Design for Flood Resilience

18 - Floodplain Management and Flood Resistant Design

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NHMA
Natural Hazard Mitigation Association

DISASTER
RISK REDUCTION
Ambassador Curriculum

Welcome!

Don Watson

Outline

1 Identify **flood risks** in Montana

2 Explain advantages of **watershed management**

3 Describe **flood resistant design**

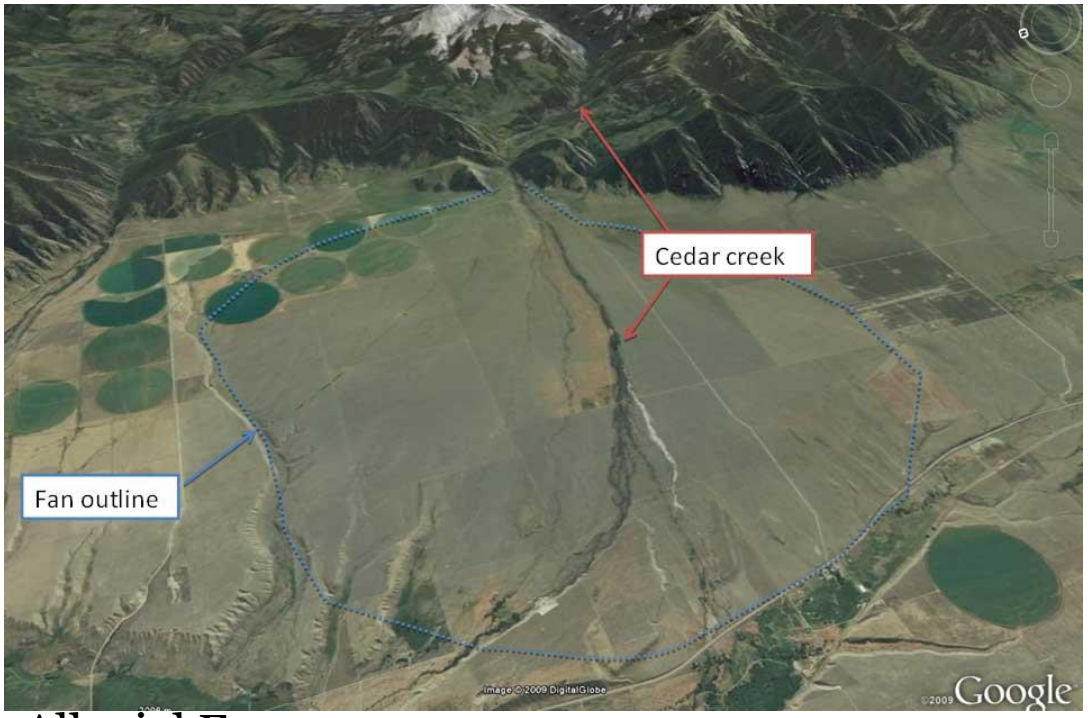
4. State the case **for all-hazard mitigation**

1

Flood risks in Montana

Flood risks

- Flooding … *"the general or temporary condition during which normally dry land is partially or completely inundated."* (NFIP F-002)*



Alluvial Fan Montana Science Partnership: Landscape/examples

Coastal
- Wave action
- Storm surge & erosion

Riverine ("inland")
- Stream overbank flooding
- Dam or levee failure

Shallow
- Surface runoff
- Urban drainage overflow

Alluvial ("uncertain flow")
- Flash floods/distant storms
- Movable streambeds

* www.fema.gov/national-flood-insurance-program/definitions

Flood impacts (NFIP)

INUNDATION of inland waters

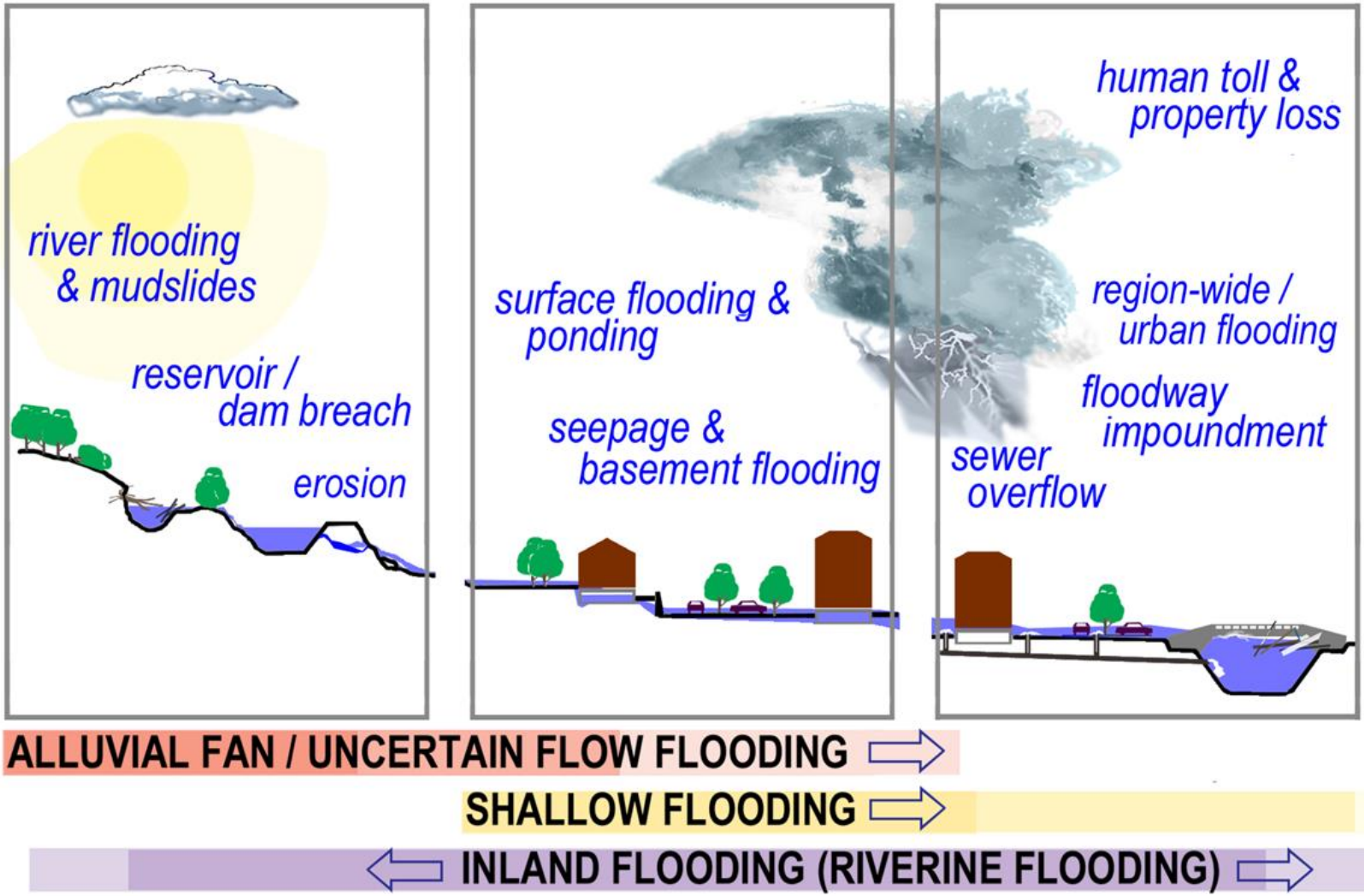
RAPID ACCUMULATION of runoff

MUDFLOW on normally dry land

COLLAPSE/SUBSIDENCE from erosion / flooding

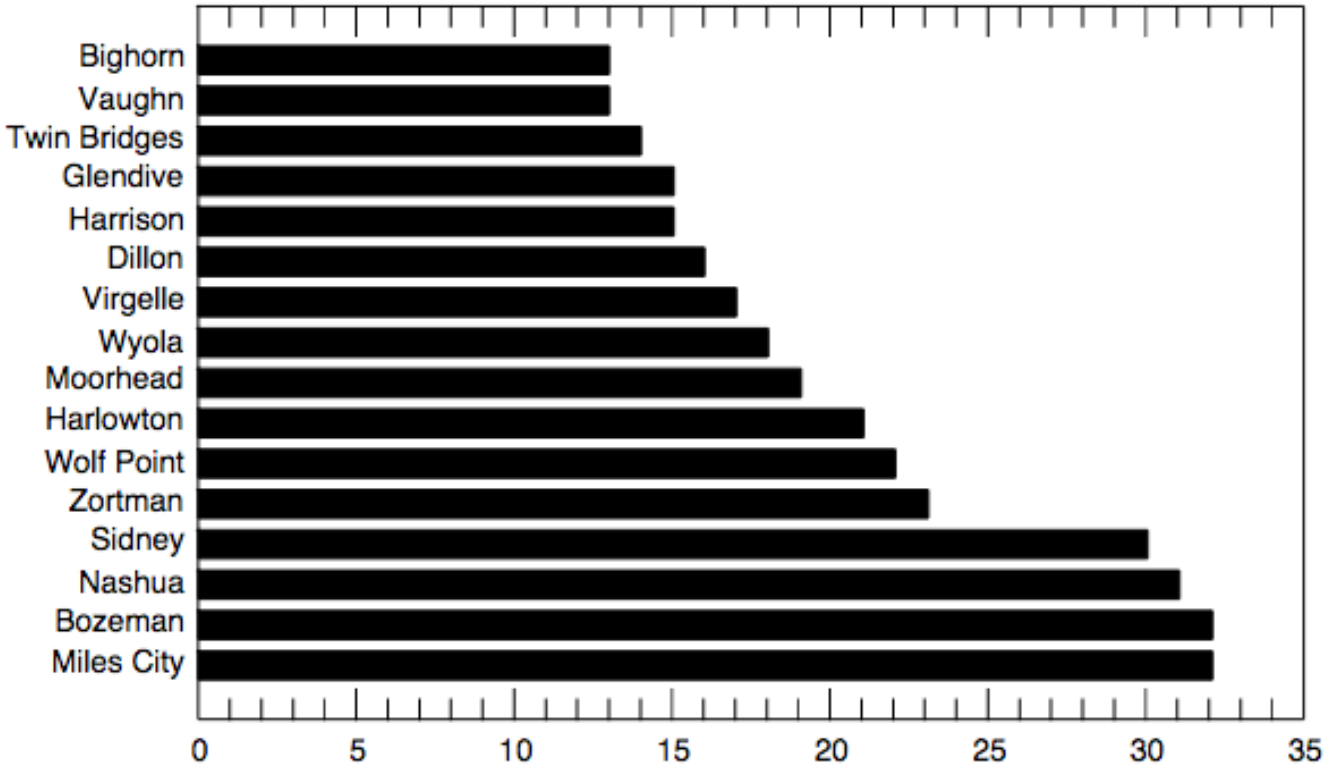
https://www.fema.gov/national-flood-insurance-program/definitions

Combined flood impacts



Ice jams

Montana is the most Ice Jam-prone of all U.S. states …Miles City and Bozeman are the Montana communities most susceptible to them. From 1894 to 1997, each racked up 32 potentially dangerous ice jams. [1]

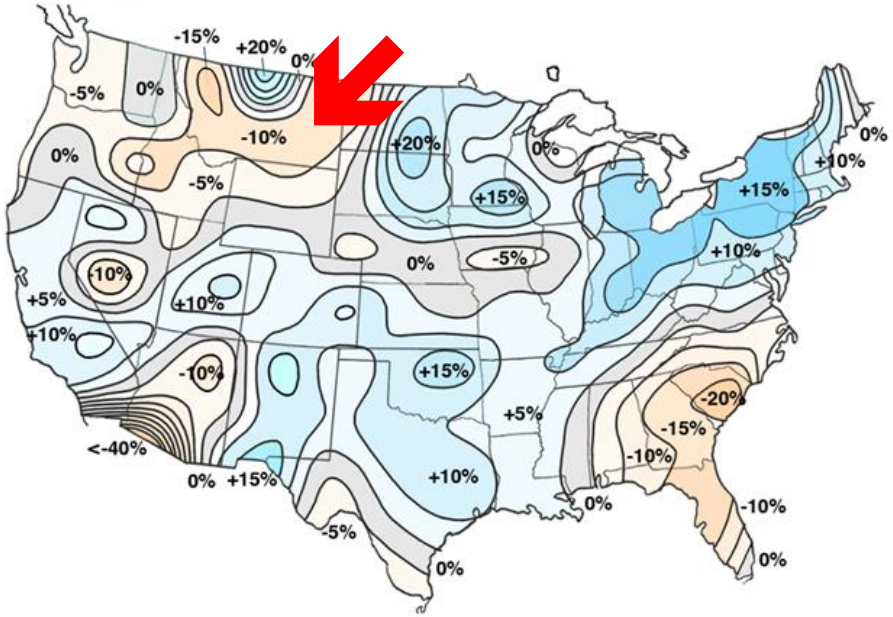


[2]

