Reducing Flood Risk and Flood Insurance Premiums for Existing Residential Buildings in Zone A

FEMA

HURRICANE SANDY RECOVERY ADVISORY *RA7, November 2013*

Purpose and Intended Audience

The Federal Emergency Management Agency (FEMA) Mitigation Assessment Team (MAT) observed inundation damage to residential buildings in New Jersey and New York whose lowest floors were below Hurricane Sandy flood levels. Based on these observations, FEMA offers the information in this advisory to residential property owners interested in reducing their flood risk and National Flood Insurance Program (NFIP) flood insurance premium for existing residential buildings located in Zone A. As property owners rebuild, it is important for them to not only consider mitigation measures that can reduce their risk for flood damage from a future flood event, but also understand how these mitigation measures affect their flood insurance premiums (see Figure 1).

The mitigation measures described in this advisory are intended to be applied to buildings that did not incur Substantial Damage during Hurricane Sandy and are not undergoing Substantial Improvement, though the information may also be useful for owners of homes that incurred Substantial Damage or are undergoing Substantial Improvements. Implementing the mitigation measures described in this advisory may qualify a home for reduced flood insurance rates. Homes that have incurred Substantial Damage or that are undergoing Substantial Improvement are required to be brought into compliance with local floodplain management regulations and building codes.

In addition to describing mitigation measures such as elevation and filling in a basement, this advisory specifically includes guidance on modifying or strengthening existing ground floor walls of a single-family home or row house/townhouse into either an open foundation or solid foundation walls, while also converting the ground floor living area to an enclosure and moving the living area so it is at or above the BFE.

The intended audiences for this Recovery Advisory are homeowners and local floodplain management and building officials, but it may also be useful for planners, contractors, and design professionals advising homeowners.

NFIP Floodplain Management Terminology

Substantial Damage: 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: 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* (2010) for more information. Homeowners should consult a local building official or floodplain administrator to determine whether their local codes and regulations have more restrictive definitions.

Figure 1: The house on the left is in the final stages of being elevated, which will result in reduced flood risk and lower flood insurance rates compared to the house on the right (Highlands, NJ)

Key Issues:

1. Repairing homes damaged during Hurricane Sandy gives building owners the opportunity to implement mitigation measures that will improve flood resistance and lower NFIP flood insurance premiums.
2. Before undertaking a mitigation project, it is critical for building owners to understand the requirements of the NFIP and building codes, including the requirements related to enclosed areas below elevated buildings.
3. Homeowners should work with a registered design professional to develop feasible and effective mitigation solutions.

This Recovery Advisory Addresses:

- Key NFIP requirements for buildings in Zone A
- Moving a building's lowest floor to or above the base flood elevation (BFE) by converting the ground floor and filling below-grade areas and basements or elevating the building
- NFIP requirements for enclosures below elevated buildings
- Elevating mechanical, electrical, and plumbing systems to appropriate levels
- Useful links and resources

Flood Hazard Identification Terminology

Flood Insurance Rate Map (FIRM): A map produced by FEMA to show flood hazard areas and risk premium zones. The SFHA and BFE are both 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 (shaded or unshaded) or Zone B/Zone C, on older FIRMs.

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 is shown on FIRMs.

Key NFIP Requirements for Buildings in Zone A

Communities that participate in the NFIP are required to adopt and enforce local regulations that apply to new construction and buildings undergoing Substantial Improvement or that have incurred Substantial Damage in areas mapped as Special Flood Hazard Areas (SFHAs). The NFIP establishes minimum criteria and design requirements specifying how structures are to be constructed to minimize the potential for flood damage. A primary requirement is that buildings must be elevated to or above the BFE (see text box for definition). Building owners can determine whether their location is in an SFHA by talking to a local floodplain administrator or building official or by reviewing the applicable Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) report, which show the extent of the SFHAs and the BFEs. For more information on NFIP maps, refer to Hurricane Sandy Recovery Advisory No. 5, *Designing for Flood Levels Above the BFE After Hurricane Sandy* (2013).

After large storm events such as Hurricane Sandy, FEMA may publish Advisory Base Flood Elevations (ABFEs) and associated ABFE Maps to support recovery and improve future resilience. FEMA has also released Preliminary Work Maps (an interim product created as part of the process of developing new FIRMs). Communities must use the latest available flood hazard information when designing recovery or mitigation activities funded using FEMA grants (e.g., Public Assistance or Hazard Mitigation Grants). Recipients of the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grants must use the latest available flood elevation plus 1 foot.

Guidance for Communities Using Post-Hurricane Sandy Flood Hazard Information

FEMA recommends that communities use BFEs obtained from Advisory BFEs (ABFEs), Preliminary Work Maps, or Preliminary FIRMs and Flood Insurance Studies (FISs), if those BFEs are higher than the BFEs in the current Effective FIS report and on current Effective FIRMs. This will help ensure that all recovery construction is built stronger, safer, and less vulnerable to future flooding events. Some communities may require the addition of freeboard (additional elevation) to the ABFE or the Effective BFE.

Guidance for using post-Hurricane Sandy flood hazard information can be found in FEMA Floodplain Management Bulletin 1-98, *Use of Flood Insurance Study (FIS) Data as Available Data* (1998) which provides information on the use of ABFEs, Preliminary Work Maps, or Preliminary FIRMs and FIS reports as "available data" for regulating floodplain development. Post-Hurricane Sandy ABFE maps are available for parts of New Jersey and New York at http://www.region2coastal.com/sandy/bestdata. FIRMs for all other areas are available at https://msc.fema.gov/.

Before beginning any construction, it is important that building owners verify with their local building department that they have all the State and local permits required to do the project. Mitigation projects such as those described in this advisory may result in the local building department making a determination that the home is undergoing Substantial Improvement. Buildings determined by a building official or floodplain administrator to have incurred Substantial Damage or to be undergoing Substantial Improvement are treated as new construction and must be brought into full compliance with the flood provisions of current building codes and local floodplain ordinances that meet or exceed the floodplain management requirements of the NFIP regulations (see text box on Substantial Damage/Substantial Improvement).

NFIP Minimum Criteria and Performance Requirements

NFIP requirements specify how new buildings should be constructed to minimize the risk of flood damage. Building codes include similar requirements. Table 1 summarizes some of the key NFIP requirements for new construction in Zone A, which includes all zones shown on FIRMs as Zones A, AE, A1-A30, AR, AO, and AH. The information in Table 1 is discussed in more detail in other sections of this Recovery Advisory.

