

Wet-floodproofed accessory structures must comply with the following measures:

- Use is limited to parking of vehicles and storage
- Utilities are elevated
- Materials below the BFE are flood damage-resistant materials
- Flood opening requirements are satisfied
- Structures are anchored to resist flotation, collapse, or lateral movement under flood conditions

A best practice is to require Non-Conversion Agreements when non-elevated accessory structures are allowed. These agreements, when recorded with property deeds, inform future owners about the limitations and the wet-floodproofing measures. Accessory structures that are allowed to be wet floodproofed must not be used for any habitable or other prohibited purpose.

8 Requirements and Guidance for Installation of Flood Openings

The NFIP regulations specify installation requirements for all flood openings, whether non-engineered or engineered. See Section 9 of this Technical Bulletin for information on non-engineered and engineered flood openings. Installation requirements specify the minimum number of openings and the maximum height of openings above grade. The requirements and guidance on installation are provided in Sections 8.1 through 8.3.

8.1 Location and Minimum Number of Flood Openings

Every enclosed area is required to have at least two flood openings on exterior walls. Flood openings should be installed in at least two sides of each enclosed area to decrease the chance that all openings will be blocked by floating debris and to allow for more even filling and drainage of enclosed areas than if openings are installed on only one side. FEMA recommends that openings be distributed around the perimeter of enclosed areas unless there is clear justification for putting all of the openings on only one or two sides, such as in townhouses with limited exterior walls (see Section 8.3.4) and buildings set into sloping sites (see Section 8.3.2). If openings are not distributed around the perimeter, an imbalance in flood loads could result in damage to or collapse of walls.

LOCATION OF FLOOD OPENINGS

The IRC and IBC (by reference to ASCE 24) require flood openings “on different sides of each enclosed area” (IRC R322.2.2.1) and “in at least two walls of each enclosed area” (ASCE 24, Section 2.7.3).

Figure 11 shows a foundation plan with multiple enclosures and openings in the perimeter wall of each enclosed area. Note that the number of openings shown is for illustration purposes only; the total number of openings and the adequacy of the net open area of the openings depend on the type of opening and whether air-vent devices or engineered openings are installed.

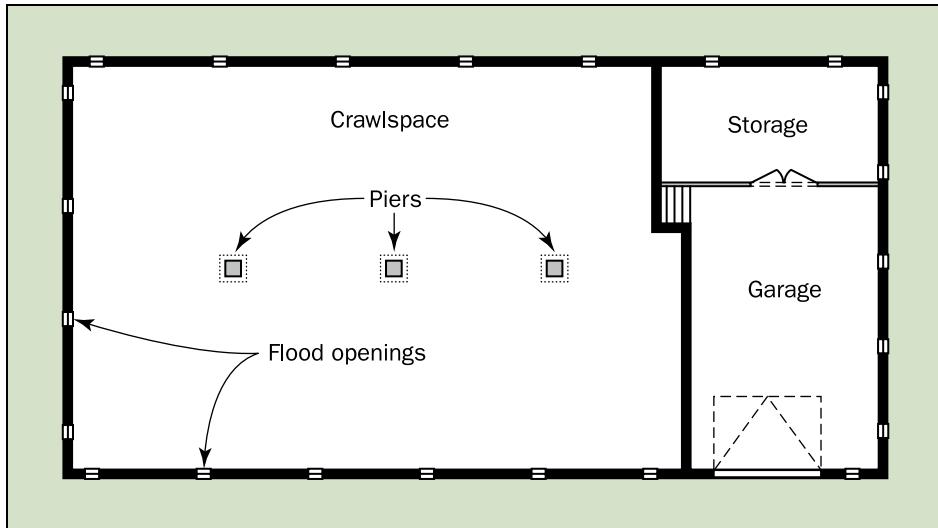


Figure 11: Foundation plan of home with multiple enclosed areas, each with flood openings (number of openings for illustration purposes only)

In some situations, openings in interior walls or partitions are necessary to ensure that floodwater can reach all enclosed areas and minimize unbalanced hydrostatic loads on interior and exterior walls. When openings are used in interior walls, the total number of openings and their net open area should be based on the size of the enclosed area, but openings in interior walls are not counted toward the required total opening requirement based on the exterior measurement of the enclosed area. To maintain safe fire separation, flood openings should not be placed in the wall separating a garage from living spaces and crawlspaces unless devices used as flood openings that are designed to satisfy fire-separation requirements are used.

