Unit 4:
Inland Hurricane Preparation in Practice

Unit 4 Objectives

At the end of this unit, you should be able to:

1. Compare the challenges of coastal and inland Emergency Managers.
2. Discuss the available planning resources to assist inland EMs in evacuation decision making.
3. Describe available flood inundation support tools.
4. Identify the purpose of the Hurricane Liaison Team.

NWS IDSS & FEMA HLT

NWS Impact-Based Decision Support Services (IDSS) & FEMA Hurricane Liaison Team (HLT) address:

- Confidence? Contingencies?
- What is the forecast/evacuation timing?
- Can we get a briefing?

NWS Impact-Based Decision Support Services (IDSS)

IDSS connects NWS forecasts and warnings to decision makers on the local, state, and Federal levels to save lives and property.

IDSS includes:

- Remote support with forecast advice through various means (such as phone calls, email, or online webinars).
- On-site support at an Emergency Operations Center.
- On-site support at an incident or event (such as NWS deployment to a wildfire).

Hurricane Liaison Team (HLT) Background

- Initial idea arose in the early 1990s
- Proven during response to the 1995 Hurricane Season
  - Erin and Opal
- Formalized in 1996
  - Request from Governor of Florida to FEMA and NHC Director

HLT Mission

The Hurricane Liaison Team's mission is to improve our Nation's capability to respond to hurricanes through the rapid exchange of critical information between the National Hurricane Center and Federal, State, Local, Tribal, and Territorial Emergency Managers.

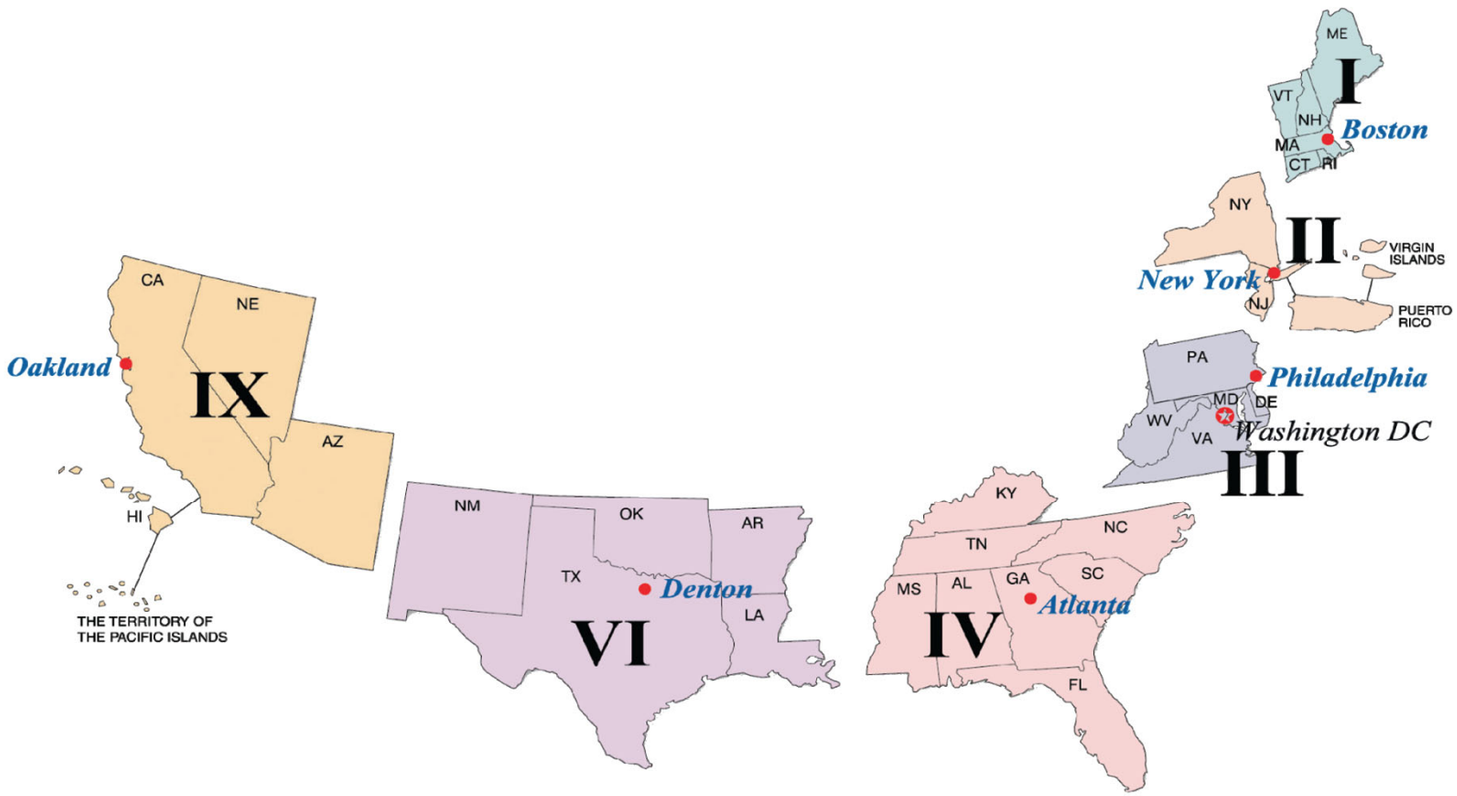
Rapid Communications

Partnership between the NWS and FEMA

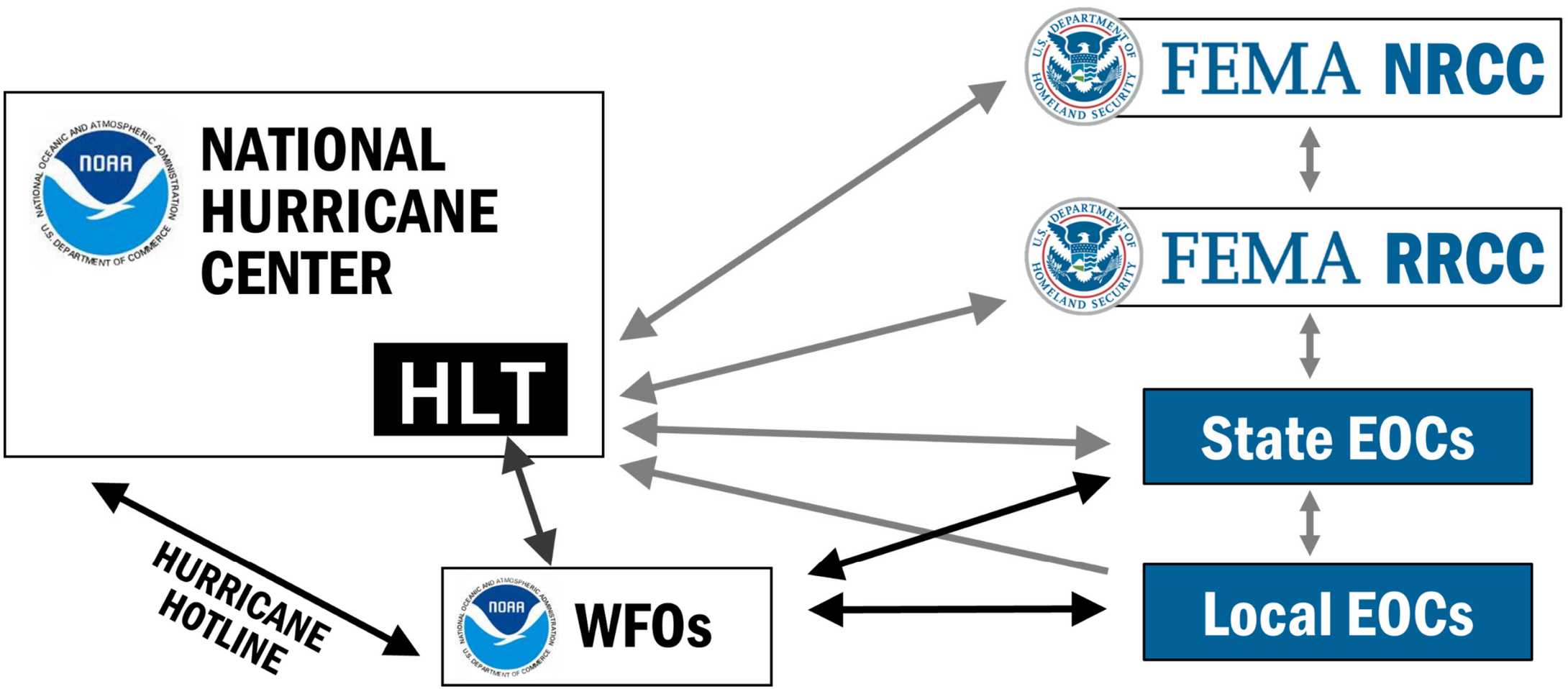
- FEMA Hurricane Program Managers
- FEMA Reservists
- FEMA Liaison to NWS National Water Center
- NWS meteorologists and hydrologists

Regional Hurricane Program Manager (RHPMs)

- Technical Knowledge
- State/Local Relationships
- Deploy to NHC



Communication Flowchart

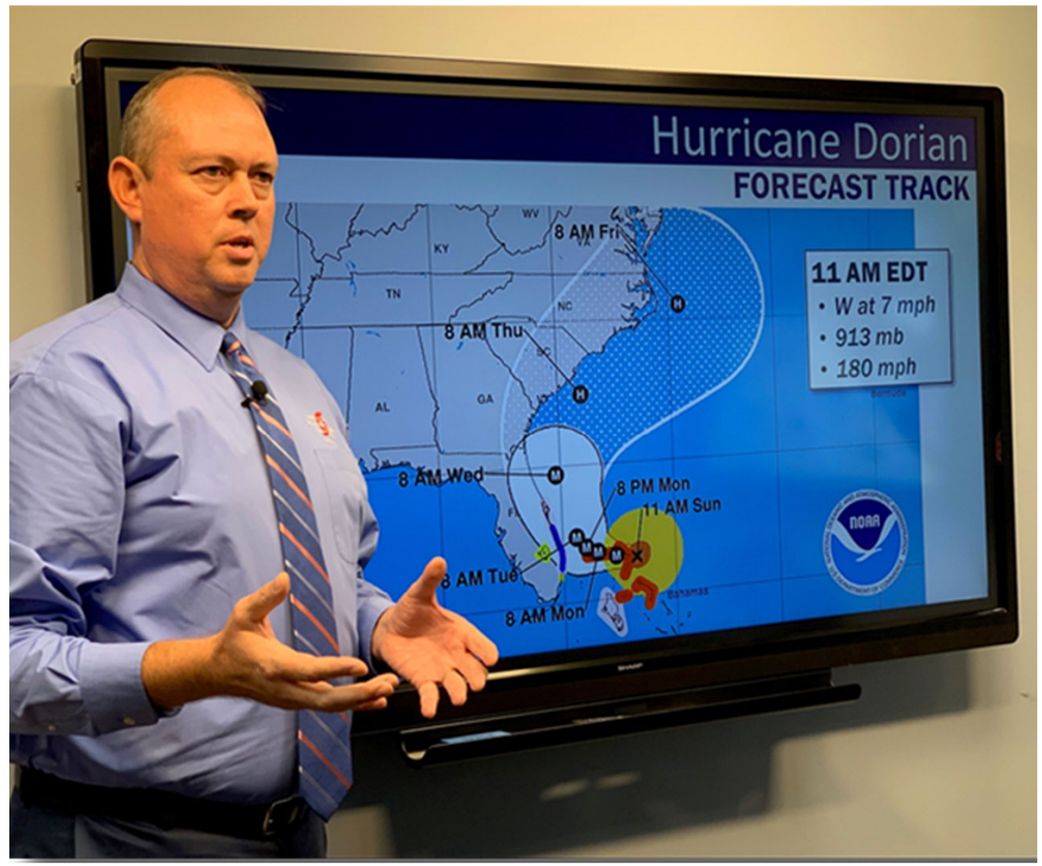


HLT Responsibilities

- Real-time interpretation, assessment and guidance;
  - Apply NHC forecasts with Regional, state, and local response evacuation plans
- Forum for EMs to ask questions,
  - Reinforce decisions
  - Assist with use of NHC forecasts and predictive modeling
- Provide NHC visibility on state and local protective actions
  - Improve messaging

HLT Responsibilities (cont.)

