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Memorandum

Subject	**Benefit-Cost Analysis**
Project Name	City of Shoreline SR 523 (N/NE 145th Street) & I-5 Interchange Improvements Project (Interchange Project)
Attention	Nytasha Walters, City of Shoreline John McKenzie, Jacobs Susan Bartlett, Jacobs
From	Dan Pitzler, Jacobs
Date	May 4, 2020

The City of Shoreline (City) SR 523 (N/NE 145th Street) & I-5 Interchange Improvements Project (Interchange Project) will have significant impacts on the Community of Shoreline, the Seattle Metropolitan Area, and the United States, by relieving a congested corridor in the State of Washington. The Interchange Project is expected to decrease transportation costs, improve long term efficiency and reliability, and increase productivity, thereby helping the United States compete in the global economy.

This report describes the results of a benefit-cost analysis (BCA) for the proposed project.

1. Summary

1.1 Project Matrix

A project matrix the summarizes the benefits of the infrastructure improvements proposed for this project is provided in Table 1.

Table 1. Project Matrix – Summary of Infrastructure - Summary of Infrastructure Improvements and Associated Benefits

Current Status/Baseline and Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts
The existing 145th Street and I-5 Interchange is a congested bottle neck for vehicles (with a failing level of service), and a high collision location for vehicles, cyclists, and pedestrians (with an accident rate three times the regional average). Zoning to support increased residential densities in this area and regional data indicates continued and significant growth in this area that will further exacerbate conditions and place additional demands on the facility. Due to its high level of congestion, transit agencies have historically largely avoided providing service on the 145th corridor. Due to its proximity to the Interchange Project and the positive benefit to it, the No Build Alternative would include a Business Access and Transit (BAT) Lane from 5th Avenue to 12th Avenue (a separate Sound Transit project) to improve westbound access to the future Shoreline South/145th Station (light rail), but no changes at other signalized intersections.	The preferred design concept for the SR-523 (N/NE 145th Street) & I-5 Interchange Improvements Project would replace two signalized intersections with modern roundabouts. These improvements will increase capacity through the two most congested intersections along the SR-523 corridor. The Build Alternative would include an improved sidewalk and landscaping along the north side of 145th Street from 5th Avenue to 12th Avenue as part of Sound Transit's Bus Rapid Transit (BRT) project, and a bus access and turn lane from approximately 6th Ave NE to west of 8th Ave NE .	This project would substantially reduce delay to automobile drivers and passengers, truck drivers, bus passengers, pedestrians and cyclists. Further it would improve safety by reducing the frequency and severity of vehicular, pedestrian, and bicycle collisions. The reduced delay would result in fuel cost savings and emissions reductions. Finally, the project will result in a modest reduction in long-term signal maintenance costs.

1.2 Project Cost

The estimated initial capital costs for the project are provided in Table 2.

Table 2. Initial Capital Costs of Alternatives (2019$)

Cost Item	No Build	Build		
		NE 145th Project	Sound Transit BRT Project	Total Build Alternative
Planning	$1,020,000	$1,200,000	$800,000	$2,000,000
Design	$3,170,000	$3,300,000	$2,200,000	$5,500,000
Right of Way	$9,500,000	$2,000,000	$1,800,000	$3,800,000
Construction	$22,000,000	$18,500,000	$17,900,000	$36,400,000
Total	**$35,690,000**	**$25,000,000**	**$22,700,000**	**$47,700,000**

Source: Jacobs compilation of estimates prepared for Sound Transit and Shoreline, 2019.

1.3 Project Benefits and Costs

The benefits from this project include reduced travel time, vehicle, pedestrian, and bicycle collisions, and emissions. The costs include design and construction costs and the cost of long-term maintenance of traffic signals. There could be some differences in the long-term cost of pavement maintenance however the differences in road, sidewalk, and landscaping maintenance are likely to be quite minor between the alternatives and were not quantified. Other benefits and costs not quantified and discussed in Section 4.6 include travel time reliability, modal diversion, work zone impacts, emergency vehicle mobility and reliability, and improved resilience.

A summary of the benefits and costs of the project compared to the No Build alignment is shown in Table 3 at a 7% real discount rate. As shown, net benefits are positive: $981.9 million with a benefit-cost ratio of 104.6.

A sensitivity analysis of the results at a 3% real discount rate is shown in Table 4. At a 3% discount rate, net benefits are greater than at a 7% discount rate. This is because most costs occur relatively soon, and benefits are realized throughout the analysis period: when the discount rate is lower, future benefits are discounted less thus resulting in higher net benefits.

The calculations of the benefits and costs analysis results in an extraordinarily high Benefit-Cost ratio. This is due to two main factors for consideration.

1) **The Build Alternative costs are relatively low compared to the No-Build Alternative**. The No Build Scenario includes considerable investments by Sound Transit to enable their future Bus Rapid Transit (BRT) line to avoid traffic congestion at the interchange project location, including several blocks of widening the roadway for a bus-only and right-turn lane. Many of these improvements by Sound Transit would not be implemented in the Build Alternative due to the travel time benefits to BRT buses gained in the Build Alternative.

2) **Travel time benefits from the roundabouts are significant**. The interchange is a highly congested bottle neck for this regional corridor, and volumes are expected to increase due to the future light rail station, high-density redevelopment around the light rail station, and regional growth. Traffic modeling and analysis for the proposed roundabouts predict substantial travel time benefits from this alternative.

In summary, this project presents a uniquely beneficial project to the Puget Sound region for improving transportation capacity, mobility, and safety for buses, pedestrians, bikes, and vehicles.

Table 3. Summary, Present Value of Benefits and Cost (7% real discount rate)

	Build Alternative
Benefits	
Residual Value Benefit	$481,000
Travel Time Saving	$847,682,000
Collision Cost Savings	$1,937,000
Fuel Cost Reduction	$141,169,000
Emissions Cost Reduction	$41,000
Total Benefits	**$991,310,000**
Total Costs	**$9,384,000**
Net Benefit	**$981,926,000**
Benefit-Cost Ratio	**104.6**

Table 4. Summary, Present Value of Benefits and Cost, (3% real discount rate)

	Build Alternative
Benefits	
Residual Value Benefit	$1,758,000
Travel Time Saving	$1,460,382,000
Collision Cost Savings	$3,604,000
Fuel Cost Reduction	$239,004,000
Emissions Cost Reduction	$67,000
Total Benefits	**$1,704,815,000**
Total Costs	**$11,045,000**
Net Benefit	**$1,693,770,000**
Benefit-Cost Ratio	**153.4**

2. Introduction

The existing 145th Street and I-5 Interchange (Figure 1) is a congested bottle neck for vehicles (with a failing level of service), and a high accident location for vehicles, cyclists, and pedestrians (with a collision rate three times the regional average). Currently, 145th Street (SR 523) crosses over I-5 on an existing bridge deck with two narrow 6-foot sidewalks, two eastbound and two westbound travel lanes (each 11-12 feet wide), and a center lane with westbound and eastbound left-turn pockets. The existing interchange left turn pockets are inadequate to handle existing traffic volumes – with queues spilling back into the east and west bound travel lanes causing significant traffic back-ups. The existing sidewalks are substandard and narrow for the amount of pedestrian and bicycle traffic predicted by the opening of the new light rail station in 2024.

