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Guthrie County Engineering and Secondary Roads

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Subject: Iowa's Farm-to-Market Network of Projects

Introduction

This memorandum summarizes the assumptions, methodology and results developed for the benefit-cost analysis of the No Build and Build Alternatives evaluated as part of Iowa's Farm-to-Market Network of Projects Multimodal Projects Discretionary Grant (MPDG) Grant Program Application. The objective of a benefit-cost analysis (BCA) is to bring all the direct effects of a transportation investment into a common measure (dollars), and to account for the fact that benefits accrue over an extended period while costs are incurred primarily in the initial years. The primary elements that can be monetized are travel time, changes in vehicle operating costs, vehicle crashes, environmental impacts, capital costs and remaining capital value, and maintenance costs. The benefit-cost analysis can provide an indication of the economic desirability of an alternative, but decision-makers must weigh the results against other considerations, effects, and impacts of the project.

Project Description

Iowa's Farm-to-Market Road System consists of intracounty and intercounty roads, within county jurisdiction, that serve principal traffic generating areas and connect such areas to other Farm-to-Market roads and primary roads. The Farm-to-Market road system acts as a corridor of commerce and is the backbone of Iowa's agricultural and manufacturing economies, which together generate 23 percent of Iowa's gross domestic product (GDP).

MPDG funding would provide improvements to over 41 miles of Farm-to-Market roadways, all of which are classified as major collectors and have experienced one or more recent fatalities. The Project consists of reconstruction or rehabilitation of six rural Farm-to-Market County roadways along with low-cost, high impact multimodal improvements in Guthrie County, and the co-applicants Chickasaw, Fayette, Mitchell, Wapello, and Webster Counties. Each sub-project improvement will enhance the state of good repair of these rural roads and make rural infrastructure compatible with Americans with Disabilities Act (ADA) standards.

Description of Project Improvements

For the purposes of this BCA, each of the six projects making up the group of projects were analyzed individually as well as a combined network of projects. Each of the six projects and its improvements are listed below. The improvements are divided into those quantified in the analysis and factors remaining unquantified.

Factors Quantified

The improvements quantified in the BCA are listed below, organized by subproject.

Chickasaw County V18

- Removal and reconstruction of a total 0.93 miles of FM V18 within the city limits of Elma in Howard County, Alta Vista in Chickasaw County, and at the V18/T76 intersection to improve the conditions of deteriorating pavement, which is nearing the end of its service life,
- Rehabilitation of 3.7 miles of V18 outside of the reconstruction limits using concrete overlay, to improve the deteriorating pavement,
- Construction of 4.2 miles of two-foot-wide paved shoulders with milled rumble strips,
- Replacement of stormwater infrastructure to expand capacity to resolve flooding along the corridor, and
- Installation of two solar powered flashing LED stop signs at the V18/T76 intersection,

Fayette County W51

This project is in collaboration with the City of Wadena.

- Rehabilitation of approximately 0.5 miles of W51 using mill and overlay within city of Wadena limits and 1.3 miles of cold-in-place recycling outside of city limits, to improve the deteriorating pavement,
- Construction of 1.47 miles of four-foot-wide paved shoulders with milled rumble strips, and

Guthrie County F65

- Rehabilitation of 11.6 miles of F65 using mill and overlay throughout the project limits to improve the deteriorating pavement,
- Construction of 10.5 miles of four-foot-wide paved shoulders with milled rumble strips,
- Installation of new and upgradation of existing signage including lighted chevrons and fluorescent signs outside of city limits to improve safety.

Mitchell County T40 and A23

This project is in collaboration with the City of Stacyville.

- Reconstruction of 0.6 miles of T40 and A23 through the city of Stacyville to improve the deteriorating pavement,

- Rehabilitation of 5.7 miles of T40 and A23 throughout the project limits outside of Stacyville limit, using milling and concrete overlays, to improve the deteriorating pavement,
- Construction of five miles of three-foot-wide paved shoulders with milled rumble strips,
- Replacement of stormwater infrastructure to expand capacity to resolve flooding along the corridor.

