North Carolina DOT
USDOT RAISE Grant Application

FLOW BETTER

Fixing **LO**w **W**ater **B**ridges for **E**mergency, **T**ransportation, **T**echnology, **E**quity, and **R**esilience

JULY 2021

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Application Information

Supplemental Materials are available online at:	https://connect.ncdot.gov/resources/RAISE-LowWater/Pages/default.aspx
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I. Project Description

The *Fixing LOw Water Bridges for Emergency, Transportation, Technology, Equity and Resilience* Project ("FLOW BETTER" or "the Project" hereafter) is the result of a thoughtful and coordinated strategy to improve access, economic competitiveness, safety, equity, and infrastructure resilience in rural, western North Carolina. The FLOW BETTER Project will reconstruct 28 bridges in the six (6) mountainous counties of Avery, Ashe, Alleghany, Caldwell, Watauga, and Wilkes in North Carolina (see Figure 6). It includes 26 low water bridges, one (1) scour critical bridge at a strategic location in the regional road network, and one (1) bridge with pedestrian fatalities. Low water bridges, for the purpose of this application, are structures built to keep low-volume roads open when the surrounding terrain does not permit road approaches to a higher bridge or the cost of a higher bridge cannot be justified. The 26 low water bridges included with the Project have reached or exceeded the end of their useful life, and are characterized by substandard barrier railings, obsolete timber decking and substructures, significant weight limit restrictions, and overtopping and wash-outs during flood conditions.

Despite these challenges, the Project bridges are important access points to rural North Carolina's High Country for regional industries, residents in Areas of Persistent Poverty, and critical services. Under current conditions (see Figure 1), the 26 low water bridges experience frequent overtopping during flood events, causing travel-time delays, repetitive damage to the timber bridge structures, and cut off access to some of the state's most vulnerable populations. The Project directly addresses the challenges of increasing infrastructure resilience in response to climate change impacts while promoting economic competitiveness in rural North Carolina by providing a more reliable roadway network for residents, industry, and critical services. The Project will incorporate technology components, including conduit on six (6) bridges for future broadband service, and six (6) stream monitoring gages.[1] These gages will be installed and connected to the NC Flood Inundation Mapping and Alert Network for Transportation (FIMAN-T) and Bridgewatch to monitor and forecast flood risk/conditions in real-time. These technology components will enhance rural access to broadband and improve public safety during flooding events.

Figure 1: Current Condition of Bridges 040093, 040351, and 040466

The FLOW BETTER Project will reconstruct each bridge with a design that is tailored to the context of the surrounding area as follows:

- The 26 low water bridges will be replaced with new structures designed to current standards for low water bridges, making them more resilient to flooding and addressing maintenance challenges.

[1] This narrative uses the U.S. Geological Survey (USGS) spelling of "gage" per the agency's use in its standard discharge records.

- The two (2) remaining bridges (960012 and 960730) will be reconstructed to bring them into a state of good repair as they currently have scouring of soil around one of the bents, poor condition of the substructure, and bents in the water which increases drift potential. Replacement reduces flooding potential, which is needed to mitigate repetitive loss, address serious safety concerns (particularly to mitigate recent pedestrian fatalities on Bridge 960730), and meet transportation needs for regional industries, emergency services, and the local community.
- Each bridge will be raised as close to the 25-year storm elevation as its physical setting will allow, reducing the frequency of overtopping and increasing reliability.
- Replacement structures will be constructed with concrete decks and modern superstructures to improve accessibility and maintenance requirements.
- Barrier rails will be installed to meet current standards, providing improved protection to motorists and pedestrians/bicyclists while allowing water to flow through, if overtopped.
- Six (6)[2] bridges will include stream gages that provide flood warning and water-level monitoring. This information will support the application of FIMAN-T and Bridgewatch, two models that allow the North Carolina Department of Transportation (NCDOT) to use the information from the stream gages to run simulations and forecasts as storm events unfold to predict future inundation by location and stresses on bridges. This information is vital when planning a storm response or screening investments to improve the resilience of the network and is of particular importance to protecting isolated households in the region who have no other means of ingress or egress.
- Six (6) [3] bridges will include conduit to accommodate future fiber optic cable installation for the region to improve Internet access, bolstering economic competitiveness and removing barriers to opportunity for disadvantaged rural populations.

Six (6) of the bridges are programmed for replacement in the coming State Transportation Improvement Program (STIP) cycle; the remaining bridges are not currently programmed. With North Carolina's unique prioritized replacement scoring process, these bridges do not meet the score needed to be considered for replacement with the available state funds. While critical to ensuring public safety, resilience, and economic growth of the region, these bridges would fail to receive state funding due to their low traffic volumes. The remaining 22 bridges need to be replaced. Without the federal funds sought through this Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant application, these 22 bridges will continue to pose unsafe conditions and impair accessibility in the region without a remedy in the foreseeable future.

Major Project Benefits

- Improved Emergency Response/Access
- Infrastructure Resilience
- Travel Time Savings
- Operation and Maintenance Savings
- Vehicle Maintenance Savings
- Increased Access and Connectivity

Transportation Challenge

Recurring flooding from both seasonal precipitation events as well as more extreme weather events is an ongoing challenge for the Project bridges. Overtopping of the low water bridges reduces roadway connectivity, creates safety hazards, and leads to increased maintenance challenges. The High Country Regional

[2] Includes Bridges 040047, 040226, 040509, 130275, 940319, and 960012.
[3] Includes Bridges 040047, 040093, 040480, 130130, 960012, and 960730.

Hazard Mitigation Plan Update (2017), which covers four of the six counties within which the Project is located, concluded that the region has a high risk of winter storm and freeze, severe thunderstorm/wind storm, hailstorm, hurricane and tropical storm, flood, and wildfire. Of note, these hazards are not statistically independent. A wildfire that removes the vegetative cover, increases the likelihood of flash flooding. Similarly, thunderstorms and tropical storms lead to flooding. The State of North Carolina Hazard Mitigation Plan (2018) also identifies Avery, Ashe, Alleghany, Caldwell, and Watauga counties declared in the Federal Emergency Management Agency (FEMA) DR-1871, severe winter storms and flooding events. The county and state hazard mitigation plans are provided in the Supplemental Materials as part of this application.

The recurrent flooding poses a risk to safety, is a burden to maintenance and operations, impacts both infrastructure and social resilience, reduces quality of life, and limits accessibility and associated economic competitiveness. These challenges are particularly impactful to low-income populations concentrated in the region. For example, by the time Hurricane Florence hit this region of the state in 2018, it had weakened to a tropical depression. Projected rain totals of 10 inches did not occur; precipitation maps from the National Weather Service show most of Ashe and Watauga counties had 4-inches of rain at its highest magnitude. This was still enough to submerge every low water bridge in Ashe County, according to reports in the *High Country Press* (September 17, 2018). No bridge could be reopened until NCDOT completed an inspection and needed repairs were made. The report highlights the risk and vulnerability of these rural communities caused by the recurring flooding[4]. Figure 2 and Figure 3 below shows general flooding conditions in the area.

Figure 2: Flooding at Bridge 040226 in Ashe County

[4] "Tropical Depression Florence Finally Leaves the High Country; Rainfall Totals Vary Across the Mountains," High Country Press, September 17, 2018. Accessed https://www.hcpress.com/news/tropical-depression-florence-finally-leaves-the-high-country-rainfall-totals-vary-across-the-mountains.html

While Tropical Storm Florence was a particularly severe event, this scale is not unprecedented in the region. The aftermath of Tropical Storm Frances and Hurricane Ivan in 2004 caused between 6-to-20 inches of rain within a 10-day period, resulting in significant flood and debris-flow damages, economic losses, environmental damages, and 11 deaths. In addition to these major hazard events, the low water bridges flood during less severe storms. Ashe County Emergency Services reports that these risks and accessibility challenges increase emergency service response times an additional five[5] to ten[6] minutes for a significant number of private homes.[7] See Supplemental Materials for bridge detour maps.

Figure 3: Flooding at Bridge 040463 on Clifton Road

Figure 4: Typical Debris Example

In addition to the impacts cited above, when these bridges flood, a vast amount of debris is deposited upon the bridges (see Figure 4). This requires a significant number of man-hours and resources from NCDOT to remove and dispose of the debris and to verify the structural integrity of the bridges, further extending the impact of flooding events that can negatively impact Areas of Persistent Poverty and adjacent natural resources.

In addition to the flooding-related safety concerns, 21 of these bridges are single-lane facilities, 26 do not have barrier rails, and 25 are posted for reduced loads, all of which cause safety concerns for the bridges. This makes it difficult and sometimes unsafe for emergency vehicles and school buses to cross. By reconstructing these bridges to meet current design standards, the potential for crashes with fatalities and injuries will be reduced.

[5] Bridge 040093 on McNeil Road.
[6] Bridges 040343 and 040226.
[7] Interview with Ashe County Emergency Services Director, June 24, 2019.

Figure 5: Flooding at Bridge 040466 on Boggs Road

Many of the bridges are also on school bus routes. Across all six (6) counties, 15 buses make approximately 31 daily trips across the Project bridges. This excludes trips for athletic events and special events. When the bridges are flooded, trips are longer, or households cannot make the trip to school until the bridge is inspected and reopened. Figure 5 shows a typical detour posting at a flooded bridge on Boggs Road in Ashe County. Some posted Project bridges cannot support the weight of a school bus, requiring longer daily routes to reach households in some of the more rural locations. In addition to limits on accessibility imposed by flooding as described above, safety and maintenance efficiency will also be improved by the Project.

