

APPENDIX: BENEFIT COST ANALYSIS METHODOLOGY

Executive Summary

The Benefit Cost Analysis (BCA) was prepared for the project application in accordance with the BCA Guidance for Discretionary Grant Programs dated June 2018. **The State Highway 28 (SH 28) Widening and Rehabilitation Project in Mayes County, Oklahoma** provides a **benefit-cost ratio of 1.60** when discounted at seven percent. This means, for every dollar invested in the project, motorists receive 160% back in benefits. Consequently, a \$29.5 million investment in the project would equal a positive net user benefit of more than \$41.8 million to the surrounding area.

Over the life of the project, the vehicle operating costs due to closure is the largest contributor to the positive cash flow projected for this project, providing a positive net present value of \$10.9 million. The load rating increase contributes \$10.4 million in positive net present value from the vehicle operating costs.

Project Definition and Approach

The existing three bridges on SH 28 over Grand Lake O' the Cherokees are functionally obsolete and structurally inadequate. The existing bridge width is 19 feet 8 inches wide, with two lanes of traffic (one way each direction) of nine feet ten inches. The bridge structures include:

- Pensacola Dam Bridge (5,669 feet or 1.07 miles)
- West Spillway Bridge (451 feet or .05 miles)
- East Spillway Bridge (410 feet or .078 miles)

The proposed project includes rehabilitation of the bridge surface and substructure, structural enhancement of the existing load carrying capacity, widening the travel lanes to twelve feet wide, and adding one longitudinal beam line to support the downstream edge of a new slab and new parapet.

The BCA for the project accounts for anticipated capital costs of the project as well as ongoing maintenance and operations cost of the project. The BCA compares these costs with the total project benefits over a twenty-year period as advised through the BCA Guidance for Discretionary Grant Programs dated June 2018. While the BCA uses a twenty-year time period, the improvements have an anticipated lifecycle of seventy-five years and will extend well past a twenty-year period.

Project Costs

The project has a total capital cost of \$29,493,084 over a two-year construction period from September 2019 to April 2021.

Table 1: Summary of Estimated Capital Costs

Environmental and Preliminary	\$958,000
Final Engineering and Construction Services	\$422,084
Bridge Rehabilitation	\$14,292,800.
Bridge A (Pensacola Dam)	\$8,808,000
Bridge B (West Spillway Bridge)	\$1,197,000
Bridge C (East Spillway Bridge)	\$1,067,000
<i>Subtotal Bridges A, B, & C</i>	<i>\$26,744,884</i>
Mobilization, Staking, SWPPP, Field Office	\$1,409,200
5% Contingency	\$1,339,000
Total Widening & Rehabilitation Estimate	\$29,493,084

Project Benefits

The following project benefits are quantified in the following sections:

- Safety (reduction in the likelihood of crashes)
- Economic Competitiveness (fuel and travel time savings)
- Environmental (emission reduction from delay savings)

Safety

The existing Pensacola Dam Roadway has two ten-foot lanes with curb and barrier immediately adjacent. The narrow roadway with barrier causes collisions and property damage. A high-level Highway Safety Manual (HSM) analysis was completed on a rural two-lane highway to determine the effects of the widened roadway on safety. The results showed that widening the lanes to twelve-foot as proposed in the project resulted in a 20 percent reduction in crashes annually. When the savings was computed in the BCA it results in more than \$400,000 in net present value. The recommended monetized values based on KABCO-level collisions were used for this BCA, as provided in the BCA Guidance for Discretionary Grant Programs dated June 2018.

Economic Competitiveness

Travel Time Savings

The economic competitiveness category quantifies multiple benefits with its analysis. First, there is the benefit of travel time savings. Travel time savings from the widening and rehabilitation are projected as the current bridges have a low load limit and the project area experiences extreme congestion, particularly on weekends during the summer months. The current weight limit of the bridges are posted at 16 tons. Based upon this relatively low weight limit it was determined that when the weight limit is

removed after the project improvements, five percent more trucks would travel on the bridge, generating significant time savings.

Second, it was estimated that due to the extreme congestion experienced in the project area during summertime weekends and holidays, 20 percent of traffic on those days would choose to take a diversion route around the project. The project team has determined that even with ongoing maintenance, the Pensacola Dam Roadway would need to be closed by the year 2040 if improvements are not completed. If the project is built, all drivers reap travel time savings from avoiding the diversion route. Because the diversion route is quite long (more than 22 miles) it was assumed only 80 percent of today's traffic would choose to make the trip under this scenario. Also, once the dam is closed to traffic the other travel time benefits due to reduced diversion stop. Third, the speed on the dam is posted at 45 mph, but based upon the speed study conducted in early July 2018 the average speed is 35 mph. This results in a travel time savings to all vehicle crossing the bridge as the widened lanes will allow vehicles to travel at the posted speed limit.

