# Levee Setback White Paper

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## Executive Summary

Humans have long grappled with the consequences of floods. River banks and floodplains have always been thought to be the ideal locations for communities due to their relatively level topography, abundant natural resources, and access to trade routes (prior to rail and interstate vehicular roadway construction). But for all the ways rivers have supported people, life in proximity to rivers has always been full of peril. Flooding, the very mechanism that supports the abundant natural resources that sustain human societies, can also be destructive. Cultures throughout the world have adapted to their rivers' flood pulses in a variety of ways. In the post-colonial United States, floodplain development and adaptation has had three primary strategies:

- Flood Control: A strategy that works to prevent floodwater from affecting people and critical infrastructure. As a concept, it has its origins in the early 1800s Manifest Destiny, which, as a matter of law, entitled colonists to migrate westward and develop land in a fashion that often resulted in damage to natural resources and the creation of new public health and safety issues. Colonists in the 1800s were encouraged to construct dam and levee rivers and drain wetlands to promote the economy of the United States, which was accelerated after the Civil War and again in the 1930s to stimulate economic growth in response to national economic recessions.
- Flood Risk Management: A strategy that relocates people and critical infrastructure away from flood sources. As a concept, this approach is an advancement on traditional methods and grounded in the real-world experiences that flood control, as a strategy, was somewhat ineffective at reducing flood risk and eliminating flood damages. This approach emphasizes public and community safety and supports the conveyance of floodwater while reducing the effects of flooding.
- Multi-Benefit Floodplain Development: A modern strategy that recognizes floodplains are important ecological, economic, and social environments and seeks to balance public safety needs with flood-compatible development that respects people, improves quality of life and economic sustainability, enhances natural resources, and promotes equitable outcomes for all floodplain communities.

According to the National Oceanic and Atmospheric Administration (NOAA) there have been $33 billion dollars in flood events affecting the United States from 1980 to 2020.[1] U.S. disaster assistance programs have provided more funding for the prevention and management of flooding than any other natural disaster (fire, earthquake, landslides, tornadoes, and blizzards), and yet annual flood damages continue to increase. The frequency, intensity, and damages associated with flood events are also increasing.

[1] National Oceanic and Atmospheric Administration (2021) Billion-Dollar Weather and Climate Disasters: Overview. Retrieved from NOAA website https://www.ncdc.noaa.gov/billions/

Levee construction throughout the United States – aimed to protect the human populations and human infrastructure behind their walls from flooding – has left a legacy of historic floodplains disconnected from their primary flood source, with many fish and wildlife species, including the populations of iconic species such as the pallid sturgeon and the piping plover, being depleted to critically low populations over time. In recent decades, severe flooding has affected areas protected by levees that were once thought to be "permanently" protected from flooding.

While flood damages occur in all regions of the country, a significant amount of those damages have taken place along heavily leveed systems, such as the Mississippi River Basin and lower Missouri River Basin as well as in other areas that contain levees such as the Snake River Basin located in the northwestern United States, or the San Joaquin River Basin located in central California.

The dynamic characteristics of river systems can be affected by the physical changes that occur due to levee construction and a river's response to levee construction contribute to levee failure through flanking, erosion, overtopping, and breaching. In regions across the country with levee systems, communities, farmland, and infrastructure have been devastated by levee unforeseen failures and associated flooding. Local and regional economies have suffered as flood events are declared national disasters and once stable or thriving tax bases suffer through the arduous process of recovery. A levee setback consists of the reparation of an existing levee which has been significantly damaged by flooding and realigning the entire levee or a portion of the levee and relocating it farther away from the river. A levee setback reconnects portions of the historic floodplain to the river, allowing more floodwater storage, better conveyance, a reduction in flood stages and increased flood resiliency. Levee setbacks can assist in the revitalization of fish and wildlife habitat, and in some situations, levees are no longer required, and communities can flourish through implementation of nonstructural measures such as elevation and floodproofing.

Unfortunately, current federal flood risk management and flood recovery programs and policies do not easily support the implementation of levee setbacks. Changes will be required to programs and policies to allow levee setbacks to be incorporated into a multi-benefit floodplain development strategy. This paper seeks to identify potential opportunities to legislatively or administratively advance the use of levee setbacks as it discusses:

- Flood risk management in the United States
- Natural, Nature-Based, and Nonstructural flood risk management solutions.
- The limitations and issues associated with existing levee systems
- The benefits associated with levee setbacks
- Barriers to the implementation of levee setbacks
- Recommendations for encouraging the implementation of setback levees

## Purpose and Scope of White Paper

The purpose of this white paper is to identify legislative and/or administrative policy changes which would support increased use of levee setbacks as a tool for managing flood risk and supporting the return of key species of fish and wildlife and to demonstrate the benefits of levee setbacks as an effective flood risk management and ecosystem restoration tool. This paper also

discusses the history of levee construction for flood protection across the United States and how levees are becoming more vulnerable to major damage or failure during large flood events. Furthermore, the white paper highlights the hurdles and barriers to the implementation of levee setbacks.

## Overview of Flood Risk Management in the United States

Rivers and streams provided the earliest modes of transportation for Native Americans as well as for the European immigrants to a young country expanding westward. Commerce traveled the natural waterways where villages located their mills and industries along the banks of the rivers. As communities grew, the population became increasingly vulnerable to the risk of flooding. The migration of European immigrants from the Atlantic shoreline, inland along rivers and streams, had a major impact on the landscape and wildlife. Timber was harvested throughout each watershed, resulting in increased runoff and significant erosion. Channels were choked full of sediment, restricting the flow of floodwater, increasing the risk of flooding. Additionally, beaver was trapped in such great numbers that the fluvial geomorphology of U.S. rivers changed. Natural floodplain wetlands diminished with the removal of beaver, as wetlands were drained, and channels straightened. The entire ecological balance was impacted as human migration and development continued moving west.

### Initial Focus of Flood Control

In the late 19th and early 20th centuries, the U.S. Congress initiated a number of actions focusing on the economic vitality of a growing country and the threat of floods to local communities and industry. The first significant federal flood control law was the Swamp Land Act of 1850. A flood on the Mississippi River in 1874 led to the creation of the Mississippi River Commission in 1879. Booming steamboat traffic on the Missouri River and a flood in 1881 led to the creation of the Missouri River Commission in 1884, but it was abolished by the River and Harbor Act of 1902. In 1917, Congress authorized the Sacramento Flood Control System (SacFCS) to address the devastating flooding of 1902 and 1909 and to implement the first comprehensive state flood control plan in the nation.

The great Mississippi River flood of 1927 resulted in the death of over 250 people, and 750,000 people were displaced for months. After this devastating flood event, which submerged an estimated 23,000 square miles, Congress enacted the Flood Control Act (FCA) of 1928, authorizing the U.S. Army Corps of Engineers (Corps) to design and construct flood control projects along the Mississippi River, its tributaries, and the Sacramento River in California.[2] This Act was the catalyst for channel straightening and levee construction throughout the Mississippi River Basin and the Central Valley of California. Figure 1 illustrates the channel modifications incorporated into the Missouri River, downstream from Omaha, Nebraska, to narrow and straighten the channel.

[2] Pub. L. 106-53

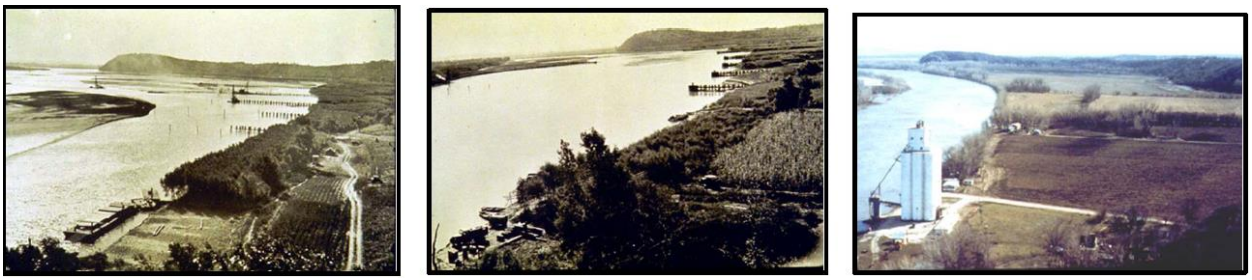

Figure 1; Rock Bluff Bend, Missouri River Channel Straightening 1934 - 1983

Sadly, much of the manual labor utilized to straighten river channels and to construct federal levees came from black sharecroppers in the South and immigrant labor in other regions of the country who were exploited for lower wages. They were required to work grueling workdays, often more than 14 hours per day. Due to the overcrowded and unsanitary living conditions within the levee work camps, as illustrated in Figure 2, workers experienced outbreaks of malaria, smallpox, and other diseases without the benefit of medical treatment. Work camps were harsh environments, and the camps persisted during the brutal summer heat and bitter winter cold, with laborers residing in canvas tents.

