2026 REPORT CARD FOR NORTH CAROLINA'S INFRASTRUCTURE

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

INFRASTRUCTUREREPORTCARD.ORG/NORTH-CAROLINA

Cover photo: North Carolina National Monument; Caspar Schlageter

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Executive Summary

The North Carolina Section of the American Society of Civil Engineers (ASCE) has released its *2026 Report Card for North Carolina's Infrastructure*, assessing seven infrastructure areas: aviation, bridges, dams, drinking water, roads, stormwater and wastewater. North Carolina's infrastructure earned an overall grade of C-, a mediocre rating which indicates a need for improvement over areas such as funding, operations and maintenance and capacity.

North Carolina is a thriving state, with an expanding economy largely because of population growth. With that population growth comes the challenges of the state's infrastructure to meet increased demands. These challenges are exacerbated by extreme weather and recently, storms such as Tropical Storm Helene, have highlighted the need for increased funding, capacity and resiliency of the state's infrastructure. While the response from multiple state agencies and dozens of municipalities showed North Carolina's durability, the storm also illustrates the need for greater commitment from the state to support our interconnected infrastructure systems. With thousands of bridges, roads, stormwater culverts, drinking water and wastewater pipes from the coast to the mountains being impacted by this historic event, North Carolina needs to be prepared for similar disasters moving forward. In addition to recovery from Tropical Storm Helene and preparing for the next big storm, improving the state's infrastructure will enhance quality of life across the state.

The Infrastructure Investment and Jobs Act (IIJA) has played a critical role in closing longstanding funding gaps across North Carolina's infrastructure systems – providing $12.3 billion in funding to projects statewide. State transportation funding grew from $150 million in FY2015 to $482 million in FY2025, allowing agencies to better manage the state's diverse terrain, from the mountainous west and the Piedmont to the coastal region. The geographic differences create unique operational and maintenance challenges; one such example is the necessary replacement of a frequently washed-out section of NC-12 near Cape Hatteras with a 2.4-mile, $145 million bridge. Other significant needs remain across additional sectors as well. The state faces a $5.97 billion dam repair backlog, including $2.83 billion for high-hazard dams. Further, EPA's 2022 Clean Watersheds Needs Survey identified $12.6 billion in sewer and wastewater treatment needs. Water quality is further shaped by aging drinking water, stormwater, and wastewater systems, many of which rely on locally generated stormwater utility fees. Population growth is also straining airport capacity as enplanements surge, with the IIJA providing $520 million to support needed aviation upgrades. Additional state funding sources have proven to be effective such the North Carolina Department of Environmental Quality (NCDEQ) which has funded $1.5 billion for drinking water since 2014. These funding sources have helped to maintain the current capacity and condition, but additional funding is needed to accommodate population growth and maintain a state of good repair.

Further funding and financing opportunities will have both immediate and long-term benefits. Additional resources will aid infrastructure improvements with critical funding shortfalls, in turn supporting quality of life and help meet the demands of recent population growth. Funding infrastructure to meet both current and future needs - as the state's population continues to grow – will better accommodate North Carolina's communities and the residents they serve.

Recommendations to Raise the Grade

1. **Investment** – Increased investment is needed to meet growing demands driven by population growth and more intense storm events. Targeted funding will help ensure that drinking water and wastewater systems, transportation infrastructure such as roads and bridges, and dams can continue to operate safely and reliably under increasing stress.

2. **Resilience** – Recent storms, such as Tropical Storm Helene and Hurricanes Matthew and Florence have demonstrated North Carolina's resilience while highlighting the need for the state to prepare for the next major storm event, including updating emergency action plans for all departments and municipalities.

3. **Safety** – North Carolina faces significant safety risks, with 1,463 high-hazard dams and rising vehicle fatalities per 100,000 residents over the past decade. Strengthening dam inspection programs and adopting comprehensive roadway safety strategies such as Vision Zero will be essential to reducing risks and improving public safety statewide.

4. **Capacity** – Capacity specifically for ageing water-related infrastructure is needed. Many wastewater and stormwater systems are past their design life cycle and are in need of upgrades. Repairing these systems will help to address water quality, flooding, and erosion.

5. **Technology** – Relying on improving technologies such as green infrastructure and artificial intelligence (AI) will help to address challenges of increasing funding and improving infrastructure all while maintaining the standard quality of life.

About the Grades

The *2026 Report Card for North Carolina's Infrastructure* was written by a committee of civil engineers across North Carolina who volunteered their time to collect and analyze data, prepare and review their findings and present their conclusions. The committee worked with staff from ASCE National and ASCE's Committee on America's Infrastructure to provide a snapshot of our state's infrastructure, as it relates to us locally and on a national level. **The Report Card sections are graded based on the following eight criteria: capacity, condition, funding, future need, operation and maintenance, public safety, resilience and innovation. ASCE defines these grades as follows:**

A	B	C	D	F
Exceptional, Fit for the Future	Good, Adequate for Now	Mediocre, Requires Attention	Poor, At Risk	Failing/ Critical, Unfit for Purpose

About The Report Card for America's Infrastructure

Every four years, America's civil engineers provide a comprehensive assessment of the nation's 18 major infrastructure categories in ASCE's *Report Card for America's Infrastructure*. Using a simple A to F school report card format, the Report Card examines current infrastructure conditions and needs, assigning grades and making recommendations to raise them.

The ASCE Committee on America's Infrastructure is made up of 52 dedicated civil engineers and infrastructure professionals from across the country, with decades of expertise in all categories, who volunteer their time to work with ASCE Infrastructure Initiatives staff to prepare the Report Card. The Committee assesses all relevant data and reports, consults with technical and industry experts, and assigns grades using the following criteria:

Methodology

CAPACITY
Does the infrastructure's capacity meet current and future demands?

CONDITION
What is the infrastructure's existing and near-future physical condition?

FUNDING
What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED
What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE
What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY
To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?

RESILIENCE
What is the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences to public safety and health, the economy, and national security?

INNOVATION
What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

In addition to this national Report Card, ASCE's sections and branches prepare state reports on a rolling basis. Visit **InfrastructureReportCard.org** to learn about your state's infrastructure.

The 2026 Report Card on North Carolina's Infrastructure

Aviation
C-

Bridges
C-

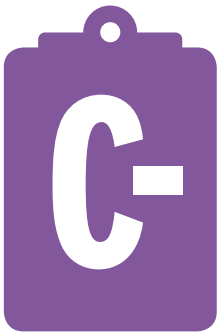
Dams
D+

Drinking Water
C+

Roads
C-

Stormwater
C-

Wastewater
D+



OVERALL GPA

Aviation

C-

GRADE COMPARISON

NC: C-

Nat'l: D+

Photo: Charlotte Airport; digidreamgrafix

AVIATION

EXECUTIVE SUMMARY

North Carolina's 72 public airports anchor a system that connects the state's citizens to 188 destinations, generating about $88 billion in economic impact, or 14.4% of the state GDP. After a pandemic-era dip, passenger volumes have rebounded—and are up roughly 20% from 2021 to 2023—intensifying capacity pressures, especially at the Raleigh-Durham airport. Recent extreme weather and safety events, including Tropical Storm Helene's impacts and broader disruptions, highlight the need for infrastructure resilience, with targeted investments needed to increase capacity, fund maintenance and air traffic control for airline safety, and modernize critical infrastructure. Sustaining safe, efficient operations will require continued federal, state, and local investment.

BACKGROUND

North Carolina is a rapidly growing state that faces the challenges of supply and demand. As the population of North Carolina grows, specifically in the bigger cities such as Raleigh, Durham, and Charlotte, their respective airports must work to provide sustainable solutions to meet the travel demands that have been placed on those airports. Other regional airports such as Asheville Regional Airport and Wilmington International, help provide links to the coast and mountains of North Carolina. These airports much achieve a high level of safety that is standard for aviation.

CAPACITY AND CONDITION

There are 72 public airports in North Carolina, and 96% of the state's population lives within a 30-minute drive of one. The state's four international airports—Charlotte, Greensboro, Raleigh, and Wilmington—recorded approximately 34.6 million enplanements in 2023.

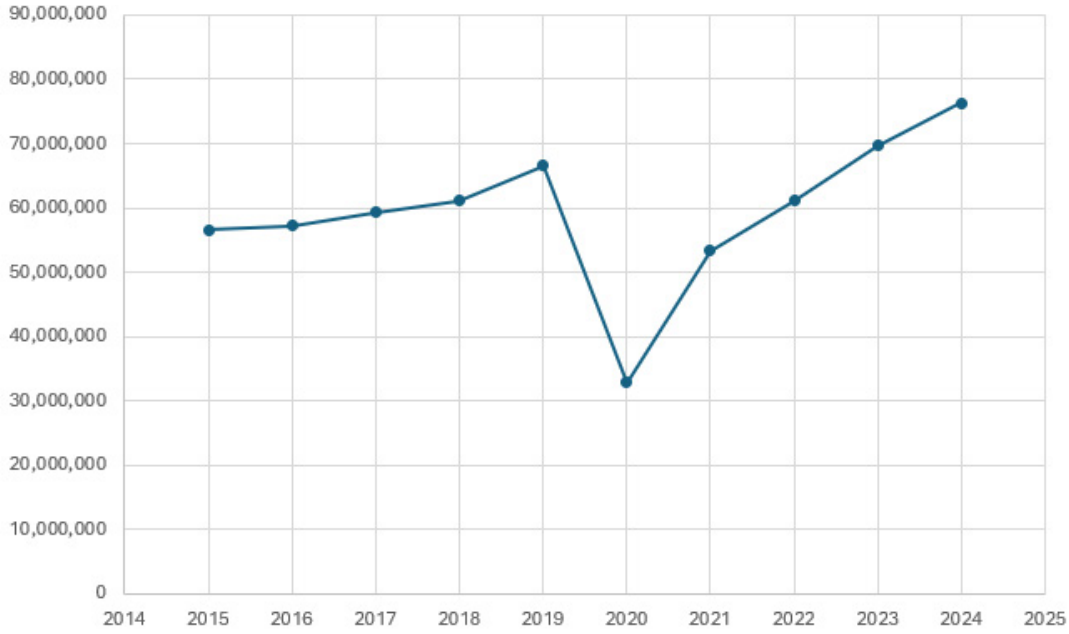
There are 10 airports in North Carolina that serve commercial passengers, and at these airports, there are 21 commercial airlines offering service to North Carolinians. These airlines connect to 188 different destinations. North Carolina accounted for roughly 4.4% of U.S. commercial enplanements in 2023—36.3 million out of 819 million nationwide.

Like many other states with travel and tourism industries, air travel in North Carolina saw a significant decline due to the COVID-19 pandemic. Post-pandemic, passenger service has fully recovered and even grown by 20% between 2021 and 2023—for a total of 74.3 million enplanements.

In 2023, aviation in North Carolina accounted for a total economic impact of $88 billion. This accounts for 14.4% of North Carolina's Gross Domestic Product (GDP). There are about 427,000 aviation jobs in North Carolina, accounting for $34 billion in personal income. These numbers are higher than the national average and illustrate the reliance that North Carolina places on aviation.

Raleigh-Durham (RDU), the second biggest airport in the state, is growing at a fast pace. In 2023, it was the fastest growing top-50 airport in the nation. While enplanements have grown at all of the state's major airports, over the last 15 years, enplanements at RDU have nearly doubled. In addition, RDU added four new airlines, 25 new destinations, and 49 new routes.

Figure 1: Enplanements per year for Charlotte (CLT), Raleigh-Durham (RDU) and Greensboro (GSO).



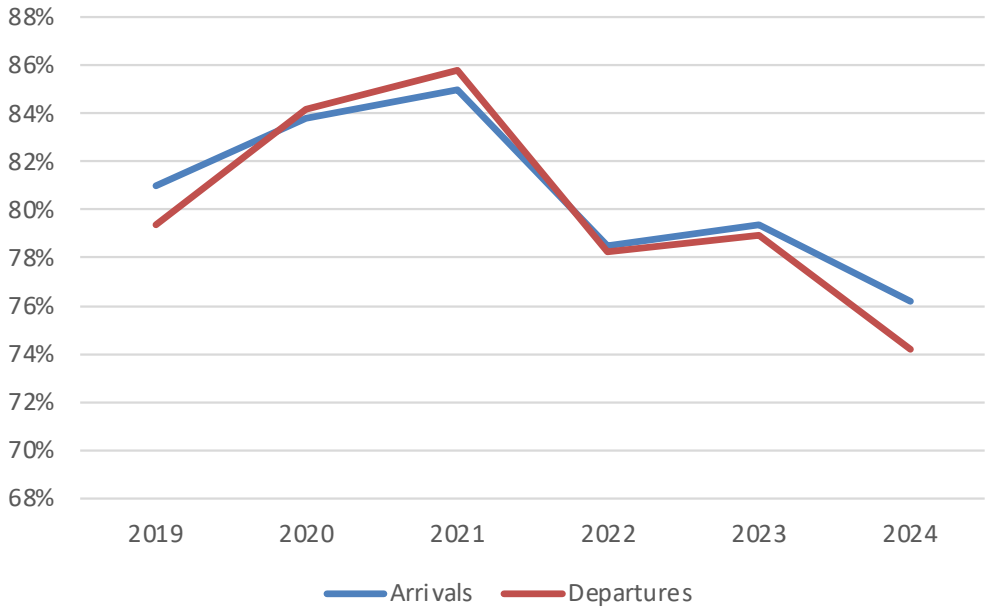
Source: National Bureau of Statistics

With North Carolina being one of the fastest growing states in the southeastern United States, the major airports are planning for growth. For example, RDU has a planned runway expansion for its main runway. Charlotte International is adding a fourth parallel runway to add capacity, and Wilmington International is expanding its terminal making Wilmington International the fastest growing airports in North Carolina.

Other airports such as Asheville Regional Airport are making improvements. In June of 2025, Asheville Regional Airport announced the 'AVL Forward project' which is the opening of a new concourse and TSA security checkpoint. In addition, Forsyth County Smith Reynolds Airport which serves Winston Salem is in the middle of 20-year master plan for its airport expansion.

Another measure of capacity is flight delays. This leads not only to frustration of passengers, but also economic impacts. Planes can be delayed for a number of reasons, including weather, staff shortages, or technology issues. In 2019, 19% of commercial flights in North Carolina were delayed at the six major airports (Charlotte, Raleigh, Greensboro, Wilmington, Asheville, and Fayetteville). This increased to 24% in 2024.

Figure 2: Arrival and Departure On Time Rates for Charlotte, Raleigh, Asheville, Wilmington, Greensboro, and Fayetteville



Source: National Bureau of Statistics

Part of Raleigh-Durham's 2040 vision plan includes landside expansion for Terminal 2. Terminal 2 is the major terminal at Raleigh-Durham's airport including all international flights. The landside expansion is about 9% complete and will modify or expand the ticketing hall, customs and border protections areas and other improvements such as pre-security concessions.

FUNDING AND FUTURE NEED

There are several sources of funding for commercial airports, including airport-generated revenue, municipal bonds, passenger facility charges, and federal, state, and local grants.

In 2024, $72.7 million in Airport Improvement Program grants were awarded to 14 major airports in North Carolina. The Infrastructure Investment and Jobs Act (IIJA) increased federal funding for airports. As of January 2025, almost $520 million in IIJA funding had been announced for airports in North Carolina. This includes funding for airside and landside needs, such as taxiways and runway improvements and terminal expansions and modernization. For example, $74 million in funding has been announced at Charlotte Douglas International Airport for terminal upgrades, including the replacement of 16 passenger bridges and rehabilitation of Concourse E.

Raleigh-Durham International Airport received about $39 million in grants in fiscal year 2024. Roughly $26 million were from the federal government, and $13 million were from state grants. This accounted for a little over 16% of the revenue for the airport and 22% of operating expenses. In 2023, Charlotte received about $83 million in grants. This accounted for roughly 26% of the airport's revenue. In 2024, Wilmington International Airport received $20 million in federal grants. This grant was crucial to carrying out its five-year development plan.

The state of North Carolina provides its own grants through the Airport Economic Development Grants program that began in 2017 and has funded 17 projects totaling $224 million.

Charlotte Douglas International Airport has three major runway and airfield projects planned over the next five years. These projects are expected to cost an estimated

$560 million and will be funded by Future General Airport Revenue Bonds (GARBS), Passenger Facility Charge (PFC) revenue, and federal Airport Improvement Program (AIP) grants. A new air traffic control facility at CLT is also planned to improve aviation safety.

Currently, RDU is in the process of upgrading its longest runway, which is labeled as 5L/23R. It's used for long-haul flights, including transatlantic flights and flights to the west coast of the United States. The project will add about 600 feet to the runway, making it 10,639 feet long. This will allow larger planes to serve Raleigh-Durham, which will also allow for more destinations. For comparison, the longest runway at Boston's Logan International Airport is 10,000 feet. This runway expansion is critical for needed increased capacity, but it does come at a cost. RDU has spent $30 million to keep the current runway operational, but the total cost of the runway expansion is projected to be around $1 billion, a part of the airport's projected $2.5 billion improvements over the coming decade.

In addition, funding has been provided for General Aviation airports. In September of 2024, nearly $2.75 million was awarded to three General Aviation airports for improvements. These airports were Hickory Regional Airport, Davidson County Executive Airport and Wayne Executive Jetport. This came from the FAA's Airport Improvement Supplemental Discretionary Grant.

OPERATION AND MAINTENANCE

Proper maintenance of airport facilities is critical to airport efficiency, security, and safety. Airports are required to have minimum operational standards as mandated by the federal government and the North Carolina Legislature through the North Carolina Department of Transportation. This includes things such as runway maintenance, aeronautical charts, and safety measures such as "No Trespassing" signs. The North Carolina Department of Transportation also has regulations regarding proper maintenance and operation to help ensure efficiency and safety of airline travel.

Airports in the state are facing some staffing shortages. A February 2025 article found that federally staffed air traffic towers in North Carolina are operating at about 72% of staffing levels. The data also found that of the six biggest airports in North Carolina, Charlotte had the lowest vacancy rate with 15% and Fayetteville had the highest 43%.

Of the 516 airports in the National Plan of Integrated Airport Systems (NPIAS) database, 72 are in North Carolina. None are rated as "failed," 7 are rated as "poor," 53 are rated as "fair," 151 are rated as "good," and 49 are rated as excellent for airport pavement.

The State Division of Aviation also offers a Safety, Preservation, and Maintenance (SPAM) Program for publicly owned and operated airports. The program provides 100% state funding to support safety and maintenance improvements, such as crack sealing, pavement markings, beacon rehabilitation, and erosion control.

In addition to the 72 publicly owned airports, there are more than 300 privately owned airports in North Carolina. These airports are termed non-NPIAS and do not receive federal and/or state funding. The regulations on these airports are therefore not as strict as state-regulated airports. For these privately owned, private-use airports, the owner is typically responsible for all maintenance and operations.

With major airports such as Charlotte Douglas International Airport, Raleigh-Durham International Airport and Wilmington International Airport making major improvements to terminals, data also reflects the need to improve conditions as demand for North Carolina airports continues to increase.

PUBLIC SAFETY AND RESILIENCE

Aviation today represents one of the safest forms of travel, and maintaining passenger safety is critical for the public's continued trust in aviation.

In 2024, the United States Congress passed the FAA Reauthorization Act of 2024, which was a step in the right direction for aviation safety.

However, near misses in North Carolina represent the need to continue to improve aviation safety. In October of 2024, there was nearly a mid-air collision at Asheville Regional Airport between a passenger jet and small airplane.

Since the beginning of 2015, North Carolina has logged 329 National Transportation Safety Board (NTSB) investigations. For that same date range, the United States recorded 16,550 reports. Thus North Carolina accounted for approximately 2% of the NTSB investigations. For that date range, North Carolina experienced 165 fatalities or serious injuries related to aviation accidents. For reference, the United States had 11,436 fatalities or serious injuries. Thus, North Carolina represents 1.4% of this data set, however North Carolina represented 0.7% of total enplanements for 2023.

In September of 2024, Tropical Storm Helene hit the western portion of North Carolina. The results were catastrophic, with widespread damage around the City of Asheville. There have been 108 verified deaths because of the storm. Damaging winds and over 17 inches of rain fell in the area over a period of two days.

The Asheville Regional Airport (AVL) played a key role in the region's recovery from Helene. The airport aided with aerial delivery through the North Carolina Air National Guard and FEMA. Coordination with FEMA and the Air National Guard was critical for the response to Helene. The airport handled the unloading and distribution of critical supplies, such as food and water with over 27 million pounds of supplies delivered through the airport.

Asheville Regional Airport had begun preparing for the storm several days in advance, and it completed its pre-storm checklist three days before the storm hit western North Carolina.

The airport worked with its carriers and other airports to make sure the response was unified and coordinated. Coordination was also required with the FAA's Atlanta Center. Helene caused disruptions to aircraft flying under instrument flights rules. When the aircraft went below 200 feet above ground level, the aircraft was required to make a switch to visual flight rules. This was not an issue for the pilots as Asheville's airport is not manned by an air traffic controller 24 hours a day, so this practice was familiar.

Following Helene, NCDOT implemented a Helene After Action Report (AAR) for General Aviation Airports in North Carolina in June of 2025. Several workshops were held with various aviation stakeholders to ensure greater safety in future events. General aviation airports contributed the Helene recovery effort as well.

North Carolina airports also coordinate with agencies such as local law enforcement and the North Carolina Department of Public Safety to ensure threats to their respective airports do not occur. Possible include terrorism and vandalism, which pose a public safety threat. In addition, all airports in North Carolina are required to follow the Division of Aviation's standards for perimeter security. This includes protective fencing and "No Trespassing" signs placed on the fence, no greater than 500' between signs.

