BRIDGES NOT BARRIERS

A Collaborative Bridge Bundle Replacement Project

BCA NARRATIVE

Better Utilizing Investments to Leverage Development (BUILD) Grant Program

Table of Contents

Contents

Table of Tables

Benefit-Cost Analysis Supplementary Documentation

1. Executive Summary

The Benefit-Cost Analysis (BCA) conducted for the ***Bridges not Barriers: A Collaborative Bridge Bundle Replacement Project*** grant application compares the costs associated with the proposed investments to the benefits of the project. To the extent possible, benefits have been monetized. Where it is not possible to assign a dollar value to a benefit, efforts have been made to quantify it. A qualitative discussion is also provided when a benefit is anticipated to be generated but is not easily monetized or quantified.

Critical bridges across North Carolina's NCDOT Division 10 counties—Anson, Cabarrus, Mecklenburg, Stanly, and Union—are vital lifelines for rural communities and industries. These bridges connect neighborhoods, support local economies, and ensure access to essential services such as healthcare, schools, and markets. Located in rural areas, they serve as key routes for residents and businesses, facilitating daily life and economic activity. Aging, load-restricted, or closed bridges disrupt this connectivity, leading to lengthy detours, increased travel times, and higher costs for residents and industries alike. Replacing these bridges is critical to maintaining safe and reliable mobility, ensuring continued access to the destinations and services that sustain community well-being and economic vitality.

This project will replace 15 deteriorating, load-restricted bridges in these five counties, improving safety, reducing travel delays, and enhancing connectivity for residents and businesses. Currently, all 15 bridges are either in poor condition, load-restricted, or have major structural issues, such as flooding, scouring, or low water, making them increasingly unsafe for travel. **Table 1** summarizes the projected benefits of this project. Monetized and non-monetized benefits are provided.

Table 1: Project Improvements and Associated Benefits, in Millions of 2023 Dollars

Benefit Category	$ Millions Over the Project Lifecycle Discounted at 3.1%
Maintenance Cost Savings	$0.37
Travel Time Benefits from Avoided Detours	$37.79
Emission Cost Savings from Avoided Detours	$25.62
Safety Benefits from Bridge Improvements	$0.81
Safety Benefits from Avoided Detours	$60.52
VOC Savings from Avoided Detours	$124.87
Resiliency from Avoided Detours	$0.04
Residual Value of Bridges	$7.67
Total Benefits	**$257.69**
Unquantified Benefits	
Reduced Pavement and Asset Maintenance Costs associated with maintaining new bridges rather than preserving old deteriorating structures.	
Maintaining Local Agricultural Competitiveness as local farms and related businesses can use heavier and larger machinery, vehicles, and equipment, currently not allowed on several of these bridges.	
Improved Travel Time Reliability due to fewer crashes and added lanes and shoulders.	
Improved freight movements as the bridges would no longer be load-posted and weight restricted for trucks.	

A 28-year period of analysis was used in the estimation of the project's benefits and costs. Construction begins in 2029 with the last bridge opening in 2031 and includes 20 years of full operations. Benefits are monetized as thoroughly as possible with the data currently available.

The total project capital costs are $24.5 million undiscounted.

Based on the analysis presented in the rest of this document, the project is expected to generate $257.7 million in discounted benefits and $20.6 million in discounted costs, using a 3.1

percent real discount rate (except for CO2 emissions, which are discounted at 2%, per USDOT guidance).Therefore, the project is expected to generate a Net Present Value of $237.1 million and a Benefit-Cost Ratio of 12.51, as presented in Table 2.

Table 2: Overall Results of the Benefit Cost Analysis, in Millions of 2023 Dollars

Project Evaluation Metric	3.1% Discount Rate
Total Discounted Benefits ($ millions)	$257.69
Total Discounted Costs ($ millions)	$20.60
Net Present Value ($ millions)	$237.09
Benefit-Cost Ratio	12.51

In addition to the monetized benefits presented in section 7, the project would generate other benefits that have not been monetized due to lack of guidance/methodology from the U.S. Department of Transportation (USDOT) or a lack of relevant data. These benefits include:

