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MIDWEST FLOODS of 2008 & IN IOWA & WISCONSIN

2 Floodplain Management Regulations, Building Codes, and Standards

This chapter discusses the floodplain management regulations, building codes, and standards adopted and enforced by the communities in Iowa and Wisconsin that were studied by the MAT. These codes and standards enable communities to manage risk through adopting and enforcing regulations.

The floodplain management regulations applicable to the areas affected by the Midwest floods of 2008 are discussed in Section 2.1. Section 2.2 presents the building codes used to regulate construction. Building code requirements specific to floods are discussed in Section 2.3. Sections 2.4 and 2.5 discuss building standards used to regulate construction. Section 2.6 discusses how to reduce flood losses through the use of International Codes. Floodplain management performance issues observed by the MAT are presented in Section 2.7.

2.1 Floodplain Management Regulations

The NFIP minimum floodplain management regulations are set forth in Title 44, Parts 59 and 60, of the Code of Federal Regulations (44 CFR §59 and 60). The key objectives of 44 CFR §59 and 60 are to reduce the risk of flood loss and minimize the impact of floods on human health, safety, and welfare.

NFIP floodplain management requirements coupled with strong building codes and development requirements can minimize flood damages, save property owners significant dollars in the long term, and reduce social disruptions and injuries. NFIP floodplain requirements form the basis of a community’s efforts to guide development in flood hazard areas. These requirements are incorporated into a community’s floodplain management ordinance. The NFIP requirements pertaining to building standards have been integrated into national consensus standards, national building codes and state building codes that are adopted by communities. Figure 2-1 illustrates how NFIP regulations interact with building codes to affect building design in communities with adopted building codes. All of the communities visited by the MAT have adopted floodplain management regulations that meet or exceed the minimum NFIP requirements.

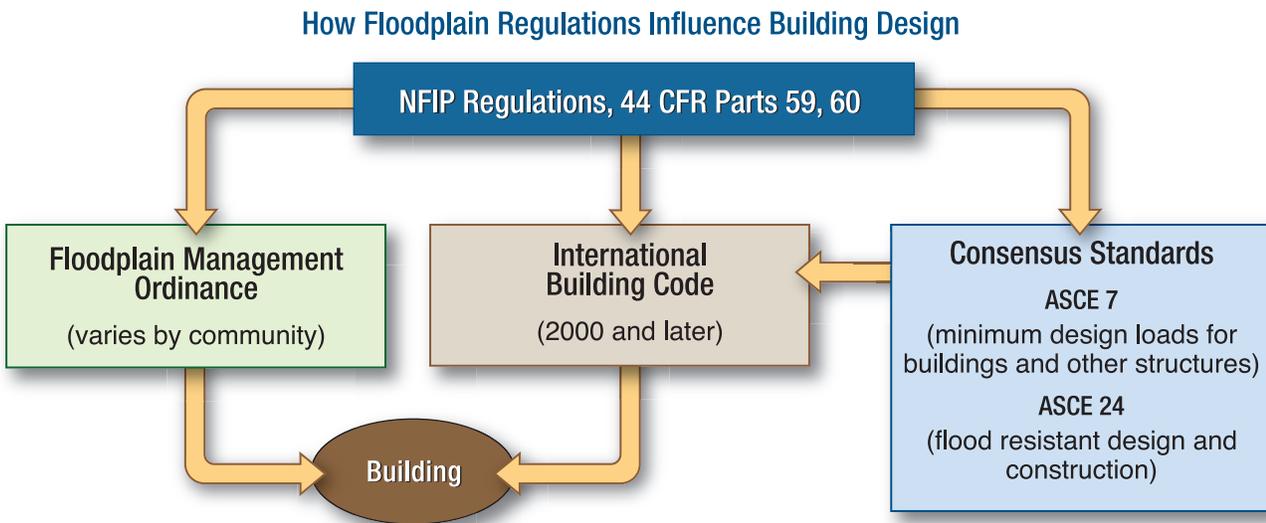


Figure 2-1. Floodplain management regulations and building design in communities with adopted building codes

2.1.1 Iowa Floodplain Management Regulations

Iowa has required permits for development in floodplains since 1965. The Legislature of the State of Iowa has in Chapter 335, Code of Iowa, as amended, delegated the power to communities to enact zoning regulations to secure safety from flood and to promote health and the general welfare. Therefore, the Iowa Department of Natural Resources (DNR) can delegate authority to a community to issue permits in the SFHA if the community has a detailed Flood Insurance Study (FIS) and is capable of exercising that authority. In communities without the delegated permit authority, all development in the SFHA requires a permit from the Iowa DNR in addition to the local permit. There are currently 595 Iowa communities with identified SFHAs.

Of these, only 136 have delegated permit authority from Iowa DNR. Projects that require a hydraulic analysis (bridges, dams, etc.) require an Iowa DNR permit prior to the granting of a local permit.

The Iowa DNR regulations require that new or substantially improved structures be elevated with the lowest floor 1 foot above the 1-percent-annual-chance flood elevation. Also, the Iowa DNR requires new or substantially improved buildings that are considered to be critical (such as hospitals and other medical care facilities; buildings containing documents, data, or instruments of high public value; buildings containing materials dangerous to the public; fuel storage facilities; etc.) to be elevated 1 foot above the 0.2-percent-annual-chance flood elevation.