INNOVATION

The two major airports in North Carolina (Raleigh-Durham and Charlotte Douglas) both have sustainability plans. As both regions are some of the fastest growing in the Southeast, it's crucial these airports invest in sustainability. Raleigh-Durham's sustainability plan focuses on things such as sustainable building infrastructure and the reduction of greenhouse gas emissions. Raleigh-Durham's plan is to have net-zero greenhouse gas emission by 2050.

RDU also focuses on materials and waste by increasing recycling practices. The airport also has a stormwater management plan to reduce stormwater pollution to nearby Crabtree Creek.

Charlotte Douglas International Airport has a similar plan, as in June of 2018 the Charlotte City Council passed a resolution to have the airport be fueled by 100% zero-carbon sources by 2030. This plan, like Raleigh-Durham's, focuses on recycling and stormwater management practices.

Additionally, Wilmington International Airport's five-year plan includes innovations for sustainability. There's a plan to focus on improved energy efficiency, which focuses on high-efficiency LED systems and other sustainable practices, such as solar energy and electric vehicles.

Charlotte Douglas International Airport also announced a partnership with the University of North Carolina – Charlotte's Engineering Program to develop an aviation innovation plan for the Charlotte Douglas Airport through innovation and workforce development.

Figure 3: Ocracoke Island Airport

RECOMMENDATIONS TO RAISE THE GRADE

- Implement a higher level of green infrastructure at higher-volume regional airports.
- Increase funding for maintenance and air traffic control to continue airline safety.
- Implement more robust life cycle and asset management plans for aging infrastructure and have funds allocated for shovel-ready projects to offset the rising costs of materials.
- Urge lawmakers to continue to support the continuous reauthorization of FAA Reauthorization.
- Implement and test emergency action plans, especially for coastal communities and those that are more prone to hurricanes.

SOURCES

American Society of Civil Engineers, "North Carolina Infrastructure Overview, State Fact Sheet," 2025.

Airport Improvement, "Asheville Regional Reflects About Surviving Hurricane Helene," 2025.

Asheville Regional Airport, "Asheville Regional Airport to Open New New North Concourse and New TSA Security Check Point June 25," 2025.

Asheville Watchdog, "Passenger jet, small plane near collided mid-air at Asheville Airport last fall, federal report says," 2025.

Barreau of Statistics, "Detailed Statistics Arrivals," 2024.

Charlotte Douglas International Airport, "Construction Projects," 2025.

Charlotte Douglas International Airport, "Sustainability," 2025.

Federal Aviation Administration, "Airport Data and Information Portal (ADIP)," 2025.

North Carolina Department of Health and Human Services, "Hurricane Helene Storm Related Fatalities," 2024.

North Carolina Department of Transportation, "Airport Economic Development Grants," 2024.

North Carolina Department of Transportation, "North Carolina Airports," 2022.

North Carolina Department of Transportation, "North Carolina Airports Program Guidance Handbook," 2024.

North Carolina Department of Transportation, "State of Aviation," 2025.

North Carolina Office of the Governor, "Response and Recovery Efforts in Western North Carolina," 2024.

Raleigh-Durham Airport Authority, "Sustainability Management Plan," 2023.

Raleigh-Durham International Airport, "Annual Comprehensive Financial Report," 2024.

Raleigh-Durham International Airport, "RDU #1 in Passenger Growth in 2023," 2024.

SOURCES (CONT.)

Senator Thom Tillis, "Tillis Announces $27 Million for Improvements to CLT and RDU Airports," 2024.

The Assembly, "Like the nation, North Carolina's Airport Towers are Understaffed," 2025.

The Business Download, "Taking Flight: North Carolina's Aviation Economic Growth," 2025.

UNC-Charlotte, "Paving Runway Innovations," 2024.

US Department of Transportation, "The Bipartisan Infrastructure Law Will Deliver for North Carolina," 2021.

WCCB Charlotte, "Federal Grants Awarded to NC Airports for Sustainability and Resilience Upgrades," 2024.

Wilmington International Airport, "Future Improvements," 2025.

Wilmington International Airport, "ILM Receives $20 Million in Federal Grants," 2024.

Wilmington International Airport, "Terminal Expansion," 2025.

Bridges

C-

GRADE COMPARISON

NC: C-

Nat'l: C

Photo: Bridge to Sunset Beach, NC; Darwin Brandis

BRIDGES

EXECUTIVE SUMMARY

As of 2024, the North Carolina Department of Transportation (NCDOT) managed 13,848 bridges across the state, with 46% rated in good condition, 46% fair, and 8% poor. While still higher than the national average, the number of bridges with "poor" ratings is down significantly from 22.8% in 2014, which is attributed to increased investment in bridge replacement, preservation, and maintenance. In total, funding has increased from $150 million in FY2015 to $482 million in FY2025. However, aging infrastructure remains a concern, with over 4,800 bridges currently over 50 years old, and expected to exceed 6,300 by 2035. To assess bridge conditions, prioritize repairs, and optimize constrained funding, NCDOT uses advanced, AI-powered tools like ArTEMIS. Despite the use of these new technologies and improved operational strengths, future bridge funding needs across North Carolina are projected to rise sharply, reaching $961 million by FY2027 with a $479 million shortfall, with budget shortfalls continuing to increase in the following years.

CAPACITY AND CONDITION

North Carolina is home to 13,848 bridges, which play a critical role in supporting the state's economy, mobility, and public safety. However, these bridges are quietly aging in place. As of 2024, 46% (6,377) of bridges were rated in good condition, 46% (6,367) in fair condition, and 8% (1,104) in poor condition. Of those bridges assessed to be in poor condition, 2.7% are interstate highways, 6% are primary roads, and 10% are secondary roads.

It is important to note that bridges in "poor" condition are still considered safe; but they have components that are deteriorating and require significant maintenance to remain in service. To fully address the issues on a "poor" condition bridge, extensive rehabilitation or replacement is required, which is more costly than maintaining or repairing a bridge before it is considered in poor condition.

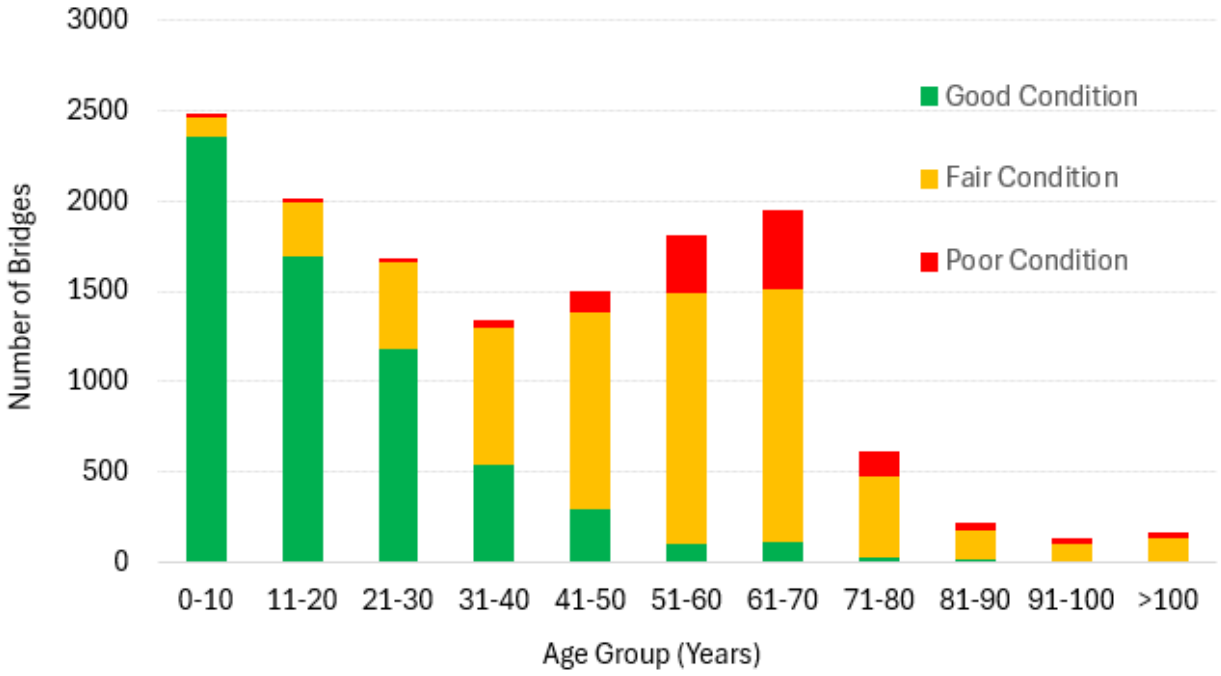
The good news is that with increased funding for bridge preservation and replacement over the past decade, North Carolina has made significant progress in improving bridge conditions. In fact, over the last 10 years, the percentage of bridges in poor condition has decreased from 22.8% to 8%, and the percentage of bridges in good condition has increased from 38.7% to 46%.

A detailed breakdown of condition is provided in the following figures. It is worth noting that as of 2024, 4,865 bridges (35.1%) are over 50 years old. By 2035, this number is projected to increase to over 6,360 bridges (45.9%), highlighting a growing population of aging bridges that will require increased maintenance and investment for continued operation.

The condition of a bridge includes assessment of all elements, including railings, decks, superstructure (the upper portion where one drives or walks), and substructure (the lower portion that supports the superstructure and transfers loads to the foundation and soils below).

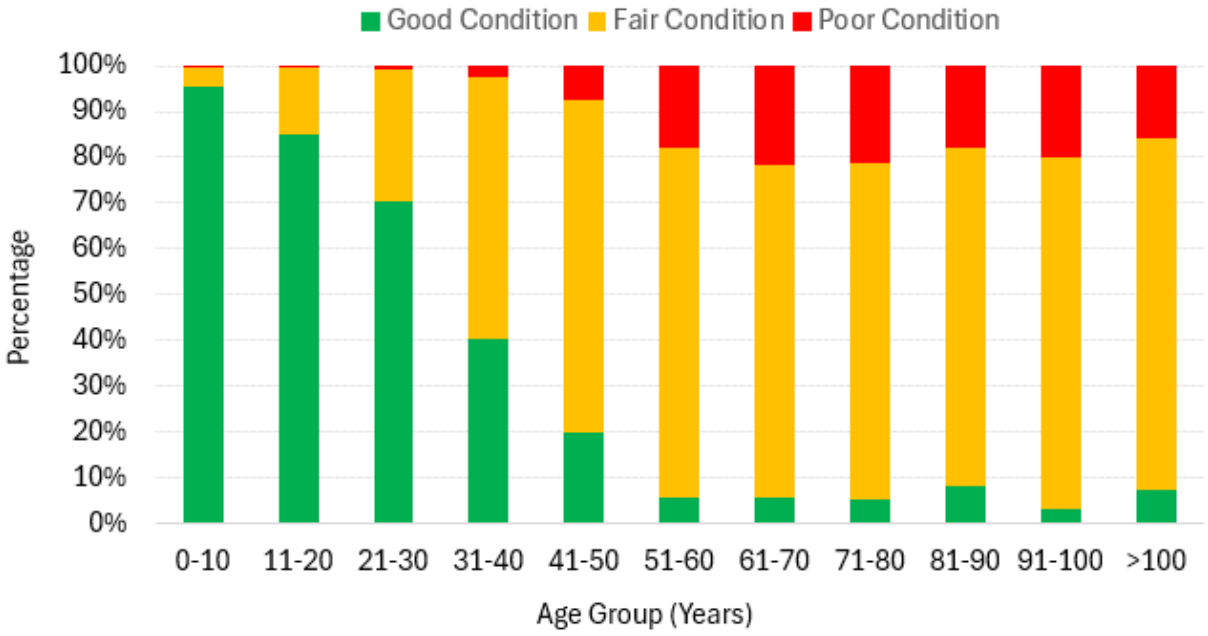
Among major structures, the Cape Fear Memorial Bridge in Wilmington stands out. At 56 years old and spanning just over a half a mile, it is functionally obsolete due to it no longer being able to effectively service traffic demands. Frequent maintenance and lift operations contribute to traffic delays and unreliable travel times. Planning and development for the replacement of this bridge is currently underway, with an estimated cost of $1.1 billion.

Figure 1. NC Bridge Condition Count by Age Group



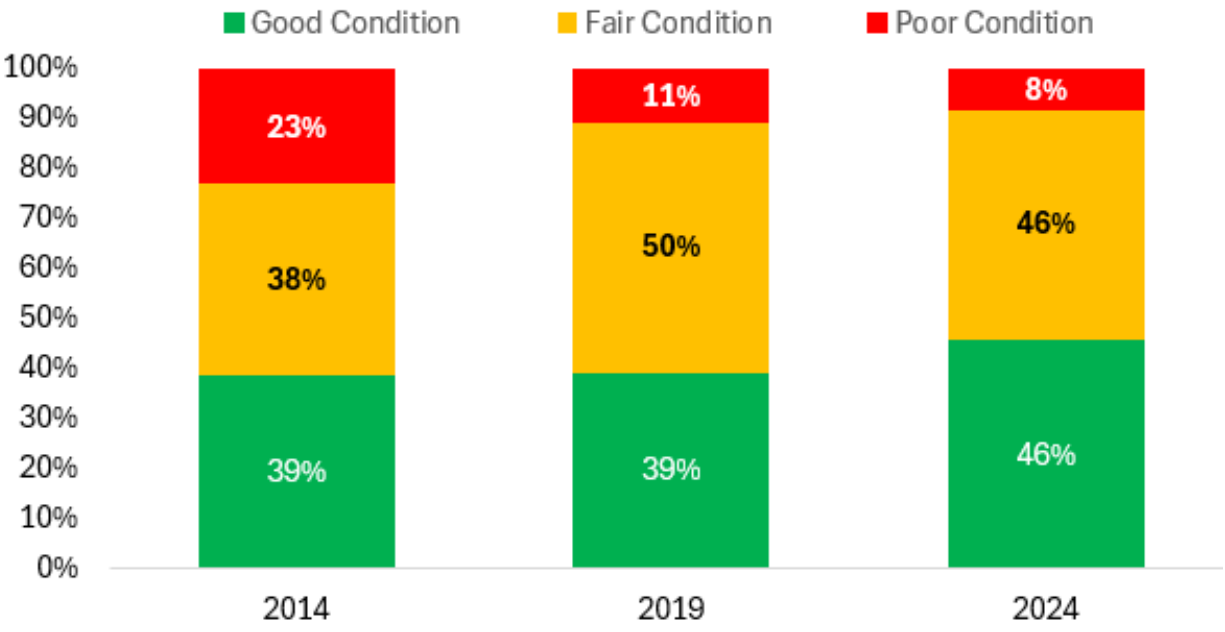
Source: NCDOT

Figure 2. NC Bridge Condition Percentage by Age Group



Source: NCDOT

Figure 3. NC Bridge Condition Percentage by Year

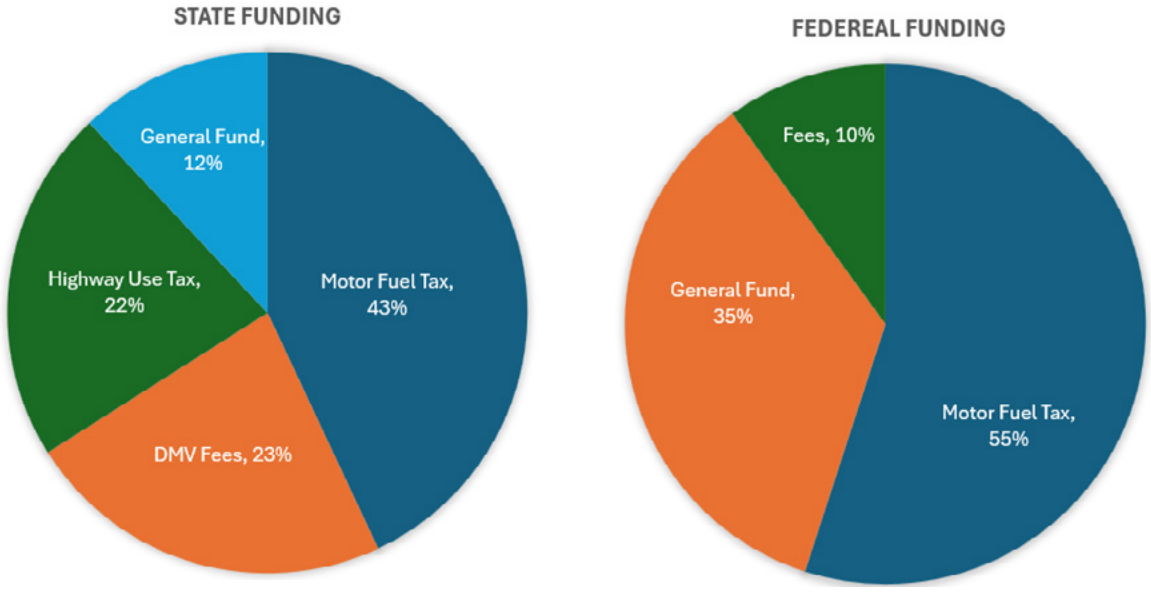


Source: NCDOT

FUNDING AND FUTURE NEED

Traditionally, NCDOT receives its funding for the state's bridges from a combination of state funding (which makes up approximately 77% of available funds) and federal funding (which makes up the remaining 23%). In 2024, state and federal funding sources are as shown in the following figure. It should be noted that while local municipalities occasionally fund and oversee small improvement projects, NCDOT is responsible for the vast majority of bridge projects, therefore local municipality funding does not significantly impact statewide funding metrics.

Figure 4. 2024 NCDOT Funding Breakdown



Sources: NCDOT, USDOT

NCDOT allocates bridge funding across three primary categories:

- Bridge Replacement: Addresses bridges that are in poor condition, and/or functionally obsolete, and no longer viable for repair. Bridge Preservation: Focuses on extending the service life of bridges in fair or good condition. Priority is given to high-value bridges (where the replacement cost would be greater than $20 million), as well as interstate and primary system bridges, which collectively carry approximately 80% of the state's daily traffic.
- Bridge Maintenance: Funded through the General Maintenance Reserve (GMR), this category supports timely repairs and routine upkeep by state bridge maintenance crews.

Between FY2015 and FY2025, NCDOT's bridge funding steadily increased from $150 million to $482 million annually. The Infrastructure Investment and Jobs Act (IIJA) increased the amount of federal funding available to the state by approximately 29%. These investments have led to measurable improvements in bridge conditions, reducing the percentage of bridges in poor condition, while increasing those rated in good condition.

However, rising inflation in construction materials, labor, and equipment—combined with rapid population growth and an aging bridge inventory—is rapidly increasing future funding needs. According to the 2024 Maintenance Operations and Performance Analysis Report (MOPAR), total bridge funding requirements are projected to reach $835 million in FY2026 and $961 million in FY2027. These figures represent a 73% and 100% increase over FY2025 levels, respectively. It should be noted that repairs for damages caused by Tropical Storm Helene in 2024 are not included in these figures, as repair determinations are

still underway. These repair needs will further strain the estimated funding shortfalls.

If funding remains at FY2025 levels, this surge in need results in projected budget shortfalls of $353 million for FY2026 and $479 million for FY2027, posing significant risks to sustaining progress and meeting the state's growing bridge demands.

According to the 2024 MOPAR report, high-value bridges—defined as those costing more than $20 million to replace—constitute only 2.5% of the total bridge inventory. However, they represent 40% of the total value of North Carolina's bridge system. A prominent example illustrating the scale of future investment needs is the planned replacement of the previously mentioned Cape Fear Memorial Bridge, with an estimated cost of $1.1 billion. In 2024, this major project received a $242 million grant through the Federal Highway Administration's competitive Bridge Investment Program, created by the IIJA. However, the federal funding was subsequently paused, highlighting the ongoing uncertainty and urgency surrounding long-term bridge investment planning and the need for stable, sustained funding sources.

Table 1: NCDOT Bridge Funding Allocations and Future Need (FY2026 & FY2027)

Source: NCDOT

Year	Bridge Replacement	Bridge Preservation	Bridge Maintenance	Total
FY 2015	$150M	-	(N/A)	$150M
FY 2016	$242M	-	(N/A)	$242M
FY 2017	$242M	-	(N/A)	$242M
FY 2018	$280M	$80M	(N/A)	$360M
FY 2019	$272M	$82M	(N/A)	$354M
FY 2020	$201M	$76M	$46M	$323M
FY 2021	$273M	$60M	$46M	$379M
FY 2022	$274M	$70M	$67M	$411M
FY 2023	$275M	$70M	$67M	$412M
FY 2024	$330M	$85M	$67M	$482M
FY 2025	$330M	$85M	$67M	$482M
FY 2026	$585M	$85M	$165M	$835M
FY 2027	$673M	$98M	$190M	$961M

OPERATION AND MAINTENANCE

NCDOT demonstrates strong operational capability through advanced asset management and data-driven decision making. In 2020, the department launched ArTEMIS (Advancing our Transportation Ecosystem through Maintenance Intelligence Solutions), an AI-powered platform designed to enhance infrastructure maintenance. ArTEMIS integrates bridge inspection data into a Bridge Index—part of the Route Score

system—to assess conditions and prioritize maintenance or replacement. It also supports the Total Cost of Ownership (TCO) model, enabling NCDOT to forecast deterioration, estimate future costs, and optimize funding across the state.