- **Pavement Condition and Asset Maintenance**: Due to their age and current condition, the existing bridges are often closed for repairs or to clear debris after a strong. With an increase in total miles traveled comes an increase in costs on pavements and other assets.
- **Local Agricultural Competitiveness**: Agricultural machinery, vehicles, and equipment continue to become bigger and heavier as farms continue to seek ways to improve productivity and remain competitive. Overtime, increasing numbers of local farms and related businesses may need to detour as average equipment size and weights increase, which will hamper some businesses' ability to compete.
- **Travel Time Reliability**: Reducing crashes on these bridges will decrease the variability of travel time across them. The inclusion of these benefits (inventory cost savings and travel time reliability) would increase the overall benefit-cost ratio. Additionally, the project will improve short and long-term employment by increasing access to existing and new jobs. Furthermore, it will create employment in project planning and construction.

1.1 State of Good Repair

Many bridges across the counties have significant structural deficiencies, including scouring, flooding, overtopping, rusted beams, and erosion. Replacing these bridges will restore them to a state of good repair and extend their service lives, reducing future maintenance costs and improving their reliability.

- Anson County: Replacement of bridges such as Mills Road Bridge (030148) and Lockhart Road Bridge (030161) will mitigate scour and cracking while preventing overtopping, ensuring long-term durability and serviceability.
- Cabarrus County: Penninger Road Culvert (120050) and Peach Orchard Road Bridge (120173) replacements will address erosion, structural undermining, and flooding risks to preserve their long-term functionality.
- Mecklenburg County: Robinson Church Road Bridge (590060) will add sidewalks along Robinson Church Road and a multi-use path along Reedy Creek under the bridge.
- Stanly County: Projects such as Old Aquadale Road Bridge (830095) and Bridge Road Bridge (830081) will address rusted beams, overtopping, and drift issues, preventing further degradation and prolonging their lifespan.
- Union County: Bridges like Monroe-Ansonville Road Bridge (890074) and Shannon Road Bridge (890312) will see improvements that address overtopping and corrosion, ensuring these assets remain reliable and safe for decades to come.

1.2 Safety Benefits

Addressing structural deficiencies now will prevent more severe safety hazards, such as collapse or total failure, while also improving travel safety for residents, businesses, and emergency services.

1.3 Qualify of Life Improvements

Six of these bridges are located within Areas of Persistent Poverty. By restoring one of the primary regional corridors, the Project will contribute to quality of live improvements by providing vulnerable populations with enhanced mobility and access to vital services.

1.4 Mobility and Community Connectivity

Restoring these bridges will reconnect communities, improve travel reliability, and reduce detour-related congestion for commuters, freight, and emergency services.

- Several of these structures are located within Areas of Persistent Poverty. The project would maintain accessible transportation for community members with limited resources.

1.5 Economic Competitiveness and Opportunity

Restoring these critical bridges will support freight movement, improve supply chain efficiency, and sustain economic activity for local and regional businesses.

- The project supports regional growth by maintaining a key transportation link throughout the Division 10 Counties, preventing further deterioration, and ensuring continued support for local and regional commerce.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the grant application for the North Carolina Department of Transportation (NCDOT): Bridges not Barriers: A Collaborative Bridge Bundle Replacement Project.

Section 3, Methodological Framework, introduces the conceptual framework used in the Benefit- Cost Analysis. Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the project is expected to generate. Monetized, quantified, and qualitative effects are highlighted. Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projections. Specific data elements and assumptions pertaining to the merit criteria are presented in Section 7, Estimation of Economic Benefits, along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its Benefit-Cost Ratio (BCR) and other project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes. Additional data tables are provided within the BCA model including annual estimates of benefits and costs to assist the U.S. Department of Transportation (USDOT) in its review of the application.[1]

3. Methodological Framework

The specific methodology developed for this application was developed using the BCA guidance developed by USDOT. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits that align with those identified in the BCA guidance;

[1] The BCA model is provided separately as part of the application.

- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs utilizing the 3.1 percent real discount rate recommended by USDOT; and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

Project costs include both the resources required to develop the project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of Iowa's roadway network, valued in monetary terms.[2]

[2] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs, November 2024 (revised).*

4. Project Overview

Decades of increasing agricultural equipment sizes and heavier freight loads have placed added stress on these bridges, often rendering them impassable and forcing lengthy detours. Load restrictions and closures disrupt students' commutes, workers' travel, and the timely delivery of goods, increasing costs for communities and businesses alike. This project will restore vital connections, ensuring a resilient and efficient transportation network for North Carolina's future.