Iowa Floodplain Management Regulations are available via the Iowa Legislature Search: <http://search.legis.state.ia.us/NXT/gateway.dll?f=templates&fn=default.htm>

2.1.2 Wisconsin Floodplain Management Regulations

The floodplain management regulations in Chapter NR 116 of the Wisconsin Administrative Code, which have been in force since 1968, are more stringent than the minimum NFIP floodplain management requirements. Wisconsin's floodplain management regulations prohibit building structures in, on, or over floodway areas if the structure is designed for human habitation. Only structures that are associated with open space use and low flood damage potential are allowed in the floodway. These low flood damage potential structures, however, are still subject to NFIP encroachment analyses and are not allowed if the project will increase flood elevations upstream or downstream by 0.01 foot or more. By contrast, minimum NFIP floodplain management requirements allow the construction of residential structures within the regulatory floodway as long as the Base (1-percent-annual-chance flood) Flood Elevation (BFE) is not increased by the construction.

According to section 116.15(3) of Wisconsin's floodplain management regulations, no modifications or additions to any buildings located in the floodway fringe are allowed unless: 1) a permit, special exception, conditional use, or variance has been granted, and 2) the modification or addition is placed on fill or is floodproofed and in compliance with section 116.13(2) of Wisconsin's floodplain management regulations.

An addition to an existing room in a nonconforming building or a building with a nonconforming



DEFINITION

A **regulatory floodway** is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations. For streams and other watercourses where FEMA has provided BFEs, but no floodway has been designated, the community must review floodplain development on a case-by-case basis to ensure that increases in water surface elevations do not occur, or identify the need to adopt a floodway if adequate information is available.



DEFINITIONS

In areas that fall within the 1-percent-annual-chance floodplain, but are outside the floodway (termed the **floodway fringe**), development will, by definition, cause no more than a 1.0-foot increase in the 1-percent-annual-chance water-surface elevation. Floodplain management through the use of the floodway concept is effective because it allows communities to develop in floodprone areas if they so choose, but limits the future increases of flood hazards to no more than 1.0-foot.

The Wisconsin Department of Natural Resources defines a **nonconforming building** as an existing lawful building that is not in conformity with the dimensional or structural requirements of the floodplain zoning ordinance for the area of the floodplain which it occupies.

Dry land access is defined as a vehicular access route above the regional flood elevation connecting floodway development in the floodplain to land outside the floodplain.

The term **regional flood** refers to a flood determined to be representative of large floods known to have occurred in Wisconsin or that may be expected to occur on a particular lake, river, or stream once in every 100 years, on average.

use may be allowed in the floodway fringe area on a one-time basis only if: 1) the addition has been granted by a permit, special exemption, conditional use or variance, 2) the addition does not exceed 60 square feet in area, and 3) the addition is 50 percent of the present assessed value of the building.

Wisconsin's requirements for new and substantially improved structures in the floodway fringe are more restrictive than those of the NFIP. The NFIP requires that new or substantially improved structures in the floodway fringe must be elevated to or above the BFE; however, Wisconsin requires 2 feet of freeboard above the BFE and dry land access for all new and substantially improved floodway fringe structures.

For development in a Zone A (an area subject to inundation by the 1-percent-annual-chance flood event where detailed hydraulic analyses have not been performed and no BFEs have been determined), the NFIP requires communities to obtain, review, and reasonably utilize BFE data and floodway data from a federal, state, or other source. However, the Wisconsin DNR regulations require an approved engineering study (in which BFEs, floodway, and floodway fringe are determined) before building permits can be issued in all SFHAs, including Zone A.

The Wisconsin DNR requires that development in a Zone A not cause an obstruction to flow or storage capacity of the floodplains and that any rise in BFEs be less than 0.01 foot. This regulation is more stringent than the corresponding minimum

NFIP regulation, which allows a rise of no more than 1 foot, when developing in the floodplain (44 CFR §60.3[d] [10]). The Wisconsin DNR regulation significantly restricts any development within a SFHA designated as Zone A.

Wisconsin Floodplain Management Regulations are available online at <http://www.legis.state.wi.us/rsb/code/nr/nr116.pdf>

2.1.3 NFIP Participation and Community Rating System

All of the communities in Iowa and Wisconsin studied by the MAT participate in the NFIP and have adopted floodplain management regulations that meet or exceed minimum NFIP requirements. One of the 17 communities visited in Iowa, and one of the 21 communities visited in Wisconsin participate in the NFIP's Community Rating System (CRS) and range from Class 6 to Class 10. These two communities conduct floodplain management activities beyond the minimum requirements of the NFIP.

Des Moines, in Polk County, Iowa, participates in the CRS program and has a CRS rating of 7. Examples of the floodplain management regulations implemented by Des Moines to earn this CRS status include:

- 1-foot freeboard requirement with new construction
- Substantial improvement regulations, which do not allow any additions to a structure in the floodplain that would increase the total square footage of the structure by 25 percent
- Protecting sanitary sewer systems from the 1-percent-annual-chance flood. Sanitary sewer systems must be watertight or located on higher ground than the BFE.
- All new construction should have dry land access during the 1-percent-annual-chance flood event
- Open space credits for any open spaces in the SFHA (such as parks, natural preserves, etc.) that prohibit construction of structures

The NFIP's CRS is a voluntary incentive program that recognizes community floodplain management activities that exceed the NFIP requirements. CRS classifications range from 1 to 10, with 1 representing the most active and the most flood hazard-resistant communities. For CRS-participating communities, flood insurance premium rates are discounted in increments of 5 percent. Thus, a class 1 community receives a 45-percent premium discount, while a class 9 community receives a 5-percent discount (a class 10 receives no discount). The CRS classifications for communities are based on 18 creditable activities, organized under 4 categories: (1) public information, (2) mapping and regulations, (3) flood damage reduction, and (4) flood preparedness. Of the more than 900 communities nationwide that participate in the CRS, over 90 percent have a rating of 7, 8, or 9.

