OKLAHOMA Transportation

I-40 Bridge Replacement over the Arkansas River at Webbers Falls

Benefit-Cost Analysis Technical Memorandum

November 1, 2024

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1 Introduction

This technical memorandum describes the results of the benefit-cost analysis (BCA) that was conducted for the I-40 Bridge Replacement over the Arkansas River at Webbers Falls Project (the Project) conducted for Oklahoma Department of Transportation's (ODOT) application for funding under the FY2024 Bridge Investment Program (BIP).

Construction is expected to begin in the third quarter of 2026, with an estimated completion in the second quarter of 2029 and the Project opening in the third quarter of 2029. The analysis realizes benefits beginning in the third quarter of 2029 for a 30-year analysis period extending through the second quarter of 2058. The balance of this memorandum describes the assumptions and methods used to develop the analysis and to estimate the value of the long-term benefits generated by the Project.

The Project is located in in eastern Oklahoma, near the Towns of Webber Falls and Gore. The bridge is approximately 2,083 feet long, with a western terminus in the Muskogee County and an eastern terminus in Sequoyah County. Figure 1 shows a map of the Project's location.

1.1 Project Understanding

This Project includes the replacement the I-40 bridge over the Arkansas River and will be constructed to ODOT's design standards, resulting in a service life of over 30 years; the completed Project will have a useful life of 75 years.

Originally built in 1967 and opened in 1968, the I-40 bridge was completed prior to the development of Vessel Collision Design[1] criteria. The bridge is fracture-critical, meaning it is more susceptible

Figure 1: Project Location

[1]*Guide Specification and Commentary for Vessel Collision Design of Highway Bridges, Volume I: Final Report. Retrieved https://rosap.ntl.bts.gov/view/dot/74807.*

to collapsing than other types of bridges because it does not have redundant structural elements to compensate load bearing for areas where multiple cracks exist. Due to the presence of Nonredundant Steel Tension Members (NSTM) main span girders, lapsed fatigue life, and historical precedence, the I-40 bridge over the Arkansas River has a high likelihood of becoming structurally deficient.

The bridge is critical infrastructure to the I-40 corridor, the third-longest Interstate highway in the US spanning over 2,500 miles from California to North Carolina. In 2020, the I-40 bridge had an average annual daily traffic (AADT) count of 10,200 passenger vehicles and an AADT of 5,700 for truck traffic; by 2040 the I-40 bridge is expected to have an AADT count of 16,300 for passenger vehicles and an AADT of 9,200 for trucks.

The realization of the Project will deliver an array of benefits to ODOT and passengers that traverse the I-40 bridge for business, personal travel, and other recreation purposes.

1.1.1 Baseline Condition

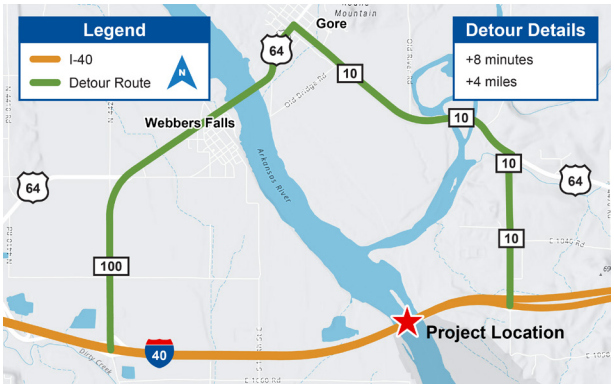
The baseline or no build condition assumes the Project will not be constructed and the I-40 bridge will continue operating with increasing likelihood of becoming structurally deficient. Due to the presence of NSTM main span girders, lapsed fatigue life, and historical precedence, the I-40 bridge over the Arkansas River has a high likelihood of becoming structurally deficient. Fatigue cycles are driven by the amount of heavy truck traffic that uses the structure daily. Given that this structure is a major stream crossing on I-40, the fatigue cycles it receives are staggering. Absent the Project, the condition of the bridge will continue to move into a 'serious, critical, or imminent failure' inspection rating.

Absent the Project, ODOT anticipates that bridge conditions will warrant the need to post load limits that restrict truck access by 2038, at which time, freight truck traffic will have to detour. Under the load limits, westbound truck traffic would take Exit 291 and detour north on Carlisle Road (Oklahoma State Highway 10) before traveling northwest on US Highway 64 to Main Street in the town of Gore, where US Highway 64 merges with Oklahoma State Highway 100. Detoured trucks would continue on US Highway 64 southwest, continuing south on Oklahoma State Highway 100 at the fork until Oklahoma State Highway 100 at Exit 287.

Absent the Project, ODOT anticipates that bridge conditions will warrant the need to close the bridge to all traffic by 2052. At this time, I-40 will be closed to all traffic between Exit 287 and Exit 291, resulting in all traffic detouring on Oklahoma State Highway 10, US Highway 64, and Oklahoma State Highway 100.

This detour would add approximately four miles and eight minutes of travel time for diverted trucks and passenger vehicles. Figure 2 displays the detour route following the closure of the I-40 bridge.

Figure 2: Detour Route Following Closure



1.1.2 Build Condition

Under the build condition, the Project will replace the existing I-40 bridge with a new bridge that will meet the ODOT design standards. This will include raising the current 33-inch railing to 42-inches (the minimum standard above deck) and widening the shoulder to accommodate a 4-foot wide inside shoulder, two 12-foot-wide driving lanes, and a 10-foot wide outside shoulder lane on each side of the median barrier located at the centerline of the bridge.

The new bridge will be constructed to ODOT's design standards, resulting in a service life of over 75 years, resulting in a more sustainable and resilient transportation network.

Table 1 displays the Project matrix that summarizes the baseline problem to be addressed, the change in baseline from the Project, and the Project benefits.

Table 1: Project Matrix

Baseline Problem to be Addressed	Change in Baseline
The baseline will not be constructed, and the I-40 bridge will continue operating with increasing likelihood of becoming structurally deficient. Absent the Project, ODOT anticipates that bridge conditions will warrant the need to post load limits that restrict truck access by 2038, at which time, freight truck traffic will have to detour. Under the load limits, westbound truck traffic would take Exit 291 and detour north on Carlisle Road (Oklahoma State Highway 10) before traveling northwest on US Highway 64 to Main Street in the town of Gore, where US Highway 64 merges with Oklahoma State Highway 100. Detoured trucks would continue on US Highway 64 southwest, continuing south on Oklahoma State Highway 100 at the fork until Oklahoma State Highway 100 at Exit 287. Absent the Project, ODOT anticipates the need to close the bridge to all traffic by 2052. At this time, I-40 will be closed to all traffic between Exit 287 and Exit 291, resulting in all traffic detouring on Oklahoma State Highway 10, US Highway 64, and Oklahoma State Highway 100. This 8-mile, 11-minute detour will add approximately 4 miles and nearly 8 minutes of travel time for detoured trucks and passenger vehicles.	Under the build condition, the Project will replace the existing I-40 bridge with a new bridge that will meet the ODOT design standards. The Project will eliminate the likelihood of posted limits or lane closures over the analysis period.

