Elevating Residential Structures within Special Flood Hazard Areas

FEMA

IOWA FLOODS OF 2016 RECOVERY ADVISORY *RA2, April 2017*

Purpose and Intended Audience

The Federal Emergency Management Agency (FEMA) Mitigation Assessment Team (MAT) reviewed flood damage to residential buildings in Linn County and Black Hawk County, Iowa, in response to the floods of 2016. The effects of these storms also were compared to the flooding effects from a series of storms which have impacted this portion of the Midwest several times since this area was last studied by the MAT in response to the 2008 floods.

Flooding along the Cedar, Wapsipinicon, and Mississippi, Rivers has occurred several times since 2008 and extended far beyond mapped Special Flood Hazard Areas (SFHA); in some instances, exceeding the mapped base flood elevations (BFEs) by several feet. The lessons learned from these flooding events by many communities were considered "success stories" of buildings designed, repaired, and reconstructed in compliance with flood-resistant design techniques set forth by the National Flood Insurance Program (NFIP) and the International Residential Code (IRC) to reduce susceptibility to future flood damage.

In preparation for similar riverine flood hazards, FEMA offers this advisory to residential property owners interested in reducing their flood risk and potentially lowering their NFIP flood insurance premiums for residential buildings located in Special Flood Hazard Areas (SFHA). As property owners rebuild, both the mitigation measures for reducing the risk of flood damage and understanding how these measures affect flood insurance premiums should be considered (see Figure 1). The intended audiences for this Recovery Advisory are homeowners, local floodplain management, and building officials, but it may also be useful for planners, contractors, and design professionals advising homeowners.

Figure 1: This house located in Linn County, Iowa was elevated resulting in reduced flood risk and lower flood insurance premiums. The original condition is shown on the top and the elevated structure is shown below. *(Photos courtesy of Linn County, Iowa Planning & Development)*

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.

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. However, existing and pre-FIRM homes that were not Substantially Damaged but remain at risk within the SFHA can be elevated to address the flood risk in their community.

Key Issues:

1. Repairing homes damaged during the Iowa flooding of 2016 gives building owners the opportunity to implement mitigation measures that will improve flood resistance and possibly 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.

In addition to describing mitigation measures such as elevating 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 a lower enclosure and moving the living area up so it is at or above the BFE.

This Recovery Advisory Addresses:

- Key NFIP requirements for buildings in SFHA's
- Moving a building's lowest floor to or above the BFE by converting the usage of the ground floor, 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. 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 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.

NOTE: The SFHAs discussed herein are for inland flooding conditions. Please refer to https://www.fema.gov/special-flood-hazard-area for additional SFHA definitions.

Key NFIP Requirements for Buildings in Special Flood Hazard Areas

Communities that participate in the NFIP are required to adopt and enforce local regulations that meet or exceed NFIP minimums, which apply to new construction and buildings undergoing Substantial Improvement or buildings which have incurred Substantial Damage in areas mapped as SFHAs. The community's local regulations establish minimum criteria and design requirements specifying how structures are to be constructed to minimize the potential for flood damage. Primarily buildings must be elevated to or above the BFE (see text box for definition). Building owners can determine whether their location is in a 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 (see the FIRM example in the Figure 2 on the following page).

Before beginning any construction, homeowners should verify with their local building department that they have obtained all the State and local permits required to perform the project. This will protect homeowners from the needless extra construction costs produced by design changes which provide compliance with regulations after construction begins. Such a situation can occur when a building is determined by a building official or floodplain administrator to have incurred Substantial Damage or to be undergoing Substantial Improvement and treated as new construction. In these situations, the building must be brought into full

compliance with the flood provisions of current building codes and local floodplain ordinances which meet or exceed the floodplain management requirements of the NFIP regulations.

