APPENDIX A:
Benefit Cost Analysis

1. Benefits Cost Analysis Technical Memo

2. Benefit Cost Analysis Model

Tulsa Community River Corridor Connections Project

INCOG

CITY OF Tulsa
A New Kind of Energy

THE CITY OF JENKS OKLAHOMA

U.S. Congressional District OK

2020 BUILD Grant Application

U.S. Department of Transportation, FY2020 Better Utilizing Investments to Leverage Development (BUILD) Application

BUILD Funds Request: $19.67 million

Tulsa Community River Corridor Connections Project

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION

FY2020 BUILD DISCRETIONARY GRANT PROGRAM

PREPARED FOR: INDIAN NATION COUNCIL OF GOVERNMENTS
MAY 18, 2020

wsp

EXECUTIVE SUMMARY

A benefit-cost analysis (BCA) was conducted for **Tulsa Community River Corridor Connections Project** (the Project) for submission to the U.S. Department of Transportation (USDOT) as a requirement of a discretionary grant application for the FY 2020 BUILD Transportation Grants program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by USDOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in January 2020. The period of analysis corresponds to 23 years and includes 3 years of construction and 20 years of benefits after operations begin in 2025.

Tulsa Community River Corridor Connections Project will increase the safety and quality of life for cyclists, pedestrians, and motorists along the Arkansas River between the cities of Tulsa and Jenks, Oklahoma. The project includes four primary components:

1. West Bank Connection Trail (Turkey Mtn. – 91st Street): Construction of west bank multi-use trail connection to and from Turkey Mountain Urban Wilderness at 71st Street to 91st Street;

2. West Bank Connection Trail (96th – 104th Street): Construction of west bank multi-use trail from the south Tulsa/Jenks pedestrian and low water dam fully connecting Turkey Mountain at 71st Street to the dam at 104th Street;

3. East Bank Connection Trail (86th – 96th Street): Reconstruction of east bank multi-use trail from 86th to 96th; and

4. East Bank Connection Trail (96th – 104th Street): Construction of new multi-use trail on the east bank from 96th St S to 104th St S.

COSTS

The capital cost for this Project is expected to be $27.6 million in undiscounted 2018 dollars through 2025. At a 7 percent real discount rate, these costs are $21.4 million. The Operations and Maintenance (O&M) costs associated with this project are estimated to be $153,125 annually, while Repair and Rehabilitation costs are assumed to be $0.

BENEFITS

In 2018 dollars, the Project is expected to generate $74.6 million in discounted benefits using a 7 percent discount rate. These monetizable benefits are derived from safety benefits of avoided collisions, increased health and mobility benefits realized from increased non-motorized activity, and residual value from the multi-use trails. This leads to an overall project Net Present Value of $59.8 million in 2018 discounted dollars and a Benefit Cost Ratio (BCR) of 3.79. The overall project benefit matrix can be seen in Table ES-1.

Table ES-1: Project Impacts and Benefits Summary, Monetary Values in Millions of 2018 Dollars

Current Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Impact Type	Monetized Results (at 7% discount rate)	Page Reference in BCA
The Project area consists of sections along the Arkansas River with unsafe travel conditions for pedestrians and cyclists	Improved roadway conditions allow for safer, more efficient travel throughout the project extent and new shared paths and bike lanes lead to fewer crashes for cyclists and pedestrians	Reduction in total crashes along project extent with new and improved shared use paths	$72.5	8
The Project area has no existing ways to commute or travel recreationally	Project improvements will contribute to more diverse mobility options for users	Commuter mobility benefits for bicyclists and pedestrians	$0.2	9
The Project area does not contribute positively to personal health of potential users	Project improvements will install infrastructure capable of supporting health benefits	Improved health benefits from increased recreation and active commuting	$0.4	9
There is no existing infrastructure in the area for INCOG to capture value on	The Project will develop assets for which the INCOG can leverage financial benefits	Residual value accrued from the remaining value on the trails at the end of the analysis period given the assets' useful lives	$2.5	9

Source: WSP, 2020

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1 INTRODUCTION

A benefit-cost analysis (BCA) was conducted for **Tulsa Community River Corridor Connections Project** (the Project) for submission to the U.S. Department of Transportation (USDOT) as a requirement of a discretionary grant application for the BUILD 2020 program. The following section describes the BCA framework, evaluation metrics, and report contents.

