Resilient Building Codes Toolkit

Webinar 2: A Practitioner's Guide

May 19, 2022

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

LISC

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Agenda

- Welcome
- How This Fits with CDBG-DR Funding and Support
- Building Code Considerations for Each Hazard
  - Wind
  - Flooding – coastal & inland
  - Wildfire
  - Extreme temperatures
- Increasing Resilience and Solving for Challenges in Codes
- Summary and Upcoming Webinar

Resilience & mitigation requirements of the Consolidated Notice

As HUD CDBG-DR grantees, it is important to understand the resilience and mitigation requirements of the Consolidated Notice.

Relevant sections include:

- Mitigation Measures **(II.A.2.b)**
- Resilience Performance Metrics **(II.A.2.c)**
- Green and Resilient Standard for New Construction and Reconstruction of Housing **(II.B.2.a)**
- Elevation standards for new construction, reconstruction, and rehabilitation of substantial damage, or rehabilitation resulting in substantial improvements **(II.B.2.c)**
- Elevation of nonresidential structure **(II.C.2)**
- Resilience Planning (Action Plan for Disaster Recovery Waiver and Alternative Requirement) **(III.C.1.i)**
- Alternative requirement for the elevation of structures when using CDBG–DR funds as the non-Federal match in a FEMA-funded project **(III.F.6.)**

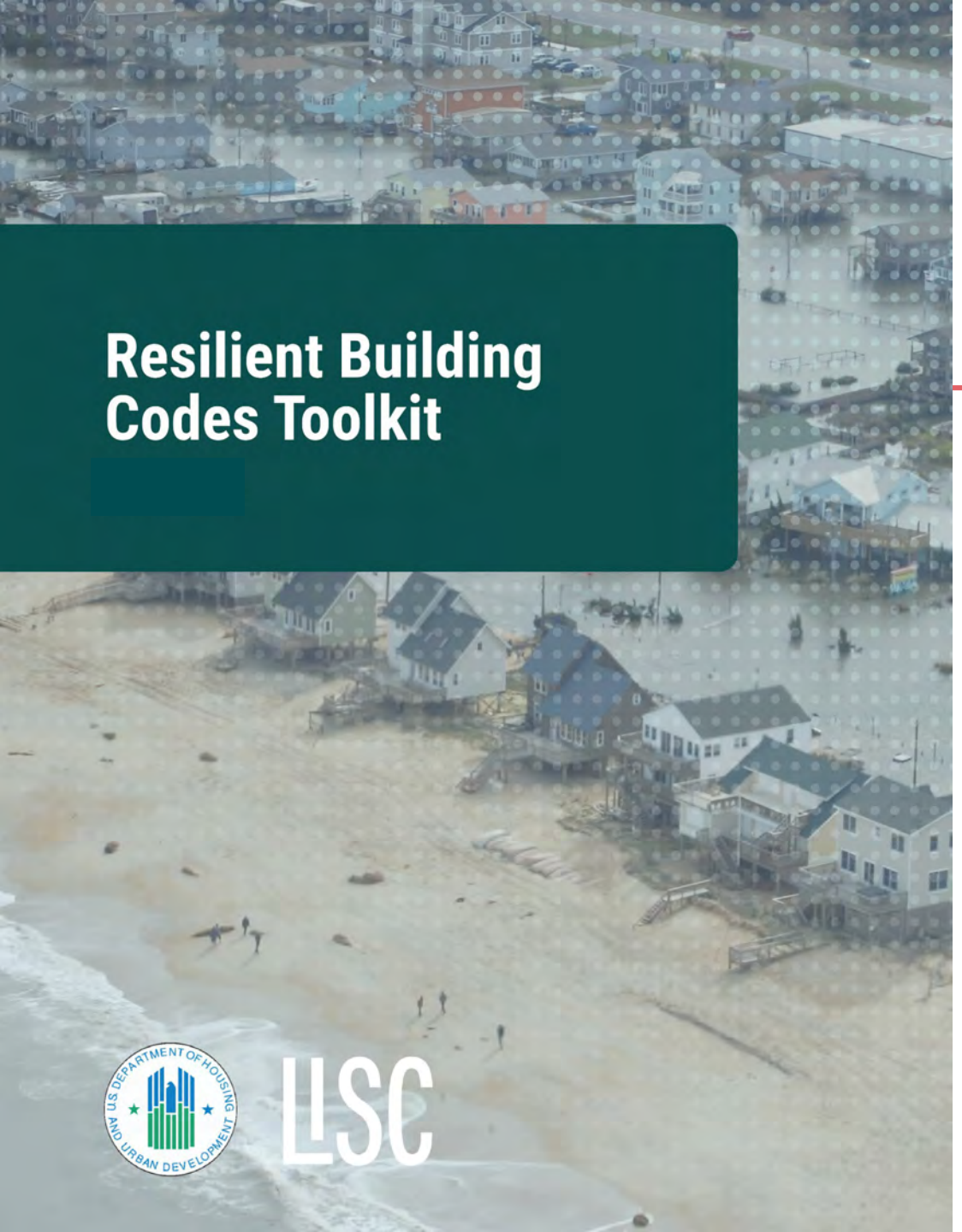
Learning objectives for this webinar

Participants will:

Learn current building code provisions for each hazard (wind, flooding, wildfire, and extreme temperatures)

Become familiar with common challenges and suggested solutions at the practitioner level

Learn beyond-code best practices to account for climate risk



Resilient Building Codes and CDBG-DR Funding

This Toolkit aims to help CDBG-DR and CDBG-MIT grantees understand the value of rebuilding to more resilient codes and higher standards.

The Toolkit:

- makes the business case for resilient codes,
- outlines the local and state processes that grantees can expect to undertake to upgrade their codes, and
- delineates how resilient codes can address different natural hazards

What this Toolkit contains

1. BUSINESS CASE OVERVIEW
2. NARRATIVE
3. CHECKLIST
4. STATE-BY-STATE GOVERNANCE SUPPLEMENTAL
5. STATE-BY-STATE PROCESS SUPPLEMENTAL
6. TECHNICAL APPENDIX

Welcome

Conduct a poll to understand who is in the room:

1. Elected official
2. Municipal employee
3. CDBG-DR grantee
4. HUD employee
5. Other public sector employee
6. Grant writer
7. Consultant
8. Other private sector

A Practitioner's Guide

Building code considerations by hazard

Relationship between building codes and other codes

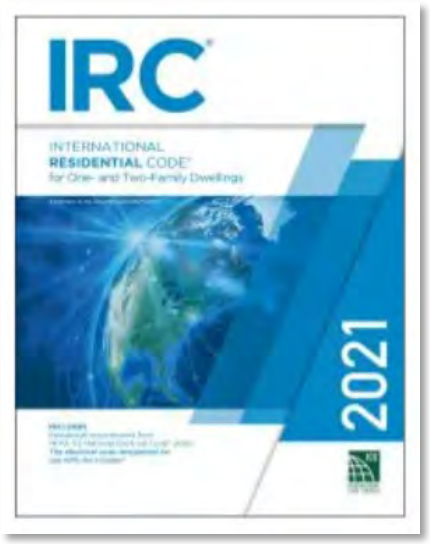
reference

OTHER CODES AND STANDARDS
International Fire Code
International Mechanical Code
International Plumbing Code
International Wildfire Urban Interface Code
International Existing Building Code
International Energy Conservation Code
Uniform Mechanical Code
Uniform Plumbing Code
National Electric Code
ACEC 7 (wind)
ACEC 24 (flooding)
ASHRAE 90.1 (heating and cooling considerations)
NFPA (fire safety)

Each state further filters these to determine which parts of the codes they adopt, amend, or choose to do neither

Residential properties and building codes

Includes residential: multifamily homes, with three or more dwellings

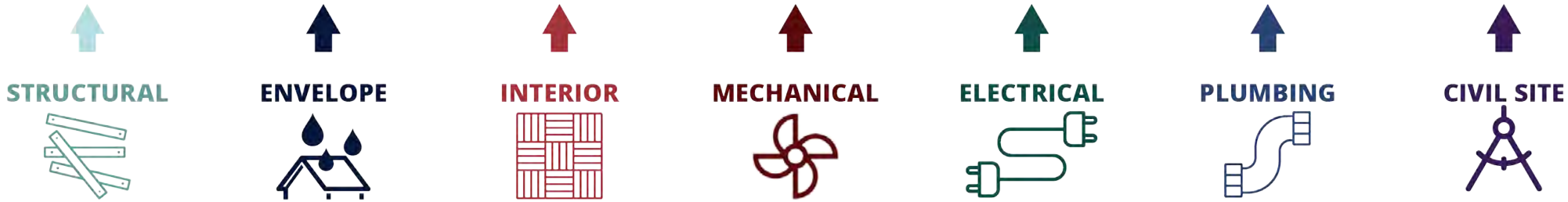


Residential: one- and two-family dwellings only

Same applicability as IBC

Referenced building codes and standards

REFERENCED CODES AND STANDARDS							
FLOOD	ASCE 24			IMC, UMC	NEC	IPC, UPC	ASCE 24
FIRE	Int. WUIC, NFPA 1140	Int. WUIC, NFPA 1140	NFPA 1140	Int. WUIC, NFPA 1140	NEC, NFPA 1140		Int. WUIC, NFPA 1140, IFC
TEMP		ASHRAE 90.1, IECC	ASHRAE 90.1, IECC	ASHRAE 90.1, IECC	ASHRAE 90.1, IECC	ASHRAE 90.1, IECC	
WIND	ASCE 7	ASCE 7					



Note: NFPA 1141 and NFPA 1144 have been incorporated into NFPA 1140, Standard for Wildland Fire Protection.

Understanding geographies

Which area do you work in?

1. Northeast
2. Mid-Atlantic
3. Southeast
4. Midwest
5. Northwest
6. West coast
7. Southwest
8. Puerto Rico
9. Nationally
10. Not listed

Wind

Winds associated with severe thunderstorms account for 50 percent of all damage in severe weather-related events in the US and are more common than tornadoes.

Roofs are especially prone to damage during these events, and wind-borne debris is a concern for all aspects of the house. In areas of tornadoes, storm shelters are common places of refuge although they may not be specifically required by code.


Dave Brenner flickr.com/photos/davebrenner/6988616867

Wind

Find the windspeeds in your community

ASCE 7 Hazard Tool
https://asce7hazardtool.online

Wind – beyond code

FORTIFIED Wind standards require roofs to be structurally tied to the building in ways that minimize their likelihood of being lifted off and damaged during significant wind events.

Taken post-Hurricane Sally in Alabama, this photo illustrates the difference in resilience between the FORTIFIED roof and traditional builds.

At that time, Alabama had 16,000 IBHS FORTIFIED roofs, all of which withstood the winds of Hurricane Sally.

Source: "Alabama's nation-leading 16,000 Fortified roofs held up well to Hurricane Sally." September 27, 2020.