- Facilitate two-way communications
  - Between the NHC and EMs
  - Common forecast picture
  - Relay EM issues to improve NWS/NHC messaging
- Video/Teleconferences
  - NHC/NWS
  - FEMA and other Federal Agencies
  - Emergency Operations Centers (EOCs)



State Meteorologists & Hurricane Programs

- In addition to NWS and FEMA HLT, your state emergency management agency may also have a State Meteorologist or Climatologist, a State Hurricane Program Manager, or State Hurricane Lead.
- These individuals often work closely with NWS and FEMA.
- They are excellent resources for state-specific tropical threats and plans.

Discussion 1: Evacuations

Activity Time: 10 minutes

Goal: Discuss the evacuation challenges that are:

- Unique to **coastal** EMs/decision-makers.
- Unique to **inland** EMs/decision-makers.

Directions:

- Pair up with a neighbor.
- Fill out the chart in the Unit 4 Discussion Handout.
- Prepare to share with class.

Coastal vs. Inland EM Challenges 1

Coastal EM Challenges/Advantages	Inland EM Challenges/Advantages
Advantage: Longer lead-time and there is enough forecast confidence to enable evacs far in advance of the storm.	Disadvantage: Flash Floods may provide little to no lead time. There is rarely enough confidence to enable evacs far in advance of the storm. Mainstem river flooding will have slightly more lead time, but still may prove difficult. Mainstem river forecasts will have greater confidence than flash flooding.
Advantage: Evacs occur prior to onset of hazards.	Disadvantage: Evacs could occur during hazardous weather, posing threats to both motorists and first responders. May be harder to communicate evac orders if communications infrastructure impacted.

Coastal vs. Inland EM Challenges 2

Coastal EM Challenges/Advantages	Inland EM Challenges/Advantages
Disadvantage: Larger-scale evacuations (100,000s, if not millions, of evacuees), who may need to travel significant distances to get to safety/comfort. “Shadow evacuees” will contribute significantly to the evacuating pop.	Advantage: Smaller-scale evacs (at least relative to coastal evacs), and evacuees may not need to travel far to get to safety/comfort. Few, if any, “shadow evacuees.”
Advantage: Predetermined surge evacuation zones, which can be communicated to the public during Blue Sky.	Disadvantage: Not many inland communities have pre-established evac zones beyond FEMA Flood Hazard Areas (which may not cover all of the flood-prone in an extreme flood event).

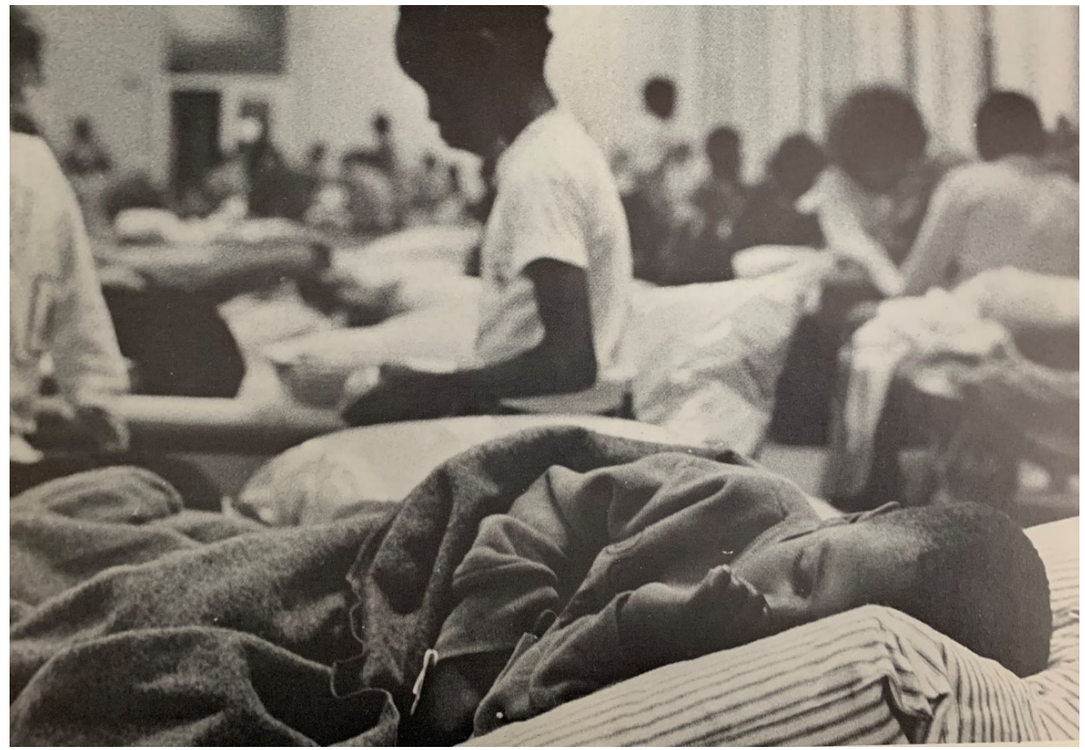
Coastal vs. Inland EM Challenges 3

Coastal EM Challenges/Advantages	Inland EM Challenges/Advantages
Advantage: Regularly updated Hurricane Evacuation Studies (HESs), including recalculated evac clearance times.	Disadvantage: There are HES-like studies for inland EMs, but they don't quite offer the same suite of tools.
Same: widespread severe impacts	Same: widespread severe impacts

Evacuations for Inland Communities

Basic Inland Evacuation Considerations:

- What areas are most susceptible to inland flooding?
- What structures will withstand the winds (if strong enough winds extend far enough inland)?
  - Need to evacuate mobile homes?
  - Structural integrity of shelter roofs?
- Community/neighborhood isolation (aka “evacuation islands”)?
- Resiliency of critical infrastructure?



Evacuations for Inland Communities 2

Inland Evacuation Timing Considerations

- Onset of hazards
- Time of day
- Ongoing Weather Hazards
- Response Time/Evacuation Departure Time (i.e., the amount of time it will take a household to respond to the evac order)
- Traffic management considerations

Evacuation Decision Considerations

Protective Action Decisions within a jurisdiction are frequently made by an elected official

- Define ultimate authority
- Consensus from other elected officials
- Verification by local ordinance or state code

Regional Considerations

Evacuation decisions by one jurisdiction **may** affect others

- Inland evacuations tend to be smaller-scale compared to coastal evacuations.
- Evacuees typically don't need to leave the town, county, or state. But there are exceptions…

Will evacuees in your jurisdiction have to go to shelters in other jurisdictions?

What are the host jurisdiction considerations?

Blue Sky and Dark Sky coordination with those jurisdictions?

Important Inland Planning Factors

Widespread infrastructure impacts that could be medium to long term include:

- **Major and secondary roads** flooded, washed out, and/or impacted by mudslides/debris. Seemingly unpredictable and random pattern to the impacts.
- **Key bridges** may be washed away by the floodwaters and/or debris.
- **Power outages** caused by flooding of grid facilities.
- **Water and sewer disruptions**, including for critical facilities (e.g., hospitals).

Important Inland Planning Factors (cont.)

- The importance of air operations given potential for severe disruption of roadway networks.
- Widespread HAZMAT threats.
- Major and potentially long-term impacts to agriculture.

Discussion 2: Vulnerable Facilities/Populations

Time: 3–5 minutes

Goal: Build a list of (1) vulnerable facilities and (2) populations that need to be accounted for when developing inland flooding plans.

Directions:

- Pair up with a neighbor.
- Fill out the chart in the Unit 4 Discussion Handout.
- Prepare to share with class.

Vulnerable Facilities

- Hospitals
- Assisted Living and Nursing Homes
- Critical Infrastructure
- Public Safety Facilities
- Industrial Facilities
- Tourist and Recreation Areas
- Mobile Homes

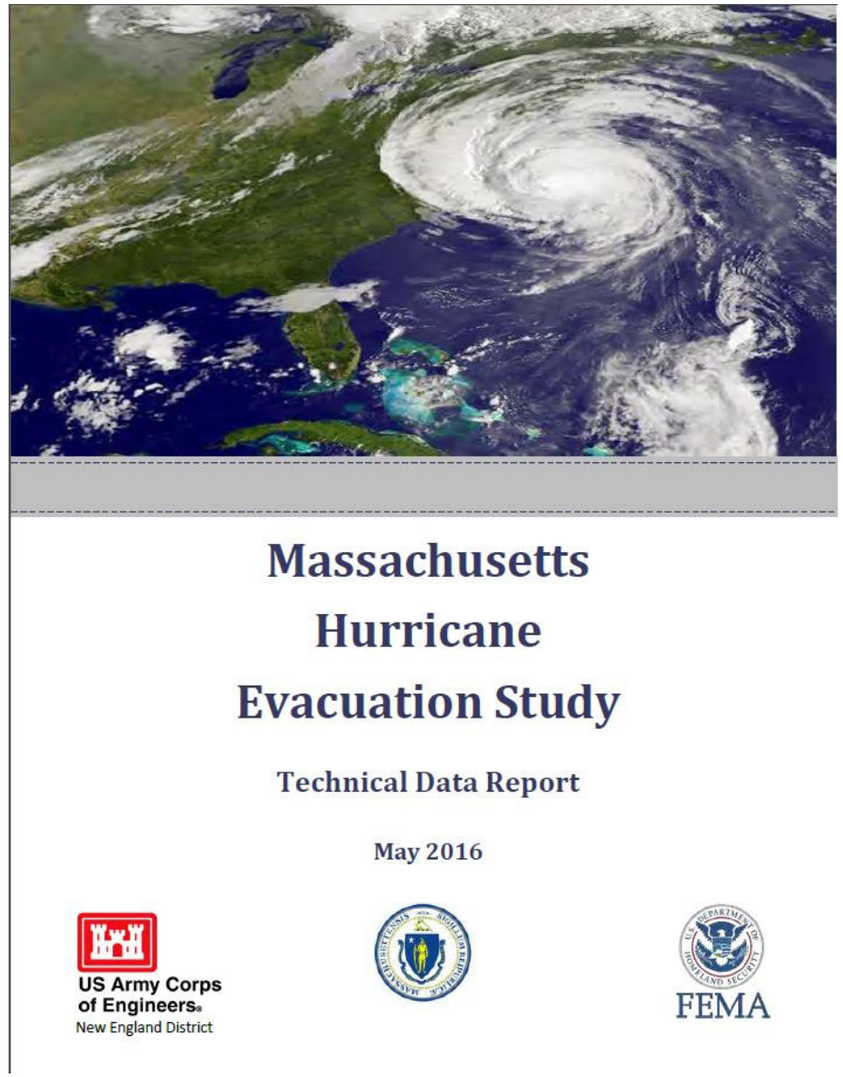
Vulnerable Populations

Socioeconomic Status	• Below Poverty • Unemployed • Income • No High School Diploma
Household Composition & Disability	• Aged 65 or Older • Aged 17 or Younger • Civilian with a Disability • Single-Parent Households
Minority Status & Language	• Minority • Speak English “Less than Well”
Housing & Transportation	• Multi-Unit Structures • Mobile Homes • Crowding • No Vehicle • Group Quarters

Hurricane Evacuation Study (HES)

- What will be wet and what stays dry?
- Who/what will be affected in your community?
- What is the public thinking?
- What are your shelter needs?
- Where is traffic going to back up?
- Evacuations from storm surge risk
- Predominantly focused on storm surge & coastal areas; currently no inland flooding equivalent

Inland EMs have other resources at their disposal.



