

Appendix Item:
Sterling Highway Phase 1B Benefit Cost Analysis

**Benefit-Cost Analysis Supplementary
Documentation**
BUILD Grants Program

Phase 1B of Sterling Highway MP 45 - 60 Project

*Alaska Department of Transportation and Public Facilities,
Alaska*

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Benefit-Cost Analysis Supplementary Documentation

1. Executive Summary

The Benefit-Cost Analysis (BCA) conducted for this BUILD grant application compares the societal benefits associated with the proposed investment to the cost of the project. To the extent possible, benefits have been monetized. A qualitative discussion is also provided when a benefit is anticipated to be generated but is not easily monetized or quantified.

The project for which this BCA is conducted is Phase 1B of the Sterling Highway MP 45-60 project. Phase 1B will rebuild the existing highway between Mile Posts 45-47 to meet current design standards. The project would also add westbound passing and eastbound passing lanes, and a pedestrian / cycling path.

As part of the National Highway System (NHS), Sterling Highway is the only road connecting the western Kenai Peninsula communities with the rest of Alaska. The highway facilitates overland travel between local cities, ports and airports. In addition, the highway serves the large influx of summer visitors to the world-class fishery in the project area. Sterling Highway (MP 37-75) was identified by the State of Alaska as a State Scenic byway in recognition of its scenery, natural setting, recreational activities, historic significance, and wildlife viewing opportunities.

Sterling Highway was constructed in the 1940s and paved in the 1950s. It is now well beyond its design life and inadequate for the level of traffic it now carries. Currently, Sterling Highway MP 45-47 is a curvy constrained alignment with limited passing opportunities, and recent traffic growth has led to considerable congestion, which is forecast to worsen in the future years. Traffic analysis conducted for the Sterling Highway MP 45-60 EIS shows that during the summer months, Sterling Highway MP 45-47 operates at Level of Service (“LOS”) grade D.

Within the Phase 1B limits, relatively high volumes of pedestrians and cyclists are present due to the high demand for the recreational areas and activities in the area. Currently, pedestrians and cyclists travel on the roadside, as no facilities exist for non-motorized users. A separated pedestrian and cycling trail is proposed as part of the Phase 1B improvements.

Phase 1B will alleviate congestion on Sterling Highway MP 45-47 and accommodate the growing number of tourists expected at Cooper Landing during the summer months. The proposed project will also reduce existing conflicts between the roadway and private driveways by reducing the number of private driveways that have access to the new highway. Additionally, the project will also widen the lanes and shoulders, and straighten sections of the road. These improvements will decrease the expected number of collisions, improve safety, and reduce the probability of hazardous materials spill.

The table below summarizes the expected impacts and associated benefits of the project. It includes brief descriptions of both monetized and non-monetized benefits.

Table ES-1: Merit Criteria and Cost-Effectiveness - Summary of Infrastructure Improvements and Associated Benefits, in Millions of Discounted 2018 Dollars

Current Status or Baseline & Problems to Be Addressed	Changes to Baseline / Alternatives	Type of Impacts	Benefits	Summary of Results (Discounted 2018\$)
<p>The Sterling Highway is a major travel corridor for the Kenai Peninsula and is the only road connection to the Western Kenai Peninsula. Sterling Highway is currently a two-lane highway with 11-foot lanes and deficient shoulders (0-2 feet wide). This portion of the highway (Phase 1B) lacks shoulders and recommended sight distances at corners and over hills.</p>	<p>Construction of the Phase 1B segment of Sterling Highway MP 45-50 would rebuild the existing highway to meet current standards, and add a westbound and eastbound passing lanes, providing safety and mobility improvement. The project would also add a multi-use pathway.</p>	Reduced congestion, increases speeds and reduced travel time for users of Sterling Highway	Reduced Travel Time Cost	\$18.17
		Reduced number of collisions	Improved Safety and Avoided Accident Costs	\$10.61
		Fuel and non-fuel operating costs from increased speeds	Reduced Vehicle Operating Cost	\$0.53
		Reduced emissions as a result of increased speed in the build case	Avoided Emission Costs	\$0.03
		State of good repair due to replacing current highway	Residual Value of Investment	\$2.10
		Reduction in the costs of maintenance and repair of road	O&M Savings	\$0.81
		Protect the Kenai River from potential environmental damage	Decrease Potential Environmental Damage	\$11.56
		Removal of current load restriction	State of Good Repair	NA
		The project will bring major renewal to aging road, upgrading it to modern design		
		Decrease of avalanche damage cost	Improved Safety and Avoided Accident Costs	NA
		Installation of highway culverts, will re-direct the melting water from avalanches and reduce the number of day with black ice	Improved Safety and Avoided Accident Costs	NA
		Provide better access to recreational opportunities for more users	Improved Connectivity	NA
		Improved connectivity from multi-use trail		

In addition to benefits that can be monetized and quantified, a number of qualitative benefits are also likely to be generated by the project. Phase 1B of the Sterling Highway project will improve the connection between the Kenai Peninsula and the broader region, and support economic growth in the region.

The period of analysis used in the monetization of benefits and costs corresponds to 35 years, including five years of project development and construction and 30 years of operation. The total project costs are estimated at \$54.5 million in 2020 dollars. For the purpose of the BCA,

costs were de-escalated to 2018 using the GDP deflator. The total 2018 (undiscounted) project costs are estimated at \$52.4 million.

All relevant data and calculations used to derive the benefits and costs of the project are shown in the BCA model that accompanies this grant application. Based on the analysis presented in the rest of this document, the project is expected to generate \$43.81 million in discounted benefits, and \$43.56 million in discounted capital costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of \$0.24 million and a Benefit/Cost Ratio of 1.01 as shown below in Table ES- 2.

