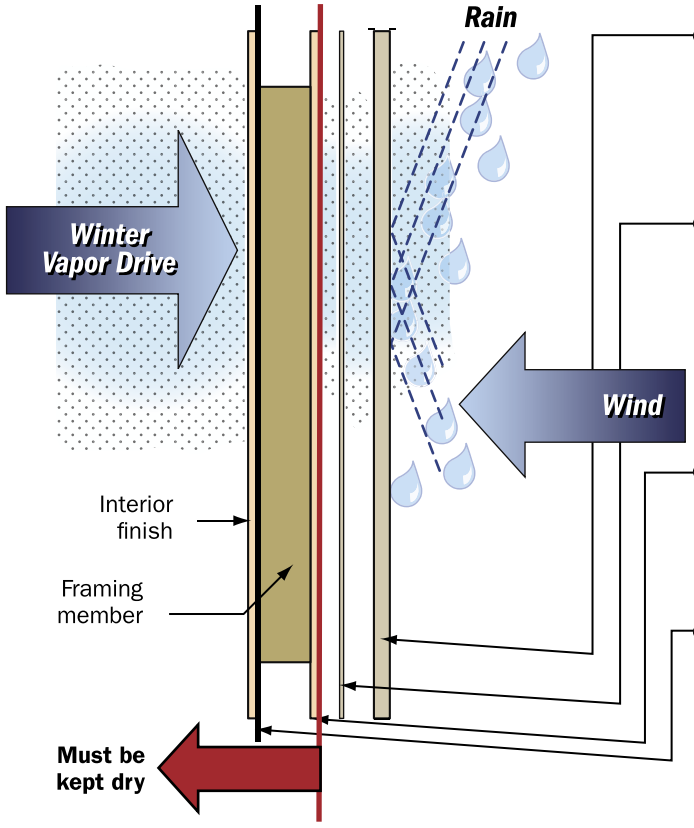
The location of water entry is often difficult to see, and the damage to substrate and structural members behind the exterior wall cladding frequently cannot be detected by visual inspection.

## Proper Lapping Is the Key...




Proper lapping of moisture barrier materials is the key to preventing water intrusion. Most water intrusion problems are related to the improper lapping of materials. Usually, flashing details around doors, windows, and penetrations are to blame. If the flashing details are right and the housewrap or building paper is properly installed, most moisture problems will be prevented. Capillary suction is a strong force and will move water in ***any*** direction. Even under conditions of light or no wind pressure, water can be wicked through seams, cracks, and joints upward behind the overlaps of horizontal siding. Proper lap distances and sealant help prevent water intrusion caused by wicking action.

## How a Redundant Moisture Barrier Works




**Siding**
The siding is the first line of defense, but by no means should it be the only protection from outside moisture. Sidings shed most of the water, but some does get through, especially in coastal areas where high winds can drive rain.

**Housewrap or Building Paper**
Housewrap or building paper is a dual-purpose protection layer. It sheds water that gets through the siding and limits air intrusion from the outside. A unique feature of this barrier is that it sheds water, but allows water vapor to pass through. This permits water vapor from the inside to pass through without condensing on the framing.

**Sheathing**
If structural sheathing is used, it should be protected from moisture. Prolonged wetting, especially without the ability to drain the moisture and dry out, will damage the sheathing.

**Vapor Retarder**
In cold regions, a vapor retarder is often used on the warm side of the wall cavity to minimize the movement of vapor from the inside of the building into the wall cavity, where it will condense on the cool framing members. Vapor retarders are typically used only where the predominant vapor drive is from the inside to the outside (cold climates).

