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MEMORANDUM

Date: 5/6/2020

To: Jessica Kinser, City of Marshalltown

From: Rob Haaland, P.E., Bolton & Menk

Subject: BUILD Grant - Benefit Cost Analysis

Highway 14 Improvements Project

Purpose

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

This stretch of undivided highway is located along the easterly side of downtown Rochester and extends from Anson Street to the north city limits. It is a 4-lane section, 1.6 miles long and includes 20 intersections. There are signalized intersections of 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 and were thus included in a corridor study. Additionally, there are numerous driveway accesses for local business to Highway 14 which pose risks.
Figure 1 shows an overview of the project location.

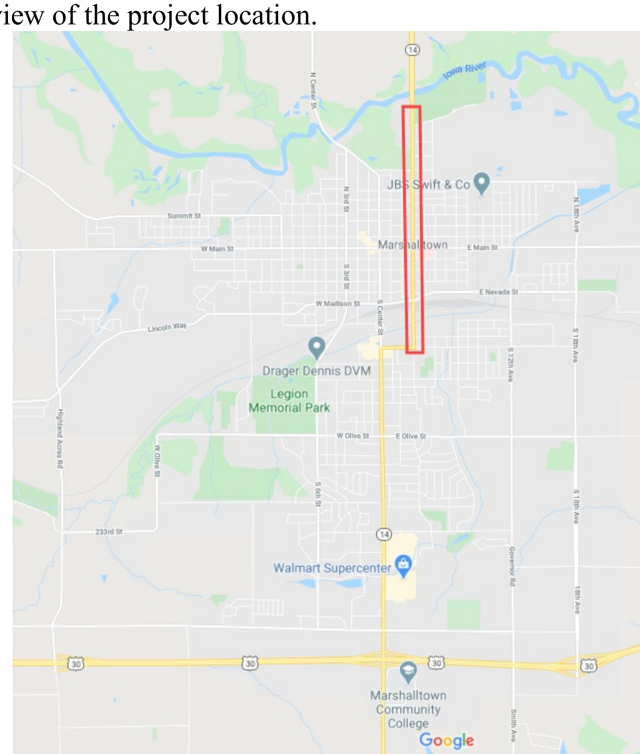

Figure 1. Project Location

To mitigate risks associated with the 4-lane section and the driveways, a 3-lane section is proposed and would incorporate driveway restrictions, additional turn lanes, new signals with improved signal timing, improved pedestrian, and separated bicycle facilities. This stretch of roadway is a key corridor for commuters during in the week and provides the primary through route from north to south in Marshalltown.

Development of a industrial park expansion in the northeast portion of town is expected between project construction and the future analysis year. 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 section with driveway restrictions, additional turn lanes, new signals with improved signal timing, improved pedestrian, and separated bicycle 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 2008-2017, showed that there were 236 crashes along the corridor. In all, there was one fatality, two incapacitating injury crashes, and 19 non-incapacitating 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. 2008-2017 Highway 14

KABCO Level	Severity	Number of Collisions
K	Killed	1
A	Incapacitating	2
B	Non-Incapacitating	23
C	Possible Injury	38
O	No Injury	172
	Total	**236**

Providing alternative modes of transportation is another priority in undertaking this project. The sidewalks in the downtown area are directly adjacent to the roadway. north of the downtown, the sidewalks are only separated from the travel lanes by a few feet, making it uncomfortable to use.
With the changes being made to separate the sidewalk and add trail along this corridor, a mode shift from cars to other forms of transportation such as transit, walking and bicycling could be realized, but was not included in the calculation. See **Table 2** for a summary of expected AADTs for build and no-build conditions.

Table 2. Expected Broadway Avenue AADTs

Alternative	Year	
	2020	2040
No-Build	10,100	11,850
Build	10,100	11,850

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 with an initial investment. Under this approach, a project with monetized benefits greater than costs has a benefit-to-cost ratio greater than one and should be 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. The costs considered for the project include surfacing, subbase/base, grading and drainage, signal and lighting construction, right-of-way acquisition, as well as engineering and design. The itemized cost breakdown of the build scenario is shown in **Table A2** at the conclusion of this technical memorandum. 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** 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 as initial cost estimates were made to be conservative.

General Assumptions

- All monetary values are discounted to the 2020 analysis year.
- The 20-year benefit period is based on a 2024 day-of-opening through the year 2043. Benefits are assumed to start January 1st, 2024 and end December 31st, 2043.
- 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** at the conclusion of this document.

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 this 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 since no intersection restrictions were made, the routing would remain the same.

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 forecast the 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 2020 and 2040 build and no-build scenarios.

Table 3. Yearly VMT and VHT

	Year	Type	No Build		Build	
VMT	2020	Cars	5,164,049	5,898,400	5,164,049	5,898,400
		Trucks	734,351		734,351	
	2040	Cars	6,058,810	6,920,400	6,058,810	6,920,400
		Trucks	861,590		861,590	
VHT	2020	Cars	192,940	213,817	202,920	224,877
		Trucks	20,877		21,957	
	2040	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 2018 economic values obtained from MnDOT that were used for this analysis. A 20-year analysis period beginning in 2021 and ending in 2040 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	$ 16.60
Truck	$ 29.50
Operating Cost (per mile)	
Auto	$ 0.41
Truck	$ 0.96
Emissions Costs (per mile)	
Auto	$ 0.06
Truck	$ 0.22

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 **($3,858,000)** for a 7 percent discount rate. 2023 and 2043 delay benefits can be seen in **Table A4** and a yearly breakdown of the benefit-cost analysis pertaining to delay can be found in **Table A5** at the conclusion of this document.