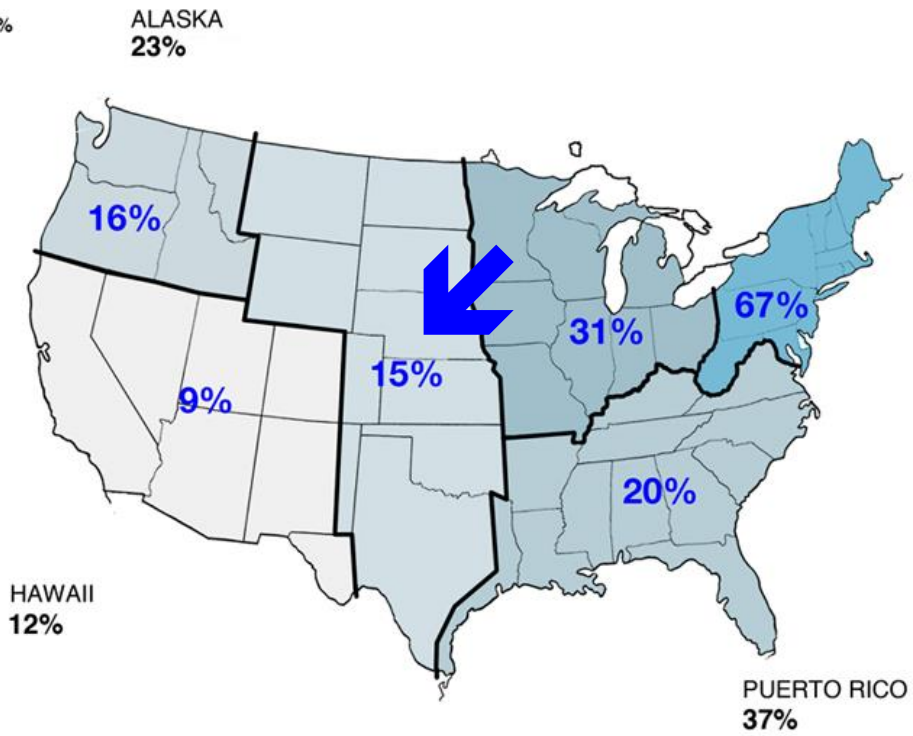
Figure 3. Montana cities with the most reported ice jams.

[1] **billingsgazette.com**/news/state-and-regional/..
[2] www.dawsoncountymontana.com/Ice Jams (2015) PDF

Precipitation trends



Observed change in annual average precipitation 1958-2008

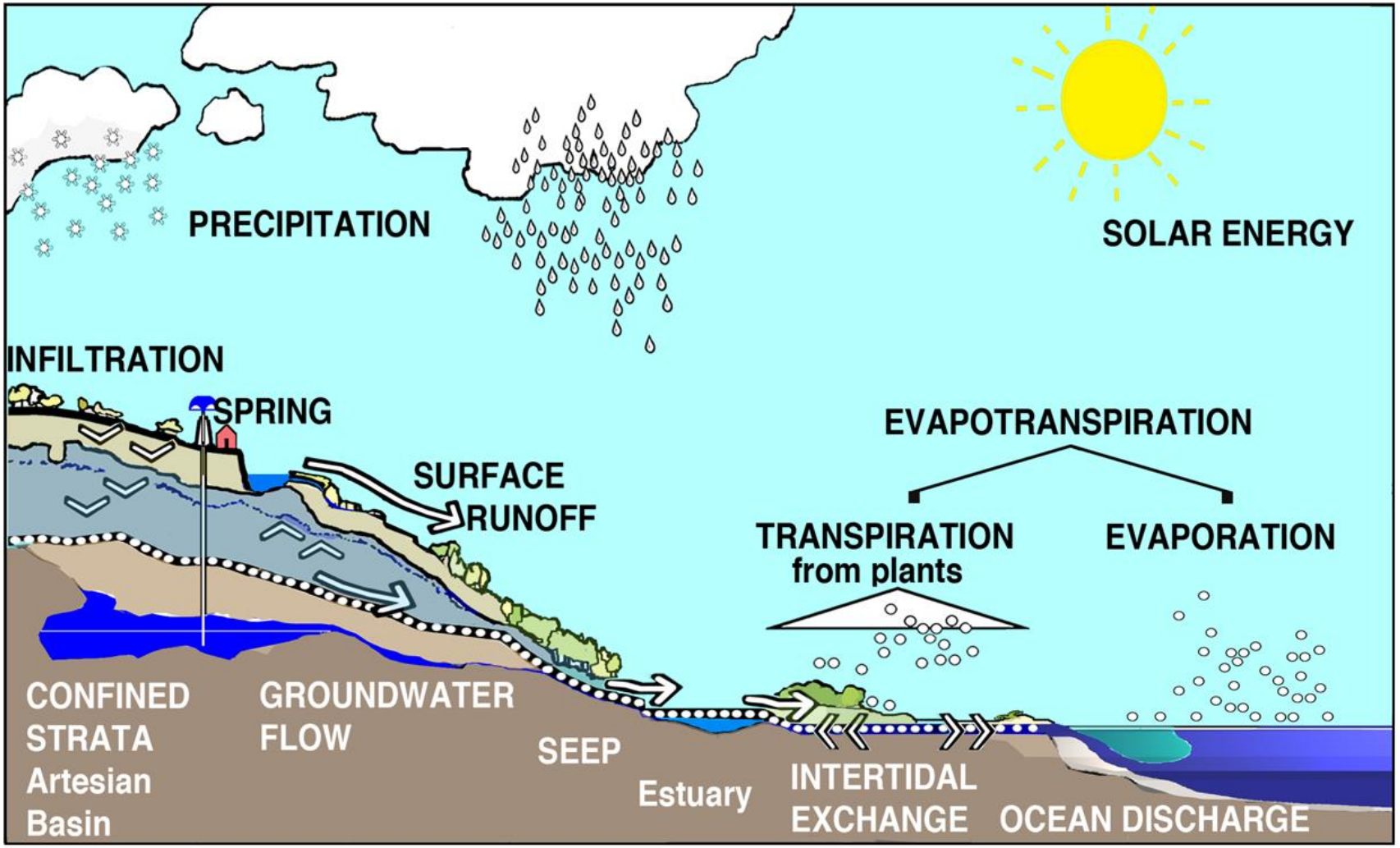


Observed change in very heavy precipation events 1958-2008
(heaviest 1% of all daily events)

