Highway MM:
Corridor of Opportunity

HIGHWAY MM
CORRIDOR OF OPPORTUNITY

US DEPARTMENT OF TRANSPORTATION
REBUILDING AMERICAN INFRASTRUCTURE WITH SUSTAINABILITY AND EQUITY (RAISE) 2024

Freight Connections

Pedestrian Safety

February 28, 2024
BCA Narrative

OZARKS TRANSPORTATION ORGANIZATION
A METROPOLITAN PLANNING ORGANIZATION

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION

The purpose of this document is to describe methodologies, provide assumptions, and cite data sources used to prepare the Benefit-Cost Analysis (BCA) for the Highway MM: Corridor of Opportunity RAISE Grant application.

Table 1 Summary of Benefits

Benefit-Cost Analysis Summary		
Benefits	Undiscounted	
Travel Time Savings	$	22,500,269
Safety	$	86,335,791
Operations and Maintenance	$	(1,612,654)
Emissions Reduction		
Non-CO2 Emissions Reduction	$	1,962,631
CO2 Emissions Reduction	$	7,211,878
Residual Value	$	3,474,433
Railroad Safety - At-Grade Rail Closing	$	791,588
Health Benefits	$	13,267,980
Amenity Benefits	$	1,747,342
Total Benefits	$	135,679,258
Total Discounted Project Costs	$	60,210,679
BCA Ratio	**2.25**	

Input values for the BCA can be found on the BCA Parameter Values Tab in the BCA Calculation Workbook as well as the workspaces on each tab.

PROJECT DESCRIPTION NO BUILD AND BUILD SCENERIO IN BCA

The project boundaries run from Interstate 44 to US 60

Build Scenario Characteristics:

- Closure of 3 Burlington Northern Santa Fe (BNSF) railroad crossings
- Build overpass over BNSF railroad tracks
- Widening road to a 4-lane primary arterial with raised medians
- Close through access to Highway MM at current US 60 Intersection and at Farm Road 103
- Two lane round-about on Highway MM at Farm Road 160
- 10-foot pedestrian shared use path
- Direct Current Charging Station near Interstate 44
- 5-foot ADA sidewalks along the corridor
- Widening of bridge over MO 360 to accommodate 4-lanes and pedestrian facilities

No Build Scenario Characteristics:

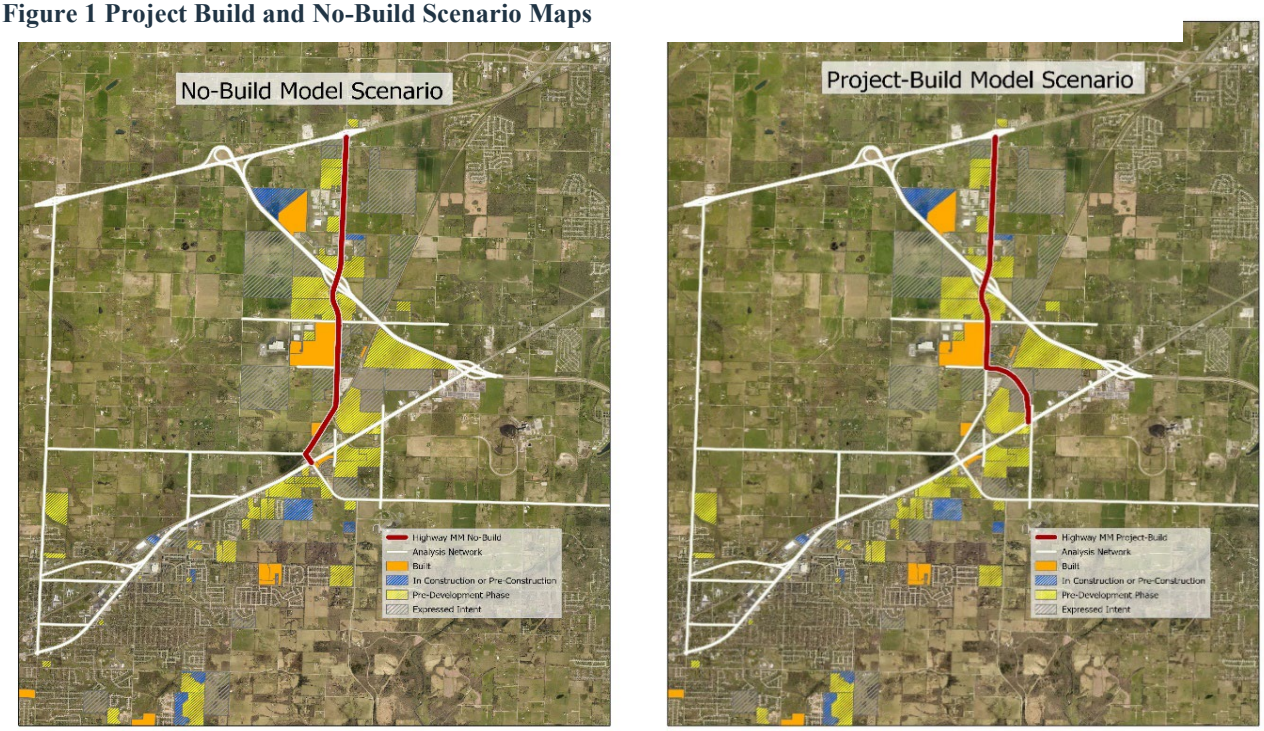
- 3 BNSF railroad crossings
- 2-lane 3.95-mile north/south minor arterial with two 12-foot wide lanes
- Three-leg stop-controlled intersection at Farm Road 160 and Highway MM
- No shared use pedestrian and bicycle path
- No Direct Current Charging Stations in vicinity
- Narrow shoulders and no pedestrian facilities
- 2-lane bridge over MO 360 with no pedestrian accommodations