Table ES- 1: Summary of BCA Outcomes, in Millions of Dollars of 2018

Project Evaluation Metric	Undiscounted	Present Value at 7% Discount Rate	Present Value at 3% Discount Rate
Total Benefits	\$160.95	\$43.81	\$86.76
Total Costs	\$52.43	\$43.56	\$48.33
Net Present Value	\$108.52	\$0.24	\$38.42
Benefit / Cost Ratio	3.07	1.01	1.79
Internal Rate of Return (%)	3.54%		

Brief descriptions of the benefits that cannot be easily monetized are provided below:

State of Good Repair

- The project will bring major renewal to an aging road, upgrading it to modern design.
- Currently the project is rated at 85% load maximum. The Project would remove the load restriction currently in place, and support efficient goods movement.

Improvement in System Reliability

- Reduction in traffic congestion typically improve the reliability of travel times. Reliability will also improve as a result of a reduction in the number of accidents and corresponding delays when lanes are blocked with the involved vehicles.

Improved Connectivity

- Connectivity for cycling would be improved in the project area through the provision of wide shoulders, as well as the construction of a multi-use path.

Economic Competitiveness

- The Kenai Rivers is a major draw for both tourists and in state visitors. Salmon fishing, trout fishing, and rafting are popular activities. Combined with the lake, river, and mountain scenery, these activities drive much of the local economy. This project would provide better access to recreational activities for more users, thus contributing to local economic development and growth.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the Sterling Highway MP 45-47 Phase 1B project:

- Section 3, Methodological Framework, introduces the conceptual framework used in the BCA;
- Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the Phase 1B of Sterling Highway project is expected to generate;
- Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projections;
- Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates;
- Estimates of the project's net present value (NPV), its benefit-cost ratio (BCR) and other project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes;
- Section 9, provides the outcomes of the sensitivity analysis. Additional data tables are provided within the BCA model including annual estimates of benefits and costs to assist the U.S. Department of Transportation (U.S. DOT) in its review of the application;¹ and
- Section 10, Summary of Benefits and Costs, presents a summary table of the benefits and costs of the project.

3. Methodological Framework

The Benefit-Cost Analysis (BCA) conducted for this project includes the monetized benefits and costs measured following USDOT guidance, as well as the quantitative and qualitative merits of the project. A BCA provides estimates of the anticipated benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. 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.²

¹ While the models and software themselves do not accompany this appendix, they are provided separately as part of the application.

² USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020.

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

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

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits with respect to the selection criteria identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects; and
- Discounting future benefits and costs with the real discount rates recommended by USDOT (7 percent, and 3 percent for sensitivity analysis).

4. Project Overview

Sterling Highway is located on the western Kenai Peninsula in South central Alaska. Sterling Highway is the only road connecting the western Kenai Peninsula communities with the rest of Alaska. The Highway serves local, and growing seasonal traffic at Cooper Landing, including a large influx of summer visitors to the project area. The grant proposal is for Phase 1B of the overall Sterling Highway MP 45-60 project.

³ Ibid.

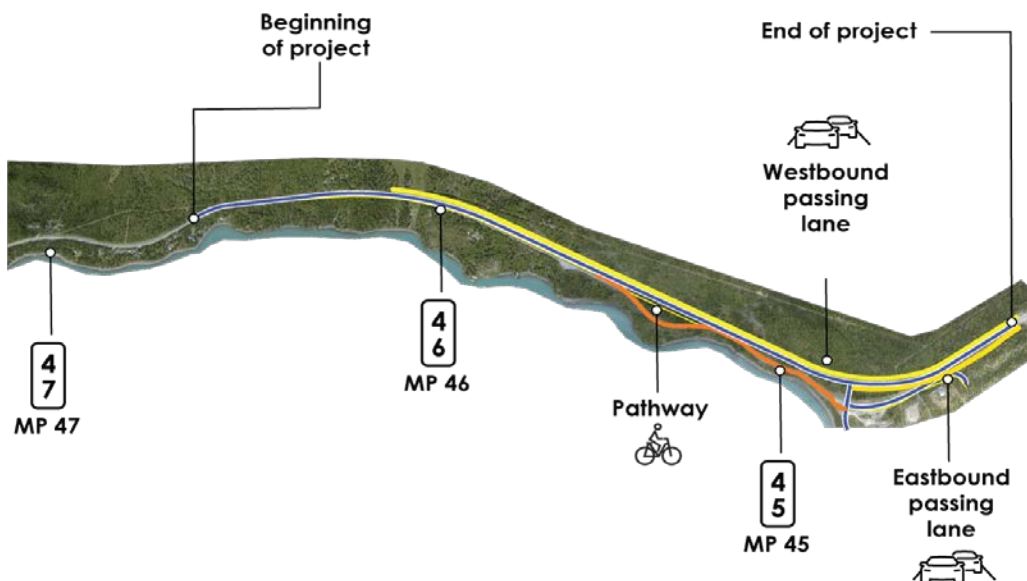


Figure 1. Phase 1B

Currently, Sterling Highway MP 45-47 is a curve constrained alignment with limited passing opportunities and increasing traffic volumes. This has recently led to considerable congestion, and congestion is forecast to worsen in the future years. Traffic analysis conducted for the Sterling Highway MP 45-60 EIS shows that during the summer months, Sterling Highway MP 45-47 operates at Level of Service (“LOS”) grade D.

The existing characteristics of the highway do not meet current design standards for a rural principal arterial road. This portion of the highway is narrow and curvy, with steep grades. It lacks sufficient shoulders, and available sight distances are inadequate.

Phase 1B of Sterling Highway MP 45-60 project is 2.5 miles, between MP 45 to 47 of the Highway. This project will:

- Widen the two traffic lanes from 11 foot lanes to 12 foot lanes;
- Widen the shoulders from 0-2 feet to 8 feet;
- Add a 12 foot westbound passing lane that transitions to an eastbound passing lane;
- Add a pedestrian / cycling trail;
- Significant “straightening” of the road;
- Reduce the number of private driveways that have access to the highway;
- Install highway culverts;
- Install additional signage;
- Construct a three legged stop-controlled intersection; and

- Increase the posted speed from 40 mph to 60 mph.

Phase 1B will alleviate congestion on Sterling Highway MP 45 – 47 and accommodate the growing number of tourists expected at Cooper Landing during the summer months. The proposed project will reduce conflicts between the highway and private driveways by reducing the number of private driveways that have access to the highway. Additionally, the proposed lane and shoulder widening, and road straightening will decrease the expected number of crashes and improve safety.

