Benefit-Cost Analysis Supplementary Documentation

BUILD Grant Program

US-281 Bridgeport Bridge over Canadian River

Oklahoma Department of Transportation

May 18, 2020

TABLE OF CONTENTS

List of Tables

Benefit-Cost Analysis Supplementary Documentation

1. Executive Summary

The Benefit-Cost Analysis conducted for this grant application compares the costs associated with the proposed investment to the benefits of the project. To the extent possible, benefits have been monetized. A qualitative discussion is also provided when a benefit is anticipated to be generated but is not easily monetized or quantified.

The project for which this BUILD grant is requested is the replacement of the Bridgeport Bridge located on route US-281 spanning the Canadian River in Caddo and Canadian Counties, Oklahoma, referred to as US-281 Bridgeport Bridge over Canadian River project.

The bridge was constructed in 1933 and is listed in the National Register of Historic Places both individually and as part of a listed segment of historic Route 66. It is a key feature of the Oklahoma Route 66 National Scenic Byway, and together with the adjacent roadway segments forms iconic historic features integral to the regional tourism economy.

Currently the US-281 Bridgeport Bridge is 24 feet wide with 2 lanes of undivided traffic. The bridge is in poor condition and is rated as structurally deficient. The bridge has been load posted to heavy traffic for some time now, and in October 2018, the load restrictions were further increased from 15 tons to 9 tons after cracks were discovered. It is anticipated that if no action is taken, the bridge will be closed permanently to all traffic beginning in January 2021 and all traffic will have to take a detour route requiring additional travel of about 11.5 miles.

The proposed Project will replace the existing 2-lane bridge on the same alignment with a new structure that is slightly wider (28 feet compared to the current 24 feet). The original truss structures will be attached to the outside of the new bridge to retain its historic aesthetic and character.

A table summarizing the changes expected from the project, and the associated quantified benefits, is provided below.

Table ES- 1. Summary of Project Infrastructure Improvements and Associated Quantified Benefits

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternatives	Type of Impacts	Population Affected by Impacts	Economic Benefit/Impact	Summary of Results
Bridgeport Bridge over the Canadian River is one of the most historically significant bridges in Oklahoma and a key feature of the Oklahoma Route 66 National Scenic Byway. Currently Bridgeport Bridge is a 2-lane undivided bridge assessed as structurally deficient. If no action is taken, the bridge will be closed permanently to all traffic in January 2021. All travelers will be forced to take a lengthy detour.	Full bridge replacement, a new structure along the same alignment; slightly wider structure with original trusses on the outside of the structure for aesthetics.	Safety: reduction in number of crashes due to avoidance of traffic detours and improved bridge geometry	Auto Users, Truck Operators, Tourists driving down Route 66	Reductions in fatalities, injuries, and property losses, reduction in accident costs on highway segment.	$17.7 million in accident cost savings to auto users and truck operators.
		Economic Competitiveness: impact on travel times due to avoidance of traffic detours	Auto Users, Truck Operators, Tourists driving down Route 66	Travel time savings to highway users.	$30.0 million in travel time savings to auto users.
		Economic Competitiveness: impacts on vehicle operating costs due to avoidance of detours.	Auto Users, Truck Operators, Tourists driving down Route 66	Vehicle operating cost impacts to highway users.	$29.3 million in vehicle operating costs
		Environmental Sustainability: impacts on vehicle emissions due to avoidance of traffic detours	Citizens of Canadian and Caddo Counties	Vehicle emissions cost savings.	$0.2 million in vehicle emission
		Agency Cost Savings / State of Good Repair	ODOT, Oklahoma residents	Agency Cost Saving	$1.1 million in agency cost saving

Note: All monetary values in the table above are in millions of 2018 discounted using a real discount rate of 7 percent.

The period of analysis used in the estimation of benefits and costs is 35 years, including about 5 years of project development and construction and 30 years of operation. Total project development and construction costs are estimated at $36.4 million in 2020 dollars. For the purpose of this BCA, the costs were de-escalated to 2018 dollars using the GDP deflator. The total (undiscounted) project costs are estimated $35.0 million, and operations and maintenance are $13.3 million.