North Carolina's industries thrive because of the transportation network, which allows goods to be moved efficiently from farm to market. Local bridges serve small, rural, and often underserved communities throughout the state. However, the transportation system continues to be challenged by degradation, which is further exacerbated by an inability for local jurisdictions to dedicate community resources for needed investment in local bridges projects.

Replacing these 15 critical bridges across Anson, Cabarrus, Mecklenburg, Stanly, and Union Counties will address structural deficiencies, reduce detour costs, and improve safety and mobility for residents and businesses. Federal BUILD grant funding, combined with NCDOT's Division Bridge Funds, will enable timely investments that local jurisdictions cannot achieve alone, breaking the cycle of deterioration and ensuring long-term economic vitality for the region.

4.1 Base Case and Alternatives

To analyze the benefits and costs associated with *Bridges not Barriers: A Collaborative Bridge Bundle Replacement Project*, a single no-build and a single build scenario have been developed. The no-build scenario reflects the continuation of current conditions:

- Operations and maintenance will continue with no major infrastructure improvements. All fifteen of these bridges are currently load restricted.
- Each of these bridges is at or near their expected life and is facing more stringent load posting or complete closure soon. The BCA models complete closure of all fifteen bridges by 2038, if this project is not funded.
- Additionally, four bridges lack guard rails proving insufficient protection for road users, and seven bridges have a scour plan of action. These issues will be addressed by the project with positive benefits.
- All fifteen bridges are load posted, which inhibits the movement of critical farm vehicles and other large trucks from utilizing the most direct routes to access their destinations, increasing vehicle miles traveled.
- Twelve of the 15 bridges are regularly closed due to storm damage. The model assumes that the recent past closure rates will continue but not increase.

4.2 Project Cost and Schedule[3]

The Project requires $24.5 million (year-of-expenditure dollars) in capital costs which includes $20.7 million for construction, contingency, and construction engineering and inspection costs; $3.1 for preliminary design; and $0.6 million for right-of-way construction. The total discounted capital costs of the project are approximately $20.4 million.

Following USDOT BCA guidance, the difference between the build and the no build operation and maintenance (O&M) costs and cyclical repaving costs are included as a disbenefit rather than a project cost.[4]

Five of the fifteen bridges (Peach Orchard Road Bridge, Robinson Church Road Bridge, Austin Grove Church Road Bridge, Old Aquadale Road Bridge, and Penninger Road Bridge) have been assigned project estimates and project numbers. These bridges are already prioritized for funding through NCDOT Division Bridge Funds and are included in the State Transportation Improvement Program (STIP) and Transportation Improvement Program (TIP).

The entire project timeline, from design/NEPA through construction, spans Q1 2027 to Q4 2030. All bridges were given an opening year of 2031, which is the latest opening date of any individual bridge. To streamline the process, the fifteen bridges are being grouped into three different bundles that will follow a similar schedule across a staggered timeline. The bridge groups reflect bridge priority based on project readiness and available resources:

- Group 1: Robinson Church Road Bridge, Austin Grove Church Road Culvert, Old Aquadale Church Road Bridge, Penninger Road Culvert
    - Construction schedule: Q2 2030 – Q2 2031
- Group 2: Peach Orchard Road Bridge, Mills Road Bridge, Potters Road Bridge, Stack Road Bridge, Monroe-Ansonville Bridge
    - Construction schedule: Q3 2029 – Q3 2030
- Group 3: Robinson Road Bridge, Bridge Port Road Bridge, Shannon Road Bridge, Bogger Hollar Road Bridge, Bridge Road Bridge, Lockhart Road Bridge
    - Construction schedule: Q4 2029 – Q4 2030

[3] All cost estimates in this section are in millions of 2023 dollars, discounted to 2023 using a 3.1 percent real discount rate

[4] USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs.* November 2024

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of the project including initial design through construction of the first bridge and including after 20 years of full operations. The monetized benefits and costs are estimated in 2022 dollars with future dollars discounted using a 3.1 percent real rate.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2023 dollars.
- The period of analysis begins in 2025 and ends in 2050. This includes project development and construction years for each bridge across five North Carolina counties, and 20 years of full operations (2031-2050);
- A constant 3.1 percent real discount rate is assumed throughout the period of analysis;
- A useful life of 75 years is utilized for the calculation of residual value for each bridge;
- An annualization factor of 365 days is applied.