TRAVEL DEMAND FORECASTING

The OTO MPO Travel Demand Model was used to forecast a "No-Build" and a "Project Build" scenario for the 2045 model year. The model base year is 2018 and was updated using VISUM version 13.0+ in 2020. The OTO's 2045 VISUM model was modified to consider the recent improvements and travel behavior within the study area more accurately. The OTO's consultant, Olsson, updated the model with known and anticipated future developments impacting the MM corridor project segments and surrounding area. A "No-Build" scenario generated travel time, delay, and volumes for 2045 along corridor segments and nearby roads with existing roadway capacities. This analysis network is highlighted in Figure 1.

The "Project Build" scenario incorporated the proposed Highway MM: Corridor of Opportunity improvements to generate travel time, delay, and volumes for 2045 for the build alternative.

Figure 1 Project Build and No-Build Scenario Maps



Based on the model runs, 2045 daily traffic volumes for "No-Build" and "Project-Build" scenarios were developed for three project segments along the Highway MM corridor.

Model output for only the project corridor segment volumes, mapped in red, were used for the travel time savings analysis.

Model output for all roadways in the analysis network was used to calculate emissions benefits using vehicle hours of delay along the entire analysis network.

Model links for both scenarios were delivered to the OTO in shapefile format. Length weighted ADT for the 2045 model scenario volumes was calculated to correspond with the MoDOT State of the System Segment lengths and 2022 base-year AADT for the three project segments. Tabs in the BCA spreadsheet contain model output from both scenarios.

Two additional years were extrapolated from the 2045 model output to agree with the BCA analysis period of 20 years through 2047. Although this was discouraged in the BCA guidance, two additional years should have minimal impact.

TRAVEL DEMAND MODEL SCENARIO TRAFFIC VOLUMES

Table 2 Travel Demand Model Scenario Traffic Volumes

Corridor Segment	2022 AADT	No-Build 2047 AADT	Project-Build 2047 AADT
Hwy MM – I-44 to MO360	12,957	23,857	28,718
Hwy MM – MO360 to Haile St*	7,693	18,630	26,333
Hwy MM – MO360 to US60*	7,693	18,630	26,333

***Both sections share one segment in MoDOT GIS Data**

TRAVEL TIME SAVINGS

Assumptions:

- Highway MM from U.S. Highway 60 to State Highway 360 is expected to reach Level-of-Service F using passenger car equivalent volumes by 2027.
- Free flow speed is estimated to be 95% of the posted speed limit.
- Daily roadway capacity used for each scenario is developed from research completed by the Florida DOT based on the 2010 Highway Capacity Manual. A value of 8,450 vehicles per lane per day (vplpd) is used as the baseline for the No-Build two-lane rural arterial and 7,900 vplpd for the Project-Build suburban four-lane arterial placing the capacity values at 16,900 and 31,600, respectively.
- The Project-Build scenario will shorten the Highway MM segment from MO 360 to US 60 to 1.95 miles from 2.18 miles.

- Growth in annual daily traffic was applied incrementally throughout the analysis period for each project segment: (2047 ADT - 2022 ADT)/(2047 – 2022)

- Percentage speed from the LOS table was used to calculate travel time in minutes for peak and off-peak periods: Length (Miles)/(Speed (mph)/60)

- Travel time differences between No Build and Project Build were used to calculate benefits incrementally across the analysis period.

The following tables depict the percentage of free flow speed (PFFS) based on the Level of Service (LOS) for two-lane highways and a derived LOS for arterials based on volume-to-capacity ratios. Vehicle occupancy rates were not applied to the TTS due to lack of detailed factors for weekday peaks and composition of travel.

