

# Designing for Flood Levels Above the BFE After Hurricane Sandy



FEMA

HURRICANE SANDY RECOVERY ADVISOR

RA5, April 2013

## Purpose and Intended Audience

Flooding in New York and New Jersey extended far beyond mapped Special Flood Hazard Areas (SFHA) and exceeded base flood elevations (BFEs) by several feet in some areas. Lessons learned from Hurricane Sandy can be used to guide repair and reconstruction efforts and design of new buildings to reduce susceptibility to future flood damage.

This Recovery Advisory reviews how coastal Flood Insurance Rate Maps (FIRMs) and BFEs are established and provides guidance on elevating buildings to minimize flood damage in cases where flood levels exceed the BFE. The intended audience for this advisory is primarily homeowners and designers, but it may be helpful to anyone involved in selecting lowest floor elevations for new construction and reconstruction of buildings in areas affected by Sandy.

### Key Issues:

1. Elevating to the BFE does not provide complete protection against flooding. Storms more severe than the base flood can and do occur.
2. FIRMs are only as accurate as the topography, bathymetry, and technical information used, and the technical analyses performed, to create them. FIRMs are a snapshot in time and may become outdated as physical conditions, climate, and engineering methods change.
3. Once flood levels exceed the lowest floor of a building, the extent of damage increases dramatically, especially in areas subject to coastal waves (Figure 1).
4. Design and construction practices can minimize damage to buildings, particularly by elevating the building higher than the minimum required elevation.

### This Recovery Advisory Addresses:

- FIRMs, FISs, and flood risk
- Building damage when flood levels rise above the lowest floor
- How high above the BFE a building should be elevated
- Effect of building elevation on flood insurance premiums
- Additional design considerations for mitigating flood damage, inside and outside mapped flood hazard zones

### Terminology

**Base flood elevation (BFE):** Elevation of flooding, including wave height, having a 1 percent chance of being equaled or exceeded in any given year (also known as "base flood" and "100-year flood"). The BFE is the basis of insurance and floodplain management requirements and are shown on FIRMs.

**Special Flood Hazard Areas (SFHAs):** Land areas subject to a 1 percent or greater chance of flooding in any given year. These areas are indicated on FIRMs as Zone AE, A1-A30, A99, AR, AO, AH, V, VO, VE, or V1-30. Mapped zones outside of the SFHA are Zone X (Zones B or C on older FIRMs).

**Flood Insurance Rate Map (FIRM):** A map produced by FEMA to show flood hazard areas and risk zones. The SFHA and BFE are both shown on FIRMs.



Figure 1: Back wall failure due to flood level above the lowest floor of a house in Ortley Beach, NJ.

## FIRMs, FISs, and Flood Risk

Constructing a building to the minimum National Flood Insurance Program (NFIP) requirements-or constructing a building outside the SFHA-is no guarantee the building will be undamaged by flooding. In order to make informed decisions during repair and reconstruction, owners, designers, and communities should understand the following:

- FIRMs are based on modeling of the best

climate conditions data at the time of the Flood Insurance Study (FIS). However, there are inherent uncertainties in the modeling and analysis of BFEs and flood hazard zones. Some FIRMs, particularly older FIRMs, may no longer accurately reflect the shoreline location, land characteristics, and actual risk during a base flood event.

- The BFE is the flood level with a 1-percent-annual chance of occurrence. In coastal areas, the BFE is based on model studies of both historical and hypothetical storms.
- Floods can and do exceed the BFE and extend beyond the SFHA. In some recent storms (Katrina [2005], Ike [2008], and Sandy [2012]), flood levels exceeded the BFE by several feet in some areas and extended far beyond the SFHA shown on the FIRM. Figure 2

shows a comparison of the mapped SFHA at the time of Sandy (yellow hatched area) and the area actually flooded by Sandy (blue shaded area) for a portion of Coney Island, NY.

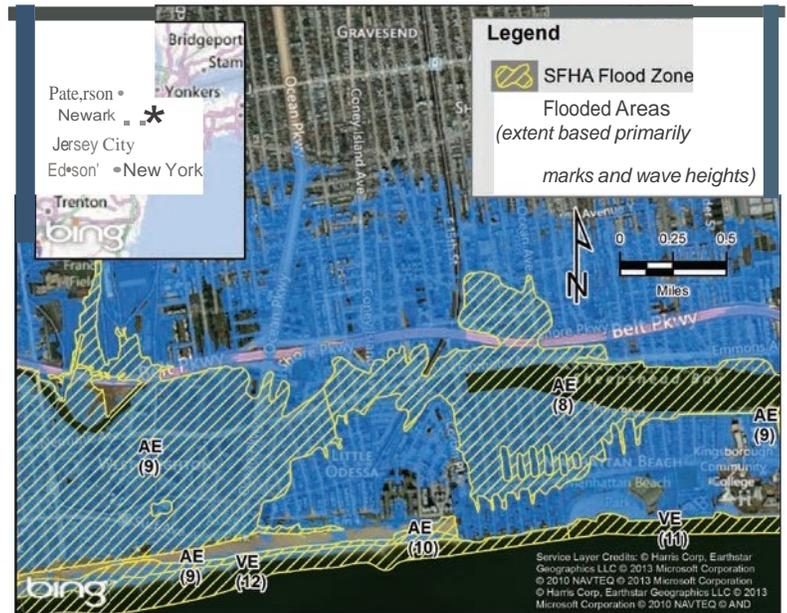


Figure 2: Comparison of SFHA and extent of inundation from Hurricane Sandy, Coney Island, NY.

### Sources of Flood Hazard Information

FIRMs and FISs.<sup>1</sup> FIRMs delineate flood hazard zones (e.g., Zone VE, Zone AE), which reflect the nature of the flood conditions expected during the base flood. FIRMs also show Zone X areas that are outside the SFHA but which are subject to flooding with a 0.2-percent-annual chance of occurrence (500-year flood).<sup>2</sup> FIRMs show BFEs associated with a flood that has a 1-percent-annual-chance of occurrence (Figure 3). BFEs in coastal areas include wave effects and are higher than storm surge stillwater levels.

FIRMs are issued after an FIS is completed, and are then adopted by communities that regulate floodplain development. FISs are prepared using the specified models and the physical, hydraulic, and climate conditions in effect at the time of the FIS. The resulting FIRMs are drawn using the FIS data. FIRMs and FISs are thus a "snapshot" of flood risk at a certain time, and can become outdated as topographic or hydraulic or climate conditions change, or as engineering methods and models improve.