6. Demand Projections

6.1 Methodology and Assumptions

Annual average daily traffic (AADT) counts were available for all fifteen bridge locations via the National Bridge Inventory (NBI). The NBI database collects truck percentages for each bridge location, allowing the analysis to use counts for both passenger vehicles and trucks. Table 3 provides the total truck traffic counts (vehicles/day) and truck percentages (% of total traffic) during the analysis period 2025-2050.

Additional information, including year of traffic estimation, can be found on the *ProjectSummary* tab of the Excel file.

Table 3: Truck Traffic Counts and Total Percentages

Bridge #	Road Name	AADT (vehicles/day)	Truck Counts (vehicles/day)	Truck Percentage (%)
120173	Peach Orchard Road	670	47	7%
030148	Mills Road	200	12	6%
890170	Potters Road	800	48	6%
890144	Stack Road	2400	144	6%
890074	Monroe-Ansonville Road	3500	245	7%
030265	Robinson Road	100	6	6%
830200	Bridge Port Road	100	6	6%
890312	Shannon Road	2300	138	6%
830106	Bogger Hollar Road	150	9	6%
830081	Bridge Road	330	20	6%
030161	Lockhart Road	100	6	6%
590060	Robinson Church Road	8600	602	7%
890067	Austin Grove Church Road	1500	105	7%
830095	Old Aquadale Road	420	25	6%
120050	Penninger Road	600	42	7%

Detour routes were determined collaboratively with each county engineer for each bridge in the event that the bridge would either be permanently closed. Detour routes were based on detour lengths in the NBI database.

Table 4 provides the length of the detour route in kilometers and miles. Two of the routes (Robinson Road and Penninger Road) demonstrate less than a mile of detours.

Table 4: Typical and Detour Route Lengths per Bridge

Bridge #	Road Name	Detour Length (kilometers)	Detour Lengths (miles)
120173	Peach Orchard Road	8.00	4.97
030148	Mills Road	8.00	4.97
890170	Potters Road	4.00	2.49
890144	Stack Road	3.00	1.86
890074	Monroe-Ansonville Road	1.00	0.62
030265	Robinson Road	0.00*	0.00*
830200	Bridge Port Road	1.00	0.62
890312	Shannon Road	6.00	3.73
830106	Bogger Hollar Road	3.00	1.86
830081	Bridge Road	8.00	4.97
030161	Lockhart Road	8.00	4.97
590060	Robinson Church Road	9.00	5.59
890067	Austin Grove Church Road	4.00	2.49
830095	Old Aquadale Road	4.00	2.49
120050	Penninger Road	0.00*	0.00*

** Detour lengths are listed as zero in the NBI*

It was assumed all traffic will use the detour if the bridge is permanently closed. Although the bridges are already all load posted to some degree, a separate, additional detour timing for trucks has not been included.

7. Estimation of Economic Benefits

7.1 Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category and provides an overview of the associated methodology, assumptions, and estimates.

List Of Benefits Analyzed

The benefits assessed for the *Bridges not Barriers* project are as follows:

- **Operations and Maintenance Reduction Savings:** The proposed improvements for each of the fifteen bridges will result in a reduction of operation and maintenance costs. These annual maintenance costs will be much higher in

the No Build scenario due to the greater likelihood of fixture for dilapidated bridges.