Elm Grove, in Waukesha County, Wisconsin, also participates in the CRS program and has a CRS status of 6. Examples of the floodplain management regulations implemented by Elm Grove to earn this CRS status include:

- 2-foot freeboard requirement with new construction
- Cumulative substantial damage/improvement—a regulation that cumulatively sums the damage/improvements over the life of a structure and requires compliance with the floodplain management regulations once the substantial damage/improvement threshold is reached
- All flammable explosive and chemical substances should be out of the floodplain (elevated or relocated)
- All weather access—any new roads built need to be above the BFE

- Acquisition mitigation regulations – the acquisition of floodprone structures
- Open space credits for any open spaces in the SFHA (such as parks, natural preserves, etc.) that inhibit construction of structures



DEFINITIONS

Pre-FIRM buildings are those built before the effective date of the first FIRM for a community. This means they were built before detailed flood hazard data and flood elevations were provided to the community and usually before the community enacted comprehensive floodplain management regulation.

Post-FIRM buildings are new construction and structures built after the effective date of the first FIRM for a community.

Coralville, in Johnson County, Iowa, had once participated in the CRS program, but due to a violation of the NFIP requirements, the CRS rating was changed to a 10. A CRS rating of 10 is equivalent to communities that are part of the NFIP, but do not participate in the CRS program.

Tables 2-1 and 2-2 show the NFIP emergency and regular entry dates and effective FIRM date for each of the communities visited by the MAT in Iowa and Wisconsin.

Table 2-1. NFIP Status for Iowa Communities Visited by the MAT

Jurisdiction	NFIP Emergency Entry Date	NFIP Regular Entry Date	Effective FIRM Date
Benton County	N/A	09/10/08	06/03/08
Vinton	07/18/74	03/02/81	06/03/08
Black Hawk County	10/20/75	11/17/82	11/17/82
Cedar Falls	07/23/71	02/01/85	02/01/85
La Porte City	02/02/76	01/02/81	03/16/04
Waterloo	05/07/71	07/03/85	07/03/85
Bremer County	08/12/90	07/16/90	03/04/08
Waverly	05/02/75	03/02/81	03/04/08
Buchanan County	12/17/90	09/01/91	07/16/08
Independence	09/24/71	05/16/77	07/16/08
Butler County	07/05/94	11/06/00	11/06/00
Clarksville	10/28/85	09/06/89	09/06/89
New Hartford	11/06/74	09/29/86	09/29/86
Shell Rock	10/01/91	05/01/92	07/05/01

Table 2-1. NFIP Status for Iowa Communities Visited by the MAT (continued)

Jurisdiction	NFIP Emergency Entry Date	NFIP Regular Entry Date	Effective FIRM Date
Johnson County	08/01/79	08/19/85	02/16/07
Coralville	08/23/74	09/29/78	02/16/07
Iowa City	02/04/72	05/02/77	02/16/07
Linn County	01/05/79	12/15/82	12/15/82
Cedar Rapids	08/13/71	12/15/82	12/15/82
Palo	06/25/76	11/17/82	11/17/82
Louisa County	10/16/74	06/01/87	02/06/91
Columbus Junction	07/29/76	02/06/91	02/06/91
Oakville	08/05/75	08/01/86	02/06/91
Polk County	09/06/78	03/01/84	03/01/84
Des Moines	09/06/74	02/04/81	07/15/88
Story County	06/01/78	06/01/83	02/20/08
Ames	07/24/74	01/02/81	02/20/08

SOURCE: NFIP, CRS, CIS

Table 2-2. NFIP Status for Wisconsin Communities Visited by the MAT

Jurisdiction	NFIP Emergency Entry Date	NFIP Regular Entry Date	Effective FIRM Date
Columbia County	07/31/75	04/15/80	04/02/08
Wisconsin Dells	07/17/75	12/18/84	06/17/08
Crawford County	03/19/71	04/20/73	05/18/00
Gays Mills	04/12/73	06/15/78	03/05/90
Soldiers Grove	04/09/71	04/03/84	03/05/90
Jefferson County	04/02/71	09/29/78	10/16/84
Jefferson	04/23/71	05/26/72	08/01/84
Fort Atkinson	11/13/70	08/06/71	06/01/84
Juneau County	07/03/75	09/18/91	09/18/91
Wonewoc	07/18/75	09/30/88	09/18/91
Lafayette County	03/10/72	09/15/78	11/05/03
Darlington	08/18/72	09/15/78	11/05/03
Milwaukee County	N/A	12/01/78	09/26/08
Milwaukee	01/30/74	03/01/82	11/19/08
Wauwatosa	02/12/74	12/01/78	09/26/08

Table 2-2. NFIP Status for Wisconsin Communities Visited by the MAT (continued)

