3 Relocate & Protect Building Systems

I. Summary

Issue:
The first and lower floors of many existing buildings are at risk because they are below flood level, and essential building equipment is often located on these lower floors.

Recommendations:
Building owners should consider relocating equipment above the flood level and follow best practices when floodproofing. Require fire protection equipment to be raised in new construction and enhance standards for hospitals.

II. Proposed Legislation, Rule or Study

The following items are covered by Appendix G governing construction in flood zones. Add clarification language found in supporting material to other parts of the code.

Electric Services

Amendments to the New York City Electrical Code:

1. Amend paragraph (A)(1) of Section 230.70 as follows:

   (1) Readily Accessible Location. The service disconnect means shall be installed at a readily accessible location above the design flood elevation either outside of a building or structure, or inside nearest the point of entrance of the service conductors.

Sprinkler and Fire Standpipe Control Valves

Amendments to the New York City Building Code:

1. Add a new Section 8.15.1.1.1.9 to Appendix Q BC Q103 as follows:

   8.15.1.1.1.9 Sprinkler control valves shall be OS&Y valves or located above the design flood elevation.

2. Add a new Section 6.2.2 (8) to Appendix Q BC Q105 as follows:

   (8) Fire standpipe control valves shall be OS&Y valves or located above the design flood elevation.

Fire and Sprinkler Booster Pumps
(Note: Prohibits installation below design flood elevation)

Amendments to the New York City Building Code:

1. Add a new Section 8.16.1.9.2 to Appendix Q BC Q102 as follows:

   8.16.1.9.2 Dry pipe valve related electrically operated alarm appurtenances shall be located above the design flood elevation.

2. Add a new section to Appendix Q BC Q104 as follows:

   Location of Sprinkler Booster Pumps: (1) Sprinkler booster pumps shall be located in a two hour rated room.
   (2) Sprinkler booster pumps shall have direct access from a two hour rated passageway or stairway.
   (3) Sprinkler booster pumps shall be installed above the design flood elevation. In buildings with occupied floors less than 300 feet in height above the lowest level of Fire Department vehicle access where locating the sprinkler booster pump above the design flood elevation is not feasible, the sprinkler system shall be supplied by gravity tanks in accordance with Section 9.1.4(4).

3. Add a new section to Appendix Q BC Q105 as follows:

   Location of Fire Pumps: (1) Fire pumps shall be located in a two hour rated room.
   (2) Fire pumps shall have direct access from a two hour rated passageway or stairway.
   (3) Fire pumps shall be installed above the design flood elevation. In buildings with occupied floors less than 300 feet in height above the lowest level of Fire Department vehicle access where locating the automatic fire pump above the design flood elevation is not feasible, the fire standpipe system shall be supplied by gravity tanks in accordance with Section 9.1.4(4).

Electrically Powered Fire Protection Equipment

Amendments to the New York City Building Code:

1. Add a new exception to Sections 903.3.10.1, 903.2.10.1.3, and 904.1 as follows:
   Exception: Electrically activated water and non-water fire extinguishing systems shall be located above the design flood elevation.

2. Add a new Section 6.9.4.4 to Appendix Q102 as follows:

   6.9.4.4 Electrically operated water flow detection devices serving sprinkler systems shall be located above the design flood elevation.

3. Add a new Section 7.2.6.6.5 to Appendix Q102 as follows:

   7.2.6.6.5 Air compressors serving sprinkler systems shall be located above the design flood elevation.

4. Add a new Section 7.3.2.6 to Appendix Q102 as follows:

   7.3.2.6 Pre-action sprinkler systems shall be located above the design flood elevation.

5. Add a new Section 7.3.3.3 to Appendix Q102 as follows:

   7.3.3.3 Deluge sprinkler systems shall be located above the design flood elevation.

6. Add a new Section 7.4.1.5 to Appendix Q102 as follows:

   7.4.1.5 Combined dry pipe and pre-action sprinkler systems shall be located above the design flood elevation.

Amendments to the New York City Fire Code:

1. Add a new Section 902.14 as follows:

   902.14 Electrically activated sprinkler systems shall be located above the design flood elevation.

2. Add a new Section 904.2.1 as follows:

   904.2.1 Electrically activated non-water fire extinguishing systems shall be located above the design flood elevation.

The following items are proposed to be newly covered by code.

