Memorandum

SRF No. 16271

To: Mel Odens, PE, Public Works Director
Kandiyohi County

From: Nick Semeja, PE

Date: November 30, 2022

Subject: CSAH 55 Highway-Rail Grade Crossing Elimination Project – 2022 CRISI Program Application Benefit-Cost Analysis Memorandum

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 the CSAH 55 Highway-Rail Grade Crossing Elimination Project – 2022 CRISI 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 and rail 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.

The Project will advance highway and railroad safety by eliminating the current at-grade BNSF crossing #067715J located along CSAH 55 near Highway 23 in Wilmar, MN, which in turn will improve the rural transportation system and regional freight network. The Project will also reconfigure the intersection of CSAH 55 and CSAH 5, addressing a geometrically deficient intersection and improving sight distances for all users.

Description of Alternatives

For the purpose of this analysis, a No Build and Build Alternative were under consideration.

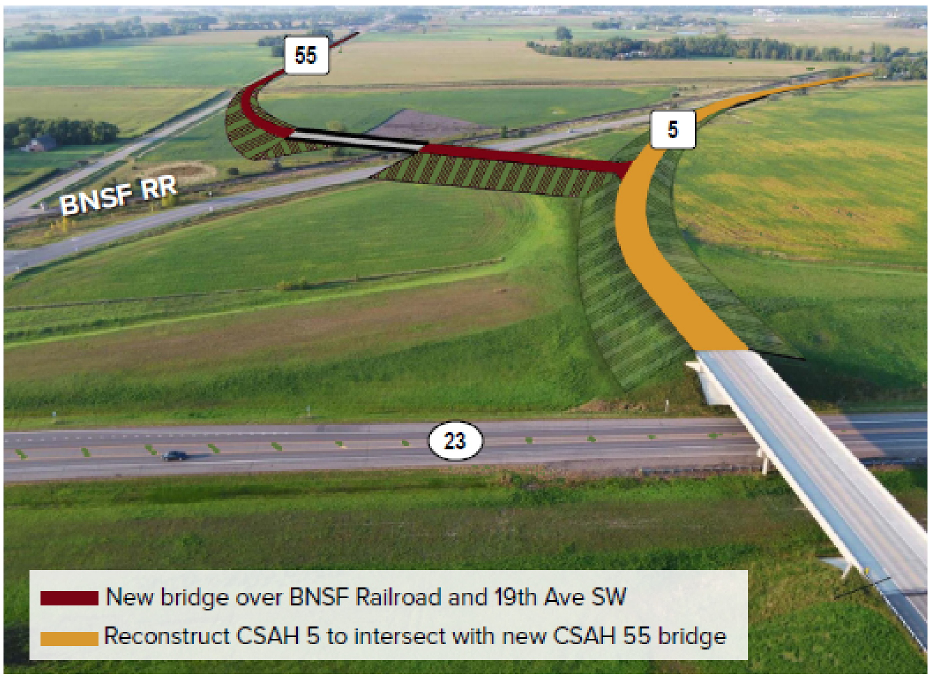
No Build Alternative

The No Build Alternative included leaving the at-grade cross along CSAH 55 in its current geometrical and operational state. With increased development and higher traffic volumes and trains anticipated in the future, the likelihood of serious crashes between vehicles and trains or pedestrians, bicycles and trains increase. Vehicle delays at railroad crossings in the area are also expected to increase as the region continues to develop.

Build Alternative

This Project is located at railroad milepost 3.119 and will permanently close the public at-grade BNSF crossing #067715J. The proposed project will construct a new two-lane overpass with standard lanes and shoulders to eliminate one at-grade rail crossing with two tracks. The project will also include improvements and realignment of approximately one mile of CSAH 55 and CSAH 5, as illustrated in Figure 1.

Figure 1. Project Elements



BCA Methodology

The following methodology and assumptions were used for the benefit-cost analysis:

1. **Main Components**: The main components analyzed included:
   - Travel time/delay (vehicle hours traveled – VHT)
   - Operating costs (vehicle miles traveled – VMT)
   - Crashes by severity
   - Environmental and air quality impacts
   - Initial capital costs
   - Remaining Capital Value: The remaining capital value (value of improvement beyond the analysis period) was considered a benefit and was added to other user benefits.
   - Operating and maintenance costs: These costs included annual inspection and maintenance costs required for the new bridge.
2. **Analysis Years**: The analysis assumed that construction would take place over a two-year period and be completed in 2025. Therefore, year 2026 was assumed to be the first full year of benefits that will be accrued from the project. Since the project includes construction of a

bridge with a projected service life far beyond a twenty-year analysis period, the analysis focused on the estimated benefits for the thirty-year period from 2026 to 2055. The present value of all benefits and costs was calculated using 2020 as the year of current dollars.

