OKLAHOMA SH-100 BRIDGE REPLACEMENT BENEFIT COST ANALYSIS

A benefit-cost analysis (BCA) was conducted for replacing the Oklahoma State Highway 100 (Ray Fine Bridge) over the Arkansas River ("the project") for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the Bridge Investment Program (BIP) 2022 program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs (the "BCA guidance"), revised March 2022.

This document summarizes the benefits and costs for rebuilding the SH-100 Bridge and refers to details in an accompanying spreadsheet. The evaluation period is through 2074, which includes two years of construction plus 50 years of benefits after operations begin in 2024. Unless otherwise stated, all dollar values are presented in real 2020 dollars (2020$), in line with the BCA guidance for FY 2022. All costs are summarized in Table 1.

TABLE 1. BCA SUMMARY

Cost/Disbenefit Item	Build Scenario	No-Build Scenario
Project Construction Costs	$18,615,721	--
Rehabilitation Costs	--	$10,813,994
Operations and Maintenance Costs	$1,699,752	$1,190,207
Additional Travel Time	$12,165,565	$29,618,864
Additional Vehicle Operating Costs	$9,164,911	$22,313,327
Emissions Costs	$705,783	$3,970,078
Total NPV	$42,351,732	$67,906,471
Benefit Cost Ratio	**1.60**	
Unmonetized Benefits	Reduction in potential for crashes of approximately 50% System redundancy for Interstate 40 between Oklahoma City and Little Rock	

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ASSUMPTIONS

AVERAGE DAILY TRAFFIC

Project and no-build alternative costs related to emissions and travel time are based on the average daily traffic (ADT) over the bridge. Traffic counts have most recently been performed in 2019 and 2020. The 2020 ADT was lower than the 2019 ADT, but this was reflective of the general decrease in traffic observed nationally due to the COVID-19 pandemic. Therefore, this analysis uses the 2019 ADT as a baseline because it is more representative of typical traffic on the bridge. Based on the 2019 traffic count, a value of 4,300 vehicles per day was determined, with 15% truck traffic.

ADT is projected to increase by a conservative 50 per year, less than a 1% increase per year for the length of the evaluation period.

DETOURS DURING BRIDGE CLOSURE

The analysis assumes that users of the SH-100 bridge will have to detour to the nearest adjacent bridge to cross the Arkansas River (the I-40 bridge) during construction of the bridge, both construction of the build alternative and any extensive rehabilitation work required under the no-build alternative. It is assumed that most of the traffic on the bridge currently is local traffic, traveling between Webbers Falls and Gore, the communities on either side of the SH-100 bridge. The detour adds approximately 10 miles to a single vehicle trip, and an estimated 15 minutes of travel time.

TRAVEL TIME AND VEHICLE OPERATING COSTS

Values used for calculation of travel time and vehicle operating costs are taken from the BCA guidance.

Average daily vehicle counts are converted to annual trips, and additional miles and time traveled are then calculated using the anticipated detour path (see “Detours During Bridge Closure”, above). It is estimated that 15% of trip volume are truck trips, with the remaining 85% representing passenger vehicle trips.

For 85% of the trips (representing the passenger vehicle trips), the resulting time delays are multiplied by the number of passengers per vehicle (1.67 from Guidance Table A-4) and the personal value of time ($16.20 from Guidance Table A-3). For the remaining 15% of trips (representing truck trips), the time delay is multiplied by the value of time for the truck driver ($32.00 from Guidance Table A-3). The values for passenger vehicles and trucks are added together to provide the cost of additional travel time resulting from the detour.

Additional vehicle operating costs are estimated by multiplying additional passenger vehicle miles from the detour by $0.45 per mile from Guidance Table A-5, and commercial truck miles by $0.94 per mile, also from Guidance Table A-5.

EMISSIONS

Values used for calculation of emissions costs are taken from the BCA guidance (Guidance Table A-6). Additional values used for analysis but not included in the guidance document are based on best practices.

As with travel time and vehicle operating costs, emissions costs are calculated based on 15% of vehicles using the bridge being trucks, and the remaining 85% representing passenger vehicles.

All emissions factors reflect an average automobile travel speed of 55 mph, the posted speed limit on the bridge. For carbon dioxide emissions, emissions factors are calculated based on fuel efficiency information from US EIA and a grams of CO2 per gallon of fuel factor from EPA’s Greenhouse Gas Equivalencies Calculator. For gasoline, this is 8,887 grams of CO2 per gallon, and for diesel this is 10,180 grams of CO2 per gallon.

UNMONETIZED BENEFITS

SAFETY

As discussed in the Grant Narrative, the new bridge will provide a safer facility for the use of drivers and bicyclists, based on the introduction of wider lanes, wider edge lines, wider shoulders, rumble strips, and pavement markings. The combinations of the crash modification factors for these improvements suggest an overall reduction of 50% across all crash types.

There have been no collisions on the bridge in the past 10 years. There have been three collisions on SH-100 adjacent to the project area (two PDO and one possible injury), but the road beyond the limits of the bridge is not necessarily representative of the bridge itself, since the lanes are wider.

