Roosevelt Memorial Bridge Investment Project

Bryan and Marshall Counties, Oklahoma

Benefit Cost Analysis

Technical Memo

August 2023

OKLAHOMA Transportation

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Benefit-Cost Analysis

Executive Summary

The Benefit-Cost Analysis (BCA) for the Roosevelt Memorial Bridge Investment Project application compares the costs and benefits of the proposed Project. To the extent possible, expected benefits were monetized. A qualitative discussion is presented for benefits that are more difficult to quantify.

The Oklahoma Department of Transportation (ODOT) proposes to construct a new multimodal bridge across Lake Texoma. Specific improvements planned as part of the project include:

- Construction of a new four-lane bridge with standard shoulders and bicycle/pedestrian accommodations carrying US-70 over Lake Texoma.
- Widening US-70 between State Park Road and Willow Springs Road to a five-lane section (two driving lanes in each direction and a center turn lane) to provide continuity with the sections to the east and west.
- Providing safety features such as lighting, median barrier, and rumble strips, turn lanes where needed at intersections, and a traffic signal and crosswalk at the State Park Road intersection to accommodate traffic from adjacent development.

Table 1 below summarizes the changes expected from the project, and the associated quantified benefits. The period of analysis used in the estimation of benefits and costs is 22 years, including two years of construction, and 20 years of operations[1]. Total project development and construction costs (undiscounted) are estimated at $214.4 million in 2021 dollars. For this BCA, cost estimates were de-escalated or escalated to 2021 dollars depending upon the year the cost estimate was completed using the GDP deflator, per USDOT BCA Guideline requirements.

All relevant data and calculations used to derive the benefits and costs of the project are shown in the BCA model that accompanies this grant application. Based on the analysis presented in the rest of this document, the Project is expected to generate $336.5 million in discounted benefits, $155.0 million in discounted capital costs, and generate $6.8 million in discounted maintenance savings, using a 7 percent real discount rate[2]. Therefore, the Project is expected to generate a Net Present Value of $188.4 million and a Benefit/Cost Ratio of 2.27 as shown below in **Table 2** and **Figure 1**.

[1] Sensitivity analysis also considered an evaluation period with 30 years of Project operations. The results of this analysis (for Project NPV and BC ratio) are reported in the BCA Sensitivity Analysis section while the BCA spreadsheet model submitted with this application contains full results.

[2] All benefits, costs and savings are discounted at 7%, except for CO2 which was discounted at 3% per USDOT BCA Guidelines

Table 1: Summary of Monetized Benefits

Baseline Status and Problems to be Addressed	Change to Baseline	Types of Impacts & Benefits	Population Affected by Impacts	Benefit Value (2021 $ millions, 7% discount)
The existing bridge is functionally obsolete and at-risk of becoming structurally deficient. Without improvement, level of service (LOS) on the bridge would decline to LOS E due to projected traffic growth. The Roosevelt Bridge has a demonstrated history of high collision rates on and near the bridge, particularly severe collisions such as injuries and fatalities. The existing Roosevelt Bridge is narrow and does not provide any pedestrian or bicycle accommodations.	ODOT proposes to construct a new four-lane bridge with standard shoulders and bicycle/pedestrian accommodations carrying US-70 over Lake Texoma, widen US-70 between State Park Road and Willow Springs Road to a five-lane section, and provide turn lanes where needed at intersections, and a traffic signal and crosswalk at the State Park Road intersection to accommodate future traffic demand.	***Impact*** - Enhanced roadway design ***Benefit*** - Improved vehicle safety	Vehicle Owners and Truck Operators	$ 82.94
		Impact - Reduced vehicular delays ***Benefit*** - Reduction in travel times	Vehicle Owners, and Truck Operators	$ 2.63
		Impact - Reduced delays through corridor ***Benefit*** - Reduced vehicle operating costs (fuel reduction)	Vehicle Owners and Truck Operators	$ 0.07
		Impact - Reduced time spent idling during delays ***Benefit*** - Emissions reduction	Vehicle Owners, Truck Operators, and Residents of adjacent communities	$ 0.01
		Impact - Removal of overhead truss structure ***Benefit*** – Elimination of bridge hits	Vehicle Owners, Truck Operators, and ODOT	$ 0.09
		Impact - New bridge ***Benefit*** – Extended residual life of bridge	ODOT	$ 20.84
		Impact - Avoided detours due to structure condition ***Benefit*** - Avoided additional travel time and operating costs	Vehicle Owners and Truck Operators	$ 229.95
Total				**$ 336.51**

