Joel Greer, Mayor
Jessica Kinser, Administrator
City of Marshalltown
24 North Center Street
Marshalltown, IA 50158
Tel - (641) 754-5701

MEMORANDUM OF BENEFIT COST ANALYSIS – FOR 2022 RAISE GRANT

Date: April 12, 2022

2022 Update Prepared By: Heather Thomas, P.E., City of Marshalltown

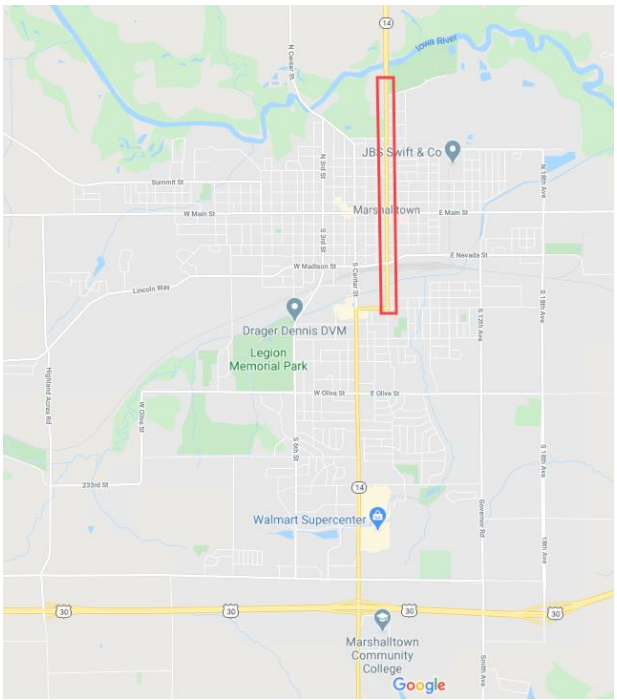
Originally Prepared By: Kelsey Retherford, P.E., Bolton & Menk

Purpose

This memorandum documents the methodology and results of a benefit-cost analysis for the proposed build alternative for the **Puerta de Marshalltown** - Highway 14 Corridor Improvements Project in Marshalltown, IA.

This stretch of undivided highway is located in the northern portion of Marshalltown. It bisects the eastern and western portions of town and is immediately adjacent to the eastern limits of downtown Marshalltown. The extents are from Anson Street at the southern limits, north to the northern city limits. It is a 1.9 mile long, 4-lane urban typical section, and includes 19 intersections. There are 6 signalized intersections located at Anson Street, Linn Street, Church Street, Main Street, State Street, and Riverside Street. In-between the signalized intersections, the intersections of May Street, Nevada Street, Marion Street, and Edgewood Street have higher use or are planned for future development; therefore, these have been analyzed in more depth. Additionally, there are numerous driveway accesses for local business to Highway 14 which pose risks. **Figure 1** shows an overview of the project location.

Figure 1. Project Location



To mitigate risks associated with a 4-lane typical section and many driveways, transportation engineers have recommended conversion to a 3-lane section. This 4-to-3 lane conversion would also incorporate driveway restrictions; new signals with improved signal timing; and improved pedestrian facilities. This stretch of roadway is a key transportation route for commuters during the work week; semi-truck traffic accessing industrial facilities; recreators accessing two prominent City parks; business and residential properties along the corridor; and provides the primary north-south through route in Marshalltown.

Development of an industrial park expansion in the northeast portion of town is currently in the bidding process and expected to be built out between the commencement of the Highway 14 Improvements and the 20-year analysis. The traffic from the development would access Highway 14 from Edgewood Street and Marion Street. This traffic was included in both future year alternatives.

For the study, a build alternative was analyzed and compared to a no-build alternative. The alternatives are listed below:

1. No-Build – Do nothing alternative
2. Build - Construct 3-lane typical section with driveway restrictions, new signals with improved signal timing, and improved pedestrian facilities.

Background Info

A primary goal for this project is to improve safety and provide multimodal transportation opportunities while maintaining traffic flow at an acceptable level of service. Using Iowa Department of Transportation (Iowa DOT) crash data from 2011-2020, it showed that there were 403 crashes along the corridor. In all, there was one fatality, four suspected serious injury crashes, and 41 suspected minor injury crashes associated with this stretch of roadway in the 10-year time period. **Table 1** shows a summary of collisions along this stretch.

Table 1. 2011-2020 Highway 14

KABCO Level	Severity	Number of Collisions
K	Fatal	1
A	Suspected Serious Injury	4
B	Suspected Minor Injury	41
C	Possible Injury	68
O	No Injury	289
	Total	**403**

Providing alternative modes of transportation is another priority with this project. The sidewalks in the downtown area are directly adjacent to the roadway. North of the downtown, the sidewalks are separated from the travel lanes by only a couple feet that is filled with sign, light, and traffic signal posts, making it uncomfortable for pedestrians to use.

With the changes being made to separate the sidewalk and the roadway and add a trail along the southern portion of the corridor to connect to an off-highway trail route, there will likely be an increase in other forms of transportation such as biking and walking. Marshalltown Municipal Transit also operates throughout town and with rejuvenation and redevelopment in the norther corridor, would likely expand routes to service this area. However, these modes were not included in calculations. Refer to **Table 2** for a summary of expected AADTs for build and no-build conditions.

Table 2. Expected Highway 14 AADTs

Alternative	Year	
	2025	2044
No-Build	10,500	12,200
Build	10,500	12,200

The purpose of a benefit-cost analysis is to express the effects of an initial investment into a common measure, base-year dollars. This accounts for benefits occurring over long periods of time, while most of the costs are incurred as an initial investment. Under this approach, a project with monetized benefits that are greater than its costs will have a benefit-to-cost ratio greater than one and therefore is considered an economically beneficial endeavor.

Benefit-Cost Methodology

The monetary benefit for this project is quantified in terms of either a reduction or increase in vehicle miles traveled (VMT), vehicle hours traveled (VHT), project area collisions, vehicle emissions, and roadway maintenance. Consideration is also given for pedestrian facilities and property values. The costs considered for the analysis include surfacing, subbase/base, grading and drainage, signal and lighting, right-of-way, utilities, as well as engineering and design fees. The itemized cost breakdown of the build scenario is shown in **Table A2** of **Appendix A**. Remaining capital values of these roadway features at the end of the analysis period are subtracted from the total cost of the project. The salvage values can be found in **Table A3** of **Appendix A** for a 7 percent discount rate.

The results of the analysis provide input for evaluating the overall benefit of the proposed improvements to the area. Since the current design is still preliminary, it should be noted that certain benefits and costs may change prior to final design; however, these changes are anticipated to be relatively minor.

General Assumptions

- All monetary values are discounted to the 2019 analysis year.
- The 20-year benefit period is based on a 2025 day-of-opening through the year 2044. Benefits are assumed to start January 1st, 2025 and end December 31st, 2044.
- Yearly Build and No-Build benefits are calculated based on linear interpolation over the 20-year analysis period.
- Longer travel times and rerouting of trips during construction years are not included in this analysis. Construction is anticipated to occur under traffic.
- Preliminary cost estimates were completed using unit costs for grading, base, and pavement. An appropriate risk factor given the early stage in the project development process was therefore used.
- 260 days per year was used in the analysis of weekday VHT, VMT, and emissions.
- Weekend VHT, VMT, and emissions were considered as well. A proportion of weekday VHT, VMT, and emissions benefits were applied to 105 weekend days per year. This process used a fraction of traffic for Saturdays and Sundays versus an average of Tuesday, Wednesday, and Thursday traffic to allocate weekend benefits since weekend traffic was not modeled as part of the traffic analysis.

