



DISASTER RISK REDUCTION (DRR)  
AMBASSADOR CURRICULUM

Instructor Guide

***Module 18:***

***Design for Flood Resilience: Part I: Floodplain  
Management and Flood Resistant Design  
Pennsylvania Flood Challenges and Opportunities***

## **THE DRR AMBASSADOR CURRICULUM**

The **goal** of the DRR Ambassador Curriculum is to facilitate Disaster Risk Reduction efforts for the whole community by:

- Engaging in discussion of how disasters can be reduced through local action
- Sharing insights among local leaders and technical experts to enable the development of cross functional solutions
- Acquiring the best-available information, knowledge of best practices, and analytic tools to enable better-informed decisions before, during, and after disasters

It is important for instructors of DRR Ambassador Curriculum modules to remember this is one module in a 24-module curriculum. The “DRR Ambassador Curriculum At-a-Glance” table, located at the end of this document, lists the modules of the Curriculum. Keep in mind the following context for the module(s) you conduct:

### **DRR-A CURRICULUM TARGET AUDIENCE**

The target audience includes those involved in community development decision-making, such as local community staff, volunteer and stakeholder groups, and federal and state officials.

### **METHODS OF DELIVERY**

Varied delivery methods will provide multiple options for access by the target audience. The DRR Ambassador modules may be presented via webinars hosted by NHMA or partner organizations, presented in conferences and/or classrooms by qualified DRR Ambassador Curriculum instructor(s), or are downloadable for individual study from the NHMA website.

### **COURSE MATERIALS**

Instructors are expected to use the instructional materials housed on the NHMA website to conduct DRR Ambassador Curriculum modules (Instructor Guide, supporting visuals, Participant Guides, and handouts). Instructors may tailor modules to specific audiences or locations as long as they do not revise the learning objectives and do not revise the materials in such a way that the participants cannot correctly complete the post-test. Instructors request the current pre/post-test for the module from NHMA.

### **CERTIFICATES OF COMPLETION**

Certificates of Completion will be awarded by NHMA to participants who successfully complete NHMA-sponsored DRR Ambassador modules. A DRR Ambassador Certificate will be awarded to individuals completing all 24 modules. Participants who choose not to take the post-test may be issued a Certificate of Attendance. Contact NHMA about obtaining certificates. Inform participants to ask their certifying boards about acceptance of NHMA DRR Ambassador certificates for continuing education credits.

# Design for Flood Resilience

Part I: Floodplain Management and Flood Resistant Design  
Pennsylvania Flood Challenges and Opportunities

**NHMA**  
Natural Hazard Mitigation Association

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**Design for Flood Resilience**, to protect communities and regions (1) by **Floodplain Management** (2) by **Flood Resistant Design** of buildings and infrastructure, with a focus on the special challenges and opportunities in Pennsylvania...

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## Welcome!

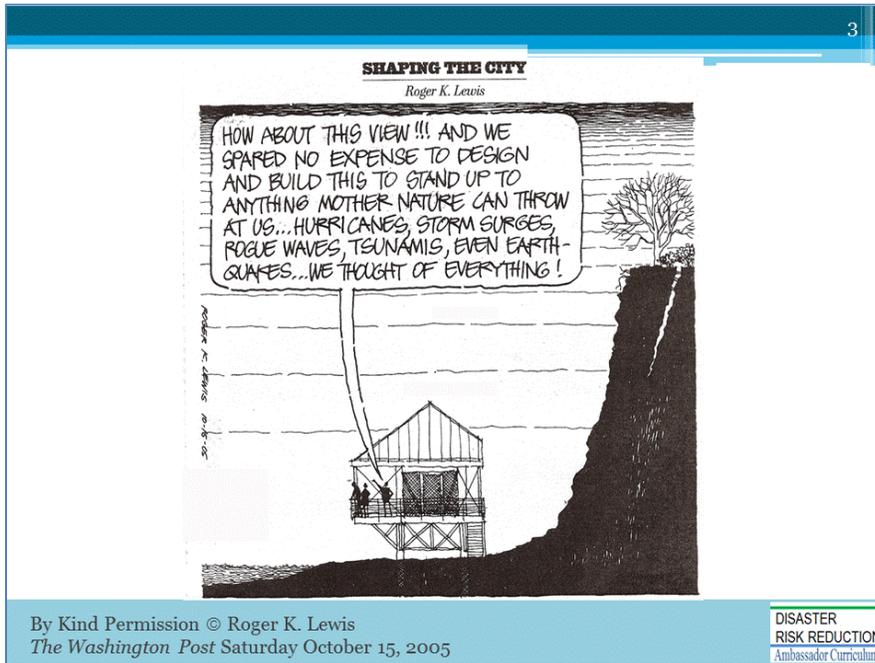
**Donald Watson, FAIA**



*This presentation is not and cannot be legal advice, nor does it necessarily represent the views of anyone other than the presenter(s).*

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- Donald Watson, FAIA is an architect and author. He has been involved in disaster mitigation planning and community development in the U.S. and abroad for over 50 years.
- This presentation includes illustrations from his most recent book, *Design for Flooding*, co-authored with Michele Adams, P.E.



The caption in the bubble reads...*“How about this VIEW!!!...We spared NO expense...to stand up to anything nature can throw at us...we thought of everything!”*

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## To Help Communities Flourish

- 1 What are we facing? **IMPACTS OF FLOODING**
- 2 What can we do? **ACTIONS / MEASURES**  
 **watershed management**  
**flood resilient design**
- 3 What are the benefits? **economy**  
**health**  
**safety**  
**fairness & equity**

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This module describes the **impacts of flooding** on our communities. It reviews the **actions we can take** to reduce flood risks—to save lives, property, and investments—and that sustain the economy, health, safety, and well-being of the whole community.

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## Learning Objectives

1. Identify the **risks** associated with different types of flooding in Pennsylvania
2. Explain the advantages of **watershed management based on future conditions**
3. Describe **flood resistant design measures** for buildings and infrastructure

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The Learning Objectives of this Module

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## Learning Objectives

1. Identify the **risks** associated with different types of flooding in Pennsylvania

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The 1<sup>st</sup> Learning Objective of this Module

## Flood Risks in the U.S.



### Riverine (“inland”)

- Stream overbank flooding
- Dam or levee failure

### Coastal

- Wave action
- Storm surge & erosion

### Shallow

- Surface runoff
- Urban drainage overflow

### Alluvial (“uncertain flow”)

- Flash floods/distant storms
- Movable streambeds

<https://www.fema.gov/national-flood-insurance-program/definitions>

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***In Pennsylvania, flood risks are principally “riverine” (inland flooding). All types of flooding may occur in the event.***

- **Riverine flooding** occurs when excessive rain, snow melt, or ice jams cause a river or stream to overflow.
- **Coastal flooding** may be experienced with extremely high tides, rising sea levels, and ocean storms.
- **Shallow water flooding** results when heavy rainfall overcomes or blocks urban drainage systems.
- **Alluvial floods occur in mountainous regions**, spreading debris flows into valley floors in a fan-shaped pattern. Alluvial floods can originate from a distant storm, follow any random path, are difficult to predict, and thus, also referred to as **“uncertain flow.”**

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## Flood Risks in Pennsylvania



**Inundation** of inland or tidal waters

<https://www.fema.gov/national-flood-insurance-program/definitions>  
 PHOTO: Pittsburgh KDKA Mar. 1, 2017 Fayette County, PA

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**Flooding** is defined by FEMA as *a general and temporary condition of partial or complete inundation of normally dry land... [of 2 or more acres, or, of 2 or more properties].*

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## Flood Risks in Pennsylvania



**Inundation** of inland or tidal waters

**Rapid Accumulation** of runoff

<https://www.fema.gov/national-flood-insurance-program/definitions>  
 PHOTOS: Pittsburgh KDKA Mar. 1, 2017 Fayette County, PA

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**Flooding by rapid accumulation of stormwater** may occur within minutes or hours of excessive rainfall, a dam or levee failure, or by ice jam release.