Benefit	Affected Population	Benefits*
State of Good Repair		
O&M Costs Avoided	Taxpayers, ODOT	$30.1
Residual Value	ODOT	$13.4
Pavement Cost Avoided	Taxpayers, ODOT, Roadway Users	$13.5

** (NPV, 2022$ in Millions) Discounted at 3.1%*

Benefit	*Affected Population*	*Benefits**
Safety and Mobility		
Construction Impacts - Increased Fatalities and Crashes	Roadway Users	-$53.3
Reduced Roadway Fatalities and Crashes	Roadway Users	$78.7
Shoulder Widening	Roadway Users	$0.4
Higher Bridge Railing (from 33" to 42")	Roadway Users	Qualitative
Economic Competitiveness and Opportunity		
Travel Time Savings	Roadway Users	$219.0
Construction Impacts – Additional Travel Time	Roadway Users	-$23.7
Vehicle Operating Cost Avoided from Detours	Roadway Users	$227.7
Congestion Reduction	Roadway Users	$12.9
Reliability from Detours	Roadway Users	Qualitative
Climate Change, Resiliency, and the Environment		
Emissions Avoided*	Roadway Users, Neighboring Communities	$139.5
Noise Avoided	Roadway Users, Neighboring Communities	$0.6
Water Run Off Improvements	ODOT, Roadway Users	Qualitative
Resiliency to Weather, Seismic, or Other Extreme Events	ODOT, Roadway Users	Qualitative
Equity and Quality of Life		
Emergency Response Savings	Roadway Users	$0.1
Innovation		
Warm Asphalt mix	ODOT, Roadway Users	Qualitative
3D Digital Project Plans	ODOT, Roadway Users	Qualitative
Accelerated Bridge Construction	ODOT, Roadway Users	Qualitative

** (NPV, 2022$ in Millions) Discounted at 3.1%*

2 Benefits Analysis Framework

The BCA is conducted in accordance with USDOT's Benefit-Cost Analysis Guidance for Discretionary Grant Programs (USDOT BCA Guidance), published in December 2023[2] and includes estimated benefits and costs based on the best available data at this stage of the planning process. The analysis also applies values from the Federal Emergency Management Agency (FEMA) benefit-cost analysis guidance[3] and the National Bridge Investment (NBI) Analysis System (NBIAS) sourced from the Federal Highway Administration (FHWA) BIP BCA Tool.[4] Generally, the analysis uses standard factors and values accepted by federal agencies for the benefits calculation except in cases where more Project-specific values or prices are available. In all such cases, modifications are noted, and references are provided for data sources.

In this analysis, the baseline condition assumes that the Project would not be built, and current conditions and operations would continue in the Project area, noted throughout the BCA as the baseline scenario. Under the baseline, the purpose of and need for the Project would not be achieved; the existing infrastructure would have to be operated and maintained as it is currently. The condition in which the Project is built is referred to the build scenario. The analysis compares the build scenario to the baseline to quantify the benefits and costs of building the Project.

The analysis applies a construction period of Quarter 3 2026 to Quarter 2 2029 and a 30-year analysis period of Quarter 3 2029 to Quarter 2 2058. Per the BCA Guidance, all values are in 2022 dollars, which avoids forecasting future inflation and escalating future values for benefits and costs accordingly. In instances where assumptions or cost estimates were expressed in dollar values for other years, the analysis applies the Chained Price Index information from the White House Office of Management and Budget's Gross Domestic Product and Deflators (GDP deflator) to bring these values to 2022-dollar figures.[5] The use of constant dollar values requires the use of a real discount rate for discounting to the present value. The analysis discounts all costs and benefits to 2022 (base year) using a 3.1 percent discount rate, consistent with the USDOT BCA Guidance.

The detailed analysis for the components of the Project is included in the I-40 ODOT BIP BCA workbook ('BCA Workbook.xlsx').

[2] *US Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, December 2023. Retrieved https://www.transportation.gov/sites/dot.gov/files/2023-12/Benefit%20Cost%20Analysis%20Guidance%202024%20Update.pdf*

[3] *Benefit-Cost Analysis Sustainment and Enhancements, updated September 2024. Accessed https://www.fema.gov/sites/default/files/documents/fema-standard-economic-values-methodology-report-v13-2024.pdf.pdf*

[4] *Bridge Investment Program Benefit-Cost Analysis Tool, updated September 2023. Accessed https://www.fhwa.dot.gov/bridge/bip/bca/BIP%20BCA%20Tool%20User%20Manual.pdf*

[5] *White House Office of Management and Budget. Historical Tables, Table 10.1 – Gross Domestic Product and Deflators Used in the Historical Tables 1940-2027. Accessed from https://www.whitehouse.gov/omb/budget/historical-tables/*

3 Analysis Assumptions

The analysis uses information from several sources from both government agencies and consultants engaged by ODOT, as well as several assumptions compliant per the BCA Guidance. The list of assumptions for the Project can be referred to in tab 3 – Inputs of the BCA Workbook. The inputs and assumptions are also summarized in Table 2 below; Table 3 displays the monetized value of emissions sourced from the BCA Guidance and Table 4 displays the emissions factors sourced from the BIP BCA Tool which uses the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) model was used to estimate per mile emissions rates (kg/mi).