Table 2: Summary of BCA Outcomes, Millions of Dollars in 2021

Project Evaluation Metric	Undiscounted	Present Value at 3% Discount Rate	Present Value at 7% Discount Rate
Total Benefits	$1,353.2	$728.4	$336.5
Total O&M (Cost) / Savings	$10.8	$8.9	$6.8
Total Capital (Cost) / Savings	$(214.4)	$(185.9)	$(155.0)
Net Present Value (NPV)	$1,149.6	$551.3	$188.4
Benefit / Cost Ratio	6.65	4.11	2.27
Internal Rate of Return	13.2%		

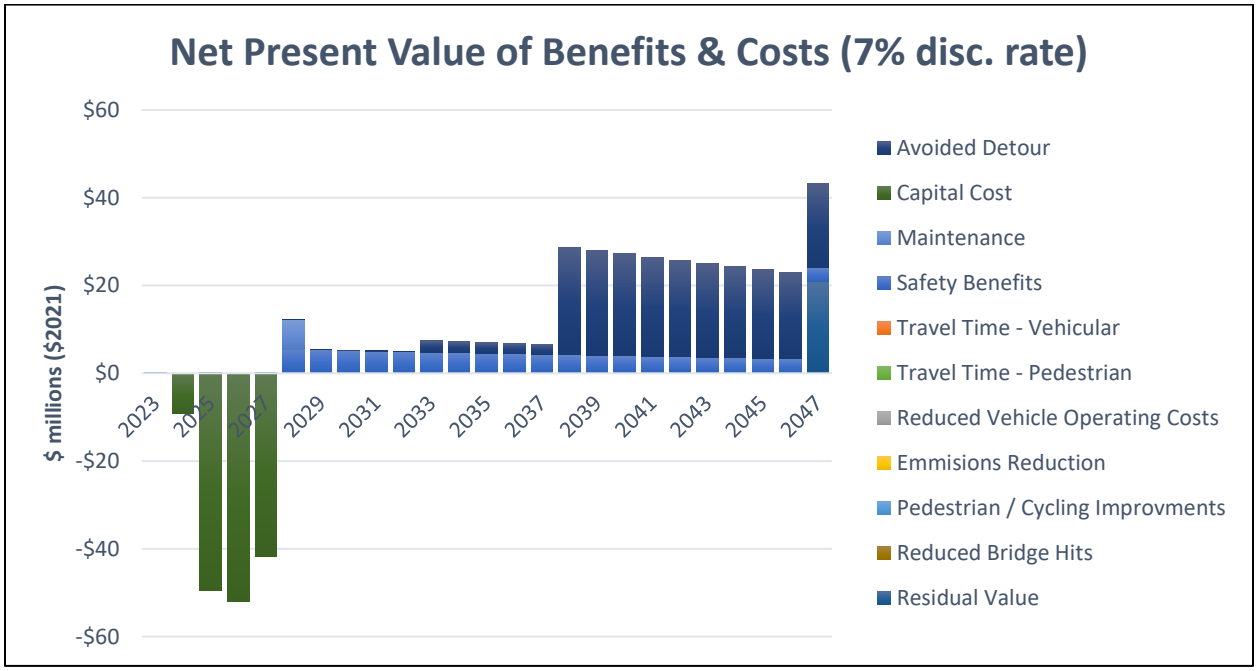

Figure 1: Net Present Value of Benefits and Costs (7% Discount Rate)

In addition to the monetized benefits, the project is expected to generate benefits that are more difficult to quantify. A brief description of those benefits is provided below. More detail is presented in the **Outcome Criteria** section of this application.

- **Equity, Multimodal Options, and Quality of Life:** The Roosevelt Bridge Project will improve the quality of life for local and regional users. As a critical east-west link, the Roosevelt Bridge provides one of only two crossings of Lake Texoma within the 30 miles between Tishomingo, OK and Denison, TX. Improving the bridge to provide a safe, multimodal crossing with sufficient capacity to meet current and future demand will improve mobility for all users for future generations. Reliability will be improved with increased capacity providing improved traffic flow, as well as additional bridge width to provide a safer facility, allow collisions to be cleared more quickly, and provide emergency responders

better access. The Project will provide accommodation for pedestrians and bicyclists where none exist today. A new multimodal crossing of Lake Texoma would offer opportunity to all sectors of the population. Given the location of Lake Texoma within a Historically Disadvantaged Community, providing bicycle and pedestrian accommodations on the bridge would increase mobility options for local underserved communities. While pedestrian and bicycle travel time savings can potentially be quantified, without sufficient data on existing pedestrian and bicycle trips this benefit was not monetized in this application.

- **Economic Impacts, Freight Movement, and Job Creation**: The existing Roosevelt Bridge currently carries 8,500 vpd with 9% trucks. This number is expected to increase to 27,300 vpd by 2050. Without improvements, LOS on US-70 is anticipated to worsen to LOS E by 2050 and result in significant congestion. The additional two lanes planned as part of the Roosevelt Bridge Project will improve safety and Level of Service on the bridge to LOS B, and remove a bottleneck created by the existing two-lane facility.