- General assumptions regarding the costs associated with project area collisions, vehicle operating costs, time costs, component service life, analysis period, and discount rates can be found in **Table A1** of **Appendix A.**

Traffic Analysis

Traffic forecasts were determined under both no-build and build scenarios. The forecasts were determined based on historical Annual Average Daily Traffic (AADT) counts available from the Iowa Department of Transportation (Iowa DOT), current year traffic count data collected in 2017. The AADT data along with historical AADT data was used to determine growth rates on Highway 14 through the corridor.

Peak Hour Volumes

Once daily traffic volumes were determined, the peak hour turning movement counts collected as part of the Highway 14 Corridor study were adjusted. Existing turning movement counts were grown and reallocated at each count location based on the forecasted AADTs for each leg of the intersection. In the build scenario, certain turning movements were reviewed to determine if they needed rerouted throughout the network based on access closures or relocations. It was determined the routing would remain the same since no intersection restrictions were made.

No Build

For the No Build forecast, the growth rate along Highway 14 was 0.5 percent with a higher growth rate of 1.5 percent in the downtown between Nevada Street and Church Street per year based on the AADT's.

Build

The Build scenario keeps the traffic flow the same; therefore, the forecasted growth rate along Highway 14 is also 0.5 percent and 1.5 percent per year based on the AADT's.

Analysis

Synchro/SimTraffic was used to analyze the various traffic scenarios and configurations. The values obtained using the modeling software provide travel distance (vehicle miles traveled - VMT) and travel time (vehicle-hours traveled - VHT) for the corridor. See **Table 3** for VMT and VHT during 2025 and 2044 build and no-build scenarios.

Table 3. Yearly VMT and VHT

	Year	Type	No Build		Build	
VMT	2025	Cars	5,164,049	5,898,400	5,164,049	5,898,400
		Trucks	734,351		734,351	
	2044	Cars	6,058,810	6,920,400	6,058,810	6,920,400
		Trucks	861,590		861,590	
VHT	2025	Cars	192,940	213,817	202,920	224,877
		Trucks	20,877		21,957	
	2044	Cars	230,273	255,190	245,885	272,491
		Trucks	24,916		26,606	

Calculation of Benefits

Economic values for VHT, VMT, and emissions were obtained from the MnDOT guidance: "Benefit-Cost Analysis for Transportation Projects". See **Table 4** for a summary of economic values that were used for this analysis. A 20-year analysis period beginning in 2025 and ending in 2044 was chosen for the benefit-cost evaluation with all values discounted to 2019 dollars.

Table 4. BCA Recommended Standard Values

Occupancy Rates in US		
Auto	1.67	
Truck	1.00	
Value of Travel Time Savings (per person-hour)		
Auto	$	16.20
Truck	$	32.00
Operating Cost (per mile)		
Auto	$	0.45
Truck	$	0.94
Emissions Costs (per mile)		
Auto	$	0.05
Truck	$	0.23

Travel Time Benefit

Delay benefit was calculated in terms of delay per person. Using USDOT's guidance of 1.67 persons per car and 1.0 persons per truck, delay was calculated by using these multipliers and the travel time reported in vehicle hours by SimTraffic. The economic costs of this delay were then quantified by using MnDOT's suggested values for auto and truck travel time savings. The benefits derived from the build scenario for travel time are estimated at **($2,834,000),** a negative benefit as a result of the increased vehicle hours, for a 7 percent discount rate. 2025 and 2044 delay benefits can be seen in **Table A4** of **Appendix A** and a yearly breakdown of the benefit-cost analysis pertaining to delay can be found in **Table A5** of **Appendix A.**

Vehicle Operation and Emissions Benefits

Vehicle operations and emissions benefit were determined by using USDOT's suggested values based on a cost per mile traveled. Since the traffic flow is not expected to change, the vehicle miles traveled are not expected to change. The benefits derived from the build scenario for vehicle emissions are estimated at **$0** for a 7 percent discount rate. 2025 and 2044 vehicle operating and emissions benefits can be seen in **Table A6** and **Table A8** of **Appendix A**. A yearly breakdown of the benefit-cost analysis pertaining to vehicle operation and emissions can be found in **Table A7** and **Table A9** of **Appendix A**.

Operation and Maintenance Benefits

Major roadway maintenance would be needed immediately and in approximately 20 years if the project does not happen. For the purposes of this analysis, the city would mill and overlay the roadway, repair tops of storm sewer intakes, and replace deficient sidewalk and ramps. The maintenance is expected to

occur with the project year for no-build conditions was estimated for 2024 and again in 2044. Using data from previous mill and overlay projects, a 3.0-inch mill with 3.0-inch overlay was selected. Utility structure adjustments would be required for the overlay. Storm sewer tops are in poor condition and need replacement. The sidewalks, particularly ramps and in poor condition and need replacement to stay within ADA requirements. More frequent maintenance activities such as crack sealing and routine activities (i.e. snow plowing) was taken to be equal between build and no-build scenarios and therefore not taken into considerations when monetizing maintenance operations.

Utility maintenance would be needed for both the build and no-build alternatives; however, the amount of maintenance for the build alternative would presumably be significantly less. However, for the purposes of this analysis the utility maintenance was assumed equal for the build and no-build alternative due to the variability and unpredictability of frequency of emergency repair that would be needed on the no-build aging infrastructure.

Iowa DOT average bid prices were used in conjunction with approximate existing asphalt area within the project boundaries along Highway 14 as a base to calculate mill and overlay costs. Previous bid costs were used to determine approximate cost of utility improvements. This figure was inflated to reflect a probable cost for year of expenditure. The year of expenditure cost in 2024 is expected to be $3,745,000 and construction is anticipated to inflate at a 5% rate for the 2044 expenditure. Total discounted maintenance benefits are **$4,501,000** at a 7 percent rate. **Table A10** of **Appendix A** shows a yearly breakdown of the benefit-cost analysis for maintenance activities.

Safety Benefits

The methodology used to complete the crash analysis and corresponding benefit-cost ratio is described in the following paragraphs. Crash reduction within the project area was determined by separating intersections and segments so that factors and state averages could be applied appropriately. Crashes were obtained from the Iowa DOT Iowa Crash Analysis Tool database for a ten-year period from 2011-2020. These collisions were then annualized and reductions and additions of crashes were added appropriately relative to geometry reconfigurations.

Highway 14 will be converted from 4-lane to 3-lane. The current and projected traffic volumes allow the conversion with limited other improvements required. The following are improvements at intersections based on the traffic study:

- At the signalized intersections, the signals will be replaced and updated to current standards.
- The signal at Riverside Street will be removed because it no longer meets warrants.
- A southbound right turn lane will be added at Anson Street for the high volume of traffic because of the State Highway 14 route.

Access management was also reviewed with multiple driveways proposed to be removed and others to be combined. The review shows 112 driveways in the 1.9 miles and 49 that can be removed.

Crash modification factors were reviewed from the Highway Safety Manual (HSM) and the Crash Modification Factors (CMFs) Clearinghouse. Crash modification factors were used to determine the anticipated number of crashes after an improvement is made to an intersection or roadway. The Crash Modification Factors (CMF) for each improvement type are as follows:

- Road Diet (4 lane to 3 lane) (CMF ID: 199)
    - Shows improvements for all crashes, but notes higher reductions for rear end crashes, sideswipe same direction crashes, and angle, oncoming left crashes
        - CMF = 0.71
- Reduce Accesses
    - >48 accesses/mi reduced to 26-48 accesses/mi (CMF ID: 177)
        - CMF = 0.71
    - 26-48 accesses/mi reduced to 10-26 accesses/mi (CMF ID: 178)
        - CMF = 0.69
    - 10-26 accesses/mi reduced to <10 accesses/mi (CMF ID: 179)
        - CMF = 0.75
- Provide a left turn lane on one approach
    - At a signalized intersection
        - CMF = 0.76 for all crashes (CMF ID: 263)
        - CMF = 0.72 for injury crashes (CMF ID: 267)
- Provide a left turn lane on two approaches
    - At an intersection with side street stop control
        - CMF = 0.53 for all crashes (CMF ID: 269)
        - CMF = 0.50 for injury crashes (CMF ID: 273)
    - At a signalized intersection
        - CMF = 0.81 for all crashes (CMF ID: 270)
        - CMF = 0.83 for injury crashes (CMF ID: 274)
- Provide a right turn lane on one approach
    - At a signalized intersection
        - CMF = 0.96 for all crashes (CMF ID: 286)
        - CMF = 0.91 for injury crashes (CMF ID: 288)

A copy of the CMFs is included in **Appendix B**. After establishing no-build and build crashes for 2020 using the CMFs, forecasted 2025 and 2044 collisions were obtained by inflating numbers according to the expected AADT growth along Highway 14 for the no-build and build scenarios.