U.S. Global Climate Research Program (USGCRP) *Scientific Assessments* 2009

www.globalchange.gov/multimedia/observed-us-precipitation-change

Our water bank account



Aquifers - Montana

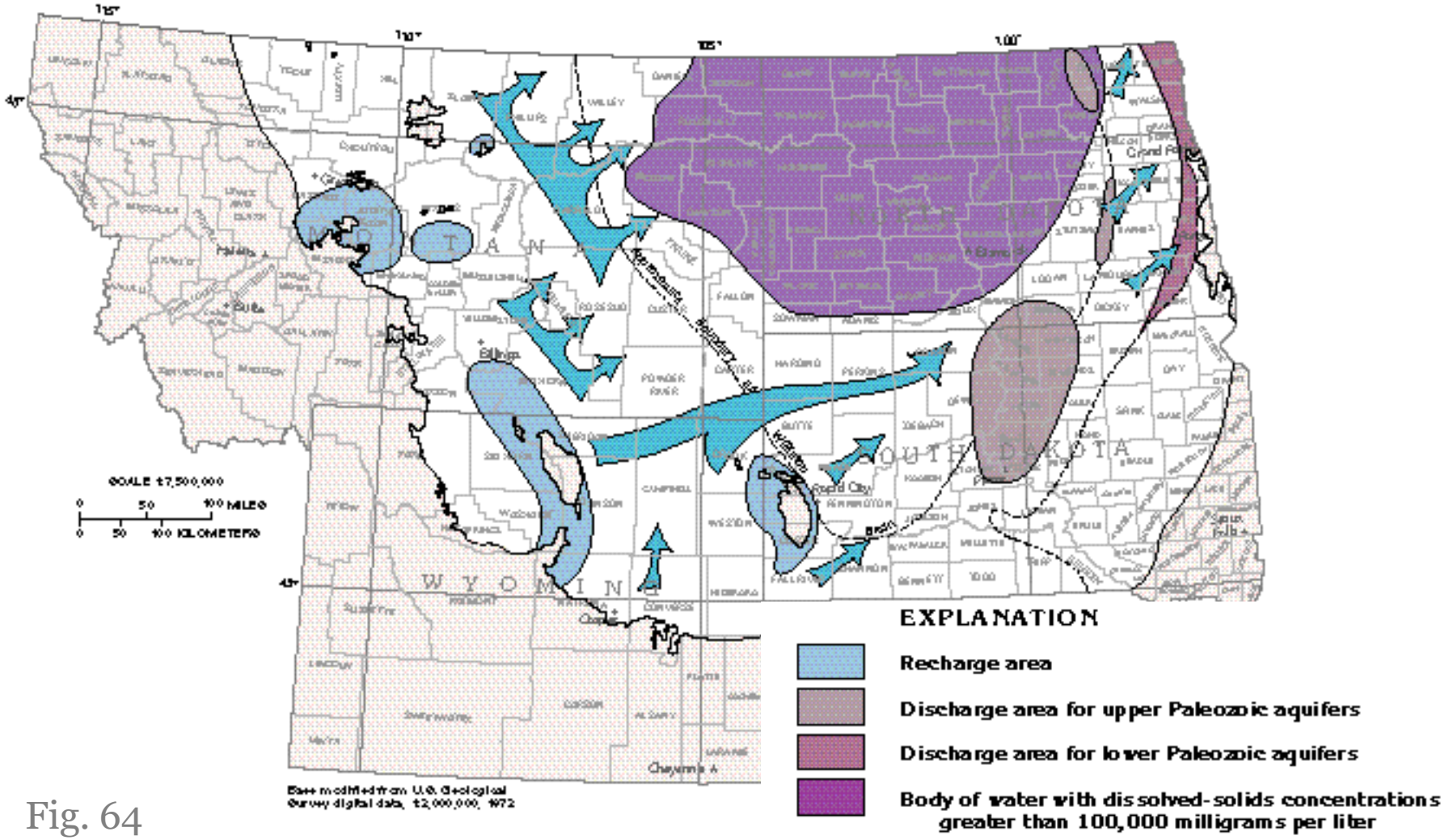


Fig. 64

https://pubs.usgs.gov/ha/ha730/ch_i/I-reg_aq_systems.html

Flood measures: retention strategies

Detention pond

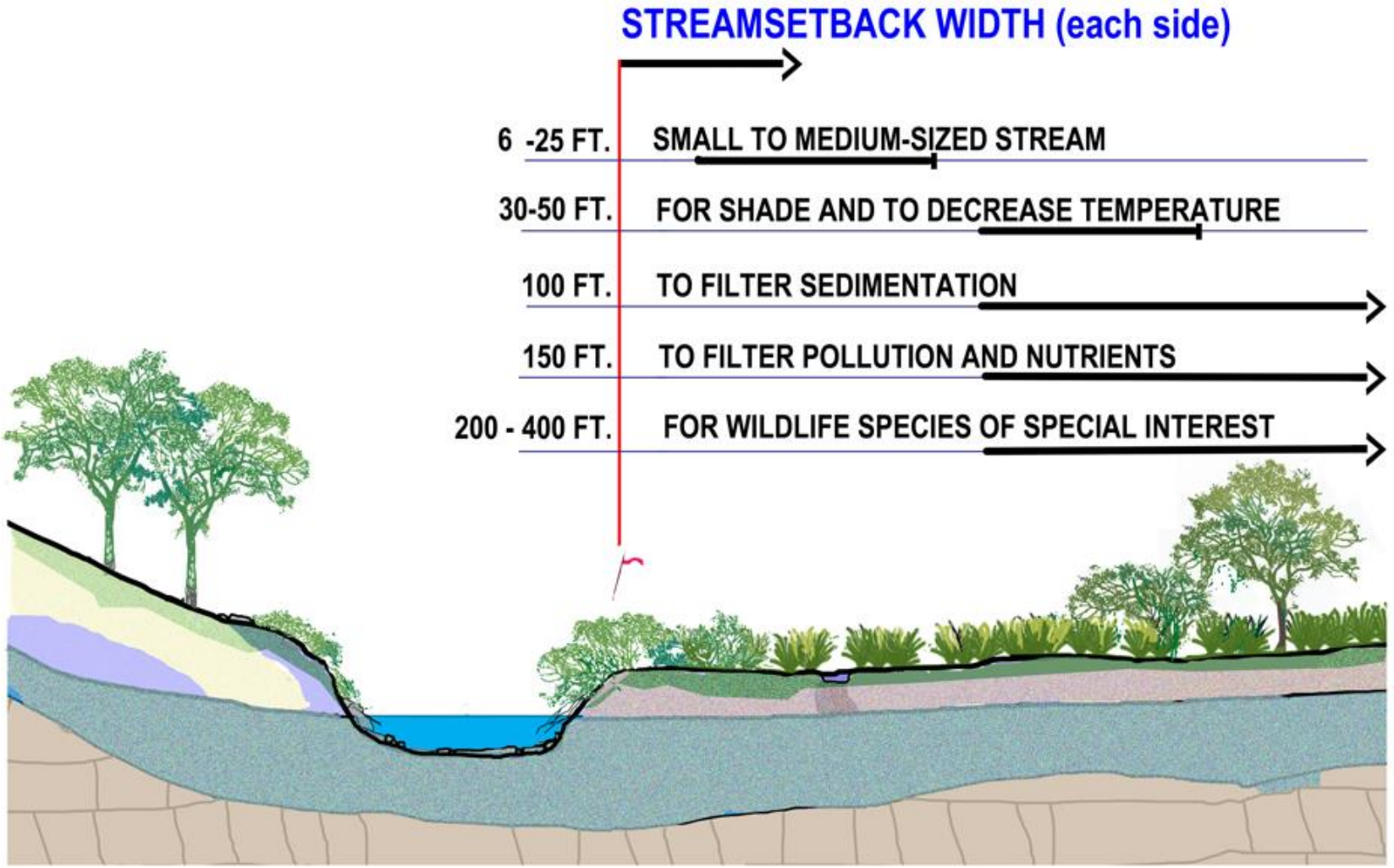
Retention pond

A newly planted, eight-row shelterbelt on State School Trust Land in Teton County
Photo by Diane Boyd, wildlife biologist, Montana Fish, Wildlife & Parks.

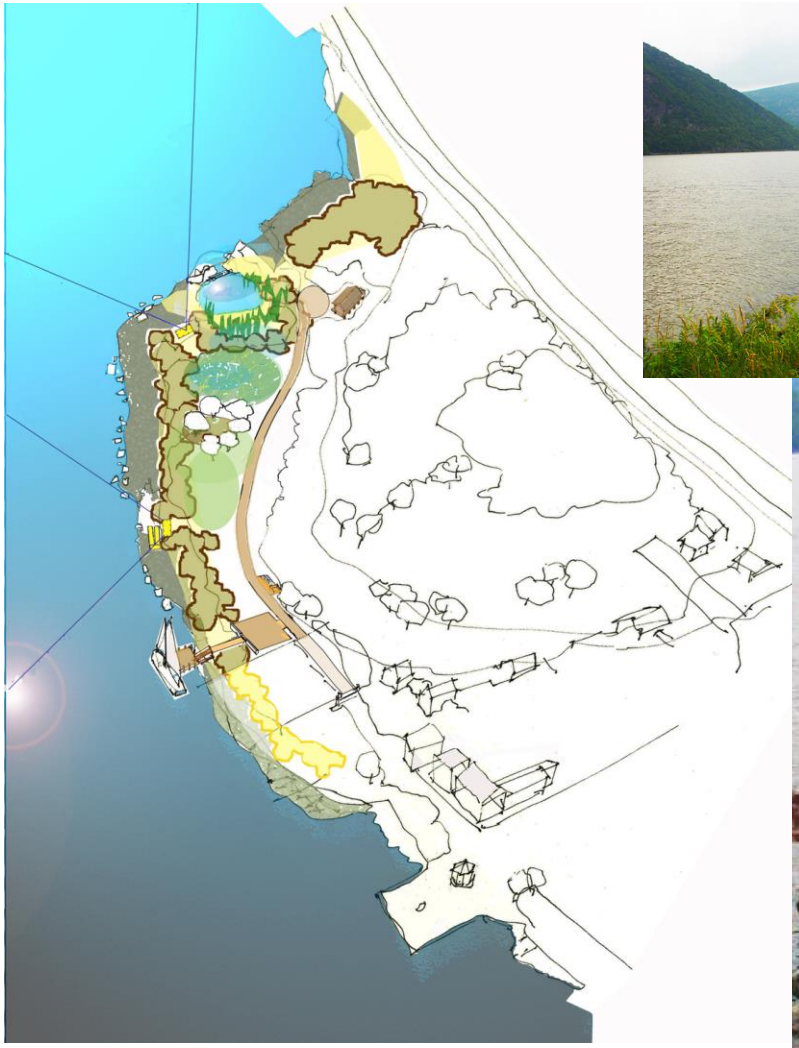
Shelter belts

arc.lib.montana.edu/msu-extension/objects/shelter belts

Flood measures: streamside buffers



Flood measures: Ice jam protection

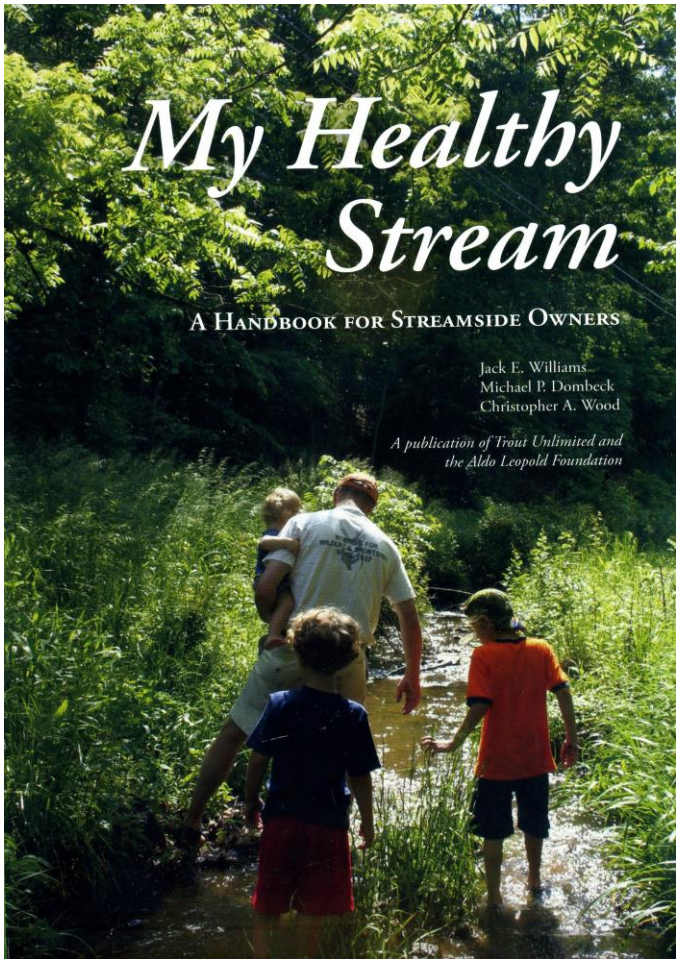


Boulder barricade
Living shoreline
Public park

www.dec.ny.gov/lands/81956.html
Dockside - Cold Spring NY Milhone & MacBroome / Donald Watson

Flood measures: stream protection

Riparian zone protection
Instream fish restoration
Willow weaving
Silt reduction
Culvert replacement
Irrigation canal screening

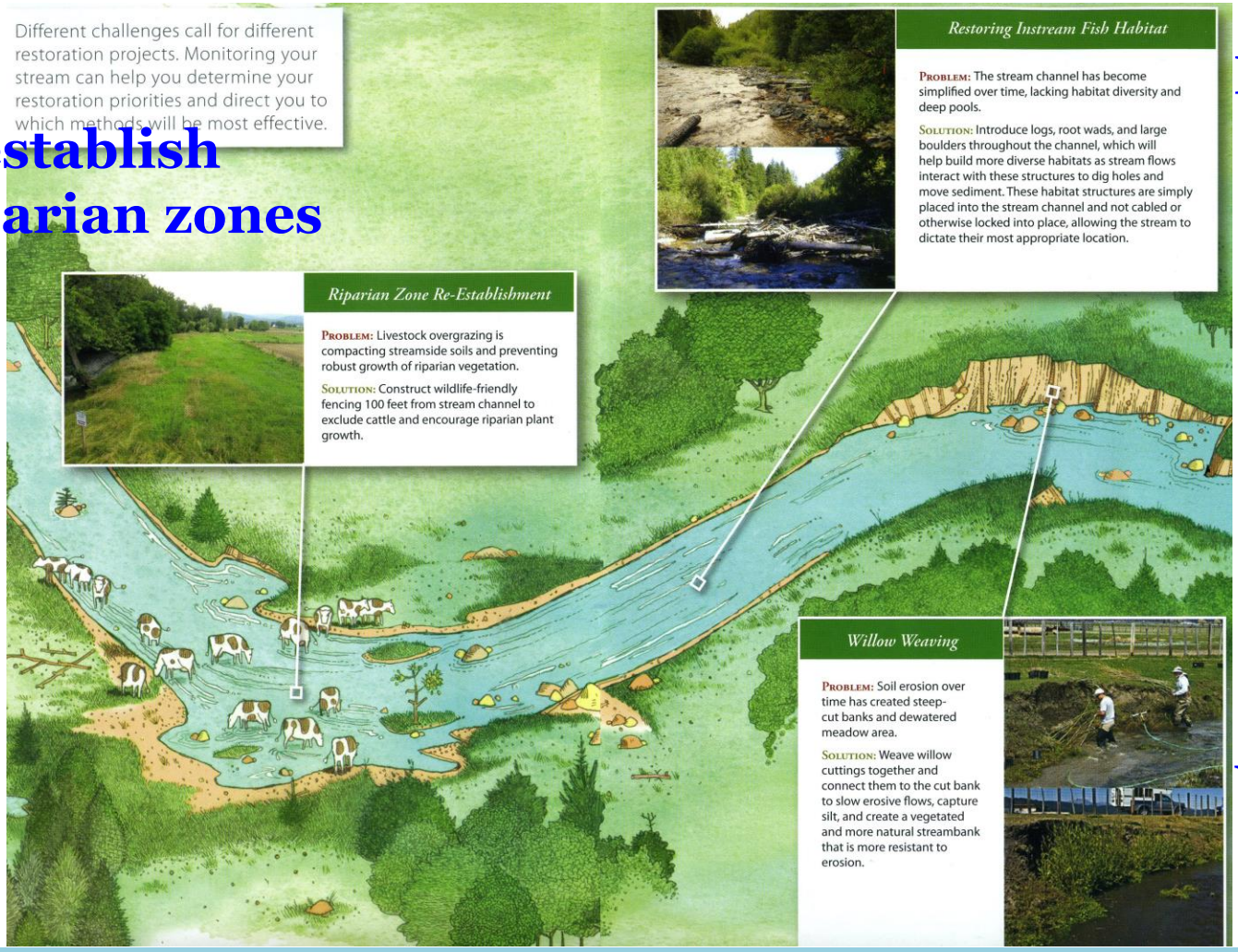


★ RECOMMENDED REFERENCE

Trout Unlimited *My Healthy Stream*
www.tu.org/wp-content/uploads/2019/02/**My-Healthy-Stream**.pdf