1.1 BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCA framework involves defining a Base Case or "No Build" Case, which is compared to the "Build" Case, where the grant request is awarded, and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project lifecycle. The importance of future welfare changes is determined through discounting, which is meant 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 USDOT in the 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case as well as under the Build;
- Estimating benefits and costs during project construction and operation, including 30 years of operations beyond the Project completion when benefits accrue;
- Using USDOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;
- Presenting dollar values in real 2018 dollars. In instances where cost estimates and benefits valuations are expressed in historical or future dollar years, using an appropriate inflation rates to adjust the values;
- Discounting future benefits and costs with a real discount rate of 7 percent consistent with USDOT guidance.

1.2 REPORT CONTENTS

Section 2 of this Appendix contains a description of **Tulsa Community River Corridor Connections Project** elements, information on the general assumptions made in the analysis, and a description of the base case compared to the build case. Section 3 provides a summary of the anticipated project costs. Section 4 reviews the expected economic benefits the project would generate, including a review of the assumptions and methodology used to calculate these benefits. Section 5 reports the high-level results of the benefit-cost analysis. Finally, Section 6 details results of a sensitivity analysis when project inputs and assumptions are modified slightly.

2 PROJECT OVERVIEW

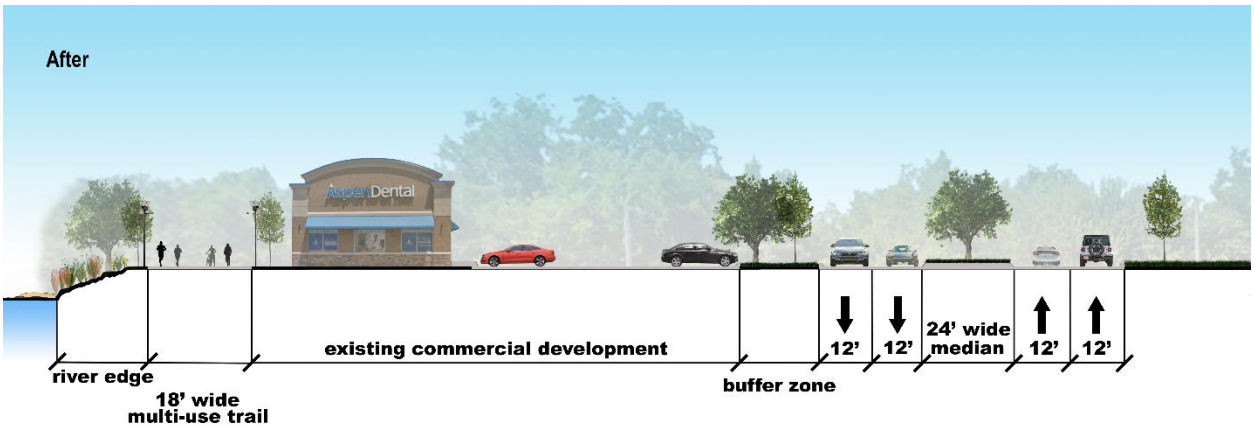
2.1 DESCRIPTION

Tulsa Community River Corridor Connections Project intends to develop critical infrastructure improvements along the Arkansas River to accommodate a growing economic center in Southern Tulsa and Jenks, Oklahoma. The project will make significant repairs and upgrades to the trails along the east and west sides of the Arkansas River centered around the future Jenks Low Water Dam and Pedestrian Bridge. The Project will separate bicycles and pedestrians from vehicular traffic on the east and west sides of the Arkansas River to provide safe travel conditions. The project will connect the communities of Southern Tulsa and Jenks with a reliable, safe, and resilient active transportation network.