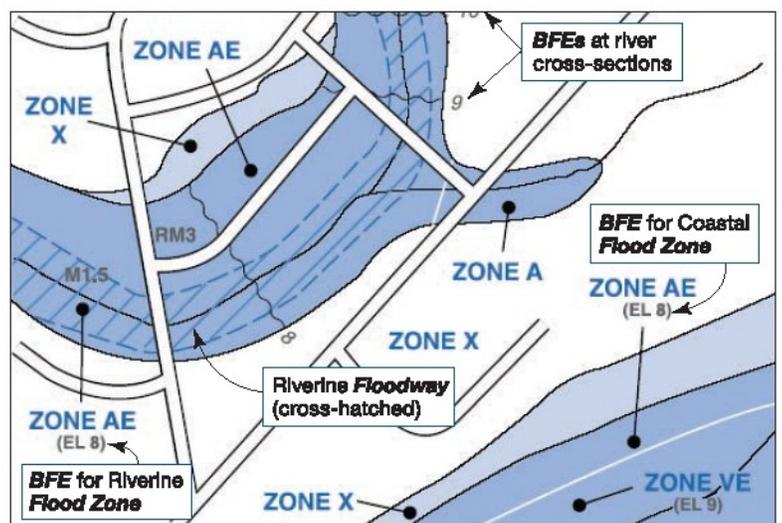


Figure 3: Sample FIRM showing flood hazard zones and BFEs.

<sup>1</sup> FIRM and FIS tutorials are available through FEMA (FEMA 2000a, FEMA 2000b)

<sup>2</sup> FIRMs may also show areas where flood risks have not been studied or determined (Zone D).

Most FIRMs produced after approximately 2005 are based on FEMA's current computer models and engineering procedures. BFEs and flood hazard zones on FIRMs that are dated many years before this may understate actual flood risk. In such cases, elevating buildings above the BFE and extending flood-resistant construction practices outside the mapped SFHA is recommended. The date of the technical studies should be verified for any referenced FIRM by reviewing the associated FIS. Some recent FIRMs, even those published since 2005, are not based on new technical studies (e.g., FIRMs for New York City dated 2007 were based on storm surge models and statistical analyses from the 1980s).

It is critical for building owners, operators, designers, and others to understand that FIRMs do not account for future impacts related to:

- Shoreline erosion, dune loss, land subsidence, and relative sea level rise
- Multiple severe storms occurring over a short period of time
- Topographic and bathymetric changes, upland development, and addition of impervious surfaces that affect drainage and/or flooding
- Degradation or settlement of seawalls, levees, and floodwalls
- Changes in storm climatology (frequency and severity)

These future conditions can be addressed through building siting decisions in concert with design considerations and mitigation actions described in subsequent sections of this advisory. More information on coastal FIRMs and BFEs can be obtained in FEMA publications, specifically: Section 3.6 of FEMA P-55, *Coastal Construction Manual* (2011 edition) and Fact Sheet No. 3 in *Home Builder's Guide to Coastal Construction* (FEMA 2010a). Section 3.7.1 of FEMA P-55 also provides guidance on evaluating a FIRM to determine whether it still reasonably depicts base flood conditions.

**Advisory Base Flood Elevation (ABFE) maps.** After severe coastal storms FEMA may issue ABFE maps for areas where the existing FIRMs no longer adequately represent the actual base flood risk. ABFE maps are based on *in-progress* or *approximate* studies. Figure 4 shows an example ABFE map. They are intended to offer guidance on elevating new and reconstructed buildings. ABFE maps provide interim information for reconstruction efforts and can be used until the new FISs and FIRMs become effective.

Use of ABFE maps is mandatory only when a State or community adopts them. ABFE maps for portions of New Jersey and New York are available at <http://www.region2coastal.com/sandyabfe>.

- *New Jersey:* ABFE maps were released for 10 New Jersey counties (Atlantic, Bergen, Burlington, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean, and Union) on December 14, 2012. New Jersey adopted the ABFE maps for reconstruction on January 24, 2013.<sup>3</sup>

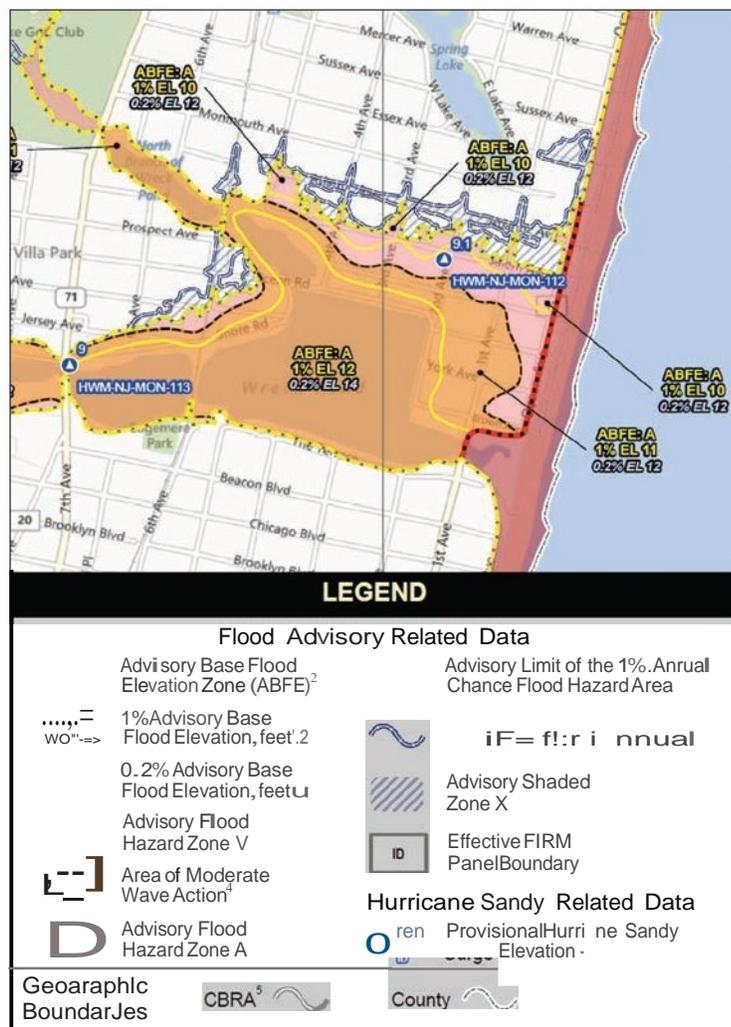


Figure 4: Example ABFE map (Monmouth County, NJ).