Routine inspections and maintenance cycles are a cornerstone of NCDOT's approach. Recognizing that all bridges age differently, inspections are conducted in accordance with National Bridge Inspection Standards (NBIS), typically every 24 months, with more frequent checks for structures in poor condition. Underwater components are inspected every 48 months when not visible from above. All inspection data is stored in the Bridge Management System (BMS), which covers both state and locally owned bridges. Long-term planning is guided by the Highway Maintenance Improvement Program (HMIP) and five-year investment plans, ensuring strategic alignment with statewide priorities.

Despite these strengths, NCDOT faces growing challenges. Aging infrastructure remains a pressing concern, with over 1,100 bridges currently classified in poor condition and many interstate structures exceeding 50 to 60 years in age. Inflation has driven up costs for labor, materials, and equipment, further straining budgets. Population growth continues to increase demand on the transportation network, accelerating wear and capacity needs. Additionally, weather-related disruptions—such as Tropical Storm Helene and localized flash flooding—have diverted resources from routine maintenance to emergency response.

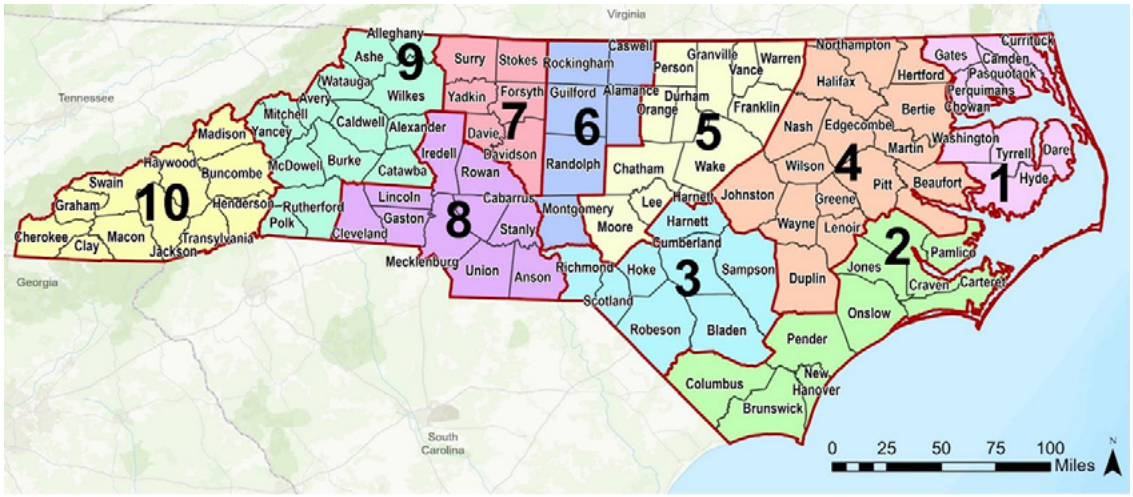
To address these challenges, NCDOT is implementing targeted strategies. The Bridge Preservation Program, funded at $85 million for FY2025, focuses on high-value, high-traffic bridges to extend service life and delay costly replacements. Routine and reactive maintenance, supported by the General Maintenance Reserve (GMR), ensures both planned and emergency repairs are addressed promptly. Condition-based prioritization, enabled by tools like the BMS and ArTEMIS, helps identify and prioritize bridges for maintenance or replacement based on real-time data and logistics. Updated performance goals outlined in the 2024 MOPAR report set ambitious targets to reduce the percentage of bridges in Poor condition by 2030: interstate bridges from 2.7% to 1%, primary route bridges from 6.0% to 4%, secondary route bridges from 10.0% to 9%, and the statewide average from 8.0% to 7%.

PUBLIC SAFETY

Bridges have weight limits to ensure public safety and protect the structure. When posted, these signs show the maximum weight a bridge can safely hold. Weight restrictions are usually posted when a bridge gets older, starts to wear down, or faces heavier traffic than it was originally built for.

A substantial number of NCDOT bridges are located in the mountainous regions of western North Carolina, where they span rugged terrain and cross mountain waterways. As of June 2025, 42 bridges across the state—representing approximately 0.30% of the total NC bridge inventory—were posted with weight limits. The highest concentrations of these posted bridges (60%) are found in the mountainous regions of the state, Divisions 11-14, as shown in the table below.

Figure 5. NCDOT Division Map



Source: NCDOT

Table 2: Number of Posted Bridges in North Carolina as of June 2025

Division	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Posted Bridges	1	4	1	4	3	1	0	0	0	3	3	5	8	9

Source: NCDOT

In September 2024, Tropical Storm Helene—a historic and powerful storm—struck western North Carolina, inflicting widespread damage across the region's infrastructure. According to estimates from NCDOT, over 800 bridges were damaged, with at least 150 requiring replacements. This has placed additional strain on the affected areas and will require years of repairs. NCDOT is working closely with consultants to finalize the needed repairs (and their costs) while combating the delays caused by FHWA staffing shortages, federal government shutdowns, and federal funding cuts.

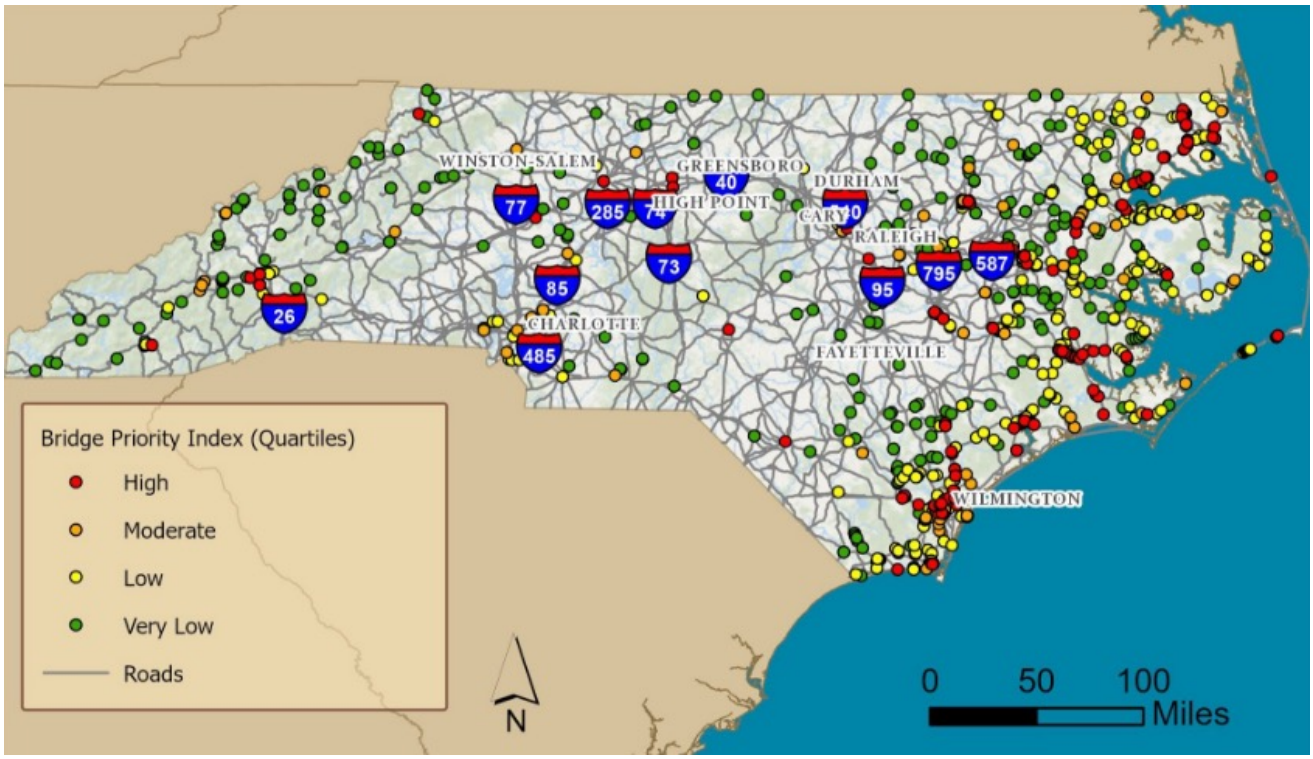
RESILIENCE

In September 2021, NCDOT adopted an official resilience policy and developed a comprehensive framework for resilience assessment and management. The policy details collaboration and communication with various stakeholders, scoping of hazards and assets, resilience assessment, resilience management, and monitoring and review.

The NCDOT Resilience Improvement Plan, published in April 2024, outlines the following key tools focused on mitigating natural disaster impacts on bridges:

- Flood Inundation Mapping Alert Network for Transportation (FIMAN-T): Provides near real-time awareness of flood impacts to roads and bridges.
- BridgeWatch: Offers real-time monitoring for structures over water and issues alerts when water elevation thresholds are exceeded.
- Bridge Sensitivity Assessment: Evaluates bridge vulnerability to flooding, geotechnical failures, sea-level rise, and other natural hazards
- Resilience Prioritization Process: Ranks vulnerable areas and projects using criteria such as criticality, exposure, and sensitivity.

Figure 6. NC Bridge Priority Index Map



Source: NCDOT

According to NCDOT's 2024 Annual Performance Report, the state achieved its goal of 90% predictive surge coverage for coastal bridges using T-SAPP, a tool that helps forecast storm surge impacts. However, as sea levels continue to rise, this coverage is expected to decline over time.

Recent federal and state policies—such as the IIJA (including the PROTECT program, focused on resilience) and North Carolina's Executive Orders 80 and 266—have enhanced support for resilience initiatives and encouraged their integration into NCDOT operations.

INNOVATION

North Carolina is advancing bridge innovation, combining rapid disaster response with cutting-edge technology, materials, and engineering. From creative temporary structures that restore access within hours to state-of-the-art inspection tools and resilient design methods, NCDOT is strengthening the safety, durability, and reliability of the state's bridge network. The examples below highlight some of the most significant innovations shaping North Carolina's bridge program in recent years. Specific examples are highlighted below.

Innovative Temporary Bridge Method: After Tropical Storm Helene caused widespread damage in September 2024, NCDOT found a creative way to quickly restore access to affected communities. The team repurposed decommissioned rail cars as bridge decks, building 40 temporary bridges in record time. Some were installed in as little as 24 hours, keeping communities connected while permanent replacements were planned. The figure below shows one of these steel flat car decks in action.

Figure 7. Temporary Bridge Repair Following Tropical Storm Helene

Source: NCDOT

Smarter Bridge Management with AI: In 2020, NCDOT introduced ArTEMIS—an advanced system powered by artificial intelligence and machine learning. This tool uses inspection data to create a Bridge Index, helping engineers understand the condition of each bridge and decide which ones need maintenance or replacement first. It also predicts future wear and costs, making it easier to plan and budget wisely.

New Material Use: The Harkers Island Bridge, opened in December 2023, is the first in North Carolina to use carbon-fiber reinforcement in-lieu of traditional steel reinforcement. This material resists corrosion and reduces maintenance needs, making it ideal for harsh coastal environments.

Innovative Data Collecting System: Ahead of Hurricane Ian in 2022, NCDOT launched a $2 million pilot program to monitor flooding risks. The system includes more than 50 stream gauges across 2,900 miles, tracking conditions at 4,000 bridges and culverts statewide to improve emergency response.

Pioneering Inspection Technology: In October 2020, North Carolina became the first state approved by the FAA to use drones beyond visual line of sight for bridge inspections. This technology proved invaluable during Tropical Storm Helene recovery, allowing teams to assess damage quickly and safely.

Innovative Design and Construction Method: The Basnight Bridge, recognized by the Deep Foundations Institute in 2019, showcases cutting-edge engineering. Built to withstand 105 mph winds, strong currents, and even vessel impacts, it uses advanced techniques like jetting large piles through dense sand to ensure long-term resilience.

RECOMMENDATIONS TO RAISE THE GRADE

- Address Funding Needs: Significant investment is required to rehabilitate or replace aging bridges. Identifying and securing additional funding sources is critical to closing the growing gap.
- Prioritize Strategic Investments: Focus resources on interstate bridges, particularly those along major freight and commuter corridors. Emphasize structures that serve as critical links for regional connectivity and economic activity.
- Leverage Technology for Smarter Maintenance: Increase utilization of the ArTEMIS AI platform to assess bridge conditions and optimize maintenance planning. Integrate bridge strategies into the Highway Maintenance Improvement Program (HMIP) for coordinated, data-driven decision making.
- Improve Return on Investment: Direct further funding to proactive maintenance, reducing the risk of costly emergency repairs.

SOURCES

North Carolina Department of Transportation, "2014 Maintenance Operations and Performance Analysis Report (MOPAR)," 2014.

North Carolina Department of Transportation, "2016 Maintenance Operations and Performance Analysis Report (MOPAR)," 2016.

North Carolina Department of Transportation, "2018 Maintenance Operations and Performance Analysis Report (MOPAR)," 2018.

North Carolina Department of Transportation, "2020 Maintenance Operations and Performance Analysis Report (MOPAR)," 2020.

North Carolina Department of Transportation, "2022 Maintenance Operations and Performance Analysis Report (MOPAR)," 2022.

North Carolina Department of Transportation, "2024 Maintenance Operations and Performance Analysis Report (MOPAR)," 2024.

North Carolina Department of Transportation, "NCDOT Resilience Improvement Plan," 2024.

North Carolina Department of Transportation, "Posted Bridges Maps," 2025.

North Carolina Department of Transportation, "SFY 2021 Annual Report," 2021.

North Carolina Department of Transportation, "SFY 2023 Annual Performance Report," 2023.

North Carolina Department of Transportation, "SFY 2024 Annual Performance Report," 2024.

U.S. Department of Transportation, "The Bipartisan Infrastructure Law Will Deliver for North Carolina," 2021.

U.S. Department of Transportation Federal Highway Administration, "Bridges and Structures," 2013–2025.

Dams

Photo: Cheoah Dam; Darrell Young

GRADE COMPARISON

NC: D+

Nat'l: D+

DAMS

EXECUTIVE SUMMARY

There are 7,448 dams in North Carolina, of which 2,350 are state-regulated or jurisdictional. These structures provide immense benefits to the state by providing water supply, flood control, irrigation, and recreation. Over 83% of the state's 2,350 jurisdictional, high hazard dams have been inspected annually since 2023. Of the high hazard dams, 45% have up-to-date Emergency Action Plans (EAPs), which is lower than the national average of 82%. Funding for state dam safety inspections has increased over the past decade, and additional funds are anticipated to address damage to dams from recent named tropical storm events. While Tropical Storm Helene devastated western North Carolina in 2024, causing catastrophic infrastructure damage, no major dam breaches were reported, and the dam infrastructure was shown to be resilient. There is a funding gap of approximately $5.97 billion for dam maintenance and repair for dams that are not rated satisfactory, nearly half of which is needed to repair high hazard dams ($2.83 billion).

BACKGROUND

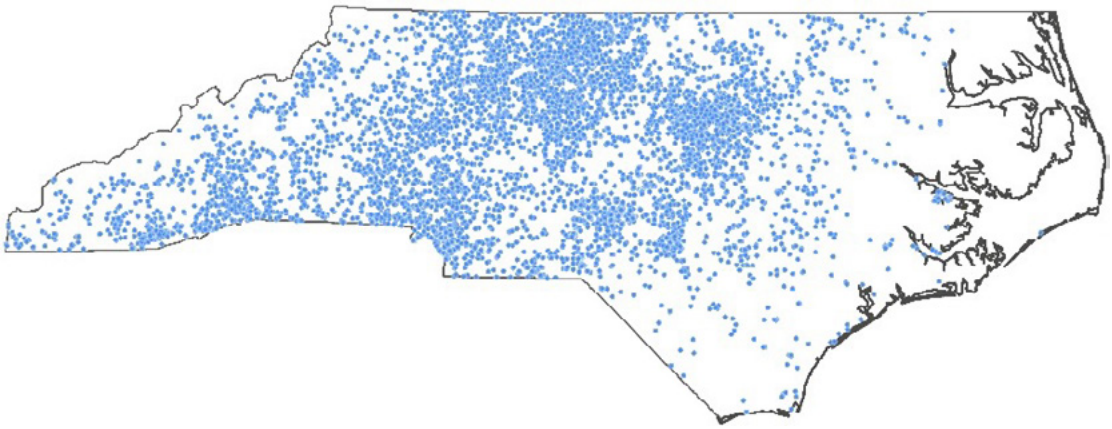
Dams provide a valuable resource to North Carolina supporting flood control, recreation, energy production, and drinking water, amongst other purposes. However, these structures can also be a hazard if not maintained and managed well. Most North Carolina dams are regulated under the authority of the North Carolina Dam Safety Program, which is part of the Land Quality Section (LQS) under the Division of Energy, Mineral, and Land Resources (DEMLR) of the North Carolina Department of Environmental Quality (NCDEQ). The Dam Safety Program's statutory authority is based on N.C. G.S. 143-215.23 titled "Dam Safety Law of 1967" as subsequently amended and associated regulations Title 15A, Subchapter 2K of the North Carolina Administrative Code titled "Dam Safety." Dams that are exempt from the Dam Safety Law of 1967 are:

- Dams constructed or operated by United States Army Corps of Engineers (USACE), Tennessee Valley Authority (TVA), or another United States government agency, when the agency designed or approved plans for the dam and supervised construction.
- Dams constructed with financial assistance by the Natural Resources Conservation Service (NRCS).
- Dams licensed by the Federal Energy Regulatory Commission (FERC) or regulated by the Nuclear Regulatory Commission (NRC).
- Dams that are under private ownership that provide protection only to land or property under that same ownership and do not pose a threat to human life below the dam.
- Dams that are less than 25 feet in height or that have an impoundment capacity of less than 50 acre-feet, unless it is determined that failure could result in the loss of human life.

CAPACITY AND CONDITION

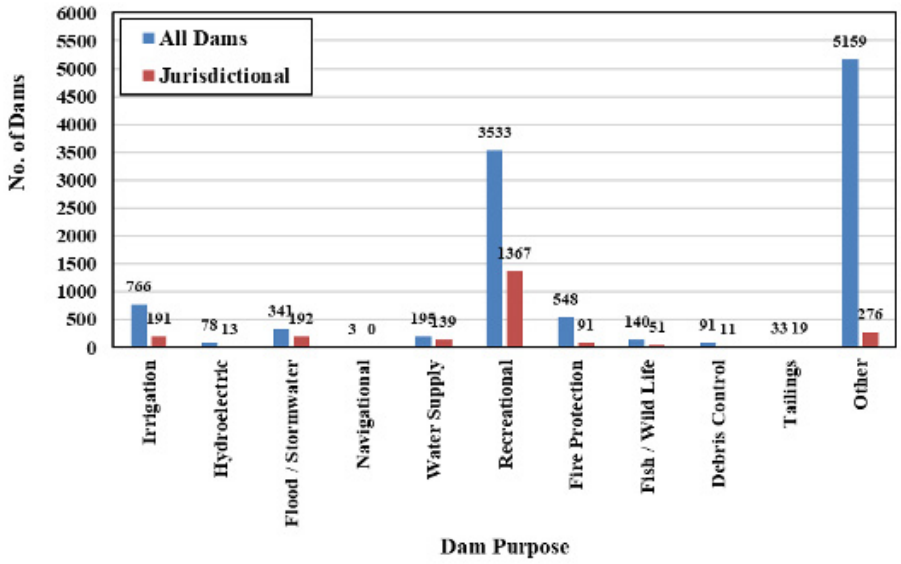
Dams are an integral part of the life of every North Carolinian, providing recreation, water supply, flood control, and energy. Per the North Carolina Dam Inventory, most recently published by the North Carolina Dam Safety Program in 2025, there are 7,448 dams in the state (Figure 1) predominantly in the central and western areas of the State. Nearly 3,500 of these dams are exempt from regulatory oversight due to their small size or being federally managed and maintained. In addition, many dams within the inventory have been removed, breached, or closed (for example, former waste impoundments). At present, there are 2,350 state regulated dams. Many dams serve several purposes, and Figure 2 illustrates the predominant use of all dams in the state compared with the actively regulated dams listed in the state inventory.

Figure 1. Dam Locations within North Carolina



Source: the NC Dam Inventory

Figure 2. Dam Use within North Carolina Dams



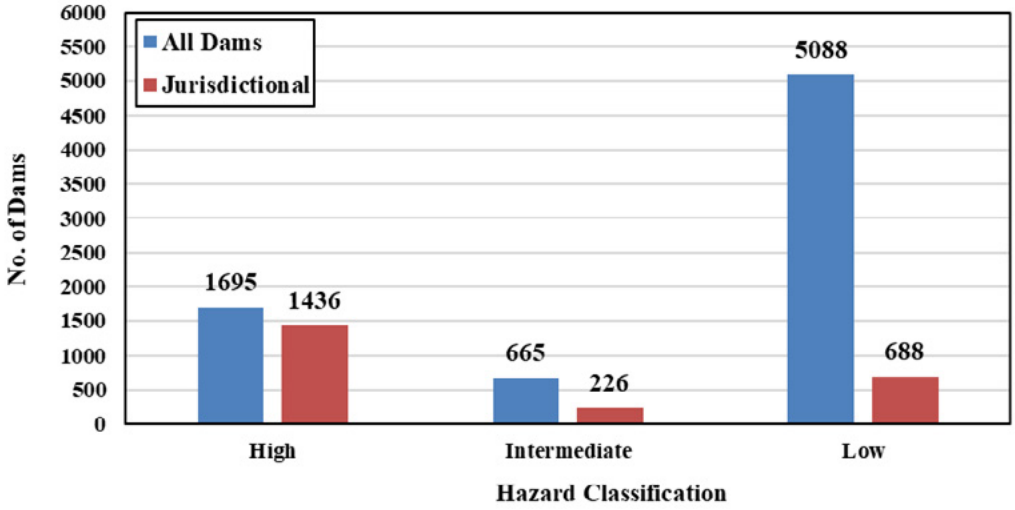
Source: the NC Dam Inventory

Figure 2 shows that nearly 58% of all jurisdictional dams are primarily used for recreational purposes. Another 12% are used for other purposes, such as waste lagoons or ponds for industrial or agricultural byproduct management.

