United States Government Accountability Office

GAO

Report to Congressional Requesters

December 2010

FEMA FLOOD MAPS

Some Standards and Processes in Place to Promote Map Accuracy and Outreach, but Opportunities Exist to Address Implementation Challenges

GAO-11-17

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GAO Highlights

Accountability • Integrity • Reliability

Highlights of GAO-11-17, a report to congressional requesters

Why GAO Did This Study

The Federal Emergency Management Agency (FEMA), a component of the Department of Homeland Security (DHS), maps flood hazard areas across the country and makes flood insurance available to more than 20,100 communities through the National Flood Insurance Program. From 2003 through 2008, FEMA spent $1.2 billion in a comprehensive effort to update the nation's flood insurance maps. In 2009, FEMA began an annual review of 20 percent of the nation's flood maps, for which Congress allocated $440 million in 2009 and 2010. As requested, GAO reviewed the actions FEMA has taken to enhance the accuracy of updated flood maps, and FEMA's outreach efforts in conducting flood mapping activities. GAO analyzed FEMA's mapping standards and information systems, tested quality assurance processes, and interviewed FEMA officials and contractors.

What GAO Recommends

Among other things, GAO recommends that FEMA establish guidance for validating data, transfer responsibility for verification audits to an independent entity, and establish goals and measures for promoting public acceptance of mapping. FEMA concurred with 10 of the 11 recommendations in this report, but disagreed with transferring verification audit duties to an independent entity because it believes its program management contractor is sufficiently independent. GAO believes this recommendation remains valid as stated in this report.

View GAO-11-17 or key components. For more information, contact William O.Jenkins, Jr.,at (202) 512-8757 or JenkinsWO@gao.gov.

What GAO Found

FEMA has taken a number of steps to enhance the accuracy of flood maps, but challenges related to implementing standards to ensure map accuracy remain. Steps FEMA has taken include adopting a risk-based method to prioritize mapping projects, implementing mapping standards and guidance, establishing risk-based standards for topographic detail to ensure that the highest risk areas have the most accurate topographic data, and implementing quality control processes for ensuring engineering data is collected and used in accordance with standards. However, FEMA's mapping standards could be improved. For example, FEMA has standards for determining the extent to which new and updated flood mapping data are sufficiently current to promote map accuracy, yet FEMA has not developed uniform guidance for the validation of existing mapping data. Doing so could help FEMA both track and report the accuracy of maps at the national and regional levels and better assess mapping data needs. FEMA's quality control process for ensuring the accuracy of flood maps could also be improved. Audits of FEMA's mapping contractors' efforts have been conducted since 2006 by an independent verification contractor; however, FEMA officials said they planned to transfer responsibility for the verification audits, part of its independent verification and validation process, to its program management contractor by the end of this year, who will then monitor FEMA's mapping contractors. The transfer of these responsibilities creates a potential conflict of interest because the program management contractor is to monitor the results of its program management efforts. According to industry best practices, verification and validation efforts should be independent and reported directly to senior management to provide added assurance that reported results on the project's status are unbiased. The performance of the verification and validation function by an entity that is technically, managerially, and financially independent of the organization in charge of what it is assessing could better position FEMA to help ensure the independence of the verification and validation function, both in appearance and in fact.

FEMA has taken a variety of steps to conduct outreach to state and local officials, including developing a national outreach strategy, but could enhance its efforts to improve public awareness and promote map acceptance. For example, FEMA has not developed performance goals or measures, or identified the resources needed for its flood mapping outreach efforts, which could help FEMA better determine whether its outreach efforts are achieving their intended results. In addition, FEMA could better quantify, allocate, and leverage resources needed to support national outreach efforts. For example, by tracking spending and using risk in its decisions for allocating outreach resources, FEMA could better allocate resources for flood mapping outreach efforts. In addition, FEMA could enhance its outreach efforts by leveraging existing flood insurance marketing resources and expertise during the mapping process to increase public acceptance of flood maps.

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Abbreviations

ASFPM	Association of State Floodplain Managers
BFE	Base Flood Elevation
CEO	Chief Executive Officer
CTP	Cooperating Technical Partners
DFIRM	Digital Flood Insurance Rate Map
DHS	Department of Homeland Security
FBS	Floodplain Boundary Standard
FEDD	Flood Elevation Determination Docket
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
IV&V	Independent Verification and Validation
LFD	Letter of Final Determination
LIDAR	Light Detection and Ranging
MIP	Mapping Information Platform
NFIP	National Flood Insurance Program
NVUE	New, Validated, or Updated Engineering
PTS	Production and Technical Services
QA/QC	Quality Assurance/Quality Control
Risk MAP	Risk Mapping Assessment and Planning
SFHA	Special Flood Hazard Area
USGS	United States Geological Survey

GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

December 2, 2010

The Honorable Sherrod Brown
Chairman
Subcommittee on Economic Policy
Committee on Banking, Housing and Urban Affairs
United States Senate

The Honorable Jeff Bingaman
United States Senate

The Honorable Charles E. Schumer
United States Senate

Unprecedented flooding in 2009 and 2010 in Atlanta, Georgia; Nashville, Tennessee; Oklahoma City, Oklahoma; and in 24 counties across Arkansas caused millions in property damages and heightened the nation's awareness of the importance of flood insurance.[1] The Federal Emergency Management Agency (FEMA), a component of the Department of Homeland Security (DHS), is responsible for mapping flood-prone areas across the country. Based upon the estimated flood risk reflected in these maps, FEMA makes flood insurance available to property owners in more than 20,000 communities that participate in the National Flood Insurance Program (NFIP). We designated the program as a "high-risk" area in March 2006 because it likely will not generate sufficient revenues to repay the billions it borrowed from the Treasury to cover flood claims from the 2005 hurricanes.[2] From 2003 through 2008, FEMA was appropriated $1.2 billion for a comprehensive effort to update the nation's inventory of flood insurance maps—known as the Map Modernization initiative. In fiscal years 2009 and 2010, Congress appropriated a total of $440 million for FEMA to continue its flood mapping efforts.[3] Federal law requires FEMA

[1] According to FEMA, 20 to 25 percent of flood claims are to communities and properties outside of a "Special Flood Hazard Area" (SFHA), which are those areas that have an estimated 1 percent annual chance of flooding.

[2] GAO's High-Risk Series identifies federal programs and operations that, in some cases, are high risk due to their greater vulnerabilities to fraud, waste, abuse, and mismanagement. GAO, *High-Risk Series: An Update*, GAO-07-310 (Washington, D.C.: January 2007).

[3] Pub. L. No. 111-83, 123 Stat. 2142, 2163 (2009); Pub. L. No. 110-329, 122 Stat. 3574, 3675 (2008).

to assess the need to revise and update the nation's flood maps at least every 5 years;[4] in response, FEMA reviews 20 percent of flood maps on an annual basis.[5]

As FEMA concluded in an August 2010 report to Congress, inaccurate maps create substantial difficulties by undermining confidence in the NFIP, leaving some individuals and organizations unaware of their risks, and imposing unnecessary costs on others whose risk is overstated.[6] FEMA established its 5-year Risk Mapping Assessment and Planning (*Risk MAP*) program in 2009 to, among other things, improve the quality of flood data used for mapping and enhance public acceptance of flood maps.

Ensuring the accuracy—and promoting public acceptance of—flood maps are ongoing challenges that FEMA faces in implementing its national flood mapping program, as evidenced by past reviews and recommendations made by us and others in assessing FEMA's efforts. For example, in our 2004 report on FEMA's mapping program, we assessed FEMA's plans to match the accuracy of flood data with communities' relative flood risk and reported that FEMA had not yet established data standards that describe the appropriate level of detail, accuracy, and analysis required to develop digital maps based on risk level.[7] We recommended that FEMA develop and implement flood-mapping data standards for data collection and analysis for communities of similar risk. FEMA agreed and, in response, established a risk-based standard for the accuracy of mapping floodplain boundaries in 2005. In our report, we also reviewed FEMA's partnerships with states and local entities that conduct mapping activities and reported that FEMA had not yet developed a clear strategy for partnering with communities with few resources and little or no experience in flood mapping. We recommended that FEMA develop and implement strategies for partnering with state and local stakeholders and establish useful

[4] 42 U.S.C. § 4101(e).

[5] For the purpose of this report, we will use the terms flood maps to describe FEMA's flood insurance map products such as Flood Insurance Rate Maps (FIRM), Digital Flood Insurance Rate Maps (DFIRM), accompanying Flood Insurance Study and other supporting technical data.

[6] Federal Emergency Management Agency, Risk Mapping, Assessment and Planning (Risk MAP): National Digital Elevation Acquisition and Utilization Plan for Floodplain Mapping (Aug. 9, 2010).

[7] GAO, *Flood Map Modernization: Program Strategy Shows Promise, but Challenges Remain*, GAO-04-417 (Washington, D.C.: Mar. 31, 2004.).

performance measures to assess its progress in increasing stakeholders' awareness and use of new maps. FEMA agreed and, in 2006, cited a number of activities the agency had taken to increase the effectiveness of its mapping partnerships, including the development and implementation of a national outreach strategy and the creation of an outreach consortium to share lessons learned. Recommendations to improve flood-mapping data quality and community outreach have also been made by the Technical Mapping Advisory Council, [8] and by the Department of Homeland Security's Office of Inspector General.[9]

You requested that we review FEMA's flood mapping program. In response, this report addresses the following objectives:

- To what extent has FEMA taken actions to enhance the accuracy of flood maps, and what challenges, if any, does FEMA face?
- To what extent has FEMA taken actions to help promote community acceptance of flood maps, and what challenges, if any, does FEMA face?

To address our first objective, we assessed FEMA's standards and guidance against criteria in recent reports by the National Academies of Sciences and the National Research Council.[10] We discussed the reports' methodologies with the authors and with relevant FEMA officials, and analyzed reviews and critiques of the Academies' reports to determine that they were appropriate for our purposes. We analyzed information on FEMA's policies and plans for flood map modernization, data from FEMA's Mapping Information Platform (MIP) for the period of October 2005 through 2009, and systems for documenting compliance with FEMA's

[8] The Technical Mapping Advisory Council was established by the National Flood Insurance Reform Act of 1994 to provide recommendations to FEMA on how to improve the accuracy, quality, distribution, dissemination, and ease of use of Flood Insurance Rate Maps, among other things. Pub. L. No. 103-325, §576, 108 Stat. 2255, 2280 (1994). The Council was created in November 1995 and it continued through November 2000. The Council submitted recommendations to the Director of FEMA in each of its Annual Reports.

[9] Department of Homeland Security Office of the Inspector General, *Challenges in FEMA's Flood Map Modernization Program*, OIG-05-44 (Washington, D.C.: September 2005.).

[10] National Research Council (U.S.), and United States. 2009 *Mapping the Zone: Improving Flood Map Accuracy*. Washington, D.C.: National Academies Press. http://www.nap.edu/catalog.php?record_id=12573 May 2009; National Research Council (U.S.). 2007. *Elevation Data for Floodplain Mapping*. Washington, D.C.: National Academies Press. http://books.nap.edu/catalog.php?record_id=11829 August 2007.

data quality standards.[11] To assess FEMA's internal controls and the reliability of computer-processed flood map data, we examined FEMA databases, including the MIP, which was designed to monitor the mapping process and the completion of FEMA's quality assurance/quality control (QA/QC) process. We tested the controls on the QA/QC process by extracting and reviewing data on all projects initiated and completed from fiscal years 2006 through 2009. We also analyzed FEMA's Floodplain Boundary Standard (FBS) and New, Validated, or Updated Engineering (NVUE) verification systems that were designed to track implementation of data accuracy requirements. We tested the controls on the FBS and NVUE compliance process by extracting and reviewing data on all projects initiated and completed from fiscal year 2006 (when the FBS was established) through 2009 and compared them against criteria in *Standards for Internal Control in the Federal Government.*[12] To assess the reliability of these databases, we compared data to FEMA's management reports, interviewed FEMA's three mapping contractors, and analyzed the original data. We determined that the FBS and NVUE compliance data were sufficiently reliable for our purposes. We also discussed FEMA's mapping process and standards with agency officials, as well as other federal stakeholders in geographic data collection and mapping, including officials at the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the U.S. Army Corps of Engineers, and subject-matter experts on flood hazards and floodplain management from national organizations, including the Association of State Floodplain Managers and the National Association of Flood & Stormwater Management Agencies, which are stakeholders to FEMA's mapping initiatives. We focused our review on FEMA's standards and processes related to flood hazard mapping for rivers and streams (commonly know as "riverine" flooding[13]), which account for about 95 percent of FEMA's flood maps, according to FEMA. As a result, we limited our scope to exclude those standards and processes related to flood hazard mapping for coastal areas and the levee certification. In addition,

[11] FEMA created the Mapping Information Platform in 2004, to enable the management, production, and sharing of flood hazard data and maps and related information in a digital environment. In March 2006, FEMA developed a Mid-Course Adjustment to its Map Modernization Initiative.

[12] GAO, *Standards for Internal Control in the Federal Government*, GAO/AIMD-00-21.3.1 (Washington, D.C.: November 1999).

[13] Riverine flooding is flooding related to or caused by a river, stream, or tributary overflowing its banks due to excessive rainfall, snowmelt, or ice.

FEMA has processes to modify and update flood map information during the time that a community's maps are in effect, called a Letter of Map Change, which is also outside the scope of our work.

To address our second objective, we analyzed information on FEMA's policies, requirements for community outreach, and data from FEMA's information management systems (discussed above) for documenting compliance with statutory and regulatory requirements for documenting coordination with state and local officials involved in mapping projects. To determine FEMA's compliance with documentation requirements, we examined FEMA's Flood Elevation Determination Dockets (FEDD) files that are established for each mapping project. We reviewed FEDD files from a probability sample of 88 counties from a population of 431 counties that had completed studies from fiscal year 2006 through 2009 that resulted in a change in base flood elevation.[14] From this sample, we reviewed mapping partners' compliance with six documentation requirements.[15] In addition, we analyzed the goals and performance measures of FEMA's outreach strategy for Map Modernization, and its *Risk MAP* national outreach strategy against prior GAO work reviewing federal agencies' practices for development of national strategies,[16] as well as FEMA's budget and staff allocations related to outreach.

To supplement our analyses of FEMA's flood mapping internal controls and program management activities related to data accuracy and community outreach, we selected four flood map modernization projects in Arizona, California, Florida, and North Carolina to visit. We selected these locations based on our 2004 review to highlight specific challenges associated with the mapping process, such as inclusion of levees, and the impact of varying degrees of community involvement and outreach in the 5 years since our review. The results from these locations cannot be generalized to all flood map modernization projects, but enabled us to describe challenges FEMA faces in conducting its national flood mapping

[14] The maximum margin of error for estimates of percentages from our sample of flood mapping projects is plus or minus 9 percentage points at the 95 percent level of statistical confidence.

[15] FEMA's requirement to maintain a flood elevation determination docket (FEDD) is found at 44 C.F.R. § 67.3.

[16] See GAO *Combating Terrorism: Evaluation of Selected Characteristics in National Strategies Related to Terrorism*, GAO-04-408T (Washington, D.C., Feb. 3, 2004), and GAO *Financial Literacy and Education Commission: Further Progress Needed to Ensure an Effective National Strategy*, GAO-07-100 (Washington, D.C., Dec. 4, 2006).

activities by talking with relevant state and local officials. An expanded discussion of our scope and methodology is described in appendix I.

