Hochatown Community Access and Pedestrian Safety Project

Benefit-Cost Analysis

Daniel Nguyen, P.E., MBA
ODOT Project Management, Division Manager
dnguyen@odot.org

FY23 MPD GRANT APPLICATION

MPD Grant Request: $20 million

1. Introduction

A Benefit-Cost Analysis (BCA) is an evaluation framework to assess the economic and social benefits and costs of an investment proposal. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. It attempts to capture the net welfare change including costs such as project capital costs, cost savings and increases in welfare (benefits), and welfare reductions where some groups are expected to be made worse off.

The BCA assesses the incremental difference between the No Build Case and the Build Case, which represents the net change in welfare. The importance of future impacts is determined through discounting, to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S Department of Transportation (USDOT) in the *Benefit-Cost Analysis Guidance for Discretionary Grant Programs* released in January 2023. This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case and a Build Case.
- Estimating benefits and costs during project construction and operation, including 20 years of operations beyond the Project completion when benefits accrue.
- Presenting dollar values in real 2021 dollars. In instances where cost estimates and benefits valuations are expressed in historical or future dollar years, using an appropriate inflation rate to adjust the values.
- Discounting future benefits and costs with a real discount rate of 7%, CO_2 emissions benefits are discounted at 3%.

2. Project Overview

2.1 DESCRIPTION

The Project area is located along United States Highway 259 (US-259), approximately 6.25 miles north of the State Highway (SH) 3 junction and extending north 6 miles into Hochatown. US-259 is a vital transportation link that provides access for recreational opportunities, commercial traffic, logging trucks, tourists, and local and regional commuters. The area has experienced a substantial increase in growth due to land investment opportunities for cabin rentals and popular nearby tourist destinations including Beavers Bend State Park.

The existing US-259 corridor within the Project area is a two-lane, undivided roadway with limited shoulder widths and stormwater conveyance through roadside ditches. There is only limited left or right turning lanes, and no bicycle or pedestrian facilities. In addition, more than 100 residential and commercial driveways directly access US-259 along that 6-mile stretch.

The Project includes the construction of a new, 1.8-mile multiuse pedestrian and bicycle trail, and the reconstruction of US-259 to improve vehicular movements, enhance safety, and provide a reliable infrastructure investment in a rural community that is often overlooked.

Table 1. Project Alternatives and Benefits Summary

Change to Baseline/Alternatives	Benefit	Population Affected	MPDG Project Outcome Criteria	Present Value (Discounted at 7%)
Capacity improvements will reduce delay and increase throughput speeds for vehicles.	Travel Time Savings	Auto Users	Economic Competitiveness and Opportunity	$34.830 million
	CO_2 Emissions Reduction	All	Environmental Sustainability	$0.710 million
Safety improvements including signalization at intersections, increased sight distance, and a continuous center turn lane.	Reduced Roadway Crashes	Auto Users	Safety	$33.040 million
Addition of sidewalk space and a multiuse trail encourages pedestrian and bicycle travel.	Pedestrian and Bicycle Journey Quality	Pedestrians and Bicyclists	Mobility and Community Connectivity	$2.730 million
	Health Benefits		Quality of Life	$8.140 million
	Vehicle Operating Cost Savings	Auto Users	Economic Competitiveness	$0.340 million
	Reduced Road Maintenance	ODOT	State of Good Repair	$0.177 million
	External Highway Use Costs	All	Quality of Life	$0.077 million

MPDG = Multimodal Project Discretionary Grant
ODOT = Oklahoma Department of Transportation

2.2 GENERAL ASSUMPTIONS

Table 2 presents some of the general assumptions of the BCA.

