City of Dyersville

RAISE Capital Grant:
BCA Narrative

Benefit-Cost Analysis

Dyersville, Iowa is requesting $25 million in US Department of Transportation (USDOT) Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant funds to enhance connectivity with the construction of a $29.9 million project to build new key roadway and bridge connections, on- and off-street bicycle facilities, and Americans with Disabilities Act (ADA) compliant sidewalk connections in this rural city. This request accounts for 86 percent of future project costs. Dyersville is burdened with disconnected roads, trails, and sidewalks, along with physical barriers during flood events and train activity which cut off critical access for emergency and city services. These missing connections also hinder growth of community connectivity in the city. USDOT resources will help Dyersville establish a complete multimodal transportation network to improve access throughout the community, build new active transportation facilities, eliminate a hazardous at-grade rail crossing, reduce emergency response times, and promote economic development.

A significant transportation concern is discontinuity among the community due to the existing design of the local roadway network, which is further exacerbated during flooding events that cut off several neighborhoods. Dyersville's disconnected road network causes numerous access problems, isolates neighborhoods, and creates challenges for emergency vehicles trying to reach flooded neighborhoods. The proposed bridges over the creek and floodplains would alleviate this issue.

The City of Dyersville's economy relies heavily on agriculture, manufacturing, and tourism, which draws more than 150,000 tourists annually. This influx of people to the small, rural, Iowan town places additional strain on local infrastructure. Additionally, 18% of Dyersville's population is 65 years old or older. The project elements will improve multimodal transportation access throughout the city for this population. In seeking to address safety and EMS response times during rail crossing closures and delays, flood events isolating neighborhoods, and increasing traffic volumes, Dyersville has proposed the construction of new east-west and north-south connections through town. The Enhancing Multimodal Connections in Dyersville project consists of five primary components:

1. East-West Connection: 13th Avenue SE connection to 12th Avenue SW over North Fork Maquoketa River.
2. North-South Connection: 7th Street SW connection to 1st Avenue W over Bear Creek and Beltline Road Overpass.
3. Multimodal Trail Connections and Wayfinding Enhancements: Multi-use trails at several locations throughout Dyersville to fill gaps in the existing trail network, promoting connectivity.
4. Electric Vehicle Charging Infrastructure: At Candy Cane Park near Arbor Court Drive and 3rd Street SE.

The proposed project aligns well with the Biden Administration's stated goals of improving the transportation network to more efficiently move people and goods. The construction of bridges over the creek and floodplains specifically addresses the need to improve safety and explicitly addresses climate change through infrastructure that enhances connectivity for all communities at all times, but particularly during the frequent flood events.

Table 1: Summary of Infrastructure Improvements and Associated Benefits

Current Status & Anticipated Changes to Baseline Conditions	Type of Impacts	Population Affected by Impacts	Economic Benefits	Undiscounted Monetized Benefits ($2021)	Merit Criteria (Section)
Undersized roads and disjointed routes with level grade crossings that top over with floodwaters and are blocked by trains, separating neighbor hoods across Dyersville.	Crash Reduction Benefit	Drivers and passengers	Monetized reduction in injury and fatality crashes.	$559 thousand	Safety (6.1)
	Emergency Response Benefit	General public	Fire and EMS will be able to arrive at emergencies faster and without obstruction	$10.2 million	
	Emissions Reduction	General public	Dollar value associated with reduced vehicle emissions	$93.4 thousand	Environmental Sustainability (6.2)

Three new resilient bridges—one over the railroad tracks and two over bodies of water—that will knit Dyersville together and be resilient against storm waters. Multi-use trails throughout Dyersville to fill gaps in the existing trail network, promoting connectivity	Reduced Mortality Benefit – New Cyclists and Pedestrians	New cyclists and pedestrians	Implied dollar value of health benefits realized by new riders and pedestrians	$2.13 million	Quality of Life (6.3)
	Facility Improvements for Cyclists and Pedestrians	Existing and new cyclists and pedestrians	Implied dollar value of amenity benefits from improved facility	$649 thousand	Mobility and Community Connectivity (6.4)
	Travel Time Savings	Drivers and passengers	Dollar value associated with travel time savings.	$5.5 million	Economic Competitiveness (6.5)
	Vehicle Operating Cost Savings	Drivers	Dollar value savings associated with VMT reduced by more efficient routes	$2.8 million	
	Pavement Maintenance Cost Savings	State and local governments	Dollar value associated with maintaining roadway pavement	$1.5 thousand	State of Good Repair (6.6)
	Residual Infrastructure Value	State and local governments;	Remaining value in infrastructure assets at the end of	$2.3 million	

		General public	the period of analysis		
	Incremental Operating and Maintenance Costs	Additional Operating and Maintenance Costs	Additional maintenance costs due to new construction	-$1.1 million	N/A (disbenefit)

The period of analysis used in the estimation of benefits and costs runs from 2020 through 2047, which includes 8 years of project development (ROW, design, and construction) and 20 years of operations. In constant 2021 dollars, total undiscounted project capital costs are $28.2 million, and discounted costs (using a 7% discount rate) are $22.6 million (see Table 2).

