5 Benefit-Cost Analysis

1. Narrative Overview

A benefit-cost analysis (BCA) was conducted for the Full Replacement of the I-195 Washington Bridge - Relieving Congestion after Emergency Shutdown for submission to the U.S. Department of Transportation (USDOT) as a requirement of a discretionary grant application for the Multimodal Project Discretionary Grant Opportunity (MPDG), National Infrastructure Project Assistance Grants (MEGA) Program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by USDOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in December 2023. The period of analysis corresponds to 33 years and includes 3 years of investment and 30 years of benefits after operations (replacement bridge) begin in 2027.

The westbound span of the Washington Bridge, a critical piece of highway infrastructure in Rhode Island, is closed and no longer serviceable due to safety concerns. Because this vital commuter and freight connector linking the City of Providence to Southern New England has not been open since Dec. 11, traffic delays have compounded every aspect of travel in this part of the state and greatly impacted others.

That is why Rhode Island Department of Transportation (RIDOT) is requesting $220.9 Million in MPDG support for the $368.3 Million Full Replacement of the I-195 Washington Bridge project.

Key factors in the BCA include travel-time costs, both with the current eastbound span’s 3-lane per direction configuration versus a fully rehabilitated structure that will properly restore westbound traffic to a new bridge. Delays, which conservatively begin at least a mile upstream of the now-closed bridge, are also analyzed along with volume considerations for the next 30 years. The results of the current short-term, no-build solution are extreme costs to both the traveling public and operation and maintenance.

The resulting benefit-cost ratio is 2.9-to-1 in this robust analysis.

APPENDIX : BENEFIT-COST ANALYSIS

EXECUTIVE SUMMARY

This benefit-cost analysis (BCA) was conducted for the Full Replacement of the I-195 Washington Bridge - Relieving Congestion after Emergency Shutdown (the **Project)** for submission to the U.S. Department of Transportation (USDOT) as a requirement of a discretionary grant application for the **Multimodal Project Discretionary Grant Opportunity (MPDG), National Infrastructure Project Assistance Grants (MEGA) Program**. The analysis was conducted in accordance with the benefit-cost methodology as outlined by USDOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in December 2023. The period of analysis corresponds to 33 years and includes 3 years of investment and 30 years of benefits after operations (replacement bridge) begin in 2027.

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That is why Rhode Island Department of Transportation (RIDOT) is requesting $220.9 Million in Multimodal Project Discretionary Grant support for the $368.3 Million Full Replacement of the I-195 Washington Bridge project.

Originally constructed in 1930 as a bascule bridge to connect Watchemoket Square in East Providence to the old Fox Point Boulevard in Providence, the Washington Bridge (Bridge No.700) spans the Seekonk River to allow travel between the Providence Metropolitan area and all points East. The original bridge was altered in 1968, replaced by the twin-spanned bridge that is currently closed on the westbound side. The assets within the project area are in dire need of rehabilitation to ensure the safety and functionality of I-195, one of the principal roadways connecting Southern New England. The Washington Bridge also provides a critical link to the western limit of I-195, which connects to several major highways nearby including I-95, I-295, US-6, RI-10, and RI-146.

A crucial segment of the interstate system, the Washington Bridge has been forced to operate well beyond the bounds of its anticipated capacity for decades. RIDOT has shifted the 90,000 vehicles every day that travel the westbound lanes onto the eastbound lanes, creating the most congested highway in Rhode Island. Even before the bridge was **closed** in late 2023, the westbound section of I-195 across the Washington Bridge was rated the 3rd highest bottleneck in the state, according to the 2021 state Congestion Management Plan. With a deck area of more than 145,000 square feet, the bridge is one of the largest structures in Rhode Island,

The Rhode Island Department of Transportation (RIDOT) is advancing final design and construction of a project to replace the existing Washington Bridge North (Washington Bridge No. 700). This facility spans the Seekonk River and, until recently, carried Interstate Route 195 (I-195) Westbound from East Providence to Providence. Recently, critical deficiencies were identified in certain structural components that, in the interest of public health and safety, required that RIDOT close the bridge to all vehicular traffic.

Full Replacement of the I-195 Washington Bridge Relieving Congestion after Emergency Shutdown

Temporary crossovers and lane shifts have been put in place to reroute I-195 Westbound traffic to the adjacent Washington Bridge South (No. 200) which now carries bidirectional traffic in a reduced lane configuration.

Closure of the existing bridge has resulted in major impacts to highway operations and traffic flow along the interstate and connected facilities in the greater Providence area. These impacts have affected all users of the system, including commuters, schools, freight/commerce, and emergency response services. RIDOT is now seeking to restore this critical link in the surface transportation system to full functionality as expeditiously as possible. The Project will be:

- Providing a new Washington Bridge superstructure and substructure;
- Resurfacing and restriping the I-195 mainline between Broadway in East Providence and the Washington Bridge to restore the bridge to its full capacity, eliminating the current lane drop and impacts from the emergency closure;
- Replacing the Gano Street off-ramp in Providence, improving the geometry of I-195 Eastbound off- and on-ramp, and improving connectivity along between the Blackstone River Bikeway and the I-195 India Point Park Pedestrian Bridge; and
- Adding an exit ramp connecting I-195 Westbound to Waterfront Drive in East Providence, a longtime priority for the local community.

The capital cost for this Project (2024-dollar estimate) is expected to be **$408.3 million or $381.3 million in 2022 dollars.** At a 3.1% discount rate, the capital costs are **$343.3 million** in discounted 2022 dollars. With a service life of 100 years, at the end of 30 years, the asset will retain 70 percent of their original value with a residual value of **$240.6 million** in undiscounted dollars and **$85.2 million** in 2022 discounted dollars. The residual value is added to the total benefits of the project as per USDOT guidance.

The quantified O&M cost savings is **$22.1 million in discounted 2022 dollars**. The No-Build O&M costs include “end-of-life cycle” demolition of the existing closed bridge in 2025 for safety reasons and to obviate future maintenance costs on the useless structure. The Build O&M costs are future ongoing expenses to maintain the new bridge once it is open in 2027 and through 2056.