We conducted this performance audit from August 2009 through December 2010, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

FEMA is the primary federal agency responsible for assisting state and local governments, private entities, and individuals to prepare for, mitigate, respond to, and recover from natural disasters, including floods. Floods are the most frequent natural disasters in the United States, causing billions of dollars of damage annually. To address the increasing amount of flood damage, the lack of readily available insurance for property owners, and the cost to the taxpayer for flood-related disaster relief, Congress passed the National Flood Insurance Act of 1968, which created the NFIP.[17] Since its inception, the NFIP has served as a key component of FEMA's efforts to minimize or mitigate the damage and financial impact of floods on the public, as well as to limit federal expenditures needed after floods occur. The NFIP seeks to minimize flood-related property losses by making flood insurance available on reasonable terms and encouraging its purchase by people who need flood insurance protection—particularly those living in the areas at highest risk of flooding, known as Special Flood Hazard Areas, designating a 1 percent annual chance of flooding. To do so, FEMA along with its state and local partners, identifies and maps flood-prone areas in the more than 20,100 communities that currently participate in the program.[18]

When the NFIP was created, the purchase of flood insurance was voluntary. Congress amended the original law in 1973 to require the purchase of flood insurance in certain circumstances. The purchase of flood insurance is required for structures in Special Flood Hazard Areas of communities participating in the program if (1) any federal loans or grants were used to acquire or build the structures or (2) the structures have

[17] Pub. L. No. 90-448, tit. XIII, 82 Stat. 572 (1968).

[18] Also included are Puerto Rico and the Virgin Islands.

outstanding mortgage loans made by lending institutions that are regulated by the federal government. Property owners located in the Special Flood Hazard Area with mortgages from federally regulated lenders are required to purchase and maintain flood insurance policies.

FEMA identifies flood hazards, assesses flood risks, and provides appropriate flood hazard and risk information to communities nationwide. To identify hazards and assess risks, mapping projects are performed in accordance with FEMA *Guidelines and Specifications*. Flood maps provide the basis for setting insurance rates and identifying properties whose owners are required to purchase flood insurance. FEMA's flood hazard maps are also used by lending institutions to determine who is required to purchase flood insurance and help ensure that flood insurance is purchased and maintained for these properties. Local government planning and zoning officials, land developers, and engineers use the maps for developing zoning regulations and designing new buildings and infrastructure to be safe from flooding. FEMA has estimated that local governments' compliance with the program's standards for new construction saves over $1 billion annually in flood damage avoided.

Stakeholders from All Levels of Government and the Private Sector Participate in the Mapping Process

FEMA's Federal Insurance and Mitigation Administration, which manages the NFIP, is comprised of three divisions: Risk Analysis, Risk Reduction, and Risk Insurance.[19] The Risk Analysis Division is responsible for flood mapping activities and develops flood mapping policy and guidance. FEMA's 10 Regional offices manage flood map production for their geographic areas. FEMA headquarters and regional staff monitor and report flood hazard mapping progress based on program management data provided by flood mapping partners.

Mapping partners can include FEMA's 3 national Production and Technical Services (PTS) contractors, as well as state and local governments or regional agencies—including those state and local governments that are participating in FEMA's Cooperating Technical Partners (CTP) program. The PTS contractors are private engineering

[19] FEMA's Risk Reduction Division performs floodplain management activities to reduce risk to life and property through the use of land use controls, building practices and other tools, in both pre- and post-disaster environments. FEMA's Risk Insurance Division provides flood insurance for property owners and encourages communities to adopt and enforces floodplain management regulations that mitigate the effects of flooding on new and improved structures.

firms working under contract to FEMA and are each responsible for a regional portfolio of flood study projects. Table 1 summarizes the roles and responsibilities of FEMA, the mapping partners, and other actors in the flood map production process.

Table 1: Mapping Partners Roles and Activities in the Flood Map Production Process

Stakeholders	Requirement or responsibility or role
FEMA headquarters staff	• Manage national flood-mapping program • Monitor local governments' adoption of maps and updates to ordinances
FEMA regional staff	• Oversee scoping meeting between all mapping partners • Manage flood-mapping process • Lead meetings to present preliminary maps with local government officials • Provide local government officials with outreach tools • Attend public meetings
Mapping partners: • Contractors • Cooperating Technical Partners (CTPs) • Other federal agencies[a]	• Assist in scoping meeting • Collect required data or validates existing data • Assist FEMA in administering flood-mapping activities (see text above) • Analyze flood hazard data sources (ie. climate, stream flow, soil, land use, elevation, hydraulic structure) • Produce flood hazard estimates • Implement quality controls • Create preliminary maps • Attend public meetings • Resolve appeals and /or protests to preliminary maps • Create final maps
State & local officials[b]	• Participate in scoping meeting • Identify data assets and needs during scoping meetings • Provide feedback on preliminary maps • May conduct outreach to individuals in the community • Collect appeals and/or protests to the preliminary maps from individuals and forwards to FEMA • Update local governments' floodplain ordinances
Community/general public (e.g., property owners, businesses, local real estate industry, etc.)	• Attend public meetings • Provide feedback on preliminary maps • May file challenges—appeals and/or protests—to preliminary maps

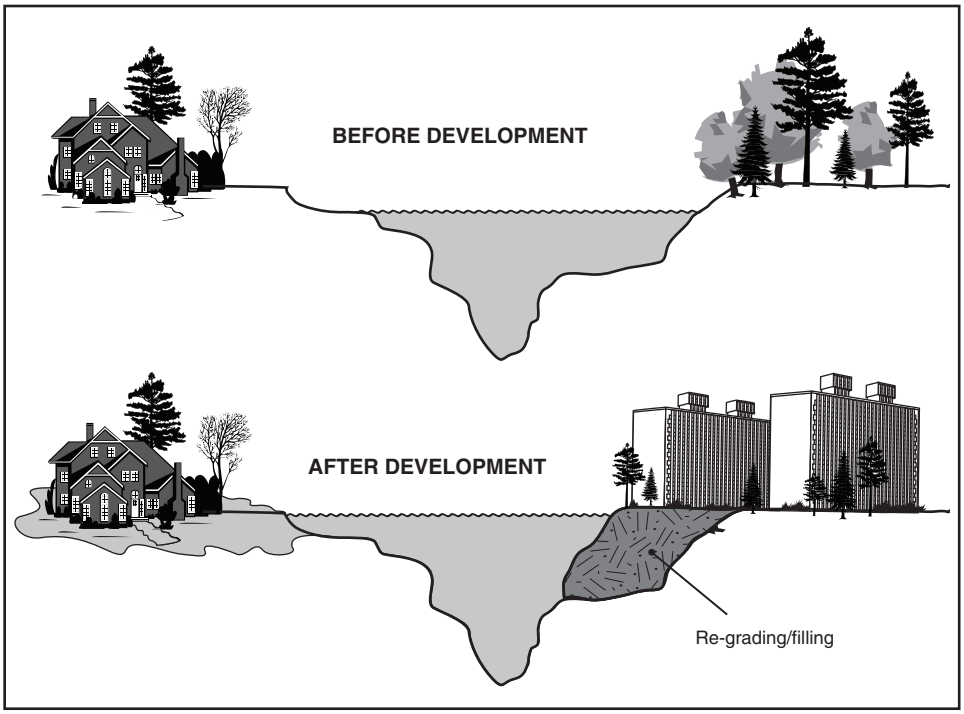
Source: GAO analysis of FEMA data.

[a] Other Federal agencies who work under interagency agreements with FEMA could include, for example, the U.S. Army Corps of Engineers, Natural Resources Conservation Service, U.S. Geological Survey, National Oceanic and Atmospheric Administration, and the Tennessee Valley Authority.

[b] State and local officials can also be Cooperating Technical Partners.

FEMA relies on local governments to provide it with notification of changing flood hazard information and to work with FEMA to collect the information needed to reflect the updated flood hazards on the flood maps. Changes to communities such as new development can affect floodplain boundaries, as shown in figure 1 below. Thus, as we noted in our 2004 report, the ultimate success of FEMA's flood mapping program depends on the level of community investment and involvement in the process.[20]

Figure 1: Effects of Development on a Riverine Floodplain



Sources: GAO analysis of FEMA data; and Art Explosion clipart.

A community's flood hazard maps can be updated in response to a FEMA-initiated study or revised study of flood hazards and subsequent revision of NFIP flood maps or through a community-initiated revision. Each year, FEMA revises existing maps in communities across the nation. Because of funding constraints, FEMA can study or revise maps for only a limited

[20] GAO-04-417.

number of communities each year. As a result, FEMA prioritizes new and revised study needs based on a cost-benefit approach whereby the highest priority is given to studies where development is greatest and where the maps are most outdated.

Overview of Flood Mapping Production Process

Topographic Accuracy

Topographic accuracy is a function of detail and age. Detail is important because detailed topography has significantly fewer errors than less detailed alternatives and better accounts for hydraulic structures—structures that affect water flow—such as buildings, dykes, river banks, and roads. Age is important because topography can change over time due to development and ecological factors such as erosion. The topographic data used in mapping studies can have significant variances in age and detail, and thus, accuracy.

Source: GAO analysis.

Base flood elevation (BFE)

The computed elevation of a flood having a 1 percent chance of being equaled or exceeded in a given year is the base flood elevation. It accounts for the volume and velocity of water moving through the watershed and reflects the cumulative effects of topography, soils, vegetation, surface permeability, and other factors. The BFE is the regulatory standard for the elevation or flood proofing of structures, and the relationship between the BFE and the elevation of a structure also determines the flood insurance premium. In general, the higher the first floor elevation, the lower the insurance premium. Consequently, the accuracy of BFEs on the flood maps is important for both regulating and insuring properties commensurate with the risk of flooding.

Source: National Academies of Science

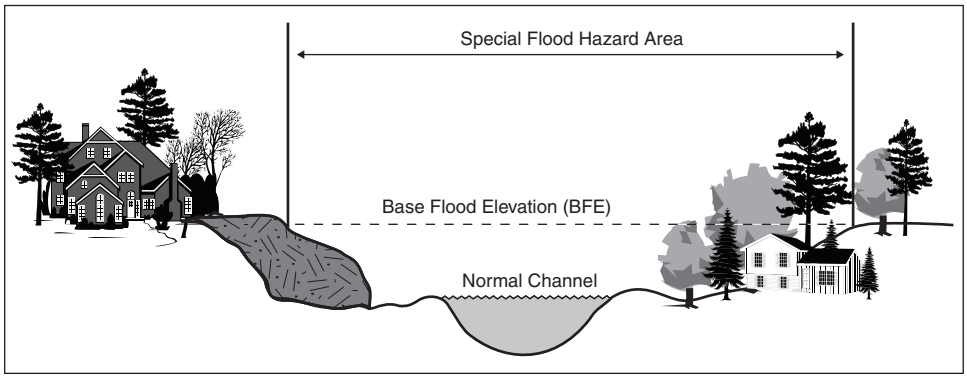
Flood mapping is a complex and technical endeavor. In order to create a map, engineers must conduct field surveys to assess the area to be studied and then develop data on the elevation of the terrain—called **topographic** data.[21] Engineers develop flood hazard data that estimates the risk of flooding by performing analyses on the **hydrologic** conditions that affect the amount of water that flows downstream during a flood (for example, soil and vegetation absorb rain and reduce runoff while pavement and other impermeable manmade surfaces increase the flow of runoff) and the **hydraulic** conditions that affect the height of floodwaters in streams or waterways (for example, bridges may create narrower channels that raise the water level as it passes under the bridge).

The results of the analyses of these different types of topographic and flood hazard engineering data are then combined and integrated into digital maps that describe how far (the floodplain boundary) and how high floodwaters will reach (the Base Flood Elevations, or BFEs) —as shown in figure 2 below. Each step in the process contributes to the ultimate accuracy of the final map but also requires judgment and involves uncertainty. Without a long and well-documented record of flooding in a floodplain, the precision of flood hazard information is difficult to determine. Because weather predictions and land use are difficult to predict, the correctness of the flood maps cannot be determined with certainty. Instead, the maps must be evaluated based on a relative correctness or general reliability of the flood maps and flood insurance

[21] According to FEMA officials, the term "field survey" within FEMA usually means actual survey measurements made by a crew on the ground, and the term "field reconnaissance" is usually used within FEMA to distinguish site visits to get an overall understanding of the area to be studied and collect information other than survey measurements. In addition, topographic data is mostly produced by aerial surveys, although certain key features are often measured by field survey because the aerial survey technology may not produce accurate results in some situations.

study.[22] Some of the factors that impact reliability of the study are the type of topographic data used, the hydrologic and hydraulic models used and the assumptions computed, and the final mapping techniques by the mapping partners.

Figure 2: Riverine Floodplain Boundary and the Base Flood Elevation



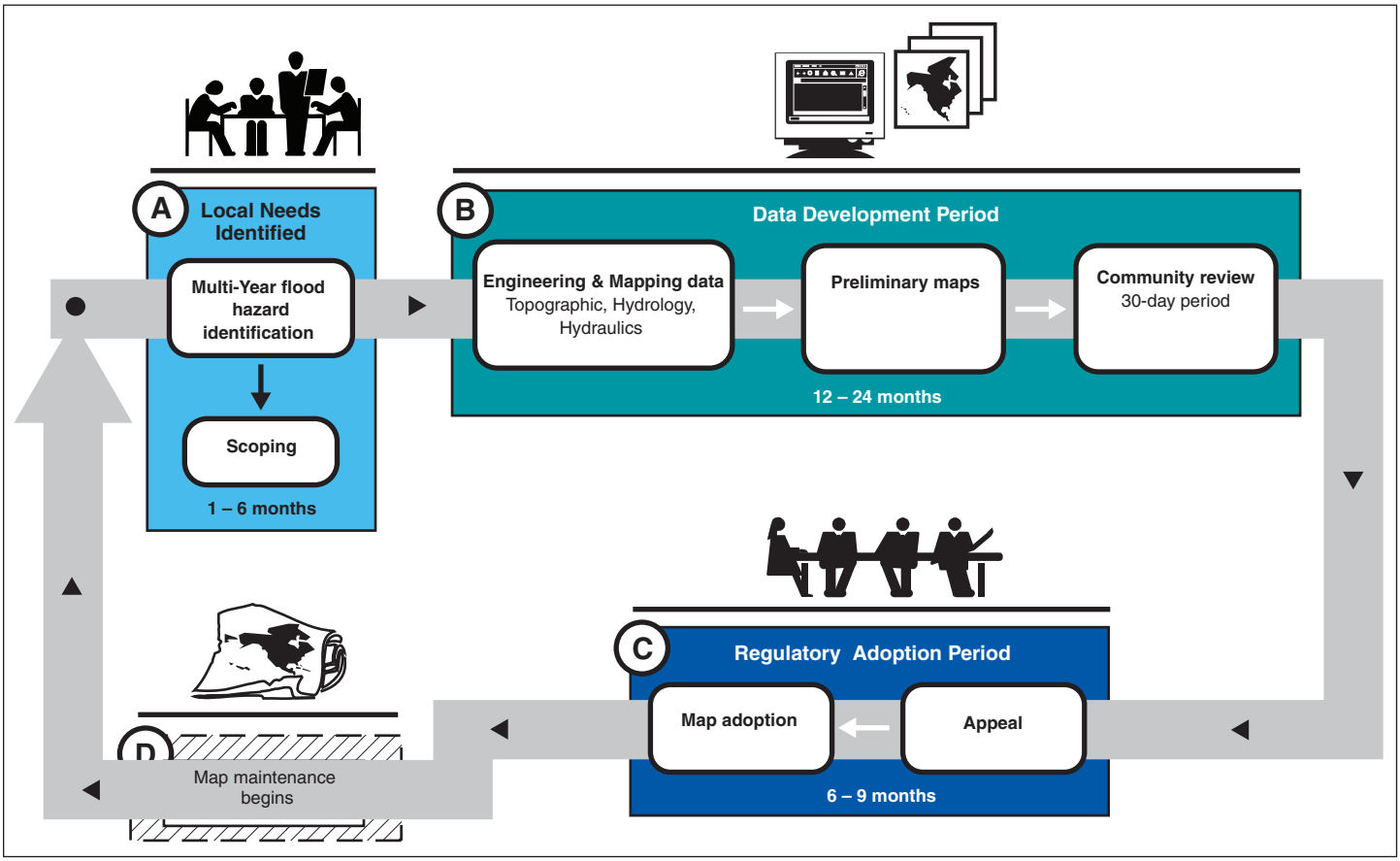
Sources: GAO analysis of FEMA data; and Art Explosion clipart.