<sup>3</sup> For more information, see "Local Flood Damage Prevention Ordinance-Adoption of Advisory Base Flood Elevation maps" (State of New Jersey 2013)

- **New York:** ABFE maps were released for six New York Counties (Bronx, Kings, New York, Richmond, Queens, and Westchester). ABFE maps were released for Westchester County and for portions of New York City on January 28, 2013. The remaining New York City ABFE maps were released on February 25, 2013. No ABFE maps will be released for Nassau and Suffolk Counties because their FIRMs are up-to-date and are based on current models and technical studies. As of January 31, 2013, New York City requires reconstruction to add freeboard above the effective BFE, but allows zoning relief for some reconstruction if owners build to the ABFE (if the ABFE is higher than the effective BFE plus freeboard).<sup>4</sup>

### Probability of Flood Level Exceeding the BFE

FIRMs depict the regulatory limits of flooding, flood elevations, and flood hazard zones for the 1-percent-annual-chance (100-year) flood event. Buildings constructed to the elevations shown on a FIRM offer protection only to the BFE. Some coastal storms result in flood levels that exceed the BFE. The blue line in Figure 5 shows the probability of a flood event that will result in floodwaters above the 100-year flood level.

As shown on the figure, there is an 18 percent chance the 100-year flood level will be exceeded in a 20-year period, a 26 percent chance it will be exceeded in a 30-year period, and a 51 percent chance it will be exceeded in a 70-year period (typical useful life of a home). Therefore, a building elevated to the BFE has a significant chance of being flooded during its useful life and elevating above the BFE reduces this chance and can also reduce flood insurance premiums for the building. Likewise, buildings sited just outside the SFHA (beyond the 100-year flood hazard area, but especially those within the 500-year flood hazard area) still have a significant chance of being flooded over their useful life.

### Building Damage When Flood Levels Rise above the Lowest Floor

Buildings are designed to resist most environmental hazards (wind, seismic, snow, etc.), but are generally designed to avoid flooding by elevating the building above the anticipated flood elevation. The reason for this difference in design approach is because of the sudden onset of damage when a flood exceeds the lowest floor elevation of a building—building elements and contents get wet, and moving water imparts large structural loads on the building.<sup>5</sup>

#### Areas Subject to Wave Action

Severe flood damage is likely in areas where waves accompany coastal flooding. In Zone V areas, waves are capable of causing Substantial Damage (refer to text

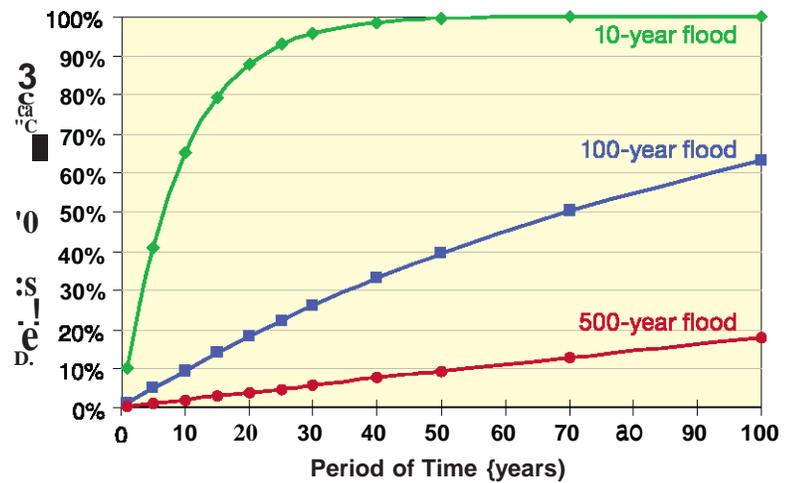


Figure 5: Probability of a flood exceeding the 10-year (10-percent-annual chance), 100-year (1-percent-annual chance), and 500-year (0.2-percent-annual chance) flood level during a given period of time (assuming no sea level rise).

#### Terminology

**Substantial Damage:** Defined by the NFIP as "damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred."

**Substantial Improvement:** Defined by the NFIP as "any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the 'start of construction' of the improvement. This term includes structures that have incurred 'Substantial Damage,' regardless of the actual repair work performed."

Refer to FEMA P-758, *Substantial Improvement/ Substantial Damage Desk Reference* (2010b) for more information. Homeowners should consult a local building official to determine whether their local codes and regulations have more restrictive definitions.

<sup>4</sup> For more information, see "Rebuilding After Sandy" webpage (New York City Department of Buildings 2013)

<sup>5</sup> Refer to the flood damage calculator at [http://www.floodsmart.gov/floodsmart/pages/floodng\\_flood\\_nsksthe\\_cost\\_of\\_floodng.jsp](http://www.floodsmart.gov/floodsmart/pages/floodng_flood_nsksthe_cost_of_floodng.jsp)

box) to some buildings when the tops of the waves reach approximately 1 to 2 feet above the top of the floor. In contrast, inundation flooding (without waves) in Zone A areas may submerge the structure without causing Substantial Damage. This difference in building damage is a result of the energy of coastal waves striking and undermining buildings. This difference was obvious in the variation in flood damage caused by Hurricane Sandy (Figures 6 and 7).



Figure 6: Wave, storm surge, and erosion damage to oceanfront house at Rockaway, NY.



Figure 7: Area subjected to shallow inundation, but not subject to waves or erosion at Long Beach, NY.

### Areas Protected by Barriers

When buildings are situated behind barriers such as dunes, seawalls, or levees, a failure of the barrier can result in rapid flooding and introduction of waves into the formerly protected area. Moreover, buildings close to barriers that fail are more likely to be physically damaged by water moving at high velocities than are buildings farther from the barrier. Buildings farther away are more likely to suffer inundation damage. Even when barriers remain intact, buildings close to them can be struck by waves that overtop the barrier.

### How High Above the BFE a Building Should be Elevated

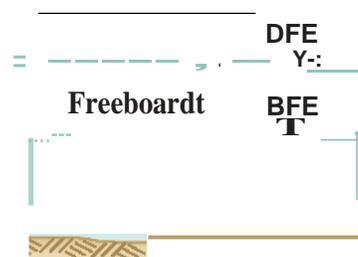
New buildings, buildings with Substantial Damage undergoing reconstruction, and buildings undergoing Substantial Improvements must be elevated so that their lowest floors are at or above the BFE. Some States and communities require elevation above the BFE; this is known as adding freeboard. Adding freeboard or regulating to a flood more severe than the base flood results in a higher minimum building elevation. This is often known as the design flood elevation (DFE).

