



# **Association of State Floodplain Managers, Inc.**

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## **TESTIMONY**

### **An Examination of Federal Flood Maps in a Changing Climate**

Before the

House Committee on Science, Space and Technology  
Subcommittee on the Environment & Subcommittee on Investigations and Oversight

By

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## **Introduction**

The Association of State Floodplain Managers is pleased to participate in this hearing to explore how flooding and sea level rise affect American property owners, how the Federal Emergency Management Agency (FEMA) uses science to inform its flood products, and whether additional federal resources are needed to research and communicate future flood risk to the public. We are especially pleased that Congress is exercising its oversight function as it examines the National Flood Mapping Program at FEMA and we appreciate the opportunity to discuss our views and recommendations for the future of the program. We thank you, Chairwoman Sherrill, Chairman Foster, Ranking Member Marshall, Ranking Member Norman and Members of your Subcommittees for your interest in this important subject.

ASFPM is a national nonprofit scientific and educational organization whose mission is to reduce flooding and to recognize the inherently important functions of our natural floodplains. ASFPM and its 37 chapters represent more than 20,000 local and state officials, private sector, academia, and other professionals engaged in all aspects of flood risk management and flood hazard mitigation, including management of local floodplain ordinances, flood risk mapping, engineering, planning, community development, hydrology, forecasting, emergency response, water resources development, protection of valuable floodplain functions, and flood insurance. All ASFPM members are concerned with reducing our nation's flood-related losses. For more information on the association, visit our website at [www.floods.org](http://www.floods.org).

## **Our Nation's Flood Risk is Increasing Dramatically**

Floods are the nation's most frequent and costly hazard. The cost to taxpayers continues to increase at an alarming rate. ASFPM estimates average annual flood losses were about \$5.6 billion in the 1990s. This increased to an average annual flood loss of \$10 billion in the 2000s, and in this past decade came close to doubling again with a conservative estimate of \$17 billion per year.

Climate change is manifesting itself in several ways as it relates to flood risk. But the two primary ways are sea level rise and more intense storms. For instance, a 2016 study updated the estimates on the amount of ice melting in Antarctica and concluded that the increase in sea level may be twice the level that was previously estimated. And, an additional source of uncertainty is the willingness and ability of the world's nations to change the trajectory of climate change. The success of agreements like the Paris Climate Conference and future agreements hold the potential to mitigate some of the projected impacts of climate change. It

appears there is increasing consistency in new scientific investigations that we have likely underestimated the amount of future sea level rise and that it is likely accelerating faster than originally projected.

In inland areas all across the country, local officials are observing more intense rainfall events. And this is showing up in the [data](#), too. Warming conditions mean more water vapor in the air. When rain-triggering conditions are favorable, more saturated air leads to heavier precipitation. One public works official from Arkansas recently noted “It was easier when we could plan for and put in stormwater infrastructure that can handle one to two inches of rain each hour, but now we are seeing events where you might get four inches of rain in a half hour, and I am not sure how we are going to handle that.” [Recent research](#) by Climate Central reinforces this observation, showing an upward trend with more days with significant rainfall events. These more intense rainfall events have resulted in an increasing threat of urban flooding, essentially when there is too much water for the local stormwater system to handle. The ASFPM Foundation recently released a [report](#) on urban flooding which concludes that much of the work to address the issue needs to happen at the state and local level; however, federal resources and assistance, including a national assessment can be an appropriate role for the federal government.

### **How Does Flooding and Sea Level Rise Affect Property Owners?**

Flooding and sea level rise affect many property owners nationwide. Unfortunately, for those less fortunate who have little financial ability to move out of high risk areas, many federal policies create a moral hazard as well. Recent studies estimate that as many as 60 million people live in flood hazard areas—whether it be the 1% annual chance (100-year) floodplain or the .2% annual chance (500-year) floodplain. This does not account for the other flood hazard areas such as storm surge zones, tsunami zones, residual risk areas as a result of impoundment or the release of waters from dams, residual risk areas from levee failures and an increasingly impactful urban flooding threat. Indeed, flood risk is far more widespread than is perceived or known. Through flood hazard identification, the flood risk can be better known, but as a society, we are not doing enough to reduce flood risk until it is often too late and a flood is bearing down on an area. Individual property owners are affected differently from flooding risks and sea level rise depending on the actions that they have or have not taken to reduce that risk.

Consider the plight of the low income renter who finds HUD subsidized housing in a flood hazard area. While rent may be cheaper, federal policy has created a moral hazard whereby those in society who can least withstand the impact of a major flood are placed squarely in harm's way. Or consider the first time homeowner who just a day before closing finds out that the property is in a special flood hazard area, and flood insurance is required on their mortgage. Typically, the news is not well received; however, some of those property owners who later face a damaging flood become true believers in the importance of flood insurance. Others spend large amounts of time and effort fighting the flood zone determination because they do not believe they are at risk. Indeed, social scientists tell us that as individuals we tend to think of low frequency, high impact events in an irrational way, often thinking it will not happen to us...until it does. Small business owners are particularly vulnerable as most of their liquid assets are tied up in their business and flood insurance is often not a consideration. Yet data shows that 40-60% of small businesses never reopen after a disaster. There is the ongoing struggle between community leaders who potentially face the loss of tax base when thinking about solutions that would reduce the occupancy of the floodplain through buyouts or long term land use planning, even though such options are in the best interest of the property owner. And there is the plight of existing at-risk property owners who, due to lenient floodplain management standards in their own community, are put at increased risk from new development because the standards and community do not account for off-site impacts. Our members often work with those who have previously flooded, and we often see impacts largely hidden from the disaster cost tallies such as heightened anxiety, suicide, stress, and other emotional and health impacts.

Living in and around floodplains is complicated and there are constantly competing priorities. When it comes to floodplains, there are no great solutions. Instead you are choosing the least worst solution. A reality that is too often overlooked is the simple fact that flood hazard areas exist regardless of maps and ultimately it is a very hazardous area.

The future flooding condition (including sea level rise) is bleak for many of the nation's communities and at-risk property owners, especially those on the coast. In a 2016 [Insight report](#), Sean Beckett the Vice President and Chief Economist of Freddie Mac wrote the following:

While technical solutions may stave off some of the worst effects of climate change, rising sea levels and spreading flood plains nonetheless appear likely to destroy billions of dollars in property and to displace millions of people. The economic losses and social disruption may

happen gradually, but they are likely to be greater in total than those experienced in the housing crisis and Great Recession. That recent experience illustrated the difficulty of allocating losses between homeowners, lenders, servicers, insurers, investors, and taxpayers in general. The delays in resolving these differences at times exacerbated the losses. Similar challenges will face the nation in dealing with the impact of climate change.

Among the several issues the report ponders, one relates to the equity in a person's home. If those homes become uninsurable and/or unmarketable, the value of the homes will plummet, perhaps to zero. Unlike after the Great Recession, homeowners will have no expectation that the values of their homes will ever recover. Especially when it comes to sea level rise, how will the housing finance system work for properties that today are dry but in 30 years—the duration of a mortgage—will largely be wet due to tides or outright continuous inundation? At what point will lenders stop providing loans in these areas?

In the 2018 report [\*Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate\*](#) by the Union of Concerned Scientists, several conclusions should raise alarm:

- Accelerating sea level rise in the lower 48 states, primarily driven by climate change, is projected to worsen tidal flooding, putting as many as 311,000 coastal homes with a collective market value of about \$117.5 billion today at risk of chronic flooding within the next 30 years—the lifespan of a typical mortgage
- The consequences of chronic flooding of properties in specific communities could translate not just into eroding property values, but also into unlivable houses and falling tax revenues that fund schools, roads and emergency services in those places. The properties at risk by 2045 currently house roughly 550,000 people and contribute nearly \$1.5 billion toward today's property tax base. These numbers jump to about 4.7 million people and \$12 billion by 2100. Municipalities are looking at even deeper revenue declines when commercial property, sales, and other business tax losses are factored in.
- With chronic inundation, homeowners and owners of commercial properties are directly at risk of significant financial losses as the value of their properties declines. Such losses have ramifications for the local community, which could see its property tax base eroded and its ability to fund local services compromised. There will also be implications for the wider economy, including for banks with outstanding mortgage loans on properties at risk of inundation, coastal property developers, investors and insurers, business owners whose places of business may face flooding, and US taxpayers, broadly, who may face increased taxes to pay for measures to cope with flooding and to reduce flood risk.

So the ultimate question from a public policy standpoint is how do we get property owners and communities ready for a future where flood risk is more significant and in some areas predictably far worse? What adjustments do we need to make in our approach to flood risk management to increase awareness of hazards and align our policies and programs to ensure a high degree of resiliency as communities face tough choices about where to grow and where to invest? Experience tells us that at the community scale, flood resilience is a multi-decadal process. The most progressive communities in the country, such as Charlotte, North Carolina or Tulsa, Oklahoma have been “mitigating” flood risk for three decades or more and still much remains to be done.

## **Data, Analysis, and Information – An Appropriate Federal Role**

If we do not have robust systems in place to provide updated and anticipated hydrologic data, flood maps, and reliable topography (and to provide sufficient resources going to research and development), we will simply never get ahead of new development in flood risk areas and create more properties at risk from flooding. ASFPM believes that that one of the most important roles the federal government can undertake in flood risk management is to provide data, analysis and information for the nation. For better or worse, the enterprise of providing current, actionable flood data is a cooperative effort among several federal agencies. Before delving further into the NFIP itself—and FEMA’s role—it is important that the subcommittees understand the overall framework under which flood risk information is generated.

One trend that we are seeing across the country is that rain events are getting more intense. To compound matters, our nation tends to use outdated hydrology which only further underestimates the risk. Hydrologic information is the key input into flood models which produce flood risk data and flood maps. Traditionally, the National Oceanic and Atmospheric Administration’s (NOAA) National Weather Service (NWS) has the responsibility for updating precipitation frequency estimates for various parts of the United States and affiliated territories. Updated precipitation frequency estimates, accompanied by additional relevant information, are published as “NOAA Atlas 14” and are available for download from the Precipitation Frequency Data Server (PFDS). This data is used in everything from hydrologic modeling for producing flood maps, to thousands of design decisions every day for development and redevelopment in our communities, highways and other infrastructure throughout the nation. However, NOAA has neither the budget nor clear mandate to provide this in a timely way. In fact, a note in NOAA’s most recent progress report extending through March 2019 indicated

that “No funding is available to extend NOAA Atlas 14 coverage to the remaining five northwestern states: ID, MT, OR, WA, WY in Volume 12.”<sup>1</sup>

Consider the [new Atlas 14 data](#) for Texas which was issued in the fall of 2018. That data basically determined that the previous 100-year rainfall amounts for Houston is now about a 25-year event. In Austin, the previous 100-year rainfall amount is now about a 50-year event. As one of ASFPM’s Texas members put it, “pretty much all of the flood maps in the state of Texas are now outdated.” And this particular Atlas 14 update was not even looking at the future. Rather it is updating 40-50 year old data that was developed in the 1960s and 1970s. ASFPM is supportive of current NOAA efforts to test the feasibility of incorporating future climate projections into precipitation frequency analysis examining the inclusion of such data into future Atlas 14 updates.

- **NOAA should be given the mandate and full budget to update our nation’s rainfall frequency information at least every 10 years and this update must include future climate projections into precipitation frequency analysis.**

Stream and tidal gages are the stethoscopes of our hydrologic network and are another important input into flood models and maps. Ask any local official about a critical data need and most will say that there needs to be more streamgages. Yet funding for even those deemed critical by the federal government is in short supply. For example, the Federal Priority Streamgages (FPS) Network (previously known as the National Streamflow Information Program) was conceived in 1999 to be a core, federally funded network. The original network design included 4,300 then active, previously discontinued, or proposed new gages that were strategically positioned across the country to address long-term Federal information needs (such as supporting NWS flood forecasts, or interstate and international compacts and decrees). At present (2018), more than 4,700 locations meet the criteria for inclusion in the FPS network, but only about 3,600 FPS streamgages are active because of funding limitations. These active FPS are supported through a combination of Federal and partner funding—less than one-quarter are fully funded by Congress through the United States Geologic Survey.

- **Congress should fully fund our critical national stream gauge and tidal gauge networks.**

Today’s flood maps are based on models that incorporate hydrologic information and topographic information. Good progress has been made in the last decade on high quality

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<sup>1</sup> [Hydrometeorological Design Studies Center Progress Report](#) for Period OCTOBER 2018 to MARCH 2019, page 4.

topographic information for the nation through the [United States Geological Survey \(USGS\) 3 Digital Elevation Program \(3DEP\)](#). These high quality topographic data inform critical decisions that are made across the nation every day ranging from immediate safety of life, property and long-term planning for infrastructure projects. Currently at 60% complete, the goal of 3DEP is to complete the acquisition of nationwide high resolution elevation data by 2023.

