The National Dam Safety Program

Biennial Report to the United States Congress

Fiscal Years 2018 – 2019

Volume I

FEMA P-2189
November 2022

Homeland Security

Federal Emergency Management Agency

Message from the Administrator

November 10, 2022

I am pleased to submit the following report, "The National Dam Safety Program Biennial Report to the United States Congress, Fiscal Years 2018–2019."

The Federal Emergency Management Agency (FEMA) prepared this report pursuant to section 10 of the *National Dam Safety Act* (NDSA) codified 33 U.S. Code § 467f. The NDSA was enacted under Section 215 of the W*ater Resources Development Act of 1996*, Pub. L. No. 104-303.

Pursuant to congressional requirements, this report is being provided to the following Members of Congress:

- The Honorable Thomas R. Carper, Chairman, Environment and Public Works Committee, U.S. Senate
- The Honorable Shelley Moore Capito, Ranking Member, Environment and Public Works Committee, U.S. Senate
- The Honorable Benjamin L. Cardin, Chair, Transportation and Infrastructure Subcommittee, Environment and Public Works Committee, U.S. Senate
- The Honorable Kevin Cramer, Ranking Member, Transportation and Infrastructure Subcommittee, Environment and Public Works Committee, U.S. Senate
- The Honorable Peter A. DeFazio, Chairman, Transportation and Infrastructure Committee, U.S. House of Representatives
- The Honorable Samuel Graves, Ranking Member, Transportation and Infrastructure Committee, U.S. House of Representatives
- The Honorable Dina Titus, Chair, Economic Development, Public Buildings, and Emergency Management Subcommittee, Transportation, and Infrastructure Committee, U.S. House of Representatives
- The Honorable Daniel Webster, Ranking Member, Economic Development, Public Buildings, and Emergency Management Subcommittee, Transportation and Infrastructure Committee, U.S. House of Representatives

Inquiries relating to this Report may be directed to FEMA's Office of External Affairs' Congressional and Intergovernmental Affairs Division at (202) 646-4500.

Sincerely,

Deanne Criswell
FEMA Administrator

Executive Summary

The National Dam Safety Program (NDSP) is an essential part of the nation's comprehensive approach to dam safety and dam risk management. In response to the Buffalo Creek flood disaster in 1972, Congress enacted Public Law 92-367, the *National Dam Inspection Act*, which authorized the United States Army Corps of Engineers (USACE) to inventory and inspect non-federal dams. In November 1977, in response to the Kelly Barnes Dam failure, President Jimmy Carter directed the USACE, in cooperation with the states, to proceed under the authority of Public Law 92-367 to inspect non-federal dams classified as high hazard potential[1] because of the downstream population at risk. In 1979, Executive Order 12148 established FEMA and provided it the authority to coordinate all national efforts in dam safety. FEMA has continued to act as the lead federal agency on dam safety in the United States and to support the safety of the nation's dam infrastructure through state assistance funds, emergency action planning, training, public outreach, researching, and creating new guidance regarding the maintenance and construction of dams.

The National Dam Safety Program Act, as amended (Section 215 of the Water Resources Development Act of 1996; P.L. 104-303; 33 U.S.C § 467f et seq.), authorizes the NDSP at $13.4 million annually. In Fiscal Year (FY) 2019, Congress appropriated $9.2 million for the program, which provided training, technical assistance, research funding, and public awareness and $6.8 million in state grants that encourage improved dam safety and public awareness (See Figure 1 for a breakdown of the National Dam Safety Program Total Authorizations[2]).

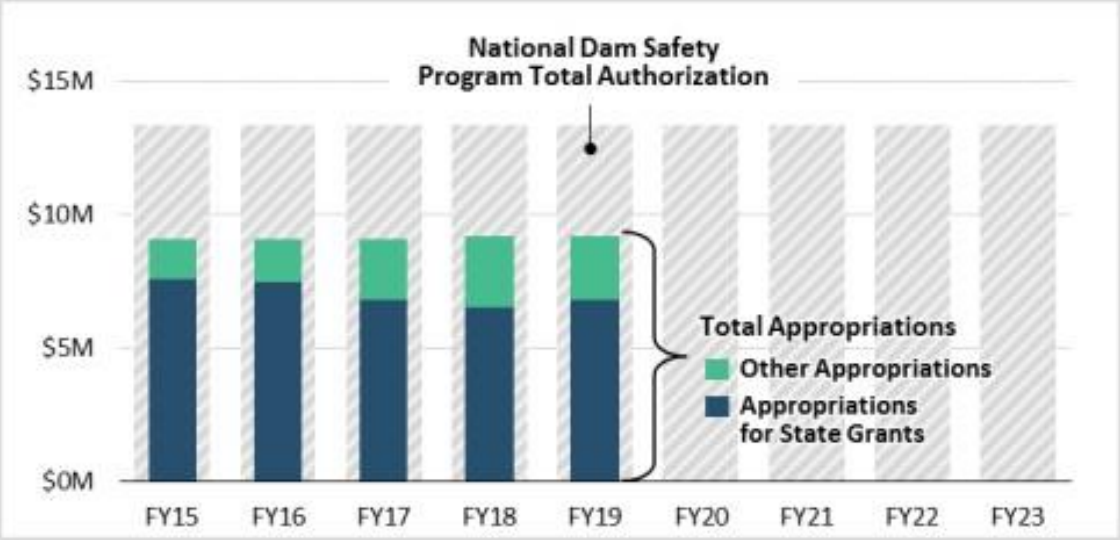

Figure 1. National Dam Safety Program Total Authorization.

[1] High Hazard Potential is a classification standard for any dam whose failure or mis-operation will cause loss of human life and significant property destruction. Source: https://www.fema.gov/emergency-managers/risk-management/dam-safety/grants#hhpd

[2] Source: Congressional Research Service Report (2019). https://www.everycrsreport.com/reports/R45981.html#_Toc23255345
Notes: Amounts are in nominal dollars. State grants are part of overall appropriations. Total annual authorization of appropriations of $13.4 million for the National Dam Safety Program includes $1 million for staff, $750,000 for training, $1.45 million for research, and $1 million for public awareness. Authorization levels and appropriations do not include High Hazard Potential Dam Rehabilitation grants.

In FY 2017, the NDSP was amended under the Water Infrastructure Improvements for the Nation Act (WIIN) which authorized FEMA to establish a new grant program under the NDSP (33 U.S.C. § 467f). Section 5006 of the WIIN Act, Rehabilitation of High Hazard Potential Dams (HHPD), provides technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible dams. FEMA received $10 million in federal assistance appropriations for the HHPD grants in FY19, and the NDSP budget expanded from $9.1M to $19.1M.

The dam incidents over the past few years have shown that, despite the progress FEMA has made through the NDSP, continued investment in dam infrastructure is required to safeguard the lives and property of American citizens. FEMA continues its NDSP mission to research new technologies and methodologies, while also assisting other entities with dam safety interests to adequately prepare communities across the nation on how to address dam risks.

Between FY 2018-2019, FEMA demonstrated progress toward all goals and objectives in the 2017-2021 NDSP Strategic Plan (Please note NDSP has been operating under a draft plan as the 2017-2021 NDSP Strategic Plan has been under review since 2017 and not yet approved). Throughout this Biennial Report, activities performed that were related to a strategic goal or objective are noted. See figure 2 for a breakdown of these goals and objectives.

Figure 2. NDSP Strategic Plan Goals and Objectives.

The following is a sample of the many accomplishments, improvements and challenges FEMA has completed through the NDSP in FY 2018 and FY 2019:

Accomplishments:

- In Spring 2018, FEMA NDSP and the National Integration Center's (NIC) Technical Assistance (TA) Program launched the Planning for Dam Safety Collaborative Technical Assistance (CTA) program for local & state communities. Three jurisdictions were invited to participate in the pilot CTA series during the Winter of 2017 for a Spring 2018 kick-off in its pilot phase.

- In FY 2019, FEMA was appropriated $10 million to implement the Rehabilitation of HHPD Grant Program. NDSP staff were furloughed due to the lapse in federal appropriations, and only had four months to plan, stand-up, announce, socialize, and provide technical assistance to interested applicants. By the end of the fiscal year, FEMA successfully appropriated all grant funds. In FY 2019, the HHPD Grant Program provided assistance for planning and other pre-construction activities.
- In February 2018 and 2019, FEMA's Emergency Management Institute (EMI), continued the tradition of conducting an annual NDSP Technical Seminar, "Sustaining Public Trust through Effective Emergency Management" and "Information Sharing and Risk Communication on the Hazards Associated with Dams and Levees." More than 200 attendees were present at each, with representation from federal agencies, state dam safety officials, and county emergency management officials.
- In response to Hurricane Irma (Category 5 event made landfall on Puerto Rico on September 6, 2017) and Hurricane Maria (Category 4 event made landfall on Puerto Rico on September 20, 2017), FEMA Region 2 coordinated disaster response with other federal and state partners and were responsible assessing the known conditions of dams, calculation of the population at risk, and screening of dams for inspections.
- According to FEMA's 2019 Preparedness Report, during the 2018 hurricane season, a focus on Community Lifelines helped response officials reframe incident information and conduct impact and causal analyses. For example, during Hurricane Florence, response officials used the Community Lifelines construct to understand the root cause and impacts of an incident involving sixty overflowing dams in North Carolina. Instead of targeting each individual dam failure, officials prioritized response missions based on relative impact to surrounding communities. This, in part, was possible because Community Lifelines provide a prioritization and sequencing structure that treat incidents holistically, rather than responding to each incident in isolation and coordinating disparately between multiple Emergency Support Functions (ESFs). Ultimately, through the Community Lifelines construct, officials prioritized and targeted the highest impact dam first, which threatened a community of 1,000 residents and required evacuation.
- In FY 2019, NDSP in partnership with the NIC published the *Dam Incident Planning Guide* which builds on the Comprehensive Preparedness Guide (CPG) 101: Developing and Maintaining Emergency Operations Plans by summarizing the concepts that a community should consider while incorporating dam incident elements into their emergency operation plans. The *Guide* instructs dam owners and operators on how to engage with emergency managers prior to an incident to ensure there is a well-coordinated response during an emergency.
- Since FY 2015 FEMA has invested NDSP research funding in the Decision Support System for Water Infrastructure Security (DSS-WISE™ Lite), a geospatial, web-based, automated dam-break flood simulation and mapping system. In FY 2019, FEMA surveyed the states, which unanimously agreed that DSS-WISE™ Lite has positively impacted their emergency response capabilities. Overwhelmingly, the case studies show that DSS-WISE™ Lite is a useful tool for enhancing dam safety, and proves to be a valuable investment.

Challenges:

- The NDSP's legislatively-mandated Strategic Plan is significantly overdue (no estimated time of completion). Further delays could result in FEMA having to develop a new Strategic Plan to align with changes since 2016.; including the WIIN Act.
- Dams provide vital benefits and water resources to communities and the economy; however, the average age of the 94,000 dams in America is 59 years old (the typical design life of a dam is 50 years). As our population grows and development continues, the overall number of high-hazard potential dams is increasing, with the number climbing to nearly 15,629 in 2020. According to the most recent American Society of Civil Engineer's (ASCE) Infrastructure Report Card (2017), it estimated that it will require an investment of nearly $45 billion to repair aging, yet critical, high hazard potential dams.
- In FY 2019, the NDSP HHPD Grant program was appropriated funding without additional staffing resources, further exacerbating the strain on the program's current resources. Consequently, NDSP is unable to implement all the programmatic grant responsibilities required by 2 CFR 200 and deliver the other statutory responsibilities of the NDSP[1]. This holds especially true for the management and administrative requirements now that the FY 2019 HHPD grants have been awarded. The program has extremely limited ability to comply with Environmental and Historic Preservation laws, executive orders, and regulations, among other requirements. The HHPD Grant Program will allow FEMA to carry out meaningful projects to rehabilitate and repair high hazard dams. Across the United States, hundreds of high hazard dams that pose an unacceptable risk have been identified and the costs to bring them all into compliance is vast.
- Public safety is of paramount importance at all dams and reservoirs. Specifically, public safety on the reservoir, in areas adjacent to the reservoir, and below the dam should be considered, particularly in recreational areas. Safety measures should include identification of high watermarks to indicate past or probable reservoir levels and streamflows, posting of safety instructions at highly visible and key locations, and providing audible safety warnings upstream of and below outlets as appropriate.
    - The nature of public interaction with dams is changing and guidance is needed to increase public safety around dams. Public interaction with dams is increasing for several reasons, including lack of awareness of hazards, public interest in "extreme" sports, recreational vehicles improving access, a perceived right of public access to sites, and the remote operation of dams. Dam owners need to consider how the public interacts with and around their dam and establish appropriate procedures, restrictions, and safety measures.
    - The basic dam owner's responsibilities are to make and keep their premises safe, avoid conduct or conditions that could injure any person, even trespassers, and correct existing dangerous conditions and post warnings. However, most states do not have the legislation in place to enforce these responsibilities. As a result, there has been an increase in litigation between cities, communities, public utilities and

private dam owners because of accidents and drownings happening around dams (See Table 1).

- FEMA, the Association of State Dam Safety Officials (ASDSO), United States Society on Dams (USSD) and International Commission on Large Dams (ICOLD) all have Public Safety Committees working joint efforts to develop guidance on these issues as there is increased awareness among dam safety professionals.

- Through coordination with USSD and ASDSO, it has been acknowledged that the Mine Safety and Health Administration (MSHA) has a number of regulatory shortcomings as it relates to tailings dams in the non-coal mining industry. Specifically MSHA does not require engineering design plans, an independent review of plans, and does not define inspection frequency for owners/operators of non-coal-mine tailings dams.
- As the professional dam industry workforce ages, engineers with more than 20 years of experience are moving towards retirement, taking with them the knowledge of the generation who designed and constructed the dams that are now more than 50 years old and may still retain original technology. In fact, as part of a working group sanctioned by the Institution of Civil Engineers' Reservoirs Committee to investigate 'Inspecting Engineer Succession Planning', Inspecting Engineer Panel members were surveyed on their plans for retirement. The result, a reported 50 percent decline in the numbers of Inspecting Engineers by 2022[3]. As an industry we are faced with the challenge to develop a sustainability strategy for dam safety and dam engineering that is not only knowledgeable about the latest technology but also maintains an understanding of older equipment and instruments. The development of partnerships that leverage private and public sector practitioners, industry organizations, and academia to sustain and foster the dam safety workforce is critical to ensure proper succession planning and knowledge transfer into the future.
- Because the NDSP statute was written before the creation of DHS in 2002 and the establishment of the Cybersecurity and Infrastructure Security Agency (CISA) in 2018, there are multiple opportunities for enhancing collaboration and strengthening collaboration between FEMA NDSP and CISA's roles and responsibilities in dam safety, dam resilience, and dam security. The NDSP recommends that CISA have a role in the Interagency Committee on Dam Safety and the National Dam Safety Review Board.

[3] British Dam Society's Dams and Reservoirs' Journal, Volume 28, Issue 2, 2018 https://www.icevirtuallibrary.com/toc/jdare/28/2.

The National Dam Safety Program: Biennial Report to the United States Congress, Fiscal Years 2018–2019

Table of Contents

MESSAGE FROM THE ADMINISTRATOR II
EXECUTIVE SUMMARY III
I. LEGISLATIVE REQUIREMENT 9
II. BACKGROUND 10
III. RESULTS AND ANALYSIS 14
IV. APPENDIX A – ACRONYMS 54
VI. APPENDIX B – RESOURCES AND WEBSITES 57

I. Legislative Requirement

This document responds to the reporting requirement set forth in Section 10(b) of the *National Dam Safety Program Act* (codified at 33 U.S.C. § 467f).

> (b) BIENNIAL REPORTS. -- Not later than 90 days after the end of each odd-numbered fiscal year, the Administrator shall submit a Report to Congress that:
>
> > (1) describes the status of the Program;
> >
> > (2) describes the progress achieved by federal agencies during the 2 preceding fiscal years in implementing the Federal Guidelines for Dam Safety;
> >
> > (3) describes the progress achieved in dam safety by states participating in the Program; and
> >
> > (4) includes any recommendations for legislative and other action that the Administrator considers necessary.

II. Background

Dams are a critical part of our nation's infrastructure, and all Americans enjoy the benefits they provide. Dams provide a range of economic, environmental, and social benefits including recreation, flood control, water supply, hydroelectric power, waste management, river navigation, and wildlife habitat.

- Recreation: Dams provide prime recreational facilities throughout the United States. Boating, skiing, camping, picnic areas, and boat launch facilities are all supported by dams.
- Flood Control: In addition to helping farmers, dams help prevent the loss of life and property caused by flooding. Flood control dams impound floodwaters and either release them under control to the river below the dam or store or divert the water for other uses. Throughout history, people have built dams to help control devastating floods.
- Water Storage: Dams create reservoirs throughout the United States that supply water for many uses, including industrial, municipal, and agricultural.
- Irrigation: Ten percent of American cropland is irrigated using water stored behind dams. Thousands of jobs are tied to producing crops grown with irrigated water.
- Mine Tailings: There are more than 1,300 mine tailings impoundments in the United States that allow the mining and processing of coal and other vital minerals while protecting the environment.
- Electrical Generation: The United States is second only to Canada in producing hydropower. Dams produce over 103,800 megawatts of renewable electricity and meet 8 to 12 percent of the nation's power needs. Hydropower is considered clean because it does not contribute to global warming, air pollution, acid rain, or ozone depletion.
- Debris Control: In some instances, dams provide enhanced environmental protection, such as the retention of hazardous materials and detrimental sedimentation.
- Navigation: Dams and locks provide for a stable system of inland river transportation throughout the heartland of the nation.