All relevant data and calculations used to derive the benefits and costs of the project are shown in the BCA model that accompany this grant application. Based on the analysis presented in the rest of this document, the project is expected to generate $78.4 million in discounted benefits, $27.9 million in discounted capital costs, and $2.2 million in discounted operations and maintenance costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $48.3 million and a Benefit/Cost Ratio of 2.73 as shown below in Table ES- 2

Table ES- 2: Summary of BCA Outcomes, in Millions of Dollars of 2018*

Project Evaluation Metric	Undiscounted	Present Value at 7% Discount Rate	Present Value at 3% Discount Rate
Total Benefits	$272.0	$78.4	$151.5
Total O&M Costs	$13.3	$2.2	$5.8
Total Costs	$35.0	$27.9	$31.7
Net Present Value	$223.7	$48.3	$114.0
Benefit / Cost Ratio	7.39	2.73	4.60
Internal Rate of Return (%)	19.0%		

**Unless indicated otherwise*

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

<u>Economic Competitiveness</u>

- Contribution to local economic development and growth. The Bridgeport Bridge is a part of the Bridgeport Hill-Hydro Route 66 Segment. The historic bridge is arguably one of the most important elements. By replacing the existing structure, and keeping the historic aesthetics, the bridge will continue supporting the regional tourism economy.

<u>Quality of Life</u>

- Enjoyment of the bridge as a tourist attraction and transportation alternative to I-40. The project will replace the bridge using its original design preserving its historical status as a tourist attraction and Route 66 as a transportation alternative to a busy Interstate.

Construction-related expenditures are also expected to generate economic impacts measured by jobs and business income in the local economies of the Canadian and Caddo Counties and across Oklahoma. Table ES-3 provides the summary results of the economic impact analysis conducted. The table shows that in the Canadian and Caddo Counties, the project is expected to generate a total of 47 jobs, $12.7 million in business output, $2.4 million in employment income, and $6.7 million in value added. The analysis from the entire state of Oklahoma perspective shows that the project is expected to generate a total of 419 jobs, $74.9 million in business output, $20.7 million in employment income, and $38.9 million in value added.

Table ES- 3: Summary of Economic Impact Analysis

Type of Effect	Output, $M	Earnings, $M	Employment (Job-Years)	Value Added, $M
Caddo and Canadian Counties				
Direct	$9.1	$1.7	31	$4.8
Indirect	$2.5	$0.4	8	$1.2
Induced	$1.1	$0.3	8	$0.7
Total	**$12.7**	**$2.4**	**47**	**$6.7**
Oklahoma				
Direct	$36.4	$9.9	180	$19.3
Indirect	$20.8	$5.3	94	$9.6
Induced	$17.6	$5.5	145	$10.1
Total	**$74.9**	**$20.7**	**419**	**$38.9**

Note: All monetary values in this table are in 2020 dollars

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the grant application for the US-281 Bridgeport Bridge over Canadian River project. The remainder of this document is organized as follows.

- Section 3, Methodological Framework, introduces the conceptual framework used in the BCA.
- Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the project is expected to generate.
- Section 5 discusses the general assumptions used in the estimation of project costs and benefits.
- Section 6, Demand Projections, provides estimates of travel demand and traffic growth.
- Section 7, Benefits Measurement, Data and Assumptions, outlines specific data elements and assumptions pertaining to the long-term outcome selection criteria along with associated benefit estimates.
- Section 8, Summary of Findings and BCA Outcomes presents estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics.
- Section 9, BCA Sensitivity Analysis, provides the results of the sensitivity analysis. Note that additional data tables are provided within the BCA model including annual estimates

of benefits and costs to assist the U.S. Department of Transportation (USDOT) in its review of the application.[1]

- Section 10, Economic Impact of the Project, provides the results of the economic impact analysis in terms of jobs and other measures of economic activity generated by construction-related expenditures.

3. Methodological Framework

The BCA conducted for this Project 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.[2]

While BCA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.[3]

The specific methodology adopted for this application is based on the BCA guidance developed by USDOT and is consistent with the BUILD program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits with respect to selection criteria identified in the Notice of Funding Opportunity (NOFO);
- 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, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by USDOT (7 percent, and 3 percent for sensitivity analysis); and
- Conducting a sensitivity analysis to assess the impacts of changes in key input assumptions.

Economic impact analysis is also conducted for this Project to provide additional results regarding the potential contribution of the Project to the local and state economies. This analysis is conducted using an input-output approach and regional input-output multipliers from the Bureau of Economic Analysis (referred to as BEA RIMS II multipliers).

[1] While the models and software themselves do not accompany this appendix, they are provided separately as part of the application.
[2] USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020.
[3] Ibid.

4. Project Overview

4.1 Project Description, Current Conditions and Challenges

The Bridgeport Bridge is located on US-281 route spanning the Canadian River in Caddo County and Canadian County, Oklahoma. The bridge is a historically significant Route 66 structure and a key feature of the Oklahoma Route 66 National Scenic Byway that is integral to the regional tourism economy.