Table 3 Level of Service Criteria for Two-Lane Highways

	Class I Highways		Class II Highways	Class III Highways
LOS	ATS (mi/h)	PTSF (%)	PTSF (%)	PFFS (%)
A	> 55	<=35	<= 40	>91.7
B	>50 - 55	>35 - 50	>40 - 55	>83.3 – 91.7
C	>45 - 50	>50 - 65	>55 – 70	>75 – 83.3
D	>40 - 45	>65 - 80	>70 – 85	>66.7 – 75
E	>= 40	>80	>85	<=66.7
F	Demand Exceeds Capacity			

Source: https://www.smatstraffic.com/2021/07/26/level-of-service/ Highway Capacity Manual: Sixth Edition

Table 4 Level of Service Criteria for Arterials Based on Volume-to-Capacity Ratios

LOS	Description	V/C Ratio
A	Free flow conditions with unimpeded maneuverability. Stopped delay at signalized intersection is minimal.	0.0 to 0.6
B	Reasonably unimpeded operations with slightly restricted maneuverability. Stopped delays are not bothersome.	0.61 to 0.7
C	Stable operations with somewhat more restrictions in making mid-block lane changes than LOS B. Motorists will experience appreciable tension while driving.	0.71 to 0.8
D	Approaching unstable operations where small increases in volume produce substantial increases in delay and decreases in speed.	0.81 to 0.9
E	Operations with significant intersection approach delays and low average speeds.	0.91 to 1.0
F	Operations with extremely low speeds caused by intersection congestion, high delay, and adverse signal progression.	> 1.0

Source: https://ccag.ca.gov/wp-content/uploads/2014/07/cmp_2005_Appendix_B.pdf Transportation Research Board, Highway Capacity Manual, Special Report 209 (Washington, D.C., 1994)

For No-Build and Project-Build scenarios, the base free flow speed along the corridor is conservatively estimated to be 95% of the posted speed limit. Regardless of whether the project is implemented, the City of Republic and MoDOT staff have indicated the posted speed limit will be reduced to 45 mph from 55 mph. In addition, the Project-Build scenario will shorten the Highway MM segment from MO 360 to US 60 to 1.95 miles from 2.18 miles. Using these parameters, it is possible to compare travel speeds for the No-Build and Project-Build scenarios and calculate annual travel time savings due to the implementation of the project. Most parameters used to calculate travel time savings benefits are available on MoDOT's Datazone AADT Map web application.

Table 5 Parameters Utilized to Calculate Travel Time Benefits

Traffic Inputs			
	I-44 to MO360	MO360 to Haile St	Haile St to US 60
MoDOT AADT 2022	12,957	7,693	7,693
Motorcycle	187	132	132
Passenger Car	7,552	3,981	3,981
PU/Panel Truck	3,731	2,351	2,351
Bus	83	86	86
Single Unit Truck	620	460	460
Combo-Semi Trailer	784	683	683
AM Peak Hr	601	356	356
PM Peak Hr	942	559	559
Model 2045 ADT No Build	23,857	18,630	18,630
Model 2045 ADT Project Build	28,718	26,333	26,333
Route Miles - No Build	1.661	0.87	1.31
Route Miles - Project Build	1.661	0.87	1.08
Annual Vehicle Miles 2022	7,855,376	2,442,912	3,678,408
Annual Vehicle Miles 2045 No Build Scenario	14,463,426	5,916,016	8,908,023
Annual Vehicle Miles 2045 Project Build Scenario	17,410,750	8,362,031	10,380,453
VMT Annual Growth No Build v. Build Scenario	0.009	0.018	0.007
Roadway Commercial % 2022	0.115	0.160	0.160
Off Peak Vol	11,414	6,778	6,778
No Build Capacity	16,900	16,900	16,900
Project Build Capacity	31,600	31,600	31,600
2045 Volume/Capacity - No Build	1.41	1.10	1.10
2045 Volume/Capacity - Project Build	0.91	0.83	0.83
Avg Travel Time Peak No Build (Minutes)	3.32	1.74	2.62
Avg Travel Time Peak Project Build (Minutes)	2.95	1.55	1.73
Avg Travel Time Off Peak No Build (Minutes)	2.95	1.55	2.62
Avg Travel Time Off Peak Project Build (Minutes)	2.67	1.40	2.16
Base Free Flow Travel Time (Minutes) No Build	2.33	1.22	1.84
Base Free Flow Travel Time (Minutes) Project Build	2.33	1.22	1.92
BFF Travel Speed (mph)	42.75	42.75	42.75
Posted Speed Limit (mph)	45	45	45
Additional Annual Users No Build	454	456	456
Additional Users Project Build	657	777	777
Percent Peak Users	0	0	0
Addition Peak Users No Build	54	54	54
Additional Peak Users Project Build	78	92	92

Sources: MoDOT Datazone AADT Map, OTO Travel Demand Model

There are positive **Travel Time Savings** of **$22,500,269** over the 20-year period.

Assumptions:

- There will be a decrease in crashes of all severity types after the two-lane rural highway is converted to a divided four-lane suburban arterial with raised medians.