**Social Injustice of Early Levee Construction**

- Black sharecroppers and immigrant labor were forced to work and live-in inhumane conditions
- Unsanitary conditions resulted in the outbreak of disease, and a large number of deaths
- Wages were barely enough to cover the cost of food and water

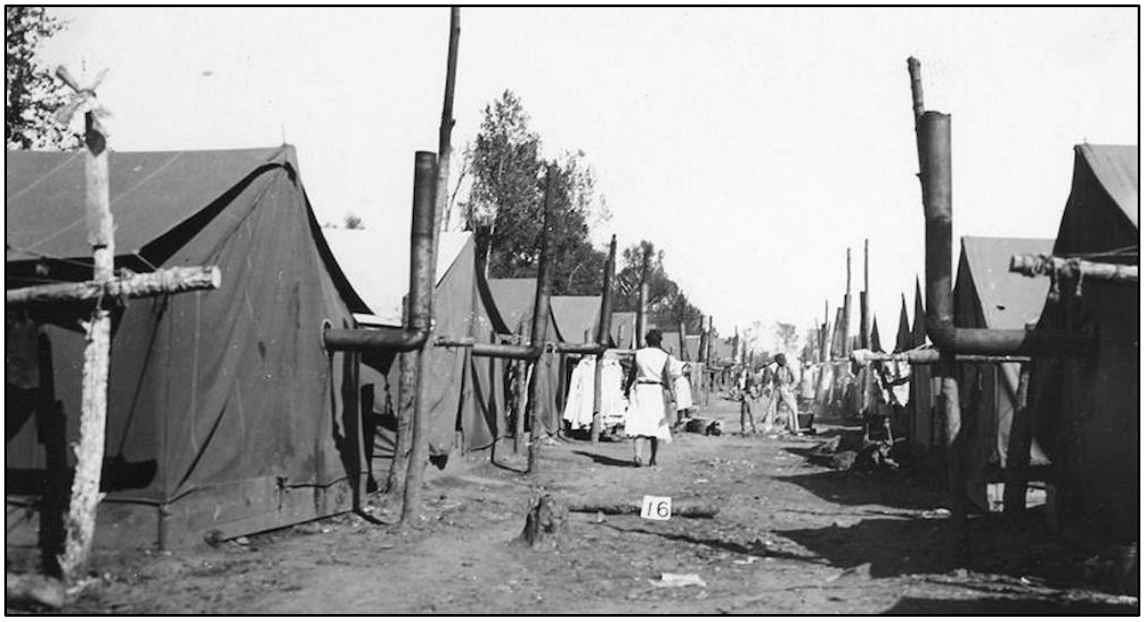

Figure 2: Mississippi River Delta Work Camp (Source: Center for Study of Southern Culture)

After enactment of the FCA 1928, Congress approved additional laws to further control the effects of flooding. The Flood Control Act of 1944 (FCA 1944) authorized the construction of dams and levees throughout the United States. In California, the FCA of 1944 authorized the

Lower San Joaquin River and Tributaries Project, which aimed to improve flood storage and consolidate river flows by authorizing dam construction and channel straightening projects.

Within the Missouri River Basin, the FCA 1944 resulted in the Pick-Sloan Plan for the management of the Missouri River for flood control, hydropower, water supply, navigation, recreation, irrigation, water quality, and fish and wildlife. The law authorized the Corps to construct federal levees from St. Louis, Missouri, to Omaha, Nebraska[3] The Act also states that proposed floodway widths between levees would vary from a minimum of 3,000 feet from Sioux City, Iowa, to Kansas City, Missouri, and 5,000 feet from Kansas City, Missouri, to the mouth. The proposed floodway widths prevented the exchange of channel flows with the historic floodplain, adversely impacting the natural ecological system. Upon full implementation of the authorities under FCA 1944, the Corps had re-engineered the Missouri River, removing natural meanders and straightening the Missouri River natural channel to shorten the total river length by over 120 miles. The Bank Stabilization and Navigation Project (BSNP) then authorized the Corps to harden the riverbanks with stone revetments to reduce erosion and to construct hundreds of miles of earthen levees along the Missouri River to reduce flooding.

The most recent Flood Control Acts (1948, 1950, and 1965) authorized the Corps to design and construct minor projects without Congressional approval and provided more authority to the Corps in lieu of states and levee districts, which had been constructing their own flood protection projects.

**Emergence of Floodplain Management**

Levee and dam construction through the federal government grew during the 1930s and 1940s, then peaked during the 1960s. Despite these investments in flood control structures, flood losses continued to rise. These losses, combined with a growing environmental ethic, resulted in a shift toward a floodplain management approach that incorporated more nonstructural solutions.

**Nonstructural Mitigation Techniques**

- According to the Corps and FEMA, nonstructural flood risk management alternatives are physical or nonphysical measures implemented to mitigate existing and future flood damages. The most common physical nonstructural measures are acquisition, relocation, elevation, basement/crawlspace abandonment, dry floodproofing and wet floodproofing. These measures are accepted by the National Flood Insurance Program, and are generally considered less detrimental to the floodplain or the environment.
- Several common nonphysical nonstructural measures are floodplain mapping, emergency preparedness plans, land use regulations, zoning, flood warning, evacuation planning, and risk communication. These measures address flood risk through regulation and best management practices and can be considered separately or in combination with other floodplain management programs and planning functions.

[3] GEI Consultants (2017) The Origin and Evolution of the California State Plan of Flood Control Levee System. Retrieved from https://www.geiconsultants.com/wp-content/uploads/2017/10/The-Origin-and-Evolution-of-the-California-State-Plan-of-Flood-Control-Levee-System.pdf

Meanwhile, the 1960s ushered forward a series of landmark environmental laws, including the National Environmental Policy Act (NEPA), requiring federal agencies to assess the environmental impacts of their proposed actions prior to making decisions; the Clean Water Act (CWA), establishing the framework for regulating discharges of pollutants into the waters of the United States; and the Endangered Species Act with a goal of protecting and preserving native species and their habitat.

Structural flood protection, such as levee construction, was known to be one of the primary activities threatening and endangering many native floodplain dependent species. Figure 3 illustrates the difference in size between salmon reared in the main channel versus salmon reared in the shallow floodplain.

In 1966, the first Unified National Program for Managing Flood Losses report recommended the creation of a national flood insurance program and integrated floodplain management that utilized structural and nonstructural approaches. Within two years, Congress had passed the National Flood Insurance Act of 1968 creating the National Flood Insurance Program and a floodplain mapping program. Updates in 1973 added funding programs for nonstructural mitigation.


Floodplain-dependent species require access to floodplain habitat for some part of their life cycle. For example, studies have shown that Chinook salmon reared in the slower, shallower water of floodplains are significantly larger in size than salmon reared in the main channel.

Figure 3; Juvenile Chinook Salmon Growth[4]

**Evolution of Nature-Based Flood Management**

Executive Order 11988; Floodplain Management (EO 11988), signed in 1977, sought to avoid negative impacts associated with modifying floodplains by federal agencies and federal-sponsored resources to integrate floodplain management within floodplain ecosystem management. Federal agencies were required to "take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains."[5] when purchasing or managing federal land, constructing or providing the financing for projects, or carrying out federal programs or

[4] Jeffres, C., J. Opperman and P. Moyle (2008), "Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California river," Environmental Biology of Fishes 83 (4): 449-458. Retrieved from http://ww.springerlink.com/content/e873456118pjl53

[5] Environmental Protection Agency (1977) Floodplain Management (Executive Order 11988). Retrieved from https://www.epa.gov/cwa-404/floodplain-management-executive-order-11988

actions.[6] EO 11988 helped to reduce the impact of floodplain development, but it did not result in widescale integration of programs.

The devastation caused by the Midwest Flood of 1993 along the Mississippi and Missouri Rivers renewed the calls to reassess the country's reliance on levees and to provide increased awareness of the need for a holistic and integrated flood management strategy. The revised Unified National Program for Floodplain Management published in 1994 recognized:

- good floodplain management aimed to achieve a reduction in the loss of life, disruption, and damage caused by floods; and
- the preservation and restoration of the natural resources and functions of floodplains.[7]

However, no major programmatic changes were undertaken to align the nation's flood management programs to support these co-equal goals. In light of the challenges associated with top-down coordination on a shared interagency vision of floodplain management, a new strategy began to emerge in the 2010s: Expand the flood management toolbox to include nature-based approaches along with structural and nonstructural approaches.[8]

**Natural and Nature-Based Solutions**

The most recent FCA was enacted in 1965. In 1974, Congress transitioned away from the FCA and enacted Water Resources Development Acts (WRDA) to incorporate additional aspects of water resources such as environmental, structural, nonstructural, navigational, and flood risk management into the authorities of the US Army Corps of Engineers. In the mid-2010s, Congress directed the Corps to consider the implementation of natural and nature-based features (NNBF) for assisting in the management of flood risk. In Section 1184 of the Water Resources Development Act (WRDA) of 2016, Congress defined a natural feature as a feature "created through the action of physical, geological, biological, and chemical processes over time." Congress also defined a nature-based feature as "a feature that is created by human design, engineering, and construction to provide risk reduction by acting in concert with natural processes."[9] Examples of NNBFs include wetlands; oyster, mussel, and coral reefs; and dunes, which are sometimes combined with hard components, such as rock gabions, stone toes, and concrete reef balls.

