

# Moving FEMA towards Probabilistic Flood Risk Analysis and Probabilistic Flood Hazard Analysis

7<sup>th</sup> Annual NRC PFHA Research Workshop

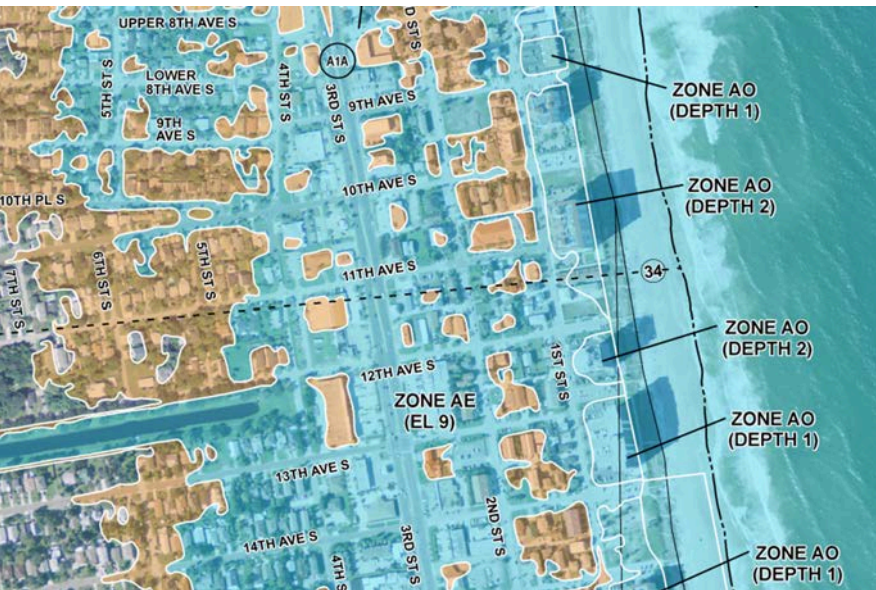
February 15, 2022

David Rosa, Ph.D. FEMA Engineering Resources Branch

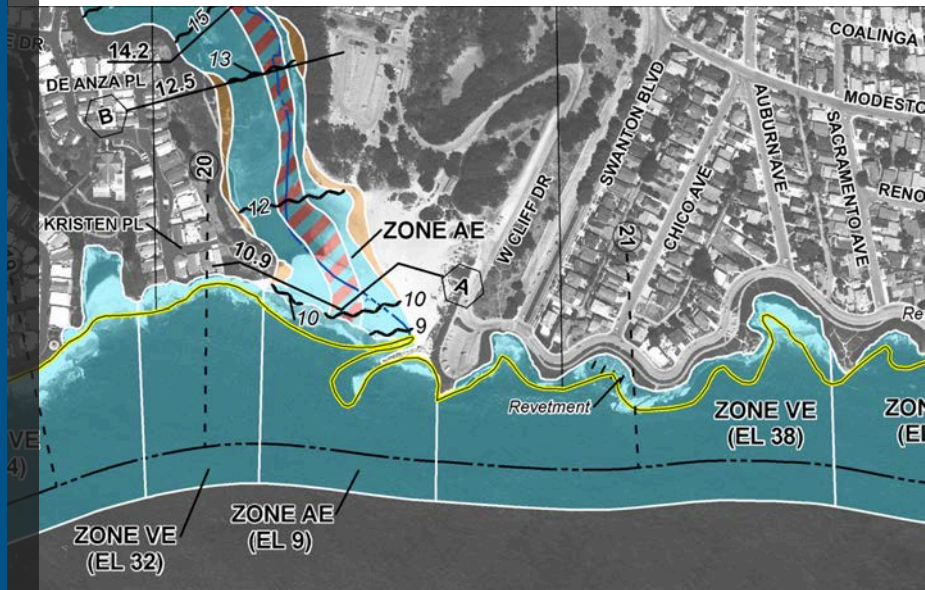
Christina Lindemer, PE FEMA Engineering Resources Branch



# Flood Insurance Rate Maps: A Binary Snapshot of Risk



**FLOODWATERS  
DON'T STOP  
AT A LINE ON  
THE MAP.**



## What do FIRMs show?

FIRMs show a specific condition: the Special Flood Hazard Area (SFHA).

## What makes them regulatory?

Regulatory FIRMs are used for flood insurance purchase requirements and floodplain management.



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- Regulatory FIRM leads people to believe that if they are 'out' of the SFHA, they are not at risk.
- Leads to communities to focus on lines on a map as a complete picture of flood risk.

### A more complete picture

- Flooding can take many forms, can be minimal or severe, can have several driving factors
- FEMA's Future of Flood Risk Data (FFRD) initiative seeks to improve the state of mapping, adopting a probabilistic, risk-based approach to displaying graduated data

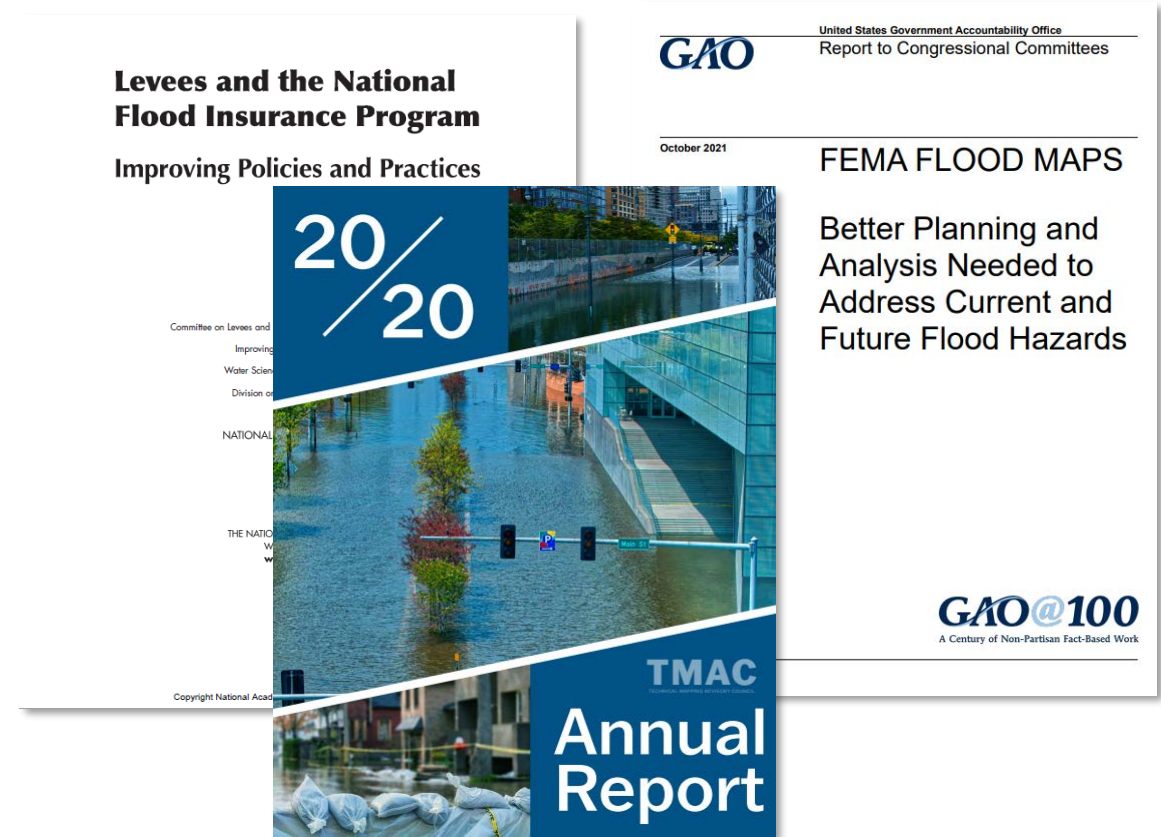


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# Transition to Future of Flood Risk Data (FFRD)