Jurisdiction	NFIP Emergency Entry Date	NFIP Regular Entry Date	Effective FIRM Date
Richland County	06/16/75	09/27/91	09/27/91
Viola	12/05/74	06/04/90	06/04/90
Rock County	02/08/74	08/01/83	08/19/08
Janesville	03/26/71	03/31/72	08/19/08
Sauk County	09/07/73	09/17/80	03/07/01
Baraboo	06/01/73	08/01/79	03/07/01
La Valle	03/05/75	09/19/84	03/07/01
North Freedom	04/22/75	09/19/84	03/07/01
Reedsburg	05/21/75	03/04/85	03/07/01
Rock Springs	04/30/75	09/18/85	03/07/01
Spring Green	08/27/75	02/01/86	03/07/01
Vernon County	09/01/72	09/29/78	11/16/90
La Farge	05/08/75	11/16/90	11/16/90
Waukesha County	05/25/73	08/01/83	11/19/08
Elm Grove	05/01/75	07/19/82	11/19/08

SOURCE: NFIP, CRS, CIS

2.2 Building Codes

Model building codes include provisions pertaining to anticipated hazards such as wind, seismic, snow, and flood loads, as well as soil conditions. When a model building code, such as the 2006 International Building Code (IBC) or the 2006 International Residential Code for One- and Two-family Dwellings (IRC), is adopted by a jurisdiction, it is a legal document that provides regulations for the construction of buildings.

The IBC is considered a performance-based model code with limited prescriptive-based requirements. The IRC is considered a prescriptive-based model code with some performance-based code requirements. Performance-based codes state the intended functional result of a code requirement, separate the intent from the means of compliance, and identify tools and methodologies to evaluate the functional result. Prescriptive-based codes contain descriptions of the requirements that have been empirically derived utilizing the accumulated judgment of a group of experts or by actual field experience.

Both the IBC and IRC refer to standards, such as *Minimum Design Loads for Buildings and Other Structures* (ASCE 7) and *Flood Resistant Design and Construction* (ASCE 24), in order to maintain

a specific level of performance throughout the building codes. The reference standard ASCE 7, which is briefly described in Section 2.4, specifies the structural load requirements for design and includes means for determining dead, live, soil, flood, snow, and earthquake loads. The reference standard ASCE 24, which is briefly described in Section 2.5, provides minimum requirements for flood-resistant design and construction of structures located in flood hazard areas. The IBC and IRC are consistent with the minimum provisions of the NFIP that pertain to design and construction of buildings.

2.2.1 Iowa Building Codes

The majority of municipalities in Iowa have adopted either the 2003 or 2006 editions of the IBC and IRC. Other communities in Iowa have adopted alternative building codes such as the 1997 Uniform Building Code (UBC). A few communities in Iowa have not yet adopted commercial and residential building codes. Table 2-3 shows adopted codes for the municipalities in Iowa that were visited by the MAT. Flood requirements from the IBC and IRC are discussed in detail in Sections 2.3.1 and 2.3.2.

Copies of the 1997 UBC, 2006 IBC, and 2006 IRC are available through the ICC website at <http://www.iccsafe.org/>.

Copies of ASCE 7 and ASCE 24 can be obtained from the American Society of Civil Engineers (ASCE) website at <https://www.asce.org>. (Note: These are referred to as “ASCE 7-05” and “ASCE 24-05” when the reference is to the specific version updated in 2005.)

The Wisconsin Uniform Dwelling Code (UDC) is available at <http://www.legis.state.wi.us/rsb/code/comm/comm020.html>.

The Wisconsin Commercial Building Code (CBC) is available at <http://www.legis.state.wi.us/rsb/code/comm/comm060.html>.

Table 2-3. Commercial and Residential Building Codes Adopted in Iowa

Location	Commercial Building Code	Residential Building Code
Benton County		
Unincorporated Areas	No Building Codes	No Building Codes
Vinton	IBC 2006	IRC 2006
Blackhawk County		
Unincorporated Areas	IBC 2003	IRC 2003
Cedar Falls	IBC 2003	IRC 2003
La Porte City	UBC 1997	UBC 1997
Waterloo	IBC 2003	IRC 2003
Bremer County		
All Areas	IBC 2006	IRC 2006
Waverly	IBC 2006	IRC 2006
Buchanan County		
Unincorporated Areas	No Building Codes	No Building Codes
Independence	IBC 2003	IRC 2003

Table 2-3. Commercial and Residential Building Codes Adopted in Iowa (continued)

Location	Commercial Building Code	Residential Building Code
Butler County		
Unincorporated Areas	No Building Codes	No Building Codes
Clarksville	No Building Codes	No Building Codes
New Hartford	No Building Codes	No Building Codes
Shell Rock	No Building Codes	No Building Codes
Johnson County		
All Areas	IBC 2006	IRC 2006
Coralville	IBC 2006	IRC 2006
Iowa City	IBC 2006	IRC 2006
Linn County		
Unincorporated Areas	IBC 2006	IRC 2006
Cedar Rapids	IBC 2006	IRC 2006
Palo	IBC 2006	IRC 2006
Louisa County		
Unincorporated Areas	No Building Codes	No Building Codes
Columbus Junction	No Building Codes	No Building Codes
Oakville	No Building Codes	No Building Codes
Polk County		
Unincorporated Areas	IBC 2006	IRC 2006
Des Moines	IBC 2006	IRC 2006
Story County		
Unincorporated Areas	No Building Codes	No Building Codes
Ames	IBC 2006	IRC 2006

