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PRACTICE ZONING FOR VULNERABLE POPULATIONS

Protecting Vulnerable Populations from Flood Hazards

By Tom Smith

In January 2021, President Biden reinstated federal rules that provide greater flood protection for federally supported infrastructure and critical facilities built in flood hazard areas. To meet the federal standard, builders must meet one of three requirements. They can make plans using data and methods informed by the "best available climate science"; build two feet above the current projected elevation for the once-every-100-year flood for most projects and three feet above that level for critical buildings like hospitals and evacuation centers; or build to elevations at which flooding is currently projected once every 500 years.

In many local jurisdictions, these federal rules should make it easier to administer local flood plain management policies that require a higher standard for public facilities considered critical or essential. Critical facilities are often defined as "a facility that provides services and functions essential to a community, especially during and after a disaster."

However, the Biden policy is not a panacea for protecting all critical facilities. The policy does not apply to critical facilities that are not supported with federal funds. Most nursing homes, assisted living facilities, and hospitals are built without federal funds.

Recent disasters clearly illustrate how vulnerable certain critical and essential facilities can be to flood hazards and how ill prepared these facilities are in terms of mitigating damages during storm events.

This article will not try to address safety and mitigation standards for all types of critical facilities but, instead, will focus on risk assessment, mitigation, and best zoning practices for a subset of essential facilities, including medical and hospital facilities, nursing homes, and assisted living facilities.

UNIQUE RISKS AT HOSPITALS, NURSING HOMES, AND ASSISTED LIVING FACILITIES

Hospitals, nursing homes, and assisted living facilities can be unsafe places during a major flood, storm surge, or hurricane. When the power goes out, these places can become very dangerous. Loss of power means ventilators, respirators, and dialysis machines don't work. In some cases, these facilities may not have back-up generators, and even where they do, these power sources can prove inadequate for the facility's power demands.

Why is there a history of panic, catastrophe, and even death associated with health care and nursing care facilities during major storms? Why do many facilities seem so poorly prepared for flooding and damaging winds? Why do so few hospitals, nursing homes, and assisted living facilities evacuate in the face of a major flood, storm surge, or hurricane?

In many cases, the hospitals or nursing homes are in terribly unsafe locations, and these locations should never have been approved by local planning and zoning authorities. In other cases, these facilities had taken little or no action to mitigate flood risks—simple things like elevating critical electrical systems, installing and elevating back-up generators, or floodproofing critical care facilities.

Hurricane Sandy

In the days leading up to Hurricane Sandy, New York Mayor Michael Bloomberg and New York Governor Andrew Cuomo sought the advice of public health experts about whether hospitals, nursing homes, and assisted living facilities in high-risk areas should evacuate prior to the storm. The consensus among the experts was that patients and residents should shelter in place.

The decision had disastrous consequences for nursing homes residents. For three days after the storm, fire, police, and ambulance crews rescued over 4,000

Michael Krieg

Following flooding from Hurricane Ike, the Indiana National Guard was called upon to assist in evacuating people from a Munster, Indiana, nursing home. Members of the National Guard and the Munster Fire Department navigate the dark and slippery stairwells of the flooded nursing home.

nursing home residents and more than 1,500 residents of various assisted living facilities (Powell et al. 2012). Without operating elevators, many residents had to be carried down emergency stairways to waiting ambulances.

The decision not to evacuate was based on the assumption that many of the elderly and disabled would suffer in the moving process. While no immediate deaths at nursing homes were attributed to the flooding, many public health experts believe that serious illnesses increased in the months following Hurricane Sandy especially where patients suffered "transfer trauma" associated with emergency evacuations.

After the storm it became clear that most nursing homes were completely unprepared to deal with the impacts of the storm. Many did not have back-up generators and many with back-up generators found them flooded or inadequate for operating all electrical systems. Many facilities had limited capabilities to communicate with emergency response agencies in the immediate aftermath of the storm when cell towers and phone lines had been destroyed or seriously compromised.