Discussion 3: Planning Resources

Time: 3–5 minutes

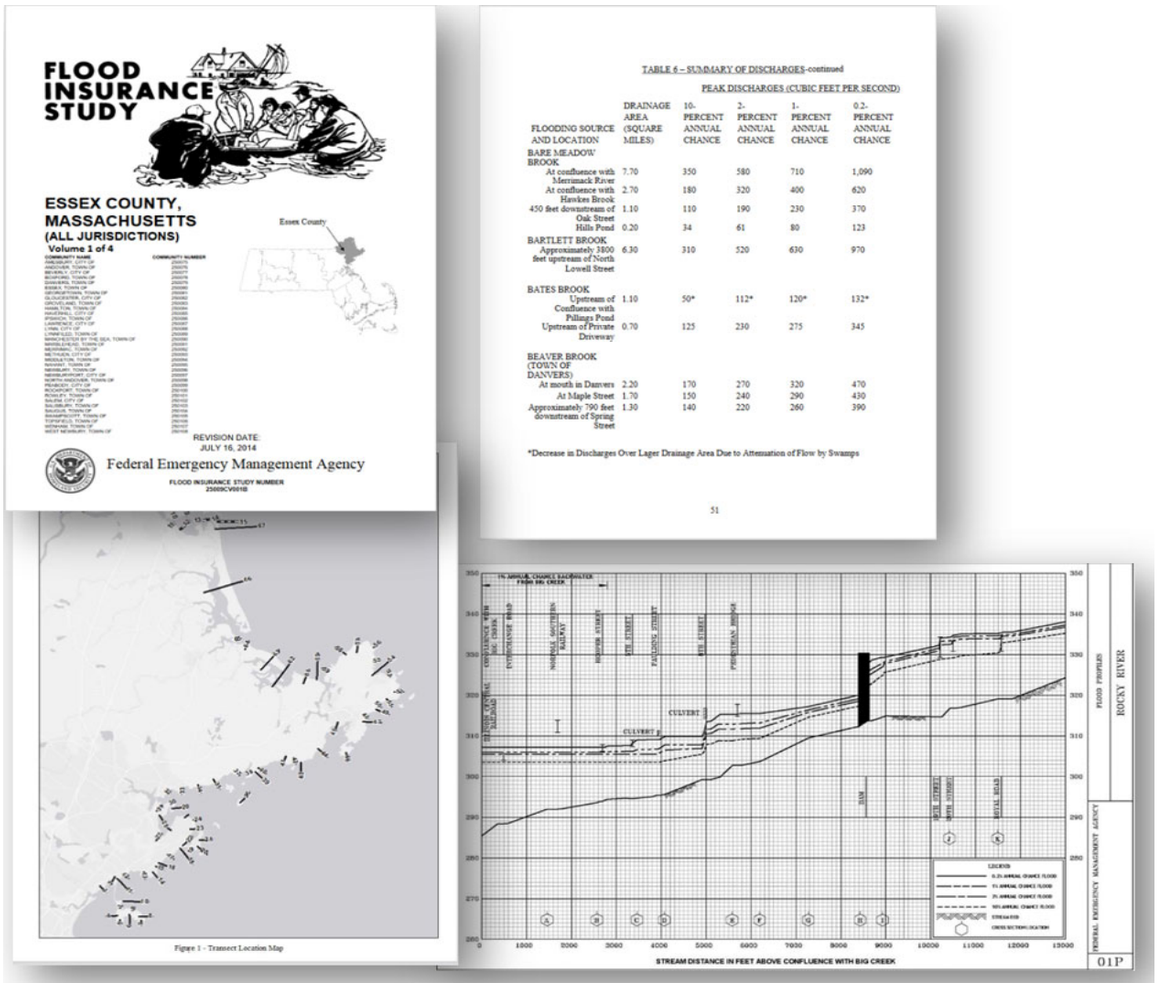
Goal: In the absence of an HES for inland EMs, what resources are you aware of in your jurisdiction/state that you can use to answer these same questions?

- Determine the extent, severity, location, and duration of hazards.
- Identify areas/neighborhoods that would need to evacuate in a given scenario.
- Identify vulnerable populations/facilities.
- Estimate shelter needs.
- Assess evacuation elements (routes, timing).

Directions:

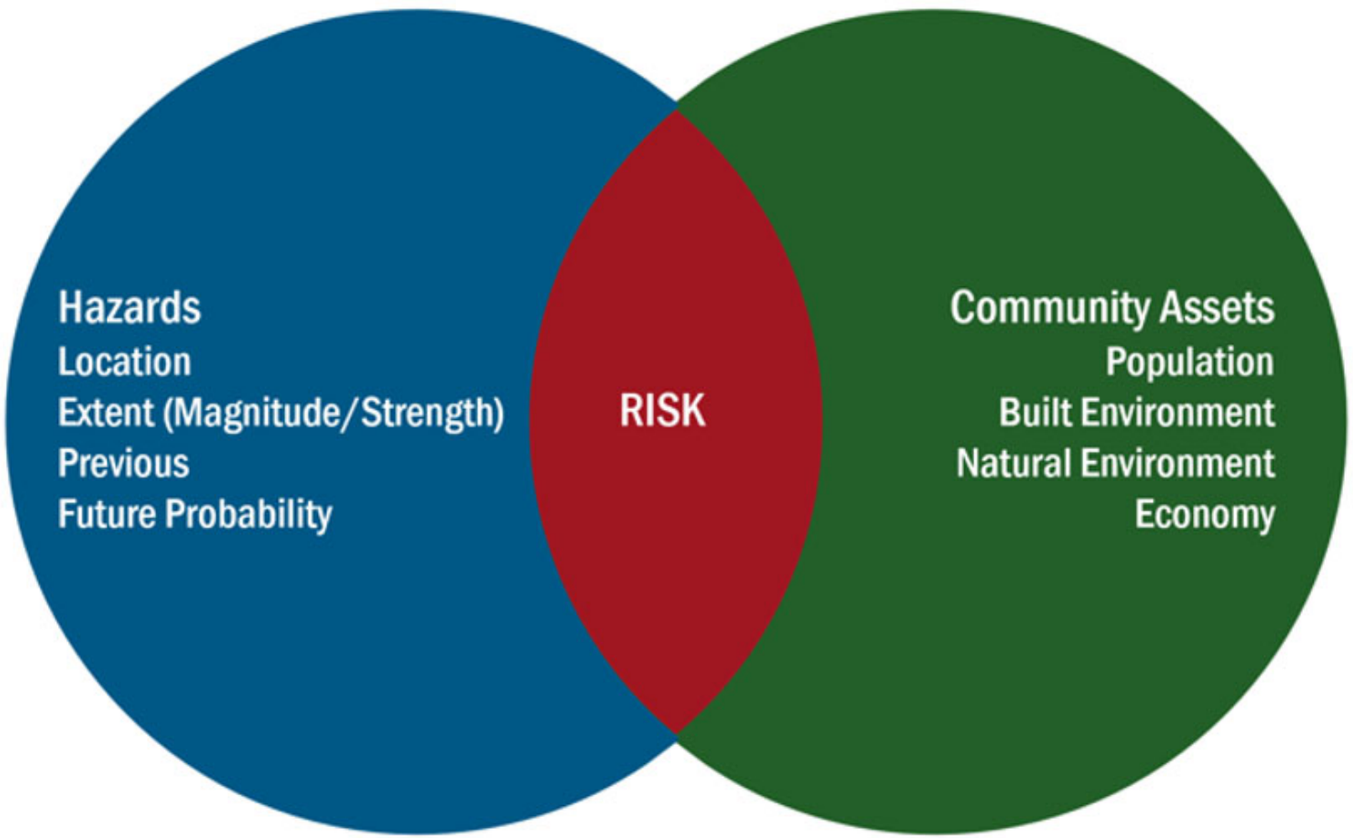
- Pair up with a neighbor.
- Fill out the chart in the Unit 4 Discussion Handout.
- Prepare to share with class.

Flood Insurance Study (FIS)



- A compilation and presentation of flood hazard areas along rivers, streams, coasts, and lakes within a community.
- A **Flood Insurance Study (FIS)** includes:
  - Cross-sections
  - Coastal transects
  - Riverine flood profiles
  - H&H engineering
- The results of the FIS are shown on FEMA's flood maps called **Flood Insurance Rate Maps (FIRMs),** and in the accompanying description of the study called an FIS report.

Hazard Mitigation Plans

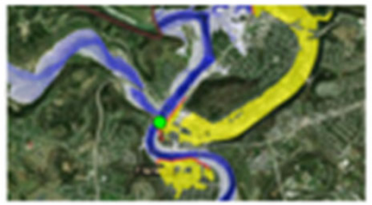


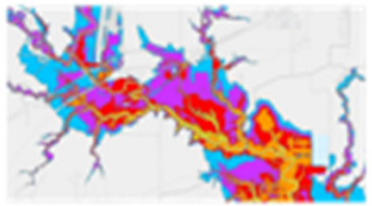
- Hazard mitigation planning reduces loss of life and property by minimizing the impact of disasters.
- State, tribal, and local governments identify natural disaster risks and vulnerabilities that are common in their area.
- Develop long-term strategies for protecting people and property from similar events.
- Mitigation plans are key to breaking the cycle of disaster damage and reconstruction.
- Updated every 5 years and required to receive hazard mitigation grant funding.

Overview of NWS Flood Inundation Mapping (FIM) Options

FEMA

Static Maps





Storm-Specific Forecast Maps

NWS Advances Hydrologic Prediction Service FIM (AHSPS FIM) – High-resolution static maps. Shows both extent and depth of possible flooding at various crest heights. Only covers >1,000 miles of rivers. (Available now).