When considering mitigation measures, it is important to remember that the house must resist multiple hazards. Buildings must be able to resist the effects of wind and water loads acting simultaneously (where applicable, seismic loads must also be addressed).

Table 1: Key NFIP Building Design Requirements for Buildings Located in Zone A

Provision	Requirement
Design and Construction 44 CFR 60.3(a)(3)(i)	Building and foundation must be designed, constructed, and adequately anchored to prevent flotation, collapse, and lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy.
Lowest Floor Elevation 44 CFR 60.3(c)(2)	Top of lowest floor (including basement) must be elevated to or above the BFE.
Flood Damage-Resistant Materials 44 CFR 60.3(a)(3)(ii)	Structural and nonstructural building materials below the BFE must be flood damage-resistant.
Enclosures 44 CFR 60.3(c)(5)	Enclosures must be used only for parking of vehicles, building access, and storage. Each enclosure must have a minimum of two flood openings on different walls to allow passage of floodwaters and the bottom of all openings must be no higher than 1 foot above grade.
Utilities 44 CFR 60.3(a)(3)(iv)	Utilities and equipment must be located (elevated) at or above the BFE or designed to prevent floodwaters from entering and accumulating in components during the base flood.

When determining the appropriate building design requirements, homeowners in Zone A should consider that if the area is remapped as Zone V in the future, they may be subject to higher flood insurance premiums. In addition, FEMA recommends applying Zone V requirements to buildings in the Coastal A Zone. For information on Zone V requirements and mitigation options, refer to Hurricane Sandy Recovery Fact Sheet No. 2, *Foundation Requirements and Recommendations for Elevated Homes* (2013).

Terminology

Coastal A Zone: The area of Zone A that is subject to coastal waves during the base flood, delineated by the Limit of Moderate Wave Action (LiMWA), also called the Area of Moderate Wave Action (MoWA) on maps and in some publications. Although the MoWA designation does not currently affect flood insurance premiums, FEMA recommends that communities apply more stringent requirements in this area, such as applying Zone V requirements, to reduce flood damage caused by wave action.

Even when not required by the community, FEMA recommends that homeowners with property in the Coastal A Zone mitigate wave action by conforming to Zone V requirements.

Additional Considerations Related to Flood Insurance Premiums

NFIP flood insurance premiums are based on a number of factors, including the flood risk zone, elevation of the lowest floor above or below the BFE, the type of building and foundation, the number of floors, and whether there is a basement or enclosure below the elevated building. One of the major factors in determining an NFIP flood insurance premium is the designation of the “lowest floor” and how high it is compared to the BFE.

NFIP flood insurance policies have limits on coverage of contents in basements and enclosures below elevated buildings. Upon

completion of any mitigation work related to elevating a building, it is important to have a surveyor complete a new Elevation Certificate[1] to document the elevation of the new lowest floor so that insurance companies can rate the building for flood insurance.

Communities may adopt minimum elevations for buildings in SFHAs that are higher than the Effective BFE, ABFE, or other available data if higher than the Effective BFE. The addition of height above the BFE expressed in feet is referred to as a freeboard requirement. While the addition of freeboard is not an NFIP minimum requirement, it does result in significantly lower flood insurance rates due to reduced flood risk. FEMA recommends the addition of at least 1 or 2 feet of freeboard to account for uncertainties, future development, and floods higher than the base flood.

Designers, contractors, and owners should contact a qualified insurance agent or the NFIP for more information about policy coverage, coverage limits, and costs.

FIRMs are a "snapshot" of conditions at the time the maps were developed. Future conditions may result in higher flood elevations and may change zone designations. Refer to Hurricane Sandy Recovery Advisory No. 5, *Designing for Flood Levels Above the BFE After Hurricane Sandy*, for more information on this and on how the recently passed Biggert-Waters Flood Insurance Reauthorization Act of 2012 may affect a property.

NFIP Floodplain Management Terminology

Basement: "Any area of the building having its floor subgrade (below ground level) on all sides."

Lowest floor: "The lowest floor of the lowest enclosed area (including a basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area, is not considered a building's lowest floor provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of §60.3" [the NFIP].

Source: Code of Federal Regulations, Title 44, Part 59.1

Moving a Building's Lowest Floor To or Above the BFE

As shown in Table 1, the lowest floor of a building must be elevated to or above the BFE to minimize flood damage and reduce flood insurance premiums. There are several ways to modify an existing home to elevate or locate the lowest floor to or above the BFE. Table 2 provides a broad overview of the mitigation measures described in the following sections and allows a comparison by building type (detached or attached), relative cost, and the level of difficulty associated with undertaking the project. Refer to FEMA P-312, *Homeowner's Guide to Retrofitting* (2009), for additional mitigation measures.

Table 2: Mitigation Measures for Elevating the Lowest Floor of a Building in Zone A

Feature of Existing Home	Building Type		Cost*	Project Difficulty
	Detached (Free-Standing)	Attached		
Mitigation Measure: Convert ground floor and fill basement (to create NFIP-compliant open foundation or compliant enclosure)				
Concrete/masonry foundation walls	Y	Y	$ – $$	Easy – Moderate
Wood-framed walls	Y	Y	$ – $$	Easy – Moderate
Basement or below grade areas	Y	Y	$	Easy
Mitigation Measure: Elevate the building or elevate floors within the building				
Existing slab-on-grade foundation	Y	**	$$$	Moderate
Existing crawlspace foundation	Y	**	$$	Moderate
Floors of row house/townhouse	Not applicable	Y	$$$$	Hard

Note: Consider using an open foundation consistent with Zone V requirements for buildings in Coastal A Zone.

Y = mitigation measure is possible.

* One dollar sign indicates a less expensive option and four dollar signs indicate the most expensive option.

** Options for attached homes such as duplexes and townhomes are complicated unless all owners elect to undertake mitigation actions together.

1 Elevation Certificate and instructions are available at https://www.fema.gov/media-library/assets/documents/160.

Some of the measures described in this advisory may be difficult to accomplish: for instance, it may not be possible to modify or strengthen the home's existing foundation if the foundation is functionally deficient, or the necessary work may be cost prohibitive to achieve the desired outcome. If it is not possible to modify or strengthen the existing foundation as described in this advisory, a registered design professional should consider other solutions outlined in FEMA's Hurricane Sandy Recovery Fact Sheet No. 2, *Foundation Requirements and Recommendations for Elevated Homes* (May 2013).