Many hospitals in New York City faced similar problems. During Hurricane Sandy, more than 6,400 hospital patients were displaced because of flooded basements, failed back-up power systems, and damaged facilities. Sandy sent about 1.7 million gallons of water into the basement of Bellevue Hospital, flooding critical electrical, water, steam, and elevator systems that are needed to run the hospital. The flooding forced the unprecedented evacuation of 715 patients from the hospital and forced its closure for the first time in its 267-year history (De Avila and Dawsey 2012).

Hurricane Katrina

The stories from Katrina are much worse than Hurricane Sandy. Leading up to the storm, state and local officials were unsure about what to do in terms of evacuation. The order from New Orleans Mayor Ray Nagin that hospitals, nursing homes, and assisted living facilities in the most vulnerable locations should evacuate came less than 24 hours before Katrina hit the city (SBCIPRHK 2006). This was far too late.

On the eve of Hurricane Katrina, the Louisiana Nursing Home Association estimated that 60–70 nursing homes would be affected by flooding from Hurricane Katrina (Brinkley 2006).

Nursing homes suffered from a shortage of staff since many staff members left the coastal areas for higher ground after Katrina came ashore. Transportation was also hard to find, and nursing home operators found it difficult to find bus services for their residents.

New Orleans had nine major hospitals. Children's Hospital and the Ochsner Foundation Hospital were on higher ground and not so affected by flooding, but all the others suffered flood damage. Most, if not all, of these hospitals had to rely on back-up power generators, and unfortunately, many of those generators were in basements that flooded. As a result, these hospitals could not operate life-saving equipment, such as kidney dialysis machines, respirators, ventilators, or defibrillators.

Overall, it is estimated that 215 people died in hospitals and nursing homes following Katrina (Reisner and Fink 2017). At the Memorial Medical Center alone, 45 dead bodies were found on September 6, 2005. At St Rita's nursing home, located near the broken levees in St Bernard's Parish, more than thirty residents apparently drowned (Fink 2013).

WHAT HAVE CITIES DONE TO PROTECT HOSPITALS, NURSING HOMES, AND ASSISTED LIVING FACILITIES?

In recent years, several cities and counties have updated their land-use and development codes to protect hospitals, nursing homes, and assisted living facilities from coastal storms and flooding.

Boulder, Colorado, Enhances Flood Protections for Critical Facilities

In Boulder, Colorado, the most serious flood threat is from flash flooding. Boulder sits at the foothills of the Rocky Mountains, and during storm events, flood waters come barreling off the mountains into 15 local creeks. These flood waters are traveling at a high velocity, and floods typically occur without warning.

Boulder regulates floodplain development through its land use code. The code establishes an overlay district for floodplains, and development permits are required as part of the land-use approval process. The city revised the code in early 2014 to enhance protections for critical facilities shortly after the city's worst flood event in September 2013 (§9-3-2).

The code defines *critical facility* as "any structure or related infrastructure, the loss of which may result in severe hazards to public health and safety or may interrupt essential services and operations for the community at any time before, during, and after a flood. Critical facilities are classified as follows: (1) essential services facility, (2) hazardous material facility, and (3) *at-risk population facility*" (§9-16-1).

Furthermore, it defines an *at-risk population facility* as "a preschool, public or private primary or secondary school, before and after school care center with twelve or more students, daycare center with twelve or more children, group home, or residential or congregate care facility with twelve or more residents" (§9-16-1).

Finally, it defines a *congregate care facility* as "a facility for long-term residence where at least 80 percent of the occupied units are occupied by at least one person who is sixty-five years of age or older" (§9-16-1).

Boulder requires facilities for at-risk populations to meet the strictest standard of flood protection. These facilities must be elevated or floodproofed in the one percent flood risk area (i.e., the 100-year floodplain); within the conveyance zone (the floodway) and within any 0.2 percent flood risk area (i.e., the 500-year floodplain). For existing facilities that are expanded or enlarged, the applicant must flood proof or elevate the lowest floor (including basement) of the expanded portion of the building to an elevation one foot above the 500-year elevation or two feet above the 100-year elevation, whichever is lower. For new buildings or buildings that are determined to be substantially modified or improved, the applicant must flood proof or elevate to one foot above the 500-year elevation or two feet above the 100-year elevation, whichever is lower.

