Southern Nevada Traffic Study

Appendix F.
BENEFIT COST ANALYSIS

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Prepared for

NEVADA DOT
SAFE AND CONNECTED

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Acronyms and Abbreviations

AAA	American Automobile Association
ATRI	American Transportation Research Institute
AVO	average vehicle occupancy
B/C	benefit-cost
BCA	Benefit-Cost Analysis
BLS	Bureau of Labor Statistics
Caltrans	California Department of Transportation
CO	carbon monoxide
CO_2	carbon dioxide
EMFAC2014	Emission Factors 2014
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
HOV	High-Occupancy Vehicle
MOVES	Motor Vehicles Emissions Simulator
NDOT	Nevada Department of Transportation's
NOx	nitrogen oxide
NPV	net present value
OES	Occupational Employment Statistics
PDO	property damage only
PM	fine particulate matter
SO_2	sulfur dioxide
U.S.	United States
USDOT	United States Department of Transportation
VHT	vehicle hours traveled
VMT	vehicle miles traveled
VOC	volatile organic compounds

"W"	“With Project" scenario (refers to the scenario with the improvements being built upon the foundational road network)
"WO"	Without Project" scenario (refers to the starting point of the comparison, or the foundational road network to which improvements are added for comparison)

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1.0 Methodology

Benefit-Cost Analysis (BCA) is a systematic approach to consistently comparing the benefits and costs of ideas and alternatives, with the goal of determining the soundness of investment decisions. BCA is used to select the better alternative while considering multiple benefits and costs by combining multiple measures of the project's effectiveness into a summary measure.

The Project Team performed BCA for the Southern Nevada Traffic Study to evaluate and compare the relative net benefits of several alternatives across the network. For each corridor in the study, The Project Team analyzed the benefits of the Build Scenario compared to the Baseline Scenario, and analyzed benefits of Ideas and Preferred Alternatives to the Build Scenario.

For the purposes of this methodology, a generic "Without Project" ("WO") scenario refers to the starting point of the comparison (or the foundational road network to which improvements are added for comparison), while a "With Project" ("W") scenario refers to the scenario with the improvements being built upon the foundational road network. For example, if Corridor Alternative is compared to Build Scenario, then Corridor Alternative is considered a "W" scenario and Build Scenario is considered a "WO" scenario. However, when the Build network is compared to the Baseline Scenario, the Build network becomes "W" and the Baseline scenario becomes "WO."

1.1 Vehicle Miles Traveled and Vehicle Hours Traveled Calculations

The Project Team calculated vehicle hours traveled (VHT) and vehicle miles traveled (VMT) based on the Aimsun Next micro-simulation data for four categories of vehicles:

- Single Occupancy Vehicles or "Car" in the Aimsun Next output, where the assumed average vehicle occupancy (AVO) is 1.
- Trucks or "Truck" in the Aimsun Next output, where the assumed AVO is 1.
- High-Occupancy Vehicle (HOV)-2 or "SR2" in the Aimsun Next output, where the assumed AVO is 2.
- HOV-3+ or "SR3" in the Aimsun Next output, where the assumed AVO is 3.

When calculating the VHT and VMT, the Project Team assumed that the trips made by vehicles that completed the network are similar to those remaining in the network at the end of the modeling period (and thus unable to complete their trips), and those waiting to enter the model if the model had run longer to accommodate these vehicles. These trips are comparable in terms of average travel time, average distance, and average speed. The Project Team also adjusted the VHT and VMT statistics by the ratio of total trips in the ”WO” and ”W” scenarios (where total trips is the sum of trips completed, trips for vehicles stuck in the network, and trips for vehicles waiting to enter the network) to ensure that the same number of trips represented both the ”WO” and ”W” scenario statistics.

The following equations were used to calculate VHT and VMT, in which WO denotes Without Project statistics, and W denotes With Project statistics:

$$VHT_{WO} = \frac{TT_{C,WO}}{Vol_{C,WO}} \times \left(Vol_{C,WO} + Vol_{I,WO} + Vol_{L,WO}\right)$$

$$VHT_{W} = \frac{TT_{C,W}}{Vol_{C,W}} \times \left(Vol_{C,WO} + Vol_{I,WO} + Vol_{L,WO}\right)$$

$$VMT_{WO} = \frac{Dist_{C,WO}}{Vol_{C,WO}} \times \left(Vol_{C,WO} + Vol_{I,WO} + Vol_{L,WO}\right)$$

$$VMT_{W} = \frac{Dist_{C,W}}{Vol_{C,W}} \times \left(Vol_{C,WO} + Vol_{I,WO} + Vol_{L,WO}\right)$$

where

TT_C = total travel time for vehicles completing the network; “Total Travel Time” in the AIMSUN Next output or “Total Travel Time (hr)” in Project Team summary output tables.

$Dist_C$ = total distance travelled for vehicles completing the network; “Total Travelled Distance” in the AIMSUN Next output or “Total Travelled Distance (mi)” in Project Team summary output tables.

Vol_C = number of vehicles completing their trips; “Vehicles Outside” in the AIMSUN Next output or “Number of Arrived Vehicles” in Project Team summary output tables.

Vol_I = number of vehicles stuck in the model; “Vehicles Inside” in the AIMSUN Next output or “Number of Active Vehicles” in Project Team summary output tables.

Vol_L = number of vehicles waiting to enter the model; “Vehicles Waiting to Enter” in the AIMSUN Next output or “Latent Vehicles (veh)” in Project Team summary output tables.

Through Aimsun Next micro-simulations, the Project Team produced estimates of vehicles, queues and travel time for 2040 roadway conditions. Corresponding values representing 2020 roadway conditions were estimated using Average Annual Daily Traffic growth rates in Table 1. These growth rates were applied for all ideas and alternatives on vehicle volume, VMT, and VHT measures.

Table 1. Average Annual Daily Traffic Growth Rates by Segment

Corridor	Annual Growth Rates (percent)
Summerlin Parkway	2.4%
I-515 North	0.8%
I-15	1.6%
CC 215	2.0%
I-215/I-515/Henderson System Interchange	0.8%

Source: Travel Demand Model

1.2 Cal-B/C Corridor

The Project Team conducted the BCA using a Nevada-specific corridor version of the California Lifecycle Benefit/Cost Analysis Model (Cal-B/C Corridor 6.2).[1] The California Department of Transportation (Caltrans) developed the original Cal-B/C model in the mid-1990s.

Cal-B/C Corridor estimates benefits using changes in VMT and VHT from travel demand or micro-simulation models. The model has a flexible design that supports a variety of input data. Cal-B/C Corridor uses analysis methods consistent with the procedures outlines in the Federal Highway Administration's (FHWA) Economic Analysis Primer (2003).

1.2.1 Year of Current Dollars

The Project Team converted all monetized parameters in the Cal-B/C Corridor model to 2018 dollars using the Consumer Price Index data from the Bureau of Labor Statistics (BLS):

- 1.0404 to convert from 2016 dollars to 2018 dollars
- 1.0187 to convert from 2017 dollars to 2018 dollars[2]

1.2.2 Period of Analysis

The U.S. Department of Transportation (USDOT) recommends that the period of analysis covers the full development and construction of the project, plus at least 20 years of operation after construction is complete to account for the benefits and costs of transportation projects.[3] The period of analysis begins in 2019 and ends in 2040. It includes project development and construction years (2019 to 2020) and 20 years of operations (2021 to 2040).

1.2.3 Real Discount Rate

The Project Team used a real discount rate of 7 percent in accordance with the Office of Management and Budget (OMB) Circular A-94 to discount benefits and costs to their present value.[4] A 3 percent real discount rate is used for the sensitivity analysis.

[1] The latest version of the Cal-B/C Corridor model can be downloaded at http://www.dot.ca.gov/hq/tpp/offices/eab/benefit_cost/files/Cal-BC62Corridor.xlsm.

[2] Source: BLS, CPI-All Urban Consumers (Current Series), Series Id: CUUR0000SA0.

[3] Source: U.S. DOT 2018, Benefit-Cost Analysis Guidance for Discretionary Grant Programs.

[4] For more information, refer to the following link: https://www.transportation.gov/regulations/omb-circular-94 (Last Accessed: August 9, 2018).

In guidance for recent TIGER[5], FASTLANE[6], INFRA[7], and BUILD[8] discretionary grant applications, USDOT has requested applicants to use a 7 percent discount rate. It has also allowed applicants to use a lower discount rate of 3 percent for a sensitivity analysis.

1.3 Estimating Benefit Categories

For this BCA, the Project Team modified the standard Cal-B/C Corridor assumptions and economic values in coordination with Nevada Department of Transportation's (NDOT) discussion of the calculations of costs and benefits in the 2017 Performance Management Report.[9]

The Project Team ran Cal-B/C Corridor to monetize the costs and benefits estimated using VMT and VHT statistics from the Aimsun Next Summary Output Tables.The following categories of user benefits were quantified for the project: travel time savings, vehicle operating cost savings, emissions savings, and accident cost savings. Note: NDOT uses the terminology "crashes" rather than "accidents." This benefit category is called "Accident Cost Savings" because that is the term used in Cal-B/C Corridor.

1.3.1 Travel Time Savings

The Project Team calculated travel time savings as the difference in the "W" and "WO" VHT, plus the difference in latent delay:

$$Travel\ Time\ Savings = \left(VHT_{WO} + Delay_{L,WO}\right) - \left(VHT_{W} + Delay_{L,W}\right)$$

where

$Delay_L$ *= latent delay of vehicles waiting to enter the model; "Total Travel Time (Waiting Out)" in the AIMSUN Next output or "Latent Delay Time (hr)" in Project Team summary output tables.*

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[5] Transportation Investment Generating Economic Recovery—The TIGER Discretionary Grant programs provide a unique opportunity for the U.S. Department of Transportation to invest in road, rail, transit, and port projects that promise to achieve critical national objectives.

