APPENDIX B

Benefit Cost Analysis

Benefit Cost Analysis Supplementary Documentation

USDOT Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant Program FY21

Spotted Road Interchange Safety and Mobility Improvement Project

Spokane International Airport

July 7th, 2021

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1. Executive Summary

Served by seven airlines and two air cargo carriers, Spokane International Airport is the second largest airport in the State of Washington and recognized by the Federal Aviation Administration (FAA) as a small hub. The Airport is an employment hub for over 3,000 people and has an important and expanding airfield and aerospace industry cluster. The Airport has a $725 million annual economic impact on the Spokane Region[1].

Traffic in the Spokane International Airport region is currently transiting on two very busy inbound and outbound airport access roads known as Airport Drive Inbound and Outbound. Vehicles use Airport Drive Inbound and Outbound and cross Spotted Road to access the Airport, nearby U.S. Highway 2, and Interstate 90. Spotted Road is a key component of the Critical Urban Freight Corridor and also provides access to the Airport Industrial Park. The Spotted Road/Airport Drive intersections and geometry are dangerous and improvements are necessary to improve safety. The combination of lower speed traffic trying to cross Airport Drive Inbound and Outbound with higher speed traffic at two intersecting points has led to multiple routine accidents many of which are serious injury accidents and fatalities. These problems persist despite installation of additional traffic safety measures. In addition, vehicles on Spotted Road approaching the intersections experience significant delay while waiting for the gap on Airport Drive to cross, which further results in vehicle fuel costs and increased emissions due to idling.

The Spotted Road Interchange Safety and Mobility Improvement Project (the Project) looks to grade-separate Spotted Road from Airport Drive Inbound and Outbound which will provide continuous / free-flow traffic for vehicles on Spotted Road travelling through the intersections. As a result, accidents at the two intersecting points can be fully mitigated in addition to realizing reductions in vehicle travel time, fuel costs, and emissions due to avoided vehicle idling.

The proposed Spotted Road Overpass project concept is presented in Figure 1.

[1] *About Spokane International Airport*. Spokane International Airport. Accessed on July 27th, 2021. https://business.spokaneairports.net/about-spokane-international

Figure 1. Spotted Road Overpass Project Concept

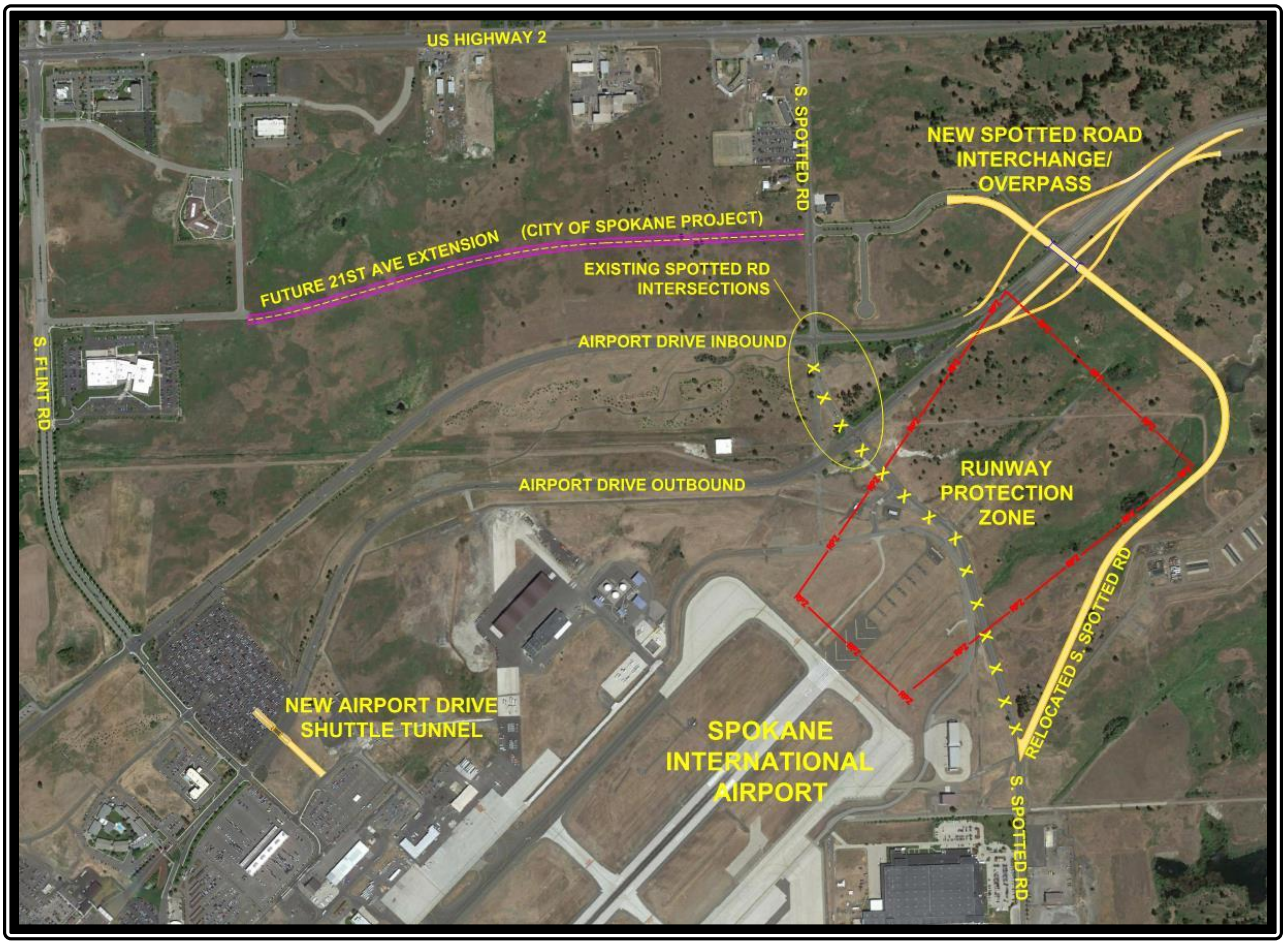

Table ES-1 summarizes the impacts and associated monetary benefits expected from the Project.

Table ES - 1: Summary of Infrastructure Improvements and Associated Benefits, in Discounted 2019 Dollars

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternatives	Type of Impacts	Economic Benefit	Summary of Results	Page Reference
Traffic in the Spokane International Airport heavily relies on Airport Drive Inbound and Outbound roadways and Spotted Road to access the airport, US. Highway 2 and Interstate 90. Spotted Road is a part of the Critical Urban Freight Corridor and also provides access to the Airport Industrial Park. However, the Spotted Road/Airport Drive intersections and geometry are dangerous and have led to multiple routine accidents, many of which are serious injury accidents and even some fatalities. In addition, vehicles on Spotted Road approaching the intersections experience significant delay while waiting for the gap on Airport Drive to cross, which further results in vehicle fuel costs and increased emissions.	The Project looks to grade-separate Spotted Road from the Airport Drive Inbound and Outbound, which will provide straight through traffic for vehicles on Spotted Road travelling through the intersections. As a result, accidents at the two intersecting points can be fully mitigated in addition to realizing reductions in vehicle travel time, fuel costs, and emissions due to avoided vehicle idling.	Travel time savings from eliminated congestion at the Spotted Road/Airport Drive intersection. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Travel Time Savings	**$1,739,258**	Page 21
		Avoided vehicle collisions from the grade-separation of Spotted Road from Airport Drive. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Improved Safety and Reduced Accident Costs	**$28,638,377**	Page 16
		Reduced maintenance costs by replacing part of the aging, existing Spotted Road with a new overpass.	Reduced Maintenance Costs	**$2,229,420**	Page 24
		Reduced vehicle fuel costs from eliminated congestion at the Spotted Road/Airport Drive intersection. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Vehicle Operating Cost Savings	**-$398,992**	Page 20
		Reduced emissions by avoided vehicle idling at the Spotted Road/Airport Drive intersections. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Reduced Emission costs	**-$97,929**	Page 17
		Residual value of the Spotted Overpass infrastructure components at the end of the study period.	Residual Value of Asset	**$0**	Page 24
		Improved travel time reliability as a result of grade separating Spotted Road from Airport Drive.	Improved Travel Time Reliability	**n/a**	Page 21

The period of analysis used in the estimation of benefits and costs is 37 years, including 7 years of Project development and construction as well as 30 years of benefits. The total Project costs include $27.89 million in 2019 dollars.