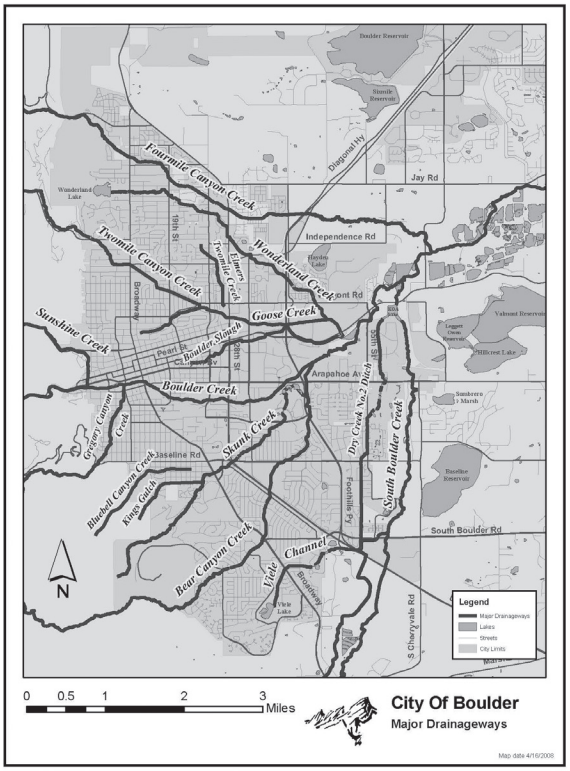
Facilities for at-risk populations are not permitted in the city's highest flood risk locations, designated as "high hazard zones." High hazard zones are mapped, and they indicate areas where floodwater depth would equal or exceed four feet or areas where the velocity of floodwaters exceed four feet per second, or where the result of depth times velocity is greater than four. The high hazard zone poses a serious risk to the safety of buildings and people. Because of life safety concerns, development in the high hazard zone is the most restricted.

Furthermore, Boulder requires facilities for at-risk populations to prepare and maintain an emergency management plan. The plan must include the following elements:

- A plan to protect employees, visitors, residents, and guests during a flash flood event
- A plan for sheltering in place or a plan for evacuation in the event that it is deemed too dangerous to shelter in place
- A plan for communications with the resident's family members, nearby hospitals, and key emergency response agencies
- A plan for preventing interruptions in the operation of key medical care technology
- A description of who is responsible for the continued maintenance of the plan

Each facility must also post signs indicating the designated routes in the event the building must be evacuated and the safest locations within buildings for employees, residents, and guests to shelter in place.

According to Christin Shepherd, P.E., CFM, Flood & Wetland Administrator, "developers, builders, and other city agencies understand the importance of the city's floodplain regulations, and there is a high-degree of cooperation." She worked for the city in September 2013, when nine inches of rain fell in a 24-hour period, and she saw, first hand, the damage a major flood can cause. Sheperd facilitated the city's hazard mitigation plan, and she worked on the maps illustrating the city's flood risks. She feels that she can be most influential when reviewing new development "where there may be opportunities to partner with developers to cluster new structures on higher ground and work to preserve the natural landscape within designated floodplains."



City of Boulder

Boulder, Colorado, is crossed by 15 major creeks. Boulder Creek typically suffers the worst flooding. Flooding in the creeks is influenced by dramatic changes in elevation since the city sits at the foothills of the Rocky Mountains.

New York City Acts to Keep Nursing Homes Out of Coastal Flood Zones

On May 12, 2021, the New York City Council adopted Zoning for Coastal Flood Resiliency, a comprehensive revision of its floodplain regulations started as part of the recovery from Hurricane Sandy. The city has 520 miles of shoreline, and approximately 15 percent of the city falls within the one percent annual chance floodplain. This vast geography contains over 80,900 buildings that are currently at a high risk of being flooded by coastal storms.

In 2012, Sandy demonstrated how vulnerable the city was to flood hazards. Flooding occurred in most of the city's designated floodplains, and it reached into neighborhoods that, at the time, were not thought to be vulnerable.