The Dam Safety Law of 1967 classifies the type of dams into three categories:

- Class A [Low Hazard]: dams located where failure may damage uninhabited low value non-residential buildings, agricultural land, or low volume roads.
- Class B [Intermediate Hazard]: dams located where failure may damage highways or secondary railroads, cause interruption of public utilities, cause minor damage to isolated homes, or cause minor damage to commercial and industrial buildings.
- Class C [High Hazard]: 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.

Figure 3. Hazard Classification of North Carolina Dams



Source: the NC Dam Inventory

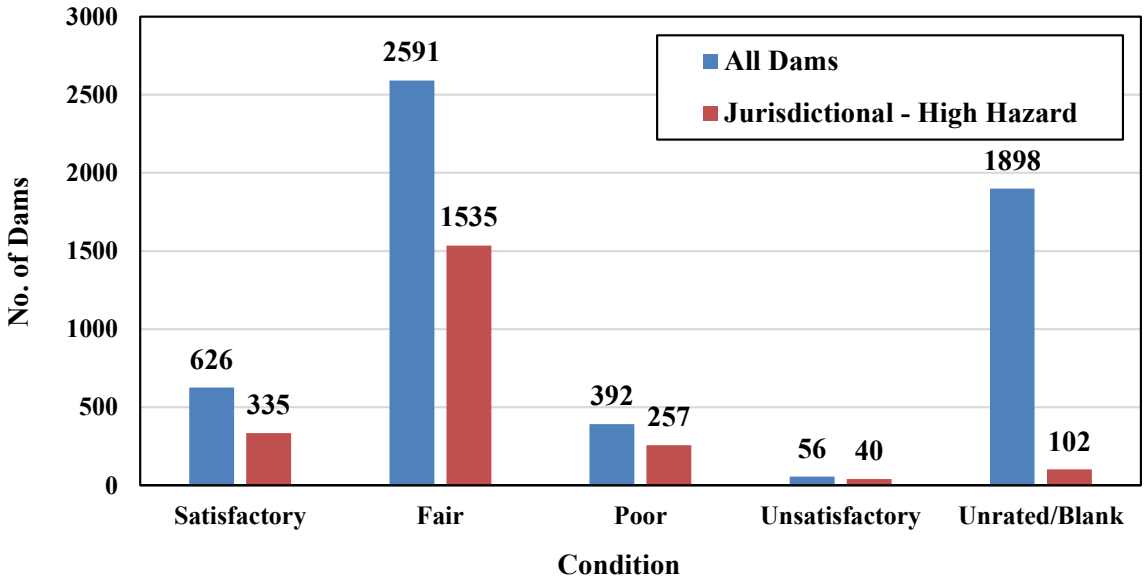
Figure 3 depicts the hazard classification for all jurisdictional dams compared to all dams. As of 2025, there are 1,436 high hazard dams or pending high hazard dams in North Carolina. These are structures that have the potential for loss of life in the event of a dam breach or failure.

The North Carolina Dam Safety Program classifies the condition of each dam with Satisfactory, Fair, Poor, or Unsatisfactory condition ratings, which are defined below:

- Satisfactory: No existing or potential dam safety deficiencies are recognized.
- Fair: No existing dam safety deficiencies are recognized for normal operating conditions.
- Poor: A dam safety deficiency is recognized for normal operating conditions that may realistically occur. Remedial action is necessary.
- Unsatisfactory: A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

The data indicate that of the 1,436 jurisdictional, high hazard dams in the state, 257 (21%) are rated as poor or unsatisfactory, and 102 (7%) have not been rated or data is not available.

Figure 4. All Dams and Jurisdictional High Hazard Dam Condition



Source: the NC Dam Inventory

Of the jurisdictional dams, most (2,350) are under 50 feet tall. 132 dams are greater than 50 feet tall; and of these, only 14 structures are greater than 100 feet tall. As of 2025, the North Carolina Dam Inventory did not provide height information on 1,617 dams. Generally, the taller the dam, the greater risk to the downstream population during a dam failure or breach.

Meanwhile, of the jurisdictional dams, most are aging significantly—788 dams of jurisdictional dams are older than 50 years in age. The inventory does not identify the construction dates for 1,168 jurisdictional dams. Only 394 jurisdictional dams were listed as having been constructed within the prior 50 years.

OPERATION AND MAINTENANCE

Operation and maintenance (O&M) activities are typically the responsibility of dam owners, which may be a local municipality, energy provider, homeowners' association, or an industry partner. While industrial partners or energy providers typically have the resources for operations, maintenance, and dam improvements, the small municipal dam owner often does not have the budget for repairs or improvements outside of routine maintenance activities. Maintenance or repair is often deferred until outside funding is secured or safety issues are imminent. The Dam Safety Program inspects high hazard potential dams every two years, and the Dam Safety Law of 1967 provides dam safety enforcement power to bring non-compliant dams into compliance, for which the program often encourages owners to implement repairs, update Emergency Action Plans (EAPs), and prepare O&M plans. Of the 1,373 high hazard potential dams listed as jurisdictional within the available dam inventory last updated online in the 2025, most have been inspected by NCDEQ within the last two years (1,968 dams). An additional 218 dams were inspected in the past five years, while the remaining structures have not been inspected recently or records for select dams are unavailable to update the inventory.

The North Carolina Dam Safety Program provides dam owners with access to a comprehensive Dam Operation, Maintenance, and Inspection Manual for download via their website. This manual was developed in 1985 and revised in 2007 to assist dam owners in regular maintenance activities, safe operation, and inspection activities. The Manual places an emphasis on small earthen embankments, which are the types of dams most commonly found in North Carolina. While

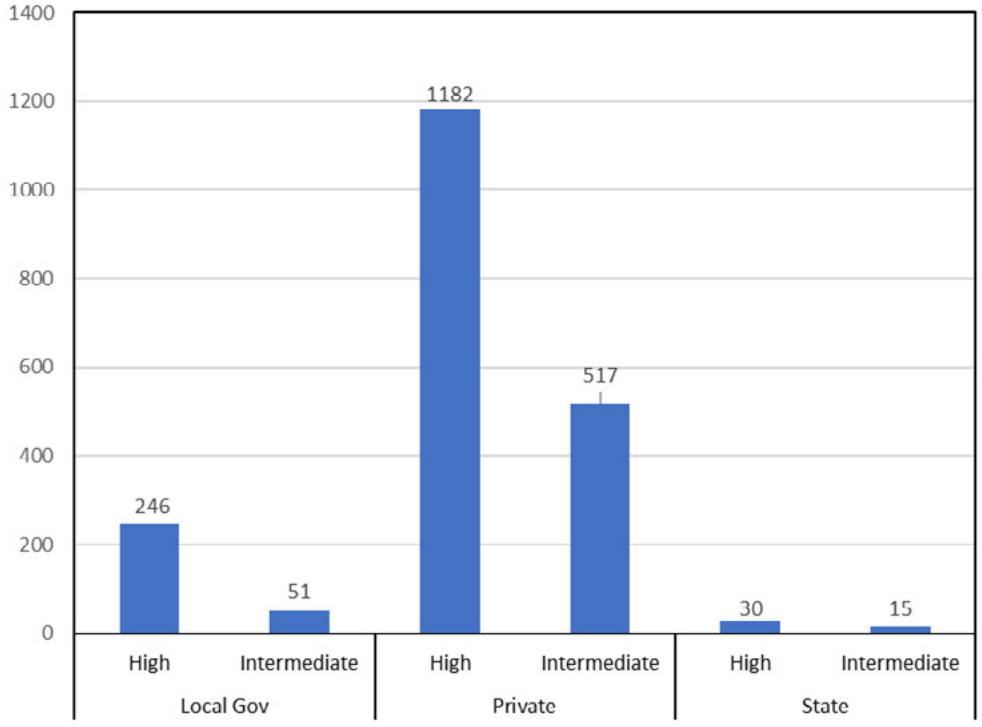
the manual is a good reference, it remains one of the few publicly available resources provided by the state, and its most recent update was nearly two decades ago. Given the evolving nature of dam safety practices, climate conditions, and infrastructure challenges, there's a growing need for more current and accessible tools. North Carolina Dam Safety has been a leader in innovation when compared to peer states in developing resources for dam owners. Continued development of user-friendly resources—such as interactive digital guides, mobile apps, or video tutorials—will better support dam owners in mitigating risks. The state has recently implemented an EAP-EZ form to better support small and medium sized dam owners.

FUNDING AND FUTURE NEED

Of the jurisdictional dams in North Carolina, only 48 are owned by the state; 313 dams are owned by local municipalities. Most dams in North Carolina are owned by private owners. The dam safety inventory lists that 28 state, 246 local, and 1,102 private dams are classified as high hazard (Figure 5). Dam rehabilitation and repair is a significant capital investment that many municipalities or small entity dam owners (i.e., homeowners' associations) cannot bear without government or external support. Depending on the prevailing topography, failure of high hazard dams can have a significant impact on safety and the economies of many North Carolina communities established downstream of the dams. As evidenced in western North Carolina by destruction caused from Tropical Storm Helene, where solely flood waters caused devastation, a potential dam breach could similarly devastate the livelihoods and communities in this area.

In addition, much of the state's power infrastructure is supported by lakes and cooling ponds formed by high hazard dams. Loss of one of these structures could cause massive flooding downstream and stress the adjacent power grid—though most power dams have access to significant funding sources and are able to maintain their dam structures.

Figure 5. High and Intermediate Hazard Class by Owner for North Carolina Dams



Source: NC Dam Safety Inventory

To implement their mission, the Dam Safety Program is funded at $2.525 million annually, which is sourced partially from state appropriations but bolstered by funding from the National Dam Safety Program (NDSP), the FEMA High Hazard Potential Dams (HHPD) program, and permit application fees (the lesser of 2.25% of construction cost or $50,000). The Dam Safety Program has been effective in securing approximately $10,900,000 in funds from the FEMA HHPD program, a larger percentage than similar states, since 2022, to bolster the program and help high hazard dam owners repair their dams. The 2021 Infrastructure Investment and Jobs Act (IIJA) also brought significant funding for the Dam Safety Program and to repair and maintain several high hazard dams within the state. As of January 2025, the legislation provided over $1.5 million for the HHPD program and $112 thousand in additional funds from the NDSP to North Carolina Dam Safety. Three dams, B. Everrett Jordan Dam, Falls Lake Dam, and W Kerr Scott Dam, received a total of nearly $11 million to make critical repairs, construct improvements, and to maintain the high hazard dams. In addition, the North Carolina Natural Resources Conservation Service (NRCS) personnel have also worked with local counties and watershed districts to secure federal funding for flood control dams.

In 2025, the Association of State Dam Safety Officials (ASDSO) estimated that the nation's dam rehabilitation costs are $165.2 billion dollars for all non-federal dams, and of this, $37.4 billion for high hazard dams. Since 2023, both figures have increased from $157.5 billion and $34.1 billion, respectively. North Carolina dams have a similar funding gap of approximately $5.97 billion for dam maintenance and repair of dams that are not rated satisfactory, nearly half of which is for repair and maintenance of high hazard dams ($2.83 billion). In late 2024, Tropical Storm Helene further exacerbated the funding needs for western North Carolina. Initially, North Carolina Office of State Management and Budget indicated that 29 public/private dams were damaged during the storm, causing over $200 million in damage. Subsequent evaluations by North Carolina Dam Safety Program found that over 44 high hazard dams were damaged. Subsequently, North Carolina has requested additional funds from various federal agencies to repair the dams and increase the program's resources. As recently as June 2025, the state legislature approved a $10 million grant program to repair dams affected by natural disasters.

PUBLIC SAFETY

The Dam Safety Law of 1967 authorizes the implementation of a dam inspection and certification program in the interest of public safety. Jurisdictional dams that are classified as high hazard (Class C) under this law are required to be inspected at least once every two years by NC Dam Safety. Additionally, owners of high hazard dams, unless otherwise exempt, are required to develop an Emergency Action Plan (EAP) and submit it to NC Dam Safety for review and approval. As of 2025, 7,448 dams are in the State's inventory. Of these, 1,436 are jurisdictional, high hazard dams that require biennial inspections and updated EAPs. According to the 2025 NC Dam Inventory, 1,058 of these jurisdictional high hazard dams have an EAP on file, or approximately 45%. The national average for dams having EAPs is 77%, according to the USACE National Inventory of Dams (NID). Furthermore, NC Dam Safety requires that EAPs should be updated annually. Over the last 10 years, North Carolina has seen a population increase of about 11%. With increasing population to previously undeveloped areas, low or intermediate hazard dams are increasingly being reclassified into high hazard dams. Thus, there is a need to update EAPs on a regular basis to protect downstream populations.

RESILIENCE

Dam infrastructure in North Carolina has shown to be resilient over the years after receiving heavy rainfall from several named tropical storms and hurricanes. In 2024, western North Carolina received heavy rainfall from Tropical Storm Helene, which battered the watersheds north and northeast of Asheville. Specifically, the town of Chimney Rock, upriver of Lake Lure, was destroyed after receiving approximately 22.5 inches of rainfall over two days, Despite lowering the reservoir by four feet before the storm, the adjacent Lake Lure filled quickly, and the

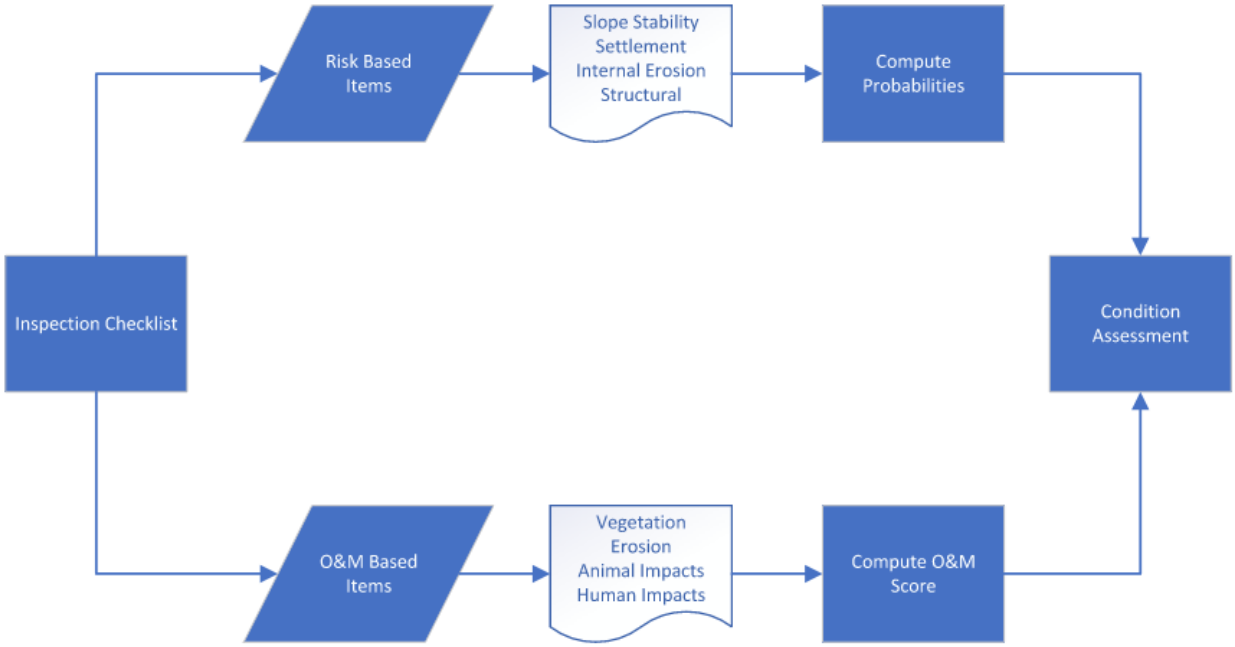
concrete dam and left abutment overtopped scouring the hillside. Rutherford County activated the dam's EAP with an Event Level 1 on September 27, 2024, which indicates that dam failure was imminent. Fortunately, the dam did not breach, and water levels returned to normal pool within a day. Prior to the storm, repairs and upgrades were being planned, with a replacement dam being designed downstream of the existing structure.

In July 2025, tropical storm Chantal caused severe flooding in Moore County, leading to the Longleaf Golf Club's Dam failure and resulting in the flooding of three downstream homes. In November 2024, NCDEQ cited deficiencies related to the spillway and issued a Dam Safety Order. While this was an extreme case, it highlights the importance of routine dam maintenance and following through on repair orders issued by State regulators.

North Carolina has received numerous heavy rainfalls generated by hurricanes and tropical storms such as Florence, Matthew, Helene, and Chantal. Only a handful of high hazard dams have failed from these events, and no fatalities have occurred. This suggests that, when the dams are in compliance with the Dam Safety Law of 1967, the structures are resilient and safe to serve the adjacent communities.

INNOVATION

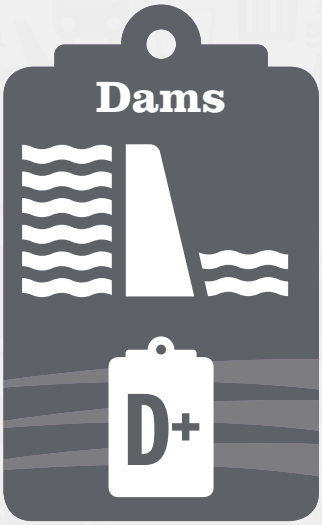
Figure 6. Risk-Based Condition Assessment Life Cycle



Source: NC Dam Safety Inventory

The North Carolina Dam Safety Program has innovated in many ways. In 2023, the ASDSO awarded the NC Dam Safety Program the Southeast Regional Award for implemented internal software programs and studies to monitor dams in the state. The innovative measures included being one of the first states to apply a risk-based approach to assess the condition and predict the annual probability of failure for a given dam.

In addition, the program led the process to update the state's probable maximum precipitation (PMP) Study, which was published in May 2025. The PMP study provides an estimate for the theoretical maximum depth of precipitation that can occur over a given area. The PMP storm, or a fraction of, is often used as the design storm for establishing the necessary performance criteria for dams and their appurtenant structures. The updated study will allow dam owners to better ascertain the hydrologic risk and their compliance with the dam safety laws.



RECOMMENDATIONS TO RAISE THE GRADE

- Secure additional funding for the North Carolina Dam Safety Program to retain the State Dam Safety Officer, retain and recruit new talent, and expand inspection and compliance services.
- Re-evaluate low and intermediate hazard dams to determine if population growth requires reclassification of dam structures.
- Continue to require high hazard dam owners to prepare and update EAPs on a yearly basis.
- Improve the EAP template to be more concise and easier to implement and encourage more dam owners to participate in emergency planning.
- Create a state loan or grant funding program for dam rehabilitation, repair, abandonment, or removal that can be accessed by all dam owners. Further expand the grant program for dams affected by natural disasters.
- Continue to leverage federal grant programs and to publicize dam owners to improve rehabilitation in the State.
- Develop updated, user-friendly resources—such as interactive digital guides, mobile apps, or video tutorials—to complement the Dam Operation, Maintenance, and Inspection Manual to better support dam owners in mitigating risks.

SOURCES

Association of State Dam Safety Officials, "The Cost of Rehabilitating Dams in the U.S.," 2025.

Federal Emergency Management Agency, "Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program," 2024.

Macrotrends, "North Carolina Population 1900 – 2024," 2024.

North Carolina Department of Environmental Quality, "North Carolina Dam Safety Inventory," 2025.

North Carolina Department of Environmental Quality, "Probable Maximum Precipitation Study," 2025.

North Carolina Office of State Budget and Management, "Hurricane Helene Recovery, Revised Damage and Needs Assessment," 2024.

The Daily Tar Heel, "North Carolina Dam Safety Program receives award for technology innovations," 2023.

Town of Lake Lure, "Hurricane Helene Summary Memo," 2025.

WRAL News, "NC inspectors found issues, ordered action, months before Moore County Dam failed during Chantal," 2025.