Tables ES-2 to ES-7 provide various summaries of the relevant data and calculations used to derive the benefits and costs of the Project. Based on the analysis presented in this document, the Project is expected to generate $32.11 million in discounted benefits and $20.50 million in discounted costs. Therefore, the Project is expected to generate a **Net Present Value of $11.61 million** and a **Benefit/Cost Ratio of 1.6**.

Table ES - 2: Overall Results of the Benefit Cost Analysis, in Millions of 2019 Dollars

Project Evaluation Metric	Discounted at 7 Percent[2]
Total Discounted Benefits	$32,110,133
Total Discounted Costs	$20,497,464
Net Present Value	$11,612,670
Benefit / Cost Ratio	1.6
Discounted Payback Period (years)	15.2 yrs
Internal Rate of Return (%)	11%

Table ES - 3: Summary of Project Costs in Undiscounted 2019 Dollars, by Funding Source

Cost Component	WSDOT	Airport Improvement Program	Local Match	USDOT RAISE Request	Total
Planning Studies/Mitigation	$145,704	$-	$2,787,805	$-	$2,933,509
Enviro/Prelim Design	$-	$-	$385,945	$-	$385,945
Design	$-	$-	$1,942,721	$-	$1,942,721
Construction	$-	$4,856,803	$3,885,442	$13,890,456	$22,632,702
Total	**$145,704**	**$4,856,803**	**$9,001,913**	**$13,890,456**	**$27,894,877**

In addition to the monetized benefits presented in this section, the Project would generate improved travel time reliability which is not quantified. A brief description is provided below.

- ***Improved Travel Time Reliability***

Vehicles approaching the Spotted Road/Airport Drive can experience significant delays while waiting for the gap to cross the two intersections, which causes variability in travel time. Grade separating Spotted Road from Airport Drive with an overpass will reduce vehicle wait times at intersections and improve travel time reliability. However, the reliability benefits are difficult to monetize in absence of detailed modelling for different roadway users.

[2] 3 percent discount rate for the benefits from reduction in CO2 emissions, and 7 percent discount rate for everything else, as per USDOT BCA Guidance, February 2021.

Table ES - 4: Summary of Total Project Benefits and Costs, 2019 Dollars

Calendar Year	Project Year	Total Benefits (Undiscounted)	Total Capital Costs (Undiscounted)	Undiscounted Net Benefits	Discounted Total Benefits	Discounted Total Costs	Discounted Net Benefits
2019	1	-	$1,048,249	-$1,048,249	-	$1,048,249	-$1,048,249
2020	2	-	$1,397,665	-$1,397,665	-	$1,306,229	-$1,306,229
2021	3	-	$873,540	-$873,540	-	$762,984	-$762,984
2022	4	-	$1,457,041	-$1,457,041	-	$1,189,379	-$1,189,379
2023	5	-	$485,680	-$485,680	-	$370,523	-$370,523
2024	6	-	$15,842,891	-$15,842,891	-	$11,295,762	-$11,295,762
2025	7	-	$6,789,811	-$6,789,811	-	$4,524,337	-$4,524,337
2026	8	$2,860,323	-	$2,860,323	$1,780,370	-	$1,780,370
2027	9	$2,931,365	-	$2,931,365	$1,705,093	-	$1,705,093
2028	10	$3,005,308	-	$3,005,308	$1,633,616	-	$1,633,616
2029	11	$3,077,337	-	$3,077,337	$1,563,214	-	$1,563,214
2030	12	$3,157,150	-	$3,157,150	$1,498,723	-	$1,498,723
2031	13	$3,240,266	-	$3,240,266	$1,437,421	-	$1,437,421
2032	14	$3,269,122	-	$3,269,122	$1,355,198	-	$1,355,198
2033	15	$3,421,778	-	$3,421,778	$1,325,567	-	$1,325,567
2034	16	$3,525,604	-	$3,525,604	$1,276,325	-	$1,276,325
2035	17	$3,633,255	-	$3,633,255	$1,229,143	-	$1,229,143
2036	18	$3,745,584	-	$3,745,584	$1,184,149	-	$1,184,149
2037	19	$3,871,347	-	$3,871,347	$1,143,753	-	$1,143,753
2038	20	$4,004,165	-	$4,004,165	$1,105,525	-	$1,105,525
2039	21	$4,123,869	-	$4,123,869	$1,063,994	-	$1,063,994
2040	22	$4,188,437	-	$4,188,437	$1,009,844	-	$1,009,844
2041	23	$4,375,248	-	$4,375,248	$985,774	-	$985,774
2042	24	$4,513,909	-	$4,513,909	$950,389	-	$950,389
2043	25	$4,652,486	-	$4,652,486	$915,391	-	$915,391
2044	26	$4,798,754	-	$4,798,754	$882,312	-	$882,312
2045	27	$4,961,782	-	$4,961,782	$852,536	-	$852,536
2046	28	$5,130,674	-	$5,130,674	$823,823	-	$823,823
2047	29	$5,315,310	-	$5,315,310	$797,587	-	$797,587
2048	30	$5,508,679	-	$5,508,679	$772,466	-	$772,466
2049	31	$5,711,957	-	$5,711,957	$748,546	-	$748,546
2050	32	$5,934,092	-	$5,934,092	$726,812	-	$726,812
2051	33	$6,108,795	-	$6,108,795	$699,245	-	$699,245
2052	34	$6,418,646	-	$6,418,646	$686,698	-	$686,698
2053	35	$6,684,349	-	$6,684,349	$668,389	-	$668,389
2054	36	$6,974,768	-	$6,974,768	$651,870	-	$651,870
2055	37	$7,284,443	-	$7,284,443	$636,358	-	$636,358
Total		**$136,428,802**	**$27,894,877**	**$108,533,926**	**$32,110,133**	**$20,497,464**	**$11,612,670**

Table ES - 5: Summary of Project Benefits by Benefit Type, in Undiscounted 2019 Dollars

