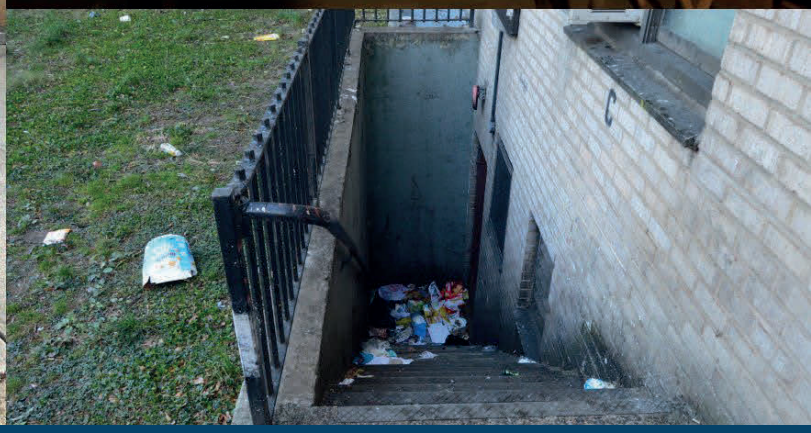

Building Performance: Egress from Floodprone Basements

Hurricane Ida NYC MAT Technical Report 2

June 2023 (Revised May 2025)

FEMA

Unless stated otherwise, all photographs and figures in this report were taken by the MAT or developed for this report.

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1. Introduction

Remnants of Hurricane Ida moved through the New York City metropolitan area on September 1, 2021, causing significant urban flooding and damage in many parts of the city. A presidential disaster was declared on September 13, 2021 (FEMA-4615-DR). As part of its response to the disaster, the Federal Emergency Management Agency (FEMA) Building Science Disaster Support program deployed a Mitigation Assessment Team (MAT) to assess the damage. MATs are composed of federal and non-federal experts in building science and other relevant disciplines. These experts assess building performance after disasters, then incorporate lessons learned to make recommendations on improving the resilience of new construction and repairs and retrofits of existing buildings.

1.1. Report Objective

The primary objectives of the FEMA Building Science Disaster Support program are to improve the resistance of buildings to natural hazards and improve the safety of building occupants. Its work includes evaluating the key causes of building damage and failure, and recommending solutions. The remnants of Hurricane Ida produced widespread urban flooding, which led to flooding of numerous below-grade and basement areas. The Hurricane Ida NYC MAT Technical Report 1, Building Performance: Basement Buildings and Urban Flooding (FEMA P-2333), notes this type of flood damage has occurred many times in the past. That report also describes the impacts of basement flooding on life safety, buildings, and building utility systems and equipment. It includes a number of recommendations to address the safety of basement occupants and the performance of buildings with floodprone basements.

This report describes the MAT's observations related to the egress of occupants from basements flooded when the capacity of stormwater drainage systems is exceeded. The observations were made during field investigations of selected locations in New York City. Figure 1 shows the locations visited by the Team. This report offers a number of the New York City's requirements for building egress and emergency access. The report makes some recommendations to improve the safety of occupants in floodprone basements and options to improve egress from floodprone basements.

> Basements and other below-grade areas that are prone to flooding by stormwater runoff should not be occupied unless deemed legal by the local jurisdiction. Building owners and occupants should be aware of the risks and know what to do when severe storm warnings are issued. Occupants of basements should have adequate ways to get out of their dwellings so they are not trapped when flooding occurs.

After deployment to New York City, the Team produced three technical reports and four fact sheets that relate to the effects of Hurricane Ida on the city. The documents focus on some construction and stormwater issues that were not considered in previous MAT investigations, including:

- Surface runoff and flooding in urbanized areas
- Stormwater collection and drainage systems
- Effects of surface flooding on buildings
- Basement flooding in urbanized areas
- Early warning systems for urban flooding
- Egress (leaving) for occupants of at-risk basements
- Flood warning and flood risk mapping
- Steps owners and residents can take to reduce risks associated with urban flooding
- Ways to enhance policies and regulations to reduce flood risks