The Route 66 corridor continues to grow in popularity as a nostalgic road trip adventure and is certain to surge in popularity with the upcoming 2026 Centennial. The Bridgeport Bridge is not only an essential historic link, it is also an essential physical link, connecting nearby Route 66 tourist attractions both east and west, from Robert's Grill (since 1926) in El Reno, OK, to the Cherokee Trading post in Calumet, OK. Just west of the bridge is Lucille's Service Station (built in 1929) in Hydro, OK, and the Route 66 Museum down the road in Clinton, OK. Route 66 travelers spend a significant amount of money during their trip contributing to the local economies.

The bridge is currently assessed as structurally deficient and in critical need of replacement. The bridge is already load posted to heavy traffic, and in October 2018, the load restrictions were further increased from 15 tons to 9 tons after cracks were discovered. It is anticipated that if no action is taken, the bridge will be closed to all traffic beginning in January 2021 forcing all traffic to take a lenghty detour of 11.5 miles.

The proposed Project will replace the existing 2-lane bridge on the same alignment with a new structure that is slightly wider (28 feet compared to the current 24 feet). The original truss structures will be attached to the outside of the new bridge to retain its historic aesthetic and character.

The Project will enhance the growing economic potential of Route 66 as a tourist destination by maintaining this historically significant bridge and preserving the route for potential tourist-driven economic development and give the opportunity for tourists to keep enjoying the scenic bridge for years to come.

The Project will also increase efficiency of the movement of people and goods by avoiding bridge closure and lengthy detours and thus improving local transportation connectivity.

4.2 Base Case and Alternative

The Base Case for the Bridgeport Bridge project is defined as the No-Build scenario. The No-Build scenario reflects the continuation of current conditions. The bridge is structurally deficient (rated 5 out of 100), it is already posted for load restrictions (at 9 tons), and it is anticipated that it will be closed to the general traffic at the beginning of 2021. Maintenance will continue after closure with significant costs forecasted for every year.

Bridge closure will force traffic traversing this bridge to use an alternative route which is longer and result in additional travel time, travel costs, vehicle emissions, and road crashes.

The Build scenario assumes that the Bridgeport Bridge will be replaced with a new structure as planned and discussed above, avoiding its permanent closure, traffic detours, and related travel costs.

4.3 Types of Impacts

The replacement of US-281 Bridgeport Bridge will avoid the impeding permanent bridge closure, which would force vehicles currently using the bridge to take an alternative route (i.e. detour) resulting in an increase in vehicle miles of travel and travel costs. Replacement of the deficient bridge can then be expected to generete significant travel time savings benefits to travellers as well as vehicle operating costs and environmental emissions savings. In addition, the project will help avoid costly bridge maintenance that would have to continue even after bridge closure.

In part due to the innovative construction and replacement of the original trusses on the new bridge, the new bridge will continue to be a scenic part of Route 66, helping attract tourists to the area and benefitting the tourism-related industries. In addition, construction-related expenditures will generate jobs in the the Caddo County and Canadian County economies and across Oklahoma.

4.4 Project Cost and Schedule[4]

Total future project development and construction costs are estimated at $35.7 in 2020 dollars. In addition, $688,000 has been incurred to date on various tasks related to project development. For the purpose of this BCA, all costs were de-escalated to 2018 dollars using the GDP deflator.[5] The adjusted cost is $35.0 million in 2018 undiscounted dollars and $27.9 million discounted at 7%. The design process is currently underway and is expected to be completed by the end of 2021. The environmental assessment effort is also underway and anticipated to be completed in January of 2021. Construction will start at the beginning of 2022 and be completed by end of July 2023. Over the project life-cycle, total operations and maintenance (O&M) costs are estimated at $2.2 million discounted at 7%. O&M costs include inspection (every other year), painting (every 10 years), joint repair (after 15 years), and deck replacement in year 30.

Table 1. Summary of Costs, Millions of 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Construction & Development Costs	$35.0	$27.9	$31.7
Operations and Maintenance	$13.3	$2.2	$5.8
Total	**$48.3**	**$30.1**	**$37.5**

[4] All cost estimates in this section are in millions of dollars of 2018, discounted to this year using a 7 percent real discount rate.

[5] The adjustment amounted to dividing 2020 costs by the deflator index of 1.0395 based on the GDP deflator for the years 2018 – 2020 (Office of Management and Budget of the White House, Table 10.1, https://www.whitehouse.gov/omb/historical-tables/)

4.5 Effects on Selection Criteria

The main benefit categories associated with the project are mapped into the selection criteria set forth by USDOT in the Notice of Funding Opportunity in the table below.