1. Base Case and Alternatives

The Base Case for Phase 1B of the Sterling Highway Project is defined as a No-Build scenario. The No-Build scenario reflects the continuation of current conditions. MP 45 – 47 of Sterling Highway will not be re-built and no additional investments are made in the project location, with current conditions remaining constant.

The Build scenario assumes that MP 45 – 47 of Sterling Highway will be re-built as planned and described above. While there are plans to depart from the current highway at MP 47 and construct a new highway that returns to the current highway at MP 55, this segment is not considered in the analysis.

4.2 Types of Impacts

Phase 1B of the Sterling Highway Project will re-build the current highway between MP 45 – 47, and add a passing lane which will significantly reduce congestion and travel times. The construction of the passing lane and the straightening of the road can be expected to generate accident cost savings benefits to travelers. Over the lifecycle of the analysis, the project will save an estimated 4.17 million person hours. The project will help avoid 2.4 fatal, 11.6 major injury, 49 minor injury, and 94 Property Damage Only (PDO) collisions.

4.3 Project Cost and Schedule

Total project development and construction costs are estimated at \$54.5 million in 2020 dollars. For the purpose of this BCA, all costs were de-escalated to 2018 dollars using the GDP deflator⁴. The adjusted cost is \$52.4 million in 2018 undiscounted dollars and \$43.6 million discounted at 7%. The design process is currently underway, and is anticipated to be completed by 2021. Construction is scheduled to start in 2021 and be completed by 2023. Over the project life-cycle, total operations and maintenance costs are estimated at -\$1.3 million discounted at 7%.

Table 1: Cost Summary Table, 2018 Dollars⁵

Calendar Year	Total Cost	Incremental O&M Expenditure
2019	\$961,981	\$0

⁴ The adjustment amounted to dividing 2020 costs by the deflator index of 1.0395 based on the GDP deflator for the years 2018 – 2020 (Office of Management and Budget of the White House, Table 10.1, <https://www.whitehouse.gov/omb/historical-tables/>)

⁵ All cost estimates in this section are in millions of discounted 2018 dollars, discounted to this year using a 7 percent real discount rate.

Calendar Year	Total Cost	Incremental O&M Expenditure
2020	\$2,404,953	\$0
2021	\$12,505,755	\$0
2022	\$28,859,435	-\$520,000
2023	\$7,695,849	\$0
2024	\$0	\$0
2025	\$0	\$0
2026	\$0	\$0
2027	\$0	-\$520,000
2028	\$0	\$0
2029	\$0	\$0
2030	\$0	\$0
2031	\$0	\$0
2032	\$0	-\$520,000
2033	\$0	\$780,000
2034	\$0	\$0
2035	\$0	\$0
2036	\$0	\$0
2037	\$0	-\$520,000
2038	\$0	\$0
2039	\$0	\$0
2040	\$0	\$0
2041	\$0	\$0
2042	\$0	-\$520,000
2043	\$0	\$780,000
2044	\$0	\$0
2045	\$0	\$0
2046	\$0	\$0
2047	\$0	-\$520,000
2048	\$0	\$0
2049	\$0	\$0
2050	\$0	\$0
2051	\$0	\$0
2052	\$0	-\$520,000
2053	\$0	\$780,000
Total	\$52,427,973	-\$1,300,000

4.4 Effect on Selection Criteria

The main benefit categories associated with the project are mapped into the selection criteria set forth by USDOT in the Notice of Funding Opportunity, and are shown in the table below.

Table 2: Expected Effects on Benefit Categories

Primary Selection Criteria	Benefit or Impact Categories	Description	Monetized	Qualitative
Economic Vitality	Reduced Travel Time Costs	Improved congestion and travel times due to additional capacity with road widened and straightened, allowing drivers to travel at faster speeds	Yes	
	Vehicle Operating Costs	Fuel operating cost savings from increased speeds	Yes	
	Removal of Current Load Restriction	Removal of the current Highway load restriction		Yes
Safety	Improved Safety and Avoided Accident Costs	Improved safety from widening the outside shoulder to improve roadway conditions and adding passing lane to improve congestion.	Yes	
	Decrease in Avalanche damage cost	Installation of additional signage		Yes
	Reduction of Day with Black Ice	Installation of highway gutter, will re-direct the melting water from avalanches and reduce the number of day with black ice		Yes
State of Good Repair	Residual Value of Investment	State of good repair due to replacing and improving road	Yes	
	Renewal of Aging Infrastructure	The project will bring major renewal to aging road, upgrading it to modern design		Yes
Environmental Protection	Decrease Potential Environmental Damage	Decrease Probability of Potential Future Spill of Hazardous Materials	Yes	
	Emissions Costs	Reduced emissions as a result of increased speeds in the build case	Yes	
Quality of Life	Improved connectivity	Provide better access to recreational opportunities for more users		Yes
		Improved connectivity from multi-use trail		
	Restore the Cooper Landing Community	Enhance the small town experience		Yes

5. General Assumptions

The BCA measures benefits against costs through a period of time, beginning at the start of construction and including 30 years of operations.

The monetized benefits and costs are estimated in 2018 dollars with future dollars discounted in compliance with BUILD requirements using a 7 percent real rate, and sensitivity testing using a 3 percent rate.

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

- Input prices are expressed in 2018 dollars;
- The period of analysis begins in 2019 and ends in 2053. It includes project development and construction years (2019 - 2023) and 30 years of operations (2024 - 2053);
- A constant 7 percent real discount rate is assumed throughout the period of analysis. A 3 percent real discount rate is used for sensitivity analysis;
- Opening year demand and benefits are inputs to the BCA and assumed to be fully realized after construction is finished in 2024 (no ramp-up); and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Build alternative.

6. Demand Projections

Accurate demand projections are needed to effectively estimate the benefits in a BCA. Demand projections for this project were estimated based on current and future Average Annual Daily Traffic (AADT) estimates.

