

**Benefit-Cost Analysis Technical
Memorandum**

Multimodal Project Discretionary Grant
Opportunity

**Elko Nevada Rail Corridor
Enhancement Project**

Nevada Department of Transportation

August 17, 2023

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Executive Summary

Located in Elko County, Nevada, the Elko Rail Corridor is a component of the broader Union Pacific Railroad (UP) Overland Route between Chicago, Illinois, and the San Francisco Bay Area. The route through Elko hosts UP freight trains, BNSF Railway (BNSF) freight trains, and two daily Amtrak California Zephyr long-distance passenger trains between Chicago and the San Francisco Bay Area with a station in Elko.

The two UP main tracks through the region are paired and typically operated directionally. Meanwhile, the UP Elko Yard is located between the two main tracks to the east of the Amtrak Station and includes working tracks for meeting, staging, or switching out through freight trains off the main tracks and internal yard tracks for staging, switching, and other activities.

Switching of UP through freight trains at the Elko Yard may require trains to occupy one or both main tracks to complete operations into and out of the adjacent yard tracks. Currently, some yard tracks are not long enough to accommodate meets with following trains or for working or staging trains off the main tracks. These conditions can result in train delays on the main tracks to the California Zephyr passenger service and freight trains in the Elko Area as well as on the rail network for several miles in either direction. Also, the current configuration constrains freight growth capacity. Future growth in freight traffic will require route diversions, resulting in increased emissions and fuel consumption, if yard improvements are not made.

Additionally, the current Amtrak Station functions as a split station, which is an inefficient platform configuration. Specifically, the island platforms serving the eastbound and westbound California Zephyr are located opposite each other, separated by an intertrack fence with no connections between the two for Amtrak passengers. Both sides of the split station are accessible only from separate roadways north and south of the UP corridor. A shuttle operated by the City of Elko connects passengers from one side to the other via the 12th Street overpass west of the station when arriving or departing on the eastbound California Zephyr.

Through the Elko Nevada Rail Corridor Enhancement Project (the Project), the Nevada Department of Transportation (NDOT) and UP will develop and construct corridor-based rail network improvements on the UP Elko and Lakeside subdivisions in the vicinity of the Amtrak Station and at the UP Elko Yard. The improvements are expected to reduce potential train delays for both passenger and freight trains, reduce train impacts on nearby at-grade crossings, improve accessibility for Amtrak passengers, and enable additional freight capacity through the corridor.

Figure ES - 1 below highlights the components of the proposed Project.

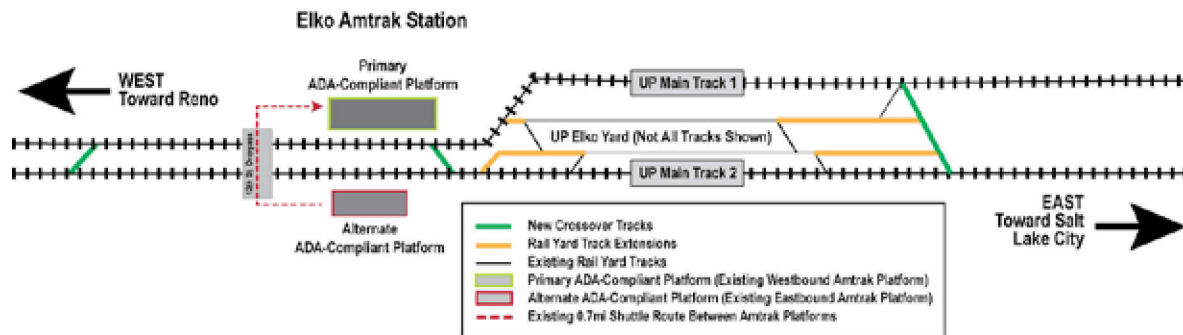


Figure ES - 1: Project Components

A Benefit-Cost Analysis (BCA) of the Project was conducted in conformance with federal guidance regarding evaluation methods and monetization values recommended by the U.S. Department of Transportation (U.S. DOT) in its January 2023 *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*. A table summarizing the changes expected from the program (and the associated benefits) is provided below.

Table ES - 1: Summary of Infrastructure Improvements and Associated Benefits

Current Status (Base Scenario) & Problems to be Addressed	Changes to Baseline (Alternative Scenario)	Types of Impact	Population Affected by Impacts	Economic Benefits	Summary of Results (2021\$, Discounted)
Located in Elko County, Nevada, the Elko Rail Corridor is a component of the broader UP Overland Route between Chicago, Illinois, and the San Francisco Bay Area in California. The route through Elko hosts UP freight trains, BNSF freight trains, and two daily Amtrak California Zephyr long-distance passenger trains between Chicago and the San Francisco Bay Area with a stop in Elko. Currently, some yard tracks are not long enough to accommodate meets with following trains or for working or staging trains off the main tracks. These conditions can result in delays to the California Zephyr passenger service and freight trains in the Elko Area and on the adjacent rail network for several miles in either direction. Future growth in freight traffic will require route diversions if yard improvements are not made. Additionally, the current Amtrak Station functions as a split station. The island platforms serving the eastbound and westbound California Zephyr are located opposite each other, separated by an intertrack fence with no	Through the Elko Rail Corridor Enhancement Project (the Project), NDOT and UP will construct corridor-based rail network improvements on the UP Elko and Lakeside subdivisions in the vicinity of the Amtrak Station and at the UP Elko Yard. The improvements are expected to reduce potential train delays for both freight and passenger trains, reduce train impacts on nearby at-grade crossings, improve accessibility for Amtrak passengers, and enable additional freight capacity through the corridor.	Transporting freight on a more direct and shorter route is expected to reduce the likelihood of freight transportation accidents.	Residents and motorists along the UP Line	Avoided Accidents from Freight Train Route Efficiencies	\$14.0 M
		Reducing train delay times for both freight and Amtrak trains is expected to translate into a reduction in emissions.	Local and State residents	Avoided greenhouse gas (GHG) Emissions from Improved Train Operations	\$1.5 M
		Reducing train occupancy durations at the 12 at-grade crossings is expected to reduce idling time for motor vehicles at the respective grade crossings.	Local and State residents	Avoided criteria air contaminants (CAC) Emissions from Improved Train Operations	\$1.7 M
		Transporting freight on a more direct and shorter route is expected to reduce emissions for freight transportation.	Local and State residents	Reduced GHG Emissions from Idling Vehicles	\$0.0 M
		Eliminating the need to shuttle Amtrak riders between platforms is expected to translate into emission reduction.	Local and State residents	Reduced CAC Emissions from Idling Vehicles	\$0.0 M
		Improving travel time for train operations by reducing train delays.	Local and regional residents	Avoided GHG Emissions from Freight Train Route Efficiencies	\$9.2 M
		Reducing delay times for train operations is	Local and regional residents	Avoided CAC Emissions from Freight Train Route Efficiencies	\$9.5 M
			Local and State residents	Avoided GHG Emissions from Shuttle Service	\$0.0 M
			Local and State residents	Avoided CAC Emissions from Shuttle Service	\$0.0 M
			Freight operators and Amtrak riders	Avoided Travel Time Costs from Train Delays	\$6.2 M
			Freight operators and Amtrak	Avoided Fuel Consumption for Trains	\$3.4 M



Current Status (Base Scenario) & Problems to be Addressed	Changes to Baseline (Alternative Scenario)	Types of Impact	Population Affected by Impacts	Economic Benefits	Summary of Results (2021\$, Discounted)
connections between the two for Amtrak passengers.		expected to reduce train fuel consumption.			
		Reducing train occupancy time at the various grade crossings is expected to translate into improve travel time for motorists.	Local motorists	Reduced Idling Time for Motorists	\$2.6 M
		Reducing train occupancy time at the various grade crossings is expected would reduce fuel costs from idling vehicles.	Local motorists	Reduced Vehicle Operating Costs	\$0.1 M
		Transporting freight on a more direct and shorter route is expected to reduce the train fuel consumption.	Rail operators	Reduced Fuel Consumption from Freight Train Route Efficiencies	\$20.2 M
		Eliminating the travel time for shuttles to transport Amtrak passengers between platforms.	Amtrak riders	Avoided Travel Time Costs from Shuttle Service	\$0.0 M
		Eliminating the agency costs related to the shuttle service.	Regional government and Amtrak	Avoided Agency Costs	\$1.4 M
		Change in operational and maintenance costs as a result of the Project.	Project sponsors	Change in O&M Costs	(\$0.2 M)
		Residual value of capital asset.	Project sponsors	Residual Value of Capital Assets	\$1.2 M

The period of analysis used in the estimation of benefits and costs corresponds to 24 years, including 4 years of design, engineering, and construction (2024 – 2027), as well as 20 full years of operation (2028 – 2047). The capital cost is estimated at \$41.1 million in capital expenditures, in 2021 dollars. The capital expenditure for this Project by year is presented in **Table ES - 2**, while the total benefits from the program by merit criteria are presented in **Table ES - 3**.

Table ES - 2: Summary of Capital Expenditure, 2021 Dollars

Year	Capital Expenditure
2023	\$0.3 M*
2024	\$2.5 M
2025	\$8.6 M
2026	\$14.9 M
2027	\$14.9 M
Total	\$41.1 M

* Costs already incurred to date.

