# Appendix B – Benefit Cost Analysis

## OVERVIEW OF APPROACH

A Benefit Cost Analysis (BCA) was conducted for the At-Grate Rail Safety Improvements to Reestablish the Heartland Flyer Northern Extension. The BCA follows the most recent 2022 USDOT guidance for BCAs, which provides both methodological guidance and specific values for monetizing several types of benefits. All values from that guidance are in 2020 dollars. All monetary values in the BCA, including costs, are expressed in constant 2020 dollars.

The following general parameters and assumptions have been used in the BCA:

- All costs and benefits are in 2020 dollars. A real discount rate of 7 percent is applied to all costs and benefits.[xxv]
- A project life cycle of 30 years is assumed with no residual value at the end of the 30-year benefit period.
- The Project construction is assumed to begin in March 2023 and end in 2027. Operational safety benefits are phased throughout the construction period based on percent completion, with full safety benefits beginning in 2028.

## PROJECT COSTS

Major project costs are summarized in Table 6. The costs summarized in the table reflect capital improvements such as smoothing the crossing surface of all 52 at-grade crossings, installing flashing-light signals and audible bell sounds at all 52 at-grade crossings, and installing medians at 20 at-grade crossings.

*Table 6. Build and No-Build Capital and Major Rehabilitation Cost Summary in Millions of 2020 Dollars*

| | No-Build | Build |
|---|---|---|
| Total Maintenance | NA | NA |
| Capital Costs* | NA | $24.3 |

*Capital costs were deflated from 2022 $ to 2020 $. Original cost estimate in 2022 $ is $26.5 million.
Source: Oklahoma DOT and Poe & Associates.

### Capital Cost

The estimated capital cost of the 52 at-grade rail improvements is $24.3 million in 2020 dollars, which includes the engineering fees and contingency. The capital costs by year are shown in Table 7 and total cost by municipalities are shown in Table 8. Approximately $21.8 million of the total capital costs are allocated toward rural areas and $4.6 million toward urban areas.

*Table 7. Capital Costs by Year (2020 Dollars)*

| | Total | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|
| Total Capital Cost | **$24,268,685** | $3,086,806 | $5,534,963 | $5,960,730 | $5,534,963 | $4,151,222 |
| Discounted at 7 Percent | **$18,816,064** | $2,746,026 | $4,601,784 | $4,631,558 | $4,019,376 | $2,817,320 |

*Table 8. Capital Cost by Municipality in 2020 Dollars*

| City | Cost |
|---|---|
| Guthrie | $2,235,274 |
| Marland | $2,554,598 |
| Mulhall | $851,533 |
| Newkirk | $1,383,741 |
| Oklahoma City | $4,257,664 |
| Orlando | $425,766 |
| Perry | $6,280,054 |
| Ponca City | $4,576,989 |
| Red Rock | $1,703,066 |
| **Total** | **$24,268,685** |

### Operations and Maintenance Costs

It is assumed that the Project will not generate any additional operating and maintenance costs above and beyond the existing no-build because the at-grade rail crossing improvements are capital improvements to upgrade existing infrastructure that will not generate any operational changes alone.

## PROJECT BENEFITS

### Monetized Benefits included in the BCA

As no major operational changes are envisioned from improving the 52 at-grade rail crossings, the primary benefit is safety. The safety upgrades and surface improvements for the 52 at-grade rail crossings will support future Amtrak service, allow higher freight and rail speeds, and potentially reduce vehicular delay at crossings. However, without any operational changes, rail speeds will remain the same and therefore freight and logistics costs, vehicular delay, emissions, and other benefits are consistent with the no-build. In summary, there are a range of future benefits that will be unlocked due to this project, but to ensure the analysis demonstrates the independent utility of the capital investment in the at-grade rail crossing, only the safety benefits were captured. Project benefits not captured in this analysis include:

- Future freight and logistics cost savings from future freight rail speed increases;
- Potential time savings for vehicles at crossings; and
- Emissions from reduced vehicle idling at crossings.

### Crash Reductions

It is anticipated that there may be a significant increase in the potential crashes at these at-grade crossings due to growth in roadway and rail traffic, which illustrates the time-critical need for the safety upgrades being proposed. The installation of new signals with gates and enhanced crossing improvements may decrease the probability of incidents occurring, leading to fewer fatalities, injuries, and unnecessary property loss. In addition, the public safety benefits that result from the Project improvements to rail operations on the Red Rock Subdivision create smoother operations and reduced costs for roadway and railroad operators, which will allow for safer freight and future passenger rail operations.

Of the 52 at-grade rail crossings, 17 of the crossings only have crossbucks, 15 have pedestals with flashing lights, 9 of the crossing locations have flashing lights on pedestals with gates, and 11 of the crossings are fitted with flashing lights, cantilevers and gates. Much of the forementioned safety equipment is out of date and difficult to repair or even find replacement parts when need. Over the last 20 years there have been 8 deaths, 17 injuries, and 23 incidents along this section of the Red Rock subdivision.[xxvi]

The highway-rail crossings identified in this grant along the Red Rock subdivision see operating train speeds range from 25 to 55 mph. The current average daily traffic counts range from 25,000 vehicles daily in Oklahoma City to 10,000 in Guthrie, 3,200 in Perry and 9,500 in Ponca City, all with traffic volumes expected to continue to increase. Given the growth of vehicular traffic in recent years, the historic crash rates used in this analysis are likely conservative under the no-build scenario as a greater volume of future vehicular traffic will be using these at-grade crossings.