- **Congress should ensure that the USGS 3DEP program is fully funded to provide high quality topographic information for the entire nation.**

Even if good flood data is developed, there are some policy hurdles preventing it from being publicly available. For example, ASFPM was pleased with the release of the US Army Corps of Engineers (Corps) [new policy](#) on Emergency Action Plans (EAPs) which requires several types of flood inundation mapping (EC 1110-2-6074). This policy standardizes inundation mapping (maps showing the areas that will be flooded when the dam or levee fails or is overtopped), and establishes inundation mapping requirements for dams and levees. In theory, having inundation mapping available to the public can help avoid debacles like those witnessed around Barker and Addicks Reservoirs post-Harvey in Texas, when thousands of homes in inundation areas of those structures were impacted. Had local land use planners, property owners and others been aware of these risks, additional steps could have been taken to reduce that risk. The new EAP policy, however, includes the following statement: *EAP maps are considered sensitive data and must be marked "For Official Use Only" according to AR 380-5 and DoDM 5200.01*. In other words, inundation maps associated with EAPs are still not publicly available. Why would we be withholding this vital information on flood risk from property buyers and owners?

The 2016 TMAC report [National Flood Mapping Program](#) Review, identified a legacy DHS policy through its Security Classification Guide for the Protection of Critical Infrastructure and Key Resources, which listed dam failure inundation maps as "For Official Use Only." However, this policy conflicts with the National Flood Mapping Program requirements that such areas be provided on Flood Insurance Rate Maps and on publicly-available databases such as National Levee Database (NLD) and National Inventory of Dams (NID). As noted in the report, a Virginia law passed in 2008 essentially requires that all inundation mapping developed for state-regulated dams be made available to communities and the public. This has now been implemented for a decade without issues and state officials there believe in supporting wider public availability of this data. More recently, when speaking to agency officials, there has been



a mistaken belief that this issue had been dealt with. It is clear to ASFPM that it has not and the unwillingness of agencies to act on it demands congressional intervention.

- **Congress should mandate that any flood risk data, including all dam/levee inundation mapping, developed by the federal government and/or associated with any federal program be made publicly available.**

More recently, flood risk data, and in particular flood insurance claims data, has been more difficult to obtain from FEMA as a result of FEMA's evolving compliance with the Federal Privacy Act. These data help inform local mitigation plans, can provide heat maps on claims hotspots, are needed to apply for and administer flood mitigation grants, property disclosure, and are useful in communicating flood risk. Given that some flood mapping programs are beginning to incorporate structure specific information, the lack of available claims data and the inherent conflict between the benefits of communicating these data and the Privacy Act need to be resolved.

For the past decade, a novel approach to data management, tool development and data dissemination has been piloted at NOAA through the Digital Coast Partnership. Developed and maintained by NOAA, hundreds of organizations and federal, state, and local agencies have contributed to this curated collection of high-quality authoritative data and tools focused on coastal and ocean issues. "More than Just Data" is the slogan of the Digital Coast because data alone is not enough, especially when users of that data do not know how it can be used, or what steps to take to get information they need. Digital Coast tools and training help users turn data into powerful information that continues to increase the coastal knowledge of our nation.

For example, one of the most popular tools being used by practitioners today on the [Digital Coast website](#) is the Sea Level Rise viewer. ASFPM was a founding member of the Digital Coast Partnership and strongly believes that to better understand the future flooding risk in coastal areas and manage that risk, programs like Digital Coast will be vital.

- **Congress should pass the Digital Coast Act.**

## **Federal Agency / Programs and Policies**

There are numerous programs and federal agencies that address the threat of flooding and floodplain management. As part of a research project in 2012, ASFPM analyzed more than 130 federal programs that had some impact on the use and development of floodplains. ASFPM works with many of the federal agencies in addressing flood risk whether it be through commenting on statutory authorities or policies, serving on task forces or advisory groups, or using our own power to convene agencies so they can work together to address cross-cutting issues.

We would like to highlight a key federal coordinating entity. In 1975, Congress established the Federal Interagency Floodplain Management Task Force (FIFM-TF). Its purpose was to carry out the responsibility of the president to prepare for the Congress proposals necessary for a Unified National Program for Floodplain Management. For more than 40 years, some form of an interagency group has worked to better understand the appropriate roles of local, state and federal governments in reducing flood losses, the interactions between human actions and natural systems in the floodplain environment and to make recommendations to reduce the loss of life and property caused by floods. Also, the task force is useful to identify and address policy or programmatic conflicts among federal agencies that may be resulting in poor floodplain management decisions. The main report of the FIFM-TF, a Unified National Program for Floodplain Management was first written in 1979, then updated in 1986 and [last updated](#) in 1995. Unfortunately, the report hasn't been updated in almost 25 years while the threats resulting from flooding have exploded. Not only is research showing significant social impacts of flooding, new flooding types like urban flooding are emerging.

Today, the FIFM-TF is still operational; however, it is under resourced and not as effectively utilized as it could be. One concern expressed by the subcommittees was the state of federal coordination on flood science, mitigation and risk communication. The FIFM-TF, if properly resourced, and enabled, could serve capably to enhance these functions.

### **The NFIP is a National Comprehensive Flood Risk Reduction Program**

Central to the nation's efforts in managing flood risk is the National Flood Insurance Program (NFIP). It was created by statute in 1968 to accomplish several objectives. Among other things, the NFIP was created to:

- Provide for the expeditious identification of and dissemination of information concerning flood-prone areas through flood mapping

- Provide communities the opportunity to voluntarily participate in the National Flood Insurance Program in order for their citizens to buy flood insurance and, as a condition of future federal financial assistance, to adopt adequate floodplain ordinances consistent with federal flood loss reduction standards
- Require the purchase of flood insurance in special flood hazard areas by property owners who are being assisted by federal programs or by federally supervised, regulated or insured lenders or agencies (mortgages from federally backed lenders).
- Encourage state and local governments to make appropriate land use adjustments to constrict the development of land exposed to flood damage so homes and businesses are safer and to minimize damage caused by flood losses and reduce future taxpayer costs for disasters
- Guide the development of proposed future construction, where practicable, away from locations threatened by flood hazards (avoidance of high risk flood areas)
- Authorize a nationwide flood insurance program through the cooperative efforts of the federal government and private insurance industry
- Provide flexibility in the program so flood insurance may be based on workable methods of distributing burdens equitably among those protected by flood insurance and the general public who benefit from lower disaster costs

Beyond merely providing flood insurance, the NFIP is unique as it integrates multiple approaches for identification of flood risk, communication of risk, and techniques to reduce flood losses and to mitigate existing flood risk. It is a unique collaborative partnership enlisting participation at the state and local level. It is a multi-faceted, multiple objective program—a four-legged stool, as it is often called. The four legs of the stool are (1) floodplain mapping, (2) flood standards, (3) flood hazard mitigation and (4) flood insurance. Altering one leg without careful consideration of impacts on the other three legs can have serious repercussions on reducing flood losses. NFIP on the whole provides substantial public benefits as it is, in effect, a national flood risk management program.

## Floodplain Mapping under the NFIP

In addition to being an important part of the NFIP, floodplain mapping is the foundation of all flood risk reduction efforts, including design and location of transportation and other infrastructure essential to support businesses and the nation's economy. The flood maps are also used for emergency warning and evacuation, community planning, and locating critical facilities like hospitals and emergency shelters. Floodplain mapping is cost-effective with at least a 2-to-1 taxpayer benefit, and floodplain maps support communities' resilience actions. Inasmuch as flood maps identify areas where new development must be built to NFIP construction standards, flood maps reduce disaster costs as such structures suffer 80% less damage than those that are not built to NFIP standards.

For most of the history of the NFIP, flood mapping was done to primarily support two functions of the NFIP: flood insurance rating and floodplain management standards. As a result, two pieces of data were typically produced: the 100-year and the 500-year flood. However, as the NFIP grew and as flood risk management became more important, the nation's citizens looked to the FEMA flood maps as the primary source of any kind of flood risk information for a given area. In 2012, Congress, for the first time, authorized a National Flood Mapping Program (NFMP) as part of the NFIP reform legislation which took this more expansive view of flood mapping. It required, among other things, several new, mandatory types of flood risks to be shown on the nation's Flood Insurance Rate Maps (FIRMs) beyond the 100-year and 500-year flood including:

1. All populated areas and areas of possible population growth located within the 100-year and 500-year floodplains;
2. Areas of residual risk, including areas that are protected by levees, dams, and other flood control structures and the level of protection provided by those structures;
3. Ensuring that current, accurate ground elevation data is used;
4. Inclusion of future conditions risk assessment and modeling incorporating the best available climate science; and
5. Including any other relevant data from NOAA, USACE, USGS and other agencies on coastal inundation, storm surge, land subsidence, coastal erosion hazards, changing lake levels and other related flood hazards.

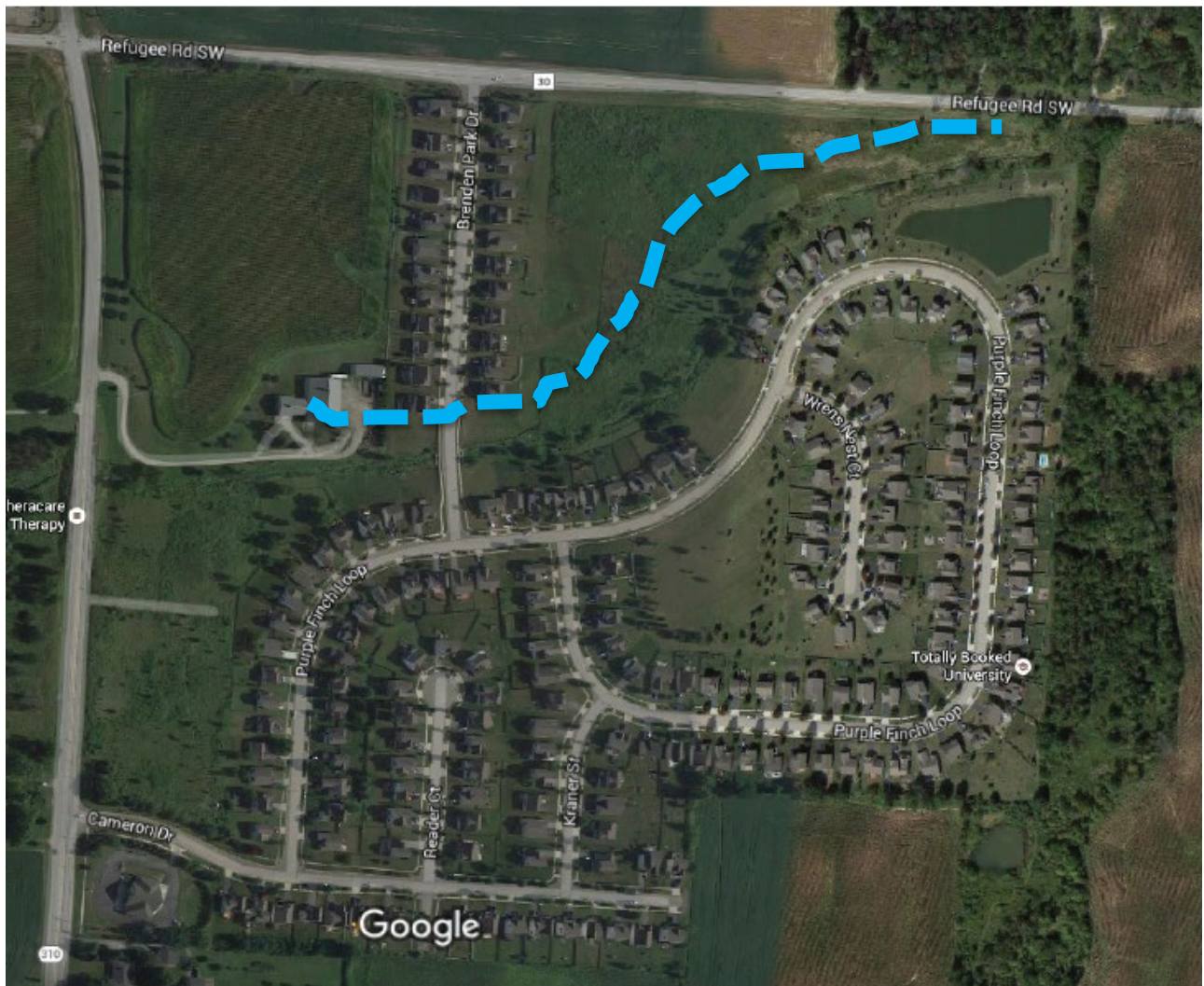
Unfortunately, ASFPM is not aware of any single flood map in the entire country that exists today where all of these data sets exist on either a FIRM panel or in the accompanying data FEMA provides. Therein lies the problem. We have had a National Flood Mapping Program authorized since 2012, but many key elements have not been implemented. In fairness to FEMA since 2012, progress has been made on improving the quality of the existing flood maps, in use of high resolution topography, and in the area of communicating information to communities and the public (either through the mapping process itself or through technologies and tools). Nevertheless, we believe these additional elements are essential for an effective national flood mapping program.