Flood measures: erosion control

Re-establish riparian zones



Restoring fish habitat

Willow weaving

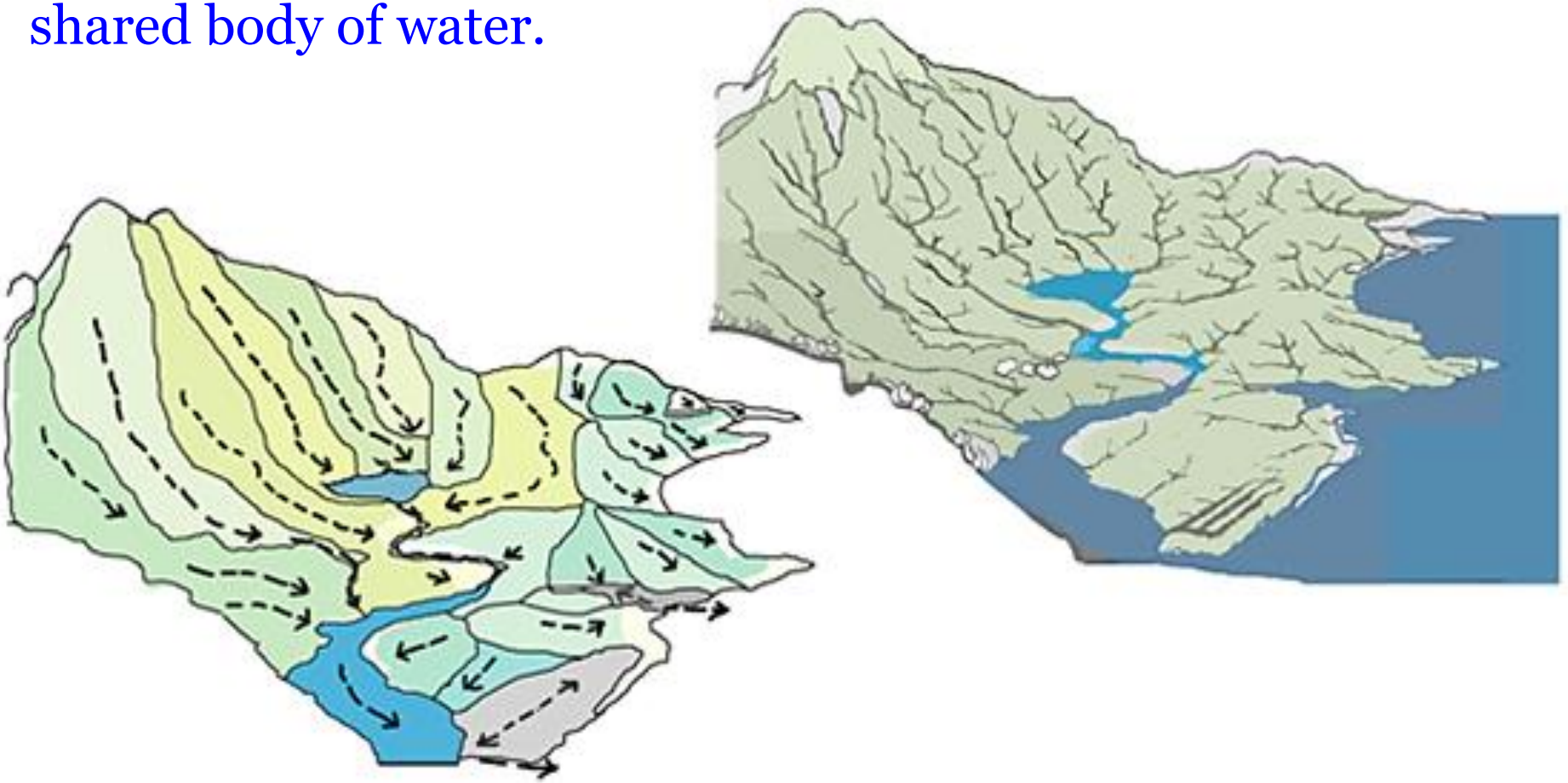
Trout Unlimited *My Healthy Stream*
www.tu.org/wp-content/uploads/2019/02/**My-Healthy-Stream**.pdf