## Flood Risks in Pennsylvania



**Inundation** of inland or tidal waters

**Rapid Accumulation** of runoff

**Mudflow** on normally dry land



<https://www.fema.gov/national-flood-insurance-program/definitions>  
 PHOTOS: Pittsburgh KDKA Aug. 30, 2016 Connellsville, Fayette County, PA

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FEMA’s flood definition includes **mudflows and landslides caused by flooding**, and qualify for federal flood disaster assistance.

## Flood Risks in Pennsylvania



**Inundation** of inland or tidal waters

**Rapid Accumulation** of runoff

**Mudflow** on normally dry land

**Collapse/Subsidence** of land resulting from erosion, waves, or water currents exceeding normal cycles that result in flood

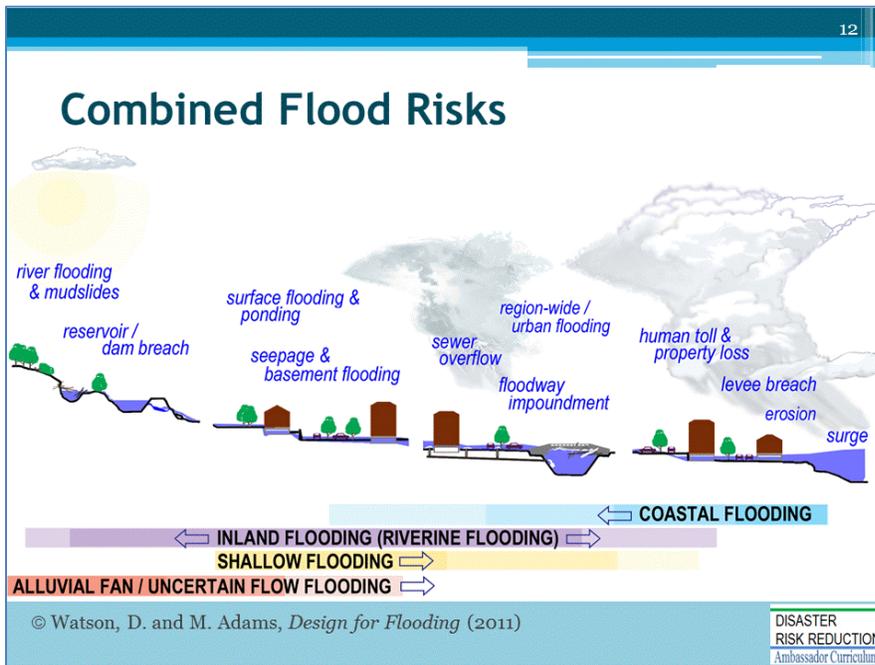


<https://www.fema.gov/national-flood-insurance-program/definitions>  
 PHOTOS: Pittsburgh KDKA Aug. 30, 2016 Connellsville, Fayette County, PA

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... [FEMA’s definition ] also includes the **collapse of land**, roads, and other infrastructure caused by flooding.

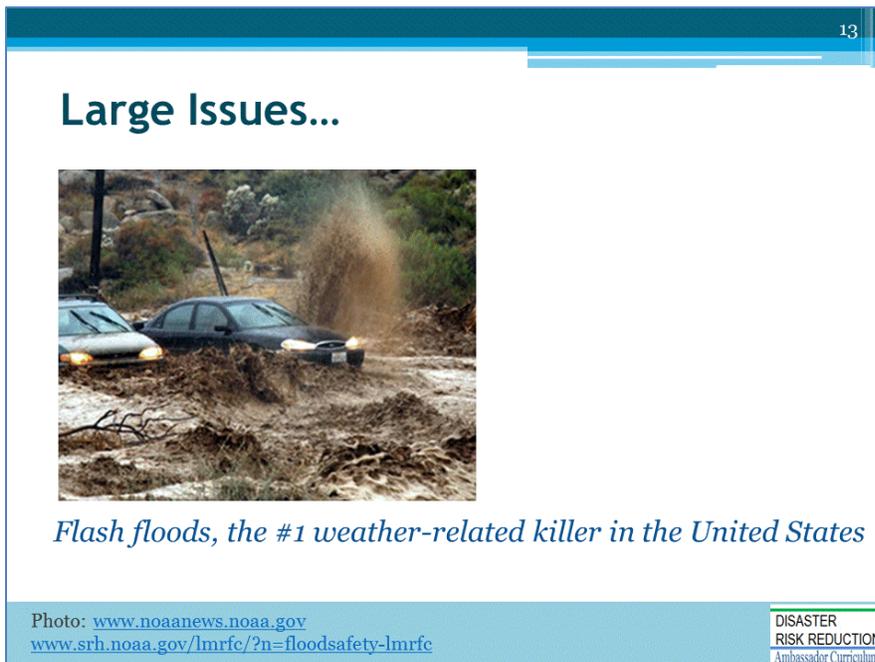
**These images are from recent Pennsylvania floods (2016-17)**, reported by KDKA Pittsburgh. Video footage on the KDKA website tells a more dramatic story of the lives and livelihoods disrupted by flooding in Pennsylvania.



**Flood risks compound one another...**Some due to the **direct impacts of a storm**—rain, wind, hail, ice, or snow.

**Indirect impacts** result when buildings and infrastructure fail, overwhelmed by the forces of wind and water.

We cannot **reduce the direct impacts** of severe weather and climate—[ ] We can reduce our **vulnerability** to risks of the **indirect impacts by preparedness: responsible management of our floodplains and by safer, stronger buildings and infrastructure.**



**Flash floods** may occur within minutes or hours of excessive rainfall ... [dam or levee failure, or ice jam release.]

## ...Small Steps



PHOTO: Crawford, OK (FEMA)

*Turn Around Don't Drown*

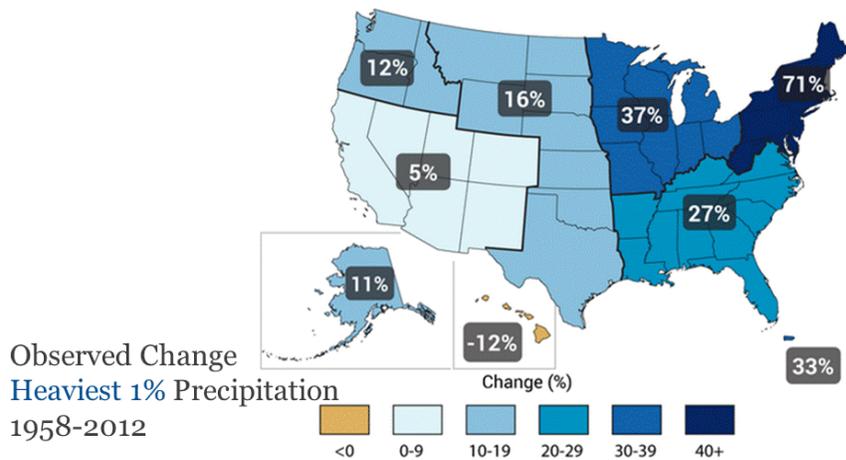
[www.srh.noaa.gov/tsa/?n=hydro\\_tadd](http://www.srh.noaa.gov/tsa/?n=hydro_tadd)  
<http://tadd.weather.gov>

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WE CAN **address high priority risks (such as flashfloods) with low cost, easily implemented actions.**

**“Turn Around Don’t Drown” or “TADD”** is a National Weather Service campaign to warn of the hazards of walking or driving through flood waters.