In WRDA 2016, Congress also included language that required the Corps to consider natural, nature-based, and nonstructural features in feasibility studies for flood-risk management, hurricane and storm damage reduction, and ecosystem restoration projects, provided that the non-federal partner consented to studying such alternatives. Section 1149 of WRDA 2018 updated that language, directing the Corps to consider natural infrastructure alternatives, alone or

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[6] U.S. Army Corps of Engineers (2015) Flood Plain Management Decision Making Process. Retrieved from https://Army Corps.contentdm.oclc.org/digital/collection/p16021coll11/id/364/

[7] Army Corps (2014) Scodari and Shabman. Review of Federal Reports on a Unified National Program for Floodplain Management, 1966-1994. https://www.iwr.usace.army.mil/Portals/70/docs/iwrreports/2014-R-02_AppendixB.pdf

[8] Some of the key pieces of legislation and guidance documents related to the federal government's use of natural, nature-based, and non-structural techniques for managing flood risk are listed in Appendix A.

[9] Pub. L. 114–322, title I, §1184

in conjunction with traditional infrastructure, for flood risk management or hurricane and storm damage risk reduction projects, where practicable. The 2018 law also requires the Corps to consider at least one alternative with natural or nature-based features when carrying out a feasibility study for an ecosystem restoration project.

In recent years, Congress has also amended the Flood Control and Coastal Emergencies (PL 84-99) Program which provides rehabilitation assistance for repairs to flood-damaged levees, to add natural and nature-based solutions such as levee setbacks and river and floodplain restoration to be eligible for funding when enrolled levees are damaged during a flood.[10] WRDA 2016 defined "nonstructural alternatives" to include stream, wetlands, and coastal restoration efforts that help reduce flood risk.[11] Congress further amended the PL 84-99 program in WRDA 2018 by specifying that "realigning" is an eligible activity under PL 84-99.[12] Finally, in WRDA 2020, the Corps was provided new authority "to study, design, and construct water resources projects for communities that have experienced repetitive flooding events and have received emergency flood fighting assistance."[13] The maximum Federal share for a project planned under this section is $17.5 million, and the Corps is required to consider a community's ability to pay in determining whether to require a non-Federal cost share.[14]

## Natural and Beneficial Functions of Floodplains

Floodplains and natural floodplain functions produce benefits for society and natural ecosystems. In floodplain management this is referred to as the "natural and beneficial functions of floodplains." These functions and their resulting benefits are illustrated in Table 1.[15]

[10] Army Corps (CITE)
[11] Pub. L. 114–322, §1176
[12] Pub. L. 115-270 §1160
[13] House Transportation & Infrastructure Committee (2020) Water Resources Development Act of 2020: Section-by-Section Summary. Retrieved from https://transportation.house.gov/imo/media/doc/WRDA%202020%20Section%20by%20Section%20Final.pdf
[14] P.L. 116-260 §119
[15] The Department of Housing and Urban Development (2002) The Natural & Beneficial Functions of Floodplains – Reducing Flood Losses by Protecting and Restoring the Floodplain Environment. Retrieved from https://www.hud.gov/sites/documents/DOC_14217.PDF

Table 1; Natural Resources of Floodplains[16,17]

| **Water Resources** | **Biologic Resources** | **Societal Resources** |
|---|---|---|
| Natural Flood and Erosion Control<br>o Provides flood storage and conveyance<br>o Reduces flood velocities<br>o Reduces peak floods<br>o Reduces sedimentation | Biological Productivity<br>o Supports high rate of plant growth<br>o Maintains biodiversity<br>o Maintains integrity of ecosystem | Harvest of Wild and Cultivated Products<br>o Enhancement of agricultural lands<br>o Provides sites for aquaculture<br>o Restores and enhances forest lands |
| Water Quality Maintenance<br>o Filters nutrients and impurities from runoff<br>o Processes organic wastes<br>o Moderates temperature fluctuations | Fish and Wildlife Habitats<br>o Provides breeding and feeding grounds<br>o Provides and enhances waterfowl habitat<br>o Protects habitats for rare, threatened and endangered species | Public Health/Welfare & Recreational Opportunities<br>o Protection of drinking water resources<br>o Provides areas of active and passive use<br>o Provides open spaces<br>o Provides aesthetic pleasure<br>o Significant cultural and historic value, particularly for Tribal communities |
| Groundwater Recharge<br>o Promotes infiltration and aquifer recharge<br>o Reduces frequency and duration of low flows | | Areas for Scientific Study/Education<br>o Cultural resources (historical/archaeological)<br>o Opportunities for environmental, biological, or other studies |

Research has demonstrated that a fully functioning floodplain that can maximize the above benefits to society requires four key attributes:

- Connectivity: The floodplain is physically accessible by water from its adjacent river or stream to allow an exchange of water, nutrients, sediment and organisms.
- Variable Flow: The floodplain is inundated with flows that vary in timing, duration, magnitude, and frequency that support native biota.
- Spatial Scale: The floodplain must have space to accommodate inundation and the resulting habitat and landscape forming processes that occur.

[16] American Rivers (2016) Reconnecting Rivers to Floodplains. Retrieved from https://www.americanrivers.org/wp-content/uploads/2016/06/ReconnectingFloodplains_WP_Final.pdf

[17] The Natural & Beneficial Functions of Floodplains: A Report for Congress by the Task Force on the Natural and Beneficial Functions of the Floodplain (2002). https://www.hud.gov/sites/documents/DOC_14217.PDF

- Habitat and Structural Diversity: The floodplain has a diversity of sediment erosion and deposition conditions, gradients of hydrologic connectivity, ecological succession and natural accumulated debris to generate habitat supportive of terrestrial and aquatic organisms.

Levees separate rivers and streams from their floodplain, thereby directly impacting connectivity and disrupting the ability of flows to inundate the floodplain and perform the dynamic processes necessary for a functioning floodplain.[18] As a result, there is a reduction in floodplain productivity, and a decrease in the fish, wildlife, and societal benefits the floodplain landscape can provide.[19,20]

## Levee Systems in the United States

Levees have been an essential component of the United States' flood risk management for decades. While the engineering analyses used for the basis of levee design have been developed over years of research and review, there are limitations which could affect the level of flood protection provided as levees age. According to the National Levee Database that is administered by the Corps, there are over 7,700 levee systems located across the country, covering over 25,600 miles and the average age of these levees are 57 years.[21]

A balance between the reduction of flood damages and the protection of fish and wildlife is a critical objective for this nation as it must increasingly deal with the effects of climate change, which has led to increased annual flood damages. Many levees provide flood protection for densely populated metropolitan areas, where significant development already exists. For these situations, especially where there is a large tax base, levees and other structural measures, such as floodwalls, interior ponding areas, and pump stations, may provide the most economically feasible measure for providing flood protection.

However, in rural areas susceptible to flooding, particularly where there is a higher incident of flood damages, either to a levee (ex. erosion, overtopping, or breaching), or to critical facilities, buildings, and infrastructure, then measures such as levee setbacks may be the most effective means of providing flood protection.

### Levee Design & Dynamic Flood Conditions Versus Static Flood Protection Systems

The engineering analysis required for levee design depends upon hydrologic conditions. The hydrology, or the flow of water through a watershed, is typically illustrated in terms of a

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[18] Opperman, Jeffrey & Luster, Ryan & McKenney, Bruce & Roberts, Michael & Meadows, Amanda. (2010). Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale1. JAWRA Journal of the American Water Resources Association. 46. 211 - 226. 10.1111/j.1752-1688.2010.00426.x.

[19] The Association of State Wetland Managers (2011) Assessing the Natural and Beneficial Functions of Floodplains – Issues and Approaches; Future Directions. https://www.aswm.org/pdf_lib/nbf.pdf

[20] Tockner, Klement & Stanford, Jack. (2002). Riverine Flood Plains: Present State and Future Trends. Environmental Conservation. 29. 308 - 330. 10.1017/S037689290200022X.

[21] Army Corps of Engineers (2021) National Levee Database. Retrieved from https://levees.sec.Army Corps.army.mil/#/

discharge-frequency curve, where the peak discharge for an event (i.e., the 1-percent annual chance exceedance flood event) is determined from a series of years of flow records for specific locations along a river. The discharge-frequency data is used in the planning process to identify the level of protection to be provided by a levee. Once the discharge-frequency curve for a river has been established, it becomes static, unless continuously updated. Levees which are designed and constructed according to a specific discharge-frequency curve become static, and the dimensions of the levee do not change over time. However, climate is dynamic and the hydrology within a watershed is continuously evolving. A levee which was designed decades ago and provided protection against the 1-percent ACE may now offer significantly less protection when compared to updated hydrology.

Additionally, floodwaters would have historically spread out across an open floodplain and lose its energy, but some levees may constrict the floodwaters to a narrow conveyance area, resulting in much greater erosive velocities and greater flood depths. This may cause the levees to become damaged or fail, requiring significant financial investment from local communities and the federal government in order to repair the levee system.

**Negative Impact to the Environment**

In the twentieth century, levees were constructed in a way that maximized the amount of land protected and minimized infrastructure costs by locating the levee on top of the river bank. When a levee is placed in the floodplain, the protected farmland behind the levee, for NRCS purposes, is identified as “prime” farmland. Any farmland exposed to flooding would lose the “prime” designation. This levee placement along the river banks allowed for the planting of vast acres of new farmland in the fertile floodplain soil, with little or no regard for future flooding. Roads and bridges took advantage of the levee placement with shorter bridge spans, minimizing construction costs.

Unfortunately, isolation of the rivers from their historic floodplains impacted the natural ecological functions and damaged the environment that fish and wildlife depend upon. The Agricultural Research Service (ARS) of the U.S. Department of Agriculture (USDA) has published several reports which illustrate the dynamic channel processes of natural rivers and streams, as well as the potential problems when a channel is straightened, shortened, and locked into place with stone revetments and streambank riprap. Figure 4 illustrates the natural evolution of meanders in a river or stream.