  The existing Roosevelt Bridge does not have sufficient capacity to accommodate the anticipated traffic demand. US-70 is an important link on the National Highway System (NHS) and provides critical east-west connectivity across southern Oklahoma, linking major freight routes such as I-35, US-69, and US-75. The City of Ardmore at I-35 and US-70 is the home of several large distribution centers including DOT Foods, Dollar General and Best Buy. Congestion on I-35 is well documented and is the subject of a major new study recently initiated by ODOT. As congestion worsens on I-35, US-70 to US-69 becomes a more attractive route for the freight supply chain to the Dallas Metroplex.

  In addition to improving freight mobility, the Project will enhance recreational and tourism opportunities by providing direct access to Federal land and a State Park. US-70 provides direct access to Lake Texoma State Park and multiple federal recreational areas surrounding Lake Texoma that are owned and managed by the USACE. Improving the Roosevelt Bridge and providing an adequate Level of Service will enhance recreational and tourism opportunities offered by these areas. Without improvement, future congestion on US-70 or detours would discourage (or eliminate) traffic from reaching Johnson Creek Public Use Area, Lake Texoma State Park, Chickasaw Nation casino, and Pointe Vista development.

- **Innovation Areas: Technology, Project Delivery, and Financing**

  Innovative Technology: ODOT commits to providing 3D computer models of the project as part of the contracting process. This technology will allow contractors to utilize the most recent GPS controlled equipment with Automated Machine Guidance in the construction process.

  Accelerated Bridge Construction (ABC): ODOT has considered ABC techniques under the assumption that a new bridge will be constructed to carry US-70 over Lake Texoma. The use of ABC techniques has the potential to shorten construction time, reduce construction costs, reduce traffic impacts, improve worker safety and improve the quality control of materials.

  Progressive Design Build (PDB): ODOT intends to deliver the Roosevelt Bridge Project as the state's first PDB project. The complexity of the US-70 over Lake Texoma Bridge has many features that would benefit from early owner and contractor collaboration. PDB

allows the owner and design-builder to collaborate at the earliest stages of the project development.

Introduction and Methodology

This document provides detailed technical information on the benefit-cost analysis (BCA) conducted in support of the grant application for the Project. The BCA includes the monetized benefits and costs measured using USDOT guidance, as well as the quantitative and qualitative merits of the project. A BCA provides estimates of the benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. Costs include both the resources required to develop the project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms.

While a BCA is just one of many tools that can be used in making decisions about infrastructure investments, it provides a useful benchmark from which to evaluate and compare potential transportation investments. The specific methodology adopted for this application is based on the BCA guidance developed by USDOT[3] and is consistent with the MPDG program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios,
- Assessing benefits with respect to project requirements listed in the MPDG Notice of Funding Opportunity (NOFO) document,
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement,
- Using USDOT guidance for the valuation of travel time savings, and safety benefits, while relying on industry best practices for the valuation of other effects,
- Discounting future benefits and costs with the real discount rate recommended by USDOT (7 percent, except for carbon dioxide, which is discounted at 3 percent, per USDOT BCA Guidelines), and
- Conducting a sensitivity analysis to assess the impacts of changes in key input assumptions.

Project Overview

The proposed Project will construct a new multimodal bridge across Lake Texoma. The existing Roosevelt Bridge carries US-70 over Lake Texoma and provides a critical east-west connection across southern Oklahoma (**Figure 2**). The bridge is 4,943 feet long and carries two traffic lanes, one in each direction, on a 24-foot-wide deck with no shoulders. The bridge was constructed in 1942 and is composed of 87 spans, including a 250-foot-long Warren through-truss, and is eligible for inclusion in the National Register of Historic Places (NRHP). The bridge is functionally obsolete and at-risk of becoming structurally deficient. The bridge currently carries 8,500 vpd.