Calendar Year	Project Year	Travel Time Savings	Improved Safety and Reduced Accident Costs	Reduced Maintenance Costs	Vehicle Operating Cost Savings	Reduced Emission costs	Residual Value of Asset
2019-2025	1 - 7	-	-	-	-	-	-
2026	8	-$41,658	$2,669,660	$278,333	-$39,565	-$6,447	-
2027	9	-$35,964	$2,736,402	$278,333	-$41,097	-$6,309	-
2028	10	-$28,818	$2,804,812	$278,333	-$42,830	-$6,189	-
2029	11	-$20,226	$2,874,932	$272,939	-$44,220	-$6,088	-
2030	12	-$9,721	$2,946,806	$272,939	-$46,892	-$5,982	-
2031	13	$1,008	$3,020,476	$272,939	-$48,156	-$6,000	-
2032	14	$12,922	$3,095,988	$216,004	-$49,763	-$6,029	-
2033	15	$32,206	$3,173,387	$272,939	-$50,631	-$6,124	-
2034	16	$54,999	$3,252,722	$275,457	-$51,436	-$6,137	-
2035	17	$81,952	$3,334,040	$275,457	-$52,048	-$6,147	-
2036	18	$113,846	$3,417,391	$272,939	-$52,444	-$6,148	-
2037	19	$152,113	$3,502,826	$275,457	-$52,913	-$6,135	-
2038	20	$197,444	$3,590,396	$275,457	-$53,029	-$6,103	-
2039	21	$227,706	$3,680,156	$275,457	-$53,310	-$6,139	-
2040	22	$260,904	$3,772,160	$216,004	-$54,459	-$6,172	-
2041	23	$297,306	$3,866,464	$272,939	-$55,106	-$6,356	-
2042	24	$337,202	$3,963,126	$275,457	-$55,423	-$6,452	-
2043	25	$379,751	$4,062,204	$272,939	-$55,866	-$6,542	-
2044	26	$422,144	$4,163,759	$275,457	-$55,967	-$6,639	-
2045	27	$480,208	$4,267,853	$275,457	-$55,058	-$6,678	-
2046	28	$544,735	$4,374,549	$272,939	-$54,856	-$6,695	-
2047	29	$616,465	$4,483,913	$275,457	-$53,839	-$6,686	-
2048	30	$696,229	$4,596,011	$275,457	-$52,291	-$6,727	-
2049	31	$785,289	$4,710,911	$272,939	-$50,529	-$6,653	-
2050	32	$884,397	$4,828,684	$275,457	-$48,056	-$6,389	-
2051	33	$994,738	$4,949,401	$216,004	-$45,101	-$6,247	-
2052	34	$1,117,646	$5,073,136	$275,457	-$41,609	-$5,983	-
2053	35	$1,254,624	$5,199,964	$272,939	-$37,513	-$5,666	-
2054	36	$1,407,368	$5,329,964	$275,457	-$32,732	-$5,288	-
2055	37	$1,577,795	$5,463,213	$275,457	-$27,178	-$4,842	-
Total		**$12,794,611**	**$117,205,306**	**$8,068,798**	**-$1,453,919**	**-$185,995**	**-**

Table ES - 6: Summary of Pertinent Quantifiable Data (Part 1)

Calendar Year	Project Year	Avoided Motor Oil Consumption (quarts)	Avoided Gasoline Consumption (gallons)	Avoided Diesel Consumption (gallons)	Personal Hours Saved (hours)	Fatalities Avoided (fatalities)	Injuries Avoided (injuries)
2019-2025	1 - 7	-	-	-	-	-	-
2026	8	-302	-5,952	-10,220	-2,128	0.12	5.56
2027	9	-302	-6,037	-10,454	-1,837	0.12	5.70
2028	10	-301	-6,111	-10,689	-1,472	0.12	5.84
2029	11	-297	-6,175	-10,926	-1,033	0.13	5.99
2030	12	-292	-6,225	-11,163	-496	0.13	6.14
2031	13	-287	-6,276	-11,406	51	0.13	6.29
2032	14	-280	-6,320	-11,653	660	0.13	6.45
2033	15	-266	-6,298	-11,882	1,645	0.14	6.61
2034	16	-247	-6,246	-12,108	2,809	0.14	6.77
2035	17	-224	-6,159	-12,327	4,186	0.15	6.94
2036	18	-195	-6,029	-12,538	5,815	0.15	7.12
2037	19	-160	-5,843	-12,736	7,769	0.15	7.30
2038	20	-116	-5,594	-12,919	10,084	0.16	7.48
2039	21	-90	-5,493	-13,160	11,630	0.16	7.67
2040	22	-61	-5,369	-13,399	13,325	0.16	7.86
2041	23	-28	-5,219	-13,637	15,184	0.17	8.05
2042	24	9	-5,041	-13,872	17,222	0.17	8.25
2043	25	48	-4,843	-14,107	19,395	0.18	8.46
2044	26	87	-4,651	-14,353	21,560	0.18	8.67
2045	27	144	-4,315	-14,557	24,526	0.19	8.89
2046	28	208	-3,924	-14,750	27,821	0.19	9.11
2047	29	279	-3,469	-14,929	31,485	0.20	9.34
2048	30	360	-2,944	-15,092	35,559	0.20	9.57
2049	31	452	-2,336	-15,236	40,107	0.21	9.81
2050	32	554	-1,639	-15,358	45,169	0.21	10.06
2051	33	669	-841	-15,455	50,805	0.22	10.31
2052	34	798	71	-15,521	57,082	0.22	10.57
2053	35	943	1,109	-15,554	64,078	0.23	10.83
2054	36	1,106	2,291	-15,548	71,879	0.23	11.10
2055	37	1,289	3,635	-15,496	80,583	0.24	11.38
Total		**3,498**	**-122,247**	**-401,043**	**653,464**	**5.10**	**244**

Table ES - 7: Summary of Pertinent Quantifiable Data (Part 2)

Calendar Year	Project Year	CO2 Emissions Avoided (tons)	NOx Emissions Avoided (tons)	PM Emissions Avoided (tons)	SO2 Emissions Avoided (tons)	VOC Emissions Avoided (tons)
2019-2025	1 - 7	-	-	-	-	-
2026	8	-89.39	-0.05	-0.0014	-0.0005	-0.0070
2027	9	-89.00	-0.04	-0.0012	-0.0005	-0.0061
2028	10	-88.55	-0.03	-0.0010	-0.0005	-0.0054
2029	11	-88.03	-0.03	-0.0009	-0.0005	-0.0047
2030	12	-87.43	-0.03	-0.0008	-0.0005	-0.0041
2031	13	-88.13	-0.02	-0.0007	-0.0005	-0.0037
2032	14	-88.79	-0.02	-0.0007	-0.0005	-0.0034
2033	15	-89.10	-0.02	-0.0006	-0.0005	-0.0031
2034	16	-89.25	-0.02	-0.0006	-0.0005	-0.0028
2035	17	-89.24	-0.01	-0.0005	-0.0005	-0.0026
2036	18	-89.01	-0.01	-0.0005	-0.0005	-0.0023
2037	19	-88.51	-0.01	-0.0004	-0.0005	-0.0021
2038	20	-87.71	-0.01	-0.0004	-0.0005	-0.0019
2039	21	-87.73	-0.01	-0.0004	-0.0005	-0.0018
2040	22	-87.66	-0.00	-0.0004	-0.0005	-0.0016
2041	23	-88.18	-0.00	-0.0004	-0.0005	-0.0016
2042	24	-88.59	-0.00	-0.0004	-0.0005	-0.0016
2043	25	-88.93	-0.00	-0.0004	-0.0005	-0.0015
2044	26	-89.35	-0.00	-0.0004	-0.0005	-0.0015
2045	27	-89.05	0.00	-0.0004	-0.0005	-0.0014
2046	28	-88.51	0.00	-0.0004	-0.0005	-0.0014
2047	29	-87.68	0.00	-0.0004	-0.0005	-0.0013
2048	30	-86.53	0.01	-0.0004	-0.0005	-0.0012
2049	31	-85.01	0.01	-0.0004	-0.0005	-0.0011
2050	32	-83.07	0.01	-0.0004	-0.0005	-0.0010
2051	33	-80.81	0.01	-0.0003	-0.0004	-0.0009
2052	34	-78.02	0.01	-0.0003	-0.0004	-0.0008
2053	35	-74.62	0.02	-0.0003	-0.0004	-0.0006
2054	36	-70.54	0.02	-0.0003	-0.0004	-0.0005
2055	37	-65.68	0.02	-0.0003	-0.0004	-0.0003
Total		**-2,572**	**-0.19**	**-0.02**	**-0.01**	**-0.07**

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the Spotted Road Interchange Safety and Mobility Improvement Project (the Project) .

