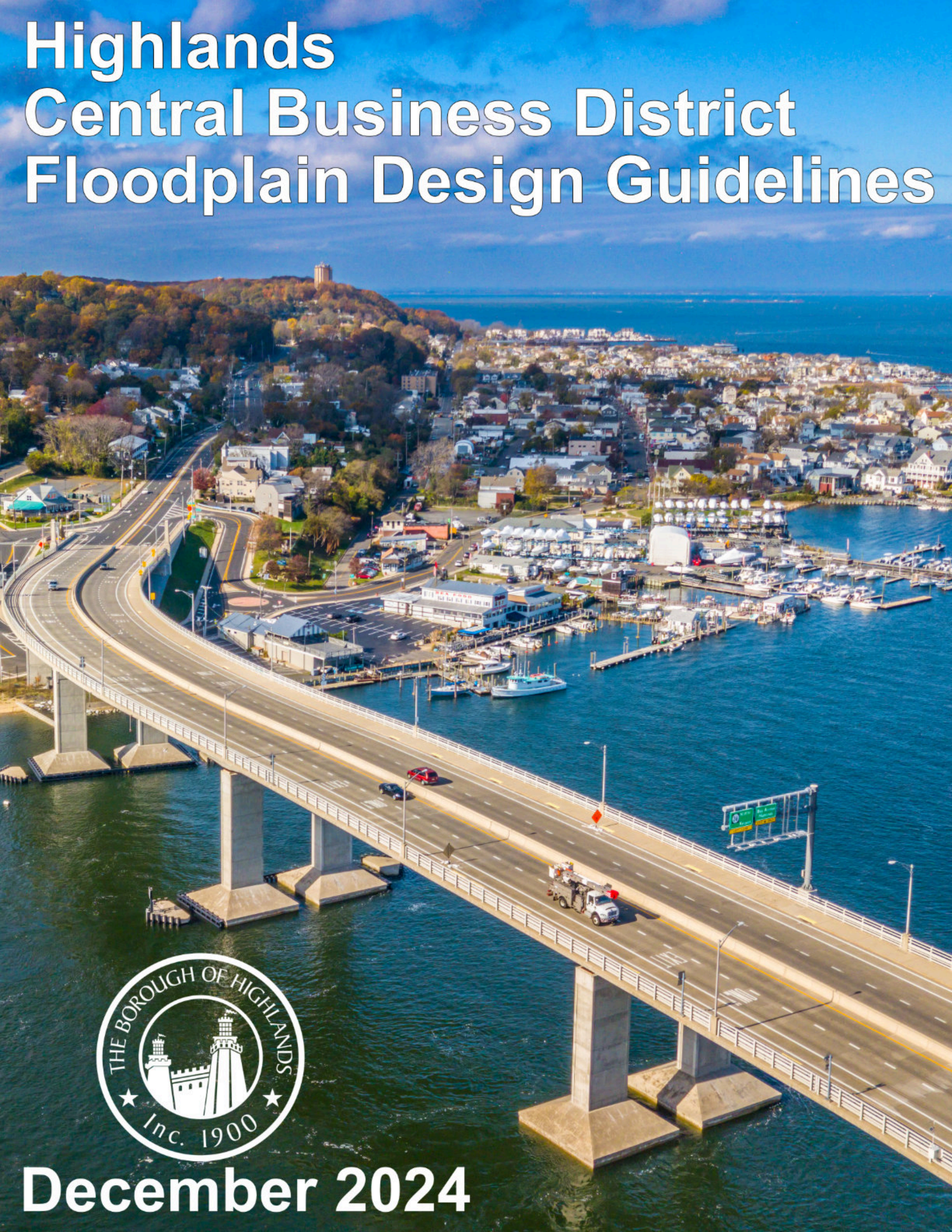
Highlands
Central Business District
Floodplain Design Guidelines



THE BOROUGH OF HIGHLANDS
Inc. 1900

December 2024

Highlands Central Business District Floodplain Design Guidelines

Glossary of Key Terms

One percent Annual Chance of Flood
Also known a s the 100-Year Flood and the Base Flood, this is defined by FEMA as a flood within 1% annual chance of occurring or being exceeded. FEMA Flood Insurance Rate Maps delineate the extent of the Base Flood, along with its corresponding Base Flood Elevations.

100-Year Floodplain
This is the extent of a flood that has a 1% annual chance of occurring or being exceeded. Also referred to a s Special Flood Hazard Areas (SHA) on FEMA Flood Insurance Rate Maps.

Base Flood Elevation (BFE)
This is defined by FEMA as the top of water elevation projected for a specified flooding scenario. BFEs listed on FEMA Flood Insurance Rate Maps are based on the 1% Annual Chance Flood.

Critical Facilities and Infrastructure
This is defined by FEMA as a facility where even a minimal risk of disruption would constitute a severe threat. FEMA includes hospitals, fire, police stations, critical record storage facilities, and similar structures within this scope. The American Society of Civil Engineers also includes facilities related to energy, water, transportation, communication systems. And natural and virtual resources withing their definition of critical facilities.

Design Flood Elevation (DFE)
This is defined by FEMA as the height of the lowest occupiable floor (when wet floodproofing), or the height of the lowest structural member of an inhabitable floor (when elevating a building). The DFE is separated from the BFE by freeboard.

Dry Floodproofing
Dry floodproofing is the practice of sealing a space or a building up to the level of the DFE or higher, to keep water from entering. When dry floodproofing, property strengthen structural members in anticipation of the hydrostatic and hydrodynamic pressure caused by flood waters. In post-FIRM buildings, dry floodproofing can only be used for non-residential A Zones.

Federal Emergency Management Agency (FEMA)
FEMA manages the federal government's response to natural and human-caused disasters. FEMA also manages the NFIP and produces Flood Insurance Rate Maps (FIRM).

FEMA Flood Zone
This is the geographic area the FEMA has defined according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area.

FEMA Zones A, AE
Defined by FEMA as areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage based on Flood Insurance Rate Maps (FIRM)

FEMA Zones V, VE
Defined by FEMA as coastal areas with a 1% or greater change of flooding and an additional hazard associated with storm waves.

Flood Insurance Rate Map (FIRM)
Maps produced by FEMA that delineate the borders of the 100-year floodplain and corresponding Base Flood Elevations. The flood projects shown on FIRMs are based on historic data, and do not include factors related to future sea level rise.

Floodproofing
Floodproofing is defined by FEMA as structural or non-structural interventions that reduce flood damage to a space or a building.

Freeboard
Freeboard is defined as the distance between the BFE and the DFE. It is defined by FEMA as a factor of safety, or a buffer between predicted flood levels and a building's lowest occupiable floor.

National Flood Insurance Program (NFIP)
NFIP is an insurance program managed by FEMA. Communities that agree to participate in the NFIP also agree to enforce floodplain regulations that meet FEMA requirements. Property owners in participating communities can purchase two types of flood insurance from NFIP: building coverage (which includes the building, foundation, appliances, and essential systems), and content coverage (which includes belongings damaged during a flood).

North American Vertical Datum of 1988 (NAVD88)
A base measurement created by the National Geodetic Survey and used to calculate of compare elevations.

Resilience
Resilience is the ability of a system to prepare for, withstand, and recover quickly from a disaster. Ideally, resilient systems should recover from an event by becoming stronger than they were prior to the stress.

Sustainability
Practices that protect the health of people and the environment.

Wet Floodproofing
Designing for the movement of water through a space or a building, which equalizes hydrostatic pressure and helps prevent structural failure. Wet floodproofing is only allowed for parking, access, crawl space and storage.

Introduction

Highlands Borough Central Business District (CBD) Redevelopment Area, designated 2022, revised and updated to include Floodplain Management Regulations, Land Use (Chapter 21) September 2024.

Charting a course for new construction and retrofitting mixed use/non-residential structures that are FEMA NFIP compliant presents daunting challenges and a new community vision for resilient construction.

Highlands Central Business District (CBD) is in a Special Flood Hazard Area (SFHA) adjacent to Sandy Hook Bay. Surrounding the CBD are bluffs where Historic Twin Lights - State Historic Site has vistas of the Atlantic Ocean, Shrewsbury River and Sandy Hook Bay and Manhattan NY skyline. Highlands has planned for this point in time for decades- and is presented with a unique opportunity to reinvent itself to promote new non-residential floodplain compliant investments for a resilient economic development future.

Aerial view Highlands Monmouth County Sandy Hook Bay, Shrewsbury River, Atlantic Ocean

Photo: ShoreGrax Aerial Photography/ Ken Braswell

Overview/Executive Summary

These **Central Business District Floodplain Design Guidelines** are intended to guide private development - both new mixed-use construction and alterations to existing buildings to become more resilient to current and future coastal flooding.

The **Central Business District Floodplain Design Guidelines** informs residents, businesses, and investors of the risks from coastal flooding and measures they can implement to reduce such risks. In parallel, the Highlands Borough Chapter 21 Zoning Floodplain Management Regulations (adopted 2022), working in tandem with the Central Business District (CBD) Redevelopment Area, are regulatory tools to influence, guide, and streamline resilient actions and eliminate barriers to implement resilient measures.

The Central Business District CBD redevelopment area promotes mixed-use investments in Highlands Borough. Highlands has a unique opportunity as a designated redevelopment area, to implement new mixed-use construction standards and floodplain management regulations. By investors combining lots in the redevelopment area, new elevated mixed-use projects are encouraged. Private-sector investments in this Bay Avenue CBD Redevelopment area will have a significant impact on the floodplain compliance for non-residential properties, by utilizing floodplain management regulations, and mitigation measures/strategies. Highlands Borough has 1,502 properties in the Special Flood Hazard Area (SFHA), with 151 properties included in the Central Business District CBD (Bay Avenue). Captain Cove Marina Redevelopment Area (one parcel) is also located in the SFHA.

This document is envisioned as a resource to help developers, investors, and property owners implement measures that better protect buildings from coastal flood damage; and simultaneously ensure that the Central Business District CBD Plan regulations are aligned to facilitate the implementation of flood protection and preparedness strategies presented here. Using these tools as a framework for coordinating parcel-level development activities, this becomes an important first line of defense to create coastal flood protection.

Planning Context

The Central Business District Redevelopment Plan, updated in 2024, incorporated the Chapter 21 Zoning Floodplain Management Regulations adopted in 2022. Half of Highlands Borough is in the Special Flood Hazard Area (SFHA), including the Central Business District. Through Community Visioning, Visual Preference Survey, Bloustein School of Planning and Public Policy 2014, a Planning Studio Team identified needed direction to develop a plan of action facing the many challenges that lie ahead in a post-Sandy environment. Stakeholder engagement identified opportunities and constraints. Today significant new investments have been made in the (SFHA) Special Flood Hazard Area residential neighborhoods through property elevation and monitored substantial improvements. Highlands is striving to become another Community Rating System CRS designated community in Monmouth County.

The Central Business District has lagged with new investments since Sandy 2012, and now faces new floodplain management regulations, including the impact of monitoring substantial improvements. Highlands has experienced a 16.1% increase in people moving in since the previous year. Double from the Monmouth County rate of 8.5% and higher than the State of New Jersey at 10.2%. (Monmouth County Planning Board).

We embark on an opportunity to create a new Central Business District CBD with new floodplain management regulations that will create a resilient business district to support the continuing transformation of the residential neighborhood through elevation and new construction of residential properties.

Urban Design and Public Space/Realm

Integration of flood-resilient design strategies will have a significant impact on the ground level condition of new and existing buildings, and subsequently the public realm. In adapting best practices to each individual project, it be will critical to address the interface between the private and public realm in a manner that ensures that access is maintained for people of all abilities, and solutions contribute to an overall enhancement of the street wall at the ground level rather than detracting from it. This document identifies measures to achieve this principle.

One of the unique opportunities working in a designated development area with the new

Highlands Central Business District Floodplain Design Guidelines

floodplain management regulations is to create public space at ground level for retrofitting and new construction projects. Using Artisan uses in the CDB Redevelopment Area to create a nautical village atmosphere, a place is created to live, work and play with the newly created ground level space created by the new standards. New public space along Bay Avenue creates the vision that Highlands has nurtured for decades-celebrating its nautical history, famous seafood restaurants in the central business district and Sandy Hook Bay waterfront.

Sustainability Co-Benefits

Potential areas where resilient design strategies can also achieve other sustainability co-benefits, such as increasing building efficiency, or creating new public space. The design guidelines provide examples, including upgrading to more efficient heating and cooling systems in addition to floodproofing when replacing equipment.

- Consider the resilience and operational benefits of an on-site renewable energy system.
- Designing and selecting operable windows for both passive ventilation and energy efficiency benefit.
- Incorporating landscaped flood protection systems that also provide recreational open space and ecosystem services

Retrofits & New Construction

Using the Redevelopment designation of Bay Avenue Central Business District, all in a Special Flood Hazard Area (SFHA) there are opportunities for innovation in:

- Design
- Building Envelope and Access
- Building Systems
- District Scale
- Supporting Strategies

Mixed-use new construction on multiple lots assembled for one project will set a new direction for the economic viability of the central business district. With the CBD Redevelopment Plan new zoning Artisan uses and floodplain design, district investments will provide a resilient future and benchmark for coastal construction in Highlands and set a new standard for the New Jersey Coastal communities.

Floodplain Management Regulations Impact Substantial Improvements on all existing residential and non-residential buildings. Projects in the redevelopment area that are compliant with floodplain management regulations will create a new watershed standard for Highlands, Monmouth County, and New Jersey.

Working collectively with Monmouth County CRS Program, FEMA Region 2, Highlands Redevelopment, and Floodplain Administration Teams have set a course to change a vision for future mixed-use projects in a floodplain-the core of Highlands future economic development and resiliency.

Sandy Hook Bay view - Highlands Waterfront *ShoreGrafx Photography Ken Braswell*

Acknowledgments

Boston Planning and Development Agency
(Coastal Resiliency drawings and photos)
1 City Hall Square #9, Boston, MA 02201
Along with their numerous partners, collaborators, and stakeholders. Their leadership, technical and visual drawings to educate communities about challenges for development and new construction in a floodplain.

Urban Land Institute

FEMA
U. S. Department of Homeland Security

Rutgers University Edward J. Bloustein School of Planning and Public Policy Planning and Design Studio A Clam-Tastic Plan in partnership with Monmouth County Planning/ Parks & Recreation , and Highlands Borough Community Partners.

