Technical Memorandum

TO:	Pedro Rodriguez, NDOT	**DATE:**	January 7, 2013
FROM:	John Karachepone, Jacobs		
SUBJECT:	USA Parkway – Benefit-Cost Analysis		
COPIES:	Bryan Gant, Jacobs		

1. INTRODUCTION AND BACKGROUND

USA Parkway (SR 439) begins at I-80 about 10 miles east of Reno at the USA Parkway Interchange. Currently, approximately six miles of the USA Parkway alignment within Storey County has been paved and the remaining is graded to the Lyon County line. The paved section is a four-lane divided arterial with open median. Extension of the USA Parkway southeast from Storey County into Lyon County to tie into US 50 in Silver Springs is proposed.

USA Parkway (SR 439) has been envisioned as an important link between US 50 and I-80. Currently, US 395 through Carson City, SR 341 through Virginia City and US 95A through Fernley are used to connect the Reno metro area with points south and east. A complete USA Parkway between US 50 and I-80 will improve this connectivity. In addition, the development of the Tahoe-Reno Industrial Center (TRIC) along USA Parkway continues to change the employment and transportation character of the region. The TRIC is planned to become a large industrial park. Figure 1-1 illustrates the proposed project in relation to surrounding roadways and land use.

Jacobs is retained by the Nevada Department of Transportation (NDOT) to provide environmental and preliminary engineering services for the proposed project. At the present time, it appears that an Environmental Assessment (EA) will be the appropriate class of action for National Environmental Policy Act (NEPA) conformance. The lead agency is the Federal Highway Administration (FHWA) with joint NDOT and Bureau of Land Management (BLM) participation. The anticipated opening year for the proposed project is 2017. The design year is 2037, consistent with NDOT's and FHWA's 20 year beyond opening year policy.

A benefit-cost analysis was completed in support of the EA, to determine whether the USA Parkway extension is an economically efficient investment. The purpose of this memorandum is to present the methodology, assumptions and the results of the benefit-cost analysis. Figure 1-2 shows the general traffic study area. This is the project traffic influence area for the traffic forecasting and traffic operations analysis for the EA; the geographic scope of the benefit-cost analysis is bigger than this traffic influence area. The geographic scope of the benefit-cost analysis corresponds to the extents of the travel demand model developed for the USA Parkway EA.

Future year traffic forecasts, anticipated Vehicle Miles Traveled (VMT), Vehicle Hours Traveled (VHT) and average speed of travel in the model area were presented in the *USA Parkway Traffic Forecast Memorandum* dated July 11, 2012. The traffic forecast memorandum was approved by NDOT on August 1, 2012 (see Appendix A).