[3] USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023 Revised

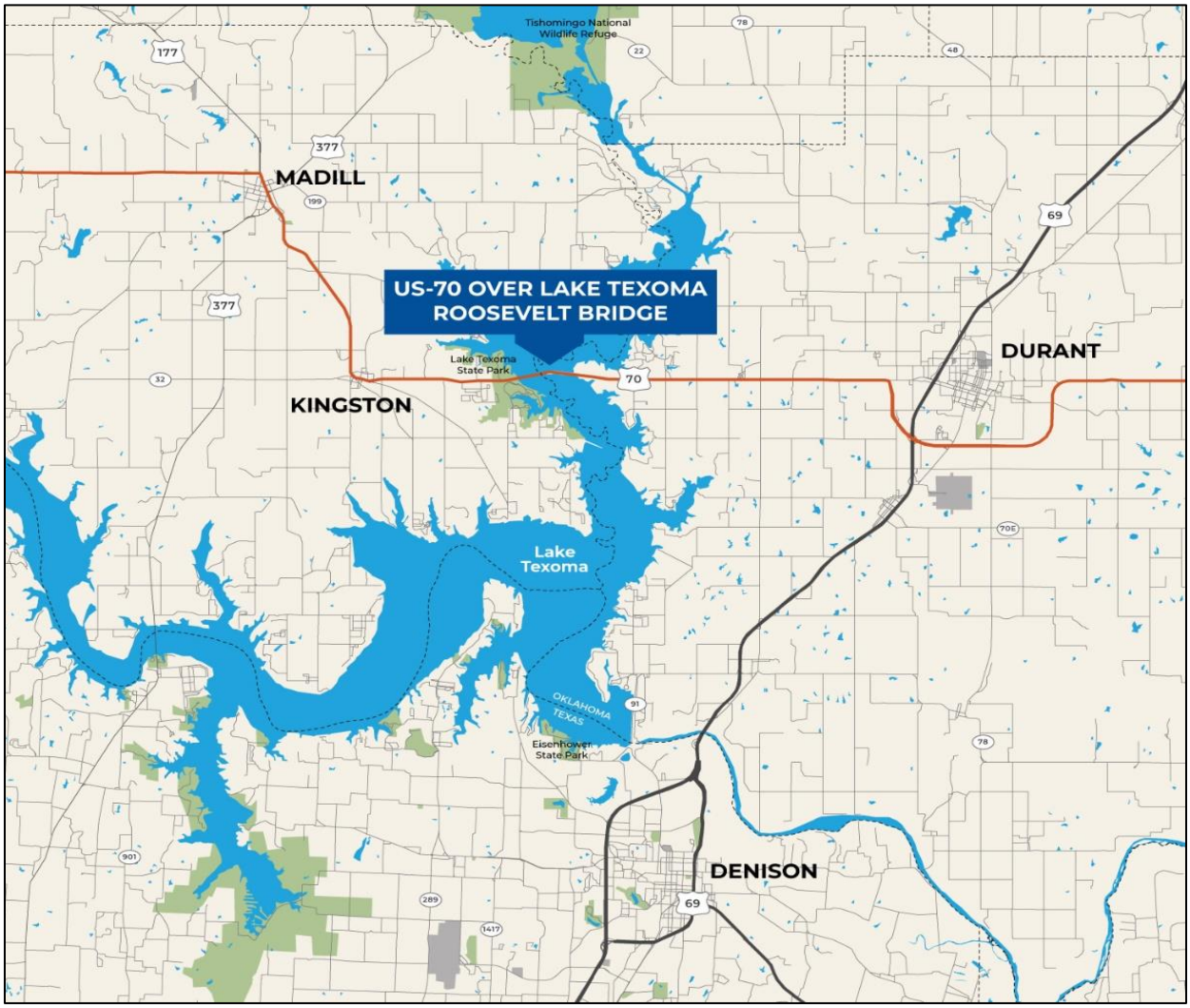

Figure 2: Roosevelt Bridge Location Map

With major development underway, future traffic volumes are anticipated to exceed 27,000 vpd by 2050.

The Project will significantly reduce fatalities and serious injuries, improve the efficiency and reliability of the movement of people and freight, increase resiliency to severe weather events, and provide affordable transportation options to a Historically Disadvantaged Community and Area of Persistent Poverty through accommodations for bicycles and pedestrians. More detail about the Project's safety, state of good repair, economic, resiliency, and equity/quality of life outcomes are presented in this application.

Specific improvements planned as part of the project include:

- Construction of a new four-lane bridge with standard shoulders and bicycle/pedestrian accommodations carrying US-70 traffic over Lake Texoma.

- Widen US-70 between State Park Road and Willow Springs Road to a five-lane section (two driving lanes in each direction and center turn lane) to provide continuity with the sections to the east and west.
- Provide safety features such as lighting, median, barrier, and rumble strips, turn lanes where needed at intersections, and a traffic signal and crosswalk at the State Park Road intersection to accommodate traffic from adjacent development.

Base Case and Alternative

The Base Case for the Project is defined as the "No Build" scenario. This scenario reflects no capital improvements within the project limits but would require certain maintenance and rehabilitation costs over the analysis period.

The Alternative Case is defined as the Build scenario as described in the Project Description section above.

Types of Impacts

The proposed Project is expected to have the following impacts:

- Reduction in travel times for automobiles and trucks from faster travel times and reduced delays,
- Reduction in vehicle operating costs due to reduced fuel used during delays,
- Reduction in expected number of crashes due to a wider bridge with standard shoulders and other safety enhancements including shoulder rumble strips, lighting, and median barrier.
- Improved pedestrian access as well as comfort and safety due to new pedestrian and bicycle accommodations,
- Reduction in emissions due to reduced travel distances, faster driving speeds, and reduced time spent idling during delays,
- Reduced potential damages from bridge hits, and
- Increased useful life of the US-70 bridge.