Table 2: Benefit-Cost Analysis Inputs

Input	*Value*	*Source*
General		
Discount Rate	3.1%	BCA Guidance for Discretionary Grant Programs- December 2023
Discount Rate - CO2	2%	
Discount Year	2022	
Dollar Year	2022	
Analysis Period (years)	30	ODOT
Project Start Year	2029	
Project End Year	2058	
Construction Start Year	2026	
Construction End Year	2029	
Quarter Year Benefits	0.25	
Half Year Benefits	0.5	
Overall Condition Rating 3 (Truck Close Year)	2038	FHWA's NBIAS software program. See tab '7-Bridge Closure'
Overall Condition Rating 2	2048	
Average time for bridge to close (years)	4	
Bridge Close Year -- Passenger Vehicles	2052	
Disbenefit	-1	Factor
Annual Escalation	3%	ODOT
Escalation year	2024	
Units		
Minutes to hours	60	https://www.inchcalculator.com/convert/minute-to-hour/
Million multipliers	1,000,000	https://www.omnicalculator.com/conversion/number-to-million
100 million multipliers	100,000,000	

Input	*Value*	*Source*
Safety		
Fatal Crashes per 100 million VMT - 2021 (Muskogee County)	2.27	https://oklahoma.gov/content/dam/ok/en/highwaysafety/documents/the-work-we-do/crash-data/2021_s1_summarybackground.pdf
Injuries per 100 million VMT- 2021 (Muskogee County)	38.33	
Total Crashes per 100 million VMT- 2021 (Muskogee County)	115	
PDO Crashes per 100 million VMT- 2023 (Muskogee County)	73.90	Derived
Fatal Crashes per 100 million VMT - 2021 (Sequoyah County)	1.61	https://oklahoma.gov/content/dam/ok/en/highwaysafety/documents/the-work-we-do/crash-data/2021_s1_summarybackground.pdf
Injuries per 100 million VMT- 2021 (Sequoyah County)	25.94	
Total Crashes per 100 million VMT- 2021 (Sequoyah County)	109.38	
PDO Crashes per 100 million VMT- 2023 (Sequoyah County)	81.83	Derived
AADT 2020- Passenger Vehicle	10,176	BIP BCA Tool- NBI Data
AADT 2040 Forecast- Passenger Vehicle	16,282	
AADT 2020- Trucks	5,724	
AADT 2040 Forecast- Trucks	9,158	
Length of I-40 Bridge (miles)	0.3	https://www.google.com/maps/dir/35.4858898,-95.0994913/35.4875591,-95.0950024/@35.4874547,-95.0992417,17.75z/data=!4m2!4m1!3e0?entry=ttu&g_p=EgoyMDI0MTAxNi4wIKXMDSoASAFQAw%3D%3D
Truck Annualization (days)	365	Assumption
Passenger Vehicles Annualization (days)	260	Assumption
Economic Competitiveness		
Speed limit - I-40 (mph)	70	Google Streetview
Travel distance, Exit 291 - Exit 287 (miles)	4	Google maps
Travel time (minutes)	3.4	Derived
Travel distance - detour (miles)	8	Google maps

Input	*Value*	*Source*
Travel time - detour (minutes)	11	Google maps
Travel Time- All Purposes	$19.60	BCA Guidance for Discretionary Grant Programs- December 2023
Travel Time- Truck Drivers	$33.50	
Vehicle Operating Cost- Light Duty Vehicles	$0.52	
Vehicle Operating Cost- Trucks	$1.32	
PDO Crash Value	$9,100	
Injury Crash Value	$313,000	
Fatal Crash Value	$14,022,900	
Marginal Pavement Costs per VMT ($/mile) - Light Duty/Rural (2000$)	$0.00	FHWA Highway Cost Allocation Study, 2000 Addendum, Table 13, https://www.fhwa.dot.gov/policy/hcas/addendum.cfm (assumes all of the trips are on urban highways)
Marginal Pavement Costs per VMT ($/mile) - Light Duty/Rural (2022$)	$0.000	Converted using GDP Deflator
Marginal Pavement Costs per VMT ($/mile) - 60 Kip 4 Axle US Truck/ Rural Interstate (2000$)	$0.06	FHWA Highway Cost Allocation Study, 2000 Addendum, Table 13, https://www.fhwa.dot.gov/policy/hcas/addendum.cfm (assumes all of the trips are on urban highways)
Marginal Pavement Costs per VMT ($/mile) - Truck/Rural (2022$)	$0.09	Converted using GDP Deflator
Marginal Congestion Costs per VMT ($/mile) - Light Duty/Rural (2022$)	$0.03	BCA Guidance for Discretionary Grant Programs- December 2023
Marginal Congestion Costs per VMT ($/mile) - Truck/Rural (2022$)	$0.08	
Marginal Noise Costs per VMT ($/ mile) - Light Duty/Rural (2022$)	$0.00	
Marginal Noise Costs per VMT ($/ mile) - Truck/Rural (2022$)	$0.004	
Emissions		
Gram to Metric Tons	0.000001	https://www.inchcalculator.com/convert/gram-to-metric-ton/
KG to Metric Tons	0.001	https://www.inchcalculator.com/convert/kilogram-to-metric-ton/
VOC per mile - Auto (grams)	1.034	https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100EVXP.txt
Cost of VOC per Ton (2015$)	$27,500	https://www.epa.gov/sites/default/files/2015-07/documents/mar07_cost_estimation.pdf
Cost of VOC per Ton (2022$)	$32,904	Converted using GDP deflator
VOC per mile - Heavy-Duty Trucks, g/ mile	0.455	https://nepis.epa.gov/ National Service Center for Environmental Publications (NSCEP)

Input	*Value*	*Source*
Residual Value		
Roadway useful life (years)	60	https://apps.bea.gov/scb/account_articles/national/wlth2594/tableC.htm
Utilities useful life (years)	60	https://apps.bea.gov/scb/account_articles/national/wlth2594/tableC.htm
Bridges useful life (years)	75	https://www.virginiadot.org/vtrc/main/online_reports/pdf/18-r1.pdf
Crash Modification Factor		
CMF from widen paved shoulder from 3ft to 5ft	0.95	https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=11
Emergency Medical Response		
Value of Statistical Life (VSL)	$12,500,000	BCA Guidance for Discretionary Grant Programs- December 2023
Cardiac arrest per population per 100,000	58.5	https://files.hudexchange.info/course-content/ndrc-nofa-benefit-cost-analysis-data-resources-and-expert-tips-webinar/FEMA-BCAR-Resource.pdf
National Rural Median Response Time for Cardiac Arrest (minutes)	8	
Survival Probability Formula	(1 + e^ - 0.26 + 0.106(x) + 0.139(x))^ - 1	
Webbers Falls to Sequoyah Hospital (miles)	25.4	Google Maps
Webbers Falls to Saint Francis (miles)	31.9	Google Maps
Webbers Falls Population (2020 Decennial)	338	https://data.census.gov/table/DECENNIALDHC2020.P1?q=Webbers%20Falls%20town,%20Oklahoma
O&M Costs Avoided		
Annual O&M Cost- Maintenance and Operations (2024$)	$40,000	ODOT- Email provided by Jason Giebler, P.E., S.E. (Bridge Division) on October 18 2024
Special Inspection- Every 2 Years (2024$)	$5,000	
NBI and NSTM Inspection- Every 2 Years (2024$)	$10,000	
Under water inspection- Every 5 Years (2024$)	$20,000	
Rehabilitation (at year 5) (2024$)	$30,000,000	
Additional Rehabilitation (25 years after initial rehab) (2024$)	$30,000,000	