[6] Fostering Advancements In Shipping And Transportation For The Long-Term Achievement Of National Efficiencies (FASTLANE)—The FAST Act establishes the Nationally Significant Freight and Highway Projects program to provide financial assistance—competitive grants, known as FASTLANE grants, or credit assistance—to nationally and regionally significant freight and highway projects that align with the program's goals.

[7] Infrastructure For Rebuilding America—The INFRA Grants program provides dedicated, discretionary funding for projects that address critical issues facing our nation's highways and bridges.

[8] Previously known as TIGER Discretionary Grants, the Better Utilizing Investments to Leverage Development, or BUILD Transportation Discretionary Grant program, provides a unique opportunity for the DOT to invest in road, rail, transit, and port projects that promise to achieve national objectives.

[9] Source: NDOT 2017, Performance Management Report, page 133. Accessed via the following: https://www.nevadadot.com/Home/ShowDocument?id=12623.

The model multiplies the number of hours saved by personal vehicle drivers and truck drivers by their corresponding vehicle occupancy rates and values of time.[10] Travel time costs are compared between the ”WO” and ”W” scenarios and the difference is the travel time savings. In addition, the latent delay was included because the Project Team assumed all vehicles represented in the model would travel during the modeled peak period and would not vary their start time or route assignment with the ”W” scenario improvements. In this case, the latent delay is accrued in addition to the generalized cost that travelers experience.

The Project Team estimated travel time parameters using sources consistent with recent USDOT guidance in valuing travel time in economic analyses. In its value of time recommendations, USDOT distinguishes among three types of automobile travel: 1) local personal travel, 2) intercity personal travel, and 3) business local and intercity travel. USDOT recommends using 50 percent of the wage rate for local personal travel, 70 percent for intercity personal travel, and 100 percent for business travel (on both local and intercity trips). While this may suggest adopting a higher ratio to the wage rate, it is worth noting that business and intercity trips comprise relatively small portions of travel. Thus, the Project Team used 50 percent of the wage rate to derive value of time for automobile travel.

The Project Team extracted wage data at the state level from the Occupational Employment Statistics (OES) Survey from the Nevada Workforce website. The OES survey is conducted in conjunction with the BLS. Using a single source makes the values of time for automobile and truck travel more consistent. The Project team used the following information for converting the values of time to 2018 dollars:

- **Automobile Travel Time Cost:** According to OES Survey, the mean hourly wage for Nevada workers in all occupations was $21.17 in May 2016.[11] The Project Team converted this value to 2018 dollars ($21.17 * 1.0404 = $22.03) using the BLS Consumer Price Index. The BCA model includes this new hourly wage rate, resulting in a value of time for automobile of $11.00 (i.e., half the wage rate rounded to the nearest 5 cents).
- **Truck Travel Time Cost:** According to OES Survey, the mean hourly wage for Heavy and Tractor-Trailer Truck Drivers in Nevada was $23.84 in May 2016. Adjusting to 2018 wages using the BLS Consumer Price Index results in wages of $24.80 ($23.84 * 1.0404). Truck Driver Fringe benefits account for 50 percent[12] of the mean hourly wage, thus $12.40 per hour in 2018. Adding the benefits to wages yields a total compensation of $37.20 per hour.

[10] The project team assumed an average vehicle occupancy of 1 for single occupancy vehicles (cars) and trucks, an average vehicle occupancy of 2 for high occupancy vehicle-2 (SR2), and an average vehicle occupancy of 3 for high occupancy vehicle-3+ (SR3).

[11] The Project Team extracted hourly wage data from the following link: http://nevadaworkforce.com/OES#last (Last Accessed: August 9, 2018).

[12] Source: Nevada DOT 2017, Performance Management Report, page 133. Accessed via the following link: https://www.nevadadot.com/Home/ShowDocument?id=12623.

The value of time for truck travel is estimated as 100 percent of the total compensation for truck drivers ($37.20). After rounding to the nearest 5 cents, the value of time for truck travel is $37.20.

The assumptions used in the estimation of travel time savings are summarized in Table 2.

Table 2. Assumption Used in the Estimation of Travel Time Savings

Variable Name	Unit	Value
Travel Time Cost—Automobile	Dollars per hour	$11.00
Travel Time Cost—Truck	Dollars per hour	$37.20

Source: HDR calculation from Occupational Employment Statistics (OES) Survey, Nevada Workforce.

1.3.2 Vehicle Operating Cost Savings

This benefit category captures fuel and non-fuel (e.g., tire wear and tear, cost of maintenance, and depreciation) for drivers of personal and commercial vehicles. The Project Team calculated vehicle operating cost savings based on VMT and VHT data for 2040, derived from the Aimsun Next Summary Output Results. The data were then entered in the BCA model. VMT and VHT were also allocated to automobile and truck based on the percent of truck traffic.

The Project Team calculated fuel costs by multiplying VMT by fuel consumption per mile and by fuel price per gallon for both the ”WO” and the ”W” scenario. Non-fuel cost is calculated by multiplying VMT by non-fuel per-mile cost (which accounts for maintenance and other vehicle ownership costs) for both cases. These costs are compared between the ”WO” and ”W” alternative and the difference is the vehicle operating cost savings.

FUEL CONSUMPTION RATES

The Project Team estimated fuel consumption rates using data from the California Air Resources Board Emission Factors 2014 (EMFAC2014) model. On December 30, 2014, the California Air Resources Board updated EMFAC from the previous version, EMFAC2011. This revision is a minor update to the EMFAC2011 model and extends emission estimates through 2050. EMFAC2014 also improves upon EMFAC2011’s modeling structure.

To estimate fuel consumption in all years of the BCA, the Project Team used a single set of fuel consumption parameters that average figures for 2016 and 2036. Table 3 presents fuel consumption rates for automobiles and trucks.

FUEL COSTS

Fuel costs used in the BCA model represent the out-of-pocket fuel costs paid by consumers. The Project Team used the American Automobile Association (AAA) Daily Fuel Gauge Report as the source for fuel cost data.[13] For automobile fuel, the Project Team used the price of mid-grade fuel ($3.494 per gallon). For truck fuel costs, the Project Team used the price of diesel fuel ($3.391 per gallon).

The fuel cost calculation excludes federal, state, and local taxes. These taxes are transfer payments and user fees for funding transportation improvements. Fuel taxes can be broken into three components: Federal fuel excise taxes, State fuel excise taxes, and State and local sales taxes. The Internal Revenue Service collects the federal fuel excise tax (18.4 cents per gallon tax on gasoline and 24.4 cents per gallon tax on diesel fuel). These taxes are deposited in the Highway Trust Fund. Nevada state taxes account for 23.8 cents per gallon on gasoline and 27.8 cents per gallon on diesel fuel.[14]

The calculations below show the estimation of fuel costs:

- Automobile Fuel Cost = $3.494 - $0.184 - $0.238 = $3.072, rounded to $3.05 per gallon
- Truck Fuel Cost = $3.391 - $0.244 - $0.278 = $2.870, rounded to $2.85 per gallon.

Table 3. Fuel Consumption Rates (gallons per mile)

Speed (mph)	Auto	Truck
5	0.1024	0.2112
10	0.0763	0.1832
15	0.0584	0.1211
20	0.0465	0.1059
25	0.0384	0.0821
30	0.0330	0.0738
35	0.0296	0.0799
40	0.0276	0.0788
45	0.0266	0.0828
50	0.0266	0.0817
55	0.0275	0.0858
60	0.0293	0.0764
65	0.0325	0.0726
70	0.0356	0.0920

Source: California Air Resources Board, EMFAC 2014. 2016 and 2036 average.
Note: Five mph is best estimate for idling.

NON-FUEL COSTS

The BCA model estimated automobile non-fuel costs as a fixed per-mile cost that includes tires, maintenance and repair, and vehicle depreciation. Other costs, such as insurance and registration, are not included because they do not vary with vehicle mileage (or at least are not very sensitive). The BCA model separated non-fuel costs from fuel costs to give users the ability to change fuel prices without having to re-estimate consumption rates.

The Project Team used the 2017 edition of AAA's "Your Driving Costs" to estimate non-fuel operating costs for automobiles. The non-fuel costs are based on the average of three sedan categories (small, medium, and large) and results in a non-fuel cost of 29.1 cents per mile in 2018 dollars.

[13] Source: AAA Daily Fuel Gauge Report http://gasprices.aaa.com/?state=NV (Last accessed: June 13, 2018).

[14] Source: Energy Information Administration 2018, Federal and state motor fuel taxes. Accessed via the following link: https://www.eia.gov/petroleum/marketing/monthly/xls/fueltaxes.xls.

The Project Team estimated non-fuel costs for trucks using values from the American Transportation Research Institute (ATRI), the research arm of the American Trucking Associations Federation. ATRI has conducted several analyses of the operational costs of trucking. These studies use costs derived directly from the trucking industry motor vehicle fleet operations. The operating costs reported include a number of categories associated with travel time and fuel operating costs in addition to non-fuel operating costs. As a result, it is important to select the appropriate categories when estimating operating costs for the BCA model. ATRI uses the following classification:

- Vehicle-Based Marginal Expenses
  - Fuel and Oil Costs
  - Truck/Trailer Lease or Purchase Payments
  - Repair and Maintenance
  - Truck Insurance Premiums
  - Permits and Licenses
  - Tires
  - Tolls
- Driver-Based Marginal Expenses
  - Driver Wages
  - Driver Benefits

The driver-based marginal expenses reflect the costs covered under the value of time for trucks. Including these costs as vehicle operating costs in the BCA model would be double counting. Likewise, the fuel and oil costs are already covered under the fuel operating costs estimated from the AAA Daily Fuel Gauge Report. The remaining costs can be included in non-fuel truck operating costs, with the exception of tolls (a transfer payment) and permits and licenses (which are associated with specialized carriers and loads).

