



NORTH CAROLINA MPDG APPLICATION

MAY 2022



SAFETY



STATE OF GOOD REPAIR



ECONOMY



RESILIENCY



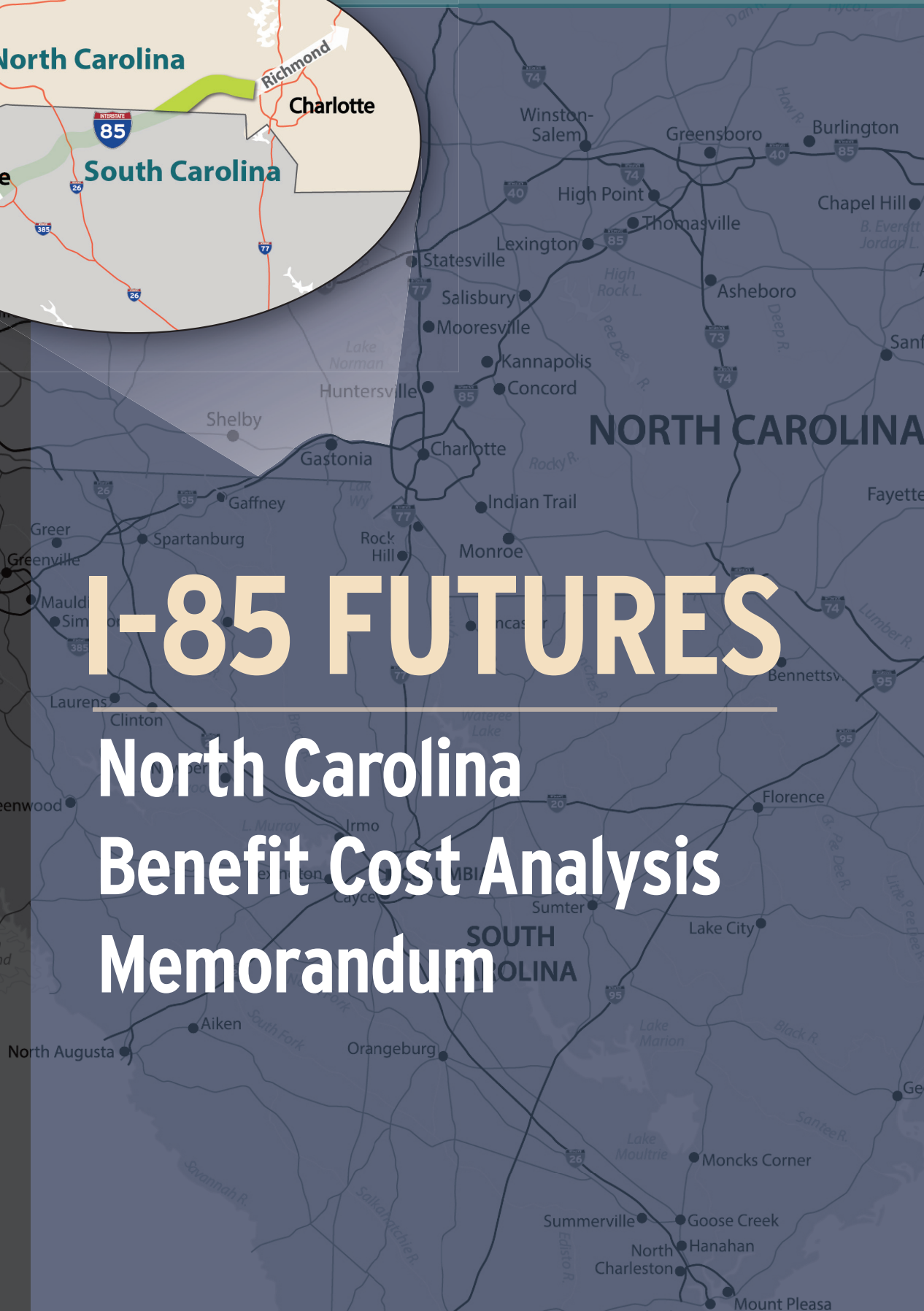
EQUITY



INNOVATION

I-85 FUTURES

North Carolina Benefit Cost Analysis Memorandum



Introduction

This technical memorandum estimates the long-term benefits associated with the I-85 Funding Transportation Utilizing Resilient Equitable Solutions (I-85 FUTURES) Project. This evaluation discusses all of the Performance Outcome Criteria mentioned in the Notice of Finding Opportunity, although for some measures a qualitative discussion is required. The assumptions and methods used to develop the Benefits-Cost Analysis (BCA) are detailed for each topic and are supported by supplementary material where appropriate.