Reduced travel-related costs are derived from avoiding traffic slow-downs due to east- and west-bound traffic sharing the still-open south span of the Washington bridge and for the estimated 20 percent of westbound traffic detouring around the Washington Bridge in the No-Build scenario versus the free flow of westbound traffic in the Build scenario. The benefits of avoiding the traffic slow-downs and additional travel miles due to detouring traffic include reductions in:

- Vehicle Operating Costs (VOC) of **$201.4 million** (**$113.7 million** discounted to 2022 dollars);
- Travel Time (TT) Costs of **$1,256.7 million** (**$709.7 million** discounted to 2022 dollars),
- Crash exposure costs **$38.0 million** (**$21.4 million** discounted to 2022 dollars);
- Emissions Costs **$48.1 million** (**$32.4 million** discounted to 2022 dollars),
- Noise Costs **$2.9 million** (**$1.7 million** discounted to 2022 dollars);
- Pavement Damage Costs **$14.2** million (**$8.0 million** discounted to 2022 dollars).

In total, the replacement bridge will eliminate the need for detour and traffic slow-downs, thus saving **$1,561.4 million** (**$886.9 million** discounted to 2022 dollars) in travel-related costs.

Considering all costs and benefits of the Project and using a 3.1% discount rate (2% for Carbon emissions), this leads to an overall discounted Net Present Value (including residual value of assets) of **$650.9 million** and a Benefit Cost Ratio (BCR) of **2.9:1**. The overall project benefit and costs are presented in Table 1.

Table 1: Project Benefits & Costs Summary

Benefits and Costs	$2022 Value	Discounted Value (2022$)
Operations and Maintenance Savings	$14,948,388	$22,112,679
Safety-Crash Reduction	$37,960,581	$21,435,897
Travel Time Savings	$1,256,741,831	$709,667,447
Vehicle Operating Cost Savings	$201,408,461	$113,733,008
Non-CO2 Emission Reduction	$4,906,339	$2,770,552
CO2 Emission Reduction	$43,230,918	$29,605,960
Avoided Highway Externality (Noise)	$2,949,833	$1,665,736
Residual Value	$240,558,355	$85,197,299
Reduced Pavement Damage	$14,231,810	$8,036,537
Total Benefits	**$1,816,936,516**	**$994,225,115**
Capital Costs	**$381,347,686**	**$343,305,010**
Benefit/Cost Ratio	**4.76**	**2.90**
Net Present Value	**$1,435,588,830**	**$650,920,105**

Source: Cambridge Systematics, Inc.

> **Full Replacement of the I-195 Washington Bridge Relieving Congestion after Emergency Shutdown**

1. INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the Full Replacement of the I-195 Washington Bridge - Relieving Congestion after Emergency Shutdown (the Project) for submission to the U.S. Department of Transportation (USDOT) Multimodal Project Discretionary Grant Opportunity (MPDG), National Infrastructure Project Assistance Grants (MEGA) Program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by USDOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in December 2023. The period of analysis corresponds to 33 years and includes 3 years of investment and 30 years of benefits after operations (replacement bridge) begin in 2027. This appendix is organized as follows:

- Section 2 contains the Project description.
- Section 3 documents the BCA methodology, including key methodological components, assumptions, and the study scenarios.
- Section 4 describes the overall impacts of the Project.
- Section 5 contains a detailed explanation and calculation of the Project benefits.
- Section 6 contains a detailed explanation and calculation of the Project costs.
- Section 7 contains the detailed results of the BCA.
- Section 8 contains the results of sensitivity analyses of critical variables' impacts on the BC ratio.

2. PROJECT DESCRIPTION

The Westbound span of the Washington Bridge, a critical piece of highway infrastructure in Rhode Island, is closed and no longer serviceable due to safety concerns. Because this vital commuter and freight connector linking the City of Providence to Southern New England has not been open since Dec. 11, traffic delay have compounded every aspect of travel in this part of the state and greatly impacted others.

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The assets within the project area are in dire need of rehabilitation to ensure the safety and functionality of I-195, one of the principal roadways connecting Southern New England. The Washington Bridge also provides a critical link to the western limit of I-195, which connects to several major highways nearby including I-95, I-295, US-6, RI-10, and RI-146.

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A crucial segment of the interstate system, the Washington Bridge has been forced to operate well beyond the bounds of its anticipated capacity for decades. RIDOT has shifted the 90,000 vehicles every day that travel the westbound lanes onto the eastbound lanes, creating the most congested highway in Rhode Island. Even before the bridge was closed in late 2023, the westbound section of I-195 across the Washington Bridge was rated the 3rd highest bottleneck in the state, according to the 2021 state Congestion Management Plan. With a deck area of more than 145,000 square feet, the bridge is one of the largest structures in Rhode Island,

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Closure of the existing bridge has resulted in major impacts to highway operations and traffic flow along the interstate and connected facilities in the greater Providence area. These impacts have affected all users of the system, including commuters, schools, freight/commerce, and emergency response services. RIDOT is now seeking to restore this critical link in the surface transportation system to full functionality as expeditiously as possible.

The bridge replacement will achieve not only the original goals of the rehabilitation project but will provide a new bridge with an intended service life of 100 years. The resultant project will thereby continue the construction process to improve the functionality of the transportation network in the area by:

- Providing a new Washington Bridge superstructure and substructure;
- Resurfacing and restriping the I-195 mainline between Broadway in East Providence and the Washington Bridge to restore the bridge to its full capacity, eliminating the current lane drop and impacts from the emergency closure;
- Replacing the Gano Street off-ramp in Providence, improving the geometry of I-195 Eastbound off- and on-ramp, and improving connectivity along between the Blackstone River Bikeway and the I-195 India Point Park Pedestrian Bridge; and
- Adding an exit ramp connecting I-195 Westbound to Waterfront Drive in East Providence, a longtime priority for the local community.

3. BENEFIT COST ANALYSIS FRAMEWORK

The BCA provides an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of a potential infrastructure project. Project benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of the project BCA is to assess whether the expected benefits of the project justify the costs from a national perspective. The BCA framework attempts to capture the net welfare change created by the project, including cost savings

and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs).