Figure 1-1 Proposed Project

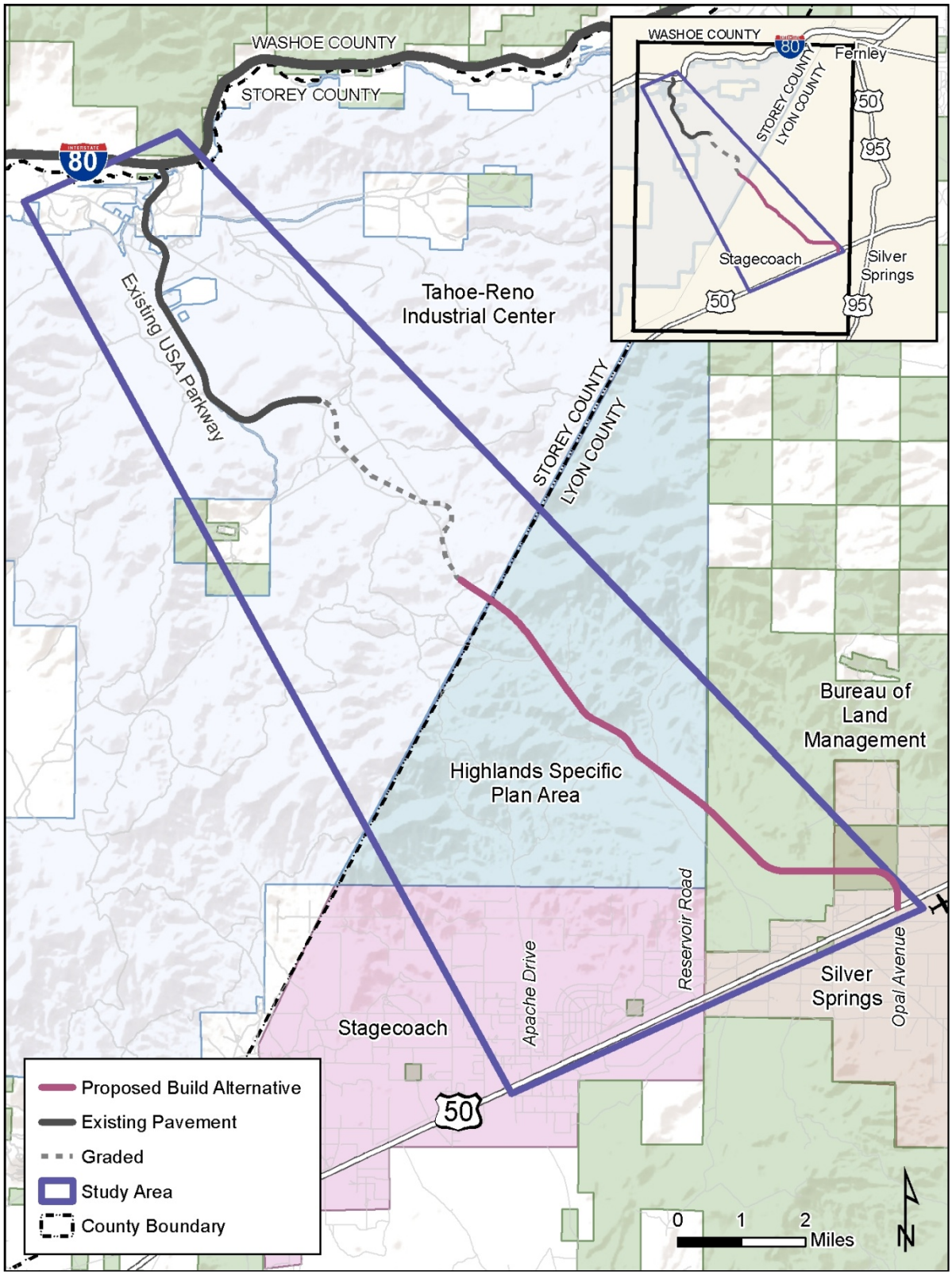


Figure 1-2 General Traffic Study Area

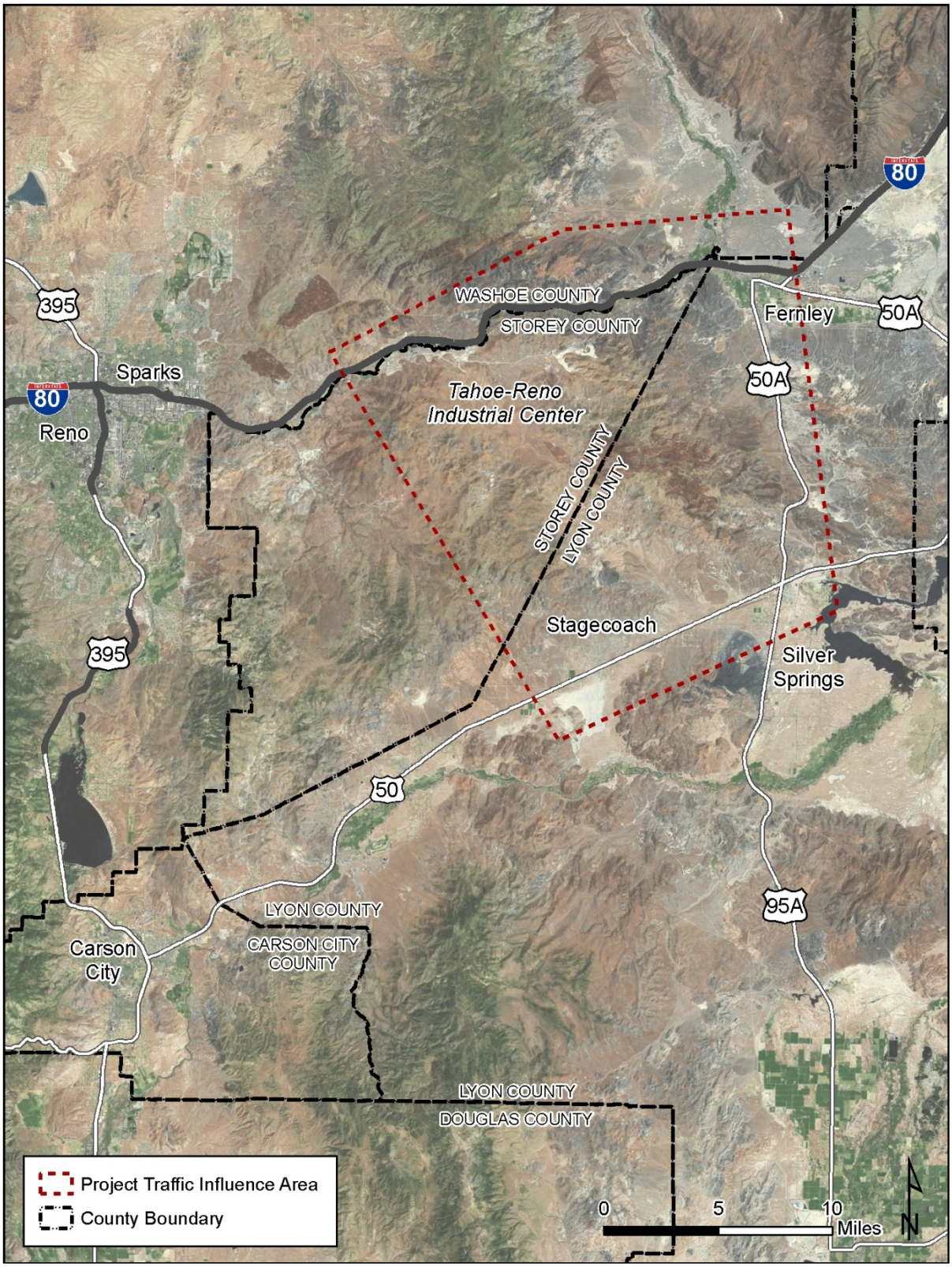


Figure 1-1 shows a "Highlands Specific Plan Area" (Highlands) south of the county line along USA Parkway. At the time of the preparation of the traffic forecasts for USA Parkway EA, it was uncertain if Highlands would be developed. Hence, the project team developed traffic forecasts for two scenarios: "With Highlands" (i.e. Highlands is built) and "No-Highlands" (Highlands does not develop). Subsequently, the No-Highlands scenario was determined to be the appropriate scenario of development in the study area by the stakeholders. Furthermore, the Highlands development is not included in the future land use plan of Lyon County. Hence, the benefit-cost analysis conducted and reported in this memorandum corresponds to the "No-Highlands" scenario presented in the *USA Parkway Traffic Forecast Memorandum*.

2. TECHNICAL GUIDANCE AND ANALYSIS TOOLS

The analyses documented in this memorandum were completed according to the following technical documents and guidelines:

- User and Non-User Benefit Analysis for Highways (Redbook), American Association of State Highway and Transportation Officials (AASHTO), September 2010.
- Economic Analysis Primer, Federal Highway Administration (FHWA), August 2003.

In addition, the analyses were conducted in accordance to the approved *USA Parkway Traffic Forecast Memorandum* and the approved *USA Parkway Traffic Operations Analysis Memorandum* (see Appendix B).

The Redbook Wizard (Redbook benefit-cost analysis tool) was used for the analyses documented in this memorandum. The Redbook benefit-cost analysis tool is an AASHTO software for guiding the analyst through the benefit-cost analysis process.

3. METHODOLOGY & ASSUMPTIONS

A benefit-cost analysis is the process of evaluating the benefits and costs associated with projects to determine the economic efficiency of the investment; in the subject case, the transportation project to extend USA Parkway. Benefits and costs may accrue over the life of the project. The total of all costs is the price that travelers must pay to travel. Any reduction in costs, results in benefits. The benefits and costs are evaluated for a transportation project by comparing with a base case (No-Action Alternative). The periodic benefits and costs accrued over the life of a project are converted to present values and a benefit-cost ratio is calculated based on these present values. The benefit-cost analysis documented in this memorandum follows the Redbook methodology.

3.1. Redbook Methodology

The Redbook methodology involves the estimation of costs, user benefits and non-user benefits. User benefits are benefits that are enjoyed by travelers directly affected by a transportation project. Non-user benefits are indirect benefits such as environmental impacts and economic influences associated with the project. Further explanation of the estimation of these benefit and cost components is provided in Section 4 and Section 5 of this Memorandum.

The Redbook, in explaining the analysis methodology for new roadways, states that *"it is much more important to take a network-wide perspective in the case of a new highway, because the effects of a new highway on traffic volumes and costs elsewhere on the network are generally more significant in the case of a new highway …. the analysis for a new highway in this case*

must be conducted on an origin-destination pair (O-D pair) basis. In this approach, the network affected by the project must be broken into a discrete number of geographic zones (usually called travel analysis zones, or TAZs).” In accordance with this guidance, the results from the travel demand models developed for the USA Parkway EA - the future year traffic forecasts, anticipated VMT, VHT and average speed of travel in the model area - were used in the benefit-cost analysis.

The Redbook benefit-cost analysis tool does not include functionality to explicitly analyze the construction of new roadways. Hence, benefits and certain cost components were calculated manually and entered into the Redbook benefit-cost analysis tool to overcome this limitation.

3.2. No-Action vs. Build Alternatives

The No-Action Alternative represents the future conditions without the proposed project (i.e. no extension of USA Parkway) whereas; Build Alternative represents the future conditions with the proposed project (extension of USA Parkway to US 50).

As per the Redbook methodology, the Build Alternative is also known as the “improved case” or the “with improvement” scenario. Similarly, the No-Action Alternative is known as the “base case” or the “without improvement” scenario. In this benefit-cost analysis, the USA Parkway extension (Build Alternative) was compared against the No-Action Alternative to determine the benefit-cost ratio of the project.