Through various stages of the mapping production process, FEMA, in consultation with mapping partners and localities, determines the flood map study's level of accuracy and precision. In making this decision, required costs and resources, budget priorities, and communities' flood hazard identification needs are considered. An overview of the mapping production process is provided in figure 3 below. This determination affects the study's cost and the resulting flood map's accuracy. Detailed flood studies incorporate greater amounts of data or more precise data into a map to provide greater granularity of information, for example, by determining BFEs within a Special Flood Hazard Area, to reduce uncertainty. In contrast, approximate flood studies generally require less precision in flood hazard data. For example, they are used for areas that are less subject to development and do not require the establishment of a regulatory base flood elevation, although base flood elevations may be identified on the flood map based on an agreement between FEMA, its

[22] A Flood Insurance Study (FIS) is a book that contains information regarding flooding in a community and is developed in conjunction with the flood insurance rate map. The FIS, also known as a flood elevation study, frequently contains a narrative of the flood history of a community and discusses the engineering methods used to develop the maps. The study also contains flood profiles for studied flooding sources and can be used to determine Base Flood Elevations for some areas.

mapping partners, and state and local governments. Even when floodplains are mapped with high accuracy, land development and natural changes to the landscape or hydrologic systems create the need for continuous map maintenance and updates.

Figure 3: Map Production Process Overview



Sources: GAO analysis of FEMA data.

Key:

A - Local needs identified – FEMA, mapping partner, and local government officials meet to discuss a plan and schedule a Scoping Meeting(s) for flood mapping project, including data needs.

B - Data Development period – Mapping partner collects data or validates existing data and uses a model to create preliminary maps. All maps inevitably contain some uncertainty because of technological limitations and budgetary constraints. Preliminary maps are presented to local government officials to identify issues. FEMA publishes notifications of new flood maps in the *Federal Register* and twice in the local newspaper. Local officials may decide to hold public meetings.

C - Regulatory Adoption Period

Appeal Period – 90-day period for local government officials or individuals to challenge the preliminary maps as scientifically or technically inaccurate because they include, for example, inaccurate flood levels, flood boundaries not matching elevation of terrain, incorrect street names, city limits, etc. – After all appeals are resolved, FEMA sends a Letter of Final Determination (LFD) to the community CEO to say the maps are now "final."

Adoption Period – After maps are final the local government must update its ordinances within 6 months. If the local government does not update its ordinances, it could be suspended from the National Flood Insurance Program.

D - Map Maintenance – After maps are final, the local government or individuals can file a "Letter" to modify or update an individual property or parcels of land within the flood maps for reasons such as new development , mitigation efforts, or the limitation of map scale and the collection of more accurate ground elevations data on a given property. In addition, map maintenance also includes re-analysis and revision of maps - not by letter, but by republishing the entire map - based either on information provided by local government or by FEMA's identification of an update need.

The National Flood Insurance Act of 1968, as amended, and federal regulations require that FEMA communicate potential changes in flood risk to the public when it decides to initiate a flood mapping study and when it is ready to release preliminary maps. At the beginning of the mapping process, FEMA is required to notify local governments.[23] When FEMA is ready to release preliminary maps, the agency must publish the proposed base flood elevations in the *Federal Register* for public comment and notify the local government of the results of the study.[24] When the final map is approved, FEMA publishes another *Federal Register* notice.[25] FEMA is required to maintain documentation of selected elements of its public notification efforts.[26] Outside of these statutory and regulatory requirements, FEMA has historically focused its outreach efforts on local

[23] FEMA is required to contact community stakeholders, such as the state coordinating agency and other appropriate community officials, to discuss the intent and nature of the proposed flood map study. 44 C.F.R. § 66.5.

[24] FEMA is required to publish the proposed flood elevations in a prominent local newspaper at least twice during the 10-day period following the notification of the community chief executive officer. Property owners have 90 days from the second newspaper publication to appeal the proposed flood elevations. 44 C.F.R. §§ 67.4, 67.5.

[25] Final flood elevations must be published in the Federal Register and copies sent to the community chief executive officer, all individual appellants, and the state-coordinating agency. 44 C.F.R. § 67.11.

[26] 44 C.F.R. §§ 66.3, 67.3.

government officials and has relied on local officials to inform the community at large (i.e., the public) of flood mapping efforts.[27]

Map Modernization to *Risk MAP*

Traditionally, flood maps were created and stored in paper format. In the early 1990s, however, some of the data and information FEMA collected to develop flood maps started becoming available in digital format. In 1997, FEMA developed its initial flood Map Modernization plan that outlined the steps necessary to update the nation's flood maps to digital format and streamline FEMA's operations in raising public awareness of the importance of the maps and responding to requests to revise them. FEMA's initial flood Map Modernization plan was to fully digitize all flood maps in the nation, first, by identifying those maps that required engineering updates and converting them to a digital format. FEMA's initial goal was to convert approximately 80 percent of existing paper maps to a digital format, update 20 percent of the existing maps with new flood risk information while converting them to digital format, and add 13,700 completely new maps (also in digital format) to cover previously unmapped communities. Then, a planned maintenance phase would follow the Map Modernization initiative, whereby these maps would be updated with new engineering data.

In March 2006, FEMA performed a mid-program evaluation that considered input from our prior work, as well as the Congress, the Department of Homeland Security's Inspector General, and other stakeholders. As a result, FEMA instituted a mid-course adjustment of the Map Modernization's program goals and objectives. FEMA's modified objectives for the initiative were to (1) produce new digital products; (2) provide new, updated, or validated engineering analyses; and (3) integrate a new Floodplain Boundary Standard into the digital maps. As part of this mid-course adjustment, FEMA ranked all 3,146 counties in the United States in terms of flood risk from highest to lowest based on a number of factors, including, among other things, population, growth trends, housing units, flood insurance policies and claims, repetitive loss properties, and flood disasters. On the basis of this ranking, FEMA established its mapping priorities that the agency used to schedule mapping projects during the

[27] Federal law provides that FEMA must encourage local officials to disseminate information concerning a flood mapping study widely within the community, so that interested persons will have an opportunity to bring all relevant facts and technical data concerning the local flood hazard to the attention of the agency during the course of the study. 42 U.S.C. § 4107.

course of its Map Modernization initiative, which FEMA detailed in their Multi-Year Flood Hazard Identification Plans. From fiscal years 2003 through 2008, FEMA spent $1.2 billion for flood map modernization. FEMA initiated the final year of production under Map Modernization in 2008.[28]

In fiscal year 2009, FEMA began a 5-year effort—*Risk MAP*—with $300 million in funding from the National Flood Insurance Fund and congressional appropriations for flood hazard mapping. According to FEMA, the vision for *Risk MAP* is to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. According to FEMA's Risk MAP, Quality Assurance Management Plan, quality data is defined as accurate, credible, timely, and efficiently delivered.

FEMA Has Taken Steps to Enhance Flood Map Accuracy, but Faces Challenges in Implementing Standards and Its Quality Assurance Process for Program Management

FEMA Has Developed Standards and a Quality Assurance Process to Enhance Map Accuracy

FEMA has implemented and tracks compliance with three standards for ensuring the quality of data used in developing flood maps: FEMA's Guidelines and Specifications; the Floodplain Boundary Standard (FBS), and 2 of the 3 elements of the New, Validated and Updated Engineering (NVUE) data standard.

[28] According to FEMA officials, production of these 2008 projects under Map Modernization continued through 2010, and some of these projects were still in progress at the time of our review.

- *Guidelines and Specifications* for Flood Hazard Mapping Partners—FEMA established the *Guidelines and Specifications* to define technical requirements, product specifications for Flood Hazard Maps and related NFIP products, and associated coordination and documentation activities. In addition, FEMA periodically amends the Guidelines and Specifications, through Procedural Memoranda. For example, in September 2010, FEMA revised *Guidelines and Specifications* for acquiring elevation to include risk-based standards for gathering and using topographic data.

- *Floodplain Boundary Standard*—In response to stakeholders concern about the quality of flood data used to develop new flood maps during the Flood Map Modernization program, FEMA issued the FBS in October 2007, in part, to help ensure that flood maps are tied to a topographic source. The purpose of the FBS is to ensure the locations of the predicted horizontal (floodplain boundary) and vertical (base flood elevation) lines drawn on flood maps are comparable to the topographic data that has been selected for the study area. For example, maps showing water running uphill could occur if inaccuracies existed when calculating the base flood elevation against the topographic data, according to mapping contractors. The FBS reduces the chance of such errors taking place, which enhances the public credibility of flood maps, according to mapping contractors. All studies contracted since 2006 must comply with the FBS. In FEMA's 2006 Mid-Course Adjustment to the Map Modernization program, the agency set a goal that 75 percent of stream miles reflected on FEMA's issued maps were to be compliant with FBS by the end of Map Modernization. [29]FEMA's last quarterly report of fiscal year 2009 indicated that FEMA had met this goal; according to the report, flood maps have reached approximately 89 percent stream mile compliance with the FBS nationally.

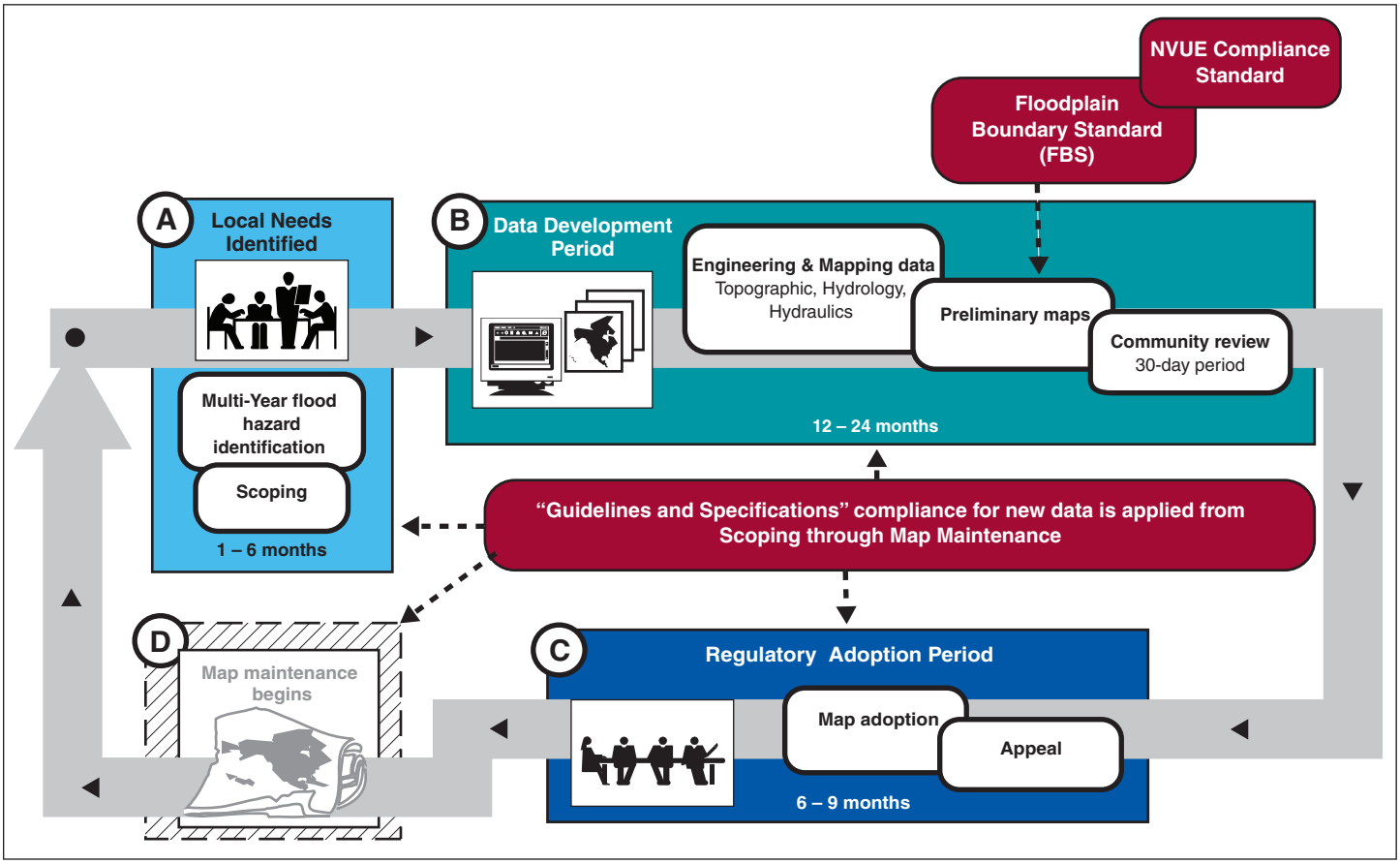
- *New, Validated, or Updated Engineering* (NVUE) standard—FEMA also developed a standard called the New, Validated, or Updated Engineering (NVUE) standard to provide a basis for assessing the engineering analysis used to develop flood elevations. FEMA developed the standard to help mapping partners determine where new study data should be collected, where updates to existing flood hazard data

[29] The total number of stream miles includes approximately 4.2 million miles of channels (waterways and rivers) and 600,000 miles of coastline shorelines (open ocean, lakes, and ponds) in the United States, according to the National Research Council, Committee on Floodplain Mapping Technologies.

should be performed, and whether previously developed flood study data could still be considered valid. FEMA issued draft guidance for validating existing data in April 2007. FEMA intends to use the NVUE data quality standard in implementing its Coordinated Needs Management System. According to officials, the Coordinated Needs Management System is an assessment tool to determine mapping needs and a means for making funding allocation decisions. FEMA officials stated that the Coordinated Needs Management System is to provide FEMA with a national assessment of data needs. However, the system is under development and is projected to be implemented nationwide in 2011. According to FEMA officials, the Coordinated Needs Management System is to track information including the flood zone designation, risk assigned, study type, and the date the analysis was completed or validated. FEMA believes that this approach will provide better detail regarding the precision of a flood hazard analysis for end users that they can understand, and will be applied in a risk-based manner.

To monitor the quality of the process used throughout development of flood maps in accordance with the standards in the Guidelines and Specifications, FEMA established the Mapping Information Platform (MIP) information system. The MIP provides mapping partners the tools and technology to create, validate, store, track and update flood data according to FEMA's standards using the MIP's map production processes. FEMA also developed quality assurance management plans and processes to work with local communities and flood mapping partners. FEMA's quality management plans identify quality assurance steps that are to occur during the creation, review, and editing of flood hazard study. On December 1, 2008, FEMA issued revised guidance for seven quality control reviews to be performed during the flood map production process. Figure 4 below provides an overview of FEMA's three data quality standards and the quality assurance process in the context of the steps in the mapping process.

Figure 4: FEMA's Map Process Steps and Map Accuracy Standards



Sources: GAO analysis of FEMA data.

In addition, FEMA established a quality assurance management system under both their Map Modernization and *Risk MAP* efforts to ensure that mapping products and processes comply with FEMA's specified requirements. Included in FEMA's quality assurance system are audits of the mapping process by Independent Verification and Validation (IV&V) audits. The IV&V contractor is to independently provide feedback to FEMA as part of the audit, such as sampling it conducted on the results of mapping projects performed by mapping partners. We previously reported that world-class, private sector corporations successfully employ best practices with quality assurance by using process controls to design

products and by controlling production processes as the production is occurring.[30] FEMA's quality management system and quality assurance process reflects the recognized best practice of reviewing the quality of the map product during the production process.

FEMA Enhanced Its Guidelines for Topographic Data by Establishing Risk-Based Standards

FEMA has recently published a quality standard to set a minimum level of topographic detail for all studies in its Guidelines and Specification. Specifically, it established standards for the level of topographic detail required to ensure that the maps of those areas at the highest risk from flooding have the most accurate topographic data, as suggested by the National Research Council and FEMA's *Risk MAP* strategy. In September 2010, FEMA published Procedural Memorandum 61 to update its *Guidelines and Specifications* requiring mapping partners to align FEMA's topographic data specifications to levels of risk for flooding, as well as account for differing characteristics of elevation that can affect the accuracy and precision of base flood elevations. This procedural memorandum identifies the specifications of elevation accuracy and precision needed based on FEMA's previously-identified risk classes for all 3,146 counties in the United States. As the National Academies of Sciences report stated, the level of detail used in a study should correspond to the area's risk. FEMA officials stated that they will only be starting new studies in areas where there are already existing updated and accurate topographic data or in areas that have sufficient need and risk to necessitate FEMA's funding the acquisition of such data.