Table 2: Summary of Project Capital Costs, in Dollars of 2021

Cost Category	Undiscounted Project Costs	Discounted Project Costs
Capital Costs	$28.2 million	$22.6 million

Per USDOT Guidance, incremental operations and maintenance (O&M) costs due to the project are classified as disbenefits, rather than costs.

A summary of the relevant data and calculations used to derive the benefits and costs (in dollars of 2021) of the project are shown in the Benefit-Cost Analysis (BCA) model Microsoft Excel file also submitted with this application package. Based on the analysis presented in the rest of this document, the project is expected to generate $23.3 million in total discounted benefits and $22.6 million in discounted capital costs, using a 7 percent real discount rate generally and a 3 percent real discount rate for carbon dioxide emissions. Therefore, the project is expected to generate a Net Present Value (NPV) of $637 thousand and a benefit-cost ratio (BCR) of 1.03.

In addition to the monetized benefits, the project will generate many benefits that are difficult to quantify and monetize in a BCA. These non-monetized benefits – which include increased jobs and economic development, expanded infrastructure to handle future Major League Baseball (MLB) games, increased infrastructure resiliency, decreased flooding impacts across Dyersville, and avoided delay at railroad grade crossings – are further discussed in the project description and merit criteria sections.

Introduction

This document provides detailed technical information on the economic analyses conducted in support of the grant application for Enhancing Multimodal Connections in Dyersville.

- Section 2, Methodological Framework, introduces the conceptual framework used in the BCA;
- Section 3, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives, a summary of cost estimates and schedule, and a description of the types of effects that the project is expected to generate;
- Section 4, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits;
- Section 5, Demand Projections, provides estimates of travel demand and traffic growth;
- Section 6, Benefits Measurement, Data and Assumptions, provides specific data elements and assumptions pertaining to the long-term outcome selection criteria, along with associated benefit estimates;
- Section 7, Summary of Findings and BCA Outcomes, presents estimates of the projects NPV, its BCR, and other project evaluation metrics; and
- Section 8, BCA Sensitivity Analysis, provides the outcomes of the sensitivity analysis.

Additional data tables are provided within the separately uploaded BCA model file, including annual estimates of benefits and costs, to assist the U.S. Department of Transportation (USDOT) in its review of the application.[1]

2. Methodological Framework

The BCA conducted for this project includes the monetized benefits and costs measured using USDOT guidance, as well as the quantitative and qualitative merits of the project. A BCA provides estimates of the benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. Project costs include the resources required to develop the project. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms. Costs of maintaining the new or improved asset over time are included as disbenefits.[2]

While BCA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.[3]

The specific methodology employed in this application was developed using the BCA guidance published by USDOT and is consistent with RAISE program guidelines. In particular, the methodology involves:

[1] *The Microsoft Excel-based BCA model is provided separately as part of the application package.*

[2] *USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023.*

[3] *Ibid.*

- Establishing existing and future conditions under the Build and No-Build scenarios;
- Assessing benefits with respect to each of the merit criteria identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of travel time improvements, safety benefits, reductions in air emissions and residual infrastructure value while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by USDOT (7 percent generally and 3 percent for carbon dioxide emissions); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

3. Project Overview

The Enhancing Multimodal Connections project will improve connectivity, emergency response times (especially in times of flooding), better handle increasing traffic volumes, improve the level of service, provide additional direct connections across Dyersville, reduce auto accidents, avoid rail conflicts, improve the pedestrian and bicycling environment, and promote economic development in Dyersville.

The City of Dyersville, Iowa seeks Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant funds to support the Enhancing Multimodal Connections in Dyersville Project. The proposed project creates sustainable, new multimodal transportation connections through key infrastructure additions that create alternative access across the North Fork of the Maquoketa River, Bear Creek, and the Canadian National (CN) Railway, connecting neighborhoods, modes, and economies within this rural town. These connectivity enhancements include a new bridge crossing across the North Fork, a new bridge connection across the Maquoketa River, new trail connectivity, wide sidewalks, bike lanes, electric vehicle (EV) charging infrastructure, and additional downtown walkability enhancements. The improvements will create resilient, sustainable, future-proof infrastructure connections to support quality of life and economic prosperity.

3.1 Base Case and Alternatives

Estimates of baseline conditions (the “No-Build” scenario) were forecasted over the analysis period and then compared to the alternative conditions of the Build scenario in the benefit-cost analysis. The Full Build scenario assumes the creation of two key bridge connections and three additional elements as described below:

1. **East-West Connection**: 13th Avenue SE connection to 12th Avenue SW over North Fork Maquoketa River

2. **North-South Connection**: 7th Street SW connection to 1st Avenue W over Bear Creek and Beltline Road Overpass.
3. **Multimodal Trail Connections and Wayfinding Enhancements**: Multi-use trails at several locations throughout Dyersville to fill gaps in the existing trail network, promoting connectivity.
4. **Electric Vehicle Charging Infrastructure:** At Candy Cane Park near Arbor Court Drive and 3rd Street SE.