The long-term quantifiable benefits are presented for the Project Outcome Criteria including: safety benefits, state of good repair, travel time savings (economic benefits), bicycle/pedestrian benefits (equity, multi-modal, and quality of life), and innovation (travel time reliability savings from fiber / broadband improvements). The benefits of climate change resiliency and improvements to the environment are included as quantitative benefits found in travel time savings and travel time reliability as a result of adding ITS and broadband. These quantitative benefits are included as a component of the economic and innovation benefits.

The final section summarizes the anticipated benefits and costs of the I-85 FUTURES project and calculates the overall Benefit-Cost Ratio.

Years of Analysis

The analysis is based on an estimated construction completion date of December 2030. A benefits period of 2030-2059 was used. This 30-year benefits period is consistent with the 2022 BCA Guidance for Discretionary Grant Programs (BCA Guidance) for projects involving the full reconstruction of highways or similar facilities.

Methodology

Benefits are estimated in accordance with the BCA Guidance. Where no specific approach was provided in the Guidance, NCDOT used best practices and research data as specified in the assumptions and methodology for each measure. The benefits quantified in the BCA use 2020 dollars (as advised by USDOT). Benefits for each Project element are described within the benefit categories.

Analysis Assumptions

A list of assumptions for the project is provided in the Benefit-Cost Analysis (BCA) workbook and summarized in Exhibits 1 and 2. Exhibit 1 displays the generalized BCA input values provided by the USDOT for a variety of categories that includes auto occupancy rates, vehicle values of time, safety crash rate values, emissions damage costs, and pedestrian and bicycle values.

Exhibit 1 - Input values from BCA Guidance

Input	Value
General Assumptions	
Analysis Period (Years)- Projects Involving Full Reconstruction of Highways	30
Discount Rate	7%
Discount Rate for Reductions in CO ₂ Emissions	3%
Dollar Year	2020
Auto Occupancy (Passenger Vehicles, All Travel)	1.67
Auto Occupancy (Trucks) ¹	1.00
Truck Value of Time (Hourly Value)	\$32.00
Passenger Vehicle Value of Time (hourly value)	\$17.80
Operating Costs per Mile (Light Duty Vehicles)	\$0.45
Operating Costs per Mile (Commercial Trucks)	\$0.94
Safety – Crash Data Assumptions	
O – No Injury	\$3,900
C – Possible Injury	\$77,200
B – Non-incapacitating	\$151,100
A – Incapacitating	\$554,800
K – Killed	\$11,600,000
U – Injured (Severity Unknown)	\$210,300
# of Accidents Reported (Unknown if Injured)	\$159,800
Property Damage Only Crashes	\$4,600
Emissions – Assumption for Damage Costs per Metric Ton	
NO _x – 2021 to 2029	\$15,600 to \$17,700
NO _x – 2030 and beyond	\$18,100
PM _{2.5} – 2021 to 2029	\$748,600 to \$854,000
PM _{2.5} – 2030 and beyond	\$867,000
CO ₂ – 2021 to 2050	\$52 to \$85
Pedestrian & Bicycle Benefits Assumptions	
Expand Sidewalk (per foot of added width)	\$0.10
Dedicated Cycling Lane (per cycling mile)	\$1.69
Value per induced walking trip (Ages 20 – 74) -Assumed 68% of trips within age range.	\$0.708
Value per induced cycling trip (Ages 20 – 64) -Assumed 59% of trips within age range.	\$6.31
Share of trips induced from non-active mode	89%

Note: Dollar values are in 2020-dollar values.

¹ – Value from https://www.fhwa.dot.gov/tpm/guidance/avo_factors.pdf

Exhibit 2 lists project-specific assumptions. Most of these project-specific assumptions come from current traffic engineering studies, including the [STIP I-5719] Project Level Traffic Forecast (2019), I-5719 Traffic Operations Analysis Technical Memorandum – Phase I (2018),

Traffic Operations Analysis Technical Memorandum – Phase II (2020), I-5719 Traffic Operations Analysis Technical Memorandum 2045 No-Build and Build Phase III (2021) and the 2021 Crash Strip Analysis. These materials are listed in the supplemental material in the BCA folder.