The BCA framework involves defining a Base or "No Build" scenario, which is compared to the "Build" scenario. The BCA assesses the incremental difference between the "Build" scenario and the "No Build" scenario 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 changes is determined through discounting, which is meant to reflect the time value of money.

KEY METHODOLOGICAL COMPONENTS

The Project BCA is conducted in accordance with the benefit-cost methodology recommended by the USDOT.[1] The methodology includes the following key components:

- Defining existing and future conditions under the "No Build" (Base) scenario and the "Build" scenario;
- Assessing the project benefits over the 30 years of operations beyond the Project completion when benefits accrue, and using USDOT recommended values to monetize changes in travel time, vehicle operating costs, and traffic crashes by severity while relying on best practices for monetization of other benefits or disbenefits;
- Estimating the project capital costs during Project construction and Project operation and maintenance costs over the 30 years of operations beyond the Project completion when benefits accrue;
- Discounting Project benefits and costs using a real discount rate of 3.1% (2% for CO_2 emissions costs) consistent with USDOT guidance (December 2023).

KEY ASSUMPTIONS

The assessment of the Project benefits and costs associated with the **Project** involve the following key assumptions:

- The evaluation period includes the design and engineering and construction during which capital expenditures are undertaken, plus 30 years of operations beyond the Project completion within which to evaluate the ongoing Project benefits and costs.
- The capital investment phase of the Project is assumed to begin in 2025, ending in 2026 at which point the Project will be deemed complete.
- The Project will be completed in 2027 and will open to vehicle traffic in 2026. The 30-year operational period will conclude in 2056. Project benefits begin in the calendar year immediately following final construction occurs.

[1] https://www.transportation.gov/sites/dot.gov/files/2023-12/Benefit%20Cost%20Analysis%20Guidance%202024%20Update.pdf.

- Estimates of Average Annual Daily Traffic (AADT), detour lengths and speeds were extracted from the Bridge Investment Program Benefit-Cost Analysis Tool (BIP BIP_BCA_Tool_v1.0.4December 2023)[2] for the north and south spans of the Washington Bridge.

- The reconstructed bridge will have a service life of 100 years. Therefore, the bridge will have a 70% residual value of the bridge costs in year 2056.

- All Project benefits and costs are conservatively assumed to occur at the end of each calendar year for purposes of present value discounting.

- Monetary values of Project costs and benefits are expressed in constant, year-end 2022 dollars.

"BUILD" AND "NO BUILD" SCENARIOS

The analysis of the **Project** considered how the balance of costs and benefits resulting from the construction of the Project would result in long-term benefits to its users and general society. This is accomplished by comparing the "Build" scenario relative to the "No-Build" scenario.

The "Build" scenario will replace the existing, closed north span of the Washington Bridge. The investment will:

- Demolish the existing, closed north span.

- Replace the closed, unsafe north bridge and make improvements to the bridge approaches.

- Increase resiliency and reducing expected ongoing maintenance costs for RIDOT.

The No-build scenario assumes that the current bridge is not replaced, but rather demolished as it would be in the Build scenario. This would be done for safety and economic reasons. The westbound traffic will continue to either detour across the south span of the Washington Bridge (80 percent of westbound traffic) or detour around the bridge (20 percent of westbound traffic travelling 1.9 miles as a detour).[3]

The demolition of the north span will occur whether the new span is built or not. In this analysis the demolition costs are treated as "end-of-life cycle" O&M cost in the No-Build scenario and in the Build scenario is treated as part of the construction process making way for the new span. This in effect creates a "wash" for the demolition costs between Build and No-Build scenarios, but they are each included for completeness of the analysis.

4. PROJECT IMPACTS

The Project would eliminate the current crowding of eastbound and westbound traffic onto the south span of the Washington Bridge which results in significant traffic slow-downs and cause 20 percent of westbound traffic to detour around the bridge. The effect of the Project is to allow all westbound traffic free flow across the new north span, allowing a free flow of eastbound traffic across the south span, and

[2] https://www.fhwa.dot.gov/bridge/bip/bca/BIP_BCA_Tool_v1.0.4_12282023.xlsb
[3] RIDOT estimates that in the No-Build scenario, 80 percent of westbound traffic would use the south span of the Washington Bridge, while 20 percent would detour around the bridge.

eliminating the need for detour routing. Due to the dynamic and recent traffic rerouting in response to the emergency closing of the north span, detailed traffic studies have not been done, but using very recent observations and conservative assumptions, the impacts are quantified. The assumptions used for the travel time and vehicle operating cost calculations are very conservative as described in the following.

In the No-Build scenario, travel times for eastbound and 80 percent of westbound traffic diverted onto the south span of the Washington Bridge have a reduced posted speed of 40 mph from 55 mph. This posted speed difference is a proxy for direct speed impacts of the diversion of traffic onto the now shared facility travelling from 1 mile upstream of the bridge and the length of the span (0.36 miles). ***In reality, observed traffic slow-downs are more severe and extend further upstream from the south bridge span in easterly and westerly directions and onto approach routes***. This analysis applies the 15-mph posted speed difference to 1.36 miles only for all eastbound and 80 percent of westbound traffic on the south span. For this traffic, only changes in travel times are considered.

For travel times and VOC, the 20 percent of westbound traffic in the No-Build scenario is assumed to detour 1.9 miles at a speed of 24 mph, per the Bridge Investment Program Benefit-Cost Analysis Tool (BIP_BCA_Tool_v1.0.4_12282023 December 2023). ***These factors are considered very conservative***, as RIDOT recommended detour routes, especially for trucks, have considerably greater distances. For this traffic, changes in travel times and travel miles are considered.

Table 2 presents the net change in travel times and vehicle miles traveled (VMT) as a result of the Project.