8.2 Height of Flood Openings Above Grade or Floor

The bottom of each flood opening must be positioned no higher than 1 foot above the higher of the final (finished) interior or exterior grade or the floor that is immediately under each opening so water will begin to flow through the opening when water rises just above the bottom of the opening. The purpose of this requirement is to satisfy the performance expectation that the difference in water levels between the interior and exterior will not exceed 1 foot as floodwater begins to rise and as it recedes from the site. To reduce the amount of water trapped inside, a good practice is to install some openings closer to grade than the maximum 1 foot allowed. See Section 8.3.6 for information on openings that extend above the BFE in areas with shallow flooding.

When interior and exterior grades are different, the higher of (1) the finished exterior grade immediately under each opening and (2) the final interior grade or floor is used to determine

ENCLOSURES BELOW GRADE ON ALL SIDES ARE BASEMENTS

An enclosure that is below grade on all sides is a basement regardless of whether the interior grade or floor is below grade because backfill, topsoil, or landscaping materials were added or because the footing trenches inside the perimeter foundation walls are not completely backfilled. Basements do not comply with the minimum NFIP requirements. In addition, the presence of such below-grade enclosures will result in higher NFIP flood insurance premiums.

the position of flood openings. The following should be considered when determining which grade or floor to use:

- **Finished exterior grade.** Care should be taken when placing backfill, topsoil, or landscaping materials around the outside of enclosures, especially solid perimeter foundation walls. If the finished exterior grade is higher than the interior grade on all sides of the building, the enclosed area will be a basement as defined by the NFIP.
- **Final interior grade or floor.** The trench that is excavated to construct footings and foundation walls must be backfilled completely; otherwise, a basement will be created. If the interior grade or floor is higher than the exterior grade, the openings must be no higher than 1 foot above the interior grade or floor.

8.3 Examples of Flood Opening Installations

The following examples of flood opening installations are described in Sections 8.3.1 through 8.3.6:

- Interior grade or floor higher than the exterior grade
- Sloping sites
- Buildings with large enclosed areas
- Townhouses with limited exterior walls
- Buildings with multiple enclosures
- Openings in areas with shallow flooding

8.3.1 Interior Grade or Floor Higher than the Exterior Grade

This section describes enclosures in which the interior grade or floor is higher than the exterior grade. As water rises against the outside of the foundation, the interior fill or slab resists the hydrostatic load. When water rises above the interior grade or slab, the lateral load will become unbalanced and therefore must be equalized with openings that allow water to automatically enter and exit.

Figure 12 is an example of a framed enclosure below a manufactured home that is elevated on columns. As indicated by the driveway on the left, the interior slab is higher than the exterior grade along the side of the building. The flood openings are within 1 foot of the interior floor surface. Here, the full-height enclosed area is used for parking of vehicles and storage.