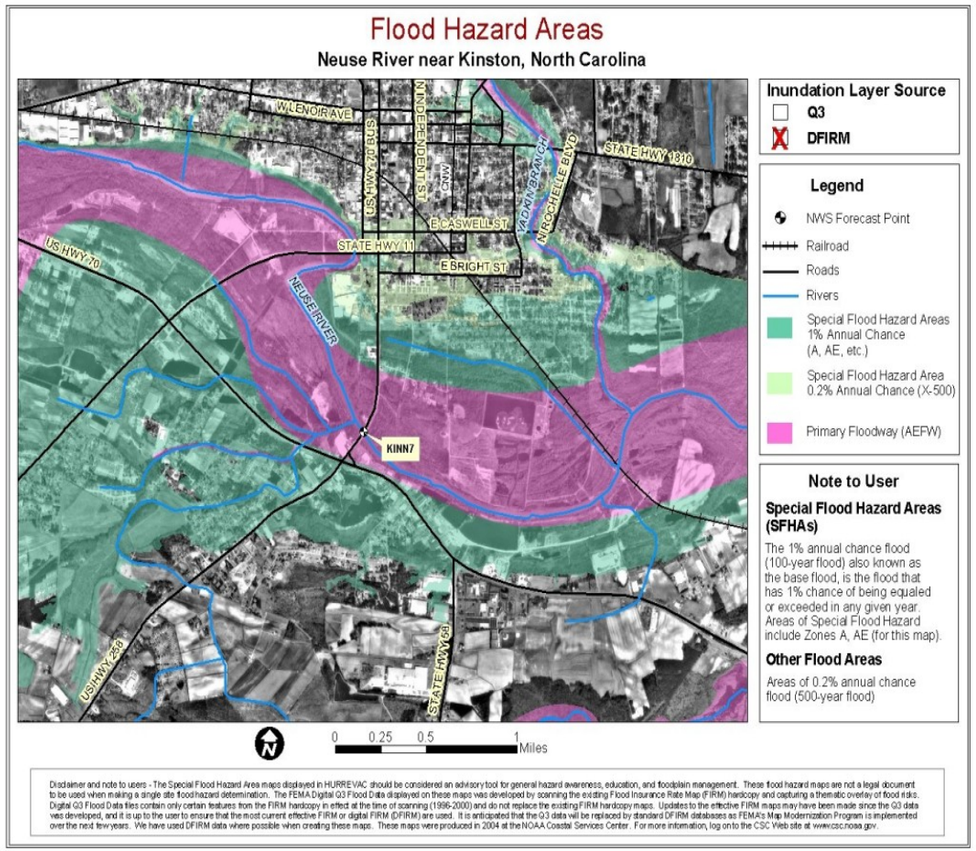
NWS Flood Categorical FIM (CatFIM) – static maps that cover ~30,000 miles of rivers. Shows likely special extent (but not depth) of flooding at various flood stage categories ("major," "moderate," "minor," etc.). (Available Spring 2024 for select basins in PA, NY, WV, OH, TX)

River Forecast Center FIM (RFC FIM) – Storm-specific forecast maps showing approximate flooding extent over next 3-5 days based on the RFC forecast for the upstream gauge. Will cover ~110,000 miles of rivers when fully implemented. (Available now for select basins in PA, NY, WV, OH, TX).

National Water Model FIM (NWM FIM) – storm-specific forecast maps showing the NWM's best approximation on possible flooding extent in the next 5 days along all streams and river based on latest weather model data and antecedent conditions. Wil cover ~3.4 million miles of rivers when fully implemented. (Available now for select basins in PA, NY, WV, OH, TX).

National Water Model Latest Analysis FIM (AnA FIM) – NWM's best approximation on current flooding extended based on latest rainfall observations and streamflow data. Will update 1.5 hours. Will cover ~3.4 million miles of rivers when fully implemented. (Available now for select basins in PA, NY, WV, OH, TX).

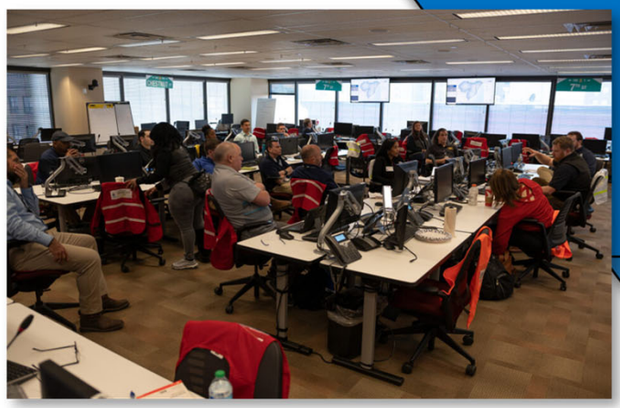
FEMA Flood Hazard Area Mapping



Flood Hazard Areas

- Map shows special flood hazard areas
- Overlay of local features
- Can be applied for GIS use
- Created for flood insurance purposes; less useful than the NWS Flood Inundation Mapping (FIM) tools for response purposes.

Possible Uses of FIMs



STRATEGIC

(Blue Sky Preparedness/Planning, Risk Assessment, Exercises)

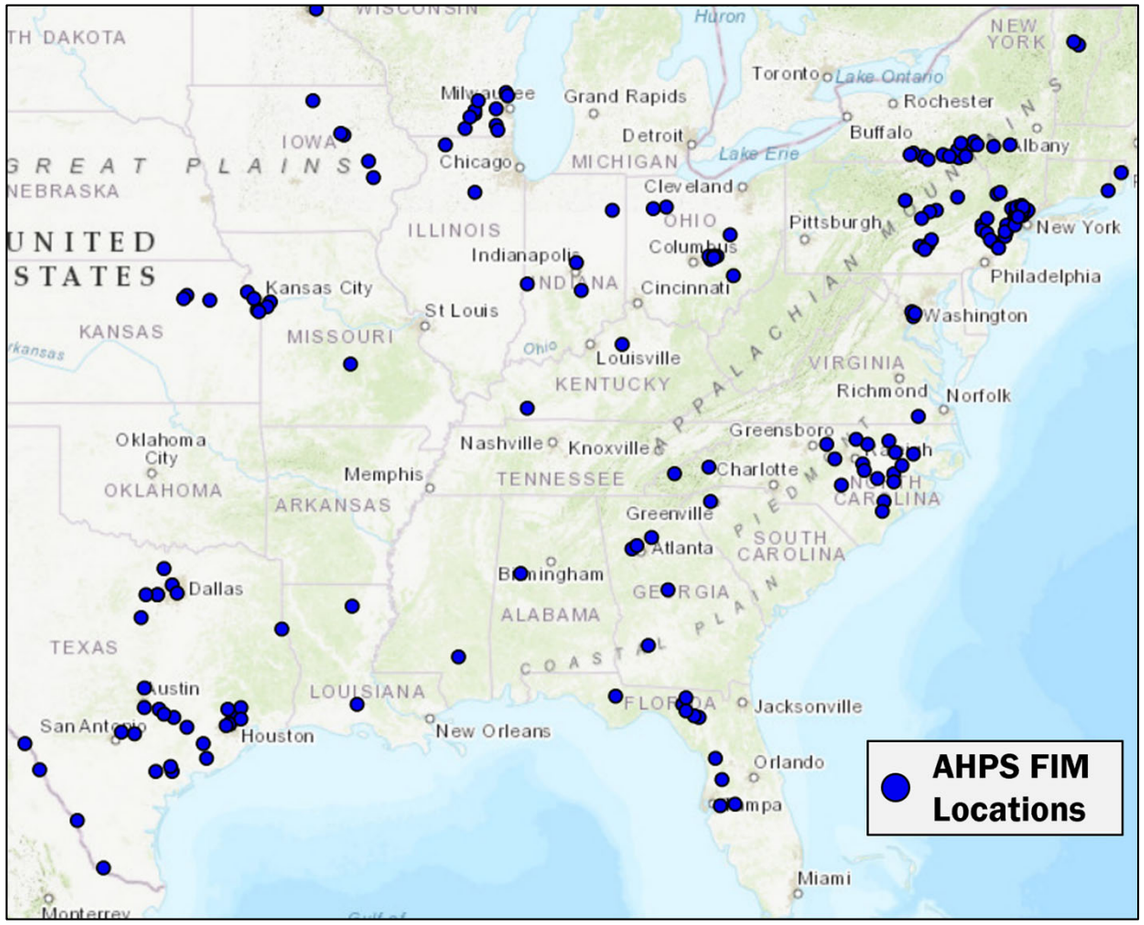
OPERATIONAL

(Dark Sky Planning, Resource Pre-positioning)

TACTICAL

(Evacuations, Search & Rescue)

NWS FIM Options – AHPS FIM



- Static map (i.e., not storm-specific) that's always available via the **Advanced Hydrologic Prediction Service (AHPS) website (hence "AHPS FIM").** <u>The name will likely change</u> when AHPS becomes the National Water Prediction Service (NWPS) in the near future.
- Currently operational.
- Shows both depth and spatial extent of possible flooding at various crest heights.
- Most detailed FIM available for Emergency Managers.
- However, covers less than 1,000 miles of rivers.