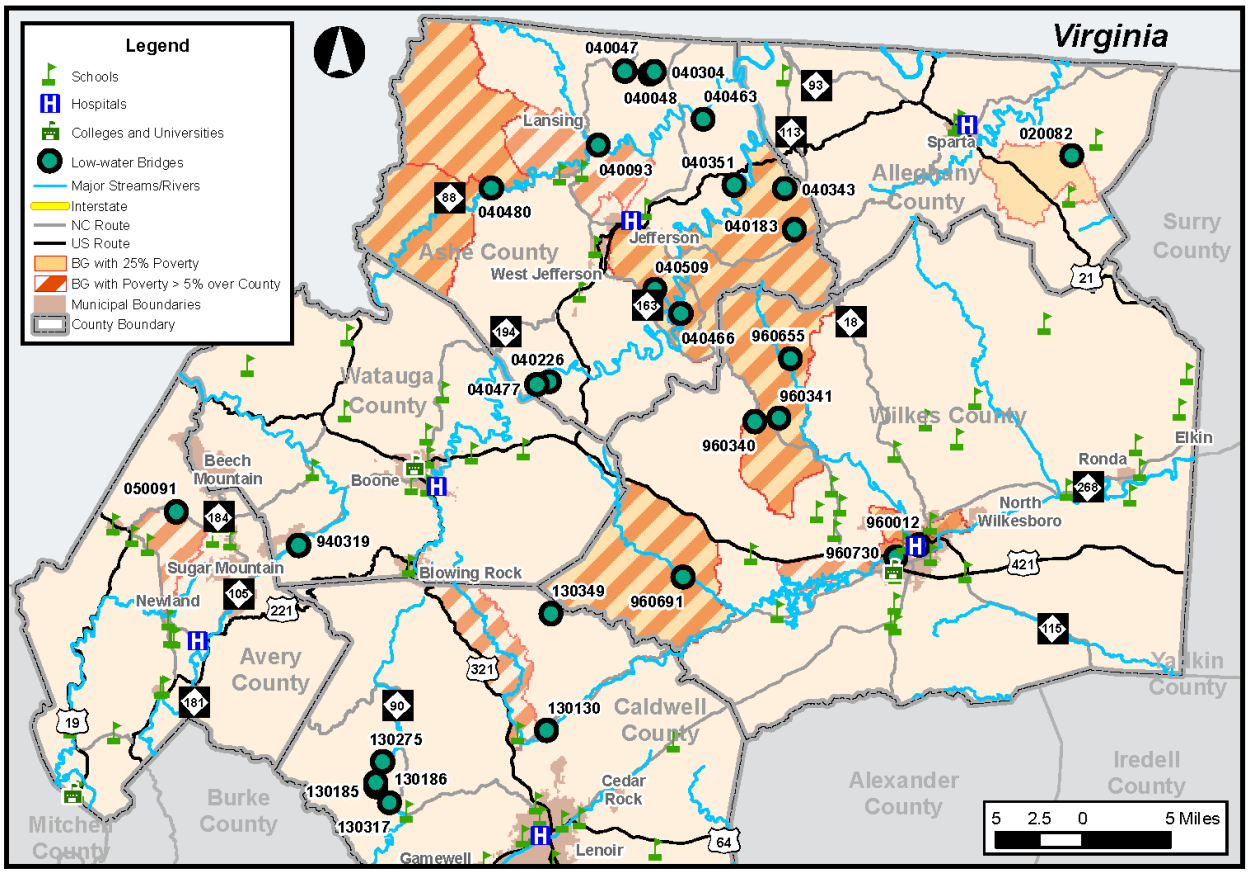
First, the ability to evacuate residents and improved facilitation of emergency response actions are important benefits of the improved bridges and provide important safety benefits stemming from their redesign. The addition of a lane and barrier rail will reduce the crash factors significantly. It is anticipated that crash frequency will fall by as much as 32 percent.

Second, bridge maintenance will become more efficient as well. Damage to bridges is predicted to decrease with the elimination of timber bridges and the use of purpose-built bridges that stand up to high water. Moreover, the new design has been developed to minimize the amount of debris that is caught on the bridge and must be cleared before the crossing can be reopened.

II. Project Location

All FLOW BETTER Project bridges are in Avery, Ashe, Alleghany, Caldwell, Watauga, and Wilkes counties in rural, western North Carolina. These six (6) counties fall within the Appalachian Regional Commission's (ARC) development area. ARC is a regional economic development agency that represents a partnership of federal, state, and local government whose primary objective is to help "distressed" counties improve their economic development potential to compete with the rest of the nation and world. To monitor economic progress, ARC has developed an index-based county economic classification system to identify and supervise the economic status of Appalachian counties. The index is comprised of three economic indicators: 1) the three-year average for the unemployment rate; 2) per capita market income; 3) and poverty rate. These values are summed and averaged to create a composite index value for each county that is compared with the equivalent measure for the nation. By this measure, rural Ashe, Wilkes, and Watauga all rank between the worst 10 percent and 25 percent of the nation's counties.[8]

Figure 6: The FLOW BETTER Project Will Replace 28 Bridges in Western North Carolina



[8] ARC Economic Levels 2013-2017 as reported in the 2017-2020 NC Appalachian Regional Commission Program Development Plan.

The Project bridges were selected according to four criteria: 1) whether the bridge was flood-prone; 2) whether the bridge lacked barrier rail and only had a curb; 3) whether the bridge was structurally deficient; 4) whether the bridge had limited alternative funding options; and 5) whether the bridge is located in or adjacent to an Area of Persistent Poverty. Supplemental Materials to this application list each of the 28 bridges by its Structure ID number and provides the geospatial (latitude and longitude) coordinates, whether it is structurally deficient or meets the legacy definition of functionally obsolete, its average daily traffic (ADT), and information on its construction.

As discussed in the Project Description section, the Project bridges, and the geographies in which they are located, are prone to severe flooding that restricts accessibility and the opportunity to reach essential services. As the impacts of climate change continue to worsen, these areas will become more vulnerable to increasingly frequent and severe weather events. Not only will essential services (such as emergency response and school bus transportation) and local economic industries be negatively impacted, but communities in Areas of Persistent Poverty will be negatively affected. These Project bridges were identified as facilities that are in immediate need of replacement to increase the resilience of the roadway network to withstand climatically induced shocks and stressors.

As illustrated in Figure 6, 16 of the bridges are in, or directly adjacent to, areas that exceed the State's environmental justice threshold for poverty and eight (8) are located in or directly adjacent to Areas of Persistent Poverty. By bringing these bridges into a state of good repair and reducing the frequency, severity, and duration of overtopping and wash-out events, the project will improve connectivity, safety, and economic opportunity for underserved populations. This is particularly important for the western region of North Carolina which lags the rest of the state in terms of economic development.

III. Grant Funds, Sources, and Uses of Project Funds

The following outlines the funding strategy for the FLOW BETTER Project. The estimated cost to replace the Project bridges and bring them to a state of good repair, install conduit on six (6) bridges, and install hydraulic sensors on six (6) bridges is $53.4 million (YOE dollars), comprised of $42.8 million (YOE dollars) provided as a match for the project and an ask amount of $10.7 million (YOE dollars). Without RAISE grant funding, this Project will likely not be completed.

The capital costs, sources, and uses of funds for all 28 Project bridges are summarized in Table 1 below. A bridge-by-bridge summary is included in the Supplemental Materials provided with this application.

- **Project ask:** NCDOT, on behalf of the six (6) rural counties, is requesting $10.7 million (YOE dollars) of RAISE capital funding to support the Project.
- **Eligible project costs**: The total estimated cost to complete the FLOW BETTER Project is $53.4 million (YOE dollars).
- **Funding commitment**: The non-federal funds for the bridges will be provided by NCDOT from the State Bridge Program (SBP). A letter of funding commitment from NCDOT is provided in the Supplemental Materials for this application.
- **Non-federal match:** A non-federal match of $42.8 million (YOE dollars) is committed to the project. Every dollar of RAISE funding leverages an additional $4 dollars of non-federal spending.
- **Budget for FLOW BETTER Project**: The budget to replace all 28 bridges is summarized in Table 1 below, identifying those sources that are non-federal, RAISE, and other federal as requested in the guidance. The table provides this information at a summary level for the total project. An individual bridge-by-bridge tabulation is provided in the Supplementary Materials.

Table 1 below provides a summary of the funding source, amount of committed or requested funds, and funding sources.

Table 1: Sources and Uses of Funds for the FLOW BETTER Project (YOE$)

Summary	Design	ROW	Utilities	Construction	Total
	Total (All 28 Bridges)				
State Match	$5,537,726	$2,630,950	$2,355,125	$32,234,738	$42,758,540
RAISE Ask	$1,384,432	$657,738	$588,781	$8,058,685	$10,689,635
Total	$6,922,158	$3,288,688	$2,943,906	$40,293,423	$53,448,175

ROW: Right-of-Way
Includes costs for flood gages and conduit

IV. Selection Criteria

The investments proposed in this RAISE application will generate a variety of benefits for residents and businesses, travelers through the region, and North Carolina taxpayers. Some of these benefits can be quantified and captured in the benefit cost analysis (BCA); many cannot and are detailed in the following section. Before moving to a discussion of each of the long-term outcomes, Table 2 provides a summary overview of how the Project aligns with the evaluation criteria.