Table 5. KABCO Collision Values

Severity	Description	2025		2044	
		No-Build	Build	No-Build	Build
K	Fatal	0.103	0.051	0.113	0.056
A	Suspected Major Injury	0.410	0.246	0.451	0.270
B	Suspected Minor Injury	4.204	2.721	4.621	2.992
C	Possible Injury	6.972	4.541	7.665	4.993
O	Property Damage Only	29.630	19.821	32.575	21.791
Total		**41.32**	**27.38**	**45.42**	**30.10**

The USDOT's value of a statistical life (VSL) provided in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs were used for the values of the crashes. A resulting benefit of **$8,928,000** was obtained for a 7 percent discount rate over the 20-year analysis period. A yearly breakdown of the benefit-cost analysis pertaining to this decrease in collisions can be seen in **Table A12** of **Appendix A**.

Pedestrian Facility Improvements

Pedestrian routes along the Highway 14 corridor were analyzed on the basis of only two intersections along the corridor to avoid double counting the pedestrian traffic. One intersection in the northern portion of the corridor (Highway 14 & Edgewood St) and one intersection in the southern portion of the corridor (Highway 14 & Church St) were selected and combined with pedestrian traffic counts collected in 2019. These counts assume traffic on the weekends is consistent with weekday traffic counts and that there is not an increase in pedestrian traffic as a result of the project. The city does; however, expect the rejuvenation and redevelopment of the Highway 14 corridor to spur additional development and investment in this area that will in turn increase pedestrian usage of these facilities. This data was combined with USDOT's guidance for the planned 1-foot (minimum) expansion of sidewalk width of $0.10 per person mile walked to come up with a resulting benefit of **$2,950.66,** as detailed in **Table A13** of **Appendix A**. This benefit is for providing a greater level of safety and comfort to those using the pedestrian facilities. A yearly breakdown of the benefit-cost analysis pertaining to the improvements to pedestrian facilities can be seen in **Table A14** of **Appendix A** and result in a benefit of **$22,287.47** based upon a 7 percent discount rate.

Property Value Increase

Highway 14 passes through the downtown business district. It connects to Highway 30 on the south side of the community and provides connectivity between adjacent residential neighborhoods. Many of the immediately surrounding residential neighborhoods are distressed and are below the low/moderate income threshold established by HUD. Many residents rely on the highway corridor for travel to employment, health care, and other daily essential services. The proposed project improvements will support the transportation needs of development through an existing transit stop and improvements to pedestrian/ bicycle facilities along the corridor. As a result of the proposed project improvements, and the transit-oriented development overlay, it is expected that redevelopment will occur along the project corridor and that property values will increase as a result of the project.

We have estimated the property value increase through the review of available properties for redevelopment that were severely dilapidated or demolished through two recent natural disasters, proposed new zoning becoming effective on April 11, 2022; and interest expressed through relationships developed through the City's Planning & Zoning Department and Marshalltown Area of Chamber if the City were to complete significant improvements to the Highway 14 corridor. The property value information was analyzed using the existing valuation of the parcels in the corridor, according to the Marshall County Assessor information.

Only a portion of the properties along the corridor were reviewed and considered reasonably likely for significant development to increase value on the basis of new or remodeled buildings. Those that were evaluated include:

1. The medical center site located in downtown was identified as a catalytic redevelopment site in the Highway 14 Corridor Plan. The estimated new value of these sites was determined by estimating the square foot of each type of new land use development identified in the concept plan and then assigning a value per square foot for each type of use. The value of the land was not adjusted, only the value of structures and/or dwellings as appropriate. The net total change was determined by the estimated value following redevelopment within the corridor.

2. An auto sales company expressed interest in bringing two dealerships to Marshalltown. Currently, much of this type of commercial business is located on the southern portion of town. With Marshalltown's commitment to significantly improving the Highway 14 corridor and investing in

the northern and downtown areas of the city – the development has agreed to locate along this stretch of Highway 14. A development agreement is underway with the City to outline the final details; however, the property has been purchased, the developer has begun renovations of the existing structures on site, and has committed to additional investment in creating two new dealerships adjacent to each other. They have a $17 million-dollar investment plan for improvements and are targeting the creation of 80-120 jobs.

3. A senior housing project has been awarded Low-Income Housing Tax Credits through the Iowa Financial Authority and additional financial support from the City at April 11th, 2022 council meeting for a 42-unit affordable housing development.

4. Multiple infill lots have opened up and many are currently city-owned as a result of the city taking possession of and demolishing structures as a result of the 2018 Tornado and 2020 Derecho. Interest from developers have been started and we anticipate generating much more with and if the Highway 14 corridor project proceeds.

The specific timing and phasing of the redevelopment is unknown at this time and was estimated incrementally over the 20-year life span of the proposed project. The medical center redevelopment concept plan proposes a development program that includes multi-level mixed residential/commercial buildings and single-story commercial buildings. Much of the health care campus is current property tax exempt and is considered a prime location for redevelopment in the corridor and in the downtown area. Private investment in the site will result in adding property tax to the City's tax roll. The following building areas are estimated:

- 87,500 square feet of residential components within the mixed-use buildings. The second and third floors are generally anticipated to be residential multifamily units.
- 62,500 square feet of commercial components within the mixed-use buildings. The first-floor uses are anticipated to be multi-tenant uses such as small retail, restaurant, or other consumer service type businesses.
- 14,800 square feet of commercial uses. The stand-alone single-story independent users are anticipated to be retail, restaurant, or other consumer service type businesses.
- 39,000 square foot adaptive reuse of a part of the existing hospital for senior housing.
- 7,000 square foot hotel.
- 20,000 square feet of townhouse or other attached on a common wall residential product.

These projects which will significantly increase property values would be phased over the 20-year life of the project and is estimated to be valued at $49,300,000 and contributes a positive net change to the overall corridor valuation by $30,500,220.

Based on the positive net change anticipated, the estimated benefit along the corridor totals $30,500,220 in the 20 years following construction. The total discounted property value increase benefits are **$18,211,000** at a 7 percent rate. A yearly breakdown of the benefit-cost analysis pertaining to Property Value can be found in **Table A15** of **Appendix A.**

Public Health Benefit

Improved public health is another benefit of the proposed project. This benefit was not quantified, but the improved pedestrian and bicycle facilities will improve public health. The project will make Highway 14 more pedestrian and bicycle friendly through the following improvements:

- Reduced crossing width of Highway 14
- Wider sidewalks
- Wider boulevard between pedestrians and vehicles
- ADA compliant facilities
- Intersection bump outs which will reduce vehicle speed, reduce the pedestrian crossing distance, and improve pedestrian visibility to vehicles
- Improved corridor lighting

Stormwater Runoff Mitigation

The project will also improve stormwater runoff management through less vehicle travel lanes, tree plantings, permeable widened boulevard space, and other green street elements where practical to reduce stormwater runoff and improve water quality. This benefit was not quantified.

Benefit-Cost Analysis Results

Table A16 of **Appendix A** shows a yearly breakdown of design and construction costs for the project. Refer to **Table 6** for a results summary of the benefit-cost analysis for the Highway 14 Improvements Project.