Project Cost and Schedule – Alternative Case

Total project capital development and construction costs are estimated at $251.0 million based on the year that each cost estimate (construction, utilities, right-of-way, and design) was developed. For this BCA, these costs were adjusted to 2021 dollars using a GDP deflator[4]. The adjusted project development and construction cost amounts then to $214.4 million in 2021 undiscounted dollars and $155.0 million discounted at 7 percent. Project construction is anticipated to start in 2025 and take three years with completion by early 2028. For simplicity, 2028 is assumed as the Project opening year and first year of Project-related benefits.

[4] The adjustment applied a factor to costs in 2018, 2022 and 2023 dollars using the GDP deflator for each of the years that were 1.08, 0.90, and 0.85, respectively (Office of Management and Budget of the White House, Table 10.1, https://www.whitehouse.gov/omb/historical-tables/) (accessed Feb 16, 2023).

The Project will require maintenance during the 20-year operating period that is estimated at $812,589 (2021 dollars). Maintenance costs include the following in 2021 dollars:

- Inspections (2-year frequency) - $17,078
- Other miscellaneous repairs (20-year frequency) - $658,891

Project Cost – Base Case

The Base Case (No Build) assumes no capital development or construction. However, the Base Case would require major maintenance and rehabilitation over the next 20 years. Maintenance costs include the following in 2021 dollars:

- Annual inspections (1-year frequency) - $42,694
- Deck replacement (25-year frequency beginning in 5 years) - $7,280,718
- Painting steel (20-year frequency beginning in 5 years) - $3,464,011
- Other miscellaneous repairs (20-year frequency beginning in 5 years) - $346,401

In 2021 dollars, the total major maintenance rehabilitation costs required are estimated at about $10.8 million undiscounted and $6.8 million discounted at 7 percent.

While the Alternative Case has maintenance costs associated with the project lifecycle planning, it is less than what would be incurred under the Base Case when discounted over time. Thus, the Alternative case creates a net savings in maintenance costs. **Table 3** provides a summary of costs.

Table 3: Summary of Project Costs, Millions of Dollars in 2021

Cost Category	Undiscounted	Present Value at 3% Discount Rate	Present Value at 7% Discount Rate
Capital Cost	214.4	185.9	155.0
Maintenance (negative is savings)	-10.8	-8.9	-6.8
Total	**203.6**	**177.1**	**148.1**

Alignment with Selection Criteria

The main benefit categories associated with the project are mapped into the merit criteria set forth by U.S. DOT in **Table 4** below.

Table 4: Benefit Categories of the Project

Criteria	Benefit(s)	Description	Monetized	Qualitative
Safety	Increased vehicle safety	Widened bridge, and addition of shoulders, rumble strips, lighting, and median barrier are expected to reduce collisions and fatalities.	Yes	Yes
	Added pedestrian and bicycle comfort and safety	The new pedestrian and bicycle accommodations will provide a safe environment for pedestrian and bicyclists	No	Yes

Criteria	Benefit(s)	Description	Monetized	Qualitative
State of Good Repair	Reduced O&M Cost	Bridge replacement will reduce O&M	Yes	Yes
	Residual Value	Useful life of interchange will be extended	Yes	Yes
	Reduced bridge hits / damages	The new vertical clearance of the proposed bridges is expected to reduce bridge hits	Yes	Yes
	Detour avoidance	Bridge replacement will avoid costly detours when the bridge is load posted and eventually closed	Yes	Yes
Economic Impacts, Freight Movement, and Job Creation	Contribution to local economic development and growth	Increased access to adjacent development will increase economic impact of mixed used real estate	No	Yes
	Travel time savings	Travel time reliability will increase the efficiency and movement of the goods and people surrounding the project.	Yes	Yes
	Access to federal recreational facilities	Increased safety and mobility will provide enhanced access to adjacent federal recreational lands.	No	No
Climate Change, Resiliency, and the Environment	Emissions reduction	The widened bridge and improved intersections are expected to reduce congestion and travel times which would reduce the amount of idling time	Yes	Yes
	Flood Resiliency	The raise in elevation of the bridge will reduce future bridge closures and detour delay	Yes	Yes
Equity, Multimodal Options, and Quality of Life	Pedestrian and bicycle accommodation	The new pedestrian and bicycle accommodations will provide a safe environment for pedestrian and bicyclists to access for park users	No	Yes
Innovation Areas: Technology, Project Delivery, and Financing	Use of New Technologies	The use of 3D models, GPS controlled equipment, and E-construction methods will be utilized in the implementation of this project.	No	Yes
	Accelerated Bridge Construction	ABCs have the potential to shorten construction time.	No	Yes