- There will be a reduction in injury crashes at the intersections of FR 160 & Hwy MM, FR 103 & US 60, US 60 & Hwy MM after conversion to a roundabout from a three-leg stop-controlled intersection, a new signalized four-leg with protected left-turns and guarded right-turns and vacating the current Hwy MM approach leg at US 60 after realignment.

Data used to calculate safety benefits were provided by MoDOT. Seven years of crash data from 1/1/2017 to 12/31/2023 were exported from MoDOT's datazone crash statistics map and used to calculate a baseline of annual averages for fatality, disabling & suspected serious injury, minor injury, and property damage only crashes. All crashes occurring along Hwy MM from I-44 to US Hwy 60 were selected for the analysis in addition to intersection locations impacted by the proposed project. The following table summarizes the seven years of crash history at specific locations of planned improvements on the Hwy MM corridor.

In the Project-Build scenario there is a positive discounted **Safety Benefit of $86,335,791** savings over the 20-year period.

CRASH HISTORY

Table 6 Crash History by Location

Location	Fatality	Disabling/Suspected Serious Injury	Minor Injury	PDO	Total
Hwy MM – I-44 to MO360	0	4	11	41	56
Hwy MM – MO360 to Haile St.	1	4	10	31	46
Hwy MM – Haile St. to US60	1	1	13	42	57
Hwy MM & FR 160	0	0	3	1	4
FR 103 & US60	0	0	3	8	11
Hwy MM & US60	0	3	20	135	158

Source: https://modatazone.modot.org/index.php/safety

CRASH MODIFICATION FACTORS

OTO staff used Highway Safety Manual (HSM) safety performance function spreadsheets to calculate expected crash frequencies for rural two-lane highways and multi-lane suburban arterials to reflect the No-Build and Project-Build scenarios using baseline crash statistics for each roadway segment and each intersection comprising the project locations.

'The HSM Part C provides a predictive method for estimating expected average crash frequencies at individual sites. This method relies on safety performance functions (SPF) that estimate predicted average crash frequency as a function of traffic volume and roadway characteristics (e.g., number of lanes, median type, intersection control, number of approach legs).' https://highways.dot.gov/safety/data-analysis-tools/highway-safety-manual

A multi-year analysis was run for each scenario using 2023 as a base year covering 25 years through 2047 with a conservative linear traffic growth rate of 1.8%. This resulted in crash frequencies using the KABCO scale for each year in the analysis period. Comparisons of the expected crash frequencies for each year in the no-build and project-build roadway conditions were used to calculate CMFs for each year in the analysis period. MoDOT crash severity levels were converted to the KABCO equivalent to calculate safety benefits consistent with the HSM reports. MoDOT's equivalent KABCO level is presented below.

Table 7 MoDOT Crash Severity Level Conversion to KABCO

MoDOT (MAIS) Level	KABCO Level
Fatal	(K) - Killed
Disabling/Suspected Serious Injury	(A) - Incapacitating
Minor Injury	(B) - Non-incapacitating
-	(C) - Possible Injury
PDO	(O) - No Injury
-	(U) - Injured (Severity Unknown)

Table 8 Summary Results for the HSM 25-Year Analysis Summary Reports

Project Scenario	Expected Total	Expected KABC	Expected PDO
No Build (Rural Two-Lane)	1,067.1	355.4	711.7
Project Build (Suburban Arterial)	1,005.7	312.8	692.9

HSM Rural Two-Lane Roads v9.1, 2016 & HSM Urbanized Arterials v9.1, 2016

The calculation of a CMF with treatment is as follows:

$$\text{CMF} = \frac{\text{Expected crash frequency with treatment}}{\text{Expected crash frequency without treatment}}$$

Applying the values for expected crash frequencies for each scenario to the CMF formula for each year in the multi-year analysis resulted in annual CMF the Project-Build scenario.

Table 9 CMFs Derived from the Multi-Year Analysis for Two-Lane Conversion to Urbanized Arterial

Year	KABC CMF	PDO CMF
2023	0.871	0.95
2024	0.872	0.96
2025	0.873	0.96
2026	0.874	0.96
2027	0.875	0.96
2028	0.876	0.96
2029	0.877	0.96
2030	0.878	0.97
2031	0.878	0.97
2032	0.879	0.97
2033	0.880	0.97
2034	0.880	0.97
2035	0.881	0.97
2036	0.882	0.98
2037	0.882	0.98
2038	0.883	0.98
2039	0.883	0.98
2040	0.883	0.98
2041	0.884	0.98
2042	0.884	0.98
2043	0.885	0.98
2044	0.885	0.99
2045	0.885	0.99
2046	0.886	0.99
2047	0.886	0.99

The annual safety benefit for each segment and intersection was calculated by applying the CMFs for that year to the annual averages for that location's crash severity levels and subsequently monetizing the crash severity level reduction to sum benefits for all locations for each year.

EMISSIONS ANALYSIS

Assumptions:

- Zero emission electric vehicles will grow to 2% of all passenger vehicles by 2027 and increase by 1% per year throughout the analysis period reaching 20% by 2047.