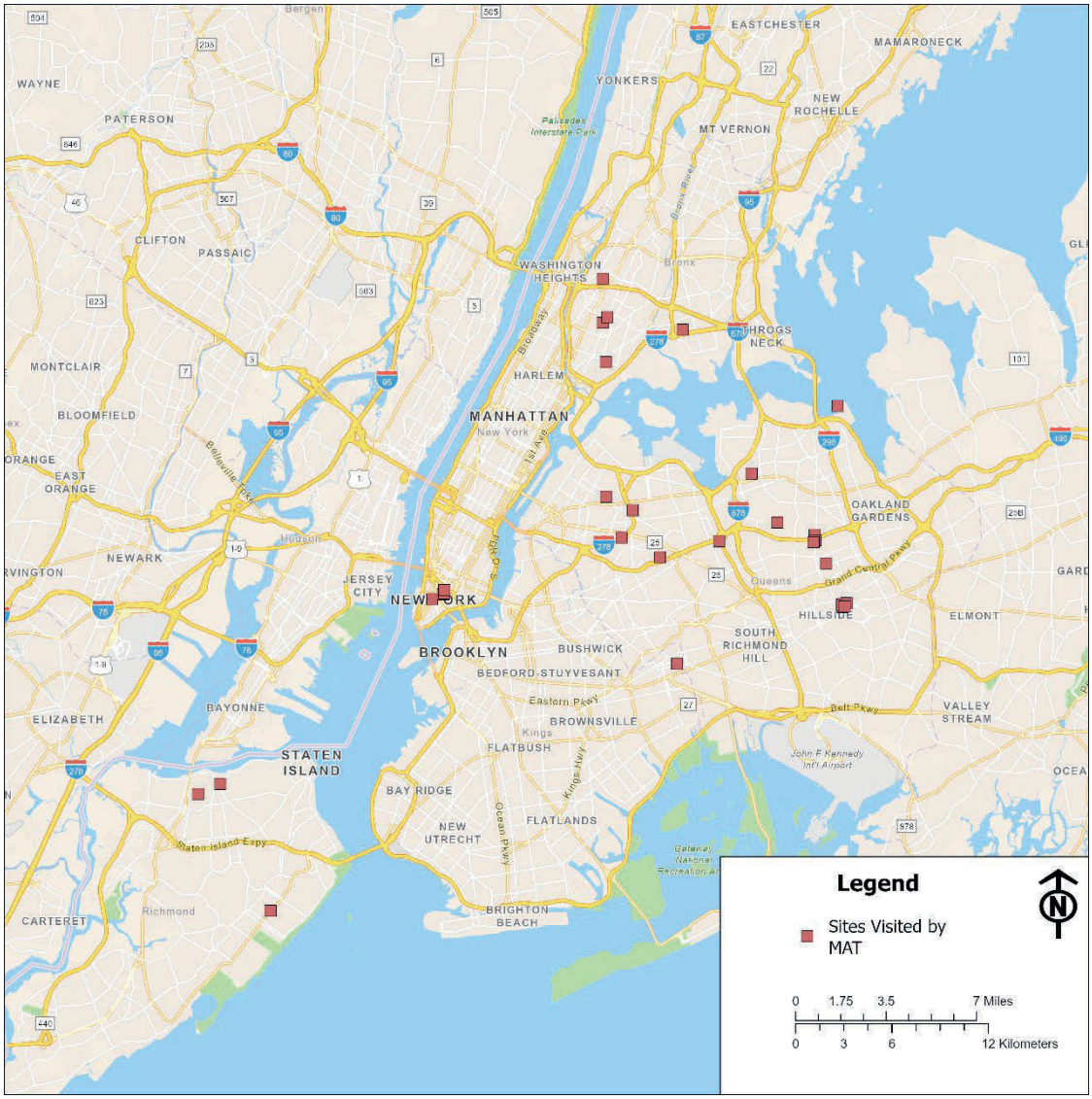
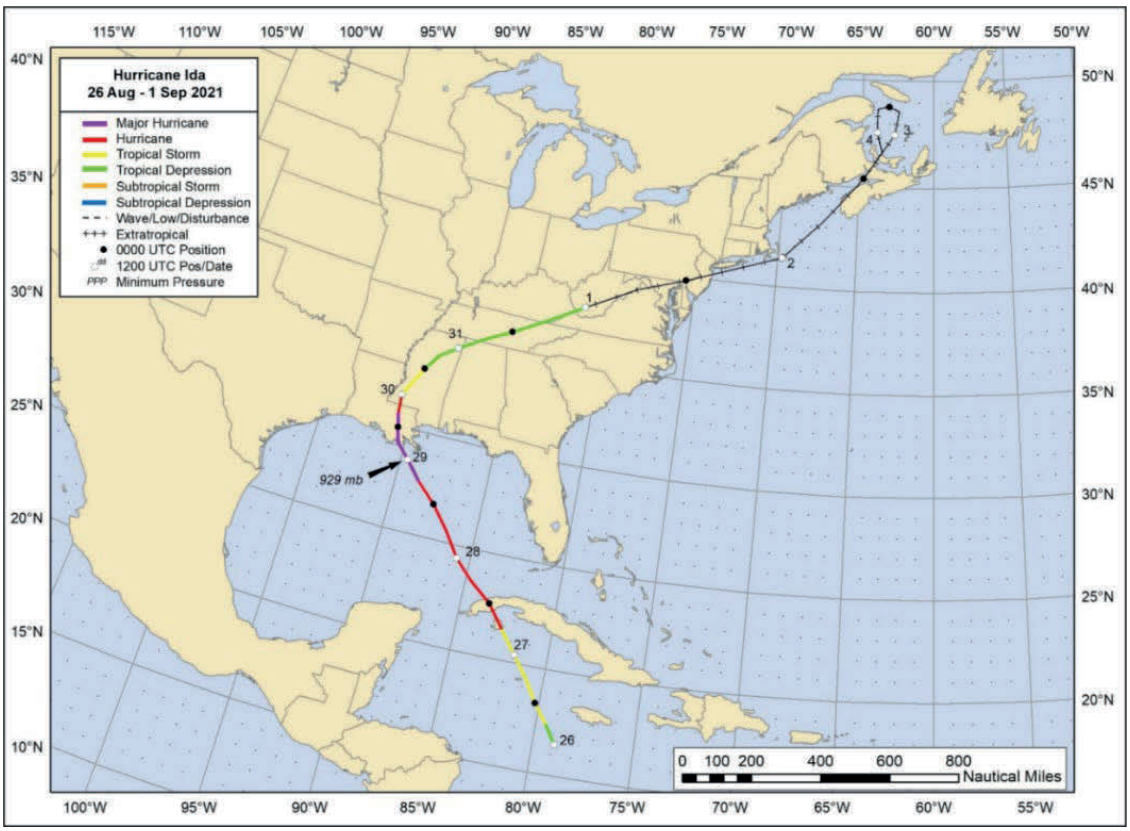