Table 2: Evaluation Criteria Narrative Matrix

Criteria		How the Project Satisfies the Criteria
Primary	Safety	Each existing one-lane bridge will be reconstructed with an improved design that adds a second lane and barrier rail along the sides of the bridge. Where technically feasible, the bridges will be raised to reduce frequency of flooding, maintaining the road network's availability for Emergency Medical Services (EMS) as needed. Avoiding detours during bridge closures, reduces vehicle miles traveled (VMT) and the potential for crashes. Project bridges will be built in a context-sensitive manner to meet the needs of the various locations they serve.
	Environmental Sustainability	The project will make the roadway network more resilient as weather related shocks and stressors become more frequent and severe due to climate change. The Project will install six (6) flood gages and water-level monitors to improve flood warning and flood monitoring. The reduction of detour driving reduces emissions and improves air quality. The elimination of timber deck bridges whose wooden components are treated with chemicals or may have remaining lead paint will reduce this exposure into the region's waterways.
	Quality of Life	The FLOW BETTER Project will reduce the repeated fragmentation of the region's transportation network due to flooding. In this rural mountainous region, flash floods come quickly with little advance warning. The improved reliability of the transport network, advance warning of unavoidable flood events allowing households to prepare, and enhanced opportunities for broadband coverage will all contribute to a higher quality of life, helping to retain and attract residents and commerce.
	Economic Competitiveness	The improvements will reduce the frequency and duration of time that bridges are out of service, saving auto and truck travel time due to detours. The Project will install conduit at six (6) strategic locations to prepare for emerging technologies to expand the existing network of rural broadband in North Carolina. The Project will provide a more reliable roadway network for agriculturally significant areas including the region's Christmas tree farms, which as a large economic contributor in North Carolina and across the nation.
	State of Good Repair	Project bridges will be reconstructed with an improved design that requires fewer regular (non-flood event driven) annual maintenance expenditures compared to bridges made of timber or which are structurally deficient. The bridges will be designed for greater resilience to overtopping, resulting in less drift and debris caught in the structure. This reduces annual repair costs and helps return the bridge to useful service more quickly.

Criteria		How the Project Satisfies the Criteria
		The reduction in detours associated by bridge closures reduces VMT and the associated wear-and-tear on neighboring roads. Bridge 960730 will be replaced to improve safety for pedestrians in the wake two pedestrian fatalities on June 5, 2021.
Secondary	Innovation (technologies)	The Project will install six (6) flood gages and water-level monitors to improve flood warning and flood monitoring. The Project will install conduit at six (6) strategic locations to prepare for emerging technologies to expand the existing network of rural broadband in North Carolina.
	Innovation (project delivery)	In early 2017, Federal Highway Administration (FHWA) and NCDOT executed a Categorical Exclusion (CE) Checklist to help streamline project delivery. The Project will also take advantage of various programs within NCDOT to streamline project delivery, including Express Design Build contracting.
	Partnership	NCDOT will lead the Project as the primary purpose and benefits are transportation focused. Through its creative partnering with North Carolina Department of Information Technology (NCDIT), NCDOT can leverage the Project transportation investment to accomplish additional community objectives such as the opportunity to expand broadband coverage, aligning with NC Governor's Executive Orders.

Primary Selection Criteria

This section provides additional detail on the Project features that align with the 2021 RAISE program's Primary Selection Criteria.

Safety

The Project improves safety in several ways. Firstly, each existing Project bridge is not constructed to current NCDOT and Federal standards. The new bridges and approaches will be designed for modern standards and vehicles, reducing the potential for fatalities, injuries, and crash costs. Chief among these improvements will be the addition of barrier rails to the sides of the bridges. As illustrated in Figure 7, the typical bridge has a short wooden "curb" to mark the edge of the bridge—there are no reflectors or other markers to aid the driver at night. NCDOT research has found that the addition of barrier railings to this type of bridge, reduces the likelihood of an injury by 32 percent. Of note, the federal crash reduction factor reported is higher, but this

Figure 7: Timber curb that is typical on Project bridges

application/BCA utilizes the lower state-specific value. These safety improvements result in $7.5 million in benefits.[9]

Secondly, as noted in the Project Description above, the ability to maintain the road connection is critical for the provision of EMS services. Interviews with county EMS directors highlighted how these bridges serve as the essential lifeline for many in the community. Project bridge closures add a significant time penalty to the emergency response (see textbox below). The value of improving emergency response is $0.5 million in benefits.[10] This includes access to emergency services, see Figure 8.

Maintaining Emergency Services to Underserved Rural Populations

Bridge 040477 on Brown Road has the potential to have a very serious impact according to the Ashe County Emergency Services Director. Each time that bridge floods, which is 3-6 times per year, there are 52 homes that become isolated. Most of the homeowners are elderly and have a high potential for needing medical assistance at any given time. Should a medical emergency occur within the subdivision, responders would have to use an unpaved, gravel or rugged overgrown route (with special permission from a property owner for emergency services use only) that is accessed from across the mountain. This alternative route is not open to residents as an ingress/egress and requires use of a four-wheel drive, all-terrain vehicle for access and would add at least an hour or more to medical response time. Ambulances, fire engines, tankers, and law enforcement vehicles would not be able to access the area

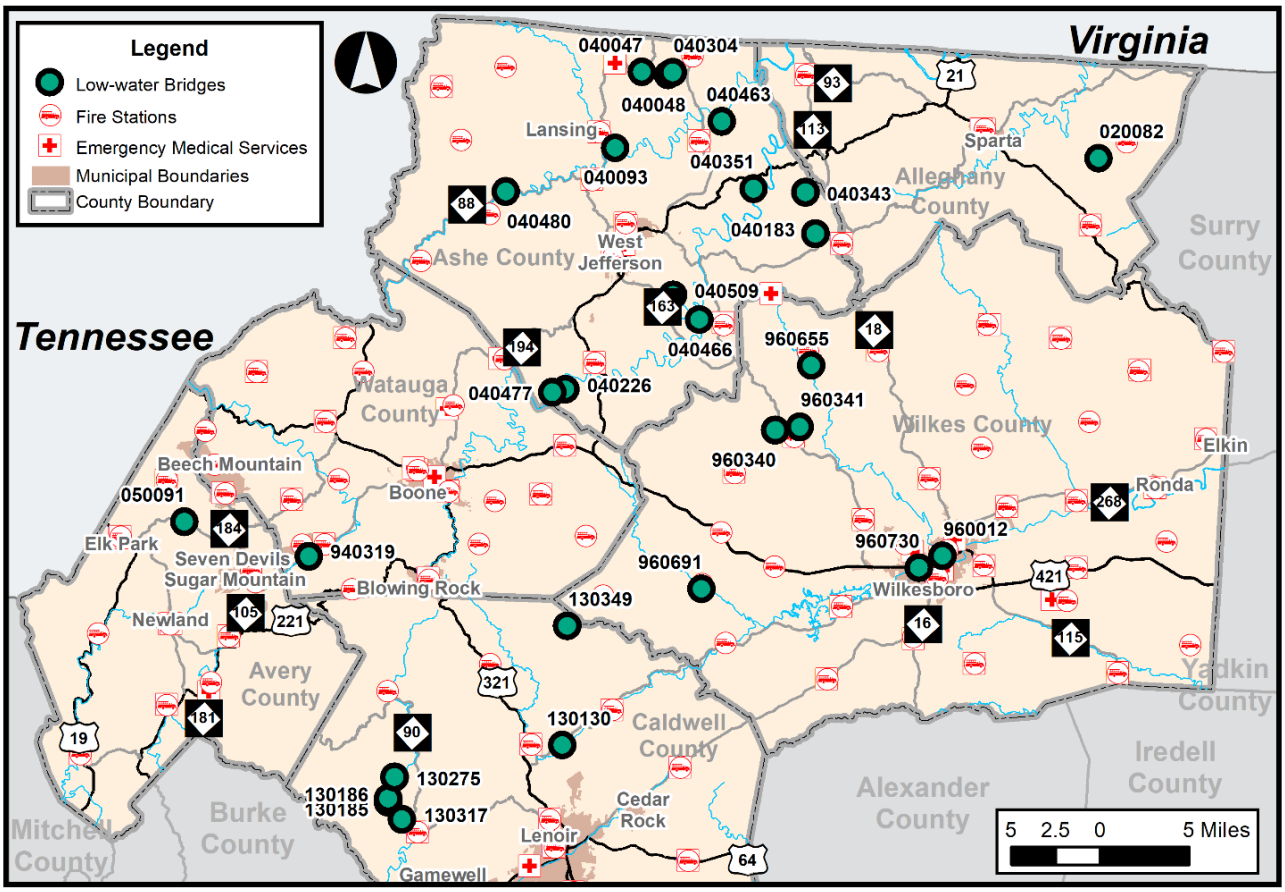
Bridges 040047, 040048, and 040304 are along the same stretch of roadways and all flood several times a year. When they all flood at the same time it creates a situation where a significant population along Helton Road, Big Helton Road, and Jim Duvall Road are isolated on both sides. It is impossible for emergency services to effectively reach the 49 homes in this area, even with the use of all-terrain vehicles.

Bridge 040466 on Boggs Road impacts several homeowners as well as a camp that provides services to terminally ill children. During flooding on this bridge, the camp is inaccessible and response times to this area are increased by approximately 10 minutes down a winding, narrow dirt road.

Bridge 040509 on Methodist Camp Road leads to a new addition to the North Carolina State park system which contains no homes but does contain some structures. When the bridge floods, the entire park is inaccessible to emergency services.

[9] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.
[10] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.