- **Accident Cost Savings:** The proposed improvements will achieve a reduction in traffic fatalities and serious injuries by providing project users with safer travel through the build scenario improvements.
- **Vehicle Operating Cost Savings:** Captures fuel cost savings and non-fuel cost savings (e.g., tire wear and tear, cost of maintenance, and depreciation) for drivers of personal and commercial vehicles.
- **Travel Time Savings:** Captures the reduced travel time for automobiles and trucks under the build scenario as a result of roadway improvements. Travel time savings will be realized by passenger vehicles, which will be able to take advantage of the higher speeds compared to those experienced in the no build scenario. Truck drivers will also benefit and save time as well. Across the fifteen bridges of observation, the percentage of heavy vehicles (trucks) that make up total volume range from 6% to 7%. Road postings and closures are expected to occur in each county, specified by pre-determined timing that is based on each county's project schedule. As a result of utilizing detour routes, the number of hours that are traveled among both trucks and passenger vehicles are expected to rise over the period of analysis. Due to the absence of numerous travel routes in certain counties, there may be a change of plans for those who are unable to endure the change.
- **Emission Cost Savings:** The proposed improvements will reduce emissions by allowing for more consistent free flow speeds. As a result of the proposed improvements, emissions will decrease for pollutants such as carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NOx), fine particulate matter (PM2.5), sulfur dioxide (SO2), and carbon dioxide (CO2).
- **Resiliency Benefit due to Avoided Detour:** Captures the annual estimation of road closures due to the storms. As a result of roadway improvements, bridges under the build scenario are expected to be closed less likely than bridges in their current state. This benefit category provides the estimation of added detours in the no build scenario.
- **Residual Value of Bridges:** New bridges will have an expected lifespan that will go beyond the period of analysis. Project users will enjoy the benefits of these bridges after the analysis therefore providing a future benefit value.

Methodology

The methodology used for estimating each of the benefits listed is presented below:

7.2 Operations and Maintenance Savings:

The expected annual costs of maintenance in the No Build and Build scenarios were determined collaboratively with the county engineers. The no build scenario will experience significant annual maintenance costs up until the anticipated bridge closure dates while the build scenario will experience a lower annual maintenance fee for its remaining useful life. Table 5 presents the maintenance costs for each bridge in build and no build scenarios.

Table 5: Average Annual Maintenance and Repair Costs for Current vs Replaced Bridges

Annual Maintenance and Repair Costs			
		Average Annual Repair and Maintenance	
Bridge #	Road Name	Current Bridge 2025-2035	After Replacement
120173	Peach Orchard Road	$400,000	$10,000
030148	Mills Road	$300,000	$10,000
890170	Potters Road	$400,000	$10,000
890144	Stack Road	$240,000	$10,000
890074	Monroe-Ansonville Road	$160,000	$10,000
030265	Robinson Road	$100,000	$10,000
830200	Bridge Port Road	$350,000	$10,000
890312	Shannon Road	$300,000	$20,000
830106	Bogger Hollar Road	$400,000	$10,000
830081	Bridge Road	$200,000	$10,000
030161	Lockhart Road	$180,000	$10,000
590060	Robinson Church Road	$300,000	$20,000
890067	Austin Grove Church Road	$250,000	$5,000
830095	Old Aquadale Road	$500,000	$10,000
120050	Penninger Road	$200,000	$5,000

Source: NC Division 10 staff.

Additional annual maintenance fees such as bridge closures by storm and costs to remove storm debris were added to the total annual maintenance.

Table 6: Average Annual Repair Costs for Storm Damage

Annual Repair Costs to Storm Damage						
Bridge #	Road Name	Current Bridges			Replaced Bridges	
		Average Number of Bridge Closures due to Storm (annual)	Average Cost to Repair Bridge	Annual Cost to Repair Bridge	Average Days per Year Bridge Closures by Storm	Cost to Repair Bridge
120173	Peach Orchard Road	2	2	$2,500	0	$0
030148	Mills Road	0	0	$0	0	$0
890170	Potters Road	0	0	$0	0	$0
890144	Stack Road	0	0	$0	0	$0
890074	Monroe-Ansonville Road	8	8	$2,000	0	$0
030265	Robinson Road	4	4	$8,000	0	$0
830200	Bridge Port Road	15	35	$15,000	0	$0
890312	Shannon Road	4	8	$8,000	0	$0
830106	Bogger Hollar Road	15	45	$10,000	0	$0
830081	Bridge Road	2	2	$15,000	0	$0
030161	Lockhart Road	12	12	$6,000	0	$0
590060	Robinson Church Road	3	3	$20,000	0	$0
890067	Austin Grove Church Road	1	1	$3,000	1	$1,000
830095	Old Aquadale Road	3	3	$10,000	0	$0
120050	Penninger Road	2	4	$20,000	1	$1,000

Additional information for all the above maintenance and repairs costs can be found on the *ProjectSummary* tab of the Excel file.

