

## **National Institute of Building Sciences**

Provider Number: G168

Improving the Flood Resistance of Buildings and Mitigation Techniques WE3B

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January 9th, 2019





Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.





### Course Description

Severe flooding can endanger life, but even moderate levels of flooding can lead to extensive damages and disruption of building operations. Water source contamination and inhibited access are significant problems, coupled with damages to structures and interior contents. Contaminated water can destroy electrical infrastructure, mechanical systems, etc. Business interruption can last from a few days to over a year. Due to climate change and revisions to FEMA flood maps in 2016, many buildings not previously categorized as being at risk are now categorized as subject to flooding. As a result, insurers are informing their clients of the potential risks and associated increases in flood insurance coverage, if flood mitigation procedures are not enacted. This presentation will discuss how to identify areas of facilities vulnerable to flooding, and the options and systems available to protect properties from potentially catastrophic damages to structures, building contents and impacts on building operations. The speakers will focus on addressing potential hazards at existing facilities. It is usually not as easy as building a levee around the property. Oftentimes, a hybrid solution must be developed, incorporating a variety of systems, including barriers, flood gates, deployable flood walls, backflow devices, storage tanks and ejector pumps, upgraded stormwater systems, etc.





### Learning Objectives

At the end of the this course, participants will be able to:

- 1. Identify areas of facilities vulnerable to flooding
- 2. Identify options available to mitigate flooding
- 3. Review process of flood mitigation design and associated construction phasing.
- 4. Create a flood emergency response plan



Weather Trends and Effects Upon Sea Level Rise and Rainfall Amounts

**Types of Flooding / Design Criteria** 

**Understanding Floodplain Mapping** 

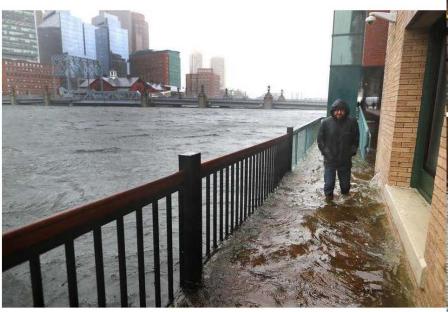
Flood Hazard Mitigation / Management Plans

### **Case Studies**

EDITORIAL

B

# **Boston's bill for climate** change is coming due



JOHN TLUMACKI/GLOBE STAFF

lay Tours

A man walks through a flooded sidewalk off Congress Street, where water was flowing over from Fort Point Channel in the Seaport District on March 2.

OCTOBER 18, 2018

## Ellicott City, Md., deluged by flash flooding as heavy rain soaks area

Maryland Gov. Larry Hogan has declared a state of emergency



Rescue personnel walk along Main Street in Ellicott City, Md., Sunday, May 27, 2018. Roaring flash floods struck the Maryland city Sunday that had been wracked by similar devastation two years ago, its main street turned into a raging river ... more >





By - Associated Press - Sunday, May 27, 2018

#### Miami Herald



#### MIAMI BEACH

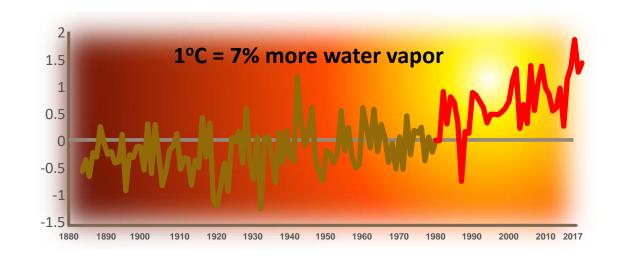
#### Before sea level rises, Miami Beach officials want to raise West Avenue 1½ to 2 feet