Table 2: Project Reduction in Vehicle Miles Travelled and Travel Hours

Year	Reduced Vehicle Miles Travelled			Reduced Travel Hours		
	Autos / Light Duty	Trucks	Total	Autos / Light Duty	Trucks	Total
2027	7,542,932	1,769,378	**9,312,311**	958,556	229,028	**1,187,583**
2028	7,579,138	1,777,871	**9,357,010**	963,157	230,127	**1,193,284**
2029	7,615,518	1,786,405	**9,401,923**	967,780	231,231	**1,199,011**
2030	7,652,073	1,794,980	**9,447,053**	972,425	232,341	**1,204,767**
2031	7,688,803	1,803,596	**9,492,399**	977,093	233,457	**1,210,549**
2032	7,725,709	1,812,253	**9,537,962**	981,783	234,577	**1,216,360**
2033	7,762,792	1,820,952	**9,583,744**	986,495	235,703	**1,222,199**
2034	7,800,054	1,829,692	**9,629,746**	991,231	236,835	**1,228,065**
2035	7,837,494	1,838,475	**9,675,969**	995,988	237,971	**1,233,960**
2036	7,875,114	1,847,300	**9,722,414**	1,000,769	239,114	**1,239,883**
2037	7,912,915	1,856,167	**9,769,081**	1,005,573	240,261	**1,245,834**
2038	7,950,897	1,865,076	**9,815,973**	1,010,400	241,415	**1,251,814**

2039	7,989,061	1,874,029	**9,863,090**	1,015,250	242,573	**1,257,823**
2040	8,027,408	1,883,024	**9,910,432**	1,020,123	243,738	**1,263,861**
2041	8,065,940	1,892,063	**9,958,002**	1,025,019	244,908	**1,269,927**
2042	8,104,656	1,901,144	**10,005,801**	1,029,939	246,083	**1,276,023**
2043	8,143,559	1,910,270	**10,053,829**	1,034,883	247,264	**1,282,148**
2044	8,182,648	1,919,439	**10,102,087**	1,039,851	248,451	**1,288,302**
2045	8,221,925	1,928,653	**10,150,577**	1,044,842	249,644	**1,294,486**
2046	8,261,390	1,937,910	**10,199,300**	1,049,857	250,842	**1,300,699**
2047	8,301,044	1,947,212	**10,248,256**	1,054,896	252,046	**1,306,943**
2048	8,340,889	1,956,559	**10,297,448**	1,059,960	253,256	**1,313,216**
2049	8,380,926	1,965,950	**10,346,876**	1,065,048	254,472	**1,319,519**
2050	8,421,154	1,975,387	**10,396,541**	1,070,160	255,693	**1,325,853**
2051	8,461,576	1,984,869	**10,446,444**	1,075,297	256,920	**1,332,217**
2052	8,502,191	1,994,396	**10,496,587**	1,080,458	258,154	**1,338,612**
2053	8,543,002	2,003,969	**10,546,971**	1,085,644	259,393	**1,345,037**
2054	8,584,008	2,013,588	**10,597,596**	1,090,855	260,638	**1,351,493**
2055	8,625,211	2,023,253	**10,648,465**	1,096,092	261,889	**1,357,981**
2056	8,666,612	2,032,965	**10,699,577**	1,101,353	263,146	**1,364,499**
Total	**242,766,639**	**56,946,825**	**299,713,464**	**30,850,776**	**7,371,171**	**38,221,947**

5. PROJECT BENEFITS

ECONOMIC IMPACTS, FREIGHT MOVEMENT, AND JOB CREATION

This Project would contribute to increasing the economic competitiveness of the region through improvements in the mobility of people and goods. It is estimated that the Project will conservatively save **300 million vehicle miles travelled**, and reduce travel time by **38.2 million hours** by avoiding traffic slow-downs and detours around the bridge, cost-avoidance benefits are measured in the assessment of economic competitiveness, including detour-related travel costs such as travel time, vehicle operating costs, crash costs, environmental impacts, system O&M costs, etc.

Of the traffic impacted by the Project, 13 to 18 percent is truck traffic. The reduction in travel time and vehicle distance traveled enables the freight truck industry to deliver goods in an improved cost- and time-efficient manner, impacting nearly all economic industries active regionally and nationally. This project will improve system operations to increase travel time reliability and improve mobility for both freight and passenger vehicles.

BUILD DETOUR AVOIDANCE: TRAVEL TIME AND VEHICLE OPERATING COST SAVINGS

The savings in travel time and miles travelled presented in Table 2 are used to calculate the change in VOTT and the change in VOC the Project will enable.

Value of Travel Time savings (VoTT) include in-vehicle travel time savings for drivers and passengers. 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. Travel time savings is calculated by multiplying the number of vehicle occupants by the corresponding value of travel time (VoTT) and the changes in Vehicle Hours of Travel (VHT) between the "Build" and the "No Build" scenarios. Per USDOT Guidance, the following vehicle occupancy rates and VOTT were used in the calculations:

- Autos/Light Duty Vehicles:**1.67** occupants per vehicle; **$19.60** per occupant per hour.
- Trucks: **1.0** occupant per vehicle; **$33.50** per occupant per hour.

Vehicle Operating Costs (VOC) comprise fuel costs and all the necessary replacement items on the vehicle and regular maintenance (e.g., oil and fluid changes, tire rotations, tire replacements, and wiper replacement), as well as truck/trailer lease or purchase payments, permits and licenses, and other related costs to owners of commercial vehicles. The estimation of these benefits is based on the detour VMT for trucks and passenger cars under the "Build" scenario (zero miles detour) relative to the "No Build" (1.9 miles detour) for 20 percent of westbound traffic. The detour VMT for trucks and passenger cars in the "No Build" scenario are multiplied by the corresponding VOC per mile recommended by USDOT:

- Autos/Light Duty Vehicles**: $0.52** per vehicle mile.
- Trucks: **$1.32** per vehicle mile.

The annual VOC and travel time cost savings of the "Build" scenario relative to the "No-Build" scenario are presented in **Table 3**. These costs reductions- **$1,458.1 million ($823.4 million** discounted to 2022 dollars) are Project benefits.