What is the gap then? ASFPM believes that the gap lies in getting the job done initially mapping the nation. Consider:

- Based on the National Hydrography Dataset (NHD) and NOAA shoreline data, there are approximately 3.5 million miles of streams and rivers, and 95,471 miles of coastlines in the nation. **Currently, only 1.14 million stream miles and 45,128 shoreline miles have flood maps. By this metric, only about 1/3 of the nation has been mapped.**
- **Over 3,300, or roughly 15%, of NFIP communities have maps over 15 years old, with many of these over 30 years old and still having “un-modernized” paper maps.**
- **Many of the added mapping requirements from 2012 haven’t even been started beyond studies and research.** This includes residual risk mapping around flood control structures and future conditions mapping. A [2016 TMAC report](#) reviewing the National Flood Mapping Program stated *“To create technically credible flood hazard data, FEMA needs to address residual risk areas in the near term. Residual risk areas associated with levees and dams are of great concern.”*

ASFPM believes this gap in data is contributing significantly to the increasing flood losses in the nation. A 2018 [study](#) shows that the total US population exposed to serious flooding is 2.6–3.1 times higher than previous estimates, and that nearly 41 million Americans live within the 100-year floodplain (compared to only 13 million when calculated using FEMA flood maps). This translates into 15.4 million housing units. The same study indicates that over 60 million people live in the 500-year floodplain.

To better understand the gap between what is mapped and what needs to be done to finish the job, here is a specific example. Cameron Chase is an 87-acre residential subdivision developed in the early 2000s in Licking County, Ohio. It is 17 miles from downtown Columbus, Ohio (metro area population 2+ million). An unnamed stream flows through the subdivision:

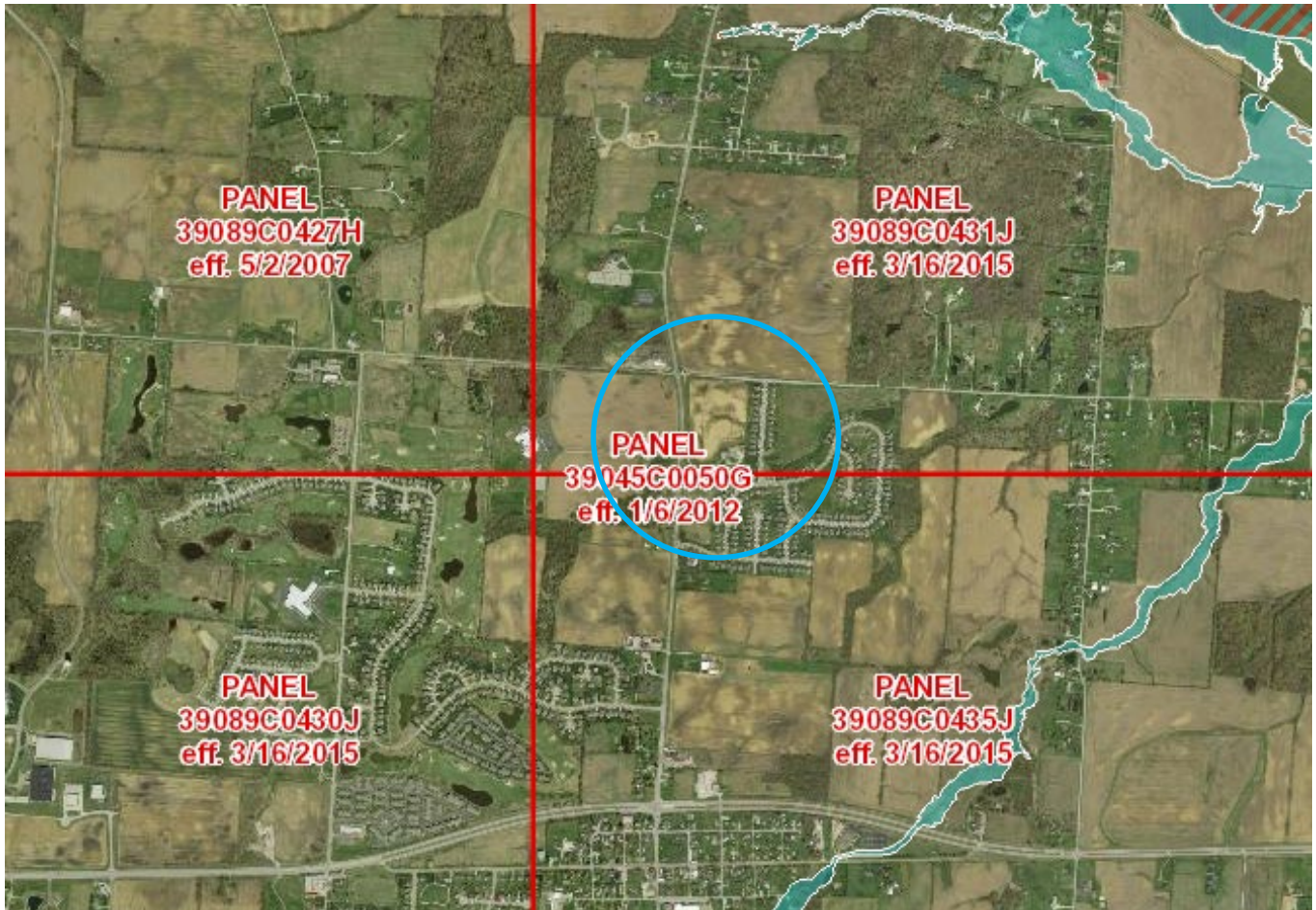


*(Above: Aerial view of Cameron Chase division, Etna Township, Licking County Ohio. The unnamed stream is highlighted as the dashed blue line)*

The unnamed stream is not mapped on the FEMA maps that were effective at the time, and even on today's maps. Why? The old guideline for mapping these small streams was that you needed about 10 square miles of land draining into the stream for it to reach a threshold for FEMA mapping in rural areas. In the case of this tributary, it only had about 760 acres, or just



over one square mile of drainage. Also, the land previously had been a cornfield, and as a result it never had enough property at risk for FEMA to map prior to development.



*(Above: Portion of FEMA FIRM Index Panel for Licking County, Ohio. The Cameron Chase subdivision is circled; note that the unnamed stream does not have a FEMA mapped floodplain – it does not show up until several miles downstream)*

Luckily, Licking County is one of the rare communities in the nation that has strong local floodplain management regulations exceeding federal minimum standards and the regulations required the developer to map the floodplain on any stream where one wasn't identified. So prior to development, a flood study (similar to one that FEMA would prepare) was completed. The result? A 100-year floodplain that ranged from 150 feet wide to 300 feet wide and, more importantly, a map to guide the proposed development and ensure that local flood protection standards applied. But most communities do not have such standards, and what happens then? The development occurs with no flood standards. What you see happening with

Cameron Chase is happening in thousands of subdivisions across the country: areas that were once cornfields and cow pastures are developing into tens of thousands of housing units. Later, after there is significant development at risk and often after a flood or two, FEMA comes in and maps it. Then the dynamic changes and everything becomes adversarial. People think FEMA put a floodplain “on them,” when it was there all along. The property owner is angry because they have to buy flood insurance at high premiums because flood elevations were previously unknown. Realtors are upset because it is a surprise and may have an impact on the future salability of homes. And local elected officials fight to minimize the size of the mapped floodplain, spending thousands of dollars on competing flood studies.

Why, then, is there such a gap in the extent of flood hazard identification? ASFPM believes there are several reasons for this.

*Funding.* Direct appropriations for flood mapping has varied significantly since the inception of the NFMP from a low as \$89 million in FY 2013 to a high of \$262.5 million in FY 2019. In ASFPM’s recently released [\*Flood Mapping for the Nation report\*](#), we estimate it will cost between \$3.2 billion and \$11.8 billion to “complete” the flood mapping in the nation, and then the steady-state annual cost to maintain this flood map inventory will be between \$107 million and \$480 million. Currently the NFMP is authorized at \$400 million in annual appropriations. The bottom line is that to complete the initial job of mapping the nation consistent with Congress’ mandate, more funding needs to be appropriated by Congress both in the form of a higher authorized amount for the NFMP and higher annual appropriations.

*Existing program momentum and metrics.* Prior to the NFMP being authorized by Congress, FEMA had just initiated a new flood mapping program called RiskMAP. However, in the years since, it did not appear that RiskMAP program nor its program metrics were ever re-evaluated or incorporated these important new mandates from Congress. Further, flood mapping priorities have been complicated by over 100 recommendations from the Technical Mapping Advisory Council which included the identification of additional mapping priorities such as structure specific information and graduated risk zones for insurance rating purposes. With no Congressional oversight, more requirements than funding and a new RiskMAP program, there was little impetus to focus on the required mapping elements under the NFMP.

Unfortunately, the adaptation of RiskMAP metrics ended up resulting in considerable confusion as to the status of flood mapping in the nation. Here are the two most egregious examples. The administration’s proposed budget for FEMA in 2021 indicates that 98% of the population



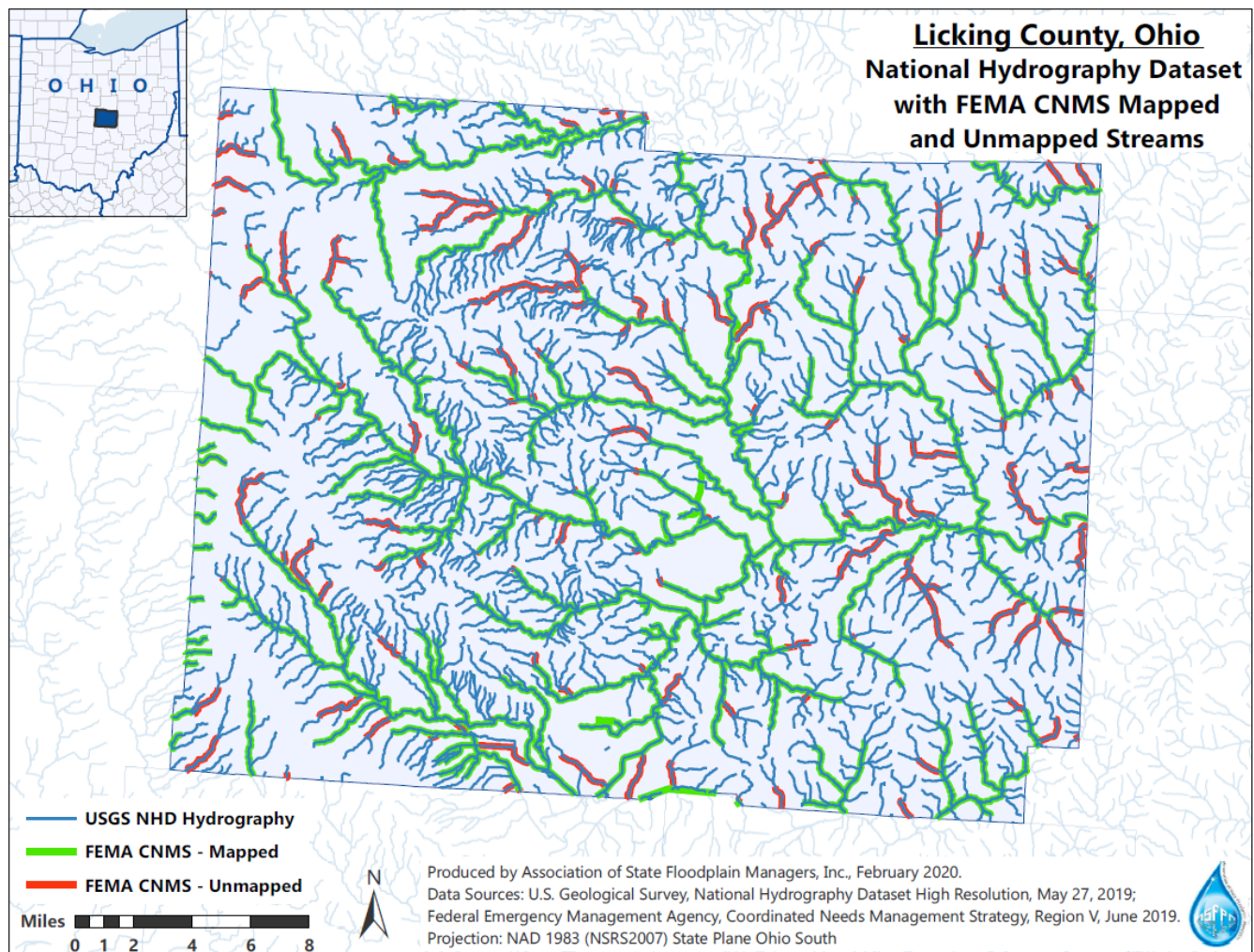
has been mapped (this is a metric FEMA's leadership has used as talking points on the topic). This metric, however, grossly overstates the population covered. This problem is discussed in the 2015 TMAC Future Conditions Assessment and Modeling report:

*However, this population metric has two challenges for moving forward. First, the metric over-predicts the population covered by a modernized map. FEMA generally studies streams that drain a drainage area of greater than one square mile. If a census block group has 10 miles of stream and only 1 mile is studied, the current metric will count 100 percent of the population within the census block group as being covered by a modernized map, as opposed to the 10 percent that may actually be covered. Therefore, the current metric can lead to a significant over-prediction of the population covered by a modernized map. This could lead policy makers to believe that flood hazards have been more widely identified than the reality. If the metric is changed to be more reflective of the streams studied within a census block group, then it may more realistically illustrate that the country has flood hazard areas defined for only somewhere **between 16 percent and 22 percent of all streams**. [EMPHASIS ADDED]*

The bottom line is that the deployment metric has been grossly misapplied and should be replaced or supplemented with a metric based on the number of stream miles studied in the nation. A program does what it measures and if we aren't measuring the number of stream miles mapped, it is hard to envision mapping for the entire nation ever getting done.