According to Manuela Powidayko, Project Manager for the coastal flooding zoning policy, an important addition to the city's coastal flooding regulations are new limitations on nursing homes. While the citywide zoning amendment is mainly focused on modifying bulk regulations to encourage long-term resiliency, it also includes new limitations on nursing homes to address the most vulnerable of city residents. Powidayko says these regulations were developed "after Hurricane Sandy made it clear that some of the city's nursing homes were vulnerable to coastal flooding." She says the new rules were developed in collaboration with New York City Emergency Management, New York City Department for the Aging, New York City Department of Health and Mental Hygiene, and the New York State Department of Health.

Under the zoning amendment, new nursing homes will no longer be permitted within "high-risk flood zones" (i.e., one percent annual chance of flooding) shown on city flood maps. The city uses the New York State Public Health Law definition of nursing homes that includes "facilities where care is available for people of all ages who need 24-hour nursing care and supervision outside of a hospital."

According to the ordinance, when nursing homes are part of a larger, elderly housing project (i.e., projects offering independent living, assisted living, and nursing

home care), the nursing care portion of the project will have to be located on a portion of the property outside of the one percent annual chance floodplain. Furthermore, under the new floodplain rules, preexisting nursing homes are limited to additions or expansions of no more than 15,000 square feet. These additions to existing homes are subject to floodproofing and flood protection standards.

Finally, nursing homes will not be permitted in areas with severe access problems during flood events, even when these areas are not designated as "high-risk flood areas." The Department of City Planning has mapped these locations, and they include neighborhoods where coastal flooding often forces the closure of local roads and bridges for extended periods. These mapped areas include several of the city's smaller islands, peninsulas, and isolated coastal areas.

Michael Marrella, AICP, Director of Waterfront and Open Space Planning, says that the new limitations were based on an assessment of the "true health consequences of major storms on the vulnerable populations housed in nursing homes." Marrella says that the city's policy on nursing homes "was informed by the studies and research that followed Hurricane Katrina, Hurricane Irma, and Hurricane Harvey"—studies that documented how nursing home residents had died or suffered significant health consequences following the storms. He says that the city's policy was informed by public health studies that highlight the risks of "trauma" when nursing home residents are evacuated and the longer-term health consequences for residents who suffer through the experience of the storm.

Most of the Zoning for Coastal Flood Resiliency policy is designed to make permanent and improve upon regulations that were passed after Hurricane Sandy to better enable the rebuilding of the city's coastal neighborhoods devastated by the storm. In 2013, the city adopted "interim" zoning rules to remove regulatory barriers that hindered the reconstruction of storm-damaged properties. However, the Department of City Planning learned, through community engagement, that there were still many barriers faced by owners of old buildings trying to rebuild, since those often do not comply or conform with current underlying zoning regulations. These barriers often lead to delays and confusion about how the city was trying to direct rebuilding efforts.

Zoning for Coastal Flood Resiliency seeks to eliminate all the existing barriers that have hindered redevelopment and new construction. The new zoning incorporates lessons learned from administering the "interim" regulations and from community feedback. The new policy is designed to encourage building and rebuilding homes and businesses that are stronger, more durable, and therefore, more capable of recovery from storms like Sandy.

Zoning for Coastal Flood Resiliency incorporates the FEMA maps of the floodplain (i.e., the one percent and 0.2 percent annual chance floodplains), and it clarifies the area where the zoning rules apply so that more buildings can be designed to meet or exceed the flood resiliency standards set by the New York City Building code. It also establishes provisions to assist with future disaster recovery, such as by expediting the permit process for homes and businesses complying with the new rules. Two other important parts of the new zoning are increased flexibility in the city rules regarding building heights so that homes can be elevated consistent with the floodplain rules and more flexible floor area regulations so that utilities can be moved out of basements without homeowners losing permitted floor area.

The city's zoning text, the floodplain maps, and public presentation slides can be viewed on the Department of City Planning's website at https://on.nyc.gov/3xpicqx.

St. Petersburg, Florida, Coastal High Hazard Regulations

In October 2020, the St. Petersburg, Florida, City Council approved changes to the city's comprehensive plan, land development regulations, and building code for "coastal high hazard areas" (Ordinance No. 428-H). These changes were controversial and passed after three years of public debate, hearings, and petitions from the city's chamber of commerce and development community.