Our dam inventory continues to deteriorate at the same time downstream and upstream populations are increasing. Currently, the average age of the dams listed in the National Inventory of Dams is fifty-nine years old which highlights the need for a fully resourced dam safety program, a critical investment in the nation's dam infrastructure and associated lifelines.

The increased frequency and severity of natural disasters in recent years have tested the nation's resilience and recovery capabilities while highlighting the importance of a 'whole community' approach to dam safety, an approach that takes into consideration the integrity of dams, emergency management preparedness for potential dam failures, and communicating the risks and impacts in areas around dams. Dam Safety is a shared responsibility, and there are many entities that have a role to play in creating a future where all dams are safer – including dam owners, engineers, emergency managers, community planners/leaders, regulators, as well as all levels of government. Dams are critical infrastructure that can be affected by:

- natural hazards (earthquakes, floods, hurricanes, etc.).
- man-made threats (human error, hacking, terrorism), and
- an imbalance between resources invested and aging dam infrastructure.

In the context of dam safety, risk comprises three parts:

- the likelihood of a triggering event (e.g., flood or earthquake),
- the likelihood of a dam safety deficiency resulting in adverse structural response (e.g., dam failure or spillway damage), and
- the magnitude of consequences resulting from the adverse event (e.g., loss of life or economic damages).

Preventing dam failure involves proper location, design, and construction of structures, regular technical inspections, operations and maintenance, and rehabilitation and repair of existing structures. Preparing and responding to dam safety concerns may involve community development planning, emergency preparation, and stakeholder awareness.[4] Dam safety policies may address risk by focusing on preventing dam failure while preparing for the consequences if failure occurs.

In recent years, more federal agency dam safety programs have shifted from a standards-based approach to a risk-management approach. A risk-management approach seeks to improve the resilience of dam infrastructure and mitigate failure of dams and related structures through inspection programs, risk reduction measures, and rehabilitation and repair. This approach prioritizes structures where failure would pose the greatest threat to life and property.

Timeline

On May 31, 1889, the South Fork Dam in Johnstown, Pennsylvania, failed after days of unusually heavy rainfall; torrents of water were sent downstream killing 2,200 people and leaving thousands homeless. The Johnstown disaster was the worst dam failure in the United States when measured by the number of lives lost and injuries sustained.

On February 26, 1972, a tailings dam in Buffalo Creek, West Virginia, failed, devastating a 16-mile valley with 6,000 inhabitants. In a matter of minutes, 125 people were killed, 1,100 people were injured, and more than 3,000 were left homeless. In response to the Buffalo Creek flood disaster in 1972, Congress enacted Public Law 92-367, the National Dam Inspection Act, which authorized the United States Army Corps of Engineers (USACE) to inventory and inspect non-federal dams.

On June 5, 1976, Teton Dam in Idaho failed, leaving 11 people dead and causing $1 billion in damage. In November 1977, Kelly Barnes Dam in Georgia failed, killing 39 people, most of them college students. These catastrophic dam failures led to national efforts to ensure the safety of America's dams.

Partly in response to the Teton Dam failure, on April 23, 1977, Presidential memorandum directed federal agencies to review their dam safety practices, addressing many elements of dam safety. Major elements included internal and external review, qualifications of personnel, integration of new technology, emergency action plans (EAPs), and review of existing dams. The agencies' reviews and the assessment of the reviews by a federal ad hoc interagency committee and by an Independent Review Panel showed that sound practices were generally used but concluded that improvements were needed in some management practices for dam safety.

[4] FEMA, Risk Reduction Measures for Dams, 2018, at https://www.fema.gov/media-library-data/1517855134487-c8c522cf93c1ccbce7e6f68abdc38253/TA1-RiskReductionMeasuresforDams_508.pdf. Hereinafter FEMA, Risk Reduction.

In 1979, Executive Order 12148 established the Federal Emergency Management Agency (FEMA) and provided it the authority to coordinate all national efforts in dam safety. FEMA has continued to act as the lead federal agency on dam safety in the United States and to support the safety of the nation's dam infrastructure through state assistance funds, emergency action planning, training, public outreach, researching, and creating new guidance regarding the maintenance and construction of dams.

In 1986, federal legislation addressed dam safety through the Water Resources Act of 1986. Title XII of this legislation authorized the state assistance program, the establishment of a National Dam Safety Review Board (NDSRB), research and training programs, and funds to maintain and update the National Inventory of Dams (NID).

The NDSP was not legislatively mandated by Congress until 1996 when it enacted the National Dam Safety Program Act as part of the Water Resources Development Act (Public Law 104-303). This act authorized the formation of the NDSRB, financial assistance in the form of grants to the state dam safety programs, and funding for maintaining the NID, research, and training related to dam safety. The act calls for FEMA to provide education on the importance of strong dam safety programs both nationally and locally. FEMA must also coordinate partnerships among all stakeholders to enhance dam safety.

The NDSP was reauthorized in 2002 under the National Dam Safety and Security Act, in 2006 under the Dam Safety Act, and again in 2014 under the Water Resource Reform and Development Act.

The President signed the "Water Infrastructure Improvements for the Nation Act" or the "WIIN Act," in December 2016, which adds a new grant program under FEMA's National Dam Safety Program (33 U.S.C. § 467f). Section 5006 of the Act, Rehabilitation of High Hazard Potential Dams (HHPD), provides technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams.

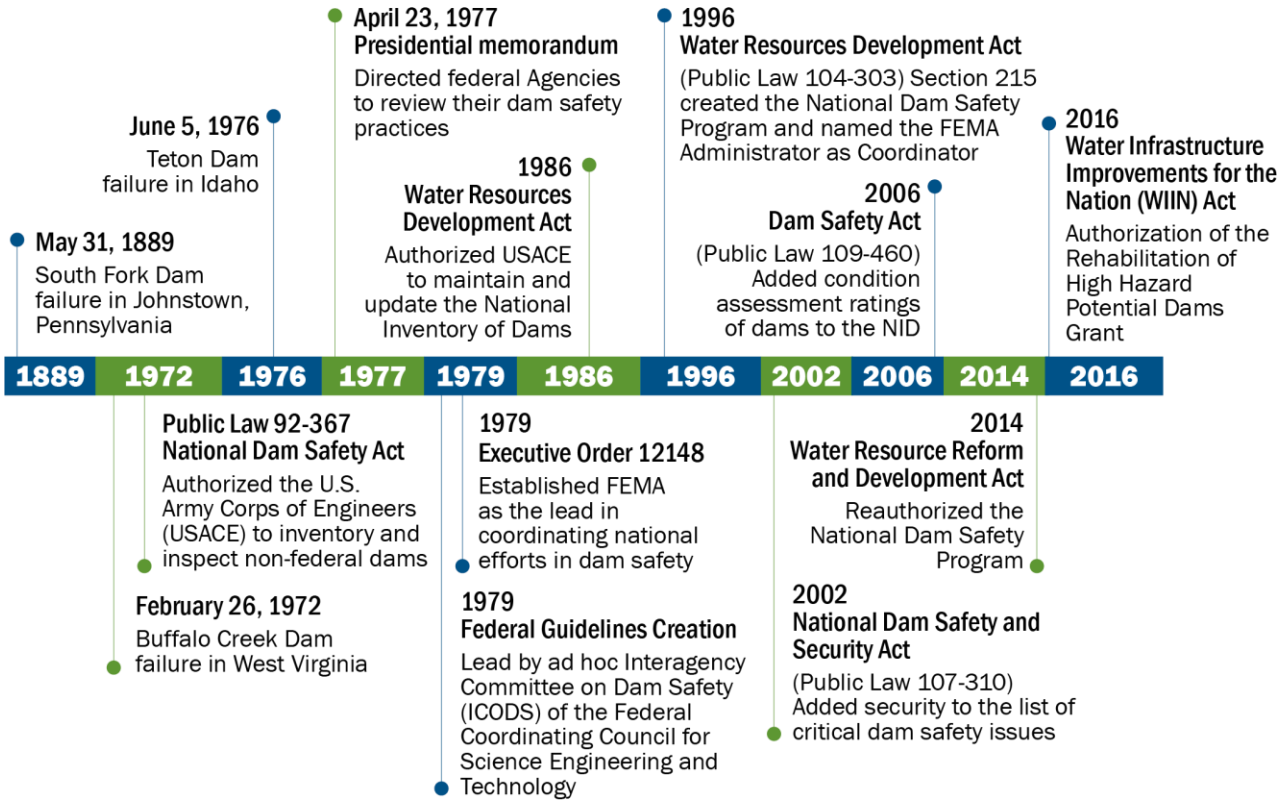

Figure 3: Dam incident and legislative timeline.

The purpose of the NDSP is to "reduce the risks to life and property from dam failure in the United States through the establishment and maintenance of an effective national dam safety program to bring together the expertise and resources of the federal and non-federal communities in achieving national dam safety hazard reduction" (33 U.S.C. § 467f).

III. Results and Analysis

Progress on FEMA's Implementation of the Federal Guidelines for Dam Safety

A. Organization, Administration, and Staffing

The NDSP plays a pivotal role in understanding the complex nature of FEMA's core competencies related to dam risk management.

FEMA headquarters currently employs three full-time employees (FTE) which include the NDSP Manager and two Civil Engineers. In FY 2016, FEMA delegated certain program and grants management responsibilities to each of the ten FEMA Regions. However, the FEMA Regional Offices were not allocated dedicated FTE dam safety positions. Rather, the delegated points of contact manage dam safety responsibilities in addition to other FEMA programs. In FY 2019, NDSP capacity was further strained as the HHPD grant program was funded without a fully developed program, and limited capability and capacity with existing staff and resources to complete program development and management (as required by 2 CFR 200) and deliver the other statutory responsibilities of the NDSP. While the NDSP operates at the most effective level possible, the lack of staff hinders the capacity at which the NDSP can be administered both nationally and to the states.

B. Dam Safety Training Activities

A key element in FEMA's dam safety strategy is training (see Figure 4 for examples of NDSP trainings). NDSP and its partners all offer a wide range of training to people who work in the dam sector through traditional in-person and online or virtual formats. Training provided through the NDSP is readily available at little or no cost to attendees. Organizations ranging from the Department of Labor's Mine Safety and Health Administration to FEMA's Emergency Management Institute (EMI) provided the learning sessions required to make ideas surrounding dam safety more broadly known to others. Please see Figure 16 for a summary of training opportunities offered by all of the National Dam Safety Review Board (NDSRB) and

Figure 4. Examples of NDSP trainings.

Interagency Committee on Dam Safety (ICODS) federal agencies. Throughout FY 2018 and FY 2019, training opportunities were offered internationally, on the web, and within classroom settings.

In Spring 2018, the FEMA National Dam Safety Program and the National Integration Center's Technical Assistance (TA) Program launched the Planning for Dam Safety Collaborative Technical Assistance (CTA) program for local and state communities. Three jurisdictions were invited to participate in the pilot CTA series during the 2017-2018 kick-off phase.

The initial CTA series was designed as a one-year collaborative cycle between local jurisdictions and FEMA representatives through a combination of in-person meetings and online webinar sessions catered to the specific needs of the participating community. Each month's session consisted of 8-10 hours of training with a different theme that was consistent with *Developing and Maintaining Operational Plans Comprehensive Preparedness Guide 101: Version 2.0*.

This CTA series was created for communities at-risk of dam-related flooding to gain a better understanding of their risk landscape and the potential consequences of dam-related emergencies. Through the program, FEMA provided tools and planning resources to help participants and helped communities to plan for emergencies related to operational discharges or dam-related infrastructure failure. Additionally, participants engaged in a facilitated planning process with community stakeholders over the yearlong cycle. The stakeholders included members of the community, emergency managers from all levels of government, dam owners & operators, elected officials, private sector representatives, community planners, non-profit partners and other individuals and organizations that could potentially face dam-related emergencies. Three counties, Manatee County, Florida, Snohomish, Washington, and Ventura, California, engaged in the first CTA series.

C. National Inventory of Dams

The National Dam Inspection Act of 1972 (33 U.S.C. § 467) authorized USACE to inventory dams in the United States. USACE published the initial NID in 1975 and has continued to maintain and update the NID through today, working closely with FEMA, ICODS, ASDSO and state regulatory offices to obtain more accurate and complete information. The goal of the NID is to include all dams in the United States that meet at least one of the following criteria:

- High hazard potential classification – incremental loss of one human life is likely if the dam fails or is mis-operated;
- Significant hazard potential classification – no probable loss of human life but possible economic loss, environmental damage, disruption of lifeline facilities, or impact on other concerns if the dam fails;
- Equal to or more than 25 feet tall and more than 15 acre-feet in storage capacity; or,
- More than 6 feet tall and equal to or more than 50 acre-feet storage capacity.

USACE maintains the NID by periodically collecting dam characteristics from every state with a formal dam safety program, Puerto Rico, and 18 federal agencies. Alabama is the only state that does not currently have dam safety legislation or a formal dam safety program, but they do share some data. With NDSRB support, USACE released the 2018 NID in January 2019 with fewer restrictions, allowing users to download or export certain NID data and to view the hazard potential classification. USACE determined that the benefits of making the information accessible to the public outweighed the security risks and to continue to restrict access to the information could pose significant challenges to facilitating effective risk communication with stakeholders, and these changes could result in more accurate and complete NID data. State or

federal agencies may restrict access to information on dams within their jurisdiction, in some cases.

D. Grant Assistance to the States

NDSP State Assistance

The primary purpose of the NDSP State Assistance grant is to provide financial assistance to the states to strengthen their dam safety programs. The states use NDSP funds for the following types of activities:

- Dam safety training for state personnel
- Increase in the number of dam inspections
- Increase in the submittal and testing of EAPs
- A timely review and issuance of permits
- Improve coordination with state emergency preparedness officials
- Identify dams in need of repair or removal
- Conduct dam safety awareness workshops and creation of dam safety videos and other outreach materials

* This money is not available for rehabilitation and repair activities.

During the reporting period of FY 2018 – FY 2019, NDSP awarded a total of $6,537,620 and $6,800,000 in dam safety program grants to 49 states and Puerto Rico.

NDSP HHPD Grant Program

Although the legislation was signed in 2016, the grant program was not appropriated until FY 2019, FEMA was appropriated $10 million to implement the HHPD Grant Program and provided assistance for planning and other pre-construction activities for eligible high hazard potential dams.

High hazard potential dams eligible under this grant must meet the following criteria:

- Non-federal dams—
    - Located in a state or territory with a state or territorial dam safety program;
    - Classified as “high hazard potential” by the dam safety agency in the state or territory where the dam is located;
    - Has an emergency action plan approved by the state or territory dam safety agency; and
    - The state or territory in which the dam is located determines either of these criteria – the dam fails to meet minimum dam safety standards of the state or territory; and the dam poses an unacceptable risk to the public.

Licensed hydroelectric dams or dams built under the authority of the Secretary of Agriculture are not eligible under this grant.

In direct alignment with FEMA's Five Year Strategic Plan 2017-2022 Objective 1.1, to increase investments and target partnerships, the objectives of the HHPD Grant program are to:

- Provide financial assistance for rehabilitation of eligible high hazard potential dams.
- Protect the federal investment by requiring operation and maintenance of the project for the 50-year period following completion of rehabilitation.
- Encourage state, local, and territorial governments to consider all dam risk in mitigation planning.
- Promote community preparedness by requiring recipients to develop and implement Floodplain Management Plans that address potential measures, practices, and policies to reduce loss of life, injuries, damage to property and facilities, public expenditures, and other adverse impacts of flooding in the area protected by the project; plans for flood fighting and evacuation; and public education and awareness of flood risks.
- Reduce the potential consequences to life and property of high hazard potential dam incidents.
- Reduce the overall number of high-hazard potential dams that pose an unacceptable risk to the public.

Beginning in FY 2020, the HHPD Grant Program will provide assistance for planning, pre-construction and construction activities toward:

- Repair;
- Removal; or
- Structural/nonstructural rehabilitation of eligible high hazard potential dams.

To be eligible for the grant, there are requirements applicants and/or sub-applicants must meet to include a FEMA-approved state hazard mitigation plan that includes all dam risks and complies with the Disaster Mitigation Act of 2000 (Public Law 106–390; 114 Stat. 1552). Moreover, all construction projects must undergo the Environmental and Historic Preservation (EHP) review process. From a programmatic stand point, these requirements demand an extensive amount of expertise, time and resources in order to properly manage the grant program.

E. Dam Safety Research

NDSP has a stated goal to "Promote research and training for state dam safety and other professionals." Research investments were made in DSS-WISE™ and the Human Consequence Module (HCOM), and the development of Risk Prioritization Methodology for the HHPD Grant Program.

DSS-WISE™

In late September 2015, FEMA entered into a five-year contract with the University of Mississippi National Center for Computational Hydroscience and Engineering to:

- Open the DSS-WISE™ Lite capability for use by state dam safety offices and FEMA staff and relevant stakeholders.
- Develop and deliver training and materials for users on how to acquire and utilize services provided.