AHPS FIM Demo 1

Instructor-Led Demonstration of the AHPS FIM Tool

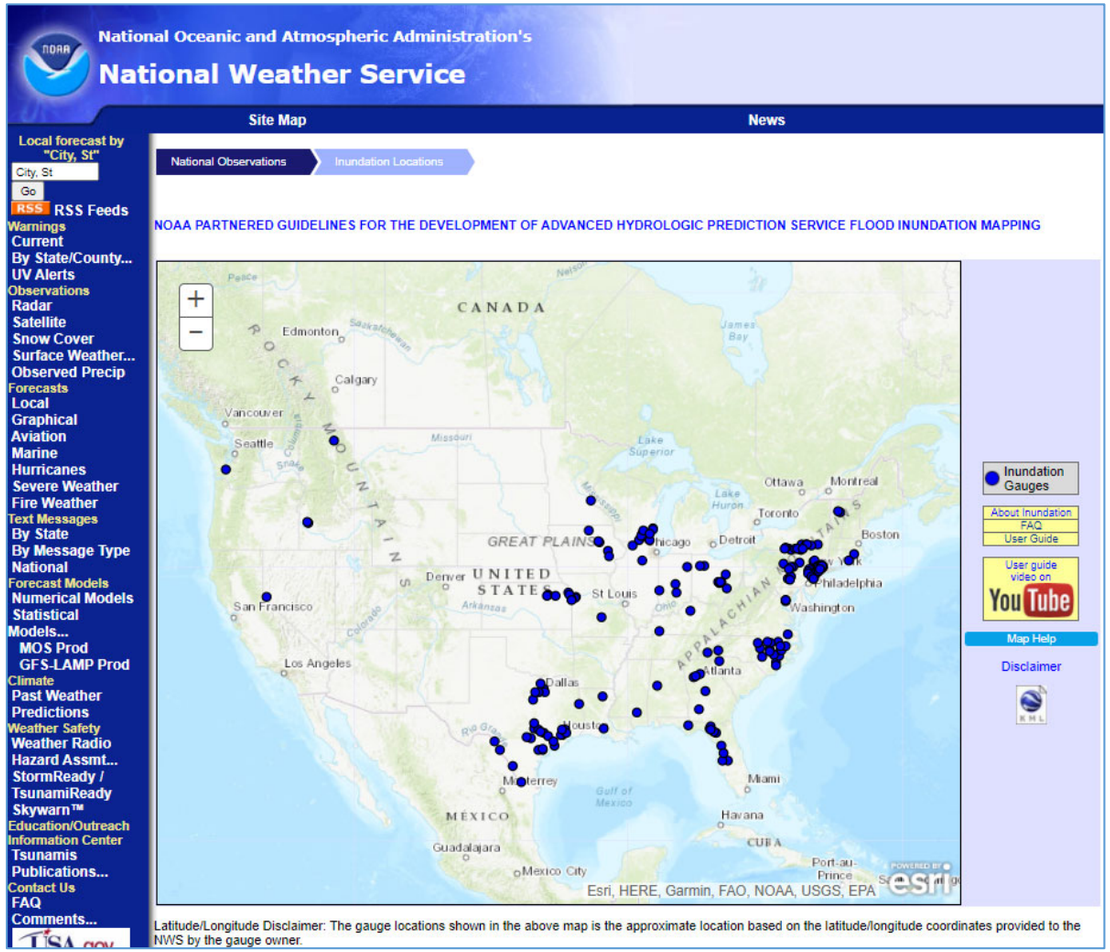
Activity Time: 5 minutes

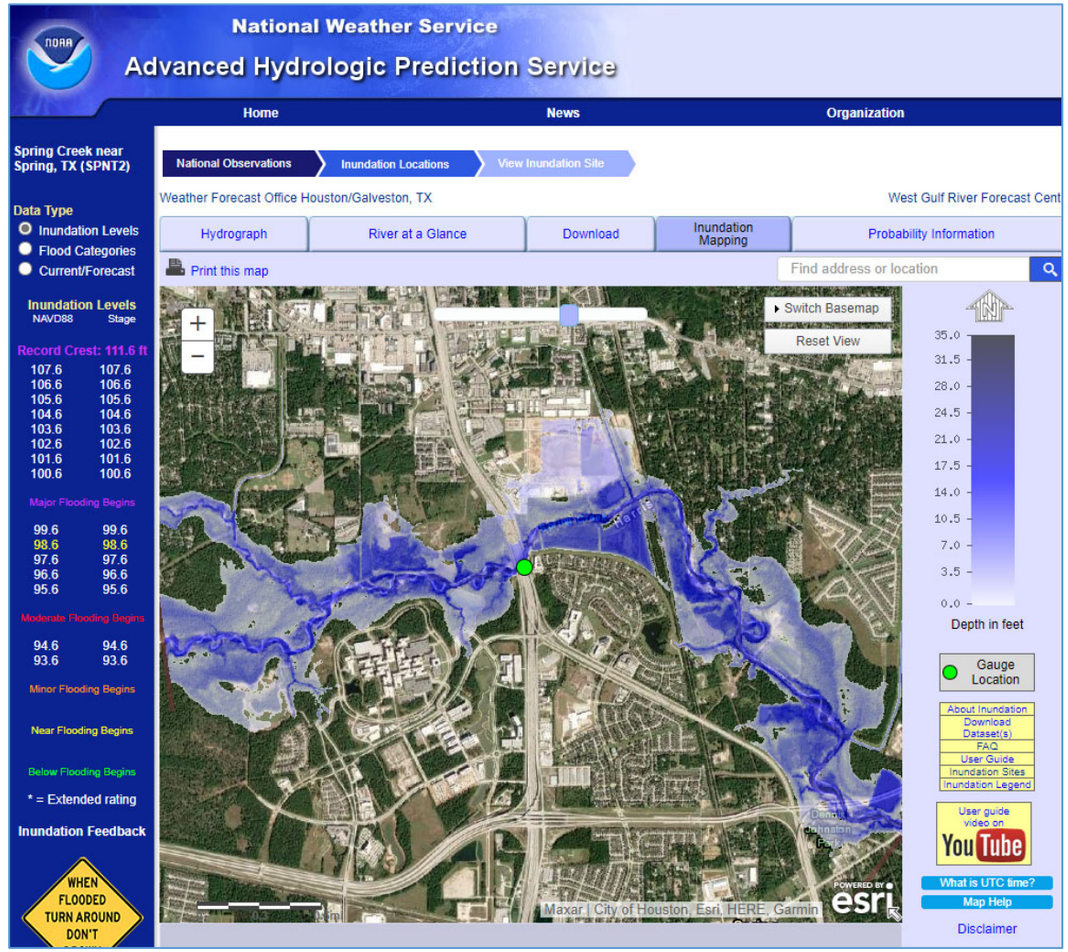
Goal: Explore the AHPS FIM Tool

(https://water.weather.gov/ahps/inundation.php)

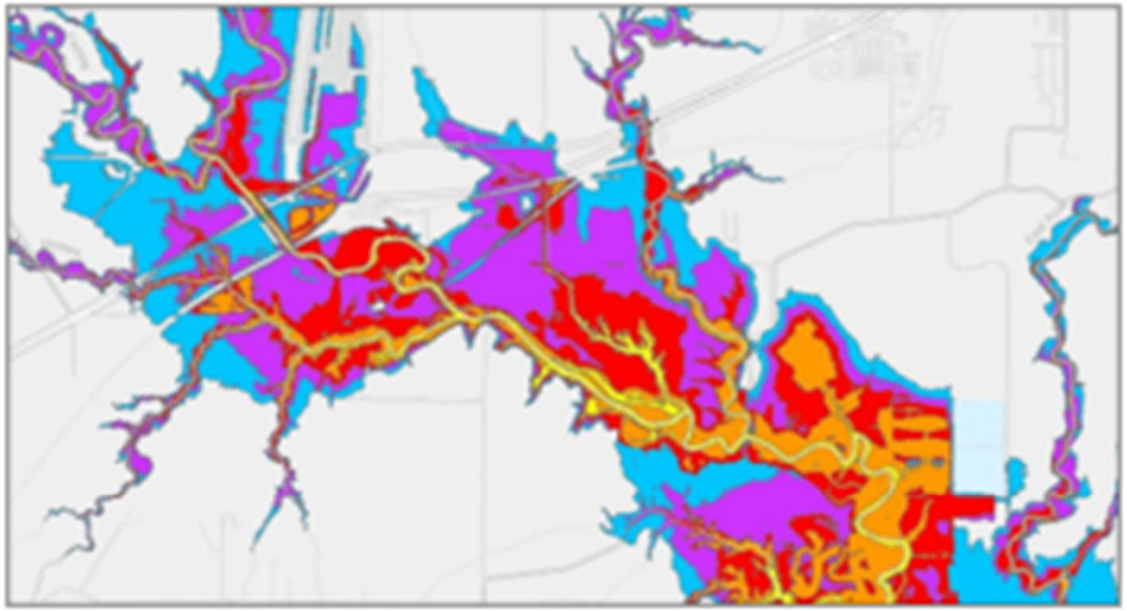
1. Layout of the interface
2. Locations of key information
3. How to set inundation levels/map features

AHPS FIM Demo 2





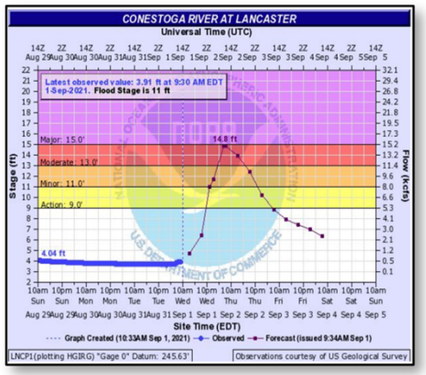
NWS FIM Options – Categorical FIM (CatFIM)



- Static map (i.e., not storm-specific) that will be always available via NWPS.
- Shows spatial extent of possible flooding at specific **flood stage categories (hence "Cat" FIM).**
- ~30,000 miles of rivers are covered.
- Will be available as an experimental (non-operational) product for select parts of the country, starting in Spring 2024.

NWS FIM Options – RFC FIM

RFC issues a crest forecast for a specific gauge.

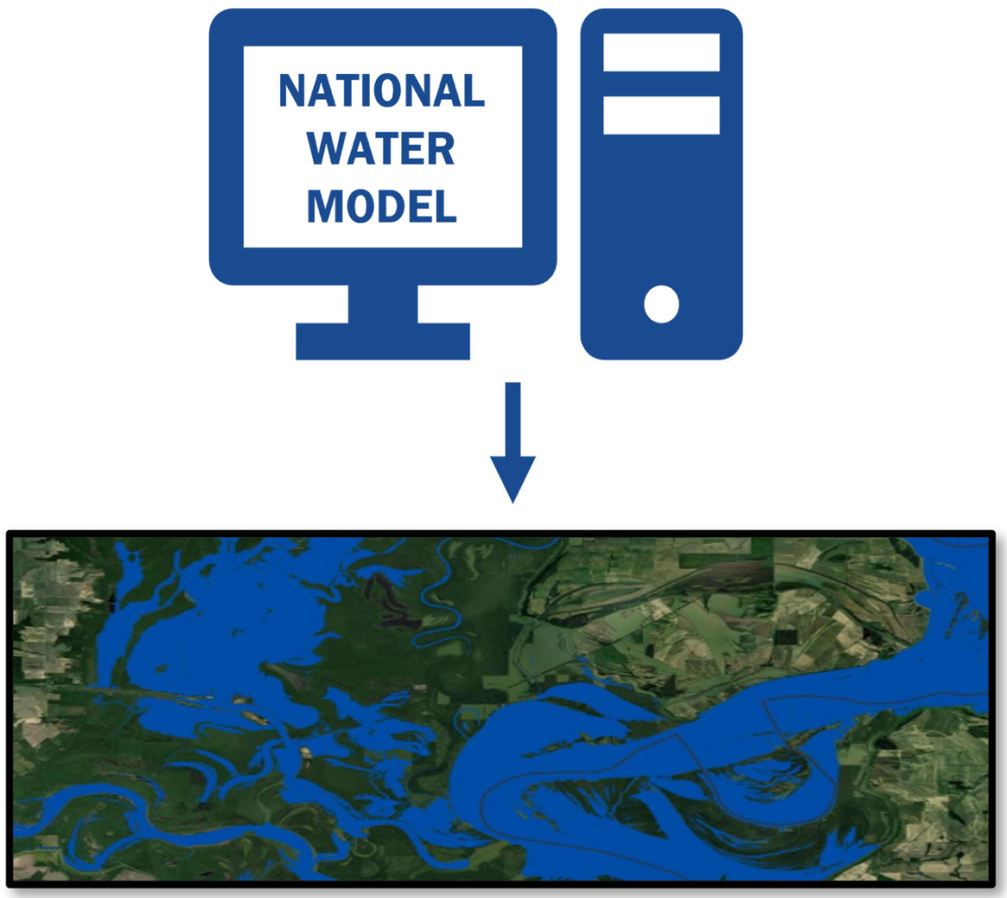


NWM approximates inundation downstream from that gauge.

- Forecast map (storm-specific) shared via NWPS when there's a potential for flooding. Looks out 3–5 days (depending on the RFC).
- Shows spatial extent of possible flooding based on the **River Forecast Center's (RFC's)** crest forecast for the upstream gauge site. It's the National Water Model's (NWM's) best approximation for inundation using the upstream RFC forecast.
- ~110,000 miles of rivers are covered.
- Most useful for river flooding threats, but not flash flooding.
- Available as an experimental (non-operational) product for select parts of the country over the next few years. Will be available for everyone by October 2026.