WARNING: Property owners should check that the design professional (engineer or architect) is registered or licensed in the State in which the work is being performed.

Regardless of the type of building construction, the NFIP enclosure requirements for the area below the lowest elevated floor (described on page 11 in the subsection titled "NFIP Requirements for Enclosed Areas below the BFE in Zone A") must be followed for the elevated building to be eligible for lower flood insurance premiums.

It may also not be possible to undertake some of the measures described in this advisory if homes are on small lots or too close to adjacent buildings. Therefore, the building and building site must be evaluated carefully when selecting the preferred mitigation measure. Projects that require a large space for equipment access or temporary relocation of a building may not be feasible on some sites; pursuing such a project on a small or constrained lot may result in a project that is complicated and expensive. If elevation is the preferred mitigation measure and the lot size and equipment access would make an individual elevation project too difficult and expensive, one solution may be to elevate multiple homes at the same time.

Converting the Ground Floor and Filling Below-Grade Areas and Basements

If the next highest floor above the ground floor is above the BFE, one way to reduce future damage and reduce flood insurance premiums may be to convert the ground floor to an open foundation or foundation walls with an enclosure. Another option is to fill the basement area if a higher floor is already at or above the BFE, in which case the higher floor can be designated as the lowest floor. How the conversion is done and whether it qualifies for lower flood insurance premiums depends on several factors, described below.

Converting a ground floor or filling in a basement requires moving all the living space and necessary electrical, heating, plumbing, and air conditioning equipment above the BFE (Figure 2). While the amount of living space is reduced, the reduction in NFIP insurance premiums may offset the inconvenience and any loss of building value. To compensate for the lost living space, it may be possible to construct an elevated lateral addition if the lot has enough space. Other options are to remove the existing roof and construct another story above the existing building or finish an unfinished attic area. Homeowners should consult with the community's floodplain manager or building official to see if this is permitted, and also consult with an engineer or architect to help develop options and determine feasible, cost-effective solutions.

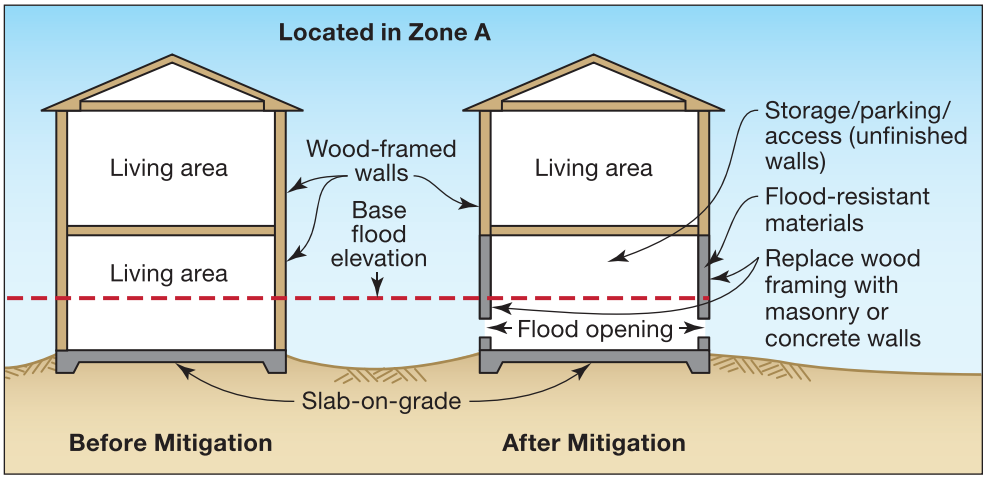


Figure 2: In Zone A, the floor below the BFE (left) can be modified to be compliant with NFIP criteria (right)

Evaluating buildings for converting ground floors. Converting a ground floor living space to an NFIP-compliant open foundation or foundation walls with a compliant enclosure, or filling in a basement, may appear to be simple solutions for some homes. However, even if only minimal remodeling of the ground floor is necessary, a registered design professional should verify that it is an appropriate mitigation measure and that the foundation walls for the ground floor are properly designed and have adequate anchoring to resist anticipated conditions (flooding, wind,

seismic, etc.). A registered design professional should evaluate the building and certify that the design and methods of construction specified for retrofitting the foundation walls are in accordance with accepted standards of practice for meeting the following provisions:

- The foundation and building attached to the foundation must be anchored to resist flotation, collapse, and lateral movement resulting from the effects of base flood water loads acting on building components below the BFE and wind, seismic, or other loads imposed on the structure.
- The potential for scour and erosion at the foundation must be anticipated for conditions associated with the base flood, including wave action.
- Enclosures below the BFE must be designed only for parking of vehicles, building access, and storage.
- Walls below the BFE and supporting the structure must be constructed using flood damage-resistant materials.
- Walls of an enclosure below the BFE must contain flood openings that will allow the automatic entry and exit of floodwater such that they comply with NFIP criteria. See FEMA Technical Bulletin 1, *Openings in Foundation Walls and Walls of Enclosures* (2008).
- To be rated for flood insurance as an elevated building, the building must have no basement, and its lowest elevated floor must be raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns.

Figure 3 is an example of a foundation wall design certification statement that can be signed by a registered design professional to certify that the design and methods of construction meet the above provisions.

Concrete or masonry foundation walls and shear walls. Homes that have foundation walls made of concrete or masonry are the easiest to convert so that the ground floor becomes an NFIP-compliant open foundation or foundation walls with an enclosure. The work required primarily entails removing any interior finishes; making sure any mechanical, electrical, and plumbing equipment are elevated so that they are at or above the BFE; and adding flood openings in the walls to automatically equalize hydrostatic flood forces on exterior walls. Refer to FEMA Technical Bulletin 1, *Openings in Foundation Walls and Walls of Enclosures* (2008), to determine the number, size, and location of flood openings the building will need.