Figure 1. Project Location Map

The problems in the interchange area are predicted to get worse. Regional data indicates continued and significant growth in this area that will further exacerbate conditions and place additional demands on the facility. Shoreline neighborhoods around the Shoreline South/145th Station have been upzoned for high-density transit-oriented development. Due to its high level of congestion, transit agencies have historically largely avoided providing service on the 145th corridor.

3. Description of Alternatives

Both the No Build and Build alternatives assume the Lynwood Link Extension project, providing light-rail services from Northgate to Snohomish County will proceed. That project will include a light rail station just north of the proposed intersection improvements for this project. Further, both projects assume transit service changes planned by King County Metro and Sound Transit will occur with changes in ridership that are common to both the No Build and Build alternatives. The intersection simulation models used to project volumes and delay for autos, trucks, bicycles, and pedestrians for this project also assumed these future changes to transit infrastructure and service.

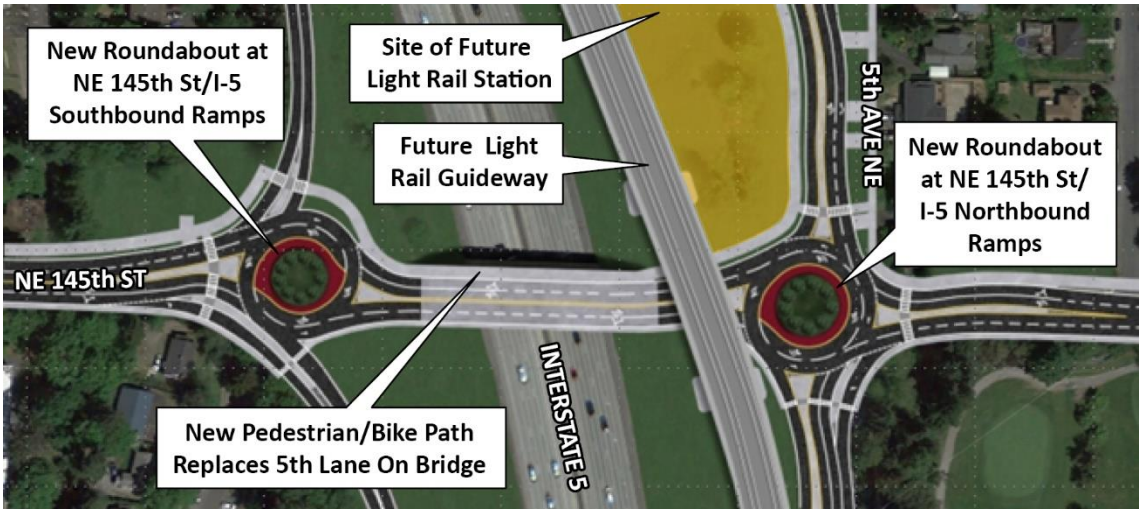
3.1 No Build Alternative

The No Build Alternative includes a series of infrastructure improvements planned by Sound Transit as part of its many ongoing regional mobility improvement programs. Sound Transit is committed to providing Bus Rapid Transit (BRT) Service to/from the future light rail station along 145th Street. In the No Build scenario, the Sound Transit improvements include a west-bound business access and transit (BAT) lane for transit speed and reliability, north sidewalk, and landscaping on 145th Street from 12th Avenue NE to 5th Avenue NE, a signalized intersection at 5th Avenue, and matches to the Lynwood Link Extension improvements east of 5th Avenue NE.

3.2 Build Alternative

The City of Shoreline led a multi-agency study to develop an innovative conceptual design for the interchange that addressed current and future concerns which were brought into the current design phase for detailed analysis with partners. The preferred design concept for the SR-523 (N/NE 145th Street) & I-5 Interchange Improvements Project would replace two signalized intersections with modern roundabouts (see Figure 2). These improvements will increase capacity through the two most congested intersections along the SR-523 corridor.

Figure 2. 145th Street Project Concept



Roundabout-controlled intersections have been demonstrated to improve safety by reducing the number of injury collisions (practically eliminating serious accidents by removing head-on and right-angle collisions) while also reducing delays for all travel modes. The existing I-5 bridge connecting these two intersections will be reconfigured from a 5-lane bridge to a 4-lane bridge and the excess space will be re-utilized for a sizeable shared pedestrian and bicycle path crossing I-5.

In addition, the Build Alternative would include an improved sidewalk along the north side of 145th Street from 6th Avenue to west of 8th Avenue as part of Sound Transit's BRT project, as well as a relatively short, BAT lane from just east of 6th Ave NE to west of 8th Ave NE. The length of the BAT lane for Sound Transit's BRT project would be considerably reduced in the Build Alternative because of the travel time benefits for transit speed and reliability that is achieved from the roundabouts at the interchange.

4. Benefits

This section describes quantified benefits (and disbenefits) of the proposed project, including residual value, travel time savings, collision cost reductions, fuel cost reductions, emissions reductions, and signal maintenance cost savings. Other qualitative benefits are described as well.

Project benefits are assumed to begin with the initial year of operations, 2024, and extend for 30 years, through 2053. Travel volumes and delay for autos and trucks were estimated using various modeling software (VISSIM, Synchro, and Sidra) with a future year of 2042. Because travel volumes and delay are uncertain beyond the end of the modeling horizon, this benefit-cost analysis keeps annual benefits from 2043 to 2053 fixed at 2042 levels.

4.1 Residual Value

The intersection improvements are estimated to have a 50-year useful life, which extends well beyond the end of the 30-year analysis period. To account for the value that extends beyond the analysis period, it was assumed that the assets will depreciate linearly, and the remaining useful life of the capital cost is added as a benefit (negative cost) in the last year of the analysis, 2054. That benefit is then discounted to the present like all other benefits and costs. The net present value of the intersection improvements is $481,000 (Build Alternative minus No Build) as shown in Table 5.