Monmouth County Planning Board
CRS Community Rating Program
Joseph Barris PP, AICP, CFM
Bridget Neary AICP, CFM

Highlands Borough Governing Body
Mayor Carolyn Broullon
Council President Jo-Anne Olszewski
Councilmember Donald Melnyk
Councilmember Karen Chelak
Councilmember Leo Cervantes
Administrator Michael Muscillo
Steven Winter, CO/CFM Highlands
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Photo/Rendering Credits
ShoreGrafx Aerial Photography/Ken Braswell
www.shoregrafx.com

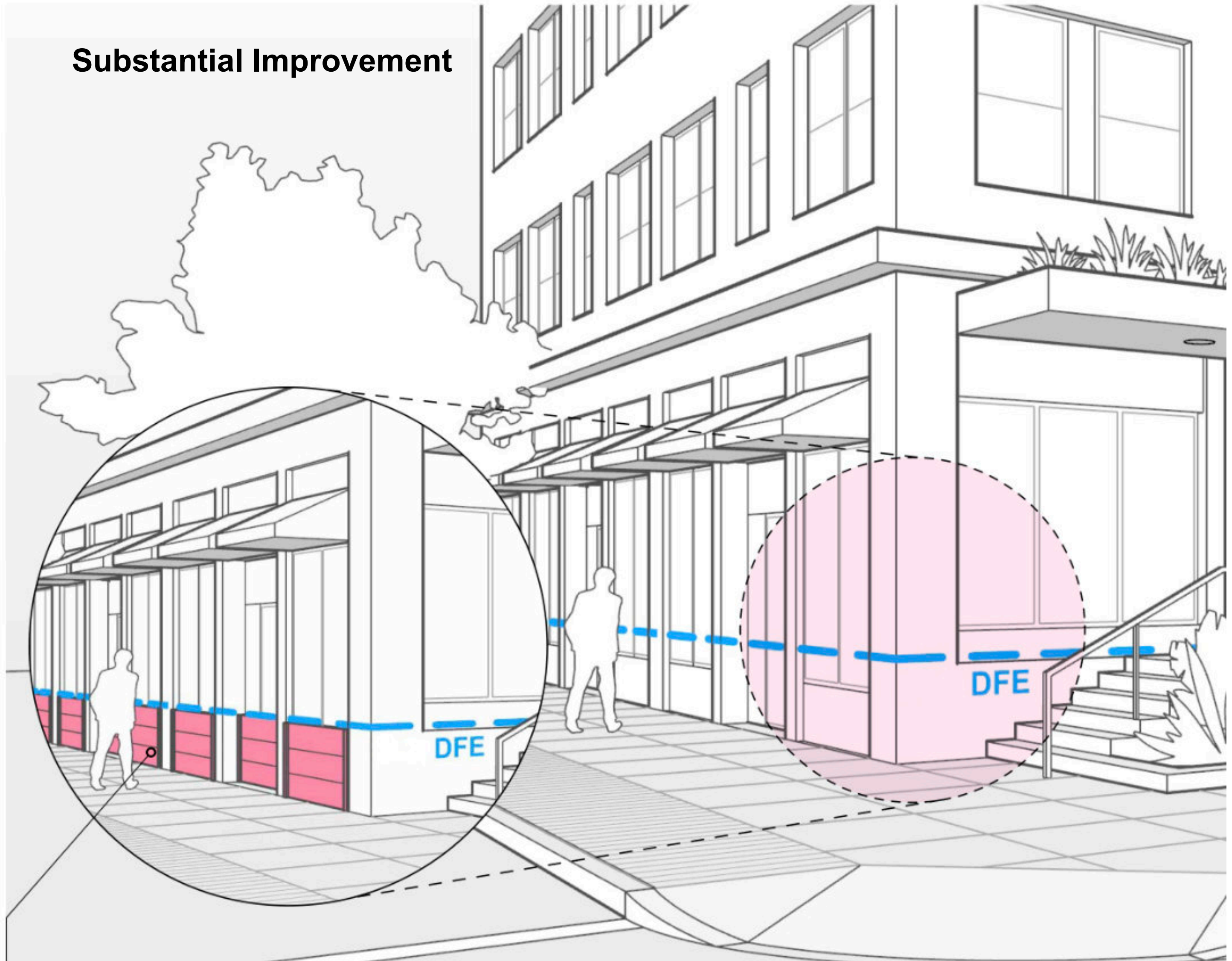
SETH DEEKEN DESIGN

SethDeekenDesign.com

Relationship to the Uniform Construction Code

Notwithstanding allowances provided for in the Central Business District Redevelopment Area, all construction shall comply with the Uniform Construction Code (UCC) (N.J.A.C. 5:23). Construction not requiring a construction permit or inspections, work performed pursuant to N.J.A.C. 5:23-2.7 (Ordinary Maintenance), or other construction not under the jurisdiction of the UCC, such as manufacturing, production, and process equipment, as defined in N.J.A.C. 5:23-1.4, shall comply with Section V - Floodplain Requirements, of the Central Business District Redevelopment Plan.

Mixed-Use Non-Residential



Resilient Design Strategy

Building Envelope and Access

Dry Floodproofing

Retail is kept at grade for sidewalk activation. During storm events, storefront doors are fitted with flood shields into built-in brackets. Retail space must be vacated prior to storm event. Walls, glazing supports, and building structure must be engineered to withstand hydrostatic pressure from floodwaters.

Building Envelope and Access

Wet Floodproofing

Residential access doors have flood vents and wet floodproofed lobby has saltwater-resistant materials. Access door and flood vents not shown.

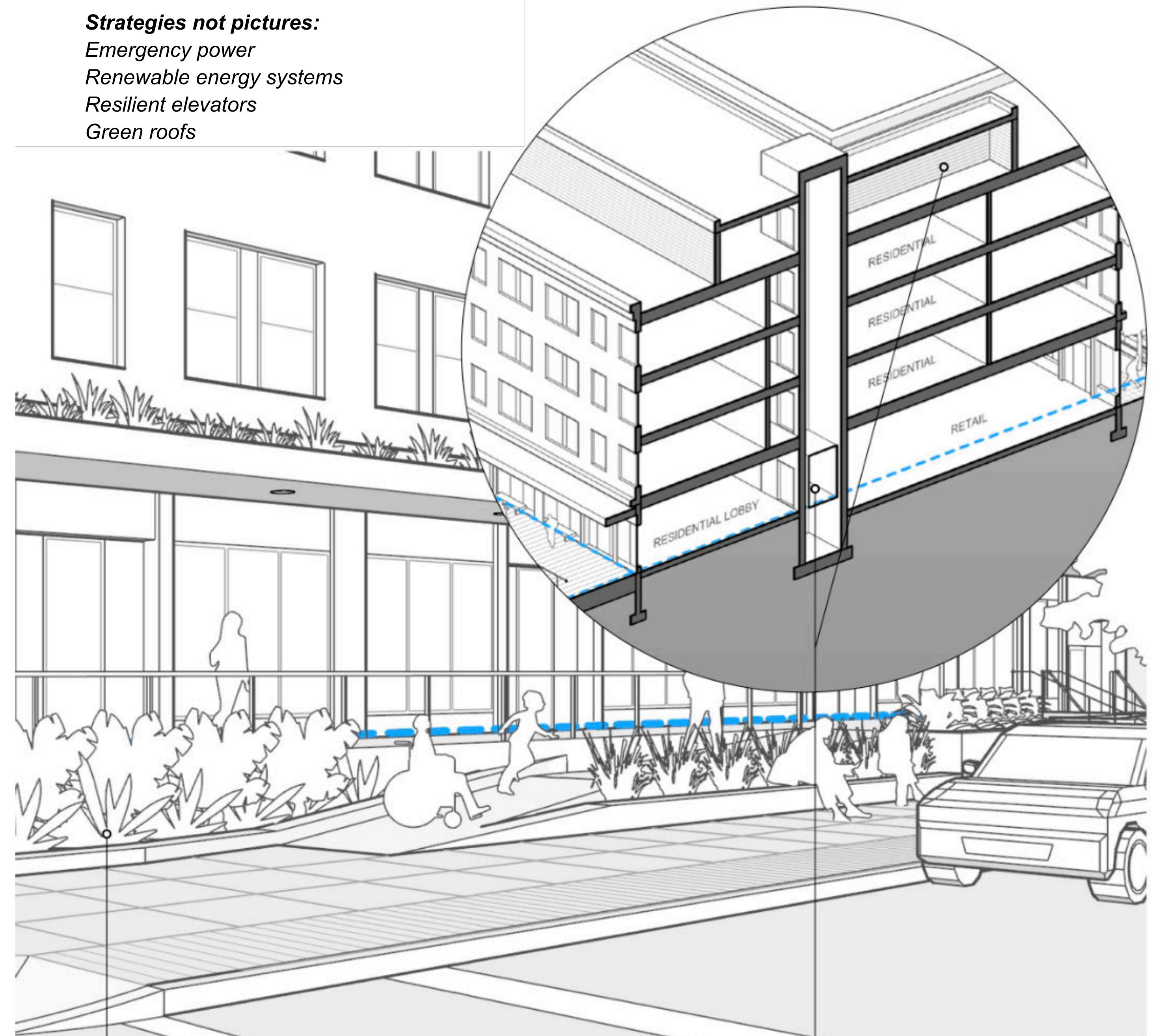
Supporting Strategy

Enhanced Envelope

Exterior insulation and high performance windows allow interior spaces to maintain interior temperatures despite loss of heating during a power outage.

Substantial Improvement Non-Residential Technical Considerations

Strategies not pictures:
Emergency power
Renewable energy systems
Resilient elevators
Green roofs



Elevate Lowest Interior Floor + Provide Exterior Circulation to DFE

Front facade is set back to allow for elevated walkways, accessible ramps, and stairs. Planters soften the transition between elevated hardscape and sidewalk, contributing to an improved public realm experience.

Protect Critical Systems

Locate critical systems and backup power generator in mechanical penthouse.

Resilient Elevators

Locate electrical controls and hydraulic pumps above the DFE. Use NEMA Type-4 rated enclosure for any electrical equipment that must be installed below the DFE.

Elevate Lowest Interior Floor with Interior Circulation to DFE

For buildings that have high first floor ceilings, a portion of the first floor may be elevated or reconstructed at or above the DFE to protect that floor from flood risk. Circulation to reach the elevated first floor level from an at-grade entry area may be provided by internal ramps and stairs.

Elevating a new or existing building's ground floor above the DFE can protect against flood damage; however, a change in ground plane may lead to the unintended consequences of disrupting the visual connection between pedestrians and building interior. One way to avoid this disruption is by providing a carefully designed interior circulation area that mediates an at-grade entry area with an elevated main floor.

Applicability

Building Type Triple decker, Townhouse, Post-War & Contemporary Mixed Use

Cost and Insurance Considerations

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- Elevation of structures insured under the NFIP may be eligible for FEMA Hazard Mitigation Assistance grants and flood insurance premium reductions.
- If a building is located within a FEMA zone, elevating the lowest floor would be a compliance activity and would not trigger a Substantial Improvement declaration.

Public Realm/Space Considerations

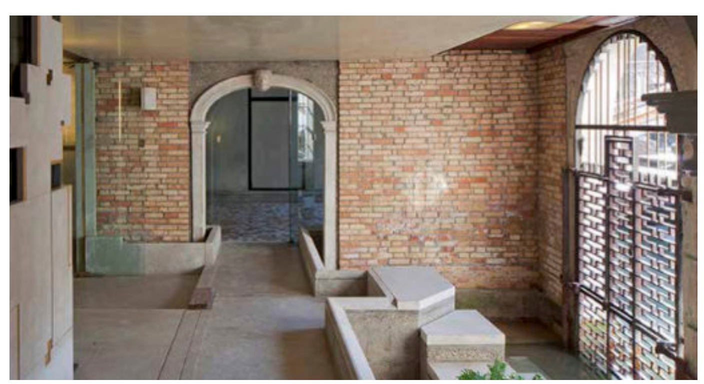
In new construction, to maintain visual connection at the sidewalk and an active streetscape circulation from at-grade lobbies (wet or dry floodproofed) can lead to elevated areas above the DFE.

This strategy may be an advantageous technique for maintaining the front façade of an historic building while enhancing the resilience of the structure.

Additional Resources

- FEMA P-1037 Reducing Flood Risk to Residential Buildings that Cannot Be Elevated
- FEMA P-467-2, Floodplain Management Bulletin - Historic Structures.

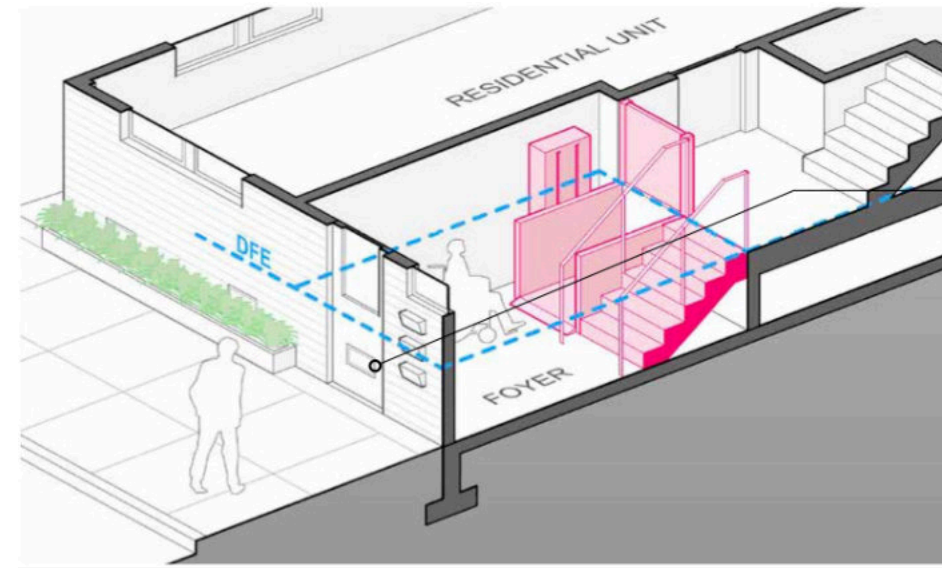
Retrofitted stairs lead to an elevated first floor in a retail shop in Darlington, Wisconsin. Photo: FEMA. 2013. Floodproofing Non- Residential Buildings.



Floodable entryway with stairs that lead to an elevated lobby at the Querini Stampalia in Venice, Italy. Architectours/ "The renovation of the Fondazione Querini Stampalia is great example of how Master Carla Scarpa integrated the new with the old."

Elevate Lowest Interior Floor Technical Considerations

Small Building Strategy



Openings

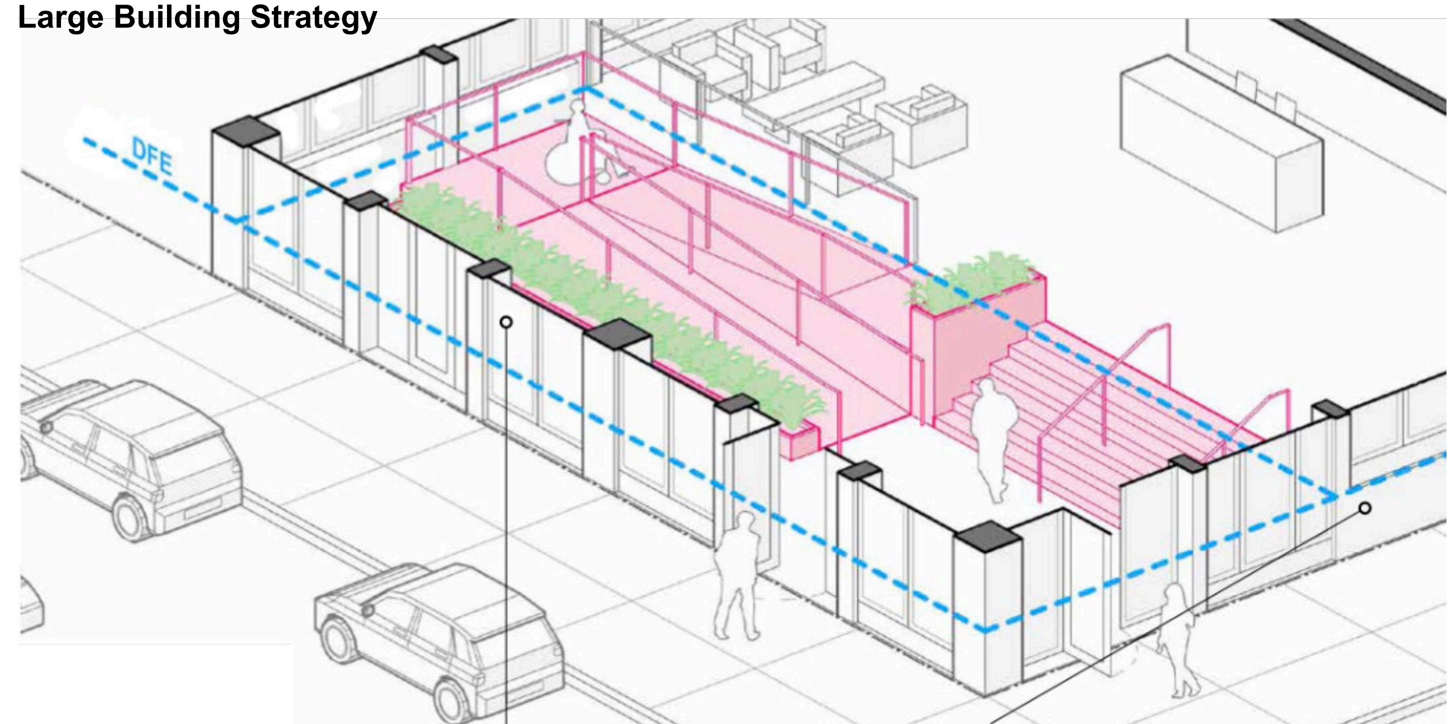
All penetrations, such as openings for HVAC, electrical, and plumbing systems, should be removed and relocated above the design flood elevation DFE.

