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MD 5 GREAT MILLS IMPROVEMENT PROJECT

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION

FY2020 BUILD DISCRETIONARY GRANT PROGRAM

PREPARED FOR: MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION (MDOT SHA)

MAY 18, 2020

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EXECUTIVE SUMMARY

A benefit-cost analysis (BCA) was conducted for the **MD 5 Great Mills Improvement Project** ("the Project") for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2020 program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in January 2020. The period of analysis corresponds to 25 years and includes 6 years of design and construction and 20 years of benefits after operations begin in 2026.

The Project serves as a principal connector for regional traffic to Great Mills Road, a vital transportation link for local Science, Technology, Engineering, and Math (STEM) employment centers supporting activities on several military installations in the region. These installations alone employ 21,500 active-duty personnel, civilians, and contractors, many of whom rely on MD 5 for access to destinations around Washington, D.C. and Maryland and in the event of a state or national emergency.

With traffic in the project area predicted to increase by 27% by 2040, traffic condition in the Great Mills area will be significantly impacted, especially along MD 5 between MD 471 and MD 246. The Project aims to reduce roadway crashes, reduce road congestion, and improve pedestrian connectivity with the expansion of a lane in each direction, the installation of bicycle lanes and sidewalks, the replacement of a bridge in "fair condition", and the installation of a right turn prohibition from Old Great Mills Road onto MD 5.

COSTS

The capital cost for this Project is expected to be $17.0 million in undiscounted 2020 dollars through 2025. At a 7 percent real discount rate, these costs are $12.1 million in 2018 dollars. Operations and maintenance (O&M) costs are projected to average $55,800 in 2018 dollars per year in the long term. As the Project is part of a structure with existing O&M costs that will remain unchanged with the project improvements over the entire 20-year analysis period, they will result in a zero net change in costs between the Build and No-Build scenarios. Finally, net rehabilitation and replacement (R&R) cost reductions are expected to total $0.3 million in undiscounted 2020 dollars over this same period, or $0.1 million in discounted 2018 dollars when discounted at 7 percent.

The capital costs related to the Project for design/engineering, right-of-way acquisition and construction activities are shown in Table ES-1.

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TABLE ES-1: Project Costs Schedule, in Millions of Undiscounted 2018 Dollars

Funding Source	2020	2021	2022	2023	2024	2025	Total
Design and Preliminary Engineering	$0.06	$0.96	$0.32	$0	$0	$0	$1.35
Right of Way Acquisition	$0	$0.41	$0.55	$0	$0	$0	$0.96
Construction	$0	$0	$0	$5.01	$5.26	$3.82	$14.09
Total	**$0.06**	**$1.37**	**$0.87**	**$5.01**	**$5.26**	**$3.82**	**$16.40**

Source: Maryland Department of Transportation State Highway Administration (MDOT SHA)

BENEFITS

In 2018 dollars, the Project is expected to generate $18.2 million in discounted benefits using a 7 percent discount rate. The Project creates these benefits primarily by reducing roadway congestion on MD 5, resulting in faster travel times and fewer roadway crashes. This leads to an overall project Net Present Value of $6.1 million and a **Benefit Cost Ratio (BCR) of 1.50**[1]. The overall project benefit matrix can be seen in Table ES-2.

Table ES-2: Project Impacts and Benefits Summary, Monetary Values in Millions of 2018 Dollars

Project Impact Categories	Change to Baseline	Type of Impact	Population Affected by Impact	Economic Benefit	Summary of Results (at 7% discount rate)	Page Reference in BCA
Economic Competitiveness	▼	Cost & Time Savings	Auto, Truck and Transit Users	Reduced travel time and costs for persons	$17.2	11
Safety	▼	# of Crashes	Road Users	Reduced crashes	$1.2	13
Agency Cost Reductions	▼	Net O&M and R&R Costs	MDOT	Reduced maintenance costs	$0.1	15

Source: WSP USA

The overall Project impacts can be seen in Table ES-3, which shows the magnitude of change and direction of the various impact categories.

[1] Per U.S. DOT guidance, operations and maintenance costs are included in the numerator along with other project benefits when calculating the benefit-cost ratio.

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Table ES-3: Project Impacts for MD 5 Great Mills Improvement Project, Cumulative 2024-2043

Category	Unit	Quantity	Direction
Vehicle-Miles Traveled	VMT	(3,267,607)	▲
Person-Hours Traveled	PHT	3,524,577	▼
Fuel Consumed	gallons	(117,276)	▲
Injury crashes	#	14	▼
Property Damage Only (PDO)	#	17	▼

Source: WSP USA

In addition to the monetized benefits presented in Table ES-2, the Project would create the following qualitative benefits:

ECONOMIC COMPETITIVENESS

- The benefits for reducing the number and severity of flooding events, while not quantified in this analysis, would result in additional travel time savings and avoided vehicle-miles traveled by eliminating the need to divert traffic on long detours to complete their journey.
- As the region continues to grow, the expansion of employment sites and commercial operations will require reliable infrastructure to fulfill their economic development objectives. Reducing regional roadway congestion supports the development of local communities and the mission of the military installations affected by the roadway delays.