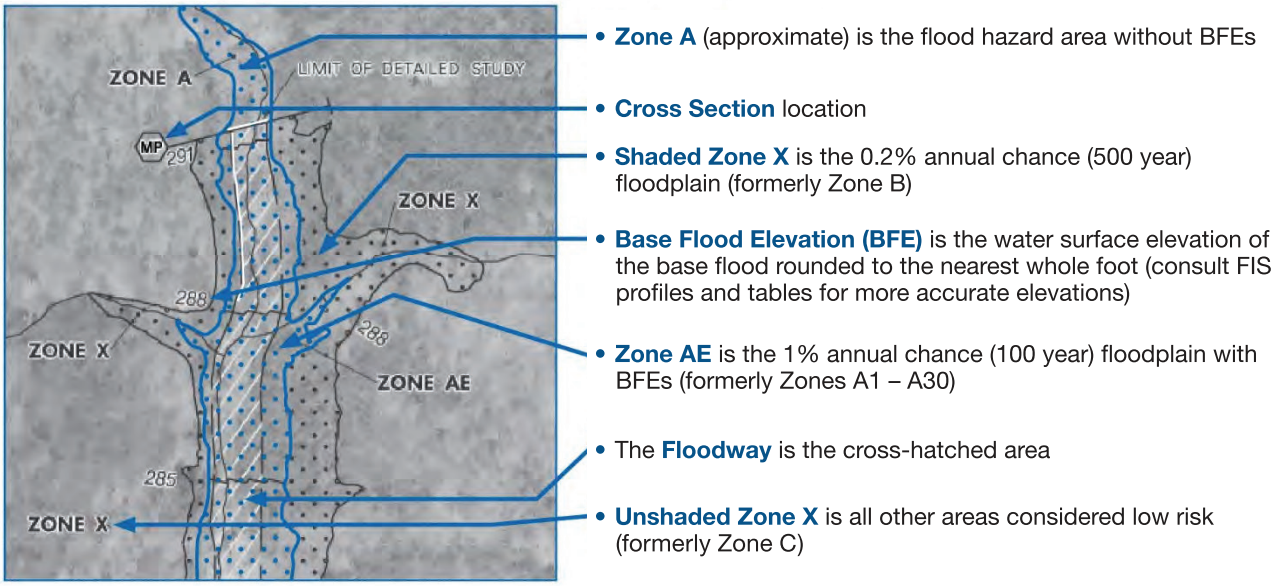


Figure 2: FEMA FIRM (Riverine) from Reducing Flood Losses Through I-Codes, 2014

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 and constructing or repairing a home to meet the unmodified flood-resistant construction criteria of the IRC will meet the minimum NFIP requirements. Table 1 summarizes some of the key NFIP requirements for new construction in SFHAs, 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.

Table 1: Key NFIP Building Design Requirements for Buildings Located in Special Flood Hazard Areas (SFHAs)

NFIP 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 used 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.*

As displayed in Table 1, there are many requirements associated with constructing buildings in SFHAs. There are additional requirements for buildings constructed within the regulatory floodway, which is the channel and adjacent land areas that must be reserved in order to discharge the base flood. Specifically, the NFIP prohibits new construction in the floodway from cumulatively increasing the water surface elevation more than a designated height. Buildings, structures and other development activities – such as fill – placed within the floodway are more likely to obstruct flood flows, causing the water to slow down and back up, resulting in higher flood elevations. These requirements are meant to protect and encourage communities from constructing in the floodway and SFHAs.

There are several ways to address the flood hazard within a community. For example, the City of Cedar Falls, Iowa, has adopted a floodplain ordinance found in the Code of Ordinances, City of Cedar Falls, Iowa that requires houses within the SFHA that are Substantially Damaged or Substantially Improved to be elevated above minimum NFIP requirements by setting the elevation requirement to the elevation of the mapped 0.2 percent (500-year) flood plus 1 foot. In addition, the City addressed the risk of flooding to several neighborhoods without the use of elevation or other construction techniques by implementing a buyout program which removed over 450 houses from the SFHA. These actions greatly lowered the flood damages to their community after several events since the 2008 Midwest floods, including the flooding of 2016. Even though the second-worst flood in the city's history occurred in 2016, the flood damages were far less compared to the flooding of 2008.

One example of a homeowner who chose to remain in the SFHA, but to address the flood hazard through elevating their residence to the City's floodplain ordinance is shown in the Figure 3.

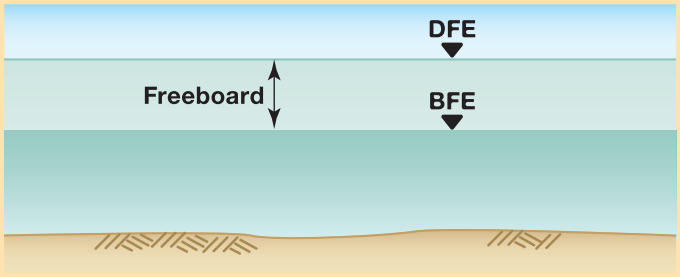
When considering mitigation measures, it is important to consider all of the hazards a house must resist.