Each of the two primary bridge elements components (the "East-West" and the "North-South") are also evaluated independently in this BCA.

3.2 Types of Impacts

The BCA measures impacts on residents and workers in Dyersville, as well as on visitors and society at large. These impacts include direct traffic impacts, vehicle emissions, infrastructure maintenance, vehicle safety, emergency response, and quality of life / health impacts.

3.3 Project Cost and Schedule

The total capital cost of the full project is estimated to be $28.2 million (undiscounted) in 2021 dollars. The project team has prepared a schedule of planning, construction and implementation, available in the main application. Future capital expenditure is scheduled to being in 2024 and conclude in 2027.

3.4 Effects on Selection Criteria

The main benefit categories associated with the project are mapped into the seven selection criteria set forth for the RAISE program in the table below.

Table 3: Benefit Categories and Expected Effects on RAISE Merit Criteria

RAISE Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
Safety	Crash Reduction Benefit	Reduced VMT will result in fewer traffic incidents resulting in costs associated with fatalities, injuries and	Yes	Yes	Yes

RAISE Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
		property damage.			
	Emergency Response Benefit	Reduced congestion and improved connections will result in improved fire and EMS emergency vehicle response times.	Yes	Yes	Yes
Environmental Sustainability	Emissions Reduction	Reductions in greenhouse gas and air pollutant emissions will result from changes in auto use as some people will opt to walk or bike rather than drive.	Yes	Yes	Yes
	Improved Infrastructure Resiliency	Adding 2 bridges over water will provide travel options during flooding events	No	No	Yes
Quality of Life	Reduced Mortality Benefit – New Cyclists	People not currently biking or walking will be induced to do so as a result of the	Yes	Yes	Yes

RAISE Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
	and Pedestrians	project, leading to increased physical activity and providing a health benefit. Benefits to existing pedestrians and cyclists are not quantified.			
Mobility and Community Connectivity	Facility improvement benefits for new and existing cyclists and pedestrians	New and existing cyclists and pedestrians will enjoy the amenities of improved sidewalks/paths	Yes	Yes	Yes
Economic Competitiveness	Travel Time Savings	Reduction in VHT for passenger vehicle and truck trips in the project area.	Yes	Yes	Yes
	Operating Cost Savings	Reduction in VMT will result in VOC savings associated with fuel, repairs and maintenance, insurance and depreciation.	Yes	Yes	Yes
State of Good Repair	Pavement maintenance savings	Reductions in auto use and VMT will also,	Yes	Yes	Yes

RAISE Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
		reduce pavement wear and tear on existing roadways.			
	Residual Infrastructure Value	Disused infrastructure brought into a state of good repair and new infrastructure constructed for the project will provide decades of use beyond the period of analysis of this BCA.	Yes	Yes	Yes
Innovation	Discussed in the application narrative.		No	No	Yes
Partnership					

4. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning in 2020 and ending in 2047, which includes 8 years of project spending and 20 years of operations.

The monetized benefits and costs are estimated in 2021 dollars with future dollars discounted in compliance with RAISE requirements using a 7 percent real discount rate generally and a 3 percent rate applied to carbon dioxide emissions.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2021 dollars;

- The period of analysis begins in 2020 and ends in 2047. It includes project ROW and design (2020 - 2025), construction (2024-2027), 2 years of partial operations (2026-2027), and 20 years of full operations (2028-2047);
- A constant 7 percent real discount rate is applied throughout the period of analysis generally, while a 3 percent real discount rate is applied to carbon dioxide emissions;
- Opening year demand is assumed to be partially realized in 2026 upon completion of the East-West and North-South components, and fully realized in 2028 upon completion of the remaining elements in the Full Build Alternative; and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Full Build alternative. Additional alternatives of the project "East-West Component" and "North-South Component" are also evaluated independently, and results are presented in Section 8.

5. Demand Projections

Multiple categories of benefits generated by the Enhancing Connections in Dyersville project result directly its implementation. These benefits include travel time savings, vehicle operating cost savings, pavement maintenance savings, crash safety benefits, emissions reductions, emergency services benefits, new cyclist and pedestrian health benefits, facility amenity benefits to existing and new cyclists and pedestrians, and residual infrastructure value. These benefits are generated primarily from the alleviation of congestion in the project area and model shift to active transportation that is expected. The monetization of these benefit categories depends on projections of future vehicle, truck and cyclist and pedestrian activity in the Build scenario, and a comparison to how this behavior differs from the No Build scenario.