## Precipitation Trends

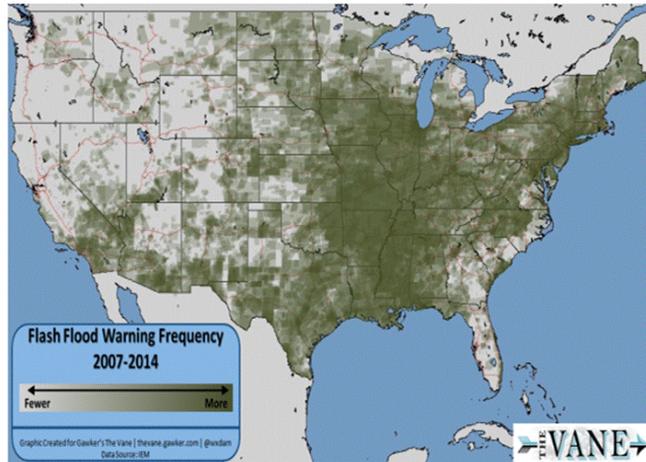


Highlights of the National Climate Assessment (2014)  
<http://nca2014.globalchange.gov/highlights>

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**Heavy downpours**—the heaviest 1% of all daily events—have increased across the U.S. over the past three to five decades. The most dramatic increase is in the Northeast, including Pennsylvania.

## Flash Flood Warning Frequency

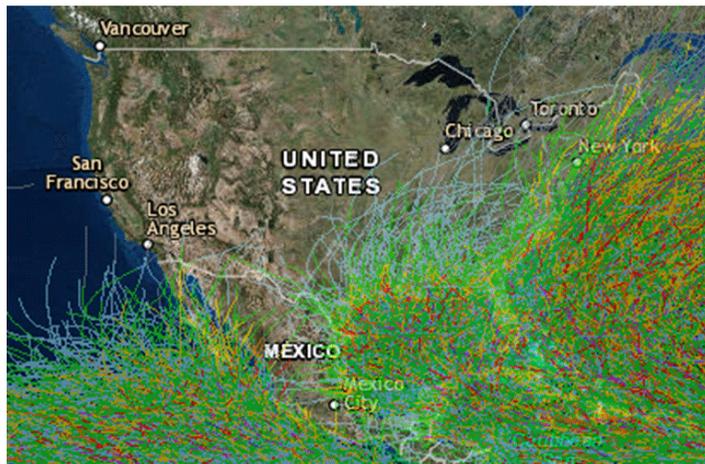


Map (2014) by Dennis Mersereau - <http://thevane.gawker.com/maps-which-parts-of-the-u-s-see-flash-floods-most-often->

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Flash floods are more common with the increase of heavy rain events, but also with increased spread of urban land development. [“Weather Dude” Dennis Mersereau mapped the locations and frequency of flash flooding (2007-2014), by recording Emergency Alert System warnings.]

## Coastal Storm Trends



Historical Hurricane Tracks - <https://coast.noaa.gov/hurricanes>

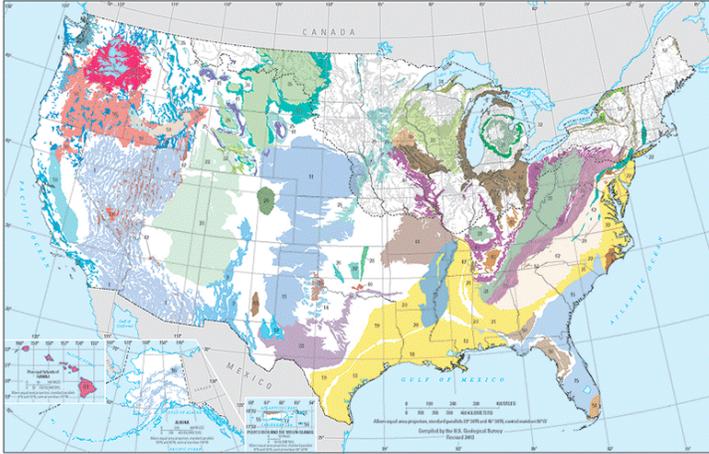
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There are more frequent and intense coastal storms\*

- Coastal storms reach far into the U.S. mainland, and have been *the origin of major flood events in Pennsylvania.*

\* [The intensity, frequency, and duration of North Atlantic hurricanes—as well as the frequency of the strongest hurricanes—have increased since the early 1980s]

## Aquifers: our water bank account



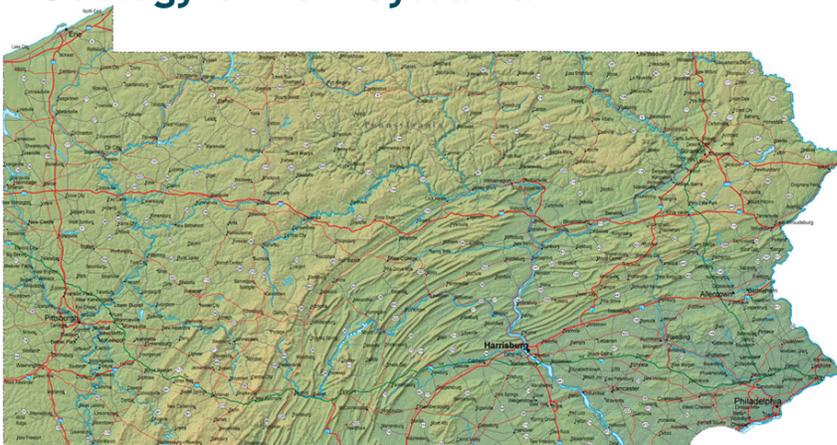
Map of the Principal Aquifers of the United States  
<https://water.usgs.gov/ogw/aquifer/map.html>

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**Managing floodplains should include “aquifer renewal.”**

- The **aquifer** [= *underground layers of water-bearing rock and soils that retain water*]. **Our water income** = rain, snow melt, and flooding if allowed to discharge back into the landscape and soil. **The aquifer is our savings account** —“our fund for a ‘non-rainy day’— available for **withdrawals** by springs and wells. [Floodwaters that overflow / discharge elsewhere = **“lost income.”**]

## Geology of Pennsylvania



[Keywordpicture.com](http://Keywordpicture.com)

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Pennsylvania’s geologic ridges, rifts, and valleys funnel water to the Susquehanna—in times (of flooding) acting as an all-too-efficient floodwater collector.

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	<p>#4292 Oct. 20-21, 2016 Roads &amp; bridges \$4.2M obligated</p>		<p>#4030 Sep. 03 Oct. 15, 2011 Tropical Storm Lee 4,542 residences (only 25% insured) \$146M obligated</p>
	<p>#4149 Jun. 26-Jul. 12, 2013 Severe storms, Tornadoes &amp; flooding \$25M obligated</p>		<p>#4025 Apr. 26- Aug. 30, 2011 Hurricane Irene \$26M obligated</p>
	<p>#4099 Oct. 26-Nov. 8, 2012 Hurricane Sandy \$12.8M obligated</p>		<p>#4003 Apr. 25-28, 2011 Roads &amp; bridges \$9.9M obligated</p>

[Disaster Declarations for Pennsylvania | FEMA.gov](http://www.fema.gov/disasters/grid/state-tribal-government)  
[www.fema.gov/disasters/grid/state-tribal-government](http://www.fema.gov/disasters/grid/state-tribal-government)

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This slide highlights major flood events in Pennsylvania of the past 5 years. **Nearly all parts of the State have been impacted, with incidents occurring from Jan. to Sept.**

(SPEAKER OPTION: discussion w/ participants for stories/ experiences with these events)

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## Case Study: Milton, PA

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The Town of Milton is one of many historic Pennsylvania communities along the Susquehanna River.

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The crest of the 1972 flood in Milton.