Table ES – 3: Summary of Benefits by Merit Criteria, 2021 Dollars

Merit Criteria	Benefit Category	Undiscounted	Discounted
Safety	Avoided Accidents from Freight Train Route Efficiencies	\$43.0 M	\$14.0 M
	Avoided GHG Emissions from Improved Train Operations	\$2.4 M	\$1.5 M
	Avoided CAC Emissions from Improved Train Operations	\$4.3 M	\$1.7 M
Environmental Sustainability	Reduced GHG Emissions from Idling Vehicles at Grade Crossings	\$0.0 M	\$0.0 M
	Reduced CAC Emissions from Idling Vehicles at Grade Crossings	\$0.0 M	\$0.0 M
	Avoided GHG Emissions from Freight Train Route Efficiencies	\$15.5 M	\$9.2 M
	Avoided CAC Emissions from Freight Train Route Efficiencies	\$26.0 M	\$9.5 M
	Avoided GHG Emissions from Shuttle Service	\$0.0 M	\$0.0 M
	Avoided CAC Emissions from Shuttle Service	\$0.0 M	\$0.0 M
	Avoided Travel Time Costs from Train Delays	\$17.9 M	\$6.2 M
Economic Competitiveness	Avoided Fuel Consumption for Trains	\$9.7 M	\$3.4 M
	Reduced Idling Time for Motorists	\$9.8 M	\$2.6 M
	Reduced Vehicle Operating Costs	\$0.3 M	\$0.1 M
	Reduced Fuel Consumption from Freight Train Route Efficiencies	\$62.6 M	\$20.2 M
	Avoided Travel Time Costs from Shuttle Service	\$0.0 M	\$0.0 M
	Avoided Agency Costs	\$4.0 M	\$1.4 M
	Change in O&M Costs	(\$0.5 M)	(\$0.2 M)
State of Good Repair	Residual Value of Capital Assets	\$7.2 M	\$1.2 M
Total		\$202.3 M	\$70.9 M

The relevant data and calculations used to derive the benefits and costs of the Project are provided in the BCA Model submitted with this application. Based on the BCA conducted (see **Table ES - 4**), the Project is expected to generate \$70.9 million in discounted benefits, while costing \$29.4 million (discounted) based on a 3 percent real discount rate for carbon dioxide (CO₂)-related impacts and a 7 percent real discount rate for all other impacts (as per U.S. DOT BCA guidance). This translates to a net present value (NPV) of \$41.5 million and a benefit-cost ratio of 2.4. Additional detailed breakdowns of the analysis, including the various assumptions and methodologies, are presented in the rest of this document.

Table ES - 4: Overall Results of the Benefit-Cost Analysis, 2021 Dollars

Evaluation Metrics	Undiscounted	Discounted
Total Benefits	\$202.3 M	\$70.9 M
Total Costs	\$41.1 M	\$29.4 M
Net Present Value (NPV)	\$161.1 M	\$41.5 M
Return on Investment (ROI)	392%	141%
Benefit-Cost Ratio (BCR)	4.9	2.4
Payback Period (years)	5.2	6.8
Internal Rate of Return (IRR)	17.0%	

1 Introduction

This document provides detailed technical information on the economic analyses conducted in support of the U.S. Department of Transportation (U.S. DOT) Fiscal Year (FY) 2023 - 2024 Multimodal Project Discretionary Grant Opportunity (MPDG) Program, specifically under the Nationally Significant Multimodal Freight and Highways Projects (INFRA) Grants Program and Rural Surface Transportation (Rural) Grants Program, for the NDOT Elko Nevada Rail Corridor Enhancement Project. This document includes the following.

- < **Section 2, Methodological Framework:** Introduces the conceptual framework used in the Benefit-Cost Analysis (BCA).
- < **Section 3, 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 volumes.
- < **Section 6, Benefits Measurement, Data, and Assumptions:** Details the specific data elements and assumptions used to address the goals of the Project to comply with MPDG program requirements.
- < **Section 7, Summary of Findings and Benefit-Cost Outcomes:** Provides estimates of the net present value (NPV), its benefit-cost ratio (BCR), and other evaluation metrics.
- < **Section 8, Benefit Cost Analysis Sensitivity:** Provides the outcome of the sensitivity analysis that evaluates the difference assumptions made in the analysis, and the impact that the variability of those assumptions may have on the overall results.

2 Methodological Framework

The BCA conducted for this Project includes monetized benefits and costs measured using U.S. Department of Transportation (U.S. DOT) guidance, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs* updated in January 2023, as well as the quantitative and qualitative merits of the Project. A BCA provides estimates of the benefits that are expected to accrue over a specified period and compares them to the anticipated costs. Costs include both the resources required to develop the Project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the Project on both users and non-users of the facility, valued in monetary terms.¹

While a BCA is just one of many tools that can be used in making decisions about infrastructure investments, U.S. DOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.²

The specific methodology employed for this application was developed using the BCA guidance developed by U.S. DOT and is consistent with the RAISE program guidelines. In particular, the methodology involves:

- ⟨ Establishing existing and future conditions under the Base Case (No-Build) and Alternative Case (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 U.S. DOT guidance for the valuation of safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- ⟨ Discounting future benefits and costs with the real discount rates recommended by the U.S. DOT (7 percent except for CO₂-related impacts, which are discounted at 3 percent); and
- ⟨ Conducting a sensitivity analysis to assess the impacts of changes in key assumptions.

¹ U.S. DOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, March 2022

² *Ibid.*

3 Overview

Located in Elko County, Nevada, the Elko Rail Corridor is a component of the broader UP Overland Route between Chicago, Illinois, and the San Francisco Bay Area in California. The route through Elko hosts UP freight trains, BNSF freight trains, and two daily Amtrak California Zephyr long-distance passenger trains between Chicago and the San Francisco Bay Area with a stop in Elko.

The two UP main tracks through the region are paired and are typically operated directionally. Meanwhile, the UP Elko Yard is located between the two main tracks to the east of the Amtrak Station and includes working tracks for meeting, staging, or switching out through freight trains off the main tracks and internal yard tracks for staging, switching, and other activities.

Switching of UP through freight trains at the Elko Yard may require trains to occupy one or both main tracks to complete operations through the adjacent yard tracks. Currently, some yard tracks are not long enough to accommodate meets with following trains or for working or staging trains off the main tracks. These conditions can result in delays to the California Zephyr and freight trains in the Elko Area and on the adjacent rail network for several miles in either direction. The current configuration constrains freight growth capacity. Future growth in freight traffic will require route diversions, resulting in increased emissions and fuel consumption, if yard improvements are not made.

Additionally, the current Amtrak Station functions as a split station. Specifically, the island platforms serving the eastbound and westbound California Zephyr are located opposite each other, separated by an intertrack fence with no connections between the two for Amtrak passengers. Both sides of the split station are accessible only from separate roadways north and south of the UP corridor, where a City of Elko operated shuttle connects passengers from one side to the other via the 12th Street overpass west of the station when arriving or departing on the eastbound California Zephyr.

Through the Elko Nevada Rail Corridor Enhancement Project, NDOT and UP will develop and construct corridor-based rail network improvements on the UP Elko and Lakeside subdivisions in the vicinity of the Amtrak Station and at the UP Elko Yard. The improvements are expected to reduce potential train delays for both freight and passenger trains, reduce train impacts on nearby at-grade crossings, improve accessibility for Amtrak passengers, and enable additional freight capacity through the corridor.

Figure 1 highlights the Project's various components.

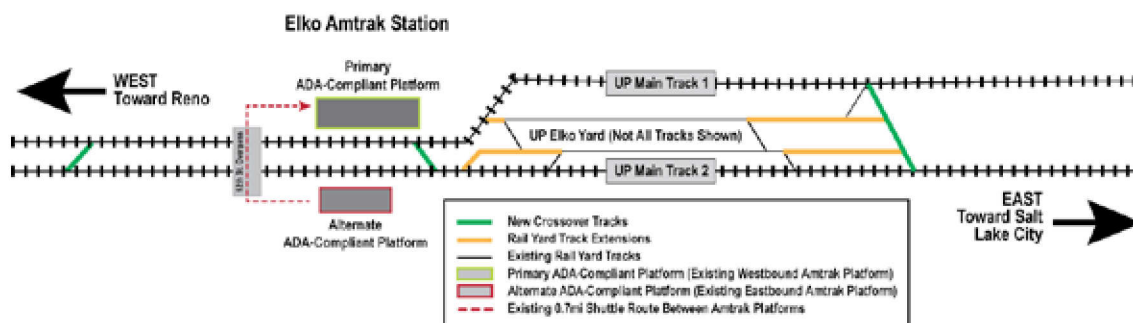


Figure 1: Project Components

3.1 Base Case

Under the Base Case, or the No-Build scenario, the Project does not proceed. As train volumes increase through the Elko region, both passenger and freight trains are expected to face increasing delay times. This is expected to translate increasing idling train emissions as well as travel time delays for passengers and freight railroads alike. The increased delays also impact at-grade crossings in the region, leading to additional time spent idle for motorists in the region.

Additionally, the bottleneck within the Elko region is expected to prevent additional freight trains from transporting goods through the region. The additional train volume will divert onto a longer and less efficient route. For the purposes of the analysis, the length of the diversion is calculated from the principal rail classification yard in Northern California (Roseville) to a common point in northern Utah before making its destination to the US Midwest and East. The additional trains would travel from Roseville (the common point within California, and UP's principal operating hub in Northern California), down south to Barstow, California, before traveling up to Ogden (the common point in Utah) via Las Vegas, Nevada, as represented by the blue line in **Figure 2**. This is the shortest route if the Overland Route is not available. In total, this translates into an additional 426 miles of travel per freight train. Furthermore, in the No-Build scenario, the eastbound and westbound Amtrak California Zephyrs continue to use the UP Overland Route and different platforms at the Elko station, necessitating a shuttle between the two sides of the track.

