NATIONAL NONSTRUCTURAL COMMITTEE

INTRODUCTION TO THE COMMITTEE, NS MEASURES AND A PLANNING EXAMPLE

Lea Adams, PE

Jodie Foster, PhD

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21 March 2019

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AGENDA

1. Introduction to the Committee
2. Background on Nonstructural
3. FY19 NNC Workplan
4. Nonstructural Measures
5. Planning Methods & Best Practices
6. Questions/Discussion

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NATIONAL NONSTRUCTURAL COMMITTEE

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https://www.usace.army.mil/Missions/Civil-Works/Project-Planning/nfpc/

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NONSTRUCTURAL PHILOSOPHY

Flood Risk = Probability x Consequences

- Nonstructural focuses on reducing consequences by:
  - Adapting to the natural characteristics of the floodplain
  - Avoiding impacts to flood stages, velocities or the environment
- Nonstructural touches on:
  - Planning
  - Field assessments
  - Implementation
  - Emergency response

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RELATED LAWS & GUIDANCE

- Water Resource Development Acts (WRDA): 1974, 1996, 1999, 2007, 2016
  - WRDA 1974, Section 73: requires consideration of nonstructural measures to reduce flood damages
  - WRDA 1999, Section 201: amended the Small Flood Control Authority to include nonstructural projects
  - WRDA 2016, Section 1184: requires consideration of nonstructural measures when studying feasibility of FRM, hurricane and CSRM projects

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USACE REGULATIONS

- **ER 1105-2-100 "Planning Guidance Notebook"**
  - Exhibit G-1: minimum of one nonstructural plan should be considered. *"The feasibility report will document that all reasonable alternatives for addressing the identified problems, <u>including non-structural measures</u> and measures beyond the authority of the Corps to implement, have been systematically formulated and evaluated in accordance with the P&G"* (supports WRDA 1974)
- **Planning Bulletin 2016-01, Planning Bulletin 2019-03**
  - Berms are structural
  - Eminent domain for buyouts
  - Aggregation of structures
  - Interest during construction

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FY19 NNC WORKPLAN

- Nonstructural Working Group
  - POCs: Rachel Shrader, NWO, Brian Maestri, MVN and Andy MacInnes, MVN
  - Connecting requests and resources for nonstructural-related needs
  - Webinars
    - January – Buyout Guidance, PB 2016-01 and PB 2019-03
    - February – Relocation Assistance, PL 91-646
    - April – Structure Inventories
    - Possible future topics – Cost Estimation, Implementation, Plan Formulation

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FY19 NNC WORKPLAN

- Nonstructural Best Practice Guides
  - Study Scoping
    - How best to aggregate structures and define damage areas?
  - Plan Formulation Steps
    - How to incorporate NS into a planning study?
  - Communication with Local Sponsors
    - What is important for local sponsors to know about NS alternatives? No one likes surprises.
  - Historic Properties
    - Older structures must be handled with care.
  - Case Studies

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FY19 NNC WORKPLAN

- Subject Matter Expert List
  - We need you!
- Interagency Nonstructural Projects
- PROSPECT Class in FY20

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NONSTRUCTURAL MEASURES

Jodie Foster, PhD – NNC Member

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NONSTRUCTURAL MEASURES

Allow for people and structures that are exposed and vulnerable to flood risk to **adapt to flooding** and to those risks associated with flooding **without changing the characteristics of the flood** …….no increased stages, velocities, or duration of flooding.

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NONSTRUCTURAL MEASURES

PHYSICAL

- Acquisition (buyout / demolition)
- Basement Fill
- Elevation
- Relocation (Individual Structures / Multiple Structures)
- Dry Flood Proofing
- Wet Flood Proofing
- Barriers – Berms Walls (Temporary / Permanent)

NONPHYSICAL

- Education / Communication
- Flood Emergency Preparedness & Warning
- Other - *National Flood Insurance Program (NFIP); Floodplain Management; Land Use Regulation (Zoning); Building Codes*

A1

NATURE BASED

- Low Impact Development / Green Infrastructure / Floodplain Restoration

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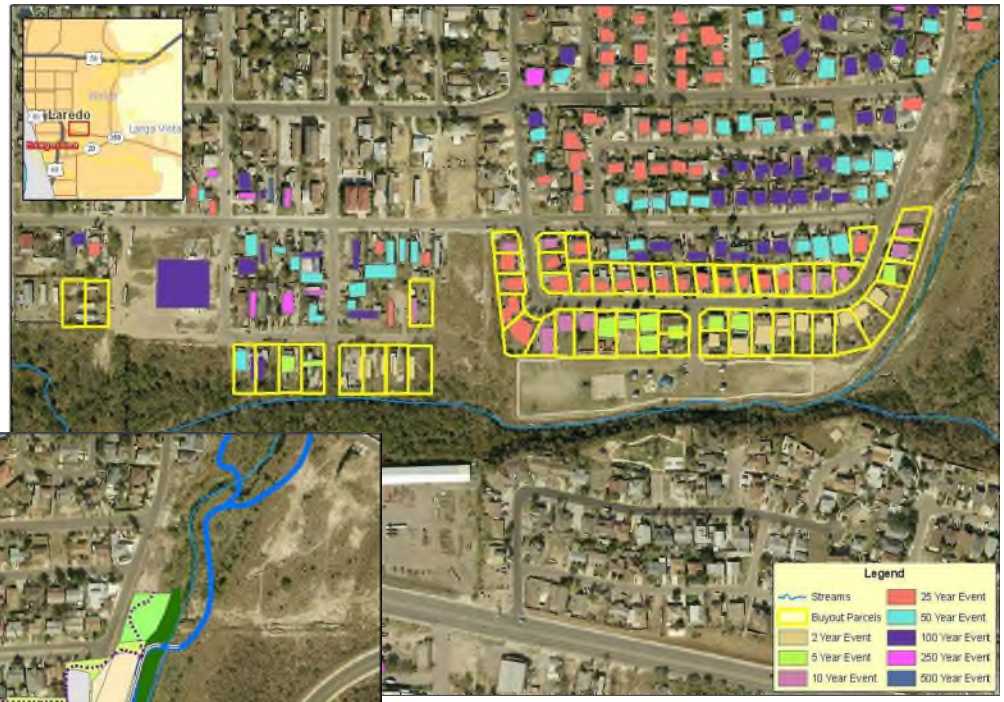
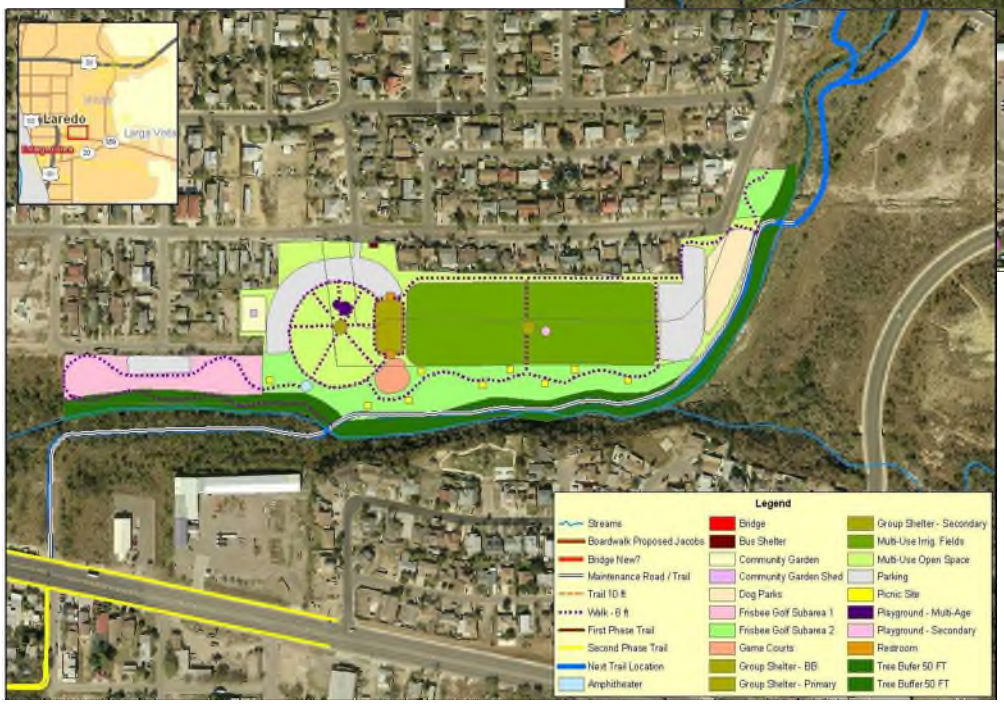
Slide 12