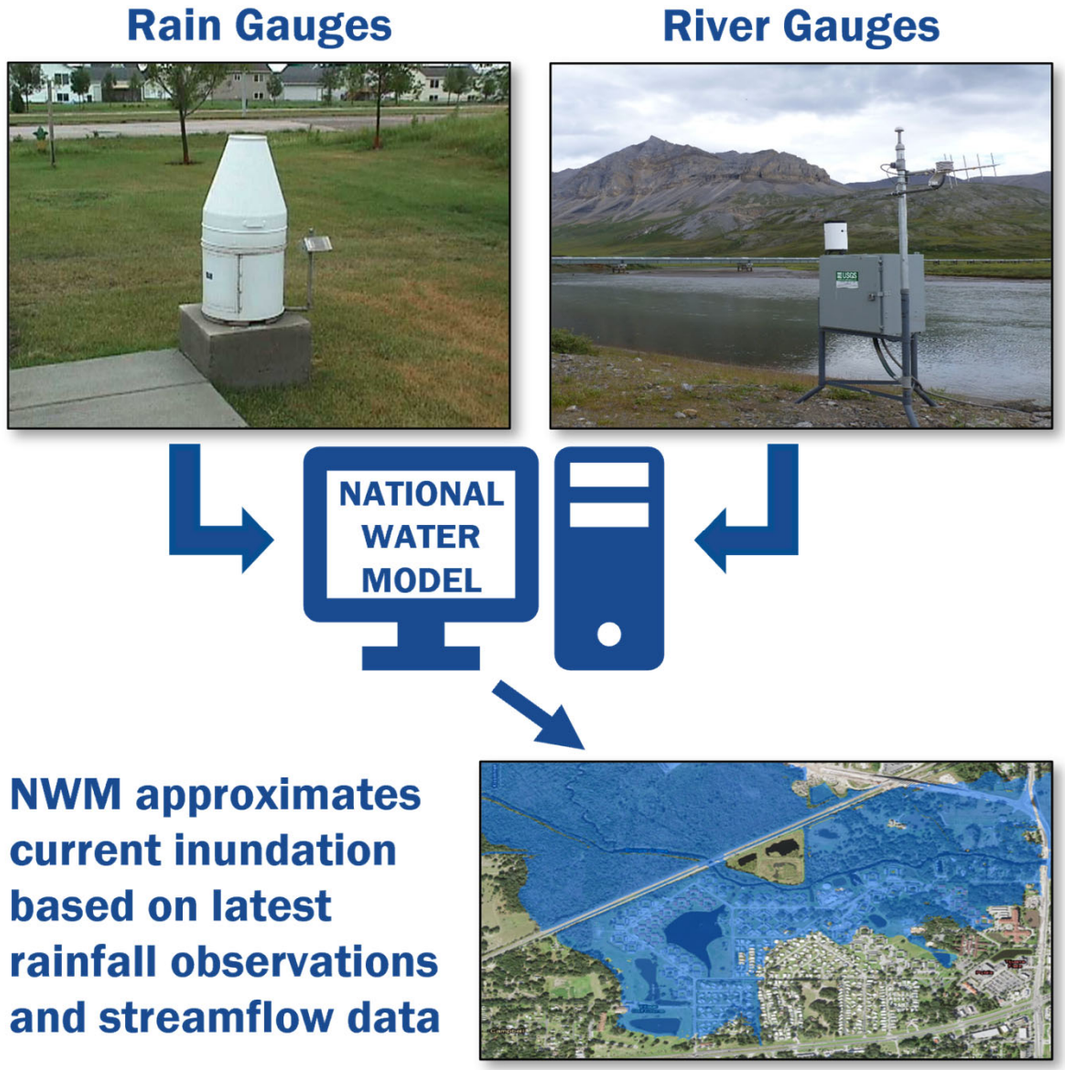
NWS FIM Options – NWM FIM

NWM provides its own forecast of approximate inundation for all streams and rivers without using RFC forecasts as guidance.



- Forecast map (storm-specific) shared via NWPS when there's a potential for flooding. Looks out 5 days.
- Shows the **National Water Model's (NWM's)** best approximation on future flooding extent for all streams and rivers based on latest weather model data and antecedent conditions.
- ~3.4M miles of rivers are covered (expands far beyond the geographic scope of the RFC FIM).
- Better for flooding on smaller rivers, streams, creeks (i.e., those without a forecast gauge site). But it's not a human-derived forecast and may have greater than normal uncertainty.
- Available as an experimental (non-operational) product for select parts of the country over the next few years. Will be available for everyone by October 2026.

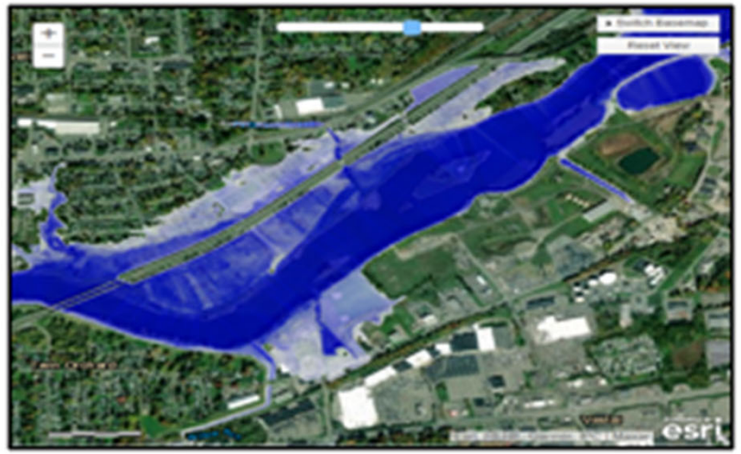
NWS FIM Options – Latest Analysis (AnA) FIM



- "Nowcast" map that is storm-specific, shared via NWPS when there is active flooding. Updated every 1.5 hours. It's not a "forecast" FIM; instead, it's the **"latest analysis" (AnA) FIM.**
- Shows the National Water Model's (NWM's) best approximation on <u>current</u> flooding extent for several streams and rivers based on latest observed rainfall and streamflow data.
- ~3.4M miles of rivers are covered (expands far beyond the geographic scope of the RFC FIM)
- Better for flash flooding on smaller streams.
- Available as an experimental (non-operational) product for select parts of the country over the next few years. Will be available for everyone by October 2026.

NWS FIM Options – Days 4-7+ Pre-Flood (and "Blue Sky" Planning)

- "What-If" Planning
  - **Ex:** What if Vestal, New York, reaches Major Flood? Which properties are at risk of river flooding?
    - **AHPS FIM** (where available), otherwise, use **CatFIM**
- Monitor river ensembles
  - **Ex:** What are the chances of Major Flooding? Where might we see the worst flooding?
    - Look at **AHPS FIM** or **CatFIM** for inundation at locations where flooding is of greatest concern.
    - **NWM FIM** for guidance along smaller rivers, streams, and creeks.

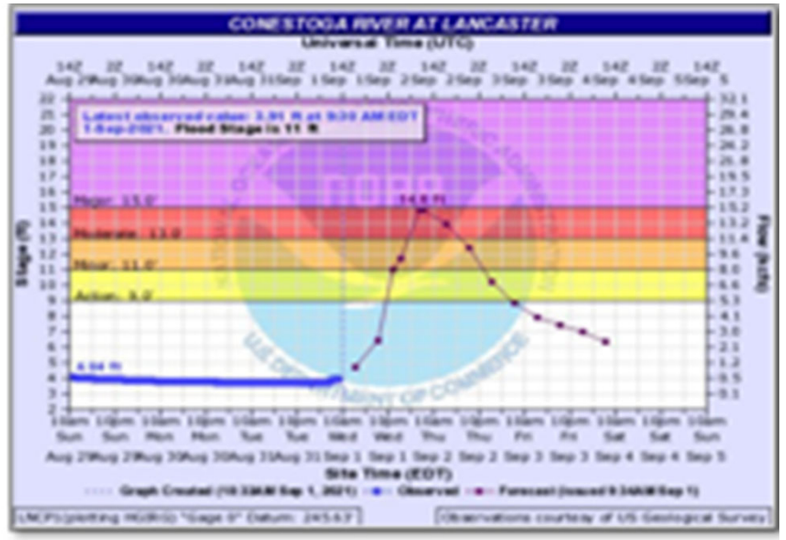


Upper Susquehanna Basin

StationID	River	City,State	Exceedance Level (ft.) 10%	30%	50%	70%	90%	Flood Levels (ft.) Action	Minor	Mod	Major
UNDN6	Susquehanna River	Unadilla, NY	13.6	8.9	7.8	7.3	5.8	9.0	11.0	13.0	14.5
RCKN6	Unadilla River	Rockdale, NY	11.8	8.4	7.4	6.5	5.8	8.0	11.0	12.0	13.0
BAIN6	Susquehanna River	Bainbridge, NY	21.0	13.0	11.1	9.2	6.7	13.0	15.0	20.0	22.0
WSRN6	Susquehanna River	Windsor, NY	19.8	13.1	11.6	9.8	7.6	13.0	17.0	19.0	20.5
CKLN6	Susquehanna River	Conklin, NY	17.4	11.5	10.0	8.4	6.5	10.0	12.0	15.0	20.0
CRTN6	Tioughnioga River	Cortland, NY	10.3	7.2	6.2	5.8	4.9	7.0	8.0	10.0	12.5
CINN6	Otselic River	Cincinnatus, NY	7.2	4.8	4.0	3.5	2.8	8.0	9.0	10.5	11.5
SHBN6	Chenango River	Sherburne, NY	9.9	7.7	6.2	5.0	3.6	6.5	8.5	9.5	10.6
GNEN6	Chenango River	Greene, NY	14.9	11.0	8.7	6.9	5.3	11.0	13.0	15.0	18.0
CNON6	Chenango River	Chenango Forks, NY	11.0	8.5	7.0	6.2	5.3	8.0	10.0	12.6	14.0
BNGN6	Susquehanna River	Binghamton, NY	15.3	11.0	9.0	7.6	5.8	12.0	14.0	15.0	18.0
VSTN6	Susquehanna River	Vestal, NY	24.1	17.1	14.1	11.8	9.3	15.0	18.0	21.0	27.0
OWGN6	Susquehanna River	Owego, NY	14.8	13.9	13.8	13.6	13.5	29.0	30.0	32.0	33.0
WYYN6	Susquehanna River	Waverly NY (Near), PA	16.3	11.0	9.0	7.3	5.8	12.0	13.0	16.0	20.0
LDYN6	Tioga River	Lindley, NY	8.5	7.7	7.2	6.9	6.0	14.0	17.0	20.0	22.0
WCRN6	Canisteo River	West Cameron, NY	9.6	8.1	7.1	6.1	5.3	11.0	17.0	18.0	21.0