Exhibit 2 - BCA Calculation Inputs – Project-Specific

Input	Value	Source
General		
Annual Average Daily Traffic Volumes (AADT)	Varies by Scenario	I-5719 Project-Level Traffic Forecast (HNTB, 2019) https://connect.ncdot.gov/projects/planning/Traffic%20Forecasts/I-5719%20Gaston%20TF/I-
Compound Annual Growth Rate (Weighted average rate of all forecast roadway segments)	1.15%	I-5719%20Gaston%20Mecklenburg%202019%20TF.pdf
VHT/VMT values in vicinity of I-85 FUTURES Project	Varies by Scenario	Metrolina Regional Model (MRM) 18v.1.1 (same version of model as used in I-5719 Project-Level Traffic Forecast)
Corridor-Level Average Travel Times and Congestion MOEs	Varies by metric	I-5719 Traffic Operations Analysis Technical Memorandum 2045 No-Build and Build Phase III (HNTB, October 2021)
Crashes (categorized by type) from 6/1/2016 to 5/31/2021	Varies by crash type	NCDOT Traffic Engineering Accident Analysis System Strip Analysis Report (Published 8/20/2021)
Crash Modification Factor (CMF) ID 8336 (Installing Additional Lane on Urban Freeway)	0.74	http://www.cmfclearinghouse.org/detail.cfm?facid=8336#commentanchor

Benefits

Criterion 1 – Safety

An in-depth crash strip analysis report was completed for the I-5719 Project based on the 5-year period from June 1, 2016 to May 31, 2021. The crash analysis assessed all 5,237 crashes that occurred during this time, including a breakdown by crash type – fatal, non-fatal injuries and property damage only crashes (types A, B, and C). The analysis found that the section of I-85 from US 321 to NC 273, the I-5719 Project, exceeded the statewide urban interstate average crash rates for total crashes, non-fatal injury crashes, night crashes, and wet weather crashes. Future Year No-Build and Build crash estimates were projected by applying study-specific crash ratios to forecasted vehicle miles traveled (VMT) to produce estimates of different crash types in the future. Benefit values were estimated by using a combination of monetized values per injury level.

The I-5719 Project will greatly enhance the safety of drivers on the facility through improved acceleration and deceleration lanes for project interchanges, the addition of auxiliary lanes where appropriate, flattened vertical and horizontal curves, widened median shoulders, and improved median barriers. After a review of multiple Crash Modification Factors (CMFs) from the CMF Clearinghouse (refer to **Exhibit 3**), it was determined that a 26 percent reduction in crashes for the I-5719 Project facility is a reasonable estimate based on CMF ID 8336 for widening and the multiple substandard features being revised to meet current standards. Using the factors

previously listed, the total safety benefit savings was found to be \$1.5 billion, with a net present value in 2020 dollars of \$336.5 million.

Exhibit 3 – Project Crash Reduction Factors

ID	Countermeasure Description	CMF	Expected Crash Reduction	Application
8336	Installing an Additional Lane on Urban Freeway	0.74	26%	CMF applied to Build scenario CMFs reviewed and considered as part of the multitude of improved roadway design safety benefits being generated from this widening.
720	Flatten Crest Vertical Curve	0.80	20%	
7441	Add Continuous Auxiliary Lane for Weaving Between Entrance Ramp and Exit Ramp	0.77	23%	
474	Extend Acceleration Lane by Approx. 98 ft	0.89	11%	
475	Extend Deceleration Lane by Approx. 100 ft	0.93	7%	
3899	Provide an Auxiliary Lane Between an Entrance Ramp and an Exit Ramp	0.77	23%	

Source: <http://www.cmfclearinghouse.org/index.cfm>.

Criterion 2 – State of Good Repair

Currently, the structures within the I-5719 Project study area are contributing to an aging, deteriorating facility with frequent and expensive maintenance costs. The I-5719 Project will provide a greatly improved facility that will have less frequent and less costly maintenance. This includes pavement preservation, bridge maintenance, and general maintenance.

Altogether, state of good repair benefits will total \$19.2 million, with a net present value in 2020 dollars of \$7.5 million.