STATE OF GOOD REPAIR

- The project improvements are predicted to help reduce the severity and frequency of flooding events affecting the roadway, reducing the damage to the pavement, the bridge and regional water management systems.

ENVIRONMENTAL SUSTAINABILITY

- The analysis does not directly quantify environmental benefits as a result of the project improvements, but the potential reduction in diverted traffic trips due to reductions in flooding events and daily roadway congestion would significantly reduce emissions and direct damages to the environment. The efficient diversion of floodwaters will reduce the harmful effects on the local plant and animal habitat.

QUALITY OF LIFE

- While the Great Mills project provides critical connections between military installations and growing businesses in the area, the corridor also connects important community landmarks, ranging from housing to public services to recreation spots. Improvements to the intersection and bridge within the project limits will help residents gain access to these community facilities and recreational amenities.

While these benefits are not easily quantifiable, they do provide real advantages and improvements that will be experienced by individuals and businesses in the region.

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1 INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the MD 5 Great Mills Improvement Project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2020 program. The following section describes the BCA framework, evaluation metrics, and report contents.

1.1 BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCA framework involves defining a Base Case or "No Build" Case, which is compared to the "Build" Case, where the grant request is awarded, and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project life-cycle. The importance of future welfare changes is determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.[2] This methodology includes the following analytical assumptions:

- Assessing benefits with respect to each of the five primary selection criteria defined by the U.S. DOT;
- Defining existing and future conditions under a No Build base case, as well as under the Build;
- Assessing the independent utility of each project if the overall application contains multiple separate projects linked together in a common objective;
- Estimating benefits and costs during project construction and operation, including 30 years of operations beyond the Project completion when benefits accrue;
- Using U.S. DOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;
- Presenting dollar values in real 2018 dollars. In instances where cost estimates and benefits valuations are expressed in historical dollar years, using an appropriate Consumer Price Index (CPI) to adjust the values; and
- Discounting future benefits and costs with a real discount rate of 7 percent consistent with U.S. DOT guidance.

[2] U.S. Department of Transportation. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. Jan 2020.

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1.2 REPORT CONTENTS

The Report illustrates the methodology, assumptions and inputs used in the benefit-cost analysis and an evaluation of its results.

Section 2 provides an explanation of the benefit-cost analysis methodology and a description of the project.

Section 3 provides a detailed explanation and calculation of the project costs.

Section 4 provides a detailed explanation and calculation of the benefit categories.

Section 5 provides the detailed results of the benefit-cost analysis.

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2 PROJECT OVERVIEW

2.1 DESCRIPTION

The Great Mills project provides a much-needed safety and traffic flow solution to a critical intersection in rural Maryland to improve the connection between key U.S. military and private sector employment centers and facilitate growth in the region. The project encompasses transportation improvements to MD 5 (Point Lookout Road) between MD 246 (Great Mills Road) and MD 471 (Indian Bridge Road) in Great Mills, St. Mary's County. Over the last 10 years, St. Mary's County has grown by 7.15 percent - the fifth highest in the State of Maryland - well above the U.S. national average of 5.96 percent. The county has the fastest-growing workforce in the State, with the highest share of high-tech jobs in its local economy in the country, mostly attributed to growth at the NAS PAX and WOLF, and to population moving from the Washington, D.C. area. This growth has resulted in increased traffic volumes in and surrounding the Great Mills project area.

New commercial and residential developments planned near and within the Great Mills project area are expected to generate higher traffic volumes and congestion, especially during peak travel periods, over the next 20 years. High traffic volumes resulting from existing development already contribute to operational failure. The additional traffic generated by future development will worsen congestion along the corridor. The intersections of MD 5/MD 471 and MD 5/MD 246 are projected to experience failing Levels of Service (LOS) in the design year of 2040.

The improvements in the project scope include:

- The widening of MD 5 (Point Lookout Road) from an undivided two-lane roadway to an undivided four-lane closed section roadway,
- 11-foot-wide outside travel lanes with 5-foot bicycle lanes,
- 5-foot-wide sidewalk along both sides of MD 5,
- A new bridge over the St. Mary's River at the same grade as the existing bridge, and
- Stormwater management facilities, drainage improvements, landscaping and stream restoration.