Table 3: Project Vehicle Operating Cost and Travel Time Benefits

Year	Travel Time Cost Savings (2022$)			Vehicle Operating Cost Savings (2022$)		
	Autos / Light Duty	Trucks	Total	Autos / Light Duty	Trucks	Total
2027	$31,375,441	$7,672,423	**$19,166,731**	$3,922,325	$2,335,579	**$6,257,904**
2028	$31,526,043	$7,709,250	**$19,258,731**	$3,941,152	$2,346,790	**$6,287,942**
2029	$31,677,368	$7,746,255	**$19,351,173**	$3,960,069	$2,358,055	**$6,318,124**
2030	$31,829,419	$7,783,437	**$19,444,059**	$3,979,078	$2,369,373	**$6,348,451**
2031	$31,982,200	$7,820,797	**$19,537,391**	$3,998,177	$2,380,746	**$6,378,924**
2032	$32,135,715	$7,858,337	**$19,631,170**	$4,017,369	$2,392,174	**$6,409,543**
2033	$32,289,966	$7,896,057	**$19,725,400**	$4,036,652	$2,403,657	**$6,440,309**
2034	$32,444,958	$7,933,958	**$19,820,082**	$4,056,028	$2,415,194	**$6,471,222**
2035	$32,600,694	$7,972,041	**$19,915,218**	$4,075,497	$2,426,787	**$6,502,284**

2036	$32,757,177	$8,010,307	**$20,010,811**	$4,095,059	$2,438,436	**$6,533,495**
2037	$32,914,412	$8,048,756	**$20,106,863**	$4,114,716	$2,450,140	**$6,564,856**
2038	$33,072,401	$8,087,391	**$20,203,376**	$4,134,466	$2,461,901	**$6,596,367**
2039	$33,231,148	$8,126,210	**$20,300,352**	$4,154,312	$2,473,718	**$6,628,029**
2040	$33,390,658	$8,165,216	**$20,397,794**	$4,174,252	$2,485,592	**$6,659,844**
2041	$33,550,933	$8,204,409	**$20,495,703**	$4,194,289	$2,497,523	**$6,691,811**
2042	$33,711,978	$8,243,790	**$20,594,082**	$4,214,421	$2,509,511	**$6,723,932**
2043	$33,873,795	$8,283,360	**$20,692,934**	$4,234,651	$2,521,556	**$6,756,207**
2044	$34,036,389	$8,323,120	**$20,792,260**	$4,254,977	$2,533,660	**$6,788,637**
2045	$34,199,764	$8,363,071	**$20,892,063**	$4,275,401	$2,545,821	**$6,821,222**
2046	$34,363,923	$8,403,214	**$20,992,345**	$4,295,923	$2,558,041	**$6,853,964**
2047	$34,528,870	$8,443,549	**$21,093,108**	$4,316,543	$2,570,320	**$6,886,863**
2048	$34,694,608	$8,484,078	**$21,194,355**	$4,337,263	$2,582,657	**$6,919,920**
2049	$34,861,142	$8,524,802	**$21,296,088**	$4,358,081	$2,595,054	**$6,953,136**
2050	$35,028,476	$8,565,721	**$21,398,309**	$4,379,000	$2,607,510	**$6,986,511**
2051	$35,196,613	$8,606,837	**$21,501,021**	$4,400,019	$2,620,026	**$7,020,046**
2052	$35,365,556	$8,648,149	**$21,604,226**	$4,421,139	$2,632,603	**$7,053,742**
2053	$35,535,311	$8,689,661	**$21,707,926**	$4,442,361	$2,645,239	**$7,087,600**
2054	$35,705,880	$8,731,371	**$21,812,124**	$4,463,684	$2,657,936	**$7,121,621**
2055	$35,877,269	$8,773,281	**$21,916,823**	$4,485,110	$2,670,694	**$7,155,804**
2056	$36,049,480	$8,815,393	**$22,022,023**	$4,506,638	$2,683,514	**$7,190,152**
Total	**$1,009,807,588**	**$246,934,243**	**$1,256,741,831**	**$126,238,652**	**$75,169,808**	**$201,408,461**

SAFETY BENEFITS (CRASH COST REDUCTION)

The Project will incorporate many design elements, which will make the proposed bridge and approaches safer facilities than what was in place prior to the north span closure. It is also expected to reduce the safety impacts of lane narrowing and concentrating eastbound and westbound traffic onto the south span, with increased on-bridge and upstream crashes due to increased congestion.

That notwithstanding, this analysis at this time can only quantify the significant safety benefits associated with eliminating detour-related roadway miles and the crashes that could occur if vehicles were forced to detour around the bridge. The calculation of these crash-reduction safety benefits is straight forward using that state-level crash rates for fatal, injury, and property damage only crashes multiplied by the increased VMT due to 20 percent of westbound traffic detouring 1.9 miles around the Washington Bridge. The crash reduction benefits are considered conservative, as explained prior, due to the short detour miles from the NBI data from USDOT BIP model.[4]

[4] https://www.fhwa.dot.gov/bridge/bip/bca/BIP_BCA_Tool_v1.0.4_12282023.xlsb

The state-level crash rates (obtained from the National Highway Traffic Safety Administration[5]) used for the analysis are:

- Property Damage Only crashes: **0.1819805** per million VMT
- Injury crashes: **0.0452947** per million VMT
- Fatal crashes: **0.0079030** per million VMT

The crash reduction benefit over the 30-year analysis horizon is estimated at **$38.0 million** (**$21.4 million** discounted to 2022). Table 4 presents the annual safety benefits.