- The annual difference in vehicle hours of delay between the No-Build and Project Build model scenarios were calculated incrementally for each year in the analysis period and used to determine grams of pollutants and fuel consumption.

The emissions benefit calculation is based on the OTO 2045 Travel Demand Model runs for the No-Build and Project-Build scenarios for the complete analysis network that includes roadways that are expected to be heavily influenced by the project. Annual vehicle hours of delay for each year in both model scenarios throughout the analysis period were calculated on the "No Build 2045 Model Output" and "Project Build 2045 Model Output" tabs in the BCA workbook, respectively. The yearly difference in vehicle hours of delay between the No-Build and Project Build scenarios was used to calculate the savings in emissions from the No-Build and Project-Build Scenarios. Idle emission rates in grams per hour were applied to the difference in vehicle hours of delay for the percentage of trucks vs passenger vehicles on the analysis network. Emission rates were derived from the EPA. The following tables provide the values for emission rates and short ton to metric ton conversion.

Table 10 Average Idle Emissions Rates (grams per hour)

Light Duty Gasoline Vehicles	
Volatile Organic Compounds (VOC)	2.683
Nitrogen Oxide (NOx)	3.515
Particulate Matter (PM2.5)	N/A
Sulfer Dioxide	N/A
Heavy Duty Diesel Vehicle	
Volatile Organic Compounds (VOC)	3.455
Nitrogen Oxide (NOx)	33.763
Particulate Matter (PM2.5)	1.1
Sulfer Dioxide	N/A

Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks, EPA, October 2008

Table 11 Unit Conversions

Grams per US Short Ton	907,185
Metric Ton to Short Ton	1.1

The damage costs for NOx and PM2.5 emissions were calculated based on the yearly value per metric ton in Table A-6 in the December 2023 US DOT BCA Guidance for Discretionary Grant Programs.

Idling Fuel Use Supporting Information

Table 12 Idling Fuel Use Supporting Data Parameters

Vehicle Type	Fuel Type	Engine Size (Liter)	Gross Vehicle Weight	Idling Fuel Use (Gal/Hr with No Load)
Compact Sedan	Gas	2	-	0.16
Large Sedan	Gas	4.6	-	0.39
Compact Sedan	Diesel	2	-	0.17
Medium Heavy Truck	Gas	5-7	19,700-26,000	0.84
Delivery Truck	Diesel	-	19,500	0.84
Tow Truck	Diesel	-	26,000	0.59
Medium Heavy Truck	Diesel	6-10	23,000-33,000	0.44
Transit Bus	Diesel	-	30,000	0.97
Combination Truck	Diesel	-	32,000	0.49
Bucket Truck	Diesel	-	37,000	0.9
Tractor Semi-Trailer	Diesel	-	80,000	0.64

https://www.energy.gov/eere/vehicles/fact-861-february-23-2015-idle-fuel-consumption-selected-gasoline-and-diesel-vehicles

Idling Fuel Use for passenger cars used the average gas use for Compact and Large Sedans (0.275) and the value for Combination Trucks (0.49) applied to the 2022 commercial percentage on the analysis network. The damage costs for CO_2, NOx, and $PM_{2.5}$ emissions were calculated based on the yearly value per metric ton in the December 2023 US DOT BCA Guidance for Discretionary Grant Programs.

Pedestrian Trail Addition VMT Reduction Emissions Calculation

Consideration was taken for the CO2 reduction that the new pedestrian walking trail would contribute. Utilizing a formula published by the California Air Resources Board in a publication found here: https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/pedestrian_facilities_technical_041519.pdf the VMT reduction was calculated below:

Table 13 Auto VMT Reduced Formula

Auto VMT Reduced Formula (D)*(ADT)*(A+C)*(L)					
Days	ADT	Adjustment Factor	Activity Center	Length	VMT
321	7,693.00	0.0019	0.002	1.08	10,401.34

- Estimated passenger car (light duty) at 22.2 mpg and Trucks and Busses at 12 mpg.
- Conservatively estimated daily traffic at 90% light duty and 10% heavy duty trucks and busses.
- Using the mpg values, converted vehicle miles travelled to gallons of fuel by vehicle type based on VMT reduced.

- Multiplied grams of CO2 released per gallon of gasoline (8,897) and diesel (10,180) for light duty and heavy duty traffic, respectively.
- Grams were converted to US short tons by dividing by 907,185 (the number of grams per short ton).
- Multiplied short tons by the cost of CO2 by calendar year.
- Guidance from (https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#burning)

This project reduces CO2 emissions by **5.14 US Short Tons** per year from the addition of the new pedestian facilities from Haile Street to US 50. This would be **102.82 US Short Tons** over the 20 years. There is **CO2 Emission Reduction Benefits** of **$7,211,878** and **Non-CO2 Emission Reduction Benefits** of **$1,962,631**.