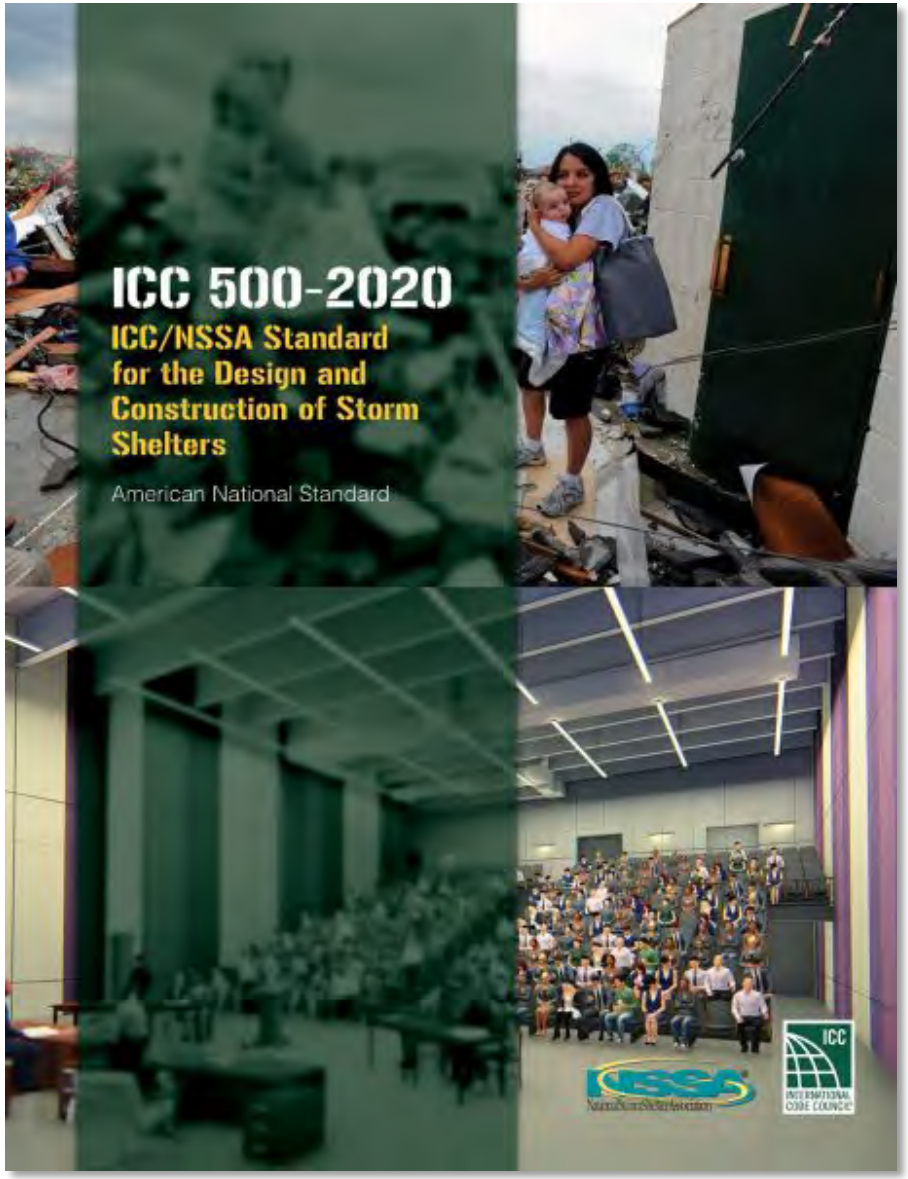
Wind – beyond code

What resources exist for tornado resilient building codes?

Storm shelters are a viable solution for people living in tornado-prone areas.

ICC/NSSA 500 Standard for the Design and Construction of Storm Shelters

Some states, like Alabama, have mandated the 2014 ICC/NSSA-500 Standard for certain building types and uses, and could be a good model for other states and communities looking to do the same.



Wind – pending changes

ENR
Engineering News-Record

April 13, 2022

Tornado Load Standard Advances Toward Inclusion in 2024 Model Building Code

A proposal to incorporate the first U.S. guidance on tornado-resistant design into the model 2024 International Building Code passed the ICC's structural committee by a vote of 14-0, at recent model code hearings in Rochester, N.Y.

Work on the tornado loads in Chapter 32 of the American Society of Civil Engineers/Structural Engineering Institute's 2022 edition of its bible on design loads, ASCE/SEI 7-22, began in 2014.

Chapter 32 provides guidance on how to resist less powerful but more frequent twisters. It applies only to buildings located in the tornado-prone region of the U.S., which is primarily the area east of the Continental Divide in the contiguous U.S. This guidance covers buildings classified as essential, such as hospitals, or representing a substantial hazard to human life in the event of failure, such as places of public assembly and schools.

LISC

Wind – current code requirements

ITEMS ADDRESSED BY THE IRC

Where windborne debris protection is required

- Requirements for storm shelter information on documents submitted for permit
- Protection of openings by requiring assemblies to pass missile tests in windborne debris regions
- Requirements for alternate protection using wood panels
- Roofing materials designed to resist high wind forces
- Roofing attachment requirements for high wind areas
- Design of structure to resist high wind forces (wall construction, anchorage details, etc.)
- Reference to ICC 500, ICC/NSSA, 2020, Standard for the Design and Construction of Storm Shelters
- References to several standards and the IBC for high wind area design options

Wind – current code requirements

(IRC continued)

Special requirements apply to the design of buildings where the ultimate design wind speed exceeds 140 mph and the building is located in a special wind region as determined by the jurisdiction. The requirements apply to items such as attachment of the structure to the foundation, attachment of the roof to the walls, connections of the roof system members, etc.

The designer has the option of designing to one of several codes/standards as follows.

1. AWC Wood Frame Construction Manual (WFCM)
2. ICC Standard for Residential Construction in High-Wind Regions (ICC 600)
3. ASCE Minimum Design Loads for Buildings and Other Structures (ASCE 7)
4. AISI Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings (AISI S230)
5. International Building Code

Wind – current code requirements

IBC – similar requirements as IRC with following nuances:

Requirements for storm shelters in emergency operations facilities and education occupancies. Storm shelter construction and location

Reference to ICC 600, 2020, Standard For Residential Construction In High-wind Regions

Wind

Modifications to code requirements for commercial buildings (IBC)

Subject	Code section	2012	2015	2018	2021
Storm shelters	423	No change	Adds buildings/occupancies where required	Adds occupant load provisions	Updates occupancy and occupant load provisions
Building wind resistance	1600	No change	Updated wind speed maps	Additional wind speed maps provided	Updated and simplified wind speed maps
Wind load calculations	1600	No change	Updated calculation methods	No change	Updated calculation methods
Storm shelters	1604	Adds section indicating seismic loads and uses regardless of wind loads in some cases	No change	Added detail on shelter design loads; occupancy risk category	No change
Roofing materials attachment	1500	No change	More stringent requirements	Addresses metal roof shingles	No change
Roofing accessory attachment	1500	Attachment requirements for metal edges	No change	No change	Attachment requirements for gutter systems
Aggregate and ballast	1500	Aggregate/ballast not allowed in some conditions	No change	No change	Aggregate allowed in all conditions with parapets as indicated.

Wind

Modifications to code requirements for residential buildings (IRC)

Subject	Code section	2012	2015	2018	2021
Windows and sliding doors	609	No change	Allows comparative analysis for different sizes than those tested	No change	No change
Exterior openings with glazing	609	No change	No change	Testing requirements for impact protection	No change
Garage doors	609	No change	No change	No change	Testing requirements for wind pressure
Soffits	704	No change	No change	No change	Requirements for soffit uplift and nailing
Photovoltaic shingles	905	No change	Additional requirements for high wind and wind resistance	No change	No change
Photovoltaic systems	907	No change	New requirements for roof-mounted systems	No change	Consolidated with 324
Photovoltaic panel systems	909	No change	New requirements for roof-mounted systems	No change	Consolidated into 324

Flood

Cost of flood damage to homes will increase 61 percent in 30 years

Roughly 4.3 million homes concentrated in Florida, California, South Carolina and Texas have a substantial risk of sustaining economic damage from flooding this year.

Source:
https://www.reuters.com/business/environment/cost-flood-damage-us-homes-will-increase-by-61-30-years-2021-02-22/

Oliver Rich flickr.com/photos/casualcapture/8135798807

Flood

Challenge: The code often references outdated, historical data to inform design.

Solution: Using future climate projection data in designs will accommodate how precipitation and flooding patterns may shift over the expected life cycle of the asset.

The Climate Toolbox

FIRST STREET FOUNDATION

The Climate Explorer

Sea Level Rise Viewer

Flood

Challenge: Fire safety codes can prohibit the installation of fuels on top of the roof. This can be an issue if back-up generators and fuel tanks are located in areas of projected flooding.

Solution: Above-ground tanks can be elevated on foundations designed to resist the forces associated with flooding. Installing tanks within vaults with access openings above the design flood elevation is another option.

In coastal high hazard areas and coastal "A Zones," the only option is to locate the tank above the design flood elevation on a foundation designed to resist flood loads, wave action and potentially impact from floating debris.

For below-ground tanks, flood-related loads are required to consider the potential eroded ground elevation. Below-ground tanks are not allowed to be located under elevated structures or attached to structures at elevations below the design flood elevation.

When determining the forces on tanks for the design of foundations and the tanks, the potential flood-related forces (loads) acting on tanks needs to be increased by 50 percent for both below-ground and above-ground tanks.

Flood

Challenge: A strict reading of ADA and egress codes could restrict the use of perimeter flood barriers.

Solution: Accessibility codes do not apply to one- and two-family dwellings which allows flexibility in how egress is maintained.

For other buildings, accommodations can be provided to make travel over the barriers accessible or delay installation of gates in the barrier until egress is completed. Some alternatives may require approval by local authorities.

