High Hazard Potential Dams: When Removal Benefits Outweigh Repair

Dams that pose a high or significant hazard to lives and/or properties are prioritized for rehabilitation. In many cases, the benefits of removing the dam may outweigh the costs of repair and maintenance.

Lifecycle of a Dam

Expiration of Dam Benefits

Like all things, dams age. The result is that the primary purpose and benefits of a dam's original intention may also eventually expire. With this expiration comes a needed assessment of the prolonged benefit of a dam's remaining lifecycle. Such benefits might include hydroelectric power, flood control, community water supply, and recreation. As dams age, the infrastructure becomes more susceptible to catastrophic failure if not properly maintained. However, even with periodic maintenance, an aging dam is still vulnerable to failure caused by extreme weather patterns and human-caused impacts. As such, additional assessments into a dam's remaining effective lifecycle should be thoroughly evaluated. This evaluation should consider the dam's original purpose, continued need, and the overall cost/benefit to maintain as related to humans and natural resources. Ultimately, the National Dam Safety Program (NDSP) aims to prevent dam failures and reduce the impacts on lives and property that would be lost from a catastrophic event. The Bipartisan Infrastructure Law provides NDSP with $733 million in grant funding, to include $75 million for dam removal.

Removal versus Other Forms of Dam Rehabilitation

Rehabilitation, as defined for the purposes of the Rehabilitation of High Hazard Potential Dams (HHPD) program, will need to be considered as dams age. The HHPD program defines "rehabilitation" as the repair, replacement, reconstruction, or removal of a dam that is carried out to meet applicable state dam safety and security standards. Several crucial aspects need to be considered when assessing dam rehabilitation. Specifically, considerations need to focus on evaluating a dam's age, functional remaining lifecycle (original purpose and current need), and structural integrity. With such assessments, removal may be determined to be the most practical and economical option.

- *Age*. The average age of dams in the National Inventory of Dams (NID) database is 61 years. Thus, it is important to consider the age of such structures when assessing the type of rehabilitation proposed and potential associated costs to accomplish.

- *Functional remaining lifecycle* (original purpose and current need). Dams are constructed for a myriad of functional uses. Specific uses include hydroelectric power, flood control, community water supply, and recreation. While a dam may provide more than one functional use, generally one original primary use can be identified. If the lifecycle of the original use has expired, any remaining functional use(s) should be considered ancillary. A common ancillary use is recreation.

- *Structural integrity*. While related to the other two aspects, it may be the primary component to consider above all else. Any structure that is degraded or at risk of imminent failure should be addressed regardless of age or remaining functional lifecycle. Depending on the issue, removal may be the most direct and expeditious process to minimize the likelihood of a catastrophic event.

For additional dam rehabilitation guidance, visit the HHPD webpage on FEMA.gov.

Environmental Benefits for Considering Dam Removal as an Option

Many dams pose an impediment to upstream and downstream migration for aquatic organisms. Specifically, fish species are some of the most impacted by such impediments. Many fish species require specific habitats to complete certain life history stages (*e.g.*, growth, reproduction, etc.) as well as the ability to move between a variety of habitat conditions on a daily or seasonal basis. These specific habitat needs usually require fish to migrate up or downstream to access food resources, to find suitable refugia, and evade predation or declining habitat conditions. When dams are present within an aquatic ecosystem, many of these fish movement patterns are severely disrupted or completely halted. In addition, instream conditions such as water quality or available habitat are negatively affected. These disruptions can result in decreases in diversity and abundance that can contribute to species population declines. Ultimately, population declines can lead to species becoming imperiled or extirpated from an impacted ecosystem. Furthermore, when a species is a narrow endemic (*i.e.*, small geographic range and/or occupies distinct habitat limited by environmental conditions), then dams can have an even more profound adverse impact. For additional information on fish passage and other environmental benefits for considering dam removal options, please visit the Federal Interagency Fish Passage Task Force's Fish Passage Portal.

Dam Removal Process Overview

Dam Removal Justifications

Dam removal justifications will vary. HHPD dams should be prioritized for removal considerations based on implications to human health, public safety, and impacts to the environment. Consider the below associated questions, and any others, as appropriate to help justify removal considerations.

- Human health: Consider these questions
    - Would failure of the dam pose an imminent threat to human life?
    - How will residents and communities within a flood inundation area be impacted if a failure occurs?

  - Are there existing threats of contaminated sediment/poor water quality associated with the current structure?

- Public safety: Consider these questions
  - How extensive would any property damage be in the event of a failure?
  - Could dam failure become a precursor for additional structural failures (*i.e.*, are there other dams/water control structures that could be impacted)?
  - What infrastructure would be impacted with a dam failure?
  - What are the anticipated timelines for completion of needed repairs?
- Environmental benefits: Consider these questions
  - Will restoring a stream's hydrologic regime further minimize flooding impacts, thus also reducing threats to human health and safety?
  - Are there state or federally listed, or other ecologically or economically important, aquatic species that may benefit by reconnecting fragmented habitats associated with the dam?
  - Will there be improvements to water quality, reduction of or improvements in sediment deposition, and overall stream/watershed health restoration if a dam is removed?