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 operations are estimated at **$0** for a 7 percent discount rate. The benefits derived from the build scenario for vehicle emissions are estimated at **$0** for a 7 percent discount rate. 2023 and 2043 delay benefits can be seen in **Table A6** and **Table A8**. A yearly breakdown of the benefit-cost analysis pertaining to vehicle operation and emissions can be found in **Table A7** and **Table A9** at the conclusion of this document.

Operation and Maintenance benefits

Roadway and utilities maintenance would be needed if the project does not happen. The City would mill and overlay of the roadway, repair 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 2023. 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.

Iowa DOT average bid prices were used in conjunction with approximate existing asphalt area within the project boundaries along Broadway Avenue as a base to calculate mill and overlay costs. Previous bid costs were used to determine approximate cost of sewer and watermain lining. This figure was inflated to reflect a probable cost for year of expenditure. The year of expenditure cost in 2023 is expected to be $2,816,423. Total discounted maintenance benefits are **$2,632,000** at a 7 percent rate. **Table A10** shows a yearly breakdown of the benefit-cost analysis for maintenance activities.

Safety Analysis

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 2008-2017. 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.
- A southbound right turn lane will be added at Anson Street for the high volume of traffic because of the Highway 14 route.
- The signal at Riverside Street will be removed because it no longer meets warrants.

Access management was also reviewed with multiple driveways proposed to be removed and others to be combined. The review shows 112 driveways in the 1.6 miles and 49 that can be removed.

Crash modification factors were reviewed from the Highway Safety Manual and the Crash Modification Clearinghouse. Crash modification factors are based on the existing conditions with 1.0 for the existing condition and changes creating an improved situation being below 1.0 and changes creating a negative impact being above 1.0. The Crash Modification Factors (CMF) for each improvement type are as follows:

- Road Diet (4 lan to 3 lane) (from HSM)
  - 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 = 0.71
  - 26-48 accesses/mi reduced to 10-26 accesses/mi
    - CMF = 0.69
  - 10-26 accesses/mi reduced to <10 accesses/mi
    - CMF = 0.75
- Provide a left turn lane on one approach
  - At a signalized intersection
    - CMF = 0.90 for all crashes and 0.91 for injury crashes
- Provide a left turn lane on two approaches
  - At an intersection with side street stop control
    - CMF = 0.53 for all crashes and 0.50 for injury crashes
  - At a signalized intersection
    - CMF = 0.81 for all crashes and 0.83 for injury crashes

- Provide a right turn lane on one approach
    - At a signalized intersection
        - CMF = 0.96 for all crashes and 0.91 for injury crashes

After establishing no-build and build crashes for 2015 using the CMFs, forecasted 2020 and 2040 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	2020		2040	
		No-Build	Build	No-Build	Build
K	Fatal	0.100	0.050	0.103	0.052
A	suspected Major Injury	0.200	0.103	0.206	0.106
B	Suspected Minor Injury	2.300	1.567	2.370	1.615
C	Possible Injury	3.800	2.679	3.915	2.760
O	Property Damage Only	17.200	12.113	17.722	12.481
Sum		23.60	16.51	24.32	17.01

The USDOT's value of VSL provided in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs were used for the values of the crashes. A resulting benefit of **$7,092,000** 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**.

Property Value Increase

The Highway 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 the transit stop, pedestrian, and bicycle improvements 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 and proposed zoning. For this project, the estimated benefit along the corridor totals $18,500,000 in the 20 years following construction. The total discounted property value increase benefits are **$11,545,000** at a 7 percent rate. A yearly breakdown of the benefit-cost analysis pertaining to Property Value can be found in **Table A13** at the conclusion of this document.

Benefit-Cost Analysis Results

Table A14 shows a yearly breakdown of design and construction costs for the project. See **Table 6** for a results summary of the benefit-cost analysis for the Highway 14 Improvements Project.

Table 6. Benefit-Cost Analysis Summary

Item	PV (7% Discount Rate)
Travel Time Benefit	$ (3,858,000.00)
Collision Reduction Benefit	$ 7,092,000.00
Operation and Maintenance Benefit	$ 2,632,000.00
Emissions Benefit	$ -
Vehicle Operating Benefit	$ -
Property Value Benefit	$ 11,546,000.00
PV Total Benefit	**$ 17,412,000.00**
PV Total Cost	**$ 8,542,000.00**
PV Salvage Value	$ 270,000.00
(PV Total Cost - Salvage Value)	**$ 8,272,000.00**
Benefit-Cost Ratio	**2.105**

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 A15** at the conclusion of this technical memorandum.

Resources Used

"Benefit- Cost Analysis Guidance for Discretionary Grant Programs." Office of the Secretary. U.S. Department of Transportation, //www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.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, //www.cmfclearinghouse.org/

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

Appendix