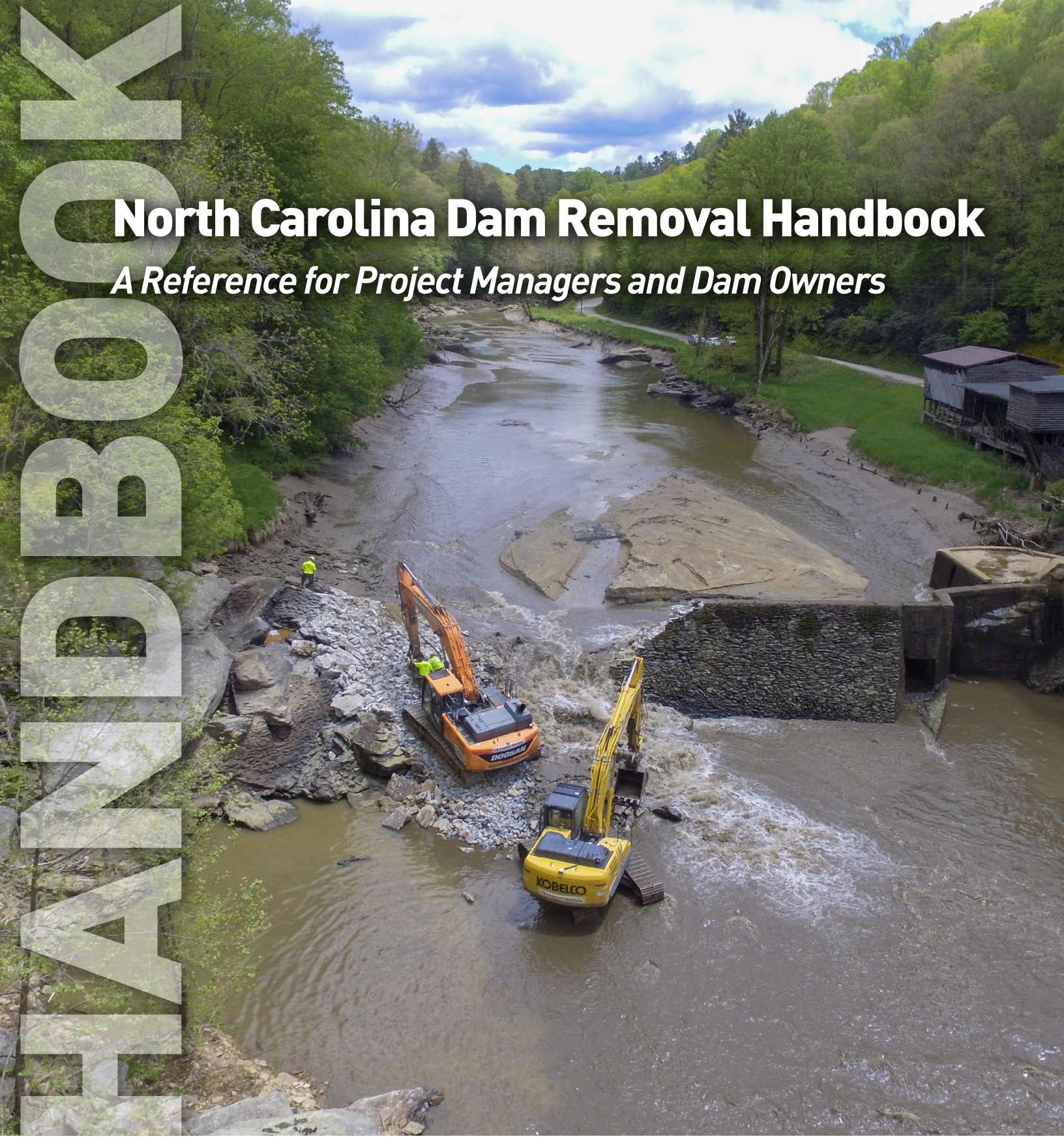
# North Carolina Dam Removal Handbook

*A Reference for Project Managers and Dam Owners*




**November 2022**

The North Carolina Aquatic Connectivity Team

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# ACKNOWLEDGEMENTS

The North Carolina Aquatic Connectivity Team (NC ACT) was created in 2010 to bring together a wide range of partners representing state and federal agencies, universities, and conservation organizations to establish a peer-to-peer learning network that supports and accelerates removal of dams across the State. NC ACT is an interdisciplinary, inter-organizational team that serves as the statewide leader in aquatic connectivity efforts. Our mission is to restore connectivity, habitat, and ecological function to streams in North Carolina by identifying, assessing, and facilitating removal of barriers to aquatic species passage. The objectives to support this mission are to identify high-priority dam, culvert, or other aquatic barrier removal projects, implement dam, culvert, or other aquatic barrier removal projects, and encourage sound policies and regulations for aquatic barrier removal and prevention. The creation of the North Carolina Dam Removal Handbook would not be possible without the efforts of the following NC ACT Regulatory Committee members who served as authors, contributors, and reviewers, making time in their exceptionally busy professional lives to share their expertise and their organizations' knowledge, processes, and resource information. A special acknowledgement to Lisa Perras Gordon and Margaret Stebbins for their leadership and steadfast optimism to ensure this project was completed.

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**Cover photo:** *Ward's Mill Dam during removal May 2021, photo credit Wildlands Engineering.*

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# ACRONYMS

| | |
|---|---|
| ACHP | Advisory Council on Historic Preservation |
| AU | Assessment Unit |
| CWA | Clean Water Act |
| EPA | United States Environmental Protection Agency |
| ER | Environmental Review |
| ESA | Endangered Species Act |
| FEMA | Federal Emergency Management Agency |
| FERC | Federal Energy Regulatory Commission |
| FPA | Federal Power Act |
| GNIS | Geographic Names Information System |
| GIS | Geographic Information System |
| HUC | Hydrologic Unit Code |
| IPaC | Information for Planning and Consultation |
| IR | Integrated Report |
| MOA | Memorandum of Agreement |
| NCAC | North Carolina Administrative Code |
| NCACT | North Carolina Aquatic Connectivity Team |
| NCDEQ | North Carolina Department of Environmental Quality |
| NCDEMLR | North Carolina Division of Energy, Mineral, and Land Resources |
| NCDWR | North Carolina Division of Water Resources |
| NCDMS | North Carolina Division of Mitigation Services |
| NCWRC | North Carolina Wildlife Resources Commission |
| NHPA | National Historic Preservation Act |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| NID | National Inventory of Dams |
| NMFS | National Marine Fisheries Service |
| NPDES | National Pollutant Discharge Elimination System |
| NWP | Nationwide Permit |
| NCACT | North Carolina Aquatic Connectivity Team |
| OSA | Office of State Archaeology |
| PCN | Pre-construction Notification |
| RGL | Regulatory Guidance Letter |
| SARP | Southeast Aquatic Resource Partnership |
| SHPO | State Historic Preservation Office |
| T&E | Threatened & Endangered |
| TVA | Tennessee Valley Authority |
| TMDL | Total Maximum Daily Load |
| USACE | United States Army Corps of Engineers |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |

# GLOSSARY OF TERMS

**Bankfull:** The elevation on the stream bank where flow begins to spill over onto the floodplain.

**Breached Dam:** An opening created through a dam that allows drainage of the impounded waters. A breach can be intentional and controlled, such as during removal, or uncontrolled, such as during an extreme weather event.

**Dam:** An artificial barrier, together with its associated works, constructed in or across a waterway for the primary purpose of impounding or diverting water.

**Diadromous:** Fish that spend portions of their life cycles partially in fresh water and partially in salt water which includes anadromous fish (which spend most of their adult lives at sea and return to fresh water to spawn) and catadromous fish (which spend most of their time in fresh water and return to sea to spawn.)

**Headcut:** Downcutting of the streambed in the upstream direction.

**Historic Property:** Any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places

**HPOWEB:** Publicly accessible GIS-based web platform that displays historic resource data recorded by the North Carolina State Historic Preservation Office.

**Low-head Dam:** See Dam. For the purposes of the USACE's NWP, the term "low-head dam" is generally defined as a dam or weir built across a stream to pass flows from upstream over all, or nearly all, of the width of the dam crest and does not have a separate spillway or spillway gates, but it may have an uncontrolled spillway. The dam crest is the top of the dam from left abutment to right abutment. A low-head dam may have been built for a range of purposes (e.g., check dam, mill dam, irrigation, water supply, recreation, hydroelectric, or cooling pond), but in all cases, it provides little or no storage function.

**Run-of-River Dam:** A riverine or stream dam that is designed or operated to release water at approximately the same rate as the natural streamflow.

**Regulated Dam:** A dam that is operated such that flows released are higher or lower than the natural streamflow. Such purposes include flood control, hydropower production, and water storage.

**Spillway:** The structure over or through which flow is discharged from a reservoir.

**StoryMap:** A web map that has been thoughtfully created, given context, and provided with supporting information so it becomes a stand-alone resource.

**Tailwater:** The body of water immediately downstream of a dam.

**Thalweg:** The line of deepest water along the channel of a stream.

**Undertaking:** Per Section 106 of the National Historic Preservation Act of 1966, Federal Undertakings are projects or actions requiring a federal permit, license or approval; and those subject to state or local regulation administered pursuant to a delegation or approval by a federal agency.

# PURPOSE OF THIS HANDBOOK

This Handbook is intended to provide dam owners and project managers in North Carolina with the information and resources needed to undertake a dam removal project. All such projects have unique aspects and varying complexities, depending on the primary factors driving project initiation and permitting, including removing barriers to aquatic connectivity, restoring water quality, improving dam safety, removing a recreational hazard, reducing costs for dam owners, or protecting endangered species and historic or cultural sites. While many excellent sources of information on dam removal are available, this Handbook is specifically intended to address the process for North Carolina, providing links to the most-up-to-date information on state resources and regulatory agencies. This Handbook provides information and references for a step-by-step approach to dam removal, encompassing conception and planning, information gathering, funding, design, permitting, and removal. The process is not linear. Each of the steps may proceed at different speeds, with many occurring at the same time or in different order.

# WHY REMOVE DAMS IN NORTH CAROLINA?

North Carolina's rivers are the lifeblood of its communities, providing fresh, clean water for life to thrive. Dam building, pollution, development, and other impacts have stressed or impaired many aquatic communities that depend on NC rivers and streams. Few things have such a fundamental impact on a river as a dam. While some of the more than 26,000 dams currently spanning North Carolina's waterways provide important services, many are either obsolete or offer benefits that no longer outweigh their costs. Dams obstruct waterways, pose public safety hazards, harm Tribal Nations' cultural values, prevent aquatic life from accessing essential habitat, impact water quality and flow, limit recreational and economic opportunities, and can increase flood risk and greenhouse gas emissions.

Voluntary removal (or, decommissioning) of unwanted dams is increasing nationwide, offering benefits for dam owners, communities, state and local economies, anglers, boaters, wildlife, and the environment. All dams are potentially dangerous, and their removal eliminates the risk of dam failure and the dangerous currents below dams that kill dozens of people annually across the U.S., according to the Association of State Dam Safety Officials.

Dam removal is one of the most efficient ways to restore streams and stream functions; it immediately opens access to the habitat above the site of the former dam and restores natural sediment and nutrient flow downstream. Dam removal also builds resiliency to combat the impacts of climate change that are stressing freshwater resources and communities in North Carolina. Increasing climate variability and volatility will continue to increase the frequency and severity of extreme storms, floods, and droughts. North Carolina has seen these effects with significant rainfall and flooding associated with hurricanes and tropical storms in 2016, 2018, and beyond. Dam removal mitigates these impacts of climate change by restoring natural flow and water temperature regimes, restoring floodplains and allowing aquatic species to migrate to climate refugia where conditions better meet their needs.

**Figure 1: Shuford Dam before, during and after dam removal.**

Photo Credits: Jeffrey Rich (bottom left), Jeremy Monroe, Freshwater Illustrated (top left), and Erin Singer McCombs (right)

# BENEFITS OF REMOVING DAMS

- **River Restoration:** Removing dams rapidly restores river and stream ecosystem processes, including sediment transport, flow patterns, and floodplain functions. Free-flowing streams and rivers are more resilient to the effects of climate change, such as increasing temperatures, changing precipitation patterns, and more frequent floods and droughts.

- **Fish and other aquatic species:** Dam removal can help restore North Carolina's once thriving migratory fish runs, which were a significant contributor to the cultural landscape and heritage of Native Americans and early settlers of the state. Shad, sturgeon, striped bass, suckers, and many other species have been shown to quickly return to spawning grounds once barriers are removed providing an opportunity to return long lost cultural fishing traditions. Other aquatic organisms, such as freshwater mussels, salamanders, and crayfish, can also expand upstream once a dam is removed. These efforts also restore habitat for species endemic to North Carolina, such as those that formerly thrived in shoals (the shallow, fast-moving areas of water on bedrock or cobble) long ago flooded by impounded waters (see Sicklefin Redhorse, pg 8.)

- **Tribal Benefits:** Tribal peoples in North Carolina continue to retain a strong connection to intact river systems and their ecological processes that support important cultural, economic, and recreational services. Removing dams can have significant benefits for Tribes through the restoration of native aquatic species and habitats, fluvial processes, and cultural traditions.

- **Environmental Justice:** Dams cause harm to communities when culturally significant places and food resources are no longer available, water quality diminishes, and access is no longer available. When a dam is removed, migratory fish can return to historic runs, the ecology improves, and accessibility is restored.

- **Maintenance costs:** Dam owners may find the one-time cost of removing a dam is significantly lower than the cost of maintaining or repairing an aging structure that has outlasted its usefulness or presents a safety hazard.

- **Dam Safety:** It is estimated that half of the total number of dams identified in the North Carolina Dam Safety Program's inventory were constructed before the establishment of the Dam Safety Law of 1967. Many of those dams have long outlived their design lifespan. Dam removal improves public safety by eliminating risk of a dam failure and potential impacts to populations downstream. Dam owners can decrease public safety concerns – and their own potential liability – through a removal process that is properly planned, implemented, and permitted through the state dam safety office.

- **Safety for Recreational River Users:** Each year, fatalities result when swimmers, paddlers, or anglers get trapped in the hydraulics below low-head dams. Removing obsolete dams permanently eliminates this danger and, potentially, any associated liability for the dam owner.

- **Economic Benefits to Local Communities:** When dams come down, safe recreation can be established with water trails, parks, and greenways that support the local economy. A restored river helps create jobs, increases tax revenue, reduces flooding, and revitalizes fisheries.

- **Water quality:** Removing dams can significantly improve water quality, increasing dissolved oxygen, reestablishing natural water temperature patterns, and reducing downstream erosion.

- **Benefits to the Coastal Zone:** Coastal erosion can increase when river sediment is held behind dams. Restoring sediment to the coastal zone by removing dams may help to reverse deficits to coastal areas and create land building, thereby making coastlines more resilient to a changing climate.[1]

[1] Warrick, J.A., Stevens, A.W., Miller, I.M. *et al*. World's largest dam removal reverses coastal erosion. *Sci Rep* 9, 13968 (2019). https://doi.org/10.1038/s41598-019-50387-7

## The Sicklefin Redhorse: A mighty sucker that can benefit from dam removal

The Sicklefin Redhorse is a large sucker species that is only found in the Little Tennessee and Hiwassee River basins in southwestern North Carolina and northern Georgia. This robust sucker can weigh up to 3.5 pounds and is golden olive-colored, with a sickle-shaped dorsal fin and a red tail fin. Although it was "discovered" by the scientific community in 1992, it has been known by Cherokee for centuries as Ugiidatli, or "wearing a feather". The Sicklefin Redhorse was an important food resource for the Cherokee, and its range has been greatly fragmented by dams and impoundments constructed over the past 100 years. The Cherokee call a river Ga-na-hi-da A-sga-ya, or "the long man"; damming a river disrupts the lifecycle of this body, much like a tourniquet constricts the blood flow in a person's body.

The Sicklefin Redhorse is a potadromous species, meaning it migrates entirely in fresh water, moving upstream into shoal habitats to breed in the spring and then back downstream into deeper waters after spawning. This sucker is one of several redhorse species and other sucker species (e.g., White Sucker) that migrate in the spring to their spawning shoals. The Sicklefin Redhorse stands out among redhorse species in that it requires long stretches of river to spawn and successfully reproduce. Its migration is essential to successful reproduction; dams arrest this upstream movement, and impounded waters behind dams inundate spawning shoals. Removal of the Dillsboro Dam on the Tuckasegee River in 2010 enabled the Sicklefin Redhorse to expand its range upriver; biologists continue to work towards the removal of other dams on the Tuckasegee River and Oconaluftee River to restore this mighty fish to more of its historical range.

Sicklefin Redhorse (photo credit: NCFishes.com)

# INTRODUCTION AND OVERVIEW OF DAMS IN NORTH CAROLINA

Dams provide many useful functions, such as generating hydropower, supplying drinking water, mitigating flooding, and providing recreation across the country. However, many aging dams no longer serve their intended purpose, or their benefits no longer outweigh the costs. Dam removal has emerged as a viable means to restore connectivity for aquatic life in rivers and streams, reduce the risk of failure, enable safe passage for river and stream recreation, and provide dam owners with a cost-effective option for addressing unsafe infrastructure.

According to American Rivers' database on dam removals, over 1,951 dams have been removed in the United States. Despite the COVID pandemic, 57 dams were removed in 2021, reconnecting 2,131 upstream river miles.[2] Some examples of dam removals in North Carolina are included as case studies throughout this Handbook.

Ample opportunities exist to remove dams. There are two inventories of 'regulated' dams that have some permitting, licensing, or regulatory requirements. They are:

- The U.S. Army Corps of Engineers' (USACE) National Inventory of Dams (NID), which identified over 91,000 dams nationwide of various sizes and hazard classification as of October 2022.[3] The NID is updated annually based on submissions from each State Dam Safety Program.

- The North Carolina Dam Safety Program which has 6,117 dams in its inventory as of October 2022.[4] Of those, approximately half are regulated by the Program. The remaining dams are exempt either because they do not meet the size criteria for regulation set forth by the Program, or they are regulated by another Federal agency (e.g., USACE, FERC, NRCS, Tennessee Valley Authority (TVA)). Approximately 55 percent listed in the inventory are privately owned, and about half were built before the Dams and Reservoir Safety Act Law of 1967. (*See also Section 3.5.3 Dam Safety Program*)

However, these databases are not a complete picture of the number of dams nationwide. There may be many small and medium sized dams that are not regulated by any program or may not be included in state dam safety databases. The total number, including all regulated and unregulated dams in the US, is estimated to range from 2,000,000 to as many as 2,500,000.[5] As many as 75 to 95% of these smaller dams, such as those built to support the early mill economy, are considered obsolete and may no longer serve a functional purpose.[6,7]

**There are an estimated**

**2,500,000**

**dams in the U.S.**

**As many as**

**75 to 90%**

**are obsolete and no longer serve any purpose.**

**Many are public safety hazards.**

[2] 69 Dams Removed in 2020 https://www.americanrivers.org/2021/02/69-dams-removed-in-2020/

[3] https://nid.usace.army.mil/#/

[4] In North Carolina, the Dam Safety Program resides within the Division of Energy, Mineral, and Land Resources (DEMLR), part of NCDEQ.

[5] Poff, N.L., and Hart, D.D. (2002). *How dams vary and why it matters for the emerging science of dam removal*. BioScience, v. 52, no. 8, p. 659–668. http://dx.doi.org/10.1641/0006-3568(2002)052[0659:HDVAWI]2.0.CO;2

[6] Graf WL. (1993). Landscapes, commodities, and ecosystems: *The relationship between policy and science for American rivers.* Pages 11–42 in Water Science and Technology Board, National Research Council. Sustaining Our Water Resources. Washington (DC): National Academy Press

[7] U.S. Environmental Protection Agency. (2016). Frequently Asked Questions on Removal of Obsolete Dams. Retrieved from https://www.epa.gov/cwa-404/frequent-questions-removal-obsolete-dams

Since 2010, the Southeast Aquatic Resource Partnership (SARP), researchers, and other conservation practitioners have worked to identify dams in the Southeastern U.S. that are not in the NID. While the total number of dams in the Southeast is not known, over 317,000 dams have been identified within SARP's Comprehensive Southeast Aquatic Barrier Inventory. Approximately eight percent (or over 26,000) of all Southeastern dams are in North Carolina, and about 23 percent of them meet the criteria to be regulated under the state Dams and Reservoirs Safety Program. The remaining dams are unregulated by any state or federal programs.