Input	*Value*	*Source*
Annual O&M Cost- Maintenance and Operations (2022$)	$37,260	Converted using GDP Deflator
Special Inspection- Every 2 Years (2022$)	$4,660	
NBI and NSTM Inspection- Every 2 Years (2022$)	$9,310	
Under water inspection- Every 5 Years (2022$)	$18,630	
Rehabilitation (at year 5) (2022$)	$27,941,400	
Additional Rehabilitation (25 years after initial rehab) (2022$)	$27,941,400	
O&M Costs		
Special Inspection- Every 2 Years (2024$)	$5,000	ODOT- Email provided by Jason Giebler, P.E., S.E. (Bridge Division) on October 18 2024
NBI and NSTM Inspection (2024$)	$10,000	
Under water inspection- Every 5 Years (2024$)	$20,000	
Silane Bridge Deck (2024$)	$250,000	
Special Inspection- Every 2 Years (2022$)	$4,660	Converted using GDP Deflator
NBI and NSTM Inspection- Every 2 Years (2022$)	$9,310	
Under water inspection- Every 5 Years (2022$)	$18,630	
Silane Bridge Deck (2022$)	$232,800	
Construction Travel Time Disbenefits		
Construction Close Date- Start	2026	ODOT
Construction Close Date- End	2029	
Construction zone speed limit	55	https://www.ncsl.org/transportation/state-strategies-to-boost-work-zone-safety-on-roadways
I-40 Freeflow Speed Limit (miles/hour)	70	https://okdot.maps.arcgis.com/apps/webappviewer/index.html?id=6555de44b6314ab2a71bb0620e52ea78
Crash Modification Factor -Central Median Value	0.29	Validation and Application of Highway Safety Manual (Part D) in Florida, Abdel-Aty et al., 2014, https://rosap.ntl.bts.gov/view/dot/27272
Construction Zone Length (miles)	4	Google Maps
Congestion Factor	0.78	https://publications.iowa.gov/27272/1/Final%20Report_work_zone_activity_traffic_flow_impacts_w_cvr.pdf

Table 3: Monetized Value of Emissions

Damage Costs for Emissions per Metric Ton* by Emission Type	NO_x	SO_x	$PM_{2.5}$**	CO_2
2021				
2022				
2023	$19,800	$52,900	$951,000	$228
2024	$20,100	$23,800	$963,200	$233
2025	$20,300	$54,800	$975,500	$237
2026	$20,600	$56,100	$993,500	$241
2027	$21,000	$57,400	$1,011,900	$245
2028	$21,300	$58,700	$1,030,600	$250
2029	$21,700	$60,100	$1,069,000	$253
2030	$22,000	$61,500	$1,069,000	$257
2031	$22,000	$61,500	$1,069,000	$262
2032	$22,000	$61,500	$1,069,000	$265
2033	$22,000	$61,500	$1,069,000	$270
2034	$22,000	$61,500	$1,069,000	$274
2035	$22,000	$61,500	$1,069,000	$278
2036	$22,000	$61,500	$1,069,000	$282
2037	$22,000	$61,500	$1,069,000	$287
2038	$22,000	$61,500	$1,069,000	$290
2039	$22,000	$61,500	$1,069,000	$294
2040	$22,000	$61,500	$1,069,000	$299
2041	$22,000	$61,500	$1,069,000	$303
2042	$22,000	$61,500	$1,069,000	$308
2043	$22,000	$61,500	$1,069,000	$312
2044	$22,000	$61,500	$1,069,000	$317
2045	$22,000	$61,500	$1,069,000	$321
2046	$22,000	$61,500	$1,069,000	$326
2047	$22,000	$61,500	$1,069,000	$331
2048	$22,000	$61,500	$1,069,000	$336
2049	$22,000	$61,500	$1,069,000	$340
2050	$22,000	$61,500	$1,069,000	$345
2051	$22,000	$61,500	$1,069,000	$349
2052	$22,000	$61,500	$1,069,000	$353
2053	$22,000	$61,500	$1,069,000	$357
2054	$22,000	$61,500	$1,069,000	$357
2055	$22,000	$61,500	$1,069,000	$357
2056	$22,000	$61,500	$1,069,000	$357
2057	$22,000	$61,500	$1,069,000	$357
2058	$22,000	$61,500	$1,069,000	$357

Table 4: Emissions Factors

Model Run Year	NO_x (kg/mi)	SO_x (kg/mi)	$PM_{2.5}$ (kg/mi)	CO_2 (kg/mi)
Passenger				
2020	0.0003927	0.0000021	0.0000064	0.3207694
2030	0.0000752	0.0000017	0.0000036	0.2609348
2040	0.0000118	0.0000015	0.0000027	0.2304285
2050	0.0000060	0.0000014	0.0000026	0.2206812
Trucks				
2020	0.0053832	0.0000044	0.0001855	1.2011386
2030	0.0019418	0.0000039	0.0000544	1.0675270
2040	0.0010109	0.0000035	0.0000160	0.9607431
2050	0.0008992	0.0000033	0.0000145	0.9053248

4 Benefits Methods

Most Project benefits are derived from changes in vehicle miles traveled (VMT) and vehicle hours traveled (VHT). Under the baseline scenario, truck traffic will be diverted beginning in 2038 and all traffic will be diverted beginning in 2052, resulting in an additional four miles and eight minutes of travel time for each detoured truck and passenger vehicle.

The analysis applies data from the NBI database sourced from the FHWA BIP BCA tool to develop traffic forecasts. The tool provides average annual daily traffic (AADT) for 2020, forecasts AADT for 2040. The analysis uses the I-40 bridge structure number '17051' in Sequoyah County to identify AADT counts in 2020 and AADT projections in 2040, which are displayed in Table 5; the analysis uses the data in Table 5 to derive the compound annual growth rate (CAGR) to estimate the AADT counts in interim years and to project through the remainder of the 30-year analysis period.

The analysis applies an annualization factor of 365 for truck traffic and an annualization factor of 260 for passenger vehicle traffic to derive annual truck and passenger vehicle trips through the analysis period.

The analysis calculates VMT avoided by applying the detour of 4 miles to the annualized traffic for trucks and passenger vehicles. Over the 30-year analysis period, the Project will result in 488.0 million VMT avoided (332.1 million truck VMT and 155.9 million passenger vehicle VMT), shown below in Table 6.