#### BY JOEY FLECHAS jflechas@MlamiHerald.com

January 22, 2015 06:00 PM Updated January 23, 2015 06:18 PM

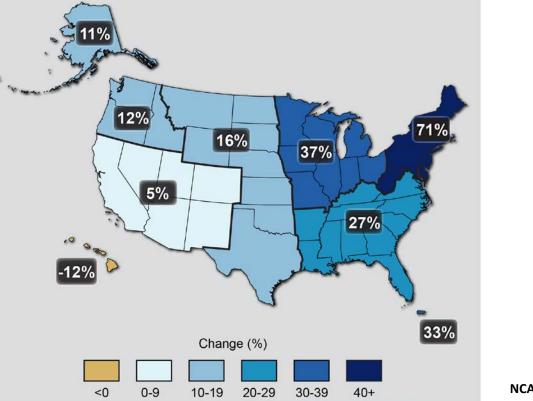
In an area that has seen its fair share of roadwork during the past few years, city officials want to raise West Avenue between  $1\frac{1}{2}$  to 2 feet during the next few years in an effort to prepare one of the lowest-lying points of Miami Beach for anticipated sea level rise.





NOAA National Centers for Environmental information, Climate at a Glance: Global Time Series, published January 2018, from http://www.ncdc.noaa.gov/cag/

## **Global Mean Temperature is Increasing**

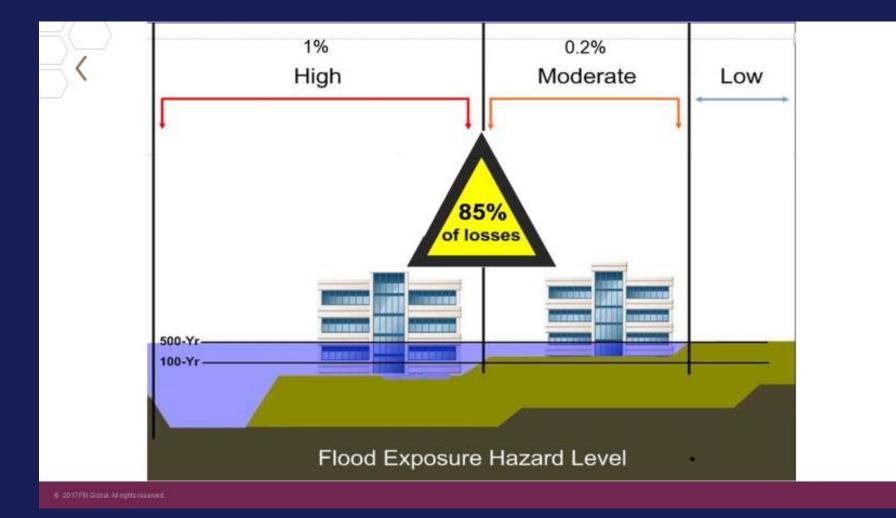


NCA3\_Climate\_Change\_Impacts

## **Observed Change in Very Heavy Precipitation**



# **Types of Flooding**



# **Sheet Flow**

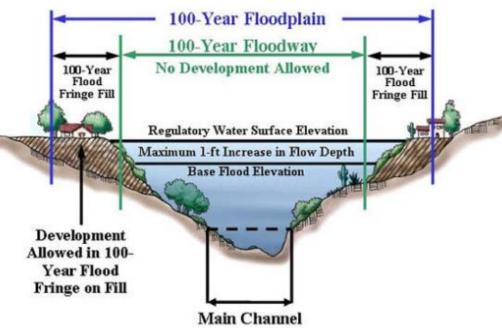
- Localized Site Flooding
- Not Associated with a FEMA Flood Zone



# Rivers and Streams

- Zone A / AE
  1% Base Flood Elevation (100 year flood plain)
- Floodway –Velocity Zone
- Zone X 0.2% Base Flood Elevation (500 year flood plain)