The assumptions used in the estimation of vehicle operating cost savings are summarized in Table 4.

Table 4. Assumption Used in the Estimation of Vehicle Operating Cost Savings

Variable Name	Unit	Value	Source
Fuel Cost (Excludes Tax)—Automobile	Dollars per gallon	$3.05	HDR computation from AAA Daily Fuel Gauge Report
Fuel Cost (Excludes Tax)—Truck	Dollars per gallon	$2.85	HDR computation from AAA Daily Fuel Gauge Report
Non Fuel Cost—Automobile	Cents per mile	29.1¢	American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: A 2017 Update

Table 4. Assumption Used in the Estimation of Vehicle Operating Cost Savings

Variable Name	Unit	Value	Source
Non Fuel Cost—Truck	Cents per mile	47.4¢	American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: A 2017 Update

1.3.3 Emissions Savings

Emissions savings were estimated using the difference in speed between the ”WO” and ”W” scenarios, monetized with emission rates and the costs of pollutant emissions. There are five types of emissions measured in the analysis: volatile organic compounds (VOC), nitrogen oxide (NO_x), fine particulate matter (PM), sulfur dioxide (SO_2), and carbon dioxide (CO_2).

The Project Team identified emission rates (emissions per mile traveled) for these pollutants by running the Environmental Protection Agency’s Motor Vehicle Emission Stimulator (version MOVES2014a) for Clark County, Nevada, and collecting the emission rates for all relevant pollutants (carbon dioxide [CO_2], carbon monoxide [CO], nitrogen oxide [NO_x], particulate matter [PM], sulfur dioxide [SO_2], and volatile organic compounds [VOC]) for different speed bins (5 mile increments), different years (2020 and 2040), and different vehicle types (automobiles and trucks). The Project Team linearly interpolated the emission rates for those years between 2020 and 2040.

The Project Team monetized the emissions using damage costs (dollars per short ton) consistent with those found in United States Department of Transportation’s (USDOT) Benefit-Cost Analysis Guidance for Discretionary Grant Programs from June 2018, which is consistent with NDOT practices. Because Cal-B/C Corridor estimates impacts in U.S. short tons, the monetization values for U.S. short tons have been used. USDOT does not currently recommend unit values for reduction in CO_2.The assumptions used in the estimation of emissions savings are summarized in Table 5.

Table 5. Assumptions Used in the Estimation of Emissions Savings

Variable Name	Unit	Value
VOC	Dollars per short ton	$1,941
NOx	Dollars per short ton	$7,649
PM	Dollars per short ton	$349,872
SO_2	Dollars per short ton	$45,204
CO_2	Dollars per short ton	$0

Source: HDR computation from USDOT’s BCA Guidance, 2018.

1.3.4 Accident Cost Savings

Cal-B/C Corridor, used as the basis for the BCA model, does not include accident cost savings by default. The Project Team estimated accident cost savings of the different alternatives for each relevant corridor based on the forecasted reduction in the number of accidents in the project area attributable to the improvements.[15] Accident cost savings for the analyzed alternatives stem from a reduction in accident rates—reduction in the frequency or severity of accidents for a given level of traffic—because the improvements make the facility safer and make the traffic less prone to accidents. The Project Team quantified the benefits using the number of accidents avoided as a result of the project improvements. The difference between monetized accident costs under the ”WO” scenario and each ”W” scenario (i.e., improved facility) is the benefit (reduction in accident costs) of the alternative analyzed.

The Project Team conducted an analysis that calculates anticipated accident reductions resulting from improvements for each Corridor Alternative (no accident reductions were analyzed for improvements in the ”W” scenario). Accident reductions were estimated using the crash rates by severity, crash reduction factors, and VMT in each ”W” scenario compared to the corresponding ”WO" scenario. The Project Team used as inputs the number of crashes avoided for each Corridor Alternative.

Table 6 provides a summary of the differences in accidents between the Build Alternative (”WO” scenario) and each Preferred Alternative (”W" scenario) for 2020 and 2040, and for the following accident severity types: fatal (K), severe (A), moderate (B), minor (C), and property damage only (PDO). The Project Team used linear interpolation techniques to derive estimates of accident reduction in all years between the opening year (2021) and the 2040 horizon year.

Table 6. Differences in Accidents Between Build Alternative (”WO” scenario) Preferred Alternatives (”W" scenario)

Corridor	Year	Accident Reduction (in absolute values)				
		K	A	B	C	PDO
I-15/I-215/CC 215 Preferred Alternative vs. Build	2020	0.2	0.5	2.8	16.1	36.9
I-15/I-215/CC 215 Preferred Alternative vs. Build	2040	0.3	0.6	3.6	20.4	48.5
I-15/I-215/CC 215 Ideas 4,5	2020	0.2	0.5	2.3	15.2	32.6
I-15/I-215/CC 215 Ideas 4,5	2040	0.5	1.1	5.4	34.2	73.5
I-15 (South of Russell Rd)	2020	0.1	0.1	1.8	5.3	10.7
I-15 (South of Russell Rd)	2040	0.1	0.3	3.4	10.4	20.5
Summerlin Parkway Corridor Alternative vs. Build	2020	0.2	0.5	2.2	10.8	27.6
Summerlin Parkway Corridor Alternative vs. Build	2040	0.5	1.1	5.2	26.1	64.4
CC 215 Preferred Alternative vs. Build	2020	0.2	0.4	2.2	11.3	25.0
CC 215 Preferred Alternative vs. Build	2040	0.3	0.6	3.4	17.5	39.2
I-515N (S of Charleston Blvd to I-15/I-515)	2020	0.0	0.0	0.1	0.3	0.5

[15] Accident cost savings were not estimated for each individual idea.

Table 6. Differences in Accidents Between Build Alternative (”WO” scenario) Preferred Alternatives (”W" scenario)

Corridor	Year	Accident Reduction (in absolute values)				
		K	A	B	C	PDO
I-515N (S of Charleston Blvd to I-15/I-515)	2040	0.0	0.0	0.5	2.0	4.0
I-215 (Windmill to I-215/I-515)	2020	0.0	0.0	0.4	0.8	1.9
I-215 (Windmill to I-215/I-515)	2040	0.0	0.0	0.4	0.9	1.3
I-515 (Boulder Hwy to I-215/I-515)	2020	0.0	0.1	1.9	3.6	9.1
I-515 (Boulder Hwy to I-215/I-515)	2040	0.1	0.2	4.4	11.7	26.3
Henderson System Interchange Preferred Alternative 1	2020	0.2	0.4	1.8	1.7	5.4
Henderson System Interchange Preferred Alternative 1	2040	0.6	0.6	4.4	7.2	20.4
Henderson System Interchange Preferred Alternative 2	2020	0.2	0.3	1.4	-0.3	2.7
Henderson System Interchange Preferred Alternative 2	2040	0.6	0.5	3.8	4.1	16.3

The Project Team then estimated accident cost savings for each year by multiplying the number of avoided accidents by severity type by their associated costs. The Project Team used accident cost data (costs per event) provided by NDOT Traffic Safety Division and presented in the NDOT 2017 Performance Management Report. NDOT derived these costs using Highway Safety Manual’s Crash Cost Estimates and converted into 2016 dollars. The Project Team then converted and rounded these costs into 2018 dollars using the BLS Consumer Price Index data.

The Project Team converted these costs per event (i.e., cost per fatality, cost per severe injury,and others.) to costs per accident to correspond with the data on accident reduction. Costs per accident are higher than costs per event because, for example, a fatal accident can involve multiple fatalities and injuries; therefore, the cost of a single accident is likely higher than one event. Table 7 provides the accident costs used by the Project Team in the estimation of safety benefits.

Table 7. Event and Accident Costs by Severity, 2018 Dollars

Accident Severity	Accident Cost ($/event)	Accident Cost ($/accident)
Fatal (K)	$6,000,000	$6,600,000
Severe (A)	$317,600	$476,636
Moderate (B)	$116,100	$186,476
Minor (C)	$65,500	$113,612
PDO	$10,600	$38,200

Source: NDOT Traffic Safety Division. The Project Team converted the values from 2016 to 2018 dollars. Accident Cost ($/accident) were estimated by the Project Team.

1.4 Discounting Costs

The Project Team uses the cost estimates for each idea as inputs to the BCA. These are assumed to be Total Project Capital Costs, in 2018 dollars. Project costs for Preferred Alternatives are simply the sum of the capital costs for the Idea components that comprise the Preferred Alternative. The Project Team assumes that all constructions can be completed in 2 years (2019 and 2020), with capital costs equally spread across these years. Costs are discounted to 2018 dollars based on year of expenditure.

1.5 I-215/I-515/Henderson System Interchange Split

The Project Team modeled I-215, I-515, and the Henderson System Interchange as one network, because they are highly dependent and interrelated traffic systems. In order to estimate BCA results for distinct sections of the I-215/I-515/Henderson Interchange network, the Project Team estimated benefits from link level data consistent with the BCA for the overall network under both Preferred Alternatives.

First, the Henderson System Interchange improvements (i.e., Idea 88 and Idea 95 for Preferred Alternative 1 and Preferred Alternative 2, respectively) were compared to the Build Scenario to estimate the benefits for the system interchange in isolation. Then the Project Team used a link level analysis to estimate the split of benefits between the I-215 and I-515 corridors. Using this distribution, benefits from I-215/I-515 interstate improvements were allocated to the I-215 section and the I-515 section separately. The estimated benefits from the interchange improvements and the estimated benefits from the interstate improvements comprise all the benefits reaped from the I-215/I-515/Henderson Interchange network.

1.6 Sensitivity Testing

The Project Team reported the project costs and benefits discounted at 7 percent and 3 percent.