In the No-Action Alternative, USA Parkway is not extended, and hence I-80 and US 50 are not connected. There are no major direct north-south routes for approximately 30 miles between US 395, which connects the City of Reno to Carson City, and US 95A, which connects the communities of Fernley, Silver Springs, and Yerington. The lack of north-south routes connecting I-80 and US 50 results in out-of-direction travel for trips between the US 50 corridor communities (Stage Coach and Silver Springs) and major job centers in the cities of Reno and Sparks and TRIC. Vehicles travelling to TRIC from the southern region of the study area are forced to travel east along US 50, north along US 95A and west along I-80 to reach the TRIC. Table 3-1 illustrates the additional travel distance and travel time incurred by travelers between select origin-destination pairs if USA Parkway does not get extended to US 50. Qualitatively, the benefits due to the USA Parkway extension result from the reduced amount of travel by the travelers.

The nature of regional travel was quantitatively determined for the Build Alternative and the No-Action Alternative by the travel demand models developed for this project. The *USA Parkway Traffic Forecast Memorandum* (Appendix A) provides a detailed explanation of these travel demand models. Table 3-2 lists the model area VMT and VHT for the year 2010, year 2017 and year 2035. For the future year models, VMT and VHT are reported for both the No-Action Alternative and the Build Alternative; these form the basis for the calculation of benefits.

Table 3-1: Comparison of Travel Distances and Travel Times between Select Origin-Destination Pairs - No-Action Alternative vs. Build Alternative

Origin-Destination	Travel Distance No-Action Alternative (miles)	Travel Distance Build Alternative (miles)	Percent Reduction in Travel Distance	Travel Time No-Action Alternative (minutes)	Travel Time Build Alternative (minutes)	Percent Reduction in Travel Time
Silver Springs to Reno	49	42	14%	45	42	7%
Silver Springs to TRIC	32	19	41%	32	20	38%
Stagecoach to TRIC	42	23	45%	40	25	38%

The travel time estimates are approximate values based on the travel distance and the posted speed limit, calculated without consideration of the impact of congestion.

Source: USA Parkway Traffic Operations Analysis Memorandum, Jacobs 2012

Table 3-2: Model Area VMT and VHT

Model Run	Daily VMT	Daily VHT	Average Speed
Year 2010 Base Year	2,075,000	47,900	43
Year 2035 No-Action	4,450,000	112,900	38
Change from 2010	2,375,000	65,000	-5
Percentage	114%	136%	-13%
Year 2035 Build	3,999,000	98,700	40
Change from No-Action	-451,000	-14,200	2
Percentage	-10%	-13%	6%
Year 2017 No-Action	2,625,000	62,600	42
Change from 2010	550,000	14,700	-1
Percentage	27%	31%	-2%
Year 2017 Build	2,495,000	60,100	42
Change from No-Action	-130,000	-2,500	0
Percentage	-5%	-4%	0%

VMT = Vehicle Miles Traveled; VHT = Vehicle Hours Traveled

Source: USA Parkway Traffic Forecast Memorandum, Jacobs 2012

3.3. Analysis Assumptions

A complete list of the parameters used in the benefit-cost analysis, the corresponding values, the references for these values and the underlying assumptions are shown in Appendix C. Key assumptions and references for the parameter values are listed here:

- The base year, opening year and design year of the project used in the benefit-cost analysis are year 2011, year 2017 and year 2037 respectively. The design year of the project is the final year till which the costs and benefits of the project are considered.
- Benefits were calculated for two classes of vehicles, “All Cars” and “All Trucks”. The daily proportion of trucks used in the analysis is 24% as per the approved USA Parkway Traffic Forecast Memorandum.
- The average vehicle occupancy used in the analysis for “All Cars” is 1.5, as per the approved USA Parkway Traffic Forecast Memorandum.
- The average vehicle occupancy used in the analysis for “All Trucks” is 1.05, as per the default values provided in the Redbook benefit-cost analysis tool.
- The value of an hour of time for travelers of “All Cars” and “All Trucks” is $10.61 and $25 respectively. The $25 value for “All Trucks” also takes into account the cost of delayed delivery of cargo.
    - The “value of time” estimate for cars is based on NDOT's "Updates for 2012: Discussion of the Calculations of Costs and Benefits."
    - The value of an hour of time for trucks is based on USDOT's “Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis”, September 28, 2011 and FHWA’s “The Economic Costs of Freight Transportation”.
- Cost of fuel for “All Cars” and “All Trucks” used in the analysis are based on NDOT's "Updates for 2012: Discussion of the Calculations of Costs and Benefits."
- Vehicle operating costs, including the cost for wear-and-tear of tires and maintenance of vehicles are based on NDOT's "Updates for 2012: Discussion of the Calculations of Costs and Benefits."
- User costs per accident are based on NDOT's "Updates for 2012: Discussion of the Calculations of Costs and Benefits."
- Accident/crash rates are NDOT’s estimates for year 2010.
- Project costs, including Right of way, Planning and preliminary engineering, Management and construction engineering and Construction costs are Jacobs’ preliminary estimates.
- Benefits and costs were estimated for the project without adjustment for inflation, in base year (year 2011) dollars.
- A real discount rate of seven percent was used to discount the future year benefits and costs to determine the equivalent base year dollars.

The benefit-cost ratio determined based on the parameter values listed in Appendix C is the baseline benefit-cost ratio. In order to determine the impact of changes in the parameter values on the benefit-cost ratio, a sensitivity analysis was completed.

4. BENEFITS INCLUDED IN THE ANALYSIS

Benefits of a transportation project accrue due to reduction in user costs compared to the No-Action Alternative. Benefits are realized as soon as the USA Parkway extension is opened (in year 2017) and for every year through year 2037. For the benefit-cost analysis, user benefits and non-user benefits due to the USA Parkway extension were estimated. Benefits due to the USA Parkway extension are mainly realized due to the north-south connection it provides, which reduces the amount of travel needed by the travelers in the region.

4.1. User Benefits

User benefits are the benefits that are enjoyed by the travelers directly affected by a transportation project. The following sections explain the estimation of the various user benefits.

4.1.1. Travel Time Savings

Travel time savings is one of the major components of user benefits. An approximate estimation of reduction in travel time due to the USA Parkway extension is expressed in Table 3-1. Considerable reduction in travel time is expected due to the availability of the north-south connection. In addition to the reduction in travel time due to the reduced travel distance, travel times are also likely to be reduced due to reduced congestion on existing roads in the region. The reduction in travel times is expected to be regional in nature and not confined to the project vicinity. The region-wide travel times were estimated from the travel demand models developed for this project. The reduction in VHT due to the project, compared to the No-Action Alternative is shown in Table 3-2. The estimates of reduction in VHT are available from the travel demand models both for the opening year (year 2017) and for year 2035. The VHT estimates from the travel demand models correspond to a typical weekday of the year; hence the VHT estimates were converted to correspond to an average day of the year for use in the analysis.

Next, the daily reduction in VHT (vehicle-hours per day) between the Build Alternative and the No-Action Alternative were first converted to daily reduction in Person Hours Travelled (PHT, person-hours per day) based on the average vehicle occupancy values. This reduced daily PHT or person travel time savings were converted to equivalent dollar values based on the assumed hourly value of time. These daily cost savings were then converted to annual savings for year 2017 and 2035. The savings for all other years were either interpolated or extrapolated based on these values.

Another component of benefits due to travel time savings is the reduction of costs related to freight transportation; these are the costs due to the delayed delivery of cargo. The TRIC is planned to become a large industrial park and as a result, significant truck traffic is expected to travel along USA Parkway. As explained previously, the construction of USA Parkway results in significant travel time savings; this reduction in travel time equates to reduction of inventory costs. This benefit component was accounted for by the use of the assumed value for an hour of time for the occupants of trucks ($25 an hour).