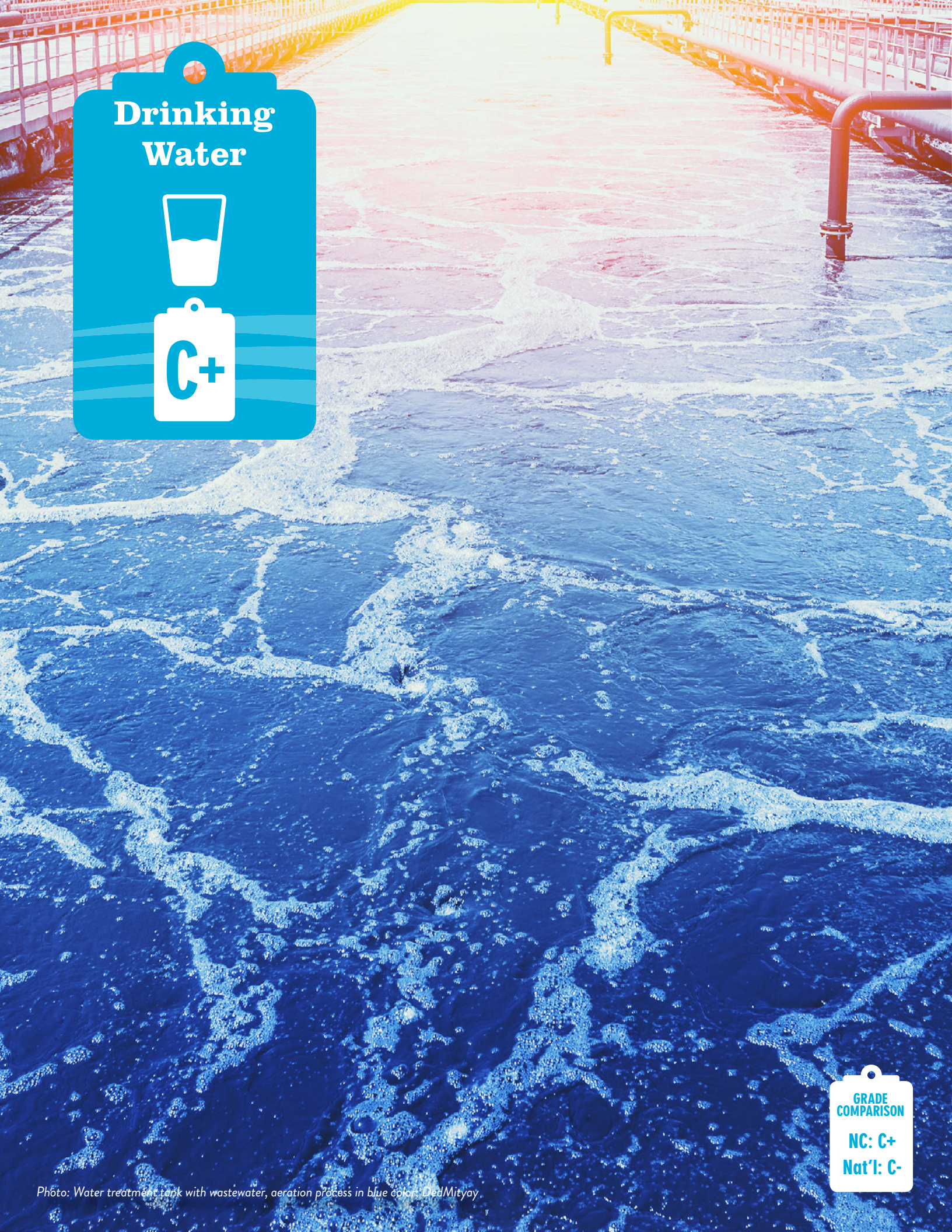


Photo: Water treatment tank with wastewater, aeration process in blue color: DedMityay

DRINKING WATER

EXECUTIVE SUMMARY

Maintaining, upgrading, and funding clean drinking water infrastructure is critical for keeping up with the continuing population growth in North Carolina. North Carolina's frequent natural disasters—including hurricanes, ice storms, and droughts—underscore the need for resilient water systems, a need made clear by the destruction from Tropical Storm Helene in 2024. There is growing concern for synthetic chemical containments, or "forever chemicals" such as PFAS and PFOAs moving through the water cycle and potentially harming people, including raising the risk of cancer. Water treatment for these containments can be challenging from both financial and operational perspectives. North Carolina has benefitted from licensed, trained operators who have chosen to make water treatment and utility work a lifelong career; however, many of these skilled professionals are retiring, and the industry must attract, train, and retain more utility operators.

BACKGROUND

North Carolina is made up of three primary regions: the Mountains, the Piedmont, and the Coastal Plain.

The Mountain region contains water systems that largely capture rainfall runoff from higher elevations in smaller watershed reservoirs that are not usually muddy or cloudy. Drinking water is generally easier to purify due to the low development density within these watersheds.

The Piedmont region—composed of cities such as Charlotte, Winston-Salem, Durham, and Raleigh—is home to most North Carolinians, and its water systems primarily draw from direct intakes on rivers or large reservoirs created by impounding rivers. Rivers such as Catawba, Deep, Mitchell, Neuse, and Cape Fear all are water supply sources for this region.

The Coastal Plain region uses both surface water supply and groundwater supply to serve its population. The largest concern of the groundwater systems revolves around dwindling water quality due to saltwater intrusion and lower freshwater levels within the aquifers.

Notwithstanding a drought of the recent past (2007-08) and periods of seasonal drought, the overall water supply of North Carolina is generally healthy, and the supply remains strong.

CAPACITY

It is estimated that the population of North Carolina in 2024 was about 11 million, and approximately 75% of these people were receiving their drinking water from a public source regulated by the North Carolina Division of Environmental Quality (NC DEQ).

North Carolina has nearly 6,000 regulated public waters systems. Some of these are considered large (serving greater than 100,000); however, the majority are small to medium water systems (serving fewer than 100,000). Table 1 indicates some of the larger water systems and the approximate population served.

Table 1: Sample of Large Drinking Water Systems in North Carolina

Source: Larry Mitchell

Utility Owner	Population Served
Charlotte Water	Greater than 1,000,000
Raleigh Water	Greater than 630,000
Winston-Salem/Forsyth County Utilities	Greater than 300,000
Cape Fear Public Utility Authority	Greater than 200,000
City of Greensboro	Greater than 320,000
Orange Water and Sewer Authority	Greater than 100,000
Fayetteville Public Works Commission	Greater than 120,000
City of Durham	Greater than 350,000
City of Asheville	Greater than 100,000
City of High Point	Greater than 100,000
Brunswick County	Greater than 150,000
Johnston County	Greater than 100,000
Onslow Water and Sewer Authority	Greater than 100,000
Davidson Water, Inc.	Greater than 150,000
Union County Water	Greater than 100,000
Greenville Utilities Commission	Greater than 100,000

Figure 1: UNC Water Tower – Orange Water and Sewer Authority, Chapel Hill, NC

Source: Wikimedia

Treatment capacity to keep pace with population growth is an ongoing challenge, and regionalization has been embraced to yield benefit to the larger population. For example, in the last five years several systems have expanded or constructed new water treatment plants to meet the growing demands. A sample list of recent or developing expansions is listed below:

- Union County/Norwood (2025)
- Brunswick County—serves several municipalities (2024)
- Kerr Lake Regional/Oxford/Henderson (2025)
- City of Durham/Chatham County/Pittsboro (under design)
- Johnston County/Clayton (2024)
- Harnett County (under design)
- Piedmont Triad Regional Water Authority (under design)

Most of these systems are within the Piedmont region, where denser population and greater industrial development require more advanced treatment processes and operations.

CONDITION

Several of North Carolina's drinking water systems contain infrastructure that was installed in the 1930s to 1950s, when pipeline materials were made of cast iron and asbestos cement. These pipes tend to develop internal corrosion deposits, become brittle, and break or leak more easily than the ductile iron and PVC pipelines installed after 1960.

Through upsizing for greater capacity, relocation of pipelines due to roadway expansions, and general water system upgrading, many of the state's water systems are systematically replacing aging water pipes through ongoing Capital Improvements Programs (CIPs). Some of the larger systems maintain a goal of replacing a

certain percentage of their water system piping each year that will lead to complete replacement over a 50-year period. For example, as early 2003, The Orange Water and Sewer Authority created a priority water system pipeline replacement model/program that focused on replacement of generally the oldest water mains. The goal of system replacement over a 50-year period for their system resulted in approximately five to seven miles of water main replacement per year.

Recent requirements to identify and plan for removal of lead water service connections have provided utilities an opportunity to evaluate the age, condition, and material of their systems down to the smallest pipeline serving a single residential customer (3/4-inch). The majority of systems in North Carolina do not contain high percentages of lead or galvanized water services, proving the system at the service is generally quality material. It was estimated in 2021 that North Carolina has approximately 3.1 million service connections with less than 1% being made of lead. For example, the Orange Water and Sewer Authority (OWASA), serving Chapel Hill and the surrounding areas with over 80,000 connections, found that approximately 100 services—or less than 0.001%— required removal due to containing lead or galvanizing. The Brunswick County water utility reported no lead service connections.

FUNDING & FUTURE NEED

North Carolina has several programs available to water systems that can provide funding via low interest loans and grants, depending on the need. These are generally managed by the NC DEQ via the Division of Water infrastructure (DWI). The most recent water infrastructure statewide assessment estimates that $20 billion is needed over the 30-year period from 2021 to 2051.

NCDEQ has provided $1.5 billion in funding assistance since 2014. $15 billion will be needed over the next 20 years. $11 billion will be needed for clean water needs to such as wastewater treatment systems.

DWI provides the following statewide data and several funding programs available to water systems. These funds were renewed through the 2021 passage of the Infrastructure Investment and Jobs Act (IIJA) through Fiscal Year 2026. The $1.2 trillion dollar federal spending package is providing approximately $1.1 billion toward clean drinking water improvements via the state revolving fund program.

- Drinking Water State Revolving Fund (DWSRF): Provides low-interest loans to local government units, nonprofit water corporations, and investor-owned drinking water companies for projects to provide safe drinking water. Congress provides funds for states to establish revolving loan programs for funding of drinking water projects, and states provide 20% matching funds.
- Community Development Block Grant – Infrastructure: Provides grants to local government units to address water and wastewater infrastructure needs in HUD-qualified low-to-moderate income communities.
- State Wastewater & Drinking Water Reserve Programs: Provide grants for technical assistance and for construction of critical needs for wastewater collection systems, wastewater treatment works, and public water system projects.
- Merger/Regionalization Feasibility Grant Program: Provides grants for studies to evaluate the potential consolidation of two or more systems into one system and the potential physical interconnection with another system for regional wastewater treatment or regional water supply.
- Asset Inventory and Assessment Grant Program: Provides grants for developing asset inventories, condition assessment of critical assets, and other components of comprehensive asset management programs.
- Viable Utilities Program: Provides funding to build a path toward viable utility systems using long-term solutions for distressed water and wastewater units in North Carolina.
- Local Assistance for Stormwater Infrastructure Investments Program (LASII): Provides grants for construction and planning for stormwater projects to improve or create infrastructure for controlling stormwater quality and quantity.

- Lead Service Line Replacement Funding: Provides funding specifically to identify, inventory, and replace lead service lines and lead connectors throughout water systems. Funds were made available in late 2023 to local governments, nonprofit water companies, and investor-owned water utilities.

In addition, recent legislation provided funding via the American Rescue Plan Act (ARPA) to units of local government throughout North Carolina. Several municipalities chose to utilize these funds for water system improvements; however, these funds will expire December 31, 2026. NC received over $2 billion investment in drinking water infrastructure statewide, which has directly funded many water system improvements. One featured project in Sampson County received over 13 million dollars to design and construct a water distribution system in the Ivanhoe area, connecting 350 homes with 40 miles of new water lines. This project was funded through the American Rescue Plan Act and state reserves, part of a $2.3 billion investment in water infrastructure statewide in 2022 timeframe.

Each drinking water system in North Carolina is responsible for setting their own rates and system development charges. These rates are to fund the enterprise fund for system operation, maintenance and upgrades and debt services. Similarly, most systems have some level of impact or system development fees that are levied for development to fund growth. In general, these fees do not keep pace with the need as a society is hesitate to pay the true value of the service.

OPERATION AND MAINTENANCE

Water utilities are required to have licensed operators maintaining their systems who are qualified depending on the system size and treatment process utilized. Water operator schools and training are offered within the industry, and there is introductory instruction at secondary educational institutions. The North Carolina One Water organization provides training and consistently conducts schools and examinations three times a year. Based on a review of attendance and exam results, the pool of certified operators is not keeping pace with the industry need.

In addition to general operation and maintenance, there is a new treatment process that requires advanced skill and knowledge. The industrialization of the watersheds is causing an increase in "forever chemicals" (PFAS/PFOA compounds) in increasing concentrations. Most medium to large sized water systems in the state are either already treating or in design for treating these chemicals. The treatment process for this advanced containment removal requires additional operational skills and increased maintenance, as well as increased energy and infrastructure.

The industry will continue to be challenged to meet operational needs as more advanced drinking water treatment plants continue to be built.

PUBLIC SAFETY

The Lead and Copper Rule Revision (LCRR) that was finalized by the EPA in 2021 was a direct result of a public safety outcry and erosion of trust related to leaching lead contaminating drinking water. North Carolina, due to its historically rural landscape and generally younger water systems (less than 100 years old) has reported a very low percentage of lead service lines; therefore, there is a very low risk of lead contamination in the state's drinking water systems.

Elevated concentrations of 1,4-dioxane and PFAS compounds (such as GenX) in the Cape Fear River Basin—serving larger water systems including Brunswick County, Cape Fear Public Utility Authority, and Fayetteville Public Works Commission—has caused media attention and heightened public awareness. It should be noted that these synthetic chemicals, however concerning, have not been proven to be carcinogens and are currently classified as "likely human carcinogen" from long-term exposure. Most of the state's water systems are addressing the removal of these and other containments. In 2023, the water systems with no violation with regards to the maximum permissible regulated contaminant levels

was 97% of NC's community water system serving over a population of 9.5 million people.

The greatest risk to public safety regarding the state's drinking water infrastructure is the reduction of the level of service due to impacts from severe weather events such as extreme cold, extreme heat (droughts), or heavy rain events that can flood reservoirs and sever water mains. This is the immediate concern that should continue to be mitigated.

RESILIENCE

Every five years, water systems are required to conduct and certify Risk and Resilience Analysis (RRA), Emergency Response Plans (ERPs), and Source Water Protection Plans (SWPPs), as required by the America's Water Infrastructure Act of 2018. These plans analyze all-hazard risk such as weather, cyber-attacks, contamination, employee risk, and other hazards that can disrupt normal operations and cause harm to the utility that customers and the public trust. These plans recently required updating in 2025, with most hazards being weather-related. In the case of many smaller systems, a lack of adequate redundancy was indicated as prominent (i.e., single water treatment plant, raw water pump station, or transmission mains).

A recent test to the resiliency of many systems in western North Carolina, Tropical Storm Helene had a severe impact on the Mountain region. Heavy rainfall and mudslides not only washed out roadways and drainage culverts but also consequently water pipelines that were installed within the roadway rights of way. Additionally, many of the mountain reservoirs that normally capture pristine rainwater and runoff were overflowing with debris and sediment and quickly overwhelmed filtration systems at the treatment plants. Many of these systems lacked traditional clarification to settle sediment prior to filtration, so they were affected for months waiting for the reservoirs to return to normal clear water conditions. The City of Asheville was without potable drinking water for over 50 days and had to use emergency portable dissolved air floatation settling to restore a small percentage of their drinking water. They are still recovering over a year later. Plans are underway to design and upgrade treatment plants for future resiliency to provide continuous sedimentation in areas where previous climate conditions did not warrant this level of treatment.

Similarly, heavy rains and storms have impacted coastal North Carolina in areas such as Wilmington and Brunswick County, where pipelines have been ripped from their underground positions during riverine and creek flooding. This was most prominent during Hurricanes Matthew and Florence. Steps have been taken since then to install many pipelines using Horizontal Directional Drilling, which allows the pipelines to be buried up to 30 feet below the river/creek bed in order to prevent "blow-outs" during flooding events.

INNOVATION

Innovation in the state's drinking water infrastructure has primarily revolved around increased use of automated controls and testing as well as reduced water usage appliances and plumbing fixtures. The lack of operational resources can partially be mitigated through increased use of automation; however, over-reliance on technology can cause additional risk related to loss of communications (such as Wi-Fi, cell phones, etc.) during circumstances beyond the operator's control.

One of the most significant changes to the water industry in recent years was an amendment allowing alternative delivery for municipal projects—specifically water treatment plants. This change has generally allowed North Carolina to utilize innovative alternative project delivery methods to help the state expand infrastructure more quickly and keep up with growing needs.

RECOMMENDATIONS TO RAISE THE GRADE

- Water systems must strive to increase rates to cover the cost of services with funding for reserves which would allow dependency on federal government grant and loan funding.
- Increase resiliency by continuing to track the systems' all-hazard risk and resilience analysis and implementing recommendations, specifically as related to redundancy.
- Increase the pool of certified operators by introducing opportunities at the high school level and increase pay to keep up with inflation.
- Continue to explore sustained monitoring and removal of synthetic "forever chemicals" in drinking water , via putting more resources toward source water protection.

SOURCES

Interview with NC ONE WATER Drinking Water Operator School Coordinator, Mr. Joe Holden.

North Carolina Department of Environmental Quality, Division of Water Infrastructure, "Water Infrastructure By the Numbers," 2025.

North Carolina Department of Environmental Quality, Division of Water Resources, Drinking Water, "Drinking Water," 2025.

North Carolina Department of Environmental Quality, "Lead Service Line Inventory," 2025.

North Carolina Department of Environmental Quality, "North Carolina Capacity Development Report For Public Water Systems", 2024.

United States Environmental Protection Agency, "Drinking Water Infrastructure Needs Survey and Assessment, Seventh Report to Congress," 2023.

University of North Carolina School of Government, "New Construction Delivery Methods Authorized for North Carolina Local Governments," 2013.

Wikimedia, "Tarheel water tower," 2025.

Photo: Blue Ridge Parkway; Dave Allen

ROADS

EXECUTIVE SUMMARY

With over 80,000 lane miles statewide under North Carolina Department of Transportation (NCDOT) ownership, North Carolina's roads are critical to mobility and commerce. However, aging assets, increasing vehicle miles traveled (VMT), and inflationary pressures are straining the system. North Carolina's road infrastructure faces mounting challenges in maintenance, funding, and modernization. Pavement conditions show that nearly two-thirds of roads are in only fair condition, requiring resurfacing or replacement within the next decade. Meanwhile, traditional funding sources such as the motor fuels tax are becoming less robust due to fuel efficiency and electric vehicle adoption. To raise the grade, decision-makers must prioritize sustainable funding reforms, invest in resilience, and expand safety initiatives.

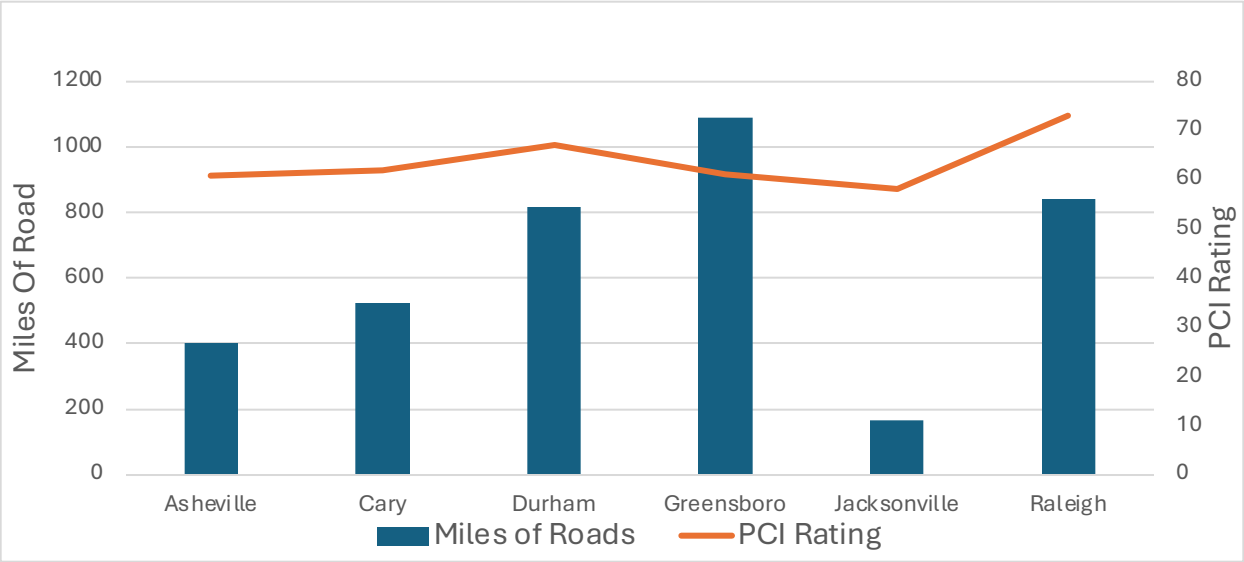
CAPACITY AND CONDITION

NCDOT maintains approximately 80,000 lane miles. Pavement condition assessments show 34.7% of non-interstate lane miles are rated as good, 63.8% as fair, and 1.5% as poor. A fair rating indicates visible wear, such as cracking and rutting, with resurfacing or replacement typically needed within five to 10 years, depending on traffic volume and climate exposure. Urban congestion continues to rise, particularly in metro areas such as Charlotte, Raleigh, and Greensboro. VMT have increased by 5% over the past five years from 122.5 million in 2019 to 127 million in 2024. This reflects both population growth and economic activity.

North Carolina is expected to become the 7th most populous state in the United States by the 2030s with an expected population of near 12 million people. Currently about 11 million people reside in North Carolina. As North Carolina continues to grow, roads must be improved and expanded to match the population growth. Expansion projects such as Interstate/State Route 540, Interstate 77, and the addition of Interstates 42 and 87 will help relieve congestion. These routes are in central North Carolina as well as Charlotte, which are the areas seeing the most growth in North Carolina.

Challenges exist for North Carolina roads. The state is geographically diverse from the mountain regions in the western part of the state, to the piedmont regions in the center of the state and onto the eastern coastline. Each has its own challenges. Tropical Storm Helene damaged or washed out 400 roads including Interstate 40 which provides key access between Asheville, Charlotte and Raleigh to cities such as Knoxville, Memphis and Nashville. In 2022, NC a 2.4 mile bridge was added to replace a section of NC Highway 12 that continuously washes out, even during moderate rainfall events. Named the Rodanthe Jughandle Bridge, the bridge cost $145 million and was completed in July of 2022.