Buildings must be able to resist the effects of wind and water loads acting simultaneously, and resist seismic loads where applicable.

Figure 3: Elevated Residence within SFHA in Cedar Falls, Iowa (Photo courtesy of City of Cedar Falls, Iowa)

Terminology

Freeboard: A factor of safety usually expressed in feet above a required flood level called the BFE for purposes of floodplain management. "Freeboard" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as bridge openings, and the hydrological effect of urbanization of the watershed



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

As shown previously 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 (2014), for additional mitigation measures.

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

Feature of Existing Home	Building Type		Cost*	Project Difficulty
	Detached (Free-Standing)	Attached (Row House/Townhouse)		
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	**	$$$	Moderate – Hard
Existing crawlspace foundation	Y	**	$$	Moderate
Floors of row house/townhouse	Not applicable	Y	$$$	Hard

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.

If it is not possible to modify or strengthen the existing foundation, a registered design professional, such as an architect or engineer, should consider other solutions. There are some mitigation measures described in this advisory which may be difficult to accomplish. For instance, it may not be possible to modify or strengthen a home's existing foundation if the foundation is structurally deficient, or if the project is cost prohibitive.

WARNING: Property owners should ensure any design professional (engineer or architect) providing assistance with an elevation project is registered or licensed in the State where the work is being performed.

A registered design professional can also assist in evaluating the building and building site for the feasibility of undertaking some of the measures described in this advisory. Homes located on small lots or located very close to adjacent buildings may prohibit equipment access or temporary relocation of a building because of access or site constraints. Commencing construction on such projects without proper evaluation may result in complications and additional expenses. In some circumstances it may be helpful to elevate multiple homes at the same time. Some row houses or townhouses are too difficult to elevate alone. Elevating multiple homes at once as a group may offer a less expensive option for all parties.

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

Some pre-FIRM existing homes have a condition where the BFE is above a lower floor level. When this condition exists, there is an opportunity to reduce future damages and reduce flood insurance premiums by using the next highest floor as living area and converting the lower floor level to a compliant use. Options for converting the lower level foundation include removing the existing foundation and replacing it with a compliant open foundation, or replacing existing foundation walls to create a compliant enclosed foundation with compliant flood openings (See Figure 4). In some cases, a registered design professional may modify existing

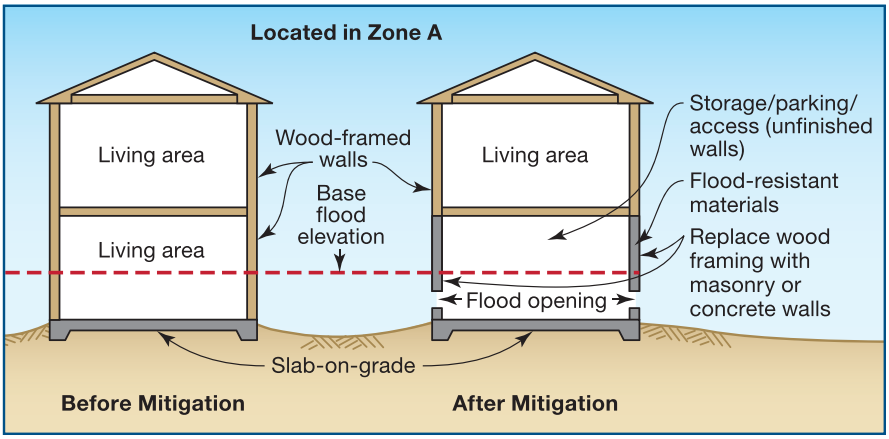


Figure 4: In Zone A, the floor below the BFE (left) can be modified to be compliant with NFIP criteria (right) by converting the lowest floor to a non-living space using flood-resistant materials.

foundation walls to be reused as compliant foundation walls after careful analysis. Another option is to fill the basement or lower floor area when a higher floor is already at or above the BFE. Afterwards, the higher floor becomes the designated lowest floor as the basement effectively is removed. Several factors dictate the conversion process of abandoning the original lowest floor and whether the modified home qualifies for lower flood insurance premiums after mitigation. These considerations are described in more detail 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. 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. Another option may involve finishing an uninhabited attic area. Additionally, a homeowner may choose to remove an existing roof and construct another story over the original building as a means of expanding the living 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.