2.1.1 *EVALUATION PERIOD*

For the project, the evaluation period includes the relevant (post-design) construction period during which capital expenditures are undertaken, plus 20 years of operations beyond the project completion within which to evaluate ongoing benefits and costs.

For the purposes of this study, it has been assumed that design of the project will begin in 2020 with construction completed by the end of 2025 and operations beginning in 2026. As such, the 20-year evaluation period concludes in 2045.

2.1.2 *DISCOUNT RATES*

For purposes of present value discounting, all benefits and costs are conservatively assumed to occur at the end of each year. Benefits accruing from the improvements are assumed to begin in the calendar year immediately following the final construction year.

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For project costs and benefits, monetary values in this analysis are expressed in constant, year-end 2018 dollars. In instances where certain cost estimates or benefit valuations were expressed in dollar values from other (historical) years, the U.S. Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U) was used to adjust them to 2018 prices.[3]

The real discount rates used for this analysis was 7.0 percent, consistent with U.S. DOT guidance for Discretionary Grant Programs[4] and OMB Circular A-4.[5]

2.2 BASE CASE AND BUILD CASE

The analysis of the project segment considered how the balance of costs and benefits resulting from the construction of the project improvements would result in long-term benefits to its users and general society. In the "Build" Case, the project includes the widening to a four-lane road and bridge with bike lanes and pedestrian sidewalks in each direction over the St. Mary's River near the intersection of MD 5 and Great Mills Road. The construction will include improved roadway turning geometry at intersections with MD 246 and MD 471. Due to the project's limited disturbance to existing roadways, construction-related closures and early year disbenefits are not assumed to occur.

The "No Build" Case examines the societal costs of increasing traffic on the existing adjacent arterial roads without any planned safety or capacity improvements, resulting in increasing crashes and traffic delays on MD 5 and increased damage to the existing bridge over St. Mary's River requiring major repair and rehabilitation.

2.2.1 *A CONSERVATIVE APPROACH*

The BCA implements a conservative approach. Each assumption or valuation was chosen to reflect this conservative approach, and at times guidelines from other documents were modified to reflect increased conservatism. Some of these conservative assumptions include:

- Travel time savings from the reduction of congestion significantly reflect peak-hour traffic, which is calculated to be approximately 30% of total daily trips;
- The analysis does not capture travel time savings, congestion reduction or crash reductions beyond the immediate project area on MD 5, although the region's major arterial roads connect through the project area, certainly resulting in knock-on benefits for regional traffic;
- The projected reduction in safety incidents of 10% used in the analysis is primarily related to improvements affecting vehicle traffic in accordance with guidance provided by U.S. DOT reviewers;
- The projected reduction in flood incidents affecting the roadway as a result of the project improvements will certainly provide benefits for road users and preserve the condition of the infrastructure, yet the

[3] U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. City Average, Series CUSR0000SA0. 1982-1984=100

[4] US DOT. BUILD 2020 NOFO: Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Updated January 29, 2020; https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance

[5] White House Office of Management and Budget, Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (October 29, 1992). (http://www.whitehouse.gov/omb/circulars_a094).

effects of these events are not captured in this analysis. While the available information on the severity and frequency of flooding events is incomplete, their constant presence demonstrates the benefits of the project to be understated; and,

- Travel delay for bus passengers traveling along Great Mills Road is assumed to remain constant during the evaluation period, despite the projected increase in traffic congestion and travel delay. As travel delay for bus users increases, it is assumed there would be a degree of mode shift from transit to personal vehicles. Additionally, the vehicle-occupancy rate for the bus trips is based on annual unlinked passenger trips over annual revenue-miles, which could understate the number of users commuting during peak hour period.

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3 PROJECT COSTS

3.1 CAPITAL COSTS

Initial project investment costs include right-of-way acquisition, engineering and design, and construction. Total capital costs of $17.0 million in undiscounted 2020 dollars were included in the project budget and included costs beginning in 2020 and ending in 2025, as shown in Table 1. Using an adjustment factor for inflation of 1.039, the total capital costs are equivalent to $12.1 million in 2018 dollars. The improved facility is expected to be open and operational at the beginning of 2026.

Table 1: Project Schedule and Costs, Millions of 2018 Dollars

Variable	Unit	Value
Design and Construction Start	year	2020
Design and Construction End	year	2025
Design and Construction Duration	years	6
Project Opening	year	2026
Capital Cost – Construction, Professional Services, and Right-of-way	2018$ M, Undiscounted	$16.4

Source: WSP USA

3.2 OPERATIONS AND MAINTENANCE COSTS

The annual costs of operating and maintaining the project are included in the analysis. In the “Build” Case, the operations and maintenance costs for the project include the regular maintenance and repairs to the replacement bridge and roadway. Since the project involves the replacement and enhancement of existing infrastructure, operating and maintenance costs for the bridge and roadway are calculated to have similar costs, yet maintenance activities will be on a deferred schedule.