6.1 Methodology

Current traffic volumes (2019), including the share of truck and RV traffic, as well as estimates of future traffic (for year 2043) were provided by the Alaska Department of Transportation and Public Facilities (Alaska DOT&PF). These traffic volumes were converted to represent monthly peak and off-peak seasonal AADT conversion factors. The factors were calculated using the Sterling Highway Milepost 45 to 60 – 2014 Traffic Study Update.

The implied traffic growth rate was used to interpolate volumes for the years in-between 2019 and 2043, and extrapolate volumes beyond 2043 until the end of the analysis period in 2053. The same traffic volumes are assumed for the Build and No-Build scenarios.

6.2 Assumptions

The assumptions used to calculate demand projections are shown below.

Table 3: Assumptions used in the Estimation of Demand

Variable Name	Unit	Value	Source
Traffic Volume (2019)	AADT	4450	Alaska Department of Transportation
Traffic Volume (2043)	AADT	5764	
Average Annual Rate of Growth	Percent	1%	
Share of Trucks	Percent	7%	
Share of RVs	Percent	17%	
Share of AADT - May	Percent	106.62%	Sterling Highway Milepost 45 to 60 – 2014 Traffic Study Update
Share of AADT - June	Percent	163.09%	
Share of AADT - July	Percent	256.36%	
Share of AADT - August	Percent	175.88%	
Share of AADT - September	Percent	114.55%	

Variable Name	Unit	Value	Source
Share of AADT - Off-Peak Months	Percent	54.76%	
Alpha		4	Parameters determined based on calibrating speed curve to local projected conditions on Sterling Highway MP 45 to MP 47
Beta		4	
Constant		2.00	
Lane Capacity	vehicles/hour/lane	1,300	Sterling Highway Milepost 45 to 60 – 2014 Traffic Study Update
Number of Peak Hours	hours	8.00	

6.3 Demand Projections

The resulting projections for average daily traffic and peak traffic are presented in the Table 4. Speeds were calculated after calibrating a speed curve to local projected conditions found in the Sterling Highway Milepost 45 to 60 – 2014 Traffic Study Update, and are shown in Figure 2. Once the capacity parameters were identified, traffic volumes for peak and off-peak tourism months were used to calculate the corresponding speed by year and peak period. The project is scheduled to open in 2024 and provides significant speed gains compared to the no build case.

Figure 2. Calibrated Speed Curve and Parameters

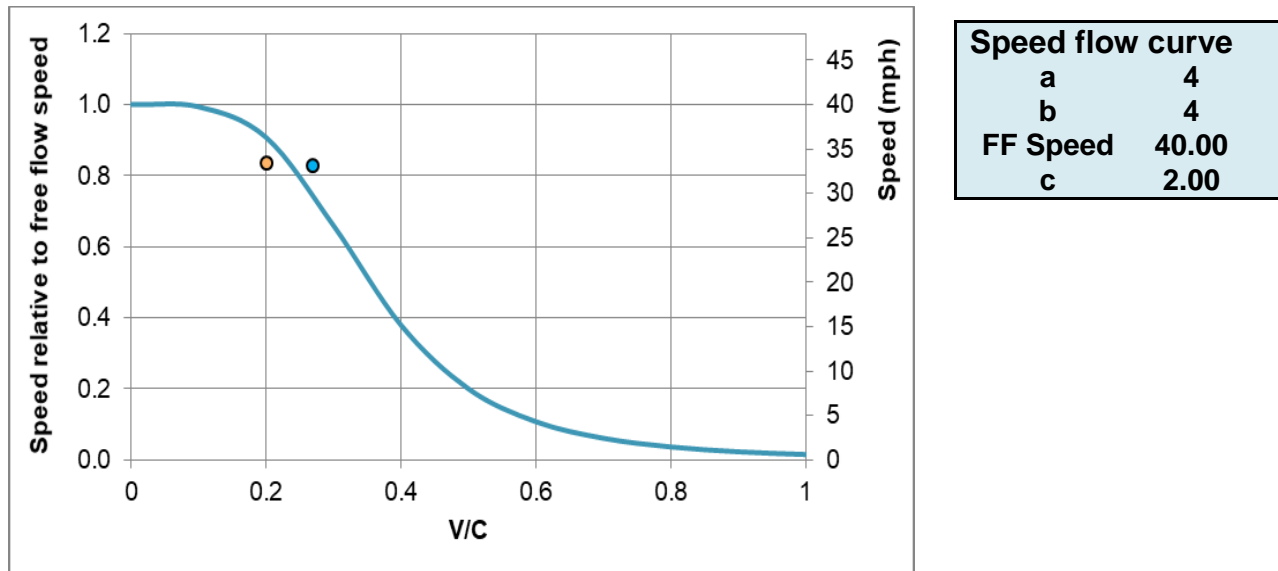


Table 4 : Demand Projections

		In Project Opening Year (2024)	2034	2044	2053
May					
No Build	Peak ADT	2922	3228	3566	3900
	Off-Peak ADT	2064	2280	2519	2755
	Peak Average Speed	39.03	38.57	37.90	37.07