Figure 1. Locations visited by the FEMA MAT after Hurricane Ida

1.2. Hurricane Ida in New York City

On August 29, 2021, Hurricane Ida made landfall as a Category 4 hurricane in Lafourche Parish, on the Louisiana coastline. This was only 50 miles west of where Hurricane Katrina made landfall on the same day in 2005. The storm generated high winds and storm surge, causing widespread damage to structures and to power and telecommunication infrastructure throughout the state. As Hurricane Ida moved inland, beyond Louisiana (Figure 2), it produced heavy rain and unsettled weather in several states. In New York City, the peak rainfall intensity in Central Park was 3.15 inches per hour, with a total of 7.13 inches of rain over a 24-hour period. It is important to note that Hurricane Ida was preceded by the remnants of Tropical Storm Fred and Hurricane Henri, which saturated the city with heavy rainfall in August.

New York City reported 13 fatalities attributed to the flooding caused by Hurricane Ida. Eleven fatalities were from drowning in the basements of single- and multi-family residential buildings.



Source: National Hurricane Center

Figure 2. Storm track of Hurricane Ida from August 26 through September 4, 2021

In some areas where the rainfall runoff exceeded the capacity of the stormwater drainage system, water flowed toward buildings, entering the basements, cellars, and below-grade spaces of numerous homes, multi-family buildings, and commercial buildings. The city generally does not allow dwelling units in basements, which are areas that are less than half a story below grade, unless specific requirements are satisfied. Cellars are subgrade areas with more than half a story below

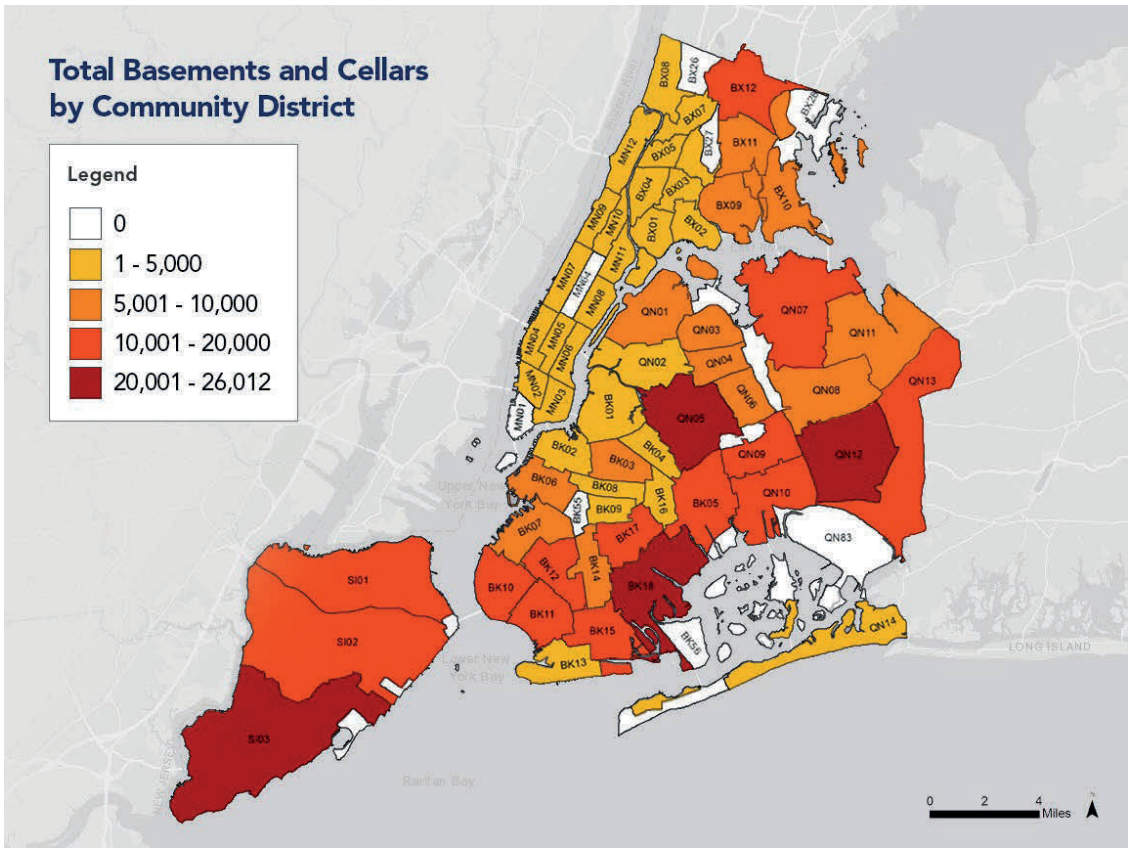
grade. The city does not allow cellars to be occupied. The basements of multi-family buildings are typically used to house equipment such as boilers and water heaters, and for storage.