2.0 Benefit-Cost Analysis Results

BCA considers multiple benefits and compares ideas and alternatives through summary measures such as the benefit-cost ratio and the net present value. Total benefits comprise travel time savings, vehicle operating cost savings, emission cost savings, and accident cost savings. Total costs comprise only the capital costs estimated for each idea. For a given Idea or Preferred Alternative (as ”W” scenario compared to Build Alternative, ”WO" Scenario), the benefit-cost (B/C) ratio is defined as the sum of all monetized benefits divided by the sum of all project costs. If the resulting ratio is greater than 1, it implies that the benefits of the project outweigh the costs. The net present value (NPV) of a project is defined as the difference between total monetized benefits and total project costs, both in terms of discounted 2018 dollars. If positive, the NPV provides a measure of the positive value of the project improvements above the project's costs. If the NPV is negative, then project costs are greater than the monetized benefits attributed to the project improvements.

2.1 Benefit-Cost Analysis Results, Discounted at 7 Percent

The results presented in this section correspond to benefits and costs discounted at 7 percent to 2018 dollars.

2.1.1 Alternatives ("W") vs. Build ("WO"), Benefit-Cost Analysis Results, Discounted at 7 Percent

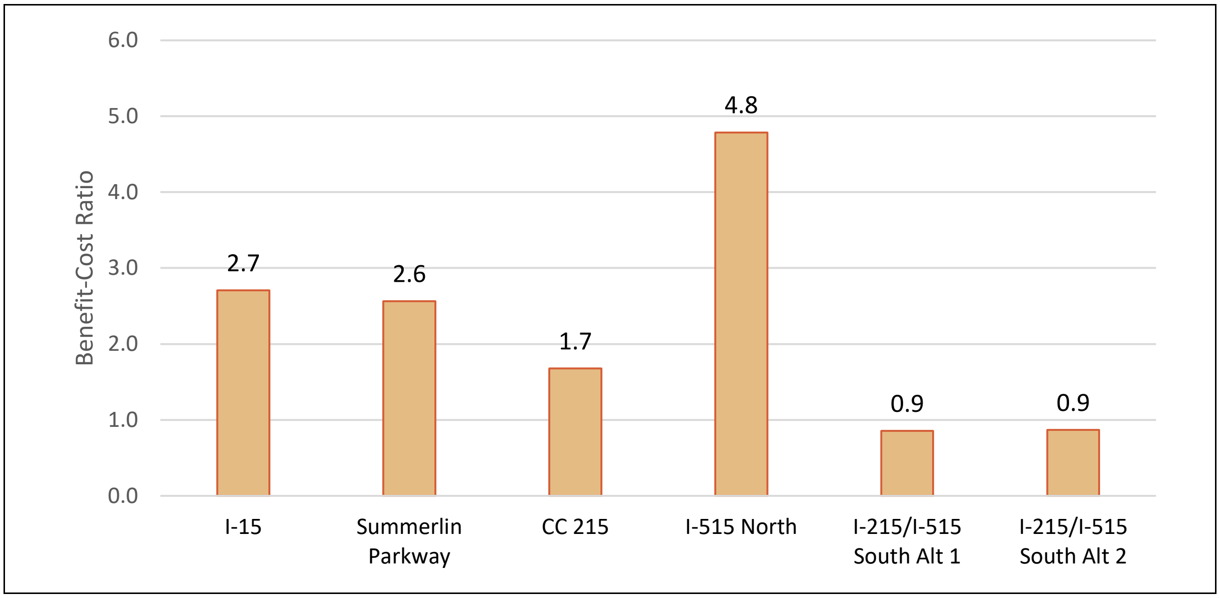
This section presents the BCA results from comparing Preferred Alternatives ("W") to the Build Alternatives ("WO"). All monetary values presented in Table 8 are in 2018 dollars.

Figure 1 provides a visual comparison of the B/C ratios across network segments.

Table 8. Benefit-Cost Analysis Results, Discounted at 7 Percent, Preferred Alternatives

Preferred Alternative	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-15 Preferred Alternative vs. Build	$112.8	$2.9	$39.8	$0.1	$155.6	$57.5	2.7	$98.1
Summerlin Pkwy Corridor Alternative vs. Build	$226.3	$12.6	$23.3	$0.2	$262.4	$102.4	2.6	$160.1
CC 215 Corridor Alt vs. Build	$407.8	$8.6	$61.5	$0.3	$478.2	$285.1	1.7	$193.1
I-515 N Corridor Alt vs. Build	$1,075.6	$20.0	$71.4	$1.0	$1,167.9	$244.0	4.8	$923.9
I-215/I-515 S Intchg Corridor Alt 1 vs. Build	$341.6	($7.1)	$2.8	$0.8	$338.0	$395.3	0.9	($57.3)
I-215/I-515 S Intchg Corridor Alt 2 vs. Build	$347.7	($12.5)	$22.7	$0.6	$358.4	$413.1	0.9	($54.8)

Figure 1. Benefit-Cost Ratio Comparison of Preferred Alternatives (Discounted at 7 Percent)



2.1.2 Ideas vs. Build, Benefit-Cost Analysis Results, Discounted at 7 Percent

This section presents the BCA results from comparing individual Ideas (”W”) to the Build Scenario (”WO”). All monetary values presented in Table 9 through Table 13 are in 2018 dollars. Figure 2 through Figure 6 provide a visual comparison of the B/C ratios across network segments.

Table 9. Benefit-Cost Analysis Results, Discounted at 7 Percent, Ideas in Segment I-15 (Sahara to Sloan)

Corridor/ Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-15 Idea 3 vs. Build	$62.4	$2.0	$0.0	$0.0	$64.4	$14.6	4.4	$49.8
I-15 Idea 7 vs. Build	$23.2	$0.7	$0.0	$0.0	$23.9	$3.8	6.4	$20.2
I-15 Idea 9 vs. Build	($7.5)	($0.5)	$0.0	($0.0)	($8.0)	$12.4	-0.6	($20.4)
I-15 Idea 11 vs. Build	$32.5	$0.1	$0.0	$0.0	$32.6	$5.2	6.3	$27.4
I-15 Ideas 4 and 5 vs. Build	$47.1	($0.2)	$33.8	$0.0	$80.7	$21.6	3.7	$59.2

Figure 2. Benefit-Cost Ratio Comparison of I-15 Segment Ideas (Discounted at 7 Percent)

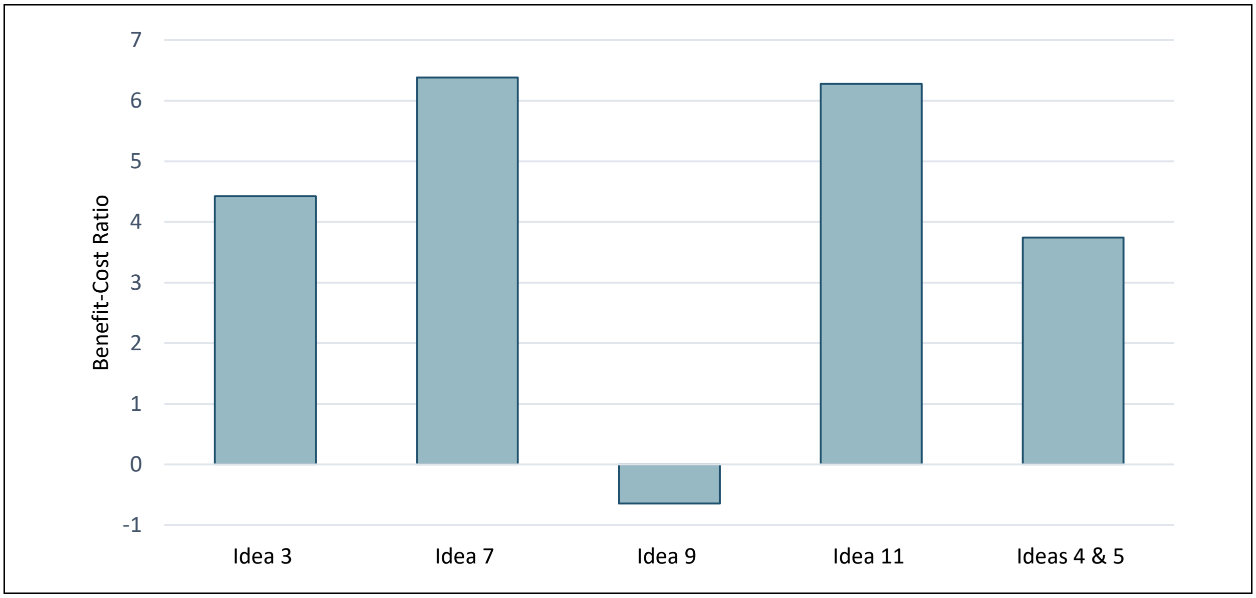


Table 10. Benefit-Cost Analysis Results, Discounted at 7 Percent, Ideas in Segment Summerlin Parkway

Corridor/ Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
Summerlin Pkwy Idea 3 vs. Build	$133.8	$8.3	$0.0	$0.1	$142.2	$10.4	13.6	$131.8
Summerlin Pkwy Idea 5 vs. Build	($39.9)	($0.2)	$0.0	$0.0	($40.1)	$30.0	-1.3	($70.1)
Summerlin Pkwy Idea 6 vs. Build	$35.3	$2.2	$0.0	$0.0	$37.5	$2.9	13.1	$34.6
Summerlin Pkwy Ideas 8 & 9 vs. Build	$71.0	$6.3	$0.0	$0.1	$77.5	$30.8	2.5	$46.6
Summerlin Pkwy Idea 10 vs. Build	$73.1	$6.3	$0.0	$0.1	$79.4	$16.1	4.9	$63.4
Summerlin Pkwy Idea 11 vs. Build	$8.1	$0.3	$0.0	$0.0	$8.4	$12.1	0.7	($3.7)

Figure 3. Benefit-Cost Ratio Comparison of Summerlin Parkway Segment Ideas (Discounted at 7 Percent)