Identifying and Prioritizing Dam Removal Projects

The HHPD Priority System Process requires that states use an HHPD risk matrix to plot dams under consideration for HHPD funding, including dam removals. The risk matrix features the likelihood of failure on one axis and the estimated consequences on the other. However, the process does not determine or recommend project outcome: repair or removal. Thus, dam removal projects will be opportunity driven. Opportunity drivers will be influenced by many factors. Below are examples of such factors, but this should not be considered an exhaustive list. Rather, focus on the overarching opportunity drivers that are readily identifiable and add others when appropriate.

- Risk assessment
  - identify alternatives (*i.e.,* removal vs. repair vs. no action)
  - assess immediate, short, and long-term threats to public safety and natural resources.
- Opportunity drivers
  - willing property owner
  - social feasibility

- partnerships
- cost (*e.g.*, removal vs. repair/maintenance)
- ecological lift/environmental benefit (*e.g.,* miles of reconnected habitat, water quality improvement, etc.)

Risk assessment is a priority because of the relative association and classification with HHPD. Once a risk assessment has been considered, the opportunity drivers will help prioritize project sites, if multiple options exist. A willing property owner is necessary for a project to proceed. This may be more complex for publicly owned dams. From there, the other aspects, including risk assessments should factor into the prioritization consideration. For more information about risk assessment for high hazard potential dams, please see the Priority System Process for the Rehabilitation of High Hazard Potential Dams Fact Sheet.

Managing the Dam Removal Process

Once a dam has been prioritized and an opportunity for removal is confirmed, the very next step should be to identify and enlist the assistance of a project manager, if not already established. This individual will be crucial for outlining the key process steps and in moving the project forward through each on a timely basis. A project manager should be someone that will stay "plugged in" during all phases of the project. The project manager does not have to have a technical background for every facet of the project, but rather be able to identify and establish partnerships and working relationships with appropriate technical personnel. The expectation should be that the project manager will "wear many hats" during the project by communicating, coordinating, and collaborating with personnel from various disciplines. As such, the project manager does not necessarily have to be the individual that identified and prioritized the dam for removal. Rather, this individual must be someone that can establish roles and responsibilities, document actions, and direct and coordinate the process moving forward. It should be the expectation that the project manager will guide the project development and keep efforts on track. An experienced project manager will have a working sense of what is or might be needed for each process step throughout the dam removal planning, design, and implementation efforts.

Dam Removal Project Components

The specific details for each component listed below can be expanded or minimized as appropriate. Every project will have unique technical issues and community concerns to take into consideration. By properly scoping a project and building the right team, it is possible to work proactively and plan for complex issues. Based on communications with entities having personal experiences (*e.g.*, on-the-ground project implementation, coordination with municipalities, participation in listening sessions, etc.), the environmental compliance process is generally considered to be an arduous task. However, with the identification of an appropriate project manager (see above), outlining the key steps, and the establishment of crucial partnerships, this can be a more fluid process. By proactively establishing working relationships with respective state and federal environmental agencies and outlining key steps and associated timelines in advance, the environmental compliance process will have a more predictable timeline. This process will also ensure that any required pre-project monitoring or data collection (*e.g.*, biological, cultural, historical, etc.) are clarified and can be performed in a timely manner to help streamline environmental compliance reviews.

Every project site will have unique logistical considerations. Proper planning and oversight of the project design and construction processes are also important for project success. These components will benefit from having an experienced project manager identified and appropriate partnerships established. Ideally, the project manager and partners will have knowledge of qualified engineering personnel and experienced and licensed construction contractors. Identifying qualified and skilled engineers, contractors, and sources for materials and equipment will also help streamline the project implementation process. Ultimately, each project will offer its own unique technical and logistical issues and no two projects will be the same. However, there are some general rules and guidance that can be considered to assist with project development and implementation. Below are some examples of items to consider when assessing a dam for removal.

Example Checklist Outline for Planning a Dam Removal

- Scoping project and general considerations
    - age of structure, historical significance, and cultural resources
    - assess and manage any potential sediment buildup per state/federal requirements
    - impacts to federally listed species
    - alterations of aquatic habitats
- Safety
    - work site considerations during removal
    - structural integrity during removal
    - control access for duration of project
- Environmental
    - compliance review and permit process
        - coordination with state and federal offices at local level
        - Clean Water Act (Section 404)
        - National Historic Preservation Act (Section 106)
        - Endangered Species Act (Section 7)
        - National Environmental Policy Act (including categorical exclusions where applicable)
        - Other federal, state, local requirements

- Partnerships
  - identify individuals/entities critical to project success
  - funding assistance
  - project collaboration, coordination, and implementation
- Design and Construction
  - engineering plans and specifications
  - materials and equipment
  - construction contractor identification
  - communication, oversight, and documentation
- Monitoring
  - pre-project (including project site assessments, aquatic and terrestrial species surveys as relative to project benefits and/or for environmental compliance processes, etc.)
  - active (during project; assessment of progress including approvals of materials or next steps)
  - post-project (including as built surveys to verify project completeness, aquatic species surveys to assess project benefits, etc.)