A1 Author, 2/21/2019

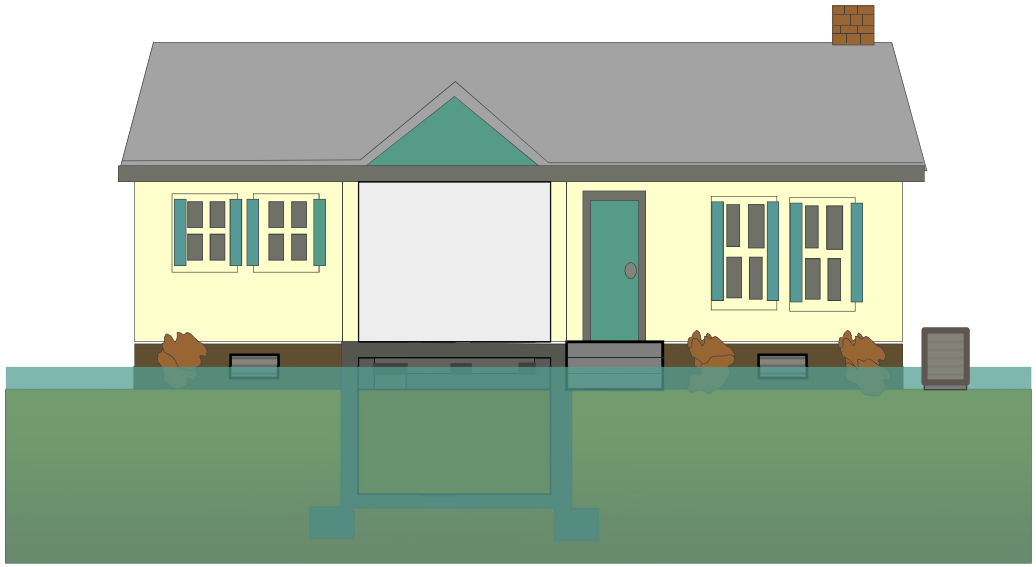
ACQUISITION / DEMOLITION

SECONDARY USE OF EVACUATED PROPERTY





BASEMENT EVACUATE / FILL



- **Evacuate Basement**
  - Relocate Storage/Other (Above Design Flood Elevation (DFE))
  - Elevate Mechanical/Electrical Equipment (Above DFE)
  - Remove Finishes & Demo Floor Slab
- **Fill Basement** (Level w/Exterior Grade & Suitable fill)
- **Install Flood Louvers/Vents/Openings**

ELEVATION ON EXTENDED FOUNDATION



Residential Structure – Grundy, VA

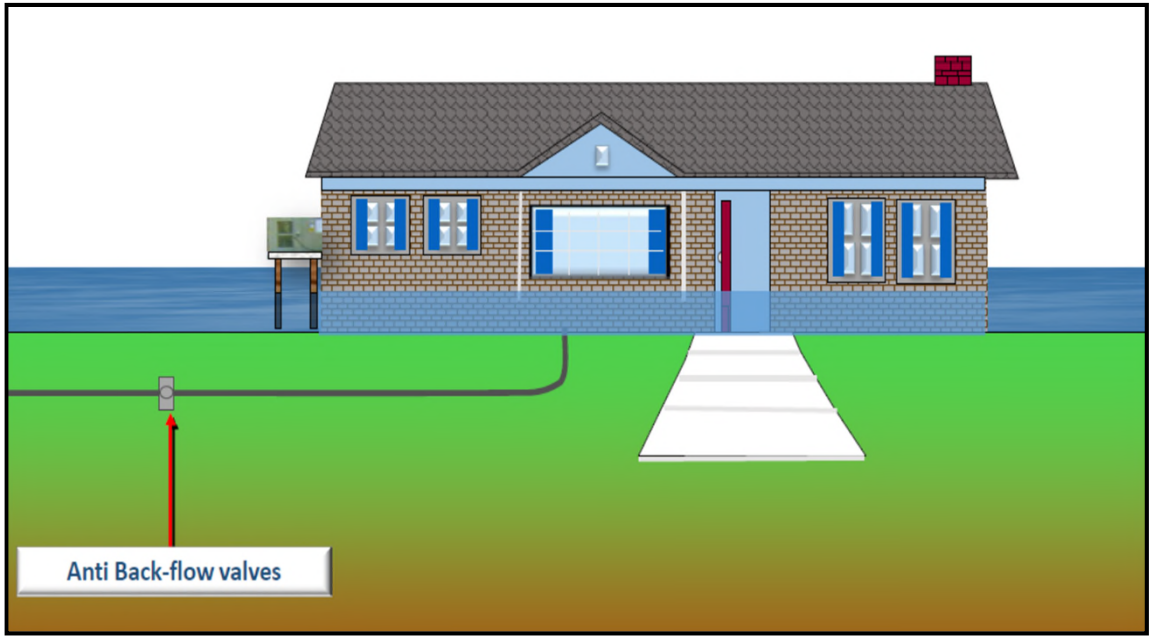
…is one of the most **common and effective** methods used to prevent flooding of living space…

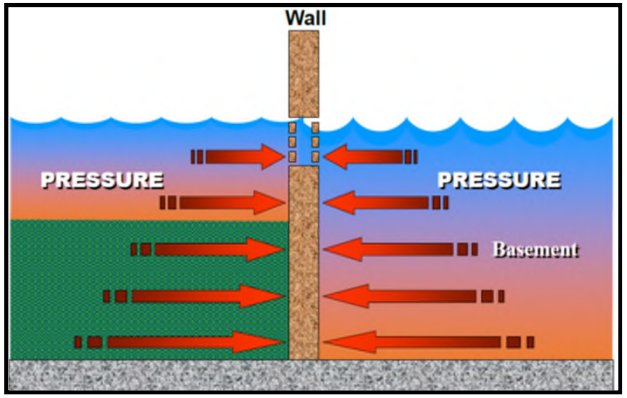
…recommend design and construction by reputable/qualified professionals and contractors…

…Not permitted in regulatory floodway…**Not** recommended areas of high flood velocities

…Acceptable in A Zones.