Fire Command Stations and Alarm Systems

Amendments to the New York City Building Code:

1. Add a new Section 907.8.1.1 to Chapter 9, Section BC 907 as follows:

   907.8.1.1 Where a zoning indicator panel and associated controls are positioned in a lobby level located below the design flood elevation, a second zoning indicator panel and associated controls shall be provided. The second panel shall have all of the annunciation and control functionality as the primary panel. The location of the second panel shall be at a level at least five feet above the design flood location and approved by the department and the Fire Department. The transfer of control to the secondary location shall be by a means that is approved by the Fire Department. All power supplies including the dedicated transfer switch for the secondary zoning indicator panel, and all elements of the fire alarm system backbone shall be located at least five feet above the design flood elevation.

Fuel Oil Tanks and Supply

Amendments to the New York City Mechanical Code:

1. Add the following exception to Section 1305.6.2:

Exception: For buildings located in a special or moderate flood hazard area, fill piping shall terminate three feet above the design flood elevation or the fill termination shall be an approved watertight terminal opening complying with Section 1305.6.5.

2. Add a new Section 1305.7.2 (5) as follows:

   (5) For buildings located in a Special Flood Hazard Area, normal vent pipes shall terminate three feet above the design flood elevation.

3. Add the following to the end of Section 1305.8.2:

   For buildings located in a Special Flood Hazard Area, emergency vent pipes shall terminate three feet above the design flood elevation.

Medical and Compressed Gas Storage Tanks

Amendments to the New York City Plumbing Code:

1. Add a new Section 1201.2 as follows:

   1201.2 Medical and compressed gas storage tanks, oxygen tanks, and other cryogenic system storage tanks serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Storage tanks serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

Amendments to the New York City Fire Code:

1. Add a new Section 2703.2.4.3 as follows:

   2703.2.4.3 Hazardous material storage tanks serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Storage tanks serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

2. Add a new Section 3003.3.3 (6) as follows:

   (6) Stationary compressed gas containers serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Compressed gas containers serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

3. Add a new Section 3203.1.3.4 as follows:

3203.1.3.4 Stationary cryogenic containers serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Cryogenic containers serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

4. Add a new Section 3503.1.2.1 as follows:

3503.1.2.1 Stationary flammable gas storage containers serving buildings located within flood zones shall be designed, constructed, installed, and anchored to resist at least 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions, in accordance with ASCE/SEI 24 and the New York City Building Code. Flammable gas containers serving critical facilities shall be elevated above the design flood elevation and must maintain service to the facility.

Hospitals

Amendments to the New York City Building Code:

1. Add the following definition to Section G201 in alphabetical order:

AREA OF MODERATE FLOOD HAZARD. The land in the floodplain delineated as subject to a 0.2 percent or greater chance of flooding in any given year. Such areas are designated on the Flood Insurance Rate Map (FIRM) as X-Zones (Shaded). Such areas are also known as the 500-year floodplain.

2. Modify the definition of “DESIGN FLOOD ELEVATION” in Section G201 as follows:

DESIGN FLOOD ELEVATION. The applicable elevation specified in ASCE/SEI 24, Tables 2-1, 4-1, 5-1, 6-1, 7-1, depending on the structural occupancy category designated in ASCE/SEI 24, Table 1-1. For Category IV structures that are hospitals, the design flood elevation shall be the elevation of the flood having a 0.2 percent chance of being equaled or exceeded in any given year, including wave height.

3. Add a new Section G304.1.2 (2.3.1) as follows:

G304.1.2 (2.3.1) Critical Facilities. In I-2 occupancies that are hospitals providing acute medical care, generators and emergency power fuel pumps shall be accessible for maintenance and repair during moderate or special hazard flood conditions.

4. Add a new Section G304.3 as follows:

G304.3 X-Zone Construction Standards. The following standards shall apply to post-FIRM construction and substantial improvements located within X-Zones.

G304.3.1 Critical Facilities. In I-2 occupancies that are hospitals providing acute medical care, all post-FIRM new buildings and substantial improvements shall comply

with the standards outlined in Section G304.1.2.

Fresh Air Intakes for Sewer Piping

Amendments to the New York City Plumbing Code:

1. Add a new Section 1002.6.1 as follows:

   1002.6.1 A relief vent or fresh air intake for a building trap serving a building located in Special Flood Hazard Areas shall be carried above grade and shall be terminated in a screened outlet located outside the building at a height above the design flood elevation.