Floodproofing below the DFE

The resulting space below the elevated interior floor should be filled to create a stem wall or retrofitted with flood openings (see wet floodproofing). Below-grade spaces for storage or parking may be maintained only if dry floodproofed in coordination with review and approval by an engineer for resistance to flood-related loads on the structure (see Dry Floodproofing). Spaces below the DFE are non-habitable.

Wet floodproofing of the entry area allows water to enter and exit through vents in the storefront wall or entry door equalizing hydrostatic pressure. The set floodproofed vestibule uses flood damage resistant materials.

Large Building Strategy



Ground Floor Height

The floor-to-ceiling height of the ground floor must be high enough to accommodate a reduced ceiling height. While many existing buildings may have this height capacity, an elevated floor may disrupt the way windows and doors relate to the first floor. so this strategy must be coordinated with the character of the existing facades and remain integrated with the public realm

Dry Floodproofing

Dry floodproofing may be utilized in a limited way to seal and reinforce the interior surfaces of the entry area and/or providing internal flood shields to prevent the seepage of water further into the building. Spaces below the DFE are non-habitable. This strategy allows for an at-grade connection between the sidewalk and the building to preserve the character of the buildings exterior (see Dry Floodproofing).

Elevate Lowest Interior Floor with Exterior Circulation to DFE

Circulation to reach the elevated first floor level is provided outside the building through exterior walkways, ramps or stairs. Design measures like planted area, seating, lighting, and contextually appropriate materials are used to contribute to visual interest - break up the scale of the larger surfaces and add to neighborhood character.

To avoid disrupting visual connectivity and interest along the streetscape designers should carefully consider the public space/real when elevating a building's first floor above the DFE for flood protection.

Applicability

Building Type Triple decker, Townhouse, Post-War & Contemporary Mixed Use

Cost and Insurance Considerations

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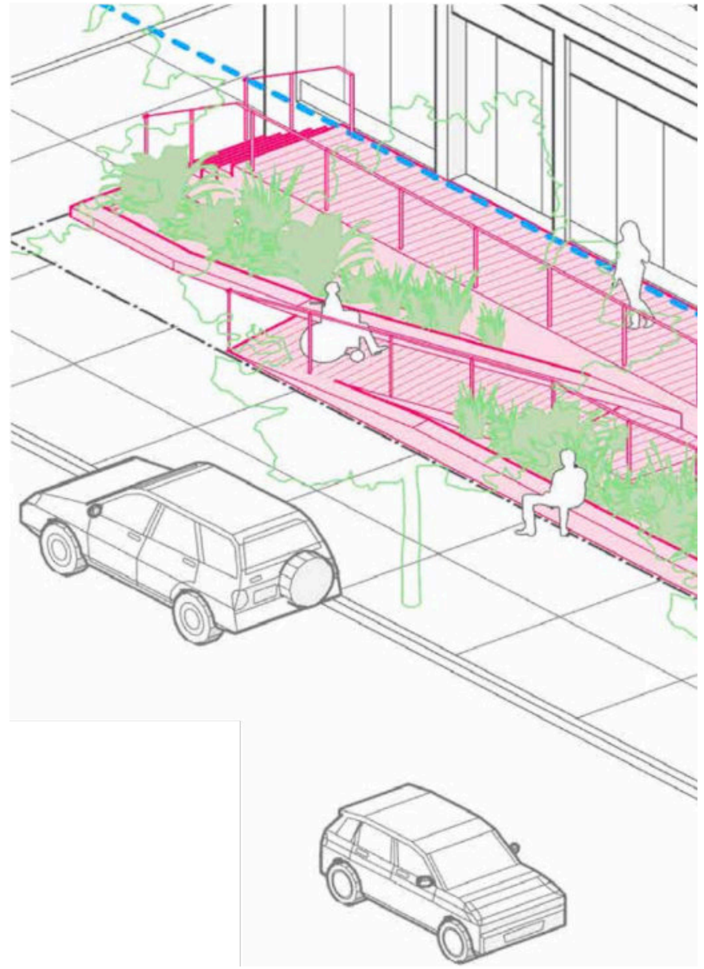
For projects within Article 25 (FEMA Zone) the elevation of structures insured under the NFIP may be eligible for FEMA Hazard Mitigation Assistance grants and flood insurance premium reductions.



Exterior Circulation and Vegetation

Saltwater tolerant planting is woven into the edges and railings that flank stairs and ramps, adding to visual interest along the sidewalk and softening the presence of paved areas. The use of vegetated areas also provides additional opportunities for stormwater and temperature mitigation.

Public Space /Realm Considerations
This strategy can enhance the public space if designed to add visual interest and to incorporate additional amenities such as landscape and seating.

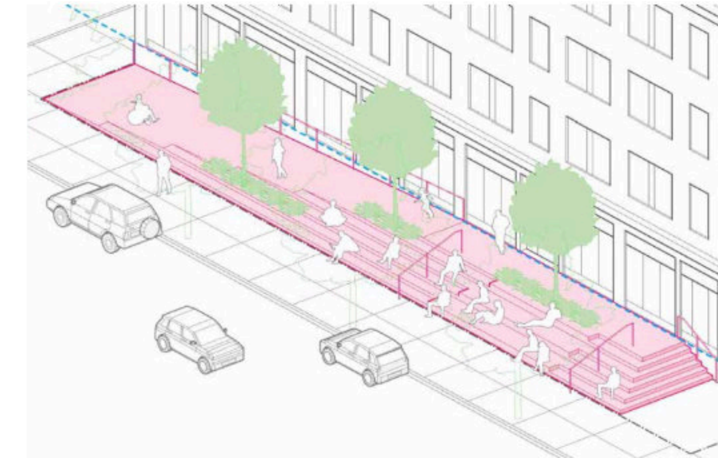
The design of exterior circulation elements should pay careful attention to universal design and accessibility: Ramps should be designed to be appealing to all users.

Additional Resources
FEMA P-1037 Reducing Flood Risk to Residential Buildings That Cannot Be Elevated.

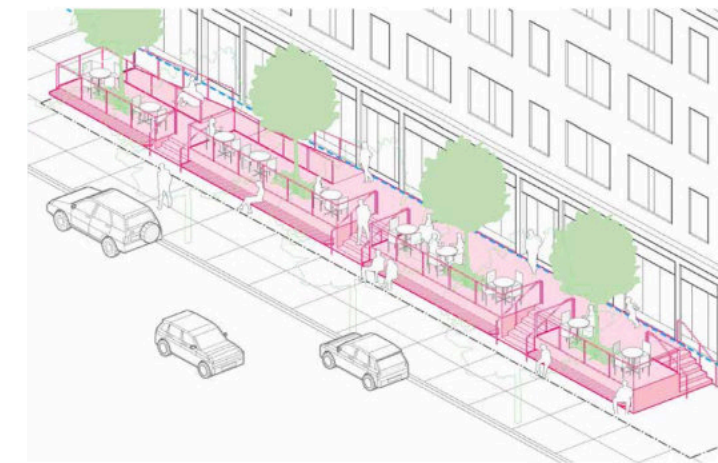
Highlands Central Business District Floodplain Design Guidelines

Exterior Circulation to DFE

Exterior Circulation and Public Seating
Internal gathering areas can blend seamlessly into stairways and ramps.

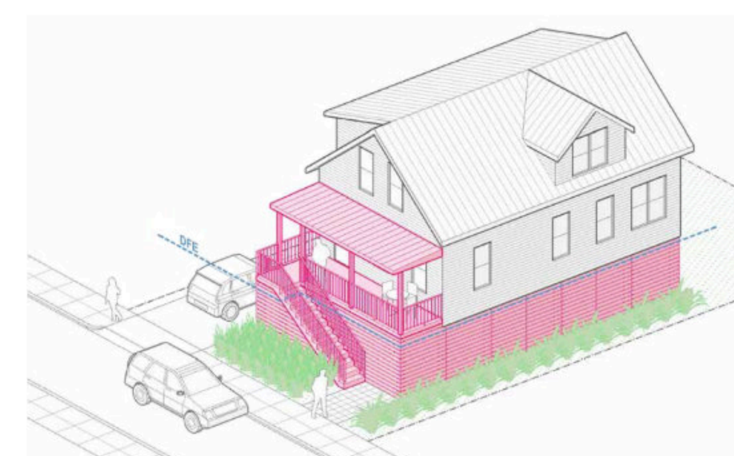


Exterior Circulation and Activated Deck
For walkways front restaurant or retail spaces, seating areas can activate the elevated areas, contributing to a lively streetscape.



Exterior Circulation for Small-Scale Residential Structures
When carefully designed to integrate with context, porches, stair railings, and screens can contribute to the human scale for sidewalk-facing areas.

Note that spaces below the DFE are non-habitable and uses are limited to parking, access, and storage, Residential structures cannot use dry floodproofing.



Exterior Circulation to DFE Technical Considerations

Alternatives for Access
If a front yard is not possible, an accessible exterior ramp may be provided with the side yard or rear yard.

Resisting Flood Loads
Stairs, rams and walkways must be designed to structurally resist design flood loads.

Floodproofing below the DFE
This strategy should be combined with floodproofing measures below the DFE to protect against flood damage. This would include either wet floodproofing to allow automatic entry and/or exit of floodwaters to dry floodproofing.

Consider the Public Right-of-way
Exterior ramps and stairs may not encroach into the pubic right-of-way. If a building has intentional setback that provided publicly accessible private space, that space may be used to accessible external ramps.

Boston Planning & Development Agency Coastal Flood Resilience

NEW CONSTRUCTION

Built Mixed-Use *Sea Bright New Jersey, Ocean Avenue. Retail above DFE Residential units with parking under DFE*

DESIGN-MIXED-USE *Three lots 15,000SF*

20,000SF Building ***Parking under DFE 17 spaces on-site 9 spaces off-site***

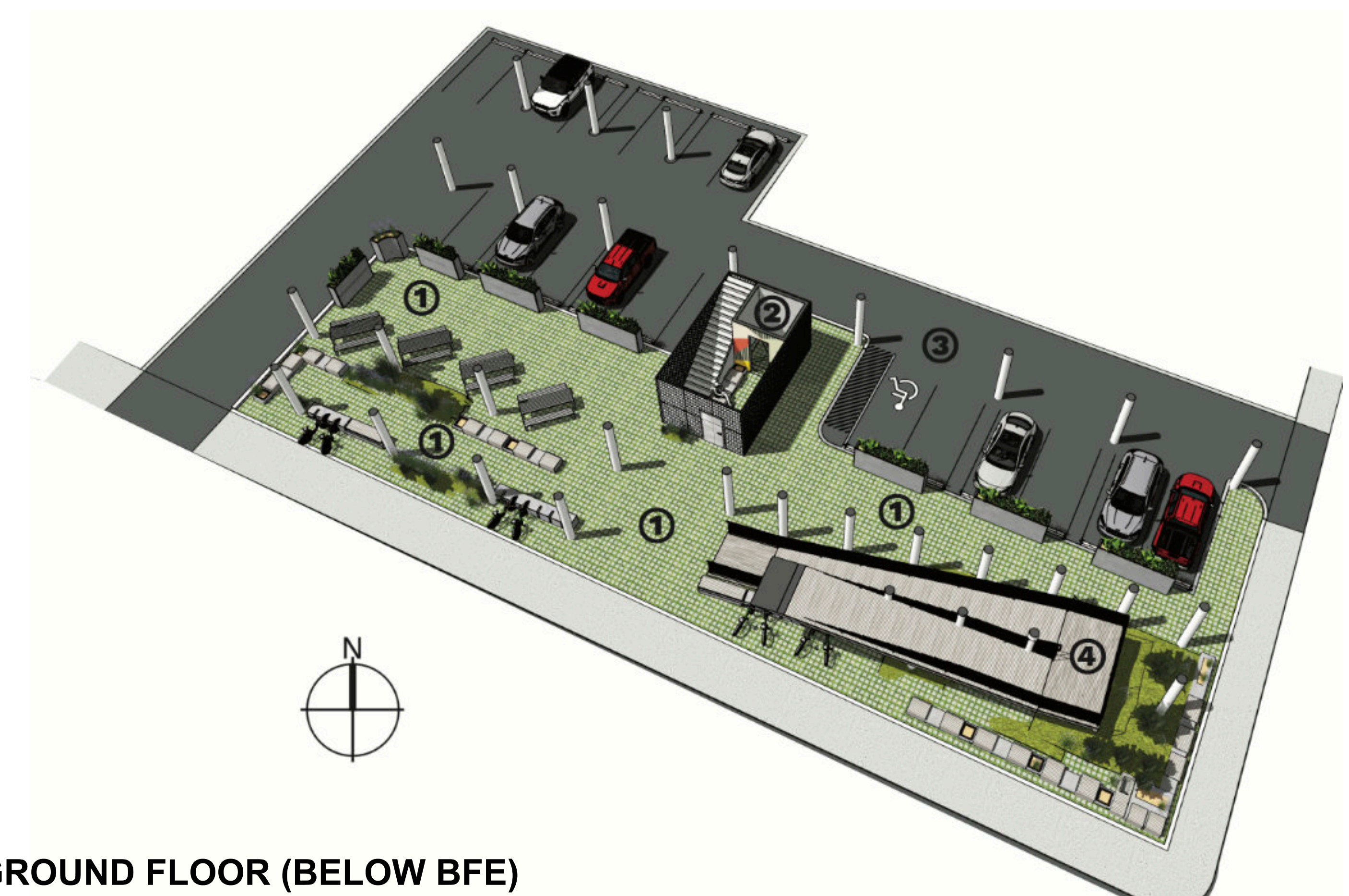
7,200SF elevated flex retail *12,800SF elevated residential*

1,400SF Ground level promenade events, gathering, placemaking to support Artisan Uses.