Wapello County T61

This project is in collaboration with the Monroe County.

- Rehabilitation of 4.6 miles of T61 using cold-in-place recycling and/or asphalt overlay to improve the deteriorating pavement,
- Installation of improved signage, milled in pavement markings, destination lighting, and solar powered flashing beacons on yield and stop signs,
- Replacement of stormwater infrastructure to expand capacity to resolve flooding along the corridor.

Webster County D36 and D20

- Rehabilitation of 11.8 miles of D36 and D20 and 0.9 miles of Main Street in Moorland, using mill and asphalt overlay to improve the deteriorating pavement,
- Construction of 11.8 miles of four-foot-wide paved shoulders with edgeline rumble strips,

Factors Unquantified

Several factors were not quantified as part of the analysis that could potentially add to the benefits assumed in the BCA. These factors include the following, organized by subproject:

Chickasaw County V18

- Replacement and installation of curb and gutter, multiuse sidewalks, ADA compliant ramps, and warning devices to upgrade the multimodal infrastructure within the city limits,
- Installation of pavement markings to improve vehicular safety,

Fayette County W51

- Construction of an eight-foot-wide multiuse sidewalk and ADA improvements throughout the city limits to upgrade the multimodal infrastructure.

Guthrie County F65

- Removal and replacement of curb and gutter throughout the project limits where applicable,

- Installation of new striping and rapid rectangular flashing beacons (RRFBs) within city limits of Menlo, Stuart, and Dexter to calm traffic¹, and

Mitchell County T40 and A23

- Curb and gutter, sidewalk ramps, paved parking, and

Wapello County T61

- Removal and replacement of curb and gutter throughout the project limits where applicable,
- Construction of ADA ramps throughout the city of Blakesburg limits to upgrade the multimodal infrastructure,
- Installation of improved signage, milled in pavement markings, destination lighting, and solar powered flashing beacons on yield and stop signs²,
- At-grade railroad crossing improvements including new crossing arms, lights, and pavement,
- Addition of higher visibility signage at Blakesburg elementary school, and at T61/Polk Street and T61/State Street intersections,
- Potentially widening at T61/South Street intersection to accommodate safer truck turning movements,
- Relocation of city utilities and electrical lines, and

Webster County D36 and D20

- Construction of 4.4 miles of ten-foot-wide asphalt trail to connect the trail system of Fort Dodge to city of Moorland and Webster County's adjacent fishing ponds,
- Installation of six-inch milled in edge line striping throughout the project limits, and
- Construction of turn lanes to improve access at D63/Carter Avenue intersection, to two industrial parks for safer and efficient freight movements.

¹ There were no known pedestrian-related crashes at the location(s) of the proposed RRFBs in Guthrie County. However, potential safety benefits may be realized throughout the life of the project.

² There were no know crashes at the location(s) of the proposed intersection improvements in Wapello County. However, potential safety benefits may be realized throughout the life of the project.

BCA Methodologies

The following section describes the global assumptions used in the benefit-cost analysis as well as methodologies used to derive costs and benefits specific to the project:

Global Assumptions

1. **Main Benefit Components:** The main benefit components analyzed included:
 - Travel time savings from fewer vehicle hours traveled (VHT)
 - Maintenance savings after improvements
 - Operating and maintenance savings from reduced roadway roughness
 - Crash cost savings after safety improvement implementation
 - Emissions reductions through vehicle efficiency
 - Remaining capital value of improvement beyond the analysis period.
2. **Economic Assumptions:** Unless stated otherwise in the individual project component sections, value of time, vehicle operating costs, emissions costs, crash costs, inflation adjustment factors, discount rate, and other economic values used in the analysis were obtained and monetized with methods and assumptions consistent with the Benefit Cost Analysis Guidance for Discretionary Grant Programs, dated January 2023.¹
3. **Calculation of Remaining Capital Value:** Project components of the initial capital costs often have service lives well beyond the analysis periods. The capital value after the analysis period is included in a project evaluation as a benefit. The remaining capital value for these projects was estimated in accordance with USDOT guidance. Project components were assumed to have a service life of 25 years based on recommendations provided by the county stakeholders of each project.