Reduced Pressure Zone Backflow Preventers

Amendments to the New York City Plumbing Code:

1. Add the following sentence to the end of Section 608.13.2:

   These devices shall be installed above the design flood elevation in flood zones.

2. Add the following sentence to the end of Section 608.13.3:

   These devices shall be installed above the design flood elevation in flood zones.

III. Supporting Information

Expanded Issue and Benefits:

If given the option between elevating critical equipment and providing flood protection on a lower floor, elevation is encouraged. Maintaining the integrity of dry floodproofing is difficult over the long term, and future alterations may unintentionally compromise floodproofing. Dry floodproofing often depends on manual strategies such as closing submarine doors, hatches, and other movable water barriers, and as a result can be defeated through simple human error during flood preparation. Elevating certain systems may have unintended consequences during non-flood emergencies and as a result, building owners (especially those responsible for critical buildings) must balance all risk factors to determine which systems, if any, are suitable for elevation above the design flood elevation (DFE).

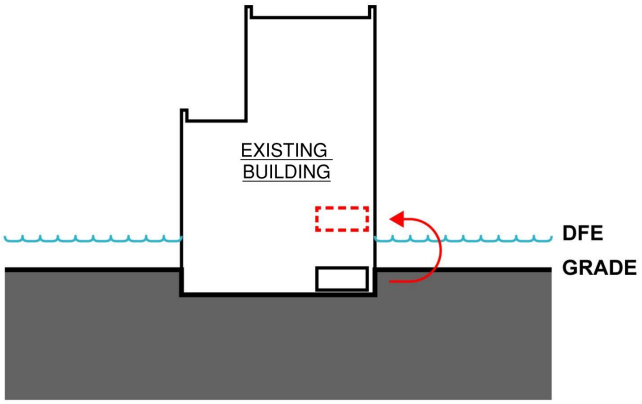

Figure 1: Moving critical utilities and attendant equipment above the DFE.

To encourage building owners to relocate critical building equipment above the DFE, the city and/or state could provide owners with incentives to move essential and/or critical building equipment and utilities above the DFE, such as zoning incentives, tax rebates, or direct offsets of incurred costs.

For some building systems, existing building codes in effect for new construction and substantial alterations already include provisions for flood resistance. However, some new code language is still recommended to make flood protection requirements more clear. The building systems affected by this clarifying code language are:

A. Electric, water, and natural gas services
B. Electrical, mechanical, and HVAC equipment
C. Fire pumps and associated fire protection equipment
D. Elevators
E. Incoming IT services

For other building systems, some new code language is recommended. This would apply to any new construction or substantial alterations where the building code applies. The building systems affected by this new code language are:

F. Fire command stations and alarm systems
G. Fuel oil tanks and supply
H. Medical and compressed gas storage tanks
I. Fresh air intakes for sewer piping
J. Reduced pressure zone backflow preventers

Part 1. Relocation/Elevation of Equipment

A. Electric, Water, and Natural Gas Services

Submersion of electrical utility services up to the first point of switch disconnect is a safety concern and can lead to excessive or irreparable damage to both utility and building systems and increase the recovery time for such systems.

To the extent possible, buildings should utilize submersible utility and electrical equipment below DFE for all equipment and wiring supplying the main building service. Where building systems are being relocated above the DFE, buildings should consider the installation of utility isolation switches to limit the extent of unprotected cable within the building.

Currently, building-owned end line boxes are not submersible and submersible boxes are not generally available in the industry. Code changes could influence the industry in securing or designing submersible end line boxes with fused disconnects, which would alleviate the impacts of flooding. Submersible cable connections could also be required, but these requirements would need to be reviewed by the Department of Buildings.

In the future, the city could consider requiring all new or significantly renovated larger buildings to provide utility space for transformation assets above the flood zone. However, this alternative would place significant additional costs on building owners, including the potential loss of valuable retail and/or commercial space. An additional supporting document with diagrams and more details about potential alternate electric installation strategies is available from the Building Resiliency Task Force.