2

Advantages of **watershed management**

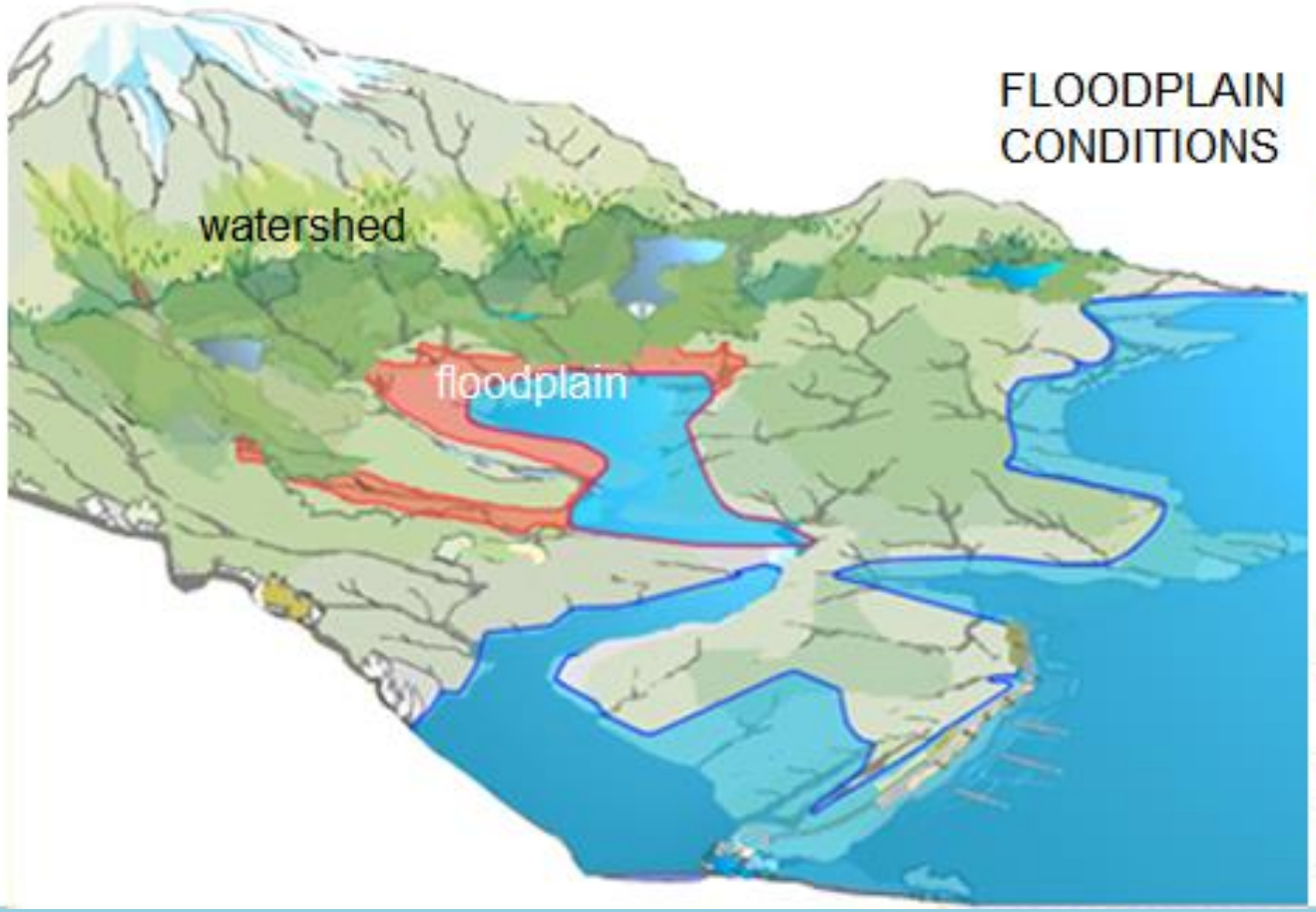
Watershed

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



Floodplain

An area of land that experiences flooding

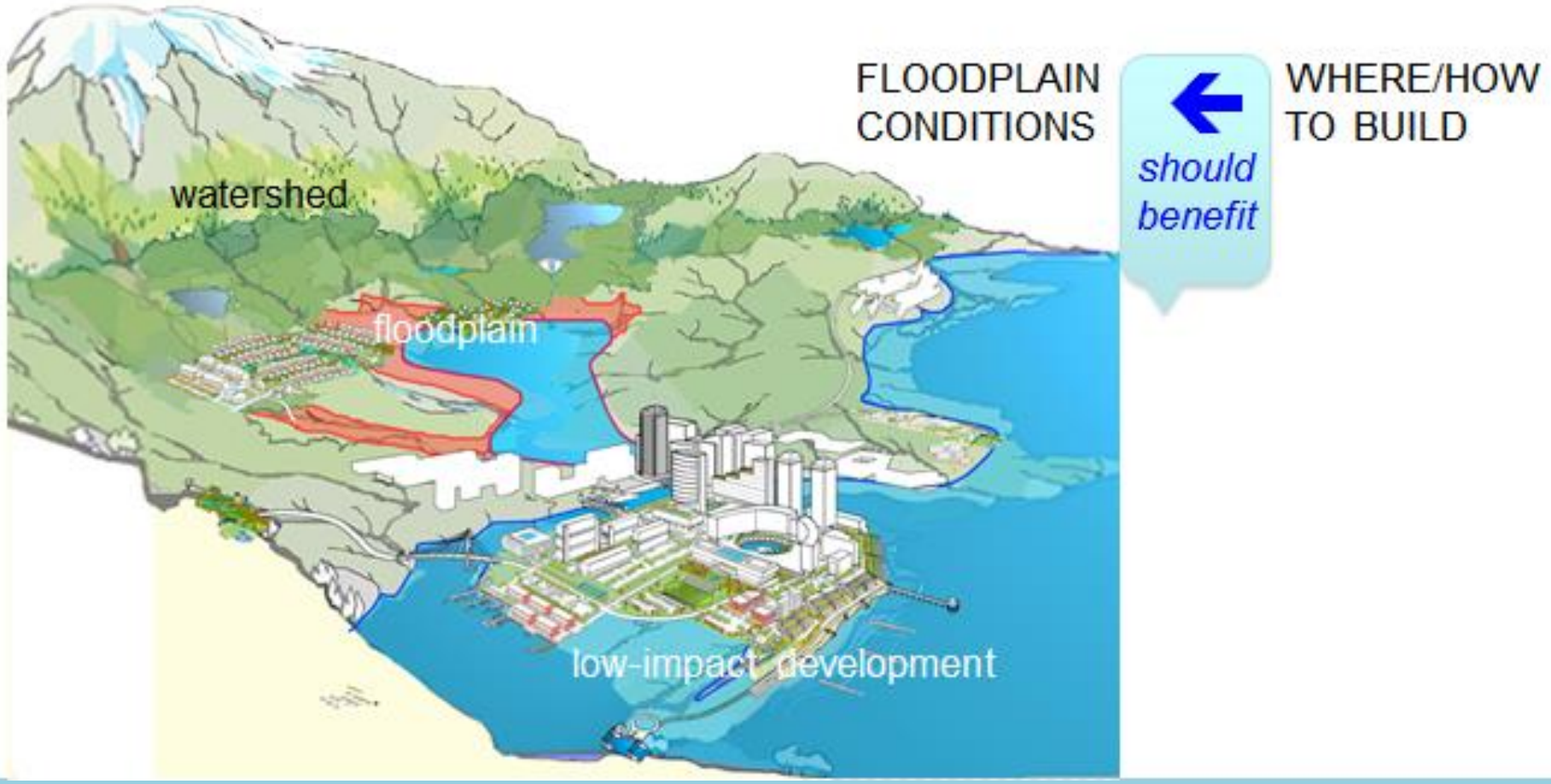


FLOODPLAIN CONDITIONS → WHERE/HOW TO BUILD

can benefit

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

Building in the Floodplain



Think like a watershed

3

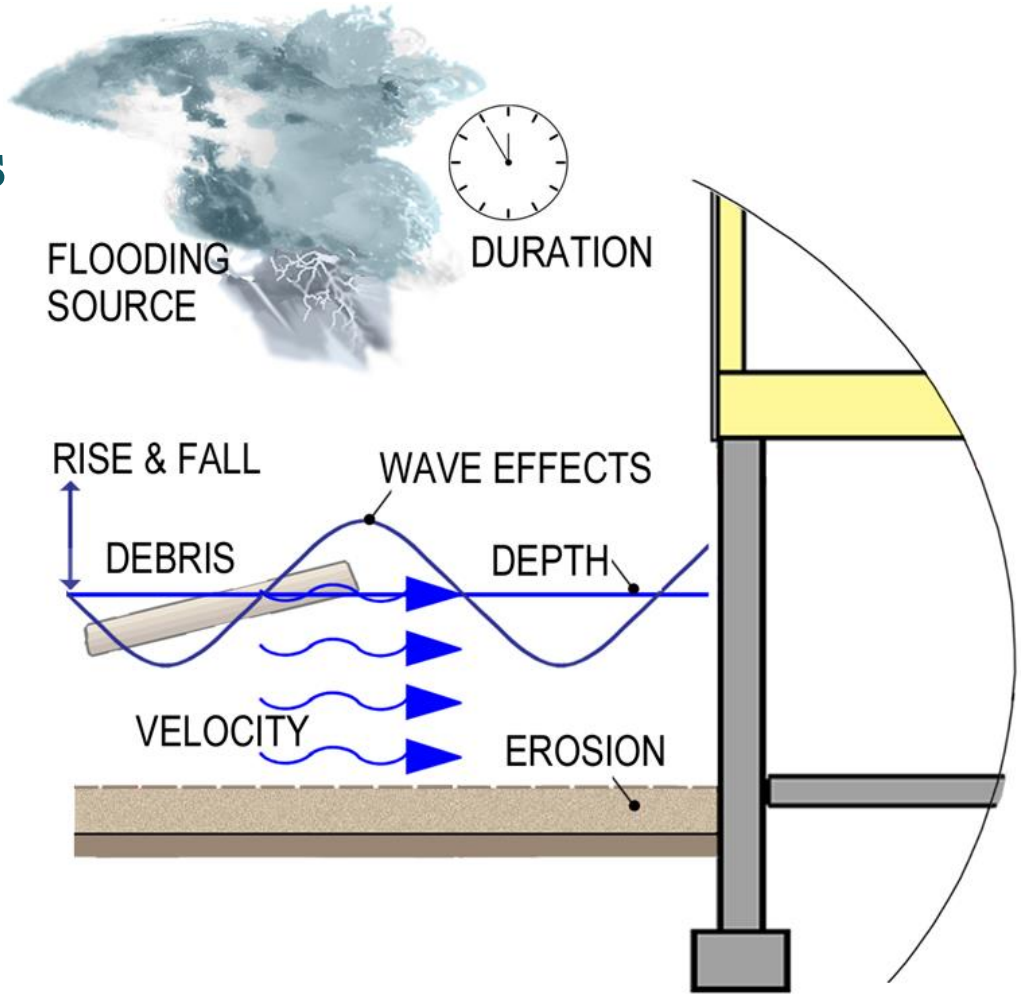
Flood resistant design

for buildings and infrastructure

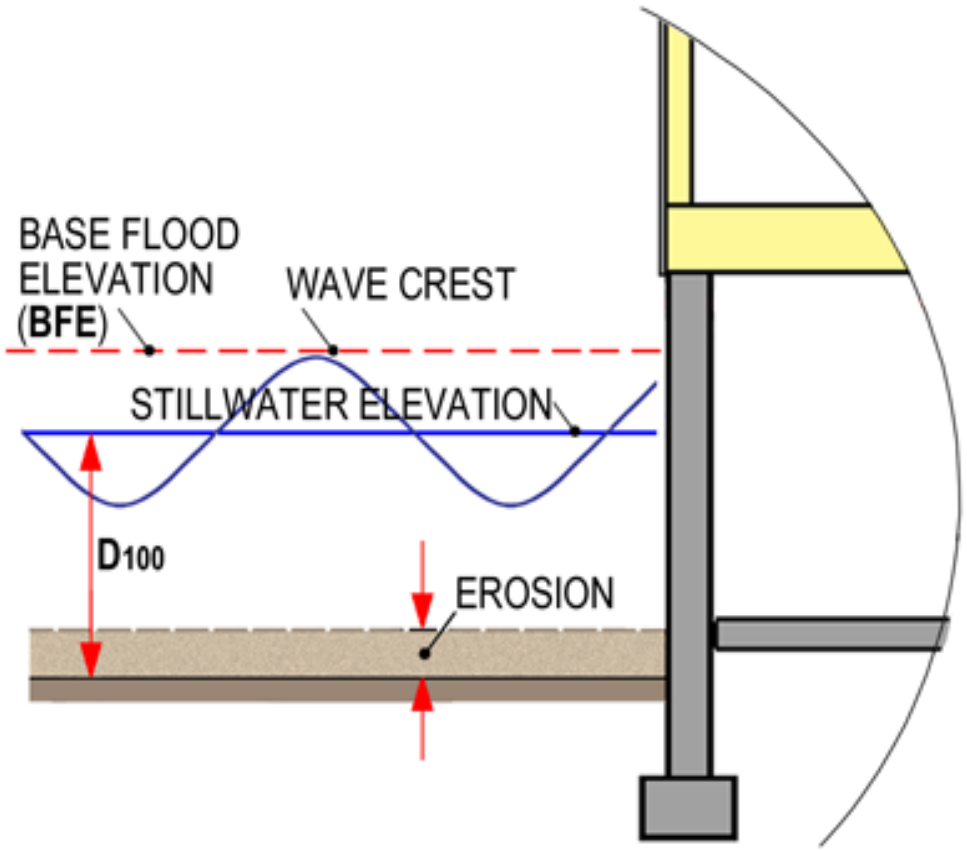
Flood Resistant Design

Flood Design Variables

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



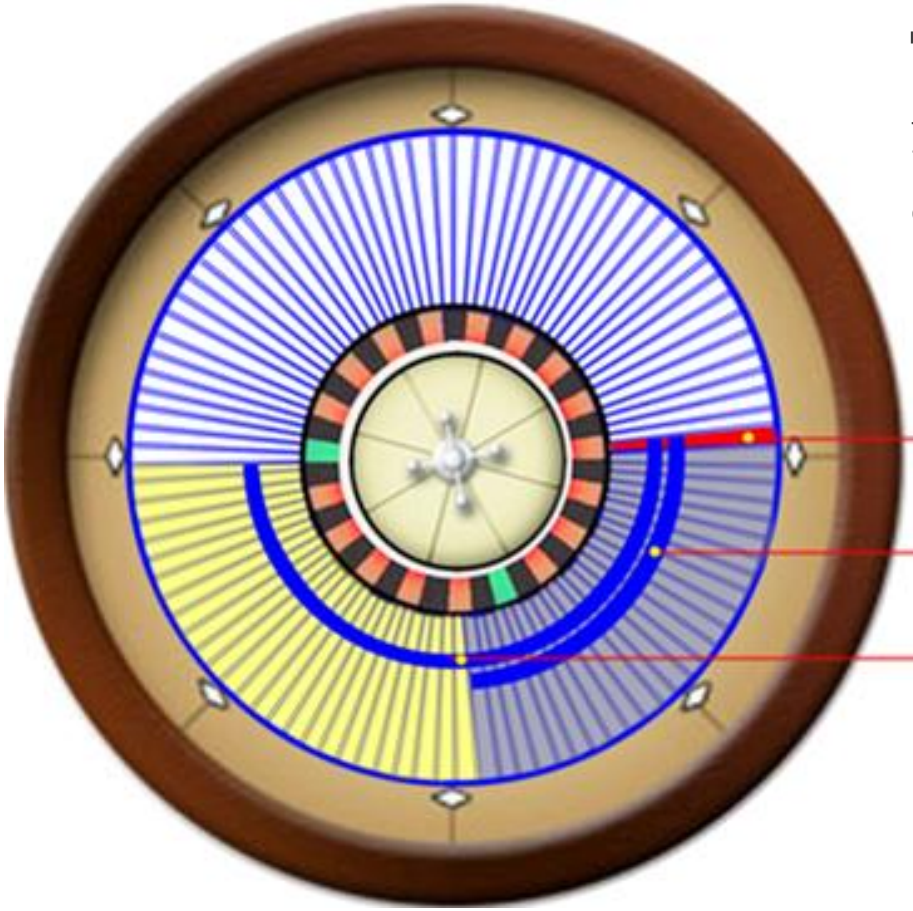
Base Flood Elevation (BFE)



- 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

Probability of a 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

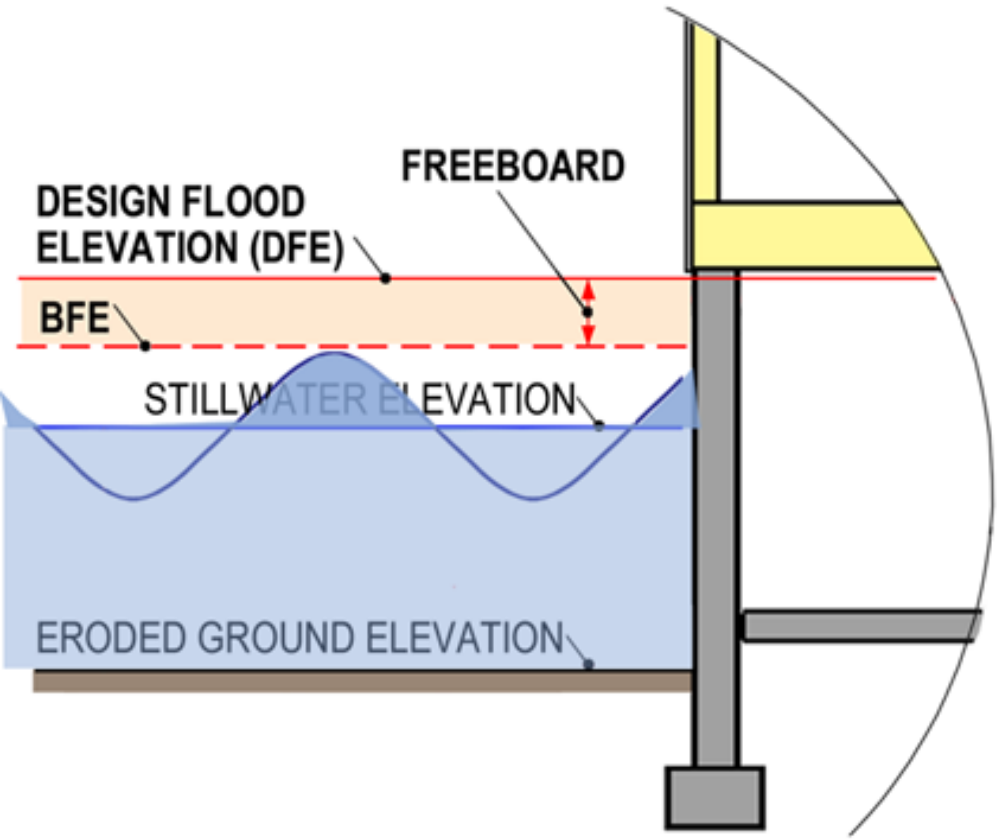
Probability Table

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%
30	96%	71%	45%	**26%**	6%	4%
50	99+%	87%	64%	39%	10%	7%
70	99.94+%	94%	76%	**51%**	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

Design Flood Elevation (DFE)