1,430SF Roof top event space

NEW CONSTRUCTION - DESIGN

SITE PLAN   TOTAL LOT SIZE = 15.000 sq ft

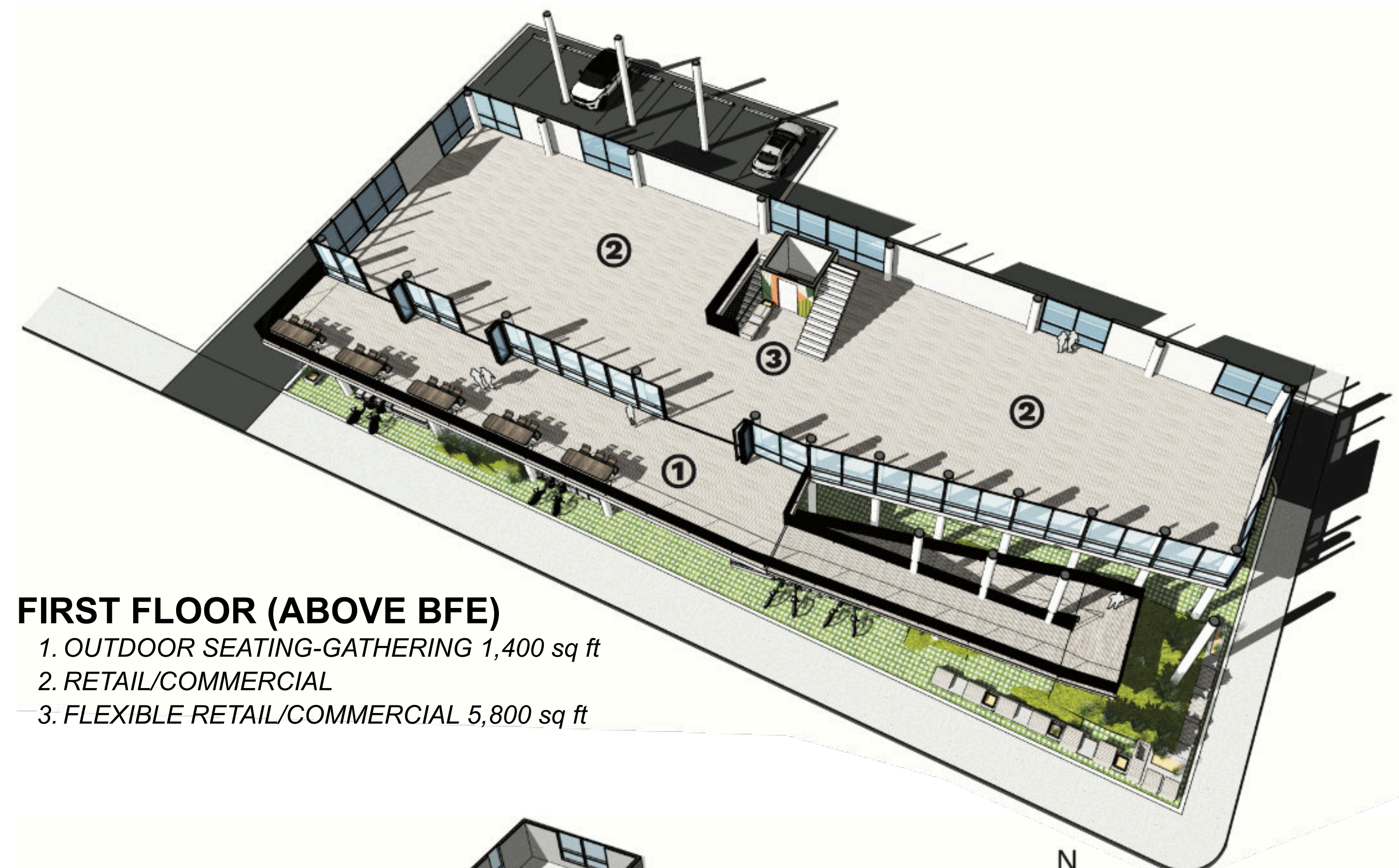


GROUND FLOOR (BELOW BFE)

GATHERING/PLACE MAKING/EVENTS

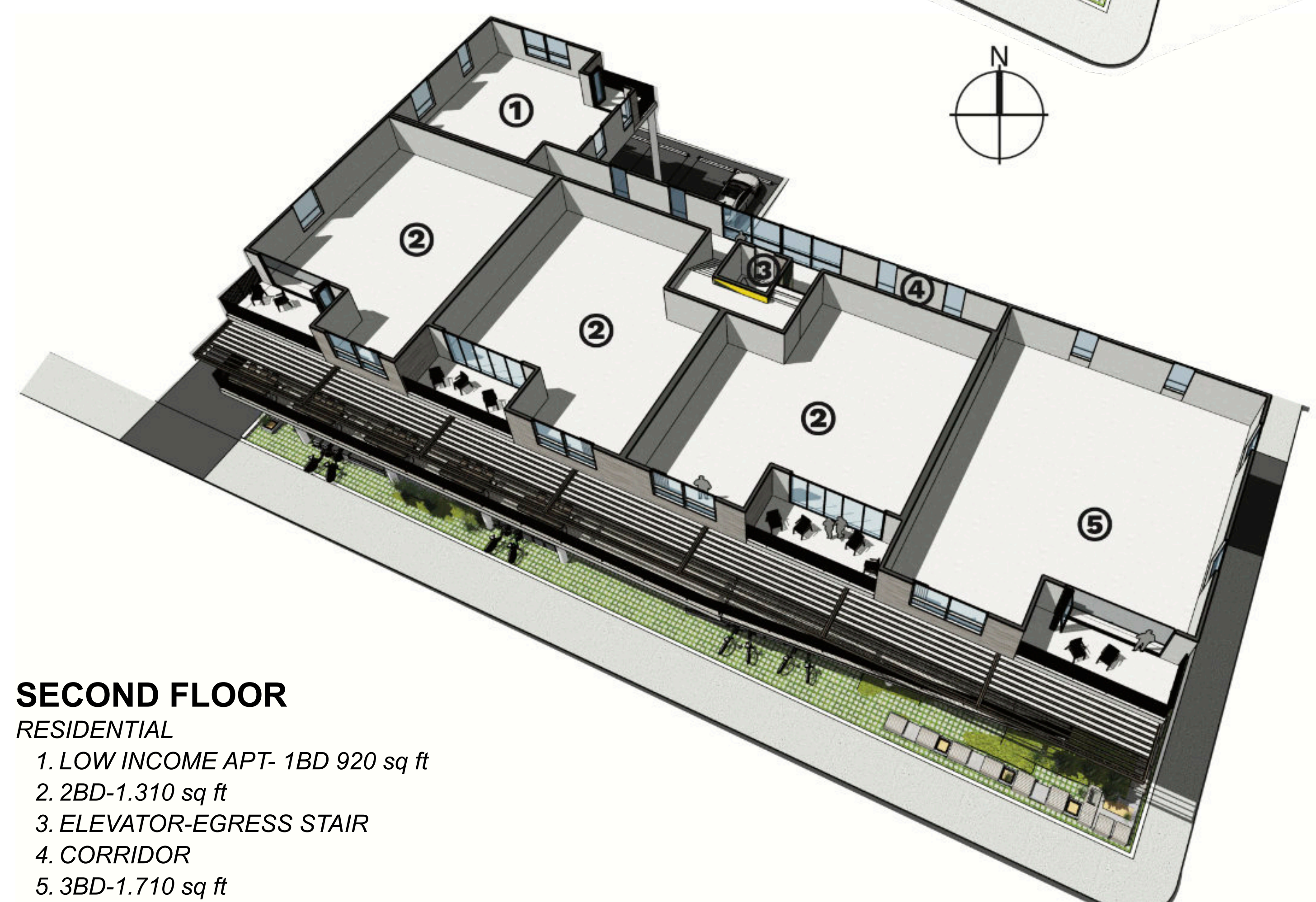
1. *MIXED USE-GATHERING/PLACE MAKING (RAIN GARDENS / PERMIABLE SURFACE/PAVERS)*
2. *MAIN ENTRANCE/ELEVATOR RESIDENTIAL*
3. *PARKING 17-ON SITE 9- OFF SITE*
4. *MAIN ENTRANCE/ADA RAMP RETAIL-COMMERCIAL*

NEW CONSTRUCTION - DESIGN



FIRST FLOOR (ABOVE BFE)

1. *OUTDOOR SEATING-GATHERING 1,400 sq ft*
2. *RETAIL/COMMERCIAL*
3. *FLEXIBLE RETAIL/COMMERCIAL 5,800 sq ft*

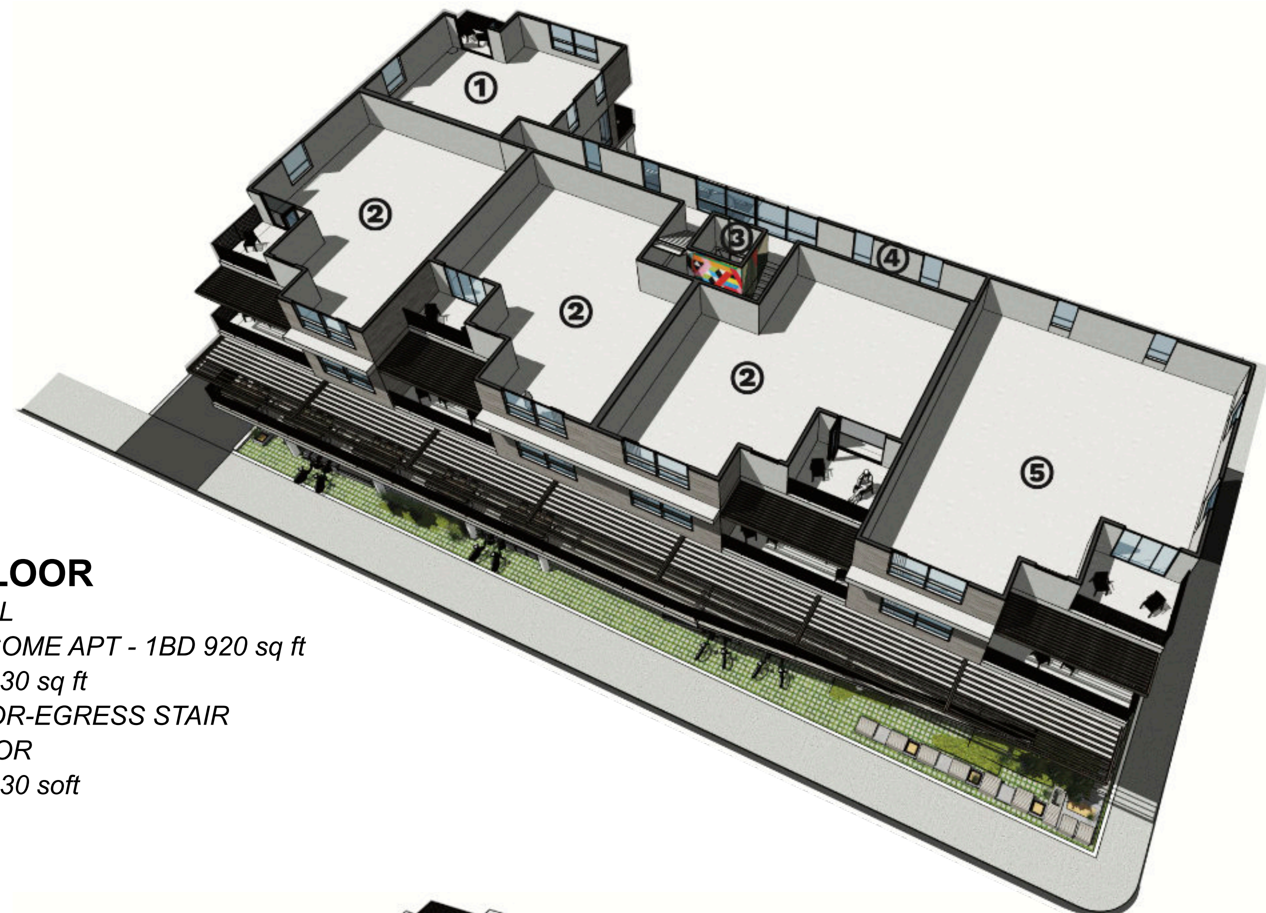


SECOND FLOOR

RESIDENTIAL

1. *LOW INCOME APT- 1BD 920 sq ft*
2. *2BD-1.310 sq ft*
3. *ELEVATOR-EGRESS STAIR*
4. *CORRIDOR*
5. *3BD-1.710 sq ft*

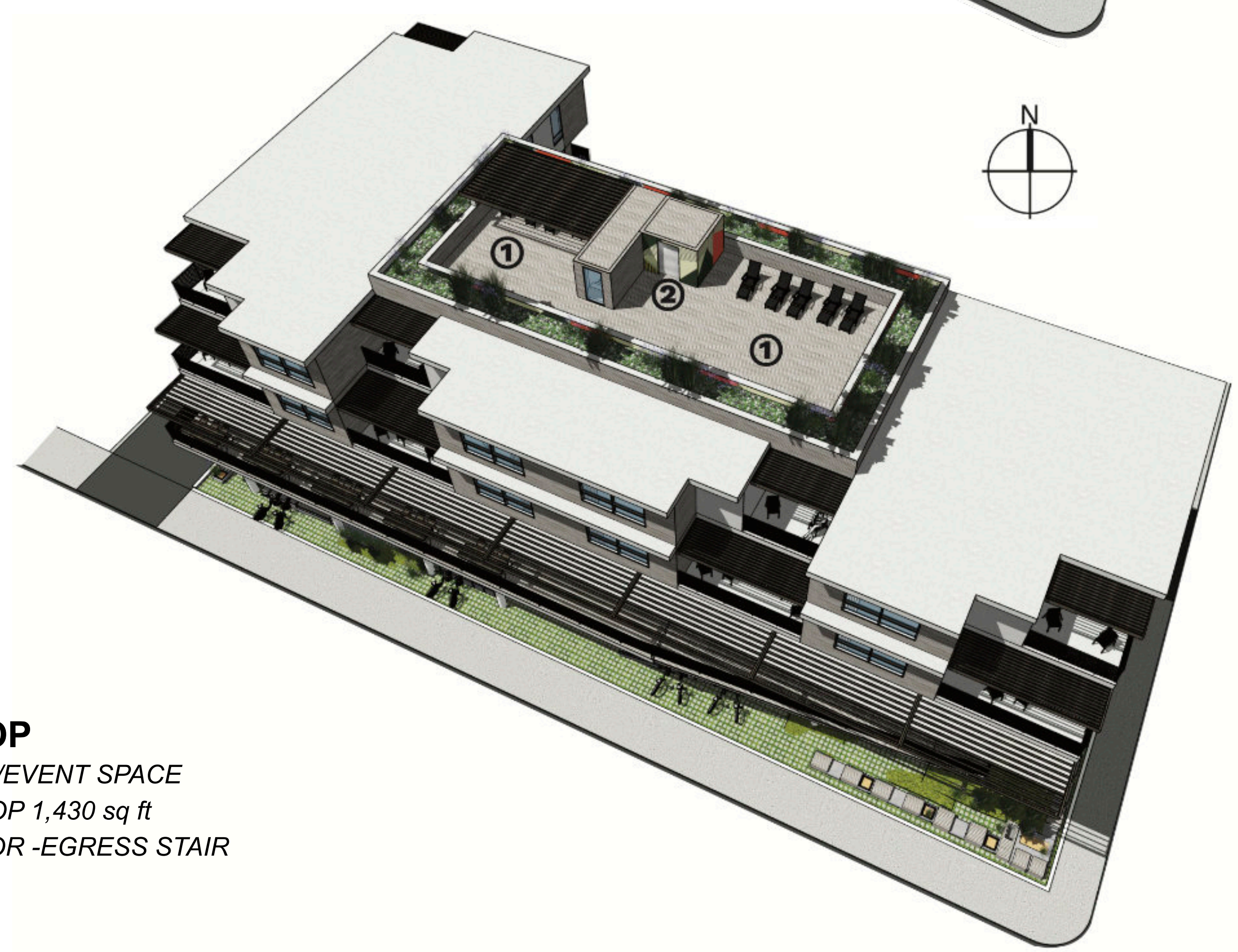
NEW CONSTRUCTION - DESIGN



THIRD FLOOR

RESIDENTIAL

1. *LOW INCOME APT - 1BD 920 sq ft*
2. *2BD - 1,230 sq ft*
3. *ELEVATOR-EGRESS STAIR*
4. *CORRIDOR*
5. *3BD - 1,630 soft*