For inside gas meters/regulators, there is minimal risk of service interruption from having service piping points of entry or meters/regulators below the flood elevation. For further reference, NYC Fuel Gas Code 301.11 Flood Hazard states the "appliance, equipment, and system installations" shall comply with Appendix G, but not the utility owned gas service piping. Aboveground gas service points of entry should be left in place unless the building is raised on piles, since there are potential risks associated with moving gas service equipment indoors or elevating gas service points of entry.

In existing buildings, it is best practice to relocate the existing water service and gas piping (and any appurtenances) such that service will not be interrupted during a flood event. Note that gas meter rooms do not require flood protection because submerging gas meters does not interrupt gas service.

It is recommended that gas regulator vents for all building types be located above the flood elevation or constructed so as to prevent water from entering or accumulating within the regulator vent piping.

Similarly, all domestic water and gas booster pumps should be located above the flood elevation. Note that booster pump failures are caused by electrical interruptions. Booster pumps are sealed and do not allow water to infiltrate the gas piping.

Implementation:

The recommendations may be difficult to implement due to space planning restrictions. However, the technology and means are readily available.

B. Electrical, Mechanical, and HVAC Equipment

Submersion of electrical equipment and wiring generally causes irreparable damage and prevents operation of other building systems. Damage is more catastrophic if electrical equipment is energized when submersion occurs. Accordingly, as best practice, existing

buildings should consider relocating equipment above the flood line.

Appendix G requires these items to be elevated or protected in new construction as well as existing buildings with substantial improvements. These buildings will need to identify suitable space, with an acceptable pathway and intercept method above the DFE for this equipment.

The following are best practice recommendations for mechanical equipment:

1. Control panels deemed critical to the functioning and habitability of a building should be located in a floodproof area or above the DFE.
2. Provide standby power for the control system head end. If critical systems will not function without the BMS system (for example, when there is no manual override for control loops), standby power should be provided. Standby power should also be provided for systems that require monitoring during an emergency (for example, demand reduction controls, fuel oil, and/or generator monitoring).
3. Locate head end above the DFE to avoid replacement following a flood event.
4. Split direct digital control (DDC) systems into below-DFE and above-DFE zones so that loss of submerged areas does not impact the rest of the building. The communication network and power source for these panels should be separated by their relationship to the DFE. This will keep communication errors from a damaged panel creating excessive “traffic” on the network, thus slowing or freezing communication on the balance of the network. Additionally, the power source for BMS equipment at or below the DFE should not service equipment above the DFE. If properly arranged, an equipment short will not interrupt power to panels operating above the DFE.
5. Prohibit DDC panels located below flood elevation from serving devices located above flood elevation.
6. Store software and program updates off-site in a secure location.
7. Include a “manual operation mode” in emergency planning documents.

C. Fire Pumps and Associated Fire Protection Equipment

As a best practice, existing buildings should relocate all non OS&Y fire standpipe and sprinkler control valves, fire pumps, jockey pumps, dry pipe valve equipment, and electrically released fire protection systems and their appurtenances above the DFE. In lieu of a pumped water supply, the city should consider allowing the use of gravity water tanks in buildings 300 feet in height or less, and should consider revising the “Fire Pump Testing” memorandum issued by DOB in 2010, which includes conflicting information regarding fire pump testing and location requirements. The revision should allow the waterproofing of fire pump rooms, as opposed to relocating them, to provide for both accessibility and flood protection.

The costs associated with this proposal will include the relocation of all equipment above the flood elevation and rerouting of piping and device wiring below grade to accommodate the relocation. It is straightforward to implement and the technology is readily available, but space planning issues may arise.

D. Elevators

Elevators may be rendered inoperable by submerged cabs, call buttons, controllers, or elevator pits. Elevator equipment is not generally designed to be water resistant, and power and control circuits that extend below the DFE could short out controllers located above the DFE if

submerged while energized.

