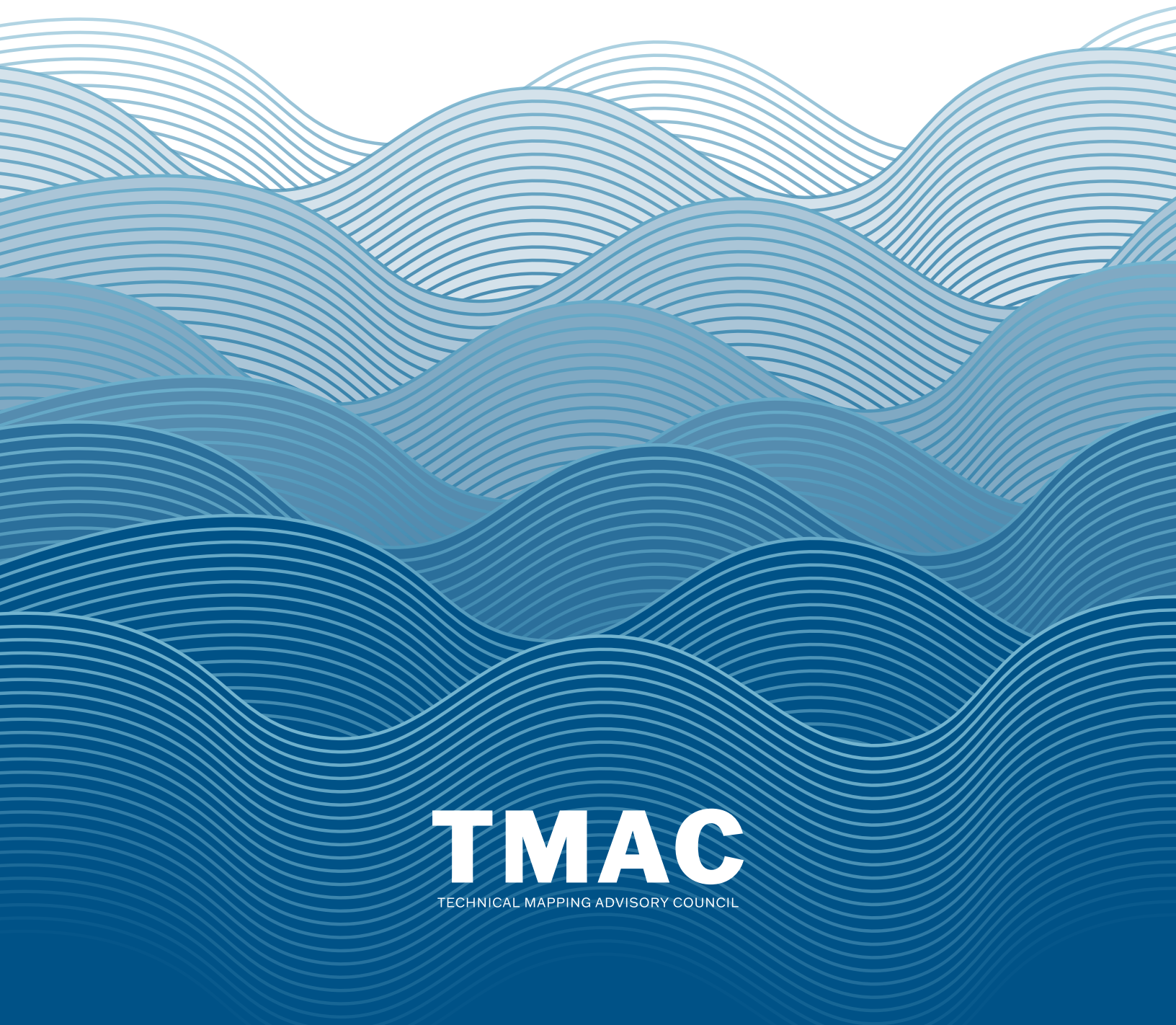
2023
Annual Report



TMAC

TECHNICAL MAPPING ADVISORY COUNCIL

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Deanne Criswell
Administrator
Federal Emergency Management Agency
500 C Street SW
Washington, DC 20472

March 29, 2024

Administrator Criswell,

As Chair of the Technical Mapping Advisory Council (TMAC), I'm pleased to forward to you the TMAC 2023 *Annual Report* for your consideration. This report spans four topic areas and includes twelve recommendations with several implementation suggestions for each.

The TMAC used a modified Design Sprint process to develop this year's recommendations. The process included developing six overarching objectives to guide our work, generating initial concepts to share with a broader set of stakeholders, and refining those concepts through deliberations based on their feedback. As part of the process, the TMAC held 29 one-hour sessions with 136 participants attending in total; the participants represented state and local governments, the lender/financial community, the development community, and various interest groups and other professionals.

Seven of the TMAC's recommendations aim to reduce the magnitude of losses (uninsured and insured) and improve transparency around the impacts that climate change and proposed development may have on flood risks to people, property, and the environment. The other five recommendations focus on improving the usability, technical credibility, and communication of hazard and risk data while facilitating a smooth transition to accommodate the changes that come with these improvements.

Several of the TMAC's 2023 recommendations propose fundamental changes to foundational elements of the mapping program and floodplain management functions of the National Flood Insurance Program. We understand that some of these recommendations may be met with controversy, fueling longstanding debates regarding how our Nation manages its shared flood risk and other difficult topics, such as who pays and how much before and after flood disasters strike. Rather than shy away from these difficult issues, the TMAC seized what it saw as a once-in-a-lifetime opportunity to offer recommendations that help put the Nation on a better path in the face of increasing flood damages and risks.

The forward-leaning recommendations identified within this report will, undoubtably, help reduce future flood losses compared to maintaining the status quo. With that said, these recommendations cannot be effectively implemented without a concurrent effort to directly address the financial challenges that have, in large part, arisen from a long patchwork legacy of prior legislative and policy decisions. The solution going forward will require all of us to work together to improve the situation for future generations.

Respectfully,

Doug Bellomo, P.E., PMP
Chair
Technical Mapping Advisory Council

Acknowledgements

The Technical Mapping Advisory Council (TMAC) would like to recognize and acknowledge the efforts of many individuals that contributed to this report. This year's report required an extraordinary effort from several subject matter experts and support staff. Each of the following people dedicated their time and expertise to the production of this report.

Subject Matter Experts

Christine Brittle
Jeff Burm
Mark Condodemetraky
Jerry Dudley
Kim Dunn
Scott Edelman
Mike Hanson
John Hill
John Ingargiola
Matt Lepinski
Corby Lewis
Karl McArthur
Soloman Miranda
Shilpa Mulik
Mary Jo Mullen
Kristin Owen
Ben Pope
Will Thomas

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This document was prepared with guidance from Section 508 of the Rehabilitation Act of 1973. If assistance or clarification is required to better interpret complex images or tables, please email fema-tmac@fema.dhs.gov.

Executive Summary

Executive Summary

Changes in our nation's land surface and climate, due to both human and natural causes, are resulting in increased flooding and flood-related damage. Increasing losses from flooding are challenging resilience building efforts across the nation, especially in our underserved and disadvantaged communities. Thankfully, more sophisticated engineering and modeling are improving our ability to identify and determine existing and future flood hazards and risks. However, these new complex methods may create challenges for some communities that participate in the National Flood Insurance Program (NFIP) and for those who support them in complying with minimum NFIP floodplain management requirements.

Challenges and Opportunities – FEMA's Request of the TMAC

Opportunities to address these challenges are the focus of the Federal Emergency Management Agency's (FEMA's) Memorandum dated April 11, 2023, from Michael Grimm, Assistant Administrator for Risk Management (see Appendix A). In the memorandum, FEMA asks the Technical Mapping Advisory Council (TMAC) to consider addressing the following:

TMAC Topic 1

Recommend if/how FEMA should modify the definition of the Special Flood Hazard Area (SFHA) [and] modify how the SFHA is currently calculated (without redefining it). Today, the SFHA is currently defined as "the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in a given year."

TMAC Topic 2

Recommend how FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded to be at or above estimated 1% annual chance exceedance flood levels (or BFEs).

TMAC Topic 3

Investigate and recommend ways for communities to overcome the administrative and technical challenges of implementing two-dimensional hydrologic and hydraulic modeling for regulatory floodplain management purposes.

TMAC Topic 4

Explore community/public product acceptance as FEMA presents regulatory flood hazard data, future conditions data, pluvial data, and graduate[d] hazard data through probabilistic methods to the public. Recommend ways that FEMA can represent all this complex data, with the possibility of additional third-party data, in a way that helps minimize confusion and increases usefulness toward reducing flood risk and disaster suffering.

The four topic areas are highly interrelated, and all directly impact how state, local, tribal, and territorial (SLTT) governments might manage flood risk, including requirements associated with the administration of the NFIP. Taking into consideration uncertainties around current estimates of flood hazards and risks and using future estimates of how those hazards and risks may change with time are just two ways the NFIP can improve our nation's flood risk management posture. To date, 20 states have adopted standards above the federal minimum NFIP participation requirements to reduce or avoid future flood losses. While FEMA estimates that over 80% of its roughly 22,600 NFIP-participating communities are deploying higher standards because of state and local leadership, some communities lack the political support necessary to adopt higher standards and many lack the capacity and capability to take advantage of new flood risk management tools and techniques.

Objectives – The Purpose Behind the Recommendations

To guide its efforts in developing recommendations, the TMAC identified six objectives as shown in Figure ES-1. At a high level, these objectives align with those of the NFIP and FEMA's current strategic plan and they include reducing flood damage and the resulting human suffering, improving flood risk management capability, and facilitating a smooth transition to optimize success should FEMA choose to implement the TMAC's recommendations as presented in this report.

The Process – Developing Ideas and Bringing in Other Voices

To conduct its assessment of the topics and develop recommendations, the TMAC took a slightly different approach than it has in the past by using a Design Sprint process to develop conceptual recommendations. The Design Sprint process was followed by facilitated listening sessions with floodplain management subject matter experts in which the TMAC shared its thinking on the topics and received feedback

Figure ES-1: The TMAC's six 2023 overarching objectives

to help inform the TMAC's development of its final recommendations. Using this approach, the TMAC developed 12 recommendations, which are summarized in Table ES-1. If implemented, the recommendations would improve how flood hazard data and products are produced and used to manage flood risk and reduce future flood losses.

Early Focus – Issuance of an Interim Report

At the time the TMAC began developing this report, FEMA was contemplating modifications to the floodplain management requirements for participation in the NFIP (Title 44 of the Code of Federal Regulations [CFR] Section 60.3). Given the strong ties between Topics 1 and 2 and FEMA's ongoing review of NFIP floodplain management requirements, FEMA asked the TMAC to focus its early efforts in these areas. Therefore, the TMAC assessed Topics 1 and 2 first and issued an Interim Report dated October 30, 2023. The report includes six recommendations, which have been incorporated with modifications into this final TMAC report for 2023. This report supersedes the Interim Report.

Recommendations, Topic Areas, and Objectives – A Summary

Table ES-1 shows how the 12 recommendations, 4 topic areas, and 6 objectives weave together, demonstrating how inter-related these issues are. All four topic areas are covered by multiple recommendations. Each recommendation helps advance multiple objectives, and many of the objectives are supported by multiple recommendations. The interconnectedness shows quite clearly how flood hazard and risk data are inherently linked to sound floodplain management, how important it is to report change and collaborate to tackle these challenges, and how many of the recommendations are aligned with improving data usability and flood hazard and risk communication.

In developing the 12 recommendations, the TMAC also provided suggestions on their implementation. These suggestions identify impacts and possible outcomes that FEMA should consider in implementing the recommendations. For example, FEMA needs to weigh the potential impacts implementation of the 12 recommendations may have on disadvantaged communities, mandatory purchase, flood insurance affordability, levee accreditations, and the current Community Rating System (CRS).

Table ES-1: TMAC 2023 Recommendations

Recommendation	Objectives					
	1 Reduce the number and overall magnitude of uninsured losses	2 Reduce future flood losses compared to maintaining the status quo	3 Improve transparency around the potential impacts that climate change and proposed development may have on flood risks to people, property, and the environment	4 Improve usability and communication of hazard and risk data	5 Improve technical credibility of hazard and risk data	6 Facilitate a smooth transition and management of technical and administrative changes
TMAC Topic 1 Recommend a new definition for the SFHA						
AR-45 FEMA should develop two new flood hazard areas: a. New Special Flood Hazard Area (SFHA) – to be used for determining mandatory purchase requirements more confidently based on existing conditions. b. New Flood-Prone Area (FPA) – to be used for floodplain management requirements based on future conditions	●	●		●	●	
AR-46 FEMA should develop new Special Flood Hazard Areas (SFHAs) based on the existing 1% annual-chance flood at the 95% confidence limit, not the median (50% confidence limit), as is currently done.	●	●		●	●	
AR-47 FEMA should require new Flood-Prone Areas (FPAs), used for floodplain management, to be based on 1% annual-chance future conditions (including land use and climate change) at the 95% confidence limit.	●	●	●	●	●	
AR-48 FEMA should develop 0.2% annual-chance flood estimates for existing conditions at the 95% confidence limit and evaluate the need for a future condition equivalent.	●			●	●	
TMAC Topic 2 Recommend ways to improving fill-based SFHA modification procedures						
AR-49 FEMA should include all requirements related to the placement of fill in Flood-Prone Areas (FPAs) within the floodplain management requirements in 44 CFR 60.3.		●	●	●		
AR-50 FEMA should require participating communities, as part of permitting duties, to quantify and place on file the impacts of proposed fill and other development on flood stages and the environment prior to issuance of the fill permit. When increases in flood elevation or potential negative environmental consequences are found and cannot be mitigated, at a minimum, impacted people and businesses and appropriate environmental agencies must be notified prior to permit issuance.			●	●	●	
TMAC Topic 3 Recommend how to overcome 2D Flood Modeling challenges **TMAC Topic 4** Recommend ways to represent complex data						
AR-51 FEMA should collaboratively establish new standards, guidance, and tools related to the development and use of data for the 2D modeling framework.				●	●	●
AR-52 FEMA should establish a standard regarding when changes to the new Special Flood Hazard Area ($SFHA_{95\%}$) or new Flood-Prone Area ($FPA_{95\%FC}$) are warranted.				●	●	●
AR-53 FEMA should establish an information technology (IT) infrastructure to support user needs in a 2D environment.				●	●	●
AR-54 FEMA should establish and distribute for comment a draft rolling Transition Plan for implementing recommendations in this 2023 TMAC Annual Report and other future programmatic changes.				●	●	●
AR-55 FEMA should develop, in partnership with states, tribes, and territories, a guidance document to assist them in drafting a new model NFIP participation ordinance that addresses recommendations outlined in this 2023 TMAC Annual Report.		●	●	●		●
AR-56 FEMA should develop, deploy, and facilitate training for implementing recommendations in this 2023 TMAC Annual Report and other future programmatic changes.				●	●	●

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Acronyms

1D	one-dimensional
2D	two-dimensional
ADFO	Alternate Designated Federal Officer
AEP	annual exceedance probability
AR	Annual Report
ASCE	American Society of Civil Engineers
ASFPM	Association of State Floodplain Managers, Inc.
BFE	base flood elevation
BW-12	Biggert-Waters Flood Insurance Reform Act of 2012
CFM	Certified Floodplain Manager
CFR	Code of Federal Regulations
CLOMR	Conditional Letter of Map Revision
CTP	Cooperating Technical Partners
DFO	Designated Federal Officer
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FHWA	Federal Highway Administration
FIMA	Federal Insurance and Mitigation Administration
FIRM	Flood Insurance Rate Map
FPA	Flood-Prone Area
$FPA_{50\%}$	FPA based on existing conditions 1% annual-chance flood at the 50% confidence limit (mean)
$FPA_{95\%FC}$	Proposed FPA based on future conditions 1% annual-chance flood at the 95% confidence limit, to be used for floodplain management
FRM	flood risk management
FY	fiscal year
GIS	geographic information system
H.R.	House of Representatives
ISAA	Information Sharing Access Agreement
IT	information technology
LIDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
LOMR-F	Letter of Map Revisions Based on Fill
NAFSMA	National Association of Flood and Stormwater Management Agencies
NFIP	National Flood Insurance Program
NGP	National Geospatial Program
NOAA	National Oceanic and Atmospheric Administration
QA	quality assurance
QC	quality control
RFI	Request for Information
Risk MAP	Risk Mapping, Assessment, and Planning Program
SME	subject matter expert
SFHA	Special Flood Hazard Area
$SFHA_{50\%}$	SFHA based on existing conditions 1% annual-chance flood at the 50% confidence limit (mean)
$SFHA_{95\%}$	Proposed SFHA based on existing conditions 1% annual-chance flood at the 95% confidence limit, to be used for mandatory purchase requirements
SFHDF	Standard Flood Hazard Determination Form
SLTT	state, local, tribal, and territorial
TMAC	Technical Mapping Advisory Council
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USDOT	U.S. Department of Transportation

Chapter 1
Introduction

Chapter 1 Introduction

Helping Americans before, during, and after disasters is the Federal Emergency Management Agency's (FEMA's) mission. One way FEMA helps is by comprehensively assessing flood hazard and risk throughout the nation and disseminating the resulting flood hazard and risk data. The data are then used by all levels of government (federal, state, local, tribal, and territorial [SLTT]), businesses, and individuals to guide mitigation decision-making, manage floodplains, and determine flood insurance pricing.

FEMA accomplishes its assessment through the mapping arm of the National Flood Insurance Program (NFIP) and the Risk Mapping, Assessment, and Planning Program (Risk MAP) (collectively referred to as the National Flood Mapping Program).

The Technical Mapping Advisory Council (TMAC), a federal advisory committee, supports FEMA in its flood hazard identification and risk assessment efforts by reviewing how FEMA carries out its responsibilities for the National Flood Mapping Program—as directed by the Biggert-Waters Flood Insurance Reform Act of 2012 (42 United States Code [U.S.C.] Sections 4001–4130) (BW-12) and the Homeowner Flood Insurance Affordability Act of 2014—and recommending ways that FEMA can improve.

National Flood Insurance Program

FEMA administers the NFIP, which was created with the passage of the National Flood Insurance Act of 1968. The NFIP is an insurance, mapping, grant, and floodplain management program that makes federally backed flood insurance available to home and business owners and renters in communities that voluntarily participate in the program. By participating in the NFIP, communities agree to adopt ordinances and enforce minimum floodplain management requirements that reduce the risk of flooding.

1.1 TMAC Background

Since being established in 2013, the TMAC has continued to successfully implement its mandate as outlined in BW-12. The TMAC has developed reports and recommendation since its inception (see Section 1.1.3 for details).

1.1.1 TMAC Authorization

BW-12 mandates that FEMA establish a federal advisory committee to provide advice and recommendations to improve the preparation of Flood Insurance Rate Maps (FIRMs) created under the NFIP and on future risks from climate change, rising sea levels, and development. Pursuant to BW-12, FEMA filed the original charter with Congress on July 29, 2013, formally establishing the TMAC (FEMA 2013).

The TMAC views components of today's NFIP as significant to a new, much stronger foundation for an improved national flood risk management (FRM) framework that recognizes the complex nature of flood risk and the diverse ways in which it is managed.

1.1.2 TMAC Responsibilities

The TMAC's Charter outlines the principles and functions of the TMAC, including the objectives and scope of TMAC activities, description of

duties, member composition, frequency of meetings, and other pertinent items related to the TMAC's establishment and operation (FEMA 2023). The TMAC's bylaws establish and describe rules of conduct, regulations, and procedures regarding its membership and operation (FEMA 2021).

According to the TMAC Charter, one of the TMAC's primary responsibilities is the submittal of an annual report to the FEMA Administrator. The report must include a description of the TMAC's activities, its evaluation of the "status and performance of FIRMs and mapping activities to revise and update FIRMs," and its recommendations to ensure that the FIRMs reflect the best available science and are based on the best available methodologies for considering the impact of future development on flood risk. Past efforts since the TMAC's establishment are summarized in Table 1-1. Previous annual reports are available on FEMA's TMAC website at https://www.fema.gov/flood-maps/guidance-reports/technical-mapping-advisory-council/reports.

1.1.3 TMAC Activities

The 16 documents that the TMAC has published since 2015, including this 2023 annual report, are listed in Table 1-1. In addition to nine annual reports, the TMAC has produced two interim reports, two summary reports, and three other reports. These reports include a total of 147 formal recommendations (including those in this report), with accompanying implementation actions. Formal recommendations from the TMAC are those that FEMA should strongly consider and implement to the extent possible within the authorities of its program. Implementation actions (referred to in this report as "implementation suggestions") provide suggestions on how to implement the formal recommendations but are not recommendations. The TMAC's reports were provided under the authorities and responsibilities described in Sections 1.1.1 and 1.1.2.

1.2 2023 TMAC

This section presents the 2023 TMAC members and describes the focus of the 2023 TMAC.

1.2.1 TMAC Members and Designated Federal Officers

The 2023 TMAC members are listed in Table 1-2. The designated federal officers (DFOs) are listed in Table 1-3.

Table 1-1: TMAC Annual Reports and Other Reports

Year	Report*
2015	TMAC 2015 Future Conditions Risk Assessment and Modeling Report TMAC 2015 Future Conditions Report – Interim TMAC 2015 Annual Report TMAC 2015 Annual Report Summary TMAC 2015 Annual Report – Interim
2016	TMAC 2016 National Flood Mapping Program Review TMAC 2016 Annual Report
2017	TMAC 2017 Annual Report
2018	TMAC 2018 Annual Report TMAC Annual Report Summary
2019	TMAC 2019 Annual Report (Memorandum)
2020	TMAC 2020 Annual Report
2021	TMAC 2021 Annual Report
2022	TMAC 2022 Annual Report
2023	TMAC 2023 Final Interim Report (superseded) TMAC 2023 Annual Report

*Links to the reports in this table are provided in Appendix B.

Table 1-2: TMAC Member List

Name	BW 12 Membership Title	Job Title, Company/Agency
Doug Bellomo (TMAC Chair)	Engineering Member	AECOM
William Lehman	USACE Representative	U.S. Army Corps of Engineers (USACE)
Edward Clark	NOAA/Commerce for Oceans and Atmosphere Designee	Deputy Director, Office for Water Prediction, National Oceanic and Atmospheric Administration (NOAA)
Maria Cox Lamm	NFIP Coordination Offices Representative	State NFIP Coordinator, South Carolina Department of Natural Resources
Vincent DiCamillo (TMAC Vice Chair)	Mapping Member	Senior Principal, Stantec Consulting
Scott Giberson	Flood Hazards Determination Firm Member	Compliance Principle, CoreLogic Flood Services
Jamie Reinke (Subcommittee 2 Co-Chair)*	State Cooperating Technical Partner Representative	Team Leader Floodplain Management Section Nebraska Department of Natural Resources
Brooke Seymour (Subcommittee 2 Co-Chair)*	Regional Flood and Storm Water Management Organization Member	Planning and Floodplain Management Director Mile High Flood Control District
Ataul Hannan	Local Cooperating Technical Partner Representative	Planning Division Director, Harris County Flood Control District
Luis Rodriguez	FEMA Designee	Director, Engineering and Modeling Division, Federal Insurance and Mitigation Administration (FIMA), Federal Emergency Management Agency (FEMA)
Jonathan Smith	U.S. Department of Agriculture Designee	Director, Resource Inventory Division, Natural Resources Conservation Service
Jeff Sparrow (Subcommittee 1 Chair)*	Floodplain Management Member	Vice President, Moffatt & Nichol
Stephen Aichele	U.S. Geological Survey Representative	National Geospatial Program (NGP) - Hydrography Program and Planning Lead
Stacey Archfield	Department of the Interior Designee	Research Hydrologist, U.S. Geological Survey Water Mission Area
Ronald Jacobson	Surveying Member	Survey Manager, Coleman Engineering

*Refer to Section 1.2.2 for a description of the subcommittees' focus areas.

Table 1-3: Designated Federal Officers

Name	FEMA Title	DFO / ADFO
Brian Koper	Emergency Management Specialist, Resilience	DFO
Sarah Abdelrahim	Emergency Management Specialist, Resilience	ADFO
David Rosa	Emergency Management Specialist, Resilience	ADFO
John Ebersole	Attorney, Resilience Legal Division	TMAC Legal Counsel/ADFO

ADFO = Alternate Designated Federal Officer
DFO = Designated Federal Officer

Members of the TMAC include designated members and additional members appointed by the FEMA Administrator, as set forth in the bylaws. The designated members are:

- FEMA Administrator or designee
- Secretary of the Interior or designee
- Secretary of Agriculture or designee
- Under Secretary of Commerce for Oceans and Atmosphere or designee

The FEMA Administrator or designee appoints the 16 additional members of the TMAC. These members are appointed based on their demonstrated knowledge and competence regarding surveying, cartography, remote sensing, geographic information system (GIS) software, or the technical aspects of preparing and using FIRMs. Currently, the TMAC has 15 appointed members (see Table 1-2).

To the maximum extent practicable, the TMAC's membership will have a balance of federal, state, local, tribal, and private members, and will reflect geographic diversity through representation from states with a coastline or other area(s) identified by the FEMA Administrator as at high risk for flooding or as Special Flood Hazard Areas (SFHAs).

1.2.2 2023 TMAC Focus

Every year, FEMA asks the TMAC to focus its efforts in specific areas to complement efforts FEMA is already undertaking to adapt and improve delivery of the National Flood Mapping Program. There is general agreement that changes in our nation's land surface and climate, due to both human and natural causes, are resulting in increased flooding and damage. Opportunities to help address this challenge are the subject of FEMA's memorandum dated April 11, 2023, from Michael Grimm, Assistant Administrator for Risk Management (the memorandum is provided in Appendix A). Specifically, FEMA asked the TMAC to address the following topics, quoted below:

TMAC Topic 1

Recommend if/how FEMA should modify the definition of the Special Flood Hazard Area (SFHA) [and] modify how the SFHA is currently calculated (without redefining it). Today, the SFHA is currently defined as "the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in a given year."

TMAC Topic 2

Recommend how FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded to be at or above estimated 1% annual chance exceedance flood levels (or BFEs).

TMAC Topic 3

Investigate and recommend ways for communities to overcome the administrative and technical challenges of implementing two-dimensional hydrologic and hydraulic modeling for regulatory floodplain management purposes.

TMAC Topic 4

Explore community/public product acceptance as FEMA presents regulatory flood hazard data, future conditions data, pluvial data, and graduate[d] hazard data through probabilistic methods to the public. Recommend ways that FEMA can represent all this complex data, with the possibility of additional third-party data, in a way that helps minimize confusion and increases usefulness toward reducing flood risk and disaster suffering.