Table 5. Residual Value, Present Value (2019$)

	Residual Value
Residual Value Benefit – No Build Alternative	$1,431,000
Residual Value Benefit – Build Alternative	$1,912,000
Net Residual Value	$481,000

4.2 Travel Time Savings

The project will result in travel time savings by individuals traveling in multiple modes: estimates have been prepared for autos and trucks, buses, and bicycles and pedestrians. The value of travel time savings was calculated in accordance U.S. DOT guidance: 2017 values were escalated to 2019 dollars using the two-year change (Q1 2017 – Q1 2019) in the gross domestic product (GDP) deflator of 3.8%. The results are $15.37 per person-hour (2019$) for all purpose local travel (autos and transit), which assumes that 95.4% of trips are personal and 4.6% of trips are business. Travel time savings for other modes are as follows: $29.70 for truck drivers and $30.63 for pedestrian and bicycles. Sections 4.2.1-4.2.3 describe the methodology used to estimate delay for autos and trucks, transit riders, and bicyclists and pedestrians. Section 4.4 reports estimated travel time savings for each travel mode.

4.2.1 Auto and Truck Delay Calculations

Annual delay for autos and heavy vehicles (trucks and buses) in the project area is shown in Table 6. Volumes and delays at intersections in the project area were modeled during the NE 145th Street Intersection Control Evaluation study (145th ICE study)[1] with follow-up modifications to reflect the most recent version of the build alternative. In that study, the City of Shoreline, Sound Transit and WSDOT reviewed the Puget Sound Regional Council (PSRC) travel demand model's (4K Models) 2040 forecasts, the forecasts used in Shoreline's 145th Corridor Study and in Sound Transit's Stage 2 forecasts to develop 2042 AM and PM peak hour forecasts. To estimate opening year 2024 traffic, a straight-line projection was developed using the 2017 existing traffic counts and the 2042 forecasts.

Estimated annual delay for intersections in the project area for the No Build Alternative in 2017 and 2042 and for the Build Alternative in 2017, 2025, and 2042 are shown in Table 6 (2025 results were interpolated to the 2024 project start date). As noted in that table, expansion factors of 3.0 and 6.0, respectively, were used to estimate delay for a 12-hour "AM" period and a 12-hour "PM" period. These were estimated using the results of one-week hourly traffic counts at 6 locations at intersections in the project area a summary of which is shown in Table 7. As shown in Table 7, this methodology aligned delay to the relationship between volume in an off peak hour to volume in the peak hour as follows: No delay if an off-peak hour's volumes are 70% or less than peak volumes, 50% delay if an off-peak hour's volumes are 70%-90% of peak hour volumes, and 100% of delay if an off-peak hour's volumes are 90% or higher than peak hour volumes. In Table 6, the hours of annual delay at each intersection is calculated as follows:

peak hour volumes * delay (in seconds) / 360 * the off-peak hour expansion factors * annual expansion factor

[1] Lochner, Prepared for the City of Shoreline. *NE 145th Street Intersection Control Evaluation Report*. Draft April 2019.

Table 6. Auto and Heavy Vehicle Delay Estimates

Expansion Factors

Auto/Truck - AM Peak to 12hr AM	3.0
Auto/Truck - PM Peak to 12hr PM	6.0
Days per year	255

	2017 AM Peak Hr		2017 PM Peak Hr		Annual Delay (hrs)
2017 Existing Conditions	**Volumes**	**Delay (s)**	**Volumes**	**Delay (s)**	
145th St NE / 5th Ave NE	3,358	63.6	3,803	30.1	**940,332**
145th St NE / SB I-5 Ramps	3,495	26.9	2,994	64.6	**1,021,786**
145th St NE / 15th Ave NE	3,348	32.1	3,695	33.5	**754,451**
145th St NE / Meridian Ave N	2,475	52.5	2,642	15.7	**452,405**
145th St NE / 1st Ave NE	2,711	84.6	2,550	21.1	**716,041**
5th Ave NE / NB I-5 ramps S of 145th St	1,208	34.2	1,555	478.7	**3,251,400**
5th Ave NE / NB I-5 ramps N of 145th St	1,307	18.4	1,452	6.8	**93,067**
Total Annual Delay (Hours)					**7,229,482**
2042 Existing Conditions					
145th St NE / 5th Ave NE	4,120	107.1	4,628	28.3	**1,494,293**
145th St NE / SB I-5 Ramps	4,171	68.5	3,713	85.3	**1,953,197**
145th St NE / 15th Ave NE	3,450	37.6	4,839	48.6	**1,275,150**
145th St NE / Meridian Ave N	2,742	94.3	2,886	18.9	**781,280**
145th St NE / 1st Ave NE	3,212	111.4	3,057	26.5	**1,104,655**
5th Ave NE / NB I-5 ramps S of 145th St	1,410	43.7	1,712	378.9	**2,887,813**
5th Ave NE / NB I-5 ramps N of 145th St	1,840	63.8	1,847	15.8	**373,484**
Total Annual Delay (Hours)					**9,869,873**
2025 Build Alternative - Roundabout Option					
145th St NE / 5th Ave NE (1)	3,676	9.7	4,111	9.4	**239,571**
145th St NE / SB I-5 Ramps (1)	3,742	8.5	3,290	10.3	**210,944**
145th St NE / 15th Ave NE	3,349	22.4	4,216	31.1	**716,662**
145th St NE / Meridian Ave N	2,557	23.3	2,733	18.2	**338,001**
145th St NE / 1st Ave NE	2,892	58.5	2,722	20.7	**598,980**
5th Ave NE / NB I-5 ramps S of 145th St	1,226	28.7	1,519	233.1	**1,579,606**
5th Ave NE and I-5 NB On Ramp (1)	1,560	18.8	1,572	20.6	**200,065**
Total Annual Delay (Hours)					**3,883,830**
2042 Build Alternative 3 - Roundabout Option					
145th St NE / 5th Ave NE (1)	4,120	13.9	4,628	52.6	**1,156,284**
145th St NE / SB I-5 Ramps (1)	4,171	15.5	3,713	14.8	**370,930**
145th St NE / 15th Ave NE	3,450	23.3	4,839	69.2	**1,593,968**
145th St NE / Meridian Ave N	2,742	59.6	2,886	19.5	**586,452**
145th St NE / 1st Ave NE	3,212	83.2	3,057	26.1	**906,979**
5th Ave NE / NB I-5 ramps S of 145th St	1,410	45.3	1,712	390.5	**2,977,008**
5th Ave NE / NB I-5 ramps N of 145th St (1)	1,840	63.8	1,847	15.8	**373,484**
Total Annual Delay (Hours)					**7,965,105**

Source: NE 145th ICE Report, Draft April 2019, updated for build alternative.