Table 2. Benefit Categories and Expected Effects on Selection Criteria

Selection Criteria	Benefit or Impact Categories	Description	Monetized	Qualitative
Safety	Reduction in number of traffic crashes, fatalities and injuries	Reduction in property losses, injuries, and deaths due to reduction in detours/out-of-direction miles traveled.	Yes	
State of Good Repair	Replacement of a structurally deficient bridge	Replacement of a deficient bridge that would be permanently closed under No Build and reduction in maintenance costs.	Yes	Yes
Economic Competitiveness	Reduction in travel times due to avoidance of detours/out-of-direction travel	Travel time savings for roadway users due to avoided detours/out-of-direction travel; this applies to trucks for load-posted bridge and all vehicles for closed bridge.	Yes	
	Impacts on vehicle operating costs due to avoidance of detours/out-of-direction travel	Reduction in monetary costs to drivers due to avoided detours/out-of-direction miles traveled.	Yes	
	Contribution to local economic development and growth	The bridge is part of the scenic Bridgeport Hill-Hydro Route 66 Segment Historic District. The new bridge will continue serving tourists and area businesses.		Yes
Quality of Life	Enjoyment of bridge as a tourist attraction and Route 66 as a transportation alternative to I-40	The project will rehabilitate the bridge in its original design preserving its historical status as a tourist attraction.		Yes
Environmental Protection	Impacts on vehicle emissions	Reduction in air pollutants due to reduction in detours/out-of-direction travel.	Yes	

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of the bridge closure and including 30 years of operations.

The monetized benefits and costs are estimated in 2018 dollars with future dollars discounted in compliance with BUILD requirements using a 7 percent real rate, and sensitivity testing at 3 percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2018 Dollars;
- The period of analysis begins in 2019 and ends in 2053. It includes project development and construction years (2019 – 2023) and 30 years of operations (2024 – 2053);
- A constant 7 percent real discount rate is assumed throughout the period of analysis. A 3 percent real discount rate is used for sensitivity analysis;
- Opening year demand and benefits are inputs to the BCA and assumed to be fully realized starting in 2024 (no ramp-up),; and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Full-Build alternative, rehabilitation of the Bridgeport Bridge.

6. Demand Projections

The traffic forecast is a critical component of the benefit-cost analysis as most of the benefits depend on the change in vehicle miles of travel between the Base Case/ No-Build and Build scenarios.

Current 2018 traffic volumes crossing the evaluated bridge, including the share of truck traffic, as well as estimates of future (for year 2060) traffic were provided by the Traffic Management Branch of the Oklahoma Department of Transportation (ODOT). Annual traffic volumes were then interpolated from these two figures using the implied average annual rate of growth. The assumptions are presented in Table 3 and traffic estimates for key years in Table 4 below.

Table 3. Assumptions Used in the Estimation of Traffic

Variable Name	Unit	Value	Source
Current Traffic Crossing Bridge (2018)	ADT	1,800	ODOT's Traffic Management Branch
Future Traffic (2060)	ADT	4,100	ODOT's Traffic Management Branch
Average Annual Rate of Growth	Percent	1.98%	Calculated from traffic inputs above.
Truck Share	Percent	21%	ODOT's Traffic Management Branch

Table 4. Traffic Projections for Bridgeport Bridge

Year	Total ADT
2019	1,836
2020	1,872
2022 (Construction Starts)	1,947
2024 (First Year of Benefits)	2,025
2025	2,065
2043	2,938
2053	3,574

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each quantifiable benefit or impact category identified in **Error! Reference source not found.** and provides an overview of the associated methodology, assumptions, and estimates.

7.1 Safety Benefits Impacts

Safety benefits include reduction in expected number of crashes due to avoidance of incremental VMTs related to detours when the Bridgeport Bridge is closed. Since the accident rates for fatality and injury accidents on the detour route are higher than on the bridge route, the proposed project is expected to generate a reduction in accidents and savings in accident costs. In addition, the new bridge structure will be somewhat wider than the existing structure. This improvement in road geometry may then contribute to an additional reduction in accidents under the Build scenario.

7.1.1 METHODOLOGY

Crash rates and crash statistics on the bridge and detour route were provided by ODOT's Collision Analysis and Safety Branch. These were applied to the annual traffic volume to forecast total number of crashes. The distribution of crashes by accident type (fatal, injury, property damage only) was assumed based on these crash statistics.

Reduction in accidents due to the improved wider bridge was estimated based on a crash modification factors (CMF) approach. The Crash Modification Factors Inventory database was searched to identify CMF's for similar road improvements. The implied reduction in accident rates was then applied to historical rates.

Safety benefits impacts were then estimated based on the number of accidents, by type, expected under No-Build versus the Build scenario and monetized using the social values of accident cost by type recommended by USDOT.

7.1.2 ASSUMPTIONS

The assumptions used in the estimation of safety benefits are summarized in the table below.