ROOF TOP

GATHERING/EVENT SPACE

1. *ROOF TOP 1,430 sq ft*
2. *ELEVATOR -EGRESS STAIR*

NEW CONSTRUCTION - DESIGN

SECTION A
STRUCTURAL - ELEVATOR

1. *REINFORCED CONCRETE COLUMN W/FOOTINGS @MIN.. 3' B.G.*
2. *HYDRAULIC ELEVATOR PIT - REINFORCED CMU BLOCK SHAFT AND PIT W/ REINFORCED CONCRETE FOOTING @ 6' B.G.*
   (ELEVATOR CAB, EQUIP, ROOM PUMP, RESERVOIR + CONTROL PANEL TO BE HOUSED ABOVE BFE)
3. *ELEVATOR SHAFT ENCLOSURE - EFMA APPROVED GLASS BLOCK W/WATERPROOF MORTAR W/ REINFORCED CONCRETE FOUNDATION AND FOOTING W/HYDROSTATIC VENTS @ 1' A.G.*
4. *LOCAL ARTIST COMPETITION TO PROVIDE GROUND FLOOR CEILING + ELEVATOR SHAFT ART*

NEW CONSTRUCTION - DESIGN

SOUTH PERSPECTIVE

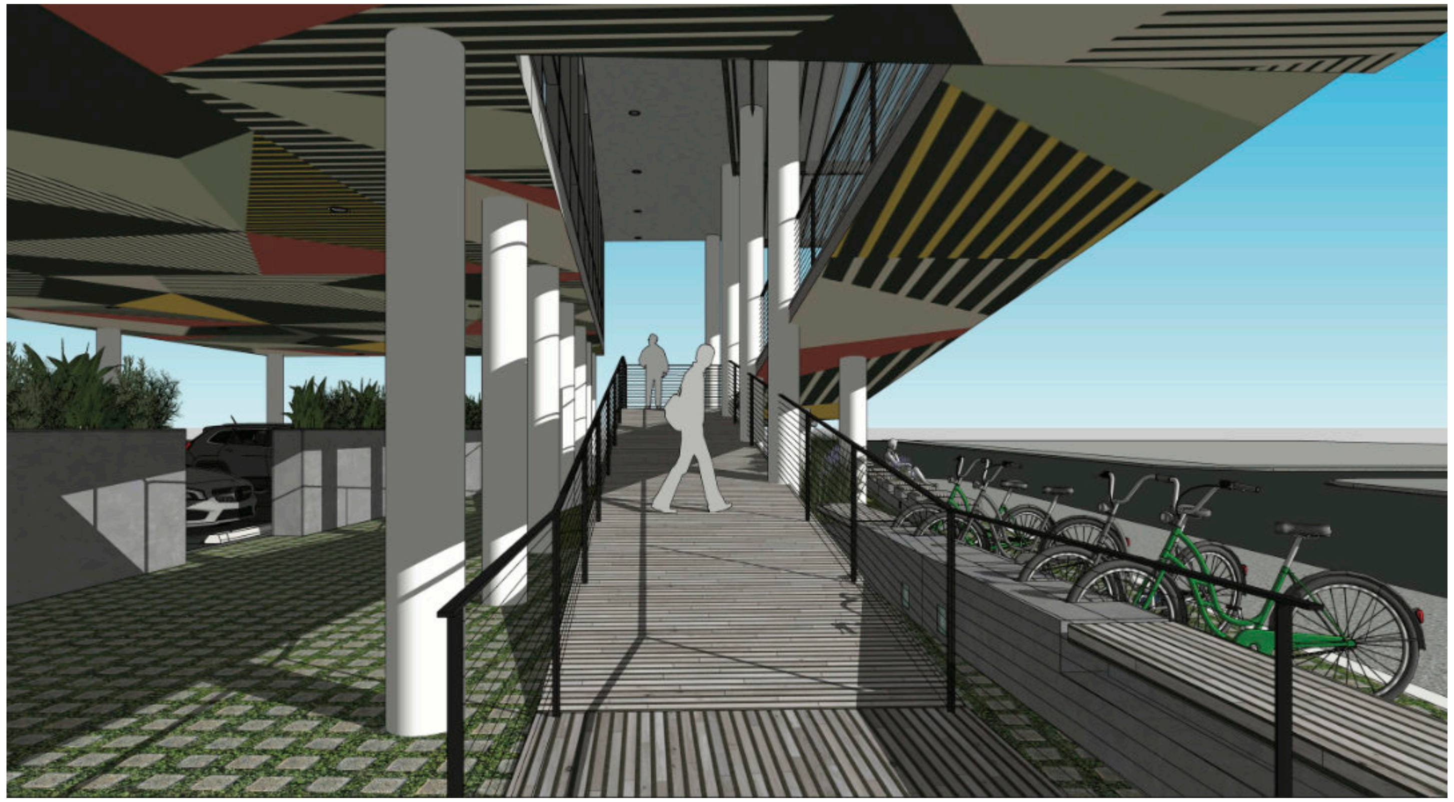
SOUTHEAST PERSPECTIVE

NEW CONSTRUCTION - DESIGN

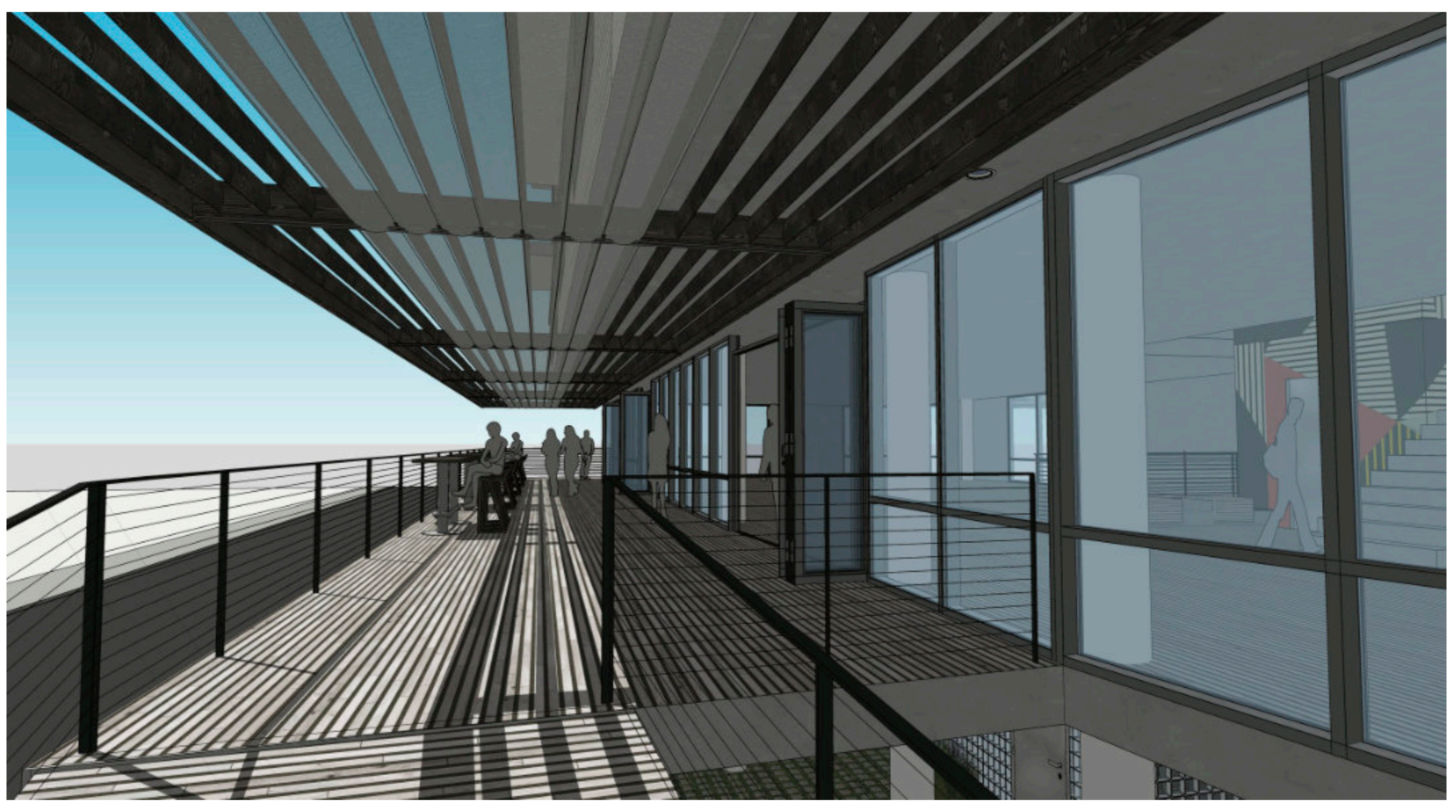
FLEXIBLE EVENT SPACE - PROMENADE

- *Elevated retail/commercial with outdoor promenade- Nautical Village*
- *Space of events, music, gathering and place making to support Artisan Uses*
- *Ground Flood (Below BFE) Parking under structure in rear*
- *Main Entrance/ADA ramp elevated retail/commercial/elevator residential*

NEW CONSTRUCTION - DESIGN



ADA Ramp/Elevator to Retail/Commercial elevated first floor outdoor seating/gathering.