7.3 Accident Cost Savings

The installation of fifteen new bridges will improve safety for travelers for each new bridge. As part of the traffic analysis, the Project Team's specialists recorded and forecasted the No-Build and Build scenario safety conditions over the project's full period. Those values were pulled into the BCA model and were used to measure the frequency of crashes at each site, in addition to the severity of each crash (per KABCO recommended scaling).

The primary benefits realized through safety were calculated first by avoided fatality and/or injury, followed by the occurrences where damages were limited exclusively to property. Regional crash rates at the county level were calculated based on bridge county location and severity level.

Crash reduction factors (CRFs) due to bridge improvements were calculated using historical crash data collected from 2019-2024. Many of the recorded crashes occurred due to current bridge condition. In order to monetize these findings (e.g., direct savings from averted fatalities/injuries, property damage, full closure, load posting), the values that arrived following an analysis of overall crash calculations were multiplied by the USDOT recommended values, by injury severity. The CRFs for each bridge are listed in Table 7.

Table 7: Crash Reduction Factors by Bridge, for each severity

Bridge #	Road Name	Fatalities CMF ID 5402*	Injuries, All Types CMF ID 6329**
120173	PEACH ORCHARD ROAD	0.58	0.58
030148	MILLS ROAD	0.58	0.58
890170	POTTERS ROAD	0.58	0.58
890144	STACK ROAD	0.61	0.43
890074	MONROE-ANSONVILLE ROAD	0.61	0.43
030265	ROBINSON ROAD	0.61	0.43
830200	BRIDGE PORT ROAD	0.58	0.58
890312	SHANNON ROAD	0.61	0.43
830106	BOGGER HOLLAR ROAD	0.61	0.43
830081	BRIDGE ROAD	0.61	0.43
030161	LOCKHART ROAD	0.61	0.43
590060	ROBINSON CHURCH ROAD	0.61	0.43
890067	AUSTIN GROVE CHURCH ROAD	0.61	0.43
830095	OLD AQUADALE ROAD	0.61	0.43
120050	PENNINGER ROAD	0.61	0.43

*Upgrade narrow unpaved shoulder (<5 ft) to wide unpaved shoulder (>5 ft)
**Widen shoulder (paved) (from 0 to 4 ft)

Additional information can be found on the *CMFs* tab of the Excel file.

7.4 Vehicle Operating Cost Savings

Calculated based on VMT data derived from the client and traffic specialists for personal vehicles and trucks. The data was then entered into the BCA model. The total annual VMT for both auto and trucks from detours were then collected. Detours will force both auto and trucks to take longer routes, increasing the value of additional operating costs. Fuel costs are calculated by multiplying VMT by fuel consumption per mile and by fuel price for both the No-Build and Build scenarios. These costs are compared between the No-Build and Build, and the difference is the vehicle operating cost savings.

7.5 Travel Time Savings

Calculated by the total number of vehicle miles traveled due to the anticipated bridge closure. The analysis pulls passenger vehicle and truck data from the NBI database and applies the total amount of expected detour over the period of analysis. A zero growth was applied due to current economic uncertainties and no available data on trucks that are choosing alternate routes because of partial or full load posting. Average vehicle occupancy and percent trucks data were also entered in the model. The model multiplies the number of hours saved by personal vehicle drivers and truck drivers by their corresponding vehicle occupancy rates and values of time. Travel time costs are compared between the No-Build and Build, and the difference is the travel time savings.

7.6 Emission Cost Savings

There are five types of emissions measured in the analysis: carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxide (NOx), fine particulate matter (PM 2.5), sulfur dioxide (SO2), and carbon dioxide (CO2). Emissions per mile travelled for these pollutants were estimated using EPA's Motor Vehicles Emissions Simulator (MOVES) model run for North Carolina, for the years spanning 2022 and 2045. The emissions are monetized using values consistent with Passenger Cars and Light Trucks in the USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2024). Each emission type was converted in units from grams per mile into metric tons. Total emission cost savings were represented in units of $ per metricton. Table 8 presents the total avoided short tons due to additional detours during the period of analysis.