The Project is located along the Arkansas River, a protected natural landmark in Oklahoma, and will impact residents, visitors, and businesses in a positive manner. As it stands, there is no safe way for pedestrians and cyclists to enjoy traveling along this section of the Arkansas River without endangering themselves by traveling on the adjacent roadways without protected sidewalks or trails. Expectedly, the project area experiences higher than normal crash rates within its one-mile radius than the rest of Tulsa or Jenks. The area is also prone to severe flooding, and the project will make resiliency improvements that will enhance the safety of motor vehicles, pedestrians, and cyclists while making quality of life improvements through new recreational, commercial retail, and transportation access. Without these critical connections made by the new trails system, southern Tulsa and Jenks will be forced to continue to travel unsafely, and critical areas of economic importance will remain disconnected from each other.

The Project will make several substantial improvements to the infrastructure impacting the economy of Tulsa, Jenks, the state of Oklahoma, and the broader region. By addressing critical safety and mobility issues while also capitalizing on the long-term value of the trails, the project will create safe and efficient connections that will support a growing population and regional economy. The Project's safety, residual value, and quality of life benefits will support the investment strategy of INCOG while also improving the lives of cyclists, pedestrians, and motor vehicles throughout the area.

Figure 1: Project Improvements



Source: City of Tulsa, 2020

2.2 GENERAL ASSUMPTIONS

For project investments, dollar figures in this analysis are expressed in constant 2018 dollars (2018$). The real discount rate used for this analysis was 7.0 percent, consistent with USDOT 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.

For the project, the evaluation period includes the 3year design/construction period during which capital expenditures are undertaken, plus 20 years of operations beyond the project completion within which to accrue benefits.

All benefits and costs are conservatively assumed to occur at the end of each year for purposes of present value discounting. Benefits accruing from the improvements are assumed to begin in the calendar year following construction's completion.

For the purposes of this study, it has been assumed that design and construction of the project begins as early as 2021 and continues through the end of 2024; it is assumed that the project would be fully complete and operational starting in 2025. The analysis period, therefore, begins in 2025 when construction begin and continues through 20 years of operations, or through 2044.

2.3 BASE CASE AND BUILD CASE

For the purposes of this BCA, the no-build/base case assumes that none of the contemplated trail improvement projects would be completed, and that the existing poor cycling and pedestrian conditions would remain in their current conditions. The no-build/base case would include none of the proposed project enhancements and would only include rehabilitation and repairs to one-mile of existing trails on the eastern side of the Arkansas River in 2030.

3 PROJECT COSTS

3.1 CAPITAL COSTS

Capital costs for this project (Table 1) are primarily associated with the actual construction. Construction costs will entail the paving and installation of multi-use trails along both the east and west banks of the Arkansas River in the cities of Jenks and Tulsa, OK. The capital costs associated with the Project come out to $27.7 million in 2018 dollars.

Table 1: Project Schedule and Costs ($2018 Millions)

Cost Category	2021	2022	2023	2024	Total
Planning and Design	$2.6	$0	$0	$0	$2.6
Right of Way	$0	$0	$0	$0	$0
Construction	$0	$8.3	$8.4	$8.4	$25.1
Total	$2.6	$8.3	$8.4	$8.4	$27.7
Total, Discounted 7%	$2.3	$6.8	$6.4	$6.0	$21.4

Source: City of Tulsa, 2020

3.2 OPERATING AND MAINTENANCE COSTS

The trail enhancements proposed under this project are expected have operating and maintenance costs at an annual rate of $153,125 in 2018 dollars, however there will be no repair and rehabilitation costs for the project.

4 PROJECT BENEFITS

The benefits of **Tulsa Community River Corridor Connections Project** include mobility and health improvements, residual value accrued on the assets, and the reduction in damage to property and humans resulting from crash incidents.

The analysis uses standardized factors provided by governmental and industry sources to efficiently determine the monetized value of user and social benefits resulting from the project improvements. Table 2 shows **Tulsa Community River Corridor Connections Project**'s long-term benefits aligned to the benefit categories.