Table 2. General BCA Assumptions

Assumption	Value
Construction Start Date	2024
Construction End Date	2026
Project Opening	2027
End of Analysis Period	2046
Operations Period	20 years (post construction)

Assumption	Value
Base Year Dollars	2021
Discount Rate (all impacts except CO_2 emissions)	7.0%
CO2 Emissions Discount Rate	3.0%

[a] USDOT BCA guidance states that projects aimed primarily at capacity expansion should use a 20-year analysis period, even if the useful physical life of the underlying infrastructure is greater than this.

3. Project Costs

3.1 CAPITAL COSTS

The project's costs including construction costs and contingency are estimated at $39,607,068 in 2022 prices. ODOT expects the construction to be completed within two years, between 2024 and 2026. For the purposes of this analysis, the project costs are split equally for year 1 and year 2 of construction.

Table 3. Construction Costs

Construction	$33,005,893
Roadway	$26,394,651
Multiuse Trail	$808,350
Sidewalk	$186,881
Signing/Striping	$156,400
Signalization	$900,000
Lighting	$1,248,000
Mobilization/Maintenance of Transportation	$1,331,260
Construction Management	$1,980,350
Contingency (20%)	$6,601,178
Project Total	$39,607,068

3.2 OPERATIONS AND MAINTENANCE COSTS

ODOT has provided a cost estimate for future Operations and Maintenance activities for the existing roadway under a No Build scenario, and for the new roadway and trail under a Build scenario. It is expected that the costs to operate and maintain an expanded roadway and trail compared to the current facility would be greater in the long term to its expanded size and function. In the near term, the costs would be lower as there should not be any significant maintenance or rehabilitation costs in the first few years of operations of a new asset. Some maintenance activities which might have taken place between 2024 and 2026 would be deferred in anticipation of construction.

Table 4. Maintenance and Rehabilitation Costs for US-259

Year	No-Build	Build
2023	$0	$0
2024	$15,000	$0
2025	$0	$0
2026	$100,000	$0
2027	$0	$0
2028	$2,000,000	$0
2029	$0	$0
2030	$0	$0
2032	$50,000	$0
2034	$0	$55,000
2036	$50,000	$0
2038	$15,000	$20,000
2040	$100,000	$50,000
2042	$0	$50,000
2044	$2,250,000	$0
2046	$0	$3,000,000

4. Project Benefits

4.1 TRAVEL TIME IMPACTS

The existing US-259 within the Project area is a two-lane, undivided roadway. The highway provides access to more than 100 residential and commercial driveways, but there are limited left or right turning lanes. The roadway is already prone to congestion, and this is expected to worsen with the expected growth of traffic and tourism in the area. The Project will increase capacity, facilitate turning movements, and reduce delay by adding a continuous center turn lane and up to two travel lanes (one in each direction). The benefit of these travel time savings has been quantified for the BCA.

Temporary traffic signals were recently installed with turn bays at SH-259A North and South, and Stevens Gap Road. The Project will further develop these temporary measures into a permanent solution as well as additional intersection improvements. This increases intersection capacity and will generate further travel time savings beyond those quantified for this analysis, including reducing delay for traffic turning onto US-259.

The baseline traffic volume assumption is 12,000 vehicles per day in both directions in 2022[1]. For this analysis, traffic volumes were assumed to grow at a rate of 2% per year throughout the analysis period, reaching 17,831 by 2042. Historical traffic growth has been significantly greater—between 5% and 15% per year on different sections of the 6-mile corridor between 2015 and 2019 (before the impacts of the pandemic). There is expected to be continued growth in local tourism. The Choctaw Landing Entertainment Resort is currently under construction on the south side of Hochatown and is due to open in 2024. A 2021 Lee Engineering traffic study estimated that the resort will generate more than 5,000 additional daily trips on weekends. On this basis, the 2% annual traffic growth assumption is very conservative for the near term but was selected in recognition of the uncertainty of longer-term growth rates.

Average travel times were estimated along the 6-mile corridor by estimating average travel speeds using the following speed-flow formula from the Transportation Research Board's Highway Capacity Manual. Average speeds were estimated for each future year with or without capacity improvements.

