Tishomingo Intersection Improvement Project

BENEFIT-COST ANALYSIS TECHNICAL MEMORANDUM

May 6, 2024

2025/2026

Multimodal Project Discretionary Grant

Rural

OKLAHOMA Transportation

DOCUMENT SUMMARY

This technical memorandum serves as a supplement to the Benefit-Cost Analysis (BCA) Spreadsheet submitted as part of the US-377 and SH-22 Junction Project ("the Project") 2024 MEGA Grant application being submitted by ODOT. The grant application has been prepared to request funds in support of the Tishomingo Intersection Improvement project, located at the intersection of US-377 and SH-22. ODOT has analyzed the costs and benefits of the project; these benefits will improve safety and mobility for vehicles utilizing the intersection.

Project Description

The project aims to address traffic conflicts at the intersection of SH-22, currently flowing uninterrupted into the branch of US-377. While this plan was satisfactory in the past, the growth in population and the increasing impact of nationwide large truck traffic have rendered it insufficient for ensuring local safety and supporting regional growth in Oklahoma. With approximately 7,600 vehicles and 874 trucks passing through this intersection on a typical day, it is evident that the existing design falls short of meeting the demands of current traffic volumes (ODOT – Highway Factors Report, 2020).

Analysis of collision data from 2017 to 2021 reveals a concerning pattern, with seven recorded collisions at this intersection. Most incidents occurred during low visibility hours and included side-swipe, rear-end, right-angle collisions, and one involving a culvert. Notably, recent traffic data beyond 2021 is not publicly available, but ongoing analysis by ODOT suggests additional collisions, including one resulting in multiple fatalities, which are expected to be documented in forthcoming reports.

Currently, a public comment period is underway to solicit input from stakeholders on proposed alternatives. Among these, Alternative 3: Modern Roundabout emerges as the most promising solution. Not only does it address present traffic challenges, but it also offers superior safety benefits compared to other alternatives.

Modern roundabouts boast a proven track record for safety by significantly reducing side-swipe and head-on collisions. Through the imposition of slower traffic movements within the circular structure, roundabouts inherently decrease the severity and frequency of crashes. Unlike alternative options, the roundabout's design incorporates curb and gutter sections at the upstream portions of the three legs entering it, effectively promoting traffic calming. This configuration provides drivers with a visual cue of a more constrained pathway, encouraging them to reduce speed for safer navigation through the intersection. Notably, this approach enhances driver awareness without necessitating the installation of traffic calming devices within travel lanes. ODOT is also considering additional measures such as transverse rumble strips and advanced warning signage to further alert drivers as they approach the roundabout. The Project is in a Rural area and is located in an Area of Persistent Poverty.

Budget Summary

The construction budget for the roundabout encompasses several key components. Material costs include items such as asphalt, concrete, curbs, gutters, signage, lighting, and landscaping. Labor costs, covering construction workers, supervisors, and project managers. Additional considerations were given for traffic control measures, including signage, barriers, flaggers, and costs for coordination with utility companies and relocation efforts. Other cost components include environmental mitigation measures, such as erosion control, stormwater. Previously incurred expenses have gone to preliminary engineering, right-of-way acquisition, and utility coordination. Overall, the construction budget for the Project is $8,160,00. The ODOT requests a Rural discretionary grant of $6,500,000 for construction of the project. This is approximately 80% of the total $8,160,000 future eligible project cost.