Figure 8: Proximity of Project Bridges to EMS

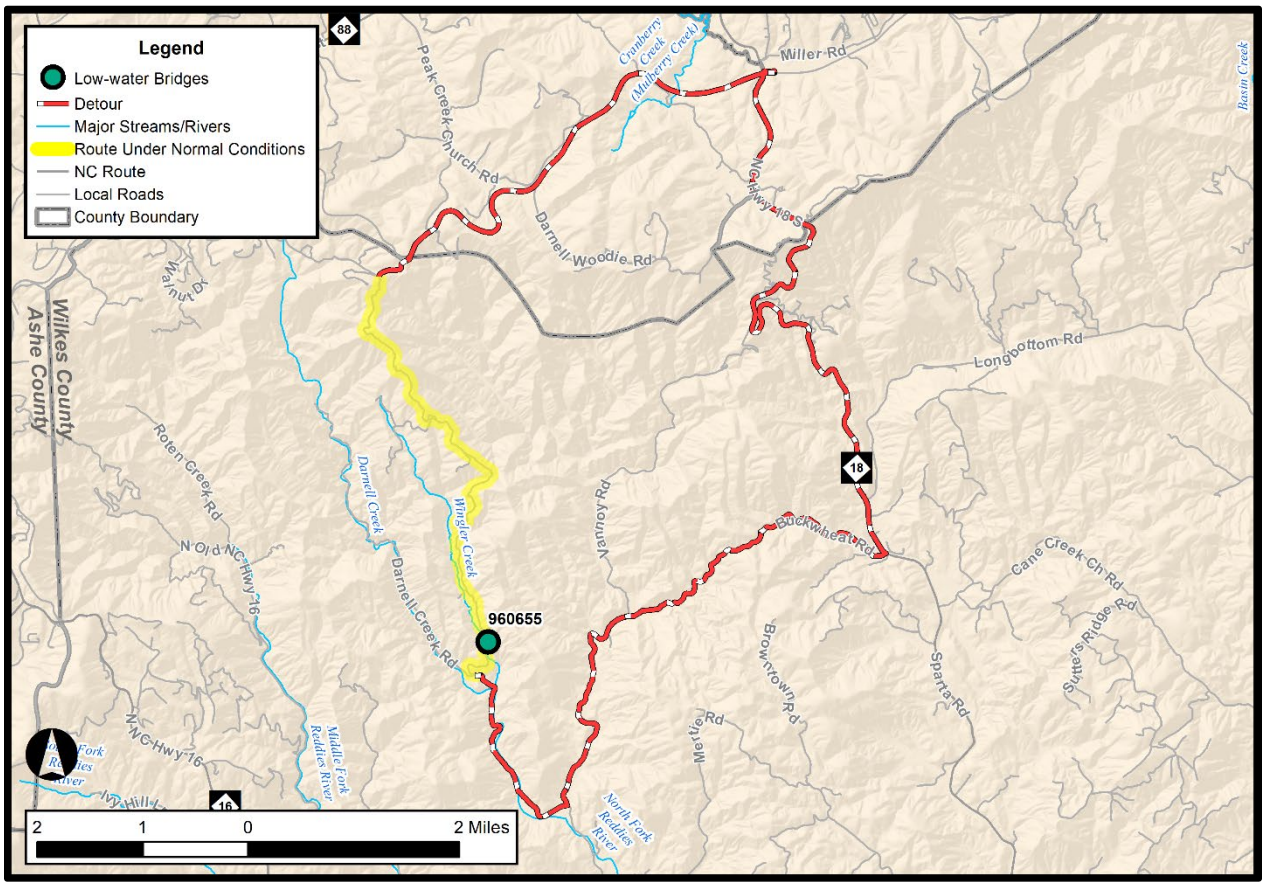


Each of the replacement bridges will be designed to capture less debris and constructed higher where technically feasible, reducing the likelihood of being flooded and unavailable for use, reducing the time needed to reopen for instances when flooding cannot be avoided. Seven of the bridges are located on dead-end streets that offer no detour option when the bridge floods, the BCA includes an economic loss for every trip not taken due to the condition of the bridges. FEMA has estimated that every trip not taken is 12 hours of time ($17.90 in 2019 dollar/per day). This metric quantifies the impacts of the potential harm that is caused by having reduced or no access to essential services, emergency services, or economic opportunities when the bridges are not passable.

Thirdly, once the bridge is replaced and able to accommodate all types of vehicles, detours will be reduced, reducing VMT and the chance of a crash. The BCA provided with this application estimates the value of the safer bridge design and the reduction in VMT. For example, the detour needed during closure on Bridge 960655 increased from 5.43 miles under normal conditions to a 19.7 mile detour (Figure 9). Please refer to the BCA Technical Memo for more information and the estimated detour lengths for each bridge. The value of VMT avoided results in $3.7 million in safety benefits.[11]

[11] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.

Figure 9: Bridge 960655 Normal vs Detour Route



Finally, Bridge 960730 on Curtis Bridge Road in the Town of Wilkesboro, has been identified as a bridge that is particularly dangerous to pedestrians. On June 5, 2021, two pedestrians were struck and killed in a hit and run collision on this bridge. The current bridge was constructed in 1952 and rehabilitated in 2010 but has a barrier rail that does not meet standards for pedestrian usage. Given the current conditions of the bridge, there is not enough room on the existing bridge to construct a sidewalk, nor can the bridge be widened without the addition of foundations, columns, and girders. This grant will allow NCDOT to promptly replace this bridge, responding to extreme safety concerns and the requests of the local population that has come together to submit a petition to have the bridge replaced as a way to improve safety and access. See Supplemental Materials for North Carolina Recovery Advocacy Project Petition.

Environmental Sustainability

Transportation is integral to North Carolina's economy, connecting manufacturers with supply chains, consumers with products and tourism, and communities to essential services. More frequent and severe weather and flood events caused from climate change disrupts the safety and reliability of these multimodal transportation networks. This is stressing resources used to keep pace with the damage inflicted by major hazard events, resulting in negative impacts on economic vitality and public health, particularly in Areas of Persistent Poverty. The new design of the Project bridges will improve environmental sustainability by increasing resilience of the structural design, material composition, and by incorporating environmental justice into all aspects of design and delivery.

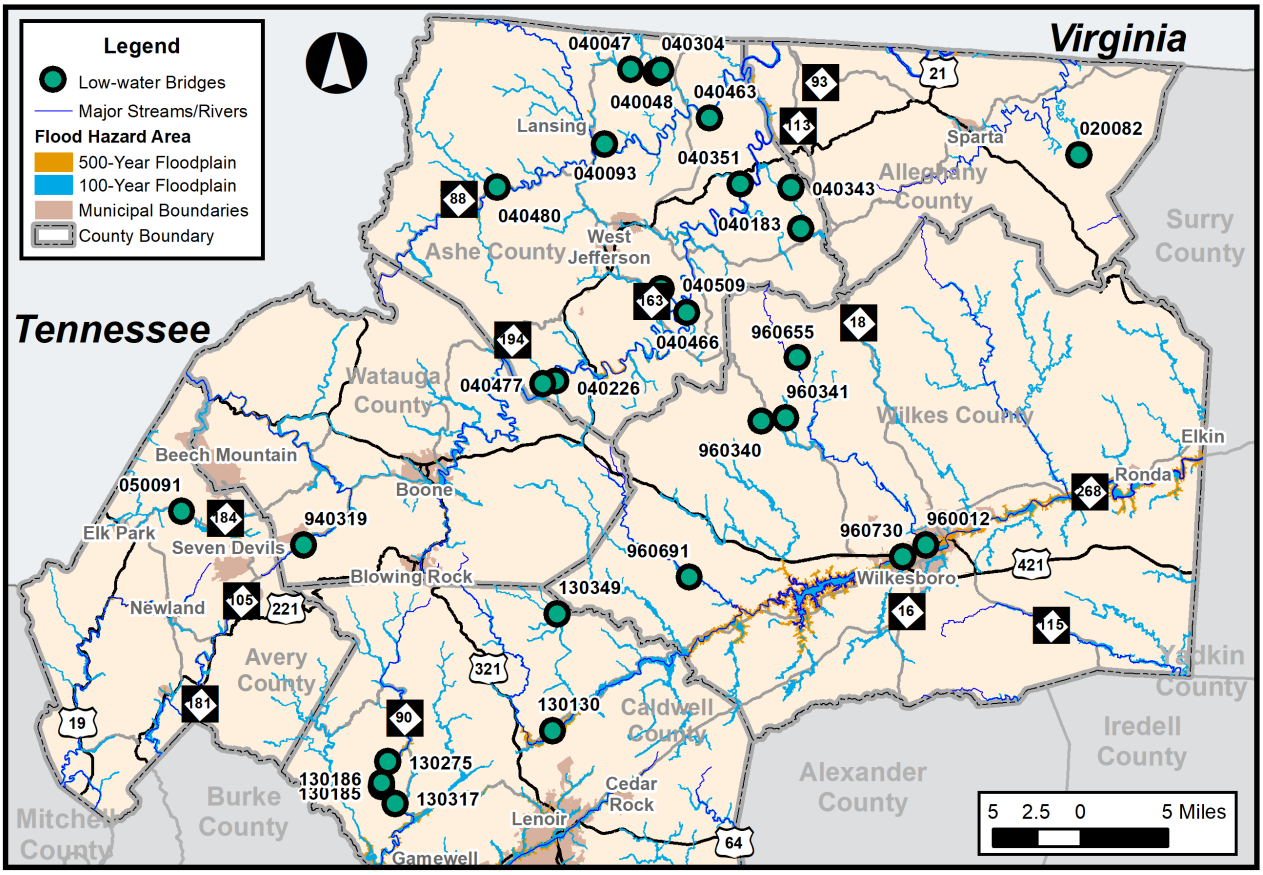
In response to Hurricanes Matthew, Florence, and Dorian, Governor Roy Cooper issued Executive Order 80 to commit North Carolina to addressing climate change and a transition to clean energy. Section 9 of the executive order and the 2020 North Carolina Climate Risk Assessment and Resilience Plan, which NCDOT contributed a chapter that outlines agency resilience targets, look to progress cabinet resilience goals and objectives. The FLOW BETTER Project directly supports the primary goals of these plans which are to increase infrastructure resilience to the impacts of climate change and reduce Greenhouse Gas (GHGs) emissions in the state to 40 percent below 2005 levels by 2025. The bridge replacement structures will be designed to meet the 25-year storm event when feasible, based on terrain and approach, within the design criteria. This aids in a reduction of repetitive loss and damage, increasing resilience of the physical infrastructure. The increased bridge span lengths will help to alleviate debris buildup, mitigating the potential of flooding that impact both historically low-income communities and sensitive wildlife species (such as the Eastern Hellbender salamanders) and ecosystems (such as trout watersheds) found in the Project area.