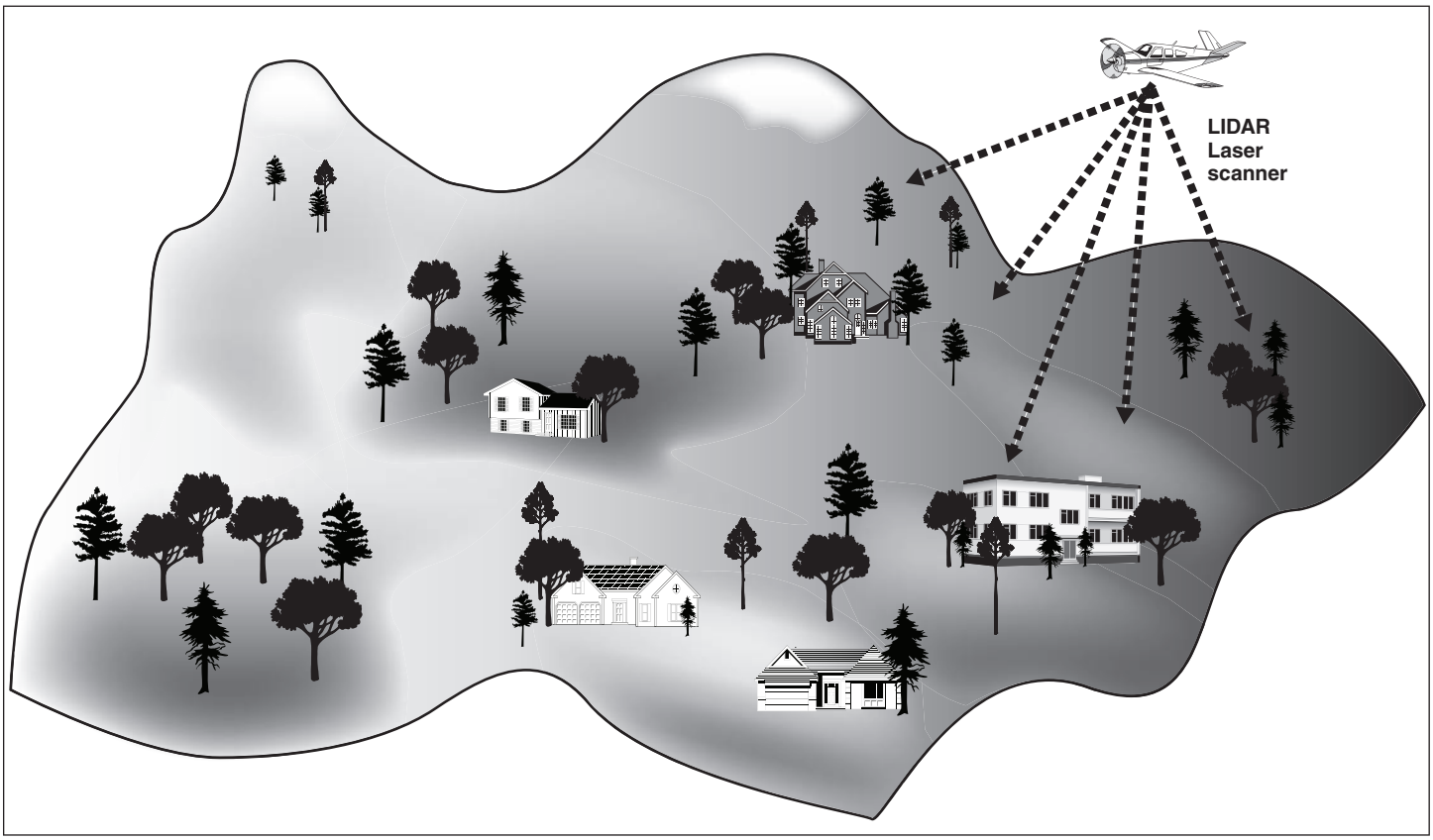
Prior to the issuance of Procedural Memorandum 61 in September 2010, FEMA delineated floodplains using the "best available" existing topographic data for the area being studied. In the absence of data provided by the mapping stakeholder or newly developed for a flood mapping project, a primary source for topographic data was the National Elevation Dataset maintained by the U.S. Geological Survey (USGS),[31] which is over 35 years old on average. FEMA's existing standards for new topographic data required data that is about 10 times more accurate than USGS topographic data and required topographic data acquired or

[30] GAO, *Best Practices: Commercial Quality Assurance Practices Offer Improvements for DOD*, NSIAD-96-162 (Washington, D.C.: Aug. 26, 1996).

[31] The National Elevation Dataset is the primary elevation data product of the U.S. Geological Service that contains the best available elevation data of the United States. According to the Service, the data set is updated on a two month cycle to integrate any newly available, improved elevation source data that are processed to a common coordinate system and unit of vertical measure.

reviewed within the last 7 years to account for changes such as human development. FEMA plans to work with local officials to determine whether the existing data held by the locality or another source (such as the USGS), meets new the new standards, or to develop new data through means such as Light Detection and Ranging (LIDAR). As illustrated in figure 5 below and as we reported in 2004, FEMA has promoted the use of LIDAR remote sensing technologies to generate highly accurate, digital elevation data. The illustration shows an airplane equipped with laser-pulsing sensors using LIDAR to gather digital elevation data to measure the contours and crevices that determine where floodwaters collect. Elevation data are a key component needed to determine flood risk and identify floodplain boundaries. According to FEMA, for very flat areas where small changes in elevation can have a large impact on where flood plain boundaries are drawn, LIDAR can provide the level of detail needed to accurately delineate these boundaries. Communities can also use detailed, digital elevation data for planning and land development purposes. FEMA expects that LIDAR will be the primary technology used to acquire new digital elevation data for *Risk MAP*.

Figure 5: Light Detection and Ranging Technology Used to Generate Digital Elevation Data



Source: GAO analysis of FEMA data and Art Explosion clipart.

In a study commissioned by FEMA and issued in 2009, the National Academies of Sciences compared the effect of using USGS data versus LIDAR data at three geographic locations using the same hydrologic and hydraulic models. For each area studied, the two different sources of topographic data resulted in different BFEs and floodplain boundary locations. The report concluded that the quality of topographic data is the most important factor in determining water surface elevations, base flood elevations, and the extent of flooding and, thus, the accuracy of flood maps for riverine areas, which account for approximately 95 percent of FEMA's flood maps. FEMA officials agreed that accurate data are essential and that even the best models cannot produce an accurate flood map with inaccurate inputs, but they said there is a point of diminishing returns where the cost of developing highly accurate topographic data outweighs its overall benefit.

Prior to fiscal year 2010, FEMA did not generally provide funding for mapping partners to acquire new topographic data in an effort to conserve resources and share responsibilities, according to FEMA officials.[32] Historically, studies at all risk levels could have used the USGS National Elevation Dataset as the best available data, if obtaining better quality data was unaffordable, according to FEMA officials. Officials from the Association of State Floodplain Managers agreed with this characterization of historical mapping efforts and said that cost constraints limit local governments and mapping partners' ability to collect extensive data, a situation that has resulted, in some cases, in poor map quality. FEMA officials acknowledged that affordability issues have been the main reason high risk areas may rely on USGS data for their study. To address this issue, FEMA officials said they planned to provide $80 million in funding in fiscal years 2010 through 2013 to acquire new topographic data.

FEMA's Existing Data Quality Standards Could Be Better Implemented to Match Mapping Data Precision with the Level of Flood Risk

FEMA's Floodplain Boundary Standard (FBS) reporting does not reflect the quality of topographic data or level of study detail, and according to FEMA officials, 1 of the 3 elements of the standard for New, Validated, and Updated Engineering (NVUE) data has not been fully implemented.

The Floodplain Boundary Standard Could More Effectively Measure Map Accuracy

The accuracy of a map's floodplain boundary, in applying the FBS for an area, is dependent on two factors—the quality of topographic data and the level of detail used for a flood study. However, the method FEMA uses in measuring FBS compliance does not account for these factors when reporting FBS compliance rates for counties. Thus, two maps using topographical data of widely varying accuracy and currency, and based on studies of different levels of detail, can both be considered FBS compliant as long as the base flood elevation and floodplain boundaries are consistent with the topographic data used in each study. Consequently, FBS compliance rates across counties do not provide a means for FEMA management to compare the relative accuracy of maps. According to

[32] The limited circumstances under which FEMA would historically provide funding for topographic data are detailed in FEMA's Geospatial Data Coordination Implementation Guide (v2.2), (March 2008) p. 68. Generally, FEMA only provides funding when existing elevation data are inadequate, i.e., do not meet the minimum accuracy required in FEMA flood mapping standards.

FEMA, the FBS was created to address problems that arose when existing paper map floodplain boundaries were transferred to digital format; the purpose was to ensure that mapping partners checked or revised preliminary maps to confirm they were consistent with available topographic data, not to compare map accuracy. The FBS, which is designed to help ensure the accuracy of floodplain delineations, is an important FEMA measure of the quality of flood maps. This is because individuals living within the floodplain boundary are considered to be in a Special Flood Hazard Area and are thereby required to purchase flood insurance while those outside of the boundary are exempt from this requirement.[33]

Stakeholders involved with the four mapping projects we contacted said that the quality of FBS as a measure of accuracy is only as good as the quality of the topographic data that measures land elevation. Because FEMA's standard has historically been that the mapping stakeholders should use the best available topographic data, the quality (including precision) of the topographical data used to match up with the floodplain boundary may vary widely depending upon the quality of what is available.

The level of detail used in a flood study determines the requirements necessary for a map to achieve FBS compliance. Detailed studies have compliance standards more stringent than approximate studies that use less accurate, often outdated topographic information and models, according to the National Academies of Sciences report. According to FEMA, the determining factors when deciding whether to perform detailed or approximate studies for communities are the level of flood risk in the area, the likelihood of additional development, and the cost and benefits of performing a detailed study versus an approximate study, as detailed studies are significantly more expensive than approximate studies. Though FEMA advises against it, some communities in the highest risk class have chosen to undergo approximate studies due to fiscal restraints.

Differences in the level of detail used in studies leads to significant variances in how precisely base flood elevations must match the elevation data used to comply with the FBS. The BFEs in detailed studies are required to be much more precise than those in approximate studies, but each are considered to be equally compliant as long as they meet the

[33] Flood insurance purchase is mandatory for all federally backed mortgages for properties in special flood hazard areas.

standards for their respective level of detail. For example, the BFE in detailed studies are required to match the topographic data within 1 foot, while BFEs in approximate studies can differ from the topographic data used by up to 20 feet and be considered compliant with FBS.[34] For the purpose of reporting whether FEMA has met its goal for the percentage of maps that are FBS compliant, a compliant detailed study counts equally with a compliant approximate study, with no consideration for the differing requirements necessary to achieve this compliance.

In 2003, we identified linkage and clarity of measures as two key attributes of successful performance measures.[35] Establishing separate measures of compliance for detailed and approximate studies could allow FEMA to better use FBS compliance rates as a measure of map accuracy; however, the data necessary to accomplish this are presently not maintained by the agency. FEMA officials said that these data were not tracked at a national level because the significant increase in mapping activities associated with Map Modernization focused agency efforts on map production rather than data collection and analysis. FEMA officials acknowledged that the agency lacked a way to systematically track, at a national level, the types of topographic data or level of project detail used in each study, which limited their ability to effectively and comprehensively describe the accuracy of flood maps. Officials also stated that they did not consider the need to use data on FBS compliance rates for management decisions on map accuracy, as they believe that national reporting of differences in the level of detail used in studies does not provide significant insight into the flood data accuracy or reliability. Nonetheless, we continue to believe that FBS compliance rates reported for detailed and approximate studies within and across counties could provide information that would both enable FEMA management to compare the relative accuracy of maps, and be a more meaningful and understandable measure to FEMA's mapping stakeholders and the general public.

[34] For approximate studies, FEMA may include a BFE, but it not considered a regulatory standard.

[35] See GAO *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, GAO-03-143 (Washington, D.C.: Nov. 22, 2002). GAO reported on nine key attributes of successful performance measures. Linkage is defined as measure that is aligned with division and agencywide goals and mission and clearly communicated throughout the organization. Clarity is defined as a measure that is clearly stated and the name and definition are consistent with the methodology used to calculate it.

While FEMA does not track this information at a national level, topographic data and other information regarding study detail, referred to as metadata, are recorded at the individual mapping project level within the MIP.[36] As part of its Quality Assurance process, FEMA requires mapping partners to submit metadata within the MIP for review. FEMA checks the information to ensure its validity and informs the mapping contractor if there are any problems that may affect map accuracy. FEMA reviews this metadata, but the agency does not retain or store the metadata in a way that enables future analysis across all mapping studies that could support the management of the mapping program. Standards for Internal Control in the Federal Government provides that agencies should identify, capture and distribute pertinent information in order to effectively carry out the agencies' duties.[37] While there is a cost associated with retaining and analyzing metadata, FEMA could minimize these costs by utilizing its existing technology, the MIP, to retain or store these data in a way that enables future analysis across all mapping studies. By doing so, FEMA could report additional information on FBS compliance and, thereby, have a potentially better measure of map accuracy. FEMA could then use this data to develop separate measures of FBS compliance for both detailed and approximate flood studies, each of which has a different range of accuracy.

FEMA Could More Fully Implement Its New, Validated, and Updated Engineering Standard

FEMA implemented its NVUE standard in 2007 to provide a basis for flood mapping partners to assess the quality of new, validated, or updated engineering data in revising maps, but has not fully developed uniform guidance for the validation of existing data. Validation guidance for mapping partners has existed in draft form since 2007, but it has not yet been used, according to FEMA officials. This guidance consists of a set list of parameters that define whether data used in the past is adequate for current use, or whether the area being studied has changed to an extent that new data is necessary.

FEMA's draft guidance on how to validate data was found to be ineffective due to differing interpretations and methodologies used by various mapping contractors, according to FEMA officials and FEMA contractors who oversaw NVUE data collection and internal controls during the Map

[36] Metadata is a concept that applies mainly to electronically archived data and is used to describe the definition, structure, and administration of data files with all contents in context to ease the use of the captured and archived data for further use.

[37] GAO/AIMD-00-21.3.1.

Modernization effort. Prior to its being found ineffective, contractors used this guidance, issued in the form of checklists, to determine if enough changes had occurred in the area being studied to render existing study data invalid. However, two regions submitted validation figures to FEMA, each of which used a different methodology to obtain their calculations. According to FEMA, the agency determined that this process was too inconsistent to be acceptable as a data quality standard, so validation of existing data was discontinued until uniform guidance could be developed in 2011, leaving only new and updated data counting as NVUE compliant.

As a result of the mid-course adjustment in 2006, FEMA set a goal of reaching an NVUE compliance rate of 30 percent, meaning 30 percent of the nation's stream miles would be mapped using new or updated engineering analysis by the end of Map Modernization. The goal under *Risk MAP* is to increase NVUE compliance to 80 percent to reflect this phase's heightened focus on ensuring data accuracy. In January 2010, FEMA reported the current rate of national NVUE compliance was 52 percent. Validating existing data could assist FEMA in reaching this compliance goal. According to the NVUE standard, it is necessary to determine the relative accuracy of flood hazard data on a community's maps before a new mapping process begins, therefore, a needs assessment must be conducted to determine whether existing flood hazard information represents current conditions and is deemed valid or current. In an August 2010 report to Congress, the agency acknowledged that its *Risk MAP* strategy relies on validating the currency of a substantial portion of existing flood hazard information. FEMA officials said the development of a final version of this guidance had been a secondary focus as the agency was focusing its Map Modernization program resources on conversion of flood maps to digital format and updating the most significant engineering needs. Now that the initial map modernization program has been completed and FEMA is implementing its *Risk MAP* strategy, complete guidance for mapping stakeholders would be an effective and timely step to further implement its new program.[38] While FEMA believes that a substantial portion of existing flood hazard information is still current in those areas where development has not been significant, establishing uniform guidance for the validation of existing data could help FEMA ensure mapping partners are consistently validating

[38] Federal Emergency Management Agency, *Risk Mapping, Assessment and Planning (Risk MAP): National Digital Elevation Acquisition and Utilization Plan for Floodplain Mapping,* (Washington, D.C.: Aug. 9, 2010.).

data, and thereby help FEMA both track and report the accuracy of maps at the national and regional levels and better assess mapping data needs.