- 1889 Spring flood
- 1894 Spring flood +29 ft. crest
- 1936 Heavy spring rain, snow melt
- 1972 Jun. Hurr. Agnes +35 ft. crest
- 1975 Sept. flood (>25% loss)
- 1996 Jan. flood w/ snow/ice/thaw

URS, *Looking to the Future: Alternatives for Reducing Flood-Related Damage in Historic Communities Milton, Pennsylvania* (2002)

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Since 1846, forty floods have exceeded Milton’s +19 ft. flood stage.  
 (review dates / history of flood). [time of year: **Incidents from January to Sept.**]

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A kayaker explores Milton during the 1894 flood.



2016

MAP: [msc.fema.gov/portal/search](https://msc.fema.gov/portal/search)  
 PHOTOS: [1] Milton Historical Society [2] Donald Watson

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The yellow arrow indicates Broadway and Front Streets, with a recent photo at the bottom right.  
***This historic main street, with beautiful buildings of great cultural and economic value, represents the public and private assets most at risk of flooding in Pennsylvania communities.***

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Looking to the Future  
 Alternatives for Reducing Flood-Related Damage in Historic Communities  
 Milton, Pennsylvania  
 June 28, 2002

URS, *Looking to the Future: Alternatives for Reducing Flood-Related Damage in Historic Communities Milton, PA* (2002) [www.phmc.pa.gov/Preservation/About/Documents](http://www.phmc.pa.gov/Preservation/About/Documents)

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A worthy report by URS Corp.—*Looking to the Future: Alternatives for Reducing Flood-Related Damage in Historic Communities*—summarizes flood mitigation measures applicable to Milton, but also to many Pennsylvania communities. Recommendations include...

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- Acquisition & Demolition
- Relocation
- Levees & floodwalls
- Stream channel alteration
- Watershed management
- Green infrastructure
- Building Elevation
- Wet floodproofing
- Dry floodproofing
- Raised streets/dry access

URS Corp., *Looking to the Future: Alternatives for Reducing Flood-Related Damage in Historic Communities Milton, Pennsylvania* (2002)

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[review list on slide]

The last measure on the list —“Raised streets / dry access” (for EMS access and evacuation)— is **not included** in the URS report, but is also worth considering [to be illustrated later in this presentation].

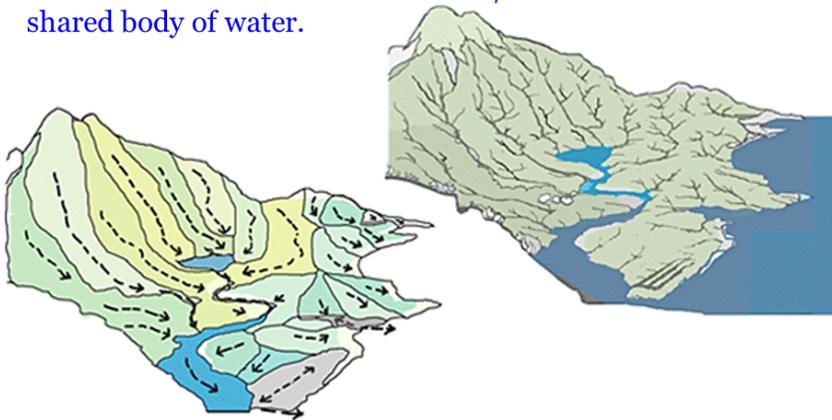
## Learning Objectives

1. Identify the **risks** associated with different types of flooding in Pennsylvania
2. Explain the advantages of **watershed management based on future conditions**

The 2<sup>nd</sup> Learning Objective of this Module

## Watershed

...the **entire** land area to which rain/snowmelt drains to a shared body of water.



© Watson, D. and M. Adams, *Design for Flooding* (2011)

A “watershed” is the “entire area of land to which rain and snowmelt drains to a shared body of water.”

What is the difference between a **watershed** and a **floodplain**?

*Simply stated...The watershed is everywhere that rain (and snow) falls and flows...*

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## Floodplain

An area of land that experiences flooding

FLOODPLAIN CONDITIONS → WHERE/HOW TO BUILD  
*can benefit*

NOTE: The regulatory floodplain is defined by probability of occurrence of flooding (typically 1% chance/year), established by the local jurisdiction.

© Watson, D. and M. Adams, *Design for Flooding* (2011)

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... “The Floodplain” is where floodwaters accumulate (on normally dry land).

Floodplain conditions—[properly accounted for]—do not have to be a risk and can benefit a community:

**(1) Providing open space, river trail corridors, access to water resources, cooler surrounds, lower cost infrastructure (by cost and risk avoidance ....building only where it is flood safe).**

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## Building in the Floodplain

FLOODPLAIN CONDITIONS ← WHERE/HOW TO BUILD  
*should benefit*

low-impact development

© Watson, D. and M. Adams, *Design for Flooding* (2011)

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In turn, building and infrastructure can and should benefit *floodplain conditions*.

**(2) Improving community health, security, and safety, along with economic and recreational benefits (“Low Impact Development”),**

**(3) Connecting the “ecosystem” functions of landscape, soil, water courses, and aquifers (“green infrastructure”).**



When floodplain management extends to the **entire watershed**, more options are available to **reduce flooding**. Advantages include: upstream and small scale measures may be more feasible, lower cost, with broader participation, and more rapid implementation.

**Dramatic improvements can be made simply by reconnecting open spaces and water courses.**

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## ASFPM’s No Adverse Impact

- **No Adverse Impact** establishes standards and practices so that actions of one property owner are not allowed to adversely affect the rights of other property owners
  - Increased flood peaks
  - Increased flood stages
  - Higher flood velocities
  - Increased erosion and sedimentation, or
  - Other impacts the community considers important

ASFPM (2004) *No Adverse Impact How-To Guides* Association of State Flood Plain Managers [http://www.floods.org/NoAdverseImpact/NAI\\_White\\_Paper.pdf](http://www.floods.org/NoAdverseImpact/NAI_White_Paper.pdf)

The Association of State Floodplain Managers (ASFPM) has published a set of recommended standards for floodplain management [included in References at the end of this module] for “No Adverse Impact,” based upon the common principle of law, that... **“actions of one property owner are not allowed to adversely affect the rights of other property owners”**

Defining specific criteria as (listed on slide...)

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## Floodplain Managers “In the Trenches”



FLOODPLAIN MANAGEMENT 2016: LOCAL PROGRAMS

Association of State Floodplain Managers  
December 2016

*“FPMs seek technical assistance for...*

- 57% Code administration
- 49% Insurance facts & interpretation
- 49% Hazard mitigation
- 48% Enforcement strategies
- 46% Regulation interpretation
- 43% Floodplain management in planning
- 44% Ideas for flood-proofing existing bldgs.
- 31% Ideas for higher standards

ASFPM Floodplain Management: Local Programs 2016  
[www.floods.org/ace-images/FPM2016-LocalPrograms\\_Final.pdf](http://www.floods.org/ace-images/FPM2016-LocalPrograms_Final.pdf)

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The ASFPM Report—***Floodplain Management 2016: Local Programs***—offers recommendations to support local floodplain managers “in the trenches” ... (review Slide list topics)

\* [survey of over 820 State and municipal officials]...

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## Naturally Resilient Communities



COASTAL FLOODING & EROSION

RIVER FLOODING & EROSION

URBAN STORMWATER FLOODING

Naturally Resilient Communities  
<http://nrcsolutions.org/mapping-planning-regulation->

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Best practices of floodplain management emphasizing nature-based measures (such as green infrastructure) are nicely summarized on the website, ***“Naturally Resilient Communities / NRCsolutions.”***

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## Building as watershed



Brock Environmental Center  
 PHOTO: © Prakash Patel courtesy SmithGroupJJR Architects

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Opportunities exist at every scale: **Brock Environmental Center, Virginia Beach VA** is *a mini-watershed*.... the first commercial building in the U.S. permitted to capture and treat rainfall as drinking water...