FIRST FLOOR OUTDOOR SEATING - GATHERING

NEW CONSTRUCTION - DESIGN

EAST PERPECTIVE

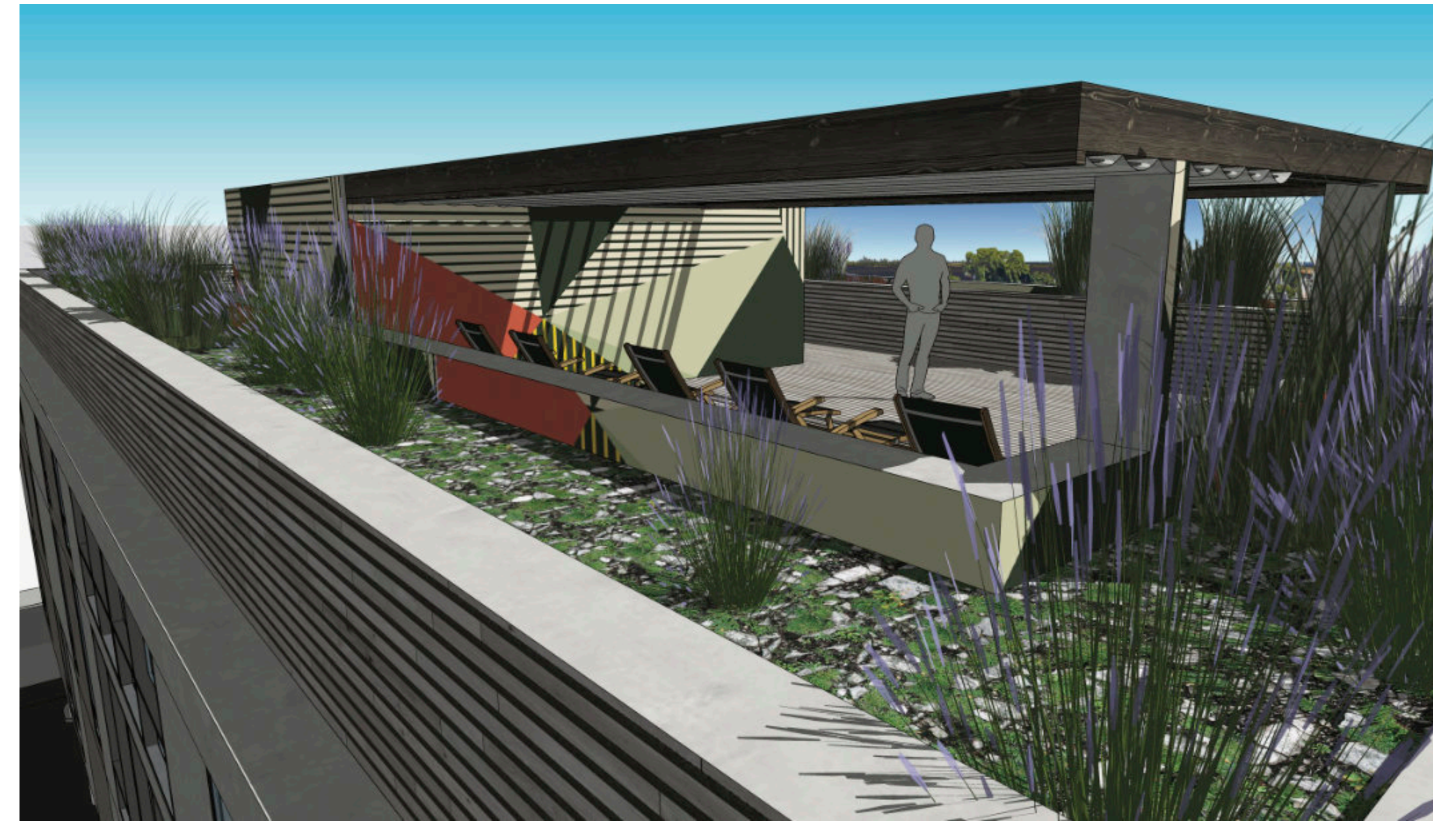
EAST PERPECTIVE

NEW CONSTRUCTION - DESIGN

NORTHEAST PERPECTIVE

NORTHWEST PERPECTIVE

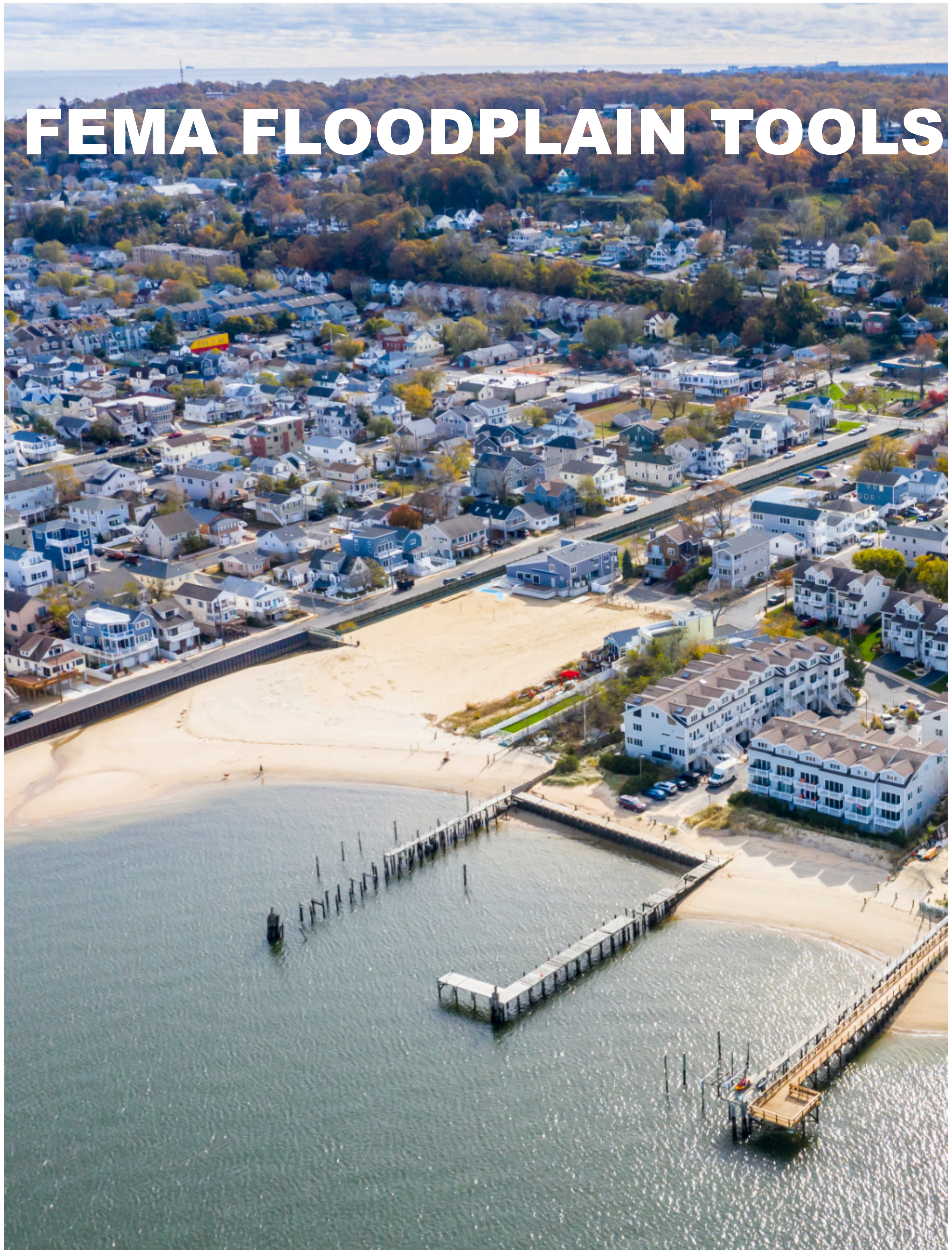
NEW CONSTRUCTION - DESIGN



NORTHWEST ROOF TOP - EVENT SPACE

SOUTHHWEST ROOF TOP - EVENT SPACE

FEMA FLOODPLAIN TOOLS



DRY FLOODPROOFING

Non-residential buildings are a category of treatments aimed at inhibiting water from entering a structure. This technique is appropriate for low flood elevations and structures that can withstand hydrostatic and hydrodynamic loads imposed by flooding.

Dry flood proofing should be thought of as a system of multiple components working together, including:

- Watertight enclosures for openings, doors, windows, and floors, including shields and barriers, often requiring human intervention prior to a storm event; types of flood shields include sliding, lift-out, modular panel, bolt-on, hinged and automatic.
- Membranes and sealants to reduce seepage of floodwater through walls and utility.
- Structural reinforcement to wall assemblies so that they can resist hydrostatic pressure, flotation, or collapse.
- Pumping and drainage systems with backup power to control water intrusion.
- Backflow or check valves to prevent the entrance of water or waste through plumbing systems.
- Flood doors and egress requirements.

Cost and Insurance Considerations

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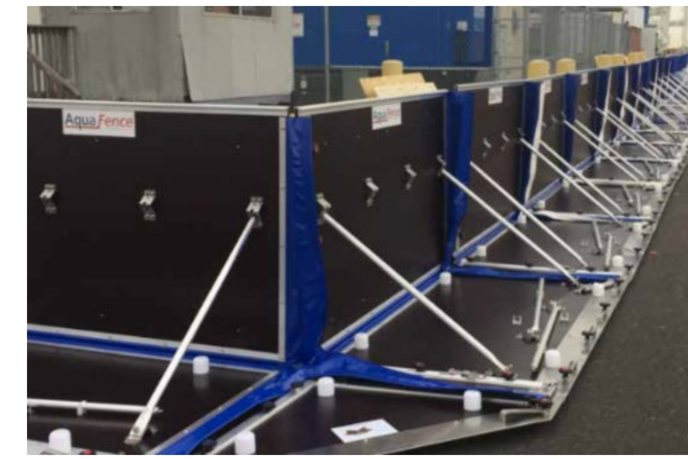
Dry floodproofing is more expensive than wet floodproofing for new construction. Cost increases for larger structures and for higher design flood elevations. Consider storage requirements and operational elements (time and cost) required to assemble any deployable features.

Residential buildings dry floodproofing does not result in NFIP premium rate reductions and is not allowed by the State Building Code for residential spaces below the FEMA BFE, plus one-foot freeboard.

Public Space Considerations

- Dry floodproofing can allow for active uses such as retail to remain on the ground floor of a building
- Proponents of using dry floodproofing should carefully study how to best integrate any permanent elements such as the mounting and brackets for shields and barriers.



Temporary. portable, and deployable food barriers
Photo: Aquafence

Flood panels connected to rem0vable posts.
Photo: Flood Panels LLC

Additional Resource

- FEMA P-956, Floodproofing Non-Residential Buildings.
- FEMA P-1037, Reducing Flood Risk to Residential Buildings That Cannot be Elevated.

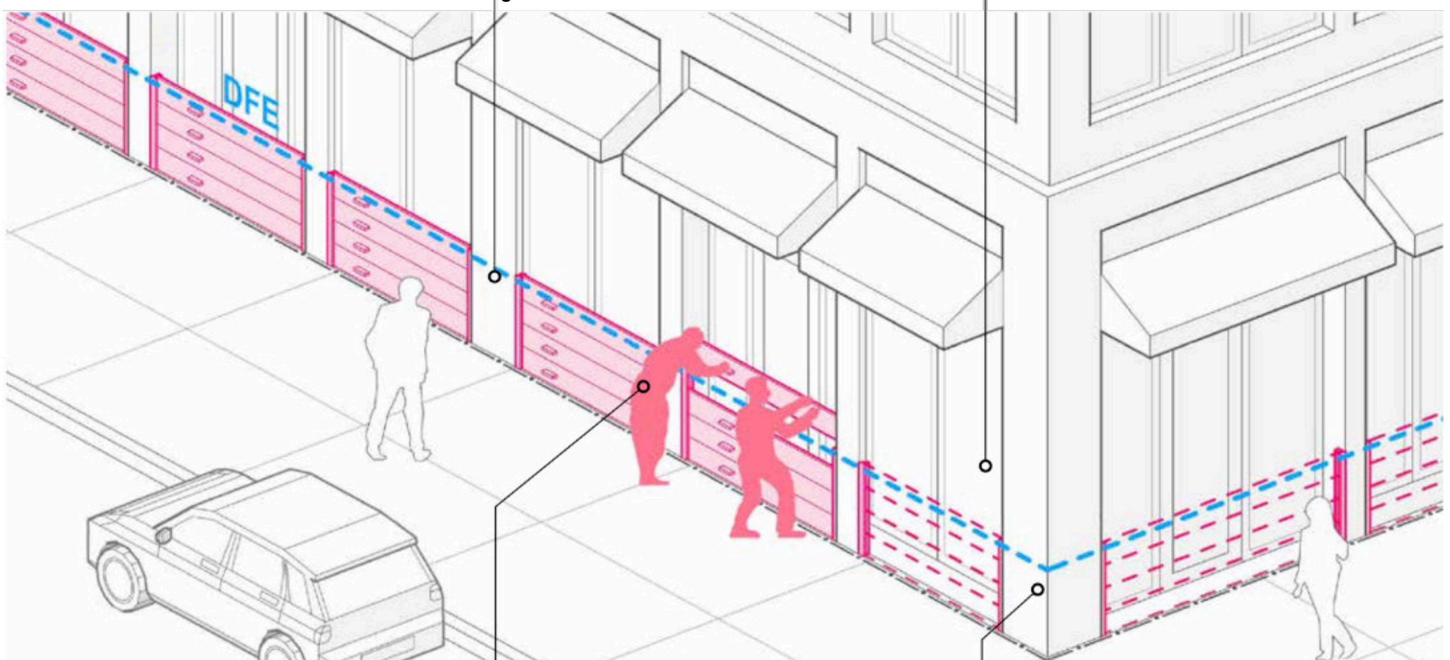
Dry Floodproofing Technical Considerations

Suitability
Dry floodproofing is not allowed to protect residential buildings, except for parts of a building that are used for access, or storage. For all other uses, if utilizing a temporary flood barrier system, consider setting the barriers back to allow for an area of building code requirements, as well as a movable code-compliant stair, handrails, and landing. Any temporary barrier or means of egress should not encroach into the public right of way.

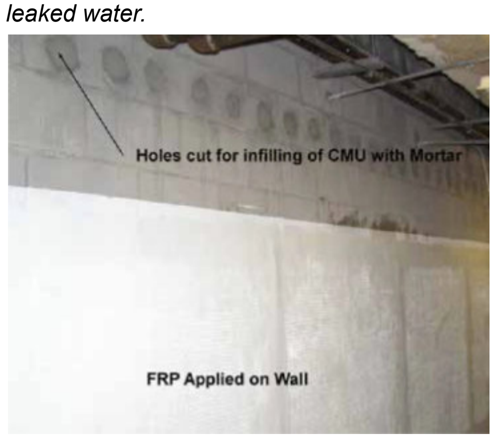
Flooding Depth
Dry floodproofing is most practical where flood depths do not exceed 3' and when flood velocities and durations are low.

Per FEMA standards, dry floodproofing is not allowed in special flood hazard areas with high velocity wave-action (V-Zones, Coastal A-Zones) because it does not protect against wave action erosion, scour, and may make the building subject to greater risk of structural failure.

Means of Egress
Flood barriers cannot block an accessible means of egress. Per ASCE 24-14, a dry floodproofed building must have at least one door satisfying building code egress requirements for an emergency escape above the applicable flood elevation.



Sealants and Interior Drainage
Waterproofing and sealants can be applied either to the exterior or interior side of walls and floors (as shown below) to make them impermeable. Water may still seep through small openings in a dry floodproofed building. Therefore, a dry floodproofed building requires a drainage system utilizing sump pumps with backup power to remove any leaked water.



Interior waterproofing and structural reinforcing Source: FEMA 2013. Floodproofing Non-Residential Buildings.

Human Intervention
Dry floodproofing often requires human intervention for storage, maintenance, and implementation of shields and barriers, along with training of building owners or facilities personnel to property deploy and maintain these systems. These dry floodproofing systems should be incorporated into a building's emergency operations plan.

Drop-in flood shields inserted into brackets Photo: Flood Panels LLC

Structural Integrity
Engineering must be performed to ensure the structure can withstand hydrostatic pressure by flood waters and saturated soils. This includes reinforcing above-grade walls and foundations to withstand these flood pressures. Because of the flood pressures imposed by water and saturate soils, dry flood proofing is most appropriate for concrete and load-bearing masonry structures without basements.

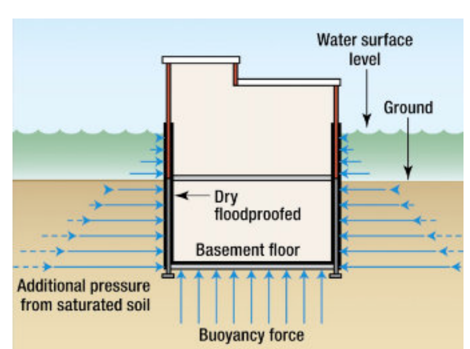


Diagram showing various hydrostatic forces on building. Source: FEMA. 2013. Floodproofing Non-Residential Buildings.

WET FLOODPROOFING

Wet floodproofing is an adaptation measure that allows flood waters to enter and exit portions of a building not used as living space such as crawl spaces, walk-out basements, or floodable ground floors.

Flood openings are important to allow water to enter and exit the structure and rise and fall at the same rate inside and outside of the building. Therefore, wet floodproofing requires proper planning for the quantity, type, and location of flood openings.

This strategy avoids structural damage by equalizing hydrostatic pressure on walls as well as damage from buoyancy or uplift forces. In addition to providing openings that allow the entry of flood waters wet floodproofing requires the use of flood-resistant materials below the flood elevation, the protection of service equipment from flood damage, and the relocation of high value contents. Examples of engineered flood openings include grilles, vents, and hinged panels that automatically open in both directions to allow water to pass.

Continuing Education Center/Photo by Smart Vent Products, Inc.

FEMA. 2013. Floodproofing Non-Residential Buildings.

Applicability
Non-Residential Structures must utilize dry flood-proofing tools

NFIP regulations do not permit wet flood-proofing to be used to bring a Substantial Improvement//Damage structure into compliance unless the area to be wet flood-proofed is used solely for parking building access, or storage (44 CFR 60.3(c)(5)).

Some non-residential buildings can benefit from using a combination or wet and dry flood proofing,

Building Type
- Multi-story or split-level buildings, where different measures can be applied to different foundation types at difference elevations.
- Residential spaces within triple decker Townhomes
- General industrial

Cost and Insurance Considerations

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- Wet floodproofing is less expensive than dry flood-proofing. Additional cost considerations should also include expenses for related measures such as building elevation, providing access to elevated areas. Installation of flood-resistant materials. Rearrangement of utility systems, and post-flood cleaning to control exposure to pollutants and prevent mold growth.
- Non-residential structures must use dry flood- proofing.

Public Space/Realm Considerations
If combined with providing interior circulation to a raised interior floor, a wet floodproofed lobby of access area can maintain at-grade connection between sidewalk and building entry.