The project improvements will not change the frequency or costs of annual operations and maintenance to maintain the quality of the asset, resulting in zero net change in costs for Maryland DOT. The annual operations and maintenance costs for the “Build” and the “No Build” Case for the project segment are shown in Table 2.

3.3 REPAIR AND REHABILITATION (R&R) COSTS

The pavement of the road and bridge lanes will need to be replaced or rehabilitated during the evaluation period. Rehabilitation of the roadway and bridge structure will occur every 10 years, according to the standard practices of the Maryland Department of Transportation Maryland State Highway Administration (MDOT SHA) Operations Department. The project improvements will defer the patching and repaving for the roadway and major restoration of the bridge from 2025 to 2043. An undiscounted value of $0.3 million in 2018 dollars was applied for net rehabilitation costs to maintain the quality of this investment, as shown in Table 2.

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Table 2: Schedule of Operations and Maintenance and Repair/Rehabilitation/Replacement Costs (in Undiscounted 2018 Dollars)

Year	Build		No Build	
	O&M	R&R	O&M	R&R
2025	$55,842	-	$55,842	$72,209
2026 - 2030	$55,842	-	$55,842	-
2031	$55,842	-	$55,842	$121,312
2032 – 2040	$55,842	-	$55,842	-
2041	$55,842	-	$55,842	$121,312
2042	$55,842	-	$55,842	-
2043	$55,842	$72,209	$55,842	-
2044	$55,842	-	$55,842	-
2045	$55,842	-	$55,842	$72,209
Total	**$1,116,837**	**$72,209**	**$1,116,837**	**$387,042**

Source: Maryland Department of Transportation State Highway Administration (MDOT SHA)

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4 PROJECT BENEFITS

The benefits of the project improvements can be described as user benefits, including travel time savings and reduction in vehicle operating costs, and social benefits, including emissions reductions and the reduction in damage to property and injuries as the result of fewer collisions. The analysis covers the following benefit categories:

- Travel Time Savings
- Safety Benefits
- Vehicle Operating Cost Savings
- Reduced Roadway Damage
- Reduced Emissions
- Improved Bicycle Commuter Mobility
- Recreational Benefits
- Health Benefits
- Agency Net O&M and R&R Costs

The analysis uses standardized factors provided by governmental and industry sources to efficiently determine the monetized value of user and social benefits resulting from the project improvements. These benefits include the reduction of existing costs or the prevention of future costs related to the operation and use of the existing road facility. Table 3 shows how the benefit categories align with the merit criteria of the BUILD Grants program.

Table 3: Project Benefits by Long-Term Outcome Category

Long-Term Outcome	Benefit (Disbenefit) Category	Description	Monetized	Qualitative
Economic Competitiveness	Travel Time Savings	Reduced travel time for persons	√	
	Net Vehicle Operating Costs	Change in vehicle operating and maintenance costs	√	√
	Net Fuel Costs	Change in vehicle fuel consumption	√	√
Safety	Reduced Incidents	Avoided pedestrian, bicycle and vehicle crashes	√	
State of Good Repair	Reduced Roadway Damage	Reduced damage to roads from reduced vehicle-miles traveled		√
Environmental Sustainability	Reduced Emissions	Lower emissions (reduced health risks)		√
Quality of Life / Livability	Recreational Benefits	Benefits for bicyclists and pedestrians		√
	Health Benefits	Benefits for bicyclists and pedestrians		√

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4.1 TRAVEL DEMAND PROJECTIONS

Traffic demand projections illustrate the growth in roadway use in response to the availability of capacity and user demand and the social costs and benefits associated with the use of the facility. Projections of future traffic patterns indicates whether project improvements will improve safety and decrease congestion and trip length with additional capacity and infrastructure features.

At the request of MDOT SHA, WRA was asked to apply the MSTM Chapter 30 process to the MD 5 Great Mills Project, which includes the redesign of MD 5 from west of MD 471 through the intersection with MD 246. For this analysis, the 2015 network and 2040 "No Build" networks were reviewed to ensure the network accurately reflected the "No Build". The "No Build" alternatives consist of 1-lane in each direction with a 2-lane left turn lane for eastbound traffic turning north. The left turn lane is not included in the model network. In addition, a south bound connection is included connecting MD 246 to MD 5 with right in / right out access for west bound MD 5 traffic. For the "Build" alternative, the corridor was coded as two lanes in each direction throughout the project limits and included the removal of the connector.