Foundation Wall Design Certification Statement

I certify that: (1) I have developed or reviewed the structural design, plans, and specifications for modification of _____(building address) and (2) that the design and methods of construction specified are in accordance with accepted standards of practice for meeting the following provisions:

- The foundation and structure attached thereto are anchored to resist flotation, collapse, and lateral movement due to the effects of base floodwater loads acting on building components below the Base Flood Elevation and wind, seismic, or other loads imposed on the structure.
- The potential for scour and erosion at the foundation has been anticipated for conditions associated with the base flood, including wave action.
- The enclosure below the Base Flood Elevation is designed only for parking of vehicles, building access, and storage.
- The walls below the Base Flood Elevation and supporting the structure are constructed using flood damage-resistant materials.
- The walls of the enclosed space below the Base Flood Elevation contain flood openings that will allow the automatic entry and exit of floodwater.
- The building has no basement and its lowest elevated floor is raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns.
- The foundation **does / does not** employ wood-frame shear walls (circle one).

Certification and Seal

This certification is to be signed and sealed by a registered professional engineer or architect authorized by law to certify structural designs. I certify the Foundation Wall Design Certification Statement.

Certifier's Name_____ License Number_____
Title_____ Company Name_____
Address_____
City_____ State_____ Zip Code_____
Signature_____ Date_____ Telephone_____

Figure 3: Sample foundation wall design certification statement

A registered design professional should evaluate the building by examining both the footing system and the foundation walls. The footing system should be checked to verify that it can resist erosion and scour and that it will not fail when floodwater rises around the house. The walls should be evaluated to make sure they tie into the footing properly and can resist forces exerted on them during flooding. Most concrete walls have reinforcing steel inside the concrete. Masonry walls should be investigated to verify the presence of reinforcing steel. If it is determined that there is no reinforcing steel or not enough reinforcement given the anticipated flood conditions, the registered design

professional should determine whether it is feasible to reinforce the walls to provide sufficient resistance.

Wood-framed walls. Homes with the lowest floor below the BFE that are built on concrete slabs with wood-framed walls do not meet the minimum floodplain management requirements of the NFIP and building codes. This advisory provides guidance for modifying or strengthening the walls of such homes so that the wood-framed walls function as shear wall foundations. However, homes modified or strengthened in this way may not be eligible for lower flood insurance premiums unless the work is considered a Substantial Improvement. To qualify for lower flood insurance, the conditions shown in the text box must be met. Both conditions are described below.

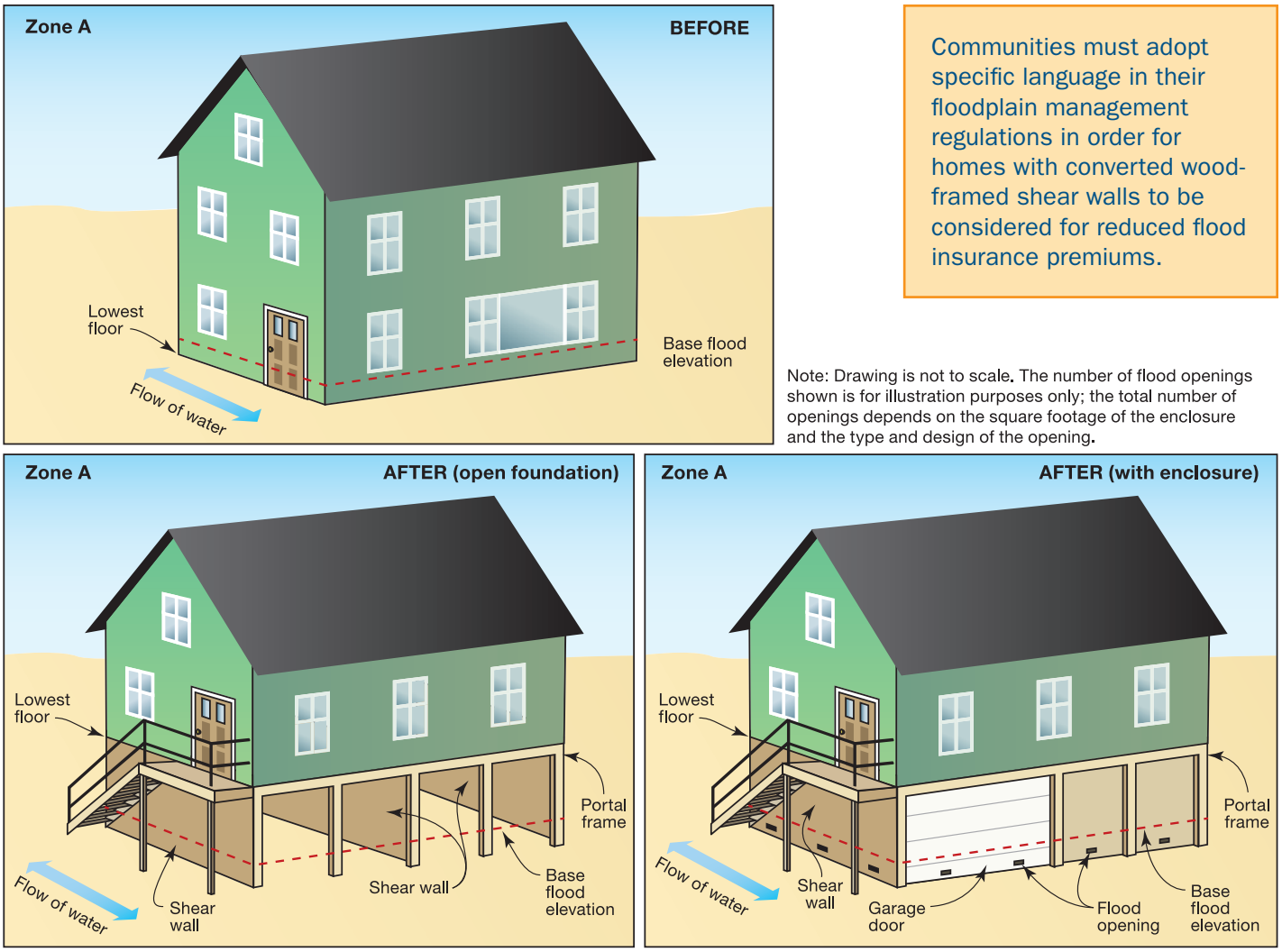
> **WARNING:** Simply strengthening wood-framed walls that are below the BFE will not result in reduced flood insurance premiums.
>
> **To qualify for lower flood insurance premiums when wood-framed walls are converted to shear walls, the following conditions need to be met:**
>
> a. The **structure must meet or exceed minimum floodplain management requirements of the NFIP and building codes**, with wood-framed shear walls designed with a continuous load path to resist all applicable flood loads and wind, seismic, or other loads imposed on the structure; and
>
> b. The **community must adopt an expanded definition of Substantial Improvement** in its floodplain management regulations to include converting ground floors built with wood-framed walls by modifying or replacing the wood-framed walls, regardless of the cost of the work (sample ordinance language is provided on page 9).