Table 5. Assumptions Used in the Estimation of Environmental Protection Benefits

Variable Name	Unit	Value	Source
Social Values of Accident Costs			US DOT, Benefit-Cost Analysis Guidance for Discretionary Grants Program, January 2020.
Fatality	$/Victim	$9,600,000	
Injury	$/Victim	$174,000	
No Injury/ PDO	$/PDO Crash	$4,400	
Accident Rate, Current on Bridge	Number per million VMT	124.82	Oklahoma Department of Transportation- Collision Analysis and Safety Branch.
Distribution of Accidents on Bridge by Severity			Calculated from ODOT collision Data for the bridge over period 2014-2018.

Variable Name	Unit	Value	Source
Fatality	% of total	0%	
Injury Accidents	% of total	0%	
No injury/ PDO	% of total	100%	
Accident Rate, Detour Route	Number per million VMT	64.5	Oklahoma Department of Transportation- Collision Analysis and Safety Branch.
Distribution of Accidents Detour Route, by Severity			Calculated from ODOT collision Data for the detour route over period 2013-2018.
Fatality	% of total	2.06%	
Injury Accidents	% of total	29.6%	
No injury/ PDO	% of total	68.3%	
Number of injured per injury crash on bridge	Number per Crash	0	Calculated from ODOT collision Data for the bridge over period 2014-2018.
Number of injured per injury crash on detour	Number per Crash	1.57	Calculated from ODOT collision Data for the detour route over period 2013-2018
Damaged vehicles per PDO crash	Number per Crash	1.59	California Department of Transportation, TASAS Unit, 2010 to 2013 average.
Crash Modification Factors - Widen Lane (add 2 ft. to both sides) - All crash types	CMF	0.77	CMF Clearinghouse, CMF ID 894. CMFs determined to mirror installation feature.

7.1.3 BENEFIT ESTIMATES

Table 6 shows that the proposed project will result in a safety benefit of $17.7 million discounted at 7 percent, or $61.8 million in undiscounted dollars.

Table 6. Estimates of Safety Benefits, Millions of 2018 Dollars

	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Monetary Value of Safety Benefits	$61.8	$17.7	$34.4

7.2 Economic Competitiveness

Economic Competitiveness criteria for BUILD grants include impacts such as improving the efficiency of movements of goods and people leading to a reduction in the costs of doing business and burden of commuting as well as improvements in overall well-being.

The rehabilitation of the Bridgeport Bridge is expected to have significant economic competitiveness impacts aligned with the above description of these merit criteria. They can be grouped under two categories of impacts:

(1) Travel time savings, and

(2) Vehicle operating costs savings.

The first category captures the reduced travel time for automobiles and trucks under the Build scenario due to the avoided detours after bridge closure. The avoided detours also save some vehicle operating costs which represent the second category of benefits.

7.2.1 METHODOLOGY

Travel Time Savings

Estimation of travel time savings due to avoidance of detours requires determination of a travel route that vehicles are currently taking when crossing the bridge and that they would likely take when the bridge closes entirely.

The travel routes (and their length) were assessed using a planning level approach (using Google maps) by considering the next best and suitable travel path in the local area.

Total travel times were calculated as the product of route travel time and the volume of vehicles. The detour route is expected to be longer than the typical route. Therefore, the difference in total travel time between the detour route and the typical route represents travel time savings under the Build scenario. The travel time savings were calculated separately for autos and trucks and monetized using value of time recommended by USDOT. The specific assumptions are shown in Table 7 below.

Vehicle Operating Costs Impacts

Vehicle operating cost savings were calculated for the incremental vehicle miles of travel due to detours as the product of the vehicle miles and the out-of-pocket travel costs for items such as fuel and maintenance. This cost was measured in terms of dollars per mile recommended by USDOT and was assumed to be constant over the analysis period.

7.2.2 ASSUMPTIONS

The specific assumptions used in the estimation of travel time savings and out-of-pocket travel cost are summarized in the table below.

Table 7. Assumptions Used in the Estimation of Economic Competitiveness Benefits

Data Item	Unit	Value	Source and Comments
Typical route			
Route length	Miles	5	Calculated based on Google maps.
Travel time	Minutes	5	Calculated based on Google maps.
Detour			
Full detour route length	Miles	11.5	Calculated based on Google maps.

Data Item	Unit	Value	Source and Comments
Full detour travel time	Minutes	13	Assumption.
Auto Traffic that would take detour	%	100%	Assumption.
Truck Traffic that would be detoured	%	100%	Assumption.
Date when bridge would be closed to traffic under no-build	-	1/1/2021	ODOT Engineering assessment.
Vehicle Operating Costs			US DOT, Benefit-Cost Analysis Guidance for Discretionary Grants Program, January 2020.
Passenger Vehicles	$ per mile	$0.41	
Trucks	$ per mile	$0.96	

7.2.3 BENEFIT ESTIMATES

The estimated benefits of economic outcomes are shown in Table 8. Total economic outcome benefits over the analysis period amount to $206.7 million in constant 2018 dollars or $59.3 million in dollars discounted at 7 percent. The benefits are approximately equally distributed between travel time savings and vehicle operating cost savings.