The TMAC recognized that assessment of these four topics and the resulting recommendations represent a significant undertaking and a once-in-a-lifetime opportunity to help put the nation on a better path in the face of increasing flood damage and flood risk. Social, economic, and environmental rewards seldom come without risk-taking. The recommendations outlined in this report are aimed at bringing better alignment to the risk-reward balance. This realignment is necessary and in part made possible because, under the NFIP, flood insurance pricing is influenced less by the data used for floodplain management than it once was. As the TMAC recommendations are considered, FEMA should recognize the potential impacts their implementation may have on disadvantaged communities, mandatory purchase, flood insurance affordability, levee accreditations, and the current Community Rating System (CRS).

The approach and process used by the TMAC to assess these topics and develop recommendations are briefly described later in this chapter and discussed in greater detail in Chapter 2. To incorporate feedback from the Design Sprint and listening sessions discussed in Chapter 2 and to develop preliminary recommendations and considerations, the TMAC formed the following two subcommittees:

- Subcommittee 1 was focused on the proposed new and refined definition of the SFHA, and on how fill placed in the SFHA should be considered (Topics 1 and 2).
- Subcommittee 2 was focused on how communities might overcome the administrative and technical challenges of implementing two-dimensional (2D) hydrologic and hydraulic modeling for regulatory floodplain management purposes, and on how to get stakeholders to understand and better accept new and complex flood hazard and risk data (Topics 3 and 4).

The subcommittee chairpersons are identified in Table 1-2.

1.2.3 Overview of 2023 TMAC Activities

The TMAC began its 2023 efforts with an administrative meeting on May 15, 2023, in which FEMA provided additional context around its 2023 Memo. Throughout the period of its assessment and report development, the TMAC held six public-facing meetings, which included time for public input, and five administrative internal working meetings, as summarized in Figure 1-1 and described in Table G-1.

Development of TMAC 2023 Objectives

As the TMAC assessed the issues, considered stakeholder feedback as part of the Design Sprint process, and reviewed previous industry feedback from responses to a FEMA November 2021 Request for Information (see Appendix E), it developed the six overarching objectives shown in Figure 1-2. These objectives provided guiding perspective in developing the recommendations in this report.

Interim Report

To support FEMA's efforts as it considers modifications to Title 44 of the Code of Federal Regulations (CFR) part 60.3, *Flood plain management criteria for flood-prone areas*, FEMA asked the TMAC to focus its early work on Topics 1 and 2, described in Section 1.2.2 above. Therefore, the TMAC assessed those two topics first and issued an Interim Report, dated October 30, 2023. The content of that report included six recommendations, which have been incorporated with modifications into this final 2023 TMAC Report.

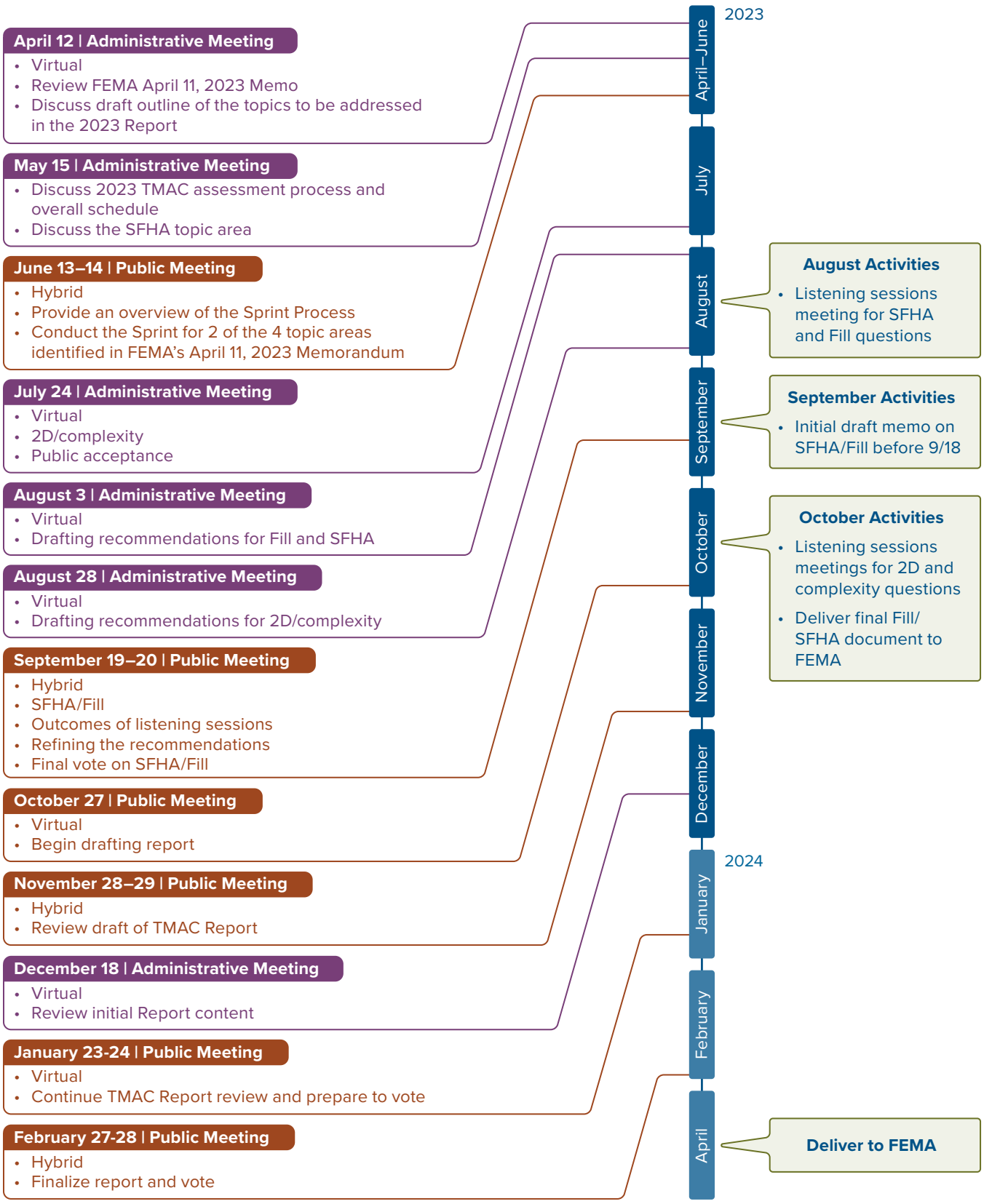


Figure 1-1: TMAC meetings in 2023

Figure 1-2: The TMAC's six 2023 overarching objectives

1.2.4 Organization of TMAC Report

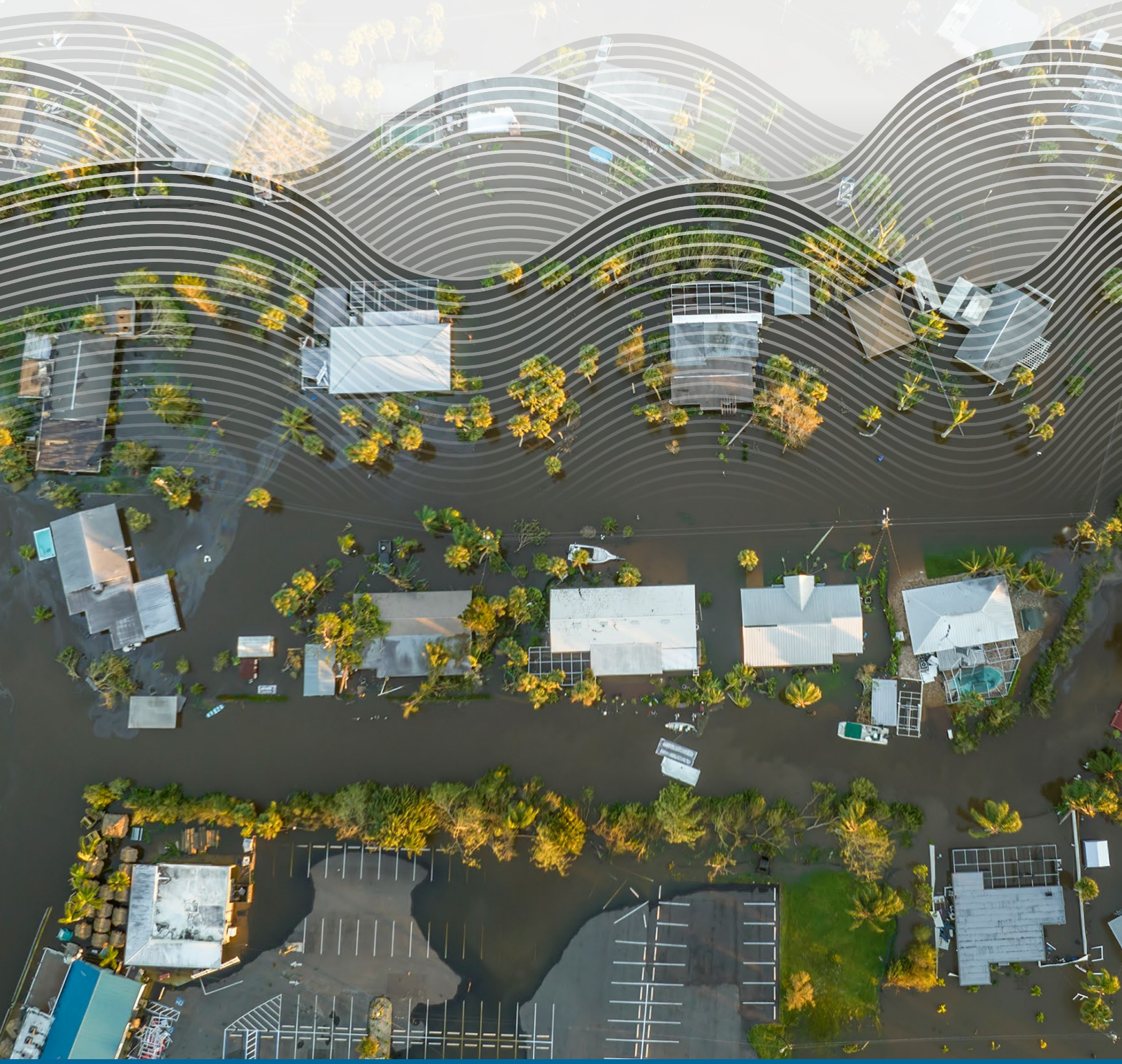
The 12 recommendations developed by the TMAC are presented in Chapters 3, 4, 5, and 6. Each recommendation is followed by a rationale and implementation suggestions that FEMA should consider when implementing the recommendations (shown in highlighted text boxes). Collectively, the 12 recommendations meet the overarching objectives established by TMAC.

Appendices provide additional support material as follows:

- Appendix A: FEMA 2023 Memorandum
- Appendix B: References
- Appendix C: Feedback from Listening Sessions
- Appendix D: Feedback from Listening Sessions
- Appendix E: FEMA RFI Assessment
- Appendix F: Statistical Analysis of the Mean 1% Annual-Chance Event and the 95% Confidence Limit 1% Annual-Chance Event
- Appendix G: TMAC Meetings and Activities
- Appendix H: Previous TMAC Recommendations Referenced in 2023 TMAC Report

Chapter 2

TMAC Approach to 2023 Assessment and High-Level Results



Chapter 2 TMAC Approach to 2023 Assessment and High-Level Results

The TMAC's traditional approach to assessing topics and developing recommendations for FEMA has been to assign the TMAC members to subcommittees that best align with their areas of expertise and to have each subcommittee assess their assigned topic(s), develop content, and draft recommendations to present to the entire TMAC membership for review, debate, and final approval. In 2023, the traditional approach was changed to a modified Design Sprint process to maximize participation of the full TMAC membership and subject matter experts (SMEs) in the review, assessment, and debate of all topic areas (see Section 2.1).

The Design Sprint process allowed the full TMAC to jointly explore the issues, define the problems, and develop and refine potential solutions. The outcomes of the process—the draft conceptual recommendations—were then shared in expertly facilitated listening sessions (see Section 2.2). The outcomes of the Design Sprint process and subsequent listening sessions were then handed off to the two TMAC subcommittees to formulate the draft final recommendations. Details of the Design Sprint process and the listening sessions are described further below.

Design Sprint

The Design Sprint concept was developed by Google and has been used widely to drive teams to conclusions on business and governmental questions and problems.

2.1 Design Sprint Process to Assess Topics and Issues

The Design Sprint has five phases: Map, Sketch, Decide, Prototype, and Test (see Figure 2-1). Each phase is typically completed in a single day. In the modified Design Sprint process developed for the TMAC, the process was divided into 2- to 6-hour sessions that took place during the TMAC's public and administrative meetings (see Table G-1). The TMAC first conducted a Design Sprint to develop recommendations for Topics 1 and 2. While this first Design Sprint process was underway, the TMAC initiated a concurrent Design Sprint to address Topics 3 and 4. The phases and the TMAC's work during the phases are described in the sections that follow.

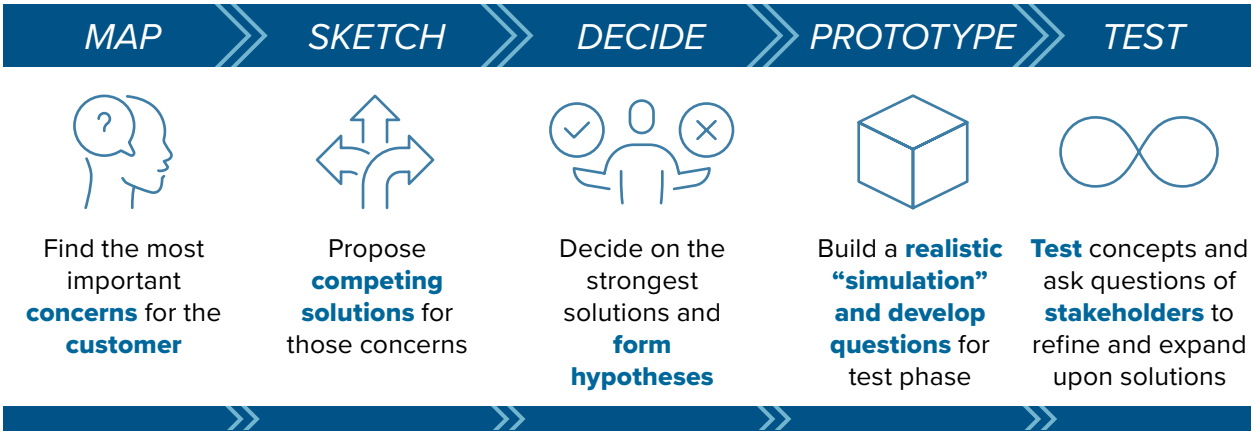


Figure 2-1: Design Sprint process

2.1.1 Map Phase

In the Map Phase, the TMAC identified the users for each of FEMA's requests and the outcome that those customers seek. The TMAC then conducted "Ask the Expert" sessions with experienced users and SMEs related to each request. Next, based on the TMAC's expertise and the "Ask the Expert" sessions, the TMAC developed maps that showed the flow of how each customer currently achieves an outcome, allowing the TMAC to identify the issues and concerns. See Figure 2-2 for an example. Lastly, the TMAC evaluated which issues and concerns could be addressed through its recommendations and which ones were outside FEMA's control. At the conclusion of the Map Phase, the TMAC voted to determine whether change was needed based on the issues or concerns that existed (see Table G-1 for dates of the meetings and decisions).

2.1.2 Sketch Phase

In the Sketch Phase, the TMAC members worked individually to brainstorm and sketch out potential solutions to the issues and concerns identified in the Map Phase. Each member then presented their best ideas to the group, including examples of where they had seen similar solutions implemented in industry. The TMAC then collaborated to combine aspects of the potential solutions and add additional detail where needed.

2.1.3 Decide Phase

In the Decide Phase, the TMAC narrowed the potential solutions developed in the Sketch Phase to a smaller set of potential solutions that the members believed had the most potential value. The TMAC discussed the merits of each potential solution and identified which potential solutions, or parts of potential solutions, to move forward with. The potential solutions were then summarized into concepts described as the "Initial Thinking" of the TMAC's recommendations. At the end of the Decide Phase, subcommittees were formed to work on the Prototype Phase. Subcommittee 1 formed following the Sprint Decide Phase on Topics 1 and 2, while Subcommittee 2 formed following the Sprint Decide Phase on Topics 3 and 4.

When the TMAC addressed Topic 4, the Decide Phase was different as compared to the three other topics (described above). Because the request was exploratory in nature, more time was spent brainstorming the issues that these products would face regarding acceptance. Less work was done by the entire TMAC in addressing these issues during this phase, and Subcommittee 2 placed a greater emphasis on identifying potential solutions to those issues before moving to the next phase.

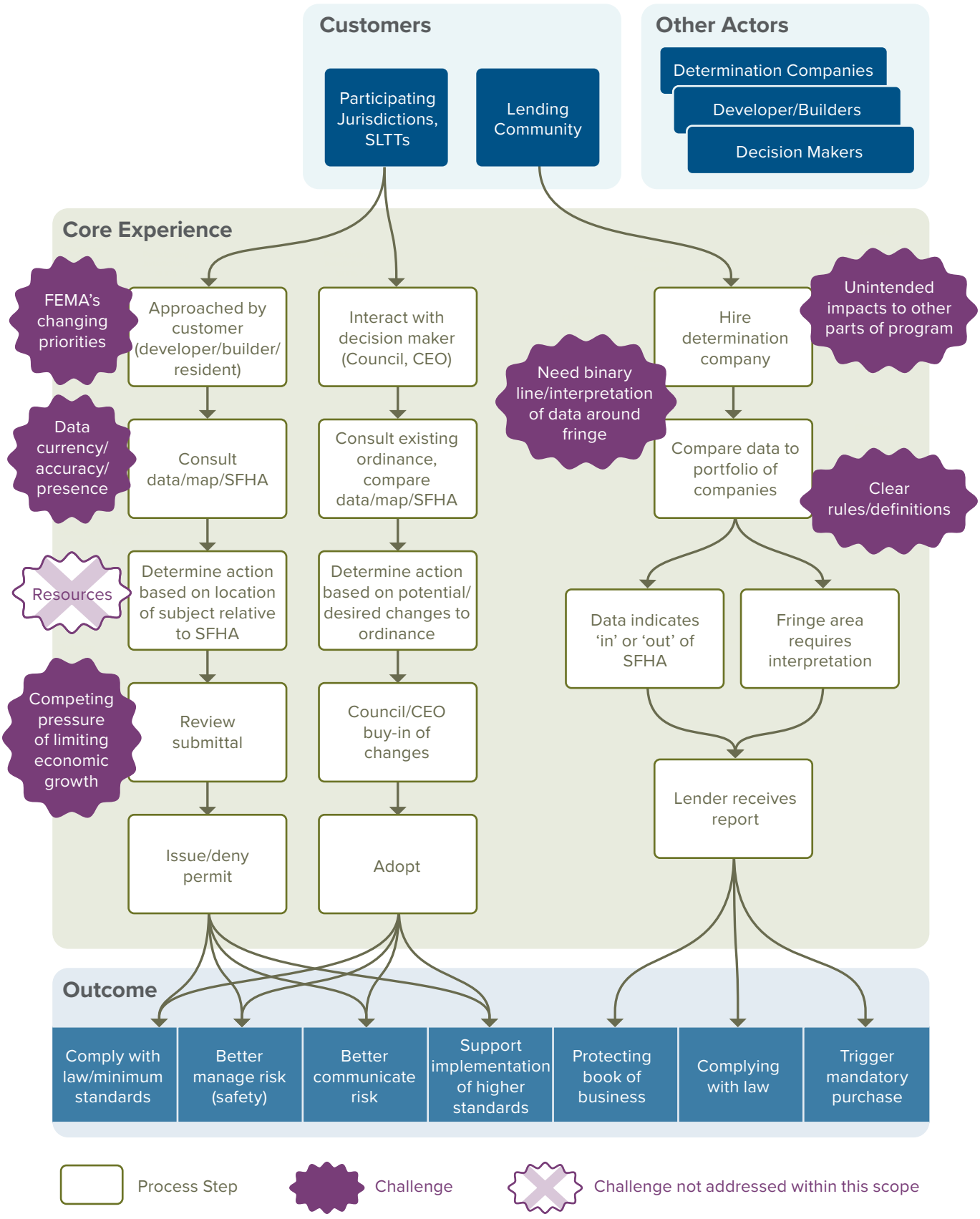


Figure 2-2: Example map from the Map Phase

2.1.4 Prototype Phase

In the Prototype Phase, the subcommittees laid out the Initial Thinking into a more detailed and consumable product that could be shared with others for their input. The subcommittees addressed any gaps in the Initial Thinking that would make the Initial Thinking easier to understand and then evaluated how best to present the Initial Thinking to stakeholders for feedback during the listening sessions. This phase resulted in a presentation that would be used in the Test Phase (see sample themes in Figure 2-3).

2.1.5 Test Phase (Listening Sessions)

In the Test Phase (referred to as listening sessions in this report), an expert facilitator conducted a series of listening sessions with a variety of stakeholders who matched the customers identified in the Map Phase. The Prototype presentation was shared in a series of sessions for feedback. Subcommittee members listened to these sessions and generated reports from the feedback that was received. The outputs of the listening sessions are discussed further in Section 2.2.

2.1.6 Concluding the Design Sprint

Once the Test Phase was completed, the subcommittees reviewed the resulting listening session reports and worked to revise the Initial Thinking. The revised Initial Thinking was presented to the full TMAC, and discussions proceeded to finalize the recommendations that are presented in this report.

Listening Session Findings Shaped Recommendations

The TMAC used input from the listening sessions to shape its recommendations. This feedback resulted in modifications to the originally developed recommendations. Additional references to the listening sessions can be found in Chapters 3 through 5.

2.2 Listening Sessions to Support Assessment and Recommendations

The listening sessions (as described in Section 2.1.5, Test Phase) were designed to share the TMAC's Initial Thinking with a wider audience and to gather feedback to inform its work.

Two sets of listening sessions were conducted. The first set focused on if/how the definition of the SFHA should be modified (Topic 1) and whether FEMA should consider changing the procedures to modify the SFHA when land is filled or graded (Topic 2). The second set explored the administrative and technical challenges of implementing 2D hydrologic and hydraulic modeling for regulatory floodplain management purposes (Topic 3) and the best ways for FEMA to present complex data (Topic 4). See Figure 2-4 for session dates, the total number of participants in each session set, and the number of participants from each identified stakeholder group. Local government officials were just under half of the participants, reflecting their status as a key audience. "Other professionals" included engineers, consultants, and other individuals who work in floodplain management, but not represented in another category.

Initial Thinking: SFHA and Fill (Topics 1 and 2)

Hazard Areas

Special Flood Hazard Area
1% annual-chance area with mandatory purchase.
Fill does not remove the SFHA designation.

Current Conditions Hazard Area
Current conditions for 1% annual-chance and other events potentially to include up to Probable Maximum Flood (PMF). Informational tool for officials, developers, and public.

Future Conditions Hazard Areas
Future conditions for 1% annual-chance and other events potentially to include up to PMF. Used by local officials to regulate development.

Use of Fill in Hazard Areas

Flood Fringe
Fill allowable after no-impact analysis.

Floodway
Fill allowable if it meets current regulatory requirements and no impact determined.

Initial Thinking: 2D Modeling and Complex Data (Topics 3 and 4)

2D Modeling

FEMA should mature its existing guidance and move toward finalizing its first set of standards for 2D methods including standardized input and output files.

FEMA should develop and roll out design standard tools and training to help communities meet minimum participation requirements while helping stakeholders make more risk informed decisions using 2D model outputs. Note that there is equal emphasis on tools and on training.

FEMA should consider modifying policies and minimum NFIP participation requirements that contemplate the delivery of 2D datasets being made available.

Complex Flood Risk Data

Conduct wider reviews and have other/outside experts affirm the data to increase trust in it.

Encourage that this data be incorporated into a master plan. Update to show how it can be used and how to mitigate risk.

Work to change the conversation to managing risk rather than managing floodplains.

Develop tools that make common usage of the data simple to perform and understand.

Outreach should expand to include billboards, PSAs and door hangers, featuring non-engineers in the materials.

Invest in education campaign for realtor community so they can help bridge the gap in educating the public on their individual risk.

Bring the community into the process early and develop local champions of the data and products.

Offer training for a variety of users at different levels of understanding for using this complex data.

Change administrative policies and rules to align with the outputs of these complex data sets.

Figure 2-3: Themes for Initial Thinking shared during listening sessions

Each of the 29 sessions lasted 1 hour and were conducted virtually by a professional facilitator. The process for both sets of listening sessions was the same. At the start of each session, the facilitator presented information on the TMAC, identified the topics the TMAC was investigating, presented various challenges identified by the TMAC related to each topic, and described the TMAC's Initial Thinking (as described in Section 2.1.4, Prototype). Participants were invited to share their initial reactions and then asked to provide input on a series of guided discussion questions. TMAC members and FEMA employees observed the sessions and provided clarifying information as needed. All sessions were recorded and transcribed.

At the conclusion of each set of sessions, transcripts were analyzed, and findings were developed based on a thematic analysis of the transcripts. The research was qualitative and designed to capture feedback from stakeholders in their own words. While efforts were made to recruit a diverse set of participants, findings cannot be generalized. In this report, qualitative descriptors are used to capture the extent of agreement among participating stakeholders. For example, words such as "broadly," "most," and "many" are used to indicate areas in which there was substantial (but not complete) agreement. Words such as "a few" and "some" indicate areas in which a minority opinion was expressed by several (but fewer than half) of all participants.

Written results from each set of listening sessions are included in Appendices C and D Brief highlights of findings from each set of sessions are included below. The TMAC used these findings to inform its thinking.

2.2.1 Highlights from First Set of Listening Sessions: Definition of SFHA and Placement of Fill in the SFHA (Topics 1 and 2)

Themes of participant responses from the first set of listening sessions follow:

- Participants supported having the SFHA as a distinct layer. However, participants thought the SFHA needs to be clear and binary so it is obvious who is and is not required to purchase insurance. Participants concurred with maintaining the SFHA at a 1% or higher chance of flooding. They noted this value is established and well understood. However, many noted that more accurate data sources may de facto adjust the 1% to better reflect actual risk (and thus increase the number of affected properties). This kind of de facto adjustment was seen as acceptable.
- Most participants supported moving toward future conditions as a floodplain management regulatory area. There was widespread acknowledgment that more flood events are happening outside the SFHA. However, regulating to future conditions was seen as complex.
- Participants did not agree about whether the placement of fill should eliminate mandatory purchase requirements for flood insurance. Interest groups and lenders supported the idea of not allowing fill to eliminate mandatory purchase. Local and state officials and other professionals supported this idea more often than opposed it but expressed concerns that were largely related to anticipated pushback from the public. Developers were opposed and stated that fill should continue to eliminate the mandatory purchase requirement.