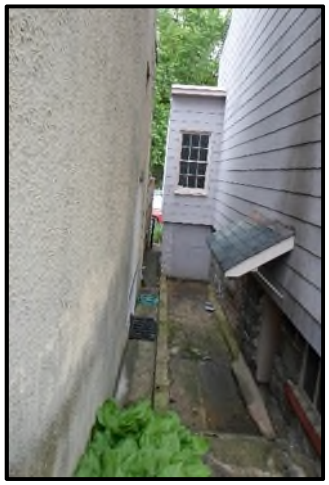
WET FLOOD PROOFING





Equalize the pressure

Ellicott City, MD : Residential/Commercial (Wet Flood Proofing Example)



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Ellicott City, MD : Residential/Commercial (Wet Flood Proofing Example)

Key Building Features:

- Masonry construction below first floor
- Unoccupied walkout basement

Considerations:

- Placement of flood vents
- Move utilities

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OTHER ELEVATIONS

Piers and posts

Elevate on fill

INTERIOR ELEVATION

RELOCATION

Lighthouse - Cape Hatteras, NC

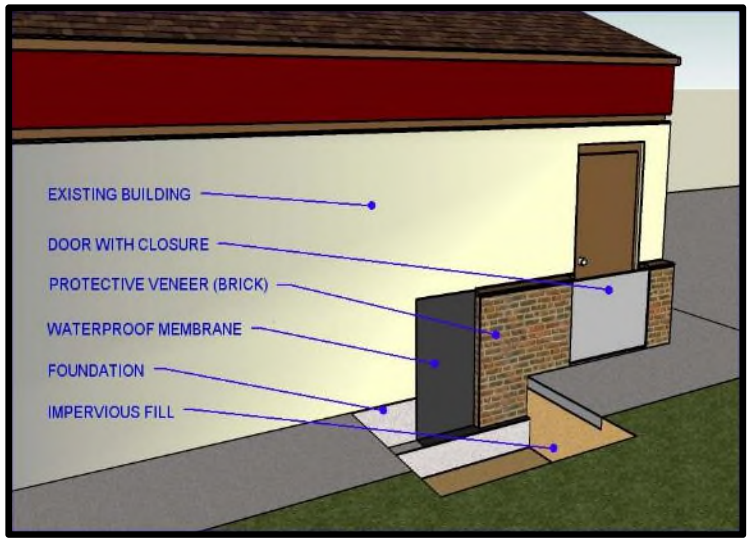
Masonry Structure

Grundy, VA

DRY FLOOD PROOFING

(Temporary)

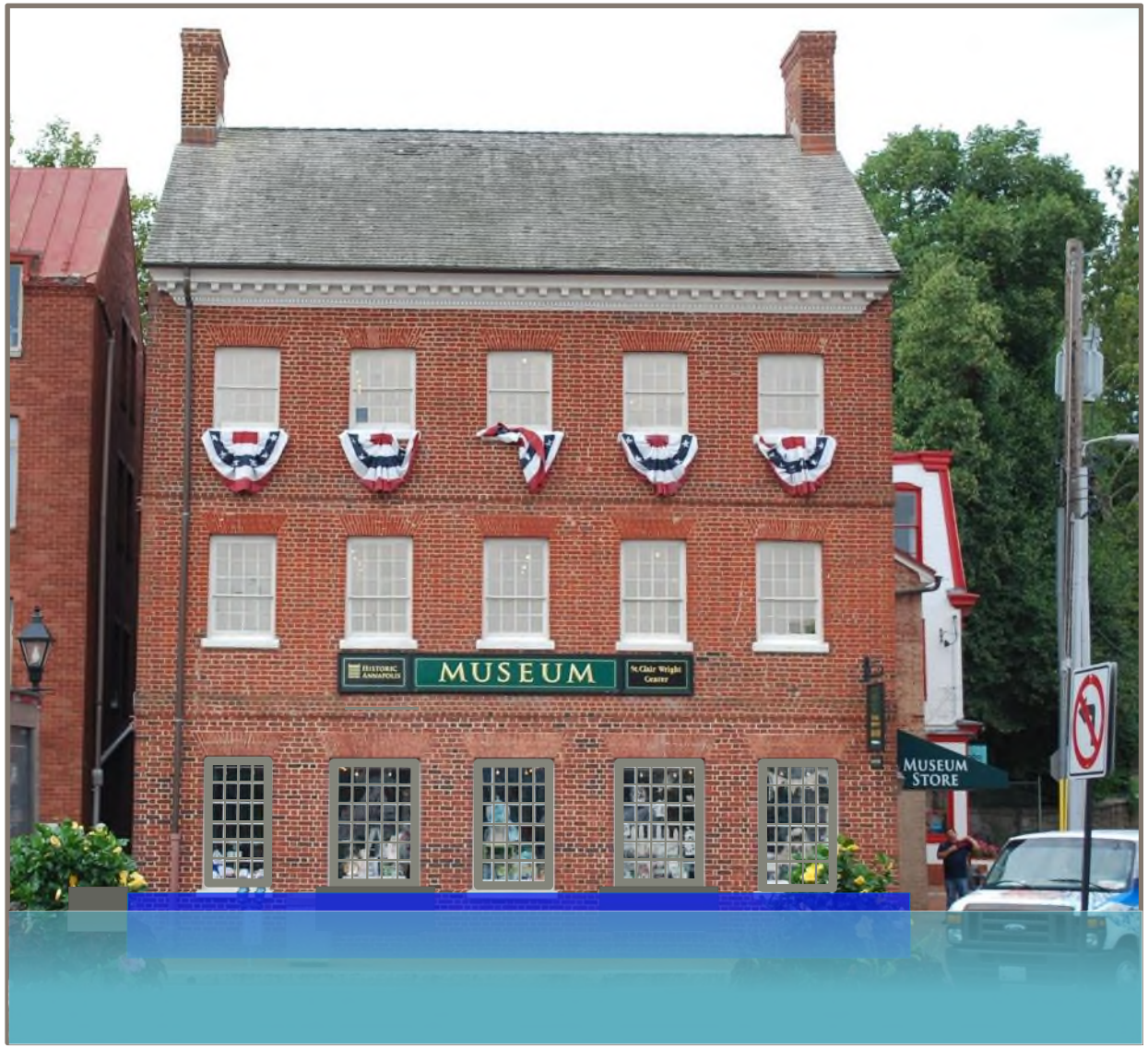
- Flood depths 3 feet or less
- Structurally sound buildings
- New design & construction
- Retrofitting existing structures
- No basement or crawl space