Table 1: Budget Summary

Funding Source	Contribution Amount	Percent
Non-federal State Contributions:	$1,660,000	20%
Rural Grant:	$6,500,000	80%
Other Federal Funding:	$0	0%
Total:	$8,160,000	100%

Benefit-Cost Analysis

Summary

The Benefit-Cost Analysis (BCA) conducted for this grant application meticulously compares the costs linked to the proposed investment with the project's anticipated benefits. To enhance clarity, efforts have been made to monetize benefits conservatively. In cases where assigning a specific dollar value proves challenging, earnest attempts have been undertaken to quantify the benefit. Furthermore, a qualitative discussion is included when a benefit is expected to arise but presents difficulties in easy monetization or quantification. This comprehensive approach ensures a thorough assessment of the project's economic viability and potential impact. Once the Tishomingo Roundabout is fully constructed, it is anticipated to have significant beneficial impacts, including:

- Decrease in vehicle crashes
- Reduction in travel time and associated delay
- Decreased emissions
- Reduction of fuel costs

These improvements will benefit the Tishomingo residents and visitors. Including freight vehicles in the region by providing a safer travel route and intersection design.
The table below summarizes the changes expected from the project and the associated benefits.

Table 2: Expected Benefits

Problems to Be Addressed	Changes to Baseline	Type of Impact	Economics Benefit	Summary of Results (discounted at 3.1%)
Inefficient intersection layout	Reduction of travel time for certain approaches	Over 17,000 hours of travel time savings	Passenger Time Value	$5,261,423
		Decreased emissions	Air quality improvement	$564,792
		Reduction in fuel usage	Decreased fuel usage	$264,845
Crash events at Wye Intersection	Install a multi-lane roundabout	Safety Improvement/ Crash Reduction	Accident Avoidance Savings	$30,645,066
Total Project Cost	$7,265,763			
Total Project Benefits	$36,736,127			
Benefit Cost Ratio (BCR)	5.06			
Net Present Value (NPV)	$29,470,364			

*2.0% for carbon emissions discouting

BCA Spreadsheet

The BCA spreadsheet that is provided as part of the application submission has been developed to align closely with the specifications outlined by the Department, reflecting a commitment to transparency and thoroughness. Additionally, a BCA technical memorandum is provided to describe the benefits calculations, methodologies used, and assumptions made. Based on the project we are seeking funding for, our tool has been tailored to capture the details specific to our proposed improvements while providing conservatives assumptions and methodologies to not overstate the impact of the project.

By integrating the latest BCA Guidance provided by the USDOT in 2024, our spreadsheet ensures adherence to current best practices and standards. This guidance serves as a the basis for our calculations, providing a framework that enables us to accurately evaluate both the costs and benefits associated with our project. Furthermore, our approach emphasizes accessibility and ease of understanding. By adhering to these principles, we aim to foster a collaborative and transparent evaluation process that ultimately enhances the quality and reliability of our analysis.

The BCA completed for this project was performed to compare the project's benefits to its costs. This process involves quantifying and monetizing all potential benefits and costs of the project over a predetermined amount of time. For the purposes of the project the operational analysis period lasted 30 years from the final completion of the project.The BCA follows the most current 2024 USDOT BCA guidance. This guidance provides procedural guidance for developing a BCA. Additionally, this guidance provides specific values for monetizing various types of benefits, such as monetization values for injury and fatal crashes. Other details related to the BCA spreadsheet include:

- Any costs and benefits developed for the BCA are expressed in 2024 dollars discounted to the year 2022
- All monetary values included in this analysis are discounted using a 3.1% real discount rate.
  - Per the BCA Guidance carbon is discounted at 2.0%
- Construction and related construction expenditures are assumed to begin in 2026 and end in 2027.
- Operation with all improvements in place is expected to commence in 2028. The analysis utilizes a 30-year period of useful life.

Project Benefits

Safety Benefits

The improved conditions associated with the roundabout will have positive impacts on safety by reducing conflict points at a major junction of two critical roadways within the area. The current intersection includes a stop control at SH-22 onto the free-flowing leg of US-377. Traffic from SH-22 is left turning, across a 45-mph traffic zone. The current intersection is subject to common problems experienced on rural highway intersections. These include crashes at rural intersections often involve high speeds, which tend to result in severe injuries or fatalities. Roughly 1/3 of annual intersection fatalities in the U.S. occur along rural, two-lane highways. Additionally, often in rural environments, drivers can miss a stop sign or traffic signal, leading to running through a stop sign or red light and resulting in an angle crash. To ensure the BCA is conservative the safety data that was analyzed included only one fatality in 2022, although more than one fatality occurred in a single crash event. Safety data used to analyze the proposed roundabout was provided by ODOT. Below is a table of the crashes that were used in the BCA summarized based on severity.