The structure, elevated above surge level, provides shaded picnic and parking beneath. Cisterns (“the mini-aquifer”) are two 1,600+ gallon tanks, where water is disinfected and protected within a dry-floodproofed and earthbermed enclosure.

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## Learning Objectives

1. Identify the **risks** associated with different types of flooding in Pennsylvania
2. Explain the advantages of **watershed management based on future conditions**
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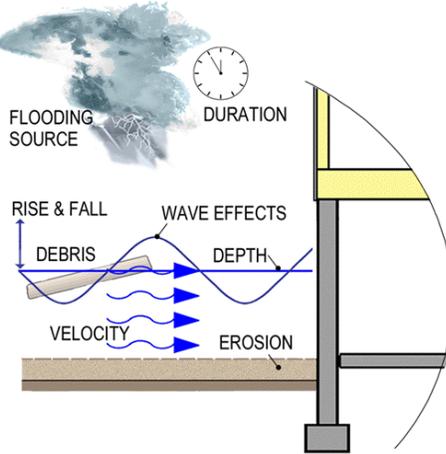
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The 3<sup>rd</sup> Learning Objective of this Module

## Flood Resistant Design

### Flood Design Variables

- Source of flooding
- Flood depth
- Flood velocity
- Flood duration
- Rate of rise and fall
- Wave effects
- Flood-borne debris
- Scour & erosion



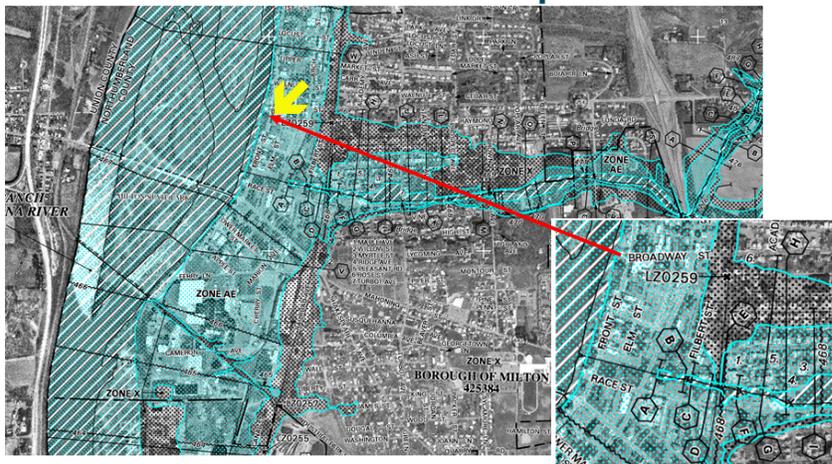
© Watson, D. and M. Adams, *Design for Flooding* (2011)

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**Flood-resistant design** requires architects and engineers to consider a range of design variables.

(review those listed on slide)

## Flood Insurance Rate Maps



MAP: [msc.fema.gov/portal/search](https://msc.fema.gov/portal/search)

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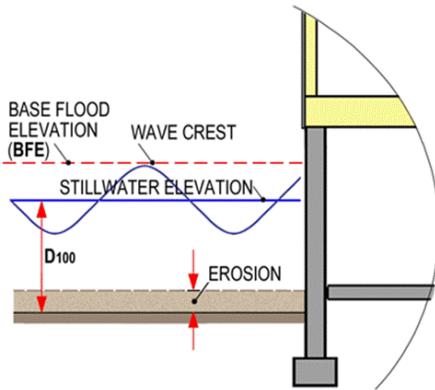
**Flood Insurance Rate Maps (FIRMs)** define Special Flood Hazard Areas (SFHAs) for purposes of National Flood Insurance Program (NFIP) insurance rates.

[This FIRM is of Milton PA. The arrow indicates Front and Broadway streets shown earlier.]

***Flood maps are not—in and of themselves—a sufficient guide to future flood risks.***

[to be discussed in detail in upcoming Mod. 20 “Limitations of FEMA Flood Maps”]

## Base Flood Elevation (BFE)



- Primarily intended for use in Federal Insurance Rates Maps (FIRMs)
- Based on *historical* flood data
- Not a sufficiently accurate indicator of *future* flood risk

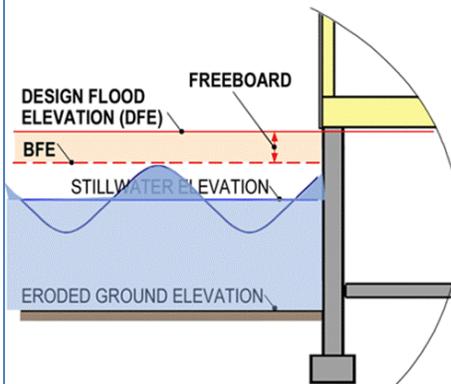
**Additional analysis of local and future probable conditions is required**

@ Donald Watson

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**Base Flood Elevation (BFE)** is defined [in FEMA guidance and on NFIP Insurance Rate Maps] as the elevation of flooding [including estimated wave heights] with a **1% probability of being equaled or exceeded in any given year**. This designation is based upon historical data and does not include future conditions (land alteration, climate change). **Additional analysis of local and future probable conditions is required.**

## Design Flood Elevation (DFE)



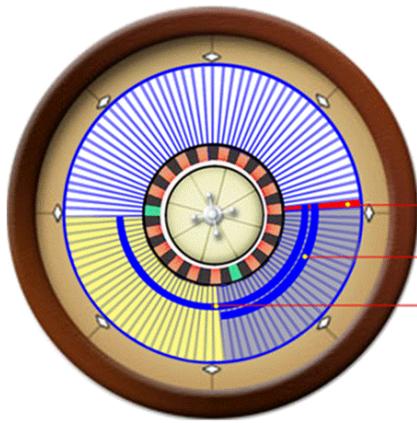
- The regulatory flood elevation established by State authorities & adopted by local jurisdictions
- May equal or exceed NFIP requirements for BFE, cannot be less
- May be higher than the BFE by adding height, called "freeboard," to represent Safety Factor above the BFE

@ Donald Watson

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**Design Flood Elevation (DFE)** is the elevation adopted in State and local zoning and building codes, as a minimum "design criteria" required for permitting. "DFE" may be adopted by the State or local jurisdictions as equal to "BFE," or may be higher, adding a safety factor above the BFE minimum, [the added height is called "freeboard."]

## Probability 1% Event



The BFE, "Base Flood Elevation" is defined by 1% probability of exceedance in any one year

- 1%** chance any one turn
- 26%** chance with 30 turns
- 51%** chance with 70 turns

**1% probability in any one year represents 26% chance over 30 years, or a 51% chance over 70 years.**

## Probability Table

PROBABILITY OF NATURAL HAZARD EVENT FOR VARIOUS PERIODS OF TIME

Length of Period (Years)	Frequency – Recurrence Interval					
	10-Year	25-Year	50-Year	100-Year	500-Year	700-Year
1	10%	4%	2%	1%	0.2%	0.1%
10	65%	34%	18%	10%	2%	1%
20	88%	56%	33%	18%	4%	3%
25	93%	64%	40%	22%	5%	4%
<b>30</b>	96%	71%	45%	<b>26%</b>	6%	4%
50	99+%	87%	64%	39%	10%	7%
<b>70</b>	99.94+%	94%	76%	<b>51%</b>	13%	10%
100	99.99+%	98%	87%	63%	18%	13%

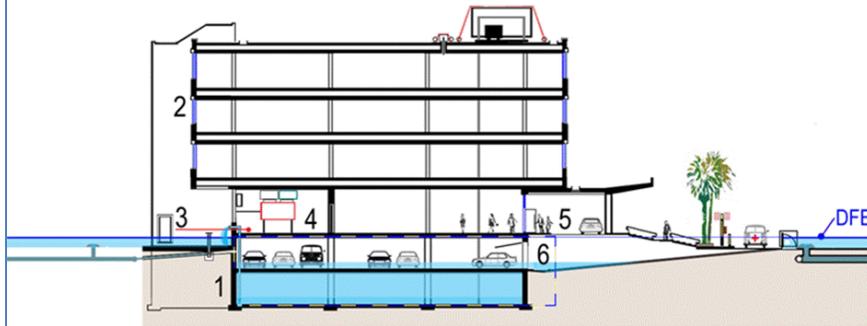
FEMA P-55 Coastal Construction Manual 4th edition (2011)  
[www.fema.gov/media-library/assets/documents/3293](http://www.fema.gov/media-library/assets/documents/3293)

**This Probability Table** shows the % probabilities that a flood event may be *equaled or exceeded* based upon the assumptions that one makes.