Figure 1: PCI Ratings and miles of road for various major municipalities



Source: City of Asheville, Town of Cary, City of Durham, City of Greensboro, City of Jacksonville, City of Raleigh

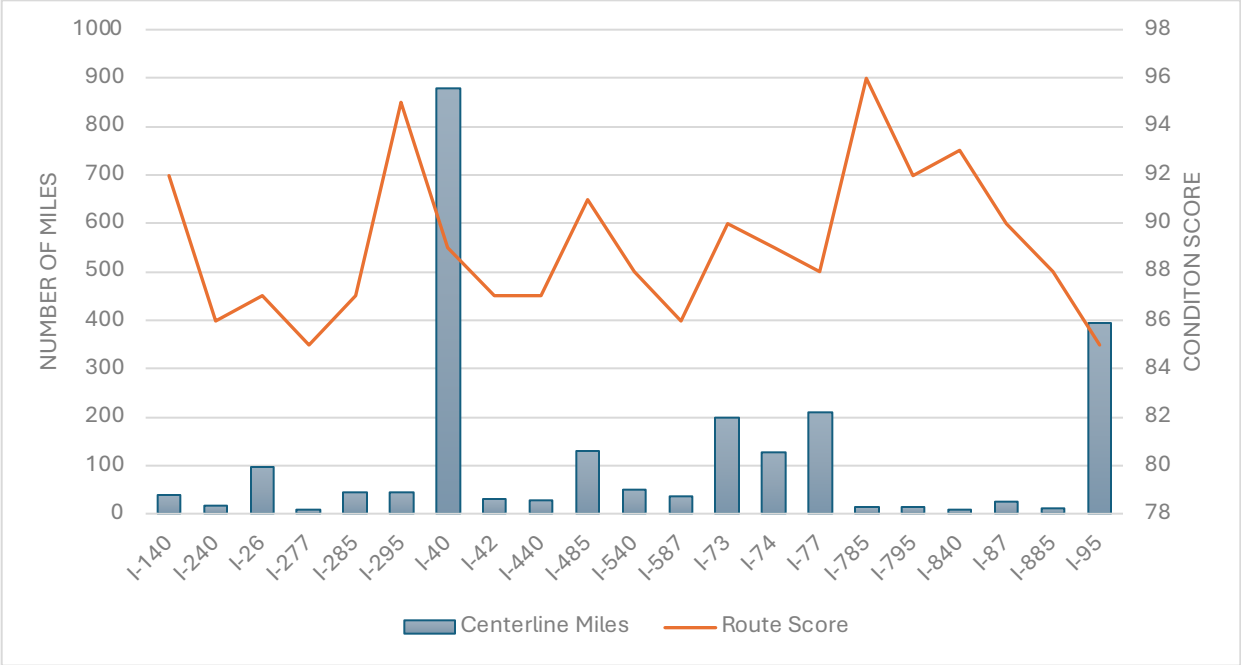
OPERATION AND MAINTENANCE

In addition to the 80,000 route miles under state maintenance, NCDOT is responsible for 13,700 bridges and over two million roadside assets such as guardrails, pipes and culverts. Staffing and equipment shortages remain a concern, as NCDOT and its contractors face challenges in recruiting skilled labor. In 2024 NCDOT reported a 22% vacancy rate for the division of highways. This number was down from 2022 which had a 25% vacancy rate. Pavement preservation remains underfunded, with most resources directed toward pavement resurfacing. Techniques such as chip seals and sand asphalt mixes are used in rural and subdivision roads to extend pavement life. Winter operations, including snow removal and de-icing, are critical to safety and mobility, especially in the western and Piedmont regions.

Coordination with other municipalities and agencies is required such as roads within a municipality such as Charlotte. These municipalities may have other infrastructure items in their roadways such as sanitary sewers. Therefore, interlocal agreements become necessary. However, maintenance of the roads falls on the owner of the road (State, local or private). The NCDOT Division of Highways has various units such as Pavement Management Unit, State Asset Management Unit and Maintenance Operations that maintain state their respective portion of the state roads as well as facilitating projects with impacted stakeholders such as other municipalities or citizens.

Without funding increases, the route scores—which measure the overall condition of a route based on pavement, bridge, and roadside asset data—are projected to decline significantly. It is projected that not increasing funding in future fiscal years (FY2027 to FY2023) will lead to an average route score decrease from 82 to 72. Therefore, NCDOT will require year-over-year increase in funding to account for inflation and regular wear-and-tear to maintain the current route score.

Figure 2: Interstate Condition Data



Source: NCDOT

Agencies have various programs for route maintenance such as their Pavement Asset Management Program (or unit). By looking at data such as PCI and Average Annual Daily Drips (AADT) a planning matrix can be developed to prioritize which road receives scheduled repairs and when. This helps decide which roads get repaired which is important when funding is limited. This approach is utilized by agencies such as the City of Durham and the City of Jacksonville.

Asheville, North Carolina

Source: Alexey Stiop

FUNDING

Funding for North Carolina's roads comes from federal, state, and local sources. North Carolina's motor fuels tax—currently a key revenue source accounting for 43% of NCDOT's budget—is currently 40.4 cents per gallon (on top of the 18.4 cent federal gas tax) and is adjusted annually based on a formula tied to population growth and the Consumer Price Index (CPI). Despite this adjustment, the tax faces sustainability issues due to rising fuel efficiency and the adoption of electric vehicles. On average, each of NCDOT's 14 divisions requires an increase in spending to approximately $275 million by FY34, with a total investment of around $2.3 billion to maintain current conditions.

The Infrastructure Investment and Jobs Act (IIJA) funded $7.2 billion for North Carolina Highways for FY2022 to FY2026 which is crucial for maintaining and improving the conditions of roads. Funding sources are divided in the table below.

Table 1: State Funding and Allocation

Resource	Highway Fund	Highway Trust Fund
Motor Fuel Tax	75%	25%
DMV Fees	Approximately 85%	Approximately 15%
Highway Use Tax	Approximately 7%	Approximately 93%
Sales Tax	25%	75%

Source NCDOT

NCDOT faces a significant challenge in modernizing its funding approach. Rising costs, increasing demands, and a shifting revenue landscape have prompted the state to explore alternatives. These include mileage-based user fees (MBUF), which charge drivers based on distance traveled rather than fuel consumed, and other fee-based mechanisms to close the funding gap.

The state utilizes the Powell Bill Program, which provides financing to municipalities that own and operate publicly used roadways. This program is funded primarily through the state's gas tax but also utilizes other highway user-based fees. In 2024, it was reported by NCDOT that 508 municipalities shared in a total yearly allocation of approximately $186 billion. These 508 municipalities represent approximately 6.4 million people in North Carolina. The allocation of these funds to the state's incorporated municipalities is based on population and miles of maintained streets, of which the data is required to be updated yearly. Charlotte received approximately $13.7 million, and Raleigh received approximately $7.2 million. The City of Durham received approximately $9.3 million in fiscal year (FY) 2024, and the City of Jacksonville received approximately $2.2 million. In the case of the City of Durham, this accounts for less than half of the city's $25 million street maintenance budget. In comparison, the City of Jacksonville depends on the yearly allocation for a majority of their needed financing for street maintenance.

FUTURE NEED

The 2024 Maintenance Operations and Performance Analysis (MOPAR) report estimates that NCDOT requires $2.86 billion in maintenance funding for FY26—a 32% increase over FY25 appropriations. This growth is driven by inflation, aging infrastructure, and expanding asset inventories.

North Carolina's future transportation needs are shaped by population growth, economic expansion, and climate resilience. The State Transportation Improvement Program (STIP) identifies over $30 billion in planned investments through 2035, including highway expansions, bridge replacements, and safety upgrades. However, projected VMT increases and urban congestion will require additional capacity and multimodal solutions.

Critical needs include pavement maintenance and rehabilitation across aging corridors. Also, safety improvements, such as guardrail upgrades, intersection redesigns, and pedestrian infrastructure. Other needs include expansion of alternative transportation modes, including intercity rail, public transit, and active transportation. Furthermore, there exists a need for planning efforts to reduce travel demand through land use coordination and telecommuting incentives. And an increased investment in digital infrastructure and smart mobility systems to support future travel behavior and freight logistics.

Without sustained investment, deferred maintenance and congestion will worsen, impacting safety, mobility, and economic competitiveness.

The 2024 MOPAR Report illustrated that publicly maintained roadways include the need for additional financing and personnel available to implement and manage the resulting programming. Staffing levels show that a need for additional staff to execute a proper street maintenance program.

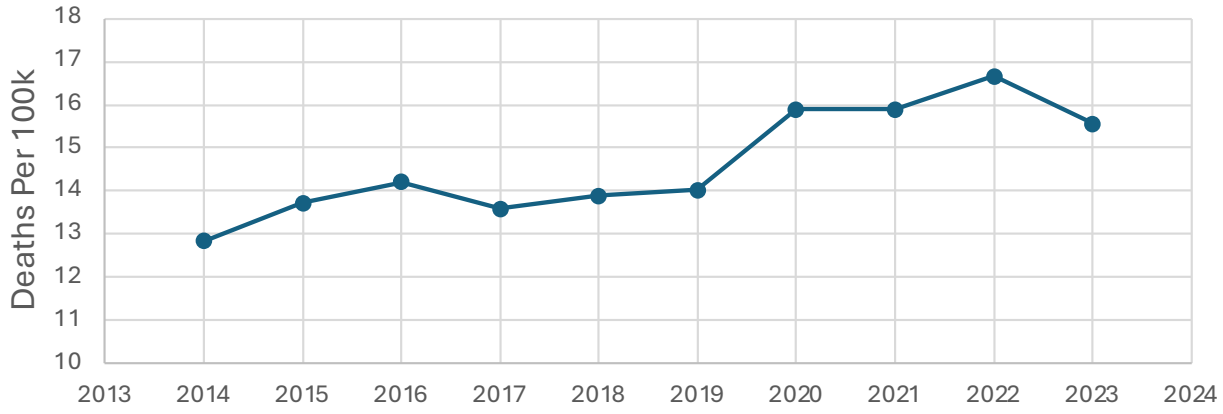
PUBLIC SAFETY

Traffic safety remains a pressing concern. In 2023, North Carolina recorded over 1,500 traffic fatalities, with a fatality rate of 1.35 per 100 million VMT—above the national average of 1.26.

NCDOT has focused on high-risk corridors and school zones implementing automated traffic enforcement, complete street policies and use of crash data analytics. Programs such as 'Vision Zero' are being implemented. NCDOT is working with municipalities such as the City of Raleigh to initiate their own 'Vision Zero' plan.

Pedestrian deaths decreased in 2023 compared to 2022, down 7.1% Thus showing some effectiveness to the programs.

Figure 3: NC Deaths Per 100k people



Source: NCDOT

Other factors to be considered as public safety concerns include damage to vehicles because of poorly maintained roadways. Municipality utilities, such as water and sewer services, can also be impacted because these pieces of critical infrastructure are commonly located beneath the locally maintained streets. Issues such as moisture infiltration on the surface of roadways can lead to damaged subgrade and, in turn, place unacceptable loads on the utilities, ultimately resulting in failure of both the roads and the critical infrastructure beneath them.

RESILIENCE AND INNOVATION

North Carolina's transportation infrastructure is increasingly vulnerable to extreme weather events, particularly hurricanes and flooding. The NCDOT Resilience Improvement Plan (RIP) outlines strategies to strengthen infrastructure against future hazards. These include upsizing (increasing the size) culverts, reinforcing embankments, and using more durable materials in flood-prone areas.

In 2022 NCDOT released a climate strategy report in an effort to improve environmental practices.

Innovative practices include:

- **Sustainability Requirements:** Incorporated into design and construction bids. NCDOT will also look at bid alternatives in an effort to consider environmentally sustainable designs.
- **Asset Management Plans:** Used to prioritize maintenance and replacement.
- **Reduce Greenhouse Gas Emissions:** Supporting the use of green infrastructure and increasing the number of zero emission vehicles (ZEV) on the roads.
- **AI and Satellite Monitoring:** Used to assess asset condition and optimize maintenance schedules.
- **Green Infrastructure:** Integrated stormwater solutions and permeable pavements to reduce runoff and improve environmental performance and transitioning from the standard dry pond detention which provided limited water quality benefits to higher-quality detention basins such as wet ponds.

These innovations are essential to building a more resilient and adaptive transportation system that can withstand future climate and economic pressures.

One promising innovation is in pavement materials—especially asphalt—where maltene-focused treatments are strengthening resilience at low cost. Maltenes are found in asphalt that help roads with elasticity and adhesion through their chemical components. Maltenes provide flexibility and help prevent cracking and raveling. This can extend the lifecycle of the pavement, which reduces maintenance needs and extends a roads' life. NCDOT is including this in its pavement preservation program.

Innovative asset management tools, including satellite imagery and AI-based grading systems, are being piloted to improve efficiency. In addition, technology has increased the efficiency and effectiveness of developing long-term maintenance plans. Manual grading of street conditions are subjective, while computer-based devices ensure consistent data collection. This is housed within various asset management programs of NCDOT such as GIS. Major muncipalities such as Raleigh and Charlotte also heavily rely on GIS and asset management programs to provide maintenance and project identification for their roads.

Tropical Storm Helene also illustrated the need for greater reslieincy in roads especially in the moutain regions. Interstate 40 a major east-west interstate. The interstate was able to reopen with 1 lane in both directions 5 months after Helene hit western North Carolina. Impacts from Helene also closed about 250 miles of the Parkway. The Blue Ridge Parkway is a crucial part for North Carolina tourism as it aides tourism for rural communities in western North Carolina and Asheville. The challenges of these roads is their remote location. Therefore funding for innovative practices to prevent damage from the next big storm is necessary.

RECOMMENDATIONS TO RAISE THE GRADE

- Modernize transportation funding by implementing MBUF or other sustainable revenue sources to reduce reliance on motor fuel taxes.
- Increase and sustain federal funding that can be used by the states.
- Increase maintenance investment by fully funding preservation and resurfacing programs to prevent asset deterioration. Implement more cost-effective maintenance techniques to preserve roadways in good condition and improve those in fair and poor condition. Prioritize critical infrastructure financing over nonessential spending.
- Scale Vision Zero, automated traffic enforcement, and pedestrian infrastructure to reduce and ultimately prevent all fatalities.
- Invest in multimodal solutions and congestion mitigation strategies to address future demand. Require recipients of tax revenue funding to implement maintenance plans that increase road grade and identify growth needs.
- Prioritize flood-prone infrastructure upgrades and integrate climate adaptation into planning to strengthen resilience.

SOURCES

City of Durham Interview

City of Jacksonville Interview

NC Chamber of Commerce, "Infrastructure Investment and Jobs Act," 2022.

NC Office of State Budget and Management, "NC to Become 7th Most Populated State in Early 2030s," 2025.

North Carolina Department of Transportation, "2022 Climate Strategy Report," 2022.

North Carolina Department of Transportation, "2024 Annual Performance Report," 2024.

North Carolina Department of Transportation, "2024 Maintenance Operations and Performance Analysis Report (MOPAR)," 2024.

North Carolina Department of Transportation, "Finance and Budget," 2025.

North Carolina Department of Transportation, "Road Inventory Data and Reports," 2024.

North Carolina Department of Transportation, "State Street – Aid Allocation to Municipalities Powell Bill," 2025.

North Carolina Department of Transportation, "State Street Aid Powel Bill Allocations Report," 2024.

North Carolina Department of Transportation DMV, "2023 North Carolina Traffic Crash Facts," 2024.

Outer Banks Vacations, "NC 12 Rodanthe Jughandle Bridge Project," 2022.

The News and Observer, "NCDOT works to reopen hundreds of roads in Western NC", 2024.

Photo: Flooding from Tropical Storm Helene

STORMWATER

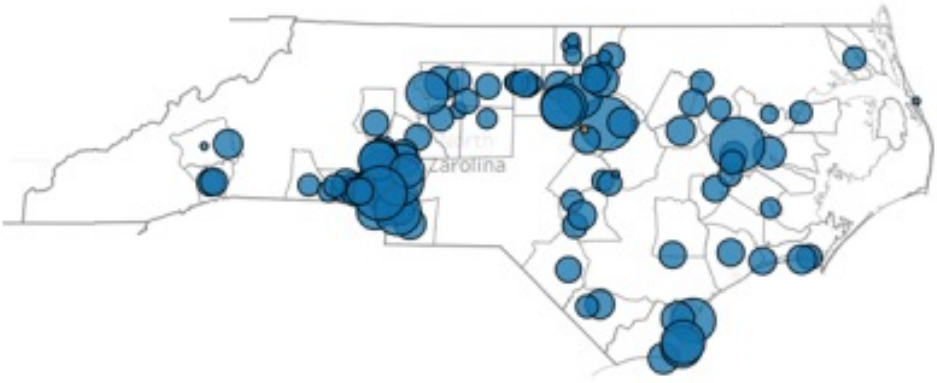
EXECUTIVE SUMMARY

North Carolina manages stormwater through 101 utilities serving about 5.1 million residents, which is roughly half the state. From the mountains through the Piedmont to the coast, stormwater infrastructure in North Carolina faces many challenges; specifically, development and funding are challenging for many municipalities. At least $2.76 billion is needed through 2034—with more than 80% of utilities reporting unmet capital needs. Fee adoption can be politically difficult, and grants, while helpful, are highly competitive. The state has also implemented an outreach and mapping program to aid citizens with flood risk awareness. This is an important tool, as studies have shown that 22% of structures that have flooded in North Carolina since 1996 are prone to repeated flooding. To sustain and grow these types of gains, closing the funding gap for needed stormwater infrastructure will require long-term, predictable investment to expand capacity, protect public safety, and build long-term resilience.

CAPACITY

There are 104 stormwater utility fee districts in North Carolina. It is estimated these utilities serve about 5.1 million residents, which is almost half of the state's 10.9 million residents in 2023. For reference, there are about 2,000 stormwater utility fee districts in the United States.

Figure 1: Location of Stormwater Utility Fees



Source UNC School of Government

The North Carolina Department of Environmental Quality (NCDEQ) is the state's permitting authority and has some capacity-related regulations. For new development, the stormwater controls must be sized using the one-year, 24-hour storm so that post-development runoff rates do not exceed pre-development rates. The one-year, 24-hour storm is the most likely probable amount of rain that could fall in a duration of 24 hours for a given year.

Individual municipalities in North Carolina may choose to implement regulations above the one-year, 24-hour event. For example, the cites of Greensboro and Winston-Salem regulate up to the 10-year storm.

Regulations such as these, as well as implementation of green stormwater infrastructure (GSI), can help mitigate flooding and water quality issues. GSI focuses on nature-based solutions such as using plants to promote water quality treatment for stormwater runoff. GSI also mitigates capacity issues by infiltrating, storing, and slowing runoff at the source. Asheville is one city that utilizes GSI through projects such as the Craven Street Improvement Project and Morris Street Improvement Project in 2017 and 2018.

CONDITION

The condition of stormwater infrastructure across North Carolina is universally unknown due to limited stormwater inventory and condition assessments, as well as a lack of publicly reported assessment data. According to the University of North Carolina Environmental Finance Center's 2021 North Carolina Local Government Stormwater Management Survey, approximately 50% of local government respondents reported not having a stormwater inventory, and 20% of respondents reported not having enough funding to meet maintenance needs, indicating less frequency of routine system observation and inspection.

An increase in the number of stormwater system inventories and condition assessments is essential to improve current understanding on conditions of the stormwater systems across the state. However, this would require increased funding to cover the cost of stormwater system mapping and condition assessment. These costs correlate strongly with population and service area, with the median cost of system mapping alone estimated to be $10,037 per square mile, or $5.69 per resident.

Despite having limited data about the location, types, and condition of stormwater systems, it can be reasonably assumed given the age of most local government and state roadways that many of the associated stormwater system components are closely reaching or have reached their useful lifespan, which can range from 50 to 100 years. Failing stormwater pipes can lead to increased flooding, erosion and sinkholes. For example, Hurricane Florence in 2018 caused sinkholes throughout the City of Wilmington. Similarly, in the immediate aftermath of Tropical Storm Helene, the City of Asheville inspected and cleaned 110 stormwater pipes. Clogged pipes from debris can cause street and structural flooding as well as increased erosion in areas impacted by the backed up stormwater.

Increasing population and urbanization, in addition to more severe weather events, are pushing the limits of the built and natural stormwater systems. Many North Carolina municipalities have been among the 100 top cities for population growth since the 2020 census, according to the latest population estimates published by the U.S. Census Bureau in 2025. In addition, according to the North Carolina Institute for Climate Studies (NCICS), there has been an upward trend in the number of heavy rainfall events, as well as a trend of rising sea levels along the coast at an average rate of 1.4 inches per decade. The most recent NCICS Climate Science Report suggests that both the frequency of severe storms and the amount of precipitation accompanying hurricanes are likely to increase in the future.

Increased development leads to added stormwater runoff volumes and velocities. As a result, stormwater infrastructure becomes damaged which causes increased flooding and erosion. This has led to a nearly 33% increase of impaired stream over the last eight years.

OPERATION & MAINTENANCE

Typical practice for stormwater operation and maintenance (O&M) requires conveying and/or treating runoff from structures and pavements to remove pollutants and promote overall water quality via various regulatory inspection and maintenance programs. The cities of Fayetteville and Greensboro both have Stormwater Management programs that maintain and plan for future stormwater infrastructure. Other smaller municipalities such as the Town of Cary and City of New Bern have their own stormwater management and asset planning programs.