(1) $$Actual\ Speed = sf/(1 + a\left(\frac{v}{c}\right)^b$$

Where:

sf = free-flow speed

v = traffic volume (measured by average vehicles per day)

c = road capacity as defined by the HCM

a = 0.15 and b = 4

The free-flow speed along the corridor was assumed to be 50 miles per hour (mph) based on an average of the speed limit[2] of 55 mph south of Hochatown and 45 mph between Hochatown and Carson Creek Road.

The resulting time savings in terms of vehicle-hours were multiplied by an assumed average vehicle occupancy of 1.67[3] and multiplied by the Value of Time of $18.80[4] to estimate the total value of time saved.

Table 5. Travel Time Savings: 2027 and 2042

	Two lanes	Three lanes	Five lanes
Road Capacity (two-way)	13,680	17,100	36,000
2022 Traffic Volume (two-way AADT)	12,000	12,000	12,000
2027 Traffic Volume (two-way AADT)	13,251	13,251	13,251
V/C Ratio	0.97	0.77	0.37

[1] Freese and Nichols. 2022. *Two-way traffic counts*.

[2] Deardoffa, Matthew D., Brady N. Wiesnerb, and Joseph Fazioc. 2011. "Estimating Free-flow Speed from Posted Speed Limit Sign."

[3] USDOT. 2023. *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*. Table A-4.

[4] USDOT. 2023. *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*. Table A-3. Recommended value for "all purpose" trips.

	Two lanes	Three lanes	Five lanes
Average Speed	44.20	47.40	50.00
Hours Saved Relative to 2-lane	-	75,508	125,227
2042 Traffic Volume (two-way AADT)	17,831	17,831	17,831
V/C Ratio	1.30	1.04	0.50
Average Speed	34.90	42.50	49.60
Hours Saved Relative to 2-lane	-	333,432	552,980

[a] Service volume for principal arterial roadways = 17,100, with a 20% reduction (13,680) if no center-turn-lane, and 36,000 for a 5-lane arterial highway, according to the Association of Central Oklahoma Governments

AADT = annual average daily traffic

V/C = volume to capacity

The improved capacity and travel time savings may induce additional travel demand. This has not been included in the BCA as a conservative approach as it is difficult to quantify and would increase the size of the travel time savings benefit.

During construction of the new roadway, there may be disruption to traffic flows causing travel time disbenefits. This was quantified using an assumption that in the Build scenario the posted speed limit during the two-year construction period will be 35 mph.

The total value of travel time savings, including the net effect of travel time disbenefit during construction, is $17.8 million for a three-lane roadway or $34.8 million for a five-lane roadway over the 20-year appraisal period (discounted, 2021 prices).

4.2 SAFETY BENEFITS

There are expected to be significant safety benefits associated with the project. The following project elements will reduce the risk of vehicular crashes:

- Left-turning vehicles will have a dedicated space away from through-traffic lanes, reducing rear-end collisions.
- Minor streets will have improved sight distance due to removing skewed approaches and improved turning radii.
- Street lighting addition will improve nighttime visibility for drivers.
- Temporary traffic signals recently installed at three key intersections will be made permanent.

Historical crash data for the last 10 years were analyzed to estimate the average annual number of collisions and injuries, disaggregated by severity, type and cause, and to identify the crashes which may be mitigated by the safety improvements in this project.

It was assumed that without any intervention (No Build scenario), the frequency and severity of crashes would continue at a similar rate to that seen in the last 10 years with an additional growth factor of 2% per year in line with the traffic growth assumption.

Crash Reduction Factors (CRF) from the Clearinghouse database were identified for the elements of the project which would improve safety. These were applied to different types of accidents depending on the safety intervention to estimate the reduction in crashes and injuries that could be expected in each year. This was multiplied by the dollar value associated with each type of injury based on the KABCO injury scale, which was developed by the National Safety Council.