This section of the technical documentation presents the pedestrian and cyclist travel projections utilized in the BCA and details the methodological approach used to estimate this activity.

5.1 Methodology

Vehicle traffic activity in the Full Build, East-West component and North-South component were provided via Traffic Model data from the City of Dyersville. The projections include daily savings in VHT and VMT in the project area for project year 1 and project year 30. Demand was increased linearly from year 1 to year 30 to estimate future daily VHT and VMT savings. Daily VHT and VMT savings values were annualized using a factor of 260 which represents the number of business days per year.

Average annual bike and walk activity was estimated using American Community Survey (ACS) population and commuter data in the project area. Daily cyclist and pedestrian traffic were annualized by a factor of 120 for trips to school, 173 for trips to work and 104 trips to services. ACS data indicates that 3.3 percent of residents age 16

and over walk to work and 1.4 percent bike to work across Iowa, but rates of walking and biking are lower in Dyersville. This analysis assumes that the rate of walking and biking in Dyersville will reach the state-wide rate as a result of project improvements. The share of school age residents who walk to school in the Build Case are estimated to be 10 percent and the share who bike to school are estimated to be 10 percent, but this will double as a result of project improvements. The average walking trips is assumed to be 0.86 miles and the average bike trip is assumed to be 2.38 miles, in accordance with USDOT BCA guidance.

6. Benefits Measurement, Data and Assumptions

This section lists the six RAISE merit criteria and describes the methodology, assumptions, and results for the benefits corresponding to each criteria. Note that the project is also expected to generate additional O&M costs due to the new construction. This disbenefit is included in the summary of BCA results in Section 8.

6.1 Safety

The project generates safety benefits in two ways. First by reducing the number of anticipated crashes in the project study area due to the reduction in vehicle miles traveled. Second, by improving connectivity in the study area the project will improve travel time for emergency response services. The Federal Emergency Management Agency (FEMA) provides guidance for monetizing improved emergency vehicle response for BCA's.[4] These benefits were estimated both fire and EMS response.

6.1.1 Methodology

Historical crashes in the study area were retrieved using the Iowa DOT Crash Analysis Tool. In the six years from 2015 through 2020, 186 crashes were documented within the project area, including 2 incapacitating injury crashes, 36 other injury crashes, and 148 property damage only (PDO) crashes. There were no fatalities in the area during that time.

Safety benefits were calculated by first aggregating recorded vehicle injury and fatality crashes within the Enhancing Connections in Dyersville project area. Average annual crash frequency rates, by crash severity, were then calculated from this aggregated data. Average annual crash frequency was then grown forward into the future by 1 percent annually.

The magnitude of anticipated crash reduction brought about by the Enhancing Dyersville Connections project was then calculated using these average crash frequencies and a CMF of 3.6 percent, as estimated during the project safety analysis

[4] *"FEMA Benefit-Cost Analysis Re-engineering (BCAR): Development of Standard Economic Values.", December 2011. Accessed at: https://files.hudexchange.info/course-content/ndrc-nofa-benefit-cost-analysis-data-resources-and-expert-tips-webinar/FEMA-BCAR-Resource.pdf*

(see Appendix B of main application). This CMF is based on the reduced VMT anticipated from the project. The resulting crash reduction was then monetized according to crash valuation parameters by severity, per USDOT BCA Guidance.

6.1.2 Assumptions

The assumptions used in the estimation of safety benefits are summarized in the table below.

Table 4. Parameters Used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Reduced Crashes			
Value of Averted Fatality (K)	$ per event	$11,800,000	USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023 (Revised)
Value of Averted Incapacitating Injury (A)	$ per event	$564,300	(ibid)
Value of Averted Non-Incapacitating Injury (B)	$ per event	$153,700	(ibid)
Value of Averted Possible Injury (C)	$ per event	$78500	(ibid)
Value of No Injury (O)	$ per event	$4,000	(ibid)
Value of Injury, Severity Unknown (U)	$ per event	$213,900	(ibid)
Value of Averted Property Damage	$ per vehicle	$4,800	(ibid)
Annual Crash Growth Rate	%	1%	HDR Assumption
Crash Reduction Factor	%	3.6%	Iowa DOT Safety and Traffic Analysis (see Application Appendix B)

EMS Benefits			
East-West Component			
Population Affected	people	1300	Approximate Population of West Dyersville
Reduced distance from improvements	miles	1.00	Approximate reduction in driving distance from Dyersville Fire Station to West Dyersville
North-South Component			
Population Affected	people	500	Approximate Population of Dyersville north of train tracks
Reduced distance from improvements	miles	1.2	Equivalent to average of 2-minute emergency vehicle delay at train tracks.

6.1.3 Benefit Estimates

Safety benefits resulting the construction of new bridges to divert traffic along safer routes and allow for faster emergency response are estimated at $559.3 thousand over the 20-year period of analysis, when discounted at 7 percent. Additionally, the project will generate significant savings in emergency services costs, accounting for $10.2 million when discounted at 7 percent. Total safety benefits of the project are $10.7 million.