4.1.2. Vehicle Operations Cost Savings

Vehicle operations cost savings is the other major component of user benefits. These accrue due to the reduced fuel consumption and reduced maintenance costs of vehicles due to the reduced amount of travel in the region. For the USA Parkway extension project, the availability of the north-south connection results in a reduction of region-wide travel.

The region-wide amount of travel was estimated by the travel demand models developed for this project. The reduction in VMT due to the project, compared to the No-Action Alternative is shown in Table 3-2. The reduction in VMT is available both for year 2017 and for year 2035. The VMT estimates from the travel demand models correspond to a typical weekday of the year; hence the VMT estimates were converted to correspond to an average day of the year for use in the analysis.

The cost of fuel and the fuel efficiency of vehicles was used to convert the reduction in fuel consumption to equivalent cost savings. The daily reduction in VMT was estimated for the year 2017 based on the Build and No-Action travel demand models. The daily reduction in VMT was then converted to an equivalent daily reduction in fuel consumption based on "Fuel Consumption for Autos and Trucks, by Average Operating Speed" values from the Redbook. This reduced fuel consumption was converted to cost savings based on the cost of fuel information. Similarly, the vehicle operations cost savings for year 2035 was obtained from the year 2035 travel demand models.

Additionally, the cost per VMT of the wear-and-tear of tires and maintenance of vehicles was used to convert the reduction in VMT to cost savings. Annual cost savings for year 2017 and year 2035 were determined based on VMT estimates from the travel demand models. The savings for all other years was either interpolated or extrapolated based on these values.

4.1.3. Accident Cost Savings

The reduction in VMT due to the USA Parkway extension results in reduced likelihood of occurrence of crashes in the region. This ultimately results in user benefits by reducing the costs of crashes borne by users of the facility. The most recent available crash rate data (year 2010) for the road class "Rural Minor Arterial" was obtained from NDOT. This is the number of crashes likely to occur per million VMT. This is shown in Table 4-1.

Table 4-1: Crash Rate (Crashes per Million VMT)

Type of Crash	Crash Rate (per Million VMT)
Fatal Crash	0.02
Injury (Non-Fatal) Crash	0.35
Property Damage Only Crash	0.71

Source: NDOT

The reduction in VMT for year 2017 and year 2035 was obtained from the travel demand models as explained in the previous section. The reduced VMT and the crash rates information was used to estimate the annual reduction in crashes for both year 2017 and year 2035. The information about the user cost per crash was obtained from NDOT's "Updates for 2012: Discussion of the Calculations of Costs and Benefits" and is shown in Table 4-2.

Table 4-2: Accident Costs (Year 2011 $)

Type of Crash	Crash Cost (dollars per crash)
Cost of Fatal Crash	$ 3,419,056
Cost of Injury (Non-Fatal) Crash	$ 92,202
Cost of Property Damage Only Crash	$ 4,554

Source: NDOT's "Updates for 2012: Discussion of the Calculations of Costs and Benefits."

The annual accident cost savings for the year 2017 and year 2035 was estimated based on the annual reduction in crashes and the cost per crash. The savings for all other years was either interpolated or extrapolated based on these values.

4.2. Non-User Benefits

Non-user benefits are indirect benefits such as environmental impacts and economic influences associated with the project. Non-user benefits are usually harder to quantify and lower in value compared to user benefits. For the USA Parkway extension project, the benefits due to vehicle emissions cost savings were estimated and are the only non-user benefits included.

Vehicle Emissions Cost Savings: The vehicle emissions cost savings were also estimated based on the reduction in total travel (reduction in VMT) in the region due to the construction of the USA Parkway extension. The air pollution costs information from the Redbook and from Oregon's "Costs of Motor Vehicle Travel: White Paper for the purpose of modeling Statewide Transportation Strategy scenarios" were used to convert the reduction in VMT into cost savings. The historical air pollution cost estimates were adjusted to base year (year 2011) dollars using the assumed inflation rate.

The annual vehicle emissions cost savings for the year 2017 and year 2035 were estimated based on the reduction in VMT for these years obtained from the travel demand models. The savings for all other years was either interpolated or extrapolated based on these values.

5. COSTS INCLUDED IN THE ANALYSIS

The costs associated with the project and considered in the benefit-cost analysis are the costs involved in the implementation (construction), operation and maintenance of the roadway.

5.1. Capital Costs

Capital costs include the initial investments made for the project. These are the project costs incurred before the opening year of the project. The following components of capital costs corresponding to the USA Parkway extension project were estimated.

- Right of Way costs
- Planning and Preliminary Engineering costs
- Management and Construction Engineering costs
- Construction costs

Initial estimates of each of these cost components were converted to construction year estimates for use in the Redbook benefit-cost analysis tool. These estimates are shown in Appendix C.

5.2. Agency Operating & Maintenance Costs

Similar to the capital costs, the agency operating and maintenance costs are incurred only for the Build Alternative of the USA Parkway project because, in the No-Action Alternative, the roadway does not exist.

5.2.1. Operating Costs

The agency operating costs are the periodic annual costs incurred by NDOT in operating the roadway. NDOT's estimate for annual operating costs per mile of roadway was obtained; this was used to estimate the total annual operating costs for the entire USA Parkway roadway. The operating cost for the existing segment of the USA Parkway roadway was also included in this estimate. This is because, with the construction of the USA Parkway extension, NDOT would be responsible for the operations of the entire USA Parkway (including the existing segment of USA Parkway) and the associated costs. The inclusion of costs for the existing USA Parkway segment in the benefit-cost analysis, also results in a conservative estimate of the benefit-cost ratio.

5.2.2. Maintenance Costs

Maintenance costs are the rehabilitation costs for the roadway. Rehabilitation is generally expected to be carried out by NDOT once every 10 years. In the estimation of costs for this benefit-cost analysis, rehabilitation costs are considered for year 2027 and year 2037, i.e. 10 years and 20 years beyond the opening year of the USA Parkway extension.

The rehabilitation costs for USA Parkway were calculated using NDOT's "Estimate Preparation Assistance" tool. Costs were estimated for the following rehabilitation strategy,

- Milling thickness – 1"
- Plantmix resurfacing thickness – 2"
- Open grade plantmix thickness – ¾"

Similar to the operating costs, the maintenance costs were also estimated for the entire USA Parkway (including existing segment). The output from NDOT's "Estimate Preparation Assistance" tool (Project Estimation Wizard), the rehabilitation cost, is provided in Appendix D.

6. RESULTS

A benefit-cost analysis was completed using the assumptions and parameter values listed in Section 3.3 and Appendix C. The benefit-cost ratio resulting from this analysis is the baseline benefit-cost ratio of the project. In addition, a sensitivity analysis was completed to determine the impact of changes in the values of selected parameters on the benefit-cost ratio; a range of values for parameters were tested in the sensitivity analysis.

6.1. Benefit-Cost Analysis

The Redbook methodology was used to complete the benefit-cost analysis. Benefits and costs were estimated for each year of the analysis period. These benefits and costs were discounted to determine the equivalent base year (year 2011) benefits and costs.