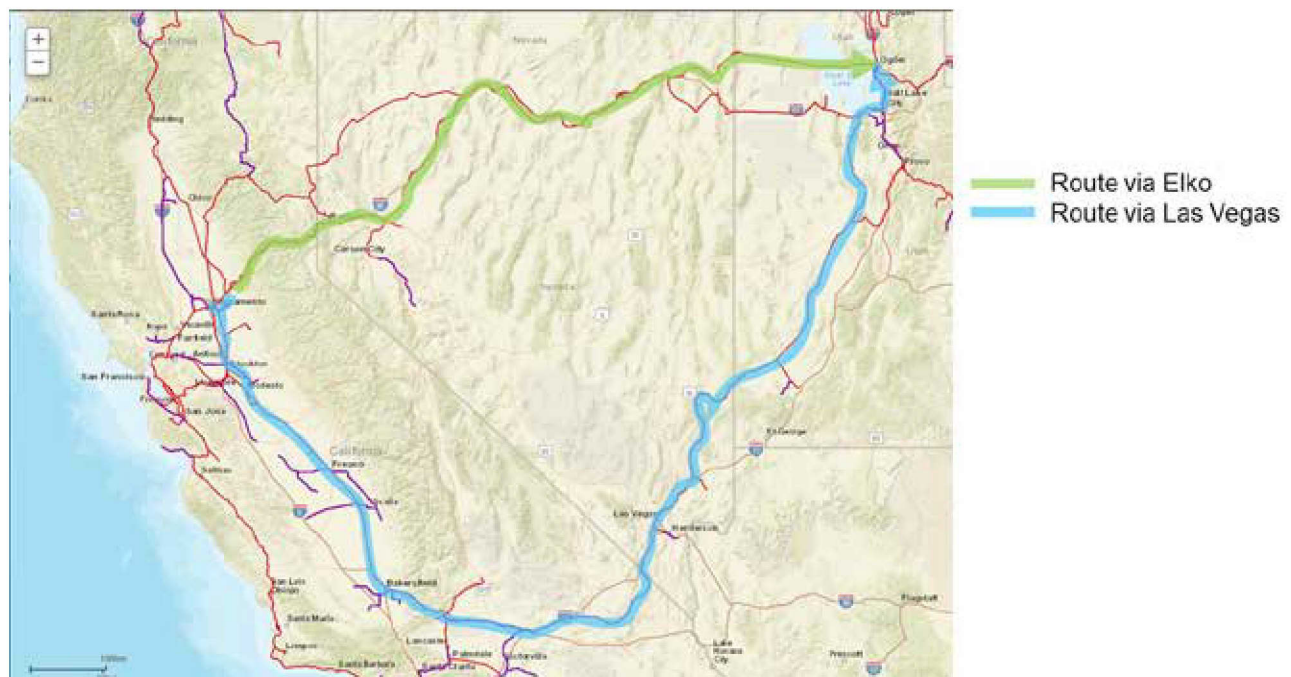


Figure 2: Freight Train Routes

3.2 Alternative Case

Under the Alternative Case, or the Build scenario, the Project proceeds as scheduled. The completion of the Project is expected to reduce the delay times both passenger and freight trains experience in the Elko area, which is expected to translate into a decrease in idling train emissions as well as travel

time impacts for passengers and operators alike. Furthermore, increased freight efficiency through the Elko Rail Corridor will result in reduced delays for motorists at at-grade crossings in the region.

Additionally, the Project is expected to improve Amtrak operations such that passengers on both eastbound and westbound trains board and deboard on the same common platform. This eliminates the need for a shuttle service transporting passengers between the two platforms on either side of the UP corridor in the current condition.

Finally, the Project is expected to provide additional network capacity and operating flexibility through the area. This is expected to generate additional freight transportation efficiencies to accommodate future freight demand. Instead of additional freight trains that originate or terminate in Northern California traveling between Roseville and Ogden via Southern California and Las Vegas, the trains would be able to travel between Roseville and Ogden via Elko, as represented by the green line in **Figure 2**. This more direct route is only 672 miles compared to the alternative and more distant route that is approximately 1,098 miles. This reduction in distance translates to a reduction in the total ton-miles for freight, which is expected to result in a decrease in emissions and the likelihood of freight transportation accidents.

3.3 Program Cost and Schedule

The capital costs would be incurred starting in 2024 through completion in 2027, with some previously incurred costs realized in 2023; the annual expenditures are summarized in **Table 1**. Capital costs are broken down by component in **Table 2**.

Table 1: Expenditure Profile, 2021 Dollars

Year	Capital Expenditure
2023	\$0.3 M*
2024	\$2.5 M
2025	\$8.6 M
2026	\$14.9 M
2027	\$14.9 M
Total	\$41.1 M

* Costs already incurred to date.

Table 2: Capital Cost by Component, 2021 Dollars

Component	Cost	Percentage of Cost
Engineering	\$1.7 M	4.1%
Right of Way	\$0.0 M	0.1%
Track Work	\$14.5 M	35.3%
Utilities	\$0.1 M	0.2%
Environmental	\$0.1 M	0.2%
Site Work	\$5.8 M	14.1%
Drainage	\$0.2 M	0.4%
Signal	\$8.1 M	19.7%
Equipment Work	\$0.2 M	0.6%
Contract Work	\$0.7 M	1.6%
Contingency	\$9.4 M	22.9%
Previously Incurred Costs	\$0.3 M	0.7%
Total	\$41.1 M	

3.4 Merit Criteria Impacts

The benefits associated with the Project are presented in **Table 3**, and they are separated by the various merit criteria.

Table 3: Expected Effects on Benefit Categories

Merit Criteria	Benefit Category	Description	Monetized	Qualitative
Safety	Avoided Accidents from Freight Train Route Efficiencies	Transporting freight on a more direct and shorter route is expected to reduce the likelihood of freight transportation accidents.	Yes	-
	Avoided greenhouse gas (GHG) Emissions from Improved Train Operations	Reducing train delay times for both freight and Amtrak trains is expected to translate into a reduction in emissions.	Yes	-
Environmental Sustainability	Avoided criteria air contaminants (CAC) Emissions from Improved Train Operations			
	Reduced GHG Emissions from Idling Vehicles	Reducing train occupancy durations at the 12 public at-grade crossings is expected to reduce idling time for motor vehicles at the respective grade crossings.	Yes	-
	Reduced CAC Emissions from Idling Vehicles			
	Avoided GHG Emissions from Freight Train Route Efficiencies	Transporting freight on a more direct and shorter route is expected to reduce emissions for freight transportation.	Yes	-
	Avoided CAC Emissions from Freight Train Route Efficiencies			
	Avoided GHG Emissions from Shuttle Service	Eliminating the need to shuttle Amtrak riders between platforms is expected to translate into emission reduction.	Yes	-
	Avoided CAC Emissions from Shuttle Service			
	Avoided Travel Time Costs from Train Delays	Improve travel time for train operations from reduced train delays.	Yes	-
Economic Competitiveness	Avoided Fuel Consumption for Trains	Reducing delay times for train operations is expected to reduce train fuel consumption.	Yes	-
	Reduced Idling Time for Motorists	Reducing train occupancy time at the various grade crossings is expected to translate into improve travel time for motorists.	Yes	-
	Reduced Vehicle Operating Costs	Reducing train occupancy time at the various grade crossings is expected would reduce fuel costs from idling vehicles.	Yes	-
	Reduced Fuel Consumption from Freight Train Route Efficiencies	Transporting freight on a more direct and shorter route is expected to reduce the train fuel consumption.	Yes	-
	Avoided Travel Time Costs from Shuttle Service	Eliminating the travel time for shuttles to transport Amtrak passengers between platforms.	Yes	-
	Avoided Agency Costs	Eliminating the agency costs related to the shuttle service.	Yes	-
State of Good Repair	Change in O&M Costs	Change in operational and maintenance costs as a result of the Project.	Yes	-
	Residual Value of Capital Assets	Residual value of capital asset.	Yes	-

4 General Assumptions

The BCA measures benefits against costs throughout a period of analysis, beginning at the start of construction and including 20 full years of operations.

The monetized benefits and costs are estimated in 2021 dollars, with future dollars discounted in compliance with U.S. DOT RAISE requirements.

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 2024 and ends in 2047; it includes project development and construction years (2024–2027) and 20 full years of operations (2028–2047); and
- ⟨ A constant 3 percent real discount rate for carbon dioxide (CO₂)-related benefits and 7 percent real discount rate for all other benefits are assumed throughout the period of analysis.

5 Demand Projections

Accurate demand projections are important to ensure reasonable BCA output results. The magnitudes of the long-term benefits accruing over the study period are a function of the freight and Amtrak volumes and delays, as well as passenger and freight volumes, and vehicles at the various grade crossings impacted by the Project.

5.1 Methodology

Train volumes, passenger and freight train delays, fuel consumption from railroad operations, and train occupancy time at public highway-rail grade crossings were determined through Rail Traffic Controller (RTC) railroad operations modeling developed by UP for the Project under the No-Build and Build scenarios. Specifically, these data points were provided for 2027 (year of project implementation) and 2047 (20 years post-implementation) for an area of operational influence in the Project region, inclusive of the Elko Amtrak Station and UP Elko Yard and immediately contiguous segments of the UP network east and west of Elko. Additionally, data points between 2027 and 2047 were interpolated based on the RTC outputs. For vehicle volumes at the various grade crossings, the existing average annual daily traffic (AADT) were determined based information from the Federal Railroad Administration (FRA) Grade Crossing Inventory for the respective grade crossings, while the future AADT was determined based on the average growth rates for traffic in rural regions of Nevada, provided by NDOT. These collective inputs were used to support development of the BCA for the Project.