Estimates indicate that potentially half of the dams in the North Carolina Dam Safety Program inventory were constructed before the establishment of the Dam Safety Law of 1967. Their original purpose was to power paper and textile mills, create water supply reservoirs, and provide impoundments for boating, fishing, and hunting recreation. Public safety concerns arise due to unmaintained dams and the age of this infrastructure. This is a nationwide problem. Even today, with new construction methods, materials, and design criteria, a dam is rarely constructed with a design lifespan that exceeds 50 years.

## Dams in North Carolina

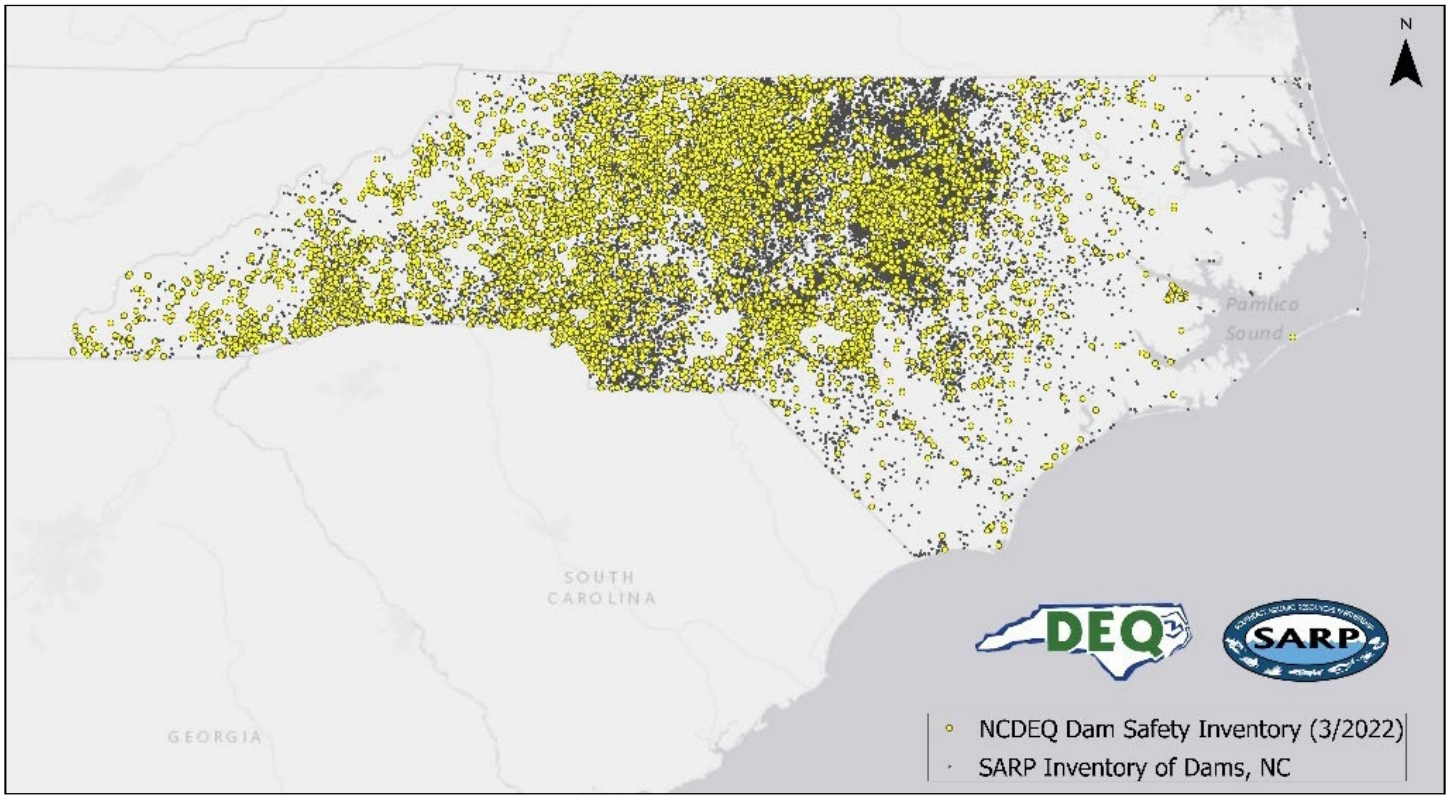
Over **26,000** dams currently identified in North Carolina

**6,117** dams inventoried by the North Carolina Dam Safety Program

**55%** of these dams are privately owned

**50%** of these dams were constructed prior to the NC Dam Safety Law of 1967

**Figure 2: Known dams in North Carolina, according to the NCDEQ Dam Safety Inventory (yellow) and the SARP Inventory of Dams (gray)**



Poor or inadequate dam maintenance increases the risk of dam failure, which can cause significant ecological and community damage downstream. Extreme weather events can stress dams beyond their design limits and/or cause overtopping, potentially causing a dam to breach. Dam breaches can release an inundation wave, resulting in considerable downstream destruction, including washed out riverbeds, significant impact to aquatic life populations, damaged roads and bridges, stranded communities, and inundated homes, schools, and businesses.

More than 80 dams have breached, partially breached, or drained in North Carolina (Table 1). Many breaches are the result of extreme rainfall events associated with hurricanes and tropical storms. These failures "exacerbated already dangerous flooding conditions and caused mandatory evacuations of communities. The threat of weakened, rain-soaked dams failing continued well after the storm had passed, causing great concern from the threat of continued evacuations in communities already dealing with property damage and safety concerns."[8] The potential for more dam failures is likely as extreme weather events increase.

Regular inspection, maintenance, and repair of dams is necessary to maintain safety and avoid breaches, but maintenance can be a high financial burden for dam owners. For more information about efforts to improve dam conditions and safety nationwide, access the webpage of the Association of State Dam Safety Officials (ASDSO).[9]

## Table 1: Dams breached or drained in North Carolina.

| Basin | Name | Stream | Status | Year |
|---|---|---|---|---|
| Broad | Phillips | Camp Creek | Breached | pre-1999 |
| Cape Fear | Arran Lakes | Little Beaver Creek | Breached | 2016 |
| Cape Fear | Bailey Lake | Beaver Creek trib. | Partial Breach | 1999 |
| Cape Fear | Blanchard | Little Alamance Creek trib. | Breached | 2005 |
| Cape Fear | Boiling Springs Lake | Allen Creek | Breached | 2018 |
| Cape Fear | Chesapeake | Carvers Creek trib. | Breached | c. 2000 |
| Cape Fear | Colee Naylor Pond | Little Coharie Creek trib. | Partial Breach | pre-2003 |
| Cape Fear | Cottonade | Beaver Creek | Breached | pre-2003 |
| Cape Fear | Craven | Reddicks Creek trib. | Partial Breach | pre-1993 |
| Cape Fear | Cross Lake | Brown Creek | Breached | pre-1993 |
| Cape Fear | Cumberland Lake | Buckhead Creek | Partial Breach | pre-1993 |
| Cape Fear | Dixon | Little Alamance Creek trib. | Breached | c. 2002 |
| Cape Fear | Unnamed (SARPID NC214) | Giffords Branch | Partial Breach | unknown |
| Cape Fear | Gainey Mill Pond | South River trib. | Partial Breach | unknown |
| Cape Fear | Guy Lake | Black River | Breached | 2016 |
| Cape Fear | Hall Lake | Rockfish Creek | Drained | pre-1998 |
| Cape Fear | House-Autry | Sevenmile Swamp | Partial Breach | 2016 |
| Cape Fear | Lake Bay | James Creek trib. | Breached | pre-1993 |
| Cape Fear | Laurel Lake | Rye Swamp | Breached | 2016 |
| Cape Fear | Linthicum Lake | Deep River trib. | Partial Breach | pre-1999 |
| Cape Fear | Martin Lake | Reedy Fork trib. | Breached | pre-1993 |
| Cape Fear | Maxwell Mill Pond | Maxwell Creek | Partial Breach | 2018 |

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[8] U.S. Environmental Protection Agency. (2016). Frequently Asked Questions on Removal of Obsolete Dams. Retrieved from https://www.epa.gov/cwa-404/frequent-questions-removal-obsolete-dams

[9] https://www.damsafety.org/

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| Basin | Name | Stream | Status | Year |
|---|---|---|---|---|
| Cape Fear | Michael Pond | Bear Creek trib. | Partial Breach | pre-1993 |
| Cape Fear | Mid Pines Lake | Mcdeeds Creek | Breached | pre-1999 |
| Cape Fear | Moore | Juniper Creek | Breached | pre-2005 |
| Cape Fear | Moose Lodge | Horsepen Creek trib. | Breached | pre-1993 |
| Cape Fear | Nicks Creek Water Intake | Nicks Creek | Partial Breach? | unknown |
| Cape Fear | Price Mill Lake | Troublesome Creek | Partial Breach | pre-1993 |
| Cape Fear | Ravenwood | Service Creek | Partial Breach | pre-1993 |
| Cape Fear | Rayconda Upper | Little Rockfish Creek trib. | Breached | 2016 |
| Cape Fear | Rose Lake | Cross Creek | Partial Breach | pre-2003 |
| Cape Fear | Rouse Pond | Beaverdam Branch | Partial Breach | 2016 |
| Cape Fear | Smith Lake | Buckhorn Creek | Breached? | pre-1993 |
| Cape Fear | Stafford Mill | N. Prong Stinking Quarter Cr. | Breached | pre-1993 |
| Cape Fear | Sunset Lake | Rockfish Creek trib. | Partial Breach | 2016 |
| Cape Fear | Surles Pond | Little Coharie Creek trib. | Partial Breach | pre-2005 |
| Cape Fear | Taylors Mill (Hope Mills No. 2) | Rockfish Creek | Breached | pre-1983 |
| Cape Fear | Unnamed (SARPID NC261) | Little River | Partial Breach | unknown |
| Cape Fear | Unnamed (SARPID NC262) | Little River | Partial Breach | unknown |
| Cape Fear | Von Cannon Lake | Nicks Creek | Breached | pre-1993 |
| Cape Fear | Wallace Lake | Buckhead Creek | Partial Breach | unknown |
| Cape Fear | Young Lake | Black River trib. | Partial Breach | 2009 |
| Catawba | Catawba Falls | Catawba River | Breached | unknown |
| Catawba | Dobbs Pond #2 | Crowders Creek trib. | Drained | pre-2005 |
| Catawba | Lady Marion | Garden Creek | Drained | 2019 |
| Catawba | Lenoir Water Supply | Zacks Fork Creek trib. | Breached | pre-1995 |
| Chowan | Farmers Chemical Assoc Lake | Chowan River trib. | Breached | unknown |
| Chowan | Whorrells Millpond | Whorrell Mill Swamp | Partial Breach | pre-1993 |
| French Broad | Cane Creek | Cane Creek | Breached | unknown |
| French Broad | Cotton | Left Fork Bean Creek | Questionable | unknown |
| French Broad | Craig | Swannanoa River | Partial Breach | 1952 |
| French Broad | Gaetani (Groves Lake) | Merrill Cove Creek | Partial Breach | pre-1994 |
| French Broad | Ivy River | Ivy River | Partial Breach | unknown |
| French Broad | Masters Mill (Loafers Glory) | Cane Creek | Partial Breach | unknown |
| Hiwassee | Peachtree Lake - Upper | Peachtree Creek | Breached | 2005 |
| Little Tennessee | Lands Creek Upstream | Lands Creek | Breached | unknown |
| Lumber | Bensons Mill Pond | Soules Swamp | Partial Breach | c. 2000 |
| Lumber | Thomas Lake #1 | Toneys Creek | Partial Breach | 2011 |
| Neuse | Aycock Millpond | Great Swamp | Breached | pre-1993 |
| Neuse | Company Mill | Crabtree Creek | Breached | c. 1935 |
| Neuse | Davis Millpond | Trotters Creek | Breached | pre-1993 |
| Neuse | Jones Lake | Crabtree Creek trib. | Partial Breach | c. 2000 |

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| Basin | Name | Stream | Status | Year |
|---|---|---|---|---|
| Neuse | Kelly's Pond | Southwest Creek | Breached | pre-2005 |
| Neuse | Tull Millpond | Southwest Creek | Breached | 2018 |
| Savannah | Frozen Lake | Frozen Creek | Partial Breach? | pre-1995 |
| Savannah | Wilson Creek Lower | Brooks Creek | Partial Breach | pre-2005 |
| Tar | Pleasants Lake | Red Bud Creek | Breached | 2007 |
| Tar | Unnamed (SARPID NC2399) | Fishing Creek | Breached? | unknown |
| Watauga | Shull's Mill | Watauga River | Breached | unknown |
| Yadkin | Alexander Lake | Smith Branch | Breached | pre-1993 |
| Yadkin | Boyd Lake | Marks Creek | Partial Breach | pre-2005 |
| Yadkin | Unnamed (SARPID NC184) | Swans Branch trib. | Drained | 2007 |
| Yadkin | Glosson Lake #1 | North Potts Creek trib. | Drained | pre-2005 |
| Yadkin | Janita Lake Lower | Salem Creek trib. | Drained | 1995 |
| Yadkin | Lower Coggins Lake | Kennedy Mill Creek trib. | Breached | pre-1993 |
| Yadkin | Martin Lake | Muddy Creek trib. | Partial Breach | 2002 |

**North Carolina is one of the Southeast's leaders in dam removal. As of October 2022, over 60 dams have been removed (Table 2), the majority since 2000. List compiled from lists maintained by American Rivers, SARP, NCDWR, and NCWRC.**

## Table 2: Dams removed in North Carolina.

| Basin | Name | Stream | Status | Year |
|---|---|---|---|---|
| Broad | Big Hungry - Lower | Big Hungry River | Removed | 2016 |
| Cape Fear | ADW | South Buffalo Creek trib. | Removed | pre-1993 |
| Cape Fear | Brown | Bull Run Creek trib. | Removed | 2009 |
| Cape Fear | Buckhorn | Buckhorn Creek | Removed | 2010 |
| Cape Fear | Carbonton | Deep River | Removed | 2006 |
| Cape Fear | Fryar Lake | South Buffalo Creek | Removed | pre-1985 |
| Cape Fear | Gant Lake | Little Alamance Creek trib. | Removed | pre-1993 |
| Cape Fear | Granite Mill | Haw River | Removed | 2016 |
| Cape Fear | Harnett Metals | Jumping Run Creek trib. | Removed | 1999 |
| Cape Fear | Latham Lake | Back Creek | Removed | pre-1993 |
| Cape Fear | Phillips Creek | Phillips Creek | Removed | 2014 |
| Cape Fear | Puryear | Haw River | Removed | 2013 |
| Cape Fear | Rock Lake | Hickory Creek trib. | Removed | pre-1993 |
| Cape Fear | Rocky R. (Woody/Hoosier) | Rocky River | Removed | 2018 |
| Cape Fear | Strickland | Bull Run Creek trib. | Removed | pre-1993 |
| Cape Fear | White Oak Lake | North Buffalo Creek trib. | Removed | pre-1993 |
| Catawba | Brookford (Shuford Mill) | Henry Fork | Removed | 2016 |
| Catawba | Freedom Park | Little Sugar Creek | Removed | 2002 |
| Catawba | Jacobs Pond | Long Creek trib. | Removed | unknown |

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| Basin | Name | Stream | Status | Year |
|---|---|---|---|---|
| Catawba | Rowland Lake Lower | Mauney Creek trib. | Removed | unknown |
| Catawba | Walker Pond | Bailey Fork trib. | Removed | 2006 |
| Catawba | Windermere | Mcalpine Creek trib. | Removed | pre-1994 |
| French Broad | Altapass (Shane Vance) | Roses Creek | Removed | 2010 |
| French Broad | Cane River | Cane River | Removed | 2017 |
| French Broad | Plumtree | North Toe River | Removed | 1993 |
| French Broad | Rush Mountain | Greer Creek | Removed | 2017 |
| French Broad | Spruce Pine | North Toe River | Removed | 2009 |
| Hiwassee | Shuler Creek Fish Barrier | Shuler Creek | Removed | 2020 |
| Little Tennessee | Cozard Mill | Cartoogechaye Creek | Removed | c. 2020 |
| Little Tennessee | Dillsboro | Tuckasegee River | Removed | 2010 |
| Little Tennessee | Santeetlah Creek Fish Barrier | Santeetlah Creek | Removed | 2016 |
| Little Tennessee | Tellico | Tellico Creek | Removed? | 2019? |
| Neuse | Cherry Hospital | Little River | Removed | 1998 |
| Neuse | Crantock Mill | Middle Creek | Removed | 2008 |
| Neuse | Eno | Eno River | Removed | 2007 |
| Neuse | Lowell Mill | Little River | Removed | 2005 |
| Neuse | Milburnie | Neuse River | Removed | 2017 |
| Neuse | Quaker Neck | Neuse River | Removed | 1998 |
| Neuse | Rains Mill | Little River | Removed | 1999 |
| Neuse | Temple Sloan | Marks Creek trib. | Removed | 2002 |
| New | Payne Branch | Middle Fk. South Fk. New R. | Removed | 2020 |
| Roanoke | W.T. Roberts | Dan River trib. | Removed | pre-1999 |
| Watauga | Ash Bear Pen | Cold Prong | Removed | 1990 |
| Watauga | Ward's Mill | Watauga River | Removed | 2021 |
| Watauga | Yonahlossee | Lance Creek | Removed | 2002? |
| Yadkin | Baucom Lake | Flag Branch | Removed | pre-1993 |
| Yadkin | Broyhill Pond | Bull Branch trib. | Removed | pre-1993 |
| Yadkin | Chandlers Dynamo | Little River | Removed | 2012 |
| Yadkin | Creed | Burkes Creek trib. | Removed | pre-1998 |
| Yadkin | Gobble Lake | Salem Creek trib. | Removed | 2000 |
| Yadkin | Hutchens | Uwharrie River trib. | Removed | 1998 |
| Yadkin | Lake Hills Club | Mill Creek Number 3 | Removed | 2009 |
| Yadkin | Lassiter Mill | Uwharrie River | Removed | 2013 |
| Yadkin | Old Troy #2 | Densons Creek | Removed | 2013 |
| Yadkin | Sidden Lower | Double Creek trib. | Removed | pre-2005 |
| Yadkin | Skyview Lake Lower | Hunting Creek trib. | Removed | pre-1993 |
| Yadkin | Smitherman | Little River | Removed | 2013 |
| Yadkin | Steels Mill | Hitchcock Creek | Removed | 2009 |
| Yadkin | Watts Lake | South Yadkin River trib. | Removed | c. 1997 |
| Yadkin | Yellow Jacket Lake | Moravian Creek | Removed | pre-1988 |

A dam owner seeking to remove a dam is encouraged to acquire the services of an engineering consultant who can assist in design, acquire the necessary regulatory permits, and oversee construction (demolition), stabilization, and monitoring following removal. Ongoing communication between the dam owner and their agents with relevant regulatory and resource agencies is critical to ensuring that what is "on paper" (1) can be implemented on the ground and in the water, and (2) considers human safety, water quality and aquatic life protection, habitat, cost effectiveness, and timing.