Table 8: Emission Reductions from Avoided Detours

Emissions	Total Avoided Short Tons
CO_2	122,236.9
NO_x	21.4
$PM_{2.5}$	0.6
SO_2	0.6

7.7 Resiliency Benefit from Avoided Detours

Calculated by the estimated amount of bridge closures due to storms for the build and no build scenarios. Auto and truck AADT for the estimated days of bridge closures in a year were quantified. The no build scenario resulted in a significant increase of miles traveled due to detours than the build scenario. Resiliency benefits considered both the additional value of time and additional vehicle operating costs due to diversion for auto and trucks. The impacts from bridge closures due to storms are presented in Table 9.

Table 9: Resiliency Impacts from Avoided Detours

Bridge #	Road Name	Resiliency Impacts on Traffic					
		Current Bridges			Replaced Bridges		
		Average Number of Bridge Closures due to Storm (annual)	Annual Auto Traffic Affected by Storm	Annual Truck Traffic Affected by Storm	Average Number of Bridge Closures due to Storm (annual)	Annual Auto Traffic Affected by Storm	Annual Truck Traffic Affected by Storm
120173	PEACH ORCHARD ROAD	2	1,340	94	0	0	0
030148	MILLS ROAD	0	0	0	0	0	0
890170	POTTERS ROAD	0	0	0	0	0	0
890144	STACK ROAD	0	0	0	0	0	0
890074	MONROE-ANSONVILLE ROAD	8	28,000	1,960	0	0	0
030265	ROBINSON ROAD	4	400	24	0	0	0
830200	BRIDGE PORT ROAD	15	3,500	210	0	0	0
890312	SHANNON ROAD	4	18,400	1,104	0	0	0
830106	BOGGER HOLLAR ROAD	15	6,750	405	0	0	0
830081	BRIDGE ROAD	2	660	40	0	0	0
030161	LOCKHART ROAD	12	1,200	72	0	0	0
590060	ROBINSON CHURCH ROAD	3	25,800	1,806	0	0	0
890067	AUSTIN GROVE CHURCH ROAD	1	1,500	105	1	1,500	105
830095	OLD AQUADALE ROAD	3	1,260	76	0	0	0
120050	PENNINGER ROAD	2	2,400	168	1	600	42

Additional information can be found on the *ProjectSummary* tab of the Excel file.

7.8 Residual Value

The residual value of the fifteen bridges was estimated using the remaining lifespan after the period of analysis. Construction costs were provided by county engineers. Bridges typically have an expected lifespan of 75 years, which surpasses the period of analysis of 20 years. Therefore, users will not experience the full cost of the bridge until after 2050.

ASSUMPTIONS

The assumptions used in the estimation of economic benefits for the project are summarized in Table 10.

Table 10: Assumptions Used in the Estimation of Economic Benefits

Variable Name	Value	Unit	Sources/Notes
General			
Base Year (for discounting)	2023	year	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Analysis Start Year	2025	year	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Construction Period	1	years	Project team
Construction Start Year	2029	year	Project team
Construction End Year	2030	year	Project team
Project Opening Year	2031	year	Project team
Last Year of Analysis	2050	year	Project team
Benefits Period	30	years	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Kilometers to Miles	0.621371	miles	Conversion
Discount Rate 1	2%	%	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Discount Rate 2	3.1%	%	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Annualization Factor	365	days per year	Total days per year
Travel Time Savings			
Value of Time - All Purposes	$21.10	2023 $ per person-hour	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Value of Time - Trucks	$35.70	2023 $ per person-hour	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Passenger Vehicle Average Vehicle Occupancy (AVO)	1.52	persons/vehicle	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Truck Average Vehicle Occupancy (AVO)	1.0	persons/vehicle	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Average Vehicle Speed - Diversion	40	mph	HDR project team assumption. Assumed same speed traveling on bridges as on diversion routes
Safety			