For the additional train traffic, the volume of freight and ton-miles were estimated based on the difference in train volumes between the No-Build and Build scenarios, assumptions for average tons of freight per train, and the respective route distances. The analysis estimates diversions from Roseville (the principal classification yard) to Ogden. If freight origins further south in the Central Valley (e.g., Fresno) and is able to access the freight rail network closer to its origin, the diversion would be shorter. The diversion distance along with assumptions regarding the diverted train volumes are tested as part of the sensitivity analysis reported at the end of this document.

5.2 Assumptions

The assumptions used in the estimation of general demand inputs for the Project are provided in **Table 4**, **Table 5**, and **Table 6**, while the assumptions used in the estimation of grade crossing-specific demand inputs for the Project are presented in **Section 9.1**.

Table 4: Assumptions Used in the Estimation of Demand – General RTC Modeling Results

Variable	Units	Value (2027)	Value (2047)
Amtrak			
Amtrak Delay (No-Build)	minutes/week	662	1,384
Amtrak Delay (Build)	minutes/week	34	115
Fuel Consumption (No-Build)	gallons/week	1,755	1,844
Fuel Consumption (Build)	gallons/week	1,690	1,710
Existing Freight Trains			
Freight Train Delay (No-Build)	minutes/week	19,365	24,249
Freight Train Delay (Build)	minutes/week	5,564	8,446
Fuel Consumption (No-Build)	gallons/week	107,052	135,068
Fuel Consumption (Build)	gallons/week	103,934	132,277

Table 5: Assumptions Used in the Estimation of Demand – Additional Diverted Traffic

Variable	Units	Value (2027)	Value (2047)
Additional Freight Trains			
Potential Freight Trains	trains/week	2.0	4.0
Average Tons per Train	tons/train	7,500	7,500

Table 6: Assumptions Used in the Estimation of Demand – General Assumptions

Variable	Units	Value	Source
Amtrak Assumptions			
Elko Annual Amtrak Passengers	passengers/year	5,274	Based on the 7,032 passengers boarding at Elko Station from January 1, 2022, to April 30, 2023. Data provided by Amtrak (2023).
Amtrak California Zephyr Daily Trains	trains/day	2.0	Based on Amtrak California Zephyr Schedule (2023).
Freight Rail Assumptions			
Route via Elko	miles	672	Data provided by UP
Alternative Route (via Barstow)	miles	1,098	
Grade Crossing Assumption			
Vehicle Demand Growth	%	1.3%	Based on NDOT studies for vehicle growth in rural areas, which ranges from 1.0% - 1.5%. Data provided by Nevada DOT (2023).
Grade Crossing Warning Device Activation and Recovery Time	mins	0.5	Industry standard

5.3 Demand Projections

The resulting projections for various demand measures are presented in **Table 7**. Additional details are available in the accompanying BCA spreadsheet model.

Table 7: Demand Projections

Category	Units	2028	2033	2038	2043	2047
Improved Train Operations						
Avoided Freight Train Delays	hours/year	12,049	12,489	12,926	13,358	13,696
Avoided Amtrak Train Delays	hours/year	564	673	803	957	1,100
Grade Crossing Impacts						
Reduced Vehicle-Hours of Delay	vehicle-hours/year	2,973	5,825	13,629	25,756	39,823
Reduced Person-Hours of Delay	person-hours/year	4,838	9,421	22,032	41,633	64,381
Improved Freight Efficiencies						
Avoided Ton-Miles	ton-miles/year	344.0 M	409.1 M	486.5 M	578.5 M	664.6 M

6 Benefits Measurement, Data, and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in **Table 3** and provides an overview of the associated methodology, assumptions, and estimates.

6.1 Safety

Accident costs and impacts on life, limb, and property are a significant component of user costs for transportation. Transportation safety is a key economic factor in the planning of roads, as well as an important indicator of transportation efficiency. Beyond the economic context, transportation safety is often the subject of public concern.

The Project would help promote U.S. DOT's long-term safety outcome through avoiding the need to divert additional freight trains along longer routes.

The Project is expected to generate substantial benefits in line with the "Safety" merit criteria, with the specific benefits described below. The safety benefits are monetized using the assumptions presented in **Table 8**.

Table 8: Assumptions used to Monetize Safety Benefits

Variable	Units	Value	Source
Value of a Statistical Life	2021\$/fatality	\$11,800,000	Treatment of the Economic Value of Preventing Fatalities and Injuries in Preparing Economic Analyses (2022) https://www.transportation.gov/officepolicy/transportation-policy/reviseddepartmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis
Average Cost per Accident Injury	2021\$/injury	\$213,900	

6.1.1 Avoided Accidents from Freight Train Route Efficiencies

6.1.1.1 METHODOLOGY

As the Project will enable freight trains to use more direct routes, it is expected to reduce the likelihood of freight transportation related accidents. Accidents are estimated based on the total ton-miles traveled and the accident rates for freight trains by severity. These impacts are then monetized using the U.S. DOT values presented in **Table 8**. Finally, the Avoided Accidents from Freight Train Route Efficiencies is just the difference in estimated accident costs between the No-Build and Build scenario.

6.1.1.2 ASSUMPTIONS

The assumptions used in the estimation of Avoided Accidents from Freight Train Route Efficiencies are summarized in **Table 9**.

Table 9: Assumptions Used in the Estimation of Avoided Accidents from Freight Train Route Efficiencies

Variable	Units	Value	Source
Freight Rail Fatalities per Billion Ton-Miles	fatalities/billion ton-miles	0.3	Calculated based on Table 2-1 and Table 1-50 per U.S. DOT Bureau of Transportation Statistics' National Transportation Statistics. Based on average from 2016-2020.
Freight Rail Injuries per Billion Ton-Miles	injuries/billion ton-miles	2.1	Calculated based on Table 2-2 and Table 1-50 per U.S. DOT Bureau of Transportation Statistics'

Variable	Units	Value	Source
			National Transportation Statistics. Based on average from 2016-2020.

6.1.2 Benefit Estimates

Table 10 provides the monetized benefit estimates of safety benefits. The estimated present value of the discounted benefits over the projected 20-year benefit period is \$14.0 million.

Table 10: Estimates of Safety Benefits

Values in 2021\$	Over the Study Period	
	Undiscounted	Discounted
Avoided Accidents from Freight Train Route Efficiencies	\$43.0 M	\$14.0 M

6.2 Environment Benefits

Environmental costs are increasingly considered an important component in the evaluation of transportation projects. The primary environmental impact of vehicle use are the exhaust emissions, which impose wide-ranging social costs on people, material, and vegetation. The negative effects of pollution depend not only on the quantity of pollution produced, but also on the types of pollutants emitted as well as the local environmental conditions into which the pollution is released. Environmental costs are separated into those for greenhouse gas emissions (GHG) from CO₂ emission and those for criteria air contaminants (CAC), which include all other pollutants.

The Project is expected to provide environmental benefits through reducing train idling time and vehicle idling at the various impacted public grade crossings, as well as improving route efficiencies for freight trains, and eliminating the use of a shuttle service for Amtrak passengers between the existing east and west platforms at Elko station.

The assumptions used to monetize the reduction in emissions are summarized in **Table 11**.

Table 11: Assumptions Used in the Estimation of Environmental Benefits – Emission Values

Social Cost of Emissions (2021\$/metric ton)					
Year	NO _x	SO _x	PM _{2.5}	CO ₂	Source/Comment
2022	\$16,600	\$44,300	\$796,700	\$56	Technical Support Document: Estimating the Benefit per Ton of Reducing PM _{2.5} Precursors from 17 Sectors (February 2018)" https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbptsd_2018.pdf
2023	\$16,800	\$45,100	\$810,500	\$57	
2024	\$17,000	\$46,000	\$824,500	\$58	
2025	\$17,200	\$46,900	\$838,800	\$59	
2026	\$17,500	\$47,800	\$852,100	\$60	
2027	\$17,900	\$48,700	\$865,600	\$61	NO _x , SO _x , and PM _{2.5} values are inflated from 2015 to 2021 dollars using the GDP deflator.
2028	\$18,200	\$49,500	\$879,400	\$62	
2029	\$18,600	\$50,400	\$893,400	\$63	
2030	\$18,900	\$51,300	\$907,600	\$65	
2031	\$18,900	\$51,300	\$907,600	\$66	
2032	\$18,900	\$51,300	\$907,600	\$67	Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (February 2021) https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf
2033	\$18,900	\$51,300	\$907,600	\$68	
2034	\$18,900	\$51,300	\$907,600	\$69	
2035	\$18,900	\$51,300	\$907,600	\$70	
2036	\$18,900	\$51,300	\$907,600	\$72	
2037	\$18,900	\$51,300	\$907,600	\$73	
2038	\$18,900	\$51,300	\$907,600	\$74	

Social Cost of Emissions (2021\$/metric ton)					
Year	NO _x	SO _x	PM _{2.5}	CO ₂	Source/Comment
2039	\$18,900	\$51,300	\$907,600	\$75	
2040	\$18,900	\$51,300	\$907,600	\$76	
2041	\$18,900	\$51,300	\$907,600	\$78	
2042	\$18,900	\$51,300	\$907,600	\$79	
2043	\$18,900	\$51,300	\$907,600	\$80	
2044	\$18,900	\$51,300	\$907,600	\$81	
2045	\$18,900	\$51,300	\$907,600	\$82	
2046	\$18,900	\$51,300	\$907,600	\$84	
2047	\$18,900	\$51,300	\$907,600	\$85	
2048	\$18,900	\$51,300	\$907,600	\$86	
2049	\$18,900	\$51,300	\$907,600	\$87	
2050+	\$18,900	\$51,300	\$907,600	\$88	

6.2.1 Avoided Emissions from Improved Train Operations

6.2.1.1 METHODOLOGY

As the Project will look to provide more flexibility for both freight and Amtrak trains through the Elko region, this is expected to translate into a reduction in the train idling time and therefore enhance the efficiency of train operations through the region. Such operational improvements are expected to result in a reduction in train emissions, which is estimated based on the gallons fuel consumed under the No-Build and Build scenarios. Specifically, the emission for each pollutant (i.e., CO₂, NO_x, VOC, PM_{2.5}, and SO₂) were estimated based on the respective gallons of fuel consumed and the emission factors for passenger and freight trains respectively, under both the No-Build and Build scenarios. To obtain the expected emissions costs, the volume of each pollutant was then converted to tons and multiplied by its monetary value (per metric ton), as presented in **Table 11**.