OPERATING & MAINTENANCE COSTS

Operating and Maintenance Costs for the Highway MM corridor were provided by MoDOT. Baseline per lane-mile costs for patching, mowing, signing, snow removal, signals, and a 10-year resurfacing cycle were calculated and applied to the existing No-Build lane-miles (7.6) to create a base year value. A three percent rate of inflation was applied year-over-year throughout the analysis period. The per lane-mile costs were then applied to the Project-Build lane-miles (14.09) and inflated at three percent year-over-year through the analysis period. The No-Build costs were subtracted from the Project-Build costs resulting in $1,612,654 Discounted Total.

Table 14 Cost of Maintenance Mile

Operations and Maintenance Cost				
Project Benefit Year	Year	No-Build O&M	Build O&M	Net Difference Cost
	2023			
	2024			
	2025			
	2026			
	2027			
1	2028	$ 116,326	$ 214,063	$ 97,738
2	2029	$ 119,815	$ 220,485	$ 100,670
3	2030	$ 123,410	$ 227,100	$ 103,690
4	2031	$ 127,112	$ 233,913	$ 106,801
5	2032	$ 130,925	$ 240,930	$ 110,005
6	2033	$ 134,853	$ 248,158	$ 113,305
7	2034	$ 138,899	$ 255,603	$ 116,704
8	3035	$ 143,066	$ 263,271	$ 120,205
9	2036	$ 147,358	$ 271,169	$ 123,811
10	2037	$ 151,778	$ 279,304	$ 127,526
11	2038	$ 156,332	$ 287,683	$ 131,351
12	2039	$ 161,022	$ 296,314	$ 135,292
13	2040	$ 165,852	$ 305,203	$ 139,351
14	2041	$ 170,828	$ 314,359	$ 143,531
15	2042	$ 175,953	$ 323,790	$ 147,837
16	2043	$ 181,231	$ 333,504	$ 152,272
17	2044	$ 186,668	$ 343,509	$ 156,840
18	2045	$ 192,268	$ 353,814	$ 161,546
19	2046	$ 198,036	$ 364,428	$ 166,392
20	2047	203,977.51	375,361.23	171,383.72
Total Costs		**$ 3,125,710**	**$5,751,960**	**$ 2,626,250**

AMENITY BENEFITS

The BCA Guidance provides recommendations for pedestrian facilities. Benefits were quantified for the following project improvements, based on a conservative AADT along the sidewalk and trail additions and a 1% annual increase sidewalk and 2% increase on the shared use path:

- Average walker trip mile .86 mile
- Expanded or new sidewalk width – 5-ft
- Expanded or new trail width – 10-ft
- Reduction of Traffic Speed by 1 mph – 10 mph reduction for sidewalk calculations
- Days per year sidewalk and trail in use – 340 days (to account for severe weather occurrence)
- Total Pedestrian Facility Improvement Value Sidewalk - $1.45
- Total Pedestrian Facility Improvement Value Shared Use Path - $1.10

The corridor currently does not have sidewalks available for pedestrians. A conservative estimate of 200 AADT along the shared use path, 150 AADT on the sidewalk, and 50 AADT from the corridor segment from Haile Street to MO 360, and 30 AADT from MO 360 to I-44 was assumed. The positive discounted **Amenity Benefit** of **$1,747,342** is realized along the corridor.

Table 15 Pedestrian Facility Inputs

Pedestrian Facility Inputs										
Segment	Number of Walkers Per Segment	Expand or new Sidewalk (per foot of added Width)		Expand or new Sidewalk (per foot of added Width)	Reducing Traffic Speed by 1 mph (for speeds greater than <45 mph)		Valute Reducing Traffic Speed by 1 mph (for speeds greater than <45 mph)	Total Pedestrian Facility Improvement $ Value	Trip Mile	Days Per Year
Shared Use Path	200	10'	0.11	1.1	0	0	0	$1.10	0.86	340
Pedestrian Improvement US 60 to Haile Street	150	5'	0.11	0.55	10	0.09	$0.90	$1.45	0.86	340
Pedestrian Improvement Haile Street to MO 360	50	5'	0.11	0.55	10	0.09	0.9	$1.45	0.86	340
Pedestrian Improvement MO 360 to I-44	30	5'	0.11	0.55	10	0.09	0.9	$1.45	0.86	340

Values from January 2023 BCA Guidance. Pedstrians from estimate of daily walkers. Springfield, MO trail counts average weekly walkers from March to September 2020 1,560. Total average usage of trail segment in Springfield area from March to September 56,160. Numbers used here are conservative and below the local average.

HEALTH BENEFITS OF INDUCED ACTIVE TRANSPORATION VALUES

The BCA Guidance provides recommendations for Mortality Reduction Benefits of Induced Active Transportation Values.