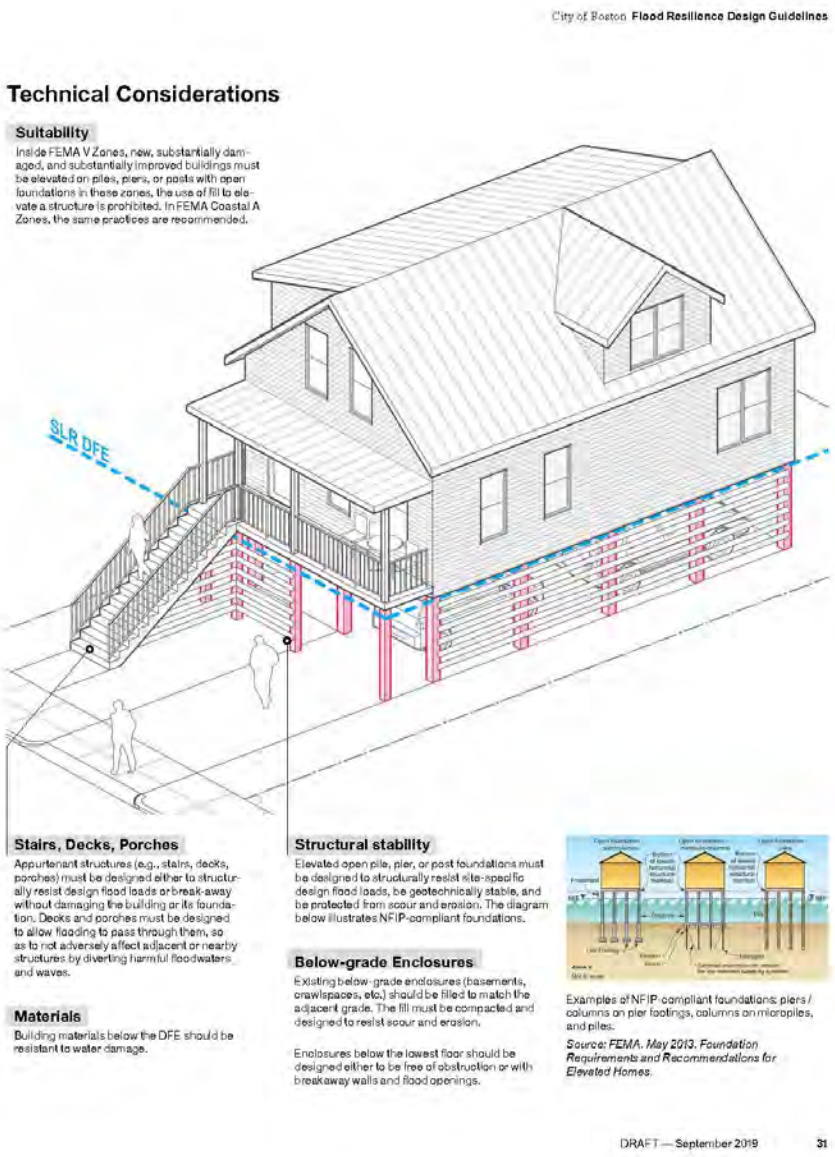
Flood

Challenge: Building codes focus on the particular asset where a community-based approach may be more effective and economical in addressing flood risk.

Solution: It may be beneficial to work in parallel with the local boards to create zoning ordinances and overlays to address the land use and modification opportunities that fall more within the planning realm than the code realm.

Flood

Local initiatives can use a combined approach of land use, zoning, and local code development and enforcement to incentivize the adoption of resilient building practices – in both new and existing structures



City of Boston **Flood Resilience Design Guidelines**

Technical Considerations

Suitability

Inside FEMA V Zones, new, substantially damaged, and substantially improved buildings must be elevated on piles, piers, or posts with open foundations in these zones, the use of fill to elevate a structure is prohibited. In FEMA Coastal A Zones, the same practices are recommended.

SLR DFE

Stairs, Decks, Porches

Appurtenant structures (e.g., stairs, decks, porches) must be designed either to structurally resist design flood loads or break-away without damaging the building or its foundation. Decks and porches must be designed to allow flooding to pass through them, so as to not adversely affect adjacent or nearby structures by diverting harmful floodwaters and waves.

Materials

Building materials below the DFE should be resistant to water damage.

Structural stability

Elevated open pile, pier, or post foundations must be designed to structurally resist site-specific design flood loads, be geotechnically stable, and be protected from scour and erosion. The diagram below illustrates NFIP-compliant foundations.

Below-grade Enclosures

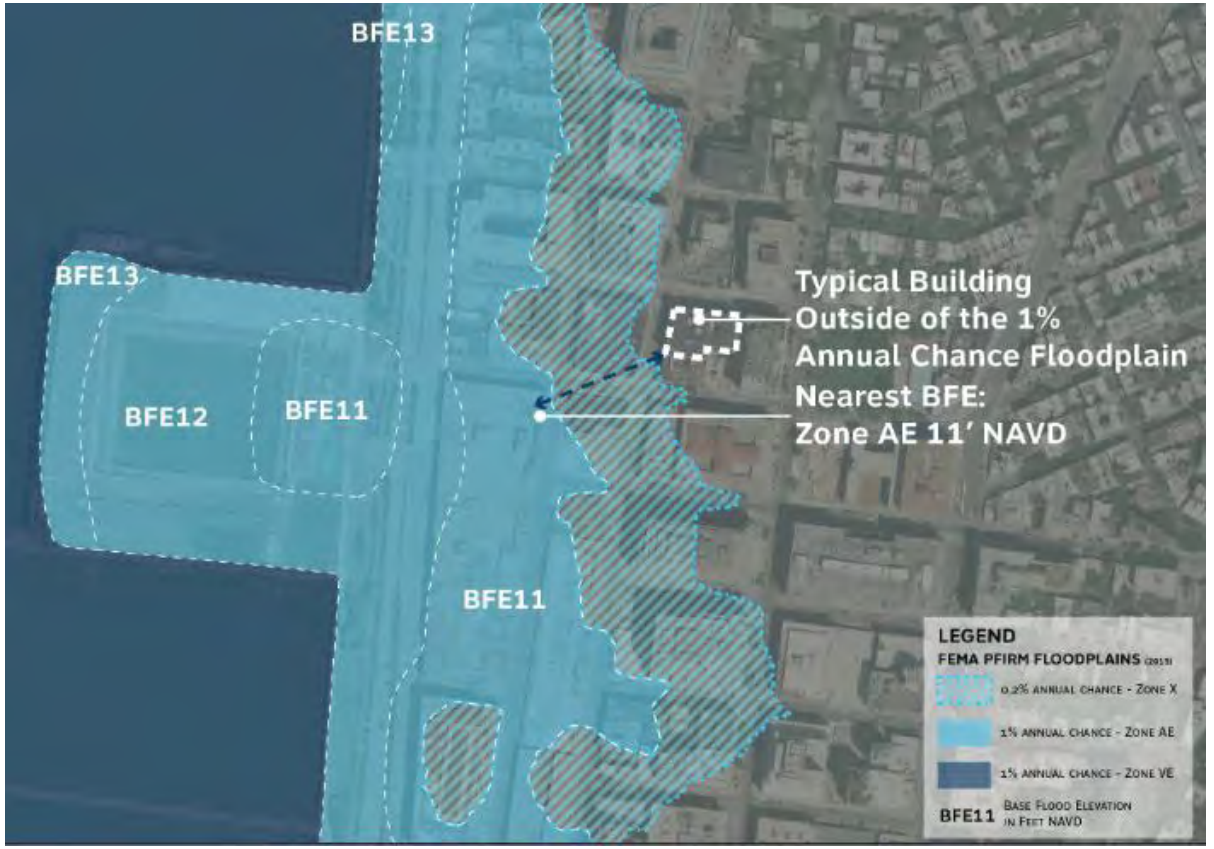
Existing below-grade enclosures (basements, crawlspaces, etc.) should be filled to match the adjacent grade. The fill must be compacted and designed to resist scour and erosion.

Enclosures below the lowest floor should be designed either to be free of obstruction or with breakaway walls and flood openings.

Examples of NFIP-compliant foundations: piers / columns on pier footings, columns on micropiles, and piles.

Source: FEMA. May 2013. Foundation Requirements and Recommendations for Elevated Homes.

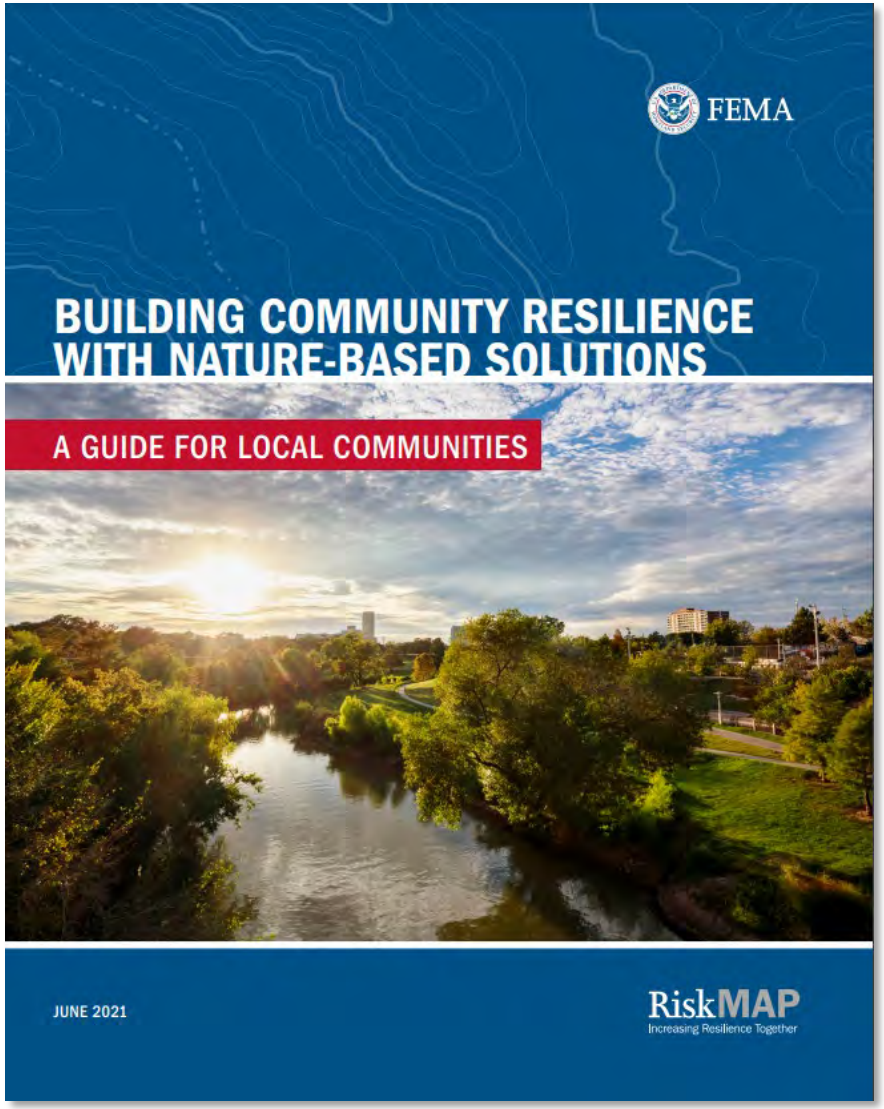
DRAFT — September 2019 31



Flood

Challenge: Nature-based solutions are less common than more traditional, engineering solutions. Owners, developers, and contractors can be hesitant to try something “new” or use technologies with fewer known applications.

Solution: If designed correctly, nature-based solutions can afford a greater resilience (including less costly maintenance, operational and replacement needs) than more traditional approaches. They often also require working across both building and zoning codes. There is a growing archive of successful NBS that practitioners can access to find the right fit.