6.2.1.2 ASSUMPTIONS

The assumptions used in the estimation of environmental benefits are summarized in **Section 9.2**.

6.2.2 Reduced Emissions from Idling Vehicles

6.2.2.1 METHODOLOGY

The Project is expected to change the times trains occupy various public grade crossings. Specifically, the Project is expected to improve yard operations in Elko such that it causes less impediment to vehicles at the various grade crossings nearby and would correspond to an overall reduction in idling time for vehicles, as well as idling vehicle emissions.

The reduction in emissions from idling vehicles are estimated based on the train occupancy time and gate times, the vehicle volumes by vehicle type, and their respective idling emission factors on a per hour basis for each of CO₂, NO_x, VOC, PM_{2.5}, and SO₂ under the No-Build and Build scenarios. To obtain the expected emission costs, the volume of each pollutant was then converted to tons and multiplied by its monetary value (per metric ton), as presented in **Table 11**.

6.2.2.2 ASSUMPTIONS

The assumptions used in the estimation of environmental benefits are summarized in **Section 9.3**.

6.2.3 Avoided Emissions from Freight Train Route Efficiencies

6.2.3.1 METHODOLOGY

The avoided emissions from freight train route efficiencies considers the change in emissions from excess future freight trains being able to travel along the more efficient Overland route rather than diverting to Southern California. Specifically, this benefit is derived by the emission factors by mode on a per ton-mile basis for each of CO₂, NO_x, VOC, PM, and SO₂ under both the No-Build and Build scenarios. To obtain the expected emission costs, the volume of each pollutant was then converted to tons and multiplied by its monetary value (per metric ton), as presented in **Table 11**.

6.2.3.2 ASSUMPTIONS

The assumptions used in the estimation of environmental benefits are summarized in **Section 9.2**, specifically the freight train emission factors.

6.2.4 Avoided Emissions from Shuttle Service

6.2.4.1 METHODOLOGY

The avoided emissions from shuttle service stems from passengers no longer needing the service as Amtrak passengers will be boarding and deboarding from the same platform. Specifically, the reduction in emissions is derived by the number of shuttle trips, the distance, and emission factors by buses on a per mile basis for each of CO₂, NO_x, VOC, PM, and SO₂ under both the No-Build and Build scenarios. To obtain the expected emission costs, the volume of each pollutant was then converted to tons and multiplied by its monetary value (per metric ton), as presented in **Table 11**.

6.2.4.2 ASSUMPTIONS

The assumptions used in the estimation of environmental benefits are summarized in **Section 9.4**.

6.2.5 Benefit Estimates

Table 12 shows the estimated environmental benefits. The estimated discounted present value over the projected 20-year benefit period is about \$21.9 million.

Table 12: Estimates of Environmental Benefits

Values in 2021\$	Over the Study Period	
	Undiscounted	Discounted
Avoided GHG Emissions from Improved Train Operations	\$2.4 M	\$1.5 M
Avoided CAC Emissions from Improved Train Operations	\$4.3 M	\$1.7 M
Reduced GHG Emissions from Idling Vehicles at Grade Crossings	\$0.0 M	\$0.0 M
Reduced CAC Emissions from Idling Vehicles at Grade Crossings	\$0.0 M	\$0.0 M
Avoided GHG Emissions from Freight Train Route Efficiencies	\$15.5 M	\$9.2 M
Avoided CAC Emissions from Freight Train Route Efficiencies	\$26.0 M	\$9.5 M
Avoided GHG Emissions from Shuttle Service	\$0.0 M	\$0.0 M
Avoided CAC Emissions from Shuttle Service	\$0.0 M	\$0.0 M
Total	\$48.3 M	\$21.9 M

6.3 Economic Competitiveness Benefits

The completion of the Project is expected to improve economic competitiveness through reducing delays, improving travel times, and reducing fuel costs.

6.3.1 Avoided Travel Time Costs from Train Delays

6.3.1.1 METHODOLOGY

As the Project is expected to reduce delay time for train operations, the estimated travel time impacts are estimated for both passenger and freight trains. For Amtrak trains, the reduction in travel time is estimated based on the difference in Amtrak train delays between No-Build and Build scenarios, as well as the average number of passengers on the Amtrak trains. For freight trains, the reduction in travel time is estimated based on the difference in freight train delays between the No-Build and Build scenarios, as well as the number of train crew per train. Finally, these impacts are monetized using the respective hourly values of travel time savings from the U.S. DOT BCA Guidance.

6.3.1.2 ASSUMPTIONS

The assumptions used in the estimation of the avoided travel time costs from train delays are summarized in **Table 13**.

Table 13: Assumptions Used in the Estimation of Avoided Travel Time Costs from Train Delays

Variable	Units	Value	Source
Locomotive Engineers per Freight Train	engineers/train	1.0	Standard assumption of one driver per vehicle
Rail Engineers per Amtrak Train	operators/train	1.0	Standard assumption of one driver per vehicle
Value of Travel Time Savings (All Purposes)	2021\$/hour	\$18.80	US DOT BCA Guidance, January 2023
Value of Travel Time Savings (Locomotive Engineers)	2021\$/hour	\$57.40	

6.3.2 Avoided Fuel Consumption for Trains

6.3.2.1 METHODOLOGY

The expected reduction in delay time for train operations in the Elko region from the Project is expected to translate into reduce fuel consumption for trains as well. This is estimated based on the reduction in fuel consumption for trains between the No-Build and Build scenarios, per RTC railroad operations modeling, and then monetized using the cost of diesel per U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2023.

6.3.2.2 ASSUMPTIONS

The assumptions used in the estimation of the avoided fuel consumption for trains are presented in **Table 4** per RTC modeling and monetized using the fuel costs presented in **Table 14**.

Table 14: Forecast of Fuel Costs

Year	Units	Gasoline	Diesel	Source
2023	2021\$/gallon	\$2.93	\$3.71	Based on Annual Energy Outlook 2023 Release. Values excludes Federal and state fuel taxes. Value adjusted to 2021 dollars.
2024		\$2.62	\$3.50	
2025		\$2.41	\$3.23	
2026		\$2.39	\$3.12	

Year	Units	Gasoline	Diesel	Source
2027		\$2.37	\$3.00	
2028		\$2.38	\$2.91	
2029		\$2.39	\$2.92	
2030		\$2.40	\$2.93	
2031		\$2.40	\$2.95	
2032		\$2.42	\$2.97	
2033		\$2.43	\$2.99	
2034		\$2.44	\$3.00	
2035		\$2.45	\$3.03	
2036		\$2.48	\$3.04	
2037		\$2.49	\$3.06	
2038		\$2.50	\$3.08	
2039		\$2.52	\$3.09	
2040		\$2.52	\$3.10	
2041		\$2.53	\$3.12	
2042		\$2.54	\$3.13	
2043		\$2.53	\$3.14	
2044		\$2.55	\$3.14	
2045		\$2.55	\$3.15	
2046		\$2.64	\$3.22	
2047		\$2.64	\$3.23	
2048		\$2.66	\$3.24	
2049		\$2.67	\$3.25	
2050+		\$2.70	\$3.25	

6.3.3 Reduced Idling Time for Motorists

6.3.3.1 METHODOLOGY

Travel time savings will be generated for motorists along the various public at-grade crossings, which is determined based on the vehicle delay at each crossing by vehicle type, the average occupancy per vehicle, and the monetization value of time per U.S. DOT BCA guidance. Finally, the travel time savings is estimated as the difference in the travel time costs between the No-Build and Build scenario.

6.3.3.2 ASSUMPTIONS

The assumptions used in the estimation of reduced idling time for motorists are summarized in **Table 15**.

Table 15: Assumptions Used in the Estimation of Reduced Idling Time for Motorists

Variable	Units	Value	Source
Auto Occupancy	persons/vehicle	1.7	US DOT, BCA Guidance January 2023; 2017 National Household Travel Survey.
Truck Occupancy	persons/vehicle	1.0	Standard assumption of driver per vehicle
School Bus Drivers	persons/vehicle	1.0	Standard assumption of one driver per vehicle
Value of Travel Time Savings (All Purposes)	2021\$/hour	\$18.80	US DOT BCA Guidance, January 2023
Value of Travel Time Savings (Truck Drivers)	2021\$/hour	\$32.40	
Value of Travel Time Savings (Bus Drivers)	2021\$/hour	\$35.00	

6.3.4 Reduced Vehicle Operating Costs

6.3.4.1 METHODOLOGY

The Project is expected to reduce the vehicle operating costs through the reduction in vehicle delay times at the various public grade crossings. For the purposes of the BCA, the vehicle operating costs in the analysis reflect only the fuel costs, which are determined based on the total hours of idling by vehicle type, fuel consumption during idling by vehicle type, and fuel costs. The vehicle operating cost savings is estimated as the difference in vehicle operating costs between No-Build and Build scenarios.