Basements, Cellars, and Below-Grade Areas

This report uses "basement" and "below-grade area" to refer to any portion of a building that is below grade that is used for any purpose. The New York City Building Code defines "basement" and "cellar" in terms of how much of the "clear height (measured from finished floor to finished ceiling)" is below grade. A basement has less than 50% of the clear height below grade while a cellar has more than 50% of the clear height below grade.

In August 2022, the New York City Comptroller issued a report, "Bringing Basement Apartments into the Light." This report estimated that one-, two- and three-family homes in the five boroughs have over 420,000 basements and cellars (Figure 3), although it does not estimate how many are occupied. The report states, "The Comptroller's Office estimates that about 10%, or 43,000, basements and cellars … are currently facing some type of flooding risk. As storms intensify, the number of basements and cellars facing coastal and extreme rainfall flood risk is estimated to grow to 136,200, a third of all basements and cellars by the 2050s."

Hurricane Ida is not the only storm to produce urban flooding that damaged buildings with basements. The heavy rainfall resulting as the remnants of Hurricane Ida passed over the city was one of many previous heavy rainfall events that flooded building basements. The city's 2009 Natural Hazard Mitigation Plan lists 60 urban flooding events between 1993 and 2007. Six of those events are reported to have flooded basements. Some events had citywide impacts, while others flooded basements in Queens (Brooklyn, Flushing, and Springfield Gardens). Notably, on January 3, 1999, people had to be rescued from basement apartments in Springfield Gardens when water rose nearly to ceiling height.



Source: NYC Comptroller's Office, 2022

Figure 3. Estimated number of basements and cellars in New York City by community district

2. Hurricane Ida MAT Observations in New York City

2.1. How Surface Water Entered Basements

Rainfall runoff entered basements when surface water elevations reached the lowest point of entry at which water could flow into the buildings. In multi-story buildings, water typically entered through loading docks, exterior stairwells, and access ramps, or through street-level windows and vents. In some one- and two-family dwellings, water entered below-grade garages after street flooding reached the crests of the driveways. In others, it flowed down exterior basement access stairs as floodwater crested the stairway thresholds.

2.2. Risks To Occupants of Floodprone Basements

The MAT visited many buildings in New York City where surface water entered basements as Hurricane Ida move across the city. Only some of those basements were occupied during the event. The Team did not visit every building where occupants drowned. In addition, the Team did not evaluate whether egress from basements conforms to requirements established by the city for legal occupancy of basements.

Occupants of floodprone basements are at risk if they are unaware that their dwellings could flood during heavy rainfall events. Another aspect of risk may be the lack of a safe path, or obstacles on the path, for occupants to evacuate to safer locations.

BASEMENT OCCUPANTS MAY BE UNAWARE OF FLOOD RISK AND HOW TO RESPOND TO WARNINGS

During heavy rainfall events that cause urban flooding, water may enter basement areas through doorways, street-level windows and vents, driveway ramps, sewer backup, or utility penetrations in the foundation walls. Basement flooding may start with little warning, and water will continue to flow in as long as the water level stays high on the outside of the building. If the flow lasts long enough, basements and below-grade areas may fill up. Building owners and property managers may not know their buildings with occupied basements are vulnerable to urban flooding. New York City's initiatives to inform the public about urban flooding are summarized in Section 5 of this report.

MANY FLOODPRONE BASEMENTS LACK UNOBSTRUCTED WAYS TO ESCAPE

Many occupied basement dwelling units in New York City satisfy the city's requirements for legal occupancy, including requirements for egress. However, other units have not yet satisfied those requirements. The city's egress requirements are summarized in Section 3 of this report.

