



# FEMA Risk MAP

Managing Floodplains with 2D Modeling



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## Overview

This document is intended to give local community officials who work with flood hazard data (e.g., floodplain managers, planners, and engineers) an idea of what to do with the information received at the close of the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment and Planning (Risk MAP) process, and how to use it to manage development in the Special Flood Hazard Area (SFHA), which is the area on a FEMA Flood Insurance Rate Map (FIRM) that determines which structures are subject to floodplain regulations as well as where flood insurance is required. It is intended to be used in conjunction with [ASFPM's FEMA Risk MAP, What to Know: Community Role](#) handout.

## Adopting the maps

Once the preliminary FEMA maps and the letter of final determination have been issued (see [ASFPM's FEMA Risk MAP, What to Know: Community Role](#) handout for more information on this process), the community has six-months from the date on the letter of final determination to adopt the map into its floodplain management ordinance; see [FEMA's Risk MAP page for more information on map adoption](#). Once the FIRM is adopted, the community must manage development and regulate in line with the model and final map.

## Accessing and managing the modeling

When you receive the model, make sure you can access and run it. You may need to take steps to gain access to the software. Ask FEMA or its Mapping Partner for steps to gain access if you do not already have access. When a developer has adjusted the model to include their planned development in the floodplain, make sure the developer provides a copy of the updated model to the community for its records so that any future development can be built on the most-up-to-date model representing flood risk in the community. When a developer has modified the engineering model, a Letter of Map Revision must be obtained to ensure the updated model continues to be the regulatory engineering model.

## Storing digital copies of the results

Flood study engineering models are expensive to build. The community should have a digital copy of the models so that those that need the models for development projects which encroach a Special Flood Hazards Area will have local access to the effective regulatory models. Due to the large file sizes associated with 2D modeling, obtaining and downloading the data from a FEMA may be challenging or problematic. Regardless, the community should request digital copies of everything created during the Risk MAP process (e.g., HEC-RAS project files, GIS shapefiles for floodplains and floodways, raster datasets for depth and velocity, PDF versions of the FIS report and FIRM panels, etc.). While the Technical Support Data Notebook may have been obtained previously, it is important to request a final version of the TSDN.



Datasets associated with 2D modeling are much larger in size than the data generated associated with steady-state or unsteady 1D modeling. However, it is important that the community request a copy of the data used to create the model as well as the data generated. The community and/or the community's consultant will then be able to review this information. Also, request information on whether the modeling has had an independent review. Some states and watershed districts review flood engineering modeling developed for communities within their area of jurisdiction.

The community should plan for duplicative storage of the data to ensure its availability and viability. The data associated with these studies is quite large and could necessitate one or more Terra-Bytes of storage. The storage types are chosen by the local community, but could range from external storage devices (low, one-time cost) to cloud storage (higher, potentially recurring cost). As mentioned above, reasonable access is important for the community so that it can provide the necessary information upon request.

## Managing development with unsteady 2D models

### When the community FIRMs include a floodway

Unsteady 2D modeling data is more informative, providing extra detail that can give better insights into true impacts to the floodway. This extra detail can help communities make better decisions around flood risk. Compared to 1D models, floodplains and floodways defined by unsteady 2D models can be difficult to administer (e.g., training requirements, cost to run, etc.).

Communities with new unsteady 2D modeling (that previously had 1D modeling) will likely see changes in the floodway limits, with a high likelihood of the floodway limits being larger. Upon the effective date of the new study, the new floodway limits must be utilized for NFIP compliance moving forward from that date or the community can adopt an alternate (more restrictive) floodway following FEMA's [Floodway Analysis and Mapping, Guidance Document No. 79](#). Communities must adopt the new boundaries prior to the effective date.

### When the community FIRMs do not include a floodway

Not all 2D modeling and related maps include a floodway. If your community has no designated floodway, your community will need to either:

- Designate a floodway (check your state's requirements). See "[Determining a regulatory floodway with unsteady 2D models](#)" section, or
- Track all increases in flood elevations to determine when the cumulative impacts exceed the surcharge threshold. Once the flood surcharge is met all additional development must meet the no-rise requirement. See "[Understanding floodway surcharge with unsteady 2D models](#)" and "[Complete a no-rise analysis](#)" section.