Criterion 3 – Economic Impacts, Freight Movement, and Job Creation

TRAVEL TIME

The Project will result in travel time savings for cars and freight vehicles in the Gastonia area. Vehicle hours of travel (VHT) – defined as total travel time in hours for passenger cars and trucks – was estimated for the No-Build and Build scenarios in the design year (2045). The difference between these two scenarios provides the foundation to quantify the hours saved for passenger cars and trucks. Travel time savings benefits were estimated using total travel time saved by autos and trucks at a value of \$17.80 per hour for passenger vehicles and \$32.00 per hour for trucks. The combination of passenger and freight vehicle time-savings will result in a total savings of \$61.2 million in the opening year and increasing to \$84.6 million at the end of the analysis period. The total travel time savings benefit is \$2.2 billion, with a net present value in 2020 dollars of \$453.5 million.

Note that these benefit values incorporate the disbenefits of increased VMT and increased emissions damages. Refer to **Exhibit 4** for a full breakdown of travel time benefits and disbenefits.

Exhibit 4 – VHT Savings Benefits and Induced VMT Disbenefits

Input	Value
Benefits	
VHT Benefits – Value of Time Savings	\$3.0 billion
Disbenefits	
VMT Increase – Operating Cost	(\$645.5) million
VMT Increase – Emissions ¹	(\$84.9) million
VMT Increase - Vehicle Crashes	(\$66.7) million
Net Benefits	
Net Benefits	\$2.2 billion
Net Benefits (NPV)	\$453.5 million

1 – The emissions disbenefits factor conservative estimates of future electric vehicle (EV) usage in the study area (note that these are conservatively lower values than the EV sales forecasts in the *NC Zero Emission Vehicle Plan* and various EV forecasts). The estimates used to adjust this disbenefit include:
 2020 – 0.1% EVs; 2030 – 5% EVs; 2040 – 20% EVs; 2050 – 40% EVs

Criterion 4 – Climate Change, Resiliency, and the Environment

The Project will provide a greatly enhanced facility relative to the aging, deteriorating facility with substandard design components. Having an improved I-85 would allow the facility to be a more reliable corridor that could better serve the National Freight Network and provide for an alternative facility during emergency events to I-95 and other nearby regional corridors.

The Project will provide for a much more efficient flow of traffic that will have less idling. Additionally, the Project will include a flood risk and vulnerability assessment that will include the installation of a Flood Warning System. For more information on quantitative aspects of climate change and resiliency considered, please refer to Criterion 3 and Criterion 6, respectively.

Criterion 5– Equity, Multimodal Options, and Quality of Life

BICYCLE / PEDESTRIAN BENEFITS

The I-5719 Project will include new active transportation infrastructure on nearly all of the roadway structures from US 321 to NC 273. These new pedestrian and bicycle facilities will provide improved connections and may begin to restore communities that were divided by the construction of I-85. There are 11 census tracts immediately adjacent to the I-5719 corridor that include 12,073 occupied housing units (per the 2020 Census). It is assumed that 75 percent of these housing units are within the project study area and that each household will make 5.5 trips/day/ household (Source: [Bureau of Transportation Statistics](#)).

It is assumed that reconnecting these communities will lead to a travel mode shift of 3 percent of all trips to be pedestrian trips and 2 percent of all trips to be bicycle trips. Additionally, there will be mortality reduction benefits for the new bicycle and pedestrian trips. Refer to **Exhibit 1** for the specifics of these assumptions.

Altogether, the bicycle/pedestrian infrastructure and reduced mortality benefits will total \$157.1 million, with a net present value in 2020 dollars of \$35.4 million.

Criterion 6– Economic Impacts, Freight Movement, and Job Creation

FIBER / ITS BENEFITS

I-85 FUTURES will include fiber optic cable and ITS improvements from the NC/SC state line to US 74. I-85 FUTURES will extend from the NC/SC state line along I-85 to connect with the fiber optic cable being installed along I-85 from I-485 to the US 74 interchange as part of the 2020 US 74 INFRA Grant. Fiber optic cable and ITS benefits were estimated to provide savings and reliability benefits worth \$202.8 million, with a net present value in 2020 dollars of \$56.9 million.

Summary

The analysis resulted in a 2.32 BCR and a \$906.5 million net present value of benefits (refer to **Exhibit 5**). This is considered a “High” economic analysis rating (the project’s benefits will exceed its costs with a BCR of at least 1.5). NCDOT has concluded that these benefits reasonably justify I-85 FUTURES’ costs.

Exhibit 5 – Total Project Benefit-Cost Analysis

Project	Capital Costs	Project Costs (NPV \$2020)	Total Net Benefit	Total Net Benefit (NPV \$2020)	Benefit-Cost Ratio
I-85 FUTURES	\$646,270,000	\$391,081,009	\$4,093,114,077	\$906,524,770	2.32