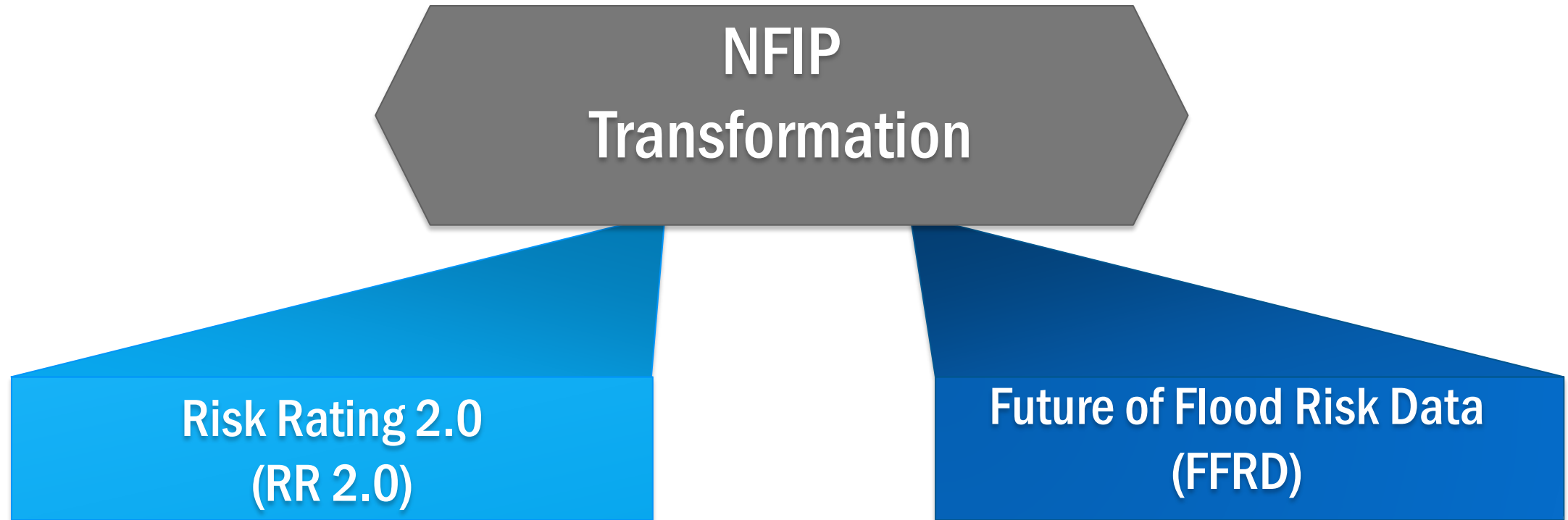
## Feedback from stakeholders

- Technical Mapping Advisory Council (TMAC)
  - GAO
  - National Academy of Sciences
  - Other Agencies
- 
- Also, unmet statutory authorities including identifying residual risk behind levees



The NFIP in transforming to a risk-informed framework that enhances the Nation's understanding of risks from flood hazards. Risk Rating 2.0 and Future of Flood Risk Data are two components of this initiative.

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# What is different about FFRD?

	Risk MAP	Future Flood Risk Data
Service Model	<i>Product (FIRMs)</i>	<i>Data service model; user decision behavior drives product</i>
Investments	<i>Project driven - base data only generated for project area</i>	<i>National scale base data with federal partners</i>
Model Coverage	<i>Patchwork of models and flood hazard assessment</i>	<i>Nationwide flood hazard/risk assessments</i>
Frequency Interval	<i>Optimized around 1-percent annual-chance</i>	<i>Multiple flood hazards, multiple frequencies</i>

# Graduated Flood Hazard and Flood Risk Application and Use Case Examples

## 1 Graduated Flood Hazard and Risk Zones

## 2 Community Higher Standards Decision Support

## 3 Mitigation Project Identification & Pipeline

## 4 Mitigation Planning

## 5 National Risk & Mitigation Tracking

## 6 Pre-Event Planning and Response Forecasting

## 7 Rapid Damage Estimates & Expedited D

## 8 Structure Triage & Damage Assessment Prioritization

## 9 Recovery Planning & Action Prioritization

**Use Case Summary**

Leverage mitigative strategy plan val. At a bas mechan compl hazard actions, mitigati while av mitigati RMD.

**Use Case Summary**

In the midst of all other fast-paced activities that occur when data that reflects the actual flood inundation and damages c data, however, in time to influence response efforts and esti is important. Similar to pre-event planning, the availability of probabilistic analyses produce can be effectively used to est turn, be used to help justify and expedite disaster declarati made available for those most severely impacted.

In order to make this possible, observed rainfall and river dis compared to the library of hydro-meteorological inputs used for the area, in order to retrieve the model(s) most closely m marks would be used as additional verification points to vali leveraged. Outputs from those models, such as flood depths and structure damages, would then become the basis for co levels (community, county, etc.) needed to support formal di reporting functionality could be built to help in the preparatio results a number of ways (structure counts and damages by of flooding, etc.)

**Use Case Summary**

Following a disaster, there has historically been a need to do field inspections estimate the potential assistance or claims requests that could come in, and the might be needed. These post-disaster inspections stand to benefit from severa increase the speed at which funding requests for assistance and claims could estimate impacts prior to any field work.

By leveraging the representative scenario(s) from the probabilistic model cata observed data, and extracting the associated flood hazard and flood risk results built that stratify the structures within a community by their flood depths and ex example, structures could be visualized based on their flood depths relative to different categories accordingly, where structures with lower flood depths might assistance (IA) grant needs, and structures with higher flood depths might anti Thresholds could be further customized to incorporate estimated flood damage structures that would likely be substantially damaged, or where actual field ins performed to verify the estimated damages. This data delivered geospatially to help them to triage structures that need actual inspections, those that might on verification, or those that may need no inspection at all.

**Use Case Summary**

Following a major flood event, when grant funds become available to affected regions, applicants (states) are faced with the complex task of deciding how to effectively and equitably allocate such funds, while sub-applicants (communities) must make a compelling argument for their specific needs. Data retrieved from the modeled flood scenario library can be used to identify the areas hardest hit and to support the case for mitigation projects in these areas.

Data and damage estimates could be leveraged for Public Assistance to streamline the project application and implementation process, to help ensure that 404 and 406 mitigation is incorporated properly and funding opportunities are not missed. Damage estimates at the structure level could also be provided to FEMA Program Delivery Managers and Recovery Support Functions (RSFs) to develop accurate budgets and cost estimates for more resilient infrastructure replacements and repairs.