The amount of freeboard to be added depends on a number of factors. Before selecting a freeboard value, building owners and designers should decide whether a freeboard mandated by a State or community is sufficient to protect a particular building or if additional freeboard is needed.

#### Terminology

**Freeboard:** The vertical difference between the lowest floor<sup>6</sup> of a building and the BFE, usually expressed in feet. It can be thought of as a factor of safety to compensate for the fact that flood levels can reach higher than the BFE.

**Design flood elevation (DFE):** Regulatory flood elevation adopted by a local community. If a community regulates to minimum NFIP requirements, the DFE is identical to the BFE. Typically, the DFE is the BFE plus any freeboard adopted by the community.



<sup>6</sup> In Zone A, lowest floor means the top of the lowest floor; in Zone V, lowest floor means the bottom of the lowest horizontal structural member of the lowest floor

## Required Design Considerations

The selection of appropriate freeboard amounts must include consideration of locally adopted requirements, as well as the importance of the building to the community during and after a hazard event.

Building owners and designers should consult with building officials and floodplain managers regarding appropriate freeboard levels above the BFE.

**Building codes and floodplain management regulations.** Building codes may contain freeboard requirements or reference other documents with freeboard requirements. The International Building Code (IBC), which serves as the basis for the New York State, New York City, and New Jersey State building codes, requires buildings to be designed and constructed in accordance with the American Society of Civil Engineers' *Standard for Flood Resistant Design and Construction* (ASCE 24). ASCE 24 requires between 0 and 3 feet of freeboard above the BFE, depending on the flood hazard zone and the importance of the building.<sup>7</sup> New York State adopted freeboard in its residential building code, and some communities in both New York and New Jersey have adopted freeboard in their floodplain management regulations. Buildings must be elevated as high as the freeboard requirement in the building code or reference standard or floodplain management regulation. Owners may choose to build even higher.

**Building height restrictions.** Some communities may limit (through zoning or building regulations or restrictive covenants) the number of building stories or may specify a maximum height above the ground that a building floor level or roof cannot exceed. Such height restrictions may limit the vertical height of a building and preclude the amount of freeboard that some owners may desire. Owners and designers should check with communities to see if height restrictions exist and work with communities to relax those restrictions to achieve improved flood damage resistance.

**Importance of the building to the community.** Certain buildings and facilities (e.g., police, fire, emergency operations centers, and hospitals) are deemed critical or essential to a community and must remain partly or fully operational during and after severe flood events. In some cases, the community may determine that other buildings and facilities (such as schools, community centers, transportation, and utilities) are critical or essential for their community and should be capable of carrying out operations immediately after a severe storm. The recommendations in this advisory can also be applied to those buildings and facilities. To maintain needed functionality, these essential buildings and facilities should be elevated or protected to a higher elevation than most commercial and residential buildings. Building codes and ASCE 24 acknowledge this need and require additional freeboard. FEMA recommends that essential facilities be elevated or protected to the higher of: the code-mandated elevation, the community-mandated elevation, or the 500-year flood elevation. Communities may wish to use the flood of record<sup>8</sup> as the elevation/protection level for essential facilities.

For more information on category classification requirements, see *Occupancy Category Table 1-1ASCE 7-05* and *Risk Category Table 1.5-1in ASCE 7-10* as well as the guidance in FEMA 543; *Design Guide for Improving Critical Facility Safety from Flooding and High Winds*, January 2007. Note: ASCE 7-05 and ASCE 7-10 use different category classifications; also, check for any modifications made by your State or local jurisdictions.

### ABFEs and BFEs

FEMA recommends that communities apply the ABFEs to new construction, Substantial Improvements, and Substantially Damaged structures to ensure that all recovery construction is built stronger, safer, and less vulnerable to future flooding events.

Freeboard must be added to the ABFE or the effective BFE, as required by the jurisdiction.

Post-Hurricane Sandy ABFE maps are available for parts of New York and New Jersey at <http://www.region2coastal.com/sandyjabfe>. FIRMs for all other areas are available at <https://jmsc.fema.gov>.

<sup>7</sup> Use of the 1998 edition of ASCE 24 is required by the 2003 edition of the IBC. Use of the 2005 edition of ASCE 24 is required by the 2006, 2009, and 2012 editions of the IBC. The 2009 and 2012 IRC permit, but do not require, use of ASCE 24-05.

<sup>8</sup> Refers to the highest recorded flood elevation for a given location.

**Grant requirements.** Hazard Mitigation Assistance and other Federal or State grants for elevating or reconstructing buildings often require projects to use ABFEs or other freeboard requirements.

### Recommended Considerations

In addition to required design considerations, FEMA recommends review of available FIRMs, FISs, and ABFE information; evaluation of possible future conditions; and consideration of building owner risk tolerance when determining appropriate freeboard amounts.

**Building owner tolerance for damage, displacement, and downtime.** Many building owners never want to go through the disruption and damage sustained during Hurricane Sandy again. Reducing the probability of this occurring again will necessitate using either large freeboard amounts when repairing and rebuilding buildings and equipment or construction of tall flood barriers (where permitted). Freeboard and other flood-resistant design and construction practices should be incorporated to the maximum extent feasible.

**Age of the Effective Flood Analysis.** See subsection on FIRMs and FISs.

**Availability of Preliminary FIRMs.** When FISs are completed, the FIRMs are first issued as "Preliminary" maps to allow the public to submit comments and appeals. Once the comment period is over and appeals, if any, have been resolved, the final maps are issued. Preliminary FIRMs represent the best available data prior to final FIRMs being adopted and becoming effective. If preliminary BFEs are higher than effective BFEs,<sup>9</sup> buildings should be elevated above the BFEs shown on Preliminary FIRMs, with the amount of freeboard depending on the other factors described in this Recovery Advisory.

**Availability of ABFEs.** FIRMs for many of the New Jersey and New York counties affected by Hurricane Sandy were based on flood studies that are more than 25 year old. FEMA had initiated new FISs prior to Hurricane Sandy, but those studies were not complete and Preliminary FIRMs had not been issued when Sandy struck. As described in the FIRMs and Flood Risk subsection of this advisory, FEMA produced ABFE maps after Hurricane Sandy using data from the restudies in progress and other information. Buildings should be elevated at least as high as the ABFEs unless more detailed studies show the ABFEs are overly conservative.