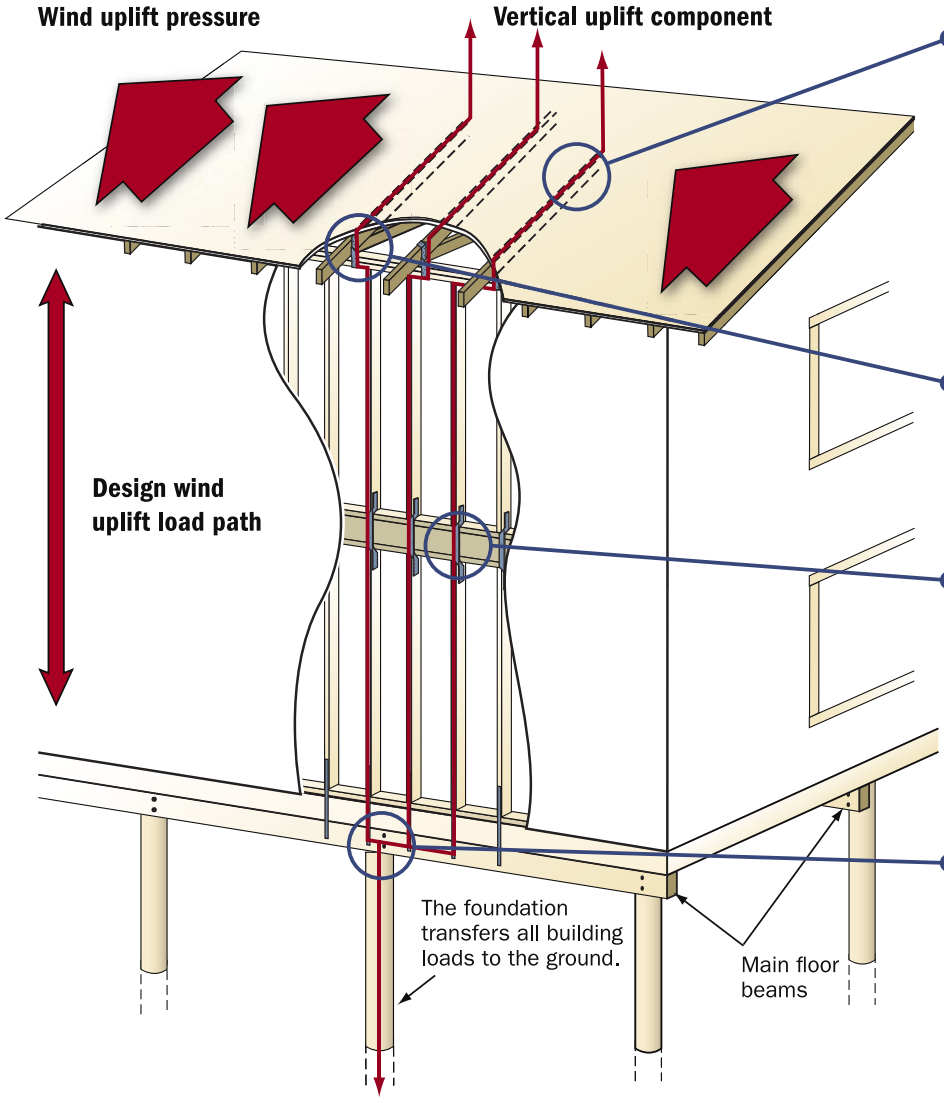
# Load Paths



**Purpose:** To illustrate the concept of load paths and highlight important connections in a ***wind uplift load path***.

## Key Issues

- Loads acting on a building follow many paths through the building and must eventually be resisted by the ground, or the building will fail.
- Loads accumulate as they are routed through key connections in a building.
- Member connections are usually the weak link in a load path.
- Failed or missed connections cause loads to be rerouted through unintended load paths.




***Vertical load path from roof to ground on a platform-and-pile-construction building. Note: Load paths will vary depending on construction type and design. Adjacent framing members will receive more load if a connection fails.***

**LINK 1**
High winds lift the roof upward. Roofing fasteners link the roof covering to the sheathing*, and sheathing fasteners link the sheathing to the roof framing members (see Fact Sheet No. 18).

* Although not a structural connection, the attachment of the roof covering to the roof sheathing is an essential part of protecting the building envelope.

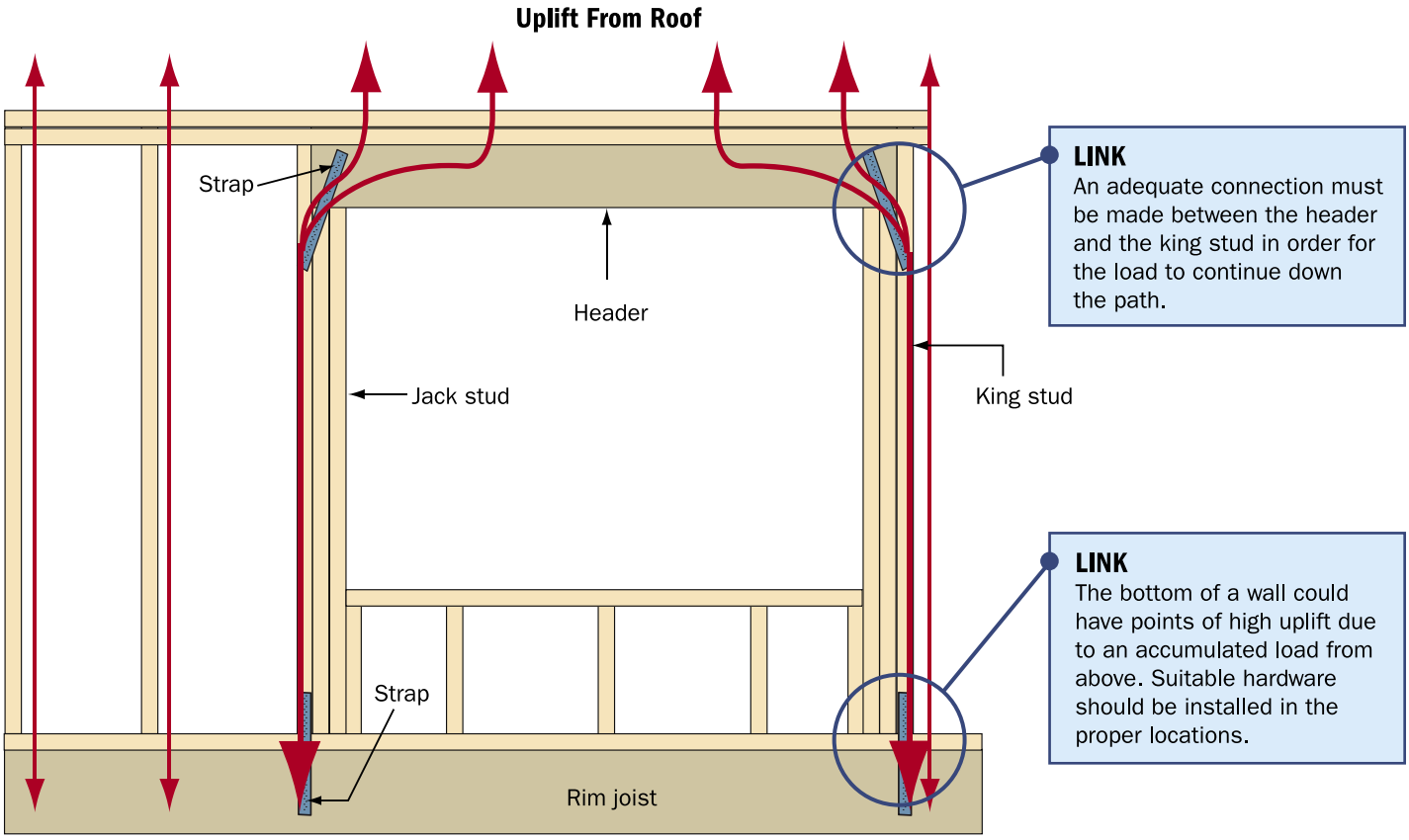
**LINK 2**
Accumulated roof load is routed through roof-to-wall connections. Special roof ties connect the roof framing to the bearing walls (see Fact Sheet No. 17).