- Participants expressed strong agreement that maps need to be updated when fill is placed. Doing so is important for proper documentation and also to fully understand the impacts to the rest of the floodplain.
- Participants concurred about the need for clarity, which emerged as a key theme throughout the sessions. Participants were open to different presentations of information (e.g., graduated risk) as long as the presentations were clarifying rather than confusing.

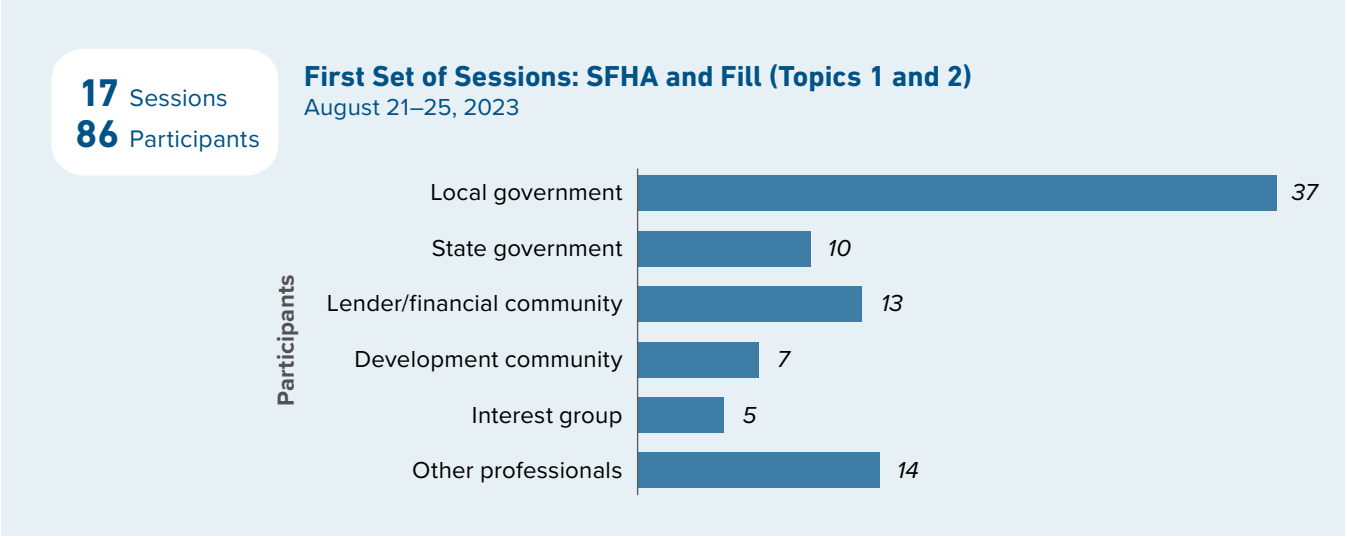


Figure 2-4: First set of listening sessions' participants by participant category

2.2.2 Highlights from Second Set of Listening Sessions: Change to 2D and Complex Data Representation (Topics 3 and 4)

Themes of participant responses from the second set of listening sessions follow:

- Participants were generally in favor of moving to 2D for regulatory floodplain management purposes. They noted that the existing standards are dated and that an update is overdue. Most see the value in 2D as a regulatory tool.
- Participants noted that 2D models often produce more accurate data, which enable better decision-making to reduce flood risk and that 2D is especially helpful for complex flood risk situations.
- Participants noted that many communities/states are already using 2D modeling (though usually not for federal, state, or local regulatory purposes) and that federal regulations and guidance specifically have been lacking in this area. Participants also thought that guidance is important to establishing consistency and encouraging even more communities to use 2D modeling.

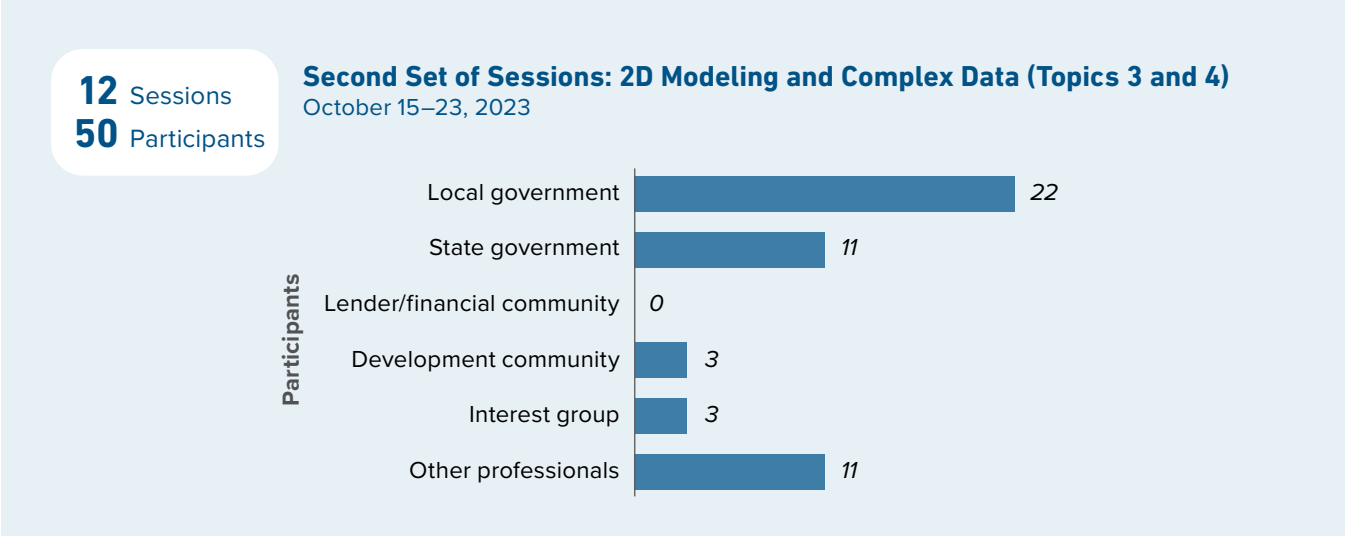


Figure 2-4: Second set of listening sessions' participants by participant category

- Of note, those participants representing smaller communities and developers had more concerns about using 2D modeling, but the concerns tended to reflect caution regarding the speed and scale at which 2D is implemented versus opposition to its adoption.
- Participants expressed various concerns about the transition to 2D, including a significant need for training, ensuring that models are accurate, concerns about model size, and cost considerations. They also noted that one-dimensional (1D) and 2D models may have different outcomes, that key concepts such as floodways may need to be redefined for 2D, and that no-rise is not a realistic standard in a 2D environment.
- Participants recommended that FEMA consider a series of tools to aid in the communication of information gathered via 2D modeling.
- Participants encouraged FEMA to allow adequate time (exact amount not specified) to prepare for the transition and to invest in supportive resources such as training, outreach, education, and financial assistance. They also thought that FEMA should develop and provide technical guidance in addition to updating its regulations.
- Overall, most participants thought communicating flood risk using 2D models would not be harder (communication is already a challenge) and that being able to present data more visually may make communication easier in some cases. They cautioned that 2D models will likely show new hazard areas that communities and residents were previously unaware of and that this may create new communication challenges.

Chapter 3
Review of the Special Flood Hazard Area Definition

Chapter 3 Review of the Special Flood Hazard Area Definition

Chapter 3 describes the outcomes of the TMAC's assessment and the recommendations that were developed related to FEMA's request that the TMAC determine if and how the definition of the SFHA should be revised. The request from FEMA's April 11, 2023, memorandum is as follows:

TMAC Topic 1

Recommend if/how FEMA should modify the definition of the Special Flood Hazard Area (SFHA) [and] modify how the SFHA is currently calculated (without redefining it). Today, the SFHA is currently defined as "the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in a given year."

The first step the TMAC took in addressing the request was to confirm in a formal vote that the definition of the SFHA needs to be reviewed. There was unanimous consensus that opportunities exist to improve the definition in a variety of ways, including how flood hazards are identified and managed.

Chapter 2 of this report describes the Design Sprint process the TMAC used to assess the challenges and develop the four unanimously approved recommendations presented in this chapter.

In developing recommendations for Topic 1, the TMAC considered three overarching objectives:

- Objective No. 1: Reduce the number and overall magnitude of uninsured losses.
- Objective No. 2: Reduce future flood losses compared to maintaining the status quo.
- Objective No. 3: Improve transparency around the potential impacts that climate change and proposed development may have on flood risks to people, property, and the environment.

Rationale for Changing How Flood Hazards are Calculated

Changes in our nation's land surface and climate, due to both human and natural causes, are resulting in increased flooding and damage. The best way to combat both the current and future threat of flooding is to consider the threat in routine land use and design practices. The American Society of Civil Engineers (ASCE) has already started addressing this challenge in ASCE 24-14, Flood Resistant Design and Construction, and Supplement 2, ASCE 7-22, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Additionally, 20 states have adopted standards above the federal minimum NFIP participation requirements to reduce and avoid flood risks.

FEMA estimates that over 80% of its roughly 22,600 NFIP-participating communities are also deploying higher standards as a result of state and local leadership. Several members of the TMAC who have roles of responsibility in floodplain and stormwater management have promoted or implemented higher standards in managing flood risk. By adapting now, these leaders are paving new practical paths for increasing resilience to flooding, and their communities stand to benefit greatly from their actions and long-term thinking.

After discussions and receiving input via listening sessions, the TMAC developed the four recommendations related to the definition of the SFHA that are discussed in the following subsections. Each recommendation is followed by the rationale for it.

The goals of the recommendations are to increase confidence in the delineated floodplain boundaries, better communicate the uncertainties in developing the floodplain boundaries, and equip floodplain managers with tools to better manage flood risks.

By implementing the recommendations described in this chapter, FEMA may be taking some near-term risks (e.g., criticism, cost, disruption to how projects are currently executed) to achieve longer-term benefits (e.g., higher flood resilience). These actions will reduce human suffering, environmental loss, and economic harm resulting from flooding when compared to the status quo.

3.1 Development of Two New Flood Hazard Areas: SFHA and FPA (Recommendation AR-45)

Recommendation AR-45

FEMA should develop two new flood hazard areas:

- New Special Flood Hazard Area (SFHA) – to be used for determining mandatory purchase requirements more confidently based on existing land use conditions
- New Flood-Prone Area (FPA) – to be used for floodplain management requirements based on future conditions

The TMAC is recommending that FEMA develop two flood hazard areas to better meet NFIP objectives.

FEMA has historically equated SFHAs to floodplains or flood-prone areas due partially to the data, technologies, and capabilities that were available when the NFIP maps were being developed in the early 1970s. The following two definitions related to the SFHA are included in 44 CFR Part 59:

> **"Area of special flood hazard/ special flood hazard area"** is the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in any given year. The area may be designated as Zone A on the FHBM. After detailed ratemaking has been completed in preparation for publication of the flood insurance rate map, Zone A usually is refined into Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, or V1-30, VE, or V. For purposes of these regulations, the term "special flood hazard area" is synonymous in meaning with the phrase "area of special flood hazard."
>
> **"Flood plain or flood-prone area"** means any land area susceptible to being inundated by water from any source (see definition of "flooding''). "Flood plain management" means the operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works and flood plain management regulations.

However, we now have the data, technologies, and capabilities to refine the SFHA using a revised method and also to differentiate the SFHA from the flood-prone area. The recommendations in Chapter 3 may not require a change in the above definitions from 44 CFR Part 59, but the

recommendations in Chapter 3 will require a change to FEMA's guidelines and standards.

Defining these two new flood hazard areas serves differing purposes and can more confidently achieve the NFIP's goal of reducing loss of life and property.

The TMAC is recommending that FEMA no longer use the current SFHA for both floodplain management and mandatory flood insurance purchase requirements but rather use a higher confidence limit to represent existing flood hazards for the purpose of mandatory purchase (SFHA) and a separate FPA representing future flood hazards for floodplain management.

Context for Existing and Future Conditions

Flood hazard information is produced using data representing physical characteristics of land and water bodies, models to estimate flooding characteristics such as water depth and flow velocities, and historical measurements of rainfall and past flooding events. In other words, it is an estimate of potential flooding conditions at a given time for a given space. An "existing conditions" flood study is therefore an estimate of what might happen given a current representation of land and water bodies, a current set of scientific methods (models), and measurements of past events.

These elements (physical characteristics of our land and water, scientific practices and methods, and historical events) are dynamic. For example, wildfires can change the landscape significantly in a very short period, new roads and bridges can impact water flow, sea level rise can change the shape of our water bodies over longer timeframes, and science is constantly being improved. A "future conditions" flood study is one that attempts to estimate what flood hazards may look like given expected physical changes to a watershed (generally limited to planned human activities such as encroaching in floodplains or adding impervious surface within a watershed) and expected changes in our weather and climate due to increasing temperatures and other factors.

3.1.1 SFHA: Existing and New

The TMAC is recommending that the new SFHA continue to be based on existing conditions (land use, physical conditions, and flooding conditions such as rainfall and flows) for the purposes of applying the federal mandatory flood insurance purchase requirement, which applies to mortgages with a federal nexus (mandatory purchase; see 42 U.S.C. 4012a). One key distinction between the current SFHA and the proposed new SFHA is increased confidence in ensuring that properties potentially exposed to the 1% annual-chance flood are covered. The TMAC firmly believes continuing to use the median (hereafter referred to as $SFHA_{50\%}$) has led to misunderstanding regarding confidence in reducing flood damage. Using a higher confidence limit will better communicate the flood risk and reduce disaster suffering due to uninsured losses or building based on thinking that structures built to current requirements are safe from the 1% annual-chance flood. As such, the TMAC is recommending that FEMA use the 95% confidence limit as its standard for the proposed new SFHA (hereafter referred to as $SFHA_{95\%}$) rather than the median value (50%) that is used today. The increase in confidence helps ensure that homes and businesses potentially exposed to 1% annual-chance floods are covered by insurance. If FEMA chooses a lower confidence limit (below

95%), it should clearly document the rationale and develop an effective strategy to communicate the probability of larger 1% annual-chance floods.

The TMAC believes it is important that the $SFHA_{95\%}$ for the mandatory purchase remain based on existing conditions versus future conditions. Lenders who must enforce the mandatory purchase requirement seek certainty, consistency, and credibility. The TMAC believes that lenders would face even greater resistance to enforcing the mandatory purchase requirement if they had to require flood insurance on homes and businesses in a prospective future 1% annual-chance floodplain.

3.1.2 FPA: Existing and New

The TMAC believes that floodplain management requirements (associated with the identification of FPAs) should be based on future conditions that allow floodplain managers to more proactively manage and reduce flood damages. The use of existing conditions flood hazard data combined with allowable increases in flood hazards has, in some cases, resulted in an unexpected increase in exposure.

An example of this challenge is the current NFIP minimum elevation requirement to build at or above the existing conditions $SFHA_{50\%}$. In some cases, this requirement—combined with allowable activities that increase flood stages by up to 1 foot—ultimately result in buildings that have their lowest floors 1 foot below flood stage and later can result in unexpected increased damage and human suffering. Using estimates of future flood elevations will help remedy this gap and is one way to better meet NFIP flood risk reduction objectives.

The TMAC is recommending that the new FPA (hereafter referred to as $FPA_{95\%FC}$) be developed for future conditions at the 95% confidence limit (see Recommendation AR-45, Recommendations AR-46, AR-47). If FEMA chooses not to use the 95% confidence limit, the TMAC would still recommend increasing the level of confidence through use of a value exceeding the median that is used today.

3.1.3 Relationship of $SFHA_{50\%}$, $SFHA_{95\%}$, and $FPA_{95\%FC}$

As described in Sections 3.1.1 and 3.1.2, the TMAC proposes splitting the current SFHA ($SFHA_{50\%}$) into two parts, one for the mandatory purchase requirement ($SFHA_{95\%}$) and another for floodplain management ($FPA_{95\%FC}$) as illustrated in Figure 3-1.

Implementation Suggestions for Recommendation AR-45

In implementing this recommendation, FEMA should consider the following:

- Continue flood studies that are already in progress without incorporating this recommendation.
- Develop a transparent transition as outlined in Recommendation AR-54, Chapter 6.
- Update FEMA guidelines and standards as needed.

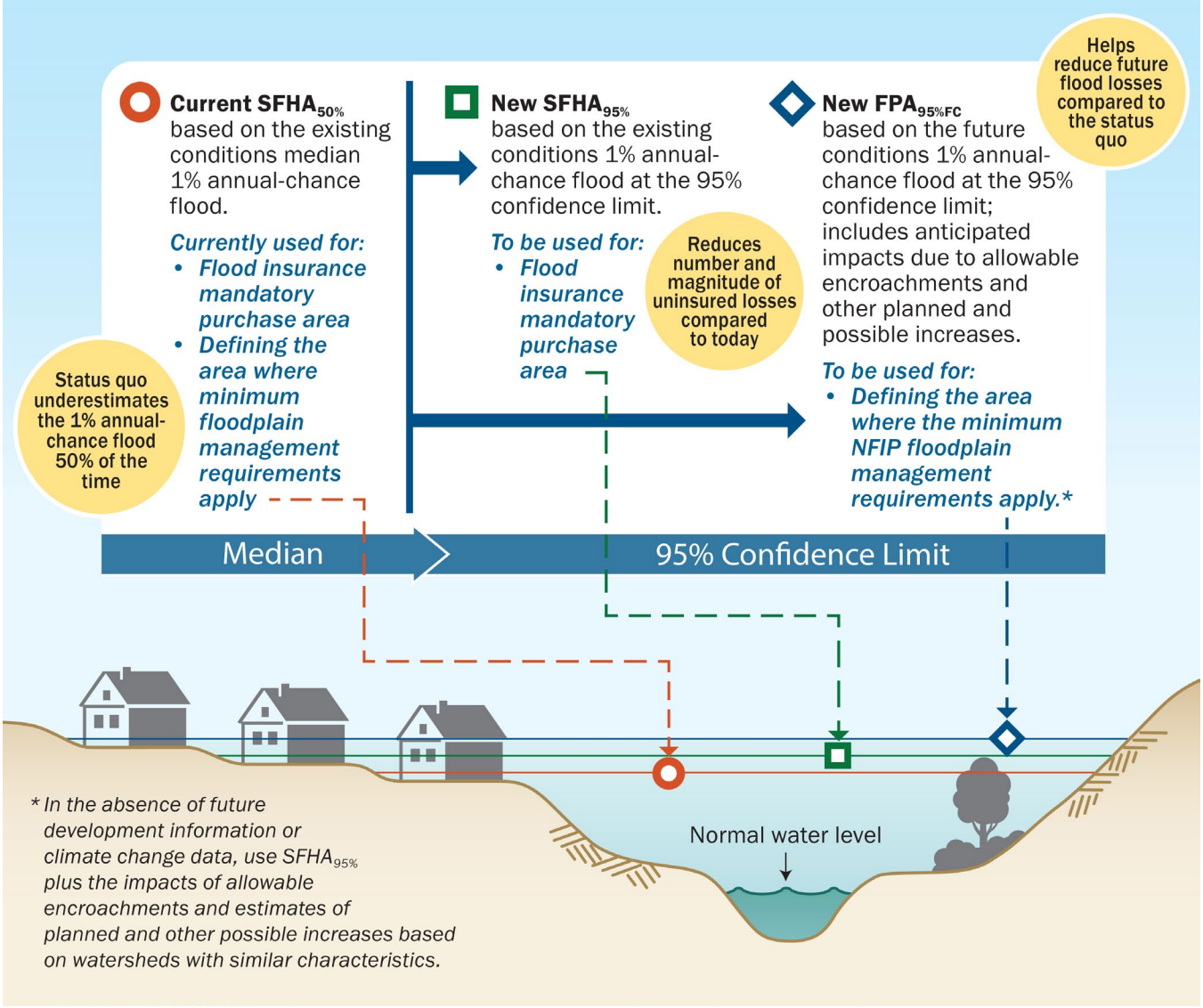


Figure 3-1: Relationship of current SFHA ($SFHA_{50\%}$) to recommended new SFHA ($SFHA_{95\%}$) and new FPA ($FPA_{95\%FC}$)

3.2 The 95% Confidence Limit (Recommendation AR-46)

The TMAC is recommending that the $SFHA_{95\%}$ continue to be the geographic area in which the mandatory purchase requirement applies.

However, for decades, the $SFHA_{50\%}$ and mandatory purchase requirement have been criticized for at least two reasons:

- Because mortgage loans are either subject to the mandatory purchase requirement or not, the perception of flood risk by some in the public is largely: "If my bank does not require flood insurance, then my home is not at risk to flooding from a 1% annual-chance event."
- Because structures outside the $SFHA_{50\%}$ are also damaged by flooding, the perception of the current mapped $SFHA_{50\%}$ is that it is too small or not accurately determined.

Recommendation AR-46

FEMA should develop new Special Flood Hazard Areas (SFHAs) based on the existing 1% annual-chance flood at the 95% confidence limit, not the median (50% confidence limit), as is currently done.

The TMAC believes that FEMA can address the criticisms by identifying the SFHA using the 95% confidence limit rather than the median 1% annual-chance flood as is done today (see Figure 3-2). The practical effect of this change is an expansion of the SFHA; however, given the noted criticisms, the current perception of the $SFHA_{50\%}$ is that it already represents this confidence limit. In other words, homes and businesses just outside today's $SFHA_{50\%}$ are subject to 1% annual-chance floods, but mapping does not show that fact, which partially explains the credibility concerns around today's $SFHA_{50\%}$ depiction. By design, the

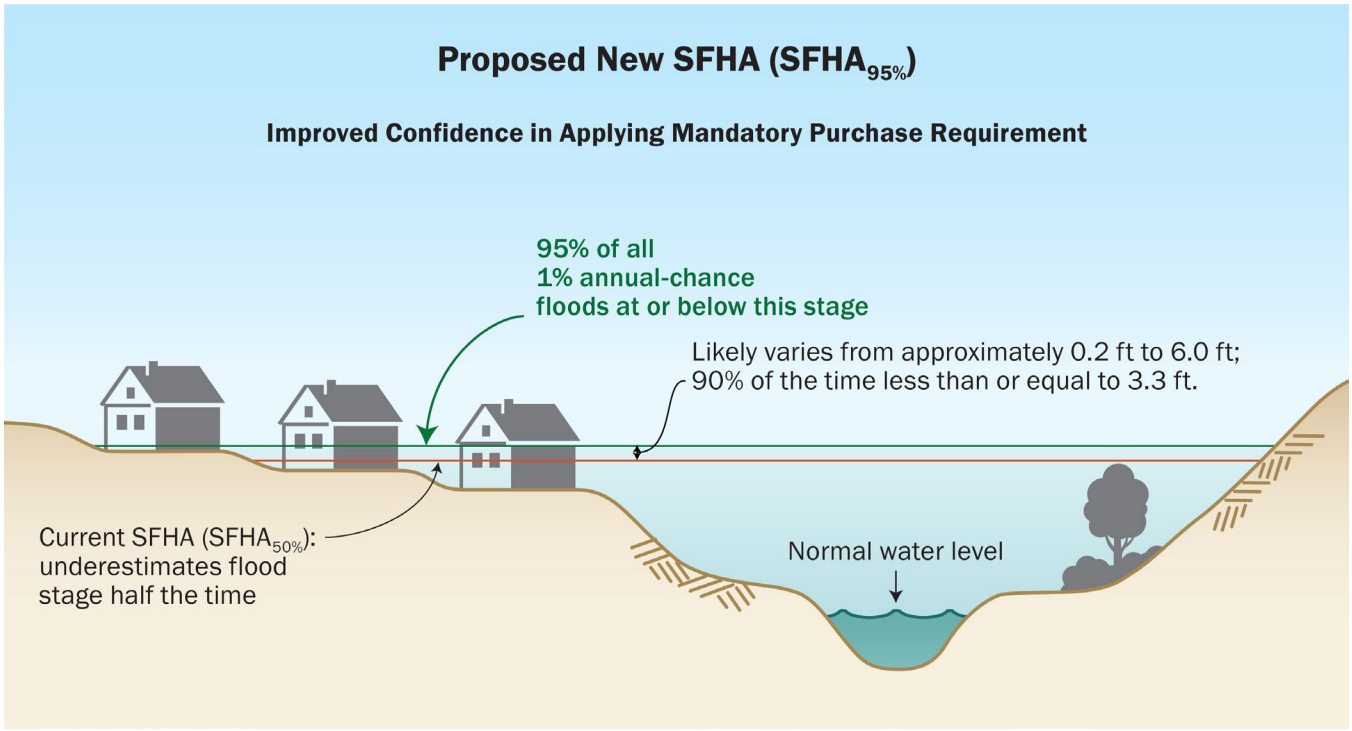


Figure 3-2: Proposed new SFHA ($SFHA_{95\%}$)

flood used to map today's $SFHA_{50\%}$ has a 50% chance of underestimating the area inundated during a 1% annual-chance event. Use of the 95% confidence limit will reduce the likelihood of underestimating the 1% annual-chance flood from 50% to 5%, a value that is more in line with other engineer practices and likely better aligned with user expectations.

Based on a limited data set, the TMAC explored how much higher above the median 100-year flood stage the proposed upper bound (95% confidence limit) on the 100-year flood stage may be. The analysis concluded the following:

- There is wide variation in the difference between the median 1% annual-chance flood stage and its corresponding 95% confidence limit. The differences based on this limited study ranged from 0.2 foot to 6.0 feet. These values demonstrate how important it is to quantify the uncertainty at any given location.
- At the 256 sites tested, the average difference between the median 1% annual-chance flood stage and the 95% confidence limit was 1.7 feet with differences less than or equal to 3.3 feet 90% of the time.
- This assessment demonstrates how quantifying the uncertainty for site-specific flood estimates can help decision makers set flood risk reduction standards at a confidence limit aligned with their objectives.

Both the estimated confidence limits and the site-specific variability range demonstrate how important it is to use statistics to inform decisions in setting first floor requirements. A floodplain administrator setting a 1-foot freeboard on top of the BFE without understanding confidence limits has no way of knowing the impact that extra 1 foot has in helping to avoid or reduce flood losses going forward. In some cases, that 1 foot might increase confidence in keeping first floor elevations above the 1% annual-chance flood stage to well over 95%, yet in other cases that same 1 foot may hardly change the current 50% confidence limit associated with today's BFEs.

Decision makers who want to be more confident that residents do not experience significant damage during a 1% annual-chance flood event should consider setting first floor elevation requirements at the 95% confidence limit (TMAC's recommendation in this report). Others may be comfortable accepting more flood risk using a lower confidence limit as long as it is at or above the minimum requirement set by the BFE on the FIRM. Regardless, it is important to communicate that 1% annual-chance floods come in various sizes and the probability of a flood of that magnitude rising above a set value can be quantified. Today there is a 50% chance that a 1% annual-chance flood will be above the published BFE. The TMAC is recommending that possibility be dropped to 5% so that users of FEMAs BFEs can be more confident in avoiding damages during a 1% annual-chance flood.