Criteria	Benefit(s)	Description	Monetized	Qualitative
	Progressive Design Build	The Project would be ODOT's first Project Design Build Project.	No	Yes

General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction and including 20 years of operations. The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices, costs, and benefits are expressed in 2021 dollars.
- The period of analysis begins in 2028 and ends in 2047. The project includes four years of project development and three years of construction in 2025 - 2028 prior to the 20-year analysis period (2028 – 2047).
- A constant 7 percent real discount rate is assumed throughout the period of analysis, except for benefits impacts related to CO_2 greenhouse (GHG) emissions which are discounted at a 3 percent real discount rate.
- Opening year demand and benefits are inputs to the BCA and are assumed to be fully realized after construction is finished and project starts operations in 2028 (no ramp-up).

Delay Forecasts

The delay forecast is a critical component of the BCA as multiple benefits depend on the vehicle delays using the Project area roads under No-Build and Build scenarios. Travel time savings for vehicles, emission reductions, and vehicle operating costs are all directly correlated with delay. Current and future delays were established for vehicular traffic as shown below in **Table 5**. While travel time benefits to pedestrian and cyclist travel times are anticipated, these were not monetized due to lack of current pedestrian/cyclist use of the bridge and an unknown number of future users.

Table 5: Vehicle Hours of Delay, 2021 and 2050

Synchro Analysis: Total Vehicle-Hours per Day	2021		2050	
	AM	PM	AM	PM
Existing	5.6	5.6	48.9	182.5
Proposed	3.4	3.6	37.5	133.0
Benefit	2.2	2.0	11.4	49.5

Source: ODOT Design Traffic Data and Synchro Analysis

Benefits

This section describes the measurement approach used for each quantifiable benefit or impact category identified in **Table 4** and provides an overview of the methodologies and assumptions. A summary of all benefits is presented in **Table 7**.

Table 7: Summary of Benefits, Millions of Dollars in 2021

Project Evaluation Metric	Undiscounted	Present Value at 3% Discount Rate	Present Value at 7% Discount Rate
Safety Benefits	256.8	153.8	82.9
Travel Time - Vehicular	8.4	5.0	2.6
Reduced Vehicle Operating Costs	0.2	0.1	0.1
Emissions Reduction*	0.0	0.0	0.0
Reduced Bridge Hits	0.3	0.2	0.1
Residual Value	121.0	56.1	20.8
Avoided Detour	966.4	513.1	230.0
Present Value of Benefit (Cost)	**1353.2**	**728.4**	**336.5**

*Benefits are less than 0.1 million but are positive

Safety Benefits

Quantified safety benefits include reduction in expected number of crashes through safety enhancements including widening from 2-lanes to 4-lanes, shoulder rumble strips, lighting, and median barrier. Using a Crash Modification Factor (CMF) approach, the project provides a CMF of 0.44[5]. This rate is expected to reduce total crashes during the analysis period from 472 total crashes (including 33 fatalities) to 208 total crashes (including 15 fatalities) under the Build alternative. The assumptions used in the estimation of safety benefits are summarized in **Table 8** below.

[5] CMF derived from combination of several countermeasures, including widening from 2 to 4 lanes (53% reduction), shoulder rumble strips (13-51% reduction), lighting (28% nighttime reduction), and median barrier (43% reduction). The countermeasures are multiplicative when added to calculate the overall crash reduction percentage.

Table 8: Safety Assumptions

Variable	Unit	Value
Property Damage Only	Incidents/year	7.20
Possible Injury	Incidents/year	1.20
Non-Incapacitating Injury	Incidents/year	1.80
Incapacitating Injury	Incidents/year	0.40
Fatality	Incidents/year	0.80
Base Year	year	2020.00
Property Damage Only	$/incident	$4,800.00
Possible Injury	$/incident	$78,500.00
Non-Incapacitating Injury	$/incident	$153,700.00
Incapacitating Injury	$/incident	$564,300.00
Fatality	$/incident	$13,046,800.00
Crash Modification Factor - Utilized	factor	0.44

Source: ODOT Collision Data, 2016-2020 and USDOT BCA Guidance for Discretionary Grant Programs

Travel Time Savings

The vehicle delays under the No-Build scenario, as shown in **Table 5**, amount to 11.2 vehicle hours of delay per day in 2021 and are forecast to increase to 208.6 vehicle hours of delay per day by 2047. The Project would reduce delays to 7.0 vehicle hours of delay per day in 2021 and 153.6 vehicle hours of delay per day in 2047, thus creating a savings of 4.2 and 55 vehicle hours per day in 2021 and 2047, respectively. The assumptions used in the estimation travel time savings for vehicles are summarized in **Table 9** below.