2.2.2 Wisconsin Building Codes

Wisconsin has adopted a statewide building and residential code. All communities must comply with the Wisconsin Uniform Dwelling Code (UDC) for residential construction and the Wisconsin Commercial Building Code (CBC) for commercial construction. The purpose of the Wisconsin UDC is to establish uniform statewide construction standards and inspection procedures for one- and two-family dwellings and manufactured dwellings. The purpose of the Wisconsin CBC is to protect the health, safety, and welfare of the public by establishing minimum standards for the

design, construction, maintenance, and inspection of public buildings, including multi-family dwellings and places of employment. The Wisconsin CBC is similar to the 2006 IBC, but has revisions that apply solely to the State of Wisconsin. The Wisconsin CBC does not explicitly address flood design and flood load regulations. Flood requirements from the Wisconsin UDC and the Wisconsin CBC are discussed in detail in Sections 2.3.3 and 2.3.4.

2.3 Flood Requirements in Building Codes

In order to make federally backed flood insurance available in a community, the community must adopt and enforce floodplain management regulations that meet or exceed the minimum requirements of the NFIP. One way for communities to regulate new or substantially improved structures in mapped flood hazard areas is by adopting building codes such as the IBC, IRC, and the International Existing Building Code (IEBC) (referred to collectively as the I-Codes). These codes, in particular, contain provisions that are consistent with the minimum flood-resistant design and construction requirements of the NFIP.

2.3.1 Flood Requirements in the 2006 International Residential Code

The IRC applies to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, removal, and demolition of detached one- and two-family dwellings and townhouses not more than three stories above grade in height with a separate means of egress, and their accessory structures. The IRC provides minimum requirements to safeguard the public safety, health, and general welfare through structural strength, means of egress, facilities, stability, sanitation, light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment.

In terms of flood-resistant construction, buildings and structures constructed in flood hazard areas should be designed and constructed in accordance with Section R324 of the IRC. Section R324 discusses flood provisions for:

- Structural systems (R324.1.1)
- Flood-resistant construction (R324.1.2)
- Establishing the design flood elevation (R324.1.3)
- Lowest floor elevations (R324.1.4)
- Protection of mechanical and electrical systems (R324.1.5)
- Protection of water supply and sanitary sewage systems (R324.1.6)
- Flood-resistant materials (R324.1.7)
- Manufactured housing (R324.1.8)
- Elevation requirements (R324.2.1)
- Enclosed areas below design flood elevations (R324.2.2)
- Foundation design and construction (R324.2.3)
- Flood hazard areas (R324.2)
- Coastal high-hazard areas (R324.3)

When a residential structure is being constructed in a flood hazard area, construction documents should include the delineation of flood hazard areas, design flood elevation, and all proposed floor elevations depending on the flood zone in which the residential structure is being constructed (R106.1.3).

2.3.2 Flood Requirements in the 2006 International Building Code

The IBC is applied to multi-family and non-residential structures. This code applies to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures. A portion of the IBC discusses construction within flood hazard areas.

The IBC explains how to establish flood hazard areas for a community (Section 1612.3). A community/municipality must first adopt a flood hazard map and supporting data for the area in question. This map should include SFHAs identified by the FEMA FIS.

In terms of flood-resistant construction, buildings and structures constructed in flood hazard areas should be designed and constructed in accordance with the following sections of the IBC:

- Accessibility (1107.7.5)
- Elevation certificate (109.3.3)
- Existing structures (3403.1, 3407.2, 3410.2.4.1)
- Flood loads (1602.1, 1603.1, 1612, 3001.2, 3102.7)
- Flood resistance (1403.5, 1403.6)
- Flood-resistant construction (Appendix G)
- Grading and fill (1803.4, 1807.1.2.1)
- Interior finishes (801.1.3)
- Site plan (106.2)
- Ventilation, under floor (1203.3.2)

Codes and regulations regarding design and construction in flood hazard areas are not thoroughly explained in the IBC; however, they are incorporated through reference by appropriate engineering standards such as ASCE 7 and ASCE 24. IBC Sections 1203.3, 1612.4, 1612.5, 3001.2, G103.1, G401.3, and G401.4 require flood-resistant design and construction to comply with requirements in ASCE 24-05.

For construction in SFHAs that is not subjected to high-velocity wave action, regulations regarding openings in walls and the equalization of hydrostatic forces should be in accordance with Section 2.6.2.1 and 2.6.2.2 of ASCE 24-05 respectively. Dry floodproofing non-residential buildings should be documented to show that regulations conform to ASCE 24-05.

2.3.3 Flood Requirements in the Wisconsin Uniform Dwelling Code

The Wisconsin UDC is a uniform statewide code that sets minimum standards for fire safety; structural strength; energy conservation; erosion control; heating, plumbing, and electrical systems; and general health and safety in new dwellings. The Wisconsin UDC covers one- and two-family housing units that have been built since June 1, 1980, and their additions or alterations. For residential homes that were built before June 1, 1980, the state does not have specific building codes. For older residential homes, the municipality may adopt any or no code. If a code is adopted, and a portion of the house is modified, remodeled, or there is new construction, that part of the home must adhere to the code adopted by the municipality.