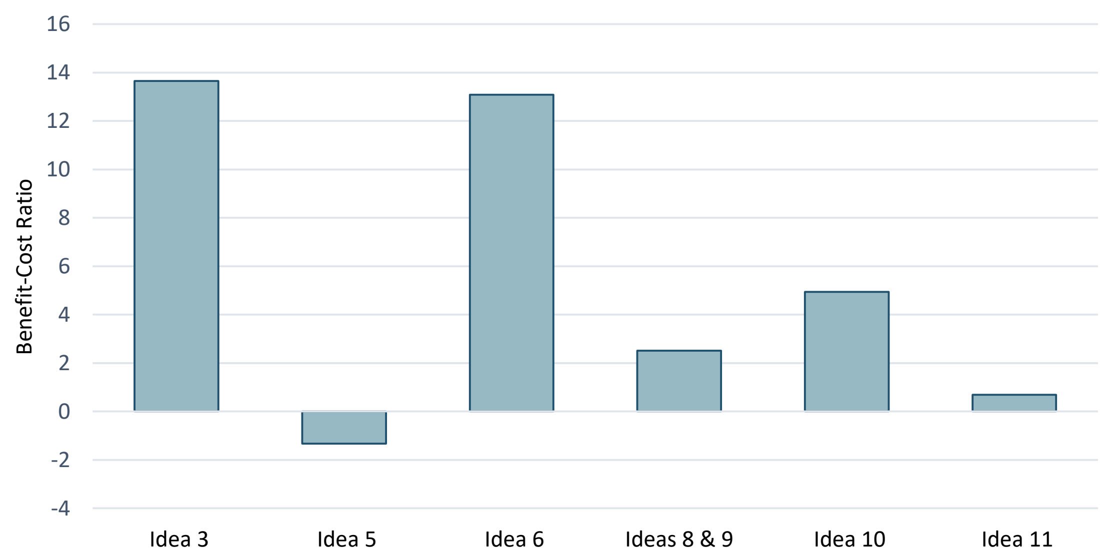


Table 11. Benefit-Cost Analysis Results, Discounted at 7 Percent, Ideas in Segment CC 215

Corridor/ Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
CC 215 Idea 10 vs. Build	$278.6	($0.5)	$0.0	$0.1	$278.2	$53.8	5.2	$224.4
CC 215 Idea 91 vs. Build	$1.9	($1.8)	$0.0	($0.0)	$0.0	$30.9	0.0	($30.8)
CC 215 Idea 92 vs. Build	$13.0	$1.4	$0.0	$0.0	$14.5	$24.5	0.6	($10.0)
CC 215 Idea 93 vs. Build	($65.6)	($0.6)	$0.0	($0.0)	($66.2)	$47.8	-1.4	($114.0)
CC 215 Idea 94 vs. Build	$21.3	$2.1	$0.0	$0.0	$23.4	$66.0	0.4	($42.6)
CC 215 Idea 95 vs. Build	$98.0	($1.4)	$0.0	($0.0)	$96.6	$62.2	1.6	$34.4

Figure 4. Benefit-Cost Ratio Comparison of CC 215 Segment Ideas (Discounted at 7 Percent)

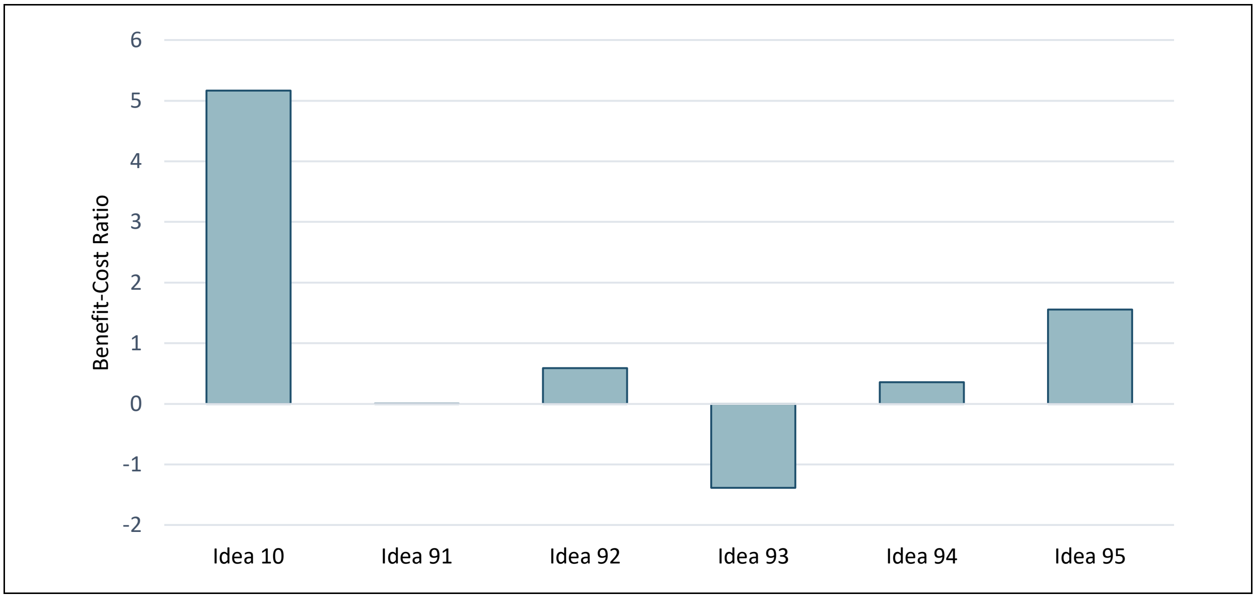


Table 12. Benefit-Cost Analysis Results, Discounted at 7 Percent, Ideas in Segment I-515 North

Corridor/ Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-515 N Idea 2 vs. Build	$621.2	$24.5	$0.0	$1.0	$646.8	$126.4	5.1	$520.3
I-515 N Idea 3 vs. Build	$390.9	($2.6)	$0.0	$0.0	$388.3	$117.6	3.3	$270.7

Figure 5. Benefit-Cost Ratio Comparison of I-515 North Segment Ideas (Discounted at 7 Percent)

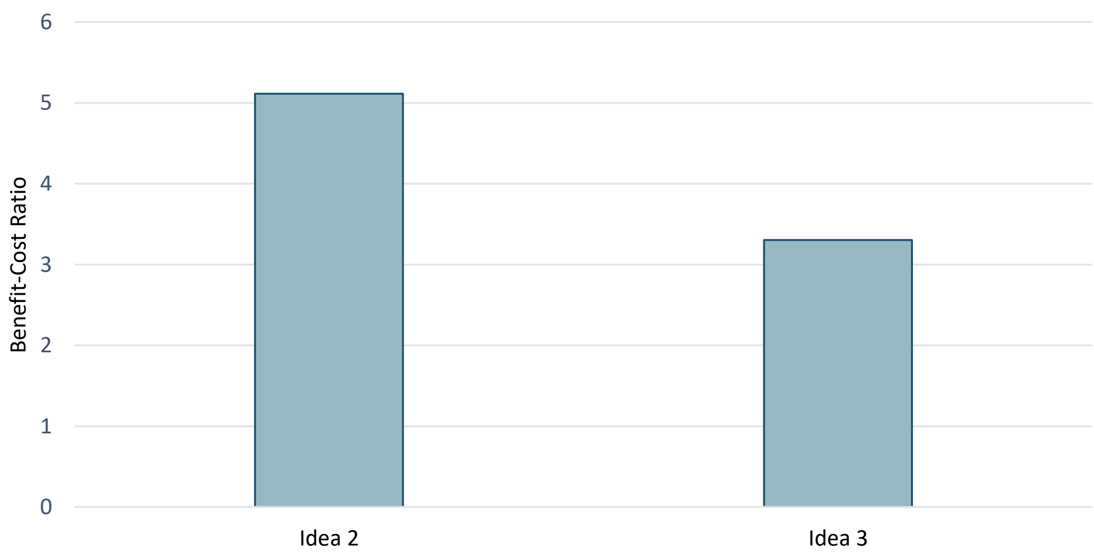
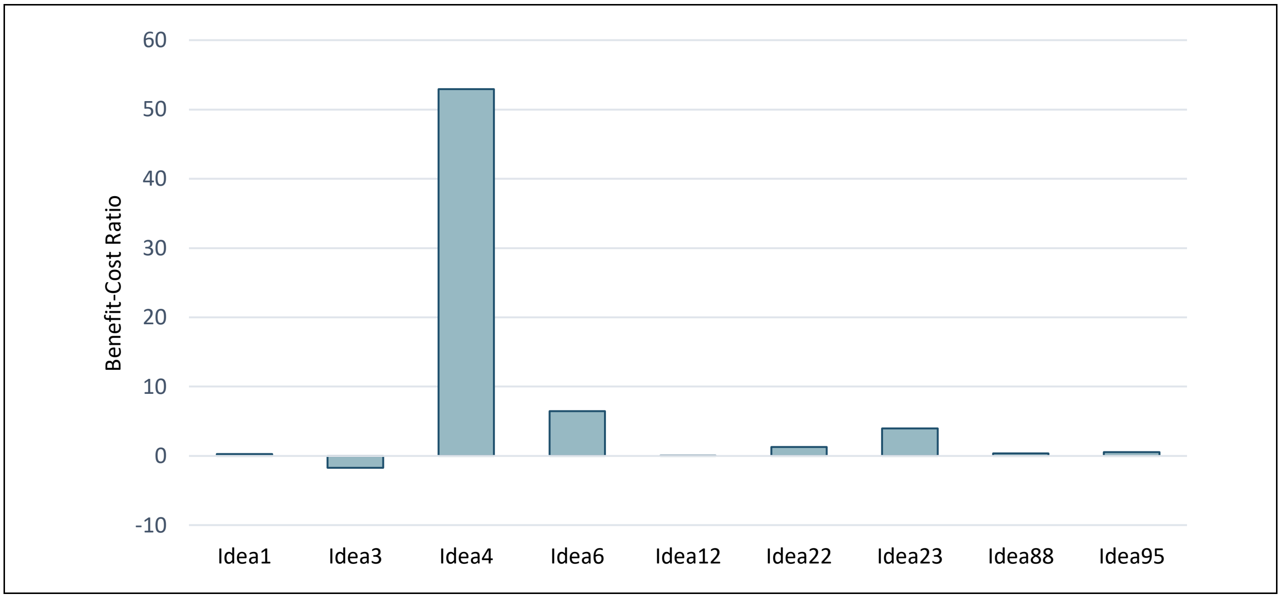