# Coastal

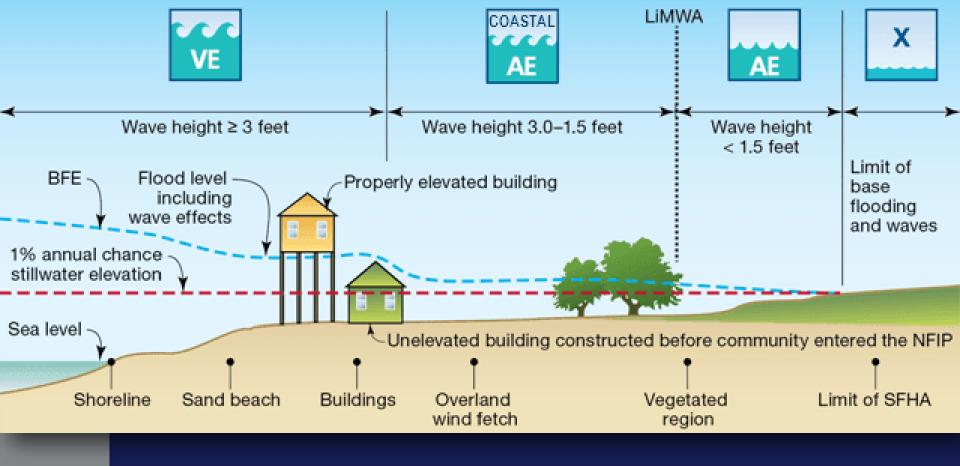
Coastal Zone VE & A/AEWave Action

Zone A/AEStillwater (1% BFE)

Zone XStillwater (0.2% BFE)







## **Coastal FEMA Flood Zones**

Types of Flood Damage:

- Hydrodynamic Forces
- Debris Impact
- Hydrostatic Forces
- Soaking
- Sediment and Contaminants





# **Understanding Floodplain Mapping**

# National Flood Insurance Program (NFIP)

- Created in 1968; changes under National Flood Insurance Reform Act of 1994
- Based on a mutual agreement between Federal Government and community
- Three basic parts
  - Mapping
  - Insurance
  - Regulations



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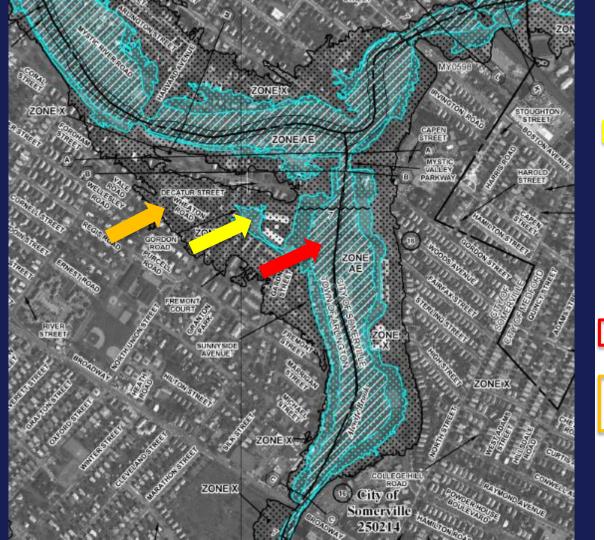
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#### LEGEND



#### SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.				
ZONE AE	Base Flood Elevations determined.				
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.				
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.				
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.				
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.				
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.				
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.				
F	LOODWAY AREAS IN ZONE AE				
The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.					
C	THER FLOOD AREAS				
ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood wit average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood				
	THER AREAS				
ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.				
ZONE D	Areas in which flood hazards are undetermined, but possible.				
//// c	OASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS				



OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

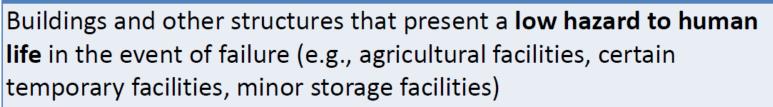
- ASCE 24 Flood Resistant Design & Construction
  - Minimum design and construction of structures in flood hazard areas (new construction, substantial Improvements, historic structure exceptions)
  - Meets or Exceeds NFIP regulations
  - Requirements are functions of Flood Hazard Areas (Zone A, V, other high risk) and Structure Classification
- FEMA Technical Bulletins
- FEMA P936 Floodproofing Non-Residential Buildings
- National Flood Insurance Program (NFIP) Regulations (44 CFR Parts 59 and 60)
- International Building Codes (I-Codes)