Table 2: Quantified Project Benefits by Merit Criteria Category

Criteria	Benefit (Disbenefit) Category	Description	Monetized (7% Discount Millions)
State of Good Repair	Residual Value	Accrued value of trail assets over the analysis period	$2.5
Safety	Reduced Collisions	Reduction in traffic fatalities/injuries, and PDO crashes	$72.5
Quality of Life	Health and Mobility Benefits	Health benefits realized from the improved lifestyle of those that switch to bicycle travel rather than automobile and use the new facilities for recreation as well as improved cyclist/pedestrian mobility options	$0.6

Source: WSP, 2020

The Project's BCA did not measure the number of trips estimated to shift from automotive trips to bicycle or pedestrian trips. In other words, the reduction in Vehicle Miles Traveled (VMT) was not measured to determine potential emissions reductions as a result of the Project's improvements. Therefore, the Project's benefits may be higher than those that are measured in this BCA because of potential reduced automotive trips and the associated health, mobility, and environmental benefits with added bicycle or pedestrian trips.

4.1 SAFETY

The safety benefits assessed in this analysis include a reduction in fatalities and injuries, as well as a reduction in other property damage crash costs resulting from the project.

Safety benefits are primarily derived from the roadway crashes that will be avoided from the trail construction efforts that remove cyclists and pedestrians from unsafe roadway travel conditions to a shared path away from oncoming traffic. The recent crash history is shown in Table 3.

Table 3: Project Area Crash History

Crash Severity	Total Crashes	Annual Rate of Crashes
O	996	199.2
C	335	67
B	212	42.4
A	55	11
K	12	2.4
U	101	20.2

The BCA uses a Crash Modification Factor (CMF) of 0.75 associated with "Install shared path" throughout the project area to determine the number of reduced crash types because of the safer trail and road conditions. The project will likely also remove motor vehicle trips from the road that could result in more accidents in crowded local landmarks like the Jenks Mall and Turkey Mountain and improves the resilience of the current riverside conditions to prevent flood-related pedestrian, cyclist, and motorist crashes. However, as a conservative estimate, just the one CMF was employed across the project area to measure crash reductions.

The annual reductions in crashes are monetized using USDOT values for crashes of different types (shown in Table 8). The project lifecycle's safety benefits are expected to total $209.1 million in 2018 undiscounted dollars, and $79.0 million in 2018 dollars at a 7 percent discounted rate, as shown in Table 3.

Table 4: Safety Estimation of Benefits, Millions of 2018 Dollars

Benefit	Undiscounted	Discounted (7%)
Fatality Reduction	$115.2	$43.5
Injury Reduction	$90.7	$34.3
Property Damage Reduction	$3.19	$1.2
Total Safety Benefits	$209.1	$79.0

Source: WSP, 2020

Table 5: Safety Benefits Assumptions and Sources

Variable	Unit	Value	Source
No Injury - O	2018$	$3,200	US DOT Guidance, January 2020
Possible Injury - C	2018$	$63,900	US DOT Guidance, January 2020
Non Incapacitating - B	2018$	$125,000	US DOT Guidance, January 2020
Incapacitating - A	2018$	$459,100	US DOT Guidance, January 2020
Killed - K	2018$	$9,600,000	US DOT Guidance, January 2020
Injured Severity Unknown	2018$	$174,000	US DOT Guidance, January 2020
Unknown If Injured (# Incidents Reported)	2018$	$132,300	US DOT Guidance, January 2020
Crash Modification Factor	Factor	0.75	CMF Clearinghouse, Factor #9250

4.2 STATE OF GOOD REPAIR & RESIDUAL VALUE

State of Good Repair and Residual Value benefits are derived from the value remaining on each investment's lifecycle value at the end of the analysis period. The design life of the trails will be 40 years. Per USDOT instruction, the project analysis period is equal to the construction period (three years) plus the operational period (20 years), for a total project analysis period of 23 years (FY 2021 – FY 2044). At the end of the project analysis period, INCOG will realize the additional benefit of the residual value of the trails that still exist. The original value of the trails will be $27.7 million (2018 dollars), amounting to $2.5 million (2018 dollars, discounted at seven percent) in residual value benefits through the end of the analysis period.

