Build It Better Leadership Forum - Sandy: A Wake Up Call for Hurricane-exposed Communities

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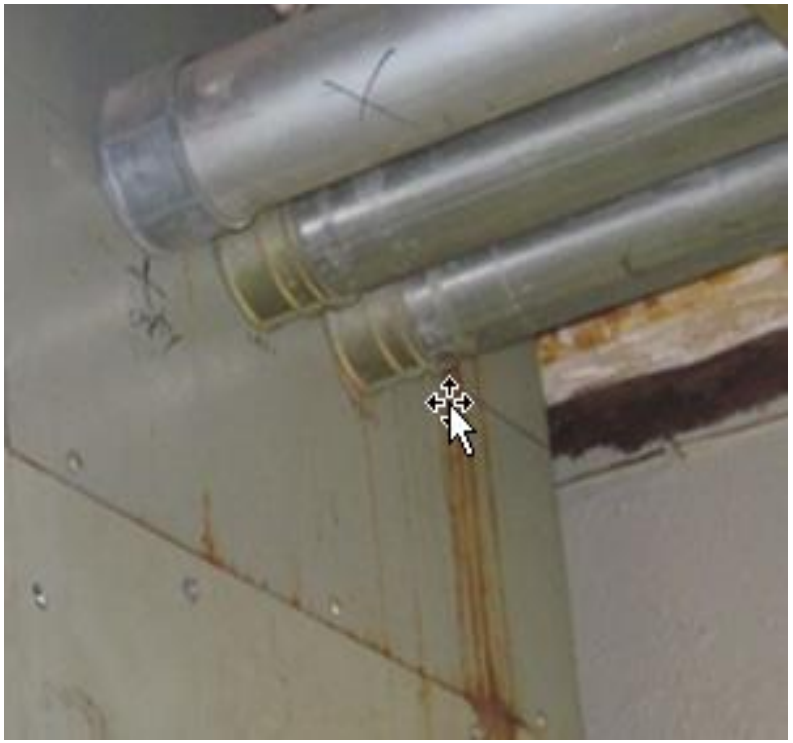
Recognizing the Risk of Flooding

- Basements and below grade spaces are extremely vulnerable to flooding.
- Any below grade opening such as a utility or electrical conduit, exhaust duct, or ventilation duct can allow water to fill the basement.
- In NYC, many utility pits, located below the sidewalks, contain transformers, electrical conduit penetrations, exhaust vents, fuel fill lines, etc.
- As the storm surge rose, these pits became basins for flood water, funneling water into basements.
- Even small gaps around poorly sealed pipes and conduits allowed flooding.

Below Grade Penetrations of Basement walls



Basement Flooding

- For many locations with flooded basements, the ground levels or first floor levels were untouched by flood waters.
- The problem was the presence of below grade penetrations.
- When flood waters entered the first floor levels, water cascaded down stairwells, elevator shafts and HVAC penetrations between floors.
- Once the storm surge receded, the basements remained full of dirty, brackish water.
- Think about these below grade openings and below the sidewalk pits the next time you stroll over some steel grating on the sidewalks of NYC.

Critical Equipment Located in Basements

- Electrical switchgear
- Boilers
- Chillers
- Emergency Generators
- Fire Pumps
- PBX Systems
- Transformers
- Elevator Pits

Recovery After the Basement Floods

- Pumping the water out is the *easiest* part of recovery
- Most of the critical infrastructure equipment may be severely damaged, and may need to be replaced.
- Removing the old equipment is time consuming and labor intensive.
- Acquiring the new equipment is time consuming and labor intensive.
- “Labor Intensive” often equals “Quite Expensive”.
- For many situations, pushing more money to expedite the purchase of replacement equipment and reinstallation, will hit a point of diminishing return.
- Money cannot always “buy time” during the difficult recovery process.
- Will the new equipment fit down the stairwell ?

Flood References Before the Storm

- Are you in a Zone A (100-yr. or 1% probability) area?
- You could find the 100-yr. flood level on the NYC FEMA Flood Insurance Rate Maps.
- Some of the maps dated back to 1980's.
- Are you in a Zone B (500-yr. or 0.2% probability) area?
- This information was located in a separate FEMA Flood Insurance Study (FIS) Book.
- What about "Storm Surge" flood levels?
- It was reported that 2/3 of the flooded homes were outside of the Zone A areas for the existing FEMA Flood Insurance Rate Maps.
- Does that fact surprise you?