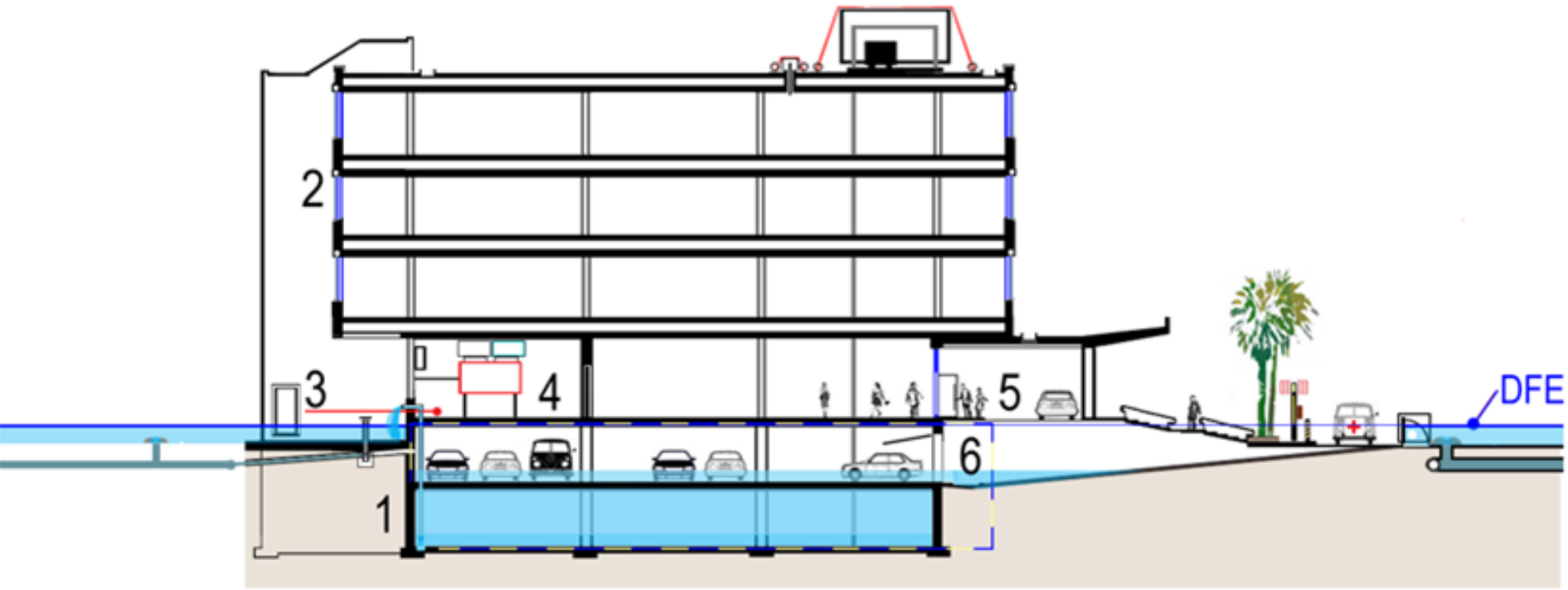
- The regulatory flood elevation established by State authorities & adopted by local jurisdictions.
- May equal or exceed NFIP requirements for BFE, cannot be less.
- May be higher than the BFE by adding height, called "freeboard," to represent Safety Factor above the BFE.

Montana Rules

FLOOD DESIGN STANDARD	NFIP Minimum Requirements	MONTANA Administrative Rules
	BFE	DFE
Freeboard	No freeboard required	Base elevation + 2 feet
Floodway Standards	** 1 foot Surcharge	** 1/2 foot Surcharge
Floodway Uses	Allows structures in Floodway with documentation of zero-rise	Prohibits habitable structures within the floodway
Mobile Home Applications	Will allow for mobile home placed in an existing mobile home park to be elevated above the adjacent grade	Requires all mobile homes to be elevated to the freeboard protection level

**with exhaustive CLOMR/LOMR

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)

4

A 2020 Update

The case for all-hazard mitigation

All-hazard mitigation

CLIMATE RISKS

Most common natural disasters
EM-DAT International Disaster Database
www.emdat.be

- FLOOD / SLR
- WINTER STORM
- WIND / TORNADO
- HEAT WAVE
- DROUGHT
- WILDFIRE
- EARTHQUAKE
- PANDEMIC DISEASE

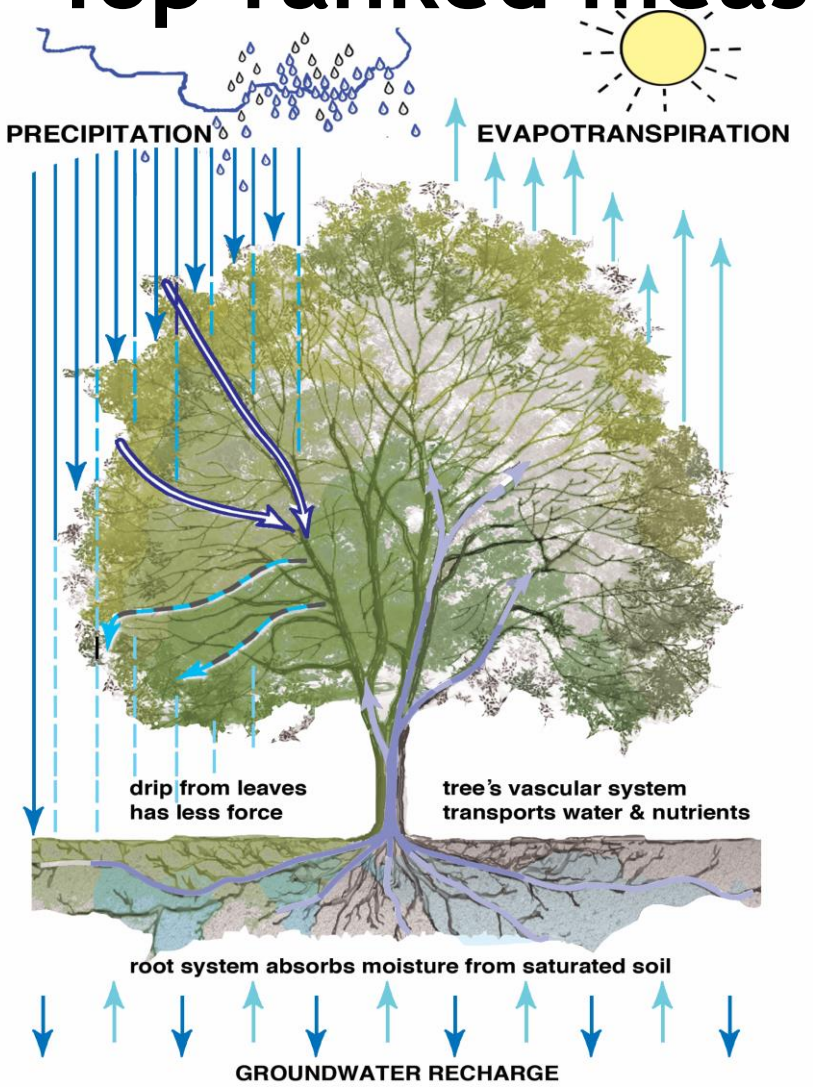
CLIMATE ACTIONS

Most popular Climate Actions (rank order)
undertaken by C40 Cities worldwide 2011-2015
compiling 10,000 registered projects

- tree planting
- flood mapping
- crisis management /warning/evacuation systems
- green roofs / walls
- storm water capture systems
- flood defences / development & operation storage
- restrict development in at risk areas
- sea level rise modeling
- projects and policies targeted at those most vulnerable
- resilience and resistance measures for buildings
- air quality initiatives
- disease prevention measures
- heat mapping and thermal imaging
- landslide risk mapping
- retrofit of existing buildings
- water efficient equipment and appliances
- community engagement / education
- cooling centers, pools, water parks / plazas
- incorporating climate change into planning documents
- promoting and incentivizing water efficiency
- additional reservoirs and wells for water storage
- water butts / rainwater capture
- public preparedness (including practice exercises / drills)
- diversification of water supply
- maintenance / repair of leaking infrastructure
- water smart metering
- water use audits
- soil retention strategies
- white roofs
- diversifying power / energy supply
- improve water supply distribution method
- shading in public spaces / markets
- biodiversity monitoring
- hazard resistant infrastructure design and construction
- awareness campaign / education to reduce water use
- cool pavement
- real time risk monitoring
- xeriscapes - low water landscape design
- cooling systems for critical infrastructure
- economic diversification measures
- optimizing delivery fuel mix of water supply
- water use restrictions and standards
- water extraction protection

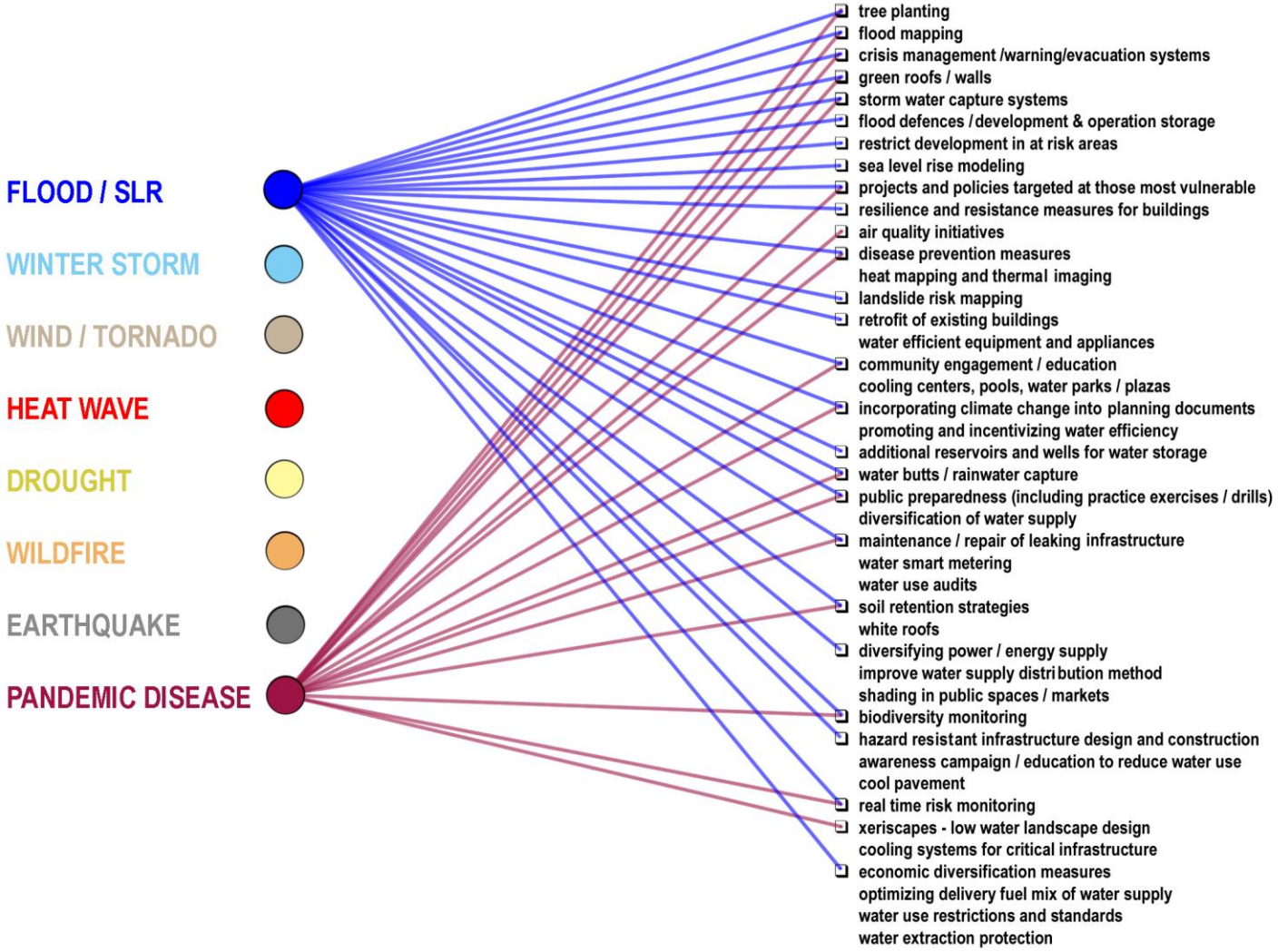
DATA SOURCE: C40 / ARUP www.cam3.c40.org:

Top-ranked measures

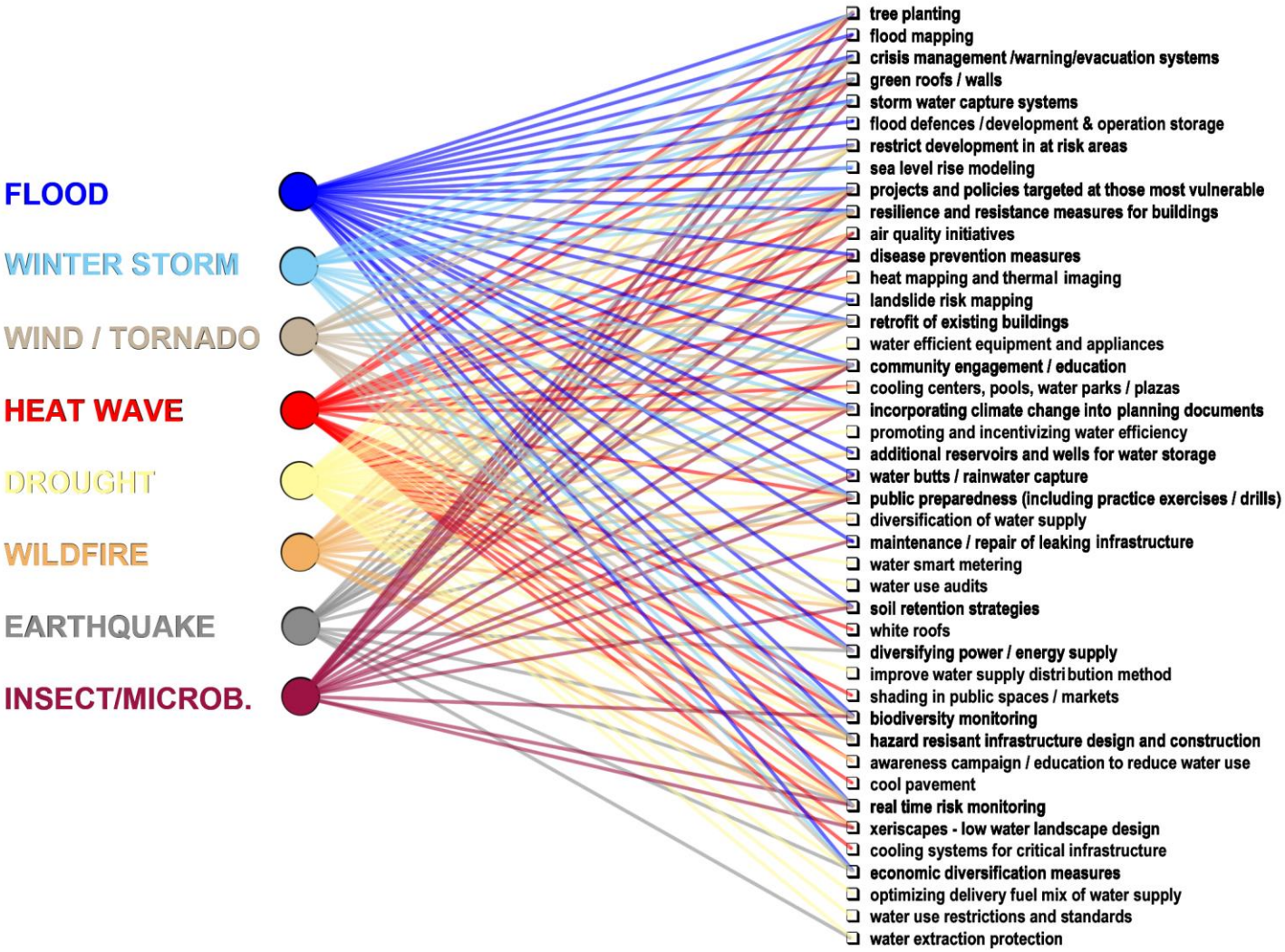


tree planting
flood mapping
crisis management /warning/evacuation systems
green roofs / walls
storm water capture systems
flood defences / development & operation storage
restrict development in at risk areas
sea level rise modeling
projects and policies targeted at those most vulnerable
resilience and resistance measures for buildings
air quality initiatives
disease prevention measures
heat mapping and thermal imaging
landslide risk mapping
retrofit of existing buildings
water efficient equipment and appliances
community engagement / education
cooling centers, pools, water parks / plazas
incorporating climate change into planning documents
promoting and incentivizing water efficiency
additional reservoirs and wells for water storage
water butts / rainwater capture
public preparedness (including practice exercises / drills)
diversification of water supply
maintenance / repair of leaking infrastructure
water smart metering
water use audits
soil retention strategies

Flood & Pandemic measures



Rainbow Resilience



Summary review

1. Identify **flood risks** in Montana
2. Explain advantages of **watershed management**
3. Describe **flood resistant design**
4. State the case **for all-hazard mitigation**

Design for Flood Resilience

RESOURCES

THANK YOU!

NHMA
Natural Hazard Mitigation Association

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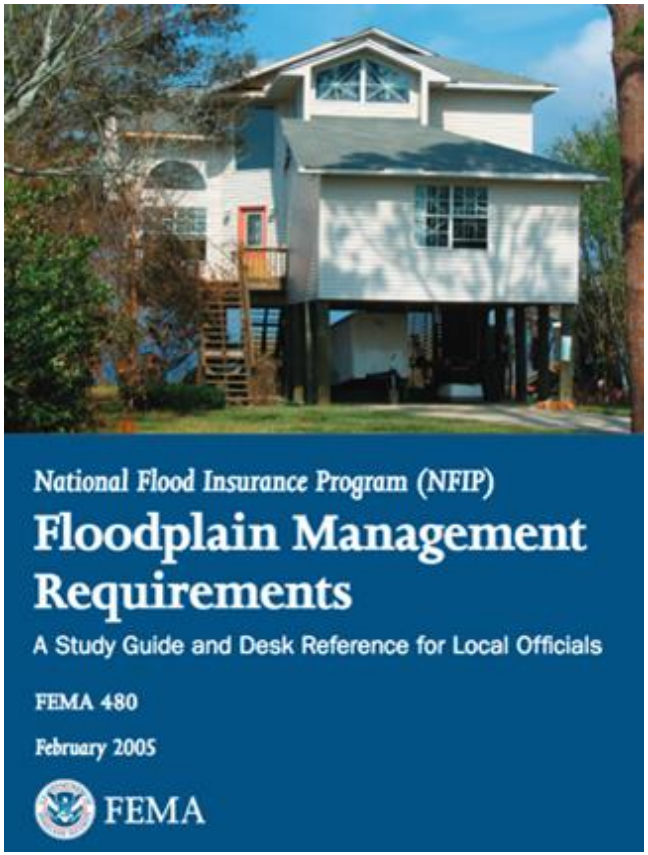
- **Questions and comments**
- **Contact information**

Natural Hazard Mitigation Association
P.O. Box 170984
Boston, MA 02117
Email: nathazma@gmail.com
www.nhma.info

FEMA 480 Floodplain Management



★ RECOMMENDED REFERENCE

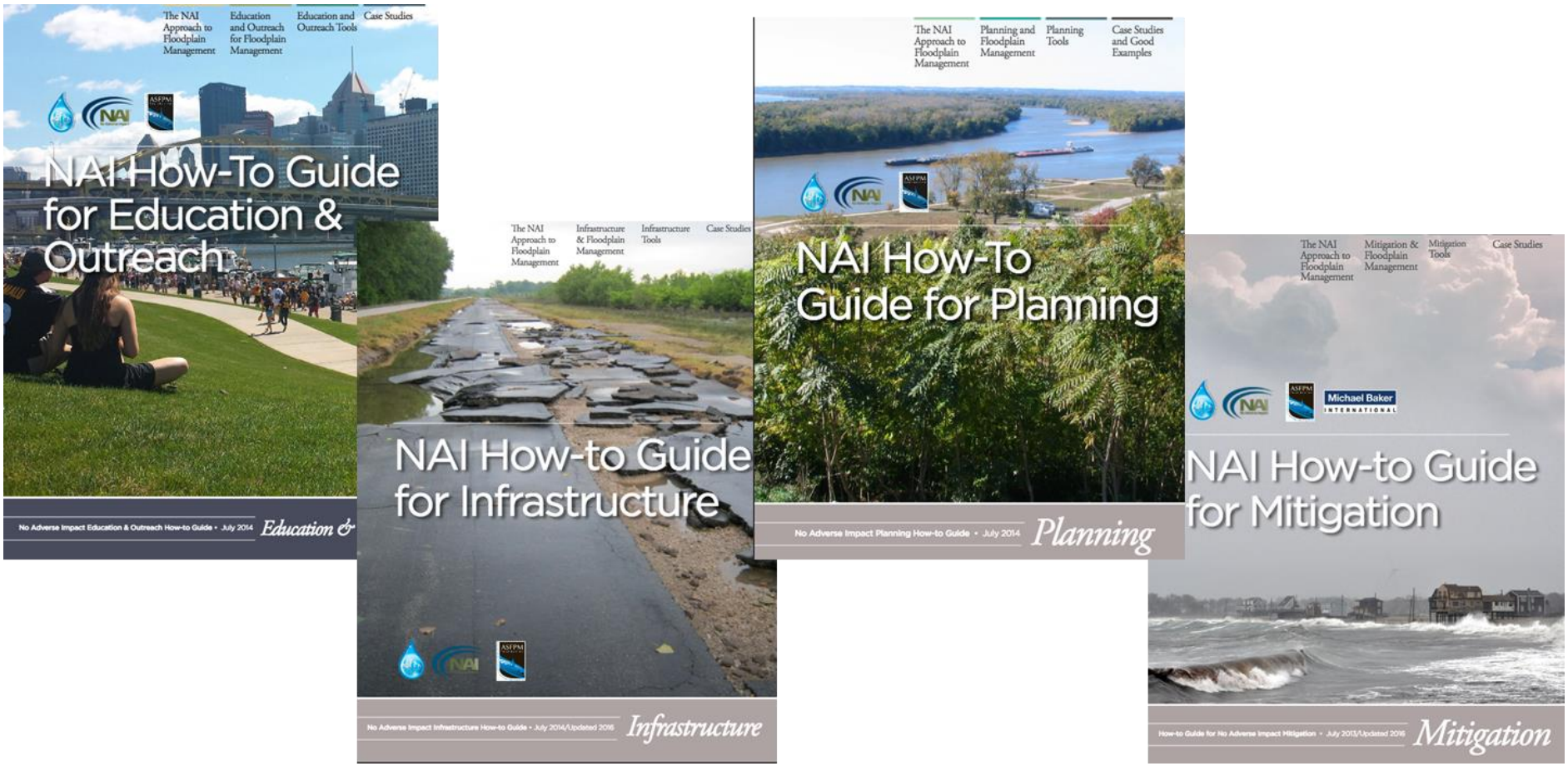
A. INTRODUCTION

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

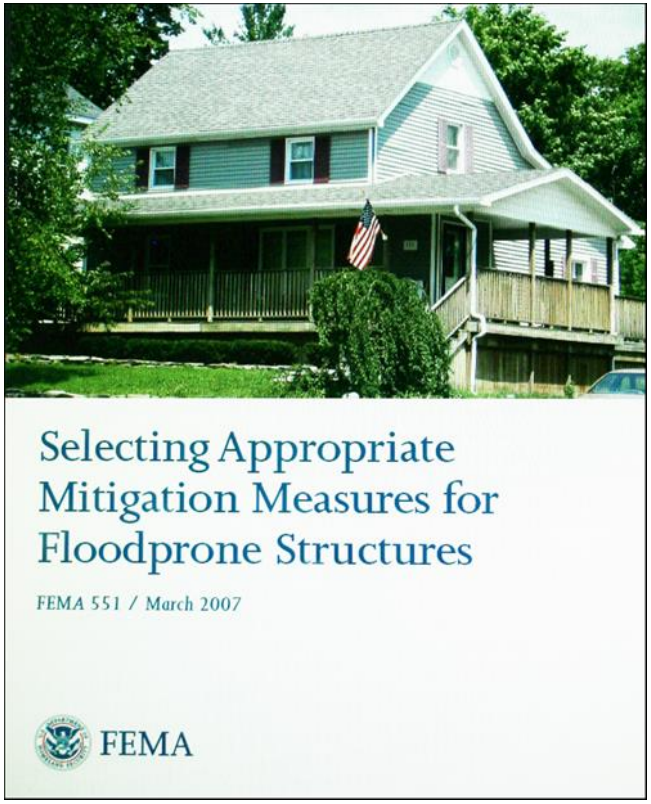
ASFPM - *No Adverse Impact* Guides



★ RECOMMENDED REFERENCES

ASFPM (2004) *No Adverse Impact How-To Guides*
http://www.floods.org/NoAdverseImpact/NAI_White_Paper.pdf