(1) Source: Updated modeling conducted by Lochner and reported in Delay Tables.xlsx

Table 7. Estimated Delay in Off-Peak Periods

	Total Delay / Peak Delay	Delay percent defined as: 0-70% = 0, 70%-90% = 0.5, >90% = 1.0
Peaking "multiplier" at 145th and 5th, all directions	**10.5**	hours of delay for one peak hour delay
AM Peak to 12 hour AM	**4.5**	hours of delay for one peak hour delay
PM Peak to 12 hour PM	**6.0**	hours of delay for one peak hour delay
Peaking "multiplier" at 145th and 1st Ave NE	**9.3**	hours of delay for one peak hour delay
AM Peak to 12 hour AM	**3.3**	hours of delay for one peak hour delay
PM Peak to 12 hour PM	**6.0**	hours of delay for one peak hour delay

Summary of Results on 5th and 145th

		Average All		Total Volume / Peak Volume	Total Delay / Peak Delay	3hr Calculations for Transit			Delay percent defined as: 0-70% = 0, 70%-90% = 0.5, >90% = 1.0
12:00	AM	139		20%	0%		20%	0%	
1:00	AM	88		12%	0%		12%	0%	**Hours of AM off peak delay per hour of AM Peak delay**
2:00	AM	72		10%	0%		10%	0%	
3:00	AM	54		8%	0%		8%	0%	
4:00	AM	88		12%	0%		12%	0%	
5:00	AM	233	AM	33%	0%		33%	0%	
6:00	AM	487		69%	0%		69%	0%	
7:00	AM	637		90%	45%		90%	100%	
8:00	AM	711		100%	100%				
9:00	AM	697		98%	98%	706			**0.2**
10:00	AM	709		100%	100%				
11:00	AM	742		104%	104%		105%	100%	
12:00	PM	799		85%	43%		88%	50%	
1:00	PM	792		85%	42%		87%	50%	
2:00	PM	867		93%	93%		95%	100%	
3:00	PM	894		96%	96%		98%	100%	
4:00	PM	912		98%	98%				
5:00	PM	935	PM	100%	100%	909			**0.4**
6:00	PM	881		94%	94%				
7:00	PM	713		76%	38%		78%	50%	
8:00	PM	564		60%	0		62%	0%	
9:00	PM	496		53%	0		55%	0%	
10:00	PM	357		38%	0		39%	0%	
11:00	PM	234		25%	0		26%	0%	

Summary of Results at NE 145th St w-o 1st Ave NE EB-WB

12:00	AM	159		15%	0%		16%	0%	
1:00	AM	101		10%	0%		10%	0%	
2:00	AM	93		9%	0%		9%	0%	
3:00	AM	67		7%	0%		7%	0%	
4:00	AM	119		11%	0%		12%	0%	
5:00	AM	301	AM	29%	0%		31%	0%	
6:00	AM	698		67%	0%		71%	0%	
7:00	AM	1014		98%	98%		103%	100%	
8:00	AM	1035		100%	100%	982			**0.2**
9:00	AM	897		87%	43%				
10:00	AM	865		84%	42%		88%	50%	
11:00	AM	897		87%	43%		91%	50%	
12:00	PM	927		85%	43%		89%	50%	
1:00	PM	933		86%	43%		89%	50%	
2:00	PM	990		91%	91%		95%	100%	
3:00	PM	1071		99%	99%		103%	100%	
4:00	PM	1037		95%	95%				
5:00	PM	1087	PM	100%	100%	1044			**0.4**
6:00	PM	1007		93%	93%				
7:00	PM	787		72%	36%		75%	50%	
8:00	PM	656		60%	0		63%	0%	
9:00	PM	527		49%	0		51%	0%	
10:00	PM	394		36%	0		38%	0%	
11:00	PM	238		22%	0		23%	0%	

Source: Summary of traffic counts at project intersections, Lochner. October and December, 2017.

The annual expansion factor means that average annual delay is calculated by multiplying average daily delay by 255.

Table 7 also shows off-peak expansion factors used to estimate annual transit delay. In the last columns of table, traffic counts are shown for a 3-hour peak period and off-peak. We used this information estimate that each off-peak transit passenger experiences 0.2 times the delay of a trip made during the AM peak and 0.4 times the delay of a trip made during the PM peak. The 145th St ICE study reports that heavy vehicles (trucks and buses) represent 3.5 percent of all vehicle traffic in the project area. Jacobs estimates that 90 percent of the heavy vehicle trips are trucks and 10 percent of the trips are buses. (This estimate is needed because other data sources are used to estimate bus transit passenger travel time savings.) Thus, for the volumes show in Table 6, 96.5 percent are assumed to be cars and 3.15 percent are assumed to be trucks.

For passenger vehicles, an average vehicle occupancy of 1.68 from US DOT benefit-cost guidance is used to calculate delay experienced by individuals[2].

4.2.2 Transit Ridership and Delay Calculations

Delay experienced by transit riders was calculated based on data developed as part of the Lynwood Link Extension work approved by the Federal Transit Administration as part of Sound Transit's New Starts submittal process. Annual ridership for the No Build and Build Alternatives and estimated delay in 2016, 2025, and 2042 are shown in Table 8 (2025 results were interpolated to the 2024 project start date). That table shows estimated daily ridership, outbound and inbound, during 3-hour AM and PM peaks and off-peak periods using 2016 service and projected services in 2042. Annual ridership is calculated using an expansion factor of 303 for King County Metro routes (the 512 only) and 290 for Sound Transit routes (all other routes).

Delay per rider was estimated by DKS and Associates 2019 for Sound Transit's SR 522 and 145th Street BRT Projects. Off-peak delay was estimated using the daily traffic count information shown in Table 7 and described in Section 4.2.1. 2016 delay was estimated to be 67 percent of 2042 delay which is the ratio between the aggregated 2017 and 2042 delay estimates shown in Table 6. Total annual delay in 2016 and 2042 is calculated by multiplying daily delay by 365. 2024 and 2025 annual delay is calculated by interpolating between 2016 and 2042.

4.2.3 Bicycle and Pedestrian Delay Calculations

For the purposes of this analysis, bicycle and pedestrian crossings and crossing times are estimated for the No Build and Build Alternatives at the two intersections where the roundabouts are proposed (NE 145th St and 5th Ave NE and NE 145th St and I-5 SB ramps).

Current intersection crossings were estimated using traffic counts during the PM peak hour during the 2017 traffic counts referenced in Section 4.2.1. The 2042 intersection crossings during the PM peak hour were estimated using the modeling for the 145th ICE study. Average crossing times were developed assuming a pedestrian walking 3.5 ft per second, no added delay at roundabouts, and 30 seconds added delay for signalized crossings. Daily pedestrian crossings were estimated using a peak-daily expansion factor of 4.0 and 300 days per year of crossings (Jacobs estimates).

As shown in Table 9, annual bicycle and pedestrian crossing times in 2042 are estimated to be 38,247 hours in the No Build Alternative and 12,327 hours in the build alternative.

[2] USDOT Benefit Cost Analysis Guidance for Discretional Grant Programs, 2018.