Category

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IV



All buildings and other structures **except those listed in Categories** I, III, and IV (e.g., most residential buildings)

Buildings and other structures that present a **substantial hazard to** III **human life** in the event of failure (e.g., schools, theaters, jails)

Buildings and other structures **designated as essential facilities** (e.g., hospitals, fire stations, police stations, emergency operations centers, power generating stations and other public utility facilities required in an emergency)

See next page for description of Flood Design Classes $ ilde{ extbf{ ex{ extbf{ extbf{ extbf{ extbf{ extb}$		Flood Design Class 1	Flood Design Class 2	Flood Design Class 3	Flood Design Class 4
Minimum Elevation* of Lowest Floor (Zone A: ASCE 24-14 Table 2-1)	Zone A not identified as Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
Minimum Elevation of Bottom of Lowest Horizontal Structural Member (Zone V: ASCE 24-14 Table 4-1)	Coastal High Hazard Areas (Zone V) and Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
Minimum Elevation Below Which Flood- Damage-Resistant Materials Shall be Used (Table ASCE 24-14 5-1)	Zone A not identified as Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
	Coastal High Hazard Areas (Zone V) and Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher

# **Dry Flood Proofing:**

A combination of measures that results in a structure, including the attendant utilities and equipment, being watertight with all elements substantially impermeable to the entrance of floodwater and with structural components having the capacity to resist flood loads.

- Building strength/building locations
- Warning time
- Flood characteristics
- Level of protection
- Seepage considerations
- Utilities



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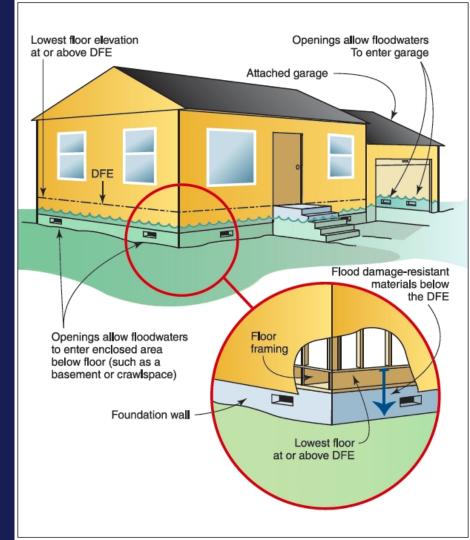
Automatic / Passive

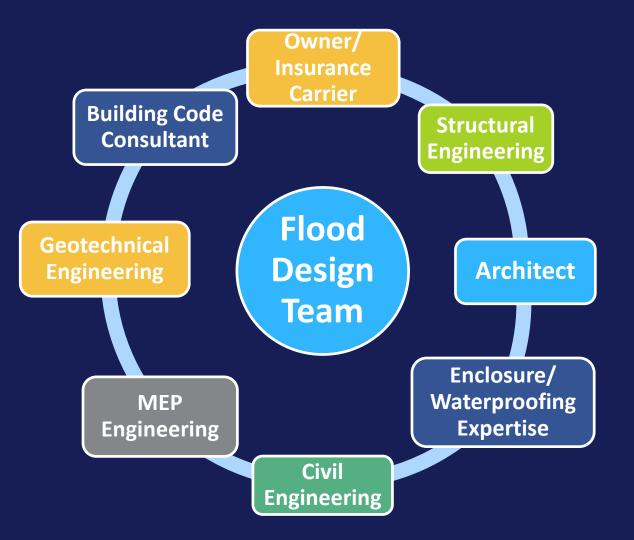
# Wet Flood Proofing:

The use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a structure, which is intentionally allowed to flood.