Table 5: 2020 and 2040 AADT for I-40 Bridge

Vehicle Type	2020	2040
Passenger Vehicle	10,200	16,300
Truck	5,700	9,200
CAGR	2.38%	2.38%

Table 6: VMT on I-40 Bridge and VMT Avoided from Detours

Project Year	VMT on I-40 Bridge	
	Truck	Passenger Vehicle
2038	12,757,000	-
2039	13,060,000	-
2040	13,371,000	-
2041	13,689,000	-
2042	14,014,000	-
2043	14,347,000	-
2044	14,688,000	-
2045	15,038,000	-
2046	15,395,000	-
2047	15,761,000	-

Year	Truck	Passenger Vehicle
2048	16,136,000	-
2049	16,520,000	-
2050	16,912,000	-
2051	17,314,000	-
2052	17,726,000	22,450,000
2053	18,148,000	22,984,000
2054	18,579,000	23,531,000
2055	19,021,000	24,090,000
2056	19,473,000	24,663,000
2057	19,936,000	25,249,000
2058	10,205,000	12,925,000
Total	**332,090,000**	**155,892,000**

Over the three-year construction period (Quarter 3 2026 to Quarter 2 2029), 29.9 million truck VMT and 37.9 million personal vehicle VMT will traverse the four-mile construction zone, shown below in Table 7.

From Quarter 3, 2029 through 2037, 7.3 million truck VMT will traverse the existing 0.3-mile bridge until it closes to truck traffic. From Quarter 3, 2029 until 2051, 29.1 million personal vehicle VMT will traverse the existing 0.3-mile bridge until it closes to personal vehicle traffic, shown below in Table 8.

Table 7: VMT on I-40 Bridge During Construction

Project Year	VMT on I-40 Bridge	
	Truck	Passenger Vehicle
2026 (Q3-Q4)	4,811,000	6,093,000
2027	9,851,000	12,475,000
2028	10,085,000	12,772,000
2029 (Q1-Q2)	5,163,000	6,538,000
Total	**29,910,000**	**37,878,000**

Table 8: VMT on I-40 Bridge During Analysis Period

Project Year	VMT on I-40 Bridge	
	Truck	Passenger Vehicle
2029 (Q3-Q4)	387,000	490,000
2030	793,000	1,004,000
2031	812,000	1,028,000
2032	831,000	1,052,000

Year	Truck	Passenger Vehicle
2033	851,000	1,077,000
2034	871,000	1,103,000
2035	892,000	1,129,000
2036	913,000	1,156,000
2037	935,000	1,184,000
2038	-	1,212,000
2039	-	1,240,000
2040	-	1,270,000
2041	-	1,300,000
2042	-	1,331,000
2043	-	1,363,000
2044	-	1,395,000
2045	-	1,428,000
2046	-	1,462,000
2047	-	1,497,000
2048	-	1,533,000
2049	-	1,569,000
2050	-	1,606,000
2051	-	1,645,000
Total	**7,283,000**	**29,076,000**

The benefits are organized in accordance with the criteria listed in the Notice of Funding Opportunity (NOFO), which include:

- **State of Good Repair**
- **Safety and Mobility**
- **Economic Competitiveness and Opportunity**
- **Climate Change, Sustainability, Resiliency, and the Environment**
- **Equity and Quality of Life**
- **Innovation**

4.1 State of Good Repair

The benefits derived under State of Good Repair include:

- **Operations and Maintenance (O&M) Costs Avoided**
- **Residual Value**
- **Pavement Costs Avoided (trucks and passenger vehicles)**

4.1.1 Operations and Maintenance Costs Avoided

The implementation of the Project will result significant O&M cost savings for ODOT while also bringing the critical I-40 Bridge to a state of good repair. Under the baseline, the poor condition of the I-40 Bridge will require ODOT to allocate funds towards the following over the 30-year analysis period:

- **Annual O&M costs**
- **Biannual special inspection costs**
- **Biannual NBI and NSTM inspection costs**
- **Under water inspection costs (every five years)**
- **Rehabilitation**

The total O&M costs avoided over the 30-year analysis period amount to $30.1 million (2022$), discounted at 3.1 percent.

4.1.2 Residual Value

The residual value of a capital investment is the useful service life of that asset which is remaining after the conclusion of the period of analysis. The analysis calculates residual value by determining the percent of useful life remaining beyond the analysis period and multiplying that value by the associated construction cost. The period of analysis is 30 years and the capital investments to construct the bridge are $71.4 million (2022$). The analysis considers the construction costs of the bridge only; other (soft) costs which account for approximately 18- percent of capital costs are not considered for residual value. The analysis assumes the bridge will have a useful service life of 75 years, utilities will have a useful life of 60 years, and roadway elements will have a useful life of 60 years.

The residual value of the remaining useful life for the Project is estimated at $13.4 million discounted at 3.1 percent.

4.1.3 Pavement Costs Avoided

The Project will result in a reduction of 488.0 million VMT, including 332.1 million truck miles avoided and 155.9 million passenger vehicle miles avoided over the 30-year analysis period. The BCA applies the marginal pavement costs of $0.09 per mile for trucks to derive the pavement costs avoided. Per the addendum to the FHWA 1997 Federal Highway Cost Allocation Study, there are not pavement costs associated with passenger vehicles on rural interstate highways.[6]

Pavement costs avoided from the reduction in VMT amount to $13.5 million (2022$) over the 30-year analysis period, discounted at 3.1 percent.

[6] *Federal Highway Administration, Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Accessed https://www.fhwa.dot.gov/policy/hcas/addendum.cfm*

4.2 Safety and Mobility

Safety benefits are derived due to VMT avoided for trucks and passenger vehicles. The benefits derived under Safety and Mobility include:

- **Increased Fatalities and Crashes from Construction (trucks and passenger vehicles)**
- **Reduced Roadway Fatalities and Crashes (trucks and passenger vehicles)**
- **Shoulder Widening (trucks and passenger vehicles)**
- **Higher Bridge Railing (from 33" to 42")**

This section also presents disbenefits associated with increased roadway fatalities and crashes for passenger vehicles and trucks resulting from the lack of a center median during the construction period.

4.2.1 Reduced Roadway Fatalities and Crashes

The Project will result in a reduction of 488 million VMT, including 332.1 million truck miles avoided and 155.9 million passenger vehicle miles avoided over the 30-year analysis period. The analysis applies the accident rates cited in Table 2 and displayed below in Table 9 to quantify the accidents avoided because of the Project.

The reduction in VMT associated with the Project will result in 9 fatal accidents avoided, 157 injuries avoided, and 380 property damage only (PDO) crashes over the 30-year analysis period, displayed in Table 10.

The analysis applies the accidents avoided by the values displayed in Table 2 to monetize the value of accidents avoided. The total value of accidents avoided from the reduction in VMT amounts to $78.7 million (2022$) over the 30-year analysis period, discounted at 3.1 percent.