In recent years, FEMA has also discussed its work towards meeting the New, Valid, or Updated Engineering (NVUE) metric over the past several years with the goal being 80% NVUE compliant. For this metric, it is important to understand what NVUE is and what it is not. It is a metric to assess the quality of the existing FEMA flood map inventory. And FEMA's flood map inventory overall has improved significantly. It is not, however, a metric to understand how much of the nation has flood mapping. The NVUE percent attained is a ratio of all NVUE study miles divided by the total miles in FEMA's mapped inventory. That means when FEMA attains 80% NVUE, it means that only about 910,000 miles of flood mapping have updated or valid studies, the remaining 230,000 miles have not been updated, and 2.36 million miles have not been mapped at all. Also, even on NVUE-attained stream miles, it is important to remember that these have not been evaluated to be "valid" when it comes to residual risk zones or future conditions. Too often, though, NVUE gets confused with completing the job of mapping the nation.

Again using Licking County as an example, the following map shows that there are 1,032 stream miles and approximately 463 of those miles are mapped (less than 50%). Because FEMA considers Licking County to have a modified digital FIRM, all of the population of the county contributes to the 98% digital data (deployment) metric. All of the blue and red streams are those that need mapping in Licking County, Ohio and nearly all of that land, especially in the western part of Licking County, is suitable for and will likely result in future residential and commercial development.



*Recognition of other federal, state and local data.* In doing research for the updated Flood Mapping for the Nation report, ASFPM was concerned when we discovered that it appeared

that FEMA had not really progressed when it came to the number of stream miles mapped in the country since the time the original report was published in 2013. Yet [the FEMA Administrator's 2016 Report to Congress on TMAC Recommendations](#) identified the completion of "large scale automated engineering for 45,000 stream miles." ASFPM believes this is a reference to the base level engineering (BLE), an innovative automated flood mapping process that provides high quality, low cost flood risk information for non-urbanized areas. More recently ASFPM inquired as to whether these BLE miles were included in FEMA's flood mapping inventory and were told they were not. Further, some states have active flood mapping programs. Indiana, for example, recently completed a milestone in their state – all streams up to a square mile of drainage have been mapped. Unfortunately, these additional miles are not included in FEMA's inventory. According to the state flood mapping coordinator, it is difficult and inefficient to tell property owners that not only do they need to look at FEMA's flood maps/inventory, but they need to look at the state's inventory as well. ASFPM suspects that progress has indeed been made on increasing the number of stream miles mapped nationwide and urges FEMA to determine how their systems can serve up and account for these additional mapping activities.

*Inclusions under the NFMP are tied to the Flood Insurance Rate Map (FIRM) which is problematic.* Since the early days of the NFIP, the primary "map" that people are familiar with is the FIRM. Yet, today, digital databases serve up "layers" of flood hazard data. For example, FEMA's National Flood Hazard Layer (NFHL) serves up not only flood map data such as the 100-year or 500-year floodplain, but also information such as Coastal Barrier Resource System (CBRA) zones. Unfortunately, under the NFMP, all of these data are to be provided on the FIRM which provides for logistical challenges and could further delay the actual release of these data. The point is that at a minimum, FEMA should be able to collect, include, track and count for the purposes of metrics, data that it generates like BLE and data from other agencies such as residual risk inundation mapping from the Corps of Engineers (mentioned earlier) which would meet the intent of providing residual risk mapping information for the purposes of the NFMP. These additional flood risk datasets could be provided through mechanisms like the NFHL.

- **As part of the reauthorization of the NFIP, Congress should increase the authorization of the National Flood Mapping Program to at least \$600 million annually.**
- **A metric must be developed for National Flood Mapping Program that measures the completeness of the required mapping elements for the entire nation.**

- **FEMA should prioritize the elimination of the paper map inventory and the modernization of all un-modernized maps.**
- **FEMA should establish national program performance standards and include various flood hazard related data layers for all flood hazard-related data layers (residual risk, base level engineering, future conditions, erosion, subsidence, closed lake basins, frazil ice, ice jams, tsunamis, debris flow and mud slides, relevant wetland and groundwater) so that data created by state, local, and other mapping partners can be readily utilized by FEMA and incorporated into the National Flood Hazard Layer and FIRMs as necessary.**
- **FEMA should develop a program and timeline to ensure future conditions flood data and residual risk data are incorporated into every new flood study.**

### **Cooperating Technical Partners Program**

While part of FEMA's flood mapping effort, it's very popular Cooperating Technical Partners (CTP) program is a mechanism whereby states, tribes, regional agencies, communities, and universities can assume delegated flood mapping responsibilities in accordance with their capabilities. This partnership capitalizes on the interest, capability and most importantly local knowledge of flood mapping issues. From a risk communication standpoint, CTPs are often viewed as a trusted source of local knowledge. For example, when a CTP is introducing a preliminary flood map in a community, there is more ownership in the products by the community which can, in turn, fundamentally change the "us versus FEMA" mentality. Previously, legislation has been introduced in Congress to somehow create a mechanism for states and communities to produce flood maps. ASFPM believes that such legislation is not needed and efforts should be made to strengthen the existing CTP program instead.

### **DHS Flood Apex R&D Program**

One deficiency ASFPM has noted is that unlike other science and regulatory agencies, FEMA does not have a robust research and development (R&D) capacity. While FEMA does well in some regards incorporating some of the best available science and technology when applied to the flood mapping program in particular, ASFPM believes that this ability is hampered by not having an internal R&D capacity. This, in turn, leads to not having an intentional R&D agenda. Intentionality is the key.

The Department of Homeland Security Science and Technology Directorate's Flood Apex Program was created in 2016 at the request of the Administrator of the Federal Emergency Management Agency (FEMA) to bring together new and emerging technologies designed to increase communities' resilience to flood disasters and provide flood predictive analytic tools

to FEMA, state and local governments, and other stakeholders. The program has a particular focus on new and emerging technologies including activities that focus on developing them. For example, one project is focused on using time-series satellite imagery to compliment flood risk mapping and visualizations. Another is using high performing and artificial intelligence to detect physical buildings from satellite images to develop a national inventory of structures in the floodplain. In short, Flood Apex has been a capable approach to addressing FEMA's R&D needs and could be of significant support to the flood mapping program in the future. Unfortunately, this program is slated to expire in FY 2021.

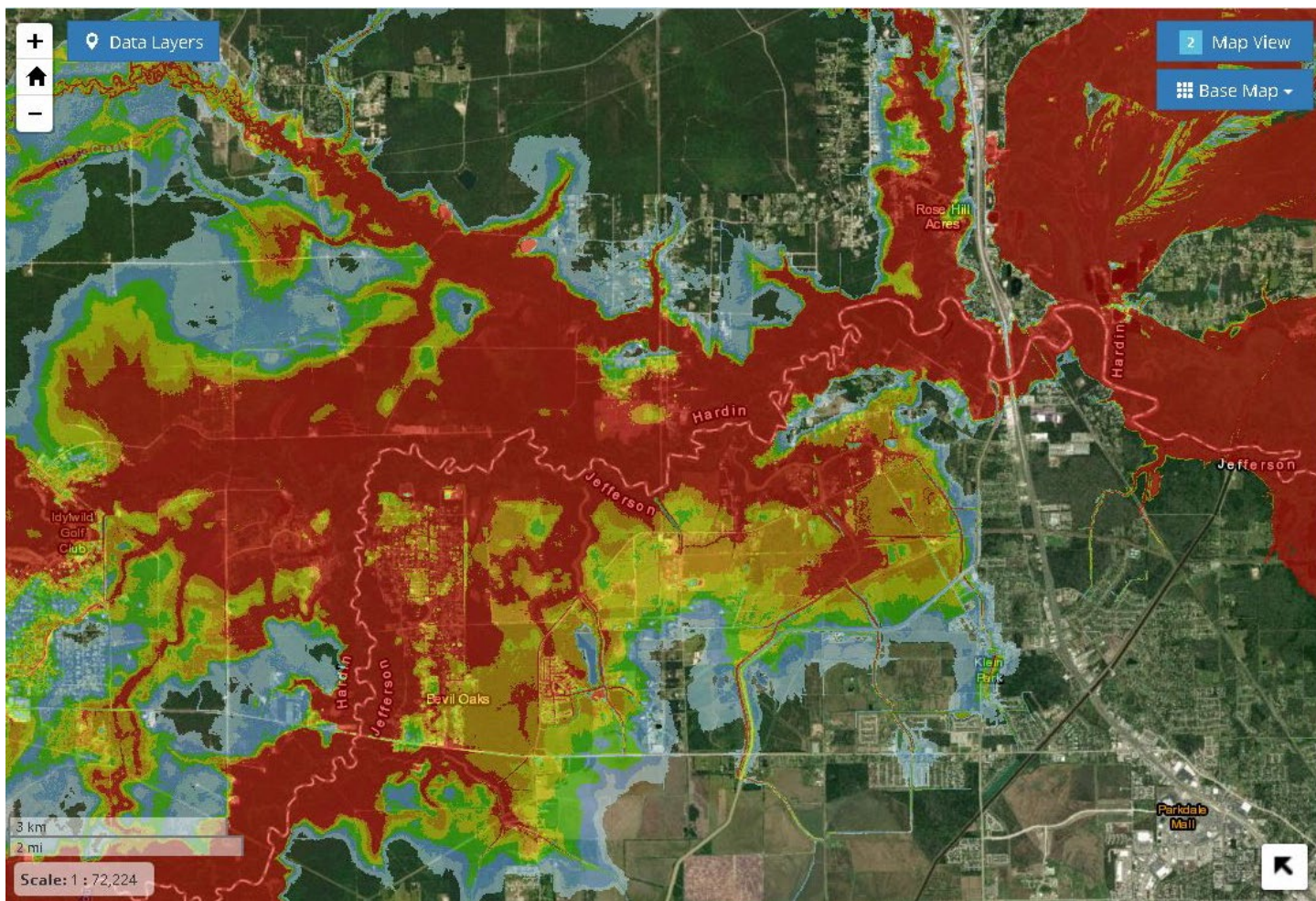
- **Congress should ensure that there is a specific function within DHS Science and Technology dedicated to Research and Development activities for flood loss reduction and ensure that FEMA's R&D needs are met.**

## In Conclusion

Floods are this nation's most frequent and costly natural disasters and the trends are worsening. Comprehensively identifying the flood hazards in the United States is the foundational step that must be taken in order to have effective flood risk reduction policies and programs. As our testimony identifies, though, the pathway to providing that information involves multiple agencies and programs. While FEMA flood maps and their mapping platform may be the ultimate point of dissemination, we have already wasted too much time in developing a true national picture of flood risk.

ASFPM appreciates this opportunity to share our observations and recommendations with the Subcommittees. For any questions, please contact Chad Berginnis, ASFPM Executive Director, at [cberginnis@floods.org](mailto:cberginnis@floods.org) (608 828-3000); or Merrie Inderfurth, ASFPM Washington Liaison, at [merrie@floods.org](mailto:merrie@floods.org) (703 732-6070).





# Flood Mapping for the Nation

A Cost Analysis for Completing and Maintaining the  
Nation's NFIP Flood Map Inventory

January 2020



## Cover Image: Estimated Base Flood Elevation (estBFE) Viewer

Screenshot of FEMA Region VI BFE viewer. Base Level Engineering (BLE) assessments are produced using high resolution ground data to create technically creditable flood hazard information that may be used to expand and modernize FEMA's current flood hazard inventory. <https://webapps.usgs.gov/infrm/estBFE/> (accessed December 2019)

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# Flood Mapping for the Nation

## A Cost Analysis for Completing and Maintaining the Nation's NFIP Flood Map Inventory

### January 2020

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The Association of State Floodplain Managers Inc. (ASFPM) published this report as part of its mission to promote education, policies and activities that mitigate current and future losses, costs and human suffering caused by flooding. Founded in 1977, the organization had over 19,000 members in 2019, including members in 37 state chapters. ASFPM supports professionals involved in floodplain management, flood hazard mitigation, flood preparedness and flood warning and recovery. Members represent local, state and federal government agencies, citizen groups, private consulting firms, academia, the insurance industry and lenders.