St. Petersburg has always had some of the strictest regulations on development in its coastal high hazard area of any Florida community. Its comprehensive plan did not allow any increases in residential density within the coastal high hazard area boundaries. Furthermore, its land development regulations prohibited the following uses in the Hurricane Evacuation A Zone (i.e., the area considered most vulnerable to storm surge and the first zone considered for evacuation):

- New hospitals, nursing homes, and assisted living facilities
- New mobile home parks
- Solid waste and commercial hazardous waste management facilities, including regional storage, treatment, or transfer sites

The city's strict limits on density increases in the coastal high hazard area became the focus of debate when, in 2016, new maps showed a Category 1 storm surge area of 16,328 acres versus the 7,705 acres identified on the 2010 map. With this updated map, the area within the coastal high hazard area more than doubled and now covered more than 41 percent of the city's land area. The expanded boundaries included areas that the city had targeted, well before the new map, for economic development, job growth, and redevelopment. These areas included the city's "innovation district," the St. Petersburg campus of the University of Southern Florida, an office park and town center, and some retail centers the city had long been trying to redevelop.

Florida statutes and the city's land development regulations define the coastal high hazard area (CHHA) as "the area below the elevation of the Category 1 storm surge line as established by the sea, lake and overland surges from hurricanes (SLOSH) computerized storm surge model." These storm surge models are prepared by the Florida Division of Emergency Management and the National Hurricane Center, and they result in maps that highlight the areas vulnerable to flooding from the lowest category of hurricane. Over time, these maps have changed as better data became available on

the dynamics of storm surge, and models were improved to illustrate wave movements and velocities during hypothetical hurricane conditions. The compromise that passed city council amended the comprehensive plan to potentially allow increased density (on a case by case basis) for about only 30 percent of the total coastal high hazard area, while changing the land development regulations and building code to require new multifamily buildings to be more resilient to storm surge, flooding, and wind. According to Elizabeth Abernethy, Director of the City of St. Petersburg Planning and Development Services Department, "changes to the building code included an additional two feet for freeboard (building elevation) above the already higher local requirement of two feet, for a total building elevation requirement of four feet above FEMA's base flood elevation. This elevation was settled on, in part, because of NOAA's 50-year mid-to-high projection for sea level rise."

The land development regulations amendments require "hurricane evacuation and re-entry plans" for all new multi-family and hotel developments. The amendments require stricter building design and construction standards for multifamily developments. These design standards are intended to result in structures that are more resilient to storm surge, wind, and sea level rise. New development can be required to pay for mitigation measures that enhance storm shelter services if additional density is granted as part of a comprehensive plan amendment.

The changes to the city's land development regulations amended the city's policy of not permitting new nursing homes, hospitals, and assisted living facilities within a Hurricane Evacuation A Zone to a policy of not permitting them within the "coastal high hazard area." Protecting the safety of the vulnerable populations remains an important city priority.

The city participates in the Pinellas County Hazard Mitigation Plan, which highlights some of the flood and hurricane risks to existing hospitals, nursing homes, and assisted living facilities. According to the county plan there is one hospital within evacuation Zone A. In addition, there are 35 assisted living facilities and seven nursing homes in evacuation Zone A. The county plan estimates that in evacuation Zone A there are nearly 400 people residing in nursing homes that may need assistance with evacuation. The plan also estimates that just more than 1,500 people in hospitals and nursing homes are located in evacuation Zone B within the county.

The safety of vulnerable populations in hospitals and nursing homes is reflected in local mitigation priorities. The county's plan calls for funding numerous flood and hurricane mitigation projects at the Bayfront Medical Center in St. Petersburg and smaller projects at the city's St. Anthony's Hospital. The plan also calls for flood mitigation projects at other area hospitals including the Morton Hospital Plant in Clearwater, Florida. At the Bayfront Medical Center, the plan calls for hardening doors, windows, and roof structures and providing enclosures to critical systems that can be damaged by wind and water during a storm.

Jocelyn Augustino

Members of the FEMA USAR (Urban Search and Rescue) task force remove residents from a nursing home affected by Hurricane Katrina.