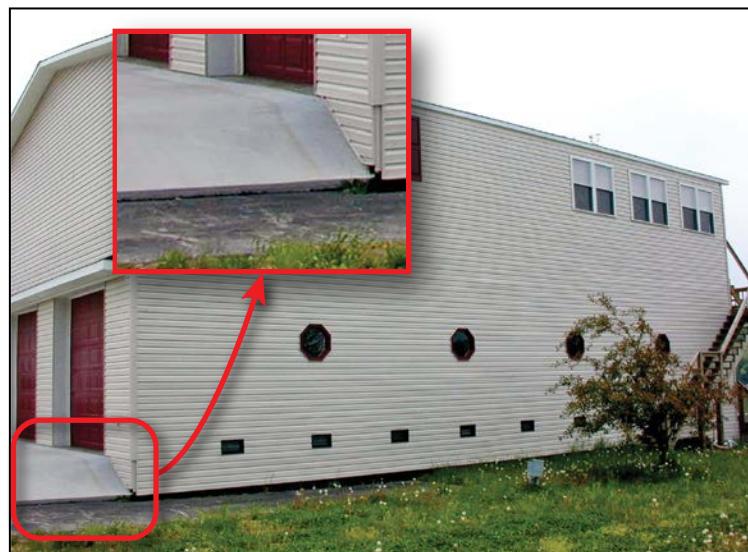


Figure 12: Manufactured home installed on columns above a full-height, framed garage (note elevation of thick driveway slab on left; the flood openings are within 1 foot of interior floor surface)

When viewed from the outside, an enclosure with the interior grade or floor higher than the exterior grade may appear non-compliant with the installation requirements for openings because the openings appear to be too high above the exterior grade. Therefore, the final documentation of as-built elevations should note the difference in interior and exterior grades. For example, if the NFIP Elevation Certificate is used, the comments should indicate whether the openings are (or are not) within 1 foot of the higher of the two grades and should explain that the interior grade or floor is higher than the exterior grade. Without the explanation, NFIP flood insurance premiums may be higher than necessary.

INTERIOR GRADE OR FLOOR ABOVE BFE

When the interior grade or floor of an enclosure below an elevated building is entirely above the BFE, flood openings are recommended but not required. When the floor of an enclosure is above the BFE, the NFIP flood insurance policy will be rated using the enclosure floor as the lowest floor rather than the next higher floor above the enclosure. Installing flood openings in these situations will result in lower NFIP flood insurance premiums.

8.3.2 Sloping Sites

Buildings on solid perimeter foundation walls set into sloping sites present a special situation for the installation of flood openings. Careful attention must be paid to the following:

- The interior grade or floor along the lowest side of the building must be at or above the exterior grade across the entire length of the lowest side, and there must be positive surface drainage away from the building; otherwise, the enclosure will be considered a basement as defined by the NFIP.
- The bottom of each opening must be no higher than 1 foot above the exterior or interior grade immediately below the opening, whichever is higher (see Figure 13).
- For flood openings to perform their intended function, they should be below the BFE.