Flood – beyond code

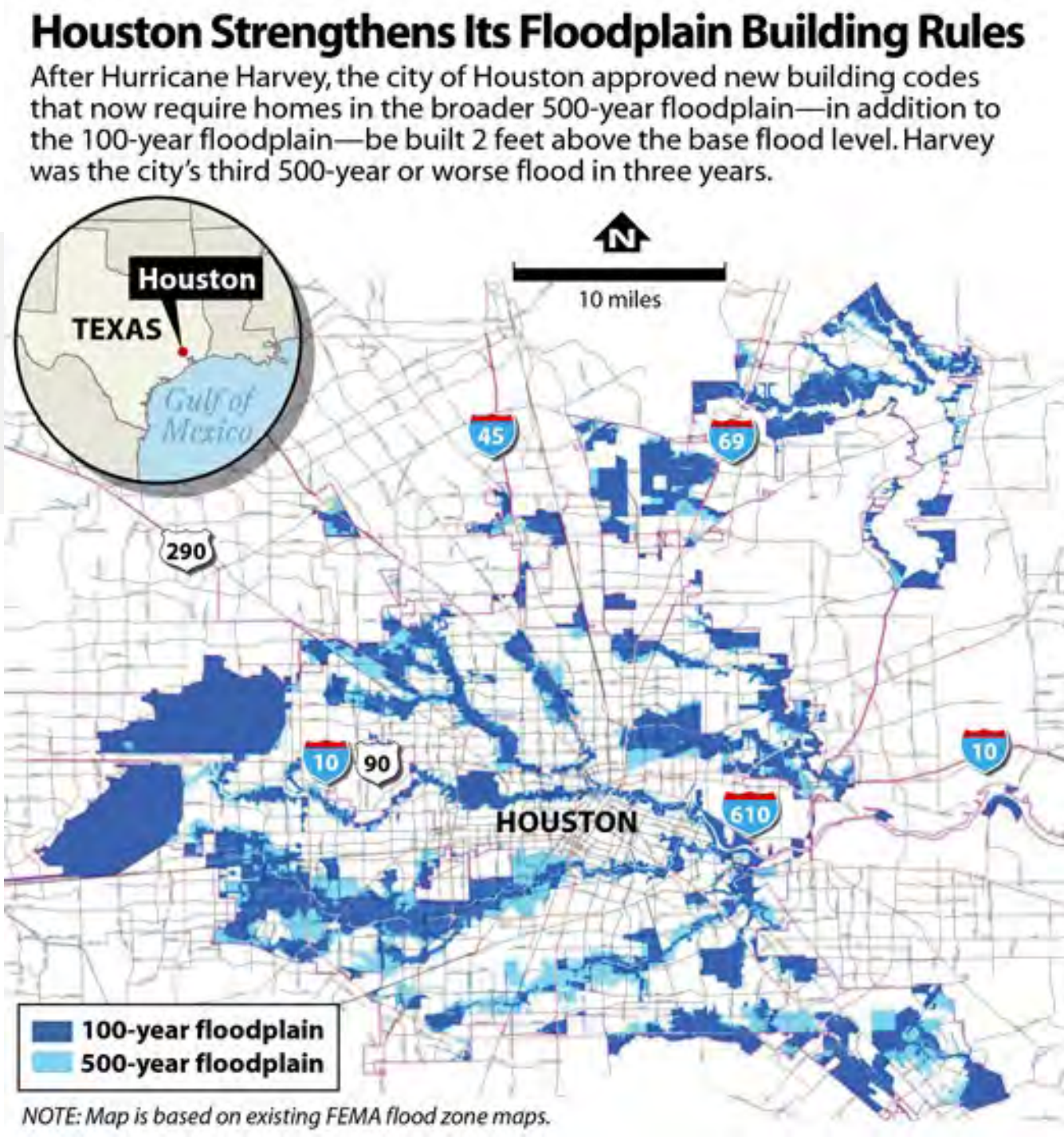
Representative adjacent single-family dwellings evaluated on concrete piles that survived the hurricane (Mexico Beach; unshaded Zone X)

The structure on the left was built in 2016 and is located in Zone X. The structure on the right was built in 2002, also in Zone X, but is located closer to the ocean.

Source: FEMA. Mitigation Assess Team Report. Hurricane Michael in Florida: Building Performance Observations, Recommendations, and Technical Guidance. February 2020.

Flood – beyond code

An estimated 84 percent of properties that flooded during Harvey would not have flooded if built to new building code standards



Flood – current code requirements

Items addressed by the IRC:

- Allows flexibility to grant modifications to requirements
- Requires use of flood hazard maps or to work with the building official to determine design flood elevations
- Documentation of flood related areas and elevations on site plans and building plans (lowest floor or lowest floor structure where wave action is possible)
- Addresses both new buildings and substantially renovated buildings (damaged or improved)
- Reference to ASCE 24*, Flood Resistant Design and Construction for buildings in floodways
- Allows conformance to ASCE 24 as an alternative to meeting IRC requirements
- Requirements for mechanical, electrical and plumbing systems related to location or protection

* HUD elevation standards may require a higher elevation than ASCE-24

Flood – current code requirements

IRC continued:

- Detailed requirements for design of buildings in high-hazard areas, "Coastal A" Zones and flood hazard areas
- Manufactured home's elevations, foundations, and anchorage
- Use limitations for spaces that are below or at base flood elevation
- Floodway analysis to demonstrate the work will not increase design flood elevations > 1 foot
- Flood hazard documentation as to how the buildings are designed to resist flooding
- Requirements for flood-damage-resistant materials for interior finishes and construction materials
- Existing building provisions (Appendix AJ, if adopted) refer to the provisions in the base code.

Flood – current code requirements

IBC requirements similar, nuances include:

- Flood structural loads for structures in flood hazard areas, coastal high hazard areas, and coastal A zones (IBC)
- Reference to ASCE 7, Minimum Design Loads for Buildings and Other Structures
- Appendix G (if adopted) contains management and administrative requirements in order to meet the National Flood Insurance Program
- Appendix J (if adopted) contains requirements associated with grading of sites.
- Requirements for flood-damage-resistant materials for interior finishes and construction materials
- Protection requirements for fire pumps
- Limitations on grading and fill
- Locations for emergency power equipment
- References to ASME A17.1, Safety Code for Elevators and Escalators, for vertical transportation equipment

Design and construction requirements – ASCE 24

- Dry floodproofing is not allowed in residential structures, residential portions of mixed-use structures or in Coastal High Hazard Areas and Coastal A Zones
- The lowest occupied floor is required to be elevated to or above the design flood elevation
- Foundations, piers, posts, columns, and piles need to be designed to resist hydrodynamic pressures, hydrostatic pressures, buoyancy, debris impact, and other loads such as soil and wind.
- If used, fill must be designed to be stable during all phases of flooding.
- The structure needs to be anchored and connected to the foundation elements to resist the effects of vertical loads, including uplift, and lateral loads.
- Interior and exterior finish and trim materials shall be flood damage resistant.

Design and construction requirements – ASCE 24

- Electric panelboards, disconnect switches and circuit breakers shall be located above the design flood elevation (DFE)
- Plumbing systems components that are below the design flood elevation are required to have backwater valves or backflow prevention devices.
- Mechanical system fuel supply lines require a float-operated, automatic shutoff valve arranged to operate when floodwaters exceed the design flood elevation. Ductwork either needs to be located above the DFE or designed to resist flood related loads and be waterproofed to prevent water from entering the ductwork.

Flood

Modifications to code requirements for commercial buildings (IBC)

Subject	Code section	2012	2015	2018	2021
Mechanical equipment in manufactured homes	Appendix G	No requirement	Required to be above design flood elevation	No change	No change
Use of alternate flood data	Appendix G	No requirement	No requirement	No requirement	Only if data has been submitted to FEMA and received approval
Floodplain administrator	Appendix G	No definition	No definition	No definition	Defines designated floodplain administrator
Water courses	Appendix G	No requirement	No requirement	Documentation maintenance requirements for officials increased	Change to floodplain administrator responsible for maintaining records

Flood

Modifications to code requirements for residential buildings (IRC)

Subject	Code section	2012	2015	2018	2021
Concrete slabs	322	No requirement	No requirement	New requirements for slabs subject to scouring/erosion	No change
Stairs and ramps	322	No requirement	No requirement	New requirements for options to resist or avoid flood loads	No change
Tanks	322	No requirement	New requirements for tank anchoring	No change	No change
Structure	322	No requirement	New requirement in Coastal Zone A for first floor horizontal structure to be 1 foot above base flood or design flood elevation	No change	No change
Openings	322	No change	Additional details with regard to openings serving areas below design flood elevation	No change	No change

Wildfire

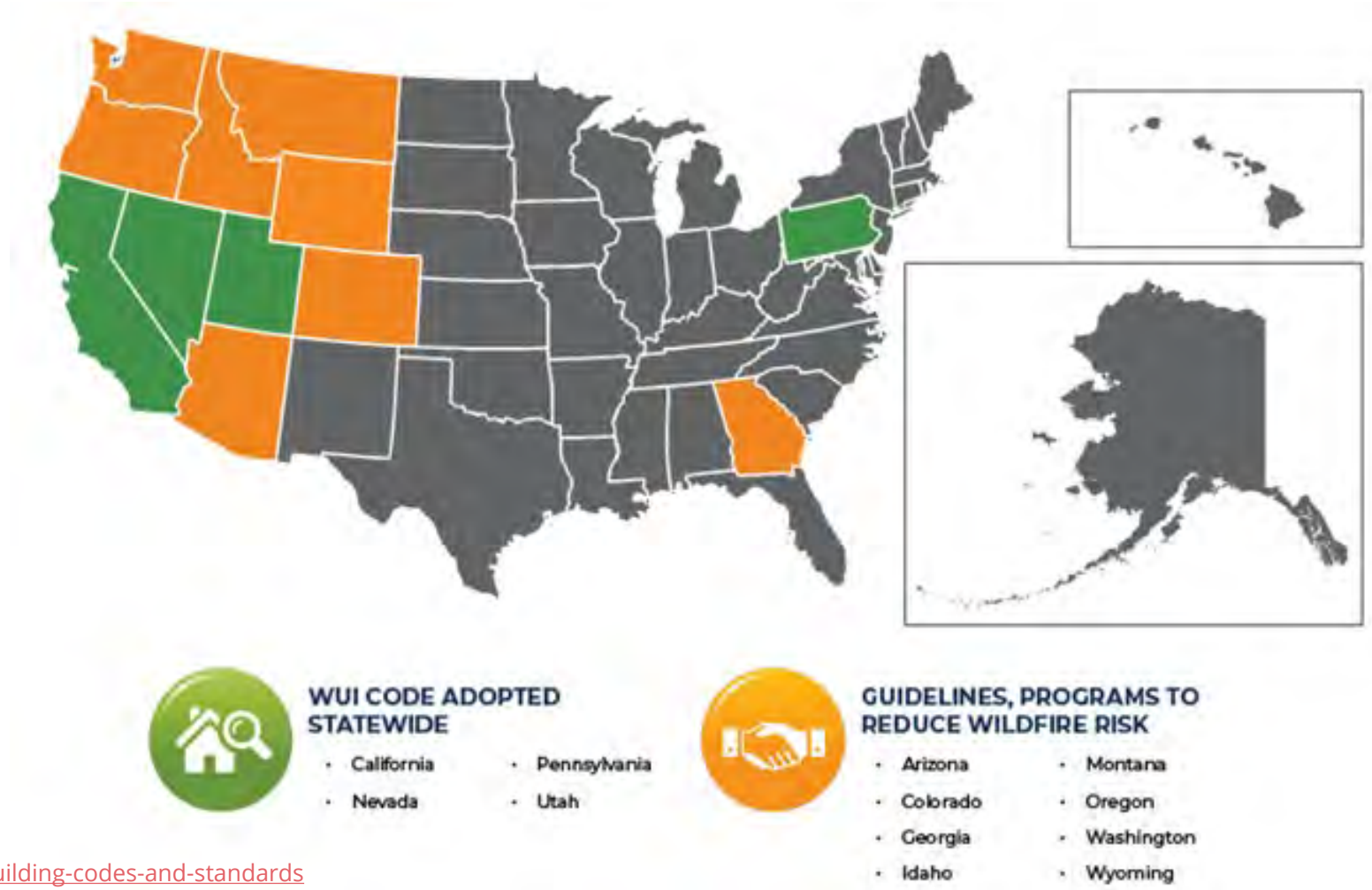
Since 1991, 19 disasters causing $1 billion or more in damage have been directly tied to wildfires.