Table 16 Mortality Reduction Benefit Input – Pedestrian

Mortality Reduction Benefit Criteria - Pedestrian						
Segment	Number of Walkers	Days per Year	Induced Walking Trips	Applicable Age Range	Benefit	Total Value of New Trips
Shared Use Path	200	340	0.89	0.68	$ 7.63	$ 296,305.92
Sidewalk - US 60 to Haile Street	150	340	0.89	0.68	$ 7.63	$ 222,229.44
Sidewalk - Farm Road 160 - MO 36	50	340	0.89	0.68	$ 7.63	$ 74,076.48
Sidewalk - MO 360 to I-44	30	340	0.89	0.68	$ 7.63	$ 44,445.89

Values from December 2023 BCA Guidance. Pedestrians from estimate of daily walkers. Springfield, MO trail counts average weekly walkers from March to September 2020 1,560. Total average usage of trail segment in Springfield area from March to September 56,160. Numbers used here are conservative and below the local average.

Table 17 Mortality Reduction Benefit Input – Bicyclist

Mortality Reduction Benefit Criteria - Bicyclist						
Segment	Number of Bicyclists	Days per Year	Induced Biking Trips	Applicable Age Range	Benefit	Total Value of New Trips
Shared Use Path	40	340	2.38	0.59	$ 6.80	$ 129,860.42
Sidewalk - US 60 to Haile Street	15	340	2.38	0.59	$ 6.80	$ 48,697.66
Sidewalk -Haile Street - MO 360	10	340	2.38	0.59	$ 6.80	$ 32,465.10
Sidewalk - MO 360 to I-44	10	340	2.38	0.59	$ 6.80	$ 32,465.10

The Ozark Greenways (ozarkgreenways.org) is a regional nonprofit that maintains and advocates for trails in the Springfield, MO region. The organization has trail counts on Springfield region trails. Using these trail count baselines, the BCA utilized bicycle and pedestrian counts that were below the local average to ensure conservative factors were applied. The BCA worksheet has a tab with the trail counts for comparison (Springfield Region Trail Counts). In addition, the national average factor of .59 for bicyclists and 0.68 for pedestrians were applied since the local trail counts did not differentiate between visitor age. The **Health Benefits** for Pedestrians and Bicyclists is **$13,267,980.**

RAILROAD SAFETY

The OTO utilized GradeDec.net, a highway-rail grade crossing investment analysis tool, developed and maintained by the Federal Railroad Administration to calculate the predicted crashes per rail crossing. The safety analysis within GradeDec.net is based on the USDOT Accident Prediction and Severity Model (APS) and Resource Allocation Method. Two rail crossings were examined in the GradeDec.net program, SS MM (Highway MM) and County Road 160 (Haile and Orr St./Farm Road 160), and Farm Road 170 in the Republic area maintained by the BNSF railroad.

The SS MM crossing currently has a railroad crossing arm at the at-grade-railroad crossing. Same AADT growth factor found in Travel Time Savings and Safety Analysis was applied to the SS MM crossing to match the predicted increase per the Traffic Demand Model.
The Project-Build is removing the two at-grade railroad crossings from I-44 to US 60. A third crossing is being removed along US 60 due to the closure at Highway MM and the BNSF overpass. The average predicted corridor accident rate of **.228395** decreases to a **zero** chance of vehicular/train collision. There is **Railroad Safety Benefits** of **$791,588**.

Table 18 Value of Safety Benefits for Highway MM At-Grade Crossing in Build Scenario

Value of Safety Benefits for Highway MM At-Grade Crossing in Build Scenerio 673274J						
Benefit Year	Calendar Year	Crash Probability	Fatal Accident Probability	Injury Accident Probability	Property Damage Probability	Value of Reduction in Fatalites, Injuries, Property Damage
0	2026 (Construction)					$ -
0	2027 (Construction)					$ -
1	2028	0.1297	0.0184	0.0397	0.0717	$ 46,511
2	2029	0.1327	0.0188	0.0406	0.0733	$ 48,350
3	2030	0.1335	0.0189	0.0408	0.0737	$ 48,840
4	2031	0.1342	0.0190	0.0411	0.0742	$ 49,303
5	2032	0.1349	0.0191	0.0413	0.0746	$ 49,776
6	2033	0.1356	0.0192	0.0415	0.0749	$ 50,223
7	2034	0.1363	0.0193	0.0417	0.0753	$ 50,647
8	2035	0.1370	0.0194	0.0419	0.0757	$ 51,081
9	2036	0.1376	0.0195	0.0421	0.0760	$ 51,492
10	2037	0.1382	0.0196	0.0423	0.0764	$ 51,879
11	2038	0.1388	0.0197	0.0425	0.0767	$ 52,281
12	2039	0.1394	0.0198	0.0426	0.0770	$ 52,657
13	2040	0.1400	0.0198	0.0428	0.0773	$ 53,028
14	2041	0.1405	0.0199	0.0430	0.0777	$ 53,395
15	2042	0.1411	0.0200	0.0431	0.0779	$ 53,757
16	2043	0.1416	0.0201	0.0433	0.0782	$ 54,097
17	2044	0.1421	0.0201	0.0435	0.0785	$ 54,432
18	2045	0.1426	0.0202	0.0436	0.0788	$ 54,769
19	2046	0.1431	0.0203	0.0438	0.0791	$ 55,098
20	2047	0.1436	0.0203	0.0439	0.0793	$ 55,421
Present Value						**$ 1,037,039**