The addition of six (6) flood gages and water-level monitors will provide flood warning and flood monitoring. The flood warning devices will accommodate safety features with the capability of activating traffic warning lights/signs, notify NCDOT maintenance staff and postings on its Traffic Incident Management System (TIMS) or send traveler alerts via hand-held mobile phones/devices, especially those crossings that lead to a dead-end where households would be cut off and isolated if the crossing were closed. The water-level monitors connect to the state's flood monitoring, modeling, and prediction systems (Bridgewatch and FIMAN-T) to leverage investments made across the state to improve the resilience of the road network. These will be also be an important technology component to the project, helping to mitigate impacts from potential, future flood events characteristic to the area. See Figure 10: FEMA Flood Hazard Areas in Proximity to Project Bridges.

In tandem with these resilience benefits, the Project supports GHG emission[12] reduction by reducing VMT and improving roadway efficiency. By reducing the frequency of overtopping and duration of bridge/roadway closures during and after flood events, the Project improves the efficiency of the transportation network and creates travel time savings for users resulting in lowered emissions of harmful GHGs. This emissions reduction supports environmental sustainability and avoids long-term environmental costs. The emissions savings total $0.2 million in benefits.[13]

[12] Transportation is considered one of the largest generators of emissions, including volatile organic compounds, nitrogen oxides, and particulate matter with a diameter less than 2.5 micrometers ($PM_{2.5}$).
[13] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.

Figure 10: FEMA Flood Hazard Areas in Proximity to Project Bridges



Contamination is another serious concern. Project bridges constructed with chemically treated timber leach pollutants into the region's waterways when overtopped. The Project will use concrete decks on the reconstructed bridges that offer longer lifecycles and lessen contaminate exposure, increasing sustainability while helping to mitigating public health concerns for environmental justice communities. As well, many of the existing bridges contain lead-based paint or primer, which can deteriorate over time and be introduced into the environment. Replacing these bridges provides greater assurance that lead paint is properly removed and disposed of during construction.

As described in Section II, the Project is located within and near Areas of Persistent Poverty and is anticipated to directly benefit these communities by helping maintain continuity and access to critical infrastructure and services. This has the potential to enhance social resilience of the region's population by decreasing the incidence bridge closures and long detours. NCDOT's commitment to equity extends to all aspects of the planning and design process, starting with outreach to the Areas of Persistent Poverty identified in the Project. Future public engagement efforts will take these environmental justice populations into account for locations and time of day for all live meetings. Areas with limited access to high-speed Internet or notable low-income areas will be assessed for the appropriate combination of digital, web, and mobile phone-based outreach in conjunction with traditional print outreach and informational efforts.

Quality of Life

The Project benefits Quality of Life in several ways. First, the low posted weight limit of many of the Project bridges cause a daily inconvenience, and limits access to essential services such as school bus service and emergency response, particularly when the bridges are flooded. The accessibility challenges posed by the poor conditions of the Project bridges limits connectivity to essential services, healthcare, and job opportunities. The Project helps address this by providing improved access for underserved communities, addressing historical equity barriers. In tandem, the Project provides improved safety which is particularly important for areas with known pedestrian fatalities as described in the Safety selection criteria, above.

Second, in instances where conduit is placed on the bridge, the improved connectivity, assuming service is provided, benefits rural households in the vicinity that tap into the service. This may help to remove barriers to rural economic growth by investing in the modern utility, addressing digital divides and equity considerations for the region.

The third benefit is the ability to move large equipment or trucks through the region, allowing local industry such as the Christmas tree farms to conduct their work more efficiently. The annual average daily traffic counts for the bridges likely omit counts of farm machinery that must divert and find another route when moving from farm to farm. This analysis provides a conservative estimate of the value of improved agricultural production efficiency in the vicinity of the bridges. The improved efficiency allows farmers to be more profitable, supporting rural incomes. The agricultural access improvement benefit is $33.2 million in benefits.[14]

Economic Competitiveness

The Project generates a variety of economic competitiveness benefits (quantifiable and qualitative) that fosters the economic regeneration of this rural region. Businesses invest when they have confidence in the health of the national economy; they invest where they have confidence in access to labor and markets. If a region's road system is perceived as less reliable due to regular repeated flooding, it will attract less investment than a place where the road system is rarely closed. The Project will result in travel time and cost savings by reducing the impact of flooding events and widening bridges from one to two lanes where possible. When flooding events do occur, the Project will reduce the potential for wash-outs and shorten the time it takes to repair and inspect the bridges, reducing the duration of time that detours are needed to navigate around the bridges. With the reduction of detours, travelers save time and avoid the cost of the extra VMT needed to make the detour. Trucks will save operating costs as well. As these bridges have a long useful life that exceeds the 20-year analysis period applied in the BCA, a residual value is estimated as well. Importantly, 10 Project bridges lead to dead end roads. When flooding occurs, the productivity and spending impacts associated with lost trips are valued as a trip not taken. The economic competitiveness benefits result in $37.2 million in benefits.[15]

The installation of conduit in the highway ROW prepares these corridors for potential adoption of connected and autonomous vehicles. While the rate of adoption for connected and autonomous vehicles is growing and the subject of much industry speculation, the transportation industry has agreed that it is no

[14] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.
[15] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.

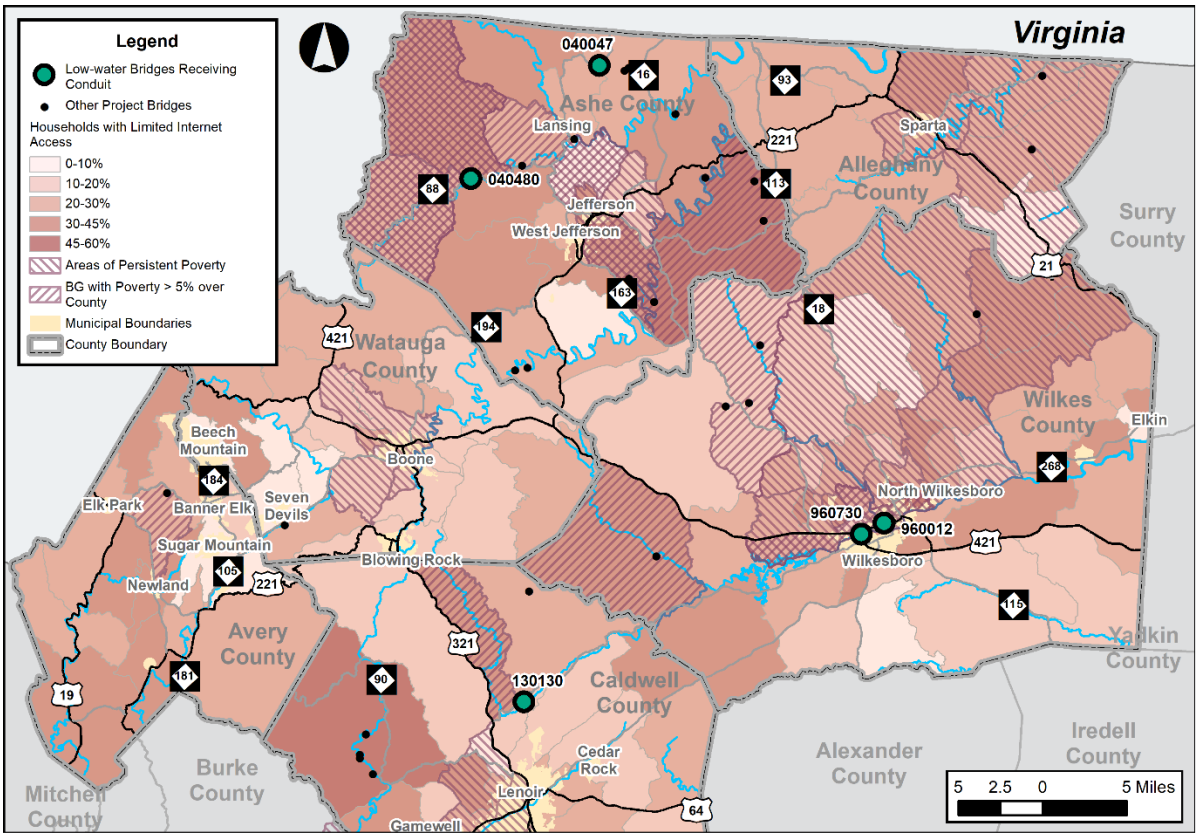
longer a question of whether there will be connected and autonomous vehicles but rather the question is when they will be prevalent. Moreover, there is a cost to not preparing to support the adoption of this emerging technology as applications of the newest transportation innovations will not be supported in lagging economies sending economic growth elsewhere.