The increase in fire risk has been tied to changes in climate, including a shift in the onset of peak wildfire season, and increased construction in the wildland urban interface (WUI).

Wildfire

Montana and Washington have since adopted 2018 IWUIC

Codes and programs by state



Source: https://ibhs.org/wildfire/wildfire-building-codes-and-standards

Wildfire

Wildfire-resistant building construction

Roofs
The best choice for roof covering material is Class A fire-rated roof covering. Look for a label that indicates the roof covering is tested and listed as Class A fire-rated roof covering.

Eaves, Soffits
Eaves and soffits are to be enclosed completely with noncombustible materials.

Gutters
Only noncombustible gutters that are equipped with covers are recommended.

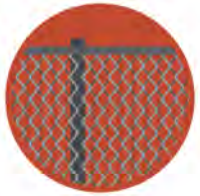
Vents
Vents in exterior walls should be a square no larger than 12 by 12 inches. All vents are to be covered with corrosion-resistant 1/8-inch mesh screens.

Exterior Wall Coverings/Siding
Exterior walls should be noncombustible materials such as concrete masonry blocks, stone, fire-retardant treated wood or any assembly that is laboratory-tested and labeled as 1-hour fire-resistance-rated.

Windows, Skylights
To reduce exposure, it is recommended double pane with tempered glass, glass blocks (windows only), or any glazing material that is tested and labeled as fire resistance-rated for at least 20 minutes be used.

Decks
Outdoor decks should be constructed with noncombustible materials or fire-retardant treated wood.

Vegetation
No vegetation or combustible material in the immediate area(5 ft) around the home. Keep vegetation and combustible material away from the perimeter of the building and at distances recommended by your Community Wildfire Protection Plan (create defensible space).



Fences
Install only noncombustible fences and gates.

Source: https://ibhs.org/wildfire/wildfire-building-codes-and-standards

Wildfire

Defensible space zones

Zones 1 and 2 currently make up to 100 feet of defensible space required by **California** law.

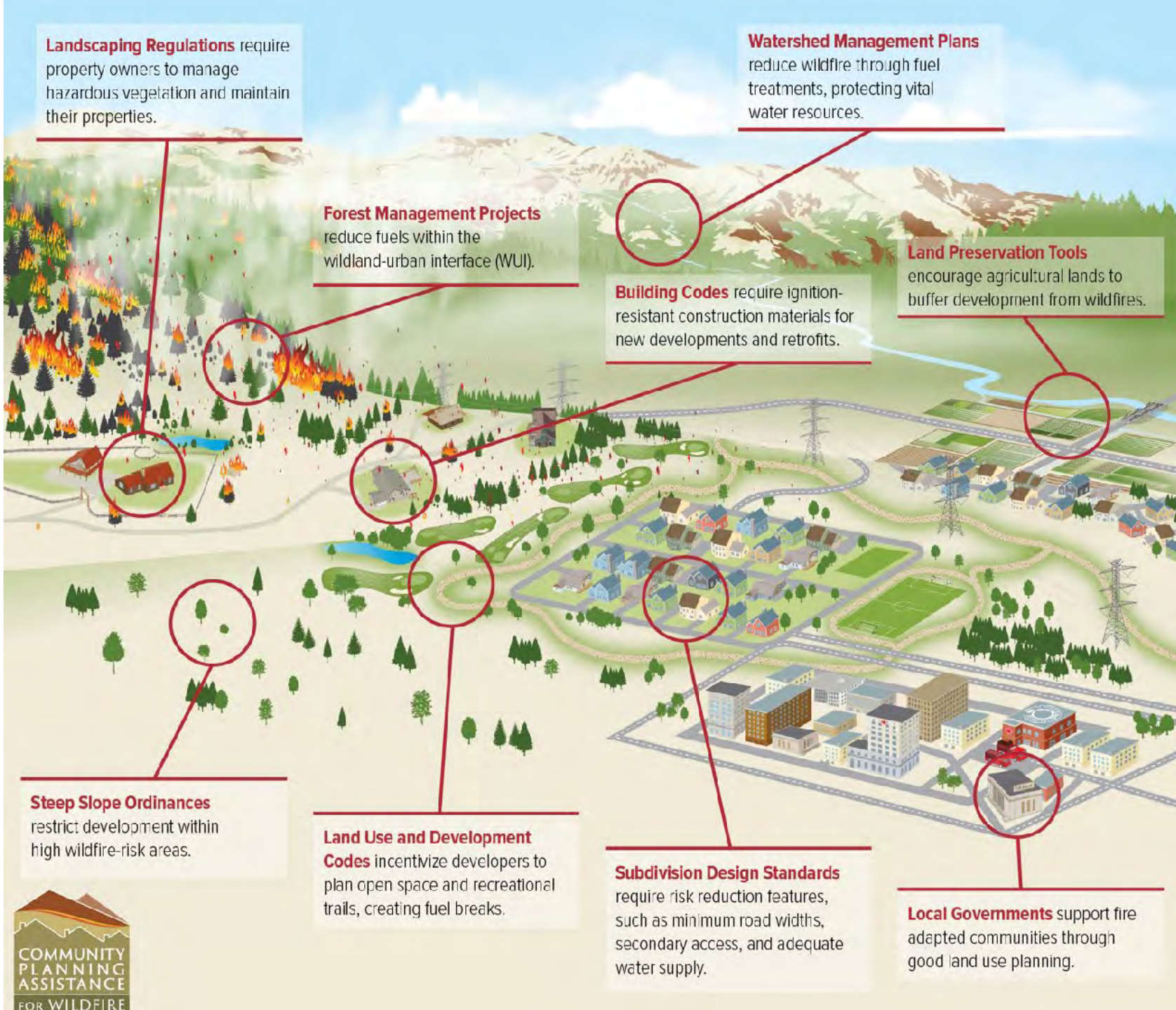
Assembly Bill 3074, passed into law in 2020, requires a third zone for defensible space. This law requires the Board of Forestry and Fire Protection to develop the regulation for a new ember-resistant zone (Zone 0) within 0-5 feet of the home by January 1, 2023.

The intensity of wildfire fuel management varies within the 100-foot perimeter of the home, with more intense fuels reduction occurring closer to your home. Start at the home and work your way out to 100 feet or to your property line, whichever is closer.

https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/#:~:text=Defensible%20Space%20Zones&text=Assembly%20Bill%203074%2C%20passed%20into,home%20by%20January%201%2C%202023.

Wildfire

Community-scale solutions



Source: Community Planning Assistance for Wildfire: Final Recommendations for Gunnison County, CO 2019