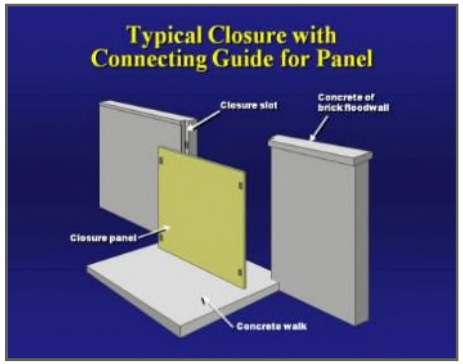
Detail

Kermit, WV (Pizza Hut)

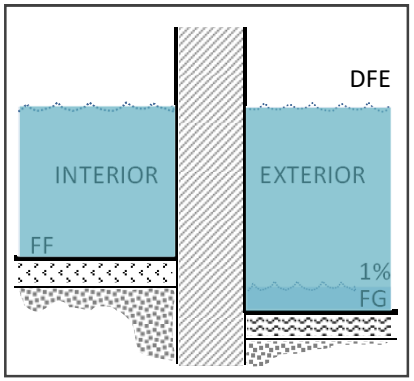
DRY FLOOD PROOFING



Temporary Barrier



Closure/Shield



BUILDING SECTION (at Grade)

Not to Scale

DRY FLOOD PROOFING

Inserts

Stop Logs

Flood Door

Panel System

Swing Gate (Driveway)

Wall Swing Gate

HISTORICALLY SENSITIVE FLOOD DOORS

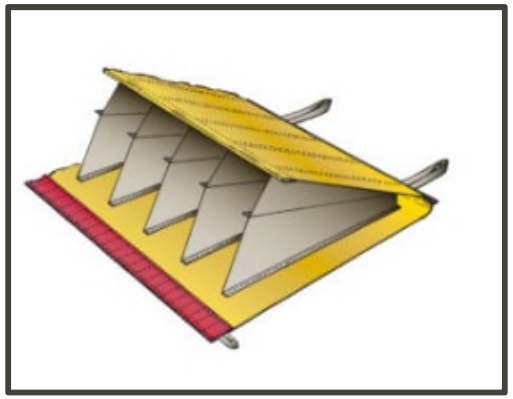
http://stormmeister.com/ *

*Not tested by USACE

TEMPORARY BARRIERS

Bladder

Manual Panels



Self Rising Panels

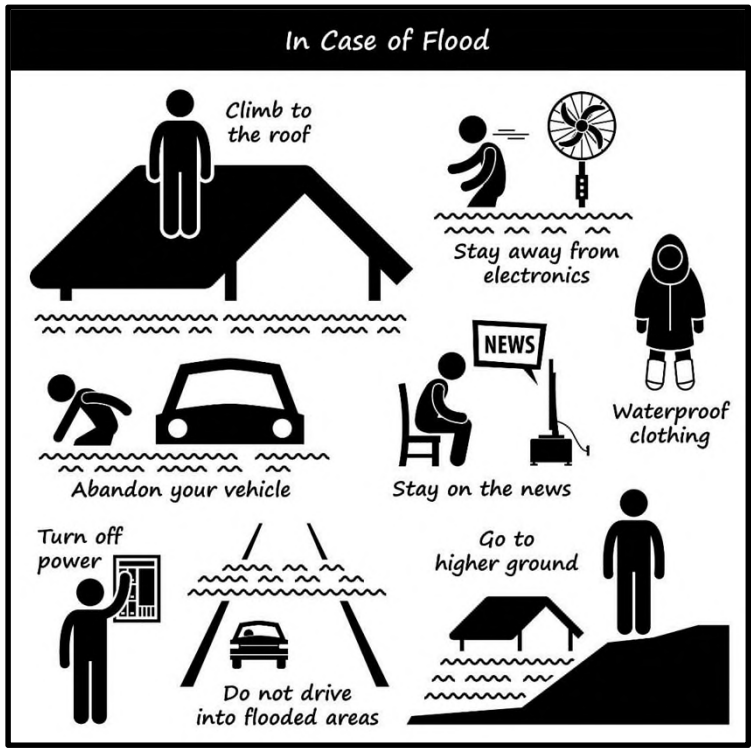
THINKING OUTSIDE THE BOX: DEBRIS BARRIERS

Bollards Hidden Behind Porch

Flood Door Behind Porch

NON-PHYSICAL MEASURES

- **Awareness - Education/ Outreach**
- **Regulations (codes, zoning, floodplain management)**
- **Warning / Evacuation**
  - Who / How / When
- **Preparedness Planning**
  - Emergency Action Plans
  - Response / Recovery
  - Evacuation Routes
  - Evacuation Centers
  - Vertical Evacuation
- **Insurance**



GREEN INFRASTRUCTURE KEY PROCESSES

- **Interception**
- **Infiltration**
- **Retention**
- **Evaporation**
- **Evapotranspiration**
- **Reuse**

Green Infrastructure can be designed to work in a variety of areas as long as it can use 1 or more of these processes

LOW IMPACT DEVELOPMENT AND GREEN INFRASTRUCTURE

- RAIN GARDEN
- PLANTER BOX
- GREEN SPACE
- POROUS PAVEMENT
- RAIN BARREL

GREEN INFRASTRUCTURE APPROACHES

Rainwater collected in planter box then channeled into rain garden
Boulder, CO

Irrigation by disconnected downspout
Denver, CO

Green roof
Salt Lake City, UT

Vegetative swale
Fort Carson, CO

Pervious pavement sidewalk
Sioux City, SD

Retention pond
Fargo, ND

PLANNING METHODS & BEST PRACTICES

Danielle Tommaso, CFM – NNC Member

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NNC BEST PRACTICE GUIDES

- Have a nonstructural planning challenge? You're not alone!
- The National Nonstructural Committee will soon publish best practice guides
  - Planning Challenges ***COMING SOON!***
    - Plan formulation and evaluation
    - Economic analysis
    - Estimating project costs
  - Design Standards
  - Implementation Methods

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KEY TAKE-AWAYS

- Structural and nonstructural measures / alternatives should be considered equally and concurrently, when a project is initiated. The recommended plan may include one or the other, or a combination.
- The USACE planning process is the same for structural and nonstructural flood risk management… The difference is in the details.
- Inventory and data requirements are very similar, but there are some differences… Awareness and knowledge of this will improve project completeness and success.

Structural ~~versus~~ *and* nonstructural flood risk management

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WHAT'S DIFFERENT? WHAT'S THE SAME?