**Future conditions.** Because FIRMs reflect conditions at the time of the FIS, owners, designers, and communities may wish to consider future conditions (such as sea level rise, subsidence, shoreline erosion, increased storm frequency/intensity, and levee settlement and failure) when deciding how high to elevate a building.

Rising sea levels have been well documented at National Oceanic and Atmospheric Administration (NOAA) tide gages in New Jersey, New York, and Long Island Sound.<sup>10</sup> Figure 8 shows an example of a sea level records between 1856 and 2006 in New York. Taken as a whole, sea level in the area affected by Hurricane Sandy has been rising at a rate of 2.4 to 4.1 millimeters/year (0.8 to 1.3 feet/century), averaging 3.0 millimeters; year (1.0 foot/century). If this rate of sea level rise continues into the future, the frequency of coastal flooding will increase. Today's base flood will be more likely to occur in the future, and future BFEs will increase above today's level. If the rate of sea level rise accelerates beyond the historical trend, as many scientists predict (New York City Panel on Climate Change 2009), sea levels could rise several feet in the next century, significantly increasing the risk of flooding to buildings inside and outside the SFHA.

Most buildings are expected to have a functional life span of many decades, so it is important to consider future conditions when designing new buildings or performing significant retrofits on existing ones. Although not incorporated into the BFE or ABFE, FEMA recommends that sea level rise be considered when selecting lowest floor elevations for new and reconstructed buildings. At a minimum, 1 foot of freeboard above the code-required freeboard is recommended to account for a continuation of the historical rate of sea level rise. Owners, designers, and communities should add additional freeboard if they want to plan for sea level rise above the historic trend. Section 3.3.4.1 of FEMA P-55, *Coastal Construction Manual* (CCM) (FEMA 2011), provides information on sea level rise statistics. Section 8.5.2 of P-55 illustrates simple procedures to estimate future effects of coastal erosion and sea level rise. State Coastal Zone Management (CZM) agencies should be consulted for erosion rate and other future conditions information that can be used with the CCM procedures.

<sup>9</sup> If effective BFEs are higher than preliminary BFEs, local regulations will require use of the effective BFEs until such time as new maps are adopted and become effective.

<sup>10</sup> Refer to NOAA Website at <http://jtidestrends.noaa.gov/jstrends.shtml>.

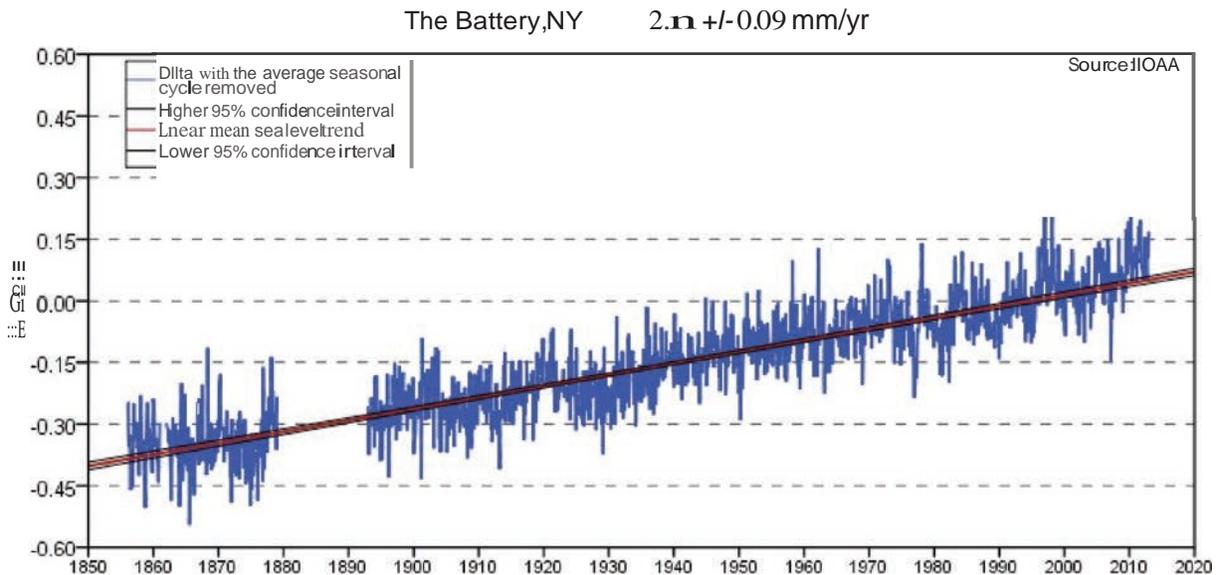


Figure 8: Sea level rise at The Battery, NY, 1856-2006 (Source: NOAA Web site).

## Effect of Building Elevation on NFIP Flood Insurance Premiums

NFIP flood insurance premiums are affected by the elevation of the building in relationship to the BFE. As part of design considerations, building owners should be aware of two things:

- Flood insurance premiums drop significantly as freeboard increases, provided equipment is not located below the BFE and any enclosed space is compliant with NFIP requirements (e.g., flood openings in Zone AE, free of obstructions in Zone VE, etc.).
- The 2012 NFIP reauthorization legislation (called the Biggert-Waters Flood Insurance Reform Act of 2012) eliminates flood insurance premium subsidies and "grandfathering" for many existing buildings that are or may be in the future below the BFE (for more detail, see the text box on page 9 titled "Biggert-Waters impact on flood insurance premiums").

### Flood Premiums and Freeboard

According to the flood insurance premium rate tables in FEMA's *Flood Insurance Manual*, premium savings can be substantial when freeboard is added to building design (FEMA 2013a). These savings can be enough to repay the added cost of elevating higher in just a few years' time (AIR 2006, FEMA 2008).

- Adding 1 foot of freeboard above the BFE can save an owner approximately 25 to 40 percent in annual flood insurance premiums, depending on the flood hazard zone and building characteristics.
- Adding 4 feet of freeboard can save approximately 50 to 65 percent in annual flood insurance premiums in some flood zones.

### Biggert-Waters Flood Insurance Reform Act of 2012

On July 6, 2012, a new law (hereafter called "Biggert-Waters") took effect, significantly changing the NFIP and how flood insurance premium rates will be determined in the future (FEMA 2012). Changes affect how buildings are rated to reflect actual flood risk and eliminate grandfathering and flood insurance premium subsidies for many buildings.

