

APPENDIX B

BENEFIT-COST ANALYSIS



BENEFIT COST ANALYSIS TECHNICAL MEMORANDUM

The City of Sioux City, Iowa has recently completed the design phase for a new viaduct within the Hoveen Valley Area. The new viaduct (referred to as the 18th Street Viaduct) will begin near the existing 18th Street intersection with Steuben Street and extend westerly over the railroad tracks owned by the Union Pacific Railroad and Canadian National/Illinois Central, and terminate at Floyd Boulevard.

This new viaduct will provide significant benefits including:

- Reduction in delays for motorists traveling in the area;
- Improved rail switching operations;
- Improved opportunities for existing and future industries with rail access; and
- Improved safety for all users.

The 18th Street Viaduct will also include accommodations for pedestrians and bicyclists connecting the adjacent neighborhoods west of Floyd Boulevard to the trail along the west bank of the Floyd River.

Baseline and Preferred Scenarios

The Preferred Scenario is predicated on the project receiving a \$16,547,000 TIGER grant (with a \$4,230,000 local match) to allow for construction be complete by the September 30, 2019. The full benefits of the project will be realized no later than October 1, 2019, with a total project cost of \$20,777,000.¹

Without a TIGER grant (Baseline Scenario), the 18th Street Viaduct project is anticipated to be deferred by approximately 11 years and would likely require Federal funds. Under this scenario, the full project would not be completed until September 30, 2030.

Construction Costs

The Preferred Scenario cost and the Baseline Scenario cost are the same. The project costs are summarized in **Table 1**.

¹ All amounts are expressed in 2015 dollars unless otherwise noted.

Table 1.**Project Costs (2015 \$)**

Total Preliminary Estimate of Construction Costs	\$14,702,000
Construction Engineering	\$1,200,000
Other Project Cost Items	\$4,875,000
Total	\$20,777,000

Schedules

Table 2 provides a timeline of the Environmental Assessment, Preliminary and Final Design, right-of-way acquisition and construction for the two scenarios. In the Baseline Scenario, the project would be constructed in 2029 and 2030, with the full benefits realized starting October 1, 2030. In the Preferred Scenario, the final design and construction schedule would be accelerated by 11 years, allowing the full benefits of the project to be realized starting October 1, 2019.

Table 2. Baseline Scenario and Preferred Scenario Schedules

	Baseline (No TIGER)	Preferred (with TIGER)
Final Design, EA, and ROW Plans	2016	2016
Additional NEPA Documentation	2028	2015
ROW Acquisition	2028	2017
Construction	2030	2019
Full Benefits Realized	2030	2019

Benefit Cost Calculation Methodology

The calculation of benefits is based on the relative difference between the Baseline and Preferred Scenarios between now (2016) and 2040. Given the two different project construction schedules outlined above, the benefits for the Preferred Scenario are completely realized in the 11-year time period between October 1, 2019 through October 1, 2030.

Based on the construction schedules, the applicable differences between the Baseline and Preferred Scenarios of the 18th Street Viaduct have been converted year-by-year to a flow of costs and benefits. The resulting benefit cost analysis is based strictly on the difference between the project being constructed with City funding (Baseline Scenario) and the accelerated project construction (Preferred Scenario), in which the benefits would be realized starting 11 years earlier.

Economic Competitiveness**Travel Time Savings**

The regional travel model shows travel pattern changes and reduced idling time at at-grade railroad crossings with the addition of the 18th Street Viaduct that result in a reduction in vehicle-hours of travel (VHT). In order to capture the full impact of the project on travel times, a comparison of the regional VHT with and without the project was done. The base year 2014 model and the 2040 model were used to calculate VHT with and without the project, and the

VHT savings for the interim years were interpolated, and a straight line growth was assumed to extend the benefit calculation to 2040.

The regional VHT results were applied appropriately to the Baseline and Preferred Scenarios using the construction schedules previously described. The VHT comparison for 2014 and 2040 is shown in **Table 3**.