Component 1. Travel Time

The current condition of the road surface along the project areas is poor. In Chickasaw and Howard Counties as well as Mitchell County this is particularly true as pavement conditions have nearly reached the point of failure. If these conditions continue to worsen, it is assumed that users of the roads will be inclined to travel at reduced speeds in a manner they are comfortable. The current posted speed along most of these roads is 45 mph with lower posted speeds in the towns along the roadways.

It is estimated that by year 2027, users of V18 in Chickasaw and Howard Counties and T40 and A23 in Mitchell County will be traveling an average of 5 mph below the 45 mph speed limit. It is assumed that once these projects are complete that users will be able to comfortably travel the 45 mph speed limit. This assumption is especially relevant to these two projects, as the roadways are in poorer condition compared to the other four and the projects include reconstruction and major rehabilitation to address the deficiencies.

Annual VHT is estimated for the two project corridors using Iowa DOT AADT data and aerial measurements on roadway length. It is estimated that without reconstruction, users of these sections

of V18, T40, and A23 incur an additional 9,891 VHT after slowing down to a 40 mph travel speed. These 9,891 annual hours are saved or avoided once the roads are reconstructed. Over the course of the project, the discounted travel time savings are \$2.4 million.

Component 2. Road Maintenance Savings

As structures or road surfaces age, they usually require maintenance more frequently than when they were first built. This is the case for the six subprojects. Part of the goal of these reconstructions and rehabilitations is to lower the yearly costs required to keep these roads functional all year.

No Build

Using the available maintenance cost data from the counties, a per-mile maintenance cost under the No Build and Build is calculated. The final calculations produce a No Build annual maintenance cost of \$11,440 per-lane-mile. This value is based on information from Chickasaw, Howard, and Fayette Counties. Projects for which maintenance estimates were not provided use this estimated per-lane-mile cost (\$11,440) to calculate No Build maintenance costs.

Build

Build maintenance costs are expected to cover standard maintenance associated with a newly updated and improved facility. It is estimated² that the annual maintenance expenditure by the Iowa DOT is about \$9,920 per-lane-mile. This is used as the Build maintenance costs. The maintenance savings found for this project are \$1.1 million in discounted benefits.

Component 3. User Operation and Vehicle Maintenance Savings

The smoothness of the surface has an impact on the long-term maintenance costs for vehicles. The costs per VMT, by class, are estimated to represent the damage incurred to a vehicle driving on a roadway as well as fuel costs. V18 in the Chickasaw area and T40 and A23 in the Mitchell area are in notably worse condition, in terms of surface roughness, than they will be after project completion. To represent the additional vehicle damage incurred by users, VMT maintenance cost is estimated³ for autos and trucks at \$0.04 per mile and \$0.09 per mile, respectively. Additional details and assumptions on costs per mile based on pavement condition can be found in the BCA Workbook. These values amount to maintenance savings of about \$1 million in real value when applied to project VMT.

Component 4. Safety Impacts

All projects have a variety of proposed safety improvements. The safety analysis determines No Build scenario crash costs using existing crash data. The crash costs associated with the Build are based on safety improvements associated with each project. A list of relevant crash modification factors (CMFs) is provided below.

Table 1. Crash Improvements CMFs and Abbreviations

Improvement	CMF	Abbreviation
Rumble Strips ⁴	0.64	RS
LED Stop Sign ⁵	0.59	LED
Improved Drainage ⁶	0.92	ID
Paved Shoulder ⁷	$e^{-(0.0321 * \Delta Width)}$	PS
Install Fluorescent Sign ⁸	0.66	IFS

Table 1 displays each CMF value or equation as well as abbreviations being used in Table 2. Table 2 also contains is a list of each improvement and associated CMF being applied for each subproject.