A registered design professional should verify all mitigation measures, even when some solutions may appear simple to homeowners. Even if only minimal remodeling of the ground floor seems necessary, a registered design professional will ensure the foundation walls for the ground floor are properly designed and have adequate anchoring to resist anticipated loads (flooding, wind, seismic, etc.). Upon completion of the design, a registered design professional should evaluate the building and certify the foundation wall design adheres to accepted standards of practice including the provisions below. Figure 5 presents 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 provisions.

- The foundation, and building attached to the foundation, must be anchored to resist flotation, collapse, and lateral movement resulting from the effects of flood loads acting on the building. Wind, seismic, or other loads imposed on the structure must also be considered.
- The potential for scour and erosion at the foundation must be anticipated for conditions associated with the base flood.
- 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 in compliance 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.

Homes with existing concrete or masonry foundation walls and shear walls.

Homes originally constructed using concrete or masonry foundation walls are typically the easiest to convert into NFIP-compliant open or enclosed foundations. The work required primarily entails removing any interior finishes; elevating all mechanical, electrical, and plumbing equipment to 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.

A registered design professional should evaluate the building by examining both the footing system and the foundation walls. The footing system should resist erosion, scour, and floodwater pressure exerted on the house. Furthermore, the foundation walls should resist forces exerted on them during a flood, and have adequate connection and transmission of forces into the footing system. The registered design professional should evaluate the walls to confirm the presence of enough reinforcing steel to resist the anticipated flood conditions. Most concrete walls have reinforcing steel inside the concrete, however, it is less certain that masonry walls will have reinforcing steel. Both situations should be evaluated, and in cases of insufficient reinforcing the registered design professional should determine whether it is feasible to reinforce the walls

to provide proper flood resistance or if new foundation walls need to be constructed.

Homes with existing wood-framed walls.

Residences with wood-framed walls built below the BFE 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 to create compliant foundation walls. Homes modified or strengthened in this way will not be eligible for lower flood insurance premiums, unless the work is considered a Substantial Improvement. To qualify for lower flood insurance, communities must adopt an expanded definition of Substantial Improvement which applies to shear walls. The following blue text box summarizes the two requirements which must be met for homeowners to qualify for reduced insurance premiums in the conversion of wood-framed walls into shear walls. These two requirements are discussed further in the following subsections.

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 5: Sample foundation wall design certification statement

(a) Replace or modify wood-framed walls: A registered design professional with experience in evaluating homes in SFHAs 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 installation of temporary cribbing or shoring which supports the house as the old walls are removed for new foundations. New foundation walls should be designed by an architect or engineer, who will pay particular attention to properly anchoring the walls into the footing system. For more information on maintaining a continuous load path, refer to FEMA P-499, Home Builder's Guide to Coastal Construction (2010) Fact Sheets 4.1, 4.2, and 4.3.

Modifying wood-framed walls can be accomplished by using a combination of wood shear walls and a series of portal frames, moment frames, or other methods. Shear walls resist the lateral (side-to-side) forces imposed by floodwaters, winds, and earthquakes. If the shear walls enclose the area below the lowest flood, the shear walls must have flood openings that automatically equalize flood forces on exterior walls. The modified foundation wall system should resist all lateral and vertical loads (due to gravity or uplift) and a registered design professional may determine additional structural sheathing (e.g., plywood sheathing), additional studs, wood blocking, anchors, fasteners, or structural connectors need to be installed. Moreover, the registered design professional should evaluate the concrete slab and footings to verify their capability of withstanding all imposed loads including the new shear wall loads. It is important to note that building codes may also require new fire protection measures, such as use of gypsum board (drywall), be incorporated into the design. Walls below the BFE with gypsum board have to be constructed using paperless gypsum board to meet flood damage-resistant material standards.

Figure 6 illustrates an example of a two-and-a-half-story house where the lowest floor is being abandoned and 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 5. Upon transfer of the property, homeowners should notify future owners that subsequent modification of the foundation walls and enclosures below elevated buildings may violate the terms of permits or the local floodplain ordinance. 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 SFHAs" of this Recovery Advisory).