NYC OEM -Natural Hazard Mitigation Document

- Prepared by the NYC Office of Emergency Management.
- Excellent explanation of flood and storm surge exposures.
- Extensive details and descriptions of the impact of flooding on the population, infrastructure and geography of NYC.
- The document and the work of the technical authors of the flood damage scenarios is proving to be very accurate.
- There have been other hurricanes and tropical storms throughout the history of NYC.
- NYC and the surrounding region was very lucky that the wind speeds were not higher.

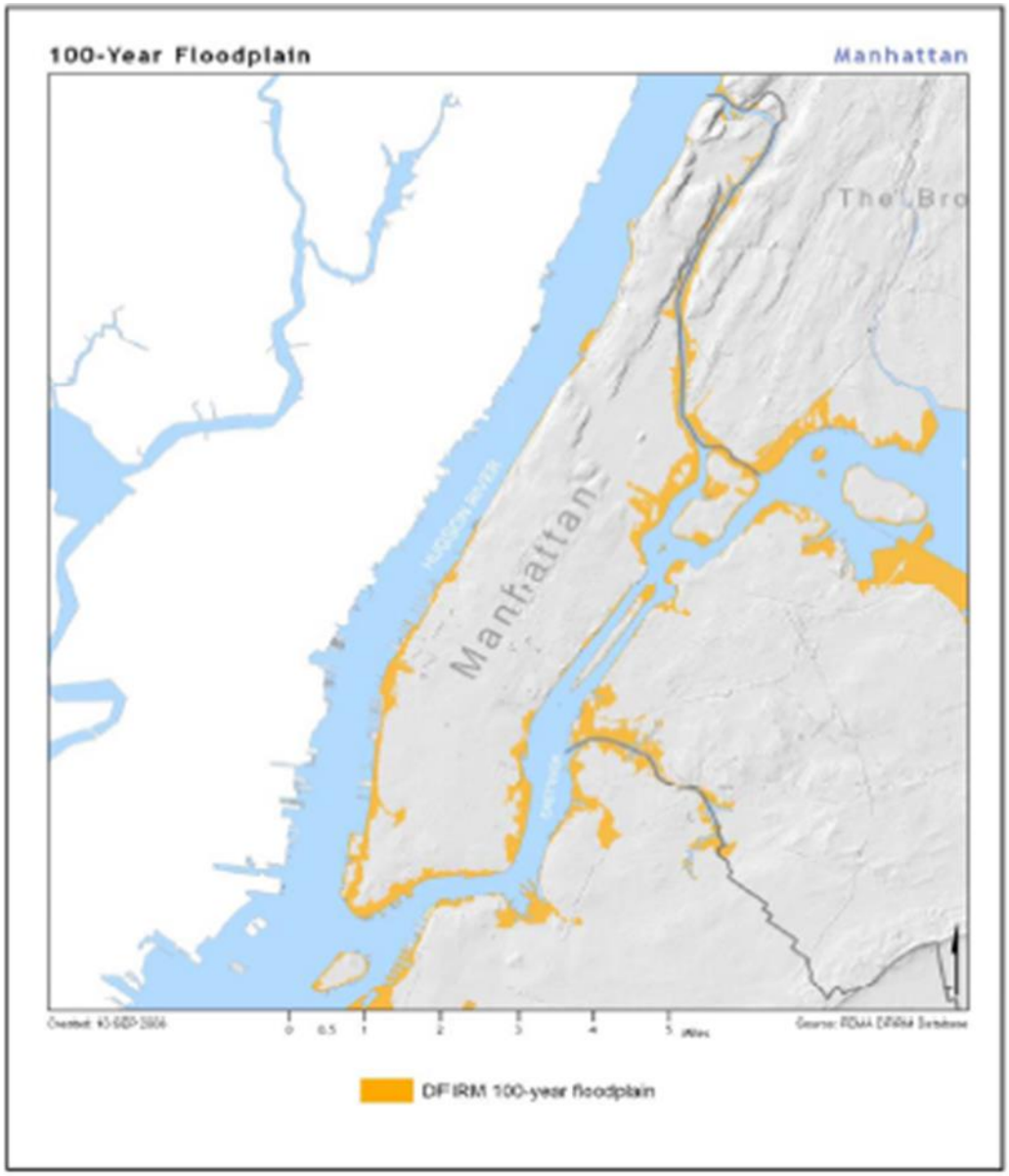
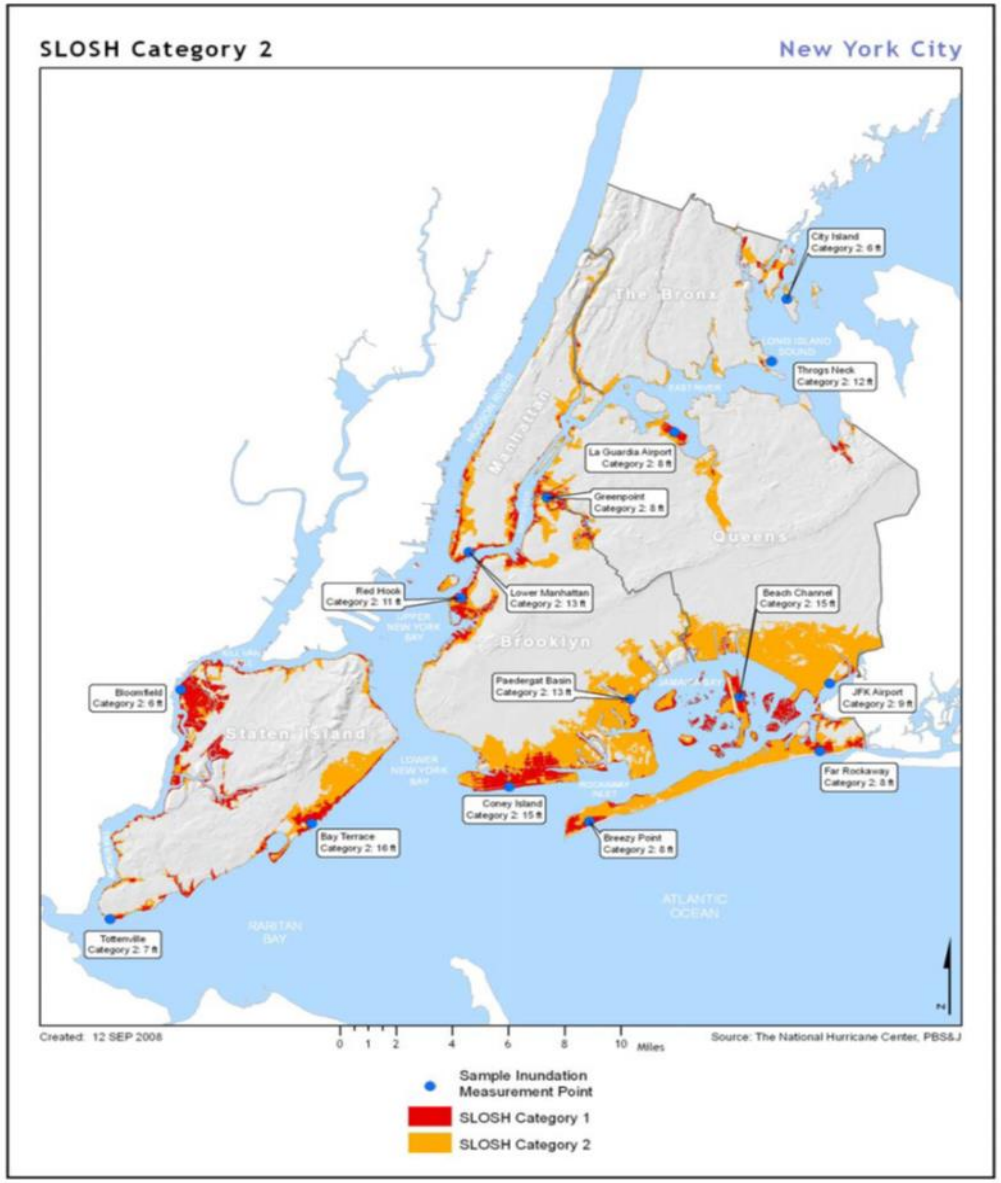
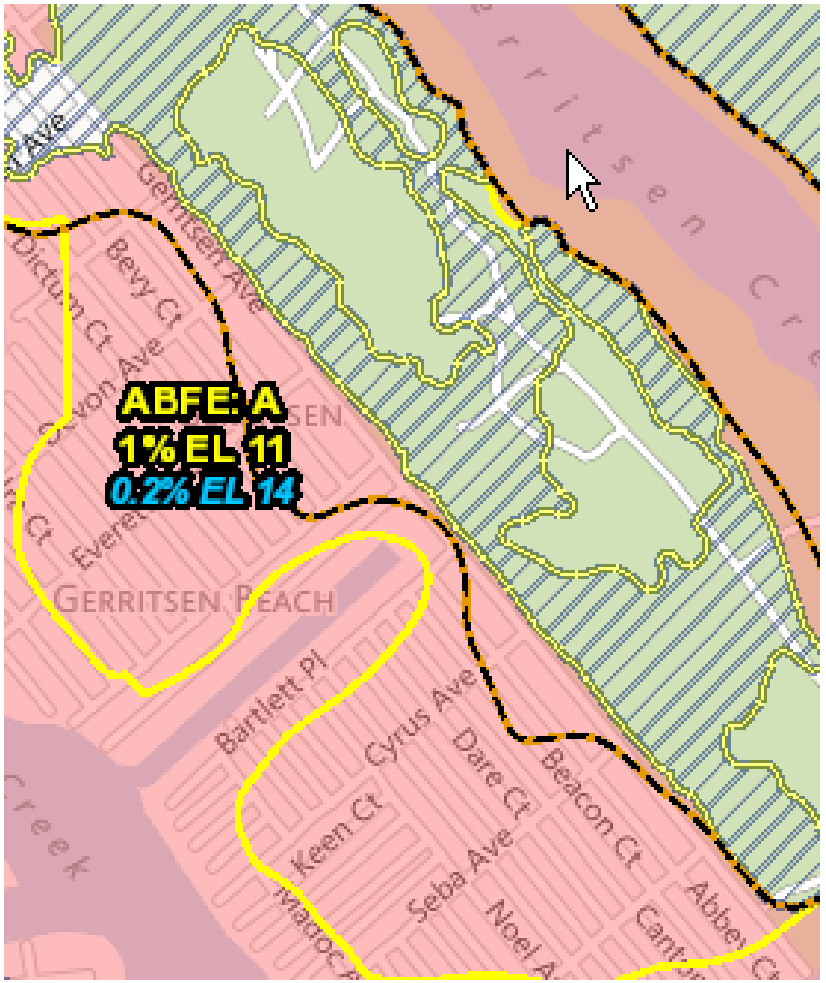