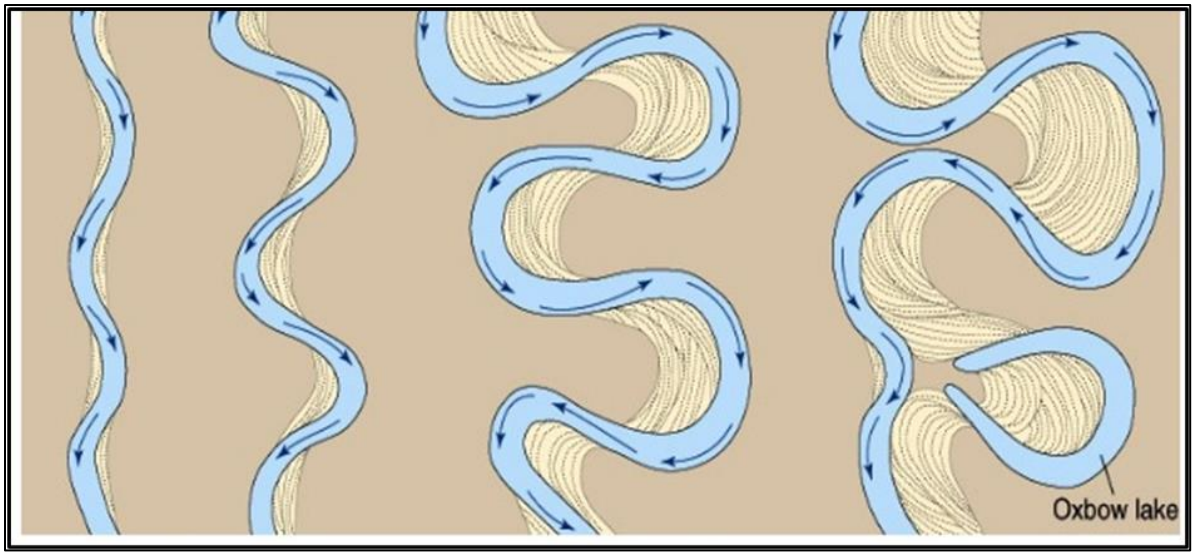

Figure 4; River Meander Evolution by USDA Agricultural Research Service

When rivers and streams are straightened, shortened, and locked into place with stone revetments and streambank riprap as they were in the 20th century, it disrupts natural channel processes, and as the connectivity between river and floodplain were interrupted, the natural and beneficial functions of the floodplains declined.[22] Without access to necessary floodplain habitat, many native floodplain dependent wildlife, native plants, and aquatic insect populations declined.

**Costs for Levee Maintenance, Repair, Recovery and Cleanup Pre- and Post-Flood Events**

The Corps has been directed by Congress to deliver vital engineering solutions, in collaboration with other federal, state, and local partners to reduce flood risk. The Corps is responsible for Emergency Support Function #3 for Public Works and Engineering under Public Law 84-99 (PL 84-99). This authority directs the Corps to perform repairs to damaged federally recognized Flood Control Works (FCW) reestablishing their pre-flood level of protection. A federal levee is categorized as being "active" in the Corps' Rehabilitation and Inspection Program (RIP) is eligible for assistance in repair of damage caused by a flood event. The RIP is a component of the Civil Emergency Management Program concerned with the inspection and rehabilitation of FCWs under authority of PL 84-99. All federally designed and constructed levees are automatically enrolled into the PL 84-99 program and nonfederal levees meeting minimum design requirements are also eligible for participation in the PL84-99 program. Annual inspections are conducted through the Corps and levee sponsor to ensure individual levees are meeting minimum program requirements for operation and maintenance.

A significant annual investment is required to ensure levees meet the minimum acceptable operational rating to operate as designed and to be eligible for rehabilitation assistance under PL 84-99. The maintenance costs vary from levee to levee and are dependent upon a levee's length, height, as well as the number of drainage structures, levee features, and proximity to the flood source, where flood stages and velocities may be more adverse. All levees participating in the PL

[22] The Department of Housing and Urban Development (2002) The Natural & Beneficial Functions of Floodplains – Reducing Flood Losses by Protecting and Restoring the Floodplain Environment.

84-99 program require annual maintenance which are the responsibility of the levee district, local community, or regional entity. Maintenance is subject to the Corps' review and typically consists of mowing, removal of woody vegetation, rodent eradication, drainage structure, relief well inspection and repair, levee crown resurfacing, and levee side slope erosion repair.

**Living with Levees**

- Flood Control Acts were enacted by Congress to prevent loss of life and property damage without the consideration of the adverse effects on the environment and natural resources.
- The construction of levees has resulted in increased development occurring without regard for floodplain management or potential flood risk located landward of the levee.
- People often do not realize that they live or work in areas protected by levees.
- As the climate continues to change and intense rainfall events become more common, the annual cost for levee operation, maintenance, repair, and replacement will increase.
- In 1994, the Unified National Program for Floodplain Management Report was published, which advocated for the need for increased floodplain management to modify human behavior to flooding, modify the impacts of flooding, and to preserve and restore the natural resources of the floodplain.
- Communities or neighborhoods having large minority populations frequently encounter difficulty in achieving the economic benefits required to reinvest and secure measurable flood risk reduction.
- There is often a disconnect between the management of the levee and the potential flood risk associated with the land use located behind the levee (residential, commercial, industrial).

During a flood event, federal and state officials as well as levee district and local officials may initiate and conduct levee surveillance in order to determine levee performance and to identify potential problem areas. If a levee or levee system has encountered issues, the surveillance intensifies throughout the flood event. If problem areas are identified along a levee, the Corps, under the PL 84-99 program, may move additional personnel or other material resources (borrow material, flood barriers, sandbags, pumps, etc.) for flood fighting purposes closer to the area of threat. If the flood threat continues to increase and the levee is in jeopardy of failing, mandatory evacuation orders may be issued for people protected by the levee.

After a flood event, the levee system and all drainage structures require detailed inspection. If the levee was breached, overtopped, or the side slopes and toes have been damaged by erosion, there could be extensive replacement and repair activities required. If flooding occurred landward of the levee, then there could be significant cleanup required for residential, commercial, public, and industrial development, infrastructure, and farmland since floodwaters and debris can decimate buildings, their contents, and surrounding land. If flooding is catastrophic, then complete recovery to pre-flood conditions of the levee may not be achievable.

Under the PL 84-99 program, the Corps will respond as soon as the flood waters have receded, and unless a levee has been severely damaged, to the point of being destroyed, the Corps will begin immediate repairs to the levee. The repairs are conducted as quickly as possible so that completion occurs prior to the next flood season. Repairing the damaged levee is the highest priority and the construction activities may not mesh well with the environment, potentially causing additional harm and damage to an altered ecological system.

### Flood Impact on Communities

Flooding can devastate communities of any size or economic standing, causing disruption to residents, employers, and community services. When flood damages are exceedingly large, it may be difficult for some communities to recover, and families may be forced to relocate away from the area due to the damages sustained to their homes or the effect of flooding on local businesses or major employers. For example, the community of Pacific Junction, Iowa was devastated by flooding in 2019, and nearly a year after the flood, 75 percent of families had not returned.[23] In the case of Pacific Junction, many of those families will never return as they accepted FEMA buyouts. When a buyout occurs, the property is no longer available for development and must remain without being occupied. As families relocate, less property taxes are collected, and business revenue can dwindle as fewer residents remain in the area. Since the tax base provides funding for public services, schools, infrastructure, and salaries, a decrease in the tax base could result in fewer services, school closings, less infrastructure maintenance, and job loss.

## Benefits of Levee Setbacks

As flooding increases across the country, and the damages to homes, businesses, industry, infrastructure, and farmland continue to rise, there is an increasing awareness of the need to try new approaches to flood risk management. These approaches include nonstructural, natural and nature-based, as well as levee setbacks.

### Defining a Levee Setback

A levee setback is defined as a realignment of an existing levee or construction of a new levee away from the active river channel.[24] The setback typically results in better flood water conveyance, as well as a reduction in flood stages and flood velocities. Levee setbacks are an example of combining a structural element, the levee, with reconnection of the historic floodplain, the environmental element, to reduce flood risk. Modification of an existing levee can improve the upstream, downstream, and adjacent flood conditions. Any modification to a federal project requires approval from the Corps and must meet all requirements under Section 14 of the Rivers and Harbors Act of 1899.[25]

**Levee Setback**
A levee setback is the removal and/or replacement of an entire levee or substantial portion of an existing levee and relocating it onto a new alignment, resulting in lower river stages and lower velocities during a flood event. The setback provides for the reconnection of all of or a portion of the historic floodplain.

Setting a levee back from its original alignment, farther away from the source of flooding, will result in a more resilient levee and can result in a wide range of

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[23] KETV 7 (2020) Pacific Junction still rebuilding after last year's catastrophic flooding. Retrieved https://www.ketv.com/article/pacific-junction-still-rebuilding-after-last-years-catastrophic-flooding/31141640#

[24] Army Corps of Engineers (2017) Levee setbacks: An innovative, cost-effective, and sustainable solution for improved flood risk management. Retrieved from https://Army Corps.contentdm.oclc.org/digital/collection/p266001coll1/id/4239/

[25] Army Corps of Engineers. Section 408. Retrieved from https://www.Army Corps.army.mil/Missions/Civil-Works/Section408/

economic and environmental benefits. Figure 5 illustrates a levee setback located along the Missouri River in Atchison County, Missouri and Appendix A provides examples of levee setback projects located across the country.