Table 8. Estimates of Travel Time Savings, Millions of 2018 Dollars

	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Monetary Value of Travel Time Saving	$104.6	$30.0	$58.1
Monetary Value of Vehicle Operating Cost Savings	$102.1	$29.3	$56.7
Total	**$206.7**	**$59.3**	**$114.9**

7.3 Environmental Protection Impacts

The replacement of US-281 Bridgeport Bridge is expected to have an impact on vehicle emissions and emissions costs due to the avoidance of additional vehicle miles of travel associated with the longer detour route. This section presents the methodology and assumptions.

7.3.1 METHODOLOGY

Emissions impacts were calculated for the incremental vehicle miles of travel due to detours as the product of these vehicle miles of travel and the social cost of vehicle emissions (dollars per mile). That cost was calculated using vehicle emissions rates (grams of emission per mile) and social cost of emission for various categories of air pollutants (dollars per ton of emissions) recommended by USDOT. Auto and truck emission rates were adopted from Cal-B/C, a nationally recognized sketch planning model for benefit-cost analysis of transportation infrastructure projects developed by the California Department of Transportation. The rates used in most recent version of Cal-B/C are based on fuel consumption rates and emission factors from EMFAC 2014 model. This analysis focuses on Criteria Air Contaminant (CAC) emissions (NOx, VOC, SOx, and

PM2.5). The speed assumed for the calculations is 65 mph. The BCA spreadsheet model provided with this application contains full details of the calculations of cost per mile, including the specific emission factors assumed for each pollutant.

7.3.2 ASSUMPTIONS

The table below presents the assumptions regarding social costs of vehicle emissions and resulting cost of emissions per VMT.

Table 9. Assumptions Used in the Estimation of Environmental Benefits

Variable Name	Unit	Value	Source
Social Costs of Pollution, by Pollutant			US DOT, Benefit-Cost Analysis Guidance for Discretionary Grants Program, January 2020.
Nitrogen Oxides (NOx)	$ per metric ton	$9,480	
Fine Particulate Matter (PM2.5)	$ per metric ton	$426,925	
Sulfur Dioxide (SO2)	$ per metric ton	$55,226	
Volatile Organic Compounds (VOC)	$ per metric ton	$2,315	
Aggregate Emission Costs, 2019-2035			Calculated by HDR for assumed average speed of 65mph
Auto	$/mile	$0.0025	
Truck	$/mile	$0.0210	
Aggregate Emission Costs, 2036-2043			Calculated by HDR for assumed average speed of 65mph.
Auto	$/mile	$0.0008	
Truck	$/mile	$0.0026	

7.3.3 BENEFIT ESTIMATES

The estimated benefits of vehicle operating cost savings are shown in **Error! Reference source not found.**. Total environmental benefits over the analysis period amount to $0.6 million in constant 2018 Dollars or $0.2 million in dollars discounted at 7 percent.

Table 10. Estimates of Environmental Benefits, Millions of 2018 Dollars

	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Monetary Value of Environmental Benefits	$0.6	$0.2	$0.4

7.4 Agency Costs Savings / State of Good Repair

The project structure is now well beyond its design life span. Without replacement or reconstruction, the structure will be closed permanently but would still require extensive inspections and maintenance to ensure general safety.

7.4.1 METHODOLOGY

ODOT estimated annual operating and maintenance costs of the structure after its closure. Under Build, these expenditures will not be required, and thus will become a savings to ODOT. (Note that operations and maintenance costs of the Project under Build are captured separately under project O&M costs).

7.4.2 ASSUMPTIONS

The specific assumptions used in the estimation agency costs savings are summarized in the table below.

Table 11. Assumption Used in the Estimation of Agency Cost Savings

Variable Name	Unit	Value	Source
Annual Operating and Maintenance Cost in 2020	$	$46,650	Oklahoma Department of Transportation
Annual Operating and Maintenance Cost after Bridge Closure	$	$93,300	Oklahoma Department of Transportation

7.4.3 BENEFIT ESTIMATES

The estimated benefits of agency costs savings are shown in Table 12. Total agency costs savings over the analysis period amount to $2.1 million in constant 2018 dollars or $1.0 million in dollars discounted at 7 percent.