The Wisconsin UDC has a minimal amount of information regarding flood-resistant construction. It does, however, provide regulations with regard to constructing in the SFHA. All new construction in the floodway fringe must be elevated so that the lowest floor and all basement floor surfaces are located at or above the BFE. Additionally, the Wisconsin DNR requires that any increase in the flood elevation caused by development in the floodway fringe be less than or equal to 0.01 foot, based on a comparison of existing and proposed conditions, as discussed in Section 2.1.2 above.

According to the Wisconsin UDC, Section 21.33, a certified dry-floodproofed basement may be placed no more than 5 feet below the BFE if an engineer has designed it to be watertight and impermeable. The certified dry-floodproofed basement does not have any limitations regarding occupancy. After Section 21.33, the Wisconsin UDC states that the Wisconsin DNR and FEMA have applicable regulations and guidelines for basements built below the BFE. Section NR 116.13 (2) (a) of the Wisconsin DNR states that

...an exception to the basement requirement may be granted by the department, but only in those communities granted such exception by the Federal Emergency Management Agency (FEMA) on or before [the effective date of this rule].

Enclosed spaces that are not certified dry-floodproofed may be used as spaces for means of egress, entrance foyers, stairways, or storage for incidental and mobile items. These fully enclosed spaces must be designed to allow the hydrostatic pressure to equalize on both sides of an exterior wall by allowing the entry and exit of floodwaters. In order to effectively accomplish this and in accordance with the NFIP minimum floodplain management standards as set forth in 44 CFR §60.3(c) (5), the following design criteria must be met:

- There must be a minimum of two openings on different sides of each enclosed area. If a building has more than one enclosed area, each area must have openings on exterior walls to allow floodwater to directly enter and exit.
- The total area of all openings must be at least 1 square inch for each 1 square foot of enclosed area.
- The bottom of each opening can be no more than 1 foot above the adjacent grade.
- Louvers, screens, or other opening covers must not block or impede the automatic flow of floodwaters into and out of the enclosed area and the cross-sectional area of such screens and louvers must be deducted from the opening's net area.

Other important regulations regarding construction in the floodplain found in the Wisconsin UDC include the following:

- For new construction, a registered land surveyor, architect, or engineer must certify the actual elevation in relation to the mean sea level of the lowest structural member required to be elevated by the provisions in the Wisconsin UDC.
- The structural systems of all residential structures must be designed, connected, and anchored to resist flotation, collapse, or permanent lateral movement due to structural loads and stresses at the BFE.
- All electrical and mechanical equipment must be placed above the BFE or be designed to prevent contact with the equipment in case of a flood up to the BFE.
- Areas below the BFE need to be constructed using flood-resistant materials and methods designed to minimize flood and water damage.
- The Wisconsin DNR floodplain ordinance requires contiguous dry land access from a structure to land outside of the floodplain.

The Wisconsin UDC does not reference floodplain requirements from codes and standards such as IBC 2006, ASCE 7-05, and ASCE 24-05. Instead, the Wisconsin UDC references Chapter NR 116 of Wisconsin's Floodplain Management Program. Section NR 116.16 states:

When floodproofing measures are required by either a municipal floodplain zoning ordinance or some other regulation which incorporates by reference the floodproofing requirements of this chapter, such measures shall be designed to withstand the flood depths, pressures, velocities, impact and uplift forces and other factors associated with the regional flood, to assure that the structures are watertight and completely dry to the flood protection elevation without human intervention during flooding.

Therefore, additional flood protection is required by the local floodplain management ordinance for Wisconsin.

2.3.4 Flood Requirements in the Wisconsin Commercial Building Codes

The Wisconsin CBC is similar to the IBC; however, it includes amendments specific to the State of Wisconsin. The four major differences for flood requirements between the two codes are related to flood design, flood loads, flood hazard areas, and grading/fill in flood hazard areas.

The Wisconsin CBC does not explicitly address:

- Flood design to be included in the construction documents (IBC 1603.1.6).
- Flood load (hydrostatic, high velocity, and wave loads) regulations (IBC 1612).
- Grading and fill in flood hazard areas from the IBC (IBC 1803.4).
- Floodproofing in flood hazard areas (IBC 1807.1.2.1).

Although the Wisconsin CBC does not explicitly state how full protection is provided to buildings located in SFHAs, it is accomplished by the use of notes explaining that the regulations and standards of other state agencies will apply to commercial buildings. Since the Wisconsin DNR's floodplain management regulations are mandated by the state, both the Wisconsin CBC and NR 116 must be followed. (See the NR 116 excerpt at the end of Section 2.3.3.)

2.4 Flood Requirements in ASCE 7-05

ASCE 7-05 provides minimum load requirements for the design of buildings and other structures. It discusses the provisions that should be applied to buildings and other structures located in areas prone to flooding as defined on a FEMA flood hazard map. Since 1995, ASCE 7 has included flood load provisions. The following sections of ASCE 7-05 address flood loads.

- Section 2.3 (*Load Combinations*, including different load combinations for Zone V and Coastal Zone A)
- Section 5.3 (*Design Requirements*, which covers design loads, erosion and scour, and loads on breakaway walls)
- Section 5.4 (*Flood Loads*, which covers hydrostatic, hydrodynamic, wave, and impact loads, and load criteria for breakaway walls)

The IBC references the ASCE 7-05 standard only when discussing dry floodproofing. It defines dry floodproofing as a combination of design modifications that results in a building or structure, including the attendant utility and sanitary facilities, being watertight with walls substantially impermeable to the passage of water and with structural components having the capacity to resist loads as identified in ASCE 7-05.