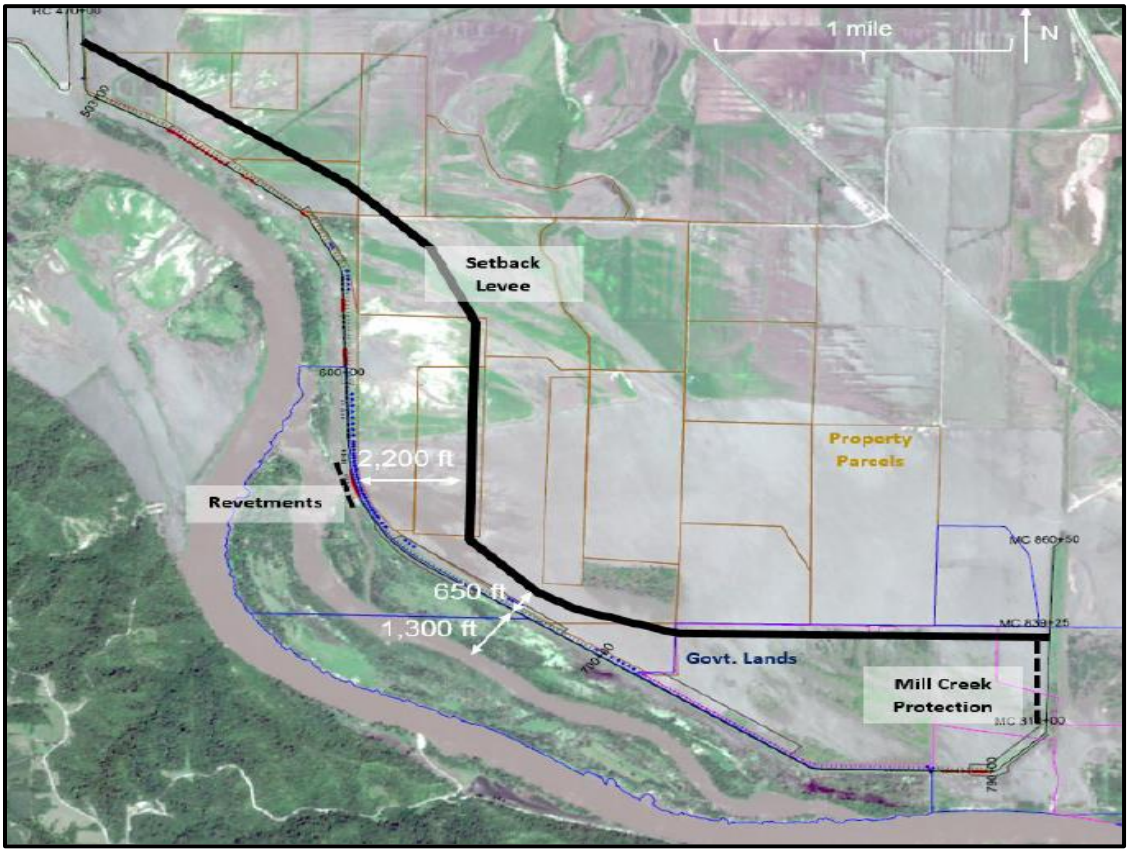


Figure 5; Illustration of L-536 Setback on the Missouri River in Atchison County, MO
Source: US Army Corps of Engineers

**Decreased Risk of Levee Failure**

Throughout the history of US flood protection and levee construction, there has always been a desire to place levees near the riverbank, thereby ensuring the largest amount of flood-free property landward of the levee system. During a flood event, the risk of levee overtopping or failure increases as the water levels continue to rise. When a levee is setback from its original location, it provides the river more room to flow, decreasing the risk of flooding to local communities, infrastructure, and farmland.

**Decreased Maintenance, Repair, and Operation Cost**

Large flood events, such as the events we have seen over the last couple of decades within the Missouri and Mississippi River Basins, have resulted in extensive damages to levees as well as to levee features such as riverward and landward berms, crown material, interior drainage structures, closures, and relief wells. If the levee is active in the PL 84-99 program, then the majority, if not all of flood damages will be paid for by the federal government. Figure 6 illustrates the portfolio of levees maintained by the Corps.

Under PL 84-99, the federal government must allocate substantial annual funding for repairs, and according to current Corps policy, the government will pay to repair a levee even if it has been damaged during consecutive years of flooding. Since a setback levee is located farther back from the river or stream, it is at a decreased risk of overtopping and failure, resulting in lower annual costs for levee maintenance, repair, and operation. Since setting back a levee will decrease the probability of damage or failure to the levee, it will also likely reduce the need for emergency response activities, including extensive surveillance, cleanup and recovery, that follow an event which leads to levee failure, providing cost-savings for local, state, and federal agencies and ultimately, the American taxpayers.

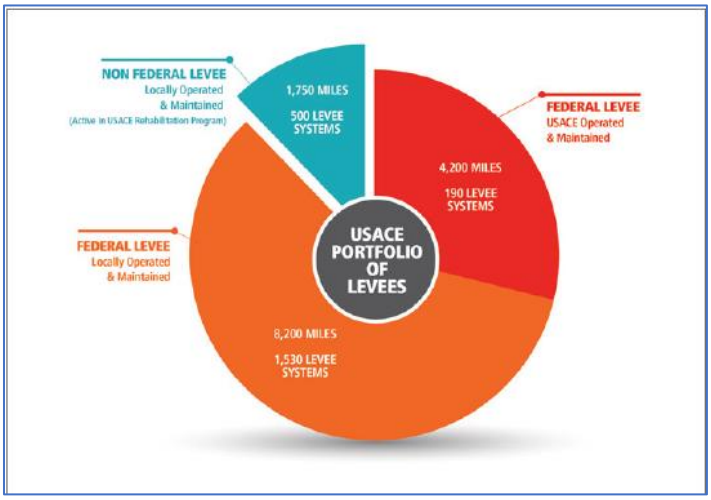


Figure 6; Federal vs Nonfederal Levee Data (Source; Corps' Levee Portfolio Report)[26]

**Potential Direct and Indirect Benefits on Flood and Crop Insurance**

There are significant risks and costs associated with flooding to individuals and the local, regional, state, and US economies. The federal government has enacted laws and programs for the prevention of life loss and insurance for property damage to buildings and crop losses due to flooding.

Some levees provide the federally determined minimum required level of protection in order to be certified as providing flood protection to habitable structures.

**100-Year Flood**
The 1-percent annual chance flood event is also referred to as the base flood or more commonly, the 100-year flood event. This flood has a 1-percent chance of occurring any given year.

The federal standard is for protection from a 1-percent annual chance exceedance (ACE) occurrence of flooding, typically referred to as the 100-year flood, in order to waive the requirements of flood insurance on every insurable building located landward of the levee. Without the certified levee, all insurable buildings would be required to carry flood insurance or be mitigated via nonstructural techniques from sustaining flood damages up to and including the 1-percent ACE flood event.

[26] Army Corps of Engineers (2018) A Summary of Risks and Benefits Associated with the Army Corps Levee Portfolio. Retrieved from https://Army Corps.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/7167

Levee setbacks and restoration of natural floodplains can reduce flood insurance, crop insurance, and disaster recovery costs.[27] During this era of climate change, a levee setback has the potential of being more resilient to flooding than the original levee and can provide direct as well as indirect benefits to the local, regional, state, and US economies through loss avoidance.

The federal government reimburses some of the cost of property damage to a building owner through the National Flood Insurance Program (NFIP), as administered by FEMA. Through the NFIP, policy holders are insured against property loss through annual premiums which are based on the vulnerability of their insurable buildings to flood risk. The greater the risk, the higher the insurance premiums are to the building owner. If buildings are located landward of a levee which has not been certified by FEMA to prevent flooding up to the 1% annual chance exceedance flood event (typically referred to as the 100-year flood), then the building owners either purchase flood insurance through the NFIP or take a chance that their property will not flood and continue to function without the benefit of flood insurance. If a levee setback project is implemented for a levee reach which has been identified as being particularly vulnerable to flooding, the setback may be more resilient to flooding and the buildings located landward of the levee may be deemed to have no risk or very low risk of flooding. The direct benefit to building owners for having a more resilient levee is lower flood insurance premiums or that there is no requirement for flood insurance, and the indirect benefit to taxpayers is that there is a significantly reduced response and payout from the federal government after a flood event.

The USDA – Risk Management Agency (RMA) is the federal representative for crop insurance. For the RMA, flooding to cropland is one of many potential risks associated with farming. If agricultural land is determined to be vulnerable to flooding, then crop insurance would reflect that vulnerability through premiums purchased annually by the landowner. The RMA reimburses landowners for insured farmland after crops have been damaged from flooding. If a levee setback is determined to be more resilient to flooding by the RMA, the landowners could achieve a direct benefit through lower crop insurance premiums and there could be an indirect benefit to taxpayers as crop insurance payouts and the federal response to flooding could be reduced.