Table 12. Estimates of Agency Costs Savings, Millions of 2018 Dollars

	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Monetary Value of Agency Costs Savings	$3.0	$1.1	$1.9

8. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are estimated over the lifecycle of the project (35 years from 2019 to 2053). As stated earlier, construction is expected to be completed by July 2023. Benefits accrue during the operation of the project (over the years 2024-2053).

Table 13. Overall Results of the Benefit Cost Analysis, Millions of 2018 Dollars*

Project Evaluation Metric	Undiscounted	Present Value at 7% Discount Rate	Present Value at 3% Discount Rate
Total Benefits	$272.0	$78.4	$151.5
Total O&M Costs	$13.3	$2.2	$5.8
Total Costs	$35.0	$27.9	$31.7
Net Present Value	$223.7	$48.3	$114.0
Benefit / Cost Ratio	7.39	2.73	4.60
Internal Rate of Return (%)		19.0%	

Unless indicated otherwise

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 19 percent. With a 7 percent real discount rate, the $27.9 million investment would result in $78.4 million in total benefits, net present value of $48.3 and a Benefit/Cost ratio of approximately 2.73.

With a 3 percent real discount rate, the Net Present Value of the project is $114.0 million, for a Benefit/Cost ratio of 4.6.

The table below compiles all project benefits evaluated. The table demonstrates that the vast majority of project benefits (at 75.7 percent) is accounted for by travel time savings and vehicle operating cost savings. Reduction in accident costs accounts for 22.6 percent of the overall benefits. Agency cost saving account for 1.4 percent, while environmental cost savings account for 0.3 percent.

Table 14. Overall Benefits, Millions of 2018 Dollars

Benefit Categories	Over Project Lifecycle		
	Undiscounted	Present Value at 7% Discount Rate	Present Value at 3% Discount Rate
Travel Time Savings	$104.6	$30.0	$58.1
Vehicle Operating Cost Savings	$102.1	$29.3	$56.7
Reduction in Accident Costs	$61.8	$17.7	$34.4
Environmental Cost Savings	$0.6	$0.2	$0.4
Agency Cost Saving	$3.0	$1.1	$1.9
Total Benefits	**$272.0**	**$78.4**	**$151.5**

9. BCA Sensitivity Analysis

The BCA outcomes presented in previous sections rely on a large number of 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 variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables."

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, in particular, 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 value of travel time, value of statistical life, capital cost estimate, and annual O&M. The changes in the value of statistical life and capital cost estimate are the parameters that have the greatest impact on net present value.

The outcomes of the quantitative analysis for the changes in value of travel time, value of statistical life, capital cost estimate, and rate of growth in traffic estimate using a 7 percent discount rate are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers. The table demonstrates that this project features strong performance even in situations when key input values change in the direction that reduces net benefits. In all situations examined, BC ratio remains well above 2.

Table 15. Quantitative Assessment of Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV	% Change in NPV	New B/C Ratio
Value of Travel Time	Lower Bound of Range Recommended by US DOT ($10.63 for autos and $23.58 for trucks)	$40.0	-17.2%	2.44
	Upper Bound of Range Recommended by US DOT ($18.17 for autos and $35.42 for trucks)	$54.2	12.2%	2.95
Value of Statistical Life	Lower Bound of Range Recommended by US DOT ($5.4 million)	$42.8	-11.4%	2.54
	Upper Bound of Range Recommended by US DOT ($13.4 million)	$53.3	10.3%	2.91
Capital Cost Estimate	25% Reduction	$54.9	13.7%	3.59
	25% Increase	$41.7	-13.7%	2.21
Rate of Growth in Traffic	Reduction from 1.98% to 1% Annually	$36.8	-23.8%	2.32

10. Economic Impact of the Project

Economic impact of the proposed project was also assessed in terms of the jobs and other measures of economic activity generated by construction and related project expenditures.

10.1 Methodology

The methodology represents an input/output approach based on RIMS II multipliers from the Bureau of Economic Analysis (BEA). BEA RIMS II multipliers are widely used in economic impact modeling to forecast the effect of a given change in the economy's activity (such as an infrastructure construction project) on the local, regional, and national economy. The change is specified in terms of incremental expenditures on construction, equipment, supplies, maintenance, etc. The results are typically presented as estimates of incremental employment, business output, employment income, and value added attributable to the project analyzed, all in terms of direct, indirect, and induced impacts.

Direct impacts are the immediate effects of project expenditures such as employment of construction workers and business revenues of the construction company. Indirect impacts are employment of workers and business revenues of firms supplying input materials and services to the construction company and throughout the supply chain. Induced impacts capture the effects of re-spending of workers' income on consumption goods and services.