### Suggested Citation:

Association of State Floodplain Managers. 2020. *Flood Mapping for the Nation: A Cost Analysis for Completing and Maintaining the Nation's NFIP Flood Map Inventory*. Madison, WI.

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# Flood Mapping for the Nation

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## Executive Summary

Since the inception of the National Flood Insurance Program (NFIP) in 1969, the nation has invested **\$6.6 billion (\$10.6 billion in 2019 dollars)** in flood hazard mapping to date, and realized multiple benefits from that investment. These benefits go beyond its uses for the NFIP to include community planning, design and construction of key infrastructure such as highways, bridges, water treatment facilities and much more. Commercial, private and public safety uses of flood hazard information reduce flood losses that would otherwise be paid for by taxpayers through federal and state disaster assistance. With a 2-to-1 benefit ratio, the \$10.6 billion in investment equates to nearly \$22 billion in savings from avoided flood damages.

Direct average annual flood losses have increased from approximately \$4 billion per year in the 1980's to roughly \$17 billion per year between 2010 and 2018. These direct losses are likely under-reported and do not include indirect losses related to business closures, lost tax revenue, and public and mental health costs that often disproportionality impact socially vulnerable communities more. With increases in frequency and amount of heavy rainfall and hurricanes due to climate change and increased development pressure in coastal areas and watersheds, flood losses are expected to continue their upward trend.

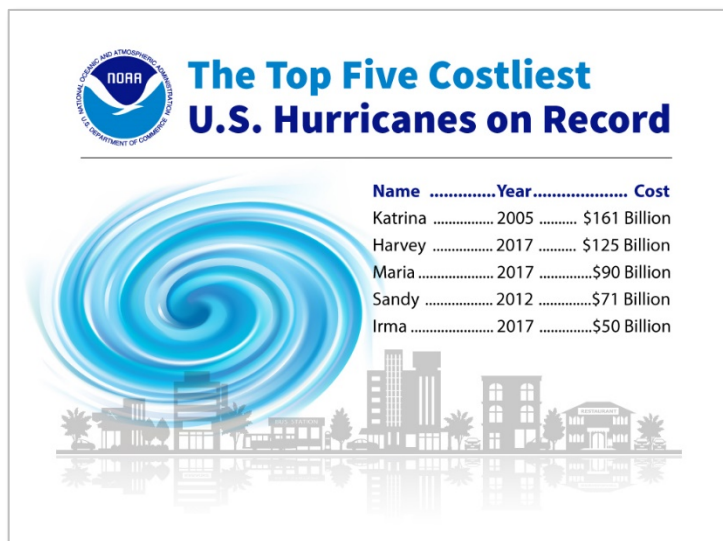
We are far from completing the initial job of mapping the nation. Complete and adequate flood hazard mapping for the nation would reduce current and future flood losses. Roughly 1.14 million miles of streams have been mapped out of the approximately 3.5 million miles of streams in the country, meaning only 33% of the rivers and streams in the country have flood hazard information available. Existing maps must be continually reviewed and updated to keep them accurate and the remaining 2.3 million miles of streams need flood hazard maps.

The Association of State Floodplain Managers (ASFPM) has developed an estimate of the total cost to adequately complete and maintain flood hazard mapping for all U.S. communities based on the parameters specified in the Biggert-Waters Flood Insurance Reform Act of 2012. This estimate shows the cost to complete flood mapping for the nation ranges from **\$3.2 billion to \$11.8 billion** (basis for cost difference explained on p. 14). The steady-state cost to then maintain accurate and up-to-date flood maps ranges from **\$107 million to \$480 million** annually. Congress will need to decide how quickly we need to have flood mapping available to every community, and then set a level of funding that will achieve that goal.



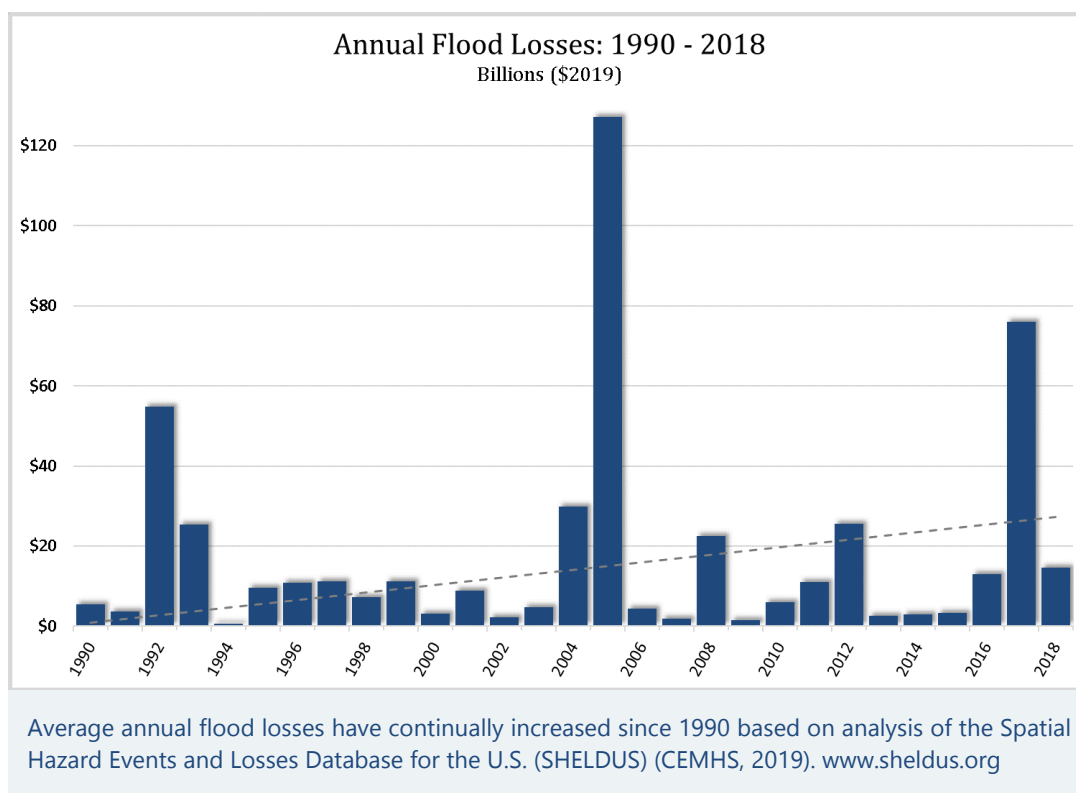
## Costs and Impacts of Flooding

Since the beginning of 2017, the nation has experienced 11 U.S. billion-dollar weather disasters resulting from hurricanes and flood-related events. Sadly, three of the costliest hurricanes resulting in heavy flood losses occurred in 2017. Hurricane Harvey was the second costliest on record and 2017 set the record for the most disasters and costs in the US. The cost of the top five hurricanes since Katrina in 2005 reach almost \$500 billion.



Floods are the leading cause of natural disaster losses in the United States, having cost approximately \$155 billion in property damage since 2010 and accounting for a majority of federally declared natural disasters.

Direct average annual flood losses have jumped from approximately \$4 billion per year in the 1980s, to nearly \$17 billion per year between 2010 and 2018, with some years far beyond that.



But the costs of flooding go far beyond these direct losses not included here. Unfortunately, the direct losses reported here are likely under-reported and do not include indirect losses related to business closures, lost tax revenue, and public and mental health costs that often more disproportionality impact socially vulnerable communities.

## **Individuals and businesses.**

The effects of direct flood losses on individuals has been well documented. In addition to physical property losses, other indirect costs include lost wages, agricultural losses for crops and livestock, expenses for evacuating, risk for first responders and significant physical and mental health issues following the event, which for the most part have not been documented. For businesses, the effect of flooding is pronounced.

Approximately 40 to 60 percent of small businesses do not reopen after a disaster (FEMA, 2015) and another 25 percent fail within one year according to FEMA. Similar statistics from the United States Small Business Administration indicate that over 90 percent of businesses fail within two years after being struck by a disaster.

Businesses also experience indirect losses, such as lost revenues from being closed which, in turn, means lost taxes, jobs, and wages throughout the community. Businesses can additionally be impacted by employees being unable to get to work due to transportation system failures or their own homes being devastated. Supply lines can also be disrupted.

Across the nation, about 8.7 million properties are located within flood-prone areas.

Roughly 40 to 60 percent of small businesses never reopen their doors following a disaster.

**Communities.** Communities suffer as well. Local funds earmarked for other uses must instead go to flood repair and recovery, physical and mental health, and the use of community resources (staff, equipment, and infrastructure) for response and rescue. Community infrastructure can be severely impacted, including the costliest elements such as water and wastewater treatment facilities. Debris collection and environmental cleanup can be significant. Local taxes (income, property, etc.) are reduced, both in the short and long term. While some of these costs will be reimbursed by the federal taxpayers in large disasters, smaller and more common disasters do not get federally declared and those costs are borne by states and communities as well as the property owners.

**States.** State infrastructure such as roads, bridges, and emergency facilities can be damaged or destroyed. State impacts of flooding include the diversion of state resources from necessary programs to response and recovery programs. State taxes (income, property, etc.) are reduced.

**Federal Government.** All taxpayers pay for the consequences of flooding. If property owners do not have flood insurance, taxpayers provide assistance through disaster relief. The casualty loss deduction allowance and lost wages due to business closure result in forgone tax revenue. Insurance subsidies, through either crop or flood insurance, result in costs to the U.S. Treasury.

## What Does Flood Mapping for the Nation Mean?

FEMA is responsible for undertaking studies nationwide to identify areas having special flood, mudslide, and flood related erosion hazards; assess flood risk; and designate insurance zones. FEMA develops, in coordination with participating communities, Flood Insurance Rate Maps (FIRMs) that depict the community's flood hazards. With the passage of the Biggert-Waters Flood Insurance Reform Act of 2012, the **National Flood Mapping Program** (NFMP) was officially authorized and required FEMA to identify several new types of flood hazards including future conditions mapping described in the next section.

"All flood hazard areas need to be mapped in order for the NFIP to fulfill its potential for reducing the rate of flood-related disaster costs." (Technical Mapping Advisory Council, 2000)

Section 100216 of the Biggert-Waters Flood Insurance Reform Act of 2012, Pub. L. No: 112-141, established the NFMP and describes the responsibility of FEMA to develop and maintain flood maps that are adequate to: 1) Make flood risk determinations and 2) Be used by state and local governments in managing development and reduce the risks associated with flooding. To accomplish this, the 2012 Act requires that FEMA shall review, update, and maintain NFIP maps with respect to:

1. All populated areas and areas of possible population growth located within the 100-year and 500-year floodplains<sup>1</sup>;
2. Areas of residual risk, including areas that are protected by levees, dams, and other flood control structures and the level of protection provided by those structures;
3. Ensuring that current, accurate ground elevation data is used;
4. Inclusion of future conditions risk assessment and modeling incorporating the best available climate science; and
5. Including any other relevant data from NOAA, USACE, USGS and other agencies on coastal inundation, storm surge, land subsidence, coastal erosion hazards, changing lake levels and other related flood hazards.

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<sup>1</sup> ASFPM defines areas of possible population growth as any area that a property owner has the legal right to develop. Many rural floodplain managers will attest that rural subdivisions may be developed far away from existing population centers.

## Future Conditions, Costs, and Impacts

The United States currently has a population of about 329 million, which is expected to be about 380 million by 2040 and 417 million by 2060. This population increase, combined with our desire to live near water, will lead to significantly increased pressure to develop in flood risk areas. Recent reports from the Government Accountability Office (GAO) and the National Climate Assessment and Development Advisory Committee indicate that there will be significant risk exposure to families, communities, infrastructure, and federal assets due to climate change and sea level rise.