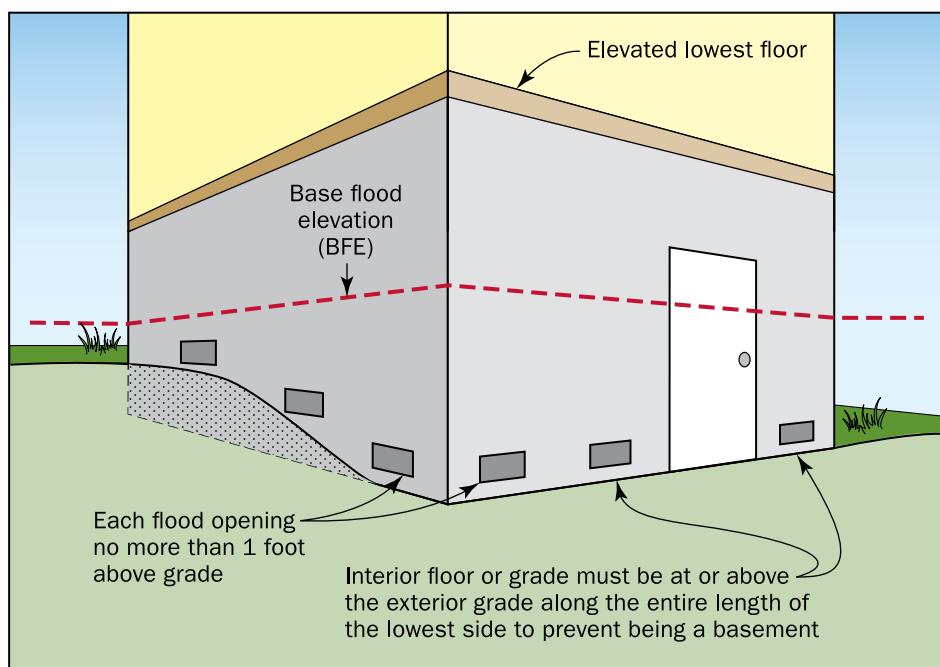


Figure 13: Flood openings in enclosure walls on a sloping site

- Interior partitions and load-bearing walls must have openings to allow water to readily reach every enclosed area (see Section 8.3.5 for information on buildings with multiple enclosures).

8.3.3 Buildings with Large Enclosed Areas

Some buildings, especially commercial and industrial buildings, have large under-floor spaces, crawlspaces, or enclosures. Flood openings may be stacked or grouped (see Figure 14), or large-dimension openings may be used, provided all of the requirements for openings are satisfied. Vertically stacked or closely spaced openings function together as one opening, and the bottom of the lowest opening must be no higher than 1 foot above the exterior grade or interior grade, whichever is higher.

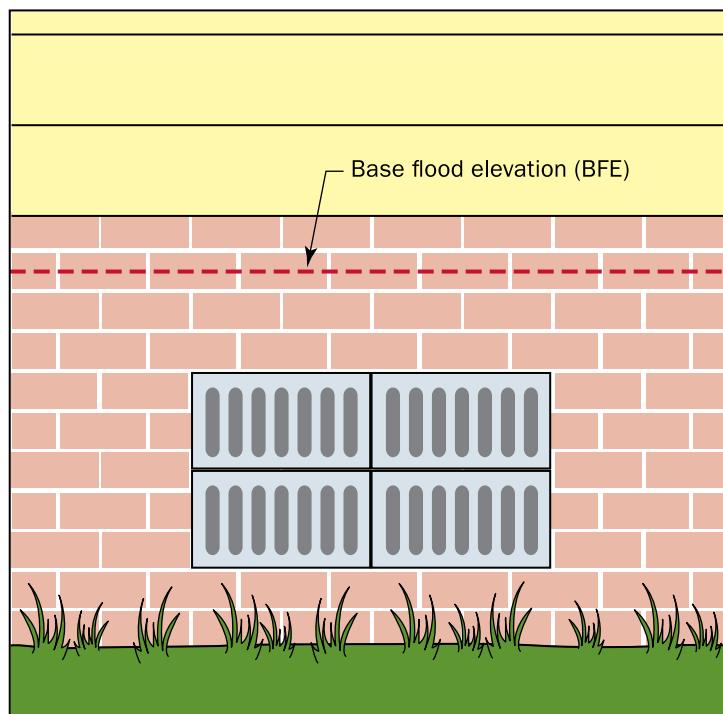


Figure 14: Flood openings that are stacked and closely grouped to satisfy the required total net open area

8.3.4 Townhouses with Limited Exterior Walls

Townhouses are single-family dwelling units constructed in groups of three or more attached units in which each unit extends from foundation to roof with exterior walls on at least two sides. Flood openings are required for townhouses in SFHAs that are constructed with solid perimeter foundation walls or solid walls surrounding enclosed areas under the elevated portion of the building.

Because interior townhouse units have less linear exterior wall length than end units, meeting all of the requirements for flood openings can be a challenge, especially the requirement for adequate opening area and the requirement that each enclosed area have openings. If openings cannot be provided in at least two exterior walls of each enclosed area, the NFIP allows all openings to be installed in one wall.

The design of interior townhouse units can satisfy the guidance that openings should be located on different sides of each enclosed area if interior partitions and walls have openings to connect enclosed spaces from front to back. Figure 15 shows suggested locations for openings. Note that the number of openings in Figure 15 is for illustration purposes only; the total number of openings and the adequacy of the opening area depend on the type of opening and whether non-engineered or engineered openings are installed. Fire-safety limitations generally preclude openings in the walls that separate townhouse units.