Table 3. Vehicle Hours of Travel (VHT) per Day

	2014	2040
No Action (without the Project)	1,296	2,255
18 th Street Viaduct	321	346
<i>Difference (VHT Savings per day)</i>	975	1,909

Relative to the Baseline Scenario, the Preferred Scenario would save more than 3.7 million vehicle hours of travel between 2019 and 2030. Recognizing an average vehicle occupancy rate of 1.07 persons per vehicle, the Preferred Scenario would save just over 4.0 million person hours.

Monetization of Travel Time Savings

Travel time savings were not estimated separately for local personal travel and local business travel. Instead, the “All Purposes” value of travel time savings (\$13.45 per hour in 2014 dollars, converted to \$13.47 in 2015 dollars using the CPI-U) from the TIGER and FASTLANE BCA Resource Guide was used.

Table 4 presents the net present value of travel time between 2016 and 2040 for the Baseline and Preferred Scenarios within the study area. These are calculated by multiplying the value of travel time savings, average vehicle occupancy and the vehicle hours of travel from the regional model.

Table 4. Time Travel Costs (2016 - 2040)

Scenario	NPV (2015 \$)
Baseline (no TIGER)	\$70,052,981
Preferred (with TIGER)	\$32,407,007
TIGER Grant Savings	\$37,645,974

Note: Net Present Value (NPV) calculated at a 3.0 percent discount rate.

See attached spreadsheet for NPV at 7.0 percent discount rate.

Vehicle Operating Cost Savings

Compared to the Baseline Scenario, the Preferred Scenario will see an increase in Vehicle Miles Traveled (VMT) and a decrease in both VHT and idling time. As such, the magnitude of any cost savings is unknown. For this Benefit Cost Analysis, the conservative assumption was made that there were no vehicle operating cost savings due to the 18th Street Viaduct.

Environmental Sustainability

Air Quality Benefits

The reduction in VHT and increase in VMT (as documented in the Economic Competiveness discussion) will reduce total tailpipe emissions for volatile organic compounds (VOCs) and CO₂ and increase tailpipe emissions for nitrogen oxides (NO_x) and CO. Running emission rates for the project area were obtained from the Iowa DOT's Mobile6.2 program guidance as shown in **Table 5**.

Table 5. 2014 Running Emission Factors (grams/mile of travel)

	2014	2040
Carbon Monoxide (CO)	3.6	0.9
Carbon Dioxide (CO ₂)	480.0	300.0
Volatile Organic Compounds (VOC)	0.20	0.04
Nitrogen Oxides (NO _x)	1.00	0.20

Idling emission rates for the project area were also obtained from the Iowa DOT's Mobile6.2 program guidance as shown in **Table 6**.

Table 6. 2014 Running Emission Factors (grams/hour)

	2014	2040
Carbon Monoxide (CO)	20.0	3.2
Carbon Dioxide (CO ₂)	3620.0	2150.0
Volatile Organic Compounds (VOC)	2.3	0.3
Nitrogen Oxides (NO _x)	4.6	0.5

Monetization of Air Quality Benefits

The running emissions factors for the criteria air pollutants were multiplied by the VMH and VMT changes in each year to calculate the total change in air pollutants resulting for the Preferred Scenario compared to the Baseline Scenario. The values for calculating the dollar benefits of reductions in tons of CO₂, NO_x, and VOC per year are taken from the TIGER and FASTLANE BCA Resource Guide.² Currently, no Federal guidelines exist regarding the valuation of reductions in carbon monoxide (CO). For the purpose of this analysis, reductions in carbon monoxide have not been monetized.

Table 7 presents the net present value of VOC emissions between 2016 and 2040 for the Baseline and Preferred Scenarios. Completing the 18th Street Viaduct under the Preferred Scenario has a Net Present Value benefit in 2015 dollars of reduced VOCs of \$3,897.

² See attached spreadsheet for actual values used.

Table 7. VOC Costs (2016 – 2040)

Scenario	NPV (2015 \$)
Baseline (no TIGER)	\$86,686
Preferred (with TIGER)	\$82,789
TIGER Grant Savings	\$3,897

*Note: Net Present Value (NPV) calculated at a 3.0 percent discount rate.
See attached spreadsheet for NPV at 7.0 percent discount rate.*

Table 8 presents the net present value of NOx emissions between 2016 and 2040 for the Baseline and Preferred Scenarios. Due to the increase in VMT, NOx impacts actually increase under the Preferred Scenario relative to the Baseline Scenario. Completing the 18th Street Viaduct under the Preferred Scenario has a Net Present Value cost in 2015 dollars of increased VOCs of \$23,252.