Variable Name	Value	Unit	Sources/Notes
Cost of No Injury (O)	$5,300	2023 $/event	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Cost of Possible Injury	$118,000	2023 $/event	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Cost of Non-Incapacitating Injury	$246,900	2023 $/event	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Cost of Incapacitating injury	$1,254,700	2023 $/event	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Cost of Fatal injury	$13,200,000	2023 $/event	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Cost of Damaged Vehicle (PDO)	$9,500	2023 $/vehicle	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Vehicles Damaged per PDO Crash - Bundle 10	1.10	events/crash	NCDOT project information
Cost of PDO Crash - Bundle 10	$10,450	2023 $/event	NCDOT project information
Emissions Cost Inputs			
Environmental Damage Costs	Multiple values	2023 $/ton	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Operating Cost Inputs			
Light Duty Vehicles	$0.56	$/mile	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)
Commercial Trucks	$1.27	$/mile	U.S.DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs November 2024 (Revised)

AGGREGATION OF BENEFIT ESTIMATES

Table 11 presents the benefit estimates by benefit categories over the project's lifecycle. Vehicle Operating Cost Savings ($124.9 million) is the largest benefit by category, followed by Safety Benefits from Avoided Detours ($60.5 million). Travel Time Benefits from Avoided Detours ($37.8 million) and Resiliency Benefit from Avoided Detours ($0.04 million) provide sources of benefit related to bridge closures. Safety Benefits from Bridge Improvements result in $0.8 million in total benefit. New bridges reduce the need to perform the frequent maintenance repairs that would arise over time in the No-Build

scenario and delay the commute of personal and business travelers. The O&M cost savings would be $0.4 million. Increased efficiency in the flow of traffic from the resulting project improvements results in societal benefits via the emission cost reductions ($25.6 million). The residual value of the bridges results in $7.7 million.

Table 11: Estimates of Economic Benefits, in Millions of 2023 Dollars

Benefit Category	Over the Project Lifecycle Discounted at 3.1%
Maintenance Cost Savings	$0.37
Travel Time Benefits from Avoided Detours	$37.79
Emission Cost Savings from Avoided Detours	$25.62
Safety Benefits from Bridge Improvements	$0.81
Safety Benefits from Avoided Detours	$60.52
VOC Savings from Avoided Detours	$124.87
Resiliency from Avoided Detours	$0.04
Residual Value of Bridges	$7.67
Total Benefits	**$257.69**

*Total may not sum up due to rounding

7.9 Comparison of Benefits and Costs

The project's benefits exceed the costs over the life cycle of this project. Total benefits work out to be monetized and valued at approximately $257.7 million, while total costs are valued at $20.6 million. The net present value (NPV) for the Bridges not Barriers project is slated to be $237.1 million.

8. Summary of Findings and BCA Outcomes

Based on the analysis presented in the rest of this document, the project is expected to generate $257.7 million in discounted benefits and $20.6 million in discounted costs, using a 3.1 percent real discount rate (except for CO2 emissions, which are discounted at 2%, per USDOT guidance).

Therefore, the project is expected to generate a Net Present Value of $237.1 million and a Benefit-Cost Ratio of 12.51.

Table 12: Results of the Benefit-Cost Analysis, in Millions of Dollars

Project Evaluation Metric	3.1% Discount Rate
Total Discounted Benefits ($ millions)	$257.69
Total Discounted Costs ($ millions)	$20.60
Net Present Value ($ millions)	$237.09
Benefit-Cost Ratio	12.51

The largest category of benefits is vehicle operating costs (VOC) followed by safety benefits and then travel time benefits, as shown in Table 13. These represent the impact of the long detours on overall project benefits.

Table 13: Benefits for Bridges not Barriers

Benefit Category	$ Millions Over the Project Lifecycle	
	Undiscounted	Discounted at 3.1%
Maintenance Cost Savings	$1.16	$0.37
Travel Time Benefits from Avoided Detours	$71.28	$37.79
Emission Cost Savings from Avoided Detours	$37.52	$25.62
Safety Benefits from Bridge Improvements	$1.36	$0.81
Safety Benefits from Avoided Detours	$107.39	$60.52
VOC Savings from Avoided Detours	$235.54	$124.87
Resiliency from Avoided Detours	$0.04	$0.04
Residual Value of Bridges	$17.49	$7.67
Total Benefits	**$471.78**	**$257.69**