Of importance to property owners, some buildings constructed in compliance with today's BFEs and flood hazard zones may be subject to significantly higher flood insurance premiums in the future if revised FIRMs show higher BFEs and increased flood risk. For more information, please see FEMA's *Flood Insurance Reform Act of 2012: Impact of changes to the NFIP* (FEMA 2013b).

## Additional Design Considerations for Mitigating Flood Damage Inside and Outside Mapped Flood Hazard Zones

In addition to the design considerations described in other sections of this advisory, the following recommendations can help building owners minimize damage in the event that coastal flood levels rise above the BFE.

### Design for Hazardous Wave Conditions

In addition to adding freeboard, buildings should be designed to withstand more hazardous wave conditions than the FIRM indicates (see Figure 10). Anticipate future conditions, including:

- Zone V conditions extending inland into the Coastal A Zone.
- Coastal A Zone (1.5- to 3-foot wave heights during the base flood) extending into the mapped Zone A.
- Zone A flood conditions extending landward of the SFHA boundary into Zone X (extend the freeboard elevation landward until the ground rises to this elevation). See Figure 10, A-2.<sup>11</sup>
- In other words, if a building is situated in one flood zone but is close to a more hazardous zone, property owners should consider designing, elevating, and using construction methods as if the building were located in the more hazardous zone.

### Elevate Bottom of Lowest Horizontal Structural Member to BFE

In all areas where flooding is anticipated, inside and outside the mapped SFHA, elevate the lowest floor so that the bottom of the lowest horizontal structural member is above the BFE (see Figures 11 and 12).

Even though the NFIP and some building codes allow the top of the lowest floor to be set equal to the BFE in Zone A, the top of the floor should be set above the BFE. Otherwise, the floor systems, floor coverings, floor insulation, lower walls, and utilities contained therein will incur flood damage during the base flood. In addition to structural damage, inundation may lead to costly repairs from mold or floodwater contamination.

### Design Loads

In Zones V and A, design loads and conditions (hydrostatic loads, hydrodynamic loads, wave loads, floating debris loads, and erosion and scour) should be calculated using 100-year flood conditions. Loads can be based on freeboard levels if desired, but freeboard is usually used as a factor of safety against getting wet, not for design load calculations.<sup>12</sup>

### Biggert-Waters impact on flood insurance premiums

According to *Changes in the Flood Insurance Program: Preliminary Considerations for Rebuilding* (FEMA 2012):

*Under the new law, flood insurance premium rates on many properties in special flood hazard areas will increase. The new rates will reflect the full flood risk of an insured building and some insurance subsidies and discounts will be phased-out and eventually eliminated.*

*Rates on almost all buildings that are, or will be, in special flood hazard areas will be revised over time to reflect full flood risks. Based on various conditions set forth in the law, subsidies and grandfathered rates will be eliminated for most properties in the future.*

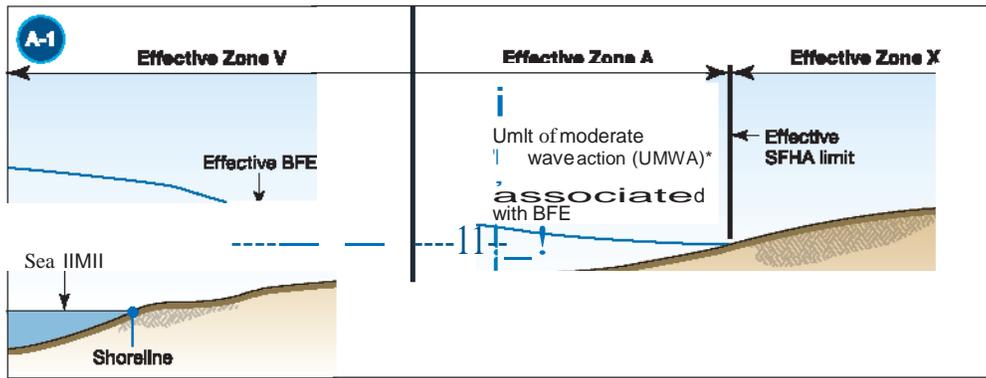
*Subsidies will be phased out for the following types of properties: non-primary residences, severe repetitive loss properties, business properties, and properties that have incurred flood-related damages where claims payments exceed the fair market value of the property.*

*Policy rates will also increase based on one or all of the following circumstances:*

- *After a change of ownership;*
- *After there is a lapse in insurance coverage;*
- *When a new or revised flood insurance rate map is issued; or*
- *If there is substantial damage or improvement to a building.*

<sup>11</sup> If in Zone X, completing an Elevation Certificate may help implement this recommendation.

<sup>12</sup> If the design flood is defined as a higher flood return period (e.g., 500-year flood), the design loads should be based on the higher flood level.