		In Project Opening Year (2024)	2034	2044	2053
	Off-peak Average Speed	39.98	39.98	39.97	39.95
Build	Peak ADT	2922	3228	3566	3900
	Off-peak ADT	2064	2280	2519	2755
	Peak Average Speed	59.71	59.56	59.35	59.08
	Off-peak Average Speed	60.00	59.99	59.99	59.99
June					
No Build	Peak ADT	4470	4937	5454	5965
	Off-Peak ADT	3158	3488	3853	4214
	Peak Average Speed	35.20	33.24	30.71	27.92
	Off-peak Average Speed	39.92	39.87	39.81	39.73
Build	Peak ADT	4470	4937	5454	5965
	Off-peak ADT	3158	3488	3853	4214
	Peak Average Speed	58.42	57.68	56.62	55.27
	Off-peak Average Speed	59.97	59.96	59.94	59.92
July					
No Build	Peak ADT	7026	7761	8573	9377
	Off-Peak ADT	4964	5483	6057	6625
	Peak Average Speed	21.82	17.85	14.05	10.98
	Off-peak Average Speed	39.49	39.24	38.88	38.42
Build	Peak ADT	7026	7761	8573	9377
	Off-peak ADT	4964	5483	6057	6625
	Peak Average Speed	51.52	48.19	43.96	39.42
	Off-peak Average Speed	59.85	59.77	59.66	59.52
August					
No Build	Peak ADT	4820	5325	5882	6433
	Off-Peak ADT	3406	3762	4156	4545
	Peak Average Speed	33.77	31.38	28.38	25.23
	Off-peak Average Speed	39.89	39.83	39.75	39.64
Build	Peak ADT	4820	5325	5882	6433
	Off-peak ADT	3406	3762	4156	4545
	Peak Average Speed	57.89	56.91	55.51	53.78
	Off-peak Average Speed	59.97	59.95	59.92	59.89
September					
No Build	Peak ADT	3139	3468	3831	4190
	Off-Peak ADT	2218	2450	2706	2960
	Peak Average Speed	38.71	38.12	37.26	36.19
	Off-peak Average Speed	39.98	39.97	39.95	39.93
Build	Peak ADT	3139	3468	3831	4190
	Off-peak ADT	2218	2450	2706	2960

		In Project Opening Year (2024)	2034	2044	2053
	Peak Average Speed	59.61	59.42	59.14	58.78
	Off-peak Average Speed	59.99	59.99	59.99	59.98
Off-peak Months					
No Build	Peak ADT	1501	1658	1831	2003
	Off-Peak ADT	1060	1171	1294	1415
	Peak Average Speed	39.93	39.90	39.85	39.78
	Off-peak Average Speed	40.00	40.00	40.00	40.00
Build	Peak ADT	1501	1658	1831	2003
	Off-peak ADT	1060	1171	1294	1415
	Peak Average Speed	59.98	59.97	59.95	59.93
	Off-peak Average Speed	60.00	60.00	60.00	60.00

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each quantifiable benefit or impact category identified in Table 2 and provides an overview of the associated methodology, assumptions, and estimates.

The benefits assessed for the Phase 1B of the Sterling Highway MP45-60 project are the following:

- **Travel Time Savings:** captures the reduced travel time for automobiles, RVs, and trucks under the build scenario as a result of increased average speeds.
- **Vehicle Operating Cost Savings:** captures the reduced vehicle operating costs for automobiles, RVs, and trucks under the build scenario as a result of increased speeds.
- **Emission Cost Savings:** captures the emissions reduction for automobiles and trucks under the build scenario as a result of increases in the average speed.
- **Accident Cost Savings:** captures the expected reduction in accident cost savings under the build scenario as a result of re-building the highway to meet current highway design standards.
- **Reduced Risk of Spills:** captures the expected reduction on the probability of hazardous material spill as a result of re-building the highway to meet current highway design standards.
- **Residual Value:** captures the benefits associated with remaining life of the re-construction of the road.

The general assumptions used in the estimation of the benefits for the Phase 1B Sterling Highway MP 45-60 project are summarized in the table below.

Table 5: General Assumption Used in the Benefit-Cost Analysis

Variable Name	Unit	Value	Source
---------------	------	-------	--------

Variable Name	Unit	Value	Source
Discount Rate	%	7%	U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020
Project Development Begins	Year	2019	Project Schedule
Project Opens	Year	2024	
Operational Period of Analysis	Years	30	U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020
Days in May	Days	31	Known
Days in June	Days	30	
Days in July	Days	31	
Days in August	Days	31	
Days in September	Days	30	
Days in Off-peak Tourism Months	Days	212	
Peak hours	Hours	8	Calculated from the Sterling Highway Milepost 45 to 60 – 2014 Traffic Study Update
Percent of Traffic in Peak Period	%	58.6%	
Percent Trucks	%	7%	Alaska Department of Transportation and Public Facilities
Percent RVs	%	17%	
Percent Automobiles	%	76%	

7.1 Travel Time Benefits

Travel time saving captures the reduced travel time for automobile, RVs, and trucks under the Build scenario due to the increased average speed. Changes in travel time between the build and no build case were monetized using USDOT guidance for the value of time for trucks and automobiles.

The construction of the westbound passing lane would generate additional travel time savings, by enabling vehicles to more readily pass heavy or slow vehicles, and thereby improving the flow of traffic for the general traffic stream.

7.1.1 METHODOLOGY

Travel time savings are calculated based on the vehicle hours travelled as determined by the annual traffic, segment length, and segment speed. Average daily traffic was broken out to peak tourism months and off-peak tourism months. These values were further broken out to peak and off-peak times to calculate actual speeds during these two periods based on the roadway capacity.

Annual vehicle miles were determined based on AADT and the segment length, and vehicle hours travelled were generated by dividing the vehicle miles travelled by average speed. Annual vehicle hours were broken out to truck hours, RV hours, and automobile hours to account for the differences in the value of time for the different types of vehicles. The vehicle hours travelled were then converted to person hours, based on the vehicle occupancy recommended in the USDOT guidance. These person hours were then monetized using the USDOT guidance for the value of time.

In order to capture the travel time saving generated by the construction of the westbound passing lane, Cal-BC's "Passing Lane" model was used. The annual traffic volume, segment length, and segment speed were used as key inputs.

7.1.2 ASSUMPTIONS

In addition to the general assumptions listed above, the following assumptions were used in the estimation of travel time benefits.

Table 6: Assumptions used in the Estimation of Travel Time Savings

Variable Name	Unit	Value	Source
Average Vehicle Occupancy - Auto	people/vehicle	1.67	2017 National Household Travel Survey
Average Vehicle Occupancy - RVs	people/vehicle	1.83	
Average Vehicle Occupancy - Trucks	people/vehicle	1.00	
Value of Time - Auto	\$/hr	\$15.2	USDOT BCA Guidance 2020 (\$2018)
Value of Time - Truck	\$/hr	\$29.5	

7.1.3 BENEFITS ESTIMATES

The table below shows the benefit estimates calculated over the life cycle of the project, due to the travel speed increases associated with the build case. At a 7% discount rate, travel time benefits are \$18.2 million over the project lifecycle.