The following are recommended as best practice for elevators:

- Tractor elevator equipment and control panels should be located above the DFE.
- Locate hydraulic elevator equipment that is susceptible to water damage above the DFE.
- Call and control circuits that are installed below the DFE should allow for isolation in the event of water infiltration or flooding.
- Emergency protocols need to be established to protect the elevators in the event of water infiltration or flooding.
- Connection to the central control station should be waterproofed.
- Provide automatic visual indication that cars are out of service at the elevator control panel.
- Electrical equipment should, to the extent possible, be constructed and installed to withstand water infiltration or flooding. Mitigation should include waterproof enclosures designed to withstand expected submersion depths. Wiring outside of the waterproof enclosure should be waterproof, although availability of waterproof wiring systems is limited, with most designed for simple outdoor installation rather than flooding. Further product development is required to address this.
- Install a water detection switch in the elevator pit that, when activated, will send the elevators to a floor above the DFE. Where feasible, existing buildings should follow Appendix G Section 7.5.1 and install controls that prevent recall of elevators into flooded areas. This controls should be installed even in areas that are dry-floodproofed, since floodproofing can fail.
- Relocate elevator management system display computers above the DFE.
- Evaluate the feasibility of replacing steel compensation cables with coated compensation chains.
- All switches and wiring installed below the DFE should be waterproofed to the NEMA 4 standard.
- Escalators should not have auxiliary controllers located in the lower end pit if it is below the DFE.

A valuable source of additional information is FEMA Technical Bulletin 4 (November 2010), “Elevator Installation for Buildings Located in Special Flood Hazard Areas.”

E. Incoming IT Services

All new buildings should consider locating at least one service entry room above the DFE, with all primary building services (e.g., fire alarm system central office connectivity, building management voice and data circuits, etc.) located in this elevated service entry room. It is recommended that incoming IT services be protected within conduit between the building point of entry and the service entry rooms.

F. Fire Command Stations and Alarm Systems

Fire command stations in lobbies are not always accessible during floods or adverse weather conditions. If the power and/or the head end electronic architecture for the fire alarm system are located in a flood zone, they can become inoperable. As best practice in existing buildings, consider relocating the head end components (inclusive of voice communication system and

support power) of the fire alarm system, as well as data gathering panels and any other active element of the fire alarm system backbone above the DFE. (Note: there is no code limitation or guidance regarding the location of the fire alarm system technology head end or data gathering panels. Code and the AHJ only govern the position of the fire command station and any fire alarm system devices.)

This proposal also recommends a new code requirement for a second (redundant) fire command station, which becomes automatically and/or manually operational in the event that the primary panel becomes inoperable. This second fire command station, recommended to be located five feet above the DFE, should be easily accessible via a stairwell. The secondary command station would become the primary head end of the system (replacing the lobby, or primary FCS panel) only through an FDNY approved process that is under the control of the FDNY and Building Management. FDNY must control any transfer between command stations to eliminate confusion during a fire event.

A protocol should be considered that allows the recall position of elevators during a fire alarm activation to be above the DFE, provided that this location is readily accessible from the lobby or the street. It is preferable that the elevators in this scenario recall to the same level as the secondary fire command station.

Additional costs for new construction include the additional fire command center equipment and the potential loss of usable square footage for the secondary fire command center. The installation costs of a secondary fire command center and relocation of DGPs will be minimal. Depending on the design of the building, and the ultimate location of the secondary position of the fire command station, there may or may not be costs associated with the architectural impacts (stair access, mezzanine creation, lost FAR floor space, etc.).

G. Fuel Oil Tanks and Supply

Flooding of fuel tanks and pumps creates environmental issues, and renders the fuel system inoperable. This proposal recommends raising or floodproofing vulnerable elements of the fuel system.

Costs are minor for new construction projects, but in existing buildings they can be very high. If the fill location is above the design flood elevation, there may be a cost increase for fuel oil suppliers to reach this position. Costs are slightly higher to maintain monitoring and protection systems.

However, the savings from this proposal are considerable. The cost to clean up fuel-contaminated water can be large, especially if there is a spill into a building or public area. If floodwater enters the fuel tank and reaches boilers or generators, the damage can be significant. Additionally, protecting fuel systems helps prevent the need to relocate occupants if a building cannot be occupied due to loss of building heat or lack of emergency or standby generators.

Some of the waterproof equipment required by this proposal is readily available while other products require special order. If these recommendations become law, the products are likely to be more readily available. Alarm devices to sense oil and/or water are available. Submersible rooms are common in the marine industry, but not common to building construction. For protection of tanks above the DFE, existing technology (fire rated room construction, foam fire

protection, etc.) that is readily available can be utilized.

Some equipment may be rated for use while being continuously submerged. Equipment rated for this use has an ingress protection (IP) rating of IPX8.