During the rainfall caused by remnants of Hurricane Ida, basement flooding put some occupants at extreme risk when water flowing through windows and exterior basement stairways obstructed the only way they had to escape (see Figure 4). Obstructed paths can result in injuries and loss of life. Exit paths may be obstructed in several ways, including:

- Exterior doors may open outward. When water accumulates against doors to exterior stairwells and driveway ramps, the hydrostatic pressure applied by water against doors can make it difficult, if not impossible, to open doors that swing outward. Similarly, water flowing through or accumulating against basement windows means people cannot escape through windows even if the windows are large enough to climb through.

- Basement windows may be too small or too high above the floor to be used for escape or may have security bars blocking escape if water against doors prevents them from opening (see Figure 5).

- Some basement areas do not have a defined path to escape. Some do not have direct paths to the exterior, and some have limited access to upper floors. When basements of one- and two-family dwellings are converted, the door at the top of interior stairs may be locked or secured and basement occupants are not able to leave that way.

Source: Still image from video; Internet Clips, 2021

Source: Still image from video; Daily Mail, 2021

Figure 4. Surface water entering below-grade dwelling unit through window (left); NYPD officer searching flooded basement where three fatalities occurred (right)

Figure 5. Basement window too high and too small for escape (left) and basement window with security bars (right)

3. Egress: Summary of New York City Requirements

The express intent and purpose of the New York City Building Code is to "provide reasonable minimum requirements and standards … in the interest of public safety, health, welfare and the environment …" Similarly, the intent and purpose of the New York City Fire Code is to "establish

reasonable minimum requirements for life safety and property protection." And the purpose of the New York City Housing Maintenance Code is to enforce minimum standards of health and safety.

The city's codes have many general and specific requirements for means of egress and emergency escape and rescue openings (see definitions). Several factors govern when those requirements must be satisfied for both new construction and existing buildings. Safety of building occupants and emergency personnel are the reasons for these requirements. Occupants of buildings that have adequate means of egress, and emergency escape and rescue openings when required, are safer when evacuation is necessary. Evacuations may be necessary because of fire, flood, or other reasons.

New York City Code Definitions

Means of Egress. A continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a public way. A means of egress consists of three separate and distinct parts: the exit access, the exit, and the exit discharge.

Emergency Escape and Rescue Opening. An operable window, door, or other similar device that provides for a means of egress and access of rescue in the event of an emergency.

Building owners and design professionals must determine which code requirements apply when they develop plans for new construction and proposals for work on existing buildings. The list below is not a comprehensive summary of all code requirements for means of egress and emergency escape and rescue openings. Requirements may differ depending on whether buildings are proposed for construction or are existing buildings proposed to be altered or have changes in occupancy classification. The following summarizes some requirements that pertain to occupancy of basements:

- **New Buildings.** The NYC Building Code specifies that buildings and portions of buildings must be designed to comply with the requirements for means of egress. Some buildings that are classified as residential must also have emergency escape and rescue openings provided in sleeping rooms. Where below-grade areas have sleeping rooms, each room must have an emergency escape and rescue opening. There are some situations where that requirement does not apply, depending on fire protection measures.

- **Multiple Family Buildings and Escape Openings.** The NYC Building Code requires certain residential buildings to provide emergency escape and rescue openings. These openings are required for buildings with multiple dwelling units and buildings with sleeping rooms below grade. The code requires below-grade areas that have window wells deeper than 44 inches to have permanently affixed ladders or steps to allow occupants to get out of the window wells.

- **Existing Buildings and Change of Occupancy.** The NYC Building Code requires assignment of an occupancy classification to each building or portion of a building (e.g., mercantile, assembly, residential). Proposed changes in occupancy classification are governed by the building code, including changes in occupancy classification to allow legal dwelling units in basements.

Changes in occupancy must comply with the code provisions for the proposed classification depending on a number of factors. Compliance includes satisfying the requirements for means of egress and, in some circumstances, the requirements for emergency escape and rescue openings. When a change of occupancy affects only a space, the rest of the building must be altered as necessary to protect the safety and welfare of the occupants. In general, the city allows work on buildings that complied with prior codes to be performed in accordance with those codes. Alterations for changes in occupancy may comply with a prior code provided no danger to general safety and public welfare is created.

- **Alteration of Existing Buildings.** The NYC Building Code governs alterations of existing buildings, including alterations to create legal dwelling units in basements. Depending on the amount of alteration proposed, the alterations and the altered portions of a building must be fully code compliant. In general, the city allows work on buildings that complied with prior codes to be performed in accordance with those codes. Compliance includes satisfying the requirements for means of egress. The requirements for emergency escape and rescue openings must be satisfied if the alterations are designed to comply with the current code. Alterations for changes in occupancy may comply with a prior code provided no danger to general safety and public welfare is created.