**Relevant Stakeholder Groups**

**End-Users**

**Technical Feasibility**

**Practical Feasibility**

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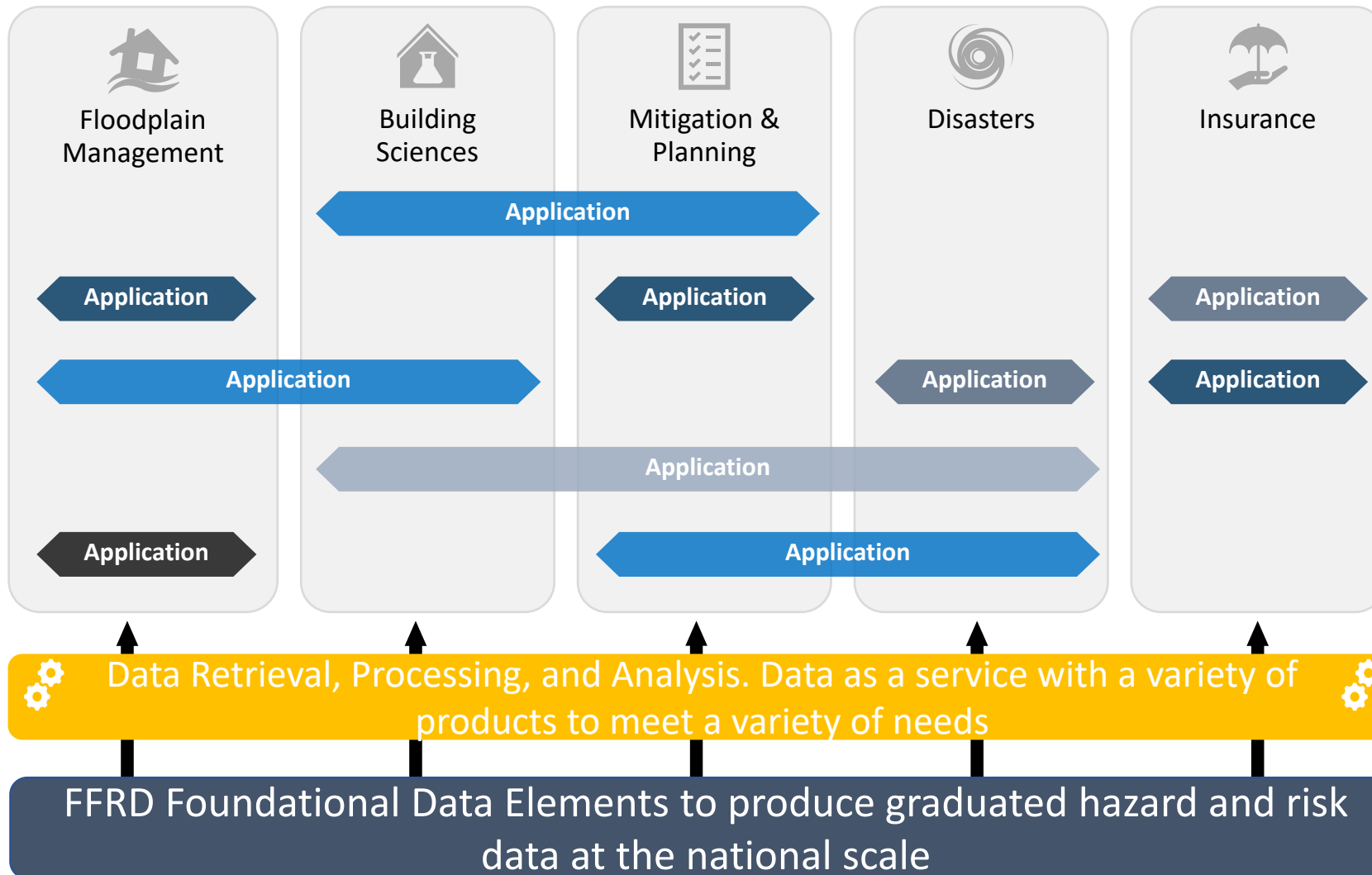
**Practical Feasibility**



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# Reimagining the Opportunities created by improved Hazard and Risk Data

## ► FFRD Concept/Use Case Alignment to Individual Stakeholders



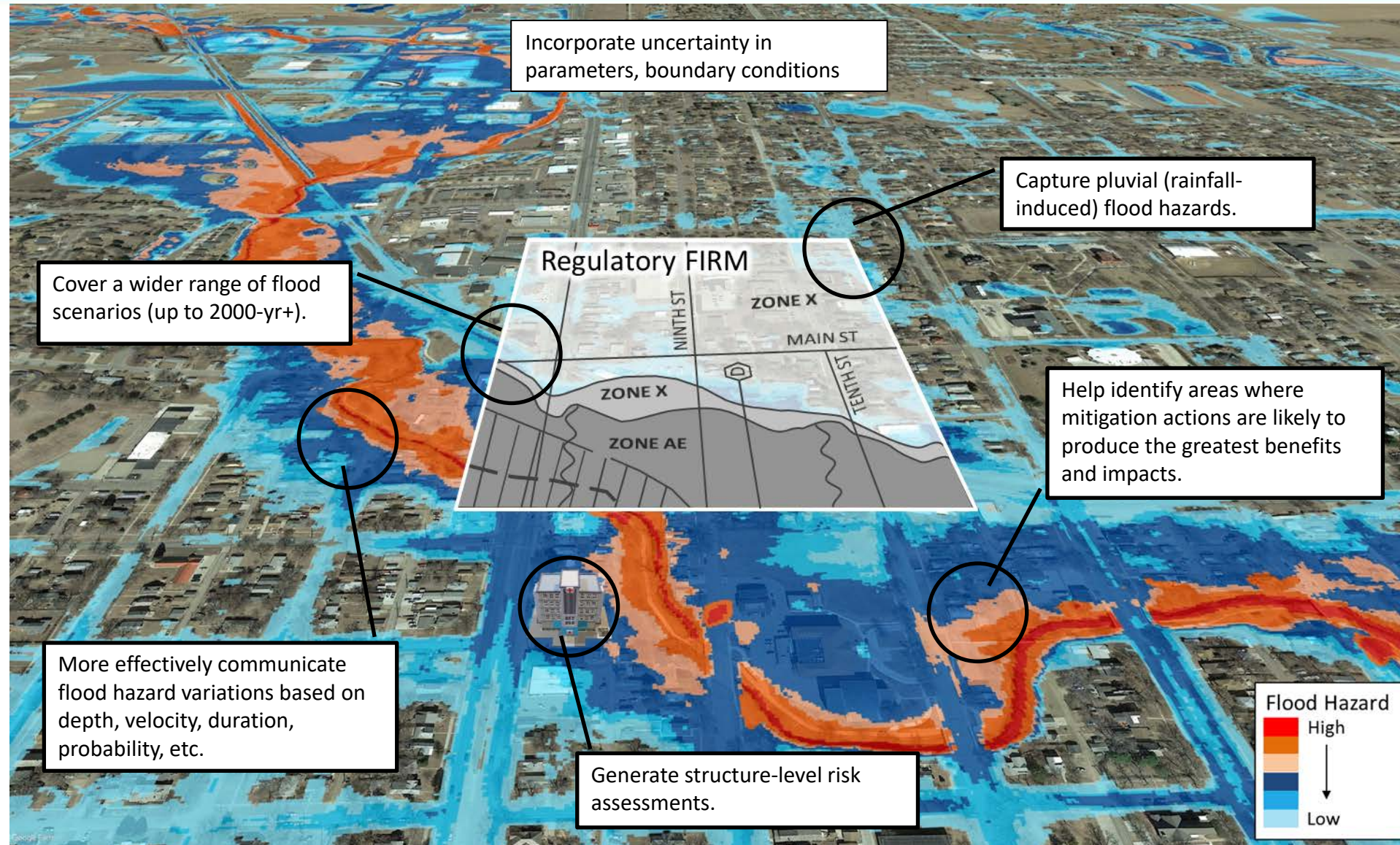
## Applications of FFRD

- Data applications by multiple stake-holders with cross-cutting benefits
- Flexibility for FEMA, other agencies, state and local partners, private entities, and other data users to develop tools and products to help meet their needs in reducing flood risk and increasing resiliency