- **Section 3 – Methodological Framework** introduces the conceptual framework used in the Benefit Cost Analysis (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 Project is expected to generate.
- **Section 5 – General Assumptions** discusses the general assumptions used in the estimation of project costs and benefits.
- **Section 6 – Traffic Projections** describes the methodology used to obtain estimates of forecasted traffic volumes used to calculate benefits.
- **Section 7 – Estimation of Economic Benefits** details the specific data elements and assumptions used to address the goals of the Project and to comply with program requirements.
- **Section 8– Summary of Findings and BCA Outcomes** estimates the Project's Net Present Value (NPV), its Benefit/Cost Ratio (BCR) and other project evaluation metrics.
- **Section 9 – Sensitivity Analysis** 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 Project.

Additional data tables are provided within the BCA model including annual estimates of benefits and costs to assist the U.S. Department of Transportation (USDOT) in its review of the application[3].

3. Methodological Framework

The specific methodology developed for this application was developed using the above BCA principles and is consistent with the USDOT Benefit-Cost Analysis Guidance for Discretionary Applications (February 2021). In particular, the methodology involves:

- Establishing existing and future conditions under the Build and No Build Cases;
- Assessing benefits with respect to each of the merit criteria identified in the Notice of Funding Opportunity;
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of benefits; and
- Discounting future benefits and costs with the real discount rate recommended by the DOT (3 percent for the benefits from reduction in CO_2 emissions, 7 percent for everything else).

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

4. Project Overview

Served by seven airlines and two air cargo carriers, Spokane International Airport is the second largest airport in the State of Washington and recognized by the Federal Aviation Administration (FAA) as a small hub. The Airport is an employment hub for over 3,000 people and has an important and expanding airfield and aerospace industry cluster. The Airport has a $725 million annual economic impact on the Spokane Region[4].

Traffic in the Spokane International Airport region is currently transiting on two very busy inbound and outbound airport access roads known as Airport Drive Inbound and Outbound. Vehicles use Airport Drive Inbound and Outbound and cross Spotted Road to access the Airport, nearby U.S. Highway 2, and Interstate 90. Spotted Road is a key component of the Critical Urban Freight Corridor and also provides access to the Airport Industrial Park. The Spotted Road/Airport Drive intersections and geometry are dangerous and improvements are necessary to improve safety. The combination of lower speed traffic trying to cross Airport Drive Inbound and Outbound with higher speed traffic at two intersecting points has led to multiple routine accidents many of which are serious injury accidents and fatalities. These problems persist despite installation of additional traffic safety measures. In addition, vehicles on Spotted Road approaching the intersections experience significant delay while waiting for the gap on Airport Drive to cross, which further results in vehicle fuel costs and increased emissions due to idling.

The Spotted Road Interchange Safety and Mobility Improvement Project (the Project) looks to grade-separate Spotted Road from Airport Drive Inbound and Outbound which will provide continuous / free-flow traffic for vehicles on Spotted Road travelling through the intersections. As a result, accidents at the two intersecting points can be fully mitigated in addition to realizing reductions in vehicle travel time, fuel costs, and emissions due to avoided vehicle idling.

4.1. No Build and Build Cases

In the No Build Case, all traffic travelling on Spotted Road and Airport Drive will continue to approach the Spotted Road/Airport Drive intersections. The combination of lower speed traffic on Spotted road trying to cross the inbound and outbound of Airport Drive with higher speed traffic is likely to cause routine accidents including serious injuries and fatalities. In addition, vehicles transiting on Spotted Road have to stop and wait for a gap to cross the Spotted Road/Airport Drive intersections which results in travel time delays, and additional vehicle operating costs and emissions from idling. Moreover, significant maintenance costs for the existing Spotted Road have been incurred in recent years and more rehabilitation and reconstruction for the roadway is anticipated in the future.

In the Build Case, the Project looks to relocate the Spotted Road/Airport Drive interchange to the east with a new grade separated Spotted Road overpass above and across Airport Drive, which will provide straight through free-flow traffic for vehicles on Spotted Road travelling through the Spotted Road/Airport Drive intersections. As a result, accidents happening at the two intersections will be fully avoided. In the meantime, vehicle wait times, operating costs, and emissions associated with idling at the intersections can be eliminated. However, there are slight disbenefits associated with the longer route travelled on the overpass (compared to the existing Spotted Road).

[4] *About Spokane International Airport*. Spokane International Airport. Accessed on July 27th, 2021. https://business.spokaneairports.net/about-spokane-international

4.2. Project Cost

The Project leverages funding to provide optimal project cost delivery. Table 1 summarizes the Project's capital expenditures over time. Construction is expected to be complete in 2025 to allow the Spotted Road Overpass to be fully operational in 2026. For the purposes of the BCA, all benefits begin to accrue after substantial completion of the Project and starting in the first year of operations (2026).

Table 1: Cost Summary Table, 2019 Dollars

Calendar Year	Capital Expenditures
2019	$1,048,249
2020	$1,397,665
2021	$873,540
2022	$1,457,041
2023	$485,680
2024	$15,842,891
2025	$6,789,811
Total	**$27,894,877**

4.3. Benefit Outcomes

The main benefit categories associated with the Project are summarized in the table below.

Table 2: Expected Effects on Benefit Categories

Merit Criteria	Impact Categories	Description	Inclusion
Safety	Improved Safety and Reduced Accident Costs	Avoided vehicle collisions from the grade-separation of Spotted Road from Airport Drive. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Monetized
State of Good Repair	Reduced Maintenance Costs	Reduced maintenance costs by replacing part of the aging, existing Spotted Road with a new overpass.	Monetized
	Residual Value of Asset	Residual value of the Spotted Overpass infrastructure components at the end of the study period.	Monetized
Economic Competitiveness	Vehicle Operating Cost Savings	Reduced vehicle fuel costs from eliminated congestion at the Spotted Road/Airport Drive intersection. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Monetized
Environmental Sustainability	Reduced Emission costs	Reduced emissions by avoided vehicle idling at the Spotted Road/Airport Drive intersections. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Monetized
Quality of Life	Travel Time Savings	Travel time savings from eliminated congestion at the Spotted Road/Airport Drive intersection. There is disbenefit associated with the longer route provided by the Spotted overpass, compared to the existing Spotted Road.	Monetized
	Improved Travel Time Reliability	Improved travel time reliability as a result of grade separating Spotted Road from Airport Drive.	Qualitative

5. General Assumptions

General assumptions used for the entire BCA analysis for the Project are provided in Table 3.

Table 3: General Assumptions Used in the Analysis

Variable Name	Unit	Value	Source
Real Discount Factor	%	7%	USDOT BCA Guidance, February 2021.
Real Discount Factor – Benefits from Reduction in CO_2 Emissions	%	3%	
Base Year of Analysis	year	2019	
First Year of Analysis	year	2019	Project Schedule
Project Completion	year	2025	Project Schedule
First Year of Benefits	year	2026	Project Schedule
End Year of Analysis	year	2055	Calculated value based on first year of benefits and the total years of benefits
Years of Benefits	years	30	Based on the maximum benefit years for BCA from 2021 USDOT BCA guidance.
Average Distance Travelled, Southbound of Spotted Road - No Build	miles	0.9	Weighted average distances for vehicles travelling through Spotted Road/Airport Drive intersections, based on the percent share of traffic from each direction. Distance retrieved from Google maps, and provided by JUB Engineers Inc. Airport Traffic Study, 2015.
Average Distance Travelled, Northbound of Spotted Road - No Build	miles	0.7	
Average Distance Travelled, Southbound of Spotted Road - Build	miles	1.0	
Average Distance Travelled, Northbound of Spotted Road - Build	miles	1.2	
Grams per Short Ton	grams	907,185	Known
Short Ton per Metric Ton	ton/metric ton	1.10	Known
Days per Year	days	365	Known
Feet per Mile	feet	5,208	Known

6. Traffic Projections

6.1. Methodology

Robust traffic projections are important to ensure the reasonable BCA output results. Historical vehicles approaching the Spotted Road/Airport Drive intersections during the AM and PM peak hours were collected by Iteris as part of the traffic count collection and traffic study conducted for Spokane International Airport[5]. Daily peak hour traffic counts for August, October and December of 2019 are shown in Table 4 below.