The analysis incorporates growth projections developed by MDOT SHA using travel forecasting and analysis to project traffic patterns within the project segment on MD 5 from 2016 to 2040. The travel demand analysis resulted in a projected annual traffic growth rate of 1.45% for the project segment, which is reflected in the traffic projections in this study. As Great Mills is designated as a community within the Lexington Park metro area and the project segment performs as a key corridor for regional travel, the induced demand due to the project improvements in the local area is captured in the regional traffic growth projections. The factors and assumptions related to the traffic modeling in the project area are detailed in the table below.

Table 4: Demand Projection Assumptions and Sources

Variable	Unit	Value	Source
Average Daily Trips - MD 471 to MD 246 on MD 5 – 2016	trips	21,800	Maryland DOT SHA Travel Demand Forecasting
Average Daily Trips - MD 471 to MD 246 on MD 5 – 2040	trips	27,600	Maryland DOT SHA Travel Demand Forecasting
Average Daily Trips – Compound Annual Growth Rate	%	1.45%	Maryland DOT SHA Travel Demand Forecasting
% Peak Period Trips of Total Daily Traffic	%	28.9%	Maryland DOT SHA Travel Demand Forecasting
Average Daily VMTs - MD 471 to MD 246 on MD 5 – 2016	VMTs	20,492	Maryland DOT SHA Travel Demand Forecasting
Average Daily VMTs - MD 471 to MD 246 on MD 5 – 2040	VMTs	25,944	Maryland DOT SHA Travel Demand Forecasting
Average Speed - MD 471 to MD 246 on MD 5 – 2016	mph	29	Maryland DOT SHA Travel Demand Forecasting

Average Speed - MD 471 to MD 246 on MD 5 – 2040 – Build	mph	31	Maryland DOT SHA Travel Demand Forecasting
Average Speed - MD 471 to MD 246 on MD 5 – 2040 – No Build	mph	14	Maryland DOT SHA Travel Demand Forecasting
Average Traffic Mix – Auto/Truck	%	99%/1%	St. Mary's County Transportation Plan, 2006
Daily Peak Period Auto Vehicle Occupancy	users/auto	1.48	US DOT BCA Guidance, January 2020
Weekly Peak Period Bus Trips	trips/weekday	12	St. Mary's County Transportation Department
Daily Peak Period Local Bus Vehicle Occupancy	passengers/bus	5.43	St. Mary's County Government/Federal Transit Administration NTD
Annualization Factor	days/year	250	WSP

The effects of the project improvements are captured in the travel time savings during the peak period; traffic is assumed to be travel at free-flow speeds outside of the peak period. The peak period is defined as 6 am to 9 am and 3 pm to 6 pm, capturing the commute traffic traveling in both directions. After the construction of the project improvements, a steady ramp-up in improved traffic performance over the analysis period is modeled to capture changes in travel behavior as a long-term trend. While the project segment does not experience variations in the number of vehicle-miles traveled between the Build and No Build scenarios, the effect of the project improvements on regional traffic demonstrates an increase in trips while the average length of total trips decreases due to less detour behavior. The project area represents a choke point in the regional traffic system, therefore changes in travel time are captured there and do not include regional impacts. The resulting demand projections are presented in the following table.

Table 5: No Build and Build Demand Projections

Variable	Project Opening Year			Final Year of Analysis		
	No Build	Build	Net Change	No Build	Build	Net Change
Total Weekday ADTs – MD 471 to MD 246 on MD 5	24,052	24,052	0	28,426	28,426	0
Total Weekday VMTs – MD 471 to MD 246 on MD 5	22,609	22,609	0	26,720	26,720	0
Average Speed (mph) – MD 471 to MD 246 on MD 5	18 mph	28 mph	+ 10 MPH	10 mph	31 mph	+ 21 MPH

Daily Peak Period VHTs – MD 471 to MD 246 on MD 5	433	270	- 163 hours	1,213	305	- 908 Hours
Total Weekday VMTs – Lexington Park Area	1,941,589	1,941,906	+ 317 VMT	2,471,037	2,472,062	+ 1,024 VMT

Source: Maryland Department of Transportation State Highway Administration (MDOT SHA), WSP USA

4.2 ECONOMIC COMPETITIVENESS

This project would contribute to increasing the economic competitiveness of the Nation through improvements in the mobility of people and goods in the study area. Two types of societal benefits are measured in the assessment of economic competitiveness: travel time savings and vehicle operating cost savings. The analysis quantifies benefits related to travel time savings associated with the project improvements, yet largely describes vehicle operating cost savings in qualitative terms.