Programs include, but are not limited to, regular inspections of stormwater control measure (SCM) devices, such as ponds, engineered wetlands, bioretention facilities, swales, and permeable pavements, and coordination among municipalities, counties, and the North Carolina DEQ.

Interdisciplinary education and awareness are encouraged in a variety of settings, with the notable example of the Department of Biological and Agricultural Engineering at North Carolina State University which offers citizens, municipalities, and agencies an opportunity to collaborate with academic and professional communities on operations and maintenance of stormwater pipes and streams.

Local citizens are encouraged to perform basic maintenance activities for private stormwater facilities located within their properties. One significant challenge to ensuring proper maintenance of private stormwater facilities is in educating the public regarding about their maintenance responsibility. Unless there is a public drainage easement, it remains on the private property owner to maintain stormwater infrastructure on their property. Throughout the state, NCDOT maintains stormwater infrastructure in state right-of-way and municipalities also maintain stormwater infrastructure for right-of-way in their jurisdiction.

Municipalities generally rely on in-house staff, utilizing their maintenance budgets, to satisfy federal and state permit requirements for inspection frequencies and recordkeeping for their facilities. These staff are responsible for inspection and reporting associated with state and federal regulatory requirements such as Total Maximum Daily Loads (TMDLs), National Pollutant Discharge Elimination System (NPDES) program management, and Stormwater Pollution Prevention (SWPP) and Spill Prevention, Control, and Countermeasure (SPCC) plans. Specialty tasks that may require professional services contracting include repairs of erosion and slopes, stormwater pipe lining and point repairs, vegetation removal and control, earthwork and grading, vacuum truck utilization, dredging, and open channel restoration.

The State of North Carolina has 109 active NPDES Municipal Separate Storm Sewer Systems (MS4). Under those permits, all 109 communities are required to provide public education and outreach, public involvement and participation, illicit discharge elimination and runoff controls for construction sites. MS4 permits are required for North Carolina municipalities with 10,000 people or more.

The state of North Carolina through NCDEQ has public outreach programs to assist the public and municipalities on the importance of proper stormwater management and maintenance on private property. Smaller municipalities such as the City of Hendersonville and Town of Morrisville also have public outreach programs. The Town of Morrisville now has annual 5k stormwater race, called the 'Runoff 5k' to educate the public about stormwater management.

FUNDING

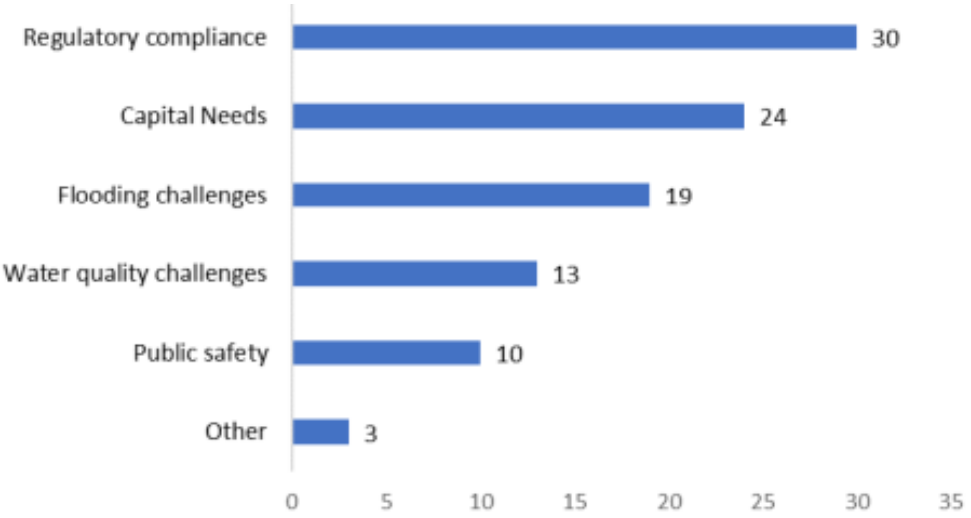
Providing stormwater services is a capital-intensive activity for local governments in North Carolina. According to the Pilot North Carolina Stormwater Needs Assessment published in September 2021 by the University of North Carolina School of Government's Environmental Finance Center (SOG EFC), statewide municipal stormwater capital needs for the period between 2020 and 2034 are projected to total at least $2.76 billion.

The primary source of stormwater funding for just over 100 local governments is through stormwater utility fee revenues. Supplementary sources of funding include general fund dollars and grants. These funding sources support operation and maintenance, regulatory

commitments, and capital improvements; however, based on data from the SOG EFC's 2021 North Carolina Local Government Stormwater Management Survey, over 80% of the responding stormwater utilities reported having unmet future capital improvement needs, with approximately 25% of respondents reporting not having completed any capital projects due to funding constraints.

Despite these gaps, trends in stormwater fees show that local governments are working to lessen these shortfalls, with 30 stormwater utilities increasing their stormwater fees in fiscal years 2022 and 2023. Local governments without stormwater utilities primarily rely on general fund dollars. Many of these governments report that they are not charging a fee due to perceptions of being politically or operationally infeasible.

Figure 2: Stormwater Fee Survey



Source UNC School of Government

The North Carolina Department of Transportation (NCDOT) requires state funding for the maintenance of 390,000 stormwater pipes that provide drainage for over 81,000 miles of state-owned roadways. Maintenance is covered by the General Maintenance Reserve Fund, which has an estimated fiscal year 2025 appropriation of $916 million, according to the NCDOT 2024 Maintenance Operations and Performance Analysis Report (MOPAR).

NCDOT stormwater services are funded by the state and federal government. In recent years, funding for roadway preservation fell short of the amount needed to adequately maintain the state's roads; however, beginning in 2023 and extending through 2032 NCDOT expects to receive an additional $9.7 billion from increased sales tax revenues.

Through the American Rescue Plan Act (ARPA), the North Carolina Legislature earmarked $82 million to be awarded for stormwater projects through the Local Assistance for Stormwater Infrastructure Investments (LASII) program. As of August 2023, the full amount appropriated for LASII stormwater grants has been awarded. The total funding requested exceeded the available funding by over $160 million.

The Infrastructure Investment and Jobs Act (IIJA) provided $7.2 billion to NCDOT for surface transportation investments in North Carolina. The commitment is for at least $410 million each year for five years (2022 – 2026) and supports ancillary stormwater infrastructure investment; however, a specific percentage was not directly set aside for stormwater. As of 2025, the majority of IIJA grant award funds for North Carolina, totaling over $1.8 billion, were paused because USDOT agreements were not yet in place. This pause has caused concerns regarding delays and potential cancellations of critical projects. It is not clear whether these funds will fully materialize or be reauthorized after expiration in 2026.

The Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) grant program was set to provide hazard mitigation assistance to communities, with stormwater infrastructure projects being a major contender for funding. However, proposed elimination of the BRIC program will likely revoke a substantial amount of this $160 million commitment. Recent BRIC projects in North Carolina include the 2023 Maple Avenue Green Stormwater Project in Maysville. The $3.7 million project upsized culverts and added bioretention cells to help with flooding and water quality.

The Flood Resiliency Blueprint program represents the largest statewide flood mitigation investment in state history and is intended to support the planning, evaluation, and implementation of flood resilience projects. The program is funded by the North Carolina General Assembly and has allocated $96 million to the Division of Mitigation Services to fund priority projects in the Neuse, Cape Fear, French Broad, Tar-Pamlico, White Oak, and Lumber River Basins. To date, Blueprint has begun implementation of 61 projects through a commitment of $74 million. These projects represent a broad range of resilience investments, including stormwater management and flood resilient transportation systems projects.

The number of applicants and level of funding demand demonstrates the need for capital improvement resources, as communicated through the SOG EFC Stormwater Management Survey. Grant programs are vital for helping meet capital improvement gaps for our state and local governments. Unfortunately, these programs are extremely competitive and serve as non-sustainable funding resources, which can make them unreliable for critical, time-sensitive upgrades to stormwater systems.

FUTURE NEED

Limited information is available regarding future stormwater infrastructure needs in North Carolina. Larger cities such as Charlotte, Fayetteville and Raleigh will include watershed planning as a service within their stormwater divisions, which is used to forecast future municipal needs and identify projects that can be designed and constructed within a given short-term capital improvement program. Best practices for watershed planning include frequent public engagement and interaction to allow for "boots on the ground" observations which can be used to complement stormwater modeling and planning efforts.

Municipalities will need to continue investing in technologies such as mapping software, computer-aided design (CAD), and even artificial intelligence (AI). CAD and AI will help with modeling, asset management and watershed planning.

PUBLIC SAFETY AND RESILIENCE

Impacts from events such as Tropical Storm Helene in 2024 have shown the need for an increase in stormwater-resilient infrastructure. Since 2015 there have been six federally declared disasters related to flooding in North Carolina.

In the last 10 years, 13 tropical storms have caused deaths in North Carolina. The three most deadly were Helene (107 deaths in 2024), Florence (43 deaths in 2018), and Matthew (28 deaths in 2016). Many communities impacted by Hurricane Matthew were still in the process of recovering when Hurricane Florence made landfall. Some communities such as Lumberton saw multiple 100-year storms (having a 1% annual chance of occurring) or greater happening in a two-year period. Lumberton, through the NCDEQ Flood Resiliency Blueprint is acquiring four parcels in the floodplain that repeatedly flood. The parcels will improve public safety by removing structures in the floodplain while providing floodplain improvements.

The most recent tropical storm, Helene, devastated much of western North Carolina, with high winds and torrential rainfall (17+ inches) in Asheville. However, agencies such as the North Carolina Department of Public Safety (NCDPS) and FEMA worked together in a unified response to form a coordinated effort to reduce loss of life and impacts once the storm had passed.

While FEMA floodplain maps are available in all states, NCDPS has created easily accessible tools for the public to gauge flood risks in the state. Two interactive maps—Flood Risk Information System (FRIS) and Flood Inundation Mapping and Alert Network (FIMAN)—help the public make informed decisions regarding real-time flood levels.

Flood risk awareness is essential to community resilience. A study found that between 1996 and 2020, 90,000 (2.3%) buildings in North Carolina flooded at least once. Of those 90,000 buildings, 20,000 (22%) flooded more than once. Furthermore, the study also found that 43% of flooded buildings were outside of the FEMA Special Flood Hazard Area. The FEMA Special Flood Hazard Area is defined as 1% annual chance of flooding.

However, it's not just hurricanes or tropical storms that pose a safety threat; unnamed, and many times unexpected, severe storms also pose a safety threat. For example, the Rose Lane community is comprised of 54 homes in a residential subdivision in Raleigh. Rose Lane floods one to two times a year where it crosses Walnut Creek and is a one-way in, one-way out road. As a result, during these floods, residents are unable to get in or out of their neighborhood during these events. The City of Raleigh has allocated capital improvement funds through the Rose Lane Safe Access Project to assist the Rose Lane community.

Related, the City of New Bern recently completed the Jack Smith Creek Wetland Project to help reduce flooding and improve water quality in an underserved area. The wetland drains 1,000 acres of residential and commercial land. The 38-acre wetland project totaled $2.6 million. This project was done in coordination with the City of New Bern and the NC Resilience Exchange.

INNOVATION

Green stormwater infrastructure (GSI) practices use a nature-based approach to mitigating stormwater impacts. This focuses on plants and other elements to try and capture and infiltrate the water to best mimic the natural water cycle. Traditional Stormwater Control Measures (SCMs) such as detention basins and dry ponds simply detain the water then pass it along at a reduced rate. While these are effective at reducing water quantity, there are very little water quality benefits. GSI help reduce stormwater quantity and quality. Examples include bioretention facilities, green roofs, and rainwater harvesting. These GSI measures also reduce construction costs, which allows for more funding for other areas.

Major cities in North Carolina have programs committed to implementing GSI. The City of Raleigh has implemented a GSI program that promotes uses of these principles on city-funded projects as well as projects funded by private development. The City provides incentives for privately funded developers to go above and beyond code regulations for GSI projects.

The City of Charlotte also has a sustainable stormwater management strategy that works toward implementing green infrastructure. This program focuses on reducing flooding risks and improving water quality of surface water in Charlotte's drainage basins.

Other large jurisdictions, such as the Town of Cary, City of Durham, and Wake County, have their own GSI programs that focus on using standard GSI practices as a catalyst for innovative solutions. While this represents a small portion of the state, these are in areas that are seeing the most development. Implementing GSI in any form advances innovation by integrating nature-based design with smart technologies can deliver multiple stormwater benefits.

Another NC Resilience Exchange project was in Greenville which included a culvert upgrade and major GSI components such as constructed wetlands, permeable pavers and bioretention ponds at Town Creek. The total project cost was $33 million with $16 million funded by a Clean Water State Revolving Fund.

RECOMMENDATIONS TO RAISE THE GRADE

- Encourage legislation that requires more communities to create a stormwater utility fee so funds can be directly allocated to stormwater maintenance.
- Establish a statewide GIS database of stormwater inventory in public property and, where applicable, in private property.
- Encourage more communities to use green stormwater infrastructure.
- Promote standards in areas that see repeated flooding to regulate higher-intensity storms; for example, regulating the 10-year storm instead of the one-year storm.
- Expand funding for public safety funding through assessment and mapping of flood risks outside of FEMA-mapped areas.
- Urge additional state funding for stormwater to communities that cannot afford stormwater improvements.
- Create a state-led data-based approach in coordination with localities for prioritizing stormwater projects.

SOURCES

AGU, "Reconstructing repetitive flood exposure across 78 events from 1996 to 2020 in North Carolina, USA. Earth's Future," 2025.

City of Charlotte, "Sustainable Stormwater Management Strategy for a Thriving City," 2021.

City of Raleigh, "Green Stormwater Infrastructure Initiatives," 2025.

City of Raleigh, "Rose Lane Safe Access Flood Resilience Project," 2025.

Federal Emergency Management Agency, "Community Rating System," 2025.

FEMA, "FY 2023 Building Resilient Infrastructure and Communities," 2024.

NCDEQ NPDES MS4 Program, "Permittees and Permit Requirements," 2025.

NC Newsline, "More than 1,200 new miles of NC rivers, streams proposed for impaired waters list," 2019.

NC Resilience Exchange, "Success Story: Greenville Green Infrastructure," 2025.

NC Resilience Exchange, "Success Story: Managing Stormwater with Wetlands," 2025.

North Carolina Department of Environmental Quality, "Flood Resiliency Blueprint," 2025.

North Carolina Department of Environmental Quality, "More Resilient by Design: North Carolina's Flood Resiliency Blueprint," 2025.

SOURCES (cont.)

North Carolina Department of Environmental Quality, "Permittees & Permit Requirements," 2025.

North Carolina Department of Environmental Quality, "Section .1000 – Stormwater Management," 2025.

North Carolina Department of Environmental Quality, "Stormwater Funding Program," 2025.

North Carolina Department of Environmental Quality, Division of Water Infrastructure, "Report to the North Carolina General Assembly's Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources and the Fiscal Research Division, Local Assistance for Stormwater Infrastructure Investments Grants Annual Report," 2023.

North Carolina Institute for Climate Studies, "North Carolina Climate Science Report: Report Findings and Executive Summary," September 2020.

Rainbow Restoration, "The 10 States Hit Most Often by Hurricanes and How to Prepare," 2025.

State of North Carolina Department of Transportation, "2024 Maintenance Operations and Performance Analysis Report (MOPAR)," 2024.

State of North Carolina, Office of the Governor, "February 20, 2025: Letter from Governor Stein to Secretary Duffy re: DOT Grant Awards," 2025.

State of North Carolina, Office of the Governor, "North Carolina Faces the Effects After Republican Legislators Blocked Resilient Building Codes, Losing Millions in FEMA Funding," 2024.

The Watershed Institute, "Stormwater Utilities," 2025.

TRIP, "Keeping North Carolina Mobile: Providing a Modern, Reliable and Sustainable Transportation System in the Tar Heel State," 2024.

University of North Carolina School of Government Environmental Finance Center, "Pilot North Carolina Stormwater Needs Assessment," 2021.

University of North Carolina School of Government Environmental Finance Center, "Results of the 2021 North Carolina Local Government Stormwater Management Survey," 2021.

Photo: Sewer pipe; Happyphotons

WASTEWATER

EXECUTIVE SUMMARY

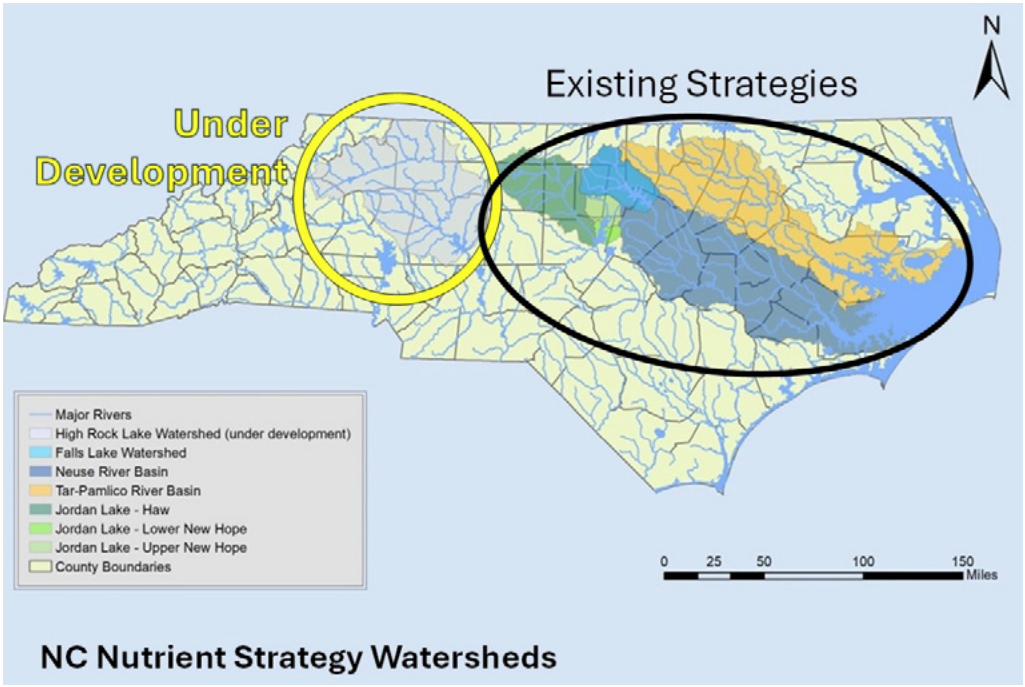
North Carolina is now the ninth most populous state and the eighth fastest-growing, expanding at 1.5% annually. Its two largest counties (Wake (Raleigh) and Mecklenburg (Charlotte)) are planning to expand or build new wastewater treatment plants to keep pace with rapid growth. As population shifts from small towns to larger cities, declining customer bases place additional financial strain on small utilities, which already struggle to maintain sewer and wastewater systems. Many must charge higher sewer rates to offset the loss of customers. The recent 2022 EPA Clean Watersheds Needs Survey identified approximately $12.6 billion in projected sewer and wastewater treatment needs in North Carolina. Though there has been an influx of funding for infrastructure projects in the state, there is still a shortfall to complete all needed projects and there is a growing emphasis in the state to raise utility user rates to meet operation and maintenance needs.

BACKGROUND

The North Carolina Department of Environmental Quality (DEQ) utilizes a basin wide planning approach to manage and protect the water quality in the state's 17 river basins. All 17 basins have issued basin plans which are used to direct water quality regulations in each river basin. These basin plans are updated periodically to track population, land use, and all major industrial and municipal wastewater permitted discharge systems, in addition to networks of ambient monitoring stations to assess water quality issues. Agricultural and stormwater practices are considered, as well, in assessing river basin water quality.

Nutrients levels can be an indicator of waterway health. In nutrient-sensitive river basins, calibrated river modeling is used to assist in the management of future waste load allocations and to establish nutrient strategies as well as total maximum daily limits (TMDLs) for National Pollutant Discharge Elimination System (NPDES) permitted facilities. Currently there are four river basins/watersheds that have nutrient-sensitive water management strategies with nutrient trading associations established: Neuse River Basin, Tar-Pamlico River Basin, Falls Lake Watershed, and Jordan Lake Watershed. A fifth, the High Rock Lake Watershed, is currently under development.

Figure 1. NC Nutrient Strategy Watersheds

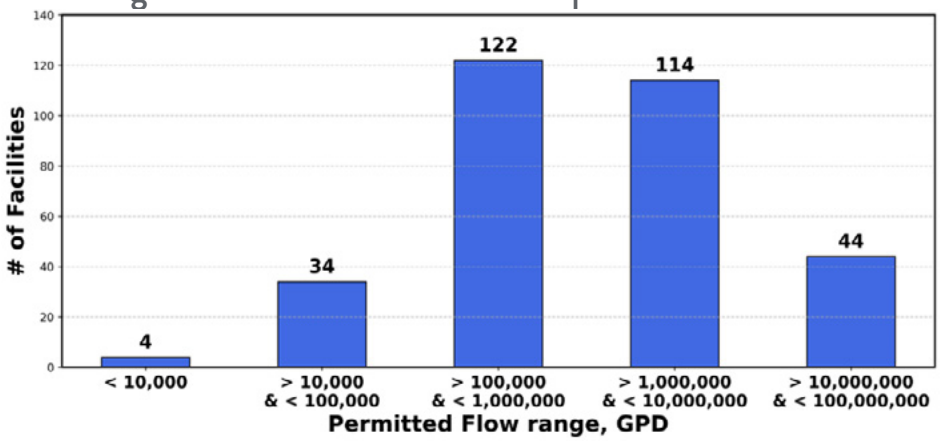


Source: NCDEQ

CAPACITY AND CONDITION

There are approximately 284 municipal NPDES-permitted wastewater treatment plants (WWTPs) in North Carolina. The largest three WWTPs in the state are the City of Raleigh's Neuse River plant (treating 75 million gallons per day (MGD)), Charlotte's McAlpine Creek plant (64 MGD), and Greensboro's T.Z. Osborne plant (56 MGD). Additionally, there are 34 municipal WWTPs that are "non-discharge" permitted facilities, with the most common being spray irrigation of the treated wastewater onto irrigatable land. The largest of these is in Jacksonville (9 MGD). The majority of municipal WWTPs in North Carolina are in the range of 100,000 GPD to 10 MGD, as shown in the figure below.