- The planning process doesn't change when you consider nonstructural measures
- Applicable guidance still applies
- Important to remember:
  - Consider P&G accounts, life safety, residual risk, and study-specific planning objectives
  - Consider and document eight-step decision-making process (EO 11988)

We will focus on considerations and best practices unique to nonstructural plan formulation, evaluation, and selection

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NONSTRUCTURAL PLAN FORMULATION

- Not an afterthought – part of formulation from day one
- Minimum of one nonstructural plan should be considered (EO 11988/ER 1105-2-100 Exhibit G-1)
- Consider all nonstructural measures regardless of who and which program can implement
  - Many measures are not within the purview of the USACE CW mission
  - USACE, FEMA, HUD, states, local municipalities, homeowners, businesses, etc.
  - Silver Jackets Program has list of different types of programs

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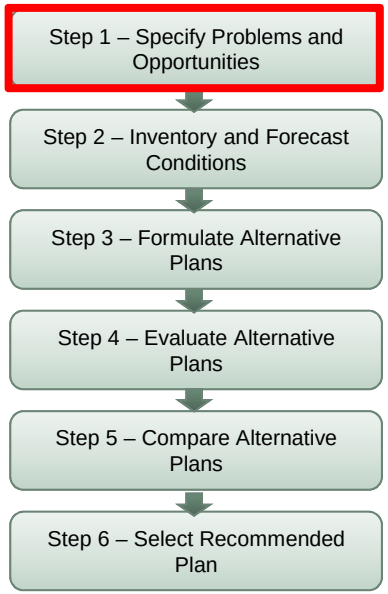
STEP 1:
SPECIFY PROBLEMS AND OPPORTUNITIES

- **Problem identification**
  - Impacts of flooding ← **most apparent focus of study**
  - Life safety, residual risk, OSE (community cohesion, resilience)
- **Opportunities**
  - Build on problems
  - Not limited to NED
  - Life safety, residual risk, OSE

Best practice: Think about how problems and opportunities will help form objectives, and how those objectives will be quantified (metrics, thresholds, etc.)



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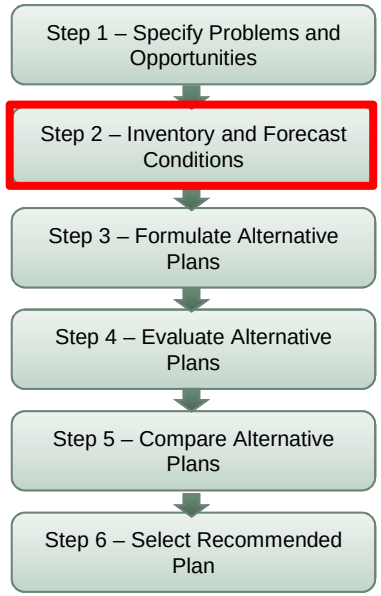
STEP 2:
INVENTORY AND FORECAST CONDITIONS

- **Characterize historic and existing conditions, and future-without project (FWOP) conditions**
  - Hydraulic modeling, structure inventory, identify environmental and cultural considerations, mapping
- **Common considerations:**
  - Land use and development
  - Projects by others
  - Post-disaster actions



<u>Best practice</u>: Document historic structures (need to maintain historic integrity may impact screening of measures)

<u>Best practice</u>: coordinate with Federal, state, and local agencies after disasters

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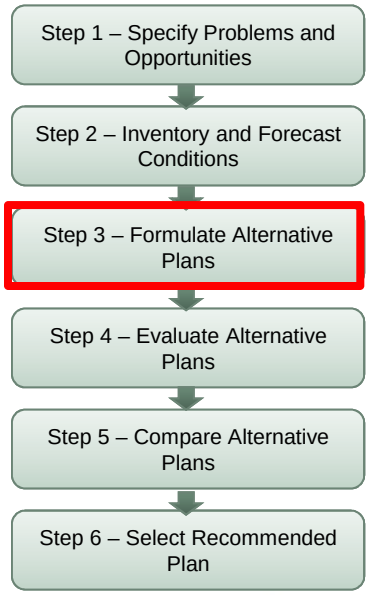
STEP 3: FORMULATE ALTERNATIVE PLANS

- Similar to procedures used for all FRM and CSRM studies
- Plan formulation strategy and objectives will help you screen and combine measures. They likely focus on:
  - Managing risk of economic damages
  - Economic damage centers (geography)
  - Minimization of life loss
  - Supporting community resilience and cohesion
  - Critical or existing infrastructure
  - Focus on regional vs. local solutions
- Structural and nonstructural measures can work together to manage flood risk



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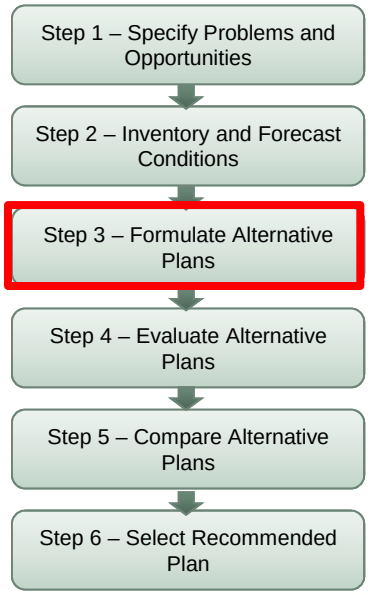
UNIQUE NONSTRUCTURAL CONSIDERATIONS

- Must consider one primarily nonstructural plan
- Participation: voluntary vs. mandatory nonstructural measures
- Federally-led implementation
- Historic properties (potential constraint or consideration)
- Environmental and land use impacts
- Using a logical aggregation method for considering nonstructural measures



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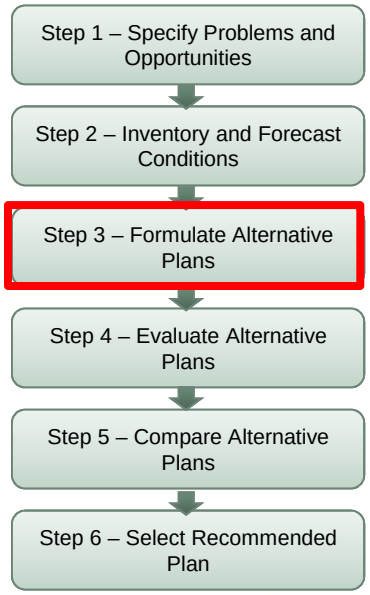
USING A LOGICAL AGGREGATION METHOD

- Neighborhoods or communities sharing common floodplains
- Neighborhoods or communities sharing common infrastructure
- Structures within other geophysical boundaries or sharing other flood characteristics
- Census block or tract boundaries
- Main floor elevation/first floor elevation

<u>Best practice</u>: Document logic and methodology for aggregation in decision document



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EXAMPLE: DELINEATING FLOODPLAINS

- Pick one or more floodplains during initial formulation (1%, 4%, 10%, etc.)
- May choose to compare economic damages reduced for different floodplains

Step 1 – Specify Problems and Opportunities

Step 2 – Inventory and Forecast Conditions

Step 3 – Formulate Alternative Plans

Step 4 – Evaluate Alternative Plans

Step 5 – Compare Alternative Plans

Step 6 – Select Recommended Plan

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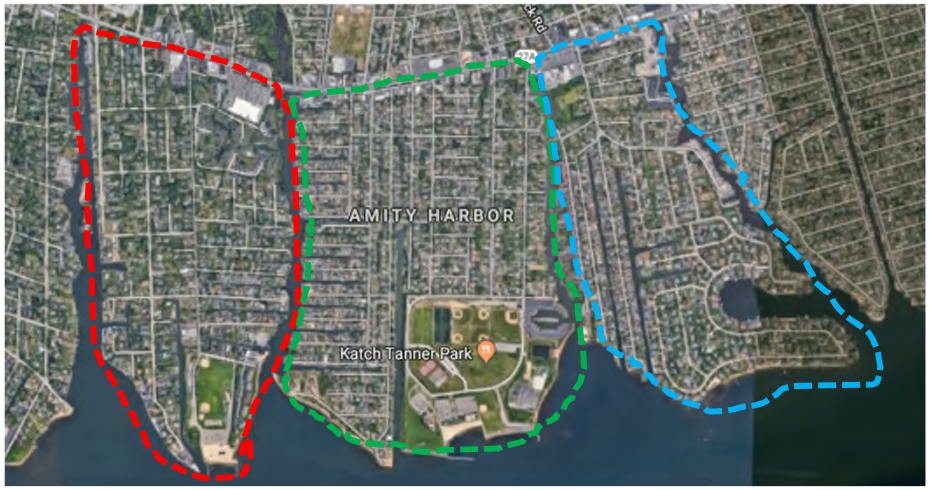
EXAMPLE: AGGREGATION BY MAIN FLOOR ELEVATION