(a) Replace or modify wood-framed walls: A registered design professional with experience in evaluating homes in Zone A should determine whether modifying the wood-framed walls is feasible or if it would be more beneficial to replace the wood-framed walls with masonry or concrete foundation walls, piers, or columns. Replacing the walls requires installing temporary cribbing or shoring so the old walls can be removed and new foundation walls can be constructed. New foundation walls should be designed by an architect or engineer, who should pay particular attention to properly anchoring the walls to the footing or existing slab. For more information on maintaining a continuous load path, refer to Hurricane Sandy Recovery Advisory No. 1, *Improving Connections in Elevated Buildings* (2013) and FEMA P-499, *Home Builder's Guide to Coastal Construction* (2010) Fact Sheets 4.1, 4.2, and 4.3.

In Zone A, a possible alternative to replacing wood-framed walls with concrete or masonry is to modify the walls by using a combination of wood shear walls and a series of portal frames, moment frames, or other methods to create an open foundation or foundation shear walls with a compliant enclosure. Shear walls are walls that are designed to resist the lateral (side-to-side) forces imposed by floodwater, wind, and earthquakes. Shear walls should be oriented parallel to the direction of floodwater movement. The existing wood-framed walls may need to be modified so they can resist all lateral and vertical loads (due to gravity or uplift from the wind), and a registered design professional must evaluate whether the load capacity of the wall needs to be increased by adding additional structural sheathing (e.g., plywood sheathing), additional studs, wood blocking, anchors, fasteners, or structural connectors. If shear walls are used and the area below the lowest floor is enclosed, the walls connecting the shear walls should not be structurally connected, and should be designed to fail under base flood conditions. An example of such a wall is described in FEMA Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings* (2008). If the shear walls are completely enclosed, the walls must have flood openings that automatically equalize hydrostatic flood forces on exterior walls.

Building codes may also require that fire protection measures, such as use of gypsum board (drywall), be incorporated into the design. Walls below the BFE with gypsum board would have to be constructed using paperless gypsum board. The registered design professional should also inspect the concrete slab and footings to verify that they are capable of withstanding the loads that the shear walls will transfer to them.

Figure 4 illustrates an example of a two-and-a-half-story house where the ground-level wood-framed walls are converted to a series of shear walls and portal frames. All the wall sections and open foundation elements below the BFE must be constructed of flood damage-resistant materials, and any enclosed area below the BFE must meet all NFIP requirements for enclosures. Homeowners should keep documentation of modifications to the wood-framed wall systems, including design certifications described above and shown in Figure 3, and should notify future owners that subsequent modification of the foundation walls and enclosures below elevated buildings may violate the terms of permits. The best way to accomplish this is for communities to require non-conversion agreements (described in the section titled "NFIP Requirements for Enclosed Areas Below the BFE in Zone A" on page 11).



Communities must adopt specific language in their floodplain management regulations in order for homes with converted wood-framed shear walls to be considered for reduced flood insurance premiums.

Note: Drawing is not to scale. The number of flood openings shown is for illustration purposes only; the total number of openings depends on the square footage of the enclosure and the type and design of the opening.

Figure 4: Before (2.5-story house at-grade) and after (1.5-story house with NFIP-compliant open foundation or compliant enclosure below the BFE) of a house in Zone A with the lower floor converted using a shear wall and portal frame foundation system

(b) Adopt optional definition of "Substantial Improvement" to qualify homes with modified wood-framed walls for reduced flood insurance premiums. The optional Substantial Improvement definition (shown in text box on page 9) would explicitly include the work to modify ground-floor wood-framed walls to become an NFIP-compliant open shear wall foundation or foundation shear walls with a compliant enclosure, regardless of the cost of the work. This would allow the building to be rated by the NFIP as an elevated building with lower flood insurance rates. However, any subsequent changes to the building inconsistent with the community's floodplain management regulations would be deemed a violation of the permit and could result in a rerating of the policy. For example, an owner who changes the use of an enclosure (e.g., by adding a bathroom or turning it into a bedroom) or who blocks the flood openings would have violated the conditions of the permit.

Information on filling a basement. Buildings with basements are susceptible to structural damage if floodwater enters the basement. Insurance premiums can be significantly reduced by filling the basement using gravel and soil, and modifying the remaining space above the fill to meet NFIP requirements for enclosures below the BFE. The fill should be placed at least up to the adjacent grade (ground) level. Also, although filling a basement will likely result in lower insurance premiums, other retrofits may be necessary to maximize premium reductions. Note that if it is likely the house will be elevated in the future, it is much better to elevate at the same time the basement is filled to avoid complications.

It is important to plan for proper drainage when filling a basement. If fill is placed on top of the original basement slab, any water that enters the area may be trapped in the original basement and have no way to drain. To provide drainage, the basement slab can be broken up, or drain holes or trenches can be cut through the slab. A registered design professional may recommend a system of underdrains be installed to improve drainage.

Optional Local Ordinance Provision for Conversion of Wood-Framed Ground Floors
(underlined text must be added to the NFIP definition)

Substantial improvement means 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 which have incurred "substantial damage", regardless of the actual repair work performed. Substantial improvement also means a structure in which a ground floor with wood-framed walls is converted to an open wood-framed shear wall foundation or a wood-framed shear wall foundation with enclosed areas in accordance with ***[community inserts applicable provisions of its floodplain management regulations and building codes]***, regardless of the cost of the work determined to meet or exceed those requirements before the "start of construction". The term does not, however, include either:

(1) Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions or

(2) Any alteration of a "historic structure", provided that the alteration will not preclude the structure's continued designation as a "historic structure".

It can be difficult for a contractor to properly compact fill placed in an existing basement because mobilizing and using compaction machinery can be difficult in a confined space. Therefore, some settlement of fill should be expected after initial placement. Additional fill may be needed to maintain the required fill level in the basement after the initial fill has settled.

Row house/townhouse: Row houses have been constructed in New Jersey and New York since the late nineteenth century. Many of these buildings consist of two to three stories of upper floors and a lower level or walk-out basement that is not below grade on all sides. Walk-out basements that are not below grade on all sides are not classified as a basement per NFIP criteria if the ground is sloped so that water drains freely away from the building.