\* LIMWA not shown on older FIRMs

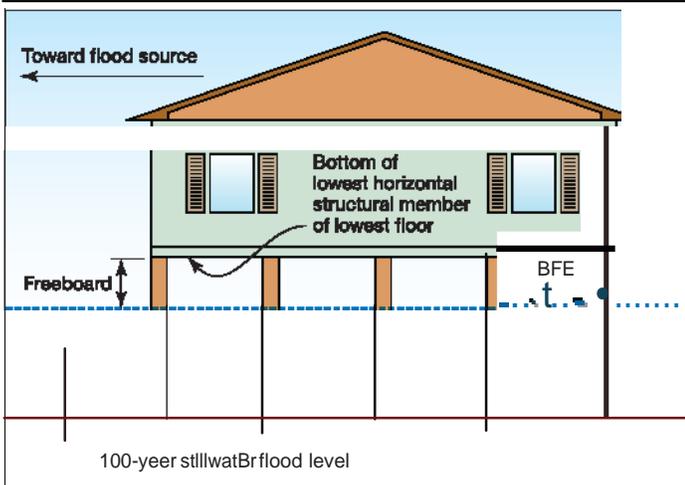
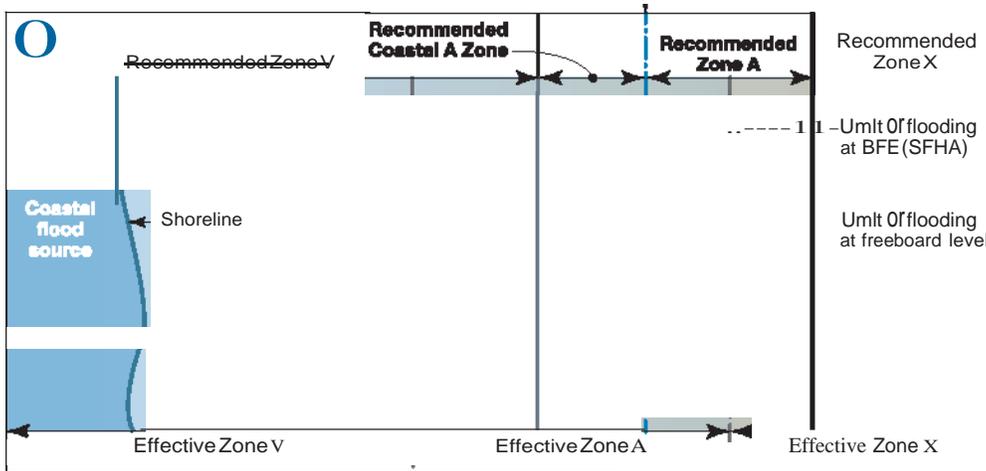
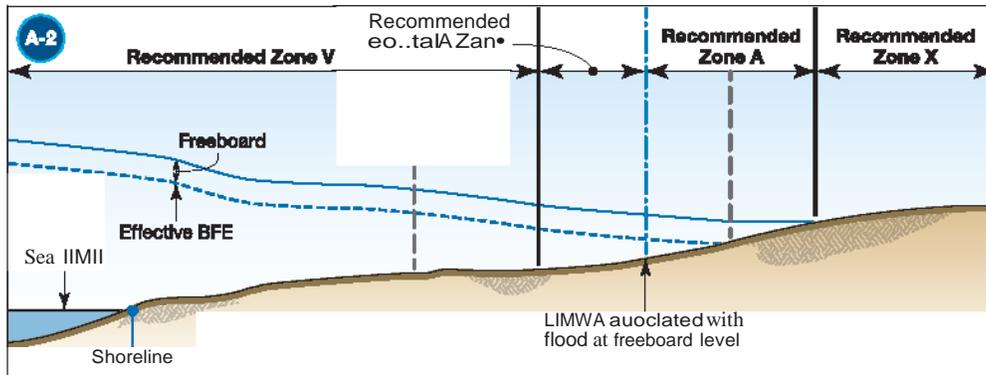


Figure 11; Recommended construction in anticipated Zone V and Coastal A Zones.

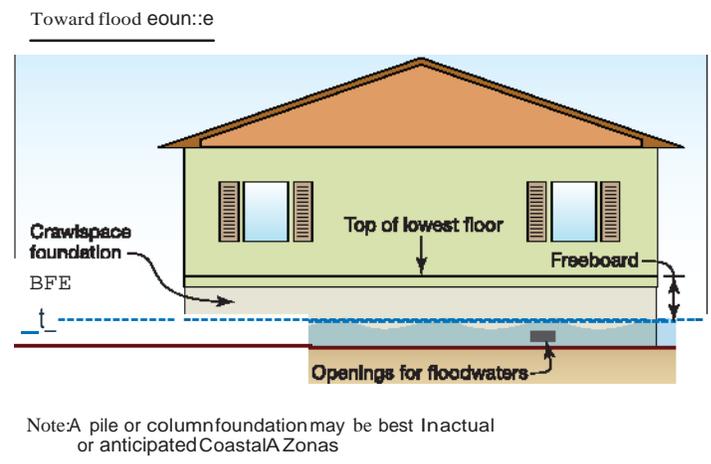


Figure 12: Recommended elevation in landward portion of Zone A. Applies also in Zone X where flooding is anticipated or likely; in Zone X, substitute freeboard elevation for BFE.

Figure 10. Higher flood levels shift flood zones landward. Figure A-1 shows a cross-section of existing coastal flood hazards. Figure A-2 shows how recommended flood hazard zones shift as higher flood levels occur or higher freeboard is considered. Figure B is a map view comparing the existing and recommended flood hazard zones.

Property owners sometimes ask if elevating a home will result in higher wind loads on the building. Calculations indicate that wind pressures on elevated buildings are nominally higher than for non-elevated buildings, and therefore this is not generally a concern (FEMA 2009). Although the incremental wind load is generally small, the increased wind loads should be considered in foundation design and in the attachments of the elevated house to the foundation.

### Use Strong Connections

Use strong connections between the foundations and the elevated building to prevent the building from floating or washing off the foundation if flood levels rise above the lowest floor. Refer also to Hurricane Sandy Recovery Advisory No. 1, *Improving Connections in Elevated Coastal Residential Buildings* (2013).

### Use Flood Damage-Resistant Materials

Flood damage-resistant building materials and methods should be used not only below the lowest floor, but also for wall construction and floor finishes sitting directly on the lowest floor. For example, consider using drainable, dryable interior wall assemblies similar to those illustrated in Figure 13. This allows interior walls to be opened up and dried after a flood that rises above the lowest floor. Walls should be designed and constructed to accommodate flooding without damage (LSU 2012). To prevent wicking and limit flood damage, building owners can use the following flood damage-resistant methods and materials:

- Construct walls with pressure-treated wood framing and with horizontal gaps in the wallboard (a chair rail can be used to conceal the gap)
- Elevate electrical outlets, wiring, and circuit panels to a location above the horizontal gap
- Install rigid or closed-cell insulation in lower portions of walls
- Below the horizontal gaps, use non-paper-faced gypsum wallboard, concrete board, or a removable wainscot; use a water-resistant drywall primer and finish with latex paint
- Use water-resistant flooring with waterproof, marine-grade adhesive

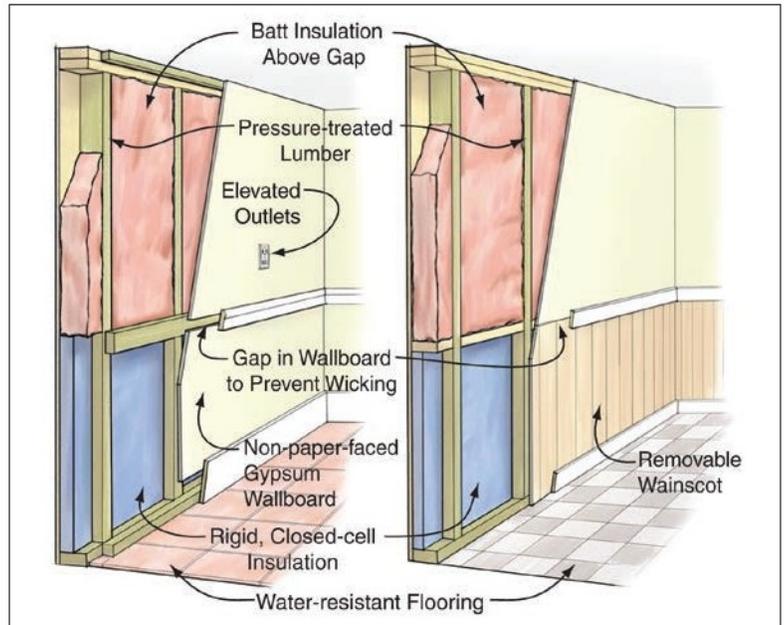


Figure 13: Wet floodproofing techniques for interior wall construction; details may vary depending on wall construction (Source: LSU, 2012).