# What does FFRD tell us about the Nation's Risk?

## Comparison of Probabilistic Data to Traditional FIS Products

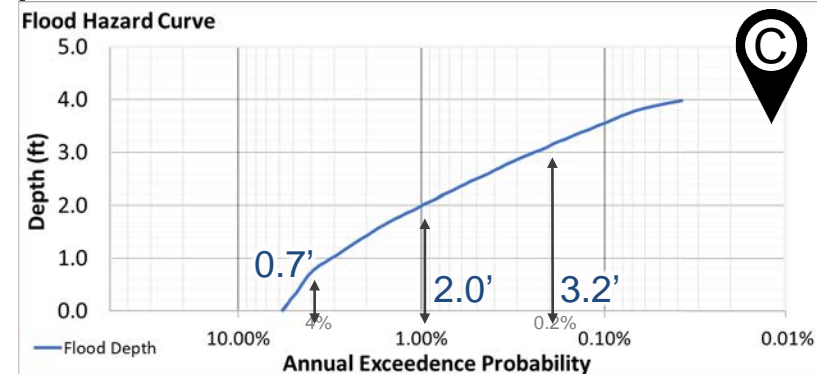
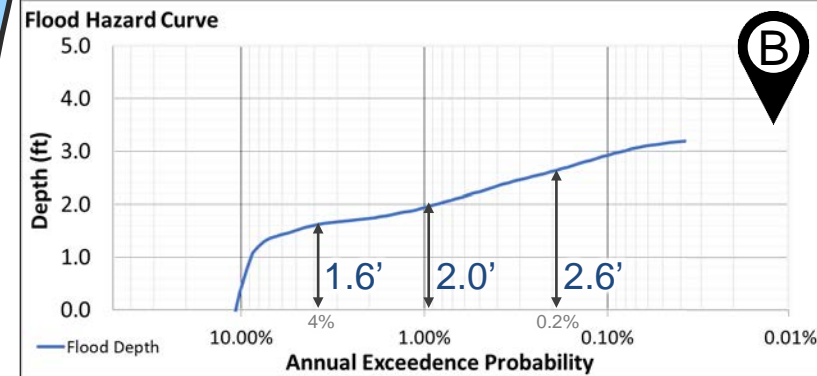
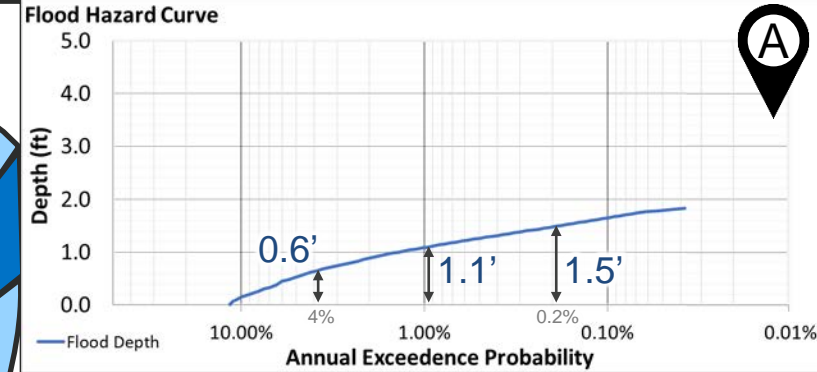
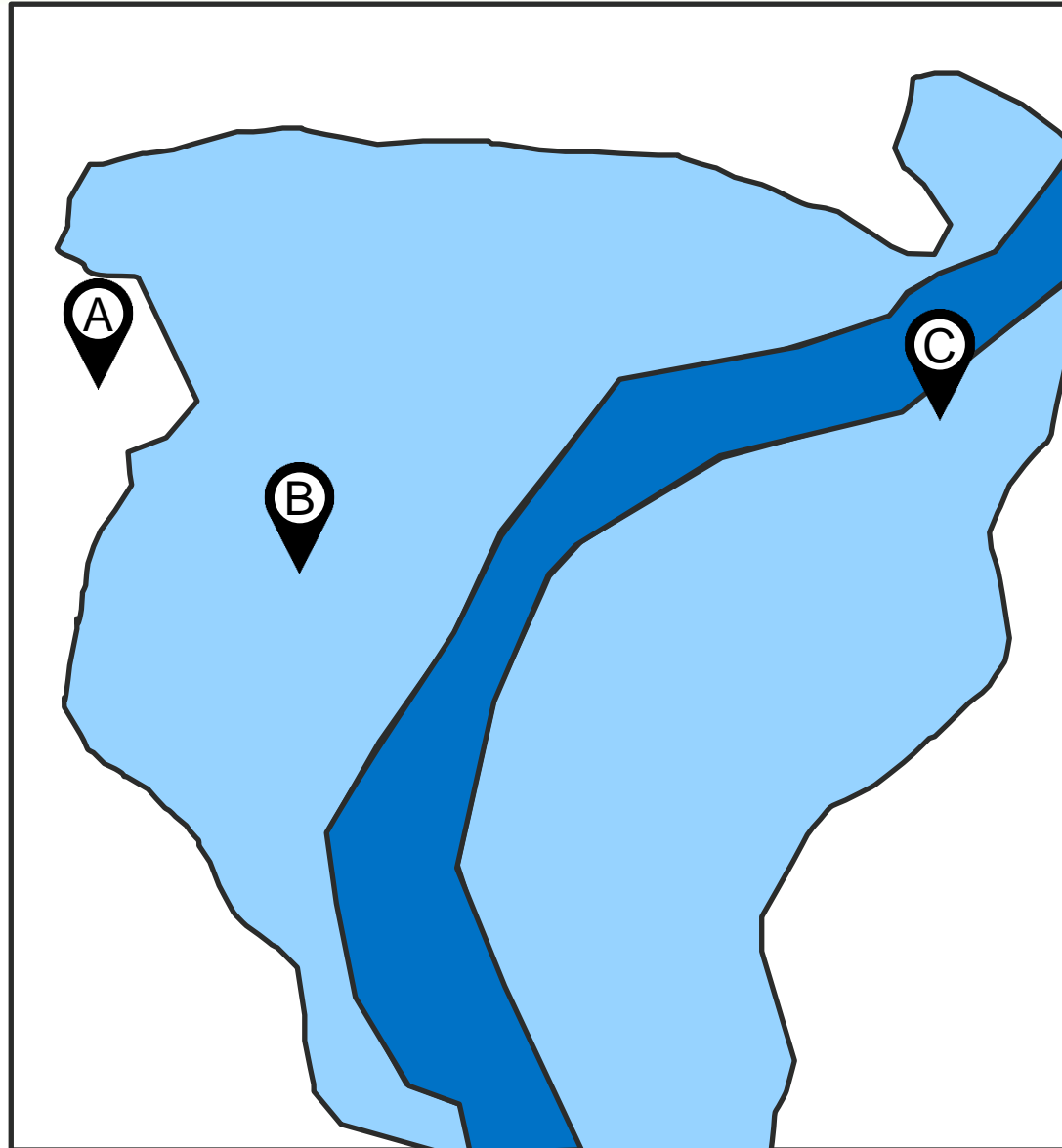