Table 7: Estimates of Travel Time Benefits, Millions of 2018 Dollars

	Over the Project Lifecycle		
	Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Travel Time Savings	\$64.5	\$18.2	\$35.5

7.2 Vehicle Operating Cost Benefits

Vehicle operating costs, which are calculated on a per mile basis, examine the difference in speed travelled between the build and no build case and represent the second category of benefits.

7.2.1 METHODOLOGY

Fuel savings were calculated based on the breakout of annual vehicle miles by trucks, RVs, and automobiles. Given the average speed in the Build and No Build cases, fuel consumption rates per mile were applied. The values were then multiplied by the retail price of diesel and gasoline as provided by the EIA in the Annual Energy Outlook 2018, less taxes to determine annual fuel costs.

In order to capture the impact of the construction of the westbound passing lane, Cal-BC's "Passing Lane" model was used. The annual traffic volume, segment length, and segment speed were used as key inputs.

7.2.2 ASSUMPTIONS

The following assumptions were used to estimate the vehicle operating cost benefits.

Table 8: Assumptions used in the Estimation of Vehicle Operating Cost Benefits

Variable Name	Unit	Year	Value	Source
Gasoline Retail Price	2018 \$/gallon	2019	\$2.09	Annual Energy Outlook 2018 Release; Gasoline sales weighted-average price for all grades. Excludes Federal, State, and Local taxes. Prices are assumed constant past 2050 due to uncertainty and to allow estimates to be made conservatively.
		2020	\$2.07	
		2021	\$2.07	
		2022	\$2.08	
		2023	\$2.07	
		2024	\$2.04	
		2025	\$2.07	
		2026	\$2.10	
		2027	\$2.13	
		2028	\$2.15	
		2029	\$2.19	
		2030	\$2.27	
		2031	\$2.30	
		2032	\$2.32	
		2033	\$2.38	
		2034	\$2.42	
		2035	\$2.46	
		2036	\$2.49	
		2037	\$2.51	
		2038	\$2.54	
		2039	\$2.58	
		2040	\$2.60	
		2041	\$2.62	
		2042	\$2.67	
		2043	\$2.70	
		2044	\$2.72	
		2045	\$2.77	
		2046	\$2.78	
		2047	\$2.83	
		2048	\$2.87	
2049	\$2.90			
2050	\$2.93			
2051	\$2.93			
2052	\$2.93			
2053	\$2.93			
Diesel Retail Price	2018 \$/gallon	2019	\$2.41	Annual Energy Outlook 2018 Release; Gasoline sales weighted-average price
		2020	\$2.31	
		2021	\$2.33	

Variable Name	Unit	Year	Value	Source
		2022	\$2.37	for all grades. Excludes Federal, State, and Local taxes. Prices are assumed constant past 2050 due to uncertainty and to allow estimates to be made conservatively.
		2023	\$2.40	
		2024	\$2.46	
		2025	\$2.48	
		2026	\$2.54	
		2027	\$2.55	
		2028	\$2.60	
		2029	\$2.64	
		2030	\$2.71	
		2031	\$2.75	
		2032	\$2.77	
		2033	\$2.83	
		2034	\$2.86	
		2035	\$2.90	
		2036	\$2.93	
		2037	\$2.96	
		2038	\$2.99	
		2039	\$3.03	
		2040	\$3.03	
		2041	\$3.06	
		2042	\$3.11	
		2043	\$3.14	
		2044	\$3.17	
		2045	\$3.22	
		2046	\$3.23	
		2047	\$3.26	
		2048	\$3.30	
		2049	\$3.32	
		2050	\$3.35	
		2051	\$3.35	
		2052	\$3.35	
		2053	\$3.35	

7.2.3 BENEFITS ESTIMATES

The table below shows the benefit estimates calculated over the life cycle of the project. At a 7% discount rate, vehicle operating cost benefits are \$0.5 million over the project lifecycle.

Table 9: Estimates of Vehicle Operating Cost Benefits, Millions of 2018 Dollars

	Over the Project Lifecycle		
	Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent

	Over the Project Lifecycle		
	Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Vehicle Operating Cost Benefits	\$2.2	\$0.5	\$1.1

7.3 Accident Cost Benefits

Safety benefits include reductions in the expected number of collisions due to highway straightening, adding a passing lane, and the construction of a three-legged stop-controlled intersection. The new road will also have wider lanes and shoulders, further contributing to collision reductions in the Build scenario.

7.3.1 METHODOLOGY

Road Safety

As part of the Sterling Highway MP 45-60 Environmental Impact Statement (EIS), collision prediction models for future collision frequency and severity were developed for the year 2043 using the Highway Safety Manual (HSM) Predictive Method⁶ for the No-Build and Build scenarios. The EIS models predict future collision frequency and severity, using the KABCO system for collision severity.⁷ The HSM models estimate the total number of collisions and the HSM's default severity distribution was used to estimate collision frequency by severity. The models' incorporated calibration factors for the state of Alaska applicable to facility types within the project limits.

The prediction models developed for the EIS were used as base models for the collision predictions within the Phase 1B limits. Proposed roadway improvements as described in the EIS for the Build scenario were assumed. For the year 2043, the prediction models incorporated a daily traffic volume of 5,650 vehicles per day for the entirety of the Phase 1B limits. A one percent annual increase in traffic volume was assumed for the analysis period.

To predict collisions for the entire analysis period, the collisions predictions for 2043 were linearly extrapolated forward for 2044-2053 and backward for 2024-2042, according to the one percent annual change in traffic volumes. In the HSM Predictive Method models for rural two-way two-lane roads, predicted collision frequency and traffic volumes are approximately linearly-related.

The HSM Predictive Method models predict collisions, not persons injured in collisions. Depending on vehicle occupancy, persons injured may be higher than the collision frequency. Data comparing the collision frequency and persons injured were gathered from the Fatality Analysis Reporting System (FARS), managed by the National Highway Traffic Safety Administration.⁸ To convert predicted collision frequency into persons injured, ratios of injuries per collision were developed. Predicted collision frequency was multiplied by the ratios to compute predicted injured persons.