2. **Economic Assumptions**: The value of time, vehicle operating costs, emissions costs, and cost of crashes were obtained from the *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, dated March 2022.[1] The analysis was completed using an assumed discount rate of seven percent.

3. **Development of Travel Time Delay**: Travel time benefits for vehicle users are expected to be realized once the at-grade rail crossing is removed. As discussed in the project application document, a 2016 study revealed that trains take an average of 15 minutes to pass through the crossing and that a total of 2.5 hours of daily delay occurred at the study crossing as vehicles were waiting for trains to pass. Based on the existing AADT along CSAH 55 of 860 vehicles,[2] this averages to 0.17 minutes of delay per vehicle. Considering that there are ten trains passing through the crossing each day, the assumption regarding total delay can also be expressed such that exactly one vehicle is waiting for the entire 15-minute duration in which trains are crossing, on average.

   The analysis also considered impacts due to programmed land development in the area, background population growth, and expected growth in freight traveling by rail. There are three developments adjacent to CSAH 55 near the project area[3] that are expected to be completed by year 2026 (i.e. the project opening year). Trips by mode for each of these developments were provided by Kandiyohi County staff and are summarized in Table 1.

Table 1. Land Development Weekly Trip Summary

Land Development	Passenger Cars	Heavy Trucks	Trains
Nexyst	2180	-	1-2
FedEx	3200	300	-
Epitopix	1000	96	-

   These trips were converted to daily trips and distributed across the network based on existing AADTs. Trips were assumed to travel north towards Highway 12, travel south towards Highway 23, or travel east to the City of Wilmar. The two corridors that can facilitate trips to these locations are CSAH 55 and CSAH 5. The directional distribution of new development trips for each corridor can be found in the BCA Workbook. Note that an average of 1.5 new trains per week was applied to the existing number of trains and vehicle delay to estimate

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[1] https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf
[2] https://www.dot.state.mn.us/traffic/data/tma.html
[3] Nexyst and FedEx developments are located just north of Highway 40 between CSAH 55 and CSAH 5. The Epitopix development is an expansion at the existing site located along CSAH 55 near Highway 12.

additional delay due to the additional one-to-two weekly trains. A similar effort was performed using background growth in rail freight on the BNSF line. BNSF provided estimates of two percent annual growth in freight, which was applied linearly over the analysis period assuming rail cars and eventually additional trains would have to be added to accommodate the increase in freight.

Background population growth was obtained from the City of Wilmar Comprehensive Plan.[4] An annual growth rate of 0.54% was calculated based on the population growth between year 2000 and year 2007. The growth rate was applied to existing AADTs to determine an increase in vehicle delay at the rail crossing.

Lastly, project sponsors are expecting a diversion in trips from CSAH 5 to CSAH 55 due to the removal of the at-grade crossing. The assumption is that vehicles traveling to/from the southwest (e.g. along Highway 23) would experience less delay and have a more reliability trip if they avoided the at-grade crossing on CSAH 5 (located just north of 19th Avenue SW). Based on AADTs on Highway 23 east and west of the project area, it was assumed roughly half the vehicles on the south end of CSAH 5 would divert to the more optimal route along CSAH 55. Average vehicle delay reductions associated with the removal of the at-grade crossing were applied to the diverted trips in a similar manner as previously described in this section.

Travel time benefits were extrapolated based on the assumed growth in background population and rail freight. Savings due to the reduction of VHT were calculated using costs per hour that account for vehicle occupancy and different vehicle types.

4. **Vehicle Occupancy and Vehicle Types**: The composite cost per mile used in the BCA accounted for the percentage split of autos and trucks in the travel area. The composite cost per hour accounted for vehicle occupancy ratios, and the percent split of autos and trucks traveling in the area. Key assumptions for these areas included:
    - The truck percentage used in the analysis was 5.0 percent and was based on recent daily traffic and heavy truck counts in the project area provided in the MnDOT Traffic Mapping Application.[5] Note that project sponsors recently estimated heavy vehicle percentages to be closer to 50 percent in the project area. The heavy vehicle percentage used in the analysis assumed the lower of the two available data points to provide a conservative estimate of user benefits associated with travel time savings and vehicle operating costs.
    - Vehicle occupancy that was used in the analysis is consistent with values provided by the *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, dated March 2022. The analysis assumed 1.67 people per automobile and 1.00 people per truck.