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 in this Recovery Advisory in the section titled: **Optional Local Ordinance Provision for Conversion of Wood-Framed Ground Floors**

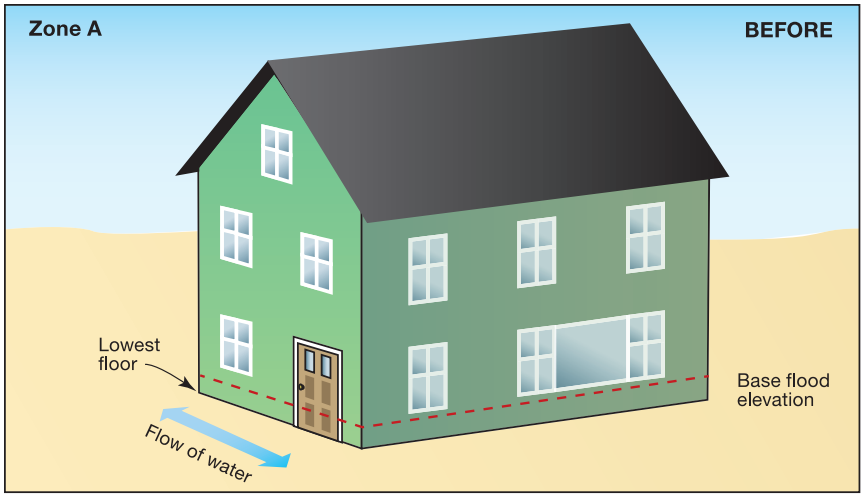
(b) Adopt optional definition of "Substantial Improvement" to qualify homes with modified wood-framed walls for reduced flood insurance premiums. The optional Substantial Improvement definition (shown in the subsequent text box) would explicitly include the work to modify ground-floor wood-framed walls to become an NFIP-compliant shear wall foundation, regardless of the cost of the work. This would allow the building to be rated by the NFIP as an elevated building that would qualify for 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.

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. <u>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"</u>. The term does not, however, include either:

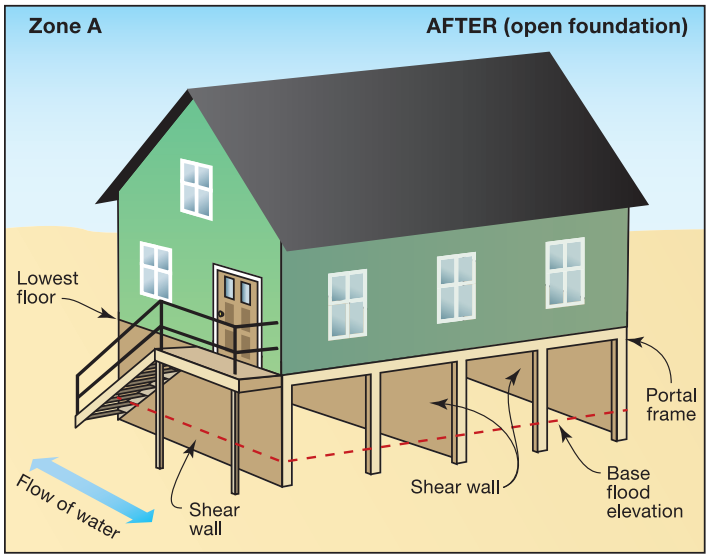
(1) Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions or

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



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.



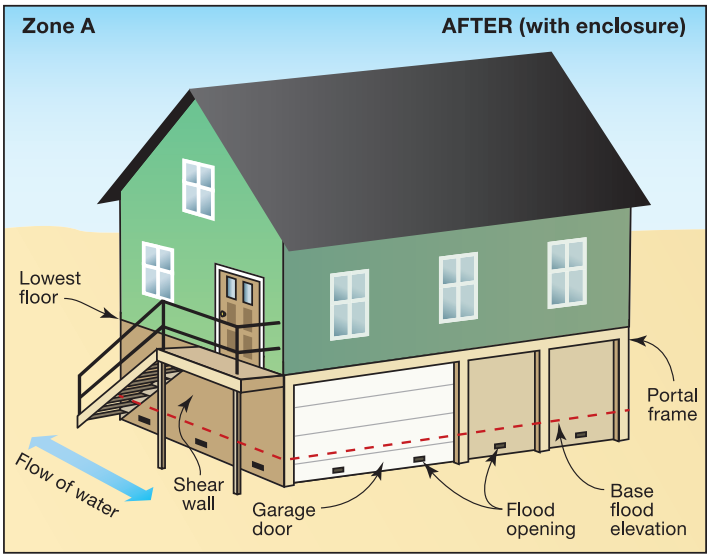


Figure 6: Before (2.5-story house at-grade) and after (1.5-story house with NFIP-compliant open foundation or compliant enclosure below the BFE) of a house in the SFHA with the lower floor converted using a shear wall and portal frame foundation system

Information on filling a basement. Buildings with basements are susceptible to structural damage if floodwaters enter 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. The fill should be placed at least up to the adjacent grade (ground) level. Although filling a basement will likely result in lower insurance premiums, other retrofits may be necessary to maximize premium reductions. Homeowners should 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 entering 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. Additionally, a registered design professional may recommend a system of underdrains be installed to improve drainage.