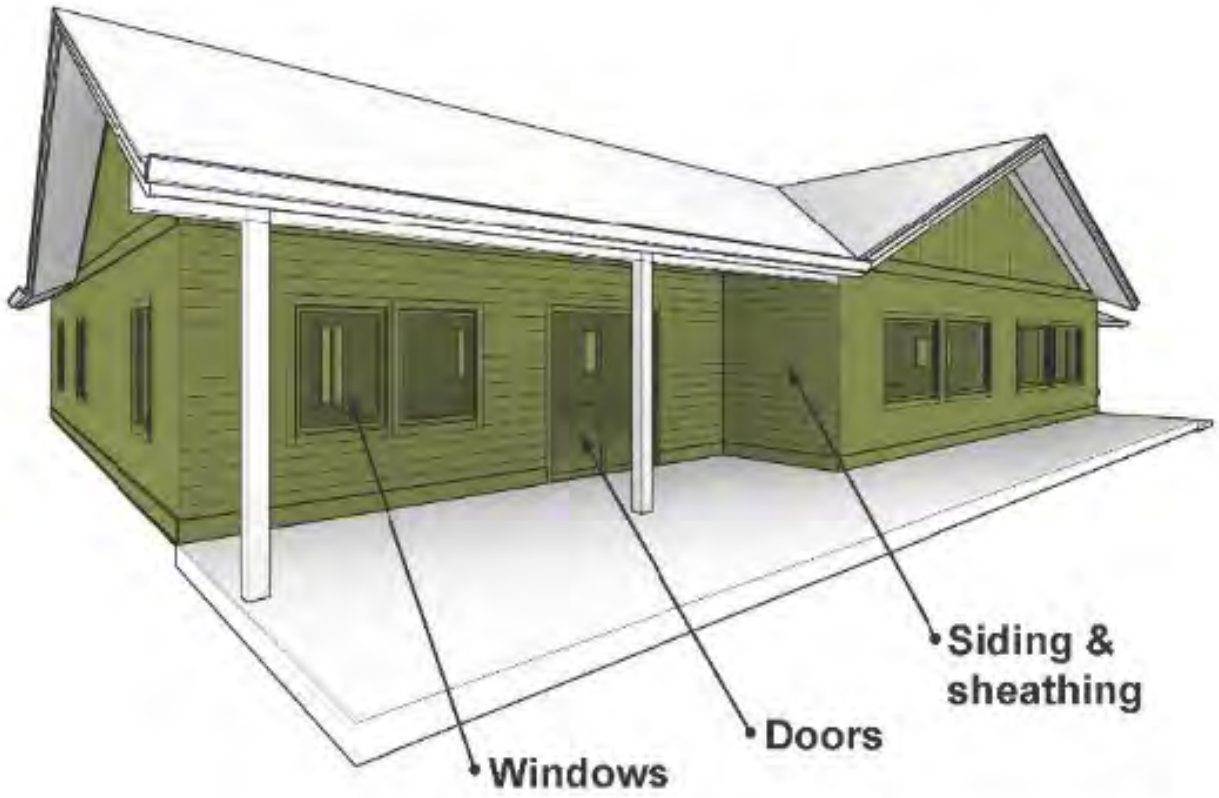
Wildfire

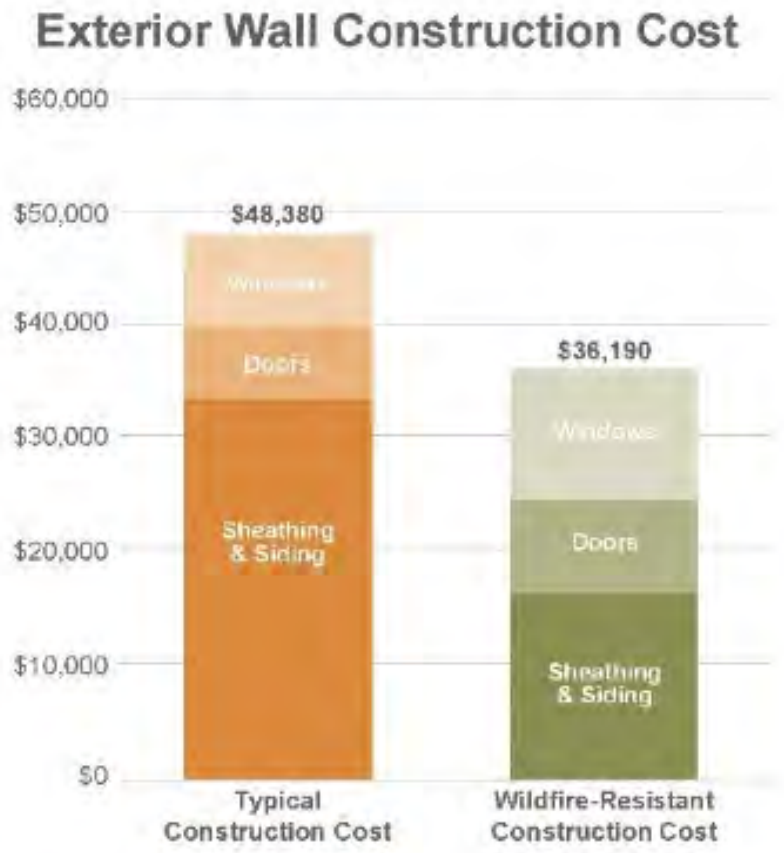
House in Elkorn, OR
Representative example of fire-hardened home that **survived the Beachie Creek Fire** in Oregon. The home was built with concrete siding, a cement porch, metal roof with no gutter and air vents. and vegetation had been cleared near the home.

A recent study showed that it could cost less money to build a wildfire-resilient home than a more conventional design.

Source: Headwater Economics, 2018 — Building a Wildfire Resistant Home: Codes and Costs

Wildfire





Source: Headwaters Economics. **Building a Wildfire-Resistant Home: Codes and Costs.**

Wildfire

ITEMS ADDRESSED BY THE IFC AND IBC:

- Combustibility of materials used for roof covering (IBC)
- Vegetative fuels adjacent to the structure (IFC)

ITEMS ADDRESSED BY THE IWUIC:

- Classification of wildland/urban interface areas within jurisdiction boundaries
- Requirement for a Fire Protection Plan
- Firefighting water supply
- Emergency services access to the site
- Structure construction materials and arrangement based on fire hazard severity
- Automatic sprinkler requirements based on fire hazard severity
- Control of nearby combustible materials and vegetation
- Maintenance schedule for continued mitigation
- Allowable roofing materials for roofing replacement

Appendices (if adopted) contain detailed requirements related to several of the items listed above.

Wildfire

Mitigation measures IBC, IFC, AND IWUIC are based on the following assessment:

- Location of structure geographically
- Weather conditions at various times of the year
- Other exposing/exposed structures
- Combustibility of materials used in structure
- Vegetative fuels adjacent to the structure
- Vehicles or fixed or mobile equipment that may present an ignition source
- Other sources of fuel, fire spread or ignition that may impact the structure

Wildfire

Mitigation measures in NFPA 1 and NFPA 1140 include:

- Ignition sources
- Emergency service apparatus access
- Approved water supply
- Removal of combustibles and accessory structures within 30 feet of structure
- Non-combustible materials on exterior walls
- Roof coverings rated as Class A
- Exterior glazing shall be tempered glass with specified fire rating
- Roof gutters and downspouts non-combustible, including debris prevention

Wildfire

Modifications to code requirements for commercial buildings (IBC)

Subject	Code section	2012	2015	2018	2021
Roof covering	1500	Reference to IWUIC with regard to Class of roofing	No change	No change	No change

There are no references to wildfire building code provisions in the IRC and only a minimal reference (see above) in the IBC.

Adoption of additional wildfire resilience considerations happens at the state, county, municipal or individual levels.

Extreme temperatures

In June 2021, a heat dome settled across the Pacific NW resulting in temperatures as high as 120 F; a one-in–1,000 year event.

In February 2021, a long-duration cold snap hit Texas, forcing people to use cars, shelters and heated stores to stay warm.

Extreme temperatures

Climate region guide
Seven of the eight U.S. climate zones recognized by Building America occur in the continental United States. The sub-arctic U.S. climate zone, not shown on the map, appears only in Alaska.

Source:
https://www.energy.gov/eere/buildings/building-america-climate-specific-guidance

Extreme temperatures

Challenge: The code often references outdated, historical data to inform design.

Solution:

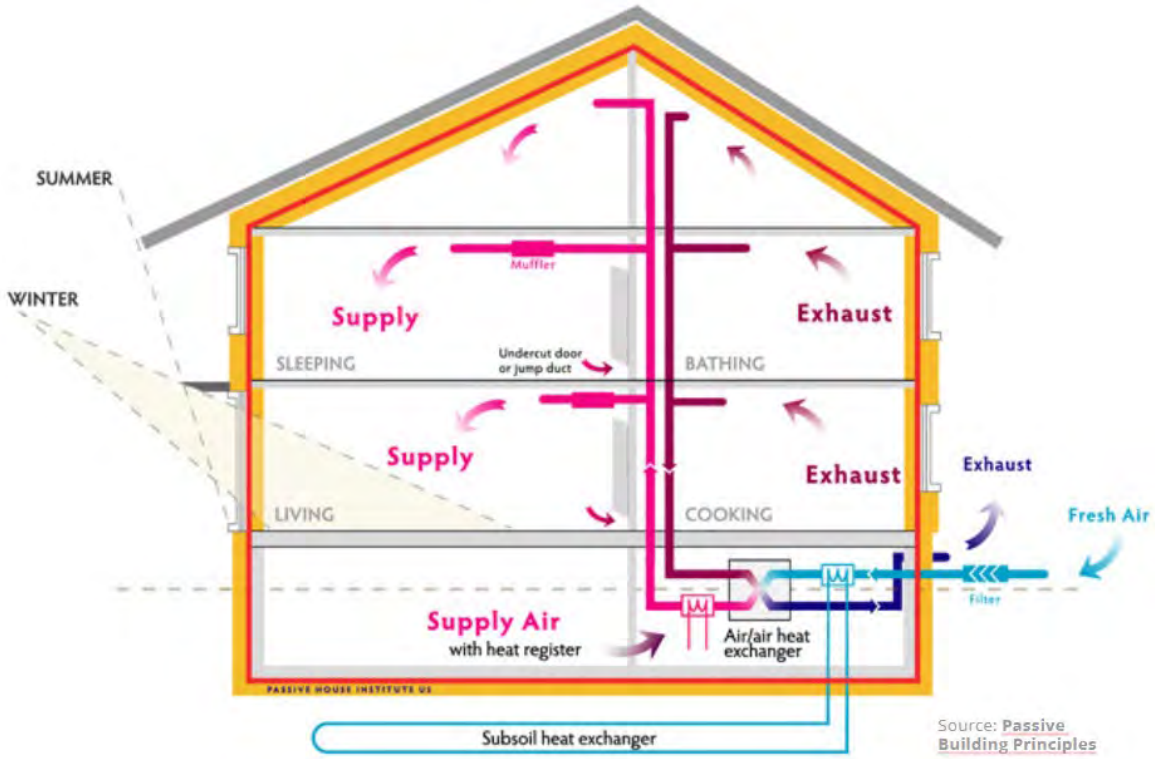
Where to find climate projection data:

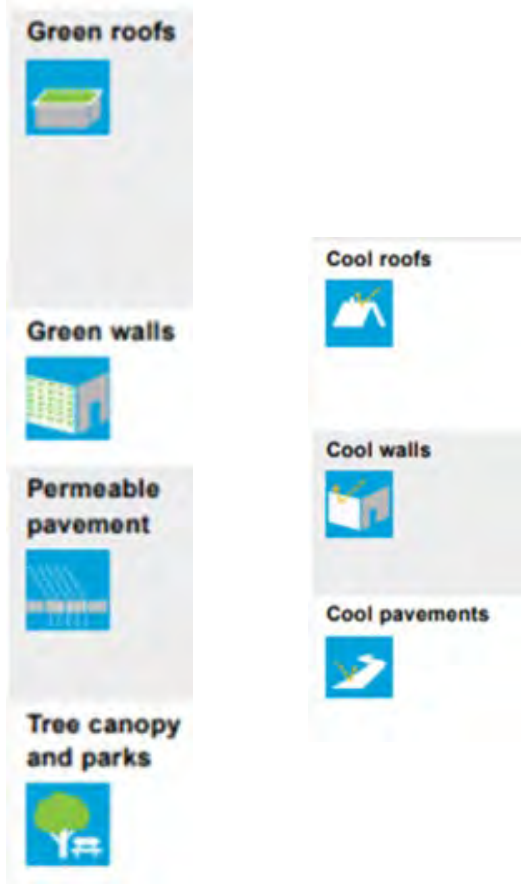
Climate Toolbox: Shift in average annual temperatures, number of days above and below 32 degrees F, and number of days greater than 90 and 100 degrees Fahrenheit

The Climate Explorer: Similar data plus heating and cooling degree days (the number of days fuel is needed to either heat or cool a building to a comfortable temperature)