The Project will result in safety disbenefits during construction activities that are scheduled to occur between Quarter 3 2026 and Quarter 2 2029. During construction, the existing I-40 bridge will operate in partial capacity, with one lane of traffic operating in each direction. As such, there will not be a center median separating bi-directional traffic through the duration of the four-mile construction zone.

Center medians provide significant safety benefits by reducing the risk of head on collisions and accidents. The analysis utilizes a crash modification factor (CMF) of 0.29 for center medians.[7] According to

Table 9: Accident Rates

Accident Severity	Muskogee County	Sequoyah County	Average
Fatal Crashes per 100 million VMT	2.3	1.6	**1.9**
Injuries Crashes per 100 million VMT	38.3	25.9	**32.1**
PDO Crashes per 100 million VMT	73.9	81.8	**77.9**

[7] *Abdel-Aty, Mohamed A., Chris Lee, Juneyoung Park, Jung-Han Wang, Muamer Abuzwidah, and Saif Al-Arifi, Validation and Application of Highway Safety Manual (Part D) in Florida, Final Report, May 2014. Accessed https://rosap.ntl.bts.gov/view/dot/27272*

the FHWA CMF Clearinghouse, a CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site; CMFs are generally used to calculate the reduction in the expected number of crashes after implementing a countermeasure on a road or intersection. During construction, the Project will temporarily remove the center median counter measure, resulting in a temporary increase in accidents.

To calculate the increase in accidents from the temporary removal of the center median, the analysis first multiplies VMT from Table 7 to the accident rates displayed in Table 10 to quantify the number of fatal, injury, and PDO accidents anticipated. Finally, the analysis divides the anticipated number of fatal, injury, and PDO accidents avoided by the CMF of 0.29 to determine the anticipated number of accidents following the removal of the center median during construction activities. The analysis calculates the net increase in accidents following the removal of the center median during construction, as displayed in Table 11.

The analysis multiplies the increase in accidents during construction by the values displayed in Table 2 to monetize the value of safety disbenefits during construction. The total value of accidents increased from the removal of the center median during construction amount to $53.3 million (2022$) over the 30-year analysis period, discounted at 3.1 percent.

4.2.2 Shoulder Widening

In widening the highway shoulders, the Project will result in additional accidents avoided. Under the baseline scenario, the I-40 bridge will be open to trucks from Quarter 3 2029 until 2038 and to

Table 10: Accidents Avoided

Accident Severity	Trucks	Passenger Vehicle	Total
Fatal Crashes Avoided	6	3	**9**
Injury Crashes Avoided	107	50	**157**
PDO Crashes Avoided	259	121	**380**

Table 11: Increase in Accidents during Construction

Accident Severity	Trucks	Passenger Vehicle	Total
Fatal Crashes	1	2	**3**
Injuries Crashes	23	30	**53**
PDO Crashes	57	72	**129**

Table 12: Accidents on the I-40 Bridge while in Operation

Accident Severity	Trucks	Passenger Vehicle	Total
Fatal Crashes	0.1	0.6	**0.7**
Injuries Crashes	2.3	9.3	**11.7**
PDO Crashes	5.7	22.6	**28.3**

passenger vehicles until 2052, resulting in 36.4 million VMT (7.3 million VMT from trucks and 29.1 million VMT from passenger vehicles) over the length of the bridge. The Project applies the accident rates displayed in Table 12 to quantify the number of accidents that would occur under the baseline while the bridge is in operation.

Wider highway shoulders deliver safety benefits by reducing the likelihood of an accident in the event a vehicle needs to pull over due to an emergency. The analysis applies a CMF of 0.95, to calculate the reduction in accidents following the implementation of wider shoulders; the reduction in accidents resulting from the implementation of wider shoulders is displayed in Table 13.

The total value of accidents avoided from the increased shoulder widths amount to $0.4 million (2022$) over the 30-year analysis period, discounted at 3.1 percent.

The net value of accidents avoided amount to $25.8 million (2022$) over the 30-year analysis period, discounted at 3.1 percent.

4.2.3 Higher Bridge Railing (from 33” to 42”)

The current bridge does not meet the American Association of State Highway and Transportation Official’s (AASHTO) design and safety standards with a railing 33 inches above the raised section of the deck. The present minimum height requirement for bridge railings is 42 inches. By incorporating a higher bridge railing, the Project will generate several safety benefits. In the baseline scenario, passenger vehicles and trucks would be at an increased risk of going over the edge in the event of a collision. With the improved railing, not only would standards be up to date, but the Project would result in additional accidents avoided and enhanced safety, specifically for larger vehicles and trucks benefiting from the improved containment the higher railing provides.

4.3 Economic Competitiveness and Opportunity

The benefits derived under Economic Competitiveness and Opportunity include:

- **Additional Travel Time Cost from Construction (trucks and passenger vehicles)**
- **Travel Time Savings (TTS) (trucks and passenger vehicles)**
- **Vehicle Operating Cost Avoided (VOC) (trucks and passenger vehicles)**
- **Congestion Reduction (trucks and passenger vehicles)**
- **Reliability from Detours**

In addition, the Project will result in travel time disbenefits during construction activities.

Table 13: Reduction in Accidents from Wider Shoulders

Accident Severity	Trucks	Passenger Vehicle	Total
Fatal Crashes Avoided	0	0	0
Injuries Crashes Avoided	0	0	1
PDO Crashes Avoided	0	1	1

4.3.1 Travel Time Savings

The Project will result in a reduction of 15.4 million VHT, including a travel time savings of 10.5 million hours from trucks and a travel time savings of 4.9 million hours from passenger vehicles over the 30-year analysis period. The analysis applies the value of time of $33.50 (2022$) for trucks and $19.60 (2022$) for passenger vehicles to monetize travel time savings.

The total travel time savings amount to $219.0 million, including $158.5 million from trucks and $60.5 million from passenger vehicles, over the 30-year analysis period, discounted at 3.1 percent.

The analysis calculates travel time disbenefits resulting from the additional travel time passenger vehicles and trucks will incur during the construction of the new I-40 bridge. Construction of the Project is set to begin in Quarter 3 of 2026 and end in Quarter 2 of 2029. During this period, the I-40 bridge will close one lane in both directions, increasing travel time for passenger vehicles and trucks crossing the bridge. The lane reductions will be accompanied by a construction work zone of 4 miles with a speed limit of 55 miles per hour, a reduction in 15 miles per hour from the baseline speed limit of 70 miles per hour. The analysis applies an additional speed reduction factor of 0.78, resulting in an assumed travel speed of 43 miles per hour throughout the construction zone. This speed limit reduction will lead to an additional 1.1 million vehicle hours traveled. The analysis applies the value of travel time of $33.50 (2022$) for trucks and $19.60 (2022$) for passenger vehicles to monetize travel time disbenefits.