It can be difficult for a contractor to properly compact fill placed in an existing basement because the confined space limits access for compaction machinery. Therefore, some settlement of fill should be expected after initial placement. After the initial settlement, additional fill may be required to maintain a level matching the adjacent grade.

Row house/townhouse: Row houses use common partition walls between neighbors and may consist of upper floors and a lower level or walk-out basement. Walk-out basements that are not below grade on all sides are not classified as basements, per NFIP criteria, if the ground slope allows water to drain freely away from the building.

To potentially qualify for lower flood insurance premiums, it may be necessary to convert the ground floor to a 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 7). 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 7). In such situations, exterior 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 possible to convert the ground floor to a NFIP-compliant open foundation or compliant enclosure and make adjustments to the upper floors, such as moving utilities and mechanical equipment to higher floors. Acceptable uses of areas below the BFE are described in the subsection "Use of Enclosed Areas" later in this Recovery Advisory.

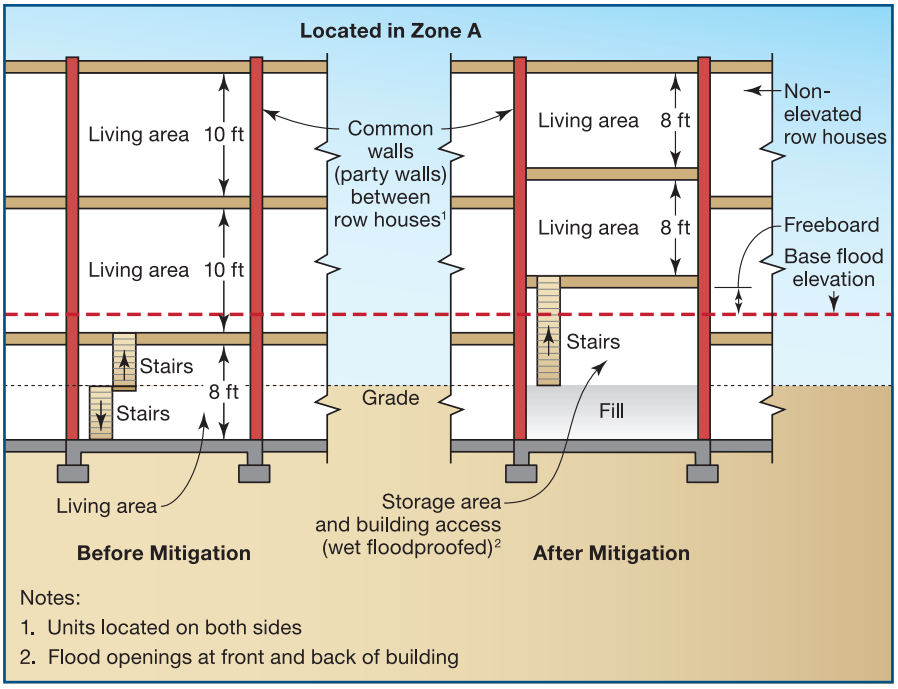


Figure 7: A row house with the floor levels being elevated to maximize living area above the BFE in Zone A

Elevating Buildings

Elevating a home involves raising the lowest floor with living area to be at or above the BFE based upon the elevation requirements of the community as set forth in their floodplain ordinance. Elevation projects typically involve separating the building from its foundation, modifying the existing foundation or constructing a new and 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* (2014).

The type of new foundation that can be modified or reconstructed 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 or modified 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.

Houses with slab-on-grade foundations.

Although slab-on-grade houses may be difficult to raise, a number of options exist for raising the structure without the slab and providing a new floor system. The most common method of elevating a house in a SFHA with a slab-on-grade involves cutting the walls away from the slab, raising the house, constructing a new foundation system, and providing a new floor system.

Elevated homes constructed with an enclosure must incorporate flood openings into the walls. Figures 8 shows an example of slab on grade home that has been elevated on column foundation. Figure 9 displays a slab-on-grade house elevated with a new floor system which is supported by a crawlspace. Because the crawlspace is below the lowest floor/living area, the walls have incorporated flood openings.