Table 6. Benefit-Cost Analysis Summary

Item	BCA	
	PV (7% Discount Rate)	
Travel Time Benefit	$	(2,834,000.00)
Collision Reduction Benefit	$	8,928,000.00
Operation and Maintenance Benefit	$	4,501,000.00
Emissions Benefit	$	-
Vehicle Operating Benefit	$	-
Pedestrian Facility Benefit	$	22,000.00
Property Value Benefit	$	18,211,000.00
PV Total Benefit	**$**	**28,828,000.00**
PV Total Cost	**$**	**22,210,000.00**
PV Salvage Value	$	1,828,000.00
(PV Total Cost - Salvage Value)	**$**	**20,382,000.00**
Benefit-Cost Ratio	**1.414**	

The analysis indicates that the build option has a benefit-cost ratio greater than 1.0, meaning that it is an economically beneficial project. The benefits of the project are estimated to be higher than the costs associated with the construction of the project. In addition, we believe that the estimated property value increase over the analysis period is conservative. A more complete breakdown of both the project costs and benefits can be found in **Table A17** of **Appendix A.**

Resources Used

"Benefit-Cost Analysis Guidance for Discretionary Grant Programs." Office of the Secretary. U.S. Department of Transportation, https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf

"Highway Safety Manual" Washington D.C. American Association of State Highway and Transportation Officials. 2010. Book

"Crash Modification Factors Clearinghouse." *Safety Research Center*, U.S. Department of Transportation Federal Highway Administration, http://www.cmfclearinghouse.org/

"Iowa Crash Analysis Tool." Iowa Department of Transportation, https://icat.iowadot.gov/

Appendix A

Benefit-Cost Analysis

Table A1

Assumptions Used in this Benefit-Cost Analysis

Injury Costs[1]

Property Damage Only	$	4,600.00
MAIS 1 (Minor)	$	35,400.00
MAIS 2 (Moderate)	$	554,600.00
MAIS 3 (Serious)	$	1,239,000.00
MAIS 4 (Severe)	$	3,138,800.00
MAIS 5 (Critical)	$	6,997,400.00
MAIS 6 (Not Survivable)	$	11,800,000.00

Time Costs[1]

Automobile (per person-hour)	$	16.20
Heavy Vehicle (per person-hour)	$	32.00

Average Vehicle Occupancy Rates[1]

Passenger Vehicles (Weekday Peak)	$	1.48
Passenger Vehicles (Weekday Off-Peak)	$	1.58
Passenger Vehicles (Weekend)	$	2.02
Passenger Vehicles (All Travel)	$	1.67

Vehicle Operating Costs[1]

Automobile (per mile)	$	0.45
Heavy Vehicle (per mile)	$	0.94

Emissions Costs[2]

Automobile (per mile)[2]	$	0.05
Heavy Vehicle (per mile)[2]	$	0.23

Routine Pavement Management Cost: No-Build

Mill and Overlay, Storm Sewer Intake and Sidewalk Adjustments to maintain ADA Compliance (2024)	$	3,745,000.00

Component Service Life (Years)

Engineering	0
Right-of-Way	100
Bridge & Water Main	60
Mass Grading and Drainage/Sewer	50
Base	40
Surface	25
Signal System	20

Analysis Period

20 Years (2025-2044)

Build Year

2024-2025

Discount Rate (Annual)

7.0%

Sources

1. Benefit-Cost Analysis Guidance for Discretionary Grant Programs, U.S. DOT March 2022
2. MnDOT Benefit-Cost Analysis for Transporation Projects, 2021

Benefit-Cost Analysis

Table A2

Project Costs

Item	No-Build	Build
Surfacing	$ -	$ 3,989,206.00
Subbase/Base	$ -	$ 818,418.00
Grading and Drainage/Sewer	$ -	$ 5,037,784.00
Major Structures	$ -	$ 11,105,113.00
Right-of-Way	$ -	$ 26,250.00
Engineering	$ -	$ 4,654,095.00
Lighting/Signals	$ -	$ 2,970,959.00
Other Costs	$ -	$ 3,001,572.00
Total Cost	**$ -**	**$ 31,603,397.00**
PV (7% Discount Rate)	**$ -**	**$ 22,205,755.16**

Benefit-Cost Analysis

Table A3

Project Salvage Values

Item	No-Build	Build
Surfacing	$ -	$ 695,900.00
Subbase/Base	$ -	$ 396,100.00
Grading and Drainage/Sewer	$ -	$ 2,958,300.00
Major Structures	$ -	$ 7,285,200.00
Right-of-Way	$ -	$ 20,500.00
Engineering	$ -	$ -
Lighting/Signals	$ -	$ -
Other Costs	$ -	$ -
Total Salvage Value	**$ -**	**$ 11,356,000.00**
PV (7% Discount Rate)	**$ -**	**$ 1,827,525.25**

Benefit-Cost Analysis

Table A4

Travel Time Analysis

	Veh-Hour				Hourly Value[1]		Cost			Difference (Benefit)
	Weekday		Weekend							
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Total	
2025 No Build	133,346	18,962	59,595	1,914	$ 27.05	$ 32.00	$ 5,219,803.80	$ 668,058.04	$ 5,887,861.84	**$ (304,544.58)**
2025 Build	140,243	19,943	62,677	2,013	$ 27.05	$ 32.00	$ 5,489,793.65	$ 702,612.76	$ 6,192,406.42	
2044 No Build	159,148	22,631	71,126	2,285	$ 27.05	$ 32.00	$ 6,229,815.34	$ 797,324.64	$ 7,027,139.99	**$ (476,416.27)**
2044 Build	169,937	24,166	75,948	2,440	$ 27.05	$ 32.00	$ 6,652,175.71	$ 851,380.55	$ 7,503,556.26	

Notes:

[1]Car hourly rate based upon $16.20 value per person and an occupancy rate of 1.67 per vehicle.

[2]Weekend traffic is assumed to have 25 percent of the trucks as a normal weekday.

Benefit-Cost Analysis

Table A5

Travel Time Benefit

	Travel Time Cost	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025	$ 5,887,861.84	$ 6,192,406.42
2026	$ 6,001,789.65	$ 6,323,521.40
2027	$ 6,058,753.56	$ 6,389,078.89
2028	$ 6,115,717.47	$ 6,454,636.38
2029	$ 6,172,681.38	$ 6,520,193.88
2030	$ 6,229,645.28	$ 6,585,751.37
2031	$ 6,286,609.19	$ 6,651,308.86
2032	$ 6,343,573.10	$ 6,716,866.35
2033	$ 6,400,537.00	$ 6,782,423.84
2034	$ 6,457,500.91	$ 6,847,981.34
2035	$ 6,514,464.82	$ 6,913,538.83
2036	$ 6,571,428.73	$ 6,979,096.32
2037	$ 6,628,392.63	$ 7,044,653.81
2038	$ 6,685,356.54	$ 7,110,211.30
2039	$ 6,742,320.45	$ 7,175,768.80
2040	$ 6,799,284.36	$ 7,241,326.29
2041	$ 6,856,248.26	$ 7,306,883.78
2042	$ 6,913,212.17	$ 7,372,441.27
2043	$ 6,970,176.08	$ 7,437,998.76
2044	$ 7,027,139.99	$ 7,503,556.26

	Undiscounted Travel Time Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ (304,544.58)
2026		$ (321,731.75)
2027		$ (330,325.33)
2028		$ (338,918.92)
2029		$ (347,512.50)
2030		$ (356,106.09)
2031		$ (364,699.67)
2032		$ (373,293.25)
2033		$ (381,886.84)
2034		$ (390,480.42)
2035		$ (399,074.01)
2036		$ (407,667.59)
2037		$ (416,261.18)
2038		$ (424,854.76)
2039		$ (433,448.35)
2040		$ (442,041.93)
2041		$ (450,635.52)
2042		$ (459,229.10)
2043		$ (467,822.69)
2044		$ (476,416.27)
	Total	$ (7,886,950.74)