6.3.4.2 ASSUMPTIONS

The assumptions used in the estimation of reduced vehicle operating costs are summarized in **Table 16** and monetized using the fuel costs presented earlier in **Table 14**.

Table 16: Assumptions Used in the Estimation of Reduced Vehicle Operating Costs

Variable	Units	Value	Source
Gasoline Burned at Idle - Autos	gallons/hour	0.3	US DOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Average of gasoline passenger vehicles.
Diesel Fuel Burned at Idle - Trucks	gallons/hour	0.8	US DOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Medium Heavy Trucks.
Diesel Fuel Burned at Idle - School Buses	gallons/hour	1.0	US DOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Transit Bus

6.3.5 Reduced Fuel Consumption from Freight Train Route Efficiencies

6.3.5.1 METHODOLOGY

As the Project will allow additional freight trains to transport goods over a more efficient and direct route, it is expected to translate into a reduction in fuel consumption for transporting freight. This is estimated by comparing the total fuel consumed under the No-Build and Build scenarios, which are dependent on the ton-miles of freight transported under the respective scenarios and the fuel efficiency for freight trains. The reduced fuel consumption from freight train route efficiencies is estimated based on the difference in fuel consumption and the fuel costs obtained from the U.S. EIA's AEO 2023.

6.3.5.2 ASSUMPTIONS

The assumptions used in the estimation of reduced fuel consumption from freight train route efficiencies are summarized in **Table 17** and monetized using the fuel costs presented in **Table 14**.

Table 17: Assumptions Used in the Estimation of Reduced Fuel Consumption from Freight Train Route Efficiencies

Variable	Units	Value	Source
UP Fuel Efficiency	ton-miles/gallon	480.0	Based on: Union Pacific. <i>Insights: How Are Locomotives Getting More Fuel Efficient for the Railroad Industry?</i> ; April 5, 2022

6.3.6 Avoided Travel Time Costs from Shuttle Service

6.3.6.1 METHODOLOGY

As the Project will no longer require the use of a shuttle service to transport Amtrak passengers from one side of the UP corridor to another to access platforms, it is expected to eliminate the marginal travel time costs from using the shuttle service. This is estimated based on the total passenger miles and the average speeds that the shuttle travels. The change in travel time costs is then monetized based on values from the U.S. DOT BCA Guidance.

6.3.6.2 ASSUMPTIONS

The assumptions used in the estimation of avoided travel time costs from shuttle service are summarized in **Table 18**.

Table 18: Assumptions Used in the Estimation of Avoided Travel Time Costs from Shuttle Service

Variable	Units	Value	Source
Proportion of Passengers Shuttled EB to WB	%	50.0%	Assuming half the passengers will require the shuttle service
Average Occupancy of Shuttle	passengers/shuttle	3.6	Estimated based on the number of passengers boarding at Elko Station and the annual train volumes. Adjusted to directionality.
Route Distance, EB to WB Platform	miles	0.7	2020 Nevada State Rail Plan
Shuttle Time	minutes	2.0	Google Maps
Value of Travel Time Savings (All Purposes)	2021\$/hour	\$18.80	US DOT BCA Guidance, January 2023
Value of Travel Time Savings (Bus Drivers)	2021\$/hour	\$35.00	

6.3.7 Avoided Agency Costs

6.3.7.1 METHODOLOGY

As the Project will no longer require the use of a shuttle service, the City of Elko and Amtrak are expected to experience a reduction in agency costs. Specifically, current shuttle service cost approximately \$200,000 per year contract.³ Future costs are expected to be the same in constant dollars.

6.3.7.2 ASSUMPTIONS

The assumptions used in the estimation of avoided agency costs from shuttle service are summarized in **Table 19**.

Table 19: Assumptions Used in the Estimation of Avoided Agency Costs

Variable	Units	Value	Source
Transit Contract Value per Year	\$/year	\$200,000	Based reported contract value from Adella Harding, <i>Elko Daily</i> : "County to Shuttle Amtrak Passengers," June 16 2021.

³ Adella Harding. *Elko Daily*. "County to Shuttle Amtrak Passengers," June 16, 2021.

6.3.8 Benefit Estimates

Table 12 shows the estimated economic competitiveness benefits. The estimated discounted present value over the projected 20-year benefit period is about \$33.8 million.

Table 20: Estimates of Environmental Benefits

Values in 2021\$	Over the Study Period	
	Undiscounted	Discounted
Avoided Travel Time Costs from Train Delays	\$17.9 M	\$6.2 M
Avoided Fuel Consumption for Trains	\$9.7 M	\$3.4 M
Reduced Idling Time for Motorists	\$9.8 M	\$2.6 M
Reduced Vehicle Operating Costs	\$0.3 M	\$0.1 M
Reduced Fuel Consumption from Freight Train Route Efficiencies	\$62.6 M	\$20.2 M
Avoided Travel Time Costs from Shuttle Service	\$0.0 M	\$0.0 M
Avoided Agency Costs	\$4.0 M	\$1.4 M
Total	\$104.3 M	\$33.8 M

6.4 State of Good Repair

6.4.1 Change in O&M Costs

6.4.1.1 METHODOLOGY

As the Project will incorporate additional infrastructure and equipment within the Elko region to improve train traffic fluidity and improve capacity through along the UP network, it is expected to translate into an increase in Operations and Maintenance (O&M) costs. This is expected to be slightly offset with new infrastructure requiring less maintenance than the older infrastructure that it is replacing, but this effect is not included in the analysis.

6.4.1.2 ASSUMPTIONS

The assumptions used in the estimation of change in O&M costs are summarized in **Table 21**.

Table 21: Assumptions Used in the Estimation of Change in O&M Costs

Variable	Units	Value	Source
O&M - No-Build	\$/year	\$100,000	UP estimate
O&M - Build	\$/year	\$125,000	UP estimate

6.4.2 Residual Value of Capital Assets

6.4.2.1 METHODOLOGY

The residual value of capital assets is calculated in line with U.S. DOT's BCA guidance, based on an estimated useful life of 40 years for the new rail infrastructure.

6.4.2.2 ASSUMPTIONS

The assumptions used in the estimation of the residual value of capital assets are summarized in **Table 22**.

Table 22: Assumptions Used in the Estimation of Residual Value of Capital Assets

Variable	Units	Value	Source
Useful Life of Rail	years	40.0	Assumption of 40 years for relatively light use of new track based on industry experience. Expected tie replacement, ballast lifts, and surface maintenance starting within 25 years, but excluded on an incremental basis as compared to existing infrastructure.

6.4.3 Benefit Estimates

Table 23 shows the estimates of the change in O&M costs and the residual value of capital assets. The estimated discounted present value over the projected 20-year benefit period is \$1.1 million.

Table 23: Estimates of the State of Good Repair

Values in 2021\$	Over the Study Period	
	Undiscounted	Discounted
Change in O&M Costs	(\$0.5 M)	(\$0.2 M)
Residual Value of Capital Assets	\$7.2 M	\$1.2 M
Total	\$6.7 M	\$1.1 M

Note: Totals do not match due to rounding.

7 Summary of Findings and Benefit-Cost Outcomes

Table 24 and **Table 25** summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the Project (24 years). As previously stated, construction is expected to be completed by 2027. Benefits accrue during the full operation of the Project, starting in 2028.

Table 24: Benefit Estimates by Merit Criteria

Merit Criteria	Benefit Category	Undiscounted	Discounted
Safety	Avoided Accidents from Freight Train Route Efficiencies	\$43.0 M	\$14.0 M
	Avoided GHG Emissions from Improved Train Operations	\$2.4 M	\$1.5 M
	Avoided CAC Emissions from Improved Train Operations	\$4.3 M	\$1.7 M
Environmental Sustainability	Reduced GHG Emissions from Idling Vehicles at Grade Crossings	\$0.0 M	\$0.0 M
	Reduced CAC Emissions from Idling Vehicles at grade Crossings	\$0.0 M	\$0.0 M
	Avoided GHG Emissions from Freight Train Route Efficiencies	\$15.5 M	\$9.2 M
	Avoided CAC Emissions from Freight Train Route Efficiencies	\$26.0 M	\$9.5 M
	Avoided GHG Emissions from Shuttle Service	\$0.0 M	\$0.0 M
	Avoided CAC Emissions from Shuttle Service	\$0.0 M	\$0.0 M
	Avoided Travel Time Costs from Train Delays	\$17.9 M	\$6.2 M
Economic Competitiveness	Avoided Fuel Consumption for Trains	\$9.7 M	\$3.4 M
	Reduced Idling Time for Motorists	\$9.8 M	\$2.6 M
	Reduced Vehicle Operating Costs	\$0.3 M	\$0.1 M
	Reduced Fuel Consumption from Freight Train Route Efficiencies	\$62.6 M	\$20.2 M
	Avoided Travel Time Costs from Shuttle Service	\$0.0 M	\$0.0 M
	Avoided Agency Costs	\$4.0 M	\$1.4 M
	Change in O&M Costs	(\$0.5 M)	(\$0.2 M)
State of Good Repair	Residual Value of Capital Assets	\$7.2 M	\$1.2 M
Total		\$202.3 M	\$70.9 M

Table 25: Overall Results of the Benefit Cost Analysis, Millions of 2021 Dollars

Evaluation Metrics	Undiscounted	Discounted
Total Benefits	\$202.3 M	\$70.9 M
Total Costs	\$41.1 M	\$29.4 M
Net Present Value (NPV)	\$161.1 M	\$41.5 M
Return on Investment (ROI)	392%	141%
Benefit-Cost Ratio (BCR)	4.9	2.4
Payback Period (years)	5.2	6.8
Internal Rate of Return (IRR)	17.0%	

Considering all monetized benefits and costs, the estimated internal rate of return of the Project is 17.0 percent. With a 3 percent real discount rate for CO₂-related impacts and 7 percent real discount rate for all other impacts, the \$29.4 million investment would result in \$70.9 million in total benefits for a NPV of \$41.5 million and a BCR of approximately 2.4.