Figure 8: An elevated house on concrete columns which originally had a slab on grade, Linn County, Iowa. (Photo courtesy of Linn County, Iowa Planning & Development)

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, or piers. The crawlspace or open space underneath the house allows access to place steel beams under the house for lifting and raising the house with a series of jacks. Outside equipment such as air conditioning compressors should be elevated along with the house itself. Any duct work in the crawlspace often needs to be replaced during the process.

When elevating a house on a crawlspace, the foundation walls that form the crawlspace can be replaced or extended. A new foundation of either continuous masonry or cast-in-place concrete walls is constructed along with higher interior piers. Although the minimum BFE requirement for SFHAs positions the top of the lowest floor at the BFE, additional elevation to incorporate freeboard is encouraged and beneficial. In cases where there is ductwork below the lowest floor, elevating above the BFE can be less expensive and easier than retrofitting the under-floor ductwork to prevent floodwater infiltration or separately relocating utility equipment.

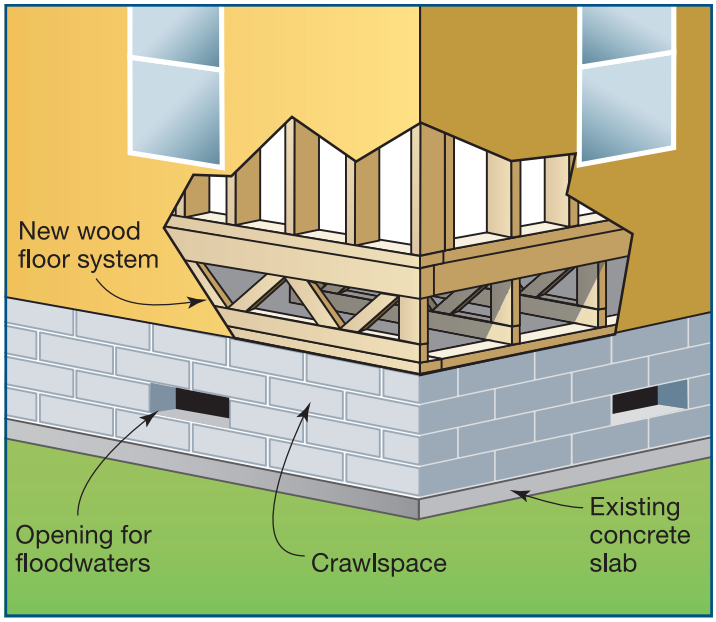


Figure 9: An elevated house with flood openings which originally had a slab on grade (adapted from FEMA P-259 Figure 5E-19).

NFIP Requirements for Enclosed Areas Below the BFE in SFHAs

Foundations and enclosed areas below the BFE must follow special NFIP criteria because of exposure to flood waters. The following section focuses on areas below the BFE and provides a detailed explanation of key requirements, methods of reducing risk, and obtaining the lowest flood insurance premium. A general overview of NFIP design requirements for buildings in SFHAs was provided in Table 1.

Use of Enclosed Areas

The NFIP insurance and building design regulations permit usage of enclosed areas below the BFE 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 prohibited and inconsistent with the allowable uses of an unfinished enclosed area. Furthermore, areas below the BFE can be rendered non-compliant by installing features which are inconsistent with the permitted usages described earlier. For instance, changing the use of enclosed areas by installing a bathroom or converting the area into a bedroom will violate the NFIP policy and may result in significantly higher flood insurance premiums.

To verify appropriate usage of enclosures below the BFE for consistency with NFIP criteria, some communities use a “non-conversion agreement”. This agreement is a deed that restricts property owners from converting or modifying the enclosed area below the elevated building, and establishes an agreement to maintain the space 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. Property owners who fail to maintain compliance may be subject to enforcement action by the community. This could include 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. All building materials below the BFE, as specified by the NFIP, must be flood damage-resistant (refer to Terminology text box for definition). FEMA Technical Bulletin 2, Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas (2008) offers additional details on the usage and requirements of these materials. 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 to all buildings in SFHAs that have enclosed areas below the elevated building. This requirement helps prevent walls from damage or failure during a flood because the flood openings help to relieve the pressure of standing or slow-moving water against the walls. 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.