The total travel time disbenefits amount to $23.7 million, including $13.6 million from trucks and $10.1 million from passenger vehicles, over the 30-year analysis period, discounted at 3.1 percent.

The net travel time savings amount to $195.3 million over the 30-year analysis period, discounted at 3.1 percent.

4.3.2 Vehicle Operating Cost Avoided

The Project will lead to a reduction of 488.0 million VMT, including 332.1 million truck miles avoided and 155.9 passenger vehicle miles avoided over the 30-year analysis period, resulting in vehicle operating costs avoided. The analysis applies the truck operating costs of $1.32 (2022$) per mile and the passenger vehicle operating costs of $0.52 (2022$) per mile to monetize vehicle operating costs avoided.

The total vehicle operating costs avoided amount to $277.7 million, including $197.9 million from trucks and $29.8 million from passenger vehicles, over the 30-year analysis period, discounted at 3.1 percent.

4.3.3 Congestion Reduction

The Project will lead to a reduction of 488.0 million VMT, including 332.1 million truck miles avoided and 155.9 million passenger vehicle miles avoided over the 30-year analysis period, resulting in congestion costs avoided. The analysis applies the marginal congestion costs of $0.08 (2022$) per mile for trucks and $0.03 per mile for personal vehicles to monetize the marginal social costs of congestion avoided.

The total marginal social costs of congestion avoided amount to $12.9 million, including $11.2 million from trucks and $1.7 million from passenger vehicles, over the 30-year analysis period, discounted at 3.1 percent.

4.3.4 Reliability from Detours

Closure of the bridge to trucks in 2038 and passenger vehicles in 2052 will require trips to detour from the I-40 bridge to US Highway 64. In addition to traffic flows on US Highway 64, the diverted traffic flows will cause congestion and bottlenecks for travelers, impacting trip reliability and causing delays for commuters. Further, there is a cost for businesses that depend on reliable freight transportation to deliver goods and services, as delayed shipments and disrupted supply chains can have severe economic implications.

4.4 Climate Change, Sustainability, Resiliency, and the Environment

Climate Change, Resilience, and the Environment outcomes capture the benefits of decreased in emissions associated with personal VMT avoided as well as truck ton-miles avoided under the no-build scenario. The benefits derived under Climate Change, Sustainability, Resiliency, and the Environment include:

- **Emissions Avoided (trucks and passenger vehicles)**
- **Noise Avoided (trucks and passenger vehicles)**
- **Water Run Off Improvements**
- **Resiliency to Weather, Seismic, or Other Extreme Events**

4.4.1 Emissions Avoided

The Project will result in a reduction of 488.0 million VMT, including 332.1 million truck miles avoided and 155.9 million passenger vehicle miles avoided over the 30-year analysis period. The Project will create environmental benefits resulting in the reduction of volatile organic compounds (VOC), nitrous oxide (NOx), particulate matter (PM2.5), sulfur oxides (SOX), and carbon dioxide (CO2). The environmental benefits are a result of VMT avoided following implementation of the Project. This will eliminate the need for passengers to take detours.

The analysis sources emissions rates from various sources to determine the emissions per mile by vehicle type, cited in Table 4. The analysis calculates the reduction in emissions by multiplying the VMT avoided to the damage costs for emissions per metric ton per the BCA Guidance as displayed in Table 3.

The total value of emissions avoided from the reduction in passenger VMT amounts to $139.5 million, including $128.5 million from trucks and $11.0 million from passenger vehicles, over the 30-year analysis period, discounted at 3.1 percent, with the exception of carbon dioxide which is discounted at 2 percent in accordance with BCA Guidance.

4.4.2 Noise Avoided

The Project will result in a reduction of 488.0 million VMT, including 332.1 million truck miles avoided and 155.9 million passenger vehicle miles avoided over the 30-year analysis period, resulting in a reduction in noise pollution generated from vehicle engines. The analysis applies the marginal noise costs of $0.004 (2022$) per mile for trucks and $0.0002 (2022$) per mile for personal vehicles to total VMT avoided to monetize the marginal social costs of noise pollution avoided.

The total marginal social costs of noise pollution avoided amount to $0.6 million, including $0.6 million from trucks and less than $0.1 million from passenger vehicles, over the 30-year analysis period, discounted at 3.1 percent.

4.4.3 Water Run Off Improvements

The new bridge will be constructed to ODOT's latest design standards, which include design guidelines for improved pavement drainage, gutter flow, and control of stormwater runoff.[8] Per the guide, new drainage facilities will collect stormwater runoff and convey it through the roadway right-of-way in a manner that adequately drains the roadway and minimizes the potential for flooding and erosion to adjacent properties. The new bridge will be designed to reduce the risk of traffic interruption resulting from flooding, therefore lowering the likelihood of the bridge halting, or closing to traffic.

4.4.4 Resiliency to Weather, Seismic, or Other Extreme Events

The new bridge will be constructed to ODOT's latest design standards, which includes assessing and providing a response plan to the bridge conditions and serviceability in the event of a significant weather, seismic, or other extreme events.[9] The new bridge structures will reduce the likelihood of induced bridge damage, ensuring the safety of passengers on the bridge and limiting corrective action such as traffic restrictions and bridge closures.

4.5 Equity and Quality of Life

The benefits associated with equity and quality of life include emergency response savings.

4.5.1 Emergency Response Savings

The eventual bridge closure presents a safety issue for residents of Muskogee and Sequoyah Counties as detours following the closure of the bridge can delay emergency response vehicles from accessing residents and properties during emergencies. The Project will allow continued access for these emergency vehicles, resulting in emergency response savings for the Project area.

The analysis calculated this benefit using a methodology outlined in a FEMA Benefit-Cost Analysis Re-engineering document.[10] First, the analysis found the average distance between hospitals in the area surrounding the Project, as well as the total population in the area utilizing 2020 Census data. The analysis escalated the 2020 population data by 2.4 percent annually, commensurate with annual traffic growth, through the duration of the analysis period.