Table 4. Daily Peak Hour Traffic at Spotted Road/Airport Drive Intersections[6]

Spotted Road/Airport Drive Intersection	Aug-19				Oct-19				Dec-19			
	North Leg		South Leg		North Leg		South Leg		North Leg		South Leg	
	T	R/L	T	R/L	T	R/L	T	R/L	T	R/L	T	R/L
AM Peak Hour Traffic												

[5] Spokane International Airport – Traffic Count Collection and Traffic Study. Iteris, 2019.

[6] AM Peak Hour is between 10:45 AM and 11:45 AM, PM Peak Hour is between 1 PM and 2 PM. Spokane International Airport – Traffic Count Collection and Traffic Study, 2019. Iteris.

Spotted Road/Airport Drive Intersection	Aug-19				Oct-19				Dec-19			
	North Leg		South Leg		North Leg		South Leg		North Leg		South Leg	
	T	R/L	T	R/L	T	R/L	T	R/L	T	R/L	T	R/L
Inbound & Spotted	40	16	58	54	61	16	40	61	44	13	58	57
Outbound & Spotted	49	7	94	10	71	10	80	9	46	8	96	15
PM Peak Hour Traffic												
Inbound & Spotted	71	29	58	66	60	13	57	61	54	11	32	52
Outbound & Spotted	75	11	104	12	80	4	104	18	68	7	75	12

Note: T means through traffic. R/L means turning traffic.

An average was taken between AM and PM peak hour traffic to obtain the daily peak hour average, which was then prorated to Average Daily Traffic (ADT) using the percent share of peak hour traffic to ADT. An annual growth rate of 2.5% was applied to forecast future traffic volumes.

6.2. Assumptions

General assumptions used for the traffic projection are provided in Table 4.

Table 5: Assumptions used in the Estimation of Demand

Variable Name	Unit	Value	Source
Traffic Annual Growth Rate	%	2.5%	Spokane International Airport Traffic Study, 2015. Prepared by JUB Engineers Inc.
Percent Share of Trucks in the Study Area	%	20%	Calculated value.
Percent Share of Passenger Cars in the Study Area	%	80%	Average percent share of passenger cars in the area. Information retrieved from Spokane International Airport Traffic Count Collection and Traffic Study, 2019, prepared by Iteris.
Percent Share of Peak Hour Traffic	%	8.4%	Calculated based on the percent share of peak hour counts over average daily traffic on Flightline Avenue near Spokane International Airport.

6.3. Traffic Projections

Table 6 below shows the projection of traffic volumes at the Spotted Road/Airport Drive intersections.

Table 6: Traffic Volume Projections

Spotted Road/Airport Drive Intersection	In Project Opening Year (2026)	2036	2046
Inbound & Spotted	978,016	1,251,943	1,602,593
Outbound & Spotted	962,650	1,251,943	1,602,593

7. Estimation of Economic Benefits

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

7.1. Safety Benefits

Accident costs, and impacts on life, limb and property, are a significant component of costs to both road and rail users. Safety is a key economic factor in transportation efficiency, while outside of the economic context, safety is often the object of public concern and a leading social issue.

The proposed Project would contribute to full accident mitigations by grade separating Spotted Road from Airport Drive Inbound and Outbound, such that lower speed traffic on Spotted road can cross inbound and outbound of Airport Drive directly without interfering with higher speed traffic. However, vehicles will experience a slightly longer route when travelling on the overpass, compared to the existing Spotted Road, which will bring a minor safety disbenefit to the overall result.

Methodology

Safety benefits were estimated by monetizing the avoided fatalities and injuries as a result of the Spotted Road overpass. Total fatalities and injuries at the Spotted Road/Airport Drive intersections from 2010 to 2019 were provided by Spokane International Airport, as shown in Table 7 below. The BCA assumes that accidents at the Spotted Road/Airport Drive intersections in the No Build case grow at the same rate as the traffic volume. These accidents can be fully avoided by grade separating the Spotted Road in the Build case.

Table 7. Historical Fatalities and Injuries at Spotted Road/Airport Drive Intersections[7]

Incident Type	2010-2019 Total	10-year Average
Fatalities	1	0.1
Serious Injury	2	0.2
Evident Injury (Moderate)	17	1.7
Possible Injury (Minor)	30	3

In order to estimate the disbenefit associated with the longer route travelled on the overpass compared to the existing Spotted Road, accident rates were calculated on a per mile basis, which were then applied to the incremental vehicle miles travelled (difference between the No Build and Build cases) to estimate the number of fatalities and injuries.

The fatalities and injuries were then monetized based on assumptions in Table 8. The difference in total accident costs between No Build and Build cases determines the improved safety and avoided accident costs.

Assumptions

The assumptions used in the estimation of safety benefits from avoided accident costs are summarized in the table below.

Table 8: Assumptions used in the Estimation of Safety Benefits from Avoided Accident Costs

Variable Name	Unit	Value	Source
Fatal Crashes per Million VMT	fatal crashes/ million vmt	0.01	Calculated based on total vehicle miles travelled and total crashes by type in Spokane County in

[7] Source: Spokane International Airport. Accident data provided by Spokane Regional Transportation Council on behalf of WSDOT. Accidents for Spotted Road with Airport Drive Inbound and Outbound are used.

Variable Name	Unit	Value	Source
Serious Injury Crashes per Million VMT	injury crashes/ million vmt	0.03	2019. Total vehicle miles travelled retrieved from Washington State Department of Transportation, Highway Performance Monitoring System. Total crashes by type obtained from Washington State Department of Transportation, Crash Data Portal on all types of roadways.
Minor Injury Crashes per Million VMT	injury crashes/ million vmt	0.59	
Fatalities per Fatal Crash	Fatalities /fatal crash	1.02	Calculated from Spokane County crash statistics between 2016 and 2020. Crash statistics obtained Washington State Department of Transportation, Crash Data Portal on all types of roadways.
Serious Injuries per Serious Injury Crash	Injuries /injury crash	1.17	
Minor Injuries per Minor Injury Collision	Injuries /injury crash	1.27	Washington State Department of Transportation. 2015 Annual Collision Summary. https://www.wsdot.wa.gov/mapsdata/crash/pdf/2015_Annual_Collision_Summary.pdf
Crash Reduction Factor by adding the Spotted Road Overpass	%	100%	Assuming Spotted Road/Airport Drive intersection related incidents can be fully mitigated by grade separating Spotted Road.
Value of a Statistical Life	2019$/fatality	$10,900,000	USDOT BCA Guidance. February, 2021. Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2016) https://www.transportation.gov/officepolicy/transportation-policy/reviseddepartmental-guidance-on-valuation-of-astatistical-life-in-economic-analysis Values in 2019$.
Cost of Serious Injury ($/injury)	2019$/injury	$1,144,500	
Cost of Moderate Injury ($/injury)	2019$/injury	$512,300	
Cost of Minor Injury ($/injury)	2019$/injury	$32,700	

Benefit Estimates

The table below shows the estimates of safety benefits from avoided accident costs. With a 7 percent discount rate applied to the benefits, the estimated present value of benefits over the Project life cycle is $41.48 million dollars.