In addition to the information provided in this Handbook, project managers and dam owners may find the following resources of value:

- American Rivers' Restoration Tools and Resources[10] page is a digital guide including videos, fact sheets, and reports about removing dams, replacing culverts, and restoring floodplains.
- American Rivers' Removing Small Dams, A Basic Guide for Project Managers[11] provides general information on project management and design, potential funding sources, and recommendations on community involvement.
- The Environmental Protection Agency's (EPA) Frequently Asked Questions on Removal of Obsolete Dams[12] provides information on water quality, Clean Water Act (CWA) permitting requirements, and EPA-related funding sources.
- American Rivers' Funding Restoration Projects[13] provides a list of funding sources that can support dam removal projects.
- A wide variety of other state-specific guides are also available, for instance Massachusetts,[14] New York,[15] Texas,[16] Georgia,[17] South Carolina,[18] and Vermont.[19]
- SARP Aquatic Barrier Inventory and Prioritization Tool, where you can visualize your project on the map and the ecological benefits and priority of removing the structure at http://connectivity.sarpdata.com.
- American Rivers maintains a list of dam removal design engineers which they have pre-qualified (Master Service Agreement firms). The list is available from American Rivers' staff.[20]

[10] *Restoration Tools and Resources* https://www.americanrivers.org/conservation-resources/river-restoration/

[11] *Removing Small Dams, A Basic Guide for Project Managers* https://s3.amazonaws.com/american-rivers-website/wp-content/uploads/2016/05/24144210/NatlDamProjectManagerGuide_06112015.pdf

[12] *Frequently Asked Questions on Removal of Obsolete Dams* https://www.epa.gov/sites/default/files/2016-12/documents/2016_december_2_clean_final_dam_removal_faqs_0.pdf

[13] *Funding Restoration Projects* https://www.americanrivers.org/river-restoration-funding-sources/

[14] https://www.mass.gov/guides/deciding-to-remove-your-dam

[15] *Aquatic Connectivity and Barrier Removal Restoring Free-Flowing Rivers in the Hudson River Watershed Reconnecting Our Streams* https://www.dec.ny.gov/lands/99489.html

[16] https://www.tceq.texas.gov/downloads/compliance/publications/gi/gi-358.pdf

[17] https://ga-act.org/wp-content/uploads/2020/06/Georgia_Dam_Handbook_06012020.pdf

[18] *Removal of Obsolete Dams, A Handbook for Project Managers and Dam Owners* https://www.americanrivers.org/wp-content/uploads/2022/01/SC-Dam-Removal-Handbook_FNL.pdf

[19] https://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/drw_usersguide.pdf

[20] The authors and contributors of this publication, including state and federal agencies, do not endorse these engineering firms, do not consider them as pre-qualified, nor does the inclusion of this reference relate to any permitting outcomes by using these firms.

# STEP 1: RESEARCH THE DAM

## Section 1.1 Getting Started

The first step in beginning a dam removal project is to gather information about the dam and secure permission from the dam owner to pursue removal. The project manager or dam owner can save costs and time by gathering data and information before beginning the permitting process or selecting an engineer to construct the project.[21] As noted throughout this document, the project manager or dam owner should keep an open line of communication with the regulatory agencies, primarily USACE and the North Carolina Department of Environmental Quality (NCDEQ), following the completion of a pre-application meeting and/or once a permit is submitted. This communication is critical to determining how much information is needed for the federal CWA permitting process.

Outlined below is the information typically needed for permitting, designing the dam removal, and conducting community outreach. The amount and types of information needed for permitting will vary based on the specific project's constraints and environmental considerations. Not all information outlined below may be needed.

The name (if available) and address of the dam will be needed for all subsequent steps. Map and satellite views in Google Maps and Google Earth are excellent resources to help determine the GPS coordinates (latitude and longitude) of the dam and/or its physical address, or the closest address nearby. SARP's Southeast Aquatic Barrier Prioritization Tool is also a great resource to help identify the exact location of a dam.[22]

## Section 1.2 Determining the Current Dam Ownership

Establishing dam ownership is complex and often not straightforward. As stated in the North Carolina Administrative Code (NCAC), 15A NCAC 02K .0104, "owner" is defined as the individual or association of individuals owning the property on which the dam exists, or is to be constructed, and the persons financially responsible for the construction. In general, the boundaries lines of the property per the county tax records (land titles, easements, convenances, agreements) along with previous permits are used to determine who owns any portion of the dam or appurtenant works of the dam.

*Prior to proceeding with a dam removal project, all local, state, and federal permits must be obtained.*

The definition of ownership can include the operator of a dam that performs functions to preserve or protect a dam or reservoir or holds an easement to perform these functions. The position of the North Carolina Dam Safety Program is that any legally valid property interest counts as dam ownership, including both rights of way and easements. The Dam Safety Act considers all parties with property interests in a dam to be equal owners.

As of October 2022, the North Carolina Dam Safety inventory indicates that approximately 55 percent of the dams in North Carolina are privately owned. The remainder are owned by Federal, State, or Local Governments.

In addition to determining basic ownership of the dam, project managers will also need to determine:

- Who currently owns the property on either side of the dam?
- Who currently owns land below the dam that could be impacted by its removal?
- Could owners of waterfront property be impacted by the removal of impounded waters (e.g., docks and private boat ramps)?

Many resources are available to help determine this information in North Carolina, including:

- Property appraisal, tax parcel information, and the dam owner's name may be found through online property search sites available through each County's tax assessor office. Access to information varies by county.
- Adjacent property owners/neighbors may be sources of information, but deed recorded plats from county courthouses are the best tool to identify ownership when it is debated.
- Local libraries, historical associations, and museums are excellent sources of local information when searching for the name of a dam, its address, and coordinates.

[21] Note: The process of removing a dam is often called "construction," a term used throughout this Handbook to refer to active removal of the dam.

[22] *Southeast Aquatic Barrier Prioritization Tool* https://connectivity.sarpdata.com/

## Section 1.3 Physical Properties of the Dam

Researching the historical background of a dam may provide important information on the original design and materials used to construct it — information that is critical for estimating costs of removal and design for construction. Once a dam owner has decided to proceed with removal, information on the physical construction of the dam and surrounding structures should be collected to aid in the permitting process if available. Technical plans and other historical information may not be available for older dams.

The following information should be compiled to support the design and construction methodology that will be detailed in permitting applications:

- Maps or photographs that show the dam and the surrounding landscape, such as historic aerials, USDA soil maps, topo maps, etc.
- Technical plans on the dam, including 'as-builts' showing construction material if available.
- Dam dimensions (i.e., height and width).
- Date constructed. If the date of a dam's construction is known, but other construction details are lacking, local newspapers may be able to provide additional information about a dam's history.
- Date modified (any significant additions, upgrades, repairs, operation and maintenance history).
- Construction material (e.g., earthen, rock, concrete, fill material inside dam, mixed, etc.).
- Original purpose (hydropower, amenity pond, water supply, etc.)
- Current dam function. Is water impounded creating a backwater effect, lake, or pond behind the dam? Is water freely flowing over the dam without causing significant modification of the width of the stream or river channel upstream of the dam? Are water flows affected at various stream flows (low-flow, drought periods vs high flow events)?
- Ancillary features.
  - For hydropower facilities:
    - Is there a powerhouse, turbines, sluice run, bypass channel, etc.?
    - Are the control structures currently functioning?
    - Do gates still open? Have they been removed?
    - Are panels missing?
    - Is there water passing through the dam?
  - For earthen dams:
    - Is there a roadway on the top of the dam?
    - Are there functioning overflow spillways or discharge pipes?
    - Is there uncontrolled seepage through the dam?
    - If seepage is observed, are there any signs of material/soil transport?
    - Are foliage/trees growing on any part of the dam? If so, what is the size? **The North Carolina Dam Safety Program should be contacted for guidance on how to remove vegetation.**

*Determined by the size of the dam, owners of regulated dams have responsibilities for maintaining their dam to ensure its structural integrity, the safety of those who recreate on or around the dam, and the liability associated with any potential dam failure. Maintaining obsolete dams that no longer serve a purpose over a long period of time can often prove costly compared to the one-time cost of removal.*

## Section 1.4 Public Infrastructure

A project manager or dam owner should identify public infrastructure upstream and downstream that could be impacted by removal of the dam. Downstream landowners may be impacted by increased flood flows if the dam provides flood control or reduced flood elevations for run of river dams; upstream landowners may be impacted by the disappearance of the backwater pool created by the dam. The latter is important if there are surface water intakes or discharge points associated with National Pollution Discharge Elimination System (NPDES) permits. When considering potential infrastructure impacts upstream, a project manager or dam owner should include the length of the backwater effect of any impounded waters, which can be determined by measuring from the top of the dam back to the bed of the river.

The following should be noted:

- Note approximate distance from dam to bridges, abutments, and retaining walls with information on bridges by county.
- Identify roads either on the dam or those in close proximity and their ownership (state, local, private) by contacting the county or the North Carolina Department of Transportation.
- Identify water utility lines (e.g., sewer/stormwater) by contacting local public works departments.
- Identify underground and aerial utility lines (e.g., gas, electric, telecommunications, cable) by visual observation or online resources.[23] For information on utilities in the area, visit https://nc811.org/.
- Consult Google Earth to identify land uses, structures, infrastructure, and other important features that might not be obvious or visible during a site visit.

## Section 1.5 Historical Significance of the Dam and the River Prior to the Dam's Construction

One consideration before dam removal should be whether removing the dam has the potential to adversely affect a historic property — which could include the dam itself. The National Historic Preservation Act (NHPA) [54 U.S.C. § 300308] defines a historic property as any "prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places (NRHP), including artifacts, records, and material remains relating to the district, site, building, structure, or object."[24,25] Objects, buildings, and structures, including dams, are generally considered to be historic if they are 50 years old or older, although occasionally exceptions occur when considering whether a property is eligible for listing in the National Register.

Federal undertakings, including those that require a federal permit, should be subject to the Section 106 review process under the NHPA, to assess the potential impacts a Federal action will have on historic properties.[26] Similarly, pursuant to § 121-12 of the North Carolina General Statutes, state agencies should take into account the effect of a state undertaking on any district, site, building, structure, or object that is listed in the NRHP. In North Carolina, determinations of effect review processes are coordinated between the lead federal agency, often the USACE for dam removal projects, and the State Historic Preservation Office (SHPO) within the Division of Historical Resources, Department of Natural and Cultural Resources.[27] Federal agency coordination with the Environmental Review (ER) Branch of the NC SHPO is typically done after a permit application has been submitted.

Consequently, detailed information on when a dam and associated structures were built, and their historical significance, is needed for the permitting process. Knowing the river's cultural significance is also important as well as its historic uses before the dam was constructed. Historic names or references to pre-dam natural features (e.g., shoals, ferry crossings, wildlife, or aquatic life) may indicate use by American Indians and early settlers. Books, photographs, maps, and other historical documents can provide details about historical dam ownership, construction, and use.

Begin the research process by accessing the following resources:

- HPOWEB — a free, publicly accessible GIS-based web platform developed by NC SHPO shows all built-environment resources within the state recorded by NC SHPO as "of interest" or those that are noted to be historic.[28] HPOWEB also shows the location of all NRHP-listed architectural resource properties in the state and provides a link to the nomination for that property. Archaeological site data is not provided in this service.
    - Note that not all properties in North Carolina have been recorded or evaluated and the NC SHPO should

[23] Utility Line Locator https://nc811.org

[24] NHPA as explained by the National Conference of State Historic Preservation Officers - https://ncshpo.org/resources/national-historic-preservation-act-of-1966/

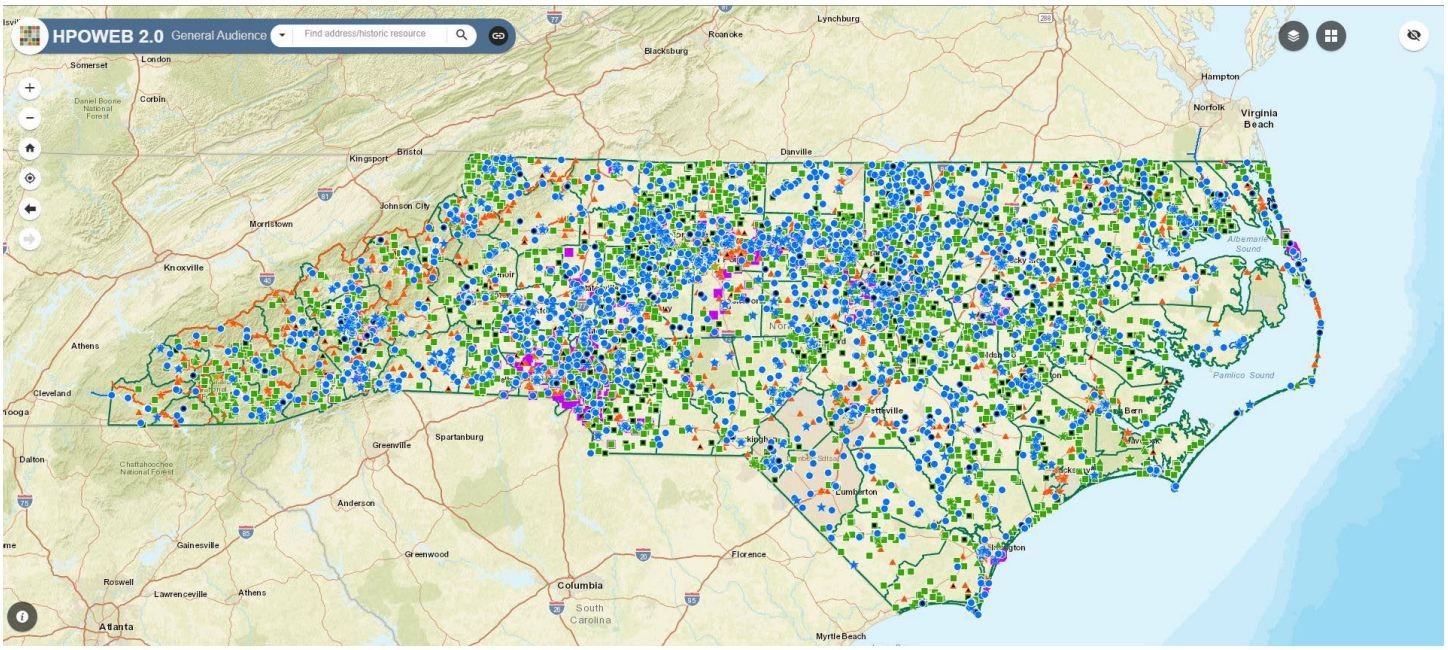
[25] National Register of Historic Places - https://www.nps.gov/subjects/nationalregister/index.htm

[26] ACHP Citizen's Guide to Section 106 - https://www.achp.gov/sites/default/files/documents/2017-01/CitizenGuide.pdf

[27] ACHP Citizen's Guide to Section 106 - https://www.achp.gov/sites/default/files/documents/2017-01/CitizenGuide.pdf

[28] NC SHPO HPOWEB 2.0 - gis.ncdcr.gov

## Figure 3: Screenshot of HPOWEB showing locations of architectural resource recorded in North Carolina.




be consulted on any property over 50 years old even if it does not appear as a recorded resource on HPOWEB.

- The NC Office of State Archaeology should also be consulted on all dam removal projects, regardless of the age of the dam, due to the potential for ground disturbance to impact archaeological sites.

If the dam is not recorded as a historic resource and its age is unknown, the following resources may help identify a range of dates within which it was constructed:

- N.C. Dam Inventory – Compiled and hosted by the NC Department of Environmental Quality.[29]
- Historic Aerials such as those made available online by the NC Department of Transportation Photogrammetry Unit.[30]
- Historic topographic maps developed and hosted by the United States Geological Survey.[31]
- Historic NC maps can be reviewed online at the North Carolina Maps website hosted by the University of North Carolina – Chapel Hill library.[32]
- Sanborn Fire Insurance Maps – Access online at North Carolina Maps or the Library of Congress.[33,34]

Prior to submission of a Federal or State permitting application, a preliminary review is available by request from the SHPO ER Branch. A preliminary review can indicate if the dam is a historic property or if further investigation is needed. Instructions for submitting a request for preliminary review can be found at the NC SHPO ER Branch webpage, where a checklist of required information is available along with Historic Structure Survey Reports for past dam removal projects.[35] In addition, SHPO ER staff can answer questions about submissions or past dam removal projects and their impacts to historic properties. Completed documentation should be submitted electronically.

[29] Dam Safety | NCDEQ - https://deq.nc.gov/about/divisions/energy-mineral-and-land-resources/dam-safety

[30] ArcGIS - NCDOT Historical Aerial Imagery Index - https://www.arcgis.com/home/webmap/viewer.html?webmap=91e02b76dce4470ebd7ec240ad202a04

[31] USGS Historical Topographic Map Explorer - https://livingatlas.arcgis.com/topoexplorer/index.html

[32] North Carolina Maps: Home (unc.edu) - https://web.lib.unc.edu/nc-maps/

[33] North Carolina Maps: Sanborn (unc.edu) - https://web.lib.unc.edu/nc-maps/sanborn.php

[34] Library of Congress: Geography and Map Division - https://www.loc.gov/rr/geogmap/sanborn/

[35] NC SHPO Environmental Review Branch - https://www.ncdcr.gov/state-historic-preservation-office/environmental-review

## Section 1.6 Current Regulatory Status of the Dam

Determining if a dam is regulated by a State or Federal program depends on many factors and is a critical step in the process.

### Section 1.6.1 | North Carolina Dams Safety

Dams and reservoirs have been constructed long before State or Federal dam regulations were in place. After multiple dam failures and related fatalities in the United States, the federal government inspected known "high hazard" dams. The findings of the inspection program were responsible for the establishment of dam safety programs in most states, and, ultimately, the creation of the National Dam Safety Program, which supports dam safety programs in 49 states.

The Dam Safety Law of 1967 is the basis of North Carolina's dam safety program. Its purpose is to "provide for the certification and inspection of dams in the interest of public health, safety, and welfare, in order to reduce the risk of failure of dams; to prevent injuries to persons, damage to downstream property and loss of reservoir storage; and to ensure maintenance of minimum stream flows of adequate quantity and quality below dams." The law confers upon NCDEQ the regulatory authority to accomplish the purposes of the Act, including the power to promulgate regulations, require permits, conduct inspections, guide removal and decommissioning, and take enforcement actions. The Dam Safety Law's rules and regulations are set forth in 15A NCAC 02K. These regulations ultimately set the requirements and best practices to encourage and promote effective dam safety to reduce the risk to human life, property, and the environment from dam-related hazards.

The regulations create a tiered program based on a dam size (small, medium, large, and very large) and potential hazard (low, intermediate, or high) classification system.

| Size | Total Storage (ac-ft)[1] | Height (ft)[1] |
|---|---|---|
| Small | less than 750 | less than 35 |
| Medium | equal to or greater than 750 and less than 7,500 | equal to or greater than 35 and less than 50 |
| Large | equal to or greater than 7,500 and less than 50,000 | equal to or greater than 50 and less than 100 |
| Very Large | equal to or greater than 50,000 | equal to or greater than 100 |

Note: The factor determining the largest size shall govern.

| Hazard Classification | Hazard Potential |
|---|---|
| Low (class A) | Class A. Includes dams located where failure may damage uninhabited low value non-residential buildings, agricultural land, or low volume roads. |
| Intermediate (class B) | Class B. Includes dams located where failure may damage highways or secondary railroads, cause interruption of use or service of public utilities, cause minor damage to isolated homes, or cause minor damage to commercial and industrial buildings. Damage to these structures is considered minor only when (1) they are located in back-water areas not subjected to the direct path of the breach flood wave; and (2) they will experience no more than 1.5 feet of flood rise due to breaching above the lowest ground elevation adjacent to the outside foundation walls or no more than 1.5 feet of flood rise due to breaching above the lowest floor elevation of the structure, the lower of the two elevations governing. All other damage potential will be considered serious. |
| High (class C) | Class C. Includes dams located where failure will likely cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, primary highways, or major railroads. |

These regulations specify the administrative process for obtaining approval from the North Carolina Dam Safety Program for a new dam or the modification, repair, or removal of an existing dam. They cover the specifics of the permit application package and general design criteria a dam must meet. The design and submittal must be carried out by a professional engineer licensed in North Carolina.

### Section 1.6.2 | Federal Energy Regulatory Commission Licensed Dams

The Federal Energy Regulatory Commission (FERC) regulates non-federal dams that produce hydroelectricity and fall under the FERC's jurisdiction pursuant to Section 23(b)(1) of the Federal Power Act (FPA).[36] All FERC licensed projects regularly submit compliance and other documents that address the physical details and characteristics of a dam. Information about FERC licensed dams is available via FERC's website.[37] Some dams are "exempt" from licensing and do not need to meet requirements of Part I of the FPA usually because they are small hydropower operations. Exemptions are granted in perpetuity.

[36] FERC does not regulate federal dams, including those operated by the USACE.

[37] *FERC Hydropower Projects* https://www.ferc.gov/industries-data/hydropower

**FERC Licenses:** FERC has 20 hydroelectric licensed projects in North Carolina, some of which include multiple dams and reservoirs under one license (Table 3). There are also several FERC-licensed hydroelectric projects in adjoining states that affect North Carolina waters that are not listed.