8 Benefit Cost Analysis Sensitivity

The BCA outcomes presented in the previous sections rely on many assumptions and long-term projections, all of which are subject to 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 sensitivity analysis can also be used to:

- < Evaluate the impact of changes in individual 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 outcomes of the quantitative analysis for the Project, using a 3 percent discount rate for CO₂-related impacts and 7 percent discount rate for all other impacts, are summarized in **Table 26**.

As previously mentioned, the assumptions related to the diversion of freight traffic along a shorter and more efficient route due to the Project. In addition, other sensitivities were also considered.

Table 26: Sensitivity Analysis Results

Original NPV (Discounted)	Original BCR	Parameters	Change in Parameters	New NPV (Discounted)	Change in NPV	New BCR
\$41.5 M	2.4	Change in Capital Costs	Increase capital costs by 25%	\$34.6 M	-16.8%	1.9
			Decrease capital costs by 25%	\$48.5 M	+16.8%	3.2
		Change in the Total Trains Diverted (2047)	Consider only 2 freight trains per week are diverted	\$27.4 M	-33.9%	1.9
			Consider 6 freight trains per week are diverted	\$53.2 M	+28.1%	2.8
		Diverted Route	Assume cargo originates further south in the Central Valley and the difference between routes is reduced by 200 miles	\$16.7 M	-59.9%	1.6
		Exclude Shuttle Impacts	Exclude the cost savings from the no longer necessary shuttle service	\$40.1 M	-3.4%	2.4

Based on the results presented above, a 25 percent change in the capital cost is expected to result in a 16.8 percent change to the NPV, resulting in an NPV ranging from \$34.6 million to \$48.5 million. Excluding the benefits related to the shuttle service (assuming it is retained after the project is completed) reduces the NPV by 3.4 percent, resulting in an NPV of \$40.1 million.

Adjusting the assumptions related the diversion of freight trains is expected to have the largest change to the results. Assuming the number of diverted trains do not grow in the future and stay constant at 2 train per week would result in a BCR of 1.9. Meanwhile, assuming by 2047 there are a total of 6 diverted trains per week, it would result in a BCR of 2.8. Finally, assuming the cargo originates just south of Fresno would reduce the difference between the route via Elko and the alternative route by 200 miles would translate to an NPV \$16.7 million and a BCR of 1.6.

However, despite the various scenarios considered, the overall BCR is robust, with a value greater than 1.5.



9 Supplementary Tables

This section presents additional assumptions used within the BCA. A complete list of assumptions used in the analysis is also available within the accompanying BCA model.

9.1 Grade Crossing Demand Assumptions

Table 27: Grade Crossing Inputs (1/2)

Variable	Units	State Highway 278 in Carlin (MP 533.17)	Tomera Ranch Road in Carlin (MP 533.63)	B Street in Carlin (MP 534.06)	Fourth Street in Carlin (MP 534.39)	Tenth Street in Carlin (MP 534.80)	Hot Springs Road in Elko (MP 554.87)
AADT	vehicles/day	560	10	150	190	670	510
Year of AADT Observation	year	2018	2018	2018	2018	2018	2018
Truck Share	%	10.0%	7.0%	7.0%	7.0%	7.0%	5.0%
Daily School Buses	school buses/day	2	0	0	0	0	0
RTC Model Results (No-Build)							
Total Occupancy Time (2027)	hours/day	2.6	3.8	5.4	3.9	3.4	2.1
Total Occupancy Time (2047)	hours/day	4.4	5.5	7.4	5.6	5.2	2.2
Trains per Day (2027)	trains/day	11.2	11.2	11.2	12.5	12.5	9.4
Trains per Day (2047)	trains/day	12.8	12.8	12.8	14.1	14.1	10.9
RTC Model Results (Build)							
Total Occupancy Time (2027)	hours/day	2.6	3.6	5.5	4.0	3.5	2.1
Total Occupancy Time (2047)	hours/day	2.8	3.8	5.6	4.2	3.7	2.3
Trains per Day (2027)	trains/day	11.3	11.3	11.3	12.7	12.7	9.5
Trains per Day (2047)	trains/day	12.8	12.8	12.8	14.2	14.2	11.0

Table 28: Grade Crossing Inputs (2/2)

Variable	Units	State Highway 229 in Halleck (MP 576.78)	Deeth Road in Deeth (MP 589.53)	State Highway 278 in Carlin (MP 642.61)	Hot Springs Road in Elko (MP 664.35)	State Highway 229 in Halleck (MP 577.27)	Deeth Road in Deeth (MP 589.28)
AADT	vehicles/day	250	20	740	510	250	50
Year of AADT Observation	year	2018	2018	2018	2018	2018	2018
Truck Share	%	10.0%	4.0%	10.0%	5.0%	10.0%	7.0%
Daily School Buses	school buses/day	4	2	2	0	4	2
RTC Model Results (No-Build)							
Total Occupancy Time (2027)	hours/day	1.7	1.8	2.9	3.6	2.5	2.5
Total Occupancy Time (2047)	hours/day	2.0	2.1	5.6	8.7	3.3	3.4
Trains per Day (2027)	trains/day	8.7	8.7	9.8	9.9	8.9	8.9
Trains per Day (2047)	trains/day	10.3	10.3	11.2	11.3	10.2	10.2



Variable	Units	State Highway 229 in Halleck (MP 576.78)	Deeth Road in Deeth (MP 589.53)	State Highway 278 in Carlin (MP 642.61)	Hot Springs Road in Elko (MP 664.35)	State Highway 229 in Halleck (MP 577.27)	Deeth Road in Deeth (MP 589.28)
RTC Model Results (Build)							
Total Occupancy Time (2027)	hours/day	1.7	1.8	2.8	3.0	2.5	2.6
Total Occupancy Time (2047)	hours/day	1.9	2.1	3.9	6.3	5.2	3.6
Trains per Day (2027)	trains/day	8.6	8.6	9.9	10.0	9.3	9.3
Trains per Day (2047)	trains/day	9.9	9.9	11.6	11.6	11.1	11.1

9.2 Emission Factors – Freight and Amtrak Trains

Table 29: Emission Factors – Freight Trains

Year	Freight Train Emissions (grams/gallon)						Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	CO ₂		
2023	84.00	3.159	1.843	1.880	10,217		Data from United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009.
2024	79.00	2.948	1.649	1.880	10,217		
2025	74.00	2.738	1.552	1.880	10,217		
2026	69.00	2.633	1.455	1.880	10,217		
2027	65.00	2.422	1.358	1.880	10,217		
2028	61.00	2.211	1.261	1.880	10,217		
2029	57.00	2.106	1.067	1.880	10,217		
2030	53.00	2.001	0.970	1.880	10,217		
2031	49.00	1.790	0.970	1.880	10,217		
2032	46.00	1.685	0.873	1.880	10,217		
2033	43.00	1.580	0.776	1.880	10,217		
2034	40.00	1.474	0.679	1.880	10,217		
2035	37.00	1.369	0.679	1.880	10,217		
2036	35.00	1.264	0.582	1.880	10,217		
2037	33.00	1.264	0.582	1.880	10,217		
2038	31.00	1.158	0.485	1.880	10,217		
2039	29.00	1.158	0.485	1.880	10,217		
2040	28.00	1.053	0.388	1.880	10,217		
2041	28.00	1.053	0.388	1.880	10,217		
2042	28.00	1.053	0.388	1.880	10,217		
2043	28.00	1.053	0.388	1.880	10,217		
2044	28.00	1.053	0.388	1.880	10,217		
2045+	28.00	1.053	0.388	1.880	10,217		

Table 30: Emission Factors – Amtrak Trains

Year	Passenger Train Emissions (grams/gallon)					Source/Comment
	NOx	VOC	PM _{2.5}	SO ₂	CO ₂	
2023	78.00	2.527	1.649	1.880	10,217	Data from United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009.
2024	73.00	2.317	1.455	1.880	10,217	
2025	68.00	2.106	1.358	1.880	10,217	
2026	64.00	1.895	1.164	1.880	10,217	
2027	60.00	1.685	1.067	1.880	10,217	
2028	56.00	1.580	0.970	1.880	10,217	
2029	52.00	1.369	0.873	1.880	10,217	
2030	49.00	1.264	0.776	1.880	10,217	
2031	46.00	1.158	0.679	1.880	10,217	
2032	42.00	1.053	0.679	1.880	10,217	
2033	39.00	0.948	0.582	1.880	10,217	
2034	36.00	0.842	0.582	1.880	10,217	
2035	33.00	0.737	0.485	1.880	10,217	
2036	30.00	0.737	0.485	1.880	10,217	
2037	28.00	0.632	0.388	1.880	10,217	
2038	26.00	0.632	0.388	1.880	10,217	
2039	24.00	0.527	0.388	1.880	10,217	
2040	23.00	0.527	0.291	1.880	10,217	
2041	23.00	0.527	0.291	1.880	10,217	
2042	23.00	0.527	0.291	1.880	10,217	
2043	23.00	0.527	0.291	1.880	10,217	
2044	23.00	0.527	0.291	1.880	10,217	
2045+	23.00	0.527	0.291	1.880	10,217	