Figure 62: Manhattan 100-Year Floodplain



Recognizing the Risk of Flooding

- Floor Elevation
- Elevation of Vital Equipment
- 100-yr. Flood Level
- 500-yr. Flood Level
- Storm Surge Level ?
- Use new FEMA Advisory Base Flood Elevations (ABFE's)
- Online ABFE's include 500-yr. or Storm Surge Levels
- Elevate Equipment (ASCE 24)
- "Flood Proof" Basement if possible
- Develop a Flood Emergency Response Plan



Wind and Roofing

- The wind speeds were less than the minimum ASCE-7 code required wind speeds for most of the areas impacted by Sandy.

- The roofs, especially the commercial roofs, should have performed very well during the storm, because they should have been designed to meet the minimum code wind speeds.

- We did see consistent problems with in adequately secured edge metal or roof flashing.

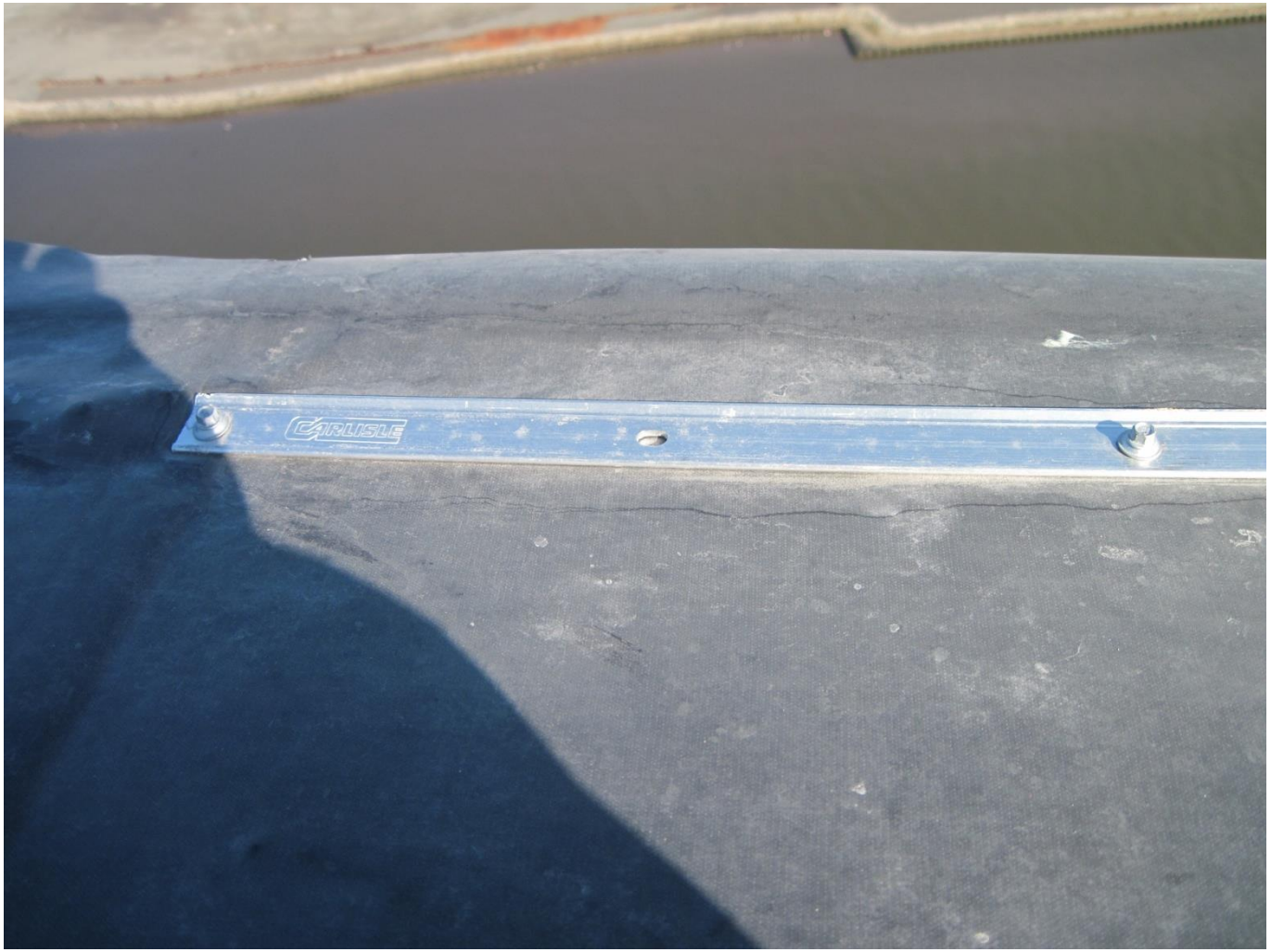
- Think of this metal closure at the edge of your roof as the “pop top” or “zipper” to your roof. When this inadequately installed component fails, a large portion of your roof can simply peel away

Edge Metal Flashing Securement

Preventing Membrane “Peel Away”

- Fully-adhered or fully-glued single ply membranes were a predominant roof system for many locations in the north east.
- These systems are in concept, an industrial sheet of rubber membrane glued to the surface of mechanically fastened insulation boards.
- These types of system are susceptible to failure in “peel mode” where the membrane is lifted and peeled away from the surface of the insulation board.