## Table 3: Hydroelectric projects in North Carolina with FERC licenses.

| Project Number | Project Name | Licensee | Stream | # Dams / Total Capacity (MW) |
|---|---|---|---|---|
| P-432 | Walters | Duke Energy Progress LLC | Pigeon River | 1 / 108.6 |
| P-2009 | Gaston & Roanoke Rapids | Dominion Power | Roanoke River | 2 / 328.0 |
| P-2169 | Brookfield Smoky Mountain | Brookfield Smoky Mountain Hydro LLC | Little Tennessee River, Cheoah River | 2 / 231.5[a] |
| P-2197 | Yadkin | Eagle Creek Renewable Energy | Yadkin River | 4 / 203.0 |
| P-2206 | Yadkin-Pee Dee | Duke Energy Progress LLC | Yadkin-Pee Dee River | 2 / 108.6 |
| P-2232 | Catawba-Wateree | Duke Energy Carolinas LLC | Catawba River | 6 / 509.2[b] |
| P-2601 | Bryson | Northbrook Carolina Hydro II LLC | Oconaluftee River | 1 / 0.98 |
| P-2603 | Franklin | Northbrook Carolina Hydro II LLC | Little Tennessee River | 1 / 1.04 |
| P-2607 | Spencer Mountain | Spencer Mountain Hydropower LLC | South Fork Catawba River | 1 / 0.64 |
| P-2619 | Mission | Northbrook Carolina Hydro II LLC | Hiwassee River | 1 / 1.80 |
| P-2686 | West Fork | Duke Energy Carolinas LLC | West Fork, Tuckasegee River | 2 / 24.6 |
| P-2692 | Nantahala | Duke Energy Carolinas LLC | Nantahala River, Whiteoak Creek | 3 / 43.2 |
| P-2694 | Queens Creek | Duke Energy Carolinas LLC | Queens Creek | 1 / 0.98 |
| P-2698 | East Fork | Duke Energy Carolinas LLC | East Fork Tuckasegee River | 4 / 25.2 |
| P-4093 | Bynum Dam[c] | McMahan Hydroelectric LLC | Haw River | 1 / 0.60 |
| P-11169 | Avalon Dam | Avalon Hydropower LLC | Mayo River | 1 / 1.28 |
| P-11219 | Mayo Dam | Mayo Hydropower LLC | Mayo River | 1 / 1.32 |
| P-11264 | Cooleemee | South Yadkin Power, Inc. | South Yadkin River | 1 / 1.42 |
| P-11437 | Jordan Dam | Jordan Hydroelectric Limited Partnership | Haw River | 1 / 4.40 |
| P-12642 | W. Kerr Scott[d] | Wilkesboro Hydropower LLC | Yadkin River | 1 / 4.00 |

[a] An additional 2 dams with a capacity of 192.6 MW are located in Tennessee
[b] An additional 5 dams with a capacity of 333.9 MW are located in South Carolina
[c] Currently not operating due to dispute over ownership
[d] License issued in 2012 but powerhouse never built

## Table 4: Hydroelectric projects in North Carolina with FERC exemptions.

| Project Number | Project Name | Licensee | Stream | Capacity (KW) |
|---|---|---|---|---|
| P-2380 | Marshall | Duke Energy Carolinas LLC | French Broad River | 5,000 |
| P-3457 | Capitola | French Broad Electric Membership Corp. | French Broad River | 3,000 |
| P-3932 | Little River | Hydrodyne Energy LLC | Little River (Montgomery Co.) | 575 |
| P-4186 | McAdenville | Stowe Mills, Inc. | South Fork Catawba River | 1,040 |
| P-4509 | Saxapahaw | Haw River Hydro Co. | Haw River | 1,500 |
| P-4815 | Eury Dam | EWP LLC | Little River (Montgomery Co.) | 792 |
| P-4827 | High Shoals | High Shoals LLC | South Fork Catawba River | 1,680 |
| P-6276 | Lockville Dam | Lockville Hydropower Co. | Deep River | 1,760 |
| P-6322 | Sharpe Falls | Sharpes Falls Power | North Fork New River | 175 |
| P-6492 | Hardins[a] | Hardins Resources Co. | South Fork Catawba River | 720 |
| P-6559 | Cox Lake | H. Bruce Cox | Deep River | 375 |
| P-6619 | Raeford | Lake Upchurch Dam Preservation Assoc. | Rockfish Creek | 560 |
| P-7404 | Glencoe | Glencoe Mill LLC | Haw River | 600 |
| P-7478 | Coleridge | Deep River Hydro LLC | Deep River | 480 |
| P-7497 | Craggy Dam | Metropolitan Sewerage Dist. Buncombe Co. | French Broad River | 2,400 |
| P-7509 | Ivy River | Madison Hydro Partners | Ivy River | 1,200 |
| P-7679 | Caroleen Mills | James Bocell | Second Broad River | 280 |
| P-7742 | Long Shoals | Green Energy Trans LLC | South Fork Catawba River | 750 |
| P-7987 | High Falls | UP Property 2 LLC | Deep River | 600 |

[a] Not operating since at least 2008

Surrendered or Revoked FERC Licenses/Exemptions: Some hydropower dams may no longer be profitable, no longer generate hydropower, or may need expensive maintenance. In these instances, hydroelectric dam owners may choose to surrender their licenses or exemptions to FERC. Also, licenses or exemptions of inoperable projects may be terminated by FERC through a process of implied surrender. Surrendered projects may also have to be decommissioned (i.e., ensure the facility is not operational and meets safety requirements). Most surrenders do not require dam removal, but the owner may choose that option.

On rare occasions, FERC can revoke a license under the enforcement authority of the FPA. Dam owners are not automatically required to remove dams if a license is revoked, but FERC may have additional requirements in revoking the license, such as decommissioning all hydropower equipment.

At least 12 dams formerly regulated by FERC remain in North Carolina (Table 5). While no longer producing hydropower, some provide other functions. For example, Idols Dam is a backup water supply for the City of Winston-Salem. Others, such as Lake Junaluska and Lake Tahoma, create a reservoir amenity for houses. Responsibility for the safety of surrendered projects passes from FERC to North Carolina Division of Energy, Mineral, and Land Resources (NCDEMLR), provided the dam meets the height or storage requirements set out in NCGS Section NCGS § 143-215.23 through 143-215.37.

## Table 5: Extant dams in North Carolina with surrendered or revoked FERC licenses or exemptions.

| Project Number | Project Name | Former Licensee/Exemptee | Stream | Year |
|---|---|---|---|---|
| P-693 | Cullasaja | Fall Line Hydro Co. | Cullasaja River | 1986 |
| P-2541 | Cascade | Cascade Power Co. | Little River (Transylvania Co.) | 2002 |
| P-2585 | Idols | Northbrook Hydro | Yadkin River | 2001 |
| P-3156 | Worthville Dam | Miller and Miller | Deep River | 2011 |
| P-3474 | Lake Junaluska | Lake Junaluska Assembly | Richland Creek | 1995 |
| P-3722 | North State Dam | Bruce Massey | Lower Little River | 1987 |
| P-4021 | Lake Tahoma | Buck Creek Corp. | Buck Creek | 2002 |
| P-7783 | Cedar Falls | Piedmont Triad Water Authority | Deep River | 2013 |
| P-8119 | Sherrill Hydro | Harold Sherrill | South Yadkin River | 1989 |
| P-9548 | Southside | Rhyne Mills Inc. | South Fork Catawba River | 1994 |
| P-10812 | Henrietta Mills | Daniel Evans | Second Broad River | 2009 |
| P-11392 | Ramseur | J&T Hydro Co. | Deep River | 2011 |

# CASE STUDY

## Ward's Mill Dam Removal Project
## Watauga River, North Carolina

**Status:** Removed May 2021. Phase 2, restoration of bank line was completed in 2022.

**Owner:** Ray and Virginia Ward

**Partners:** The strong core project management team of American Rivers, Blue Ridge Resource Conservation and Development Council, and MountainTrue's Watauga Riverkeeper was key to the success of this project. Also critical was the dedication of other partners and funders: Buncombe County Soil and Water, Bonneville Environmental Foundation, North Carolina Division of Water Resources, and the U.S. Fish and Wildlife Service.

**Location:** Sugar Grove, Watauga County, NC (36.24119, -81.83051) Watauga, North Carolina, Tennessee Subbasin. HUC8: 06010103

**Statistics:** Dam Height: 20 feet • Dam Length: 130 feet • Year Built: 1890 • Dam Use: Hydropower

**Habitat Benefits:** Reconnects 140 miles (25 mainstem miles) of the Watauga River

**Priority Species:** Resident trout, green floater mussels (*Lasmigona subviridis*) and the Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*), the largest salamander in the U.S.

**Recreation:** Improved public safety, opened additional miles for river transit recreation, increased sport fishing and use of formerly impounded area with the exposure of large in-stream boulders.

**Challenges:** Heavy rains in the spring of 2021 caused cancellation of planned removal dates, compounded by the schedule constraints of the U.S. Fish and Wildlife Service crew that removed the dam. Additionally, during construction, a local gas shortage precipitated by a pipeline issue caused some challenges with operating the equipment.

Ward's Mill Dam during construction, May 2021
Photo courtesy of American Rivers

**Permits and Federal Review:** The owners of this Ward's Mill Dam chose to surrender their FERC hydropower license. Section 404 Clean Water Act permitted using Nationwide Permit 27; adverse effects to historic properties resolved through implementation of a Memorandum of Agreement. Treatment measures increased project cost and included recording of the history of Ward's Mill Dam, Context Study of historic mill complexes in 3 counties, and publication of a digital StoryMap describing the history of Ward's Mill Complex and the reasons for removal.

**Additional Background:** The project budget was $500k.

**For more information, see the following resources:**

- https://mountaintrue.org/ward-mill-dam-removal-connects-aquatic-habitat-makes-river-healthier/
- https://www.americanrivers.org/2021/06/watauga-river-free-flowing-again/
- Historic Structures Report: https://files.nc.gov/ncdcr/historic-preservation-office/PDFs/ER_20-0338.pdf
- StoryMap: https://storymaps.arcgis.com/stories/c33a5f837a45419eb7e2eb98dfd1d40c

# STEP 2: RESEARCH THE RIVER AND SURROUNDING LANDSCAPE

**Researching the river ecosystem and surrounding riparian area is critical to understanding the potential impact of dam removal. This section provides resources for the project manager or dam owner preparing to research the area around the dam.**

## Section 2.1 Basic Description of the Resource

In addition to the United States Geological Survey's (USGS) printed maps of rivers and surrounding landscape, its National Map Viewer is a good resource for basic information that may be needed for the permitting process:[38]

- Zoom in on the topo map to see the official name of a stream or river from the US Geographic Names Information System. Small streams may not have official names.
- Identify tributaries and any confluences with other major rivers up or downstream.
- Identify the stream by segment description, if necessary; e.g. "from Hwy 110 to the confluence with Big Creek."
- Determine if an impounded waterbody has a name that differs from that of the dam.
- Turn on the "Watershed Boundary Dataset" layer to obtain a watershed Hydrologic Unit Code, (often referred to as HUC) name and number.
- Find USGS stream gage locations in the "Point Event" sublayer within the "National Hydrography Dataset" layer.
- Obtain land cover classifications and topographic/elevation data from various layers.
- Obtain more information by clicking the "Add Data" button on the top row, then click the downward arrow to change the search option to "ArcGIS Online," and then enter a search for "North Carolina Dam Inventory." A layer hosted by North Carolina Department of Environment and Natural Resources (NCDENR) should come up, which can be added to a map by clicking "ADD". This layer includes useful data about most dams in the state. Numerous fields with additional information are available by right-clicking on the three dots next to the new layer in the Layer List and then choosing "View Attribute Table."

Other good resources for information about rivers and streams include the following:

- SARP's Southeast Aquatic Barrier Prioritization Tool provides information about various aquatic passage barriers, including dams.[39] Its easy-to-read summary report of dams and their watersheds can be exported as a PDF.
- The USGS StreamStats can be used to delineate drainage areas for user-selected stream sites along with basin characteristics (including land use) and estimates of flow statistics.[40]
- USGS National Water Dashboard is an interactive site providing real-time water data collected in context with weather-related events.[41]
- USGS Daily Streamflow Conditions provides real-time daily streamflow conditions and discharge (cubic feet per second).[42]
- USGS National Water Information System Mapper provides access to current and historical observations to surface water and groundwater sites.[43]

Accessing the dam for its removal poses additional considerations. Wetlands are often part of riparian areas that may be associated with the stream above and below the dam. To help avoid impacts and minimize damage to these

[38] United States Geological Survey (USGS) National Map Viewer https://viewer.nationalmap.gov/advanced-viewer/

[39] Southeast Aquatic Barrier Prioritization Tool https://connectivity.sarpdata.com/

[40] USGS Stream Stats https://streamstats.usgs.gov/ss/

[41] USGS National Water Dashboard https://dashboard.waterdata.usgs.gov/app/nwd/

[42] USGS Daily Streamflow Conditions https://waterdata.usgs.gov/nwis/rt

[43] USGS National Water Information System Mapper https://maps.waterdata.usgs.gov/mapper/index.html

important resources, the project manager or dam owner can utilize the following resources as a preliminary guide:

- The US Fish and Wildlife Service (USFWS) National Wetland Inventory Wetlands Mapper predicts the location of wetlands.[44]

- The NRCS Web Soil Survey tool allows an area to be selected and evaluated for the presence of hydric soils, which are one indicator of the likelihood of wetlands onsite.[45] Look for "Hydric Rating by Map Unit" in the Land Classification section of the Suitabilities and Limitation for Use tab.

American Rivers' *Removing Small Dams: A Basic Guide for Project Managers* (pg. 16) details a process for completing geomorphological surveys and base mapping, which will be needed to assess hydraulics and sediment. [46] This guide states that the survey should include:

1. Cross sections of the river and adjacent land, upstream and downstream of the dam.
2. A longitudinal profile of the "thalweg" (i.e., the deepest part of the river channel) through the impoundment following the draining of the impoundment, upstream and downstream of the dam.
3. A survey of the depth of soft sediment throughout the impoundment (often described as the "depth of refusal," or the point where a rod hits a harder surface and cannot easily be pushed farther down).
4. A delineation of the resource areas that will be affected, including wetlands, and ordinary high water mark and low water marks.[47] (For additional information on wetlands and sediment, see Sections 2.5 and 2.6, respectively.)
5. A hydrology and hydraulics (H&H) assessment to assess the magnitude and frequency of flows in the river (including depths, velocity, and scour potential).

## Section 2.2 Water Quality

Information about documented impacts the dam has had on water quality may be needed for the permitting process. This information can also be used if applying for grants or funding tied to demonstrating that water quality may be improved by dam removal. According to EPA, "[v]irtually every dam will have an impact on the river or stream where it is located, although the types and extent of the impact will vary based on the size, operation, and purpose of the dam as well as the size and general characteristics of the waterway. In general, increased retention time of water behind dams causes physical, thermal, and chemical changes to take place both in the impounded and downstream waters." [48] These changes may impact water quality related to nutrients, temperature, sediments, algal blooms, dissolved oxygen, pH, hydrogen sulfide, iron, manganese, and other metals. The presence of the dam may also cause impacts to aquatic life as measured through biological sampling and metrics, including macroinvertebrates (e.g., mayflies, stoneflies and caddisflies), mussels, or fish. For more information on water quality and dams under the CWA, as well as the potential for grants to address dams that cause water quality impacts, see EPA's Frequently Asked Questions on Removal of Obsolete Dams. [49]

*For water quality information that is specific to a proposed removal of an obsolete dam or if you are planning to remove a dam in North Carolina, please contact the NCDEQ Division of Water Resources' water quality assessment coordinator, Cam McNutt at cam.mcnutt@ncdenr.gov. For additional information, see Step 6.4, pg. 51.*

[44] USFWS National Wetland Inventory Wetlands Mapper https://www.fws.gov/wetlands/data/mapper.html

[45] NRCS Web Soil Survey https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

[46] Removing Small Dams: A Basic Guide for Project Managers https://www.americanrivers.org/2015/06/want-to-remove-a-dam-not-sure-where-to-start-check-this-guide-out/

[47] Ordinary High Water Mark is defined as, "...that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." Corps Regulatory Guidance Letter, 2005 (RGL 05-05), and 33 CFR 328.3(e)

[48] U.S. Environmental Protection Agency. (2016). *Frequently Asked Questions on Removal of Obsolete Dams.* Retrieved from https://www.epa.gov/cwa-404/frequent-questions-removal-obsolete-dams

[49] Ibid.

## Section 2.3 Aquatic Resources

The Southeastern United States is known globally for its aquatic biodiversity. However, many species are currently imperiled, and many more may become so without future conservation and restoration efforts.[50] North Carolina's streams and rivers support a wide diversity of aquatic life that can be affected by dams in various ways. The first step in understanding the potential ecological effects of dam removal is to identify the species found in the vicinity that could be positively or negatively impacted by its removal. The project manager should contact North Carolina Wildlife Resources Commission (NCWRC) and if applicable, USFWS and National Marine Fisheries Service (NMFS), biologists early in the process for input on the aquatic community and dam removal.

North Carolina's Natural Heritage Program (NCNHP) gathers data on the abundance and distribution of rare, threatened, and endangered species across the state from the agency's own biologists as well as from universities and other state and federal agencies. The NCNHP database can provide a dam owner or project manager with a list of species that could be within the vicinity of the dam structure and access roads and may be affected by the dam removal project.[51]

The USFWS and the NMFS are charged with protecting threatened or endangered (T&E) species, designated critical habitat under the Endangered Species Act (ESA), the Fish and Wildlife Coordination Act, and essential fish habitat under the Magnuson–Stevens Fishery Coordination and Management Act. To determine if T&E species are present, explore the USFWS's Information for Planning and Consultation (IPAC) tool for species under the jurisdiction of the USFWS. A list of T&E species by county is *available online* from the USFWS and NCNHP.[52] More information about these species and associated critical habitat is available from the agency.[53,54] If T&E species are present, be sure to note the requirements to consult with the USFWS by following the steps in the IPAC tool or directly with NMFS, more fully discussed in Step 3. Note that impounding water through dams has caused or contributed to the endangerment of some imperiled species, particularly those adapted to free-flowing water throughout the southeastern US. Removing dams may provide opportunities to restore local populations of some species.

To protect aquatic life, consideration should be given to the amount of accumulated sediment behind a dam. A rapid release of such material can have numerous impacts on water quality factors (e.g., dissolved oxygen), or can lead to suffocation and burial of bottom-dwelling species, such as freshwater mussels. Minimizing short-term impacts, like disturbance of mussels, is important to maximize long term benefit of dam removal. See freshwater mussel inset [pg. 30] for suggestions on how to manage these efforts.

While dams obstruct flows and change sediment processes in stream systems, altering behavior of fishes and the makeup of fish communities, they can also serve beneficial purposes, such as keeping invasive species from impacting fish communities upstream of the dam. In fact, there may be compelling ecological reasons to keep a dam in place; to determine if this is the case, it is especially important to involve state and federal agency biologists early on in project evaluation.

Consideration of the species that may benefit from the dam removal project could provide opportunities for collaboration with state and federal agencies and potential grant funding. Identifying key species and habitats, both aquatic and terrestrial, in the area affected by the dam removal is a requirement of the state and federal permitting process. The following questions should be addressed:

- Are rare (i.e., State Wildlife Action Plan conservation priorities), threatened, or endangered species present in the project area? Search for a list of potential species in the project area through the Natural Heritage Program database and consult with NCWRC biologists.[55]
- Are economically or recreationally important aquatic or riparian species in the project area?
- Consider how removal of the dam may positively or negatively impact species. For instance, will dam removal

[50] Duncan, E. *et al.* (2019). *Illuminating hotspots of imperiled aquatic biodiversity in the Southeastern US. Global Ecology and Conservation.* https://www.sciencedirect.com/science/article/pii/S2351989418304451

[51] To access the Natural Heritage Database, visit: https://www.ncnhp.org

[52] NCNHP Species/Community search webpage: https://www.ncnhp.org/data/speciescommunity-search

[53] NOAA Fisheries North Carolina Threatened and Endangered Species and Critical Habitats Under NOAA Fisheries Jurisdiction: https://www.fisheries.noaa.gov/southeast/consultations/threatened-and-endangered-species-list-north-carolina

[54] NOAA Fisheries Endangered Species Conservation: Critical Habitat https://www.fisheries.noaa.gov/national/endangered-species-conservation/critical-habitat

[55] https://www.ncnhp.org/data/speciescommunity-search

allow fish movement above and below the dam? Will released sediment affect species or habitat downstream?