- Building strength
- Warning time
- Flood-damage-resistant-materials

Utilities







# Flood Risk...



2017: 3 Hurricanes, 26 Days, 2500 loss locations, \$75-\$145 billion loss estimated industry wide



## Hurricane Harvey was a Flood Event



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The Value of Risk Improvement

Flood losses experienced by FM Global clients who met our guidelines cost almost **5X Iess** than those that did not

## **Hurricane Harvey**

FM Global clients completed physical improvements and reduced their **OVERAL** loss exposure

by \$820 million/\$23 million average

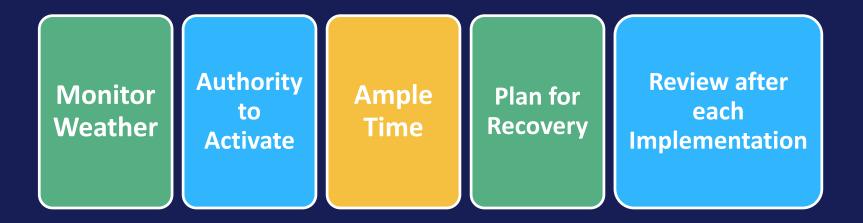
## **Hurricane Harvey**

# Flood Hazard Mitigation:

- Resiliency Goals
- Identifying areas of facilities vulnerable to flooding
- Develop flood emergency response plan (FERP)
- Identify options available to mitigate flooding
- ANSI/FM 2510 Approved Products



# FERP - Simple Steps During Normal Working Hours to Mitigate Loss





Match the Right Solution to the Scenario (Warning and Installation Time)

### If you are flood exposed, what can you do?

Besides moving out of the flood zone!

Relocate stock, particularly high-value items or those critical to continued operation Relocate equipment, such as portable electronic equipment, computers, testing and quality-control devices, dies and patterns, etc.



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Relocate critical drawings, records, files



### **Raise Equipment and Supplies**



# **Flood Barrier Examples**

# Protect Openings

Check all water entry points:

Front door Side door Loading dock door Windows Vents Pipe penetrations Underground pipes





# Protect individual pieces of equipment or portions of the building







## Flood Mitigation Products – Perimeter Barriers



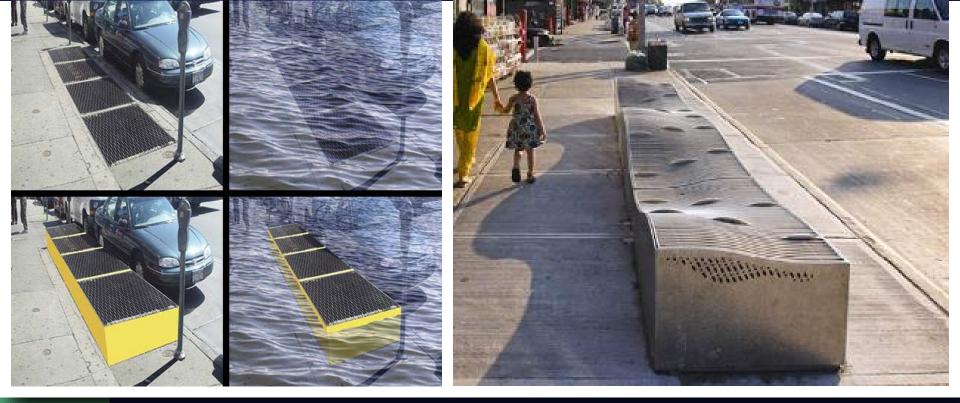
### **Permanent Flood Protection Barriers**



### All Barriers Should Meet ANSI/FM 2510 Standards

HANDAN

### Perimeter flood panel system



### Flood Protection for Subway Vents – Queens, NY



# Flood Mitigation Products – Opening Barriers



## **Automatic Pop-Up**



## Manually Deployed Opening Barrier

### One Client's Story: Flooded in May 2015 and April 2016

- Office tower
- Outside the 500-year zone
- Four feet of water in garage
- Building utilities located in garage