For some areas, particularly ungaged areas, uncertainties in calculating the 1% annual-chance flood may be large. When this is the case, further investments to narrow those uncertainties may be warranted, including adding additional gages. In areas that mainly require the use of regression equations, these uncertainties may be abnormally large, resulting in extreme increases in 1% annual-chance discharges. When uncertainties cannot be reduced, additional guidance may be needed on how to handle situations where values appear unrealistic.

3.2.1 Lending Viewpoint

Ostensibly, banks and other lending institutions subject to enforcing the mandatory purchase requirement seek a clear and consistent standard that is backed by sound science and engineering.

A clear and consistent standard protects assets and reduces the likelihood that borrowers, homeowners, and business owners will be unprepared and uninsured in the event of a flood. When uninsured flood losses occur, borrowers living in homes outside the $SFHA_{50\%}$ who were not subject to the mandatory purchase requirement often look to their mortgage company as being at fault.

A bank executive shared the following perspective during the Gilbert F. White National Flood Policy Forum in 2004 (Moye 2004):

> Because of a perceived rise in flood occurrences on properties lying outside the SFHA, the lending community has become more suspicious of the standard's accurate application. Even if the misleading nomenclature can be overcome through better education and communication, the specter of inaccuracy will stand, particularly since the standard serves as the determinant for the purchase of flood insurance. Mindful that development and construction proceed in accordance with a property's floodplain designation, the lending community wants the mandatory program based on an accurate and consistently applied standard which balances safe land use with economic benefit, a standard that can be easily interpreted and understood, so that borrowers know the risk and will act responsibly. The lending community will willingly devote resources for education and communication of such a standard, whether it be the current standard accurately applied, or one that finally may be found to be more appropriate.

In 2004 and even before, there was concern that enforcement of the mandatory purchase requirement should apply to a larger geographic area. In fact, following the devastation of Hurricanes Katrina and Rita in 2005, Congress seriously considered legislation (H.R. 4320, National Flood Insurance Program Commitment to Policyholders and Reform Act of 2005) that would have expanded the definition of the $SFHA_{50\%}$ to the 500-year floodplain; however, the language for expanding the definition was removed and changed by amendment to a recommendation for "a study regarding the impact, effectiveness, and feasibility of amending the … mandatory flood insurance coverage purchase requirements … to all properties located in the 500-year floodplain." The bill was not passed and the study was not conducted.

3.2.2 Building on Earlier TMAC Recommendations

Whether the mandatory purchase requirement applies to structures in a larger geographic area or not, it is important that FEMA attempt to overcome perceptions that the current $SFHA_{50\%}$ represents the maximum of all possible 1% annual-chance floods. This can be done through better education and communication regarding the uncertainty around the $SFHA_{50\%}$. The TMAC refers FEMA to the *2018 TMAC Annual Report*, which includes an entire chapter (Chapter 2, Communicating Uncertainty) and the following two recommendations on communicating the prior uncertainty:

- **AR-30 (2018):** FEMA should establish upper and lower bounds for the 1-percent-annual-chance exceedance flood elevation using a confidence interval size of their choosing and use those limits to map the SFHA "Boundary Zone" —the area where this SFHA boundary is most likely to be. FEMA should share SFHA Boundary Zone information with the public, and other key interested parties, test how it is received, and make improvements prior to formalizing any specific standards or policy for routine map updates.

- **AR-31 (2018):** As part of efforts to communicate uncertainty, FEMA should periodically conduct behavioral risk audits and address the biases that characterize how individuals process information on flood risk to their property. The audits and actions taken (including language regarding the likelihood of flooding) to address biases will also help other key stakeholders, such as floodplain managers, local officials, lenders, developers, and real estate agents, to encourage property owners to invest in cost-effective mitigation measures and purchase flood insurance before the next flood occurs.

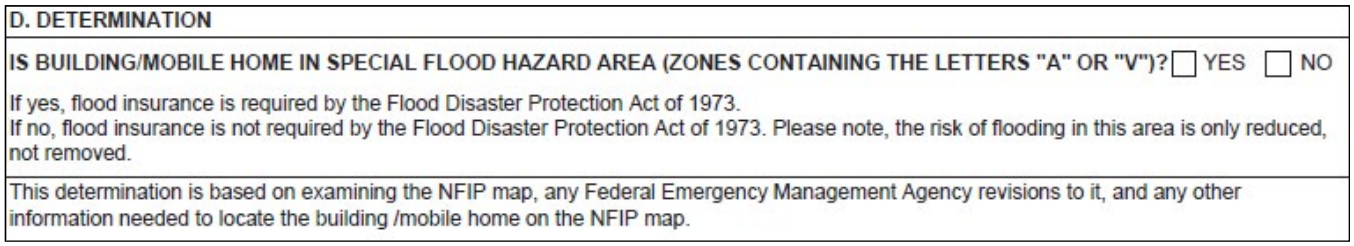
Improve Communication

One action that FEMA could take to improve the communication between lender and borrower is to revise FEMA Form FF-206-FY-21-116, Standard Flood Hazard Determination Form (SFHDF). In 1994, Congress required that FEMA develop and maintain a standard form to facilitate the determination of the mandatory purchase requirement by federally regulated lending institutions, which became the SFHDF. The current SFHDF includes a question that requires a binary response: "Is Building/Mobile Home in Special Flood Hazard Area?" (see Figure 3-3).

As currently phrased, the question perpetuates the idea that flood risk is a simple in-or-out proposition. While additional language attempts to communicate that flood risk is "not removed" by the determination and that the determination is only "based on examining the NFIP map," FEMA can do more to communicate uncertainty around this determination.

Reduce Uninsured Losses

FEMA has traditionally developed the $SFHA_{50\%}$ based on a median 1% annual-chance flood. The rationale for selecting the median sized 1% annual-chance flood included, among other reasons, the idea of establishing a reasonable metric for flood insurance pricing. Today, however, the median 1% annual-chance flood elevation (or BFE) plays a much smaller role in rate setting for flood insurance premiums. Moreover, FEMA states that "between 2015 and 2019 policyholders outside of high-risk areas filed more than 40% of all NFIP flood insurance claims" and received "one-third of disaster assistance for flooding" (www.floodsmart.gov). Uninsured losses and NFIP policies that are not properly rated place a burden on homeowners, lenders, and the public who carry the tax burden for federally funded disaster recovery.



D. DETERMINATION
IS BUILDING/MOBILE HOME IN SPECIAL FLOOD HAZARD AREA (ZONES CONTAINING THE LETTERS "A" OR "V")? ☐ YES ☐ NO If yes, flood insurance is required by the Flood Disaster Protection Act of 1973. If no, flood insurance is not required by the Flood Disaster Protection Act of 1973. Please note, the risk of flooding in this area is only reduced, not removed.
This determination is based on examining the NFIP map, any Federal Emergency Management Agency revisions to it, and any other information needed to locate the building /mobile home on the NFIP map.

Figure 3-3: Excerpt of FEMA Form FF-206-FY-21-116, Standard Flood Hazard Determination Form

3.2.3 Improved Communication May Not Be Enough

Through its past recommendations and as part of deliberations leading to this report, the TMAC has become less optimistic that improved communication alone will remedy misconceptions about the current $SFHA_{50\%}$. The new FEMA rating tools address the proper rating of policies, including those beyond the reach of the median 1% annual-chance flood, and will help improve understanding of flood risk; however, the new rating tools alone will not fully resolve the concern that those exposed to the 1% annual-chance flood have insurance coverage.

In fact, some TMAC members have first-hand experience with flood survivors who did not purchase insurance because, being outside the $SFHA_{50\%}$, they thought they were beyond the reach of the 1% annual-chance flood. Unfortunately, despite often clear communications that flooding still occurs outside the $SFHA_{50\%}$, many come away with an "I'm safe" conclusion that is based in part on a misunderstanding of the technical details.

Current SFHA

The current $SFHA_{50\%}$ (determined by the BFE) is better described as the land inundated by a median 1% annual-chance flood—a low confidence choice if the intent is to have insurance and flood risk reduction measures in place for those potentially exposed to 1% annual-chance flooding.

The recommendation to use the 95% confidence limit to identify the area in which the mandatory purchase applies accomplishes the following:

- Improves confidence in reaching insurance coverage goals
- Reduces risk (and surprise) to homeowners, lenders, and taxpayers in areas just outside the current mapped median 1% annual-chance flood

Though a 5% chance of being impacted by the 1% annual-chance flood would still exist, use of the 95% confidence limit would move the NFIP's hazard identification process closer to general engineering practices where people have come to assume that compliance with a given standard will eliminate (or nearly eliminate) the odds of loss or failure.

Implementation Suggestions for Recommendation AR-46

In implementing this recommendation, FEMA should consider the following:

- Execute a concerted outreach campaign and provide training to floodplain managers on the use of proposed new $SFHA_{95\%}$.
- Consider further investments to narrow uncertainties in calculating the 1% annual-chance flood for some areas, particularly ungaged areas, including adding additional gages. Develop additional guidance for cases when uncertainties cannot be reduced to handle situations where values appear unrealistic.
- Review the NFIP regulations, standards, guidelines, processes, and procedures to ensure all potential impacts have been addressed or analyzed.
- Develop a transparent Transition Plan as outlined in Recommendation AR-54, Chapter 6.

3.3 Development of a New Flood-Prone Area (Recommendation AR-47)

As discussed earlier, FEMA has historically used the SFHA as a means of implementing both mandatory purchase requirements and minimum floodplain management standards. The current $SFHA_{50\%}$ is identified using a median size 1% annual-chance flood, formulated using conditions at the time the flood study was conducted.

Using existing conditions for floodplain management purposes puts floodplain managers in the uncomfortable position of managing the floodplain based on conditions that are quickly outdated and do not accurately represent planned or future hazards. In other words, floodplain managers are unable to be proactive and thus find themselves needing to find solutions to problems that could have been avoided. Many communities have recognized this shortcoming and have taken steps to develop data or ordinances that allow them to manage their flood hazards based on future conditions. In many cases, this is done simply by adding a freeboard value to the FEMA-provided BFEs and requiring all structures to be built above this elevation (BFE + freeboard). If the nation's flood risk is to be reduced, we must manage development with the future in mind to avoid creating new risks.

In its *Future Conditions Risk Assessment and Modeling* report (TMAC 2015a), the TMAC made recommendations regarding FEMA's provision of future conditions flood risk products. The report states:

> The availability of future conditions flood risk products, tools, and information will help communities make more informed development decisions that mitigate the loss of life and property by lessening the impact of future disasters. This information will also enable current local property owners to become more resilient. Risk information supported by future conditions data can save lives; protect property and the environment; and allow for focused, planned recovery when keeping future conditions flood hazards in mind.

Recommendation AR-47

FEMA should require new FPAs, used for floodplain management, to be based on 1% annual-chance future conditions (including land use and climate change) at the 95% confidence limit.

The importance of these flood risk products for improving resilience was re-affirmed by the TMAC in the 2021 Annual Report.

The TMAC recognizes that determining future conditions can be complex and difficult for some communities, and this was a topic of discussion during the listening sessions. However, there was support from the listening session participants to use future conditions for floodplain management purposes.

The TMAC is recommending that FEMA develop a new $FPA_{95\%FC}$ in addition to the new $SFHA_{95\%}$. Figure 3-4 depicts the TMAC's concept of developing the $FPA_{95\%FC}$ elevation and associated boundary. The $FPA_{95\%FC}$ should be based on the 95% confidence limit 1% annual-chance flood plus the allowable floodway surcharge (no greater than 1 foot) plus other increases due to climate changes and planned land use. The $FPA_{95\%FC}$ would reflect the horizontal extent of the $FPA_{95\%FC}$ elevation. As discussed in Section 3.2, use of the 95% confidence limit will reduce the likelihood of underestimating the 1% annual-chance flood from 50% to 5%.

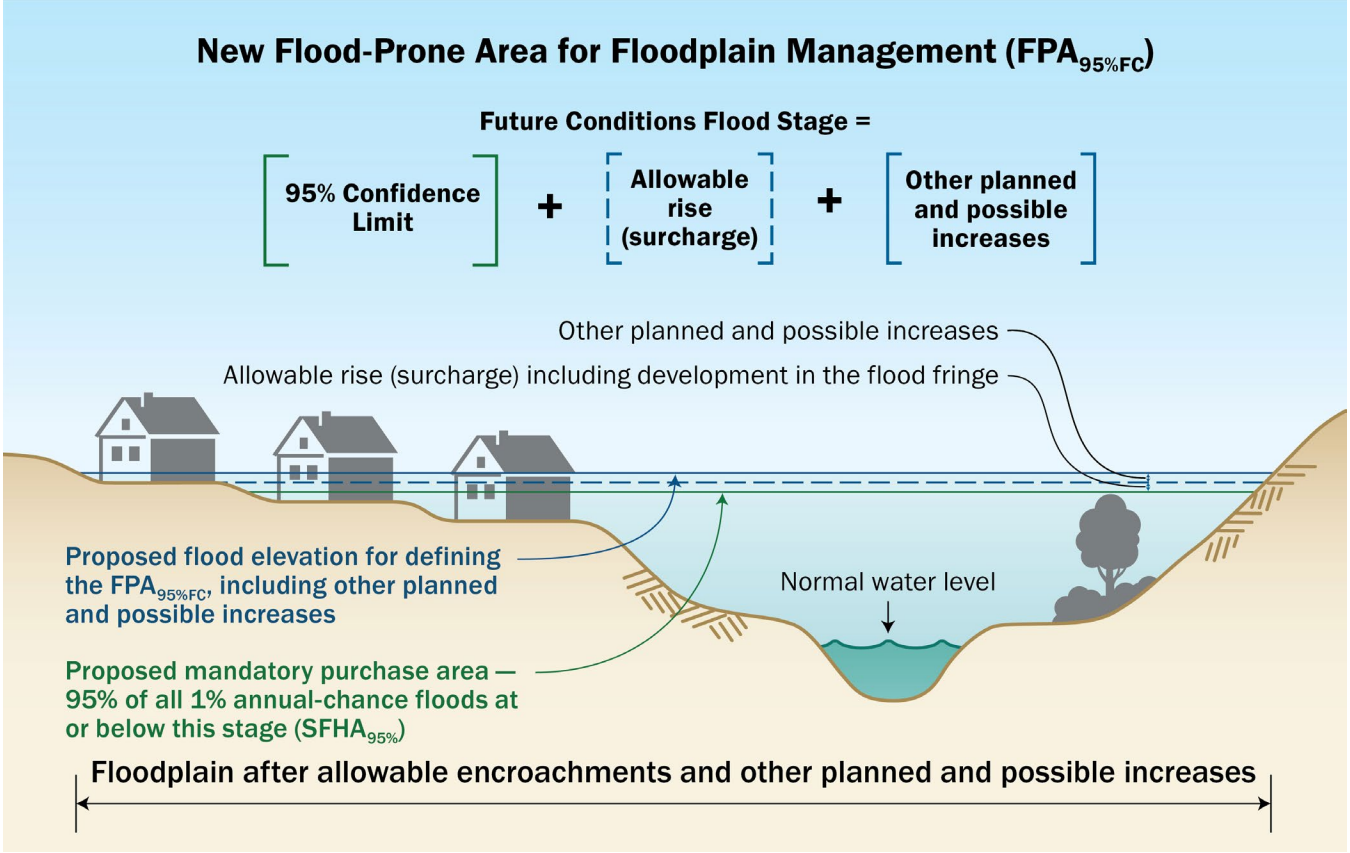


Figure 3-4: Defining a new FPA ($FPA_{95\%FC}$)

There is a hypothesis that the median 0.2% annual-chance floodplain and the 1% annual-chance floodplain at the 95% confidence limit are similar. There are some indications that this may be the case, but the TMAC did not do an exhaustive examination of this hypothesis. Communities should use the 0.2% annual-chance median floodplain currently available until the 1% annual-chance 95% confidence limit floodplain can be determined and made available for floodplain management purposes.

The floodway concept was created as a floodplain management tool. If FEMA implemented Recommendations AR-45, AR-46, and AR-47, there may not be a need to develop floodways. However, the TMAC considered the possibility that FEMA will not implement all of the recommendations. During its deliberations, the TMAC discussed whether the floodway should be developed based on the modeling used to develop the $SFHA_{95\%}$ or the $FPA_{95\%FC}$. The TMAC agreed that the floodway be based on the model used to develop the $SFHA_{95\%}$ (existing conditions at the 95% confidence limit), as presented in Recommendation AR -47.

Implementation Suggestions for Recommendation AR-47

In implementing this recommendation, FEMA should consider the following:

- Execute a concerted outreach campaign and provide training to floodplain managers on the use of the $FPA_{95\%FC}$.
- Estimate freeboard amounts to add to floodway surcharge values as a proxy for other planned and possible increases in 1% annual-chance future conditions where needed. Estimated amounts may be needed when communities do not have adequate land use information to determine the impact of future development, do not have planned development that is expected to change flood conditions, or may not have sufficient information to determine the impacts of climate change. Freeboard estimates could be based on reviewing watersheds with similar physical and climatological characteristics across the nation, which can be credibly applied to watersheds where insufficient data exist to estimate future conditions.
- In the rare situations in which the $FPA_{95\%FC}$ is smaller than the $SFHA_{95\%}$, use the larger area for floodplain management. Increasing flood risks by ignoring the current conditions and hedging on expected lower hazards in the future is unwise.
- In situations where the $SFHA_{95\%}$ and $FPA_{95\%FC}$ are similar to one another, consider not making a distinction between the two areas.
- Consider encouraging communities to use the median 0.2% annual-chance floodplain currently available until the 95% confidence limit 1% annual-chance floodplain can be determined and made available for floodplain management purposes.
- Review the NFIP regulations, standards, guidelines, processes, and procedures to ensure all potential impacts have been addressed or analyzed. Adopting Recommendation AR-47 will lead to a fundamental change to the operations of the NFIP.
- Develop a transparent Transition Plan as outlined in Recommendation AR-54, Chapter 6.

3.4 New 0.2% Annual-Chance Floodplain (Recommendation AR-48)

FEMA should continue to develop the 0.2% annual-chance flood consistent with the proposed $SFHA_{95\%}$ and $FPA_{95\%FC}$ boundaries and elevations. That is, the 0.2% annual-chance boundary and elevation should be set at the 95% confidence limit and developed based on the same parameters used to develop the 95% confidence limit 1% annual-chance flood. Consistent use of the 95% confidence limit is an important part of clear communication as noted earlier. Use of the median 0.2% annual-chance flood would likely result in confusion, particularly in areas where it is at or below the 1% annual-chance flood at the 95% confidence limit.

Recommendation AR-48

FEMA should develop 0.2% annual-chance flood estimates for existing conditions at the 95% confidence limit and evaluate the need for a future condition equivalent.

Implementation Suggestions for Recommendation AR-48

In implementing this recommendation, FEMA should consider the following:

- Implement the suggestions presented for Recommendations AR-45 and AR-46.
- Develop a transparent Transition Plan as outlined in Recommendation AR-54, Chapter 6.

Chapter 4

Consideration of Fill in the Special Flood Hazard Area

Chapter 4 Consideration of Fill in the Special Flood Hazard Area

Chapter 4 describes the outcomes of the TMAC's assessment and recommendations related to FEMA's request that the TMAC determine how the placement of fill in an SFHA should be considered in modifying the SFHA. The chapter expands on the recommendations considered and the reasoning for the recommendations presented in the Interim Report submitted on October 30, 2023. The request in FEMA's April 11, 2023, Memorandum is as follows:

TMAC Topic 2

Recommend how FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded to be at or above estimated 1% annual chance exceedance flood levels (or BFEs).

Since the establishment of the NFIP floodplain management requirements, the use of fill to elevate proposed structures is an acceptable way for elevating first-floor elevations above the BFE in many situations, though there are exceptions (e.g., in floodways and Zone VE areas). On a yearly basis, FEMA receives and processes over 3,600 requests for issuance of Letters of Map Revision Based on Fill (LOMR-Fs) and Conditional LOMR-Fs. The placement of fill for this purpose can reduce the carrying capacity of the floodplain, leading to increased flood risk over time. As illustrated in Figure 4-1, fill placement and other encroachments in the SFHA can adversely affect other homeowners who would otherwise be above the 1% annual-chance flood level. Cumulatively, fill and other encroachments placed in the floodplain to elevate homes and/or gain exclusion from the SFHA are allowed to increase the BFE by up to 1 foot.

In many cases, where states or communities have not implemented higher standards than what is required by 44 CFR 60.3, which is the regulation that addresses floodplain management criteria for flood-prone areas, first-floor elevations are set precisely at the BFE leaving no margin of error and yet remove the mandatory purchase requirement. This can lead to a false sense of security by leaving the property owner with an impression that their structure is no longer subject to potential 1% annual-chance flooding. Additionally, in some cases, entire parcels or lots are being filled to gain exclusion from the minimum floodplain management requirements of the NFIP. Once the land is removed from the SFHA, structures with basements are sometimes built, posing life safety risks to basement occupants.

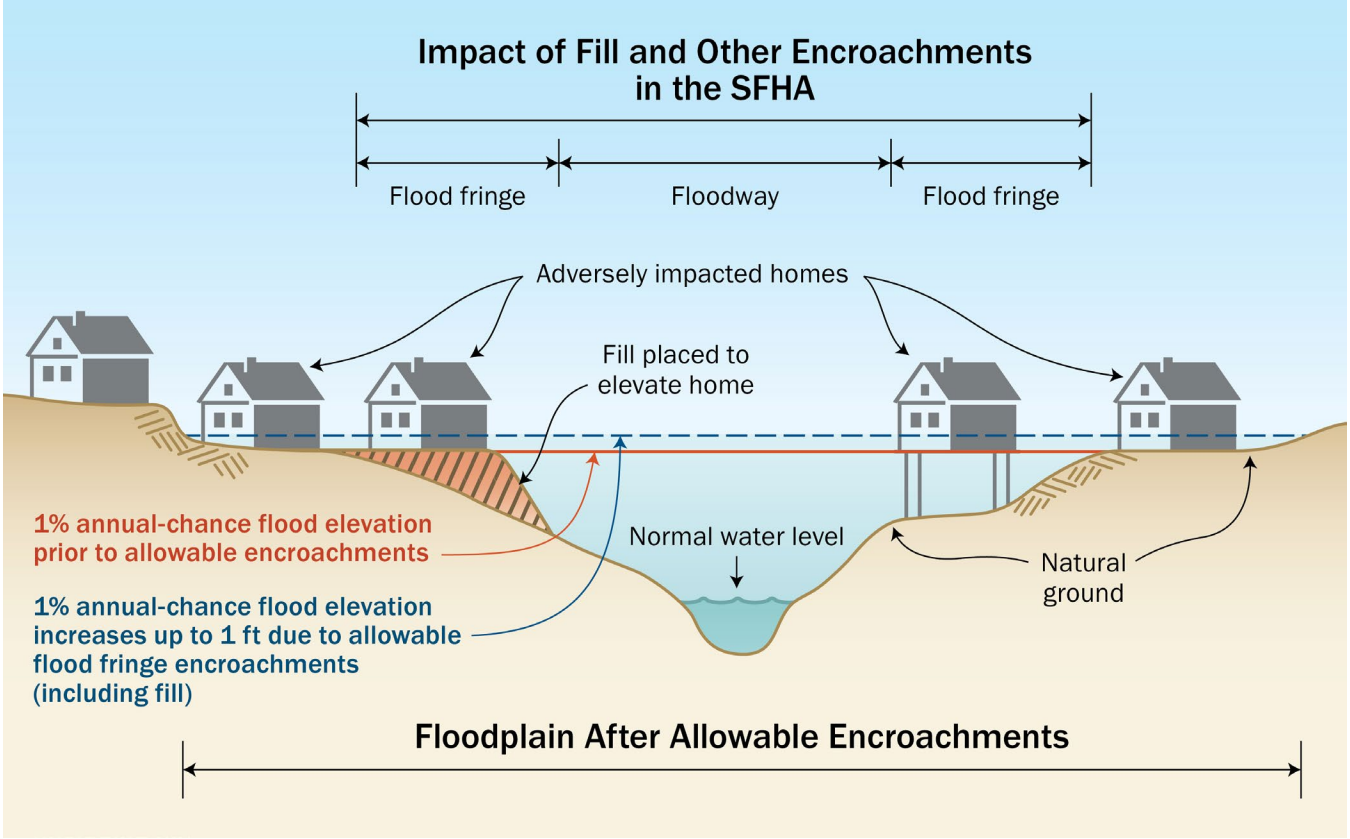


Figure 4-1: Impact of fill placed in SFHA - example

Initial Concepts

As a result of the TMAC's review of current regulations governing the placement of fill in the $SFHA_{50\%}$, the TMAC developed a few initial concepts (described in Chapter 2 as Initial Thinking, refer to Figure 2-3).

1. Not allowing fill in the area subject to the 1% annual-chance flood.
2. Maintaining the mandatory purchase requirement for structures removed from the $SFHA_{50\%}$ based on the placement of fill.
3. Including all requirements related to the placement of fill in $FPA_{50\%}$ to be included as part of the floodplain management requirements in 44 CFR 60.3.
4. Requiring participating communities, as part of their permitting duties, to quantify and keep on file the potential impacts of the proposed fill and other development on the flood stages and the environment prior to issuance of the fill permit. Also, when the proposed fill is anticipated to increase flood elevation or negative environmental consequences are found and cannot be mitigated, at a minimum, property owners and other appropriate agencies must be notified prior to issuance of the fill permit.

Listening Sessions

To get feedback and ideas related to these initial concepts, the TMAC held 17 listening sessions with stakeholders that included state and local government, developers, financial institutions, community developers, interest groups and other professionals. Several ideas related to these concepts were discussed during the listening sessions. As a result of feedback obtained during the listening sessions, the TMAC re-evaluated the above four initial concepts as follows:

1. *Not allowing fill in the 1% annual-chance flood*

During the listening sessions, financial institutions and developers were open to considering changes in regulations as long as there is adequate time to understand the changes and adjust their processes. State and local governments indicated restrictions on fill may not be acceptable because they would restrict the installation of critical infrastructure in these areas. During the listening sessions, state transportation officials noted that the ability to fill in the flood fringe was very important to their work.