- Provide an online technical support hotline for users.
- Develop additional two-dimensional modeling capabilities during the four optional years that can be used by state dam safety offices and FEMA to conduct analytics in various areas of interest, such as dam/levee breach floods, fluvial floods, landslide waves, and their consequences.

Background

- Providing the DSS-WISE™ Lite capability to state dam safety offices aligns with FEMA Strategic Goal 1: Build a Culture of Preparedness, and Objective 1.1 and 1.3: Incentivize Investments that Reduce Risk, Including Pre-disaster Mitigation, and Reduce Disaster Costs at All Levels and Help People Prepare for Disasters. Providing this capability also enables FEMA to meet NDSP objective 5, which is set forth in the Dam Safety Act of 2006: Develop technical materials for federal and state dam safety programs.
- The DSS-WISE™ Lite capability also enables FEMA Headquarters and Regional Offices to run rapid dam break inundation analyses when existing data is not available. The DSS-WISE™ capability can be leveraged by multiple components within FEMA. Dam inundation maps can be used to support FEMA's Risk Mapping, Planning and Assessment (Risk MAP) activities, response and recovery planning, and emergency preparedness activities such as planning and designing exercise scenarios.
- FEMA has invested $2,605,966 in DSS-WISE™ Lite, and there are over 900 active users across forty states. Over 5,000 unique dams have been modeled, and many dams have completed multiple simulations. Over 20,000 successful dam breach simulations have been completed with DSS-WISE™ Lite.

DSS-WISE™ HCOM

DSS-WISE™ HCOM is an analytical module for automated assessment of the human consequences of dam-break floods. The National Center for Computational Hydroscience and Engineering (NCCHE) and the University of Mississippi developed the module with funding provided by FEMA through a contract with Argonne National Laboratory (see Figure 5 for a summary of DSS-WISE™ Case Studies when an Emergency Action Plan was Activated).

DSS-WISE™ State Case Studies

2018: Snelling, California

In California, an Emergency Action Plan (EAP) was activated for Moccasin Lower Dam during a flood event due to inadequate spillway capacity that resulted in high seepage flows at the downstream toe of the dam and potential for dam overtopping. DSS-WISE™ Lite confirmed a dam failure would flood the fish hatchery downstream, impact a highway road, and be absorbed by the downstream reservoir, which led officials to dewater the reservoir through a water supply tunnel to alleviate seepage concerns and prevent overtopping.

2018: South Carolina

In South Carolina, multiple EAPs were activated for several dams during the approach of Hurricane Florence. Dam Safety Program staff identified dams that were expected to receive the most rainfall and conducted DSS-WISE™ Lite simulations to evaluate hazard classifications and ascertain accurate mapping would be available for distribution to emergency management.

2019: Soda Springs, California

In California, Lake Van Norden Dam suffered damage to the spillway channel concrete liner. The dam owner's approved inundation map was used during the incident, but DSS-WISE™ Lite was used to confirm the owner's inundation area and flood parameters.

Figure 5. Three DSS-WISE™ Case Studies when an Emergency Action Plan was activated.

HHPD Grant Program Risk Prioritization Methodology

Background

The Consolidated Appropriations Act of 2019 was signed by the President on February 15, 2019, which appropriated $10 million for the first year of the HHPD Grant Program. Within four months, FEMA developed the official Notice of Funding Opportunity (NOFO) and provided guidance and outreach support to potential applicants. The official NOFO was released on May 22, 2019, and the application submission deadline was July 8, 2019. This timeline gave potential applicants six weeks to comply with the HHPD Grant Program requirements, including risk-based prioritization and the documentation of unacceptable risk to the public for each eligible dam.

Legislative Grant Requirements

33 U.S.C. § 467 f–2 - Rehabilitation of high hazard potential dams contains the requirements the HHPD Grant Program must promulgate, including the use of a risk-based priority system to prioritize eligible high hazard potential dams that meet the "unacceptable risk to the public" criteria. The following subsections describe the requirements that directly relate to the definition of "unacceptable risk to the public."

- 33 U.S.C. § 467f **Priority system:** The Administrator, in consultation with the Board, shall develop a risk-based priority system for use in identifying eligible high hazard potential dams for which grants may be made.

- The term “unacceptable risk to the public” is used in the definition of “eligible high hazard potential dam” in the enabling legislation of the HHPD:
    - **Eligible High Hazard Potential Dam:** In general, the term “eligible high hazard potential dam” means a non-federal dam that—
        - (i) is located in a state with a state dam safety program;
        - (ii) is classified as “high hazard potential” by the state dam safety agency in the state in which the dam is located;
        - (iii) has an EAP approved by the relevant state dam safety agency; and
        - (iv) the state in which the dam is located determines—
            - (I) fails to meet minimum dam safety standards of the state; and
            - (II) poses an *unacceptable risk to the public.*
- The number of grant eligible dams considered “unacceptable risk to the public” is used in the formula established by statute to determine the available funding states may receive under the HHPD program.
    - **33 U.S. Code § 467 f–2 (g)(2) Allocation of funds:** The total amount of funds made available to carry out this section for each fiscal year shall be distributed as follows:
        - (A) Equal distribution: ⅓ shall be distributed equally among the states in which the projects for which applications are submitted under subsection (c)(1) are located.
        - (B) Need-based: ⅔ shall be distributed among the states in which the projects for which applications are submitted under subsection (c)(1) are located based on the proportion that—
            - (i) the number of eligible high hazard potential dams in the state; bears to
            - (ii) the number of eligible high hazard potential dams in all such states.

FY19 Definition & Issue Statement

For the FY 2019 rollout of the HHPD grant program, NDSP developed the following definition for "unacceptable risk to the public":

For purposes of this HHPD grant program, the determination of ***unacceptable risk to the public*** *is to be made by the state dam safety program, the agency of the state that is authorized by state statute to manage the state participation in the National Dam Safety Program.*

A dam poses unacceptable risk to the public when the dam requires remediation or risk reduction measures due to deficiencies caused by inadequate dam design, construction methods, or the results of inadequate operation and maintenance.

For a dam to be considered an unacceptable risk to the public for funding under the HHPD Grant Program, it must meet all the following conditions:

1. *Does not meet the minimum dam safety standards of the state (not including operations and maintenance actions)*
2. *State dam safety program has documented the deficiencies at the dam that must be reduced, eliminated or mitigated*
3. *Official notice of the determination of the documented deficiency (s) has been communicated to the dam owner to address the* ***unacceptable risk to the public*** *to implement interim risk reduction measures until permanent risk reduction measures are implemented in a manner that is acceptable to the state.*

The definition was intended to provide a minimum standard for the states to determine the number of dams deemed as unacceptable risk resulting in an equitable distribution of grant funding to states. However, during the FY 2019 HHPD Grant cycle, applicants had different interpretations of how to meet the "unacceptable risk to the public" criteria. Applicants that had previously completed risk-based analysis or semi-quantitative risk analysis of their dams had a very good understanding of which dams met the eligibility criteria; whereas applicants that had not evaluated their dams tended to submit longer lists of dams based on the NID condition assessment or inspection reports that cited dam safety issues such as deferred maintenance, insufficient spillway capacity based on updated state regulations, and other safety issues that may not pose an urgent risk. Due to this issue, some applicants that submitted a longer lists of dams were allocated more funding than those who had a better understanding of their dam risk.

Following the FY 2019 HHPD Grant cycle and initial "unacceptable risk to the public" definition, it has been determined that the applicants need more definitive guidance on how to determine which dams meet the criteria of posing an unacceptable risk to the public. FEMA, in consultation with the NDSRB, is developing guidance for the determination of "unacceptable risk to the public" in advance of the FY 2020/2021 Grant cycles.

F. Public Awareness and Outreach

In accordance with the NDSP goal to develop guidance and resources to engage with stakeholders to increase awareness of effective methods to reduce risks related to dams, NDSP

and the NDSRB have made the issue of information sharing an ongoing priority. The following is a vignette captured from a National Public Radio [5]and Omaha World-Herald[6] article.

In March 2019, a state of emergency was declared in Iowa, South Dakota, Wisconsin, and Nebraska due to historic flooding from a bomb cyclone and heavy rain. The Niobrara River, impounded by Spencer Dam, swelled with heavy rain, snowmelt and ice breakage. On the early morning of March 14, 2019, the dam was breached, sending an 11-foot wall of water downstream.

Among those affected was Anthony Ruzicka, a cattle farmer in northeastern Nebraska, 40 miles downstream. The Niobrara River runs about a half mile from his fifth-generation farm. Shortly before the dam broke, he got a call that it was going to fail, and two hours later, his fifth generation farm was wiped away.

Ruzicka didn't have flood insurance because he didn't know his home was at risk of flooding from an out of sight dam. Anthony Ruzicka is just one of many Americans who are being harmed by a lack of information sharing by high hazard potential dam owners. He and his family were thankfully safe, but Kenny Angel, who lived just below the dam, lost his life.

The following is a summary of insights and actions currently underway to combat this issue.

The Situation

Hazard Creep

High hazard potential dams exist in every state and affect the lives of thousands downstream. Most communities in the United States are within the proximity of at least one dam. In many cases, large populations, vital elements of our infrastructure, jobs, and businesses are located downstream of dams. There is an increasing number of these high hazard potential structures - not because more high hazard potential dams are being built but due to the increasing development occurring downstream.

Restricted Information Sharing

In general, there is restricted sharing of dam risk on high hazard potential dams between the federal dam owners and the potentially impacted community. Policies vary. However, the philosophy surrounding information sharing in some organizations is evolving. For example, USACE currently only shares inundation maps with those who have signed a non-disclosure

[5] Kelly , Mary Lousie, and Aisla Chang. "Nebraska Flooding Threatens Livelihood Of Cattle Farmers." *National Public Radio (NPR)*, March 19, 2019. https://www.npr.org/2019/03/19/704893541/nebraska-flooding-threatens-livelihood-of-cattle-farmers.

[6] Hammel, Paul. "Spencer Dam Collapse May Be First in Nation Caused by Giant Ice Chunks, Inspector Says." *Omaha World-Herald*, April 9, 2009. https://www.omaha.com/news/state_and_regional/spencer-dam-collapse-may-be-first-in-nation-caused-by/article_e0af7571-9264-5691-bd5c-344f4e940e85.html#11.

agreement (NDA). However, new guidance currently being written, will remove the NDA requirement and will permit inundation maps to be made available through the NID website.

Some large, non-federal dam owners emulate federal policies and resist sharing inundation maps (although state law may require that they be made public). This trickle-down effect has become a burden for some emergency managers, floodplain managers, and other community officials as they try to improve their community's resilience to dam-related flood hazards.

Impacts

The Community Rating System Program Activity 630 Credit is based on a state's:

- *Assessment of condition of dams*
- *Risk communication and public awareness*
- *Promotion of EAPs by operators*

Additionally, there must be at least one insurable building within the community subject to inundation if failure of a high hazard potential dam occurs and the community must be in compliance with the State Dam Safety (SDS) program. Possible SDS credit = up to 45 points.

Current dams sector information sharing practices can have a negative impact on the National Flood Insurance Program (NFIP) and, consequently, public safety. More specifically:

- Unsuspecting Communities. Many high hazard potential dams can have impacts on unsuspecting communities. Inundation zones can stretch for miles, and as a result, many communities may not be aware of the potential flood risk associated with these dams. This lack of awareness may lead to communities having weak (or no) evacuation plans and no strategy to mitigate dam related flood risk.
- Low NFIP Participation. We see low NFIP participation as home and small business owners opt out of flood insurance, not realizing that:
    - Standard homeowners' insurance does not cover flood risk; and
    - They *have* a flood risk due to spillway releases, or in an extreme case, failure of the dam.
- False Sense of Security. A lack of awareness of dam hazards can also create a false sense of security for floodplain residents. Unlike levees, they do not need flood conditions to

fail. They can be breached with little or no warning and send a wall of water downstream. Dam failures, like the Spencer Dam failure, destroy properties and take lives.

- Lack of Communication. Some floodplain managers, emergency managers and local officials are frustrated by the lack of information sharing. It prevents them from fully engaging in the NFIP Community Rating System (CRS). CRS activities contribute towards providing flood insurance and improving floodplain management. CRS communities that achieve a Class 1 rating can save homeowners up to 45 percent on flood insurance. However, without completing Activity 630 (the dam safety credit), floodplain managers cannot maximize the points and class earned for their communities. Floodplain managers are missing access to key information from high hazard potential dams and federal dams that impact their communities. They cannot fully participate in Activity 630, and therefore are relegated to a lesser class than they otherwise could obtain with the necessary information. This gap is not limited to a specific region but is prevalent across the United States.

Solutions

- Develop Partnerships. Dam owners need to engage with partner emergency managers, floodplain managers and local officials to understand how information sharing is important to the downstream communities potentially affected by their structures. Similarly, local jurisdictions need to listen to and help identify ways to remain sensitive to dam owner concerns. Building trust will enable a better understanding of what local jurisdictions need to increase public safety and reduce property loss.
- Discuss Broader Information Sharing. Continuing the work started by the Interagency ICODS and the NDSRB, the National Dam Safety Program needs to revisit information sharing practices for all high hazard potential dams, including federally owned and non-federal hydroelectric dams regulated by FERC. All dam owners have a responsibility to the communities to make available information necessary to adequately prepare themselves for a dam incident. However, this responsibility also includes ensuring the security of dams and the reliability of their associated lifelines, as well as the preservation of lines of communication during an emergency.
- Education. Inundation maps are a valuable tool in the hands of those who fully understand the information they convey and the assumptions on which they are based. If made available to the public, understanding risk in context is critical.

G. Publications and Resources

To encourage individual and community responsibility for dam safety, NDSP coordinates through two federal partnerships, the NDSRB and the ICODS. It is through these partnerships that the NDSP is able to leverage resources and subject matter expertise to produce technical manuals and guidelines each year. A detailed list of publications and resources including fact sheets, technical guidance, etc. is available in the resources section at the end of this Report.

H. Incidents During the Reporting Period[7]

As reported by the federal agencies, Table 1 includes incidents that occurred during the FY2018-2019 reporting period. Incidents include activities that caused an EAP to be activated or when a dam operation (or mis-operation) resulted in community involvement.

Table 1. Dam Incidents: FY 2018 – 2019.

Dam Incidents: FY 2018 - 2019		
Dam Name	**Location**	**Incident Type**
Menagers Dam	Ali Chuk, AZ	Hydrologic Event; near overtopping. (FY18 into FY19)
Oglala Dam	Pine Ridge, SD	Internal erosion event; spillway foundation piping
Lake Pushmataha Dam	Philadelphia, MS	Internal erosion event; actively piping
Mission Dam	St. Ignatius, MT	Cylinder gate failure
Wildhorse Dam	Mountain City, NV	Wildfire in contributing basin, gate failure, newly observed concrete cracking
Priest Rapids Dam	Mattawa, WA	High pressures found in lift joint in concrete spillway section
LaBarge Dam	Caledonia, MI	New area of seepage on embankment during high water event
Raeford Dam	Raeford, NC	During Hurricane Florence, flows passed down damaged auxiliary spillway
Devil's Kitchen Dam	Marfion, IL	Severe flooding caused the activation of auxiliary spillway causing some erosion of the fuse plug spillway and downstream erosion
Eightmile Lake Dam	Leavenworth, WA	Embankment overtopping event. Watershed burned above the dam causing temporary increase in runoff which caused the dam to overtop. Emergency measures were implemented to avert a failure. Dam is part of a withholding with in the national forest.
Upper Letts Lake	Mendocino National Forest, CA	Fire burned over dam killing a number of trees in the embankment. Dam hazard is currently being evaluated. The dam is being monitored. Planning is underway to reconstruct the embankment
San Bernadino National Forest 4	San Bernadino National Forest, Hemet, CA	High intensity fire burned over dam leaving 7 foot holes in the embankment from vegetation that was burned. Screening level hazard evaluation resulted in determination that the dam is a high hazard. Construction of breach is currently underway (11/21/2018) to abate the risk
Warden Slurry Impoundment	Centertown, KY	A potentially hazardous condition was discovered at the Warden Slurry impoundment in the form of excessive and progressive seepage that made the stability of the dam questionable. The

[7] This aligns with Goal 1, Objective 4 of the NDSP Strategic Plan.