⁶ *Highway Safety Manual*. American Association of State Highway Transportation Officials. 2010.

⁷ *Manual on Classification of Motor Vehicle Traffic Accidents*. American National Standards Institute. August 2007. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/07D16>

⁸ *Fatality Analysis Reporting System*. National Highway Traffic Safety Administration. Accessed 2020. <https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars>

The number of person injured per collision, by type, and the number of vehicles involved in PDO collisions, expected under No-Build versus Build scenario were monetized using the social values of accident cost by type recommended by USDOT.

Pedestrian and Cyclist Safety

According to Alaska statewide fatal collision data from 2011-2015,⁹ 15.3 percent of fatalities were pedestrians and 2.4 percent involved cyclists for the entire state. In addition to the change in predicted fatalities between the No-Build and Build scenarios, the separated trail as part of the Build scenario is assumed to reduce fatalities by 17.7 percent (15.3+2.4=17.7). Data for the percentage of serious injuries that are pedestrians and cyclists could not be found. Therefore, the same combined percentage of 17.7 percent is assumed for reductions in serious injuries due to the proposed trail. To compute the potential reduction in fatalities and serious injuries due to the separated trail, the No-Build fatality and serious injury predictions are multiplied by 17.7 percent.

7.3.2 ASSUMPTIONS

The following assumptions were used to estimate the accident cost savings.

Table 10: Assumptions used in the Estimation of Accident Cost Savings Benefits

Variable Name	Unit	Value	Source
Calibration factor - Two-lane rural highway segments	factor	1.25	Calibration of the Highway Safety Manual for the State of Alaska. Alaska Department of Transportation and Public Facilities. 2016
Calibration factor - Three-legged stop-controlled intersections	factor	0.81	
Number of Injuries per Fatal Collision	Number per Event	1.07	Calculated from Fatality Analysis Reporting System (FARS)
Number of Injuries per Major Injury Collision	Number per Event	1.23	
Number of Injuries per Minor Injury Collision	Number per Event	1.40	
Cost of a Fatal	\$/fatality	\$9,600,000	January 2020 Benefit-Cost Analysis Guidance, Table A-1 pg. 30
Cost of an Major Injury	\$/major injury	\$459,100	
Cost of Minor Injury	\$/minor injury	\$125,000	
Cost of a Property Damage Only (PDO) Collision	\$/PDO	\$4,400	The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (revised May 2015). Inflated to 2018 dollars using the GDP deflator.

7.3.3 BENEFITS ESTIMATES

The table below shows the benefit estimates calculated over the life cycle of the project, broken out by accident type. At a 7% discount rate, accident cost savings are \$10.6 million over the project lifecycle.

Table 11: Estimates of Emission Cost Benefits, Millions of 2018 Dollars

⁹ *Fatal Crash Data*. Alaska Department of Transportation and Public Facilities. 2016. <http://dot.alaska.gov/stwdp/ing/hwysafety/data.shtml>

	Over the Project Lifecycle		
	Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Fatal Collision Savings	\$23.4	\$7.0	\$13.3
Injury Collision Savings	\$11.4	\$3.4	\$6.5
PDO Collision Savings	\$0.4	\$0.1	\$0.2
Total	\$35.3	\$10.6	\$20.0

7.4 Emission Costs

The proposed project would result in an increase in speed, which is expected to marginally decrease emissions.

7.4.1 METHODOLOGY

Emission cost savings were calculated based on the speeds in the Build and No-Build cases. Emission factors from the EPA’s Motor Vehicle Emission Simulator (MOVES) for carbon dioxide, nitrogen oxides, fine particulate matter, sulfur oxides, and volatile organic compounds were applied to the vehicle miles travelled, broken out by automobile, RV, and truck, to determine the metric tons produced in each case. The value of each greenhouse gas was then applied based on the USDOT guidance, converted from dollars per short ton to dollars per metric ton.

In order to capture the impact of the construction of the westbound passing lane, Cal-BC’s “Passing Lane” model was used. The annual traffic volume, segment length, and segment speed were used as key inputs.

7.4.2 ASSUMPTIONS

The following assumptions were used to estimate the Emission Cost Savings.

Table 12: Assumptions used in the Estimation of Avoided Emissions Costs

Variable Name	Unit	Year	Value	Source
Grams/Metric Ton	grams/metric ton	2019-2053	1,000,000	Known
Volatile Organic Compounds (VOC)	\$/metric ton	2019-2053	\$2,315	The Safer Affordable Fuel-Efficient Vehicles Rule for MY2021-MY2026 Passenger Cars and Light Trucks Preliminary Regulatory Impact Analysis (October 2018)
Nitrogen Oxides (NOx)	\$/metric ton	2019-2053	\$9,480	
Fine Particulate Matter (PM)	\$/metric ton	2019-2053	\$426,925	
Sulfur Dioxide (SO2)	\$/metric ton	2019-2053	\$55,226	
Carbon Dioxide	2018 \$/Ton	2019	\$1.00	Values based on the Preliminary Regulatory Impact Analysis for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks (July 2018). Prices assumed constant past 2050 to
		2020	\$1.00	
		2021	\$1.00	
		2022	\$1.00	
		2023	\$1.00	
		2024	\$1.00	
		2025	\$1.00	
2026	\$1.00			

Variable Name	Unit	Year	Value	Source
		2027	\$1.00	account for benefits conservatively.
		2028	\$1.00	
		2029	\$1.00	
		2030	\$1.00	
		2031	\$1.20	
		2032	\$1.40	
		2033	\$1.60	
		2034	\$1.80	
		2035	\$2.00	
		2036	\$2.00	
		2037	\$2.00	
		2038	\$2.00	
		2039	\$2.00	
		2040	\$2.00	
		2041	\$2.00	
		2042	\$2.00	
		2043	\$2.00	
		2044	\$2.00	
		2045	\$2.00	
		2046	\$2.00	
		2047	\$2.00	
		2048	\$2.00	
		2049	\$2.00	
		2050	\$2.00	
		2051	\$2.00	
		2052	\$2.00	
		2053	\$2.00	

7.4.3 BENEFITS ESTIMATES

The table below shows the benefit estimates calculated over the life cycle of the project. At a 7% discount rate, emission cost savings are negligible.