[RED ARROW: 1% any one year. BLUE: 26% chance in any 30-year period. YELLOW: 51% chance in any 70-year period.]

***If flood regulations were to adopt the statistical "500-year base flood" as the "DFE minimum design standard," risk probabilities are greatly reduced (by a factor of 4-5).***

## Flood Resistant Design



- 1 - Foundation is intact
- 2 - Envelope is impact resistant
- 3 - Lowest Fl. is above DFE
- 4 - Utilities are intact & operational
- 5 - Building is safe and accessible
- 6 - Breakaway elements (as needed)

© Watson, D. and M. Adams, *Design for Flooding* (2011)

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Principles of flood resistant design for commercial buildings are... [indicated on this slide]

## Flood Mitigation existing residential



Selecting Appropriate Mitigation Measures for Floodprone Structures

FEMA 551 / March 2007



FEMA 551

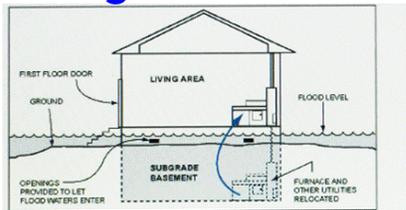


Figure 6-6. Wet floodproofing with a wet floodproofed subgrade basement (Source: FEMA 512)

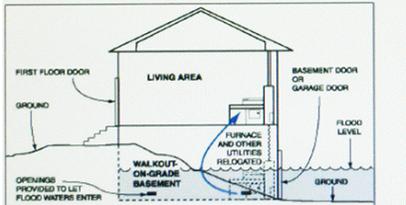


Figure 6-7. A structure with a wet floodproofed walkout-on-grade basement

Selecting Appropriate Mitigation Measures for Floodprone Structures (2007)  
FEMA 551 [www.fema.gov/media-library-data/fema551.pdf](http://www.fema.gov/media-library-data/fema551.pdf)

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Existing residential structures present challenges to achieve flood resistant design.

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## Flood Mitigation existing commercial

new slide

**Protecting Building Utility Systems From Flood Damage**  
Principles and Practices for the Design and Construction of Flood Resistant Building Utility Systems  
FEMA P-348, Edition 2 / February 2017  
FEMA

**FEMA P-346**

foundation underpinned to resist flotation

lower portion of window permanently closed with masonry

mechanical & electrical equipment raised above BFE

alarm system

removable flood gates for service bays and doors

emergency egress / access

back-up generator

fuel tanks located above DFE

backflow valve on sanitary sewer line

waterproof coating on wall exterior

sump pump

Protecting Building Utility Systems from Flood Damage (2017)  
FEMA P-346 [www.fema.gov/media-library/assets/documents/3](http://www.fema.gov/media-library/assets/documents/3)

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**Commercial and institutional buildings** may use dry floodproofing measures in upgrading existing buildings or new construction, subject to local regulatory approvals. THIS IS A NEW SLIDE: to include **FEMA P-346** *Protecting Utility Systems from Flood Damage* ... an excellent new release from FEMA that details measures for both residential and commercial buildings.

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## Flood Mitigation commercial district

**East Biloxi MS**

1' ABOVE BASE FLOOD ELEVATION

BASE FLOOD ELEVATION

8'-0" MAX.

≤ 3' BELOW BASE FLOOD ELEVATION

GRADE

STREET

PUBLIC

PRIVATE

**Residential**

- Elevation
- Conventional materials

+

**Non-Residential**

- Wet floodproofing (restricted use)
- Dry floodproofing (special permit)
- \* Flood gates
- \* Maintenance staff
- \* Emergency power
- \* Emergency pumps

Perkes, David *Floodproof Construction*  
<https://www.nado.org/wp-content/uploads/2014/09/Perkes-Presentation.pdf>

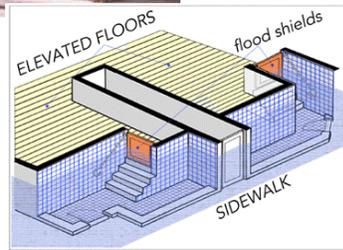
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Ambassador Curriculum

In recovery after Hurricane Katrina, “build back better” actions along **East Biloxi’s principal Commercial Street** including: (1) raised sidewalks, (2) “dry-floodproofing” for commercial properties (shops), and (3) mixed-use zoning, permitting residential or commercial uses above.

## Historic Structures



Darlington WI



- Acquisition and demolition/clean-up
- Businesses difficult to elevate afforded as much flood protection as possible (MEP)
- Historic buildings retrofitted with dry floodproof measures
- Business doubled in commercial value after floodproofing

“Mitigation Leads to Preservation and Economic Recovery”  
<http://emergencymanagement.wi.gov/mitigation/stories/hm-darlington>

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In recovery from 1993 Midwest flooding, historic **Darlington Wisconsin Main Street** has been restored, including dry floodproofing, with flood gates installed inside the entryways, to preserve the character and appearance of the historic street.

## Critical Facilities



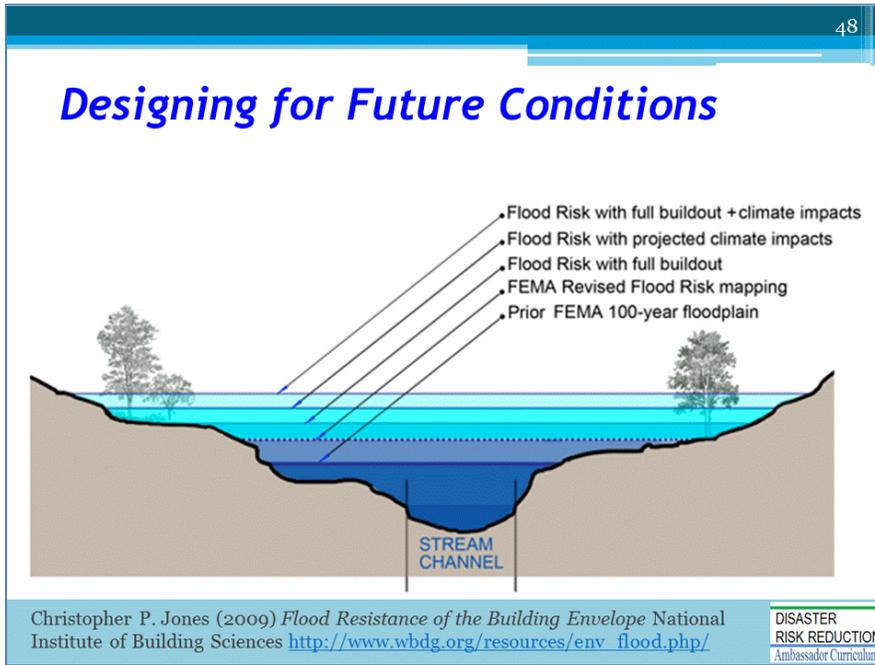
**Spaulding Hospital, Cambridge, MA**  
 Steinkamp Photography Perkins+Will, Architects