Table 19 Value of Safety Benefits for Farm Road 160 At-Grade Crossing in Build Scenario

Value of Haile and Orr St. At-Grade Crosssing Closure 673272V						
Benefit Year	Calendar Year	Crash Probability	Fatal Accident Probability	Injury Accident Probability	Property Damage Probability	Value of Reduction in Crashes, Injuries, and Fatalities
0	2026 (Construction)					$ -
0	2027 (Construction)					$ -
1	2028	0.0266	0.0038	0.0067	0.0162	$ 3,635.55
2	2029	0.0298	0.0042	0.0091	0.0165	$ 4,773.95
3	2030	0.0265	0.0038	0.0066	0.0161	$ 3,617.23
4	2031	0.0265	0.0038	0.0066	0.0162	$ 3,621.51
5	2032	0.0266	0.0038	0.0066	0.0162	$ 3,631.27
6	2033	0.0266	0.0038	0.0067	0.0162	$ 3,636.79
7	2034	0.0267	0.0038	0.0067	0.0162	$ 3,645.96
8	2035	0.0267	0.0038	0.0067	0.0163	$ 3,655.76
9	2036	0.0268	0.0038	0.0067	0.0163	$ 3,661.29
10	2037	0.0268	0.0038	0.0067	0.0163	$ 3,670.48
11	2038	0.0269	0.0038	0.0067	0.0163	$ 3,676.55
12	2039	0.0269	0.0038	0.0067	0.0164	$ 3,685.76
13	2040	0.0269	0.0038	0.0067	0.0164	$ 3,698.21
14	2041	0.0270	0.0038	0.0067	0.0164	$ 3,703.67
15	2042	0.0270	0.0038	0.0068	0.0164	$ 3,713.00
16	2043	0.0271	0.0038	0.0068	0.0165	$ 3,718.55
17	2044	0.0271	0.0038	0.0068	0.0165	$ 3,728.35
18	2045	0.0271	0.0038	0.0068	0.0165	$ 3,733.81
19	2046	0.0272	0.0039	0.0068	0.0165	$ 3,743.18
20	2047	0.0272	0.0039	0.0068	0.0166	$ 3,752.47
Present Value						**$ 74,703**

Table 20 Value of Removing Farm Road 170 At-Grade Crossing in Build Scenario

Value of Safety Benefits for Highway MM At-Grade Crossing in Build Scenerio 673275R						
Benefit Year	Calendar Year	Crash Probability	Fatal Accident Probability	Injury Accident Probability	Property Damage Probability	Value of Reduction in Crashes, Injuries, and Fatalities
0	2026 (Construction)					$ -
0	2027 (Construction)					$ -
1	2028	0.0288	0.0041	0.0088	0.0159	$ 6,755.90
2	2029	0.0265	0.0038	0.0066	0.0161	$ 5,269.10
3	2030	0.0298	0.0042	0.0091	0.0165	$ 7,065.81
4	2031	0.0304	0.0043	0.0093	0.0168	$ 7,226.91
5	2032	0.0306	0.0043	0.0094	0.0169	$ 7,306.29
6	2033	0.0309	0.0044	0.0095	0.0171	$ 7,385.25
7	2034	0.0311	0.0044	0.0095	0.0172	$ 7,454.38
8	2035	0.0314	0.0044	0.0096	0.0173	$ 7,522.49
9	2036	0.0316	0.0045	0.0097	0.0175	$ 7,600.86
10	2037	0.0318	0.0045	0.0097	0.0176	$ 7,663.65
11	2038	0.0045	0.0045	0.0098	0.0177	$ 5,980.24
12	2039	0.0323	0.0046	0.0099	0.0178	$ 7,793.53
13	2040	0.0325	0.0046	0.0099	0.0179	$ 7,860.60
14	2041	0.0327	0.0046	0.0100	0.0181	$ 7,922.10
15	2042	0.0329	0.0047	0.0101	0.0182	$ 7,983.67
16	2043	0.0331	0.0047	0.0101	0.0183	$ 8,040.22
17	2044	0.0332	0.0047	0.0102	0.0184	$ 8,095.79
18	2045	0.0334	0.0047	0.0102	0.0185	$ 8,151.82
19	2046	0.0336	0.0048	0.0103	0.0186	$ 8,212.67
20	2047	0.0338	0.0048	0.0103	0.0187	$ 8,262.61
Present Value						**$ 149,554**