Table 9: Estimates of Safety Benefits from Avoided Accident Costs, 2019 Dollars

	Over the Project Lifecycle	
	In Constant Dollars	Discounted at 7 Percent
Savings from Reduced Fatalities	$55,625,521	$13,591,745
Savings from Reduced Injuries	$61,579,786	$15,046,632
Total	**$117,205,306**	**$28,638,377**

7.2. Environmental Sustainability Benefits

Environmental costs are increasingly considered as an important component in the evaluation of transportation projects and the main environmental impacts of vehicle use and exhaust emissions can 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 and the conditions into which the pollution is released.

The proposed Project would reduce vehicle emissions from idling with the construction of the overpass. However, vehicles will experience a slightly longer route when travelling on the overpass, compared to the existing Spotted Road, which results in a small net disbenefit to the overall result.

Methodology

Vehicle delay time in the No Build case was used to estimate total emissions released from vehicle idling at Spotted Road/Airport Drive intersections, which was then multiplied by the appropriate emission factors. for tons of nitrogen oxides (NO_x), particulate matter (PM), sulfur dioxide (SO_2), carbon dioxide (CO_2) and volatile organic compounds (VOC) emitted per year. Each pollutant, measured in tons, is then multiplied by its monetary value to get the total emission cost in the No Build case. Grade separating the Spotted Road in the Build case would eliminate emissions related to vehicle idling.

In order to estimate the disbenefit associated with the longer route travelled on the overpass compared to the existing Spotted Road, vehicle miles travelled in No Build and Build cases were used to estimate the total emissions released. Vehicle miles travelled were multiplied by the appropriate emission factors , and then monetized to get the total emission costs.

The change in total emission costs between No Build and Build cases indicates the total avoided emission costs as a result of the Project.

Assumptions

The assumptions used in the estimation of environmental sustainability benefits from reduced emission costs are summarized in tables below.

Table 10: Freight Truck and Rail Emission Factors

Variable Name	Unit	Year	NO_x	PM	SO_2	CO_2	VOC	Source
Freight Truck Emission Factors - Driving	grams/mile	2020-2060	Varies by year					MOVES run in June 2021 for Spokane County, Washington. Truck emissions used a weighted average of passenger truck (80%), single unit long-haul truck (10%), and single unit short-haul truck(10%) based on the vehicle type percent share in the study area, with diesel as the fuel. Automobile emissions used passenger car as the vehicle type, with gasoline as the fuel type. An average travel speed of 30 mph in the No Build case and 35 mph in the Build case were used. MOVES values were gathered from 2020, 2030, 2040, 2050 and 2060. Values were interpolated between those years.
Automobile Emission Factors - Driving	grams/mile	2020-2060	Varies by year					
Freight Truck Emission Factors - Idling	grams/hour	2020-2060	Varies by year					MOVES run in June 2021 for Spokane County, Washington. Truck emissions used a weighted average of passenger truck (80%), single unit long-haul truck (10%), and single unit short-haul truck(10%) based on the vehicle type percent share in the study area, with diesel as the fuel. Automobile emissions used passenger car as the vehicle type, with gasoline as the fuel type. An average speed bin of 2.5 mph were used to represent emission rates when idling. MOVES values were gathered from 2020, 2030, 2040,
Automobile Emission Factors - Idling	grams/hour	2020-2060	Varies by year					

Variable Name	Unit	Year	NO_x	PM	SO_2	CO_2	VOC	Source
								2050 and 2060. Values were interpolated between those years.

Table 11: Monetized Values of Emissions

Year	Social Cost of Emissions (2019$/metric ton)				Source
	CO_2	NO_X	PM2.5	SO_2	
2026	$58	$17,300	$818,600	$46,200	CO2 Values based on the Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (August 2016) https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf. Values are inflated from 2007 dollars to 2019 dollars using the GDP deflator. Per US DOT Benefit Cost Analysis Guidance 2021, CO2 emissions values will be discounted using a 3 percent discount rate, while all other benefit streams will be discounted by 7%. Other values from the Safer Affordable Fuel-Efficient Vehicles Rule for MY2021-MY2026 Passenger Cars and Light Trucks Preliminary Regulatory Impact Analysis (March 2020)" https://nhtsa.gov/sites/nhtsa.dotgov/files/documents/final_safe_fria_web_version_200701.pdf. Values are inflated from 2016 dollars to 2019 dollars using the GDP deflator, and are kept constant beyond 2050.
2027	$59	$17,500	$829,800	$46,900	
2028	$60	$17,700	$841,200	$47,600	
2029	$61	$18,000	$852,700	$48,200	
2030	$62	$18,000	$852,700	$48,200	
2031	$63	$18,000	$852,700	$48,200	
2032	$64	$18,000	$852,700	$48,200	
2033	$66	$18,000	$852,700	$48,200	
2034	$67	$18,000	$852,700	$48,200	
2035	$68	$18,000	$852,700	$48,200	
2036	$69	$18,000	$852,700	$48,200	
2037	$70	$18,000	$852,700	$48,200	
2038	$71	$18,000	$852,700	$48,200	
2039	$72	$18,000	$852,700	$48,200	
2040	$73	$18,000	$852,700	$48,200	
2041	$75	$18,000	$852,700	$48,200	
2042	$76	$18,000	$852,700	$48,200	
2043	$77	$18,000	$852,700	$48,200	
2044	$78	$18,000	$852,700	$48,200	
2045	$79	$18,000	$852,700	$48,200	
2046	$80	$18,000	$852,700	$48,200	
2047	$81	$18,000	$852,700	$48,200	
2048	$83	$18,000	$852,700	$48,200	
2049	$84	$18,000	$852,700	$48,200	
2050	$83	$18,000	$852,700	$48,200	
2051	$84	$18,000	$852,700	$48,200	
2052	$84	$18,000	$852,700	$48,200	
2053	$84	$18,000	$852,700	$48,200	
2054	$84	$18,000	$852,700	$48,200	
2055	$84	$18,000	$852,700	$48,200	

Benefit Estimates

The table below shows the estimates of environmental sustainability benefits from reduced emission costs. With a 3 percent discount rate for benefits from reduction in CO_2 emissions (per USDOT Guidance), and 7 percent discount rate for everything else, the total present value results in a net disbenefit of -$97.93 thousand dollars.

Table 12: Estimates of Environmental Sustainability Benefits from Avoided Emission Costs, 2019 Dollars

	Over the Project Lifecycle	
	In Constant Dollars	Discounted at 7 Percent[8]
Green House Gas (GHG)	-$170,218	-$91,382
Criteria Air Contaminants (CAC)	-$15,777	-$6,548
Total	**-$185,995**	**-$97,929**

7.3. Economic Competitiveness Benefits

The proposed Spotted Road overpass looks to avoid vehicle operating costs associated with idling at the Spotted Road/Airport Drive intersections, since vehicles will be able to travel through Spotted Road directly, without waiting for gaps to cross at the intersections. However, vehicles will experience a slightly longer route when travelling on the overpass, compared to the existing Spotted Road, which will bring a disbenefit to the overall result.

Methodology

The elimination in vehicle idling time is directly related to the construction of the Spotted Road overpass. Vehicle delay time in the No Build case was multiplied by the fuel and motor oil consumption rate to obtain annual estimates of fuel and motor oil consumptions from idling. These volume estimates were multiplied by the respective cost per unit of fuel and motor oil in order to derive an estimate of the vehicle operating costs which are fully mitigated in the Build case.