Table 2. Crash Modification Factors Applied

County	K	A	B	C	O
Chickasaw	ID, RS, PS, IFS	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID
Fayette	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID
Guthrie	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID
Mitchell	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID, RS, PS	ID
Wapello	ID, RS, LED	ID, RS	ID, RS	ID, RS	ID
Webster	ID, RS	ID, RS	ID, RS	ID, RS	ID

Table 3 shows which CMFs were applied to each severity of crash for all projects. The choices of which CMFs to use were based on the locations of existing crashes on the corridor, the location of the improvements, as well as a crash’s KABCO crash severity.

Table 3. Overall Crash Reduction

Scenario	K	A	B	C	O
Avoided Crashes	9.2	9.5	23.3	40.0	36.5

Applying the CMFs in Table 2 to the expected crashes over the analysis period yields reductions in all types of crashes including more than nine fatal crashes. The total value of crash reductions as a result of this project is about \$45.2 million in discounted benefits.

Component 5. Emissions Impacts

The speed of a motor vehicle has an impact on its fuel economy. At a speed of about 55 mph marginal fuel economy decreases as speed increases. Decreasing travel speed under 55 mph results in a marginal decrease in average vehicle fuel efficiency.⁹ Increased drive time at lower speeds decreases the fuel economy of vehicles. In the Chickasaw and Mitchell projects, significant surface degradation is expected to reduce average user travel speed to 40 mph from 45 mph, the speed limit and assumed speed at which users will travel on a surface in good condition. The 5 mph speed reduction implies an overall increase in VHT for the analysis period. This VHT increase is expected to increase emissions. The estimated avoided emissions by type are shown in Table 4. The total value of the emissions savings is about \$39 thousand in discounted benefits.

Table 4. Emissions Avoided

Emission Type	Reduction
CO2 (metric tons)	-481.4
NOx (kg)	-554.8
SO2 (kg)	-2.6
PM2.5 (kg)	-10.5

Component 6. Remaining Capital Value

Remaining capital value refers to the useful life of the capital construction projects after the 20 year analysis period is over. With reconstruction and rehabilitation, these roads are estimated to have 25 years of valuable life. This means that after the 20 year analysis period is complete, about 20 percent of the total nominal value remains. When this value is discounted the total real remaining capital value at the end of the analysis period is about \$1.3 million or about 4.5 percent of the real construction costs.

BCA Results

The benefit-cost analysis provides an indication of the economic desirability of a scenario, but results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is at least 1.0. The larger the ratio number, the greater the benefits per unit cost. Results of the benefit-cost analysis are shown in

Table 5 for the total project, and for each of the six project components. See Attachment A for the complete benefit-cost analysis workbook.

Table 5. Total Project Benefits

Total Project	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$51.4 million	\$28.6 million	1.8	\$22.8 million

Table 6. Chickasaw Project Benefits

Chickasaw County	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$7.7 million	\$4.9 million	1.6	\$2.8 million

Table 7. Fayette Project Benefits

Fayette County	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$4.9 million	\$1.6 million	3.0	\$3.3 million

Table 8. Guthrie Project Benefits

Guthrie County	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$9.5 million	\$5.9 million	1.6	\$3.6 million

Table 9. Mitchell Project Benefits

Mitchell County	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$7.5 million	\$5.8 million	1.3	\$1.7 million

Table 10. Wapello Project Benefits

Wapello County	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$8.1 million	\$2.5 million	3.3	\$5.6 million

Table 11. Webster Project Benefits

Webster County	Project Benefits (2021 Dollars)	Initial Capital Cost (2021 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2021 Dollars)
No Build vs. Build	\$13.7 million	\$7.9 million	1.7	\$5.8 million

References

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