Extreme temperatures

Scale of intervention — Building Level

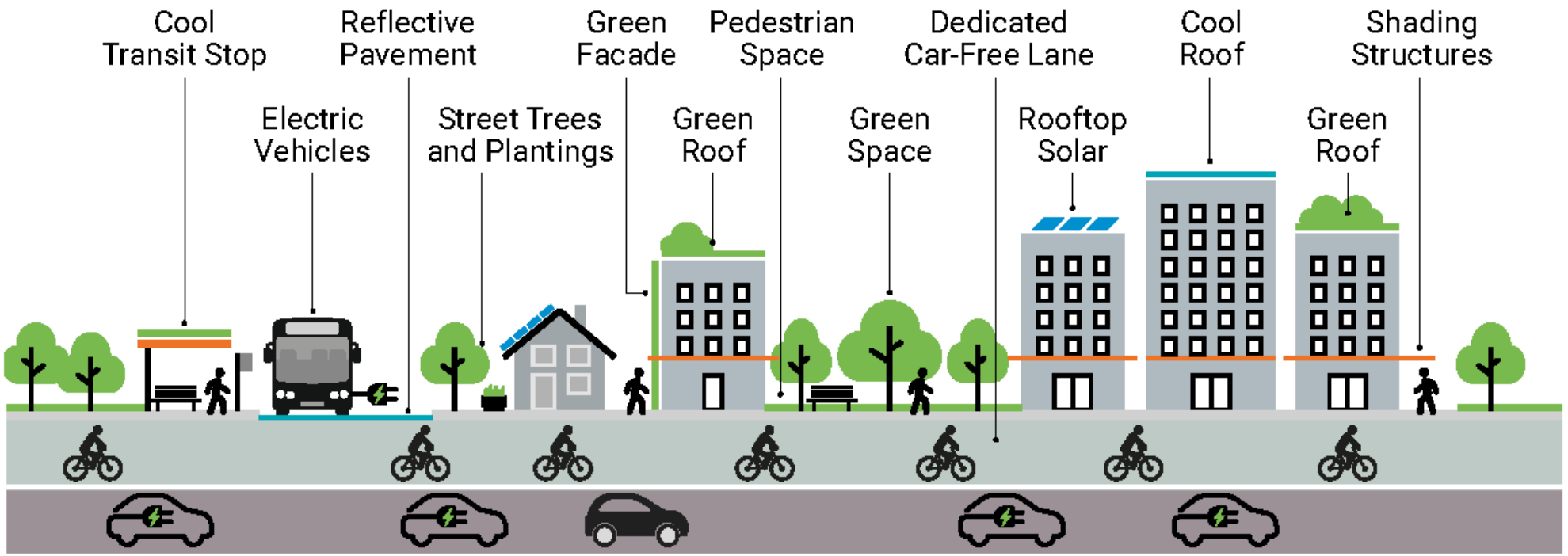




Source: ESMAP. 2020. Primer for Cool Cities: Reducing Excessive Urban Heat. Energy Sector Management Assistance Program (ESMAP) Knowledge Series 031/20. Washington, DC: World Bank.

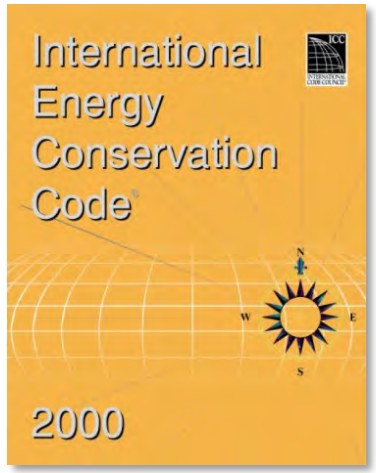
Extreme temperatures

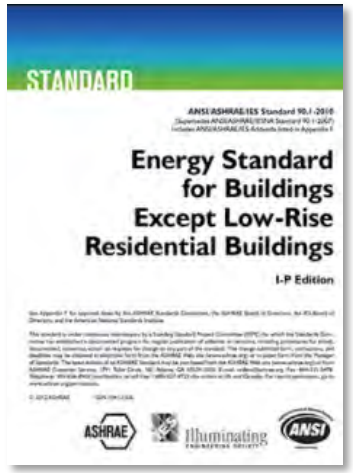
Scale of intervention — City and Town Level



Source: https://rmi.org/insight/sustainable-urban-cooling-handbook/#:~:text=Beating%20the%20Heat%3A%20A%20Sustainable%20Cooling%20Handbook%20for%20Cities%2C%20published,%2C%20building%2C%20or%20household%20scale

Extreme temperatures





1975
ASHRAE Standard 90-1975: developed in response to the 1970s energy crisis

1999
ASHRAE 90.1

2000
IECC
Inaugural year

2001–2016
ASHRAE 90.1
3-year cycle

2003–2018
IECC
3-year cycle

2019
ASHRAE 90.1

2021
IECC

Sources: ASHRAE (2021); ICC (2021); DOE (2021)

Extreme temperatures

Modifications to code requirements for commercial buildings (IECC)

Subject	Code section	2012	2015	2018	2021
Kitchen exhaust air	403	No requirement	Added requirements for kitchen exhaust	No change	No change
Coolers and freezers	403	No requirement	Requirements for freezers and coolers added	No change	More detailed requirements added
Lighting	405	No change	Significant changes to lighting power and lighting control requirements	Added changes to lighting controls and reductions in lighting power allowances	Added changes to lighting controls and reductions in numerous lighting power allowances
Parking garage lighting	405	No requirement	No requirement	No requirement	Added parking garage lighting controls requirements
Exterior lighting	405	No change	No change	Reduction in exterior lighting power allowances and exceptions added	Changes to lighting power calculations

Extreme temperatures

Modifications to code requirements for commercial buildings (IECC)

Subject	Code section	2012	2015	2018	2021
Climate zones	R301	No change	Tropical zones added	Revised climate zone naming	Adds significant detail for international climate zone determination
Insulation marking	R303	No requirement	No requirement	No requirement	Detailed marking requirements or certification required
Building enclosure	R402	No change	Significant changes to requirements for walls and openings.	Increased insulation for heated slabs, clarifies insulation requirements for various components	Clarifies prescriptive versus performance requirements; updated U-factors; R-values
Performance testing	R402	No requirement	No requirement	No requirement	Building envelope testing requirement added
Equipment sizing	R403	No change	No change	More detailed equipment sizing requirements added	No change
Controls	R403	Minor changes to mechanical system controls added	Changes to mechanical system controls added	Significant changes to mechanical system controls added	No change
Economizers	R403	Requirements for economizers added	Requirements clarified	No change	No change

Extreme temperatures

Modifications to code requirements for residential buildings (IRC)

Subject	Code section	2012	2015	2018	2021
Heat recovery	1103	No requirement	No requirement	No requirement	Heat recovery ventilation required in some zones
Required energy efficiency options	1108	No change	No change	No change	Additional energy efficiency package options
Reports	1106	No requirement	Compliance reports required for permits and C of O	No change	Additional detail to compliance report requirements
Solar	Appendix T	No requirement	No requirement	Requirement for solar ready zone added	No change

Increasing resilience and solving for challenges in codes

Increasing Resilience through Codes

- Model codes updated every three years to incorporate latest research, lessons learned and technology/process updates
    - Example: Outcomes from Joplin tornadoes led to code change proposals for 2024 codes
- Growing focus on building impacts on social and economic resilience
    - Example: Life- safety (ability to safely escape a failing building) → Functional recovery (expectations on continued building operations)
    - Example: Role of energy codes in supporting passive survivability, grid resilience
- Supporting innovation in construction, including off-site construction
    - Example: New ICC Standards (1200 & 1205) for design, fabrication, assembly and compliance

Increasing Resilience through Codes

- Incorporating forward looking climate science
    - Buildings expected to last >50 years, risks they will face in the future different than those in the past
    - Codes and standards need to adapt to assure these changing risks are addressed
    - Codes and standards organizations working with relevant federal agencies (NOAA, NASA, NIST) to match climate science with building industry needs
    - ICC working with code development bodies in Canada, Australia and New Zealand to develop an approach and identify research needs

Step 1

How codes currently use climate data

Step 2

Potential approaches to include future-focused climate data

Step 3

Develop International Resilience Guideline

Step 4

Apply International Resilience Guideline in I-Codes context

Building on a Strong Foundation

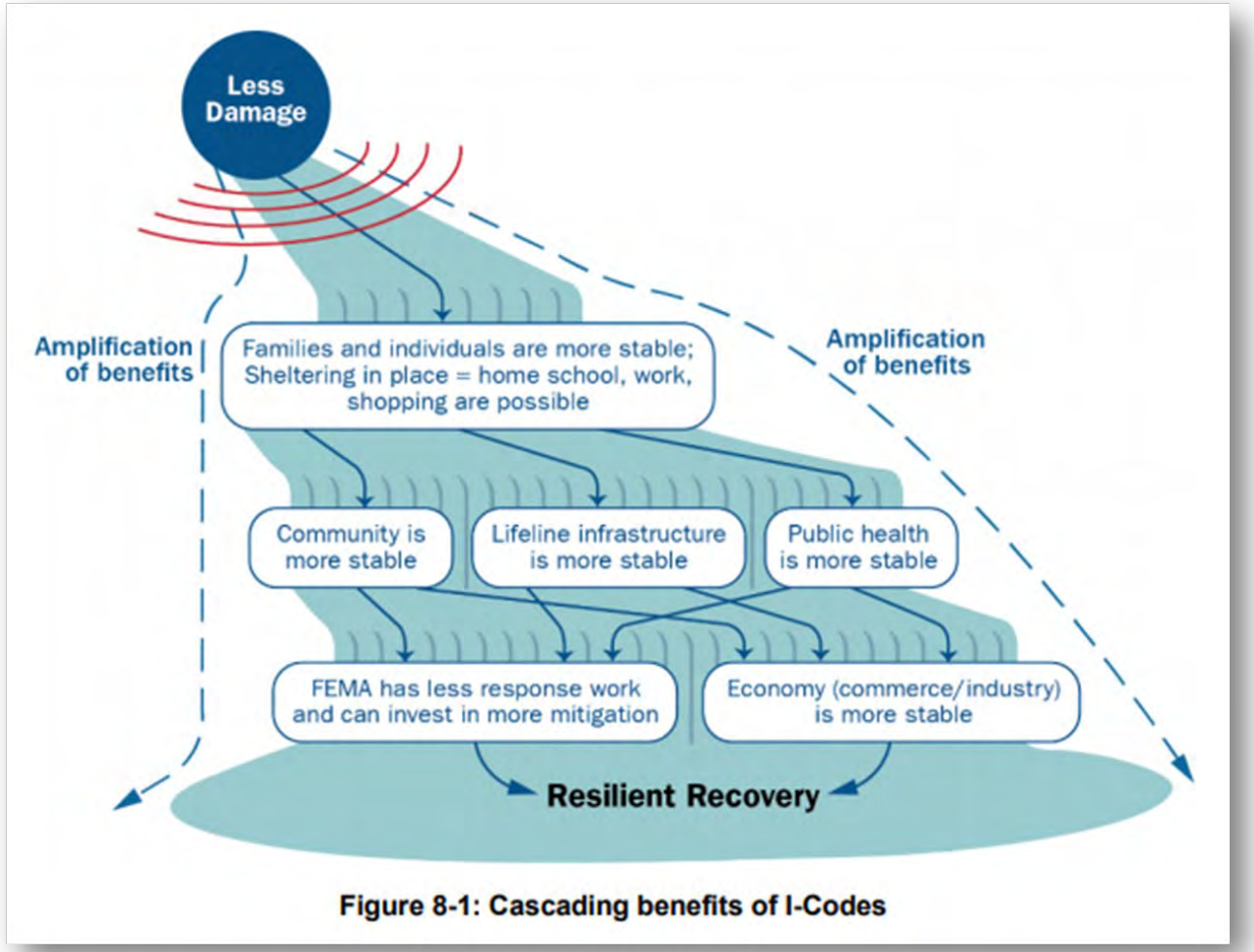


Figure 8-1: Cascading benefits of I-Codes

www.resilientalliance.org

Enforcement challenges

Challenge: Having adequate capacity to ensure enforcement of building code compliance is a challenge for many states and municipalities.