Table 8. NOx Costs (2016 – 2040)

Scenario	NPV (2015 \$)
Baseline (no TIGER)	\$1,514,005
Preferred (with TIGER)	\$1,537,256
TIGER Grant Savings	(\$23,252)

*Note: Net Present Value (NPV) calculated at a 3.0 percent discount rate.
See attached spreadsheet for NPV at 7.0 percent discount rate.*

Table 9 presents the net present value of CO2 emissions between 2016 and 2040 for the Baseline and Preferred Scenarios. The social cost of CO2 emissions were calculated using the recommended monetized value of CO2 provided in the TIGER and FASTLANE BCA Resource Guide.³ Due to the decrease in VHT (through idling) CO2 emissions decrease in the Preferred Scenario relative to the Baseline Scenario. Completing the 18th Street Viaduct under the Preferred Scenario has a Net Present Value benefit in 2015 dollars of reduced CO2 of \$142,187.

Table 9. CO2 Costs (2016 – 2040)

Scenario	NPV (2015 \$)
Baseline (no TIGER)	\$10,484,927
Preferred (with TIGER)	\$10,342,741
TIGER Grant Savings	\$142,187

*Note: Net Present Value (NPV) calculated at a 3.0 percent discount rate,
Per TIGER and FASTLANE BCA Resource Guide.*

Summary of Environmental Sustainability Benefits

The 18th Street Viaduct will eliminate substantial idling at at-grade railroad crossings and therefore reduce VHT. While VMT will increase under the Preferred Scenario, implementation of

³ See attached spreadsheet for actual values used.

the project in the Preferred Scenario still results in net air quality benefits valued at a Net Present Value of \$122,832 in 2015 dollars.

Safety

The 18th Street Viaduct will reduce the number of crashes through two primary effects:

- Closing intersections; and
- Closing railroad crossings.

Reduced Number of Intersection-related Crashes

Using data from CMF Clearinghouse, 2011-2013 Crash Data from the Iowa DOT, and other sources, the Study Team calculated the reduction in Property Damage Only (PDO), injury, and fatal crashes from closing or modifying five intersections:

- 11th Street and Floyd Blvd;
- 11th Street and Steuben Street;
- 18th/19th Street and Floyd Blvd;
- 18th Street and Steuben Street; and
- 18th Street Viaduct and Floyd Blvd (new).

Table 10 shows the Baseline (no TIGER grant) and Preferred Scenario (with TIGER grant) total estimated crashes at the affected intersections in 2014 and 2040.

Table 10. Crashes at the Affected Intersections

	2014	2040
Baseline (no TIGER)	12.33	24.31
Preferred (with TIGER)	8.92	15.21
TIGER Grant Reduction	3.41	9.10

Monetization of Reduced Number of Crashes

The dollar benefit of reductions in injury and fatal crashes for intersection modifications was estimated using the DOT's *Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses* (2016) as provided in the TIGER and FASTLANE BCA Resource Guide. Because the estimated reductions for injury crashes at the affected intersections were not available by AIS level, the Study Team used the weighted value of the Injured Severity Unknown column in the KABCO/Unknown – AIS Data Conversion Matrix provided in the TIGER and FASTLANE BCA Resource Guide to develop the value of injuries. Using that information, the value of a statistical life in 2015 dollars by injury classification as used for the 18th Street Benefit Cost Analysis is detailed in **Table 11**.

Table 11. Value of Avoided Injuries

Injury Severity	Total Benefit (2015 \$)
Injury	\$174,030
Fatal	\$9,600,000

Per the TIGER and FASTLANE BCA Resource Guide, PDO crashes were valued at \$4,198 in 2015 dollars.

Table 12 presents the Net Present Value of PDO, Injury, and Fatal crashes at the five affected intersections for the period 2016 through 2040 in 2015 dollars. Reduced crash costs for the Preferred Scenario relative to the Baseline Scenario would yield a Net Present Value benefit of \$2,917,829.