- Mechanical, electrical, emergency generators in roof pent housing
- Key floors above predicted BFE 2085
- Water resistant materials below BFE
- Energy conserving envelope
- Operable windows, daylighting, shading

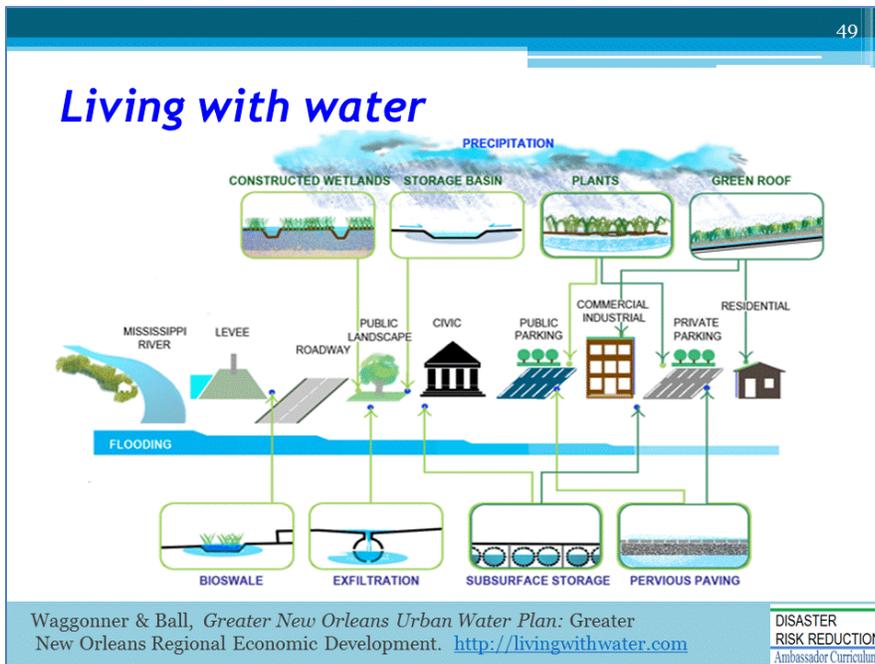
Alex Wilson Resilient Design Institute  
<http://www.resilientdesign.org/how-to-make-a-hospital-resilient>

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Critical facilities may include police, fire, emergency offices, community shelters, hospitals, schools and day-care centers, power generating stations, water and wastewater treatment plants, and, by local designation, may also include food depots and stores, pharmacies, and gas stations. ***Spaulding Hospital goes beyond regulatory requirements and addresses future probable conditions of climate change and sea level rise.***



FEMA considers future conditions in flood mapping **if the community being studied requests and participates in the study**. An exemplar is Charlotte-Mecklenburg NC [...a module in the NHMA Curriculum].



New Orleans’s **Urban Water Plan**, “*living with water*” proposes a comprehensive program to convert sites into “water gardens,” to replace roads with permeable sidewalks, and to extend green infrastructure, including subsurface storage.

## Case Study: Resilient Bridgeport



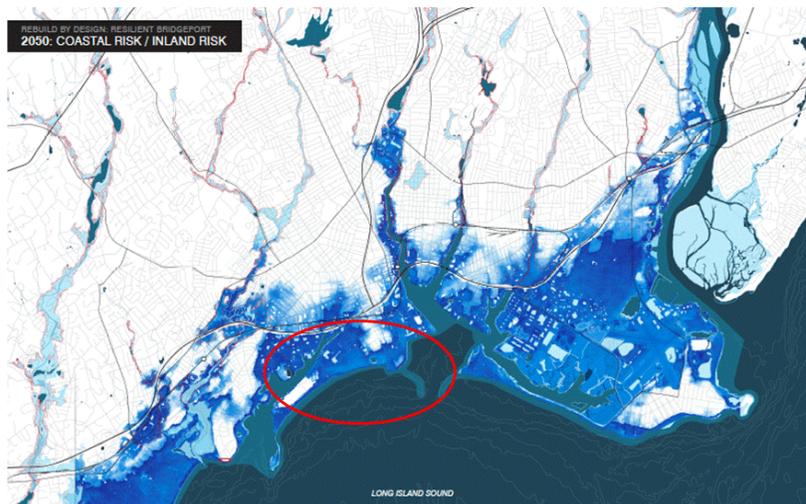
Seaside Village, Bridgeport CT

US HUD Rebuild By Design *Resilient Bridgeport* Waggoner & Ball Architects  
<http://resilientbridgeport.com>

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Seaside Village, Bridgeport CT is one of the first garden communities in the U.S., built in 1918 during Bridgeport’s manufacturing heyday, to provide emergency housing for defense workers.

[About 257 units, @1,000 square feet, designed to resemble a European village, added to the National Register of Historic Places in 1990.]



US HUD Rebuild By Design *Resilient Bridgeport* Waggoner & Ball Architects  
<http://resilientbridgeport.com>

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2050 projection of coastal and inland flood risk

## Raised Street / Subsurface Storage



US HUD Rebuild By Design *Resilient Bridgeport* Waggonner & Ball Architects  
<http://resilientbridgeport.com>

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Proposed raised street (providing dry access and emergency egress) PLUS subsurface storage system (stormwater detention). **To help community members visualize options, the use of physical models...**

## Community Engagement



US HUD Rebuild By Design *Resilient Bridgeport* Waggonner & Ball Architects  
<http://resilientbridgeport.com> PHOTO: D. Watson

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...proved to be invaluable as a communication/decision tool. Shown here is a **physical model of the hydrology (stormwater infrastructure and surface flow downstream)**. [community engagement meetings held in an open street-front office with staffed “walk-in” hours.]

**Community engagement is a key to successful watershed planning and floodplain management.**

## Economic Revitalization



**Save The Bay Providence RI**  
Croxton Partnership, Architects

- Brownfield re-use
- Living shoreline
- Green architecture

- Daylighting the river
- Hurricane flood gates
- Green infrastructure

**Providence River Providence RI**



@ Watson, D. and M. Adams, *Design for Flooding* (2011)  
PHOTOS: Donald Watson

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A second key is to integrate watershed management into comprehensive plans for community economic planning and renewal.

## Low Impact Development (LID)



**Seaside Florida Form-Based Zoning**  
Planners: Duany/ Plater-Zyberk

- Urban District zoning
- Mixed-use
- Walkable/ bikable
- Traffic calming
- Flood resistant design
- Green Infrastructure

Photo: Philosophyandthecity

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A third key is to combine the best practices of energy saving and Low Impact Development (LID) by encouraging compact, efficient land coverage and infrastructure [including green infrastructure].

*The following module 19 by Michele Adams describes these measures in more detail.*

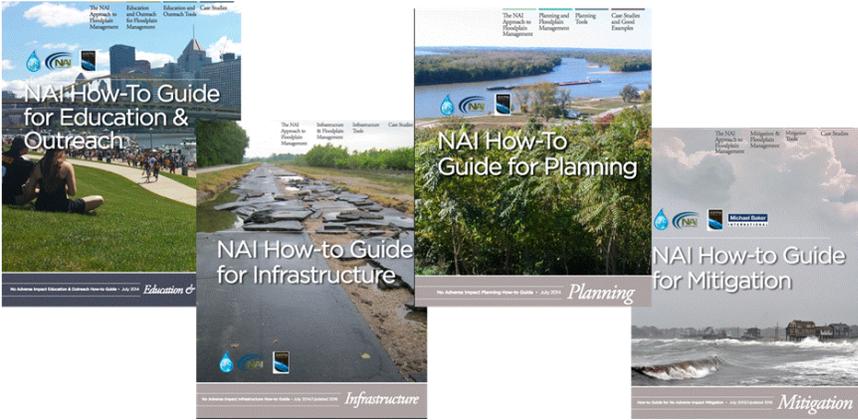
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# RESOURCES

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## ASFPM - No Adverse Impact Guides



ASFPM (2009) *No Adverse Impact How-To Guides* Association of State Flood Plain Managers [/www.floods.org/NoAdverseImpact/NAI\\_White\\_Paper.pdf](http://www.floods.org/NoAdverseImpact/NAI_White_Paper.pdf)

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The **Association of State Flood Plain Managers (ASFPM)** provides detailed guides to floodplain management best practices to achieve “No Adverse Impact.”