Other Florida Cities and Counties

In Florida, 80 percent of the state's population lives in coastal communities. The location and safety of hospitals, nursing homes, and assisted living facilities has been a sensitive issue for Florida communities for decades. Many local emergency managers in the state's coastal communities have had experience evacuating residents of these facilities during storms.

Many Florida communities require new nursing homes, assisted living facilities, and hospitals to have their first floors elevated above the base flood elevation. In many cases, they require these facilities to be located two to three feet above the base flood elevation. The elevation of the base flood is the flood elevation that has a one percent chance of being equaled or exceeded in any given year.

Reddington Shores, for example, defines *critical facilities* in its flood damage prevention ordinance to include hospitals, nursing homes, police stations, fire stations, emergency operation centers, hazardous material facilities, and utility facilities (§90-32 et seq.). The city's code directs these critical facilities to be located outside of flood hazard areas but provides that if "feasible sites…are not available" then "critical facilities must be elevated or protected to an elevation three feet above the base flood elevation."

Most Florida communities must also comply with the Florida Building Code, which requires nursing homes and hospitals to meet a series of safety standards, including requirements for foundations and structural elements to be capable of withstanding certain hydrostatic loads, for the use of flood resistant building materials and for electrical systems, and for HVAC systems and other utilities to be elevated or meet certain standards for floodproofing.

In coastal high hazard areas, many local governments go further. In Escambia County, nursing homes and other adult care facilities are authorized in certain residential districts but prohibited in designated coastal high hazard areas (Part III §4-5.6). Citrus County also discourages nursing homes and assisted living facilities in areas that are shown as coastal high hazard areas on the

county's land development code atlas, but the code allows one exception (§3540.F). In general, nursing homes and assisted living facilities are a conditional use in the county's residential and lower density commercial and office districts and a permitted use in the General Commercial District, where these uses are "limited within the Coastal High Hazard Area to those sites with direct access to a principal roadway" (§2412). The county has a classification system for roads, including principal and minor arterials, major and minor collector streets, and local roads.

CONCLUSION

In many communities it is not enough to require nursing homes, assisted living facilities, and hospitals to elevate their structures above the base flood elevation. In big storms elevating these facilities can mean that vulnerable residents are stranded and uncared for until the flood waters recede. Elevating structures does not eliminate the trauma when long-term residents of these facilities need to be evacuated before, during, or immediately after a storm.

The threat of trauma is real. Professor Lindsey Peterson at the School of Aging at the University of Southern Florida says many "long-term residents of nursing homes are frail, some suffering from Alzheimer disease and heart disease, making them more susceptible to the trauma associated with emergency evacuations."

The best solution is a land-use plan and zoning code that keeps the most vulnerable and fragile populations out of high-risk flood zones. However, this type of policy is not so easy to achieve.

In many coastal communities, all development is clustered near the shore. The Atlantic Seaboard and the Gulf of Mexico are full of beach towns, shoreline communities, and communities built on peninsulas, islands, and capes. These communities have limited options for siting hospitals, nursing homes, and assisted living facilities outside of areas at threat from flooding, storm surge, and coastal hazards.

These risks are also relevant to communities that experience flash flooding. In some of the arid states of the Great Plains, flash flooding can occur because the soil cannot absorb heavy rains, and runoff overwhelms local infrastructure. In communities like Boulder, Colorado, flash flooding is a threat because it sits at the foothills of the Rocky Mountains. Flash flooding is also a risk in communities with large dams, levees, and flood retention facilities, where there is a risk of catastrophic failure.

Many local hazard mitigation plans identify "at-risk" populations and identify facilities that house fragile and vulnerable populations. Land-use planners need to use these plans to assess the risks to these facilities and craft zoning strategies that will keep these facilities safe in the event of dangerous floods.

ABOUT THE AUTHOR

Tom Smith is an adjunct lecturer in the graduate program of the college of urban planning and public policy at the University of Illinois Chicago. He previously worked in the Risk Analysis Branch of FEMA Region V and traveled to New York City as part of FEMA's response team for Hurricane Sandy.

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205 N. Michigan Ave.
Suite 1200
Chicago, IL 60601–5927

DOES YOUR ZONING CODE MITIGATE RISKS TO VULNERABLE POPULATIONS?

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