To prepare for and support these emerging technologies, six (6) Project bridges being reconstructed will have conduits and/or hangers added to the structure to accommodate the addition of potential, future broadband connectivity, the cost of which is included in the BCA. See Figure 11 for low-water bridges receiving conduit in relationship to households with limited Internet access, Areas of Persistent Poverty, and counties with high rates of poverty. By providing the "envelope" for fiber on these crossings, it reduces the cost and technical challenges for private or public cooperative providers to offer Internet service in these areas. The integration of broadband considerations with the structure's design and construction helps foster rural Internet access, particularly in Areas of Persistent Poverty, through improved speeds and reliability. According to the North Carolina Broadband Infrastructure Office, 95 percent of state residents lacking broadband access are in rural areas[16]. Many Internet applications require higher speed Internet capability with the result that rural households and businesses reliant on dial-up or lower speed services are effectively closed out of that part of the digital economy. Moreover, while some Internet services can be provided via satellite, hilly terrain and atmospheric conditions constrain the reliability relative to fiber-based broadband. These bridge locations were chosen based on their proximity to hospitals, emergency medical services, schools, and within "fiber-loop gaps" near primary routes.

Additionally, the bridges selected provide the most opportunity for future economic growth and will help move the state North Carolina toward its broadband goals. The North Carolina General Assembly created a special State grant program to close the broadband gap in the state's rural areas by appropriating $10 million to NCDIT. NCDOT will be working closely with NCDIT to leverage those funds for increased broadband infrastructure in conjunction with the Project, where applicable. North Carolina's State Broadband Plan has the "overarching goal for every North Carolinian to have affordable access to broadband service – wireline or wireless – if they so choose, by June 2021." The FLOW BETTER Project directly supports that objective. Literature suggests that the relationship between broadband adoption and rural growth is positive and significant. For example, Whitacre, et al (2014) concludes that "Results suggest that high levels of broadband adoption in rural areas do causally (and positively) impact income growth between 2001 and 2010 as well as (negatively) influence unemployment growth. Similarly, low levels of broadband adoption in rural areas lead to declines in the number of firms and total employment numbers in the county."

[16] Wynia, Erin and Joanne Hovis, "Leaping the Digital Divide: Encouraging Policies and Partnerships to Improve Broadband Access Across North Carolina," North Carolina League of Municipalities, April 2018.

Figure 11: Low-water Bridges Receiving Conduit in Relationship to Demographic Need



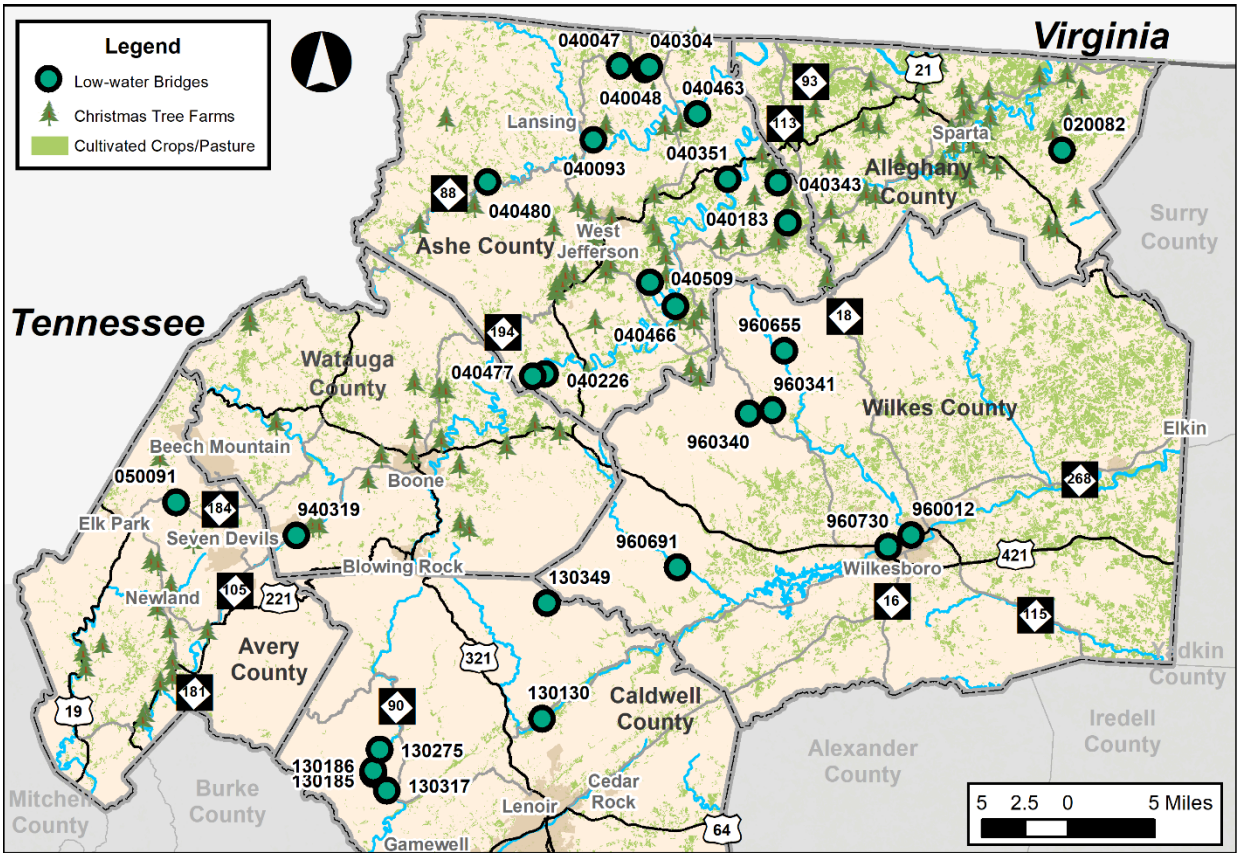
The Project is also located in an area with agricultural significance to both the state and national economy. Much of the area has land use defined as cultivated crop/pastureland (see Figure 12) for the robust Christmas tree industry and associated holiday wreath industry, which anchors the regional economy. The industry is reliant on trucks to export the trees and wreaths across the country. North Carolina produces over 20 percent of the real Christmas trees in the United States, and the state's Christmas tree industry is ranked second in the nation[17]. Over 850 Christmas tree growers, who produce approximately 50 million trees on more than 38,000 acres, rely on the surrounding network of rural roads and bridges to get to the next stop in the supply chain. The seed, fertilizer, and fuel needed to run the Christmas tree farms are similarly delivered by truck. Because transportation costs are a significant share of the production process; improvements to the transportation system improve farmers' and foresters' bottom line. For example, trucking can account for as much as 40-60 percent of the total logging cost.[18] North Carolina's Christmas tree market also has a significant drive-in component, where households in the surrounding region drive to cut their own tree and drive it home. The value of the Christmas tree industry is more than just the wholesale value of the trees themselves, which was over $87 million in

[17] Our Mission (n.d), North Carolina Christmas Tree Association, Online: https://ncchristmastrees.com/our-story/our-mission/

[18] "Trucking is often the most expensive phase of a timber harvesting operation, accounting for as much as 40-60 percent of the total logging cost," as reported in William A. Schaffer and William Stuart, 2009, "A Checklist for Efficient Log Trucking," Virginia Cooperative Extension, publication 420-094.

2017 according to the United States Department of Agriculture Census[19]. It is estimated that every dollar earned by growers' cycles as much as 2.5 times in local communities as the wages are spent and profits reinvested in raising, equipment, and vehicles[20]. Improving the Project bridges will support North Carolina's Christmas tree and broader agricultural industry by providing a safer, more reliable network for all legs of the supply chain as well as tourists that support the region's economy.

Figure 12: Density of Christmas Tree Farms in Proximity to Project Bridges



State of Good Repair

The Project bridges are characterized by obsolete timber construction, substandard barrier rails, bridge postings that are inadequate for trucks and emergency vehicle weights, and frequent overtopping during flood events. Most of the Project bridges were originally constructed of timber and steel I-beams, which are vulnerable to corrosion from repeated exposure to water. To facilitate a more resilient structure, the new bridges will be constructed primarily of concrete which is more resistant to corrosion than steel.

[19] Our Mission (n.d), North Carolina Christmas Tree Association, Online: https://ncchristmastrees.com/our-story/our-mission/

[20] Sidebottom, J. 2009. The Christmas tree industry in western North Carolina. In: Dumroese, R.K.; Riley, L.E., tech. coords. 2009. National Proceedings: Forest and Conservation Nursery Associations—2008. Proc. RMRS-P-58. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 71–73. Online: http://www.fs.fed.us/rm/pubs/rmrs_p058.html. Accessed https://www.fs.fed.us/rm/pubs/rmrs_p058/rmrs_p058_071_073.pdf

The bridge girders and deck will be as shallow as possible and will be anchored to the foundations to better withstand overtopping and uplift stresses.