7%	PV Travel Time Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ (202,930.91)
2026		$ (200,358.36)
2027		$ (192,252.35)
2028		$ (184,349.43)
2029		$ (176,657.73)
2030		$ (169,183.44)
2031		$ (161,931.02)
2032		$ (154,903.43)
2033		$ (148,102.30)
2034		$ (141,528.08)
2035		$ (135,180.17)
2036		$ (129,057.12)
2037		$ (123,156.66)
2038		$ (117,475.88)
2039		$ (112,011.29)
2040		$ (106,758.91)
2041		$ (101,714.37)
2042		$ (96,872.95)
2043		$ (92,229.66)
2044		$ (87,779.31)
	Total	$ (2,834,433.37)

Benefit-Cost Analysis

Table A6

Vehicle Operating Analysis

	Vehicle Miles Traveled				Value Per Mile[1]		Cost			Difference (Benefit)
	Weekday		Weekend							
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Total	
2025 No Build	3,678,501	523,099	1,485,548	211,252	$ 0.45	$ 0.94	$ 2,323,822.14	$ 690,289.75	$ 3,014,111.89	$ -
2025 Build	3,678,501	523,099	1,485,548	211,252	$ 0.45	$ 0.94	$ 2,323,822.14	$ 690,289.75	$ 3,014,111.89	
2044 No Build	4,315,865	613,735	1,742,945	247,855	$ 0.45	$ 0.94	$ 2,726,464.59	$ 809,894.41	$ 3,536,359.00	$ -
2044 Build	4,315,865	613,735	1,742,945	247,855	$ 0.45	$ 0.94	$ 2,726,464.59	$ 809,894.41	$ 3,536,359.00	

Notes:

Weekend traffic is assumed to have 25 percent of the trucks as a normal weekday.

Benefit-Cost Analysis

Table A7

Vehicle Operating Benefits

		Annual Vehicle Operating Cost	
Year	Project Year	No-Build	Build
2018	-6		
2019	-5		
2020	-4		
2021	-3		
2022	-2		
2023	-1		
2024	0		
2025	1	$ 3,014,111.89	$ 3,014,111.89
2026	2	$ 3,066,336.60	$ 3,066,336.60
2027	3	$ 3,092,448.96	$ 3,092,448.96
2028	4	$ 3,118,561.31	$ 3,118,561.31
2029	5	$ 3,144,673.67	$ 3,144,673.67
2030	6	$ 3,170,786.03	$ 3,170,786.03
2031	7	$ 3,196,898.38	$ 3,196,898.38
2032	8	$ 3,223,010.74	$ 3,223,010.74
2033	9	$ 3,249,123.09	$ 3,249,123.09
2034	10	$ 3,275,235.45	$ 3,275,235.45
2035	11	$ 3,301,347.80	$ 3,301,347.80
2036	12	$ 3,327,460.16	$ 3,327,460.16
2037	13	$ 3,353,572.51	$ 3,353,572.51
2038	14	$ 3,379,684.87	$ 3,379,684.87
2039	15	$ 3,405,797.22	$ 3,405,797.22
2040	16	$ 3,431,909.58	$ 3,431,909.58
2041	17	$ 3,458,021.94	$ 3,458,021.94
2042	18	$ 3,484,134.29	$ 3,484,134.29
2043	19	$ 3,510,246.65	$ 3,510,246.65
2044	20	$ 3,536,359.00	$ 3,536,359.00

	Undiscounted Operating Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ -
2026		$ -
2027		$ -
2028		$ -
2029		$ -
2030		$ -
2031		$ -
2032		$ -
2033		$ -
2034		$ -
2035		$ -
2036		$ -
2037		$ -
2038		$ -
2039		$ -
2040		$ -
2041		$ -
2042		$ -
2043		$ -
2044		$ -
	Total	$ -

7%	PV Operating Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ -
2026		$ -
2027		$ -
2028		$ -
2029		$ -
2030		$ -
2031		$ -
2032		$ -
2033		$ -
2034		$ -
2035		$ -
2036		$ -
2037		$ -
2038		$ -
2039		$ -
2040		$ -
2041		$ -
2042		$ -
2043		$ -
2044		$ -
	Total	$ -

Benefit-Cost Analysis

Table A8

Environmental Analysis

	Vehicle Miles Traveled				Value Per Mile		Cost			Difference (Benefit)
	Weekday		Weekend							
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Total	
2025 No Build	3,678,501	523,099	1,485,548	211,252	$ 0.05	$ 0.23	$ 258,202.46	$ 168,900.68	$ 427,103.14	$ -
2025 Build	3,678,501	523,099	1,485,548	211,252	$ 0.05	$ 0.23	$ 258,202.46	$ 168,900.68	$ 427,103.14	
2044 No Build	4,315,865	613,735	1,742,945	247,855	$ 0.05	$ 0.23	$ 302,940.51	$ 198,165.65	$ 501,106.16	$ -
2044 Build	4,315,865	613,735	1,742,945	247,855	$ 0.05	$ 0.23	$ 302,940.51	$ 198,165.65	$ 501,106.16	

Notes:

Weekend traffic is assumed to have 25 percent of the trucks as a normal weekday.

Benefit-Cost Analysis

Table A9

Environmental Benefit

	Environmental Cost	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025	$ 427,103.14	$ 427,103.14
2026	$ 434,503.45	$ 434,503.45
2027	$ 438,203.60	$ 438,203.60
2028	$ 441,903.75	$ 441,903.75
2029	$ 445,603.90	$ 445,603.90
2030	$ 449,304.05	$ 449,304.05
2031	$ 453,004.20	$ 453,004.20
2032	$ 456,704.35	$ 456,704.35
2033	$ 460,404.50	$ 460,404.50
2034	$ 464,104.65	$ 464,104.65
2035	$ 467,804.81	$ 467,804.81
2036	$ 471,504.96	$ 471,504.96
2037	$ 475,205.11	$ 475,205.11
2038	$ 478,905.26	$ 478,905.26
2039	$ 482,605.41	$ 482,605.41
2040	$ 486,305.56	$ 486,305.56
2041	$ 490,005.71	$ 490,005.71
2042	$ 493,705.86	$ 493,705.86
2043	$ 497,406.01	$ 497,406.01
2044	$ 501,106.16	$ 501,106.16

	Undiscounted Environmental Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ -
2026		$ -
2027		$ -
2028		$ -
2029		$ -
2030		$ -
2031		$ -
2032		$ -
2033		$ -
2034		$ -
2035		$ -
2036		$ -
2037		$ -
2038		$ -
2039		$ -
2040		$ -
2041		$ -
2042		$ -
2043		$ -
2044		$ -
	Total	$ -

7%	PV Environmental Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ -
2026		$ -
2027		$ -
2028		$ -
2029		$ -
2030		$ -
2031		$ -
2032		$ -
2033		$ -
2034		$ -
2035		$ -
2036		$ -
2037		$ -
2038		$ -
2039		$ -
2040		$ -
2041		$ -
2042		$ -
2043		$ -
2044		$ -
	Total	$ -

Benefit-Cost Analysis

Table A10

Operation and Maintenance Benefit

	No-Build Maintenance Costs	
Year	Activity	Cost
2018		$ -
2019		$ -
2020		$ -
2021		$ -
2022		$ -
2023		$ -
2024	Mill and Overlay, Storm Sewer and Sidewalk Adjustments for ADA	$ 3,745,000.00
2025		$ -
2026		$ -
2027		$ -
2028		$ -
2029		$ -
2030		$ -
2031		$ -
2032		$ -
2033		$ -
2034		$ -
2035		$ -
2036		$ -
2037		$ -
2038		$ -
2039		$ -
2040		$ -
2041		$ -
2042		$ -
2043		$ -
2044	Mill and Overlay, Storm Sewer and Sidewalk Adjustments for ADA	$ 9,936,599.91