With the reduction of roadway congestion resulting from the project improvements, travel time savings are a significant direct benefit for users of the road facility. The user benefits represent a reduction of future costs related to the personal and commercial use of the roadway. The reduction in time delays allows personnel to reach employment centers and freight trucks to deliver equipment and materials to technical facilities and military installations in a cost- and time-efficient manner, impacting economic industries throughout the region. As a central component in improving traffic movements throughout St. Mary's County, the project improvements facilitate the development of commercial properties and employment sites in the Lexington Area, while improving connectivity to regional pedestrian and bicyclist infrastructure.

4.2.1 *TRAVEL TIME SAVINGS*

Travel time savings includes in-vehicle travel time savings for auto drivers and passengers and truck drivers. Travel time is considered a cost to users, and its value depends on the disutility that travelers attribute to time spent traveling. A reduction in travel time translates into more time available for work, leisure, or other activities. The MD 5 Great Mills Improvement Project will provide additional capacity on a vital connector in the region, alleviating peak-hour congestion on adjacent arterials with reduced travel time and higher travel speeds for commuters, freight traffic and recreational users throughout the region. The reduction in travel time for the project is calculated to be $17.2 million in discounted 2018 dollars.

Table 6: Travel Time Savings Estimation of Benefits, Millions of 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Travel Time Savings - Auto	$0.97	$0.61	$56.76	$16.53
Travel Time Savings - Truck	$0.01	$0.01	$0.92	$0.27
Travel Time Savings - Bus Passengers	$0.06	$0.04	$1.23	$0.44

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Total	**$1.05**	**$0.65**	**$58.91**	**$17.23**

Source: WSP USA

The assumptions used in the estimation of travel time savings benefits are presented in the following table.

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Table 7: Travel Time Savings Assumptions and Sources

Variable	Unit	Value	Source
Value of Travel Time Savings - Personal, Local	2018$ per person hour	$15.20	U.S. DOT BCA Guidance, January 2020
Value of Travel Time Savings - Business, Local	2018$ per person hour	$27.10	U.S. DOT BCA Guidance, January 2020
Value of Travel Time Savings - All Purposes, Local	2018$ per person hour	$16.60	U.S. DOT BCA Guidance, January 2020

4.2.2 *VEHICLE OPERATING COST SAVINGS*

Vehicle operating cost savings includes the cost of fuel, as well as maintenance and repair, replacement of tires, and the depreciation of the vehicle over time. The project improvements do not measurably reduce the direct distance through the project area, yet the reductions in road congestion and faster travel times could incidentally reduce fuel consumption and general wear-and-tear by minimizing idling in stop-go traffic. Additionally, as the project improvements aim to reduce the frequency and severity of flooding events on MD 5, it would avoid the need for drivers to take lengthy detours around the flooded area to complete their journey, thereby reducing total vehicle-miles traveled. The induced demand experienced in the regional traffic system as a result of the project improvements will increase total vehicle-miles traveled and thereby generate net vehicle maintenance and operations costs of $0.4 million in discounted 2018 dollars. The breakdown of the costs for autos and trucks are shown in the table below.

Table 8: Estimated Net Vehicle Maintenance and Operations Costs, Millions of 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Vehicle O&M Costs - Auto	($0.032)	($0.020)	($1.326)	($0.410)
Vehicle O&M Costs - Truck	($0.001)	($0.000)	($0.031)	($0.010)
Total Net Vehicle O&M Costs	**($0.033)**	**($0.020)**	**($1.358)**	**($0.420)**

Source: WSP USA

The assumptions used in the estimation of vehicle maintenance and operation costs are presented in the following table.

Table 9: Vehicle Operations and Maintenance Costs Assumptions and Sources

Variable	Unit	Value	Source
Vehicle Operating Costs - Light Duty Vehicles	2018$ / VMT	$0.41	USDOT BCA Guidance Jan 2020
Vehicle Operating Costs - Commercial Trucks	2018$ / VMT	$0.96	USDOT BCA Guidance Jan 2020

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4.3 SAFETY

The safety benefits assessed in this analysis include a reduction in fatalities and injuries, as well as a reduction in other property damage crash costs resulting directly from the project. Due to the mix of residential neighborhoods and commercial developments in the vicinity, the traffic in the area around Great Mills includes personal vehicles, freight trucks, on-road bicyclists and pedestrians.

The constriction of daily commuter traffic down to two lanes on MD 5 and Great Mills Road leads to frequent crashes resulting from inattention, abrupt stops and impatient driving. From 2009 to 2018, 162 crashes occurred within a half-mile of the project segment around the intersections of MD 5 with MD 246 and MD 471, of which resulted in 85 significant injuries, detailed below in Table 10. The project segment experiences an average of 6.9 significant injuries from collisions and 8.5 collisions resulting in property damage on an annual basis, according to the crash statistics provided by Maryland DOT SHA. In this analysis, the number of projected crashes is kept constant for each year during the analysis period for a conservative approach, despite the forecasted traffic growth and the rate of change in recent years.