Providing adequate openings in enclosures below elevated townhouse units, other than end units, may be even more challenging if a multi-unit building is set into a sloping site. In this case, it may be appropriate to consider an open foundation or a backfilled stem wall foundation that does not require openings.

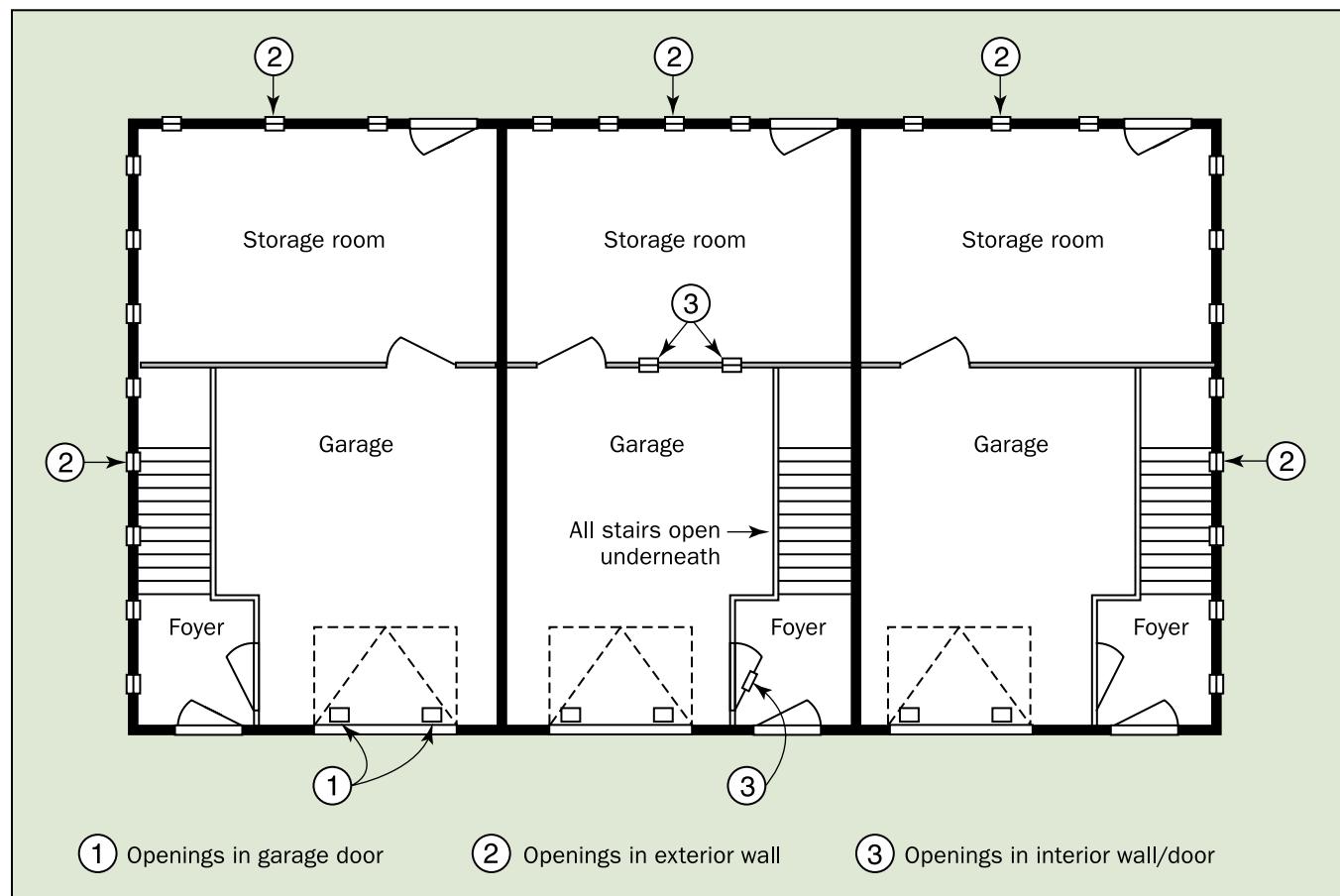


Figure 15: Suggested flood openings in enclosures under elevated townhouses (number of openings for illustration purposes only)