Table 6: Residual Value Estimation of Benefits, Millions of 2018 Dollars

Benefit	Expected Lifespan	Capital Cost	Value in Final Year	
			Undiscounted	Discounted (7%)
East Bank	40	$11.3	$5.7	$1.0
West Bank	40	$9.9	$4.9	$0.9
Turkey/91st	40	$4.3	$2.2	$0.4
86th-96th	40	$2.2	$1.1	$0.2
Total	40	$27.7	$13.8	$2.5

Source: WSP, 2020

4.3 ECONOMIC COMPETITIVENESS

The **Tulsa Community River Corridor Connections Project** will contribute to economic competitiveness by providing commuter mobility benefits to bicyclists and pedestrians while taking cars off the road, reducing travel times for cars and trucks, and reducing vehicle operating costs. The value of these benefits have not been quantified in the BCA model. The Project will also support several qualitative economic benefits. The trails will provide key connections to the downtown area of Tulsa and Jenks, Turkey Mountain, the upcoming Jenks Mall, and other Arkansas River recreational landmarks and destinations. The Project will also support several river-based recreational activities that will contribute to the local economy positively such as water taxis, water-based sports and travel, and riverside outdoor commercial centers like restaurants, outlet malls, and other gathering places.

4.4 QUALITY OF LIFE

This project will create quality of life benefits including improved health and recreation.

Health benefits are calculated for cyclists and pedestrians, both commuter and recreational, who are shifting routes to or will be using for the first time the new path. Mobility benefits are calculated for commuters and recreational pedestrians and cyclists along the trails. The Project improves users' quality of life further through improving aesthetics and natural environment to interact with, but these benefits have not been quantified.

Table 15 illustrates the quantified benefits relating to health and mobility, which total $1.8 million in undiscounted benefits over the life of the project. More detail on the methodology used to derive these estimates is below.

Table 7: Quality of Life Estimation of Benefits, Millions of 2018 Dollars

Benefit	Undiscounted	Discounted (7%)
Health Benefits	$1.2	$0.4
Environmental Sustainability and Mobility Benefits	$0.6	$0.2

Total Quality of Life Benefits	$1.8	$0.6

Source: WSP, 2020

4.4.1 *HEALTH BENEFITS*

Health benefits apply to cyclists who would otherwise not be able to use a bicycle under existing conditions. These cyclists realize benefits by increased daily physical activity, which has been shown to improve health and reduce future medical costs. The NCHRP 552 guidelines identified ten studies which estimated the overall health benefit of increased physical activity. These benefits ranged from $19 to $1,175 per new cyclist per year, with a median value of $128 (all values in 2006$). These values were adjusted to 2018$, resulting in a value of $155.58 per cyclist. The NCHRP 552 guidelines state that this benefit exists once per year for each daily new user. The benefit is thus defined as:

$$Health\ Benefit = b_n * H$$

Where

b_n = volume of daily new bicyclists (commuter and recreational)
H = per-capita health benefit, 2018$

The number of users were calculated by leveraging USDOT and NCHRP values associated with new bike and pedestrian infrastructure attracting existing and new cyclists and pedestrians to the infrastructure for both recreational and commuting purposes. These new corridor users were then multiplied by the overall project corridors distance to estimate overall VMT added from pedestrians and cyclists.

4.4.2 *RECREATIONAL BENEFITS*

The NCHRP 552 guidelines also identified benefits specifically for new recreational users of bicycle facilities. These benefits result from the time spent performing recreational activity, since this represents a revealed preference in how recreational cyclists choose to spend their time. This time is assumed to be one hour per bicyclist including preparation and clean-up time. The value of time for this benefit is assumed to be lower than the value of time used for commuters or the population at large. The NCHRP 552 guidelines indicate a value of $10 per hour in 2006 dollars, which becomes $12.17 per hour in 2018 dollars for cyclists, and commuter benefits were $16.60 per hour for cyclists and $0.18 per person-mile for pedestrians.

4.4.3 *COMMUTER BENEFITS*

USDOT BCA guidance from January 2020 identified benefits specifically for new users of bicycle and pedestrian facilities that take advantage of this new infrastructure as part of their commutes. These benefits result from the time spent commuting using active transportation means instead of by transit or motor vehicles, since this represents a revealed preference in how active transportation users choose to travel. The value of time for this benefit is assumed to be greater than the value of time used for recreational users or the population at large. USDOT BCA guidance indicates a value of $16.60 per hour for cyclists and $0.18 for pedestrians.