Based in part on the feedback received during the listening sessions, TMAC members expressed concern over the potential opposition should fill be categorically prohibited. In addition, not allowing fill could have unintended consequences, including communities dropping out of the NFIP and creating local concerns regarding necessary development for meeting other goals (e.g., wastewater treatment plants, water supply needs, and other facilities with functionally dependent uses). The TMAC concluded that not allowing any fill in the 1% annual-chance floodplain would not be a viable recommendation.

2. *Maintaining the mandatory purchase requirement for structures removed from the SFHA based on the placement of fill*

Throughout the listening sessions, the TMAC heard several reasons why such a requirement could be a hardship. First, some stakeholders believe that requiring mandatory purchase after the placement of fill would be punitive on the homeowner/property owner, who in many cases had nothing to do with the structure's design or permitting. Additionally, a burden would be placed on communities to track fill placement over time. When that tracking is lacking, it would be impossible to differentiate areas of fill versus natural grade.

Interest groups and lenders supported the idea of the placement of fill not eliminating the mandatory purchase requirement. Local and state officials and other professionals were more likely to support than oppose this idea, but expressed concerns, largely related to anticipated pushback from the local governments. Developers were opposed and think the placement of fill should continue to eliminate the mandatory purchase requirement.

The TMAC determined that maintaining the mandatory purchase requirement for structures and land removed from the $SFHA_{50\%}$ based on placement of fill would not likely be administratively feasible and could lead to inconsistent application. During the listening sessions, there was less agreement across stakeholder groups about whether the placement of fill should not be allowed to eliminate mandatory insurance.

3. *Including all requirements related to the placement of fill in FPAs to be included as part of the floodplain management requirements in 44 CFR 60.3*

Currently, 44 CFR 60.3 does not fully address fill in the FPA; however, 44 CFR 60.3 (d)(3) addresses fill in the floodway and 44 CFR 60.3 (e)(6) addresses fill in V zones. These regulations are less clear regarding fill placement in other parts of the FPA. During the listening sessions, the TMAC heard from state and local governments that believe the added regulation would assist them in planning. Developers were less inclined to be agreeable to additional regulation unless it would help clarify and make the process more uniform. The developers indicated that they need clarity on what is required so they know what to expect going into a project. Given this, the TMAC believes it would be beneficial to more clearly and comprehensively address this topic through reforms to 44 CFR 60.3.

The TMAC concluded that FEMA should include all requirements related to the placement of fill in FPAs as part of the floodplain management requirements in 44 CFR 60.3.

4. *Requiring participating communities, as part of their permitting duties, to quantify and keep on file the impacts of the proposed fill and other development on the flood stages and the environment prior to issuance of the fill permit.*

During the listening sessions, local and state governments noted that tracking and documenting the effects of fill in the FPA would be administratively challenging. Even with this potential hardship, these stakeholders generally agreed that tracking the fill being placed in the FPA and notifying those affected of potential impacts would be helpful.

Consequently, the TMAC concluded that FEMA should require participating communities, as part of their permitting duties, to quantify and keep on file the potential impacts of the proposed fill and other development on flood stages and the environment prior to issuance of the fill permit. The TMAC also concluded that when the proposed fill is anticipated to increase flood elevation or negative environmental consequences are possible and cannot be mitigated, at a minimum, the impacted people and businesses and appropriate environmental agencies must be notified prior to issuance.

Recommendation Development

Feedback from the listening sessions helped the TMAC to refine and finalize its thinking into the recommendations presented in Sections 4.1 and 4.2. These recommendations allow fill in the FPA to continue where currently allowed while increasing the awareness of the requirements and potential consequences of the placement of fill.

4.1 Requirements for Fill to Be Consolidated into 44 CFR 60.3 (Recommendation AR-49)

Recommendation AR-49

FEMA should include all requirements related to the placement of fill in Flood-Prone Areas (FPAs) within the floodplain management requirements in 44 CFR 60.3.

FEMA issues over 3,600 LOMR-Fs and Conditional LOMR-Fs each year. These actions may represent a fraction of the fill and other development taking place in the flood fringe, that portion of the current $SFHA_{50\%}$ that is outside the floodway. There are requirements related to the placement of fill provided in multiple portions of 44 CFR, as follows:

- FEMA has map change regulations in place (44 CFR 65.5) related to placing fill in the flood fringe.

- There are also regulations regarding the measurement of impacts of fill in the $SFHA_{50\%}$ at 44 CFR 60.3(d)(3).
- In 44 CFR 60.3(a)(3) there is a requirement that all proposed building sites will be reasonably safe from flooding. While not specifically mentioning fill, the placement of fill would need to be considered when evaluating whether the building site is reasonably safe from flooding.
- Encroachments into the floodplain are also addressed in 44 CFR 65.12 - Revision of flood insurance rate maps to reflect base flood elevations caused by proposed encroachments. This section then refers back to 44 CFR 60.3.

As participants indicated during listening sessions, the multiple locations of these requirements makes it difficult to understand appropriate uses of fill and when or how to communicate the impacts fill may have.

Fill is sometimes placed as a means of having land removed from the current $SFHA_{50\%}$ so that the mandatory flood insurance purchase and floodplain management requirements no longer apply. This practice can sometimes lead to the construction of basements (increasing life loss risks) or the foregoing of flood insurance purchases (increasing the taxpayer burden when floods do occur). Additionally, the placement of fill in these areas can increase hazards to nearby people and businesses. These increases can go unnoticed because there are no requirements to communicate these changes to those impacted.

The placement of fill in these areas can also have negative environmental impacts. While FEMA does require local authorities to sign a Community Acknowledgement Form stating they have met all state, local, and federal requirements (44 CFR 65.5(a)(4) before a map change based on fill can be executed, some signatories may be unaware of when or where environmental impact assessments need to be performed.

These challenges—combined with having the fill requirements in 44 CFR 60.3, 44 CFR 65.5, and 44 CFR 65.12—can leave participating communities confused and ill-equipped to understand how the use of fill might shape their communities' flood risk profiles.

Implementation Suggestions for Recommendation AR-49

In implementing this recommendation, FEMA should consider the following:

- Consolidate and clarify fill requirements related to the placement of fill in the FPA into 44 CFR 60.3 and provide training where needed to better ensure compliance with rules associated with other federal requirements.
- Consider prohibiting the use of fill as an elevation technique for residential and commercial structures in the FPA (both coastal and riverine). Alternatively, consider developing clear engineering requirements for using fill as structural support.
- Prohibit fill as a floodproofing technique (thereby prohibiting basements protected by fill in the FPA).
- Allow a limited amount of fill for bridges, dams, and water/wastewater treatment facilities along with other uses functionally dependent on proximity to water.
- As a means to document the fill and potential safety risks from the placement of fill, FEMA should consider requests for LOMR-Fs and Conditional LOMR-Fs using the MT-2 process instead of the MT-1 process as is currently done.

4.2 Quantification and Notification of Impacts of Fill Placement (Recommendation AR-50)

With limited resources, tools, or regulations at their disposal, many local governments are not able to develop procedures or adopt higher regulatory standards to quantify the impacts of fill in the SFHA on landowners or the environment. Therefore, the TMAC is recommending that FEMA require participating communities (through updates to 44 CFR 60.3) to quantify and document the impacts of proposed fill and other development on flood stages and the environment prior to the issuance of permits (refer to Figure 4-2).

Currently, the LOMR-F process allows areas to be removed from the SFHA solely based on the elevation of the ground without regard for any impacts to other properties or the environment. In riverine areas, any amount of fill placed in the flood fringe can potentially create impacts upstream, downstream, or both, but as long as the impacts are equal to or less than the minimum allowed (1 foot at a national level, less than 1 foot in areas where states or locals have adopted higher standards), there are no notification requirements.

Recommendation AR-50

FEMA should require participating communities, as part of permitting duties, to quantify and place on file the impacts of proposed fill and other development on flood stages and the environment prior to issuance of the fill permit. When increases in flood elevation or potential negative environmental consequences are found and cannot be mitigated, at a minimum, impacted people and businesses and appropriate environmental agencies must be notified prior to permit issuance.

This situation amounts to a risk transfer to uninformed landowners and environmental stewardship organizations. Ideally, communities would have a "living model" for the SFHA where fill could be included in real time and account for cumulative impacts. However, many communities lack the capability and capacity to facilitate a living model. While a requirement to notify falls short of a requirement for consent or full prohibition, it is an improvement over today's framing in which risks are allowed to be transferred to others without their knowledge.

Implementation Suggestions for Recommendation AR-50

In implementing this recommendation, FEMA should consider the following:

- When negative impacts from fill are identified, require that every effort be made to mitigate the increases in flood hazard or negative environmental consequences.
- Communicate that all applicable permits must still be obtained from the appropriate governmental agency prior to permit issuance.
- Update regulations and guidance to align with Recommendation AR-50, including the requirements to track the impacts of fill projects and the notification of appropriate parties.
- Expand fill requirements to projects in the flood fringe, not just to projects in the floodway.
- Create easy-to-use tools to assess potential impacts to flood hazards and the environment based on proposed fill placement.

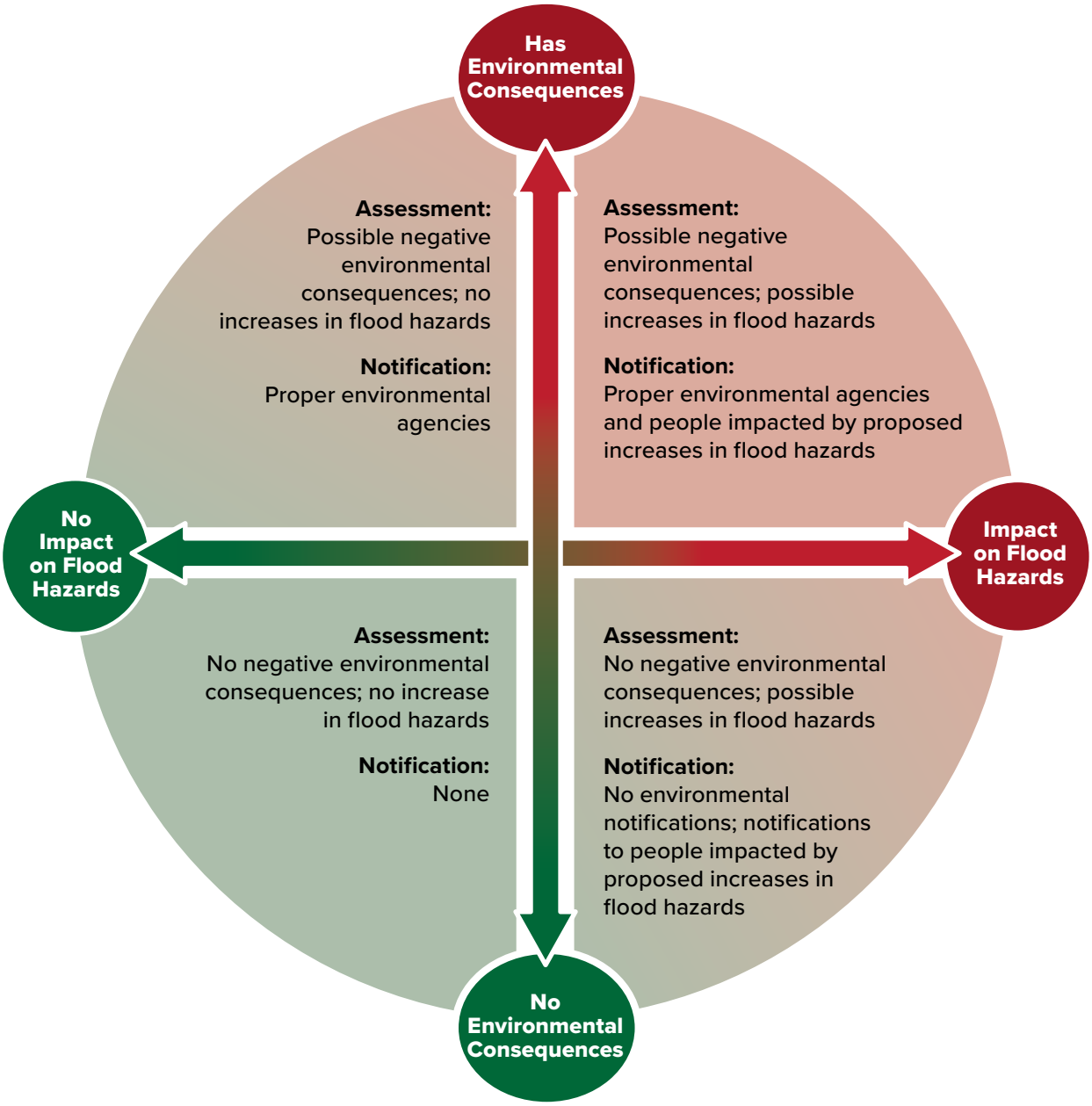


Figure 4-2: Proposed assessment and notification requirements in four proposed fill placement situations

Chapter 5

Implementation of 2D Methodologies and Representation of Complex Data

Chapter 5 Implementation of 2D Methodologies and Representation of Complex Data

Chapter 5 describes the outcomes of the TMAC's assessment and the recommendations related to two important topics identified in FEMA's April 11, 2023, memorandum to the TMAC. These topics include a path for FEMA to help communities overcome the administrative and technical challenges of implementing 2D hydrologic and hydraulic modeling for regulatory floodplain management purposes, and approaches FEMA can implement to represent complex data for communities in a manner that minimizes confusion and increases its usefulness for reducing flood risk and disaster suffering. The request in FEMA's April 11, 2023, memorandum is as follows:

TMAC Topic 3

Investigate and recommend ways for communities to overcome the administrative and technical challenges of implementing two-dimensional hydrologic and hydraulic modeling for regulatory floodplain management purposes.

TMAC Topic 4

Explore community/public product acceptance as FEMA presents regulatory flood hazard data, future conditions data, pluvial data, and graduate[d] hazard data through probabilistic methods to the public. Recommend ways that FEMA can represent all this complex data, with the possibility of additional third-party data, in a way that helps minimize confusion and increases usefulness toward reducing flood risk and disaster suffering.

Although these two topics are distinct, they are interrelated as the representation of 2D and other complex data impacts how communities use flood hazard data to implement their floodplain management regulations and influences how these data are understood and accepted by stakeholders and used to reduce future flood losses and disaster suffering.

As discussed in Chapter 2, the TMAC conducted its assessment using the Design Sprint process to facilitate development of initial concepts (referred to as Initial Thinking in Chapter 2). These initial concepts were then shared with 50 individuals representing five distinct stakeholder groups, including local government officials, state government officials, the development community,

interest groups, and other professionals. Feedback was collected via 12 separate 1-hour listening sessions (refer to Chapter 2 for additional details). This process and the subsequent feedback received helped the TMAC formulate the recommendations contained herein.

Throughout the development of these recommendations, the TMAC recognized that transitioning from the flood hazard data historically developed using steady-state 1D hydraulic models with single-focused data outputs to 2D and other complex, multifaceted data sets will require significant effort. Figure 5-1 is an example of 2D modeling output demonstrating the complexity of the data and the need for the data to be refined and interpreted before it can be applied for floodplain management purposes. This transformational change has both technical and administrative components. The recommendations developed are organized accordingly.

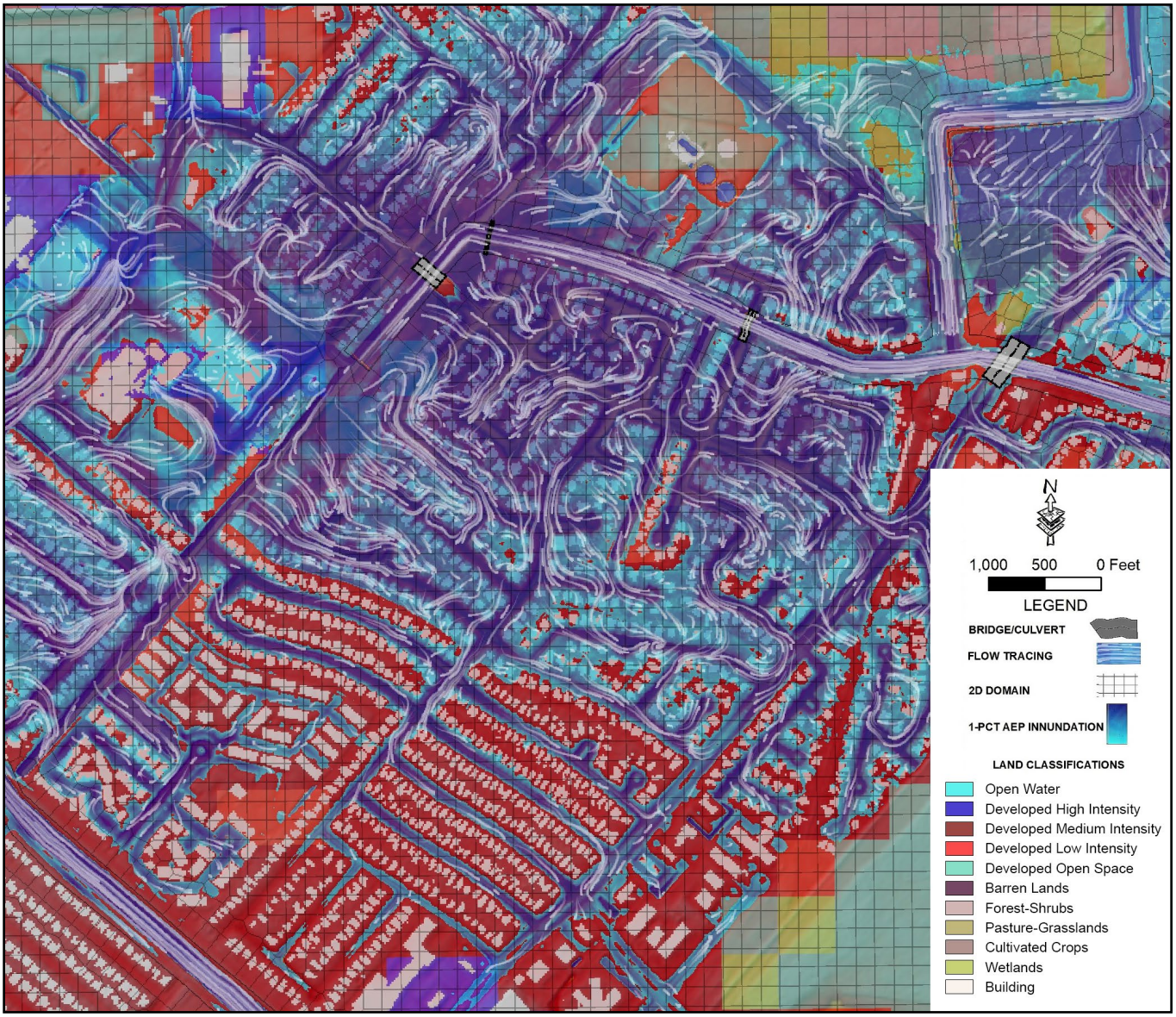


Figure 5-1: 2D watershed modeling in Harris County, TX, depicting 1% annual-chance flood hazard complexity

In developing recommendations for implementing 2D methodologies and representing complex data, TMAC considered three overarching objectives:

- Objective No. 4: Improve usability and communication of hazard and risk data.
- Objective No. 5: Improve technical credibility of hazard and risk data.
- Objective No. 6: Facilitate a smooth transition and management of technical and administrative change (discussed further in Chapter 6).

Based on these overarching objectives and the Design Sprint process, the TMAC formulated three recommendations. These recommendations are presented in the sections that follow with a narrative discussion that represents the TMAC's thinking and rationale supporting the recommendations.

5.1 Standards, Guidance, and Tools (Recommendation AR-51)

Recommendation AR-51

FEMA should collaboratively establish new standards, guidance, and tools related to the development and use of data for the 2D modeling framework.

For a successful transition to 2D modeling, FEMA must work with national partners, including other federal agencies, agencies participating in the Cooperating Technical Partners (CTP) program, NFIP coordinating offices, or NFIP participating communities. The overall goal should be to understand each group's unique needs and capabilities. The process for gathering feedback from users could follow the steps outlined in the TMAC's previous Recommendation AR-1 (from the 2015 Annual Report [TMAC 2015c], see Appendix H).

The first step in obtaining widespread acceptance of complex data is to develop programmatic and working standards that aim to achieve a consistent product across the nation. FEMA should define elements that must be consistently applied across the program, which will be especially important for watershed projects that cross jurisdictional boundaries. Secondly, existing guidance documents should be updated to reflect the changes resulting from using 2D modeling or complex data for analysis or regulatory purposes. Many users may not have the technologic framework or knowledge to be able to work with these complex models directly.

Support Easy Access to Data

FEMA should identify various user needs for specific digital tools, web viewers, and data views that allow all users easy access to the data available in their jurisdiction.

FEMA should focus on the products derived from the complex models and determine the best method for representing and delivering the data to users. FEMA must make clear how the products are intended to be used, whether for floodplain management, regulatory decision-making, or for informational purposes. As the resulting products are analyzed, FEMA should develop methods for identifying common floodplain management tools that were developed using 1D modeling techniques, such as the floodway, in a manner that makes sense when using this updated 2D modeling technology. The proposed products and deliverables should not be based on what has been used in the past. Rather, the complex models

must be analyzed to determine what database products may be required to meet existing and future needs. Products should be user-friendly and understandable, and the TMAC recommends they be well vetted by both novice and expert users. Expert users may be identified following a similar path as suggested in the TMAC's previous Recommendation AR-26 (from the 2017 Annual Report [TMAC 2017], see Appendix H). These expert users may be able to identify a wide range of users to test future products to ensure the products cover the wide spectrum of user needs.

Implementation Suggestions for Recommendation AR-51

In implementing this recommendation, FEMA should consider the following:

- Develop standards and guidance detailing parameters that must be set up consistently, especially the factors that will have the largest impact on results.
- Publish guidance outlining acceptable methods for converting 2D probabilistically derived raster flood hazard data into a vector line for use in identifying the $SFHA_{95\%}$ for mandatory purchase area, and $FPA_{95\%FC}$ for floodplain management.
- Establish clear standards and routine processes for creating and updating 2D raster and vector data sets for all FEMA flood risk and hazard products.
- Implement a process for identifying floodways using 2D methods not solely based on existing definitions, such as equal conveyance reduction and surcharge values.
- Define the database needs for 2D methods that are not based on existing products but rather based on analysis of the data that are necessary for the optimal and efficient use of 2D or complex data results.
- Create a user-friendly, reliable, technically credible, and publicly available online tool to assess the impacts of proposed development in the $SFHA_{95\%}$ and $FPA_{95\%FC}$ (as per Recommendation AR-47), including determining the amount of rise, analyzing no-rise, and tracking cumulative $FPA_{95\%FC}$ development impacts.
- Create products depicting 2D data that are developed based on the modeling results and information that is readily available and reviewable.
- Develop user personas for state NFIP coordinators, participating community floodplain managers, developers, and property owners that tailor data interaction experiences and provide straightforward informational views to help users understand flood hazards and risks at set scales and that meet minimum floodplain management requirements.
- Engage a wide range of users in conducting analyses of all FEMA flood hazard and risk products, viewers, and tools, as described above, to ensure the products meet the user's needs and are understandable and easy to use, no matter the user's experience level.

5.2 Regulatory Map Change Trigger (Recommendation AR-52)

Every floodplain management professional is aware that a regulatory map must be maintained and updated regularly to serve its intended purpose. The transition to using 2D or complex data does not change this requirement but does highlight the need for a deeper discussion on how to properly determine when an official map revision must be initiated. These complex datasets can provide much more detail and also show changes that may alter the definition of mappable impacts. For users to successfully use these data, FEMA needs to consider the existing analyses that are conducted using floodplain data, including no-rise, cumulative rise, and less than 1 foot of rise, and determine how these analyses change when using 2D or complex data considering the sensitivity of the models associated with these datasets. For example, complex data, in raster format, can depict water surface elevation changes in each model-defined cell making a no-rise in its current definition nearly impossible to achieve. As part of its evaluation, FEMA must define the level of change that warrants initiation of an official map change. This definition should be specific and understandable for floodplain management professionals responsible for implementing local programs or updating and maintaining the data. In addition, clear expectations must be set relating to who is responsible for maintaining and updating the data and the processes that must be followed.

Recommendation AR-52

FEMA should establish a standard regarding when changes to the new Special Flood Hazard Area ($SFHA_{95\%}$) or new Flood-Prone Area ($FPA_{95\%FC}$) are warranted.

In addition, if FEMA pursues Recommendation AR-45, there would be a need to define when map changes to the $SFHA_{95\%}$ and $FPA_{95\%FC}$ boundaries must occur.

- Because the $SFHA_{95\%}$ is based on existing conditions, map changes may be required similarly to the status quo. Updates will remain important to ensure the proper insurance coverage is obtained and the proper risk is communicated to those people and businesses in the highest risk areas as development changes the boundary of the $SFHA_{95\%}$.
- The $FPA_{95\%FC}$, on the other hand, is based on future conditions and FEMA must determine what changes to the future conditions need to be reflected in the $FPA_{95\%FC}$ boundary. Perhaps the data should be analyzed on a scheduled cycle to determine whether there have been significant changes to planned or other possible impacts to the flood hazards. If the future condition is based on local land use planning and development does not follow that plan, FEMA should define a trigger for when the boundary must be updated.

Implementation Suggestions for Recommendation AR-52

In implementing this recommendation, FEMA should consider the following:

- Define the threshold that warrants initiating an official FEMA map change ($SFHA_{95\%}$ or $FPA_{95\%FC}$), finding a balance between excessive map updates versus allowing unwise floodplain development to persist based on outdated maps.
- Develop a process for updating complex data and files that are required as part of the submittal package for a map change.
- Consider both technically objective drivers for official NFIP data updates, such as the use of statistical significance tests for comparing data sets, and a methodology/process to support localized updates between official NFIP data/map changes.
- Determine whether current MT-2 forms and processes need to be updated to accommodate any changes.
- Define the party responsible for updating the data during different phases, including the maintenance phase, just after a new map becomes effective and for the official FEMA map change that will be triggered based on FEMA's proposed definition, as outlined above.
- Establish guidance and training specific to the changes that are proposed for the different users of the data, including federal and state agencies, NFIP coordinating offices, NFIP participating communities, engineering firms, land developers, and other pertinent users.

5.3 IT Infrastructure (Recommendation AR-53)

Recommendation AR-53

FEMA should establish an information technology (IT) infrastructure to support user needs in a 2D environment.

As technology continues to advance, strains on existing information technology (IT) infrastructure become an increasing challenge. For FEMA to successfully transition to using 2D and complex data, the infrastructure to support the management of these data must be updated. Two-dimensional models and the resulting data are magnitudes larger than the existing data from 1D FEMA studies. For entities conducting engineering studies for FEMA to maintain acceptable budgets and schedules, a system to allow for large data uploads must be established. FEMA should reference the TMAC's previous Recommendation AR-11.2 (from the 2016 Annual Report [TMAC 2016a], see Appendix H) when determining what this future infrastructure should consider. In addition, the proposed online web viewers, tools, and similar portals must be reliable for users to adequately manage their floodplain data. By investigating the file needs to support these online tools, some complexity may be eliminated, allowing users to

update the files more efficiently and make data incorporation easier in the online platforms.