Table 10: Crashes in Project Area from 2009 to 2018

Incidents by Injury Severity	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	*Avg.*
Crashes with Injuries	5	6	4	4	13	3	8	6	4	8	**61**	*4.9*
No. of Injuries	9	8	6	5	16	4	15	6	6	10	**85**	*6.9*
Property Damage Only	7	10	9	15	11	12	10	11	4	12	**101**	*8.5*

Source: Maryland Department of Transportation State Highway Administration (MDOT SHA)

The expansion of the roadway and changes of roadway geometry on MD 5, in addition to the improved facilities for bicycles and pedestrians, are projected to reduce crashes by an average of about 10%, or an average of one to two incidents annually. The prevention of these crash incidents is calculated to save $1.3 million in discounted 2018 dollars.

Table 11: Estimation of Safety Benefits, Millions of 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Injury Reduction	$0.173	$0.108	$3.458	$1.221
Property Damage Reduction	$0.004	$0.002	$0.075	$0.026
Total Safety Benefits	**$0.177**	**$0.110**	**$3.533**	**$1.247**

Source: WSP USA

The analysis assumes accident rates modified with a crash modification factor reflective of the roadway improvements for the “Build” scenario. As a result, any changes in the number of accidents will be a result of structural changes to the safety conditions on the roadway network tied to the growth of traffic. In the debrief of

last year's application, the U.S. DOT review team determined in their research that the project improvements would result in a reduction of crashes between 0 percent and 20 percent, advising a reduction of 10 percent would be reasonable. Therefore, a crash reduction factor of 10 percent has been used in the analysis of the project improvements. The assumptions used in the estimation of safety benefits are presented in the following table.

Table 12: Safety Benefits Assumptions and Sources

Variable	Unit	Value	Source
Cost per Fatality	2018$	$9,600,000	U.S. DOT BCA Guidance, January 2020
Cost per MAIS 5 Injury	2018$	$5,692,800	U.S. DOT BCA Guidance, January 2020
Cost per MAIS 4 Injury	2018$	$2,553,600	U.S. DOT BCA Guidance, January 2020
Cost per MAIS 3 Injury	2018$	$1,008,000	U.S. DOT BCA Guidance, January 2020
Cost per MAIS 2 Injury	2018$	$451,200	U.S. DOT BCA Guidance, January 2020
Cost per MAIS 1 Injury	2018$	$28,800	U.S. DOT BCA Guidance, January 2020
Cost per Property-Damage Only Crash	2018$	$4,300	U.S. DOT BCA Guidance, January 2020
Crash Modification Factor	factor	10%	Guidance from U.S. DOT BUILD Grant Review Team

4.4 STATE OF GOOD REPAIR

The state of good repair condition benefits assessed in this analysis include maintenance and repair savings, deferral of replacement cost savings, reduced VMT which leads to less road and facility damage, as well as use of design and technologies to increase resilience performance during natural hazard events and long-term use. While prevented damage to roadway pavement is associated with reductions in VMTs, the replacement of the bridge will ensure the vital transportation link for the region will continue to operate at peak performance while reducing the probability of flooding events. While not quantified in this analysis, the improvements to the roadway and bridge will help reduce the probability that the flooding of the St. Mary's River will adversely affect the condition of the roadway or the bridge. The regional roadway network experiences a slight bump in total VMTs in the Build scenario as induced demand results in people making more trips while the average length of trips is shortened due to reductions in detouring behavior. Considering these impacts, the net effect on the analysis is determined to be negligible and therefore is described here in qualitative terms.

4.5 ENVIRONMENTAL SUSTAINABILITY

This project will create environmental and sustainability benefits relating to reduction in waterway and air pollution associated with fewer detouring events, reduced flooding events and more efficient traffic flow. While the analysis does not directly quantify environmental benefits as a result of the project improvements, the reduction in diverted

traffic trips due to reductions in flooding events and daily roadway congestion would significantly reduce emissions and direct damages to the environment. Additionally, the completion of sidewalks and lanes for bicyclists and pedestrians may induce residents to switch modes of travel for commuting or to complete short local trips by foot or an alternative to driving a car.

4.6 QUALITY OF LIFE / LIVABILITY

This project could create quality of life / livability benefits associated with encouraging pedestrian and bicyclists traffic and improving ADA access around Great Mills and Lexington Park for greater mobility. Extending and completing pedestrian infrastructure to increase connectivity within the community has been shown to induce foot and bicycle traffic for commuting and recreation. Additionally, the project improvements would build pedestrian and bicycle connections to the National Park Service-designated Southern Maryland Potomac Heritage Trail on-road bicycling route that runs on MD 5 from the county seat of Leonardtown south to Point Lookout. The improved connectivity of the regional pedestrian and bike infrastructure network will increase access to recreational opportunities, employment centers and social institutions. While the benefits of these improvements cannot be quantified with the available data, they would provide substantial benefits for local users.