Dam Incidents: FY 2018 - 2019		
Dam Name	**Location**	**Incident Type**
		operator installed a slurry discharge trunk line along the upstream slope of the dam with spigots spaced 100 feet apart. They also returned the sandy fine rejects from the fine coal cleaning circuits to the slurry stream and were able to create a beach on the upstream face of the dam. This has controlled the seepage for the short-term and eliminated the potentially hazardous condition. A geotechnical investigation found the cause of the excessive seepage to be the use of fill material for construction of the dam that did not meet the soil classification requirements of the construction specifications. Soil borings revealed zones of rock fill in the dam between about 1 and 5 feet thick
Rail Road Pond	Lilesville, NC	Excessive rain from Hurricane Florence caused impoundment to fail
Coon Creek Structure No. 23 (Bilhovde), NID WI00371	Monroe County, WI	Breach of dam from extreme rainfall event
West Fork Kickapoo Structure No. 1	Vernon County, WI	Breach of dam from extreme rainfall event
West Fork Kickapoo – MIsna Pilot Structure	Vernon County, WI	Breach of dam from extreme rainfall event
Coon Creek Structure No. 21	Monroe County, WI	Breach of dam from extreme rainfall event
Coon Creek Structure No. 29	Monroe County, WI	Breach of dam from extreme rainfall event
Santa Monica Debris Basin	Carpinteria, CA	Operation and Spillway Damage
Bear Creek Watershed Site 3	Houston County, MN	Water leakage in reservoir via sinkhole in pool area
Melvin Kruger grade stabilization structure	Greene County, IA	Back toe seepage
White Clay Dam	Pine Ridge, SD	Internal erosion event; spillway foundation piping
Prairie No. 1 Dam	Standing Rock, ND	Internal erosion event; sediment found in outlet works pipe leaks
Loup River	Genoa, NB	Failure
Toll Mountain Dam	Butte, MT	Sinkholes and slope instability developed on d/s slope of an orphaned special use dam that had been modified to raise its normal pool level; raised pool compounded by rainfall resulted in loss of available freeboard

Dam Incidents: FY 2018 - 2019		
Dam Name	**Location**	**Incident Type**
Turner Reservoir	Osage, WY	Collapse of primary spillway riser (previously documented as in poor, corroded condition) prevented passage of flow associated with rainfall events on 7/4/2019 and 7/8/2019 resulted in approximately 2 feet of scour of auxiliary spillway
Upper Fawn Lake	Red River, NM	Breach event resulting from higher than normal 2019 spring runoff and exacerbated by design flaws associated with the embankment (poor compaction; lack of freeboard; lack of filter zones) and appurtenant structures (inadequate spillway discharge capacity; lack of outlet works)
Cadman Materials W. Pond	Cherry Grove, WA	Failures of Downstream and upstream faces; no release
South Branch Park River Channels	West Hartford, CT	Cellular blocks and rip-rap displaced in many locations
CT-33 Spaulding Pond Brook Site 2	Norwich, CT	Wisteria plant roots which were allowed on the design are several feet deep into the dam
Tom Cope	Davis County, IA	Internal Erosion
Adam Smith	Davis County, IA	Internal Erosion
English Bench Site 9	Allamakee County, IA	Downstream Slope Failure and Principal Pipe Failure
Muddy Fork Str. 5	Borden, IN	Auxiliary Spillway (ASW) flow, Jun. 2019
Delaney Creek Str. 10	Salem, IN	ASW flow, Jun. 2019
Abiaca Watershed	Vaiden, MS	Top of Dam Breach
Bear Creek Site #4	Goldsboro, NC	Damage to one of the auxiliary spillways occurred during a storm event (Hurricane Florence) in September 2018.
Dam #34 Iredell Co.	Statesville, NC	Lack of Maintenance
Santa Cruz River Watershed Flood Water Retarding Structure (FWRS) Site #1	Chimayo, NM	Community involvement due to irrigation ditch being overwhelmed with water
Sebastian Martin-Black Mesa Watershed FWRSs #4,5, and 6	Espanola, NM	Community involvement due to upstream watershed modifications that divert partial flow around the dams, directly into downstream channels
Clear Branch Dam	Parkdale, OR	Movement of concrete auxiliary spillway section
Mountain Run 11	Culpeper, VA	Construction EAP activation due to potential ASW flow - notification only, no actions initiated

Dam Incidents: FY 2018 - 2019		
Dam Name	**Location**	**Incident Type**
Mountain Run 50	Culpeper, VA	Construction EAP activation due to potential ASW flow - notification only, no actions initiated
Swan Buffalo Creek Detention Dam #12	Absaraka, ND	Aux. Spillway Flow
Caddo Creek Site 21	Ardmore, OK	Landowner blocked tower with concrete, damaging auxiliary spillway
Caddo Creek Site 22	Ardmore, OK	Landowner blocked tower with concrete, damaging auxiliary spillway
Brule 26	Beresford, SD	Auxiliary spillway failure during Winter Storm Ulmer
South River 25	Sherando, VA	EAP activation due to ASW flow - notification and monitoring, no other actions initiated
South River 10A	Sherando, VA	EAP activation due to ASW flow - notification and monitoring, no other actions initiated
Quartermaster Creek Site 19B	Leedey, OK	Piping, Gypsum Sink Holes
Bear Creek Site 3	Clinton, OK	Piping, Gypsum Sink Holes
Barnitz Creek Site 30	Anthon, OK	Tailpipe Corrosion
Barnitz Creek Site 2	Leedey, OK	Tailpipe Corrosion
West Fork Kickapoo Structure No. 3	Vernon County, WI	Spillway erosion from extreme rainfall event
Coon Creek Structure No. 25	Monroe County, WI	Spillway erosion from extreme rainfall event
Coon Creek Structure No. 24	Monroe County, WI	Dam overtopped from extreme rainfall event; spillway and groin erosion
Dry Devils and Lowrey Sites 4 and 7	Sonora, TX	ASW flow caused scouring and minor erosion of exit section
Chatuge	Murphy, NC	Inoperable spillway gate car caused flooding concern and EAP to be activated.
Bush River 2	Farmville, VA	EAP activation due to ASW flow - notification and monitoring, no other actions initiated
Bush River 7	Meherrin, VA	EAP activation due to ASW flow - notification and monitoring, no other actions initiated
Lake Williams	Aurora, CO	Surface failure, cracking for dirt on top and sides of dam

Dam Incidents: FY 2018 - 2019		
Dam Name	**Location**	**Incident Type**
Lower Bethel	Hampton, VA	None: In 2018, underwater and geophysical inspections identified deficiencies. Full rehabilitation is under design. Water levels lowered until repairs are complete
Upper Bethel	Hampton, VA	None: In 2018, underwater and geophysical inspections identified deficiencies. Full rehabilitation is under design. Water levels lowered until repairs are complete
Suukjak	Fort McCoy WI	Sluice gate sealing issue
Stockton Dam	Stockton, MO	Inoperable Tainter gate due to wire rope detached during spring maintenance before 2019 flood event. Gate was set on 15 inch cribbing and stoplog was overtopped during flood event
Longview Dam	Longview, MO	Shallow slide on upper upstream slope
Joe Pool Dam	Dallas, TX	After six shallow surface slides occurred in FY18, an additional four slides followed during FY19. The slides are located on both upstream and downstream portions of the embankment
Joe Pool Dam	Dallas, TX	During gate operation the actuator failed to stop when gate reached the closed position causing a bent stem and damaged stem guides
Lewisville Dam	Lewisville, TX	Loss of material through joints of east spillway training wall with horizontal displacement of 1.5-inches between wall and backfill
Waco Dam	Waco, TX	Shallow surface slide on downstream face of embankment 100 feet wide with a main scarp of 4 ft located near the outlet works structure
Wright Patman Dam	Texarkana, TX	During gate operations, a foreign object became lodged between the hoist cable and sheave causing damage to the steel cable
Canyon Dam	New Braunfels, TX	Cracking and movement on outlet works tower service bridge pier first reported in FY16 and several temporary repairs completed to stabilize bridge deck. New cracks developed on center pier weeks after completion of most recent repair
Canyon Dam	New Braunfels, TX	Gate operation aborted due to loss of hydraulic fluid during system pressurization
Garrison Dam - Snake Creek Embankment	Coleharbor, ND	Depression adjacent to outlet works conduit
Gavins Point Dam	Yankton, SD	Spillway Tainter gate overtopping (up to 2.4 feet)
Webbers Falls Lock and Dam	Webbers Falls, OK	Two runaway barges struck the spillway during high flows, damaged the concrete weir and sunk in front of the Tainter gates preventing gate operation
Columbia Lock and Dam	Columbia, LA	Seepage and piping of foundation material within chamber and downstream of chamber

Dam Incidents: FY 2018 - 2019		
Dam Name	**Location**	**Incident Type**
Joe Pool Dam	Duncanville, TX	Following heavy rainfall, a shallow slide developed 120 feet long and 3 feet high in the embankment dam
Fall Creek Dam	Lowell, OR	Forebay Instrumentation Failure and Spillway Gate Overtopping
Bonneville Lock & Dam	Cascade Locks, OR	Downstream Miter Gate Sill Block Failure

I. Summary Timelines of the State Dam Safety Program Performance Information

The NDSRB has been collecting dam safety program performance information from the State Dam Safety Offices since 1998 as responses to the State Evaluation Criteria report questions and more recently in the annual State Dam Safety Program Performance Questionnaire. Timelines and data trends can be generated from this information in the following areas: EAPs, Inspections, Remediation Accomplishments, Budgetary and Staffing information. This information has been collected annually; however for display purposes, the charts below (Figures 6-12) show the data in two-year intervals.

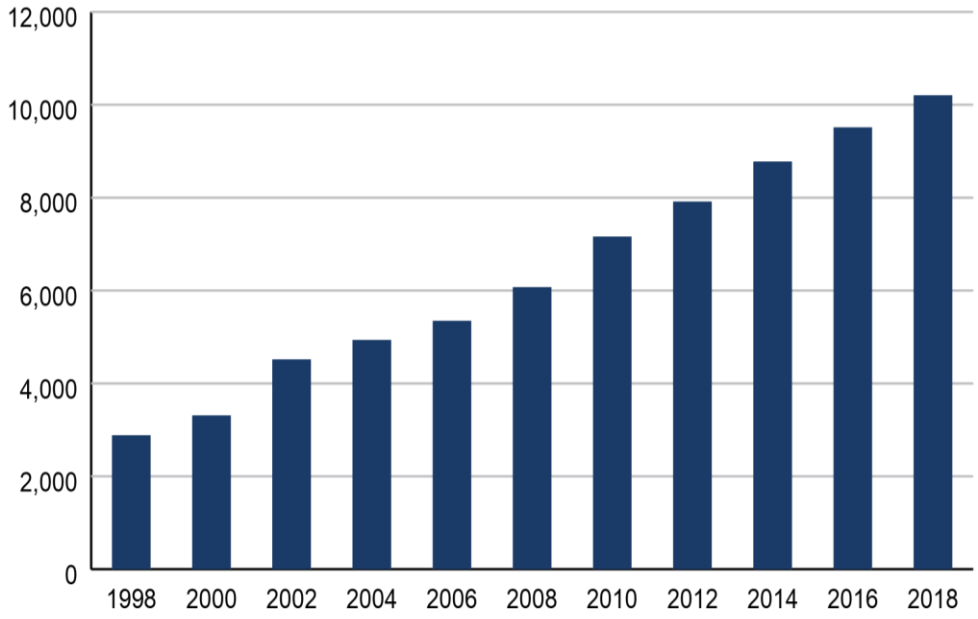

Figure 6. Number of State-Regulated High Hazard Potential Dams with an Emergency Action Plan (EAP)

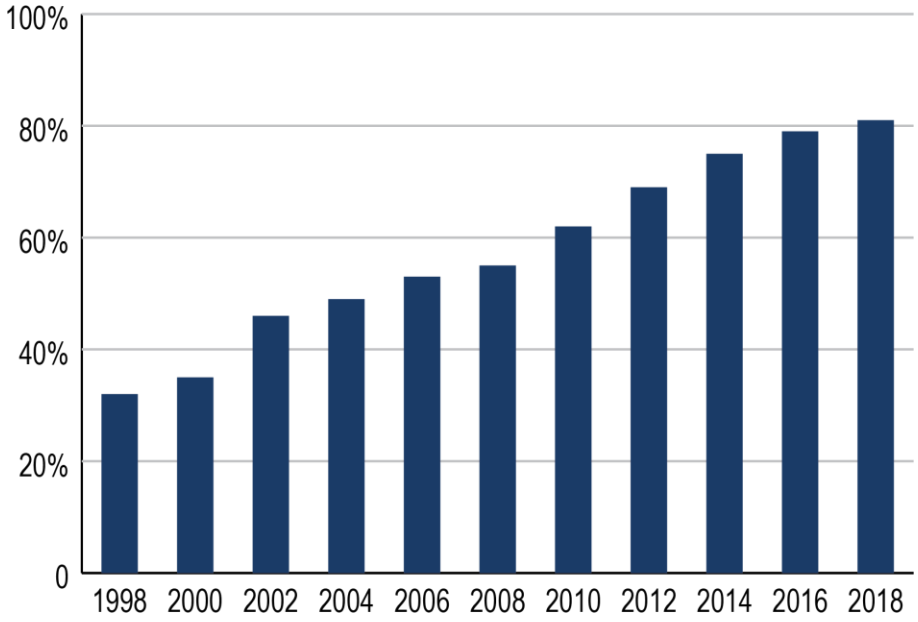

Figure 7. EAP Completion Percentage for State-Regulated High Hazard Potential Dams

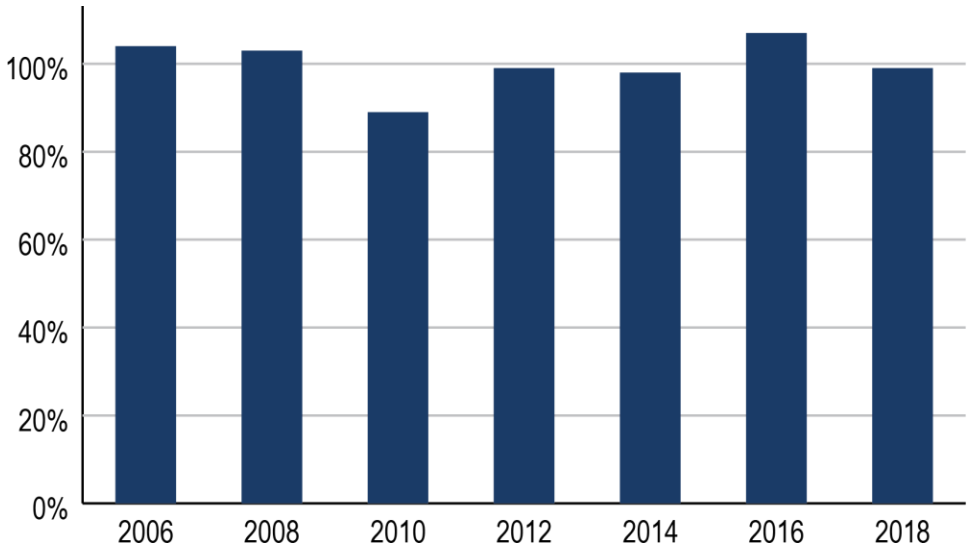

Figure 8. National Inspection Percentage of State-Regulated High Hazard Potential Dams

The National Inspection Percentage in Figure 7 is calculated based on the total number of state-regulated high hazard potential dams scheduled and inspected. Inspection percentages may vary above and below 100 percent for any given year based on a state's inspection frequency and scheduling. For 2006-08, number of high hazard potential dams were based on the NID database and not the State Dam Safety Program Performance Questionnaire annual data. In 2018, 53 percent of the states performed formal inspections for their high hazard potential dams, but 71 percent of the total high hazard potential dam inspections were formal. Formal inspections include a review to determine if the dam meets current accepted design criteria and practices. The inspection should include a review of all pertinent documents including instrumentation, operation, and maintenance and, to the degree necessary, documentation on investigation, design, and construction. This inspection should also verify that operating and emergency response instructions are available and understood, instrumentation is adequate, and data is assessed to assure structures are performing as designed.