Next, the analysis applied an emergency event to the population. This analysis utilized cardiac arrests as the defined emergency, which the American Heart Association estimates that 58.5 cardiac arrests per 100,000 people are treated by EMS personnel. The analysis multiplied this ratio (58.5/100,000) by the population, which is equal to 0.024 cardiac arrests per year for the Project. Using formula detailed in the referenced FEMA documentation, the analysis calculates the response time before a blockage (where the bridge is operational) as well as the response time after a blockage (where the bridge is closed to all traffic). The analysis used

[8] *ODOT Roadway Drainage Manual, Chapter 10 (2014). Accessed from https://oklahoma.gov/content/dam/ok/en/odot/documents/chapter-10-stormwater-drainage.pdf.*

[9] *ODOT Earthquake Response Plan (2017). Accessed from https://www.odot.org/pontis_files/Earthquake%20RespPlan.pdf*

[10] *Federal Emergency Management Agency, FEMA Benefit-Cost Analysis Re-engineering (BCAR), December 2011. Accessed https://files.hudexchange.info/course-content/ndrc-nofa-benefit-cost-analysis-data-resources-and-expert-tips-webinar/FEMA-BCAR-Resource.pdf*

these values to calculate the survival probability and number of deaths per year for both response time scenarios. The increase in deaths per year between the unblocked and the blocked scenarios yields the emergency response savings.

Finally, the analysis applied the value of statistical life (VSL) provided in the BCA Guidance equal to $12.5 million (2022$) to this increase in number of deaths for each year over the period of analysis.

The value of emergency response savings amounts to $0.1 million over the 30-year period of analysis, discounted at 3.1 percent.

4.6 Innovation

With the implementation of innovative and effective strategies, the Project will generate several qualitative benefits. These include:

- **Warm Mix Asphalt**
- **3D Digital Project Plans**
- **Accelerated Bridge Construction**

4.6.1 Warm Mix Asphalt

The Project will integrate warm mix asphalt into the paving aspects of the construction process. Warm mix asphalt is a technology that has been proven to bring several benefits, including:

- **Reduces paving costs**
- **Extends the paving season**
- **Improves asphalt compaction**
- **Allows asphalt mix to be hauled longer distances**
- **Improves working conditions by reducing exposure to fuel emissions, fumes, and odors as well as reduction of greenhouse gas emissions**

4.6.2 3D Digital Project Plans

ODOT will implement 3D digital project plans as part of the contracting process. This innovative technology will use state-of-the-art GPS-controlled automated equipment in the construction process, which reduces the risk of human error in establishing grades and elevations while improving efficiency in earthmoving during the construction process and reducing the overall cost of construction.

4.6.3 Accelerated Bridge Construction

ODOT is committed to exploring Accelerated Bridge Construction (ABC) techniques, which combine innovative planning, materials, designs, and construction methods to reduce construction-related impacts, thereby minimizing overall construction completion times and minimizing traffic disruption. Utilizing the ABC techniques allows for the construction process to be streamlined, ultimately resulting in fewer on-site construction requirements. ABC techniques play a large role in minimizing construction and traffic delays, making their implementation critical for the I-40 corridor throughout construction.

5 Cost Analysis

The Project has two cost components: the capital costs for the new infrastructure and ongoing O&M costs of that infrastructure. The components used in this analysis are described in this section.

5.1.1 Capital Costs

The Project capital costs include design and construction of roadway and bridge components, as well as costs associated with mobilization and traffic control. Capital costs were estimated in 2024 dollars with an annual escalation factor of 3-percent. The analysis takes costs, with the escalation factor removed, and converts them to 2022 dollars using the GDP deflator, resulting in a total cost of $71.4 million discounted at 3.1 percent. The detailed capital cost summary for the Project is displayed in Table 14 in 2022 dollars, rounded to the nearest thousand.

5.1.2 Operations and Maintenance Costs

The Project will require recurring O&M upkeep throughout the analysis period, which includes special inspections and NBI and NSTM inspections every two years, as well as under water inspections every five years. The Project will also require the implementation of silane bridge deck sealer in the second year of the Project's useful life.

The O&M costs of the Project amount to $0.4 million over the 30-year analysis period, discounted at 3.1 percent.

Table 14: Project Capital Costs (2022$ discounted at 3.1%)

Year	Roadway (2022$)	Utility (2022$)	Construction (2022$)	Total (2022$)
2023	$302,000	$0	$0	$302,000
2024	$293,000	$0	$0	$293,000
2025	$138,000	$199,000	$0	$337,000
2026	$0	$187,000	$12,789,000	$12,976,000
2027	$0	$0	$24,087,000	$24,087,000
2028	$0	$0	$22,682,000	$22,683,000
2029	$0	$0	$10,681,000	$10,680,000
2030	$0	$0	$0	$0
Total	**$733,000**	**$386,000**	**$70,239,000**	**$71,358,000**

6 Benefits Cost Analysis Results

Over the 30-year analysis period, the Project generates $658.5 million (2022$) in total benefits, discounted at 3.1 percent (apart from carbon dioxide, which is discounted at 2 percent). The project has a BCR of 9.2 and a NPV of $587.2 million (2022$). The summary of the Project's costs and benefits are detailed below in Table 15.

Table 15: Summary of Benefits and Costs in Millions (2029-2058, 2022$)

Costs	***Value (millions of 2022$, discounted at 3.1%)***
Capital Costs	$71.4
Total	**$71.4**
Benefits	***Value (millions of 2022$, discounted at 3.1%)***
State of Good Repair	
O&M Costs Avoided	$30.1
O&M Costs	-$0.4
Residual Value	$13.4
Pavement Cost Avoided	$13.5
Sub-Total State of Good Repair	*$56.6*
Safety and Mobility	
Construction Impacts - Increased Fatalities and Crashes	-$53.3
Reduced Roadway Fatalities and Crashes	$78.7
Shoulder Widening	$0.4
Higher Bridge Railing (from 33" to 42")	Qualitative
Sub-Total Safety	*$25.8*
Economic Competitiveness and Opportunity	
Travel Time Savings	$219.0
Construction Impacts	-$23.7
Vehicle Operating Cost Avoided from Detours	$227.7
Congestion Reduction	$12.9
Reliability from Detours	Qualitative
Sub-Total Mobility and Economic Competitiveness	**$435.9**

Benefits	***Value (millions of 2022$, discounted at 3.1%)***
Climate Change, Sustainability, Resiliency, and the Environment	
Emissions Avoided*	$139.5
Noise Avoided	$0.6
Water Run Off Improvements	Qualitative
Resiliency to Weather, Seismic, or Other Extreme Events	Qualitative
Sub-Total Climate Change, Resiliency, and the Environment	*$140.1*
Equity and Quality of Life	
Emergency Response Savings	$0.1 million
Sub-Total Quality of Life	*$0.1 million*
Innovation	
Warm Asphalt mix	Qualitative
3D Digital Project Plans	Qualitative
Accelerated Bridge Construction	Qualitative
Sub-Total Innovation	*Qualitative*
Total Benefits	**$658.5**
Benefit-Cost Ratio	9.2
Net Present Value	$587.2

**CO2 discounted at 2-percent*