# What does FFRD tell us about the Nation's Risk?

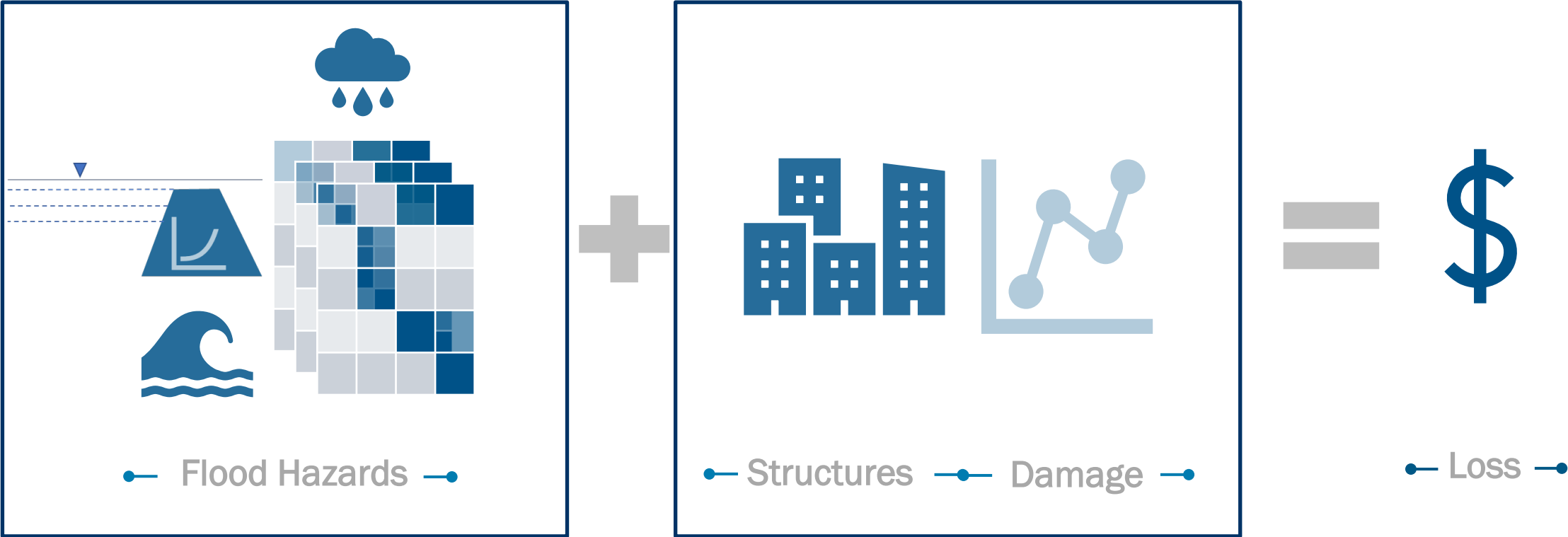
## FFRD improves the understanding of unique flood hazards

- FFRD accounts for a range of conditions, frequencies, and severities
- Instead of being “inside” or “outside” the floodplain, each structure can have an associated annual exceedance probability (AEP) for each dimension of flood hazards studied.