Figure 2. North Carolina Municipal Treatment Plants



Source: EPA

Other types of wastewater treatment facilities serve residential developments, schools, government complexes, and commercial and industrial facilities. Of these, there are 384 NPDES-permitted facilities and 256 non-discharge facilities.

Numerous of the medium to larger WWTPs in faster growing counties have wastewater flows that are over 50% - 60% of permitted capacities, and they either are or will be looking to expand their facilities in the future. However, most municipalities also struggle with leaky sewer collection systems which introduce groundwater and rainfall-induced infiltration and inflow (I/I) which consumes needed WWTP capacity, from 10% to as much as 50% of a plant's capacity in worst cases. Each municipality must balance sewer collection rehabilitation projects to reduce this I/I added flow, with the need to expand the WWTP for population growth.

Wastewater facility condition assessment, called an Asset Inventory and Assessment (AIA), is essential for a municipality to identify, track, and plan for currently needed infrastructure rehabilitation and repair projects, while at the same time planning for future capital improvement projects. Most large and medium-size municipalities in North Carolina have a completed (or at least partially completed) AIA active program, which is often connected to an active work-order operation & maintenance (O&M) plan. However, many small municipalities struggle to maintain a current AIA program, and numerous small municipalities have not even started an infrastructure AIA program.

It is noteworthy to acknowledge that approximately 50% of homes in North Carolina are on septic systems or decentralized wastewater systems, which is considerably higher than the national average of about 25%. This reflects the rural nature of most counties in the state. Additionally, many coastal areas, including the barrier islands, rely almost exclusively on septic systems and decentralized systems that use subsurface drainfields, although some coastal communities are starting to explore more centralized sewer treatment systems.

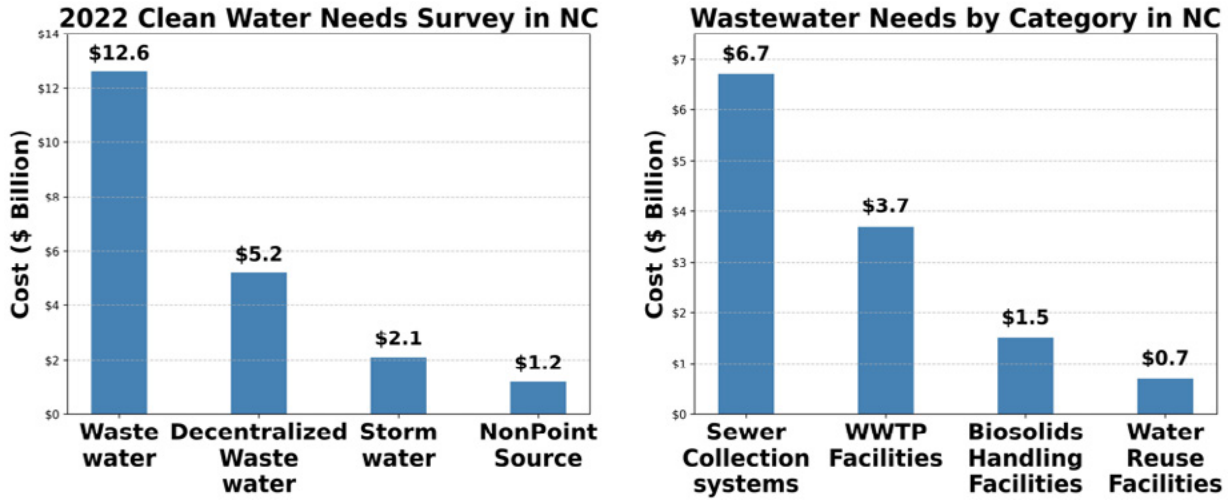
The Viable Utility Reserve (VUR) program

The VUR program was established in 2020 to identify those local governments that need assistance to move toward viability of their water and/or sewer utility, with operational, management, financial, and debt criteria being used to determine if the local government is designated as "distressed." There are certain requirements associated with being designated as distressed, including governing board education and training, the requirement to conduct an asset assessment and rate study, and development of a long-term infrastructure and financial plan. Special grant VUR funding has been made available to distressed local governments to accomplish these requirements, and in many cases, the VUR has funded needed construction projects to help alleviate and foster the path toward long-term viability. Reevaluation of each local government's viability criteria occurs annually with updated annual audits. The number of local governments designated as "distressed" as of 2025 is 151.

FUNDING AND FUTURE NEED

Comprehensive statewide wastewater infrastructure capital investment needs for each state were summarized in the 2022 Clean Watersheds Needs Survey (CWNS), published by the US Environmental Protection Agency (EPA). This survey assessed wastewater capital needs mostly from capital improvements plans (CIP) adopted by each state and local governments. Included in the survey for North Carolina was also the decentralized wastewater needs in all 100 of the state's counties, as well as stormwater needs and nonpoint source needs. Overall, the wastewater capital investment need in North Carolina is $12.6 billion, and the decentralized wastewater need is another $5.2 billion. The $12.6 billion wastewater needs are further broken down by major categories of sewer collection needs ($6.7 million), WWTP facilities ($3.7 billion), biosolids handling facilities ($1.5 billion), and water reuse facilities ($0.7 billion). Combined sewer overflow (CSO) systems, where stormwater is collected by sewer pipes, are not allowed in North Carolina by statute.

Figure 3. Clean Water and Waster Needs by Category



Source: EPA

The top five local governments with the highest wastewater funding needs account for 50% of the entire state's needs, as shown below, totaling $6.3 billion, with Charlotte Water having the largest single need at $4.2 billion.

Table 1. Top 5 Local Government Wastewater Needs

Top 5 Local Government Wastewater Needs (from EPA's 2022 Clean Watersheds Needs Survey)	Total Need ($ Billions)
City of Charlotte (Charlotte Water)	$4.20
City of Raleigh	$1.05
Fayetteville Public Works Commission	$0.46
Cape Fear Public Utilities	$0.33
Water & Sewer Authority of Cabarrus County	$0.27
Total of the 5 Top Local Government Wastewater Needs	**$6.31**

Source: NCDEQ

The high funding need in Charlotte is partially due to new wastewater infrastructure currently being constructed, the new Stowe Regional Water Resource Recovery Facility, to be completed in 2026. This facility will serve northwestern Mecklenburg County and eastern Gaston County, and it will take two older WWTPs offline (Cities of Belmont and Mount Holly). With an estimated cost of $650 million, the Stowe facility will be a 15 MGD advanced treatment plant, expandable to 25 MGD, and is being funded by revenue bonds.

Figure 4. Construction of the Charlotte Water Stowe Regional Water Resource Recovery Facility, adjacent to the Catawba River

Source: CDM Smith

Federal funding for wastewater infrastructure through programs such as the U.S. Department of Agriculture (USDA) Clean Water State Revolving Fund (CWSRF) and the Department of Housing and Urban Development's (HUD) Community Development Block Grant (CDBG) provide many local governments with loans and grants through competitive application processes. The total amount of federal funding awarded to wastewater construction projects in North Carolina has been increasing since 2018, peaking around 2021-2023.

Larger local governments often use their own capital reserve funds for capital improvement projects or finance the projects through municipal or revenue bonds, whereas small to medium sized local governments consistently need to rely on state and federal loans and grants via competitive applications.

During the COVID pandemic time period of 2020 through 2023, multiple federal and state grant programs were initiated to help promote economic recovery. Most of these grant funds were earmarked to specific local governments for any general water and wastewater construction project needed, but some were directed for specific utility projects. Any grant funds that were not earmarked were made available for competitive funding applications from NC DEQ, similar to the SRF application process.

Table 2. Funding Source Breakdown

Year	USDA Funding ($ million)	CW SRF ($ million)	CDBG ($ million)	TOTAL ($ million)
2025	Not available	$209.7	$14.1	$229.1
2024	$56.1	$203.1	$9.7	$272.8
2023	$63.0	$216.5	$9.8	$345.0
2022	$12.0	$192.2		$340.7
2021	$100.3	$246.5	$13.8	$375.0
2020	$27.1	$188.9	$13.3	$232.0
2019	$30.6	$132.8		$163.4
2018	$65.3	$55.0		$122.5

Source: NCDEQ

1. The American Rescue Plan Act (ARPA), passed in 2021 to help economic recovery from the COVID pandemic, provided North Carolina with $1.69 billion designated for water, wastewater, and stormwater needs, with an estimated 50% for wastewater construction projects.

2. The North Carolina Legislature appropriated state grant funds for water and wastewater infrastructure at three separate funding opportunities from 2021 to 2023, with an estimation of 50% being for wastewater construction projects:

    - Session Law 2021-180 appropriated $1.51 billion for water and sewer infrastructure
    - Session Law 2022-74 appropriated $0.61 billion for water and sewer infrastructure
    - Session Law 2023-134 appropriated $1.97 billion for water and sewer infrastructure

3. The Federal government mainly through the Infrastructure Investment and Jobs Act (IIJA) has provided $537 million for water and sewer infrastructure needs in North Carolina between 2022 and 2025, with an estimated 50% being used for wastewater construction projects. IIJA funds were SRF-like loans with large amounts of principal forgiveness made available through competitive NC DEQ applications.

This large amount of federal and state grant funding from 2021 to 2023, adding up to $6.3 billion, represents approximately one-half the Clean Watersheds Needs Survey benchmark of $12.6 billion. While this funding has greatly benefited many utility systems across the state with construction projects on their capital improvement plans, the large influx of funds has presented an unforeseen challenge. Because these funds came into the state's utilities at the same time, the construction market was suddenly flooded with many construction projects going to bid with lots of cash, driving up contractor prices. Therefore, many projects had to be value-engineered down to fit the budgeted amount and, in many cases, the grant funds did not pay for as much construction as was initially projected. Since it is expected that the 2021-to-2023 grant funded construction projects will be completed by the 2026-to-2027 time period, there is already projected to be an overall decrease in utility loan and grant funding in the future, as evident in the drop in overall federal and state funding since 2023.

Tropical Storm Helene highlighted the need for sufficient funding during severe storm events. Rainfall from Tropical Storm Helene in September of 2024 caused massive flooding in many western counties in North Carolina, severing water and sewer lines, destroying sewer pump stations, and damaging four WWTPs, three of which had

to be closed temporarily due to the extensive damage. In total, 163 water and sewer systems were damaged (88 wastewater systems and 75 drinking water systems) with hundreds of miles of damaged water/sewer lines. The cost to repair and/or replace these systems is estimated to be $3.69 billion, of which two-thirds is for sewer and wastewater systems. Funding is ongoing from FEMA and state grant funds.

PFAS/PFOA compounds (often called "forever chemicals) are regulated in drinking water, but are not as this time regulated by EPA in wastewater treatment NPDES permitted facilities. However, PFAS/PFOA monitoring data is being collected in all major NPDES permitted facilities (facilities with flows over 1 million gallons per day) in order to build up a database for understanding both the PFAS/PFOA characterization in WWTP effluent and the impacts of these chemicals on the receiving streams. Most efforts to date in reducing PFAS/PFOA compounds in WWTPs has focused on monitoring sewer collection systems to identify sources, and then working with specific manufacturers to reduce or eliminate these compounds from entering into the sewer collection system.

OPERATION AND MAINTENANCE

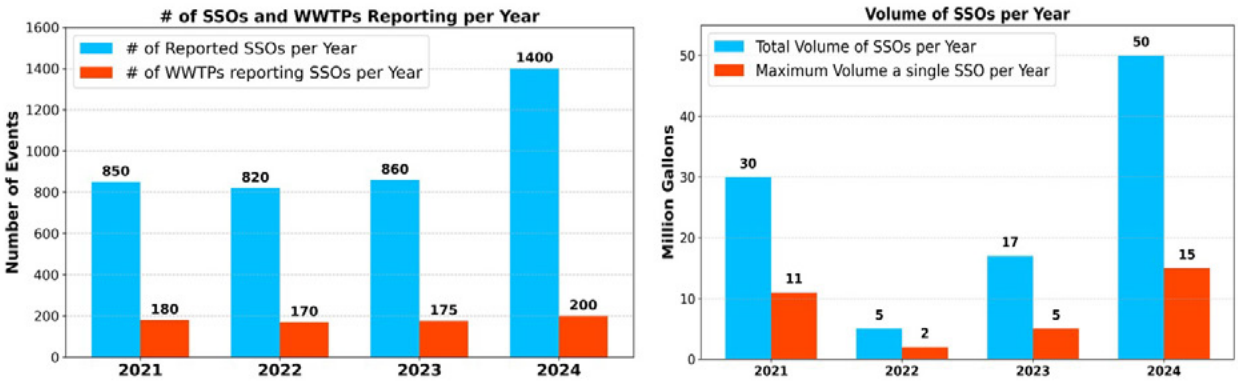
Most medium- to large-sized utilities have their own well-trained workforce to conduct routine operation and maintenance (O&M), while using contract labor for more specialty repairs. Many smaller utility systems maintain limited staff for basic maintenance procedures and use contract operators for plant operations while many utilities also face the challenge of recruiting entry-level positions and retaining mid-level positions. Organizations like the North Carolina Rural Water Association and SERCAP provide training, technical, and sometimes financial assistance to rural water and wastewater utilities. Smaller rural towns and counties with population decreases are facing the daunting task of maintaining basic utility services and repairs with reduced rate payer revenues. These towns are often forced to rely on federal and state grants to perform needed infrastructure rehabilitation, and many times, the long-neglected yearly maintenance becomes a major construction project once grant funding has been obtained. Smaller rural towns and counties often seek help from the North Carolina Regional Council of Governments (COG) or engineering consulting firms for assistance in funding applications for needed construction projects.

NC DEQ's Asset Inventory and Assessment (AIA) grants have assisted over 360 small to medium-size local governments (municipalities, counties, sanitary districts) with wastewater infrastructure inventories and condition assessments. By mapping and assessing the condition of subsurface sewer collection systems and treatment plant equipment, operators can assign the priority of maintenance required. GIS mapping tools and asset management software allow for this work to be done efficiently and effectively, providing a complete picture of local infrastructure's condition, which allows for gap analysis. Asset management data then gets assembled into future multi-year capital improvement plans to make an impact on long-term improvements and rate structures.

PUBLIC SAFETY

Approximately 60% of all municipal WWTPs in North Carolina reported sanitary sewer overflows (SSOs) from the period of 2021 through 2024, with most of these facilities reporting multiple SSOs per year. By North Carolina regulation, all SSOs and/or sewer spills over 1,000 gallons to the ground must be reported to DEQ, and any SSO and/or sewer spill that reaches a surface water body must be reported to DEQ regardless of the volume. SSOs are typically caused by a variety of operational and maintenance issues, including inadequate sewer capacity, sewer pipe breaks, blockages from debris in sewer pipes, broken cleanouts, and power failures at sewer pump stations. Excessive stormwater inflow and groundwater infiltrating (I/I) entering into the sewer collection system via pipe and sewer lateral holes and cracks can overwhelm the sewer system, causing spills at sewer manholes and even sewer pump stations.

Figure 5. Sanitary Sewery Overflow (SSO) Summary



Source: NCDEQ

Local utilities will routinely perform sewer system evaluations, which not only seek to identify sewer pipes and manholes where I/I flow is entering the system, but also seek out illegal or accidental connection of roof downspouts and stormwater to sewer laterals (pipes). Utilities that take proactive measures to remove extraneous I/I and stormwater flows will help prevent SSOs from occurring and also thereby reduce the overall sewer flow to the WWTP.

Reducing overflow helps reduce nutrient levels in nearby waterways. Nutrients like nitrogen and phosphorus are considered "plant food." Wastewater can carry too much of these nutrients into rivers and lakes, which feeds algae growth which can remove oxygen, cause illness to people and pets, and close beaches.

RESILIENCE

North Carolina has had its fair share of massive flooding in different parts of the state caused by Hurricanes Floyd (1999), Matthew (2016), Florence (2018), and most recently Tropical Storm Helene (2024). Many flooded utility systems have had to take after-the-fact measures to build resilience and emergency preparedness into their sewer and WWTP systems, by relocating pump stations to higher ground, raising walls to keep out flood waters and, in some cases, relocating the entire WWTP to higher ground. Many utilities are now planning for proactive construction projects to elevate infrastructure and ensure that emergency systems are in place for a future worst-case flooding when the next hurricane or tropical storm hits.

Tropical Storm Helene is estimated to have caused $3.69 billion in damage to the 163 water and wastewater utility systems in the western counties of North Carolina, with 88 wastewater systems and 75 drinking water systems impacted. Funding is ongoing with FEMA and other State grants. However, as with many FEMA grant projects, the funding is a work-in-progress and requires time.

Figures 7 and 8. Helene recovery Efforts

Source: WithersRavenel

INNOVATION

Numerous WWTPs in North Carolina utilize advanced biological nutrient removal (BNR) technologies to achieve the low concentrations of nitrogen and phosphorus required by the NPDES permits discharging into nutrient-sensitive waters. Beyond this, the Town of Wilkesboro is constructing a new 8.0 MGD WWTP which uses new, innovative technology called aerobic granular sludge (AGS), the first of its kind in North Carolina, and one of the first in the southeast US. This innovative activated sludge process involves a batch biological reactor that forms very large and dense wastewater biosolids, or "floc," which settles very rapidly, producing excellent quality treated wastewater, while simultaneously reducing harmful nutrients. This $72 million construction project is funded by CW SRF and state funds.

Additionally, while embedded smart sensors in waterways and sewer systems are not new, their relatively inexpensive price and the ability to easily connect (via WiFi and cellular) to the internet and cloud-based systems allows for innovative, real-time monitoring of flow, pressure, depth of water in pipes and tanks, and other indicator parameters. These monitors can alert utility operators in real-time of sanitary sewer overflows, plant process problems, pump failures, or power outages, all of which allows operators to react quickly to urgent situations, and this also allows operators to make real-time adjustments much quicker than previously. Such implemented Internet-of-Things (IoT) for water and sewer systems is affordable enough that even small towns can easily afford such sensor systems and reap the benefits of real-time data management, allowing for greater operational efficiency and immediate detection and notification of operational upsets.

RECOMMENDATIONS TO RAISE THE GRADE

- Encourage utilities to direct user rates reflective of the full cost of service, including operation, maintenance, and future capital needs. Partnerships between utilities, North Carolina Local Government Commission, and UNC School of Government can facilitate this development in setting appropriate rate structures to ensure long-term utility financial viability.
- Promote regional approaches for wastewater management that take advantage of economies of scale.
- Urge NC DEQ to fund sewer utilities involved in asset inventory and assessment (AIA), in order to fully map out and delineate all of the state's sewer and wastewater infrastructure and make accurate assessments regarding its age and condition.
- Encourage NC DEQ to expand funding for the Decentralized Onsite Septic System program and promote local government assistance to individual households for repair or replacement of their septic systems.
- Expand state loan and grant programs to help close the gap in the funding need. Special priority should be given to smaller utilities that struggle to maintain their sewer infrastructure.
- Implement regulations and allocate funding related to PFAS.

SOURCES

Charlotte Water Stowe Regional Water Resource Recovery Facility, "From Wastewater to Water Resources," n.d.

North Carolina Department of Environmental Quality, "North Carolina's Statewide Water and Wastewater Infrastructure Master Plan, The Road to Viability," 2017.

North Carolina Office of State Budget and Management, "North Carolina Now Home to Over 11 Million People," 2024.

North Carolina Office of State Budget and Management, "Hurricane Helene Recovery, Revised Damage and Needs Assessment," 2024.

U.S. Environmental Protection Agency, "2022 Clean Watersheds Needs Survey: Report to Congress," 2024.

Wilkes Journal-Patriot, "Wilkesboro wastewater expansion to cost $72 million," 2023.

Comparison of North Carolina and National Grades

CLOSING SUMMARY

This was the first Infrastructure Report Card for North Carolina since 2013. This report follows the format of the ASCE National Infrastructure Report Card. The 2025 national report card evaluated 18 categories. The North Carolina report card evaluated 7 of those 18 categories. It should be noted that while the average overall grade for North Carolina was lower than the national average, a majority of the North Carolina categories scored better than the respective grades of the national categories.

Category	NORTH CAROLINA	NATIONAL
Aviation	C-	D+
Bridges	C-	C
Dams	D+	D+
Drinking Water	C+	C-
Roads	C-	D+
Stormwater	C-	D
Wastewater	D+	D+

The 2026 Committee for the Report Card on North Carolina's Infrastructure

THE WORK ON THIS REPORT CARD WAS MADE POSSIBLE BY VOLUNTEERS FROM ASCE IN NORTH CAROLINA AND ASCE STAFF.

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