To achieve lower flood insurance premiums, it may be necessary to convert the ground floor to NFIP-compliant open foundation or compliant enclosure and modify the upper floors. If the floor above the lowest floor is also below the BFE, it will need to be raised and reconstructed to a higher elevation to or above the BFE (Figure 5). For row houses with higher ceilings typical of older construction, it may be possible to raise the floor while retaining the original floor space of the upper levels, but with lower ceiling heights (Figure 6). In such situations, walls at the front and rear of the building can often be modified to raise windows as needed. In more modern townhomes, it may be

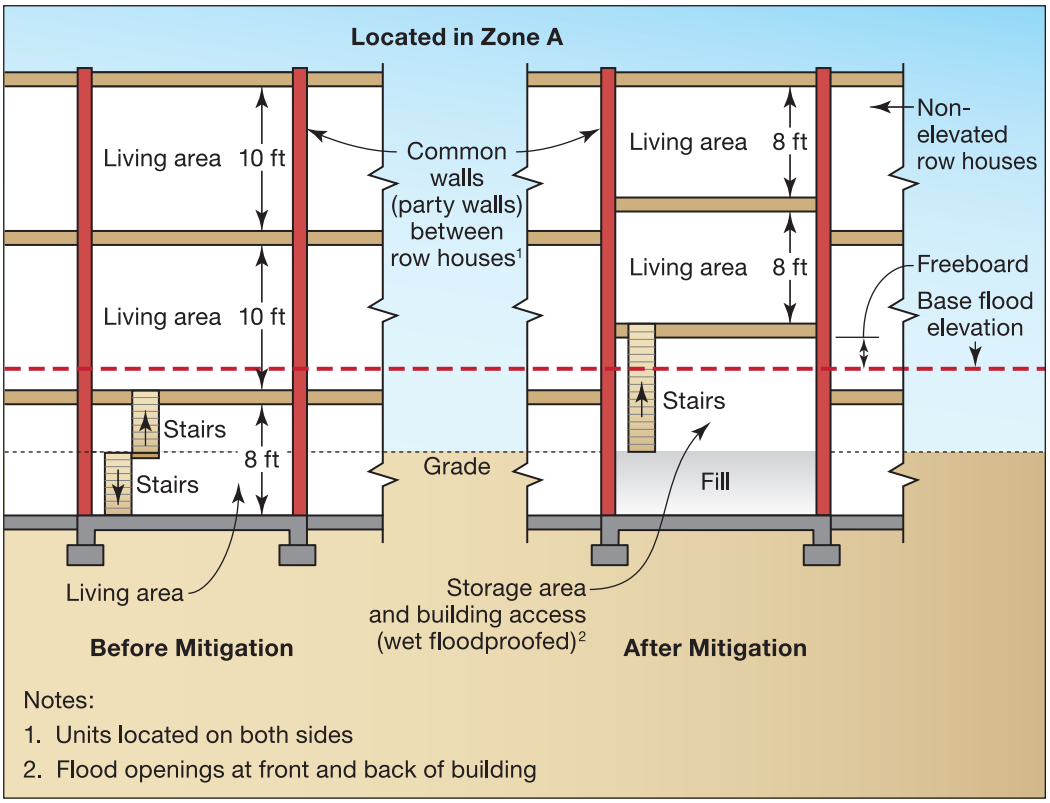


Figure 5: A row house with the floor levels being elevated to maximize living area above the BFE in Zone A

possible to convert the ground floor to an NFIP-compliant open foundation or compliant enclosure and make adjustments to the upper floors, such as moving utilities and mechanical equipment to higher floors. Uses appropriate for areas below the BFE are described in the subsection "Use of Enclosed Areas" on page 11.

Elevating Buildings

Elevating a home involves raising it so that the lowest floor is at or above the BFE or the elevation required by the community. Elevation projects typically involve separating the building from its foundation, constructing a new, higher foundation, and reattaching the building to the new foundation. For more information on the elevation process, refer to FEMA P-312, *Homeowner's Guide to Retrofitting* (2009).

The type of new foundation that can be constructed is dictated by a number of factors, including the flood zone in which the building is located, soil conditions at the site, and the design and construction of the house. The new foundation should be designed to create a continuous load path to resist all applicable flood loads and any wind, seismic, or other loads imposed on the structure. For information on how high to elevate buildings, refer to Hurricane Sandy Recovery Advisory No. 5, *Designing for Flood Levels Above the BFE After Hurricane Sandy* (FEMA 2013).

Figure 6: Elevation of a floor system in a row house. The old floor joist system (outlined in red) was removed and the gaps left by the joists filled. The new floor joist system (red arrow), designed by an engineer, was installed at a higher elevation (Brooklyn, NY).

Slab-on-grade houses.
Although slab-on-grade houses may be difficult to raise, a number of options exist with regard to raising the structure with the slab or without the slab (in which case a new floor system must be provided).

There are two common options for elevating a house in Zone A where the first floor of the living space is on a slab: (1) cut the walls away from the slab, raise the house, construct foundation walls and/or foundation piers, and construct a new wooden floor system (Figure 7); or (2) elevate the whole house including the concrete slab and then construct the new foundation under the slab. Because there are unknown design variables associated with elevating a house with the slab attached, the first option of raising the house above the existing foundation and constructing

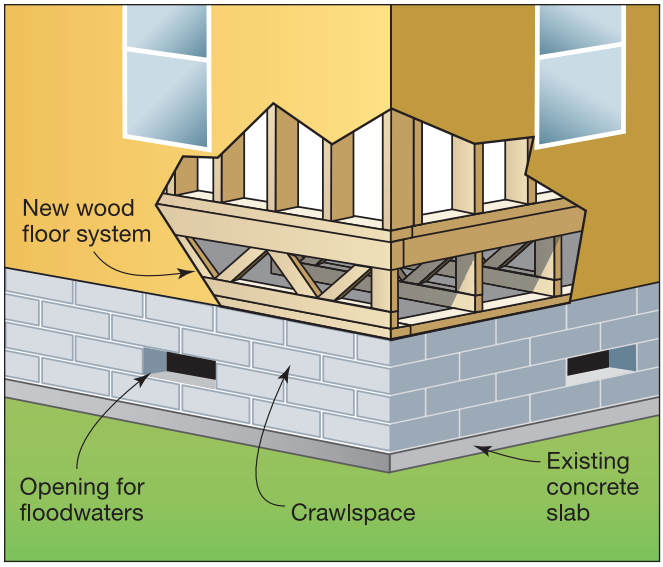


Figure 7: Mitigating a slab-on-grade house by elevating an existing wood-framed house without the slab and installing a new wood truss floor system (adapted from FEMA P-259 Figure 5E-19)

Figure 8: This house in Zone A was detached from its slab foundation (which remains) and elevated on masonry piers. The floor system is supported by new wood joists (Mandeville, LA).

a new floor system is generally preferred. Figure 8, illustrating option 1, shows a completed slab-on-grade elevation project with the walls separated from the poured slab (which remains on the ground) and a new wood-framed floor system added. If the elevation results in an enclosure below the lowest floor, flood openings are required.