Table 12. Crash Costs (2016 – 2040)

Scenario	NPV (2015 \$)
Baseline (no TIGER)	\$20,821,428
Preferred (with TIGER)	\$17,903,600
TIGER Grant Savings	\$2,917,829

Note: Net Present Value (NPV) calculated at a 3.0 percent discount rate.

See attached spreadsheet for NPV calculations at a 7.0 percent discount rate.

Reduced Number of Crashes due to Railroad Crossing Closures

The Study Team calculated the statistical value of safety improvements due to closing two at-grade railroad crossings (11th Street and 18th Street) using the Federal Railroad Administration’s (FRA’s) Quiet Zone Calculator. That calculator includes value estimates of the reduction in PDO, injury, and fatal crashes due to closing at-grade crossings.⁴ Those estimates are provided below in the section *Monetization of Reduced Number of Crashes*.

Table 13 presents the Net Present Value of the benefit of closing the affected at-grade railroad crossings for the period 2016 through 2040 in 2015 dollars. NPV of the at-grade railroad crossing closures associated with the 18th Street Viaduct project is \$230,354.

⁴ A description of the methodology and risk index used in the Quiet Zone Calculator are provided in the Federal Register/Vol.71, No. 159 p. 47664. AIS levels and statistical values of a life are parallel to the USDOT methodology described in the TIGER and FASTLANE BCA Resource Guide.

Table 13. Benefits of At-grade Railroad Crossing Closures (2016 – 2040)

Scenario	NPV (2015 \$)
Baseline (no TIGER)	\$177,434
Preferred (with TIGER)	\$407,789
TIGER Grant Savings	\$230,354

Note: Net Present Value (NPV) calculated at a 3.0 percent discount rate. See attached spreadsheet for NPV calculations at a 7.0 percent discount rate.

Summary of Economic Value of Safety Improvements

Combining safety improvements for the affected intersections and the at-grade railroad crossings, the 18th Street Viaduct is estimated to provide a Net Present Value of \$3.1 million in 2015 dollars.

State of Good Repair

Pavement Maintenance Costs

Pavement Maintenance Costs for the 18th Street Viaduct are assumed to be a resurface after the first 20 years at a cost of \$450,000 in 2015 dollars, or an annual amortized cost of \$22,500. A comparison of the Baseline Scenario and the Preferred Scenario show a net increase in maintenance costs as shown in **Table 14**.

Table 14. Maintenance Costs (2016 – 2040)

	NPV Costs (2015 \$)
Baseline (No TIGER)	\$126,803
Preferred (With TIGER)	\$313,159
<i>Additional Maintenance Costs</i>	<i>\$186,356</i>

Note: NPV calculated at a 3.0 percent discount rate. See attached spreadsheet for calculation of NPV at 7.0 percent discount rate.

Benefit Cost Analysis Results

Construction of the project in the Preferred Scenario (with a TIGER grant) is expected to bring significant benefits in comparison to the Baseline Scenario (without a TIGER grant). The TIGER grant would allow the 18th Street Viaduct to be constructed on an accelerated schedule – estimated to be 11 years sooner than it would otherwise be built. The benefit to cost ratio has been calculated at approximately 2.2:1 using a 3 percent discount rate, and 1.7:1 using a 7 percent discount rate.

Expressed an alternate way, the Net Present Value of the stream of benefits less costs for the study period (2016 through 2014) for the 18th Street Viaduct is \$35.5 million using a 3 percent discount rate and \$19.7 million using a 7 percent discount rate. Either way, the project has a substantial net value to society.

The primary monetized benefits of completing the project in the Preferred Scenario include:

- Travel time savings as a result of less idling at railroad crossings
- Improved air quality as a result of reduced VMT and mode-shift
- Fewer crashes as a result of the new Extension

Additional benefits that would accrue from the project but are not monetized and not included in the benefit cost calculation include:

- Improved rail switching operations;
- Improved opportunities for existing and future industries with rail access; and
- Accommodations for pedestrians and bicyclists connecting the adjacent neighborhoods west of Floyd Boulevard to the trail along the west bank of the Floyd River.