	Maintenance Costs	
Year	No-Build	Build
2018	$ -	$ -
2019	$ -	$ -
2020	$ -	$ -
2021	$ -	$ -
2022	$ -	$ -
2023	$ -	$ -
2024	$ 3,745,000.00	$ -
2025	$ -	$ -
2026	$ -	$ -
2027	$ -	$ -
2028	$ -	$ -
2029	$ -	$ -
2030	$ -	$ -
2031	$ -	$ -
2032	$ -	$ -
2033	$ -	$ -
2034	$ -	$ -
2035	$ -	$ -
2036	$ -	$ -
2037	$ -	$ -
2038	$ -	$ -
2039	$ -	$ -
2040	$ -	$ -
2041	$ -	$ -
2042	$ -	$ -
2043	$ -	$ -
2044	$ 9,936,599.91	$ -

	Undiscounted Maintenance Benefit	
Year	No-Build	Build
2018	$ -	$ -
2019	$ -	$ -
2020	$ -	$ -
2021	$ -	$ -
2022	$ -	$ -
2023	$ -	$ -
2024	$ -	$ 3,745,000.00
2025	$ -	$ -
2026	$ -	$ -
2027	$ -	$ -
2028	$ -	$ -
2029	$ -	$ -
2030	$ -	$ -
2031	$ -	$ -
2032	$ -	$ -
2033	$ -	$ -
2034	$ -	$ -
2035	$ -	$ -
2036	$ -	$ -
2037	$ -	$ -
2038	$ -	$ -
2039	$ -	$ -
2040	$ -	$ -
2041	$ -	$ -
2042	$ -	$ -
2043	$ -	$ -
2044	$ -	$ 9,936,599.91
	Total	$ 13,681,599.91

7%	PV Maintenance Benefit	
Year	No-Build	Build
2018	$ -	$ -
2019	$ -	$ -
2020	$ -	$ -
2021	$ -	$ -
2022	$ -	$ -
2023	$ -	$ -
2024	$ -	$ 2,670,133.24
2025	$ -	$ -
2026	$ -	$ -
2027	$ -	$ -
2028	$ -	$ -
2029	$ -	$ -
2030	$ -	$ -
2031	$ -	$ -
2032	$ -	$ -
2033	$ -	$ -
2034	$ -	$ -
2035	$ -	$ -
2036	$ -	$ -
2037	$ -	$ -
2038	$ -	$ -
2039	$ -	$ -
2040	$ -	$ -
2041	$ -	$ -
2042	$ -	$ -
2043	$ -	$ -
2044	$ -	$ 1,830,810.36
	Total	$ 4,500,943.60

Benefit-Cost Analysis

Table A11

Crash Value

2025 No-Build KABCO Crash Costs

Crash Severity	Total Crashes per year	Unit Value	Value
K	0.10253	$ 11,600,000.00	$ 1,189,291.45
A	0.41010	$ 554,800.00	$ 227,523.76
B	4.20353	$ 151,100.00	$ 635,153.40
C	6.97171	$ 77,200.00	$ 538,215.90
O	29.62976	$ 3,900.00	$ 115,556.07
Sum	41.31763	Total	$ 2,705,740.58

2025 Build KABCO Crash Costs

Crash Severity	Total Crashes per year	Unit Value	Value
K	0.05126	$ 11,600,000.00	$ 594,645.73
A	0.24597	$ 554,800.00	$ 136,463.06
B	2.72139	$ 151,100.00	$ 411,201.41
C	4.54143	$ 77,200.00	$ 350,598.58
O	19.82090	$ 3,900.00	$ 77,301.49
Sum	27.38094	Total	$ 1,570,210.28

2044 No-Build KABCO Crash Costs

Crash Severity	Total Crashes per year	Unit Value	Value
K	0.11272	$ 11,600,000.00	$ 1,307,505.34
A	0.45086	$ 554,800.00	$ 250,139.30
B	4.62136	$ 151,100.00	$ 698,286.75
C	7.66469	$ 77,200.00	$ 591,713.80
O	32.57492	$ 3,900.00	$ 127,042.18
Sum	45.42454	Total	$ 2,974,687.37

2044 Build KABCO Crash Costs

Crash Severity	Total Crashes per year	Unit Value	Value
K	0.05636	$ 11,600,000.00	$ 653,752.67
A	0.27042	$ 554,800.00	$ 150,027.30
B	2.99189	$ 151,100.00	$ 452,074.25
C	4.99284	$ 77,200.00	$ 385,447.59
O	21.79106	$ 3,900.00	$ 84,985.15
Sum	30.10257	Total	$ 1,726,286.96

Benefit-Cost Analysis

Table A12

Collision Reduction Benefit

	Collision Cost	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025	$ 2,705,740.58	$ 1,570,210.28
2026	$ 2,732,635.26	$ 1,585,817.95
2027	$ 2,746,082.60	$ 1,593,621.78
2028	$ 2,759,529.94	$ 1,601,425.61
2029	$ 2,772,977.28	$ 1,609,229.45
2030	$ 2,786,424.62	$ 1,617,033.28
2031	$ 2,799,871.96	$ 1,624,837.12
2032	$ 2,813,319.30	$ 1,632,640.95
2033	$ 2,826,766.63	$ 1,640,444.78
2034	$ 2,840,213.97	$ 1,648,248.62
2035	$ 2,853,661.31	$ 1,656,052.45
2036	$ 2,867,108.65	$ 1,663,856.28
2037	$ 2,880,555.99	$ 1,671,660.12
2038	$ 2,894,003.33	$ 1,679,463.95
2039	$ 2,907,450.67	$ 1,687,267.79
2040	$ 2,920,898.01	$ 1,695,071.62
2041	$ 2,934,345.35	$ 1,702,875.45
2042	$ 2,947,792.69	$ 1,710,679.29
2043	$ 2,961,240.03	$ 1,718,483.12
2044	$ 2,974,687.37	$ 1,726,286.96

	Undiscounted Collision Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ 1,135,530.30
2026		$ 1,146,817.31
2027		$ 1,152,460.82
2028		$ 1,158,104.33
2029		$ 1,163,747.83
2030		$ 1,169,391.34
2031		$ 1,175,034.84
2032		$ 1,180,678.35
2033		$ 1,186,321.85
2034		$ 1,191,965.36
2035		$ 1,197,608.86
2036		$ 1,203,252.37
2037		$ 1,208,895.87
2038		$ 1,214,539.38
2039		$ 1,220,182.88
2040		$ 1,225,826.39
2041		$ 1,231,469.89
2042		$ 1,237,113.40
2043		$ 1,242,756.90
2044		$ 1,248,400.41
	Total	$ 23,890,098.68

7%	PV Collision Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ 756,651.79
2026		$ 714,180.19
2027		$ 670,742.69
2028		$ 629,932.02
2029		$ 591,590.39
2030		$ 555,569.40
2031		$ 521,729.52
2032		$ 489,939.54
2033		$ 460,076.07
2034		$ 432,023.10
2035		$ 405,671.56
2036		$ 380,918.88
2037		$ 357,668.67
2038		$ 335,830.26
2039		$ 315,318.44
2040		$ 296,053.11
2041		$ 277,958.97
2042		$ 260,965.22
2043		$ 245,005.32
2044		$ 230,016.75
	Total	$ 8,927,841.88

Benefit-Cost Analysis

Table A13

Pedestrian Facility Improvements

Intersection[1]	Pedestrians Per Day[2]	Average Trip Length (miles)	Value per Person Mile Walked[3]	Benefit
Hwy 14 & Edgewood	17	0.86	$ 0.10	$ 533.63
Hwy 14 & Church	77	0.86	$ 0.10	$ 2,417.03
				$ 2,950.66

Notes:

[1]2019 Traffic Counts at two corridor intersections to aviod double counting

[2]Assumed same number of pedestrians during the weekend

[3]Benefit-Cost Analysis Guidance for Discretionary Grant Programs, U.S. DOT March 2022, 1 foot expansion of sidewalk