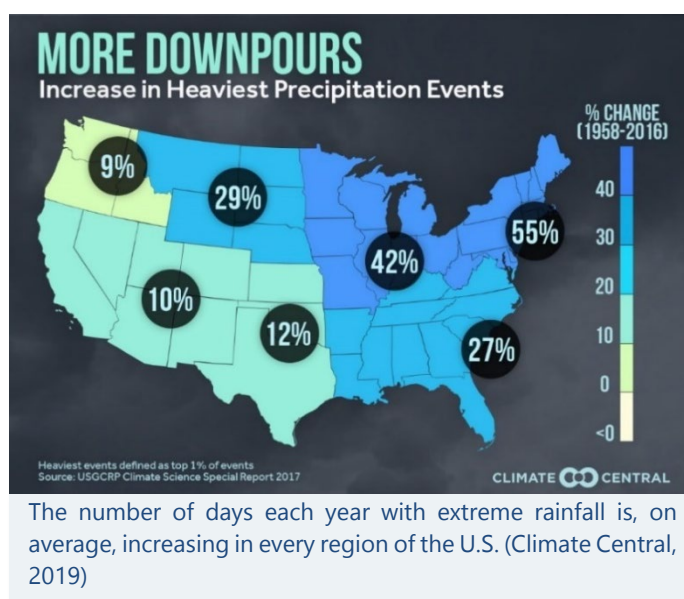
### What is the future condition?

Future costs and impacts of flooding will be driven primarily by two factors: **development** and **climate change**. Development occurs as a result of population changes, land use policies, and redevelopment of existing sites. Development anywhere in the watershed increases impervious surfaces, thus increasing runoff and flooding. Climate change is primarily realized through sea level rise, and more intense storms (including rainfall and hurricanes). One study on the impact of climate change and population growth on the NFIP indicated that by 2100, the 1% annual chance floodplain would increase in size by 45% in riverine areas (AECOM, 2013). Of that growth, 30% would be attributable to development and 70% to climate change. The same study predicted that coastal special flood hazard areas would increase by as much as 55% by 2100.

Newer studies show that sea level rise is accelerating (R.S. Nerem, 2018), and that a majority of coastal communities will experience 30 days of high tide flooding annually by 2050 (NOAA Office for Coastal Management, 2020).

All areas of the country are experiencing more heavy rainfall events, which means more flooding. Trend data over the past 60 years – which is not even accounting for future conditions – shows this well. According to the Fourth National Climate Assessment (USGCRP, 2018) “Heavy precipitation is becoming more intense and more frequent across most of the United States, particularly in the Northeast and Midwest, and these trends are projected to continue in the future.”

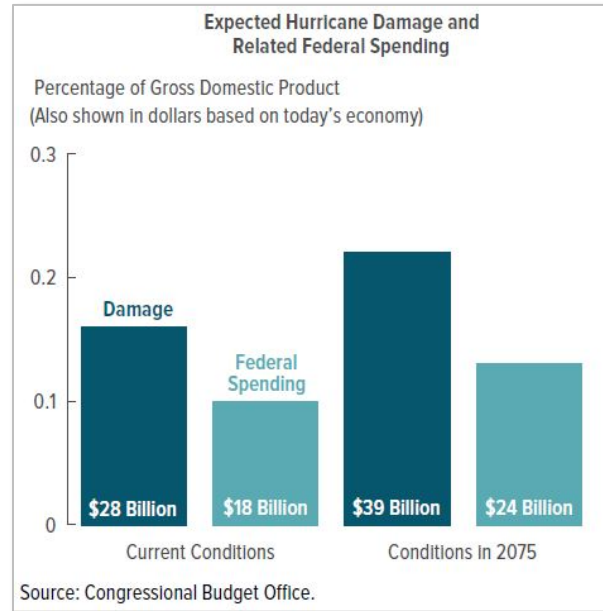
Today, stormwater systems that were designed to handle rainfalls of 1-2 inches per hour cannot handle 4 inches in a half hour without serious flooding.



In coastal areas, these conditions are exacerbated by sea level rise and more intense tropical storms. These, in turn, mean storm surges that push further inland and more frequent high tide flooding, sometimes referred to as “nuisance” flooding, estimated to be from 300% to 900% more frequent within US coastal communities than it was just 50 years ago (NOAA Office for Coastal Management, 2020).

## What are the costs and impacts?

Financial impacts of flooding are high and will be higher in the future. Trends indicate that the federal taxpayer is paying a greater share of disaster costs than any time in history. A recent analysis shows that from 1989 to 2004, federal aid as a percentage of all economic costs from major hurricane events averaged 26% (J. David Cummings, 2010). Currently, the federal aid proportion has jumped dramatically to 64% and has been forecast to stay above 60% through the year 2075 (Congressional Budget Office, 2016).



## Importance of Flood Mapping

It is nearly impossible to take action and reduce risk from flood hazards that haven't been identified. While it is estimated that 13 million Americans live in the FEMA identified 1% annual chance floodplain (or the 100-year floodplain or special flood hazard area), new models estimate that as many as 41 million Americans may live in the true 1% annual chance floodplain today (Wing, et al., 2018). That number increases to over 60 million for those that live in both the 1% and the 0.2% annual chance floodplain (or the 500-year floodplain).

Maps will not prevent floods from occurring, but they are an essential tool in avoiding or minimizing the damage to property and loss of life caused by floods, and for communicating flood risk. Without complete or accurate flood maps, local officials face serious difficulties in guiding development away from the most hazardous areas or to ensure that development is properly built to protect lives and property. The lack of maps showing which areas would flood in the mid-20<sup>th</sup> century was the reason the private insurance sector would not provide private flood insurance.

Complete and updated flood hazard mapping for the nation is the foundation to any subsequent actions to reduce flood risk.

Consider the following two scenarios:

- A developer proposes a new residential subdivisions of hundreds of new homes. The piece of land has a small stream on it which has never had a floodplain identified by FEMA because the land was previously farmed and had low flood risk. Because the minimum NFIP land use/development standards and community subdivision regulations do not require the developer to generate flood data or maps, the subdivision is developed, and homes encroach on the natural – but unidentified – floodplain. Roads serving the homes are too low and bridges in the subdivision are undersized. Later, because the area is now at risk (since there is now development on the former farm field), FEMA maps the area and the identified floodplain shows the newly built structures at risk from flooding. Homeowners are angry, local officials are angry, and everybody is fighting the new flood maps because they don't want flood insurance mandated for their home. But the worst part is that we are creating tomorrow's flood problems today because we have not identified floodplains on all of the rivers and streams that could potentially be developed. Flood maps must be done ahead of development.
- A homeowners' association owns a dam. Unfortunately, the residual risk areas of that dam (areas protected by the dam, areas impacted by a downstream release of the dam or failure of the dam) have never been identified and several new residential subdivisions have since been built below the dam. Then, one year, a storm strikes, weakening the dam. The next year a bigger storm hits and the dam fails. Because nobody ever knew the residual risk in the first place, several homes were flooded and lives were lost.

In both scenarios, complete, up-to-date flood maps would have averted disaster losses to life and property. Yet both of these scenarios happen all over the country – hundreds of subdivisions are being built right now on streams and rivers with no identified floodplains and thousands of unknowing homeowners live in residual risk zones below dams.

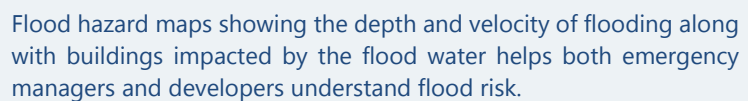
The reality is that flood maps are used for many purposes. FEMA's Flood Insurance Rate Maps (FIRMs) – the primary type of flood maps in the United States – are used not only for flood insurance, but also development regulations, and flood preparation, evacuation, and response planning for those at risk.

Government officials use flood maps to:

- establish zoning, land-use and building standards;
- to support land use, infrastructure, transportation, flood warning, evacuation, and emergency management planning;
- and to prepare for and respond to floods.



potential flood prone area is not mapped, the community has no tool to adequately guide development to be safer and to mitigate future flood losses. Local governments, with state assistance and authority, are the level of government with the tools to reduce future flood losses. Those tools are land use standards and building codes, which are used to guide development to lower flood risk areas, and to build resilience in flood risk areas so future damages and risk are reduced. Without flood mapping of the flood prone area there is no real tool to communicate flood risk to community officials, citizens or businesses. The sale of flood insurance is not mandated in areas outside special flood hazard areas mapped on FIRMs. Without adequate, accurate, and current maps, neither construction nor the insurance regulatory elements of the program can be effective (Technical Mapping Advisory Council, 2000).



In 2008, the State of North Carolina used the same methodology as FEMA, and calculated a benefit-cost ratio of 2.3 to 1. The North Carolina report further determined the following range of values of avoided losses per stream mile studied:

<b>Flood Study Type</b>	<b>Range of losses avoided (per stream mile)</b>
Detailed Study	\$5,482 - \$6,166
Limited Detailed Study	\$1,713 - \$2,539
Approximate Study	\$721

The North Carolina report indicates that for the 29,733 stream miles studied throughout the state, the average benefit provided is \$3,400 per year per mile and clearly shows significantly higher benefits of having more detailed flood studies (State of North Carolina, 2008).

Also, the flood mapping program tries to maximize diverse funding sources. The program operates through fees and appropriated funds. It incentivizes cost-sharing and leverages state and locally collected data. In fact, for every dollar appropriated since 2012, \$1.30 has been added by alternative state, local and other funding sources.

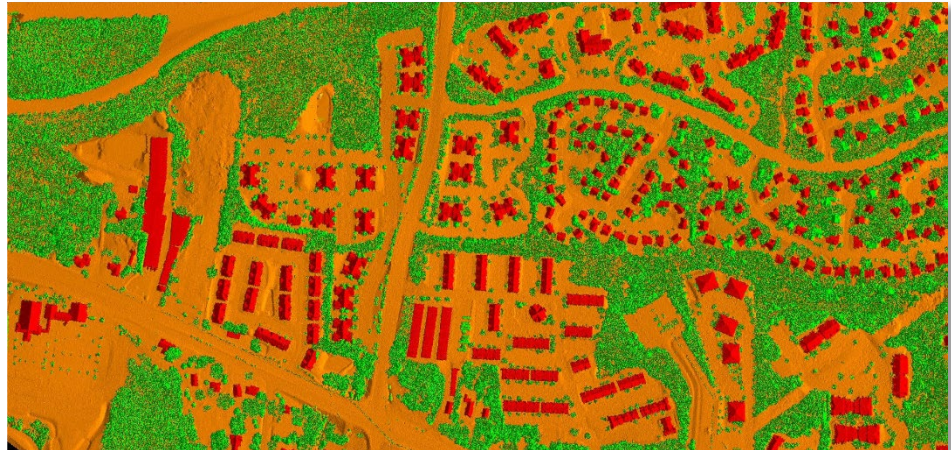
**Flood mapping reduces disaster costs.** Development that complies with the floodplain management requirements is better protected against major flood-related damage. Since flood mapping is the basis for community floodplain management regulations, then it stands to reason that new construction in mapped floodplains would have to comply with such codes and be constructed to be more resilient in future disasters. In fact, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance (Federal Emergency Management Agency, 2012). Lower damage amounts can be a proxy for lower impacts and demands on disaster assistance. In its final report the TMAC indicated that a small investment in mapping can result in huge savings in flood-related disaster assistance in the future (Technical Mapping Advisory Council, 2000).

## **Importance of Elevation Data**

High-quality topographic or elevation data is essential in the creation of high quality flood maps and flood hazard data. The 3D Elevation Program (3DEP) managed by the U.S. Geological Survey (USGS) National Geospatial Program has responded to the growing needs for high-quality topographic data. The goal of 3DEP is to complete acquisition of nationwide Lidar by 2023 to provide the first-ever national baseline of consistent high-resolution elevation data. 3DEP is based on the National Enhanced Elevation Assessment (NEEA) that documented "... more than 600 business uses across 34 federal agencies, all 50 states, selected local government and tribal offices, and private and nonprofit organizations." (USGS, 2019).



The 3DEP program began in 2016 and provides more than \$690 million annually in new benefits to government entities, the private sector, and citizens and realizes a 5:1 return on investment. Through Federal fiscal year 2018, \$382 million has been spent with an estimated \$629 million needed to complete high-quality topographic data for



Lidar data can be used to extract building footprints (in red) and identify the finished floor elevation in order to quantify potential damage based on flooding depths and to determine if buildings are above the base flood elevation. Image courtesy of John Dorman, North Carolina Flood Mapping Program.

the country (USGS, 2019). Acknowledging how essential quality topographic data is to credible flood hazard information, FEMA has invested over \$190 million since fiscal year 2014 in LiDAR through the 3DEP program.