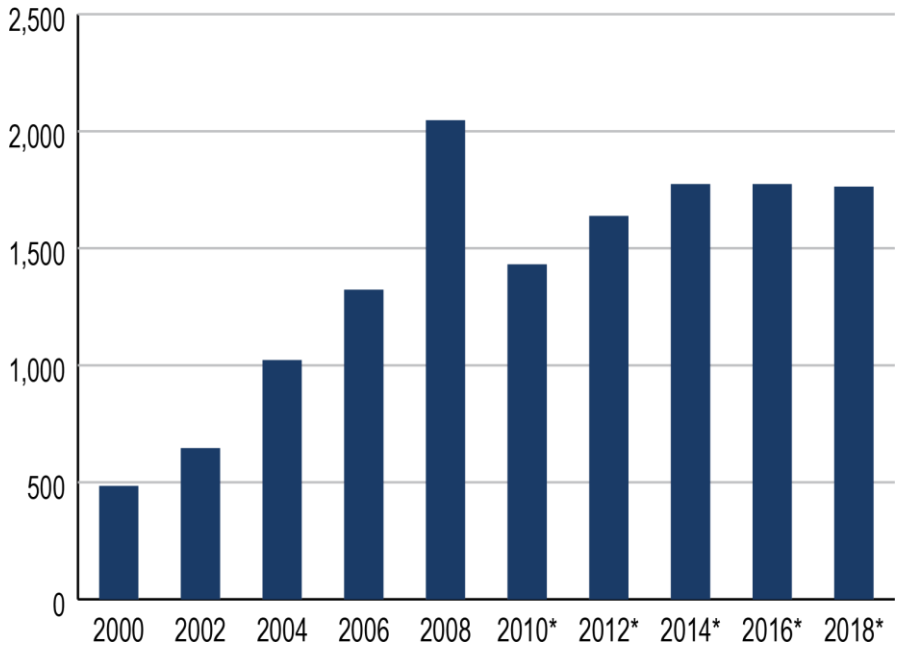

Figure 9. Number of State-Regulated High Hazard Potential Dams Identified to be in Need of Remediation

*To simplify reporting, beginning in 2009, the data in Figure 9 has been extracted from the NID Condition Assessment Data Field. * In 2010, 66 percent of state regulated high hazard potential dams had a condition assessment, 2012 - 71 percent, 2014 - 76 percent, 2016 - 85 percent and 2018 - 85 percent. Therefore, the 2010-18 numbers may be low estimates as the NID data is not complete.*

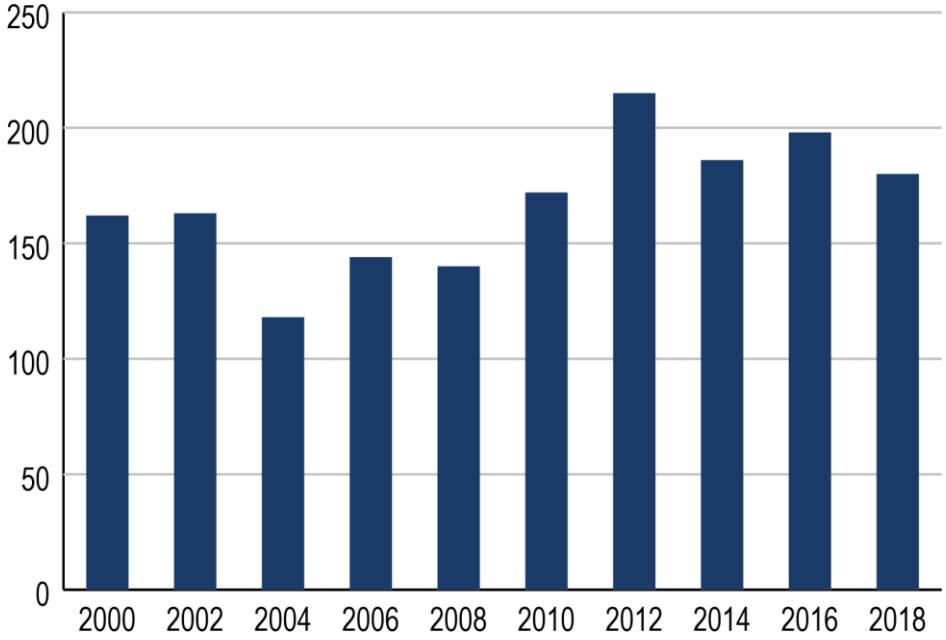

Figure 10. Number of State-Regulated High Hazard Potential Dams That Have Been Remediated (that is construction has been completed) During the Reporting Period Because of Dam Safety Deficiencies

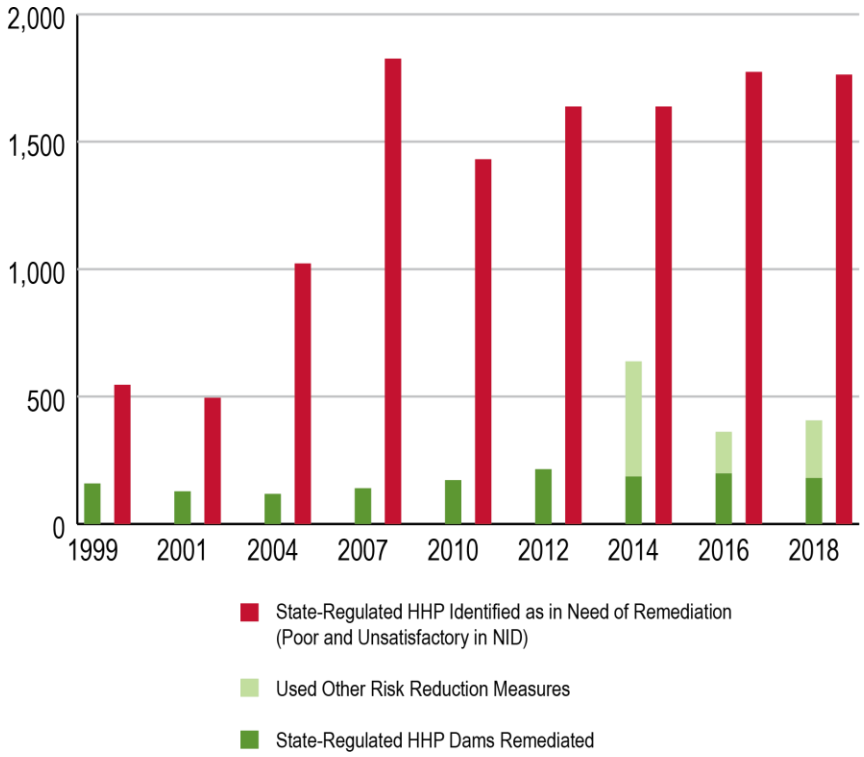

Figure 11. Number of State-Regulated High Hazard Potential Dams That Have Been Remediated or Other Risk Reduction Measures Utilized During the Reporting Period Because of Hydraulic/Structural Deficiencies

Note: Beginning in 2013, the information on dams using other risk reduction measures was included in the questionnaire.

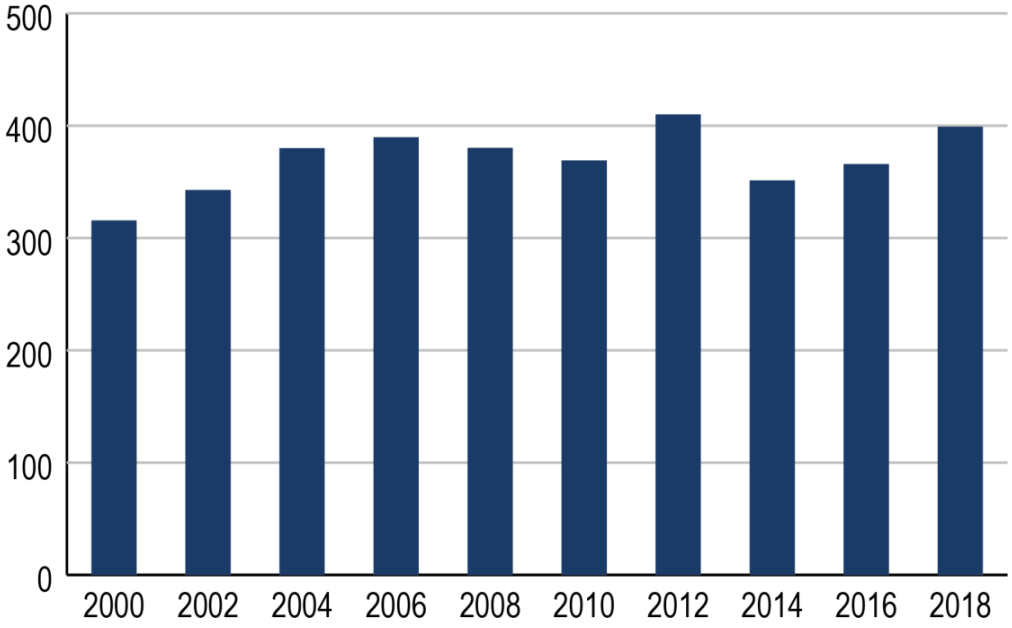

Figure 12. Number of Full Time Equivalent Technical Staff

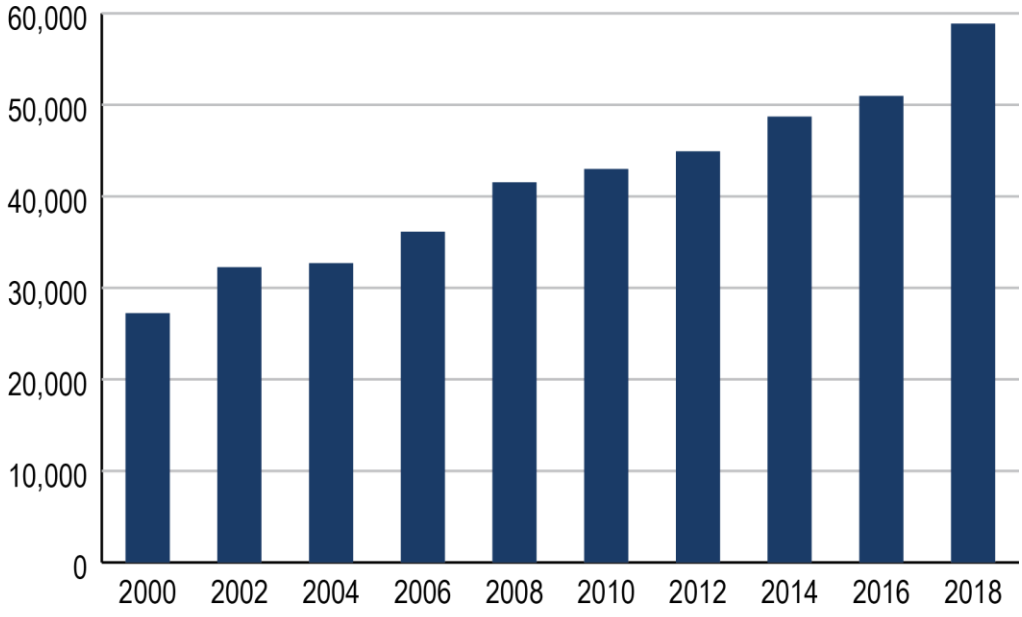

Figure 13. Total State Dam Safety Programs Budgetary Information, $1,000

J. The Mission is Ours: Summaries from Key NDSP Partners[8]

Federal Agencies

Dam safety is a joint responsibility of dam owners, states, and federal agencies. Since the implementation of the Federal Guidelines for Dam Safety in 1979, federal agencies have done an exemplary job in ensuring the safety and improvement of dams within their jurisdiction by sharing resources. Many Federal agencies also maintain comprehensive research and development and training programs and have incorporated security considerations and requirements into these programs to protect their dams against terrorist threats.

As part of preparing this Report, FEMA solicits information from all federal agencies through a Federal Questionnaire. The following is a summary of data collected via the Federal Questionnaire.

Federal Agencies

The federal government is directly responsible for maintaining the safety of federally owned and Large Capacity Federal[9] dams. The USACE and the Department of the Interior's Bureau of Reclamation (BOR) own 42 percent of federal dams, including many large dams. The remaining federal dams are owned by or under the jurisdiction of the Forest Service (FS), Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), Department of Defense (DOD) – U.S. Army, U.S. Navy, U.S. Air Force and U.S. Marine Corps, Bureau of Indian Affairs (BIA), Tennessee Valley Authority (TVA), National Park Service (NPS), Department of Energy (DOE), and International Boundary and Water Commission (IBWC). Congress has provided various authorities for these agencies to conduct dam safety activities, rehabilitation, and repair.

Inspections, Rehabilitation, and Repair

The *Federal Guidelines for Dam Safety* recommends that agencies formally inspect[10] each dam that they own or is under their jurisdiction at least once every five years; however, some agencies require more frequent inspections and base the frequency of inspections on the dam's hazard potential. Inspections may result in an update of the dam's hazard potential and condition assessment (see Figure 15 for the status of hazard potential and condition assessments of federal dams). Inspections typically are funded through agency Operations and Maintenance (O&M) budgets (see Table 2 for a summary of federal dam inspections during the reporting period. Note: U.S. Department of Agriculture's Agricultural Research Services (ARS) and Natural Resources Conservation Service (NRCS), U.S. Department of Labor's Mine Safety and Health Administration (MSHA), Federal Energy Regulatory Commission (FERC), Nuclear Regulatory

---

[8] This aligns with Goal 5, Objective 12 of the NDSP Strategic Plan.

[9] A dam with a height of 15 meters (49.21 feet) or greater from lowest foundation to crest or a dam between 5 meters (16.40 feet) and 15 meters (49.21 feet) impounding more than 3 million cubic meters. Source: https://www.icold-cigb.org/GB/dams/definition_of_a_large_dam.asp

[10] Formal inspections include a review to determine if the dam meets current accepted design criteria and practices. The inspection should include a review of all pertinent documents including instrumentation, operation, and maintenance and, to the degree necessary, documentation on investigation, design, and construction. This inspection should also verify that operating and emergency response instructions are available and understood, instrumentation is adequate and data is assessed to assure structures are performing as designed.

Commission (NRC), and Office of Surface Mining Reclamation and Enforcement (OSMRE) do not own any dams, only regulate/inspect them.).

Table 2. Formal Dam Inspections.

Formal Dam Inspections						
	Number of Dams, FY18			Number of Dams, FY19		
Agency	High Hazard Potential	Significant Hazard Potential	Low Hazard Potential	High Hazard Potential	Significant Hazard Potential	Low Hazard Potential
ARS	1	0	0	1	0	0
BIA	138	0	19	139	0	19
BLM	7	0	138	7	0	138
USBR	59	0	0	64	0	0
DOE	2	2	1	2	2	1
FERC	860	212	635	860	212	635
FWS	3	0	61	9	0	33
FS	5	0	0	2	0	0
IBWC	3	2	2	0	0	0
MSHA	0	0	0	0	0	0
NPS	12	7	13	0	4	4
NRCS	1317	619	6255	1276	520	4901
NRC	0	0	1	0	0	6
OSMRE	80	88	392	80	88	392
TVA	10	1	0	14	2	1
USAF	5	1	1	0	0	5
U.S. Army	2	4	43	16	1	32
USACE	101	27	9	93	35	3
USMC	1	0	3	2	0	1
U.S. Navy	1	2	3	1	0	4

After identifying dam safety deficiencies[11], federal agencies may undertake risk reduction measures or rehabilitation and repair activities. Agencies may not have funding available to immediately undertake all non-urgent rehabilitation and repair; rather, they generally prioritize their rehabilitation and repair investments based on risk and/or various forms of assessment and schedule these activities in conjunction with the budget process. At some agencies, dam rehabilitation and repair needs must compete for funding with other construction projects (e.g., buildings and levees). Please see Figure 14 and 15 for a summary of federal dam rehabilitation projects and estimated costs.

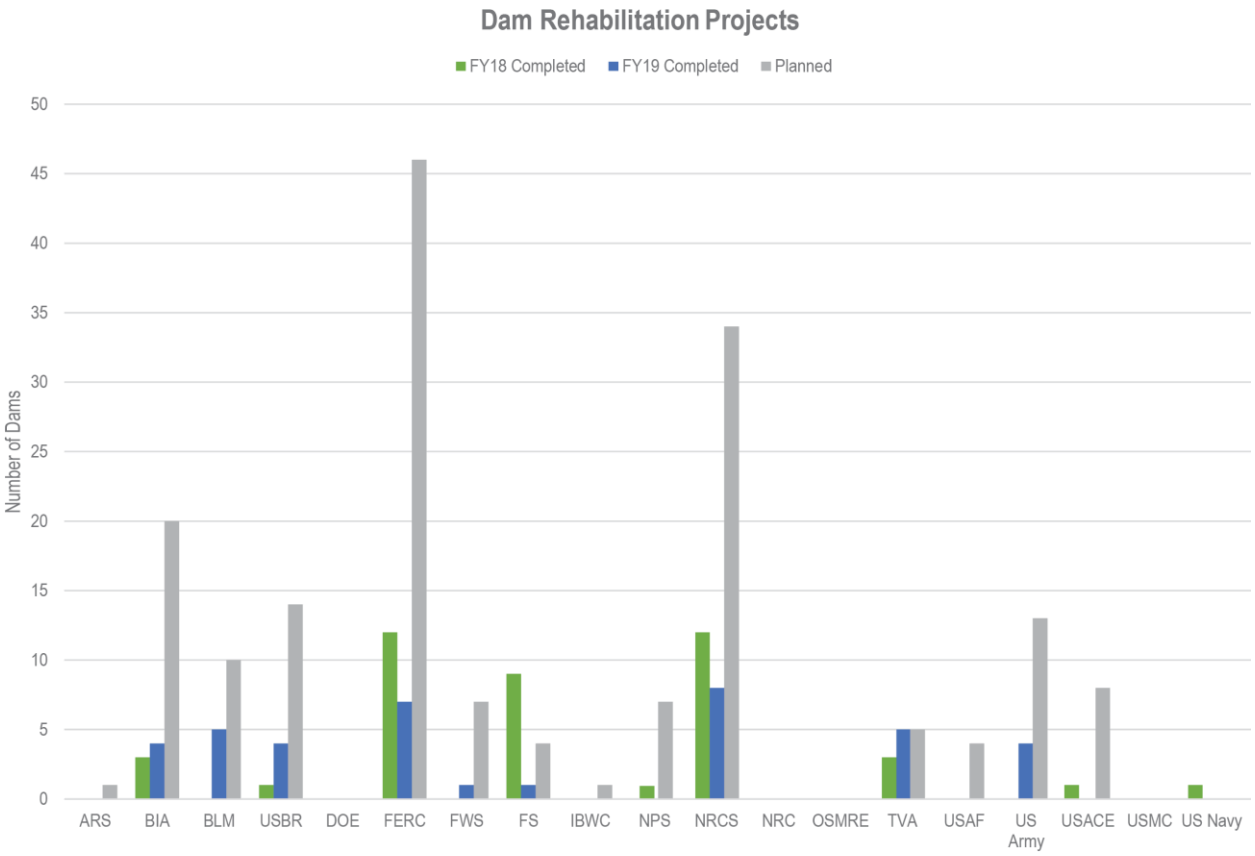

Figure 14. Dam Rehabilitation Projects.