4.7 AGENCY COST REDUCTIONS

Project improvements resulting in reductions in agency costs related to the operation, maintenance, repair or rehabilitation of an asset can be the result of improved management processes or the replacement of underperforming equipment. The bridge structure will require significant rehabilitation in the next 20 years as it approaches the end of its useful life amidst increasingly frequent flood events and regular wear and tear according to the schedule in section 3.3. The lifespan of the roadway is estimated at 20 years before requiring complete replacement; the existing roadway is slated for replacement in 2025. The construction of the project improvements will defer scheduled maintenance and repair on the bridge and roadway, resulting in reduced costs over the analysis period. The expansion of the four-lane roadway bridge and the construction of dedicated bike and pedestrian infrastructure will result in cost reductions totaling $0.1 million in discounted 2018 dollars.

Table 13: Agency Estimation of Net O&M and R&R Costs, Millions of 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
O&M Costs	-	-	-	-
R&R Costs	$0.07	$0.05	$0.31	$0.13
Total Agency O&M and R&R Costs	**$0.07**	**$0.05**	**$0.31**	**$0.13**

Source: WSP USA

The assumptions used in the estimation of net operations & maintenance and repair & rehabilitation costs are presented in the following table.

Table 14: Agency Costs Reduction Assumptions and Sources

Variable	Unit	Schedule	Source

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Operations & Maintenance Costs	2018$	Annual	MDOT SHA
Repair & Rehabilitation – Road (No Build)	2018$	2025, then every 20 years	MDOT SHA
Repair & Rehabilitation – Bridge (No Build)	2018$	2031, then every 10 years	MDOT SHA
Repair & Rehabilitation – Road (Build)	2018$	20 Years after Construction	MDOT SHA
Repair & Rehabilitation – Bridge (Build)	2018$	50 Years after Construction	MDOT SHA

4.8 RESIDUAL VALUE

The residual capital value (RCV) is calculated by determining the percentage of useful life remaining beyond the analysis period and multiplying that percentage by the construction cost for that component. The design life of the roadway is estimated at 20 years following construction, therefore there would be no remaining residual value at the end of the analysis period. While engineer's estimate assumes a 50-year useful life to be reasonable for the bridge structure, the analysis set the useful life of the bridge structure at 20 years, effectively calculating the residual value to be null.

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5 SUMMARY OF RESULTS

5.1 EVALUATION MEASURES

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the Project into monetary units and compares them. The following common benefit-cost evaluation measures are included in this BCA:

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
- Benefit Cost Ratio (BCR): The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.
- Internal Rate of Return (IRR): The IRR is the discount rate which makes the NPV from the Project equal to zero. In other words, it is the discount rate at which the Project breaks even. Generally, the greater the IRR, the more desirable the Project.

5.2 BCA RESULTS

The table below presents the evaluation results for the project. Results are presented in undiscounted 2018 dollars and 2018 dollars discounted at 7 percent, as prescribed by the U.S. DOT BCA Guidance. All benefits and costs were estimated in constant 2018 dollars over an evaluation period extending 20 years beyond system completion in 2025.

The total benefits from the project improvements within the analysis period are calculated to be $18.2 million in discounted 2018 dollars. The total capital costs, including engineering, construction, and right-of-way and land acquisition, are calculated to be $12.1 million in discounted 2018 dollars. The difference of the discounted benefits and costs equal a net present value of $6.1 million in discounted 2018 dollars, resulting in a benefit-cost ratio (BCR) of 1.50.

Table 15: Benefit Cost Analysis Results, Millions of 2018 Dollars

BCA Metric	Project Lifecycle	
	Undiscounted	Discounted (7%)
Total Benefits	$61.4	$18.2
Total Costs	$16.4	$12.1
Net Present Value (NPV)	$45.0	$6.1
Benefit Cost Ratio (BCR)	3.74	1.50
Internal Rate of Return (IRR)	11%	N/A

Source: WSP USA

The benefits over the project lifecycle are presented in the table below by U.S. DOT long-term outcome category.

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Table 16: Benefits by Long-Term Outcome, Millions of 2018 Dollars

Type of Benefit	Undiscounted	Discounted
Travel Time Savings	$58.91	$17.23
Safety	$3.53	$1.25
Vehicle Operating Cost Savings (including Fuel)	($1.36)	($0.42)
Reduced Agency O&M Costs	$0.31	$0.13

Source: WSP USA