Table 6 shows the CRFs used, in terms of the percentage decrease in accidents.

Table 6. Crash Reduction Factors

CRF ID	Intervention	CRF	Crashes This CRF is Applied to (Annual Average Number of Crashes)
2338	Install two-way left-turn lane on two-lane road	-31.4%	All crashes on the corridor
7983	Install a traffic signal	-36.1%	Crashes within 250-foot buffer of a newly signalized intersection
11027	Install lighting	-41.9%	Crashes within 100-foot buffer of where new lighting will be installed
307	Increase triangle sight distance	-48%	Crashes within 250-foot buffer of where sight distance will be improved

Table 7. Monetized Crash Values

Crash Type (KABCO Injury Scale)	Monetized Value per Incident (2021 dollars)	Accidents Avoided
No Injury - O	$4,000	-47% (6.2 per year)
Possible Injury - C	$78,500	-51% (2.6 per year)
Non-Incapacitating - B	$153,700	-44% (0.8 per year)
Incapacitating - A	$564,300	-60% (0.4 per year)
Killed - K	$11,800,000	-52% (0.2 per year)
Total		-49% (10.3 per year)

The total value is $33 million over the 20-year appraisal period (discounted, 2021 prices).

The analysis only includes a reduction in vehicular crashes because the historical crash data involved vehicles only. The project is also expected to generate significant improvements for pedestrians with the pedestrian crossings at intersections and installation of sidewalks and a trail. This represents an additional safety benefit beyond the value quantified for this analysis.

4.3 ACTIVE TRAVEL BENEFITS

The Project includes the construction of a multiuse trail and building sidewalks alongside US-259. This will benefit existing pedestrians and cyclists, and also generate additional pedestrian trips and cycling trips.

DEMAND

The number of daily pedestrian and cycling trips was estimated based on the assumptions shown in the table below for the number of residents and visitors, daily trip rate, and mode shares. This was assumed to represent the level of active travel demand in the Build scenario following installation of the multiuse trail and sidewalks. This was estimated at 604 daily pedestrian trips and 135 daily cycling trips, compared against only 200 pedestrian trips and 50 cycling trips in the base scenario.

These numbers were assumed to grow at 2% per year, in line with local traffic and tourism growth.

ACTIVE TRAVEL JOURNEY QUALITY

This impact is generated as a result of the new multimodal infrastructure in comparison to the current lack of pedestrian or cycling infrastructure. This benefit accrues to both new and existing pedestrians/cyclists.

The pedestrian journey quality benefit is $1.10 per person-mile traveled in pedestrian mode ($0.55 for induced pedestrian trips due to the “rule of a half” for new users) assuming the sidewalk and trail will be 10 feet wide. This is multiplied by the average pedestrian trip distance of 0.86 miles and the number of existing pedestrian trips in each forecast year.

The bicycle journey quality benefit is $1.77 for dedicated cycling land multiplied by the average bicycle trip distance of 2.38 miles and the number of cyclists in each forecast year.

The Project’s total active travel journey quality benefits are $2.7 million over the 20-year appraisal period (discounted, 2021 prices).

ACTIVE TRAVEL HEALTH BENEFITS

This benefit is due to an increase in physical activity from an increase in pedestrian activity and cycling leading to improved cardiovascular health and a reduction in mortality risks. We apply $7.20 per induced pedestrian trip and $6.42 per induced bike trip.

The total value is $8.1 million over the 20-year appraisal period (discounted, 2021 prices).