FEMA's Independent Verification and Validation Process Helps Ensure Maps Meet Minimum Requirements, but the Process Could Be Improved to Better Ensure Compliance and Data Reliability

FEMA has developed a quality assurance process to help ensure that mapping efforts are performed in accordance with minimum data quality standards, procedures, and requirements, including independent verification and validation (IV&V) audits of a sample of FEMA's completed mapping projects. However, we identified problems with this process, which could impede FEMA's ability to ensure mapping efforts are performed in accordance with requirements in FEMA's Guidelines & Specifications. The use of verification and validation is a recognized key practice for large and complex system development and acquisition projects. The purpose of the verification and validation function is to provide management with objective insight into the program's processes and associated work products. For example, IV&V audits can help FEMA identify problems related to compliance with data quality standards. However, the number of flood studies selected annually for IV&V is not based on probability sampling that would allow the results of the audits to be generalized to a larger population and used for quality assurance purposes. In addition, FEMA officials said the agency planned to transfer responsibility for the IV&V process to its program management contractor. However, the transfer of the responsibilities could create a potential conflict of interest because the program management contractor will be monitoring the results of its own program management efforts. Finally, the manner in which problems related to compliance with data quality standards has been documented in IV&V audit reports does not facilitate systematic analysis that could further enhance quality management efforts.

IV&V Is Not Based on Probability Sampling

According to the IV&V auditor, its monthly reviews were based on a nonprobability sample of map studies and it did not take steps to ensure that the audit results would be generalizable to the entire population of map studies. Specifically, FEMA officials told us that although the IV&V contractor reported in its April 2010 report[39] that map products are frequently not meeting FEMA's *Guidelines and Specifications*, FEMA regards these as minor issues in the agency's overall quality assurance framework because the IV&V contractor based their conclusions on a small sample of map studies (i.e., a nonprobability sample). The major limitation of nonprobability sampling is that the results cannot be

[39] Apptis, *IV&V Audit Report* (April 2010).

generalized to a larger population, because some members of the population being studied have no chance or an unknown chance of being selected as part of the sample. However, if FEMA's IV&V auditor used probability sampling, FEMA program officials would have been better positioned to know whether the audit issues were isolated events or indicative of more systemic issues in its flood mapping efforts.

We recognize that conducting probability samples of map studies could involve additional costs. However, not conducting IV&V audits on a generalizable sample could also be costly. This is because using a generalizable sample could better position FEMA to identify and resolve systemic issues in flood mapping efforts, which is a critical task in helping to ensure that future efforts are performed in accordance with FEMA's standards and quality assurance management plans. FEMA officials stated that the terms of work for a new IV&V audit contractor had not yet been finalized and that while the officials had not determined whether the benefits outweigh the costs of conducting probability samples, they felt that reviewing the results from probability samples would be beneficial. Implementing probability samples in its IV&V audit process, to the extent that the benefits outweigh the costs, could help FEMA management use the results from its IV&V auditing process more strategically.

Transfer of IV&V Responsibilities to Program Management Contractor Creates Potential Conflict of Interest

Audits of FEMA's mapping contractors' efforts have been conducted since 2006 by an independent verification contractor; however, FEMA officials said they planned to transfer responsibility for the IV&V process to its program management contractor by the end of this year, which will then monitor the FEMA's mapping contractors. The transfer of these responsibilities creates a potential conflict of interest because the program management contractor is to monitor the results of its program management efforts. FEMA officials said they integrated the verification and validation process into its program management contract because the current IV&V contract was expiring and they believed that using FEMA's program management contractor for the product quality management would be the most effective and efficient approach for an integrated quality management program. FEMA officials did not believe the revised approach limited the program management contractor's independence or presented a conflict of interest. FEMA's quality management plan called for independent verification and validation of activities of the Program Manager as well as the mapping contractors. FEMA officials stated that, in situations where program activities of the program management contractor are to audited, FEMA officials would either perform the audit or hire an external auditor. Nevertheless, as we recently reported, the independence of the verification and validation contractor is a key

component of a reliable verification and validation function.[40] According to industry best practices, the verification and validation activity should be independent of the project and report directly to senior management to provide added assurance that reported results on the project's status are unbiased. An effective verification and validation review process should provide an objective assessment to management. The verification and validation reports should identify to senior management the issues or weaknesses that increase the risks associated with the project or portfolio so that they can be promptly addressed. FEMA management has correctly recognized the importance of such a function; however, the performance of the verification and validation function by an entity that is technically, managerially, and financially independent of the organization in charge of what it is assessing could better position FEMA to help ensure the independence of the verification and validation function, both in appearance and in fact.

Documentation of Compliance Problems Does Not Facilitate Analysis

Under FEMA's Independent Verification and Validation audit process, the IV&V auditor is not required to present its findings in a format readily conducive for performance monitoring and data analysis. For example, according to one PTS contractor, FEMA advised its mapping contractors that the IV&V audit findings are informational, rather than actionable; therefore, the contractors are not required to implement or track any changes. However, we found that at least one of the PTS contractors does have a system for addressing corrective action based on the IV&V audit findings—a corrective action process that is documented in the contractor's Quality Management Plan that it provided to FEMA. The corrective action process is used to address deficiencies identified by the IV&V auditor and prevent future occurrences during the mapping process, which are reported to FEMA through a quarterly internal quality audit report.

Standards for Internal Control in the Federal Government states that monitoring should assess the quality of performance over time and ensure that the findings of audits and other reviews are promptly resolved.[41] In addition, we have previously reported that when agencies lacked systematic analysis and reporting of data, it adversely affected their ability

[40] GAO, *Financial Management Systems: DHS Faces Challenges to Successfully Consolidating its Existing Disparate Systems*, GAO-10-210T (Washington, D.C.: Oct. 29, 2009).

[41] GAO, GAO/AIMD-00-21.3.1.

to provide complete information on the results of their operations.[42] We reported that this type of information could be useful to better understand the nature of a problem, to help plan ways to address it, and to assess progress made. In our analysis, we found that FEMA has several opportunities for improving quality outcomes using its current practices. First, FEMA could devise its own systematic data collection framework for the audits. Second, FEMA could provide more guidance to the IV&V auditor on how to present the audit findings. The IV&V auditor reported that FEMA provided no guidance on how to present the results of the monthly audits. FEMA could also require more comprehensive reporting as part of its agreement with the mapping contractors, similar to the internal efforts of the mapping contractor described above. The IV&V auditing process could include all three mapping contractors and relevant Cooperating Technical Partners, and FEMA could provide similar guidelines for reporting metrics. The IV&V audits collectively produce data that could be used to enhance FEMA's quality management if the information is leveraged properly. For example, a database of audit findings that is readily searchable could be used to identify trends, quantity recurring problems, and potentially isolate mapping issues to a specific region or PTS contractor. Therefore, in the absence of systematic data reporting, FEMA's ability to establish a corrective action plan to resolve issues, one of the key requirements of its quality assurance management program, is greatly diminished. FEMA officials stated that they have not required systematic data reporting of IV&V audit results because they viewed the findings as isolated cases to find individual map irregularities to assist regions in improving map accuracy rather than potentially systemic issues. However, FEMA officials agreed with our assessment that a methodical approach to IV&V data collection could allow the agency to better track map quality issues, better analyze the data, and more easily adopt a corrective action plan. These actions could ensure that FEMA adhere to its quality management plan and enhance map quality.

[42] GAO, *Firearms Trafficking: U.S. Efforts to Combat Arms Trafficking to Mexico Face Planning and Coordination Challenges*, GAO-09-709 (Washington, D.C.: June 18, 2009).

FEMA Has Taken Actions to Improve Outreach Efforts but Could Enhance Its Efforts to Improve Awareness and Promote Map Acceptance

FEMA Is Developing Toolkits and a Lessons Learned Library for State and Local Mapping Stakeholders and Intends to Use Social Media Tools to Reach Out to the Public

FEMA has taken steps to increase the accessibility of outreach toolkits and the awareness of outreach practices, through the Internet and internet-based social media tools, to better equip state and local officials with the resources needed to effectively reach out to the public regarding flood mapping. FEMA previously developed and distributed outreach toolkits for state and local officials at the regional level by regional contractors. Under *Risk MAP*, FEMA's program management contractor is developing standardized outreach toolkits for state and local officials, which FEMA plans to provide nationally. FEMA is also developing a Lessons Learned Library and a secure Web site for flood mapping partners. As the outreach toolkits that include standardized information and templates are developed, the site is designed to share resources among FEMA regions and with state and local officials. FEMA officials said that the site also includes information from national and regional conferences that can be used by FEMA Regions and state and local officials to conduct outreach to the public. According to FEMA officials, FEMA Regions will use the secure Web site to upload examples of their key practices and associated materials.

In addition to better equipping state and local officials with the resources needed to effectively reach out to the public, FEMA is also conducting outreach directly to the public. Specifically, while FEMA's regulatory and statutory flood mapping outreach requirements focus on notifying the public about flood mapping through newspaper publications and *Federal Register* notices, FEMA officials said they were considering the use of

social media sites as well.[43] FEMA has been engaging in internet-based social media tools and Web sites nationwide as part of its mission to prepare the nation for disasters. FEMA uses these tools— such as national-level news feeds that provide subscribers with automated updated information and a multimedia site that hosts videos, podcasts, photos and text-based documents— for flood mapping outreach efforts as part of their outreach strategy.

FEMA's *Risk MAP* goals with social media include providing timely and accurate information related to disaster preparedness response and recovery and providing the public with another avenue for insight into the agency's operations. In addition, FEMA's use of social media provides additional outreach and channels for input. According to FEMA, citizens can engage more easily with the emergency management community through social media sites, and increase their role in disaster preparedness, response, and recovery. For example, FEMA has been using Twitter since October 2008 as a means to offer information about the agency's mission, efforts, and perspective. The agency also launched a YouTube page in October 2008 to provide stories about how its programs work in communities nationwide as they prepare for, respond to, and recover from disasters. FEMA believes that these tools could help the agency and its state and local mapping partners to more effectively communicate with communities about flood mapping efforts.

FEMA Does Not Maintain Most Required Public Notification Documentation

In our review of a random sample of files containing documentation of public notification efforts, we found that FEMA does not maintain the required documentation for public notification. Further, FEMA does not have a process in place to ensure that its mapping partners consistently document their actions to notify the public. FEMA is required by law to document certain actions taken to notify the public regarding the status of its flood mapping efforts. FEMA has requirements in place for mapping partners to provide such required documentation, but it does not have a process in place to ensure that mapping partners are meeting these documentation requirements. As a result, FEMA cannot be reasonably assured that it is complying with public notification regulations.

[43] USA.gov introduces Web 2.0 and social media as umbrella terms that define the various activities that integrate technology, social interaction, and content creation. USA.gov cites FEMA as an example of an agency that is using online content and technology to achieve its mission and goals.

FEMA is required to maintain a Flood Elevation Determination Docket (FEDD) file for every local government that is affected by a flood mapping project that results in a change in base flood elevation.[44] The FEDD file provides a record of all matters pertaining to flood elevation determinations, including public notification requirements established by the National Flood Insurance Act of 1968. These FEDD files are required to contain documentation demonstrating that a mapping contractor took the following six public notification actions:

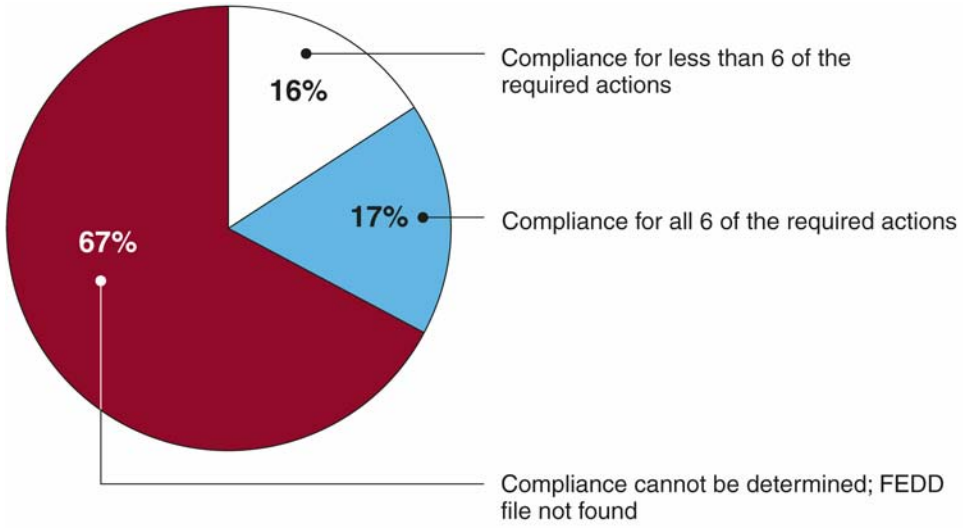
- notifying the community's CEO of the proposed flood elevation determination,
- notifying the public of the proposed flood elevation determination via an initial newspaper publication,
- notifying the public of the proposed flood elevation determination via a 2nd newspaper publication,
- notifying the public of the proposed flood elevation determination via a notice in the *Federal Register*,
- notifying the public of the final flood elevation determination via a notice in the *Federal Register*, and
- notifying the community's CEO of the final flood elevation determination.

Based on our file review of a random sample of counties with flood mapping projects, FEMA did not have a FEDD folder on file for approximately 67 percent of the counties that had completed mapping projects since 2005.[45] We estimate that FEMA complied with some, but not all documentation requirements for 16 percent of the counties, and complied with all 6 documentation requirements for the remaining 17 percent, as illustrated in figure 6 below. Because FEMA does not sufficiently maintain documentation of its public notification activities, the FEDD files do not provide a means for the agency to provide reasonable assurance that it is complying with public notification regulations. As a result, FEMA cannot use the FEDD files to determine the extent to which a community was notified about new mapping projects in accordance with the six public notification actions.

[44] 44 C.F.R. § 67.3.

[45] The maximum margin of error for estimates of percentages from our sample counties is plus or minus 9 percentage points at the 95 percent level of statistical confidence.

Figure 6: Estimated Compliance Rates with FEMA Documentation Regulations: Counties Having Flood Mapping Projects Since 2005 That Resulted in a Change in Base Flood Elevation



Source: GAO analysis of FEMA data.

FEMA officials said that they rely on mapping partners to document completion of public notification requirements in FEDD files and FEMA provides mapping partners with background on public notification documentation requirements. FEMA also directs mapping partners to document compliance with notification requirements in FEMA's Document Control Procedures Manual. In reviewing FEMA's manual, we determined that if mapping contractors followed the guidance in the manual, they should be able to comply with public notification documentation requirements. FEMA's manual provides details on the procedures to be followed and the documents to be used for each NFIP map action including FEMA-initiated, FEMA-contracted, and community-initiated map studies and revisions.

FEMA relies on mapping partners to comply with these requirements, but the agency does not have a process in place to ensure that these mapping partners consistently document their actions to notify the public. FEMA regulations require that public notification documentation reside in FEDD files, which we observed as part of our file review, as shown in figure 7 below.

Figure 7: GAO Analyst Examining Files at FEMA's Engineering Library

Source: GAO.

FEMA's contractor oversees its Engineering Library, where the hard copy FEDD files are maintained. FEMA officials said that the agency is aware that its mapping partners are not complying with public notification documentation requirements and is drafting a procedural memorandum that reiterates the processes that mapping partners are to comply with to ensure that all documentation from completed studies are sent to FEMA in a timely manner.