- **Illegal Residential Conversions.** The NYC Building Code states that it is unlawful to convert any dwelling for occupancy by more than the legally authorized number of dwelling units unless the conversion is in accordance with the code. This provision would apply to illegal conversion of basements to dwelling units. The code authorizes the city to inspect buildings when complaints of illegal conversions are submitted or violations are observed.

- **Legal Occupancy of Cellars and Basement.** The NYC Housing Maintenance Code lists many requirements for legal occupancy of cellars and basements. Some requirements established by New York State vary depending on whether the below-grade spaces are in buildings with multiple dwellings, converted dwellings, or one- and two-family dwellings. Some requirements vary depending on when buildings were constructed. In general, all dwelling units in basements and cellars must have windows for lighting and ventilation. Minimum dimensions of those windows are specified, but not in terms of whether windows meet requirements for emergency egress.

- **Emergency Preparedness Plans.** The NYC Fire Code requires owners of certain buildings to develop fire protection and emergency preparedness plans for timely implementation of procedures in the event of a fire or non-fire emergency. Most buildings with multiple dwelling units must have fire and emergency preparedness plans and notices. The notices must be posted in each dwelling unit and at other locations. One purpose for these notices is to inform building occupants, building staff, and visitors about sheltering and evacuation procedures.

- **Posting Temporary Emergency Information.** The NYC Housing Maintenance Code requires owners of residential buildings, where at least one dwelling unit is not occupied by the owner, to post temporary emergency information. The notices must be posted in common areas to identify whether the building is located in a hurricane evacuation zone, the location of the nearest

evacuation center, and other information about preparing for an anticipated weather event. The code requires removal of notices after passage of a weather emergency or natural disaster event. Figure 6 illustrates a permanent notice informing residents that the building is in hurricane evacuation zone 4.

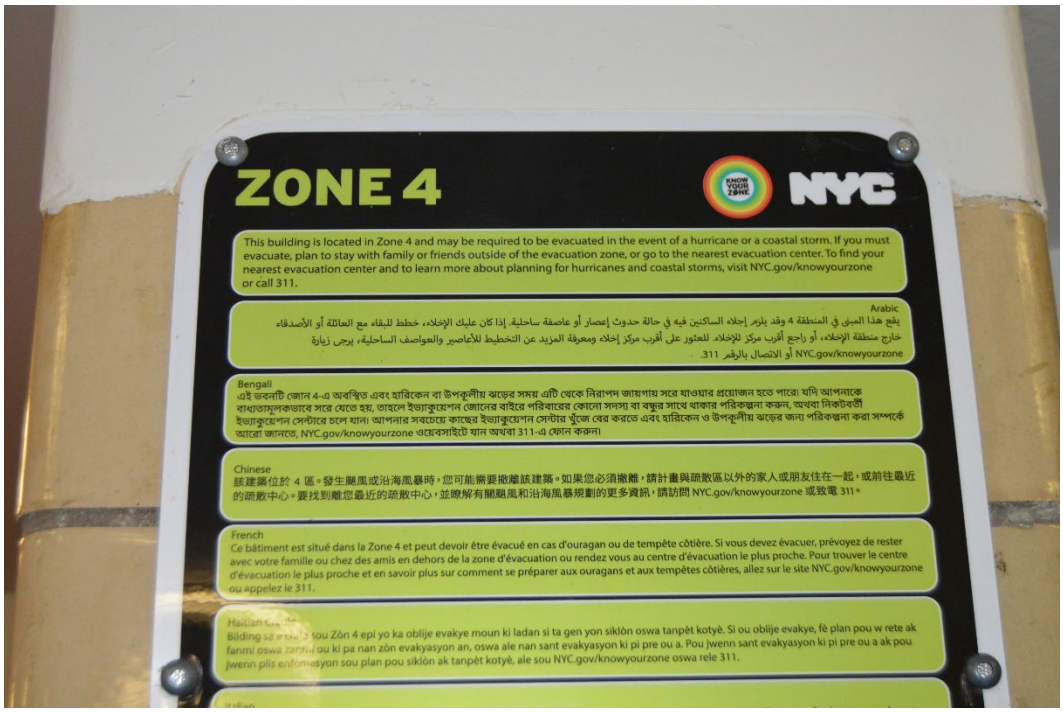


Figure 6. Hurricane evacuation zone notice posted at Sotomayor Houses in New York City

4. Occupied Basements: New York City Agencies and Initiatives

New York City, like most cities, has a shortage of safe, affordable housing. City leadership recognizes that basement dwelling units are part of its multi-faceted approach to long-term solutions. The following summarizes some city agencies and initiatives that pertain to occupancy of basements:

- The **Mayor's Office of Climate & Environmental Justice** works to implement policies that close the gap on environmental and health disparities by advancing access and inclusion for people at every level of the city's planning and decision-making process.
    - With the **Department of Environmental Protection** and **New York City Emergency Management**, the office is using a FEMA grant to study where installing backwater valves in sewer lines will be effective to reduce backflow of sewage into buildings. Buildings with basements and below-grade areas are most susceptible to sewage backflow when located in

parts of the city served by combined stormwater and sewage drainage systems. The study will examine social and physical vulnerability factors as part of recommending priority areas.