Table 8. Assumptions for Estimating Active Travel Demand

Parameter	Value	Source
Resident population	250	ODOT
Daily visitors	6,500	Beavers Bend State Park visitor numbers: 2,283,600 in 2021

Parameter	Value	Source
Daily trips per resident and visitor in the project area	3.2	2017 NHTSA: Table 13, Trips per day in rural areas
% Pedestrian	2.9%	2017 NHTS: Table 26
% Bicycle	1.1%	2017 NHTS: Table 26
Number of daily pedestrians: No Build Build	 200 604	 StreetLight Big Data Analytics Calculation
Number of daily bicyclists: No Build Build	 50 135	 StreetLight Big Data Analytics Calculation
Pedestrian journey quality benefit, per mile per 1 foot width of sidewalk	$0.11	USDOT BCA Guidance 2023: Table A-8
Bicycle journey quality benefit, per mile	$1.77	USDOT BCA Guidance 2023: Table A-9
Average pedestrian trip distance (miles)	0.86	USDOT BCA Guidance 2023: Table A-8
Average cycle trip distance (miles)	2.38	USDOT BCA Guidance 2023: Table A-9

NHTSA = National Highway Traffic Safety Administration

4.4 BENEFITS OF A REDUCTION IN VEHICLE MILES TRAVELED

In addition to journey quality and health benefits due to walking and cycling improvements, there will also be a reduction in vehicle trips, and vehicle miles traveled (VMT), as some drivers switch to pedestrian or cycling modes for some short-distance trips. The estimated increase in pedestrian trips is 163,000 in 2027, with a corresponding reduction in vehicle miles of 83,800 in 2027, assuming an average pedestrian trip distance of 0.86 miles and an average vehicle occupancy of 1.67.

This represents a benefit of the project in terms of a reduction in user and external costs associated with driving.

VEHICLE OPERATING COST SAVINGS

For every vehicle mile reduced, users benefit from $0.46 reduced vehicle operating costs, including gasoline, maintenance, tire wear, and depreciation[5]. The total estimated value is $338,600 over the 20-year appraisal period (discounted, 2021 prices).

EXTERNAL HIGHWAYS USE COSTS REDUCTION

The reduction in VMT also leads to a reduction in external highway use costs including congestion, noise, and safety. Note that the reduction in *external* safety costs is additional to the safety improvement described and previously quantified.

The total estimated value is $76,500 over the 20-year appraisal period (discounted, 2021 prices).

STATE OF GOOD REPAIR

Every 1 mile of VMT reduced is assumed to generate a savings of $0.25 for reduced cost of maintenance, with a total estimated value of $177,000 PV over the analysis period.

Table 9. Assumptions for VMT Reduction Benefits

Parameter	Value	Source
Average vehicle occupancy	1.67	USDOT BCA Guidance 2023: Table A-4
Average pedestrian trip distance (miles)	0.86	USDOT BCA Guidance 2023: Table A-8
Average cycle trip distance (miles)	2.38	USDOT BCA Guidance 2023: Table A-9
Vehicle operating cost per VMT	$0.46	USDOT BCA Guidance 2023: Table A-5
External highway use cost per VMT (2021 $) Congestion Noise Safety	 $0.028 $0.0002 $0.080	USDOT BCA Guidance 2023: Table A-14, Light-Duty Vehicles - Rural
Roadway Maintenance Cost Savings per VMT	$0.25	UK TAG Databook A5.4.2. *

*USDOT BCA guidance does not include a recommended figure for Roadway Maintenance Cost savings associated with reduced VMT, so this figure was taken from the UK Transport Appraisal Guidance (TAG), converted to miles, to dollars, and to 2021 prices. This was found to be similar to a value recommended in a 2015 US DOT Pavement Comparative Analysis Technical Report.

4.5 EMISSIONS REDUCTION

Emissions will be reduced as a result of the capacity improvements which reduce delays and increase average speeds along the corridor. The fuel consumption for the No Build vs. Build (that is, with and without congestion) was estimated for each year using fuel consumption values from the U.S. Energy Information Administration (EIA) Annual Energy Outlook 2022, which increase over time between 25 to 30 miles per gallon. These were adjusted using fuel efficiency factors sourced from EIA in 2013, which reflect the reductions in fuel efficiency when average speeds decrease between 50 mph and 30 mph. The average speeds with and without capacity improvements were used for this calculation, calculated as described in Section 4.1, Travel Time Impacts.