Additional Resources
- FEMA P-936 Floodproofing Non-Residential Buildings
- FEMA Technical Bulletin 1 Openings in Foundation Walls and Walls of Enclosures
- Floodproofing.com

Wet Floodproofing Technical Considerations

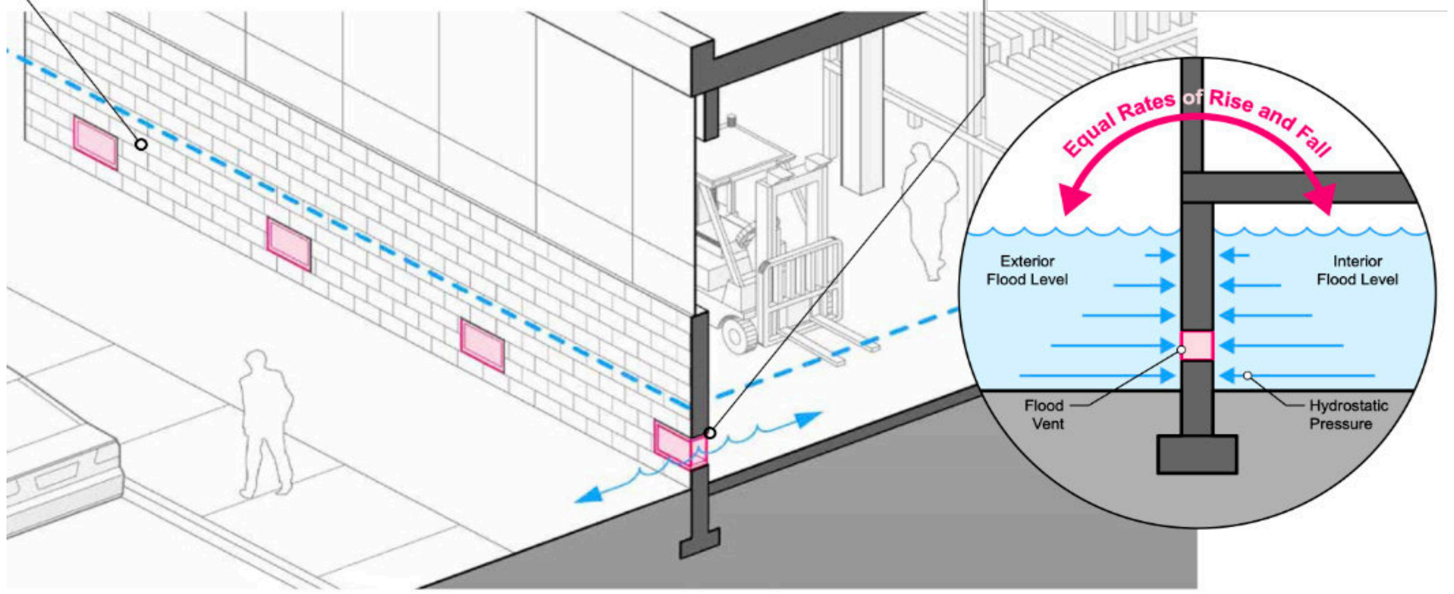
Materials

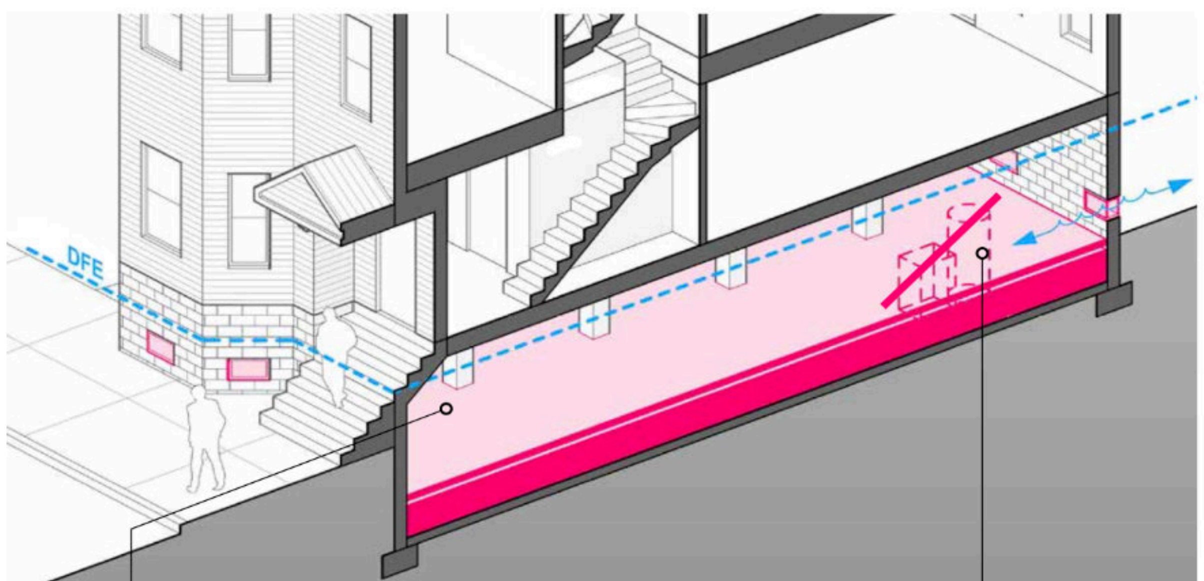
Use flood-damage-resistant materials in wet floodproofed enclosures, such as concrete, stone, masonry block, ceramic and clay tile, pressure-treated lumber, epoxy-based paints, and metal. These materials may require additional treatment to protect against damage from repeated saltwater inundation. Avoid paper-faced gypsum wall board and non-treated wood. (See Flood-damage Resistant Materials.) Water from flooding may carry contaminants so post-flooding health risks should be mitigated by contracting certified clean-up professionals. Hazardous household materials should not be stored in wet floodproofed spaces. After flooding, objects and materials that have been exposed to water should be cleaned and dried or disposed of following guidelines from local officials. Affected areas should be allowed to adequately dry with 24 hours to prevent mold growth.

Openings

Per FEMA standards for non-engineered openings, at least two wall openings (one in two different walls) below the base flood elevation in each enclosed area should be provided, at a location of no more than 1' above grade. One square inch of opening for every square foot of enclosed floor area should be provided.

Openings should be carefully maintained to ensure they are not clogged with debris and can be opened if movable parts are part of





Spaces below the DFE

When wet floodproofing a retrofitted building, sub-grade spaces should be filled to the nearest adjacent grade to allow water to drain out of the structure slowly by gravity. Pumping can cause serio structural damage if surrounding soils are still saturated and is not recommended. Spaces below the DFE are non-habitable and use is limited to storage, parking, and access.

Utilities

Any utility or service equipment such as ductwork, heaters, and electrical lines should be removed from a wet floodproofed space and relocated above the design flood elevation.

FLOOD DAMAGE-RESISTANT MATERIALS

Flood damage resistant materials are any building material component or system capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage.

These materials are used in conjunction with other strategies in this guide such as wet and dry floodproofing to prevent damage where contact with floodwaters may occur. Flood damage-resistant materials remain intact during wetting and drying and do not deteriorate when cleaned for pollutant removal after a flood event, facilitating faster, safer, and less expense post storm recovery.

The NFIP classifies material types according to their ability to withstand flood damage. **Highly resistant materials include** *concrete, stone, masonry block, ceramic and clay tile*, Pressure treated and naturally decay-resistant lumber, epoxy-based paints and metal. **Vulnerable material include** *gypsum wall board blown in and fiberglass batt insulation carpeting and oriented strand board*.

Building Type Non-residential spaces

- Consider the combination of materials when evaluating flood damage resistance. For example, plastic sheet or tile flooring adhered to a concrete slab (both damage-resistant materials) would together qualify as a flood damage-resistant assembly.
- If the same plastic subfloor the assembly would not qualify as flood damage-resistant, because the floor finish restricts drying of the more vulnerable plywood subfloor.
- Adhesives between materials, as well as fasteners and connectors that hold assemblies together, should be considered when evaluating the resistance of surfaces below the flood elevation.

Applicability

Building Type Non-Residential spaces

- As an incremental solution for buildings outside of the FEMA floodplain, partial retrofitting of ground floor spaces with flood damage resistant materials can make cleaning and repair easier in the event of flooding. Lower portions of a wall under the flood elevation can be fitted or retrofitted with flood tolerant materials or with materials that can be easily removed and replaced.

Cost and Insurance Considerations

- The use of flood damage resistant materials can contribute to eligibility for insurance premium reductions for projects insured under the NFIP.
- Dry floodproofing methods should not be used in FEMA V Zone for spaces below the lowest floor.

Additional Resources

FEMA Technical Bulletin 2: Flood Damage Resistant Material Requirement

Class Descriptions
Flood Damaged Resistant Materials

Class descriptions of flood damage-resistant materials

The NFIP classifies material types according to their ability to withstand flood damage.

NFIP Class	*Class Description*	*Example Materials*
ACCEPTABLE		
Class 5	Highly resistant to floodwater* damage, including damage caused by moving water. These materials can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants. Materials in this class are permitted for partially enclosed or outside uses with essentially unmitigated flood exposure.	▪ Concrete ▪ Stone ▪ Masonry Block ▪ Ceramic and clay tile ▪ Pressure-treated lumber
▪ Class 4	Resistant to floodwater damage from wetting and drying but less durable when exposed to moving water. These materials can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants. Materials in this class may be exposed to and/or submerged in floodwaters in interior spaces and do not require special waterproofing protection.	
UNACCEPTABLE		
Class 3	Resistant to flood water damage from wetting and drying but less durable when exposed to moving water. These materials can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants. Materials in this class may be exposed to and/or submerged in flood waters in interior spaces and do not require special waterproofing protection.	▪ Gypsum wall board ▪ Blown-in and fiberglass batt insulation ▪ Carpeting ▪ Oriented strand board
Class 2	Not resistant to clean water damage. Materials in this class are used in predominantly dry spaces that may be subject to occasional water vapor and/or slight seepage. These materials can not survive the wetting and drying associated with floods	
Class 1	Not resistant to clean water damage or moisture damage. Materials in this class are used in spaces with conditions of complete dryness. These materials cannot survive the wetting and drying associated with floods.	

Source: NFIP Technical Bulletin 2 (FEMA2008a).

- Floodwater is assumed to be considered "black" water; black water contains pollutants such as sewage, chemicals, heavy metals, or other toxic substances that are potentially hazardous to humans.
- Moving water is defined as water moving at low velocities of 5' per second or less. Water moving at velocities greater than 5' per second may cause structural damage to building materials.
- Some materials can be successfully cleaned of most of the pollutants typically found in floodwater. However, some individual pollutants such as heating oil can be extremely difficult to remove from uncoated concrete. These materials are flood damage-resistant except when exposed to individual pollutants that cannot be successfully cleaned.
- Clean water includes potable water as well as "gray" water; gray water is wastewater collected from normal uses (e.g. laundry, bathing, food preparation).

PROTECT CRITICAL SYSTEMS

Building utility systems, including electrical and mechanical equipment, should be protected from flood risk to avoid costly damage, safety risks, and loss of habitability and other critical building functions during a flood event. This should be among the highest priority resilience actions for property owners.

For all new construction and substantial improvements, electrical, heating, ventilation, plumbing and air-conditioning equipment and other service facilities shall be designed and/or located to prevent water from entering or accumulating withing the components during conditions of flooding. These systems and equipment include:

Mechanical
- Air-handler, condenser units, and heat pumps
- Ductwork and piping
- Fuel storage tanks
- Water heaters
- Fire-suppression sprinkler controls
- Elevator machine rooms

Electrical
- Electrical panels and switchgear
- Backup generators
- Alarm controls and components
- Service wiring and receptacles
- Building management systems
- Telecommunications equipment
- Electric and gas meters
- Utility shut-off switches

With proper planning new buildings can easily accommodate the protection of critical systems by locating equipment in upper floors or in a mechanical penthouse.

Elevate
Outdoor equipment or ground floor equipment located in spaces with high ceilings can usually be elevated on pedestals or platforms to bring the systems above the flood elevations.

Relocate
Depending on the available space within an existing building, service equipment from a basement or other areas below the flood level can be relocated to an upper floor to bring the equipment and distribution systems above the flood elevation.

Protect in Place
When elevating and relocating are not practical or feasible, the last option to increase the resilience of critical systems is to protect them in place. This includes elevating to the greatest extent possible and dry floodproofing with low floodwalls and shields and with anchors and tie downs to prevent flotation.

Cost and Insurance Considerations

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- Relocating/replacing critical utilities is also an opportunity to upgrade and increase the energy efficiency of a building's systems, which may lead to a reduction in annual utility costs.
- FEMA V Zones, elevating mechanical equipment is required for NFIP premium reduction.
- When replacing equipment, choosing high-efficiency models can reduce energy use, utility bills, greenhouse gases and other pollution.

Additional Resources
FEMA 348: Protecting Building Utilities from Flood Damage.

FEMA P-312: Homeowners Guide to Retrofitting

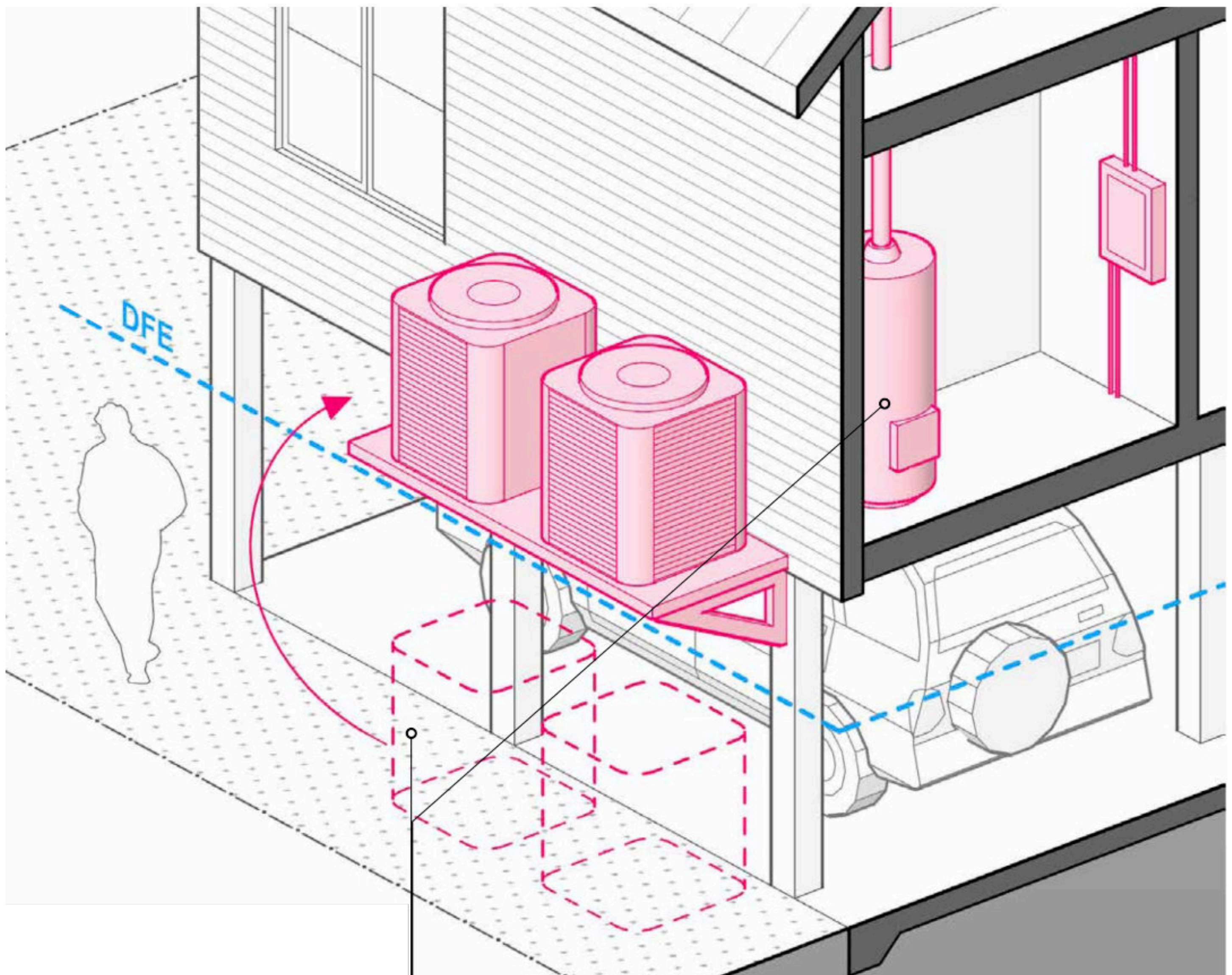
FEMA Recovery Advisory 2: Reducing Flood Effects in Critical Facilities.

Protect Critical Systems Technical Considerations

Repair and Replacement
Use natural cycles of repair and replacement as opportunities to improve the flood resilience of building utility systems and equipment. For example, replacing an old furnace in the basement with a more compact mini-split heat pump can improve efficiency, reduce fossil fuel use, and make relocating or elevating heating and cooling systems more feasible in space-constrained buildings.