Many socially vulnerable and disadvantaged communities lack the resources for the IT infrastructure required to handle these complex datasets; therefore, FEMA should focus on delivery methods that make the data accessible for those users. However, for jurisdictions that are actively updating and maintaining their modeling data, the files should be easy to access to meet their needs. Where communities lack the ability to access digital data, FEMA should create templates that allow users the ability to obtain the information they need in a printable format. FEMA can focus on using existing relationships, such as with NFIP Coordinating Offices or CTPs, to assist in providing communities with the information they need in the format they need.

Implementation Suggestions for Recommendation AR-53

In implementing this recommendation, FEMA should consider the following:

- Develop upgrades to IT infrastructure to allow for easier upload, storage, and download of large datasets.
- Use a systems approach to IT upgrades and maintenance.
- Develop a digital portal for SLTTs that allows them to download regulatory data on demand without having to go through the Information Sharing Access Agreement (ISAA) process for access.
- Focus production and distribution of all flood risk and hazard products on transferring and using the data digitally and, as much as possible, transfer and use regulatory data digitally as allowable.
- For jurisdictions unable to access data digitally due to lack of capability or capacity, a printed or static instance of the data may be needed; FEMA should offer a standard printed product that can be delivered through existing FEMA partnerships, whether a CTP or State NFIP Coordinating Office. FEMA should focus on delivery methods that make the data accessible for all users.
- Make data displays consistent with common views across user personas (given data vintages) at speeds that facilitate efficient online tasks.

Chapter 6
Transition and Implementation

Chapter 6 Transition and Implementation

Chapter 6 describes TMAC's recommendations for transition and implementation. The 2023 topics assessed by the TMAC, and the recommendations developed and discussed in Chapters 3, 4, and 5 above, have significant impacts on the future of flood risk analysis and floodplain management across our nation.

If adopted by FEMA, the recommendations presented will potentially require regulatory reform and take a significant period of time to fully implement. Additionally, the TMAC recognizes that change management is as critical as the changes themselves. Therefore, the TMAC has developed three additional recommendations described in this chapter that address steps towards transitioning from the current state to the future state. Further, two clear messages received in listening sessions from a broad range of stakeholders were the desire for advanced notice of program changes and the desire to receive advanced training and guidance. The recommendations described in this chapter address these concerns.

6.1 Transition Plan (Recommendation AR-54)

When large-scale changes are planned for implementation in any established program, advanced planning for accommodating the transition to these changes is vital for success. A key theme from the listening sessions revolved around the attendees accepting the shift to new modeling technologies and the need for revisions to aging definitions throughout the program. Many stakeholders expressed the concern that the change would be thrust upon them without warning, and they would be responsible for making programmatic changes on the local level that they are not prepared for. To address this concern, the TMAC recommends FEMA work with constituents to develop a feasible Transition Plan for implementing the recommendations outlined in this report.

Recommendation AR-54

FEMA should establish and distribute for comment a draft rolling Transition Plan for implementing recommendations in this 2023 TMAC Annual Report and other future programmatic changes.

Implementing Recommendation AR-54, to develop a Transition Plan, could be coupled and leveraged with actions related to the TMAC's previous Recommendation AR-27 (from the 2017 Annual Report [TMAC 2017], see Appendix H), which proposes a transition plan to move from a single 1% annual-chance flood line to a graduated flood risk approach and to the $SFHA_{95\%}$ and $FPA_{95\%FC}$ recommended in this 2023 TMAC report.

Transition Plan Considerations Related to AR-45 to AR-50

The definition of the current $SFHA_{50\%}$ is well established and has not changed significantly since the inception of the NFIP. Any changes to how the current $SFHA_{50\%}$ is defined or computed and how local floodplain management is expected to occur will require careful consideration of the

impact the change has on a variety of program stakeholders. To accomplish this, FEMA should work with key users to develop a consistent method to transition to the new products in a way that will not overly disrupt common operations. The Transition Plan should include actions related to Recommendations AR-45 through AR-50 as presented in this report.

Transition Plan Considerations Related to AR-51 to AR-55

The shift to 2D modeling for use in regulatory flood hazard data and the inclusion of other complex technical data—such as pluvial flood hazards, future conditions, and graduated flood hazards—introduces new challenges for floodplain managers and other stakeholders and user groups. A consistent theme emerged during the listening sessions highlighting the need for adequate transition time and clear messaging if and when these updated approaches may take effect. This need was coupled with a resounding request for the development of consistent standards and training. A thoughtful Transition Plan should address when, how, and where use of complex data will be required.

Implementation Suggestions for Recommendation AR-54

In implementing this recommendation, FEMA should consider the following (grouped by topic areas):

Specific Considerations

- Make the Transition Plan broad, beyond technical issues, and include addressing non-technical challenges associated with implementation.
- Weave change management concepts or transition planning elements into other plans, whether existing or under development, including those across the NFIP enterprise. Provide a single view of proposed changes across the organization to help users track proposed changes.
- Use the Transition Plan to support communication on all proposed changes to products and viewers. Include in the plan anticipated actions related to training, email notifications, publication in newsletters and outreach materials, webinars, conferences, and development of a website where relevant updates can be regularly announced.
- In developing the Transition Plan, consider impacts to disadvantaged communities and how to best address their unique needs.
- In the Transition Plan, address the needs of communities that may lack the capacity or capability of accessing the data. Focus on using existing partnerships, such as NFIP Coordinating Offices, to help provide communities with the support or resources they may need.

NFIP/Compliance Considerations

- Provide a path to more quickly navigate the transition period for users that are moving forward with 2D data. Identify options that can be implemented immediately while official standards are established. Concentrate on incentivizing early adoption of the improved flood risk management concepts rather than creating obstacles to its implementation.

- In the Transition Plan, identify options for meeting current NFIP regulatory requirements while waiting for the full implementation of the programmatic changes, including any proposed changes to 44 CFR 60.3.
- Do not withhold or delay the dissemination of flood risk or hazard data or floodplain management improvements for fear of creating housing or insurance affordability challenges; such action will only lead to increased risk and greater problems in the future. Address affordability challenges directly by offering subsidies or accepting the risk transfers to the general taxpayer.

Mapping Considerations

- Wisely transition into 2D for use in regulatory products and the $SFHA_{95\%}$ and $FPA_{95\%FC}$ by setting a date when new FEMA-funded map updates will use 2D methods resulting in the $SFHA_{95\%}$ and $FPA_{95\%FC}$. Allow traditional 1D studies already underway to continue to completion, unless there is a compelling reason to update to 2D methods (this could be optional for projects in the pipeline).
- Consider the impacts that changing from $SFHA_{50\%}$ to $SFHA_{95\%}$ would have on existing levee certification and accreditation status as well as impacts on the CRS program. Striking a balance between the objectives of proper flood risk communication, sound floodplain management practices, and the promotion of implementing standards that exceed federal minimum participation requirements will be challenging. A more thorough review of the NFIP enterprise will be required to ensure all potential impacts have been addressed or analyzed.
- Consider that adequate financial resources need to be in place for all parties to effectively transition (i.e., the transition must be cost effective and realistic to address fiscal constraints).

6.2 Model Ordinances Guidance (Recommendation AR-55)

If Recommendations AR-45 to AR-50 are adopted, FEMA must partner with states, tribes, and territories to develop guidance outlining the required changes to model ordinances. This guidance should be developed in a manner that ensures the ordinances adopted and enforced by local programs meet the minimum standards of the NFIP based on the $SFHA_{95\%}$, which will be used for mandatory purchase requirements, and the $FPA_{95\%FC}$, which will be used for floodplain management regulation (see Recommendation AR-45 in Sections 3.1).

Recommendation AR-55

FEMA should develop, in partnership with states, tribes, and territories, a guidance document to assist them in drafting a new model NFIP participation ordinance that addresses recommendations outlined in this 2023 TMAC Annual Report.

In addition, as part of this effort, FEMA should identify who is responsible for maintaining and updating the two boundaries, including specific triggers for when an official FEMA LOMR will be required for either boundary. Guidance should be developed and provided to those administering

the local floodplain management ordinance regarding the required documentation that must be retained for potential FEMA audits verifying compliance with the NFIP.

Changes to the model ordinance language will also be required based on any language changes required to incorporate 2D or complex data, specifically related to no-rise analyses, tracking cumulative rise, definitions of allowable impacts to neighboring properties, and understanding existing terminology when using these new data, such as the phrase "reasonably safe from flooding."

Model Ordinance Guidance

The model ordinance guidance should use clear and concise language that makes it easy for states, tribes, and territories to incorporate the language into established model ordinances and for floodplain management professionals to understand the uses for the $SFHA_{95\%}$ and $FPA_{95\%FC}$ datasets.

Implementation Suggestions for Recommendation AR-55

In implementing this recommendation, FEMA should consider the following:

- Work with state, tribe, and territorial governments to develop model ordinance guidance that outlines the necessary changes to meet or exceed NFIP participation requirements as new data standards, floodplain management, and flood area definitions are developed.
- Include language in the guidance that improves the alignment of local floodplain management programs with emerging building standards and codes regarding building foundation types and use of fill for structural elevation or support.
- Consider that adequate financial resources need to be in place for all parties to effectively transition (i.e., the transition must be cost effective and realistic to address fiscal constraints).

6.3 Training (Recommendation AR-56)

Recommendation AR-56

FEMA should develop, deploy, and facilitate training for implementing recommendations in this 2023 TMAC Annual Report and other future programmatic changes.

The TMAC is recommending widespread changes to FEMA's mapping program and the NFIP to best use 2D and complex data and to promote wise floodplain use. To ensure users and floodplain management regulators are equipped to understand these changes, adequate training will be vital. FEMA must develop and deploy training for varying levels of experience in floodplain management and in using the various types of data. FEMA should aim to continually roll out additional training courses as tools are developed and additional changes are incorporated into the various processes and programs.

A tiered approach to training would work best, where each training course builds off earlier, and less technically intense, training courses. In addition, the courses should target different users, offering the best avenue for users to continue to build their knowledge and trust in the data. The various user communities should be identified, as described in Recommendation AR-51 (Section 5.1), and specific training for these users should be created covering topics that relate to how those users interact with and manipulate the available floodplain management products, including complex and 2D data.

Training

The training must be focused on meeting user needs based on their role and level of experience.

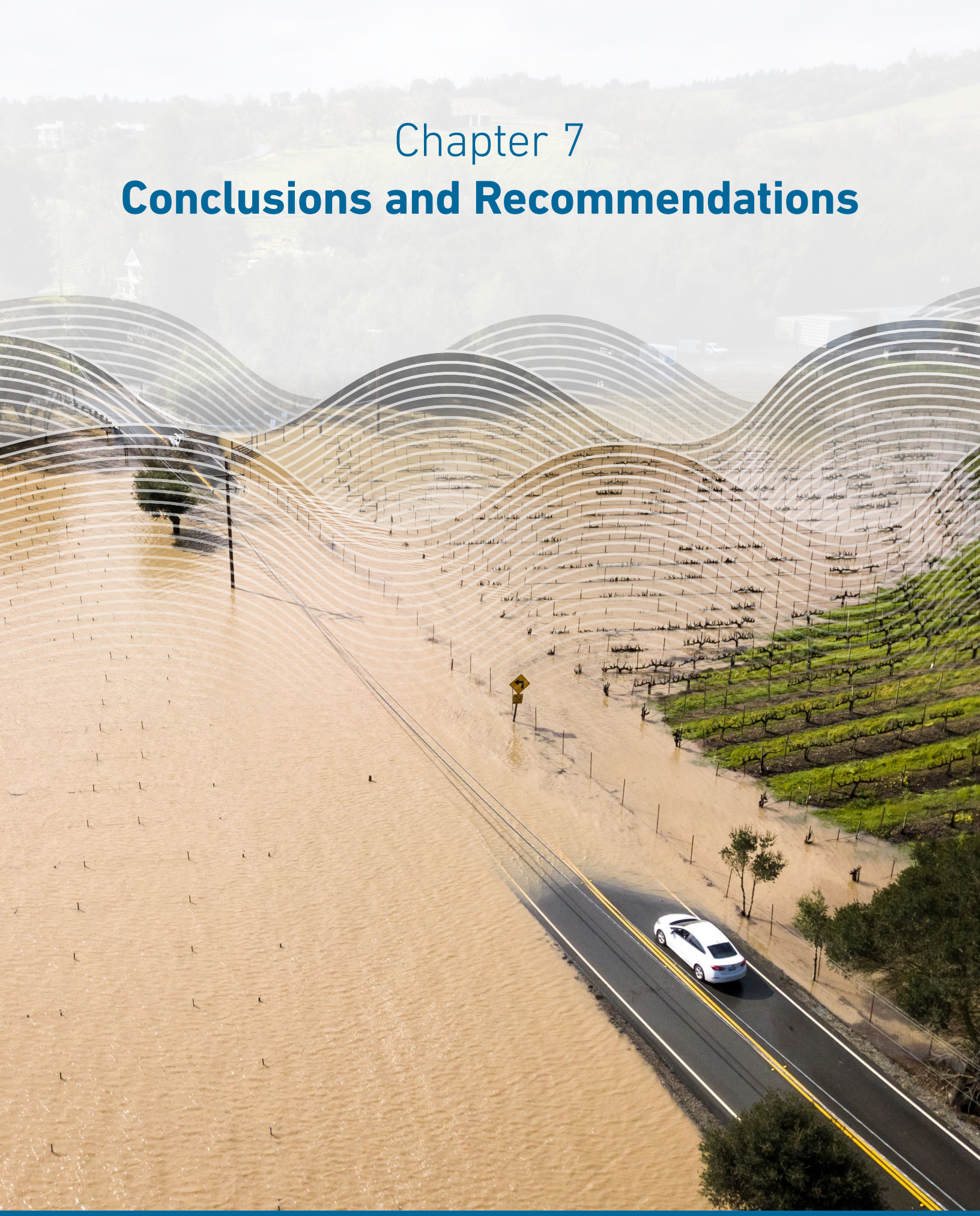
By creating tiers of training for a wide range of users, FEMA is best serving the entire floodplain management community, whether a floodplain administrator or a hydraulic engineer. FEMA should also partner with state NFIP coordinating offices, CTPs, and other established partners to deploy the training courses in diverse formats, including online, hybrid, and in-person allowing the most flexibility for all.

Implementation Suggestions for Recommendation AR-56

In implementing this recommendation, FEMA should consider the following:

- Communicate all proposed changes to products and viewers using a variety of methods, including training, email notification, publication in newsletters and outreach materials, webinars, conferences, and perhaps hosting a website with relevant updates being announced regularly or having the Association of State Floodplain Managers, Inc. (ASFPM), National Association of Flood and Stormwater Management Agencies (NAFSMA), American Society of Civil Engineers (ASCE), and/or other professional organizations help with website announcements/outreach.
- Develop standard online guidance and training courses to aid users in understanding how to interact with the data and tools available to meet program participation requirements.
- Develop standard online training courses to aid flood hazard and risk producers in developing data and information needed to meet program participation requirements.
- Work with state NFIP coordinators to help those without the capacity or capability to access the data, tools, guidance, or online training.
- Determine whether training alone will be sufficient for all floodplain administrators to achieve proper compliance and enforcement of minimum standards; some floodplain administrators may need access to resources (financial or in the form of low-cost/no-cost assistance).

Chapter 7
Conclusions and Recommendations



Chapter 7 Conclusions and Recommendations

FEMA's Memorandum dated April 11, 2023, identified four topic areas for the TMAC to consider as it developed this 2023 Annual Report to assist FEMA in updating the underpinning floodplain management requirements of the NFIP and improving development of flood hazard and risk data to better reflect current and future flood conditions. Based on its assessments of the four topic areas, the TMAC developed recommendations to better achieve long standing goals of the NFIP.

Chapter 7 provides a brief summation of the four 2023 TMAC assessment topics, including key takeaways and a recap of the TMAC's recommendations by topic area. Detailed background, content, and commentary are contained in Chapters 3 through 6 of this report.

These four Chapters also include implementation suggestions for each recommendation. A crosswalk of the TMAC chapters and the four assessment topics presented in FEMA's memorandum is provided in Table 7-1.

Table 7-1: Cross Walk of TMAC Report to FEMA Memorandum

TMAC Report	FEMA s Memorandum
Chapter 3: Review of the Special Flood Hazard Area Definition	**Topic 1** Recommend if/how FEMA should modify the definition of the Special Flood Hazard Area (SFHA), [and] modify how the SFHA is currently calculated (without redefining it). Today, the SFHA is currently defined as "the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in a given year."
Chapter 4: Consideration of Fill in the Special Flood Hazard Area	**Topic 2** Recommend how FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded to be at or above estimated 1% annual chance exceedance flood levels (or BFEs).
Chapter 5: Implementing 2D Methodologies and Representation of Complex Data	**Topics 3 and 4** Investigate and recommend ways for communities to overcome the administrative and technical challenges of implementing two-dimensional hydrologic and hydraulic modeling for regulatory floodplain management purposes. And Recommend ways that FEMA can represent all this complex data, with the possibility of additional third-party data, in a way that helps minimize confusion and increases usefulness toward reducing flood risk and disaster suffering.
Chapter 6: Transition and Implementation	**Topics 1- 4** Although not identified as a TMAC focus for 2023 in FEMA's Memorandum, this addresses steps towards transitioning from the current state to the future state as it pertains to TMAC recommendations related to Topics 1-4.

7.1 Review of the Special Flood Hazard Area Definition

Early in its deliberations, the TMAC concluded that the definition of the $SFHA_{50\%}$ would benefit from change. There was also agreement that the 1% annual-chance flood standard was still sound but that the method of computing the 1% annual-chance flood needs to change to increase confidence in its ability to reduce flood damage and insure against flood losses (since it currently underestimates flood stage half the time). To address this concern, the TMAC proposes using the 95% confidence limit rather than continuing to use the median 1% annual-chance flood.

In addition to this change, the TMAC also determined that using future flood hazard and risk information for floodplain management will help communities avoid unintended flood losses by helping them consider the combined impacts of planned development and climate change.

However, flood insurance requirements are more equitable when based on existing conditions; therefore, the TMAC recommends that FEMA define two flood hazard areas: (1) A new SFHA (using the 95% confidence limit, $SFHA_{95\%}$) to be used for determining mandatory flood insurance purchase requirements based on existing conditions, and (2) a new FPA ($FPA_{95\%FC}$) that would need to be developed to account for the anticipated impacts of future development and climate change and could then be used for floodplain management requirements based on the 95% confidence limit. The TMAC's suggested requirement to go to the 95% confidence limit and consider future impacts also extends to the 0.2% annual-chance floodplain.

The TMAC's recommendations pertaining to the definition of the SFHA are as follows:

Recommendation AR-45

FEMA should develop two new flood hazard areas:

a. New Special Flood Hazard Area (SFHA) – to be used for determining mandatory purchase requirements more confidently based on existing conditions.

b. New Flood-Prone Area (FPA) – to be used for floodplain management requirements based on future conditions.

Recommendation AR-46

FEMA should develop new Special Flood Hazard Areas (SFHAs) based on the existing 1% annual-chance flood at the 95% confidence limit, not the median (50% confidence limit), as is currently done.

Recommendation AR-47

FEMA should require new Flood-Prone Areas (FPAs), used for floodplain management, to be based on 1% annual-chance future conditions (including land use and climate change) at the 95% confidence limit.

Recommendation AR-48

FEMA should develop 0.2% annual-chance flood estimates for existing conditions at the 95% confidence limit and evaluate the need for a future condition equivalent.

7.2 Consideration of Fill in the Special Flood Hazard Area

Since its inception, the NFIP has allowed the use of earthen fill as a mechanism for elevating structures above the 1% annual-chance floodplain, in certain instances. However, the placement of fill within the SFHA can result in increases in the flood levels and by design will increase them by at least 1 foot when considering the cumulative impacts of multiple floodplain encroachments.

The TMAC concluded that prohibiting all fill and development in the SFHA is not a viable option given wide variability in floodplain characteristics and a variety of project types that are either functionally dependent on floodplain use or provide benefits that warrant risk taking. To address the issue of fill in the SFHA, the TMAC recommends that FEMA increase its notifications when proposed actions will likely increase flood hazards or risks and that all requirements regarding fill placement be consolidated within NFIP participation requirements rather than scattered throughout federal regulations.

The TMAC's recommendations pertaining to fill in the SFHA are as follows:

Recommendation AR-49

FEMA should include all requirements related to the placement of fill in Flood-Prone Areas (FPAs) within the floodplain management requirements in 44 CFR 60.3.

Recommendation AR-50

FEMA should require participating communities, as part of permitting duties, to quantify and place on file the impacts of proposed fill and other development on flood stages and the environment prior to issuance of the fill permit. When increases in flood elevation or potential negative environmental consequences are found and cannot be mitigated, at a minimum, impacted people and businesses and appropriate environmental agencies must be notified prior to permit issuance.

7.3 Implementing 2D Methodologies and Representation of Complex Data

Sophisticated engineering and modeling, including 2D modeling, is now accessible and used to better identify and determine existing and future flood hazards and risks. The TMAC confirmed through listening sessions that there is general agreement among a wide range of end-users that these methodologies better estimate flood hazards in many situations.

However, the TMAC notes that these methodologies are more complex than older methodologies. The added complexity could potentially impede acceptance of the resulting data and may create additional challenges for communities participating in the NFIP when used to develop regulatory flood risk products. Overcoming these challenges will require the establishment of consistent standards for data development and maintenance along with the provision of training and tools to facilitate implementation.

The TMAC's recommendations pertaining to the implementation of 2D methodologies and representation of complex data are as follows:

Recommendation AR-51

FEMA should collaboratively establish new standards, guidance, and tools related to the development and use of data for the 2D modeling framework.

Recommendation AR-52

FEMA should establish a standard regarding when changes to the new Special Flood Hazard Area ($SFHA_{95\%}$) or new Flood-Prone Area ($FPA_{95\%FC}$) are warranted.

Recommendation AR-53

FEMA should establish an information technology (IT) infrastructure to support user needs in a 2D environment.

7.4 Transition and Implementation

If adopted by FEMA, the TMAC's recommendations as presented in Sections 7.1, 7.2, and 7.3 (reflecting the narrative in Chapters 3, 4, and 5, respectively) represent transformative changes for the NFIP.

Transition from the current approach to what is proposed in this 2023 TMAC Annual report will take time and significant effort. Stakeholders need to be involved and get advanced notice of upcoming changes to successfully adapt to new requirements or approaches. Further, because programmatic changes will ultimately take root at the local level, the TMAC recommends that a comprehensive living Transition Plan be developed and maintained for industry, non-profit organizations, academic institutions, and others.

The TMAC's recommendations pertaining to transition and implementation are as follows:

Recommendation AR-54

FEMA should establish and distribute for comment a draft rolling Transition Plan for implementing recommendations in this 2023 TMAC Annual Report and other future programmatic changes.

Recommendation AR-55

FEMA should develop, in partnership with states, tribes, and territories, a guidance document to assist them in drafting a new model NFIP participation ordinance that addresses recommendations outlined in this 2023 TMAC Annual Report.

Recommendation AR-56

FEMA should develop, deploy, and facilitate training for implementing recommendations in this 2023 TMAC Annual Report and other future programmatic changes.

7.5 Conclusion

The TMAC believes that the 2023 assessment and recommendations are significant and provide a once-in-a-lifetime opportunity to help put the nation on a better path in the face of increasing flood damage and flood risk. Social, economic, and environmental rewards seldom come without risk-taking. The resulting changes based on these TMAC recommendations will most certainly take time and significant effort to develop and implement; however, these recommendations bring a better alignment to the risk-reward balance that are well worth the time and investment.

Estimating the costs associated with implementing these recommendations is not within the scope of the TMAC's assessment; however, FEMA should consider costs, recognizing that costs could exceed benefits in the near term. Moreover, by implementing these recommendations, FEMA will be taking near-term actions to achieve longer-term prosperity, a much better outcome than maintaining the status quo.

Appendix A

FEMA 2023 Memorandum

U.S. Department of Homeland Security
Washington, DC 20472

FEMA

April 11, 2023

Mr. Douglas Bellomo, P.E.
Vice President, AECOM
3101 Wilson Boulevard, Suite 900
Arlington, VA 22201

Dear Mr. Bellomo,

The Biggert-Waters Flood Insurance Reform Act of 2012 established the Technical Mapping Advisory Council (TMAC) to review and make recommendations to the Federal Emergency Management Agency (FEMA) on matters related to the National Flood Mapping Program. Through the Risk Mapping, Assessment, and Planning program (Risk MAP), FEMA continues to deliver quality flood hazard data that increases public awareness and leads to action that reduces risk to life and property, in collaboration with state, local, and tribal governments. As you are aware, future conditions and equity continue to be strategic priorities for FEMA as a whole, as well as for Risk MAP.

In 2022, the TMAC evaluated barriers that disadvantaged communities face in understanding their flood risk, and how to improve stakeholder engagements with disadvantaged communities. Equity continues to be a cross-cutting priority for the Agency as reflected in FEMA's 2022-2026 Strategic Plan (https://www.fema.gov/about/strategic-plan). FEMA is continuing to explore how to deliver Risk MAP more equitably, both in the context of the current program and as the program evolves to deliver probabilistic flood hazard and graduated flood risk information.

FEMA requests the TMAC consider the following items when producing its findings and any recommendations for the 2023 Annual Report. We specifically request the following:

- Investigate and recommend ways for communities to overcome the administrative and technical challenges of implementing 2-dimensional hydrologic and hydraulic modeling for regulatory floodplain management purposes.
- FEMA produces regulatory flood hazard information, and is in the process of producing future conditions flood hazard information, including a probabilistic data set. Explore community/public product acceptance as FEMA presents regulatory flood hazard data, future conditions data, pluvial data, and graduate hazard data through probabilistic methods to the public. Recommend ways that FEMA can represent all this complex data, with the possibility of additional third-party data, in a way that helps minimize confusion and increases usefulness toward reducing flood risk and disaster suffering.

Name
Date
Page #

To the degree possible, please provide any preliminary recommendations within approximately 10 months from the date of this letter on these two topics:

- Recommend if/how FEMA should modify the definition of the Special Flood Hazard Area (SFHA), modify how the SFHA is currently calculated (without redefining it). Today, the SFHA is currently defined as "the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in a given year."
- Recommend how FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded to be at or above estimated 1% annual chance exceedance flood levels (or BFEs).