Solution:

- **Affidavit process:** designers sign-off on compliance through a legal document
- **Joint services**: communities come together regionally to support positions and enforcement activities
- **Third-party inspectors:** non-municipal entities are used to conduct inspections

Enforcement challenges

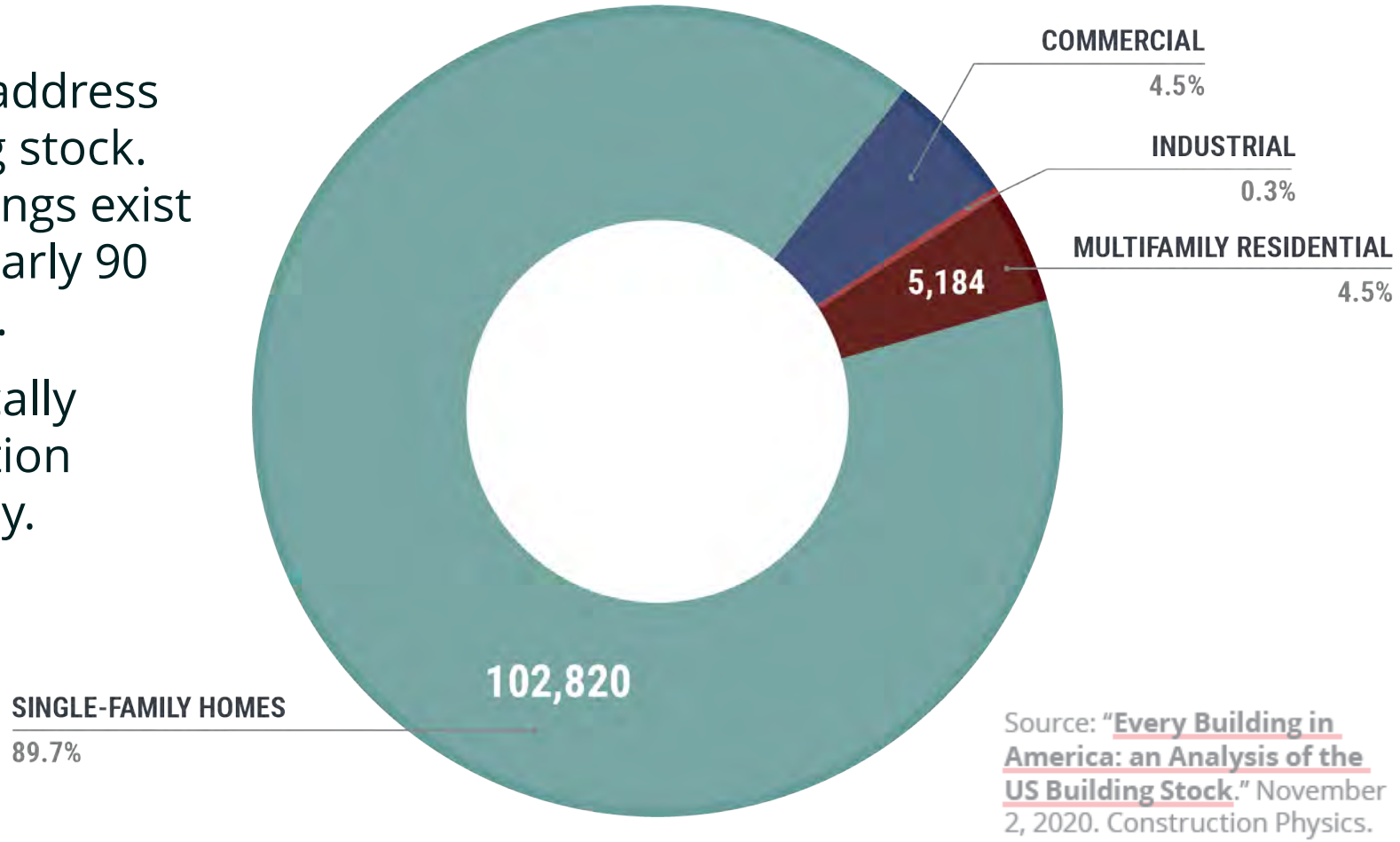
Third-party inspectors

One example of this is GOVmotus, a program developed by the Institute for Building Technology and Safety (IBTS). This program allows for remote inspection services via a hosted software platform and can be used to provide building department services, inspections, and quality assurances to jurisdictions that otherwise may not have the capacity to perform these on their own.

Existing building stock

Challenge: It can be difficult to address resilience in the existing building stock. Approximately 111 million buildings exist in the United States, of which nearly 90 percent are single-family homes.

Code requirements are not typically triggered unless there is renovation retrofit, or a change in occupancy.



Source: "Every Building in America: an Analysis of the US Building Stock." November 2, 2020. Construction Physics.

Existing building stock

Solution

Leveraging CDBG-DR funding to address resilience needs in St Augustine's existing building stock

St. Augustine, Florida, is the oldest city in America and almost at capacity as far as development is concerned. Traditional revenue sources are insufficient to address flood resilience needs within existing building stock.

The municipality is using CDBG-DR funding to invest in resilience retrofits for those low- to moderate-income households that experienced repetitive losses from flooding. Possible actions included the option to demolish and rebuild, to elevate the structure or to move.

Existing building stock

Solution

Making the most of a natural disaster

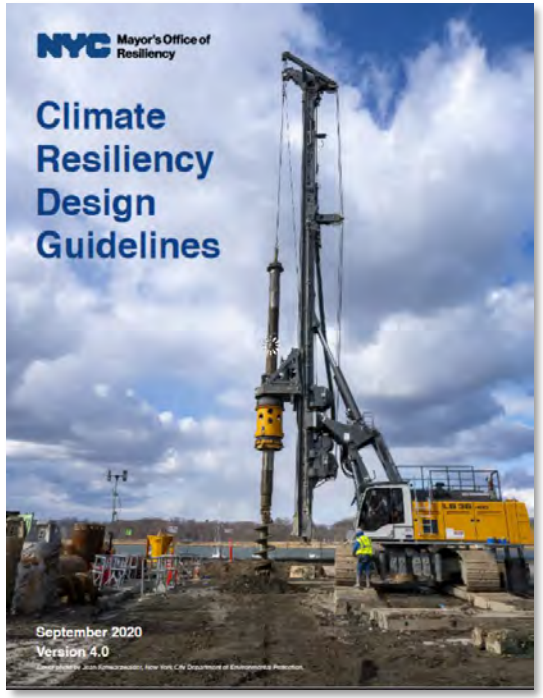
It is often difficult to think about long-term resilience directly following a major event. However, these events can also present the rare opportunity to build back better and differently.

EPA has partnered with Smart Home America and the Gulf of Mexico Alliance to proactively identify these opportunities and make the process less cumbersome for local communities.

Existing building stock

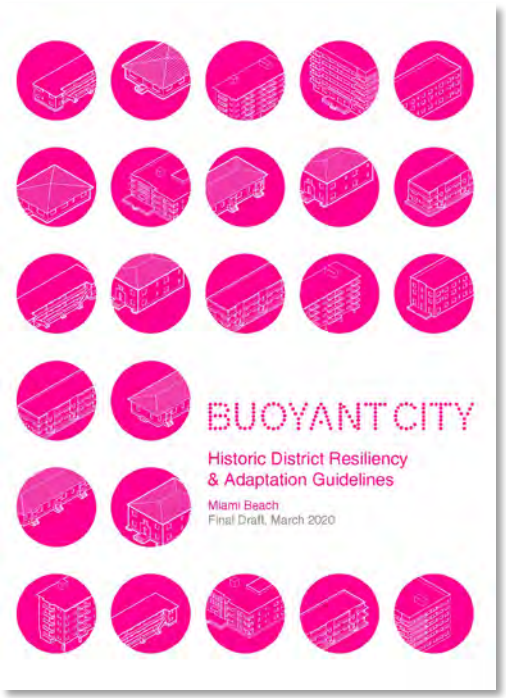
Solution

Local initiatives that use a combined approach of land use, zoning, and local code development and enforcement to incentivize adoption of resilient building practices in both new and existing structures



NYC Resilience Program

Boston Coastal Flood Resilience Design Guidelines & Flood Resilience Overlay District



Miami Beach — Buoyant City

Funding

Challenge: Funding and technical assistance can be an issue when moving forward with building code initiatives. States and/or communities might not have sufficient resources to take the next steps.

Solution:

Funding

Solution:

FEMA Program Reference Matrix

Program	Flood	Fire	All hazard	Annual programming	Post-disaster	Mitigation project grants	Capability / capacity building, building code administration, & technical assistance grants	Nature-based solutions projects	Training, preparedness, technical assistance from FEMA
Sea level rise & flood maps	✓			✓					✓
Mitigation planning			✓	✓					✓
Building resilient infrastructure & communities			✓	✓		✓	✓	✓	✓
National flood insurance program	✓			✓			✓		
Flood mitigation assistance	✓			✓		✓	✓	✓	
National exercise program			✓	✓					✓
Fire-adapted communities		✓		✓					✓
Public assistance			✓		✓	✓	✓	✓	
Hazard mitigation grant program			✓		✓	✓	✓	✓	
Hazard mitigation grant program post-fire		✓			✓	✓		✓	

Summary

- Existing codes provide opportunities to address resilience to climate change
- There are additional “beyond-code” and best practices that owners and communities could leverage to increase that level of resilience
- Existing buildings may not fall under the jurisdiction of building codes, but there are ways in which current systems can be used to address those needs
- Sometimes the best solution may be a combination of building codes working in concert with zoning ordinances and community-scale planning efforts

Upcoming webinar

Webinar 3 **Action at the Community Level**
May 26, 2:00 p.m. ET

Participants will:

- Discover the role you can play at the local level to address resilience in the building codes
- Become familiar with building code governance at the national, state, and local levels
- Gain insights into how state-level code adoptions influence local actions
- Learn how communities can enhance resilience within building codes, including an outline of the steps involved

For more information, please email drsipolicyunit@hud.gov

LISC