The current state of the Project bridges led to unsafe and inefficient travel and leave residents stranded without means of egress during flood events. The Project is needed to bring the bridges into a state of good repair. In doing so, the Project will address vulnerabilities and improve the mobility of goods and people, contributing to economic growth. To bring the roads into a state of good repair, the Project will address the following design elements:

- **Timber decking and substructure**: Twenty-six of the bridges have timber decks and one (1) has timber in the substructure. These bridges are obsolete as they would not be built in this manner today and are dangerous when overtopped as the water action can loosen the timbers and float them down the river, stranding citizens.
- **End of useful life:** Twenty-six of the bridges were built before 1975 putting them at the end of their useful lives. Untreated wood generally has a lifespan of 10 years in North Carolina's climate. The most common wood treatment over the last 120 years has been creosote, which extends the life of the wood on average to between 25 and 35 years, although some bridges have lasted longer. Repeated flooding accelerates the deterioration of the Project bridges.
- **Structural and functional deficiency:** Fourteen (14) bridges are structurally deficient and 23 meet the legacy definition of functionally obsolete. Two (2) of the bridges have bents in the water that increase drift potential, where bridge replacement will reduce or eliminate the number of bents thereby reducing flood potential.
- **Substandard barrier rails:** Twenty-six of the bridges were constructed with low side curbs only and need to be upgraded with barrier rails to improve safety. The upgraded railings will be designed to handle vehicle impacts as well as to allow water to pass through it. The replacement structures will also utilize bridge barrier rails meeting current test-level requirements for safety.
- **Bridge Postings:** Twenty-five of the bridges are posted for legal load weight restrictions that are inadequate for emergency vehicle, school buses and legal truck weights.
- **Inadequate width:** Twenty-one of the bridges are single-lane structures connecting two-lane roadways, requiring opposing traffic to “take turns” to cross the bridge.
- **Inadequate span length:** The existing bridge span lengths range from 20-30 feet and are prone to collect debris. The new bridge spans will primarily be 50 feet or greater and will greatly reduce the collection of debris that adds stress to the bridge, accelerates scour, and must be periodically removed. The Project bridges will be raised to the extent practicable to reduce and minimize the frequency of overtopping and provide for a more resilient structure.
- **Asphalt repair:** Repeated inundations damage the asphalt bridge surface, leading to frequent replacement and higher maintenance costs. The concrete deck surface will not require an asphalt overlay, eliminating any future repairs associated with asphalt damage.

In addition to these concerns, 14 Project bridges are frequently overtopped, and another 12 periodically overtop during heavy rain events. The ability to raise each bridge varies with the local conditions and terrain. The bridge’s Level of Service (LOS) relates to the frequency with which the bridges are designed to flood. For example, some of the bridges have a LOS of 0.5 in the No Build, indicating that they are designed to flood twice per year. In the Build, bridges will be improved up to at least a LOS of 2, or once

every two years. Bridges will be improved to a greater degree, as allowable by geometry and other localized considerations. Where flooding cannot be avoided, the Project bridges will be designed to allow the water to flow across more easily. The Project will result in crossings that are measurably less flood prone, yielding a less vulnerable and more reliable road network. These improvements will also reduce post-storm maintenance and repair costs, yielding bridges with more usable days at a lower overall operation and maintenance cost. The state of good repair benefit is estimated at $5.2 million[21].

Secondary Selection Criteria

This section provides additional detail on the Project features that align with the 2021 RAISE program's Secondary Selection Criteria.

Project Applicant and Partnership

NCDOT (the Project applicant) along with NCDIT (the Project partner) are strong advocates for the Project and have obtained the endorsement of several regional and local stakeholders. The Project letters of support can be found on the grant application website: https://connect.ncdot.gov/resources/RAISE-LowWater/Pages/default.aspx.

NCDOT

NCDOT is responsible for maintaining approximately 80,000 miles of roadways and 18,000 bridges and culverts across North Carolina, as well as supporting rail, aviation, ferry, public transit, bicycle, and pedestrian transportation.

With an annual operating budget of about $5.0 billion, NCDOT is responsible for raising and maintaining the State's transportation network. Federal funding accounts for a little over 20 percent of NCDOT's overall budget and about 45 percent of its construction budget, generated through the federal motor fuel tax and vehicle fees (mostly on trucks). NCDOT understands the United States Department of Transportation (USDOT) reporting requirements and maintains the records and accounting systems that will allow it to comply with USDOT's reporting and administration requirements.

The Department's role(s) for the Project includes:

- RAISE 2021 Discretionary Grant Applicant and Recipient responsible for administering the grant if selected for award
- Funding partner
- Owner of the ROW
- Aids in ensuring efficient integration of the RAISE 2021 Project into the existing regional transportation network
- Oversight of the capital project delivery
- Innovative modeling lead for the FIMAN-T and Bridgewatch implementation

[21] In discounted 2019$ over a twenty-year benefit period for all 28 Project bridges.

NCDIT

NCDIT is committed to providing outstanding service to the North Carolinians they serve. Led by the State Chief Information Officer, the Department is the leading provider of information technology services to state agencies, local governments, and educational institutions across North Carolina. The Department's services include hosting, networking, telecommunications, desktop computing, and unified communications including email and calendaring. Of note, in 2018 the North Carolina Legislature appropriated $10 million to NCDIT for a rural broadband grant program. NCDIT's role for the Project is to continue working with NCDOT on development around technical needs regarding broadband.

Partnership

NCDOT and NCDIT routinely collaborate on projects and together are committed to expanding broadband in rural North Carolina and removing barriers to opportunity for the region's underserved populations and Areas of Persistent Poverty. NCDOT has successfully developed and matured successful partnerships related to Broadband internally with NCDIT. These successful partnerships developed through multiple grant projects. NCDOT and NCDIT are successfully partnering to install broadband fiber along the I-95, US 70, and US 74 corridors under an Infrastructure for Rebuilding America (INFRA) Grant. The I-95 and US 70 project received $147 million in INFRA Grant funding for improvements including the construction of 181 miles of fiber along I-95 from South Carolina to Virginia and 120 miles of fiber along US 70 from Raleigh to Morehead City.

Innovation (Technologies)

As described in the Environmental Sustainability section above, the Project will install six (6) flood gages and water-level monitors to improve flood warning and flood monitoring. These systems provide an important component that utilizes sensor technology to enhance real-time understanding of conditions at the bridges during both regular flooding and major flood hazard events.

Running conduit on six (6) bridges helps to prepare the region for potential, future fiber optic cable as service providers look to make investments in the area. This is also in accordance with Executive Order No. 91, which mandates the promotion of expanding access and removing barriers to broadband infrastructure, and the 'Dig Once' Policy that provides ready-made conduit installation during construction projects. The introduction of broadband capability to the bridge structures supports broadband adoption in rural areas in two ways. First, it can be directly tied-in to dark fiber, or an unused optical fiber available for lease, and help connect the first mile provider to the last mile consumer. In some cases, just making the connection over a water crossing reduces the up-front cost of providing service (a barrier to entry in rural markets) and helps private providers enter rural markets. When these barriers can be overcome, there is evidence that the economic return on investment can be high. Recent research presented at the 2018 Economic Returns to Rural Infrastructure Investment Workshop found that a $1 increase in zip code per capita broadband loan results in about a $1.08 increase in annual payroll per worker, implying a rate of return of about 8 percent[22].

[22] Dinterman, R., Telecommunications Policy (2016), http://dx.doi.org/10.1016/j.telpol.2016.12.004

Innovation (Project Delivery)

Categorical Exclusion (CE) Checklist

In 2019, FHWA and NCDOT executed a CE Programmatic Agreement. The agreement (updated 2019) prescribed use of a CE checklist, rather than the larger document-style CE to help streamline project delivery. NCDOT anticipates that 95 percent of all environmental documentation requirements can be met with this CE Checklist pursuant to this agreement. Based on the nature of the Project and NCDOT's experience, it is anticipated that the completion of a CE checklist will satisfy National Environmental Policy Act (NEPA) requirements.

Integrated Project Delivery (IPD)

In 2018, NCDOT announced the IPD initiative, a culture where "we promise what we are going to do and deliver what we promise." The purpose of IPD is to improve project delivery with transparent, repeatable, and accountable processes that are effective and efficient, to meet the NCDOT Secretary's "12-24-36" mandate. "12-24-36" refers to the number of months to complete environmental documentation and preliminary engineering: 12 months for a CE; 24 months for an Environmental Assessment; and 36 months for an Environmental Impact Statement. In response, NCDOT undertook the task of reviewing all policies and procedures and challenging staff to come up with more efficient ways of delivering projects. Recommendations are now being implemented and new policies and procedures drafted for a new model focused on tailoring project development to the individual characteristics of a project. The key elements of the model are continuity in staff using a "project custodian" that stays with the Project, more robust environmental and engineering screening earlier in the process to identify issues and allow for right-sizing of the project development process, and fewer re-do loops by integrating project planning, environmental analysis, and design into a coordinated process.

Express Design-Build

NCDOT's Express Design Build process will be used to quickly procure a design-build team and to rapidly design and construct the Project. Bridges selected for Express Design-Build will be assigned based on factors such as proximity, bridge type, detour routing, and scheduling. The number and schedule for these design build projects will be identified during potential future phases of the Project.

Project ATLAS (Advancing Transportation through Linkages, Automation, and Screening)

In 2019, NCDOT released Project ATLAS, a web-based platform that provides a data access and storage framework to support informed project development. ATLAS consolidates statewide spatial data from a variety of into a single source with geographic information system (GIS) based tools for screening and mapping environmental features and identifying potential constraints and impacts. In addition, the ATLAS Workbench provides a forum for managing projects and storing key project documents. The Workbench steps teams through all facets of the project lifecycle and tracks the progression of a project based on reporting from multiple NCDOT Units. Since its initial release in June 2019, more than 1,100 NCDOT and private engineering consultant staff have been trained to use ATLAS, and it is being incorporated into all aspects of project delivery.