Houses with crawlspaces or open foundations. Houses on crawlspaces or open foundations are generally the easiest and least expensive houses to elevate. They are usually one- or two-story houses built on masonry or concrete crawlspace walls, piers, or columns. The crawlspace or open space underneath the house allows access to place the steel beams under the house for lifting and raising the house with a series of jacks (Figure 9). Outside equipment such as air conditioning compressors should be elevated, and duct work in the crawlspace often needs to be replaced during the process.

Figure 9: A house in the final process of being elevated in Zone A. The columns have been poured and the cribbing and steel lifting beams (red arrows) will be ready to be removed soon (Highlands, NJ).

When elevating a house on a crawlspace, to achieve the necessary height, the foundation walls that form crawlspaces can be replaced or extended. A new foundation of either a continuous masonry or poured concrete walls is constructed along with higher interior piers. Although the minimum Zone A requirement is that the top of the lowest floor must be at the BFE, additional elevation high enough that the under-floor ductwork is above the BFE is usually less expensive and easier than retrofitting under-floor ductwork to prevent floodwater infiltration or separately relocating utility equipment.

NFIP Requirements for Enclosed Areas Below the BFE in Zone A

While the main portions of elevated buildings are above the BFE, the foundation and any enclosed areas below the BFE are exposed to flood forces. An overview of NFIP design requirements for buildings in Zone A is provided in Table 1. The following is a more detailed explanation of some of the key requirements and some information on reducing risk and obtaining the lowest flood insurance premium.

Use of Enclosed Areas

The NFIP insurance and building design regulations specify that enclosed areas below the BFE can only be used for:

- Parking of vehicles (attached garages or parking areas below elevated buildings)
- Building access (stairwells, foyers, elevators)
- Storage (low-value items recommended only)

Installing utility stub-outs (i.e., purposely placed utility access points for future connections) is inconsistent with the allowable uses of an unfinished enclosed area.

It is important to understand how an otherwise compliant area below the BFE can be rendered non-compliant by installing features that are inconsistent with the limitations on use. Changing the use—for instance, if a bathroom is installed or the area is converted to a bedroom—may result in significantly higher flood insurance premiums.

To verify that the use of an enclosure below the BFE is consistent with NFIP criteria, some communities use a "non-conversion agreement," which is a deed restriction stating that the property owner will not convert or modify the enclosed area below the elevated building, and will maintain it in accordance with the conditions of the permit for the life of the property. Non-conversion agreements are usually binding to future owners, heirs, successors, personal representatives, and assignees, and many communities require recordation on property deeds. When such agreements are used, property owners who fail to maintain compliance may be subject to enforcement action by the community, a possible rerating of their flood insurance policy, or a denial of flood insurance coverage by FEMA if the property is declared by a State or local authority to be in violation of State or local floodplain management regulations.

Flood Damage-Resistant Materials

Careful attention to compliance with the NFIP regulations for flood damage-resistant materials is important during design, plan review, construction, and inspection. Compliance influences the building's vulnerability to flood damage, the cost of flood insurance, and the building's ability to recover after a flood event.

Flood damage-resistant materials. In all flood zones, every part of a building that is below the BFE is susceptible to flooding during the base flood. The NFIP regulations require the use of flood damage-resistant building materials (refer to text box). For more information, see FEMA Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas* (2008) and FEMA Technical Bulletin 8, *Corrosion Protection for Metal Connectors in Coastal Areas for Structures Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program* (1996). As defined in Table 1 of FEMA Technical Bulletin 2, only Class 4 materials (resistant to floodwater damage from wetting and drying, but less durable when exposed to moving water) and Class 5 materials (highly resistant to floodwater damage, including damage caused by moving water) are acceptable for use below the BFE.

Terminology

As defined in FEMA Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas* (2008):

Flood damage-resistant material: Any building product [material, component or system] capable of withstanding direct and *prolonged contact* with floodwaters without sustaining *significant damage*.

Prolonged contact: At least 72 hours.

Significant damage: Damage requiring more than *cosmetic repair*.

Cosmetic repair: Cleaning, sanitizing, and resurfacing (e.g., sanding, repair of joints, repainting) of the material. The cost of cosmetic repair should also be less than the cost of replacement of affected materials and systems.

Finished interiors. Finishing the interior of enclosures with drywall or other finish materials is not permitted unless necessary to comply with life-safety and fire code requirements. NFIP flood insurance will not pay a claim for finish materials in basements or in enclosed areas below elevated buildings, even if those materials are rated as flood damage-resistant.

Flood Openings

NFIP requirements related to flood openings apply only to buildings in Zone A that have enclosed areas below the elevated building. If enclosure walls are not equipped with flood openings to relieve the pressure of standing or slow-moving water against them, the walls can be damaged or fail during a flood. Figure 10 illustrates the placement of flood openings in a typical above-grade crawlspace foundation wall.

FEMA Technical Bulletin 1, *Openings in Foundation Walls and Walls of Enclosures* (2008), explains the NFIP requirements for flood openings and provides guidance for prescriptive (non-engineered) openings and engineered openings. Non-engineered openings are required to have 1 square inch of net open area for every square foot of enclosed area. As an alternative, engineered openings without those specifications may be used, provided they are designed and certified by a registered design professional as meeting certain performance characteristics described in Technical Bulletin 1.