RIMS II multipliers are available for a range of industries at various levels of aggregation. Therefore, project expenditures have to be allocated to an appropriate input-output industry. For the purpose of this analysis, expenditures related to this project were divided into two broad categories: (1) general construction, and (2) pre-construction/engineering and design. The first category was matched to the transportation structures, highways and streets construction industry, while the second was matched to the architectural, engineering, and related services industry (both from the detailed industries set).

The BEA RIMS II multipliers used here were for 2017 (and based on 2012 Benchmark Input-output National Tables). To adjust for the inflationary effects between the years 2017 to 2020 (the year of construction-related expenditure), for the purpose of this analysis, all employment multipliers were divided by the inflation rate corresponding to those years.

Simulation of economic impacts also requires assumptions regarding the percentage of total expenditures that would be spent in the area for which the impacts are estimated. It is acknowledged that procurement plans have not been developed yet and contracts have not been awarded to suppliers. For the purpose of this analysis, it was assumed that 25 percent of project expenditures would be spent locally in the project area (assumed here to be represented by the Canadian County and Caddo County) and 75 percent elsewhere within the State of Oklahoma.

This analysis was conducted at the County level (combined area of Canadian County and Caddo County) and the State level to illustrate local impacts as well as broader impacts in a larger geographic area.

10.2 Assumptions

The expenditure assumptions used in this economic impact analysis are summarized in the table below. Note that this analysis assumes that all project expenditures are spent within the state (i.e. either in the Canadian and Caddo Counties or elsewhere in Oklahoma).

Table 16: Assumptions Regarding Distribution of Project Expenditures and Industrial Allocation

Expenditure Item	Total Amount $M	Percent Spent		Industry Matched
		Canadian and Caddo Counties	Remainder of Oklahoma	
General Construction (Superstructure and Substructure Rehabilitation, Painting, Removal of Existing Structure, Roadway)	$34.9	25.0%	75.0%	Transportation Structures, Highways, and Streets Construction
Pre-construction (Design, Utilities, Environmental)	$1.5	25.0%	75.0%	Architectural, Engineering, and Related Services

Note: All monetary values are in 2020 dollars

10.3 Results

Table 17 shows the economic impacts of construction in Canadian and Caddo Counties. The table shows that construction activities related to the project are expected to generate a total of

47 jobs, $12.7 million in business output, $2.4 million in employment income, and $6.7 million in value added. Over 90 percent of the impacts are due to the general construction expenditures.

Table 17: Local Economic Impacts of Bridgeport Bridge Construction

Type of Effect	Output, $M	Earnings, $M	Employment (Job-Years)	Value Added, $M
General Construction				
Direct	$8.7	$1.6	29	$4.6
Indirect	$2.4	$0.4	8	$1.2
Induced	$1.0	$0.2	8	$0.6
Total	**$12.2**	**$2.2**	**44**	**$6.4**
Pre-Construction				
Direct	$0.4	$0.13	2	$0.2
Indirect	$0.07	$0.02	0	$0.03
Induced	$0.08	$0.02	1	$0.05
Total	**$0.5**	**$0.2**	**3**	**$0.3**
Total Combined				
Direct	$9.1	$1.7	31	$4.8
Indirect	$2.5	$0.4	8	$1.2
Induced	$1.1	$0.3	8	$0.7
Total	**$12.7**	**$2.4**	**47**	**$6.7**

Note: All monetary values are in 2020 dollars. All impacts represent cumulative impacts over the construction period.

Table 18 shows the economic impacts of construction across Oklahoma. The table shows that construction activities related to the project are expected to generate a total of 419 jobs, $74.9 million in business output, $20.7 million in employment income, and $38.9 million in value added. As with the local impact, over 90 percent of the impacts are due to the general construction expenditures.

Table 18: Economic Impacts of Bridgeport Bridge Construction in all of Oklahoma

Type of Effect	Output, $M	Earnings, $M	Employment (Job-Years)	Value Added, $M
General Construction				
Direct	$34.9	$9.2	170	$18.3
Indirect	$20.3	$5.1	89	$9.4
Induced	$16.7	$5.2	138	$9.5
Total	**$71.9**	**$19.6**	**397**	**$37.2**
Pre-Construction				
Direct	$1.5	$0.63	9	$1.0
Indirect	$0.53	$0.20	5	$0.2
Induced	$0.94	$0.29	8	$0.5
Total	**$3.0**	**$1.1**	**22**	**$1.8**

Total Combined				
Direct	$36.4	$9.9	180	$19.3
Indirect	$20.8	$5.3	94	$9.6
Induced	$17.6	$5.5	145	$10.1
Total	**$74.9**	**$20.7**	**419**	**$38.9**

Note: All monetary values are in 2020 dollars. All impacts represent cumulative impacts over the construction period.