Table 8. Transit Ridership and Delay Estimates

2016 Model - Passengers in Project Area

Transit Routes	Passengers																		Total	Annualized Ridership, Incremental Model Outputs
	PM (3-HR Peak)						AM (3-HR Peak)						Off Peak (rest of day)							
	Outbound			Inbound			Outbound			Inbound			Outbound			Inbound				
301	713									713									1,426	432,078
303	267	11								196	82								556	168,468
304	173	17								153	37								380	115,140
308	170	1								167	4								342	103,626
347	113	16	47	93	27	55	93	27	55	113	16	47	156	34	138	128	52	148	1,358	411,474
373 (1)	182	18		155	44														399	120,897
512 (1)				307	87		311	83											788	228,520
Total	1,728			768			569			1,528			328			328			5,249	1,580,203
Annual Ridership	**523,584**			**227,582**			**167,285**			**462,984**			**99,384**			**99,384**			**1,580,203**	

(1) This route is shown in service tables to operate both direction in the peak but model includes only one.

Source: Parameters are based on standard calculations used in the incremental modeling process originally developed by Sound Transit that have been used in the New Starts submittal process with FTA.

2042 Model - Passengers in Project Area

Transit Routes	Passengers																		Total	Annualized Ridership, Incremental Model Outputs
	PM (3-HR Peak)						AM (3-HR Peak)						Off Peak (rest of day)							
	Outbound			Inbound			Outbound			Inbound			Outbound			Inbound				
28	216	178		178	216		178	216		216	178		249	310		310	249		2,694	816,282
1019S				507	619		399	727					548	851		925	474		5,050	1,530,150
1019N				224	366		179	224					430	780		793	416		3,412	1,033,836
Zbus4a	1017	1017		136	136		136	136		1017	1017		775	775		683	683		7,528	2,280,984
Zbus4b	1017	1017		138	138								775	775		702	702		5,264	1,594,992
Total	4,462			2,658			2,195			2,428			6,268			5,937			23,948	7,256,244
Annual Ridership	**1,351,986**			**805,374**			**665,085**			**735,684**			**1,899,204**			**1,798,911**			**7,256,244**	

Source: Parameters are based on standard calculations used in the incremental modeling process originally developed by Sound Transit that have been used in the New Starts submittal process with FTA.

Annualization Factor For Ridership KCM (1)	303
Annualization Factor For Ridership ST Exp (1)	290

(1) Source: Annualization rates for ridership were taken from data calculated as part of the Lynnwood Link Extension work that was approved by FTA as part of the New Starts submittal process

	Passengers						
	PM (3-HR Peak)		AM (3-HR Peak)		Off Peak (rest of day)		Annual
Delay - 2016							
Delay per Rider (sec)	48.9	36.2	78.4	22.1	24.7	6.5	
Annual Delay (hrs)	71,108	22,863	36,413	28,424	6,831	1,787	167,427

2016 Delay as a percent of 2042 delay	67%	Based on 5th and 145th no build intersection modeling.
Off Peak delay/rider as percent of PM peak delay	39%	Based on traffic counts in the project area (see Section 2.4.1).
Off Peak delay/rider as percent of AM peak delay	22%	Based on traffic counts in the project area (see Section 2.4.1).

Delay - 2042 No Build							
Delay per Rider (sec) (1)	73.0	54.0	117.0	33.0	36.9	9.7	
Annual Delay (hrs)	274,153	120,806	216,153	67,438	194,903	48,304	921,756
Delay - 2042 Build							
Delay per Rider (sec) (1)	11.7	34.0	17.3	21.8	5.6	6.2	
Annual Delay (hrs)	43,940	76,063	31,961	44,550	29,748	30,981	257,243

Delay - 2025 No Build	
Delay - annual growth rate	6.8%
Delay (annual, hrs)	302,171
Delay - 2025 Build	1.7%
Delay (annual, hrs)	194,263

(1) Source = DKS and Associates 2019 for Sound Transit SR 522 and 145th Street BRT Project.

Table 9. Bicycle and Pedestrian Delay Estimates

2017 PM Peak Bicycle and Pedestrian Crossings

Bicycle and Pedestrian Crossings, PM Peak

	Approach				
	East	West	North	South	Total
145th St. @ 5th Ave.	9	n.a.	10	29	48
145th St. @ SB I-5 Ramp	1	27	6	28	62

Source: Lochner, Rob B email, June 14, 2019.

Crossing Times (seconds)

	Approach			
	East	West	North	South
145th St. @ 5th Ave.	48	n.a.	55	51
145th St. @ SB I-5 Ramp	n.a.	n.a.	44	47

Source: Lochner, Two RAB w ped crossing time.pdf.

Total PM Peak Crossing Times (seconds)

	Approach				
	East	West	North	South	Total
145th St. @ 5th Ave.	432	n.a.	550	1,479	2,461
145th St. @ SB I-5 Ramp	n.a.	n.a.	264	1,316	1,580
Total Annual Crossing Times (hours)					13,470

2042 No Build PM Peak Build Bicycle and Pedestrian Crossings

Bicycle and Pedestrian Crossings, PM Peak

	Approach				
	East	West	North	South	Total
145th St. @ 5th Ave.	97	n.a.	37	37	171
145th St. @ SB I-5 Ramp	0	56	6	56	118

Source: Lochner. 2042 Future Ped Volumes.pdf, 2019.

Crossing Times (seconds)

	Approach			
	East	West	North	South
145th St. @ 5th Ave.	48	n.a.	55	51
145th St. @ SB I-5 Ramp	n.a.	n.a.	44	47

Source: Lochner, Two RAB w ped crossing time.pdf.

Total PM Peak Crossing Times (seconds)

	Approach				
	East	West	North	South	Total
145th St. @ 5th Ave.	4,656	n.a.	2,035	1,887	8,578
145th St. @ SB I-5 Ramp	n.a.	n.a.	264	2,632	2,896
Total Annual Crossing Times (hours)					38,247

2042 Build PM Peak Build Bicycle and Pedestrian Crossings

Bicycle and Pedestrian Crossings, PM Peak

	Approach				
	East	West	North	South	Total
145th St. @ 5th Ave.	97	n.a.	37	37	171
145th St. @ SB I-5 Ramp	0	56	6	56	118

Source: Lochner. 2042 Future Ped Volumes.pdf, 2019.

Crossing Times (seconds)

	Approach			
	East	West	North	South
145th St. @ 5th Ave.	22	n.a.	17	7
145th St. @ SB I-5 Ramp	n.a.	25	10	11

Source: Lochner, Two RAB w ped crossing time.pdf.