Per the Federal Code of Regulations (CFR) 60.3(c)(10), “the community shall...require until a regulatory floodway is designated, that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on the community's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.”

Note, your state may require a more restrictive floodway surcharge threshold than the federal maximum of one foot; check your state’s requirements.

## **Determining a regulatory floodway with unsteady 2D models**

Some models may be usable as-is but sometimes additional runs may be needed to determine a reasonable floodway that best meets the FEMA guidelines. The following adjustments may be necessary:

- Iterations of running the model to eliminate as many locations as possible that have surcharges greater than 1.5’ or less than -0.5’
- Further widening the floodway where building surcharges are greater than 1.0’

Note, if option two is used, the capacity increase may result in additional structures or parcels that were previously mapped outside the floodplain being added to the floodway. In 2024, Kasraie Consulting completed a study for ASFP that assessed how the Federal Emergency Management Agency’s (FEMA) new, updated Guidance for Flood Risk Analysis and Mapping document (Guidance Document No. 79, 2023) works for studies based on 2D modeling, in particular with respect to floodway generation. To do this, Kasraie Consulting analyzed five (5) previously developed 2D flood studies with a floodway component. When the floodways were widened in the five studies, the floodplain expanded between 1%-3%. In one model, this expansion added over 150 new structures to the floodplain.

## **Understanding floodway surcharge with unsteady 2D models**

When flood waters spread out beyond the floodway, the amount of inundation in the filled flood fringe should be less than the full allowable surcharge amount. Traditional 1D modeling averages results, including floodway surcharge, across a single cross-section. In contrast, 2D models are raster-based and provide results at each cell, which makes the outcomes more sensitive to minor changes in the floodway. Even small changes can create added sensitivity.



The federal standard allowable surcharge is 1-foot, but some states and communities have more restrictive standards (e.g., 0.5-foot surcharge); make sure to check your allowable surcharge standard. As a result of this increase sensitivity, 2D floodway models often do not meet the allowable surcharge of 0–1 foot (or lesser amount if required by state or local higher standards) at every cell. It is very difficult to have all surcharges (i.e., every cell) lie within -0.5' to 1.5', the range listed in FEMA's Guidance Document No. 79.

Individual projects in the flood fringe can create localized impacts, increasing potential hazards and costs for neighboring properties. For example, small high points, agricultural berms, and 1D-2D boundaries can create localized surcharge values outside the desired range. This new surcharge averaging and evaluation of insurable structures methodology is intended to provide some flexibility and reduce the need for unreasonable, excessive effort to address minor, localized issues created by the model's sensitivity. None of the studies analyzed for ASFPM by Kasraie Consulting were able to meet FEMA's 2D Floodway Evaluation Criteria, however, and most of the cells that violated FEMA guidance were located along the 1D-2D boundary or immediately adjacent to interior high points in the terrain surrounding ponds/lakes in the overbank.

### Beware misleading graphics

Graphics and depth grids that show the surcharge amount only within the floodway are misleading because they imply that the surcharge does not leave the floodway. Except where there is a continuous levee along the floodway, this interpretation is incorrect. Conversely showing the amount of surcharge across the entire floodplain (and beyond) can overstate the impact. The Kasraie Consulting analysis found that if the entire flood fringe is filled to the BFE, a significant portion of the filled flood fringe will still be inundated; an average inundation of 0.2'-0.8' was found across the five studies. Kasraie Consulting suggests a depth grid showing the allowable surcharge everywhere might better inform communities of the more realistic effect of the floodway surcharge, rather than an analysis of the impact of the floodway surcharge across the entire mapped Special Flood Hazard Area. Showing surcharges only within the floodway does not provide an accurate representation of true physical conditions.

### Completing no-rise analysis

For a no-rise analysis using 2D modeling, results can be averaged along evaluation lines to show that the proposal does not increase flood elevations. This is similar to how results are averaged at cross sections in a 1D model. However, averaging at evaluation lines is only acceptable if no insurable structures are impacted.