Energy Audits
Building owners should conduct an energy audit to identify opportunities for improvements in energy efficiency to coincide with resilience upgrades. This is not only limited to replacing old equipment with higher-efficiency models. An energy audit can reveal how upgrades to the building envelope can reduce heating and cooling loads, which can result in equipment down-sizing in addition to added efficiency.

Utility Coordination
Coordinate with the local utility company when planning modifications to the placement of electric and/or gas meters.



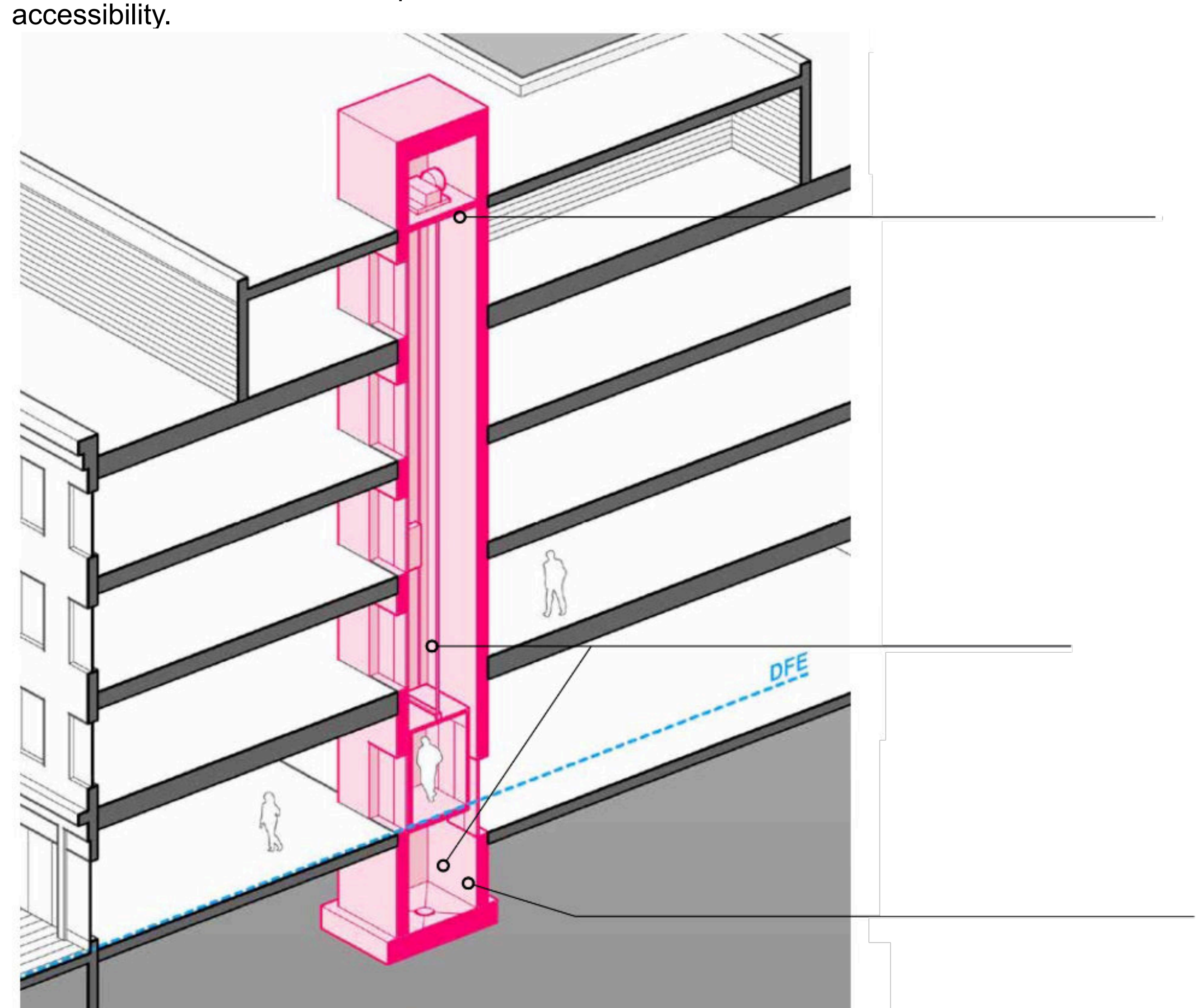
Protecting in Place
If protecting in place is the most feasible option, watertight walls and shields are most practical when flood depths are less than 3'. Utilize a watertight closure panel if a floodwall is too high to step over. Utilize anchors and tie-downs to hold equipment in place.

Elevating Equipment
When relocating or elevating MEP systems, consider horizontal and vertical clearance for routine maintenance; venting requirements for combustion equipment; drain pans for equipment containing water storage to prevent leakage; and provisions to prevent equipment from freezing.

Resilient Elevators

Resilient elevators include strategies to protect or relocate vulnerable motors and controls, protecting the elevator cab, and providing backup power solutions.

Elevator systems are vulnerable to flood damage because elevator pits and control components typically extend below the lowest floor. Hydraulic elevators may face damage to the hydraulic cylinder and piping, whereas traction elevators may be exposed to damage to hoist ropes and wiring. By raising or making watertight components that are sensitive to water exposure and establishing flood-protected backup power, flood damage to elevators can be avoided and post-flood accessibility.



Cost and Insurance Considerations

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Additional Resources
FEMA 348: Protecting Building Utilities from Flood Damage

FEMA Technical Bulletin 4: Elevator Installations for Buildings Located in Special Flood Hazard Areas in accordance with the NFIP (National Flood Insurance Program)

BACKUP SYSTEMS

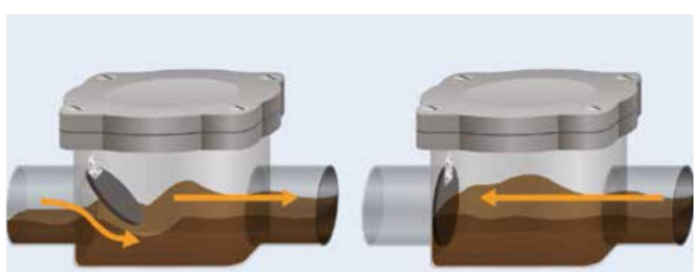
Backup water management systems, including sump pumps and backflow preventors protect buildings from unintended flood water entry in conjunction with floodproofing strategies.

Sump Pumps

Sump pumps remove water from below-grade spaces that may have made its way through gaps in sealed openings or walls. They also remove water from an underdrain system at the perimeter of below grade walls or under a slab on grade.

Backflow Prevention

Sewage backflow can happen for a variety of reasons although the risk is largest during flood and extreme storm events. Options for backflow prevention include check, gate, and dual backflow values. Backflow preventers are already required by Building Codes.



Backflow Prevention

Consider installing a sewer backup alarm to warn the building occupants when a backwater valve is activated and to curtail plumbing fixture use.

Backflow prevention devices require regular inspection and maintenance to ensure functionality and to check that debris is not caught in the valve or cleanout

Graphics: Enterprise Green Communities/ Strategies for Multifamily Building Resilience.

Cost and Insurance Considerations

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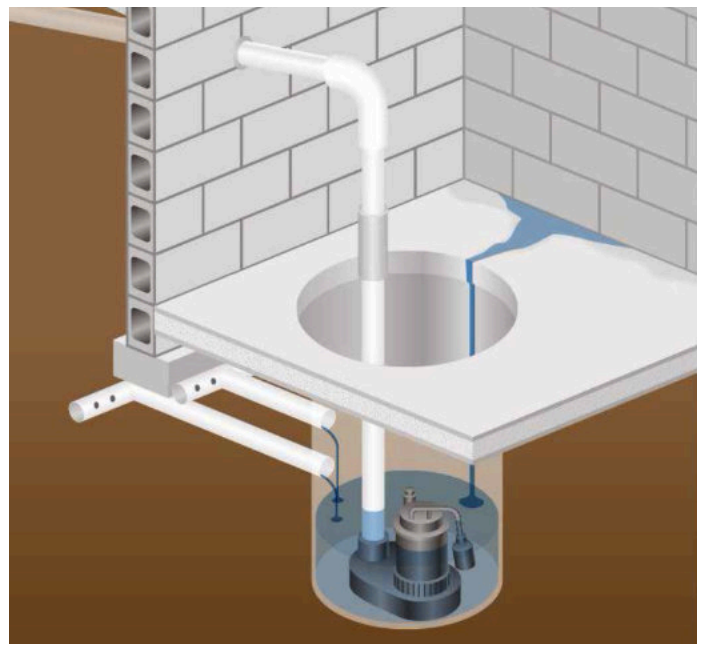
- Property owners are responsible for installing and maintaining backflow prevention devices.
- A backflow preventer is a relatively inexpensive device to retrofit in smaller buildings, although cost increases with larger commercial buildings.



Sump Pump

Sump pumps and internal drainage systems should be properly maintained to remove sediment or debris that has settled in the sump. Refer to requirements by the Uniform State Plumbing Code, before installation.

Ensure that a heavy-duty, properly sealed lid is placed on the sump pump. Some soils below buildings contain radon or other pollutants that can be released into an enclosed space through a sump that is not adequately covered.

Sump pumps run on electricity. and therefore backup power should be considered to maintain functionality during a power outage.

Additional Resources

FEMA P-936: Floodproofing Non-Residential Buildings.

FEMA 348: Protecting Building Utilities from Flood Damage.

FEMA Technical Bulletin 4: Elevator Installation for Buildings Located in Special Flood Hazard Areas.

Highlands Central Business District Floodplain Design Guidelines

Enhanced Building Envelope

Renovations and New Construction a better performing exterior envelope can improve the way existing and new construction maintain comfortable indoor conditions during outages.

Building Envelope upgrades that have the greatest impact on indoor temperature include:

- increase wall roof and floor insulation
- operable energy-efficient well-sealing windows
- sealing of cracks and leaks in a building's air barrier
- exterior shading devices
- cooling roof surfaces

While each upgrade can improve a building's resilience, addressing measures can together achieve multiple benefits - such as savings on both energy and equipment costs.

Assessments

Conduct an energy audit to identify problem areas and prioritize efficiency measures. An energy audit should consider mechanical systems as well as envelope upgrades, because enhancing the building envelope can often reduce the energy demand on heating and cooling equipment which can result in the downsizing of systems. Consider future repairs and the life cycle of the building's components to coincide energy efficiency investments with the natural cycle of repair and replacement.

Wall and Roof

Adding wall and roof insulation slows the rate of heat and cool loss from interior to exterior. Insulation can be retrofitted to older buildings by adding a layer of insulation on either the interior or exterior side of a wall or roof. The R-value of the insulation should be calculated and upgraded to appropriate targets meeting, at a minimum, energy code insulation levels (the higher the R-value the better).

Windows

For windows, a lower U-value for both the glazing and frame will mean more heat is retained in the winter. Triple glazed windows are the best performing but typically cost more than double-glazing. In the summer, a window's solar heat gain coefficient (SHGC) will influence how well the glazing can reflect the sun's heat to keep an indoor space cool; this is most often accomplished with low-emissivity (low-e) coatings. Consider well-sealing operable windows to allow for passive ventilation.

Window treatments like overhangs, awning, screens, and curtains on south, east, and west facing windows can control overheating by blocking the sun in the summer.

Shading elements are the most effective when installed on the exterior side of the window South-facing windows are the easiest to protect using simple overhangs designed to block high-angle summer sun while letting in the lower-angle winter sun.

Air Leakage

Air leakage can be evaluated using a blower door test which can also help to target areas of the building to seal and weatherstrip. When improving a building's air tightness, ensure a proper ventilation system is in place, such as balanced whole-building energy recovery ventilation to control indoor moisture levels.

Cost and Insurance

These resilience measures significantly save energy. While the first costs may be significant long-term operational savings can be captured in the form of reduced heating/cooling bills.

Building envelope measures combine resilience benefits with the reduction of building heating and cooling loads. Upgrades make interiors more comfortable in general by minimizing drafts and cold spots in the winter, mitigating excess solar heat in the summer.

On-Site Energy Generation

In the event of a blackout, providing reliable on-site backup power for continued operation of critical services can increase a building's resilience. A backup power system includes generation equipment, dedicated circuitry, and associated components.

Examples of power generation include:

- Fuel-fired generator, with stored fuel supply
- Piped natural gas generator
- Bi-Model-Solar-Electric system with battery storage
- Combined heat and power, sometimes referred to as Cogeneration or “Cogen”, generates on-site electricity and utilizes waste thermal energy for heating end-uses.

Each of these systems vary in terms of energy or fuel storage, quantity of emissions, fuel cost, safety, and maintenance. Because emergency generators sit idle 99% of the time, they may not be as reliable in the event of interrupted power, as systems that are designed for continued use such as solar-electric with storage and Cogen.

Technical Considerations

Depending on building use and size, electrical loads, essential for life safety are required by state building code to be powered by emergency systems, Such as emergency:

- Voice/alarm communication systems
- Means of egress lighting
- Fire suppression system and elevators
- Standby systems for other safety measures

In addition to required loads, identify, and prioritize which electrical loads and equipment are most important to turn on the backup power supply.

For example:

Consider providing back-up power to sump pumps if the building is also employing dry floodproofing techniques, or domestic water pumps, if they are part of a building's access to potable water.

Generators

Rooftop mounting

- Consider building an enclosure to provide protection from air-borne debris during a storm.
- Weight of large equipment - ensure that the structure can carry the added live load of the generator.
- Develop an emergency equipment operations and maintenance plan.
- Generators often create elevated levels of noise and vibration, so mounting and allocation should be coordinated to avoid disturbing occupants.
- Ensure adequate ventilation for any indoor equipment.

Zoning Permit is required and Building codes typically require regular inspections and testing.

Solar Electric Systems

Grid-connected solar electric systems have inverters that are designed to automatically cease power production as a safety precaution if the electrical grid goes down. Any design for a system that switches to battery backup during an outage, such as an SC coupled system, needs to be coordinated with local authorities for full system compliance.

Cost and Insurance Considerations

Cost of emergency generators is tied to the type and capacity of the system.

- Solar electric systems, upfront costs for panels and battery storage systems can be high. First costs can be offset by federal, state, and local tax credits/utility incentive programs.

Long-term savings can be captured through avoided electricity costs and building value appreciation.

Additional Resources

FEMA Recovery Advisory 2: Reducing Flood Effects in Critical Facilities.

Temporary Flood Barriers

Temporary flood barriers are vertical flood protection structures used as a more robust efficient and effective alternative to sandbags.

Various products exist, ranging from systems made up of modular structural components that must be brought on-site from storage and assembled by a team of workers, to systems that are permanently installed on-site in ground or wall recesses and automatically deployed using the buoyancy forces of rising flood water.

In the context of district and site scale strategies, temporary flood barriers are most applicable for blocking narrow flood pathways between permanent elevated structural barriers, and where more permanent solutions are constrained by cost, limited available space, existing development and infrastructure, or the need to maintain access at existing grade under all but storm conditions.

Temporary flood barriers may be considered flood walls or components there of for purposes of flood insurance. For a flood wall system and the area protected by it to be recognized for National Flood Insurance Program purposes it must meet specific design inspection, and maintenance requirements set by the US Army Corps of Engineers.

Modifying a FEMA Flood Insurance Map to recognize the protection provided by a flood wall also requires completing a Letter of Map Revision process, administered by FEMA, flood walls may not be used to bring a substantially damaged or substantially improved structure into compliance.

Photo: Aquafence