Table 13: Estimates of Emission Cost Benefits, 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Emission Cost Benefits	\$93,637	\$30,435	\$54,812.45

7.5 Spill Risk

Widening the lanes and shoulders, and adding a passing lane will improve safety along the corridor and decrease the possibility of major spill of hazardous materials. According to the

Environmental Impact Statement, the proposed project would decrease the probability of a major spill of hazardous material by 50 percent. As a result, the project would avoid spilling 2,430 gallons of hazardous materials.

7.5.1 METHODOLOGY

Spill savings were broken down between clean-up cost savings and reduced tourism cost savings. Clean-up cost were calculated based on the probability of a major spill event in the Build and No Build cases. The probability was multiplied by the possible gallons per spill. These values were monetized using the clean-up cost calculated from the office of Hazardous Material Safety Incident Report Database’s HAZMAT data.

Reduced tourism cost savings were also calculated using the probability of a major spill event in the Build and No Build Cases. The probability was multiplied by the number of regional tourists to determine the number of tourists that would be affected. These values were monetized using the value Alaskans place on recreational fishing.

7.5.2 ASSUMPTIONS

The following assumptions were used to estimate the avoided spill.

Table 14: Assumptions used in the Estimation of Avoided Spill

Variable Name	Unit	Value	Source
Probability of Major Spills	%	2%	Environmental Impact Statement
Reduction of Probability of Major Spills – Build Scenario	%	50%	
Gallons per Spills	gal	8,100	
Total Clean-up Cost	\$/gallon	\$152.38	Calculated using HAZMAT data obtained from the Office of Hazardous Materials Safety Incident Report Database. Limited to report involved in Alaska after 2000.
Regional Tourists	Tourists/yr	127,000	Alaska Visitor Statistics Program (AVSP) VII by Alaska Travel Industry Association. May 2017
Value of Alaskans on recreation fishing	2018\$	\$951.38	Economic Values of Sport, Personal Use, and Commercial Salmon Fishing in Upped Cook Inlet by the Kenai River Sport fishing Association. January 2008. \$776 2016 dollars, inflated to 2018 dollars

7.5.3 BENEFITS ESTIMATES

The table below shows the benefit estimates calculated over the life cycle of the project. At a 7% discount rate, spills savings are \$11.6 million.

Table 15: Estimates of Emission Cost Benefits, Millions of 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Avoided Spills	\$36.6	\$11.6	\$21.3

7.6 Residual Value

To quantify the benefits associated with remaining life of the re-construction of the road, the residual value of the project is captured.

7.6.1 METHODOLOGY

The residual value of the re-construction of the project at the end of the analysis period is considered as a benefit. To calculate the residual value, it is assumed that the original cost of the project depreciated in a linear manner over its service life.

7.6.2 ASSUMPTIONS

The assumption used in the estimation of the residual value of the project are summarized in Table 16. The residual value is assessed in 2053, the final year of the 30-year period of operations.

Table 16: Assumptions Used in the Estimation of Residual Value

Variable Name	Unit	Value	Source
Capital Cost of the Project	\$	\$52,427,973	Alaska Department of Transportation and Public Facilities
Expected Life Span of the Project	Year	50	
Length of the Analysis	Year	30	U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020

7.6.3 BENEFITS ESTIMATES

Table 17 displays the residual value of the project at the end of the project lifecycle. The residual value of the project is \$2.10 million, discounted at 7%.

Table 17: Estimates of Residual Value Benefits, Millions of 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Residual Value	\$20.97	\$2.10	\$7.68

8. Summary of Findings and BCA outcomes

The tables below summarize the BCA findings. Annual costs and benefits are estimated over the lifecycle of the project (35 years from 2019 to 2053). As stated earlier, construction is expected to be completed by 2023. Benefits accrue during the operation of the project (over the years 2024-2043).

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 3.54 percent. With a 7 percent real discount rate, the \$43.6 million investment would result in \$43.8 million in total benefits, net present value of \$0.2 million and a Benefit/Cost ratio of approximately 1.01.

With a 3 percent real discount rate, the Net Present Value of the project \$38.4 million, for a benefit/Cost ratio of 1.79.

Table 18. Overall Results of the Benefit-Cost Analysis, Millions of 2018 Dollars

Project Evaluation Metric	Constant Dollars	Discounted at 7%	Discounted at 7%
Total Benefits	\$160.9	\$43.8	\$86.8
Total Costs	\$52.4	\$43.6	\$48.3
Net Present Value	\$108.5	\$0.2	\$38.4
Benefit-Cost Ratio	3.07	1.01	1.79
Return on Investment (%)	2.07	0.01	0.79
Payback Period (years)	12.9	>35 yr	16.9
Internal Rate of Return (%)	3.54%		

The table below compiles the values of monetized benefits, based on the assumptions presented above. The project is estimated to produce benefits valued at \$43.8 million at a 7% discount factor over the project lifecycle. Travel time savings is the largest and most significant benefits, accounting for over forty percent is the monetized benefits.

Table 19: Estimates of Economic Benefits, Millions of 2018 Dollars

Benefits	Over the Project Lifecycle		
	Constant Dollars	Discounted at 7%	Discounted at 3%
Travel Time Savings	\$64.5	\$18.2	\$35.5
Accident Cost Savings	\$35.3	\$10.6	\$20.0
Vehicle Operating Cost Savings	\$2.2	\$0.5	\$1.1
Reduced Risk of Spills	\$36.6	\$11.6	\$21.3
Emissions Cost Savings	\$0.1	\$0.0	\$0.1
Residual Value	\$21.0	\$2.1	\$7.7
O&M Cost Savings	\$1.3	\$0.8	\$1.0
Total Benefits	\$160.9	\$43.8	\$86.8