Designers should account for the increase in hydrostatic test pressure of the tank that occurs when vent pipe terminations are raised.

An excellent source of additional information about protecting fuel tanks is FEMA's Hurricane Sandy Recovery Advisory RA6, "Protecting Building Fuel Systems from Flood Damage."

H. Medical and Compressed Gas Storage Tanks

Current codes do not address protecting medical or compressed gas tanks during flooding. However, critical facilities must elevate this equipment to maintain service in the event of a flood. Although implementation is simple and required technology is available, the costs for existing buildings may be significant.

The climate modeling performed on behalf of the city and given to the Task Force as guidance predicts that many facilities in the current 500-year flood zone will begin experiencing 100-year floods sometime between the years 2020 and 2050. As such, it is prudent for critical facilities to plan for this contingency. Furthermore, the city should consider requiring critical facilities within the current 500-year flood zone to comply with Appendix G.

An excellent guide to further information for critical facilities is FEMA's Hurricane Sandy Recovery Advisory RA2 (April 2013), "Reducing Flood Effects in Critical Facilities."

I. Fresh Air Intakes for Sewer Piping

Locating fresh air intakes for sewer piping above the DFE will prevent water from entering lower levels through these intakes, mitigating water damage and the potential influx of toxic or hazardous materials.

The cost associated with this proposal includes additional fresh air intake piping from each sanitary house trap. This provision should be easy to implement, as the technology and means are readily available and well understood.

J. Reduced Pressure Zone Backflow Preventers

Reduced Pressure Principal Backflow Preventers (RPZs) are devices that use two independent check valves plumbed in series with a pressure-monitored chamber in between. The chamber is kept at a lower pressure than the incoming pressure. A differential relief valve is provided on the chamber to relieve excess pressure during a backflow condition. It is imperative that these devices are prevented from being submerged, since they are capable of introducing contaminated water into the potable water supply.

The NYC Department of Environmental Protection (DEP) often allows RPZs to be installed below grade if an engineered calculation is submitted (see NYC DEP Revised Supplement to the NYS Department of Health Handbook for Cross Connection Control pp. 4 and 7). This calculation

assumes that the RPZ is discharging at the maximum flow rate based on the incoming water service pressure for a period of eight hours, but does not take into effect environmentally induced flood conditions. If flooding submerges the device and a discharge occurs, the device may not be able to operate as intended. This variance should be disallowed in flood zones for subgrade installations.

Associated costs include the installation, drainage and space requirements both in existing and new construction**.** This proposal is easy to implement in new construction, but may be burdensome in existing buildings due to increased space requirements and the drainage requirements of the device. The technology and means are readily available.

Part 2. Best Practices for Floodproofing

1. Elevate the enclosed lower occupied floors above the DFE in existing noncomplying buildings.

Elevating lower floors above the DFE in existing buildings presents many significant challenges for building owners. Street wall issues, including required transparencies of street walls in certain districts, are at odds with an active street life. Raising the ground floors above the DFE could have a negative impact by potentially creating large expanses of opaque street walls, which may preclude the street level activity intended by the Zoning Resolution. Dry floodproofing, including perimeter floodproofing (barriers/shields) of lower floors, may be a more desirable and feasible mitigation solution for existing and new buildings with street grades below the DFE, but dry floodproofing is only allowed in nonresidential buildings and nonresidential portions of mixed-use buildings. Wet floodproofing is another option that may be considered in lieu of raising floors and equipment; however, this could limit the use of the space at the base of buildings, including the use and enjoyment of the area.

Elevating lower floors of an existing building above the DFE could be achieved in two ways:

A. Raising the entire building (feasible only for smaller scale buildings). Shown in Figure 2A.
B. Removing existing floors and reconfiguring/building new floors above the DFE (requiring a change/limitation of the use of the floors that would remain below the DFE). Shown in Figure 2B.