Standards for Internal Control in the Federal Government states that controls should generally be designed to assure that ongoing monitoring occurs in the course of normal operations. This may include regular management and supervisory activities, comparisons, reconciliations, and other actions to ensure compliance with applicable laws and regulations. FEMA established its Mapping Information Platform (MIP) to manage the mapping production process, and the system includes data fields for each of the public notification requirements, but the agency does not use the information in the MIP to document compliance. Mapping partners have used the MIP to document four of the six public notification requirements

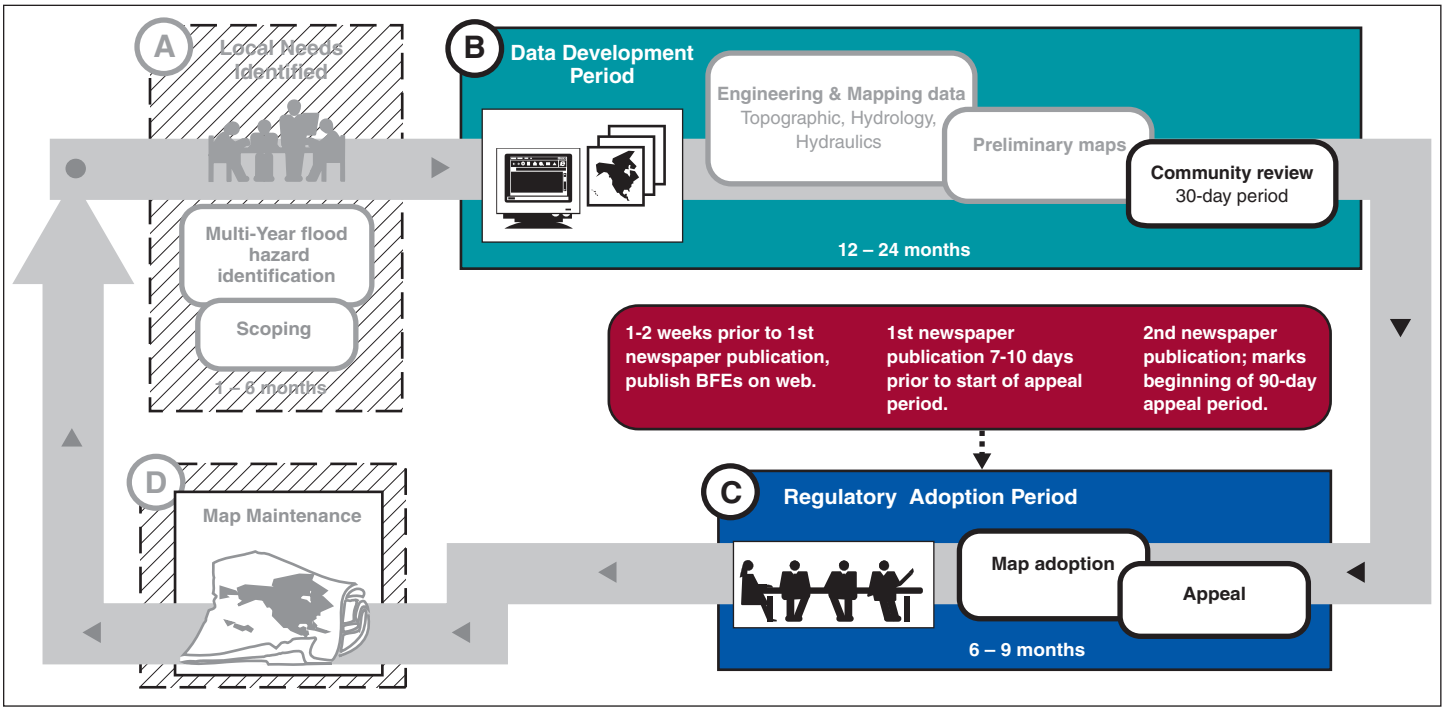
(related to publications in the local newspaper for preliminary maps and the *Federal Register* for preliminary and final maps). However FEMA management does not have access to the two data fields in the MIP related to requirements to notify the community's CEO of the proposed flood elevation determination and of the final flood elevation determination. FEMA officials said that these two fields could be made accessible so that all six public notification requirements could be documented by mapping partners in the MIP. FEMA officials said that they do not use the MIP to document compliance with public notification requirements because the FEDD folder is the official record maintained for that purpose. A mechanism to monitor compliance with public notification documentation regulations and statutes could help FEMA obtain reasonable assurance that its contractors are complying with documentation requirements, which can help FEMA ensure that the public is being notified as required.

FEMA Could Better Assess the Effectiveness of Its Outreach Efforts

FEMA is collecting some data on the quantity and nature of appeals to the mapping studies, but the agency is not capturing data on all appeals and protests in a manner that could be used to inform its decisions about where to focus outreach efforts. Before flood maps that result in a change in base flood elevation become effective, regulations require that FEMA hold a 90-day appeals period.[46] Appeals and protests can be submitted by state and local officials or by individual members of the public. Appeals challenge the proposed base flood elevation based on technical or scientific inaccuracy, while all other challenges to the flood maps are treated as protests. State and local officials are responsible for collecting and reviewing all individual appeals and protests and forwarding them to FEMA. An official may also submit an appeal on behalf of the local government itself. Figure 8 below provides an overview of the flood mapping process and where the appeals period occurs in the process.

[46] 44 C.F.R. § 67.5.

Figure 8: Overview of Outreach Steps in the Flood Mapping Process



Sources: GAO analysis of FEMA data and Art Explosion clipart.

FEMA divides appeals into two groups—eligible and ineligible. FEMA defines eligible appeals as appeals from communities or individuals which are based on knowledge or information indicating that the elevations proposed by FEMA are scientifically or technically inaccurate and that contain supporting documentation. To qualify as eligible appeals, requests must also be submitted to FEMA within the 90-day appeal period. FEMA defines ineligible appeals as appeals that do not meet these requirements—for example, if an appeal is based on something other than the scientific or technical accuracy of the elevations, or does not include supporting documentation.

During our analysis of the MIP, we found that FEMA does not broadly capture information on the appeals and protest that can be used to analyze trends nationally. For example, FEMA does not use the MIP to track ineligible appeals or protests from local communities or individuals, even though these appeals and protests may reflect state and local officials' or the public's disagreement with a flood map. Rather, when FEMA receives

ineligible appeals or protests, it combines the data in the MIP with comments that are received from state and local officials prior to the end of the appeal period. FEMA then labels all of the ineligible appeals, protests, and comments as protests, even though ineligible appeals data could serve as an indicator of the public's acceptance of, or resistance to, flood maps. FEMA officials stated that they do not comprehensively collect and analyze data on appeals and protests, as FEMA uses information in the MIP for project-by-project supervision of flood map studies, rather than as a strategic management tool to analyze trends. Also, FEMA has not yet considered the costs and benefits of such analyses. We have previously reported that in order to monitor progress, performance data should be gathered to determine how well performance goals are being achieved.[47] While we recognize there is a cost associated with collecting and analyzing all data on appeals and protests, should FEMA determine that the benefits outweigh the costs, taking such action could help FEMA evaluate the extent to which public acceptance is being achieved and better target outreach activities to more resistant communities.

In addition, FEMA has not established guidance for how to collect and review appeals and protests, nor has it established guidance on how to report appeals and protests data in the MIP. Instead, flood community officials are directed to collect the appeals and protest data, review them, and decide which ones to submit to FEMA. Once FEMA receives the appeals and protests, it reviews them to determine whether they are eligible. If any issues arise or if additional supporting data is needed, FEMA will work with community officials, mapping contractors, or other mapping partners to acquire it. FEMA resolves appeals using the documentation originally submitted or it will consider additional data or supporting information if supplied generally within 30 days.

However, in the absence of guidance on a standardized process, state and local officials may collect and review appeals and protests in different manners from one another, or from FEMA, and FEMA officials stated that they do not know what process any one contractor used to make its decisions about which appeals and protests to refer to FEMA. For example, in the case of Hillsborough County, Florida, county officials stated that they received over 1,000 appeals and protests. The county hired

[47] GAO, 2010 *Census: Cost and Design Issues Need to Be Addressed Soon*, GAO-04-37 (Washington, D.C.: Jan. 15, 2004).

a contractor to review the appeals and protests the county received; the contractor consolidated them into approximately 400 appeals and protests, and responded to the remainder at the local level, according to the contractor. After the contractor's review and recommendation, the county submitted approximately 150 appeals and protests to FEMA for review and disposition. FEMA officials then aggregated these appeals and protests to input into the MIP, according to FEMA officials. MIP records indicate that Hillsborough County, Florida, has 60 appeals and protests from this study. Thus, more than 1,000 appeals and protests were condensed to a fraction of that total, and FEMA has no way of knowing what criteria its contractor used when making decisions about which appeals and protests it submitted to FEMA. FEMA officials acknowledged that they have not established a standardized process for contractors on how to enter appeals and protest data.

In 2009, FEMA identified appeals and disputes arising from the study and mapping process as a concern of mapping partners, and requested the Association of State Floodplain Managers to review FEMA's mapping processes to identify ways of improving the quality and effectiveness of FEMA's communications with state and local officials prior to and during the floodplain study and mapping process. This study is still ongoing and is expected to be completed by the end of year 2010.[48] *Standards for Internal Control in the Federal Government* provides that agencies to establish policies and procedures, techniques and mechanisms to enforce management's directives. Providing guidance to standardize the process mapping partners use to make decisions about which appeals and protests to submit to FEMA could help the agency better ensure it has complete information on appeals and protests in each community.

[48] In addition to contracting with ASFPM to review appeals process, FEMA officials said that, beginning in November 2010, they planned to implement an additional process for appeals resolution. Specifically, FEMA has created an independent Scientific Resolution Panel that can be convened when deemed necessary by FEMA or by a joint agreement between FEMA and an appellant. The Scientific Resolution Panel is to review and resolve conflicting data related to proposed BFEs as provided for in the National Flood Insurance Act, as amended.

FEMA Has Not Identified Performance Goals or Developed Measures to Evaluate Its Efforts to Increase Public Acceptance of Flood Maps

FEMA has not identified performance goals for public acceptance of flood maps and has not developed measures to evaluate the extent to which it would achieve these goals. FEMA's Risk MAP National Outreach Strategy includes objectives for achieving 5 percent increases in the publics' and local officials' awareness and understanding of flood risk and future vulnerability to flooding by fiscal year 2011. However, this strategy does not include a performance goal and performance measures for the public's acceptance of flood maps. While we recognize that developing measures to gauge public acceptance of flood maps is not easy, it is possible to develop indicators of public resistance to flood maps. For example, the volume of appeals and protests of a particular mapping study could be an indicator of public resistance to flood maps. Thus, FEMA could develop a performance goal related to increasing public acceptance of flood maps and could use ineligible appeals as an indicator of the public's resistance of flood maps, which could serve as a performance measure for this goal. For example, assuming that a certain percentage of individuals will be opposed to a map if it requires them to purchase flood insurance, FEMA could determine an expected rate of ineligible appeals and use this as a baseline measure.

Our past work on the experience of leading organizations has demonstrated that the principles of establishing measurable goals and related measures, developing strategies for achieving results, and identifying the resources that will be required to achieve the goals are the basic underpinning for performance-based management—a means to strengthen program performance.[49] FEMA officials stated that they have considered developing performance goals and measures related to public acceptance of maps, but have not taken any action to date. According to FEMA officials, the agency does not currently collect information on outreach activities because it is not within the scope of the Risk MAP Quality Assurance Management Plan. While this plan identifies quality standards and metrics for outreach as potential future scope, it does not identify in what years such outreach metrics are to be addressed. Developing performance goals and measures for public acceptance of

[49] For example, see GAO, *Managing for Results: Enhancing Agency Use of Performance Information for Management Decision Making*, GAO-05-927 (Washington, D.C.: Sept. 9, 2005); GAO, *Program Evaluation: Studies Helped Agencies Measure or Explain Program Performance*, GAO/GGD-00-204 (Washington, D.C.: Sept. 29, 2000); GAO, *Agency Performance Plans: Examples of Practices That Can Improve Usefulness to Decisionmakers*, GAO/GGD/AIMD-99-69 (Washington, D.C.: Feb. 26, 1999); and GAO, *Managing for Results: Strengthening Regulatory Agencies' Performance Management Practices*, GAO/GGD-00-10 (Washington, D.C.: Oct. 28, 1999).

flood maps could help FEMA better determine whether its outreach efforts are achieving their intended results.

FEMA Has Not Determined What Resources Are Needed for Outreach and Has Not Established Risk-Based Mapping Priorities for Outreach Activities

FEMA has not determined the financial or human resources that are necessary to conduct flood mapping outreach efforts. FEMA officials, and the state and local officials we spoke with in all four mapping project we reviewed said that they devote most of their resources to map production. As a result, outreach activities that could lead to increased map acceptance may be under-resourced because map accuracy is a higher priority for FEMA and its mapping partners. For example, FEMA does not have a line-item in its budget for flood mapping outreach, and agency officials said that outreach staffing costs are paid out of general NFIP funds, and are not individually tracked. In addition, FEMA is unable to analyze outreach spending within the CTP program as a whole. However, while FEMA is able to track total state and local contributions under their CTP contracts,[50] FEMA is unable to specifically track the amount of funding going toward outreach versus other mapping activities, according to FEMA officials.

FEMA's *Risk MAP* strategy states as one of its goals to improve the utilization of resources, but the agency cannot determine this if it does not track the resources it is devoting to its various activities. Furthermore, a key purpose of the Government Performance and Results Act[51] is to create closer and clearer links between the process of allocating scarce resources and the expected results to be achieved with those resources.[52] FEMA officials stated that annual budgeting for its flood mapping activities is allocated across FEMA regions based on the regions' level of mapping activities and by FEMA's risk based strategy, and it is up to each region to identify the outreach personnel and resources needed within their regional mapping budgets. However, FEMA officials could not provide us with budget or expenditure information on outreach activities at FEMA regions

[50] According to the CTP program guidance, if a CTP has agreed to perform outreach activities, FEMA may match funds from CTPs for outreach activities up to 10 percent.

[51] Pub. L. No. 103-62, 107 Stat. 285 (1993).

[52] GAO, *Performance Budgeting: OMB's Performance Rating Tool Presents Opportunities and Challenges For Evaluating Program Performance*, GAO-04-550T (Washington, D.C.: Mar. 11, 2004).

because FEMA has not established a reporting structure with which the regions can provide that information to it.

In addition, while FEMA has developed its *Risk MAP* outreach strategy, it has not developed a risk-based approach for conducting outreach activities for flood mapping that could enable it to target resources effectively. In 2004, as part of Map Modernization, FEMA established risk-based mapping priorities by ranking all 3,146 counties from highest to lowest for risk of flooding based on a number of factors, including population, growth trends, housing units, flood insurance policies and claims, repetitive loss properties, and flood disasters. FEMA has not incorporated these risk-based priorities into its *Risk MAP* outreach strategy. FEMA officials stated that risk class is considered in an effort to anticipate possible outreach needs on a case-by-case basis. According to FEMA officials, certain issues will trigger a greater emphasis on outreach efforts. For example, as result of an increased focus on protection provided by levees since 2005, some communities—historically protected by levees—are now considered to be Special Flood Hazard Areas and subject to mandatory purchase of flood insurance.[53] While FEMA's approach considers these issues on a case-by-case basis, its response to events is reactive to these events and does not enable FEMA to systematically plan and budget its resources more efficiently and effectively. We reported in December 2005, that risk management is a widely endorsed strategy for helping policymakers make decisions about allocating finite resources.[54] By providing a reporting structure for regions to identify and justify their outreach resource needs, FEMA could better plan for and report on specific outreach activities for flood mapping on a regional or national level. Likewise, by using risk in its decisions regarding the allocation of outreach resources—for example, by considering the number of high risk counties or the number of mapping projects under way in a particular region—FEMA could ensure that its resources for flood mapping outreach efforts are allocated in the most effective manner.

[53] In 2011, we plan to respond to a congressional mandate to review FEMA's management of national levee systems.

[54] GAO, *Risk Management: Further Refinements Needed to Assess Risks and Prioritize Protective Measures at Ports and Other Critical Infrastructure*, GAO-06-91 (Washington, D.C.: Dec. 15, 2006).