Table 13. Benefit-Cost Analysis Results, Discounted at 7 Percent, Ideas in Segment I-215/ I-515/Henderson System Interchange

Corridor/ Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-215/I-515 S Intchg Idea 1 vs. Build	$11.4	($0.3)	$0.0	$0.1	$11.3	$45.1	0.3	($33.8)
I-215/I-515 S Intchg Idea 3 vs. Build	($32.7)	($4.2)	$0.0	$0.0	($36.8)	$21.7	-1.7	($58.5)
I-215/I-515 S Intchg Idea 4 vs. Build	$56.9	$1.2	$0.0	$0.2	$58.3	$1.1	52.9	$57.2
I-215/I-515 S Intchg Idea 6 vs. Build	$59.1	($1.4)	$0.0	$0.1	$57.8	$8.9	6.5	$48.9
I-215/I-515 S Intchg Idea 12 vs. Build	$0.2	$3.1	$0.0	$0.3	$3.5	$88.3	0.0	($84.8)
I-215/I-515 S Intchg Idea 22 vs. Build	$78.3	($0.6)	$0.0	$0.1	$77.7	$60.7	1.3	$17.0
I-215/I-515 S Intchg Idea 23 vs. Build	$136.3	($6.6)	$0.0	$0.0	$129.7	$32.7	4.0	$97.0
I-215/I-515 S Intchg Idea 88 vs. Build	$43.8	$3.4	$2.8	$0.7	$50.7	$136.8	0.4	($86.1)
I-215/I-515 S Intchg Idea 95 vs. Build	$64.5	($4.5)	$22.7	$0.6	$83.3	$154.6	0.5	($71.3)

Figure 6. Benefit-Cost Ratio Comparison of I-215/I-515/Henderson System Interchange Segment Ideas (Discounted at 7 Percent)



2.1.3 I-215/I-515/Henderson Interchange Section, Benefit-Cost Analysis Results, Discounted at 7 Percent

This section presents the results of the additional analysis for the segment I-215/I-515/ Henderson Interchange. The benefits presented in Table 14 are representative of comparisons to the Build Alternative (Without Project), with costs and benefits discounted at 7 percent.

Table 14. Benefit-Cost Analysis Results by Section, Discounted at 7 Percent, I-215/I-515/ Henderson Interchange

Section and Scenario	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-215 Corridor Alternative 1 (Gillespie Street to Gibson Road)	$116.4	$120.0	1.0	($3.7)
I-515 Corridor Alternative 1 (Boulder Highway to Auto Show Drive)	$170.9	$138.5	1.2	$32.4
Henderson System Interchange Alternative 1 (Idea 88)	$50.7	$136.8	0.4	($86.1)
I-215 Corridor Alternative 2 (Gillespie Street to Gibson Road)	$118.9	$120.0	1.0	($1.1)
I-515 Corridor Alternative 2 (Boulder Highway to Auto Show Drive)	$156.2	$138.5	1.1	$17.7
Henderson System Interchange Alternative 2 (Idea 95)	$83.3	$154.6	0.5	($71.3)

2.1.4 Build vs. Baseline Benefit-Cost Analysis Results, Discounted at 7 Percent

This section presents the BCA results from comparing the Build Scenario ("W") to the Baseline Scenario ("WO"). All monetary values presented in Table 15 are in 2018 dollars.

Table 15. Build (W) to Baseline (WO) Benefit-Cost Analysis Results by Segment, Discounted at 7 Percent

Corridor/ Scenario	Travel Time Savings*	Veh. Op. Cost Savings	Accident Cost Savings**	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
Summerlin Pkwy Build vs. Baseline	$59.5	$10.0	$0.0	$0.1	$69.6	$55.6	1.3	$14.0
I-515 N Build vs. Baseline	$201.4	$20.8	$0.0	$0.5	$222.6	$754.2	0.3	($531.5)
I-15 Build vs. Baseline	$213.4	$4.6	$0.0	$0.8	$218.7	$312.8	0.7	($94.0)
CC 215 Build vs. Baseline	$199.8	$16.4	$0.0	$0.3	$216.5	$11.9	18.2	204.6
I-215/I-515 S Intchg Build vs. Baseline	$479.2	$35.6	$0.0	$0.1	$514.9	$246.8	2.1	$268.1

* Includes benefits of attracting additional vehicles to new lanes.

** Not estimated for build scenario.

2.2 BCA Results, Discounted at 3 Percent

The results presented in this section correspond to benefits and costs discounted at 3 percent to 2018 dollars.

2.2.1 Alternatives (W) vs. Build (WO) BCA Results, Discounted at 3 Percent

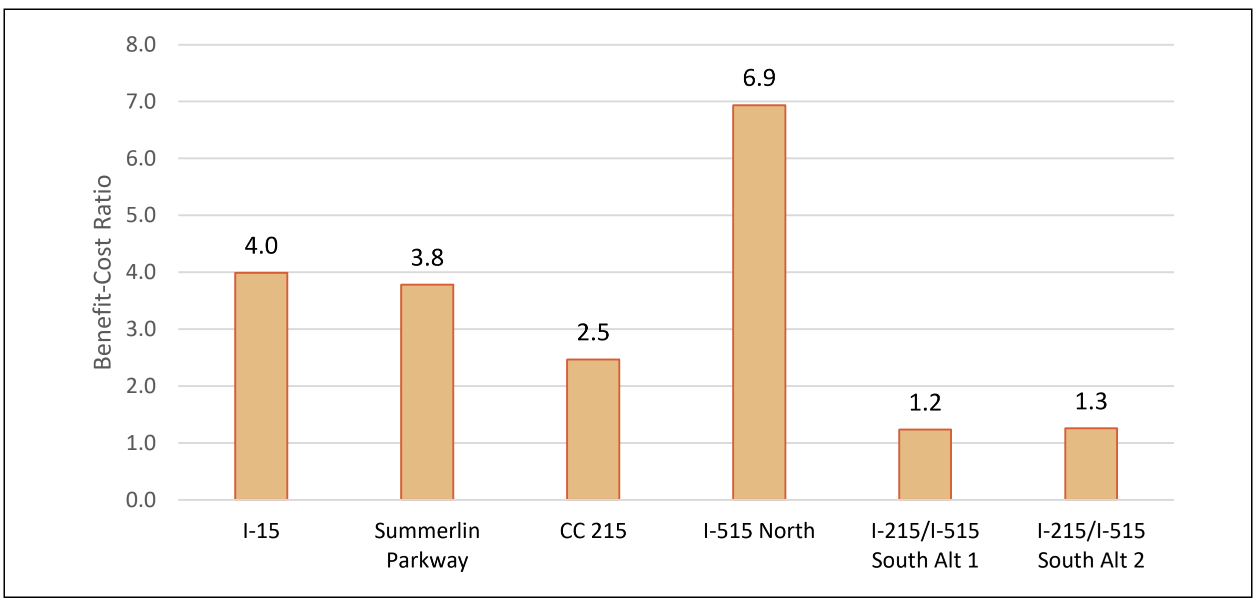
This section presents the BCA results from comparing Preferred Alternatives ("W") to the Build Scenario ("WO"). All monetary values presented in Table 16 are in 2018 dollars.

Figure 7 provides a visual comparison of the B/C ratios across network segments.

Table 16. Benefit-Cost Analysis Results, Discounted at 3 Percent, Preferred Alternatives (W)

Preferred Alternative	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-15 Preferred Alternative vs. Build	$174.3	$4.5	$64.1	$0.1	$242.9	$60.9	4.0	$182.0
Summerlin Pkwy Corridor Alternative vs. Build	$353.0	$19.6	$36.7	$0.3	$409.6	$108.3	3.8	$301.3
CC 215 Corridor Alt vs. Build	$633.1	$13.4	$98.2	$0.4	$745.0	$301.7	2.5	$443.2
I-515 N Corridor Alt vs. Build	$1,645.9	$30.5	$113.9	$1.4	$1,791.7	$258.3	6.9	$1,533.4
I-215/I-515 S Intchg Corridor Alt 1 vs. Build	$522.7	($10.9)	$4.2	$1.0	$517.0	$418.4	1.2	$98.6
I-215/I-515 S Intchg Corridor Alt 2 vs. Build	$532.0	($19.2)	$36.4	$0.7	$550.0	$437.2	1.3	$112.7

Figure 7. Benefit-Cost Ratio Comparison of Preferred Alternatives (Discounted at 3 Percent)



2.2.2 Ideas vs. Build BCA Results, Discounted at 3 Percent

This section presents the BCA results from comparing individual Ideas to the Build Scenario. All monetary values presented in Table 17 through Table 21 are in 2018 dollars. Figure 8 through Figure 12 provide a visual comparison of the B/C ratios across network segments.