# FFRD highlights where there is RISK



# Potential Applications for Graduated Flood Risk Data

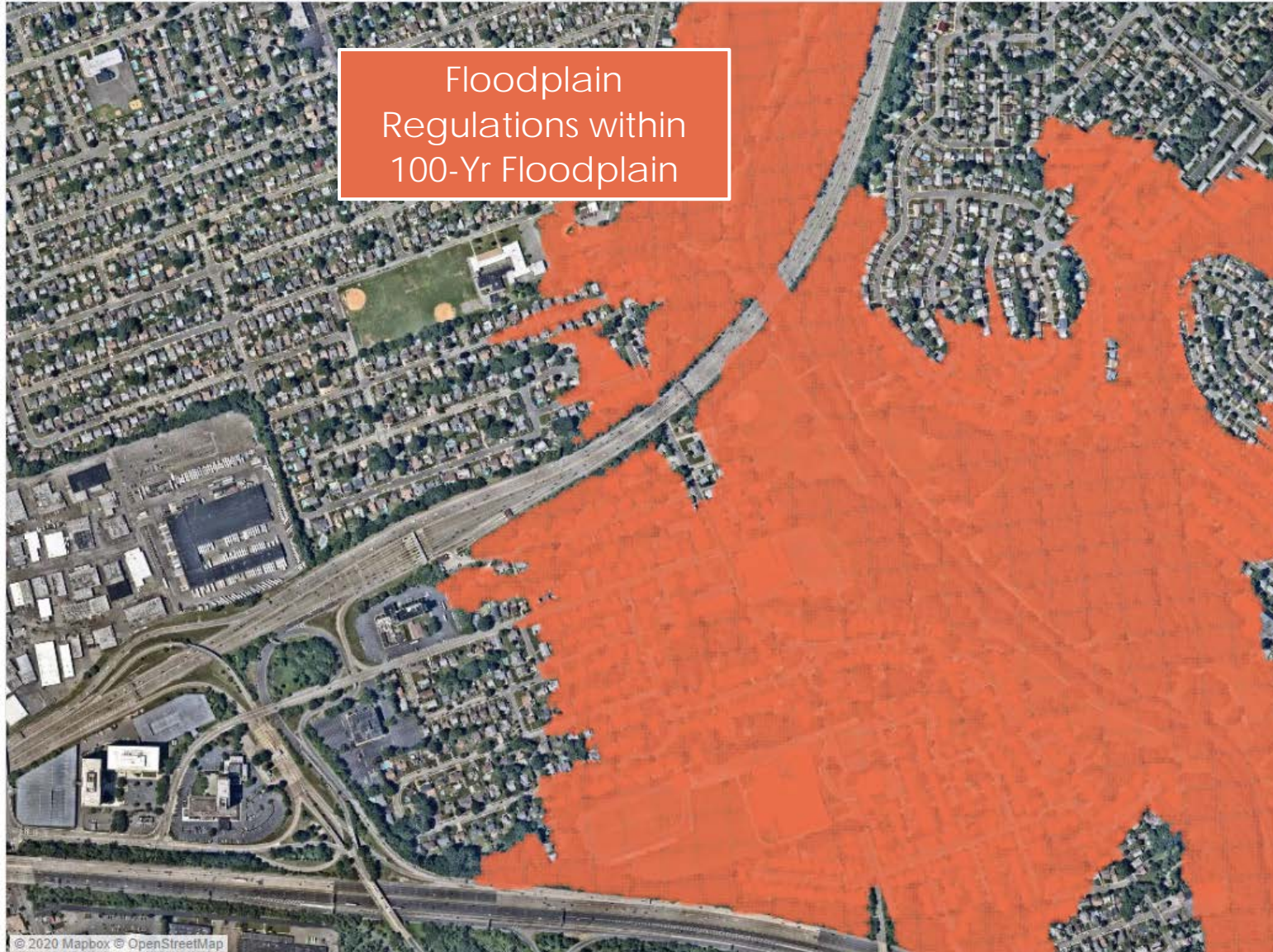


# Hazard Data Beyond the SFHA



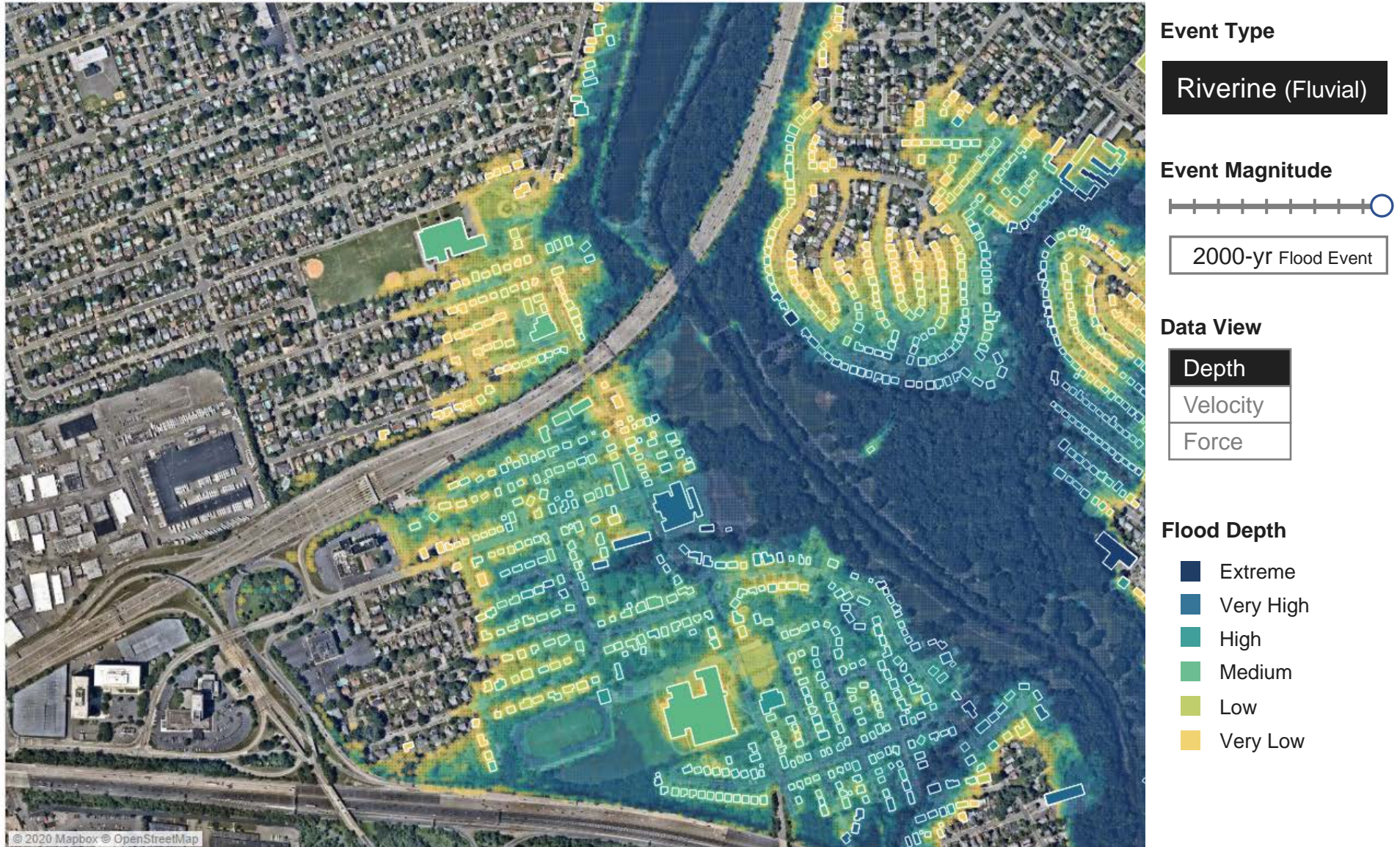


# Hazard Data Beyond the SFHA



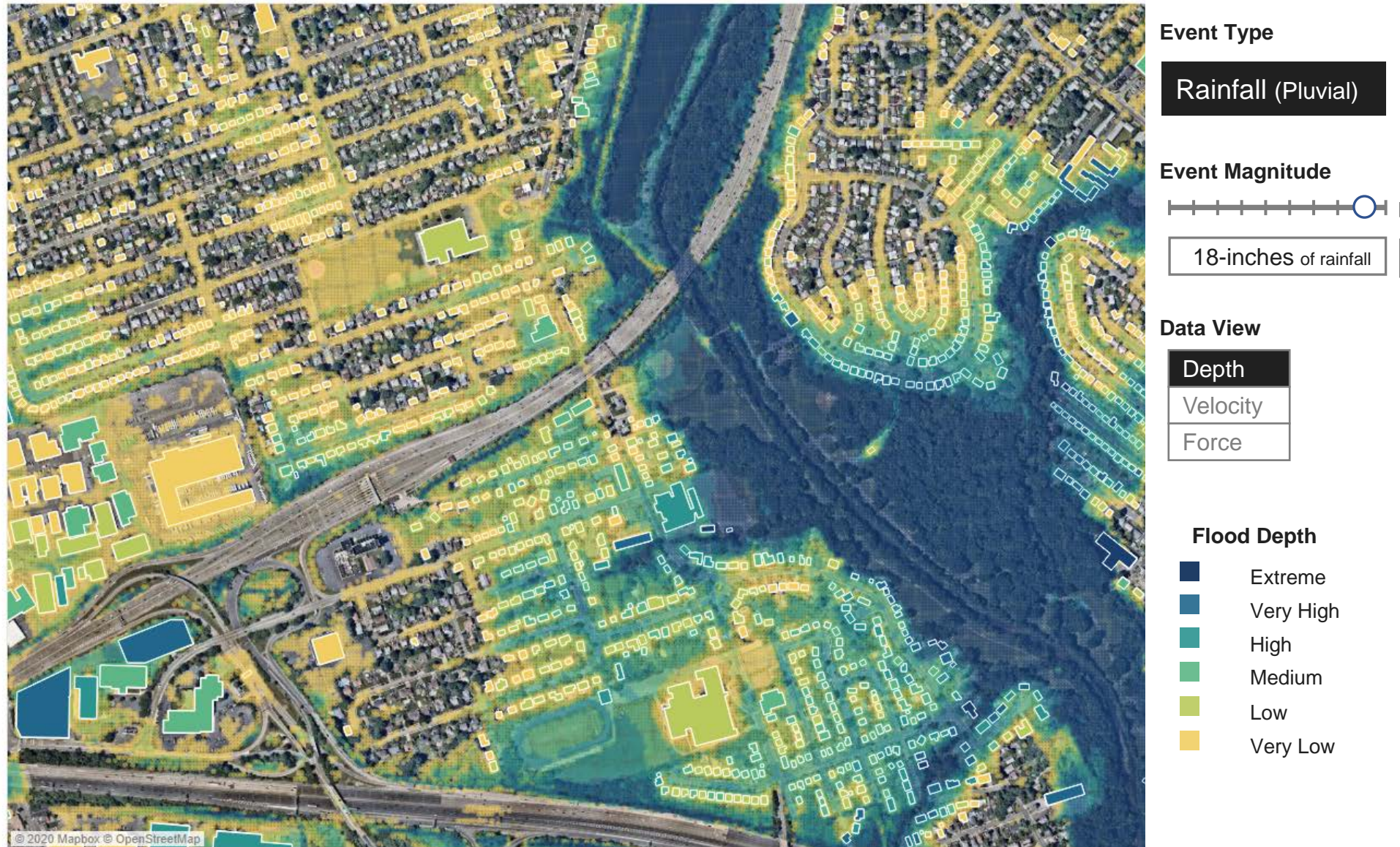


# Beyond the SFHA: Fluvial Scenarios





# Beyond the SFHA: Pluvial Scenarios





# Beyond the SFHA: Graduated Hazard



## Event Type

Combined (P+F)