## FEMA 480 Floodplain Management



National Flood Insurance Program (NFIP)  
**Floodplain Management Requirements**  
 A Study Guide and Desk Reference for Local Officials  
 FEMA 480  
 February 2005

FEMA 480 Unit O, p. O-3

### A. INTRODUCTION

The responsibility for reducing flood losses is shared by all units of government—local, state and federal—and the private sector.

Fulfilling this responsibility depends on having the knowledge and skills to plan and implement needed floodplain management measures. The fundamental floodplain management program that most others are built on is the National Flood Insurance Program (NFIP).

FEMA 480 *Floodplain Management Requirements* (2005)  
[www.fema.gov/floodplain-management-requirements](http://www.fema.gov/floodplain-management-requirements)

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## FEMA Technical Bulletins



**User's Guide to Technical Bulletins**  
 Developed in accordance with the National Flood Insurance Program  
 Technical Bulletin 0 / March 2009

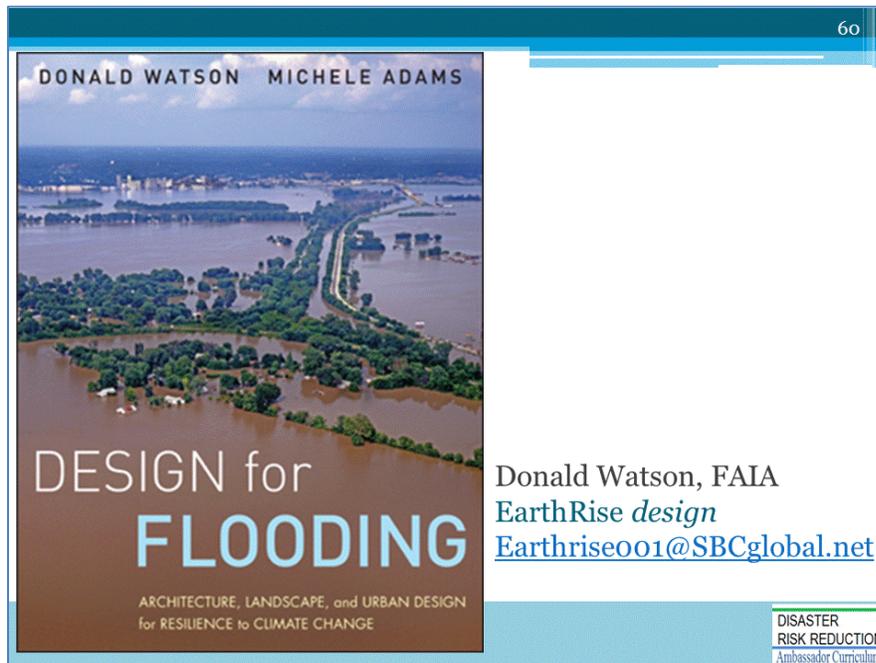
### Representative titles

0. User's Guide to Technical Bulletins
1. Openings in Walls of Enclosures
2. Flood Damage-Resistant Materials
3. Non-Residential Floodproofing
4. Elevator Installation
5. Free-of-Obstruction Requirements

FEMA *User's Guide to Technical Bulletins* (2009)  
<https://www.fema.gov/media-library/assets/documents/1169>

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**FEMA Technical Bulletins** provide detailed recommendations for specific flood resistant measures, informed by post-disaster forensic analysis and lessons learned.



This presentation is based on material originally published in *Design for Flooding*, Donald Watson and Michele Adams, authors. John Wiley Publishing, 2011.

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## Review of Key Learning Objectives

1. Identify the **direct** and **indirect risks** associated with different types of flooding  
**WHAT ARE THE RISKS ASSOCIATED WITH SHALLOW FLOODING?**
2. Explain the advantages of **watershed management planning based on future conditions** for disaster risk reduction  
**WHAT IS THE ADVANTAGE OF WATERSHED MANAGEMENT BASED ON FUTURE CONDITIONS?**
3. Describe **flood resistant design measures** for buildings and infrastructure  
**WHICH OF THE FOLLOWING DESIGN MEASURES IS INTENDED SPECIFICALLY TO ENSURE UTILITIES ARE INTACT AND USABLE?**

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Discussion to engage participants and to assist achievement of Learning Objectives

1. **What are the risks associated with shallow flooding?**
2. **What is the advantage of watershed management based on future conditions?**
3. **Which of the following design measures is intended specifically to ensure utilities are intact and usable?**

## Thank You for Your Participation!



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- **Questions and/or comments**
- **Contact information**  
Natural Hazard Mitigation Association  
P.O. Box 170984  
Boston, MA 02117  
Email: [nathazma@gmail.com](mailto:nathazma@gmail.com)  
[www.nhma.info](http://www.nhma.info)



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**Record on easel pad any recommendations or questions to be addressed outside of the presentation.**

**DRR AMBASSADOR CURRICULUM AT-A-GLANCE**

<b>I. Disaster Risk Reduction for a Safe and Prosperous Future</b>	
1	Introduction to the Natural Hazard Mitigation Association and Disaster Risk Reduction Ambassador Curriculum
2	Introduction to Disaster Risk Reduction as a Foundation of Community Resilience
3	Leadership for Disaster Risk Reduction
4	Community Disaster Risk Reduction and Adaptation
5	Approaching the Challenge of Disaster Risk Reduction: NIST Community Resilience Guide
<b>II. Forming a Community's Vision for Disaster Risk Reduction</b>	
6	Risk Assessment through Storytelling: An Asset-Based Approach
7	Achieving Community Buy-in for Disaster Risk Reduction: Win-Win Approaches
8	Leveraging Resources to Improve Disaster Risk Reduction
<b>III. Realizable, Practical, and Affordable Approaches for Moving from a Vision for Disaster Risk Reduction to a Strategy</b>	
9	Selecting and Implementing a Strategy for Addressing Community Disaster Risk Problems
10	Integrating Hazard Mitigation into Local Planning
11	Beyond Codes and Low-Impact Development
12	Creating the Plan: A Sustainable Floodplain Management Process Model
<b>IV. Resources and Tools for Implementing a Community's Disaster Risk Reduction Strategy</b>	
13	Climate and Weather Tools and Trends
14	Risk Assessment Basics
15	Legal and Policy Opportunities for Disaster Risk Reduction
16	Linking Catastrophe Insurance to Disaster Risk Reduction
<b>V. Resources for Hazard-Specific Disaster Risk Reduction</b>	
17	Living with Water: Inland and Coastal Flooding
18	Design for Flood Resilience: Part I: Floodplain Management and Flood Resistant Design
19	Design for Flood Resilience: Part II: Green Infrastructure / Low Impact Development
20	Overcoming Impediments to Flood Resilience: Paths Forward
21	Wildfire Mitigation
22	The Wildfire-Flood Connection
23	Severe Thunderstorm/ Tornado Safe Rooms
24	From Policy to Engineering: Earthquake Risks