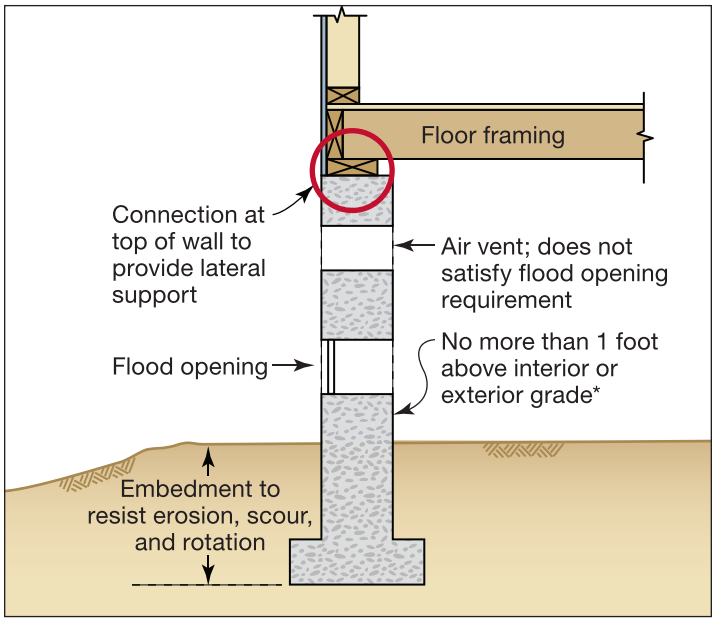


Figure 10: Flood opening in typical crawlspace foundation (adapted from FEMA P-259 Figure 5E-13)

Walls Below the BFE in Zone A

Elevated buildings in Zone A should have the lowest floor raised above ground level on foundation walls, shear walls, posts, piers, pilings, or columns. Although new homes may be elevated on earthen fill, use of fill as a mitigation measure to elevate existing homes in coastal areas is rare and discouraged because of the potential for undermining by erosion and scour. To be

recognized by NFIP flood insurance as an elevated building, foundation walls (with some exceptions for shear walls) should be constructed of masonry or concrete. The NFIP uses the following definitions when determining "lowest floor elevation" for flood insurance purposes:

- *Foundation Walls:* Masonry walls, poured concrete walls, or precast concrete walls, regardless of height, that extend above grade and support the weight of a building.
- *Solid Perimeter Foundation Walls:* Walls that are used as a means of elevating a building in Zone A areas and that must contain sufficient openings to allow for the unimpeded flow of floodwater more than 1 foot deep.
- *Shear Walls*: Walls used for structural support but not structurally joined or enclosed at the ends (except by breakaway walls). Shear walls should be parallel, or nearly parallel, to the flow of the water and can be used in any flood zone. (Note that this definition is different from that typically used by structural engineers and other design professionals.)

Homes that have foundation walls that are different from the NFIP Flood Insurance Manual definitions shown here may incur higher flood insurance premiums.

Buildings in Zone A that are elevated on foundation walls should have a distinct footing underneath the foundation wall. Before considering a building retrofit, both the footing and the foundation wall should be evaluated by a registered design professional who can verify that the foundation system is capable of resisting all necessary loads (see subsection "Concrete or masonry foundation walls and shear walls" on page 6). Which mitigation option is selected may depend on the results of the foundation system evaluation and the retrofits required to resist applicable loads and bring the foundation into compliance.

Elevating Mechanical, Electrical, and Plumbing Systems to Appropriate Levels

As shown in Table 1, utilities and equipment must be elevated to or above the BFE or designed to prevent floodwater from entering and accumulating in components during the base flood. The NFIP requires utility systems to be protected from flood damage in buildings that have incurred Substantial Damage or that are undergoing Substantial Improvement, using the same criteria as new construction.

Mechanical, electrical, and plumbing systems in existing buildings can often be effectively protected from flood damage by elevating them on platforms. The easiest and most practical time to undertake this effort is during construction, renovations, or repairs. Additional information on elevating equipment can be found in the Hurricane Sandy Recovery Advisory No. 3, *Restoring Mechanical, Electrical, and Plumbing Systems in Non-Substantially Damaged Residential Buildings* (February 2013) and in FEMA P-348, *Protecting Utilities from Flood Damage* (1999).

Resources and Useful Links

The following resources describe numerous mitigation options with sufficient detail to complete an elevation mitigation project.

- FEMA NFIP Technical Bulletins. Available from http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins.
  - Technical Bulletin 1: *Openings in Foundation Walls and Walls of Enclosures* (2008).
  - Technical Bulletin 2: *Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas* (2008).
  - Technical Bulletin 5: *Free-of-Obstruction Requirements for Buildings Located in Coastal High Hazard Areas in accordance with the National Flood Insurance Program* (2008).
  - Technical Bulletin 8: *Corrosion Protection for Metal Connectors in Coastal Areas for Structures Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program* (1996).
  - Technical Bulletin 9. *Design and Construction Guidance for Breakaway Walls Below Coastal Buildings* (2008).
- FEMA Hurricane Sandy Recovery Advisories. 2013. Available from http://www.fema.gov/media-library/assets/documents/30966.
  - Hurricane Sandy Recovery Advisory No. 1, *Improving Connections in Elevated Coastal Residential Buildings.*

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 www.region2coastal.com.

– Hurricane Sandy Recovery Advisory No. 3, *Restoring Mechanical, Electrical, and Plumbing Systems in Non-Substantially Damaged Residential Buildings*.

– Hurricane Sandy Recovery Advisory No. 5, *Designing for Flood Levels Above the BFE After Hurricane Sandy*.

- FEMA Hurricane Sandy Fact Sheet No. 2, *Foundation Requirements and Recommendations for Elevated Homes.* Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/32506.
- FEMA Floodplain Management Bulletin 1-98. 1998. *Use of Flood Insurance Study (FIS) Data as Available Data.* Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/7401.
- FEMA P-348. 1999. *Protecting Utilities from Flood Damage*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/3729.
- FEMA P-312. 2009. *Homeowner's Guide to Retrofitting*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/480.
- FEMA P-757. 2009. *Hurricane Ike in Texas and Louisiana: Mitigation Assessment Team Report.* Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/15498.
- FEMA P-499. 2010. *Home Builder's Guide to Coastal Construction*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/6131.
- FEMA P-55. 2011. *Coastal Construction Manual.* Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/3293.
- FEMA P-259. 2012. *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/3001.
- FEMA 086-0-33. 2012. *National Flood Insurance Program Elevation Certificate and Instructions*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/160.
- FEMA. 2013. *National Flood Insurance Program Flood Insurance Manual*. Washington, DC. Available at http://www.fema.gov/flood-insurance-manual.

For more information, see the FEMA Building Science Frequently Asked Questions Web site at http://www.fema.gov/frequently-asked-questions.

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