## Aggregated Hazard

Annual Probability  
of Flooding

Average  
Annualized Depth

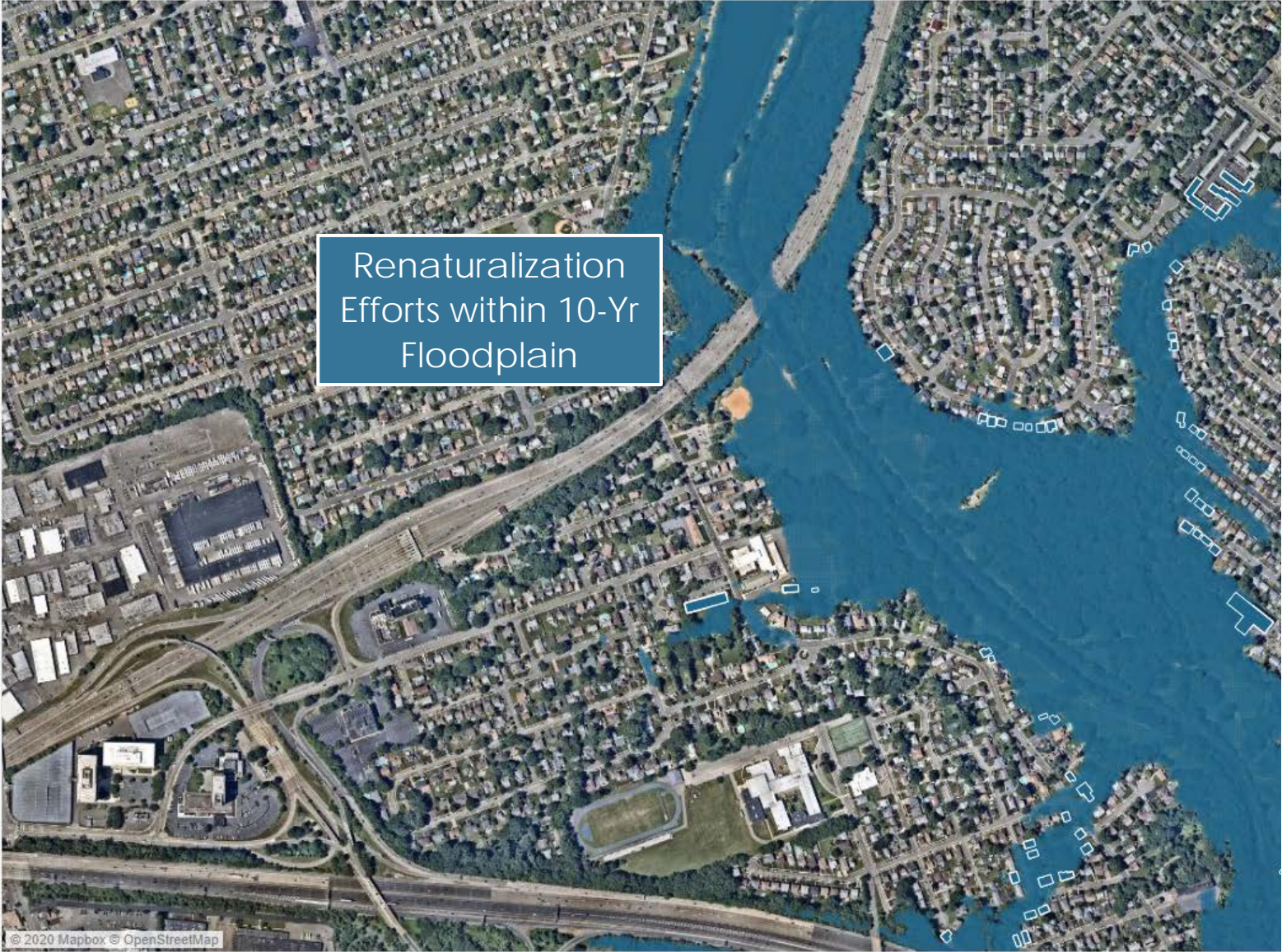
Average  
Annualized Loss

## Annual Probability of Flooding

- 50% - Extreme
- 10% - Very High
- 5% - High
- 1% - Medium
- .2% - Low
- .1% - Very Low



# Graduated Flood Zones by Hazard Level



Event Type

Combined (P+F)

Aggregated Hazard

Annual Probability of Flooding
Average Annualized Depth
Average Annualized Loss

- Annual Probability of Flooding
- 50% - Extreme
  - 10% - Very High
  - 2% - High
  - 1% - Medium
  - .2% - Low
  - .1% - Very Low



# Graduated Flood Zones by Hazard Level





# Graduated Flood Zones by Hazard Level



## Event Type

Combined (P+F)

## Aggregated Hazard

Annual Probability of Flooding

Average Annualized Depth

Average Annualized Loss

## Annual Probability of Flooding

- 50% - Extreme
- 10% - Very High
- 2% - High
- 1% - Medium
- .2% - Low
- .1% - Very Low



# Graduated Risk at the Building Level





# Graduated Risk Hot Spots



## Event Type

Combined (P+F)