- Will migratory fishes, including those that migrate between the ocean and fresh water (e.g., American Eel, shad, or sturgeon) or those that migrate entirely in fresh water (e.g., Robust Redhorse), benefit from the removal?
- Will non-migratory species benefit from the removal?
- Would dam removal create, restore, or enhance habitat for species (e.g., support mussels; increase aquatic diversity; enable spawning by species of concern)?
- Are there important species (e.g., mussels) that may experience short-term or long-term negative impacts from dam removal?
- Are invasive/nuisance plant or animal species present above and/or below the dam? Would dam removal allow invasive species to expand their distribution? Review the complete list of invasive aquatic plant species in the NC Aquatic Nuisance Species Management Plan.[56]

## Section 2.4 Connectivity

Dams act as barriers to aquatic organism passage, significantly altering the migration of native diadromous fishes — those that require access between freshwaters and saltwater habitats to complete their lifecycles, and potamodromous fishes — those that migrate to different habitats within freshwaters to complete their lifecycles.[57] Removing dams can provide significant benefits for increasing the range of these fishes and access to critical habitats. As noted in Section 2.3, other aquatic taxa can benefit from restored connectivity, as well.

SARP's Comprehensive Southeast Aquatic Barrier Inventory includes over 400,000 dams and approximately 37,000 assessed road stream crossings. Together with the Conservation Biology Institute and Astute Spruce, SARP has created an online tool called the Southeast Aquatic Barrier Prioritization Tool, which allows users to (1) visualize the inventory of barriers, (2) understand information about each barrier's river network, and (3) identify top priority structures for removal based on the geographic area of interest. The results can be used to work with the NC ACT members and landowners to implement passage projects. The tool can also be used to understand the potential impact of dam removal,

### Benefits of Connectivity: American Eel

The American Eel is an intriguing fish and is widespread and abundant across the eastern half of North Carolina. A catadromous species, this fish spends most of its life in fresh water and returns to the Sargasso Sea in the Atlantic Ocean to spawn, after which it dies. The transparent and ribbon-like larvae float in the ocean for up to a year before transforming into glass eels as they enter the coastal rivers and sounds during late winter and spring. As they begin their migration up into fresh water, they metamorphose into the elver stage and can occur in the thousands at the mouths of rivers and creeks and below obstructions such as dams. Three of the large hydroelectric facilities in North Carolina regulated by FERC (Roanoke Rapids and Gaston dams on the Roanoke River and Blewett Falls on the Pee Dee River) require improvements for eel passage, which should help increase their abundance upstream of these large barriers. Specialized fish ladders, called eelways, were operational in 2010 at the Roanoke Rapids Dam and in the first four years over two million elvers were passed up and over this large dam.

Dam removal provides eels access to habitat, improves water quality, and restores natural flow patterns, which supports population growth and survival. Since eels reach slow maturity at a slow rate, barriers and dams affecting eel passage negatively impact recruitment and over time this contributes to a continuous decline in the population.

[56] https://deq.nc.gov/media/11595/download

[57] Anadromous species live part of their life cycle in salt water but return to fresh water to spawn. In North Carolina, these species include American Shad, Hickory Shad, Blueback Herring, Alewife, Atlantic Sturgeon, Shortnose Sturgeon and Striped Bass. Catadromous species, such as American Eel, live in fresh water and return to salt water to spawn. Potamodromous species live entirely within fresh water; however, they spend much of their lifecycle downstream and migrate upstream to spawn. In North Carolina, Sicklefin Redhorse is an example of a potamodromous species.

including, for example, the number of miles accessible by species with the removal of the dam. To explore how many river miles may be gained, click on "Start Prioritizing", then "Prioritize dams." Once the map opens, select "State" then begin typing, "North Carolina." Zoom to the area of interest and click, "Select dams in this area." Once a particular dam is selected, the tool will provide information on Feasibility & Conservation Benefit, Miles Gained, Dam Height, Threatened & Endangered Species, and more. A project specific pdf can be downloaded for each dam in the inventory that outlines ecological indicator statistics and prioritization results.

## Section 2.5 Wetlands

The presence of wetlands and other waters of the United States regulated under Federal law is an important consideration in the regulatory permitting process. Wetlands are defined by EPA and USACE as "...areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."[58,59]

Dam removal could have direct and immediate effects on any existing wetlands within the project area. Natural wetlands may have existed on the lowest terraces of the floodplain before impoundment, and removal of the dam could prompt reestablishment of the original wetland community. Alternatively, wetlands that were created by a dam could be cut off from their water source post-removal or may no longer continue as wetlands. These areas would then have relict hydric soils (soils that are no longer either permanently or seasonally saturated by water), and the vegetative community may eventually become dominated by upland species. A qualified wetland delineator should be engaged to identify and map all wetlands potentially affected by the project. Regulatory agencies may consider the relative environmental condition and functionality of the wetlands, which means that a functional assessment may also be required. Various functional assessment methods are available, one or more of which may be applicable when used by a qualified wetland assessor.

## Section 2.6 Sediment

Addressing sediment will likely be a key component of working with the regulatory agencies during the permitting process. All rivers contain sediment, which consists of sand, silt, clay, gravel, rocks, minerals, and organic matter. The movement of sediment through waterbodies is an important geophysical process that distributes nutrients and other materials across the landscape. Dams slow the flow of water and impede the natural movement of sediment downstream, causing it to build up behind a dam over time, making it an important issue to consider in dam removal projects. Waters downstream of a dam may have been sediment-starved while the dam was present, and dam removal will play an important role in restoring natural sediment transport dynamics. However, release of sediment can cause abrasion or bury aquatic plants, animals, or habitat.[60] If rare and or listed animals are present downstream, it is essential to consult with NCWRC and USFWS biologists to evaluate the risk of sediment impacts to these species, develop a plan to manage sediment, and possibly move animals.

Sediment can also be contaminated with pollutants, putting downstream drinking water and aquatic life at risk if released without remediation. Properly collecting and analyzing data on the quantity and quality of sediment upstream of a dam is critical to safely managing it in a removal project. The process is iterative, starting with readily available information that is reanalyzed as more data become available.[61]

Sediment quantity can vary depending on the dam design, location, and historic land use surrounding and upstream of the body of water. For example, some low-head dams may have comparatively little sediment trapped within their impoundments due to the constant flow of water over the dam.

[58] How Wetlands are Defined and Identified under CWA Section 404 https://www.epa.gov/cwa-404/how-wetlands-are-defined-and-identified-under-cwa-section-404

[59] For more information, see https://www.epa.gov/cwa-404/how-wetlands-are-defined-and-identified-under-cwa-section-404

[60] https://www.epa.gov/cwa-404/frequent-questions-removal-obsolete-dams

[61] Subcommittee on Sedimentation. (2017). Dam Removal Analysis Guidelines for Sediment. U.S. Department of Interior. Retrieved from https://acwi.gov/sos/pubs/dam_removal_analysis_guidelines_for_sos_final_vote_2017_12_22_508.pdf

Measuring relative sediment volume is done by finding the ratio of the existing reservoir sediment mass to the average annual sediment mass entering the reservoir.[62] If the volume is determined to be negligible, the USACE may determine that no extensive sediment investigations are needed. Volumes that are greater than negligible will likely require further investigation. Work with USACE and resource agencies to determine how sediment will be addressed during removal. USACE Regulatory Guidance Letter (RGL) 05-04 provides guidance regarding which releases of sediments from or through dams require a USACE permit.

In some cases, physical removal of accumulated sediment may be appropriate to protect downstream aquatic resources.

## Freshwater Mussels And Dam Removal

North Carolina is home to over 60 species of freshwater mussels. Freshwater mussels filter water are an essential part of the aquatic food web. They also serve as nature's water treatment system, with a single mussel able to filter up to 15 gallons of water per day. Interestingly, they rely on fish hosts to expand their range and transform from their young larval stage into young mussels. Dam removal can help imperiled freshwater mussel populations thrive by improving access to their fish hosts and suitable habitat. During dam removals it is important to manage projects well to increase long-term benefits and reduce short-term impacts to these sensitive species. Project managers should consider the following guidelines when mussels are present:

- Prioritize breached dams with high scouring
- Identify which mussels are present in the project area and gather information on distribution and life history
- Consider the timing of project
- Manage sediment appropriately (e.g., excavation, tiered drawn down)
- Manage flow velocities
- Relocate mussels in heavily impacted areas
- Monitor populations pre- and post- removal
- Partner with resource agencies (e.g., NCWRC and USFWS) and academics

**Figure 4:** (Left) Endangered Appalachian elktoe mussel from the Cheoah River, NC. (Center and Right) A wavy-rayed lampmussel in the Cheoah displaying both forms of its larva lure, one fish-like one worm-like, to attract a fish to complete the transformation of her babies into adults. Photos by Erin Singer McCombs.

[62] Ibid.

However, excavating sediment from an impoundment and depositing it in upland areas nearby will add to the expense of a dam removal. In addition, not all impoundments are readily accessible by the heavy equipment needed to remove and transport accumulated sediment. Project managers should coordinate with their design engineers and resource agencies to determine the best alternatives for managing sediment in impoundments. If sediment removal is recommended, opportunities may exist to use it in construction projects. If not, project managers will need to identify appropriate places on- or offsite to relocate removed sediment. Transporting sediment offsite will increase costs but may be necessary.

If involved parties determine that allowing sediment to return to the river channel below the dam is the best alternative, the project manager should take steps to mitigate sediment impacts during the dam removal process. Mitigative measures will vary from project to project, but could include slowly dewatering the impoundment, stabilizing streambanks with plantings, and timing the dam removal to take advantage of periods of optimal flows or avoid periods of critical life stages for aquatic organisms affected by sediment.

A due diligence review will be needed to determine if the sediment behind the dam may be contaminated by pollutants. Contamination occurs when pollutants enter an upstream waterbody through stormwater runoff, effluent discharge, or illegal dumping; the slow water behind the dam causes contaminants to settle and accumulate in the sediments.[63] The potential for contamination can often be informed by investigating the historical land use and human activities of the upstream watershed. For example, sediment contamination could be the result of industrial manufacturing upstream of the dam. Extensive land clearing activities for agriculture or development and high proportions of impervious surface are other indicators of potential sediment contamination. Work with USACE to determine if sediment chemistry sampling and analysis is needed. For references that may be helpful, see the EPA's Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual, the Bureau of Reclamation's Dam Removal Analysis Guidelines for Sediment or EPA's Inland Testing Manual.[64,65,66]

## Hitchcock Creek Blue Trail

In 2009, the City of Rockingham worked with American Rivers and other partners to remove the obsolete, century-old Steele's Mill Dam on Hitchcock Creek removing an eyesore that degraded water quality and creating a premier paddling destination. "After the paper industries moved out of Rockingham, Steele's Mill Dam no longer served a purpose. The community of Rockingham understood the opportunities a free-flowing Hitchcock Creek could have for the community. Ten years later, the social and economic benefits we've experienced in Rockingham has far exceeded our expectations," Monty Crump, City Manager.

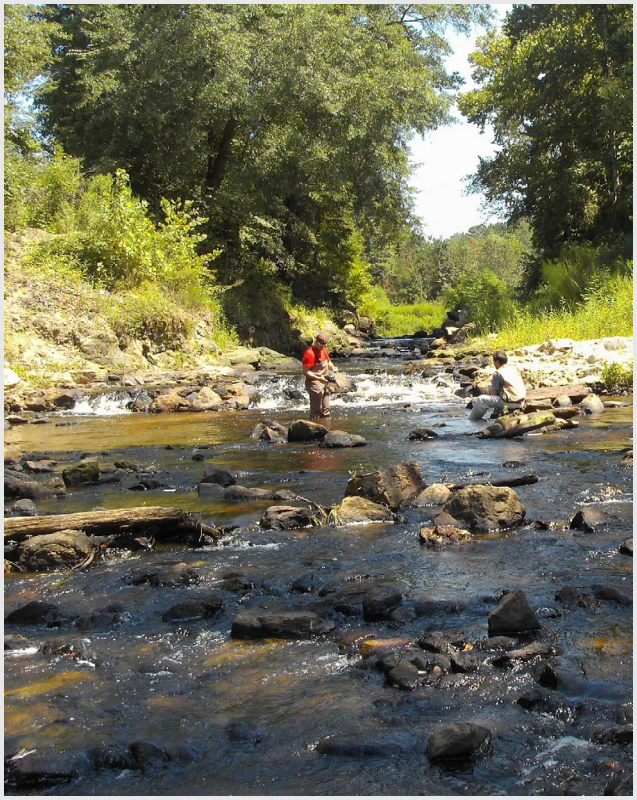


Photo Credit: Lynette Batt

[63] Ibid.

[64] FEPA-823-B-01-002 https://www.epa.gov/sites/default/files/2015-09/documents/collectionmanual.pdf

[65] Bureau of Reclamation https://rsm.usace.army.mil/initiatives/other/DamRemovalAnalysisGuidelines2017_508.pdf

[66] EPA-823-B-98-004 https://www.epa.gov/sites/default/files/2015-08/documents/inland_testing_manual_0.pdf

## Section 2.7 Federal Emergency Management Agency (FEMA) Flood Hazard

FEMA creates flood hazard maps that outline the flood risk areas in communities nationwide. Dam removal projects located in Special Flood Hazard Areas may have special requirements. For more information, review FEMA's Flood Maps and handbook *Living with Dams: Know Your Risks* or the National Dam Safety Program publications library.[67,68,69] To understand the permitting steps required per the local communities Flood Damage Prevention Ordinance, contact the Local Floodplain Manager for the community in which the project is located.[70]

## Section 2.8 Recreation, Economic Benefits and Public Safety

North Carolina's rivers and streams are highly popular for recreation. All major rivers and many streams are used for boating and fishing. Information on the river's recreational uses may not be needed for the permitting process but could be of value as the dam owner or project manager conducts community outreach on the project. Understanding the current recreational uses of the affected waterbodies is an important step in understanding project benefits for the community and river users. Protecting freshwater ecosystems through restoration also supports a thriving economy.

Environmental restoration, which includes dam removal, contributes 220,000 jobs and $25 billion to the nation's economy.[71] Dam removal projects have driven social and economic development in smaller communities in North Carolina and created new opportunities for ecotourism.[72] [See Hitchcock Blue Trail inset, pg. 31] Removal of dams may improve opportunities for paddle sports and provide sport-fishing opportunities for species adapted to free-flowing water. Dam removal can also provide opportunities to develop water trails, which can be economically important especially to rural communities. River-focused tourism can also stimulate indirect economic benefits through increases in tax revenue, real estate value, and employment.[73]

Investing in infrastructure for outdoor recreation attracts new businesses and an active workforce, strengthening the local economy and social wellbeing.[74] According to the Outdoor Industry Association, the number of people participating in outdoor recreation (including bicycling, camping, fishing, hunting, trail and water sports and wildlife viewing) across the United States is growing rapidly. In 2020, approximately 160 million people enjoyed an outdoor activity at least once — about 7.1 million more people than in the previous year.[75]

The Bureau of Economic Analysis estimates that in 2020, outdoor recreation had an approximately $10 billion impact to the economy of North Carolina.[76] According to 2017 report by the U.S. National Oceanic and Atmospheric Administration (NOAA), a river restored through means like dam removal drives economic benefits creates jobs, increases recreation, reduces flooding impacts, and revitalizes fisheries.[77] What's

[67] FEMA's Flood Maps https://www.fema.gov/flood-maps?web=1&wdLOR=c783C141B-C5F3-4956-BF19-5B614E3C43C1

[68] Living with Dams: Know Your Risks https://www.fema.gov/sites/default/files/2020-08/fema_living-with-dams_p-956.pdf

[69] National Dam Safety Program https://www.fema.gov/emergency-managers/risk-management/dam-safety/publications

[70] National Flood Insurance Program directory https://www.dnr.sc.gov/water/flood/documents/nfipadmindirectory.pdf

[71] American Rivers. (2020) Rivers as Economic Engines. https://s3.amazonaws.com/american-rivers-website/wp-content/uploads/2020/07/09223525/ECONOMIC-ENGINES-Report-2020.pdf

[72] https://medium.com/ecotourism-benefits-through-river-conservation/rockingham-north-carolina-1ec92a8cd4d4

[73] Warren, N. (2015). An Economic Argument for Water Trails. River Management Society. Retrieved https://www.river-management.org/assets/WaterTrails/economic%20argument%20for%20water%20trails.pdf

[74] Outdoor Industry Association. (2017). The Outdoor Recreation Economy North Carolina. Retrieved from https://outdoorindustry.org/wp-content/uploads/2017/07/OIA_RecEcoState_NC.pdf

[75] 2021 Outdoor Participation Trends Report, Outdoor Foundation. https://outdoorindustry.org/resource/2021-outdoor-participation-trends-report/

[76] 2020 North Carolina Outdoor Recreation Satellite Account, Bureau of Economic Analysis, U.S. Department of Commerce. https://outdoorindustry.org/state/north-carolina

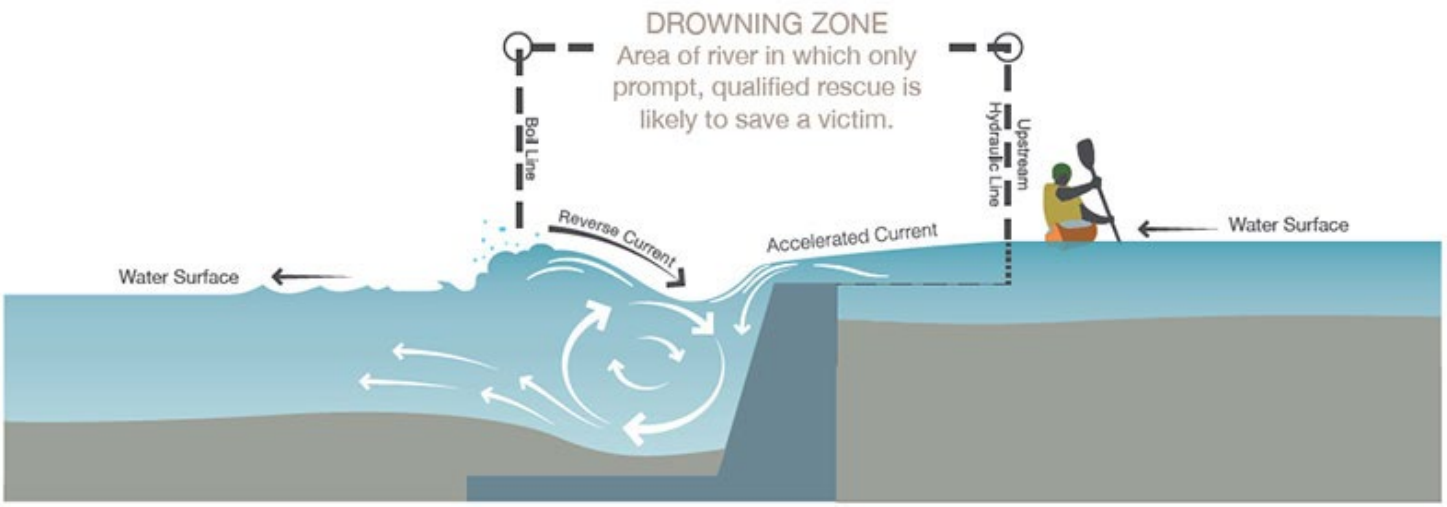
[77] Giselle Samonte, Peter Edwards, Julia Royster, Victoria Ramenzoni, and Summer Morlock. 2017. Socioeconomic Benefits of Habitat Restoration. NOAA Tech. Memo. NMFS-OHC-1, 66 p.

more, outdoor recreation is resilient to economic downturns and can even escalate when they occur.