[11] A dam safety deficiency is an unacceptable dam condition that may affect the safety of the dam either in the near term or in the future. Source Federal Guidelines for Dam Safety https://www.fema.gov/media-library-data/20130726-1502-20490-5785/fema-93.pdf

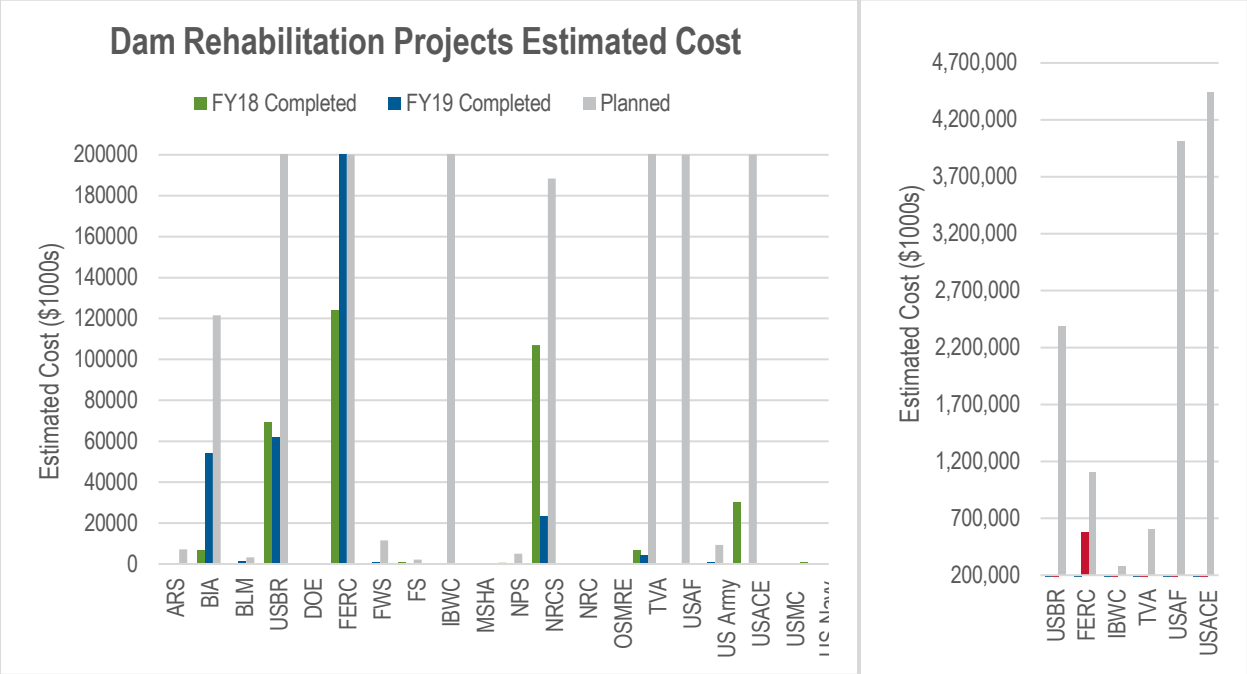

Figure 15. Dam Rehabilitation Projects Estimated Cost.

Training and Staffing

The NDSP Training Program is designed to help state, local and tribal governments obtain the knowledge, tools, and support that they need to plan and implement effective dam safety strategies. Resources available through the program include instructor-led courses, web-based courses, and videos. A key pillar of the NDSP, all of the federal partners both offer and participate in a number of training opportunities throughout the year (see Figure 16 for a summary of number employees trained/hours).

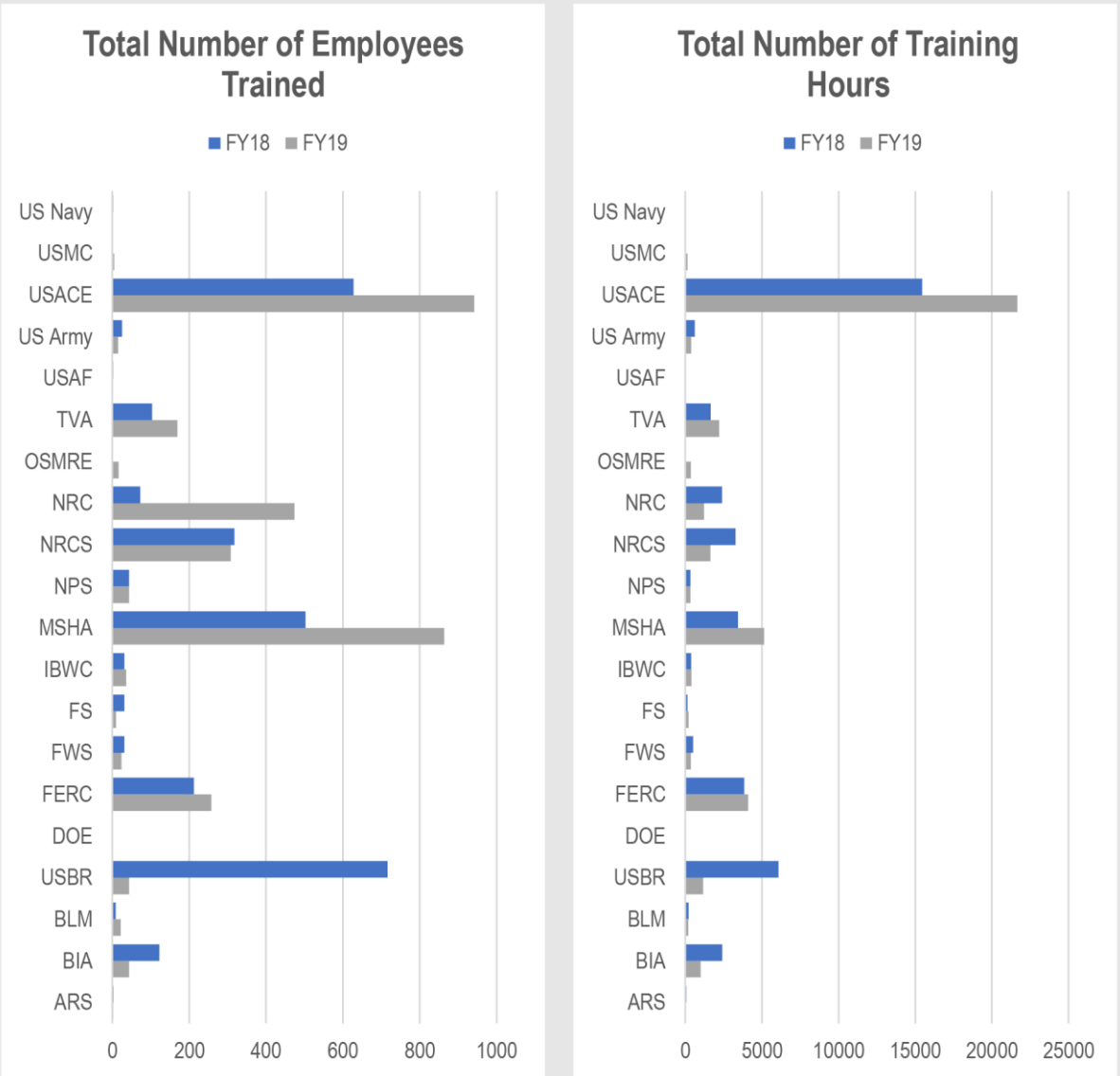

Figure 16. Total number of employees trained and total number of training hours side-by-side comparison.

Staffing amongst the federal agencies varies greatly. Table 3 summarizes each agency's staff rates by measure of Full Time Employees (FTEs) and category.

Table 3. Staffing by Job Type.

Staffing by Job Type								
	Number FTEs, FY18				Number FTEs, FY19			
Agency	Admin / Clerical	Technical	Other	Total	Admin / Clerical	Technical	Other	Total
ARS	1	1	1	3	1	1	1	3
BIA	2	39	0	41	2	39	0	41
BLM	0	3.25	0	3.25	0	4	0	4
USBR	3	14	0	17	3	15	0	18
DOE	0	0	0	0	0	0	0	0
FEMA	0	3	0	3	0	3	0	3
FERC	7	113	0	120	6	123	0	129
FWS	0.1	4	0	4.1	0.1	3.5	0	3.6
FS	0	6.95	0	6.95	0	6.75	0	6.75
IBWC	1	11	1	13	1	10	4	15
MSHA	2	10	20	32	2	10	18	30
NPS	0	1	0	1	0	1	0	1
NRCS	54	231	228	513	54	231	228	513
NRC	0.008	0.27	0	0.278	0.01	0.28	0	0.29
OSMRE	0	28	1	29	0	4	1	5
TVA	3	98	44.2	145.2	3	98	46.2	147.2
USAF	0	7	13	20	0	7	13	20
U.S. Army	1	48	0	49	1	34.15	2	37.15
USACE	50	360	144	554	50	361	173	584
USMC	0	0.5	0	0.5	50	0.5	0	0.5
U.S. Navy	0	1.25	0	1.25	0	1.25	0	1.25
	Total:			1556.53	Total:			1562.74

FEMA Related Programs

In addition to the initiatives set forth directly by NDSP, there are a number of programs within FEMA that provide resources and services that support dam hazard risk mitigation, preparedness, response, or recovery. The following is a summary of some of those efforts.

FEMA Regional Dam Safety

In FY 2016, FEMA delegated certain program and grants management responsibilities to each of the ten FEMA Regions. However, the FEMA Regional Offices were not allocated dedicated FTE dam safety positions. Rather, the delegated points of contact manage dam safety responsibilities in addition to other FEMA programs.

On March 2, 2016, former FEMA Administrator Craig Fugate signed a Delegation of Authority to the Regional Administrators (FDA 0106-1). The delegation of authority contains and includes the following elements:

a. Delegation of authorities
b. Appendix A – General authorities
c. Appendix B – Response and Recovery duties and powers
d. Appendix C – Federal Insurance and Mitigation duties and powers
e. Appendix D – Preparedness duties and powers
f. Appendix E – Federal Award Management Authorities Definitions and Summary
g. Appendix F – Non-exclusive list of the sources of authority relevant to this delegation
h. Appendix G – Statutory Duties of the Regional Administrator, Section 507 of the Homeland Security Act of 2002, Pub. L. No. 107-296 (2002) (codified as amended at 6 U.S.C. § 317, and 5 U.S.C. § 7106(a)(2)(D))
i. Appendix H – General description and table of authorities delegated to Regional Administrators in Title 44 of the Code of Federal Regulations, as amended.
j. Appendix I – Baseline Organizational Structure

The following is a summary of FEMA Dam Safety regional efforts pursuant with the duties and powers outlined in the Delegation of Authority (FDA 0106-1):

a. Act as a liaison between FEMA and federal, state, local, and private partners to identify and assess high risk dams and to work with partners to develop community and regional preparedness, response, recovery, and mitigation strategies for those risks.
b. Coordinated consideration of dam risks into multi-hazard planning, exercise planning and execution, and emergency operation planning and activities.
c. Work across FEMA Directorates and with federal, state, local, and private partners to develop dam risk communication and public awareness strategies.
d. Provided subject matter expertise in the FEMA Regional Response Coordination Center (RRCC) and/or Joint Field Office (JFO) during dam-related emergencies and disasters.

e. Support the coordination and provision of training for state dam safety staff and inspectors pursuant to Section 10 of the National Dam Safety Program Act, Pub. L. No. 92-367 (1972) (codified as amended at 33 U.S.C. § 467g-1).

f. Manage, administer, and conduct application budget review, award package creation, award approval, grantee award notification, release of funds, award amendment, cash management analysis, financial monitoring, closeout, and audit resolution activities with respect to National Dam Safety grants pursuant to Section 8 of the National Dam Safety Program Act, Pub. L. No. 92-367 (1972) (codified as amended at 33 U.S.C. § 467f).

Based on the regional FY2018 and FY2019 best practices and lessons learned, the following summarizes recommended regional Dam Safety Program enhancements:

- Support the development of regional and state preparedness, response, recovery, and mitigation strategies through the offering of grant programs, trainings, workshops, collaboration and networking opportunities with dam safety state partners and stakeholders.
    - Opportunities for states and regions to share technical best practices on Dam inventory management, viewer applications, modelling, and Emergency Management Applications.
- Annually validate dam safety state partners and stakeholders' point-of-contact information for emergency response activation (critical data sharing and emergency operations coordination) for dam breach and failure.
- Facilitate improved information sharing processes between Regional Response Division and dam safety state partners and stakeholders for all high hazard dams, including federally owned.
- Assist in interdivisional coordination within the Response division to include operations collaboration and capacity building for dam failure incidents.
- Enhanced coordination between regional dam safety program staff and mitigation planning staff to ensure dam risk is adequately included in state and local hazard mitigation plans.
- Coordinate with External Affairs and Floodplain Management and Insurance Branch to reframe flood risk and dam safety public messaging:
    - Increase public safety and risk awareness for people living downstream of the dams. When dams age, deteriorate, or malfunction, they can release sudden, dangerous flood flows resulting in public safety and property damage risks; outreach and messaging to include flood insurance.

Hazard Mitigation Assistance

Hazard Mitigation is any action taken to reduce or eliminate long term risk to people and property from natural disasters. Hazard Mitigation projects may include, but are not limited to, buy-outs, elevations, and safe rooms. Currently, FEMA administers three programs that provide funding for eligible mitigation projects that reduce disaster losses and protect life and property from future disaster damage. The three programs are the Hazard Mitigation Grant Program, the Flood Mitigation Assistance Program, and the Pre-Disaster Mitigation Program. In FY 2018 and FY 2019, FEMA provided $10,310,146.00 in Hazard Mitigation Assistance (HMA) funding to complete three dam-related projects (See Table 4 for a summary of HMA Dam-Related

Projects). This will protect the life, safety, and welfare of the homes, property, bridges, roadways, public parks, and public utility infrastructures located below the dam.

Table 4. FY18 and FY19 HMA Dam-Related Projects.

FY18/19 HMA Dam-Related Projects					
Project Title	**County**	**Program Area**	**Project Amount**	**Federal Share Obliged**	**Type**
5 percent Mendocino County Dam Inundation Zone Delineation Mapping & Risk Reduction Plan	Mendocino, CA	Hazard Mitigation Grant Program (HMGP)	$149,303	$111,997.24	800.1: Miscellaneous
Resilient Infrastructure Dam Safety Mitigation at Goose Pasture Tarn Dam	Summit, CO	Pre-Disaster Mitigation Grant Program (PDM)	$18,884,795	$10,000,000.00	402.3: Infrastructure Protective Measures
Hobart Reservoir Dam Advance Assistance	Washoe, NV	PDM	$264,816	$198,149.34	904.2: Advance Assistance (Flood Mitigation Assistance (FMA) and PDM)
		Totals:	**$19,298,914**	**$10,310,146.00**	

Public Assistance Program

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as Amended (Stafford Act), Title 42 of the United States Code (U.S.C.) § 5121 et seq., authorizes the President to provide federal assistance when the magnitude of an incident or threatened incident exceeds the affected state, territorial, tribal, and local government capabilities to respond or recover. The purpose of the Public Assistance (PA) Grant Program is to support communities' recovery from major disasters by providing them with grant assistance for debris removal, life-saving emergency protective measures, and restoring public infrastructure. Local governments, states, tribes, territories, and certain private nonprofit organizations are eligible to apply. Please see Table 5 below for a summary of relevant Public Assistance projects from the reporting period.

Table 5. FY18 and FY19 Public Assistance Projects.