**Environmental Benefits of Levee Setbacks**

Levee placement and construction has prevented the natural and beneficial ecological functioning of floodplains. As described above, without a properly functioning floodplain, communities can lose the flood storage and water filtration benefits provided by native floodplains, among a multitude of other benefits. Fish and wildlife can also lose access to critical habitat. Levee setbacks offer opportunities for increased environmental benefits through the restoration and reconnection of the historic floodplain, which is critical for restoring natural ecosystem function, slowing and storing floodwaters, and sustaining native fish and wildlife habitat.

[27] Freshwater Network. The Nature Conservancy (2019). Retrieved from https://freshwaternetwork.org/innovative-tools/floodplain-prioritization-tool/the-value-of-floodplains/

**Benefits of Levee Setbacks**

- Levee setbacks may result in increased flood resiliency due to decreased flood stages and lower flood velocities which result in diminished chances of overtopping and erosion of the levee.
- Levee setbacks may result in lower annual operation and maintenance costs.
- If a setback meets the minimum federal requirements of the National Flood Insurance Program, flood insurance would not be required for habitable structures located landward of the levee.
- If a setback is deemed more resilient to flooding, then crop insurance, as managed through the USDA's Risk Management Agency, may have lower premiums for cropland located landward of the levee.
- Levee setbacks create opportunities for restoring natural ecosystem functions through reconnection of the historic floodplain and allow the exchange of floodplain flows which are vital to the propagation and sustainability of native flora and fauna.

## Barriers to the Use of Levee Setbacks

Unfortunately, the process for implementing a federal levee setback can be complicated. Each levee is unique in composition, the level of flood protection provided, vulnerability to flood damage, and impact on the environment. Since the total cost to setback a Congressionally authorized levee is high, it is unlikely that a setback could be implemented without the occurrence of a major flood event significantly damaging the existing levee and the additional benefits (as compared to costs) achieved from the enhanced flood risk management, environmental, and recreational benefits associated with a levee setback project analysis. As previously discussed, the Corps is authorized under PL 84-99 for the repair and/or replacement of each Congressionally authorized levee at the federal government's expense, but only after a damaging flood event. Actions that can be taken following a flood event are primarily dependent upon the severity of damage to the levee, and the economic feasibility of repairing the levee on its existing alignment. To a certain extent, it is also dependent upon the desires of the levee district which is responsible for the levee's annual operation and maintenance.

### Time Constraints

When a federal levee is severely damaged from flooding, the typical response is to conduct repairs immediately in order to prevent additional flood damages from occurring landward of the levee for the remainder of the current or next flood season. Without a prior levee setback assessment in place, flood protection may be too time sensitive to allow for lengthy planning, design, coordination, and construction activities to implement a setback prior to the next flood event. One of the popular incentives of the PL 84-99 program is that the Corps will begin considering repairs to a damaged levee as soon as the floodwaters recede. A levee setback can be time consuming, with numerous tasks such as planning, design, coordination, real estate determinations, identification of borrow material, and construction needing to take place in order to achieve the pre-flood level of protection. The time required from concept to completion of a levee setback is dependent upon the length of the setback and accomplishing all tasks. On average, a levee setback may take one or more construction seasons to be completed.

## Program Constraints and Agency Silos

Individual federal agency programs were created at different times, for different needs, and all agencies are required to follow their specific programs as directed in their program implementation language. Federal agencies operate independently from one another and often their programs appear to oppose rather than support the same outcomes. As an example, NRCS conservation easement programs restrict the placement of a federal setback levee onto an existing conservation easement, even though the setback could result in reconnection of the historic floodplain with a net increase in acres for environmental purposes.

Within the PL 84-99 program, the Corps is authorized to provide rehabilitation assistance for a damaged levee, but the agency is required to only consider the least cost alternative for repairing the levee. No resources are available under this program to conduct a levee setback assessment prior to a flood event. There are additional programs managed by the Corps, which could potentially be used to conduct levee setback assessments, but within those programs, a project sponsor who provides 50 percent of the study costs and up to 50 percent of the project implementation costs for an economically feasible project must be identified.

Additionally, federal agencies conduct business in accordance with their Congressional mandates, and each agency's programs are limited according to its jurisdiction, which creates internal silos from which their programs are managed. However, a levee setback project requires collaboration between agencies for the planning, design, construction, and real estate requirements of the setback to be successful.

## Mapping of Repetitively Damaged Levees and Conservation Easements

There are numerous digital mapping applications which illustrate all types of informative water resources and levee data. However, there are no data layers which illustrate levees which have incurred repetitive damages from prior flood events, or conservation easements associated with federal or state programs which could be combined to illustrate conservation easements in the vicinity of repetitively damaged levees. Appendix B provides several examples of useful mapping tools.

**Barriers to Levee Setback Implementation**

- Time constraints in coordinating, planning, designing, acquiring real estate, and completing construction in response to emergency recovery activities after a flood event.
- Programmatic silos within federal and state agencies preventing mutual cooperation.
- PL 84-99 program restriction on conducting levee setback assessments prior to flooding.
- Identifying a local sponsor for providing 50% of study costs and up to 50% of project implementation costs for an economically feasible project under Corps directed programs.
- Mapping programs exist at the federal and state levels, but mapping is not currently available to illustrate repetitively damaged levees or the conservation easements located in the vicinity of these levee systems.

## Recommendations to Encourage the Implementation of Levee Setbacks

Even as interest in levee setbacks continues to increase, there are federal regulations and policies which must be modified to allow for the increased use of setback levees. These recommendations include both policy changes that could be completed by the Corps and other federal agencies as well as recommendations that would require Congressional action to change existing regulations.

**Require the Corps to Include Information on Repetitively Damaged Levees in the National Levee Database.** The National Levee Database (NLD), developed and administered by the Corps, is the primary resource for comprehensive information about federal and nonfederal levees. The database contains information related to flood risk, levee system evaluation for the National Flood Insurance Program (NFIP), and levee system inspections; however, Congress should require that the NLD include annual levee damages recorded by levee name, location, and extent of damages. This will help determine if any federal or nonfederal levees are becoming or have become susceptible to repetitive flood damages.

**Update the Corps Engineering Regulation 500-1-1; Civil Emergency Management Program (referred to as PL 84-99).** PL 84-99 policy should be modified to include levee setbacks as an integral component to the emergency response/post-disaster assistance of the program. Rather than limiting post-disaster activities to only repairing (structural) or entirely removing (nonstructural) the existing levee, incorporation of the consideration of a levee setback into PL 84-99 policy would expand the array of mitigative actions to include repair, removal, or realignment (setback). Inclusion of the levee setback alternative would result in a more flood resilient levee system, elimination or significant reduction in levee repairs after flood events, and restoration of diminished fish and wildlife habitat.

**Modify the PL 84-99 Program to Provide the Corps with Acquisition Authority.** Under authority of the PL 84-99 program, the Corps is required to identify an economically feasible least-cost alternative prior to initiating repairs to a damaged levee. Those repairs may consist of a levee setback if the existing levee has incurred significant damage. Program regulations require the levee sponsor to provide the real estate for levee repairs or a setback. While levee setbacks have been shown to reduce flood risk, improve resiliency, and increase environmental benefits, the ability of a project sponsor to raise the funds to provide compensation for the adjacent landowner whose property would be located riverward of the setback levee is often a major concern and obstacle to project implementation. The PL 84-99 program should be modified to provide the Corps with real estate authority to acquire or lease this property for conservation purposes.

**Update Corps Guidance on the Section 408 Program.** Section 408 provides that the Corps may grant permission for another party to alter a federal levee if the agency determines that the proposed alterations will not harm the public interest and will not impair the usefulness of the project.[28] Assigning a coordinator from the state, in addition to the Corps District Section 408 Coordinator, would help ensure timeliness and continuity of project modifications moving

[28] Army Corps (2018) What is Section 408? Retrieved from https://www.saj.usace.army.mil/408/

through the Section 408 process. By being an effective point of contact for the Corps and serving as an intermediator between the Corps and project sponsor, a state coordinator would also help ensure the project is carried out in a way that is consistent with local requests through the Section 408 process.

**Ensure Effective Implementation of the Principles, Requirements & Guidelines (PR&G)**. The Principles, Requirements & Guidelines (PR&G) are the standards that the Corps uses to evaluate the feasibility and effectiveness of civil works projects under authorities and appropriations in WRDA. In WRDA 2020, Congress directed the Corps to issue final agency procedures for the PR&G by June 2021. Congress should ensure the Corps carries out an extensive public outreach as part of the development of final agency procedures, currently delayed as the new administration continues to transition into leaderships roles within the Corps. Further, the final agency guidance should fully account for the environmental and societal benefits and costs of Corps sponsored projects. This shift toward a full accounting would increase the likelihood that levee setbacks receive a more competitive benefit-cost ratio, with the environmental and societal benefits of levee setbacks significantly outweighing the costs. Additionally, the Corps' Engineering Regulation 1110-2-100; Planning Guidance Notebook, should be revised to incorporate water resources strategies which adhere to and advocate for the PR&G, through stakeholder review and comment.

**Incorporate Levee Setbacks into the Levee Safety Program Risk Assessment.** The Corps Levee Safety Program Engineering Circular 1165-2-218, establishes the policies for implementing the Corps Levee Safety Program. [29] Although the program includes activities (inspections, risk assessments, sharing information, inventorying data, operation, maintenance, and repair) which require the collaboration of the Corps and levee sponsor, there is no mention of levee setbacks, nor the potential for increasing resiliency and reducing flood risk via the implementation of levee setbacks. It is recommended that in conjunction with levee risk assessments, the Corps be directed to consider the feasibility of increasing resiliency by conducting levee setback analyses on levees susceptible to repetitive damage or failure from flooding.