Benefit-Cost Analysis

Table A14

Pedestrian Facility Improvement

	Undiscounted Pedestrian Facility Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ 2,950.66
2026		$ 2,950.66
2027		$ 2,950.66
2028		$ 2,950.66
2029		$ 2,950.66
2030		$ 2,950.66
2031		$ 2,950.66
2032		$ 2,950.66
2033		$ 2,950.66
2034		$ 2,950.66
2035		$ 2,950.66
2036		$ 2,950.66
2037		$ 2,950.66
2038		$ 2,950.66
2039		$ 2,950.66
2040		$ 2,950.66
2041		$ 2,950.66
2042		$ 2,950.66
2043		$ 2,950.66
2044		$ 2,950.66
	Total	$ 59,013.20

7%	PV Pedestrian Benefit	
Year	No-Build	Build
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		$ 1,966.15
2026		$ 1,837.52
2027		$ 1,717.31
2028		$ 1,604.96
2029		$ 1,499.97
2030		$ 1,401.84
2031		$ 1,310.13
2032		$ 1,224.42
2033		$ 1,144.32
2034		$ 1,069.45
2035		$ 999.49
2036		$ 934.10
2037		$ 872.99
2038		$ 815.88
2039		$ 762.51
2040		$ 712.62
2041		$ 666.00
2042		$ 622.43
2043		$ 581.71
2044		$ 543.66
	Total	$ 22,287.47

Benefit-Cost Analysis

Table A15

Property Value Increase

	Property Values Improvement	
Year	Activity	Cost
2018		
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029	Residential	$ 1,914,000.00
2030		
2031		
2032	Major Mixed/Commercial	$ 29,550,000.00
2033		
2034	Mixed	$ 4,887,000.00
2035		
2036	Senior living	$ 4,490,000.00
2037		
2038		
2039	Hotel	$ 3,118,000.00
2040		
2041		
2042		
2043		
2044	Commercial	$ 5,307,000.00

	Property Value Costs	
Year	No-Build	Build
2018	$ -	$ -
2019	$ -	$ -
2020	$ -	$ -
2021	$ -	$ -
2022	$ -	$ -
2023	$ -	$ -
2024	$ -	$ -
2025	$ -	$ -
2026	$ -	$ -
2027	$ -	$ -
2028	$ -	$ -
2029	$ -	$ 1,914,000.00
2030	$ -	$ -
2031	$ -	$ -
2032	$ -	$ 29,550,000.00
2033	$ -	$ -
2034	$ -	$ 4,887,000.00
2035	$ -	$ -
2036	$ -	$ 4,490,000.00
2037	$ -	$ -
2038	$ -	$ -
2039	$ -	$ 3,118,000.00
2040	$ -	$ -
2041	$ -	$ -
2042	$ -	$ -
2043	$ -	$ -
2044	$ -	$ 5,307,000.00

	Undiscounted Property Value Benefit	
Year	No-Build	Build
2018	$ -	$ -
2019	$ -	$ -
2020	$ -	$ -
2021	$ -	$ -
2022	$ -	$ -
2023	$ -	$ -
2024	$ -	$ -
2025	$ -	$ -
2026	$ -	$ -
2027	$ -	$ -
2028	$ -	$ -
2029	$ -	$ 1,914,000.00
2030	$ -	$ -
2031	$ -	$ -
2032	$ -	$ 29,550,000.00
2033	$ -	$ -
2034	$ -	$ 4,887,000.00
2035	$ -	$ -
2036	$ -	$ 4,490,000.00
2037	$ -	$ -
2038	$ -	$ -
2039	$ -	$ 3,118,000.00
2040	$ -	$ -
2041	$ -	$ -
2042	$ -	$ -
2043	$ -	$ -
2044	$ -	$ 5,307,000.00
	Total	$ 49,266,000.00

7%	PV Property Value Benefit	
Year	No-Build	Build
2018		$ -
2019		$ -
2020		$ -
2021		$ -
2022		$ -
2023		$ -
2024		$ -
2025		$ -
2026		$ -
2027		$ -
2028		$ -
2029		$ 972,980.55
2030		$ -
2031		$ -
2032		$ 12,262,199.44
2033		$ -
2034		$ 1,771,273.70
2035		$ -
2036		$ 1,421,419.01
2037		$ -
2038		$ -
2039		$ 805,750.45
2040		$ -
2041		$ -
2042		$ -
2043		$ -
2044		$ 977,810.39
	Total	$ 18,211,433.53

Benefit-Cost Analysis

Table A16

Design and Construction Cost

Year	Project Year	2022 Raw Design & Construction Costs	
		No-Build	Build
2018	-6	$ -	
2019	-5	$ -	$ 48,500.00
2020	-4	$ -	$ 44,185.00
2021	-3	$ -	$ 30,000.00
2022	-2	$ -	$ 100,000.00
2023	-1	$ -	$ 2,322,315.00
2024	0	$ -	$ 16,770,000.00
2025	1	$ -	$ 9,030,000.00
2026	2	$ -	$ -
2027	3	$ -	$ -
2028	4	$ -	$ -
2029	5	$ -	$ -
2030	6	$ -	$ -
2031	7	$ -	$ -
2032	8	$ -	$ -
2033	9	$ -	$ -
2034	10	$ -	$ -
2035	11	$ -	$ -
2036	12	$ -	$ -
2037	13	$ -	$ -
2038	14	$ -	$ -
2039	15	$ -	$ -
2040	16	$ -	$ -
2041	17	$ -	$ -
2042	18	$ -	$ -
2043	19	$ -	$ -
2044	20	$ -	$ -
		Total	$ 28,345,000.00

5% Inflation beyond 2022

Year	Project Year	Undiscounted Design & Construction Costs w Inflation	
		No-Build	Build
2018	-6	$ -	
2019	-5	$ -	$ 48,500.00
2020	-4	$ -	$ 44,185.00
2021	-3	$ -	$ 30,000.00
2022	-2	$ -	$ 100,000.00
2023	-1	$ -	$ 2,438,431.00
2024	0	$ -	$ 18,488,925.00
2025	1	$ -	$ 10,453,356.00
2026	2	$ -	$ -
2027	3	$ -	$ -
2028	4	$ -	$ -
2029	5	$ -	$ -
2030	6	$ -	$ -
2031	7	$ -	$ -
2032	8	$ -	$ -
2033	9	$ -	$ -
2034	10	$ -	$ -
2035	11	$ -	$ -
2036	12	$ -	$ -
2037	13	$ -	$ -
2038	14	$ -	$ -
2039	15	$ -	$ -
2040	16	$ -	$ -
2041	17	$ -	$ -
2042	18	$ -	$ -
2043	19	$ -	$ -
2044	20	$ -	$ -
		Total	$ 31,603,397.00

7% Discount Rate, 2019 Base Year

Year	Project Year	Base Year	PV Design & Construction Costs	
			No-Build	Build
2018	-6	-1	$ -	$ -
2019	-5	0	$ -	$ 48,500.00
2020	-4	1	$ -	$ 41,294.39
2021	-3	2	$ -	$ 26,203.16
2022	-2	3	$ -	$ 81,629.79
2023	-1	4	$ -	$ 1,860,267.33
2024	0	5	$ -	$ 13,182,348.00
2025	1	6	$ -	$ 6,965,512.48
2026	2	7	$ -	$ -
2027	3	8	$ -	$ -
2028	4	9	$ -	$ -
2029	5	10	$ -	$ -
2030	6	11	$ -	$ -
2031	7	12	$ -	$ -
2032	8	13	$ -	$ -
2033	9	14	$ -	$ -
2034	10	15	$ -	$ -
2035	11	16	$ -	$ -
2036	12	17	$ -	$ -
2037	13	18	$ -	$ -
2038	14	19	$ -	$ -
2039	15	20	$ -	$ -
2040	16	21	$ -	$ -
2041	17	22	$ -	$ -
2042	18	23	$ -	$ -
2043	19	24	$ -	$ -
2044	20	25	$ -	$ -
			Total	$ 22,205,755.16