FY18 Public Assistance Projects			
Facility Name	**Applicant Name**	**State**	**Federal Share Obliged**
Galesville Dam	Galesville	WI	$22,700.83
Vernon Co Land Water Conservation - Dams County Wide	Vernon County Land & Water Conservation Department	WI	$9,355.55

FY18 Public Assistance Projects

Facility Name	Applicant Name	State	Federal Share Obliged
Vernon Lake Dam	Louisiana Dept Of Transportation & Development	LA	$699,381.15
AR 6-16	Pueblo of Acoma	NM	$268,654.50
Crow Point Dirt Tank	Pueblo of Acoma	NM	$7,836.89
South Dirt Tank	Pueblo of Acoma	NM	$172,803.32
Berry Hill Ranch-Middle Pasture Dirt Tank	Pueblo of Acoma	NM	$1,106,906.87
Gottlieb Roadside Tank	Pueblo of Acoma	NM	$119,515.50
Black Mesa Northeast Diversion Breach	Pueblo of Acoma	NM	$59,374.69
Sedimentation Pond North Side of Acomita Lake	Pueblo of Acoma	NM	$14,594.04
57 Dirt Tank - Largo Canyon	Pueblo of Acoma	NM	$8,842.96
Horace West Dirt Tank	Pueblo of Acoma	NM	$31,028.07
Upstream Valley Flood Control Dam	Pueblo of Acoma	NM	$4,791.97
Hanks Dirt Tank Blue Bird Tank Pottery Dam Spongebob Retention Dam	Pueblo of Acoma	NM	$197,692.00
Upstream Valley Flood Retention Dam	Pueblo of Acoma	NM	$17,387.20
Bar 15 - 5 Berm	Pueblo of Acoma	NM	$2,147,665.79
Tank #5 Fox Trap Canyon	Pueblo of Acoma	NM	$607,344.08
Warren Fish Hatchery Dam	New Hampshire Fish and Game	NH	$4,073.18
		Total:	**$5,499,948.59**

FY19 Public Assistance Projects

Facility Name	Applicant Name	State	Federal Share Obliged
Drainage Structure-Lake Spillway	Leawood	KS	$58,048.74
Jameson Lake Mwtf10a	Montecito Water District	CA	$36,750.00
Flood Control (FC)- Romero, Upper West Toro, and Arroyo Paredon Debris Basins	Santa Barbara (County)	CA	$72,701.41
Town of Farmington - Drainage Outfall Erosion Failure	Farmington (Town of)	ME	$18,321.33
City Lake Dam	Edmonton	KY	$5,885.72
Parks - Vettiner Dam, Spillway, & Cartpath	Louisville Metro Government	KY	$81,691.07
West Race Buoy Line	City of South Bend, Venues, Parks & Arts Dept	IN	$17,556.75
Myers Arm No. 7	Marshall Drainage Board	IN	$16,179.63
Huron Creek Dam	Houghton	MI	$3,014.92

FY19 Public Assistance Projects			
Facility Name	**Applicant Name**	**State**	**Federal Share Obliged**
Redridge Dam - Concrete and Beam Restoration Wooden Dam Structure	Stanton (Township of)	MI	$189,795.00
Radigan Dam	Dairyland (Town of)	WI	$249,919.50
Cranberry Creek Dam	Douglas County Forestry Department	WI	$108,750.00
Sawgrass Dam Embankment Repairs	Ankeny	IA	$93,576.97
Mill Pond Berm	Nora Springs	IA	$14,933.65
Drainage Site 46B	Webster Co. Drainage Districts	IA	$44,401.98
Lake Hanska Water Control	Minnesota Department of Natural Resources	MN	$16,746.22
Okabena-Ocheda Watershed District (WD) spillways Okabena-Ocheda WD- Prairie View Spillway	Okabena-Ocheda Watershed District	MN	$42,535.21
Overflow Repair at Sewer Ponds	Redwood Falls	MN	$6,466.56
Springdale Water Retention Project 21	Springdale (Township of)	MN	$50,874.86
Clyde Lucas Lake Dam Spillway	Asheboro	NC	$2,913.11
Campus-wide Storm Water Management Pond Repairs	Cape Fear Community College	NC	$6,944.51
College Lake Dam	Fayetteville	NC	$22,890.27
Chesapeake Dam	Fayetteville	NC	$13,625.23
Fish Ladder Replacement	Hope Mills	NC	$4,823.24
Maxton Dam Engineering Study	Lumbee Tribe of North Carolina	NC	$38,147.25
Dutch Buffalo Creek Raw Water Intake Dam	Mount Pleasant	NC	$172,500.00
Agriculture Horticultural Crops Research Station	Nc Department of Agricultural & Consumer Services	NC	$2,545.90
Forest Hills Elementary School (ES) (328) Wrightsboro ES	New Hanover County School District	NC	$42,832.37
Lake	Pine Bluff	NC	$63,161.48
Tabor Lake Dam	Tabor City	NC	$300,981.45
Walnut Creek, Village	Walnut Creek	NC	$9,022.95
Greenfield Lake Breach/Failure	Wilmington	NC	$14,965.03
Darpo Dam - Darlington County	Darlington (County)	SC	$44,820.75
Erosion of Emergency Earthen Spillway	Pageland	SC	$44,887.50
Georgetown - Winyah Location - Dike Slide	Public Service Commission of South Carolina Doing Business As (BDA) Santee Cooper	SC	$2,882.55
Check Dam on Lovell Rd stream	Elmira (Town Of)	NY	$3,875.92
Lannie Rowe Spillway	Callaway	FL	$8,498.39
Sneads - Drainage Ditch	Sneads	FL	$5,195.37
Lake Emery Rehabilitation District-Richards Mill Dam	Lake Emery Rehabilitation & Preservation District	WI	$10,643.81

FY19 Public Assistance Projects			
Facility Name	**Applicant Name**	**State**	**Federal Share Obliged**
West Fork (WF)-Plot Klinkner (PK) Coon Creek (CC)-15 (Swenson) CC-41 (Dahlen)	Vernon County Lwcd (Dams)	WI	$30,650.36
CC-17 (Melby)	Vernon County Lwcd (Dams)	WI	$2,688.70
Yellowstone Irrigation Diversion Structure	Yellowstone Irrigation District	MT	$298,172.25
Yellowstone Irrigation Diversion Structure	Yellowstone Irrigation District	MT	$192,443.25
Ashland Area Municipal Authority Weir Damage	Ashland Area Municipal Authority	PA	$96,453.75
Mahanoy Township Authority Dam No. 6 Mahanoy Township Authority Pole Run Dam No. 4 Spillway Damage. Mahanoy Township Authority Waste House Dam No. 1 Spillway Damage	Mahanoy Township Authority	PA	$36,618.46
Ditch #3 Ditch #4	Tohono O'odham Farming Authority	AZ	$97,016.12
Siphon Line	Tohono O'odham Farming Authority	AZ	$230,532.75
Hydraulic Dam at Wastewater Treatment Plant -Shady Lane	Rocky Mount Town	VA	$20,987.96
Upper and Lower Powhatan Lake Combination with Powhatan Lake Dam	Virginia Department of Game & Inland Fisheries	VA	$31,244.63
King and Queen Dam/Spillway Damages	Virginia Department of Game & Inland Fisheries	VA	$44,245.61
Wirtz Dam	Lower Colorado River Authority	TX	$24,298.52
Feeder Canal (Custer County)	Farwell Irrigation District	NE	$25,887.98
In- Take Structure	Loup Power District	NE	$1,222,182.75
Lake Berm	Sid #3 - Lake Ventura	NE	$42,300.00
City Dam and Reservoir	Springfield Water Co	KY	$497,135.61
Lake Hemet Spillway Spillway Emergency Protective Measures	Lake Hemet Municipal Water District	CA	$13,442.26
Lake Overcup Dam (Hazard Mitigation Requested)	Arkansas Game & Fish Commission	AR	$29,560.26
		Total:	**$4,880,167.82**

Other Related Programs

In addition to the initiatives set forth directly by NDSP, there are a number of programs outside of FEMA, including private sector partners, that provide resources and services that support dam hazard risk mitigation, preparedness, response, or recovery. The following is a summary of some of those efforts.

Cybersecurity and Infrastructure Security Agency

Presidential Policy Directive (PPD)-21, *Critical Infrastructure Security and Resilience*, advances a national unity of effort to strengthen and maintain secure, functioning and resilient critical infrastructure. PPD-21 establishes national policy on critical infrastructure security and resilience. This is a shared responsibility among the federal, state, local, tribal and territorial entities, and public and private owners and operators of critical infrastructure (herein referred to as "critical infrastructure owners and operators"). This directive also refines and clarifies the critical infrastructure-related functions, roles, and responsibilities across the federal government, as well as enhances overall coordination and collaboration. Federal Sector Specific Agencies (SSAs) are responsible for the 16 sectors defined. As such, the Department of Homeland Security's Cybersecurity and Infrastructure Security Agency (CISA) serves as the SSA for the Dams Sector.

CISA actively collaborates with sector stakeholders (including federal, state, local, tribal and territorial partners) to identify and implement programs that enhance the protection and resilience of dams across the nation. This collaboration occurs under the auspices of the Critical Infrastructure Partnership Advisory Council (CIPAC). The CIPAC framework provides a forum that allows government and private sector partners to conduct effective information sharing and coordinate a broad spectrum of infrastructure security activities across all sectors. As part of the CIPAC framework, the Dams Sector Coordinating Council and Government Coordinating Council constitute a focal point for public-private coordination of cybersecurity and infrastructure security efforts for dams and related facilities.

Protective programs and resilience strategies encompass a wide spectrum of efforts, including implementing active or passive countermeasures and improving security protocols, hardening or retrofitting facilities to improve their performance under extreme loadings, implementing cyber-security measures, building operational redundancy, implementing back-up systems to minimize disruptions, implementing consequence-mitigation programs, conducting exercises, enhancing business continuity planning, and designing and planning multi-scenario restoration and recovery procedures. Effective information exchange among owners, regulators, and their associated communities can also contribute to enhancing the protection and resilience of the Dams Sector.

The collaborative partnership among government and non-government entities across the Dams Sector has resulted in the development of a variety of tools and products focused on improving protection and enhancing resilience. To ensure all dams stakeholders may access information related to protective programs, sector partners collaborated with CISA to update a series of guides on personnel screening, surveillance and suspicious activity, emergency preparedness, and cybersecurity. In addition, a sector profile and landscape document were developed. Reference documents and training resources are accessible through the Homeland Security Information Network - Critical Infrastructure (HSIN-CI) Dams Portal.

In support of the implementation of Executive Order 13636 (Improving Critical Infrastructure Cybersecurity), a Dams Sector Cybersecurity Working Group was established under the direction of both the Dams Sector Government Coordinating Council and Sector Coordinating Council. The Working Group's ongoing activities support the national policy implementation to effectively integrate both physical and cybersecurity initiatives at the national level as defined by PPD-21 and the executive order. For example, CISA, in collaboration with the Cybersecurity Working Group, initiated an update to the 2015 Dams Sector Cybersecurity Framework

Implementation Guidance to rollout in early 2020, this guidance document enables an organization—regardless of its size, degree of risk, or cybersecurity sophistication—to apply the principles and effective practices of cyber risk management to improve the security and resilience of its critical infrastructure. It recommends an approach that enables organizations to prioritize their cybersecurity decisions based on individual business needs without additional regulatory requirements.

Other important activities have focused on information sharing and outreach efforts. For example, the 2018 Dams Sector Information Sharing Drill provided sector partners an opportunity to test the sector's information sharing protocols as described in the 2015 Dams Sector Information Sharing Resource Guide. The drill was made relevant to all participants through the use of an all-hazards approach that did not focus on any particular project or region, allowing partners to test their own organization's processes as well as the sector's processes in an effort to enhance security and resilience.

Further, CISA offered field-delivered courses. The instructor-led Dam Security and Protection Technical Seminar was conducted once in 2018 prior to being updated and rebranded as the Security and Protection for Dams and Levees workshop in 2019. The new workshop was piloted in the summer of 2019. This workshop provides owners/operators, state dam safety officials, and other sector stakeholders with information pertaining to security, protection and crisis management issues in order to improve understanding of dam-related security and protection concepts. The goal of the workshop is to help integrate security, protection, and resilience strategies into stakeholders' respective risk management strategies, and leverage existing Dams Sector reference materials to provide a depth and breadth of expertise and knowledge regarding dam security and protection.

Federal partners work in collaboration to continue research on the vulnerabilities associated with embankment dams (blast impact and mechanical excavation analyses), concrete dams (waterside blast impact), and spillway gate structures (land and water-side blast impact and mechanical analysis). The research also includes designing and testing of risk mitigation measures that can potentially be utilized by sector partners for risk reduction at their assets.

CISA, through a competitive process administered by the National Institute of Hometown Security, implemented the National Infrastructure Protection Plan Security and Resilience Challenge. The purpose of the challenge was to provide an opportunity for the critical infrastructure community to identify, develop, and fund state-of-the-art, cost-effective projects that address near-term needs and strengthen the security and resilience of critical infrastructure. Two of the selected projects fell within the purview of the Dams Sector, the Condition Assessment Procedures for Concrete Dams with Post-Tensioned Anchors and Biopolymer-Stabilized Earth Materials for Resilient and Adaptable Infrastructure.

CISA responded to requests for information and conducted outreach to real world incidents. Automated alerts from HSIN keeps sector partners informed of suspicious activities, incidents, and developing threats across the Dams Sector and interdependent sectors.

ASDSO Report to the NDSP Biennial Report

The Association of State Dam Officials (ASDSO) is a national non-profit organization dedicated to improving dam safety in the U.S. The mission of ASDSO is to improve the condition and

safety of dams and reduce the consequences associated with dam incidents, through education, support for state dam safety programs and fostering a unified dam safety community.

ASDSO is directed by and primarily represents the interests of state dam safety regulatory programs across the U.S.

The pursuit of a cohesive national approach to dam safety, which includes working closely with the National Dam Safety Program (NDSP) on mutual goals, is one key to meeting the mission. Raising awareness, providing technical training, establishing forums for information exchange, facilitating financing for dam safety activities, and advocating for strong state dam safety programs continue to be of critical importance.

During the last two years, ASDSO has made strides toward its goals. Below is a snapshot of ASDSO activities.

Improving State and Owners Dam Safety Programs

ASDSO annually monitors and analyzes state dam safety performance data and looks at trends over time. This data is submitted by states in partnership with the U.S. Army Corps of Engineers' annual call for data via the National Inventory of Dams project. Each state routinely receives a "report card" or "dashboard" analysis of its program performance from ASDSO; comparing the state to nationally agreed-upon measures including number of inspections, number of EAPs on file, and state budgets for dam safety. Each state answers questions comparing their programs to the FEMA Model State Dam Safety Program. ASDSO continues to provide these report cards to the NDSP to inform decisions about improvements to the State Dam Safety Assistance Program.

During the report period, ASDSO compiled and analyzed the 2017 and 2018 performance data provided by states. Individual state reports were developed and national statistics were compiled and used to identify trends and improvements in state benchmarks and during federal and state legislative visits or media interviews. Here is a snapshot of data trends based on state program input.

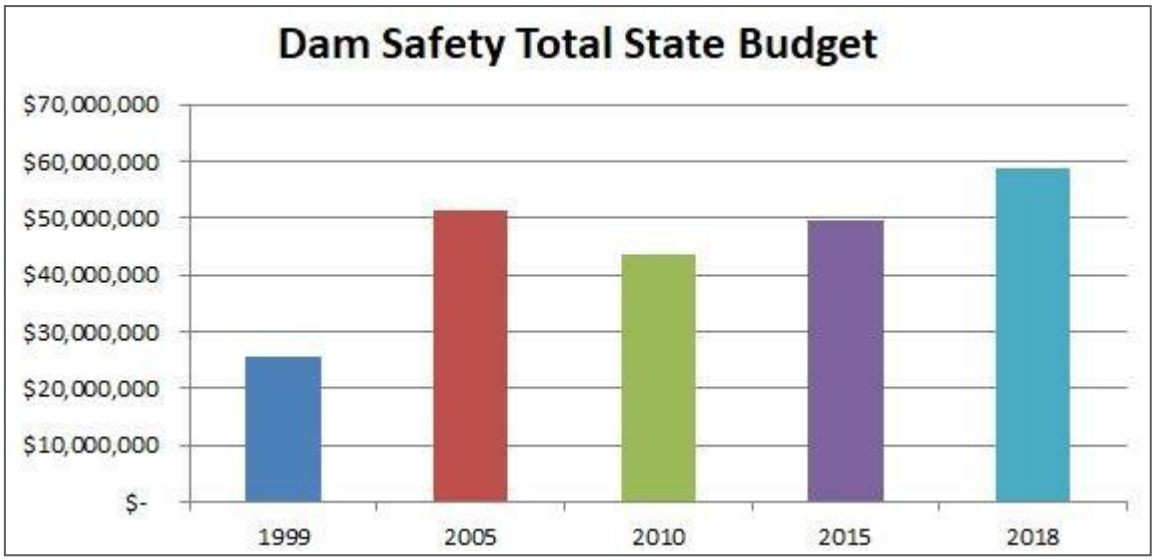

Figure 17. ASDSO Dam Safety Total State Budget.

Comparison to Model State Dam Safety Program				
State Authorities	State Compliance			
	1989	1998	2010	2018
Legislation (5)	64%	73%	85%	85%
Inspection (4)	54%	68%	74%	78%
Enforcement (4)	66%	79%	90%	92%
EAP & Response (4)	51%	62%	72%	78%
Permitting (3)	58%	67%	75%	77%
Education & Training (3)		59%	72%	75%
Public Relations (1)		13%	30%	32%
Weighted Percentage	59%	66%	77%	80%

Figure 18. Collective comparison of all states submitting data against the FEMA Model State Dam Safety Program categories. State authorities are weighted, shown in parentheses.