In order to estimate the disbenefit associated with the longer route travelled on the overpass compared to the existing Spotted Road, vehicle miles travelled in No Build and Build cases were multiplied by the fuel and motor oil consumption rate, and then monetized to get the total vehicle operating costs.

The change in total vehicle operating costs between No Build and Build cases indicates the total vehicle operating cost savings as a result of the Project.

Assumptions

The assumptions used in the estimation of economic competitiveness benefits from vehicle operating cost savings are summarized in Table 13 below.

Table 13: Assumptions used in the Estimation of Economic Competitiveness Benefits from Vehicle Operating Cost Savings

Variable Name	Unit	Value	Source
Motor Oil Consumption at Idle - Autos	quarts/hour	0.03	Based on U.S. DOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000 miles and assuming that "One hour of idle time is equal to approximately 25 miles of driving" (Ford Motor Company, 2011)
Motor Oil Consumption at Idle - Trucks	quarts/hour	0.03	
Motor Oil Consumption, Driving - Autos	quarts/mile	0.00	
Motor Oil Consumption, Driving - Trucks	quarts/mile	0.00	
Gasoline Burned at Idle - Autos	gallons/hour	0.36	US DOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction

[8] 3 percent discount rate for the benefits from reduction in CO2 emissions, and 7 percent discount rate for everything else, as per USDOT BCA Guidance, February 2021.

Variable Name	Unit	Value	Source
Diesel Fuel Burned at Idle - Trucks	gallons/hour	0.49	Savings Worksheet" (2014) - Average of gasoline passenger vehicles.
Average Automobile Fuel Economy	miles/gallon	36.90	Bureau of Transportation Statistics. Table 4-23 Average Fuel Efficiency of U.S. Light Duty Vehicles
Average Heavy-Duty Diesel Vehicle Fuel Economy	miles/gallon	6.30	EPA. MOBILE6.2 output is for heavy-duty diesel vehicles (HDDV).
Cost of Motor Oil - Autos	2019$/quart	$10.72	Average Oil Price Sourced From HERS Model and Inflated to 2019$ by Motor Oil CPI (BLS CUUR0000SS47021).
Cost of Motor Oil - Trucks	2019$/quart	$4.29	Average Oil Price Sourced From HERS Model and Inflated to 2019$ by Motor Oil CPI (BLS CUUR0000SS47021).
Gasoline Prices	2019$/gallon	varies by year	EIA's Annual Energy Outlook 2021. Table 57: Components of Selected Petroleum Product Prices. Fuel prices are net of state and federal taxes. Values were deflated from 2020$ to 2019$, per USDOT guidance. https://www.eia.gov/outlooks/aeo/tables_ref.php
Diesel Fuel Prices	2019$/gallon	varies by year	

Benefit Estimates

The table below shows the estimation of economic competitiveness benefits from vehicle operating cost savings. With a 7 percent discount rate, the total present value results in a net disbenefit of -$399 thousand dollars.

Table 14: Estimates of Economic Competitiveness Benefits from Avoided Congestion Costs, 2019 Dollars

	Over the Project Lifecycle	
	In Constant Dollars	Discounted at 7 Percent
Vehicle Operating Cost Savings	-$1,453,919	-$398,992
Total	**-$1,453,919**	**-$398,992**

7.4. Quality of Life

The proposed Project would generate travel time savings for vehicle drivers and passengers, which falls under the quality of life merit criteria Currently, vehicles travelling through the Spotted Road/Airport Drive intersections have to stop at intersections and wait for the gap to cross. This can be eliminated with the construction of the overpass. However, vehicles will experience a slightly longer route when travelling on the overpass, compared to the existing Spotted Road, which will bring a minor disbenefit to the overall result.

Methodology

In the No Build case, almost all vehicles approaching the Spotted Road/Airport Drive intersections experience some delay while either waiting for a gap to cross the intersections, or waiting for vehicles ahead to cross first. The relationship between traffic volumes on Spotted Road approaching the intersections and vehicle delay time is not linear. Instead, there is an exponential growth in vehicle delay time when more vehicles are observed at the intersections. This means that if the intersections experience twice the usual traffic volume, the delay time will be more than double. A traffic study for Spokane International Airport conducted by JUB Engineers Inc. in 2015 provided daily historical traffic volumes and vehicle delay time during the peak hour at the Spotted Road/Airport Drive intersections, and conducted

projections using traffic simulation models for 2019, 2024, and 2034. Results are shown in Table 15 and Table 16 below.

Table 15. Historical and Forecast Traffic Volume

Midday Peak Hour Traffic	2014				2019				2024				2034			
	North Leg		South Leg		North Leg		South Leg		North Leg		South Leg		North Leg		South Leg	
	T	L/R	T	L/R	T	L/R	T	L/R	T	L/R	T	L/R	T	L/R	T	L/R
Inbound & Spotted	90	35	85	35	105	40	95	40	125	50	105	45	170	65	125	50
Outbound & Spotted	90	5	90	10	105	5	100	10	125	5	110	10	170	10	130	15

Note: T means through traffic. L/R means turning traffic.

Table 16. Historical and Forecast Vehicle Delay Time

Midday Peak hour delay (seconds)	2014		2019		2024		2034	
	North Leg	South Leg	North Leg	South Leg	North Leg	South Leg	North Leg	South Leg
Inbound & Spotted	14.8	16.8	16.6	19.6	19.9	24.7	40.1	65.3
Outbound & Spotted	20	16.6	25	18.8	34.5	21.6	147.8	34.9

As a result of this non-linear pattern between peak hour traffic volumes and vehicle delay time at the intersections, the BCA assumed the relationship found in the JUB traffic study report was still valid, and peak hour delay times were applied to the current traffic projection when they matched the closest to the number in the JUB traffic study report. In other words, the relationship between peak hour delay and traffic projection was maintained and applied to years where the data was most suitable. For example, it was assumed the peak hour delay time at Spotted Road/Airport Drive Inbound north leg was still 14.8 seconds when the peak hour traffic reached 125. Therefore, 14.8 seconds of delay was applied to the year when the current peak hour traffic projection was closest to 125. Delay time for other years was either interpolated or applied the delay time Compound Annual Growth Rate (CAGR) between 2014 and 2034. In order to estimate the delay time throughout the day, it was assumed the delay time at Spotted Road/Airport Drive intersections in relation to traffic volumes followed a normal distribution. That is, the average delay time for all vehicles approaching the intersections throughout the day is half of the peak hour delay. Sensitivity analyses were conducted (see Section 9) to monetize travel time savings during the peak hour only. Once the Spotted Road overpass is operational, the vehicle idling time at previous intersections can be fully eliminated.

In order to estimate the disbenefit associated with the longer route travelled on the overpass compared to the existing Spotted Road, total vehicle miles travelled in No Build and Build cases were divided by the corresponding driving speed to estimate total vehicle travel time.

Vehicle idling and travel time was then multiplied by the average vehicle occupancy rate in order to estimate personal travel time, which was monetized based on the value of time assumptions summarized in Table 17 below. The difference in total travel time savings between No Build and Build cases determines the total travel time savings.

Assumptions

The assumptions used in the estimation of quality of life benefits from travel time savings are summarized in the table below.

Table 17: Assumptions used in the Estimation of Quality of Life Benefits from Travel Time Savings

Variable Name	Unit	Value	Source
Average Driving Speed - No Build	mph	30	Speed limit for the existing Spotted Road, south of Airport Drive outbound and in between Airport Drive Inbound and Outbound
Average Driving Speed - Build	mph	35	Speed limit for the proposed Spotted overpass.
Average Vehicle Occupancy - Auto (All Travel)	people/veh	1.67	USDOT BCA Guidance. February, 2021. 2017 National Household Travel Survey.
Average Vehicle Occupancy - Truck	people/veh	1.00	Assuming one truck driver per vehicle.
Value of Travel Time - Auto Passengers (All Purposes)	2019$/hr	$17.9	USDOT BCA Guidance. February, 2021. U.S. DOT Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis.
Value of Travel Time - Truck Drivers	2019$/hr	$30.8	

Benefit Estimates

The table below shows the quality of life benefits from travel times savings. With a 7 percent discount rate, the estimated present value of benefits over the Project life cycle is $1.74 million dollars.