Table 6-1 lists the annual benefits and costs for the USA Parkway extension project, expressed in base year (year 2011) dollars. These discounted benefits and costs were used to determine the final benefit-cost ratio. Figure 6-1 shows the annual benefits and costs expected to be accrued due to the USA Parkway extension project. Figure 6-1 illustrates the distribution of costs and benefits over the life of the project. Majority of the costs, the capital costs are incurred during the pre-construction and construction phases. The maintenance (rehabilitation) costs expected to be incurred in year 2027 and year 2037 are the other major component of costs. It

can be noted that the annual agency operating costs are not expected to be significant, compared to the other cost and benefit components. It can also be seen that the benefits increase over the life of the project, from the opening year till the design year.

Figure 6-2 shows the share of the different benefit components in base year dollars. It can be seen that the benefits due to travel time savings and vehicle operations cost savings are the major benefit components. It is noted that the vehicle operations cost savings constitute a significant portion of the total benefits due to the project. This is because of the reduction in travel distances and VMT in the region due to the USA Parkway extension project, as shown in Table 3-1 and Table 3-2.

The baseline benefit-cost ratio for the USA Parkway extension project is estimated to be **9.1.** This indicates that the USA Parkway extension is an economically efficient investment.

Table 6-1: Annual Benefits and Costs (Year 2011 $)

Year	Benefits (Year 2011 $)				Costs (Year 2011 $)	
	Travel Time Savings	Vehicle Operations Cost Savings	Accident Cost Savings	Vehicle Emissions Cost Savings	Capital Costs	Operating & Maintenance Costs
2011	-	-	-	-	$ 1,000,000	-
2012	-	-	-	-	$ 934,579	-
2013	-	-	-	-	$ 7,860,949	-
2014	-	-	-	-	$ 816,298	-
2015	-	-	-	-	$ 762,895	-
2016	-	-	-	-	$ 44,205,143	-
2017	$ 10,778,397	$ 10,899,195	$ 3,165,200	$ 1,056,816	-	$ 165,821
2018	$ 11,035,265	$ 10,894,752	$ 3,159,962	$ 1,055,067	-	$ 154,973
2019	$ 11,298,255	$ 10,890,310	$ 3,154,732	$ 1,053,321	-	$ 144,835
2020	$ 11,567,513	$ 10,885,871	$ 3,149,511	$ 1,051,578	-	$ 135,359
2021	$ 11,843,187	$ 10,881,433	$ 3,144,298	$ 1,049,837	-	$ 126,504
2022	$ 12,125,431	$ 10,876,998	$ 3,139,094	$ 1,048,100	-	$ 118,228
2023	$ 12,414,402	$ 10,872,564	$ 3,133,899	$ 1,046,365	-	$ 110,494
2024	$ 12,710,259	$ 10,868,132	$ 3,128,712	$ 1,044,633	-	$ 103,265
2025	$ 13,013,167	$ 10,863,701	$ 3,123,534	$ 1,042,904	-	$ 96,509
2026	$ 13,323,294	$ 10,859,273	$ 3,118,365	$ 1,041,178	-	$ 90,196
2027	$ 13,640,812	$ 10,854,846	$ 3,113,204	$ 1,039,455	-	$ 6,082,797
2028	$ 13,965,896	$ 10,850,421	$ 3,108,051	$ 1,037,735	-	$ 78,780
2029	$ 14,298,729	$ 10,845,998	$ 3,102,907	$ 1,036,017	-	$ 73,627
2030	$ 14,639,493	$ 10,841,577	$ 3,097,772	$ 1,034,303	-	$ 68,810

Table 6-1: Annual Benefits and Costs (Year 2011 $)

Year	Benefits (Year 2011 $)				Costs (Year 2011 $)	
	Travel Time Savings	Vehicle Operations Cost Savings	Accident Cost Savings	Vehicle Emissions Cost Savings	Capital Costs	Operating & Maintenance Costs
2031	$ 14,988,378	$ 10,837,157	$ 3,092,645	$ 1,032,591	-	$ 64,308
2032	$ 15,345,577	$ 10,832,740	$ 3,087,527	$ 1,030,882	-	$ 60,101
2033	$ 15,711,290	$ 10,828,324	$ 3,082,417	$ 1,029,176	-	$ 56,169
2034	$ 16,085,718	$ 10,823,910	$ 3,077,315	$ 1,027,473	-	$ 52,495
2035	$ 16,469,069	$ 10,819,497	$ 3,072,222	$ 1,025,772	-	$ 49,060
2036	$ 16,861,556	$ 10,815,087	$ 3,067,138	$ 1,024,074	-	$ 45,851
2037	$ 17,263,397	$ 10,810,678	$ 3,062,061	$ 1,022,379	-	$ 3,092,186
Total Benefits = $ 604,541,774					**Total Costs = $ 66,550,233**	
Final B/C Ratio = 9.1						

Figure 6-1 Annual Benefits and Costs – Discounted Base Year Value (Year 2011 $)