Total PM Peak Crossing Times (seconds)

	Approach				
	East	West	North	South	Total
145th St. @ 5th Ave.	2,134	n.a.	629	259	3,022
145th St. @ SB I-5 Ramp	n.a.	n.a.	60	616	676
Total Annual Crossing Times (hours)					12,327

PM Peak Hour to Daily Expansion Factor	4.0	Source: Jacobs estimates
Days per Year	300	Source: Jacobs estimates

Note: No crossing allowed today for west leg of 145th St @ SB I-5 ramp: thus this leg is excluded from estimates

Note: Crossing times based on a pedestrian walking 3.5 ft per second, no added delay at roundabouts, and 30 seconds added delay for signalized crossings.

4.2.4 Total Travel Time Savings

The present value of travel time savings by mode are shown in Table 10. As shown, the 30-year present value benefit of annual travel time savings in 2019 dollars is $847.7 million.

Table 10. Present Value of Travel Time Savings, 2024-2053 (7% real discount rate)

	Travel Time Savings
No Build Delay, Autos	$2,083,824,000
No Build Delay, Trucks	$98,658,000
No Build Delay, Buses	$77,280,000
No Build Delay, Bicycle and Pedestrians	$7,842,000
Build Delay, Autos	$1,323,315,000
Build Delay, Trucks	$62,652,000
Build Delay, Buses	$31,160,000
Build Delay, Bicycle and Pedestrians	$2,794,000
Total Travel Time Savings	**$847,682,000**

4.3 Vehicle Collision Cost Reductions

The estimated reduction in vehicle collisions resulting from the project are shown in Table 11. A collision modification factor of 0.79 is used for converting a signalized intersection to a roundabout. Five-year collision history in the project vicinity was used to represent historical collision frequencies. It was assumed that collisions per vehicle would remain constant through time which implies that collisions will increase proportional to volumes all other things being equal. Projected volume increases (from Section 4.2.1) are used to estimate future collisions. The dollar value of reduced vehicle injuries and property damages are taken from US DOT benefit-cost guidance. The present value of vehicle collision cost reductions is shown in Table 12.

The estimates shown in this section reflect collisions from all travel modes: no attempt to break out bicycle and pedestrian from motor vehicle collisions was made. It's possible that a more in-depth analysis with separated crash modification factors for vehicles compared to bicycles and pedestrians could result in slightly different collision cost estimates. Further, the vehicle travel time saving estimates shown in Table 10 and the collision cost estimates shown in Table 11 do not account for the impact of collisions on travel delay. The reduction in collisions resulting from the Build Alternative would result in reduced delay associated with collisions. As a result, the monetized benefits shown in this analysis are conservative and likely understate the actual benefits of the Build Alternative.

Table 11. Calculation of Collision Reduction Estimates

CMF for Converting Signal Control to Roundabout

CMF 0.79

Source: WSDOT CMF Table.

Based on Source Document: NCHRP Report 705 "Evaluation of Safety Strategies at Signalized Intersections"

Historical Collision Statistics in Project Vicinity

KABCO	5-yr total	Annual Avg	2017 No Build	Est 2017 Build Alternative
Property damage only	716	143	143	113
C, Possible injury	196	39	39	31
B, Evident, Non-incapacitating	63	13	13	10
A, Incapacitating, Serious Injury	0	0	0	0
K, Killed, Fatal collision	0	0	0	0
U, Injured, severity unknown	3	1	0.6	0.5

Source: Officer Reported Crashes occurring in project area, provided by Lochner, 2019.

Historical and Forecast Crashes at Intersections being Replaced by Roundabouts

145th and I-5 SB Ramp	5-yr total	Annual Avg			No Build			Build		
Total	56		2017 No Build	Est 2017 Build Alternative	2017	2025	2042	2017	2025	2042
Peak Traffic Volumes (AM+PM)					7,161	7,788	8,748	7,161	7,788	8,748
Property damage only	39	7.8	7.8	6.2	7.8	8.5	9.5	n.a.	6.7	7.5
C, Possible injury	13	2.6	2.6	2.0	2.6	2.8	3.1	n.a.	2.2	2.5
B, Evident, Non-incapacitating	4	0.8	0.8	0.7	0.8	0.9	1.0	n.a.	0.7	0.8

145th and 5th Ave NE	5-yr total	Annual Avg			No Build			Build		
	96		2017 No Build	Est 2017 Build Alternative	2017	2025	2042	2017	2025	2042
Total					6,489	7,032	7,884	6,489	7,032	7,884
Property damage only	67	13.4	13.4	10.6	13.4	14.5	16.3	n.a.	11.5	12.9
C, Possible injury	22	4.4	4.4	3.5	4.4	4.8	5.3	n.a.	3.8	4.2
B, Evident, Non-incapacitating	7	1.4	1.4	1.1	1.4	1.5	1.7	n.a.	1.2	1.4

Both Intersections					No Build			Build		
Total	5-yr total	Annual Avg	2017 No Build	Est 2017 Build Alternative	2017	2025	2042	2017	2025	2042
Property damage only	106	21.2	21.2	16.7	21.2	23.0	25.8	n.a.	18.2	20.4
C, Possible injury	35	7.0	7.0	5.5	7.0	7.6	8.5	n.a.	6.0	6.7
B, Evident, Non-incapacitating	11	2.2	2.2	1.8	2.2	2.4	2.7	n.a.	1.9	2.2

Table 12. Present Value of Vehicle Collision Cost Savings, 2024-2053 (7% real discount rate)

	Collision Cost Savings
Property damage only	$216,000
Possible injury	$1,057,000
Evident, non-incapacitating	$664,000
Total Vehicle Collision Cost Savings	**$1,937,000**

4.4 Vehicle Operating Costs

For the Interchange Project any change in vehicle operating costs will be small and too difficult to measure with any degree of accuracy. Vehicles may travel slightly fewer feet with a roundabout compared to a signalized intersection, but there may be slightly more tire wear associated with the roundabout. Thus, no changes in vehicle operating costs are estimated for this analysis.

4.5 Fuel Cost Reductions

Fuel cost reductions for autos and trucks are estimated using the following parameters and sources:

- $3.50 per gallon gasoline and $3.46 per gallon for diesel: AAA Gas Prices for Seattle-Bellevue-Tacoma, July 7, 2019[3].
- Fleet average fuel economy of 23.6 miles per gallon for cars, from AAA Your Cost of Driving[4], 2019, and 6.4 miles per gallon for trucks from An Analysis of the Operational Costs of Trucking, 2018 update[5].
- Fleet average fuel economy was multiplied by 28.3 percent which is the ratio of fleet average fuel economy at 5 miles per hour (to simulate delay conditions) and 50 miles per hour (for fleet average conditions) from California Air Resources Board CO2e methodology[6].

Fuel use was converted to gallons per hour assuming 5 miles per gallon and multiplied by annual delay estimates for autos as trucks (see Section 4.2.1). The present value of fuel cost savings for autos and trucks is shown in Table 13. As shown, the present value of estimated fuel cost savings is $141 million.