**Establish a Nature-Based Community of Practice within the Civil Works Program.** The Corps should consider nature-based flood risk management projects equitably with structural projects. The Corps should establish a Community of Practice (CoP) within the Civil Works Program. The CoP would be the center of expertise for coordinating nature-based activities across the agency, would coordinate with the Engineering with Nature CoP, manage laboratory needs, establish a library of resources, develop policy, and provide internal training to increase the capacity of the Corps to engage in more nature-based projects.

**Congress Should Direct Funding Toward Support for Setback Assessments and Design.** The Corps has the planning and engineering capabilities and expertise to evaluate the economic, environmental, and flood resiliency benefits of potential levee setbacks. As the administrating agency for the National Levee Database (NLD), the Corps maintains historical records (design,

[29] Army Corps (2018) Circular No. 1165-2-220. Retrieved from https://www.publications.usace.army.mil/Portals/76/Publications/EngineerCirculars/EC_1165-2-220.pdf?ver=2018-09-07-115729-890

construction, annual inspections, and flood-related repairs) which are invaluable in the assessment of potential levee setbacks. Annual funding should be provided to the Corps for their collaboration with local, state and other federal agencies in the identification and assessment of potential levee setback locations.

**Utilize the Corps' Silver Jackets and Floodplain Management Services Programs.** The objective of the Corps' Silver Jacket (SJ) and Floodplain Management Services Program (FPMS) are to develop collaborative, comprehensive, and sustainable multiagency teams and water resources-related studies to improve life safety and reduce flood damages across the country. The SJ and FPMS programs should be used to the fullest extent possible as a resource to bring together other local, state, and federal agencies to leverage resources for analyzing and implementing levee setbacks to decrease flood risk and increase environmental benefits.

**Ensure USDA's NRCS Conservation Easement Programs Support the Use of Land for Setbacks**. Congress has established two USDA NRCS conservation easement programs that include authorities relevant to levee setbacks and providing landowners with recovery assistance after a disaster —the Emergency Watershed Program Floodplain Easement (EWP-FPE) and the Agricultural Conservation Easement Program Wetland Reserve Easement (ACEP-WRE). [30,31] While both programs are powerful tools for the conservation of wetlands and other natural habitats on agricultural lands, Congressional changes to these existing conservation easement programs may be required to allow the NRCS to more effectively and efficiently partner with federal, state and local agencies and private landowners on levee setback projects. For example, the EWP-FPE restricts activities that can occur on existing easement property, possibly prohibiting the realignment of a levee setback or associated infrastructure**.** [32] Program modifications should be considered to allow the NRCS to participate in projects reconnecting historic floodplains. Opportunities for the NRCS to identify potential modifications for amending existing conservation easements to incorporate the setback levee and associated infrastructure should be explored. Further, alternatives such as replacement conservation acres in the vicinity of the EWP-FPE acres to address impacts to existing easements from a levee footprint and utility or roadway infrastructure need to be examined.

**The Corps Should Utilize Pre-Flood Appraisals for Recovery Program Land Transactions.** Many landowners whose property is located in the vicinity of rivers invest significant sums of money annually into the land in order to sustain crop productivity. Repetitive flooding can take a toll on the land requiring more effort to remove sand and other debris transported by the floodwaters and more application of herbicides and fertilizers to bring the land back to pre-flood productivity. The Corps' recovery programs would benefit if the agency were to purchase lands at the pre-flood appraised value, similar to the NRCS' valuation for conservation easements, rather than the post-flood appraised value.

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[30] USDA (2021) Emergency Watershed Protection (EWP). Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

[31] USDA (2021) Agricultural Conservation Easement Program – Wetland Reserve Easements. Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/pia/programs/easements/acep/?cid=nrcseprd1448832

[32] USDA (2021) Emergency Watershed Protection Program Assistance. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/pollinate/?cid=nrcs142p2_044223

**Direct the U.S. Fish and Wildlife Service to Explore Opportunities to Use Levee Setbacks.** The U.S. Fish and Wildlife Service (FWS) oversees the National Wildlife Refuge System (NWRS). There could be opportunities for levee setbacks within the land holdings of the NWRS, which should be considered. Many wildlife refuges are located along major river systems near federal levee systems and several refuges contain levees, under the FWS' jurisdiction, which have encountered repetitive damages from flooding in recent years. As an example, the Desoto National Wildlife Refuge, located along the Missouri River, in Harrison County, Iowa maintains an earthen levee which has been damaged repetitively during flood events over the past twenty years. Rather than considering a levee setback which could possibly benefit the refuge and surrounding landowners, the FWS continues to repair the levee, at great expense. The FWS should be charged with identifying levee setback opportunities within the NWRS.

**Direct the Federal Highway Administration to Explore Opportunities to Support Levee Setbacks.** Numerous interstate and highway transportation corridors are vulnerable to flooding from the failure of levees, and the damages and extensive detours associated with levee failure have led to public safety concerns and significant costs to local and regional economies. The Federal Highway Administration (FHWA) provides funding to state Department of Transportation (DOT) agencies for interstate and highway construction, maintenance, and repair. Congress should direct FHWA. in coordination with state DOTs, to explore opportunities to support levee setbacks. This would require FHWA to identify transportation corridors which have been adversely impacted by flooding from levee failures and support levee setbacks and other pre-disaster mitigation projects to reduce risk and increase flood resiliency for transportation systems.

**Modify or Develop Memorandums of Understanding Between Federal Agencies.** Common barriers to implementation of levee setbacks involve program conflicts between agencies, typically where the Corps has responsibility for the levee and a different agency has a conservation easement in place or oversees the land where the levee setback would ideally be located. A Memorandum of Understanding (MOU), whether national or regional, could support active partnering between agencies (i.e., Corps, FWS, NRCS, FHWA, and state agencies), specifying a process to eliminate the programmatic issues which often arise between agencies.

## Summary

While traditional flood risk management and infrastructure approaches will always have a role in the Corps' work, the utilization of new approaches, such as the use of levee setbacks, could help increase the resiliency of communities, including communities along the Mississippi, Missouri, Snake, and San Joaquin Rivers. The use of natural infrastructure approaches would also provide co-benefits such as enhanced fish and wildlife habitat, improved outdoor recreation opportunities, and decreased levee maintenance and repair costs. However, in order to allow for such approaches, changes will need to be made to federal, state, and local laws and policies. The potential solutions included above could help increase the opportunity for local communities to use levee setbacks to meet their infrastructure needs while becoming more resilient to flooding.

# Appendix A: Levee Setback Examples

The following are examples of levee setback projects which have already been designed and implemented or are in the process of being implemented.

## Missouri River Levee Setback Projects

### Federal Levee L-575 Setback

This 5.9-mile-long levee setback is located in Fremont County, Iowa, along the Missouri River near State Highway 2. It is the first of its type and size within the Missouri River watershed. The setback was proposed after review of flooding through 2011, which indicated that the levee had been significantly damaged on several occasions. During and following storm events in 2011, Highway 2 across the Missouri River was closed to traffic for months due to flooding. All traffic was routed to alternate highways in western Iowa and eastern Nebraska, resulting in longer commute times. The heavy commercial vehicles re-routed from State Highway 2 also took a toll on the alternate road surfaces and resulted in significant maintenance for the regional transportation system.

The significant flooding and repeated breach of this section of levee was due to a major constriction point in the system where Highway 2 crosses the Missouri River. At this location, the river conveyance area (the distance between levees or the distance between levee and natural high elevation) narrowed from 3,000 feet to 1,000 feet as the river flowed under the Highway 2 bridge. During large flood events, the constriction point caused an increase in stages and velocities, resulting in overtopping and breaching of Federal Levee L-575. The levee failure in turn caused significant flooding that resulted in negative impacts to local communities, farmland, and critical infrastructure. Working with landowners, the levee district, local and state governments, and NRCS, the Corps was able to set the levee back from the river and expand the constriction point from 1,000 to 3,000 feet. Figure B1 illustrates the L-575 levee breach and the resulting levee setback.

NRCS staff worked diligently to modify easement language and terms to support the location of the levee setback. Additional box culverts, which increase conveyance of the river, were placed into the Highway 2 bridge approach, resulting in an estimated stage decrease of two-feet during the 1-percent ACE flood event. The levee setback and bridge re-design were tested during the historic flood event of 2019, and the Federal Levee L-575 setback did not incur flood damages as witnessed along the remainder of the Missouri River Levee System.[33]

[33] Army Corps (2021) L575 Levee Restoration Information. Retrieved from https://www.nwo.usace.army.mil/Omaha-District-System-Restoration-Team/L575/

Figure B1; Missouri River Levee L-575 Breach Area and Setback Location

Federal Levee L-536 Setback

This federal levee was constructed in Atchison and Holt Counties (Missouri) during the 1950s. The flood of 2019 caused the levee to breach in seven locations, resulting in the flooding of over 56,000 acres, including approximately 200 homes and businesses. Residents were forced to evacuate for several months. The Atchison County Levee District, landowners, Missouri state agencies, The Nature Conservancy, NRCS, the Corps, and numerous state agencies all worked together on a proposal for the levee breach along L-536, and plans were developed to set the levee back from the river.