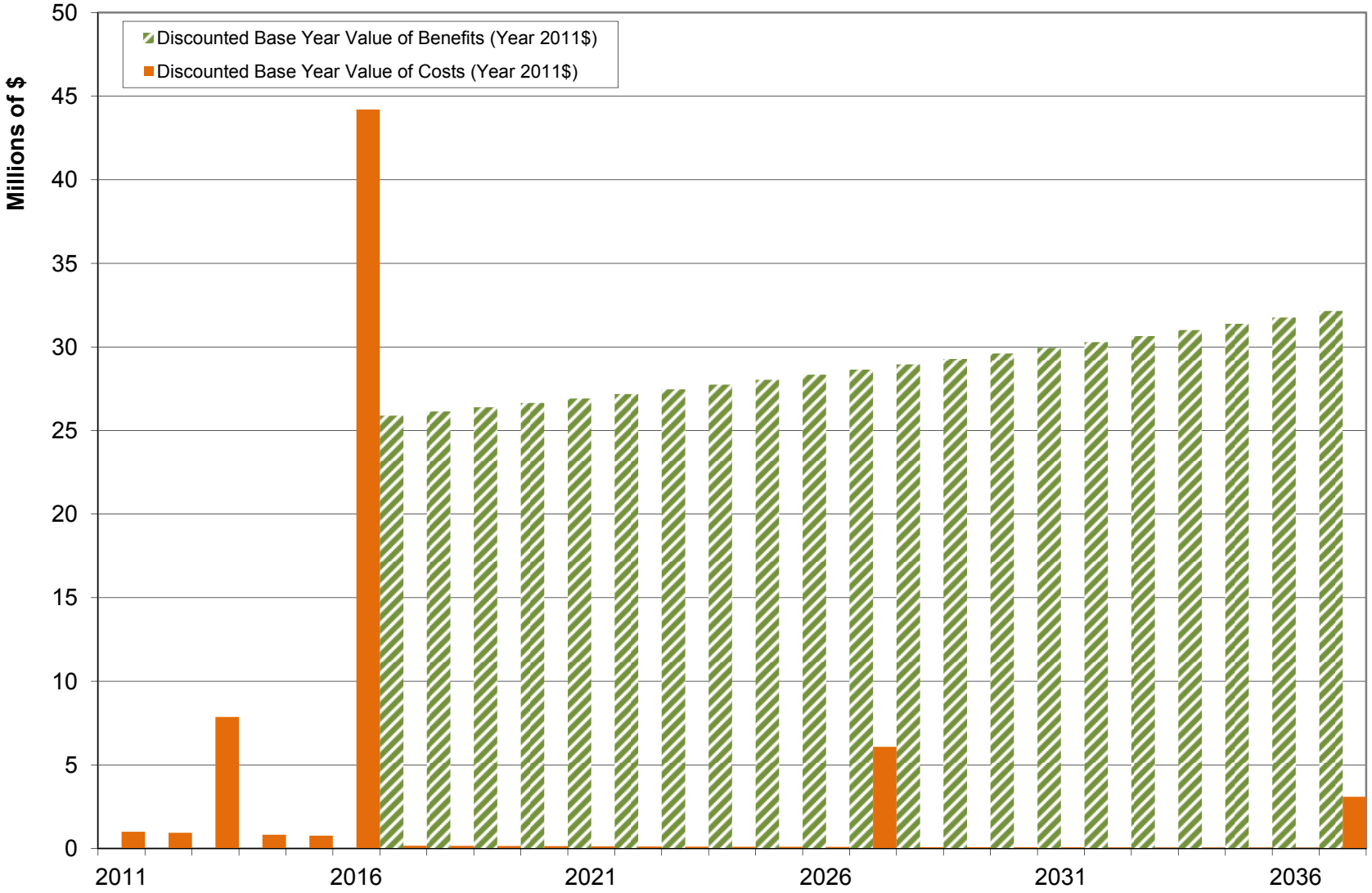
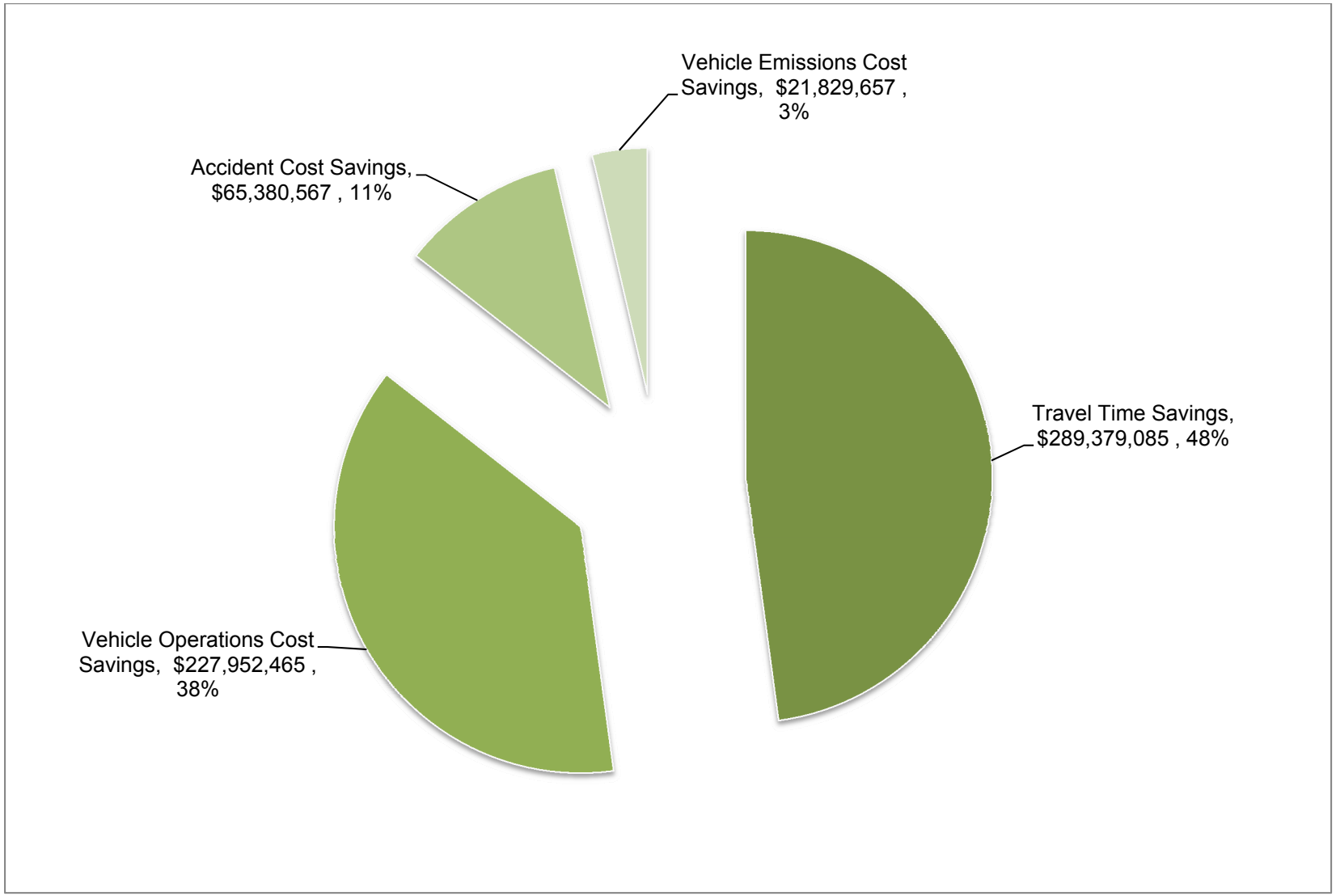


Figure 6-2 Share of Total Benefits by Component – Discounted Base Year Value (Year 2011 $)



6.2. Sensitivity Analysis

The results of the benefit-cost analysis may be influenced disproportionately by the change in values used for the analysis parameters. Hence, a sensitivity analysis was completed to determine the impact of changes in the values of analysis parameters on the benefit-cost ratio. The parameter values listed in Section 3.3 and Appendix C were used as the baseline values and the sensitivity analysis was performed by changing the values of certain parameters one at a time. The sensitivity analysis helps to determine the risks involved with the project corresponding to different values of the analysis parameters.

The results of the sensitivity analysis are illustrated in Figure 6-3, Figure 6-4, Figure 6-5 and Figure 6-6. The following are the key results of the sensitivity analysis,

- The baseline discount rate is seven percent. A three percent and five percent discount rate, both of which are less conservative than the seven percent value, result in a greater benefit-cost ratio compared to the baseline benefit-cost ratio.
    - A change in the discount rate is noted to result in a significant change in the benefit-cost ratio. Hence, the conservative value (seven percent) has been used in the baseline benefit-cost analysis.
- The baseline value of an hour of time for the occupants of cars is $10.61/hour. A lower value ($10/hour) of time results in a lower benefit-cost ratio; whereas a higher value ($20/hour) of time results in a greater benefit-cost ratio.
    - A change in the value of this parameter is noted to result in a significant change in the benefit-cost ratio. This is because of the significant contribution of travel time savings to the overall benefits of the project and the proportion of cars in the vehicle mix.
- A change in the value of the other analysis parameters such as the value of time for the occupants of trucks, the price of gasoline and the price of diesel resulted only in a marginal change in the benefit-cost ratio.

In addition, to represent a more adverse scenario, an analysis was conducted with critical values for all the parameters mentioned above. The parameters used in this analysis are: discount rate at seven percent, value of an hour of time for the occupants of cars at $10/hour, value of an hour of time for the occupants of trucks at $20/hour, price of gasoline at $2.50/gallon and price of diesel at $2.75/gallon. The resulting benefit-cost ratio for the USA Parkway extension project is estimated to be **7.8.** This indicates that the benefits of the USA Parkway extension are greater than the costs even for a more adverse scenario.