## Aggregated Hazard

Annual Probability  
of Flooding

Average  
Annualized Depth

Average  
Annualized Loss

● Heat Map

## Risk Hot Spots

- Extreme
- Very High
- High
- Medium
- Low



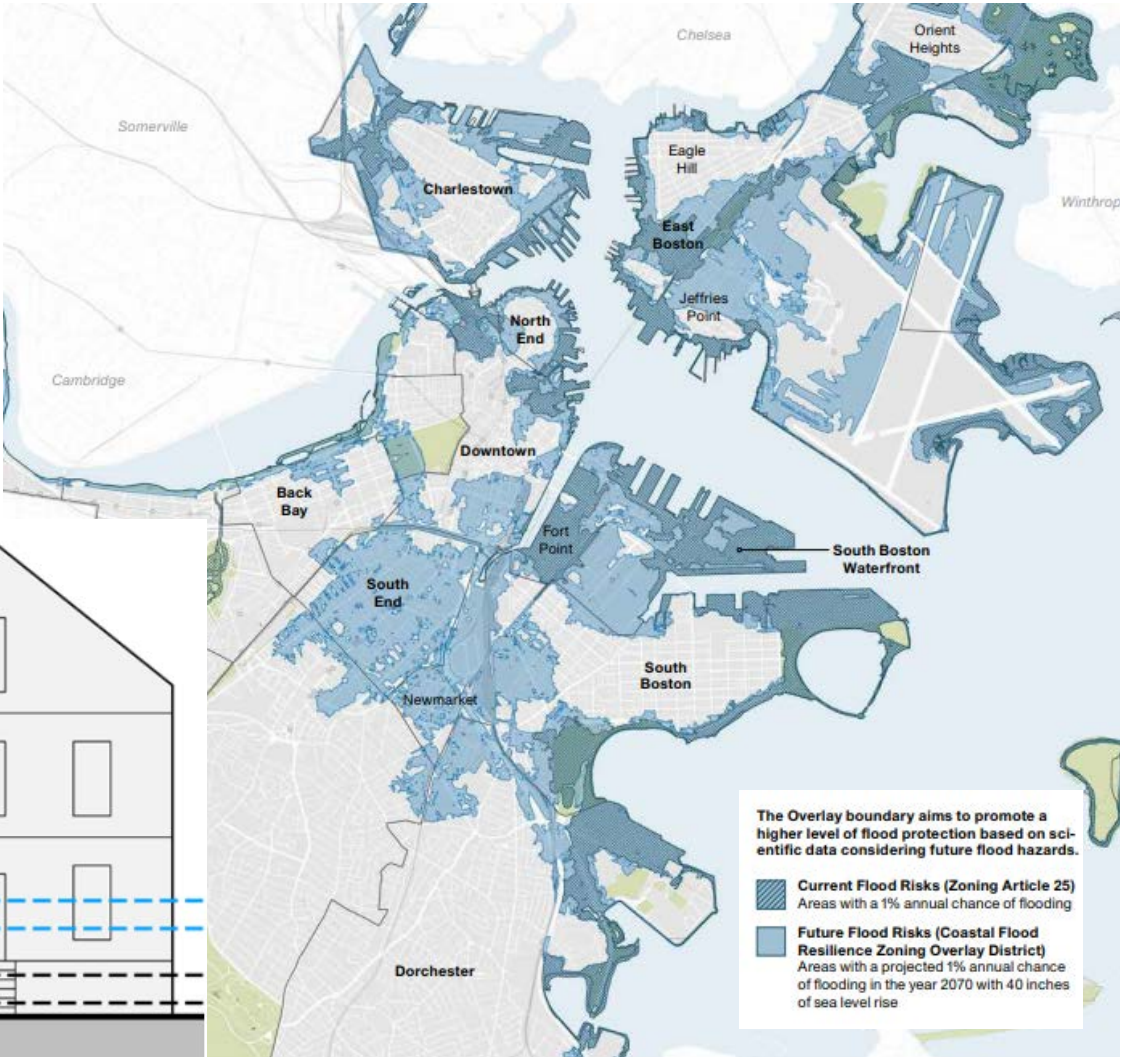
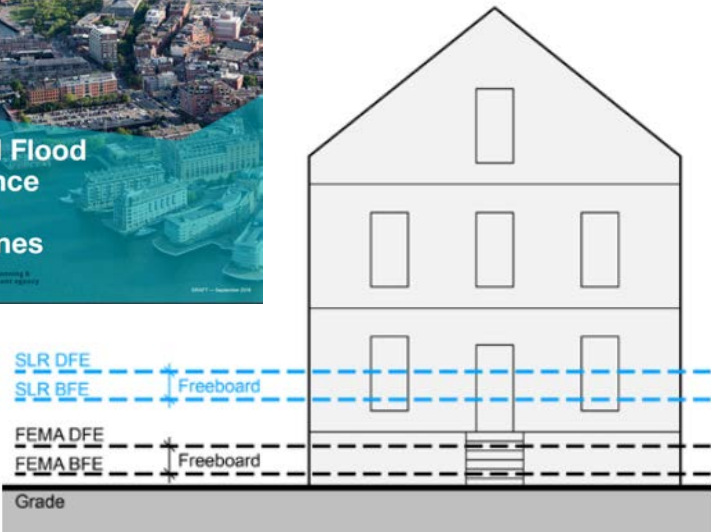
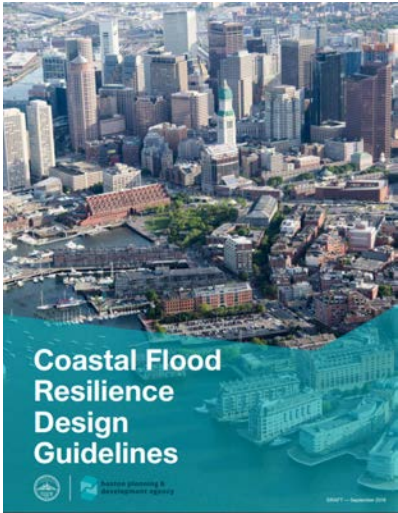
# Graduated Flood Zones by Existing Risk





Example:

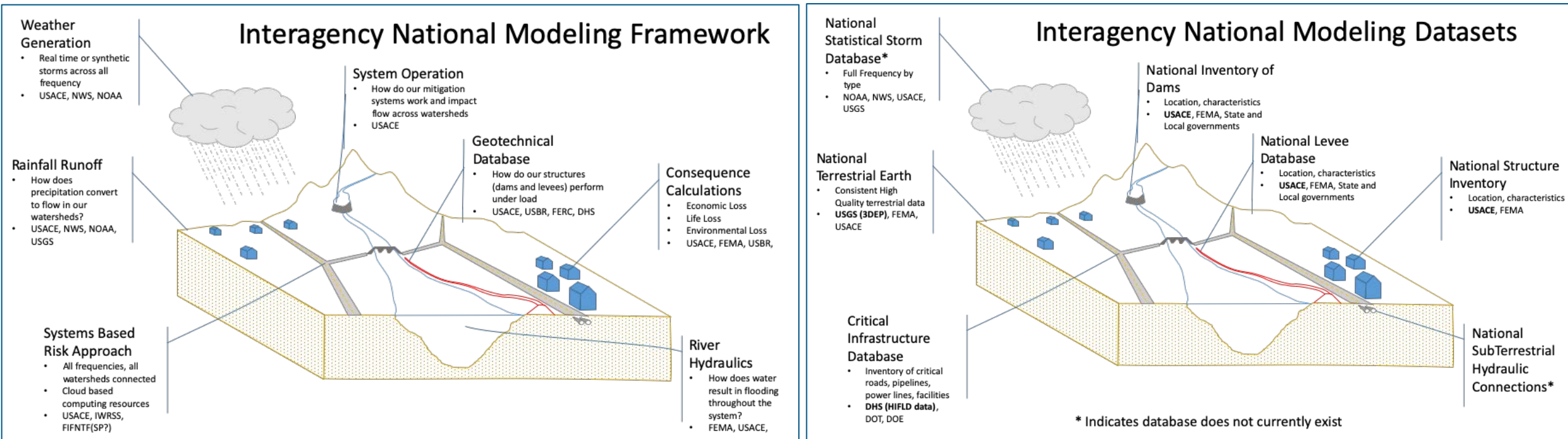
City of Boston Coastal Flood Resilience Zoning Overlay





# Authorities of FEMA and Other Federal Agencies

The increased data set and methodology for the shift to graduated risk can't be done by FEMA alone...



...so we are currently exploring the best way to leverage the strengths of our federal, state, local, tribal, and territorial community partners to develop and deliver graduated risk data.

FEMA

USGS

USACE

IWRSS

NOAA

NWS



FEMA

**RiskMAP**  
Increasing Resilience Together

# Q & A



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