Table 3: Vehicle Collision Severity Breakdown

SEVERITY	2017	2018	2019	2020	2021	2022
No Injury (Property Damage Only)	1	0	2	2	0	0
Possible Injury	0	0	0	0	0	0
Non-incapacitating	0	1	1	0	0	
Incapacitating	**0**	0	0	0	0	0
Killed	**0**	0	0	0	0	1

For the purposes of the safety benefits quantified for the BCA the following assumptions and available data sources:

- In order to properly quantify the impacts of crashes taking place at or near the roundabout crashes were investigated based on accident type and travelers involved
- A percent reduction factor of 71% was used based on the findings of: NCHRP Report 572: Applying Roundabouts in the United States (2007)
  - https://www.cmfclearinghouse.org/detail.php?facid=229
  - Rodegerdts, L. A., Blogg, M., Wemple, E., Myers, E., Kyte, M., Dixon, M., List, G., Flannery, A., Troutbeck, R., Brilon, W., Wu, N., Persaud, B., Lyon, C., Harkey, D., and Carter, D., "NCHRP Report 572: Applying Roundabouts in the United States." Washington, D.C., Transportation Research Board, National Research Council, (2007)
- To be conservative the build condition did not consider an increase in crashes over the analysis period
- Other improvements that are being made but not considered within the BCA are lighting improvements and other improvements that will be brought to current standards.
- The value of accidents was based on KABCO values established in the USDOT 2024 BCA Guidance

Table 4: Crash Severity

Number	Severity	KABCO
1	No Injury (Property Damage Only)	O
2	Possible Injury	C
3	Non-incapacitating	B
4	Incapacitating	A
5	Killed	K

Travel Time Benefits

The travel time benefits are related to the improvements made by a free flowing roundabout. This analysis utilized the results of a Synchro analysis that compared the existing conditions to the roundabout alternative. Roundabouts offer several benefits for travel time compared to traditional intersections. Firstly, roundabouts typically facilitate continuous traffic flow, minimizing the need for vehicles to come to a complete stop, as is common at signalized intersections. This uninterrupted flow reduces delays and queueing, resulting in shorter travel times for motorists.

Moreover, roundabouts promote efficient traffic movement by eliminating left turns across opposing lanes of traffic, which can be time-consuming and risky at conventional intersections. Instead, vehicles enter the roundabout in one direction and navigate around the central island to exit, reducing the likelihood of conflicts and delays. Modern roundabouts are designed to accommodate lower travel speeds, typically around 15-25 miles per hour. While this may seem counterintuitive, it actually contributes to smoother traffic flow and shorter travel times by reducing the need for sudden stops and accelerating, which can lead to congestion and delays.

Importantly, based on the existing conditions, roundabouts tend to have simpler geometric layouts compared to complex signalized intersections, making them easier to navigate for drivers. This simplicity, combined with the continuous flow of traffic, results in more predictable travel times and reduced variability in journey durations. This projects anticipates the following benefits to travel time:

- Reduced Stop Wait Times
- More Continuous Flow of Traffic

The savings are based on the AM and PM peak hour analysis that provided delay per vehicle. Therefore this analysis for travel time savings is conservative and did did not consider generl time savings outside of the peak hours. This is noteworthy because the travel time savings always impact the emissions reduction and decreases in vehicle operating costs. Other cosevrative assumptions made during the travel time analysis include no adjustment for freight traffic. Annually, over 17,000 hours will saved during the peak periods alone. This is based on the following general assumptions being made:

- No annual growth rate was applied to the current traffic counts
- Average vehicle occupancy was assumed to be 1.67 based on the USDOT 2024 BCA Guidance
- The annualization factor for all calculations was 260 days, based on peak period volumes being used

Emissions Benefits

Emissions benefits will be generated by the reduction in the minutes of delay for passenger vehicles. These improvements will result in reduced idling time by all vehicles in the ointersectiob, in turn resulting in a reduction in emissions. Emission rates were referenced from the Environmental Protection Agency (EPA) idling vehicle emissions for passenger cars, light-medium trucks, and heavy. These rates were for nitrogen oxides (NOx), particulate matter (PM2.5), carbon dioxide (CO_2) emissions, and sulfur dioxide (SOx).