The IRC does not explicitly refer to ASCE 7-05; however, the IRC has adopted ASCE 7-05 by reference, meaning that flood loads must be considered for buildings following the IRC. The Wisconsin UDC and Wisconsin CBC do not refer to this standard.

2.5 Flood Requirements in ASCE 24-05

ASCE 24-05 provides minimum requirements for flood-resistant design and construction of structures that are subject to building code requirements and that are located in whole or in part in flood hazard areas. The first edition of ASCE 24 was published in 1998 and is referenced in the 2000 and 2003 editions of the IBC. The 2005 edition is a major revision and expansion of the standard, which is referenced in the 2006 IBC. The IBC states: "The design and construction of buildings and structures located in flood hazard areas, including flood hazard areas subject to high-velocity wave action, shall be in accordance with ASCE 24-05."

ASCE 24-05 specifies minimum requirements for flood-resistant design and construction of buildings and structures located in flood hazard areas, including floodways, coastal high-hazard areas, and other high-risk flood hazard areas such as alluvial fans, flash flood areas, mudslide areas,

erosion-prone areas, and high-velocity areas. The basic design requirements that are addressed in ASCE 24-05 are:

- Flood loads (references ASCE 7-05)
- Load combinations (references ASCE 7-05)
- Elevation of the lowest floor
- Foundation requirements and geotechnical considerations
- Use of fill
- Anchoring and connections

Materials, wet and dry floodproofing, utility installations, building access, and miscellaneous construction provisions are also included in sections of ASCE 24-05. In addition, ASCE 24-05 includes specifications for the design of pile, post, pier, column, and shear wall foundations. Considerable detail is specified for pilings as a function of pile types and connections.

The IRC, Wisconsin UDC, and Wisconsin CBC do not refer to ASCE 24-05. These codes are prescriptive and do not require specific designs for buildings that are constructed in agreement with the code.

2.6 Reducing Flood Losses Through the International Codes (FEMA 9-7032)

With the publication of the I-Codes, the opportunity exists for communities to integrate building safety and floodplain management. In cooperation with the ICC, FEMA produced the guide *Reducing Flood Losses through the International Codes: Meeting the Requirements of the National Flood Insurance Program* to help communities decide how best to accomplish that integration in order to initiate or continue participation in the NFIP. The guide also includes detailed comparisons of the NFIP regulations and the flood resistant provisions of the I-Codes. It should be noted that this publication is neither a code nor standard.

2.7 NFIP and State Floodplain Management Regulations and Performance Issues

The MAT noted several building design issues that were associated with NFIP and state floodplain management regulations. These building design issues dealt with basements, foundation and enclosure wall openings, substantial improvements, and dry-land access requirements. The subsections below help explain these regulations. Specific examples of these performance issues are discussed in Chapter 3 of the MAT report.

2.7.1 Basements

According to NFIP requirements, a basement is defined as any area of the building having its floor below ground level on all sides. NFIP regulations require that the lowest floor of a residential structure, including basement, built within the SFHA be at or above the BFE (44 CFR §60.3[c][2]).

As noted in section 2.3.3, basements below the BFE, where the placement of engineered earthen fill was not used, are allowed only in communities that have obtained a basement exception from FEMA. Buildings with floodproofed basements must have their design certified by a registered engineer or architect and are more difficult and more expensive to construct than buildings elevated above the BFE. As of this date, only 54 communities nationwide are approved for residential basement exceptions, including Clive, Independence, and La Porte City in Iowa and Allouez, Ashwaubenon, Brown County, Depere, Green Bay, Howard, and Shiocton in Wisconsin.

The MAT visited properties in La Porte City, Iowa, to observe basement construction in a basement-exception community and noted good examples of properly floodproofed basements that performed well during the flood (Chapter 3, Figure 3-43). The MAT also observed pre-FIRM structures with basements that experienced basement wall collapse due to hydrostatic forces (Chapter 3, Figure 3-21).

2.7.2 Foundation and Enclosure Wall Openings

NFIP regulations require that foundation and enclosure walls subject to the 1-percent-annual-chance flood contain openings designed by a registered professional so as to permit the automatic entry and exit of floodwaters. These openings allow floodwaters to reach equal levels on both sides of the walls and thereby lessen the potential for damage from hydrostatic pressure. The requirement for openings applies to all new and substantially improved buildings in Zone A and is detailed in FEMA Technical Bulletin 1 (August 2008). NFIP regulations (44 CFR §60.3[c][5]) state that a community shall:

Require, for all new construction and substantial improvements, that fully enclosed areas below the lowest floor that are usable solely for parking of vehicles, building access, or storage in an area other than a basement and which are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters.

The MAT observed several examples of improper construction of flood openings in Iowa, particularly among new construction and recently completed elevations. In some cases, flood openings were too high, or opening sizes were inadequate in relation to the square footage of the structure. The MAT also observed cases where openings appeared to be blocked by finished materials, such as drywall, indicating a possible compliance issue with both flood opening requirements and the requirements for areas below the BFE. Finished materials blocking flood openings may indicate a conversion of lower level areas into habitable space, a violation of the NFIP regulations. Chapter 3, Figure 3-50, shows a newly elevated house, located in the SFHA, with inadequately sized vents, approximately 3 feet above grade.