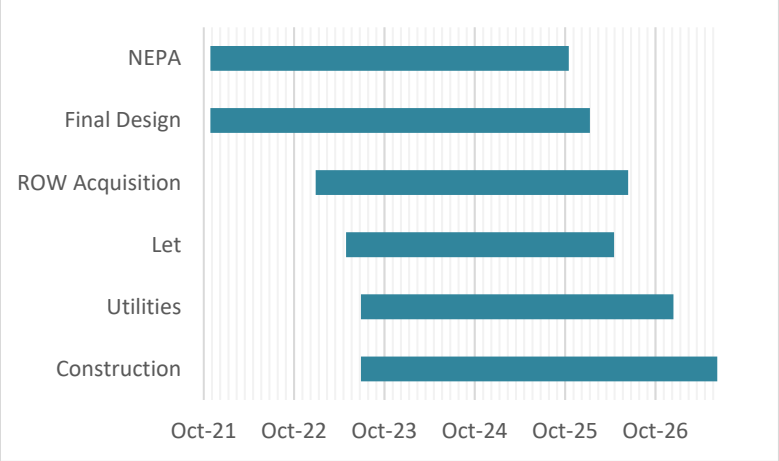
V. Environmental Risk

The FLOW BETTER Project is technically feasible with low levels of environmental and project risk. NCDOT has delivered thousands of similar projects. Bridge repair and replacement is one of NCDOT's primary functions; this grant funding will allow NCDOT to address serious safety and state of good repair issues to create a more resilient infrastructure network in rural western North Carolina. The addition of broadband conduit and sensor gages are easy additions that do not require significant design changes to the typical bridge that NCDOT constructs. Specifically, NCDOT is coordinating with NCDIT to ensure that the conduit meets relevant state and Federal specifications. The Project bridges will be constructed in stages, eliminating the amount of full road closure during construction. It is anticipated to be structurally feasible for some bridges or major bridge components to be constructed off-site using less material and causing fewer disruptions than on-site construction. Should the Project be approved for RAISE grant funding, NCDOT is ready for obligation as soon as the necessary documentation is executed. All proposed investments are located within an active roadway corridor, with no change to existing land use.

Project Schedule

Figure 13 depicts the Project schedule. The Project can get underway immediately after the grant agreement is signed. Upon obligation of funds, NCDOT will complete the CE Checklist, final design, utilities coordination/relocation, and complete the ROW easement transfer for all 28 bridges concurrently, although individual bridges may have slightly different schedules and milestone dates depending on the complexity of utilities, ROW, and construction needs. All preconstruction activities are expected to be phased over several years. Construction to bring the bridges into a state of good repair is anticipated to be phased over several years and will also occur concurrently. The window for bridge construction could be affected by adverse weather conditions. An early winter or unseasonably long snow season could alter the planned construction schedule. This risk is mitigated by the fact that the individual bridge projects can be undertaken concurrently, and majority of bridges only requires one construction season for completion. Construction will be completed well in advance of the September 30, 2029 deadline to expend all funds, as outlined in the Notice of Funding Opportunity. Each of the individual 28 bridge construction schedules are provided in the Schedule Attachment provided in the Supplemental Materials.

Figure 13: Project Schedule Timeline



Note: The schedule is aggregated for the 28 bridges resulting in overlapping tasks.

Required Approvals

Environmental Permit and Reviews

All 28 of the Project bridges in this grant application have been screened for impacts to the natural and human environment using NCDOT's ATLAS tool (see the Environment Risk section for more information; copies of the screening checklist are provided in the Supplemental Materials to this application). These issues would be further evaluated during project development, and NCDOT would coordinate with appropriate regulatory agencies to avoid or minimize impacts. No potentially significant issues were found that would prohibit the Project from being documented using a CE, pursuant to the NEPA. Each CE will be processed in accordance with the Programmatic Agreement between the FHWA, North Carolina Division, and NCDOT Regarding the Processing of Actions Classified as Categorical Exclusion for Federal-Aid Highway Projects signed on January 27, 2017. The Project bridges are anticipated to be Type II CE's, which authorizes NCDOT to approve the documents without additional FHWA coordination or approval.

The Project will be required to comply with permitting requirements pursuant to Sections 401/404 of the Clean Water Act. Permitting requirements would be coordinated with the United States Army Corps of Engineers (USACE) and the North Carolina Department of Environmental Quality (NCDEQ). The improvements will cross Waters of the United States; therefore, the Project would likely fall under requirements for the Nationwide Permit 14 (Linear Transportation Projects). The USACE holds the final discretion as to what permit will be required to authorize construction. Any mitigation required as a condition of the permit will be provided by NCDEQ's Division of Mitigation Services.

State and Local Approvals

No legislative approvals are required to complete the Project.

Federal Transportation Requirements

Beyond the NEPA process described above, there are no federal requirements affecting state or local planning for the Project. The inclusion of rural conduit for broadband is consistent with the Administration's emphasis on increasing rural broadband access across the United States. It is also consistent with the sustained national emphasis on supporting economic development in the Appalachian Region through the designated area administered by the Appalachian Regional Commission.

Assessment of Project Risks and Mitigation Strategies

NCDOT has completed work like the proposed FLOW BETTER Project and has not experienced significant procurement delays. The Project area is currently utilized for transportation purposes and is situated within an active roadway corridor, reducing many potential risks.

NCDOT tracks Construction Project Delivery in terms of budget and schedule as part of its own performance metrics. The 2020 Annual Report on Performance describes the outcomes for FY 2020 and the prior year comparator (the most recent data available). Table 3 illustrates that the Department met its target. The NCDOT is familiar with federal funding obligations and construction procedures.

Table 3: NCDOT Project Delivery Performance

Performance Measure	How NCDOT Measures It	Target	Previous (FY 2019)	Current (FY 2020)	Target Met
Construction Projects – On Schedule	Percentage completed on schedule	More than 90%	91%	92%	✓
Construction Projects – On Budget	Total budget overrun on completed projects	Less than 5%	-1.9%	-0.1%	✓

Source: 2020 NCDOT Annual Report on Performance.

VI. Benefit Cost Analysis

The Project construction anticipates completion of the last Project bridge in 2027. To capture a full 20 years of operation for each Project, a benefits period of 2024-2047 was selected. The exhibit below summarizes the discounted value of the benefits and costs of the total Project during the 20-year analysis period. Taken in total across all 28 bridges and using a 7 percent discount rate, the benefits and residual savings provide over $51.2 million dollars of net benefits over the analysis period. Compared to a similarly discounted cost estimate, the Benefit Cost Ratio (BCR) for the total Project is 2.35. This estimate includes the disbenefit of construction disruption.

As each rural bridge has independent utility, a separate BCA was developed for each bridge. Fourteen (14) of the 28 bridges have an individual BCR above 2.0 and 25 have a ratio above 1.0 (inclusive of those above 2.0). While three of the 28 bridges do not cross a 1.0 BCR threshold at 7 percent, they all reflect a BCR over 0.81 —a high bar for rural low-volume bridges. Importantly, the bridges surpass the 1.0 threshold as a group, indicating the Project benefits justify the cost. The reason a few bridges do not result in BCRs over 1.0 is primarily due to the high cost of the bridge replacement and the low AADT in these rural areas (40-80 vehicles per day), resulting in lower net benefits than would be the case if there were more traffic on the bridges. For details on the BCA and the methodologies used, including individual bridge results, please see the technical memorandum and BCA workbook included in the Supplemental Materials (https://connect.ncdot.gov/resources/RAISE-LowWater/Pages/default.aspx).

Table 4: Total Project BCA Results

	20 Year Benefits Period Values stated in 2019$ (Millions) Discounted at 7%
Costs	
Capital Costs	$38.0
Total Costs	***$38.0***
Benefits	
Safety Benefits	
Reduced Roadway Fatalities and Crashes	$3.7
Safety Improvements at Bridges	$7.5
Emergency Access Benefit	$0.5
Sub-Total	$11.7
State of Good Repair Benefits	
Roadway Maintenance Savings	$0.003

	20 Year Benefits Period Values stated in 2019$ (Millions) Discounted at 7%
Bridge Repair Costs Avoided	$5.1
Bridge Current Maintenance Costs Avoided	$0.1
Sub-Total	$5.2
Economic Competitiveness Benefits	
Travel Time Savings Detours	$2.7
Travel Time Savings Bridge Lanes	$0.3
Auto Travel Cost Savings	$2.3
Residual Savings	$4.4
Truck Operating Savings	$4.0
Trip Not Taken	$23.6
Sub-Total	$37.2
Environmental Protection	
Emissions Savings	$0.2
Sub-Total	$0.2
Quality of Life	
Agricultural Access Improvement	$33.2
Sub-Total	$33.2
Net Operating & Maintenance Costs	$1.6
Total Benefits	***$89.2***
Net Benefits (2019 $M)	$51.2
Benefit-Cost Ratio	2.35

VII. Summary

The Project delivers multiple types of benefits including environmental sustainability, quality of life, safety, state of good repair, economic competitiveness, innovative project delivery, and partnerships. The Project is cost effective and its benefit-cost ratio for all major components is 2.35. The Project is expected to expend all funds by September 30, 2029. Letters of commitment from the Project sponsor (NCDOT) are provided in the Supplemental Materials to this application. Lastly, the Project likely cannot be completed without RAISE grant funding. Receipt of RAISE grant funding is imperative to the Project due to limitations on state expenditures to improve the Project Roads to State Highway System standards, as well as USACE constraints on funding non-mission essential infrastructure, as described in Section III.