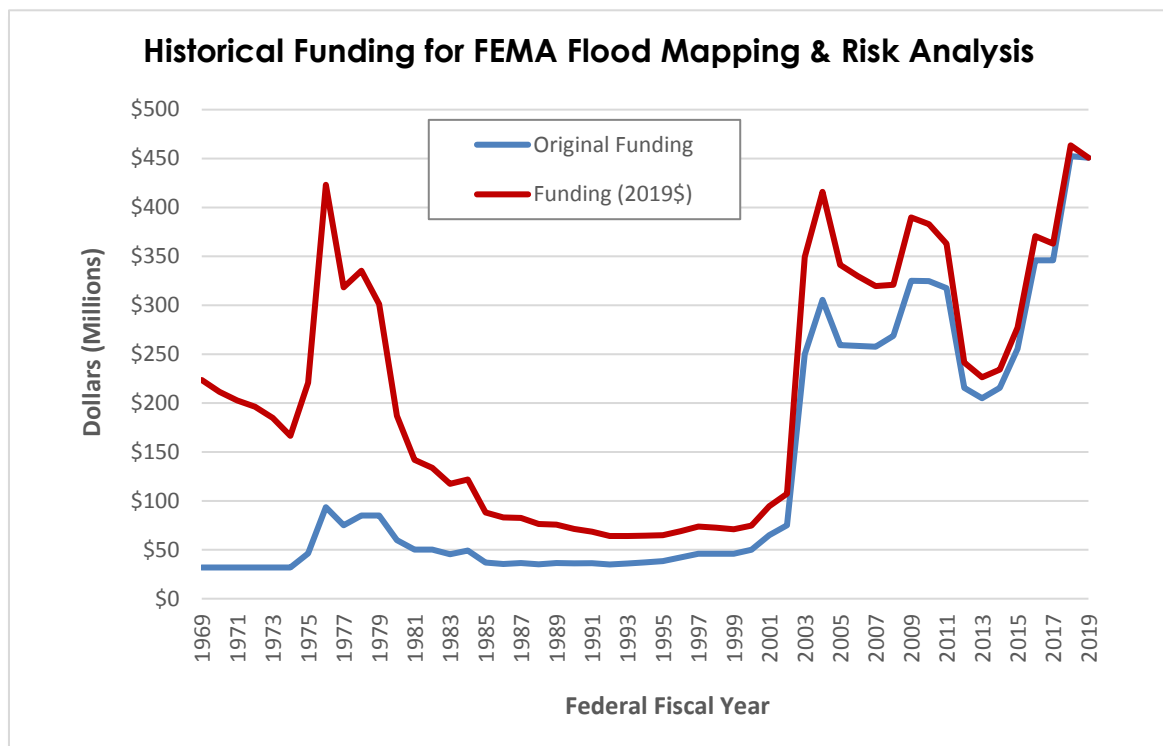
## History and Current Status of Flood Hazard Mapping

### Funding Sources – Appropriations and Fee Income

Flood hazard mapping and risk analysis is funded through the NFIP by two methods: direct annual appropriations from Congress, and since 1990, a Federal Policy Fee collected on receipts from premiums of flood insurance policies. Overall funding for the nation's flood hazard mapping and risk analysis program varies from year to year, with direct appropriations being as low as only \$89 million as recent as FY2013, and reaching \$262.5 million in direct appropriations in FY2019. Spending authority from fee collection for FY2019 includes \$188.3 million for floodplain management and flood mapping. The combined total for FY2019 is \$450.8 million (Congressional Research Service, 2019).

As identified in the original 2013 Flood Mapping for the Nation report, the majority of the floodplain mapping funding to produce new flood maps is derived from the direct annual appropriation for floodplain mapping. The majority of the Federal Policy Fee is used for operating the flood mapping program, including staffing, program management, IT infrastructure, maintaining a call center to support FEMA customers, acquisition services, and research and development. It also supports the cost for processing Letters of Map Change including Letters of Map Amendments (LOMA) and Letters of Map Revision (LOMR), all of which do not provide a significant contribution to the effort to develop new or updated maps.

Since the inception of the NFIP, an estimated **\$6.6 billion (\$10.6 billion in 2019 dollars)** has been invested in the nation's flood hazard mapping and risk analysis program. This amount includes both appropriated and fee generated funds.



## Return on Existing Investment in the Nation's Flood Maps

**What have been the results of investing in the nation's flood maps to date?** The NFIP now claims there are \$1.6 billion in avoided damages every year for buildings constructed in compliance with NFIP standards (FEMA, 2018). The Federal taxpayer would have largely paid for these losses through disaster relief and other programs. These losses avoided would have not been possible without the flood maps. So the investment in flood mapping since the inception of the program until now can be offset by losses avoided in just over six years.

- Over 22,000 communities participate in the NFIP. Those that have reasonably good flood data have been able to reduce flood damages to new development. Nearly, 5.1 million flood insurance policy holders have their financial investment in homes and businesses protected by flood insurance. These are all potential damages that are paid through an insurance mechanism rather than disaster assistance. Those who live at risk pay for at least part of the cost of those decisions. NONE of this would be possible without flood maps.
- Investment in floodplain mapping since 2003 has resulted in the creation of a digital platform for flood maps. This was a huge undertaking given that previous flood maps were developed using multiple, older cartographic methods. Now, the digital platform is

compatible with modern Geographic Information Systems, which means the maps can be integrated into federal, state, and local systems; positioning the nation to move quickly and more cost effectively to develop new and updated maps for every community in the nation. Furthermore, additional informational GIS datasets can be provided on the platform for use at the state and local level.

## Cost of Flood Mapping for the Nation

### Key Assumptions

To complete flood maps and flood risk data for the nation, it is necessary to make certain key assumptions about the mapping program. Below is the list of the key assumptions made in this report as it relates to what constitutes mapping the nation.

**Assumption #1: The framework for mapping the nation going forward has been established in the 2012 Reform Act and dovetails well with FEMA’s Risk MAP program and previous recommendations to improve floodplain mapping.** In the past, and in the absence of clear Congressional direction, the mapping program was almost solely focused on supporting flood insurance rating as well as serving as a tool for the adoption and enforcement of local floodplain management regulations. However, the purpose of the National Flood Mapping Program is clearly meant to fulfill a broader mandate – to create the nation’s flood risk data set so states, communities, and individuals can take action to reduce losses.

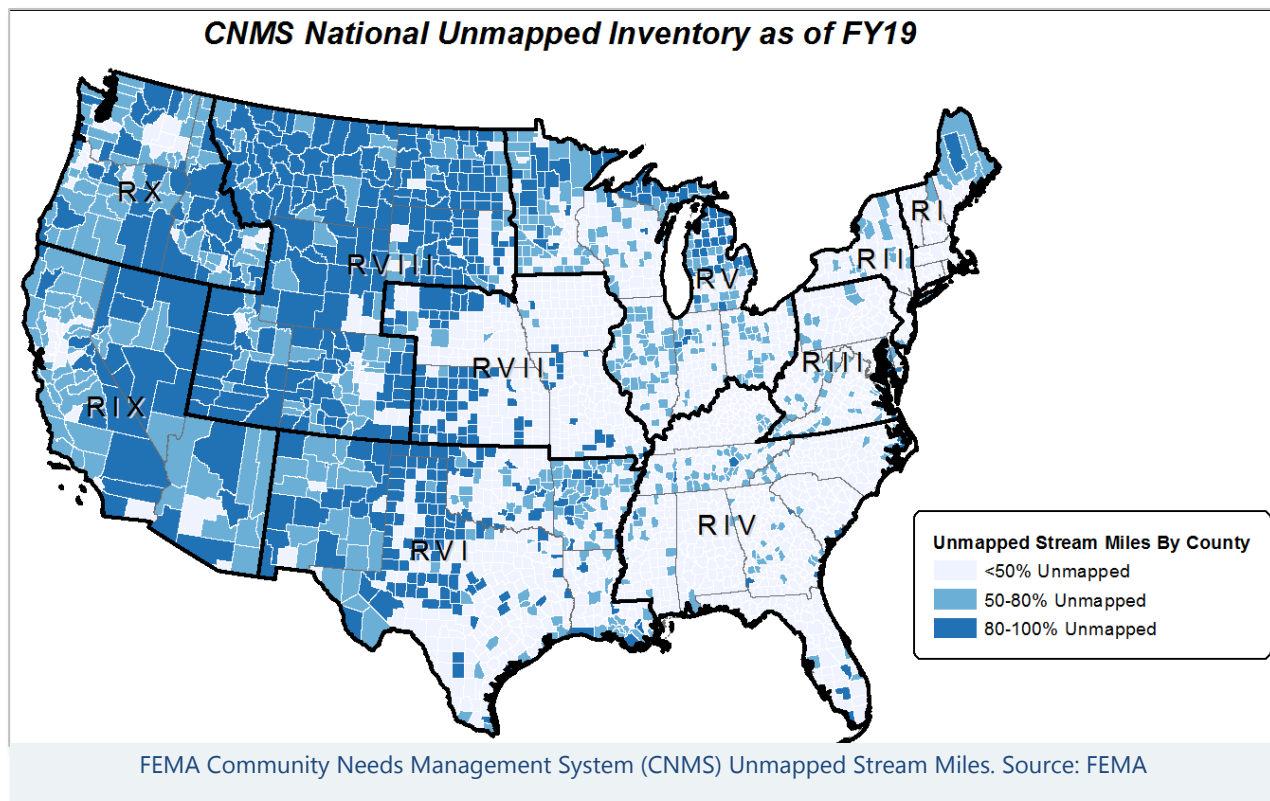
FEMA’s Risk MAP program moved the discussion of flood hazard identification away from just the 1% annual chance flood and Flood Insurance Rate Maps to identifying multiple types of flood hazards and frequencies of flood risk. Further, the discussion has been shifted more to future and current risk, and what the property owner/community can do to reduce or mitigate risk, rather than whether a person is in or out of the Special Flood Hazard Area for purposes of determining mandatory flood insurance.

The Act makes a clear and unequivocal statement that flood maps produced by FEMA will be forward looking and inclusive of several types of flood risk data. Congress has, in effect, acknowledged what most state and local officials already know – that the FEMA flood map data should be the default and minimum national dataset for flood risk.

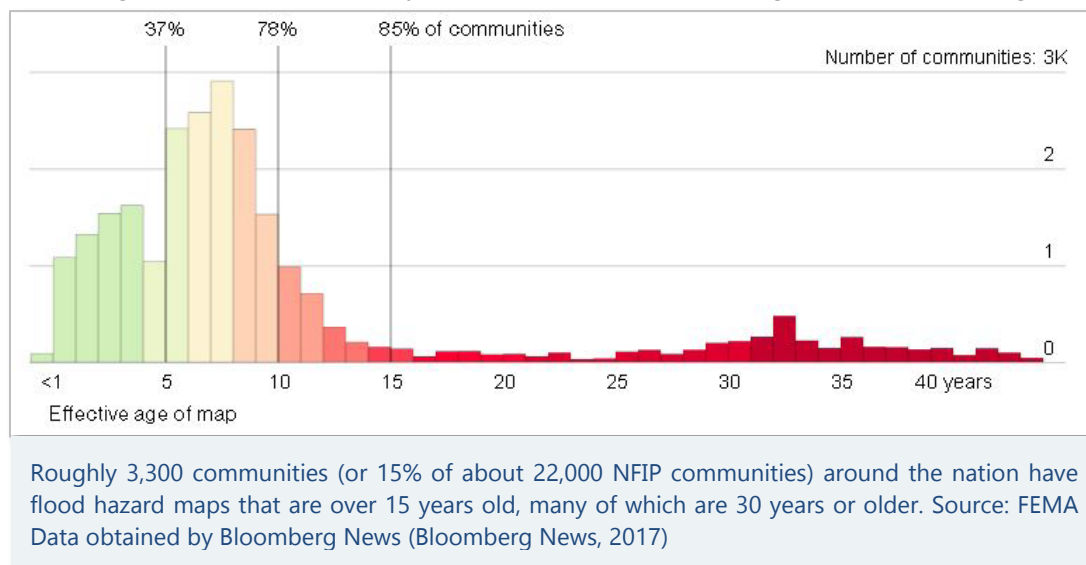
**Assumption #2: Flood data and maps are developed for the entire nation.** Based on the National Hydrography Dataset (NHD), there are approximately 3.5 million miles of streams in the nation. Currently, about 1.14 million stream miles have flood maps or just over 33% of the 3.5 million stream miles. For coastal or shoreline mapping, NOAA’s official value for total length of U.S. shoreline is 95,471 miles (NOAA, 2018). Currently, about 44,158 miles of shoreline have flood maps or just over 46% of NOAA’s total.

FEMA’s floodplain mapping programs to this point have chosen to prioritize limited resources to those areas of greatest population and flood insurance policies on the assumption these are the highest risk areas. While this approach has produced accurate and detailed maps in counties

and communities with higher population levels (even in these communities there are flood prone areas that have not yet been mapped), there remains much more to be done. There are an estimated **2.3 million river and stream miles** and just over **50,000 coastal miles** that are not mapped as part of a Special Flood Hazard Area (SFHA).



There are over 6,500 counties and communities throughout the nation identified as not having flood maps at all and roughly 3,300 communities that have maps over 15 years old, with several of these having paper maps over 30 years old and based on using obsolete mapping methods.



The current approach ignores lesser populated areas that have considerable flood risk, especially in relation to the local economy, and may have rapidly developing areas with no flood data to guide development. These communities are found all over the nation and continue to find themselves less able to be resilient because the foundational flood data does not exist. Unmapped flood hazard areas present a serious threat to people who may choose to buy or build within them (Technical Mapping Advisory Council, 2000). Furthermore, much of that development may occur without regulation and pay less than full actuarial flood insurance rates, contributing to the NFIP deficit.