- Typically, there are different main floor elevations in communities
  - May vary within a town, neighborhood, or even block



Ranches
+0.5 ft NAVD88

Elevated
+10.0 ft NAVD88

Bungalows
+3.0 ft NAVD88

+10 ft NAVD88

+10 ft NAVD88

+2.0 ft NAVD88

+10 ft NAVD88

+4.0 ft N.88

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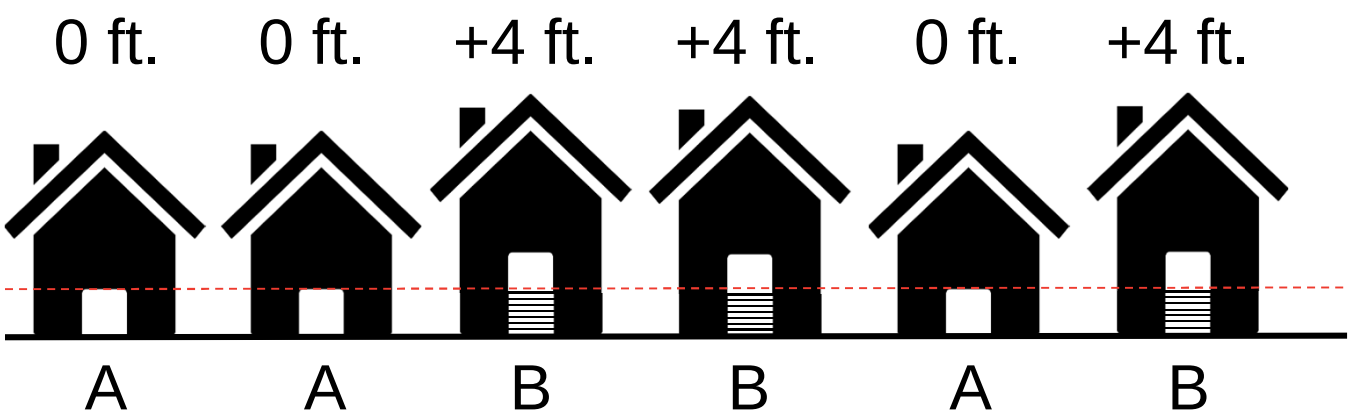
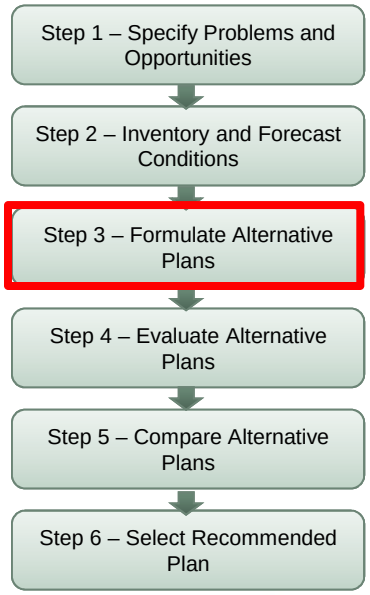
EXAMPLE: AGGREGATION BY MAIN FLOOR ELEVATION

- Typically, there are different main floor elevations in communities
- Banding by different MFEs → increments
- Economic analysis using different increments

Main floor elevations (feet NAVD88)





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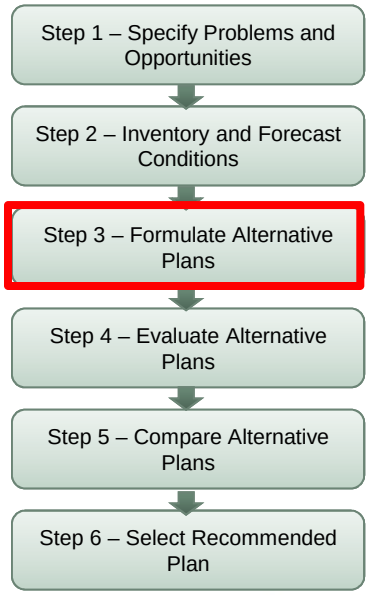
IDENTIFYING AND SCREENING STRUCTURAL AND NONSTRUCTURAL MEASURES

- May consider nonstructural measures as a group during initial plan formulation
  - Ask first: Does a nonstructural approach meet objectives and avoid constraints?
- Eventually screen different types of nonstructural measures for each aggregate or structure

<u>Best practice</u>: consider planning objectives and constraints



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IDENTIFYING AND SCREENING NONSTRUCTURAL MEASURES

- <u>Best practice</u>: Pocket Tool - Flood Damage Reduction Matrix (located on National Nonstructural Committee website)

	FLOOD DAMAGE REDUCTION MEASURES																		
	NON-STRUCTURAL MITIGATION MEASURES																STRUCTURAL MITIGATION MEASURES			
														NFIP						
FLOOD DAMAGE REDUCTION MATRIX	Elevation on Existing Walls	Elevation on Piers	Elevation on Posts or Columns	Elevation on Fill	Relocation	Buyout/ Acquisition	Floodwalls and Levees	Floodwalls and Levees with Closures	Dry Flood Proofing	Wet Flood Proofing	Flood Warning Flood Response	Flood Plain Regulation	Flood Insurance	Flood Mitigation 1	Channel	Levee/Wall	Dams	Diversions
Flooding Characteristics																			
Flood Depth																			
Shallow (<3 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Moderate (3 to 6 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Deep (greater than 6 ft)	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Flood Velocity																			
Slow (less than 3 fps)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Moderate (3 to 5 fps)	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Fast (greater than 5 fps)	N	N	N	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
Flash Flooding																			
Yes (less than 1 hour)	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y
No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ice and Debris Flow																			
Yes	N	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Characteristics																			
Site Location																			
Coastal Flood Plain																			
Beach Front	N	N	N	Y	N	Y	Y	N	N	N	N	Y	Y	Y	Y	N	?	N	N
Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Soil Type																			
Permeable	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Building Characteristics																			
Structure Foundation																			
Slab on Grade	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Crawl Space	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Basement	Y	N	N	N	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Structure Construction																			
Concrete or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Structure Condition																			
Excellent to Good	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fair to Poor	N	N	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y	?	Y	Y	Y	Y
NED/NR/Regional Economic Development Characteristics																			
Economic																			
Structure Protected	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	*	N	Y	Y	Y	Y	Y
Cost to Implement	H	H	H	H	H	H	H	H	H	L	L	L	L	L	H/M	H	H	H	H
Potential Flood Insurance Cost Reduction (Residential)	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	-	Y	Y	Y	Y	Y
Potential Flood Insurance Cost Reduction (Commercial)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	-	Y	Y	Y	Y	Y
Potential Adverse Flooding Impact on Other Property	N	N	N	N	Y	N	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y
Reduction in Admin Costs of NFIP	N	N	N	N	Y	Y	Y	N	N	N	N	N	*	-	?	?	?	?	?
Reduction in Costs of Disaster Relief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reduction in Emergency Costs	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	?	Y	Y	Y	Y
Reduction in Damage to Public Infrastructure	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	?	Y	Y	Y	Y
Potential for Catastrophic Damages if Design Elevation Exceeded	N	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	Y	Y	N
Promotes Flood Plain Development	N	N	N	N	N	N	N	N	N	N	N	N	N	*	N	Y	Y	Y	Y
Environmental																			
Ecosystem Restoration Possible	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
Potential Adverse Environmental Impact	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y
Recreation																			
Recreation Potential	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	?	N	N	Y	N
Social																			
Community Remains Intact	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	*	Y	Y	Y	Y	Y
Population Protected	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	?	Y	Y	Y	Y
Potential Structure Marketability Increase	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	*	N	Y	Y	Y	Y	Y