References for these values can be found here:

- https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
- https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves

The time value used to calculate the emissions was based on the delay analysis described in the previous section. The emissions benefits were calculated based on the following assumptions and available data sources:

- USDOT 2024 BCA Guidance for emissions costs metric per ton for nitrogen oxides (NOx), particulate matter (PM2.5) and sulfur dioxide (SOx).
- USDOT 2024 BCA Guidance for emissions costs per metric ton carbon dioxide (CO_2) emissions
- No annual growth factor to traffic was applied
- Average vehicle occupancy was assumed to be 1.67 based on the USDOT 2024 BCA Guidance

Vehicle Operating Costs

Fuel savings benefits were based on the passenger vehicles hours of delay and all commercial vehicle hours of delay. The 17,795 hours of delay per year that were avoided was used for the 30-year analysis period. Fuel costs were based on 2024 fuel prices for gasoline and diesel in Oklahoma. The fuel savings were calculated based on the following assumptions and available data sources:

- Fuel consumed while idling, for passenger vehicles, measured at gallons per hour, was 0.28 (gal/hr) for a average light and heavy sedan.
    - » https://gasprices.aaa.com/?state=OK
- Average cost of gasoline (2024$s, net of fuel taxes): $3.20

BCA Results

The Benefit-Cost Analysis completed for this application was based on the project improvements, available and verified data, and 2024 USDOT Standard BCA Guidance. This 2024 analysis indicates that the project will provide quantifiable benefits through the reduction of crash rates, travel time delay savings, traveler costs, and air pollution. A chart describing the benefits by type is shown below. As anticipated the project is anticipated to yield high safety benefits based on the roundabout being installed. Other major benefits come from travel time svaings, whith smaller savings coming from reduced fuel costs and emssions.

The expected benefits and results are summarized below, the project is expected to create over $36M in quantifiable benefits. The project estimates a Benefit Cost Ration of 5.06, with a Net Present Value of over $29M.

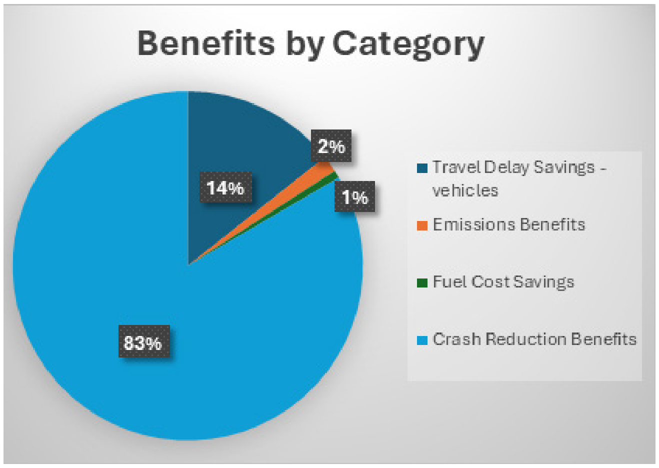

Figure 1

Table 5: Benefits Summary

Benefit Type	Summary of Results (discounted at 3.1%*)
Travel Time	$5,261,423
Emissions	$564,792
Vehicle Operating Costs	$264,845
Safety Benefits	$30,645,066
Total Project Cost	**$7,265,763**
Total Project Benefits	**$36,736,127**
Benefit Cost Ratio (BCR)	**5.06**
Net Present Value (NPV)	**$29,470,364**