Imperiling recreation and economic growth, dams can also create safety concerns due to the dangerous hydraulic conditions that can occur below them. (See Figure 5).[78] Lowhead or run-of-river dams are especially treacherous for recreational users.[79] These dams are characterized by low height and little storage capacity, allowing water to consistently flow over the top of the spillway. Tranquil flow upstream and downstream can cause a low-head dam to blend in with the river. Tubers or paddlers approaching from upstream may have difficulty seeing these deadly hazards until it's too late to avoid them. Often referred to as "drowning machines" by dam safety experts, water flow over lowhead dams creates dangerous currents downstream of the spillway.[80,81] The circular flow patterns known as hydraulic rollers entrap boaters, anglers and swimmers. Dams as little as three feet high can create hydraulic rollers strong enough to cause drownings. The hydraulics are practically inescapable for anyone or anything passing over the dam; even those approaching from below can become entrapped. A regional example of this hazard is the Milburnie Dam near Raleigh, North Carolina where 15 drownings were known to have occurred below the dam prior to removal in 2017.[82] There is no national database to track the deaths associated with dams; however, researchers at Brigham Young University compiled a database listing at least 555 deaths at 276 low-head dams since the 1950s.[83]

## Figure 5: Lowhead dams create hydraulic conditions that drown people yearly.

Source: Iowa DNR.




[78] Wright, K., and Tschantz, B. (2011). Hidden Dangers and Public Safety at Low-head Dams. The Journal of Dam Safety 9 (1). Retrieved from https://damsafety.org/sites/default/files/TschantzWright_PublicSftyLowDams_JDS2011_1.pdf

[79] Kern, E. W., Hotchkiss, R. H. and Ames, D. P. (2015) Introducing a Low-Head Dam Fatality Database and Internet Information Portal. Journal of the American Water Resources Association. https://onlinelibrary.wiley.com/doi/abs/10.1111/jawr.12289

[80] Introducing a Low-Head Dam Fatality Database and Internet Information Portal https://www.researchgate.net/publication/273641278_Introducing_a_Low-Head_Dam_Fatality_Database_and_Internet_Information_Portall

[81] Dangerous Currents at Low-head Dams https://krcproject.groups.et.byu.net/

[82] Info Kit Milburnie Dam Removal Restoration https://milburniedam.com/wp-content/uploads/2017/10/MilburnieDam-MediaKit-Final-2.pdf

[83] Kern, E., Guymon, J., Walbridge, C., and Tschantz, D. B. Locations of Fatalities at Submerged Hydraulic Jumps. Brigham Young University. Retrieved from http://krcproject.groups.et.byu.net/browse.php

# CASE STUDY

## Milburnie Dam Removal
## Neuse River, Wake County North Carolina

**Status:** Removed in Fall 2017. Currently being monitoring for performance standards to meet mitigation bank credit.

**Owner:** Family of Howard Twiggs (prior to removal) and Restoration Systems, LLC (following removal)

**Partners:** Restoration Systems, LLC, Three Oaks Engineering,

Location: Upper Neuse River (HUC 03020201), Raleigh, Wake County, NC

**Statistics:** 600 feet wide and 15 feet high run-of-the-river dam. Normal pool level was at 13.3 feet. Primary spillway was over 200 feet long. Decommissioned and nonfunctioning hydroelectric generating facility. Originally built in the late 19th Century with a combination of stone masonry and concrete.

**Habitat Benefits:** Added 15 miles of access and returns the Neuse River to free flowing for over 250 miles from the Pamlico Sound to the dam at Falls Lake in Wake County. Removes over 6 miles of lentic habitat created by the run-of-the-river impoundment.

**Priority Species:** American Shad (*Alosa sapidissima*), Striped Bass (*Morone saxatilis*), Neuse River Waterdog (*Necturus lewisi*), and several species of mussels.

**Recreation:** 6 additional miles of the Neuse River opened to river transit, increase sport fishing for American Shad and Striped Bass, adjacent greenways and elevated platforms for birdwatching.

**Challenges:** Sediment management, historic/cultural preservation, rare/threatened/endangered species, 160 landowners along the Neuse River solicited for comments, creation of a mitigation bank to provide stream and wetland credit for restoration, wetland preservation, establishing riparian vegetation on low-flow bench.

**Permits and Federal Review:** FERC License surrendered, Clean Water Act Section 404 permit, Rivers and Harbor Act Section 10 permit, Endangered Species Act Section 7 consultation, Magnuson-Stevens Fishery Conservation and Management Act consultation, North Carolina CWA Section 401 Certification, Dam Safety Review, National Historic Preservation Act Section 106 consultation.

Photo of Milburnie Dam Courtesy of Restoration Systems, LLC.

**Additional Background:**

- The Milburnie Dam was rapidly deteriorating and had exceeded its design lifetime by many decades. Electrical power had not been produced from the site in many years, and the facility was obviously obsolete.
- The Milburnie Dam was a major safely concern, with concentrated river current running through the abandoned powerhouse that had drowned more than 15 people including children.
- The property and buildings were constantly subject to trespass and vandalism, activity which increased dramatically with the establishment of new city parks and the Raleigh Greenway.
- Due to scarce state and federal funds at the time, the most viable option for funding the removal of the dam was permitting the project as a "Mitigation Bank," in order to produce mitigation "credits" for sale as required to off-set damage to other waterways in the region.
- The Milburnie Dam was the last impediment to migratory fish on the Neuse River from the coast, particularly the sport fish American Shad and Striped Bass. The removal was the continuation of a comprehensive watershed-wide process to remove and restore the ecological integrity of the Neuse River. Four dams had been previously removed downstream on the Neuse and its tributaries.

# STEP 3: UNDERSTANDING THE FEDERAL AND STATE REGULATORY PROCESS FOR OBTAINING A PERMIT

## Section 3.1 Federal Regulatory Authorities Overview

Section 404 of the CWA requires that a permit be obtained before dredged or fill material can be discharged into jurisdictional waters of the United States, with some limited exemptions for forestry, ranching, and farming activities. The USACE is the primary agency for issuing Department of the Army permits, conducting or verifying jurisdictional determinations, as well as enforcing permit conditions (for more information see EPA 404 Permit Program).[84] The EPA works closely with the USACE to interpret policy, guidance, and environmental criteria used in permitting, as outlined in the Section 404(b)(1) guidelines (40 CFR Part 230).

Section 10 of the Rivers and Harbors Act (1899) governs the construction and modification of structures created in navigable waters of the United States. A list of these waters is maintained by the USACE.[85] On a case-by-case basis, dam breaching, dam modification, or dam removal activities may require a permit under Section 404 and/or Section 10. USACE guidance states that "... if a dam operator modifies or deviates from normal operation of the dam in such a manner that bottom sediment accumulated behind a dam could be removed and transported downstream through the dam, either deliberately or accidentally, that activity may require a permit pursuant to Section 404." (RGL 05-04).

Additionally, Section 408 (33 USC 408) requires USACE to process requests by private, public, tribal, or other federal entities to make alterations to, or temporarily or permanently occupy or use, any federally authorized Civil Works project. In addition to structures, alteration of flowage easements and other associated areas are subject to Section 408 review. The USACE Project Manager will determine whether a proposed project has the potential to adversely affect a federally-authorized project.

## Section 3.2 USACE Permitting Overview, Wilmington Corps District

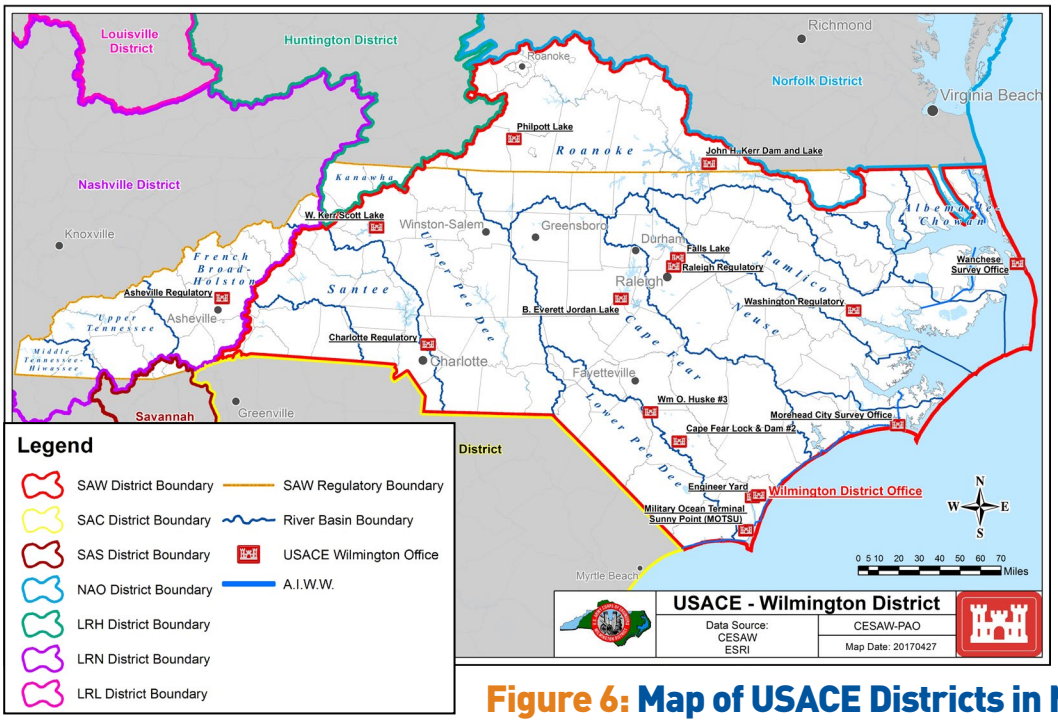



**Figure 6: Map of USACE Districts in North Carolina.**

The USACE South Atlantic Division of the Corps includes five districts in the Southeastern U.S.: Charleston, Jacksonville, Mobile, Savannah, and Wilmington. Applications for federal permits to remove a dam located within the geographic boundaries of the State of North Carolina are processed by the Regulatory Division of the Wilmington District. If a dam removal project is proposed on waters forming State boundaries, applicable Corps Districts with adjoining regulatory boundaries will determine the "lead" District for permit

[84] EPA Permit Program under CWA Section 404 https://www.epa.gov/cwa-404/permit-program-under-cwa-section-404

[85] Federal Navigable Waters https://www.saw.usace.army.mil/Missions/Navigation/

application and processing. Persons or parties planning dam removal projects on rivers or streams forming within North Carolina state boundaries should begin that process by contacting the appropriate District field office for a determination.

The Wilmington District has five Regulatory office locations that cover the State of North Carolina. Permit applications and project submittals should be submitted to the office that covers the County.

The email addresses for the five Wilmington District USACE Regulatory Field Offices are:

Wilmington Regulatory Field Office:
WilmingtonNCREG@usace.army.mil

Washington Regulatory Field Office:
WashingtonNCREG@usace.army.mil

Raleigh Regulatory Field Office:
RaleighNCREG@usace.army.mil

Charlotte Regulatory Field Office:
CharlotteNCREG@usace.army.mil

Asheville Regulatory Field Office:
AshevilleNCREG@usace.army.mil

## Section 3.2.1 | Individual v. General Permits

Two types of USACE permits may be used to authorize a dam removal project – an Individual Permit or one or more general permits. There are also two types of general permits – Regional General Permits and Nationwide Permits (NWP). The USACE District office decides on a case-by-case basis which type of permit is needed. Large, complex projects with potential for significant impacts may require review and authorization under the individual permit process. Small projects expected to have minimal adverse effects may be handled under the general permit process.

Applicants should begin to collect the information on their project as outlined in Steps 1 & 2 for initial scoping of the project. Once that is done, but prior to completing and submitting any permitting forms, applicants should begin the informal process by discussing the proposed project with the appropriate USACE office.

***Maintaining clear and open lines of communication with USACE Project Manager (PM) is the best way to facilitate timely and accurate Section 404 regulatory review.***

### Nationwide Permits

NWPs that have been, or potentially could be used for dam removal in North Carolina:

**NWP No. 3 Maintenance**

- The repair, rehabilitation, or replacement of any previously authorized fill.
- The removal of previously authorized structures.

**NWP No. 27 Aquatic Habitat Restoration, Enhancement, and Establishment Activities**

- Activity must result in net increase in aquatic resource functions.
- Activity must result in aquatic habitat that resembles reference conditions.

**NWP No. 33 Temporary Construction, Access, and Dewatering**

- Temporary structures, work, and discharges necessary for construction activities.

**NWP No. 53 Removal of Low-Head Dams**

- Low-head dams are defined as dams built to pass flow over all or nearly all of width of dam
- Structure must be deposited in an area with no waters of the U.S.

The length of the regulatory process will depend in large part on the type of permit required, the complexity of the proposed project, the quality and thoroughness of information submitted by the applicant, and the applicant's responsiveness to requests for information from the USACE.

The applicant can begin the process of applying for a permit at any time and can find additional information on the USACE webpage.[86]

[86] USACE Wilmington District https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program

After the permit application is received, USACE will determine whether the proposed work will require an individual permit or whether the project may proceed under one of the NWPs described on page 33.

After the permit application is received, USACE will determine whether the proposed work will require an individual permit or whether the project may proceed under one of the NWPs described above.

**Nationwide Permits:** If USACE determines the project can proceed under one or more NWPs, it will designate which NWP(s) is/are most appropriate. NWP 3 *for Maintenance, NWP 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities*, NWP 33 for *Temporary Construction, Access, and Dewatering,* or NWP 53 *Removal of Low Head Dams* (see Nationwide Permits sidebar, pg. 36). Most dam removal projects in North Carolina have used NWP 27.

**Individual Permit:** If USACE determines that the project will require an individual permit, the applicant must complete the Joint Federal and State Application Form and submit it to USACE.

Relevant forms and information for the permit application:

**Joint Federal and State Application Form:** This form is required for all permit application submittals.

**Regional Conditions:** All NWPs have associated Regional Conditions, which are updated every time the NWPs are re-issued (typically every 5 years). Visit Wilmington District's website for the current version of the Regional Conditions and associated NWP information.

## Section 3.2.2 | Compensatory Mitigation

Compensatory mitigation is the "restoration, establishment, enhancement, or preservation of aquatic resources for the purpose of offsetting losses of aquatic resources resulting from activities authorized by Corps of Engineers' permits."[87] Typically, compensatory mitigation is not required for dam removal projects as they often are considered restoration projects. However, some dam removals can be part of a compensatory mitigation plan to provide 'credits' for aquatic resource impacts of other independent projects. The criteria for a compensatory mitigation plan can be found at 33 CFR 332 and the current version of the Wilmington District's guidelines for preparing a compensatory mitigation plan found on the Wilmington District's website.[88]

This regulation and the guidelines include information for mitigation banks and permittee responsible mitigation plans. Most sites used for compensatory mitigation require a legal protective instrument, which can include a conservation easement or restrictive covenant. USACE RGL 18-01 provides guidance on factors to consider when generating credit for the removal of obsolete dams or other structures, recommends mitigation credit, and suggests how to treat losses of wetlands that may result from the removal of the dam or structure.[89] Dam removal projects, including those proposed for compensatory mitigation credit, can involve monitoring and may require more detail in the submittal.

## Section 3.3 Federal Emergency Management Agency (FEMA) Floodplain Management Mapping

Because removing a dam will result in changes to floodplain conditions, the FEMA Flood Mapping program may require updates to their floodplain mapping via a Letter of Map Revision (LOMR) or a Conditional Letter of Map Revision (CLOMR).[90] Updates to flood maps are a collaboration between the community and FEMA. Every community that participates in the National Flood Insurance Program has a floodplain administrator who works with FEMA during the mapping process and when revising the maps.[91] Fees for these letters can be substantial; see Flood Map — Related Fees and contact the local Floodplain Administrator early in the dam removal process to determine project-specific needs for floodplain mapping.[92,93] In some instances, FEMA has waived the review fee for dam removal projects.

[87] https://www.nae.usace.army.mil/Portals/74/docs/regulatory/Mitigation/MitigationRuleBrochure.pdf

[88] USACE Wilmington District Website https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Mitigation/

[89] USACE Regulatory Guidance Letter https://www.nap.usace.army.mil/Portals/39/docs/regulatory/regs/RGL-18-01-Determination-of-Compensatory-Mitigation-Credits-for-Dams-Structures-Removal.pdf?ver=2019-02-22-140711-787

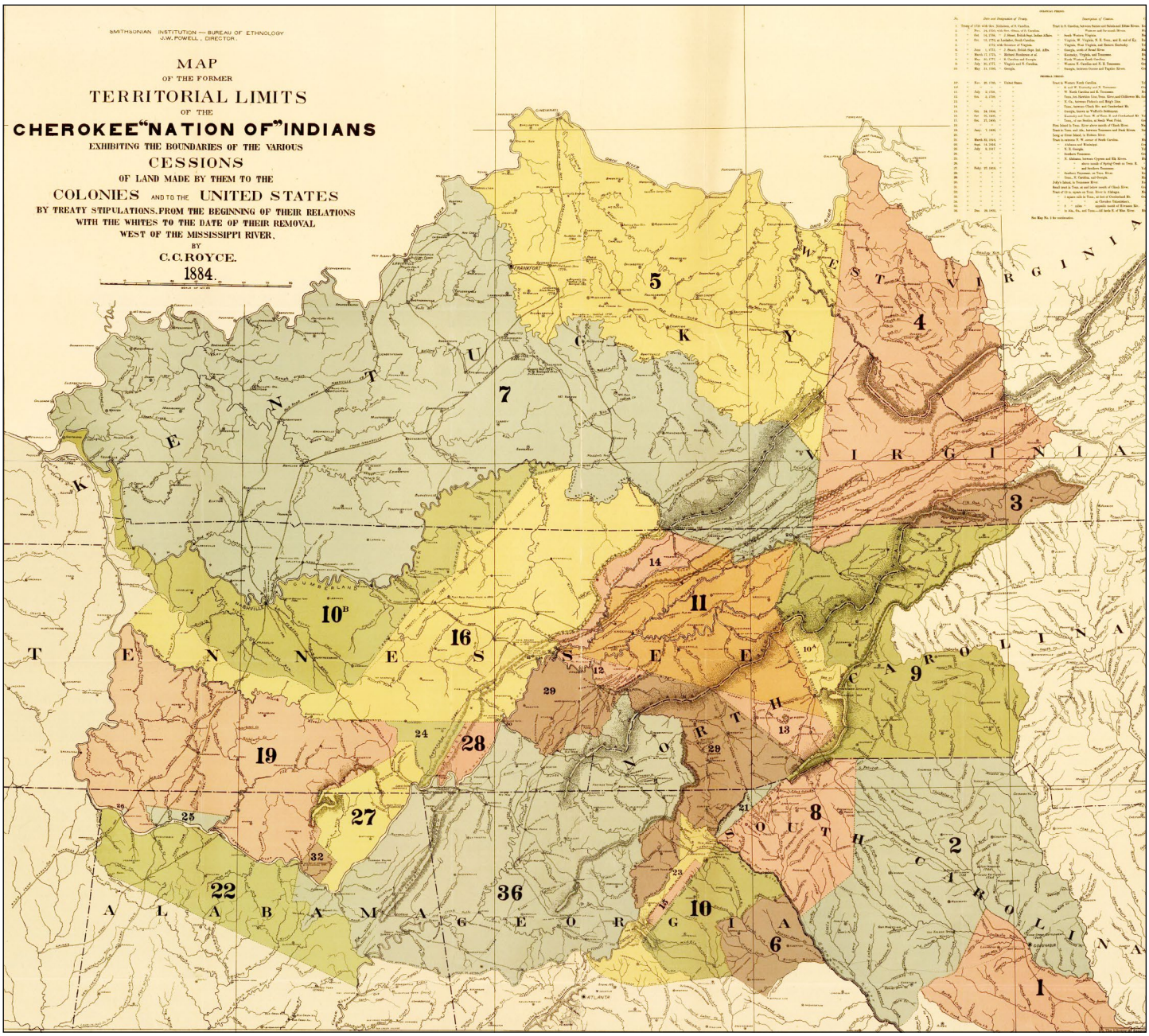
[90] FEMA Flood Maps Website https://www.fema.gov/flood-maps?web=1&wdLOR=c23E6BCCD-BE42-A744-8A05-AAEFD2E68604

[91] FEMA Flood Insurance Website https://www.fema.gov/flood-insurance

[92] FEMA Flood Map-Related Fees Website https://www.fema.gov/flood-maps/change-your-flood-zone/status/flood-map-related-fees?web=1&wdLOR=c034A305C-A866-6746-90BD-0628530F2D1D

[93] NC Floodplain Management Website https://flood.nc.gov/ncflood/ncfip.html

## Figure 7: Royce Map of Territorial Limits of the Cherokee Nation of Indians




## Section 3.4 Tribal Coordination

The Tribal Historic Preservation Office should be consulted on all projects that are within the Eastern Band of Cherokee Indians' historic aboriginal landscape in Western North Carolina (see Figure 7). This process will occur when a federal action is initiated, such as when a USACE permit is submitted. The federal agency, in this case the USACE, must initiate the government-to-government consultation under regulation 36CFR800 (section 106 NHPA).