Step 1 – Specify Problems and Opportunities

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FLOOD DAMAGE REDUCTION MATRIX

- Can be used to identify site-appropriate nonstructural measures for individual structures (FWOP conditions will help determine)
- Can be used to screen measures based on a logical Y/N flowchart

January 2018	FLOOD DAMAGE REDUCTION MEASURES												
	NONSTRUCTURAL MITIGATION MEASURES												
											NFIP		
FLOOD DAMAGE REDUCTION MATRIX	Elevation on Foundation Walls	Elevation on Piers	Elevation on Posts or Columns	Elevation on Piles	Elevation on Fill	Relocation	Buyout/ Acquisition	Dry Flood Proofing	Wet Flood Proofing	Flood Warning Preparedness	Flood Plain Regulation	Flood Insurance	Flood Mitigation 1
Flooding Characteristics													
Flood Depth													
Shallow (<3 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Moderate (3 to 6 ft)	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Deep (greater than 6 ft)	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Flood Velocity													
Slow (less than 3 fps)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Moderate (3 to 5 fps)	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y
Fast (greater than 5 fps)	N	N	N	Y	N	Y	Y	N	N	Y	Y	Y	Y
Flash Flooding													
Yes (less than 1 hour)	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y
No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ice and Debris Flow													
Yes	N	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y
No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
aracteristics													
Site Location													
Coastal Flood Plain													
Beach Front	N	N	N	Y	N	Y	Y	N	N	Y	Y	Y	Y
Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Step 1 – Specify Problems and Opportunities

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EXAMPLE USE OF MATRIX

Matrix Characteristic	Assessment
Flood Depth - Deep (less than 3 feet)	Y
Flood Velocity – Slow (less than 3 fps)	Y
Flash Flooding – Yes (less than 1 hour)	Y
Site Location – Coastal Floodplain Interior (low velocity)	Y
Soil Type - Permeable	Y
Structure Foundation - Basement	Y
Structure Condition – Excellent to Good	Y
Economics – Potential Flood Insurance Cost Reduction	Y
Social – Community Remains Intact	Y

Result: “Elevation on Foundation Walls”

Step 1 – Specify Problems and Opportunities

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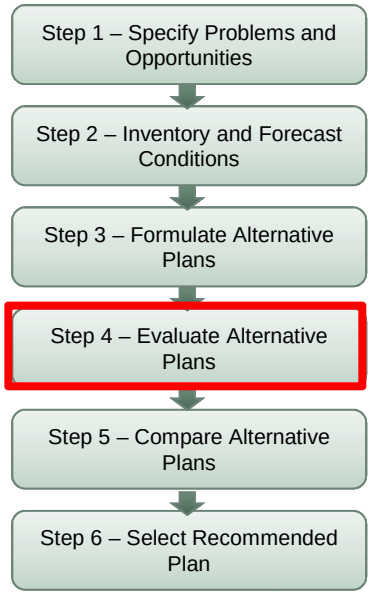
STEP 4:
EVALUATE ALTERNATIVE PLANS

- Similar to procedures used for all FRM and CSRM studies, including those for structural measures (WRDA 1999, Section 219)
- **Main goals:**
  - Evaluate and document plans' economic benefits, and their impacts on the prevention of loss of life and residual risk
  - Consider environmental, social, and cultural factors



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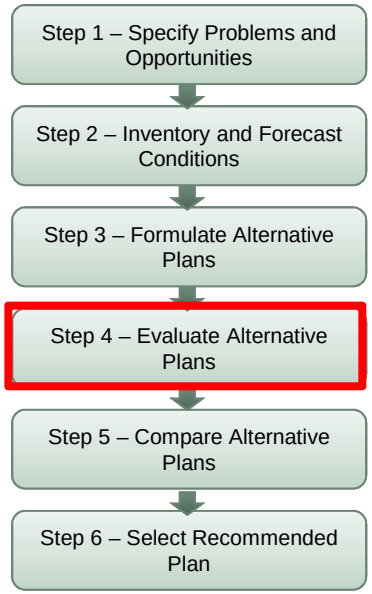
UNIQUE NONSTRUCTURAL CONSIDERATIONS

- Appropriate level of incremental analysis (PB 2019-03)
- Consider project performance under:
  - Different participation rates - sensitivity analysis (PB 2019-03)
  - Different relative sea level change (RSLC) scenarios - sensitivity analysis
- Consider benefits of alternative use of land (ER 1105-2-100 and PB 2016-01)
- Recreation benefits not limited for justification (ER 1105-2-100, Appendix E)



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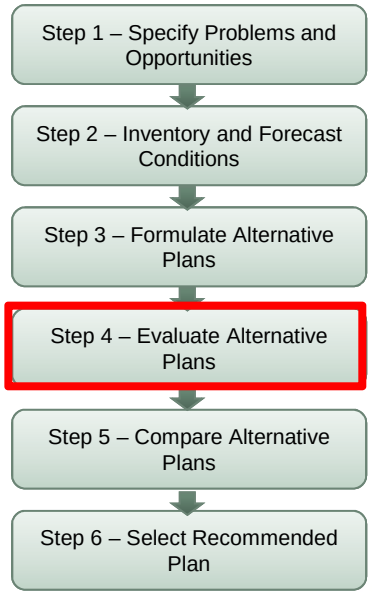
COST ESTIMATING

- **Look to recent projects in your District and local data**
- **Include cost of relocating eligible residents** (Public Law 91-646, Uniform Relocation Assistance)
  - Renters only, not homeowners