The resulting values for CO2 emissions range between 345 grams per mile in 2022, to 280 or 341 grams per mile in 2046, with or without capacity improvements.

Emissions will also decrease as a result of the reduction in VMT because of the increase in pedestrian and cycling activities. This has been calculated for CO_2 as well as the most common local air pollutants generated by transportation activities, including sulfur oxides, nitrogen oxides, and fine particulate matter.

Auto emissions factors for each of these pollutants is based on California Air Resources Board's EMFAC2017 Mobile Emissions Inventory for 2024 and 2044, with other years calculated based on the compound average growth rate between those years. This was applied to the damage costs of each pollutant per metric ton.[6]

Benefits from reductions in CO_2 emissions are discounted at a 3% rate. The total estimated value is $705,700 over the 20-year appraisal period (discounted, 2021 prices).

4.6 RESIDUAL VALUE

A residual value has been included because the project assets are expected to have several years of useful service life remaining at the end of the 22-year analysis period. The estimated service life of the expanded road is 30 years, meaning the assets have a residual life span of 8 years. We assume a linear reduction in the value of the asset every year. The value of each year is $39.6 million / 30 = $1.32 million. Therefore, the residual value in 2046 (non-discounted) is $10.6 million.

Table 10. Residual Value Assumptions

Item	Value
Assets Life Span	30 years
Analysis Period	22 years
Residual Value (non-discounted)	$10.6 million
Residual Value (2021 PV dollars)	$1.3 million

4.7 NON-MONETIZED ECONOMIC BENEFITS

This project is expected to generate additional wider economic benefits which are not quantified in this BCA. This is in line with US DOT guidance which states that these benefits would be included in an Economic Impact Analysis, distinct from a BCA. The project is expected to support and stimulate economic growth and employment opportunities in the local area in several ways:

- Growth in local tourism in the region including the Beaver Bend State Park and local hotels, cabins, and other hospitality due to improved accessibility and alleviating congestion issues during peak tourism periods.
- Attracting customers to the businesses in the Hochatown, which will in turn attract more businesses and hospitality to the corridor, by improving the street scape and making it more pedestrian friendly.
- Supporting the success of the Choctaw Landing Entertainment complex opening on the edge of Hochatown, which is expected to generate up to 2000 new jobs, by improving the capacity of local access roads.

[6] USDOT. 2023. *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*. Table A-6.

- Stimulating trade growth due to road capacity improvements allowing the road to service additional heavy trucks. This will also mitigate risks to supply chain security brought by extreme weather events.
- Improved accessibility to employment opportunities due to decreased congestion and travel times.

5. Summary of Results

The results presented below show the highest cost option of expanding the roadway to five lanes, with two lanes in each direction and a center turn lane. The Benefit Cost Ratio is more than 2, indicating that the benefits of the project are more than double that of the costs. Alternative design solutions are still under consideration, including a three-lane or four-lane design, which could still deliver most of the safety and active travel benefits and some capacity improvements at a lower cost. These alternatives were found to have a comparable Benefit Cost Ratio.

Table 11. Benefit Cost Analysis Results

Discounted2021 -dollar values

Benefit Cost Ratio	2.92
Net Present Value	$53,935,000
TOTAL BENEFITS (Discounted)	$81,981,200
Safety Benefits	$33,042,000
Time Savings	$34,829,400
Active Travel Journey Quality Benefits	$2,726,100
Active Travel Health Benefits	$8,139,700
Vehicle Operating Cost Saving	$338,600
Emissions Reduction	$705,700
State of Good Repair	$177,000
External Highway Use Costs	$76,600
Residual Value	$1,946,000
TOTAL COSTS (Discounted)	$28,046,300
Capital Costs	$29,233,600
Maintenance	($1,187,300)