It is noted that in all tested scenarios within the sensitivity analysis, the benefit-cost ratio is greater than 2.0. Hence, the USA Parkway extension project is an economically efficient investment.

Figure 6-3 Sensitivity Analysis – Variation of B/C Ratio

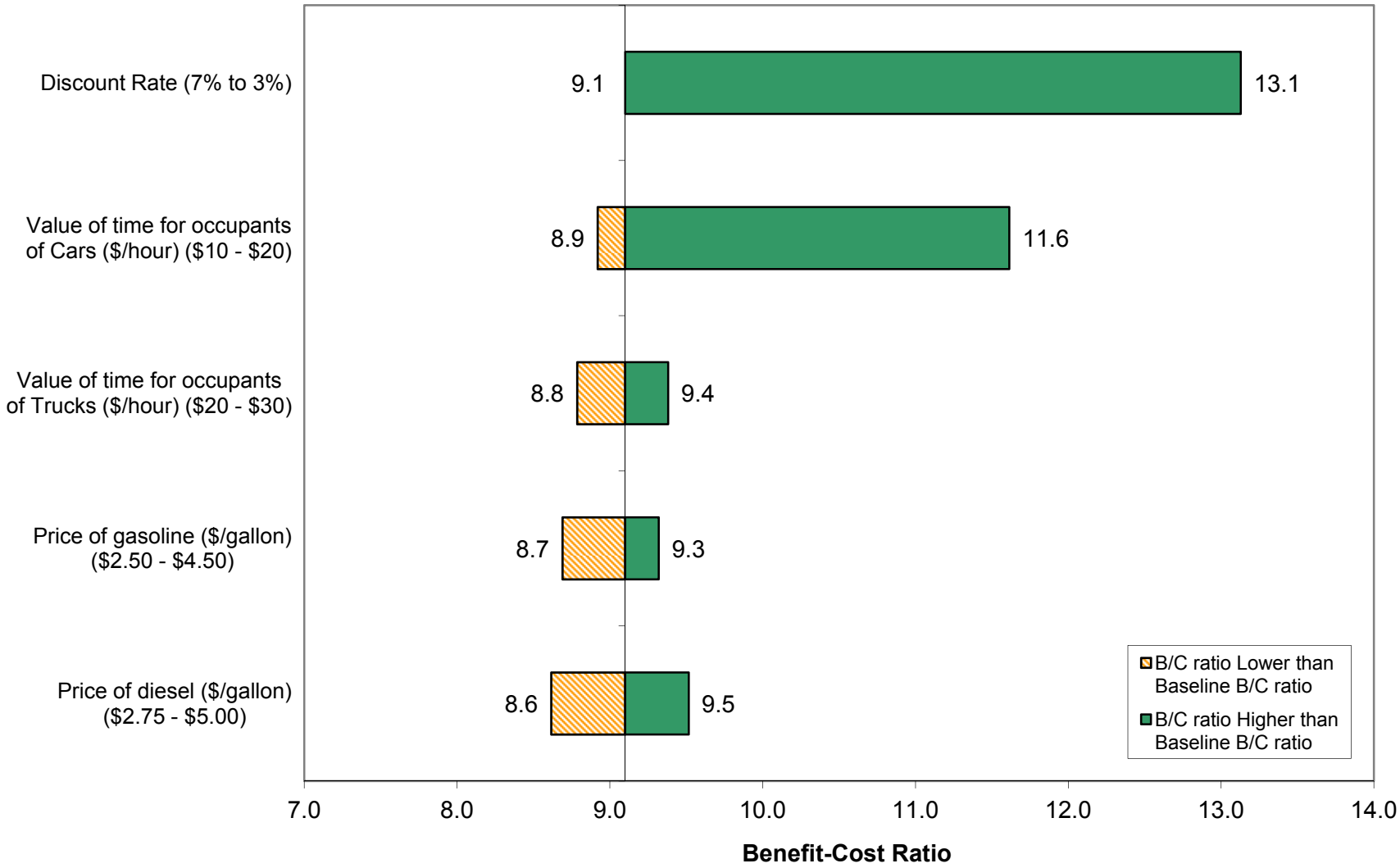


Figure 6-4 Sensitivity Analysis - Variation of B/C Ratio for a Range of Values of "Discount Rate"

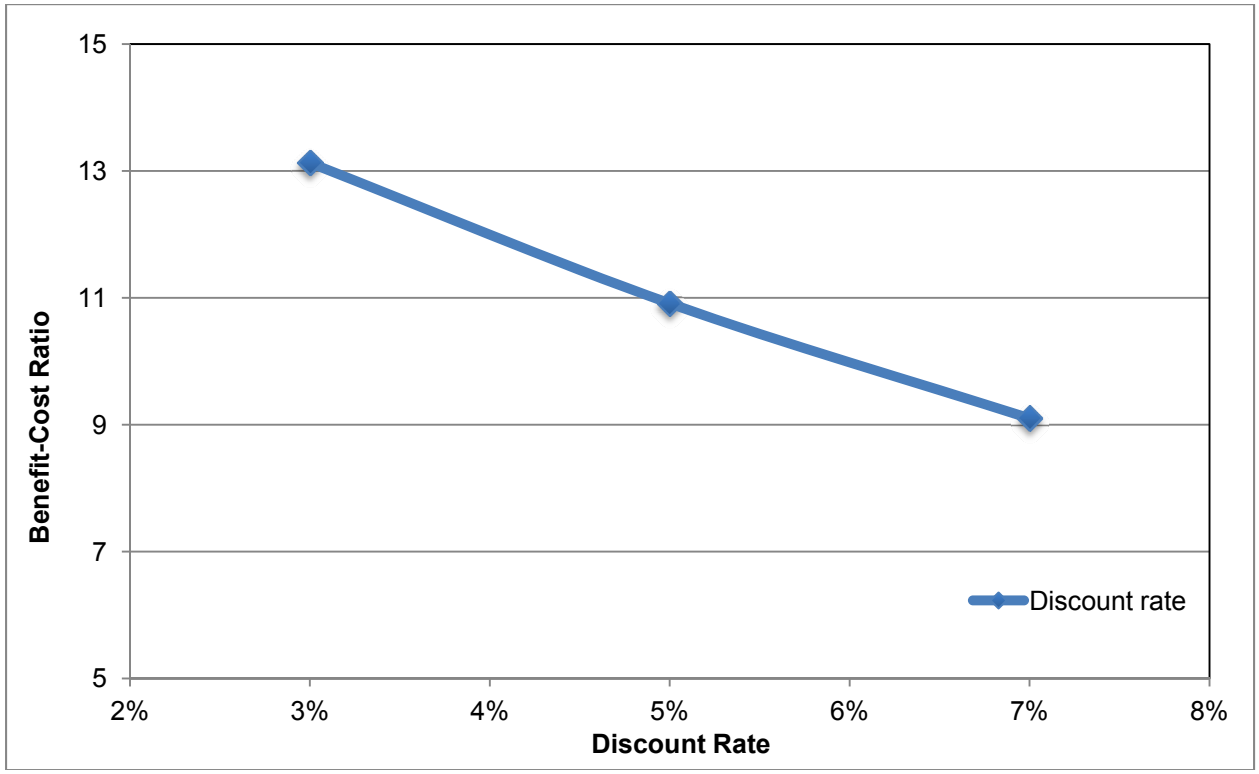


Figure 6-5 Sensitivity Analysis - Variation of B/C Ratio for a Range of Values of "Value of Time"