Table 17. Benefit-Cost Analysis Results, Discounted at 3 Percent, Ideas in Segment I-15 (Sahara to Sloan)

Corridor/ Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-15 Idea 3 vs. Build	$96.3	$3.1	$0.0	$0.0	$99.5	$15.4	6.5	$84.1
I-15 Idea 7 vs. Build	$35.8	$1.1	$0.0	$0.0	$37.0	$4.0	9.3	$33.0
I-15 Idea 9 vs. Build	($11.7)	($0.7)	$0.0	($0.0)	($12.4)	$13.2	-0.9	($25.5)
I-15 Idea 11 vs. Build	$50.2	$0.2	$0.0	$0.0	$50.4	$5.5	9.2	$44.9
I-15 Ideas 4 & 5 vs. Build	$72.8	($0.3)	$54.7	$0.0	$127.3	$22.8	5.6	$104.4

Figure 8. Benefit-Cost Ratio Comparison of I-15 Segment Ideas (Discounted at 3 Percent)

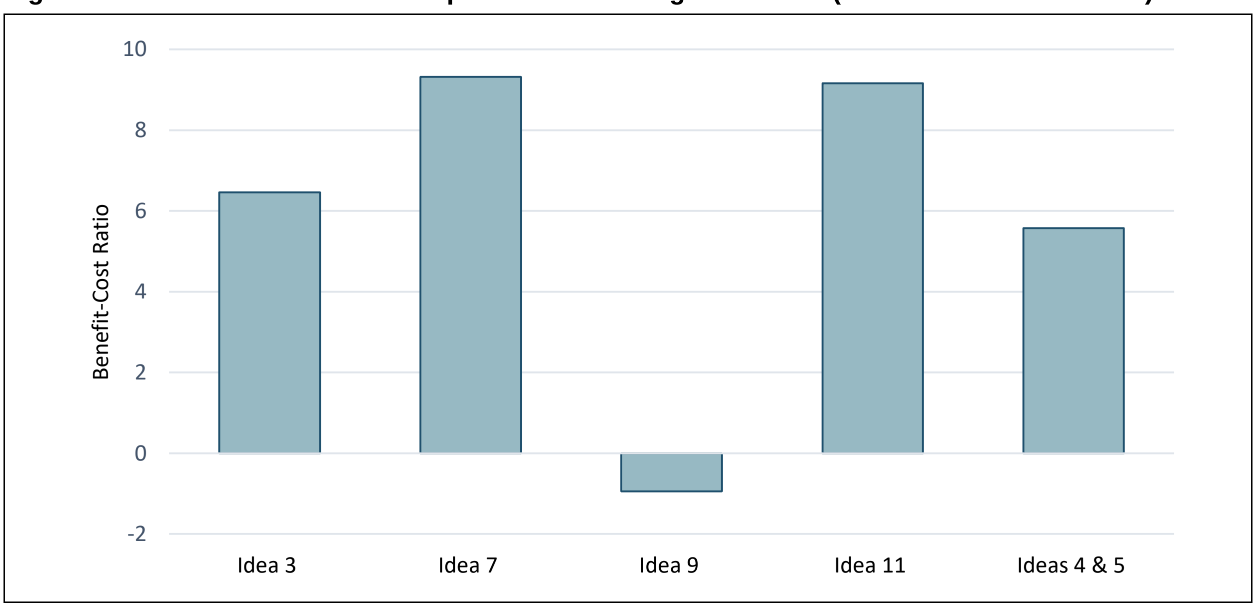


Table 18. Benefit-Cost Analysis Results, Discounted at 3 Percent, Ideas in Segment Summerlin Parkway

Corridor/Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
Summerlin Pkwy Idea 3 vs. Build	$208.7	$13.0	$0.0	$0.1	$221.8	$11.0	20.1	$210.8
Summerlin Pkwy Idea 5 vs. Build	($62.2)	($0.3)	$0.0	$0.0	($62.5)	$31.8	-2.0	($94.3)
Summerlin Pkwy Idea 6 vs. Build	$55.0	$3.4	$0.0	$0.0	$58.5	$3.0	19.3	$55.5
Summerlin Pkwy Ideas 8 & 9 vs. Build	$110.8	$9.9	$0.0	$0.2	$120.8	$32.6	3.7	$88.2
Summerlin Pkwy Idea 10 vs. Build	$114.0	$9.8	$0.0	$0.1	$123.9	$17.0	7.3	$106.9
Summerlin Pkwy Idea 11 vs. Build	$12.6	$0.5	$0.0	$0.0	$13.1	$12.8	1.0	$0.2

Figure 9. Benefit-Cost Ratio Comparison of Summerlin Parkway Segment Ideas (Discounted at 3 Percent)

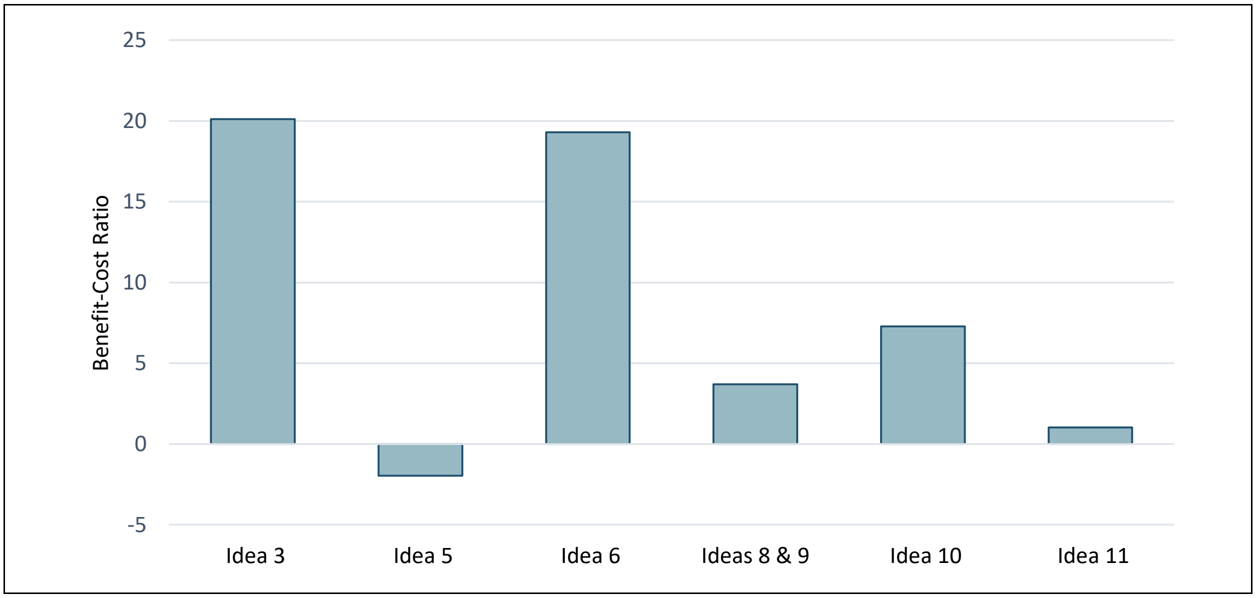


Table 19. Benefit-Cost Analysis Results, Discounted at 3 Percent, Ideas in Segment CC 215

Corridor/Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
CC 215 Idea 10 vs. Build	$432.6	($0.8)	$0.0	$0.1	$432.0	$57.0	7.6	$375.0
CC 215 Idea 91 vs. Build	$2.9	($2.9)	$0.0	($0.0)	$0.0	$32.7	0.0	($32.6)
CC 215 Idea 92 vs. Build	$20.3	$2.2	$0.0	$0.0	$22.5	$25.9	0.9	($3.4)
CC 215 Idea 93 vs. Build	($101.8)	($1.0)	$0.0	($0.0)	($102.8)	$50.6	-2.0	($153.4)
CC 215 Idea 94 vs. Build	$33.0	$3.3	$0.0	$0.0	$36.3	$69.8	0.5	($33.5)
CC 215 Idea 95 vs. Build	$152.1	($2.2)	$0.0	($0.0)	$149.9	$65.8	2.3	$84.1

Figure 10. Benefit-Cost Ratio Comparison of CC 215 Segment Ideas (Discounted at 3 Percent)

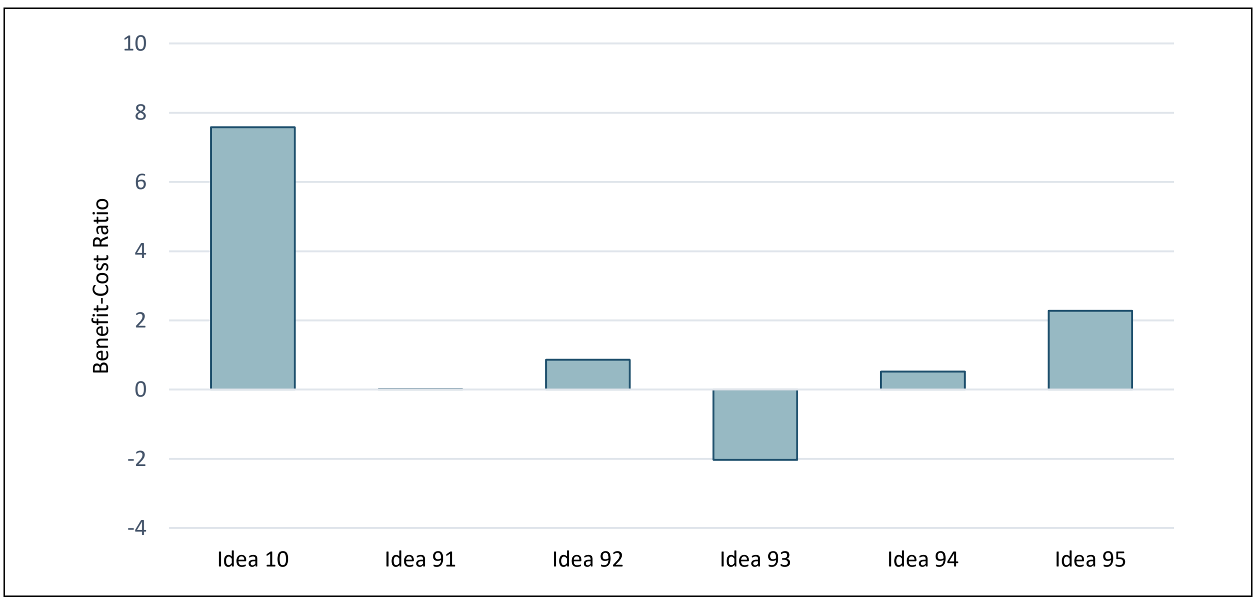


Table 20. Benefit-Cost Analysis Results, Discounted at 3 Percent, Ideas in Segment I-515 North