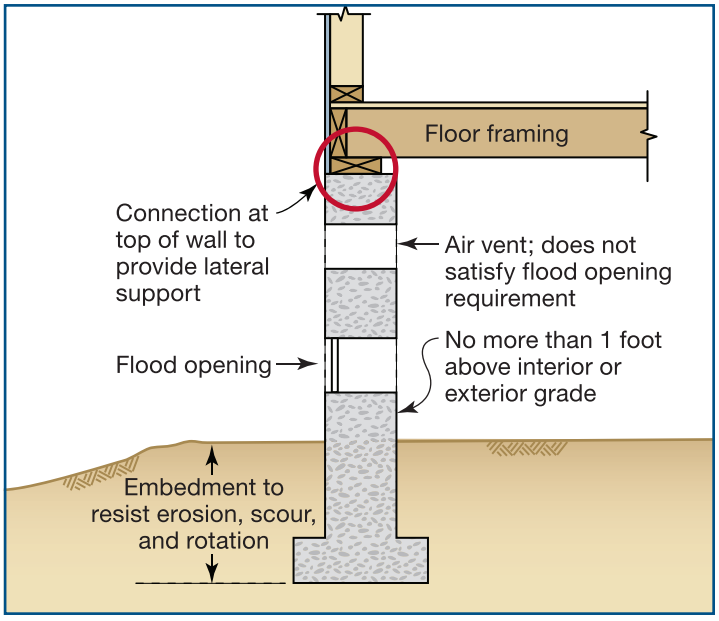


Figure 10: Flood opening in typical crawlspace foundation (adapted from FEMA P-259 Figure 5E-13)

Walls Below the BFE in Special Flood Hazard Areas (SFHAs)

Elevated buildings in SFHAs should have the lowest floor raised above ground level on foundation walls, shear walls, posts, piers, pilings, or columns. 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:

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

- *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. 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.)

Buildings in SFHAs 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" earlier in this Recovery Advisory). 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 Iowa Floods of 2016 Recovery Advisory #4, *Flood Protection and Elevation of Building Utilities* (April 2017) and in FEMA P-348, *Protecting Building Utility Systems from Flood Damage* (2017).

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 to document the elevation of the new lowest floor so that insurance companies can rate the building for flood insurance. Elevation Certificate and instructions are available at https://www.fema.gov/media-library/assets/documents/160.

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

As noted several times in this RA, communities may adopt minimum elevations for buildings in SFHAs that are higher than the Effective BFE, or higher than other regulated design flood elevations (DFE). As mentioned earlier, communities are encouraged to adopt additional freeboard. 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. 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.

The state of Iowa has mandated a minimum 1-foot freeboard above the BFE to help protect communities against flood damages and assist in reducing flood insurance rates. Some communities within the state of Iowa have also exceeded these minimum requirements, such as Cedar Falls, which uses a 1-foot freeboard above the 500-year flood elevation, and the City of Palo, which has incorporated the use of 2 feet of freeboard above the 100-year flood elevation. Building officials with Linn County also recommend exceeding the minimum state/county requirements of 1 foot of freeboard above the BFE because experience with recent damaging floods has shown the extra effort is worth the protection it provides against damages from future floods. Designers, contractors, and owners should contact a qualified insurance agent or the NFIP for more information about policy coverage, coverage limits, and costs.

Resources and Useful Links

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

The FEMA Region VII Web page provides useful information and links for disaster survivors and recovering communities including available FEMA assistance and recovery initiatives. Please refer to https://www.fema.gov/region-vii-ia-ks-mo-ne

- FEMA NFIP Technical Bulletins. Available from https://www.fema.gov/media-library/resources-documents/collections/4
  - 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 in accordance with the National Flood Insurance Program* (2008).
- 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. 2017. *Protecting Building Utility Systems from Flood Damage*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/3729.
- FEMA P-312. 2014. *Homeowner's Guide to Retrofitting*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/480.
- 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-765. 2009. *Midwest Floods of 2008 in Iowa and Wisconsin: Mitigation Assessment Team Report*. Washington, DC. Available at https://www.fema.gov/media-library/assets/documents/17329.
- 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. 2016. *National Flood Insurance Program Elevation Certificate and Instructions*. Washington, DC. Available at http://www.fema.gov/media-library/assets/documents/160.
- FEMA. 2016. *National Flood Insurance Program Flood Insurance Manual*. Washington, DC. Available at http://www.fema.gov/flood-insurance-manual.
- FEMA. 2017. *National Flood Insurance Program: Definitions*. Washington, DC. Available at https://www.fema.gov/national-flood-insurance-program/definitions#F
- FEMA P-758. 2010. *Substantial Improvement/Substantial Damage Desk Reference*. Washington, DC. Available at https://www.fema.gov/media-library/assets/documents/18562.

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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