Safety has not been monetized in this analysis because of the lack of data for collisions on the bridge. However, the improvement in safety resulting from the improved roadway facility should be considered as an unmonetized benefit, especially as ADT will continue to increase over the bridge.

SYSTEM REDUNDANCY

The Grant Narrative also discusses the value of the SH-100 bridge as a redundant link across the Arkansas River. The I-40 bridge, 6 miles south of the SH-100 bridge, carries a significant amount of traffic across the Arkansas River. The criticality of this link was demonstrated in 2002 when the I-40 bridge collapsed, and traffic had to be rerouted across the SH-100 bridge. If the SH-100 bridge had not been available to carry traffic at that time, users of I-40 traveling between Oklahoma City and Little Rock, Arkansas would have needed to make a detour of at least 30 miles to cross the Arkansas River via state highway bridges in either Muskogee or Cowlington.

Since the I-40 bridge has been strengthened against the cause of the 2002 collapse (a barge strike), and is maintained such that future failures are not anticipated to occur, the use of the SH-100 bridge as a redundant link in the interstate system has not been quantified in the BCA. However, there is a clear benefit to having a nearby alternative route for interstate traffic if temporary closure of the I-40 bridge is required for any reason, from routine maintenance of the roadway to extreme weather events such as floods.

PROJECT COSTS (“BUILD ALTERNATIVE”)

The proposed project will cost $25,520,000 for demolition and rebuilding. The construction work is estimated to be split over a two-year period. Construction is expected to start in June 2024 and conclude in December 2025. The NPV of these costs is $18.6 million.

After rebuilding the bridge, periodic maintenance will be required to maintain state of good repair. It is anticipated that the cost of operations and maintenance will be significantly lower for the new bridge than for the existing bridge. Operation and maintenance costs are expected to total $13.7 million from 2025 through 2073, with a total NPV over that period of $1.7 million.

The other major costs (or disbenefits) of the project are borne by users of the bridge and the general public. These include the cost of travel time delays, additional vehicle operating costs, and emissions. These costs are based on:

- Average daily traffic counts for bridge traffic
- The additional time and distance required for vehicle traffic that must be rerouted over the two-year bridge demolition and replacement period.
- The emissions generated by the additional travel distance.

It was assumed that under the build alternative, all typical bridge users would be detoured to the I-40 bridge during construction of the new SH-100 bridge, for a period of 18 months (6 months in 2024 and 12 months in 2025). All disbenefits related to travel time delay, additional vehicle operating costs, and emissions for the build alternative are incurred in those two years.

The NPV for the total of time delays for the two-year project is $12.1 million, while the NPV for additional vehicle operating costs is $9.2 million. The NPV for the cost of emissions resulting from the detour is $0.7 million.

The total NPV cost for building the project is $42.3 million.

NO-BUILD ALTERNATIVE

The no-build alternative is vastly different than the proposed project. Rather than entirely replacing the bridge, the no build alternative includes periodic rehabilitation projects starting in 2027 and occurring every 4 years. Since the bridge is reaching the end of its useful design life, an increasing amount of rehabilitation work will be required to maintain the bridge in a useable condition. ODOT estimates that the rehabilitation project required in 2026 will cost $3.0 million. Future rehabilitation work may be expected to increase in cost due to continued deterioration of the structure and related increases in use of materials. The NPV of this rehabilitation work is projected to be $10.8 million.

In addition to the periodic rehabilitation costs, the O&M costs for the existing bridge may also be expected to increase over time from $100,000 per year to $230,000 per year in 2074, also reflecting continued deterioration of the structure. The NPV of these no-build O&M costs is projected at $1.2 million.

It is expected that the bridge will require closure to traffic during the periodic rehabilitation projects work, with an average closure duration of 11 months. It is also assumed that the SH-100 bridge will be weight-restricted starting in 2040 due to continued deterioration. In this case, all trucks will need to use the detour starting in 2040. Disbenefits related to travel time delay, additional vehicle operating costs, and emissions for the no-build alternative are incurred in the years affected by closures and weight restriction.

The NPV for the total of time delays is $29.6 million, while the NPV for additional vehicle operating costs is $22.3 million. The NPV for the cost of emissions resulting from the detour is $3.9 million.

The total NPV cost for the no-build scenario is $67.9 million.

BCA RATIO

Based on the NPV costs for the project and no-build scenarios, the benefit cost ratio of this project is 1.60. This does not include the unmonetized benefits of building the project, as discussed above.

BCA ANALYSIS USING A SHORTER 30 YEAR EVALUATION PERIOD

In addition to the BCA analysis presented above, the BCA analysis spreadsheet includes three additional tabs with a 30-year evaluation period rather than the 50-year evaluation period that may be more appropriate for a project with an expected lifetime of 50 to 70 years. The data and analysis included in these additional tabs is identical to the three 50-year tabs but deletes the last 20 years of projections.

As may be expected, the additional costs for the no build alternative under the 50-year horizon continue to grow given the projected deterioration of the current structure, and ignoring these growing costs reduces the net benefits that will be realized by the proposed Project. The result of excluding these long-term benefits reduces the calculated Benefit Cost Ratio from the 1.60 value under the 50 year horizon time horizon to a 1.37 BCR.