**LINK 3**
Upper walls transfer loads directly to the lower walls. The floor framing is bypassed by using metal straps or extended exterior sheathing that directly connects upper wall studs to the lower wall studs. A similar connection is used to connect the lower wall to the main floor beam.

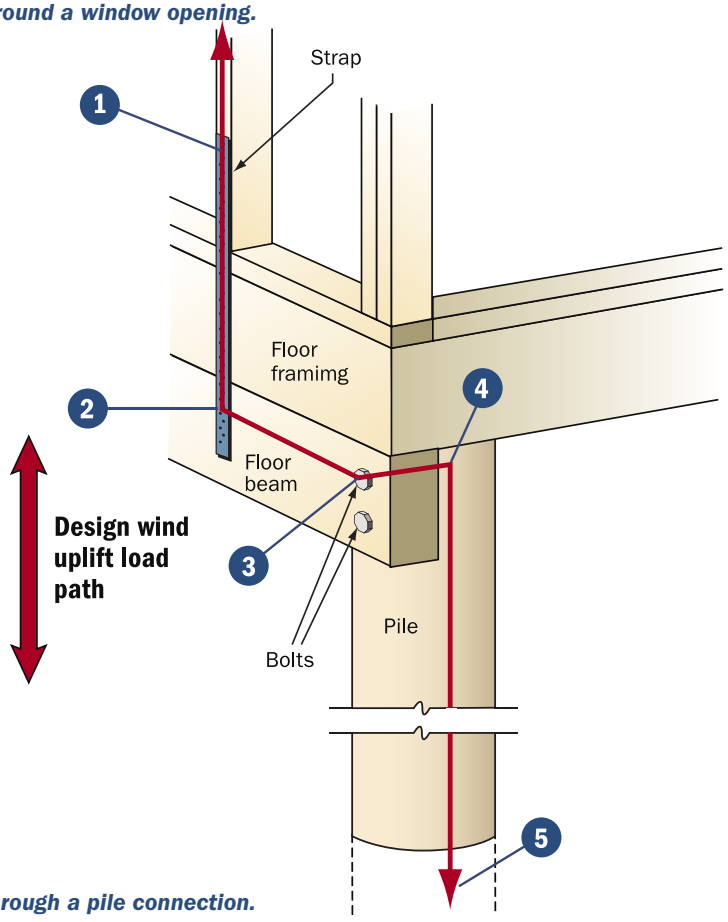
**LINK 4**
The accumulated uplift force is transferred from the main floor beams to the pile foundation with special brackets or bolts (see Fact Sheet No. 13). **Note:** Some of this load is offset by the weight of the building.

Note: Horizontal load paths transferring shear from upper stories to the ground must also be analyzed.

If a connection fails, an alternative load path will form. If the members and connections in the new load path have inadequate resistance, progressive failure can occur. Loads must be routed around openings, such as windows and doors. Accumulated loads on headers are transferred to the studs on the sides of the opening.




*Load path around a window opening.*




*Load path through a pile connection.*

Load paths can be complex through a connection. It is important that each link within the connection be strong enough to transfer the full design load.

The detail at left shows a typical floor-to-pile connection. Uplift loads are transferred through the joint in the following order.

1. from upper story to strap
2. from strap to floor beam
3. from floor beam to bolts
4. from bolts to pile
5. from pile to ground