Table 5: Estimates of Safety Benefits, 2021 Dollars

	Over the Project Lifecycle	
	Undiscounted	**Discounted**
Crash Safety Benefits	$1,497,278	$559,389
Emergency Services Benefits	$26,546,253	$10,182,380
Total Safety Benefits	**$28,043,531**	**$10,741,769**

6.2 Environmental Sustainability

The project will contribute to environmental sustainability by reducing vehicle emissions. This comes from creating connections that result in more direct travel, and also inducing some drivers to travel by non-automotive modes on these new connections. Additionally the project enhances infrastructure resiliency by providing traffic bridges to avoid flooding on the roadways.

6.2.1 Methodology

Reduced vehicle miles travelled as a result of mode-shift to improved pedestrian and bicycle transportation infrastructure and more direct car routes was also calculated from the demand forecasts previously discussed in Section 5. These projections of reduced VMT in the Build scenario were combined with emissions rates for vehicles, in grams per mile, sourced from the EPA MOVES model to calculate total reduced emissions. Total quantities of reduced emissions from both sources, by pollutant, were further monetized according to USDOT BCA Guidance.

By constructing two bridges over waterways in the study area, the project will also provide more resilient infrastructure. Vehicles will no longer be delayed by flooding events on these corridors. These benefits were not monetized as part of the BCA.

6.2.2 Assumptions

The assumptions used in the estimation of environmental sustainability benefits are summarized in the table below.

Note that emissions rates sourced from the EPA MOVES database are time series data. The values represented in the table below correspond with emissions rates as of 2020, which are generally representative for summary purposes of the more detailed time series emissions rates employed in the BCA model.

Table 6: Assumptions Used in the Estimation of Environmental Sustainability Benefits

Variable Name	Unit	Value	Source
Value of Reduced Emissions: CO2	$ per metric ton	$52 - $88	USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023 (Revised)
Value of Reduced Emissions: NOx	$ per metric ton	$15,600 - $18,900	(ibid)
Value of Reduced Emissions: PM2.5	$ per metric ton	$748,600 - $907,600	(ibid)

Value of Reduced Emissions: SO2	$ per metric ton	$41,500 - $51,300	(ibid)
Passenger Vehicles			
Emissions Factor: CO2	grams per mile	155.4677	EPA MOVES Database, for speeds from 30 mph. Values shown for year 2020
Emissions Factor: NOx	grams per mile	0.0780	(ibid)
Emissions Factor: PM2.5	grams per mile	0.0011	(ibid)
Emissions Factor: SO2	grams per mile	0.0010	(ibid)
Trucks			
Emissions Factor: CO2	grams per mile	764.8437	EPA MOVES Database, for speeds from 30 mph. Values shown for year 2020
Emissions Factor: NOx	grams per mile	2.3542	(ibid)
Emissions Factor: PM2.5	grams per mile	0.0636	(ibid)
Emissions Factor: SO2	grams per mile	0.0026	(ibid)

6.2.3 Benefit Estimates

The project improvements are estimated to decrease air contaminant emissions over the study period, as drivers divert to biking and walking trips. This minor monetized benefit is estimated to total approximately $93,405 over twenty years when discounted by 7 percent, with a 3 percent discount rate applied to carbon dioxide emissions.

Table 7: Estimates of Environmental Sustainability Benefits, 2021 Dollars

	Over the Project Lifecycle	
	Undiscounted	Discounted
Emissions Reduction Benefits	$153,469	$93,405

6.3 Quality of Life

The project will generate quality of life benefits by encouraging new pedestrians and cyclists to use the improved sidewalk facility. These new pedestrians and cyclists will enjoy increased health benefits from the additional exercise.

In terms of monetized quality of life benefits, the proposed project is expected to generate health benefits for induced cyclists and pedestrians. Health benefits are monetized as reduced mortality risk, per USDOT BCA Guidance.

6.3.1 Methodology

Pedestrian and cyclist trips in the project study area are estimated based on local population statistics and the portion of residents who walk and cycle to school and to work as described in Section 5. The project improvements are expected to generate induced pedestrian and cyclist trips, who will benefit from reduced mortality risk. These additional trips are monetized based on USDOT BCA guidance.

6.3.2 Assumptions

The assumptions and parameters used in the estimation of quality of life benefits are summarized in the table below.

Table 8: Assumptions Used in the Estimation of Quality of Life Benefits

Variable Name	Unit	Value	Source
Percent population 20-74	%	68%	USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023 (Revised)
Percent population 20-64	%	59%	(ibid)
Percent of induced trips from non-AT	%	89%	(ibid)
Value per pedestrian trip	$/trip	$7.20	(ibid)
Value per cyclist trip	$/trip	$6.42	(ibid)
Annualization Factors			

Walk/Bike to School	days per year	120	HDR Assumption. 2/3rds of full 180 day school year.
Walk/Bike to Work	days per year	173	HDR Assumption. 2/3rds of 260 day work year.
Walk/Bike to Services	days per year	104	HDR Assumption. Two trips per week.