Table 9: Travel Time Saving Assumptions - Vehicles

Variable	Unit	Value
All Purposes	$/person/hr	$18.80
Passenger Vehicles All Travel	per/veh	1.67
Heavy Vehicle Occupancy	per/veh	1

Source: USDOT BCA Guidance for Discretionary Grant Programs

Reduced Vehicle Operating Costs

While the Project will not reduce total vehicle miles traveled, it will reduce total vehicle delay, which in turn reduces fuel consumption. The SYNCHRO analysis provided total fuel consumption (gallons/day). Total gallons were monetized[6] with calculations provided within the BCA model. The total value of reduced vehicle operating cost through reduced fuel consumption equates to $0.07 million, discounted at 7%. **Table 10** summarizes these benefits.

[6] Based on values provided by Energy Information Administration: Energy Outlook, March 2022

Table 10: Estimated Fuel Consumption Savings (gal.), 2021 and 2049

Synchro Analysis: Fuel Consumption (gal.)	2021		2050	
	AM	PM	AM	PM
Existing	122	136	412	547
Proposed	122	136	410	530
Benefit	0	0.0	2	17

Source: ODOT Design Traffic Data, Synchro Modeling

Emissions Reduction

Similar to reduced vehicle operating costs, all emissions reductions will be achieved by the Project through reduced delay since total vehicle miles remain unchanged. The Project's added capacity reduces the time vehicles are idling due to delays. The SYNCHRO analysis provided total kilogram (kg) of emissions per day for carbon dioxide (CO_2), nitrogen oxide (NO_X) and volatile organic compounds (VOC); however, only CO_2 and NO_X were monetized for the BCA. Total emissions are shown in **Table 11** below.

Table 11: Anticipated Emissions Reduction

Emissions (kg)	2021				2050			
	AM		PM		AM		PM	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
CO_2	8.5	8.5	9.51	9.47	28.8	28.6	38.2	37
NO_X	1.65	1.65	1.85	1.84	5.6	5.6	7.4	7.2
VOC	1.97	1.97	2.21	2.2	6.7	6.6	8.9	8.6

Source: ODOT Design Traffic Data, Synchro Modeling

The benefit associated with emissions reductions is positive albeit negligible and totals to $5,303 discounted at 7%, except for CO_2 which was discounted at 3% per USDOT BCA Guidelines.

Reduced Bridge Hits

The Project will replace the existing bridge structure that has a truss span with insufficient vertical clearance and is more subject to vehicle hits. The Project would construct a new bridge without the truss span, eliminating the potential for a vehicle hit.

Based on historical data on past bridge hits on the truss span, the Project would eliminate the risk of bridge hits which translates to a benefit of $88,240 discounted at 7% (**Table 12**).

Table 12: Bridge Hit Reduction

Variable	Unit	Value
Number of Bridge Hits	count	3
Period of Bridge Hits Analyzed	years	18
Probability of Bridge Hit	incidents / Period	300.00%
Probability of Bridge Hit	incidents / year	16.67%
Bridge Replacement Cost	$	Full replacement cost not considered
Average bridge damage per hit	$	$ 75,000
Total cost of bridge hit	$/incident	$ 75,000

Source: ODOT

Residual Value

The residual value of project assets was calculated assuming a straight-line depreciation and a design life of 75 years for the bridge structure. No other project components were assumed to have any remaining useful life at the end of the analysis period. Under the No Build scenario, the existing bridges would not have any remaining useful life in 2047. The residual value was added to project benefits in the last year of the analysis period, 2047. Related assumptions are provided in **Table 13** below.

Table 13: Residual Value

Variable	Unit	Value
Residual Cost (Project Structure Cost)	$	$ 165,000,000
Useful Life (Project Structure)	Years	75
Existing Asset Useful Value	$	$ -

Source: ODOT

Based on the assumptions provided in **Table 15** above, the residual value translates to a benefit of $20.8 million discounted at 7%.

Avoided Detours

The avoided detours benefit was calculated to estimate the benefit of eliminating future detours due to flood events and structural degradation. The closest detour to cross Lake Texoma is to use Route 199 to the north.

The estimate of when the existing bridge would require load posting and ultimately closure under a no-build scenario is based on known condition and engineering judgement. According to the ODOT State Bridge Engineer, it is likely the existing bridge will require posting within 5 years. However, to be conservative, 10 years was used in this analysis for posting, and 15 years to closure. Based on the assumptions provided in **Table 14** below, the Project would eliminate future detours which translates to a benefit of $230.0 million discounted at 7%.