Note, a single insurable structure database is not available. Several local and national data sets representing buildings or building centroids exist. The two major national data sets are the Microsoft Building Footprints and USACE National Structure Inventory. To properly determine if no insurable structure is impacted there must be a comparison against the proposed SFHA boundary and the best available aerial photography, such as the National Agriculture Inventory Program or Google Maps photos.

One way to ensure the no-rise finding confirms that no insurable structures are impacted is to require the submitting engineer to include an Acknowledgments Statement (see Appendix A).

Note that individual encroachments or impacts may not show a measurable change but the cumulative impacts of those same encroachments may result in a measurable rise. Therefore, any no rise analysis should include all previously approved no-rise analyses to ensure there is no rise (i.e., cumulative impacts). At some point, the cumulative impacts will result in a measurable rise.

## **Using evaluation lines and velocity in unsteady 2D models**

Base Flood Elevation and evaluation lines are provided on maps developed with unsteady 2D modeling. When using unsteady 2D modeling results for determining regulatory elevations associated with development proposals, the elevations developed for individual cells are the best way to determine the appropriate elevation; as a reminder, 2D modeling generates elevations and velocities at grid cells in a geographic information system (GIS). If the community does not have the GIS capability to use the gridded results, it is suggested that the community use a straight line between BFE lines and interpolate to determine the appropriate elevation. A Flood Insurance Study Profile may not be developed with an unsteady 2D model; if a Flood Insurance Study Profile is available, however, it should be utilized.

Another advantage of using the gridded results is that they include velocity data. High-velocity zones are critical for building design (e.g., breakaway walls, foundations), emergency management (e.g., identification of evacuation routes and debris accumulation locations), and infrastructure design (e.g., determining scour potential for bridges and culverts).

As previously mentioned, evaluation lines in 2D floodway analysis may be thought of as virtual hydraulic cross sections similar to the physical cross sections used in steady-state and unsteady 1D modeling. FEMA's Guidance for evaluation line placement states that "profile slope between any two evaluation lines or evaluation lines and BFE lines should be relatively constant."



The combination of BFE lines and evaluation lines produce a credible water surface elevation grid that captures the variability in the model results and aligns with FEMA's mapping requirements. Based on this guidance, it may be reasonable to scale a BFE estimate from the evaluation lines and/or BFE lines on a map. For more information on evaluation lines, refer to FEMA's [Floodway Analysis and Mapping, Guidance Document No. 79](#).

## Reviewing project and permitting requests

The way the community will most commonly use the model and its output, data, or associated mapping is to determine base flood elevations and flow velocities for proposed development sites and/or construction projects when reviewing projects and permitting requests. (Note, for sites located between whole foot BFE or elevation lines, the community may need to interpolate between the lines to determine the BFE at that location.) Determining BFEs can be done from the final FIS or FIRMs with no need to access the model itself.

Depending upon impact of the encroachment into the floodplain, the BFE may increase, resulting in increased flood risks upstream and/or downstream of the encroachment. The community or developer should run the model for project review or permitting requests to determine the impacts of encroachment within the floodplain. To support this process, the community should share any files, maps, and data associated with the model with developers so that the developer can demonstrate the impacts on the development on the floodplain as part of the permitting process. A community may hire a contractor to assist in the review of the permittee's model for the permitting process, or to fully run the permitting review process.

As an example, a community in the Western United States requires developers to engage an engineer to ensure no more than a 1-foot cumulative rise across not only the county but two neighboring counties. They require this to be done by overlaying the proposed project over the original 2D hydraulic model. Having one model for the whole system, rather than allowing developers to create their own, ensures consistency. While this helps ensure the cumulative impacts are not exceeded, this community has had pushback from developers regarding the administration (e.g., FEMA requires use of most restrictive data) and extra costs for the engineering fees to run the modeling. On the other hand, this method ensures that small communities who do not have the capacity to track the impact of potential development in its own or in neighboring communities to do so.



Cover image: Flooding in Strong City, Kansas. May 9, 2019.  
Image by Scott Wiltse via ASFPM Flickr.

Association of State Floodplain Managers  
[www.Floods.org](http://www.Floods.org)