Benefit-Cost Analysis

Table A17

Marshalltown Highway 14 Re-construction BCA Summary

Item	BCA	
	PV (7% Discount Rate)	
Travel Time Benefit	$	(2,834,000.00)
Collision Reduction Benefit	$	8,928,000.00
Operation and Maintenance Benefit	$	4,501,000.00
Emissions Benefit	$	-
Vehicle Operating Benefit	$	-
Pedestrian Facility Benefit	$	22,000.00
Property Value Benefit	$	18,211,000.00
PV Total Benefit	**$**	**28,828,000.00**
Major Structures	$	7,731,000.00
Surfacing	$	2,778,000.00
Grading and Drainage/Sewer	$	3,507,000.00
Lighting/Signals	$	2,069,000.00
Subbase/Base	$	570,000.00
Engineering	$	3,444,000.00
Right-of-Way	$	21,000.00
Other Costs	$	2,090,000.00
PV Total Cost	**$**	**22,210,000.00**
PV Salvage Value	$	1,828,000.00
(PV Total Cost - Salvage Value)	**$**	**20,382,000.00**
Benefit-Cost Ratio	**1.414**	

Appendix B

CMF / CRF Details

CMF ID: 177

Reduce driveways from 48 to 26-48 per mile

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Access management

Study: ***Handbook of Road Safety Measures*, Elvik, R. and Vaa, T., 2004**

Star Quality Rating:	★★★☆☆

Crash Modification Factor (CMF)	
Value:	0.71
Adjusted Standard Error:	0.04
Unadjusted Standard Error:	0.02

Crash Reduction Factor (CRF)	
Value:	29 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	4
Unadjusted Standard Error:	2

Applicability

Crash Type:	All
Crash Severity:	A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Minor Arterial
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban and suburban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	
Country:	

Type of Methodology Used:	9
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF / CRF Details

CMF ID: 178

Reduce driveways from 26-48 to 10-24 per mile

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Access management

Study: ***Handbook of Road Safety Measures*, Elvik, R. and Vaa, T., 2004**

Star Quality Rating:	★★★☆☆

Crash Modification Factor (CMF)	
Value:	0.69
Adjusted Standard Error:	0.02
Unadjusted Standard Error:	0.01

Crash Reduction Factor (CRF)	
Value:	31 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	2
Unadjusted Standard Error:	1

Applicability

Crash Type:	All
Crash Severity:	A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Minor Arterial
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban and suburban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	
Country:	

Type of Methodology Used:	9
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 179

Reduce driveways from 10-24 to less than 10 per mile

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Access management

Study: ***Handbook of Road Safety Measures*, Elvik, R. and Vaa, T., 2004**

Star Quality Rating:	★★★☆☆

Crash Modification Factor (CMF)	
Value:	0.75
Adjusted Standard Error:	0.03
Unadjusted Standard Error:	0.02

Crash Reduction Factor (CRF)	
Value:	25 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	3
Unadjusted Standard Error:	2

Applicability

Crash Type:	All
Crash Severity:	A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Minor Arterial
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban and suburban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	
Country:	

Type of Methodology Used:	9
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 199

Road diet (Convert 4-lane undivided road to 2-lanes plus turning lane)

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Roadway

Study: ***Crash Reduction Factors for Traffic Engineering and ITS Improvements*****, Harkey et al., 2008**

Star Quality Rating:	★★★★★

Crash Modification Factor (CMF)	
Value:	0.71
Adjusted Standard Error:	0.02
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	29 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	2

Unadjusted Standard Error:	

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Minor Arterial
Number of Lanes:	4
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 261

Provide a left-turn lane on one major-road approach

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.73
Adjusted Standard Error:	0.04
Unadjusted Standard Error:	0.03

Crash Reduction Factor (CRF)	
Value:	27 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	4

Unadjusted Standard Error:	3

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	1500 to 40600 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	200 to 8000 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 263

Provide a left-turn lane on one major-road approach

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.76
Adjusted Standard Error:	0.03
Unadjusted Standard Error:	0.03

Crash Reduction Factor (CRF)	
Value:	24 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	3

Unadjusted Standard Error:	3

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	4600 to 40300 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	100 to 13700 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 265

Provide a left-turn lane on one major-road approach

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.71
Adjusted Standard Error:	0.05
Unadjusted Standard Error:	0.04

Crash Reduction Factor (CRF)	
Value:	29 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	5

Unadjusted Standard Error:	4

Applicability

Crash Type:	All
Crash Severity:	K (fatal),A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	1500 to 40600 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	200 to 8000 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 267

Provide a left-turn lane on one major-road approach

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.72
Adjusted Standard Error:	0.06
Unadjusted Standard Error:	0.05

Crash Reduction Factor (CRF)	
Value:	28 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	6

Unadjusted Standard Error:	5

Applicability

Crash Type:	All
Crash Severity:	K (fatal),A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	4600 to 40300 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	100 to 13700 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 269

Provide a left-turn lane on both major-road approaches

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.53
Adjusted Standard Error:	0.04
Unadjusted Standard Error:	0.04

Crash Reduction Factor (CRF)	
Value:	47 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	4

Unadjusted Standard Error:	4

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	1500 to 40600 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	200 to 8000 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF / CRF Details

CMF ID: 270

Provide a left-turn lane on both major-road approaches

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.81
Adjusted Standard Error:	0.13
Unadjusted Standard Error:	0.11

Crash Reduction Factor (CRF)	
Value:	19 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	13

Unadjusted Standard Error:	11

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	7200 to 55100 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	550 to 2600 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 273

Provide a left-turn lane on both major-road approaches

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.5
Adjusted Standard Error:	0.06
Unadjusted Standard Error:	0.05

Crash Reduction Factor (CRF)	
Value:	50 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	6

Unadjusted Standard Error:	5

Applicability

Crash Type:	All
Crash Severity:	K (fatal),A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	1500 to 40600 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	200 to 8000 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 274

Provide a left-turn lane on both major-road approaches

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.83
Adjusted Standard Error:	0.02
Unadjusted Standard Error:	0.02

Crash Reduction Factor (CRF)	
Value:	17 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	2

Unadjusted Standard Error:	2

Applicability

Crash Type:	All
Crash Severity:	K (fatal),A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	7200 to 55100 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	550 to 2600 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 286

Provide a right-turn lane on one major-road approach

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.96
Adjusted Standard Error:	0.02
Unadjusted Standard Error:	0.02

Crash Reduction Factor (CRF)	
Value:	4 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	2

Unadjusted Standard Error:	2

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	All
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	3-leg,4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	7200 to 55100 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	550 to 8400 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

CMF / CRF Details

CMF ID: 288

Provide a right-turn lane on one major-road approach

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***Safety Effectiveness of Intersection Left- and Right-Turn Lanes*****, Harwood et al., 2002**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.91
Adjusted Standard Error:	0.04
Unadjusted Standard Error:	0.03

Crash Reduction Factor (CRF)	
Value:	9 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	4

Unadjusted Standard Error:	3

Applicability

Crash Type:	All
Crash Severity:	K (fatal),A (serious injury),B (minor injury),C (possible injury)
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	All
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	3-leg,4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	7200 to 55100 Average Daily Traffic (ADT)
Minor Road Traffic Volume:	550 to 8400 Average Daily Traffic (ADT)

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	2
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM The number of crashes in the after period were not reported in this study, however, they have been recorded as 300 to give 10 points as a beneift of doubt for one or more of the following: (1) number of miles/sites in the reference/treatment group, (2) number of crashes in the references/treatment group, (3) reporting AADTs for the aggregate dataset but not for the disaggragate dataset used for CMF development.

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center