Table 4: Project Crash Reduction Benefits

Year	Reduced Crash Costs (2022$)			
	PDO Crashes	Injury Crashes	Fatal Crashes	Total
2027	$15,421	$132,023	$1,032,018	**$1,179,462**
2028	$15,495	$132,657	$1,036,972	**$1,185,124**
2029	$15,570	$133,293	$1,041,949	**$1,190,812**
2030	$15,645	$133,933	$1,046,951	**$1,196,528**
2031	$15,720	$134,576	$1,051,976	**$1,202,272**
2032	$15,795	$135,222	$1,057,025	**$1,208,042**
2033	$15,871	$135,871	$1,062,099	**$1,213,841**
2034	$15,947	$136,523	$1,067,197	**$1,219,667**
2035	$16,024	$137,179	$1,072,320	**$1,225,522**
2036	$16,101	$137,837	$1,077,467	**$1,231,404**
2037	$16,178	$138,499	$1,082,639	**$1,237,315**
2038	$16,255	$139,163	$1,087,835	**$1,243,254**
2039	$16,333	$139,831	$1,093,057	**$1,249,222**
2040	$16,412	$140,503	$1,098,304	**$1,255,218**
2041	$16,491	$141,177	$1,103,575	**$1,261,243**
2042	$16,570	$141,855	$1,108,873	**$1,267,297**
2043	$16,649	$142,536	$1,114,195	**$1,273,380**
2044	$16,729	$143,220	$1,119,543	**$1,279,492**
2045	$16,810	$143,907	$1,124,917	**$1,285,634**

[5] https://www.nhtsa.gov/sites/nhtsa.gov/files/2023-05/RI_FY2022HSPAR-tag.pdf
https://cdan.dot.gov/tsftables/tsfar.htm#

2046	$16,890	$144,598	$1,130,317	**$1,291,805**
2047	$16,971	$145,292	$1,135,742	**$1,298,006**
2048	$17,053	$145,989	$1,141,194	**$1,304,236**
2049	$17,135	$146,690	$1,146,672	**$1,310,496**
2050	$17,217	$147,394	$1,152,176	**$1,316,787**
2051	$17,300	$148,102	$1,157,706	**$1,323,107**
2052	$17,383	$148,813	$1,163,263	**$1,329,458**
2053	$17,466	$149,527	$1,168,847	**$1,335,840**
2054	$17,550	$150,245	$1,174,457	**$1,342,252**
2055	$17,634	$150,966	$1,180,095	**$1,348,695**
2056	$17,719	$151,690	$1,185,759	**$1,355,168**
Total	**$496,332**	**$4,249,110**	**$33,215,139**	**$37,960,581**

Source: Cambridge Systematics, Inc.

ENVIRONMENTAL BENEFITS

This analysis examined the potential automotive emissions associated with the "No-Build" detour that would be avoided if the Project is built. Similar to the safety benefits, the emissions reduction calculations are based on avoiding the detour around the bridge for 20 percent of westbound traffic. USDOT provides monetized values per VMT for CO_2 and Non-CO_2 emissions. For autos/light duty vehicles, these are: $0.107 and $0.012 per VMT for CO_2 and Non-CO_2 emissions, respectively. For trucks, these are: $0.303 and $0.035 per VMT for CO_2 and Non-CO_2 emissions, respectively.

Multiplying these values by the avoided detour-related VMT, provides the emissions reduction benefits of the Project. Over 30 years, the Project reduces CO_2 costs by **$43.2 million ($29.6 million** discounted to 2022) and Non-CO_2 emissions by **$4.9 million ($2.8 million** discounted to 2022). Table 5 presents the annual emissions reduction benefits.

Table 5: Project Vehicle Emissions Benefits

Year	CO^2 Emissions Cost Reductions Autos/LD	CO^2 Emissions Cost Reductions Trucks	Non-CO2 Emissions Cost Autos/LD	Non-CO^2 Emissions Cost Trucks	Total Emissions Reductions All Vehicles
2027	$807,094	$536,122	$90,515	$61,928	**$1,495,659**
2028	$810,968	$538,695	$90,950	$62,225	**$1,502,838**
2029	$814,860	$541,281	$91,386	$62,524	**$1,510,052**
2030	$818,772	$543,879	$91,825	$62,824	**$1,517,300**
2031	$822,702	$546,490	$92,266	$63,126	**$1,524,583**
2032	$826,651	$549,113	$92,709	$63,429	**$1,531,901**
2033	$830,619	$551,748	$93,154	$63,733	**$1,539,254**
2034	$834,606	$554,397	$93,601	$64,039	**$1,546,642**

2035	$838,612	$557,058	$94,050	$64,347	**$1,554,066**
2036	$842,637	$559,732	$94,501	$64,655	**$1,561,526**
2037	$846,682	$562,419	$94,955	$64,966	**$1,569,021**
2038	$850,746	$565,118	$95,411	$65,278	**$1,576,552**
2039	$854,830	$567,831	$95,869	$65,591	**$1,584,120**
2040	$858,933	$570,556	$96,329	$65,906	**$1,591,724**
2041	$863,056	$573,295	$96,791	$66,222	**$1,599,364**
2042	$867,198	$576,047	$97,256	$66,540	**$1,607,041**
2043	$871,361	$578,812	$97,723	$66,859	**$1,614,755**
2044	$875,543	$581,590	$98,192	$67,180	**$1,622,506**
2045	$879,746	$584,382	$98,663	$67,503	**$1,630,294**
2046	$883,969	$587,187	$99,137	$67,827	**$1,638,119**
2047	$888,212	$590,005	$99,613	$68,152	**$1,645,982**
2048	$892,475	$592,837	$100,091	$68,480	**$1,653,883**
2049	$896,759	$595,683	$100,571	$68,808	**$1,661,821**
2050	$901,063	$598,542	$101,054	$69,139	**$1,669,798**
2051	$905,389	$601,415	$101,539	$69,470	**$1,677,813**
2052	$909,734	$604,302	$102,026	$69,804	**$1,685,867**
2053	$914,101	$607,203	$102,516	$70,139	**$1,693,959**
2054	$918,489	$610,117	$103,008	$70,476	**$1,702,090**
2055	$922,898	$613,046	$103,503	$70,814	**$1,710,260**
2056	$927,328	$615,988	$103,999	$71,154	**$1,718,469**
Total	**$25,976,030**	**$17,254,888**	**$2,913,200**	**$1,993,139**	**$48,137,257**

Source: Cambridge Systematics, Inc.