The base travel time savings due to the increase in average speed has a net present value of \$1.4 million. The load rating travel time savings, resulting from the removal of weight limits and the corresponding increase in truck traffic has a net present value of \$4.9 million. The net present value of the travel time savings resulting from a reduction in travel time savings is \$2.8 million. Finally, the travel time savings resulting from not closing the bridge to traffic has a net present value of \$5.2 million. This results in a total of \$14.4 million in net present value savings for travel times as a direct result of the project (See Table 4).

Vehicle Operating Costs

In addition, to the travel time savings the vehicle operating costs were also saved for each of the items above. The base vehicle operating cost (VOC) savings due to the increase in average speed has a net present value of \$0 as there is no change in distance traveled for this item. The load rating VOC savings, resulting from the removal of weight limits and the corresponding increase in truck traffic has a net present value of \$10.4 million. The net present value of the VOC savings resulting from a reduction in travel time savings is \$6 million (See Table 5). Finally, the travel time savings resulting from not closing the bridge to traffic has a net present value of \$10.9 million. This results in a total of \$27.2 million in net present value savings for travel times as a direct result of the project. The recommended monetized values of time savings and vehicle operating costs were used for this BCA, as provided in the BCA Guidance for Discretionary Grant Programs dated June 2018.

Environmental Protection

The reduction in greenhouse gases (GHG) was also computed for the benefit cost analysis. Due to the high projected traffic growth and increase in truck traffic if the project is completed the emissions are expected to increase over existing conditions. This results in a negative net present value of approximately \$120,000 contributing against the other benefits to the project (See Table 6).

Summary of Benefits

As summarized in the tables below, the project benefits for the rehabilitation and widening of the SH 28 Pensacola Dam and Spillway bridges over a 20-year period result in approximately \$41,815,398 in net present value for an investment of \$29,493,084.

Table 2: BCA Summary

Direct Benefits	User	Discount Rate	7.00%
		Net Present Value	\$15,743,532
		Internal Rate of Return	11.04%
		Benefit/Cost Ratio	1.60

Table 3: BCA Cost Summary

	Project Costs		
	Capital	Maintenance	Total Costs
2018	\$ -	\$0	\$0
2019	\$ 8,493,084	\$0	\$8,493,084
2020	\$ 21,000,000	\$0	\$21,000,000
2021	\$0	\$6,000	\$6,000
2022	\$0	\$6,000	\$6,000
2023	\$0	\$6,000	\$6,000
2024	\$0	\$6,000	\$6,000
2025	\$0	\$6,000	\$6,000
2026	\$0	\$6,000	\$6,000
2027	\$0	\$6,000	\$6,000
2028	\$0	\$6,000	\$6,000
2029	\$0	\$6,000	\$6,000
2030	\$0	\$6,000	\$6,000
2031	\$0	\$6,000	\$6,000
2032	\$0	\$8,000	\$8,000
2033	\$0	\$8,000	\$8,000
2034	\$0	\$8,000	\$8,000
2035	\$0	\$8,000	\$8,000
2036	\$0	\$8,000	\$8,000
2037	\$0	\$8,000	\$8,000
2038	\$0	\$8,000	\$8,000
2039	\$0	\$8,000	\$8,000
2040	\$0	\$8,000	\$8,000
2041	(\$1,281,949)	\$8,000	(\$1,273,949)
Total	\$ 28,211,135.00	\$ 146,000.00	\$ 28,357,135.00
Discounted Total	\$26,009,252	\$62,614	\$26,071,866