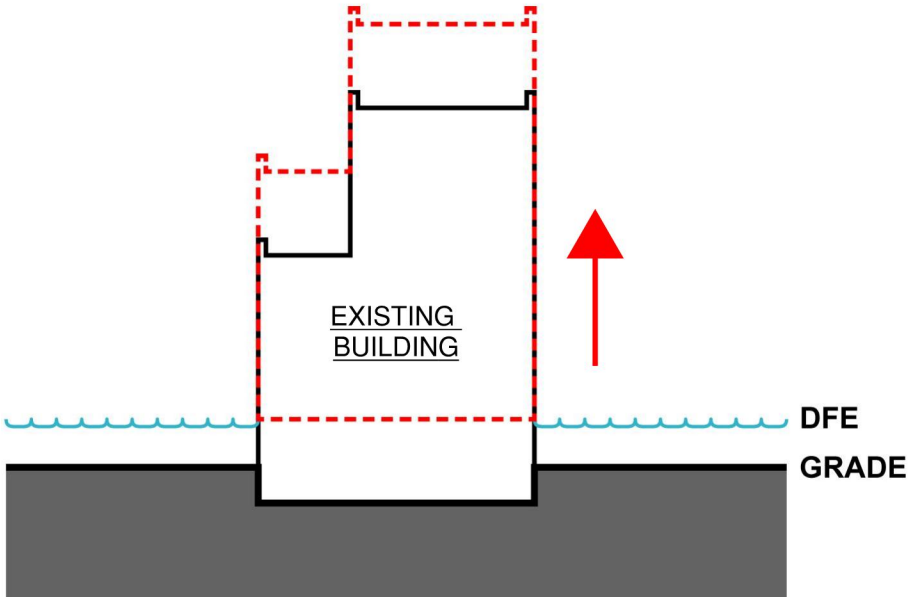

Figure 2A: Raising building above the DFE. (Limitations on use for areas/floors below the DFE).

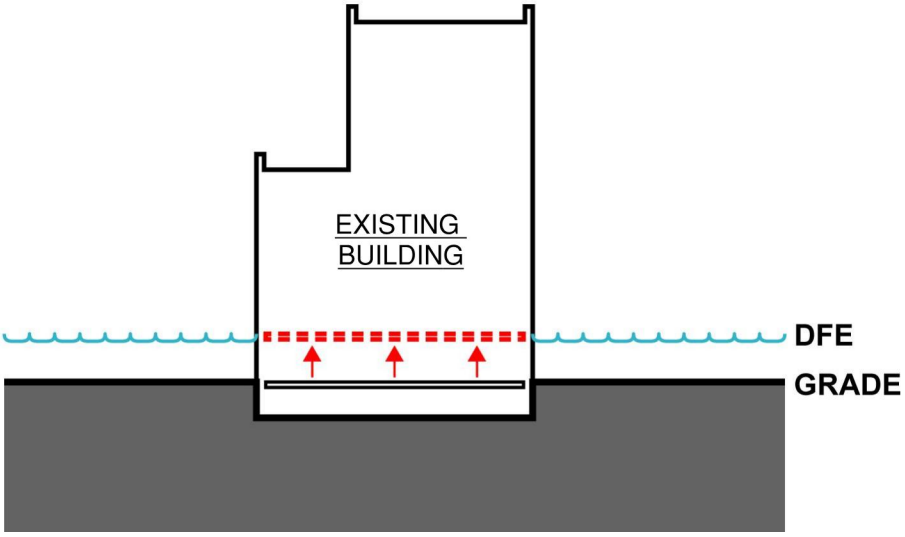

Figure 2B: Raising/reconfiguring lower occupied floors to be above the DFE. (Limitations on use for areas/floors below the DFE).

2. Dry Floodproof Basements

Water entry points at basements must be specifically addressed. Special attention must be given to detailing specific components of these assemblies:

- Sidewalk doors: Frames set within the sidewalks are to be watertight, and doors within

frames to be sealed. Prior to a flood event, the doors must be closed and sealed. Alternately, interior flood doors could be provided at the foundation walls that could be closed during flood events.

- Vaults & utility penetrations through foundation walls: Special attention to the detailing of pipe, conduit, and cable connections into buildings must be addressed. Inspections and flood testing are needed to ensure that all possible water entry points are addressed at walls, ceilings, and floors.

Complexities and issues include:

- Reinforcing existing foundation walls if they are not capable of resisting the additional pressure. Adding reinforcing may impact space and require internal reconfigurations of spaces and equipment locations.
- Complexity of detailing penetrations into foundation walls and interfaces with utility vaults and other components.