- The **Department of Buildings** enforces the New York City Building Code and Construction Codes.
  - The department reviews permit applications and plans for compliance, inspects construction for compliance, identifies and resolves violations of the codes.
  - The NYC Quality of Life Unit is part of the department. The unit conducts field inspections in response to complaints of illegal conversions performed without first obtaining permits and approvals. Reported locations are inspected to identify potentially hazardous conditions. The city offers several tips to help tenants recognize whether a unit is an illegal dwelling. One suggestion for tenants to check is whether there is an adequate means of egress (way out). Tenants of legal units should be able to get to all available exits either directly from the unit or a public hallway.
- The **Department of Housing Preservation and Development** is charged with promoting quality and affordability in the city's housing, and diversity and strength in the city's neighborhoods. The city supports legalization of existing basement apartments and development of affordable dwelling units to increase the supply of housing and meet its fair housing goals. The department enforces the New York City Housing Maintenance Code to maintain minimum standards for health and safety. The department has many programs and initiatives. Some of the department's initiatives have bearing on occupied basements.
  - The department's basement apartment conversion pilot program identified a barrier to conversion is the state Multiple Dwelling Law. Without changes to the law, the high cost of conversions will continue to obstruct legal conversions. If changes are enacted by the legislature, the department will reexamine implementation of a city-wide conversion program.
  - The department conducts in-home assessments of 1-4 family homes and multi-family buildings. The materials used by staff may be expanded to include resilience, energy efficiency, and deferred maintenance needs. When funded, the HomeFix program provides eligible owners access to low- or no-interest and potentially forgivable loads for home repairs.
- **New York City Emergency Management** coordinates citywide emergency planning and response for all types and scales of emergencies.
  - The office manages NotifyNYC to provide New Yorkers alerts and messages about a range of occurrences, including emergency alerts and weather emergencies.
  - After Hurricane Ida, the office developed enhanced communications to basement occupants to inform them about pending emergencies and urge evacuation. Delivery of the enhanced messaging will be guided by a database of occupied basements and whether those occupied basements are in areas identified as prone to urban flooding.

5. Public Awareness of Urban Flooding

New York City develops robust ways to contact residents to inform and alert them about flood risks, including:

- **NotifyNYC.** Part of New York City Emergency Management, NotifyNYC provides New Yorkers alerts and messages about a range of occurrences, including emergency alerts and weather emergencies. The alerts are available in several languages. Learn more and sign up online to receive alerts at https://a858-nycnotify.nyc.gov/.
- **Rainfall Ready NYC.** The Department of Environmental Protection produced the Rainfall Ready NYC Action Plan, online at https://www.nyc.gov/site/dep/whats-new/rainfall-ready-nyc.page. The website has information to help people plan and prepare for storms, monitor conditions during storms, and recover rapidly after damaging events. A link allows people to sign up to receive alerts from the city's official source of information about emergencies, including weather emergencies.
- **FloodHelpNY**. A project of the Center for New York City Neighborhoods, Inc., which is supported by the city, FloodHelpNY is a primary resource for New York residents and businesses to learn about flood risks, flood retrofits, stormwater flooding, future conditions, and flood insurance. The Community Flood Action Toolkit was designed to help property owners make informed decisions to reduce flood risk and lower the cost of flood insurance. Access the site at https://www.floodhelpny.org.

6. Recommendations

The FEMA Hurricane Ida NYC MAT Technical Report 1, Building Performance: Basement Buildings and Urban Flooding, offers recommendations to encourage building owners to evaluate options to mitigate flooding of basements and below-grade areas. However, even if buildings are modified to keep water out of basements, some risk remains if heavy rainfall events produce rainfall runoff that rises higher than the level of protection. Similar risks are present when owners and occupants place temporary barriers to block points of water entry. Building occupants, especially those who live in basements, must not assume that measures to keep water out mean the buildings are safe when flooding occurs.

The recommendations in this section are based on the MAT observations at selected sites visited after Hurricane Ida impacted New York City. The Team did not visit every building where occupants drowned. In addition, the Team did not evaluate whether egress from basements conforms to requirements established by the city for legal occupancy of basements. The recommendations are intended to assist the city, building owners, residents, and others to enhance safety for building occupants, especially those who live in basements.

Some recommendations suggest the city encourage or require building owners to take action. Requirements for actions could be triggered when owners apply for permits to do certain types of improvements, alterations, additions, or replacement of mechanical equipment. Encouragement may

take many forms, from providing information to developing ways to financially support actions, such as a grant program or other incentives.