Table 18: Estimates of Quality of Life Benefits from Travel Time Savings, 2019 Dollars

	Over the Project Lifecycle	
	In Constant Dollars	Discounted at 7 Percent
Travel Time Savings	$12,794,611	$1,739,258
Total	**$12,794,611**	**$1,739,258**

In addition to the monetized benefits, the Project would generate improved travel time reliability benefits that are difficult to quantify in absence of detailed traffic modelling. A brief description provided below.

- ***Improved Travel Time Reliability***

Vehicles approaching the Spotted Road/Airport Drive can experience significant delays while waiting for the gap to cross the two intersections, which causes variability in travel time. Grade separating Spotted Road from Airport Drive with an overpass will reduce vehicle wait times at intersections and improve travel time reliability. However, reliability benefits are difficult to monetize for different roadway users.

7.5. State of Good Repair Benefits

The state of good repair benefits are designed to capture benefits from maintaining infrastructure in good condition. This is captured through reduced maintenance costs and the residual value of assets. The residual value captures any useful life left on the assets constructed, and the reduced maintenance costs captures changes in maintenance costs between the No Build and Build Cases.

Methodology

Residual value of the Spotted Road overpass at the end of the study period was calculated using straight line depreciation methodology.

The existing Spotted Road has been aging, and an increasing amount of maintenance costs have been observed during the past few years as a result of increasing rehabilitation and reconstruction of part of the Spotted Road. This can be reduced significantly by replacing it with the new Spotted Road overpass. Therefore, the reduced maintenance costs captured the difference in maintenance costs between Build and No Build cases.

Assumptions

The assumptions used in the estimation of state of good repair benefits are summarized in the table below.

Table 19: Assumptions used in the Estimation of State of Good Repair Benefits

Variable Name	Unit	Value	Source
Years of Benefits	years	30	Based on the maximum benefit years for BCA from 2021 USDOT BCA guidance.
Spotted Road Overpass Useful Life	years	30	Spokane International Airport.
Spotted Road Annual Maintenance Costs - No Build	2019$/year	$278,333	An average of historical maintenance costs of the existing Spotted Road from 2017 to 2019. Data provided by Spokane International Airport.
Spotted Road Overpass Annual Maintenance Costs - Build	2019$/year	Varies by year	Spokane International Airport.

Table 20: Spotted Road Overpass Annual Maintenance Costs, 2019 Dollars

Year	Description	Cost (2019 dollars)
2026-2028	No Maintenance Required	$-
2029	Striping	$5,394
2030	Striping	$5,394
2031	Striping	$5,394
2032	Crack Seal and Asphalt Surface Treatment (Chip Seal)	$62,330
2033	Striping	$5,394
2034	Patching	$2,877
2035	Patching	$2,877
2036	Striping	$5,394
2037	Patching	$2,877
2038	Patching	$2,877

Year	Description	Cost (2019 dollars)
2039	Patching	$2,877
2040	Crack Seal and Asphalt Surface Treatment (Chip Seal)	$62,330
2041	Striping	$5,394
2042	Patching	$2,877
2043	Striping	$5,394
2044	Patching	$2,877
2045	Patching	$2,877
2046	Striping	$5,394
2047	Patching	$2,877
2048	Patching	$2,877
2049	Striping	$5,394
2050	Patching	$2,877
2051	Crack Seal and Asphalt Surface Treatment (Chip Seal)	$62,330
2052	Patching	$2,877
2053	Striping	$5,394
2054	Patching	$2,877
2055	Patching	$2,877

Benefit Estimates

The table below shows estimates of state of good repair benefits. With a 7 percent discount rate, the estimated present value of benefits over the Project life cycle is $2.23 million dollars.

Table 21: Estimates of State of Good Repair Benefits, 2019 Dollars

	Over the Project Lifecycle	
	In Constant Dollars	Discounted at 7 Percent
Reduced Maintenance Costs	$8,068,798	$2,229,420
Residual Value of Asset	$-	$-
Total	**$8,068,798**	**$2,229,420**

8. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the Project (37 years). As stated earlier, the benefits are accrued starting in the first full year of operations, assumed to be 2026. Benefits accrue over the assumed 30 year benefit period.

Table 22: Overall Results of the Benefit Cost Analysis, in Millions of 2019 Dollars

Project Evaluation Metric	Discounted at 7 Percent[9]
Total Discounted Benefits	$32,110,133
Total Discounted Costs	$20,497,464
Net Present Value	$11,612,670
Benefit / Cost Ratio	1.6
Discounted Payback Period (years)	15.2 yrs
Internal Rate of Return (%)	11%

Considering all monetized benefits and costs, the estimated internal rate of return of the Project is 11 percent. The $20.50 million investment would result in $32.11 million in total benefits for a Net Present Value (NPV) of $11.61 million and a Benefit/Cost ratio (BCR) of 1.6.

Table 23: Estimates of Monetized Benefits, 2019 Dollars

Benefit Category	Over the Project Lifecycle	
	In Constant Dollars	Discounted at 7 Percent[10]
Travel Time Savings	$12,794,611	$1,739,258
Improved Safety and Reduced Accident Costs	$117,205,306	$28,638,377
Reduced Maintenance Costs	$8,068,798	$2,229,420
Vehicle Operating Cost Savings	-$1,453,919	-$398,992
Reduced Emission Costs	-$185,995	-$97,929
Residual Value of Asset	$-	$-
Total	**$136,428,802**	**$32,110,133**

[9] 3 percent discount rate for the benefits from reduction in CO2 emissions, and 7 percent discount rate for everything else, as per USDOT BCA Guidance, February 2021.

[10] Ibid.

9. Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections, both of which are subject to considerable 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 "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable;
- 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 sensitivity analysis for the Project are summarized in Table 24. The table provides the percentage changes in the Project NPV associated with variations in variables or parameters.

First of all, the model considers delay time for vehicles on Spotted Road, waiting to cross the intersections during both peak and off-peak hours. Additional sensitivity analysis was conducted to exclude delay time during off-peak hours. This scenario yielded an NPV of $8.34 million and a BCR of 1.4 .

In addition, sensitivity analysis was also conducted with a 20-year benefit period instead of 30, which offers a more conservative approach. The results are still robust with a NPV of $5.70 million and BCR of 1.3.

Finally, a 15% change in future capital cost estimates results in a 23.4% change in NPV, and a BCR range of 1.4 to 1.8, indicating that uncertainty in the cost estimates does not put net public benefits at risk.

Overall, in all instances of the sensitivity analysis, the benefit-cost ratio remains above 1.0 and demonstrates that even with conservative assumptions, the Project improvements are expected to generate a substantial amount of public benefits.

Table 24: Sensitivity Analysis Results

Parameter	Change in Parameter Value	New NPV	Change in NPV	New B/C Ratio
Project Capital Cost	-15% of project capital cost	$14.33 M	23.4%	1.8
	+15% of project capital cost	$8.89 M	-23.4%	1.4
Years of Benefit	20 years of benefit	$5.70 M	-50.9%	1.3
Off Peak Delay Time	Assuming vehicles approaching the Spotted Road/Airport Drive intersections do not experience any delay during off-peak hours.	$8.34 M	-28.2%	1.4