6.3.3 Benefit Estimates

Quality of life benefits achieved through improved active transportation infrastructure are estimated to total $2.1 million over 20 years of project operations, discounted at 7 percent.

Table 9: Estimates of Quality of Life Benefits, 2021 Dollars

	Over the Project Lifecycle	
	Undiscounted	Discounted
Mortality Reduction Benefits to New Cyclists and Pedestrians	$5,543,305	$2,126,252

6.4 Mobility and Community Connectivity

The focus of this project is to improve mobility in the city of Dyersville by constructing new east-west and north-south connections through town. This improves mobility for vehicles (as captured through reduced travel time, vehicle operating costs, and emissions) as well as for pedestrians and cyclists. These benefits are discussed in this section and are monetized through the facility amenity benefits as per USDOT BCA Guidance.

6.4.1 Methodology

As discussed in Sections 5 and 6.3, pedestrians and cyclists trips in the project study area are estimated based on local population statistics and the portion of residents who walk and cycle to school and to work. Both existing and induced pedestrians and cyclists will enjoy benefits from the sidewalks as part of the new east-west and north-south connections. Benefits are calculated based on the length of the facility improvements, and monetization values provided in USDOT BCA guidance. In

particular, if the length of the facility improvement is greater than the average trip distance advised in the USDOT BCA guidance, then the improved facility length is capped by the average trip length.

6.4.2 Assumptions

The assumptions and parameters used in the estimation of mobility and community connectivity benefits are summarized in the table below.

Table 10: Assumptions Used in the Estimation of Mobility and Community Connectivity Benefits

Variable Name	Unit	Value	Source
Additional feet of sidewalk added - bridges	feet	10	HDR assumption based on minimum sidewalk width. Assume sidewalk is added to both sides of the new bridge
Value per foot of expanded sidewalk - bridges	$/foot per mile	$0.11	USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023
Value of new sidewalk - bridges & trails	$ per mile	$1.10	HDR Calculation based on project width
Additional feet of sidewalk added - trails	feet	10	
Value of new sidewalk - trails	$ per mile	$2.20	HDR Calculation based on project width
Value of new cycling path	$ per mile	$1.49	USDOT Benefit-Cost Analysis Guidance, January 2023
Length of Facility Improvement- Pedestrians			
East-West Component	miles	0.63	Improved pedestrian path length capped by average trip length
North-South Component	miles	0.86	Improved pedestrian path length capped by average trip length
Full Project Trails	miles	0.86	Total improved trip length, both segments

Length of Facility Improvement- Cyclists			
East-West Component	miles	0.63	Improved cyclist path length capped by average trip length
North-South Component	miles	1.05	Improved cyclist path length capped by average trip length
Full Project Trails	miles	2.11	Total improved trip length, both segments

6.4.3 Benefits Estimate

Mobility benefits of the project are estimated to be $649 thousand over 20 years of project operations, discounted at 7 percent.

Table 11: Estimates of Mobility Benefits, 2021 Dollars

	Over the Project Lifecycle	
	Undiscounted	Discounted
Facility Improvement Benefits to Cyclists and Pedestrians	$1,693,456	$649,561

6.5 Economic Competitiveness

The Enhancing Connections in Dyersville project will contribute to enhancing economic competitiveness through increased access to jobs and multi-modal time and vehicle operating cost savings for travelers in the study area. The project is expected to result in travel time savings for vehicles, trucks, pedestrians and cyclists on the roads of Dyersville.

6.5.1 Methodology

As discussed in Section 5, projections of daily vehicle hours and vehicle miles saved for autos and trucks were estimated in the Full Build, East-West and North-South component as part of the Traffic Model data from the City of Dyersville. Savings were interpolated between the base and forecast year and monetized based on USDOT BCA guidance.

For pedestrians and cyclists, the travel distance avoided due to the project east-west and north-south connections was multiplied by existing trips to estimate the avoided miles traveled. This was applied to an average speed of travel for pedestrians and cyclists to get person-hours saved due to the project. Avoided travel time was monetized based on USDOT BCA Guidance.

6.5.2 Assumptions

The assumptions and parameters used in the estimation of mobility and community connectivity benefits are summarized in the table below.