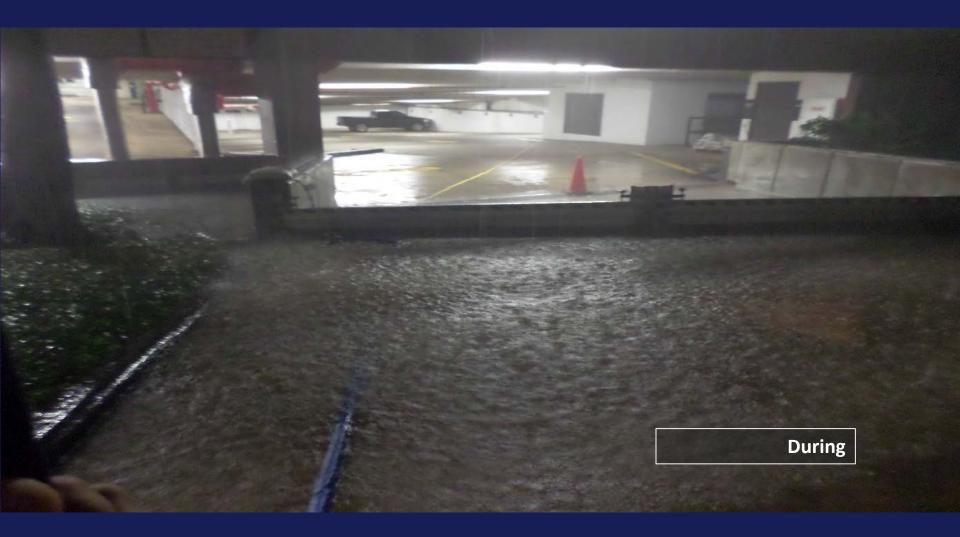
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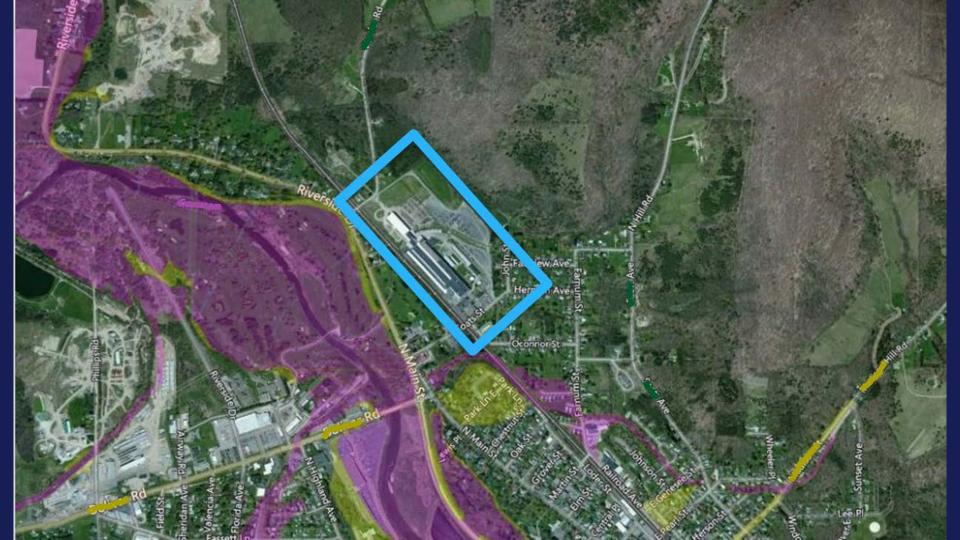