## Resources and Useful Unks

- AIR (American Institutes for Research). 2006. *Evaluation of the National Flood Insurance Program's Building Standards*. Available at <http://www.fema.gov/library/viewRecord.do?id=2592>.
- ASCE (American Society of Civil Engineers). 2005. *Standard for Flood Resistant Design and Construction*. ASCE 24-05.
- FEMA (Federal Emergency Management Agency). 2000a. *How to Read a Flood Insurance Rate Map- Tutorial*. Available at <http://www.fema.gov/library/viewRecord.do?id=2324>.
- FEMA. 2000b. *How to Read a Flood Insurance Study- Tutorial*. Available at <http://www.fema.gov/library/viewRecord.do?id=2325>.

The FEMA Region II Web page provides useful information and links for disaster survivors and recovering communities including available FEMA assistance and recovery initiatives. Please refer to <http://www.region2coastal.com>.

- FEMA. 2007. *Design Guide for Improving Critical Facility Safety from Flooding and High Winds*. FEMA 543. Available at <http://jwww.fema.gov/libraryjviewRecord.do?fromSearch=fromsearch&id=2441>
- FEMA. 2008. *2008 Supplement to the 2006 Evaluation of the National Flood Insurance Program's Building Standards*. Washington D.C.
- FEMA. 2009. *Local Officials Guide for Coastal Construction*. FEMA P-762. Available at <http://jwww.fema.gov/technology-transfer/home-builders-guide-coastal-construction-technical-fact-sheet-series-fema-p-499>.
- FEMA. 2010a. *Home Builder's Guide to Coastal Construction Fact Sheets Series*. FEMA P-499. Available at <http://jwww.fema.gov/technology-transfer/home-builders-guide-coastal-construction-technical-fact-sheet-series-fema-p-499>.
- FEMA. 2010b. *Substantial Improvement/Substantial Damage Desk Reference*. FEMA P-758. Available at <http://jwww.fema.gov/libraryjviewRecord.do?fromSearch=fromsearch&id=4160>.
- FEMA. 2011. *Coastal Construction Manual*. FEMA P-55. Available at <http://jwww.fema.gov/libraryjviewRecord.do?id=1671> Accessed March 11, 2013.
- FEMA. 2012. *Changes in the Flood Insurance Program: Preliminary Considerations for Rebuilding*. Available at <http://jwww.seasideparknj.org/jwp-content/uploads/2012/12/NFIP-Fact-Sheet.pdf>.
- FEMA. 2013a. *Flood Insurance Manual, January 1, 2013 edition*. Available at <http://jwww.fema.gov/flood-insurance-manual>.
- FEMA. 2013b. *Flood Insurance Reform Act of 2012: Impact of changes to the NFIP*. Available at <http://jwww.fema.gov/libraryjviewRecord.do?id=7187>. Accessed April 4, 2013.
- Louisiana State University Agricultural Center. 2012. "Wet Floodproofing." Web page available at [http://jwww.lsuagcenter.com/jen/family\\_home/home\\_design\\_construction/Design\\_Remodelling+Renovation/Preventing+Flood+Damage/Wet+Floodproofing.htm](http://jwww.lsuagcenter.com/jen/family_home/home_design_construction/Design_Remodelling+Renovation/Preventing+Flood+Damage/Wet+Floodproofing.htm). Accessed March 3, 2013.
- New York City Department of Buildings. 2013. "Rebuilding After Sandy." Webpage available at [http://jwww.nyc.gov/html/dob/html/rebuilding\\_after\\_sandy\\_storm\\_update.shtml](http://jwww.nyc.gov/html/dob/html/rebuilding_after_sandy_storm_update.shtml). Accessed April 2, 2013.
- New York City Panel on Climate Change. 2009. *Climate Risk Information*. February 17, 2009. Available at [http://jwww.nyc.gov/html/jom/pdf/2009/NPCC\\_CRI.pdf](http://jwww.nyc.gov/html/jom/pdf/2009/NPCC_CRI.pdf).
- NOAA (National Oceanic and Atmospheric Administration). 2013. *Sea Levels Online*. Available at <http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml>. Accessed March 11, 2013.
- State of New Jersey. 2013. "Local Flood Damage Prevention Ordinance -Adoption of Advisory Base Flood Elevation Maps." Letter published February 4, 2013. Available at <http://jwww.nj.gov/dep/floodcontrol/docsj20130204community-abfe-letter.pdf>.

For more information, see the FEMA Building Science Frequently Asked Questions website at <http://jwww.fema.gov/frequently-asked-questions>.

If you have any additional questions on FEMA Building Science Publications, contact the helpline at [FEMA-BuildingScienceHelp@fema.dhs.gov](mailto:FEMA-BuildingScienceHelp@fema.dhs.gov) or 866-927-2104.

You may also sign up for the FEMA Building Science e-mail subscription, which is updated with publication releases and FEMA Building Science activities. Subscribe at [https://jpublic.govdelivery.com/accounts/USDHSFEMA/subscriberjnew?topic\\_id=USDHSFEMA\\_193](https://jpublic.govdelivery.com/accounts/USDHSFEMA/subscriberjnew?topic_id=USDHSFEMA_193).

Visit the Building Science Branch of the Risk Reduction Division at FEMA's Federal Insurance and Mitigation Administration at <http://jwww.fema.gov/building-science>.

To order publications, contact the FEMA Distribution Center:

Call: 1-800-480-2520  
(Monday-Friday, 8 a.m.-5 p.m., EST)

Fax: 240-699-0525

E-mail: [FEMA-Publications-Warehouse@fema.dhs.gov](mailto:FEMA-Publications-Warehouse@fema.dhs.gov)

Additional FEMA documents can be found in the FEMA Library at <http://jwww.fema.gov/library>.

Please scan this QR code to visit the FEMA Building Science Web page.