Table 12: Assumptions Used in the Estimation of Economic Competitiveness Benefits

Variable Name	Unit	Value	Source
Average Vehicle Occupancy - Passenger Vehicles (All Travel)	persons/ vehicle	1.67	USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023. Appendix A, Table A-4
Average Vehicle Occupancy - Trucks	persons/ vehicle	1.00	HDR Assumption
Travel Time Cost - Local Travel (All Purposes)	$ / person-hour	$18.80	USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023.
Travel Time Cost - Truck Drivers	$ / person-hour	$32.40	(ibid)
Travel Time Cost - Walkers and Cyclists	$ / person-hour	$34.00	(ibid)
Average Cycling Speed	mph	9.80	(ibid)
Average Walking Speed	mph	3.20	(ibid)
Vehicle Operating Cost - Light Duty Vehicles	$/ mile	$0.46	(ibid)
Vehicle Operating Cost - Commercial Trucks	$/ mile	$1.01	(ibid)

6.5.3 Benefits Estimate

Economic competitiveness benefits of the project are estimated to be $8.4 million over 20 years of project operations, discounted at 7 percent.

Table 13: Estimates of Economic Competitiveness Benefits, 2021 Dollars

	Over the Project Lifecycle	
	Undiscounted	Discounted
Travel Time Savings	$14,384,570	$5,563,286
Vehicle Operating Cost Savings	$7,321,896	$2,825,927
Total Economic Competitiveness Benefits	**$21,706,466**	**$8,389,213**

6.6 State of Good Repair

The project will contribute to the state of good repair by reducing the vehicle miles traveled both through the reduced trip length as well as modal diversion from driving to walking or cycling. The project will also generate residual value benefits from the three new bridges constructed, which will each have a useful life longer than the 20-year operations period used in the BCA.

6.6.1 Methodology

To estimate the reduced pavement maintenance costs, total reduced VMT was calculated. As discussed during Section 6.5, vehicle miles saved for autos and trucks was estimated in the Full Build, East-West and North-South component as part of the Traffic Model data from the City of Dyersville. These reduced miles were monetized based on the marginal external costs of pavement damage by vehicle class, as estimated by the 1997 Federal Highway Cost Allocation Study (inflated to 2021 dollars).

Additionally, as discussed during Section 6.3, the project is expected to generate new pedestrian and cyclist trips resulting, in part, from modal diversion. However, since the external cost of pavement damage from automobiles in rural areas is negligible, these benefits were not monetized in the BCA.

The residual value of investment was calculated by applying straight line depreciation to the capital value of structure items constructed across the Enhancing Connections in Dyersville project area according to the minimum years of service life for these infrastructure assets and the analysis period of the BCA.

6.6.2 Assumptions

The assumptions used in the estimation of state of good repair benefits are summarized in the table below.

Table 14: Assumptions Used in the Estimation of State of Good Repair Benefits

Variable Name	Unit	Value	Source
External cost of pavement damage by autos on a rural interstate	$/mile	$0.000	Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Inflated to $2020 based on GDP implicit price deflators.
External cost of pavement damage by trucks on a rural interstate	$/mile	$0.015	(ibid)
Service life of bridges	years	100	City of Dyersville

6.6.3 Benefit Estimates

Total discounted state of good repair benefits are estimated to be approximately $2.3 million over the period of analysis.

Table 15: Estimates of State of Good Repair Benefits, 2021 Dollars

	Over the Project Lifecycle	
	Undiscounted	Discounted
Pavement Maintenance Cost Savings	$4,017	$1,550
Residual Infrastructure Value	$13,199,736	$2,272,935
Total State of Good Repair Benefits	$13,203,753	$2,274,485

7. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. The findings have been aggregated into the Full Build, East-West Component, and North-South Component. Annual costs and benefits are computed over the lifecycle of the project and, as stated earlier, construction is expected to be completed in 2027, with a first full year of benefits in 2028. Benefits accrue during the full operation of the project, for twenty years through 2047.

Table 16: Full Build Overall Results of the Benefit Cost Analysis, 2021 Dollars

Project Evaluation Metric	Undiscounted	Discounted
Total Net Benefits ($ millions)	$67.6	$23.2
Total Costs ($ millions)	$28.2	$22.6

Net Present Value ($ millions)	$39.4	$0.6
Benefit / Cost Ratio	2.40	1.03
Internal Rate of Return (%)	7.3% *	
Payback Period (years)	17	27

** IRR is based on undiscounted series*

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 7.3 percent. With a 7 percent real discount rate (and a 3 percent rate applied to carbon dioxide emissions), the investment would result in $2.4 million in Net Present Value (discounted benefits in excess of discounted costs) and a benefit-cost ratio of approximately 1.03.

Table 17: East-West Component Overall Results of the Benefit Cost Analysis, 2021 Dollars

Project Evaluation Metric	Undiscounted	Discounted
Total Net Benefits ($ millions)	$44.3	$16.0
Total Costs ($ millions)	$9.8	$8.2
Net Present Value ($ millions)	$34.5	$7.8
Benefit / Cost Ratio	4.54	1.96
Internal Rate of Return (%)	14.5%	
Payback Period (years)	11	14

** IRR is based on undiscounted series*

Considering all monetized benefits and costs for the East-West component, the estimated internal rate of return of the project is 14.5 percent. With a 7 percent real discount rate (and a 3 percent rate applied to carbon dioxide emissions), the investment would result in $7.8 million in Net Present Value (discounted benefits in excess of discounted costs) and a benefit-cost ratio of approximately 1.96.