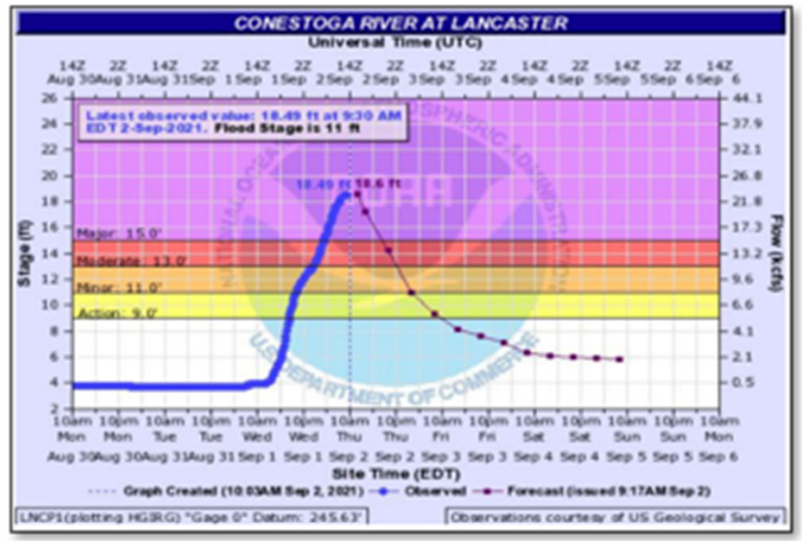
NWS FIM Options – Days 1–3 Pre-Flood

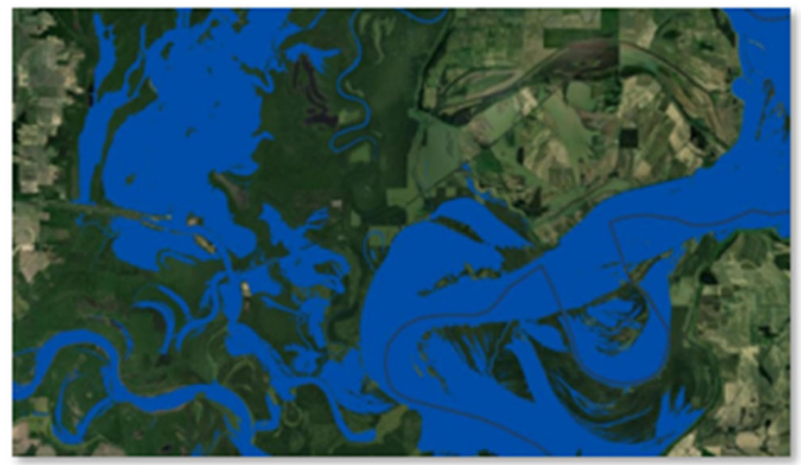
- Forecast confidence is increasing
  - Move towards deterministic forecasts
- NWS River Forecasts are available
  - **Ex:** River forecasts show widespread Moderate to Major Flooding
    - Look at corresponding crest height on **AHPS FIM** (where available)
    - Elsewhere, look at **RFC FIM**
    - **NWM FIM** for smaller streams
- What if flooding is worse than predicted?
  - **Ex:** What if river flooding is XX feet higher than predicted? What if a Moderate flood goes to Major?
    - Look at 1-ft intervals on **AHPS FIM; CatFIM**



NWS FIM Options – While Flooding is Ongoing

- Consult NWS River Forecasts for crest
  - Look at corresponding crest height on **AHPS FIM** (where available).
  - Elsewhere, look at **RFC FIM.**
- What if flooding is worse than predicted?
  - **Ex:** How much higher can river flooding get before the water treatment plant is inundated?
    - **AHPS FIM; CatFIM**
- For small streams/flash flooding:
  - Look at current conditions on **AnA FIM.**
  - **NWM FIM** can show where additional rises might be expected.
  - **NWM FIMs** are not recommended for larger rivers where **AHPS FIM** or **RFC FIM** is available.





NWS FIM Example – Hurricane Ida (2021)

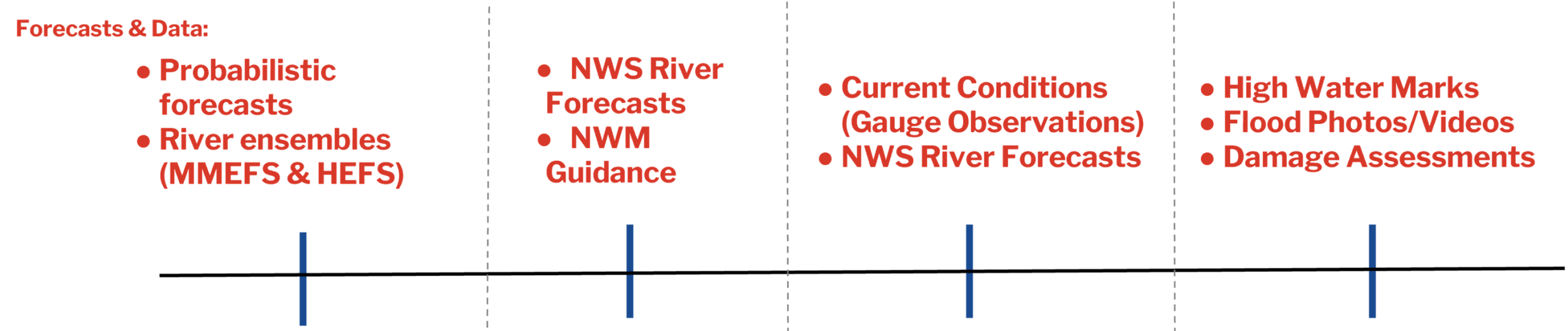
FEMA

Inundation crosses Millcross Road, as indicated by NWS CatFIM

Lancaster, PA - NWS CatFIM

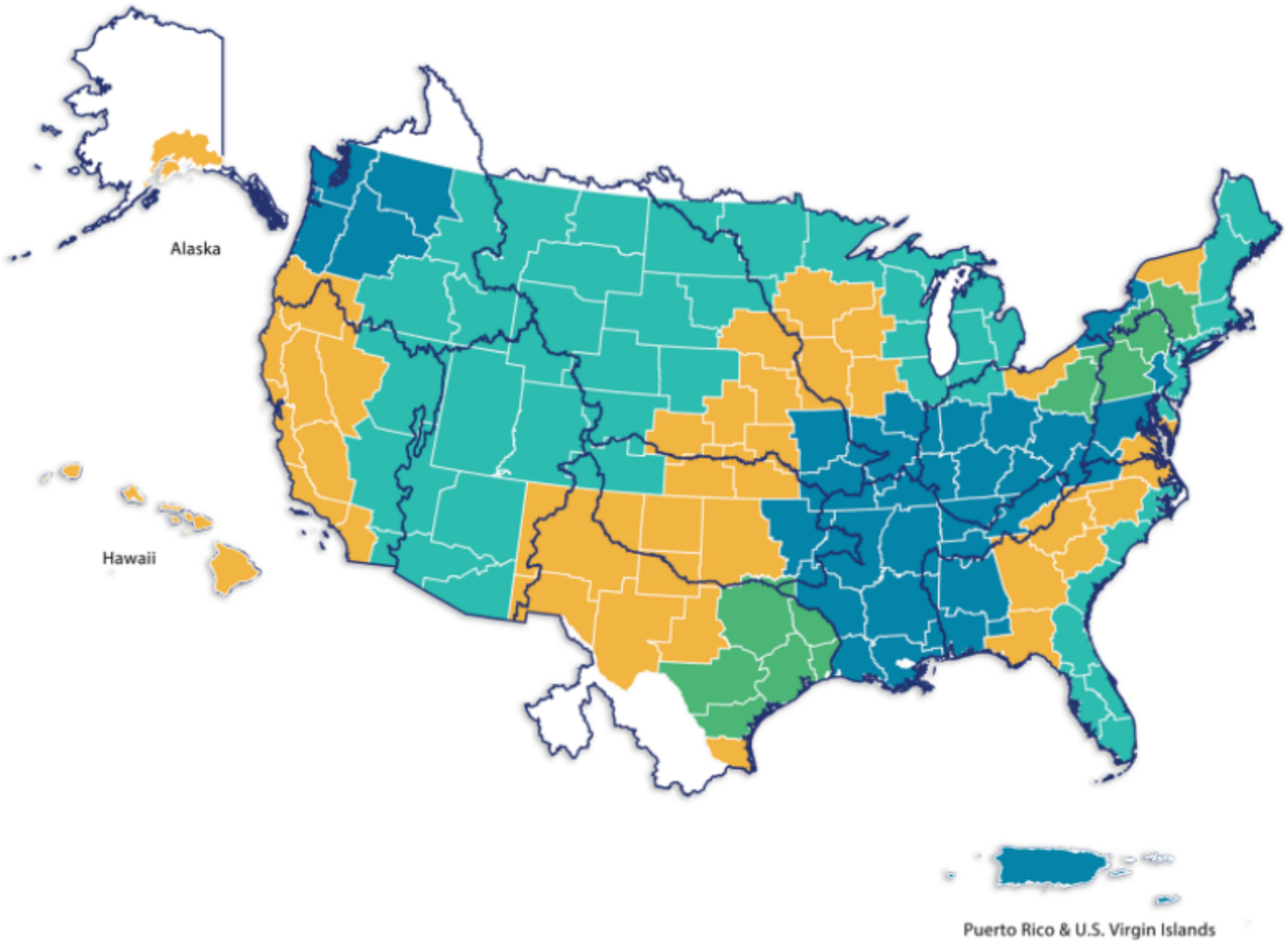
Flooding along Millcross Road in Lancaster, PA after Ida, Sept 2021

NWS FIM Use Before, During, and After a Flood Event



FIM Considerations

NWS FIM Rollout



Map Legend

10% Population served by **October 2023**.

30% Population served by **October 2024**.

60% Population served by **October 2025**.

100% Population served by **October 2026**.

NWS County Warning Areas

NWS River Forecast Center Boundaries

*100% is approximate. Does not include all parts of Alaska, American Samoa, and Guam Implementation areas are subject to change

Dam Hazards

Dam failure threat level terminology can vary between dam operators, which can easily cause confusion.

- Work with your dam operators in blue sky to understand their processes and language.

Dam inundation flood analysis (hasty analysis program used by some WFOs).

Exercises!

Operational Timeframe

- Understand pre-existing conditions, hazard-related or infrastructure/facilities.
- Ensure internal and external communication channels are open.
- Realize the operational timeframe.
- Anticipate staffing issues/local issues that may impact the activation.

Execution Plan/Checklist/Timeline

Comprehensive guide to direct hurricane preparedness and decision-making for both pre-season and impending hazards.

Decisions and Actions are effective if they are based on:

- An understanding of tropical cyclones
- Hazards
- Community vulnerabilities
- Forecast products
- Good decision-making process

Public and private involvement is essential!