9.3 Emission Factors – Idling Vehicles

Table 31: Emission Factors – Idling Passenger Vehicles

Year	Idling Vehicle Emissions - Vehicles (grams/hour)					Source/Comment
	NOx	VOC	PM _{2.5}	SO ₂	CO ₂	
2023	3.04	0.668	0.146	0.011	1,969	Based on MOVES average annual emission factors for passenger vehicles in Elko County, Nevada. Assuming idling passenger vehicles have the same emissions profile as passenger vehicles traveling at 2.5 miles per hour. MOVES model run in July 2023.
2024	2.75	0.596	0.129	0.010	1,925	
2025	2.46	0.524	0.113	0.010	1,880	
2026	2.17	0.452	0.096	0.010	1,836	
2027	1.88	0.380	0.079	0.010	1,792	
2028	1.59	0.308	0.063	0.009	1,747	
2029	1.30	0.237	0.046	0.009	1,703	
2030	1.00	0.165	0.029	0.009	1,658	
2031	0.95	0.153	0.027	0.009	1,643	
2032	0.90	0.142	0.024	0.009	1,627	
2033	0.85	0.131	0.022	0.009	1,612	
2034	0.80	0.120	0.019	0.009	1,597	
2035	0.74	0.109	0.017	0.008	1,581	

Year	Idling Vehicle Emissions - Vehicles (grams/hour)				Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	CO ₂
2036	0.69	0.098	0.014	0.008	1,566
2037	0.64	0.087	0.012	0.008	1,550
2038	0.59	0.075	0.009	0.008	1,535
2039	0.54	0.064	0.007	0.008	1,519
2040	0.49	0.053	0.004	0.008	1,504
2041	0.48	0.053	0.004	0.008	1,500
2042	0.48	0.053	0.004	0.008	1,497
2043	0.47	0.052	0.004	0.008	1,494
2044	0.47	0.052	0.004	0.008	1,490
2045	0.46	0.052	0.004	0.008	1,487
2046	0.46	0.051	0.004	0.008	1,483
2047	0.45	0.051	0.004	0.008	1,480
2048	0.45	0.050	0.004	0.008	1,476
2049	0.44	0.050	0.004	0.008	1,473
2050	0.44	0.050	0.004	0.008	1,470
2051	0.44	0.050	0.004	0.008	1,469
2052	0.44	0.050	0.004	0.008	1,469
2053	0.44	0.050	0.004	0.008	1,468
2054	0.44	0.050	0.004	0.008	1,468
2055	0.44	0.050	0.004	0.008	1,467
2056	0.44	0.050	0.004	0.008	1,467

Table 32: Emission Factors – Idling Trucks

Year	Idling Vehicle Emissions - Trucks (grams/hour)				Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	CO ₂
2023	15.79	2.321	0.283	0.023	4,714
2024	15.19	2.153	0.257	0.022	4,656
2025	14.59	1.984	0.231	0.022	4,599
2026	13.99	1.816	0.204	0.022	4,541
2027	13.39	1.647	0.178	0.022	4,484
2028	12.79	1.479	0.152	0.022	4,426
2029	12.19	1.310	0.125	0.021	4,369
2030	11.59	1.142	0.099	0.021	4,311
2031	11.57	1.071	0.095	0.021	4,258
2032	11.56	1.001	0.090	0.020	4,204
2033	11.54	0.930	0.086	0.020	4,151
2034	11.53	0.860	0.081	0.020	4,097
2035	11.51	0.789	0.077	0.019	4,044
2036	11.49	0.719	0.072	0.019	3,990
2037	11.48	0.648	0.068	0.018	3,936
2038	11.46	0.578	0.063	0.018	3,883
2039	11.45	0.507	0.059	0.018	3,829
2040	11.43	0.436	0.054	0.017	3,776
2041	11.42	0.435	0.054	0.017	3,770
2042	11.41	0.433	0.053	0.017	3,765

Based on MOVES average annual emission factors for trucks in Elko County, Nevada. Assuming idling trucks have the same emissions profile as trucks traveling at 2.5 miles per hour. MOVES model run in July 2023.

Year	Idling Vehicle Emissions - Trucks (grams/hour)				Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	
2043	11.39	0.432	0.053	0.017	3,760
2044	11.38	0.431	0.053	0.017	3,755
2045	11.37	0.429	0.052	0.017	3,750
2046	11.35	0.428	0.052	0.017	3,745
2047	11.34	0.426	0.051	0.017	3,740
2048	11.33	0.425	0.051	0.017	3,734
2049	11.32	0.423	0.050	0.017	3,729
2050	11.30	0.422	0.050	0.017	3,724
2051	11.30	0.421	0.050	0.017	3,723
2052	11.29	0.420	0.049	0.017	3,723
2053	11.29	0.419	0.049	0.017	3,722
2054	11.28	0.419	0.049	0.017	3,721
2055	11.28	0.418	0.048	0.017	3,720
2056	11.27	0.417	0.048	0.017	3,719

Table 33: Emission Factors – Idling School Buses

Year	Idling Vehicle Emissions - School Buses (grams/hour)				Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	
2023	13.68	2.718	0.399	0.027	5,341
2024	13.00	2.495	0.361	0.027	5,281
2025	12.33	2.272	0.323	0.026	5,221
2026	11.66	2.049	0.285	0.026	5,162
2027	10.99	1.826	0.247	0.026	5,102
2028	10.32	1.603	0.209	0.026	5,042
2029	9.65	1.380	0.171	0.025	4,983
2030	8.98	1.157	0.133	0.025	4,923
2031	8.85	1.117	0.125	0.025	4,886
2032	8.73	1.078	0.117	0.025	4,848
2033	8.60	1.038	0.109	0.025	4,811
2034	8.47	0.998	0.101	0.025	4,773
2035	8.35	0.958	0.094	0.024	4,736
2036	8.22	0.918	0.086	0.024	4,699
2037	8.10	0.879	0.078	0.024	4,661
2038	7.97	0.839	0.070	0.024	4,624
2039	7.85	0.799	0.062	0.024	4,587
2040	7.72	0.759	0.054	0.024	4,549
2041	7.71	0.758	0.053	0.023	4,534
2042	7.71	0.756	0.053	0.023	4,519
2043	7.70	0.754	0.052	0.023	4,503
2044	7.70	0.753	0.052	0.023	4,488
2045	7.69	0.751	0.052	0.023	4,473
2046	7.69	0.749	0.051	0.023	4,458
2047	7.68	0.748	0.051	0.023	4,442
2048	7.68	0.746	0.051	0.023	4,427
2049	7.67	0.744	0.050	0.023	4,412

Based on MOVES average annual emission factors for school buses in Elko County, Nevada. Assuming idling school buses have the same emissions profile as school buses traveling at 2.5 miles per hour. MOVES model run in July 2023.

Year	Idling Vehicle Emissions - School Buses (grams/hour)				Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	
2050	7.67	0.743	0.050	0.023	4,397
2051	7.67	0.743	0.050	0.023	4,395
2052	7.67	0.743	0.050	0.023	4,394
2053	7.67	0.743	0.050	0.023	4,392
2054	7.67	0.743	0.050	0.023	4,391
2055	7.67	0.744	0.050	0.023	4,389
2056	7.67	0.744	0.050	0.023	4,388

9.4 Emission Factors – Shuttle Buses

Table 34: Emission Factors – Shuttle Buses

Year	Emission Factors – Shuttle Buses (grams/mile)					Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	CO ₂	
2023	4.27	0.857	0.096	0.009	1,874	Based on MOVES average annual emission factors for shuttle buses in Elko County, Nevada. Assuming shuttle buses are traveling at 20 mph. MOVES model run in July 2023.
2024	4.06	0.830	0.088	0.009	1,859	
2025	3.84	0.803	0.079	0.009	1,845	
2026	3.63	0.776	0.070	0.009	1,830	
2027	3.41	0.749	0.061	0.008	1,816	
2028	3.20	0.723	0.052	0.008	1,801	
2029	2.98	0.696	0.043	0.008	1,786	
2030	2.77	0.669	0.034	0.008	1,772	
2031	2.72	0.662	0.032	0.008	1,760	
2032	2.67	0.656	0.030	0.008	1,749	
2033	2.62	0.649	0.028	0.008	1,737	
2034	2.57	0.643	0.026	0.008	1,726	
2035	2.52	0.636	0.024	0.008	1,714	
2036	2.48	0.629	0.022	0.008	1,702	
2037	2.43	0.623	0.020	0.008	1,691	
2038	2.38	0.616	0.017	0.008	1,679	
2039	2.33	0.610	0.015	0.008	1,668	
2040	2.28	0.603	0.013	0.008	1,656	
2041	2.28	0.603	0.013	0.008	1,652	
2042	2.27	0.603	0.013	0.008	1,647	
2043	2.27	0.603	0.013	0.008	1,642	
2044	2.27	0.602	0.013	0.008	1,637	
2045	2.27	0.602	0.013	0.007	1,633	
2046	2.27	0.602	0.013	0.007	1,628	
2047	2.26	0.602	0.013	0.007	1,623	
2048	2.26	0.602	0.013	0.007	1,619	
2049	2.26	0.601	0.013	0.007	1,614	
2050	2.26	0.601	0.013	0.007	1,609	
2051	2.26	0.601	0.013	0.007	1,609	
2052	2.26	0.602	0.013	0.007	1,608	
2053	2.26	0.602	0.013	0.007	1,607	



Year	Emission Factors – Shuttle Buses (grams/mile)					Source/Comment
	NO _x	VOC	PM _{2.5}	SO ₂	CO ₂	
2054	2.26	0.602	0.013	0.007	1,607	
2055	2.26	0.602	0.013	0.007	1,606	
2056	2.26	0.602	0.013	0.007	1,605	