Table 14: Avoided Detour Assumptions

Variable	Unit	Value
Base Detour Year	Year	2023
Truck Detour - Years from Base Detour Year until load restrictions	Years	10
Total Detour - Years from Base Detour Year until bridge closes	Years	15
Flood Event - Frequency of Detours	Years	15
Flood Event - Duration	Days	7
Additional duration from Detour (Detour - Existing)	mins	24
Detour Length	Miles	20.9

Source: ODOT

As shown in **Figure 3**, a closure of the Roosevelt Bridge would result in a detour of approximately 40.5 miles (red route). For the purposes of determining a detour distance, it is assumed the majority of the traffic is travelling a distance at minimum of 19.6 miles between Kingston and Durant (green route), creating a 20.9-mile detour.

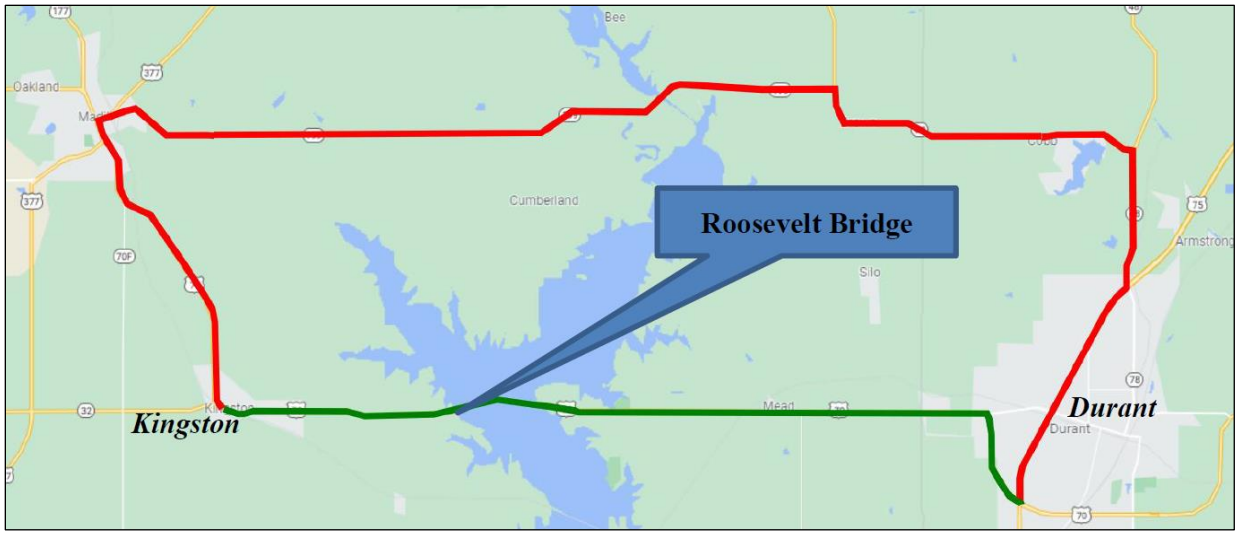

Figure 3: Roosevelt Bridge Detour

The impact of detours related to structural degradation assumed the bridge would be load posted in 2033 and trucks would be forced to use the detour, while a full closure would occur by 2038. Flood events, based on the assumptions in **Table 14** are not accounted for once the detour related to structural degradation is place. Additional sensitivities are included for this variable to the significance of its benefit.

BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on many assumptions and long-term projections, both of which are subject to considerable uncertainty. The primary purpose of the sensitivity analysis is to help identify the "critical variables"—the variables and model parameters whose variations have the greatest impact on the BCA outcomes.

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables—how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable, and
- Assess the robustness of the BCA and evaluate whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The sensitivity analysis was conducted with respect to changes in the detour assumptions, value of CMF, capital cost, as well as years of operations included in Project BCA analysis. The outcomes of the analysis are summarized in **Table 16** below. The table provides the percentage changes in project NPV associated with variations in variables or parameters.

Table 16: BCA Sensitivity Analysis

Parameters	Change in Parameter Value	New NPV	% Change in NPV	New B/C Ratio
Future Detour Timing	5 Years Earlier	$323.27	71.6%	3.18
	5 Years Later	$70.83	-62.4%	1.48
CMF	20% Reduction	$201.40	6.9%	2.36
	20% Increase	$175.34	-6.9%	2.18
Capital Cost	20% Reduction	$215.20	14.2%	2.77
	20% Increase	$161.54	-14.2%	1.92
Analysis Period	30 Year Analysis Period	$342.04	81.6%	3.28

The table demonstrates that under the alternative parameter values that may depress Project NPV, the Project maintains NPV above zero and BC Ratio of 1.48 or higher. When the number of years of Project operations is increased from 20 to 30, Project NPV increases by 81.6 percent to $342.04 million and the BC ratio increases to 3.28.