In assessing and producing findings and recommendations related to the issues described above, FEMA expects TMAC to use its judgement and expertise and that of supporting SMEs which could result in TMAC exploring related issues and topics beyond the specific scope described in this memo.

As in previous years, the TMAC should deliver its findings and any recommendations in an annual report. The insight that the TMAC provides this year will help ensure that FEMA is delivering the Risk MAP program in a way that serves the entire nation more effectively and equitably. FEMA greatly appreciates the TMAC's continued dedication and expertise.

Sincerely,

MICHAEL M GRIMM
Digitally signed by MICHAEL M GRIMM
Date: 2023.04.11 15:20:26 -04'00'

Michael M. Grimm
Assistant Administrator for Risk Management
Federal Insurance and Mitigation Administration
Federal Emergency Management Agency

Appendix B

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Appendix C

Feedback from the First Set of Listening Sessions: Definition of SFHA and Placement of Fill in the SFHA (Topics 1 and 2)

C.1 Introduction

To inform its work related to determining whether the definition of the Special Flood Hazard Area (SFHA) should be modified, as well as whether the Federal Emergency Management Agency (FEMA) should consider changing procedures for modifying the SFHA when land is filled or graded, the Technical Mapping Advisory Council (TMAC) commissioned a series of listening sessions. The purpose of the listening sessions was to obtain input on the TMAC's Initial Thinking related to the definition of the SFHA and the placement of fill. The TMAC considered this input when making its final recommendations.

C.2 Methodology

A series of 17 listening sessions was conducted from August 21 to 25, 2023. Each session lasted 1 hour and was conducted virtually. The sessions were facilitated by an independent researcher. At the start of each session, the facilitator presented information on the TMAC, identified the topics/questions the TMAC is investigating, presented various challenges identified by the TMAC, and described the TMAC's Initial Thinking.

The TMAC's Initial Thinking on these topics included:

- That there should be three distinct hazard areas: the SFHA (to be used for determining the mandatory flood insurance purchase requirement), current conditions (for informational purposes), and future conditions (as the regulatory area).
- That placement of fill would not eliminate the requirement for mandatory purchase of flood insurance.
- That fill would be allowed to be placed in the fringe and the floodway after analysis showed no impact on hazards and/or risks, including social justice impacts.
- That current conditions would be updated to reflect fill placement, but the SFHA would not (since placement of fill would not remove the requirement for mandatory purchase).

Once the moderator presented the information, participants were asked to provide their initial reactions. They were then asked to answer a series of guided discussion questions to gather additional feedback.

A total of 86 participants took part in the sessions. Sessions were stratified according to the following audience segments:

- Local government officials (37)
- State government officials (10)
- Lender/financial community members (13)
- Development community members (7)

- Interest group members (5)
- Other professionals (such as consultants and engineers) (14)

All sessions were recorded and transcribed. Transcripts were analyzed, and findings were grouped thematically. These grouped findings are summarized below.

C.3 Findings

C.3.1 SFHA as a Distinct Layer

Broadly, there was support for having the SFHA as a distinct layer. However, the SFHA needs to be clear and binary, so it is obvious who is and is not required to purchase flood insurance.

Participants concurred with maintaining the SFHA at a 1% or higher annual chance of flooding. This value is established and well understood. However, many noted that more accurate data sources may de facto adjust the 1% annual-chance flood to better reflect actual risk (and thus increase the number of affected properties). This was seen as acceptable.

- "I don't know that I see a different event being used. I think it would be a monumental shift through the insurance industry. And I don't see an issue maintaining the 1% annual chance storm being the boundary for mandatory purchase." —*Local government official*
- "I don't think the issue is necessarily the 1% standard. Again, I think it is … about sort of the frequency with which the updates are being done. I don't think there's anything wrong with a 1% annual chance protection standard. But what we need to do is keep whatever we're tagging with that description up to date." —*Interest group member*

Some participants were concerned that adding any additional layer will add complexity and lead to confusion. Thus, clear messaging around any changes is seen as important.

C.3.2 Current Conditions as an Informational Layer

While additional information was viewed as helpful, having an additional layer solely for informational purposes was seen as adding complexity. Thus, participants had mixed support for adding current conditions for informational purposes only. Several expressed concerns about separating current conditions from the SFHA and believed that this could also lead to confusion.

- "I'm having a hard time with the question of saying that we're going to map current conditions but not update the Special Flood Hazard Area. So it seems to me that if we have current condition information, that should be updating the map." —*Local government official*
- "I do have some heartburn separating it from this mandatory purchase requirement of the SFHA. And having, in a sense, two existing condition flood risk maps being shown for separate purposes." —*State government official*

- "It could be helpful. But it could also just be more stuff that is just more information. Then when I have to speak to a homeowner, and I have three different maps in front of them, and I'm telling them, 'Well, this is the most restrictive,' but they're like, 'Well, how are the other three all that different?' Sometimes that's going to be a hard conversation." —*Local government official*
- "I think my concern with it is, unless I'm misunderstanding, another layer, another detail to understand. And the thing that we constantly talk about and that we've heard already here is simplify things to make them more intuitive." —*Lender/financial community member*

Many participants also did not understand the proposed distinction between the SFHA and current conditions. Several also noted that keeping maps current can be a challenge for some communities.

- "I suspect that the public would probably find that pretty confusing, because why wouldn't mandatory purchase be based on current flood conditions? And what would be the difference between those two? I think the other aspect of that is if we know that current conditions are different than what the SFHA is, why wouldn't we change the SFHA to match what we think current conditions are?" —*Local government official*
- "One of my concerns with both the current conditions and future … is that these would be updated … fairly often. So that is a concern only because in many states like mine, we don't have auto-adopt. And so the states have to go through the whole FEMA preliminary process, and the towns have to adopt the new maps. I would think that if you're going to do that, and you're going to have some regular updates across the nation, that you would want to allow every state to have communities with auto-adopt." —*State government official*

C.3.3 Future Conditions for Floodplain Management

Most participants supported moving toward future conditions as a regulatory area (several localities are already doing this or considering this). There was widespread acknowledgement that more flood events are happening outside the SFHA.

Regulating future conditions is seen as complex. Concerns include 1) a lack of consensus on which inputs/models to use; 2) a lack of agreement on the future time frame; 3) data uncertainties rapidly increasing as the time frame gets longer; 4) pushback against regulating using conditions that do not currently exist; and 5) difficulty for some communities to develop and maintain future conditions.

- "The challenge with future condition is always … you want some foreseeable reasonable future condition; you don't want something that's going to be like 20 years down the line. Something in the near future that you could predict, 'Yeah, it's going to get constructed.' And you could remap a future condition." —*Local government official*
- "I'm loath to make the smaller communities have to figure out future conditions for them[selves] … my familiarity with the future conditions with these groups of communities was all based on future land use, not precipitation data. So if you sit there and take a little teeny-tiny town of less

than 1,000 people and tell them, 'You now have to regulate to the future conditions,' they're going to say, 'No, thank you.' And then we'll see a lot of issues with communities not able to keep up and maintain the requirements of the National Flood Insurance Program." —*State government official*

- "Future land use is going to be very unique to each individual locality. And so I don't quite understand how FEMA is going to be able to map that, I guess. It's going to require a lot of coordination between FEMA, the states, and the localities. And, depending on what locality you're dealing with, they may not have data readily available or in a format that would be usable for this purpose. Particularly rural, smaller, and lower-income communities." —*Local government official*
- "I'm looking at that through the lens of an attorney. And when I look at that, and I think about that, it makes me think of, you're regulating somebody, and you're impacting them, based on future conditions that you're not certain are going to occur." —*Development community member*

Some communities have adopted an approach of adding a margin of safety (e.g., additional feet of freeboard) as a way to regulate toward the future without reaching consensus on these issues.

- "It's a struggle to get residents and stakeholders and other developers and stuff to all agree. So we did a couple analyses on this and still couldn't get consensus. So currently, in our county, we've got an extra 1-foot freeboard requirement over and above our already 1-foot freeboard, and that'll get replaced whenever we actually agree on future conditions." —*Local government official*

C.3.4 Placement of Fill

There was less agreement about whether the placement of fill should eliminate mandatory purchase. Interest groups and lenders supported the idea of fill not eliminating mandatory purchase. Local and state officials and other professionals more often supported than opposed this idea, but they expressed concerns, largely related to anticipated pushback from the community. Developers were opposed and thought fill should continue to eliminate mandatory purchase.

- "Advantages would probably be more people getting flood insurance, which given how many floods there have been in areas that are considered to not be Special Flood Hazard Areas, that would probably overall be a good thing." —*Other professional*
- "As a homeowner, if I went to someone, did a project for my house, got myself out of it, like if I was on the boundary of the map, and then I was still paying the insurance, my question would be like, 'Why am I still paying all this money for the insurance if I did all this work to get out of that risk?' And that'd be a tough question to answer." —*Local government official*

- "You are effectively making a certain amount of property undevelopable. And some people would say that's maybe what they want to see. Obviously, the development community doesn't want to see that." —*Development community member*

Many participants across all groups noted that this would be very challenging to apply retroactively and would be hard to justify as future maps are created (e.g., via LIDAR) that show topography that reflects fill.

- "I mean, at some point the fill is just kind of natural grade." —*Local government official*
- "We've got statewide LIDAR. And the LIDAR, depending on when it was flown, picks up not only the footprint of that building, but the fill underneath it with the bare earth data." —*State government official*

Some participants questioned why insurance would be required if the risk had been mitigated. However, others expressed a concern that fill does not truly mitigate risk, and often displaces risk.

- "To me, it really is just black and white of if the fill moved that person outside of the 1% annual chance of flooding, then I think they should be allowed to map out. And if you're telling me that the fill doesn't accomplish that, then they shouldn't be allowed to map out." —*Lender/financial community member*

C.3.5 Desired Additional Inputs into Modeling

Participants were asked to identify what other inputs they would like to see in models. They noted interest in several areas, including:

- Flow velocities (many are interested in depth times velocity)
- Climate inputs, including both sea level change and changes in precipitation
- High-intensity events
- Current permeable areas
- Future land use/development
- Stormwater capacity
- Pluvial risk
- Levees and possible dam breaches/inundation
- Gradients
- Erosion zones
- Flood duration

C.3.6 Special Concerns of State Departments of Transportation (DOTs)

State transportation officials noted that the ability to place fill in the flood fringe was very important to their work. They strongly cautioned against any changes that would interfere with this work.

- "We still make it possible for folks to be able to do things in the flood fringe area, like place fill, because one of the reasons the floodway was created in the first place … [was] to say we're not going to infringe on all property rights. … So especially from an infrastructure standpoint, if I can't put certain things in the flood fringe, then I cannot build public infrastructure with public dollars. And nobody does more work in a floodway in any given state than a Department of Transportation." —*State government official*
- "I have to do that all the time across the state—all of my bridge piers, culverts, roadways, and all of the infrastructure that I am mandated by the Federal Highway Administration, USDOT, and Congress to replace, maintain, and keep functional—are generally at one point or another going to cross a floodway. … I need the tools that make it easy, like a notarized certification for me to try to crunch some numbers to prove that I'm not causing an adverse impact on others. And I believe that is totally appropriate." —*State government official*
- "If we weren't allowed to operate within the floodway, I think the cost to DOTs across the country would skyrocket." —*State government official*

C.3.7 Need to Keep Maps Updated

There was strong agreement that maps need to be updated when fill is placed. This is important both for proper documentation and also to fully understand the impacts to the rest of the floodplain.

- "Every time you fill something … I think there should be a map of change as a record, not only because it's a good thing to keep in the record, but also, it probably helps a lot of engineers and other people to know what's going on here. Because a lot of time when we do our … modeling stuff, we'll see a lot of topography changes that we were not aware of, and then we have to dig into research and a lot of reports and contact a lot of people to find out." —*Other professional*
- "The slides were describing that the fill areas in the floodplain would not be mapped as being out. So it's still being shown as being mapped in. I'm really curious to know, is that in perpetuity into the future? And how do we keep track of that? Because sometimes it's already hard enough to keep track of, say, different no-rise scenarios or things like that, that are going on. So if those areas would always be mapped in, how do we keep track of that so we know not to map them in when that study is redeveloped in the future? I'm concerned about how to manage that aspect of things." —*State government official*

C.3.8 Need for Clarity

One key recurring theme throughout all of the sessions was the need for clarity. Participants are open to different presentations of information as long as those presentations clarify rather than add confusion. Many noted that community members struggle to properly understand risk information (e.g., they may think they are no longer at risk in the time period immediately after a "100-year flood").

- "I do think that if there were an ideal way to present this information, it would not include things such as 1%, 0.2%, 5%, 10%, 100-year flood zone, 500-year flood zone, or 100-year floodplain, none of that. I think if you wanted to be able to show it to people in a helpful way, you could have a graphic that says … 'Here's your house. Here's where we predict water could be at in 5 years. Here's where we predict water could be in 10 years.' Something very easy for people to see." —*Lender/financial community member*
- "A lot of times it's just about explaining to people the risks and what's involved with where they're building and understanding where the data from these maps come from. And that, just because there's a line on that map, does not mean that you're safe if you're 5 feet on the other side of it." —*State government official*

C.4 Conclusions

The TMAC members made several adjustments to their Initial Thinking based on these conversations and the continued discussions of the group. Feedback from these listening sessions was helpful for the TMAC in making its recommendations.

Appendix D

Feedback from the Second Set of Listening Sessions: Change to 2D and Complex Data Representation (Topics 3 and 4)

D.1 Introduction

To inform its work related to the administrative and technical challenges of implementing two-dimensional (2D) hydrologic and hydraulic modeling for regulatory floodplain management purposes, and to explore the best ways for the Federal Emergency Management Agency (FEMA) to present complex data, the Technical Mapping Advisory Council (TMAC) commissioned a series of listening sessions. The purpose of the listening sessions was to obtain input on the TMAC's Initial Thinking related to the use of 2D modeling for regulatory floodplain management purposes and how best to represent and present complex data. The TMAC considered this input when making its final recommendations.

D.2 Methodology

A series of 12 listening sessions was conducted from October 5 to 13, 2023. Each session lasted 1 hour, and sessions were conducted virtually. The sessions were facilitated by an independent researcher. At the start of each session, the facilitator presented information on the TMAC, identified the topics/questions the TMAC is investigating, presented various challenges identified by the TMAC, and described the TMAC's Initial Thinking, which included the following:

- That FEMA should develop and finalize standards for 2D deliverables.
- That FEMA should provide standard tools and training to help communities meet minimum participation requirements using 2D models, and information to go beyond these requirements.
- That FEMA should modify policies, products, and minimum requirements to allow efficient delivery and use of 2D regulatory data.
- A series of suggestions to make products easier to adopt and understand, such as:
  - Products need to be vetted and trusted.
  - Bring the community into the process early and develop local champions.
  - Offer training for a variety of users at a variety of levels.
  - Invest in a robust education and outreach campaign.
  - Develop tools that make the common uses of the data very simple.
  - Change administrative policies and rules to align with 2D data.
  - Work to change the conversation to managing risk rather than managing floodplains.
- A series of suggestions to increase the usefulness of complex data, such as:
  - Tailor visualizations of the data to users' needs.
  - Provide examples of how risk data can have a wide variety of uses.
  - Establish a system or process to make it easier to maintain and update this data.
  - Develop a guide on how to incorporate this data into master plans.

Once the moderator had presented the information, participants were asked to provide their initial reactions. They were then asked to answer a series of guided discussion questions to gather additional feedback.

A total of 50 participants took part in the sessions. Sessions were stratified according to the following audience segments:

- Local government officials (22)
- State government officials (11) (representing nine different states)
- Other professionals (such as consultants and engineers) (11)
- Development community members (3)
- Interest group members (3)

Participants were intentionally recruited to reflect diversity with respect to both community size and prior experience with 2D. Local officials represented communities of the following sizes:

- Small (50,000 or fewer): 3
- Midsize (50,001 to 150,000): 2
- Large (150,001 to 500,000): 3
- Very large (500,001 or more): 11

Other professionals worked in communities of the following sizes:

- Small (50,000 or fewer): 2
- Midsize (50,001 to 150,000): 1
- Large (150,001 to 500,000): 3
- Very large (500,001 or more): 4

Participants also had a mix of experience using 2D modeling, including:

- Not at all familiar/low familiarity: 4
- Somewhat familiar/nonuser: 13
- Very familiar/nonuser: 7
- 2D model user: 26

All sessions were recorded and transcribed. Transcripts were analyzed, and findings were grouped thematically. These grouped findings are summarized below.

D.3 Findings

D.3.1 Interest/Acceptance of 2D

Generally, participants were in favor of movement toward 2D for regulatory floodplain management purposes. They noted that the existing standards are dated, and an update is overdue. Most see the value in 2D as a regulatory tool.

- "Everything about the NFIP minimum requirements is based on a 1D model that's 40-plus years old. … But it's 2023. … The policies, products, and minimum requirements just really need a broader focus than they had originally." —*Local government official*
- "That was going to be my main focus, too, is the regulations. I mean, if that was the only recommendation you made this time, for it to happen, get that done." —*State government official*
- "My overall thought is having a 2D model does better capture the elevations. I think it creates a better map, especially if you have a sinuous river and you've got cross-sections that actually end up crossing each other in a 1D model. And sometimes it just doesn't make sense to do 1D when you have 2D available. But I feel like all of our FIRM and NFIP approach is geared towards 1D." —*Other professional*

Participants noted that many communities/states are already using 2D modeling (though usually not for regulatory purposes), and that federal regulations and guidance have been lacking in this area. Guidance is important to establish consistency, and also to encourage even more communities to use 2D modeling.

- "It feels like FEMA is playing catch-up. … The regulatory environment that exists today was created in the 1970s, I believe, for a very simplistic kind of hand calculation model. There hasn't really been an update to the guidance and the regulatory environment since those days." —*Other professional*
- "I feel like we've been lagging in adopting it for FEMA floodplains. … But I just feel like we're at a stage where we need to be more progressive and just roll with the idea of 2D modeling and try to educate people more about 2D instead of doing comparisons." —*Interest group member*
- "I think the biggest problem right now is the regulations are written for 1D modeling. And it's tough for floodplain regulators when you come in with a 2D model to meld that with the 1D regulations." —State government official

Participants noted that 2D models often present more accurate data, which enables better decision-making to reduce flood risk. The use of 2D is especially helpful for complex flood risk situations.

- "We've been utilizing two-dimensional modeling quite a bit. … It is quite a load on our staff to try to have people who can get into that model and do the review. But it does give us a

superior product, especially where we have an awful lot of steep terrain." —*Local government official*

- "Right now we have a consultant contract where we are developing 2D models in some of the problematic areas where there is a lot of flooding. And I know that 2D is better for those purposes. It gives more accurate results." —*Local government official*
- "I know for an engineering tool, 2D modeling is a much better tool than the 1D modeling." —*State government official*
- "What I've seen with 2D models … would be drastically different than what the 1D is, because it can capture split flows and modeling areas that maybe weren't captured before." —*Other professional*

Those representing smaller communities and developers had more concerns about 2D, but these concerns tended to be regarding the speed and scale at which 2D is implemented rather than opposition to its adoption. And even these participants tended to see the benefits of 2D.

- "My community does not want to deal with this at all. So it's a total challenge. I think at least having some more visual models will help the community improve the communication as to what the true issues are." —*Local government official*
- "I think 2D needs a little more maturity. And that'll allow more organic growth in our industry. I think from FEMA's perspective, and FEMA's direct partners, you have a lot of technical capability. I think that when you look down below that level, there's going to be a huge gap in technical capability." —*Development community member*

D.3.2 Impact of 2D Modeling on Various Roles

A change to allow 2D modeling for regulatory floodplain management purposes was seen as having limited impact on the roles of most participants in the sessions. Findings below are reported by job category, but the primary impact on all roles was a need for additional training and information.

Local government officials who were less familiar with 2D noted that this transition will require training. They would need guidance on how to review models and how to use any needed software, and it may be more work (especially initially) to review 2D models. However, several also noted that their jobs would benefit from having more information available, and that it may be helpful to see data in new ways.

- "We are interested in 2D models, because I think they better reflect our terrain. But … we're not really sure how to review it. … We need guidance on what we should be looking for in the review process, and then also guidance to give to our engineers." —*Local government official*
- "I personally have not worked a lot with 2D models. I think they're fabulous and great. But I start to think about some of the challenges and floodway regulations and flood fringe regulations. … It would put more on me initially. But I do think it would actually empower

my role as well. … I think there's more realism with a 2D model that people can see and understand." —*Local government official*

- "I think some of the way that it would impact us is hopefully just providing more accurate models." —*Local government official*

Local government officials who are more familiar with 2D said the impact to their role would be small. Most are already using 2D in at least some capacity, and they noted that 2D leads to better flood risk identification. However, it will change how they interact with community members, especially as 2D modeling identifies a greater number of properties at risk. Some also noted that they would like the option to continue to use one-dimensional (1D) models in some circumstances, as 1D models can be quicker and easier to process and are fully appropriate for some situations.

- "I think our role will largely stay the same in being the local experts for defining flood risk and helping folks through the development process, the permitting process, for city projects, development-driven projects. But I think the key difference will be probably the community outreach, and [communicating] how we interpret those maps." —*Local government official*
- "We've got areas where we have the sheet flow and how it's running through neighborhoods and different things, that were really overestimated in the past with the 1D model by just assuming the worst-case kind of a thing. And so I mean it's been able to help us have a better understanding of how the water is actually flowing and then looking at better alluvial fans areas." —*Local government official*
- "I don't see any particular change to what we're already doing since we're accepting the 2D modeling and currently reviewing it. So I think it's going to just remain status quo. The only concern I have is that … sometimes … the solution can be solved with a 1D model. So still holding open those possibilities when it's appropriate to use a 1D model." —*Local government official*

State officials largely thought the transition to 2D would be manageable, but they noted several areas where they expected to see an impact. These included the need for additional training, challenges supporting local communities through the transition, the need to modify state regulations to allow for 2D, and answering questions from the community about what has changed and why. State officials also largely believed this transition was inevitable.

- "Everybody knows we need to be switching to 2D here pretty soon. But since this data is still primarily 1D, it's going to be some learning curve to come up to speed for how we do our work, particularly in the short term." —*State government official*
- "That's going to be something that we are going to be tricky with, because we have a lot of large communities as well as very, very small communities that don't even have really internet service in some locations." —*State government official*

Other professionals who took part in the listening sessions largely are using 2D already. While they see 2D as having significant benefits, they are more aware of some of the challenges and concerns. For example, they noted that 2D models are very data intensive. They said training and

communication will be important to help others understand the benefits of this transition. One suggested that FEMA should begin this transition by doing pilot projects.

- "I'm having to become GIS-savvy to manage all the datasets. … I'm totally all for engineers embracing technology and getting best available data. So I just know if 2D floodplain [modeling] was coming down the pipeline, I would just have to train up for it." —*Other professional*
- "We've got to get our folks trained up using this 2D for models. … And then obviously trying to convince our clients that this is better." —*Other professional*

Developers' primary concerns about the transition related to whether it will slow down development. They indicated that certainty is important to the development community. They anticipate that the review process may take longer; however, they also note that 2D modeling may lead to more accurate results.

- "Our development clients, they don't care about any of this. But their main drive is having a process that's predictable and that we know how to get through." —*Development community member*
- "I think what it would do is it would make the CLOMR/LOMR process more complex." —*Development community member*
- "Obviously, I really like 2D. It gives us some really great answers that 1D won't give us in terms of design. And it also gives us answers in terms of the flooding that we don't get." —*Development community member*

Interest groups thought the transition would lead to more conversations about flood risk. They did not think the transition would have much impact on the regulatory process.

- "My team would be really glad if 2D becomes the norm and the regulation. I feel like it will invite more talk about the science of 2D. People will talk more about how the flow behaves near the buildings. And I feel like it will really force us or encourage us to study more." —*Interest group member*
- "From [the perspective of] sort of the permit-writing Joe or Jill Floodplain Administrator, I'm not sure a lot would change, quite frankly. I think in many ways people are sort of dimensionality agnostic, if you will, from a permitting perspective." —*Interest group member*

D.3.3 Concerns about 2D

Participants noted several concerns related to the adoption of 2D modeling for regulatory floodplain management purposes that the TMAC and FEMA should consider. These include the following:

Significant need for training: There was strong agreement that individuals at all levels will need training to transition to 2D. This includes everyone from the engineers producing the models to reviewers, regulators, and members of the public. Training needs are greater in communities that

lack resources or where there is frequent staff turnover. One participant noted that even colleges and universities are not adequately training in 2D. Training is important to help create consistency in how 2D models are implemented.

- "I think that training would be the hardest part for us. I know we had one 2D model that one of our engineers had to use, and they just were really not sure what to do with it." —*Local government official*
- "We have a lot of turnover. And how certain communities, especially the smaller communities that don't have staff, don't have resources, will be able to implement or even understand how to implement some of these results and products [is a concern]." —*State government official*
- "I graduated in 2018 from [a] master's [program], and there was no 2D modeling course at that time at [redacted] University, which is one of the premier universities in the U.S. And I just believe that situation hasn't changed much since then." —*Interest group member*
- "[There is] a need for consistency from state to state, and more importantly from floodplain manager to floodplain manager. When states go to submit a CLOMR or LOMR, they're getting very different responses, anywhere from cooperation and encouragement to 'No, you can only do that if you update the entire reach to a 2D model.' " —*Other professional*

E**nsuring that models are accurate:** 2D models are complex, and many participants are concerned that 2D models could be created that are inaccurate if not reviewed carefully. They recommended that systems be put into place to ensure greater accountability for the accuracy of 2D models.

- "QA/QC is key to the success and to get good results, because anybody can put together a 2D model. You just need a surface and hydrology, and you run it, and it gives you a result. But if you don't know what to look for … that can really give you good or bad results." —*Local government official*
- "If you just, out of the box, use a 2D model without really kind of knowing your local situation, you can get some very bad results." —*Local government official*
- "State regulators have to make sure that people who are making these models are accountable. The licensing boards are testing these concepts. CFM, ASFPM, and [state organization], they need to include the 2D in their exam criteria." —*Interest group member*

Issues related to large model size: 2D models contain a lot of data. Several participants said some communities, especially small communities, do not have the IT infrastructure to create and utilize 2D models. The large size of these models also makes them difficult to share, and large files sometimes become corrupted.

- "It's just a huge amount of data to manage. … You're getting so many data points that it's actually becoming very, very difficult to manage. And engineering firms or hydraulic people are now turning into technology people because we're really spending our time figuring out how we're managing all this data." —*Other professional*

- "When we have public meetings, it's hard to even just to get [some communities] to be able to join a Zoom call, because they don't have broadband, or they don't have a computer that works for that." —*State government official*
- "I personally just published a 2D model which was 20 gigabytes in size. And my colleagues are having issues where one of those files goes corrupt." —*Interest group member*

Cost considerations: Participants noted several costs associated with 2D modeling. These include training, additional staff time for creating the models, software costs, upgrading computers, and data storage and processing costs. They also expressed concerns about who will pay for these costs. Likewise, developers expressed concerns that reviewing 2D models will take more time, which increases development costs.