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[4] Table 1A: https://cms5.revize.com/revize/cityofwillmar/Willmar%20Comprehensive%20Plan%202009.pdf
[5] https://www.dot.state.mn.us/traffic/data/tma.html

5. **Safety Analysis**: The project is expected to provide safety benefits by removing the risk of collisions between trains and vehicles, bicyclists, and pedestrians. A ten-year history (2012-2021) of train collisions at the CSAH 55 and CSAH 5 crossings was collected from the Minnesota Crash Mapping Analysis Tool.[6] There was one observed vehicle/train collision at the CSAH 55 crossing and two observed collisions at the CSAH 5 crossing, resulting in an expected number of vehicle/train collisions per year of 0.1 and 0.2, respectively. Crash records for the three observed crashes are in the BCA Workbook for reference. The Federal Railroad Administration's Web Accident Predictive System[7] was also used to estimate the annual frequency of collisions. The CSAH 55 and CSAH 5 crossings had a predicted number of 0.013 and 0.021 collisions, respectively. However, the observed crashes from MnDOT's database were not included in FRA's crash prediction tool, which likely skewed the predicted number of collisions lower than what is expected. The analysis used a conservative assumption by averaging observed rates and those estimated by FRA, despite the missing data in the FRA tool, for the annual frequency in train collisions.

   Since the sample size of existing collisions was relatively low, and the FRA tool did not predict injury severity of collisions, a distribution of deaths and injuries for highway-rail incidents was obtained from the National Safety Council[8] (table provided in BCA Workbook) and applied to expected collisions in the analysis. Collisions were monetized using fatal and injury crash costs provided in the USDOT BCA Guidance. The number of annual collisions were also grown using programmed land development, background population growth, and growth in rail freight assumptions discussed previously.

6. **Environmental and Air Quality Impacts and Vehicle Operating Costs**: Changes in emissions are expected to be impacted by the time vehicles spend idling at rail crossings. The change in vehicle delay between No Build and Build conditions was obtained from the travel time analysis and converted to equivalents of vehicle-miles traveled (VMT) by applying fuel consumption for idling vehicles to average miles per gallon for passenger cars. The change in VMT equivalents was then applied to emission rates by vehicle type. Average emission rates per vehicle type were obtained from the Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES) version 3. Emission rates per vehicle type are provided in the attached BCA Workbook.

   The change in VMT equivalents was also assumed to impact vehicle operating costs. Total change in emissions and vehicle operating costs per mile traveled by mode were valued in accordance with the Benefit Cost Analysis Guidance for Discretionary Grant Programs, dated March 2022 (Updated).

7. **Operating and Maintenance Costs**: Routine annual maintenance costs associated with maintaining and inspecting the bridge under the Build Alternative were considered in the BCA.

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[6] http://www.dot.state.mn.us/stateaid/mncmat2.html
[7] https://safetydata.fra.dot.gov/webaps/
[8] https://injuryfacts.nsc.org/home-and-community/safety-topics/railroad-deaths-and-injuries/

An annual cost of $0.35 per square foot of bridge deck, resulting in $4,949 annually, was assumed for bridge inspection and maintenance.[9]

8. **Calculation of Remaining Capital Value**: Because the grade separated crossing is expected to have a service life well beyond the 30-year analysis period, the remaining capital value was calculated for the Build Alternative. This value was expressed in terms of 2020 dollars and was added to other project benefits in accordance with USDOT guidance. In determining the remaining capital value of the Build Alternative, project life was assumed to have a linear depreciation from the time construction was completed to the end of its 80-year service life.

9. **Factors Not Quantified**: 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:
   - Impacts to freight costs due to reduction in collisions between rail and heavy commercial vehicles.
   - Safety impacts associated with improving geometric deficiencies including sight distance at the CSAH 55 and CSAH 5 intersection.
   - Travel time and vehicle operating cost benefits associated with more efficient operations on the local transportation network due to the roadway realignment.

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 1. See Attachment A for the complete benefit-cost workbook

Table 1 - Total Project Results

	Initial Capital Cost (2020 Dollars)	Project Benefits (2020) Dollars	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2020 Dollars)
No Build vs. Build	$7.1 million	$22.5 million	3.2	$15.4 million

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[9] Preliminary bridge designs propose 14,140 square feet of bridge deck.

Attachment
BCA Workbook