Flood Mitigation existing residential



FEMA 551

★ RECOMMENDED REFERENCE

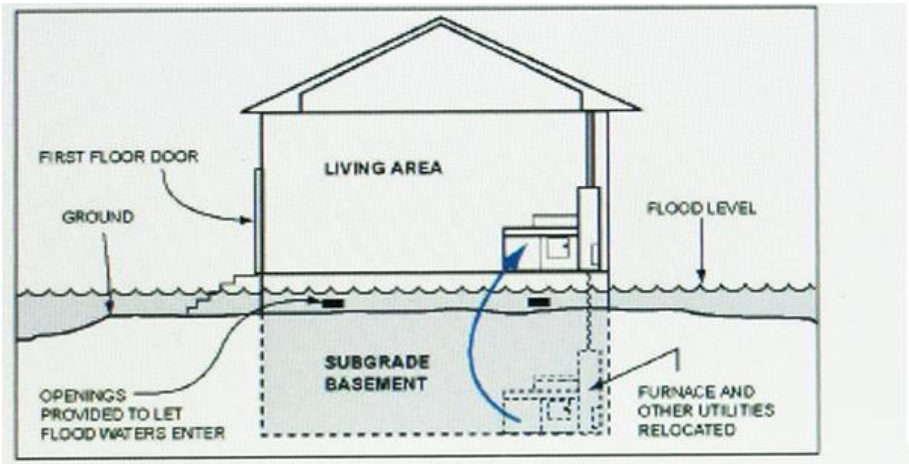


Figure 6-6. Wet floodproofing with a wet floodproofed subgrade basement
(Source: FEMA 312)

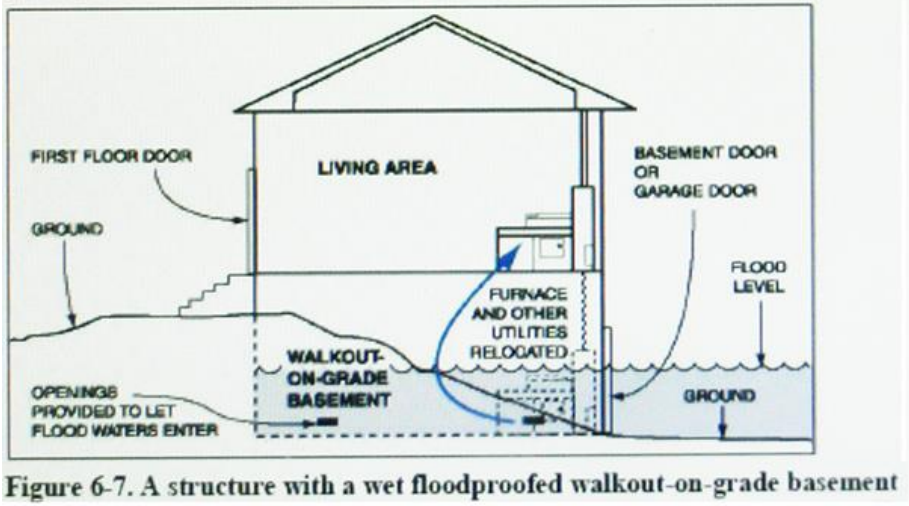
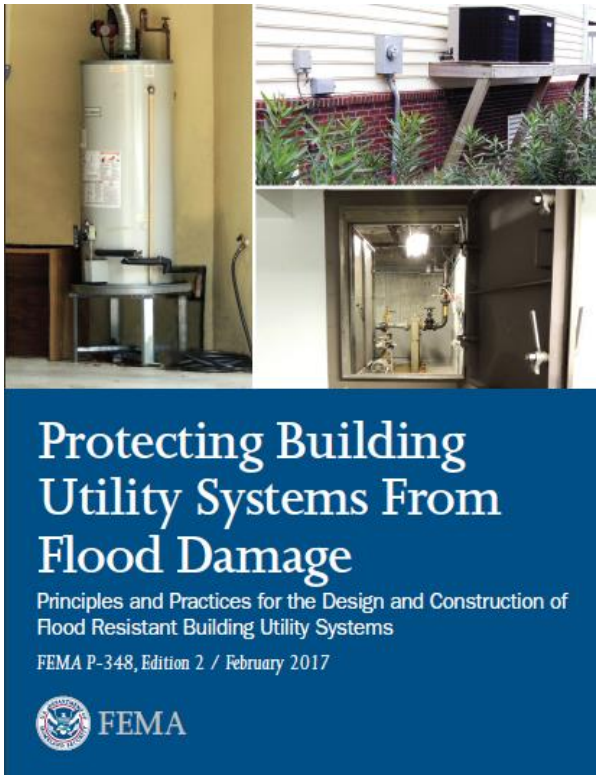


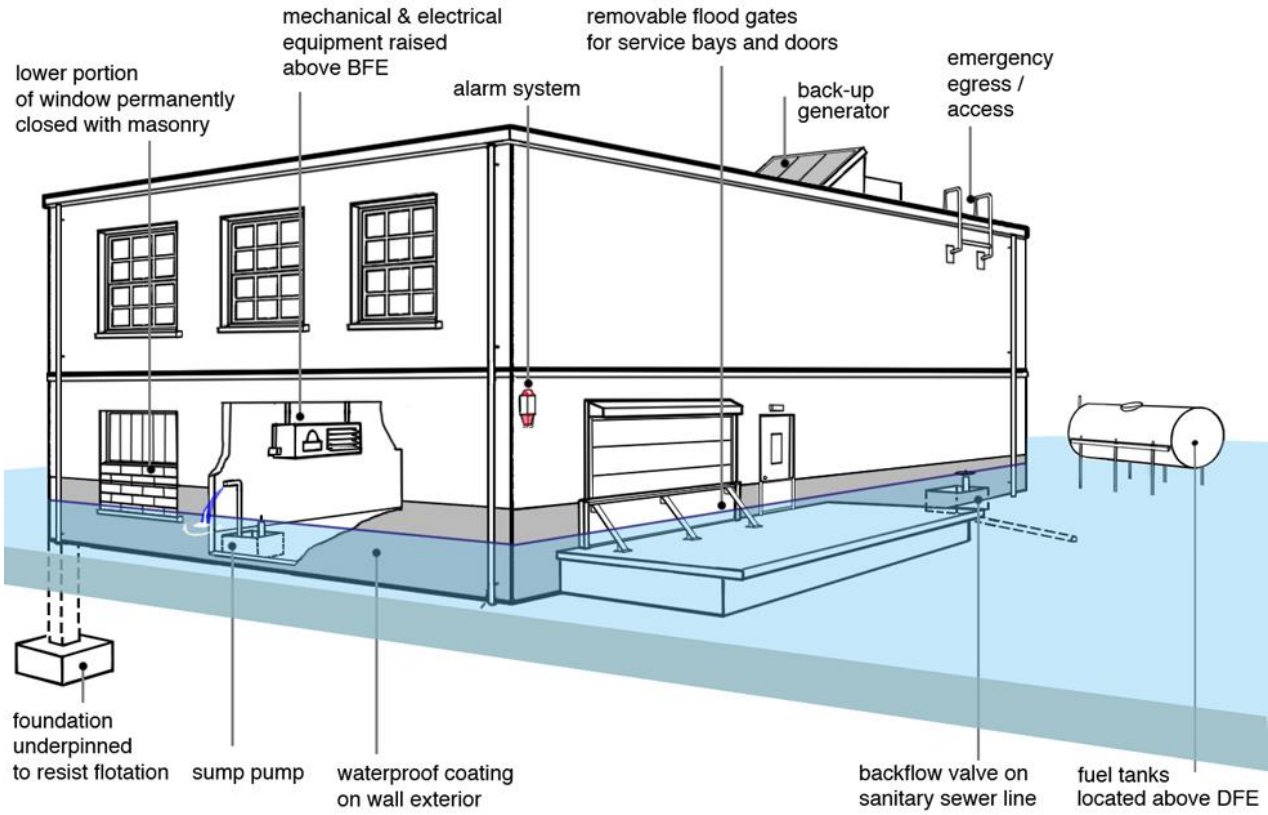
Figure 6-7. A structure with a wet floodproofed walkout-on-grade basement

FEMA 551 www.fema.gov/media-library-data/fema551.pdf

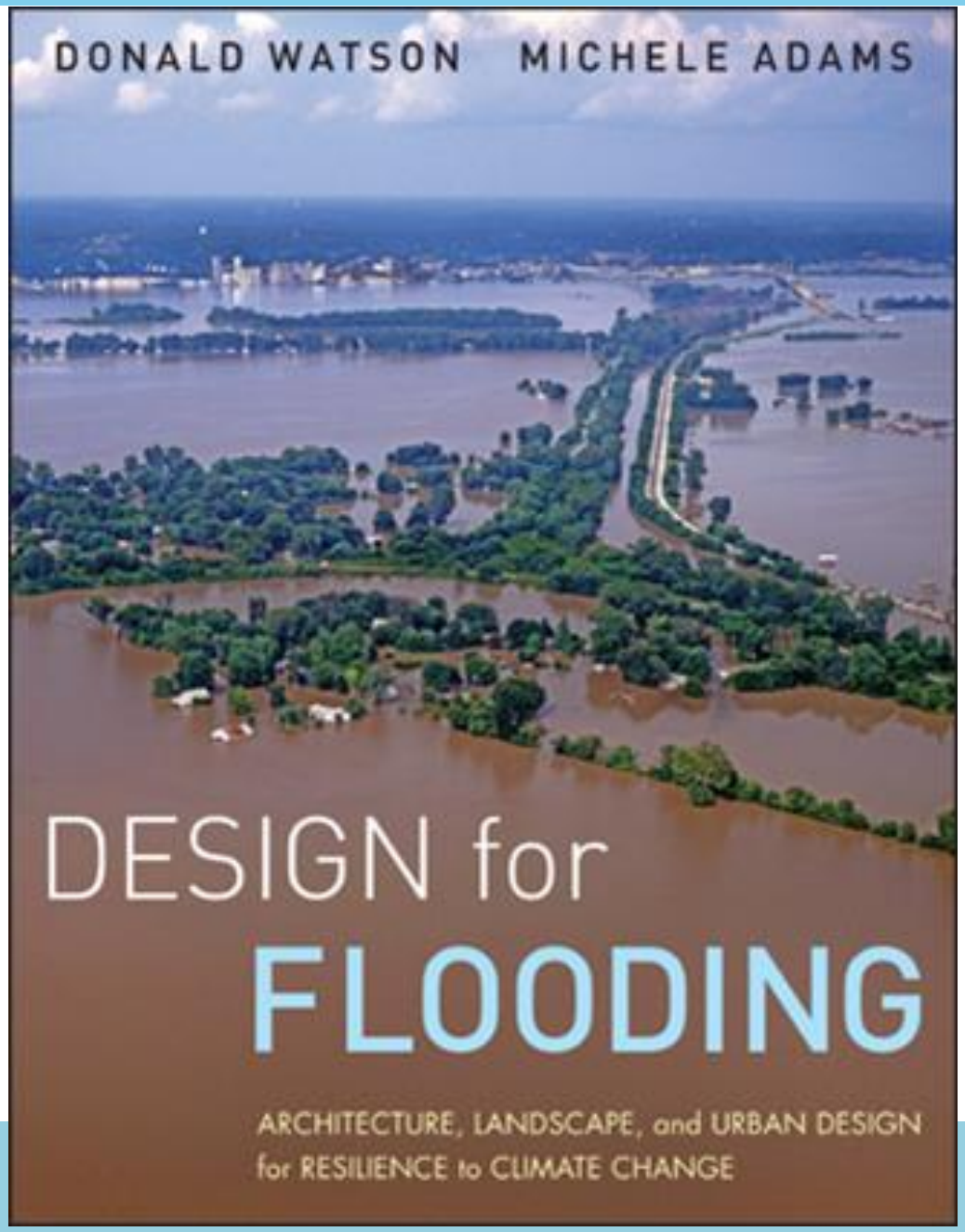
Flood Mitigation existing commercial



FEMA P-346



Protecting Building Utility Systems from Flood Damage (2017)
FEMA P-346 www.**fema**.gov/media-library/assets/documents/3.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DESIGN for
FLOODING
ARCHITECTURE, LANDSCAPE, and URBAN DESIGN
for RESILIENCE to CLIMATE CHANGE