- "You could run the [1D] model in two seconds. Compared to [2D]—depending on the size of 2D model, sometimes it could take 2 hours, 3 hours to run. So if you forget to make changes to rain, or you added the wrong hydrograph, I mean, you run it, then after 2 hours, you find out, 'Oh, that's not the right input.' " —*Local government official*
- "Everybody in the engineering world is getting squeezed into subscription of a very expensive software, specifically 2D modeling that can handle all this." —*Other professional*
- "Not every agency … is that adept at understanding and analyzing the data as you go through it. It just adds to time and I guess honestly frustrations of trying to get things approved and moved along. The businesses we're in, obviously, your time is money." —*Development community member*

Differences between 1D and 2D: Several participants expressed concerns related to the different outputs of 2D vs. 1D models. Their concerns include that no-rise is not a realistic standard to achieve in 2D models, that the concept of a floodway is different in a 2D model, and that Letters of Map Revision (LOMRs) / Conditional Letters of Map Revision (CLOMRs) can be more challenging in a 2D environment.

- "2D models are so sensitive that if you do anything in the floodplain, you're going to get a rise somewhere." —*State government official*
- "Even the concept of the floodway in a two-dimensional environment with bifurcated flows and split flows, the floodway concept kind of breaks down in a lot of these environments that we're now working in." —*Other professional*
- "We're always kind of having to make adjustments to the 2D modeling to try and get it to conform to the 1D modeling in order to process CLOMRs and LOMRs, which currently require that we tie in upstream and downstream. So I guess my concern would be how would FEMA be addressing CLOMR and LOMR requirements?" —*Local government official*

Technical challenges: Participants identified the following technical challenges with 2D models:

- Computational time is longer.
- It's more challenging to do revisions.

- Models may not work as well in steep gradient areas.
- Models can produce odd results, e.g., having water higher on one side of a river.
- More challenging tie-ins upstream and downstream.
- Difficult to connect models or transition from 2D to 1D models.
- Challenges documenting storage/attenuation.
- The concept of a floodway is different in 2D.
- It's difficult to achieve no-rise in 2D.
- Some 2D models are proprietary, so it's hard to mix and match models across platforms.

Some specific comments were:

- "With some of the 2D that we have right now, you can have little segments of modeling for the different reaches. … And if people are pulling out little pieces and modifying those for their map revisions, nothing goes back the same way." —*State government official*
- "It routes water very differently. … Attenuation was a really big issue. And so we would start modeling floods through major watercourses or major watershed basins, where you get down to the end of the model and there was zero water left. There basically was no floodplain, even though it's an area where we know locally from historic precedent that it floods." —*Local government official*
- "Most states don't see a clear explanation on how to transition from a current 1D model to a 2D and what that looks like. … The whole concept of a no-rise analysis in 2D modeling is going to be much more difficult to achieve." —*Other professional*

Need to revise existing regulations: Existing regulations do not work well with 2D modeling; many participants noted that trying to use existing regulations with 2D models creates several issues (e.g., related to different model outputs). Changing code at the federal, state, and local level is also seen as a challenge.

- "There's still a little bit of this propensity to try and fit the square peg into the round hole. And they're trying to currently make the regulatory products from a 2D model kind of fit the 1D world." —*Other professional*
- "Our city code is not set up right now for two-dimensional modeling. So it would be a fairly heavy lift to start revamping that code and get buy-in from city council members and some nontechnical folks for how we can benefit from this increased data." —*Local government official*
- "The current CFR [Code of Federal Regulations] is written for a 1D floodway and defines what a floodway is. But the floodways that we're seeing—or at least that I'm seeing—don't really meet that definition. … So a change to the CFR is going to be required." —*Other professional*

D.3.4 Suggestions to Overcome Concerns

Participants offered the following suggestions to address these concerns related to 2D modeling:

FEMA should provide clear messaging on what is changing and why. This includes the following:

- Clearly describing the transition to 2D modeling, including what is changing and the timeline for any changes.
- Clearly describing the benefits of 2D modeling, for example, how 2D modeling handles risk better.
- Providing clear guidance on how to achieve compliance using 2D models, with as little subjectivity as possible.

Some specific comments were:

- "I think for FEMA, maybe they've already created this, but creating a really clear vision and mission statement of why 2D is better, and how it improves floodplain management." —*Other professional*
- "We as engineers totally understand what we mean when we're talking 1D versus 2D. And the community will have no clue what we're talking about. So maybe something along the lines of what are we talking about when we're talking [about] the difference between 1D and 2D flood data? And how does that actually affect floodplains, mapping, and flood risks?" —*Local government official*
- "I think the main thing is … clear standards. Whatever they are, they need to be clear, with very little subjectivity." —*Development community member*

FEMA should update its regulations/memorandums to incorporate the use of 2D modeling for regulatory floodplain management. This should include the following:

- Redefining or reconsidering the definition of a floodway.
- Allowing for more tolerance or "wiggle room" related to no-rise, e.g., allowing de minimis rise such as a tenth of a foot, or even half a foot.
- Updating the 1982 memorandum from FEMA to the Federal Highway Administration (FHWA) (www.fhwa.dot.gov/engineering/hydraulics/policymemo/820625.pdf) to address 2D modeling.
- Speaking to various stakeholders as regulations are updated to make sure all perspectives are considered.
- Some specific comments were:
- "The definition of a floodway is equal encroachment, less than 1 foot of rise. And I don't think that the floodways that are being shown on 2D models always meet that definition." —*Other professional*

- "The floodplain was mapped in 2D, but they were holding us to the 1D regulations. And with 2D modeling, you basically put a pimple in the floodplain, you may not get a rise where you're at, but you're going to get a rise somewhere. And the people reviewing that were having a hard time with that." —*State government official*
- "One of the things in [state redacted] that we've had a lot of conversations around is an old 1982 memo between FEMA and FHWA on how to implement the NFIP program just in the one-dimensional state. … Anything that we can do … to update that 1982 memo as we look to move to the 2D modeling world would be greatly appreciated." —*State government official*

FEMA should plan for adequate transition time. Some participants said regulations should be implemented or rolled out slowly so communities have time to adjust. Another approach may be to conduct pilot studies before making changes on a broader scale.

- "I've seen a push towards a full watershed-level analysis with rain-on-grid and probabilistic aspects and all this stuff. I just can't even fathom going to that. … I mean, 2D modeling is awesome. And it offers a lot of benefit. But I think we need to be careful not to bite off more than we can handle." —*Other professional*
- "FEMA should initiate some pilot projects, as they have done in the past when rolling out new technology. … And I also think that the rollout should be in larger communities, not a universal rollout, as the tools are developed and the protocols are developed on how to implement it." —*Other professional*

FEMA should provide financial assistance and resources to aid in the transition to 2D modeling. This may include the following:

- Making 2D models and 2D software publicly available.
- Providing public access tools for users to be able to download and view 2D data for a variety of use cases.
- Providing financial assistance (e.g., grants) for communities that need help in the transition to 2D modeling.
- Support for universities to create and teach courses on 2D modeling.

Some specific comments were:

- "FEMA needs to have everything in-house. They need to make sure their data is available. No private company is creating paywalls in front of that data. That's very important." —*Interest group member*
- "GIS data is somewhat proprietary. You have to subscribe or pay a fee, or you have to ask for some GIS data in a certain area. If that could become more globally available through FEMA, at least the information needed to run 2D modeling, I think that would be really helpful." —*Local government official*

FEMA should provide robust training or guidance on how to employ 2D models for regulatory floodplain management purposes. This should include the following:

- Guidance on how to create models.
- Guidance on how to review models, including accountability standards.
- Guidance on how to work across platforms/different software products.
- Common errors and warnings that occur in 2D modeling.
- Guidance on addressing issues such as how to handle coarseness, how to calibrate models, how to address no-rise, how to connect a 2D model to a 1D model, how to smooth data, and how to know when sufficient data have been identified.

Some specific comments were:

- "Some examples, maybe, of what you would expect us to look for and what would be a good example of what we should be asking for as a submittal from people to prove that it's a no-rise." —*Local government official*
- "I think that FEMA would need to develop some very specific guidelines on how to interpret the mapping and how to implement it—'Here's the approach, here's what we stand behind'—so that we're not just all doing it our own way and guessing through things." —*Local government official*

D.3.5 Concerns about Communicating Complex Data

Most participants thought communicating flood risk using 2D models would not be harder (communication is already a challenge), and that being able to present data more visually may make communication easier in some cases.

- "In some ways, it's easier to communicate 2D flood data because it's a little bit more physical." —*Local government official*
- "If anything, I think maybe communicating the data would be a little easier in 2D just because … it allows you to show where the flow paths are going more accurately." —*Other professional*
- "In a lot of respects, the 2D modeling communication is much better. You can do heat maps for everything. You can do heat maps for velocity, you can do heat maps for scour, you can do existing and proposed, the difference between the elevations." —*State government official*
- "I would agree that 2D is easier to communicate than the 1D. … When we would do urban flood studies, it was awesome. Having that terrain showing where the water goes, because it doesn't just stay in a waterway. … We always said a picture [is] worth a thousand words." —*Other professional*

However, a few respondents thought the additional data captured may make communication more complex. They cautioned that 2D models will likely show new hazard areas that communities and residents were previously unaware of, and this may create new communication challenges. Additionally, they noted that it was important to communicate the uncertainty inherent in 2D models.

- "What I can see as a struggle for communities moving forward as we transition from 1D to 2D is having to explain to homeowners and property owners that their risk has always been there, but now it's actually captured with better hydraulic modeling." —*Other professional*
- "The most difficult thing about communicating this is that the 2D model shows something that looks very, very precise. And each time you do that, people think that the data and all the underlying facts are that much more precise than the previous models. … I think it's really important to be able to communicate the uncertainty." —*Local government official*

2D models also have some different assumptions built into them. Respondents noted that it's harder for outside parties to validate and check 2D models.

- "You have to make some assumptions about future conditions, pluvial data, [and] probabilistic [methods]. And so whereas currently you can just say, 'Well, we base the rainfall data for the hydrology on existing data, and we base the Q100 [flood level likely to be exceed only once every 100 years] on existing streamflow data,' now you're trying to project into the future, and it's a lot more opportunity for people to sort of argue about your assumptions." —*Local government official*
- "With 1D, there's some standard tables, and there's things that print that can give you a pretty good idea, if you can just look at that. You don't necessarily have to have an electronic model. … Is there a way to actually review a 2D model without just actually getting the electronic files and running it yourself and looking at it?" —*Development community member*

Other concerns related to communicating complex 2D data included the following:

- Insufficient resources to develop communication models and tools.
- Challenges related to identifying the right level of detail to present in communication tools, including the ability to customize data and views for different audiences.
- Challenges related to the complexity of the information and the ability of all audiences to understand and utilize the information.
- Challenges related to displaying and sharing large amounts of data.
- Training for different audiences to be able to correctly use and understand communication tools, including how 2D models differ from 1D models.
- The ability for users to quickly and easily identify the data they need.
- The large size of the models.

D.3.6 Suggestions for Communicating Complex Data

Participants offered the following suggestions to better enable communication of complex data:

- Communication products and tools should include relevant context to help all users understand the information available, as well as how it differs from information previously available.
- Communication products and tools should include training/information on how to use the tools.
- Communication products and tools should include relevant caveats related to uncertainties.
- Information should be shared online using cloud-based storage to make it most accessible.
- Online data tools should be easy to use and contain relevant information such as velocities, depths, and possible flood risks at the individual property level for different user categories.
- Online data viewers should not require users to have access to geographic information system (GIS) or high-powered computers. Access should be available from multiple platforms.
- Online data tools should consider and manage the amount of data being shown, paying attention to usability across platforms.
- Data should be available to accommodate the needs of various user types. Data download options should also be tailored to different user types.
- Data viewers should strive to create consistency in adjacent boundaries between 2D and 1D models.
- Visuals may be helpful to show the differences between 1D and 2D data. Animation may be helpful to demonstrate flood risk.
- Communication products and tools should enable easy access to critical data such as base flood elevations (BFEs) and whether a property is subject to regulation.

D.3.7 Desire for Specific Products or Information

Several specific types of products or tools were identified as useful. Participants expressed interest in the following:

A tool that would show FEMA recommendations for different views and use cases.

- "If there was a way to draw a polygon or something and say, 'What's the highest number in here?' that might be helpful, as opposed to just having to individually identify each dot." *—Local government official*
- "I think it would be great to be able to go to a map and click on a point and say, 'Here's where I'm proposing a development or here's my community. What models are available to me?' … Those nonregulatory products beyond just what is floodplain and what's not, those depth grids, and those velocity grids I think are great tools. The ability to show overtopping recurrence intervals or what level of flood does it take to get to a particular point on a map." *—Other professional*

Tools that allow customization of data.

- "There [are] a lot of peripheral products that come out of these 2D models. And I think [it would be good to] customize them for the individual communities … like looking at some of their hazard mitigation plans, maybe. Or … the risk of flooding over the course of 30 years, so the [usual] length of a mortgage." —*State government official*

The ability to point and click on a map and see what data are available.

- "If there could be a way for people to be able to get things in a format that's a little less intimidating than clicking around a bunch of spots. If you could click at the locations you wanted, and then maybe get it to give you a table that gives you the elevation by grid cell or something. … It would be nice to be able to get all the elevations from that grid to not have to click on each one and see it on the screen." —*Local government official*

Digital tools that would allow property owners to see and understand their flood risk.

- "Having some type of dashboards for individual property owners to really kind of get a full understanding of what their flood risk is on their particular property." —*Other professional*

Tools that point users to additional data, e.g., in the FEMA library, or access to existing 2D models.

- "A beefed-up FEMA library. So that models could be checked in and out easier and obtained by the standard user." —*Development community member*

Tools that allow users to customize existing GIS maps and show different views.

- "You really need an online interactive map tool that is super user-friendly to the general public but is underlaid with the data that the engineers in your community care about, like velocity. And supporting those mapping tools, so that they're super-functional and available 24/7/365." —*Local government official*
- Participants noted that the following examples may be useful to review when considering communication products:
- West Virginia Flood Tool (https://www.mapwv.gov/flood/)
- U.S. Geological Survey flood inundation map (https://fim.wim.usgs.gov/fim/)
- Colorado Flood Hazard Mapping (https://coloradohazardmapping.com/floodHazard)
- FEMA's Flood Risk Report (https://www.fema.gov/flood-maps/tools-resources/risk-map/products)
- FEMA's Flood Map Service Center (as a place to share information) (https://msc.fema.gov/portal/home)

D.4 Conclusions

The suggestions contained here represent the viewpoints of listening sessions participants. The TMAC considered these suggestions in making its recommendations to FEMA, but these suggestions do not constitute an endorsement of any particular viewpoint.

Appendix E

Assessment of FEMA's Request for Information Docket No. 86 FR 56713

E.1 Background

This analysis was performed to inform the Technical Mapping Advisory Council's (TMAC's) recommendations about two elements of the FEMA Memo:

- If/how FEMA should modify the definition of the Special Flood Hazard Area (SFHA) or modify how the SFHA is currently calculated (without redefining it). The SFHA is currently defined as "the land in the floodplain within a community subject to a 1 percent or greater chance of flooding in a given year."
- How FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded to be at or above estimated 1% annual chance exceedance flood levels (or base flood elevations [BFEs]).

In November of 2021, FEMA put out a Request for Information (RFI) titled, "National Flood Insurance Program's Floodplain Management Standards for Land Management and Use, and an Assessment of the Program's Impact on Threatened and Endangered Species and Their Habitats." The RFI asked 76 questions, and the TMAC co-chair refined this analysis by identifying eight questions relevant to understanding stakeholder sentiment as it applies to the FEMA Memo. Using these criteria, the sample size was 122 comments.

E.2 Methods

All data gathered for this analysis was qualitative. A team performed a content analysis to identify patterns by grouping sentiments into concepts and themes (recommendations) generated from a sample of the data. A single response could be tagged multiple times with different themes.

Analysts captured the responses, recommendations, and rationale from each comment relating to the eight questions of interest from the RFI. Each question received a "Yes" or "No" response depending on the nature of the question. If the commenter's sentiment was not clear, or the commenter did not specifically address the question, then the data was tagged as "Unclear" or "No Comment" respectively.

E.3 Results

In relation to modifying the definition or calculation method of the SFHA, this analysis found that 95% of commenters with clear sentiments (104 of 110) feel the SFHA is not currently sufficient.

When each comment was tagged for themes, as seen in Figure E-1, it was found that commenters would like to see climate change (46), equity (46), nature-based solutions (41), government coordination (41), and building codes (32) integrated more thoroughly within the SFHA.

Figure E-1: SFHA word cloud

Responses relating to how FEMA might consider changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded were analyzed through comments relating to two questions from the RFI:

- Should FEMA reconsider its mapping practices, including the issuance of Letters of Map Revision based on Fill (LOMR-Fs)?
- Should the placement of fill material, defined as material used to raise a portion of a property to or above the BFE within the SFHA, be prohibited by the National Flood Insurance Program (NFIP) minimum floodplain management standards?

When comments were analyzed as to whether FEMA should reconsider the issuance of LOMR-Fs, 48 commenters had clear sentiments (Table E-1). Of those with clear sentiments, 88% (42 of 48) of commenters felt FEMA should reconsider its mapping practices, including the issuance of LOMR-F.

Table E-1: LOMR-F Sentiments

Sentiment	Occurrence	Percentage
No	6	5%
Unclear	7	6%
Yes	42	34%
No Comment	67	55%
Total	122	100%

As seen in Table E-2 when responses were analyzed as to whether the placement of fill material should be prohibited by the NFIP minimum floodplain management standards, commenters responded with a near equal number of yes and no sentiments. Of the responses with clear sentiments, 51% (20 of 39) of commenters felt FEMA should prohibit the use of fill within the NFIP.

Table E-2: Fill Sentiments

Sentiment	Occurrence	Percentage
No	19	16%
Unclear	10	8%
Yes	20	16%
No Comment	73	60%
Total	122	100%

E.4 Uncertainty

The RFI used as the basis of this analysis is loosely related to the two FEMA memorandum preliminary requests (see Appendix A) and was not a direct request aligning with the priorities. As a result, the data only include responses of commenters interested in the original intent of the RFI.

The RFI contained 18 question sets and a total of 76 questions. The TMAC co-chair reviewed the RFI questions and isolated eight questions that directly related to the SFHA and LOMR-F requests, reducing the answer pool from 369 comments to 122 comments. Sample size for this analysis was small compared to how many users there are of FEMA NFIP products who would be impacted by changes made to the SFHA or LOMR-F procedures. To our knowledge, there was no targeted outreach effort to solicit feedback from NFIP users.

E.5 Outcome

Results from this analysis indicate there is support for modifying the definition of the SFHA or how it's calculated, and there is support for changing procedures for modifying the SFHA through letters of map change and map updates when land is filled or graded.

Appendix F

Statistical Analysis of Median 1% Annual-Chance Event and 95% Confidence Limit 1% Annual-Chance Event

F.1 Introduction

The Technical Mapping Advisory Council (TMAC) used existing data to estimate how much higher the 95% confidence limit might be above the median 1% annual-chance-exceedance flood stage (1% ACEFS). To do this, a team of analysts followed the 7-step process described below and concluded the following:

- There is wide variation in the difference between the median 1% ACEFS and its corresponding 95% confidence limit. The differences based on this limited study ranged from 0.2 foot to 6.0 feet. These values demonstrate how important it is to quantify the uncertainty at any given location.
- At the 256 sites tested, the average difference between the median 1% ACEFS and the 95% confidence limit was 1.7 feet with differences less than or equal to 3.3 feet 90% of the time.
- This assessment demonstrates how quantifying the uncertainty for site-specific flood estimates can help decision makers set flood risk reduction standards at a confidence limit aligned with their objectives.

F.2 Seven-Step Process

The following shows the 7-step process for estimating expected differences between the median 1% annual-chance exceedance flood stage and various confidence limits:

1. Identify unregulated U.S. Geological Survey (USGS) gauges with rating curves and more than 30 years of unregulated records. Result: 682 sites scattered throughout the 50 states and the District of Columbia.
2. Assemble annual flow data for each site, including the peak annual flow, mean, standard deviation, and skew. Use the skew and desired probability to determine Kg,p using Haan, 1977 , Table 7.7.
3. Compute annual exceedance flow rate probabilities at each site using the USGS Bulletin 17B (B17B) Log Pearson III method (USGS 1982). Use a simplified B17B method of fitting the log Pearson III distribution to simplify computation given the large number of gages.
4. Compute the 95% confidence limit discharge at each site using B17B Appendix 9, equations 9-3 through 9-6).
5. Compute the 1% ACEFS at each site using the median and 95% confidence limit flow rate. Compute the stages using USGS rating curves for each of the 682 sites. (For 426 sites, the computed median or 95% confidence limit for the 1% ACEFS was greater than the upper limit of the rating curve. These gages were removed from the data set, leaving 256 sites.)
6. For each of the remain 256 sites, compute the difference between the median 1% ACEFS and 95% confidence limit ACEFS and round to the nearest 0.1 foot. (One of the 256 sites was eliminated as an outlier, leaving 255 sites.)
7. Compute the minimum, maximum, and average differences at all 255 sites along with their percentiles.

Appendix G

TMAC Meetings and Activities

Table G-1: TMAC Meetings and Activities

Date	Activity	Purpose
April 12, 2023	Administrative Meeting	The TMAC reviewed the April 11, 2023 memorandum from FEMA and discussed the draft outline of the topics to be addressed in the 2023 TMAC report.
May 15, 2023	Administrative Meeting	Introduction of the 2023 TMAC members and the FEMA 2023 TMAC request.
June 13/14, 2023	Public Meeting	The TMAC reviewed the Request for Information (RFI) analysis and overviewed the Design Sprint Process. The TMAC conducted the Map Phase of the Design Sprint for Topics 1 and 2, regarding the SFHA and fill in the SFHA , respectively, identified in FEMA's April 11, 2023, Memorandum. Outcomes included a vote that the TMAC should proceed with developing recommendations to drive change for these topic areas.
July 24, 2023	Administrative Meeting	The TMAC conducted the Map Phase of the Design Sprint for Topic 3, related to 2D modeling for floodplain management, identified in FEMA's April 11, 2023, Memorandum. Outcomes included a basis for developing recommendations in future meetings.
August 3, 2023	Administrative Meeting	The TMAC conducted the Sketch and Decide Phases of the Design Sprint process. Outcomes included the formation of the Subcommittee 1 (SFHA) and drafts of the Initial Thinking to be refined by the subcommittee for the listening sessions.
August 21-25, 2023	First Set of Listening Sessions	The TMAC collected feedback from various audience groups on Topics 1 and 2 to inform the work of the TMAC.
August 28, 2023	Administrative Meeting	The TMAC conducted the Sketch and Decide Phases of the Design Sprint process. Outcomes included the formation of the Subcommittee 2 (Complex Data) and drafts of the Initial Thinking to be refined by the subcommittee for the listening sessions.
September 19/20, 2024	Public Meeting	The TMAC reviewed listening session feedback from the first set of sessions and reviewed the draft recommendations regarding Topics 1 and 2, regarding the SFHA definition and fill in the SFHA. Outcomes included TMAC votes on moving forward with draft recommendations and drafting the Interim Report.
October 15-23, 2023	Second Set of Listening Sessions	The TMAC collected feedback from various audience groups on Topics 3 and 4 to inform the work of the TMAC.
October 27, 2023	Public Meeting	The TMAC shared its Interim Report on Topics 1and 2, regarding the SFHA definition and fill in the SFHA and conducted a final vote on recommendations for those topic areas. The TMAC also shared emerging recommendations for Topics 3 and 4, regarding 2D modeling for floodplain management and complex data representation.

Date	Activity	Purpose
November 28/29, 2023	Public Meeting	The TMAC reviewed outcomes of the Design Sprint and second set of listening sessions and shared notional recommendations on Topics 3 (2D modeling) and 4 (communicating complex data) as well as reports on the activities and progress of the two TMAC subcommittees.
December 18, 2023	Administrative Meeting	The TMAC reviewed Chapter 5, consolidated draft recommendations regarding Topics 3 and 4 (regarding 2D modeling for floodplain management and complex data representation), and developed actions to complete first draft of the final report.
January 23/24, 2024	Public Meeting	The TMAC discussed the draft report and requested public comment. The TMAC voted on final draft recommendations.
February 27/28, 2024	Public Meeting	The TMAC presented the final draft report and voted to finalize and publish the report.

Appendix H

Previous TMAC Recommendations Referenced in 2023 TMAC Report

Table H-1: Previous TMAC Recommendations Referenced in 2023 TMAC Report

Recommendation No.	TMAC Report Year	Recommendation
AR 01	2015 AR	FEMA should establish and implement a process to assess the present and anticipated flood hazard and flood risk products to meet the needs of the various users. As part of this process, FEMA should routinely: a) Conduct a systematic evaluation of current regulatory and non-regulatory products (data, maps, reports, etc.,) to determine if these products are valued by users, eliminating products which do not cost-effectively meet needs; b) Consider user requirements prior to any updates or changes to data format, applications, standards, products, or practices are implemented; c) Proactively seek to provide authoritative, easy to access and use, timely, and informative products and tools; and, d) Consider future flood hazards and flood risk.
AR 11.2	2016 AR	FEMA should take into consideration the following items at the next review of the MIP system: • Integrate the MIP and KDP process into one system. • Provide mapping partners more visibility on Data Validation Tasks (i.e., who is responsible for these tasks at the Regional office) and ensure more proactive coordination is implemented before and after the data validation tasks. • The MIP should take into account the uniqueness of CTPs and enable more flexibility in all areas of the flood production process, including product upload, geographic areas, metadata requirements, and QC reviews. • Transition the MIP to a geodatabase system, similar to the CNMS, in which information is saved geospatially and run customized queries and reporting for Regional offices, mapping partners, and CTPs. • Enhance functionality to create auto-generation of template correspondence (e.g., SOMA letters). • Provide greater flexibility in user controls. • Provide additional user access to related information. • Add risk product workflows. • Integrate an efficient solution to seamless mapping or HUC or State geographic areas.
AR 26	2017 AR	FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line.
AR 27	2017 AR	FEMA should develop, in coordination with stakeholders, a transition plan for moving away from the 1-percent-annual-chance flood line.

TMAC

TECHNICAL MAPPING ADVISORY COUNCIL