## Section 3.5 State Regulatory Overview

The State of North Carolina has permitting/certification/approval procedures in multiple program areas that applicants must follow when considering dam removal.

### Section 3.5.1 | Section 401 Water Quality Certification

NCDEQ's Section 401 & Buffer Permitting Branch is responsible for implementing the state's waters, wetlands, and riparian buffer regulatory programs and assisting with compliance and enforcement procedures.[94] Section 401 of the CWA requires that the State issue certification for any activity that requires a Federal permit and may result in a discharge to State waters. The certification must state that applicable effluent limits and water quality standards will not be violated.

All activities requiring a Federal 404 permit (a U.S. Army Corps of Engineers permit for the discharge of dredged or fill material) result in a discharge to waters or wetlands, so NCDEQ must take certification action on all 404 permit applications. During review of applications for Water Quality Certification, the Department looks at whether feasible alternatives exist, if the activity is water dependent, and the intended purpose of the activity. Certification is denied, for example, if a feasible alternative to the activity would reduce adverse consequences on water quality and classified uses. The Federal permit cannot be issued if certification is denied.

During the 401/404 permitting process, the NCWRC and other resource agencies may recommend that dam removal projects be avoided during certain periods during the year to minimize impacts to certain species. For example, in the mountains, a trout moratorium may be recommended to minimize impacts to trout reproduction; this moratorium restricts work from occurring while trout spawn and when eggs and fry are particularly vulnerable.

#### Section 3.5.1.1 | Trout Buffer Variance

If a stream is classified by NCDWR as a trout water (or an unnamed tributary to a trout water), there are specific rules to protect that stream's riparian buffer. If the project disturbs the buffer zone, a trout buffer variance may be needed, which is obtained by NCDEMLR. For additional information on these requirements, see the trout waters frequently asked questions brochure at https://deq.nc.gov/about/divisions/water-resources/water-planning/classification-standards/classifications.

### Section 3.5.2 | NPDES Permitting for Construction Stormwater Permits

NCDEQ is the permitting authority in North Carolina for the NPDES Stormwater Program as delegated by the EPA. As the permitting authority, NCDEQ must regulate stormwater runoff from construction sites into surface waters. The agency also requires an approval under the State Erosion and Sediment Control Program and coordinates this effort with NPDES requirements. Anyone planning any construction/land-disturbing activity (including clearing, grading, and excavating) within the State of North Carolina must first obtain an approved Erosion and Sedimentation Plan (E&SC) through NCDEQ or delegated local program. The next step is to apply for coverage under the NPDES NCG010000 Construction Stormwater Permit and provide that approval documentation. For additional information on these requirements, consult the Stormwater Program's website at https://deq.nc.gov/about/divisions/energy-mineral-and-land-resources/stormwater/stormwater-program/npdes-construction-program.

### Section 3.5.3 | North Carolina Dam Safety Program

As outlined under the Dam Safety Law of 1967, a structure that meets any of the following criteria is considered a dam and is subject to state regulation. The subject structure (1) is at least 25 feet tall (vertical height, measured from highest point on crest of dam to lowest point on downstream side of dam), or (2) has the ability to store at least 50 acre-feet (volume) of water at maximum capacity, or (3) has the potential to cause loss of life in the event of failure (i.e., be considered high hazard), regardless of height or storage capacity.

NCDEQ is responsible for reviewing and approving dam owner/engineer proposed hazard classifications. It is essential to understand that the hazard classification of a dam is determined solely by the consequences of failure of that specific dam. This classification is not a measure of the likelihood or probability of failure (i.e., a high hazard dam is not inherently more likely to fail than a low hazard dam). It also independent of the condition of the dam. Dams are also assigned a size classification, either small, medium, large, and very large. Tables outlining the size and hazard classification criteria are presented in Section 1.6.1.

[94] https://deq.nc.gov/about/divisions/water-resources/water-quality-permitting/401-buffer-permitting-branch

The Dam Safety Law contains eight circumstances where a dam may be exempt from regulation by NCDEQ, as stated in §143-215.25A, as follows:

**(a)** Except as otherwise provided in this Part, this Part does not apply to any dam:

(1) Constructed by the United States Army Corps of Engineers, the Tennessee Valley Authority, or another agency of the United States government, when the agency designed or approved plans for the dam and supervised its construction.

(2) Constructed with financial assistance from the United States Natural Resources Conservation Service, when that agency designed or approved plans for the dam and supervised its construction.

(3) Licensed by the Federal Energy Regulatory Commission, or for which a license application is pending with the Federal Energy Regulatory Commission.

(4) For use in connection with electric generating facilities regulated by the Nuclear Regulatory Commission.

(5) Under a single private ownership that provides protection only to land or other property under the same ownership and that does not pose a threat to human life or property below the dam.

(6) That is less than 25 feet in height or that has an impoundment capacity of less than 50 acre-feet, unless the Department determines that failure of the dam could result in loss of human life or significant damage to property below the dam.

(7) Constructed for and maintains the purpose of providing water for agricultural use, when a person who is licensed as a professional engineer or is employed by the Natural Resources Conservation Service, county, or local Soil and Water Conservation District, and has federal engineering job approval authority under Chapter 89C of the General Statutes designed or approved plans for the dam, supervised its construction, and registered the dam with the Division of Energy, Mineral, and Land Resources of the Department prior to construction of the dam. This exemption shall not apply to dams that are determined to be high-hazard by the Department.

(8) That is less than 20 feet in height or that has an impoundment capacity of less than 15 acre-feet, when a qualified engineer who demonstrates to the satisfaction of the Department experience in dam design conducts dam failure analyses based on both storm-induced failure and normal weather geologic, structural, or seismic failure scenarios and determines that the dam is not a high hazard dam.

Dam owners who choose to remove a state-regulated dam are required to obtain approval from the North Carolina Dam Safety Program. The dam owner must utilize a licensed Professional Engineer registered in North Carolina to prepare an application that includes, but is not limited to, construction plans, specifications, and calculations that demonstrate how the removal is to be conducted in accordance with the Dam Safety Law of 1967 and NCAC 15A 02K regulations. Once the application is approved and the dam has been removed (also known as decommissioned), the dam owner will need obtain a certificate of final approval. This certificate is obtained by submitting as-built plans for review and approval, along with any required fees. The North Carolina Dam Safety Program will review the as-builts and conduct a site visit to ensure construction/decommissioning was completed in accordance with the approved plans. Once final approval is issued, the owner will have no further responsibilities under the Law.

The NCDEQ Dam Safety Program notes the importance of recognizing that in some cases, removing a dam may increase the frequency of floods in downstream areas. Most dams, especially regulated dams, provide some storage for inflows and discharge at a near constant rate. This is especially true of higher return interval floods such as 1-, 5-, 10-year, and possibly the 25- and 50-year, floods. Larger floods, such as the 100-year flood and above, are generally passed through a dam's emergency spillway, and thus are not attenuated by the dam. Removal of a dam, and the flood attenuation it provides, may cause the downstream area to experience flooding from the smaller magnitude but more frequent events. For this reason, NCDEQ will require the Professional Engineer to address the hydrologic impacts of removing the dam. Local flood ordinances and dams in FEMA-regulated floodways may impose additional requirements where the flood response in downstream areas will be affected.

When removing a state-regulated dam, the Professional Engineer should consider design issues including:

- Removal of the entire structure versus an engineered breach: Where the entire structure is not being removed, the engineer must provide calculations to justify the width of the section of dam to be removed and the extent of the dam that is to remain.
- The dam removal should seek to restore the natural stream bed geometry. Where the entire dam is not being removed,

the center of the engineered breach of the dam should be located in the original stream bed. The width of the engineered breach should be at least as wide as the original stream bed.

- As a minimum, the 100-year flood should be used as the design flood for hydrologic and hydraulic analyses.
- The engineered breach should be constructed to be stable and erosion-resistant.
- The final condition should be resistant to obstruction from debris buildup. The goal is to leave the site in a "walk away and forget" condition. NCDEQ will not approve a design for removal that requires ongoing maintenance or other human intervention to sustain a dam's removed or decommissioned condition.

More information about the application process can be found on the North Carolina Dam Safety website for removing a dam.[95] The program can be contacted via email at damsafety@ncdenr.gov. Additionally, NCDEQ maintains a list of engineers who have experience with dams and a track record of successful submissions.[96] This list can be shared with dam owners upon request.

## Section 3.5.4 | State Historic Preservation Office (SHPO) Coordination

Under Step 1 of this Handbook, the applicant should have collected relevant historical background information on the dam. This and any preliminary review by the SHPO should be provided to the assigned USACE Project Manager, who will coordinate the Agency's review of the project with the SHPO's ER branch and other consulting parties (e.g., tribes, the public, etc.). Section 106 of the NHPA requires that federal agencies consider the impacts of their "undertakings"[97] on historic properties. Consulting parties can provide feedback on the locations and significance of historical resources, project alternatives, technical assistance, and potential concerns.

**Steps of the Section 106 process:**

1. **Establish the Undertaking** — What is the action and is it defined as a federal "undertaking? The Federal agency will decide if the action is an undertaking.
2. **Identify and Evaluate Historic Properties** — Are historic properties within the undertaking's area of potential effect? Consultation with the NC SHPO ER branch is required to determine the presence of historic properties and potential effects. Further work may be required to determine if historic properties are present. Such work may include a National Register eligibility evaluation of the dam/structure. An archaeological survey may also be recommended if the nature of dam removal indicates it will cause ground disturbance. All surveys and evaluations must be completed by a Secretary of the Interior's Qualified Professional and are the responsibility of the applicant.[98]
3. **Assess Effects to Historic Properties** — If historic properties are present, how will the undertaking affect their listing or potential for listing on the NRHP? A clear and defined scope of work is necessary for the SHPO to accurately assess impacts to historic properties.
4. **Resolve any Adverse Effects** — If historic properties are present and the undertaking will have an adverse effect that cannot be avoided, resolution must occur prior to permitting. How can the effect be resolved? Who needs to be party to the resolution?

If it is determined that the undertaking will adversely affect historic properties, the resolution process may add 6 to 12 months to the permitting process. Applicants should be prepared for an extended consultation period. Having knowledge of the property's historic significance and preliminary SHPO review should allow the applicant to adequately plan for the potential effects determination. Resolution of an adverse effect requires that the agency consider all alternatives that would avoid or minimize the impact to historic properties, such as maintaining the dam as-is, partial versus full breach, etc.

[95] NCDEQ Dam Safety applications page: https://deq.nc.gov/about/divisions/energy-mineral-and-land-resources/dam-safety/application-forms

[96] The authors and contributors of this publication, including state and federal agencies, do not endorse these engineers, do not consider them as pre-qualified, nor does the inclusion of this reference relate to any permitting outcomes by using these engineers.

[97] Under the Section 106 regulations and the National Historic Preservation Act (NHPA), an "undertaking" is broadly defined as any project, activity, or program with federal agency involvement, such as those carried out by federal agencies, assisted by federal agencies, or that require a federal permit, license, or approval (https://www.achp.gov/digital-library-section-106-landing/when-do-project-planning-activities-trigger-section-106-review#:~:text=Under%20the%20Section%20106%20regulations,a%20federal%20permit%2C%20license%2C%20or).

[98] Secretary of the Interior Professional Qualification Standards - https://www.nps.gov/articles/sec-standards-prof-quals.htm

If the effect cannot be minimized or avoided, the lead federal agency (e.g., USACE), SHPO, and the other consulting parties will develop and execute a legally binding Memorandum of Agreement (MOA) that will outline the actions necessary to resolve, (mitigate), the effect.[99] The MOA serves to record the undertaking, the parties, the responsibilities, and the collectively agreed upon mitigation strategies or actions. Appropriate mitigation strategies must be commensurate with the level of impact and are done in service to the public. Usually, strategies will include public education components, such as StoryMaps or interpretive panels.[100]

An adverse effect determination will not stop a dam removal altogether but will certainly delay efforts to meet the Section 106 resolution requirements. This delay may affect other requirements for approved work periods, such as the spawning seasons for endangered species. Planning ahead is key!

Applicants should be in constant contact with their USACE Project Manager, who understands the Section 106 review process and will be consulting with the SHPO and appropriate Tribal Historic Preservation Officers. Applicants should also respond promptly to the USACE Project Manager's requests for additional information required by the SHPO to keep the consultation process moving forward.

# STEP 4: PLANNING AND DESIGN OF THE PROJECT

**Once the information outlined in steps 1, 2, and 3 of this Handbook has been gathered, and the regulatory process has begun, the planning and design phase can begin. Project planning and design are case-specific and can be relatively simple or, in the case of larger projects, involve multiple intermediate steps — including a feasibility study, a conceptual design, and a preliminary design — before the final design is completed. Dam removal planning and design is not a linear process. It is the job of the dam owner's project manager to coordinate multiple work streams in synchrony through the planning, design, and implementation phases.**

## Section 4.1 Identifying Consultants

One of the most critical tasks in the dam removal process is the selection of a qualified consultant to lead the project. Environmental, economic, ecological, engineering, social, and legal complexities require a multidisciplinary approach. An effective lead consultant can assist project partners in building a successful team. Dam removal projects depend on effective communication between project partners, resource agencies, regulators, and consultants. For this reason, taking the time to carefully research the dam, the river and surrounding landscape, and the basic regulatory process before selecting consultants is essential. American Rivers holds Master Service Agreements with design and construction firms experienced in dam removal and are willing to share this list with project managers.[101] American Rivers' staff may be contacted for the latest list.

## Section 4.2 Identifying Relevant Stakeholders

From the onset of the planning process, the project team should develop a clear outreach plan on the purpose and intent of the dam removal to share with stakeholders. The plan should consider how those outside the core project will be affected by the dam removal and whether the team has existing relationships with those stakeholders. Careful consideration of equity issues as well as the values and opinions of relevant stakeholders can help to minimize conflict as information about the project becomes public. The facts

[99] ACHP Section 106 Agreement Document Guidance - https://www.achp.gov/initiatives/guidance-agreement-documents

[100] NCHPO Story Maps: https://nc.maps.arcgis.com/home/group.html?id=d56ec9c8aa77423b931f4d359f103ae6&view=list&categories=%5B%22%2FCategories%2FNCHPO+Story+Maps%22%5D#content

[101] The authors and contributors of this publication, including state and federal agencies, do not endorse these engineering firms, do not consider them as pre-qualified, nor does the inclusion of this reference relate to any permitting outcomes by using these firms.

related to benefits of dam removal included in this Handbook may provide helpful information during the outreach stage of the project.

## Section 4.3 Evaluation of Project Alternatives

As the project team assimilates information from all relevant stakeholders, it should keep in mind that the final plan will be evaluated by multiple regulatory agencies. The final design may include a comprehensive evaluation of designs using the information gathered to assess impacts to resources as well as the costs and benefits that may result from modifying the original planned design.

This process should begin with careful consideration of all potential effects of removing the dam. Much of the information required has already been described in previous sections of this Handbook. Beyond information gathered for the permitting process, this step should consider all stakeholders involved.

Examples of the types of effects to consider are:

- Ecological Effects (See Step 2 of this document for details)
- Economic Considerations
  - Dam owner costs and benefits
  - Societal costs and benefits
  - Recreational costs and benefits
  - Environmental costs and benefits
  - Property value considerations
  - Costs/risks associated with the dam
  - Availability of funding for dam repair or removal
- Societal Issues
  - Community relationship to the river
  - Environmental justice
  - Acknowledgement of labor practices used to build the dam, such as the use of enslaved labor
  - Services provided by the dam
  - Community sentiment towards the river and the dam and dam removal process
  - Historical significance of the dam
  - Recreational safety
- Technical/Engineering Issues
  - Feasibility of repairing and maintaining the existing structure
  - Feasibility and design of dam removal

Ultimately, this evaluation of project alternatives should describe a process acceptable to all relevant stakeholders.

## Section 4.4 Stages of Project Design

For very simple, straightforward projects, the information gathered in steps 1, 2, and 3 of this Handbook, plus the analysis of project alternatives, may be sufficient to develop a final project design for the purposes of permit application. This determination should be made by the lead consultant for the project. For more complex projects, and to ensure successful implementation subsequent to permitting, additional stages will likely be required. These intermediate stages may include the following.

### Section 4.4.1 | Feasibility Studies

If problems or unanswered questions arise during the early stages of information gathering and project planning, a more detailed feasibility study may be warranted. This study may be conducted by project partners with appropriate skills, by consultants, or a combination of the two. Feasibility studies often involve additional data collection including economic, technical, legal, and logistical considerations. The goal of this process

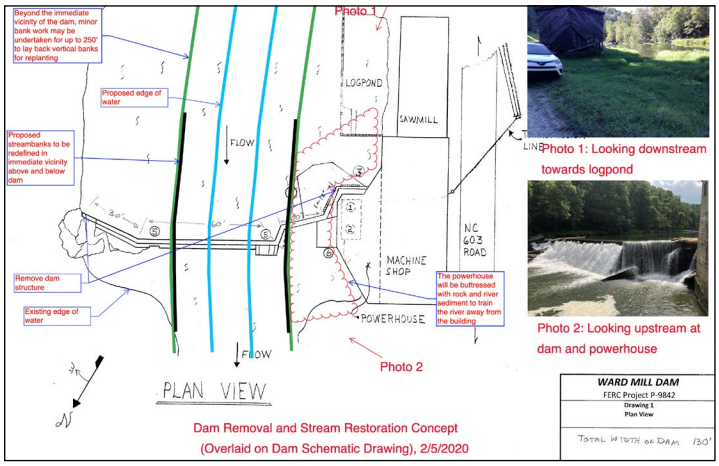
### Section 4.4.1 | Conceptual Design

Once the project team feels it has an optimal approach to meeting its goals, it can prepare a concept-level description of planned work. This concept-level description may be referred to as a "10% design" and will include preliminary drawings or other materials that can be used to articulate the overall design to key stakeholders, including regulators and agency biologists (NCWRC and if applicable, USFWS), so they can provide feedback before details are finalized.

## Section 4.4.3 | Preliminary Design

After any questions or concerns raised by key stakeholders and regulatory agencies have been addressed, a more detailed plan, sometimes referred to as a "30% design" can be prepared.

### Figure 8: Preliminary design drawings of the Ward's Mill Dam removal project by Wildlands Engineering.




## Section 4.4.4 | Final Design

The last stage of the design phase is the preparation of construction documents and specifications. These documents convey all project design requirements through detailed drawings and specifications. All required machinery, equipment, and material specifications must be clearly indicated. A technical memorandum describing the analysis process and approach will also be included. A final design plan includes a description of the process for removal, mobilization of equipment via temporary access roads, and stabilization in addition to drawings. The following list what may be included in a final design plan:

- Design drawings showing plans for dam removal, sediment management, and channel restoration plans as necessary to reflect the project complexity. Plan sheets typically include base maps and drawings of:
  - Existing site conditions;
  - Staging areas and access;
  - Removal plan;
  - Dewatering plan (sometimes completed by the contractor);
  - Delineation of resource areas;
  - Proposed plan view;
  - Proposed cross sections;
  - Proposed longitudinal profile;
  - Erosion prevention and sediment control practices;
  - Infrastructure replacement/protection; and
  - Habitat feature installation schematics
- Project specifications providing details on the construction work that will be completed. For very simple projects, specifications may be noted directly on the design plans. Typically, specification details include the following:
  - Timeline for construction and restoration;
  - Construction equipment needs;
  - Material specifications and quantities;
  - Project sequencing;
  - Staging area treatment;
  - Site access route treatment;
  - Dewatering; and
  - Other site-specific details, i.e., planting plans, traffic control, infrastructure protection, etc.