Nearly 1 million miles of streams exist on federal and state lands. While some development and infrastructure exists on these lands, the low future development potential coupled with other federal agencies primacy over such areas, this cost model only includes the cost to map federal and state lands in the high-cost range scenario. ASFPM believes that mapping these areas could have benefits; however, flood mapping could, and probably should be, developed by the owner agency as required by the federal Executive Order 11988.

**Assumption #3: The minimal flood mapping level for the nation should be based on engineering models and include the ability to readily obtain flood elevation information.**

With advances over the past decade in automated technologies to map flood hazards and risk, and with high quality topographic data, the ability exists to map large geographic areas using methods such as Base Level Engineering (BLE) (FEMA, 2018). This mapping would be done at a cheaper cost and the quality would be much improved over maps produced 30+ years ago. Even if FEMA has correctly identified the general flood hazard area, communities and citizens need flood elevation data for important things like insurance rating, assessing actual flood risk and making development decisions, and to plan for resilient community growth in order to truly manage the flood risk at the local level.

**Assumption #4: Up to date detailed elevation data (LIDAR or other topographic maps) are needed anywhere flood mapping and data are to be generated.** The accuracy of elevation data has an enormous impact on the accuracy of flood maps. Having accurate topographic data for floodplain mapping is especially critical in regions with low relief, such as coastal areas –the very areas seeing the most significant population growth and development.

**Assumption #5: Residual Risk is defined in this cost model as risk associated with levees and inundation/failure areas below dams; however, other residual risk areas should be identified.** There is a new mandate in the law that all residual risk areas be identified, such as those areas repeatedly flooded by stormwater. The cost of mapping urban stormwater flooding is not included in the cost estimates for this report. It is important that TMAC work to help further define the term and criteria.

**Assumption #6: The flood map inventory must be continuously updated.** Flood map data is not static; it changes over time. Drivers of change include: 1) Change in hydrology, i.e.



updated rainfall records and changing storm patterns, 2) Changes in land use such as population growth or development causing changes in runoff, 3) Need for detailed flood studies as new areas develop, 4) Update of data based on new models, and 5) Technological advancements that allow for more dynamic analyses and presentation of flood risk. While the initial mapping effort for the nation must be completed, there too is an annual maintenance cost for the entire flood map and data inventory. The federal government's investment in the development of flood hazard data is considerable and must not be allowed to decay as happened in the mid-1980s and 1990s (see chart on Historical Funding for FEMA Flood Mapping).

## The Cost

The national mapping program funding needs, shown in the table below, has been broken down into major program elements and provides a low and high cost associated with each. The basis for these costs are the assumptions explained in the preceding section and actual cost information obtained from FEMA, state flood mapping programs and other state and federal agencies involved in flood mapping efforts. Due to its complexity, the data behind these estimates is not included in this report, but is available from ASFPM upon request.

The most significant source of variability between the high and low range is due to assumptions made related to level of riverine flood studies for a given geographic area. While good cost data is currently available, it is important to note that changing technology as well as an assumption of nation-wide Lidar could result in reduced costs.

Program Element	Lower Range	Upper Range
Topographic Data Development – 3DEP Program	\$ 630,000,000	\$ 630,000,000
Discovery, Scoping, Risk Communication & Outreach	\$ 39,000,000	\$ 90,000,000
Riverine Flood Study	\$ 1,819,000,000	\$ 9,828,000,000
Coastal Flood Study	\$ 13,300,000	\$ 14,900,000
Levee	\$ 373,000,000	\$ 651,000,000
Dam Failure Inundation	\$ 97,000,000	\$ 199,000,000
DFIRM Production with QA/QC	\$ 156,700,000	\$ 206,000,000
Non-Regulatory Flood Risk Products	\$ 50,000,000	\$ 153,000,000
<b>Total</b>	<b>\$ 3,178,000,000</b>	<b>\$ 11,772,000,000</b>

The lower range does not include nearly 1 million miles of rivers and streams on federal and state lands, but does use the lower cost estimates associated with the latest mapping technology to generate minimal flood hazard data for rural areas. The upper range includes mapping flood hazard areas on all federal and state lands to ensure mapping of the 3.5 million

miles of rivers and streams in the nation. The upper range also considers the higher costs associated with urban areas and future development areas that as they become more developed (and thus more at-risk) there is an increased need for higher levels of detailed, engineered flood studies and thus higher costs. There is also significant variability for levee studies reflecting the relative uncertainty of the number of levee miles and the needed level of analysis.

Program Element	Lower Range	Upper Range
Steady-State Map Maintenance (Annual)	\$ 106,900,000	\$ 479,700,000
Total	<b>\$ 106,900,000</b>	<b>\$ 479,700,000</b>

In terms of map maintenance, the largest variable has to do with assumptions of map decay – or the accuracy of the map over time. Flood maps change over time due to several factors including changes in topography in the watershed, changes in development and growth, changes in precipitation, additional stream gage data, and changes in water levels in lakes and oceans. In areas where all of these are changing rapidly, maps need to be updated much more frequently than in some rural areas that have little growth and development. Also, accelerated sea level rise and climate change could result in higher decay rates than are presented in this cost estimate. All flood maps need to be periodically updated, but some more frequently than others. The more the flood maps reflect future conditions, the less the cost of updating those maps.

## Cost Savings

The cost model developed by ASFPM for this report includes estimates based on available information from states and FEMA, and is also based on current technology and methods of providing flood map data, as well as the assumptions stated earlier. ASFPM believes there are ways to achieve cost savings by leveraging funding, advances in technology and other approaches. A few of these are presented below.

1. *Efficiencies in mapping using better technology.* Throughout the FEMA Map Modernization program and in Risk MAP, FEMA has been successful in driving program efficiencies. This is also a result of changing and improving technologies. One promising approach is called Base Level Engineering (BLE) which uses automated flood modeling of more rural riverine floodplain areas where high quality topographic information exists. Given that the single biggest cost variable is riverine flood studies, the use of BLE could be a significant cost savings to the program.
2. *Leveraging other federal, state and locally collected elevation data.* Some states routinely collect and maintain statewide, high-quality LIDAR data that can be used by FEMA for flood mapping. While contributing to the aforementioned 3DEP program, FEMA is still leveraging considerable benefits from 3DEP to the nation's flood mapping program.
3. *Maintaining/expanding the Cooperating Technical Partners Program.* The CTP Program is an innovative approach to creating partnerships between the FEMA and participating NFIP communities, regional agencies, state agencies, tribes and universities that have the interest

and capability to become more active participants in the FEMA flood hazard mapping program. The result can be the leveraging of partner contributions to flood mapping projects.

## What remains to be done?

We are far from completing the initial job of mapping the nation. The framework for flood mapping as prescribed by the National Flood Mapping Program (NFMP) in the Biggert-Waters 2012 Reform Act, recognizes many of these existing needs and sets a robust course for moving forward. Unfortunately, as of January 2020, much remains to be done:

- Based on the National Hydrography Dataset (NHD) and NOAA shoreline data, there are approximately 3.5 million miles of streams and rivers, and 95,471 miles of coastlines in the nation. Currently, only 1.14 million stream miles and 45,128 shoreline miles have flood maps. By this metric, only about 1/3 of the nation has been mapped.
- Over 3,300, or roughly 15%, of NFIP communities have maps over 15 years old, with many of these over 30 years old and still having “unmodernized” paper maps. About 6,550 communities have never been mapped. Addressing both of these needs should be a priority for FEMA.
- Many of the added mapping requirements from 2012 are still not being addressed. This includes residual risk mapping around flood control structures and future conditions mapping. A 2016 TMAC report reviewing the National Flood Mapping Program stated “*To create technically credible flood hazard data, FEMA needs to address residual risk areas in the near term. Residual risk areas associated with levees and dams are of great concern.*” (Technical Mapping Advisory Council, 2016)

It should be noted that over the past several years, FEMA has stated that 90% plus of the population has been covered by a modernized map. However, this metric grossly overstates the population covered by a modernized map. This problem is discussed in the 2015 TMAC Future Conditions Assessment and Modeling Report:

*However, this population metric has two challenges for moving forward. First, the metric over-predicts the population covered by a modernized map. FEMA generally studies streams that drain a drainage area of greater than one square mile. If a census block group has 10 miles of stream and only 1 mile is studied, the current metric will count 100 percent of the population within the census block group as being covered by a modernized map, as opposed to the 10 percent that may actually be covered. Therefore, the current metric can lead to a significant over-prediction of the population covered by a modernized map. This could lead policy makers to believe that flood hazards have been more widely identified than the reality. If the metric is changed to be more reflective of the streams studied within a census block group, then it may more realistically illustrate that the country has flood hazard areas defined for only somewhere between 16 percent and 22 percent of all streams.” (FEMA Technical Mapping Advisory Council, 2015).*



Recognizing that much of the nation still needs to be mapped to adequate standards, FEMA is exploring ways to leverage new technologies to provide flood information more efficiently, accurately, and consistently across the nation through the Future of Flood Risk Data initiative. FEMA aims to provide a more comprehensive and dynamic picture of the nation's flood hazards, accounting for residual risks and multiple flood frequencies. This information could serve as a basis for a range of flood risk products. In moving towards this future, FEMA will need to develop strategic partnerships with other federal agencies, the private sector, and state, local, tribal, and territorial stakeholders. These partnerships will ensure that FEMA is leveraging the latest data and technologies, while serving the diverse needs of its customers.

## **Considerations for Congress and FEMA**

The National Flood Mapping Program has yet to achieve its aim: to produce a reasonably complete set of flood data/maps for the country that identifies multiple types of flooding hazards and also future conditions. As Congress and FEMA consider the future and funding of the National Flood Mapping Program, the following factors should be included:

- We do what we measure. There must be an easily verifiable metric developed for the National Flood Mapping Program that more accurately reflects the extent of the flood mapping completed in the nation than what is currently being used. We suggest the NFIP measure the percent of miles mapped as a metric. Unmapped miles must be studied and added to FEMA's inventory so that flood risk information is available to communities ahead of development.
- Congress will need to decide how quickly we need to have flood mapping available to every community, and then set a level of funding that will achieve that goal. The current FY2019 authorization of about \$450 million for the flood hazard mapping and risk analysis program is misleading because a much smaller amount of money is actually available (closer to \$300 million) to create new flood maps. Using the median funding level of about \$6-8 billion, one could divide by 10 if we agree the mapping should be available in 10 years. Congress should consider increasing the annual appropriation (ignoring the policy fee income since that is spent for operating costs like LOMA, LOMR, LOMC) for the national flood mapping program to accomplish that goal. Alternatively, some members of Congress have proposed a faster five-year effort in which a funding surge is appropriated to finish the job of initially mapping the nation.
- As directed by Congress in 2012, FEMA should begin providing residual risk and future conditions products as part of all flood mapping studies as soon as possible. The TMAC in its 2015 Future Conditions Report and in its 2016 National Flood Mapping Program Review support this view.
- The TMAC also identified the public policy hurdle related to the public availability of dam and related facility inundation maps. Congress may want to consider a specific provision as

part of a future NFIP reform bill or WRDA bill that would override the DHS Security Classification Guide for the Protection of Critical Infrastructure and Key Resources for dam failure inundation maps as "For Official Use Only."

- While not directly part of the National Flood Mapping Program, there is a critical need to ensure the intentional, funded update of the nation's rainfall frequency information which is a major data input into flood models. This past November, ASFPM testified that NOAA should be given the mandate and full budget to update our nation's rainfall frequency information at least every 10 years and this update must include future climate projections into precipitation frequency analysis.
- ASFPM also made a similar recommendation to fully fund the critical national stream gage and tidal gage networks. While more than 4,700 locations meet the criteria for inclusion in the Federal Priority Streamgage (FPS) Network, only 3,600 FPS are active due to funding limitations. These gages provide critical datasets over time so that trends can be identified.

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Mr. Berginnis has 26 years of experience in various aspects of natural hazard management, flood loss reduction, and land use planning / programs at the state, local and private sector level. As a state official, Mr. Berginnis worked in the Ohio Floodplain Management Program and was Ohio's State Hazard Mitigation Officer. He was involved in creating/administering the Appalachian Flood Risk Reduction Initiative, administered the Community Assistance Program, authored a comprehensive revision of the model state floodplain management regulations, oversaw state hazard mitigation operations in three Federally declared flood disasters and authored the 2008 update of Ohio's mitigation plan. As a local official, Mr. Berginnis administered land use, economic development and floodplain management programs in Perry County, Ohio as well as assisted Perry County communities with their post-disaster floodplain management responsibilities following a major flood. In the private Sector, Mr. Berginnis was the national Practice Leader in hazard mitigation for Michael Baker Jr. Inc.

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