3. Dry Floodproof Selected Building Systems and Components

Providing a secondary level of dry floodproofing in and around building systems and components can prevent system inundation as well as greatly reducing cost and time to reoccupy buildings. Selected components, such as fuel oil tanks, pump rooms, or emergency electrical rooms could be waterproofed as “submarine rooms,” so the equipment remains fully functional during a flood event. Specific attention must be paid to the penetrations and openings within the room to ensure watertightness of the assemblies.

Floodproofed areas would need to be indicated on drawings submitted to DOB to ensure that the areas are maintained as floodproofed areas/assemblies. Demarcation of penetrations, wall assemblies, and doors/openings will be required to ensure that future renovations do not compromise the integrity of the floodproof construction.

4. Design Buildings to Resist Hydrostatic Forces From Higher Design Flood Elevations

For buildings with dry floodproofed below grade spaces, flooding can impose additional hydrostatic pressures on perimeter below grade walls and the lowest slabs (structural and nonstructural). The additional “head” of water can compromise the structural integrity of perimeter below grade walls and lowest slabs causing flooding and possibly structural damage.

The design of perimeter below grade walls and slabs to resist hydrostatic forces from flooding in Special Flood Hazard Areas has been implemented through the Building Code (Appendix G) and the Mayor’s Executive Order. However, the design and construction of retroactive applications for critical structures can be challenging. Perimeter foundation walls and lower slabs may require additional reinforcement and support (lateral beams, braces, tie-downs, etc.) to resist additional hydrostatic forces beyond original design requirements.

Cost:

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals

may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

Sources:

1. New York City Building Code (2008) and Appendix G (Flood Resistant Construction).
2. Executive Order No. 233 EMERGENCY ORDER TO SUSPEND ZONING PROVISIONS TO FACILITATE RECONSTRUCTION IN ACCORDANCE WITH ENHANCED FLOOD RESISTANT CONSTRUCTION STANDARDS (February 5, 2013).
3. ASCE 24/SEI and ASCE 7-10.
4. FEMA V Zone Design and Construction Certification.
5. FEMA Maps FIS 360497 and FEMA FIRMs 360497.
6. FM Global Documents:
    a. Flood Emergency Response Plan (FM Global ***Record,*** First Quarter 2003, Volume 80, No.1).
    b. Property Loss Prevention Data Sheets (July 2012).
    c. Property Loss Prevention Data Sheets (Interim Revision October 2012).
7. NYC Zoning Resolution (multiple sections).
8. Manufacturer Product Data/Testing Reports.
9. NYCDOT, “The Rules Related to Revocable Consents,” Title 34, Chapter 7 of the Rules of the City of New York, modified February 4, 2012.
10. US Army Corp of Engineers, St. Paul District, “Flood-Fight Handbook, Preparing for a Flood,” 2009 Addition.
11. FEMA Technical Bulletin 4 (November 2010), “Elevator Installation for Buildings Located in Special Flood Hazard Areas.”
12. FEMA Hurricane Sandy Recovery Advisory RA2 (April 2013) “Reducing Flood Effects in Critical Facilities.”
13. FEMA Hurricane Sandy Recovery Advisory RA6 (April 2013) “Protecting Building Fuel Systems from Flood Damage.”

NEW CONSTRUCTION

		Commercial High Rise				Commercial Low Rise				Residential High Rise				Residential Low Rise			
		Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total
3	**Relocate & Protect Building Systems**																
	NO CONSTRUCTION COST IMPACT FOR NEW CONSTRUCTION																
	SUBTOTAL DIRECT WORK																
	Contingency																
	SUBTOTAL																
	GC Mark-ups																
	TOTAL				**$0**				**$0**				**$0**				**$0**
	SUBTOTAL				**$29,150**				**$23,650**				**$23,650**				**$23,650**
	GC Mark-ups		20%		$5,830		20%		$4,730		20%		$4,730		20%		$4,730
	TOTAL	620,000	GSF	$0.06	**$34,980**	4,000	GSF	$7.10	**$28,380**	231,000	GSF	$0.12	**$28,380**	15,000	GSF	$1.89	**$28,380**

EXISTING BUILDINGS

		Commercial High Rise				Commercial Low Rise				Residential High Rise				Residential Low Rise			
		Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total
3	**Relocate & Protect Building Systems**																
	BEST PRACTICE																
	SUBTOTAL DIRECT WORK																
	Contingency																
	SUBTOTAL																
	GC Mark-ups																
	TOTAL				-				-				-				-