STATE OF GOOD REPAIR BENEFITS

The State of Good Repair benefit category focuses on two benefit types:

- Reducing the bridge maintenance costs. In the No-Build scenario, demolition of the existing closed north span, is considered a “end-of-life cycle” O&M cost incurred in 2025. Regardless of whether the replacement bridge is built or not, this $40 million cost will be incurred. The south span, having the westbound traffic detoured onto it will require maintenance in excess of what would be required if only the eastbound traffic were using it. Therefore, these additional costs are included in the No-Build scenario.

  For the new north span in the Build scenario, periodic maintenance of the structure is accounted for in the analysis. The demolition of the existing closed north span in the Build scenario is required for the new bridge to be built, but the $40 million cost is included as part of the Project capital costs.

- Building the new span will eliminate the need for traffic to detour, thus eliminating the potential deterioration of the road by the detoured traffic.

- Residual Value of the New Bridge. The new asset is expected to have a 100-year life span with proper maintenance. At the end of the 30-year analysis period, 70 percent of the assets value will remain. This applies only to the $350 million (326.6 million in undiscounted 2022 dollars) for construction of the new bridge and does not include the cost of demolition for the existing closed span.

These benefits are described in the following sections.

REDUCED BRIDGE MAINTENANCE COSTS

RIDOT estimates of the O&M costs for the Build and No-Build scenarios are presented in Table 6.

Over the analysis period, the net O&M cost is minus **$14.9 million (minus $22.1 million** discounted to 2022). The discounted value being higher than the non-discounted value is due to the significant front loading of No-Build O&M costs in the calculation, providing a large negative O&M difference discounted much less than the later positive O&M cost differences.

Year	Operations & Maintenance Costs ($2022)		
	No Build Operations & Maintenance Costs	Build Operations & Maintenance Costs	Net Change in Operations & Maintenance Costs
2025	$37,792,286	$0	($37,792,286)
2026	$99,393	$0	($99,393)
2027	$59,262	$143,551	$84,289
2028	$59,262	$248,333	$189,072
2029	$177,785	$0	($177,785)
2030	$59,262	$143,551	$84,289
2031	$59,262	$88,332	$29,071
2032	$263,797	$0	($263,797)
2033	$59,262	$143,551	$84,289
2034	$59,262	$0	($59,262)
2035	$177,785	$143,551	($34,234)
2036	$59,262	$0	($59,262)
2037	$59,262	$248,333	$189,072
2038	$263,797	$0	($263,797)
2039	$59,262	$143,551	$84,289

2040	$59,262	$0	($59,262)
2041	$177,785	$143,551	($34,234)
2042	$59,262	$19,641,461	$19,582,199
2043	$59,262	$4,191,316	$4,132,054
2044	$263,797	$248,333	($15,463)
2045	$59,262	$0	($59,262)
2046	$59,262	$143,551	$84,289
2047	$177,785	$0	($177,785)
2048	$59,262	$143,551	$84,289
2049	$59,262	$0	($59,262)
2050	$263,797	$248,333	($15,463)
2051	$490,045	$0	($490,045)
2052	$59,262	$143,551	$84,289
2053	$59,262	$0	($59,262)
2054	$177,785	$143,551	($34,234)
2055	$59,262	$331,251	$271,990
2056	$177,785	$0	($177,785)
Total	**$41,629,587**	**$26,681,199**	**-$14,948,388**

Source: Cambridge Systematics, Inc.

REDUCED DETOUR-RELATED PAVEMENT COSTS

Pavement damage per auto/light duty vehicle and truck VMT was based on inflating the values provided for 2000 in the Federal Highway Summary Report.[6] The average pavement damage cost for autos ($0.001 per VMT) and average of urban trucks ($0.1472 per VMT) was inflated to $0.017 per VMT for autos and $0.2429 for trucks using the US Bureau of Economic Analysis GDP Price deflator values.[7]

The per mile pavement costs were applied to the VMT difference between the Build and No-Build scenarios. This change in VMT represents the detour 20 percent of the westbound traffic would make to avoid the cross over to the south span of the bridge in the No-Build scenario. The new bridge would eliminate an estimated **$14.2 million** pavement damage **($8.0 million** discounted to 2022).

NEW BRIDGE RESIDUAL VALUE

The Residual Value of the replacement bridge assumes that its original value of the replacement bridge depreciates in a linear manner over its service life. The replacement bridge is an asset with an expected useful life of 100 years and would thus retain 70 percent of its value after 30 years in service (the analysis

[6] https://www.fhwa.dot.gov/policy/hcas/summary/sum5.cfm#marginal
[7] 2000 dollars values inflated 165% to 2022 dollar values.

period). The estimated construction cost is **$343.7 million** in non-discounted 2022 dollars. After 30 years, 70% or **$240.6 million** (**$83.2 million** discounted to 2022) value of the replacement bridge remains.

OTHER BENEFITS OF THE BUILD SCENARIO

One additional benefit was quantified for this BCA. This is the Highway use externality of noise cost reduction costs. Similar to the emissions and the pavement cost reduction benefits, it is based on eliminating the potential VMT associated with detouring.

As previously mentioned, this detour would involve 20 percent of westbound traffic detouring 1.9 miles. The recommended value of noise reductions by USDOT[8] is $0.0019 per auto VMT and $0.0437 for Buses and Trucks in a rural setting. This analysis multiplied the estimated detour VMTs by the per mile noise costs to obtain the noise reduction benefit eliminating the detour. Over the 30-year analysis period, the construction of the new bridge would eliminate the potential congestion and noise costs of a detour valued at **$2.9 million ($1.7 million** discounted to 2022).

PROJECT BENEFITS SUMMARY

Total benefits for the replacement bridge project are estimated at **$1,813.0 million ($992.0 million** discounted to 2022) over 30-years. **Table 6** shows the Project long-term benefits.

Table 6: Project Benefits Summary

Benefits and Costs	$2022 Value	Discounted Value (2022$)
Operations and Maintenance Savings	$14,948,388	$22,112,679
Safety-Crash Reduction	$37,960,581	$21,435,897
Travel Time Savings	$1,256,741,831	$709,667,447
Vehicle Operating Cost Savings	$201,408,461	$113,733,008
Non-CO2 Emission Reduction	$4,906,339	$2,770,552
CO2 Emission Reduction	$43,230,918	$29,605,960
Avoided Highway Externality (Noise)	$2,949,833	$1,665,736
Residual Value	$240,558,355	$85,197,299
Reduced Pavement Damage	$14,231,810	$8,036,537
Total Benefits	**$1,816,936,516**	**$994,225,115**

Source: Cambridge Systematics, Inc.