Table 18: North-South Component Overall Results of the Benefit Cost Analysis, 2021 Dollars

Project Evaluation Metric	Undiscounted	Discounted
Total Net Benefits ($ millions)	$20.3	$6.4

Total Costs ($ millions)	$14.8	$11.8
Net Present Value ($ millions)	$5.5	($5.4)
Benefit / Cost Ratio	1.37	0.54
Internal Rate of Return (%)	2.1% *	
Payback Period (years)	27	N/A

** IRR is based on undiscounted series*

Considering all monetized benefits and costs for the North-South component, the estimated internal rate of return of the project is 2.1 percent. With a 7 percent real discount rate (and a 3 percent rate applied to carbon dioxide emissions), the investment would result in -$5.4 million in Net Present Value (discounted benefits in excess of discounted costs) and a benefit-cost ratio of approximately 0.54.

Table 19: Full Build Monetized Benefit Estimates by RAISE Merit Criteria

RAISE Merit Criteria	Benefit Categories	Discounted
Safety	Crash Safety Benefits	$10,741,768
	Emergency Services Benefits	
Environmental Sustainability	Emissions Reduction Benefits	$93,405
Quality of Life	Mortality Reduction Benefits to New Cyclists and Pedestrians	$2,126,252
Mobility and Community Connectivity	Facility Improvement Benefits to Cyclists and Pedestrians	$649,561
Economic Competitiveness	Travel Time Savings	$8,389,213
	Vehicle Operating Cost Savings	
State of Good Repair	Pavement Maintenance Cost Savings	$2,274,485
	Residual Infrastructure Value	
Disbenefits	($1,051,747)	($1,051,747)

Total Benefit Estimates	**$23,222,937**

Table 20: East-West Component Monetized Benefit Estimates by RAISE Merit Criteria

RAISE Merit Criteria	Benefit Categories	Discounted
Safety	Crash Safety Benefits	$7,171,288
	Emergency Services Benefits	
Environmental Sustainability	Emissions Reduction Benefits	$64,935
Quality of Life	Mortality Reduction Benefits to New Cyclists and Pedestrians	$871,577
Mobility and Community Connectivity	Facility Improvement Benefits to Cyclists and Pedestrians	$121,327
Economic Competitiveness	Travel Time Savings	$7,294,128
	Vehicle Operating Cost Savings	
State of Good Repair	Pavement Maintenance Cost Savings	$840,384
	Residual Infrastructure Value	
Disbenefits	Incremental O&M Costs	($331,808)
Total Benefit Estimates		**$16,031,832**

Table 21: North-South Component Monetized Benefit Estimates by RAISE Merit Criteria

RAISE Merit Criteria	Benefit Categories	Discounted
Safety	Crash Safety Benefits	$3,458,986
	Emergency Services Benefits	

Environmental Sustainability	Emissions Reduction Benefits	$8,720
Quality of Life	Mortality Reduction Benefits to New Cyclists and Pedestrians	$871,577
Mobility and Community Connectivity	Facility Improvement Benefits to Cyclists and Pedestrians	$169,912
Economic Competitiveness	Travel Time Savings	$1,297,511
	Vehicle Operating Cost Savings	
State of Good Repair	Pavement Maintenance Cost Savings	$1,157,995
	Residual Infrastructure Value	
Disbenefits	Incremental O&M Costs	($573,433)
Total Benefit Estimates		**$6,391,267**

8. BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections, both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The BCA results of the Full Build scenario as described throughout this report are compared in the table below to various sensitivity testing scenarios. The table provides the percentage changes in project NPV associated with variations in variables or parameters or calculations (listed in row), as indicated in the column headers.

Table 22: Sensitivity Analysis Results

Parameters	Change in Parameter Value	New NPV	% Change in NPV	New B/C Ratio
Discount Rate	Discount Rate of 3%	$15.6 MM	2352.3%	1.61
Benefits Period	Benefits Period of 25 Years	$1.8 MM	179.8%	1.08
Traffic Forecast	"Low" Traffic Projections	$-1.3 MM	-307.1%	0.94
	"Middle" Traffic Projections	$-0.3 MM	-153.5%	0.98
Project Component	East-West Component	$7.8 MM	1129.3%	1.96
	North-South Component	$-5.4 MM	-954.6%	0.54
Crash Reduction Safety Benefits	Reduce Crash CRF to 1%	$0.2 MM	-63.4%	1.01
Annual Additional O&M Expenses	50% Reduction in Annual Additional O&M Expense	$1.2 MM	82.5%	1.05
Bridge Service Life	Bridge Service Life of 75 Years	$0.5 MM	-29.2%	1.02