FEMA Does Not Leverage FloodSmart Marketing Resources to Enhance Its Outreach Efforts

FEMA does not leverage its existing resources by using NFIP FloodSmart marketing resources to enhance its flood mapping outreach efforts. FEMA has three divisions in its Mitigation Directorate that share roles and responsibilities in conducting outreach: the Risk Analysis Division, the Risk Insurance Division, and the Risk Reduction Division. The Risk Insurance Division is responsible for a marketing effort called FloodSmart. According to FEMA, FloodSmart is a national integrated marketing campaign that utilizes mail, television, internet, and print media as marketing tools to promote the purchase of flood insurance policies.

One mechanism FloodSmart uses to help market flood insurance is through direct mail to the public. According to FEMA officials, to support insurance agents in talking to their clients about flood insurance, FloodSmart provides insurance agents access to a Mail-On-Demand program through a Web site. The Mail-On-Demand program includes a direct mail template that informs property owners about proposed map changes in their community and how those changes may affect their flood insurance needs. The Mail-On-Demand program allows insurance agents to access a list of potential flood insurance purchasers. In addition, this Web site contains a schedule that shows the preliminary date, appeals dates, Letter of Final Determination date, and effective dates for communities undergoing a mapping study.

FEMA FloodSmart officials said they also had developed two "toolkits" of media materials that FloodSmart employees may provide to state and local officials, insurance agents, and other stakeholders. One of the toolkits is designed to provide information on the mapping process, and the second toolkit provides information on levee safety and certification and the effect of levees on FEMA flood maps. FEMA Floodsmart officials said these media kits include general templates of informational materials that can be customized for specific areas and used to communicate the importance of flood insurance surrounding map and levee changes to communities where the flood risk designation has changed as a result of an assessment or flood mapping efforts. According to FEMA officials, they created the map change toolkit materials in partnership with Hillsborough County, Florida, and the levee toolkit was developed in conjunction with the Sacramento Flood Control Agency. They said they share the toolkits at industry and stakeholder conferences, mail them out in response to specific requests, and post the materials on FloodSmart.gov. FEMA's FloodSmart marketing efforts are initiated at the request of a FEMA region. FloodSmart team members said that, in those instances, they typically do not send out direct mailers regarding the importance of flood insurance until right before maps become effective. FEMA officials stated

that the *Risk MAP* program's outreach strategy is promoting greater coordination and regular meetings between FEMA's FloodSmart team, flood mapping staff, and FEMA staff responsible for floodplain management.

FloodSmart marketing efforts could be used by FEMA in the process to help promote community awareness, education, and acceptance of flood maps. We have previously reported that collaborative efforts are enhanced when agencies identify and address needs by leveraging resources to support a common outcome.[55] In this case, FEMA's Risk Analysis Division and its Risk Insurance Division could enhance their collaboration by applying this practice. Given that FloodSmart already has efforts under way to help to educate the public on the potential flood risk in communities and to encourage them to take action, these efforts could be targeted toward educating the public about, and encouraging public acceptance of FEMA's flood mapping efforts. While FEMA officials stated that the *Risk MAP* outreach strategy is promoting greater coordination with FEMA's FloodSmart team, FEMA could enhance its flood mapping outreach efforts by leveraging FloodSmart's marketing resources and expertise to increase public acceptance of flood maps.

Conclusions

The results of the flood mapping process on individual property owners subject to resulting flood insurance requirements can be significant. To effectively implement FEMA's 5-year *Risk MAP* program goal of improving the accuracy of flood maps, FEMA will need to continue to improve its data standards and its management processes. Since federal law requires FEMA to assess the need to revise and update the nation's flood maps at least every 5 years, determining how best to use mapping resources will be crucial. Establishing separate measures of compliance for detailed and approximate studies could allow FEMA to better use FBS compliance rates as a measure of map accuracy; however, the data necessary to accomplish this are presently not maintained by the agency. By retaining and analyzing metadata, FEMA could report additional information on FBS compliance and, thereby, have a potentially better measure of map accuracy. Further, FEMA's NVUE standard provides a basis for flood mapping partners to assess the quality of new, validated, or updated engineering data in revising maps; however, establishing uniform guidance

[55] GAO, *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: Oct. 21, 2005).

for the validation of existing data could help FEMA ensure mapping partners are consistently validating data. This step could help FEMA both track and report the accuracy of maps at the national and regional levels and better assess mapping data needs. In addition, FEMA's IV&V process helps ensure that mapping efforts are performed in accordance with minimum data quality standards, procedures, and requirements. However, implementing probability sampling during the IV&V auditing process, to the extent that the benefits outweigh the costs, would ensure that the results are generalizable and could help FEMA management use the information more strategically. Likewise, to maintain the independence, both in appearance and fact, of FEMA's verification and validation function, this auditing function should be performed by an entity that is technically, managerially, and financially independent of the organization in charge of what is being assessed. And finally, in the absence of systematic data reporting, FEMA's ability to establish a corrective action plan to resolve issues identified through the IV&V process, one of the key requirements of its quality assurance management program, is greatly diminished.

Regarding outreach, FEMA has taken positive actions regarding its innovative use of new media to enhance its outreach efforts. However, there are areas in which FEMA could enhance its outreach efforts. For example, without a mechanism to monitor mapping contractors' compliance with public notification documentation requirements, FEMA is limited in its ability to provide reasonable assurance that the agency is notifying the public as required. Opportunities also exist for FEMA to better utilize data on community appeals and protests to inform its decisions about where to focus outreach efforts, and provide guidance to standardize the process by which mapping partners analyze appeals and protests data to the extent that the benefits outweigh the costs. Moreover, without specific performance goals and measures to assess the effectiveness of outreach efforts related to flood mapping, it may be difficult for FEMA to determine whether its outreach efforts are achieving their intended results. Further, by providing a reporting structure for regions to identify and justify their outreach resource needs, FEMA could better plan for and report on specific outreach activities for flood mapping on a regional or national level. Likewise, by using risk in its decisions regarding the allocation of outreach resources—for example, by considering the number of high risk counties or the number of mapping projects under way in a particular region—FEMA could ensure that its resources for flood mapping outreach efforts are allocated in the most effective manner. Finally, FEMA has the opportunity to leverage existing

resources by broadening the scope of the FloodSmart program that supports the NFIP to help promote public acceptance of flood maps.

Recommendations for Executive Action

We are making 11 overall recommendations.

To address challenges in ensuring the accuracy of flood maps, we recommend that the Administrator of the Federal Emergency Management Agency:

- establish separate measures and collect data needed to assess compliance with the Floodplain Boundary Standard for detailed and approximate flood studies, and
- establish uniform guidance for the validation of existing engineering data to help FEMA fully implement the NVUE standard and provide a basis for mapping partners to validate flood hazard data.

To enhance the independent verification and validation (IV&V) audit process, we recommend the Administrator of the Federal Emergency Management Agency:

- implement probability sampling during the IV&V audit process to the extent that the benefits outweigh the costs, to ensure that the results are generalizable for decisionmaking; and
- transfer IV&V duties back to an independent entity to help ensure impartiality; and
- adopt a systematic approach to IV&V data collection, so FEMA can better track map quality issues, more easily analyze the data, and adopt a corrective action plan.

To address challenges in improving community outreach, we recommend that the Administrator of the Federal Emergency Management Agency:

- establish a mechanism to better ensure compliance with the documentation requirements of public notification regulations;
- collect and analyze data on appeals and protests, including those on ineligible appeals, to the extent that the benefits outweigh the costs;
- issue guidance to mapping stakeholders to standardize the process for analyzing appeals and protests and submitting this data to FEMA;
- establish performance goals and measures for promoting public acceptance of flood maps;
- develop a reporting structure for regions to use to identify resources needed to conduct flood mapping outreach activities, and implement a risk-based approach to allocate outreach resources; and

- leverage, as appropriate, existing FloodSmart marketing resources and expertise to help increase public acceptance of flood maps.

Agency Comments and Our Evaluation

We provided a draft of this report to DHS for review and comment. DHS provided written comments, which are reprinted in appendix IV. DHS also provided us with technical comments, which we considered and incorporated as appropriate. We also provided a draft of this report to the U.S. Army Corps of Engineers, but it did not provide written comments on the report. However, in an email on November 3, 2010, the Corps of Engineers liaison indicated that the Corps had no comments on the report.

In commenting on the draft report, DHS stated that it concurred with 10 of the 11 recommendations. For the recommendations for which DHS concurred, the agency identified actions taken or plans to implement them. Specifically, FEMA agreed with our recommendation to establish tracking and reporting that will allow FEMA to report the level of precision by flood source. FEMA plans to implement this tracking as part of the Coordinated Needs Management System that will be fully implemented this fiscal year. FEMA agreed with our recommendation and will finalize and issue uniform guidance for the validation of existing engineering data under its New, Validated, or Updated Engineering (NVUE) standard in this fiscal year. FEMA also agreed to assess the additional costs and expected benefits to expand the scope of the IV&V, and to implement probability sampling and will work with the contractor performing audits to redesign the reporting of map quality issues. FEMA stated it will issue guidance to address our recommendations to ensure compliance with the documentation requirements and to standardize the process for submitting appeals and protests data to FEMA in order to improve the collection and analysis of this information. FEMA also stated it will explore potential new measures and look for ways to quantify and track outreach activities that are integrated into map production activities. In addition, FEMA also concurred with our recommendation to leverage existing FloodSmart marketing resources, stating that FEMA's flood mapping program is working with its FloodSmart program as part of the *Risk MAP* program to identify areas where outreach effectiveness can be increased and consistent messages can be delivered. These actions should address our recommendations and help FEMA improve its efforts to ensure flood map accuracy and enhance the agency's outreach efforts in developing and implementing new flood maps.

DHS did not concur with our fourth recommendation that the Administrator of the Federal Emergency Management Agency should

transfer independent verification and validation duties (IV&V) back to an independent entity to help ensure impartiality. The department's response stated that FEMA's Program Manager contractor is technically, managerially, and financially independent of the flood hazard development process and that the contractor is helping FEMA to integrate the program, monitor program performance, and implement a quality management process. FEMA believes that the quality audit function is more effective if it is integrated into the overall quality management process rather than performed externally to the quality management process. However, as we noted in the report, according to industry best practices, the verification and validation activity should be independent of the project and report directly to senior management to provide added assurance that reported results on the project's status are unbiased. As FEMA states, its flood mapping Program Manager contractor is an integral part of FEMA's flood mapping program management, and as such we continue to believe that the program management contractor's programmatic responsibilities and involvement prevent it from having a clearly independent role in validating and verifying the results of flood map production activities, because the contractor has a vested interest in overall program performance. Therefore, we believe that FEMA should transfer independent verification and validation duties back to an independent entity to help ensure impartiality.

We are providing copies of this report to interested congressional committees, the FEMA Administrator, the Secretary of Homeland Security and other interested parties. This report will also be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions concerning this report, please contact me at (202) 512-8757 or by e-mail at jenkinswo@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix V.

William O. Jenkins, Jr.
Director
Homeland Security & Justice Issues

Appendix I: Objective, Scope, and Methodology

This report addresses the following objectives:

- To what extent has FEMA taken actions to enhance the accuracy of flood maps and what challenges, if any, does FEMA face?
- To what extent has FEMA taken actions to help promote community acceptance of flood maps, and what challenges, if any, does FEMA face?

We focused our review on those standards and processes related to flood hazard mapping for rivers and streams (commonly know as "riverine" flooding[1]), as these account for about 95 percent of FEMA's flood maps. As a result, we limited our scope to exclude those standards and processes related to flood hazard mapping for coastal areas and the levee certification. In addition, FEMA has processes to modify and update flood map information during the time that a community's maps are in effect, called a Letter of Map Change, which is also outside the scope of our work.

To evaluate the extent that FEMA has taken actions to ensure data quality standards are consistently met for flood maps updated since 2005 and to what extent has FEMA measured whether implementation of the data quality standards results in accurate flood maps, we analyzed information on FEMA's policies and plans for flood map modernization and data from FEMA's Mapping Information Platform (MIP) and systems for documenting compliance with data quality standards. Specifically, we reviewed documents including FEMA's Risk Mapping, Assessment and Planning (*Risk MAP*) strategy, the Risk Map Multi Year Plan, and Map Modernization *Guidelines and Specifications* for Flood Hazard Mapping Partners and its associate appendices. We assessed FEMA's standards and guidance to criteria developed in recent reports by the National Academies of Sciences and the National Research Council, specifically the Academies' report "Mapping the Zone: Improving Flood Map Accuracy.[2] We discussed the reports' methodologies with the authors and with relevant FEMA officials, and analyzed reviews and critiques of the Academies' reports to determine that they were appropriate for our purposes. We tested the controls on the quality assurance /quality control

[1] Riverine flooding is flooding related to or caused by a river, stream, or tributary overflowing its banks due to excessive rainfall, snowmelt or ice.

[2] National Research Council (U.S.), and United States. 2009. *Mapping the Zone: Improving Flood Map Accuracy.* Washington, D.C.: National Academies Press. http://www.nap.edu/catalog.php?record_id=12573 May 2009.

(QA/QC) process by extracting and reviewing data on all projects initiated and completed for the period of October 2005 (corresponding to FEMA's Mid-Course Adjustment to its Map Modernization Initiative) through 2009. We also reviewed FEMA's Floodplain Boundary Standard (FBS) and New, Validated, or Updated Engineering (NVUE) verification systems that were designed to track implementation of data accuracy requirements. We tested the controls on the FBS and NVUE compliance process by extracting and reviewing data on all projects initiated and completed from fiscal year 2006 (when the FBS was established) through 2009 and compared them against criteria in Standards for Internal Control in the Federal Government.[3] To assess the reliability of these databases, we compared data to FEMA's management reports, interviewed FEMA's three mapping contractors and reviewed the original data generated by these contractors. We determined that the FBS and NVUE compliance data were sufficiently reliable for the purposes of this report. We also compared FEMA's QA/QC process to effective practices we have identified for quality assurance. [4]Finally, we discussed FEMA's mapping process and standards with agency officials, as well as officials from other federal stakeholders including the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the U.S. Army Corps of Engineers; national organizations including the Association of State Floodplain Managers, and National Association of Flood & Stormwater Management Agencies. We also discussed FEMA's mapping process and standards with agency officials, as well as officials from other federal stakeholders in geographic data collection and mapping including the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the U.S. Army Corps of Engineers and the National States Geographic Information Council; subject-matter experts on flood hazards and floodplain management from national organizations including the Association of State Floodplain Managers, and National Association of Flood & Stormwater Management Agencies who are stakeholders to FEMA's mapping initiatives, as well as state and local officials involved in mapping projects we selected in Arizona, Florida, California, and North Carolina (a discussion of the selection process is included below).

[3] GAO, *Standards for Internal Control in the Federal Government*, GAO/AIMD-00-21.3.1 (Washington, D.C.: November 1999).

[4] GAO, *Best Practices: Commercial Quality Assurance Practices Offer Improvements for DOD*, NSIAD-96-162 (Washington, D.C.: Aug. 26, 1996.).

To assess the extent to which FEMA has taken actions to help promote community acceptance, and ensured that regulatory requirements for documenting public notification efforts are consistently met for flood maps updated since 2005 we analyzed information on FEMA's policies and plans for community outreach and data from FEMA's Mapping Information Platform and systems for documenting compliance with statutory and regulatory requirements for coordination with state and local officials involved in mapping projects. Specifically, we reviewed FEMA's previous Outreach Strategy for Map Modernization and its new *Risk MAP* National Outreach Strategy, and analyzed the goals and performance measures of FEMA's outreach strategy for Map Modernization, and its new *Risk MAP* national outreach strategy against our prior work reviewing federal agencies' practices for development of national strategies compared it to effective practices we have identified for national strategies,[5] as well as review FEMA's budget and staff allocations related to outreach. To assess FEMA's internal controls and program management of community outreach efforts, we examined several FEMA databases, including the Mapping Information Platform (MIP), discussed above, designed to document state and local mapping stakeholder information. As noted above, we tested the controls on the MIP by extracting and reviewing data on all projects initiated and completed from 2005 through 2009 and assessed the reliability of these databases by checking them against documents, such as FEMA's management reports and Flood Elevation Determination Dockets (FEDD) that are established for each mapping project. We also interviewed FEMA, state, and local officials involved in flood map outreach to obtain their perspectives. For our review of FEMA's compliance with public notification documentation requirements, we examined FEMA's Flood Elevation Determination Dockets (FEDD) that are established for each mapping project, selecting a probability sample of 88 counties from a population of 431 counties that had completed studies since 2005, that resulted in a change in base flood elevation. From this probability sample we reviewed mapping partners' documentation of compliance with six documentation requirements below:

- notifying the community's CEO of the proposed flood elevation determination,

[5] See GAO, *Combating Terrorism: Evaluation of Selected Characteristics in National Strategies Related to Terrorism*, GAO-04-408T (Washington, D.C.: Feb. 3, 2004), and GAO, *Financial Literacy and Education Commission: Further Progress Needed to Ensure an Effective National Strategy*, GAO-07-100 (Washington, D.C.: Dec. 4, 2006).