- Checklists are specific to each community

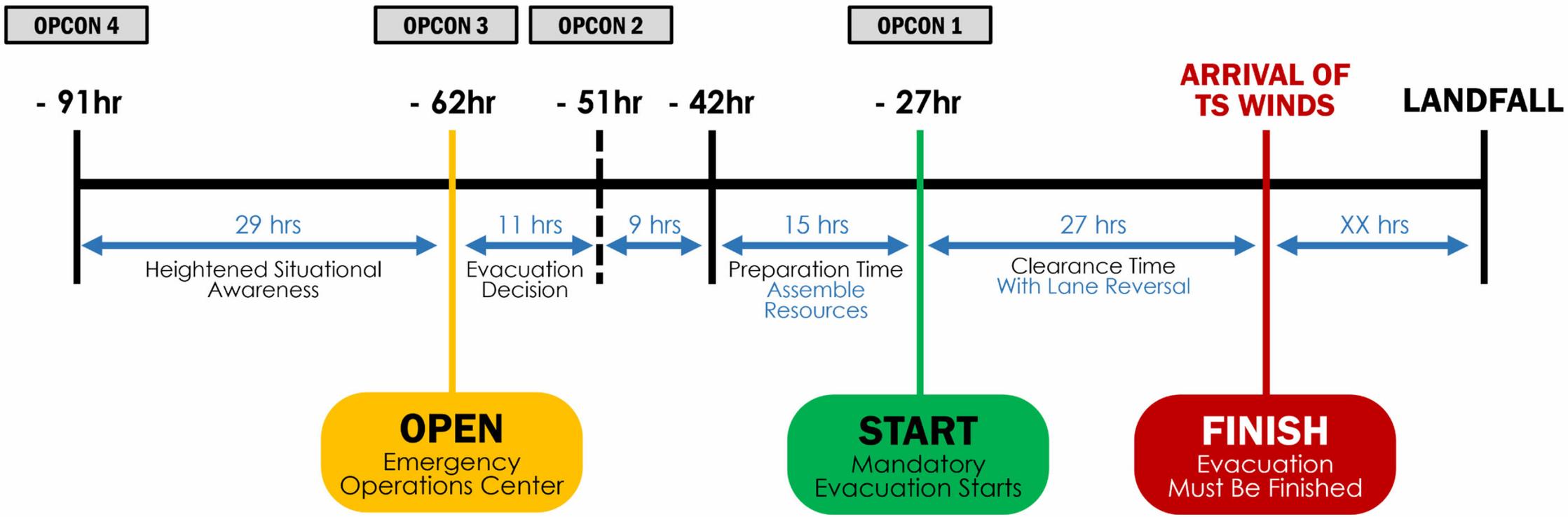
Importance of an Execution Checklist/Timeline

- Prompts for timely action
- Supports decision-making accountability
- Structures documentation
- Ensures coordination and communication

Hurricane Readiness Checklist

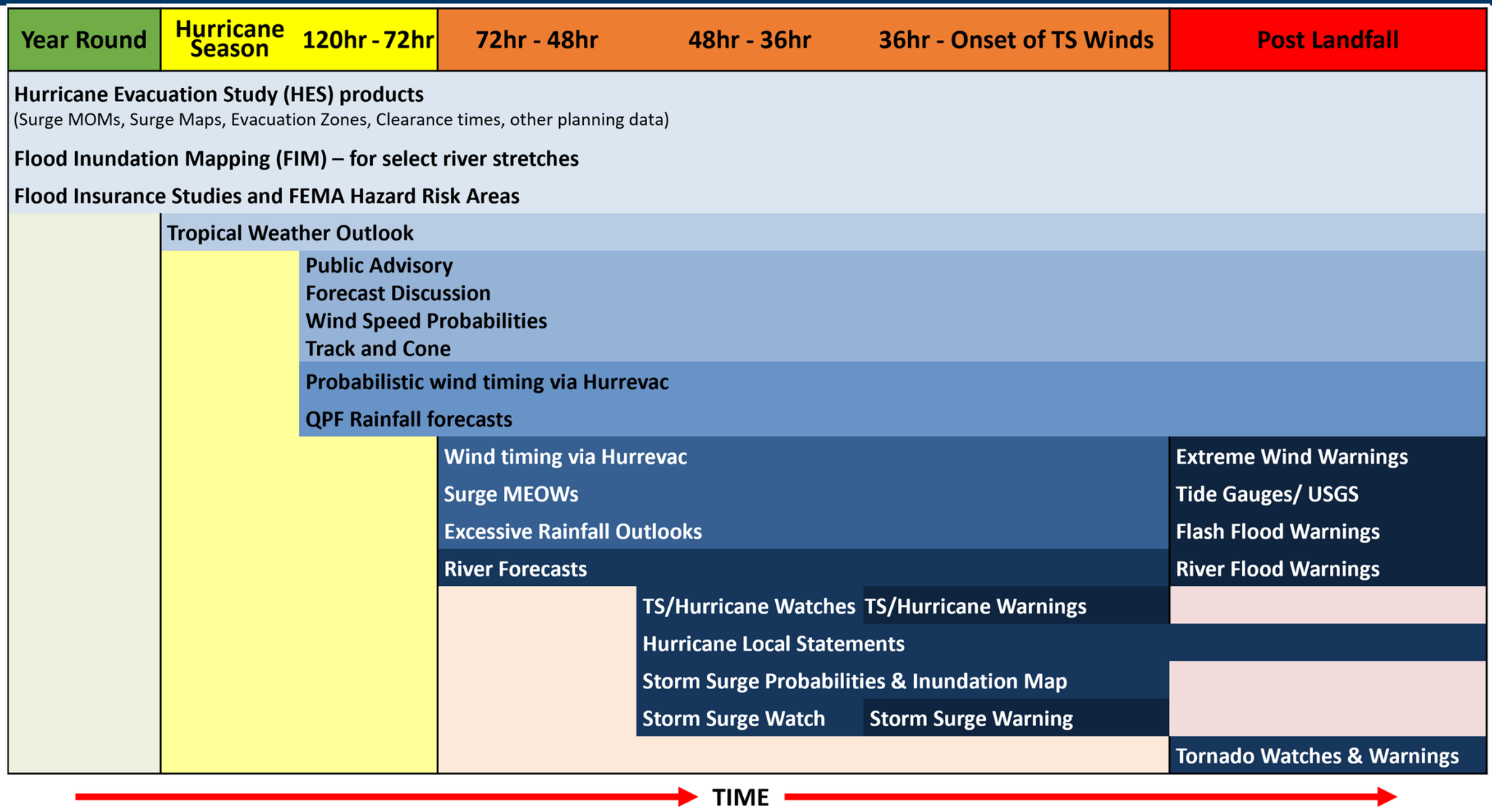
Hurricane Preparedness – prior to June 1	PRIORITY LEVEL	PERSONNEL RESPONSIBLE	STATUS OF TASK	DATE/TIME COMPLETED
Hurricane Planning				
• Update local hurricane operation, evacuation plans and resource files				
• Revise Standard Operating Procedures (SOPs)				
• Review local emergency management ordinances and update				
• Test HURREVAC and/or other hurricane tracking software				
• Review Stafford Act Policies with State Emergency Management				
• Determine evacuation decision making authority w/ line of succession				
Emergency Operations Center (EOC)				
• Replenish supplies and check equipment				
• Test communication lines				
• Update activation plans and train staff				
• Update HURREVAC to latest version				

Timeline Example



Horry County Evacuation Timeline for ABC Scenario

Forecast Product Timeline



Resource Planning

Here are common items that are most likely to be needed during disasters:

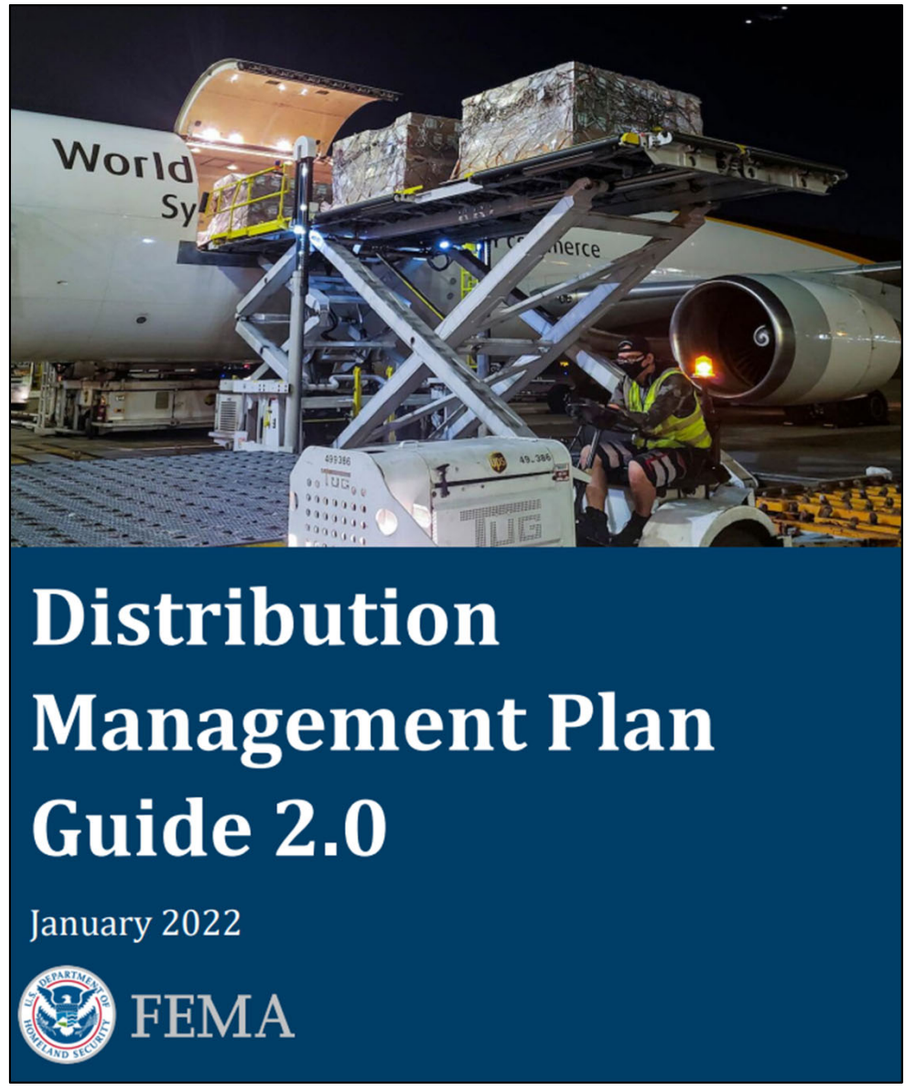
- Shelf Stable Meals
- Bottled Water
- Cots
- Blankets
- Infant Toddler Kits
- Medical Equipment/Supply Kits
- Tarps
- Blue Sheeting
- Generators
- Fuel

Resource Planning (cont.)

Prior to the storm, have a plan on how you're going to acquire critical resources, and identify specific sources.

Communicate any remaining resource gaps to stakeholders.

There are several logistical planning resources for Emergency Managers.



HURREVAC

Hurricane tracking and decision support tool

- Tropical Weather Outlook
- Tropical Cyclone track and historical error cone
- Wind probabilities and deterministic wind fields
- Tropical Storm Wind Time of Arrival
- Rainfall Forecasts and Excessive Rainfall Outlooks
- Significant River Flooding Outlooks
- Observed and forecast flood stages along rivers (although less functionality and info than on AHPS website).

Brief Course Review

- No such thing as “just a Tropical Storm.”
- Forward speed matters for inland impacts.
- Plan for tornadoes as bands come ashore, especially in the right-front quadrant of the tropical cyclone away from the center.
- The NWS and NHC has numerous products that are useful for Emergency Managers to understand TC hazards (i.e., FIM, Public Advisory, etc.) in addition to other products such as Hurrevac that aid in evacuation planning and response.
- The weaker the tropical cyclone, the less certainty about the track.
- High Risk days for excessive rainfall/flash flooding are historically fatal and costly, but also don’t let your guard down if you’re in the Moderate Risk.
- Inland flooding situations can change rapidly.
- HLT is here to help!

Questions/Comments

Final Examination

Time: 30 minutes

Activity: Complete final exam