[3] https://gasprices.aaa.com/?state=WA, Accessed July 7, 2019.

[4] https://exchange.aaa.com/automotive/driving-costs/ Accessed July 7, 2019.

[5] American Transportation Research Institute. https://atri-online.org/wp-content/uploads/2018/10/ATRI-Operational-Costs-of-Trucking-2018.pdf Accessed July 7, 2019.

[6] https://ww3.arb.ca.gov/msei/onroad/downloads/pubs/co2final.pdf Accessed July 7, 2019.

Table 13. Present Value of Fuel Cost Savings 2024-2053, (7% real discount rate)

	Fuel Cost Savings
No Build – Autos	$355,177,000
No Build – Trucks	$31,632,000
Build – Autos	$225,552,000
Build – Trucks	$20,088,000
Total Fuel Cost Savings	**$141,169,000**

Fuel cost reductions for buses are not estimated because the fuel mix of the future bus fleet is highly uncertain. Thus, quantified project benefits may be understated somewhat.

4.6 Emissions Reductions

Burning fuel results in air emissions that can damage human health and property. Table 14 shows the dollar value of emissions from U.S. DOT guidance. Those values were multiplied by the tons of each pollutant with delay converted to pollutants using grams per mile for autos and trucks traveling at an average speed of 5 miles per hour (used to estimate idling and low speeds during delay conditions).

Emission factors of criteria pollutants, including volatile organic compounds (VOC), carbon monoxide (CO), nitrogen oxides (NOx), particulate matter from vehicles travel and idling in the project study area were estimated using California Department of Transportation's CT-EMFAC2017 program for 2025 and 2042 using Emission factors were obtained using EMFAC2017 using vehicle category LDA for autos and T6 utility, diesel for trucks[7]. The emission factors for autos and trucks, in grams, are shown in Table 15. Those factors are converted to tons, then multiplied by hours of delay (from Section 4.2.1, 2025 results were interpolated to the 2024 project start date).

The present value of emissions cost reductions is shown in Table 16. As shown, there would be a modest reduction of $41,000 in emissions associated with the Build Alternative.

Table 14. Dollar Value of Emission Reductions (2019$)

Pollutant	Monetary Value	
NO_X Emission	$8,618	*Per ton*
$PM_{2.5}$ Emission	$392,287	*Per ton*
SO_2 Emission	$50,775	*Per ton*
VOC Emission	$2,077	*Per ton*
Greenhouse gas emissions[a]	$1-$2	*Per metric tonne*
Source: US DOT Benefit-Cost Guidance for Discretionary Grant Programs. December 2018. [a]*Varies by year per USDOT guidance.*		

[7] https://www.arb.ca.gov/emfac/2017/ Accessed July 7, 2019.

Table 15. Emissions, grams per hour

Emission	Autos	Trucks
Auto		
VOCs	0.2213	0.0612
NOx	0.2735	0.1585
SO2	0.0287	0.0229
CO2	2,899	2,319
PM2.5	0.0409	0.0173
Truck		
VOCs	0.2104	0.2077
NOx	22.1634	22.7589
SO2	0.1073	0.0888
CO2	11,354	9,403
PM2.5	0.0127	0.0122

EMFAC2017 using vehicle category LDA for autos and T6 utility, diesel for trucks. https://www.arb.ca.gov/emfac/2017/

Note: SOx used to estimate SO2. Based on a review of the available literature...for major point sources, SO2 represents 95% or greater of the total sulphur emission. Source: Continued improvements of inventory methodologies: Task 4.1 Improving the quality of SOx/SO2 estimates and reporting, European Commission Ref. 070201/2014/693666/FRA/ENV.C.3 , 2016

4.6.1 Benefits Not Addressed Quantitatively

4.6.1.1 Travel Time Reliability

The proposed interchange is expected to provide a benefit for passenger vehicles and other commuters during peak hour periods, by significantly reducing congestion and bottlenecks during these periods. With the reduction in congestion and bottlenecks during these peak periods, it is expected that the variation in the amount of time that vehicles are held up along this corridor will be significantly reduced. In particular, this benefits transit service and transit passengers to have more predictable and reliable arrival times and travel times.

The US DOT benefit-cost guidance states that "At this time, USDOT does not have a specific recommended methodology for valuing reliability benefits in BCA. If applicants nevertheless choose to present monetized reliability improvements in their analysis, they should carefully document the methodology and tools used, and clearly explain how the parameters used to value reliability are separate and distinct from the value of travel time savings used in the analysis." While the City believes the build alternative would result in noteworthy travel time benefits, this study does not attempt to monetize those benefits because of the complexity and uncertainty associated preparing those estimates.

4.6.1.2 Modal Diversion

While the volume of traffic along the 145th Street corridor is expected to be relatively consistent with or without the preferred alternative, the pedestrian improvements in the project area support the planned increase in bus and light rail boardings by Sound Transit, which will reduce automobile traffic in other areas, with associated savings in vehicle operating costs, accidents, and emissions. It is questionable if the planned transit increases would be achieved to the levels anticipated without these improvements, but data was not available about the potential for modal diversion away from automobiles. Thus, this potential benefit was not quantified in this analysis.

4.6.1.3 Work Zone Impacts

While any construction project will generally lead to some traffic delays during construction, the City intends to undertake measures during the construction to mitigate or reduce these delays, primarily by avoiding construction activities during peak volume periods. By avoiding construction during peak periods traffic delay during construction is likely to be relatively minor and was not quantified in this analysis. To the extent construction delay during construction occurs, the quantified net benefits for this project will be overstated somewhat.

Table 16. Present Value of Emissions Cost Reductions (2019$)

Emissions	Emissions Cost
No Build	
Auto	
VOCs	$41,000
NOx	$275,000
SO2	$1,513,000
CO2	$385,000
PM2.5	$214,000
Truck	
VOCs	$2,000
NOx	$709,000
SO2	$141,000
CO2	$38,000
PM2.5	$2,000
Build	
Auto	
VOCs	$24,000
NOx	$231,000
SO2	$1,221,000
CO2	$384,000
PM2.5	$129,000
Truck	
VOCs	$1,000
NOx	$517,000
SO2	$116,000
CO2	$38,000
PM2.5	$2,000
Total Emissions	
No Build	$3,319,000
Build	$3,278,000
Total Emissions Reductions	**$41,000**

4.6.1.4 Emergency Vehicle Mobility and Reliability

The intersection improvements will lessen delay and improve reliability for emergency vehicles traveling through the project area. Emergency vehicle volumes for the Build and No Build alternatives were unavailable for this study. Thus, the time savings associated with emergency vehicles is likely understated for circumstances when seconds may be important to an emergency response.