To estimate safety benefits of the improvements, Federal Railroad Administration (FRA) "Highway-Rail Grade Crossing Accident/Incident Reports" for each crossing were obtained from the years 2000-2020 to tabulate the total number of crashes, the severity of the crash (i.e., uninjured, injured, or killed), and the type of warning or safety technology at each crossing. The total crashes by severity and existing safety technology were then divided by 20 years to create annual crash rates for the no-build scenario. The existing no-build safety technology in place for the 52 at-grade crossings are described below in Table 9.

*Table 9. At-Grade Crossings by Type, No-Build Scenario*

| At-Grade Crossing Type (Safety Technology in Place – No-Build) | Crossing Type Count | Share of Crossings |
|---|---|---|
| Cantilever, Flashing Lights, & Gates | 11 | 21% |
| Flashing Lights and Gates | 9 | 17% |
| Flashing Lights | 15 | 29% |
| Crossbucks | 17 | 33% |
| **Total** | **52** | **100%** |

Source: FRA

For the build scenario the following crossing improvements are going to be made as shown in Table 10.

*Table 10. At-Grade Capital Safety Improvements, Build Scenario*

| Cross Improvements | Crossings Affected | Share of Crossings |
|---|---|---|
| Replace, Repair, Add Flashing Lights | 52 | 100% |
| Audible Warnings | 52 | 100% |
| Medians | 20 | 38% |

Source: Poe & Associates

For the build scenario, the overall crash rates will decline due to the new safety improvement upgrades to the 52 at-grade crossings. To estimate the change in at-grade crash rates after the improved safety measures are in place, Federal Highway Administration's (FHWA) Crash Modification Factors (CMFs) by safety technology were selected to adjust future crash rates following the safety implementation.

The Crash Reduction Factors[xxvii] (CRFs) were then calculated and applied to the existing crash rates to estimate the reduced crash rate for all crossings in the future build scenario. Table 11 summarizes CFRs, crossing distribution, and type of crossings the CFRs are applied to.

*Table 11. Crash Rate Reduction Calculations*

| Investments by Upgrade Type | CRF % Improvement | Share of Crossings | Type of Crossing Applied | CFM ID # |
|---|---|---|---|---|
| Medians | 25.8% | 38% | Cantilevers, Flashing Lights, and Gates | 8800 |
| Audio and Flashing Lights | 0.4% | 62% | Crossbucks and Flashing Lights | 11058, 11054 |

Source: FHWA CFM, Poe & Associates, and FRA.
Calculations: EBP.

These CFRs were then applied to the annual no-build crash rates for each type (i.e., uninjured, injured, and killed) to estimate the new crash rates for the 20 crossings receiving median upgrades and the remaining 32 at-grade crossings receiving audio and flashing light upgrades. The crash rates were then monetized using the most recent factors from the 2022 USDOT guidance for BCAs, which are $3,900 for no injury (property damage), $151,100 non-capacitating injury, and $11.6 million for fatal injuries all in 2020 dollars. These benefits were estimated for a 30-year operational period from 2023 to 2053 and are shown below in Table 12.

*Table 12. Monetized Crash Savings 2023-2053 by Severity*

| Severity | In 2020 Dollars | Discounted at 7 Percent | Crashes Avoided |
|---|---|---|---|
| No Injury (PDO Equivalent) | $24,114 | $6,715 | 5.8 |
| Non-Incapacitating Injury (OK Severity 3) | $738,263 | $205,592 | 4.5 |
| Fatal | $34,716,480 | $9,667,865 | 2.8 |
| **Total** | **$35,478,857** | **$9,880,173** | **13.1** |

Calculations: EBP.

The Heartland Flyer At-Grade Rail Safety Improvements will generate significant savings in the human costs of crashes. Over the 30 years, it is estimated that about 13 lives will be saved and that another five serious injury-crashes will be avoided.

### Project Benefits Not Included in the BCA

The future benefits estimated in this analysis represent only a sliver of the overall benefits from upgrading the surface and safety systems at these 52 at-grade crossings. While the safety benefits are robust, other benefits like vehicular delay, environmental improvements, and freight logistics costs are important to consider but could not be monetized to demonstrate the independent utility of these necessary improvements. The benefits of this analysis are very conservative since these improvements are necessary steps to enable future quality Amtrak passenger rail service and other potential operational freight improvements whose benefits are not monetized in this BCA.

## BCA RESULTS

Based on the assumptions, methodology, and other information presented above, the project yields a Benefit-Cost Ratio of 1.1 and a Net Present Value of $1,570,000. The results are summarized in Table 13. As described earlier, crash reductions account for the entirety of the benefits estimated for this analysis and are likely on the conservative side as the CRFs for audio and flashing lights appear to be quite small – but certifiable alternative estimates were not available.

*Table 13. BCA Results in Thousands of Dollars*

| Benefit-Cost | Amount |
|---|---|
| Discounted Initial Capital Costs | $17,266 |
| Discounted Life Cycle Cost Savings | $0 |
| Facilities Residual Value | $0 |
| **Total Discounted Costs** | **$17,266** |
| | |
| Crash Reduction Benefits | $18,836 |
| **Total Discounted Benefits** | **$18,836** |
| | |
| **Benefit Cost Ratio** | **1.1** |
| **Net Present Value** | **$1,570** |

Calculations: EBP