Corridor/Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-515 N Idea 2 vs. Build	$950.6	$37.6	$0.0	$1.4	$989.5	$133.8	7.4	$855.7
I-515 N Idea 3 vs. Build	$598.2	($3.9)	$0.0	$0.0	$594.2	$124.5	4.8	$469.8

Figure 11. Benefit-Cost Ratio Comparison of I-515 North Segment Ideas (Discounted at 3 Percent)

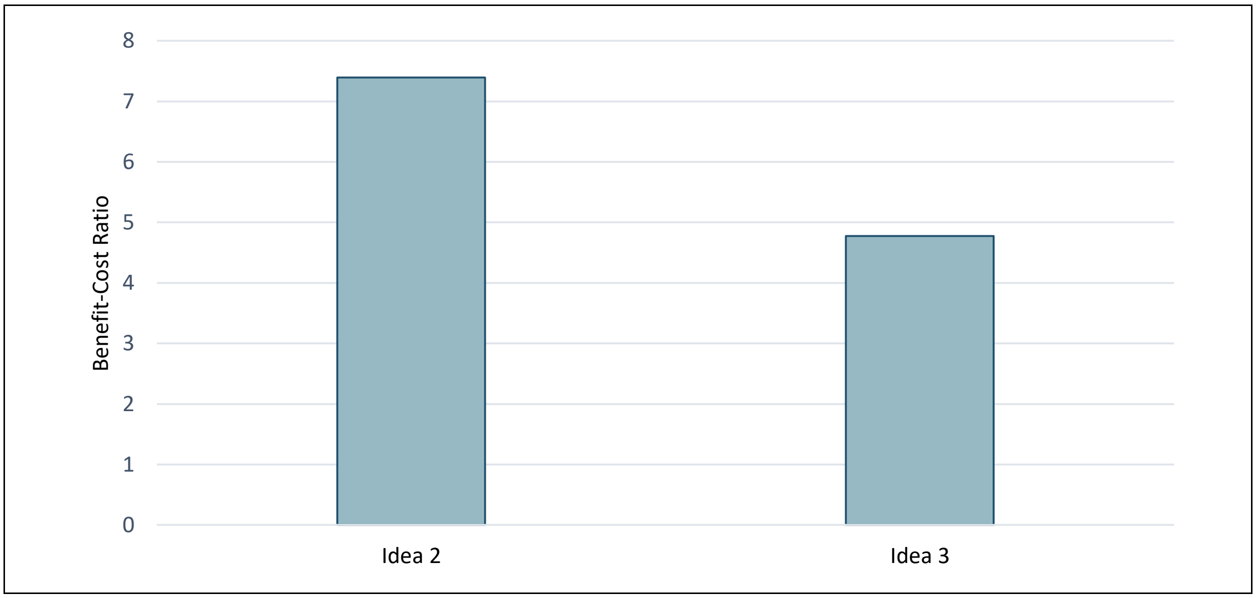


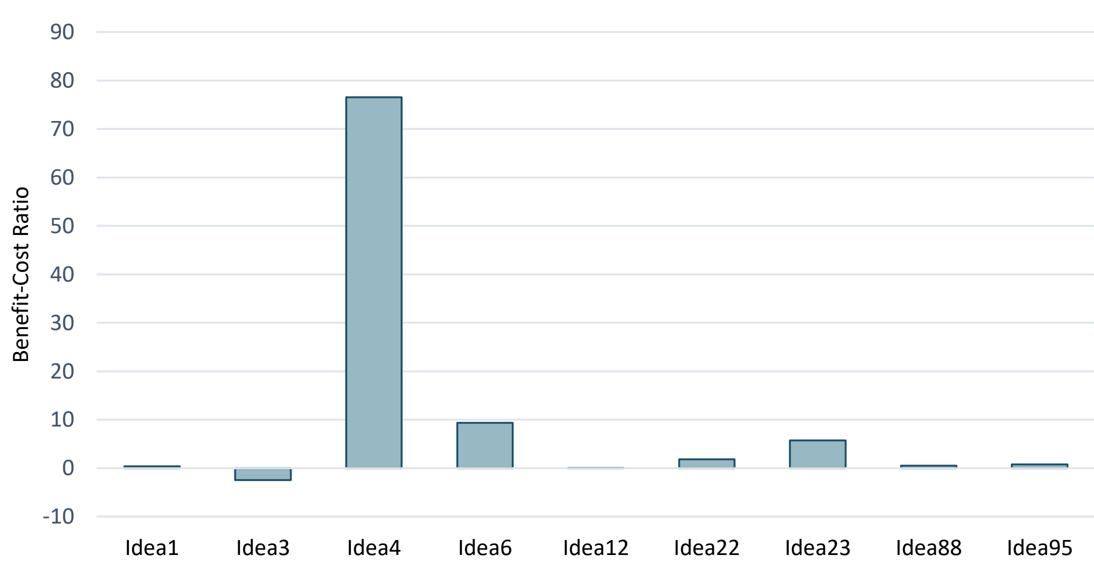
Table 21. Benefit-Cost Analysis Results, Discounted at 3 Percent, Ideas in Segment I-215/ I-515/Henderson System Interchange

Corridor/Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-215/I-515 S Intchg Idea 1 vs. Build	$17.5	($0.4)	$0.0	$0.2	$17.3	$47.7	0.4	($30.5)
I-215/I-515 S Intchg Idea 3 vs. Build	($50.0)	($6.4)	$0.0	$0.0	($56.4)	$23.0	-2.5	($79.3)
I-215/I-515 S Intchg Idea 4 vs. Build	$87.1	$1.8	$0.0	$0.2	$89.2	$1.2	76.5	$88.0
I-215/I-515 S Intchg Idea 6 vs. Build	$90.4	($2.2)	$0.0	$0.1	$88.4	$9.5	9.4	$78.9

Table 21. Benefit-Cost Analysis Results, Discounted at 3 Percent, Ideas in Segment I-215/I-515/Henderson System Interchange

Corridor/Scenario	Travel Time Savings	Veh. Op. Cost Savings	Accident Cost Savings	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-215/I-515 S Intchg Idea 12 vs. Build	$0.3	$4.7	$0.0	$0.3	$5.4	$93.5	0.1	($88.1)
I-215/I-515 S Intchg Idea 22 vs. Build	$119.8	($0.9)	$0.0	$0.1	$118.9	$64.2	1.9	$54.7
I-215/I-515 S Intchg Idea 23 vs. Build	$208.6	($10.0)	$0.0	($0.0)	$198.5	$34.6	5.7	$163.9
I-215/I-515 S Intchg Idea 88 vs. Build	$67.1	$5.2	$4.2	$0.9	$77.3	$144.7	0.5	($67.4)
I-215/I-515 S Intchg Idea 95 vs. Build	$98.8	($6.9)	$36.4	$0.8	$129.0	$163.6	0.8	($34.6)

Figure 12. Benefit-Cost Ratio Comparison of I-215/I-515/Henderson System Interchange Ideas (Discounted at 3 Percent)



2.2.3 I-215/I-515/Henderson Interchange Section BCA Results, Discounted at 3 Percent

This section presents the results of the additional analysis for the segment I-215/I-515/Henderson Interchange. The benefits presented in Table 22 are representative of comparisons to the Build Alternative (”W”), with costs and benefits discounted at 3 percent.

Table 22. Benefit-Cost Analysis Results by Section, Discounted at 3 Percent, I-215/I-515/ Henderson System Interchange

Section & Scenario	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
I-215 Corridor Alternative 1 (Gillespie Street to Gibson Road)	$178.0	$127.0	1.4	$51.0
I-515 Corridor Alternative 1 (Boulder Highway to Auto Show Drive)	$261.5	$146.6	1.8	$114.9
Henderson System Interchange Alternative 1 (Idea 88)	$77.3	$144.7	0.5	($67.4)
I-215 Corridor Alternative 2 (Gillespie Street to Gibson Road)	$181.9	$127.0	1.4	$54.9
I-515 Corridor Alternative 2 (Boulder Highway to Auto Show Drive)	$239.0	$146.6	1.6	$92.4
Henderson System Interchange Alternative 2 (Idea 95)	$129.0	$163.6	0.8	($34.6)

2.2.4 Build vs. Baseline Benefit-Cost Analysis Results, Discounted at 3 Percent

This section presents the BCA results from comparing the Build Alternative ("W") to the Baseline Scenario ("WO"). All monetary values presented in Table 23 are displayed in 2018 dollars.

Table 23. Build to Baseline Benefit-Cost Analysis Results by Segment, Discounted at 3 Percent

Corridor/Scenario	Travel Time Savings*	Veh. Op. Cost Savings	Accident Cost Savings**	Emission Cost Savings	Total Benefits ($mil)	Total Costs ($mil)	B/C Ratio	NPV ($mil)
Summerlin Pkwy Build vs. Baseline	$92.5	$15.5	$0.0	$0.2	$108.2	$58.8	1.8	$49.4
I-515 N Build vs. Baseline	$307.7	$31.8	$0.0	$0.6	$340.1	$798.1	0.4	($458.0)
I-15 Build vs. Baseline	$329.0	$7.1	$0.0	$1.0	$337.1	$331.0	1.0	$6.1
CC 215 Build vs. Baseline	$309.6	$25.5	$0.0	$0.4	$335.5	$12.6	26.6	$322.9
I-215/I-515 S Intchg Build vs. Baseline	$733.3	$54.5	$0.0	$0.2	$787.9	$261.2	3.0	$526.7

* Includes benefits of attracting additional vehicles to new lanes.
** Not estimated for build scenario.