[8] https://www.transportation.gov/sites/dot.gov/files/2023-12/Benefit%20Cost%20Analysis%20Guidance%202024%20Update.pdf

6. PROJECT COSTS

CAPITAL COSTS

The capital costs associated with the **Project** (**Table 7**) are primarily associated with the demolition of the existing closed north span and with the construction of the new span. The capital cost for this Project (2024-dollar estimate) is expected to be **$408.3 million** (including $40.0 million for demolition of the existing span) or **$381.3 million** in 2022 dollars **($343.3 million** discounted to 2022).

Table 7: Project Schedule and Costs

Variable	$2022 Value Millions $	Discounted Value (2022$ Millions)
Construction Start	2025	-
Project Completion	2026	-
Construction Duration (years)	2	-
Capital Cost	**$381.3**	**$343.3**

Source: RIDOT

7. SUMMARY OF RESULTS

EVALUATION MEASURES

The BCA 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 present value of incremental benefits is divided by the present value of incremental costs to yield the BCR. 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.

BCA RESULTS

Table 8 presents the evaluation results for the Project**.** Results are presented in undiscounted and discounted to2022. All benefits and costs were estimated over an evaluation period extending 30 years beyond project completion in 2026 (starting in 2027). The total benefits from the Project improvements within the analysis period represent **994.2 million** discounted to 2022. The total project capital costs are calculated to be **$343.3 million** when discounted to 2022. The difference of the discounted benefits and costs equal a NPV of **$650.9 million**, resulting in a BCR of **2.9:1**.

Table A-8: Benefit-Cost Summary

Benefits and Costs	$2022 Value	Discounted Value (2022$)
Total Benefits	$1,816,936,516	$994,225,115
Capital Costs	$381,347,686	$343,305,010
Benefit/Cost Ratio	**4.76**	**2.90**
Net Present Value	**$1,435,588,830**	**$650,920,105**

Source: Cambridge Systematics, Inc.

Table 9 summarizes the results of the BCA by year. The full spreadsheet model has been attached with the application.

Table 9: Project – Life-Cycle Benefit-Cost Analysis[9]

Year	Costs Undiscounted 2022$	Benefits Undiscounted 2022$	Costs Discounted 2022$	Benefits Discounted 2022$
2025	$211,221,551	$37,792,286	$192,735,730	$34,484,757
2026	$170,126,135	$99,393	$150,569,280	$87,967
2027	$0	$48,430,446	$0	$41,637,849
2028	$0	$48,558,533	$0	$40,505,618
2029	$0	$49,159,378	$0	$39,785,878
2030	$0	$49,132,417	$0	$38,581,287
2031	$0	$49,423,875	$0	$37,655,334
2032	$0	$49,954,117	$0	$36,926,389
2033	$0	$49,844,544	$0	$35,750,169
2034	$0	$50,227,753	$0	$34,953,162
2035	$0	$50,443,535	$0	$34,059,415
2036	$0	$50,710,527	$0	$33,221,445
2037	$0	$50,705,319	$0	$32,231,112
2038	$0	$51,402,481	$0	$31,701,474
2039	$0	$51,299,861	$0	$30,698,804
2040	$0	$51,690,055	$0	$30,012,452
2041	$0	$51,912,856	$0	$29,246,117
2042	$0	$32,545,440	$0	$17,860,799
2043	$0	$48,245,798	$0	$25,604,312
2044	$0	$52,644,729	$0	$27,092,675
2045	$0	$52,941,148	$0	$26,435,762
2046	$0	$53,051,430	$0	$25,704,601

[9] Benefits include O&M cost savings and Residual Value of Replacement Bridge

2047	$0	$53,568,555	$0	$25,183,359
2048	$0	$53,562,757	$0	$24,433,984
2049	$0	$53,963,814	$0	$23,885,522
2050	$0	$54,178,757	$0	$23,268,977
2051	$0	$54,913,323	$0	$22,882,481
2052	$0	$54,600,220	$0	$22,079,134
2053	$0	$55,006,257	$0	$21,582,713
2054	$0	$55,244,975	$0	$21,033,374
2055	$0	$55,203,763	$0	$20,395,519
2056	$0	$296,478,176	$0	$105,242,677
Total	**$381,347,686**	**$1,816,936,516**	**$343,305,010**	**$994,225,114**

Source: Cambridge Systematics, Inc.

8. SENSITIVITY TESTING

A sensitivity analysis is used to help identify which variables have the greatest impact on the BCA results. This analysis can be used to estimate how changes to key variables from their preferred value affect the results and how sensitive the results are to these changes. This allows for the assessment of the strength of the BCA, including whether the results reached using the preferred set of input variables are significantly different by reasonable departures from those values. **Table A-10** summarizes the key variables which have been tested for sensitivity and the results of this analysis.

First, a sensitivity was tested by decreasing the limits of the No-Build traffic slowdown to only the length of the south span of the Washington Bridge (0.36 miles). The resulting discounted BCR was **1.84:1**, with a NPV of **$289.6** million.

Second, a sensitivity was tested by increasing the cost of the of demolition of the existing span and construction of the replacement bridge by 25%. The resulting discounted BCR was **2.36:1**, with a NPV of **$573.7** million.

The analyses show that the BCA estimates are robust and demonstrate Project feasibility under extreme assumptions.

Table A-10: Project Sensitivity Analysis

Sensitivity Variable	Sensitivity Value	New BCR (Discounted)	New NPV (Millions of Discounted $2022)
Decrease traffic slow-down limits	-74%	**1.82:1**	**$289.6**
Increase Cost of Replacement Bridge	+25%	**2.36:1**	**$573.7**

Source: Cambridge Systematics, Inc.