8.3.5 Buildings with Multiple Enclosures

Every enclosed area is required to meet the requirements for enclosures, including the requirement for flood openings in exterior walls. Figure 11 in Section 8.1 shows a home foundation plan with multiple enclosures. In some situations, openings in interior walls or partitions may be necessary to ensure that floodwater can reach all areas to minimize unbalanced hydrostatic loads on load-bearing interior walls and exterior walls (see middle townhouse in Figure 15 in Section 8.3.4). When openings are used in

interior walls, the total number of openings in exterior walls and the total opening area should be based on the size of the entire enclosed area. Openings in interior walls do not count toward the total opening requirements based on the exterior measurement of the enclosed area.

8.3.6 Flood Openings in Areas with Shallow Flooding

Some FIRMs show mapped SFHAs where the depth of floodwater above grade will be shallow (2 feet or less during the base flood). Shallow flooding occurs toward the landward boundary of SFHAs and in areas identified as being subject to sheet flow or ponding. The NFIP regulations require flood openings in enclosures even if the depth of flooding is only 1 foot and the difference in water depth between the inside and outside of enclosures is 1 foot or less.

Depending on the depth of floodwater in areas with shallow flooding, flood openings may extend above the BFE if the bottom of the opening is no higher than 1 foot above the higher of the final interior grade or floor and the finished exterior grade of the crawlspace or enclosure. When flood openings extend above the BFE, alternatives to satisfy the requirements include:

- Raise the floor of the enclosure to be at or above the BFE, perhaps by using a thicker slab, resulting in no need for openings. Although this alternative satisfies the construction requirement, for NFIP flood insurance rating purposes, the top of the slab is the elevation of the lowest floor, not the next higher floor (see the text box “Interior Grade or Floor above BFE” in Section 8.3.1).
- Install openings as close to grade (or floor) as possible to maximize the open area available for inflow and outflow of floodwater (see Figure 16). The total net open area of the openings must be based on the enclosed area even if some portion of the opening is above the BFE.

NFIP ELEVATION CERTIFICATE AND SHALLOW FLOODING

The NFIP Elevation Certificate requires users to input the number of flood openings within 1.0 foot above the adjacent grade or floor. The certificate does not require users to determine how much of a flood opening is above or below the BFE.

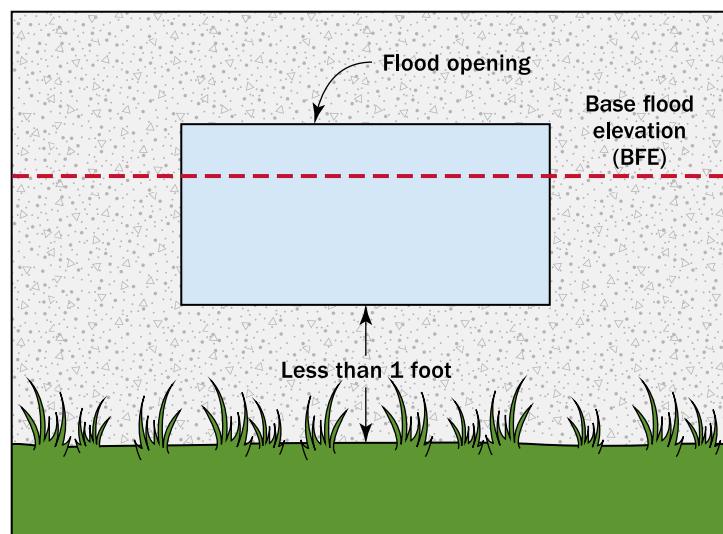


Figure 16: Bottom of the flood opening positioned as close as possible to grade (or floor) when any portion of the opening extends above the BFE