RECOMMENDATION 1. COMMUNICATION WITH BASEMENT OCCUPANTS

New York City should continue its multi-faceted approach to improve awareness of flood risks and to warn building owners and residents. The urban flooding caused by Hurricane Ida demonstrated the specific risks experienced by those who occupy floodprone basements and other below-grade areas. The city should explore options to focus specific messages to those residents, including tailoring messages for basement occupants for delivery through NotifyNYC and the NYC Alerts 911 system, and continue concerted efforts to tell residents how to sign up to receive alerts.

RECOMMENDATION 2. AUGMENT INSPECTIONS OF ILLEGAL CONVERSIONS

The NYC Department of Buildings, Quality of Life Unit, should add a flood vulnerability element to the potentially hazardous conditions that are checked in response to complaints of illegal conversions. The added element would apply when complaints identify dwelling units in basements and cellars in buildings located in areas known to be prone to surface flooding. The inspectors should do the same check when buildings are located in FEMA-mapped floodplains.

RECOMMENDATION 3. EXAMINE OPTIONS TO IMPROVE EGRESS FROM FLOODPRONE BASEMENTS

New York City should develop guidance for building owners to examine their buildings with floodprone basements to determine appropriate ways for occupants to leave when emergency conditions are expected. The guidance for multiple family buildings should encourage owners to identify space where basement occupants can shelter. For one- and two-family dwellings, the guidance should advise occupants to evacuate to safe locations when warnings are issued. The city should consider establishing a requirement for building owners to perform this examination, for example as part of requests for legal occupancy of floodprone basements or any other alteration that requires building permits.

For specific buildings, the feasibility of options to improve how occupants get out of basements is depends on building characteristics. Options to consider include:

- Provide interior routes to the first floor of multiple family buildings. Where space is limited, options might include spiral stairs, ship ladder stairs, or alternating tread stairs.
- Replace existing small or fixed basement windows with windows that open and are large and accessible enough for occupants to be able to climb out. Windows with sills that are more than 44 inches above the floor should have ladders permanently affixed to walls.
- Modify doors that lead to exterior basement stairs or driveway ramps when the doors open outward, by installing small “blow-out” panels over openings made near the bottom of doors. These lightly-attached panels installed on the inside of doors will break off as water rises against them, allowing water to flow in. This will relieve the pressure of water accumulating in stairwells,

which can prevent occupants from escaping. This option is similar to flood openings required to relieve water pressure against walls of buildings constructed in FEMA-mapped floodplains.

- Install water sensors that are integrated with sump pump systems to warn occupants and emergency responders when water levels exceed the capacity of the pump. The sensors should have backup battery power. Like fire equipment, the systems should be tested annually.

- Explore the feasibility of installing wireless speakers in the common areas of multiple family buildings with floodprone basements, to broadcast warnings when intense rainfall and flooding events are predicted and provide basement occupants more time to evacuate.

RECOMMENDATION 4. SUPPLEMENT ASSESSMENTS FOR BUILDINGS WITH FLOODPRONE BASEMENTS

New York City should consider supplementing the in-home assessments offered by the Department of Housing Preservation and Development to include information for owners of buildings with basements when those buildings are located in areas known to experience urban flooding. Similarly, the city should consider supplementing the inspections conducted when complaints of illegal conversions of basements and cellars are submitted or violations are observed. The supplementary material could include:

- A checklist similar to the checklist for owners and tenants included in the FEMA Hurricane Ida NYC MAT Fact Sheet 1, What Building Owners and Tenants Should Know About Urban Flooding (FEMA P-2333). That checklist can help those making assessments and inspectors determine whether basements are prone to flooding.

- A checklist for those making the assessments and inspectors to look at whether egress from floodprone basements can be improved.

RECOMMENDATION 5. REQUIRE PERMANENT POSTING OF EMERGENCY INFORMATION

The New York City Housing Maintenance Code should be modified to require owners of residential buildings, where at least one dwelling unit is not occupied by the owner, to post permanent notices of emergency information. The current code requires owners to post information prior to weather emergency and natural disaster events, and to remove the posting after passage of emergencies. Permanent notices should be posted in buildings located in hurricane evacuation zones, FEMA-mapped floodplains, and areas known to be prone to surface flooding. When the buildings have basement dwellings, the notices should specifically inform basement occupants of risks, the importance of evacuating before the onset of flooding, and how to sign up online to receive weather alerts from NotifyNYC.

RECOMMENDATION 6. SUPPLEMENT FIRE PROTECTION AND EMERGENCY PREPAREDNESS PLANS AND NOTICES

The New York City Fire Code specifies when fire protection and emergency preparedness plans and notices are required. The code also specifies the content of those plans and notices, which must address fire and non-fire emergencies. The city should develop example language for buildings with multiple dwelling units to address flood emergencies. The flood emergency language should be required for multi-family buildings with occupied basements when the buildings are located in FEMA-mapped floodplains and areas known to be prone to surface flooding.

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