4.6.1.5 Quality of Life

The proposed improvements are expected to improve the quality of life in the area by making facilities more ADA accessible, making walking and cycling a more pleasant experience, and other factors. These benefits are difficult to reliably monetize, and thus have been described qualitatively.

5. Costs

The initial capital costs associated with the No Build and Build Alternatives are shown in Table 17. As shown the No Build Alternative is estimated to cost $35.7 million and the Build Alternative is estimated to cost $47.4 million. It is important to note that the No Build alternative includes costs for Sound Transit's Bus Rapid Transit improvements to achieve bus transit speed and reliability that would not be implemented in the Build Alternative due to the speed and reliability benefits gained by the roundabouts.

Table 17. Initial Capital Costs of Alternatives (2019$)

Cost Item	No Build	Build		
		NE 145th Project	Sound Transit BRT Project	Total Build Alternative
Planning	$1,020,000	$1,200,000	$800,000	$2,000,000
Design	$3,170,000	$3,300,000	$2,200,000	$5,500,000
Right of Way	$9,500,000	$2,000,000	$1,800,000	$3,800,000
Construction	$22,000,000	$18,500,000	$17,900,000	$36,400,000
Total	**$35,690,000**	**$25,000,000**	**$22,700,000**	**$47,700,000**
Source: Jacobs compilation of estimates prepared for Sound Transit and Shoreline, 2019.				

During operations there will be a long-term savings in maintenance costs related to replacing two signals with the roundabouts. Historical data from the City of Shoreline suggest an annual maintenance cost of about $10,000 per signal which corresponds to a present value of savings during the 2024-2053 period of $189,000.

There could be some differences in the long-term cost of pavement maintenance however the differences in road, sidewalk, and landscaping maintenance are likely to be quite minor between the alternatives and were not quantified.

6. Summary of Benefits and Costs

The calculations of the benefits and costs analysis results in an extraordinarily high Benefit-Cost ratio. This is due to two main factors for consideration. 1) **The Build Alternative costs are relatively low compared to the No Build Alternative**. The No Build Scenario includes considerable investments by Sound Transit to enable their future Bus Rapid Transit (BRT) line avoid the traffic congestion at the interchange project location, including several blocks of widening the roadway for a bus lane. The length of BAT lane in the Build Alternative would be significantly reduced because of the travel time benefits to BRT buses gained by the roundabouts in the Build Alternative. 2) **Travel time benefits from the roundabouts are significant**. The interchange is a highly congested bottle neck for this regional corridor, and volumes are expected to increase due to the future light rail station and high-density redevelopment around the light rail station. Traffic modeling and analysis for the proposed roundabouts predict substantial travel time benefits from this alternative.

A summary of the benefits and costs of the project compared to the No Build alignment is shown in Table 18 at a 7% real discount rate. As shown, net benefits are positive: $981.9 million with a benefit-cost ratio of 104.6.

Table 18. Summary, Present Value of Benefits and Cost (7% real discount rate)

	Build Alternative
Benefits	
Residual Value Benefit	$481,000
Travel Time Saving	$847,682,000
Collision Cost Savings	$1,937,000
Fuel Cost Reduction	$141,169,000
Emissions Cost Reduction	$41,000
Total Benefits	**$991,310,000**
Total Costs	**$9,384,000**
Net Benefit	**$981,926,000**
Benefit-Cost Ratio	**104.6**

A sensitivity analysis of the results at a 3% real discount rate is shown in Table 19. At a 3% discount rate, net benefits are higher than at a 7% discount rate ($1.7 billion). This is because most costs occur relatively soon, and benefits are realized throughout the analysis period: when the discount rate is lower, future benefits are discounted less thus resulting in higher net benefits.

Table 19. Summary, Present Value of Benefits and Cost, (3% real discount rate)

	Build Alternative
Benefits	
Residual Value Benefit	$1,758,000
Travel Time Saving	$1,460,382,000
Collision Cost Savings	$3,604,000
Fuel Cost Reduction	$239,004,000
Emissions Cost Reduction	$67,000
Total Benefits	**$1,704,815,000**
Total Costs	**$11,045,000**
Net Benefit	**$1,693,770,000**
Benefit-Cost Ratio	**153.4**

The annual benefits and costs in 2019$ are shown in Table 20.

Table 20. Annual Benefit-Cost Results (2019$)

	Residual Value	Travel Time Savings	Vehicle Collision Cost Savings	Fuel Cost Reduction	Emissions Cost Reduction	Net Initial Capital Cost	Maintenance Cost
2019	$0	$0	$0	$0	$0	($956,000)	$0
2020	$0	$0	$0	$0	$0	($717,000)	$0
2021	$0	$0	$0	$0	$0	($717,000)	$0
2022	$0	$0	$0	$0	$0	$8,640,000	$0
2023	$0	$0	$0	$0	$0	$5,760,000	$0
2024	$0	$110,033,783	$202,771	$19,260,633	$6,986	$0	$20,000
2025	$0	$109,047,736	$193,021	$18,974,682	$6,559	$0	$20,000
2026	$0	$107,557,707	$194,332	$18,662,393	$6,157	$0	$20,000
2027	$0	$105,932,138	$195,652	$18,322,452	$5,780	$0	$20,000
2028	$0	$104,164,704	$196,980	$17,953,490	$5,427	$0	$20,000
2029	$0	$102,248,831	$198,318	$17,554,074	$5,095	$0	$20,000
2030	$0	$100,177,684	$199,665	$17,122,707	$4,783	$0	$20,000
2031	$0	$97,944,162	$201,021	$16,657,827	$4,490	$0	$20,000
2032	$0	$95,540,885	$202,386	$16,157,801	$4,215	$0	$20,000
2033	$0	$92,960,187	$203,761	$15,620,922	$3,957	$0	$20,000
2034	$0	$90,194,105	$205,144	$15,045,409	$3,715	$0	$20,000
2035	$0	$87,234,371	$206,538	$14,429,401	$3,488	$0	$20,000
2036	$0	$84,072,401	$207,940	$13,770,954	$3,274	$0	$20,000
2037	$0	$80,699,285	$209,352	$13,068,038	$3,074	$0	$20,000
2038	$0	$77,105,778	$210,774	$12,318,533	$2,886	$0	$20,000
2039	$0	$73,282,287	$212,205	$11,520,224	$2,709	$0	$20,000
2040	$0	$69,218,862	$213,647	$10,670,800	$2,543	$0	$20,000
2041	$0	$64,905,185	$215,097	$9,767,844	$2,388	$0	$20,000
2042	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2043	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2044	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2045	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2046	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2047	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2048	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2049	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2050	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2051	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2052	$0	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000
2053	$4,804,000	$60,330,559	$216,558	$8,808,837	$2,242	$0	$20,000