Table 4: BCA Travel Time Savings Summary

Travel Time Savings			
Base Time Savings	Load Rating Time Savings	Congestion Time Savings	Closure Time Savings
\$0	\$0	\$0	\$0
\$0	\$0	\$0	\$0
\$0	\$0	\$0	\$0
\$243,892	\$463,462	\$266,649	\$0
\$16,990	\$475,252	\$273,433	\$0
\$33,979	\$487,043	\$280,216	\$0
\$50,969	\$498,833	\$287,000	\$0
\$67,959	\$510,624	\$293,783	\$0
\$84,948	\$522,414	\$300,567	\$0
\$101,938	\$534,205	\$307,351	\$0
\$118,928	\$545,995	\$314,134	\$0
\$135,917	\$557,785	\$320,918	\$0
\$152,907	\$569,576	\$327,701	\$0
\$169,897	\$581,366	\$334,485	\$0
\$186,886	\$593,157	\$341,268	\$0
\$203,876	\$604,947	\$348,052	\$0
\$220,866	\$616,738	\$354,836	\$0
\$237,855	\$628,528	\$361,619	\$0
\$254,845	\$640,319	\$368,403	\$0
\$271,835	\$652,109	\$375,186	\$0
\$288,824	\$663,900	\$381,970	\$0
\$305,814	\$675,690	\$388,753	\$0
\$322,804	\$0	\$0	\$11,725,505
\$339,793	\$0	\$0	\$11,971,622
\$3,811,723	\$10,821,944	\$6,226,324	\$23,697,126
\$1,420,958	\$4,931,549	\$2,837,329	\$5,171,977

Table 5: BCA VOC Savings Summary

Vehicle Operating Cost (VOC) Savings			
Base VOC Savings	Load Rating VOC Savings	Congestion VOC Savings	Closure VOC Savings
\$0	\$0	\$0	\$0
\$0	\$0	\$0	\$0
\$0	\$0	\$0	\$0
\$0	\$972,754	\$559,667	\$0
\$0	\$997,501	\$573,905	\$0
\$0	\$1,022,248	\$588,142	\$0
\$0	\$1,046,995	\$602,380	\$0
\$0	\$1,071,741	\$616,618	\$0
\$0	\$1,096,488	\$630,856	\$0
\$0	\$1,121,235	\$645,094	\$0
\$0	\$1,145,982	\$659,332	\$0
\$0	\$1,170,729	\$673,570	\$0
\$0	\$1,195,476	\$687,808	\$0
\$0	\$1,220,223	\$702,046	\$0
\$0	\$1,244,970	\$716,284	\$0
\$0	\$1,269,717	\$730,522	\$0
\$0	\$1,294,464	\$744,760	\$0
\$0	\$1,319,210	\$758,998	\$0
\$0	\$1,343,957	\$773,236	\$0
\$0	\$1,368,704	\$787,474	\$0
\$0	\$1,393,451	\$801,712	\$0
\$0	\$1,418,198	\$815,950	\$0
\$0	\$0	\$0	\$24,610,515
\$0	\$0	\$0	\$25,127,087
\$0	\$22,714,042	\$13,068,353	\$49,737,602
\$0	\$10,350,766	\$5,955,235	\$10,855,398

Table 6: BCA Environmental, Safety and Total Direct Benefits Summary

Environmental	Safety		
GHG Savings¹	Crash Savings	Total Direct Benefits	Net Direct Benefits
\$0	\$0	\$0	\$0
\$0	\$0	\$0	(\$8,493,084)
\$0	\$0	\$0	(\$21,000,000)
(\$9,237)	\$38,021	\$2,535,208	\$2,529,208
(\$9,710)	\$38,769	\$2,366,139	\$2,360,139
(\$10,182)	\$39,516	\$2,440,962	\$2,434,962
(\$10,655)	\$40,264	\$2,515,786	\$2,509,786
(\$11,128)	\$41,011	\$2,590,609	\$2,584,609
(\$11,600)	\$41,759	\$2,665,432	\$2,659,432
(\$12,073)	\$42,506	\$2,740,256	\$2,734,256
(\$12,546)	\$43,254	\$2,815,079	\$2,809,079
(\$13,019)	\$44,002	\$2,889,903	\$2,883,903
(\$13,491)	\$44,749	\$2,964,726	\$2,958,726
(\$13,964)	\$45,497	\$3,039,549	\$3,033,549
(\$14,437)	\$46,244	\$3,114,373	\$3,106,373
(\$14,909)	\$46,992	\$3,189,196	\$3,181,196
(\$15,382)	\$47,739	\$3,264,020	\$3,256,020
(\$15,855)	\$48,487	\$3,338,843	\$3,330,843
(\$16,327)	\$49,234	\$3,413,666	\$3,405,666
(\$16,800)	\$49,982	\$3,488,490	\$3,480,490
(\$17,273)	\$50,729	\$3,563,313	\$3,555,313
(\$17,745)	\$51,477	\$3,638,137	\$3,630,137
(\$18,218)	\$52,224	\$36,692,829	\$36,684,829
(\$18,691)	\$52,972	\$37,472,783	\$38,746,732
(\$293,242)	\$955,428	\$130,739,299	\$102,382,164
(\$121,416)	\$413,601	\$41,815,398	\$15,743,531.98