The levee setback has an overall length of five miles and is projected to reduce the 1-percent ACE flood stage by 0.8 feet. The project should provide lower O&M costs, and less frequent need for flood-related emergency operations. It is also expected that more reliable flood protection will be provided to landward homes, businesses, infrastructure, and farmland. The levee setback resulted in over 1,000 acres of reconnected floodplain and the restoration of fish and wildlife habitat. Congress appropriated funding for disaster recovery for the NRCS EWP-FPE program for multiple states, including Missouri. The Missouri NRCS developed a ranking process for eligible landowner applications for those funds. The ranking system was beneficial to the L-536 levee setback as the levee setback lands ranked high.[34] NRCS EWP-FPE funding was a critical component of the L-536 project.

## California Levee Setback Projects

Hamilton City, California Levee Setback and Habitat Restoration

Since 1983, six major flood events have occurred along the Sacramento River, resulting in significant damage to the existing levee, flooding of adjacent farmland, buildings and infrastructure, and the forced evacuation of area residents. In 2016, work began on a 6.8-mile

[34] Army Corps of Engineers – Omaha District (2021) L536 Restoration Information. Retrieved from https://www.nwo.usace.army.mil/Omaha-District-System-Restoration-Team/L536/

levee setback that will increase resiliency and restore more than 1,400 acres of habitat.[35] The project involves Hamilton City, Reclamation District 2140, The Nature Conservancy, the CA Department of Water Resources, and the Corps.[36] The levee setback project will result in more flood risk resiliency and ecological benefits for the Central Valley of California.

Lower Elkhorn Basin Levee Setback Project

This project consists of roughly 7 miles of setback levees in the Lower Elkhorn Basin. This levee setback project will contribute to the Central Valley Flood Protection Plan goals of providing improved public safety for approximately 780,000 people by reducing river stages in the Sacramento River. The program will also increase the capacity of the Yolo and Sacramento Bypasses, which are located close to Sacramento, West Sacramento, and the rural communities of Woodland and Clarksburg.[37] The project improves ecosystem functions by increasing inundated floodplain habitat for fish rearing and improving the connection to the Sacramento Bypass Wildlife Area. Construction is expected to be completed in 2025.[38]

Southport Sacramento River Levee Setback Project

The City of West Sacramento and West Sacramento Area Flood Control Agency (WSAFCA), and the CA Dept. of Water Resources (DWR) Division of Flood Management are in the process of developing a levee setback project to address the West Sacramento's flood risk.[39] If the project is authorized and funded by Congress, four miles of levees would be set back and the remaining two miles would be strengthened. The project includes the creation of 152 acres of floodplain and riparian habitat that would provide critical habitat to native fish species.[40]

Lower Deer Creek Flood and Ecosystem Improvement Project - Tehama County

This levee setback project is currently in the planning phase and would involve the removal and setting back of levees along the creek in order to protect and restore anadromous habitat.[41] The

[35] River Partners (2021) Construction Leveraged for Conservation. Retrieved from https://riverpartners.org/project/hamilton-city/
[36] Army Corps (2019) Hamilton City Flood Damage Reduction & Ecosystem Restoration. Retrieved from https://www.spk.usace.army.mil/Missions/Civil-Works/Hamilton-City/
[37] California Department of Water Resources (2020) Lower Elkhorn Basin Levee Setback Project. Retrieved from https://water.ca.gov/Programs/Flood-Management/Flood-Projects/Lower-Elkhorn-Basin
[38] California Natural Resources Agency (2020) Project: Lower Elkhorn Basin Levee Setback. Retrieved from https://bondaccountability.resources.ca.gov/Project.aspx?ProjectPK=16327&PropositionPK=49
[39] Army Corps (2016) West Sacramento General Reevaluation Report. Retrieved from https://www.spk.usace.army.mil/Missions/Civil-Works/West-Sacramento/
[40] California Eco Restore. Southport Setback Levee Project. Retrieved from https://resources.ca.gov/CNRALegacyFiles/docs/ecorestore/projects/Southport_Setback_Levee.pdf
[41] Deer Creek Watershed Conservancy (2018) Lower Deer Creek Flood and Ecosystem Improvement Project – Phase 1. Retrieved from http://cvfpb.ca.gov/wp-content/uploads/2018/01/20180123_Lower-Deer-Creek-Flood-and-Ecosystem-Improvement-Project_OnePag....pdf

levee setbacks will reconnect the historic floodplain to the channel and enhance natural channel processes to reduce maintenance.[42]

## Washington Levee Setbacks

### Lower Tolt River Floodplain Restoration - King County

The Lower Tolt River Floodplain Restoration Project set back roughly 2,500 feet of an existing levee at an overall cost of $6.5 million. The project restored 50 acres of critical floodplain habitat for salmon spawning and rearing, and increased the resiliency of the City of Carnation by increasing the area's floodwater storage capacity. Funding for the project was provided by the City of Seattle, King County Department of Natural Resources and Parks, King County Flood Control District, King Conservation District, Washington Salmon Recovery Funding Board, Puget Sound Acquisition and Restoration Fund, and the Washington Aquatic Lands Enhancement Account.[43]

### Yakima River Gap to Gap Ecosystem Restoration Project - Yakima County

The Yakima River Gap to Gap Ecosystem Restoration Project is being implemented to set back sections of the Yakima Federal Project Levee System and other levees constructed by local Diking Improvement Districts. The levee system was originally authorized by Congress in 1937 and was constructed by the Army Corps in 1947, with major extension by local agencies in the early 1970s. Other infrastructure (highway bridges, Wastewater Treatment Plant outfall, flood gates and irrigation systems) have been reconfigured to allow setback to occur. Components of the Federal Project Levee system have been set back using PL84-99 funding during and after partial failure of those components. The Corps' Section 1135 (ecosystem restoration) authority has provided the majority of funding for ongoing setback/reconfiguration of the Federal Project Levee which will help address negative environmental impacts caused by the Yakima Levee System. Other project actions have been funded by additional programs including the Washington State Department of Ecology's Floodplains by Design program and the Yakima Basin Integrated Plan. Floodplain land acquisitions for the restoration project have moved forward via purchases by the Bureau of Reclamation or donations by the City of Yakima. Next steps for the project include a series of actions to remove and setback portions of the existing levee and restore floodplain function on approximately 1200 acres, thereby reducing future flood stages and river velocity and increasing the resiliency of infrastructure to flooding. The project will also revitalize 20 acres of side channel habitat and restore hydrologic connectivity to approximately two miles of relic channel.

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[42] California Department of Fish and Wildlife (2020) Lower Deer Creek Flood and Ecosystem Improvement Project – Restoring Habitat with the California Department of Fish and Wildlife. Retrieved from https://storymaps.arcgis.com/stories/3a5fcdb0f02342aab8f2937f1c374080

[43] King County (2016) Lower Tolt River Floodplain Restoration Project. Retrieved from https://kingcounty.gov/services/environment/animals-and-plants/restoration-projects/projects/tolt-restoration/project-schedule.aspx

Lower Russell Levee Setback – King County

The levee currently in place does not meet current engineering standards, and it was originally created to protect agricultural lands. The area is now home to a residential development and a commercial district and setting the levee back will provide enhanced flood protection for the local community. The Lower Russell Levee Setback project will also improve fish and wildlife habitat and provide better recreation opportunities. This 1.4-mile-long levee setback project is considered a priority project under the 2005 WRIA Salmon Habitat Plan, and it also supports a larger overall flood management strategy for the Lower Green River.[44]

[44] King County (2021) Lower Russell Levee Setback. Retrieved from https://kingcounty.gov/depts/dnrp/wlr/sections-programs/river-floodplain-section/capital-projects/lower-russell-levee-setback.aspx

# Appendix B: Floodplain Mapping Tools

Below is a list of mapping tool resources that could be useful for supporting the assessment, planning, design, and implementation of potential levee setbacks.

**The Nature Conservancy's (TNC) Mississippi River Floodplain Prioritization Tool.** TNC created the Floodplain Prioritization Tool (FP Tool) in partnership with several agencies including the University of Bristol and Fathom. The tool helps to identify potential locations for floodplain conservation efforts within the Mississippi River Basin. The FP Tool will allow stakeholders – including businesses, local planners, and federal, state, and local decision makers – to maximize their conservation efforts while minimizing the impact of development.[45]

**FEMA's National Flood Hazard Layer (NFHL).** The National Flood Hazard Layer (NFHL) is a geospatial database that individuals can use to understand the level of flood risk in their area, and is used to inform the National Flood Insurance Program. The mapping data is updated regularly.[46]

**U.S. Geological Survey (USGS) Flood Inundation Mapping (FIM) Program**. This tool developed by the USGS ensures local communities understand their flood risk and allows them to make cost-effective mitigation decisions.[47]

[45] The Nature Conservancy (2019) Floodplain Prioritization Tool. Retrieved from https://freshwaternetwork.org/innovative-tools/floodplain-prioritization-tool/

[46] FEMA (2021) National Flood Hazard Layer. Retrieved from https://www.fema.gov/flood-maps/national-flood-hazard-layer

[47] USGS (2020) Flood Inundation Mapping (FIM) Program. Retrieved from https://www.usgs.gov/mission-areas/water-resources/science/flood-inundation-mapping-fim-program?qt-science_center_objects=0#qt-science_center_objects