### **Case Study – River / Stream**







### **Close to Building**

### Slope of Land

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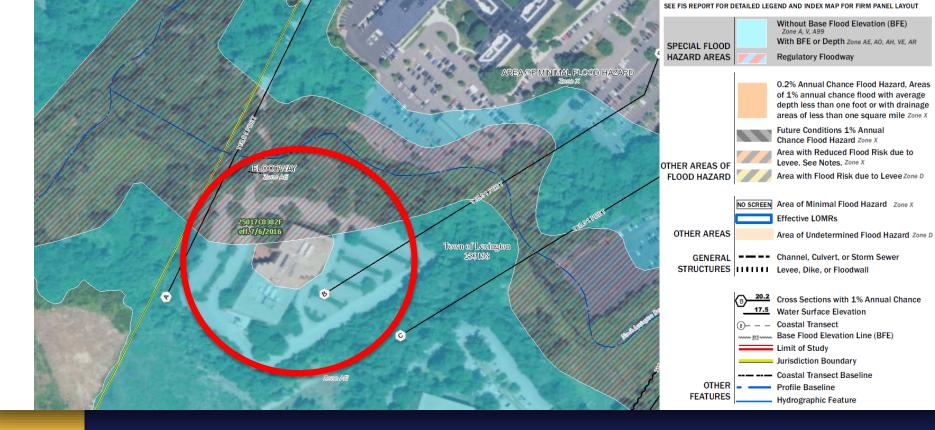
### **A River Runs Through It**

LIFT OFF BOX



### Case Study: Lexington, MA



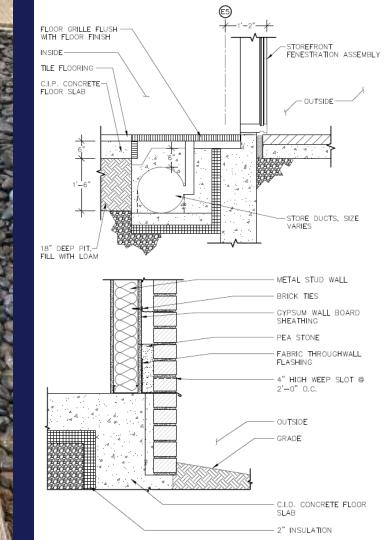


- Site within AE Zone and Regulatory Floodway
- Base Flood Elevation (BFE) is 118.50



- Base Flood Elevation (BFE) is 118.50
- Surveyed first floor found to be at 118.00
- Building is 6" below BFE

Floor mounted HVAC vents





### **Electrical/Mechanical Equipment Located on First Floor**

## Proposed Building Use: Office, Laboratory Space, and Cleanrooms

### **Flood Mitigation Options:**

### Wet Flood Proofing

Relocating all laboratory and cleanrooms to the second floor and installing isolated interior protection around mechanical, electrical, and communications rooms

### **Dry Flood Proofing**

Providing full building perimeter protection by installing permanent and/or temporary flood mitigation measures.

#### **Option 1 – Flood panel perimeter system**

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BREE.

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STARS STAR -----

#### **Option 1 – Flood panel perimeter system**

#### **Option 2 – permanent perimeter system with smaller openings**

Option 2 – permanent perimeter system with smaller openings



#### Case Study: Atlantic Avenue, Boston, MA





#### FEMA Flood Map / AE Zone, BFE Elev. 10



First Floor / Garage, ELEV=10.2' BFE=10' First Floor 2" above BFE Basement 9 ½' below BFE



Lower Level Basement Access Open Grated for Boiler Ventilation



#### **Louver Penetrations**



#### View from Sidewalk, Concrete Grade Beam



#### **Continuous and Approved Flood Barrier**



#### **Main Entrance – Unprotected**



#### Flood Barrier at Entrance, Garage and Basement Access



### **Changing How We Think**

## What Does It Take to Make "Futuristic" Ideas the Norm?







# What Does It Take to Make "Futuristic" Ideas the Norm?











### Key Takeaways

Storms Have Increased in Severity and Frequency

Even if You're Not in Flood Zone, You May Still Be Flood Exposed

If You Are Exposed, There Are Things You Can Do to Minimize Risk

www.galeassociates.com

www.fmglobal.com



This concludes The American Institute of Architects Continuing Education Systems Course