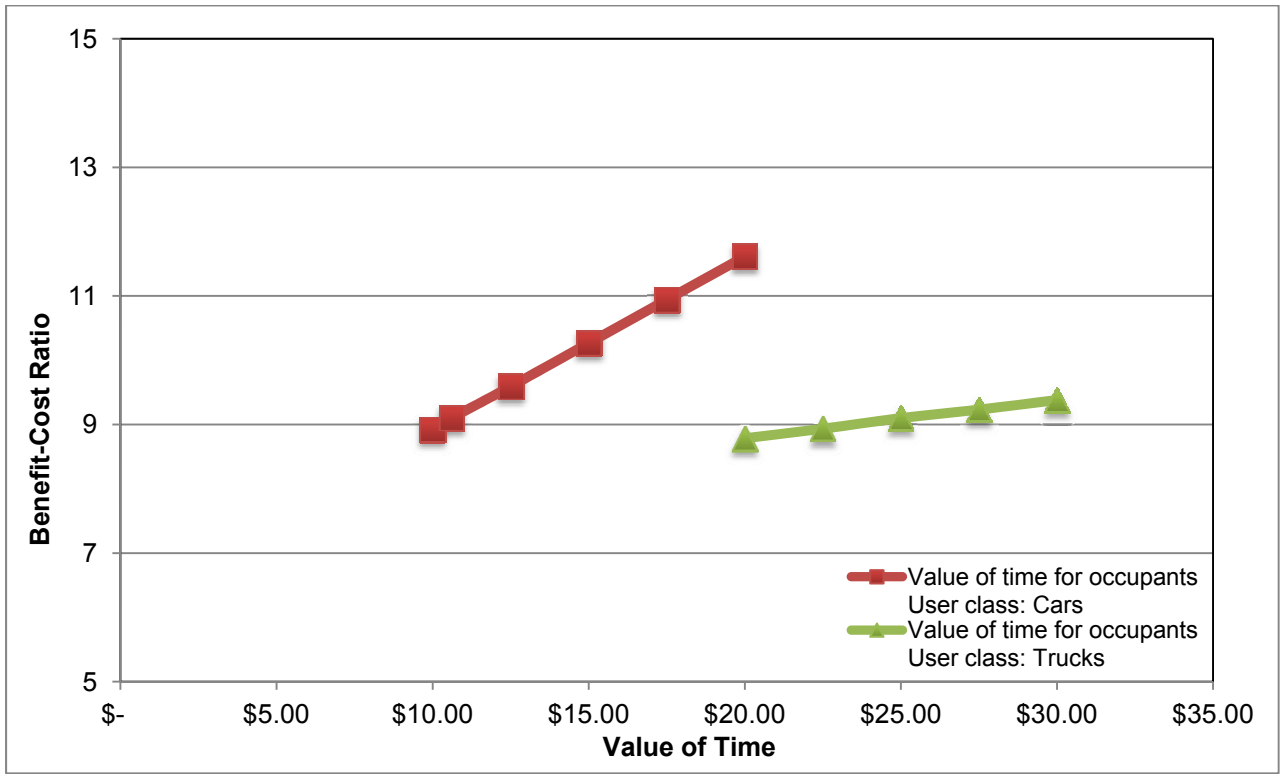
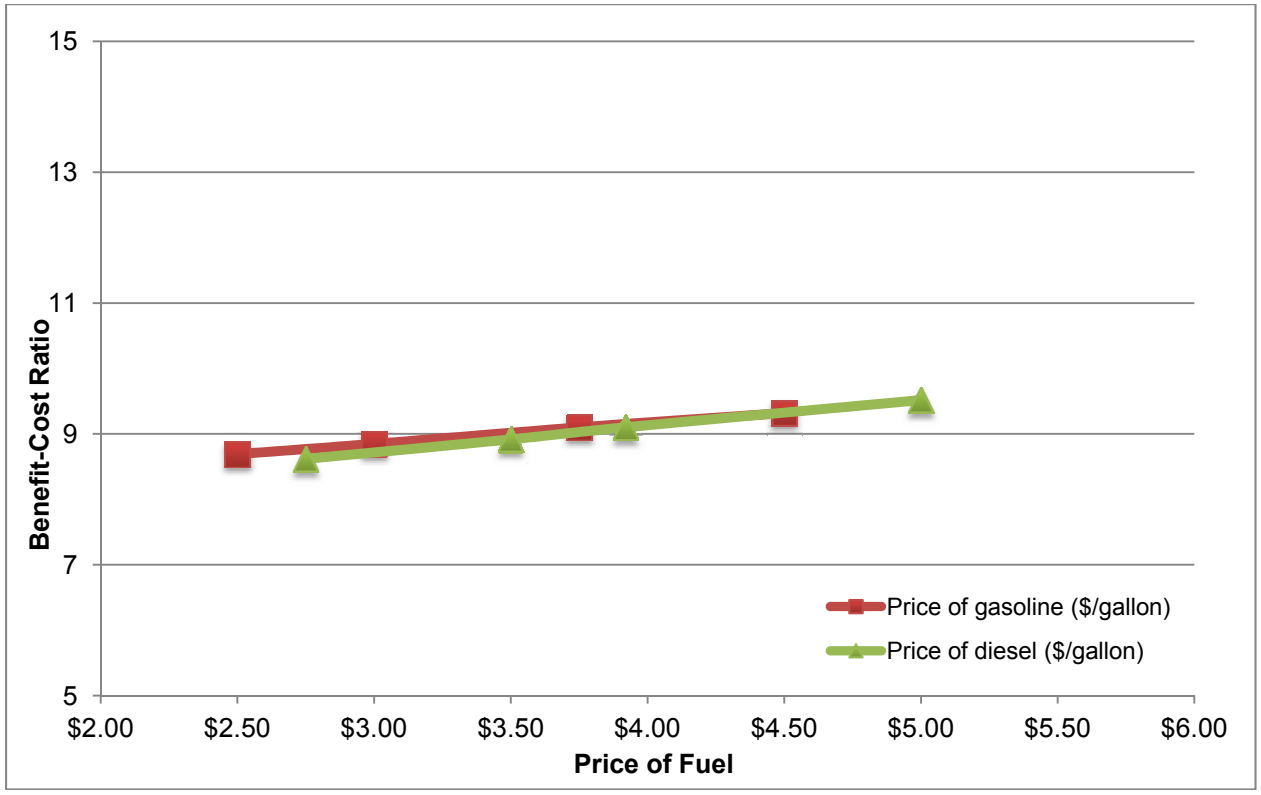


Figure 6-6 Sensitivity Analysis - Variation of B/C Ratio for a Range of Values of "Price of Fuel"



7. CONCLUSION

This Technical Memorandum presented the benefit-cost analysis completed for the USA Parkway extension project. The analysis showed that the anticipated benefits of the USA Parkway extension project significantly exceed the anticipated costs. The sensitivity analysis further indicated that the anticipated benefits exceed the costs for a wide range of the analysis parameters. The reduction in total travel and the corresponding reduction in travel time due to USA Parkway extension generate net benefits to the region. Thus, it is concluded that the USA Parkway extension is an economically efficient investment.

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