- notifying the public of the proposed flood elevation determination via an initial newspaper publication,
- notifying the public of the proposed flood elevation determination via a 2nd newspaper publication,
- notifying the public of the proposed flood elevation determination via a notice in the *Federal Register*,
- notifying the public of the final flood elevation determination via a notice in the *Federal Register*, and
- notifying the community's CEO of the final flood elevation determination.

Because we followed a probability procedure based on random selections, our sample is only one of a large number of samples that we might have drawn. Since each sample could have provided different estimates, we express our confidence in the precision of our particular sample's results as a 95 percent confidence interval (e.g., plus or minus 9 percentage points). This is the interval that would contain the actual population value for 95 percent of the samples we could have drawn. Percentage estimates based on our sample of counties have 95 percent confidence intervals no wider than +/- 9 percentage points.

To supplement our analyses of FEMA's flood mapping internal controls and program management activities related to both data accuracy and community outreach, we selected four flood map modernization projects in Arizona, Florida, California, and North Carolina. We selected these locations based on our 2004[6] review to highlight specific challenges associated with the mapping process, such as inclusion of levees, and the impact of varying degrees of community involvement and outreach in the 5 years since our review. Because we selected a nonprobability sample of flood mapping projects, the results of the information collected from these localities cannot be generalized to all mapping projects but provided insights on the challenges experienced by these localities.

We conducted this performance audit from August 2009 through December 2010, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit perform the audit to obtain

[6] GAO-04-417.

sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Key Practices for Effective Communications to the General Public

In our discussion with localities, we identified a number of potential key practices that FEMA, state and local officials, and mapping partners identified as successful. These practices included getting the public involved early-on in the mapping process through task forces, holding open houses for the public to attend, and sending direct mailers to the public. For example, Charlotte-Mecklenburg County, North Carolina, has been recognized by county officials involved with flood mapping outreach and subject matter experts in flood mapping outreach as a leader in effectively using some of these key practices. While a variety of factors can influence map acceptance, Charlotte-Mecklenburg County officials reported zero appeals and protests as a result of their 2005 mapping effort, and North Carolina state officials reported very few appeals and protests as a result of their most recent studies, which suggests their outreach efforts may have been more successful than many other counties'.

For example, Charlotte-Mecklenburg County, North Carolina, officials stated that utilizing a land use task force was vital to the public's acceptance of flood maps. To address the need for accurate current and future land use data, a land use task force is convened to represent the interests of the watershed. Task force members include homeowners' association leaders, realtors' association members, and other local leaders. The task force presents findings regarding the flood mapping to the community and engages local media to do a story. This process allows the county to gain vital support from the public and the county to say that the data used in the flood mapping is approved by the public. Furthermore, Charlotte-Mecklenburg county officials and state officials both said that early involvement from the public can make map acceptance easier later in the process. These officials stated that if the public is presented with the facts and the study's methodology early on, while it may be disgruntled when the maps are created, it will be more supportive.

Another outreach technique that was used in 3 of the 4 locations we reviewed was the use of community "open houses" set up by local governments during the appeal period of the preliminary maps. The official community meetings that FEMA holds with state and local officials can be very formal and technical, so counties host separate open houses for the public to attend, according to officials we spoke to as part of our reviews of Charlotte-Mecklenburg, Hillsborough, and Maricopa counties. These open houses are designed to accommodate members of the public's different schedules and lets them drop-in at any time. A variety of kiosks with brochures and staff are available throughout the open house. The kiosks include mapping contractors and county engineers who can provide information on modeling and data used to create the flood map

and insurance agents who can provide information on insurance rates and grandfathering. FEMA officials stated that they attempt to attend these open houses, but sometimes their travel budgets prevent them from attending.

In addition, Charlotte-Mecklenburg county officials said that direct mailers are also key to community acceptance of flood maps. The county used targeted mailings to property-owners within the watershed that was being mapped. They used these direct mailings in order to make the public aware of the mapping study/project and to seek input. Charlotte-Mecklenburg officials stated that the result of seeking input is a worthwhile effort because it helps gain public support.

Appendix III: Summary of Studies and Related Findings from 1997 through 2009

Data Quality and Community Outreach Are Long-standing Issues

Data quality and community outreach are long-standing/inherent issues in FEMA's flood mapping program. There have been other reviews of flood map accuracy in the past:

In 2004, we reviewed Flood Map Modernization.[1] We reported:

- Ensuring the accuracy and public acceptance of flood maps are fundamental challenges inherent in federal efforts to establish and maintain a national program.
- In developing digital flood maps, FEMA planned to incorporate data that are of a level of specificity and accuracy commensurate with communities' relative flood risk—there is a direct relationship between the types, quantity, and detail of the data and analysis used to develop maps and the costs of obtaining and analyzing those data.
- FEMA has developed partnerships with states and local entities for mapping activities. However, the overall effectiveness of FEMA's future partnering efforts was uncertain, especially in partnering with communities with less resources and little or no experience in flood mapping.

In 2009, the National Academy of Sciences published Mapping the Zone: Improving Flood Map Accuracy,[2] which reported that:

"…the extent of potential floods must be predicted from statistical analyses and models; all of which have uncertainties that affect the accuracy of the resulting flood map. Other findings include:

- The most appropriate flood study method to be used for a particular map depends on the accuracy of the topographic data and the overall flood risk, including flood probability, defined vulnerabilities, and consequences.
- Flood maps with base flood elevations yield greater net benefits—however, only the more expensive of FEMA's flood study methods—detailed studies and most limited detailed studies—yield a base flood elevation."

[1] GAO, *Flood Map Modernization: Program Strategy Shows Promise, but Challenges Remain*, GAO-04-417 (Washington, D.C., Mar. 31, 2004.).

[2] National Research Council (U.S.), and United States. 2009. Mapping the Zone: Improving Flood Map Accuracy. Washington, D.C.: National Academies Press. http://www.nap.edu/catalog.php?record_id=12573 May 2009

FEMA's 2001 food map progress report[3] summarizes recommendations of the Technical Mapping Advisory Council (established by Congress in the National Flood Insurance Reform Act (NFIRA) of 1994 to provide recommendations to FEMA on how to improve the accuracy, quality, distribution, and use of Flood Insurance Rate Maps. Table 2 below summarizes the findings and recommendations FEMA's flood mapping program identified by these studies.

Table 2: Historical Data Quality Issues and Recommendations in FEMA's Flood-Mapping Efforts

1997 Technical Mapping Advisory Council[a]	1998 Technical Mapping Advisory Council	GAO 2004[b]	OIG 2005[c]	National Academies of Sciences (National Research Council) 2007	National Academies of Sciences (National Research Council) 2009[d]
Base Maps. Improve base maps and review and update existing standards, in consultation with the Federal Geographic Data Committee. Ensure strict adherence to the Federal Geographic Data Committee's standards.	1. Map Availability and Accuracy. Implement programmatic changes to improve accuracy, reliability, and availability of digital and graphic map data. 2. Minimum Base Map Standards. Revise and ensure adherence to minimum base map standards, consistent with Federal Geographic Data Committee standards.	Develop and implement data standards that will enable FEMA, its contractor, and its state and local partners to identify and use consistent data collection and analysis methods for communities with similar risk.	Develop guidelines to help ensure compliance with FEMA's minimum standard for producing accurate and reliable flood insurance rate maps	Within the limits of the available elevation data, the updated floodplain maps are adequate for this purpose. The nation's land surface elevation data need to be modernized and mapped more accurately to properly support FEMA Map Modernization and the nation's flood - mapping and management needs. This report recommends a new national digital elevation data collection is required. The committee proposes that this program be called Elevation for the Nation.	The extent of potential floods must be predicted from statistical analyses and models; all of which have uncertainties that affect the accuracy of the resulting flood map. Other findings include: — The most appropriate flood study method to be used for a particular map depends on the accuracy of the topographic data and the overall flood risk, including flood probability, defined vulnerabilities, and consequences. — Flood maps with base flood elevations yield

[3] Federal Emergency Management Agency, *Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report* (May 2001).

1997 Technical Mapping Advisory Council[a]	1998 Technical Mapping Advisory Council	GAO 2004[b]	OIG 2005[c]	National Academies of Sciences (National Research Council) 2007	National Academies of Sciences (National Research Council) 2009[d]
					greater net benefits—however, only the more expensive of FEMA's flood study methods—detailed studies and most limited detailed studies—yield a base flood elevation.

Source: GAO.

[a] The Technical Mapping Advisory Council was established by Congress in the National Flood Insurance Reform Act (NFIRA) of 1994 to provide recommendations to FEMA on how to improve the accuracy, quality, distribution, and use of Flood Insurance Rate Maps (FIRMs).

[b] GAO, *Flood Map Modernization: Program Strategy Shows Promise, but Challenges Remain,* GAO-04-417 (Washington, D.C.: Mar. 31, 2004.).

[c] Department of Homeland Security Office of the Inspector General, *Challenges in FEMA's Flood Map Modernization Program,* OIG-05-44 (Washington, D.C., September 2005).

[d] National Research Council (U.S.). 2007. Elevation Data for Floodplain Mapping. Washington, D.C.: National Academies Press. http://books.nap.edu/catalog.php?record_id=11829 August 2007.

[e] National Research Council (U.S.), and United States. 2009: Mapping the Zone: Improving Flood Map Accuracy. Washington, D.C.: National Academies Press. http://www.nap.edu/catalog.php?record_id=12573 May 2009.

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Appendix IV: Comments from the Department of Homeland Security

U.S. Department of Homeland Security
Washington, DC 20528

Homeland Security

November 4, 2010

William O. Jenkins Jr
Director, Homeland Security and Justice
441 G Street, NW
U.S. Government Accountability Office
Washington, DC 20548

Dear Mr. Jenkins:

Thank you for the opportunity to review and comment on the Government Accountability Office (GAO) draft report GAO-11-17, entitled, "FEMA Flood Maps Some Standards and Processes in Place to Promote Map Accuracy and Outreach, But Opportunities Exist to Address Implementation Challenges."

The Department of Homeland Security appreciates the opportunity to highlight current efforts that will not only comply with the recommendations, but will also improve our overall operational effectiveness. The recommendations and corrective actions to address the recommendations are described below.

Recommendation 1: Establish separate measures and collect data needed to assess compliance with the Floodplain Boundary Standard for detailed and approximate flood studies.

Response: Concur. FEMA agrees with this recommendation to establish tracking and reporting that will allow FEMA to report the level of precision by flood source. FEMA plans to implement this tracking as part of the Coordinated Needs Management System (CNMS) that will be fully implemented this fiscal year. The CNMS system will provide significantly improved national tracking and reporting on the flood hazard data inventory.

Flooding sources with new and updated flood hazards must comply with the floodplain boundary standard and CNMS will track the study method for each flooding source.

Recommendation 2: Establish uniform guidance for the validation of existing engineering data to help FEMA fully implement the New, Validated, or Updated Engineering (NVUE) standard and provide a basis for mapping partners to validate flood hazard data.

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Response: Concur. FEMA will finalize and issue guidance for validation and implement a full validation assessment of the flood map inventory this fiscal year.

Recommendation 3: Implement probability sampling during the independent verification and validation (IV&V) audit process to the extent that the benefits outweigh the costs, to ensure that the results are generalizable for decision-making.

Response: Concur. FEMA's current quality management process is designed to yield acceptable quality level based on current standards. FEMA will assess the additional costs to expand the scope of the IV&V compared to the expected benefits.

Recommendation 4: Transfer independent verification and validation duties back to an independent entity to help ensure impartiality.

Response: Non-concur. The Program Manager (PM) contractor is technically, managerially and financially independent of the flood hazard development process. The PM contractor is helping FEMA to integrate the program, monitor program performance, and implement a quality management process. FEMA believes that the quality audit function is more effective if it is integrated into the overall quality management process rather than performed externally to the quality management process.

Recommendation 5: Adopt a systematic approach to IV&V data collection, so FEMA can better track map quality issues, more easily analyze the data, and adopt a corrective action plan.

Response: Concur. FEMA will work with the contractor performing audits to redesign the reporting of map quality issues.

Recommendation 6: Establish a mechanism to ensure compliance with the documentation requirements of public notification regulations.

Response: Concur. FEMA will issue a procedure memorandum to reinforce the existing contract requirements to compile and archive this data. FEMA will also transition to fully digital storage of this data on the Mapping Information Platform (MIP) and incorporate a review of the required deliverables into the quality management process.

Recommendation 7: Collect and analyze data on appeals and protests, including those on ineligible appeals, to the extent that the benefits outweigh the costs.

Response: Concur. FEMA will issue guidance consistent with recommendation 8 (below), and implement changes to the current tracking systems to implement this recommendation.

Recommendation 8: Issue guidance to mapping stakeholders to standardize the process for analyzing appeals and protests and submitting this data to FEMA.

Response: Concur. FEMA will issue guidance to support the implementation of recommendation 7 (above).

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Recommendation 9: Establish performance goals and measures for promoting public acceptance of flood maps.

Response: Concur. FEMA currently measures the community adoption rates for maps, which partially addresses acceptance, but has struggled to identify an effective measure for acceptance. FEMA will explore potential new measures, including the GAO's suggestion that measuring appeals and protests might effectively measure public acceptance.

Recommendation 10: Develop a reporting structure for regions to use to identify resources needed to conduct flood mapping outreach activities, and implement a risk-based approach to allocate outreach resources.

Response: Concur. A key component of the FEMA Risk Mapping, Assessment, and Planning (MAP) program is that it formalizes several outreach activities and products as part of a new standard project work flow. These new elements provide the structure to plan, track and report specific contract costs associated with flood mapping outreach. FEMA will make revisions to the MIP workflow to update and track new Risk MAP products and project level outreach and community engagements for earned value and other program management requirements.

Additionally, FEMA will explore ways to analyze and allocate staff outreach resources based on risk. FEMA will also look for ways to quantify and track outreach activities that are integrated into map production activities that have historically been difficult to separate from production costs.

FEMA will define a process for allocating resources to Risk MAP outreach based project risk, as well. FEMA anticipates that the risk factors for outreach may differ from the risk factors used to allocate engineering resources.

Recommendation 11: Leverage, as appropriate, existing FloodSmart marketing resources and expertise to help increase public acceptance of flood maps.

Response: Concur. As part of Risk MAP, the flood mapping program is actively engaged with FloodSmart to identify areas where their experience and work to date could increase our outreach effectiveness and deliver consistent messages across FEMA programs.

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Thank you for the opportunity to comment on this Draft Report. We look forward to working with you on future Homeland Security issues.

Sincerely,

Jerald E. Levine
Director
Departmental Audit Liaison Office

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Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

William O. Jenkins Jr., (202) 512-8757 or jenkinswo@gao.gov

Staff Acknowledgments

In addition to the contact named above, Chris Keisling (Assistant Director), John Vocino (Analyst-in-Charge), Anthony Mercaldo, Justine Lazaro, Jamie Berryhill, C. Patrick Washington, Linda Miller, David Alexander, John Smale Jr, Jerome Sandau, Mark Ramage, Christine Davis, and Tracey King made key contributions to this report.

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