## Section 4.4.5 | Pre-Construction Public Relations

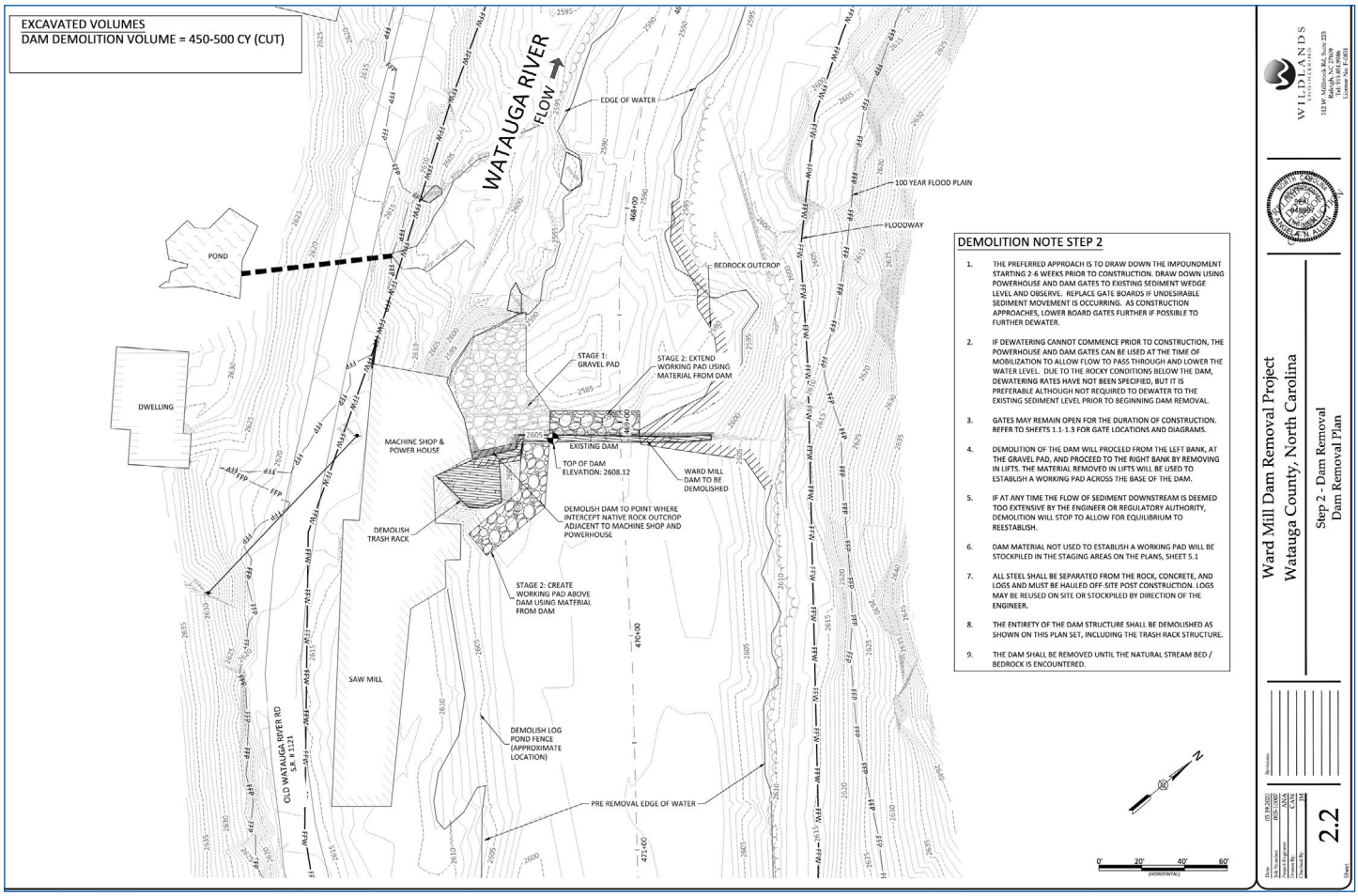
At this stage of the project, it is very important to ensure that the community is aware of the upcoming removal and has a chance to ask questions and get information. Step 7 of American's River's Removing Small Dams: A Basic Guide for Project Managers provides a good overview of this process.[102]

## Section 4.4.6 | Additional Considerations

There may be additional considerations, including:

- Data collected during the preliminary design can provide the baseline for post-project monitoring, if it will be conducted (See 'project monitoring' in Step 6: Post-Removal Actions for more information.).
- Permit Identification — The lead consultant will assist the applicant in applying for the appropriate federal, state, and local permits required. All contractors performing the dam removal work should have a copy of all permits, and a copy should be kept available on site during construction.

## Figure 9: Final design drawings of the Ward's Mill Dam removal project.




- Technical Memorandum — This memorandum, prepared to accompany all design documents submitted for permit consideration, should describe the analysis and provide a recommended approach for each issue.
- Cost Estimate — With the help of the lead consultant, the design team should develop estimates, including the costs of permitting and construction, to bring the recommended approach to completion.

[102] American Rivers Removing Small Dams
https://s3.amazonaws.com/american-rivers-website/wp-content/uploads/2016/05/24144210/NatlDamProjectManagerGuide_06112015.pdf

# CASE STUDY

## Cane River Dam Removal
## Cane River, Yancey County
## North Carolina

**Status:** Removed in Fall 2016

**Owner:** NC Department of Transportation (purchased for mitigation)

**Partners:** Blue Ridge RC&D Council, US Fish and Wildlife Service, NC Division of Water Resources, NC Wildlife Resources Commission, NC Department of Transportation, Yancey County Soil & Water Conservation District, Appalachian State University, American Rivers, Confluence Engineering, Baker Grading and Landscaping

**Location:** Cane River, French Broad River Basin, Yancey County, NC

**Statistics:** Nonfunctioning hydroelectric generating facility built in 1919. 100 feet wide and 40 feet high run-of-the-river dam, with a significant breach caused by storm events and dynamite. Although partially breached, the structure still served as a hydraulic barrier to upstream movement.

**Habitat Benefits:** Allowed free passage for the aquatic community to the upstream 27 miles of the Cane River, which is unimpounded by dams to its headwaters at Mount Mitchell State Park and the Blue Ridge Parkway, and its tributaries.

**Priority Species:** Appalachian Elktoe (*Alasmidonta raveneliana*, US and NC Endangered), Eastern Hellbender (*Cryptobranchus alleganiensis*, NC Special Concern), Striped Shiner (*Luxilus chrysocephalus*, NC Special Concern), Wavyrayed Lampmussel (*Lampsilis fasciola*, NC Special Concern)

**Recreation:** Dam and breached opening posed a dangerous hazard to boaters; dam removal eliminated this hazard and provided unimpeded passage to boaters.

**Challenges:** Sediment management, listed species, channel erosion and movement post-restoration, invasive riparian species. Burnsville wastewater treatment plant (WWTP) discharges into Cane River just downstream; in 2008, the WWTP discharged untreated waste, causing massive die-offs of Appalachian Elktoe in the Cane River, limiting upstream recolonization potential.

**Funding:** Cost of project was $875,000. Funded through grants (NC Clean Water Management Trust Fund, NC Division of Water Resources), NC Department of Transportation, and in-kind Blue Ridge RC&D Council.

**Permits and Federal Review:** Clean Water Act Section 404 permit, Endangered Species Act Section 7 consultation, North Carolina CWA Section 401 Certification, Dam Safety Review, National Historic Preservation Act Section 106 consultation, NC Division of Land Resources (trout buffer variance).

**Additional Background and Lessons Learned:**

- As there were listed species that were vulnerable to fine sediments just downstream of the dam (Appalachian Elktoe and Eastern Hellbender), the upstream sediment wedge was removed before dam removal. The project was done in 2 phases — (1) sediment removal from the upstream reach and stream restoration, and (2) dam removal.
- The Cane River is a high energy system, transporting a large amount of sediment (cobble, gravel, sand) during storm events. After the project was completed, the river adjusted during various storm events, resulting in bank erosion and downstream sediment deposition. Efforts to save existing riparian vegetation were sometimes futile. The river will continue to adjust through time, hopefully achieving a natural and dynamically stable state.
- A robust concentration of hellbenders was present just downstream of the dam, where the hydraulic energy of the dam supported ideal habitat (clean boulders and cobble). Once the dam was removed, this habitat was occluded with fine sediments and was no longer able to support hellbenders.

Cane River Dam (photo: J. Hartsell, Blue Ridge RC&D)

Cane River, post-dam removal (photo: J. Hartsell, Blue Ridge RC&D)

# STEP 5: IMPLEMENTATION AND CONSTRUCTION

**Communication between the construction contractor with oversight from the design team is important for ensuring the success of the project and accurate implementation of the plan. This communication is "built-in" when a project is contracted as a design-build, meaning the contract encompasses the design, permitting, engineering, and construction components of the project. Often projects are contracted in two parts because of funding limitations. When the construction contract is separate, the project manager can make sure the designer/engineer is responsible for oversight of human safety, habitat considerations, costs, and timing within the construction process.**

Once an initial conceptual design is available, a pre-application meeting and site visit should be scheduled with the USACE project manager, consulting engineer, and the contractor who will implement the final plan. These arrangements will allow all parties to talk through the design and make changes as needed. Additional site visits will likely be required throughout the planning and design process.

While the final approach for removing the structure may have been documented during the project planning and design phase, some issues can have a significant effect on implementation. These include:

- The condition of the dam and associated structures in terms of safety concerns such as public access to the site;
- Access to the site by contractors for construction equipment, materials and staging areas; and
- Site limitations, such as utilities or topographic constraints.

## Section 5.1 Project Deconstruction

Once the work on planning and design has been completed, and all necessary permits have been obtained, removal can be scheduled. The physical work of removal will likely take a relatively short time in comparison to all other stages of the project, especially for smaller projects. Some projects are deconstructed in multiple phases to manage sediment loads.

The project manager should work closely with the consulting team to select an experienced contractor to do the physical work of removal or deconstruction. Construction may be bid out to qualified contractors, who must be licensed, bonded, and insured. The American Rivers Master Service Agreement list of pre-qualified contractors is one resource that may be consulted.[103] In some cases, agency programs may provide qualified personnel and the appropriate equipment to complete some or all work (see inset on the USFWS National Fish Passage Program, pg. 48). During construction, the project manager and other members of the design team should always be present onsite to oversee the process. In all dam removal projects, unforeseen circumstances may arise, requiring rapid decision-making and response.

If site monitoring is required by the permit (e.g., water quality, biological, geomorphological monitoring, etc.), professionally qualified personnel should be hired. Site monitoring may help to demonstrate the ecological impact of the removal. Even if monitoring is not required by the project permit, video and photographic documentation of all critical steps of the removal process are recommended to document and help communicate outcomes to all stakeholders.

Once removal is initiated, deviating from the original project design may be necessary. In such cases, the team should communicate changes to all regulatory agencies as soon as possible and note all planned modifications on design drawings.

[103] The authors and contributors of this publication, including state and federal agencies, do not endorse these engineering firms, do not consider them as pre-qualified, nor does the inclusion of this reference relate to any permitting outcomes by using these firms.

## U.S. Fish and Wildlife Service
## National Fish Passage Program and the Southeast Aquatic Restoration Team

The U.S. Fish and Wildlife Service, National Fish Passage Program (NFPP) is a federal program which provides financial and technical assistance to reconnect aquatic habitats through the removal of barriers. The NFPP works in partnership with state and federal agencies, non-government organizations, universities, and tribes. The NFPP focuses solely on issues surrounding aquatic barriers (including obsolete dams) and restoration of waterway connectivity. This nationwide program includes the Southeast Aquatic Restoration Team, who have worked successfully with stakeholder groups in a number of states including South Carolina. The members of this team are highly experienced equipment operators who have successfully removed dams of all sizes.


For more information contact:
Tripp Boltin
USFWS - South Atlantic-Gulf and Mississippi Basin Fish Passage Coordinator
walter_boltin@fws.gov

## Section 5.2 Public Relations During Construction

A dam removal is an uncommon event and will likely get a lot of attention. It is important to plan to have sufficient personnel prepared to handle visitors to the site and inquiries from local media. While this is an excellent opportunity to tell your project's story, everyone involved must exercise all appropriate safety precautions. Prior to initiating construction, the project manager should delegate someone with detailed knowledge of the overall plan to interact with visitors. Consult the contractors and equipment operation crew and establish a designated viewing zone a safe distance from the active site.


Prior to removal, a viewing zone for visitors should be established a safe distance from the active site, or like at Shuford Dam Removal shown above create an event for visitors to interact with the constructors.  Photo credit: Rhonda Evans

# STEP 6: POST REMOVAL ACTIONS

**Monitoring project results is an important step in the dam removal process as it helps practitioners learn how to better implement projects. Not all projects include monitoring especially when funds are limited. Project managers can reach out to state agency and academic partners to see if resources are available for monitoring. If required by the permit, as in mitigation projects, environmental monitoring can demonstrate whether habitat restoration goals were met. First, a project evaluation, or as-built drawings, should be completed to determine if the engineering design was constructed properly and to ensure that the project is performing against infrastructure and public safety parameters.**

## Section 6.1 Project Evaluation

If required by the permit or of interest to the project manager or dam owner, the project team should plan to complete regular inspections of the removal site. They may seek assistance from the lead consultant in developing a checklist of issues to inspect periodically. The checklist might include visual or quantitative assessments of vegetation growth, erosion and sediment transport, and scour around remaining infrastructure, such as abutments.

## Section 6.2 Completing NHPA Section 106 Conditions

If the permit contained a Memorandum of Agreement resolving adverse effects to historic properties, the project team should plan to complete any post-dam removal treatment measures to fulfil and close out the MOA in coordination with the NC Historic Preservation Office and other parties as applicable.

## Section 6.3 Environmental Monitoring and Assessment

If required, environmental monitoring of dam removal projects will involve evaluating changes in biological/ecological, physicochemical, geomorphological, hydraulic, and hydrologic parameters to assess project success. Monitoring plans developed during the project development phase should establish pre-project baseline conditions. Trained personnel from universities, environmental consulting firms, or scientific staff from various non-profits can complete post-construction monitoring activities to evaluate changing conditions. In some cases, state or federal agencies can provide assistance with project monitoring, such as by evaluating fish populations before and after dam removal.

NOAA, in cooperation with various partners, has prepared useful monitoring-related resources including the Stream Barrier Removal Monitoring Guide by the Gulf of Maine Council on the Marine Environment and NOAA's Guide for Monitoring and Evaluation for Restoration Projects.

A useful approach to post-project monitoring includes the development of fixed photo stations to photograph the site from the same location repeatedly over time. In addition, specific parameters can be monitored to track the ecological success of a project. Broad categories include:

- Ecological Response
  - Evaluate changes in fish, benthic macroinvertebrate, and other aquatic species, groups or communities.
  - Evaluate vegetation establishment on exposed lands, quantifying both native and non-native or invasive exotic species' abundance and distribution.
- River Channel Response
  - Evaluate sediment transport and deposition, erosion, and habitat structure changes by surveying channel morphology (bedform diversity, bank stability, etc.) and analyzing bed material samples.
- Water Quality Response
  - Evaluate changes in water quality, including such parameters as water temperature, dissolved oxygen, and turbidity.
- Hydraulic Response
  - Evaluate changes in flow-velocities that may impact aquatic species movement and recreational boating safety in the river.

Drone imagery can be very useful in monitoring changes in river morphology after dam removal. (photos courtesy GA ACT)

Finally, once the removal is complete, report it to American Rivers so it can be added to their dam removal database and gets a dot on the national tracking map.[104,105]

## Section 6.4 Pre- and Post-Removal Assessments for NC Water Quality Integrated Reporting

North Carolina is using the Water Quality Integrated Reporting framework to track restoration and protection projects. This approach will help with reporting environmental as well as economic success of dam removal projects.

The Integrated Report (IR) is a combination of the CWA Sections 303(d) and 305(b) reporting requirements. Section 303(d) and the associated regulations in 40 CFR 130.7 require states to identify water quality limited segments still requiring total daily maximum loads (TMDLs) within their jurisdictions. Section 305(b) directs states to report on the overall condition of aquatic resources in their jurisdictions at the same time as the section 303(d) List submission (by April 1 of all even numbered years).

In North Carolina's IR framework process, DWR assigns each waterbody to a category. Categories, which are based on EPA guidance, represent levels of water quality criteria attainment, ranging from Category 1, where the monitored parameter meets water quality criteria, to Category 5, where a waterbody exceeds water quality criteria and a TMDL or other reduction plan is required to address the pollutant of interest.[106] Category 4 is intended for waters where available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed. EPA's IR Guidance for the 2016 303(d) listing cycle includes clarification of IR Category 4c, regarding the assessment and categorization of impairments caused by pollution not caused by a pollutant, as often is the case with hydrologic or habitat alteration.[107]

States have the option to subcategorize when appropriate, and North Carolina has done so to help facilitate tracking dam removal projects.[108] Specifically, Category 4c is assigned when a parameter exceeds criteria due to presence of a water control structure such as a dam. Once a dam removal plan is under development, waters are assigned to Category 4r for tracking purposes.

[104] American Rivers Dam Removal Database https://figshare.com/articles/dataset/American_Rivers_Dam_Removal_Database/5234068

[105] American Rivers Map of U.S. Dams Removed Since 1912: https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/dam-removal-map/

[106] Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act, July 29, 2005, at https://www.epa.gov/sites/production/files/2015-10/documents/2006irg-report.pdf

[107] Information Concerning 2016 Clean Water Act Sections 303(d), 305(b) and 314 Integrated Reporting and Listing Decisions. September 3, 2013. Memorandum from Benita Best-Wong, Director, Office of Wetlands, Oceans, and Watersheds, U.S. EPA, Washington, D.C. (August 13, 2015) https://www.epa.gov/sites/default/files/2015-10/documents/2016-ir-memo-and-cover-memo-8_13_2015.pdf

[108] 2020 Integrated Report Category Assignment Procedure. https://deq.nc.gov/media/17840/download

Three applications are used to make pre- and post-removal assessments. The first process is identification of the dam as obsolete, which is carried out by a team in NC with staff from American Rivers, Wildlife Resources Commission and NC Division of Water Resources. During each assessment cycle, by June of odd numbered years, the group will identify obsolete dams and formally assess these in Category 4c of the integrated report. The parameters and waterbody segments, identified by Assessment Units (AU), will be assessed based on the table below.

### Table 6: Integrated reporting information for dams identified as obsolete

| IR Category | Parameter | AU Assignment |
|---|---|---|
| 4c | Hydraulics | From dam backwater to dam |
| 4c | Aquatic Passage | From dam backwater to dam |
| 4c | Geomorphology | From dam backwater to dam |

Once a removal plan is developed (at least conceptually and with stakeholder agreement), then the above assessments will be adjusted as follows in the next IR cycle.

### Table 7: Integrated reporting information for dams identified as obsolete

| IR Category | Parameter | AU Assignment |
|---|---|---|
| 4r | Hydraulics | From dam backwater to dam downstream extent of dam impact reach |
| 4r | Aquatic Passage | Assessment unit will be changed to reflect all upstream waters now available to aquatic passage |
| 4r | Geomorphology | From dam backwater to downstream extent of impact reach. |

Once the dam is removed and some time period has been allowed for recovery, the post assessment IR process will occur by recategorizing the above assessments to Category 1r (assigned as a North Carolina subcategory when a parameter is meeting criteria and there is water resource restoration plan in place that addresses the parameter).

Tools and applications to complete this process include the Watershed Improvement Projects Tracker (WIPS), where the project will be identified first as proposed and then afterward as completed. Additionally, the Project Level Effectiveness Monitoring Tool (PLEM) can be used for the pre- and post-assessments. This tool will allow for DWR to make the assessments quickly and with minimal communications needed. The Project Economic Evaluation Tool (PEET) Tool can be used after the PLEM assessments to evaluate value added to the watershed in dollars and return on investment.[109]

## Looking Ahead

The NC ACT is an interdisciplinary, inter-organizational team that serves as the statewide leader in aquatic connectivity efforts. Its mission is to restore connectivity, habitat, and ecological function to streams in North Carolina by identifying, assessing, and facilitating removal of barriers to aquatic species passage. The NC ACT hopes this Handbook will assist dam owners and project managers in preparing complete applications and navigating the regulatory process.

[109] *NCDEQ Watershed Action Plan Community Tools:* https://deq.nc.gov/about/divisions/water-resources/water-resources-public-information/water-education-programs/watershed-action-plans