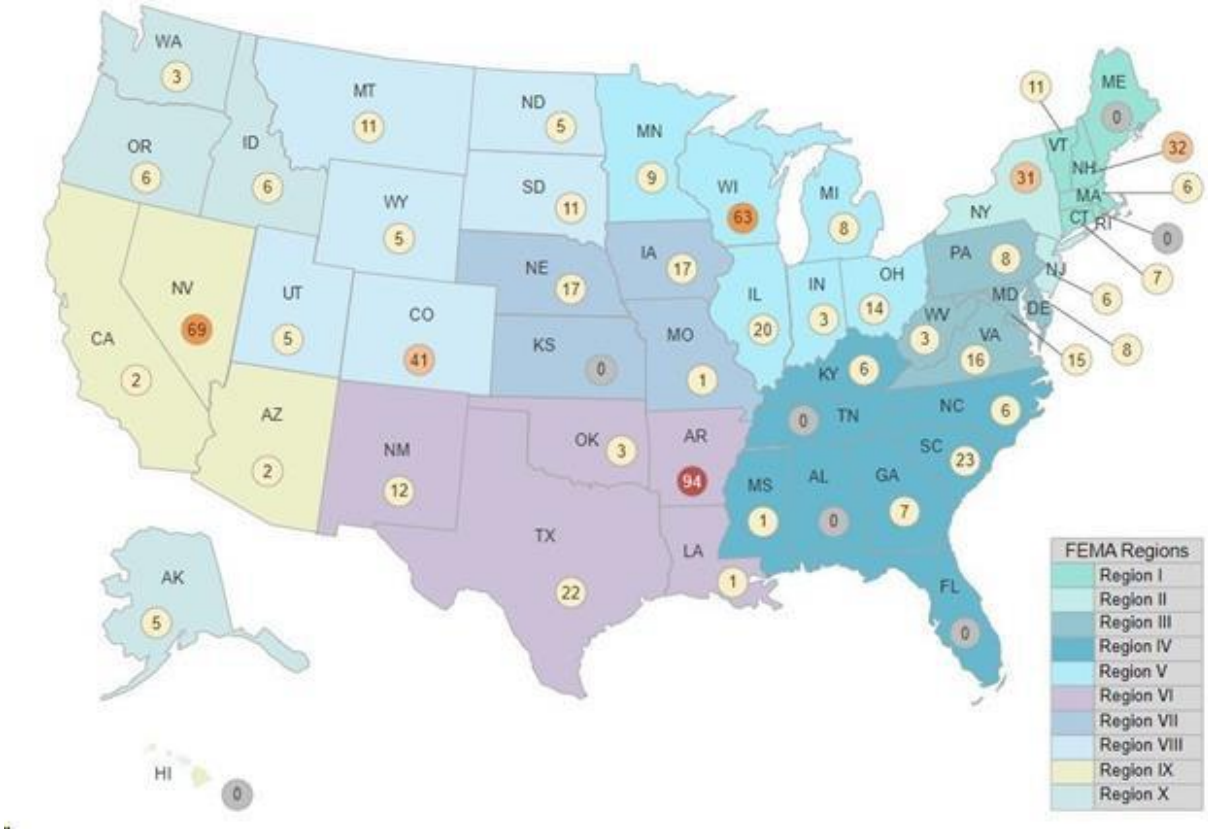

Figure 19. Number of ASDSO Webinars Accessed Per State from 10/1/18 to 9/30/19. Webinars are made available to the states through partnership with ASDSO and FEMA.

United States Society on Dams

United States Society on Dams (USSD) is an organization dedicated to advancing the role of dam and levee systems and building the community of practice. USSD's goal is to:

- Advocate: Champion the role of dam and levee systems in society.
- Educate: Be the premier source for technical information about dam and levee systems.
- Collaborate: Build networks and relationships to strengthen the community of practice.
- Cultivate: Nurture the growth of the community of practice.

For 37 years, USSD has served as a partner with the National Dam Safety Program in implementing the program's goals and objectives. USSD's current 2014–2018 Strategic Plan, which identifies the four Imperatives to advance the Mission of the Society, is aligned with the goals and objectives of the National Dam Safety Program. With a leadership change in 2018, current efforts are ongoing to update the initiatives and goals identified in the Strategic Plan for the period of 2020 through 2024.

Conclusion

The increased frequency and severity of natural disasters in recent years has tested the nation's resilience and recovery capabilities while highlighting the importance of a 'whole community' approach to dam safety, an approach that takes into consideration the integrity of dams, emergency management and preparedness for potential dam failures, and communicating the risks and impacts in areas around dams. As noted, in recent years, more federal agency dam safety programs have shifted from a standards-based approach to a risk-management approach. A risk-management approach seeks to mitigate failure of dams and related structures through inspection programs, risk reduction measures, and rehabilitation and repair, and it prioritizes structures whose failure would pose the greatest threat to life and property.

In addition to owning dams, the federal government is involved in multiple areas of dam safety through legislative and executive actions and has made significant federal investments in non-federal entities through training, technical assistance, rehabilitation, and grant programs. These initiatives and others truly highlight the federal commitment to aid non-federal dams as it relates to dam safety and dam risk management.

While the data from this period are encouraging in many areas, the larger picture of dam safety continues to be a source of concern. The average age of the 91,468 NID dams in the United States is 59 years. As the nation's population grows and development continues, the overall number of high hazard potential dams is increasing, with the number climbing to nearly 15,629 in 2019. According to the most recent ASCE Infrastructure Report Card, ASCE estimated that an investment of nearly $45 billion is necessary to repair aging yet critical high hazard potential dams. FEMA, as the lead agency for the NDSP, strongly believes that the driving force behind the NDSP is that many Americans are living below structurally deficient, high hazard potential dams; they are unaware of the risk; there is no plan in place to evacuate them to safety in the event of a failure; or there is a plan in place, but they are not aware of it. FEMA plans to address these challenges through the development and implementation of the following activities:

- In FY 2019, the NDSP HHPD Grant program was appropriated funding without additional staffing resources, further exacerbating the strain on the program's current resources. Consequently, NDSP is unable to implement all the programmatic grant

responsibilities required by 2 CFR 200 and deliver the other statutory responsibilities of the NDSP[1]. This holds especially true for the management and administrative requirements now that the FY 2019 HHPD grants have been awarded. The program has extremely limited ability to comply with Environmental and Historic Preservation laws, executive orders, and regulations, among other requirements. The HHPD Grant Program will allow FEMA to carry out meaningful projects to rehabilitate and repair high hazard dams. Across the United States, hundreds of high hazard dams that pose an unacceptable risk have been identified and the costs to bring them all into compliance is vast.

- Coordinate with states and communities to ensure dam risk is adequately included in state and local hazard mitigation plans.
- Redefine Dam Safety. We must redefine dam safety to include a "whole community" approach. This includes increasing partnership between dam owners and local jurisdiction (including emergency managers and floodplain managers). Building trust will enable a better understanding of what local jurisdictions need to increase public safety and reduce property loss.
- Share More Information. We need to revisit information sharing practices for all high hazard potential dams, including federally owned. In general, we see restricted information sharing from high hazard potential and federal dam owners and consequently we intend to work with other federal, state, and local entities to improve how dam risk information is shared.
- Implement a cohesive strategic outreach and communication effort to advance the mission of NDSP as it relates to a risk-management approach and information sharing among the "whole community."
- Develop partnerships that leverage private and public sector practitioners, industry organizations, and academia to sustain and foster the dam safety workforce that is critical to ensure proper succession planning and knowledge transfer into the future.
- Develop and deliver products and services targeted to state and local communities that address specific dam risk management and information sharing challenges. Products and services could include dam breach consequence assessments; identifying high risk dams and supporting the development of community and regional preparedness, response, recovery, and mitigation strategies for those risks; evacuation planning; EAP/Emergency Operation Plan (EOP) exercise planning; training on early warning systems; dam owner training and workshops; etc.
- Coordinate with federal, state, territorial, tribal, and private sector partners to develop guidance, procedures, safety measures and best practices regarding how the public interacts with and around dams.

Dams play a unique and vital role in the nation's overall infrastructure and lifelines. They contribute to the economic development of the United States and to the social welfare of the American public. The past few years have been a reminder that, despite the progress NDSP and its partners have made, continued investment in dam infrastructure is required to

safeguard the lives and property of American citizens. Continuing NDSP's mission in researching new technologies and methodologies, while also assisting other entities in the dam community, will help ensure the communities spread across this vast nation are adequately prepared for when an incident occurs.

IV. Appendix A – Acronyms

A&E	Architecture and Engineering
ASCE	American Society of Civil Engineers
ACSIM	Assistant Chief of Staff for Installation Management (Army)
ARS	Agricultural Research Service
ASDSO	Association of State Dam Safety Officials
ATR	Agency Technical Review (USACE)
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
C2M2	Cybersecurity Capability Maturity Model
CCR	Coal combustion residuals
CEATI	Centre for Energy Advancement through Technological Innovation
CFR	Code of Federal Regulations
CIPAC	Critical Infrastructure Partnership Advisory Council
CISA	Cybersecurity and Infrastructure Security Agency
CNIC	Commander Navy Installations Command (USN)
CR	Continuing Resolution
CRB	Consultant Review Board (USBR)
CTA	Collaborative Technical Assistance
DHS	Department of Homeland Security
DOE	Department of Energy
DSS-WISE™	Decision Support System for Water Infrastructure Security™
DSAC	Dam Safety Action Classification (USACE)
DSO	Dam Safety Officer
DSPR	Developed Dam Safety Priority Rating (USBR)
EAP	Emergency Action Plan
EHP	Environmental and Historic Preservation
EMI	Emergency Management Institute
EOC	Emergency Operation Center
EOP	Emergency Operation Plan
EPA	Environmental Protection Agency
ERPI	Electric Power Research Institute
ESA	Energy Security Act
EWS	Early Warning System
FAMS	Facility Asset Management System (BLM)
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission

FMFIA	Federal Managers' Financial Integrity Act
FPA	Federal Power Act ("the Act")
FS	Forest Service
FSM	Forest Service Manual
FTE	Full-time Employee
FY	Fiscal Year
FWS	Fish and Wildlife Service
GAO	Government Accountability Office
GRPA	Government Performance and Results Act
HHPD	High-Hazard Potential Dam
HERU	Hydraulic Engineering Research Unit (ARS)
H&H	Hydrology and Hydraulics
HSIN	Homeland Security Information Network
IBWC	International Boundary and Water Commission
IAHR	International Association for Hydro-Environment Engineering and Research
IEPR	Independent External Peer Review (USACE)
ICODS	Interagency Committee on Dam Safety
ICOLD	International Commission on Large Dams
ICS	Industrial Control Systems
IEPR	Independent External Peer Review
IRB	Independent Review Board (TVA)
IRRM	Interim risk reduction measures (USMC)
IMCOM	Installation Management Command (USA)
IRB	Independent Review Board
JBMDL	Joint Base McGuire-Dix-Lakehurst (USAF)
MARD	Ministry of Agriculture and Rural Development
MMC	Modeling, Mapping and Consequences Production Center (USACE)
MOU	Memorandum of Understanding
MSHA	Mine Safety and Health Administration
NDSA	National Dam Safety Act
NDSP	National Dam Safety Program
NDSRB	National Dam Safety Review Board
NEPA	National Environmental Policy Act
NIC	National Integration Center
NID	National Inventory of Dams
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service

OIG	Office of Inspector General
OMB	Office of Management and Budget
O&M	Operation and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement and Rehabilitation (USACE)
OIG	Office of Inspector General
OSMRE	Office of Surface Mining Reclamation and Enforcement
PA	Public Assistance
PPD	Presidential Policy Directive
Risk MAP	Risk Mapping, Planning and Assessment
RUS	Rural Utilities Service
RDSO	Regional Dam Safety Officer
SEED	Safety Evaluation of Existing Dams (FWS)
SLRA	Screening Level Risk Assessment (FS)
SMCRA	Surface Mining Control and Reclamation Act (OSMRE)
SOD	Safety of Dams (BIA)
SPRS	Southern Plains Research Station
SSA	Sector Specific Agency
TA	Technical Assistance
TVA	Tennessee Valley Authority
USA	United States of America
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USMC	United States Marine Corps
USN	United States Navy
USSD	United States Society on Dams
WIIN	Water Infrastructure Improvements for the Nation Act
WinDAM	Windows Dam Analysis Modules
WRRDA	Water Resources Reform and Development Act

VI. Appendix B – Resources and Websites

Resources

Dam Safety Technical Advisory: *Risk Reduction Measures for Dams, Risk Exposure and Residual Risk Related to Dams, Dam Awareness.* https://www.fema.gov/sites/default/files/2020-08/ta1-risk_reduction_measures_dams.pdf

North Carolina Response and Recovery Dam Response Operations Matrix. https://www.fema.gov/sites/default/files/2020-08/rr_nc_dam_response_ops_matrix_03262018.pdf

South Carolina Response and Recovery Dam Response Operations Matrix. https://www.fema.gov/sites/default/files/2020-08/rr_sc_dam_response_ops_matrix_03262018.pdf

Dam Safety Series Fact Sheets. *Use of Emerging Technologies.* https://www.fema.gov/media-library-data/1530204122667-b692aeda4fae99083c32214084df4e54/FEMANC-SCDams1Emerging_0618_508.pdf

Dam Safety Series Fact Sheets. *Notification Methods.* https://www.fema.gov/media-library-data/1530204122671-b692aeda4fae99083c32214084df4e54/FEMANC-SCDams2Notification_06122018_508.pdf

Dam Safety Series Fact Sheets. *Benefits of Pre-Event Exercises and Training.* https://www.fema.gov/media-library-data/1530204122675-b692aeda4fae99083c32214084df4e54/FEMANC-SCDams3PreEvent_06122018_508.pdf

Dam Safety Series Fact Sheets. *Proactive Actions* https://www.fema.gov/media-library-data/1530204122660-b692aeda4fae99083c32214084df4e54/FEMANC-SCDams4Proactive_06132018_508.pdf

Dam Safety Series Fact Sheets. *Benefits of Post-Event Data Collection for Dams* https://www.fema.gov/media-library-data/1530204122678-b692aeda4fae99083c32214084df4e54/FEMANC-SCDams5Post-Event_06132018_508.pdf

Dam Safety Fact Sheets. *Dam Awareness* https://www.fema.gov/media-library-data/1526412373812-a3903cfb8274083fd0bc306f19fa38e4/DamAwarenessFactSheet_508.pdf

Dam Safety Fact Sheets. *Risk Exposure of Residual Risk Related to Dams* https://www.fema.gov/media-library-data/1526652180419-3fed9910af42e4a9c68a156f1b939ed5/RiskReductionMeasuresforDamsFactSheet_V051818_508.pdf

Dam Safety Fact Sheets. *Risk Reduction Measures for Dams.* https://www.fema.gov/media-library-data/1527193851709-

3edbac44e44844985c57d3f2231deb11/RiskExposureandResidualRiskRelatedtoDamsFactSheet_052418_508.pdf

Dam Breach Report-Hurricane Matthew in North Carolina and South Carolina https://www.fema.gov/media-library-data/1535041992202-63a90deb5c6689d0ecf5a571b444502b/412017_NCSC_Dam_Breach_Report_FINAL_508compliant.pdf

Hydrologic Analysis of Hurricane Matthew's Impact on Dam Safety in North Carolina and South Carolina https://www.fema.gov/media-library-data/1535042937481-11942dab7f7f79e5f561f3e0bc0a2d9c/NCSCDamsHydrologicSummary_FINAL_8-14-18_dz.pdf

Emergency Operations Planning: Dam Incident Planning Guide. https://www.fema.gov/sites/default/files/2020-08/dam_incident_planning_guide_2019.pdf

DSS-WISE™ HCOM: *Human Consequences of Dam-Break Floods Fact Sheet* https://www.fema.gov/sites/default/files/2020-08/dss-wise_hcom_fact_sheet.pdf

DSS-WISE™ Lite: *Flood Modeling and Simulation Capability Enhancements for Dams Fact Sheet* https://www.fema.gov/sites/default/files/2020-08/dss-wise_hcom_fact_sheet.pdf

DSS-WISE™ Lite: *Web-based Automated Dam-Break Modeling/Mapping Fact Sheet* https://www.fema.gov/sites/default/files/2020-08/dss-wise_hcom_fact_sheet.pdf

Collaborative Technical Assistance Summary Sheets. https://www.fema.gov/emergency-managers/risk-management/dam-safety/technical-assistance

Dam Safety Fact Sheet 1: *Dam Considerations in Flood Mapping Studies* https://www.fema.gov/sites/default/files/2020-08/damsafety_fs1.pdf

Dam Safety Fact Sheet 2: *Considering the Residual Risk from Dams in Flood Risk Products* https://www.fema.gov/sites/default/files/2020-08/damsafety_fs2_considering_residual_risk_dams_flood_risk_products.pdf

Dam Safety Fact Sheet 3: *Risk Communication for Dams in Risk MAP* https://www.fema.gov/sites/default/files/2020-08/risk_communications_dams_risk_maps_factsheet3.pdf

Dam Safety Fact Sheet 4: *Dam Safety Awareness* https://www.fema.gov/sites/default/files/2020-08/damsafety_awareness_factsheet4.pdf

Rehabilitation of HHPD Grant Program FAQ. https://www.fema.gov/sites/default/files/2020-08/fema_HHPD-grant-program-FAQ.pdf

HHPD Grant Program Checklist. https://www.fema.gov/sites/default/files/2020-08/fema_HHPD-grant-program_checklist_6-11-2020.pdf

Rehabilitation of High Hazard Potential Dams (HHPD) Grant Program Fact Sheet. https://www.fema.gov/sites/default/files/2020-08/fema_HHPD-fact-sheet_05-15-2020.pdf

Websites

- FEMA's National Dam Safety Program: https://www.fema.gov/national-dam-safety-program
- Association of State Dam Safety Officials Website: www.damsafety.org
- Bureau of Reclamation – Completed Technology Development Projects: http://www.usbr.gov/ssle/damsafety/TechDev/index.html
- 2018 National Inventory of Dams: https://www.fema.gov/emergency-managers/risk-management/dam-safety/national-inventory-dams
- Rehabilitation of High Hazard Potential Dam Grant Program: https://www.fema.gov/emergency-managers/risk-management/dam-safety/grants#hhpd

FEMA