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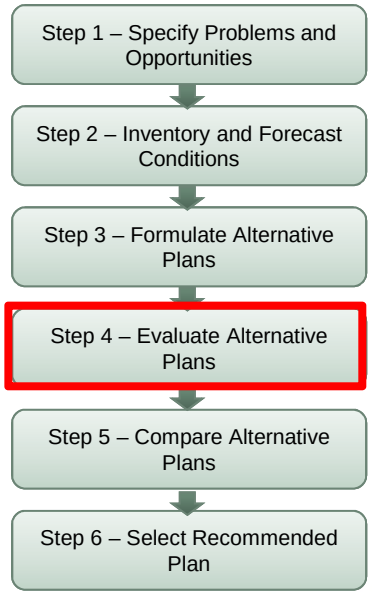
ESTIMATING ECONOMIC BENEFITS: INCREMENTAL ANALYSIS

- Incremental analysis using previously-defined aggregates or other logical groupings

	First Cost	Average Annual Cost	Average Annual Benefit	Net Benefits	BCR
Alternative NS 1 Structures at/below 10% floodplain WSEL	$283,000	$11,000	$7,000	-$5,000	0.63
Alternative NS 2 Structures at/below 4% floodplain WSEL	$7,891,000	$314,000	$395,000	$81,000	1.3
Alternative NS 3 Structures at/below 1% floodplain WSEL	$14,641,000	$583,000	$583,000	$1,000	1.00
Alternative F 1 +7.0-foot NAVD88 floodwall	$10,203,000	$737,000	$479,000	-$258,000	0.65
Alternative F 2 +8.5-foot NAVD88 floodwall	$10,605,000	$764,000	$508,000	-$257,000	0.66
Alternative F 3 +9.5-foot NAVD88 floodwall	$10,832,000	$780,000	$562,000	-$218,000	0.72
Alternative F 4 +11.5-foot floodwall	$11,897,000	$854,000	$587,000	-$267,000	0.69
Storm Surge Barrier	$374,579,000	$19,538,000	$14,200,000	-$5,338,000	0.73



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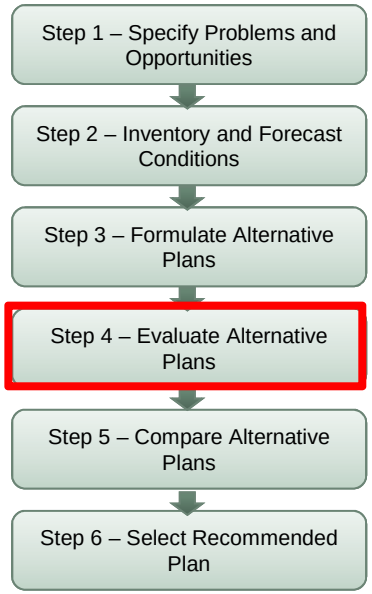
ESTIMATING ECONOMIC BENEFITS: PARTICIPATION RATES

- For plans with voluntary measures, must consider project performance under different participation rates
  - Economic net benefits may change under different scenarios

	First Cost	Average Annual Cost	Average Annual Benefit	Net Benefits	BCR
100% Participation Rate	$7,891,000	$314,000	$395,000	$81,000	1.3
90% Participation Rate	$7,091,000	$290,000	$305,000	$15,000	1.1
50% Participation Rate	$4,550,000	$245,000	$250,000	$5,000	1.0

- Best practice: estimate likely participation rates using Census data or local knowledge
- Best practice: communicate methodology at Vertical Team meetings



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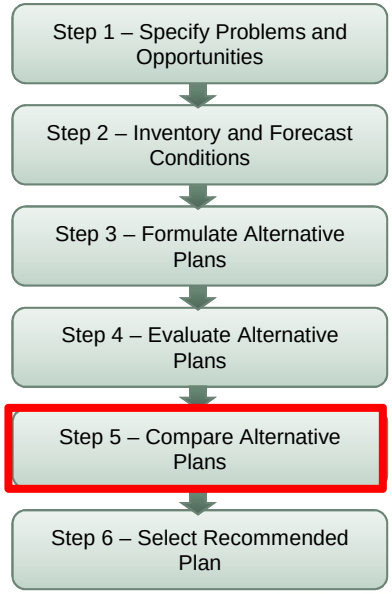
STEP 5:
COMPARE ALTERNATIVE PLANS

- **NED (project costs and economic benefits)**
  But also…
  - P&G accounts, including OSE (qualitative)
  - Life safety (qualitative)
  - Residual risk to property, critical infrastructure, etc. (quantitative)
  - Critical infrastructure, if applicable (quantitative)
    - Evacuation routes are important to consider



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STEP 6:
SELECT RECOMMENDED PLAN

- **Consider NED, P&G accounts, life safety, residual risk, and study-specific planning objectives**

PLANNING BULLETIN

US Army Corps of Engineers

No. PB 2019-03 | Issuing Office: CECW-P | Issued: 13 December 2018

Subject: Further Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Risk Management Measures

PB 2019-03 13 December 2018
Subject: Further Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Risk Management Measures

b. The federal objective to reasonably maximize net NED benefits is not the only planning objective. Project delivery teams should consider the P&G accounts, life safety, residual risk, and study-specific planning objectives when formulating, evaluating, and selecting nonstructural measures. These considerations are a fundamental component of all flood and coastal storm risk management studies. Nonstructural measures may produce benefits and costs captured in the Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE) accounts, and trade-offs between the accounts provide valuable decision information to USACE, project partners, and stakeholders.

Step 1 – Specify Problems and Opportunities
↓
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↓
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EXAMPLE: SHREWSBURY, NJ CSRM STUDY (GI)

SHREWSBURY RIVER BASIN, SEA BRIGHT, NJ

- High frequency flooding due to coastal storms
- Geographic focus on Downtown Sea Bright, NJ (economic damage center)

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SHREWSBURY RIVER BASIN, SEA BRIGHT, NJ

- Post-Hurricane Sandy local rebuilding strategy included many structure elevations
- Does Federal participation in a nonstructural plan make sense? *Let's find out…*

Home elevation, 2014

Hurricane Sandy watermark, 2012

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SHREWSBURY RIVER BASIN, SEA BRIGHT, NJ

- Logical aggregation by main floor elevation
- Flood Damage Reduction Matrix used to select nonstructural measures for each structure

	First Cost	Average Annual Cost	Average Annual Benefit	Net Benefits	BCR
Alternative NS 1 Structures at/below 10% floodplain WSEL	$283,000	$11,000	$7,000	-$5,000	0.63
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SHREWSBURY RIVER BASIN, SEA BRIGHT, NJ

- Project performance/economic benefit increase seen with: 1) 100% participation rate 2) “High” RSLC scenario
- Nonstructural measures make sense in Sea Bright, but leave gaps in flood risk management
  - Supports/similar to post-disaster rebuilding strategy
  - Evacuation route remains vulnerable → importance of robust evacuation plans
  - Residual risk is relatively high, but is reduced by local flood management actions
- **Recommended plan is part of a comprehensive strategy to reduce flood risk to life and property**

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NATIONAL RESOURCES

- National Nonstructural Committee
  - POC: Chairperson Lea Adams, HEC
  - Upcoming best practices guides
  - HQ guidance and policy
  - Website: https://www.usace.army.mil/Missions/Civil-Works/Project-Planning/nfpc/
- Nonstructural Working Group
  - POC: Rachel Shrader, NWO
  - Listserv
  - Webinars

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