- One of the most effective ways to prevent the “peeling” from ever starting during a storm, is to make sure that the roofer or installer includes termination bars or batten bars to “clamp down the membrane” to the roof deck at roof penetrations and at parapet walls.

Termination Bar to Prevent Lifting of Adhered Membrane



Batten Bars & Termination Bars

- The proper installation of the termination or batten bars at parapets, vertical transitions and penetrations are common practices in higher wind areas such as costal area in the southeast, Florida, Texas, etc.,

- Many installation we visited in the aftermath of Sandy, where adhered membranes had failed, lacked these termination bars at the rood deck edges, roof deck penetrations and on vertical parapet walls

- Once the adhered membrane begins to lift away from the insulation board, the separation of large areas of membrane can occur very rapidly during a storm.

Check your roof

- Do not assume that since your roof was not damaged, your roof is adequately designed and secured.
- Ensure that your metal edge flashing is adequately designed to withstand the design wind speed for your region.
- Have your edge metal roof flashing inspected for adequate securement. Add more fasteners to keep the vertical face of the edge metal well anchored to the exterior wall of your building.
- From the underside of your roof deck, look for rows of fasteners at the edge of the roof deck.
- Look for a perimeter of fasteners around penetrations of your steel roof deck.
- Consider sealing these gaps to prevent air infiltration beneath the membrane.