5 SUMMARY OF RESULTS

5.1 EVALUATION MEASURES

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the Project into monetary units and compares them. The following common benefit-cost evaluation measures are included in this BCA:

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
- Benefit Cost Ratio (BCR): The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.

5.2 BCA RESULTS

The table below presents the evaluation results for the project. Results are presented in undiscounted and discounted at 7 percent as prescribed by the USDOT. All benefits and costs were estimated in constant 2018 dollars over an evaluation period extending 20 years beyond system completion in 2025. The total benefits from the project improvements within the analysis period represent $81.2 million when discounted at 7 percent. The total capital costs are calculated to be $21.4 million when discounted at 7 percent. The difference of the discounted benefits and costs equal a net present value of $59.8 million, resulting in a benefit-cost ratio (BCR) of 3.79.

Table 8: Benefit Cost Analysis Results, Millions of 2018 Dollars

Benefit	Undiscounted	Discounted (7%)
Total Benefits	$221.7	$81.2
Total Costs	$27.7	$21.4
Net Present Value (NPV)	$194.1	$59.8
Benefit Cost Ratio (BCR)	8.02	3.79
Internal Rate of Return (IRR)	27%	N/A

Source: WSP, 2020

6 SENSITIVITY ANALYSIS

The BCA results above use a Crash Modification Factor (CMF) of 0.75 – derived from a previous study installing a shared path for cyclists and pedestrians – to show crash reductions are expected to increase from the Build case. To use a more localized example to test further, the Muscogee (Creek) Casino & Resort recently underwent a trail construction project similar to this project's planned improvements and experienced a 69.3% crash reduction from 2017 to 2019 compared to the equivalent period from 2014 to 2016. The sample size of the casino's crash reductions is limited, but if a similar crash reduction rate is applied only to the bike and pedestrian crashes in the project area, crash benefits will increase to $103.6 million in 2018 dollars. The new discounted BCR then becomes 4.94. On the other hand, if a more conservative CMF – for example, 0.93 – is used instead of the original 0.75 value and crashes are only reduced by 7%, the BCR becomes 1.14. This sensitivity analysis is done to indicate potential results of the project if crashes are not reduced as much as in the original Build case. Changes from original analysis are shown in Table 8.

Table 9: Sensitivity Analysis Results (Millions of 2018 dollars)

Benefit	Base	Casino Sensitivity	0.93 CMF Sensitivity
Net Present Value (NPV)	$59.8	$84.9	$2.9
Benefit Cost Ratio (BCR)	3.79	4.94	1.14

These analyses are intended to highlight the strength of the Project and INCOG's more conservative approach to crash reductions in the model, while also indicating the likelihood of the project's safety benefits being much higher than are captured in the base model. Conversely, even if the Project's crashes are not reduced as drastically as estimated, the higher CMF shows that the project will still remain a value to INCOG and USDOT compared to its costs. If a more aggressive CMF is applied or if a similar local project's results are equated to the Project, more dramatic crash reduction benefits and improved cost effectiveness are likely.

Tulsa Community River Corridor Connections Project

Indian Nations Council of Governments

Benefit Cost Analysis Model

This model contains all calculations used in the Benefit Cost Analysis for this project. The legend below provides guidance on the role of each tab, and the meaning of different colors and shading throughout the model. Sensitivity analysis may be performed by adjusting values in the lime green and orange tabs. The remaining tabs are for calculation purposes only.

Tab Reference

- Aqua Shading - Intro Materials
- Lime Green Shading - Standard Input Values, reflecting guidance from USDOT and other sources
- Orange Shading - Project Input Values, reflecting project-specific information
- Light Pink Shading - Calculations
- Purple Shading - Aggregated Costs and Benefits (Quantified)
- Green Shading - Aggregated Costs and Benefits (Monetized)
- Blue Shading - Output Tables and Charts

Cell Reference

- Light Green Cell Shading - Model Owner Input Value
- Light Yellow Cell Shading - User Input Value
- Blue Text - Input from Another Sheet
- Red Text - Exported to Another Sheet