2.7.3 Substantial Improvement

NFIP regulations (44 CFR §60.3) define substantial improvement as:

Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the “start of construction” of the improvement. This term includes structures which have incurred “substantial damage,” regardless of the actual repair work performed. 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 alterations of a “historic structure,” provided that the alteration will not preclude the structure’s continued designation as a “historic structure.”

Floodplain management requirements for new construction apply to substantial improvements. Increased Cost of Compliance coverage is available only on a structure that the community has determined is substantially damaged due to flooding.

There may be some cases where, in addition to repairs to damaged buildings, property owners may also want to make improvements, such as building a room addition onto the structure. It is likely that many flood-damaged homes in heavily impacted areas will require substantial improvement to make them habitable. Communities need to evaluate such proposals to determine whether the combined work (repairs and improvements) is a substantial improvement. The enforcement of proper codes and NFIP requirements will be crucial in protecting these structures in the future.

2.7.4 Dry Land Access Requirement

Wisconsin regulations require dry land access to development within the floodway fringe. According to Wisconsin State Statute NR 116.13, both residential and commercial development within the floodway fringe must be elevated to or above the regional flood height and have dry land access to the principal structure. Certain commercial yards, parking lots, and other accessory structures not connected to the principal structure may be below the regional flood height and not require dry land access; however, they should not be inundated more than 2 feet or subjected to velocities greater than 2 feet per second during the occurrence of the regional flood.

Figure 2-2 shows a house and driveway in Edgerton, Wisconsin, that was elevated on fill approximately 2 feet above the BFE. Figure 2-3 shows the location and BFE (784 feet) of the structure on a FIRM. This house is an example of a location that met the dry land access requirement from the Wisconsin State Statute NR 116.13.



Figure 2-2.
Elevated house and
driveway on fill
(Dane County, Wisconsin)

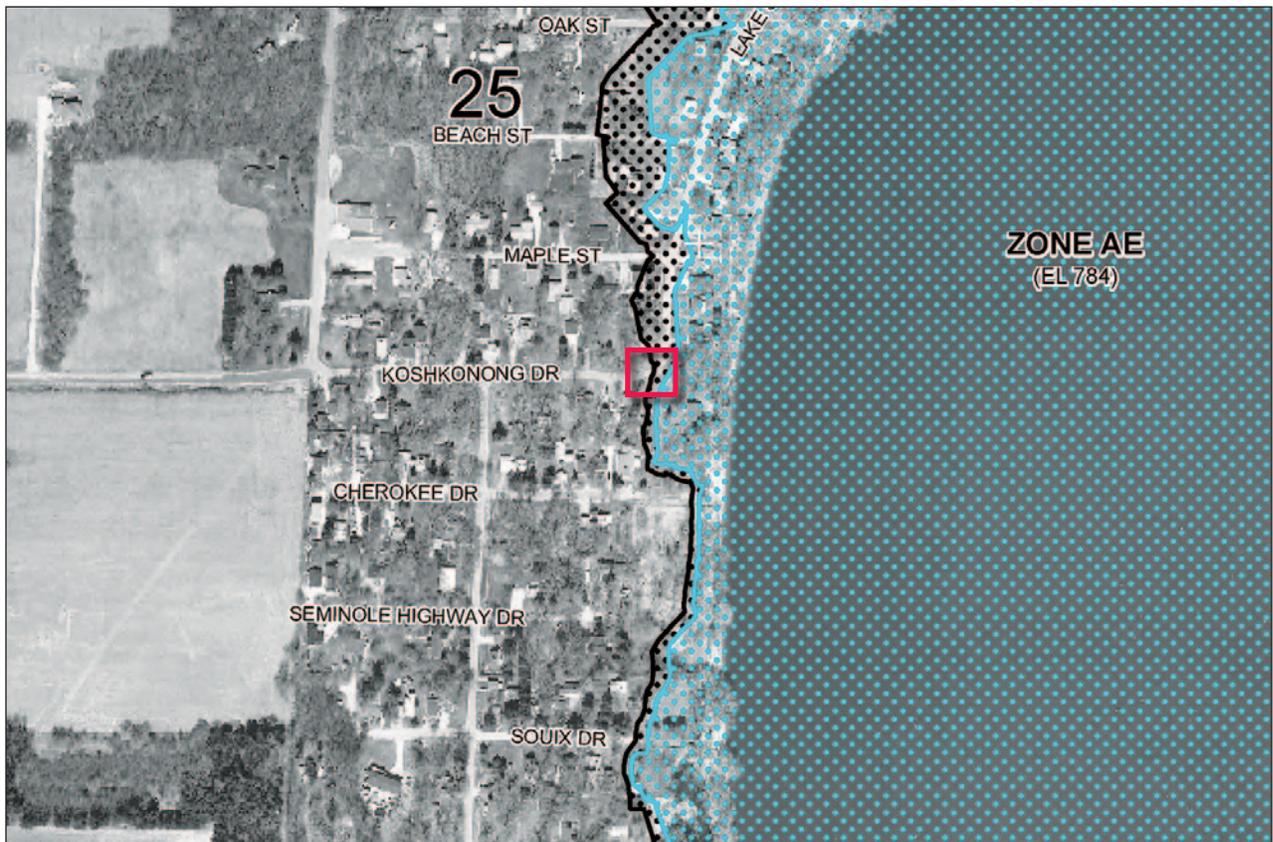


Figure 2-3. Location of elevated house

SOURCE: DANE COUNTY, WISCONSIN, FLOOD INSURANCE RATE MAP

